GARY FISKE AND ASSOCIATES, INC.
Water Resources Planning and Management

Date: April 19, 2015
From: Gary Fiske
To: Water Supply Advisory Committee
Re: Modeling Results: North Coast Reclaimed Water Exchange (CA-13)

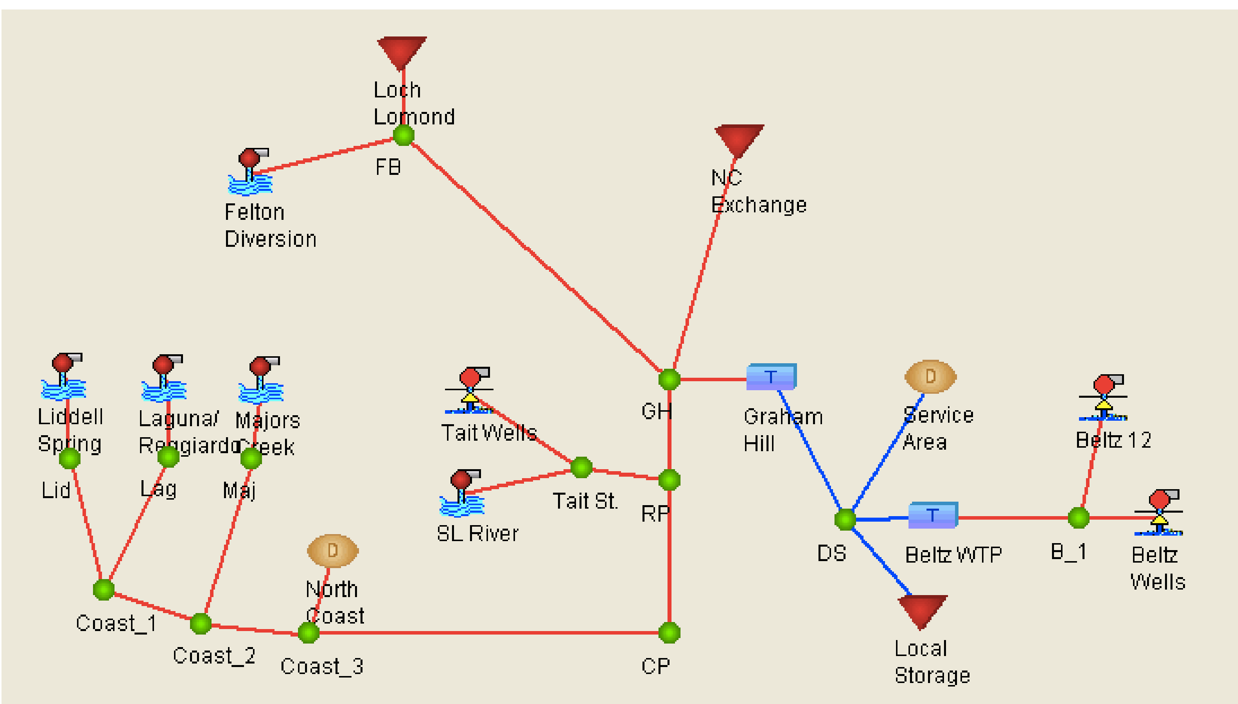
This memo reports the results of the Confluence modeling of CA-13, which sends non-potable reclaimed water to North Coast farmers in exchange for groundwater that can be extracted and treated at Graham Hill or a new treatment plant. Per discussions with Bill Faisst, it is assumed that 4.3 mgd are sent over a 180-day November-April period for a total 775 million gallons per year. The City can withdraw that water in the current year; it cannot be banked for future years.

Basically 775 mg is available from this source every year if needed to meet demand. There are assumed to be no pumping or transmission capacity limitations on utilizing this new supply.

Modeling Approach

The Confluence system schematic for this alternative is shown in Figure 1.

Figure 1. Confluence System Schematic for CA-13



Since the nature of this supply is "use it or lose it," (i.e. it cannot be stored from year to year), the model utilizes this supply on any day prior to drawing on Loch Lomond. This is the most efficient way to use such a supply since it allows for indirect banking by increasing carryover storage in Loch Lomond. As will be shown below, this indirect storage provides substantial reliability benefits.

Impacts on System Reliability

Figure 2 shows the peak-season shortage duration curves assuming DFG-5 flows with current supplies that we have seen before (see my March 9 memo). The shortages are expressed as both percentages and volumes.

Figure 2. Peak-Season Shortage Duration Curves <u>with Current System</u>: DFG-5 Flows

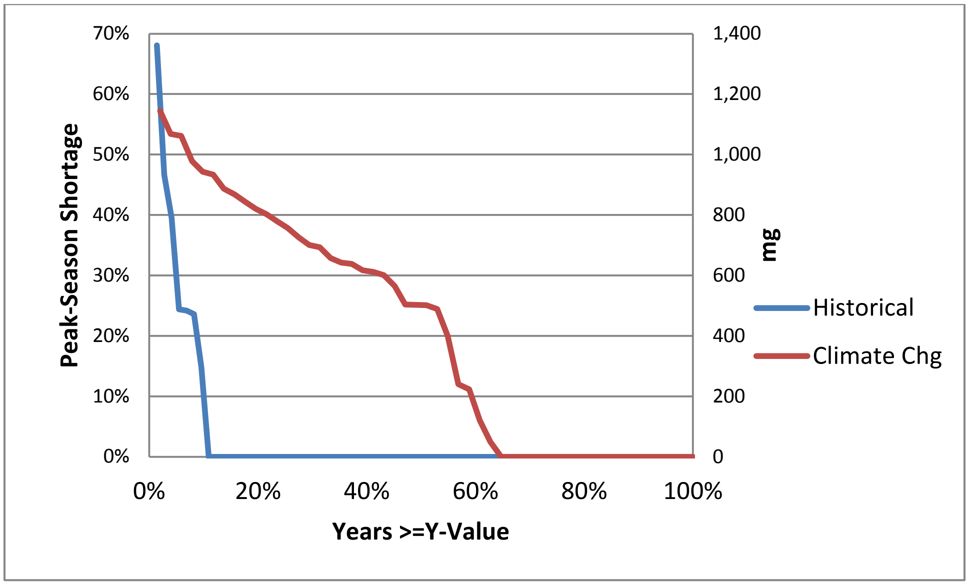


Figure 3 shows how these curves are improved through this supply alternative. Note that the horizontal axis is expanded (i.e., it only shows the lower range of probabilities) to make the chart easier to read. Tables 1 and 2 summarize the information shown in these curves in two different ways. Table 1 shows the probabilities of exceeding designated shortages in any year. Table 2 shows the probabilities of each shortage exceedance event occurring at least once over the next 30 years. Thus, for example, with historic flows, there is a 3% likelihood of a peak-season shortage greater than 5% in any year. Over the next 30 years, there is a 57% likelihood of experiencing at least one year with that size peak-season shortage.

Figure 3. Peak-Season Shortage Duration Curves with North Coast Exchange: DFG-5 Flows

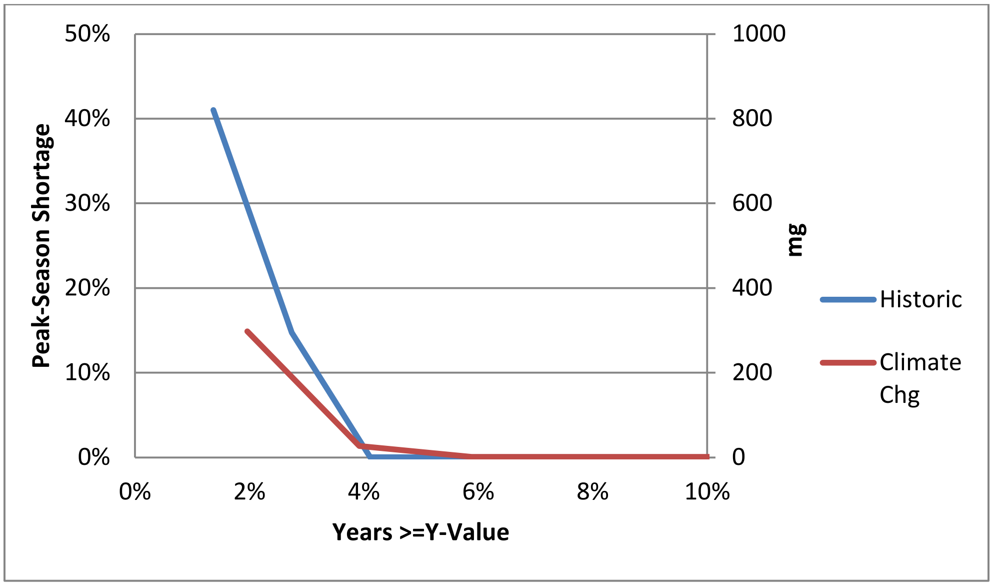


Table 1. Probabilities of Peak-Season Shortage Events in Any Year: DFG-5 Flows

Shortage Event	Historic	Climate Change
>50%	0%	0%
>25%	1%	0%
>15%	1%	0%
>5%	3%	2%

Table 2. Probabilities of Occurrence of Peak-Season Shortage Events Over 30-Year Period: DFG-5 Flows

Shortage Event	Historic	Climate Change
>50%	0%	0%
>25%	34%	0%
>15%	34%	0%
>5%	57%	45%

The shortage profiles with both historic flows and climate change are improved significantly:

- For both historic flows and climate change, this supply option confines shortages to the one or two worst drought years. In all other years, shortages are reduced to zero.

- The reliability improvement from this alternative is greater with climate change than with historic flows. In fact, the reliability profile with this alternative assuming climate change is actually better than with historic flows.

- With climate change, this alternative reduces the worst-year shortage to about 15%.

Project Yield

The difference between the highest point in Figure 2 and Figure 3 tell us the worst-year yield of this alternative, i.e., how well this alternative does in reducing the worst-year peak-season shortage. Expressed volumetrically, this difference is about 530 mg with historic flows, and 850 mg with climate change. Across all hydrologic conditions, the average reduction in peak-season shortage is about 45 mg with historic flows and 410 mg with climate change.

These benefits accrue for two reasons:

- The production (less losses) of the source itself <u>plus</u>
- The change in production of Loch Lomond (which in many hydrologic years is negative)[1]

The second point is important. In dry years, the benefit of these alternatives derive not only from the recycled water produced in that year, but also from added production from Loch Lomond. In those years, Loch Lomond begins at higher elevations because use of the recycled water in previous years allowed the lake to “rest”.

Needed Infrastructure Capacities

The assumed daily recycled water production in the off-peak months, and thus the needed capacity of the transmission line to move reclaimed water to the North Coast, is 4.3 mgd. Figure 4 shows the duration curves of the daily source production during the peak season, which provide information on the capacity requirements for the extraction wells and the transmission from the North Coast to the treatment plant. The maximum production is between 10 and 11 mgd.

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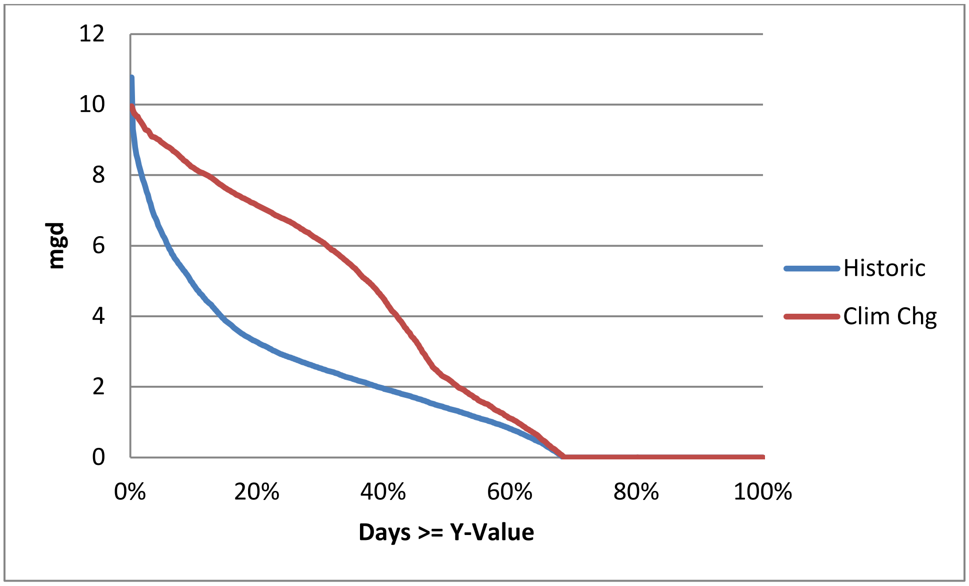
[1] The total also includes a slight increase in Tait Street production sent to GHWTP because of the assumed unlimited diversion capacity.

Figure 4. Duration Curves of Daily North Coast Exchange Production



Conclusion

Fixed (hydrology-independent) sources have very different system impacts than sources that vary with streamflows. CA-13, the exchange of non-potable recycled water for North Coast groundwater, provides 775 mg of additional supply every year. The actual benefit of this source in dry years is significantly greater than this because of the ability to indirectly bank some of this water in Loch Lomond.

The reliability benefit of this alternative is substantial, actually somewhat greater under climate change. The worst-year peak-season shortage with climate change is brought down to 15%. With historic flows, it is 40%, still a substantial improvement but well above our target. Shortages in all hydrologic years other than the worst drought sequence are brought to zero.

Of course, larger fixed sources (e.g. IPR, with annual production of 1330 mg) will produce greater benefits.