Midpeninsula Regional Open Space District

# Memorandum

DATE: January 25, 2023

MEMO TO: Board of Directors

THROUGH: Ana Ruiz, General Manager

FROM: Craig Beckman, Skyline Area Manager

SUBJECT: Fog Collection Report

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In 2015, the prior Midpeninsula Regional Open Space District (District) General Manager Steve Abbors directed staff to research the potential use of fog collection as an alternative water source during drought conditions. He created an Innovations Team (Team) with support of the former Assistant General Manager Kevin Woodhouse to look at fog harvesting.

Initial research by the Team included consultation with Alicia Torregrosa, a United States Geological Survey (USGS) researcher with expertise in fog patterns and fog collection. Based on discussions with Ms. Torregrosa, the Team proposed a research project to evaluate different materials for collecting water from fog at two different locations. Staff installed collection devices with 4 different collection fabrics and precise monitoring devices to assess the volume of water collected from each material. Ms. Torregrosa also contributed specialized devices to assess particulate size to further understand the collection characteristics of the devices. Data collected on District lands was intended to complement other regional research conducted by USGS and others. The Board approved the research plan in November 2015. Activities from the fog collection research was included in a segment of *Open Roads* with Doug McConnell.

A presentation given to the Board on June 14, 2017 (R17-14) (minutes) summarized the fog patterns, showed locations of other collection systems in the region, described the USGS contributions to the research (including sophisticated equipment, staff time, and materials from NBD Nanotechnologies and Deckard Sorenson), discussed the Team's installation of the collectors at Purisima Creek Redwoods and Skyline Ridge Open Space Preserves, and summarized early data collection. The following were identified as next steps:

- After sufficient data was collected, staff would report out on the information in a way that supports decision making regarding the installation of practical collectors at other locations.
- Staff would continue to maintain existing collectors into the future as long as they provide useful data for USGS research.

Moreover, the following was presented as possible future considerations:

- Identify sites for small scale wildlife watering troughs supplied through fog collection in collaboration with the Natural Resources Department.
- Consider evaluating the installation of one or more large fog collection arrays as a water supply source at Big Dipper Ranch, La Honda, Toto Ranch, or Mindego Hill. This would require a review of mesh architecture, such as mesh layering, evaluation of collection data results, additional assessment of fog water content locations to determine appropriate sites and scale, finding a site with water needs, and an aesthetic evaluation of designs.

The funding Ms. Torregrosa was receiving through USGS was ended by Congress in spring 2018 and she has since been unable to continue with the research. She was the only one with the technical ability and expertise to gather and interpret the data. Since that time, the collection devices have not been maintained and are not collecting data.

In 2020, Ms Torregrosa prepared a report, *Liquid water content, coastal fog events, San Mateo County, California*, which reviewed the data collected at District sites. Per the report:

> Measurements of liquid water content (LWC) of coastal fog events were collected using specialized fog water collection units during the hot dry summer season (July to September) and continued through the winter. These data were assembled to explore the potential of fog water collection as a water resource for Midpeninsula Regional Open Space District public lands in San Mateo County, California. Simultaneous meteorological measurements were collected for four variables: wind, temperature, humidity, and solar radiation. The dataset includes ~12,000 records for two summers (2016 and 2017) at two sites. One site was a grassland near the Skyline Field Office (SFO) and the other in a Douglas fir forest clearing at the North Purisima (NPUR) trailhead in Purisima Creek Redwoods Open Space Preserve.
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> The fog water collecting experiment also compared six different mesh types for collection efficiency, three coated with NBD-Nano hydrophobic formulation and three left uncoated. Each mesh was affixed to standard 1.00 m2 frames. The three mesh types were coated or left uncoated. They were: 1) double-layer 35% shade coefficient Raschel; 2) stainless steel 0.02 inches, 49% shade coefficient (*sic*) wire mesh, and 3) FogHaTin, a 3-dimensional specialty textile weave. The data show that the highest collection, 67 liters (17 gallons), came during the fog event of August 14, 2017 at SFO. The NBD coated FogHaTin mesh collected the most water (14 liters – *3.7 gallons*) from that fog event and the uncoated metal collected the least (12 liters- *3.17 gallons*). The total collected from all 18 fog events that occurred during the August 4 through September 20, 2017 period was 171.34 liters *(45 gallons)* at SFO and 44.95 liters *(12 gallons)* at NPUR.

Since the USGS-led research ended, District staff have not invested additional time in continuing the data collection or evaluating the value of fog collection for practical purposes on District property. Staff concluded that based on the experimental results, effective fog collection sites at large enough scales are not located in proximity to cattle operations or residential sites to support livestock or domestic water needs. Natural Resources Department staff advised that fog collection for wildlife water troughs would not add enough value for wildlife to justify the effort needed to maintain fog collectors.

Intuitive attempts to visualize the scale of fog harvesting devices relative to the volume of water required to reliably support operations (e.g., cattle grazing requires from 3 to 30 gallons per day of water per cow; a household typically uses 40-50 gallons per day per person) indicate that the scale and appearance of the collectors would likely be infeasible, even if using the most

productive NBD coated FogHaTin mesh. The research indicated that 1 square meter of the most productive material produced 3.7 gallons in one fog event. To produce 200 gallons per day (10-20 cows or household of 4 people) would require 54 square meters (581 square feet) of material or about 6-feet high x 96-feet long. This water volume is only produced on days with significant fog; therefore, more surface would be needed to store sufficient water to get through dry periods.

Alternatives utilizing large water storage tanks with water supplied by springs or rainwater can better serve as a summer water source. A rainwater collection and storage tank system has been installed at the Russian Ridge Open Space Preserve parking lot to provide water for nearby plants managed by Grassroots Ecology. Although the site has required supplemental water deliveries, the rainwater collection system has gathered a few hundred gallons of water each year. The 10-foot x 10-foot collection surface on the roof of the restroom can produce 2,244 gallons of water with a typical rainfall of 36 inches in the area. Use of larger surfaces (building roof size) and larger storage tanks can store supplemental water to be used during dry periods. The District has installed water storage tanks supplied by wells, springs, and creeks in cattle grazing areas, such as Big Dipper and Driscoll Ranch, to extend the water availability during drier months, when water production from these sources can significantly diminish.

Further research could be reestablished with support from the USGS to contribute more information to climate change weather patterns and other research interests. Ms. Torregrosa observed differences between the collector sites that would be of interest for further research – the Skyline Ridge site collected three times (3x) the amount of water as compared to the Purisima site, which may be explained by natural fog harvesting characteristics of the fetch in grassland versus Douglas fir forest. Forested areas likely reduce the amount of human-collected fog harvest due to the natural fog harvest collection that occurs within our native evergreen tree canopy. Native redwoods and Douglas fir, for example, efficiently transform fog into a reliable water source (into dew and water drips) during the summer months as natural irrigation.

An email correspondence with Ms. Torregrosa in December 2022 indicates that the general conclusions about the limited value of practical fog use as described in this memo are reasonable. She also expressed recent conversations she has had with other fog researchers and there may be opportunities to collaborate on future research involving District property that can be discussed in the future.

San Mateo County Parks and Peninsula Open Space Trust examined the potential use of fog harvesting as an option for water needs at the new Tunitas Creek County Park. They decided to utilize a creek diversion that was considered reliable compared to the fog collection that was considered “experimental” with unproven reliability for the onsite residence and a proposed new facility. Peninsula Open Space Trust has installed a Zero Mass Water Collector at one of the residences on Cloverdale Ranch, which extracts water from the air using solar energy to supplement the limited spring supply. The Zero Mass Water system produces a consistent 5 liters per day for drinking and cooking use only. The spring water source provides toilet and washing water.

There are currently no plans to resume research or implement a fog collection system. It is unlikely that fog will be considered as a practical source of water for District uses in the future given the low production of water from the test sites. Recognizing that the prevalence of fog and changes in fog production and natural fog drip in response to climate change have the potential to affect coastal habitats, it would be worthwhile for the District to consider resuming fog collection research when and if the USGS has the capacity to resume studies on District lands.