Appendix C11
Modeling of Lower Basin Tributaries in the Colorado River Simulation System

Appendix C11 — Modeling of Lower Basin Tributaries in the Colorado River Simulation System

1.0 Overview

The Colorado River Simulation System (CRSS) is the primary modeling tool used in the Bureau of Reclamation's (Reclamation) long-term planning studies for the Colorado River Basin (Basin) and is the primary modeling tool for the Colorado River Basin Water Supply and Demand Study (Study). CRSS simulates the operation of the major Colorado River system reservoirs on a monthly time step and provides information regarding the projected future state of the system in terms of output variables, which include the amount of water in storage, reservoir elevations, releases from the dams, diversions to and return flows from the water users, and the amount of water flowing at various points throughout the system. Major inputs to the model include projected natural flows[1] at 29 locations throughout the Basin (20 in the Upper Basin upstream of and including the Lees Ferry gaging station in Arizona, and 9 below Lees Ferry, including the Paria River and inflow points in the Lower Basin[2]). For four of the inflow points below Lees Ferry (the Paria, Little Colorado, Virgin, and Bill Williams rivers), CRSS uses historical inflows (not natural flows) based on U.S. Geological Survey (USGS) streamflow records. In addition, the Gila River is not included in CRSS.

Many Colorado River planning studies have been completed over the past two decades in which this treatment of the major Lower Basin tributaries was used; however, questions regarding the adequacy of the treatment of the Lower Basin tributaries in CRSS for the Study arose during the phases focused on assessing future water supply and demand. Although some limitations were imposed on the Study by this treatment, through other approaches the Study was able to examine several important issues, including potential climate change impacts on the tributaries represented in CRSS, future demand scenarios on those tributaries, and future demand scenarios for the Colorado River from the central Arizona planning area (Gila River Basin) factoring in other water supplies within that basin (see subsequent discussions).

This appendix provides technical information regarding the treatment of the Lower Basin tributaries in CRSS, including the availability of the data and information necessary to compute natural flows. Additionally, three commitments are made to engage in efforts independent of the Study: 1) to resolve and correct the methodological and data inconsistencies in Reclamation's Consumptive Uses and Losses Reports (CU&L Reports) (Reclamation, 2005, 2012a, 2012b, 2012c) pertaining to all of the Lower Basin tributaries, in collaboration with the Colorado River Basin States (Basin States); and 2) to develop natural flows for the Little Colorado, Virgin, and Bill Williams rivers and to modify CRSS to use natural flows for those tributaries; and 3) to

[1] Natural flow represents the flow that would have occurred at the location had depletions and reservoir regulation not been present upstream of that location.

[2] The Lower Basin includes those parts of the states of Arizona, California, Nevada, New Mexico, and Utah within and from which waters naturally drain into the Colorado River System below Lee Ferry.

explore the feasibility and necessity of computing natural flows for the Gila River Basin and adding that tributary to CRSS.

1.1 Introduction

This appendix first provides background regarding the methodologies that have been used to estimate and report historical consumptive uses and losses data throughout the Basin. The efforts over the past decade to resolve inconsistencies in the Upper Basin data are summarized, as well as the efforts in the Lower Basin, which to date have been directed primarily toward measuring and reporting consumptive uses and losses from the mainstem of the Colorado River. Next, for each Lower Basin tributary, the current representation in CRSS is discussed along with the data from Reclamation's CU&L Reports. Discussion is also provided on additional sources of data and information relevant to the estimate of consumptive uses and losses on these tributaries. Finally, commitments are made for work independent of the Study to resolve the technical issues identified.

2.0 Background

CRSS, which evolved from programming efforts in the late 1970s and early 1980s, is used to simulate the future conditions of the Colorado River system for planning studies. The basis of the simulation is a mass balance calculation that accounts for water entering the system, water leaving the system (e.g., from consumptive use of water, trans-Basin diversions, evaporation, etc.), and water moving through the system (i.e., water stored in reservoirs or flowing in river reaches).

Input data and information for the model include physical parameters, initial reservoir conditions, reservoir operating rules, and the diversion and return flow schedules for entities in the Basin States and the United Mexican States. Input data for the model also include natural flow at 29 locations throughout the system (20 in the Upper Basin upstream of and including the Lees Ferry gaging station in Arizona, and 9 below Lees Ferry, including the Paria River and inflow points in the Lower Basin), where natural flow represents the flow that would have occurred at the location had depletions and reservoir regulation not been present upstream of that location. Using these inputs, the model simulates the future state of the system in terms of output variables, which include the amount of water in storage, reservoir elevations, releases from the dams, diversions to and return flows from the water users, and the amount of water flowing at various points throughout the system.

The computation of natural flows for use in CRSS began in the early 1980s. At that time, different approaches (in terms of the methodologies and data) were taken for the computations of Upper Basin and Lower Basin natural flows. Over time, although the data and, in some cases, the methodologies, have been improved, these differences have remained. The following sections summarize these data, methodologies, and differences.

2.1 Computation of Natural Flows above Lees Ferry, AZ

The first computation of natural flows above Lees Ferry was done in the 1980s and is described in the *DRAFT Colorado River Simulation System Hydrology Data Base* report (Reclamation, 1983). This report describes the methods employed to determine natural flows (and the salinity of those flows) at the 20 locations in the Upper Basin mainstem and tributaries for the time

period 1906 to 1970. The accompanying data provide the monthly consumptive uses and losses and reservoir regulation data that were used in those computations.

In 1968, the Colorado River Basin Project Act (CRBPA) directed the Secretary of the Interior (Secretary) to

> make reports as to the annual consumptive uses and losses of water from the Colorado River system after each successive five-year period starting on October 1, 1970. Such reports shall include a detailed breakdown of the beneficial consumptive use of water on a State-by-State basis. Specific figures on quantities consumptively used from the major tributary streams flowing into the Colorado River shall also be included on a State-by-State basis. Such reports shall be prepared in consultation with the States of the lower basin individually and with the Upper Colorado River Commission, and shall be transmitted to the President, the Congress, and to the Governors of each State signatory to the Colorado River Compact…

These reports (the CU&L Reports[3]) have been prepared by Reclamation, in collaboration with the Basin States, for every five-year period from 1971 to 2005. To date, the report covering 2001 to 2005 is in final review and a provisional report covering the period 2006 to 2008 has been prepared.

The CU&L Reports estimate consumptive uses and losses across eight categories: reservoir evaporation, irrigated agriculture, livestock, stockponds, thermal electric power, minerals, municipal and industrial (M&I), and exports and imports. Specific methodologies are employed for each category and a large amount of data from a variety of sources is required. For example, to estimate consumptive use for irrigated agriculture, information regarding the actual acreage for specific crop types is coupled with weather data (precipitation, temperature, and frost dates) to estimate net evapotranspiration. Other specific information used includes data drawn from other published reports such as the USGS water use reports[4] as well as data supplied by specific entities.

Over a multi-year period in the early 2000s, the natural flow and salinity data for the Upper Basin was reviewed and re-developed for the period 1971 to 1995. A major component of this effort was resolving data and methodological inconsistencies found throughout the CU&L Reports up to that time. Based on these efforts, consistent data collection and computational methodologies were developed and are continually reviewed and updated to provide the best available information.

The review and re-development effort of the consumptive uses and losses data included:

1. Review and collection of weather data (precipitation, temperature, and frost dates) used within the modified Blaney-Criddle method required to estimate net evapotranspiration from irrigated croplands.

[3] Available at: http://www.usbr.gov/uc/library/envdocs/reports/crs/crsul.html.

[4] Available at: http://water.usgs.gov/watuse/.

2. Review and computation of irrigated acres estimates to ensure an objective methodology to estimate acreage from multiple datasets (geographic information systems coverage, Census of Agriculture reports, and county agriculture statistics report) was employed when possible.
3. Review and computation of irrigated agriculture consumptive use to ensure a consistent representation of the modified Blaney-Criddle method within a single software package.
4. Review and correction of reservoir evaporation estimates to ensure that the same set of reservoirs were used from one reporting period to the next, including the incorporation of new reservoirs constructed after 1971.
5. Review and correction of USGS water use records used to assist in estimates of mineral and M&I uses.
6. Review and collection of export and import uses to ensure consistent reporting of trans-Basin exports and imports from one report period to the next, including the proper accounting of trans-Basin exports and imports constructed or decommissioned since 1971.
7. Correction of data entry errors and design of data entry and storage methods to assist in the implementation of quality control measures.

The estimates from the CU&L Reports are used to compute natural flow[5] in the Upper Basin for the period after 1970. As the consumptive uses and losses information is updated, the Upper Basin natural flows are also re-computed to ensure consistency. To this end, the Upper Basin states have raised issues regarding limitations, inconsistencies, and problems with the current consumptive uses and losses information, and Reclamation will continue to improve the consumptive uses and losses data through coordination and discussion with the Basin States.

2.2 Computation of Natural Flows below Lees Ferry, AZ

Methodologies and data used to develop the flows (and the salinity of those flows) for the nine inflow points below Lees Ferry from 1906 through 1982 for the tributaries and from 1935 through 1982 for the mainstem are described in *Colorado River Simulation System, Hydrology Data Base Lower Colorado Region (Lees Ferry to Imperial Dam*) (Reclamation, 1985). These nine inflow points represent tributary inflows as well as "gains and losses" within mainstem reaches. The inflow points representing tributary inflows are the Paria River, the Little Colorado River, the Virgin River, and the Bill Williams River. The inflow points representing mainstem gains and losses are Lees Ferry to Grand Canyon, Grand Canyon to Hoover Dam, Hoover Dam to Davis Dam, Davis Dam to Parker Dam, and Parker Dam to Imperial Dam.

Flows on the tributaries are computed not as natural flows, but instead by using historical, gaged streamflows. The report details the methodologies used to fill in missing records and extend the available records for these tributaries back to 1906.

Flows representing historical gains and losses along the mainstem reaches are estimates of natural flows, calculated by adjusting historical gaged streamflows for reservoir regulation and consumptive uses and losses that occurred in the reach. The report details the methodologies

[5] Additional information is available at http://www.usbr.gov/lc/region/g4000/NaturalFlow/current.html.

used to fill in the missing consumptive use and historical gaged streamflow records to compute the reach gains back to 1935.

Regarding the Gila River, located in Reach 6 (defined in the 1985 report as "Imperial Dam to International Boundary with Mexico"), the report states "Reach 6 is scheduled for completion during 1985. It is presently assumed that the reach gains, losses, and tributary inflows between Imperial Dam and the International Boundary sum to zero" (Reclamation, 1985). If any further work was done to estimate natural flows on this reach, it was not documented. The configuration of CRSS reflects this statement in that the Gila River is not included.

In 1992, the methodologies of the May 1985 report were reviewed and updated in *Colorado River Simulation System, Hydrology Data Base Lower Colorado Region (Lees Ferry to Imperial Dam)* (Reclamation, 1992). Data discrepancies were corrected and the flows on the mainstem reaches were extended back to 1906, in most cases using monthly averages from a later period.

Both the mainstem reach flows and the tributary inflows have since been re-visited and re-developed using methodologies described in Lee and Salas (2006). This was necessary as new information and techniques for record extension became available. The record extension technique is based on a multiple linear regression model that includes an error term in order to maintain a degree of variability in the extended records comparable to those of available historical reference gages.

As noted above, in 1968, the CRBPA directed the Secretary, in consultation with the Basin States, to report on the annual consumptive uses and losses of water from the Colorado River system after each successive 5-year period, starting on October 1, 1970, and directed that

> such reports shall include a detailed breakdown of the beneficial consumptive use of water on a State-by-State basis. Specific figures on quantities consumptively used from the major tributary streams flowing into the Colorado River shall also be included on a State-by-State basis…

In addition to this direction, the 1964 U.S. Supreme Court Decree in *Arizona v. California* (Consolidated Decree, 2006) directed the Secretary to make annual reports available that include the

> diversions of water from the mainstream, return flow of such water to the stream as is available for consumptive use in the United States or in satisfaction of the Mexican Treaty obligation, and consumptive use of such water. These quantities shall be stated separately as to each diverter from the mainstream, each point of diversion, and each of the States of Arizona, California and Nevada.

Reclamation accounts for the use of Colorado River water from the mainstem in the Lower Basin using a "diversion minus return flow" methodology, whereby the diversions and return flows are measured or estimated for each water user. Reclamation publishes this information each year in the Colorado River Accounting and Water Use Reports: Arizona, California, and Nevada (Water Accounting Reports[6]). As the Lower Basin mainstem use has grown to its full apportionment, the Decree accounting process has evolved into a real-time accounting system that tracks Lower Basin mainstem use daily and provides updates of the estimated use-to-date and projected use to

[6] Available at: http://www.usbr.gov/lc/region/g4000/wtracct.html.

the end of the calendar year[7], in addition to providing the official Water Accounting Report after the completion of each calendar year.

The CU&L Reports include information taken from the Water Accounting Reports for mainstem Lower Basin use and also estimate consumptive uses and losses in the Lower Basin tributaries back to 1971. The methodologies used in the CU&L Reports to estimate Lower Basin tributary use are similar to those used for the Upper Basin. Due to the Lower Colorado Region's focus on Decree accounting and the real-time monitoring system, the data, information, and methodologies for estimating Lower Basin tributary consumptive uses and losses have not received a great deal of attention over the past several years, and the quality of the resulting information has suffered (see data presented in the following section). Similar issues that were corrected with the Upper Basin tributary data are likely to exist and will need to be corrected for the Lower Basin; however, these investigations have not occurred to date.

Reclamation updates the natural flow[8] for the five locations on the mainstem annually using the data provided in the Water Accounting Reports. The approach for the four tributary locations has not been modified since the May 1985 report (i.e., Reclamation has not attempted to compute natural flows at these locations) and these flows are updated annually using the latest USGS streamflow records.

In the following sections, a preliminary examination of the Lower Basin tributary data is presented and specific commitments are made to engage in efforts independent of the Study to improve the information regarding Lower Basin consumptive uses and losses and to enhance the capabilities of CRSS.

3.0 Current Information Pertaining to the Little Colorado, Virgin, and Bill Williams Rivers

3.1 Current Representation in CRSS

For the Little Colorado River, the Virgin River, and the Bill Williams River, flows at specific gage locations near the confluence of the tributary and the Colorado River mainstem have been used to generate future inflow sequences for input to CRSS. A similar approach has also been used for the Paria River. This approach is inconsistent, and therefore work will be completed as described below; however, due to timing and resource limitations, this work was not completed within the Study.

By using gage data to represent the flow at these locations, it was assumed that historical consumptive uses and losses above the gages on those tributaries may be ignored for modeling purposes. As discussed in *Technical Report C – Water Demand Assessment*, the Study explored a range of plausible demand scenarios and the current representation of these tributaries did not preclude the exploration of additional future demands on those tributaries.

The approach is as follows: the USGS streamflow gage with the longest historical record nearest the confluence of the tributary and the Colorado River mainstem is used for the period that it is

[7] Available at: http://www.usbr.gov/lc/region/g4000/hourly/forecast11.pdf.

[8] Available at: http://www.usbr.gov/lc/region/g4000/NaturalFlow/Final-MethodsCmptgNatFlow.pdf.

available, and a record extension technique (see Lee and Salas, 2006, for more information) is used to reconstruct the flows back to 1906. The record extension technique is based on a multiple linear regression model that includes an error term in order to maintain a degree of variability in the extended records comparable to those of available historical reference gages.

Figures C11-1 through C11-3 present the historical inflow record used to generate future inflow sequences for input to CRSS for the Little Colorado, Virgin, and Bill Williams rivers. The flow record includes the historical USGS streamflow (solid line) and the reconstructed flow using the record extension technique discussed above (dotted line).

FIGURE C11-1
Historical Flow for the Little Colorado River near Cameron, AZ, 1906–2008

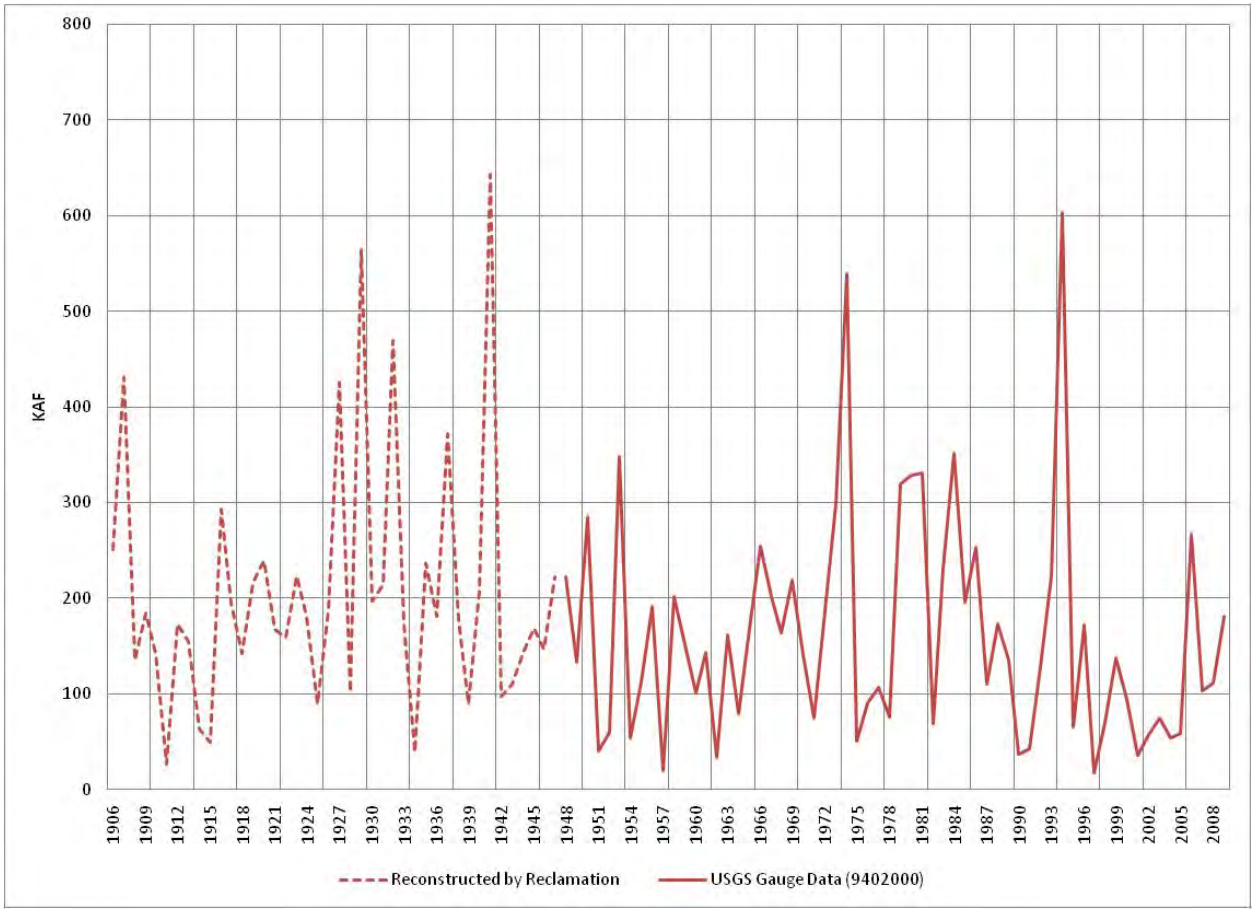


FIGURE C11-2
Historical Flow for the Virgin River at Littlefield, AZ, 1906–2008

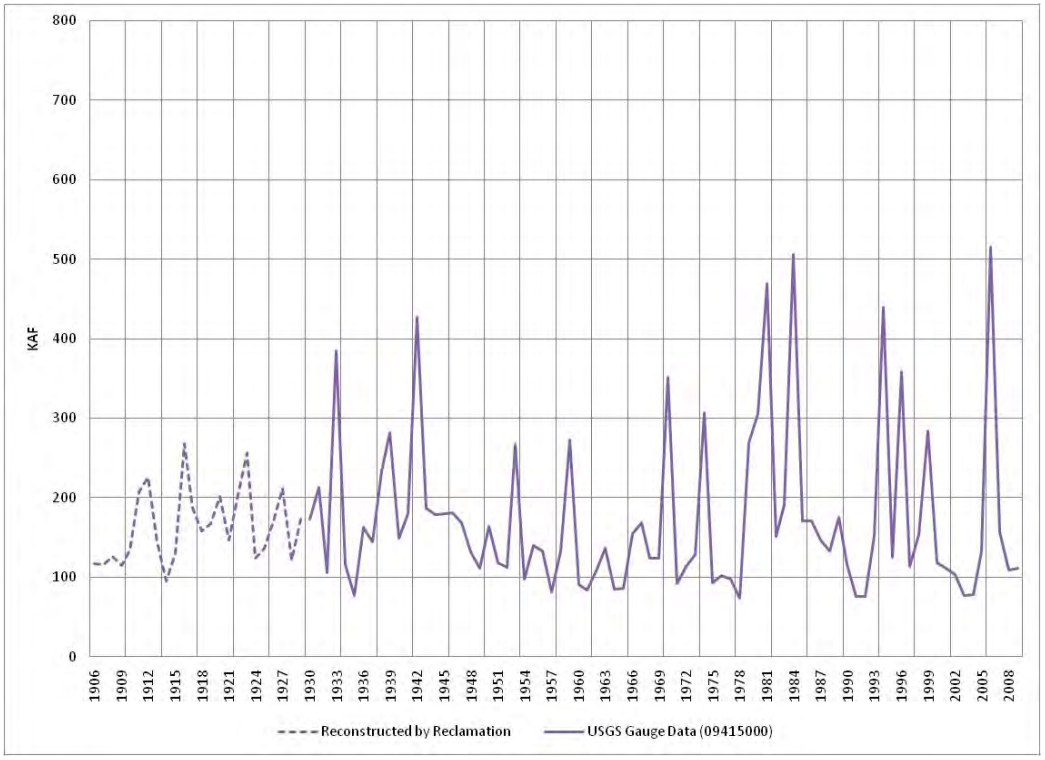
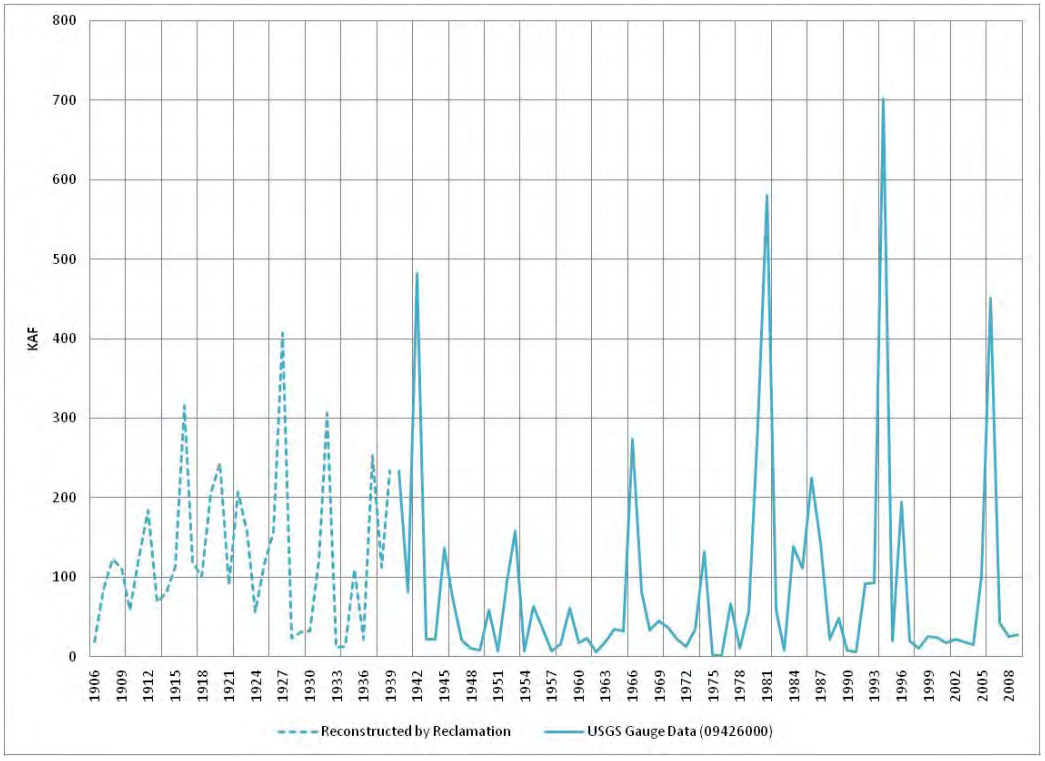


FIGURE C11-3
Historical Flow for the Bill Williams River below Alamo Dam, AZ, 1906–2008



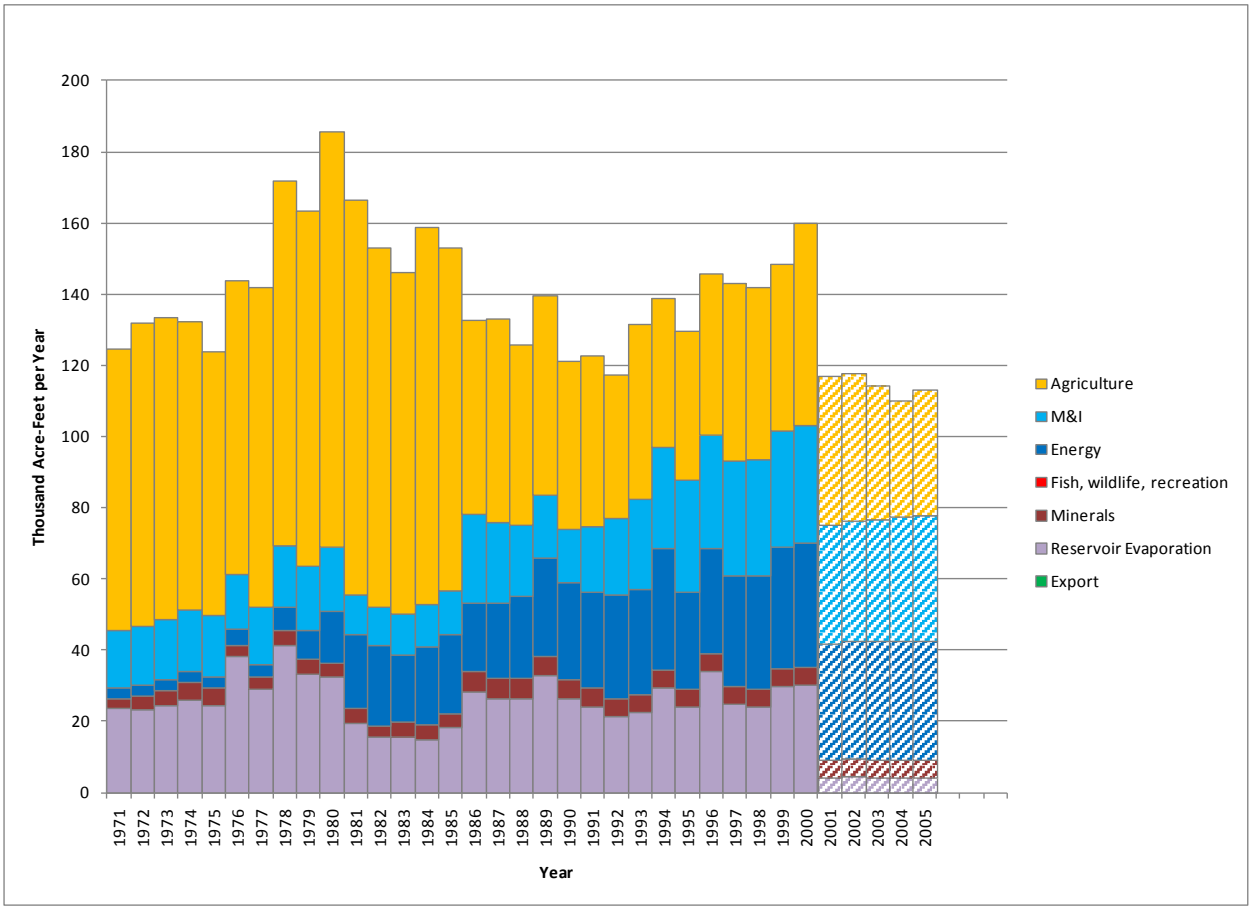
3.2 Consumptive Uses and Losses Data

3.2.1 Data from Reclamation's Consumptive Uses and Losses Reports from 1971 to 2005

Consumptive uses and losses data for the Lower Basin tributaries have been reported from 1971 to 2005 in the CU&L Reports; however, as discussed above, these data have not received the same level of scrutiny and analysis as the Upper Basin data.

Figure C11-4 shows Little Colorado River consumptive uses and losses from the CU&L Reports. Inconsistencies due to the 5-year reporting periods are evident in the reservoir evaporation category, particularly in the sudden decline in the 1981 to 1985 and the 2001 to 2005 periods. A similar inconsistency can be seen in the M&I category, which has the lowest use (averaging about 10,000 acre-feet per year) during 1981 to 1985.

FIGURE C11-4
Historical Consumptive Uses and Losses for the Little Colorado River[1], 1971–2005

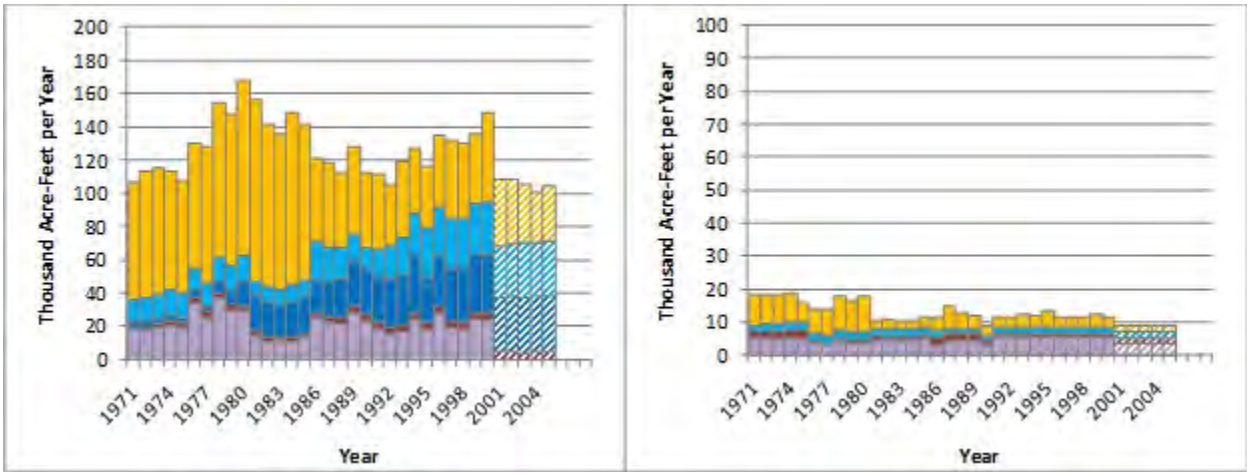


[1] Data shown in cross hatch are currently being investigated and likely contain data and methodological inconsistencies.

These inconsistencies from one reporting period to another may result from several factors, including (1) different methods to determine M&I uses and losses employed each reporting period, (2) different personnel creating the report each reporting period, and (3) a lack of considering previous reports when computing the estimate for a current report. As discussed previously, similar problems existed in the Upper Basin CU&L Reports prior to Reclamation's review and re-computation of the data, and these reasons were identified for the inconsistencies in that data.

The Little Colorado River originates in New Mexico and flows through northeastern Arizona before discharging into the Colorado River in the Grand Canyon. Figure C11-5 shows Arizona (left) and New Mexico (right) consumptive uses and losses on the Little Colorado River from the CU&L Reports. The inconsistencies originating from the 5-year reporting periods are again evident in the both the reservoir evaporation and M&I category for Arizona. Note the New Mexico y-axis is double the scale of Figure C11-4 to allow visualization of individual categories. The 5-year reporting periods are again evident in the agriculture, reservoir evaporation, and mineral categories.

FIGURE C11-5
Arizona portion (left) and New Mexico portion (right) of Little Colorado River Consumptive Uses and Losses[1], 1971–2005

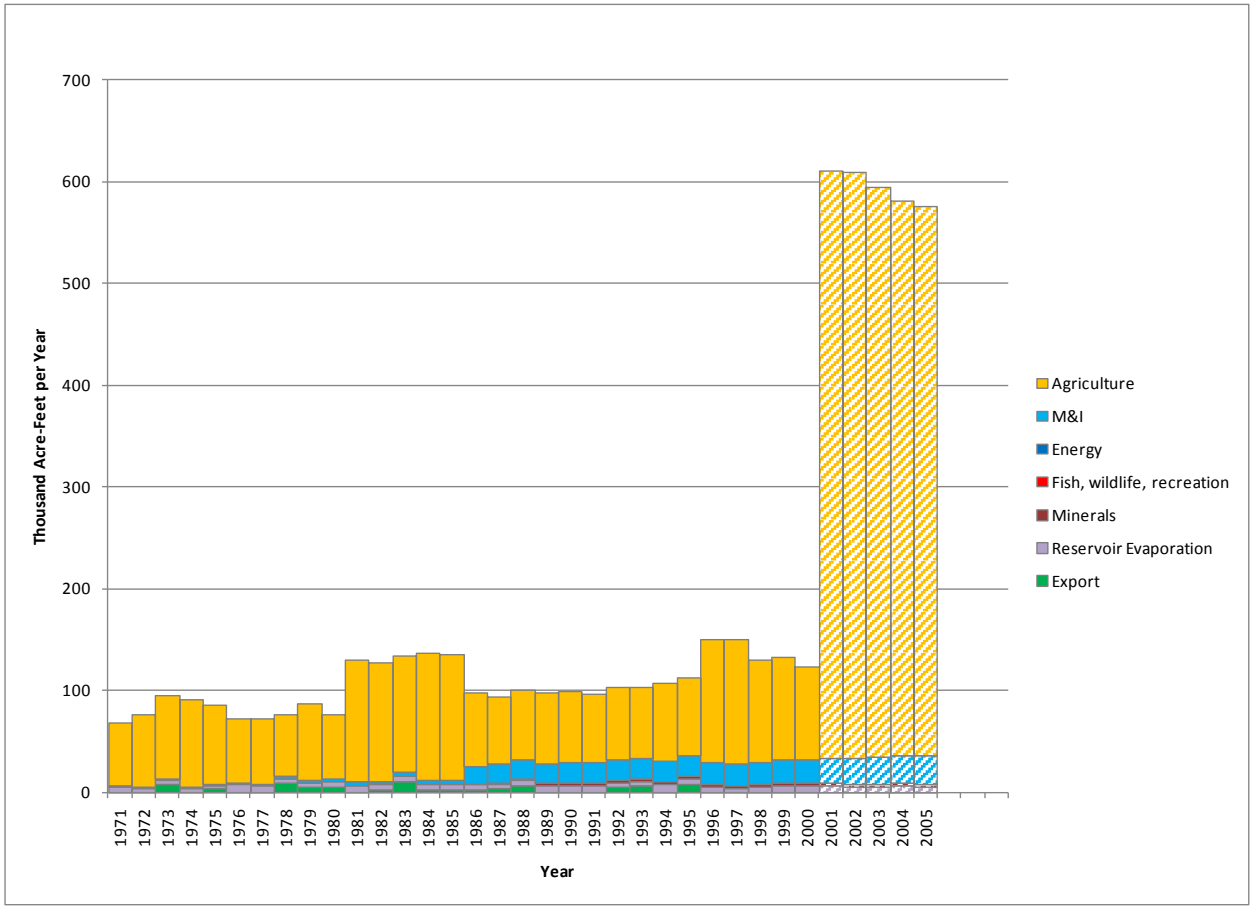


[1] Data shown in cross hatch are currently being investigated and likely contain data and methodological inconsistencies.

The Virgin River originates in Utah and flows through the northwest corner of Arizona and a portion of eastern Nevada before discharging into Lake Mead. Figure C11-6 shows consumptive uses and losses on the Virgin River from the CU&L Reports. The 5-year reporting periods are again evident, especially in the agriculture category. Obvious shifts in agriculture use occur between reporting periods. In particular, there is a large shift upward in agricultural consumptive use in 2001 to 2005 that is likely due to data and methodological inconsistencies and is currently being investigated.

Figure C11-7 shows the Arizona (top-left), Nevada (top-right), and Utah (bottom-left) consumptive uses and losses on the Virgin River. Again, shifts in categories consistently occur at the transition of reporting periods. Note the y-axis is increased by 2 for Arizona and by 10 for Nevada from Figure C11-7 to allow visualization of individual categories.

FIGURE C11-6
Historical Consumptive Uses and Losses for the Virgin River1, 1971–2005



[1] Data shown in cross hatch are currently being investigated and likely contain data and methodological inconsistencies.

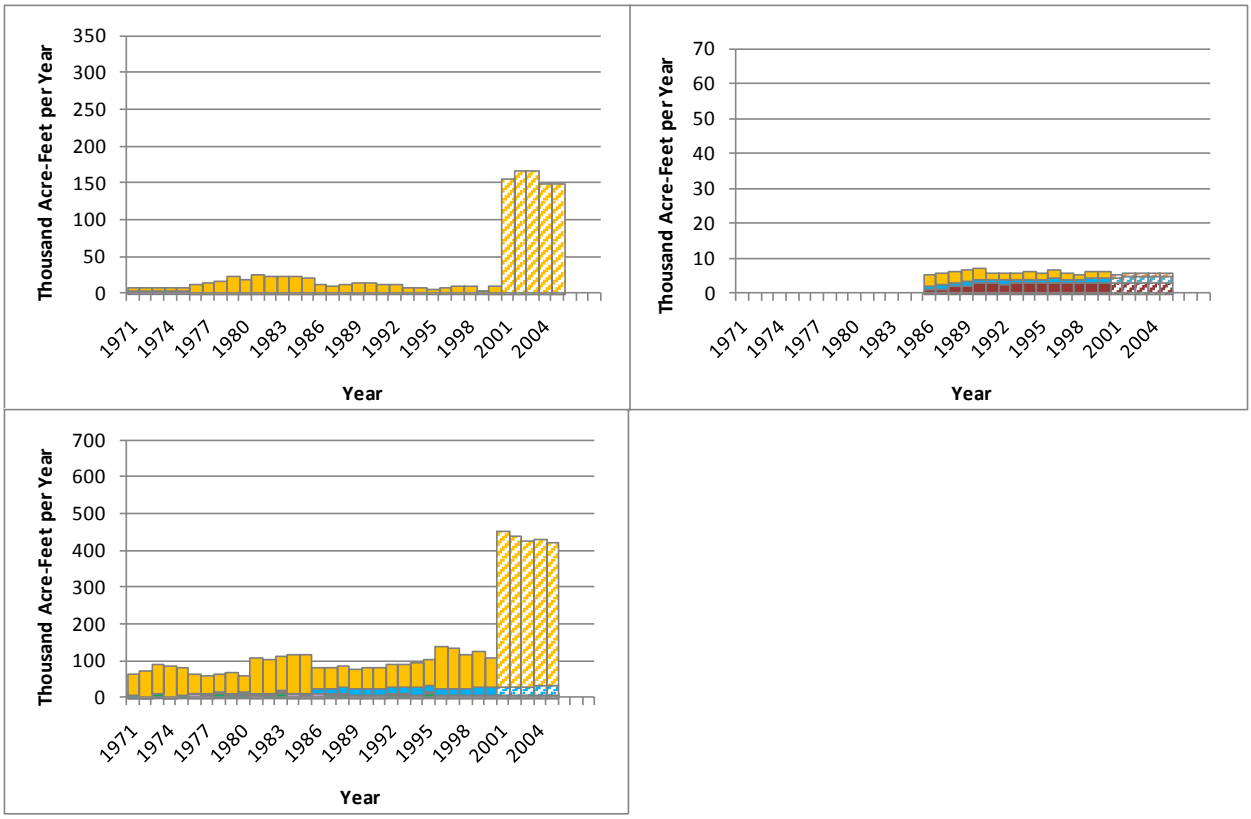
The Bill Williams River originates in the west-central portion of Arizona and discharges into Lake Havasu near Parker Dam. Figure C11-8 shows consumptive uses and losses on the Bill Williams River from the CU&L Reports. The 5-year reporting periods are again evident in the agriculture, mineral, and reservoir evaporation categories. Shifts in these categories consistently occur at the transition of reporting periods. In particular, there is a large shift upward in agricultural consumptive use in 2001 to 2005 that is likely due to data and methodological inconsistencies and is currently being investigated.

3.2.2 Other Data and Information Sources

Several sources beyond Reclamation's CU&L Reports provide information regarding consumptive uses and losses on the Little Colorado, Virgin, and Bill Williams rivers. For the Little Colorado and Bill Williams rivers, information sources include the *Arizona Water Atlas* published by the Arizona Department of Water Resources (ADWR), studies by the State of New Mexico, USGS, the U.S. Army Corps of Engineers, and Reclamation.

For the Virgin River, information sources include reports prepared as part of the Utah State Water Plan, the *Arizona Water Atlas*, studies by the Natural Resources Conservation Service, and Dixie Project investigations by Reclamation.

FIGURE C11-7
Arizona (top-left), Nevada (top-right), and Utah (bottom-left) portions of Virgin River Consumptive Uses and Losses1, 1971–2005



[1] Data shown in cross hatch are currently being investigated and likely contain data and methodological inconsistencies.

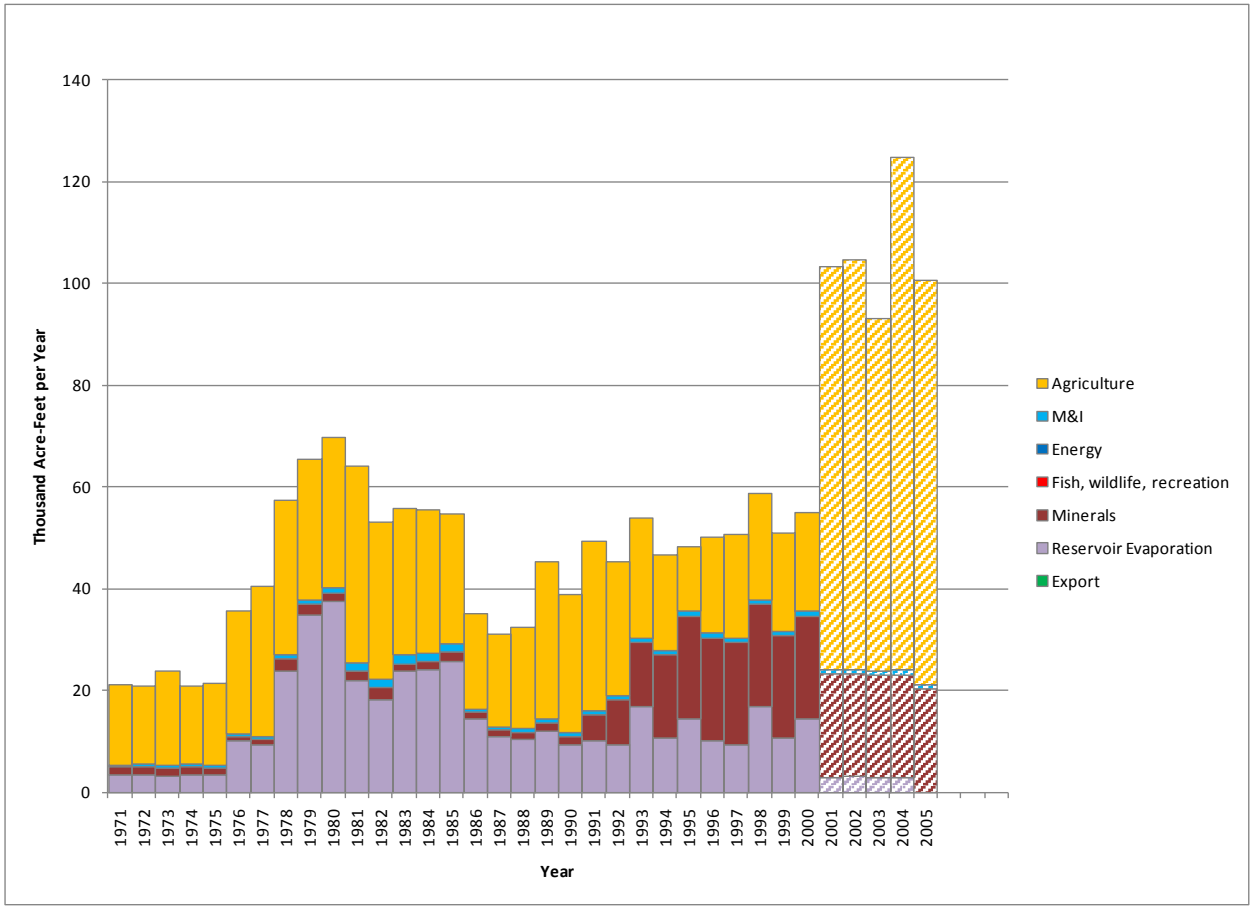
In addition, the Lower Colorado Region, recognizing the need to improve information on historical flows for these tributaries, has been collaborating with the University of Arizona's Laboratory of Tree-Ring Research to develop tree-ring reconstructions of streamflow for these tributaries since 2005. Information gained from this effort can be used to further the development of natural flows on these tributaries.

3.2.3 Future Work

The consumptive uses and losses reported in the CU&L Reports for the Little Colorado, Virgin, and Bill Williams rivers show inconsistencies similar to those observed in the Upper Basin reports before Reclamation's multi-year effort to address and correct data and methodological inconsistencies undertaken in the early 2000s. Furthermore, the methodologies used in the CU&L Reports do not distinguish between consumptive uses and losses from tributary water and non-tributary water along these tributaries. In efforts independent of the Study, Reclamation will work to resolve these issues in collaboration with the states in the Lower Basin.

Additionally, in efforts independent of the Study, natural flows for the Little Colorado, Virgin, and Bill Williams rivers will be developed along with the necessary modifications to CRSS in order to use these natural flows. Major activities required to develop natural flows for these tributaries include:

FIGURE C11-8
Historical Consumptive Uses and Losses for the Bill Williams River1, 1971–2005



[1] Data shown in cross hatch are currently being investigated and likely contain data and methodological inconsistencies.

- Collect data and develop methodologies to extend consumptive uses and losses estimates for these Lower Basin tributaries from 1971 (the earliest data reported in the CU&L Reports) back to 1906 (the start of the natural flow record)
- Collect data and apply methodologies to remove the effects of historical reservoir regulation on these tributaries (e.g., Alamo Dam on the Bill Williams River), and account for reservoir regulation in the future
- Develop projected future demand schedules for uses along these tributaries for input to the model in collaboration with the states of the Lower Basin

4.0 Current Information Pertaining to the Gila River

4.1 Current Representation in CRSS

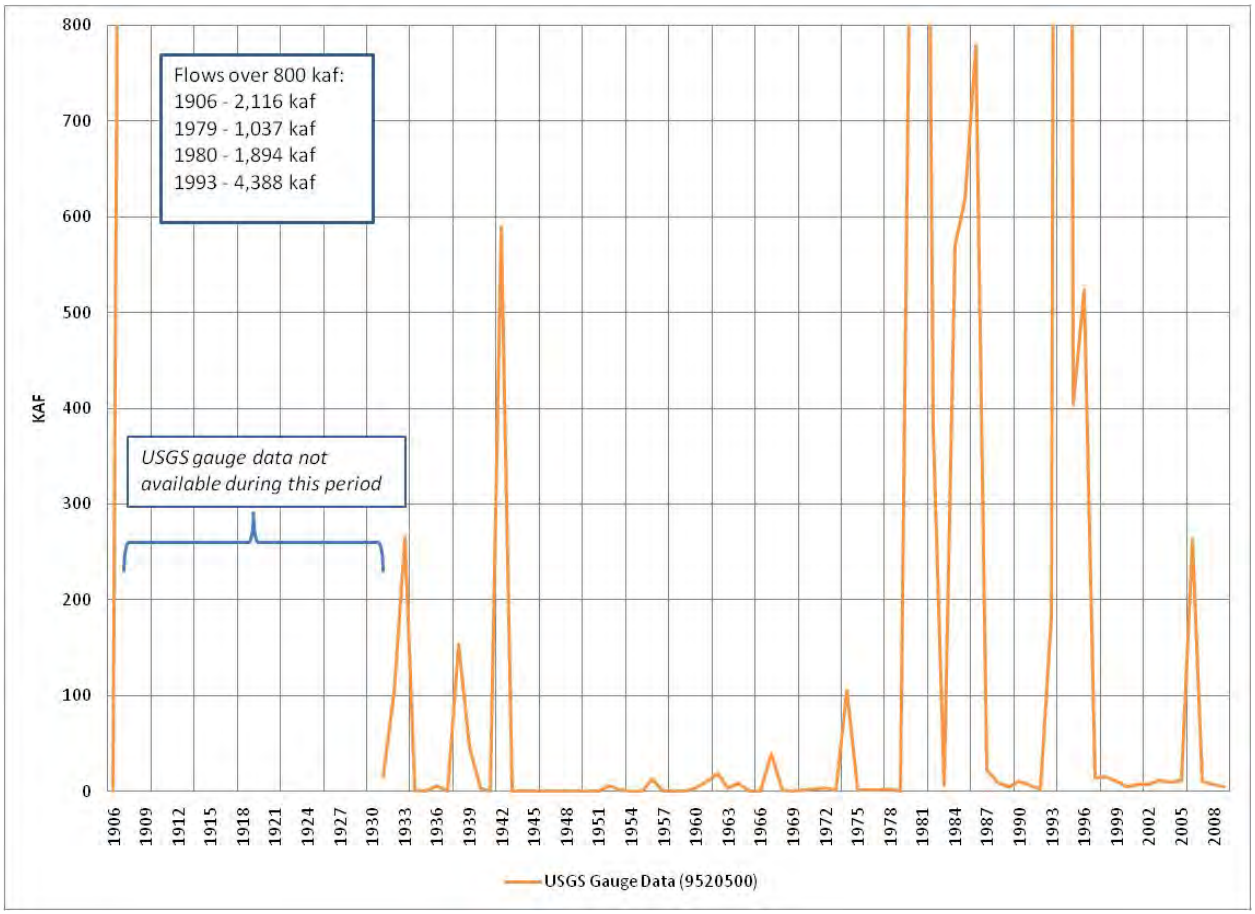
Although the Gila River drains a large portion of the Colorado River Basin, it has not been represented in CRSS since the model's inception. Flows from the Gila River seldom reach the mainstem of the Colorado River, and when they do, the flows are very sporadic and are typically

of high magnitude, as illustrated in Figure C11-9. The confluence of the Gila River and the Colorado River mainstem is downstream of all the major storage reservoirs in the United States.

Although the Gila River is not explicitly represented in CRSS, exploration of future water demands and water supplies in the Gila River Basin was implicitly accomplished for the Study by the representation of Arizona's demand as expressed in the quantified demand scenarios.

Figure C11-9 shows the USGS gage for the Gila River near Dome, Arizona (upstream of confluence with Colorado River) and illustrates the sporadic nature of the Gila River flow. The dataset is complete back to 1930 but incomplete from 1906 to 1930.

FIGURE C11-9
Historical Flow for the Gila River near Dome, AZ, 1906 and 1930–2008



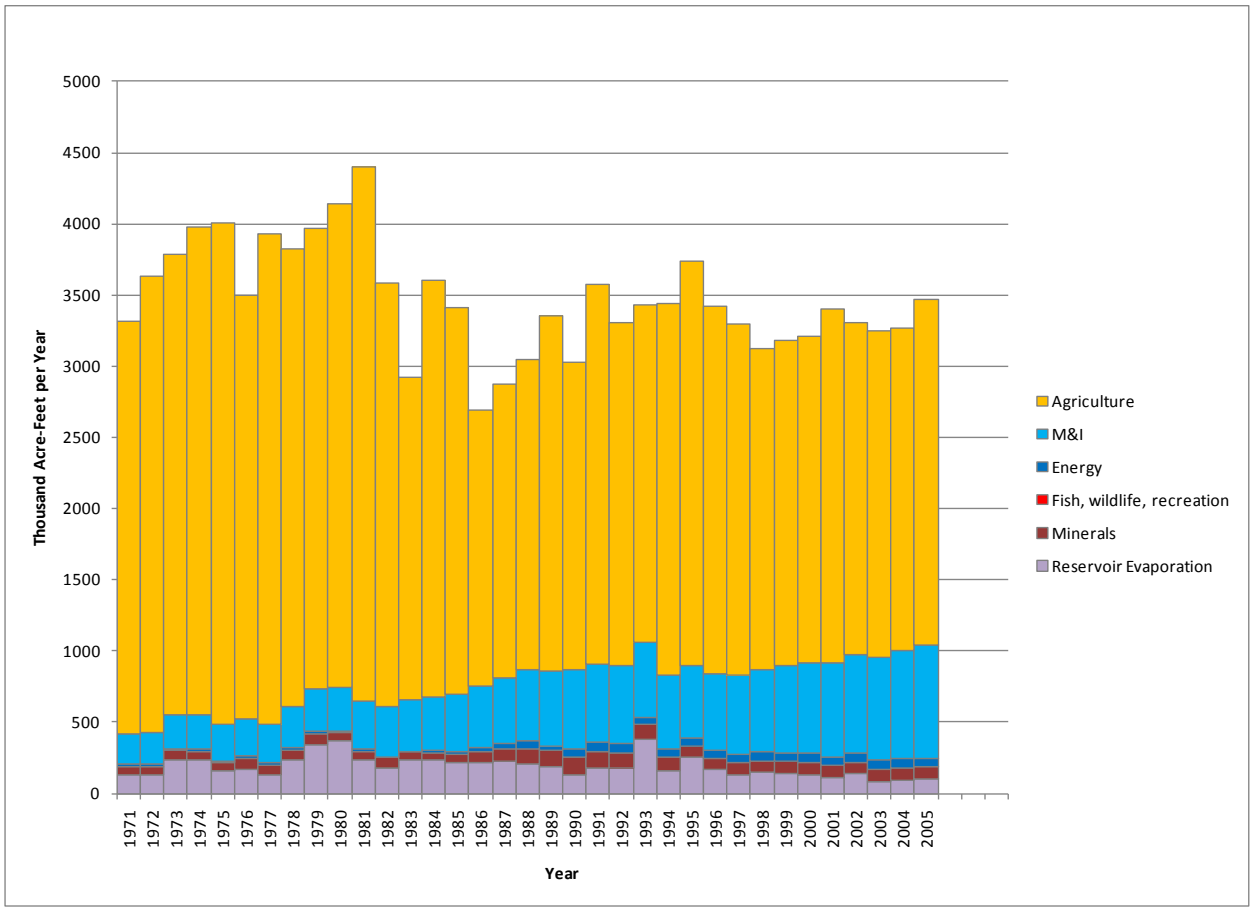
4.2 Consumptive Uses and Losses Data

4.2.1 Data from Reclamation's Consumptive Uses and Losses Reports from 1971 to 2005

Figure C11-10 shows the consumptive uses and losses on the Gila River from the CU&L Reports. Figure C11-11 shows these losses broken out by state: Arizona and New Mexico. Data inconsistencies associated with the 5-year reporting periods are suspected although they are more difficult to discern because the magnitudes of those inconsistencies are likely smaller relative to the total use in the Gila River tributary. The CU&L Reports report the annual CAP delivery, but

do not provide information regarding the category of use of that water[9]. Furthermore, the contribution of the non-tributary groundwater use and supplies are not considered in the CU&L Reports. Other tributaries have sources of water other than tributary water; however, the issue is more significant with respect to the Gila River because the other sources supply a relatively larger portion of the consumptive use.

FIGURE C11-10
Historical Consumptive Uses and Losses for the Gila River, 1971–2005

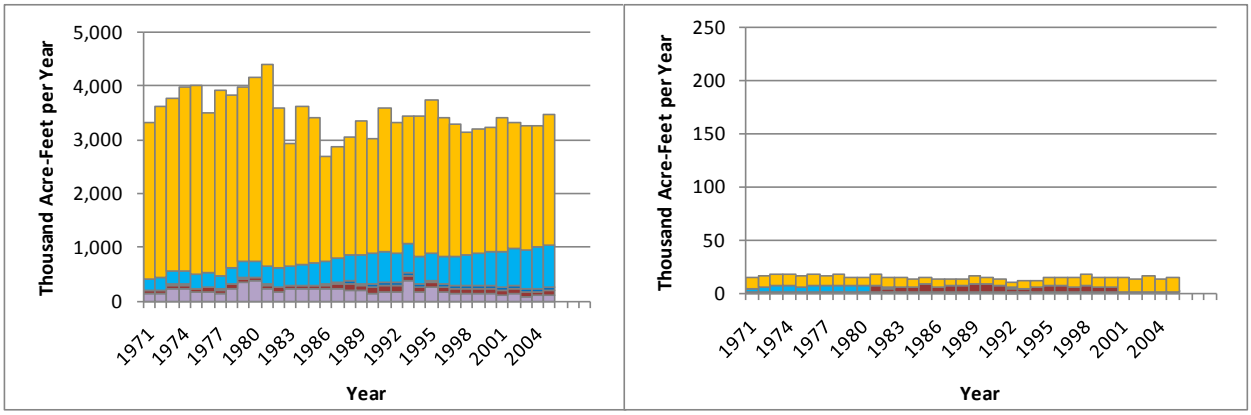


4.2.2 Other Data and Information Sources

Several sources beyond Reclamation's CU&L Reports provide information regarding consumptive uses and losses on the Gila River. These sources include the *Arizona Water Atlas* published by the ADWR and studies by the State of New Mexico, USGS, and Reclamation. In addition, the Western Water Assessment at the University of Colorado is presently developing tree-ring reconstructions of streamflow on the Gila River.

[9] Arizona provided a breakdown by use category of CAP deliveries from the mainstem to the Gila River Basin (see appendix C6).

FIGURE C11-11
Arizona (left) and New Mexico (right) Gila River Consumptive Uses and Losses, 1971–2005



4.2.3 Future Work

The consumptive uses and losses reported in the CU&L Reports for the Gila River show inconsistencies similar to those observed in the Upper Basin reports before Reclamation's multi-year effort to address and correct data and methodological inconsistencies undertaken in the early 2000s. Furthermore, the methodologies used in the CU&L Reports do not distinguish between consumptive uses and losses from tributary water and non-tributary water in the Gila River Basin. In efforts independent of the Study, Reclamation will work to resolve these issues in collaboration with the Basin States. In addition, a commitment is made to explore the feasibility and usefulness of computing natural flows for the Gila River Basin and the feasibility and usefulness of adding that basin to CRSS.

5.0 Summary

In the current configuration of CRSS, historical inflows based on USGS streamflow records have been used to generate future inflow sequences for the Little Colorado, Virgin, and Bill Williams rivers, inconsistent with the approach taken for the other tributaries (with the exception of the Paria River). In addition, the Gila River is not included in CRSS. This approach was used for past Colorado River planning studies; however, questions regarding the adequacy of the treatment of the Lower Basin tributaries in CRSS for the Study arose during the phases focused on assessing future water supply and demand. Although some limitations were imposed on the Study by this treatment the Study was able to examine several important issues, including potential climate change impacts on the tributaries represented in CRSS, future demand scenarios on those tributaries, and future demand scenarios for the Colorado River from the central Arizona planning area (Gila River Basin) factoring in other water supplies within that basin through other approaches.

Consumptive uses and losses estimates reported in Reclamation's CU&L Reports show methodological and data inconsistencies for these Lower Basin tributaries. Similar inconsistencies were present in the Upper Basin estimates before Reclamation's multi-year effort in the early 2000s to resolve them. Reclamation, in collaboration with the Basin States, is committed to resolving the issues on the Lower Basin tributaries in an effort independent of the Study. Additional data and information sources are available, and research efforts are ongoing

concerning consumptive uses and losses estimates on these tributaries. These sources will be utilized and coordination with ongoing efforts will be accomplished as appropriate.

Also, in an effort independent of the Study, Reclamation is committed to developing natural flows on the Little Colorado, Virgin, and Bill Williams rivers and modifying CRSS to use these flows. This effort will require the extension of consumptive use and loss estimates from 1906 to 1971, the development of methodologies to account for past and future reservoir regulation, and the development of future demand schedules for those tributaries. In addition, a commitment is made to explore the feasibility and usefulness of computing natural flows for the Gila River Basin and the feasibility and usefulness of adding that basin to CRSS.

6.0 References

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