SNOW SURVEY ON WEBER RIVER, APRIL 19 to 21, 1929

by

George D. Clyde,

Utah Experiment Station.

On April 19 to 21, inclusive, a survey of the snow cover conditions on the Weber River was made by the writer accompanied by Philip H. Sorenson, deputy water commissioner. This survey covered the area above Oakley on the main fork of the river. This is the first year a snow survey has been made on the river and it is difficult to make a close estimate of the water that may be expected.

From Oakley to Wilde's upper ranch the trip was made by buggy and sleigh. From the ranch to Holiday Park the trip was made entirely on snow shoes.

The snow cover on the south exposures was patchy up to about 8,000 feet. Above 8,000 feet the cover was continuous, deep, and well drifted. The north exposures were well covered right down into the bottom of the canyon, but the cover was rather thin and porous, containing only about 33 per cent water. There has been considerable melting of the lower snow, but very little has run off. It has been absorbed by the soil. On March 31, 1929 there was four feet of snow at Wilde's Ranch. On April 20, 1929 there was only 17 inches at the ranch. Most of the water which melted from this cover was absorbed by the soil and it is not yet saturated.

Wilde's Ranch is at elevation 7,050 feet. From there up to elevation 7,600 feet the snow cover increases in depth from 17 inches to 40 inches.

The snow cover on the flats about a mile above Smith & Morehouse Creek is 40 inches deep and contains 13.3 inches of water. From this point up to Holiday Park there is no increase in depth or water content of the snow cover. Measurements made in Holiday Park show an average depth of 38 inches of snow, containing 12.3 inches of water. The snow cover is coarse and granulated showing that some of the water has left the snow cover even as high as Holiday Park. There is no evidence that any of this water has yet reached the river. It is being absorbed by the soil cover and most of it will run off later in the season.

The runoff this year is starting about one month later than a year ago. This is advantageous because it helps to hold the water back. The total runoff this year will probably be greater than in 1928 by a few percent.

The temperature conditions will largely govern the time of runoff. If the temperature rises for several days the runoff will be rapid and the river will reach flood proportions due to the large quantities of low snow. On the other hand if the weather remains cool the runoff will occur gradually and much of the water will be absorbed by the soil. In either event due to the late spring much of the water from the snow cover is going into the ground and this condition will probably cause the river to hold up better during July, August, and September than it did in 1928.

In spite of the slightly better prospects over 1928 there will probably be a water shortage during late July and August. It is advisable for the water users on the upper river, who are raising hay and grass to start applying water as soon as the river raises and keep their ground well soaked as long as the high water lasts.

Those living along the river channel should take precaution against the spring floods, which are sure to come if the temperature rises steadily for three or four days.

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PROSPECTIVE WATER SUPPLY, UTAH 1929

Utah has a total area of about 84,990 square miles of which 67.1% is above 5,000 feet, 20.1% above 7,000 feet, 1.2% above 8,000 feet, and 1.% above 10,000 feet elevation. Approximately 80% of the runoff of streams in Utah comes from areas above 7,000 feet. In other words, 80% of our water supply is derived from 20% of the land area.

The existing knowledge of the precipitation on and the runoff from the high watersheds, is clearly inadequate for the fullest utilization of the available water supply, for the proper operation of reservoirs, for proper flood control, and for an economical operation of hydro-electric systems. A survey of the conditions on this producing area before runoff starts, will furnish valuable information as to the amount and distribution of the runoff to be expected.

In Utah approximately 80% of the precipitation on the high watersheds falls in the form of snow. This snow accumulates during the winter season and when it melts in the spring and early summer, it forms the source of water supply for the major portion of the water used for irrigation, municipal, and power purposes. The Geological Survey records of stream flow indicate that about 70% of the total annual discharge of the streams in Utah occurs

between April 1 and the following October 1. As the snow cover is usually gone up to 7,000 feet elevation by April 1 and as the summer precipitation contributes little to stream flow, it is evident that the snow cover above 7,000 feet is the reservoir from which the major portion of our water supply is drawn.

The amount and distribution of water which can be expected during any one season depends largely upon the extent of the snow cover, the early spring rains, and the spring and early summer temperatures. The amount of runoff is determined largely by the snow cover but its occurrence is dependent upon temperature and the topography and geology of the particular drainage area. ~~The snow cover determines the amount of the runoff and the temperature determines its distribution.~~

Due to the fact that high water sheds are in the main inaccessible during the winter months, very few records of snow cover are available. This deficiency of data was early recognized by the Weather Bureau who they were working out the climate of the State. As early as 1909, J. Cecil Alter, now Meterologist for the U. S. Weather Bureau, started studying the snow cover, but due to lack of funds, little progress was made. Later Dr. Church, of the University of Nevada, did much in determining the relation between snow cover and runoff in the Sierra Nevada Mountains. In 1915, the Forest Service

in cooperation with the U. S. Weather Bureau, established snow stakes in an attempt to determine the precipitation on the high water sheds. However, the snow stakes record only the depth of snow, and these depth measurements proved very unsatisfactory due to the fact that the density of the snow cover varied very widely from year to year, and from point to point on a given snow cover. As a result, these snow stake readings showed little relation to the resulting runoff.

In 1933, the Utah Experiment Station began to study the relationship between precipitation and runoff from high watersheds, as a basis for forecasting the probable water supply at the beginning of the irrigation season.

The fundamental assumption in such a study is that over a long period of time the total water supply on the earth is constant. This means that the total inflow must equal the total outflow. Precipitation, mainly in the form of rain and snow, constitutes the inflow. The outflow is composed of runoff (surface and underground), evaporation, transpiration, water used by plants and ground storage. Runoff is therefore only a part of the outflow, but on most watersheds it constitutes the major part. Runoff is a residue and equals the precipitation minus the losses, the evaporation, transpiration, watershed leakage, water used by plants, and accumulation or diminution of ground storage being considered as losses. These many factors, together with

temperature, wind, abnormal fall and early spring rains, and winter melting, all effect the relationship between precipitation and runoff. The factors have different weights on different water sheds and act in different ways at different times. Each water hed has differ nt characteristics and the relationship between precipitation and runoff is determined largely by these differences. A relationship between runoff and precipitation must be developed for each different watershed according to the differences in the determining factors. In making forecasts, a single watershed, or a group of similar watersheds, should be considered as a unit.

Studies made by the Utah Experiment Station indicate that in arid regions, where the major portion of the precipitation falls as snow, the accumulated snow cover above the line of winter melting is the most important single factor in the determination of the runoff. Measurements of the accumulated snow cover on the high watersheds at the end of the precipitation season, together with a knowledge of the watershed characteristics, form the basis of water supply forecasts.

To determine the extent and water content of the snow cover, manual snow surveys are made over the watersheds at the end of the precipitation season which is usually between March 25 and April 15.

The high watersheds, when covered with snow, are practically inaccessible. The survey parties must travel on snow shoes or skiis and are often subject to extreme weather conditions. Provisions are usually stored in cabins on the watershed in the fall in order that the survey party may travel light when going over the snow.

Snow surveys, to be representative, must be made above the line of winter melting which is above 7,500 feet elevation in Northern and Central Utah, and above 8,500 feet in Eastern and Southern Utah. The amount and distribution of the accumulated snow cover is determined by measuring the depth and density ~~of the snow cover~~ over selected courses which represent average conditions throughout the drainage basins considered. The courses vary in length from one-half to one mile, depending upon wind conditions, topography, and exposure of snow cover, and are blazed so that the measurements are made at the same points year after year. Observations of depth and water content of snow cover are taken every 100 feet. The equipment for measuring the snow cover consists of a seamless steel tube calibrated in inches, one and five-eighths inches inside diameter with a milled cutter one and one-half inches inside diameter in the end, and a spring balance for weighing the core of snow. The tube is pushed vertically downward, cutting out a core of snow which remains in the

tube when it is withdrawn. The tube is first weighed empty and then with the core in it. The difference in weight equals the water content in inches. This equipment has proven very satisfactory and permits a rapid determination of depth and water content of the snow cover.

Detailed snow surveys have been made on the watersheds of Northern Utah since 1924. In cooperation with water commissioners, annual snow surveys are now being conducted on the Weber River, Provo River, Sevier River, Wasatch Plateau, and Kolob Plateau. These cooperative surveys have not yet been conducted a sufficient number of years to furnish a basis of forecasting the runoff. The forecast for these streams is based on a field study of conditions and a general comparison with other years. The water commissioners on each of these streams have submitted a statement covering the estimated water supply for 1929.

NORTHERN UTAH

The seasonal snow survey over the Northern Utah watersheds was made April 4 to the 9 inclusive. This survey covered a area about 40 miles long which is representative of the watersheds of Blacksmith Fork, Little Bear, Logan, and Cub Rivers.

At Franklin Basin, elevation 6,700 feet, which lies at the head of the Logan River, there was an average snow cover 84 inches deep containing 31.1

inches of water. The area in the vicinity of Tony Grove Lake, at elevation 8,300, showed an average cover of 97 inches depth, containing 41.9 inches of water. These two stations are about 15 miles apart. Mt. Logan lies about 25 miles south of Tony Grove Lake and at a little higher elevation. The average snow cover on this area was 91 inches deep containing 35 inches of water.

The depth and water content of the snow cover decreases with elevation. At elevation 6,200 feet, the average snow cover was 30 inches deep containing 12.4 inches of water. Some of the low snow had melted and the water gone into the ground. The snow cover, however, extends to lower elevations this year than any year since 1923. The snow cover over Northern Utah this year is approximately 120% of the 1924-28, inclusive, average. The snow is drifted and well packed. Outside of the low snow, which will come off with the first warm spell, the conditions in Northern Utah point to a well sustained late season flow on all streams north of the Ogden River. The September discharge of the Logan River for 1928 was 170 second feet, which was considerably higher than any of the previous 4 years. This indicates that the ground storage on the watershed is getting back to normal and a greater percent of the snow cover can be expected to run off this year.

The normal April to September, inclusive, runoff from the Logan River drainage area for the period 1924-28 inclusive, is 130,000 acre feet. This

is considerably below the average April to October runoff for the past 30 years because the last five years have been abnormally low. The runoff in 1926 was only 73% of normal. The ground storage was badly depleted. The snow cover in 1927 was 130% of normal, but due to the dry year preceeding it, the runoff was not proportional to the snow cover. In 1928 the snow cover in Northern Utah was just normal, but the runoff was nearly equal to that in 1927 with snow cover 130% of normal. The runoff the preceeding year and the condition of the ground storage, play an important part in the precipitation-runoff relations. This is particularly true when a wet year follows an extremely dry year.

The runoff during 1928 was 149,600 acre feet, from a snow cover containing on an average of 3 inches less water than is at present on the watershed.

The runoff for the period April to October, inclusive, 1929, should exceed that in 1928 by at least 25,000 acre feet making the total April-October runoff approximately 175,000 acre feet. The peak flow will probably reach 1,500 second feet, which will tax the channel through Logan City to carry it. The low water flow should not be less than 200 second feet as conpared with 125 to 170 second feet for the last 5 years.

The Blacksmith Fork should yield approximately 70,000 acre feet or 20% more than in 1928.

Due to the large quantity of low snow, it is expected that the streams will rise more rapidly, reach higher peaks and that the high water will last probably two weeks longer than in 1928.

People living near the stream channels should take precaution to see that the channel is clear and unobstructed in order to avoid damage from spring floods.

The small streams are expected to yield about the same low water flow as in 1928, but the Logan, Blacksmith Fork, Little Bear, and Cub Rivers, should hold up considerably better than in 1928.

SALT LAKE CITY WATERSHED

The forecast for the Salt Lake City watershed is based on the measurements taken in Brighton Basin by Salt Lake City Water Department and at Alta in Little Cottonwood Canyon and reported by the U. S. Weather Bureau. The average water content of the snow cover in Brighton Basin on April 1, for the past 12 years has been 23.5 inches. At alta, elevation 9,300 feet, the average depth of water has been 26.4 inches. This year the water average content at Brighton and Alta, is about 29.5 inches. The snow cover above 8,000 feet on the Salt Lake City Watershed is approximately 118 per cent above normal. The runoff during 1928 was well sustained, and the total flow during the season April 1 to October 1, 1929 will probably exceed the flow during 1928 by about 20%.

WEBER RIVER

Due to the recent storms, the seasonal snow survey has not yet been made on the head waters of the Weber River. Reports from Oakley from those who work in the canyon, indicate a snow cover similar to that in 1928. Records of snow cover in Northern Utah and at Brighton and Alta indicate a snow cover 15 to 20% above normal.

The Weber river above Oakley has a drainage area of only 165 square miles, but it ranges in elevation from 6,500 to 11,500 feet. It has a rather elongated basin for about 10 miles above Oakley. Above that point, it takes a fan shape. The river heads in a glaciated area that has a very thin soil covering. The water runs off as soon as it leaves the snow. The flow reaches a high stage quickly and recedes just as fast. Conditions on the Weber River are right for a rather high flood stage although the total flow will probably not exceed 15 to 20% above that of 1928.

PROVO RIVER

Mr. Frank Weitz, Water Commissioner on the Provo River, has for many years been studying the relationship between the discharge of the river at Provo and the precipitation. He has found that there is a close relationship between the October to April, inclusive, precipitation at Heber, and the discharge of the Provo River during July, August and September at Provo.

Mr. Lentz makes the following statement of probable water supply on the Provo River for 1929:

October to April precipitation 1928-29	8.96 inches
Mean October to April precipitation	10.82 "
Accumulation, October to April 1928-29	--1.86 "
Percentage of 1928-29 to Mean	83%

2.16 inches of rain fell at Heber April 1 to April 10, and brought the seasonal precipitation up to 96%.

Forecast:--

Provo River should deliver for the months of July, August, and September 1929 a mean of 285 second feet.

The annual snow surveys which are made by Mr. H. C. Cleary of Heber City, have not yet been reported. These surveys are made over the snow waters of the Provo River in the vicinity of Lake Fork and Mt. Timpanogos, and furnish an excellent index of the probable high water conditions and the total April to October runoff.

SNOW SURVEYS ON PROVO RIVER DRAINAGE AREA

Snow cover measurements have been made on the Wasatch Plateau by the Forest Service since about 1922. In the spring of 1925, snow courses were established by the Utah Experiment Station on the Cooseberry watershed which lies near the north end of the Plateau. The Price River, Cottonwood Creek,

Huntington Creek, and Ferron Creek, all heads on the east and north side of this Plateau. The streams tributary to the San Pitch River, are fed by the snows on the west side of the Plateau. The 1929 seasonal snow survey is not yet completed on this water shed. Reports have been received however from the key stations at the Marsh Ranger Station, at the Great Basin Experiment Station, and at the Seeley Creek Ranger Station. These stations are all above 8,000 feet elevation and furnish a good index of the snow cover on the Wasatch Plateau. The average depth of water on the Wasatch Plateau, above 8,000 feet elevation, for the past 5 years, is 17.0 inches. The April 1 report from the key stations indicates an average cover of 24.4 inches of water or 144% of normal. There were some al heavy storms on this area last fall and the range was pretty well saturated. Mr. Seth Allerton, Forest Ranger at the Marsh Station, reports the snow extremely heavy and well packed, with more snow at low elevations than there has been for the past five years. The runoff from the Wasatch Plateau this year will probably exceed 140% of the past five years average. The runoff from this area usually starts about the 20th of April and the high water is over by the 15th of May. This year the runoff will probably come earlier due to low snow, but will not reach its peak until after May 15. It will, however, reach a higher peak than a year ago and the high water will probably last from one to two weeks longer.

SEVIER RIVER

Mr. Brice McBride, Water Commissioner on the Sevier River, has just returned from an extended survey over the Sevier River Watershed. The following statement by Mr. McBride, indicates the prospective water supply for 1929:

"At Kimberly the average snow layer on the snow course was 48 inches with a water content of fifty per cent. This is better than a year ago. The surrounding country was well covered and drifting was good.

At Panguitach Lake there was 15 inches of snow with only twenty-five per cent water content. This is about the same as was found last year.

The flats along the road from the head of Red Canyon to the Tropic Dump were bare. The mountains at the head of East Fork looked about the same as a year ago.

In the Koosharem and Widtsoe Valleys there is still some low snow to come out, but all the low snow in the Panguitch, Circleville, and Clear Creek Valleys is out.

On April 7th the Otter Creek Reservoir contained 24,400 ac. ft. at a gage height of 23.0 feet as compared with 31,000 ac. ft. a year ago. A deficiency of 6,600 acre feet.

was in 1928.

2-- The Northern Utah watersheds have a heavy, well-packed, snow cover which should yield a runoff 15 to 20% above 1928. The low water flow on Logan River should not be less than 200 second feet and on the Blacksmith Fork, not less than 95 second feet. Conditions are right for high spring floods and precaution should be taken to prevent undue damage.

3-- The runoff from the Salt Lake City watershed should exceed by about 20% the runoff in 1928.

4-- The discharge of the Weber River at Oakley will exceed that of 1928 by about 20%.

5-- Commissioner Wentz on the Provo River reports that the July to September flow of the Provo River will be slightly less than in 1928.

6-- Water prospects on the San Pitch and Price Rivers are considerably better than in 1928, and the runoff may be as much as 40% higher.

7-- Commissioner Fife reports conditions on Coal Creek and the Kolob Plateau to be similar to 1928 with small hopes for greater stream flow.

8-- Sevier River : The conditions on the Sevier River are variable but in the main are better than a year ago.

9-- The few records of snow cover in the Uinta Mountains indicate conditions similar to 1928.

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SAN PITCH AND PRICE RIVER DRAINAGE AREAS

Snow cover measurements have been made on the Wasatch Plateau by the Forest Service since about 1922. In the spring of 1925, snow courses were established by the Utah Experiment Station on the Gooseberry watershed which lies near the north end of the Plateau. The Price River, Cottonwood Creek,

Huntington Creek, and Ferron Creek, all head on the east and north side of this Plateau. The streams tributary to the San Pitch River, are fed by the snows on the west side of the Plateau. The 1929 seasonal snow survey is not yet completed on this water shed. Reports however have been received from the key stations at the Mammoth Ranger Station, at the Great Basin Experiment Station, and at the Seeley Creek Ranger Station. These stations are all above 8,000 feet elevation and furnish a good index of the snow cover on the Wasatch Plateau. The average depth of water on the Wasatch Plateau, above 8,000 feet elevation, for the past 5 years, is 17.0 inches. The April 1 report from the key stations indicated an average cover of 24.4 inches of water or 144% of normal. There were several heavy storms on this area last fall and the range was pretty well saturated. Mr. Seth Allerton, Forest Ranger at the Mammoth Station, reports the snow extremely heavy and well packed, with more snow at low elevations than there has been for the past five years. The runoff from the Wasatch Plateau this year will probably exceed 140% of the past five years average. The runoff from this area usually starts about the 20th of April and the high water is over by the 15th of May. This year the runoff will probably come earlier due to low snow, but will not reach its peak until after May 15. It will, however, reach a higher peak than a year ago and the high water will probably last from one to two weeks longer.

SEVIER RIVER

Mr. Brice McBride, Water Commissioner on the Sevier River, has just returned from an extended survey over the Sevier River Watershed. The following statement by Mr. McBride, indicates the prospective water supply for 1929:

"At Kimberly the average snow layer on the snow course was 48 inches with a water content of fifty per cent. This is better than a year ago. The surrounding country was well covered and drifting was good.

At Panguitach Lake there was 15 inches of snow with only twenty-five per cent water content. This is about the same as was found last year.

The flats along the road from the head of Red Canyon to the Tropic Dump were bare. The mountains at the head of East Fork looked about the same as a year ago.

In the Kooshorem and Widtsoe Valleys there is still some low snow to come out, but all the low snow in the Panguitch, Circleville, and Clear Creek Valleys is out.

On April 7th the Otter Creek Reservoir contained 24,400 ac. ft. at a gage height of 23.0 feet as compared with 31,000 ac. ft. a year ago. A deficiency of 6,600 acre feet.

Predicting water conditions is hard even when the depth of snow in the mountains is known on account of ground conditions, temperature, and rain storms. In general, I would say that the primary water will be about 5 per cent higher than last season with either of two monthly divisions. If we get a quick runoff, the May and June primary will be better than last season and the July, August, and September no better, (summer storms excluded). A slow melting condition will give us about the same early primary as last season and a slightly better late primary. Second and third class rights have better chances than they had at the same time last year.

The Otter Creek will probably pick up the 6,600 feet deficiency from the low snow in Otter Creek and East Fork Valleys so that we can figure on Otter Creek storage the same as last year.

The moisture conditions in Richfield Valley are considerably better than a year ago.

Considering the valley moisture in connection with the snow conditions in the mountains, my suggestion to users planning their season's use is to plan on the same delivery as was received last year and hold the first irrigation off as long as the valley moisture will take care of it. In my opinion, the present status of the water supply does not warrant the use of any water until actually needed.

Under the plan of operation it must be remembered that all primary water the river has made since the first of April will be available for future draft so that no one is losing any water by not pulling it now.

The above remarks apply to the primary companies owning water in the Otter Creek Reservoir.

For users under the Piute Reservoir, the conditions at present are not so favorable. The supply on hand at this writing is only two-thirds of last year's supply. The chances of getting more from now on depends on how the snow melts. A slow runoff with much of the snow getting into the ground will mean no more storage water. A quick runoff will increase the present supply, but as far as the present supply of snow indicates, there will be no more than last year available.

The above statement is for Piute, Otter Creek, and the Upper River down to West View Canal, the so-called Morse Decree. The Higgin's Decree from West View Canal to end of river will be about 10 per cent better than last year on Class A primary and a fair chance of increase in 2nd and 3rd class rights over a year ago. The Sevier Bridge Reservoir will have exactly the same supply as last year, namely 89,280 acre feet. The canals out of San Pitch River and the Gunnison Reservoir and the Salina Creek canals should have a much better year".

was in 1928.

2-- The Northern Utah watersheds have a heavy, well-packed, snow cover which should yield a runoff 15 to 20% above 1928. The low water flow on Logan River should not be less than 200 second feet and on the Blacksmith Fork, not less than 95 Second feet. Conditions are right for high spring floods and precaution should be taken to prevent undue damage.

3-- The runoff from the Salt Lake City watershed should exceed by about 20% the runoff in 1928.

4-- The discharge of the Weber River at Oakley will exceed that of 1928 by about 20%.

5-- Commissioner Wentz on the Provo River reports that the July to September flow of the Provo River will be slightly less than in 1928.

6-- Water prospects on the San Pitch and Price Rivers are considerably better than in 1928, and the runoff may be as much as 40% higher.

7-- Commissioner Fife reports conditions on Coal Creek and the Kolob Plateau to be similar to 1928 ith small hopes for a greater stream flow.

8-- Sevier River : The conditions on the Sevier River are variable but are in the main better than a year ago.

9-- The few records of snow cover in the Uinta Mountains indicate conditions similar to 1928.