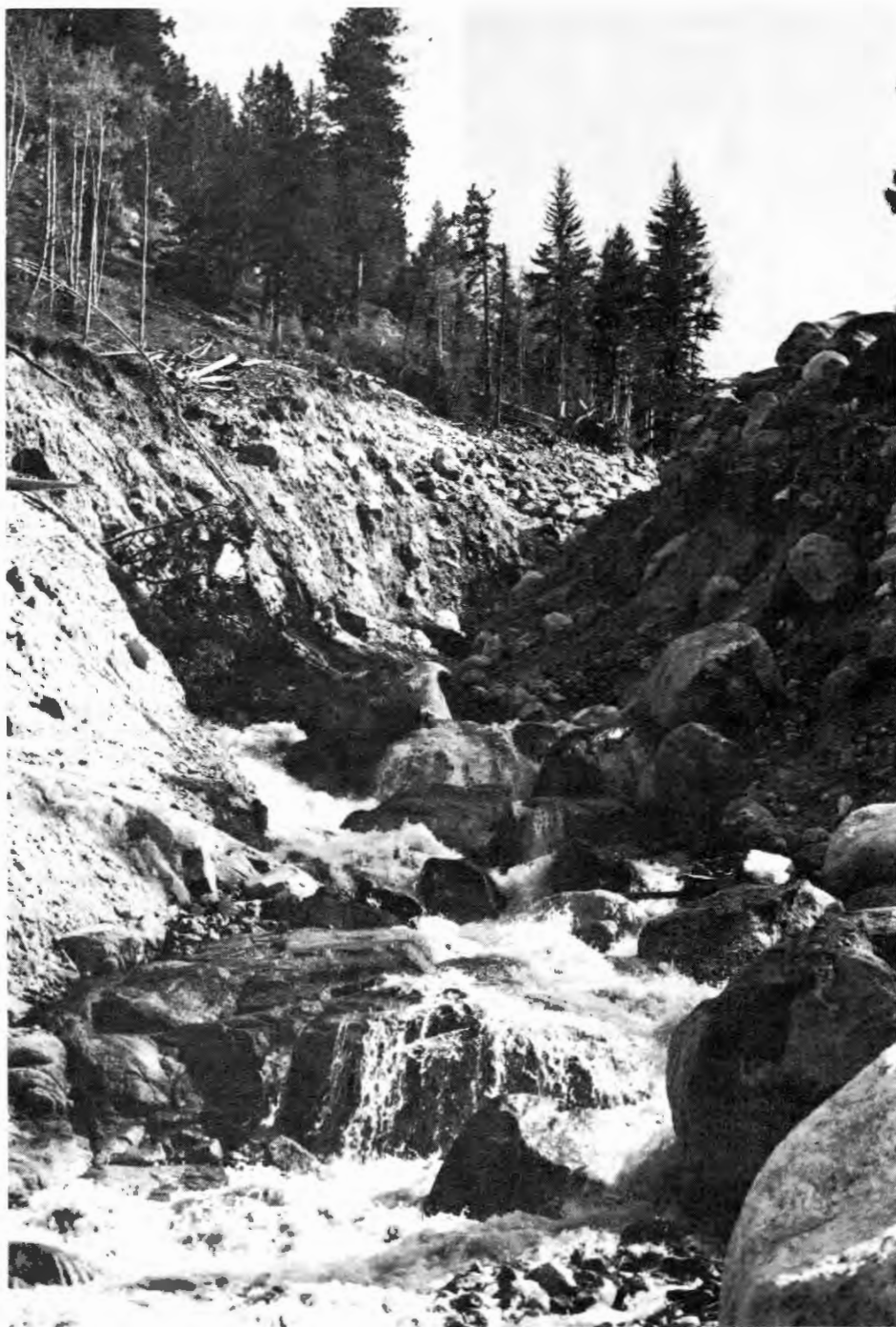




Lawn Lake Flood in Rocky Mountain National Park cut the channel of the Roaring River as much as 50 feet.

Geomorphology, Sediment Transport, and Hydrology

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We have been studying the Fall River intensively since the Lawn Lake dam disaster. Work has been concentrated on the Horseshoe Park reach because the sedimentary impact of the flood was greatest there.

The 1983 results are preliminary and data reduction is incomplete. However, an initial examination of the

data has yielded some interesting information and allowed some immediate conclusions. To present these findings, each project is briefly reviewed in turn.

Stage-Discharge Curve for Gauging Station

Discharge, the most important single flow parameter in any river study, is difficult to estimate and time-consuming to measure. Therefore, the first step in the study was to locate a stable section and establish a relationship between water surface elevation (stage) and flow rate (discharge).

At Horseshoe Park the best stable section is at the Trail Ridge Road (Highway 34) bridge . . . a concrete culvert structure. A stage board and continuous recorder have been installed and a stage-discharge curve developed by stream gauging. At present this is the only gauging station on the Fall River.

Mapping and Surveying of Fall River Channel

The channel of the Fall River in Horseshoe Park has been monitored throughout the snowmelt hydrograph for 1983. The data show remarkable differences in channel response to the influx of sediment in different reaches.

In reach 1, the uppermost reach studied, the channel is braided. The original, meandering channel of the Fall River is completely buried in alluvial fan sediment. Deposition, mostly of gravel and cobbles, is spread over a wide area on the fan and consists of filling and tearing away of distributary channels together with erosion of new distributaries.

In reach 2, adjacent downstream, the sinuous channel has changed little from its pre-flood condition. The channel's lateral stability can be attributed to almost nonerodible banks of cohesive meander belt deposits bound by dense vegetation.

In complete contrast, the highly sinuous, meandering channel in Reach 3, further downstream, has not been able to transport the sediment input from upstream. The channel here has been filled with sand, leading to a complete loss of channel capacity. Downstream in Reach 4, little has changed so far. The sediment wave in Reach 3 has not yet arrived, although it will do so early spring runoff 1984.

Measurements of Bedload and Suspended Load

Direct measurements at two sites explain in process terms the results of the channel surveys. At the upstream site (Reach 2), high rates of transport have been recorded all through the hydrograph. Unsteadiness is evident, probably associated with sporadic inputs of sediment by slump failures in the ravines on the Roaring River. These unstable slopes could provide significant sediment supply for many years to come.

Transport rates at the downstream site (Reach 4) were very much lower, explaining the sediment accumulation in Reach 3. The "wave" of sediment is moving slowly downstream, and transport rates did begin to increase at the end of the snowmelt hydrograph.

No sediment comes from the Fall River upstream of Horseshoe Park because the new lake, caused by ponding behind the alluvial fan, traps all incoming sediment. This simplifies the task of isolating sediment sources that are confined to the Roaring River basin.

Bed Armoring

The size of bed material has been monitored in Reach 1. Transport of gravel and coarser bed material is strongly influenced by selective transport of finer grains, leaving a coarsening surface layer. This pro-



A 42 acre alluvial fan, deposited by the Lawn Lake Flood in Rocky Mountain National Park, contained an estimated 10 million cubic feet of material.

cess is called armoring. In the lack of a coarse sediment input, armoring leads eventually to the formation of an immobile, coarse surface layer – a pavement. If there is a continuing supply of sediment from upstream, a coarse, mobile bed forms but paving does not occur. Armoring and paving have important effects on channel development in rivers with coarse beds and must be taken into account when modeling channel development.

The bed material data show progressive armoring throughout the reach. Initially the sediments were almost homogeneous with depth, but quickly a coarser layer developed. Upstream of the Roaring River-Fall River confluence, armoring progressed to paving because of the lack of sediment supply from the new lake. At the end of the summer an immobile paved bed had developed. Downstream of the confluence an armored, mobile bed developed, but phases of coarsening were interspersed by periods of fining, associated with large unsteady inputs of sediment from the Roaring River. Overall, though, the armoring trend was clear.

Bend Flow Measurements

Intensive studies of the flow and sedimentary processes in consecutive bends in the meandering Reach 4 are being made. The measurements show a "classic" flow pattern of primary and secondary velocities.

Secondary flow is dominated by a skew-induced cell taking surface water towards the outer bank, where there is a small cell of reverse rotation. At the inner bank, flow over the point bar is radially outwards.

The intent of this study is to continue these bend flow measurements in subsequent runoff seasons as the sediment stored in Reach 3 moves into Reach 4.

Very few data sets for such situations exist even though bend response to high sediment supply is a topic of some interest.

Summary

The research at Horseshoe Park has shown the response of the Fall River to be variable and complex. The river is competent to transport the material being supplied and thus has the power to change its channel markedly. The intensive data being gathered will allow quantification of the response mechanism and the flow and sediment processes involved. The site is unique and deserves detailed, extensive study for the advancement of both pure and applied science.

Thorne, Schumm and Harvey are with the faculty at Colorado State University. Pitlick, Rau, Zevenbergen, Biedenharn, Bradley and Siegenthaler are graduate students.