PRELIMINARY REPORT—MONOLAYER BEHAVIOR STUDIES, 1959

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ABSTRACT

During the fall of 1959, monolayer behavior studies were made on two lakes in the southwest; Boulder Basin of Lake Mead, Nevada, and Lake Sahuaro near Phoenix, Arizona.

These studies were made to evaluate the effect of geographical and climatological conditions on movement and behavior of monolayers. The Lake Sahuaro tests also were used to provide data for design and development of improved methods of application and maintenance of a film on this lake in anticipation of full-scale, evaporation-reduction tests to be performed there during the summer of 1960.

The Lake Mead studies produced the following general points of information:

1. Wind pattern was primarily onshore-offshore for the season of the year studied

2. Early morning winds were generally heavier and tending from the north

3. Film was very persistent apparently because of four factors: large size of basin, steep walls forming the basin, variable onshore-offshore wind pattern, and probable low bacterial attrition

4. It appears that maintaining of a monolayer under the conditions found at Lake Mead during these tests would not be too difficult and that a significant coverage could be retained for reasonable lengths of time

The Lake Sahuaro studies produced the following general points of information:

1. Wind pattern was primarily controlled by canyons entering the basin. Southerly winds were dominant during the test period

2. Film was very persistent apparently because of three factors: steep walls of the lake, variable, low velocity winds, and probably low bacterial attrition
3. Under similar conditions, a full-scale treatment of Lake Sahuaro could probably be accomplished with reasonably high percent coverage for long periods of time by use of strategically located dispensers near the shoreline.
INTRODUCTION

Presented here is a brief preliminary report on monolayer behavior studies made in 1959 at Boulder Basin of Lake Mead, and at Lake Sahuaro near Phoenix, Arizona. A more detailed report will be prepared after the data have been processed.

During the periods of November 24 to December 6, 1959, and December 9 to December 17, 1959, monolayer behavior tests were conducted on Boulder Basin and Lake Sahuaro, respectively. Tests were conducted by personnel from the Denver office of the Bureau of Reclamation with the assistance of Reclamation field personnel, the National Park Service, and the U. S. Weather Bureau, and with the cooperation of the Salt River Valley Water Users' Association.

The tests were made to study the effect of geographic and climatological conditions, especially wind, upon movement and persistence of a monolayer, and to provide information for use in the design and development of improved methods of application and maintenance of a monolayer.

LAKE MEAD STUDIES

General Background

The Boulder Basin of Lake Mead was chosen for the first monolayer behavior test because previous extension studies of the dominant wind patterns on the lake had been made. These studies, which revealed a diurnal onshore-offshore wind pattern were made jointly in 1950 and 1951 by the Bureau of Reclamation, U. S. Weather Bureau, U. S. Geological Survey, and others. Results of these studies are described in "Wind Patterns of Lower Lake Mead," U. S. Department of Commerce, Weather Bureau, Technical Paper No. 22, 1953, and U. S. Geological Survey Professional Paper No. 298 "Water Loss Investigations: Lake Mead Studies, 1958."

The main objectives at Lake Mead were to determine the effect of the wind on the persistence and movement of the film.

Instrumentation

A wind station, consisting of an anemometer and windsock, was erected at each of nine locations (Figure 1). These locations were the same as those used in the 1950-1951 wind studies, and were so located as to present a relatively detailed picture of wind speeds and directions in the basin.
Monolayer Application

The monolayer was applied over a relatively small area at the center of the basin. This location was chosen to assure the maximum time interval before the film washed ashore, and also to avoid atypical wind patterns due to proximity of land masses. A typical treatment consisted of the application of 500 pounds of powdered alcohol, which was sifted through a 3/8-inch screen to prevent dispensing of large lumps of the material (Figure 2). By applying the film in this way, small lumps were available which aided in determining film location during very calm periods, and in locating beached films. These lumps also helped to differentiate between the various materials which were used in forming the monolayers.

Results and Observations

Anemometer readings, instantaneous wind speeds, and wind directions were taken two or three times daily. Aerial observations of the position, size, and shape of the monolayer were made from one to four times a day in order to determine the effect of the existing field conditions on film behavior (Figure 3). Supplementary observations were made by boat to determine the origin of the monolayer.

Analysis

Preliminary analysis of the data obtained at Boulder Basin indicates that onshore-offshore winds of low magnitude were superimposed upon general northerly winds in the mornings, and near calm conditions in the afternoons. Wind directions were often modified by the adjacent land masses. Winds were generally mild (under 18 mph), and on many afternoons, the velocities dropped to 1 or 2 mph throughout the basin. The morning winds averaged 6 to 7 mph with occasional readings exceeding 10 mph.

Immediately after treatment, a monolayer would form and continue to increase in size under the influence of the wind and innate ability of the material to spread on a water surface. The film coverage, being a function of wind direction and speed, was at a minimum when the wind blew continuously in one direction for any extended length of time. The film would concentrate against the downwind shore, but after a change in the direction of the wind, the monolayer would again expand and coverage would greatly increase.

The monolayers were very persistent at the Boulder Basin. At the conclusion of these tests, films from treatments made at
least 1 week earlier were still present, and contributing significantly to the coverage of the basin (Figures 4 and 5). This persistence is attributed to several factors, among which are: (1) the large size of Boulder Basin, (2) the steep rock walls bounding a large portion of the basin, (3) the variable onshore-offshore wind patterns, and (4) probable low bacterial attrition.

LAKE SAHUARO STUDIES

General Background

The monolayer behavior tests conducted at Lake Sahuro were performed to supplement those previously conducted at Lake Mead, and also to investigate problems unique to this lake in the establishment and maintenance of a monolayer. This information is required for a proposed full-scale evaporation reduction investigation at Lake Sahuro during the summer of 1960 to be conducted by the Bureau of Reclamation, in cooperation with the Salt River Valley Water Users' Association and the Geological Survey.

Instrumentation

At Sahuro, wind observation stations were placed at five selected points around the lake (Figure 6). These stations were so located as to give an overall picture of wind conditions at the lake surface. Steep rock walls forming a large portion of the lake boundary exert significant influence on the wind patterns over the lake. For this reason, a wind station was placed at the upper and lower ends of the canyon, and at three other points along the lakeshore (Figure 7). In addition to these stations, there was an instrument raft near the middle of the lake on which was mounted an anemometer for measuring total wind movement over the water surface at that point. Data from these stations were recorded several times each day.

Monolayer Application

The monolayer was established over an area about 300 to 400 yards in diameter in the vicinity of the instrument raft, and was observed several times daily to determine its size, shape, and path of movement (Figure 8). The monolayer forming material was dispensed simply by dusting the powdered alcohol onto the water surface from a boat. About 50 pounds of material were applied during each treatment; a treatment being applied daily if weather conditions permitted. Two different materials were used in these tests, and the difference in physical appearance of the residual lumps and flakes of the two helped in identifying and
determining the origin of monolayers scattered over the lake several hours or even days after the applications.

Analysis

Preliminary analysis of the data shows that during these tests, the winds tended to be generally of low velocity, and from a southerly direction. The prominent surrounding canyon walls had a large effect on the direction of the wind. Winds in the area were channeled through the two canyons entering the lake from the east, and from the large canyon to the south. Wind speeds on the lake averaged about 3 mph with a maximum of about 9 mph and with variable direction.

Film movements were complex with fairly rapid movement resulting from wind speeds as low as 3 mph. The films tended to concentrate along the shoreline during periods of moderate winds, but would rebound to cover a large portion of the lake when the wind died down.

Several factors, such as probable low bacterial attrition, steep rock walls forming a major portion of the basin, and low speed winds of variable direction helped to maintain the monolayer during these tests.

DISCUSSION AND CONCLUSIONS

These studies have shown that each test site presents problems which are unique. Two of the major factors affecting film behavior and persistence are the geographic and climatologic conditions. Each of these factors varies from lake to lake, thereby forcing evaluation of each test site on an individual basis.

The Lake Mead studies produced these general points of information:

1. Wind patterns are primarily diurnal onshore-offshore for this season of the year
2. Early morning winds were generally heavier and tending from the north
3. The films were quite persistent, due to three factors: steep walls of the lake, variable wind pattern, and probably low bacterial attrition
4. It appears that maintaining of a monolayer under the conditions found at Lake Mead during these tests would not be too difficult and that a significant coverage could be retained for reasonable lengths of time.

The Lake Sahuaro studies presented conditions similar to those at Lake Mead, except for the size of the reservoir, and the strong influence of the surrounding land on the wind patterns. These general conclusions were drawn from the preliminary evaluation of the Lake Sahuaro test results:

1. The wind pattern was determined primarily by canyons entering the basin. Southerly winds were dominant.

2. Film was very persistent due to steepness of surrounding walls, variable winds, and low bacterial attrition.

3. Under similar conditions, a full-scale treatment of Lake Sahuaro could probably be accomplished with reasonably high percent coverage for long periods of time by use of strategically located shoreline dispensers.
Figure 2—Photograph showing monolayer forming material being dispensed from a boat at Lake Mead
Figure 4--Photograph of Lake Mead showing monomolecular films. The light spots in the center foreground and at the far side of the lake indicate the presence of a monolayer.

Figure 5--Photograph of Lake Mead showing monomolecular films. In this picture, the monolayers appear as the dark areas in the center and right foreground.
SAHUARO LAKE MONOLAYER
BEHAVIOR STUDIES 1959

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OBSERVER

REMARKS

SCALE IN FEET

Fig. 6

MAP SHOWING WIND STATION LOCATIONS

WIND STATION LOCATION
Figure 7--View of Lake Sahuaro showing a typical wind station at the center foreground

Figure 8--Photograph of Lake Sahuaro in which a monolayer applied about 2 hours previously appears as the shiny areas at right center, and monolayers from previous day's treatments appear as the shiny area along the shore