Tools for Stream Management Planning

Assessing flow in data-poor environments

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Problem identification

The Issue

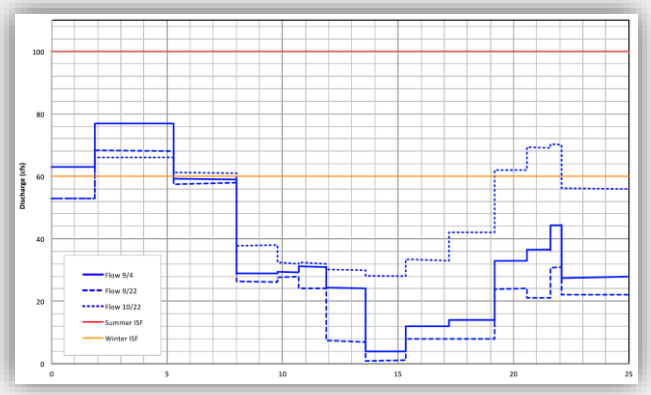
Existing gauge sites and modeled locations (StateMod or other hydrology models) are frequently inadequate to describe one or more of the following aspects of flow-related issues in your watershed:

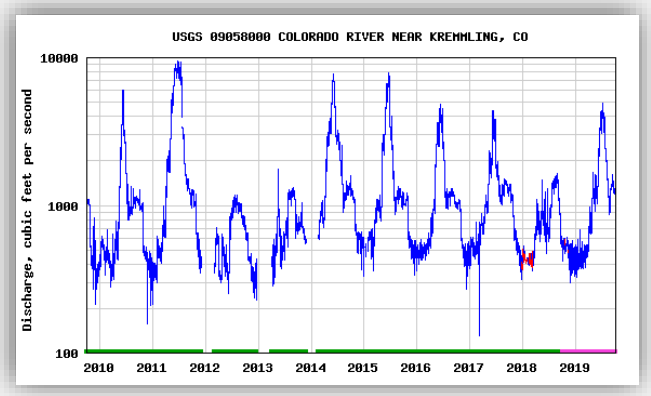
Location (*Where/what reaches? How long of a reach*?)

Timing (*When does the issue occur?* intra-seasonal, summer, winter?)

Frequency (*How often does it occur*? annually, 1-in-3, decadal?)

Magnitude (*How severe is the alteration?* impact to ecosystem or recreation?)





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Data collection options

Method	Data products	Description	Cost Range
Photo observations/ site visits	Anecdotal/ non-quantitative	Awareness' level data collection; can highlight geographic locations of problem reaches and allow for linkages to specific diversions/water rights if property access is available, but will not quantity the timing, duration, and frequency of low flow issues.	Volunteer or staff time
Staff gauge with manual observations	Semi-quantitative, discrete (non-continuous) obs.	Similar to above, but begins to fix flow observations to a specific stage for comparison over time. Stage is not directly translatable to flow until a ratings curve is built. Building a ratings curve involves repeated flow measurements at variable stages to create a statistical relationship or equation (the 'curve') relating the two.	Installation costs + ongoing calibration, volunteer (skilled) or staff time
Automated stage reading	Quantitative for level, presence /absence of flow. Does not provide flow/volume estimate without a stage curve	Records the elevation or depth of a water surface over time. Options include pressure transducers, bubblers, stilling wells, radar or sonic sensors, etc. Pressure sensors must be immersed in-channel and record the depth up to the surface. Radar or sonic sensors are elevated above the channel and record the distance down to the water surface. These options all record stage not flow, but can be related to flow by building a ratings curve as described above.	Submersible transducer or height reader $500 to several thousand $
Stream gauge	Quantitative for flow, continuous record	Gauges at their simplest consist of a stage reading (via one of the above methods) combined with repeated discharge measurements at a variety of flows. Once enough discharge readings have been taken and related to a specific stage measurement, discharge can then be continuously estimated solely from the stage reading (assuming the channel shape does not change over time at the stage measurement location). Logger set ups may be as simple as a data recorder that is manually downloaded in the field occasionally, or involve real-time communications via radio or satellite uplinks.	Privately operated (depends on set-up) Agency-operated: ~$30K/yr

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Data collection options

Discrete Estimation methods

For estimating 'typical' flow parameters such as average discharge, maximum discharge, or specific design flow criteria (1 in 10 year flow, 24 hour flow, etc.) various statistical methods attempt to relate runoff volumes to variables like watershed area, elevation, land cover, and precipitation.

These hydrological estimation techniques are utilized in various ways in models like StateMod. Some web apps that utilize these relationships have been developed for the Colorado region. It is also possible to create a locally specific relationship if many other gauges and data sources already exist in your area.

Existing apps:

USGS StreamStats https://streamstats.usgs.gov/ss/

CSU eRAMS http://www.erams.com/flowanalysis

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Data collection options

About gauges

Depending on resources available and goals, an actual stream gauge (a location with continuous stage collection paired with occasionally repeated flow measurements) can consist of a variety of configurations, costs, and operation requirements (human time and expertise)

Least-costly, variable time-intensive	Staff gauge + flow measurements; requires a daily manual observation of staff gauge reading, or reading at whatever time step is of interest to project.
	Data recorder + flow measurements, download field logger data, no automated reporting
Most-costly, highly time-intensive initially, less later	Data recorder + flow measurements, continuous/automated via radio or satellite uplink

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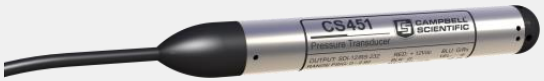
Data collection options

Equipment Examples

Staff Gauge
(can be professionally elevation-surveyed to a local benchmark)

Submersible pressure transducer
(requires a data logger)



Non-submersible height sensor
(requires a data logger)

Automated gauge
(can be offline [i.e. logger] or online [internet uplink] data recording)

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Choosing an approach

What do I want to know?	Options	Description
Are there reaches in the watershed that experience significant flow issues?	Document presence/absence of dry or low-flow reaches. Local knowledge/social data collection	Volunteer or staff site visits during low water years; take pictures, make notes, mapping, etc. Identify locations of significant diversions using state tools (Hydrobase structure search) and local knowledge, access stream above/below/between. Utilize local narrative sources: ranchers, anglers, long-time residents or adjacent property owners; interview water commissioners, mayor domos, ditch walkers, etc. Don't underestimate your local institutional knowledge and interest in your project!
I want to quantify flow impairment at an 'awareness' level for outreach/education/ advocacy.	Presence/absence documentation as above. Synoptic flow measurements	Synoptic flow measurements involve taking discharge at many locations over a short time period (hours to a couple days) during which flows and diversions are assumed to remain relatively constant. Observation sites should bracket major diversions and tributaries to enable creation of a longitudinal flow profile of the stream reach(es) of interest. This is a one-off (single observation or a few observations over a season) type of effort that can be field-intensive for short times. For example, see: http://www.roaringfork.org/publications/2012-snapshot-assessment/
I know I have a flow issue on one or more reaches; I want to quantify one or more of following for a purpose beyond just public awareness: ***Timing,*** ***Frequency,*** ***Duration***	Presence/absence of flow using stage-level readers or frequent field discharge observations. Establish one or more gauge sites.	If a site is known to dry up or experience very low flows, but the timing and duration is simply not well understood; either deploying a regular visual observer or leaving a water level reader (to identify fully dry periods) may suffice. Loggers may be desirable for remote or hard-to-access sites. A daily drive-by may suffice for a more accessible site. If a site does not dry up fully, and it is desired to definitively quantify flows for comparison to an instream flow right or other some other social/ecological flow target; establishment of some variety of gauging may be necessary. If it is a long river reach that is recharged and swept multiple times, or involves many reaches; multiple gauges may be prohibitively expensive. Taking measurements at only a few sites then estimating other linked reaches of interest by backing out diversion flows or summing in tributary inflows may be possible. These types of measurements will not be 'legal' observations in the sense that they could be used to administer a flow call or provide supporting evidence for an instream flow right shortage, but will be highly useful in describing your system. High-flow years may not supply opportunities to gather this type of data.

Measuring discharge? How is it done

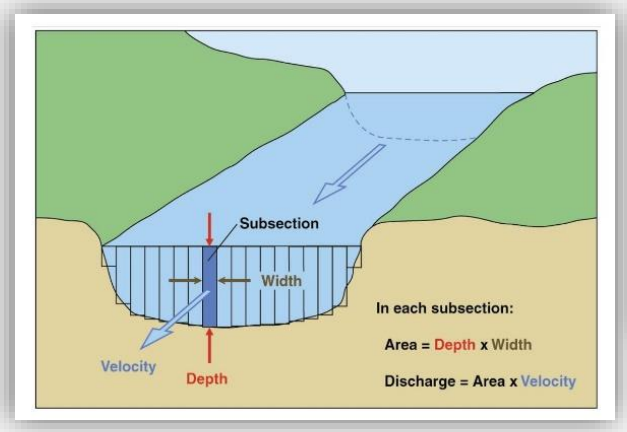
A **velocimeter** – Equipment that measures water speed; can be mechanical (propeller), acoustic doppler, electromagnetic etc.

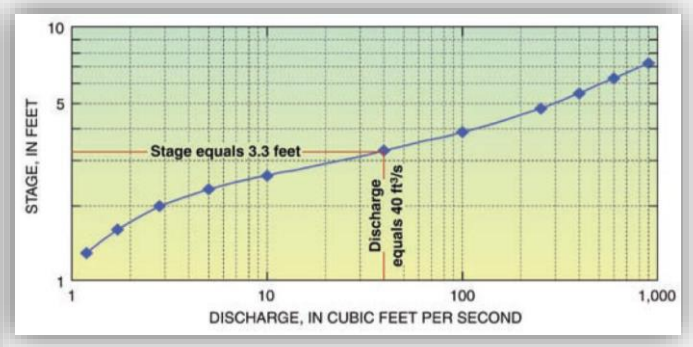
A **good site** – Stream channel shape determines your ability to measure flow accurately and safely. Sites need to be accessible, safe, not in riffles or rapids, not in pools, not have a lot of eddies and cross currents etc. Shallow and slow *runs or glides* are best, but are not always present on your reach.

Additional equipment: Engineers tape, stakes, flow staff, waders, field books, etc.

Knowledge and understanding of discharge measurement concepts and principles (can be trained pretty quick for small, wade-able streams). A measurement usually takes about 1-2 hours.

Examples from: https://www.usgs.gov/special-topic/water-science-school/science/how-streamflow-measured?qt-science_center_objects=0#qt-science_center_objects





Figures adapted from: Nielsen, J.P., and Norris, J.M., 2007, From the river to you—USGS real-time streamflow information: U.S. Geological Survey Fact Sheet 2007–3043, 4 p. (Also available at http://pubs.usgs.gov/ fs/2007/3043/.)

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For additional questions and feedback, or help with your hydrologic data collection needs:

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