

Graphical Comparisons of Observed and Unimpaired Flows Prior to and following Implementation of 2003 Ecosystem Flow Guidance

And

Trends in Channel Depths

Savannah River at Augusta and Savannah River near Clyo

Produced in preparation for a Savannah River Ecosystem Flow Workshop

By C.Rhett Jackson, Lynsey Long, and Mary Louise Jacques. November 12, 2012.

Introduction

We compared observed flows in the Savannah River with simulated unimpaired flows (the flows that would have occurred in the absence of the dams) to describe and quantify how the operation of the Savannah River dams has altered hydrograph behavior in the river. These comparisons were done for two periods; 1) 1950 – 2003, the period from the completion of the first dam to the inception of the ecological flow guidelines, and 2) 2004 – 2009, the period since the implementation of the ecological flow guidelines. For each period, we looked at flows at two locations: the USGS gage at Augusta (gage #02197000) and the USGS gage at Clyo (gage #02198500). These gages both have long term observed flow records and also have unimpaired flow simulations. At each location, we compare the cumulative flow duration curves, and seasonal flow duration curves for the observed and unimpaired flows for each of the periods above. We also present representative hydrographs for dry, near-average (referred to as average), and wet years. Since we do not expect that the ecosystem flow recommendations of 2003 have altered the behavior of annual peaks, we present a single comparison of the peak flow recurrence curves for the unimpaired and observed peak flows.

The unimpaired flows were developed for the Georgia DNR by Arcadis consultants (Arcadis, April 12, 2010). From their executive summary:

Unimpaired flows are those flows in the main stem of rivers that would have historically occurred if the flows had not been altered by human activities such as water withdrawals, discharges, and installation and operation of flow regulation structures such as dams. In developing unimpaired flows, some human influences cannot be accounted for because either they have not been recorded or they are not readily quantifiable (i.e., the effects of changing land uses on runoff and streamflow). Quantifiable human influences addressed in this study include streamflow regulation effects of manmade reservoirs and water consumption for municipal, industrial, agricultural, and thermal power uses. In some reaches, groundwater pumping reduces surface water flows; these have been taken into account in the development of unimpaired flows. Thus, while flows developed in this study are not entirely unimpaired in the literal sense, they do capture the major reversible human influences.

These simulated unimpaired flows allow us to estimate how the management of the reservoirs has altered downstream hydrology prior to and following the implementation of the 2003 ecosystem flows guidance.

Arcadis U.S., Inc. 2010. Unimpaired Flow Data Report: Surface Water Availability Modeling and Technical Analysis for Statewide Water Management Plan. April 12, 2010. 203pp.

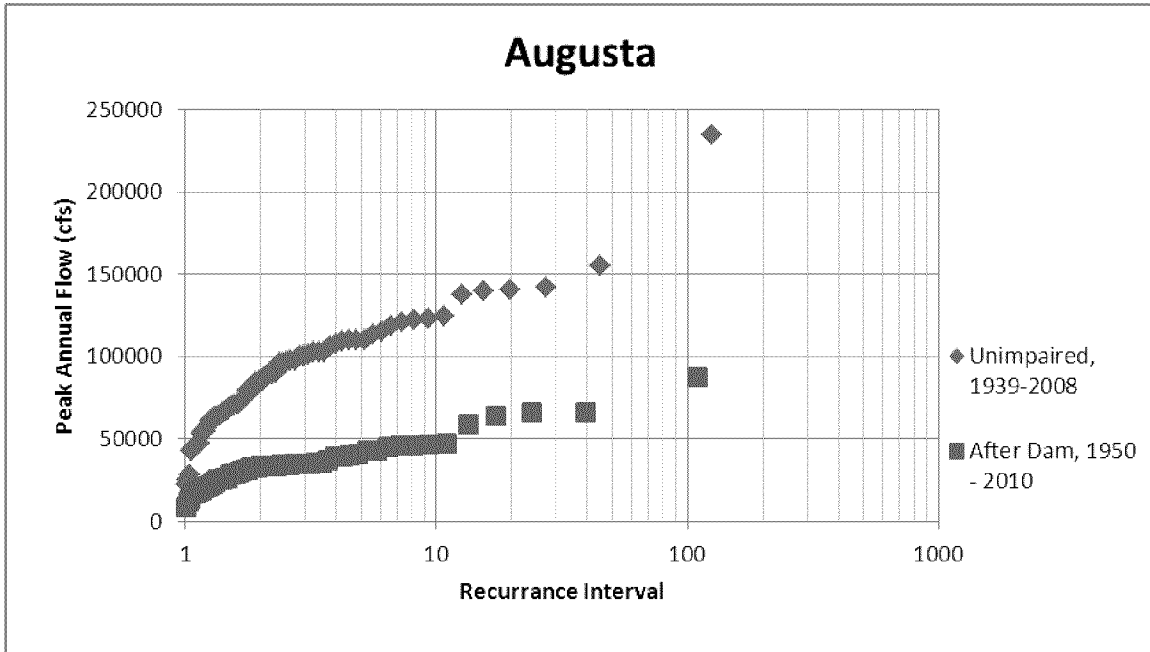
Following the presentation of flow data, this report also includes an assessment of trends in channel depths determined from periodic navigation cross sections measured by the USACE.

Graphical Comparison of Hydrographs and Streamflow Statistics

1950-2003

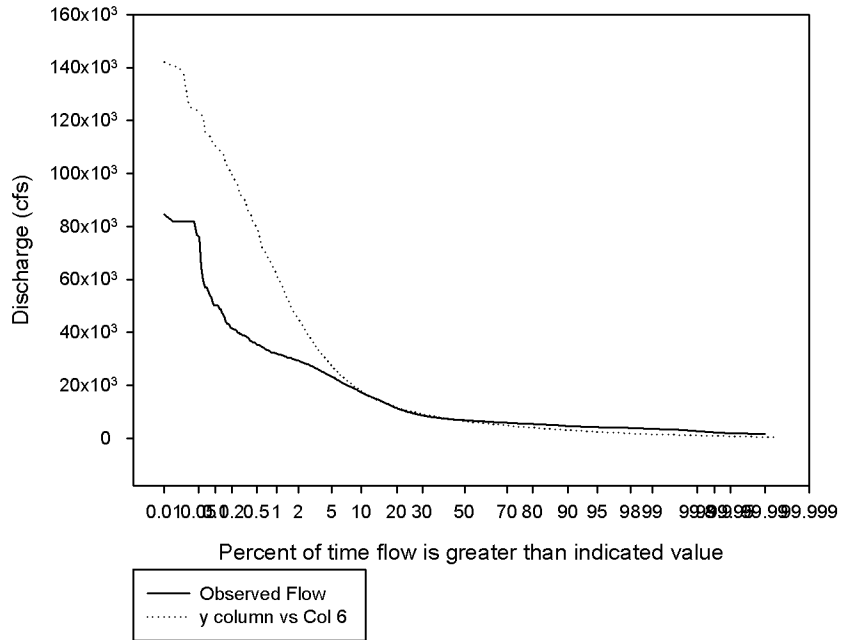
Augusta

Peak Flow Recurrence



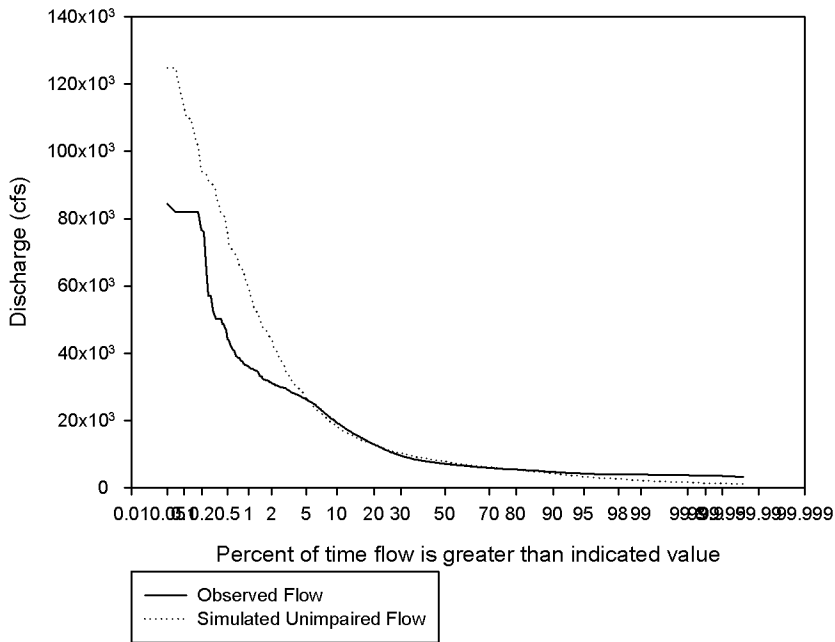
Flow Durations

Flow Duration for the Savannah River at Augusta (1950-2003)

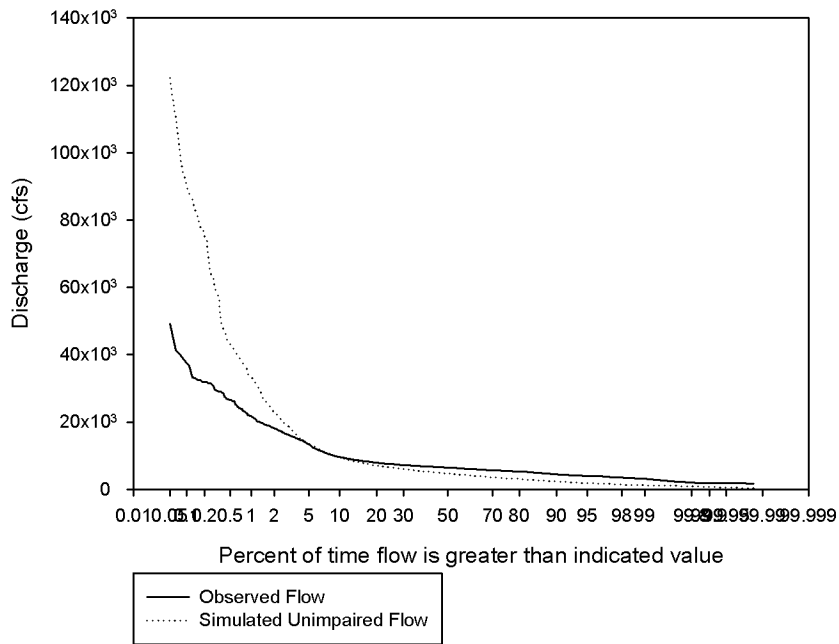


By Season

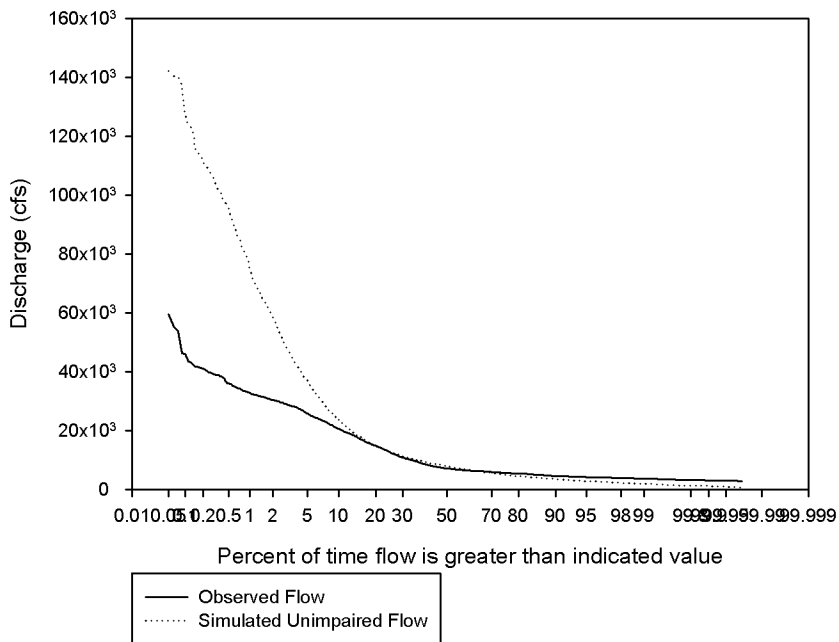
Flow Duration for the Savannah River at Augusta, April-June (1950-2003)



Flow Duration for the Savannah River at Augusta, July-October (1950-2003)



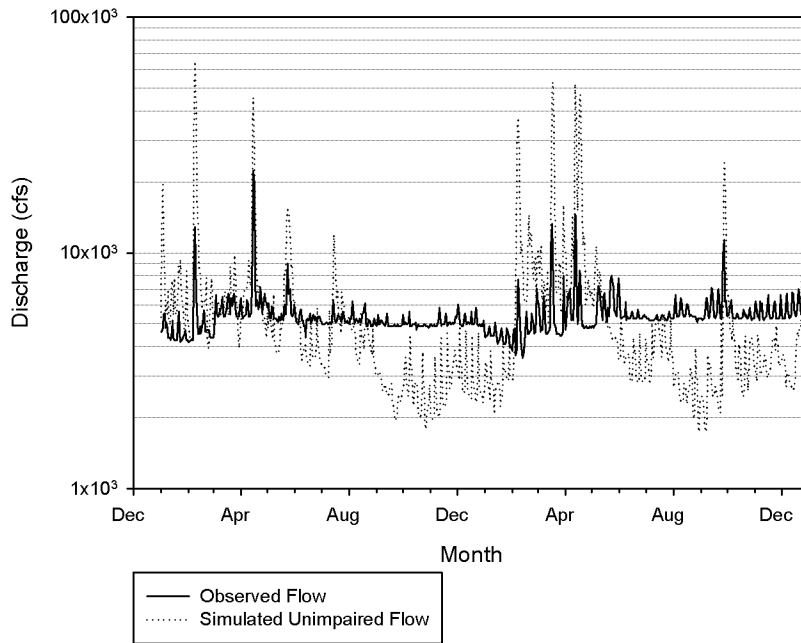
Flow Duration for the Savannah River at Augusta, November-March (1950-2003)



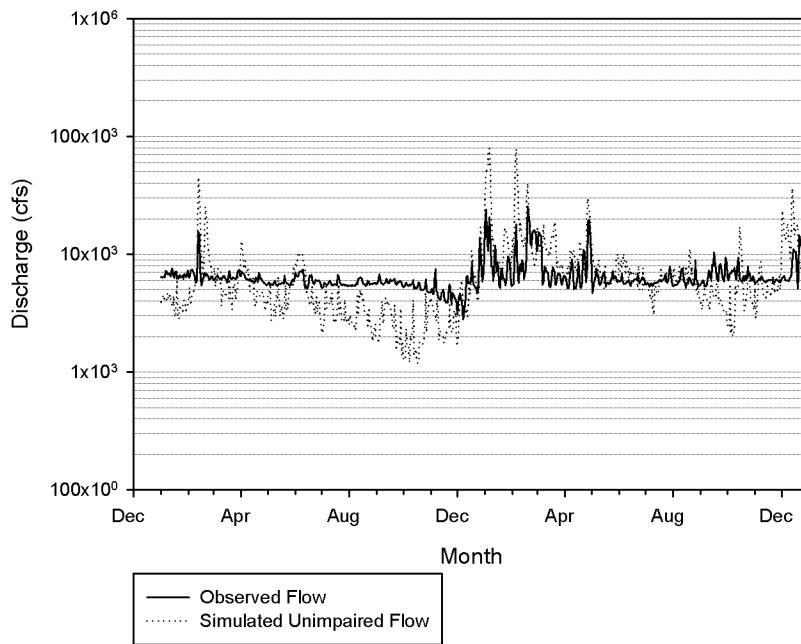
Representative Hydrographs

Dry years

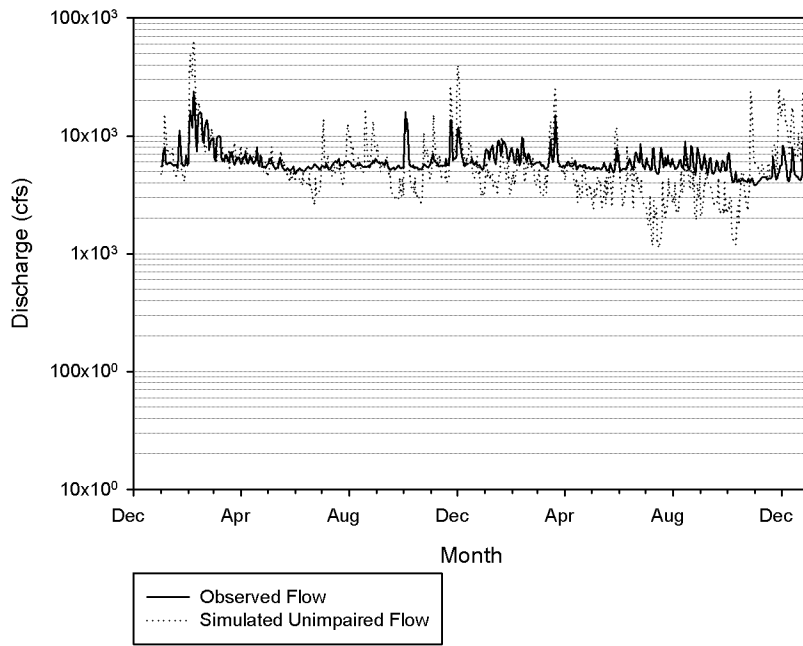
Hydrograph for Savannah River at Augusta, 1955-1956



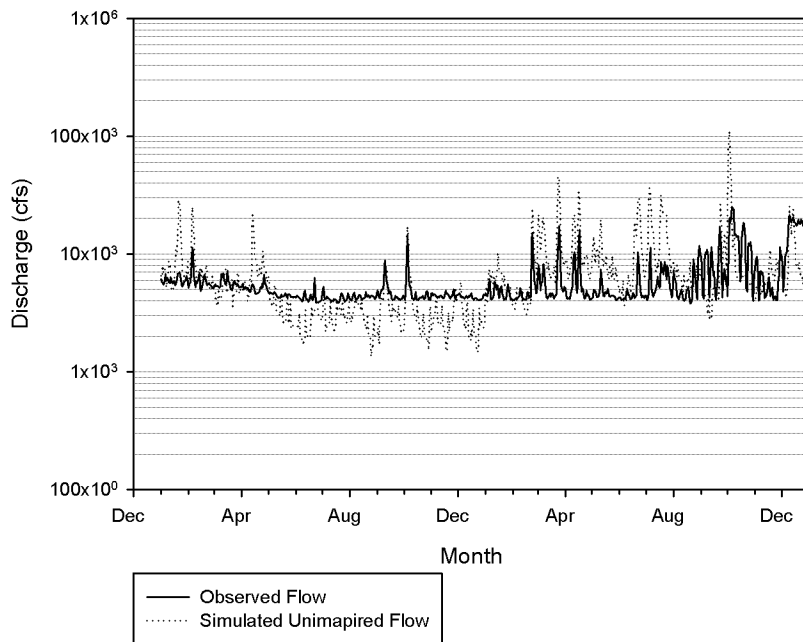
Hydrograph for the Savannah River at Augusta, 1981-1982



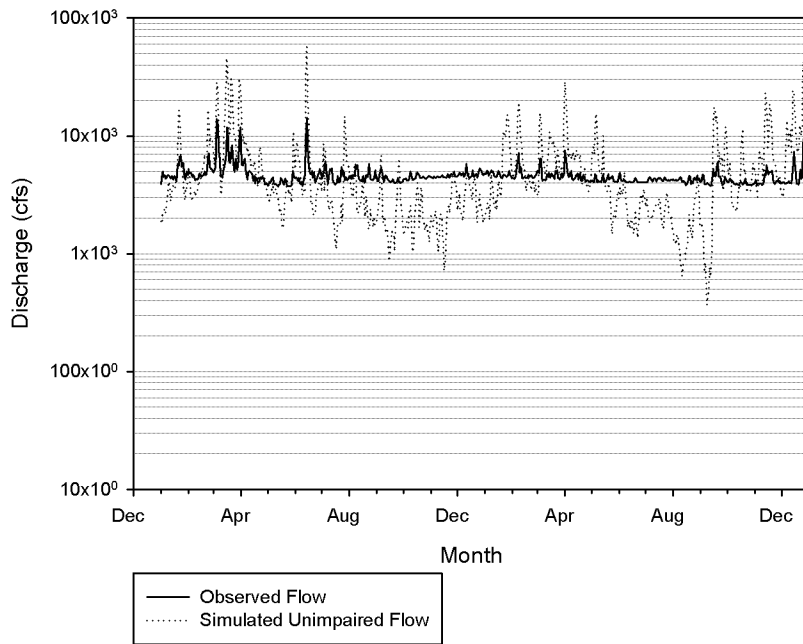
Hydrograph for the Savannah River at Augusta, 1985-1986



Hydrograph for the Savannah River at Augusta, 1988-1989

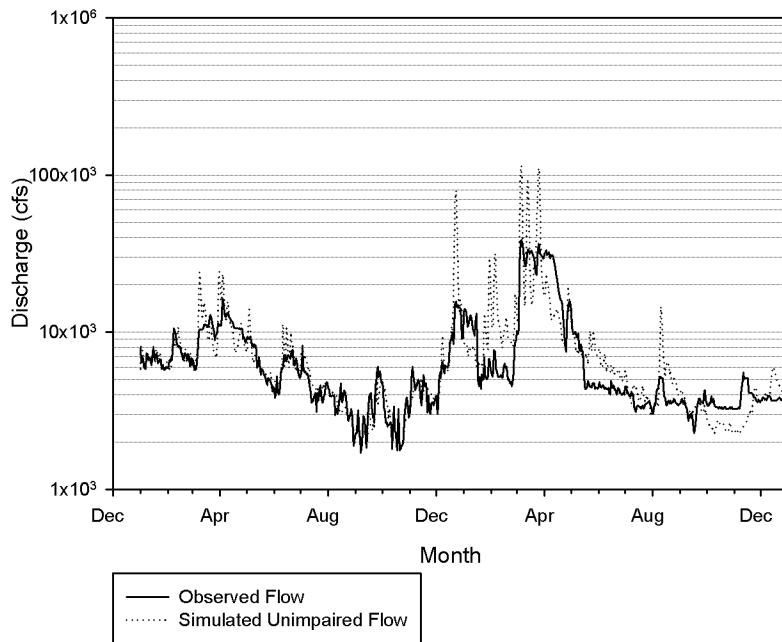


Hydrograph for the Savannah River at Augusta, 2001-2002

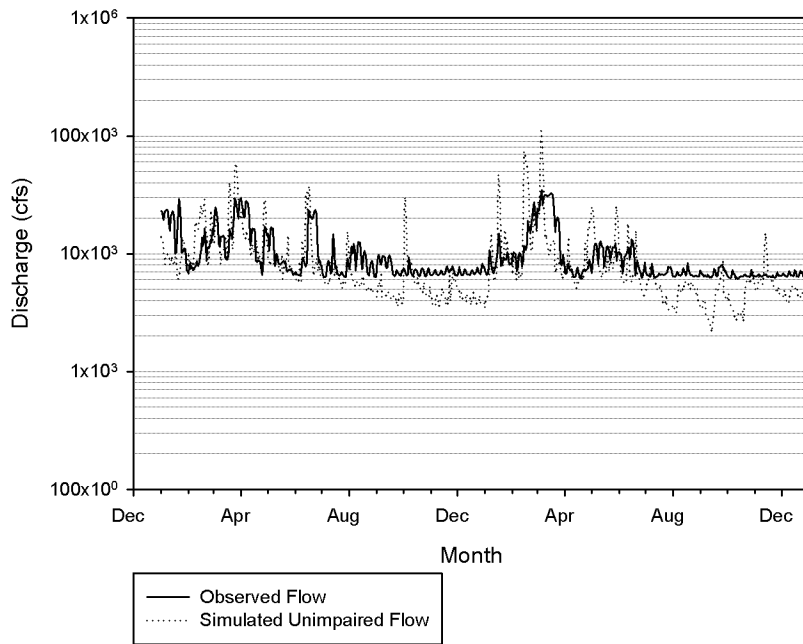


Average years

Hydrograph for Savannah River at Augusta, 1951-1952

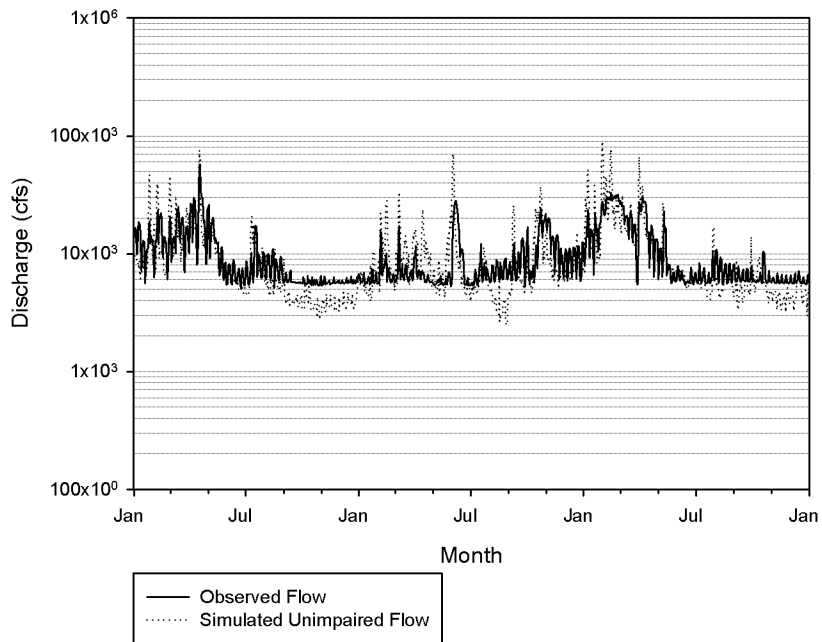


Hydrograph for the Savannah River at Augusta, 1965-1966

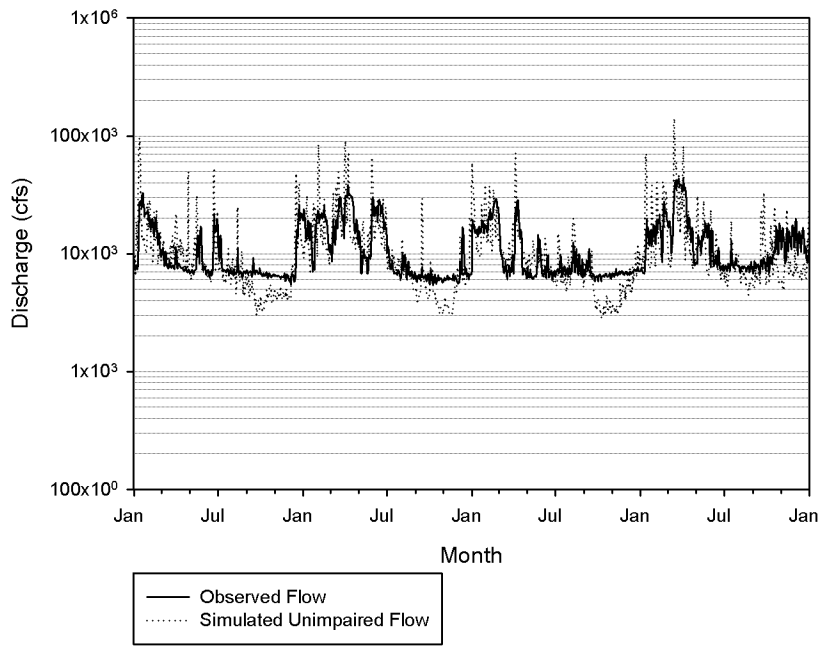


Wet years

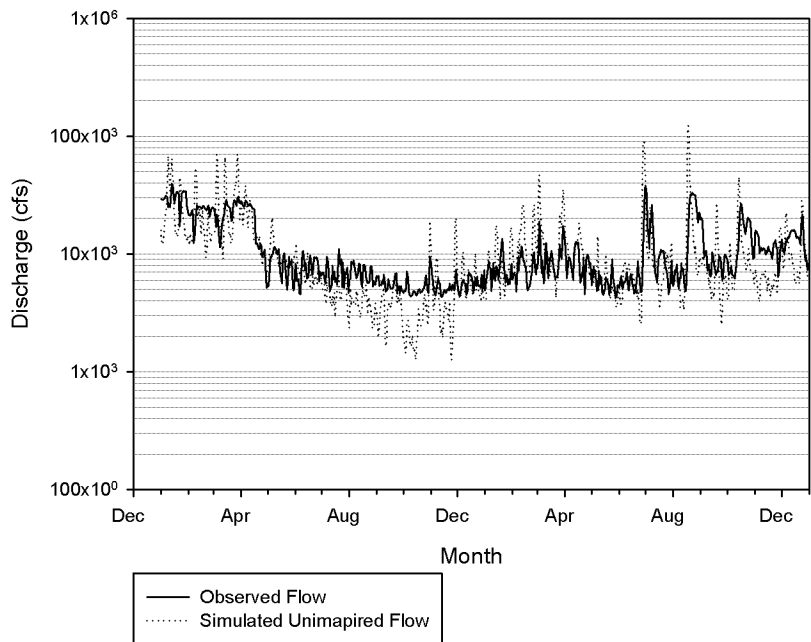
Hydrograph for the Savannah River at Augusta, 1958-1960



Hydrograph for the Savannah River at Augusta, 1972-1975

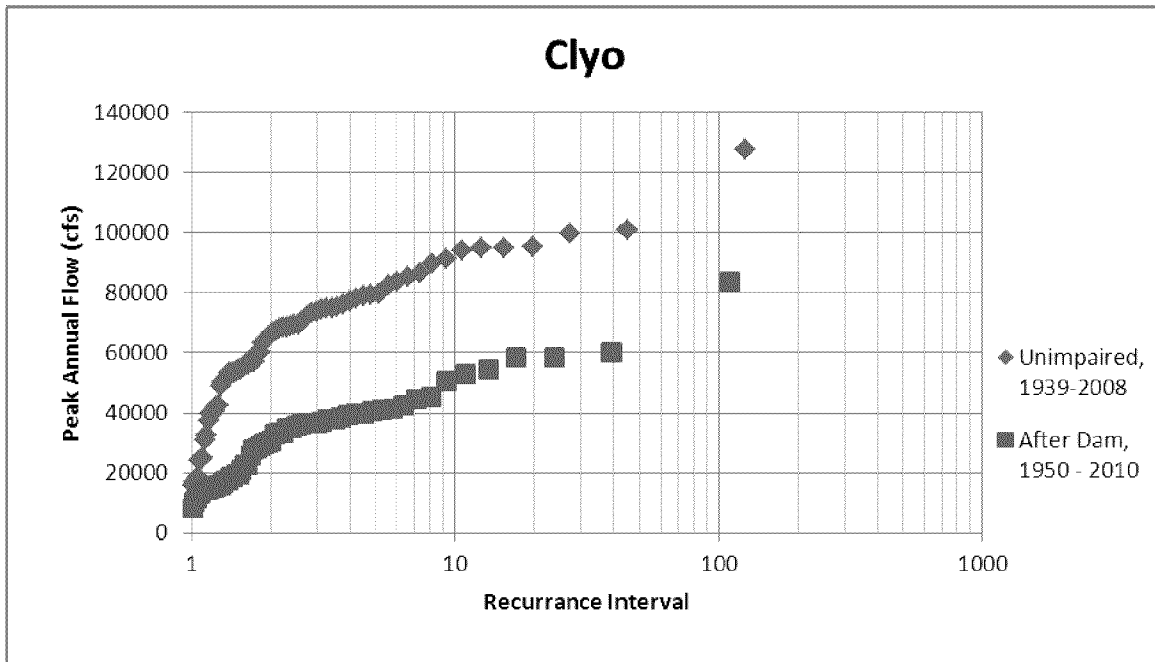


Hydrograph for the Savannah River at Augusta, 1993-1994



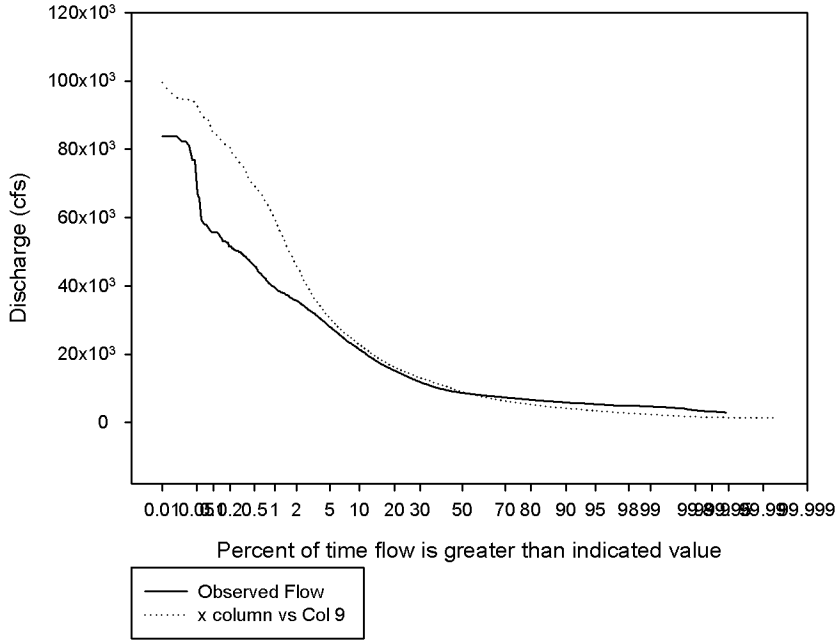
Clyo

Peaks



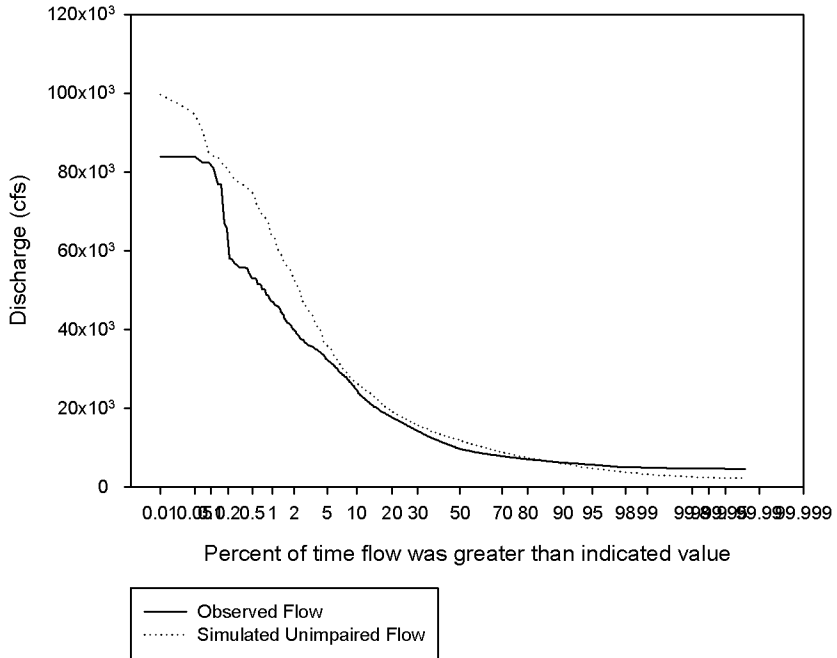
Durations

Flow Duration for the Savannah River at Clyo (1950-2003)

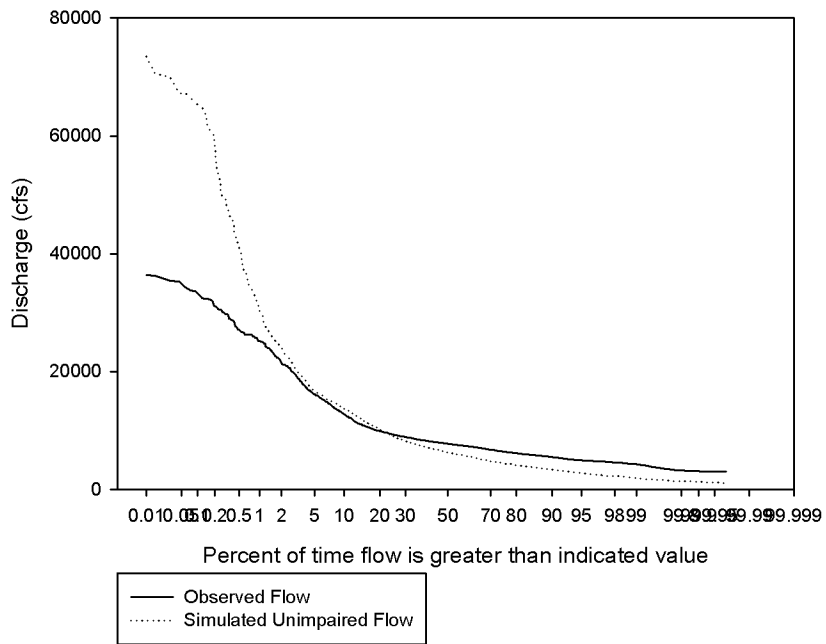


By Season

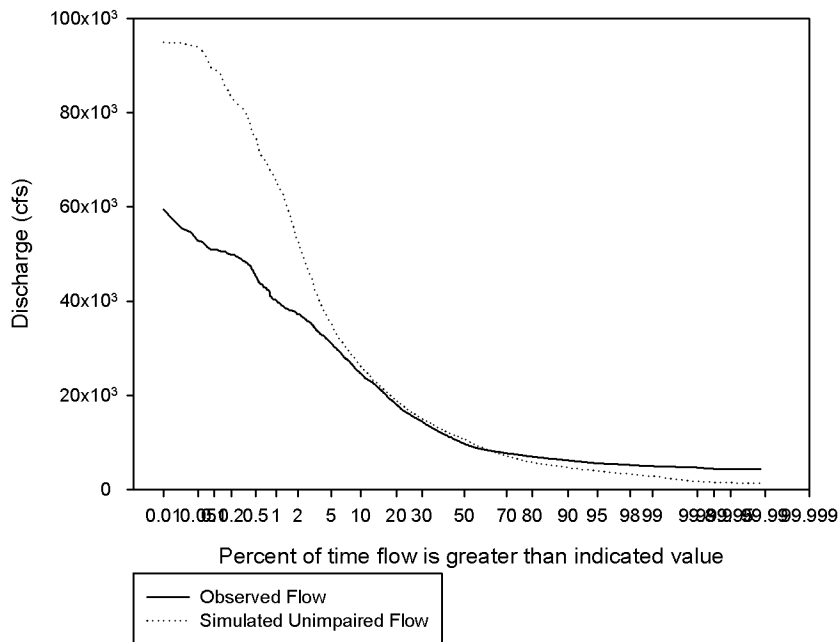
Flow Duration for the Savannah River at Clyo, April-June (1950-2003)



Flow Duration for the Savannah River at Clyo, July-October (1950-2003)

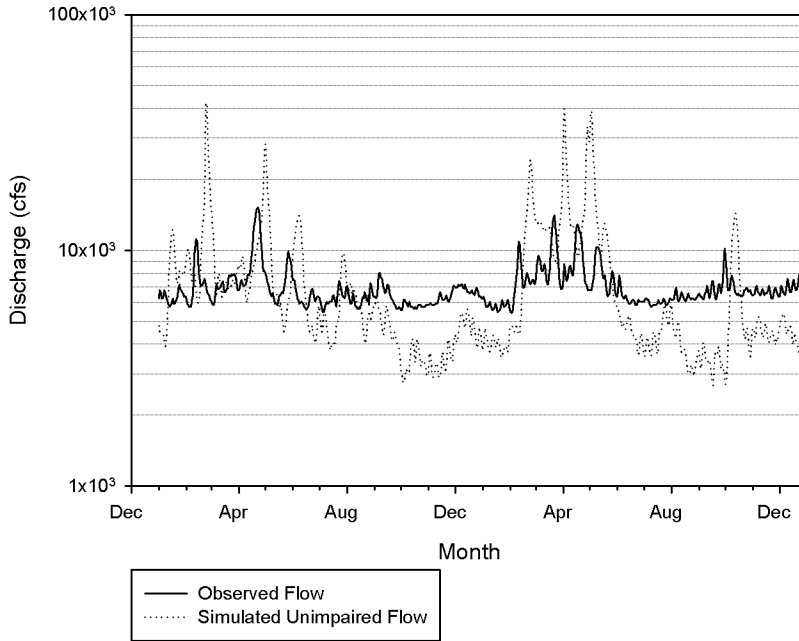


Flow Duration for the Savannah River at Clyo, November-March (1950-2003)

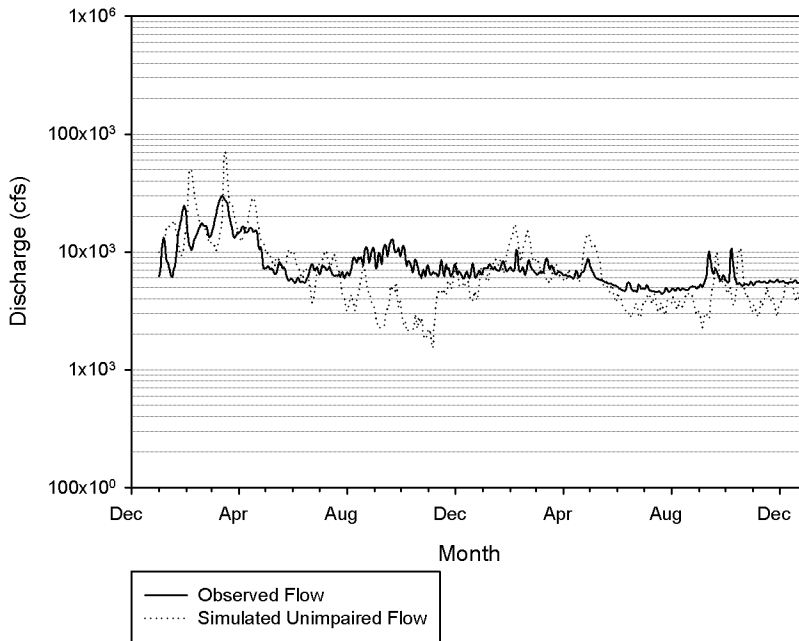


Representative Hydrographs
Dry years

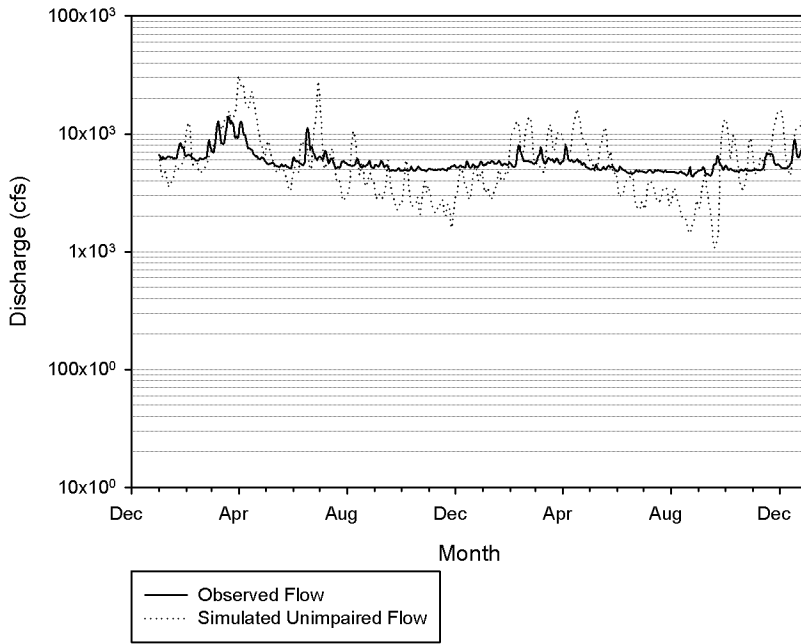
Hydrograph for the Savannah River at Clyo, 1955-1956



Hydrograph for the Savannah River at Clyo, 1987-1988

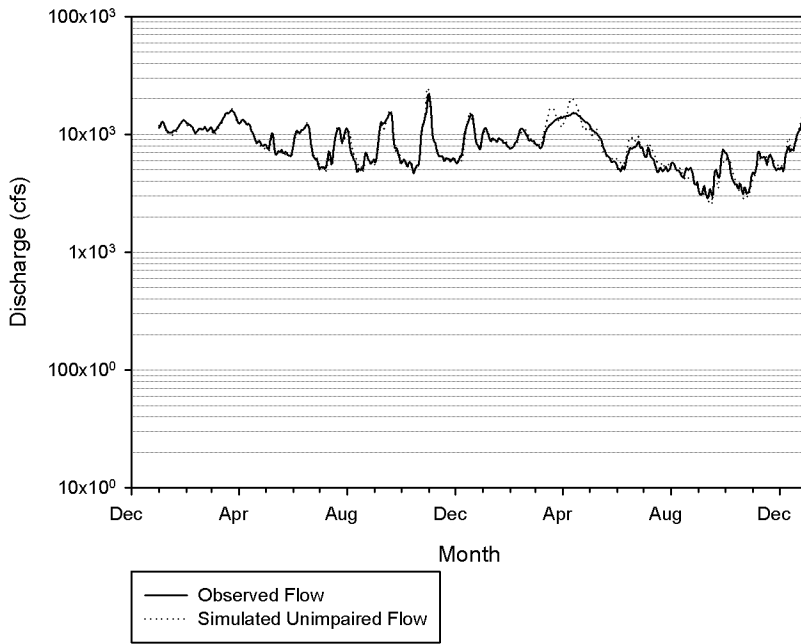


Hydrograph for the Savannah River at Clyo, 2001-2002

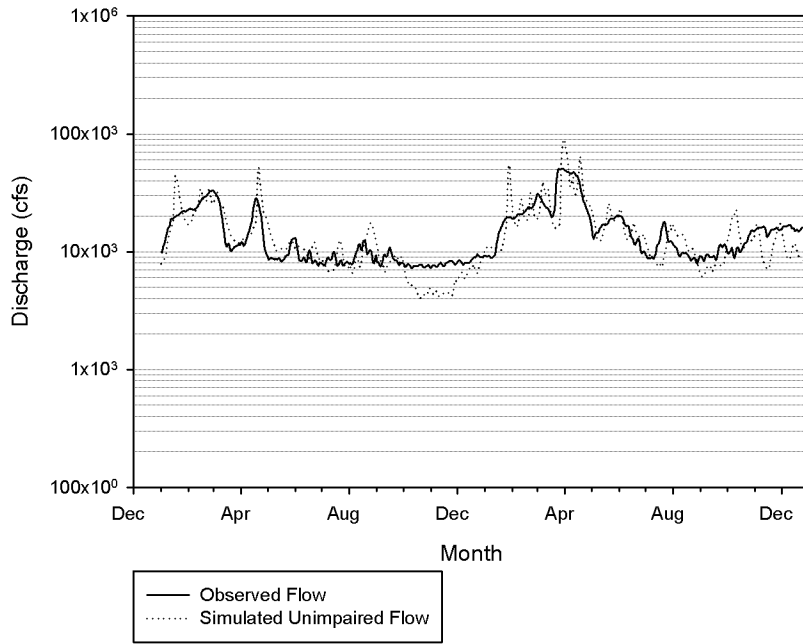


Average years

Hydrograph for the Savannah River at Clyo, 1950-1951

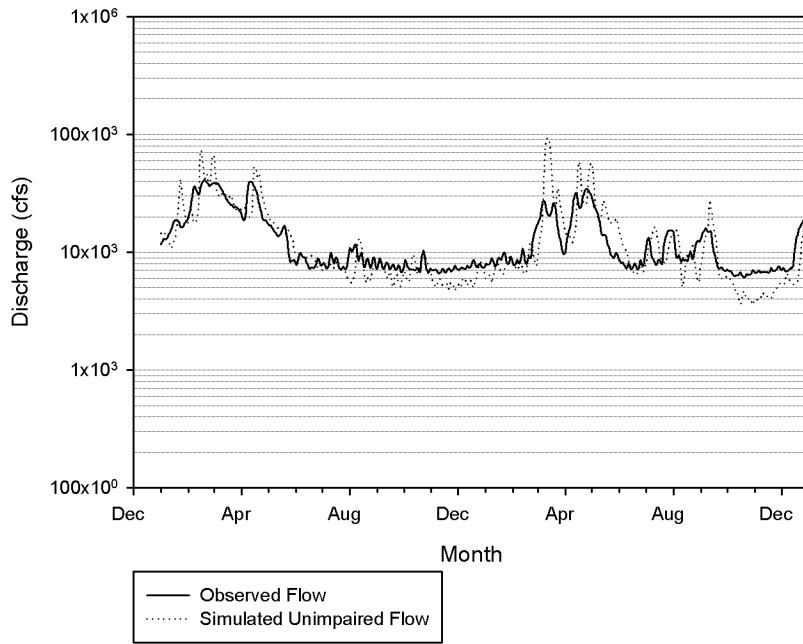


Hydrograph for the Savannah River at Clyo, 1974-1975

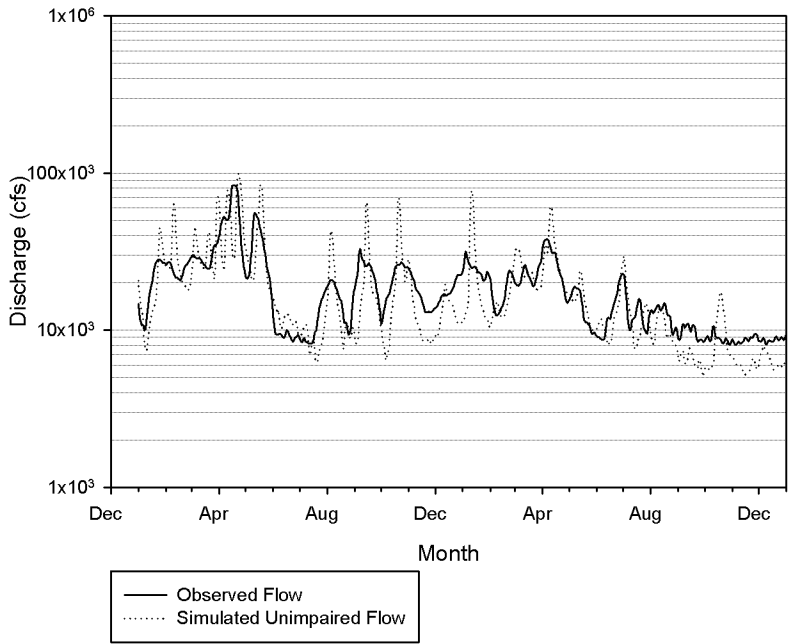


Wet years

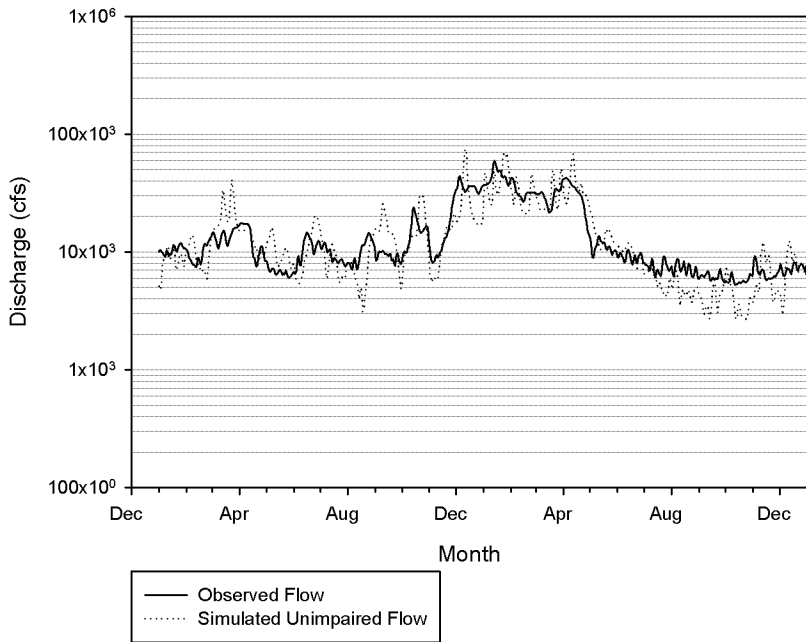
Hydrograph for the Savannah River at Clyo, 1960-1961



Hydrograph for the Savannah River at Clyo, 1964-1965



Hydrograph for the Savannah River at Clyo, 1992-1993

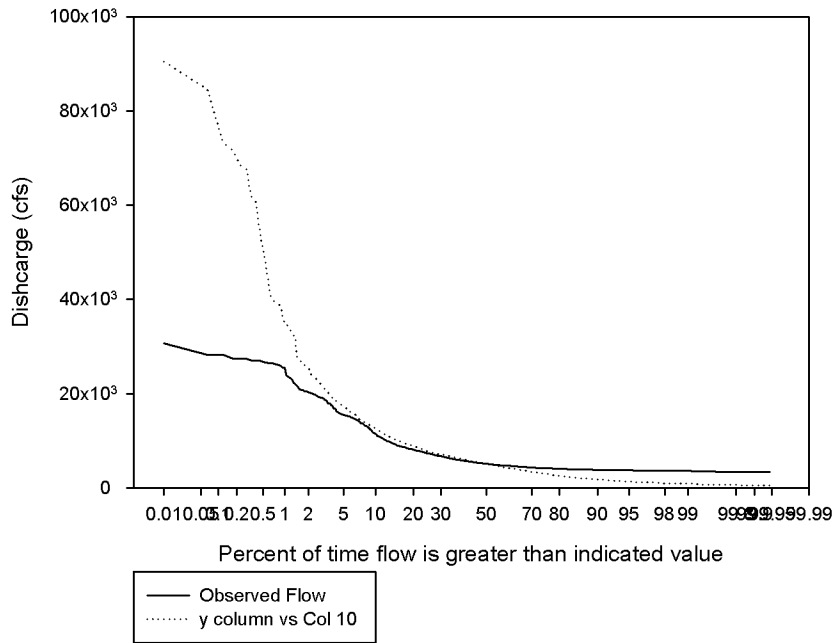


2004 – 2009

Augusta

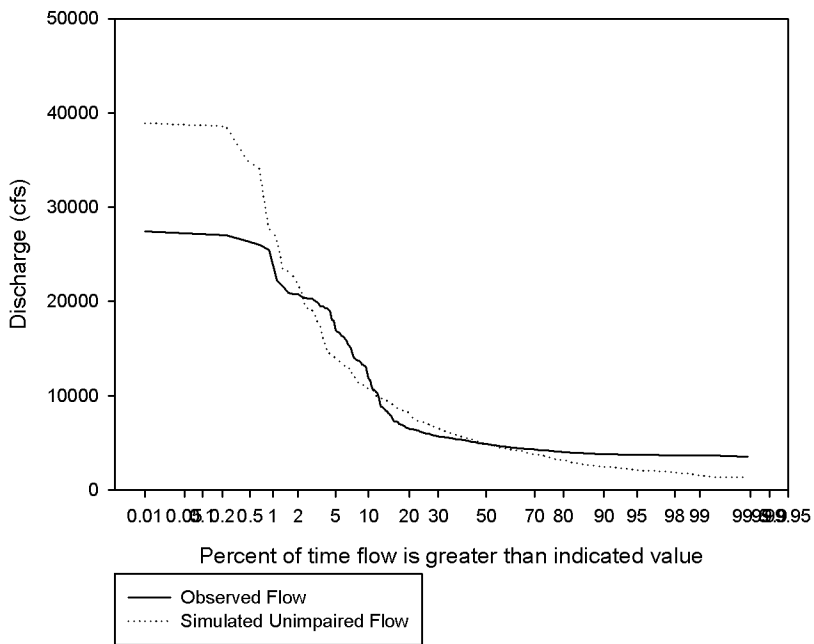
Durations

Flow Duration for the Savannah River at Augusta (2004-2008)

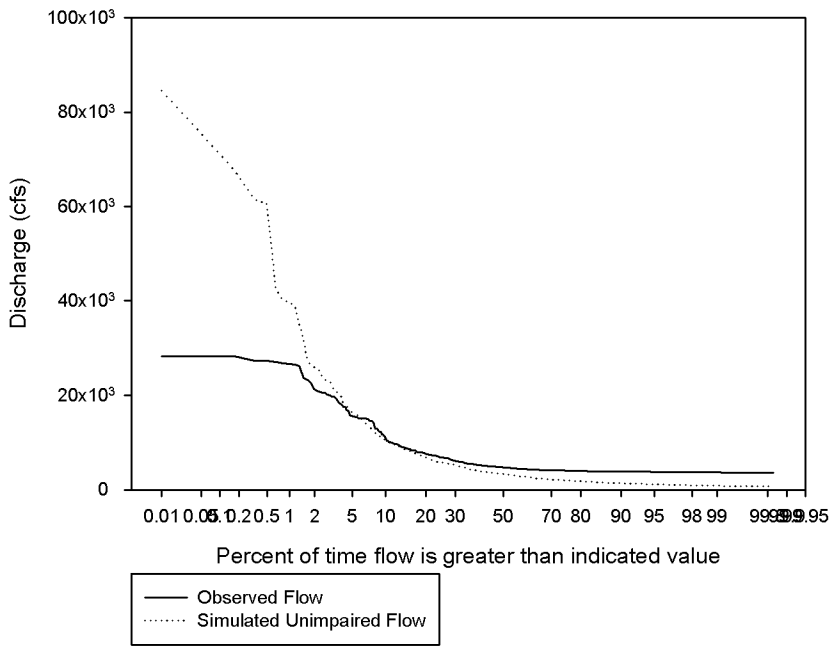


By Season

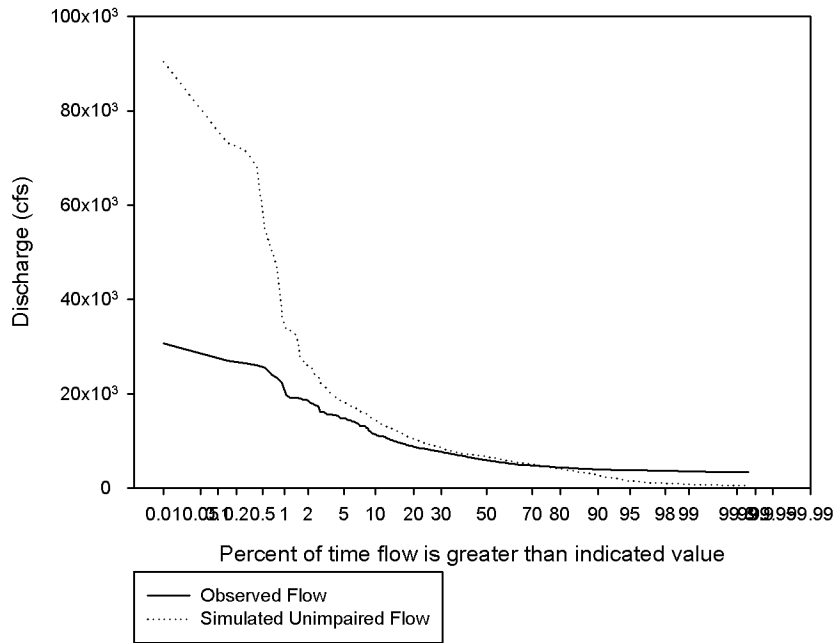
Flow Duration for the Savannah River at Augusta, April-June (2004-2008)



Flow Duration for the Savannah River at Augusta, July-October (2004-2008)



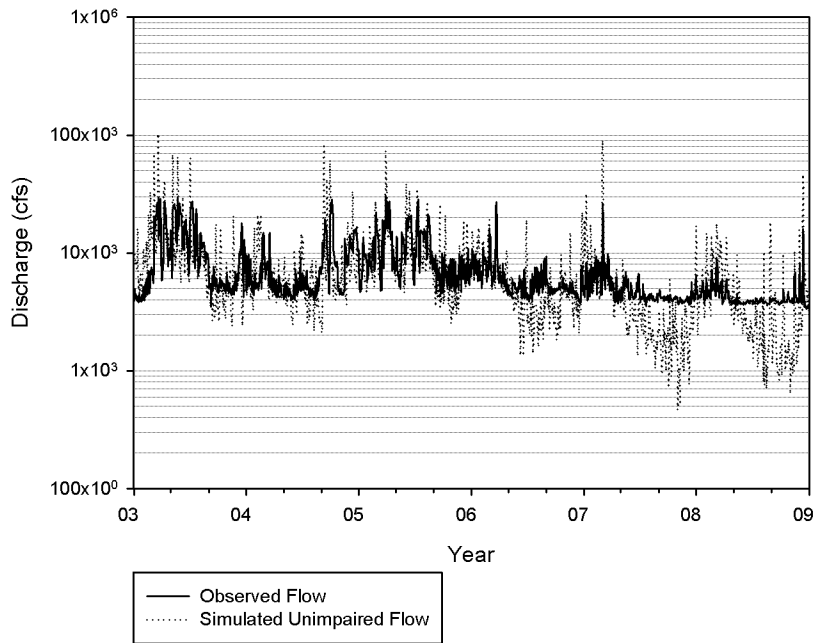
Flow Duration for the Savannah River at Augusta, November-March (2004-2008)



Representative Hydrographs

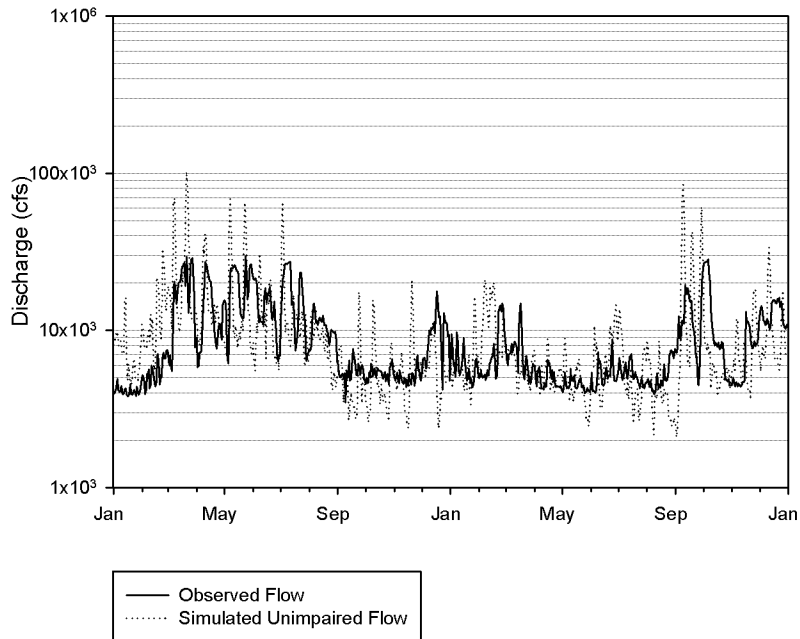
All Years

Hydrograph for the Savannah River at Augusta (2004-2008)



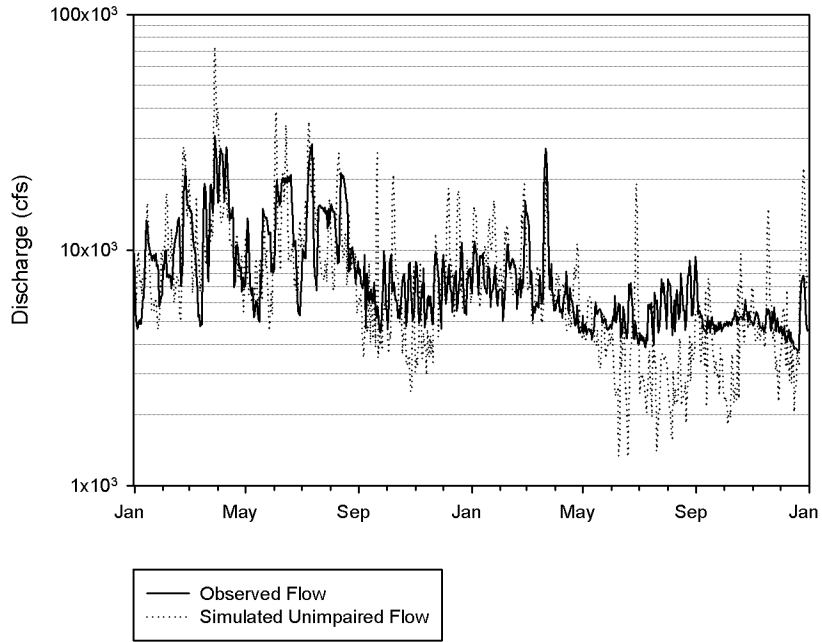
2003-2004

Hydrograph for the Savannah River at Augusta (2003-2004)



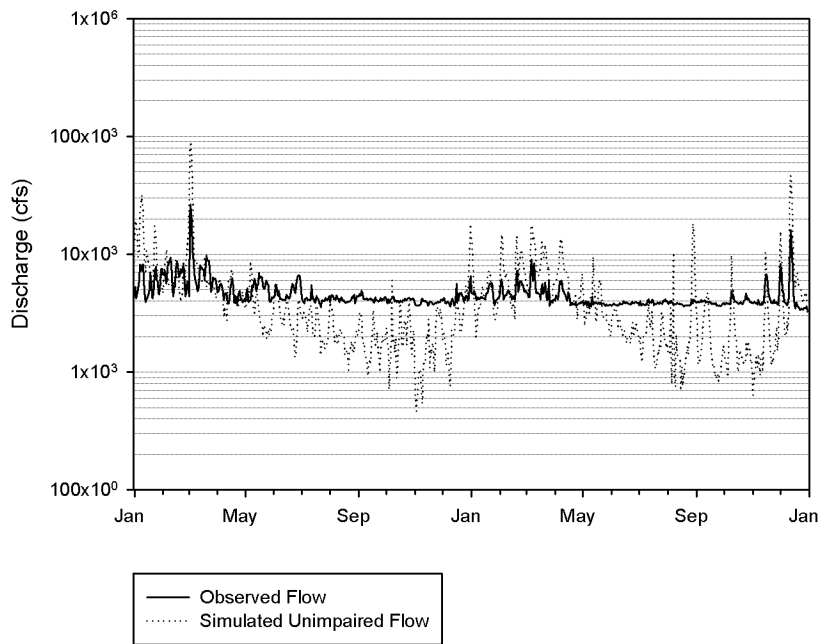
2005-2006

Hydrograph for the Savannah River at Augusta (2005-2006)



2007-2008

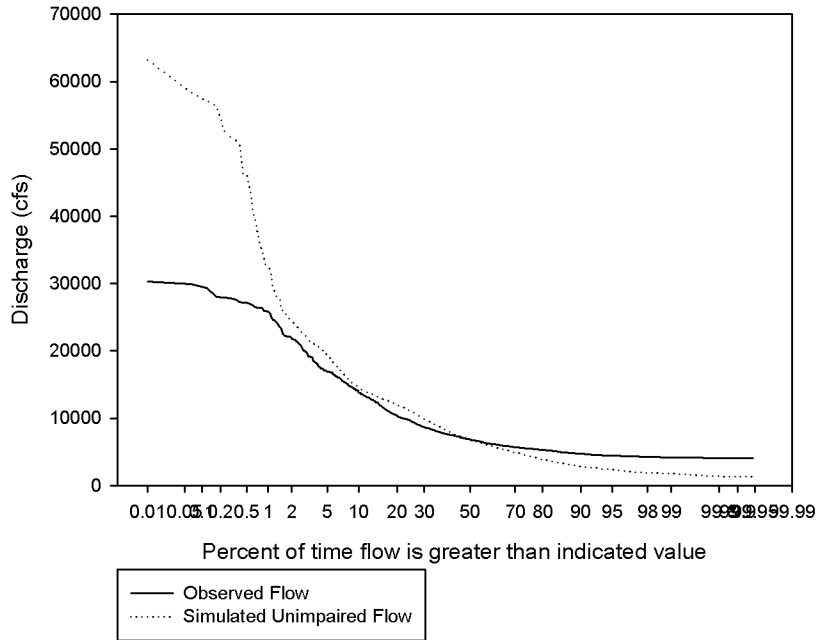
Hydrograph for the Savannah River at Augusta (2007-2008)



Clyo

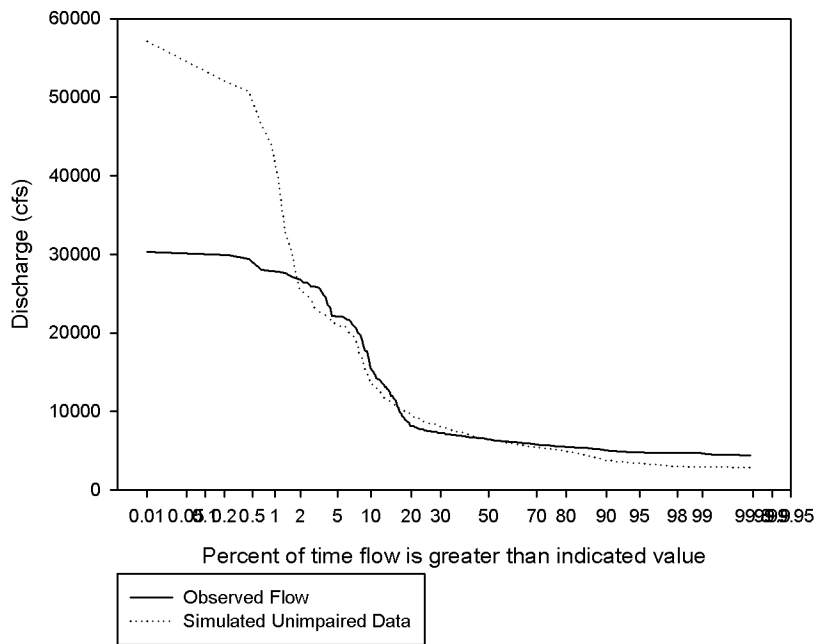
Durations

Flow Duration for the Savannah River at Clyo (2004-2008)

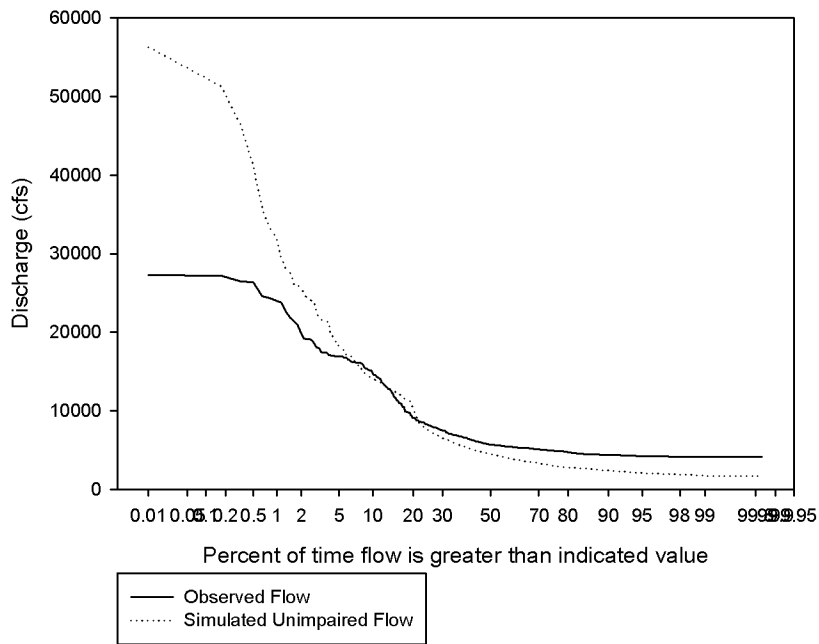


By Season

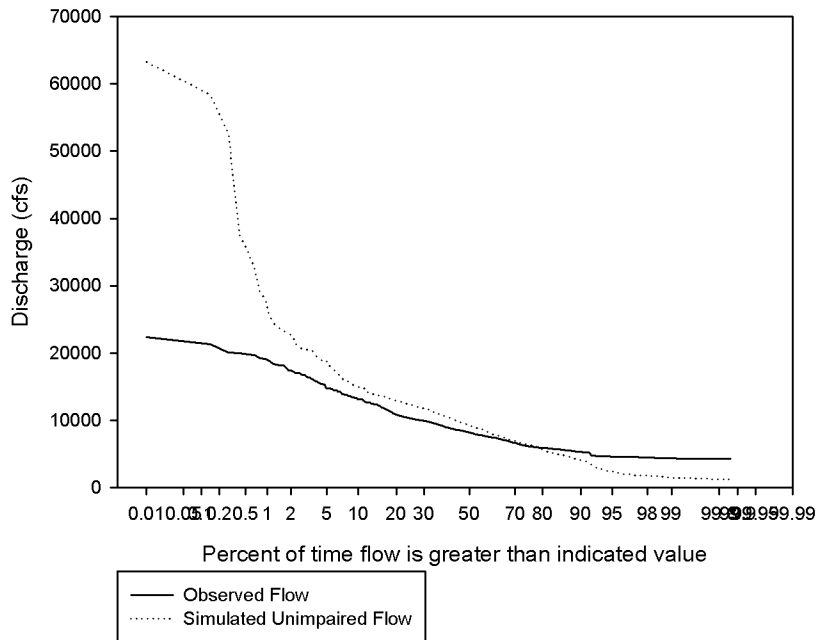
Flow Duration of the Savannah River at Clyo, April-June (2004-2008)



Flow Duration for the Savannah River at Clyo, July-October (2004-2008)



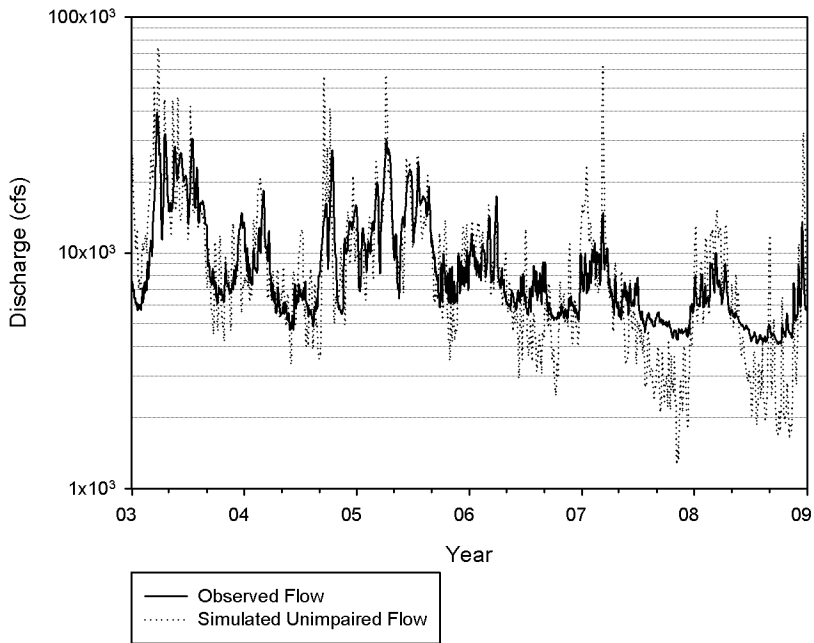
Flow Duration for the Savannah River at Clyo, November-March (2004-2008)



Representative Hydrographs

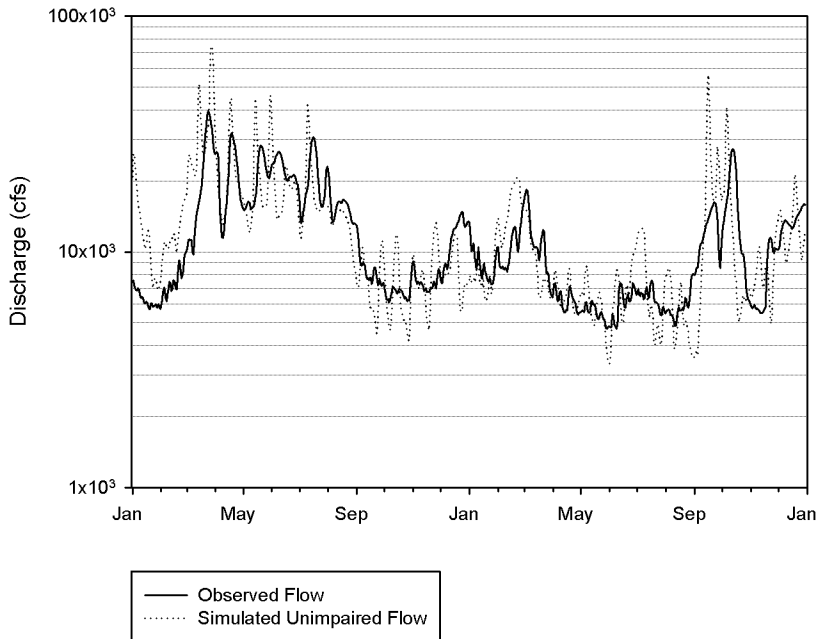
All Years

Hydrograph for the Savannah River at Clyo (2003-2008)



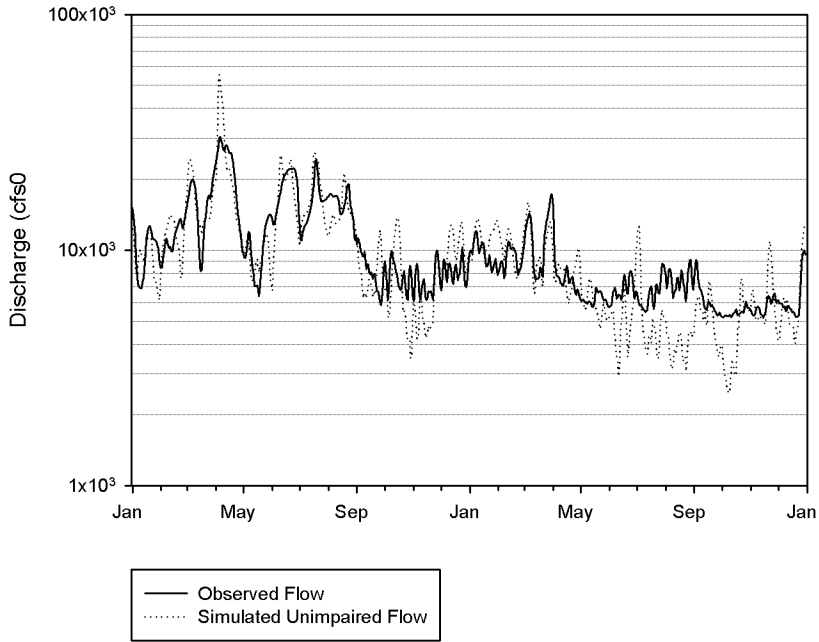
2003-2004

Hydrograph for the Savannah River at Clyo (2003-2004)



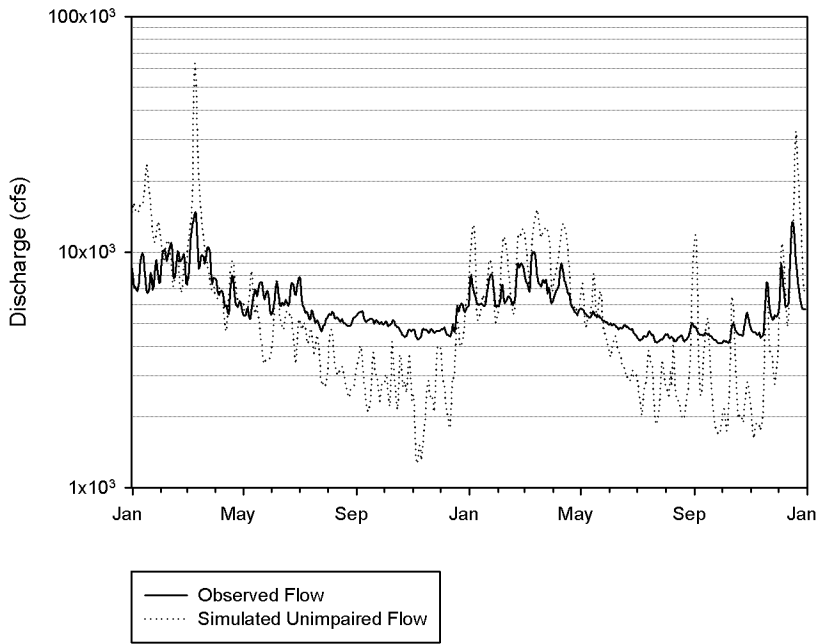
2005-2006

Hydrograph for the Savannah River at Clyo (2005-2006)



2007-2008

Hydrograph for the Savannah River at Clyo (2007-2008)



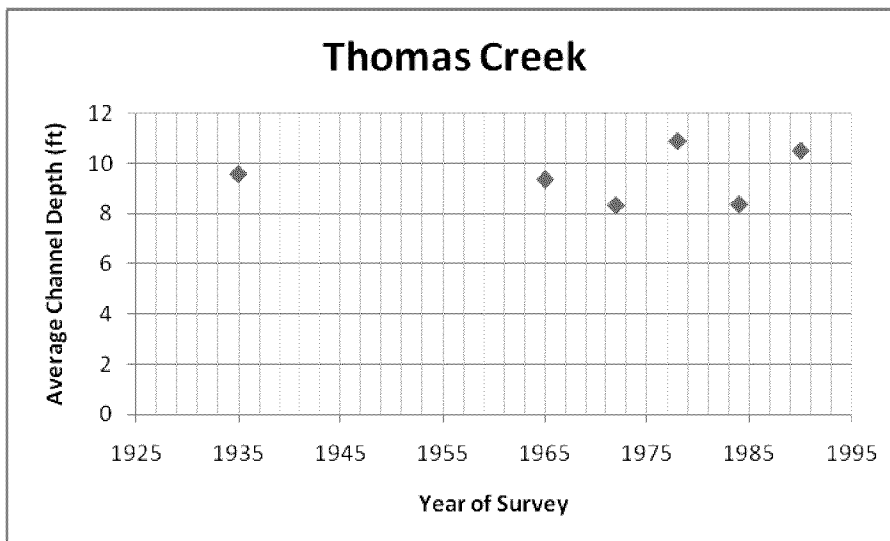
Channel Depth Analysis

A channel depth analysis was performed to identify and quantify trends in bed elevations and cross sections. Cross-section data was obtained from USACE surveys for the Savannah River from 1935, 1965, 1972, 1978, 1984, and 1990. Various straight-a-ways were chosen along the river from the Savannah River Bluff Lock and Dam to Clyo, GA according to easily identifiable landmarks. For each landmark, three to four cross-sections were recorded. The 1935 survey had six landmarks from RM 183-132. In 1965 seven more were added, making thirteen landmarks sampled in 1965 and subsequent years and extending the survey range down to RM 61 near Clyo, GA.

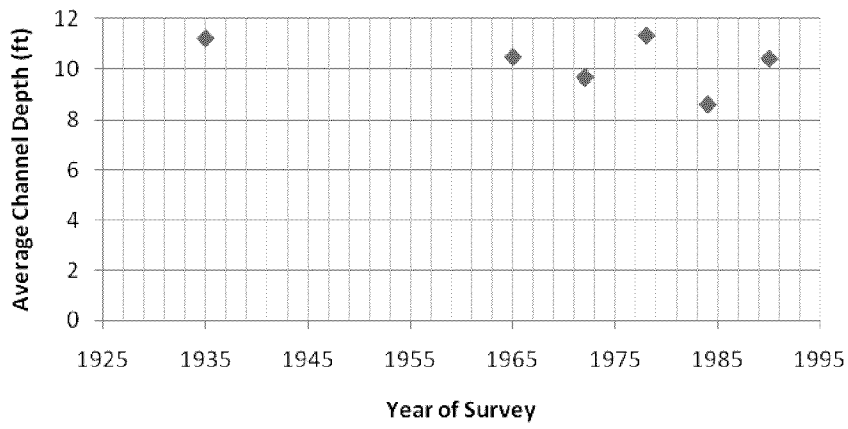
The plane of reference for the 1935 survey was 4000 cfs. The 1984 and 1990 surveys clearly indicated 6300 cfs as the plane of reference, however, the 1965, 1972, and 1978 surveys did not indicate a plane of reference so 6300 cfs is assumed. The 1935 survey's plane of reference was rectified to the subsequent survey years using a rating curve obtained from USGS for Gage 02197500 near Millhaven, GA. A difference of 2.95 ft was added to the six 1935 surveys.

The average depth of each cross section was calculated. The average channel depth of each landmark was calculated by averaging the average depths of each of its cross sections. This was done for every year the landmark was surveyed and these averages were graphed (figures below).

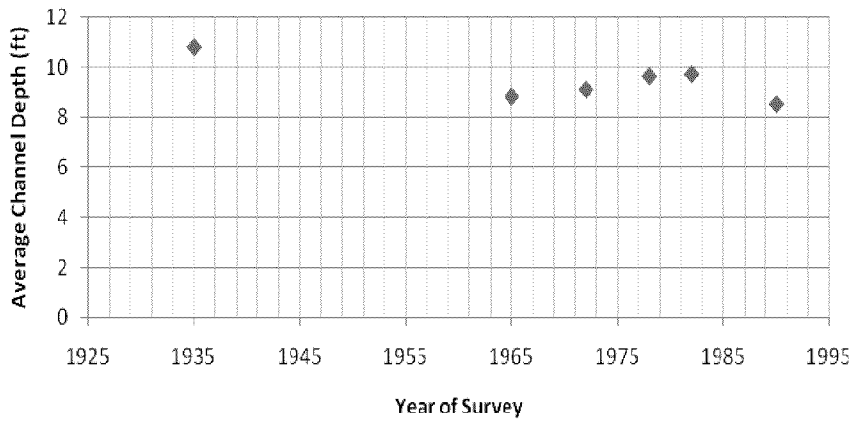
The water depths show no trends since 1965. Two sites, directly upriver of Utley Landing and Stony Bluff Landing, indicate a drop in channel depth of three to four feet between 1935 and 1965. Four other sites with 1935 data do not show this change. Because of the change in reference flows and the need to attempt to correct for this change, confidence in the 1935-1965 comparisons is not high. In terms of channel depth, the data indicate relative channel stability since 1965.



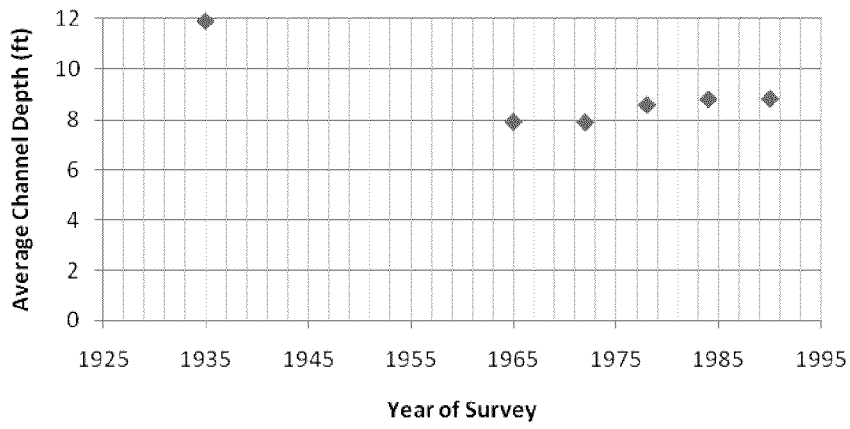
Straightaway past Bailey's Cut



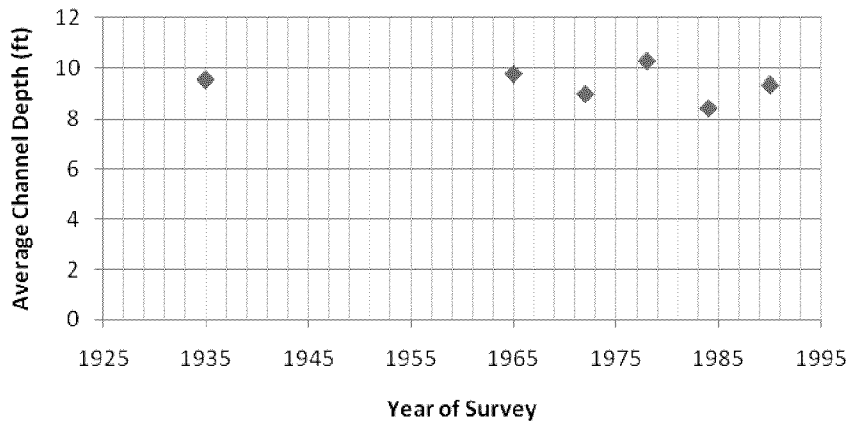
Eagle Point



Directly Upriver of Utley Landing



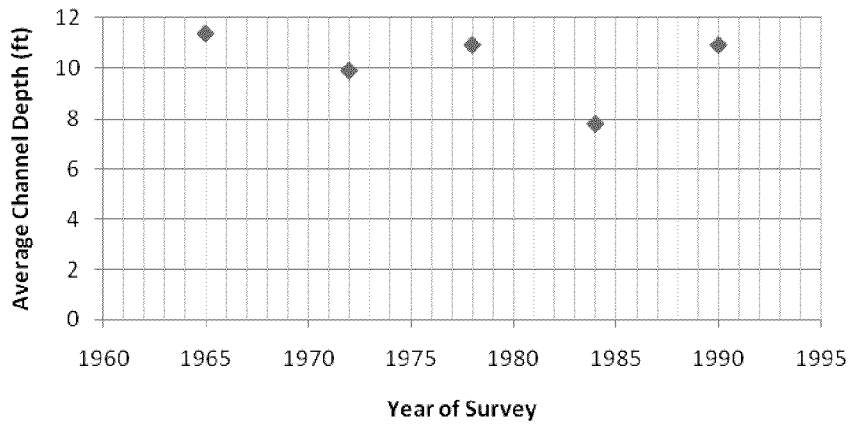
Chandler's Landing



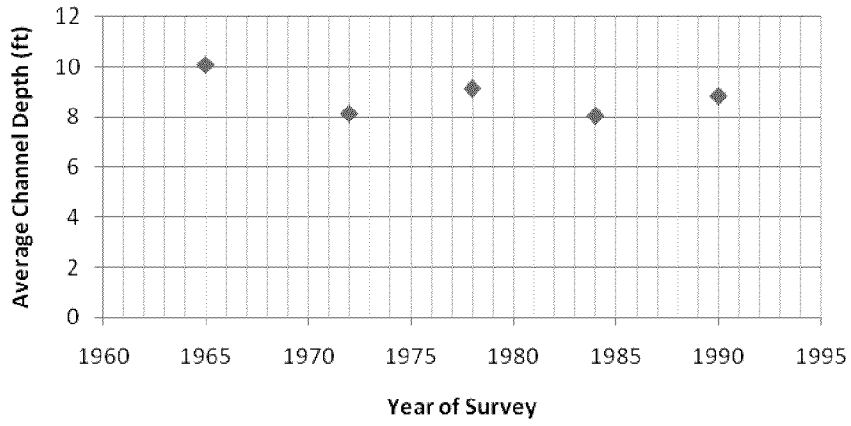
Stony Bluff Landing



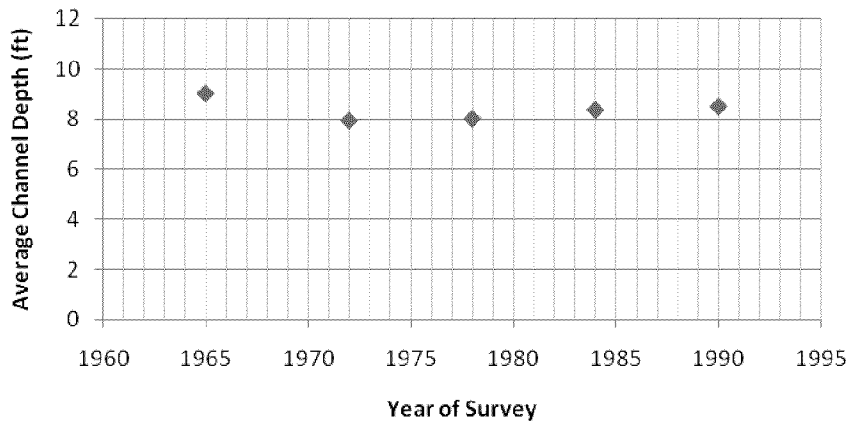
Johnson's Landing



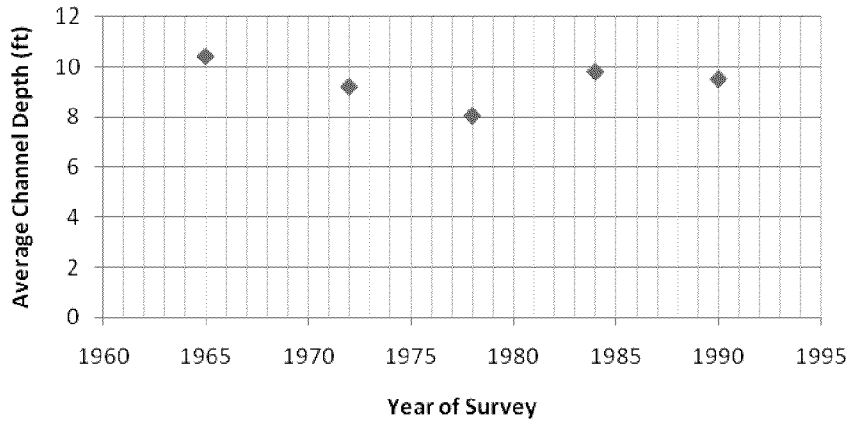
King Creek Landing



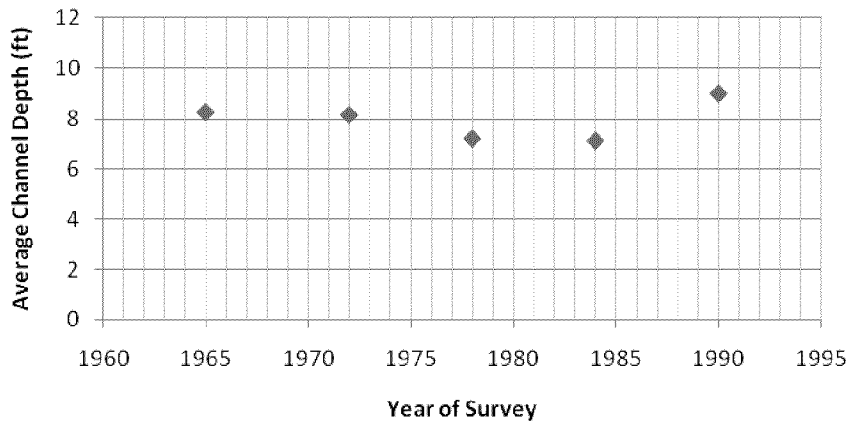
Cutoff No. 15



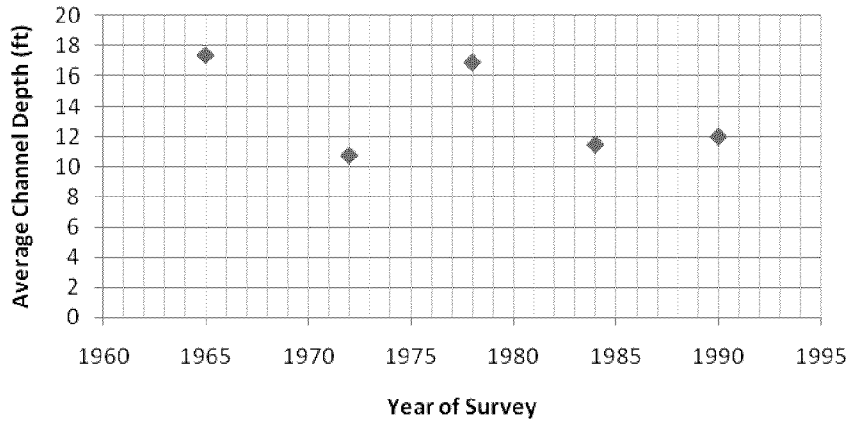
Poor Robin Landing



Willow Oak Point



Porter's Landing



State Highway 119 - Clys

