Streamflow Forecasting in the Rio Grande Basin

Forecasting 101

Then and now: Manual snow course measurements have tracked snow for nearly a century, and continue today alongside new technology

Since 1935, the Natural Resources Conservation Service (NRCS) and other agencies have monitored snowpack and forecast water supplies for rivers and waterways in the Rio Grande Basin. As forest and climate conditions change, traditional snowpack–streamflow relationships have shifted, leading to the development of additional forecasting tools to support water management and downstream deliveries.

Left: From the Irrigation Research Papers, Water Resources Archive, Colorado State University Libraries. https://hdl.handle.net/10217/178534. Right: Credit Cassandra McCuen

Why do Accurate Forecasts Matter?

Under the Rio Grande Compact, Colorado must deliver a portion of annual streamflow in the Rio Grande and Conejos Rivers to New Mexico, with requirements varying by river conditions. In wet years, Colorado delivers more water; in dry years, the states share shortages. Colorado's Division of Water Resources (DWR) manages these deliveries primarily through **curtailment**, or restricting diversions to leave water in the river. If streamflow forecasts overestimate flows, curtailments may be set too high, leaving irrigators watching runoff surge past their headgates during early-season high flows. If forecasts underestimate flows, curtailments may come later and more severely, when water is scarce and crops need it most. Accurate streamflow forecasts are therefore critical to meeting Compact requirements and protecting water users' rights.

Go With the Snow

Streamflows in the Rio Grande Basin depend largely on mountain snowpack. The NRCS operates 19 SNOTEL sites in watersheds draining to the basin, which transmit precipitation and weather data daily, along with manual snow course measurements. Water managers are working to add permanent and temporary ground-based monitoring stations to refine models and improve streamflow forecast accuracy.

SNOTEL station at Elwood
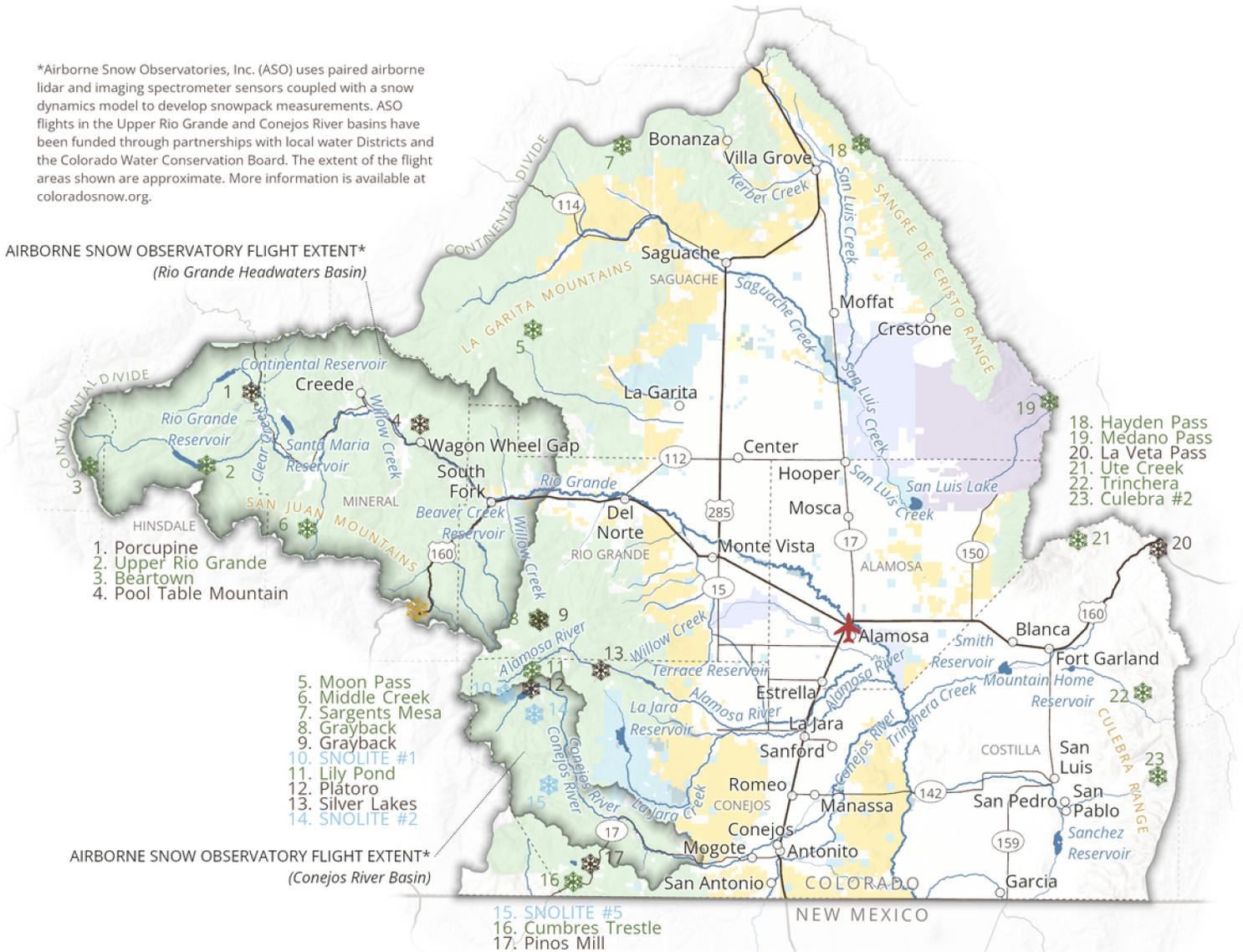Credit: Heather Dutton

Eye on the Sky

Station-based weather monitoring provides critical long-term data but is limited to fixed locations, leaving gaps that affect streamflow forecasts. To address this, a Doppler radar was installed in 2019 at the San Luis Valley Regional Airport, improving water supply forecasting, storm warnings, travel management, and emergency response. Water managers also partner with the Colorado Water Conservation Board (CWCB) to use airborne Light Detection and Ranging (LiDAR) technology to measure snow depth, snow water equivalent, and other characteristics across entire watersheds. These data are validated with SNOTEL and manual measurements and used in models to improve understanding of snow conditions and support decisions such as Rio Grande Compact administration.

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RIO GRANDE
BASIN
ROUNDTABLE

*Airborne Snow Observatories, Inc. (ASO) uses paired airborne lidar and imaging spectrometer sensors coupled with a snow dynamics model to develop snowpack measurements. ASO flights in the Upper Rio Grande and Conejos River basins have been funded through partnerships with local water Districts and the Colorado Water Conservation Board. The extent of the flight areas shown are approximate. More information is available at coloradosnow.org.

AIRBORNE SNOW OBSERVATORY FLIGHT EXTENT*
(Rio Grande Headwaters Basin)

1. Porcupine
2. Upper Rio Grande
3. Beartown
4. Pool Table Mountain

5. Moon Pass
6. Middle Creek
7. Sargents Mesa
8. Grayback
9. Grayback
10. SNOLITE #1
11. Lily Pond
12. Platoro
13. Silver Lakes
14. SNOLITE #2

AIRBORNE SNOW OBSERVATORY FLIGHT EXTENT*
(Conejos River Basin)

15. SNOLITE #5
16. Cumbres Trestle
17. Pinos Mill

18. Hayden Pass
19. Medano Pass
20. La Veta Pass
21. Ute Creek
22. Trinchera
23. Culebra #2

Map labels: Bonanza, Villa Grove, Saguache, Moffat, Crestone, La Garita, Creede, Wagon Wheel Gap, South Fork, Center, Hooper, Mosca, Del Norte, Monte Vista, Alamosa, Blanca, Fort Garland, Estrella, La Jara, Sanford, San Luis, Romeo, Manassa, San Pedro, San Pablo, Conejos, Mogote, Antonito, San Antonio, Garcia

Ranges/features: CONTINENTAL DIVIDE, LA GARITA MOUNTAINS, SAN JUAN MOUNTAINS, SANGRE DE CRISTO RANGE, CULEBRA RANGE, Continental Reservoir, Rio Grande Reservoir, Santa Maria Reservoir, Beaver Creek Reservoir, Terrace Reservoir, Smith Reservoir, Mountain Home Reservoir, Sanchez Reservoir, San Luis Lake, Kerber Creek, Saguache Creek, San Luis Creek, Rio Grande, Willow Creek, Alamosa River, Conejos River, La Jara Creek, Trinchera Creek

Counties: HINSDALE, MINERAL, SAGUACHE, RIO GRANDE, ALAMOSA, CONEJOS, COSTILLA

COLORADO / NEW MEXICO

Legend

- US Forest Service
- State
- County, City, Local
- Bureau of Reclamation
- Bureau of Land Management
- US Fish and Wildlife Service
- National Park Service
- Undetermined or Private

- ❄ SNOLITE Site
- ❄ SNOTEL Site
- ❄ Snow Course Site
- ❄ Colorado Dust-On-Snow (CODOS) Site
- ✈ San Luis Valley Doppler Radar
- ☐ Airborne Snow Observatory Flight Extent*

0 5 10 Miles

Denver

Map created: February 2024

Snotel, Snolite, and Snow Course sites are current as of January 2024, and locations may change.

Sources: US Forest Service, BLM, Natural Resources Conservation Service, Rio Grande Basin Roundtable, Esri, CGIAR, USGS.