Snow surveys as a logical engineering problem

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DIVISION OF IRRIGATION

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Mr. W. W. McLaughlin, Chief
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Soil Conservation Service
P. O. Box 180
Berkeley, California

Dear Mr. McLaughlin:

This is in reply to your memorandum concerning the matter of snow surveys as an engineering subject.

For your information I am enclosing a brief discussion entitled "Snow Surveys as a Logical Engineering Problem," and other comments pertinent to this subject.

Very truly yours,

R. L. Parshall
Senior Irrigation Engineer

Enc:
Snow, as precipitation, assumes quite a different characteristic from that of rain. In the former the moisture is precipitated as ice crystals which accumulate in great depths, especially in the high mountain areas where in places wind piles the snow into huge drifts, sometimes as much as one hundred feet or more in depth. In the latter case precipitation, as rain, immediately is dissipated either as absorption into the ground or as runoff accumulations in streams. In both instances the retarded runoff from the snow cover and the immediate accumulations in streams from rain are taken to be strictly engineering problems.

The snow held in place on the ground represents a potential water supply and the net runoff appearing as stream flow depends upon many factors such as prevailing winds, temperatures, exposure, earth conditions, topography, elevation and vegetation. In the eastern states the snow cover problem is not one concerning irrigation, but rather the relation to flood flows. The recent Ohio River floods recalls the effect of a snow cover on a frozen ground surface with a copious rainfall on the snow later. This physical combination gave rise to an important engineering problem relative to the extent of the runoff and the necessary immediate protection against the loss of life and property. Over the past years engineering literature is crowded with papers and discussions bearing upon the subject of runoff as related to precipitation.

Because of the vital importance of water supplies for irrigation in the west, the engineers in these mountain and plain states, west of the 100th meridian, are greatly concerned. As a matter of fact, since irrigation became
a recognized practice in the settlement and development of the west, the practicing engineer has played an important role. His keen judgment and foresight in the building of irrigation systems and projects were founded on knowledge of water supplies which in turn went back to the snow banks in the high mountain country.

The continuing contact and interest of the engineer with water supplies has in recent years been greatly emphasized due to the persistent drought conditions and dwindling stream flows. Because of the immediate need to conserve irrigation supplies, and use with greater efficiency, the engineer has directed the plan with credit. He has found that to improve the economical use of the available supply, it was essential to measure the potential runoff held in snow and ice storage in the mountains in order to manipulate the supplies in storage reservoirs to the greatest advantage.

There is a definite and undisputed engineering relationship, as applied to irrigation, between snow cover and the distribution of water supplies. Water held in storage reservoirs for irrigation, municipal use or any other purpose and used to meet the demand of service must, without question, be allied to engineering principles and directed by men with engineering training and experience. It would be difficult to differentiate between water stored in reservoirs for immediate use and water stored in snow and ice for future use. In either state of preservation certain losses occur. For the reservoir, evaporation takes place, and to allow for such losses engineers have for many years been engaged in the study of approximating these losses for the purpose of evaluating the net useful volume that will be available to meet the demand. The problem of leakage and waste also concerns the engineer in devising means
to reduce to a minimum the percolation loss through the sides and bottom of the storage basin, and in the design of water systems he so arranges the details of construction that waste of the supply in operation will be held to a low figure. Likewise, for the potential supply in the high mountains, in the form of snow and ice, the engineer is studying the problem in the attempt to correct for shrinkage due to loss by evaporation and deep percolation and to arrive ultimately at the net volume that will be available for useful purposes as applied to municipal, irrigation and power needs.
SNOW SURVEYS AS A MEANS OF FORECASTING STREAMFLOW

by

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The forecasting of the water supply for irrigation, hydro-electric power, municipalities and for flood protection by observation of snow courses has been carried on for several years especially in Nevada, California, Utah and other western states. Because of the importance and accuracy of this method of predicting run-off, $15,000 was appropriated last year by Congress for the Bureau of Agricultural Engineering to extend the scope of snow surveying in several western states by establishing new courses and furnishing snow sampling equipment.

At this time about 500 snow courses are being observed in the mountain areas of this western country and a few in British Columbia, Canada. Because of the interest in this project, especially in connection with irrigation water supplies, a number of new courses will be established during the summer and fall months of this year in Wyoming and Colorado. During 1935 about 50 snow courses were observed in Wyoming.

The primary purpose of the snow course surveys is to make available reliable information of the water supply for irrigation in order that the farmer may better plan his crop program. These forecasts are, of course, valuable to municipalities in relation to domestic water supplies, to
to industrial and hydro-electric power plants, to business enterprises, and as well as to determine the possibility of the menace of spring flood flows.

To ascertain the expected amount of run-off in acre-feet from the watershed, snow cover measurements are taken on these snow courses which are located in the mountain areas at high elevations above the line of winter melting.

A snow course, covering an area of a few acres, usually consists of two intersecting straight lines varying from 500 to 1000 feet or more in length. Blazed trees or high posts mark the end points of the lines. The course is located preferably on the north slope, on comparatively level ground, protected by a fringe of trees or brush to prevent the snow drifting as much as possible and should be reasonably free from brush, tree stumps, buildings and large rocks.

To make the snow survey special equipment is used which consists of an aluminum alloy tube made up of sections 2 1/2 feet long with screw joints. This sampling tube which is equipped with a cutter is about 1 1/2 inches in diameter and has a graduated scale in inches on the outside. A spring balance and hanger, or cradle, for weighing the tube completes the equipment. After the tube is assembled to the required length and weighed, it is thrust down into the snow at each station of 25, 50 or 100 feet apart on the course line as previously determined. The toothed cutter at the bottom end will cut through hard snow crusts or ice by rotating the tube with the hands. After reaching the ground surface, the tube with the enclosed snow core is withdrawn
and weighed. The difference in the two weights of the tube is the water content in inches of the snow at the point of sampling. The notes of the observations are recorded, and from these data the average depth of snow and water content are determined. From 25 to 50 samplings taken over the entire course constitute a survey. The important result of the summary is the average water content in inches, and these measurements form the basis or index of the potential water supply held in the form of snow and ice on the watershed. The surveys are made during the later winter and early spring months usually on the last day of the month.

During the early winter, for fresh snow the ratio of the water content to depth may be less than one-fifth while for the late spring snows the water content per foot of depth is greater. These snow course data are correlated with the stream run-off in acre-feet, which is determined at some permanent gaging station on the stream. Many years of stream flow records are available on practically all of the major streams. While it may be said that snow surveys are a new project in Colorado and Wyoming, snow course observations have been made in the Jackson Hole country, Wyoming, for a number of years.

After three to five years of records have been obtained, it is believed that it will be possible to correlate the water content of the snow cover on the courses to the run-off in acre-feet from the watershed, and thus forecast the water supply for irrigation.
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