MEMORANDUM

TO: 10825 STEERING COMMITTEE
FILES

FROM: ECOLOGICAL RESOURCE CONSULTANTS
GRAND RIVER CONSULTING

DATE: January 4, 2008

SUBJECT: HYDROLOGY MEMO
RELEASE OF 2,700 ACRE FEET FROM LAKE GRANBY

Lake Granby may be a potential source of 2,700 acre feet of Recovery Program water. The specific terms and conditions in which this source of water may become available are not fully understood at this time. However, this memorandum summarizes the operation of Lake Granby in conjunction with the 10825 Alternatives Assessment, in the event that 2,700 acre feet of water becomes available from this facility.

An evaluation of the potential changes in stream flow downstream of the reservoir is provided for three locations:

- Colorado River near Kremmling (Attachments 2.1 though 2.4)
- Colorado River at Hot Sulphur Springs (Attachments 3.1 through 3.4)
- Colorado River below Lake Granby (Attachments 4.1 through 4.4)

LAKE GRANBY ALTERNATIVE

Lake Granby is a 540,000 acre foot reservoir located on the Colorado River. It is the second largest reservoir in Colorado and serves as the primary storage reservoir in the Colorado-Big Thompson (C-BT) system. Major tributary inflows to the reservoir include Arapaho Creek, Stillwater Creek, Columbine Creek and the Roaring Fork. Water is also pumped to Lake Granby from Willow Creek Reservoir and Windy Gap Reservoir. Outflow from the reservoir is either through spills to the Colorado River or to Shadow Mountain Reservoir via the Granby Pump Canal. From Grand Lake, which is hydraulically connected to Shadow Mountain Reservoir, water is delivered to the East Slope via the Adams Tunnel.

For purposes of this assessment we have assumed that 2,700 acre feet (AF) of water from Lake Granby is released every year. The remainder of the 10825 Water would be provided from other sources which may include, but not be limited to, the existing Ruedi Reservoir and the proposed Sulphur Gulch Reservoir.

Using Lake Granby paired with either Ruedi Reservoir or Sulphur Gulch Reservoir would supply all of the 10825 Water in every year, including drought years. Under these scenarios, 8,125 AF would be released from Ruedi Reservoir, Sulphur Gulch Reservoir or other sources and 2,700 AF (approximately ¼ of the 10825 requirement) would be released from Lake Granby in *every* year.

Unlike alternatives utilizing Williams Fork Reservoir or Wolford Mountain Reservoir (C3 and C4), which include releases of 2,700 AF from Williams Fork Reservoir in above average and wet years, releases of 2,700 AF from Lake Granby would be made every year including dry years. Headwater benefits, most significantly upstream of Hot Sulphur Springs on the Colorado River, would occur in all years. The 2,700 AF of releases from Lake Granby would occur from the beginning of August through early October when flows in the Colorado River are typically low. These Recovery Program releases from Lake Granby would enhance stream flow at upstream sites in Grand County.

RESULTS

This alternative was analyzed using Denver Water's PACSM results for a future scenario with projects like the Windy Gap Firming Project on-line, Grand and Summit County demands at build-out, and Denver Water's average annual demand. A brief overview of the operation and hydrologic effects of this alternative in each of the representative study years is provided below.

Dry Year (1977). Attachments 2.1, 3.1 and 4.1 illustrate dry year flows in the Colorado River at the gage near Kremmling, at the Hot Sulphur Springs gage, and below Lake Granby with and without the 2,700 AF of Recovery Program Water. In a dry year like 1977 Recovery Program releases high in the basin would consist of releases from the Wolford Mountain Reservoir fish pool (6,000 AF) from mid-September through mid-October and 10825 releases from Lake Granby from late August through late September. Releases of 2,700 acre feet would be made from Lake Granby from August 1st though late September. These releases would maintain a flow of between 25 cfs and 50 cfs below Lake Granby during this period. This specific release schedule has been optimized in an attempt to provide the most benefit to the Colorado River at Hot Sulphur Springs and upstream locations.

The flow in the Colorado River below Lake Granby is dominated by releases from Lake Granby, which are primarily made to meet the minimum flow requirement measured at the USGS gage near Granby. The instream flow requirements below Lake Granby are as follows:

- September through April: 20 cfs
- May through July: 75 cfs
- August: 40 cfs

During months that Lake Granby is not spilling, the amount released from Lake Granby reflects what is needed to achieve the instream flow requirement at the downstream gage. Therefore, the release is generally a fairly constant rate through the month, particularly in winter months when there are no diversions occurring between Lake Granby and the gage. The instream flow requirement may be reduced by 15 to 30 percent from May through September when the advanced forecast of inflow to the Three Lakes system (Lake Granby, Shadow Mountain Reservoir and Grand Lake) and Willow Creek Reservoir is less than 230,000 AF. For this analysis, it was assumed that the instream flow requirement below Lake Granby would be reduced by 30 percent in a dry year like 1977. With this alternative, the 10825 Water would double stream flow levels in the uppermost reach below Lake Granby, to just over 50 cfs in August, and about 40 cfs in September, which is substantially in excess of the minimum flow bypasses that would otherwise occur.

Below Average Year (1988). Attachments 2.2, 3.2 and 4.2 illustrate below average year flows in the Colorado River at the gage near Kremmling, at the Hot Sulphur Springs gage, and below Lake Granby with and without the 2,700 AF of Recovery Program Water. In a below average year like 1988, Recovery Program releases high in the basin would consist of releases from the Wolford Mountain Reservoir 6K pool in October, releases from the Green Mountain surplus HUP from mid-September through October, and 10825 releases from Lake Granby from late August through late September. Releases of between 10 cfs and 30 cfs would be made from Lake Granby from August 1 through early October. This release schedule would maintain a flow of about 50 cfs below Lake Granby, and would partially fill late summer "holes" in the Colorado River at Hot Sulphur Springs.

Above Average Year (1982). Attachments 2.3, 3.3 and 4.3 illustrate the above average year flows in the Colorado River at the gage near Kremmling, at the Hot Sulphur Springs gage, and below Lake Granby with and without the 2,700 AF of Recovery Program Water. In an above average year like 1982, Recovery Program releases high in the basin would consist of Green Mountain Surplus HUP water and 10825 releases from Lake Granby. There would be no water released from the Wolford Mountain Reservoir 6K pool in an above average year. Releases of between 10 cfs and 30 cfs would be made from Lake Granby from August 1 through early October. This release schedule would maintain a flow of about 50 cfs below Lake Granby, and would partially fill late summer "holes" in the Colorado River at Hot Sulphur Springs. Note that the base discharge below Lake Granby shown in attachment 4.3 reflects the instream flow requirement and does not include spills during the runoff period.

Wet Year (1983). Attachments 2.4, 3.4 and 4.4 illustrate the wet year flows in the Colorado River at the gage near Kremmling, at the Hot Sulphur Springs gage, and below Lake Granby with and without the 2,700 AF of Recovery Program Water. In a wet year like 1983, Recovery Program releases high in the basin would consist of Green Mountain Surplus HUP water and the 10825 Water releases from Lake Granby. There would be no water released from the Wolford Mountain Reservoir 6K pool in a wet year. Releases of between 10 cfs and 30 cfs would be made from Lake Granby from August 1 through early October. This release schedule would maintain a flow of about 50 cfs below Lake Granby, and would partially fill late summer "holes" in the Colorado River at Hot Sulphur Springs. Note that the base

discharge below Lake Granby shown in attachment 4.4 reflects the instream flow requirement and does not include spills during the runoff period.

CONCLUSIONS

Any alternatives that utilize Lake Granby would provide headwaters benefits in all years because reservoir releases would increase late fall stream flow of the Colorado River downstream of Lake Granby. This alternative would have a relatively small effect on the storage contents in Lake Granby. Also, this alternative may have a small effect on stream flow during snowmelt runoff, as additional water would be stored at this time for release later in the year for 10825 purposes.

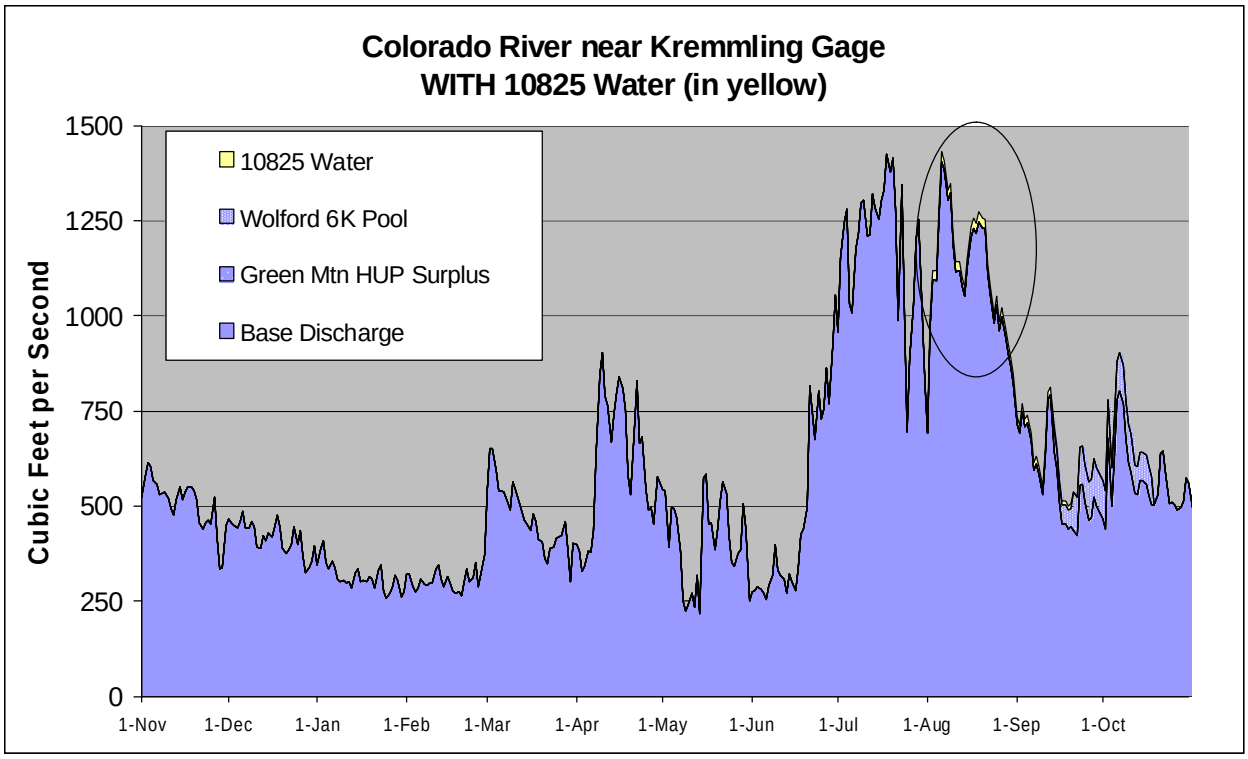
The release of water from Lake Granby results in a relatively large proportional increase of stream flow downstream of the reservoir, through the Hot Sulphur Springs area. Downstream of the Williams Fork River, the proportional changes in stream flow are relatively minor.

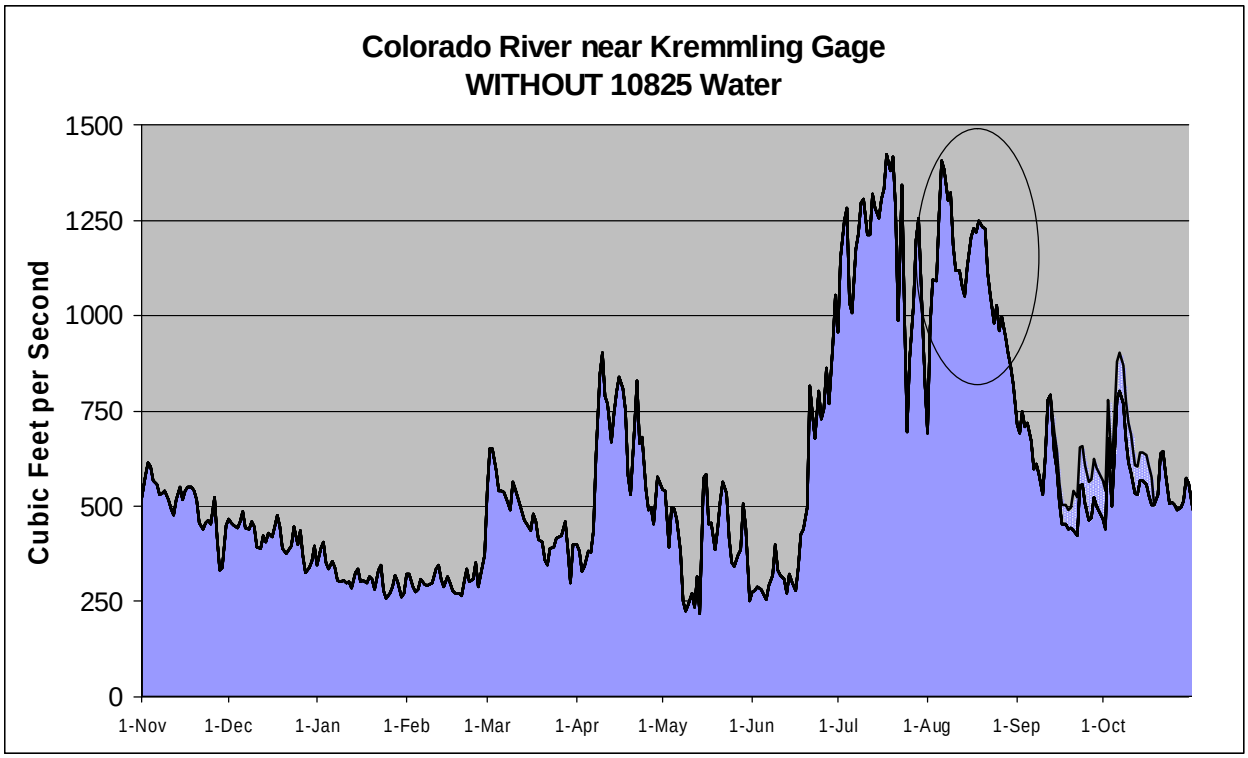
As analyzed herein, the Granby releases are made to maintain a flow of about 50 cfs below the reservoir from early August through the early October period. Other release schedules may provide additional benefits to aquatic habitat below Granby Reservoir. The impact of these potential releases to aquatic habitat of the Colorado River will be addressed by other specialists.

The specific conditions under which this source of water may become available are not fully understood at this time. However, in the event that 2,700 acre feet of water becomes available from this facility, the relative increases in late-summer stream flow upstream of the Williams Fork River would be substantial.

ATTACHMENT 2.1

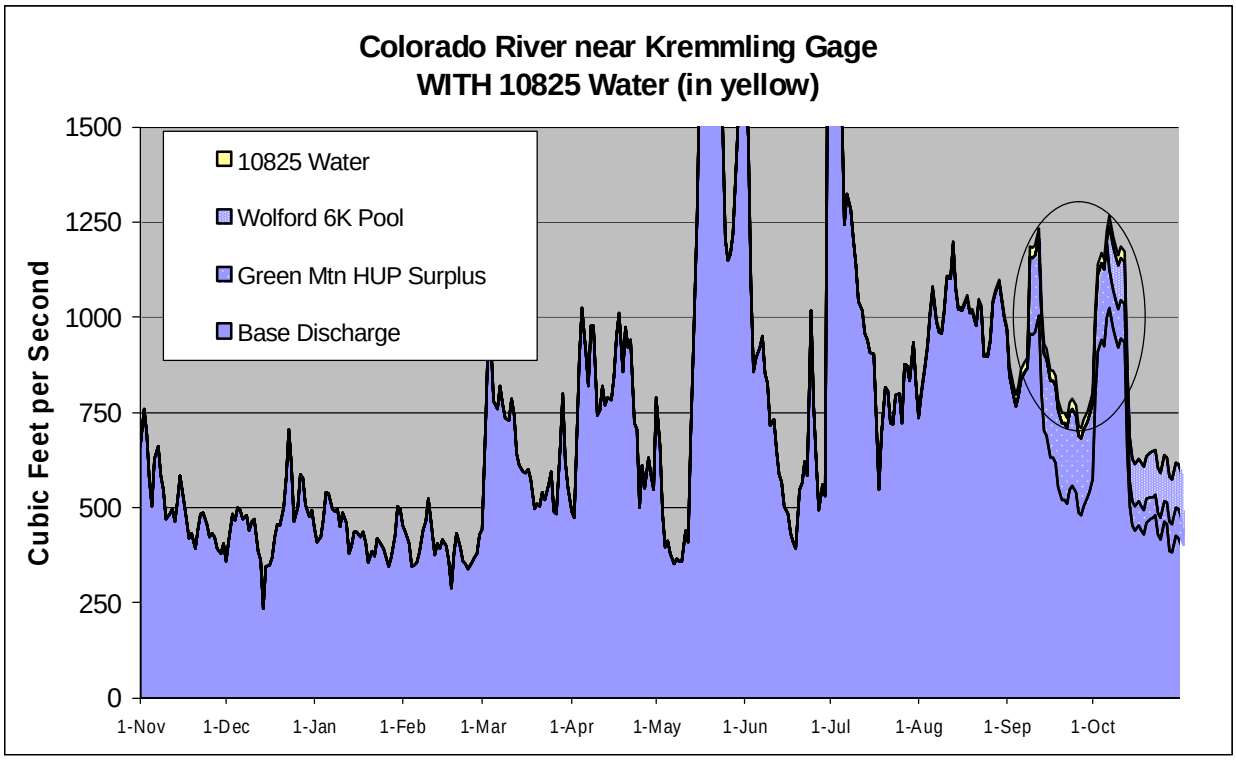
GRANBY RESERVOIR: ANNUAL RELEASE OF 2,700 AF **DRY YEAR (1977)**

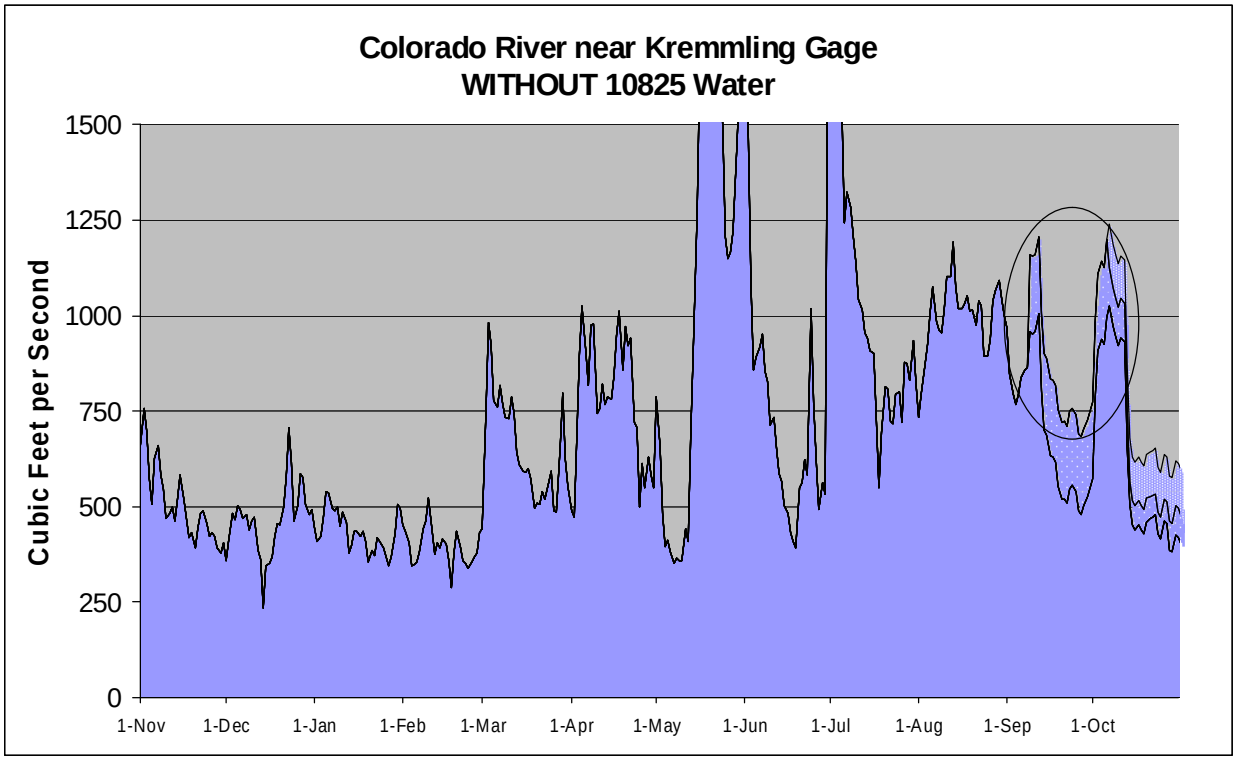




ATTACHMENT 2.2

GRANBY RESERVOIR: ANNUAL RELEASE OF 2,700 AF BELOW AVERAGE (1988)





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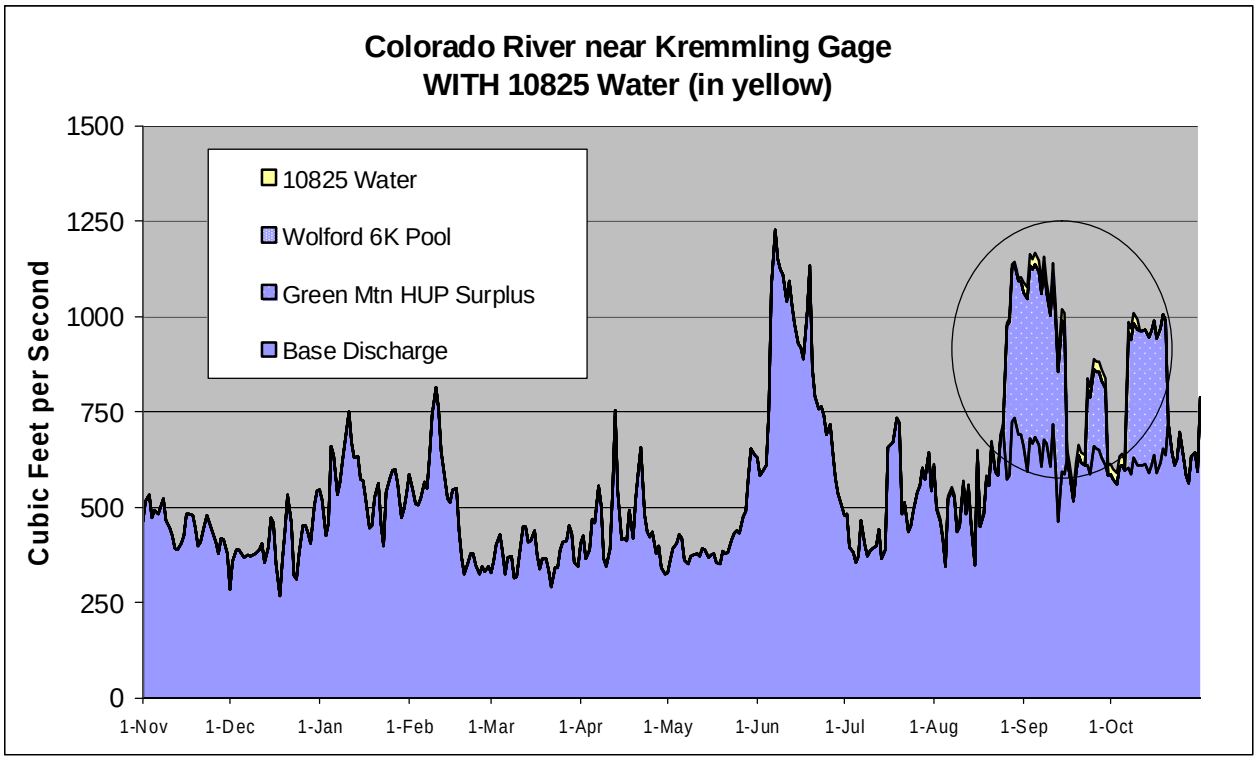
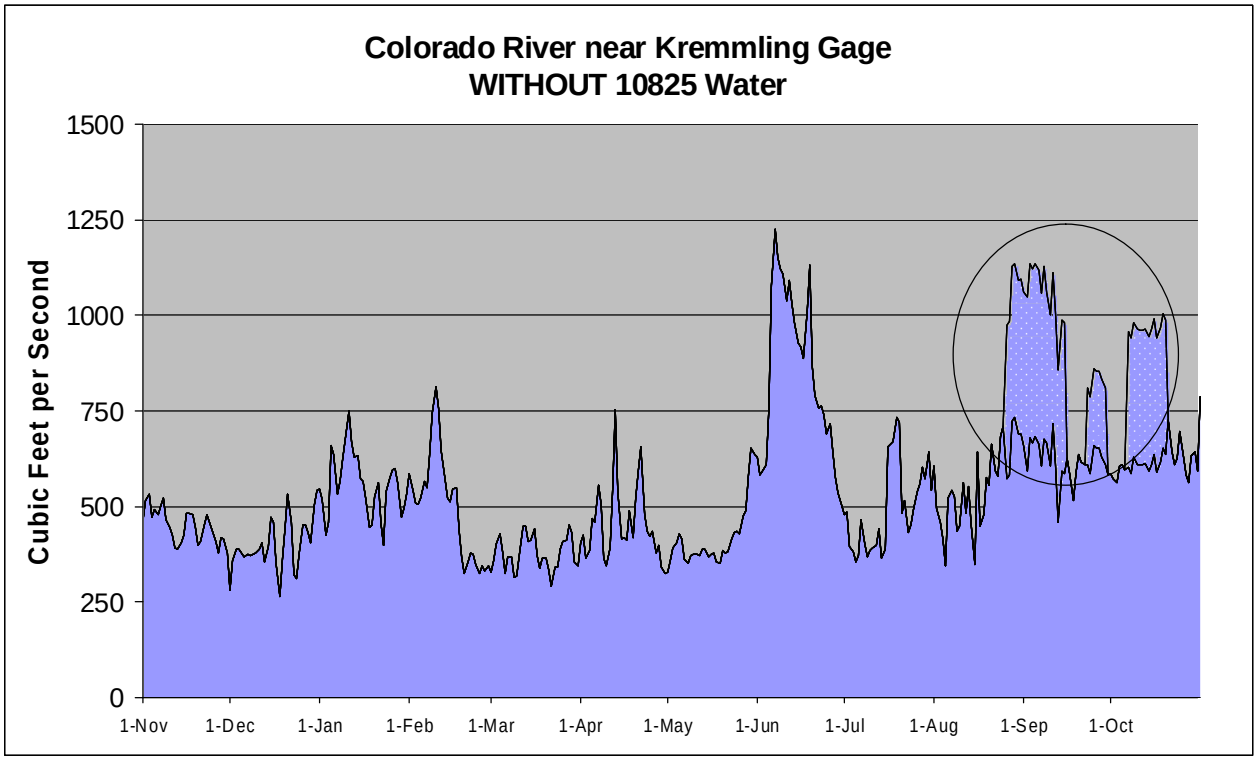
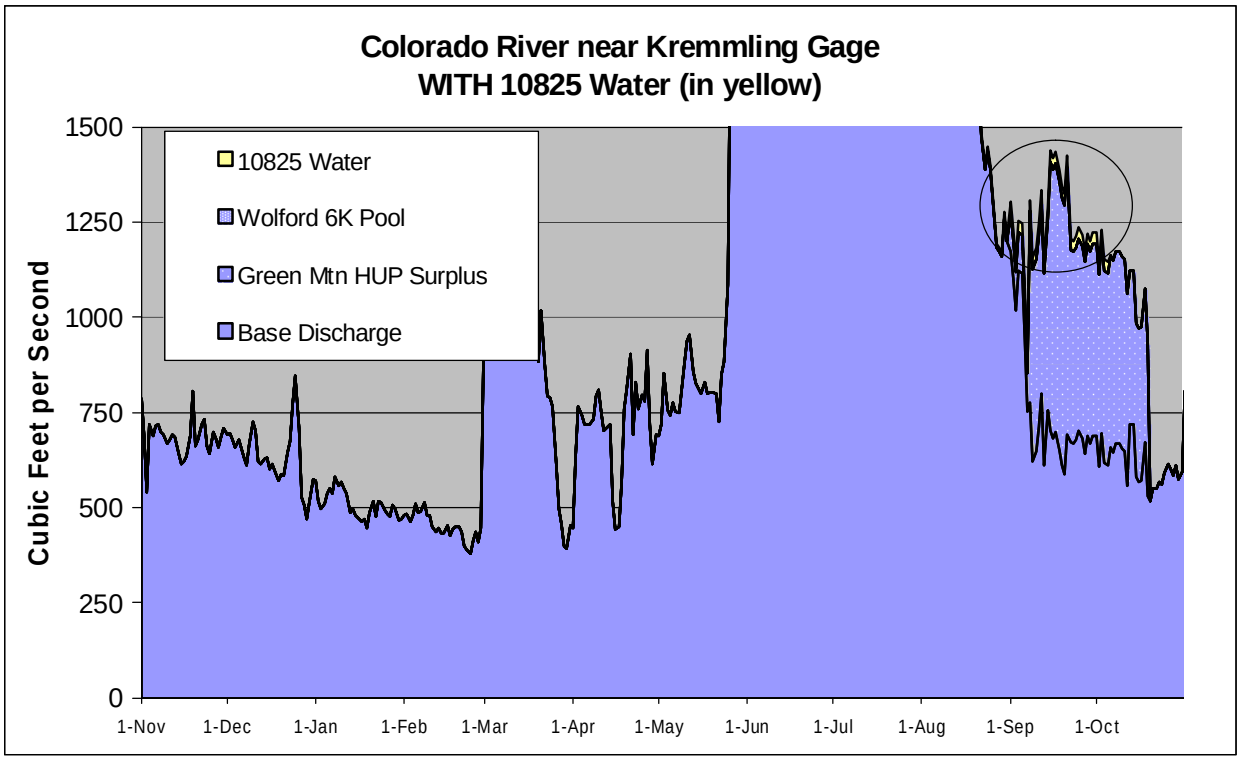
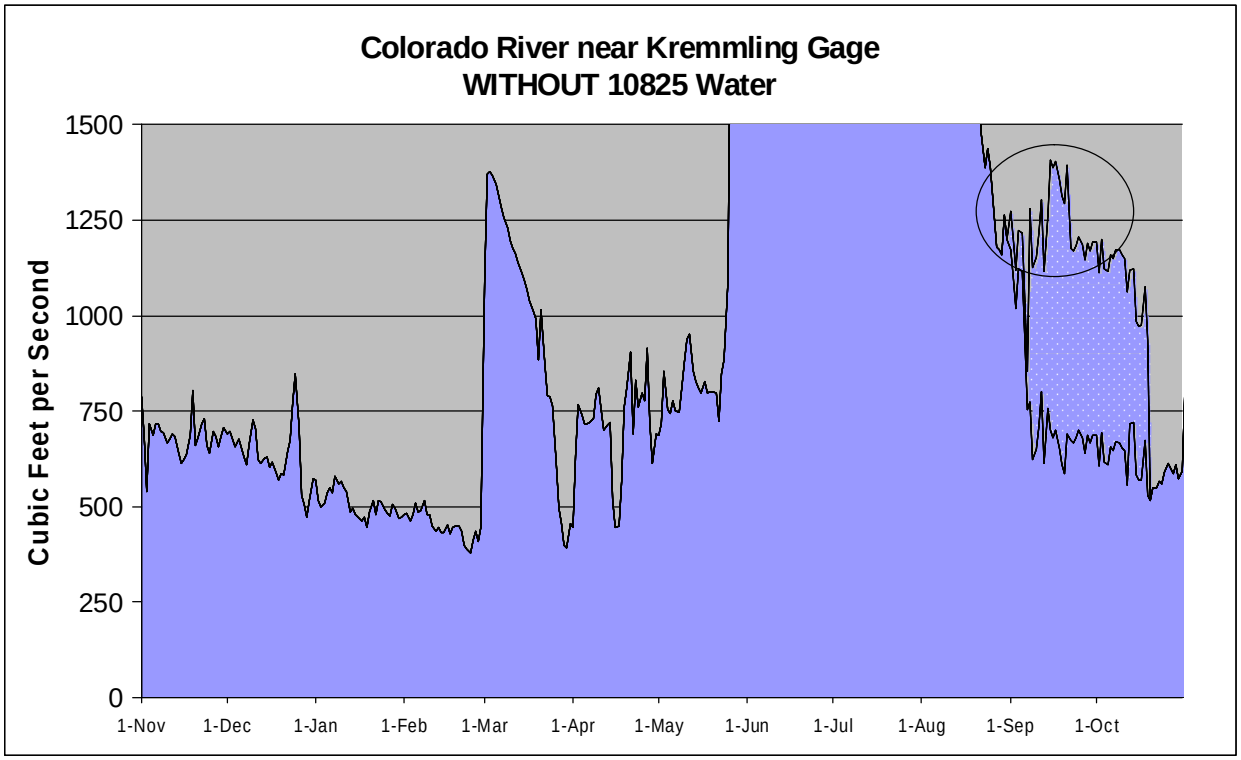




ATTACHMENT 2.4

GRANBY RESERVOIR: ANNUAL RELEASE OF 2,700 AF WET YEAR (1983)





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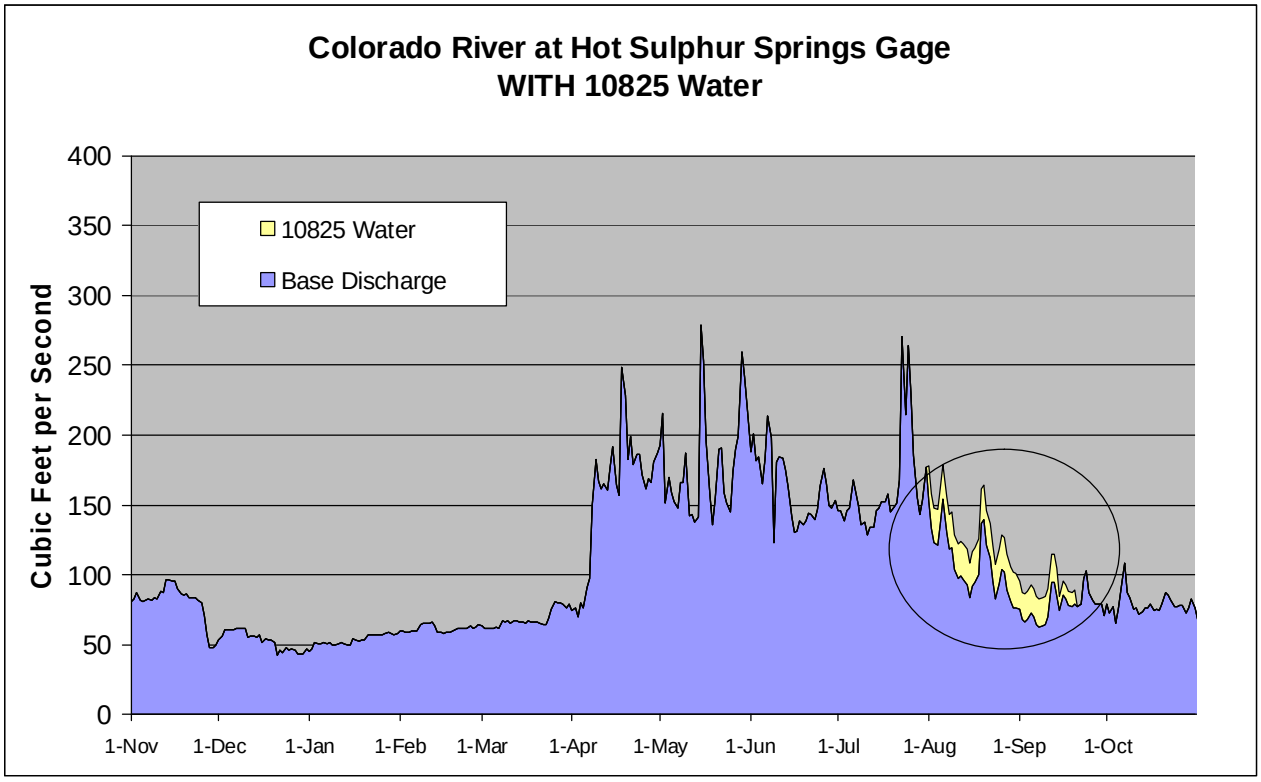

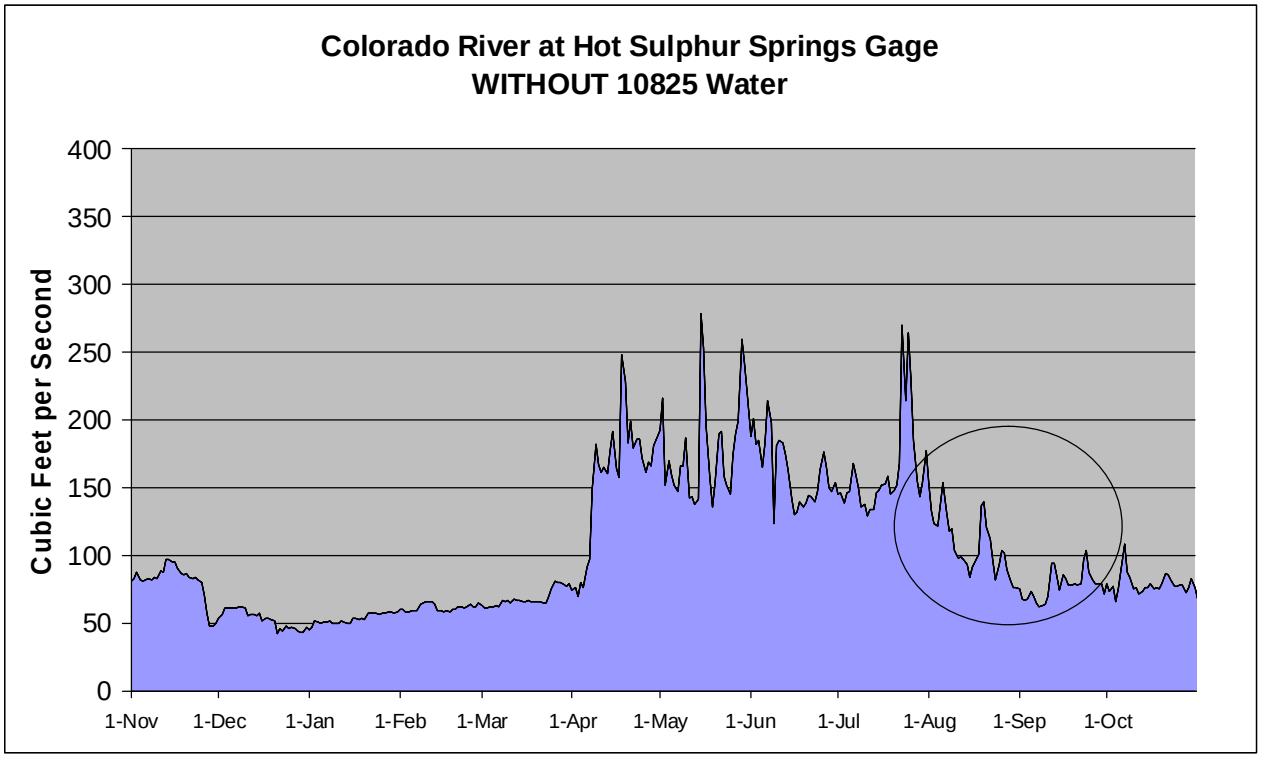

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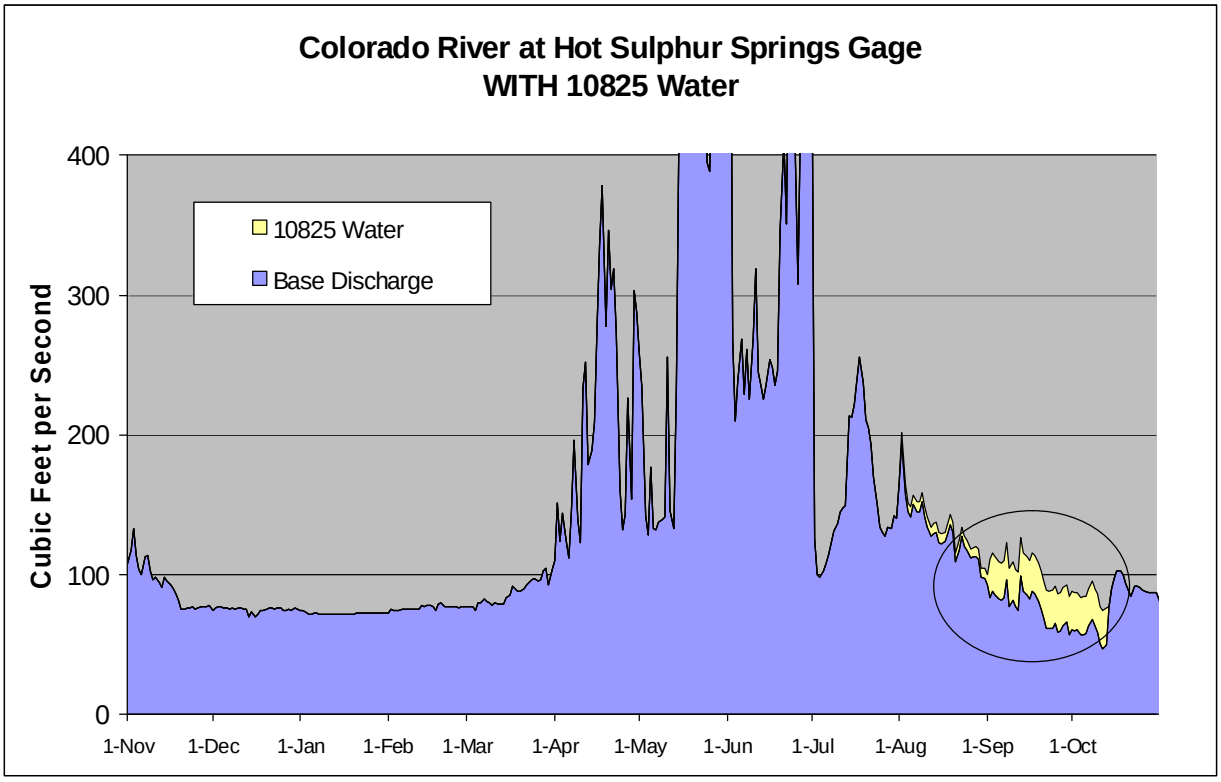

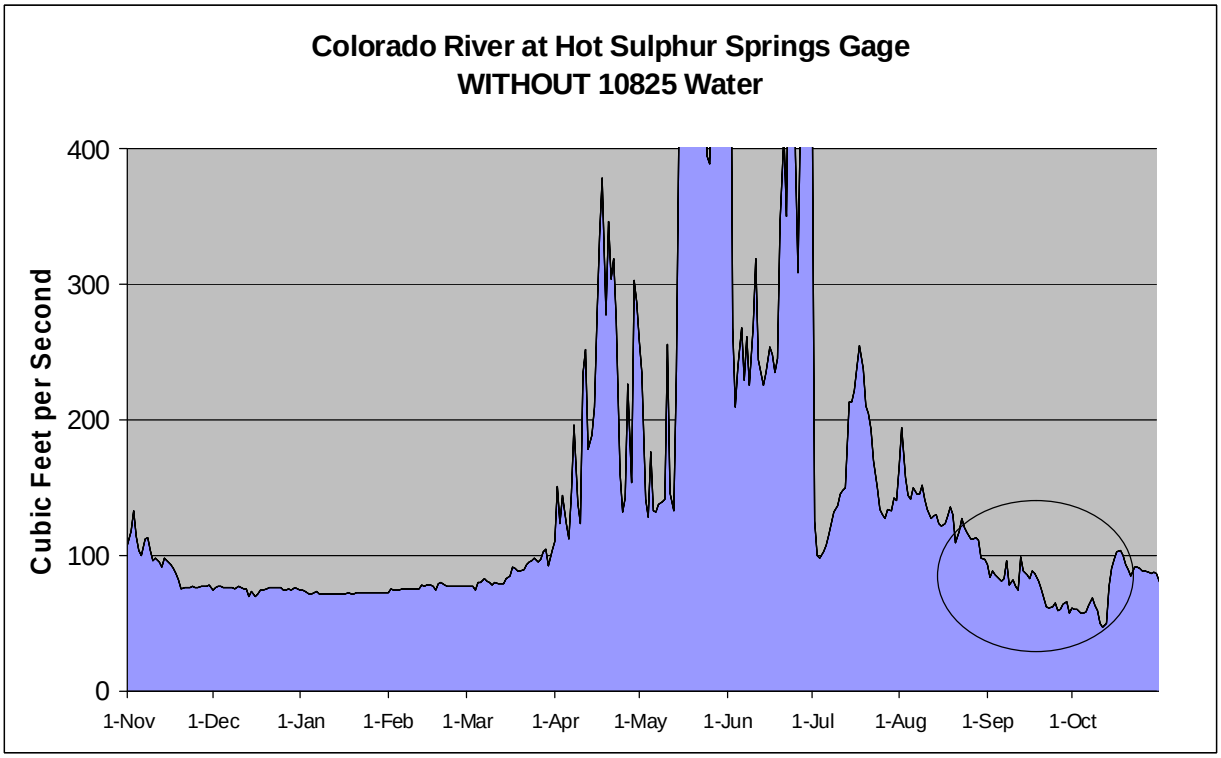

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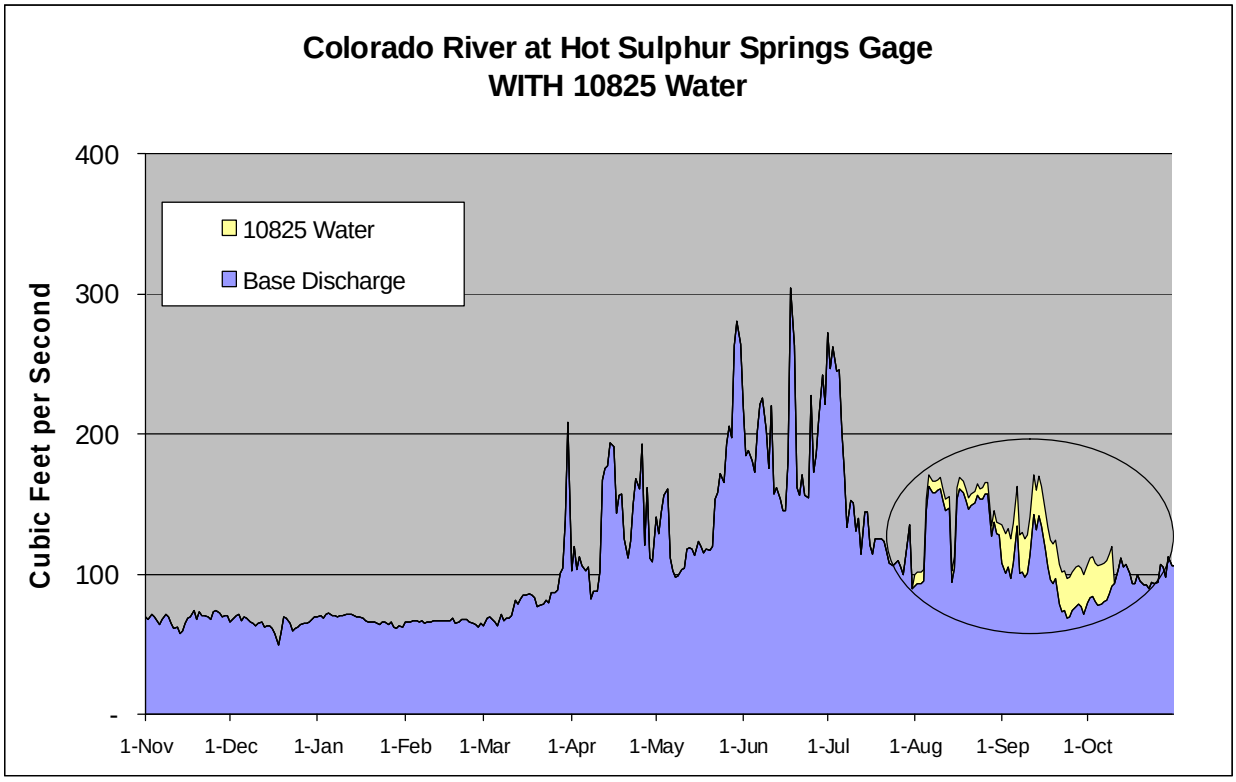

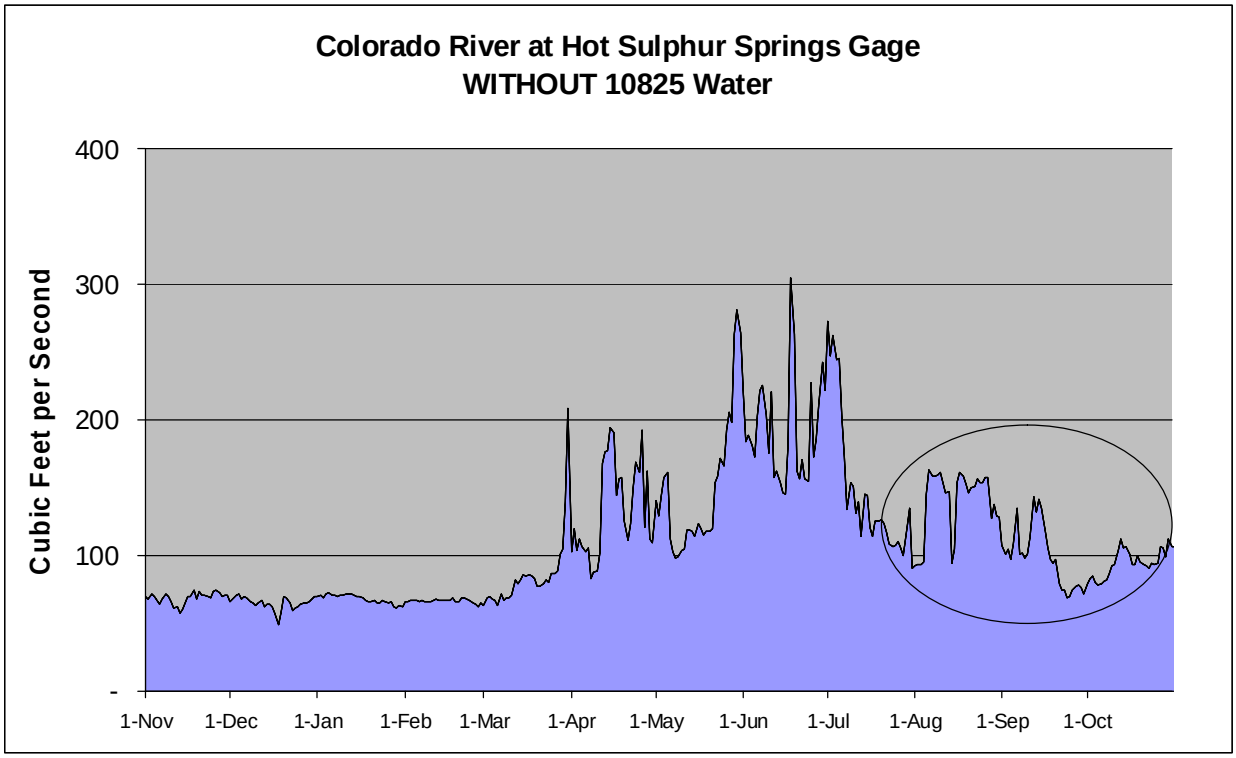

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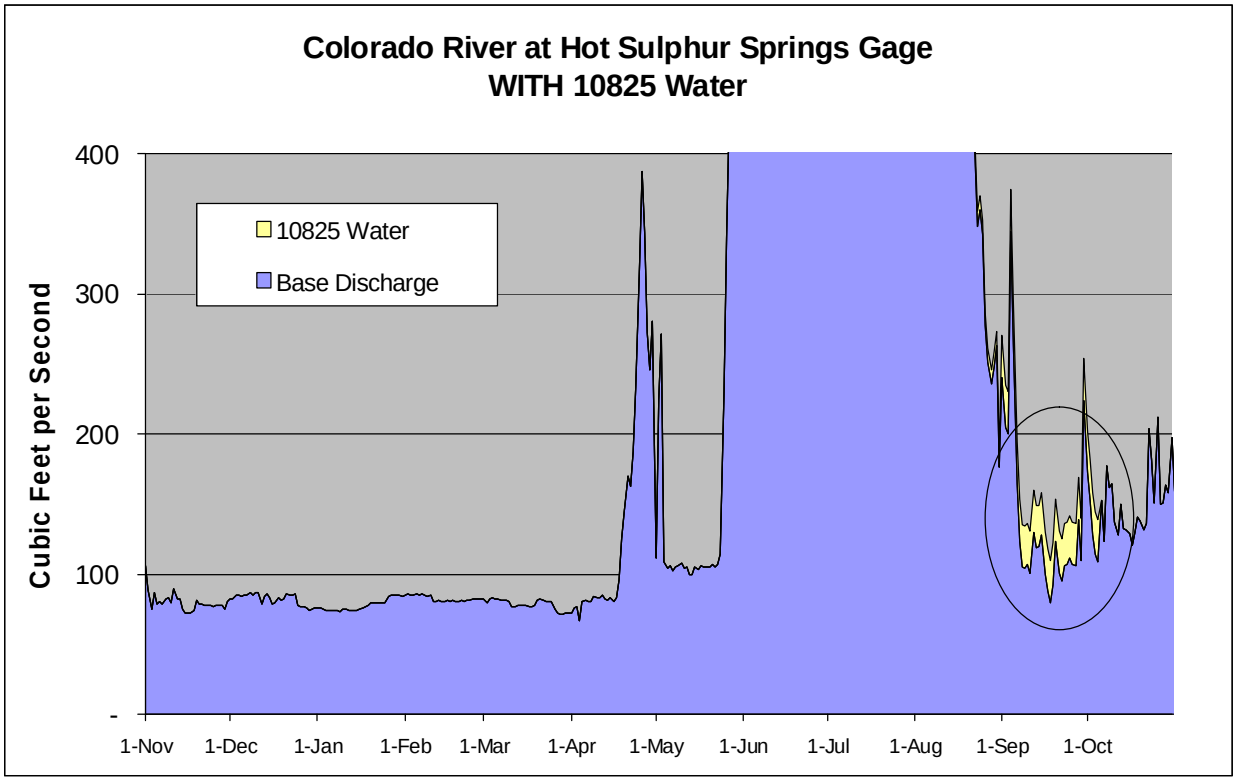

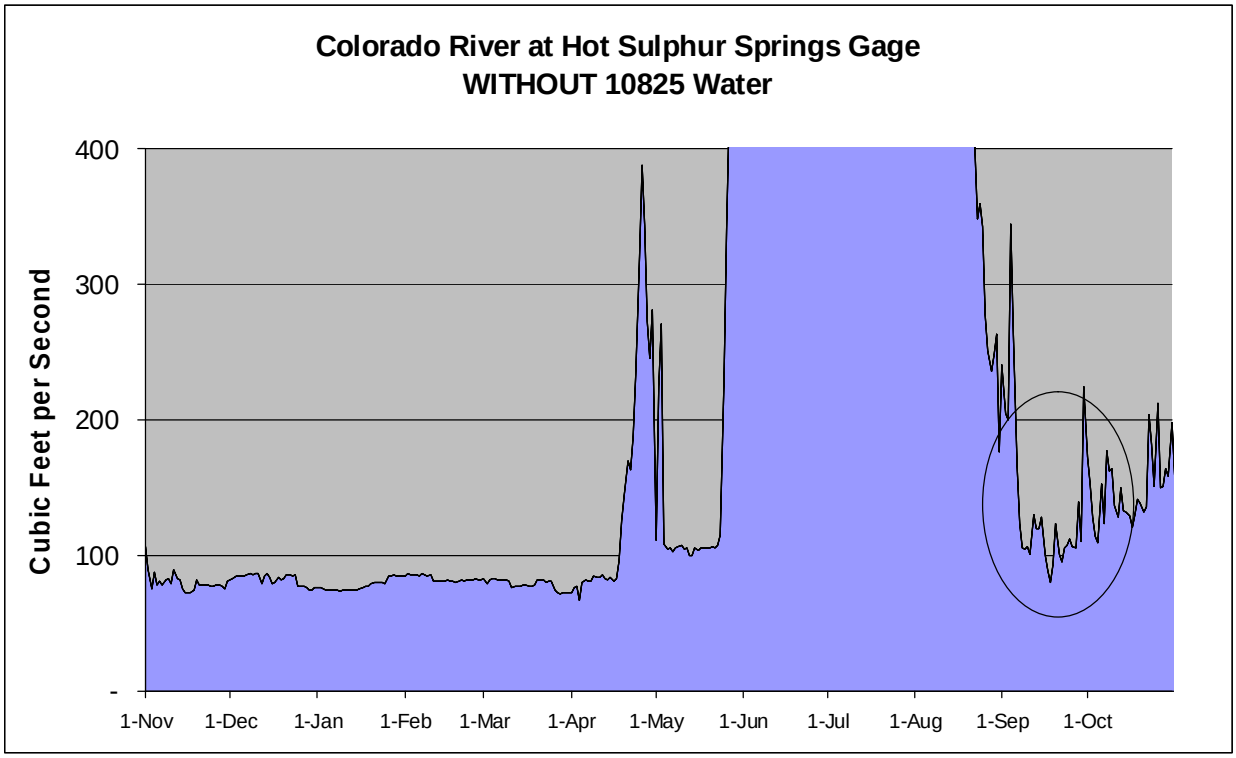

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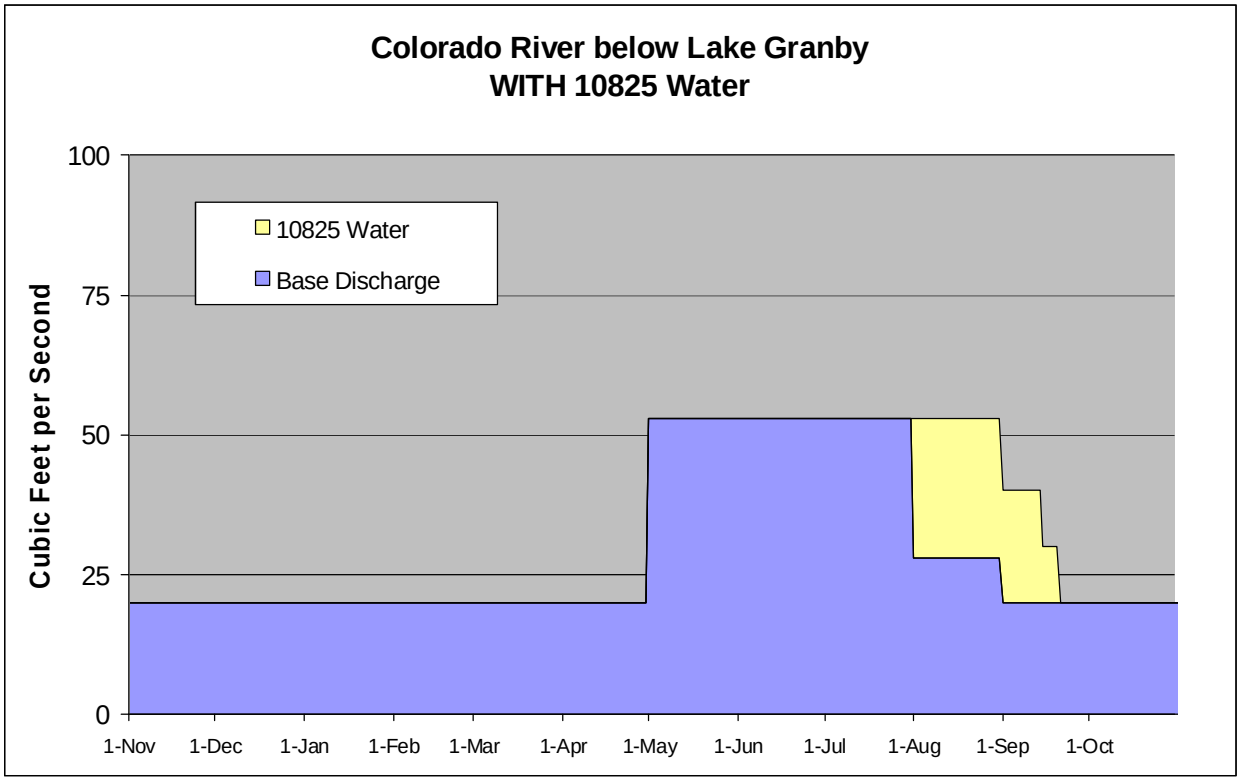

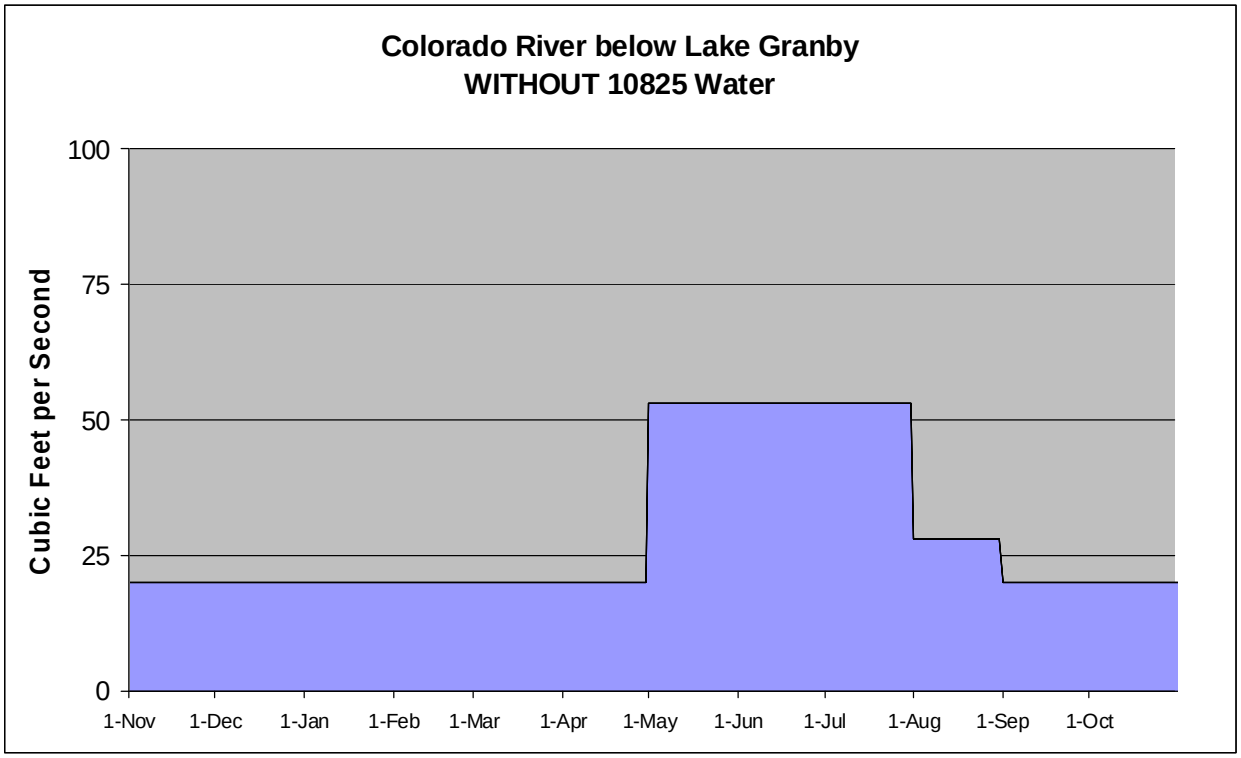

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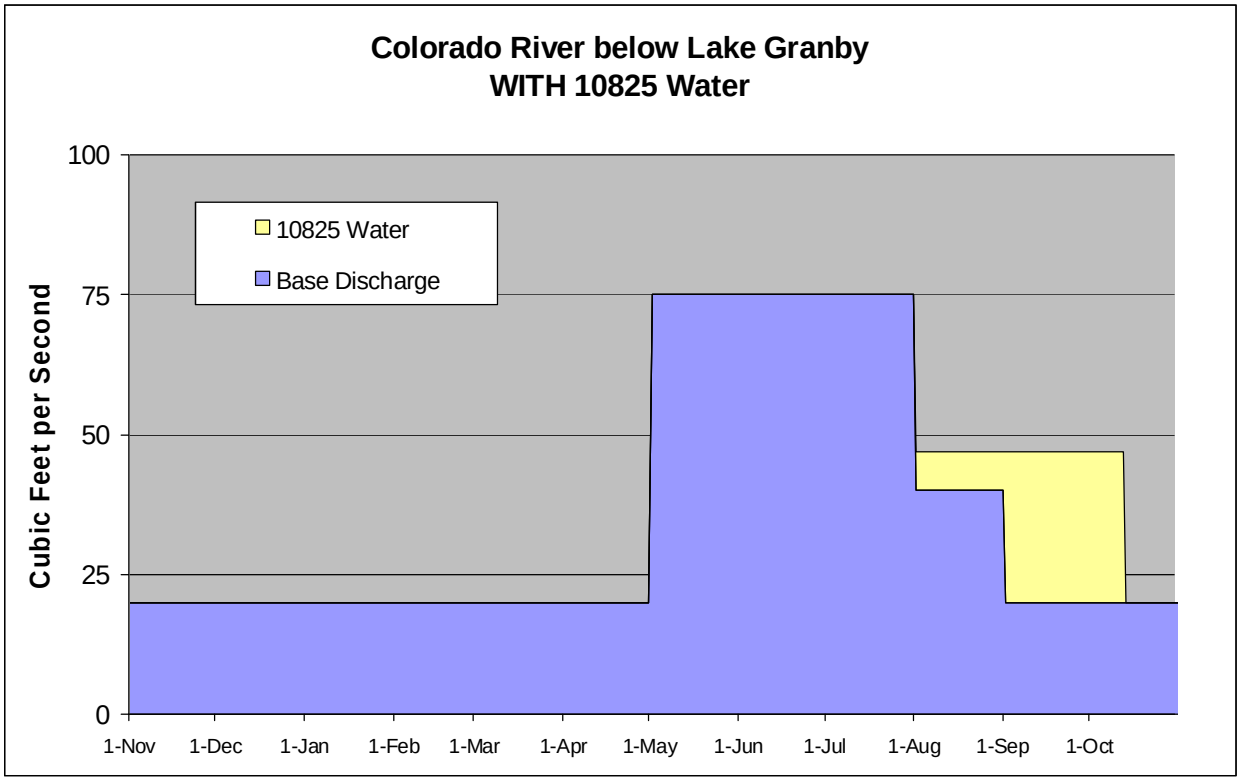

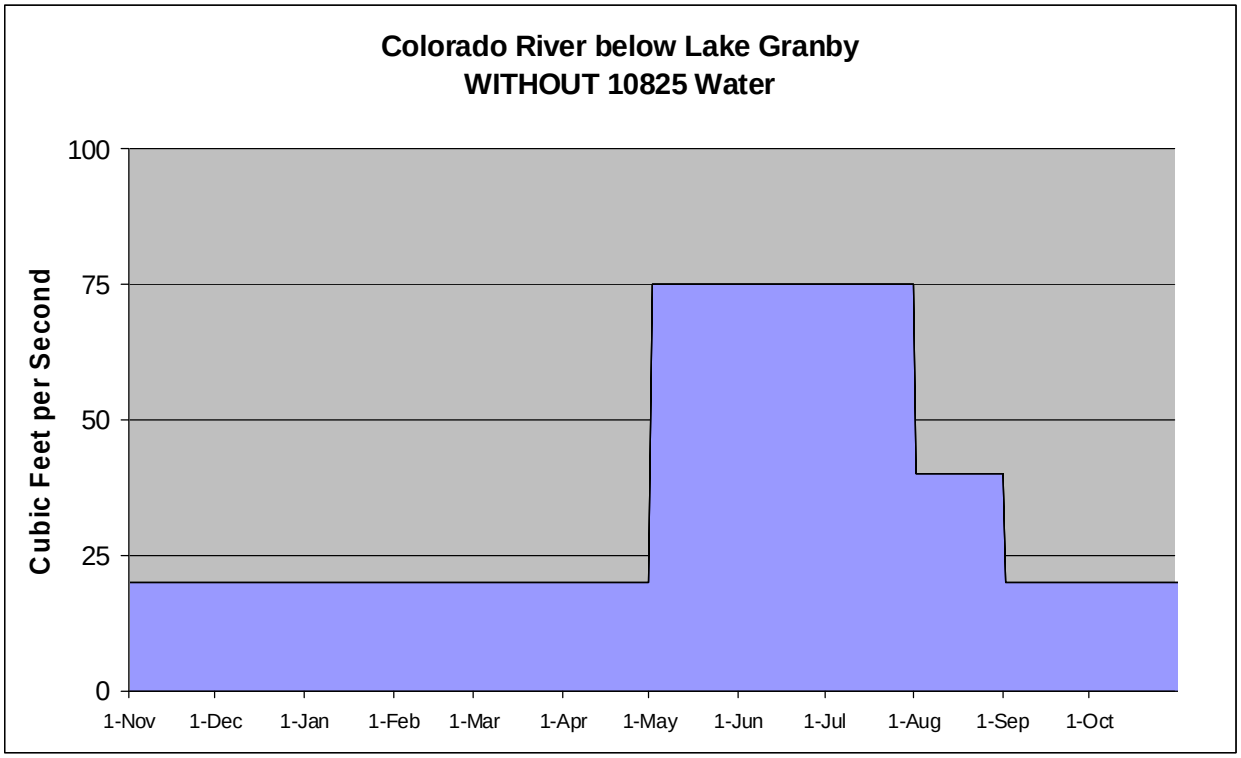

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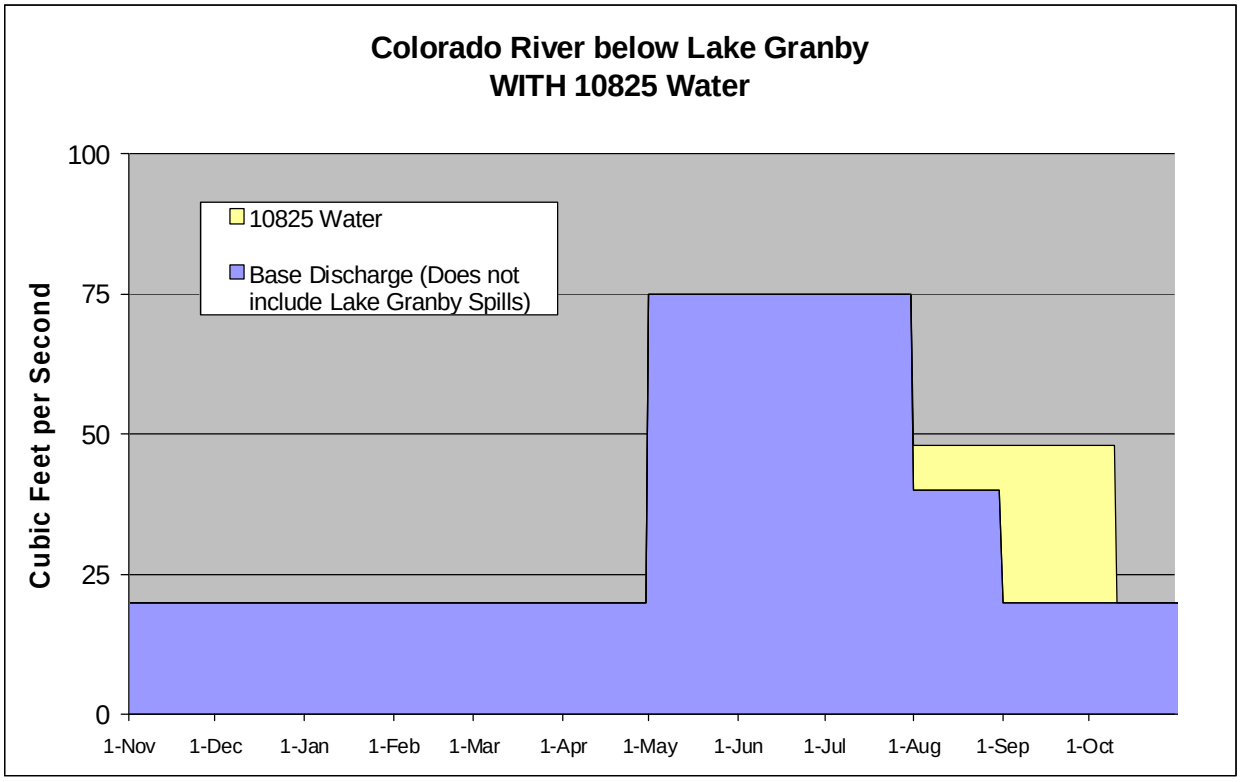

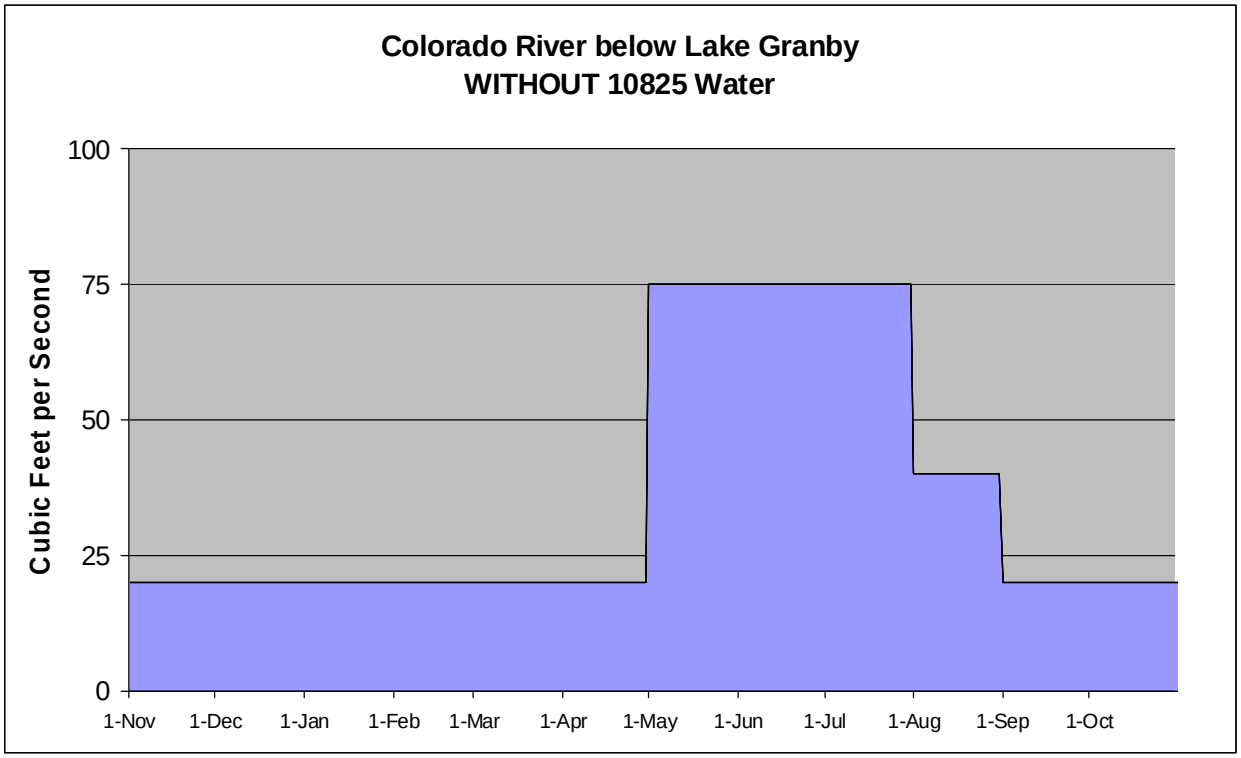

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