Mount Mansfield Paired Watershed Study

U.S. Geological Survey
Vermont Monitoring Cooperative

Water Year 2001

In September 2000, the USGS established stream gages on the West Branch of the Little River near Bingham Falls (West Branch), and on Ranch Brook near Stowe (Ranch Brook). West Branch watershed has an area of 11.84 km^2 and Ranch Brook watershed has an area of 9.84 km^2. West Branch drains the entire Stowe Mountain Resort, which occupies much of the basin. Ranch Brook is an undisturbed forested basin. The gages were set up to investigate differences in hydrology that may arise from these differences in land use, and to collect baseline information on West Branch prior to proposed expansion of the resort. This report is a brief summary of the hydrology of the two watersheds during the first full year of operation, Water Year 2001 (October 2000 through September 2001).

Runoff, or streamflow per unit area, is consistently greater in the West Branch basin (Figure 1). A note on flow units may be helpful to understand the figures. In this summary we report stream runoff in units of millimeters (25.4 millimeters = 1 inch), obtained by dividing the total volume of water passing through a stream gage by the land area of the watershed. In this way, streamflow is normalized to basin area, and runoff from different basins can be directly compared to each other and to the amount of precipitation. For example, two adjacent watersheds of different size but similar hydrologic characteristics might both yield 50 millimeters (mm) of runoff in a month that they received 100 mm of precipitation. Thus the bars in Figure 1 already account for the greater size of West Branch; its streamflow *per unit area* is larger than that of Ranch Brook.

Although runoff was greater in each month at West Branch, the two basins had very similar runoff in December and January. In these months, water was withdrawn from West Branch for snowmaking. The snowmaking withdrawal point is just upstream of the stream gage, thus snowmaking water is counted only once - when it ultimately passes through the stream gage during snowmelt. In April runoff was again fairly similar in the two basins (on a percentage basis). Sustained high flows occur in April from snowmelt, and the two basins tend to generate similar runoff rates during the highest flows (Figure

2). In May, the runoff ratio shifted sharply back to a greater output from West Branch. This may be partially due to retardation of melt from the machine-made snow and skier-compacted snow. It should be noted that snow conditions in the winter of 2001 worked to minimize potential effects of development on differences in flow in the two basins. An unusual abundance of natural snow led to far less machine-made snow produced than in a typical year. At the basin scale, machine-made snow made up very little of the snowpack and melting of the natural snowpack dominated both watersheds. Yet, the high diurnal peaks on May 1-4 and the sustained flow differential throughout May (Figure 2) clearly showed that the snowpack persisted at West Branch and contributed meltwater to streamflow for a much longer time than at Ranch Brook. The main reason for the greater sustained snowmelt in May probably is that West Branch accumulated a greater snowpack.

The causes of runoff differences in the two basins are under investigation. The development in the West Branch basin should tend to produce sharper hydrograph (graph of streamflow versus time) peaks with a shorter response time to precipitation. In other words, the development might affect the *shape* of the hydrograph, but shouldn't appreciably affect its *size*, i.e. the runoff amount. Aside from the absolute difference in magnitude of runoff, the streamflow characteristics of the two watersheds are remarkably similar. In most storms, the shapes of the hydrographs are similar, and the timing of initial rise and peak flow are relatively synchronous (Figure 2). The peak flow magnitudes tend to be larger at the West Branch watershed, in keeping with its consistently larger flow per unit area. The most likely cause of the greater runoff at West Branch is that it receives much greater precipitation than Ranch Brook.

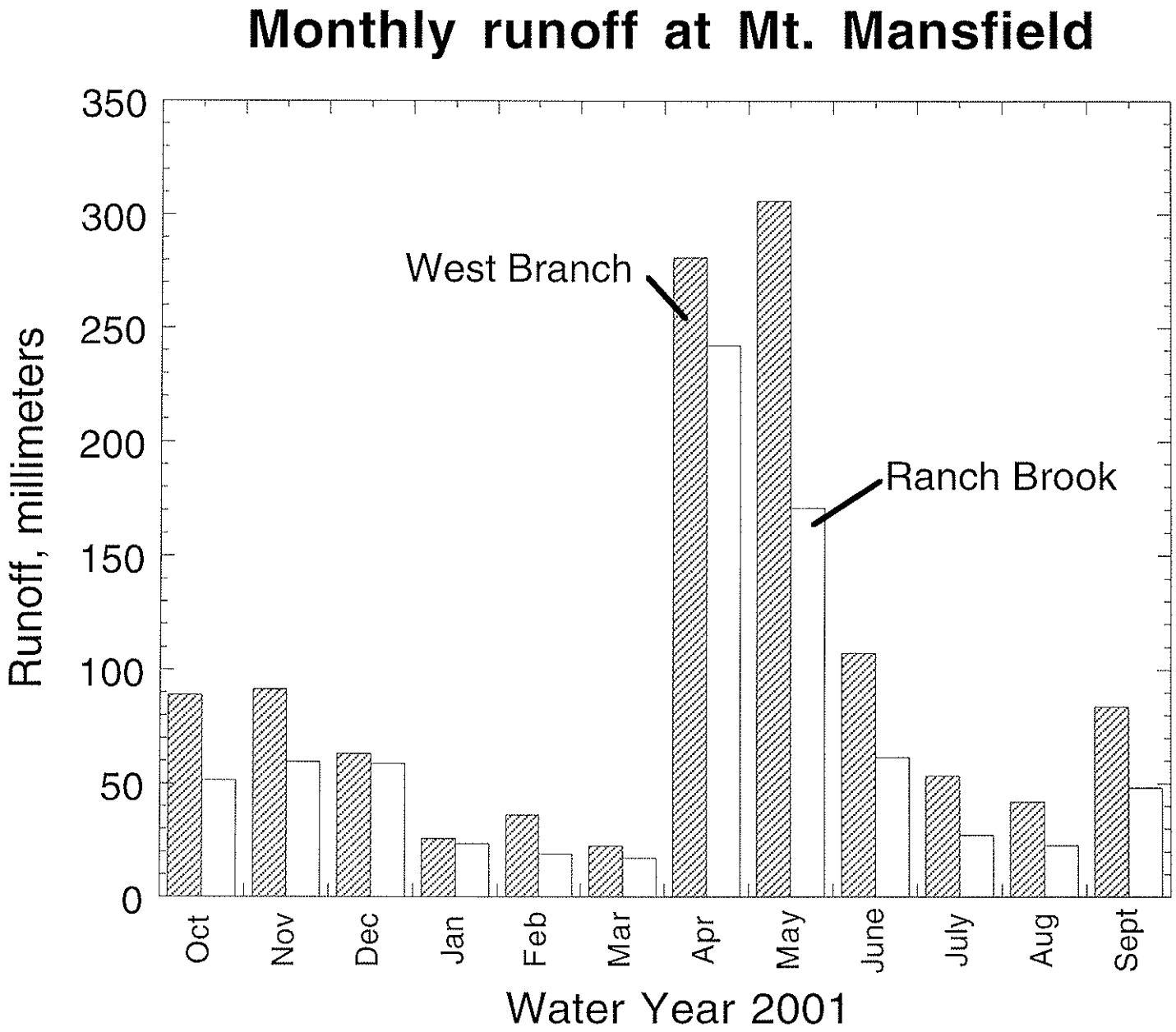
There was somewhat more variability in the hydrologic response to summer storms (Figure 3). Although some of this difference may result from different rainfall patterns in the two basins, there was a consistent tendency for a sharper and more rapid response at the developed West Branch basin. Summer rainstorms tend to be high-intensity events that produce relatively small amounts of streamflow because most of the rain is absorbed by dry summer soils; this was especially true during the drought-like summer of 2001. The larger and more rapid response to small storms at West Branch, most notably on July 10, 11, and 17 (Figure 3), may be a result of rapid runoff over near-stream impervious surfaces associated with development in that basin.

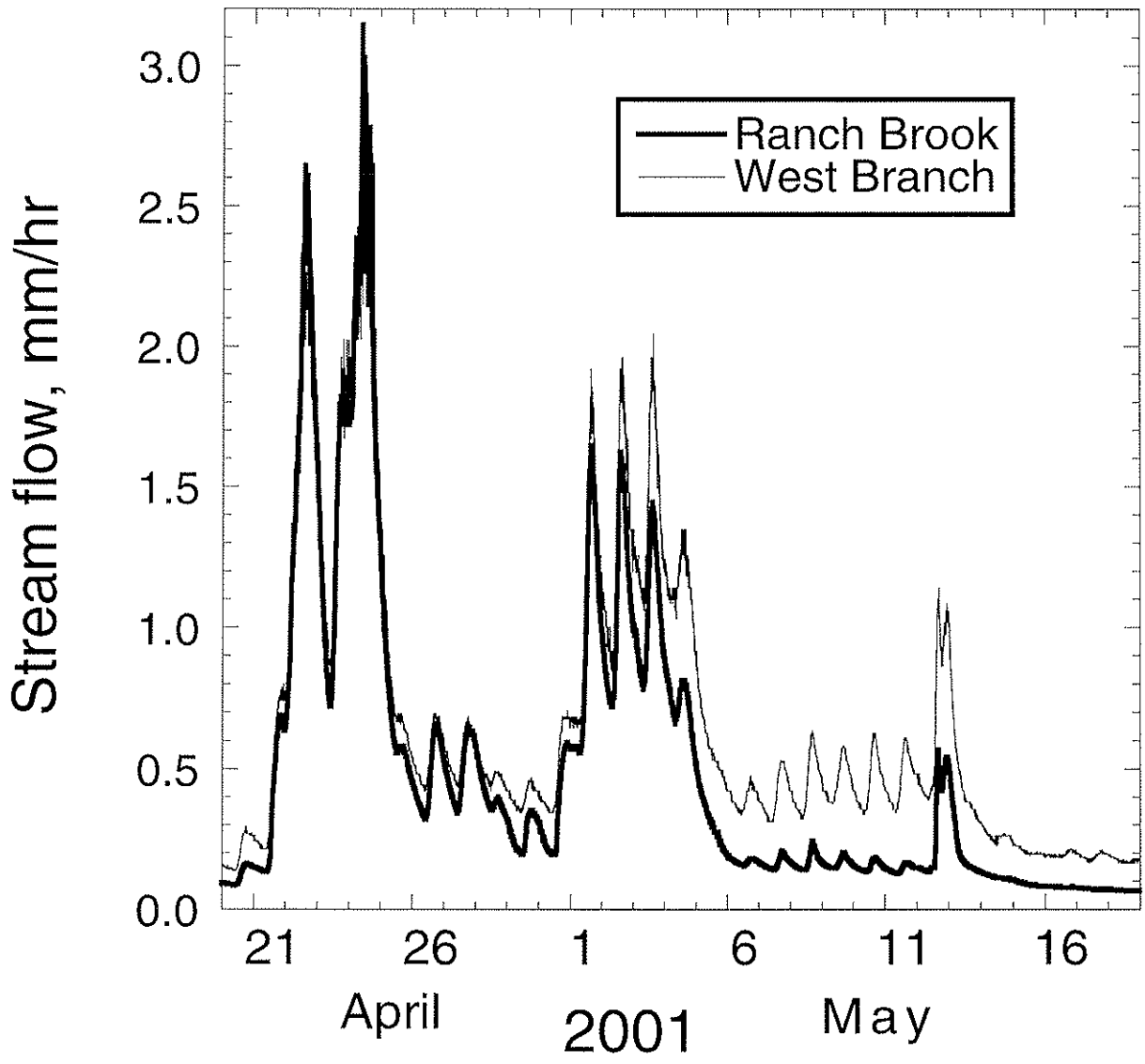
Figure captions

Figure 1. Monthly runoff at West Branch and Ranch Brook for Water Year 2001.

Figure 2. Runoff comparison of West Branch and Ranch Brook during the 2001 spring snowmelt.

Figure 3. Runoff comparison of West Branch and Ranch Brook during a series of storms in July 2001.


Monthly runoff at Mt. Mansfield
Runoff, millimeters
350
300
250
200
150
100
50
0
West Branch
Ranch Brook
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Water Year 2001


Stream flow, mm/hr
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Ranch Brook
West Branch
21
26
1
6
11
16
April
2001
May

2001 - 2

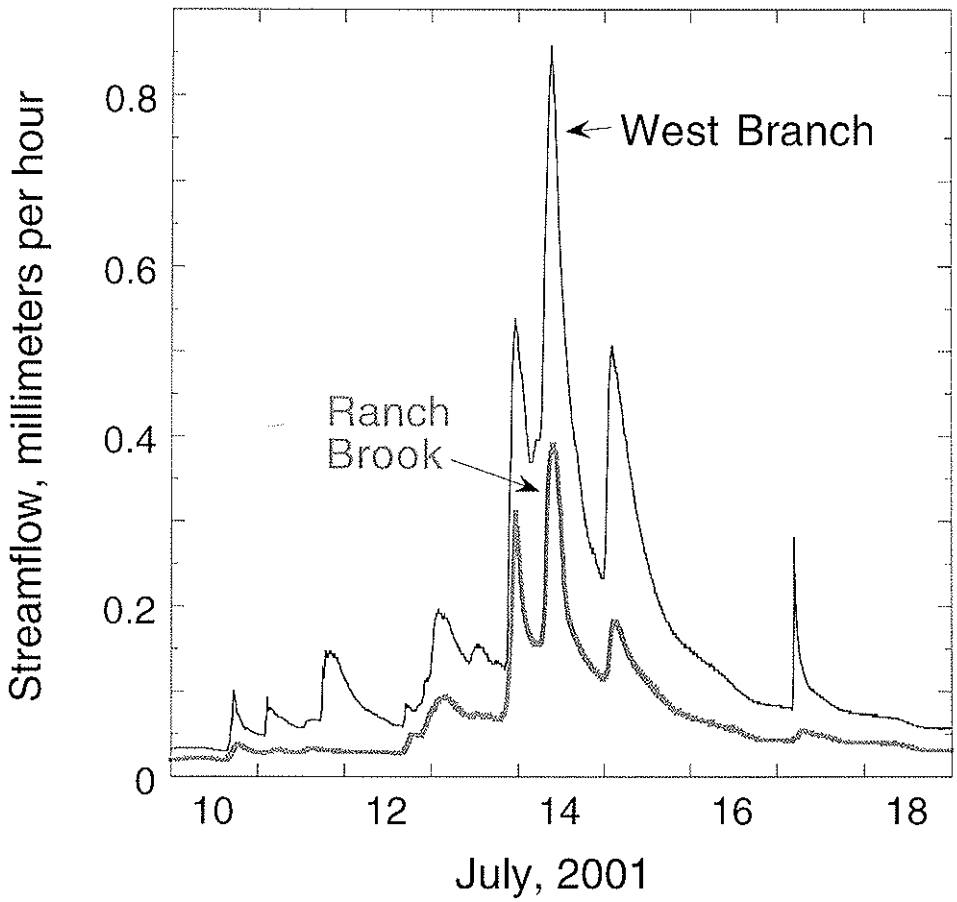

Streamflow, millimeters per hour
0.8
0.6
0.4
0.2
0
West Branch
Ranch
Brook
10
12
14
16
18
July, 2001

Figure 3