Hydrologic Modeling of the Santa Clara River Watershed with the U.S. EPA Hydrologic Simulation Program - FORTRAN (HSPF)

APPENDICES

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APPENDICES

APPENDIX A

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SESPE CREEK WATERSHED AT FILLMORE

Title Page

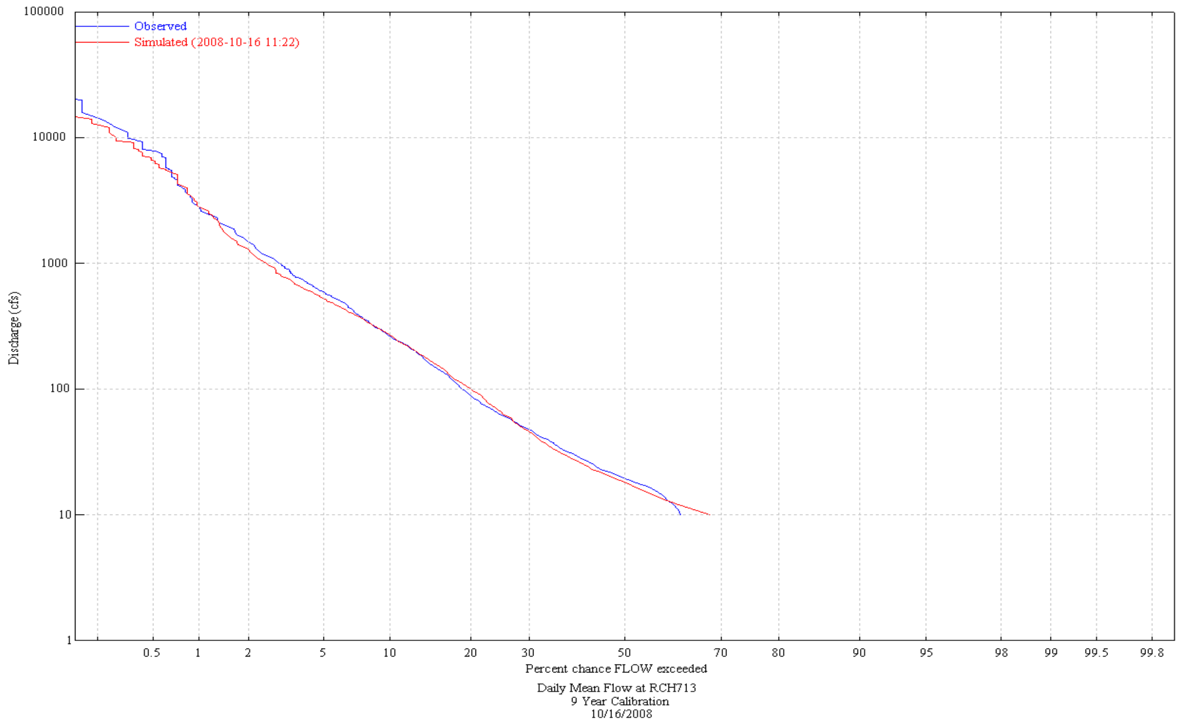

Figure 1 Simulated and Observed Daily Flow Duration Curve at Fillmore

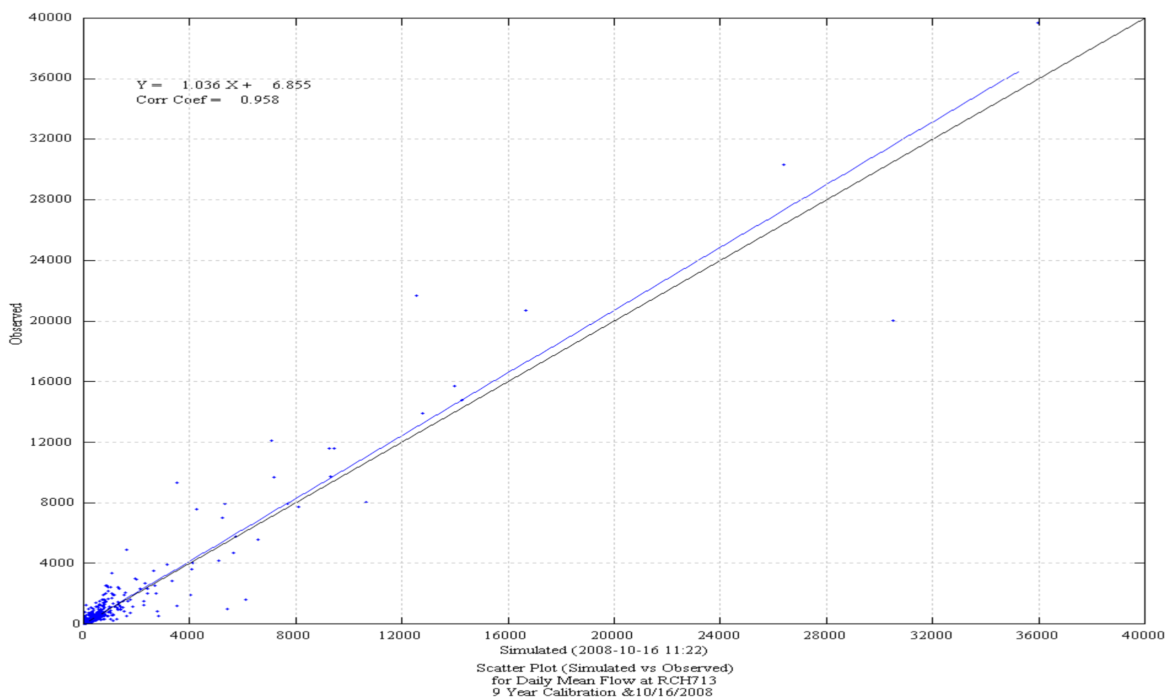

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Fillmore

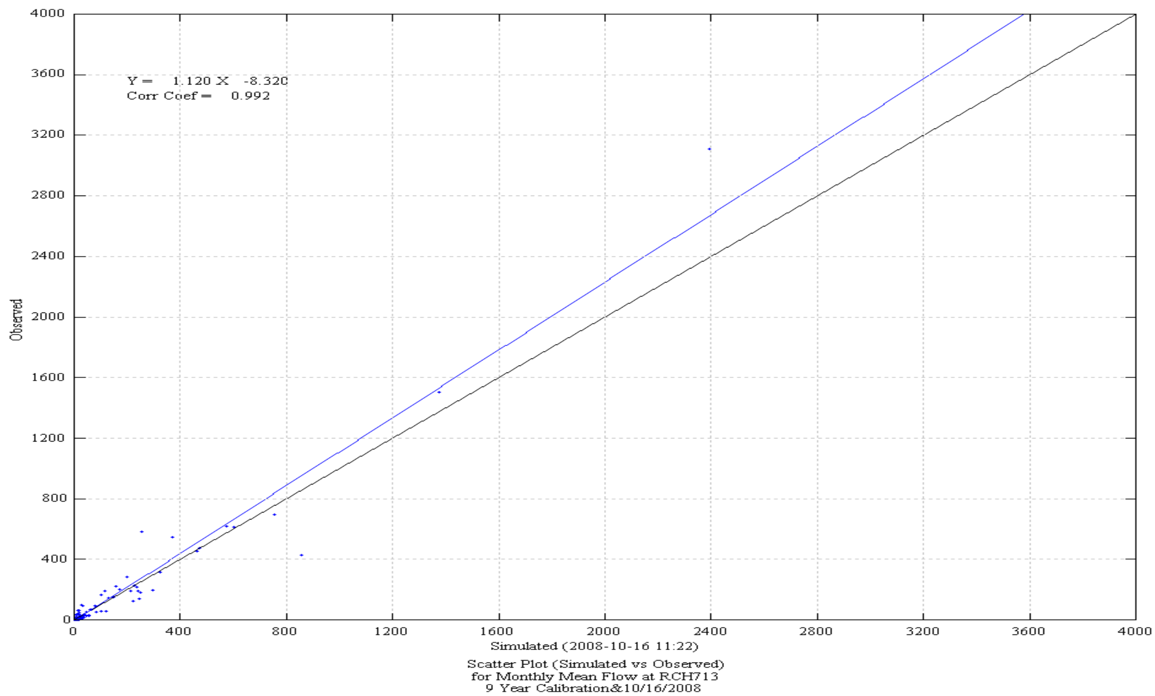

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Fillmore

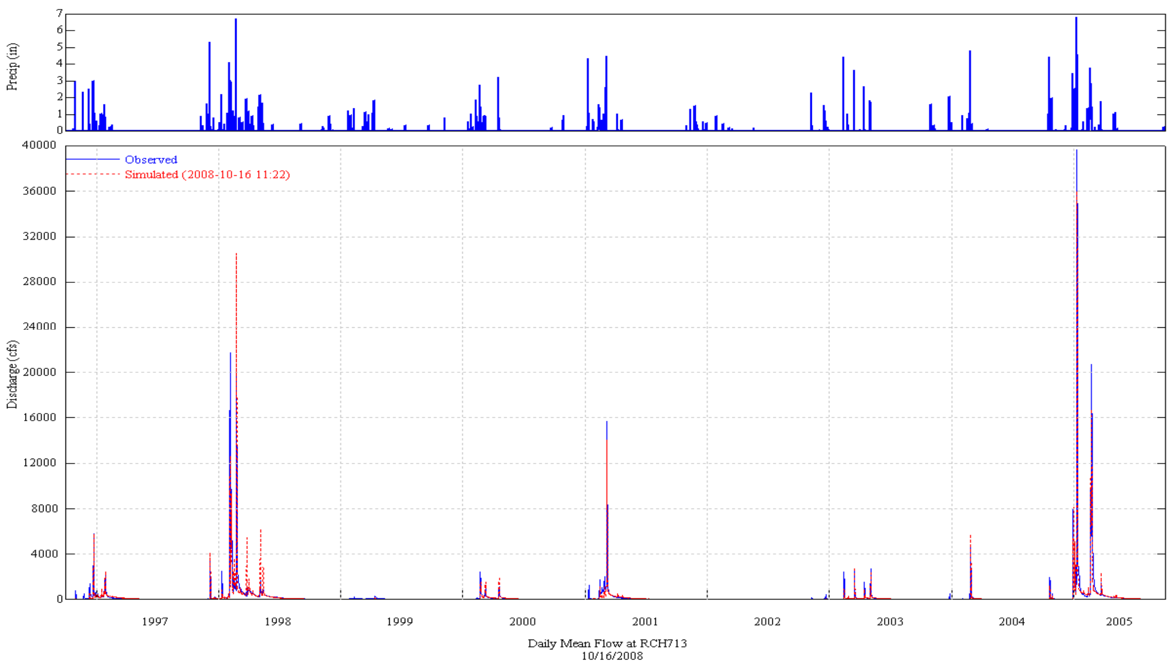

Figure 4 Simulated and Observed Daily Flow at Fillmore (WY 1997-2005)

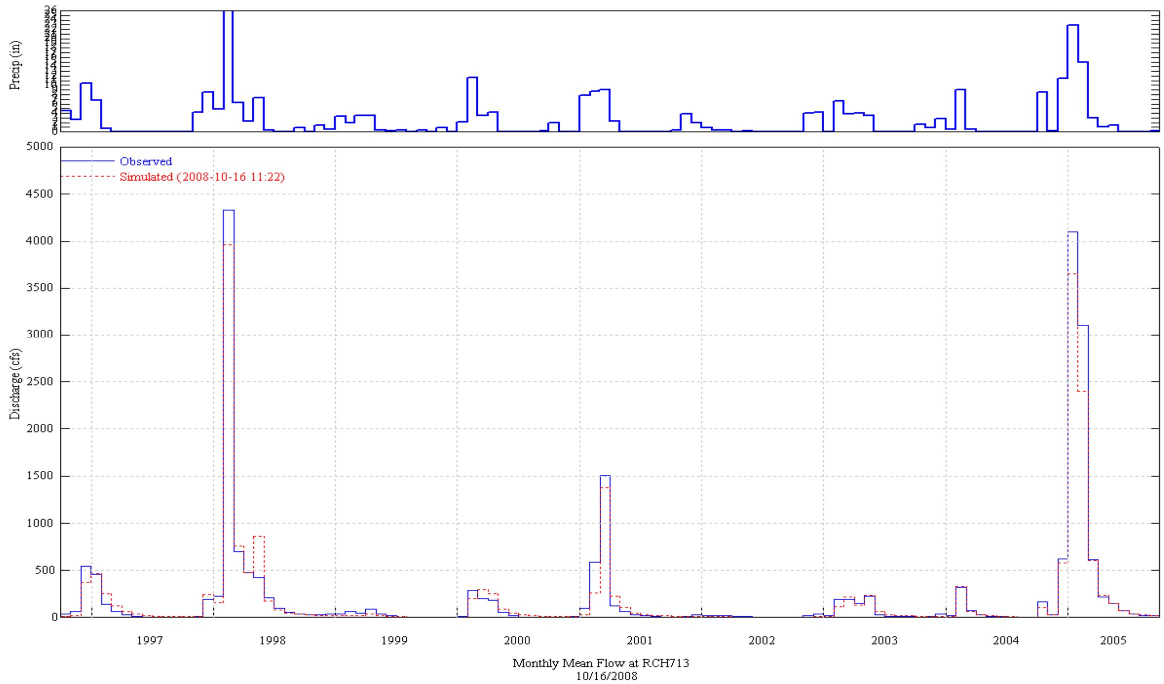

Figure 5 Simulated and Observed Monthly Flow at Fillmore (WY 1997-2005)

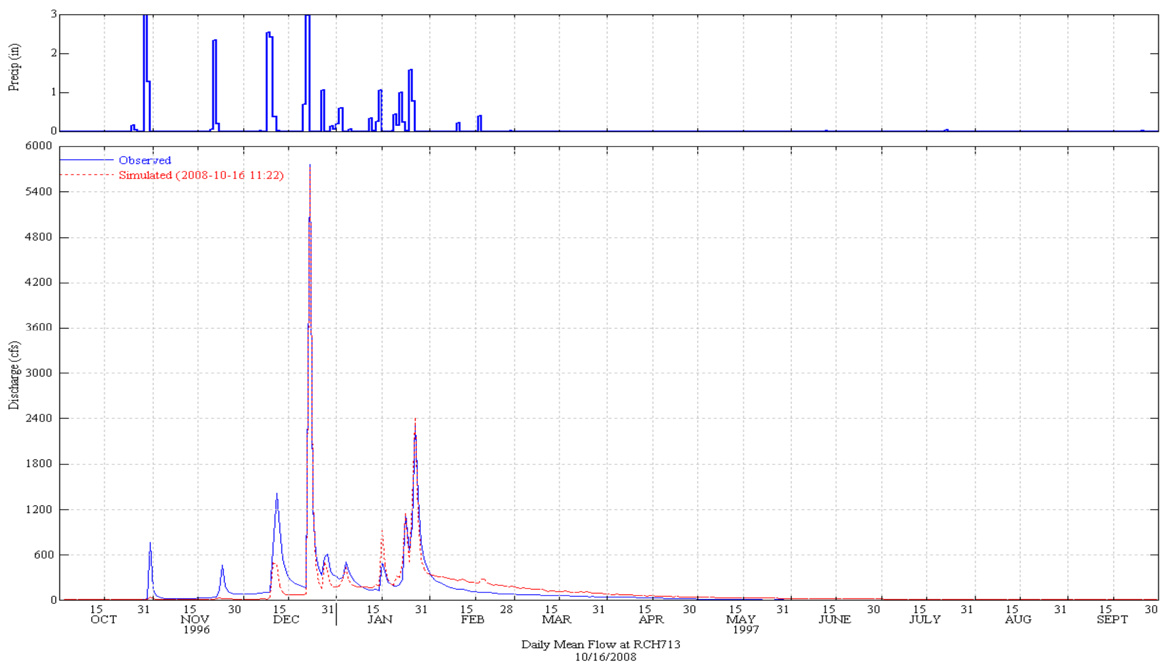

Figure 6 Simulated and Observed Daily Flow at Fillmore (WY 1997)

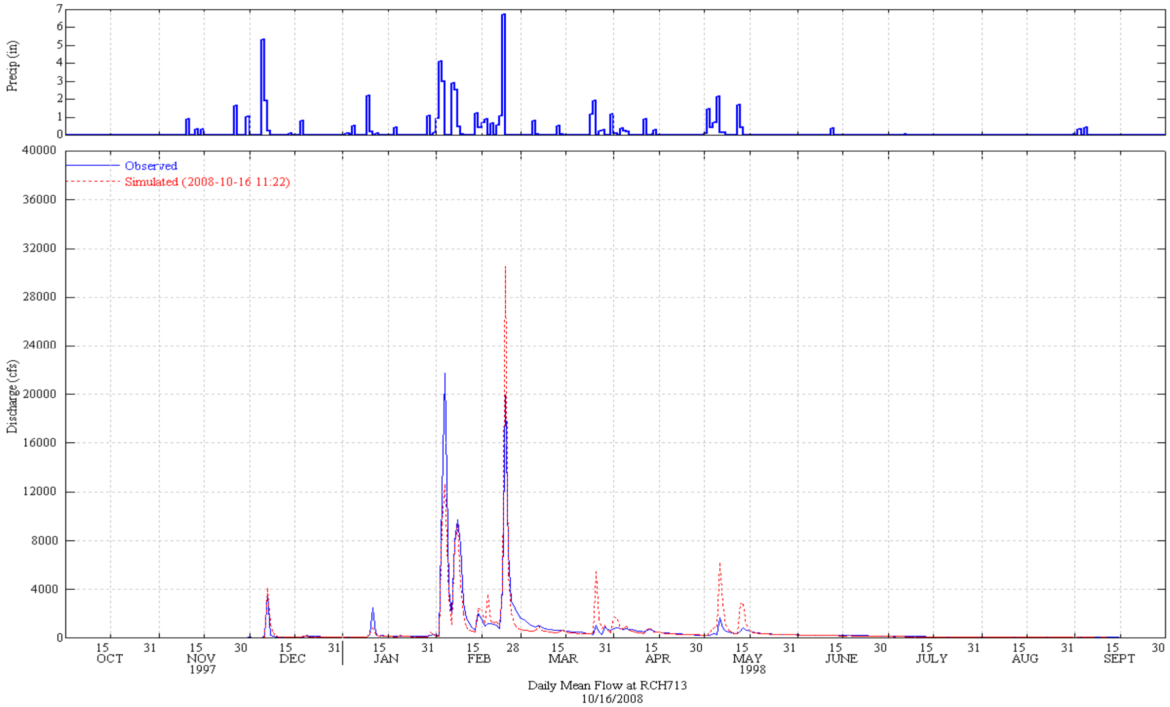

Figure 7 Simulated and Observed Daily Flow at Fillmore (WY 1998)

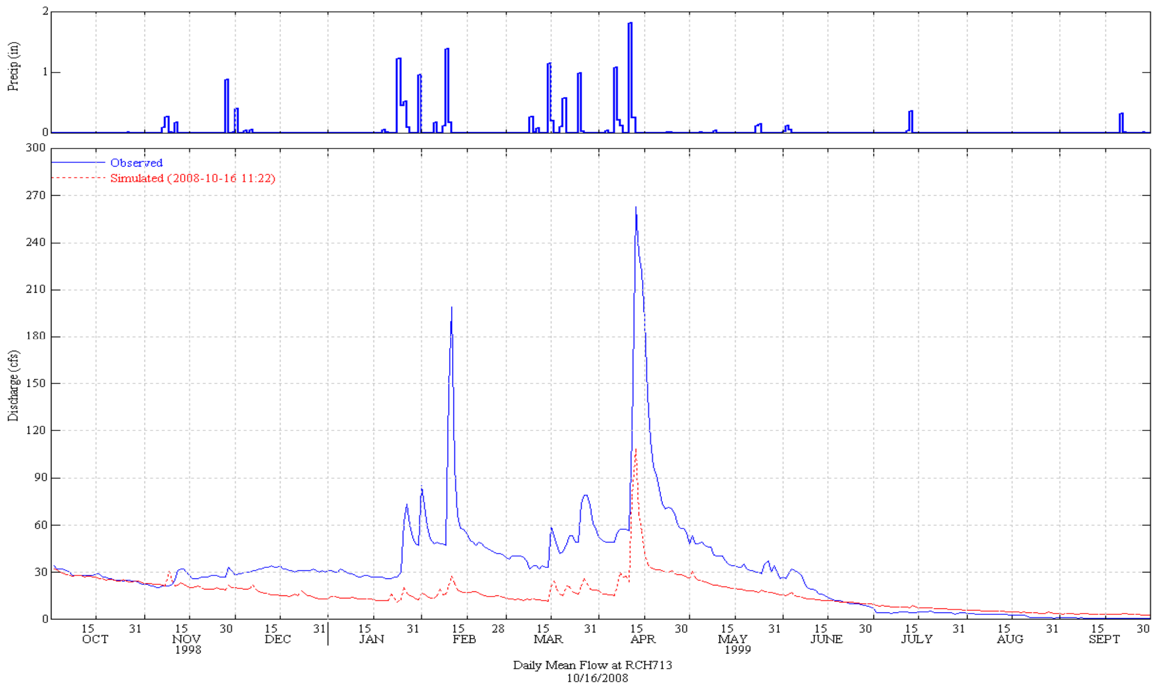

Figure 8 Simulated and Observed Daily Flow at Fillmore (WY 1999)

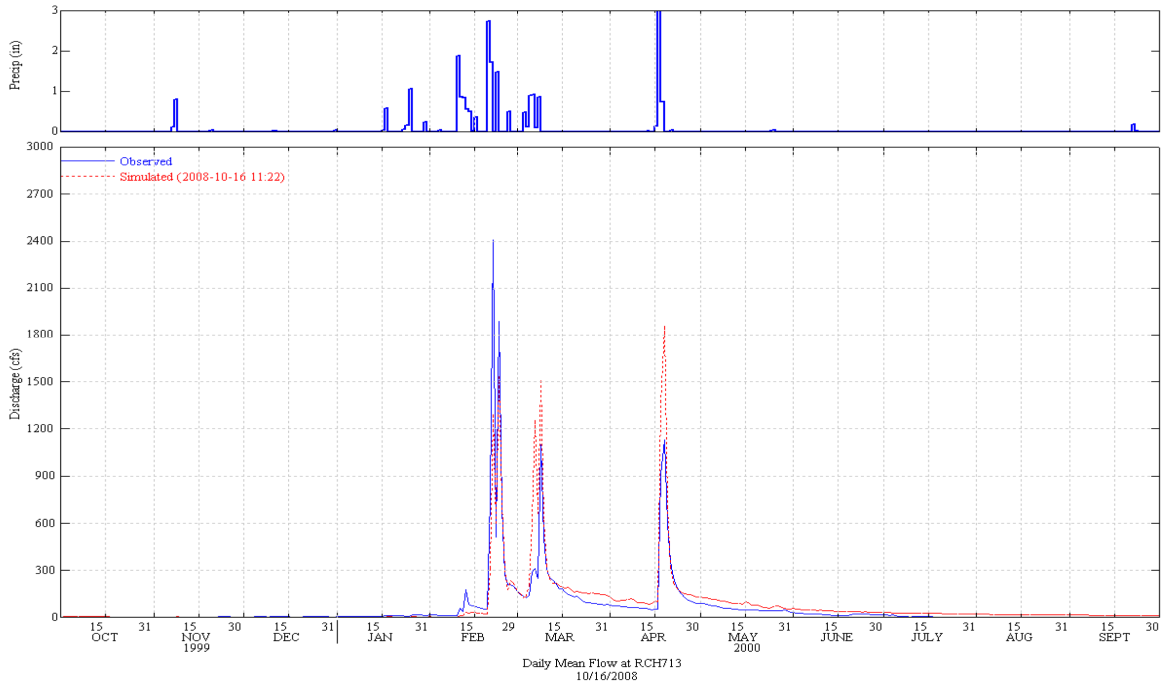

Figure 9 Simulated and Observed Daily Flow at Fillmore (WY 2000)

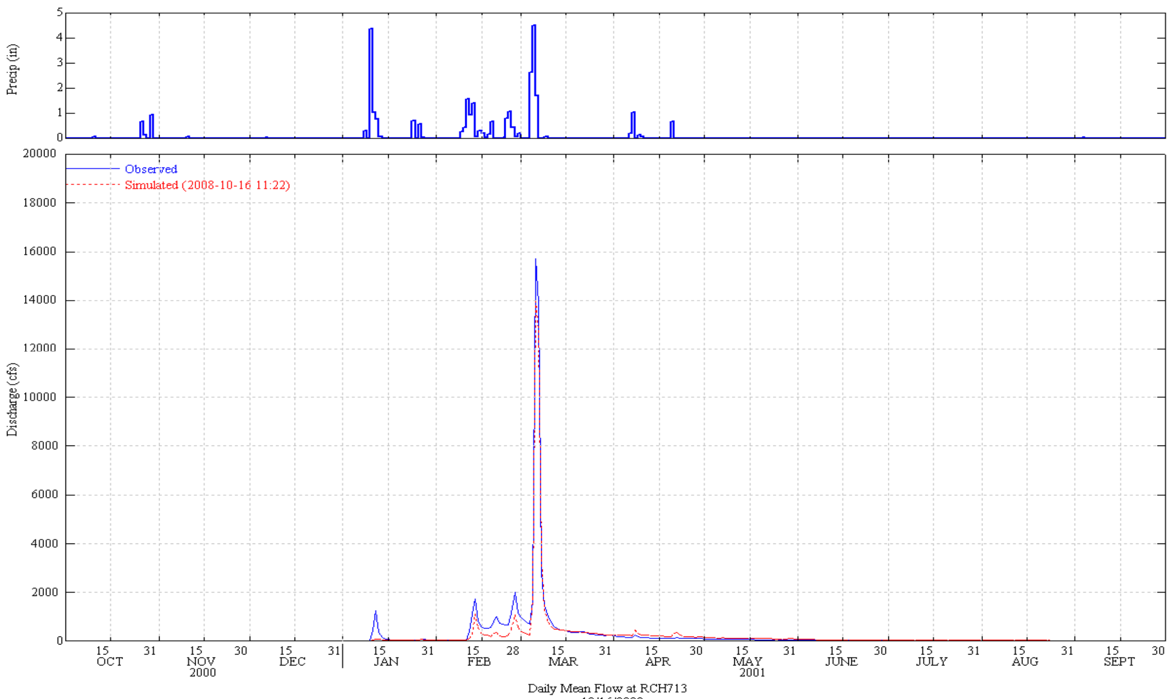

Figure 10 Simulated and Observed Daily Flow at Fillmore (WY 2001)

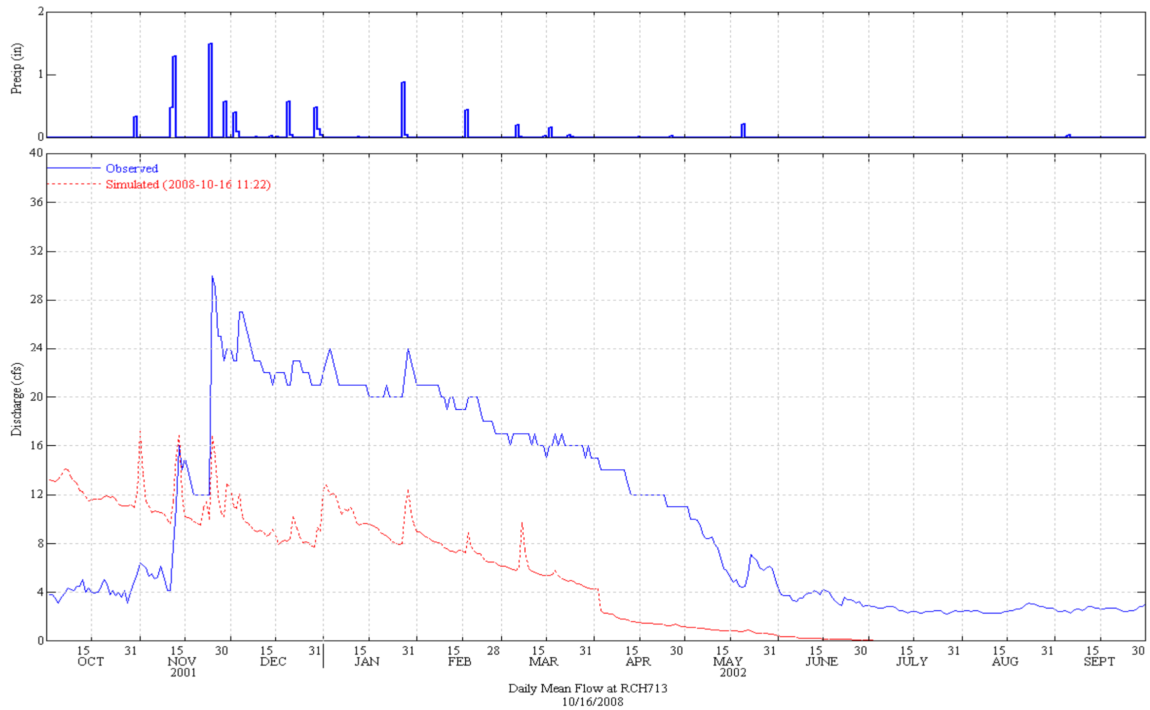

Figure 11 Simulated and Observed Daily Flow at Fillmore (WY 2002)

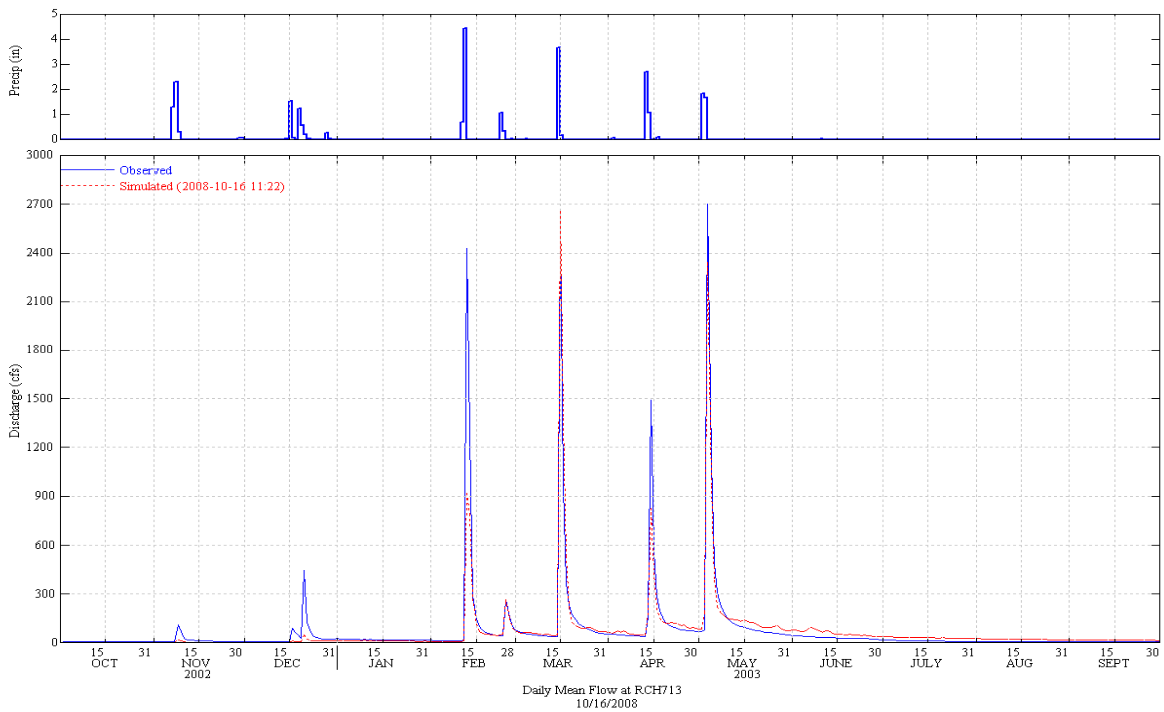

Figure 12 Simulated and Observed Daily Flow at Fillmore (WY 2003)

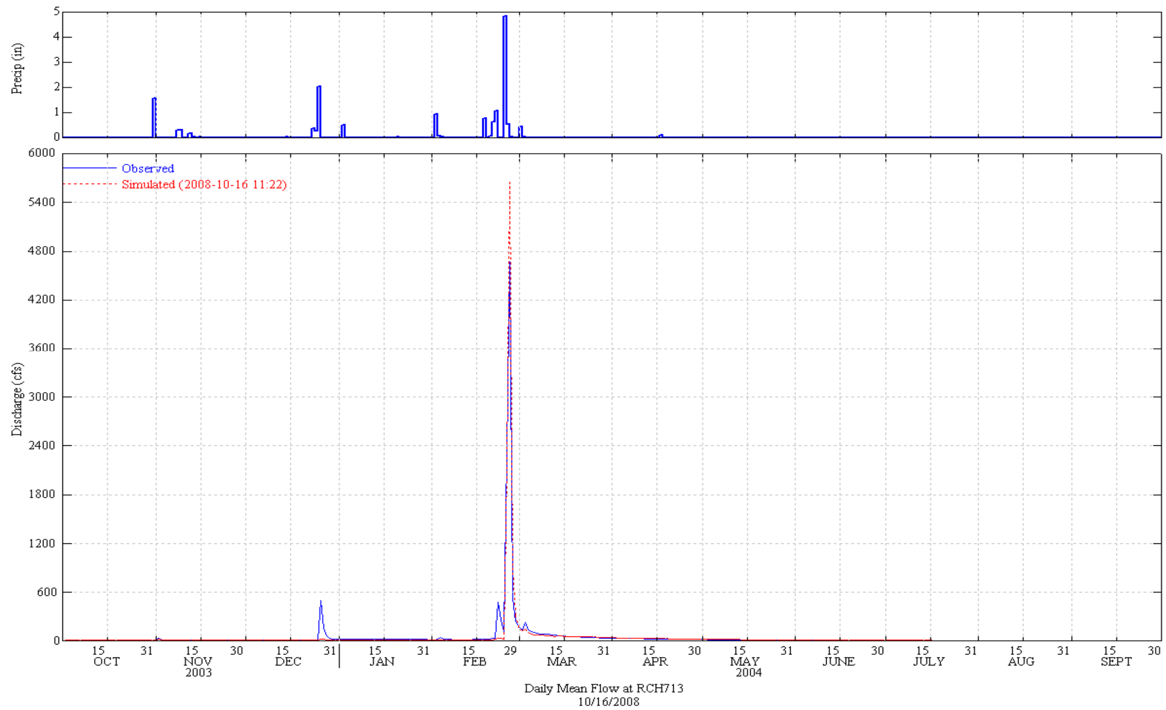

Figure 13 Simulated and Observed Daily Flow at Fillmore (WY 2004)

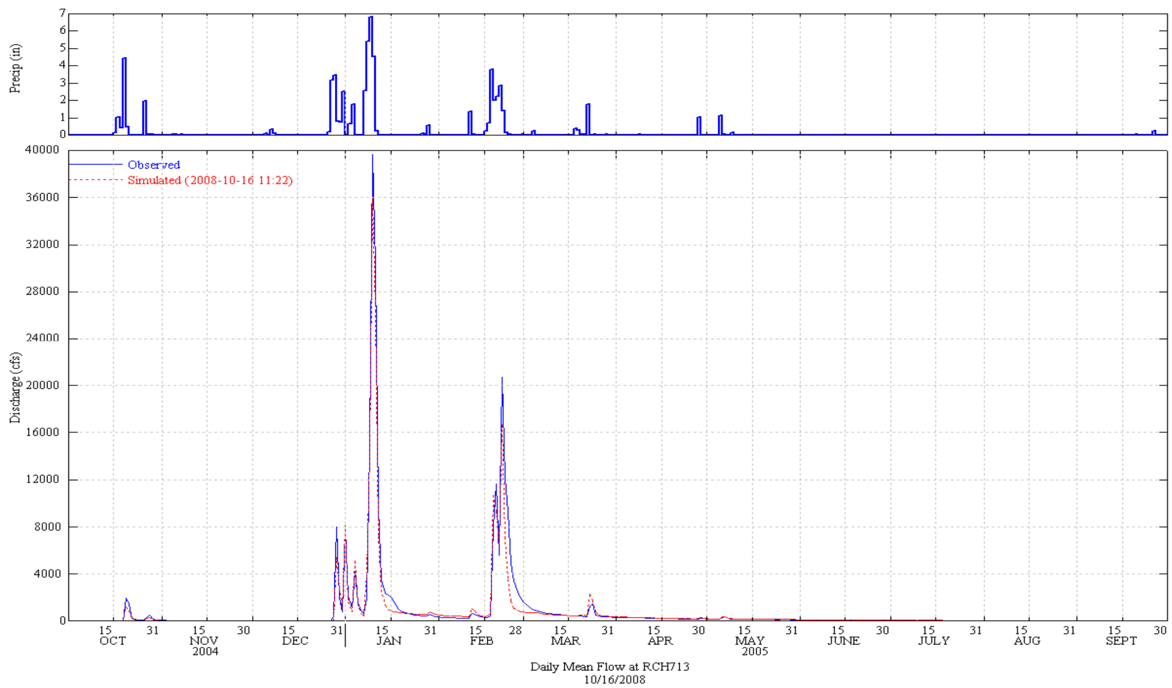

Figure 14 Simulated and Observed Daily Flow at Fillmore (WY 2005)

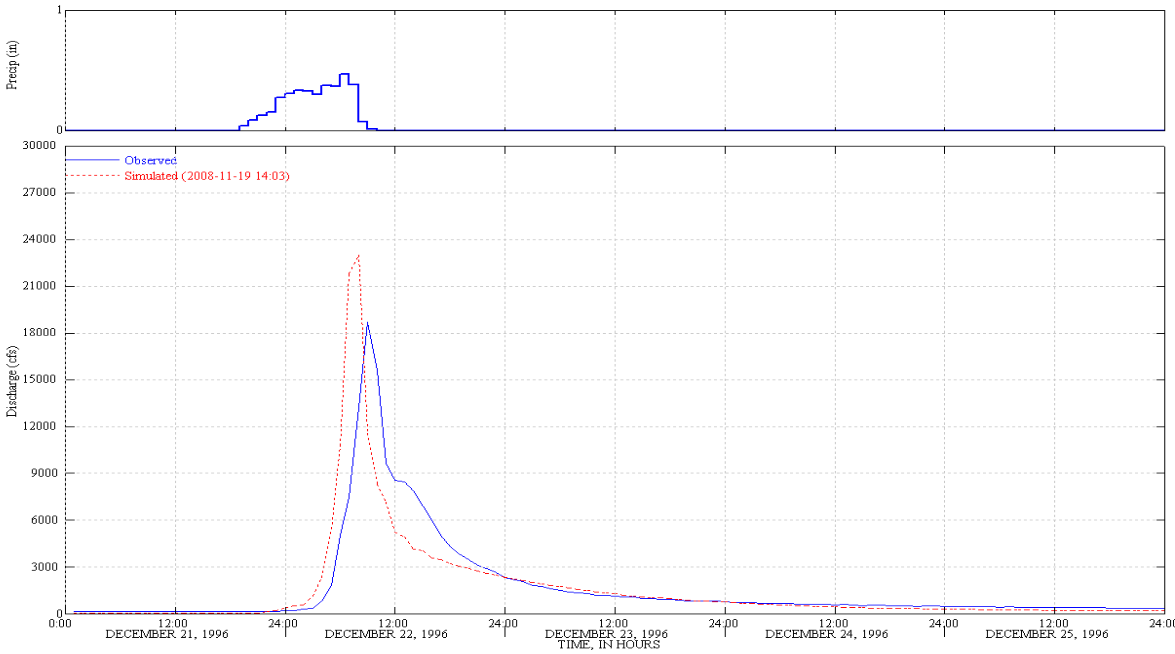

Figure 15 Simulated and Observed December 22, 1996 Storm Event

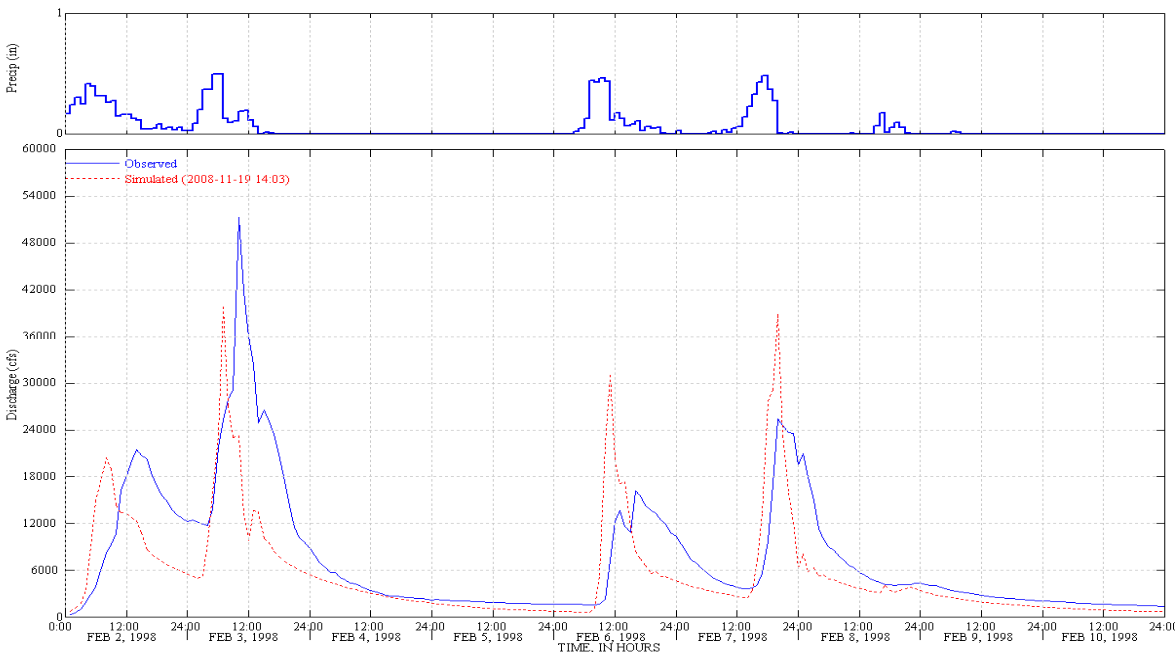

Figure 16 Simulated and Observed February 2-8, 1998 Storm Event

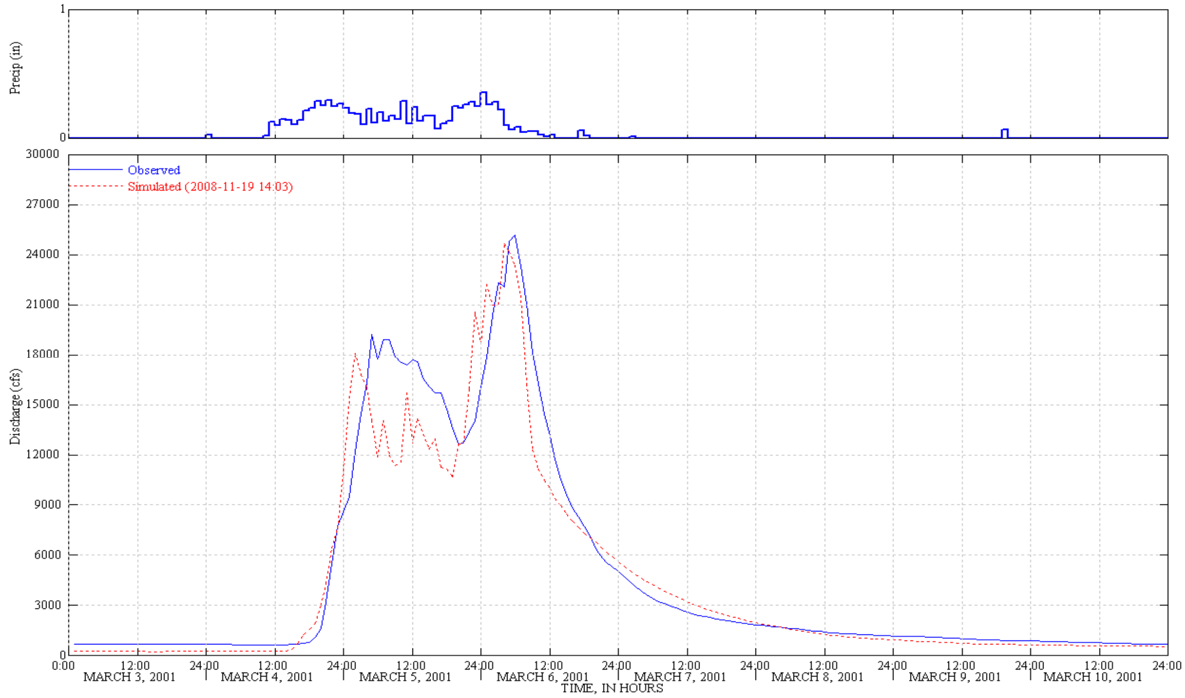

Figure 17 Simulated and Observed March 4-7, 2001 Storm Event

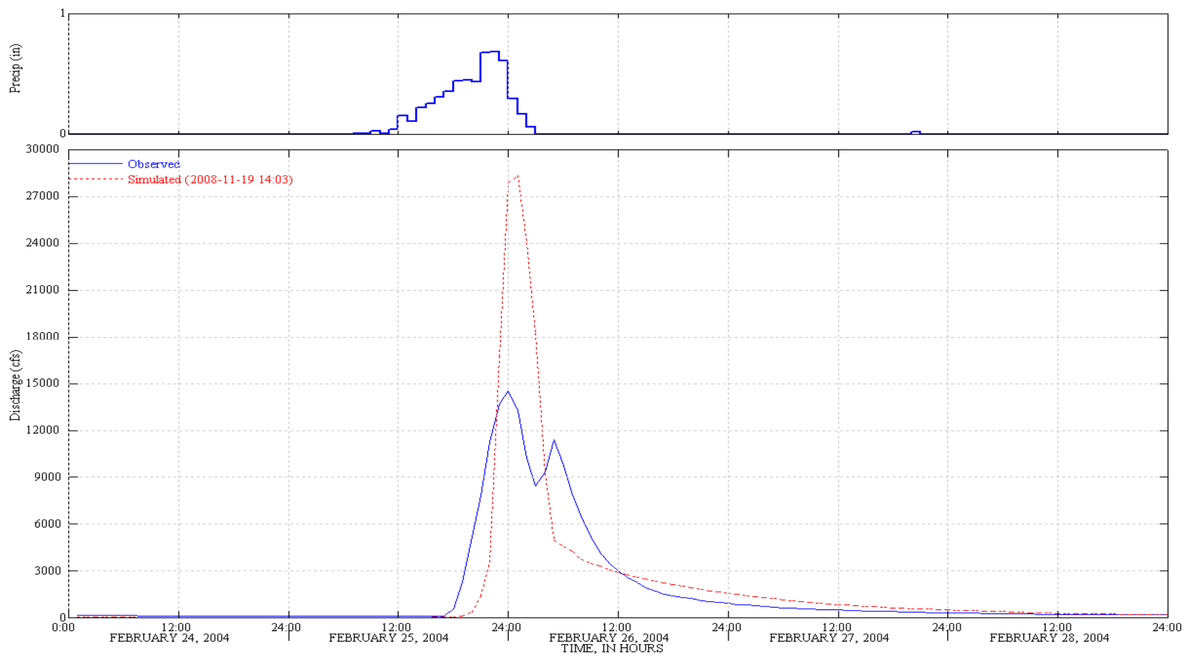

Figure 18 Simulated and Observed February 25-26, 2004 Storm Event

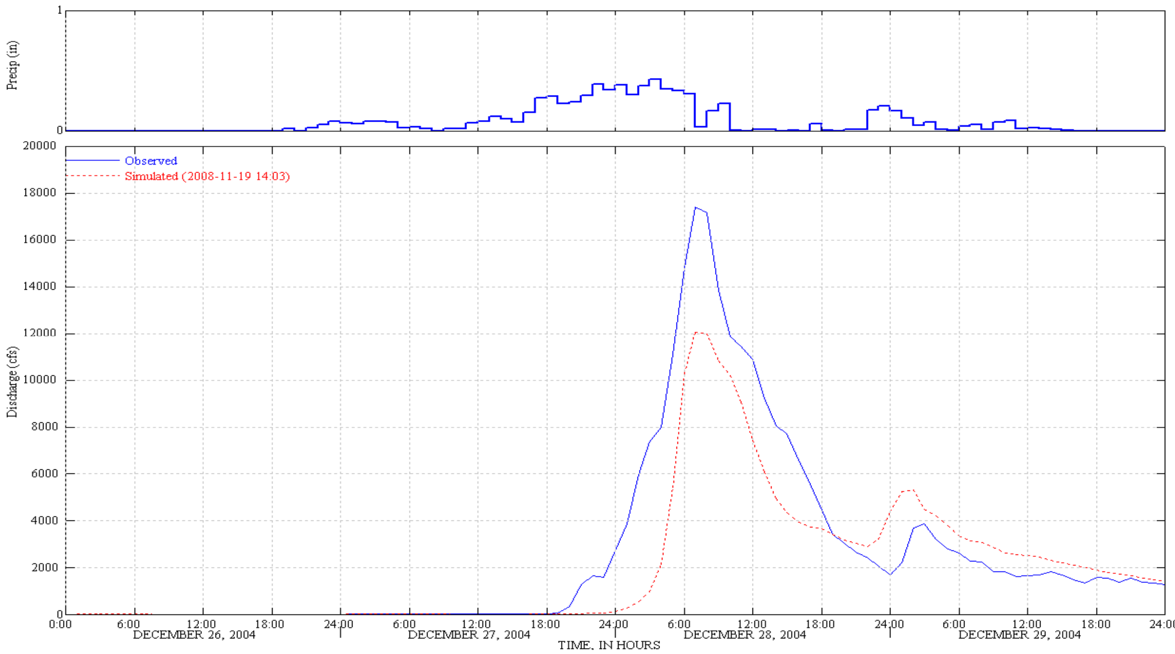

Figure 19 Simulated and Observed December 27-29, 2004 Storm Event

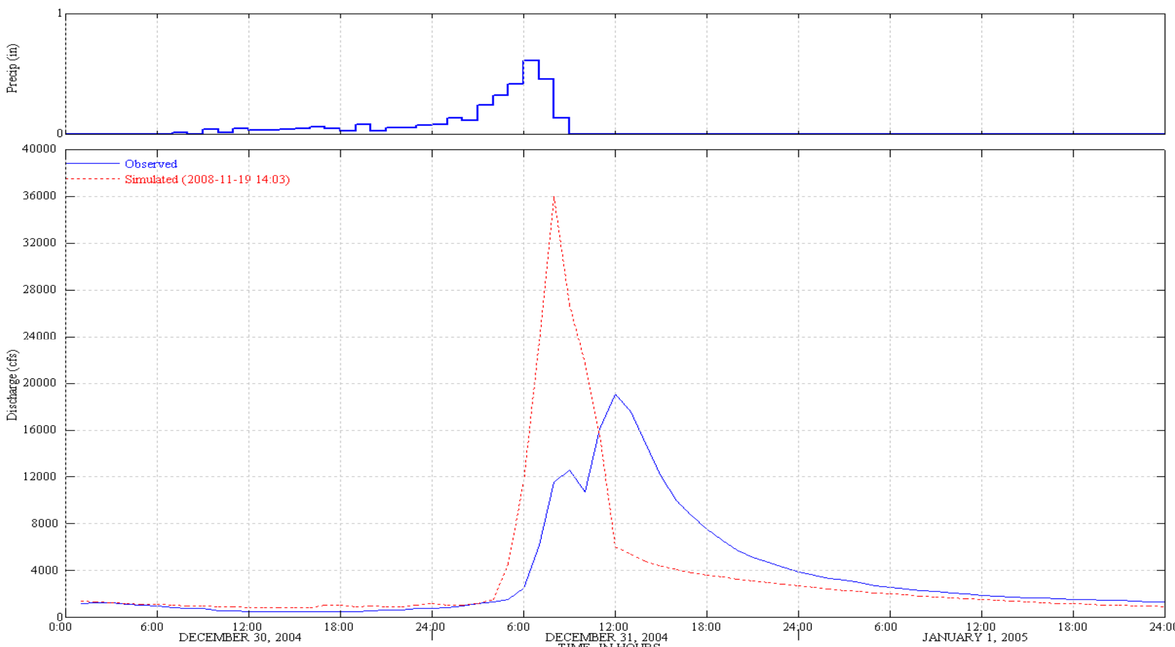

Figure 20 Simulated and Observed December 31, 2004 Storm Event

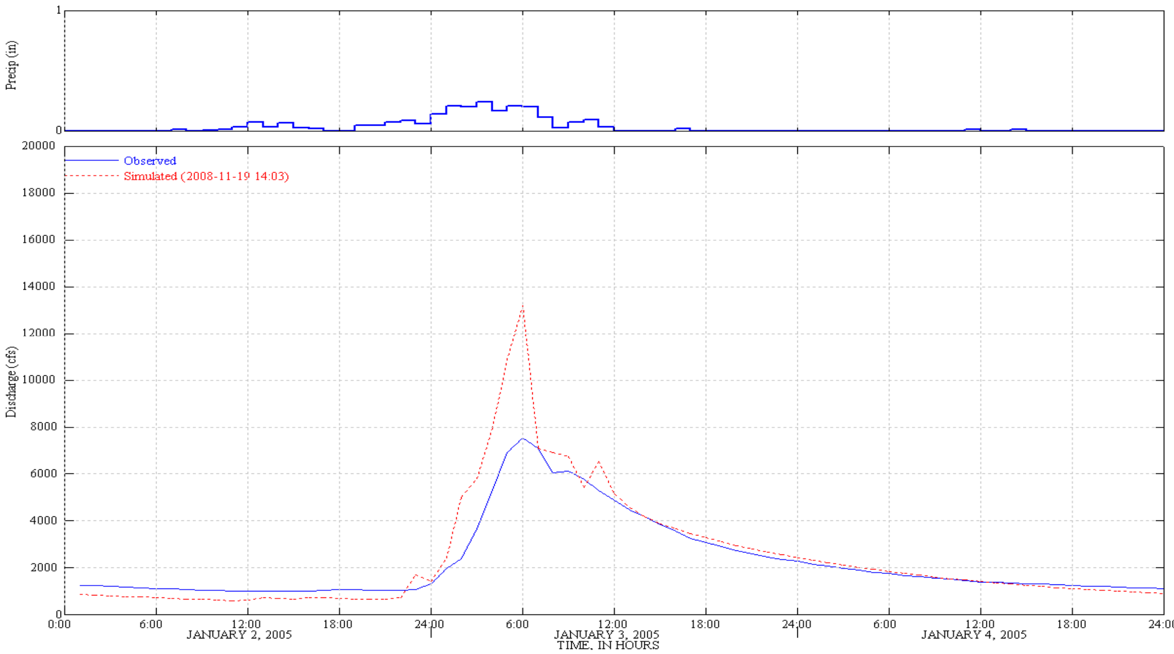

Figure 21 Simulated and Observed January 3, 2005 Storm Event

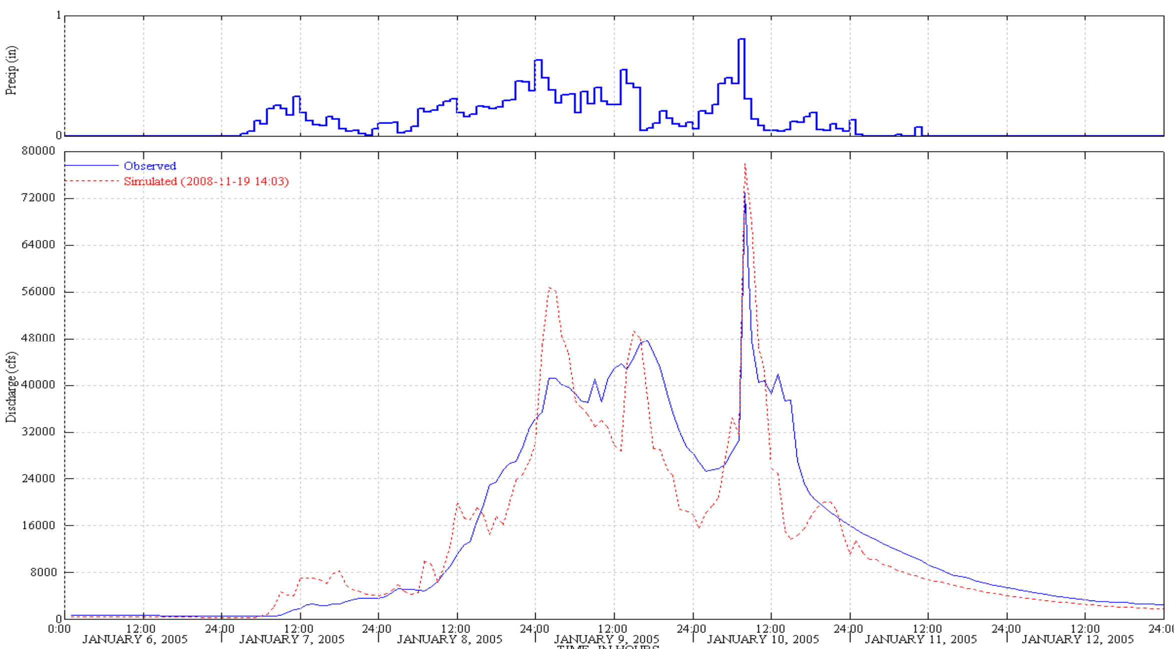

Figure 22 Simulated and Observed January 8-10, 2005 Storm Event

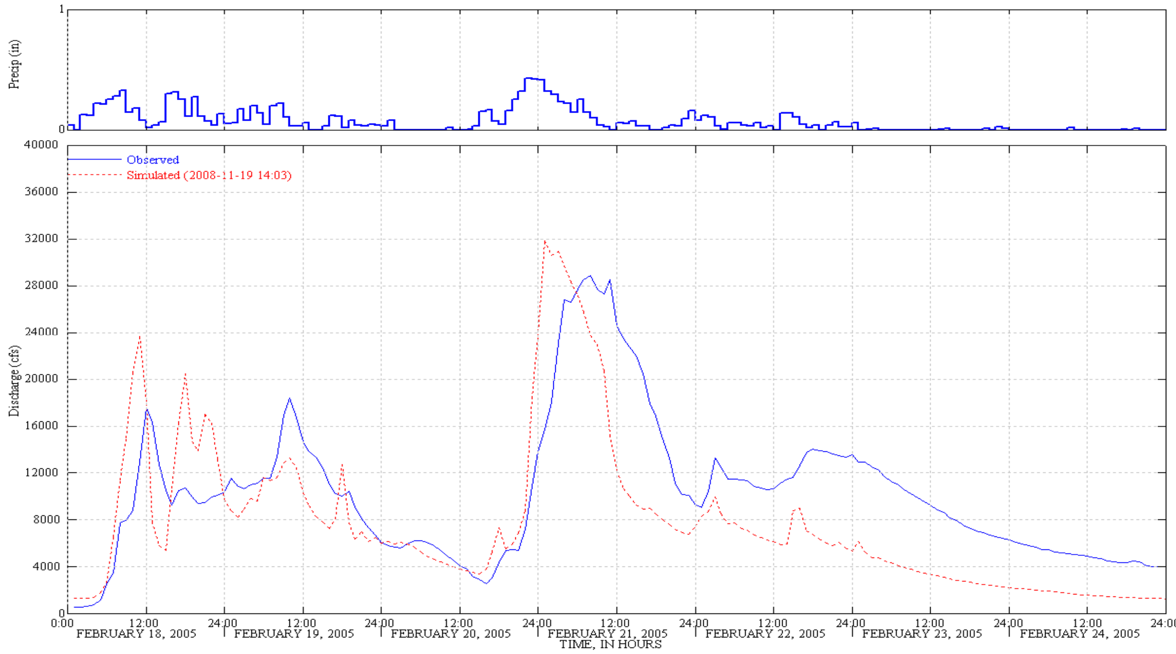

Figure 23 Simulated and Observed February 18-24, 2005 Storm Event

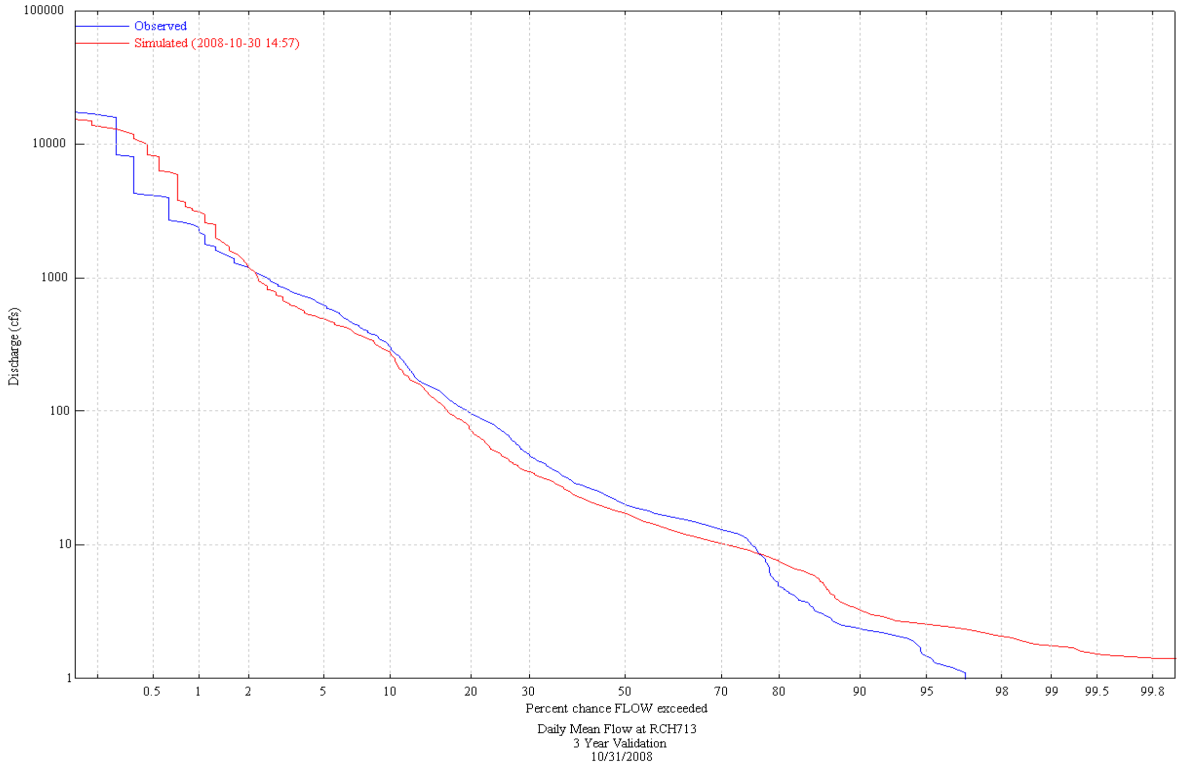

Figure 24 Simulated and Observed Daily Flow Duration Curve at Fillmore

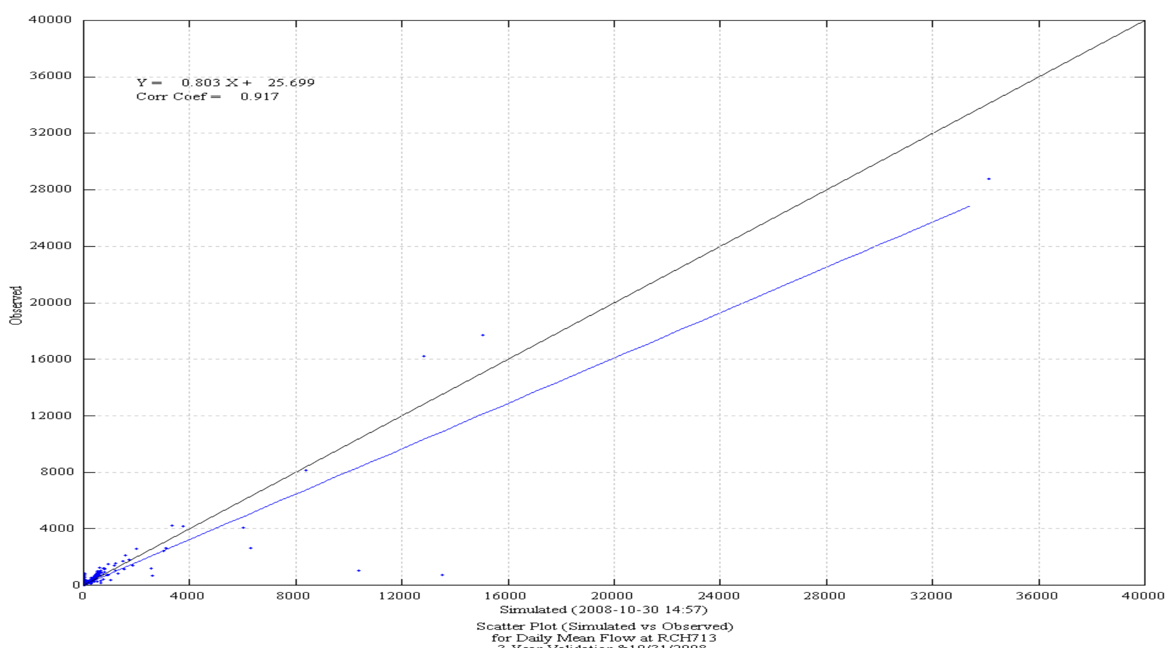

Figure 25 Daily Scatter Plot of Simulated versus Observed Flow at Fillmore

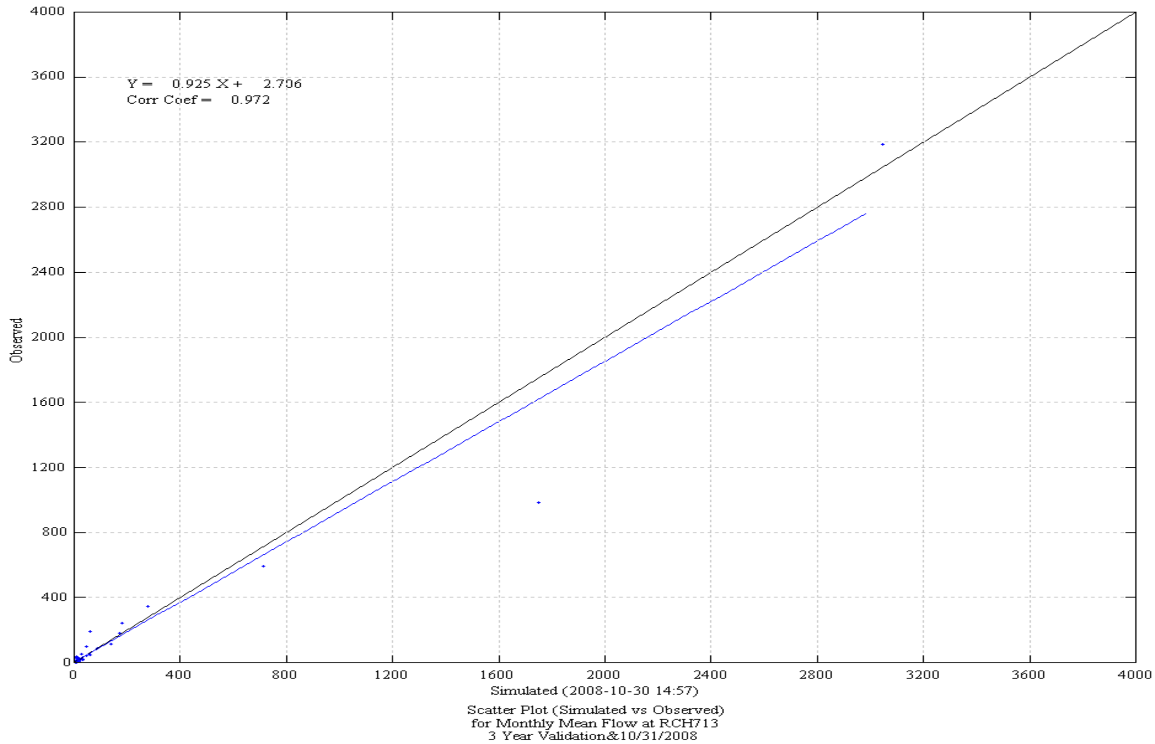

Figure 26 Monthly Scatter Plot of Simulated versus Observed Flow at Fillmore

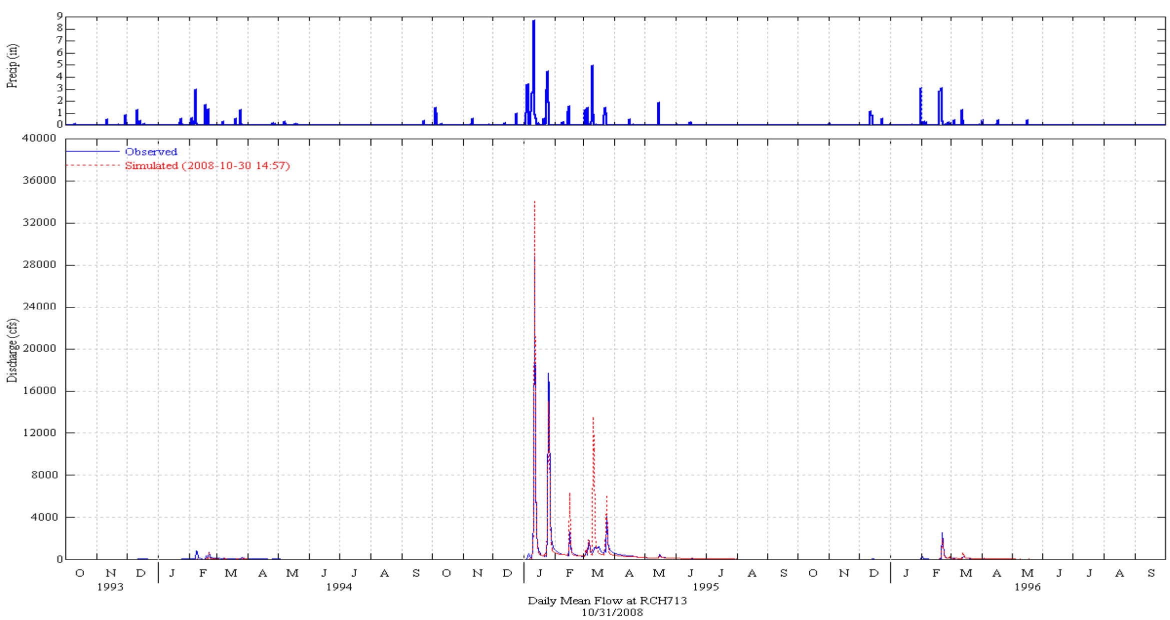

Figure 27 Simulated and Observed Daily Flow at Fillmore (WY 1994-1996)

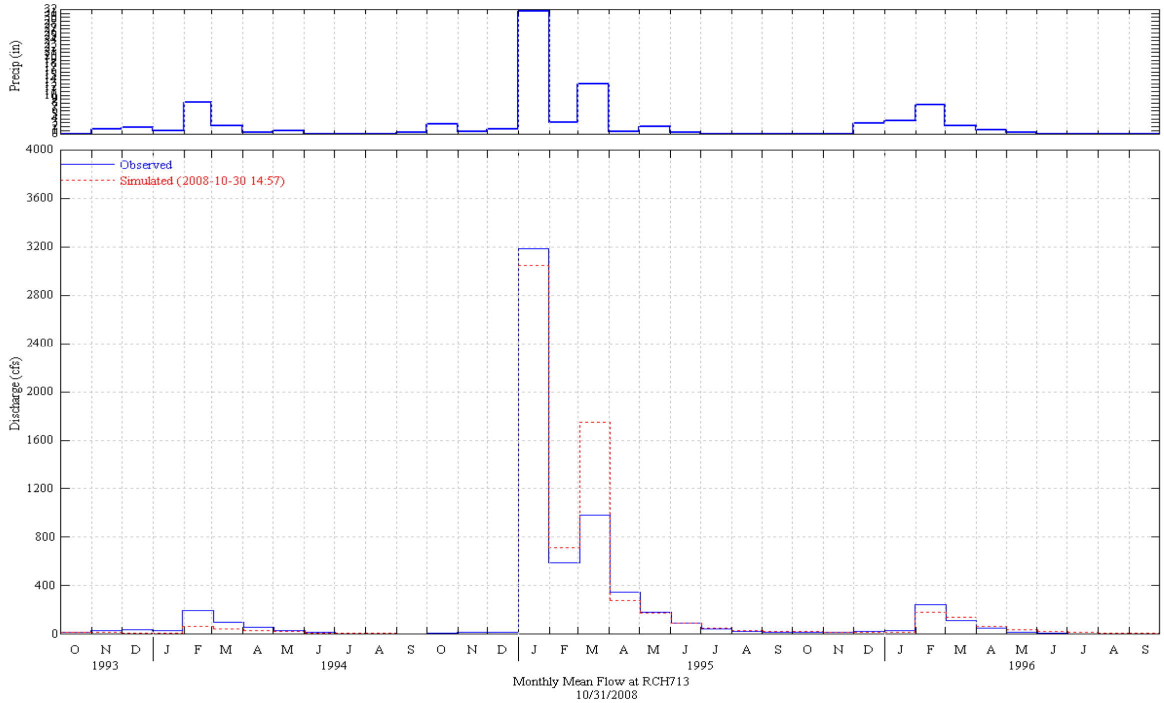

Figure 28 Simulated and Observed Monthly Flow at Fillmore (WY 1994-1996)

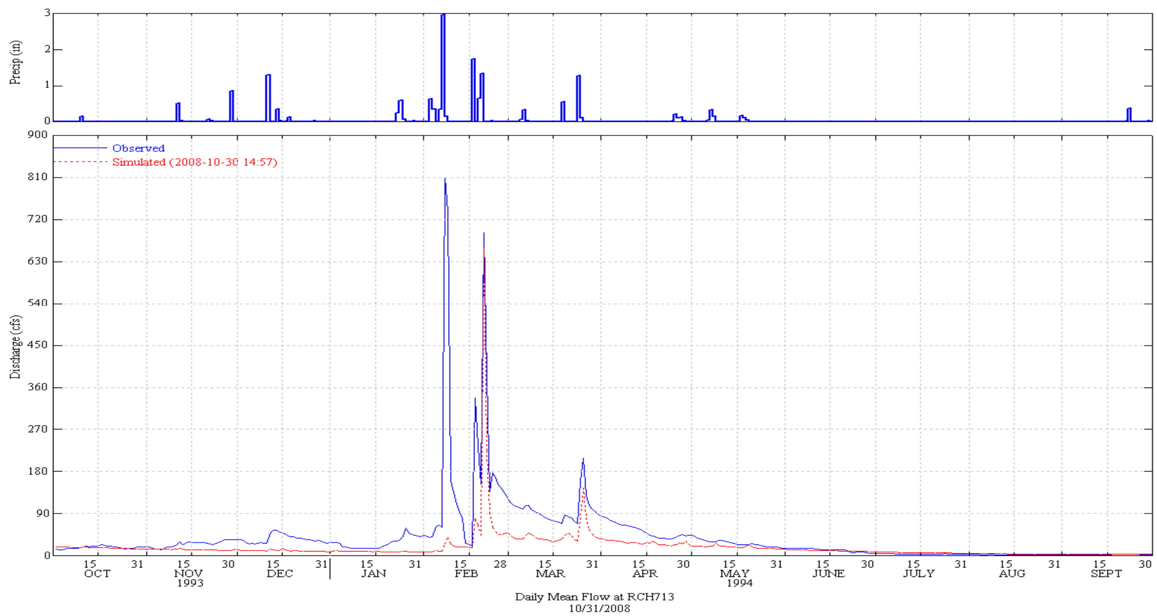

Figure 29 Simulated and Observed Daily Flow at Fillmore (WY 1994)

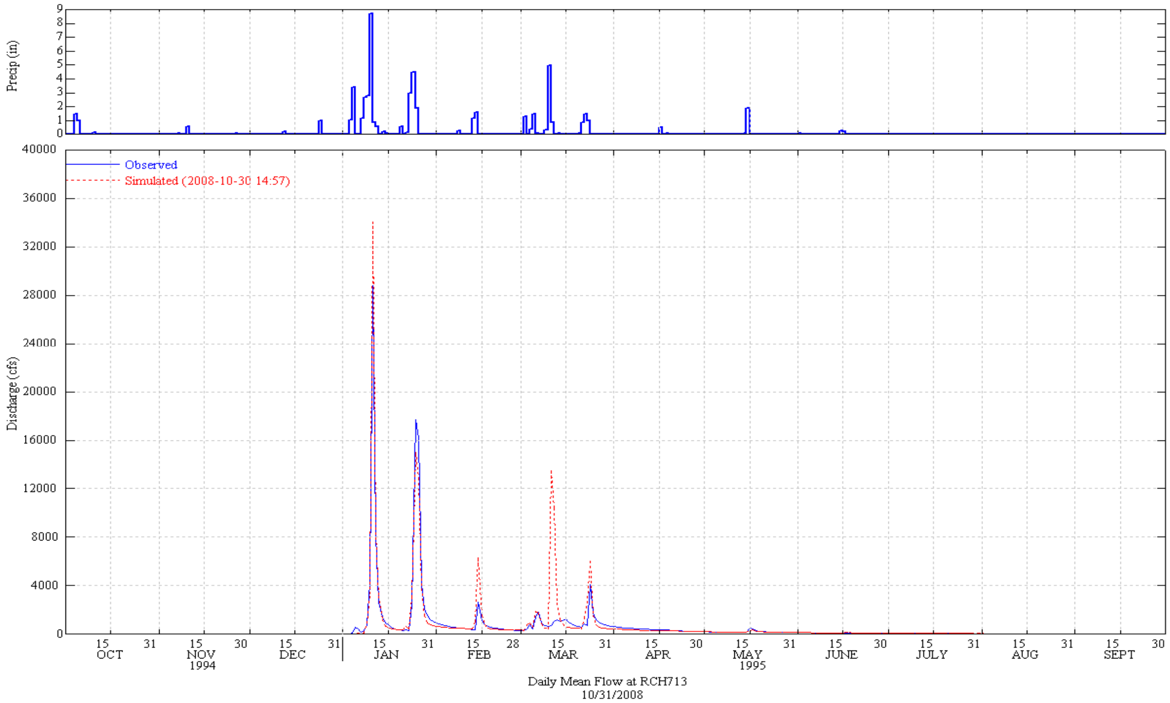

Figure 30 Simulated and Observed Daily Flow at Fillmore (WY 1995)

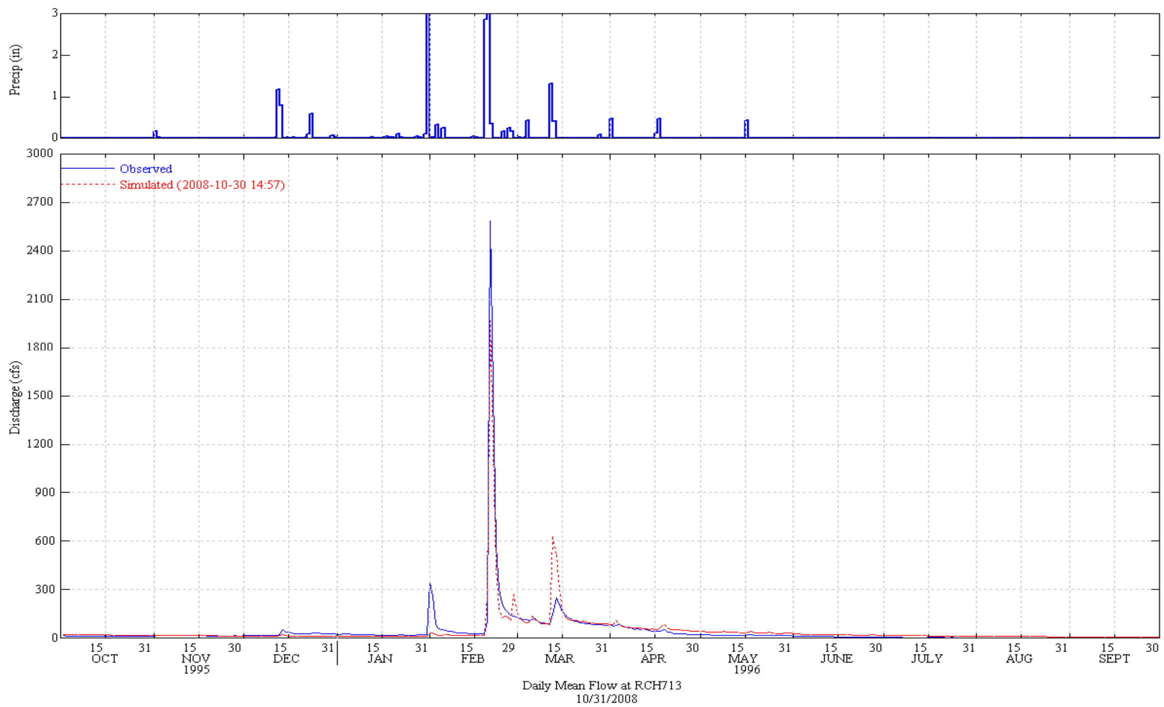

Figure 31 Simulated and Observed Daily Flow at Fillmore (WY 1996)

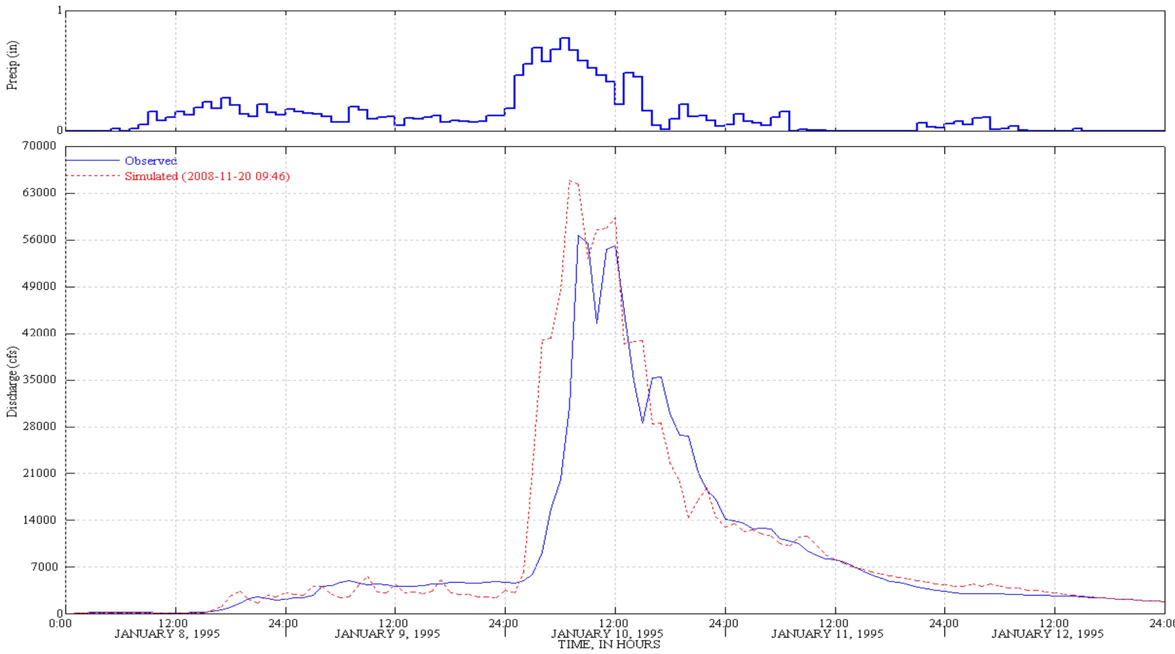

Figure 32 Simulated and Observed January 8-12, 1995 Storm Event

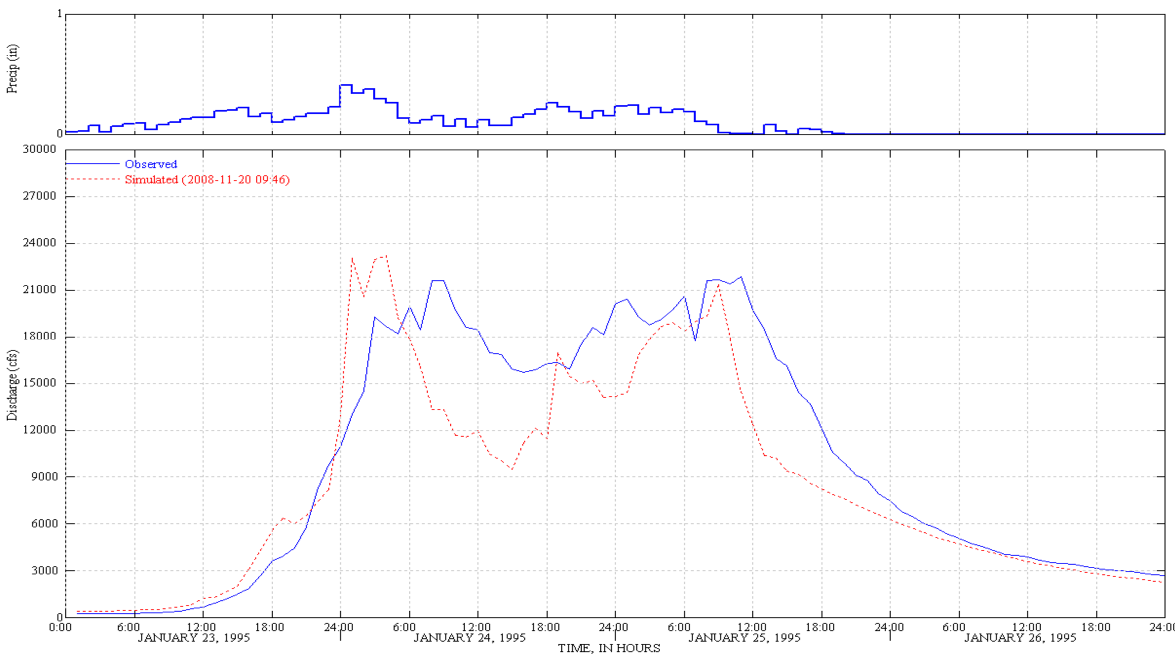

Figure 33 Simulated and Observed January 23-26, 1995 Storm Event

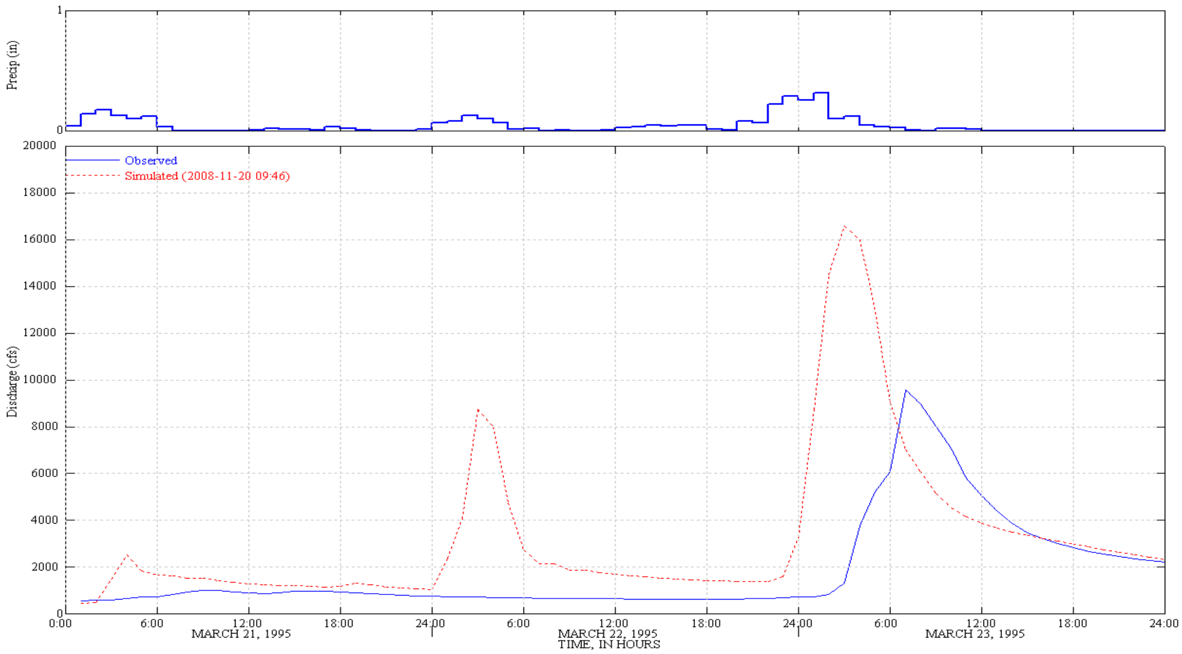

Figure 34 Simulated and Observed March 21-23, 1995 Storm Event

APPENDIX B

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SESPE CREEK WATERSHED AT WHEELER SPRINGS

Title Page

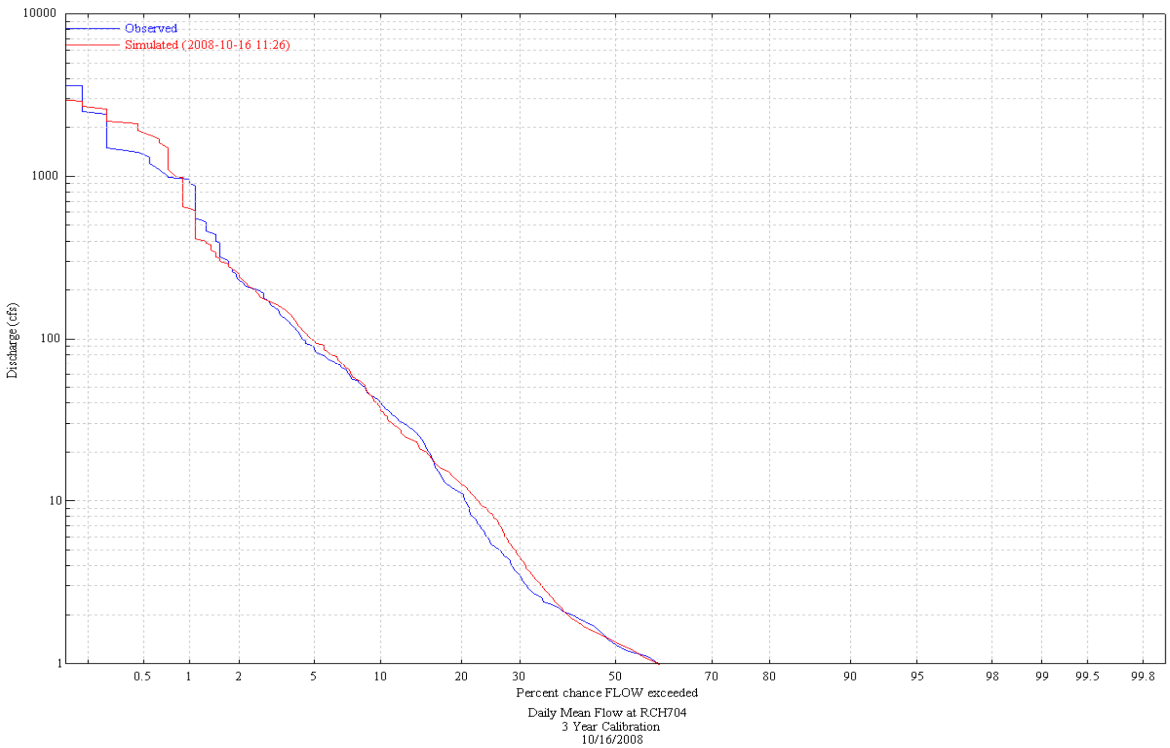

Figure 1 Simulated and Observed Daily Flow Duration Curve at Wheeler Springs

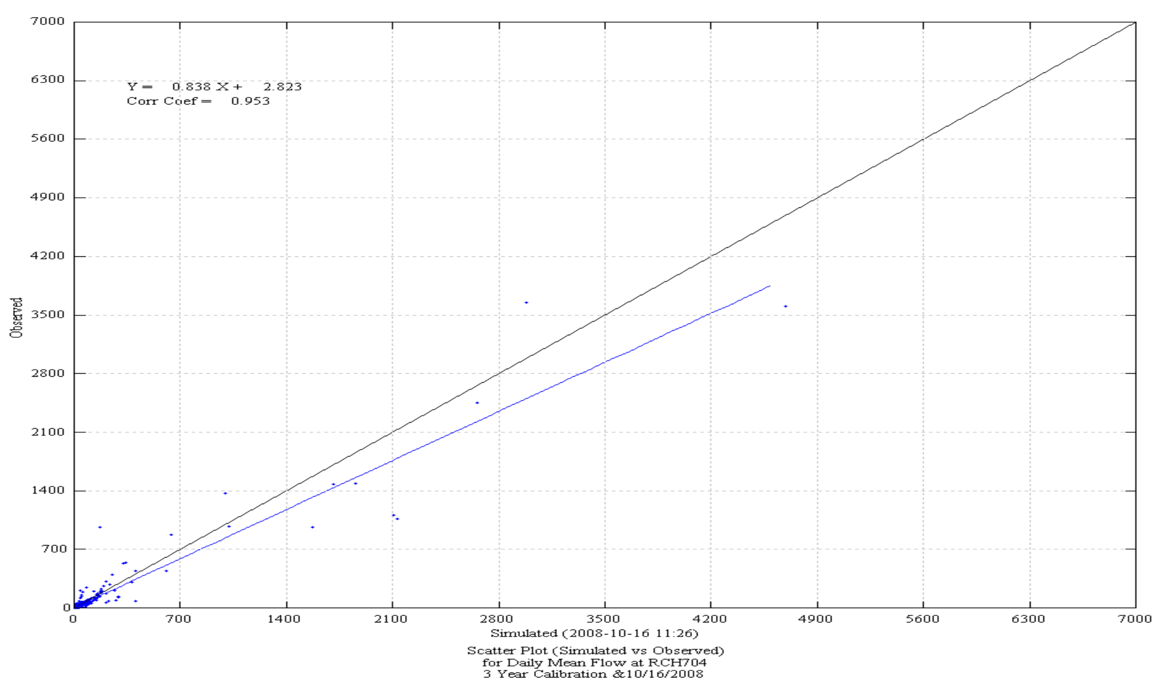

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Wheeler Springs

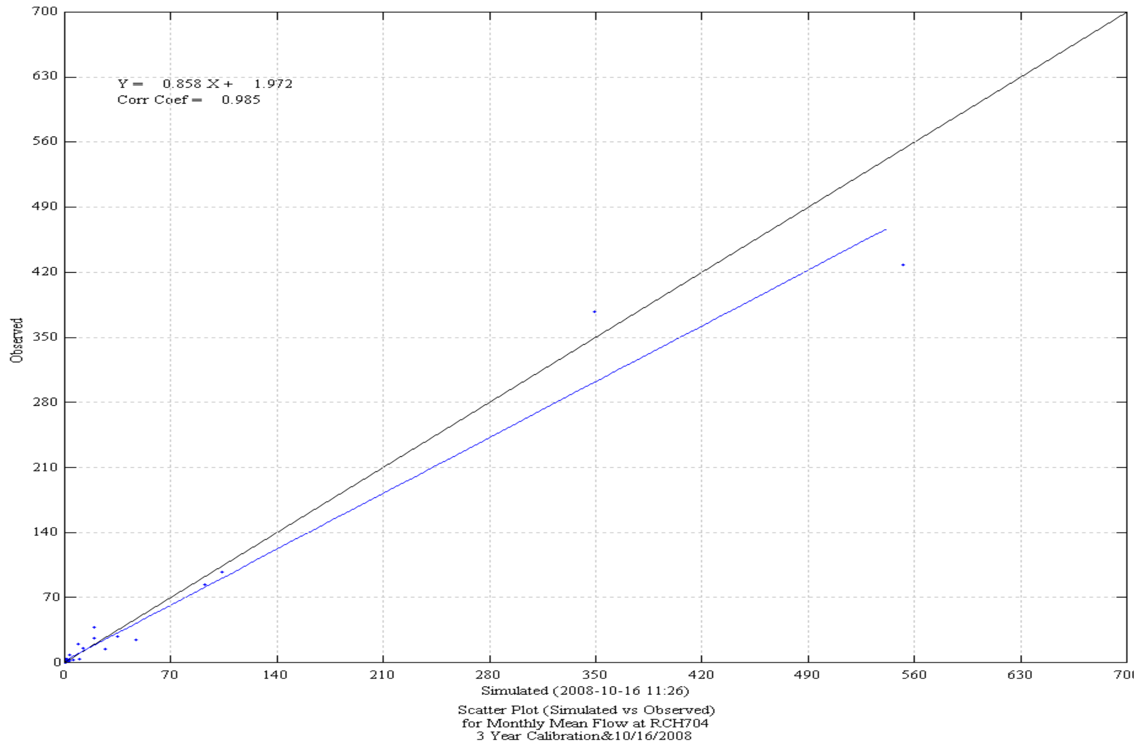

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Wheeler Springs

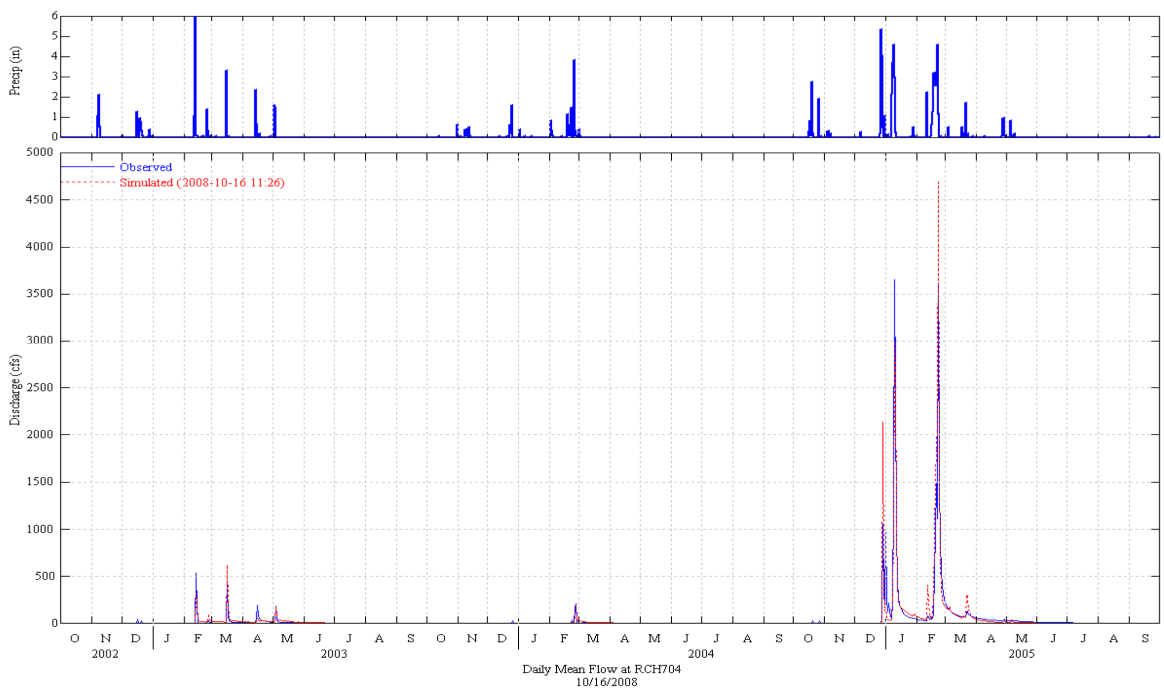

Figure 4 Simulated and Observed Daily Flow at Wheeler Springs (WY 2003-2005)

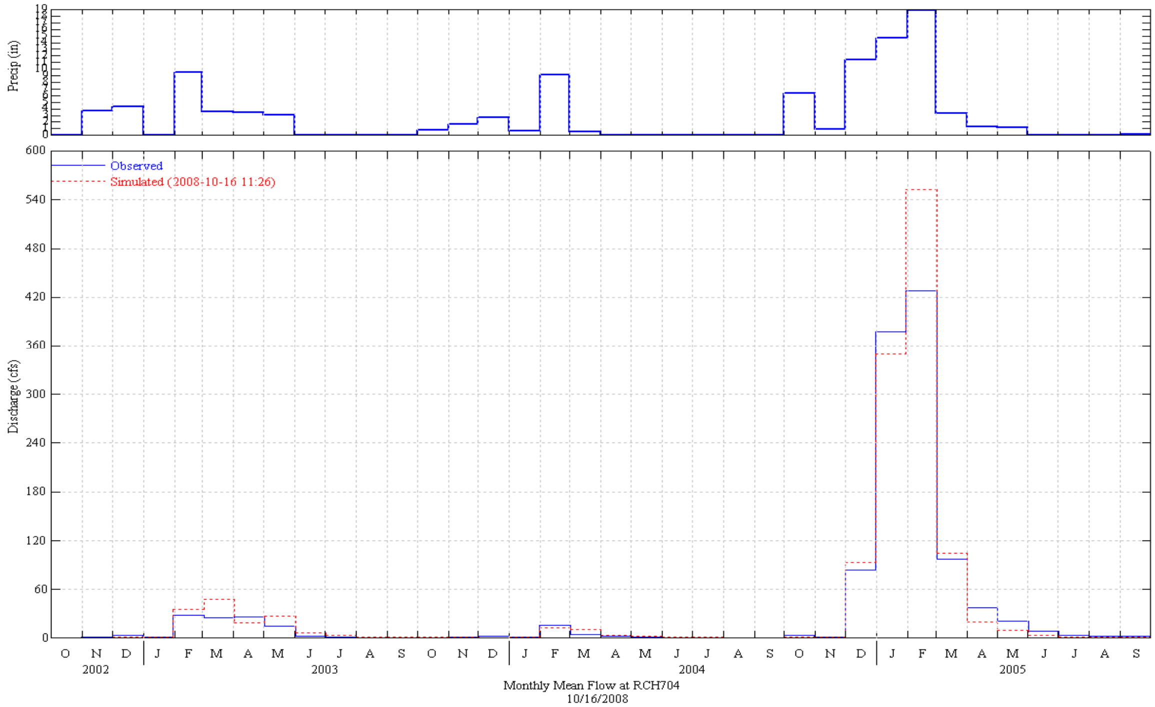

Figure 5 Simulated and Observed Monthly Flow at Wheeler Springs (WY 2003-2005)

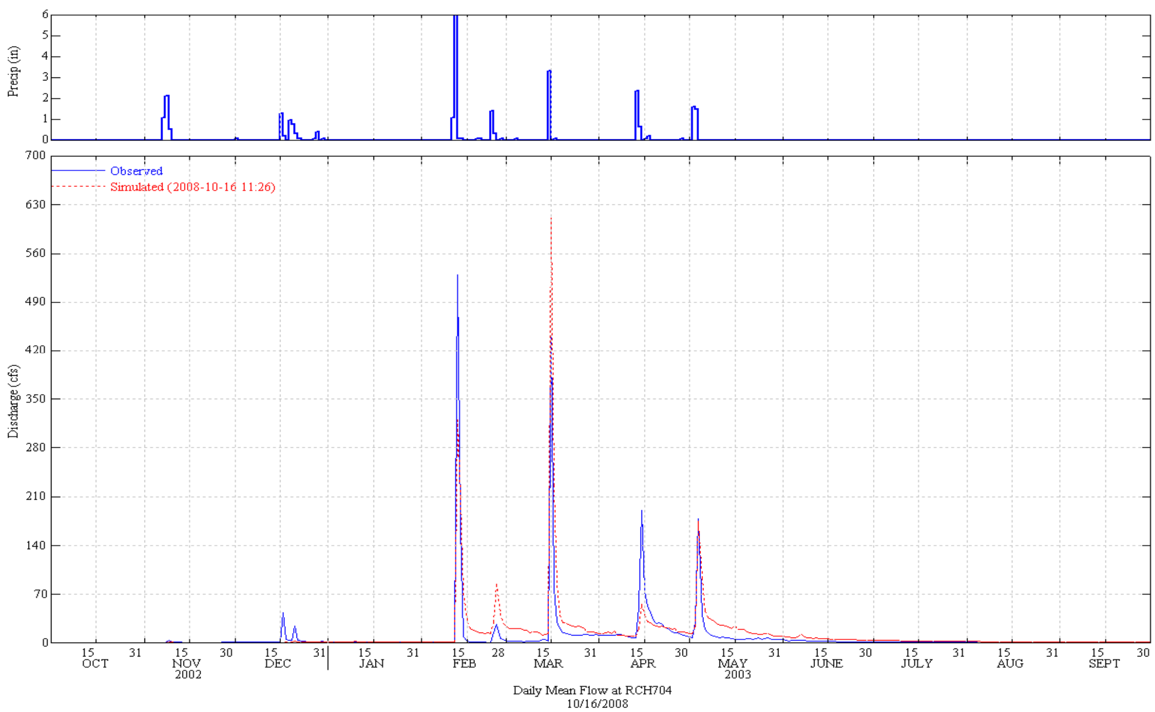

Figure 6 Simulated and Observed Daily Flow at Wheeler Springs (WY 2003)

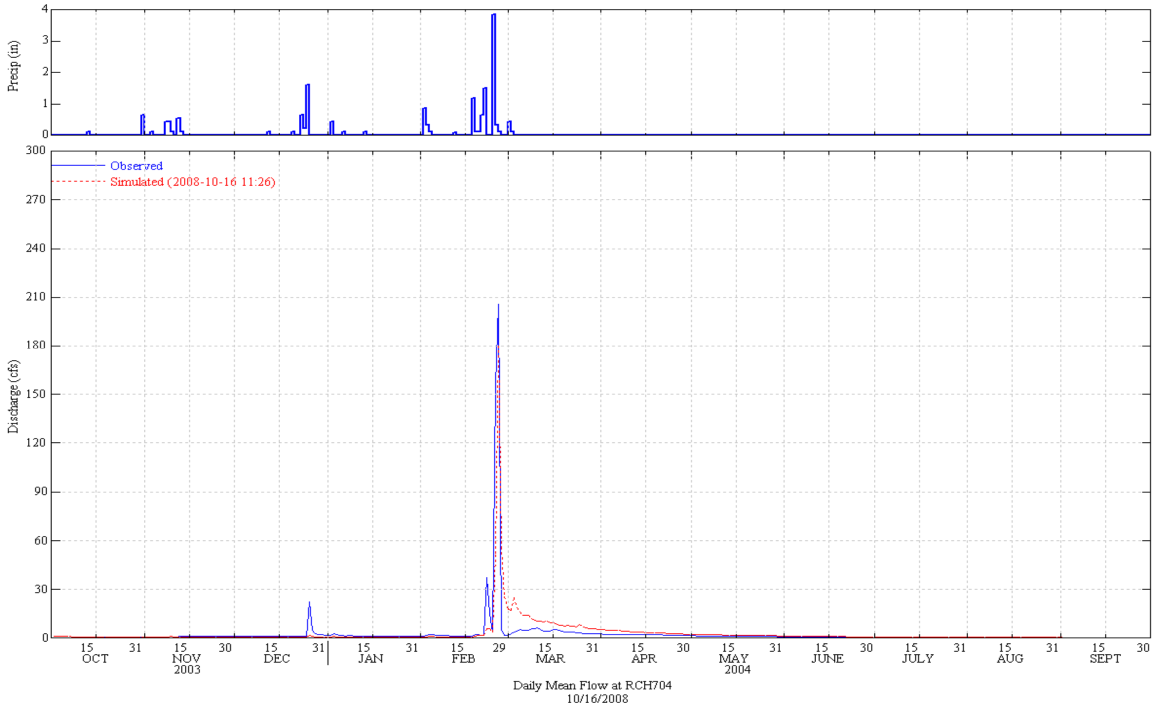

Figure 7 Simulated and Observed Daily Flow at Wheeler Springs (WY 2004)

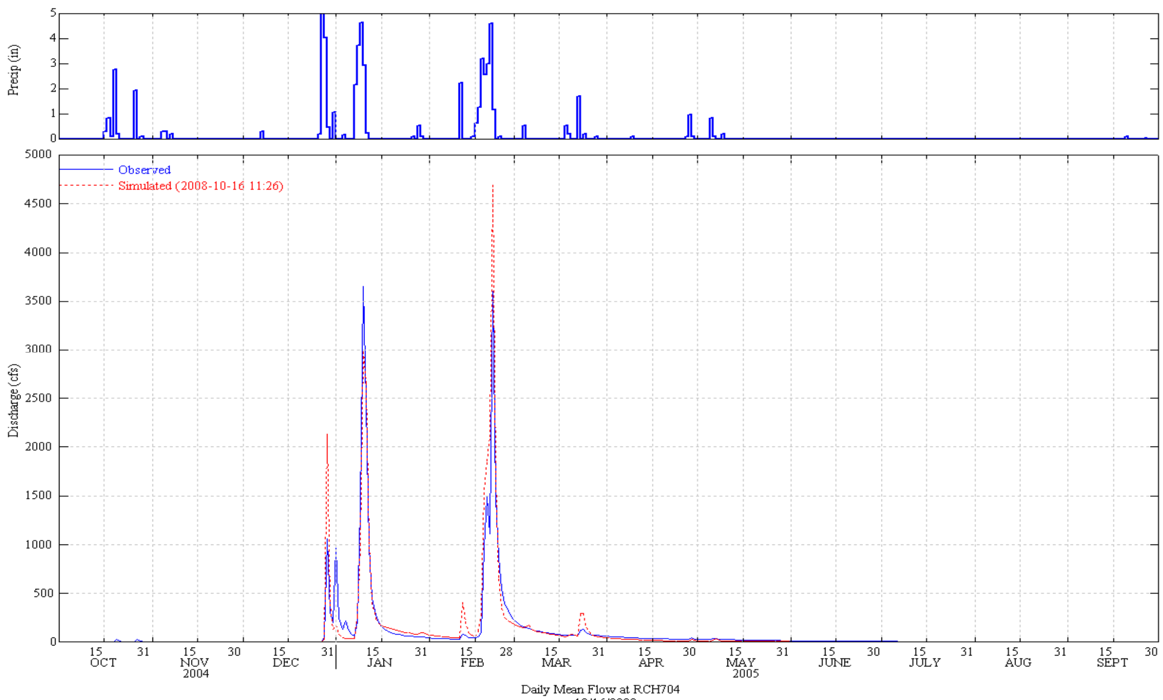

Figure 8 Simulated and Observed Daily Flow at Wheeler Springs (WY 2005)

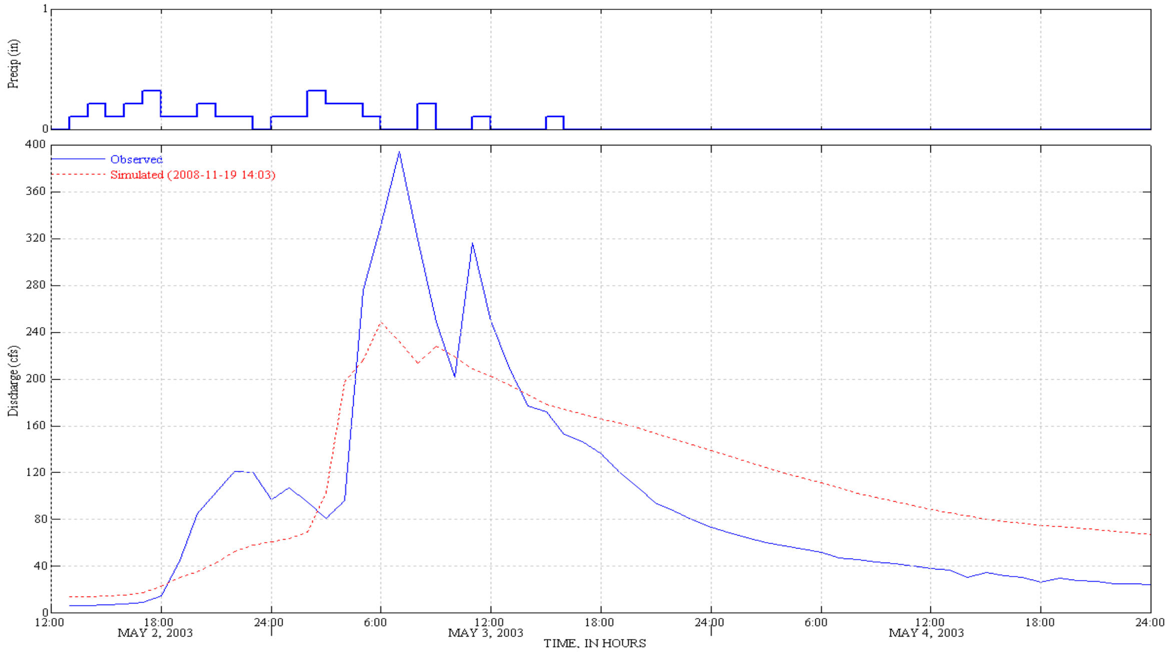

Figure 9 Simulated and Observed May 2-3, 2003 Storm Event

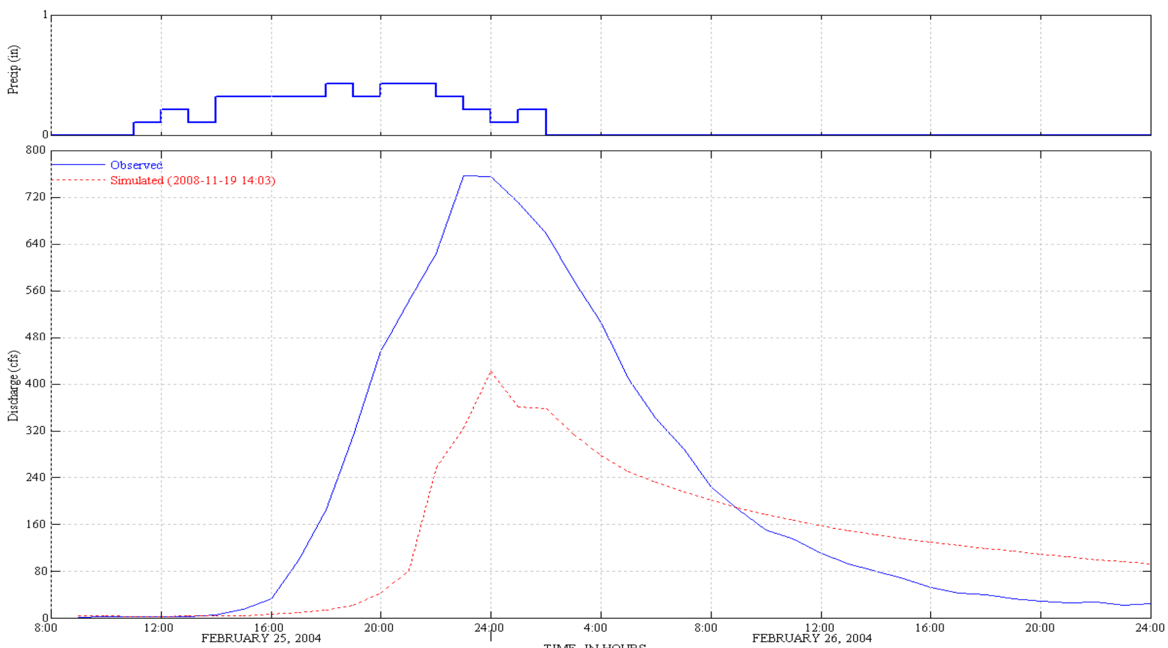

Figure 10 Simulated and Observed February 25-26, 2004 Storm Event

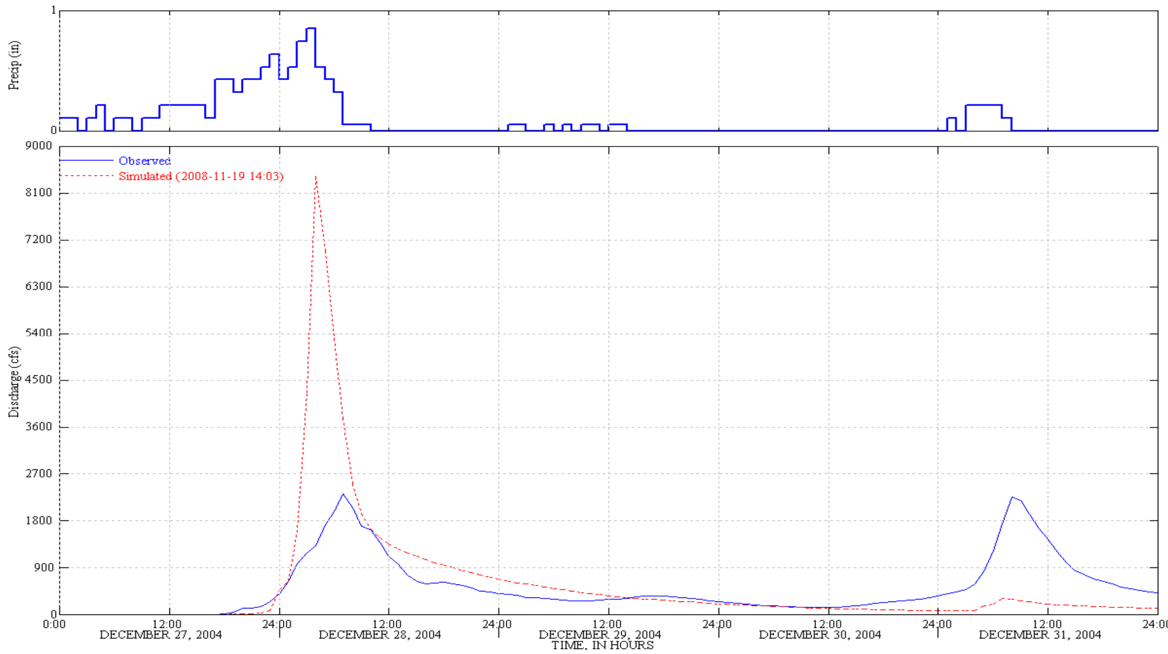

Figure 11 Simulated and Observed December 27-31, 2004 Storm Event

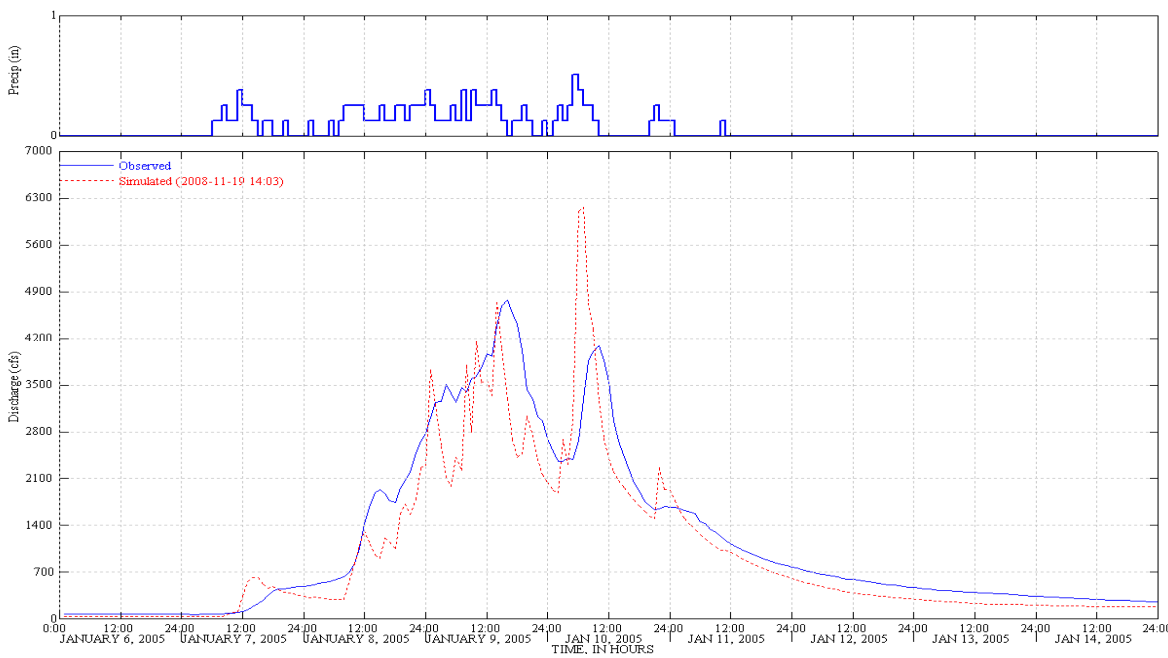

Figure 12 Simulated and Observed January 6-12, 2005 Storm Event

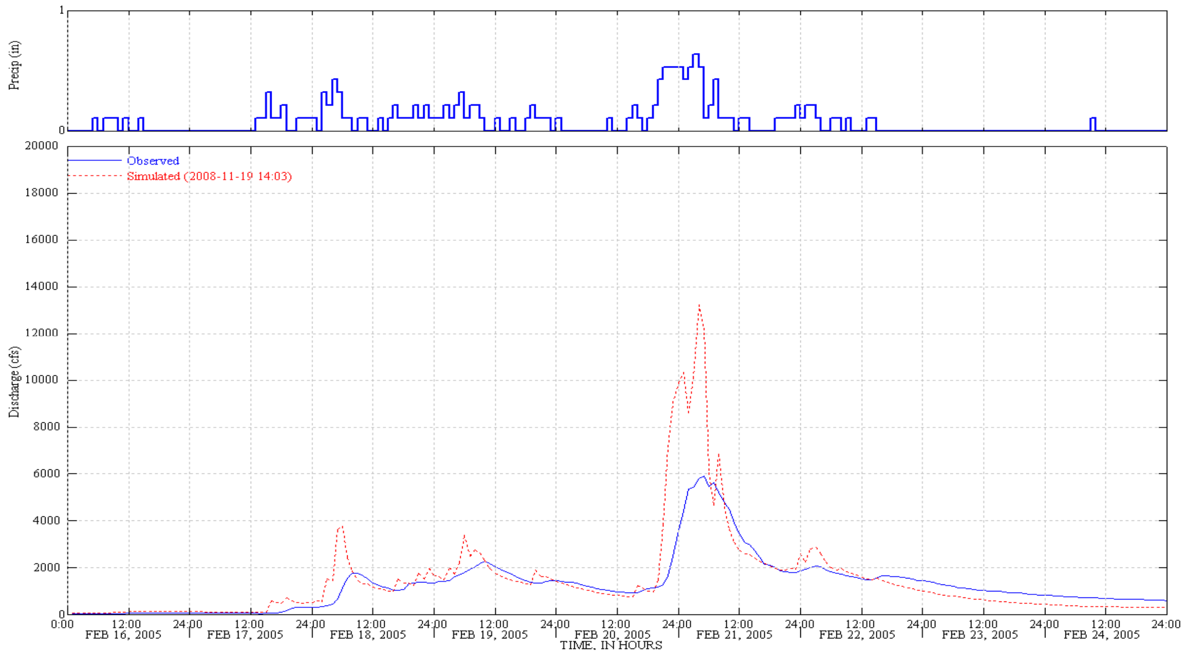

Figure 13 Simulated and Observed February 16-25, 2005 Storm Event

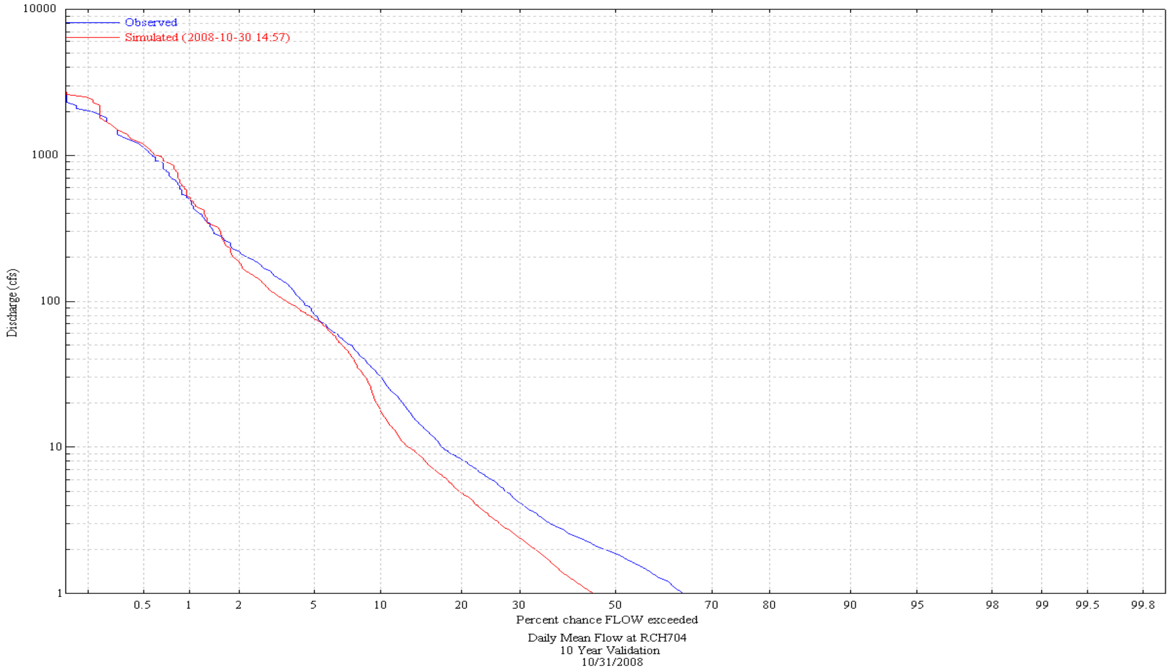

Figure 14 Simulated and Observed Daily Flow Duration Curve at Wheeler Springs

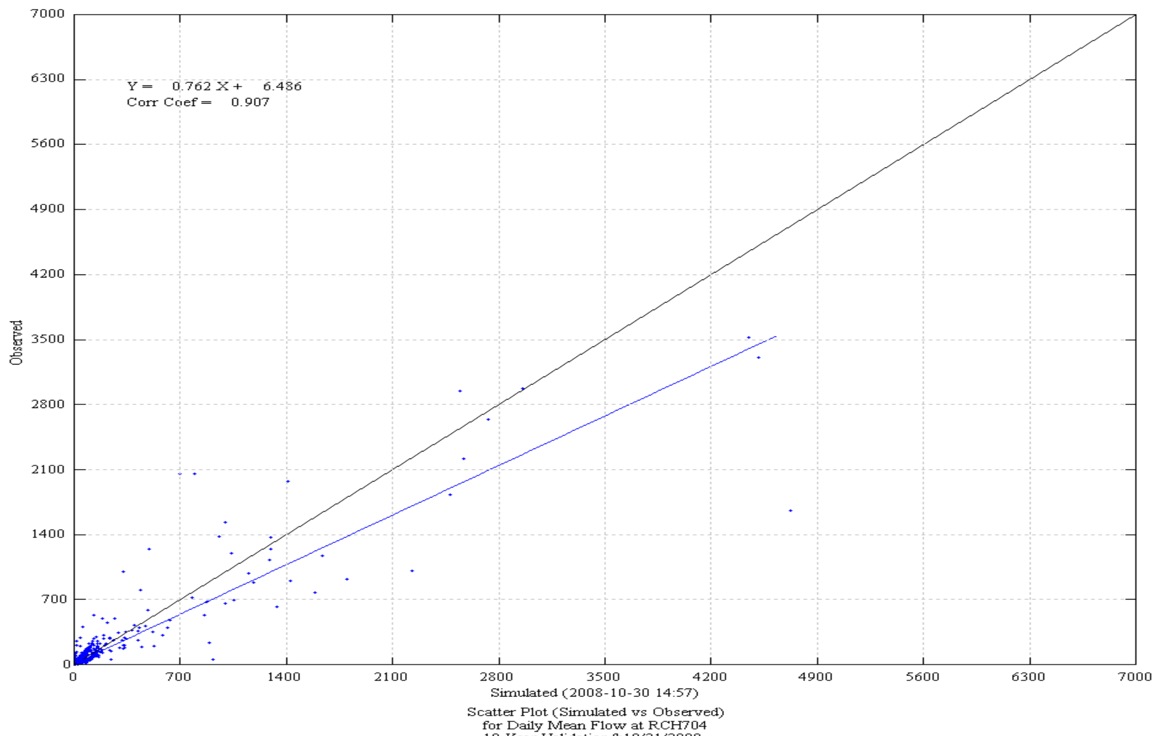

Figure 15 Daily Scatter Plot of Simulated versus Observed Flow at Wheeler Springs

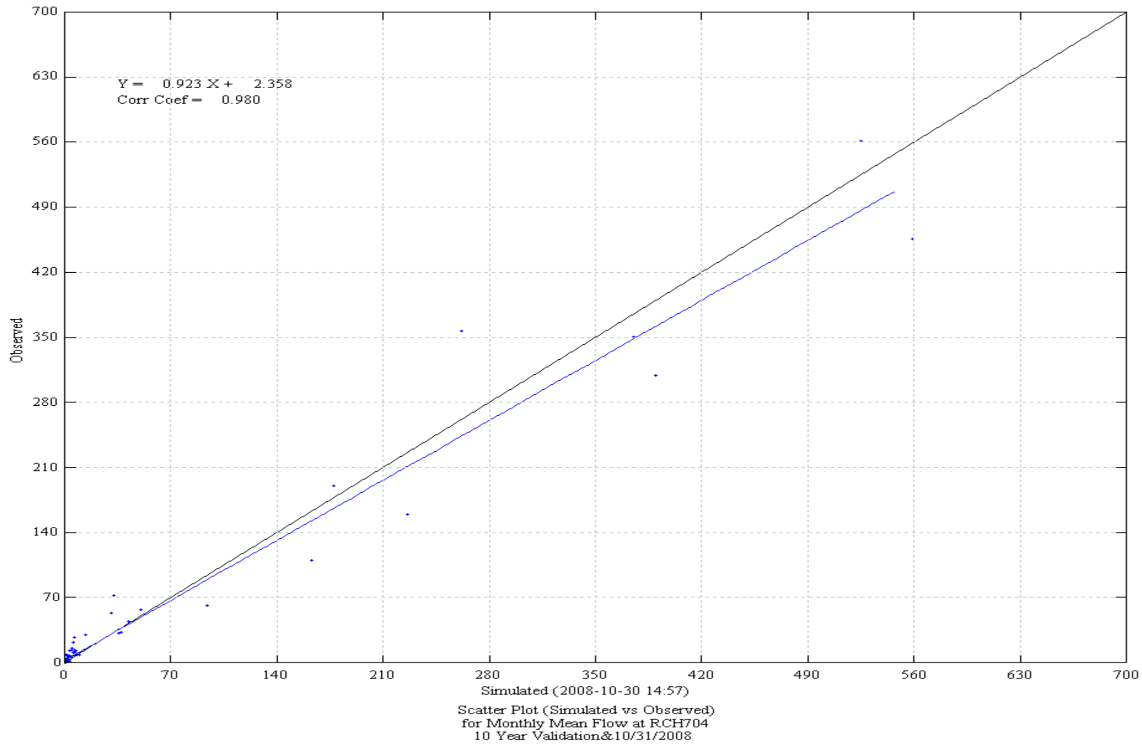

Figure 16 Monthly Scatter Plot of Simulated versus Observed Flow at Wheeler Springs

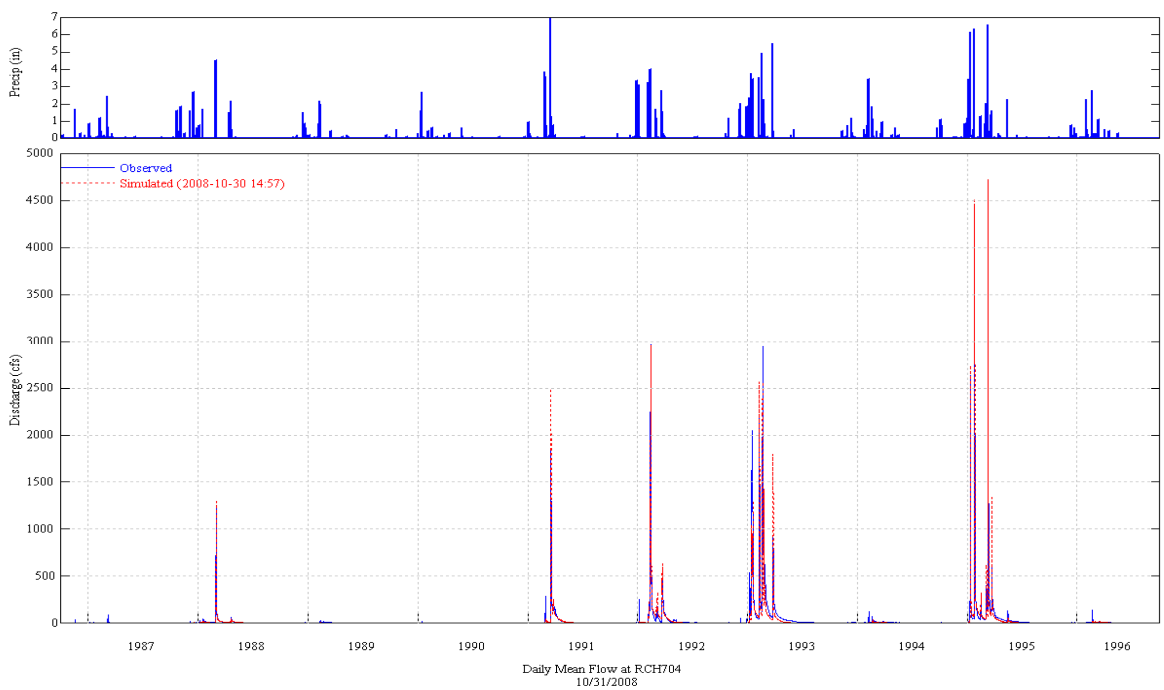

Figure 17 Simulated and Observed Daily Flow at Wheeler Springs (WY 1987-1996)

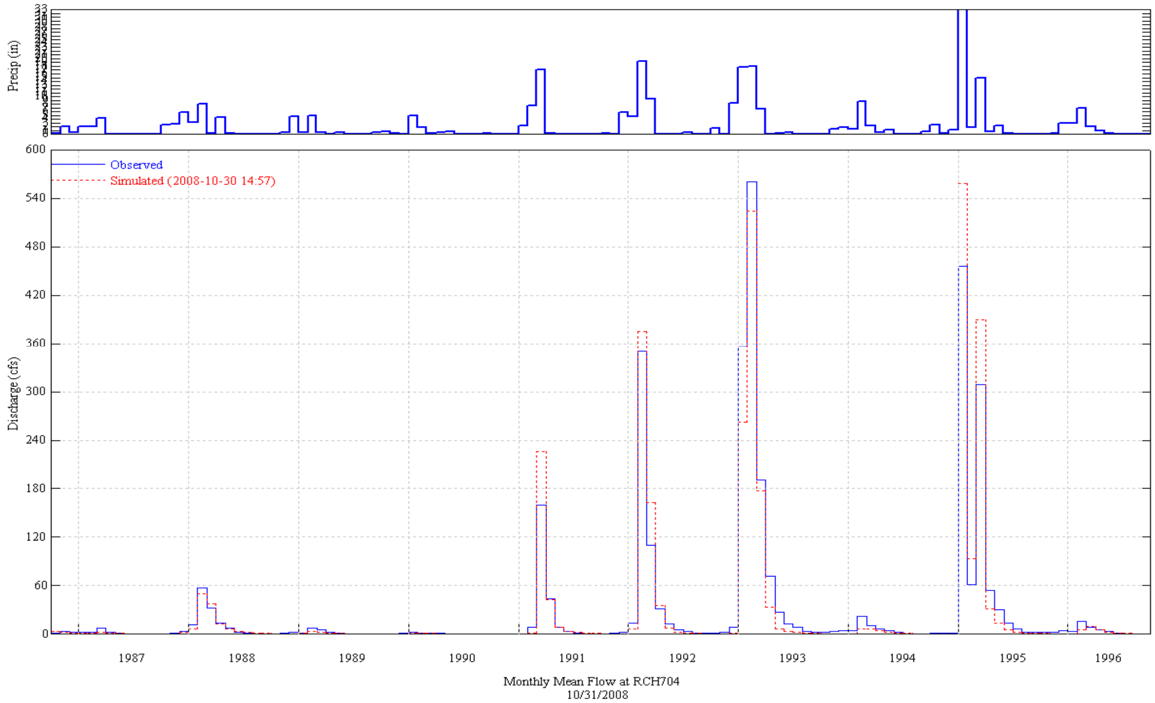

Figure 18 Simulated and Observed Monthly Flow at Wheeler Springs (WY 1987-1996)

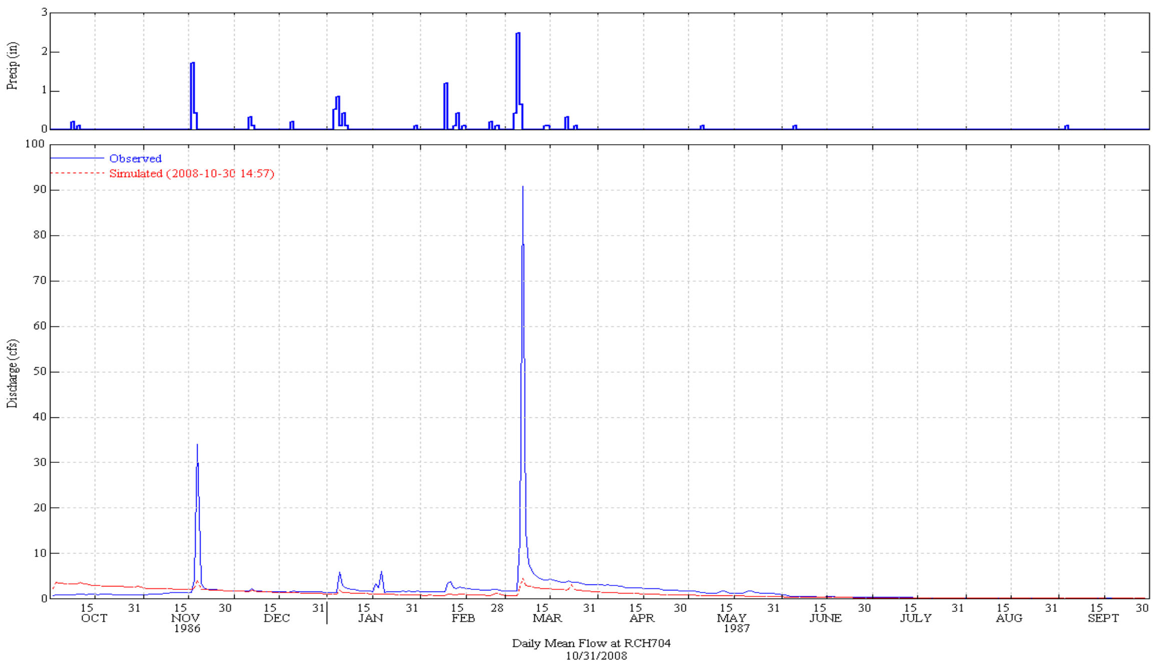

Figure 19 Simulated and Observed Daily Flow at Wheeler Springs (WY 1987)

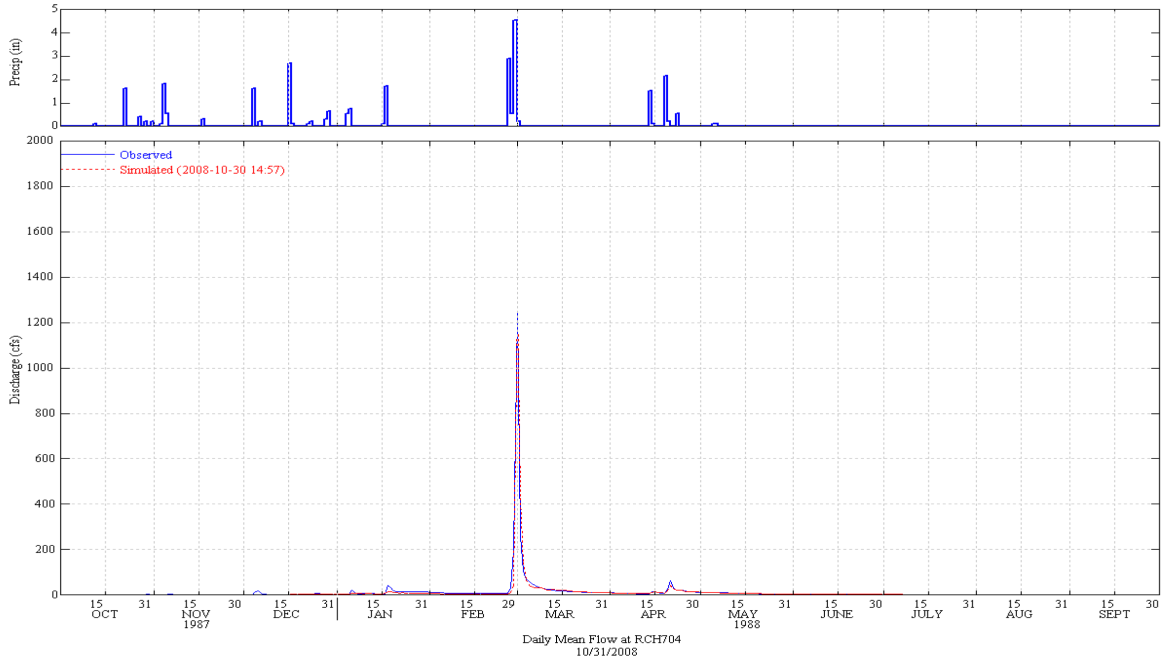

Figure 20 Simulated and Observed Daily Flow at Wheeler Springs (WY 1988)

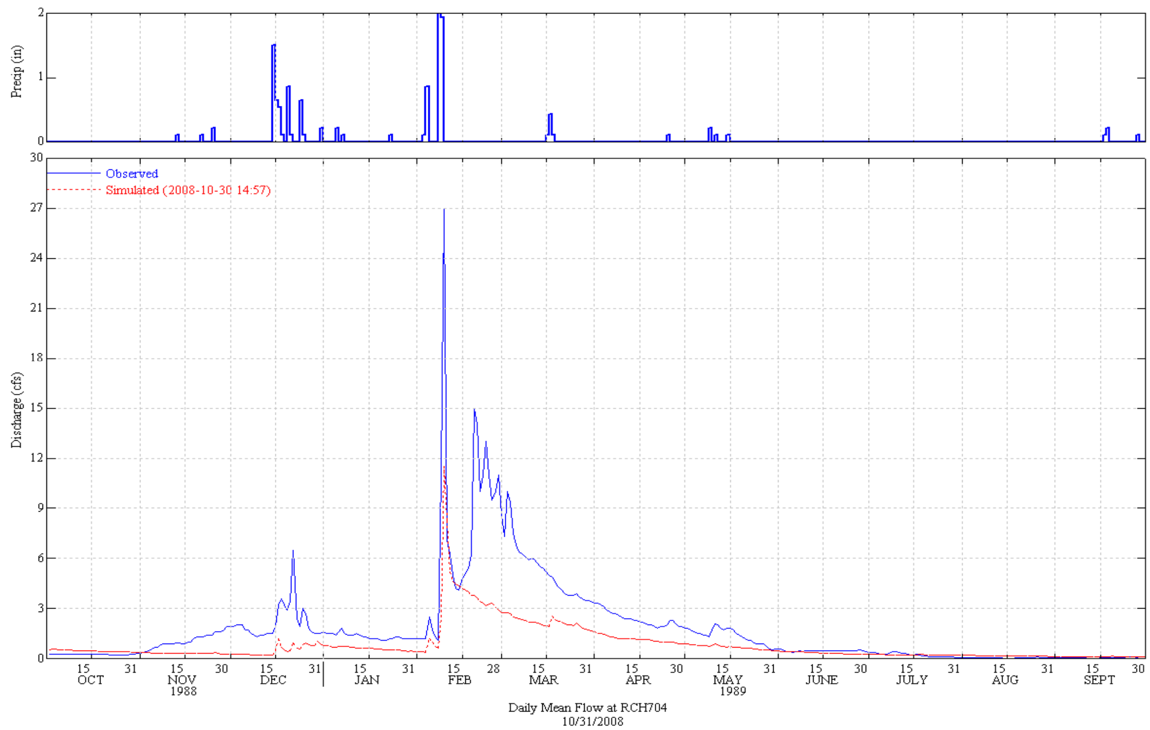

Figure 21 Simulated and Observed Daily Flow at Wheeler Springs (WY 1989)

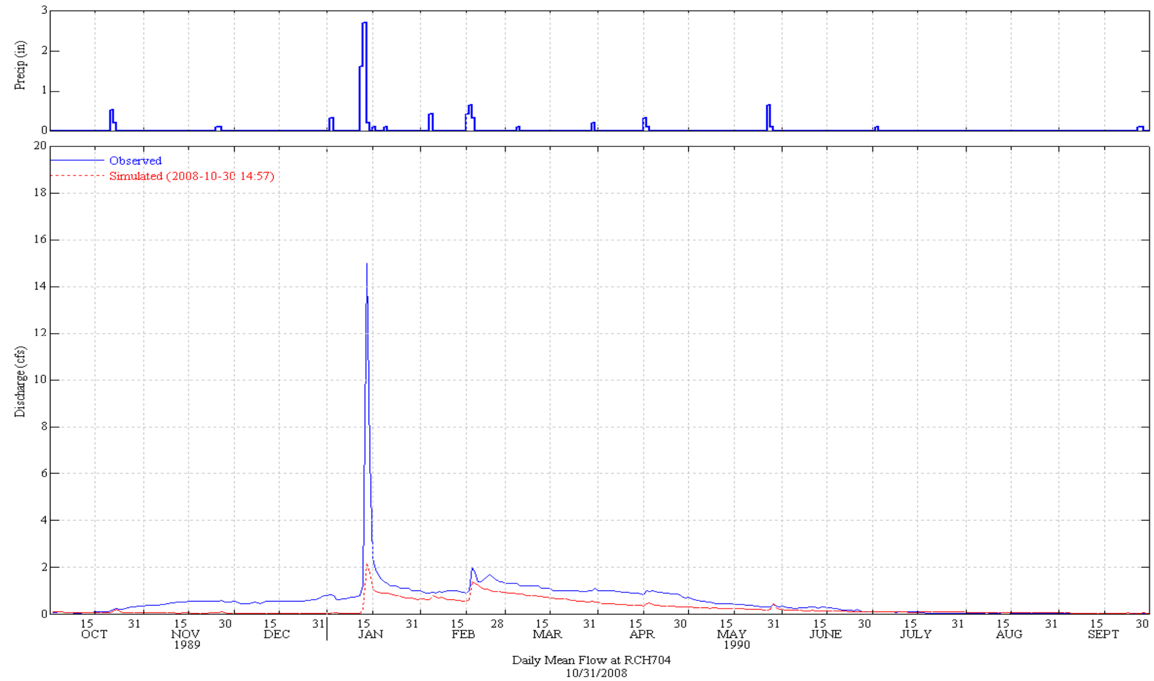

Figure 22 Simulated and Observed Daily Flow at Wheeler Springs (WY 1990)

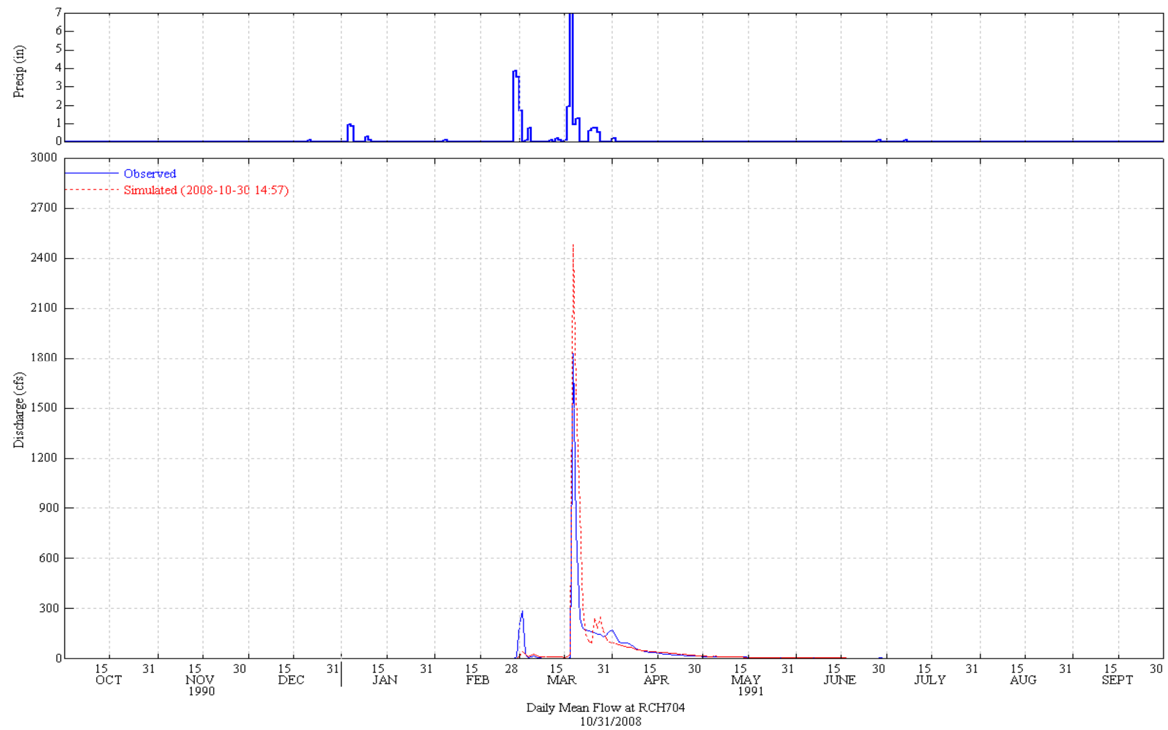

Figure 23 Simulated and Observed Daily Flow at Wheeler Springs (WY 1991)

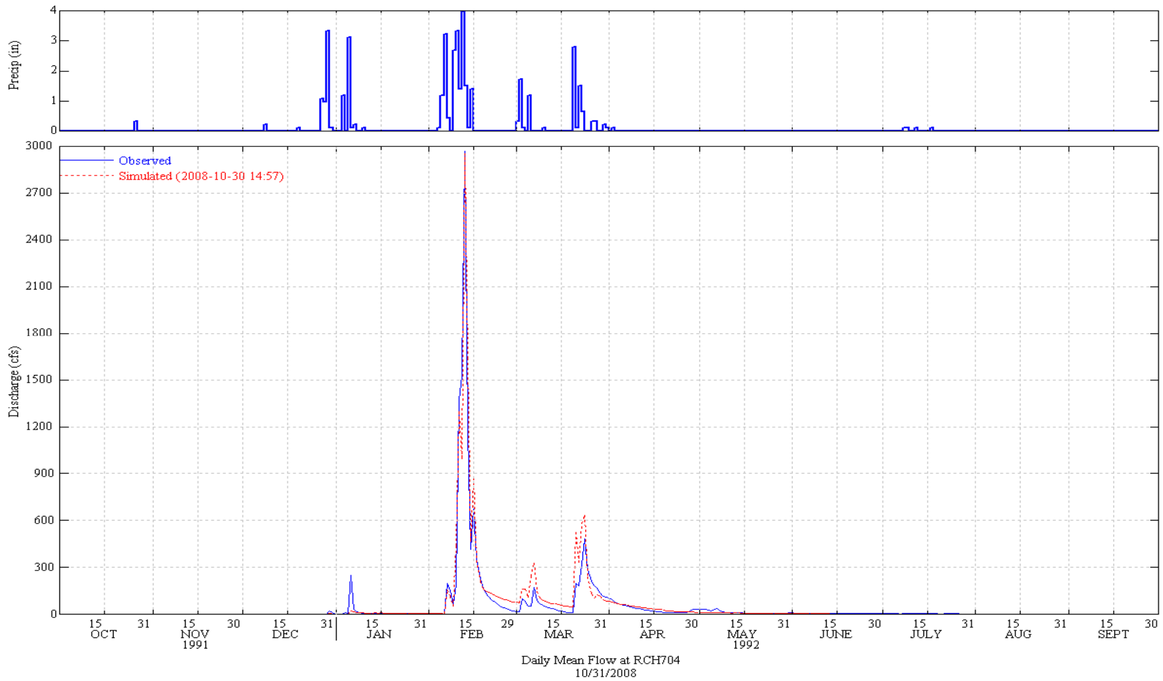

Figure 24 Simulated and Observed Daily Flow at Wheeler Springs (WY 1992)

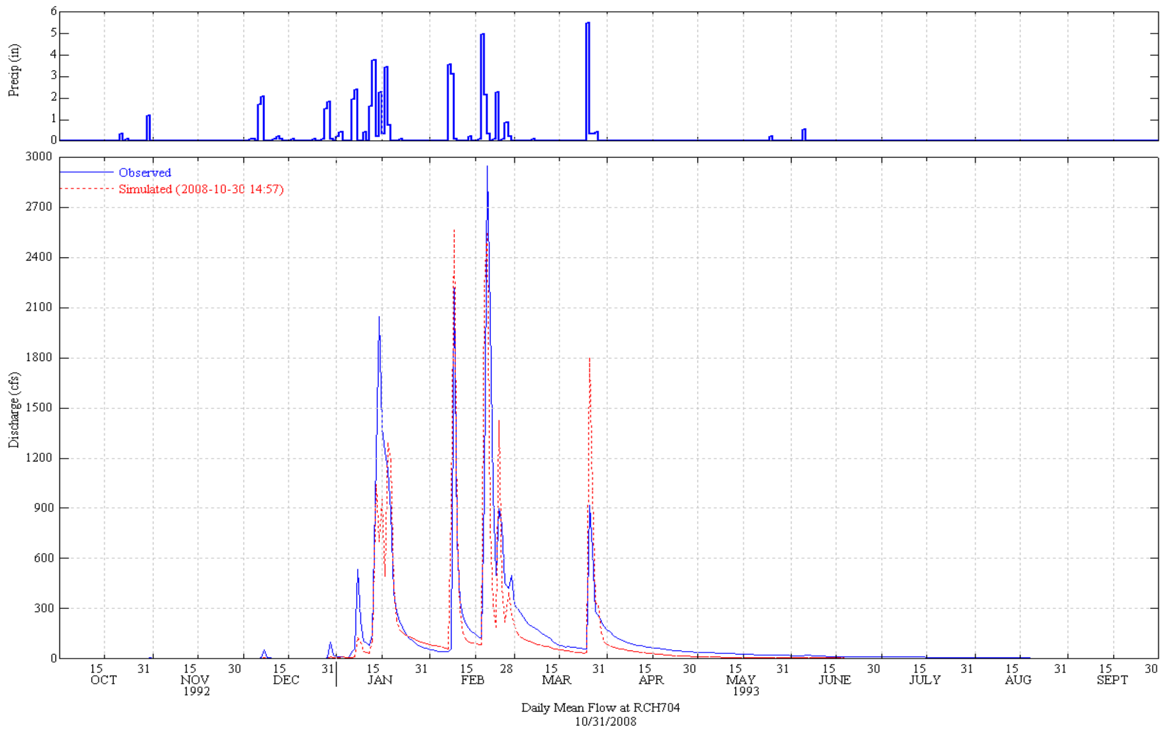

Figure 25 Simulated and Observed Daily Flow at Wheeler Springs (WY 1993)

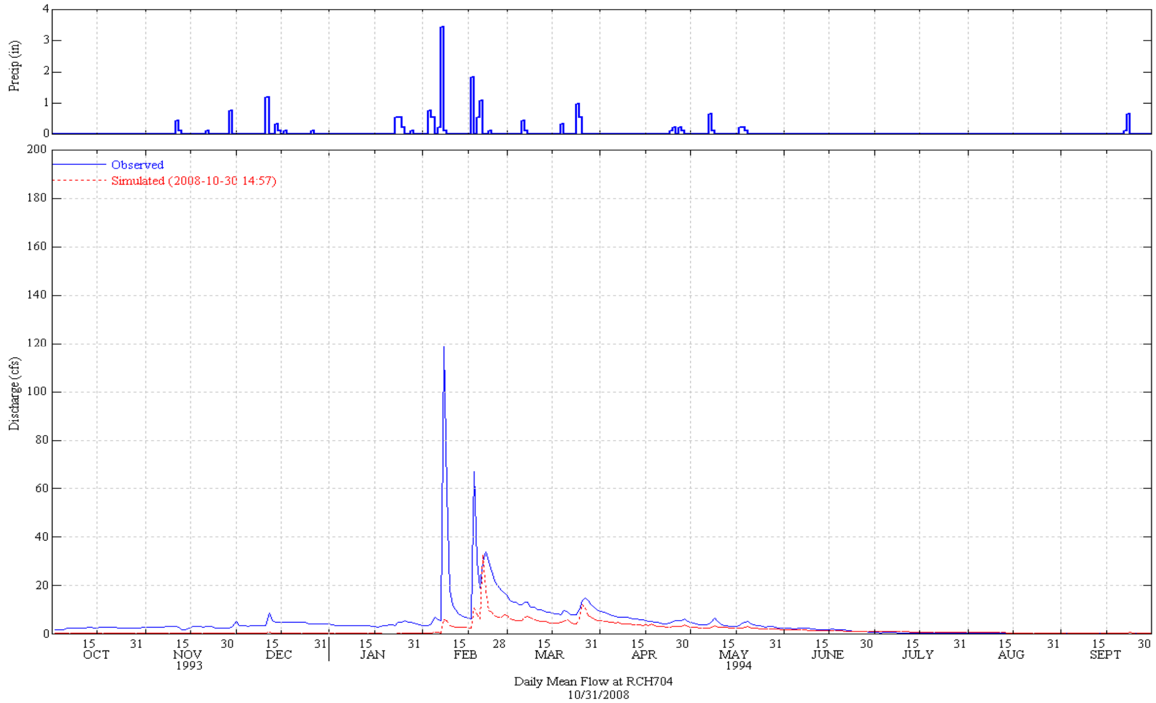

Figure 26 Simulated and Observed Daily Flow at Wheeler Springs (WY 1994)

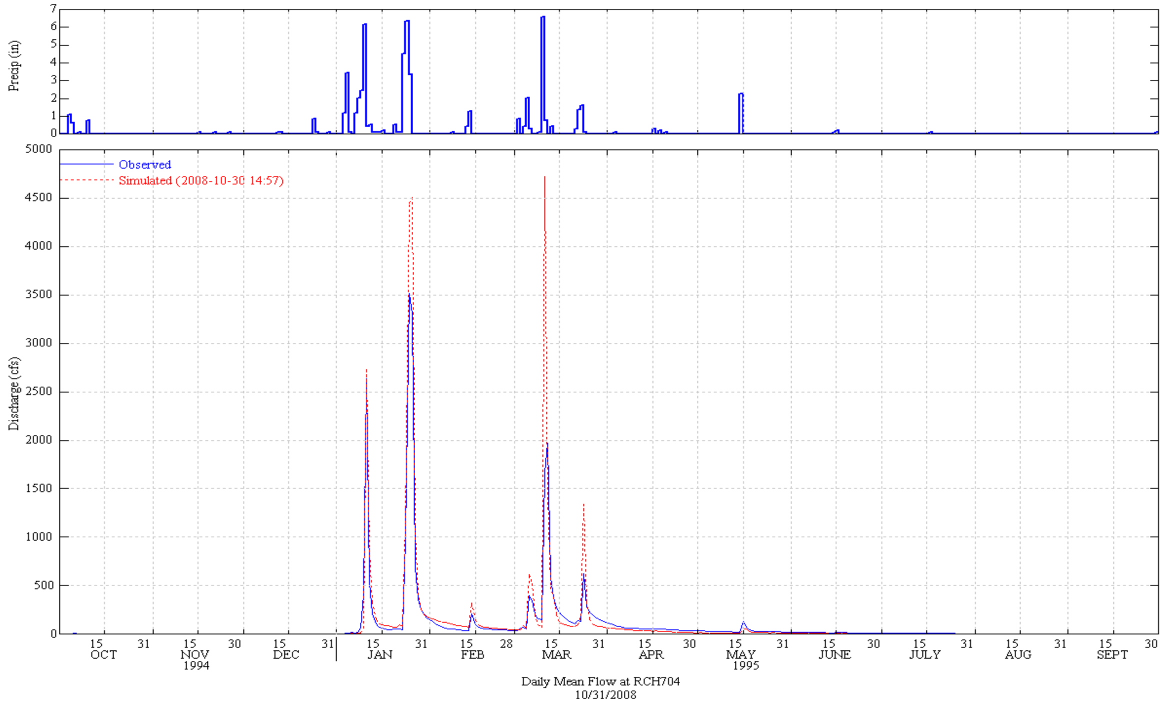

Figure 27 Simulated and Observed Daily Flow at Wheeler Springs (WY 1995)

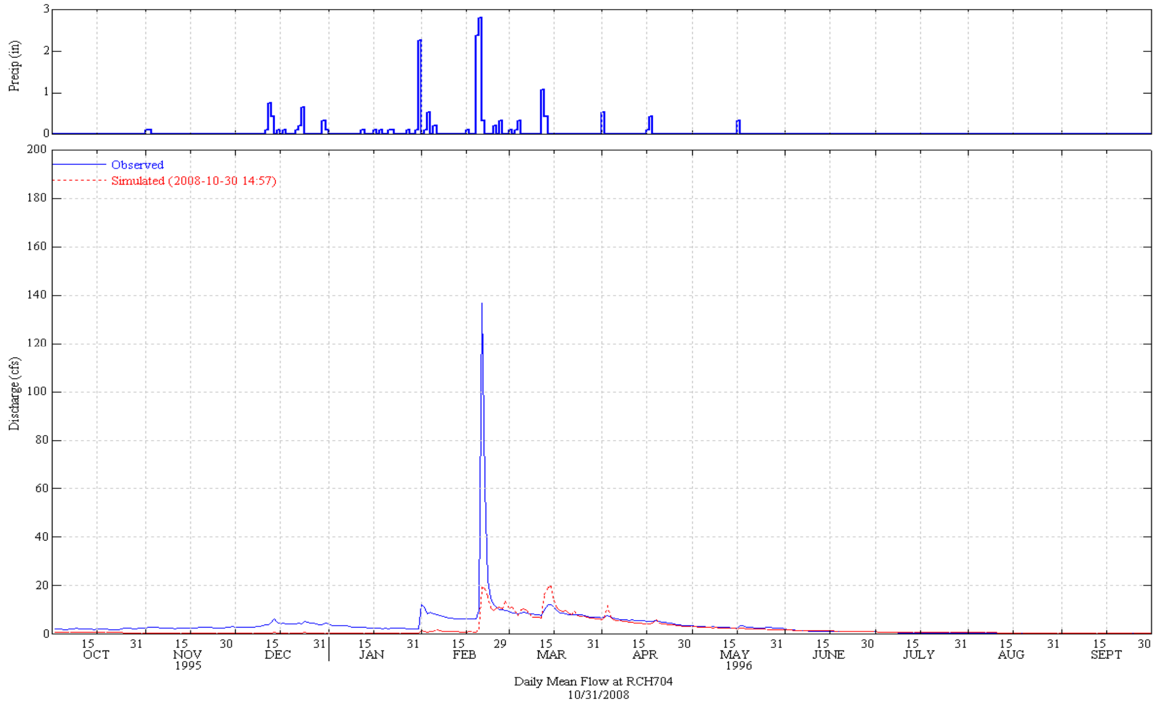

Figure 28 Simulated and Observed Daily Flow at Wheeler Springs (WY 1996)

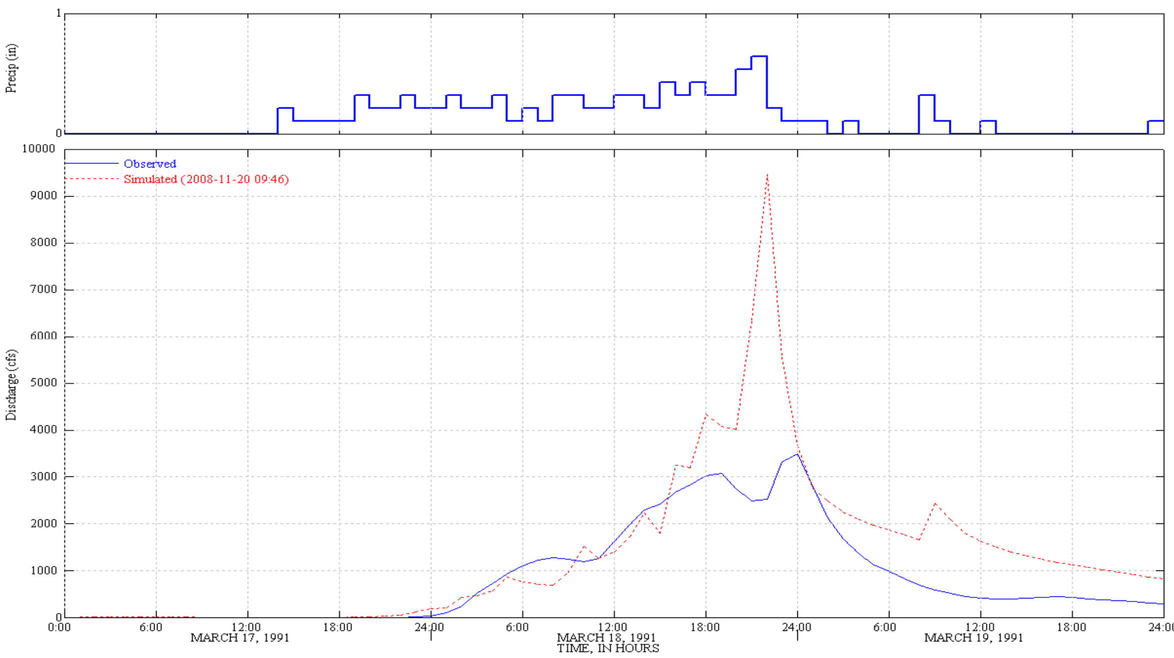

Figure 29 Simulated and Observed March 17-19, 1991 Storm Event

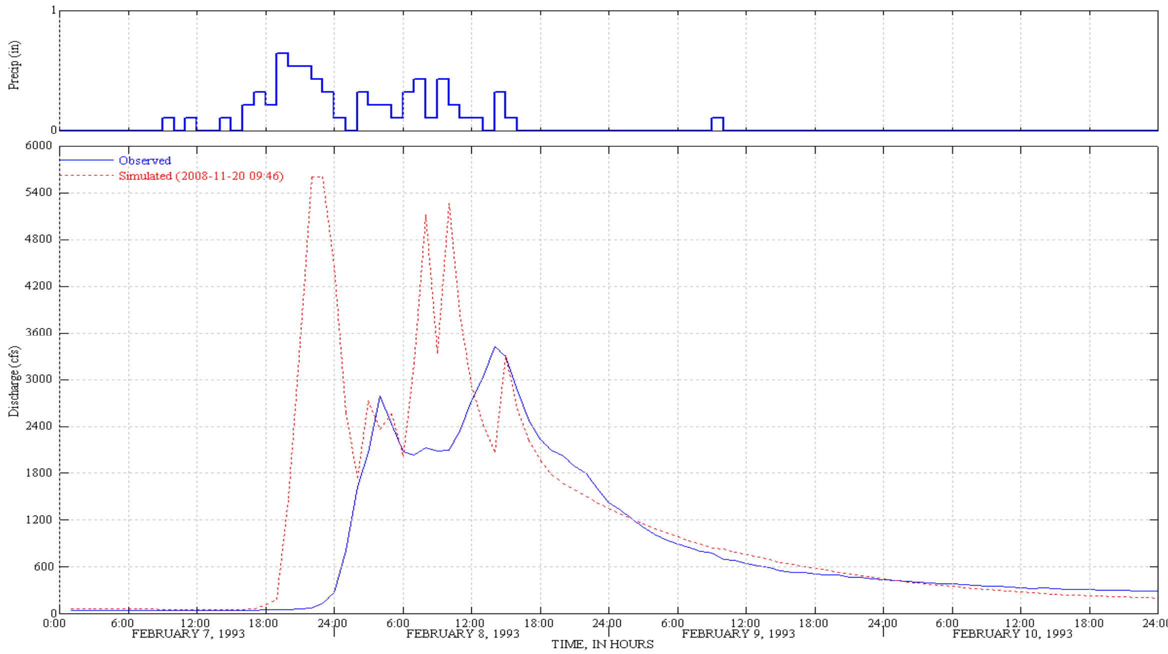

Figure 30 Simulated and Observed February 7-10, 1993 Storm Event

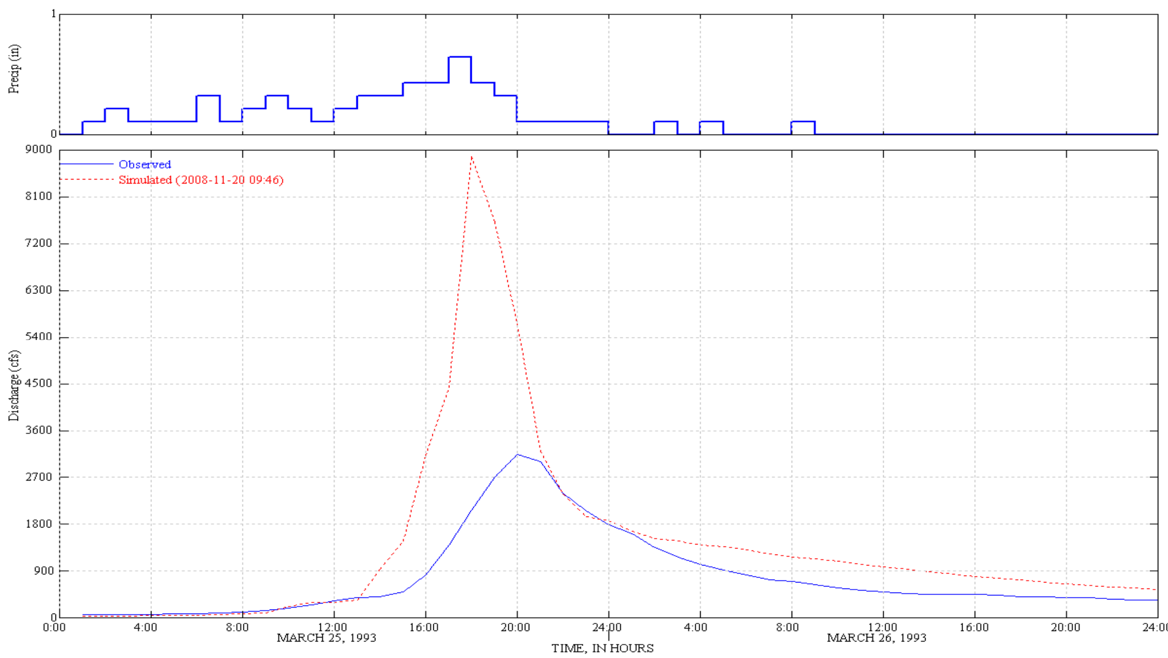

Figure 31 Simulated and Observed March 25-26, 1993 Storm Event

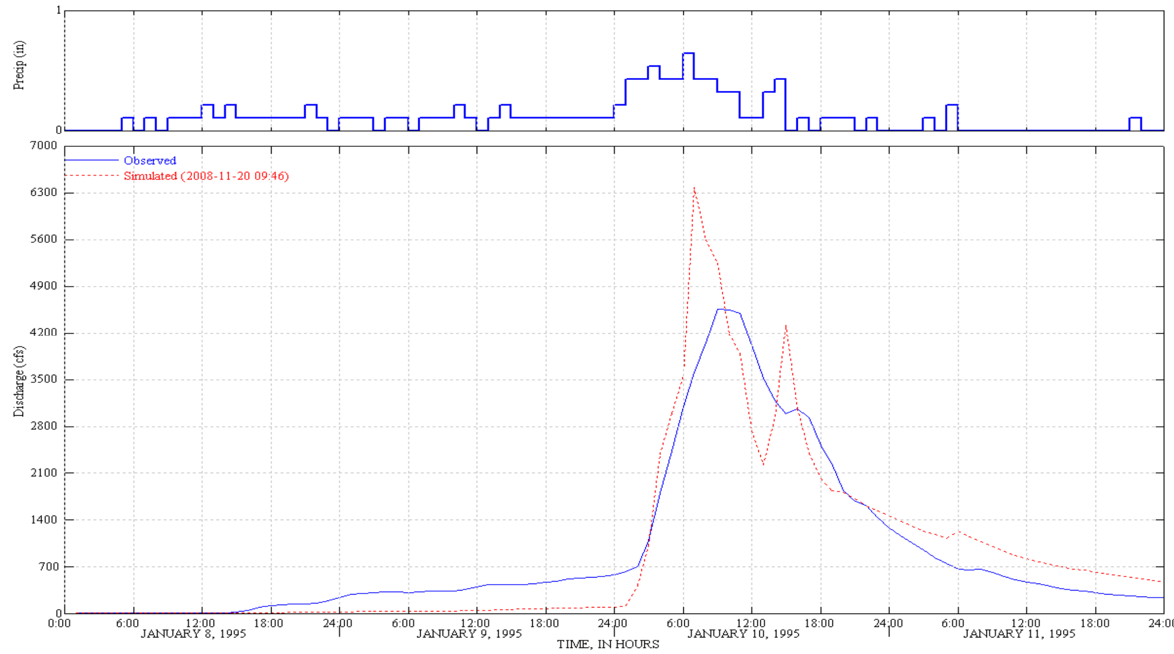

Figure 32 Simulated and Observed January 8-11, 1995 Storm Event

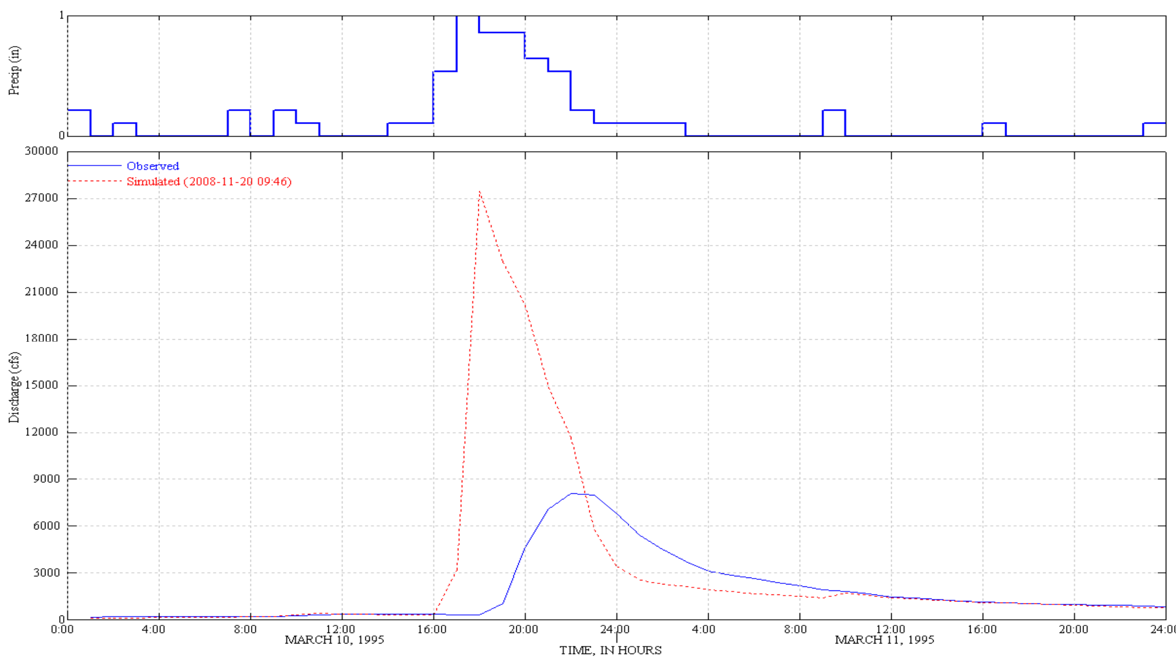

Figure 33 Simulated and Observed March 10-11, 1995 Storm Event

APPENDIX C

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE POLE CREEK WATERSHED

Title Page

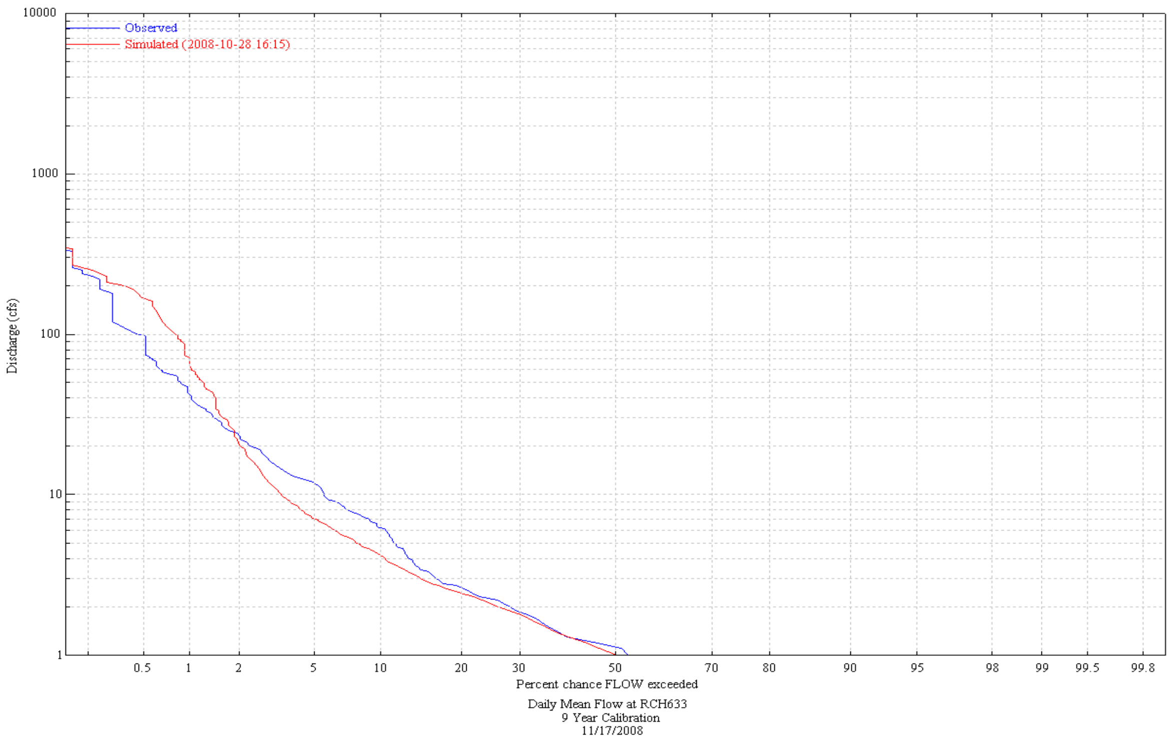

Figure 1 Simulated and Observed Daily Flow Duration Curve at Pole

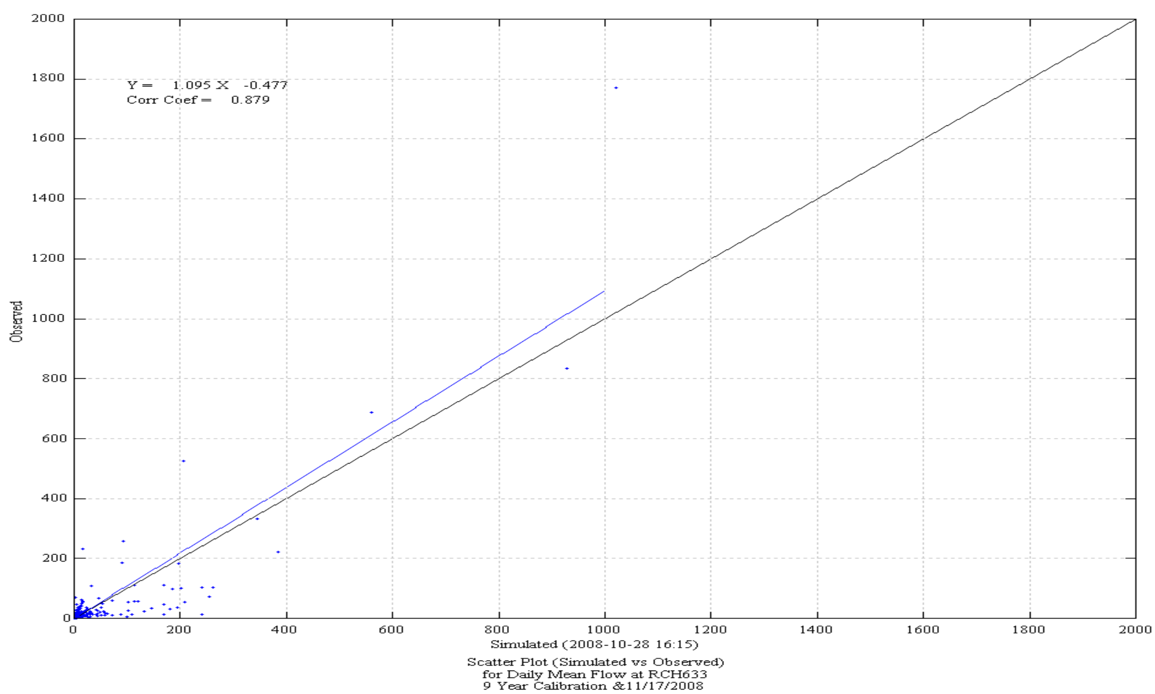

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Pole

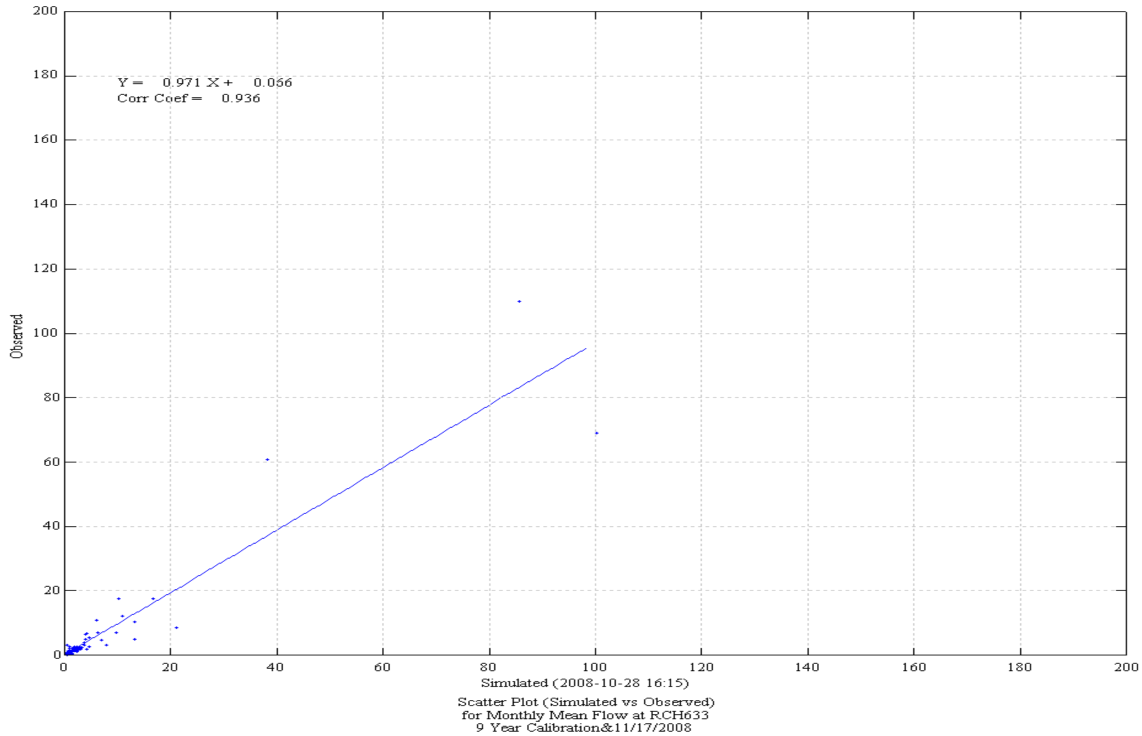

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Pole

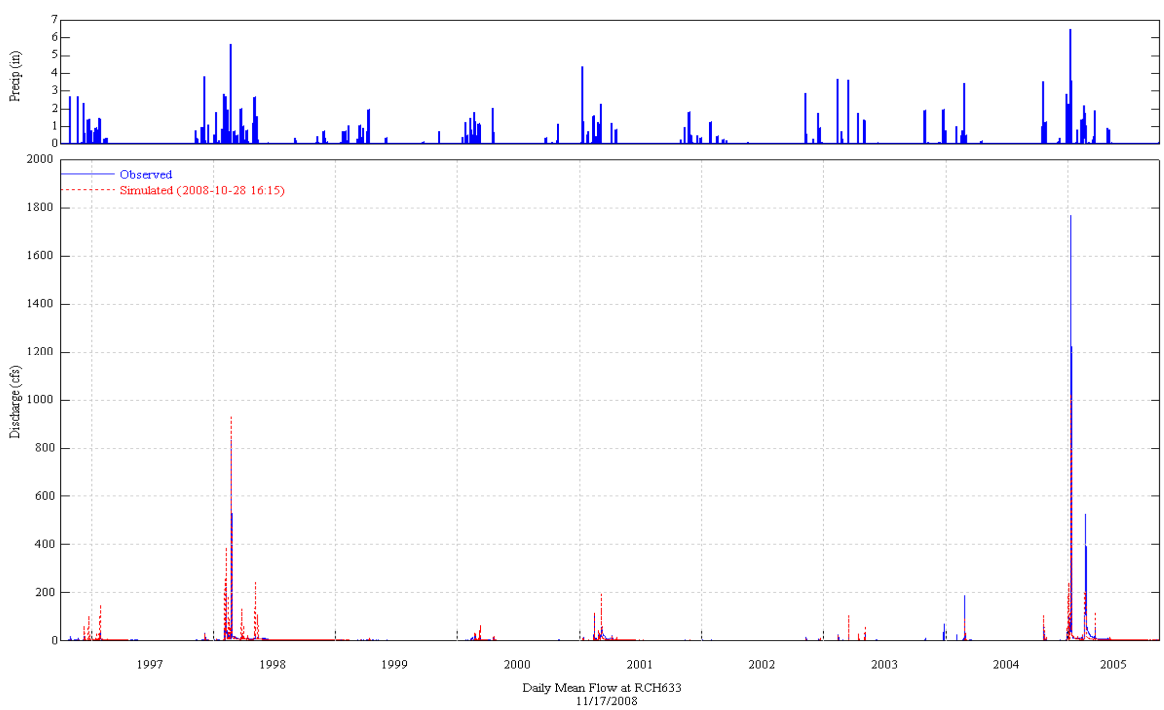

Figure 4 Simulated and Observed Daily Flow at Pole (WY 1997-2005)

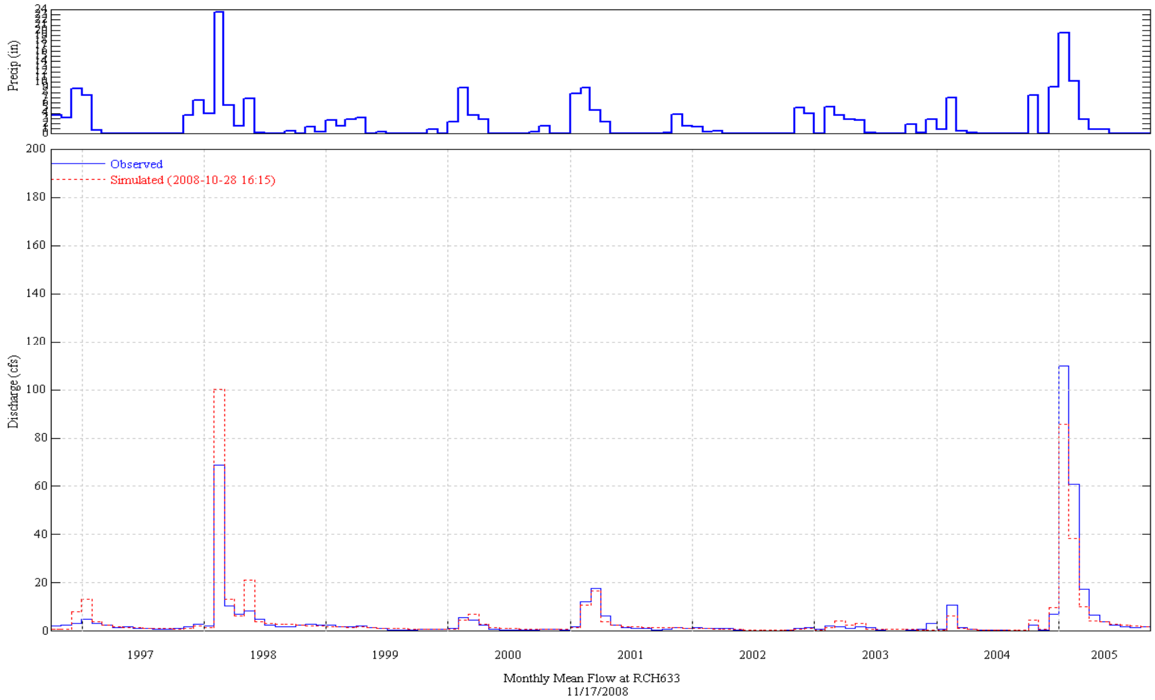

Figure 5 Simulated and Observed Monthly Flow at Pole (WY 1997-2005)

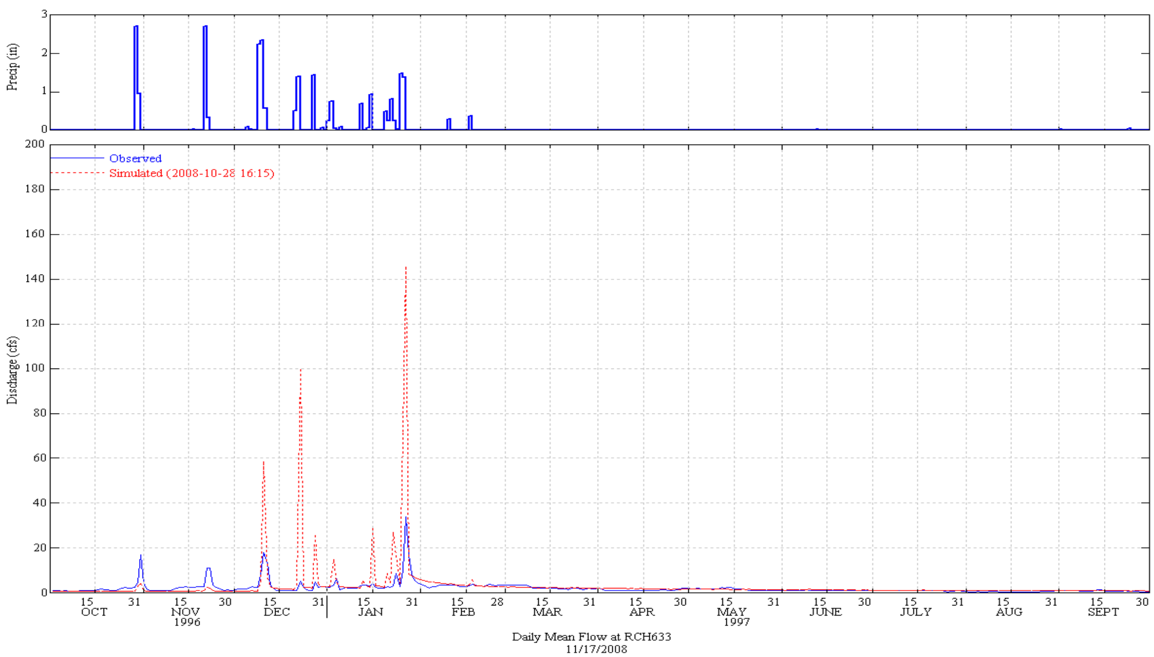

Figure 6 Simulated and Observed Daily Flow at Pole (WY 1997)

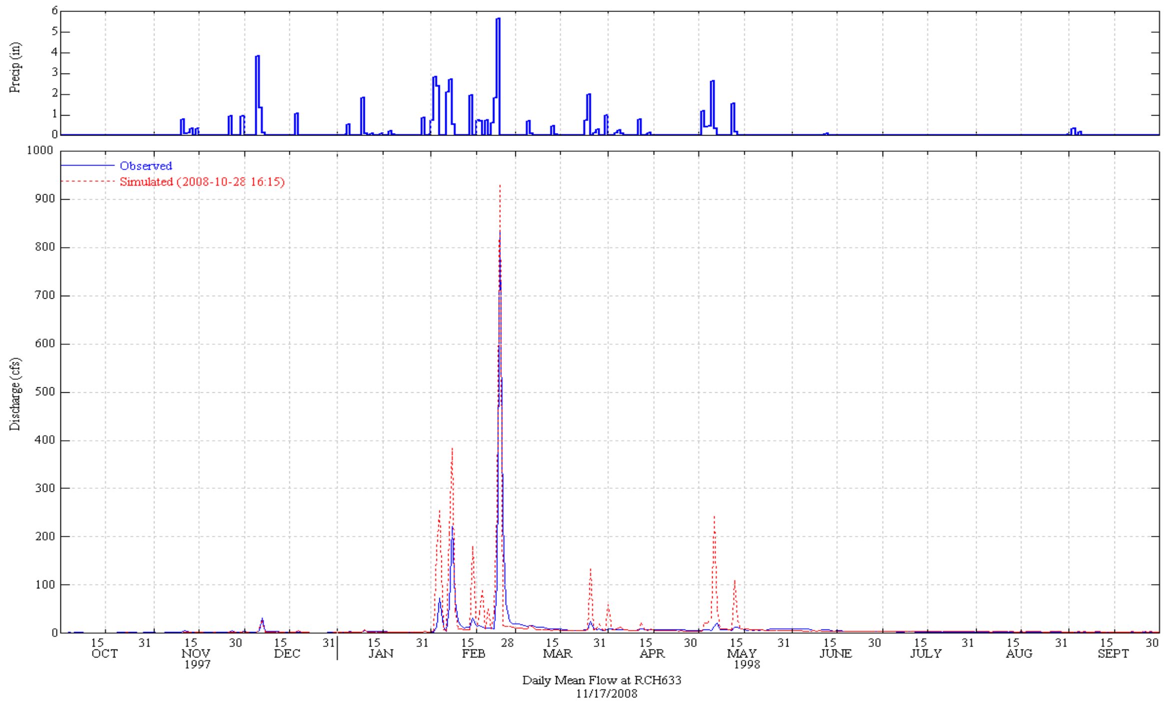

Figure 7 Simulated and Observed Daily Flow at Pole (WY 1998)

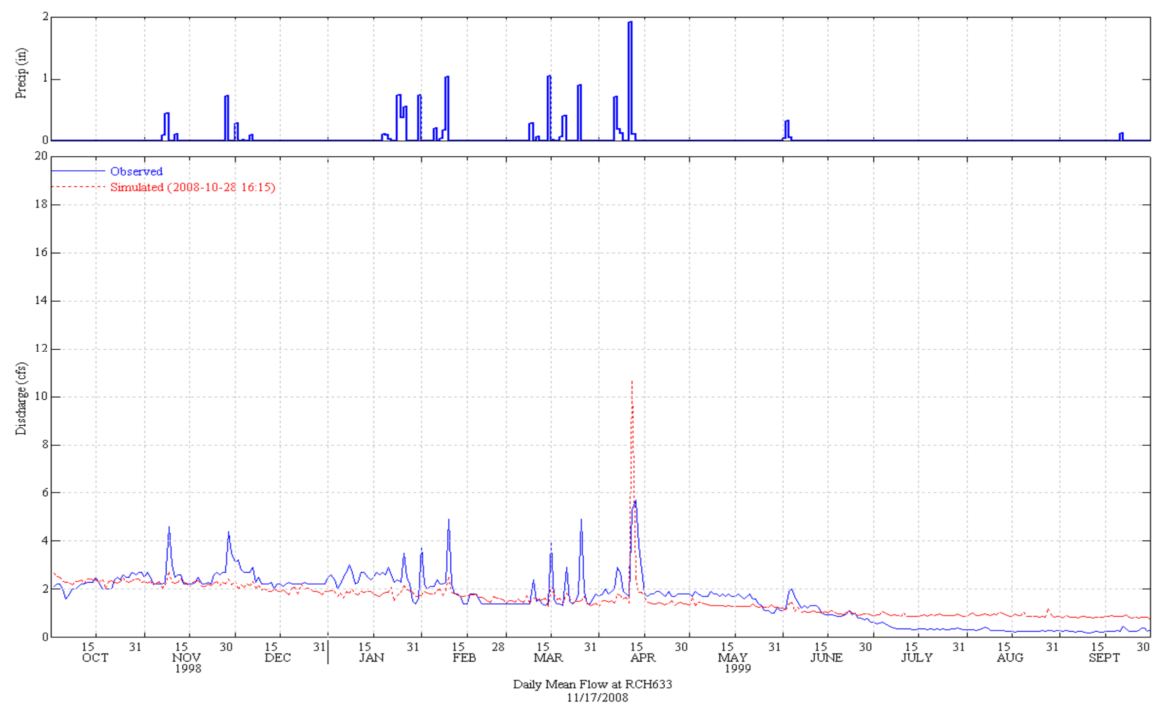

Figure 8 Simulated and Observed Daily Flow at Pole (WY 1999)

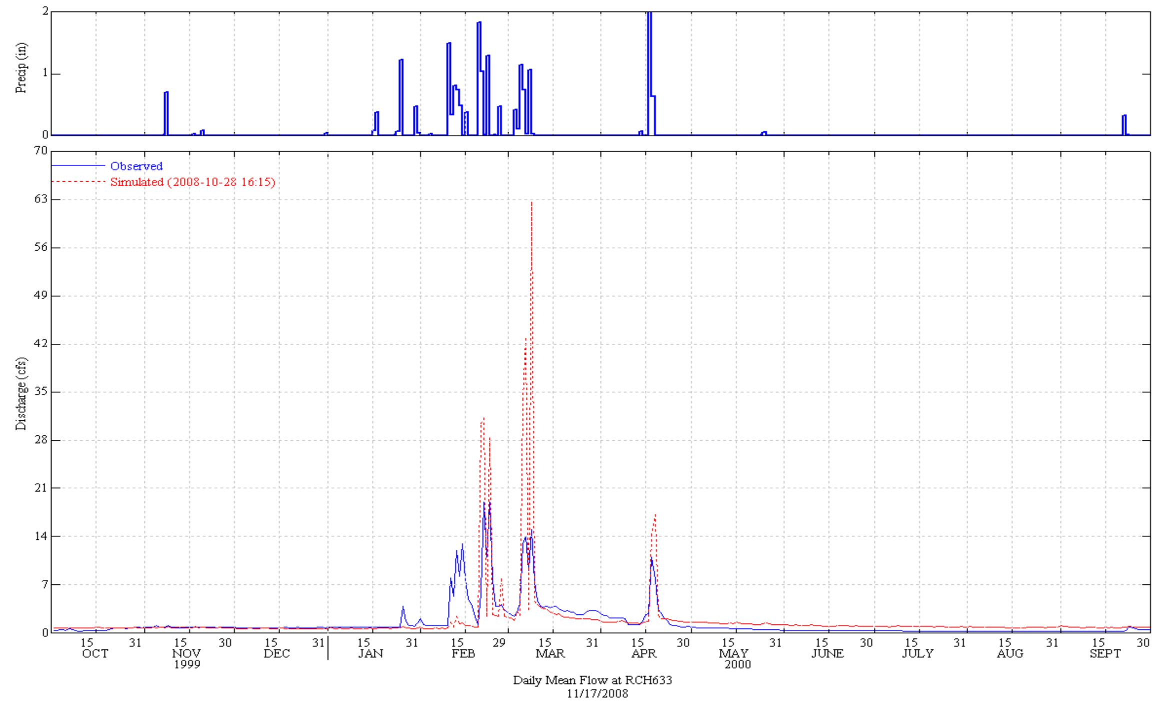

Figure 9 Simulated and Observed Daily Flow at Pole (WY 2000)

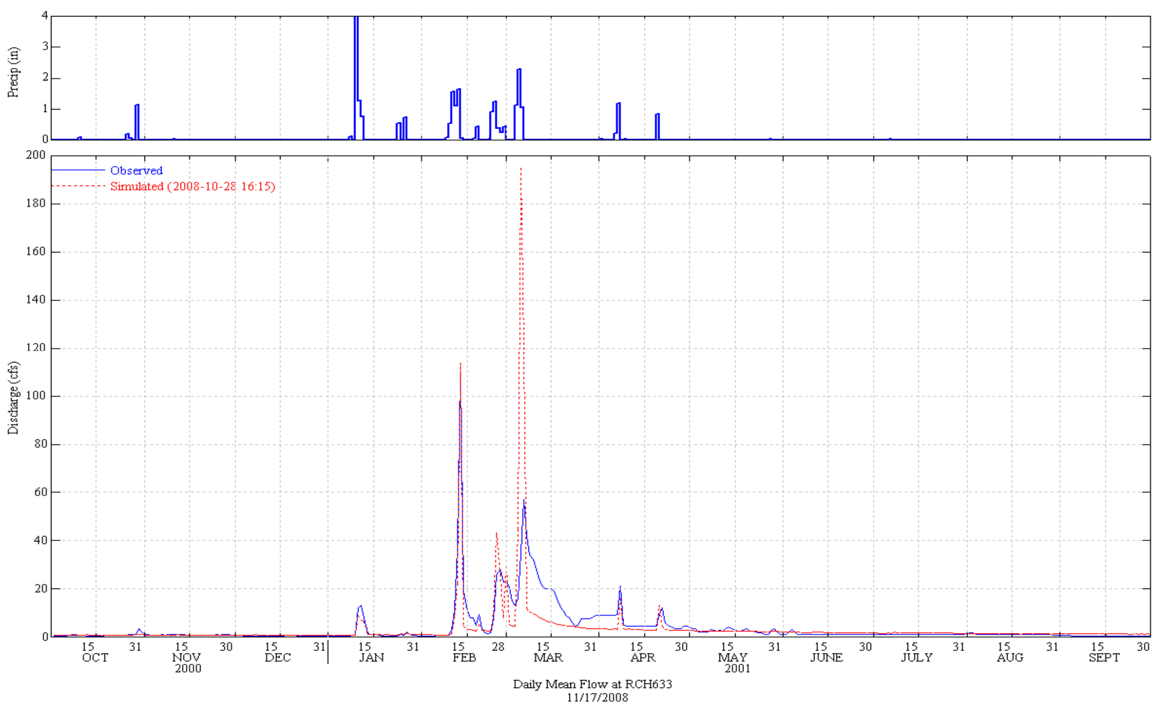

Figure 10 Simulated and Observed Daily Flow at Pole (WY 2001)

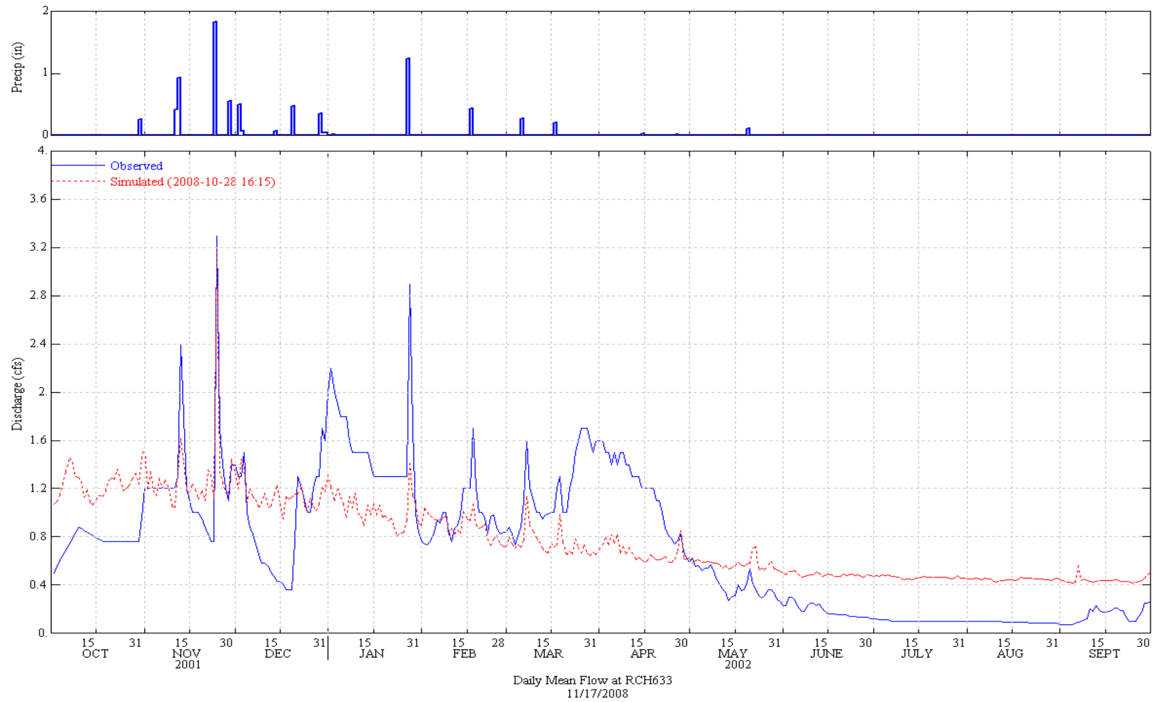

Figure 11 Simulated and Observed Daily Flow at Pole (WY 2002)

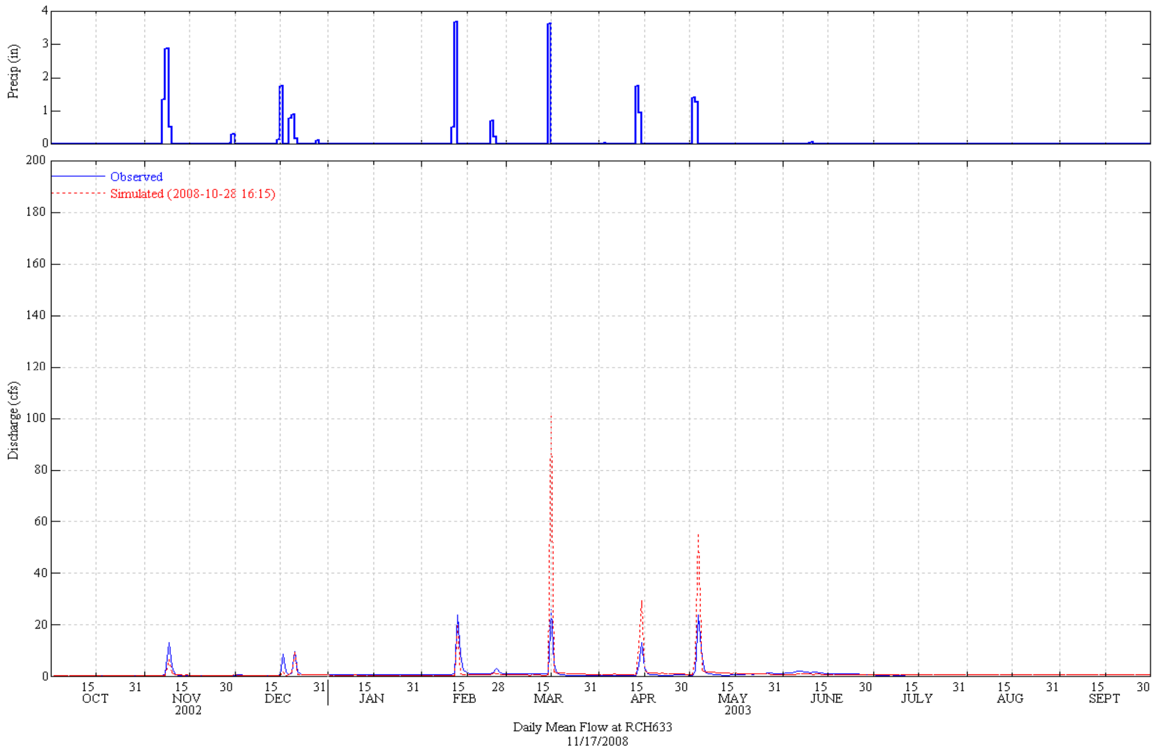

Figure 12 Simulated and Observed Daily Flow at Pole (WY 2003)

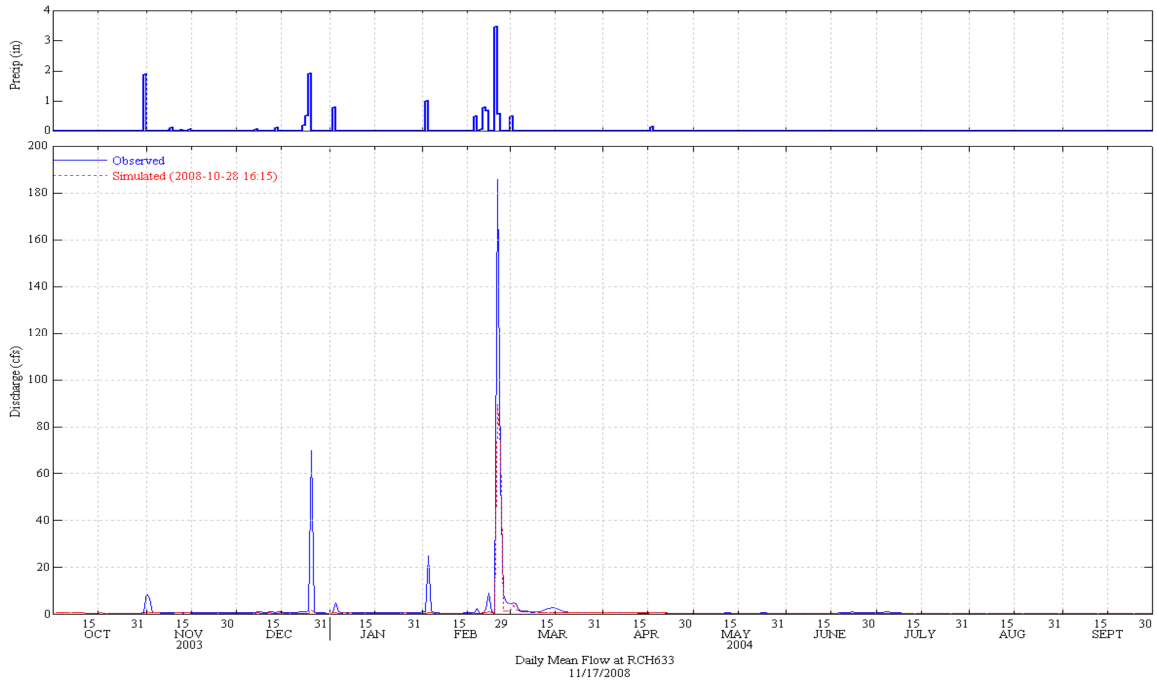

Figure 13 Simulated and Observed Daily Flow at Pole (WY 2004)

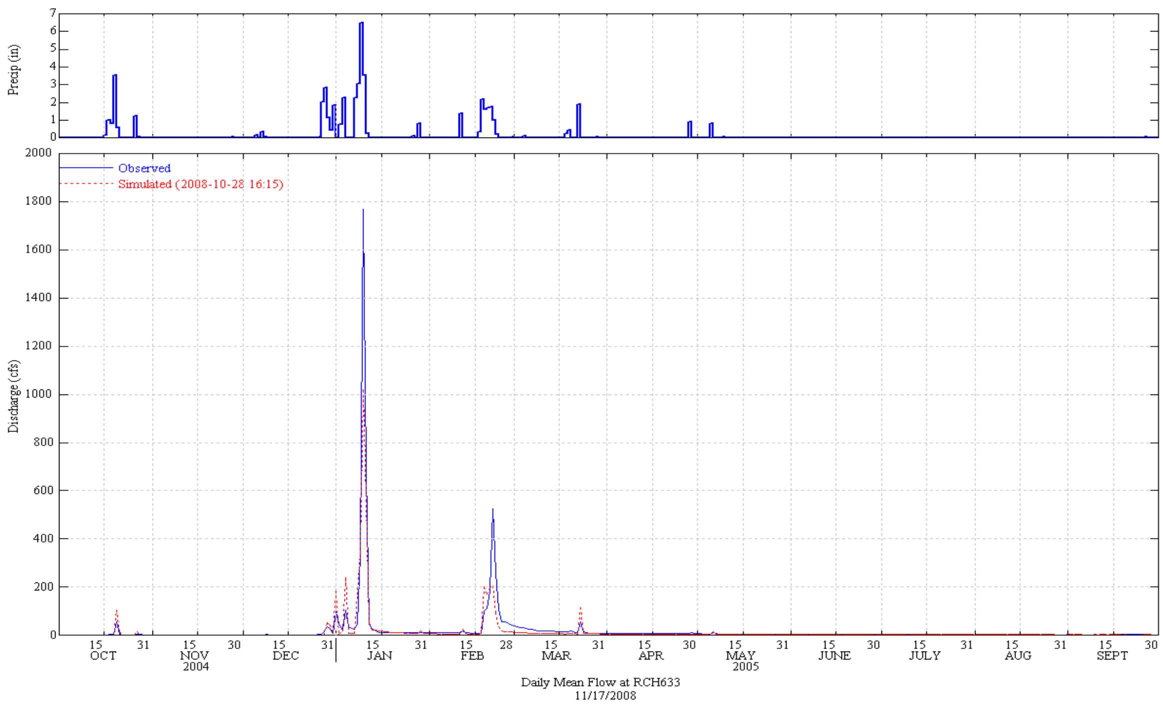

Figure 14 Simulated and Observed Daily Flow at Pole (WY 2005)

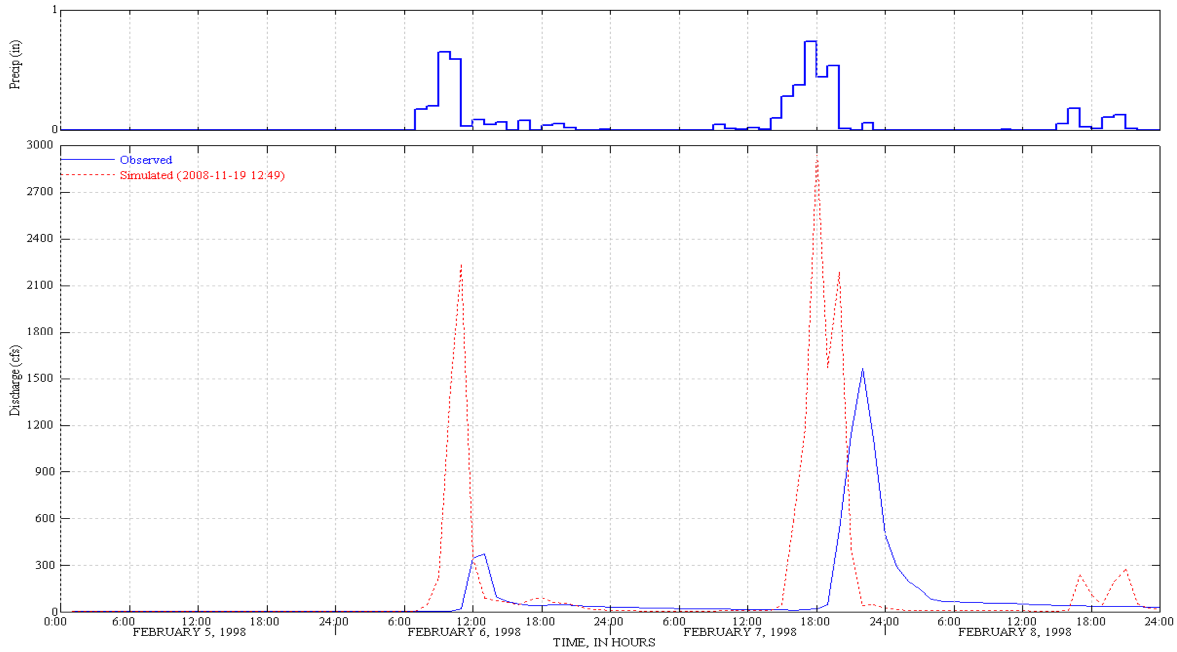

Figure 15 Simulated and Observed February 5, 1998 Storm Event

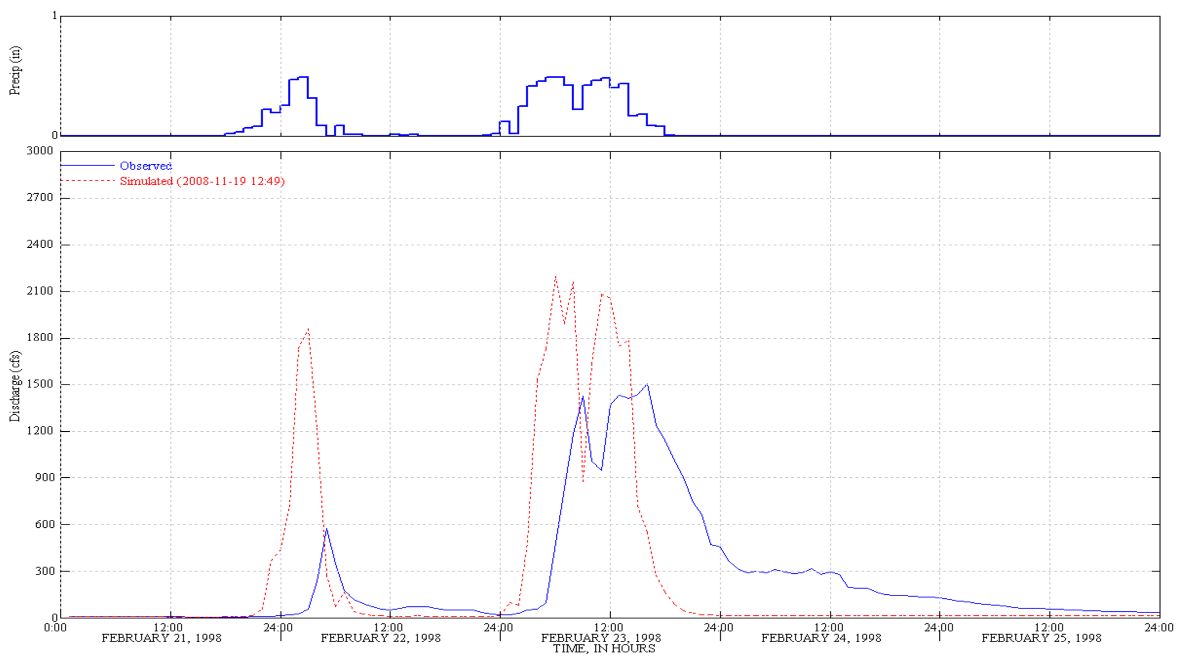

Figure 16 Simulated and Observed February 21, 1998 Storm Event

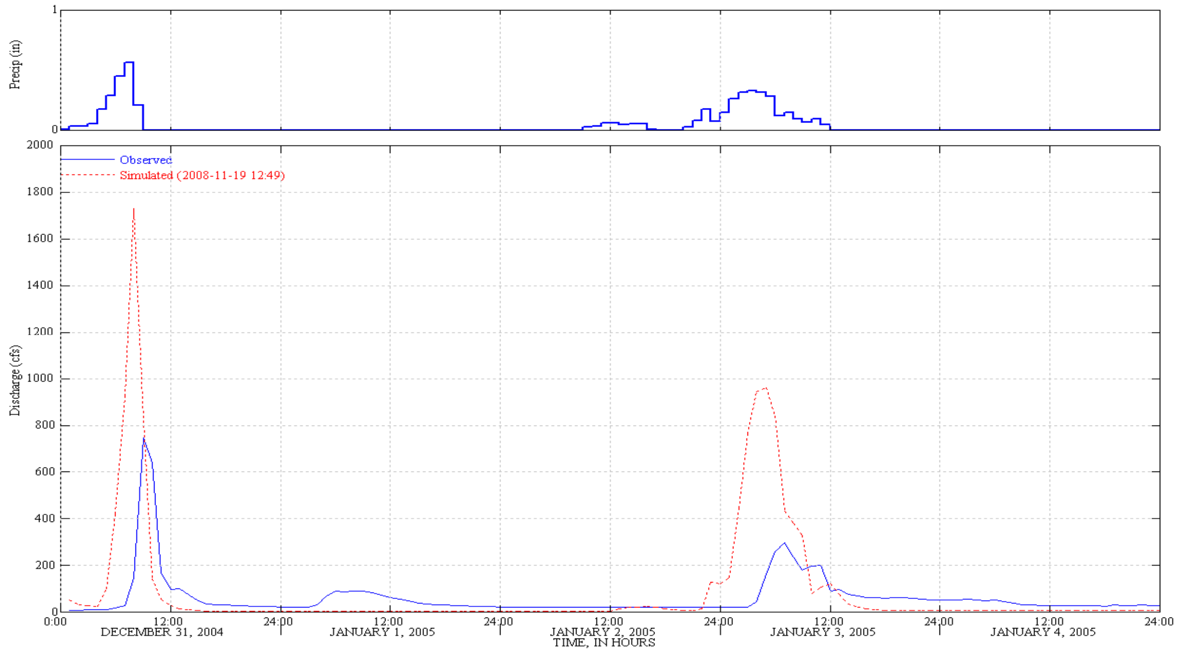

Figure 17 Simulated and Observed December 31, 2004 Storm Event

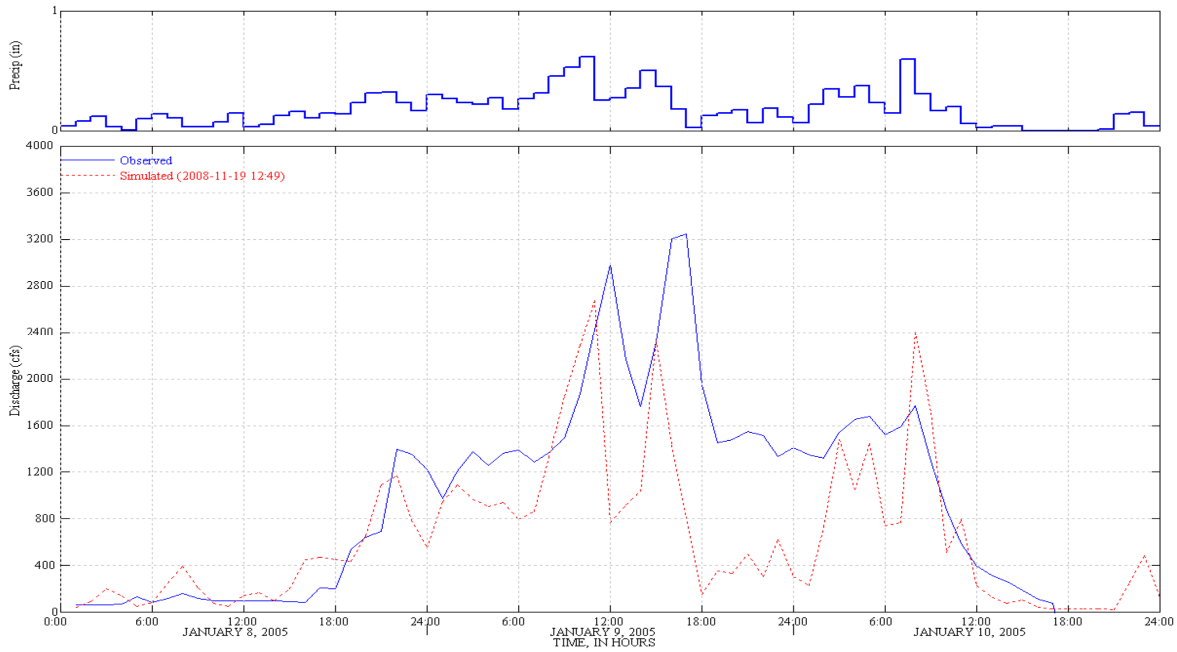

Figure 18 Simulated and Observed January 8, 2005 Storm Event

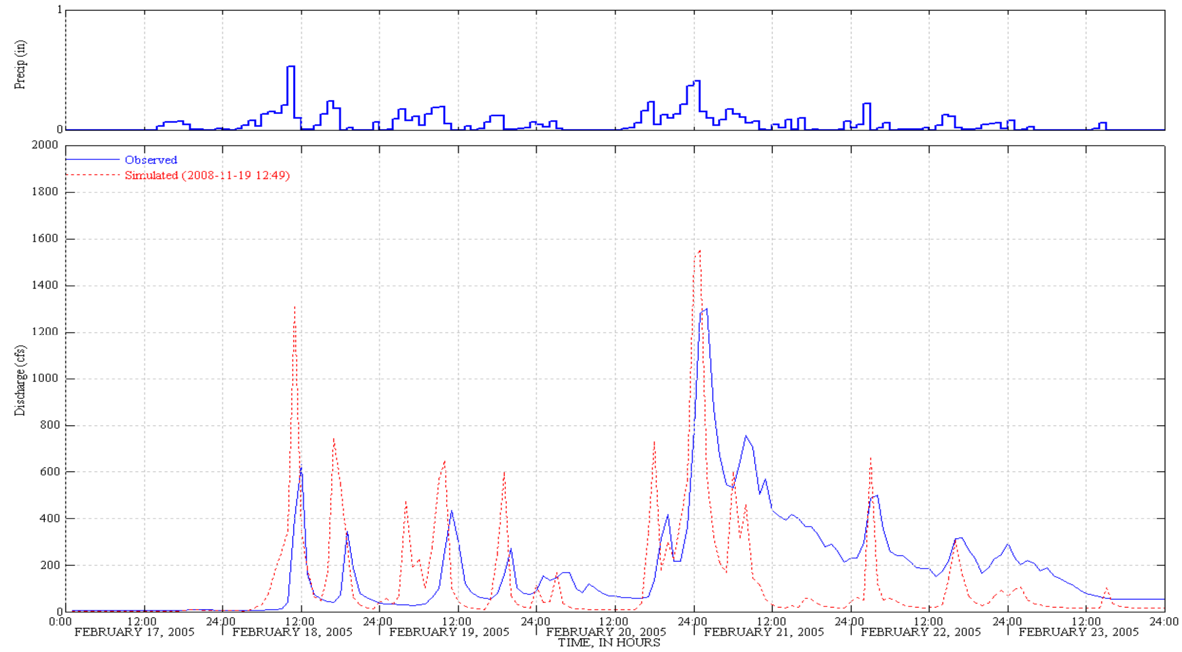

Figure 19 Simulated and Observed February 17, 2005 Storm Event

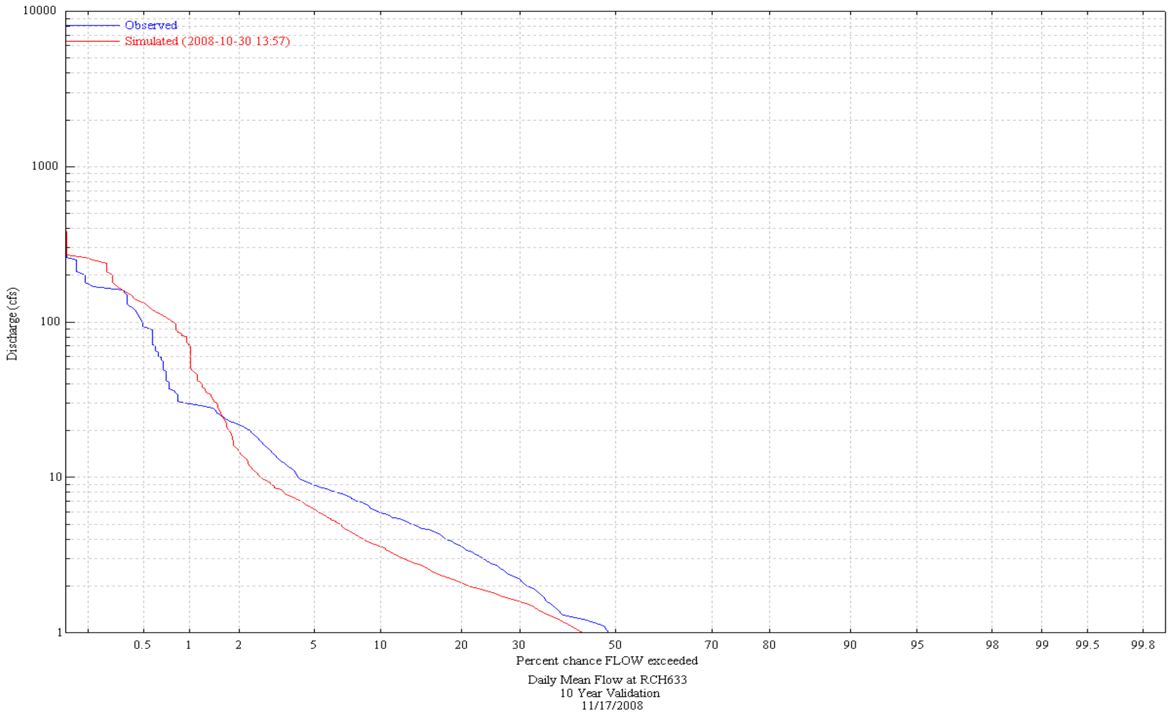

Figure 20 Simulated and Observed Daily Flow Duration Curve at Pole

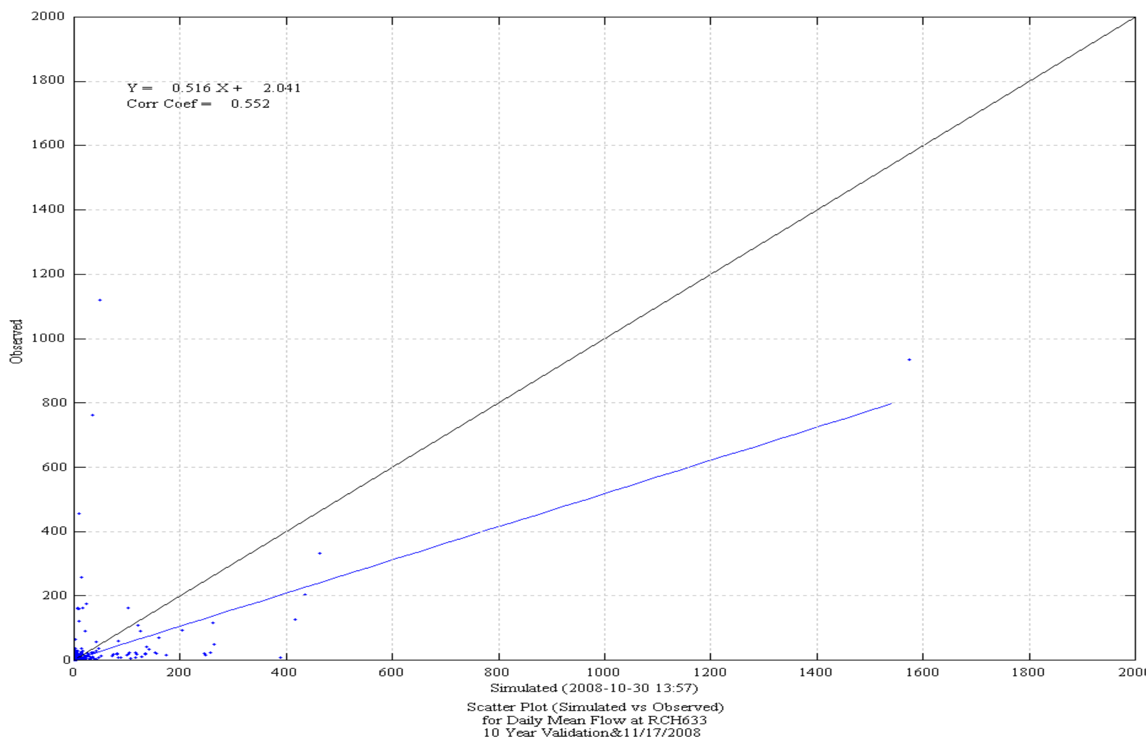

Figure 21 Daily Scatter Plot of Simulated versus Observed Flow at Pole

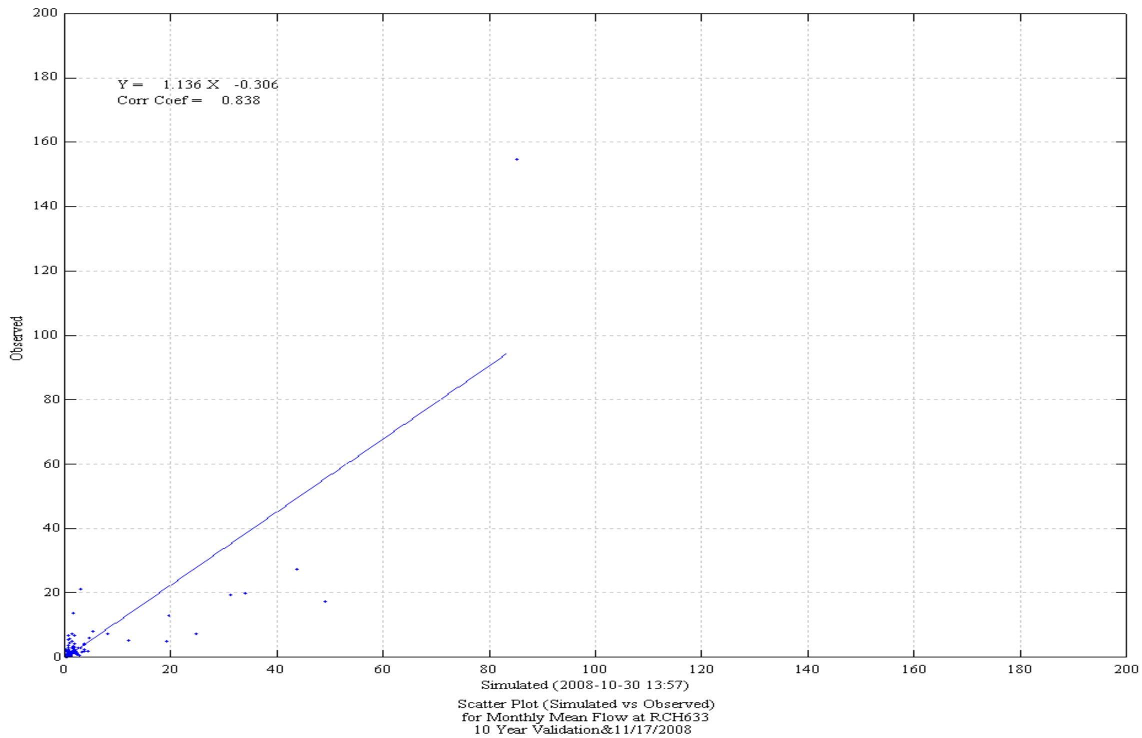

Figure 22 Monthly Scatter Plot of Simulated versus Observed Flow at Pole

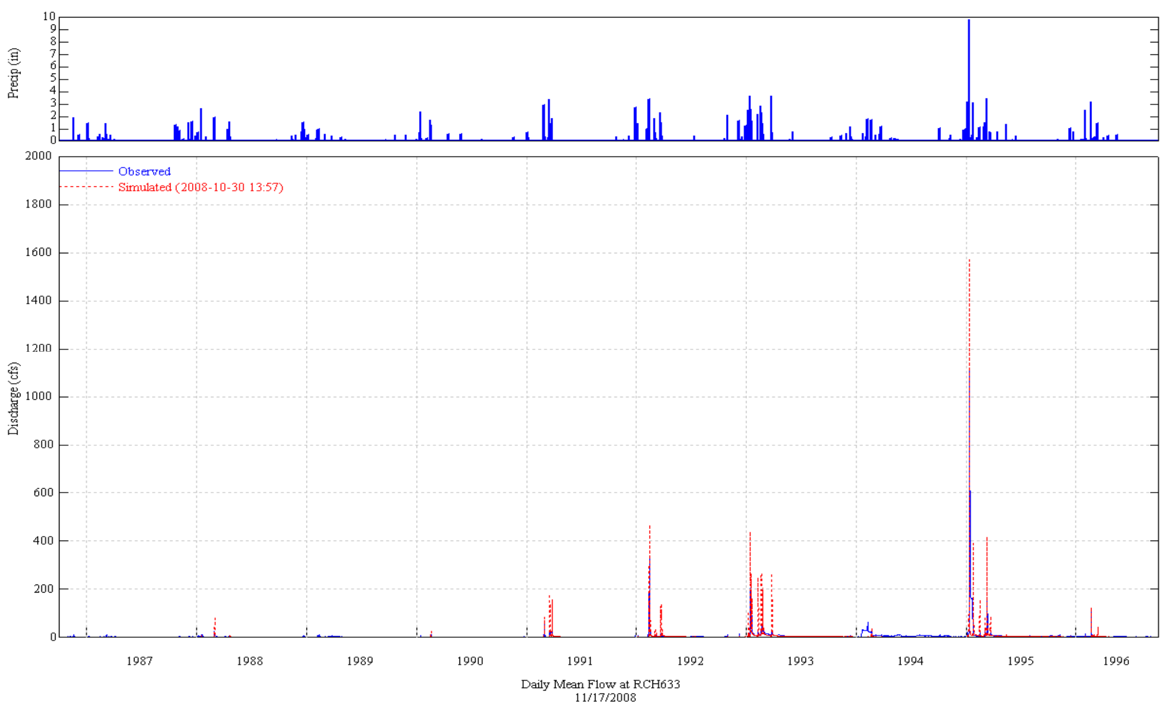

Figure 23 Simulated and Observed Daily Flow at Pole (WY 1987-1996)

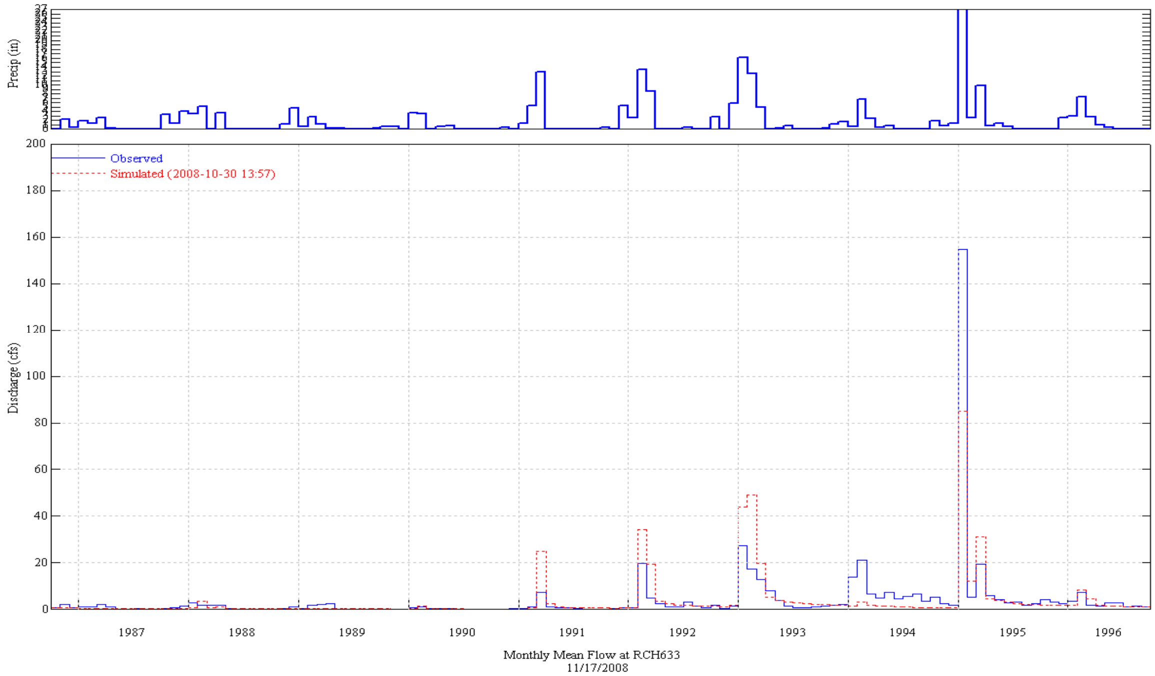

Figure 24 Simulated and Observed Monthly Flow at Pole (WY 1987-1996)

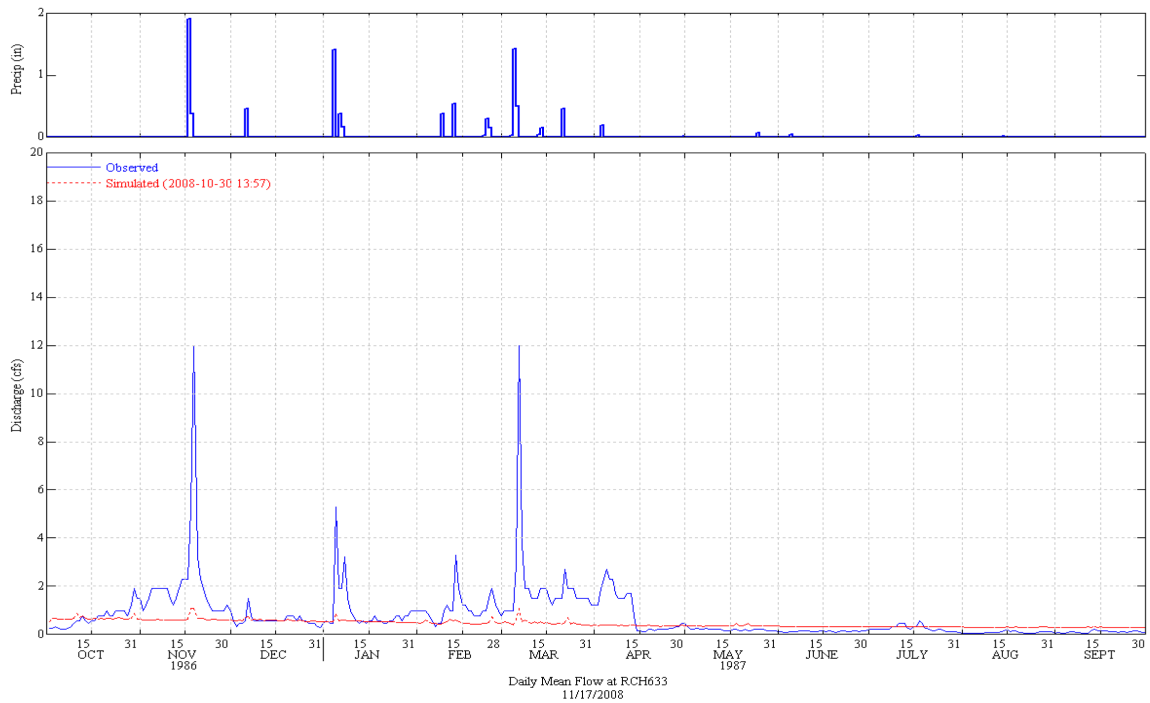

Figure 25 Simulated and Observed Daily Flow at Pole (WY 1987)

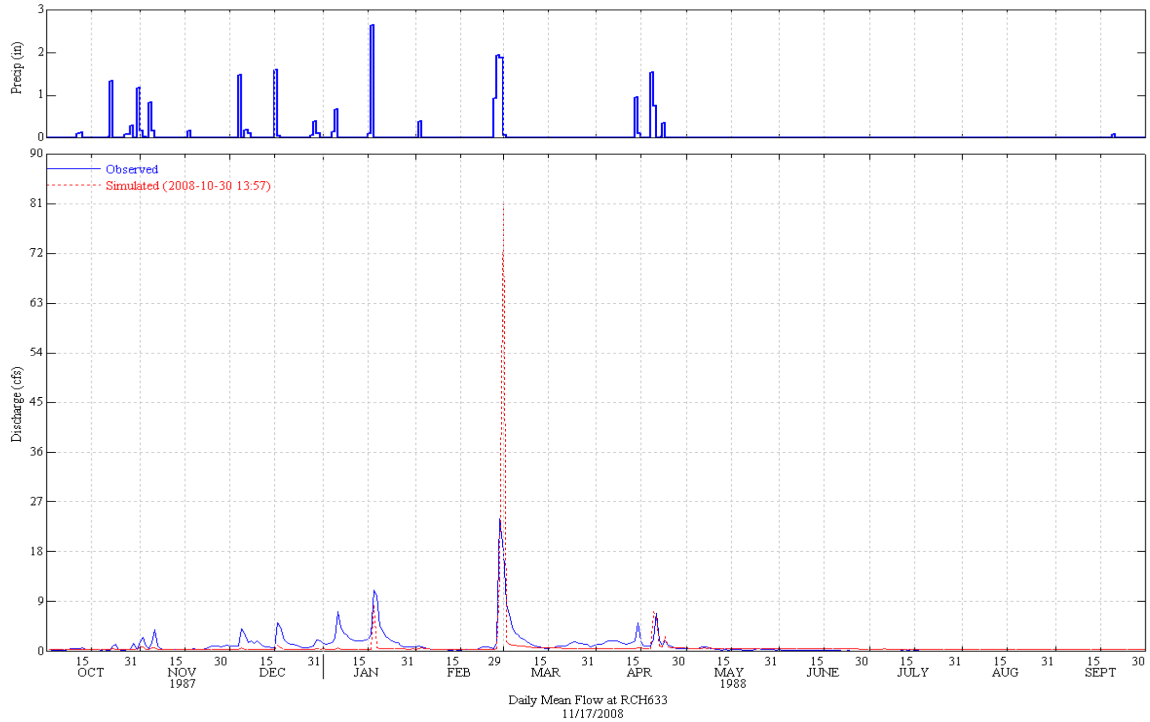

Figure 26 Simulated and Observed Daily Flow at Pole (WY 1988)

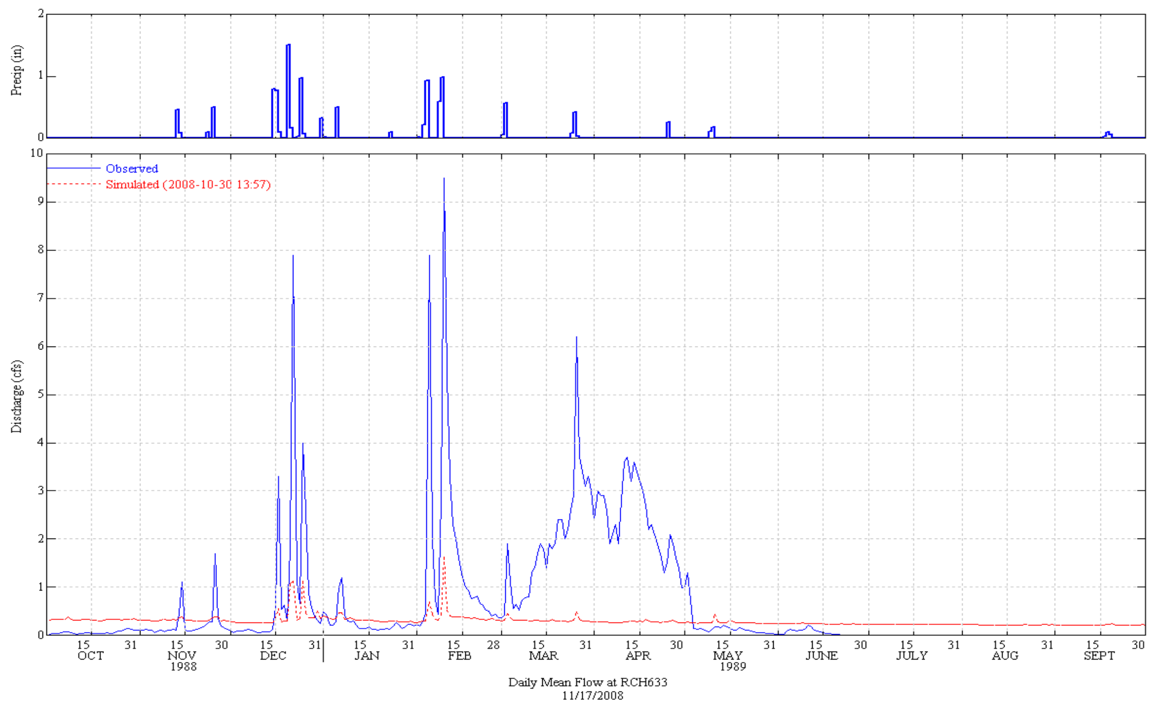

Figure 27 Simulated and Observed Daily Flow at Pole (WY 1989)

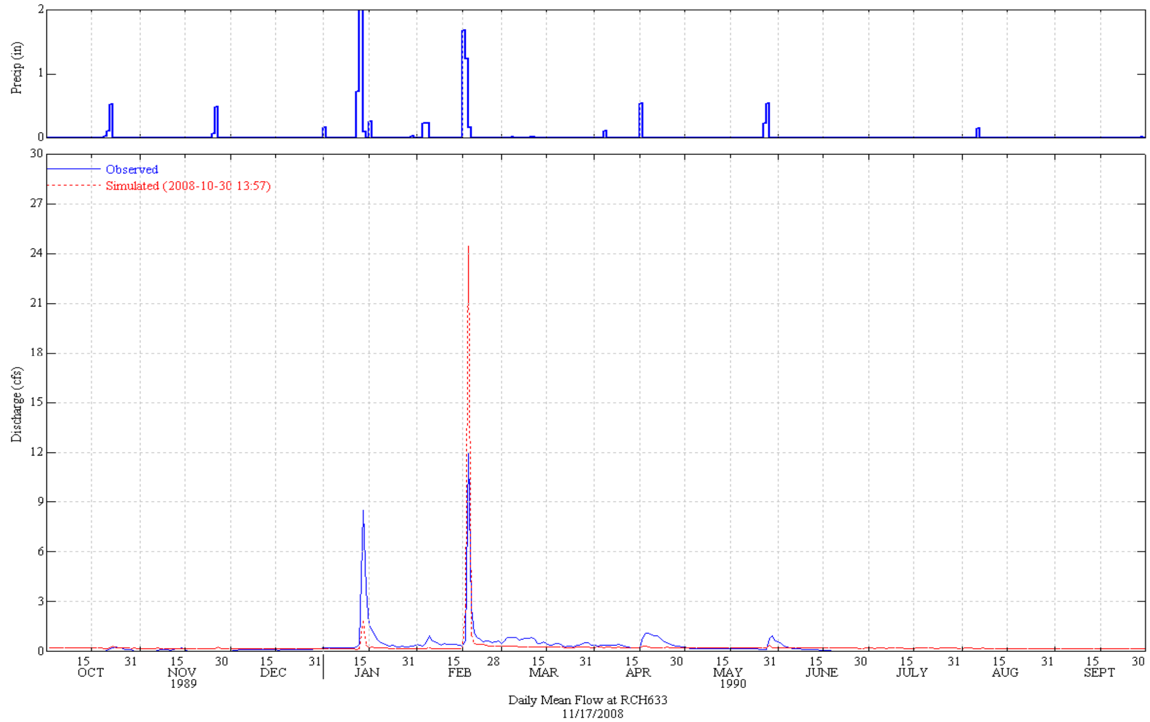

Figure 28 Simulated and Observed Daily Flow at Pole (WY 1990)

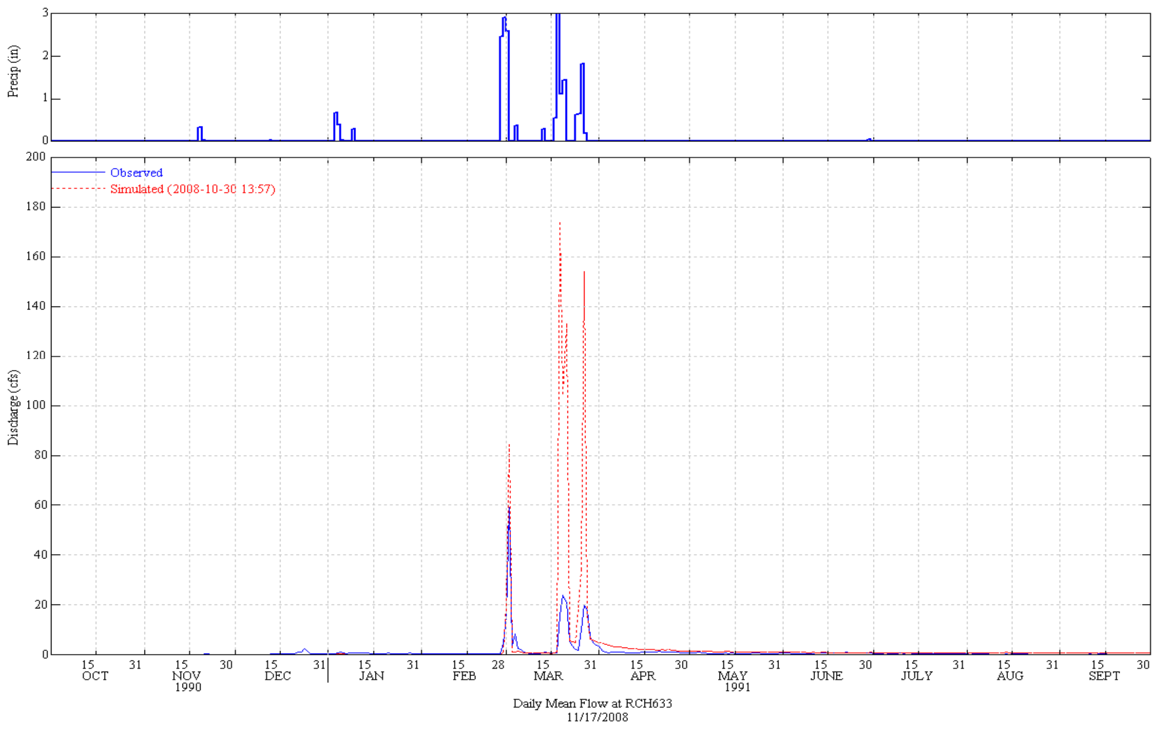

Figure 29 Simulated and Observed Daily Flow at Pole (WY 1991)

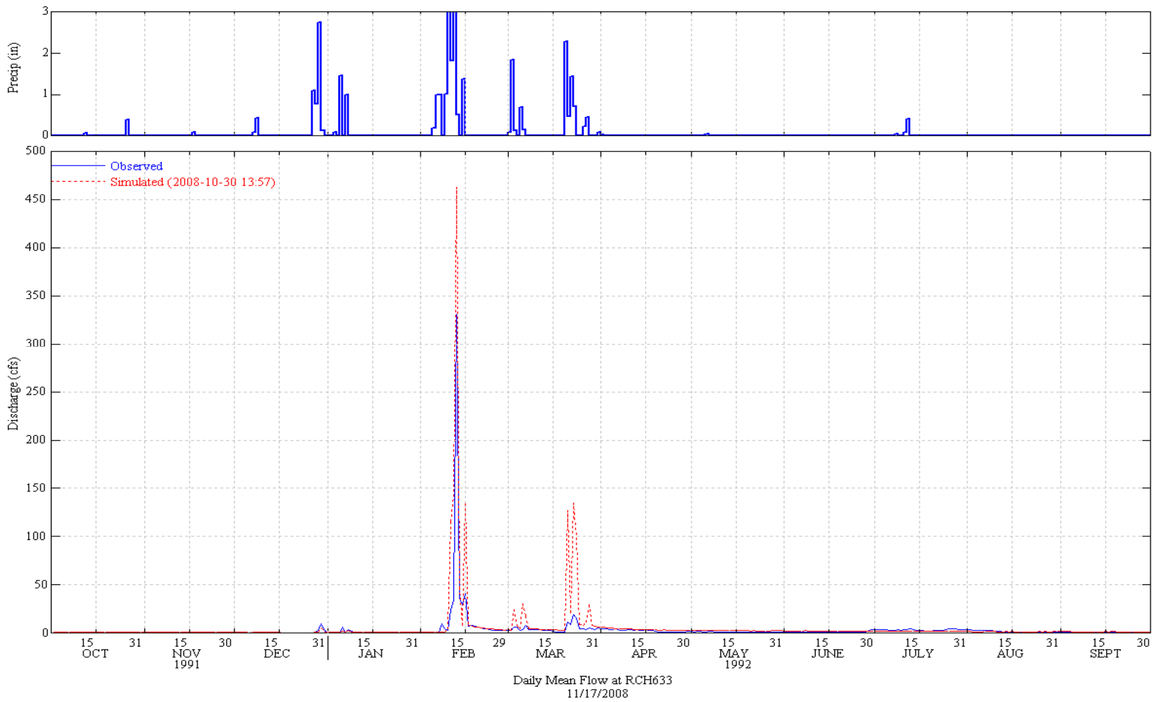

Figure 30 Simulated and Observed Daily Flow at Pole (WY 1992)

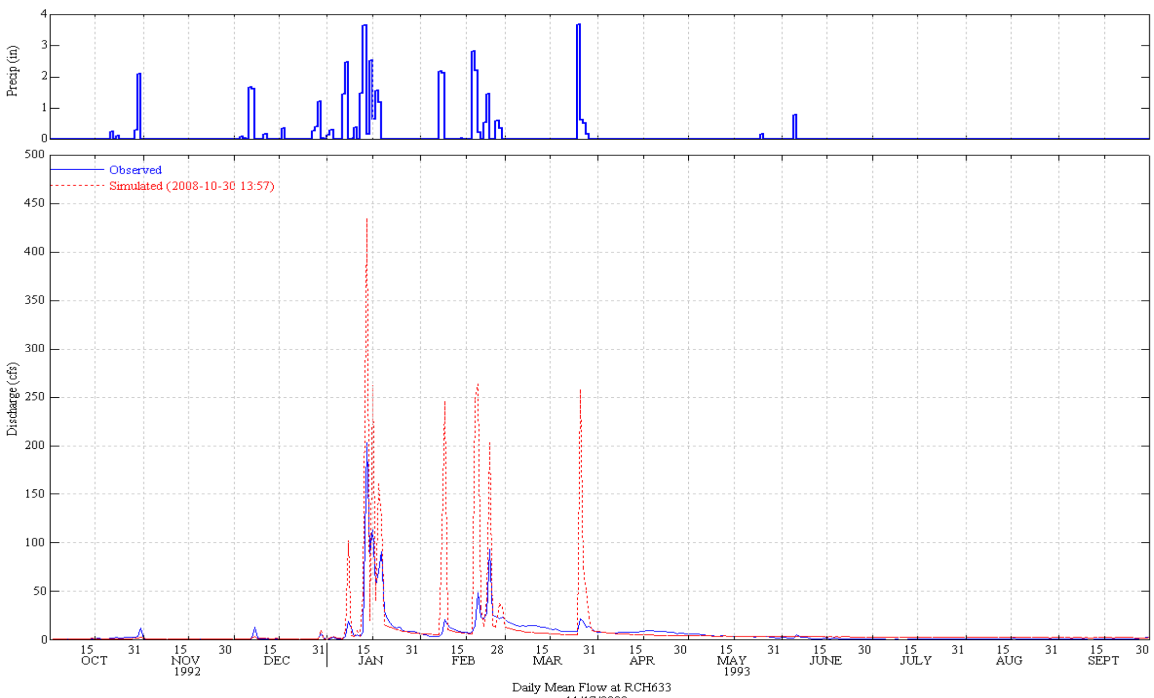

Figure 31 Simulated and Observed Daily Flow at Pole (WY 1993)

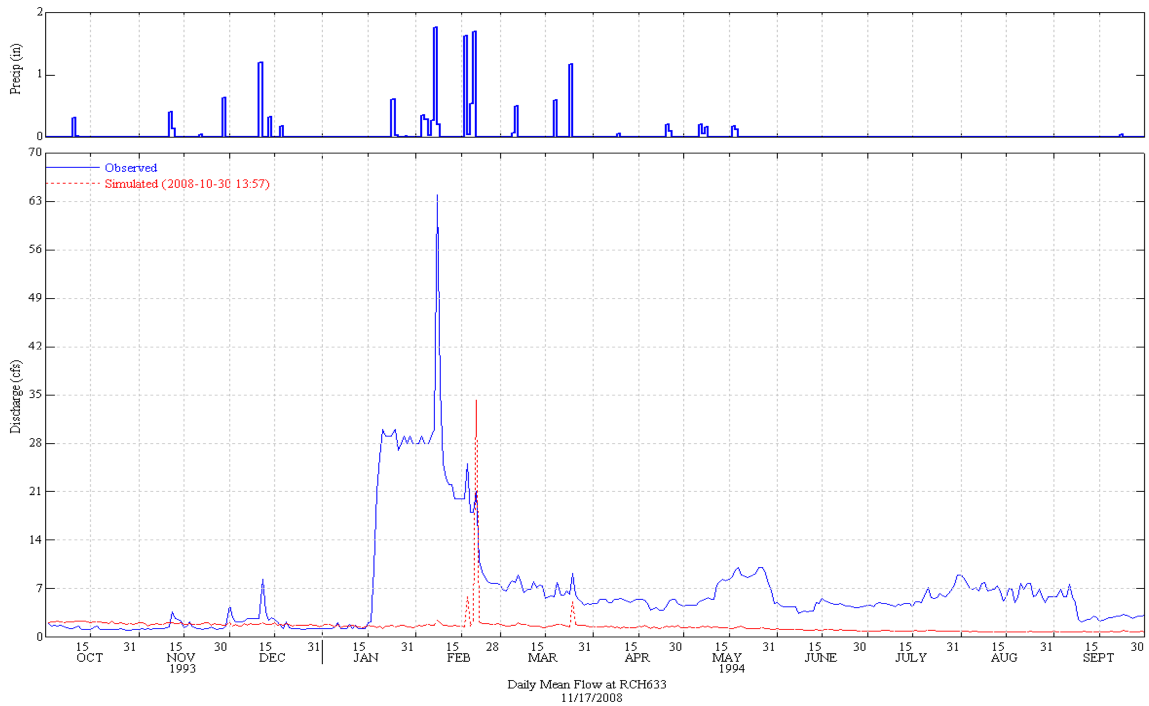

Figure 32 Simulated and Observed Daily Flow at Pole (WY 1994)

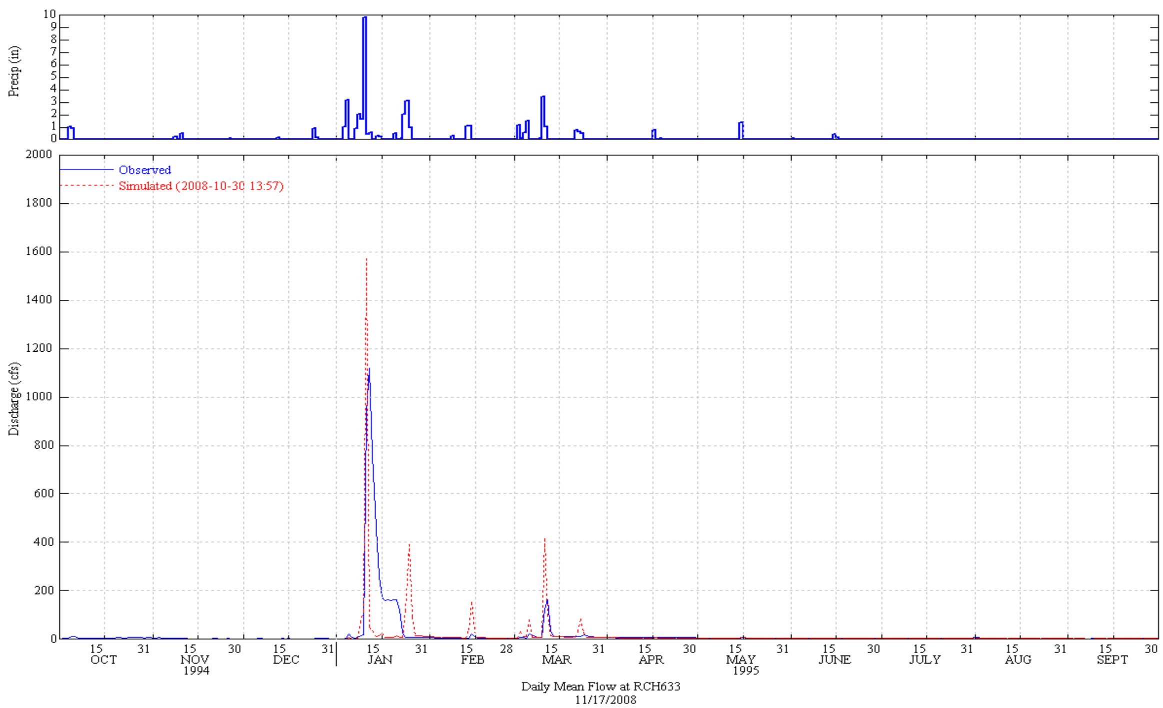

Figure 33 Simulated and Observed Daily Flow at Pole (WY 1995)

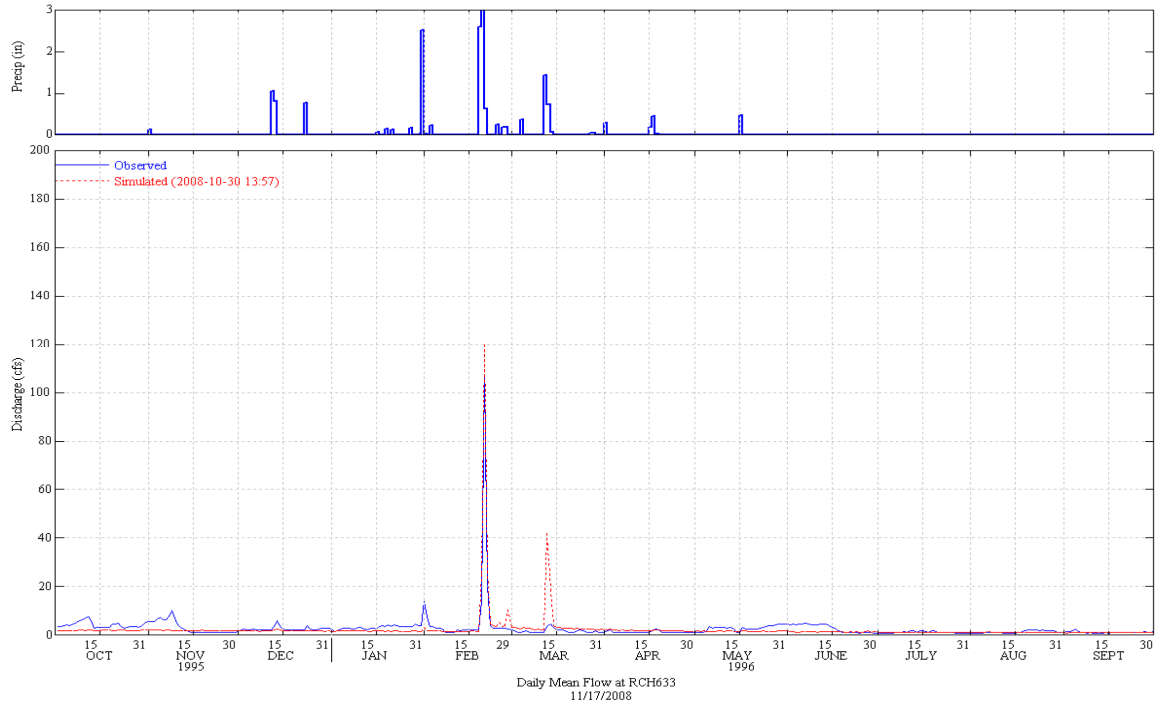

Figure 34 Simulated and Observed Daily Flow at Pole (WY 1996)

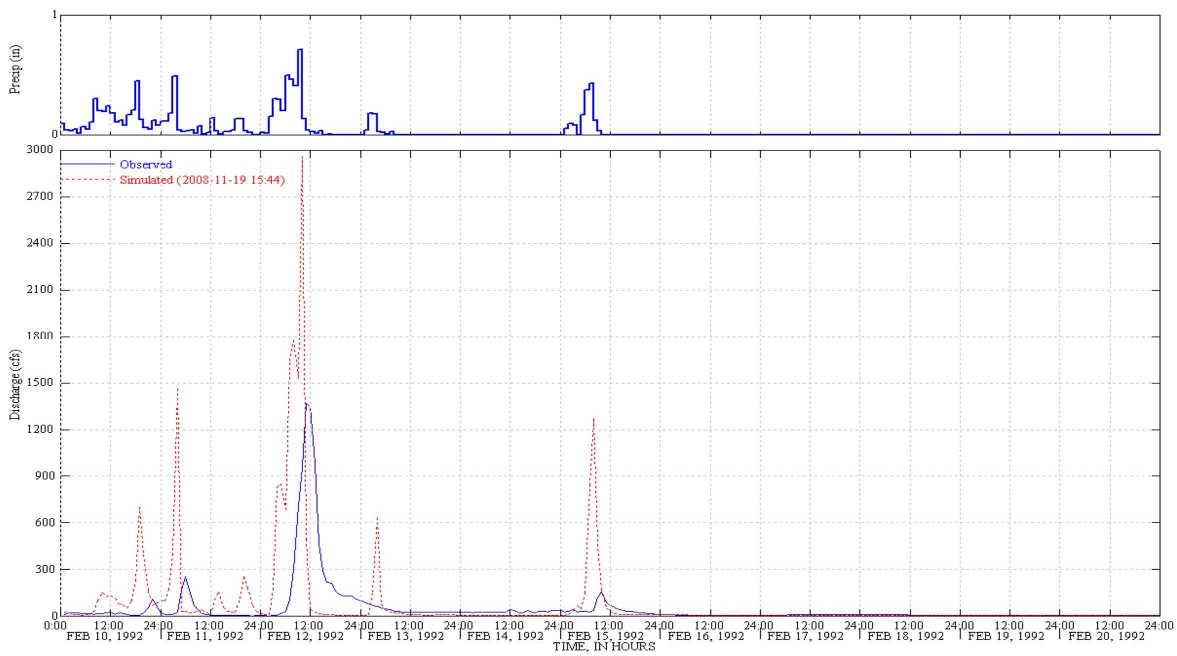

Figure 35 Simulated and Observed February 10, 1992 Storm Event

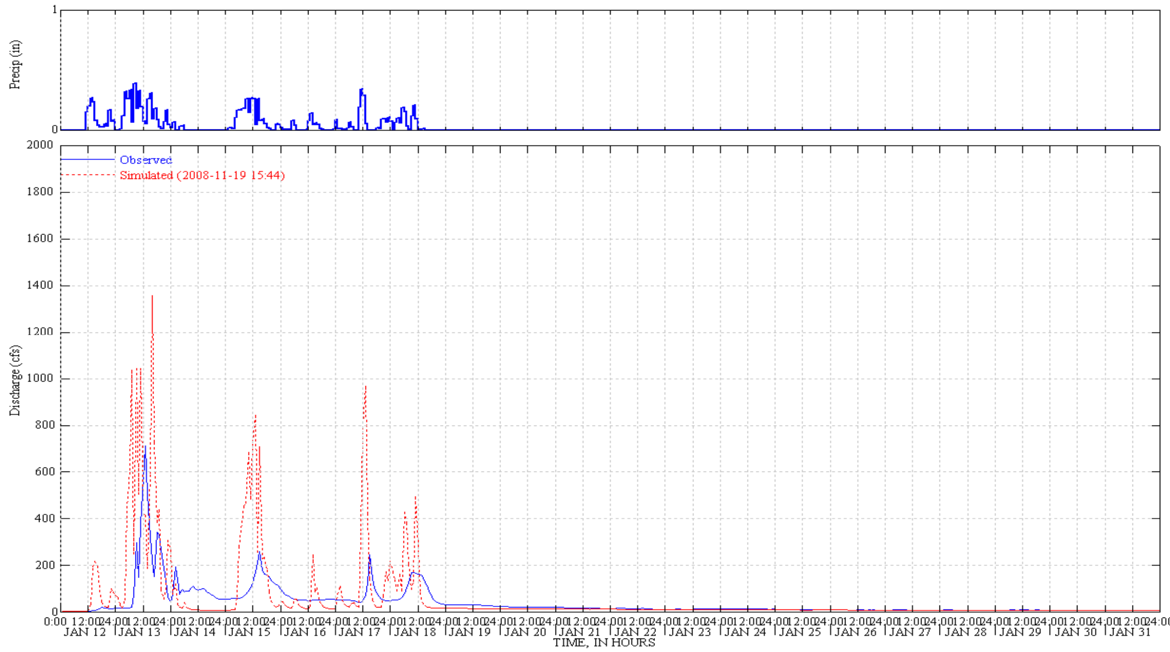

Figure 36 Simulated and Observed January 12, 1993 Storm Event

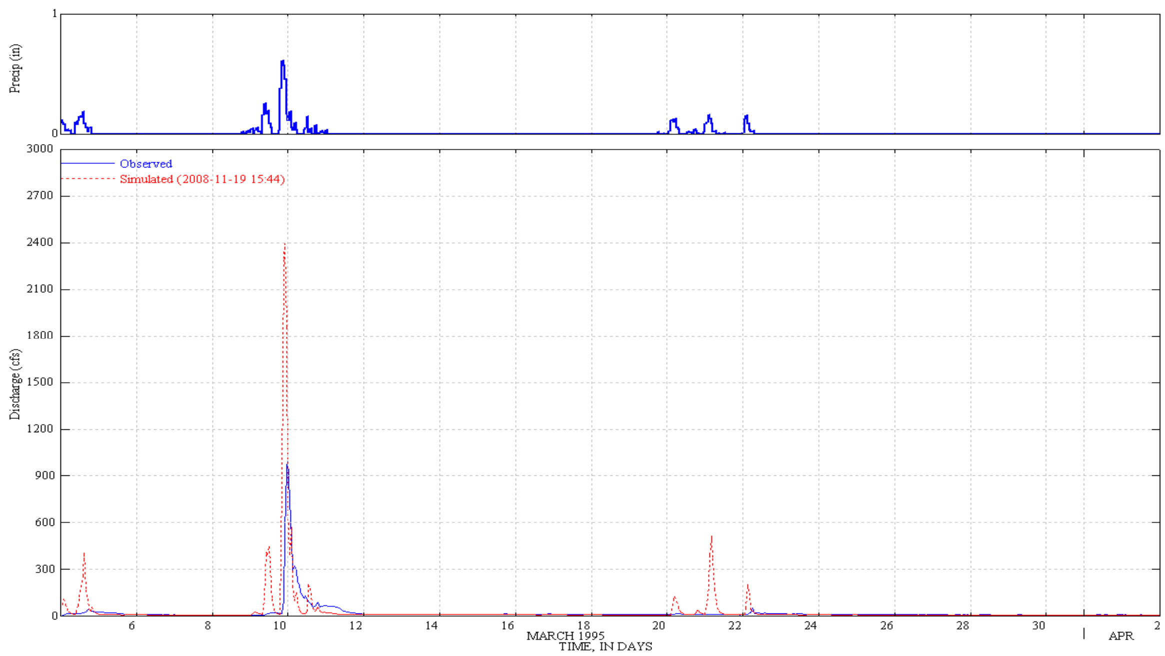

Figure 37 Simulated and Observed March 5, 1995 Storm Event

APPENDIX D

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE HOPPER CREEK WATERSHED

Title Page

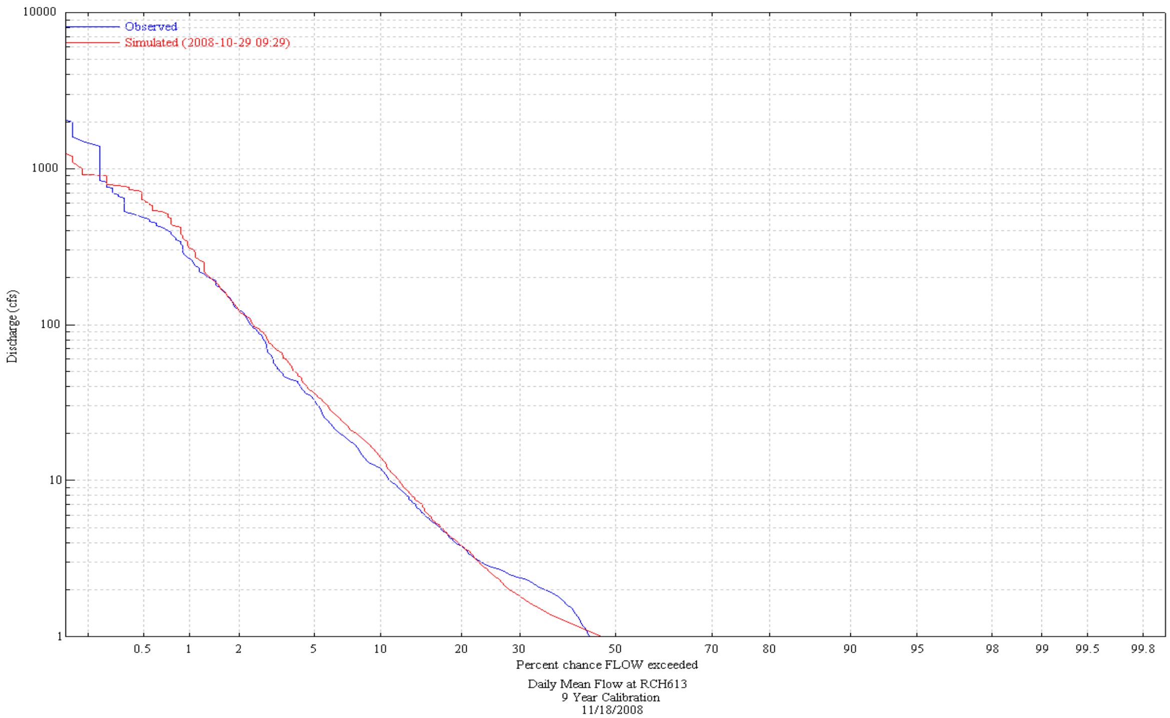

Figure 1 Simulated and Observed Daily Flow Duration Curve at Hopper

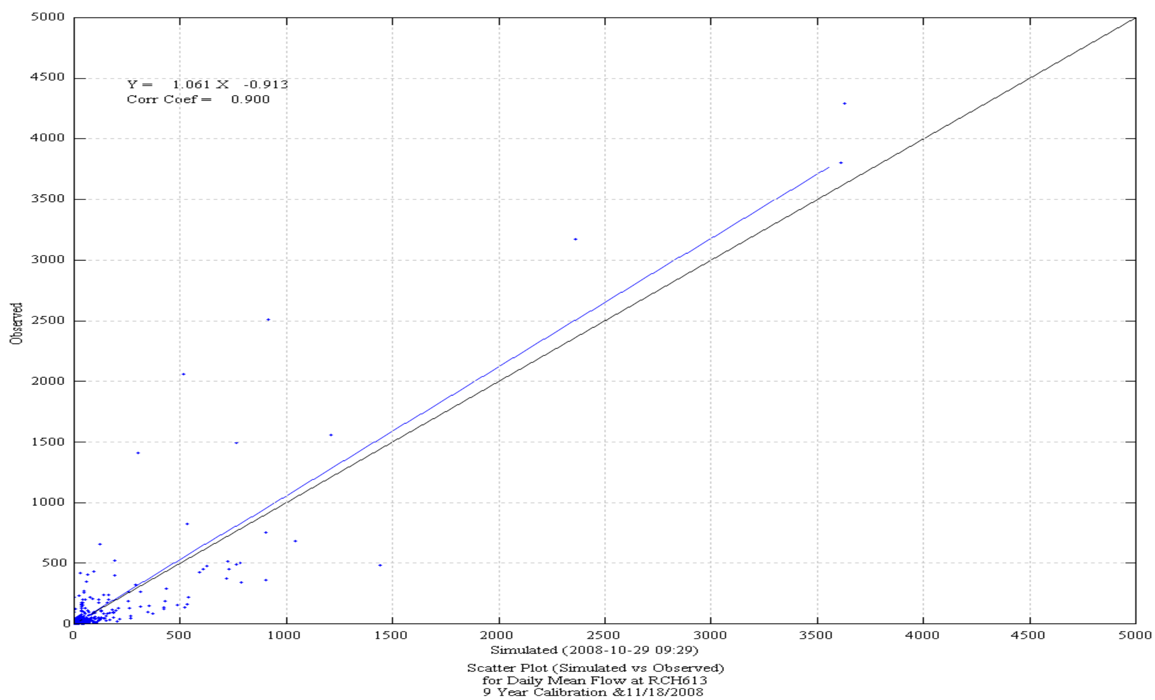

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Hopper

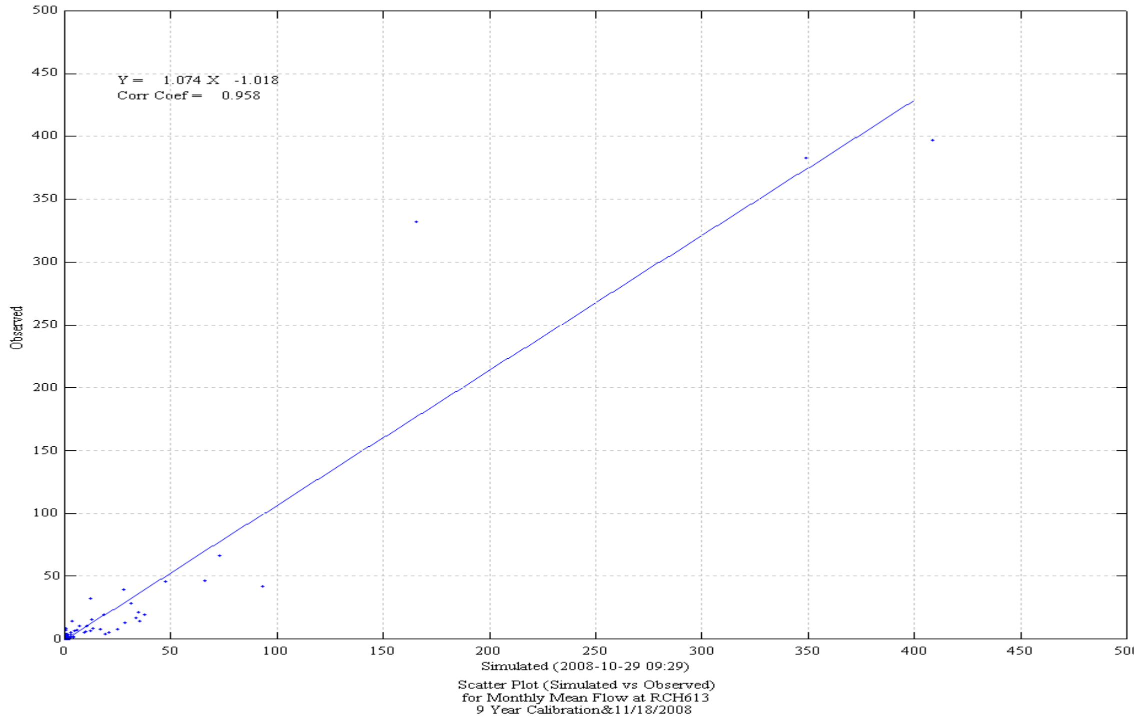

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Hopper

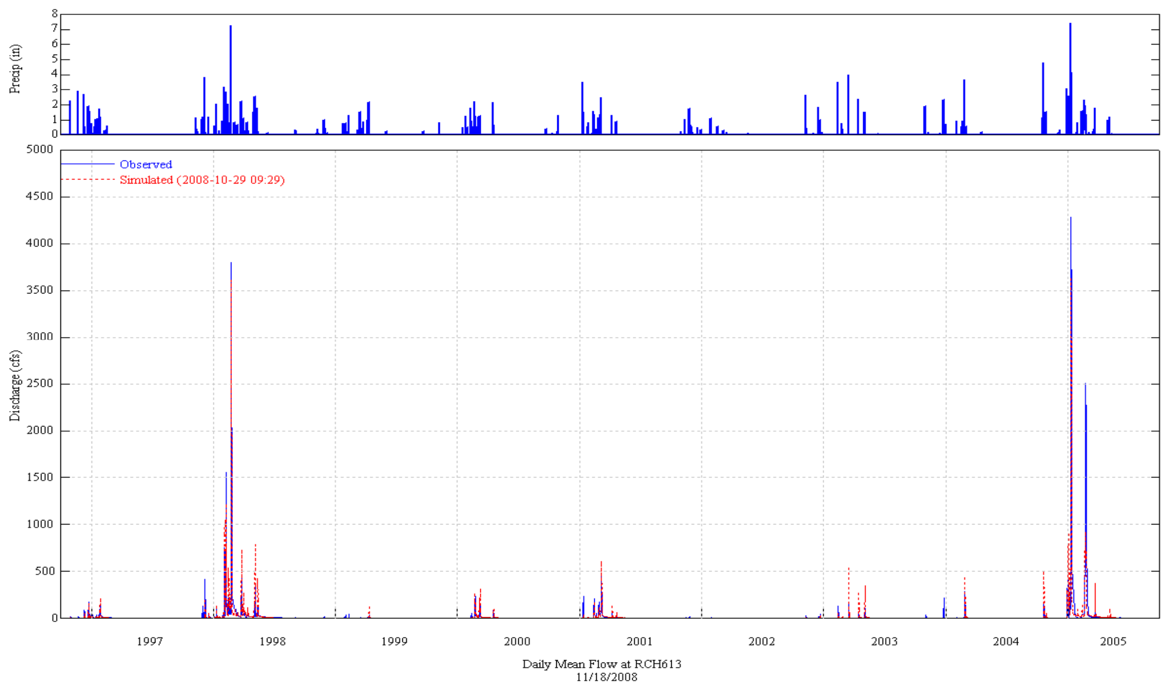

Figure 4 Simulated and Observed Daily Flow at Hopper (WY 1997-2005)

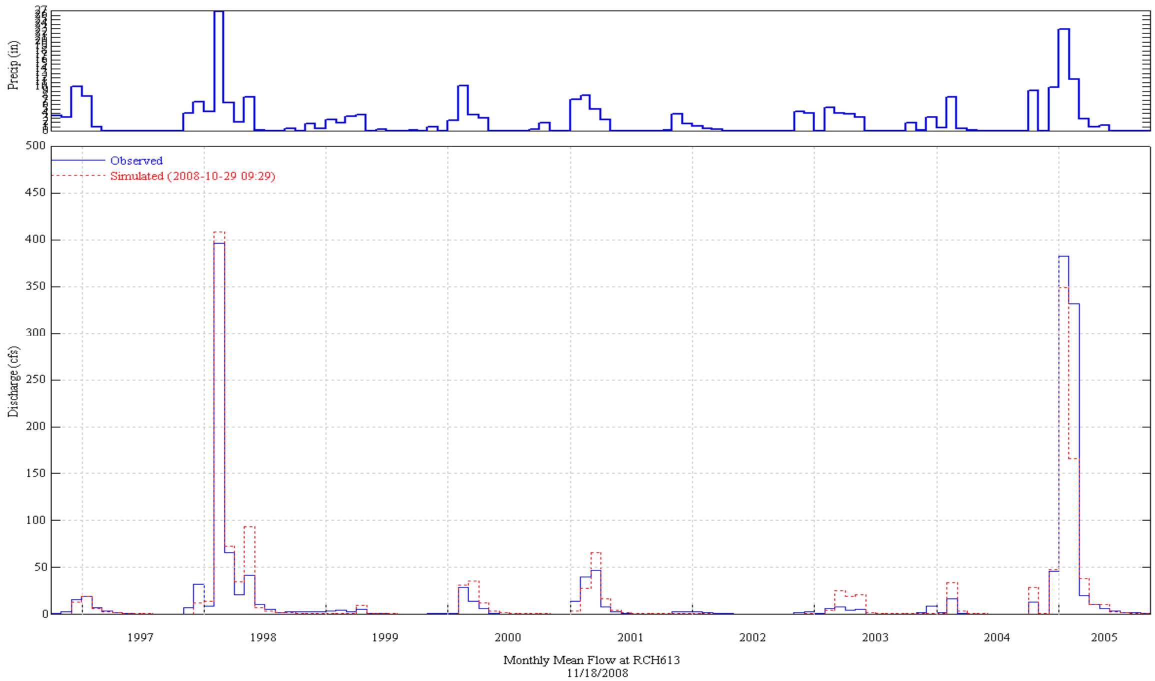

Figure 5 Simulated and Observed Monthly Flow at Hopper (WY 1997-2005)

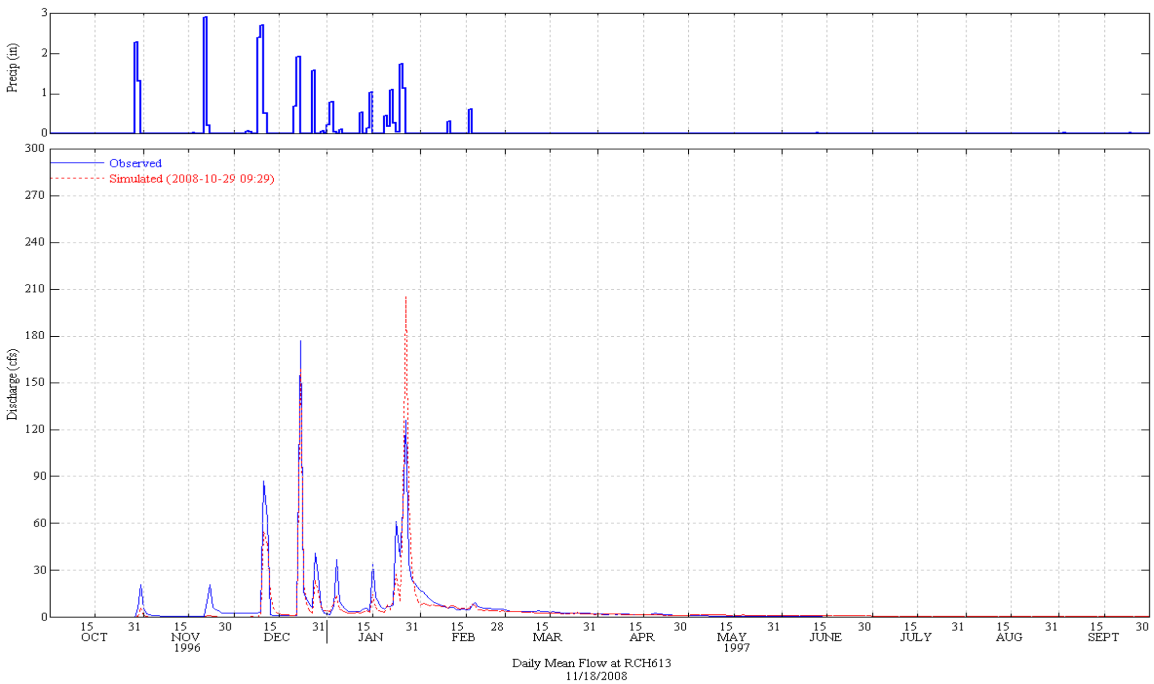

Figure 6 Simulated and Observed Daily Flow at Hopper (WY 1997)

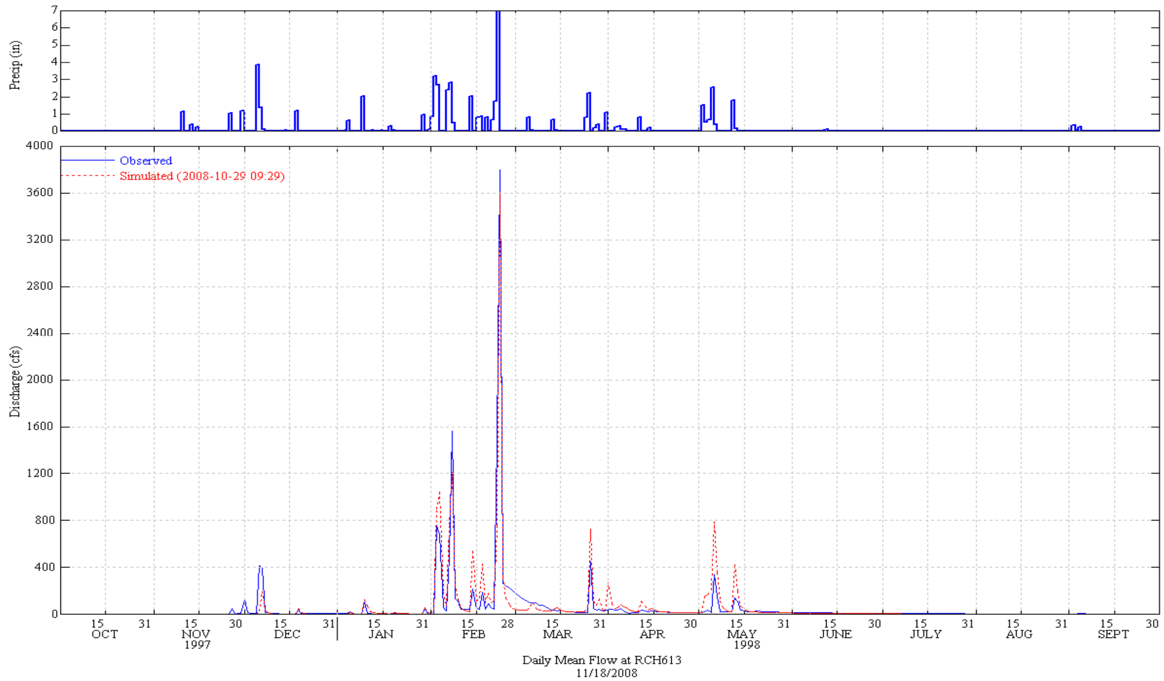

Figure 7 Simulated and Observed Daily Flow at Hopper (WY 1998)

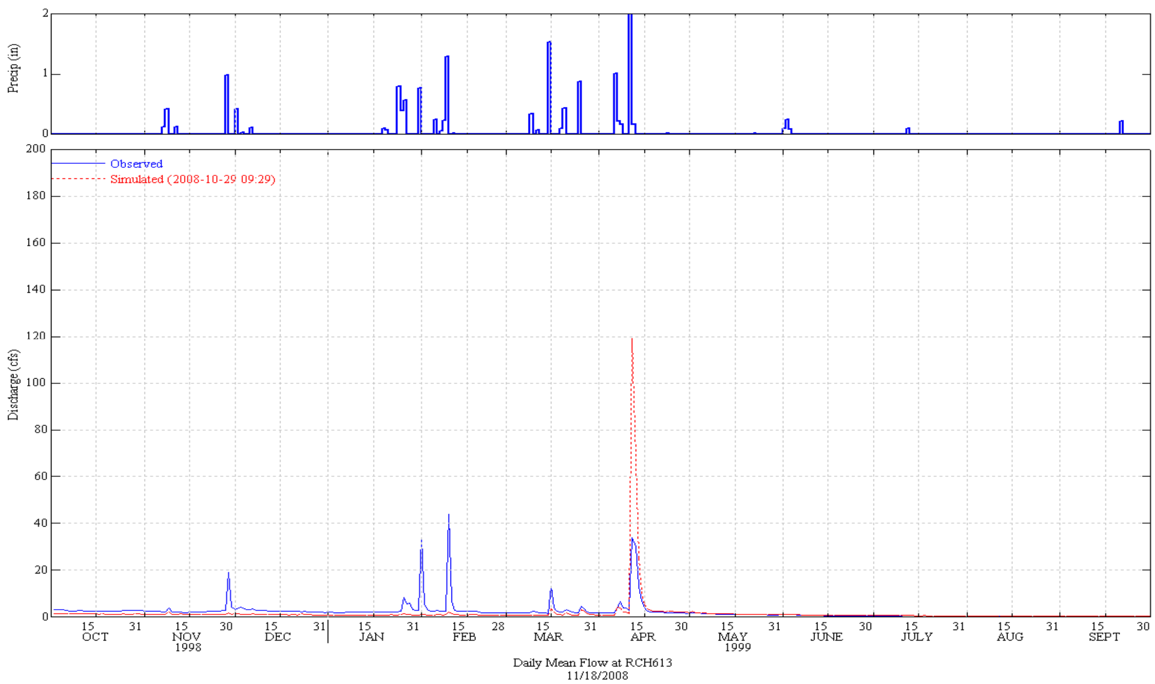

Figure 8 Simulated and Observed Daily Flow at Hopper (WY 1999)

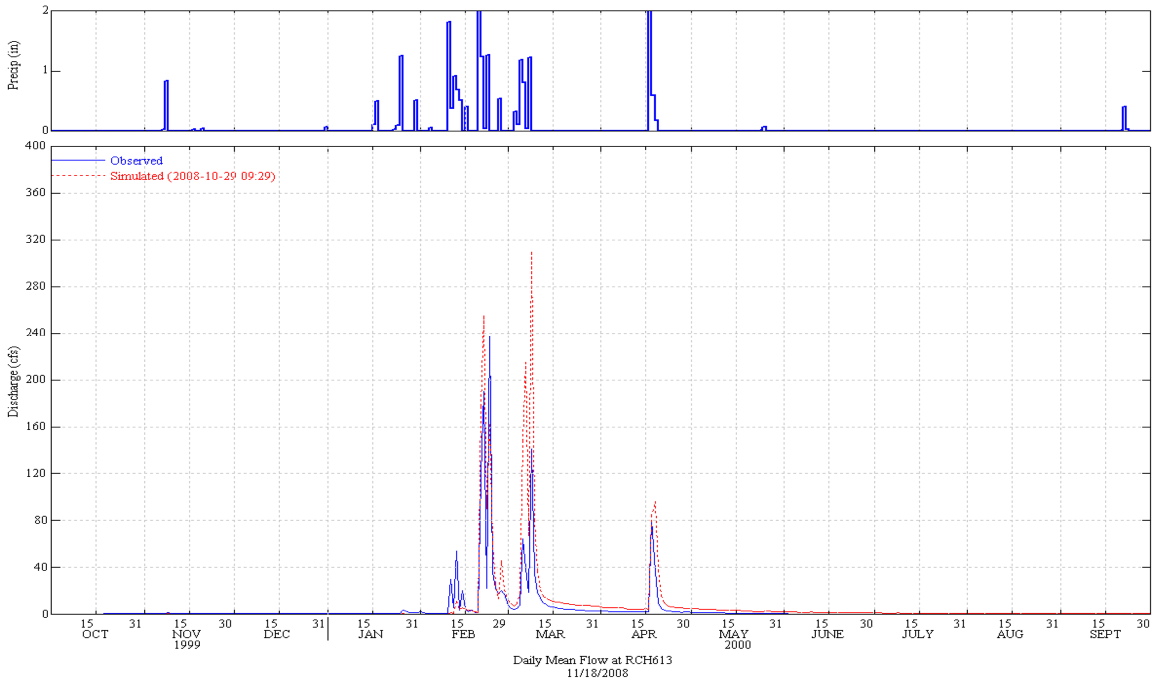

Figure 9 Simulated and Observed Daily Flow at Hopper (WY 2000)

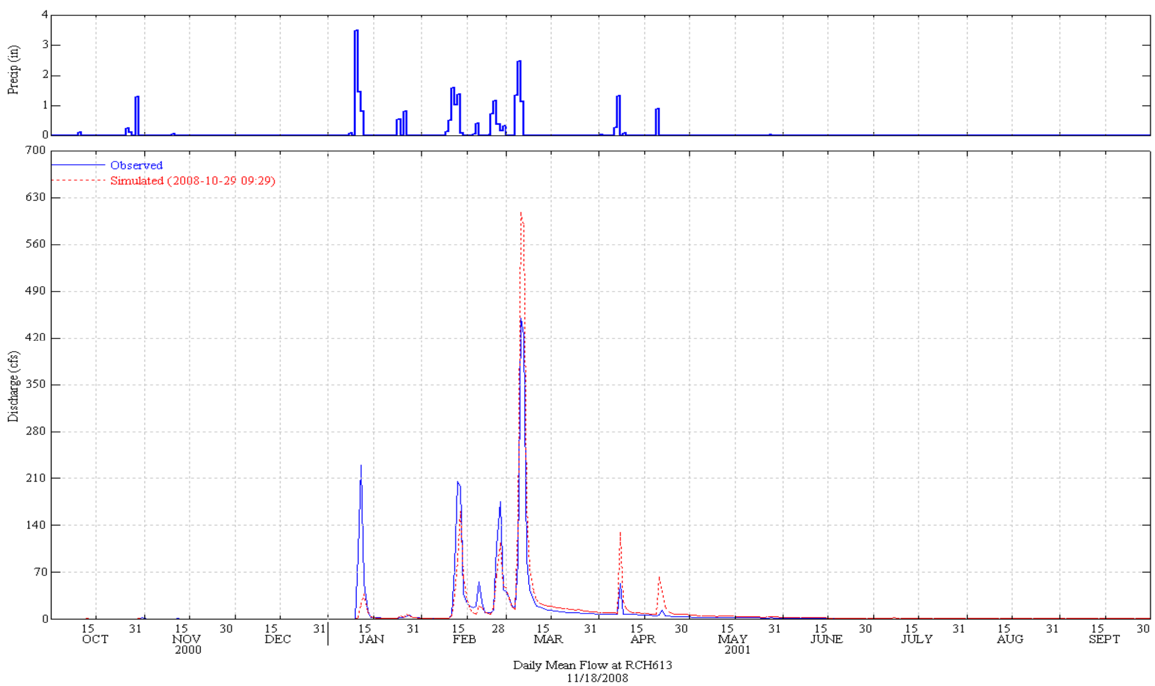

Figure 10 Simulated and Observed Daily Flow at Hopper (WY 2001)

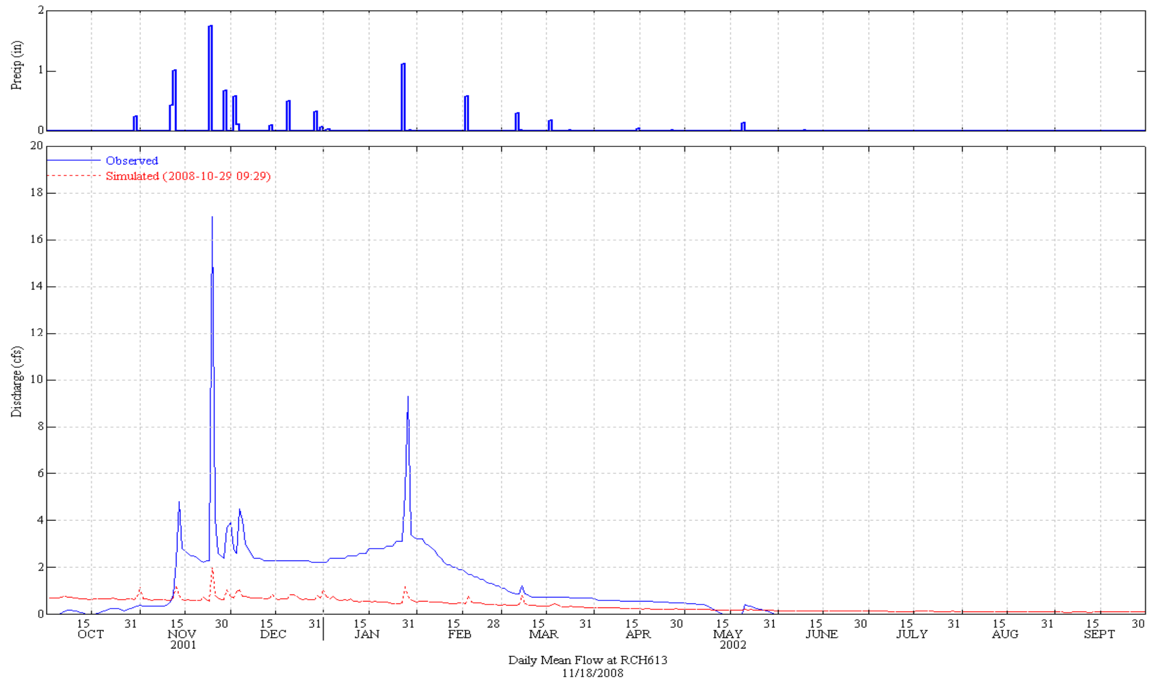

Figure 11 Simulated and Observed Daily Flow at Hopper (WY 2002)

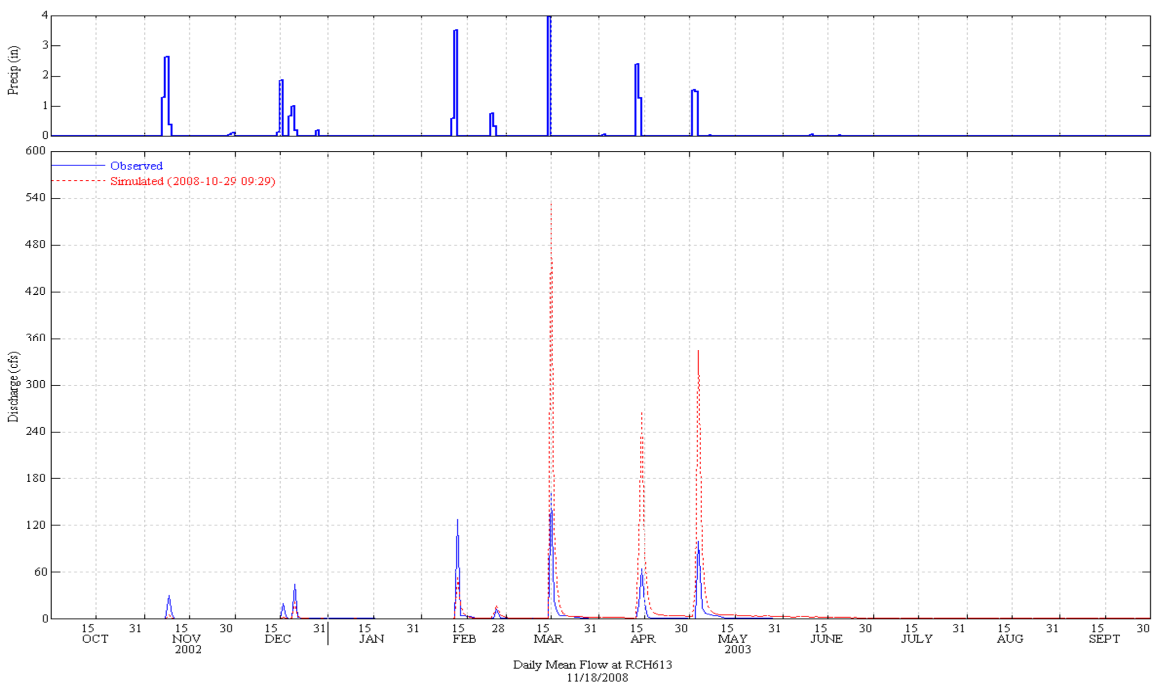

Figure 12 Simulated and Observed Daily Flow at Hopper (WY 2003)

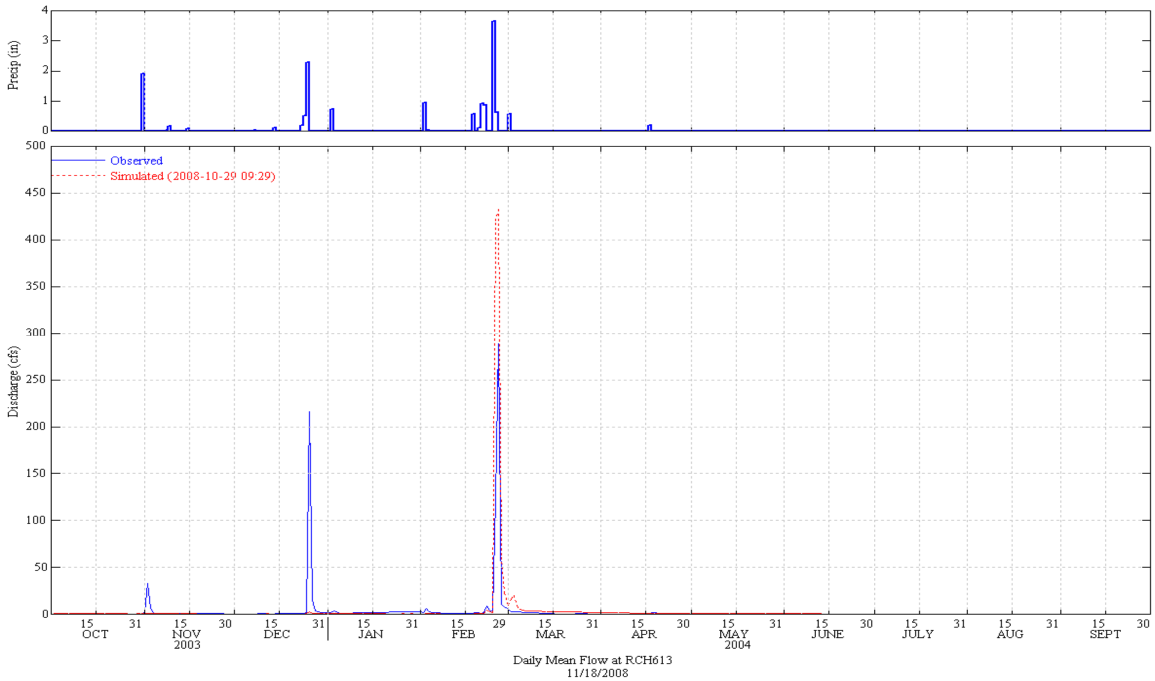

Figure 13 Simulated and Observed Daily Flow at Hopper (WY 2004)

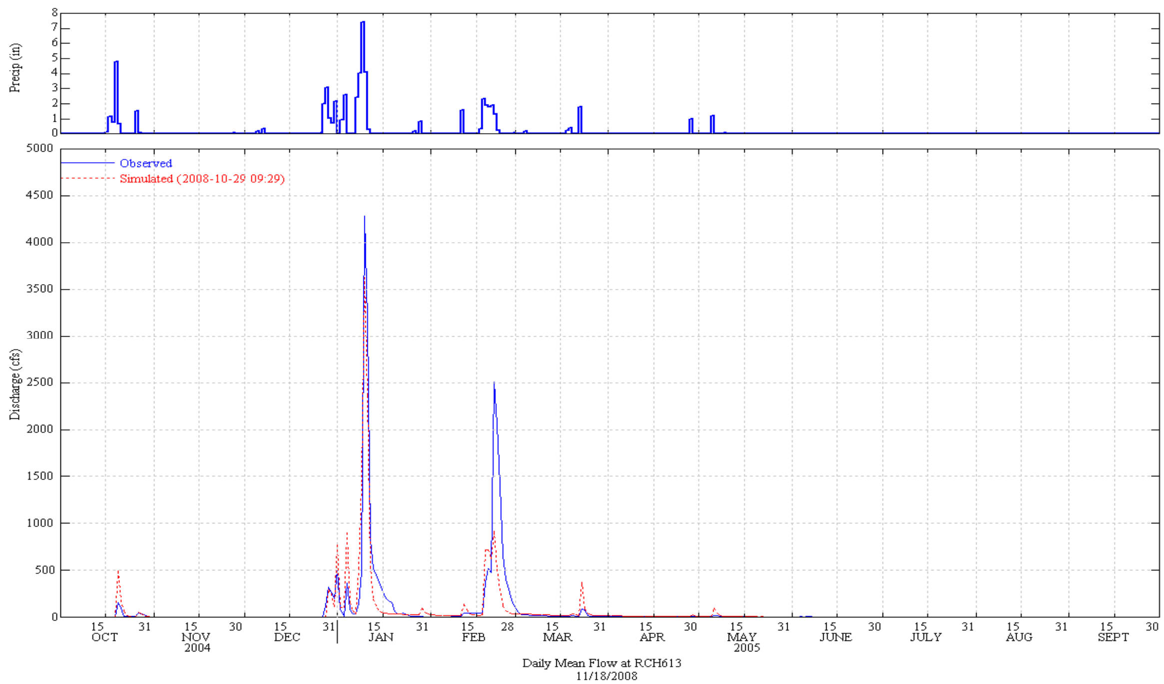

Figure 14 Simulated and Observed Daily Flow at Hopper (WY 2005)

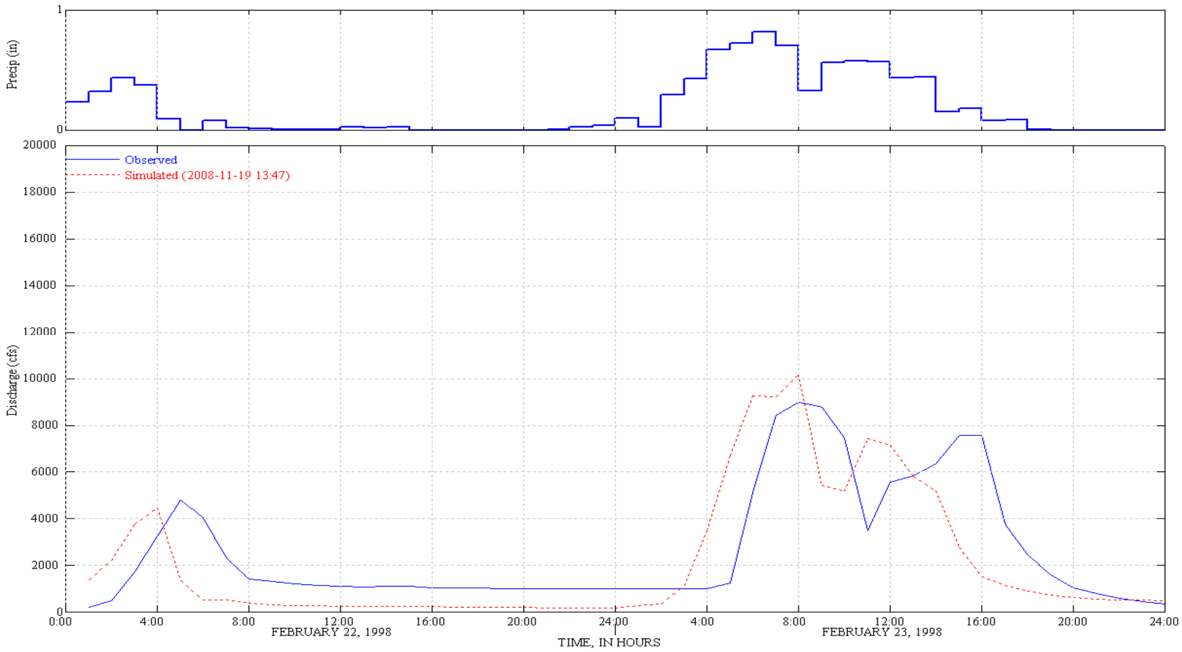

Figure 15 Simulated and Observed February 22, 1998 Storm Event

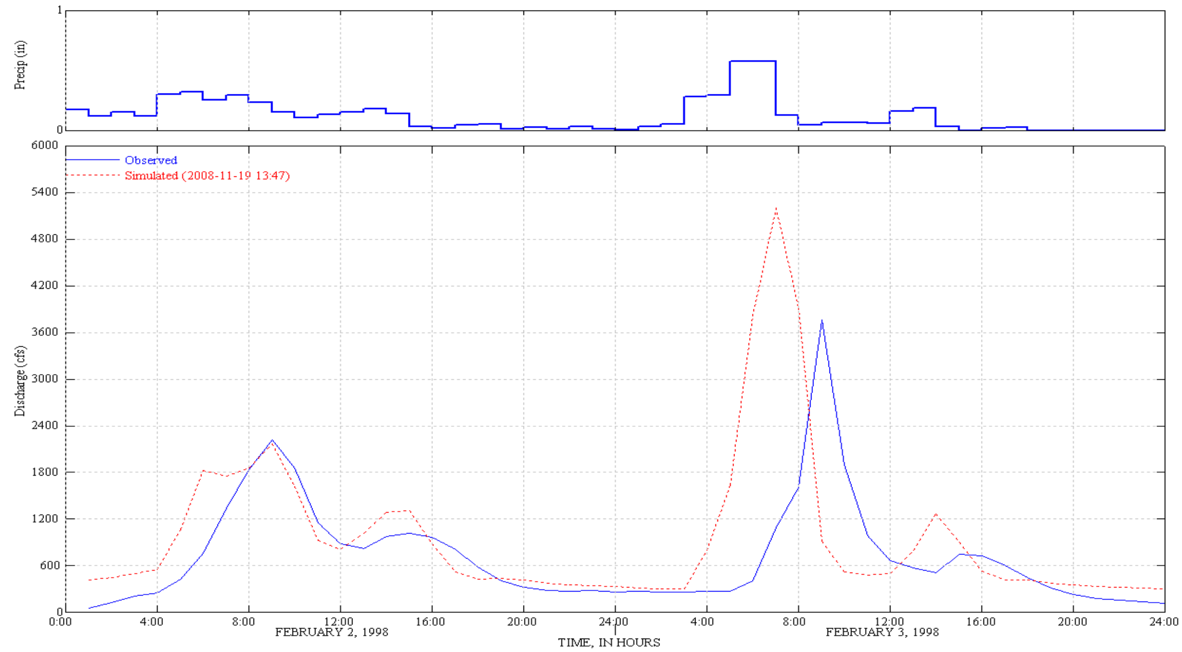

Figure 16 Simulated and Observed February 2, 1998 Storm Event

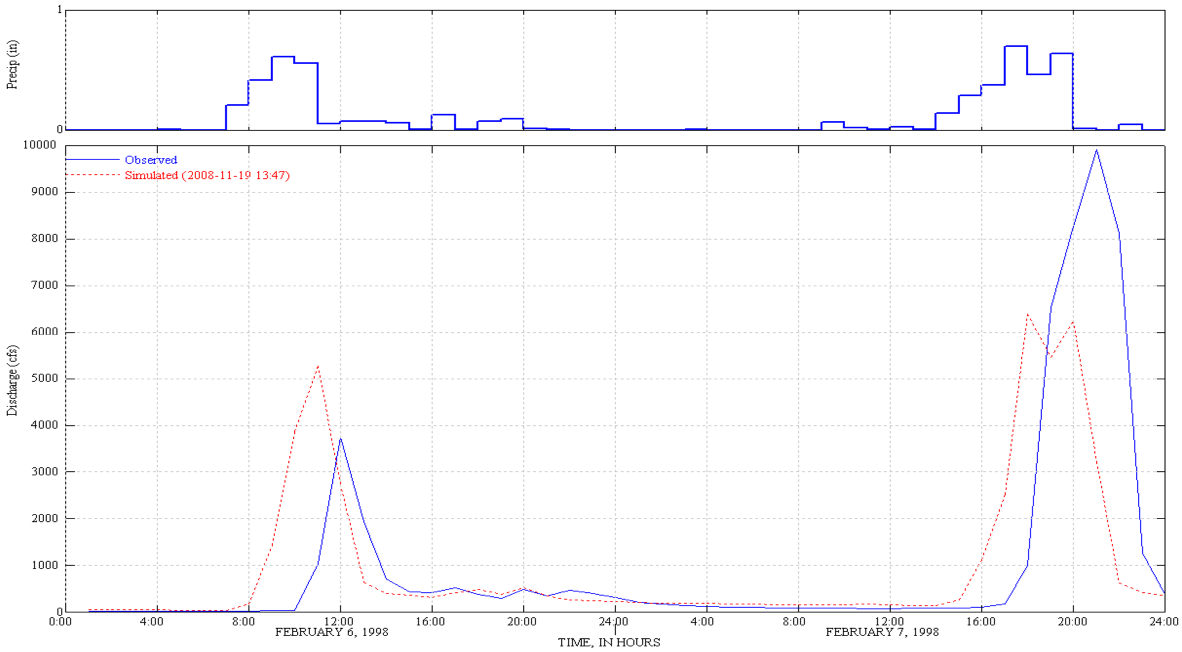

Figure 17 Simulated and Observed February 6, 1998 Storm Event

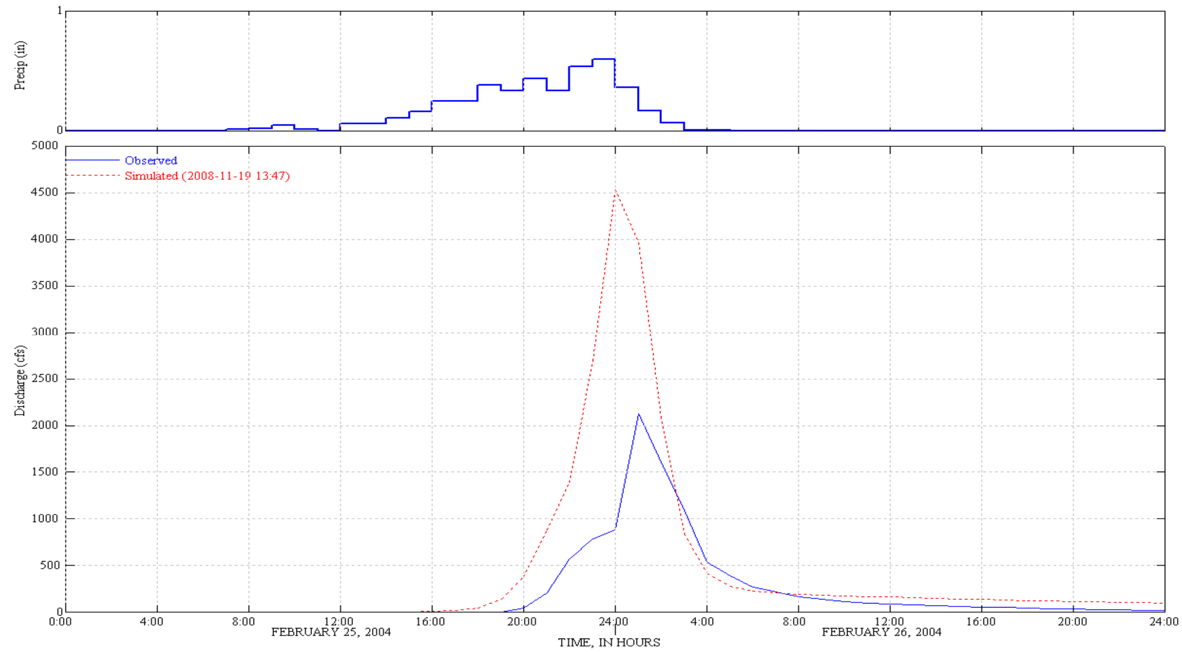

Figure 18 Simulated and Observed February 25, 2004 Storm Event

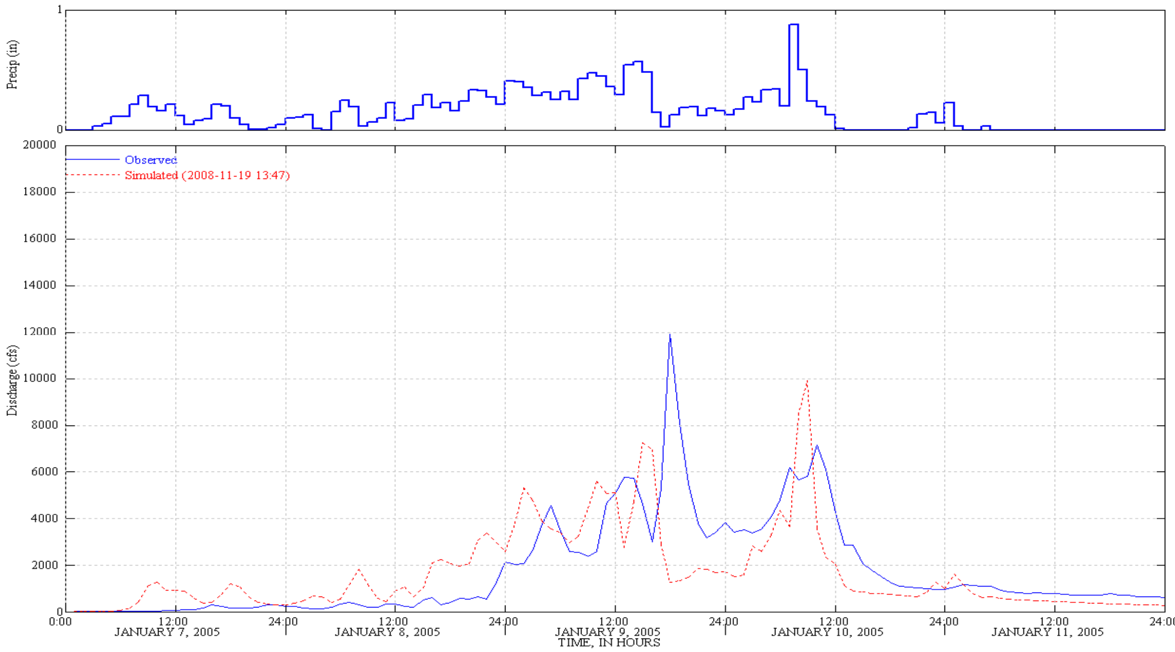

Figure 19 Simulated and Observed January 7, 2005 Storm Event

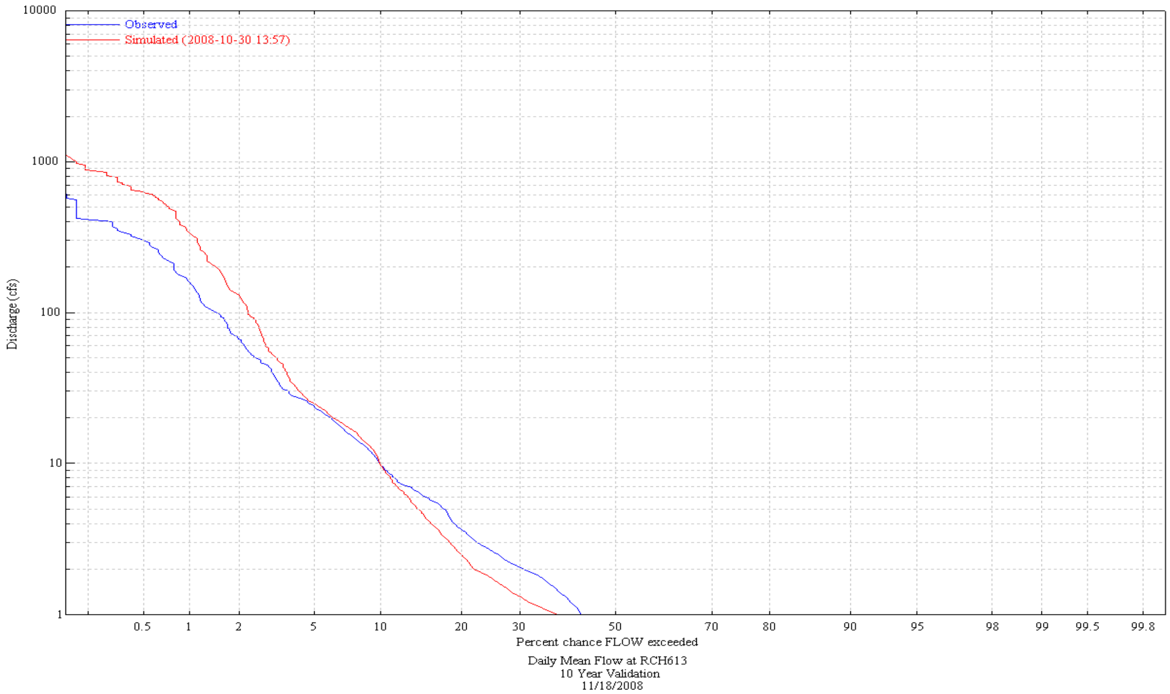

Figure 20 Simulated and Observed Daily Flow Duration Curve at Hopper

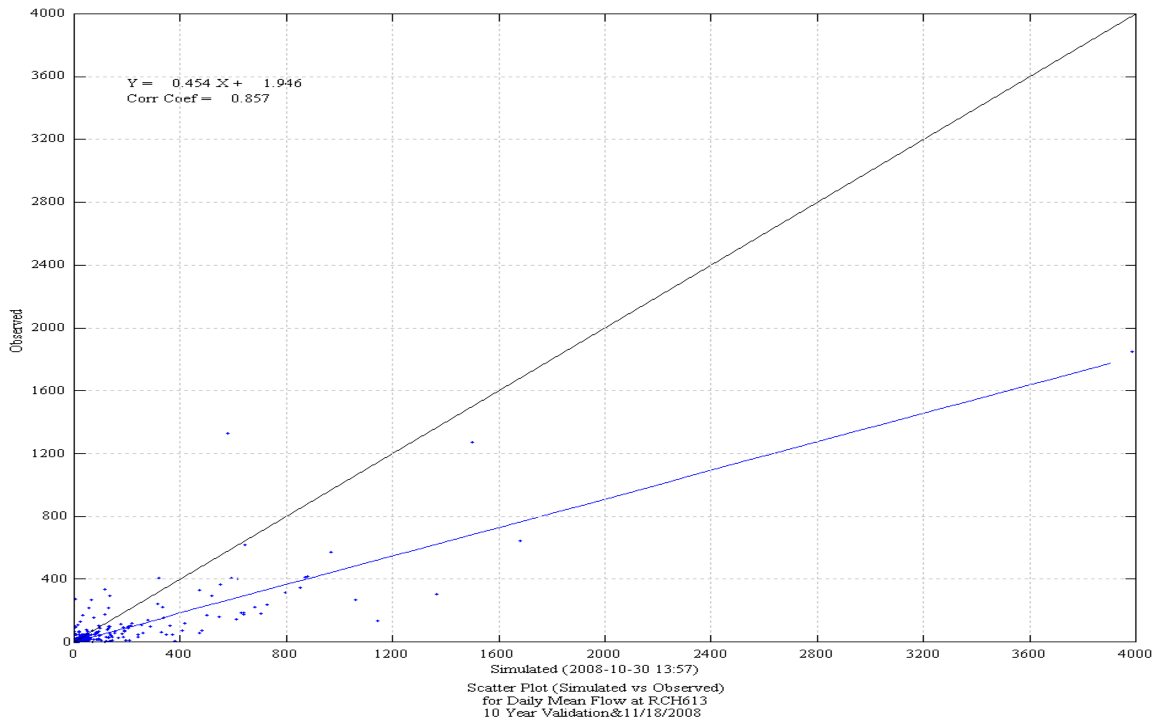

Figure 21 Daily Scatter Plot of Simulated versus Observed Flow at Hopper

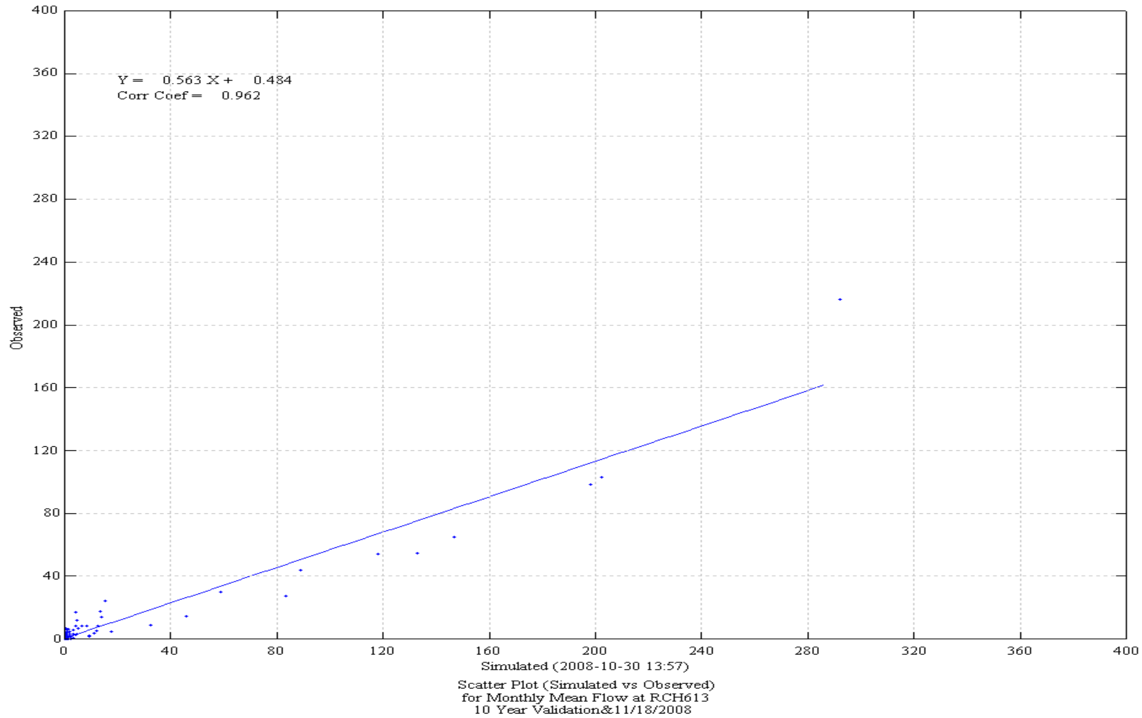

Figure 22 Monthly Scatter Plot of Simulated versus Observed Flow at Hopper

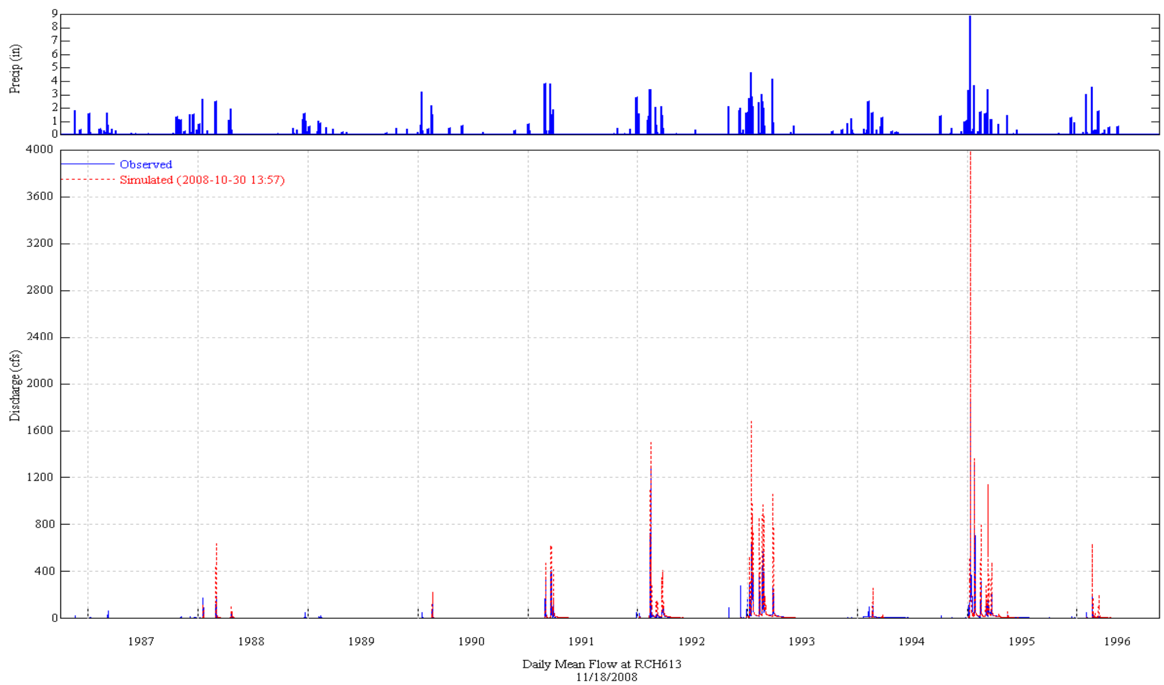

Figure 23 Simulated and Observed Daily Flow at Hopper (WY 1987-1996)

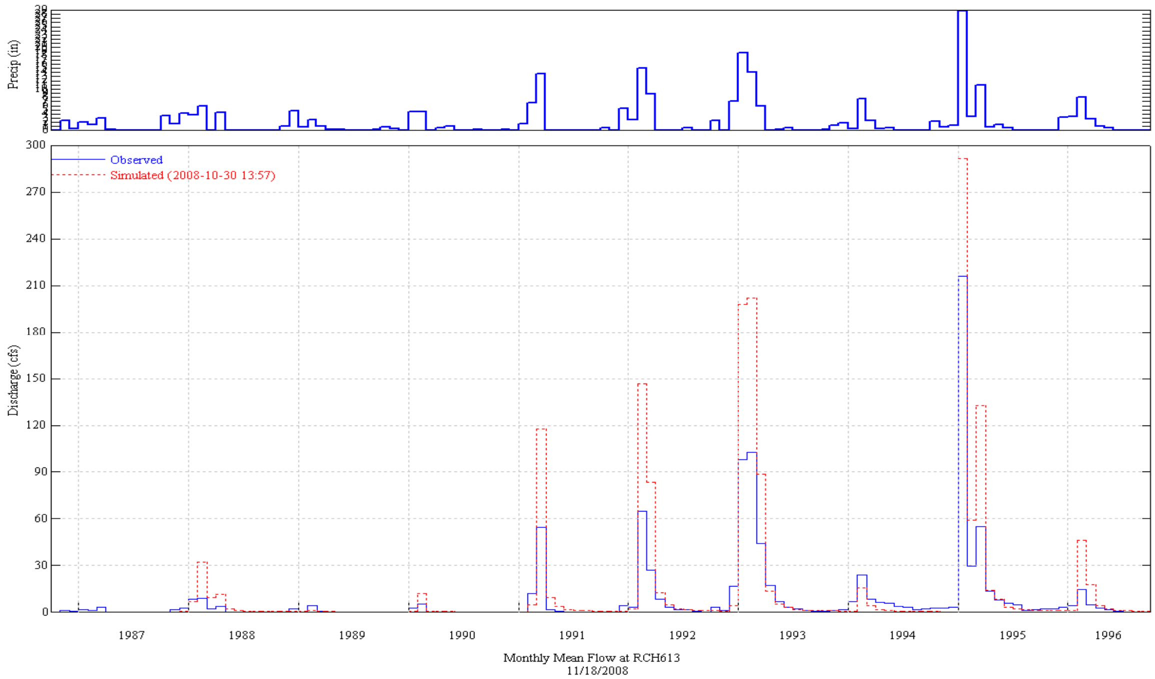

Figure 24 Simulated and Observed Monthly Flow at Hopper (WY 1987-1996)

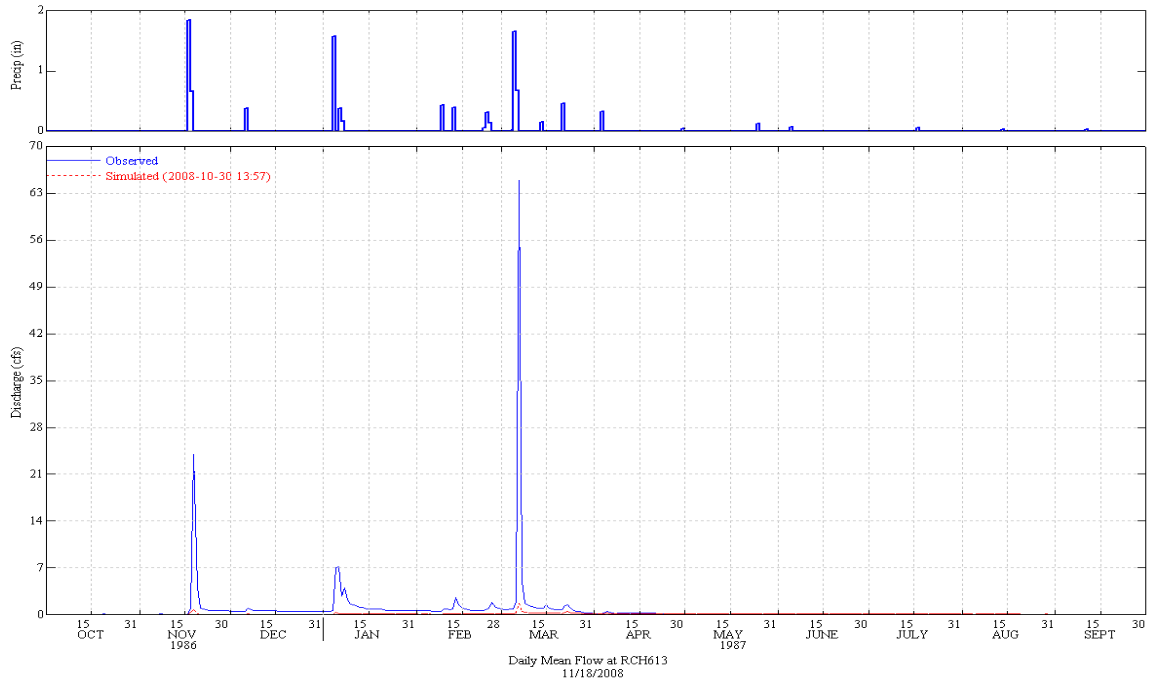

Figure 25 Simulated and Observed Daily Flow at Hopper (WY 1987)

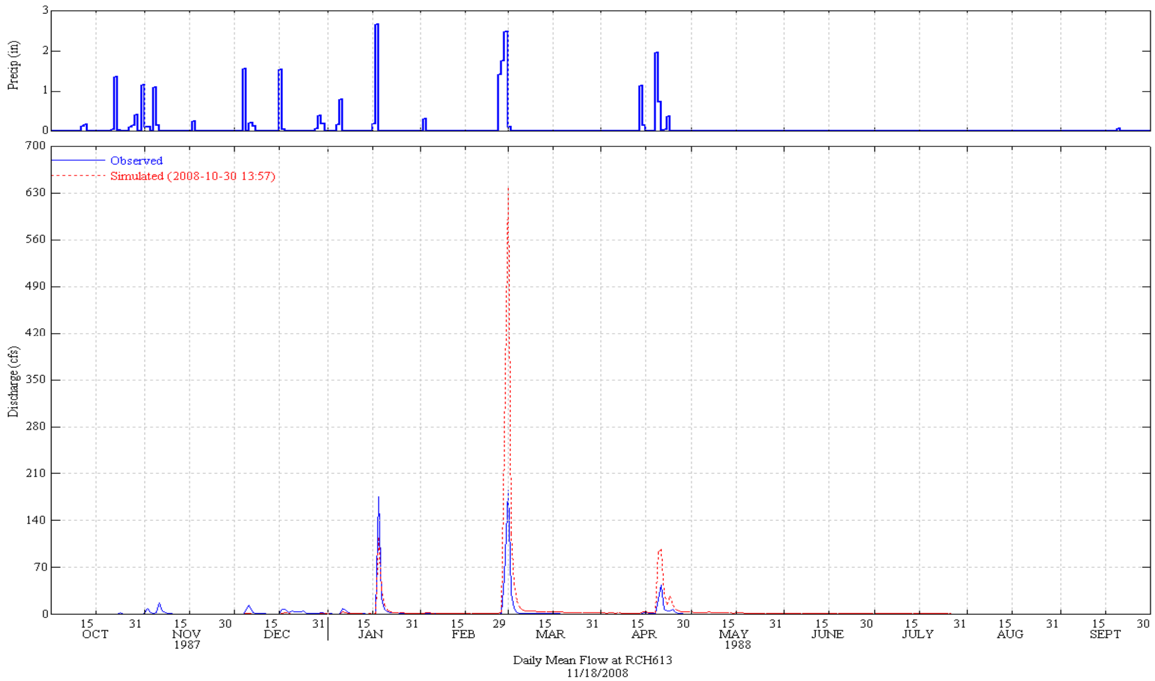

Figure 26 Simulated and Observed Daily Flow at Hopper (WY 1988)

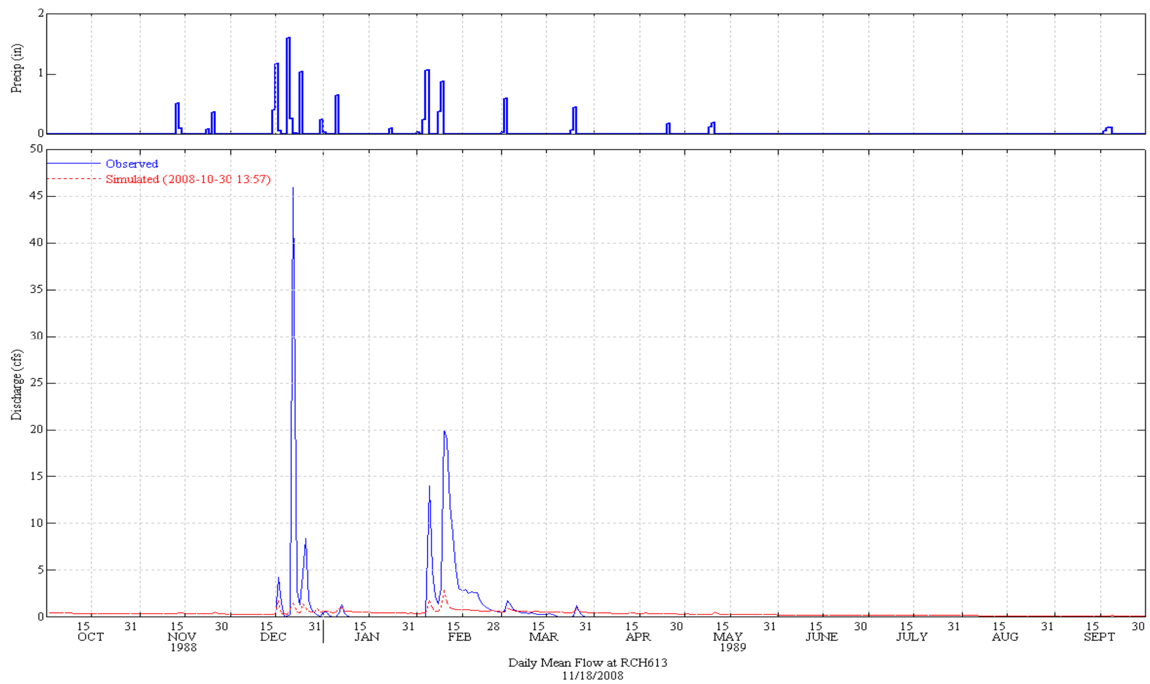

Figure 27 Simulated and Observed Daily Flow at Hopper (WY 1989)

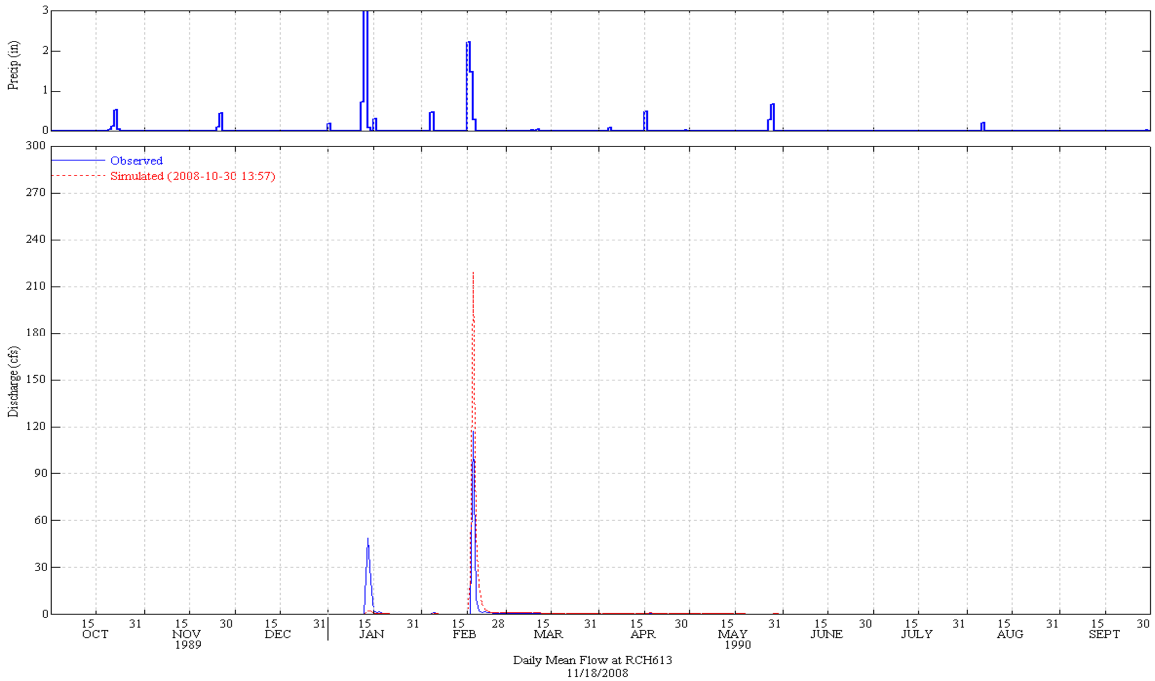

Figure 28 Simulated and Observed Daily Flow at Hopper (WY 1990)

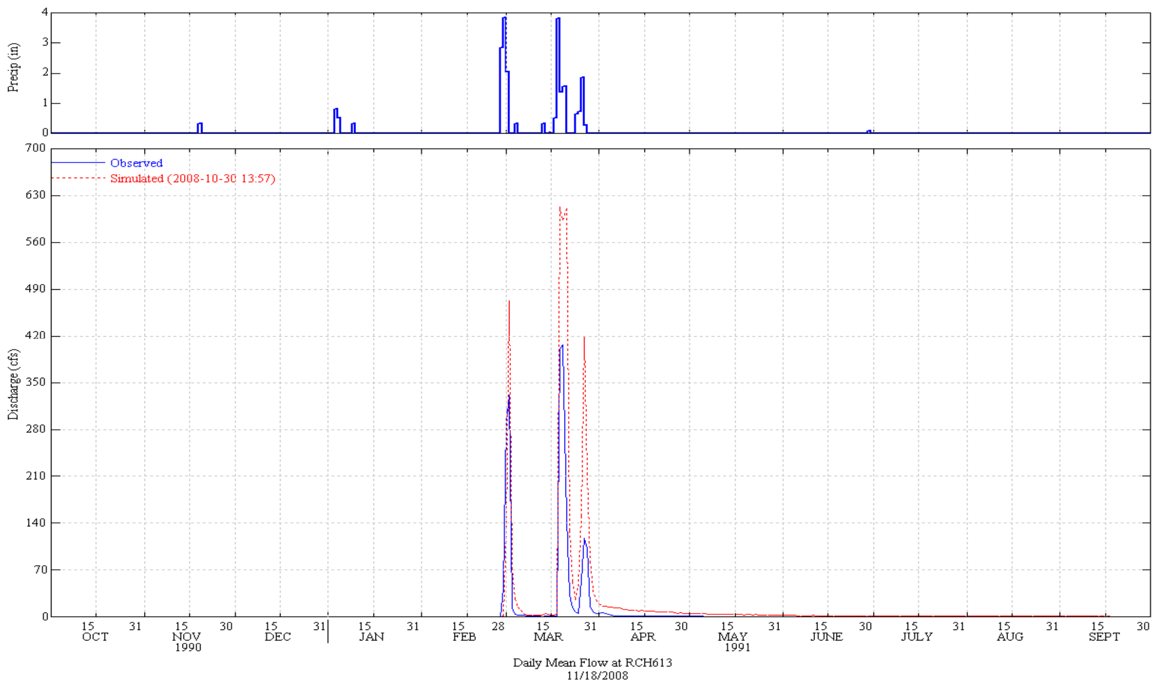

Figure 29 Simulated and Observed Daily Flow at Hopper (WY 1991)

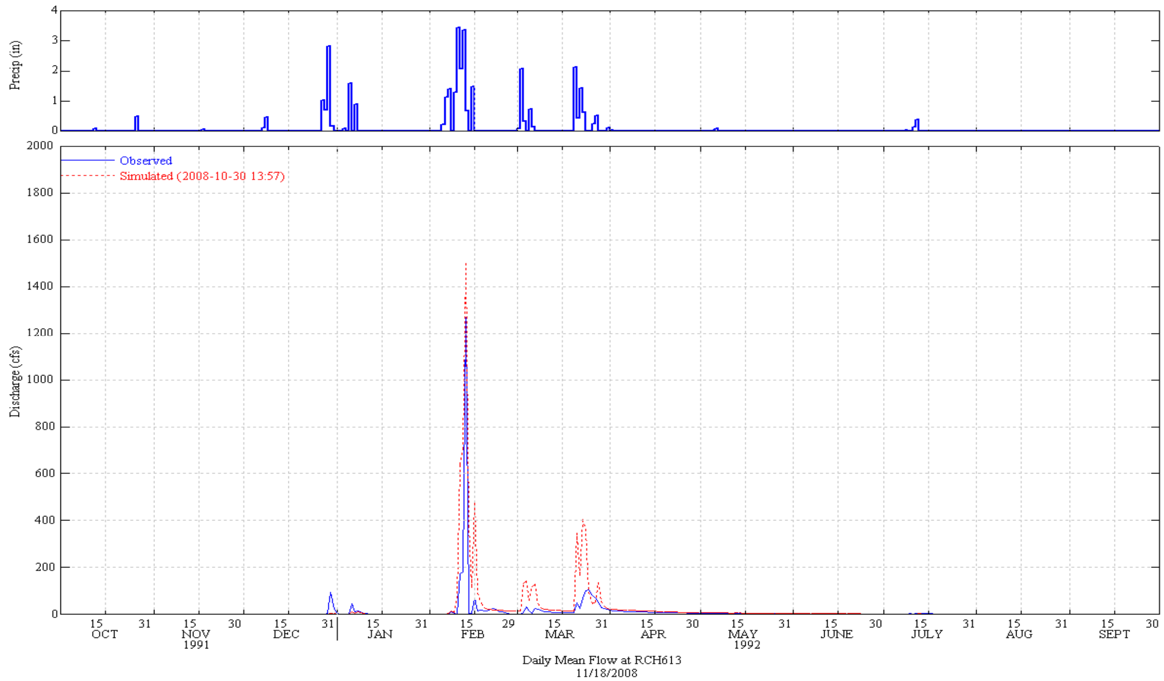

Figure 30 Simulated and Observed Daily Flow at Hopper (WY 1992)

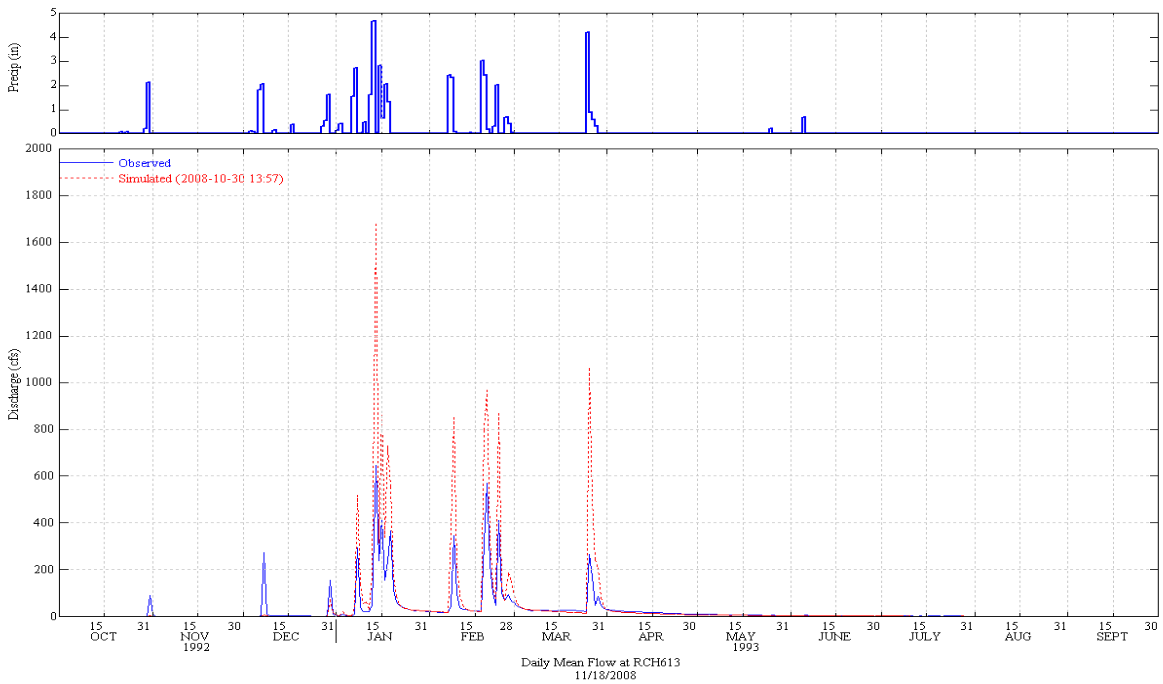

Figure 31 Simulated and Observed Daily Flow at Hopper (WY 1993)

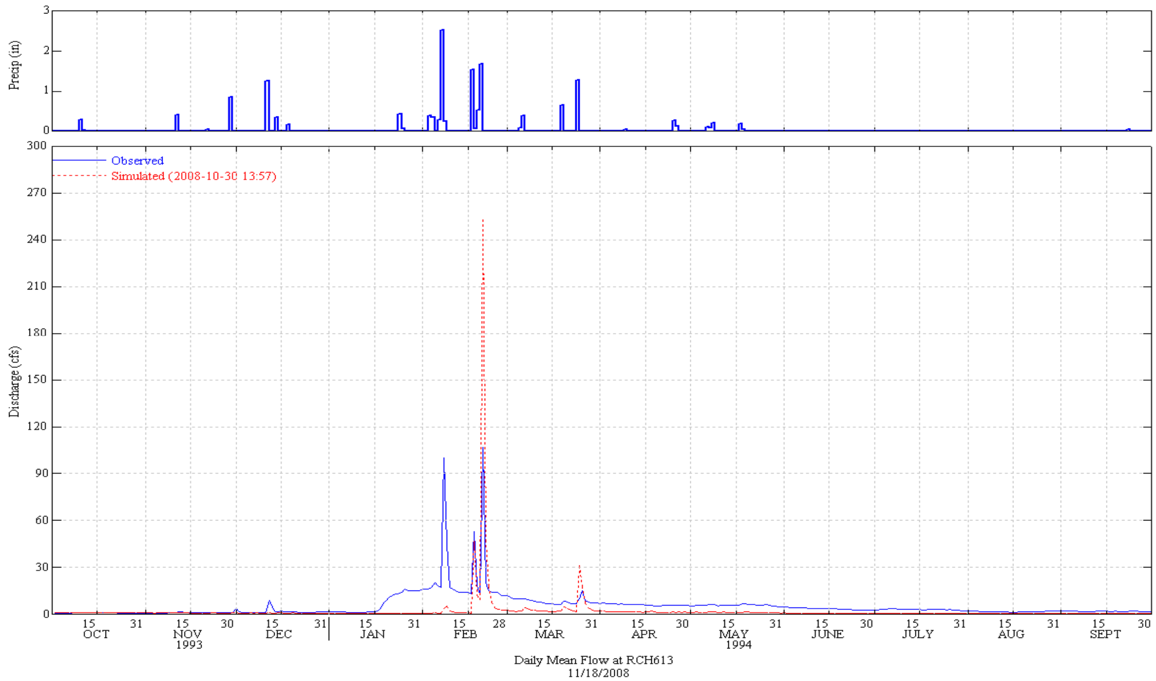

Figure 32 Simulated and Observed Daily Flow at Hopper (WY 1994)

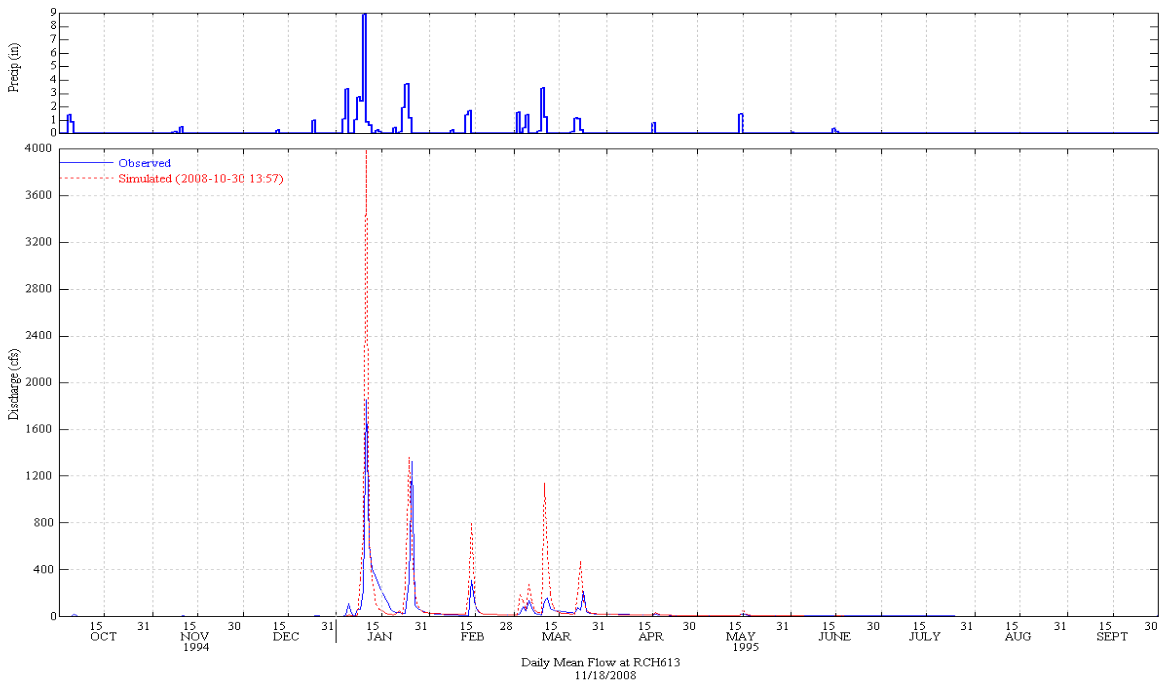

Figure 33 Simulated and Observed Daily Flow at Hopper (WY 1995)

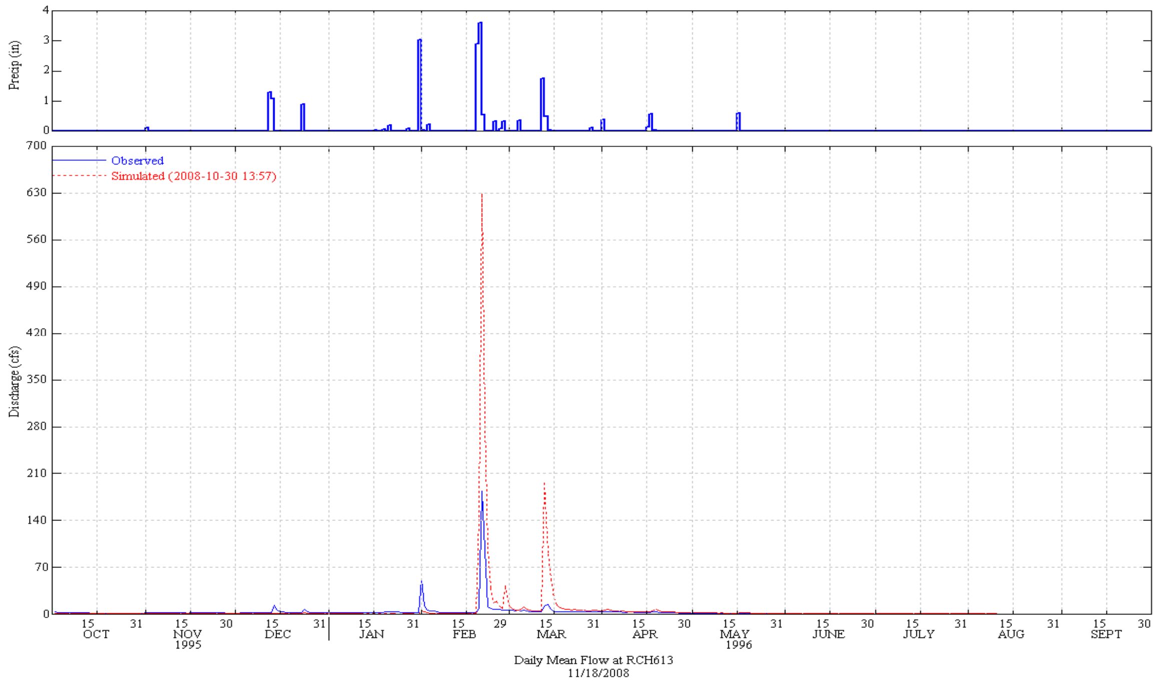

Figure 34 Simulated and Observed Daily Flow at Hopper (WY 1996)

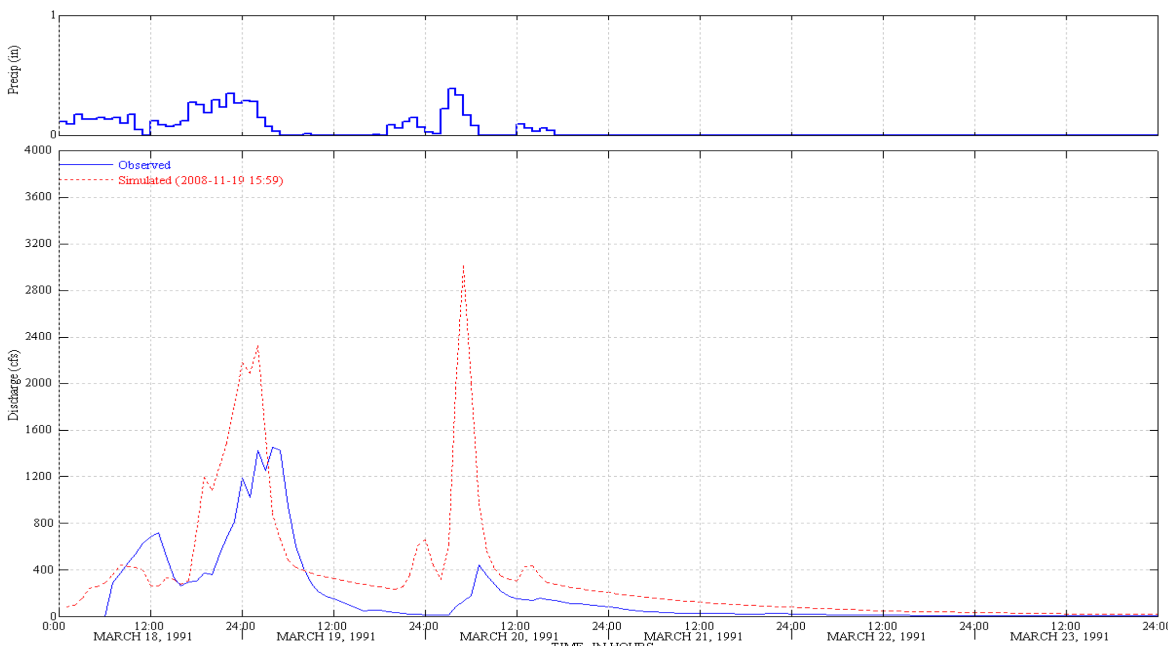

Figure 35 Simulated and Observed March 18, 1991 Storm Event

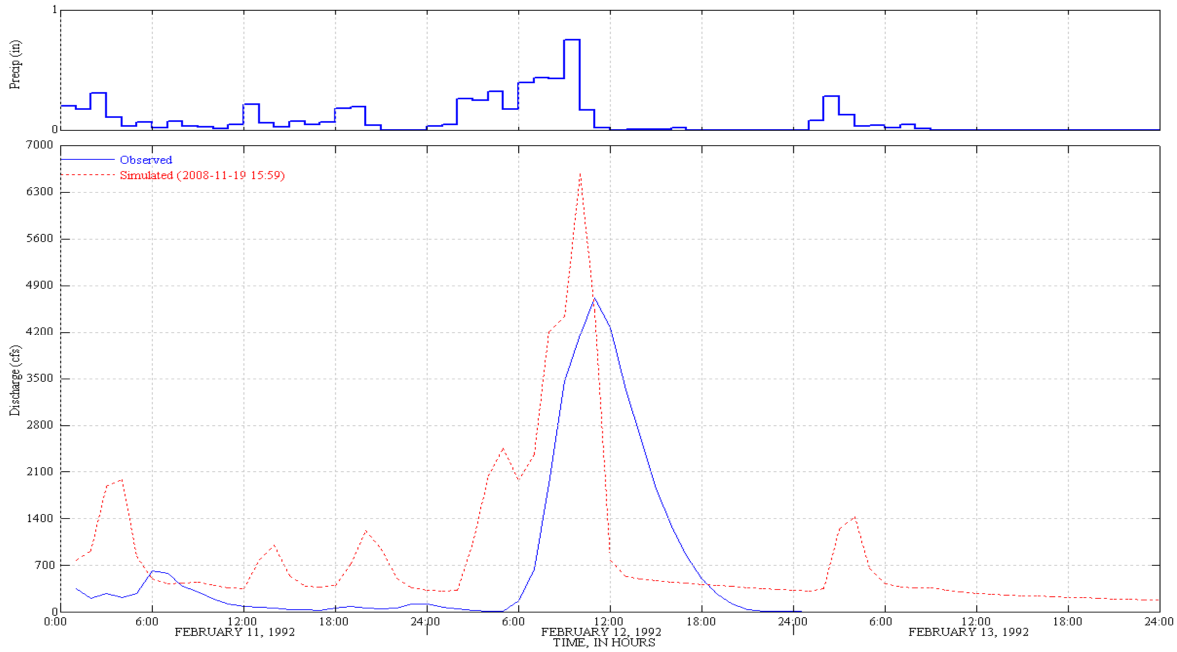

Figure 36 Simulated and Observed February 11, 1992 Storm Event

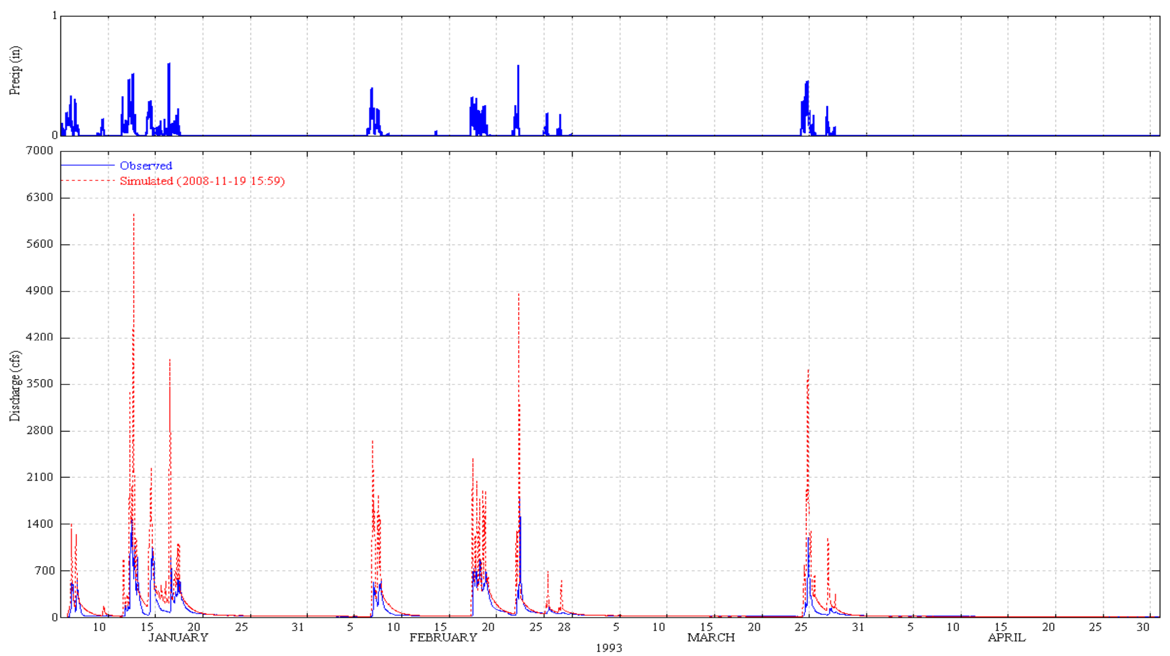

Figure 37 Simulated and Observed January 6, 1993 Storm Event

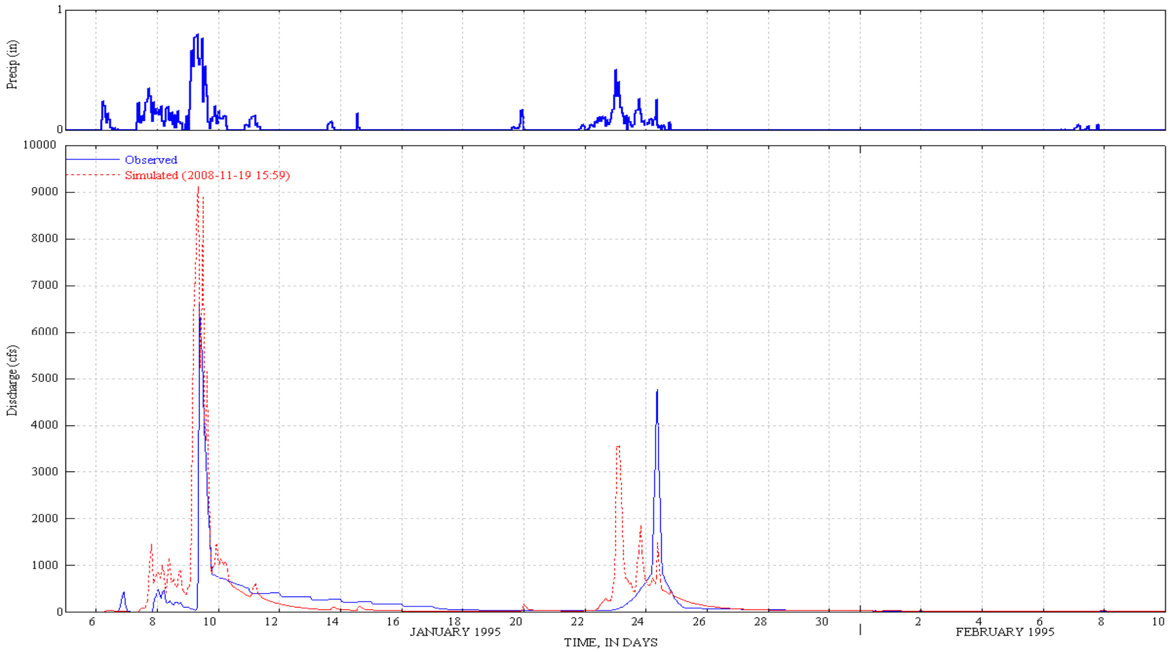

Figure 38 Simulated and Observed January 7, 1995 Storm Event

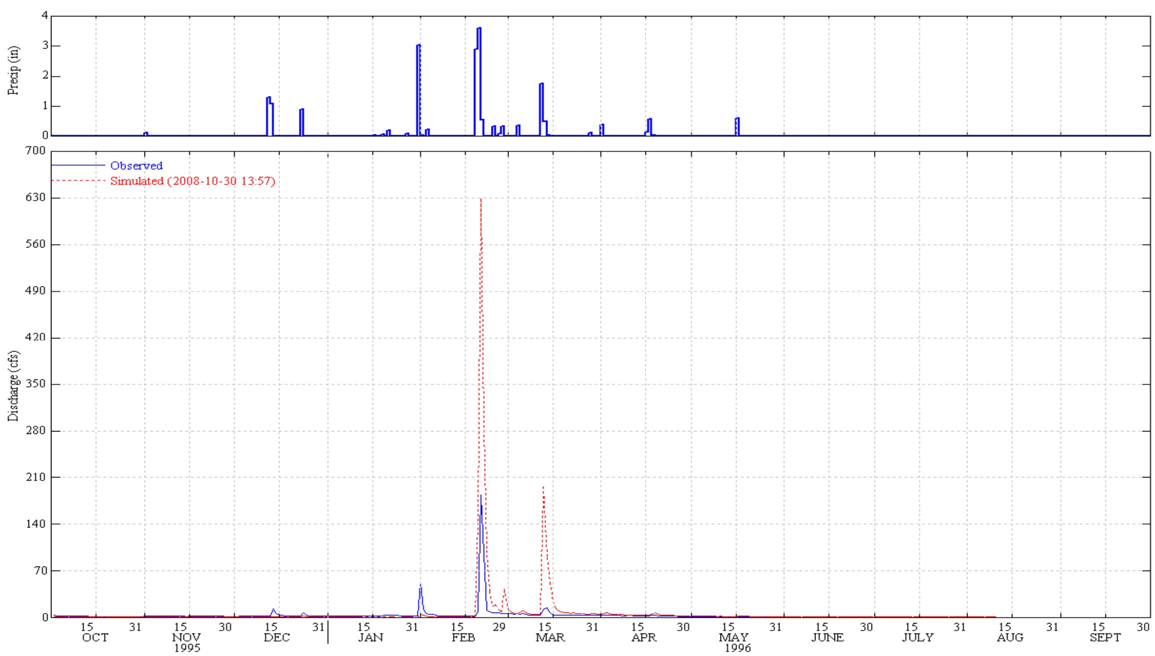

Figure 39 Simulated and Observed February 20, 1996 Storm Event

APPENDIX E

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SANTA PAULA CREEK WATERSHED

Title Page

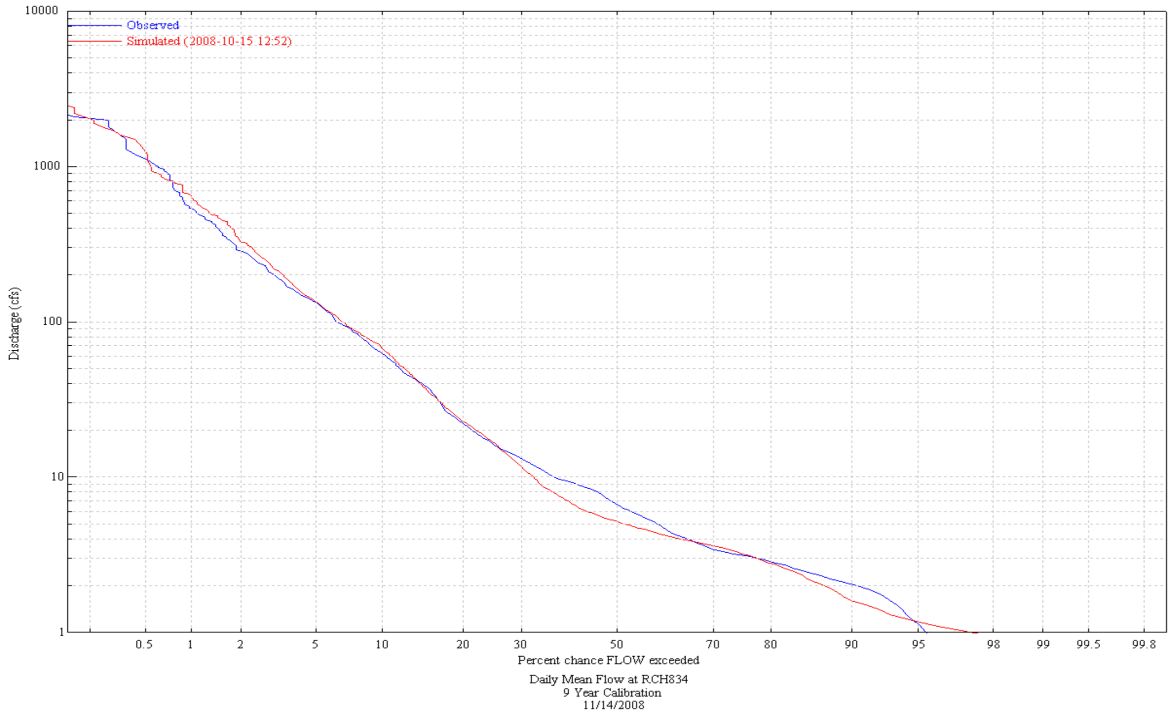

Figure 1 Simulated and Observed Daily Flow Duration Curve at Santa Paula

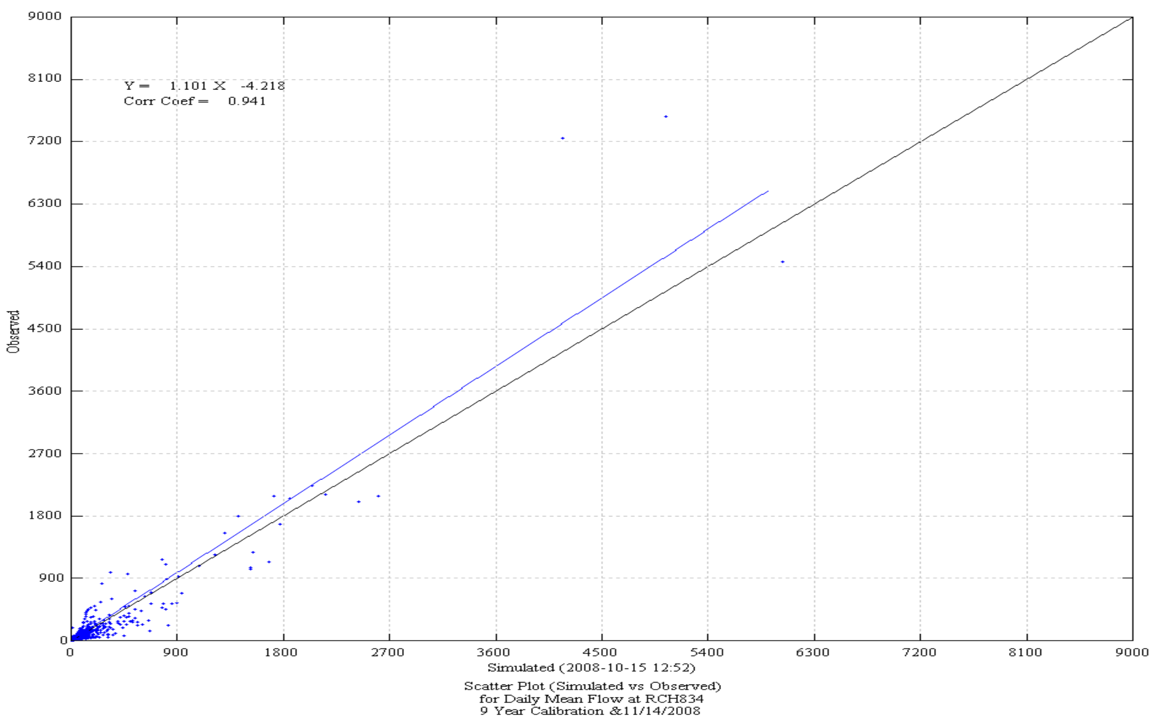

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Santa Paula

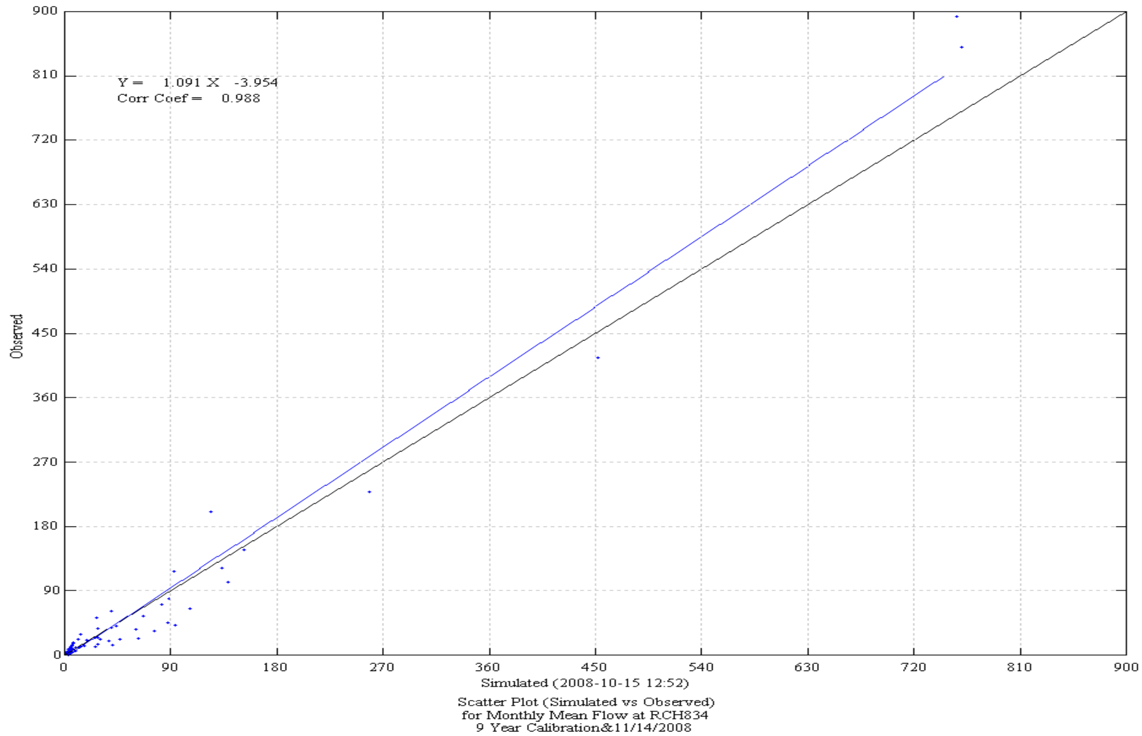

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Santa Paula

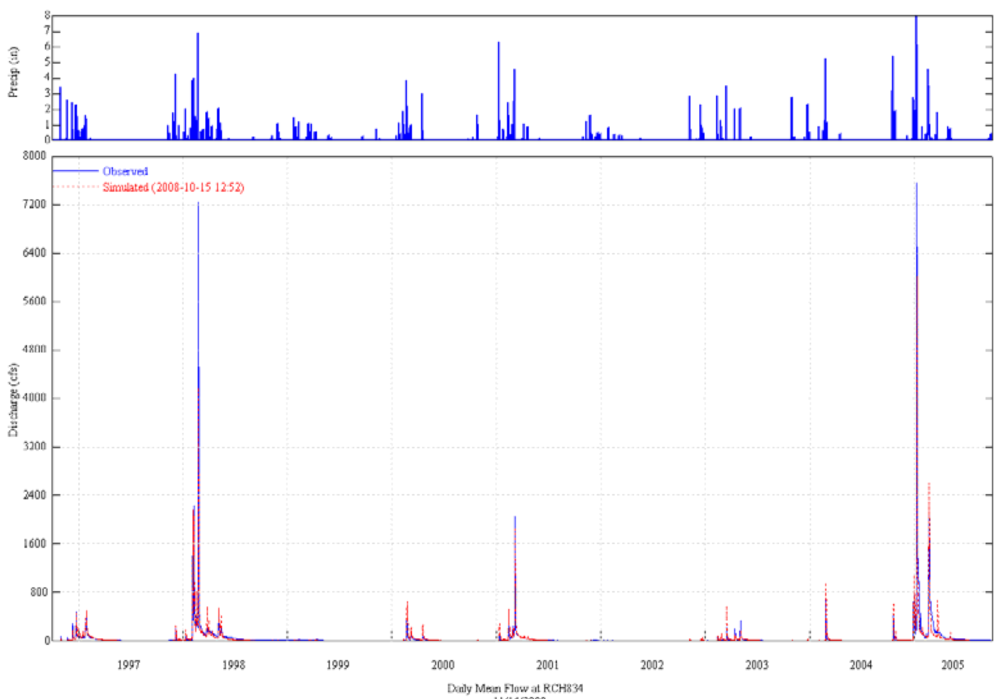

Figure 4 Simulated and Observed Daily Flow at Santa Paula (WY 1997-2005)

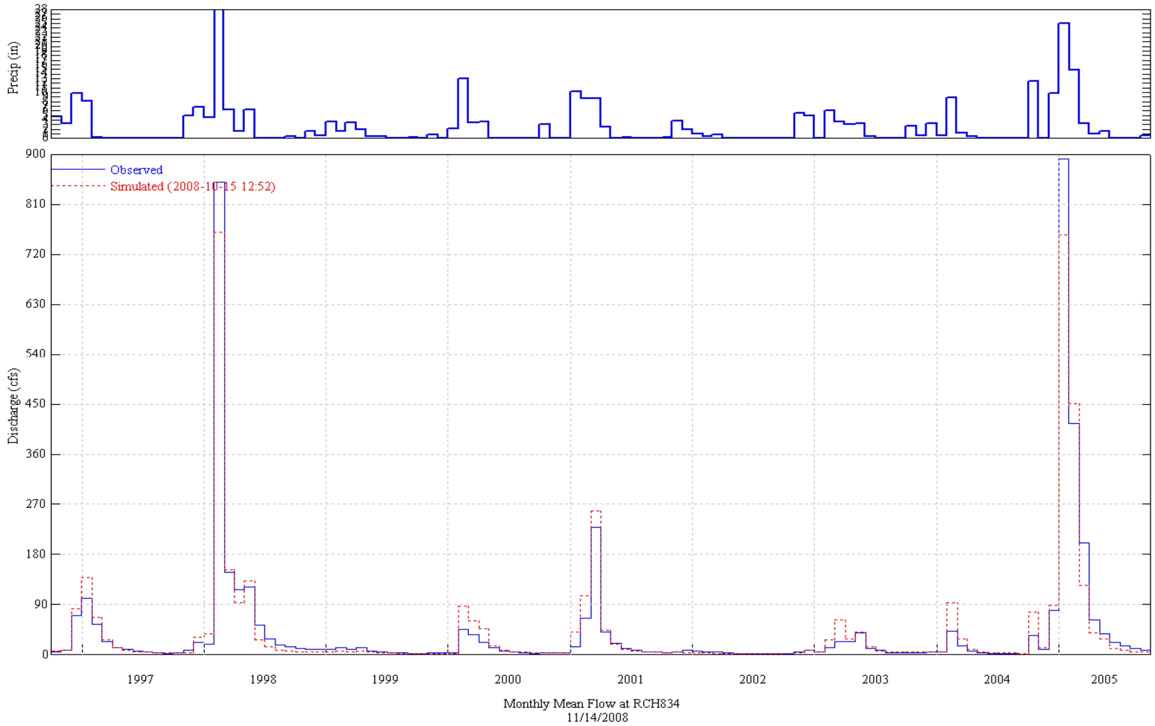

Figure 5 Simulated and Observed Monthly Flow at Santa Paula (WY 1997-2005)

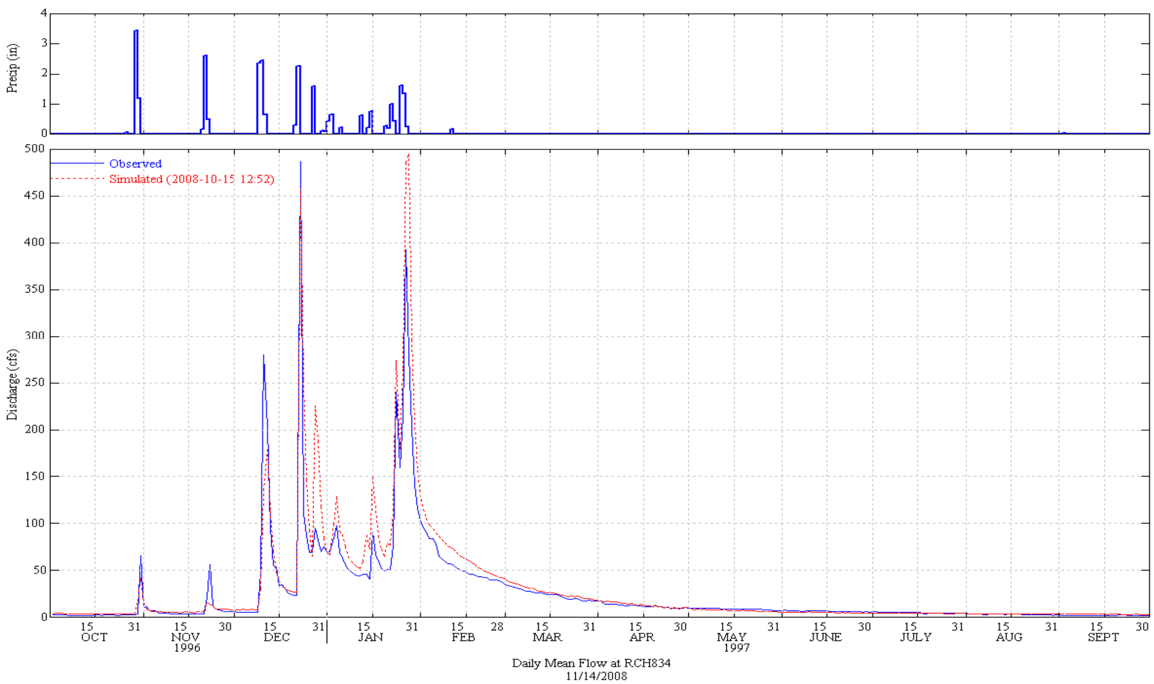

Figure 6 Simulated and Observed Daily Flow at Santa Paula (WY 1997)

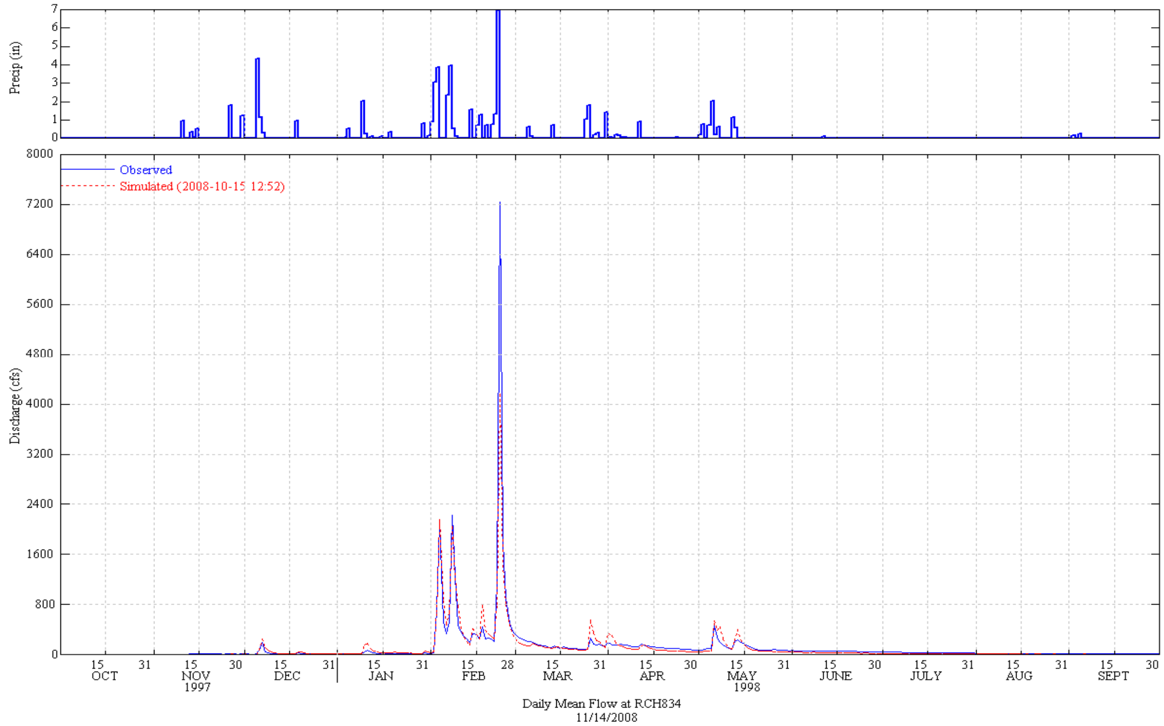

Figure 7 Simulated and Observed Daily Flow at Santa Paula (WY 1998)

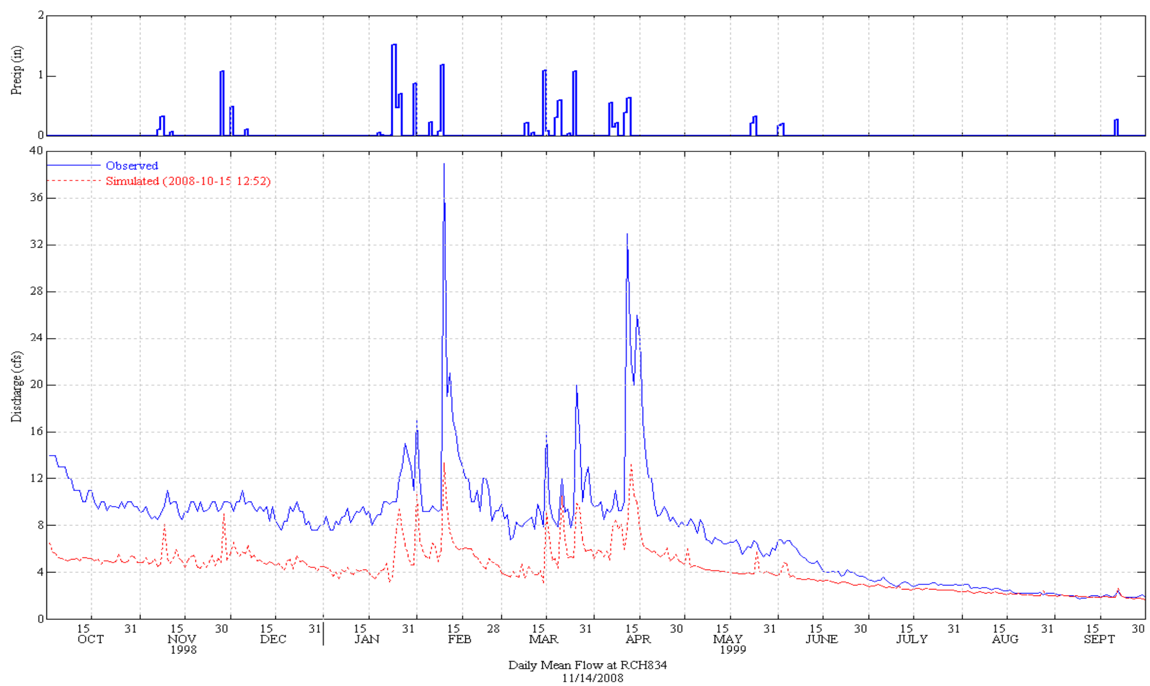

Figure 8 Simulated and Observed Daily Flow at Santa Paula (WY 1999)

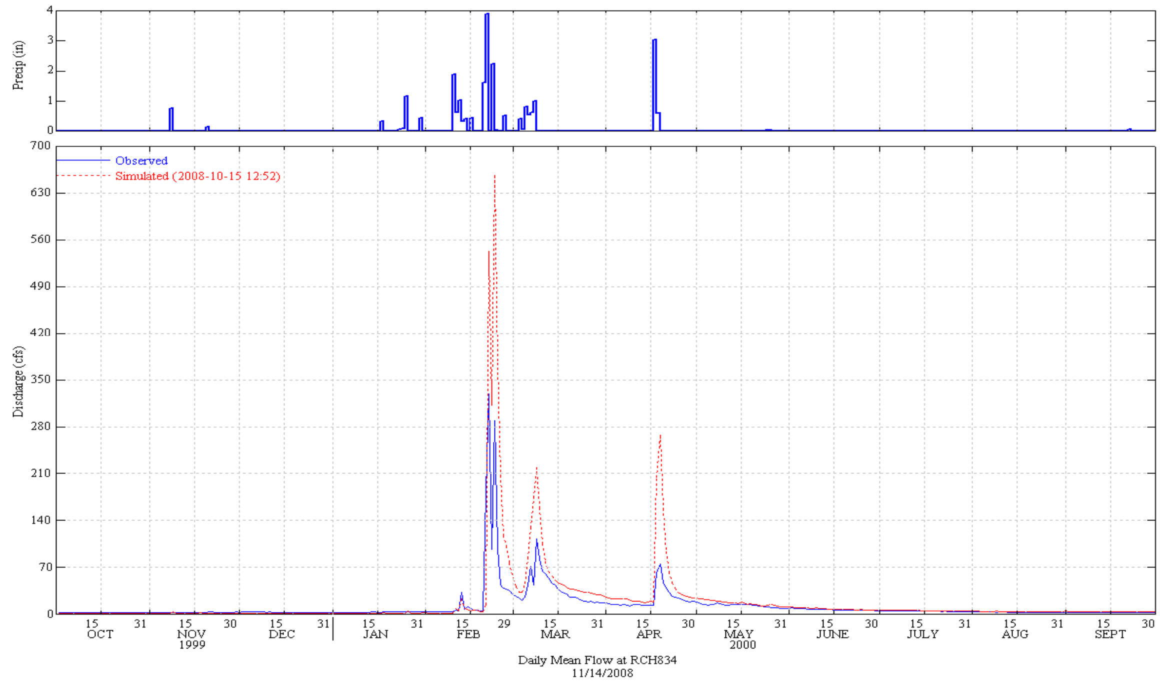

Figure 9 Simulated and Observed Daily Flow at Santa Paula (WY 2000)

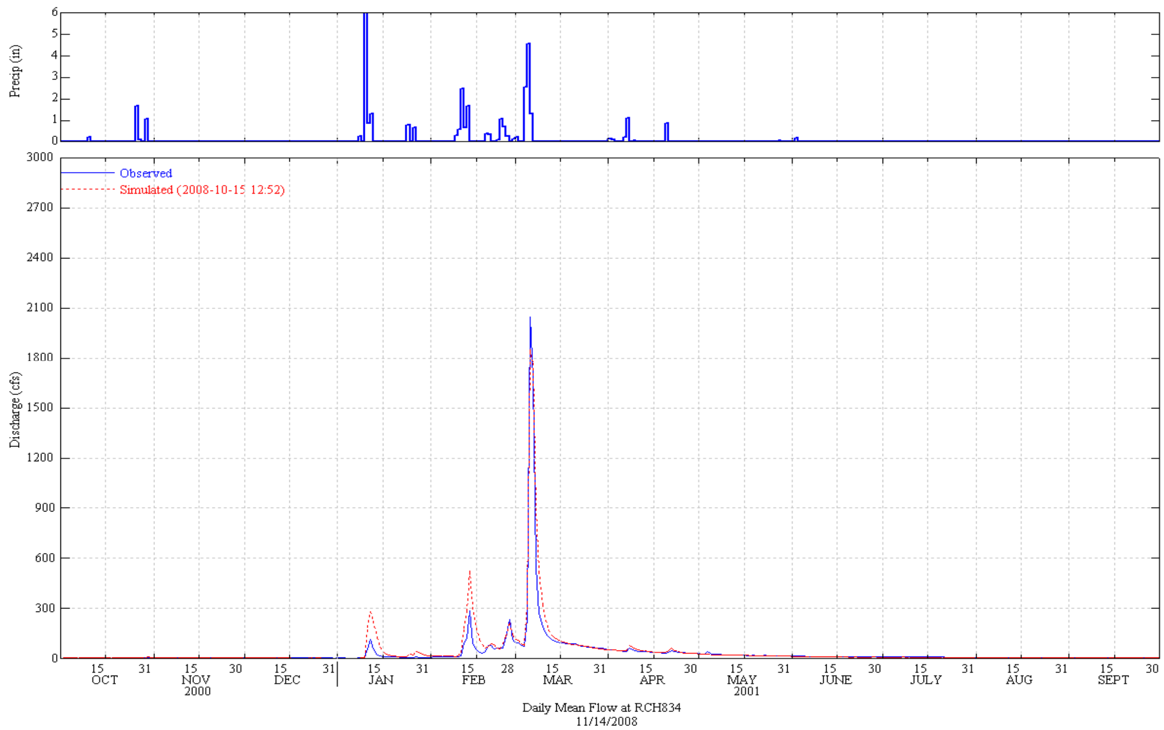

Figure 10 Simulated and Observed Daily Flow at Santa Paula (WY 2001)

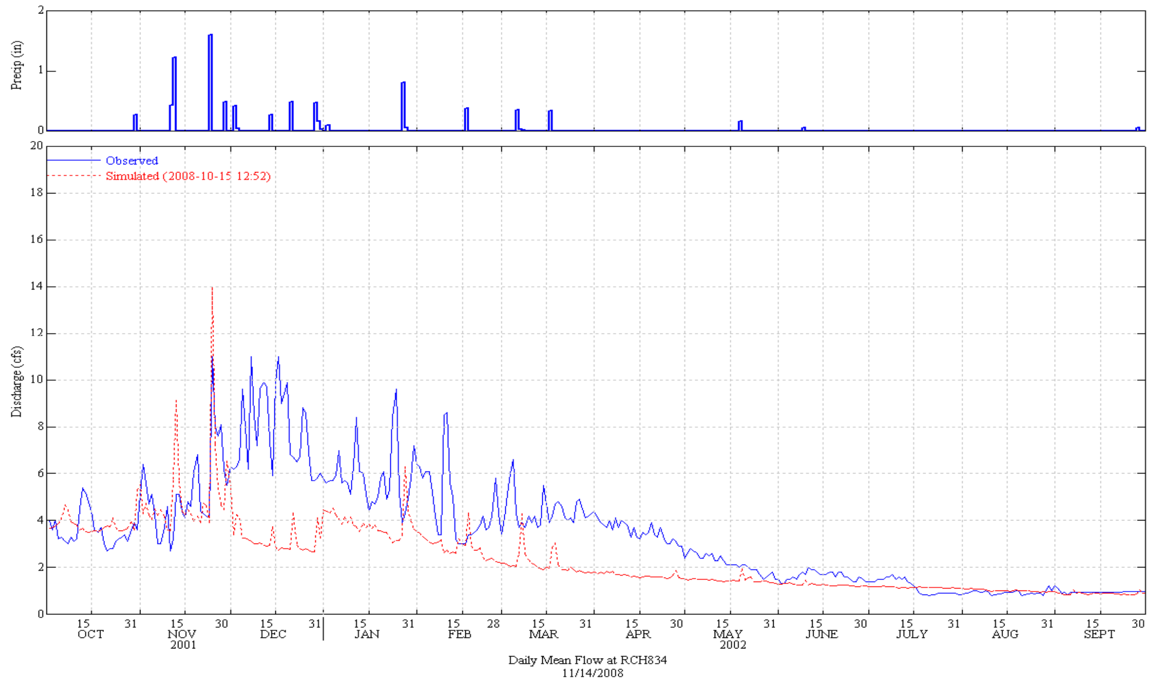

Figure 11 Simulated and Observed Daily Flow at Santa Paula (WY 2002)

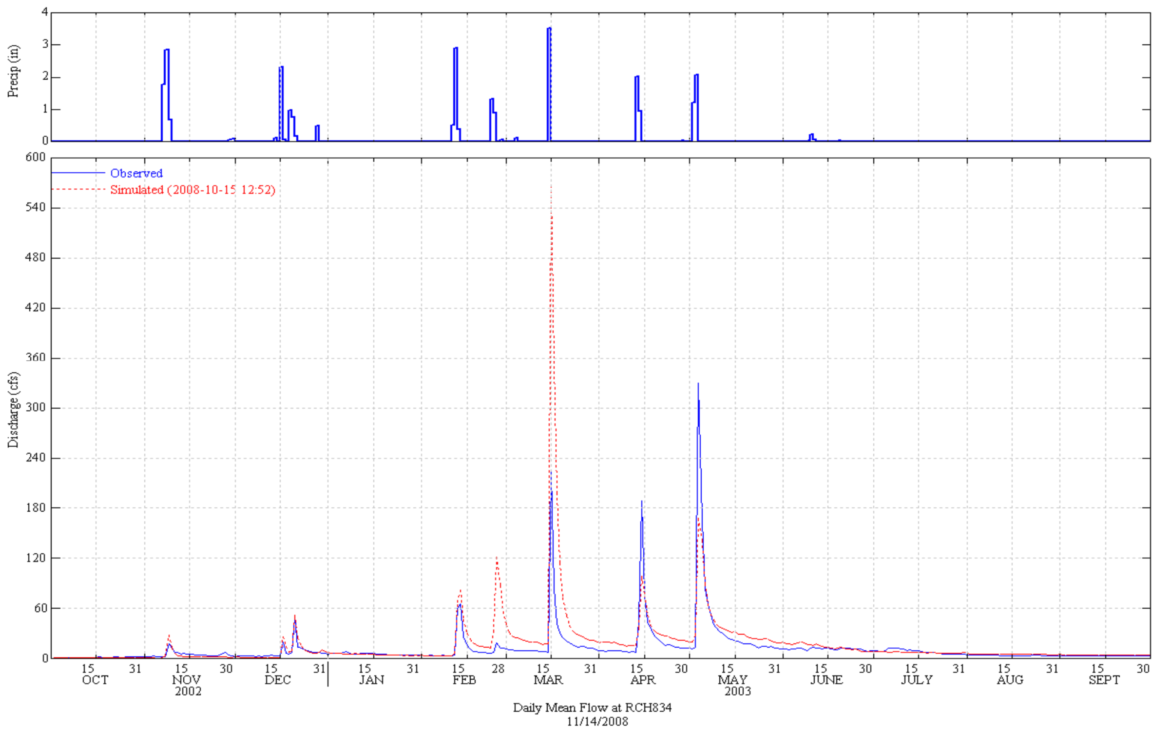

Figure 12 Simulated and Observed Daily Flow at Santa Paula (WY 2003)

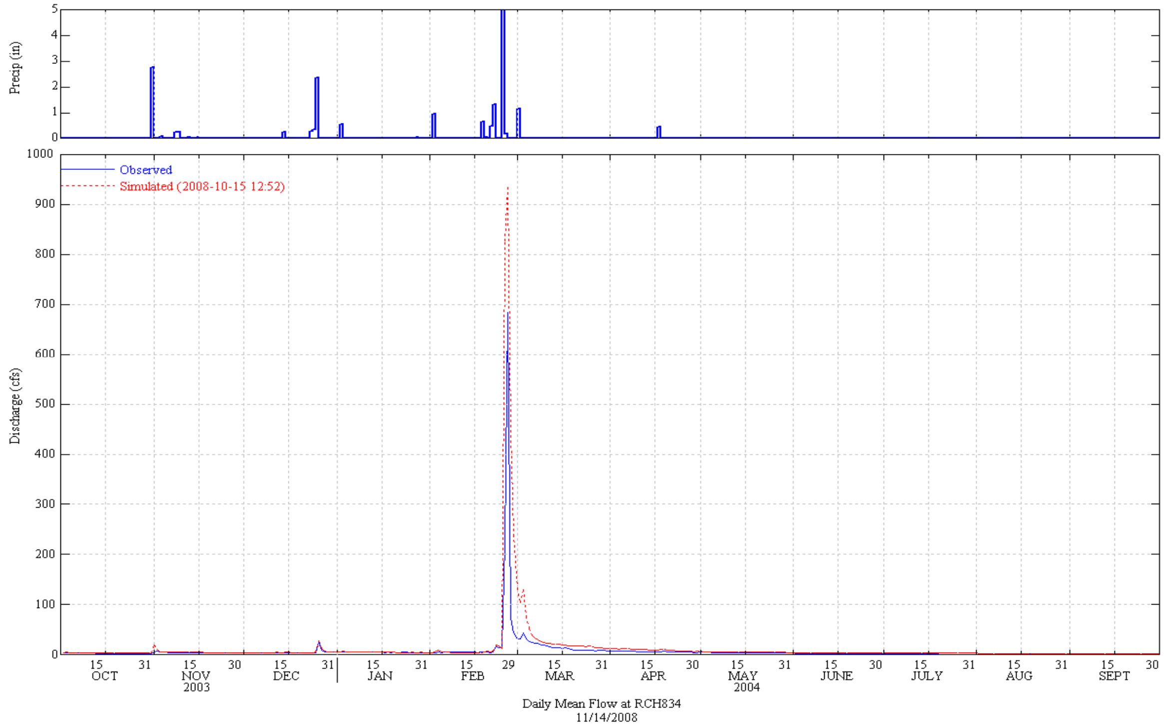

Figure 13 Simulated and Observed Daily Flow at Santa Paula (WY 2004)

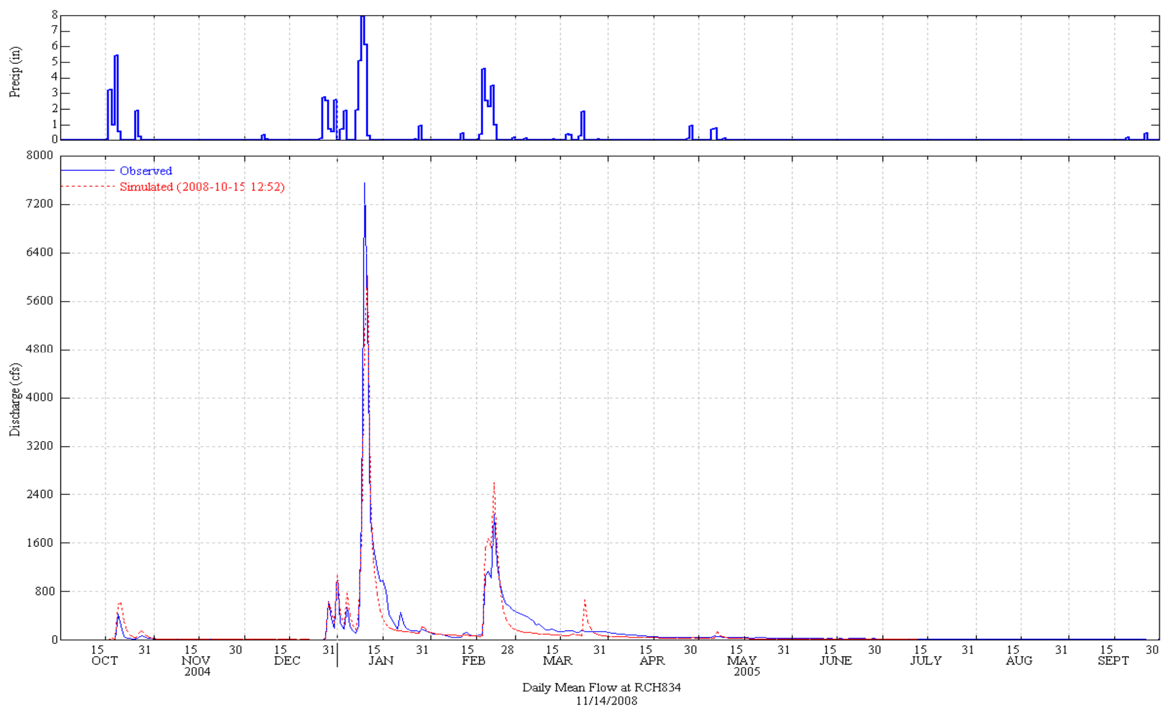

Figure 14 Simulated and Observed Daily Flow at Santa Paula (WY 2005)

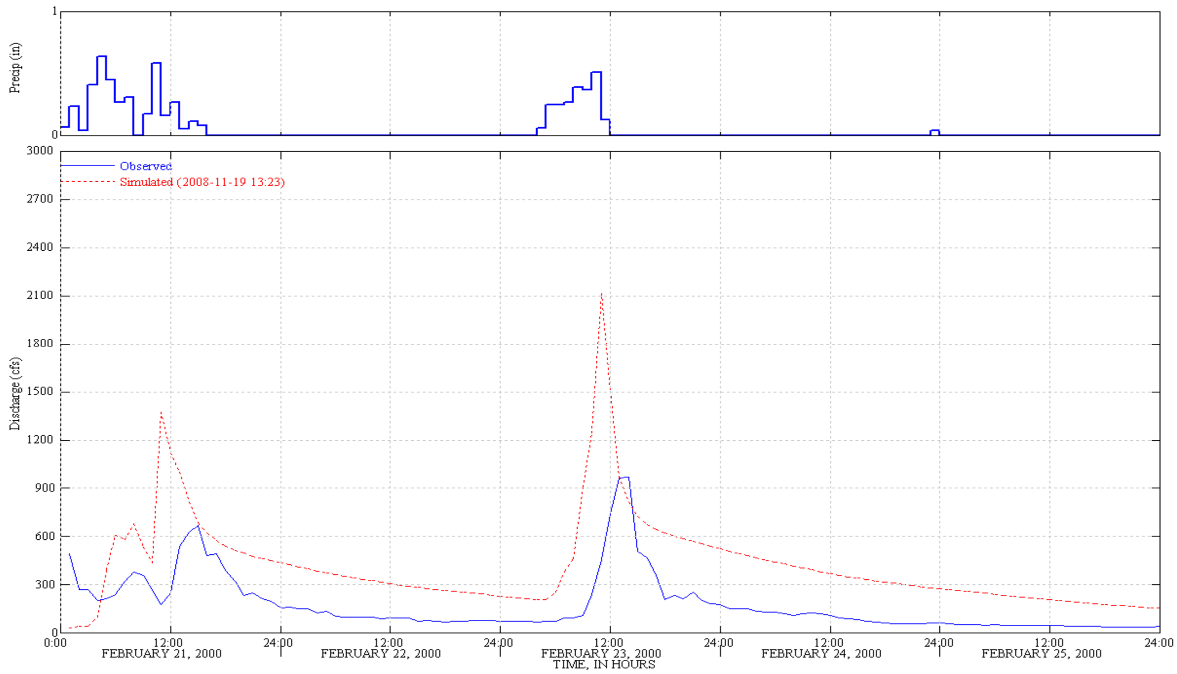

Figure 15 Simulated and Observed February 21, 2000 Storm Event

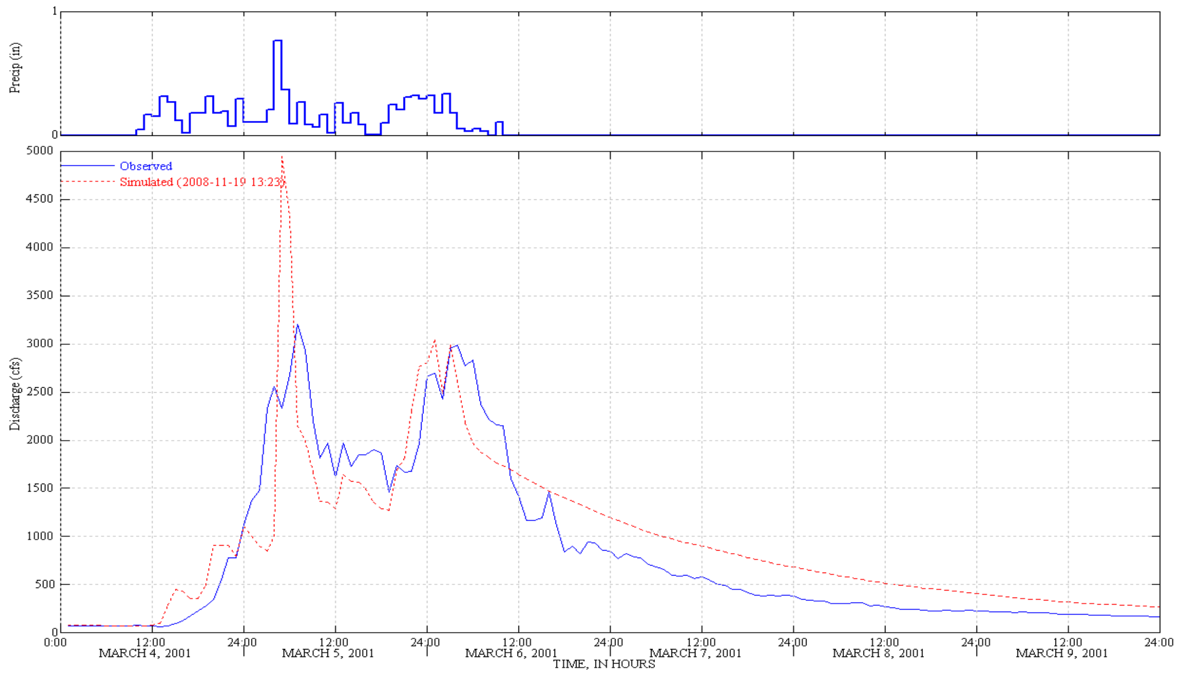

Figure 16 Simulated and Observed March 4, 2001 Storm Event

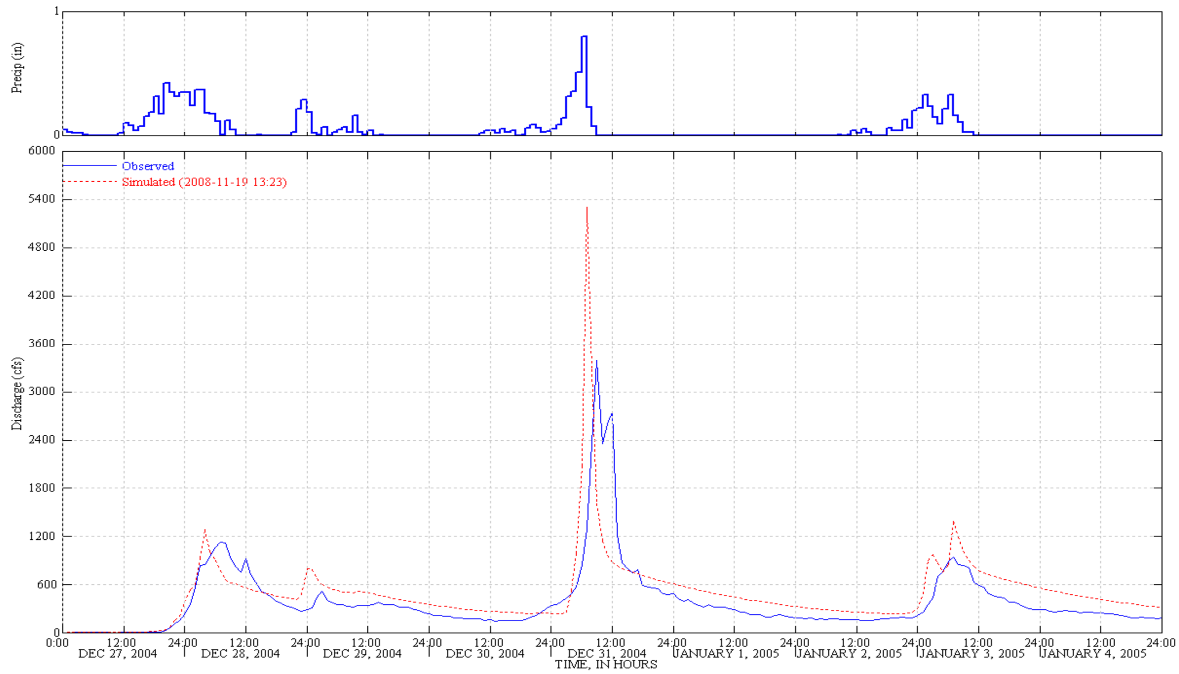

Figure 17 Simulated and Observed December 27, 2004 Storm Event

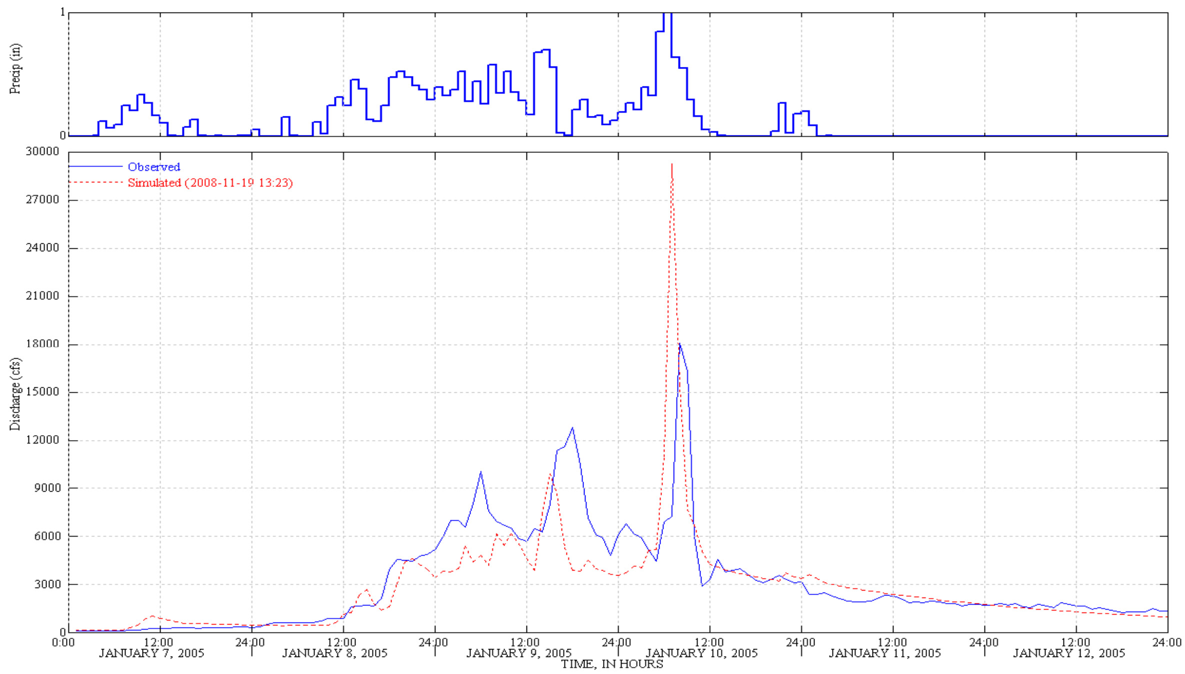

Figure 18 Simulated and Observed January 7, 2005 Storm Event

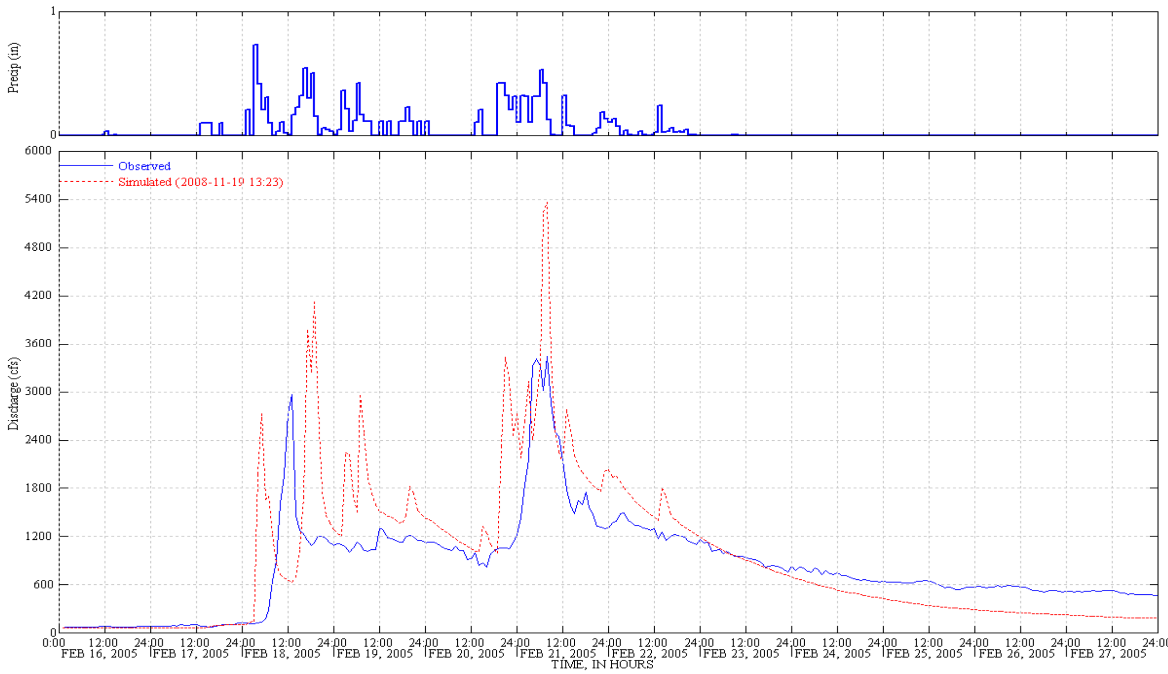

Figure 19 Simulated and Observed February 16, 2005 Storm Event

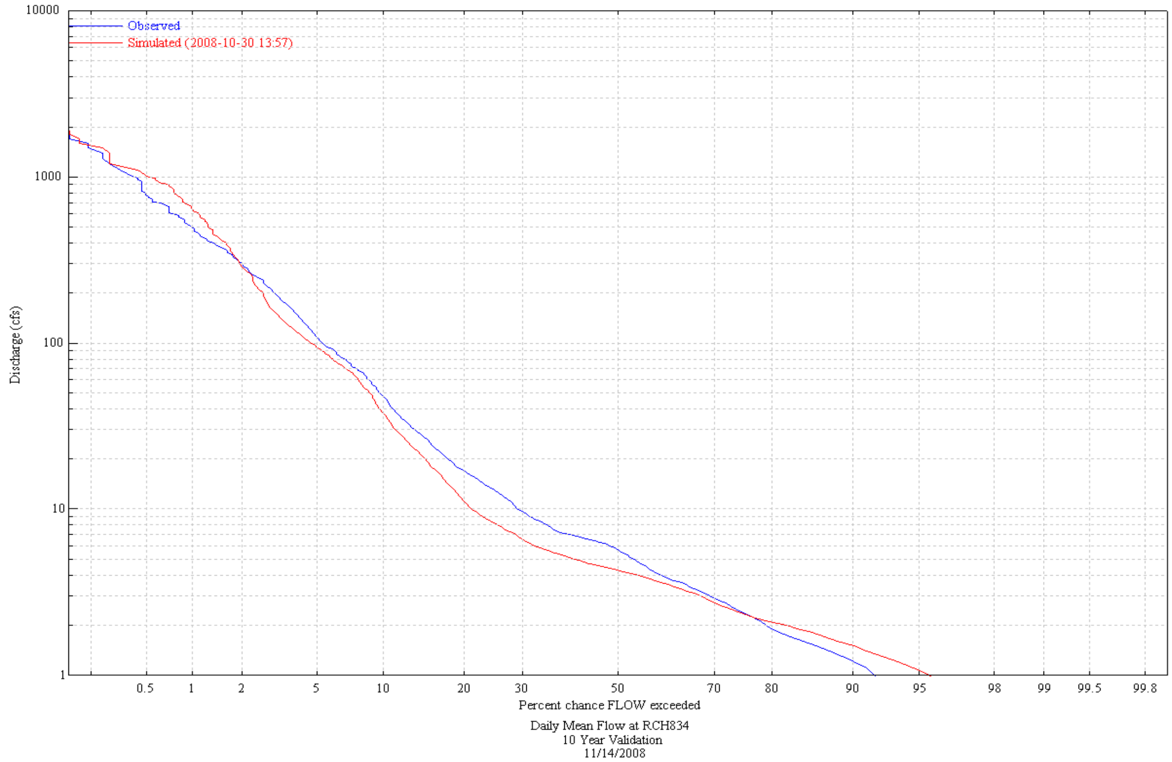

Figure 20 Simulated and Observed Daily Flow Duration Curve at Santa Paula

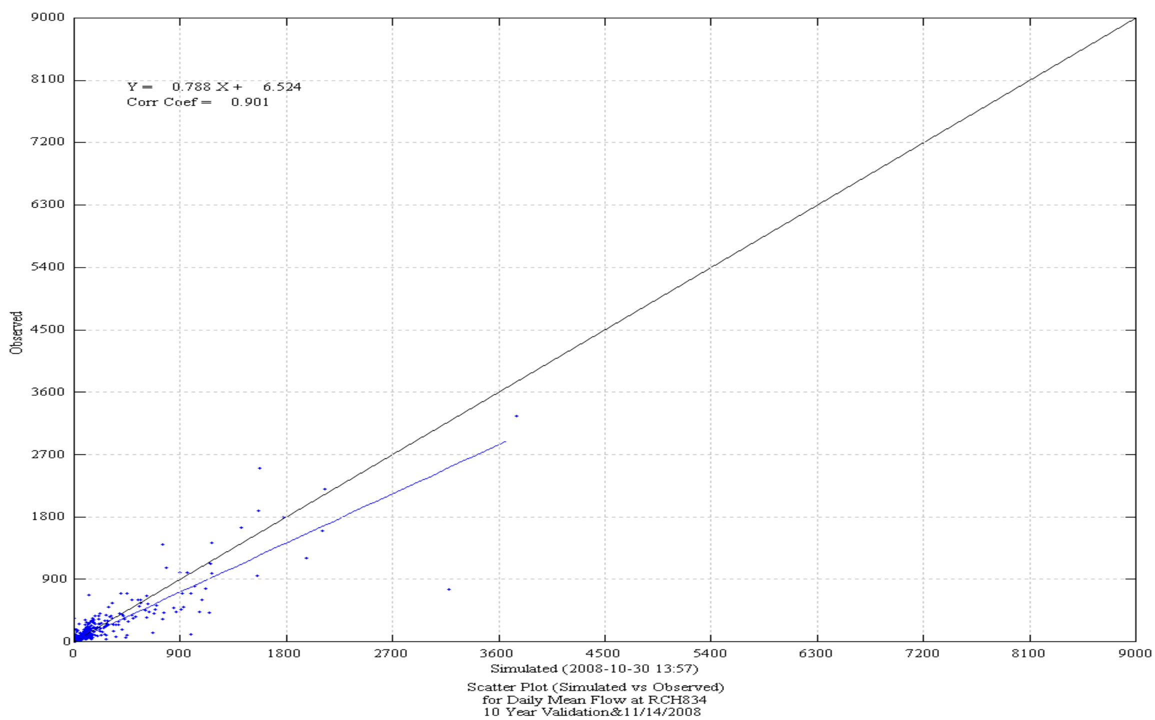

Figure 21 Daily Scatter Plot of Simulated versus Observed Flow at Santa Paula

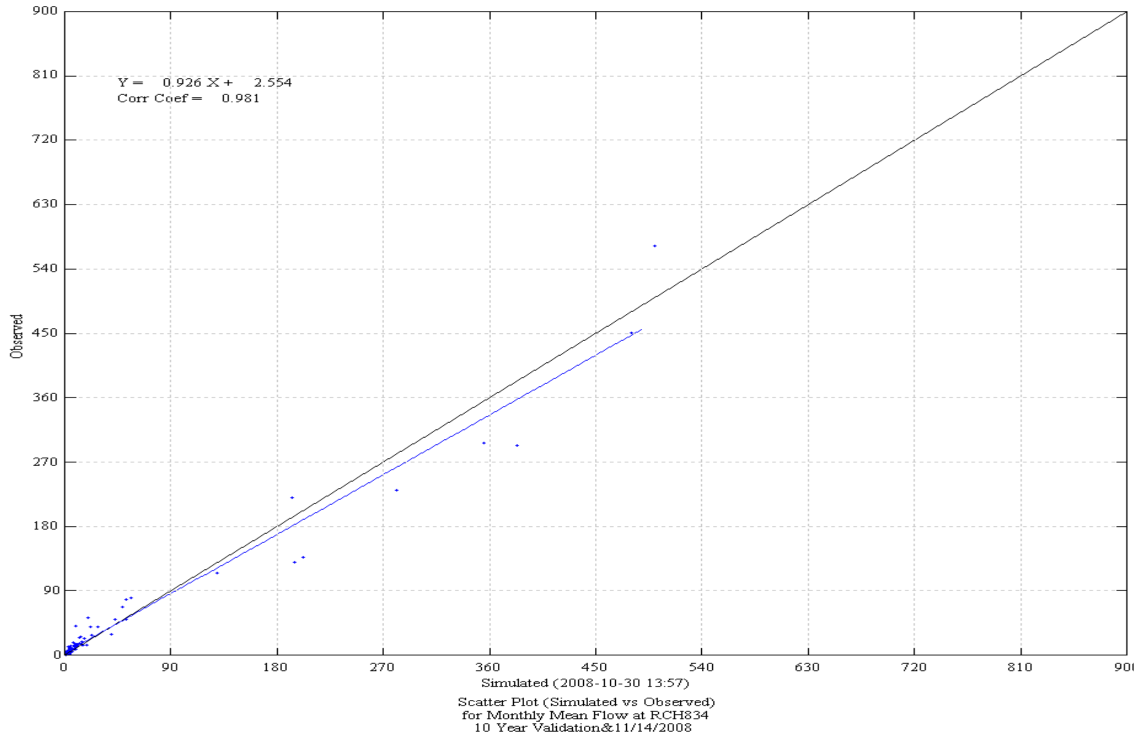

Figure 22 Monthly Scatter Plot of Simulated versus Observed Flow at Santa Paula

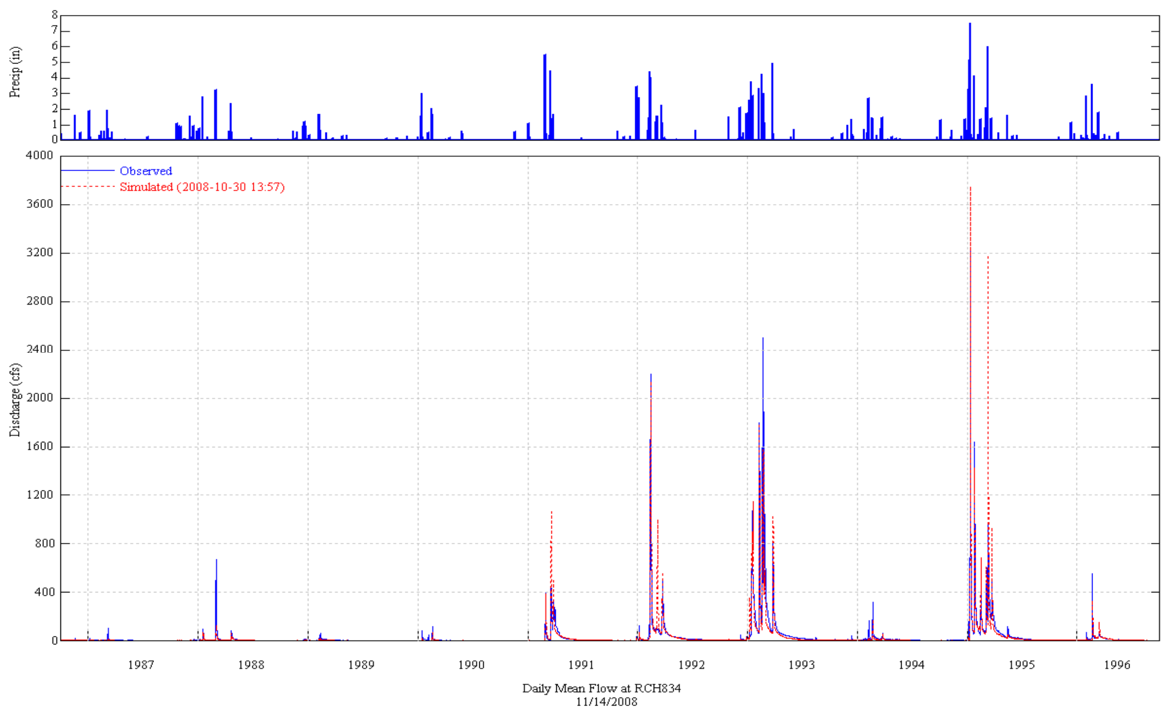

Figure 23 Simulated and Observed Daily Flow at Santa Paula (WY 1987-1996)

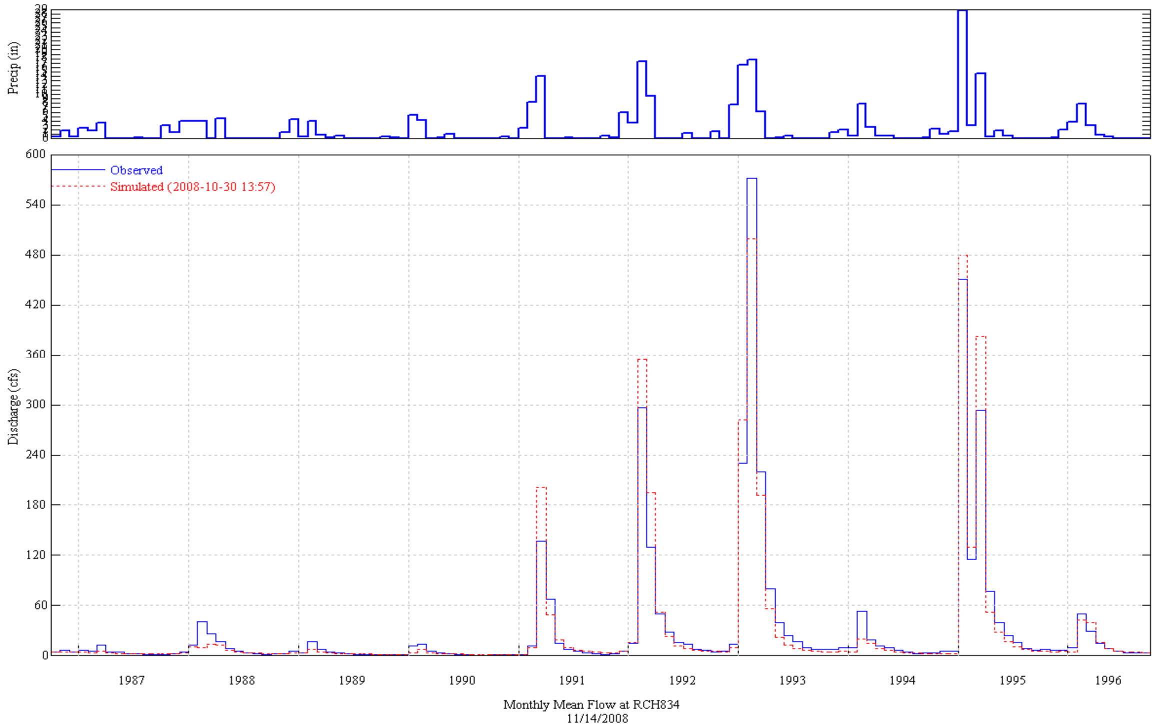

Figure 24 Simulated and Observed Monthly Flow at Santa Paula (WY 1987-1996)

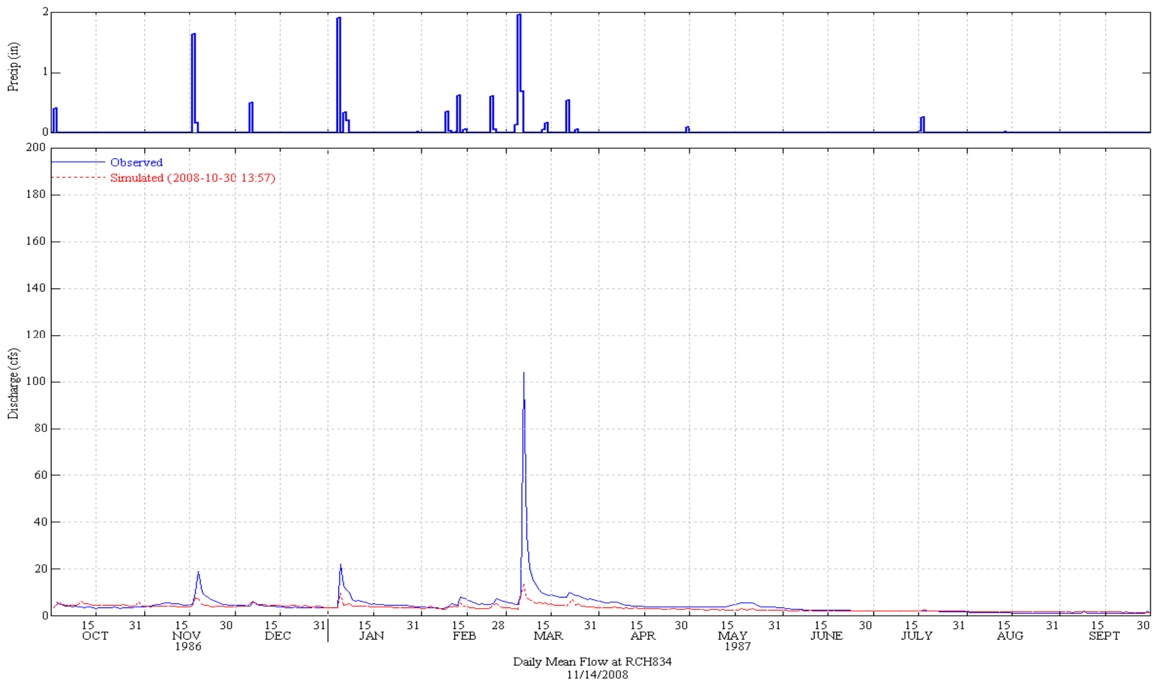

Figure 25 Simulated and Observed Daily Flow at Santa Paula (WY 1987)

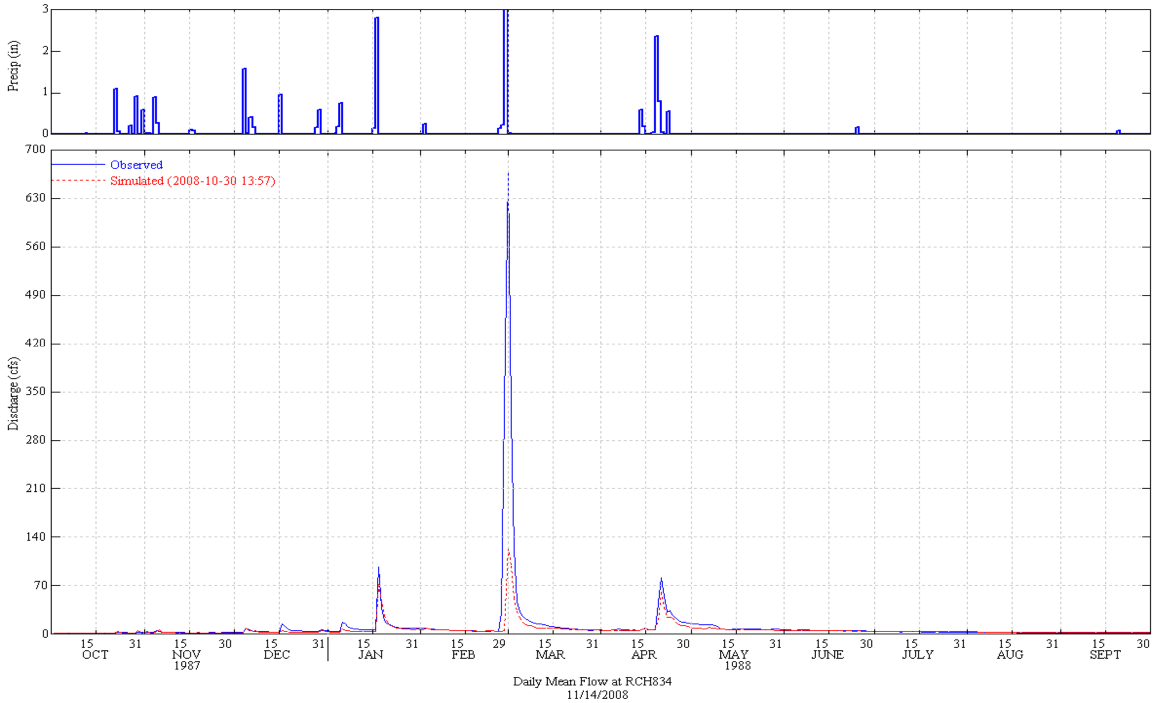

Figure 26 Simulated and Observed Daily Flow at Santa Paula (WY 1988)

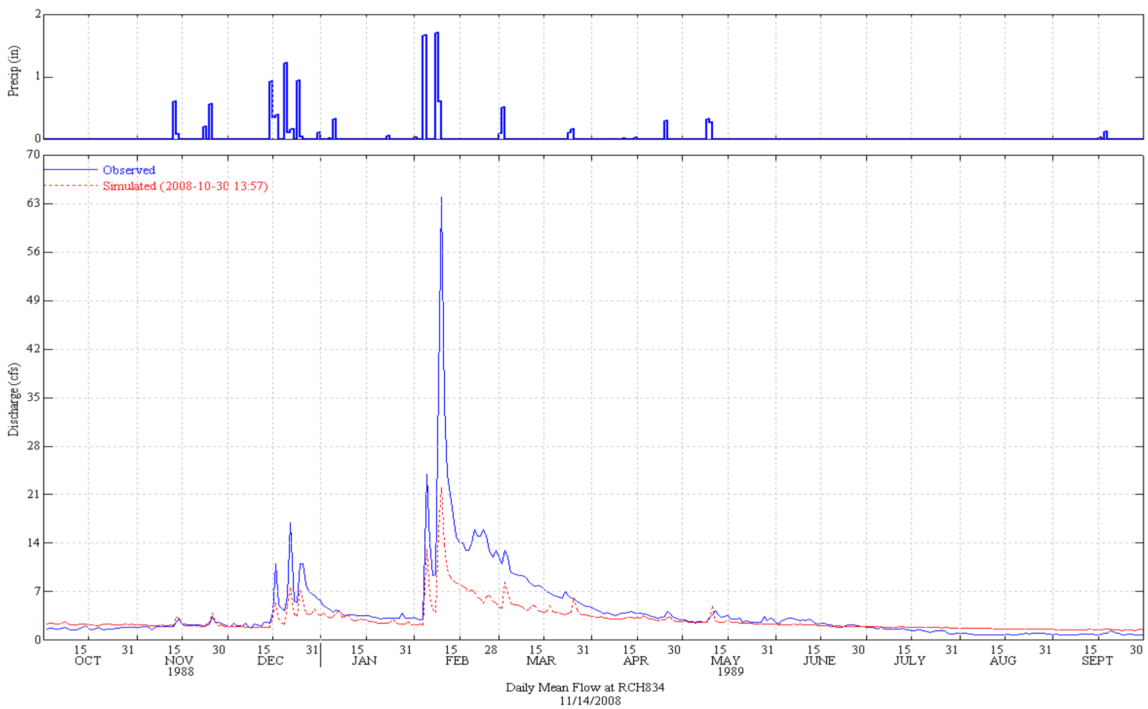

Figure 27 Simulated and Observed Daily Flow at Santa Paula (WY 1989)

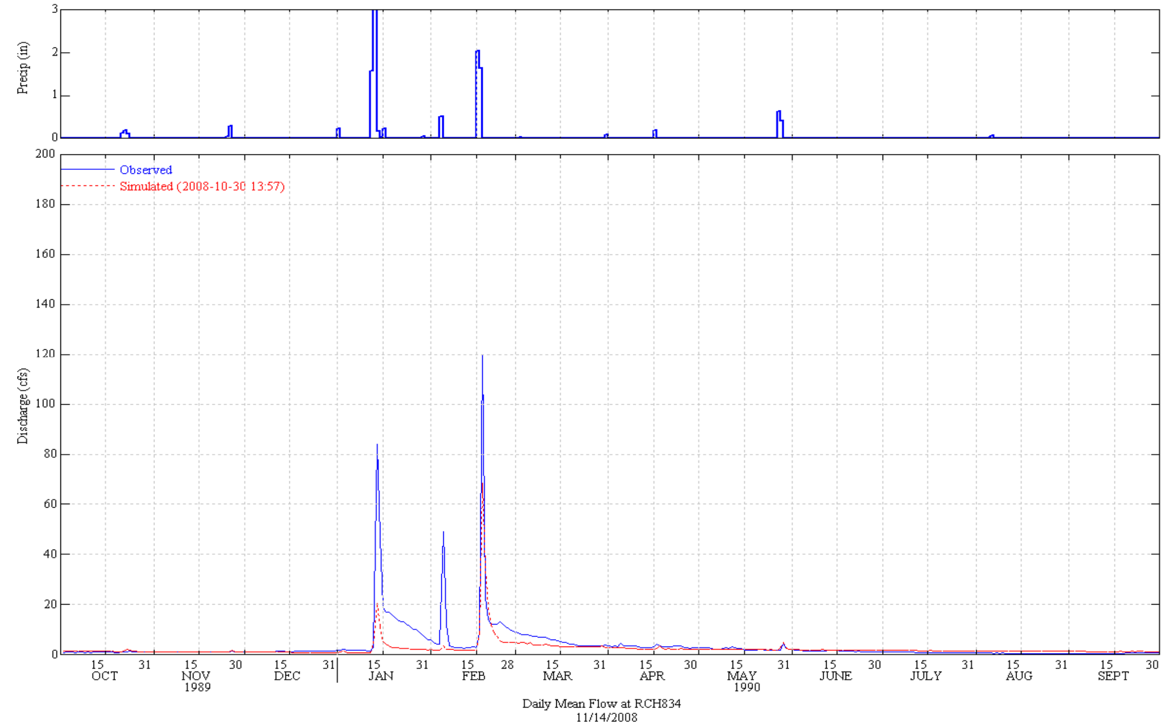

Figure 28 Simulated and Observed Daily Flow at Santa Paula (WY 1990)

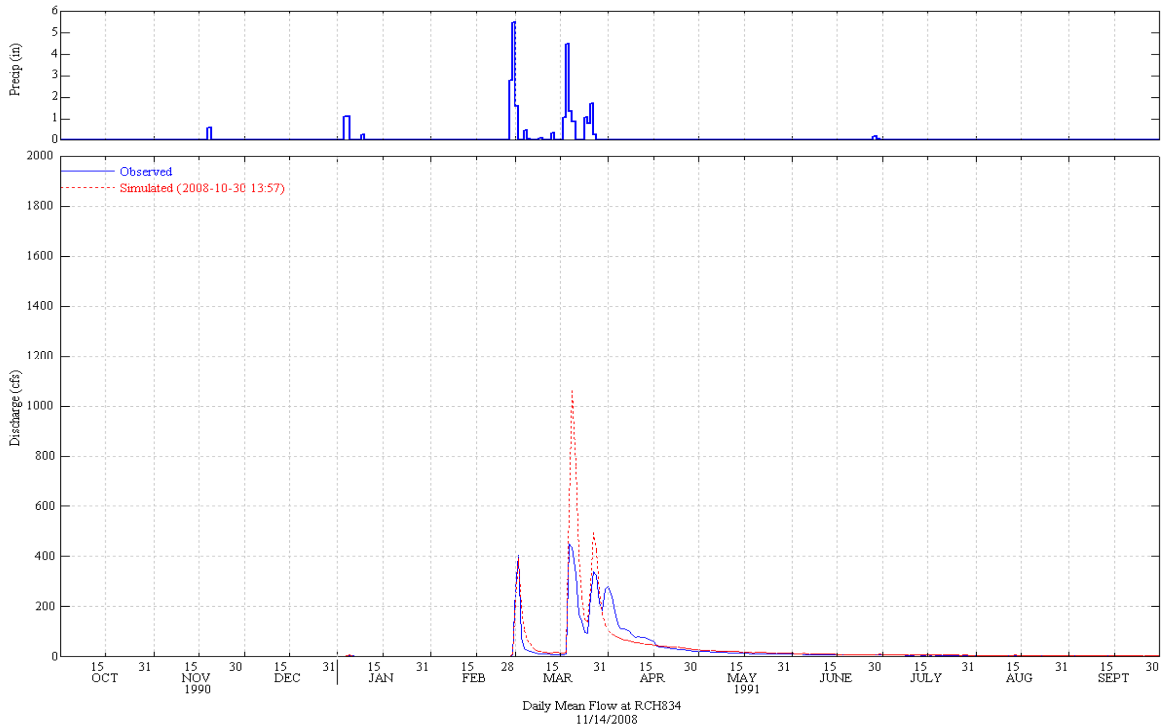

Figure 29 Simulated and Observed Daily Flow at Santa Paula (WY 1991)

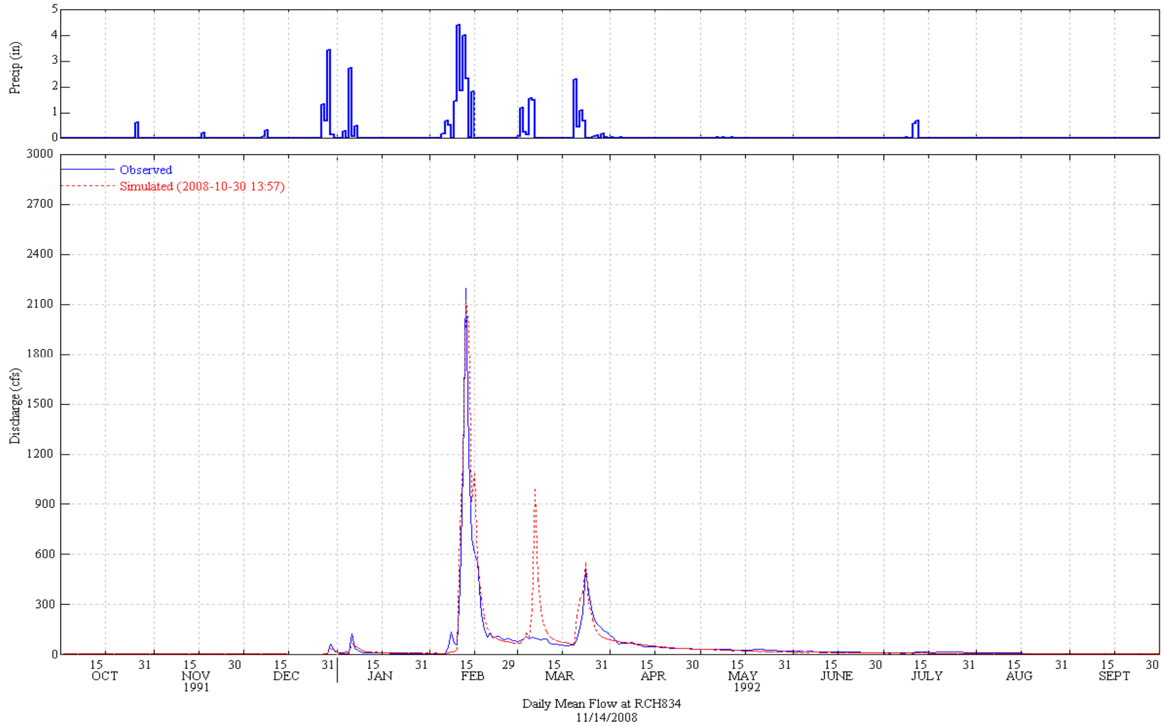

Figure 30 Simulated and Observed Daily Flow at Santa Paula (WY 1992)

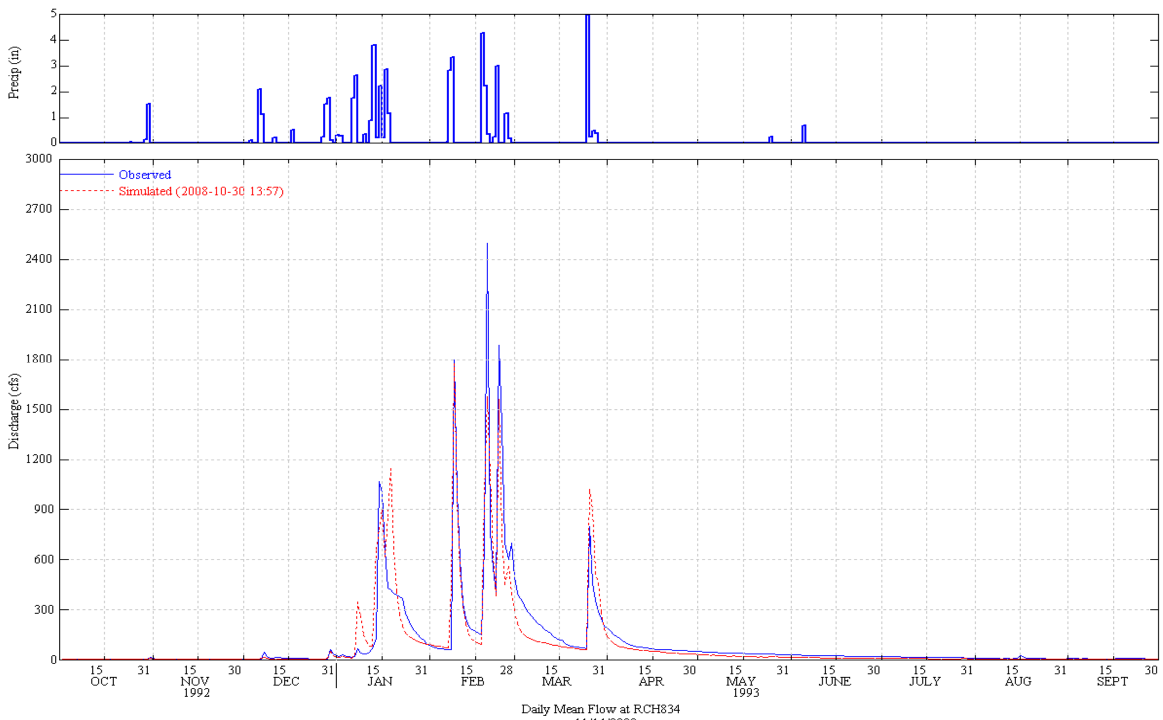

Figure 31 Simulated and Observed Daily Flow at Santa Paula (WY 1993)

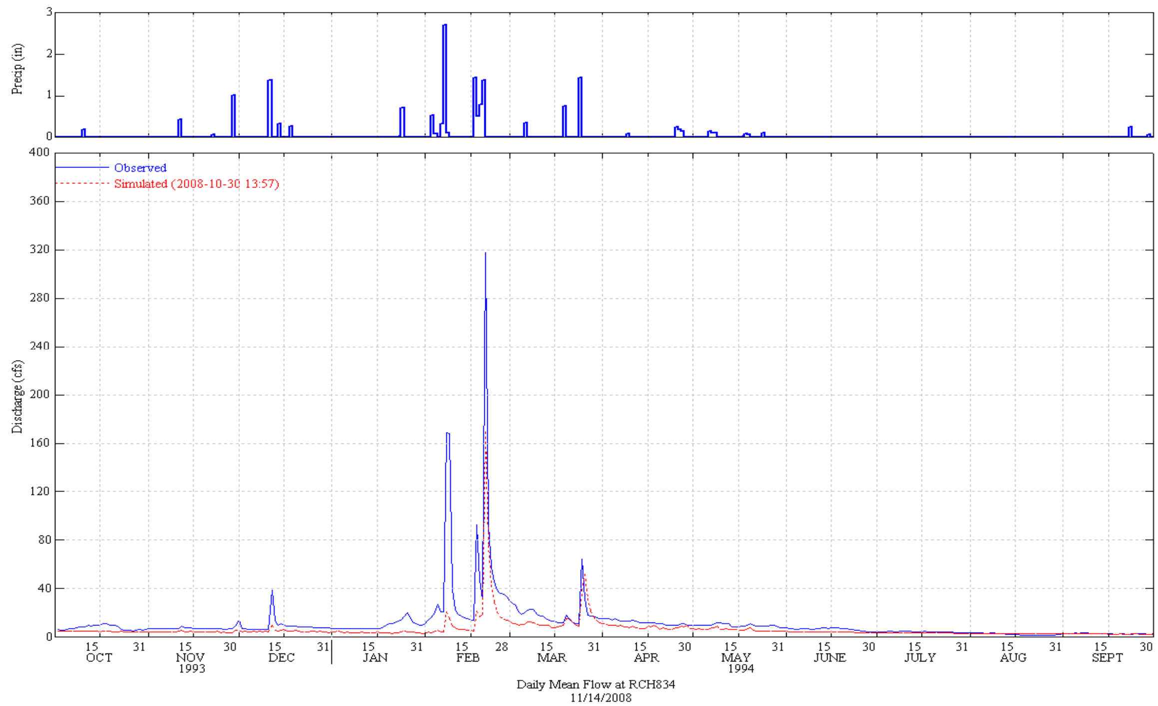

Figure 32 Simulated and Observed Daily Flow at Santa Paula (WY 1994)

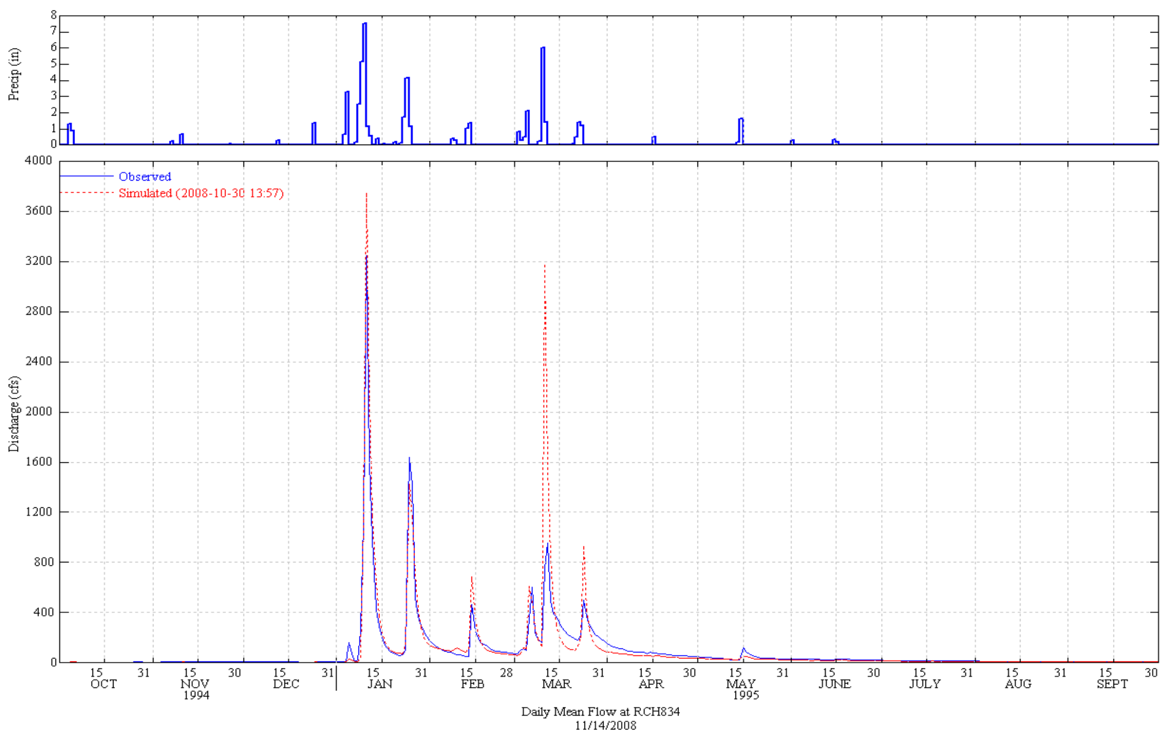

Figure 33 Simulated and Observed Daily Flow at Santa Paula (WY 1995)

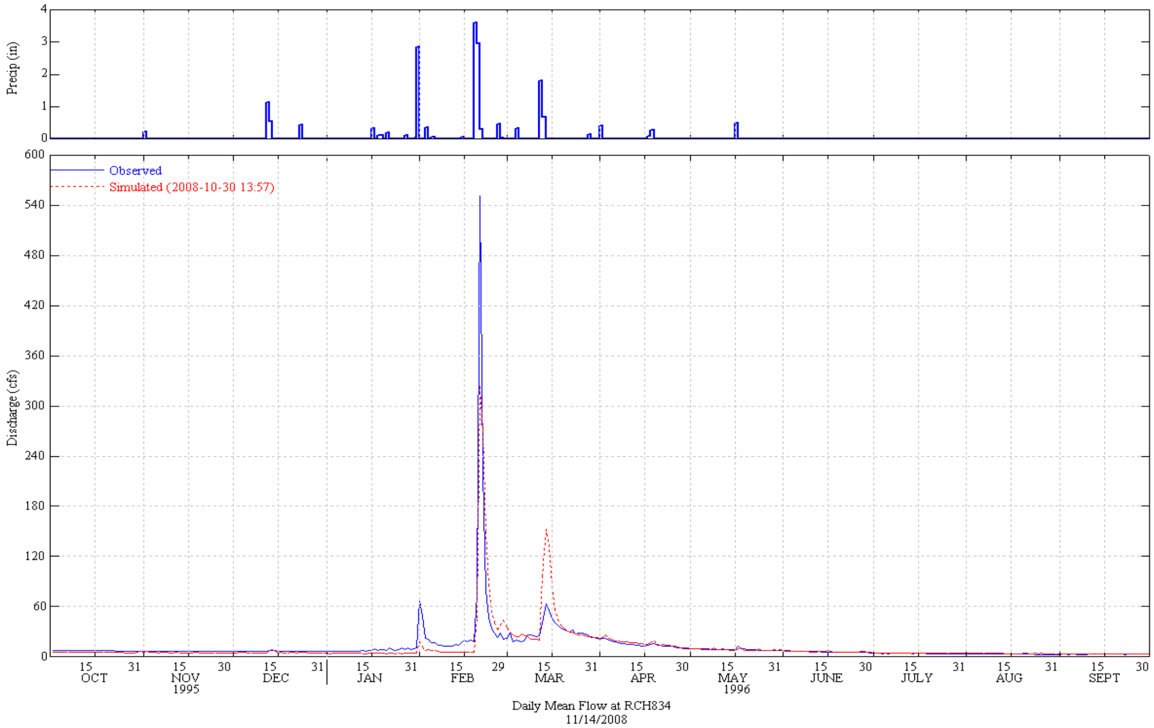

Figure 34 Simulated and Observed Daily Flow at Santa Paula (WY 1996)

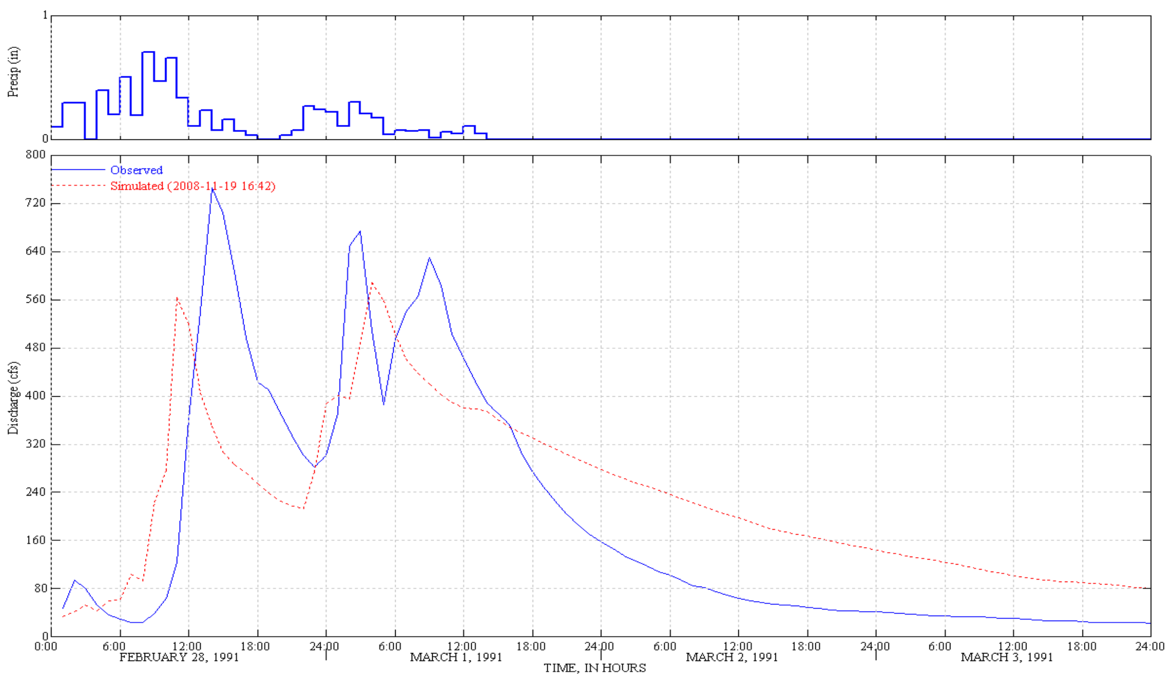

Figure 35 Simulated and Observed February 28, 1991 Storm Event

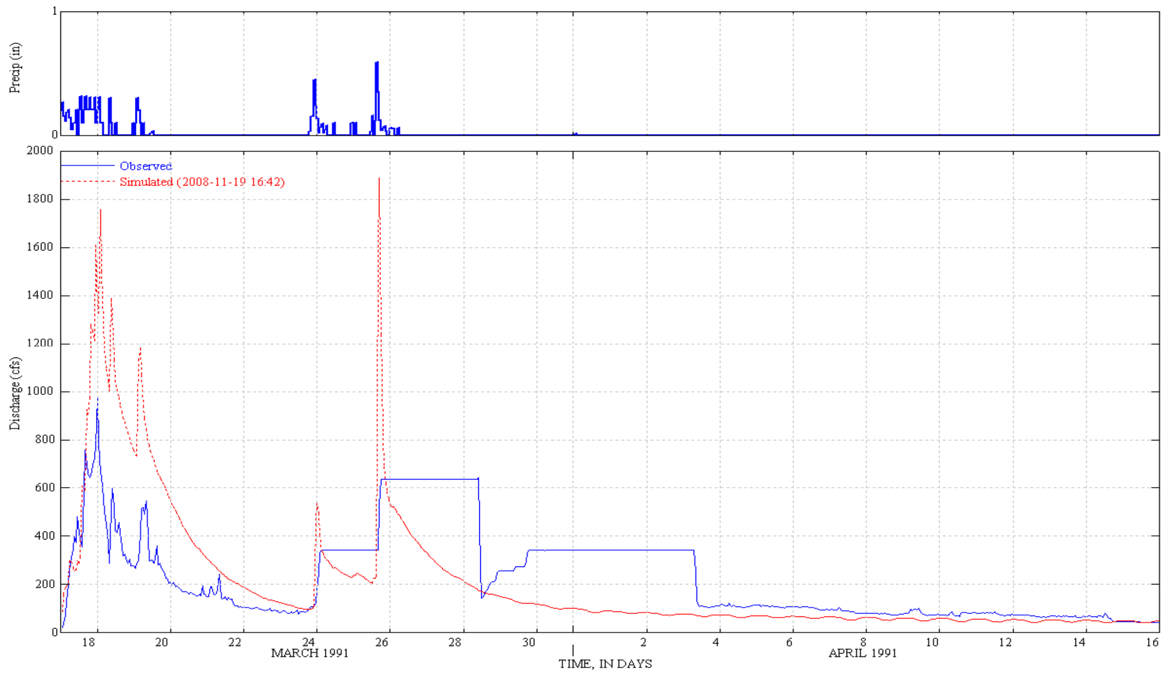

Figure 36 Simulated and Observed March 18, 1991 Storm Event

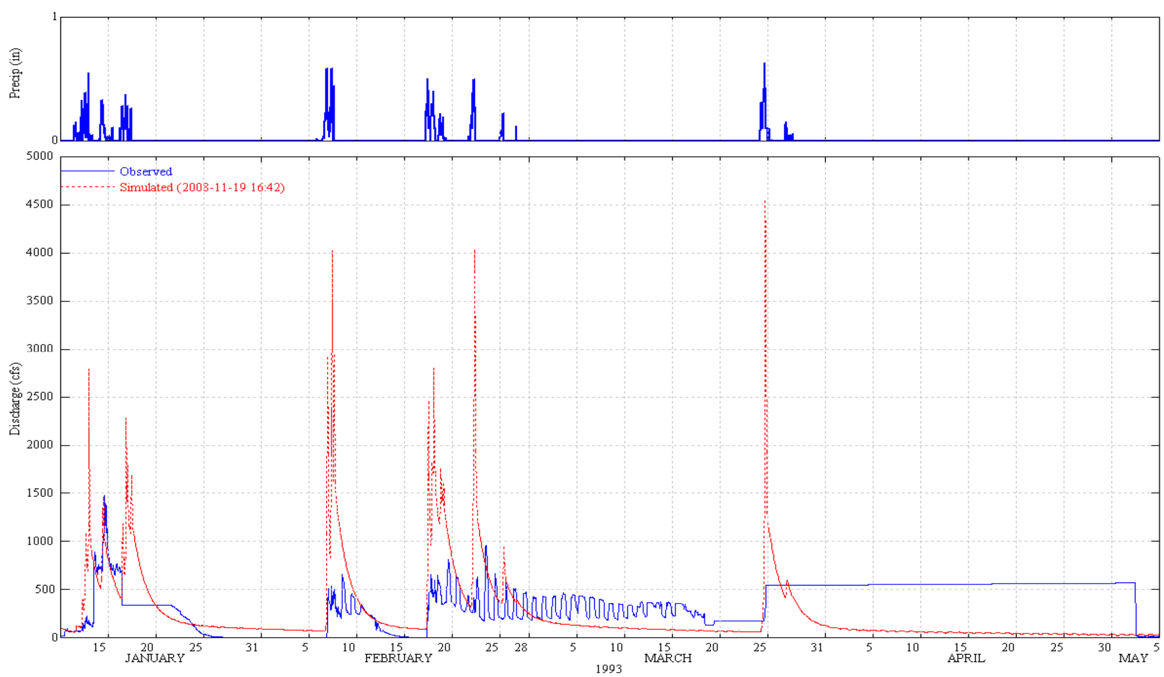

Figure 37 Simulated and Observed January 11, 1993 Storm Event

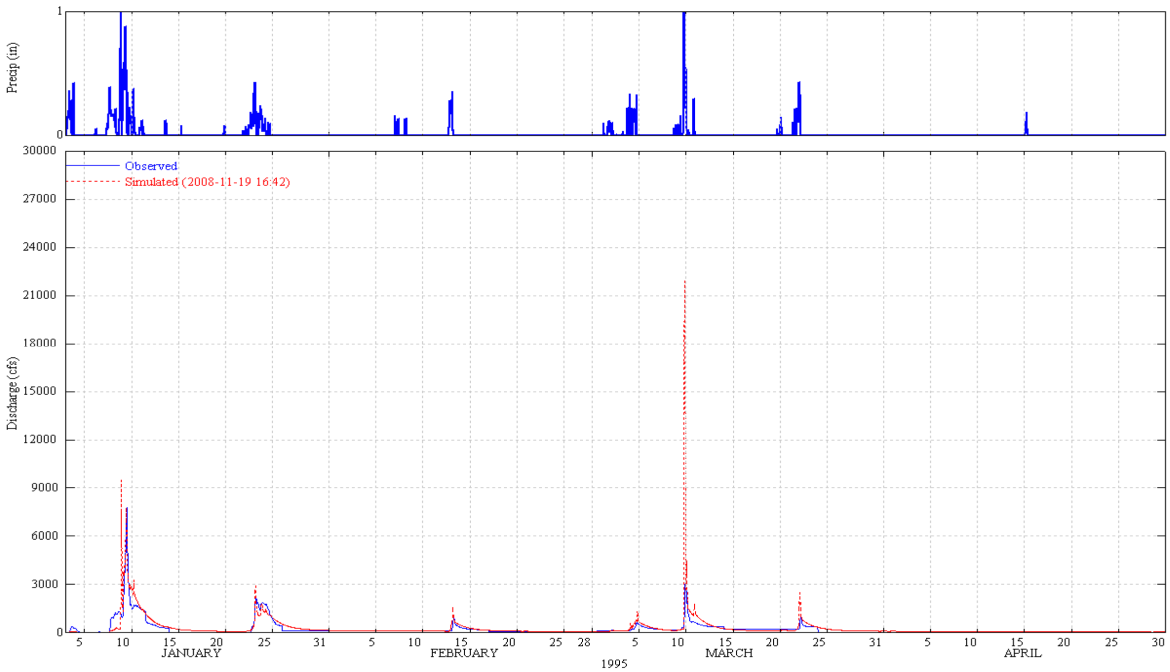

Figure 38 Simulated and Observed January 8, 1995 Storm Event

APPENDIX F

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE UPPER PIRU WATERSHED

Title Page

CALIBRATION

VALIDATION

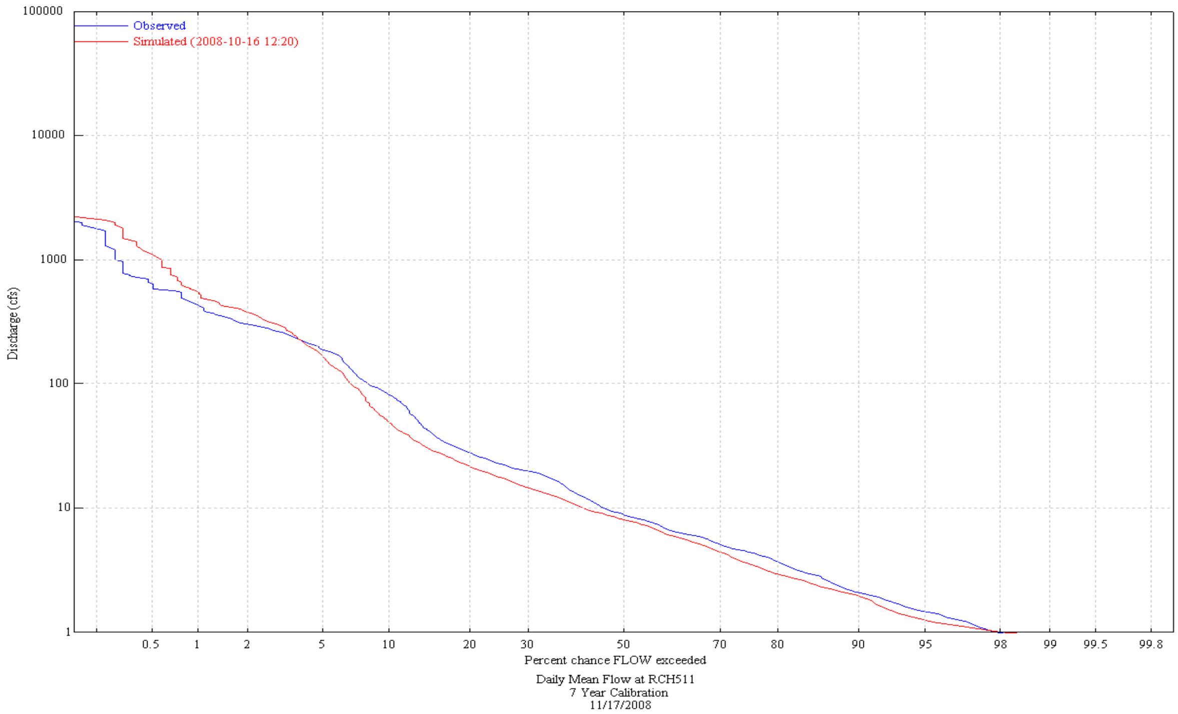

Figure 1 Simulated and Observed Daily Flow Duration Curve at Up-Piru

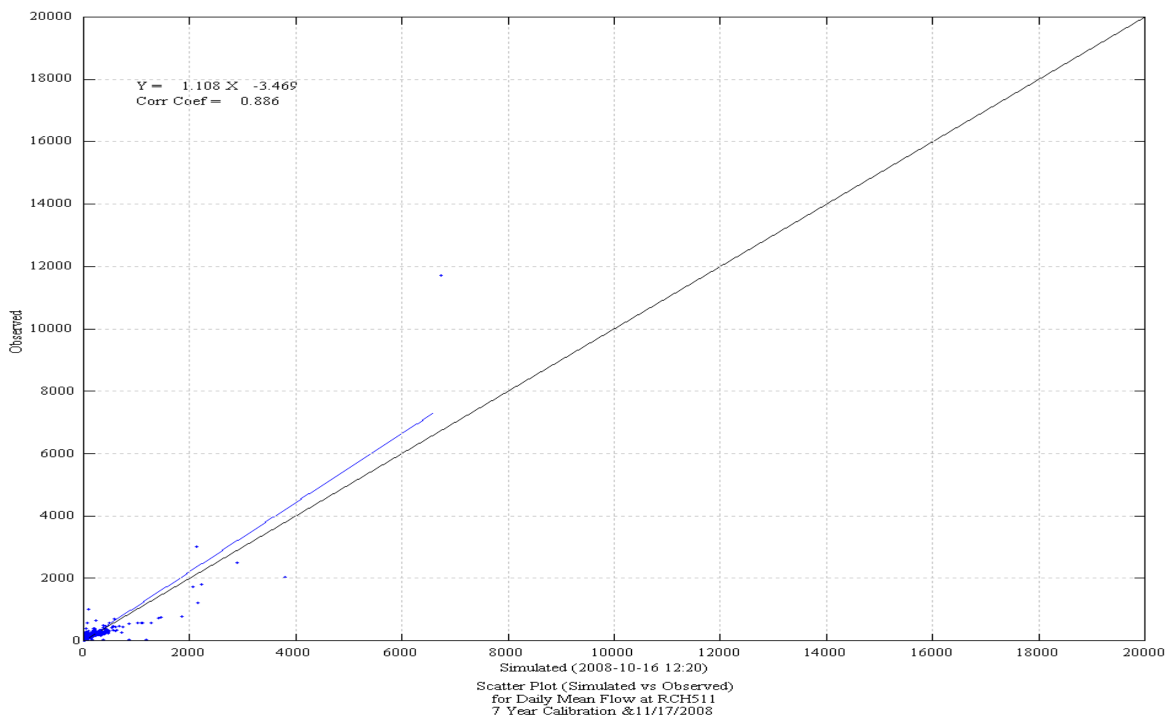

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Up-Piru

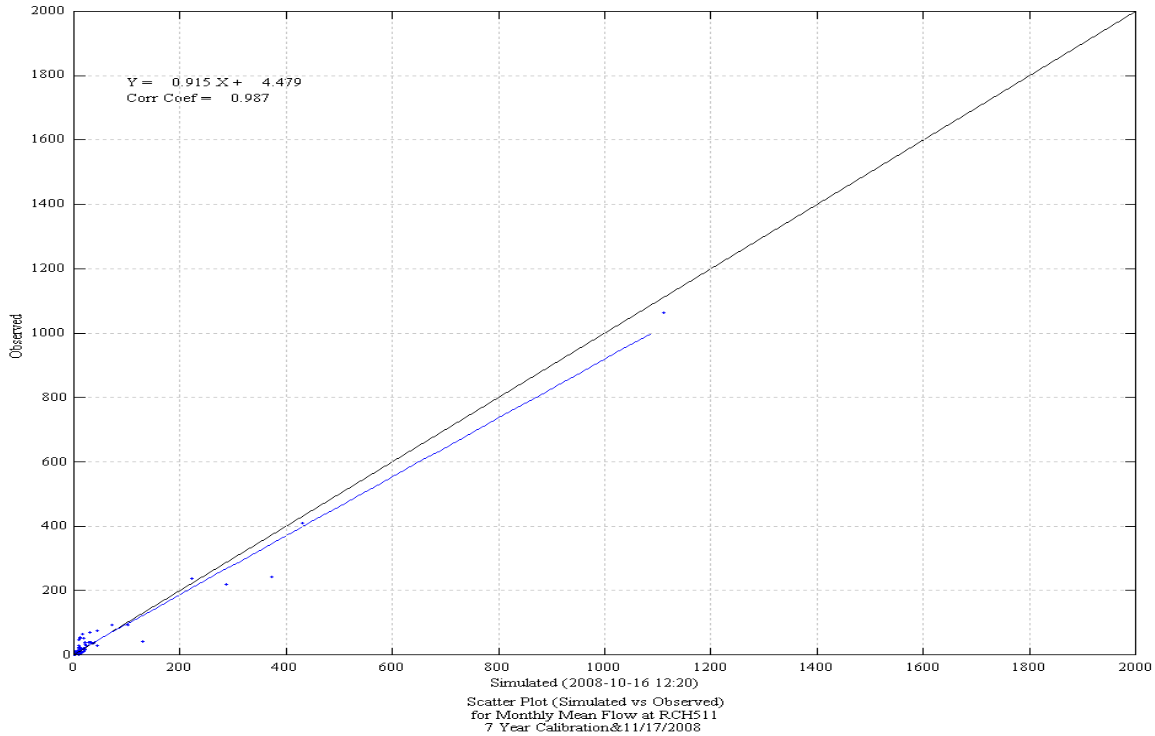

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Up-Piru

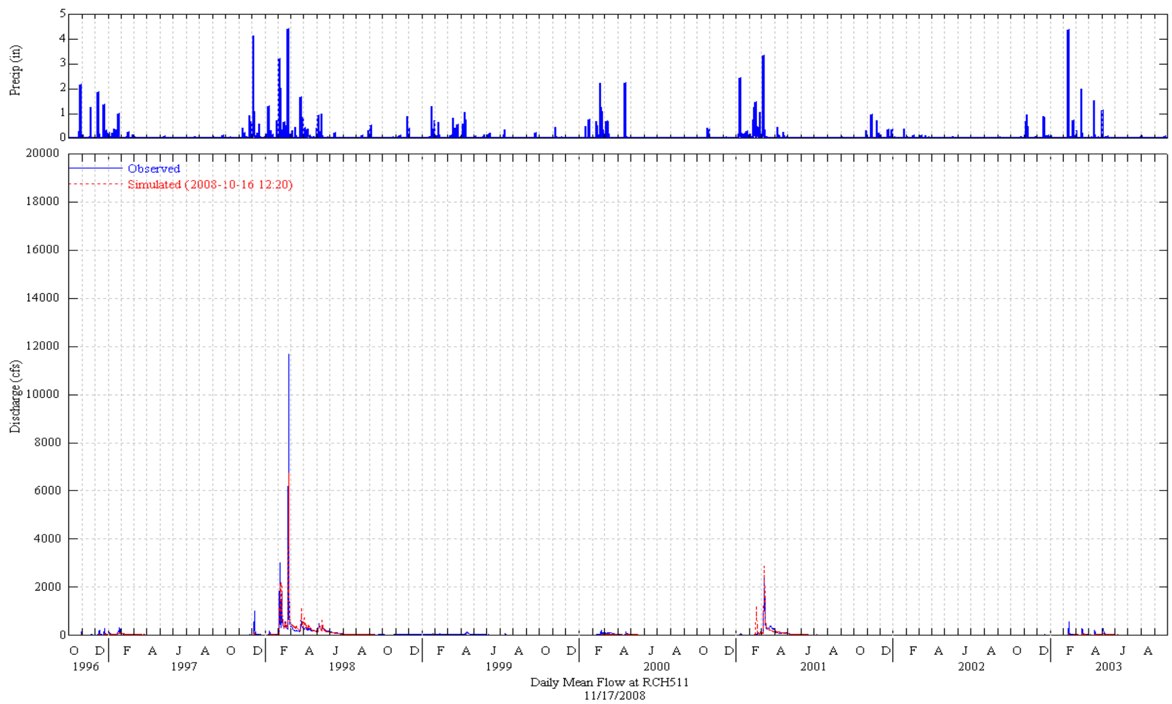

Figure 4 Simulated and Observed Daily Flow at Up-Piru (WY 1997-2003)

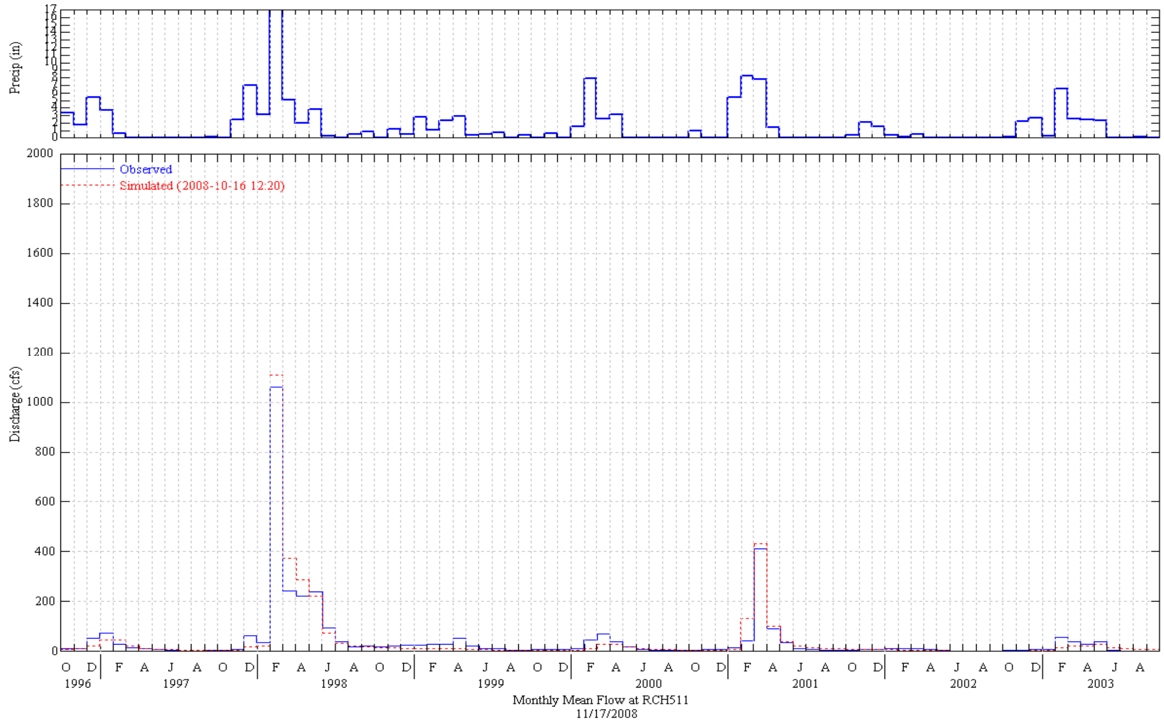

Figure 5 Simulated and Observed Monthly Flow at Up-Piru (WY 1997-2003)

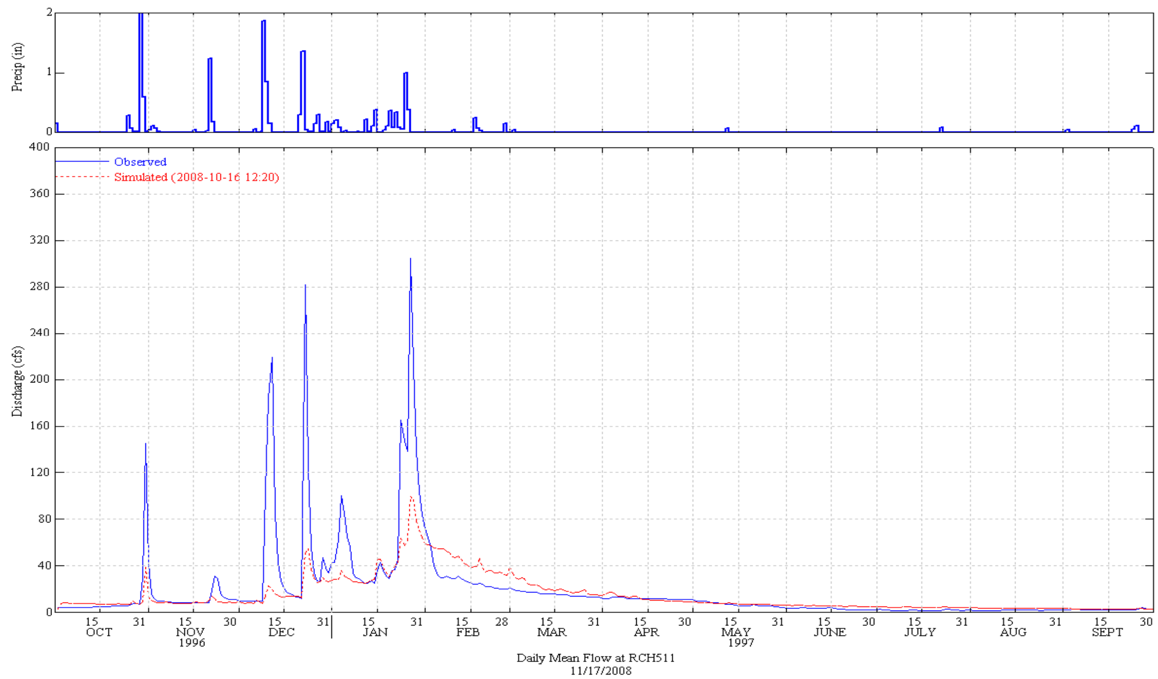

Figure 6 Simulated and Observed Daily Flow at Up-Piru (WY 1997)

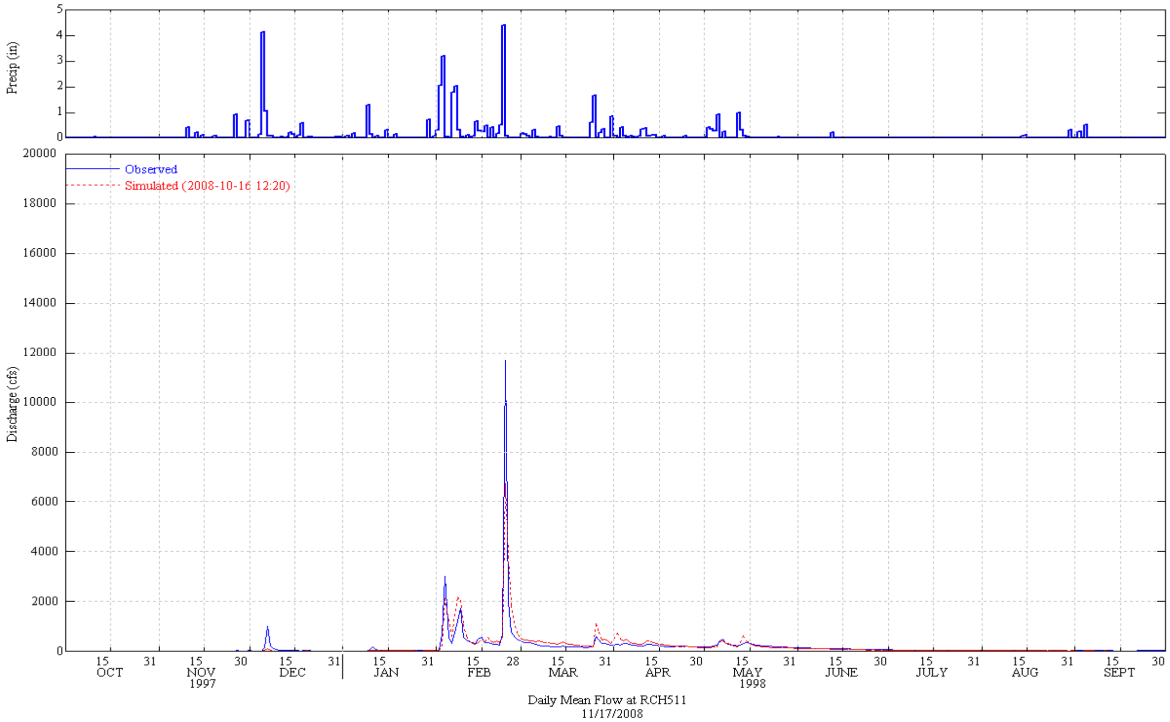

Figure 7 Simulated and Observed Daily Flow at Up-Piru (WY 1998)

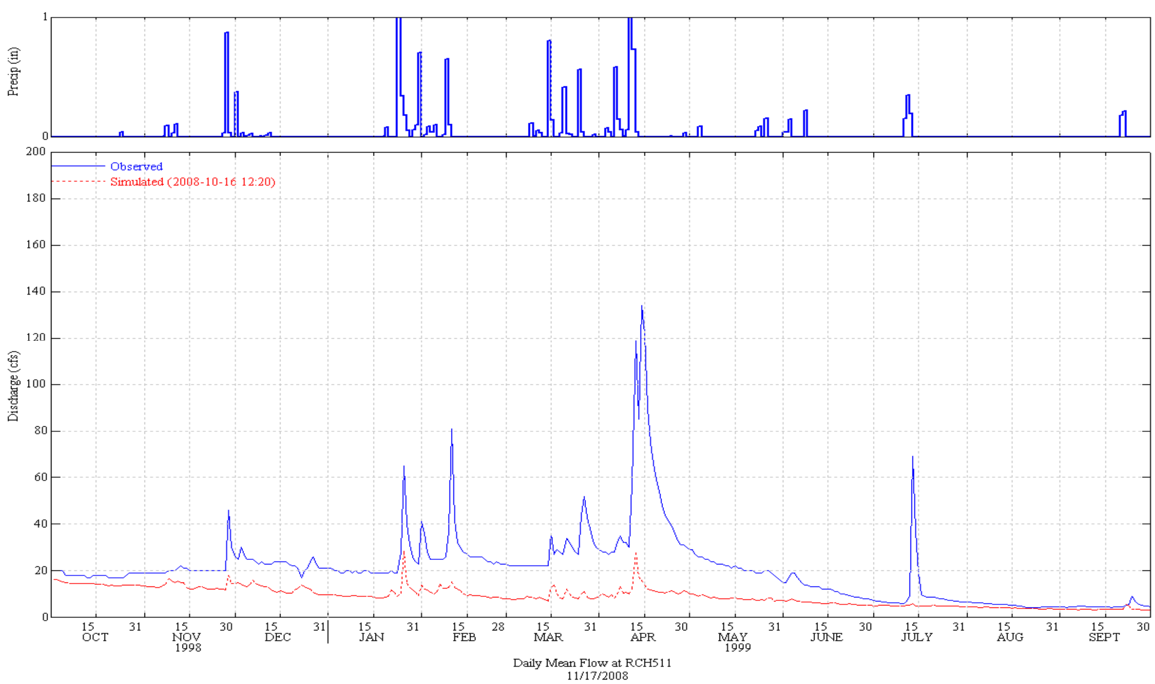

Figure 8 Simulated and Observed Daily Flow at Up-Piru (WY 1999)

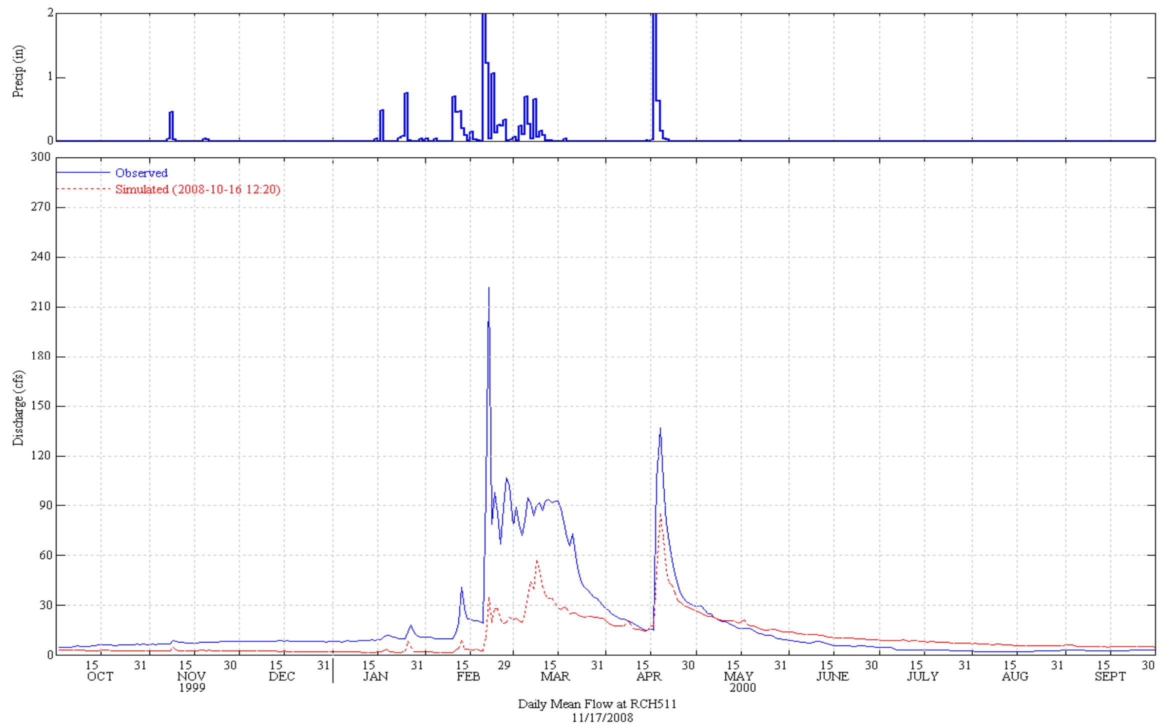

Figure 9 Simulated and Observed Daily Flow at Up-Piru (WY 2000)

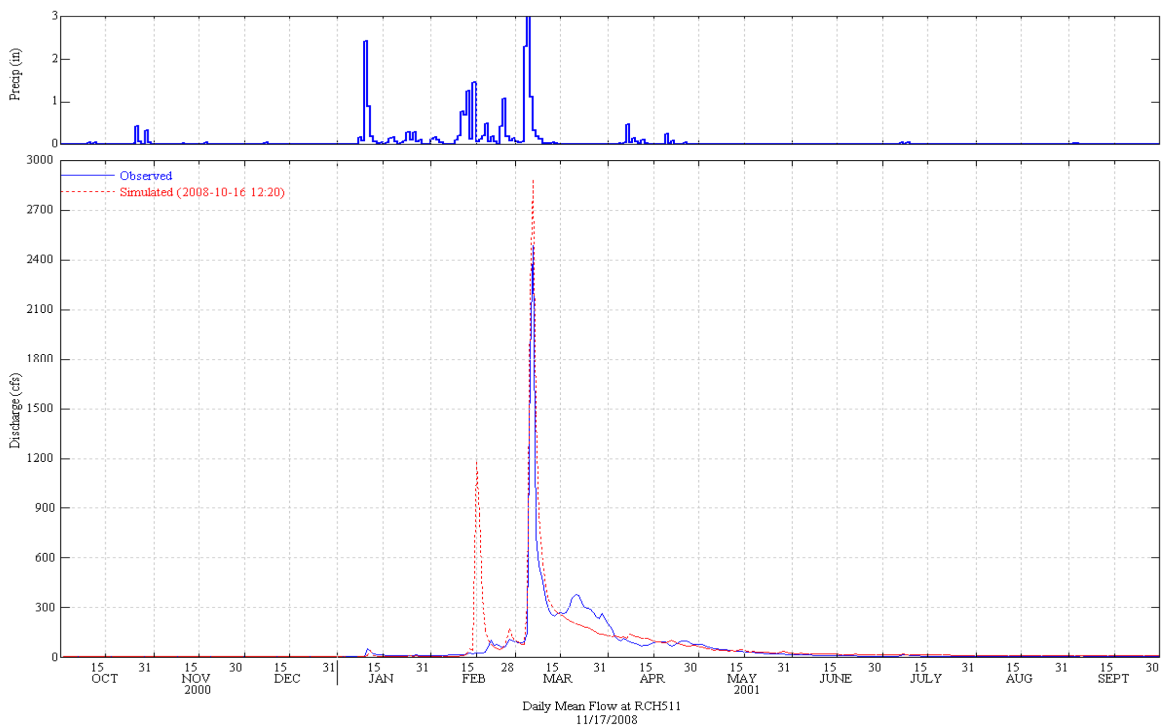

Figure 10 Simulated and Observed Daily Flow at Up-Piru (WY 2001)

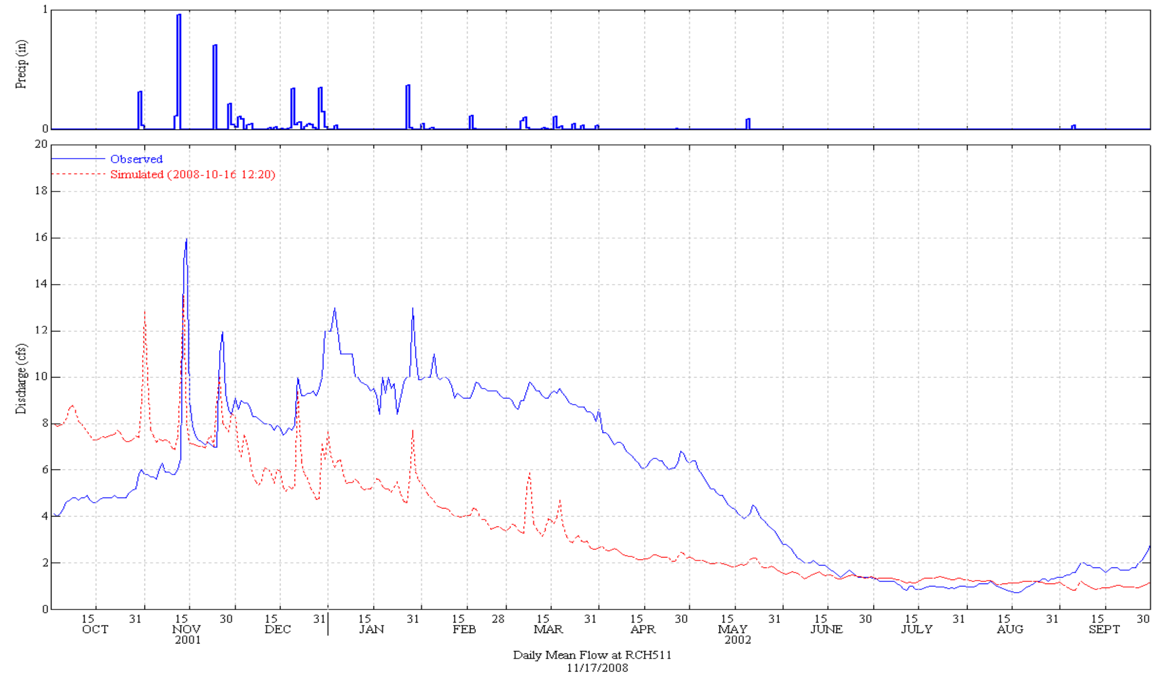

Figure 11 Simulated and Observed Daily Flow at Up-Piru (WY 2002)

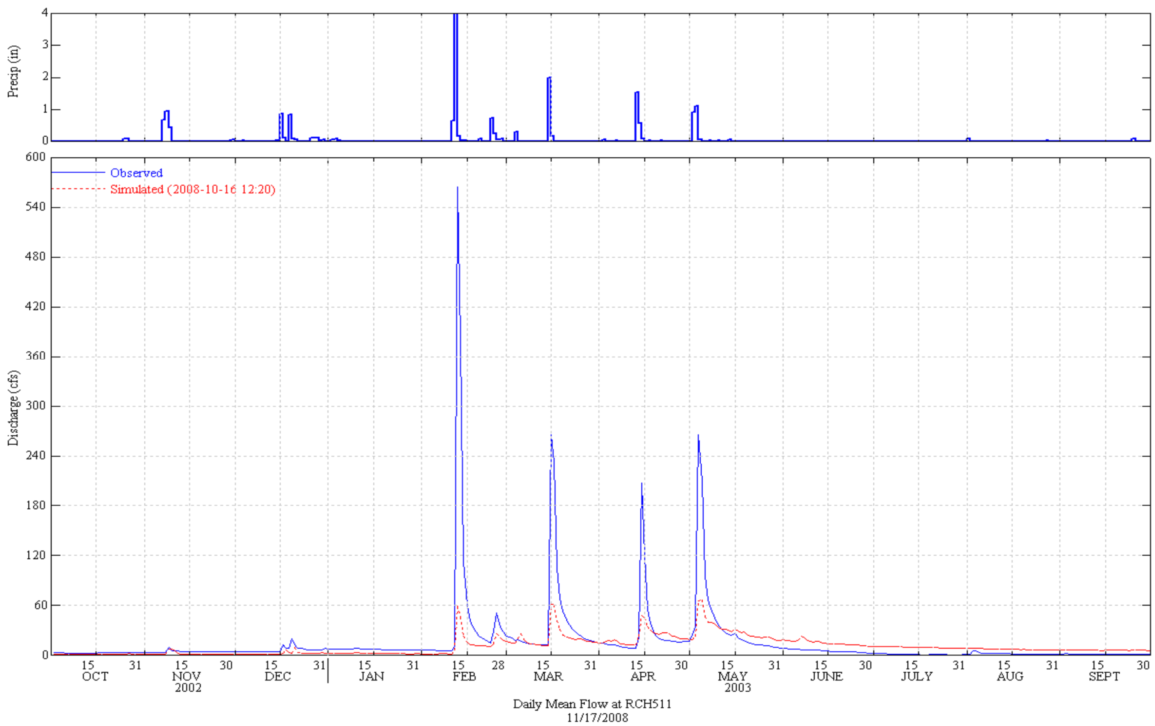

Figure 12 Simulated and Observed Daily Flow at Up-Piru (WY 2003)

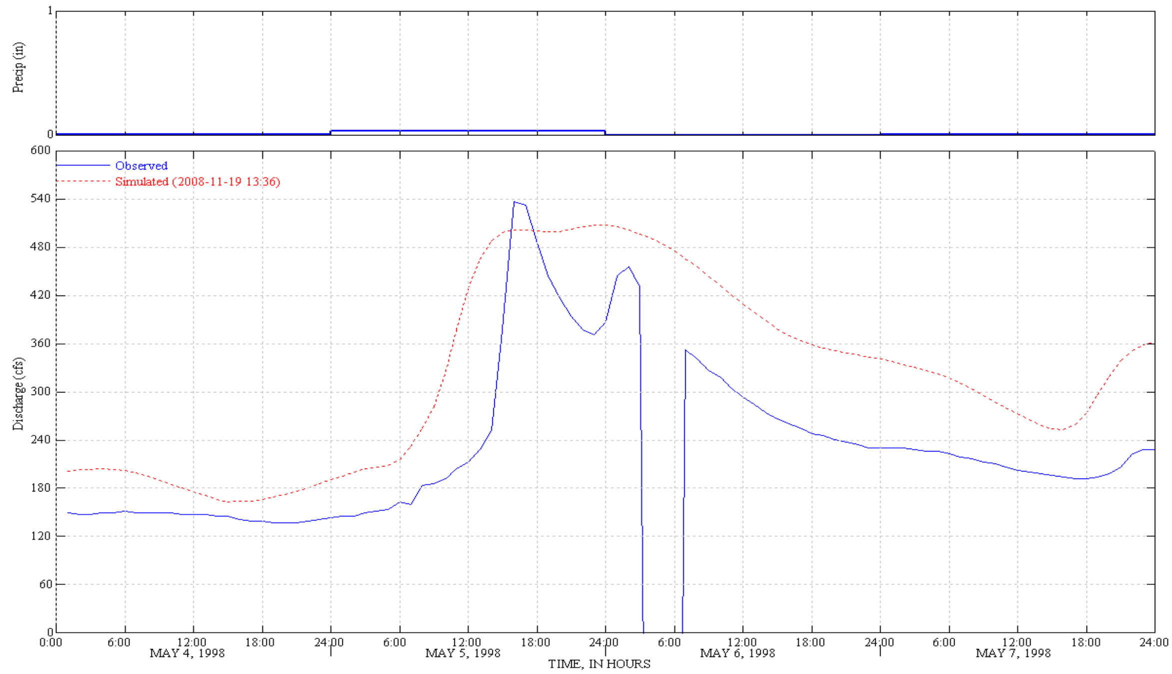

Figure 13 Simulated and Observed May 4, 1998 Storm Event

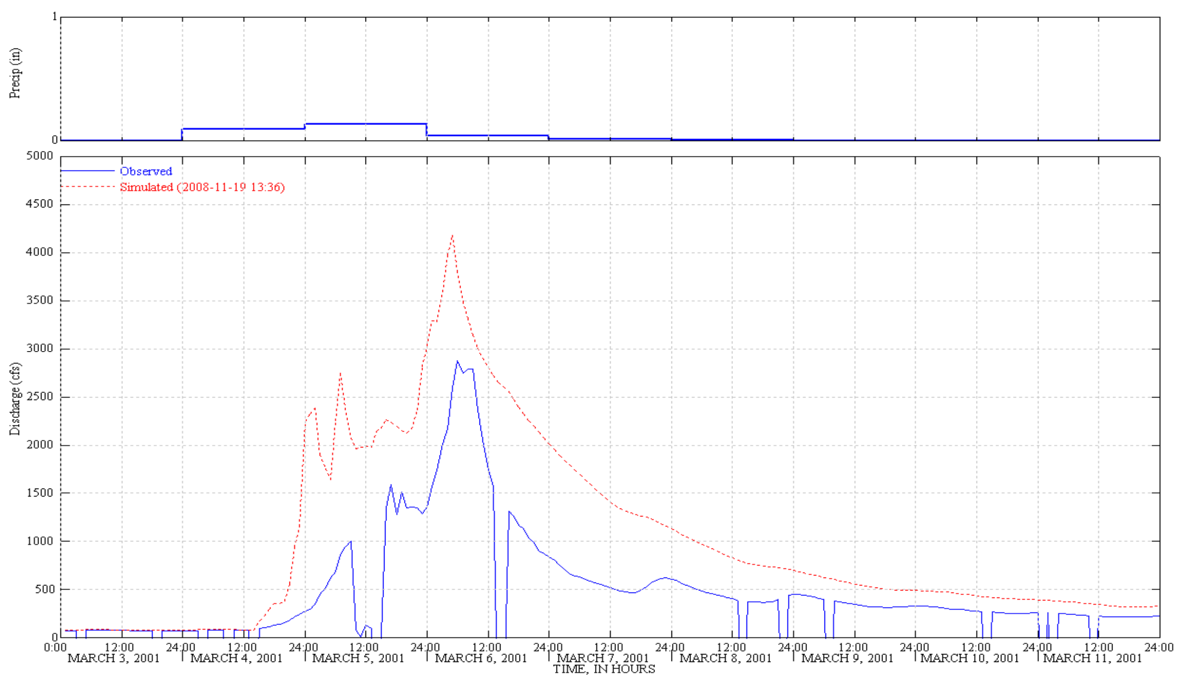

Figure 14 Simulated and Observed March 3, 2001 Storm Event

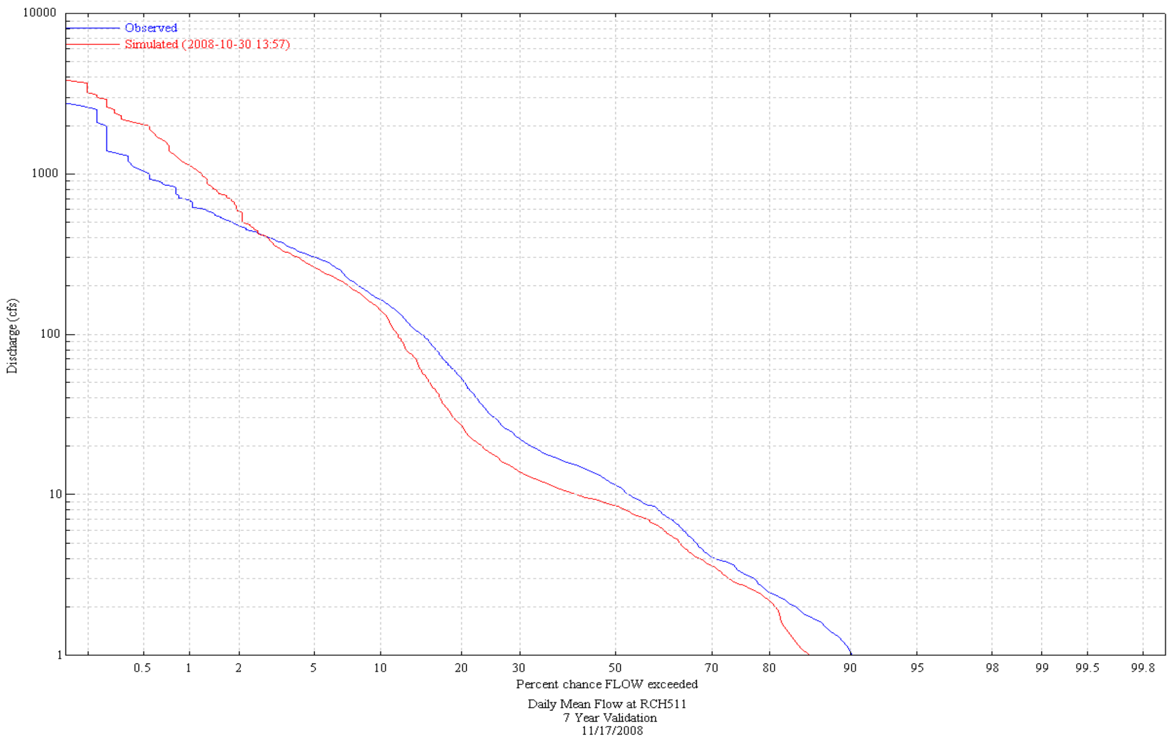

Figure 15 Simulated and Observed Daily Flow Duration Curve at Up-Piru

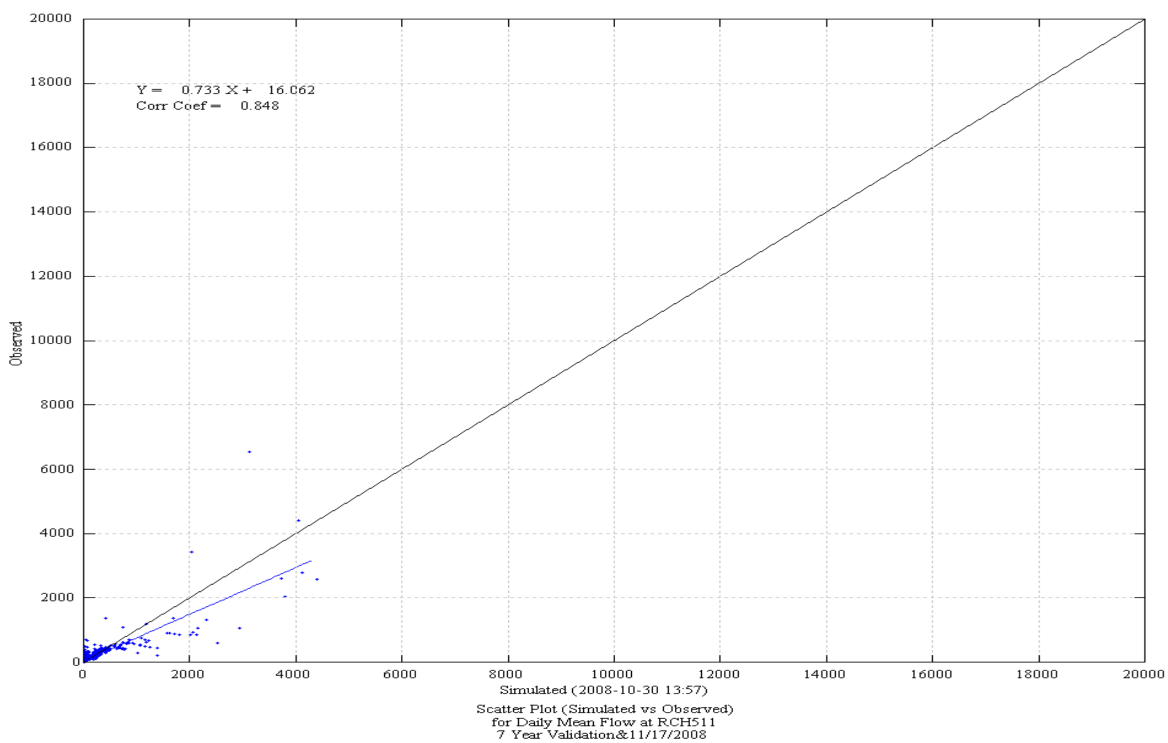

Figure 16 Daily Scatter Plot of Simulated versus Observed Flow at Up-Piru

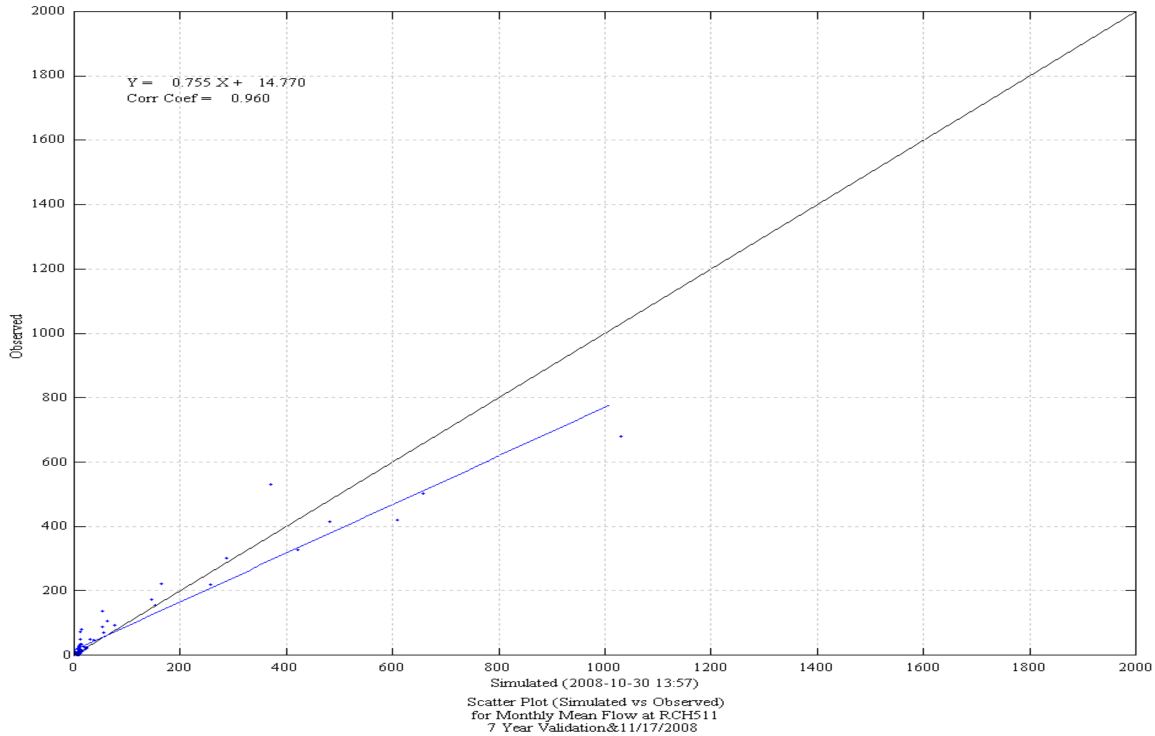

Figure 17 Monthly Scatter Plot of Simulated versus Observed Flow at Up-Piru

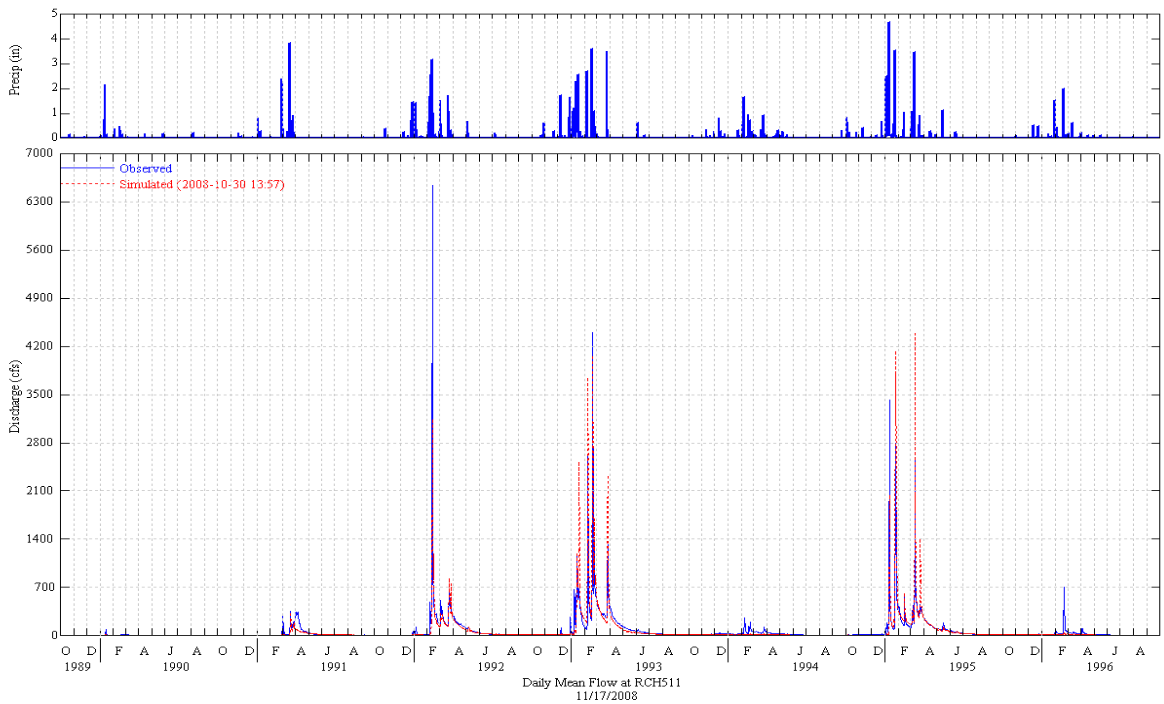

Figure 18 Simulated and Observed Daily Flow at Up-Piru (WY 1990-1996)

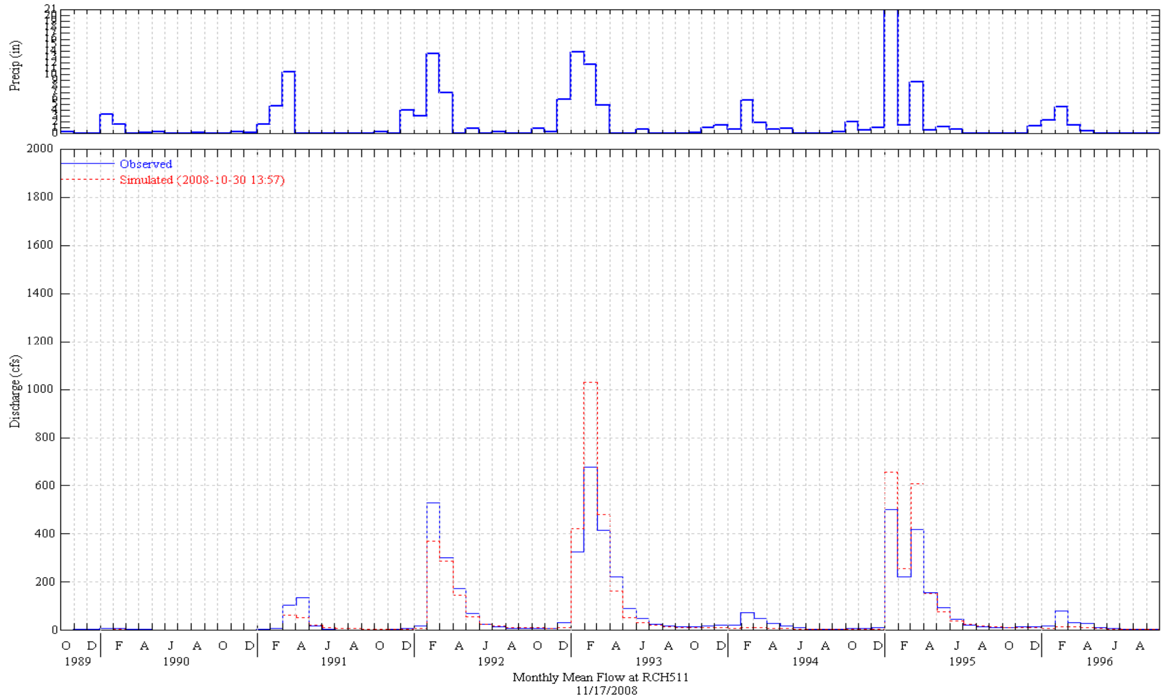

Figure 19 Simulated and Observed Monthly Flow at Up-Piru (WY 1990-1996)

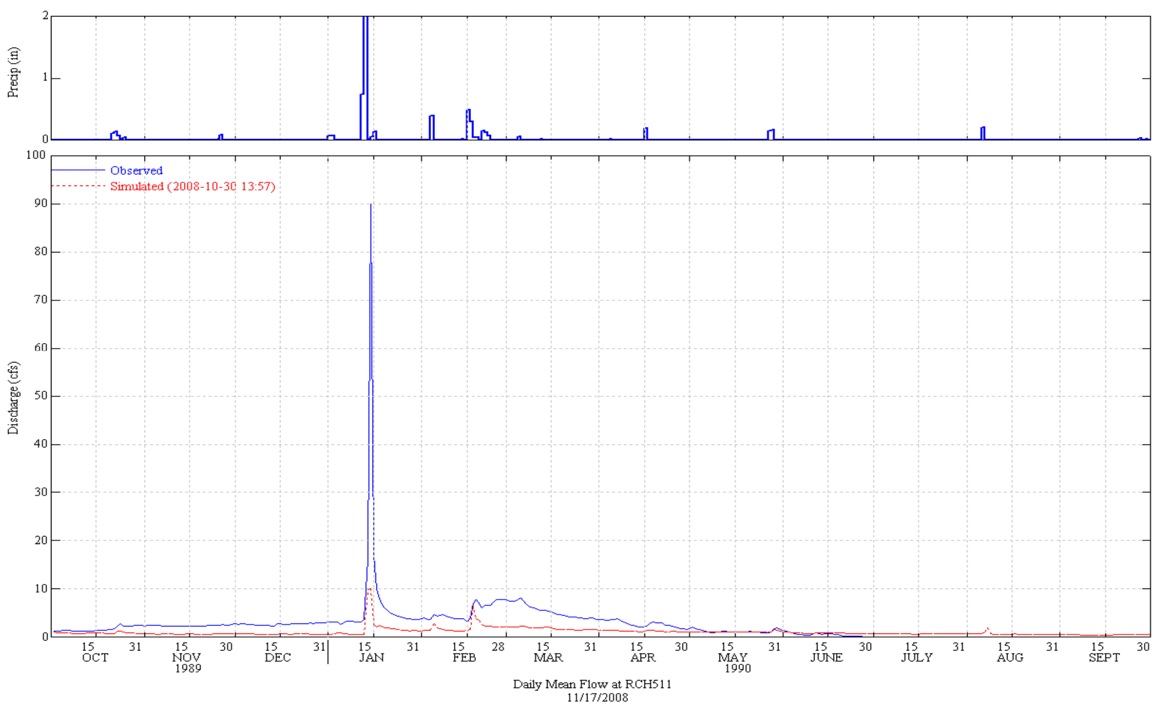

Figure 20 Simulated and Observed Daily Flow at Up-Piru (WY 1990)

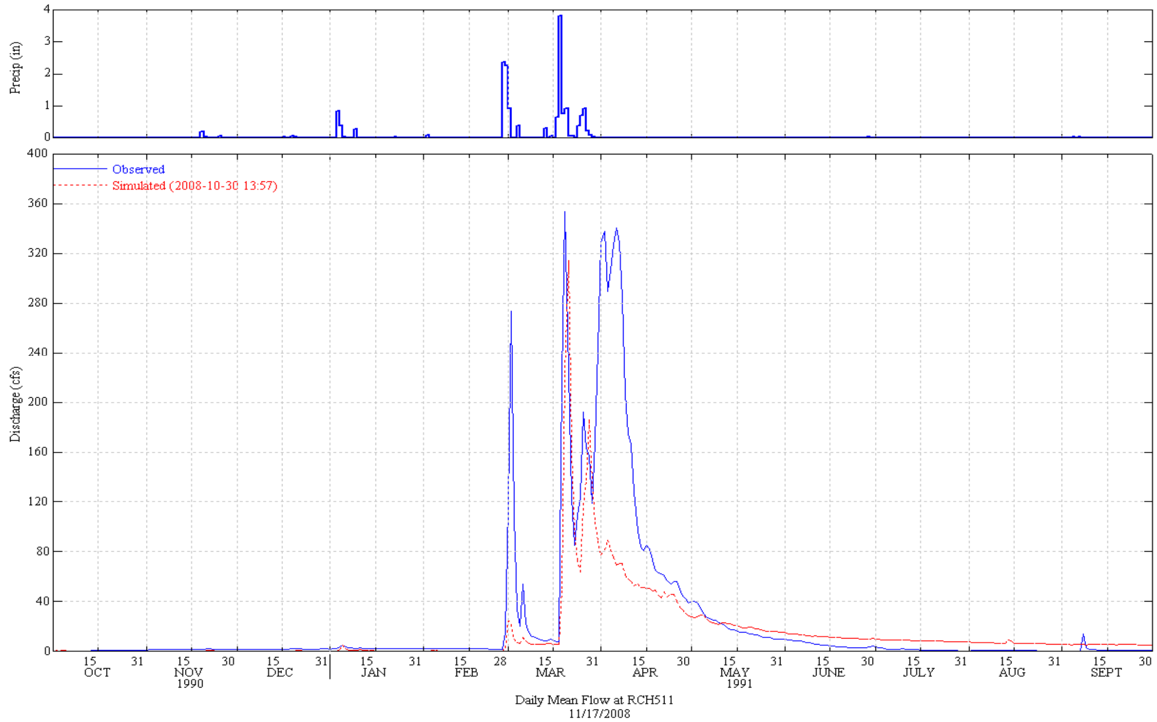

Figure 21 Simulated and Observed Daily Flow at Up-Piru (WY 1991)

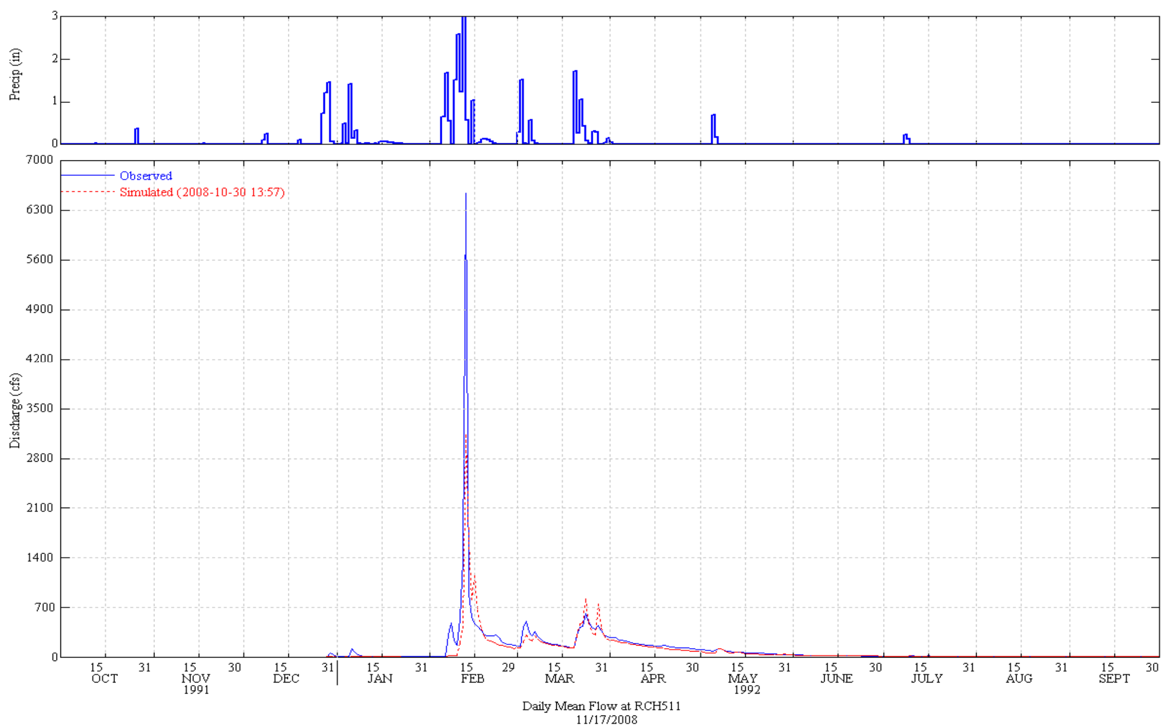

Figure 22 Simulated and Observed Daily Flow at Up-Piru (WY 1992)

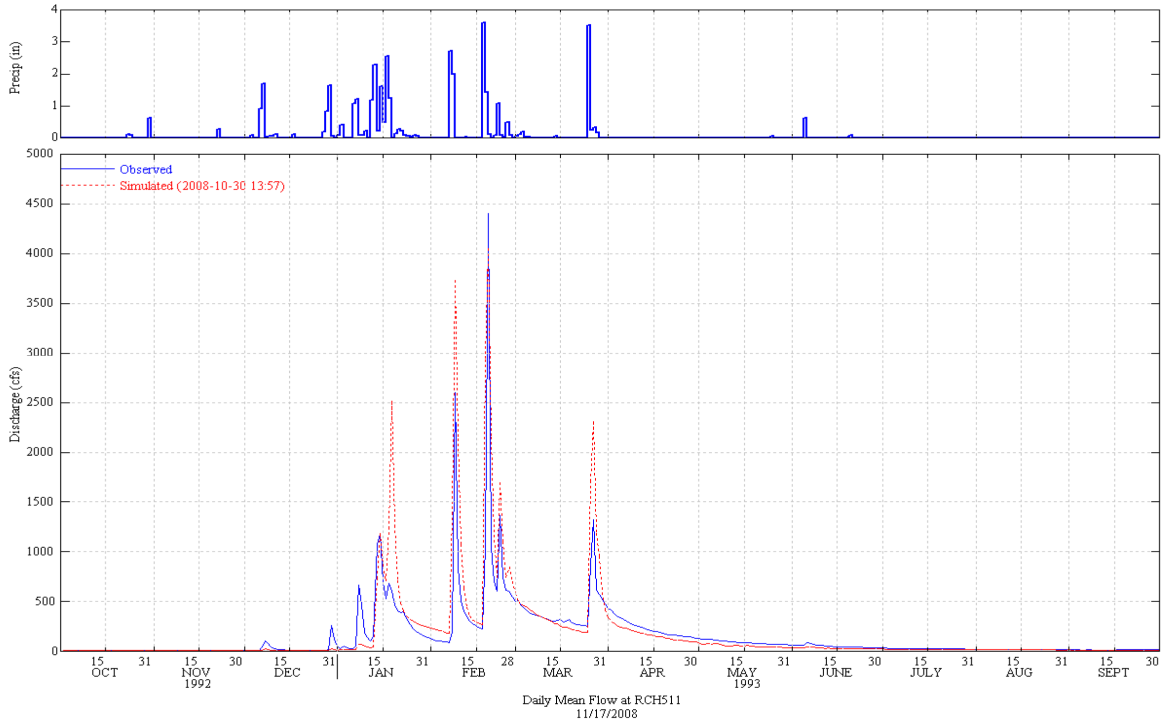

Figure 23 Simulated and Observed Daily Flow at Up-Piru (WY 1993)

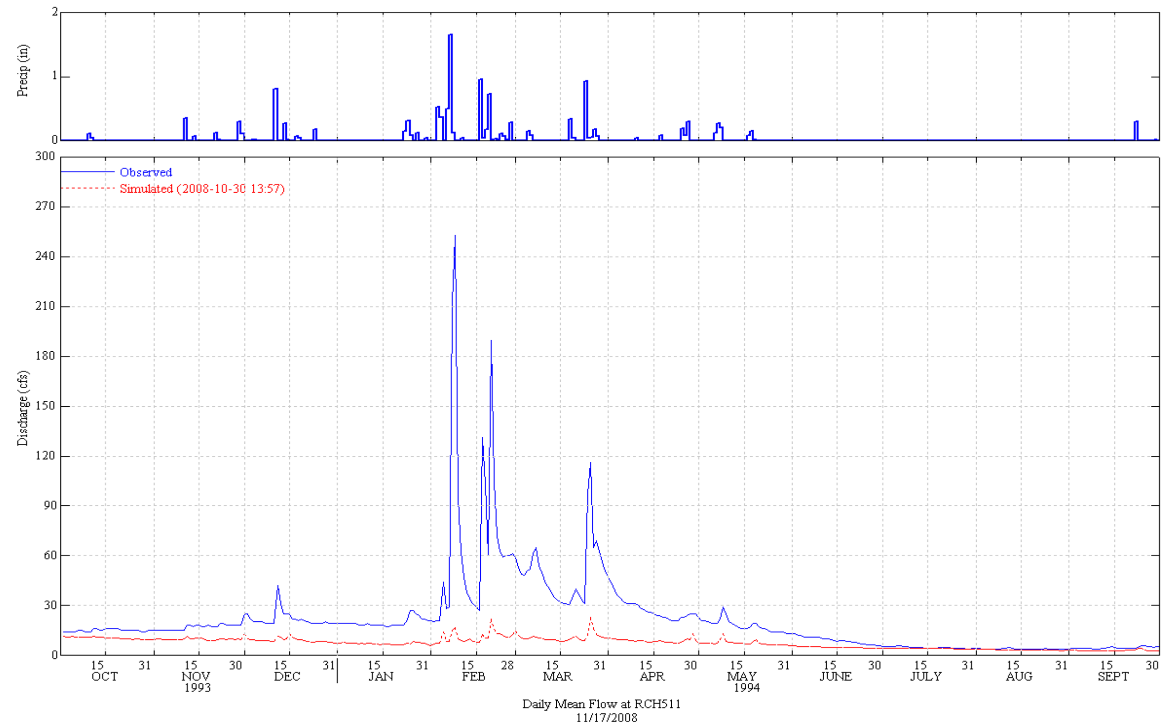

Figure 24 Simulated and Observed Daily Flow at Up-Piru (WY 1994)

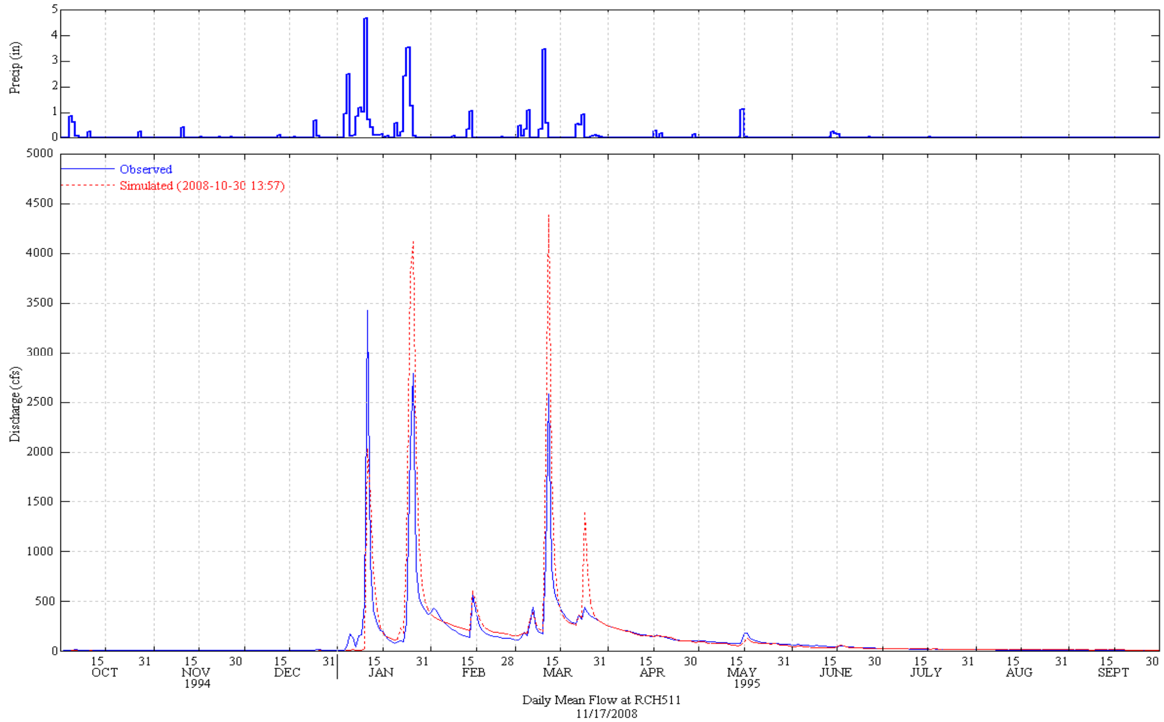

Figure 25 Simulated and Observed Daily Flow at Up-Piru (WY 1995)

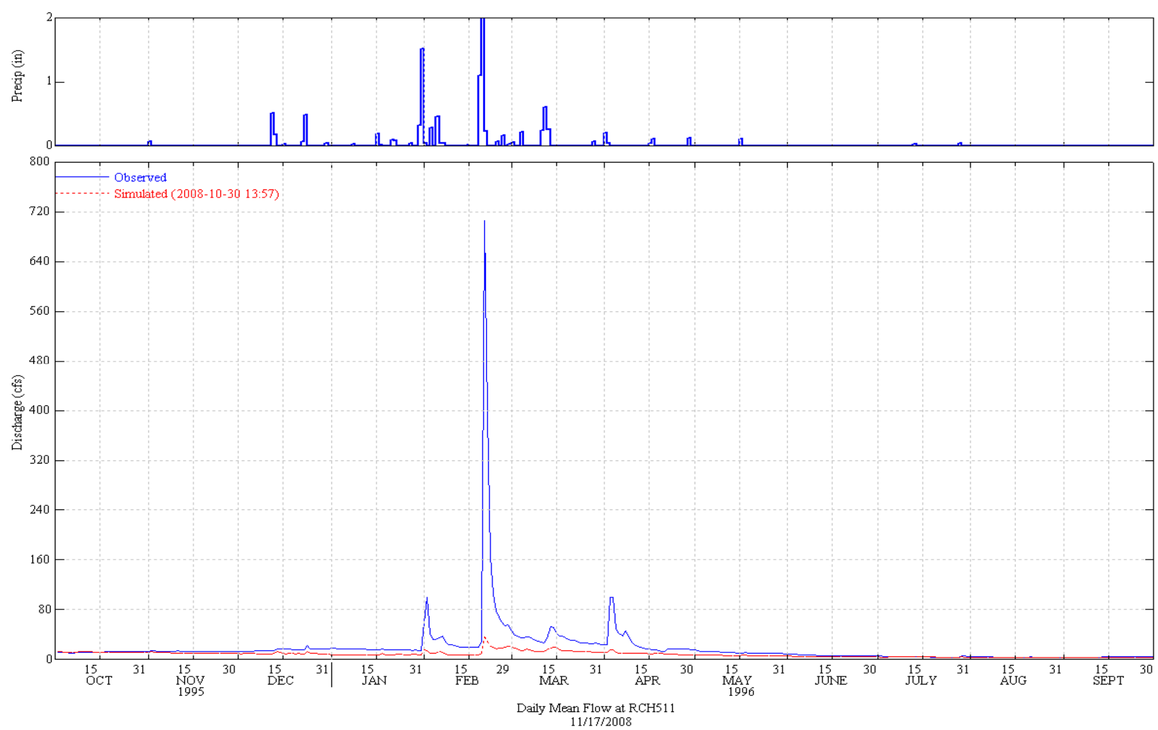

Figure 26 Simulated and Observed Daily Flow at Up-Piru (WY 1996)

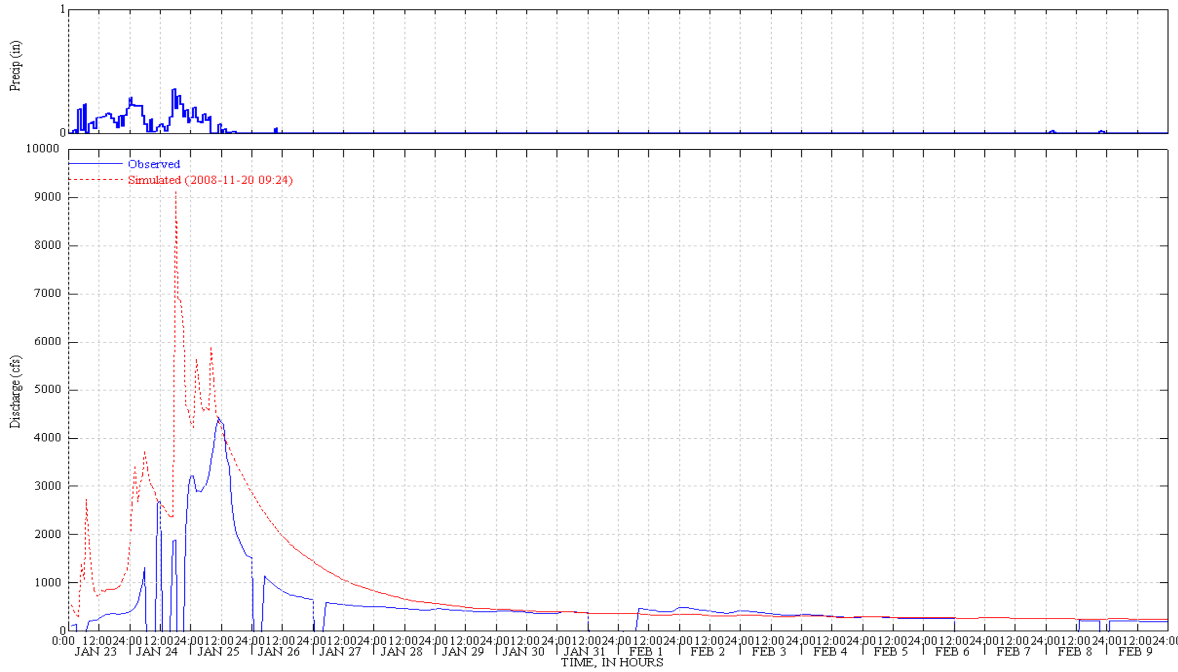

Figure 27 Simulated and Observed January 23, 1995 Storm Event

APPENDIX G

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SANTA CLARA RIVER WATERSHED AT LANG

Title Page

CALIBRATION

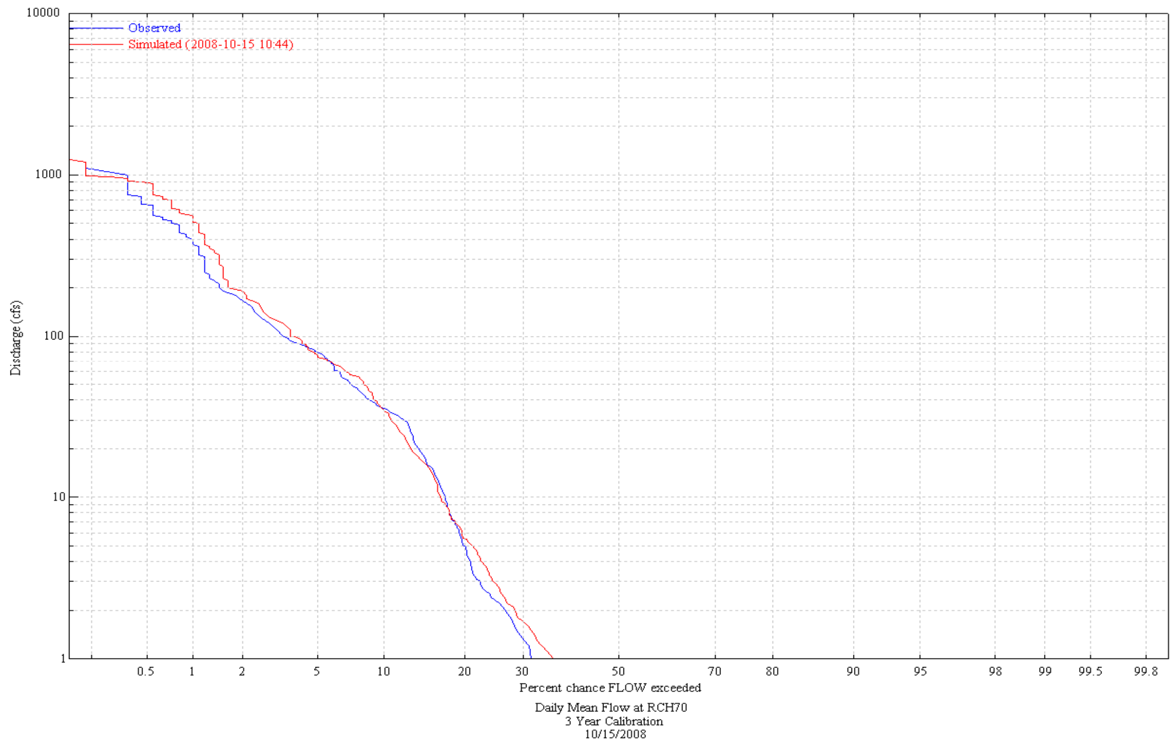

Figure 1 Simulated and Observed Daily Flow Duration Curve at Lang

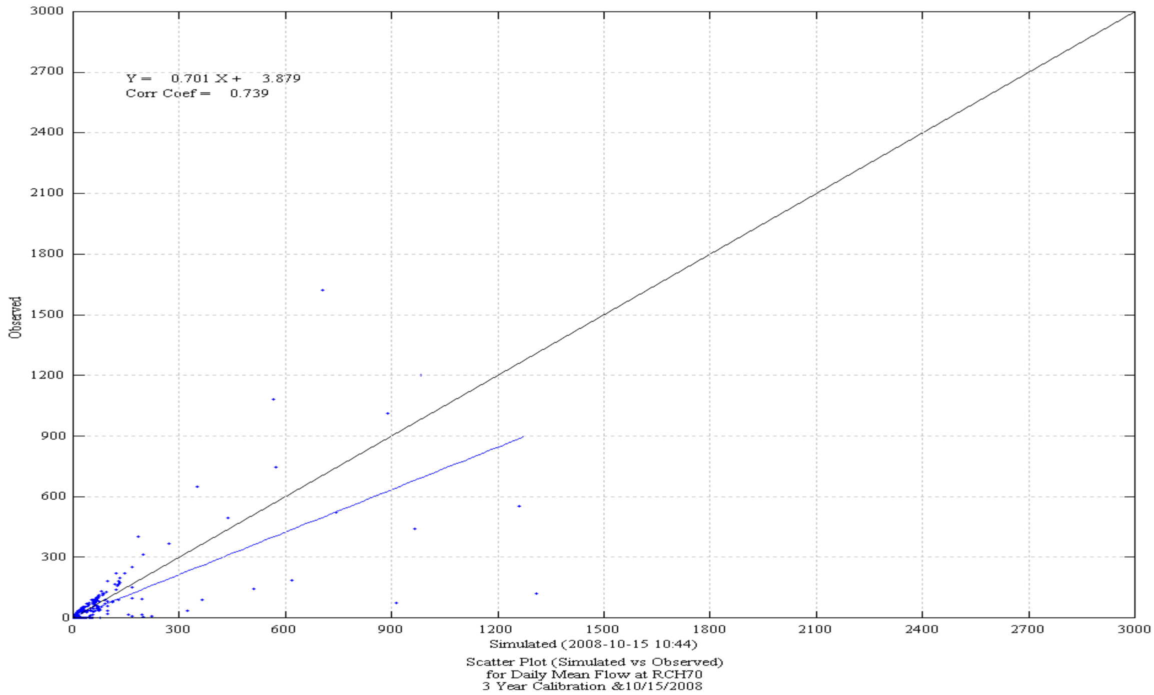

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Lang

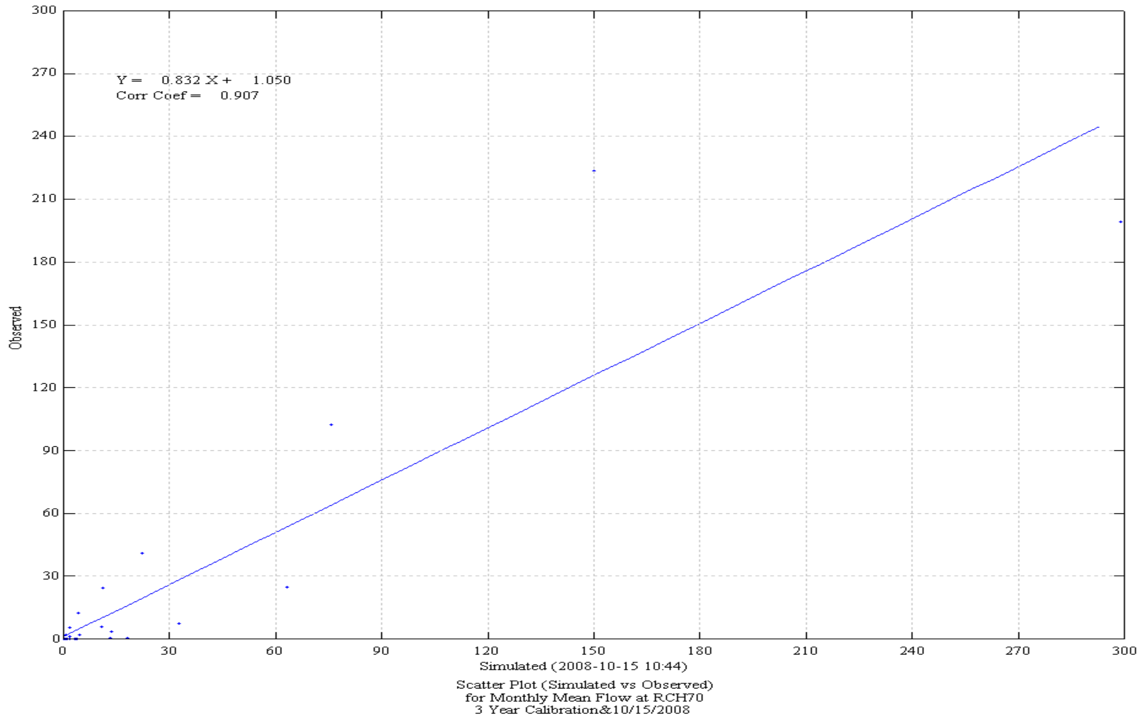

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Lang

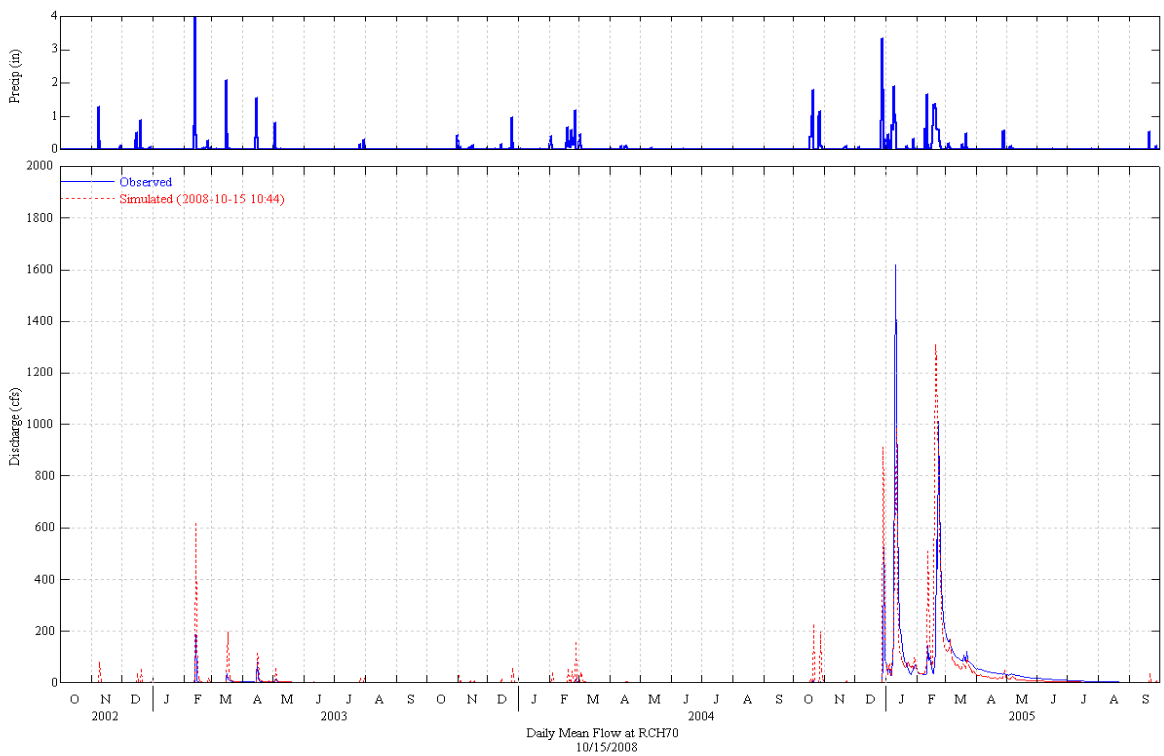

Figure 4 Simulated and Observed Daily Flow at Lang (WY 2003-2005)

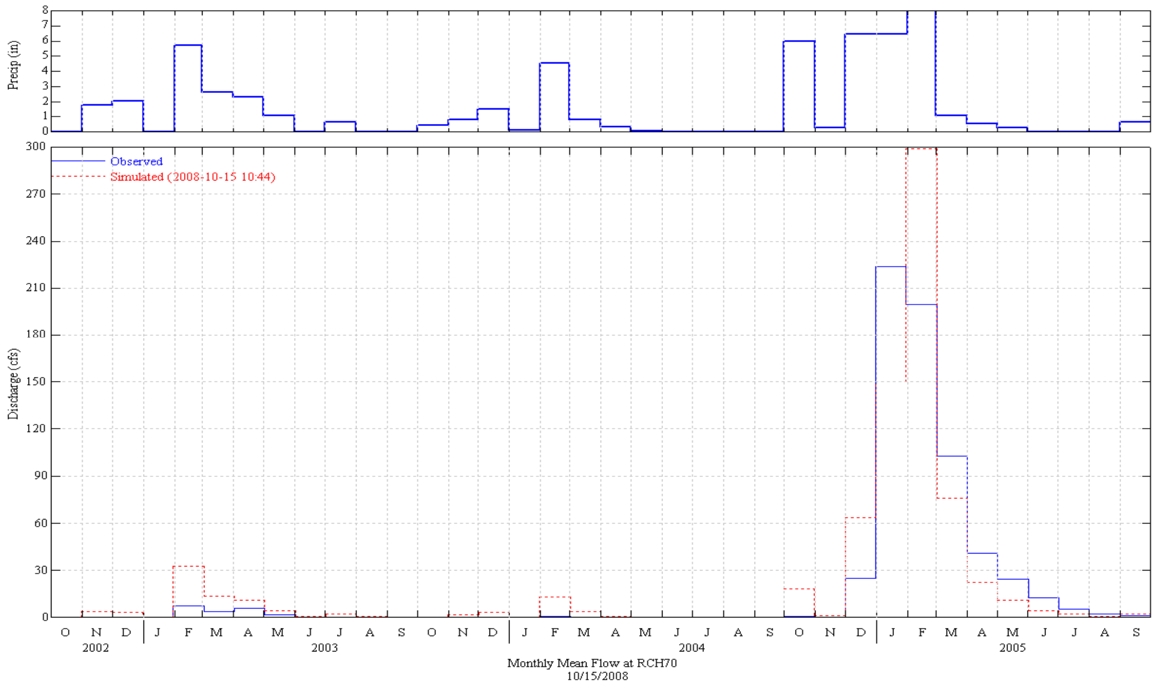

Figure 5 Simulated and Observed Monthly Flow at Lang (WY 2003-2005)

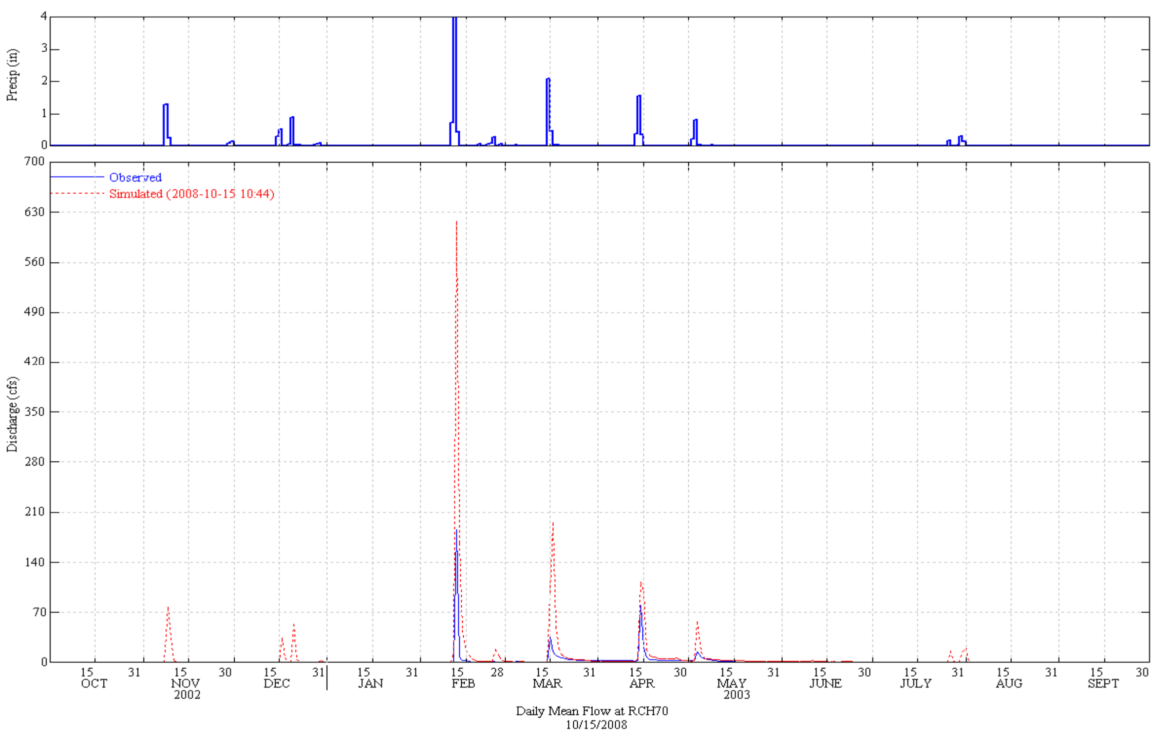

Figure 6 Simulated and Observed Daily Flow at Lang (WY 2003)

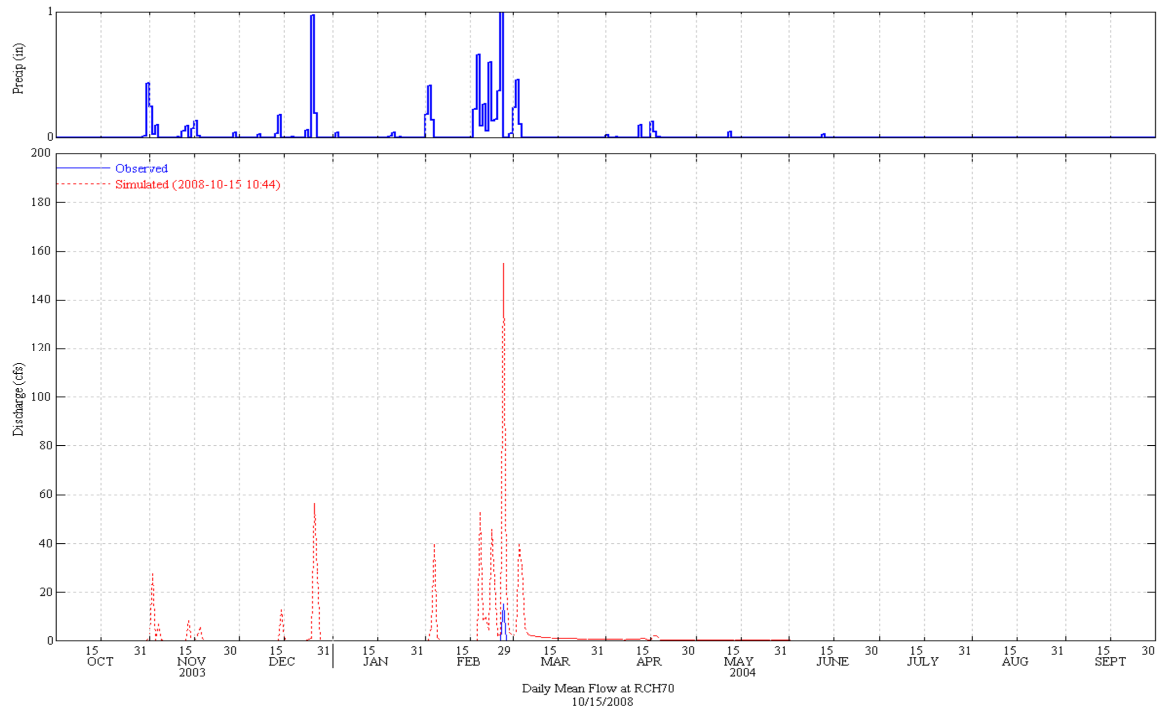

Figure 7 Simulated and Observed Daily Flow at Lang (WY 2004)

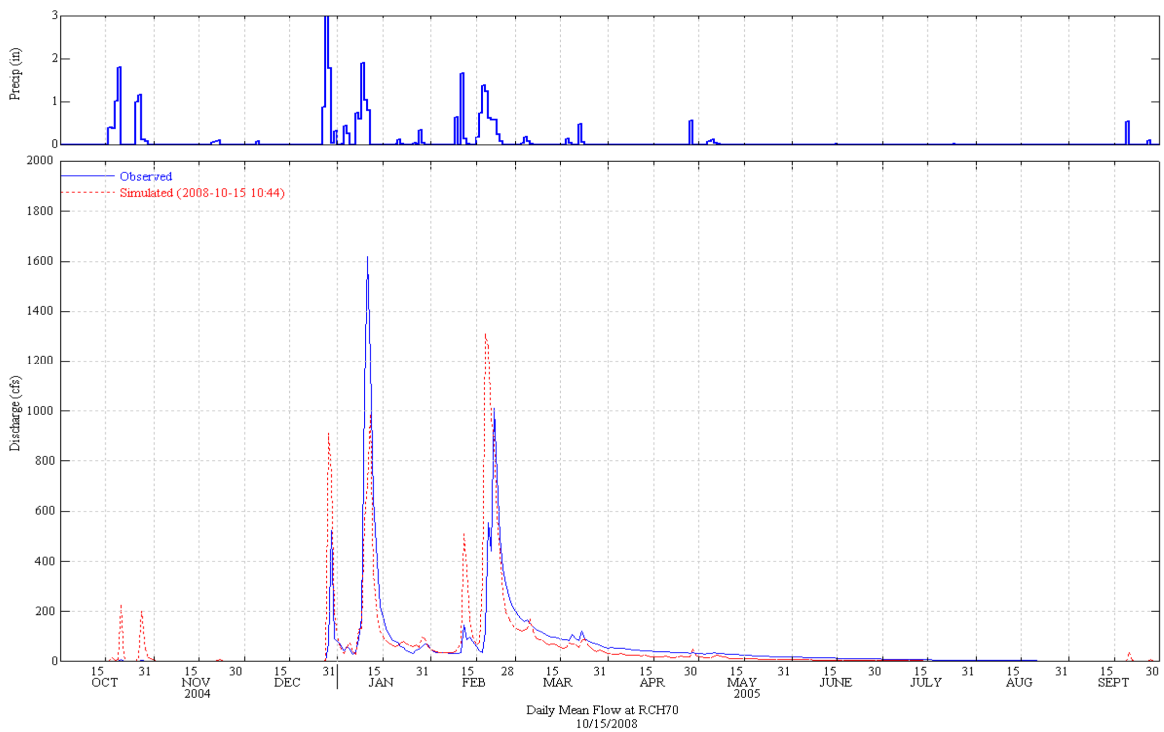

Figure 8 Simulated and Observed Daily Flow at Lang (WY 2005)

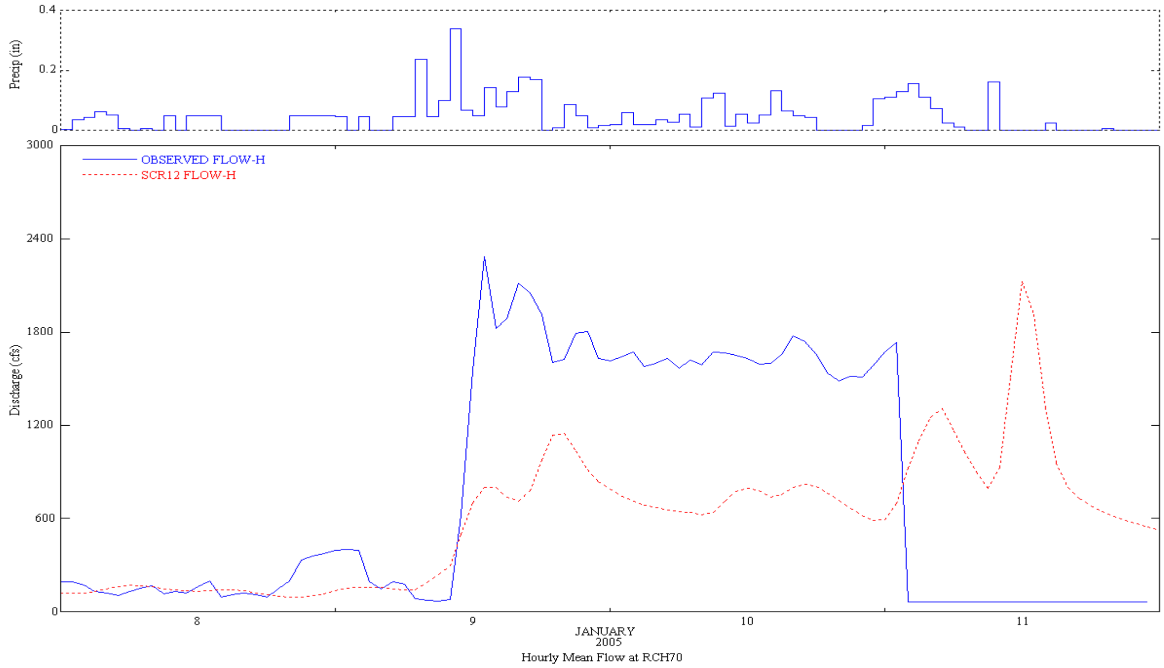

Figure 9 Simulated and Observed January 8-11, 2005 Storm Event

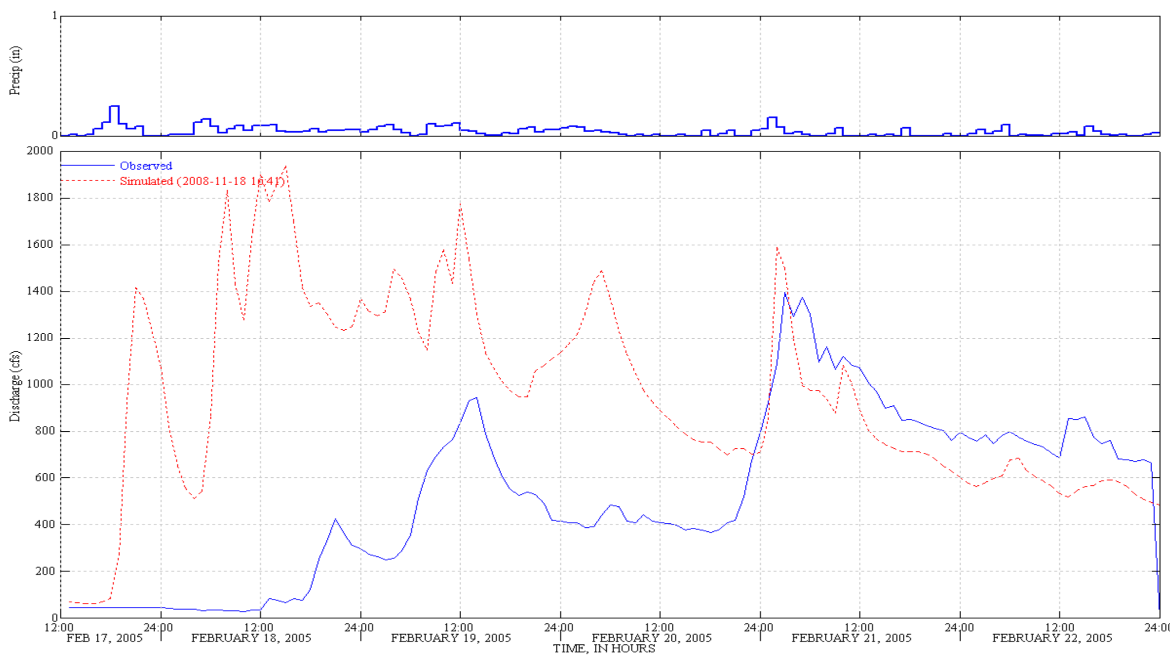

Figure 10 Simulated and Observed February 17-22, 2005 Storm Event

APPENDIX H

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SANTA CLARA RIVER WATERSHED AT HWY99

Title | Page

<u>CALIBRATION</u>

<u>VALIDATION</u>

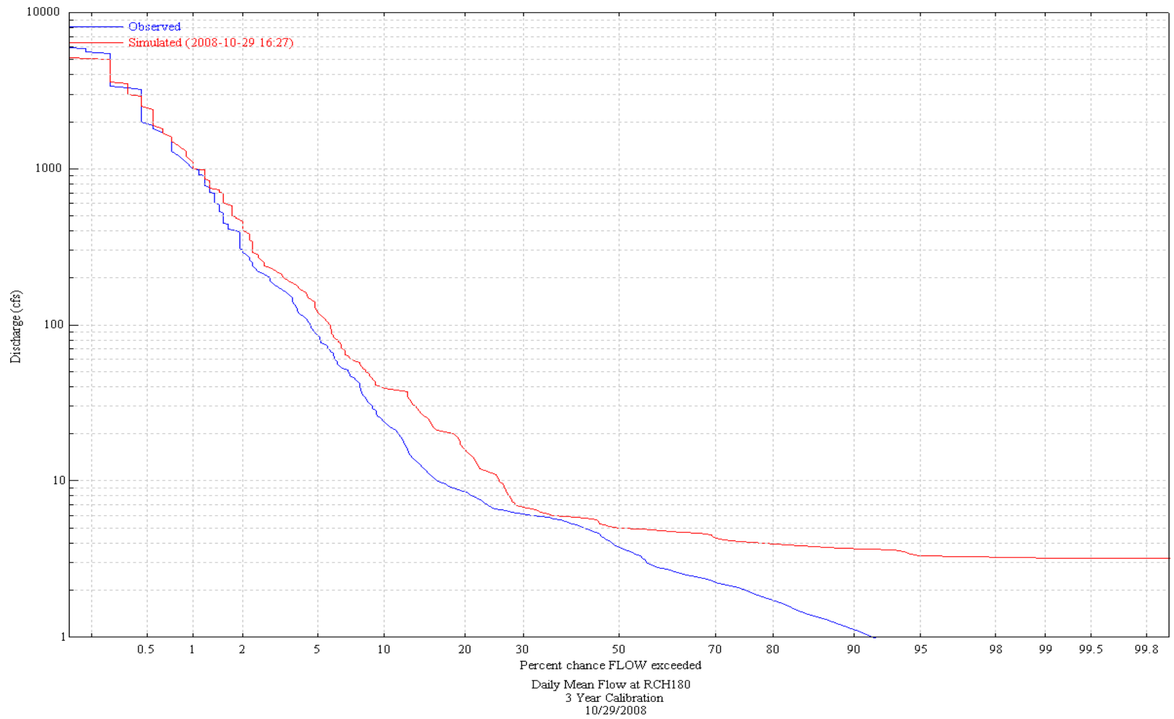

Figure 1 Simulated and Observed Daily Flow Duration Curve at HWY99

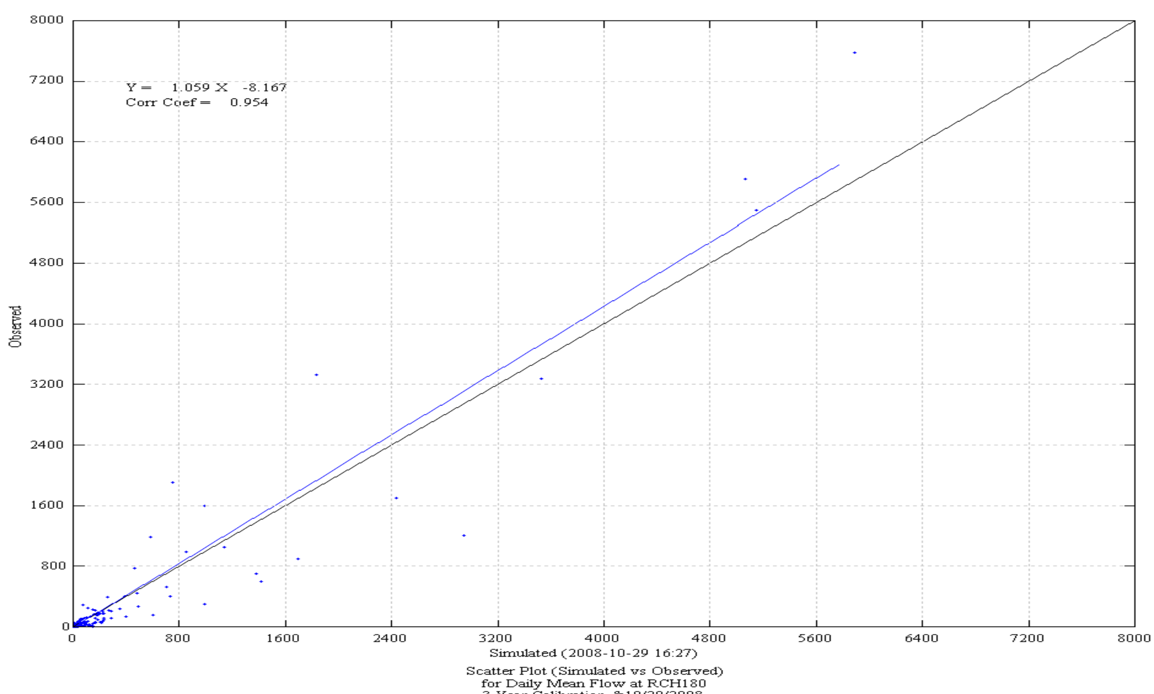

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at HWY99

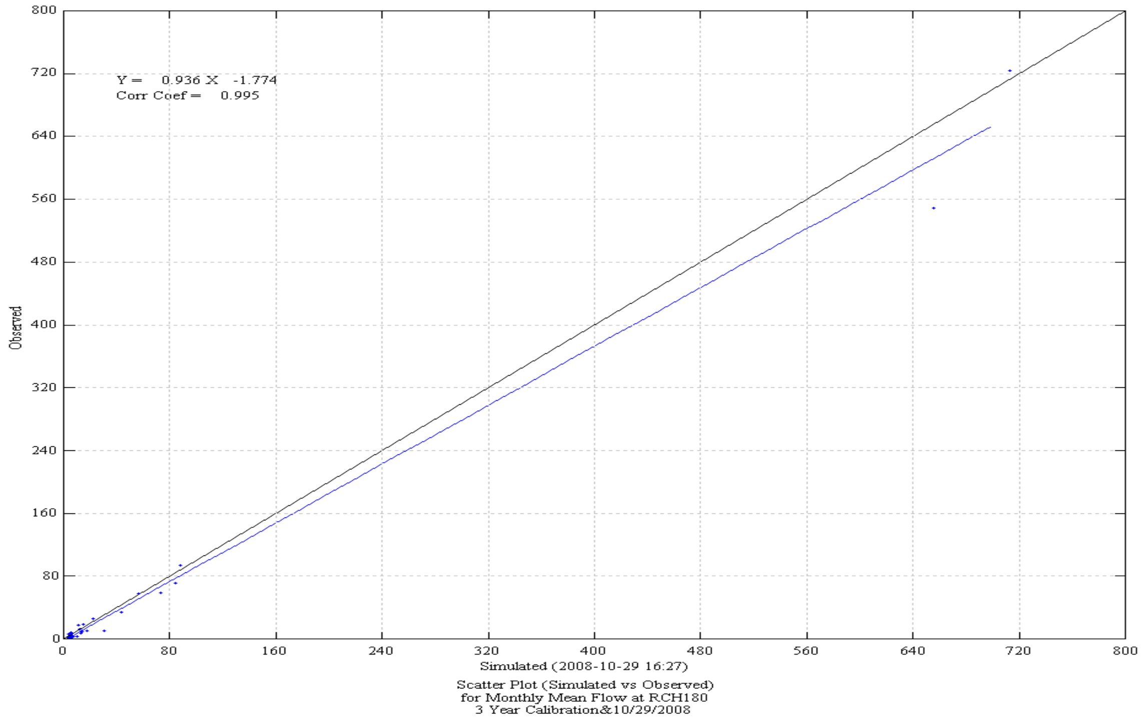

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at HWY99

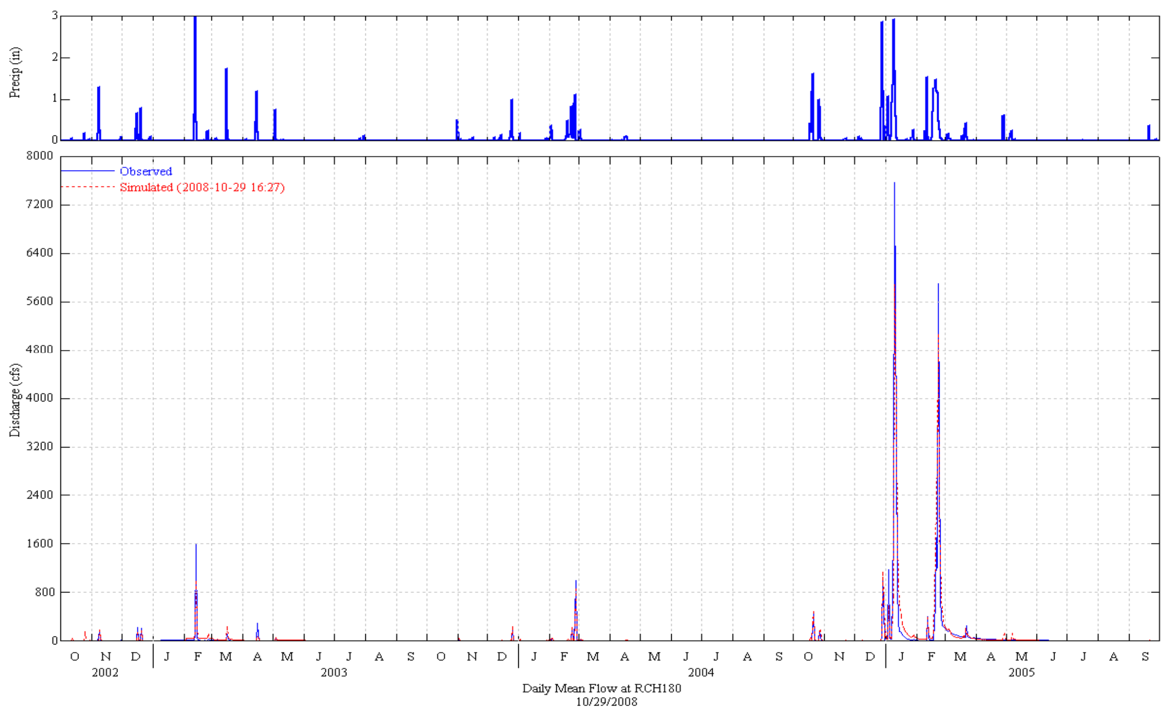

Figure 4 Simulated and Observed Daily Flow at HWY99 (WY 2003-2005)

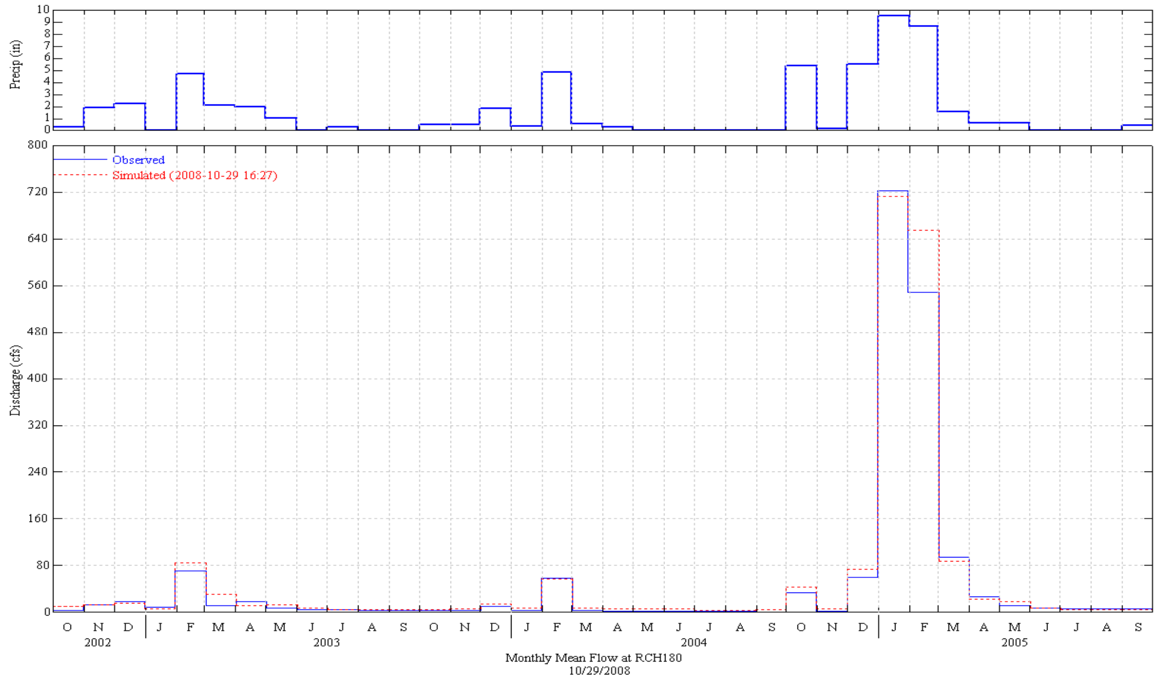

Figure 5 Simulated and Observed Monthly Flow at HWY99 (WY 2003-2005)

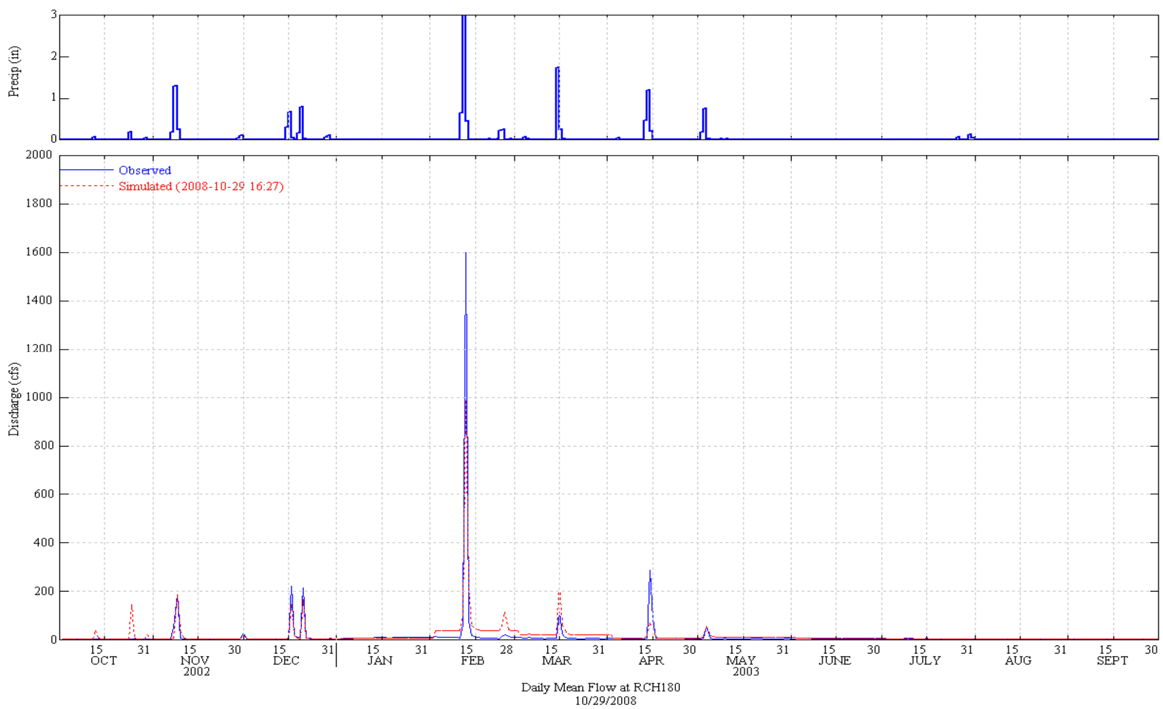

Figure 6 Simulated and Observed Daily Flow at HWY99 (WY 2003)

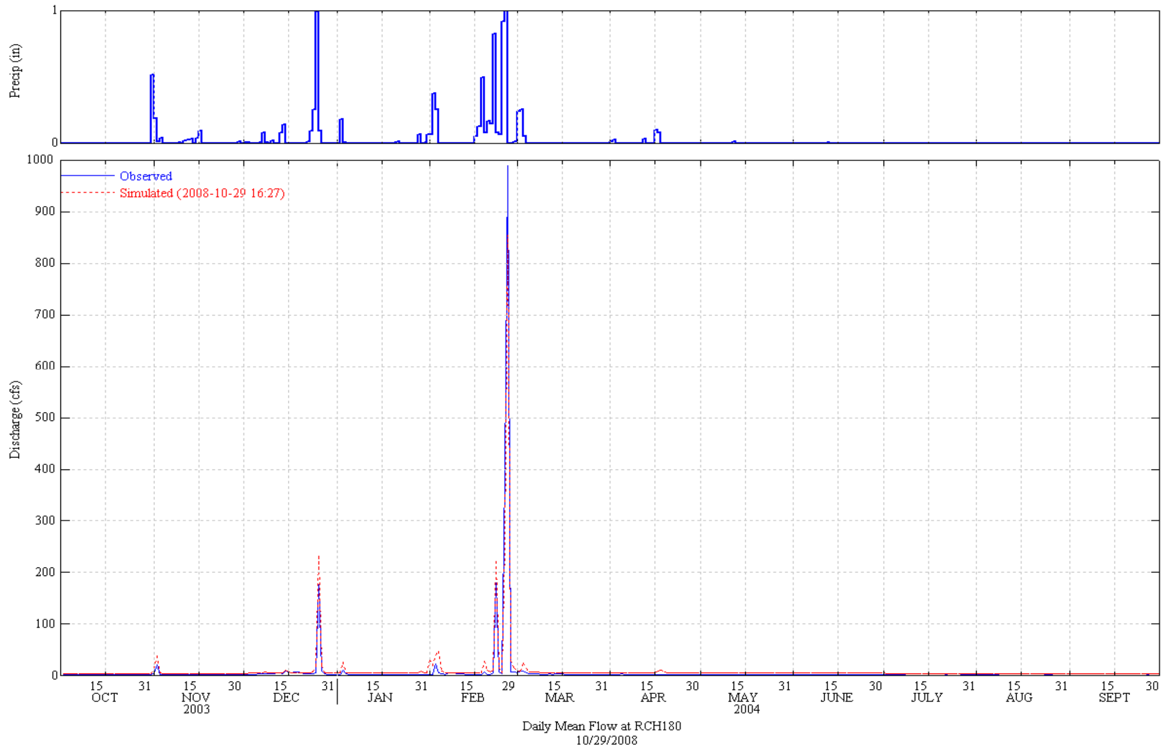

Figure 7 Simulated and Observed Daily Flow at HWY99 (WY 2004)

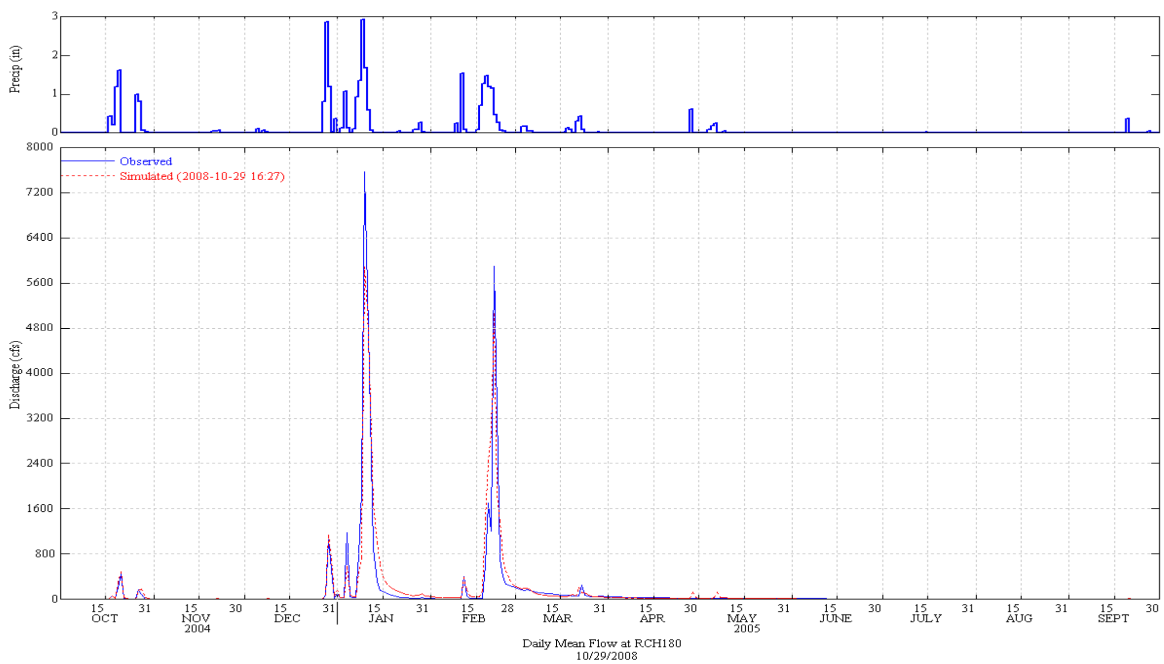

Figure 8 Simulated and Observed Daily Flow at HWY99 (WY 2005)

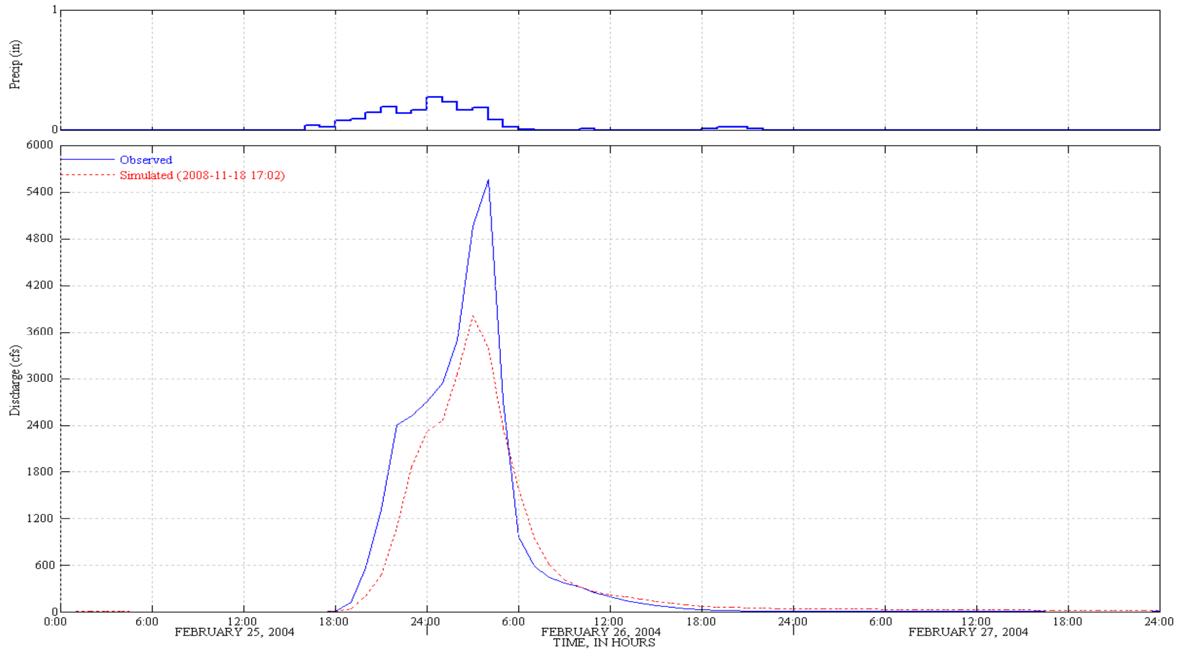

Figure 9 Simulated and Observed February 25-27, 2004 Storm Event

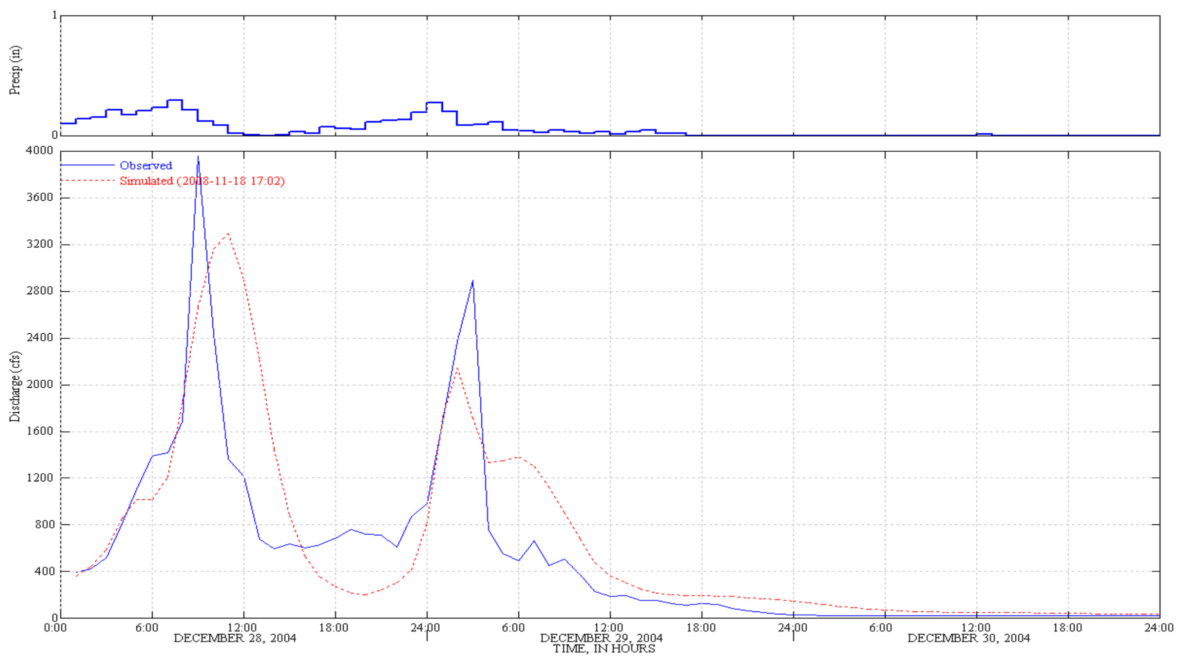

Figure 10 Simulated and Observed December 28-30, 2004 Storm Event

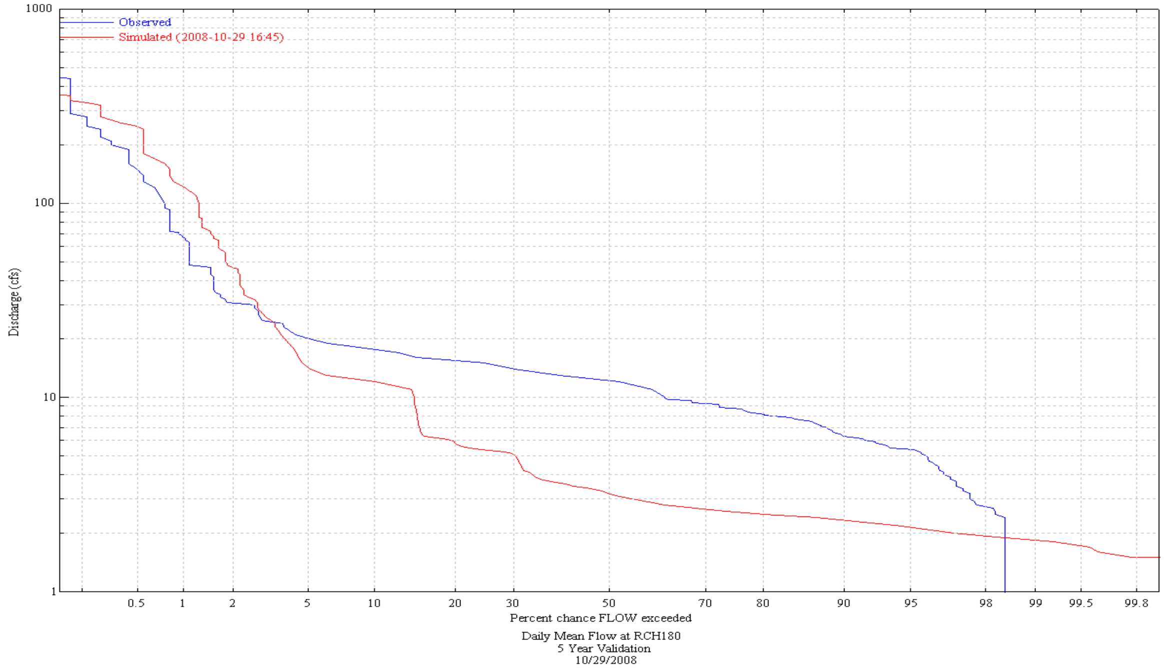

Figure 11 Simulated and Observed Daily Flow Duration Curve at HWY99

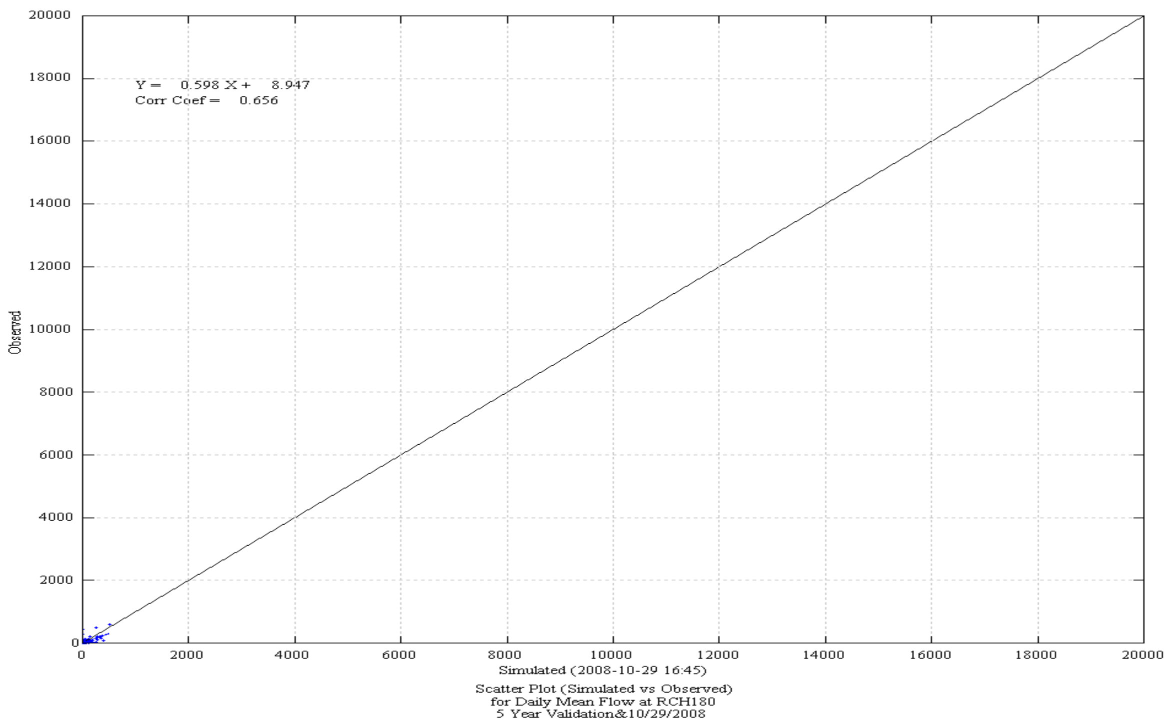

Figure 12 Daily Scatter Plot of Simulated versus Observed Flow at HWY99

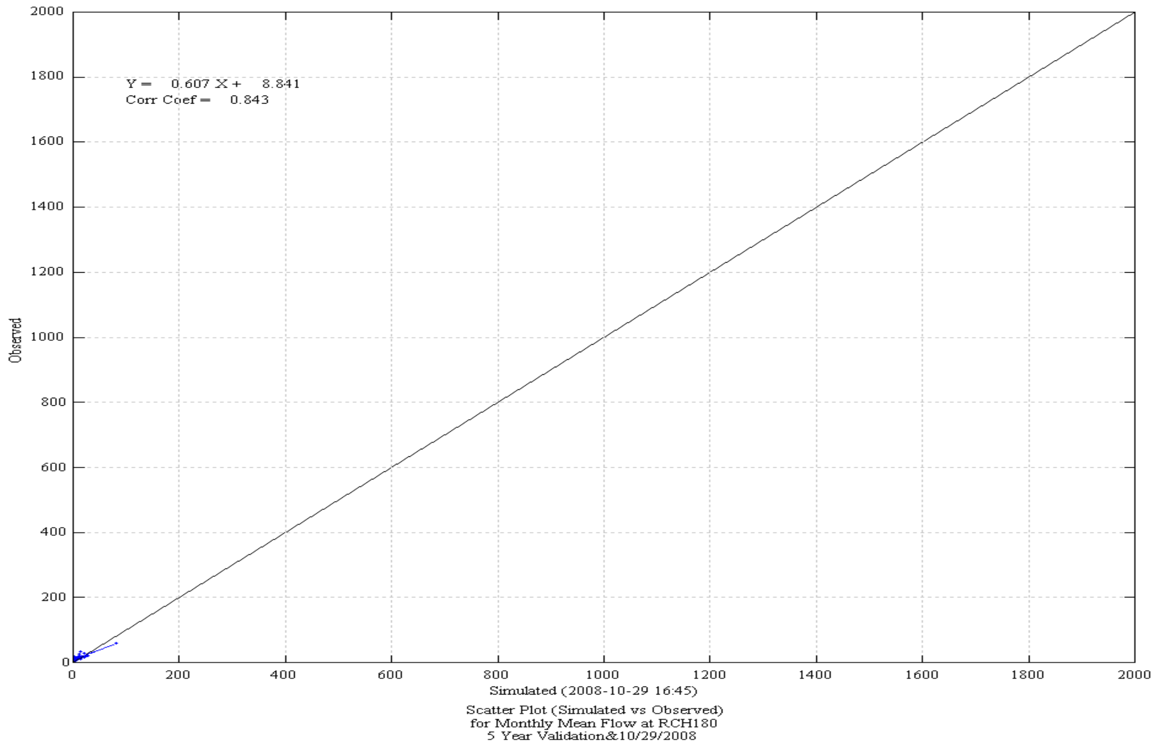

Figure 13 Monthly Scatter Plot of Simulated versus Observed Flow at HWY99

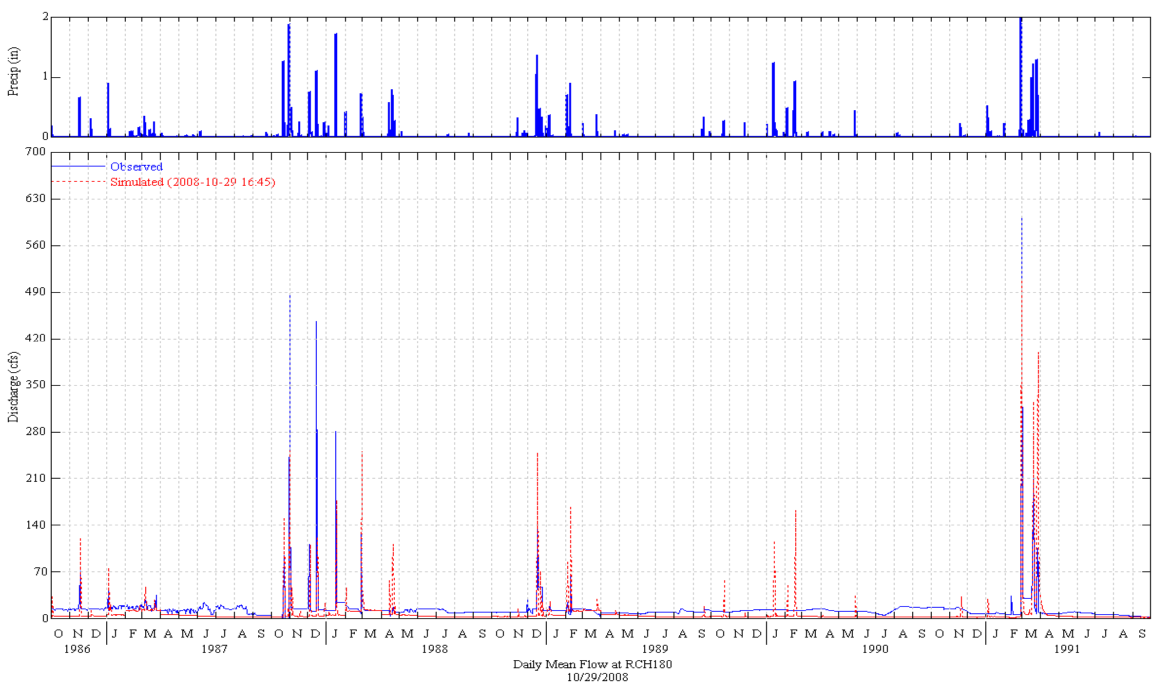

Figure 14 Simulated and Observed Daily Flow at HWY99 (WY 1987-1991)

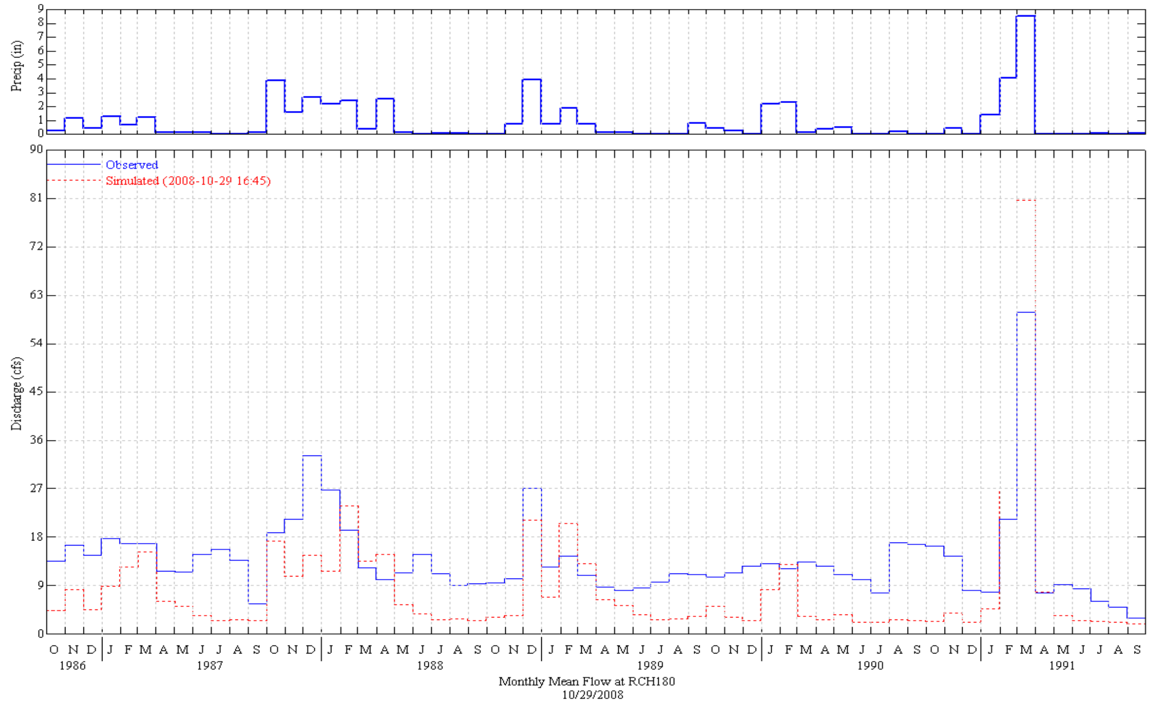

Figure 15 Simulated and Observed Monthly Flow at HWY99 (WY 1987-1991)

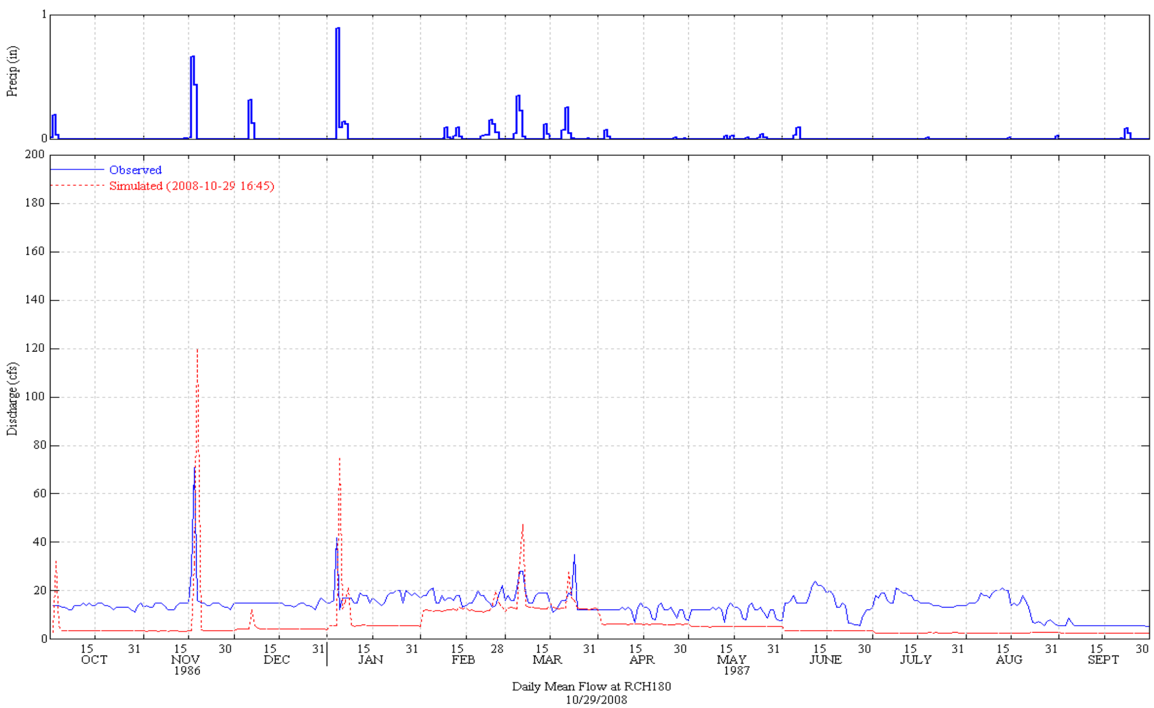

Figure 16 Simulated and Observed Daily Flow at HWY99 (WY 1987)

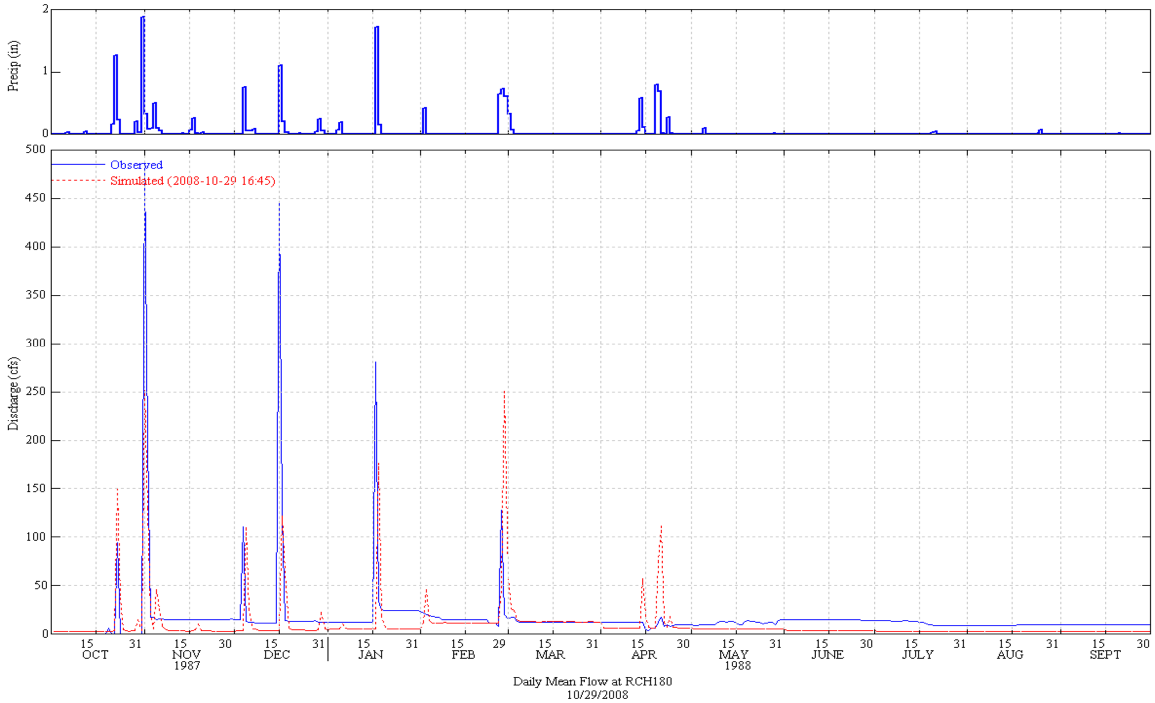

Figure 17 Simulated and Observed Daily Flow at HWY99 (WY 1988)

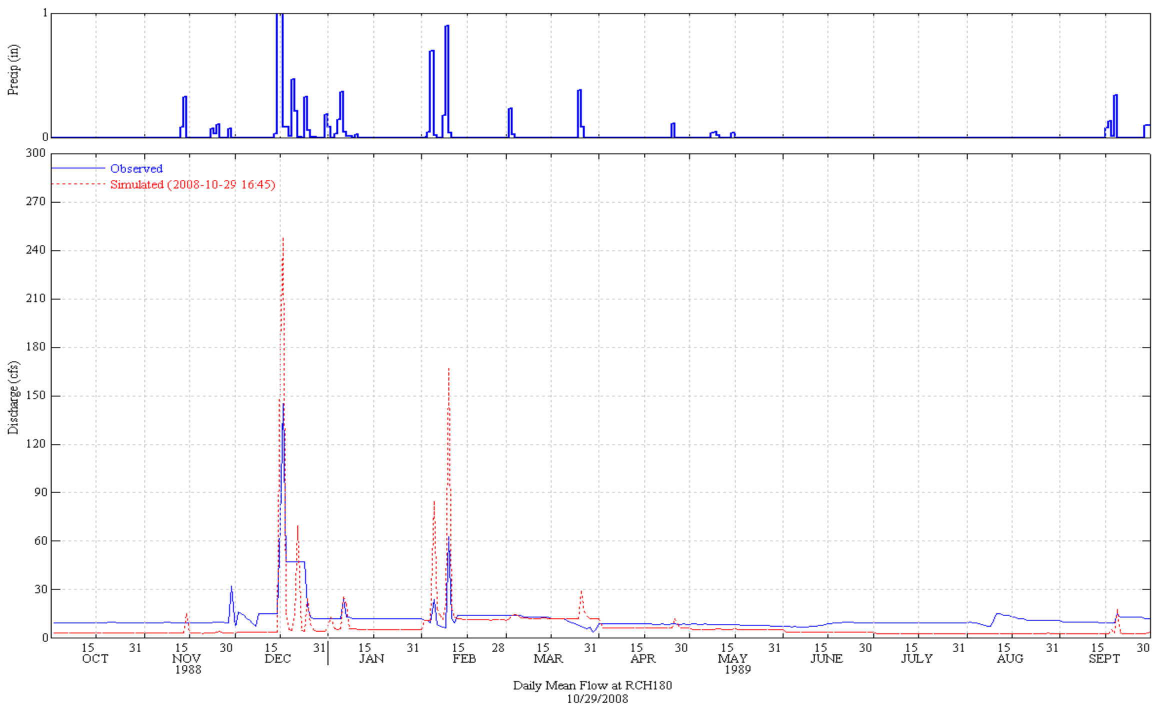

Figure 18 Simulated and Observed Daily Flow at HWY99 (WY 1989)

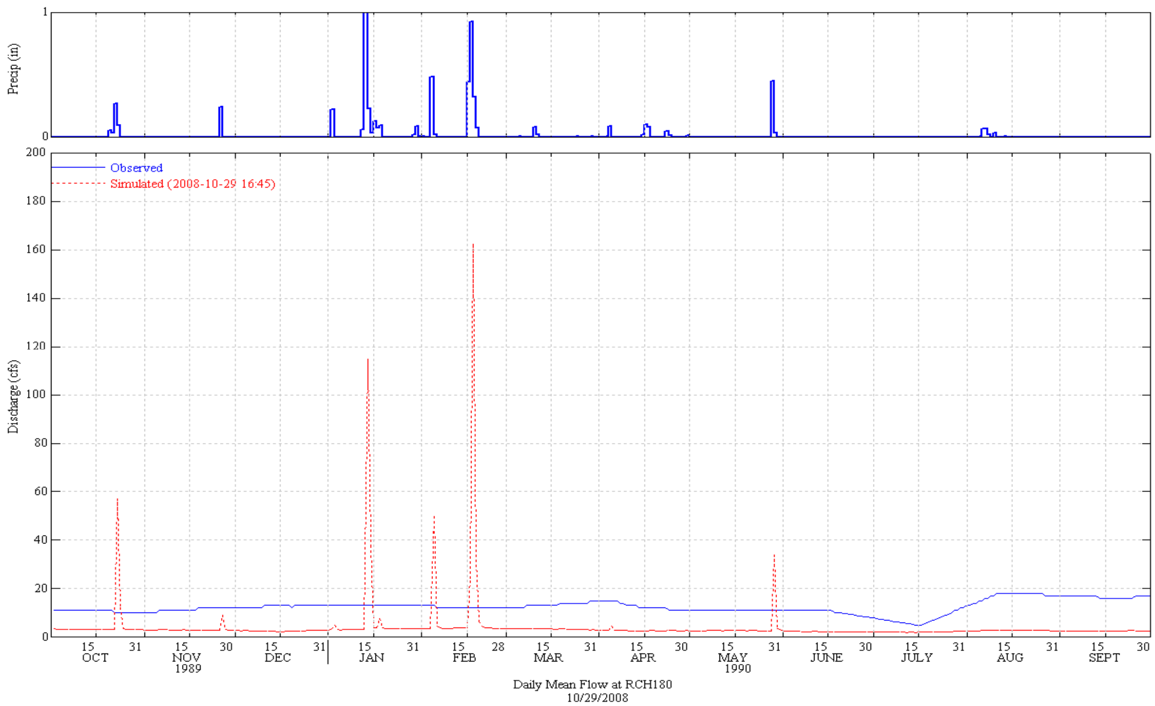

Figure 19 Simulated and Observed Daily Flow at HWY99 (WY 1990)

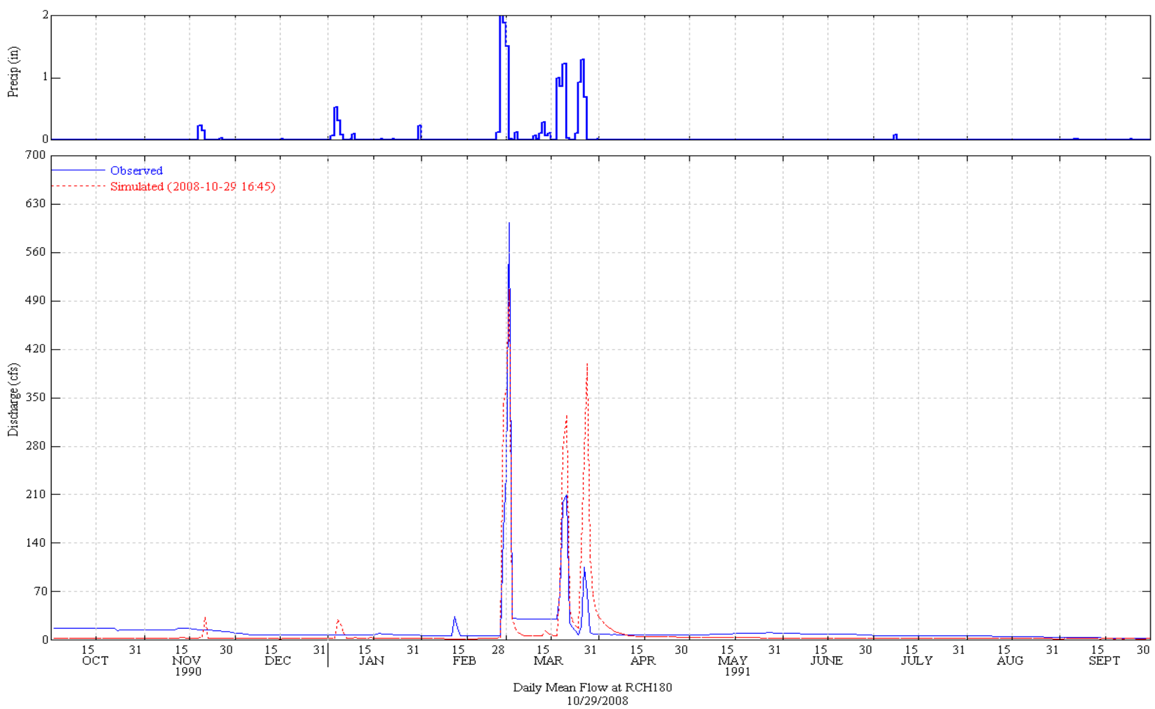

Figure 20 Simulated and Observed Daily Flow at HWY99 (WY 1991)

APPENDIX I

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SANTA CLARA RIVER WATERSHED AT COUNTY LINE

Title Page

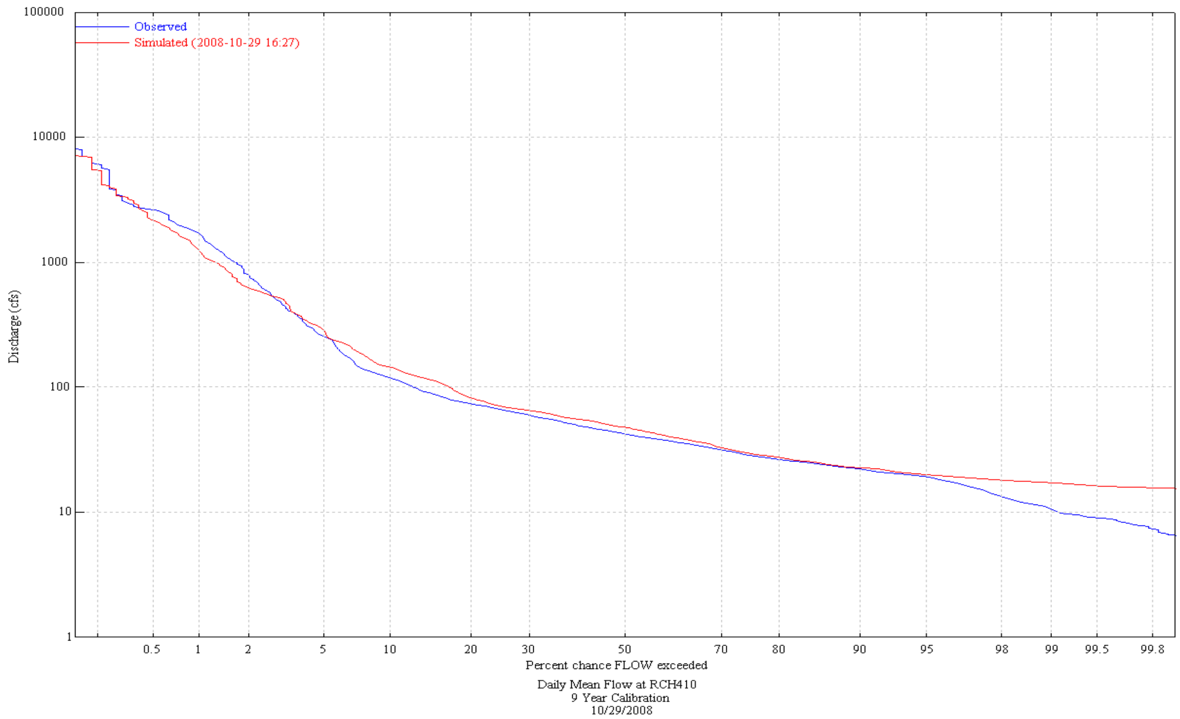

Figure 1 Simulated and Observed Daily Flow Duration Curve at Co. Line

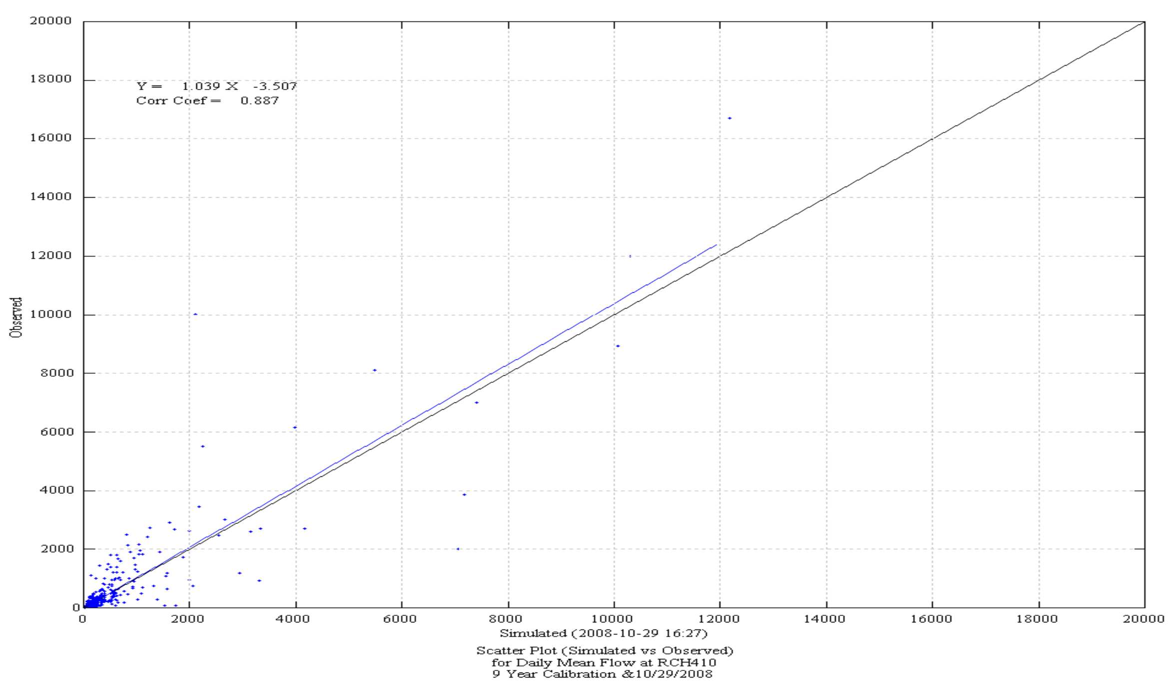

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Co. Line

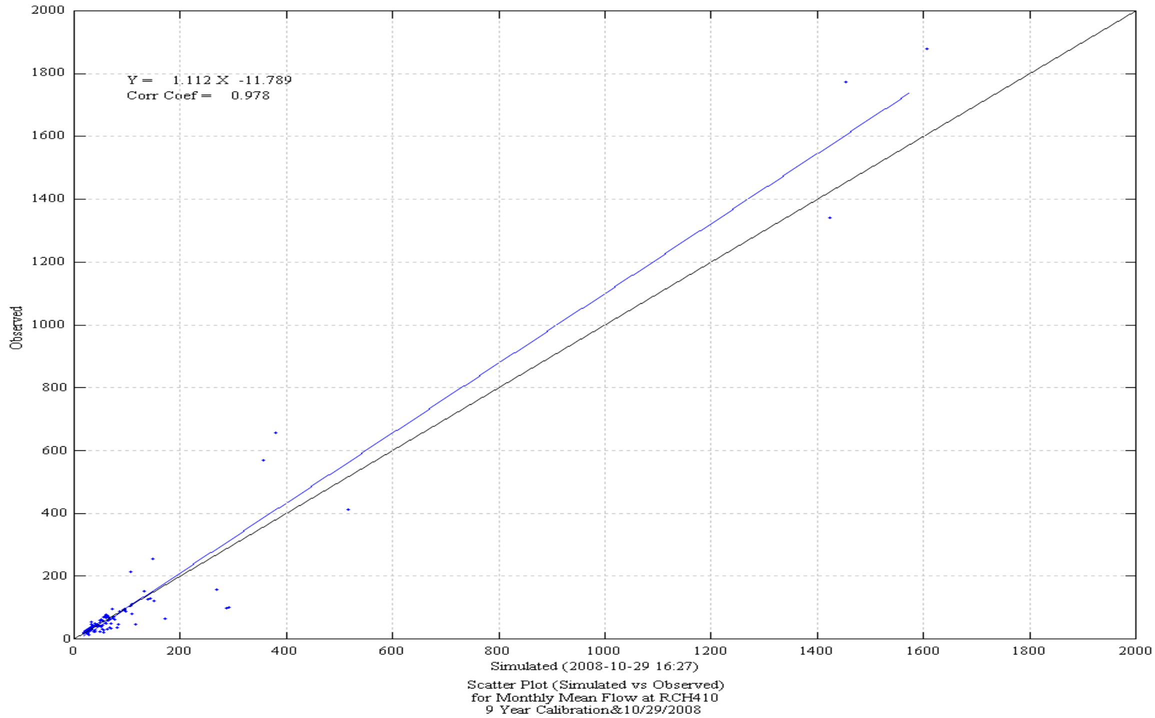

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Co. Line

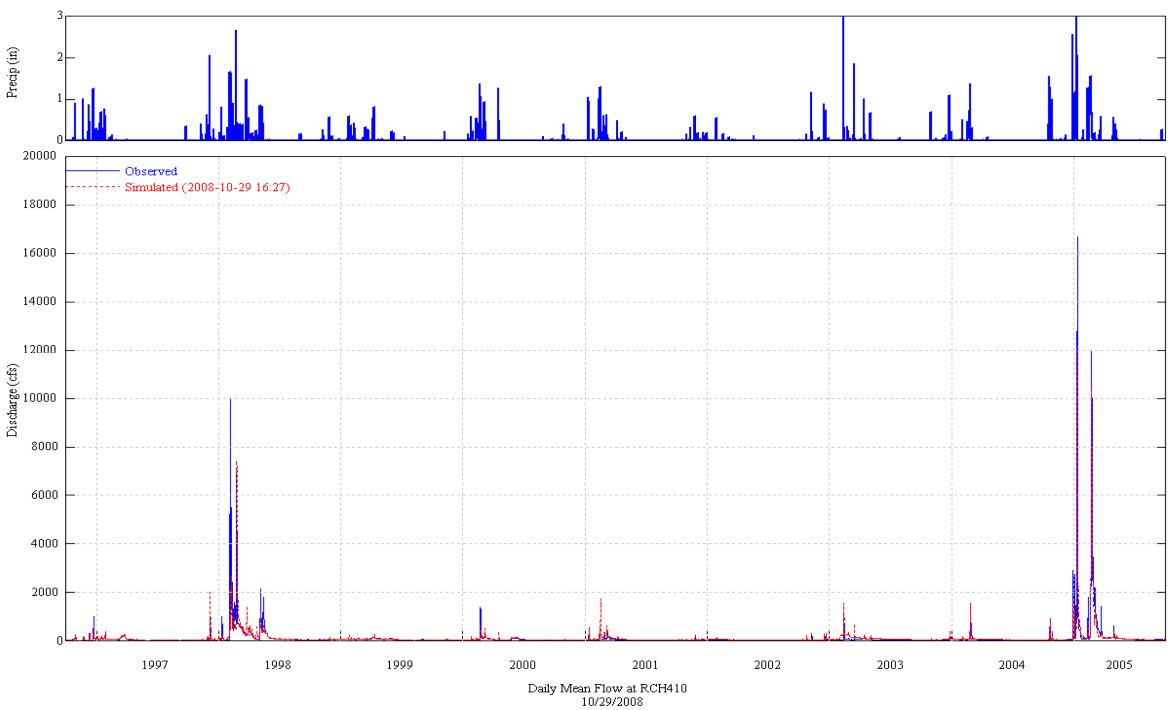

Figure 4 Simulated and Observed Daily Flow at Co. Line (WY 1997-2005)

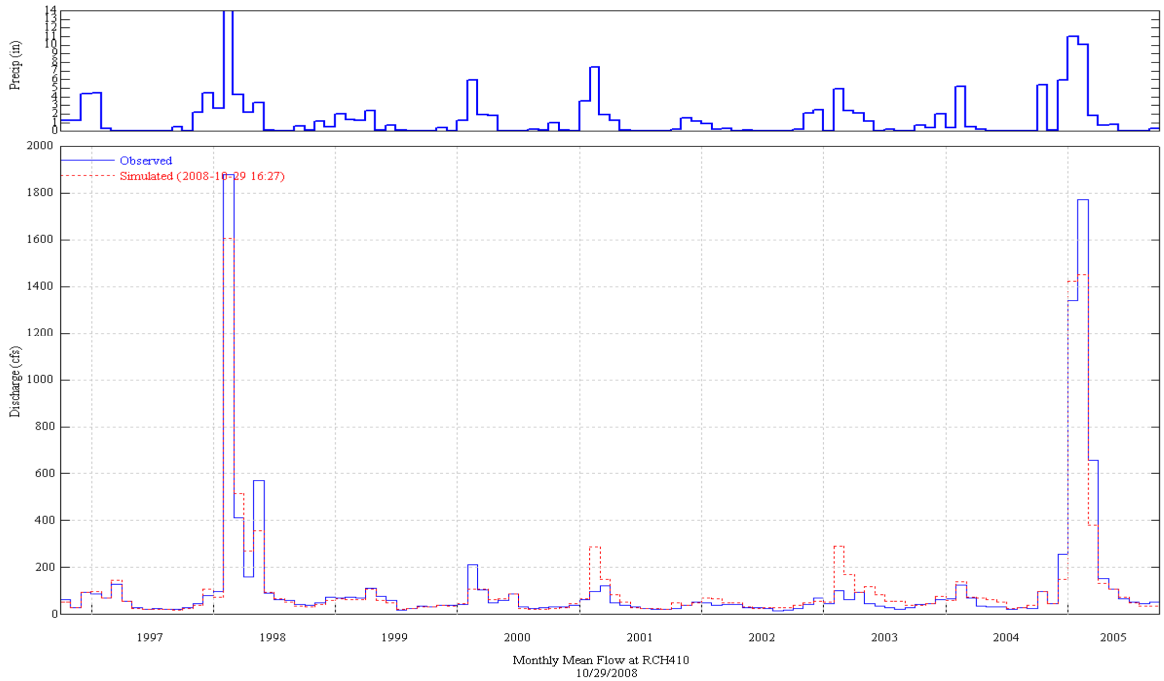

Figure 5 Simulated and Observed Monthly Flow at Co. Line (WY 1997-2005)

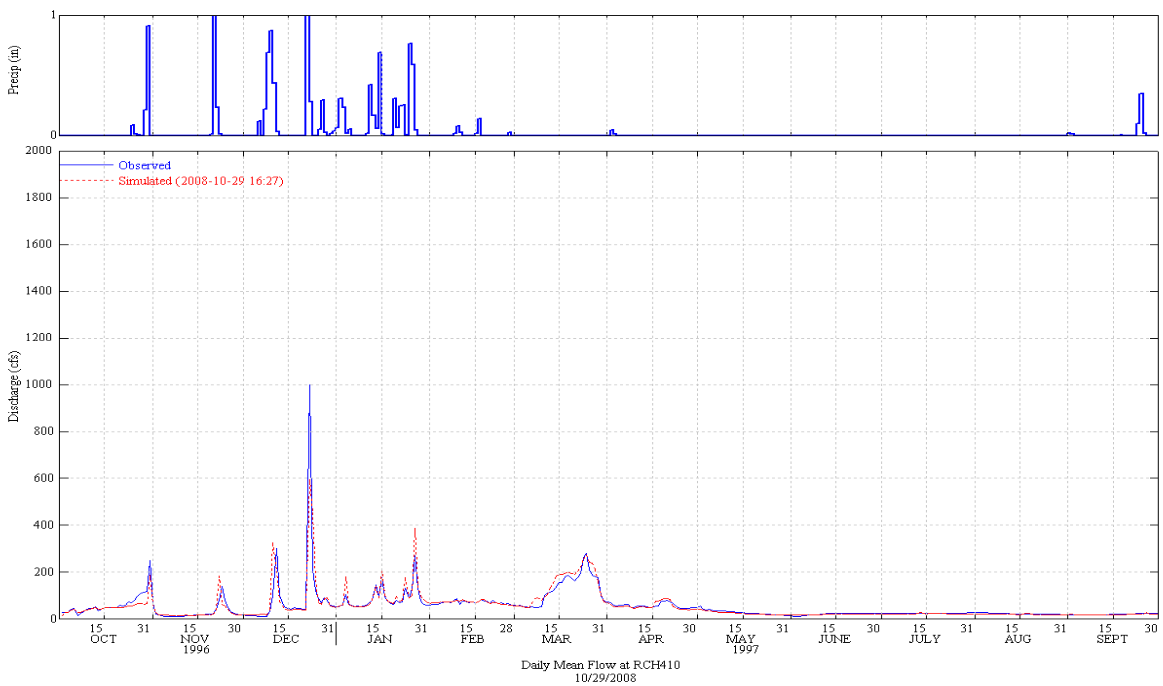

Figure 6 Simulated and Observed Daily Flow at Co. Line (WY 1997)

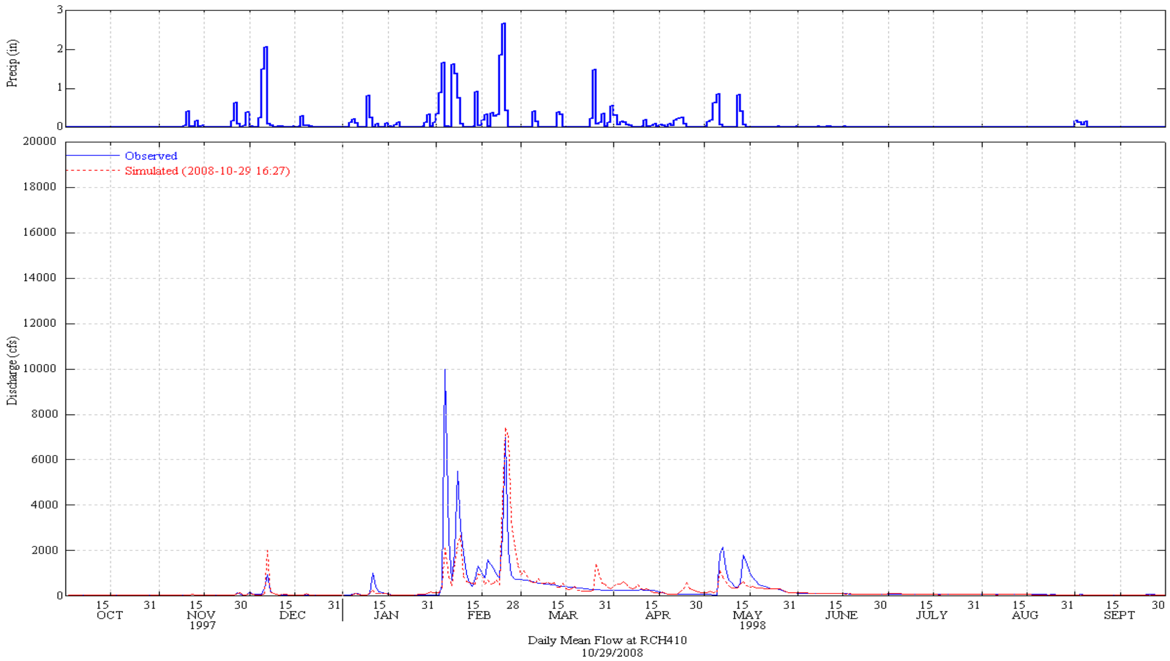

Figure 7 Simulated and Observed Daily Flow at Co. Line (WY 1998)

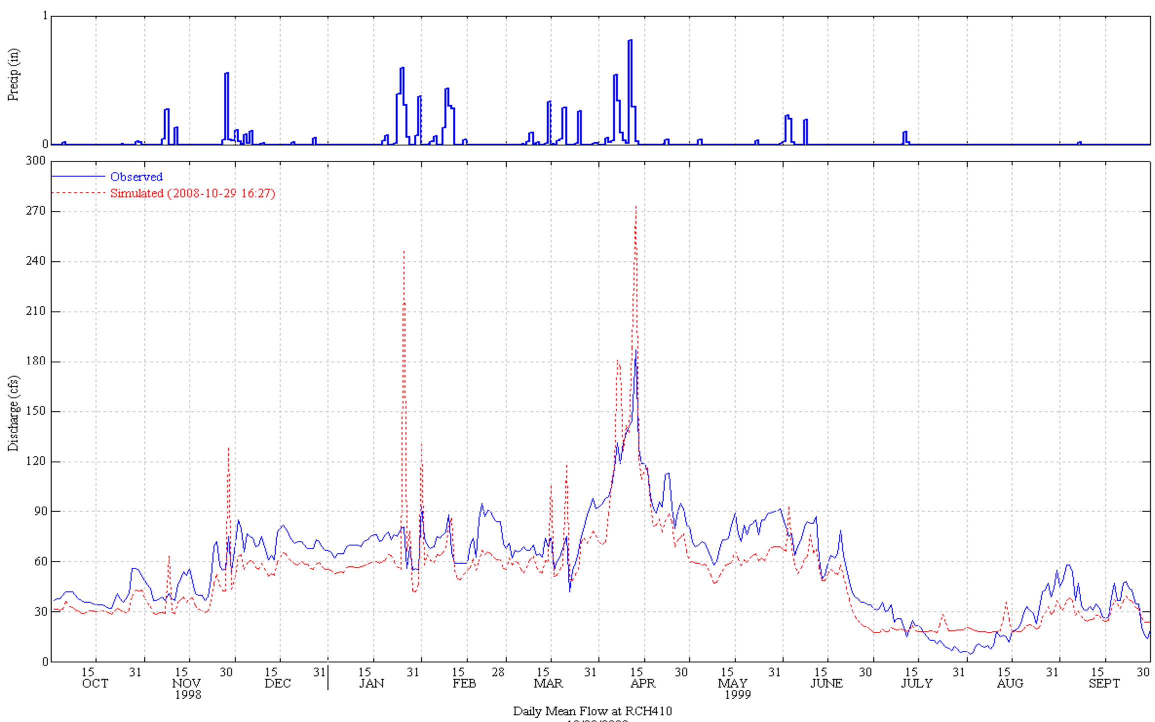

Figure 8 Simulated and Observed Daily Flow at Co. Line (WY 1999)

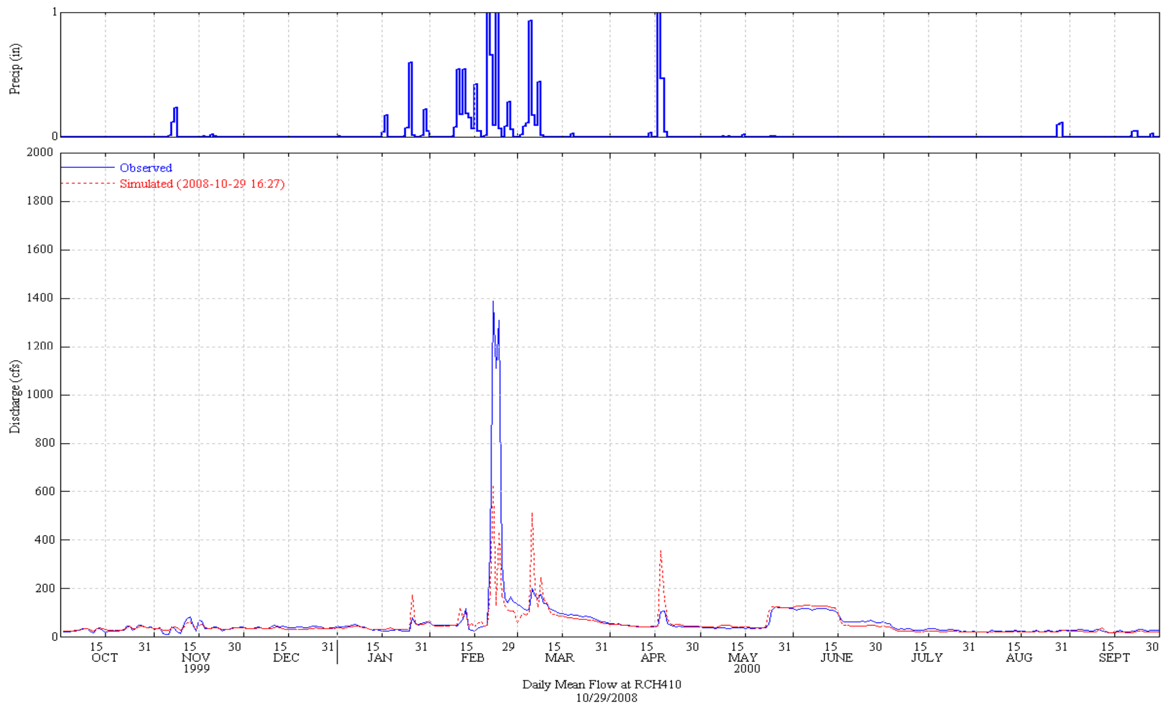

Figure 9 Simulated and Observed Daily Flow at Co. Line (WY 2000)

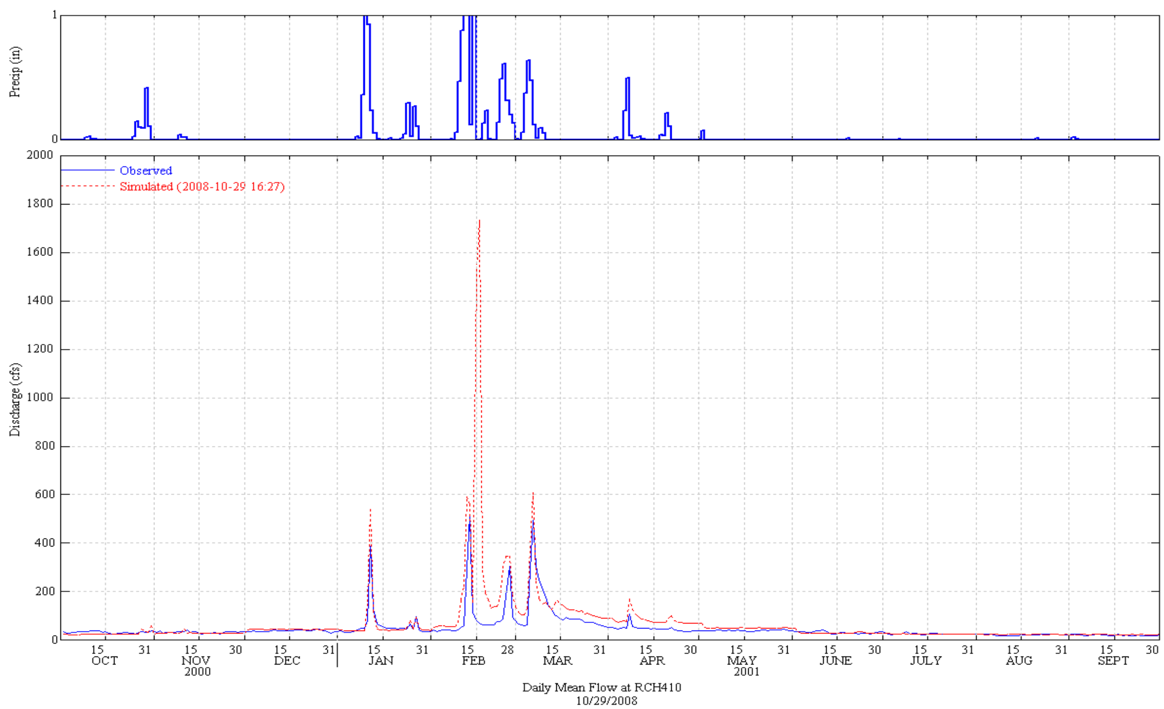

Figure 10 Simulated and Observed Daily Flow at Co. Line (WY 2001)

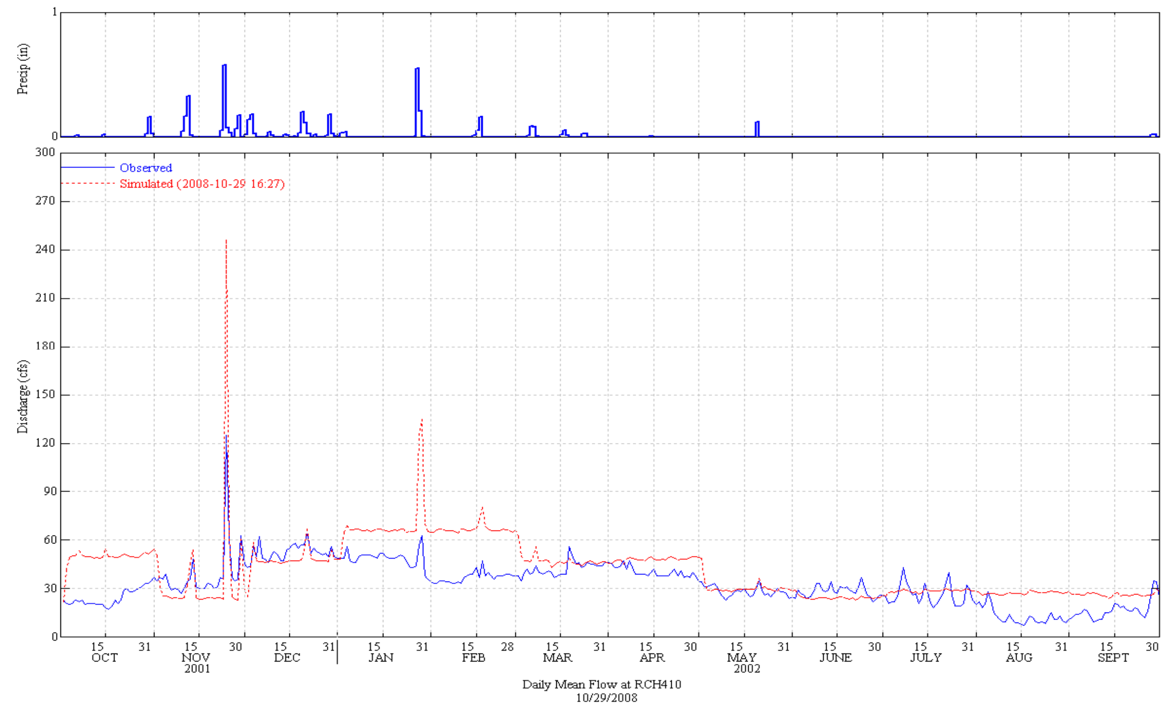

Figure 11 Simulated and Observed Daily Flow at Co. Line (WY 2002)

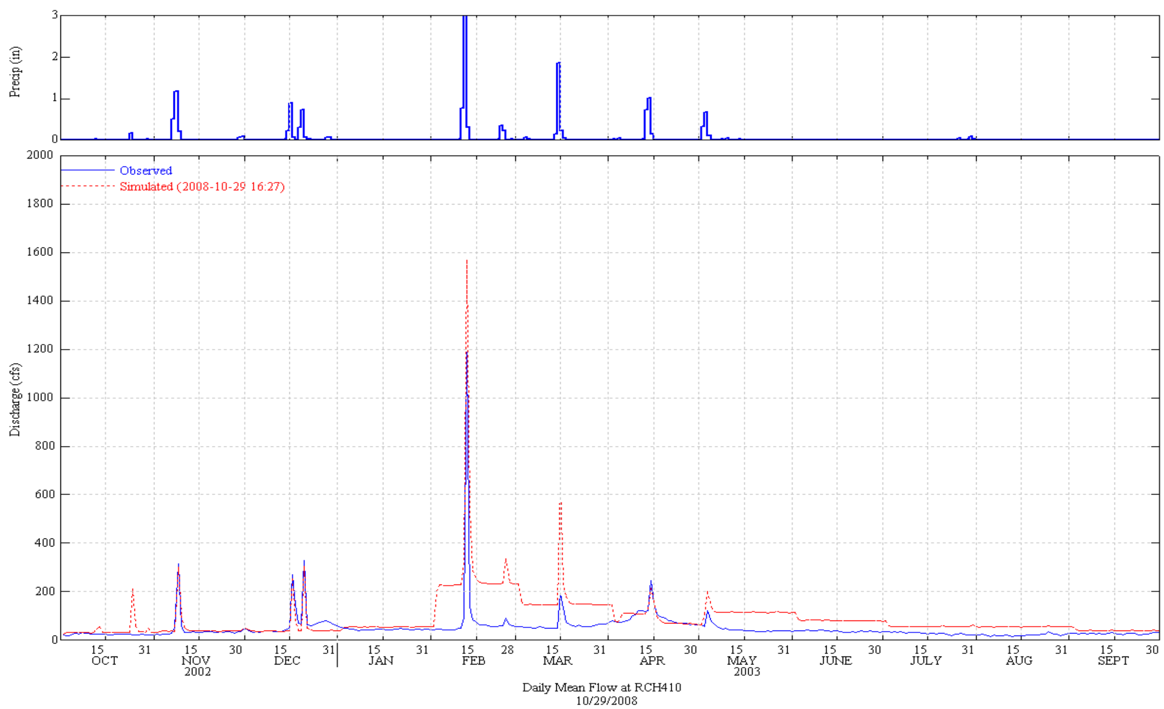

Figure 12 Simulated and Observed Daily Flow at Co. Line (WY 2003)

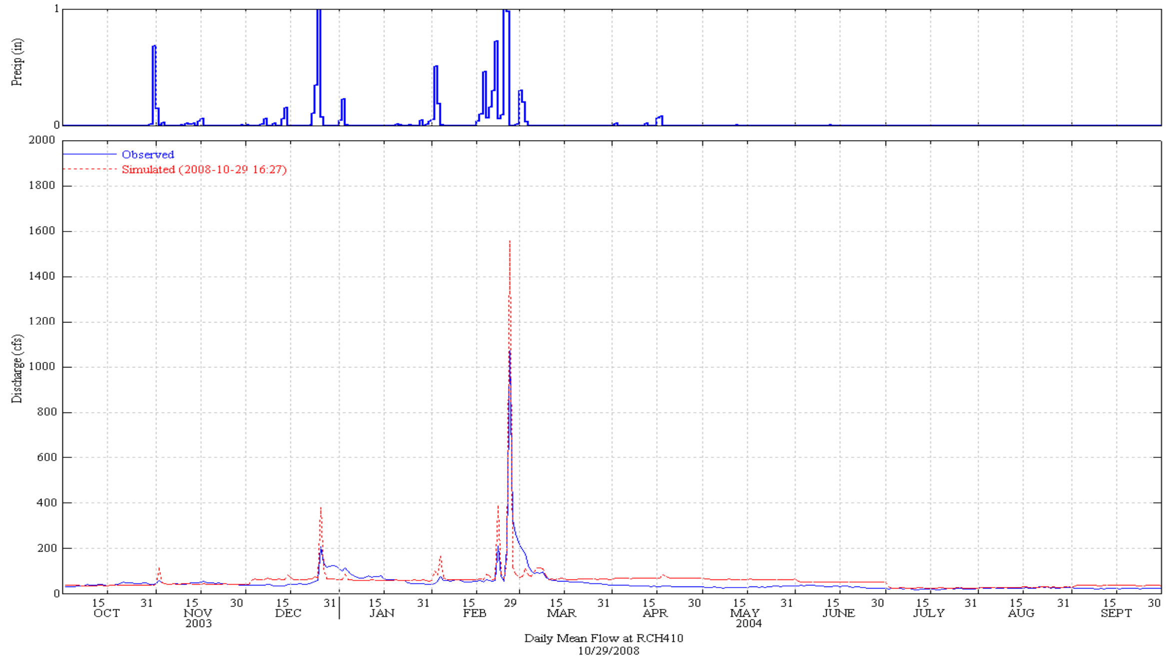

Figure 13 Simulated and Observed Daily Flow at Co. Line (WY 2004)

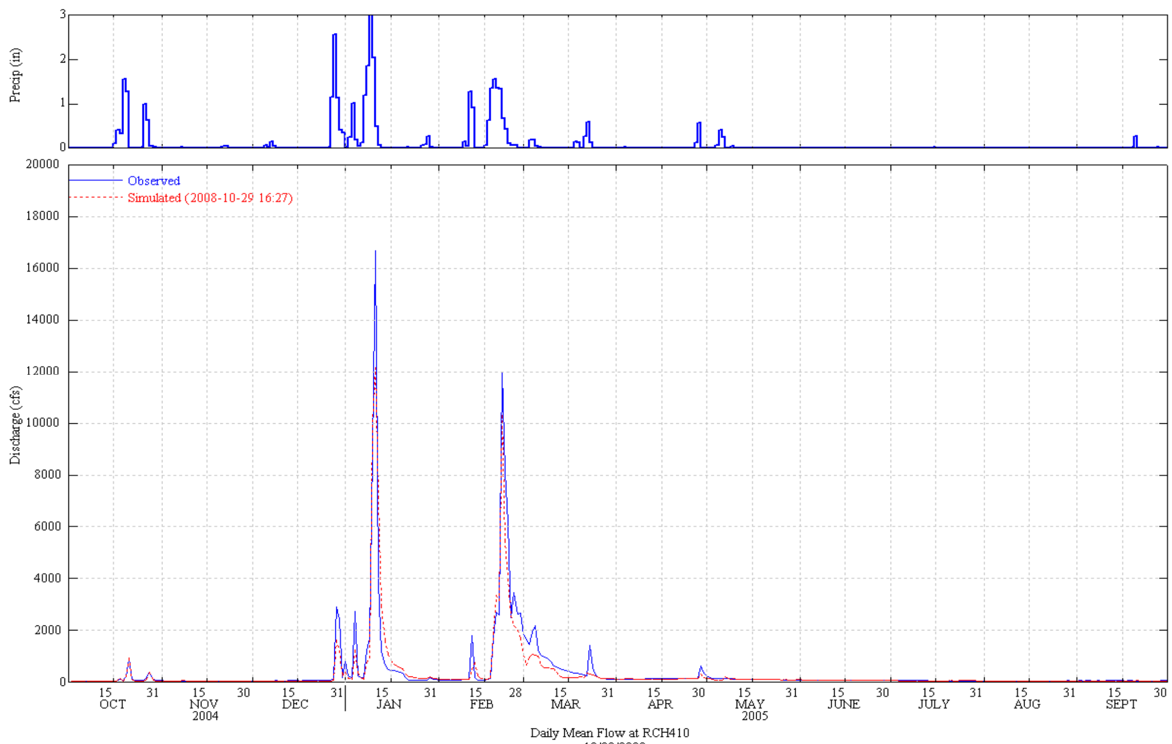

Figure 14 Simulated and Observed Daily Flow at Co. Line (WY 2005)

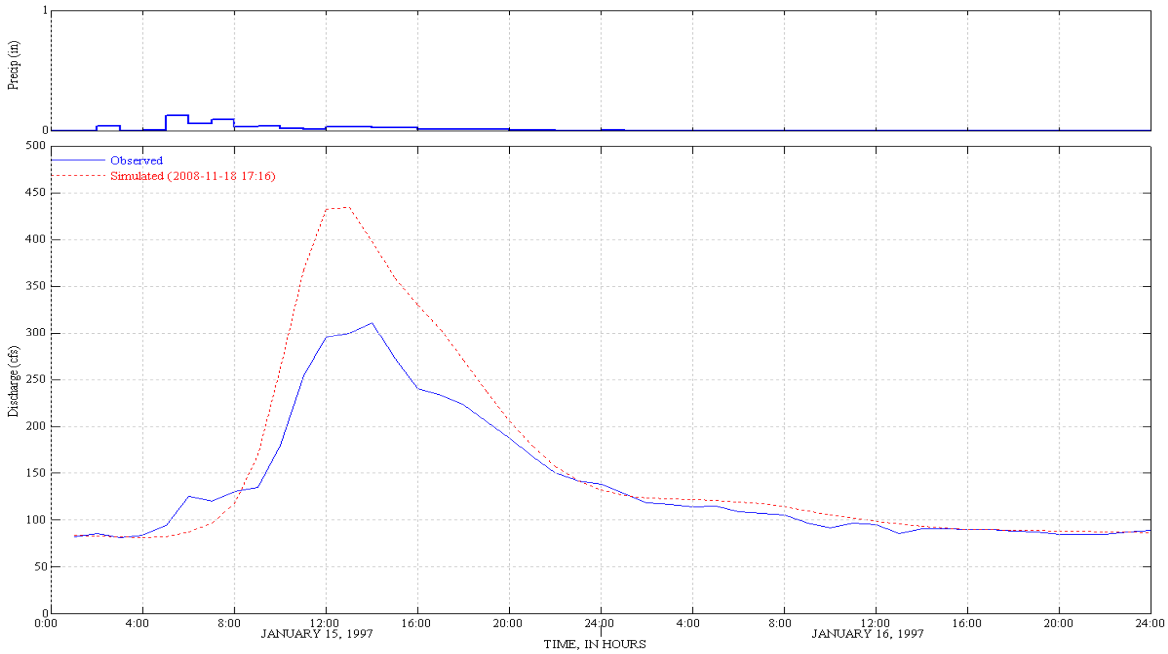

Figure 15 Simulated and Observed January 15, 1997 Storm Event

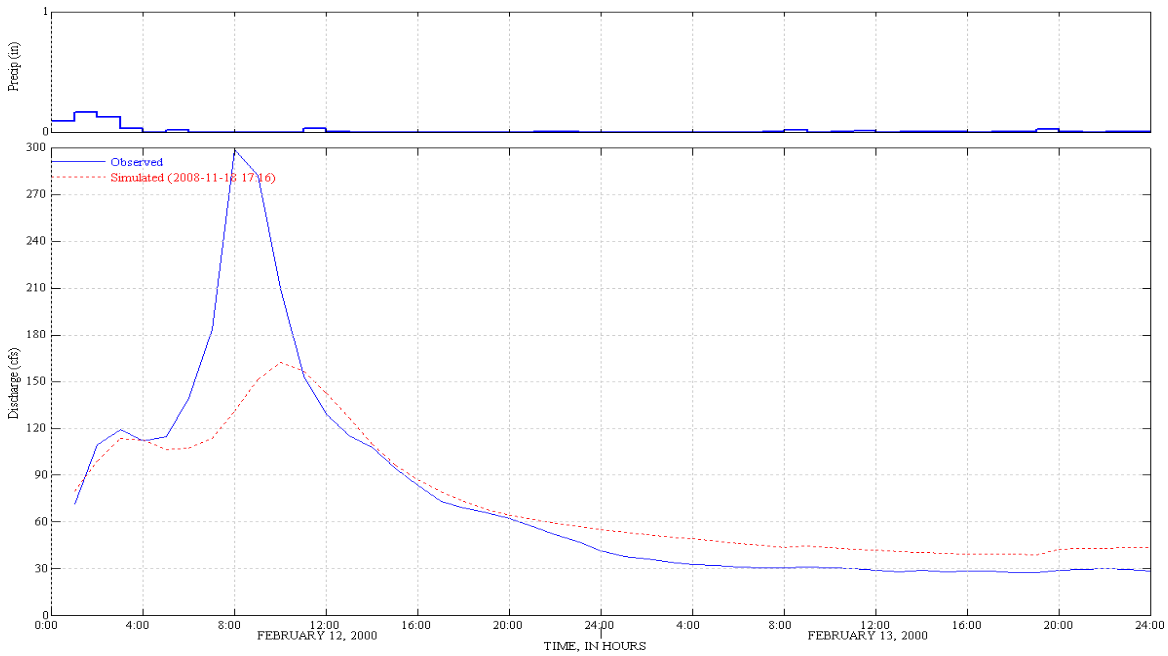

Figure 16 Simulated and Observed February 12, 2000 Storm Event

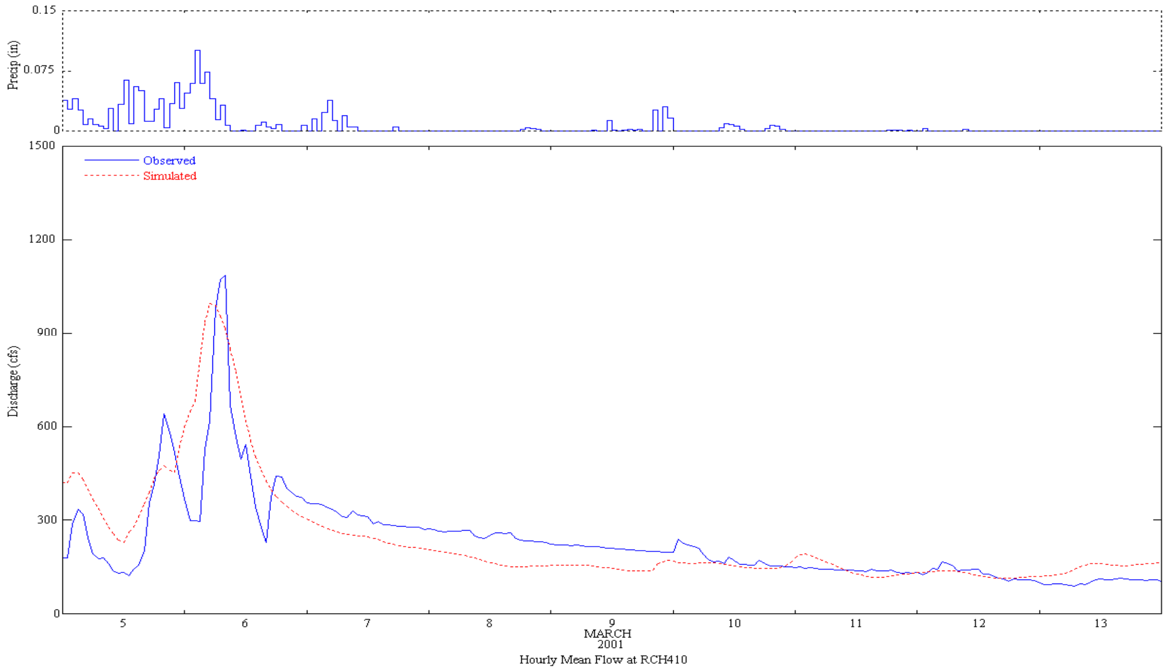

Figure 17 Simulated and Observed March 5, 2001 Storm Event

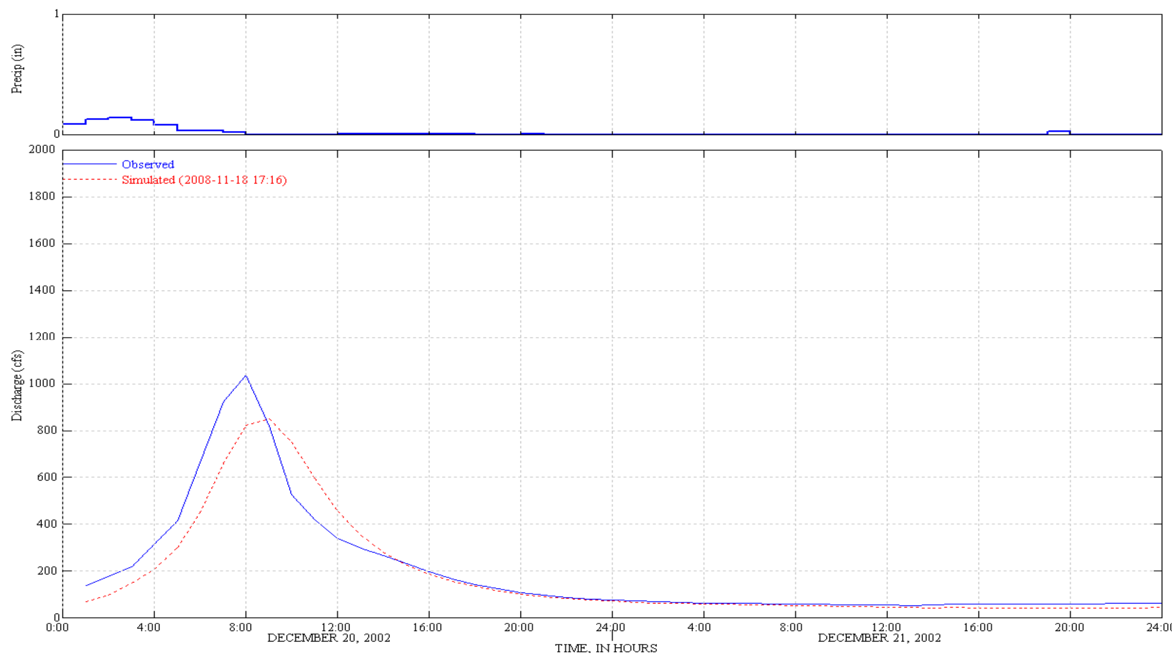

Figure 18 Simulated and Observed December 20, 2002 Storm Event

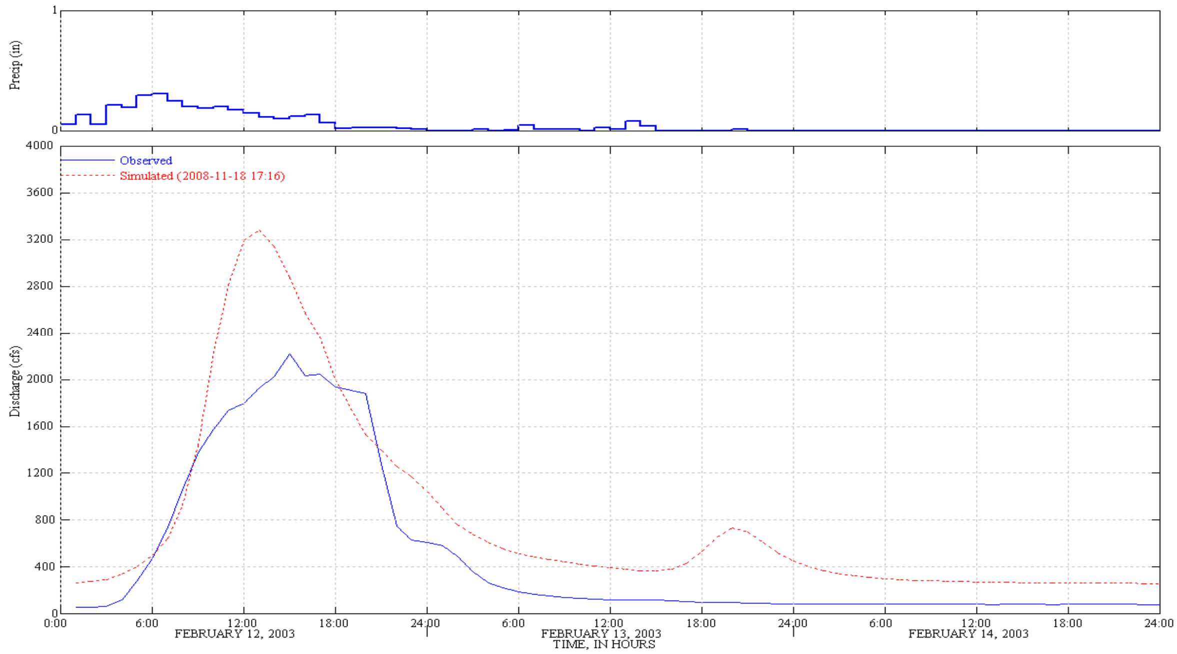

Figure 19 Simulated and Observed February 12, 2003 Storm Event

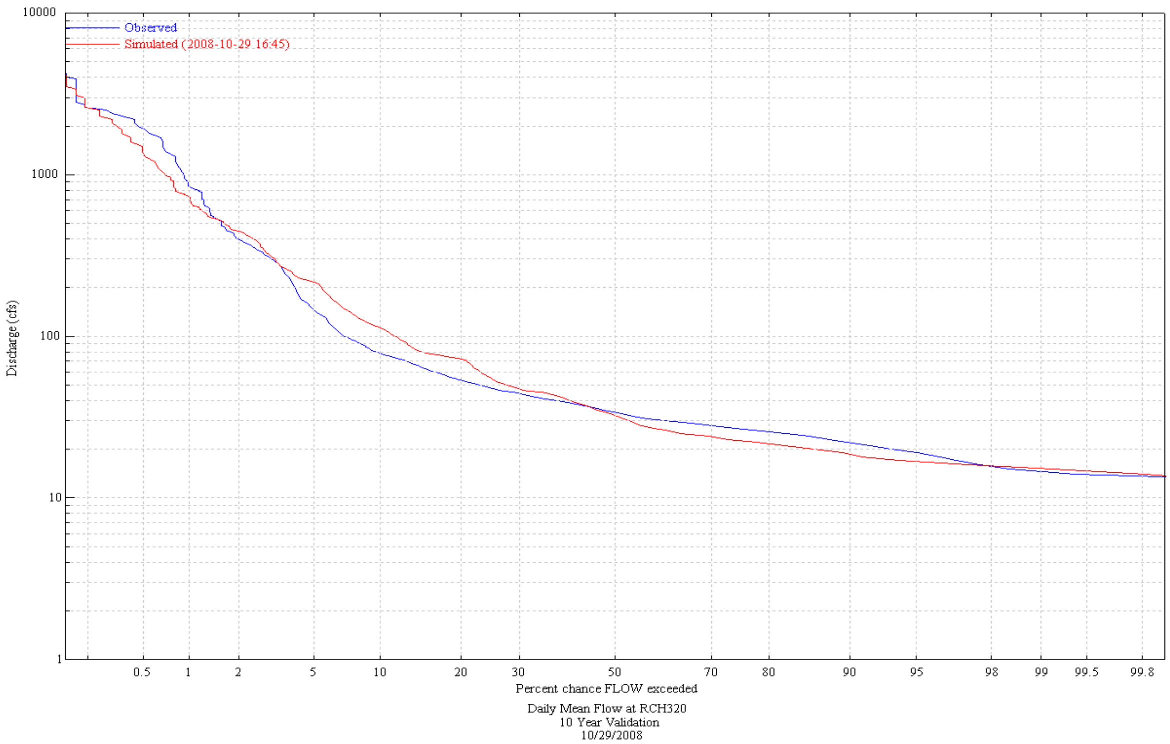

Figure 20 Simulated and Observed Daily Flow Duration Curve at Co. Line

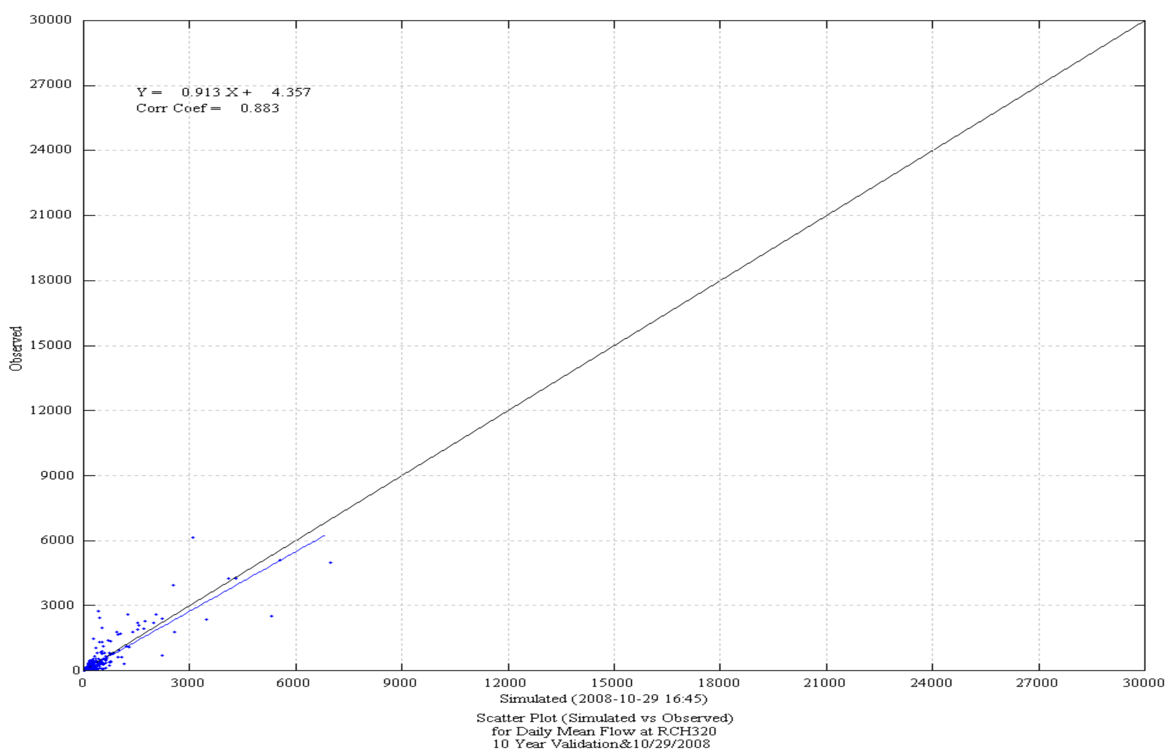

Figure 21 Daily Scatter Plot of Simulated versus Observed Flow at Co. Line

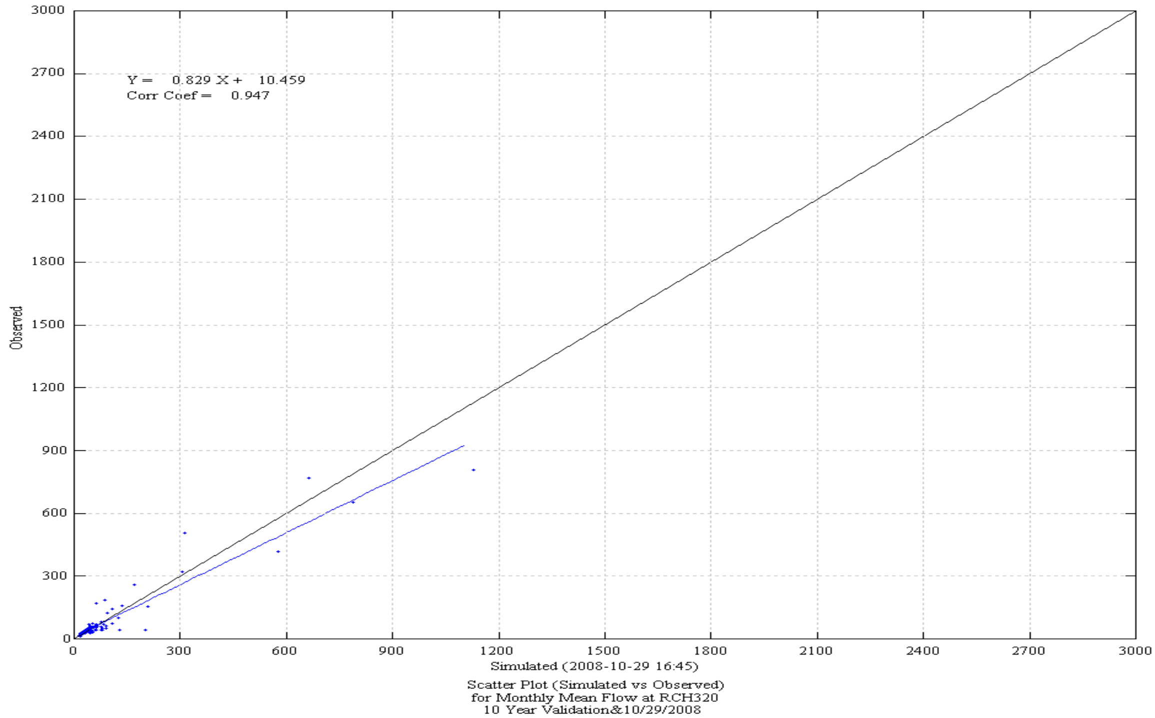

Figure 22 Monthly Scatter Plot of Simulated versus Observed Flow at Co. Line

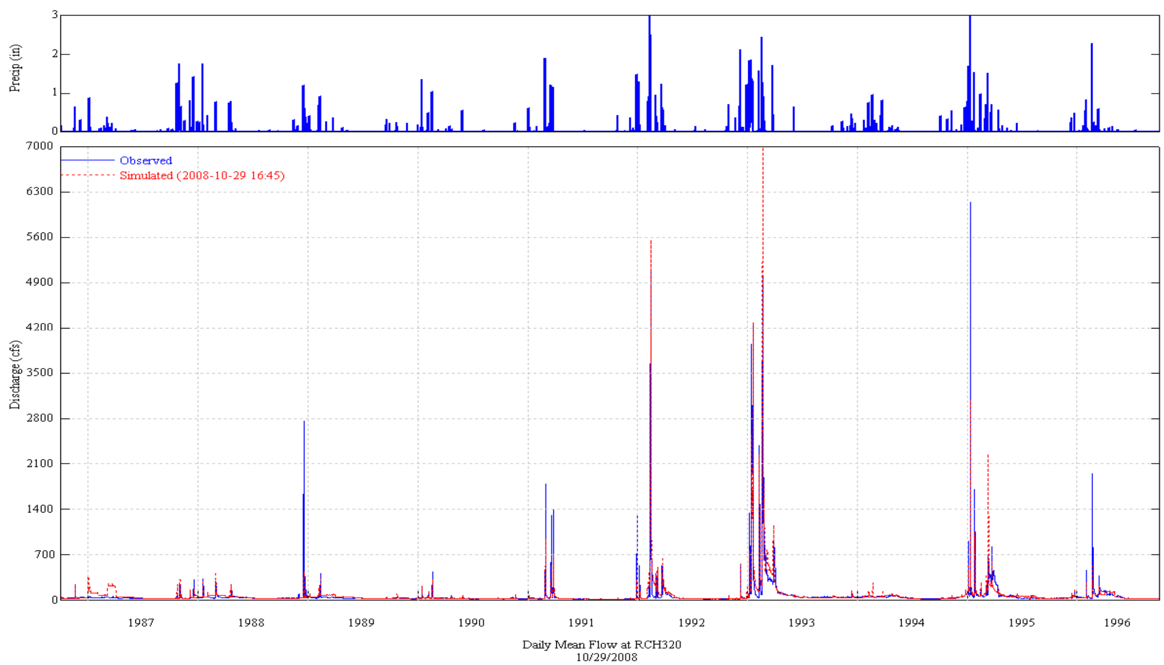

Figure 23 Simulated and Observed Daily Flow at Co. Line (WY 1987-1996)

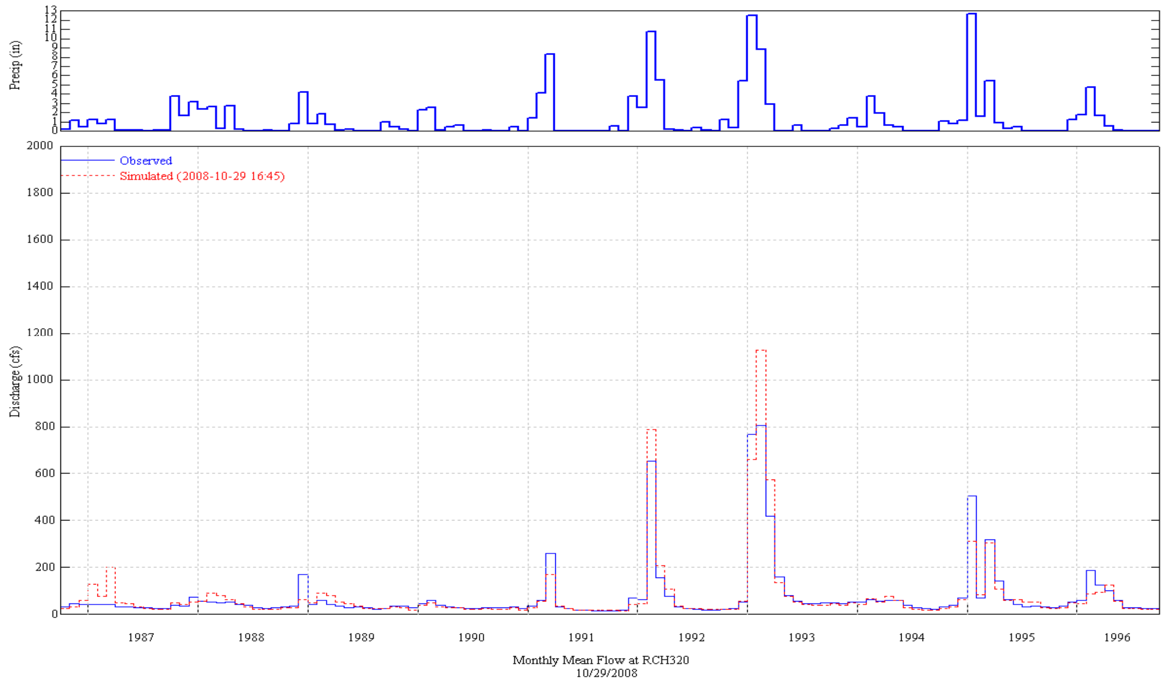

Figure 24 Simulated and Observed Monthly Flow at Co. Line (WY 1987-1996)

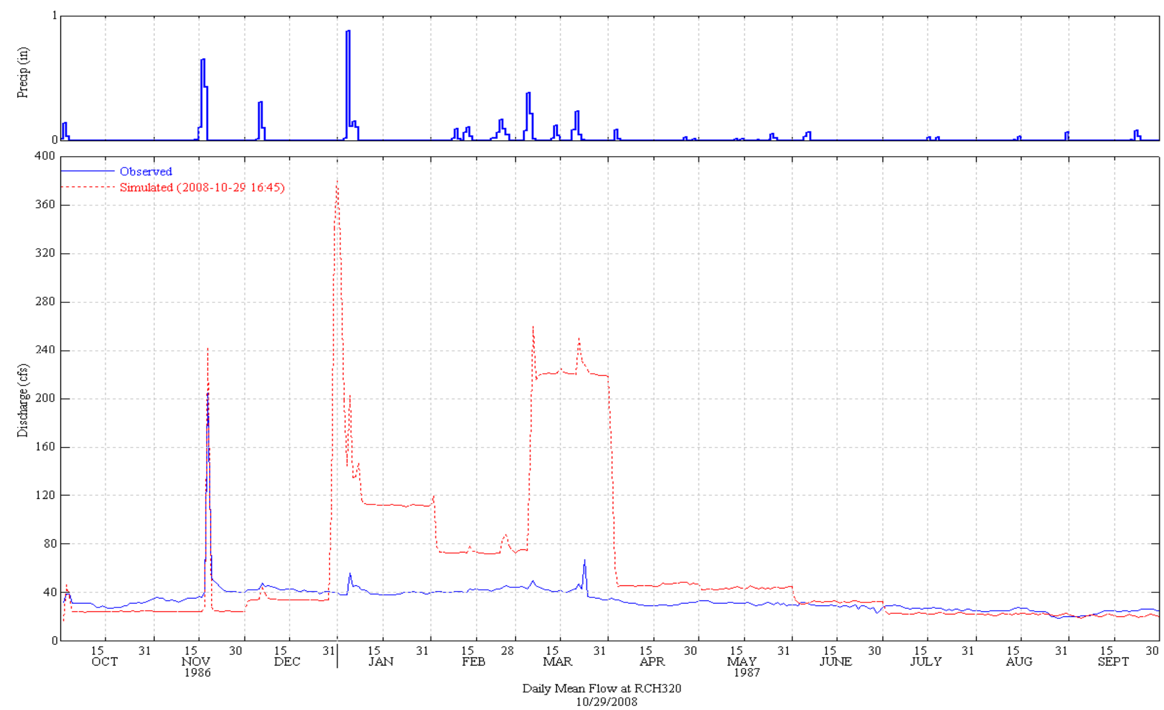

Figure 25 Simulated and Observed Daily Flow at Co. Line (WY 1987)

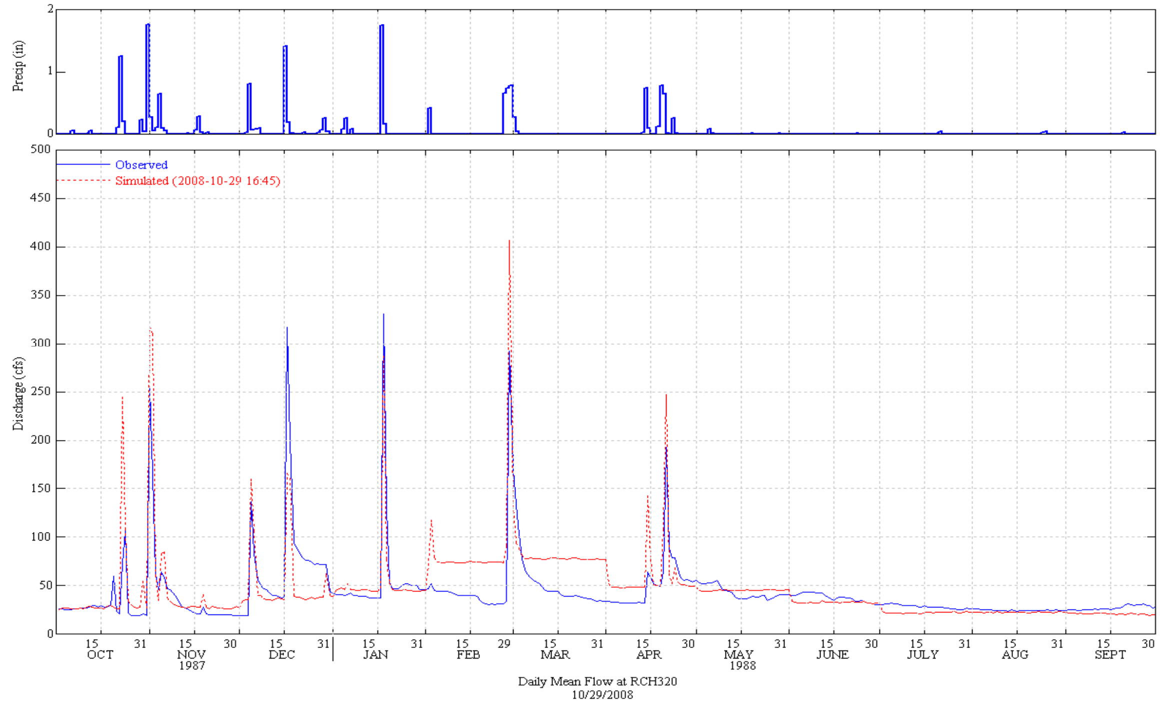

Figure 26 Simulated and Observed Daily Flow at Co. Line (WY 1988)

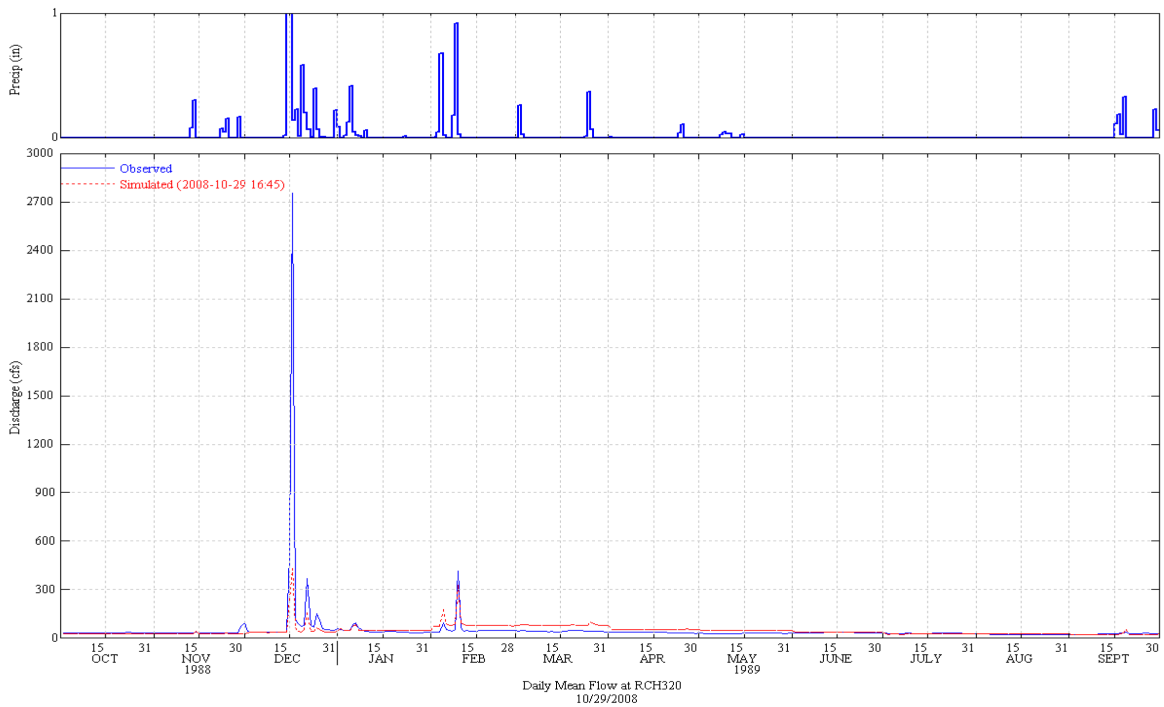

Figure 27 Simulated and Observed Daily Flow at Co. Line (WY 1989)

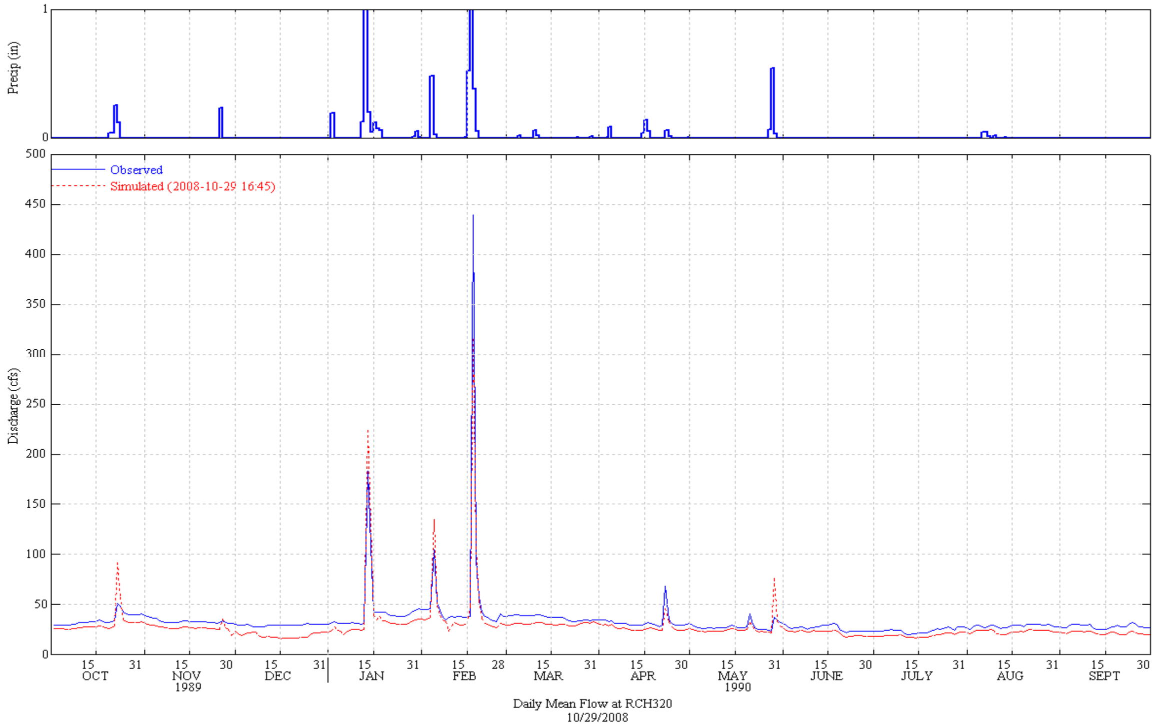

Figure 28 Simulated and Observed Daily Flow at Co. Line (WY 1990)

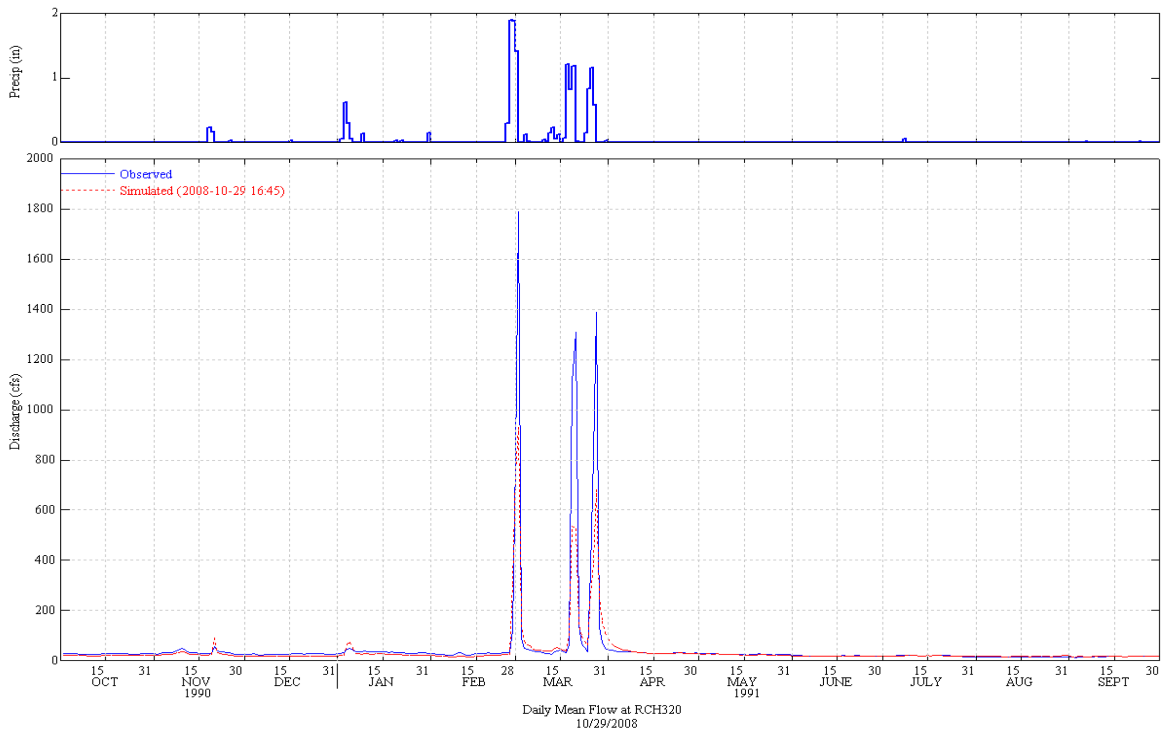

Figure 29 Simulated and Observed Daily Flow at Co. Line (WY 1991)

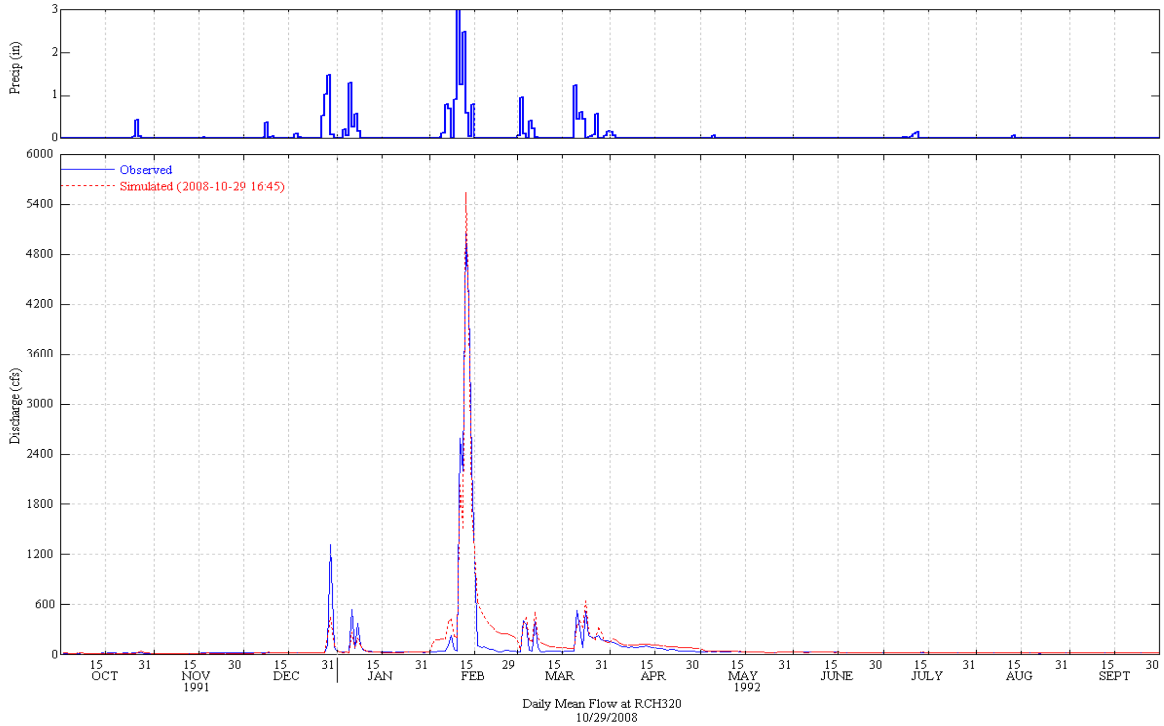

Figure 30 Simulated and Observed Daily Flow at Co. Line (WY 1992)

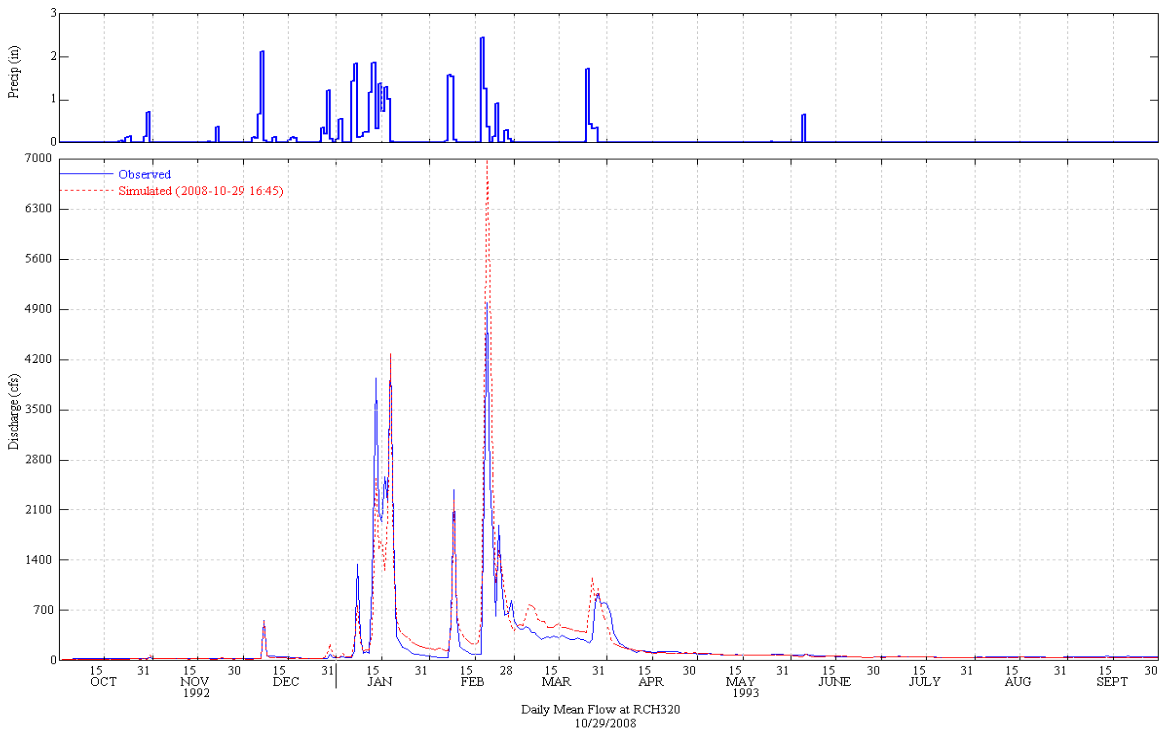

Figure 31 Simulated and Observed Daily Flow at Co. Line (WY 1993)

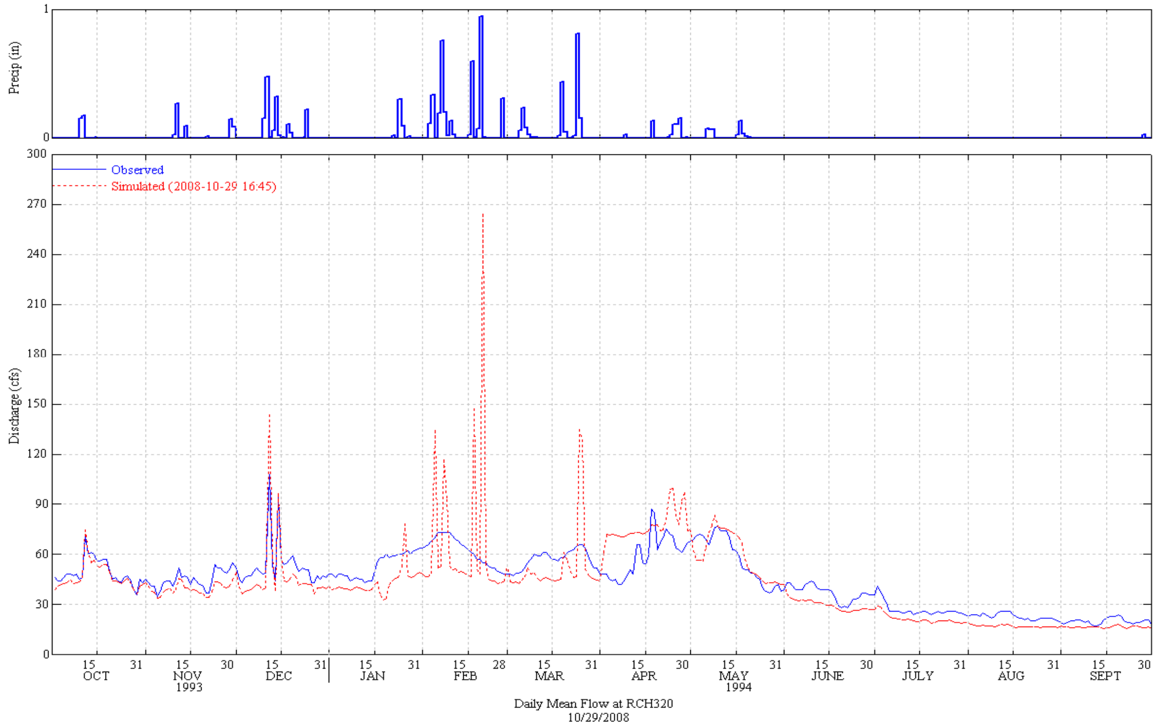

Figure 32 Simulated and Observed Daily Flow at Co. Line (WY 1994)

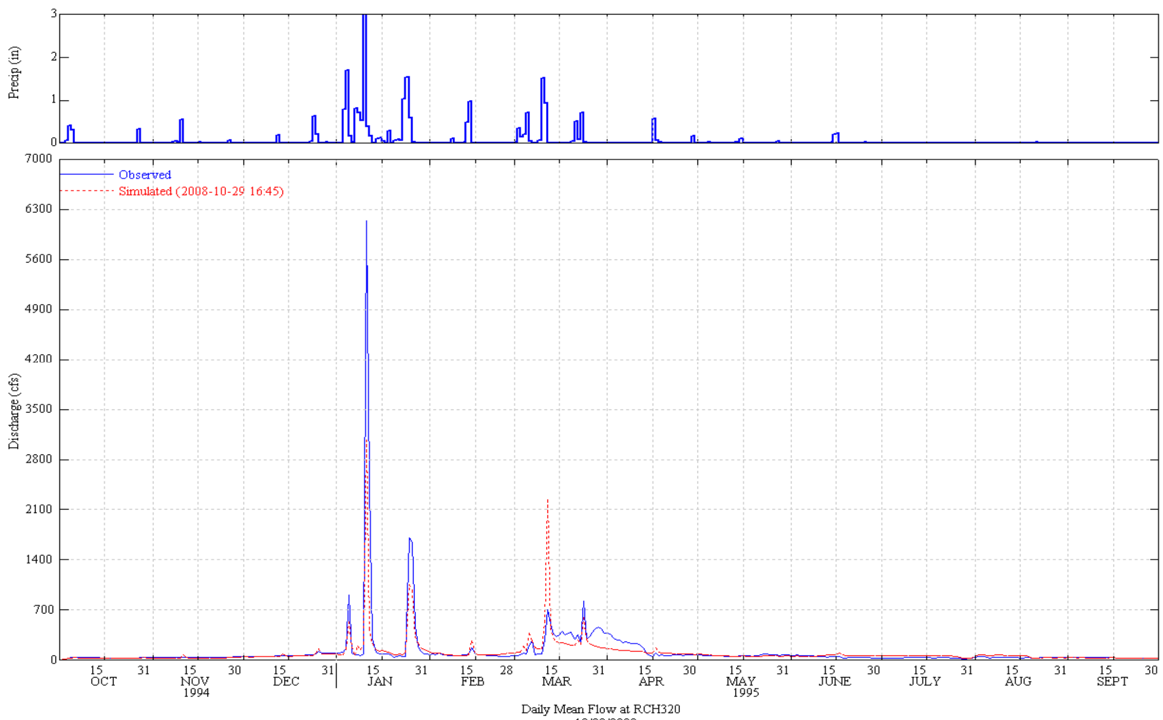

Figure 33 Simulated and Observed Daily Flow at Co. Line (WY 1995)

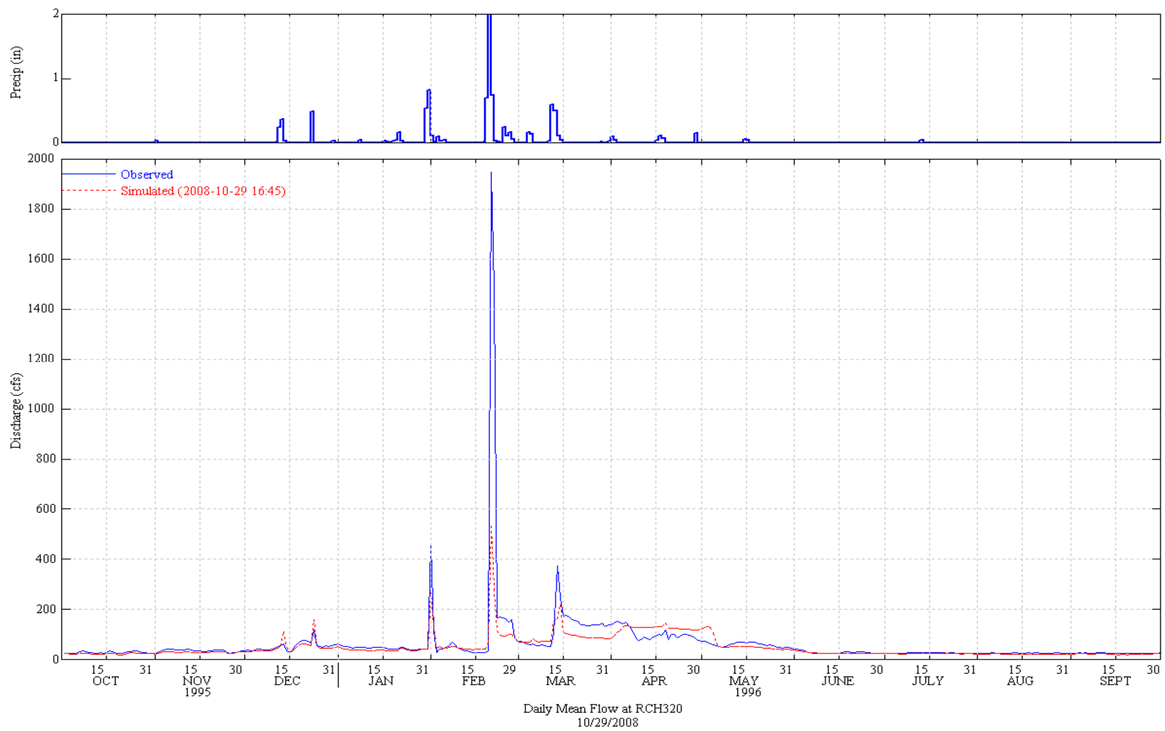

Figure 34 Simulated and Observed Daily Flow at Co. Line (WY 1996)

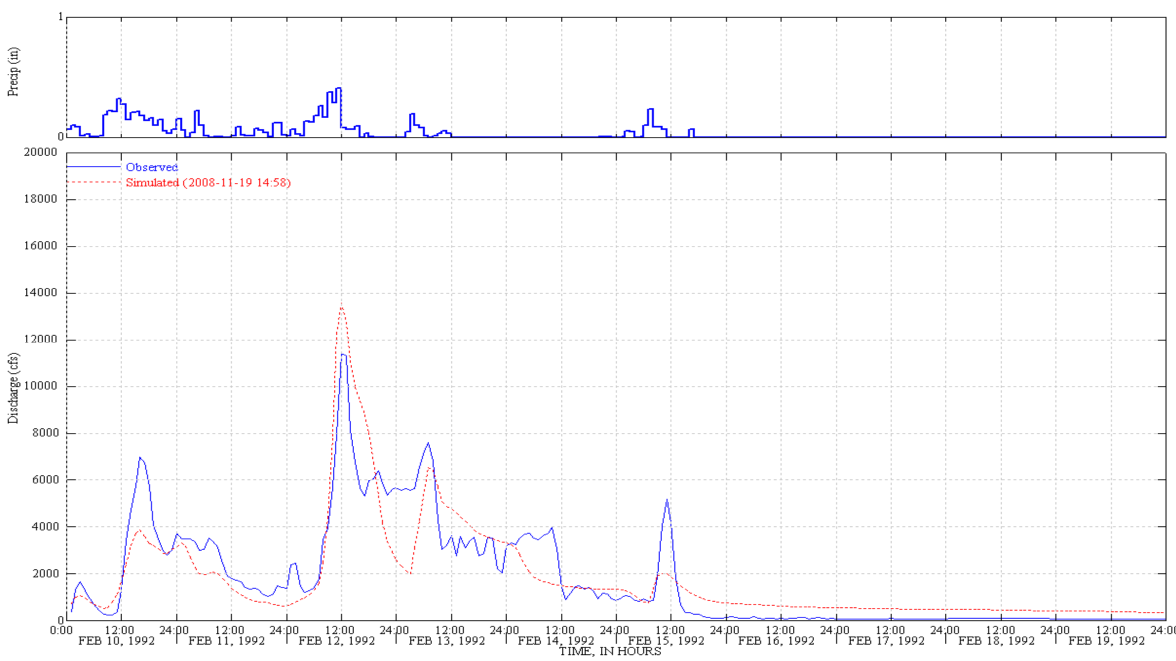

Figure 35 Simulated and Observed February 10, 1992 Storm Event

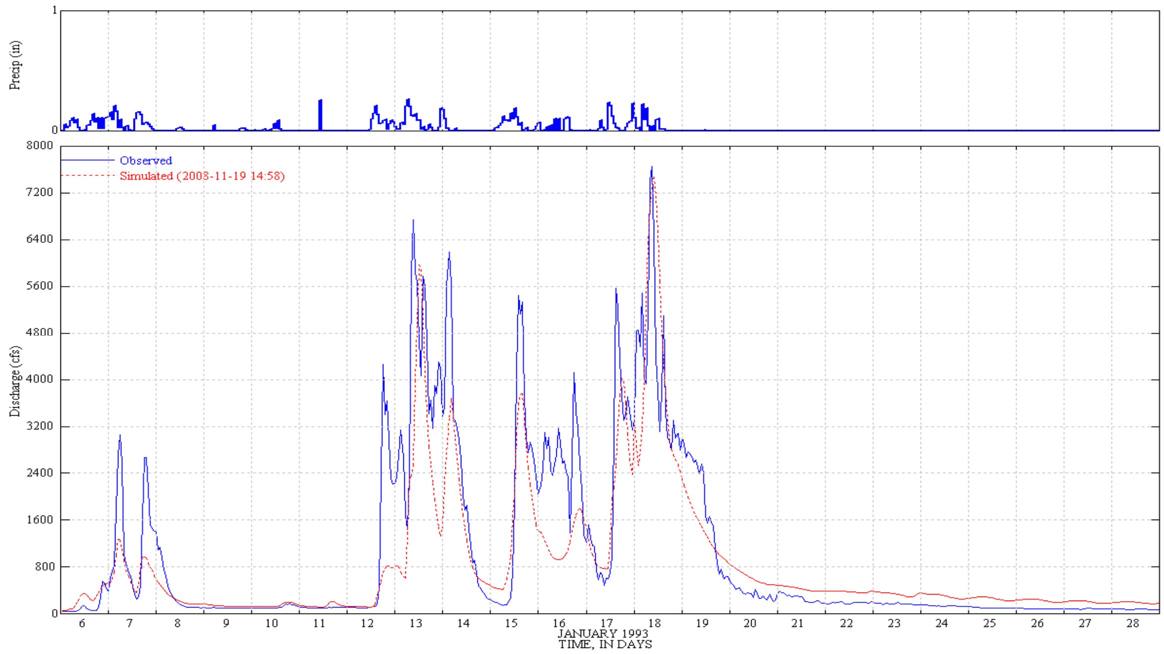

Figure 36 Simulated and Observed January 6, 1993 Storm Event

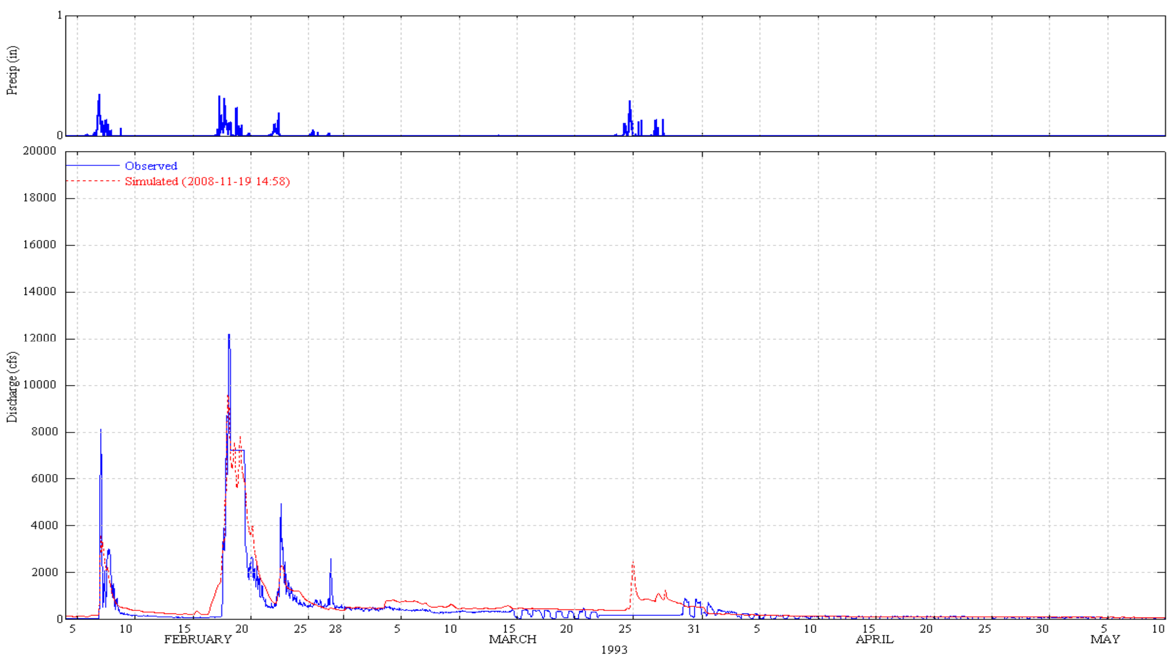

Figure 37 Simulated and Observed February 7, 1993 Storm Event

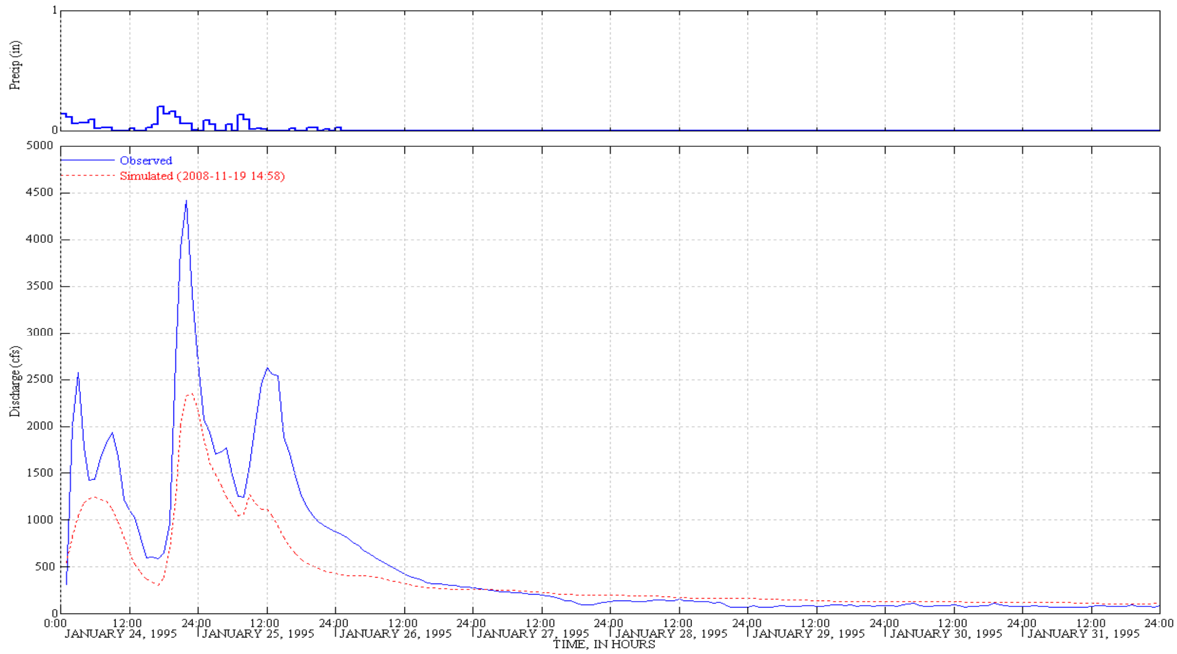

Figure 38 Simulated and Observed January 24, 1995 Storm Event

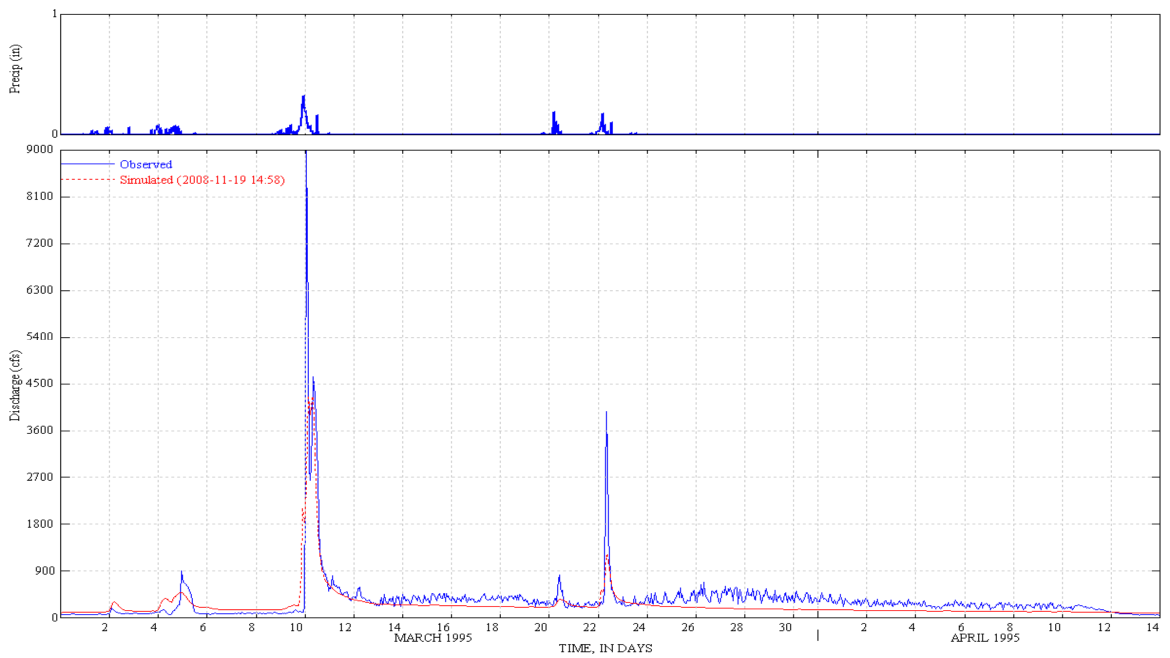

Figure 39 Simulated and Observed March 3, 1995 Storm Event

APPENDIX J

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE PIRU CREEK WATERSHED ABOVE PIRU

Title Page

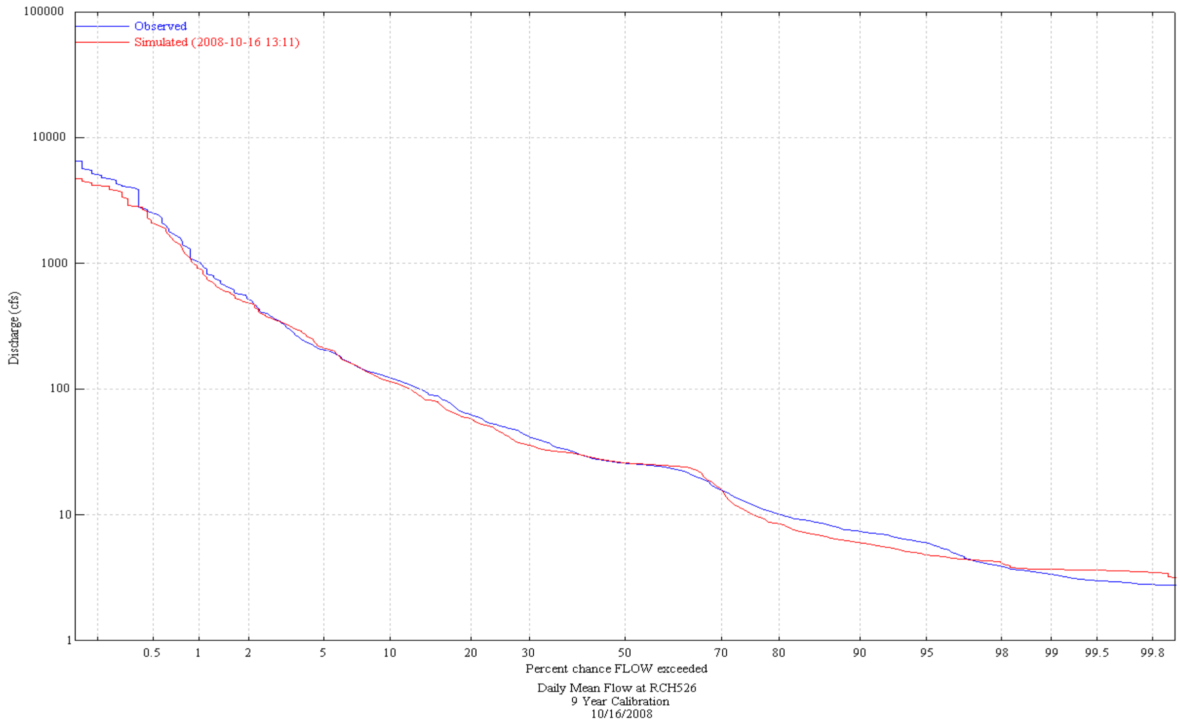

Figure 1 Simulated and Observed Daily Flow Duration Curve at Ab. Piru

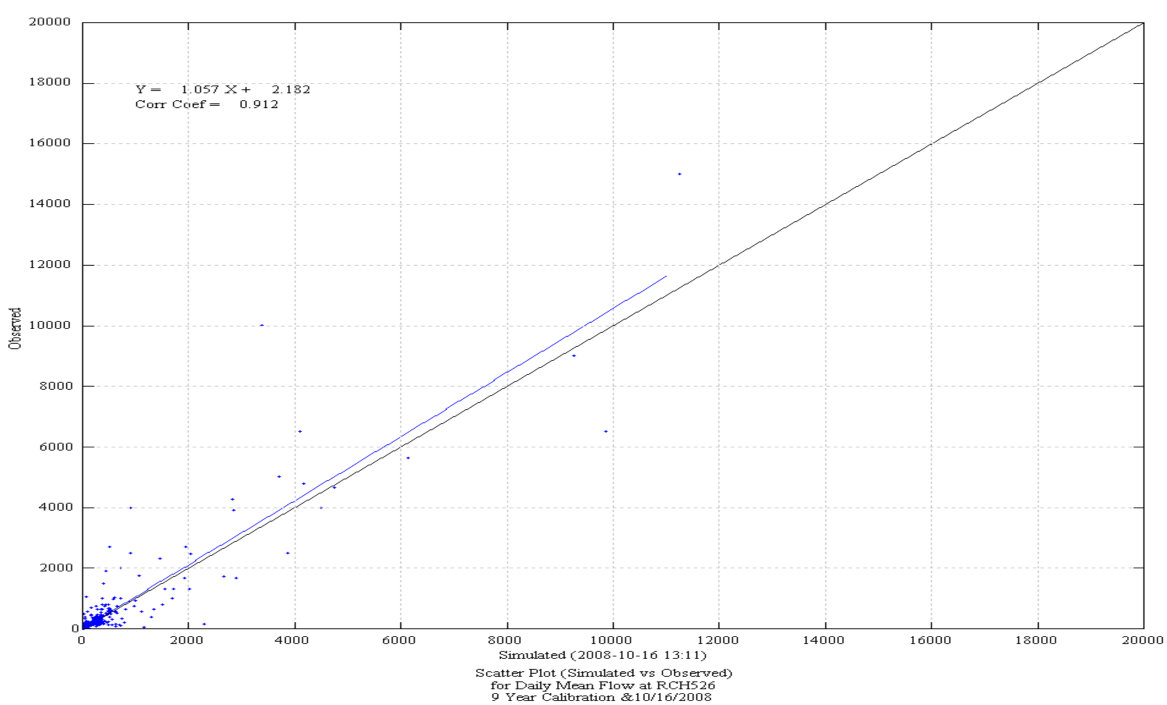

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Ab. Piru

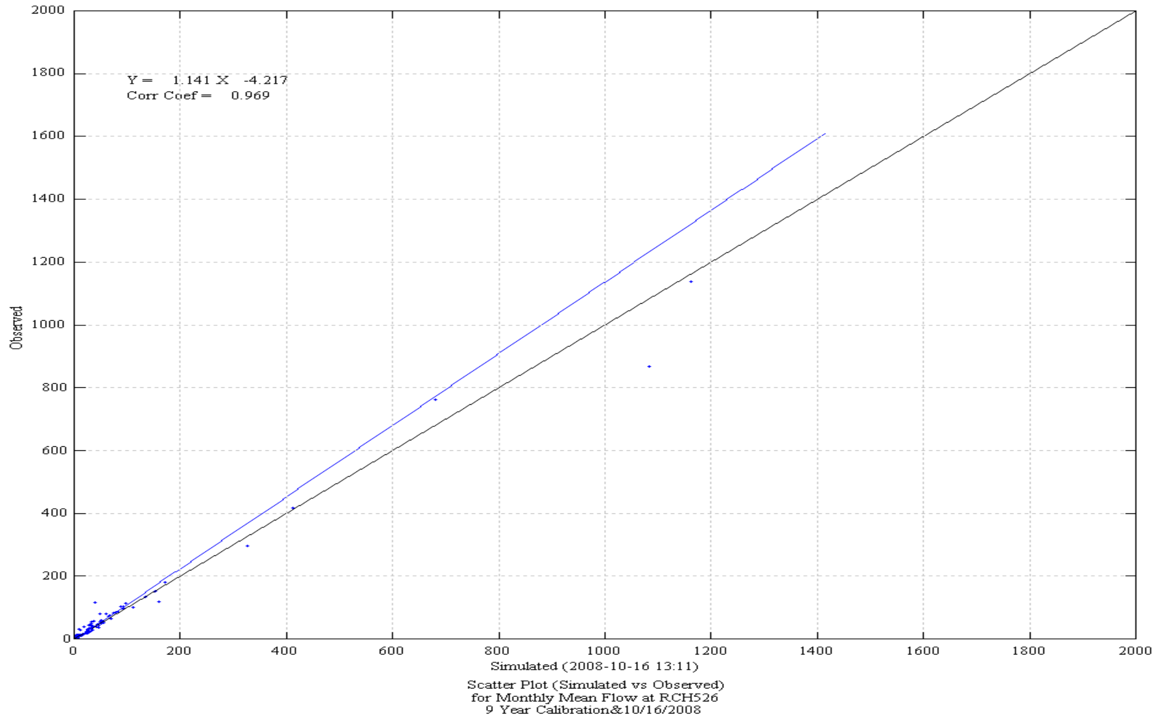

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Ab. Piru

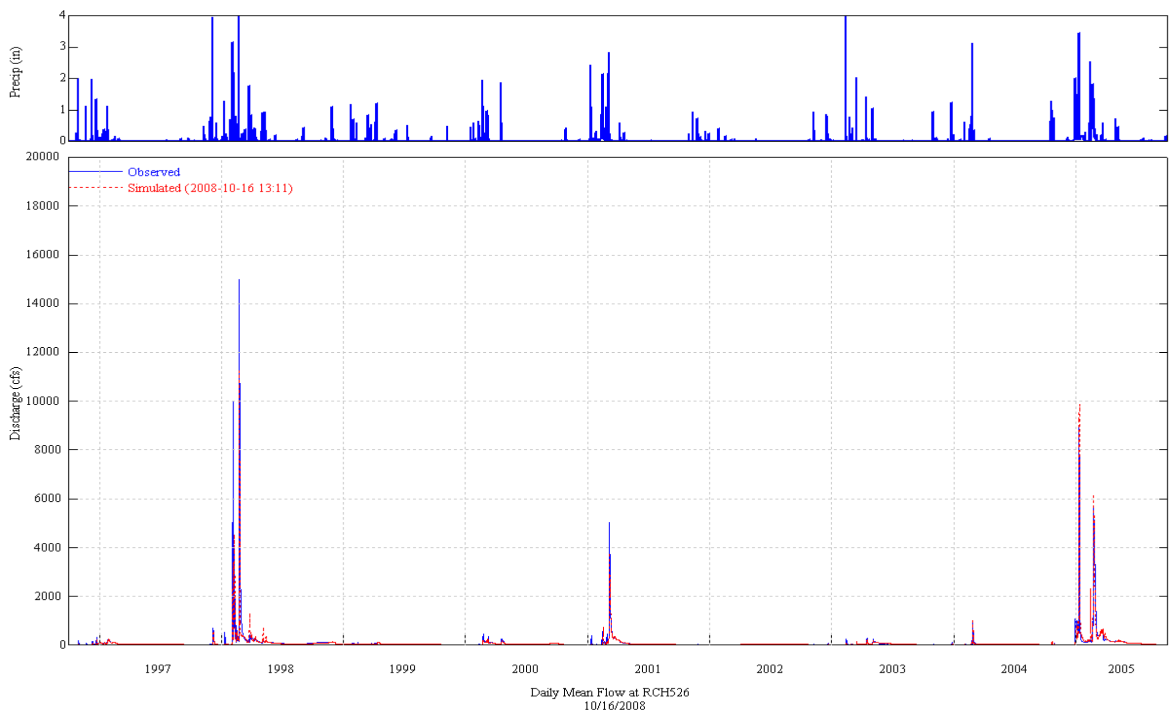

Figure 4 Simulated and Observed Daily Flow at Ab. Piru (WY 1997-2005)

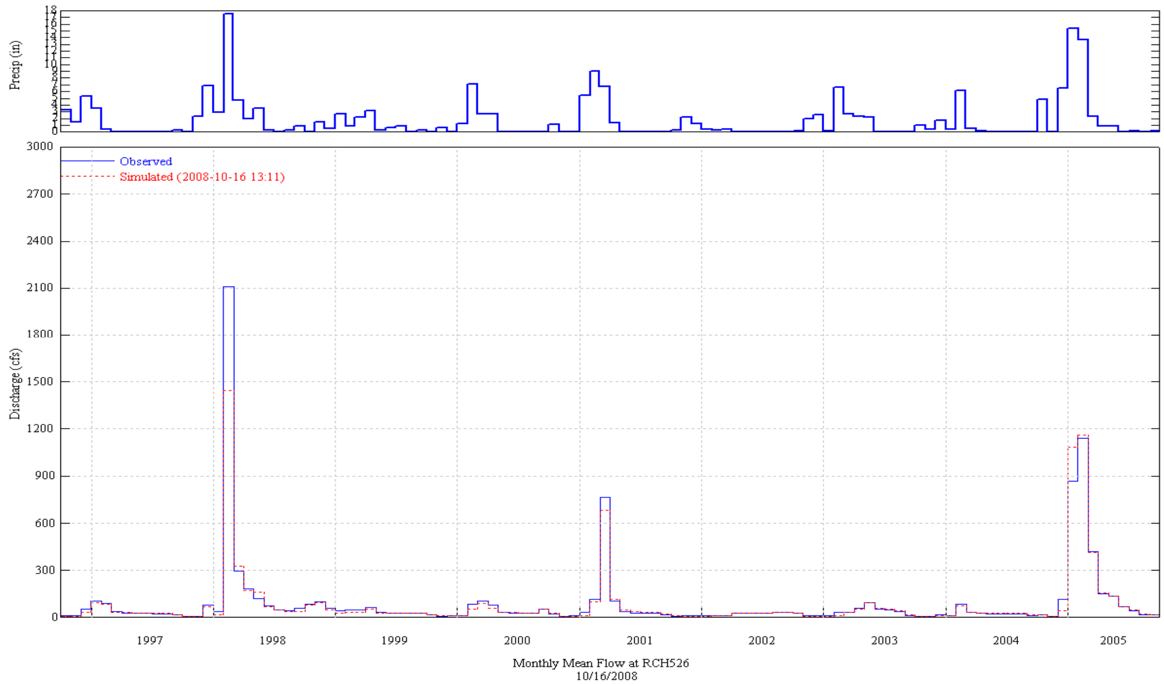

Figure 5 Simulated and Observed Monthly Flow at Ab. Piru (WY 1997-2005)

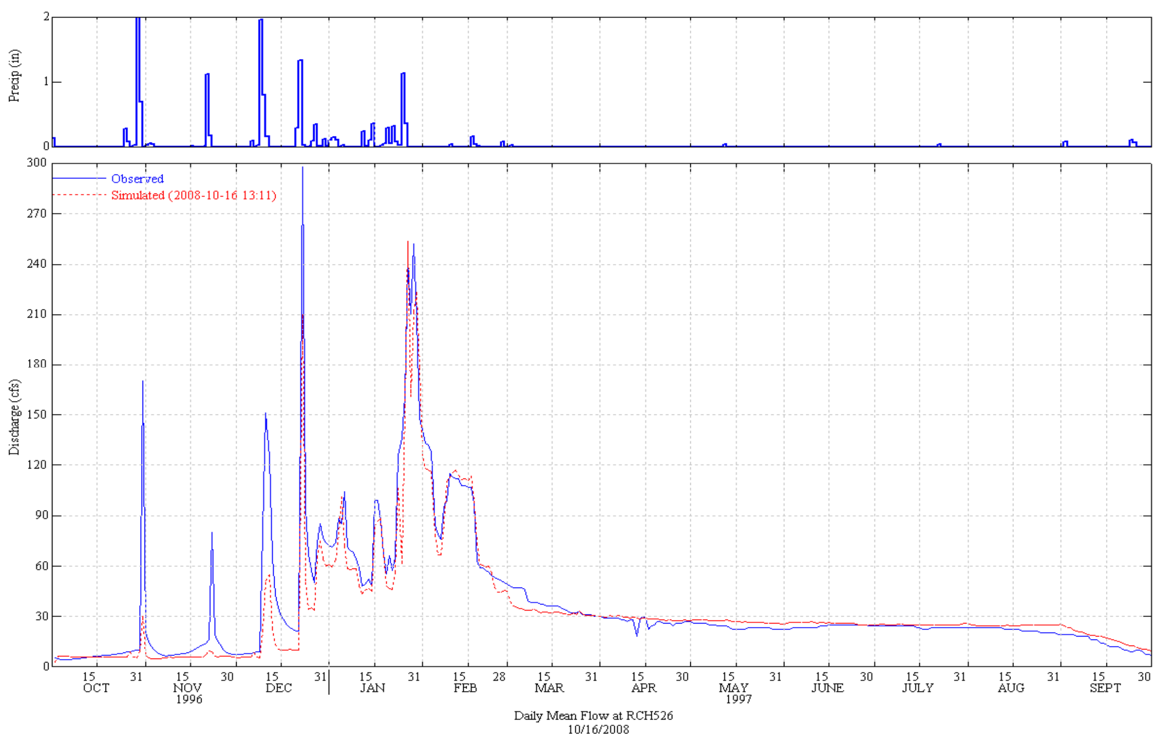

Figure 6 Simulated and Observed Daily Flow at Ab. Piru (WY 1997)

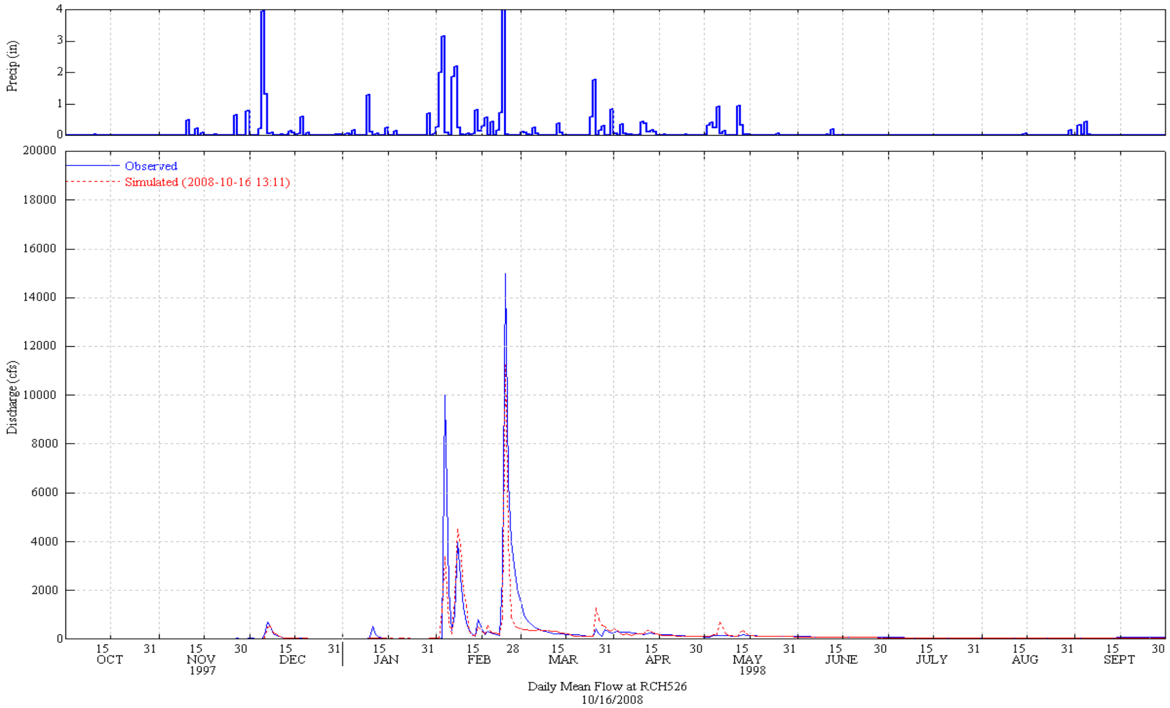

Figure 7 Simulated and Observed Daily Flow at Ab. Piru (WY 1998)

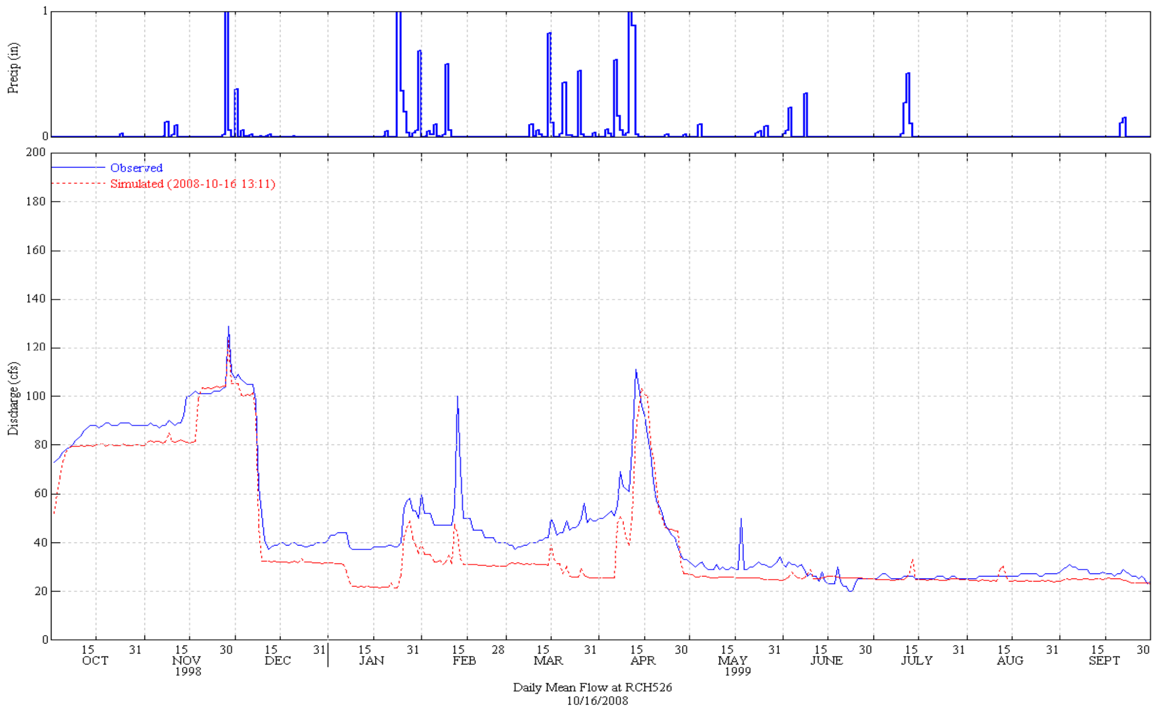

Figure 8 Simulated and Observed Daily Flow at Ab. Piru (WY 1999)

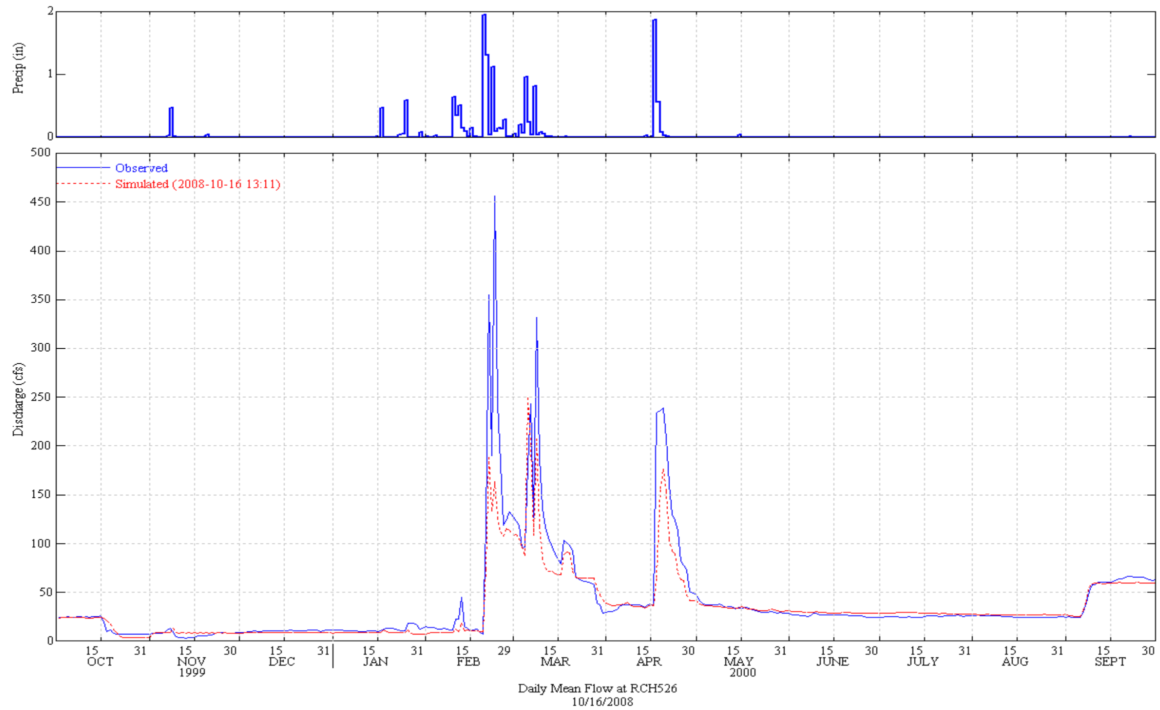

Figure 9 Simulated and Observed Daily Flow at Ab. Piru (WY 2000)

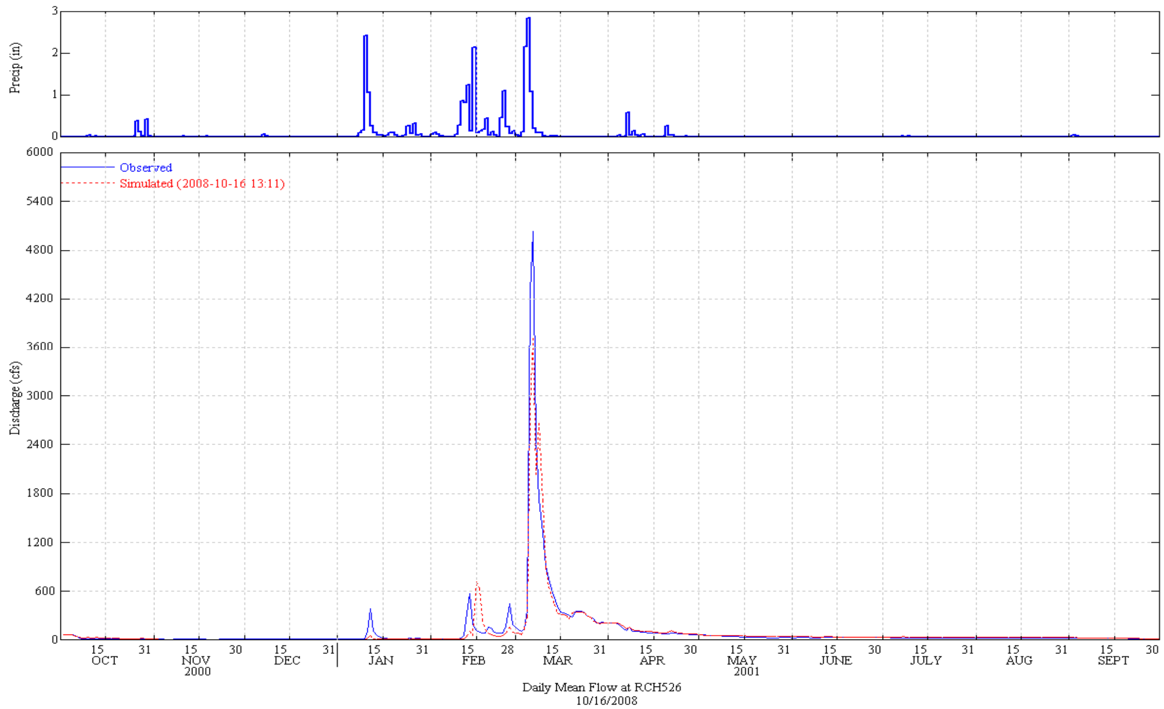

Figure 10 Simulated and Observed Daily Flow at Ab. Piru (WY 2001)

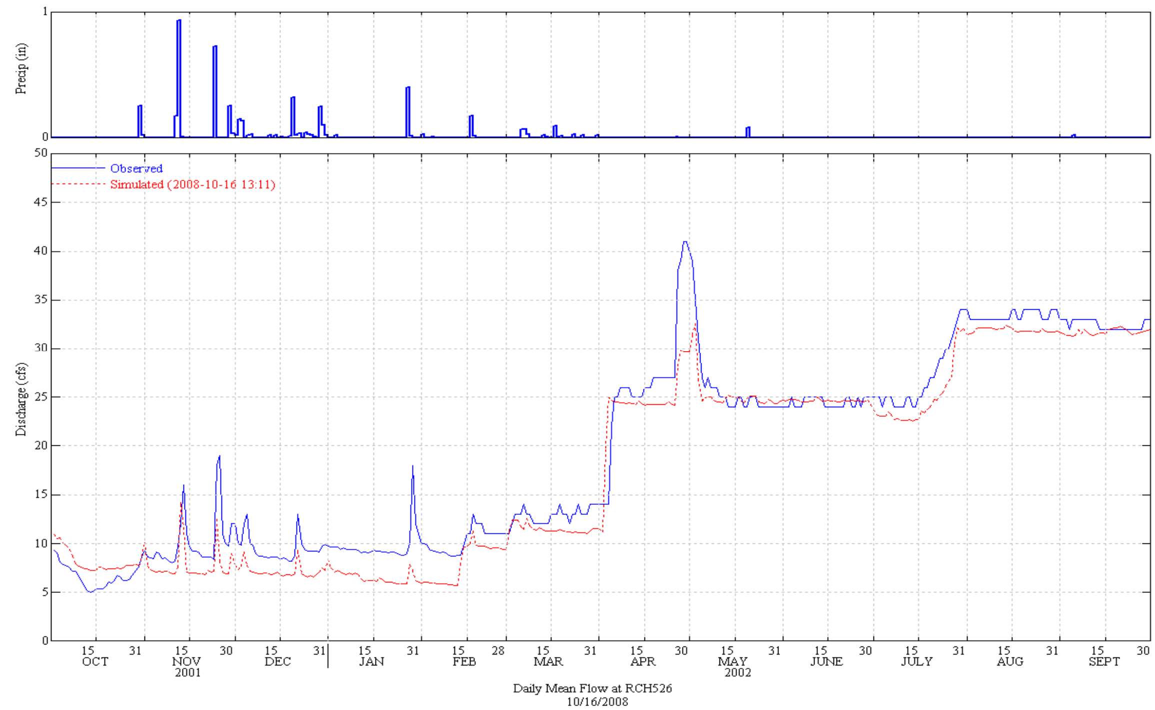

Figure 11 Simulated and Observed Daily Flow at Ab. Piru (WY 2002)

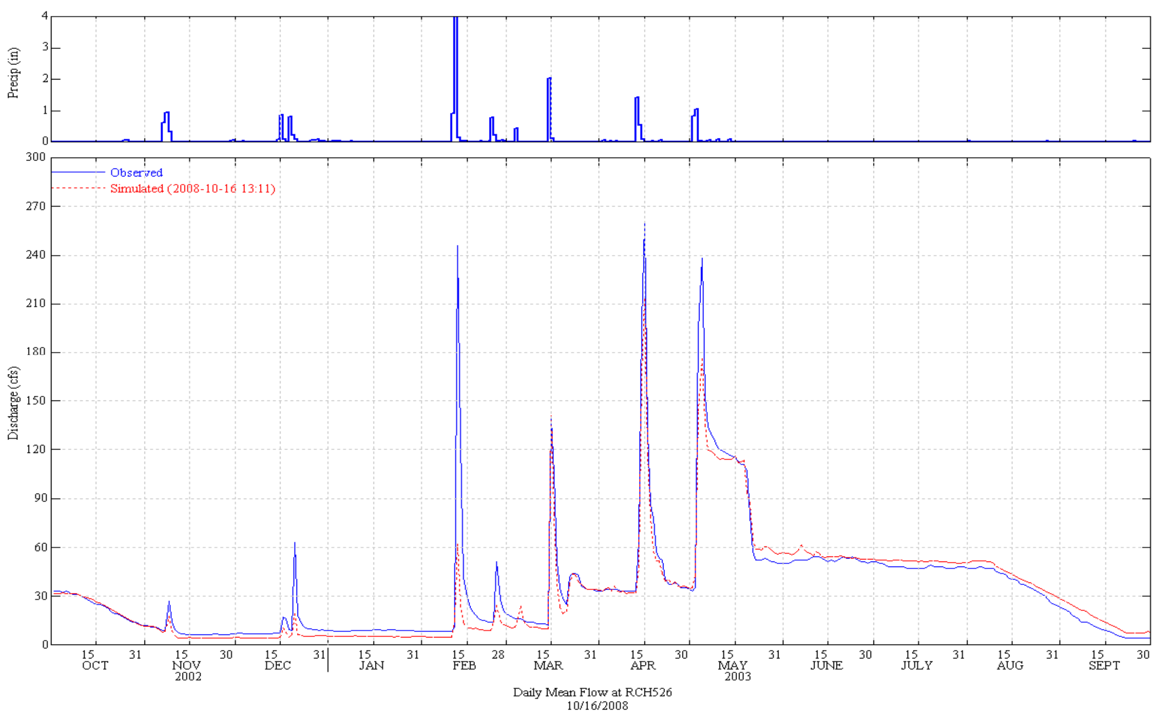

Figure 12 Simulated and Observed Daily Flow at Ab. Piru (WY 2003)

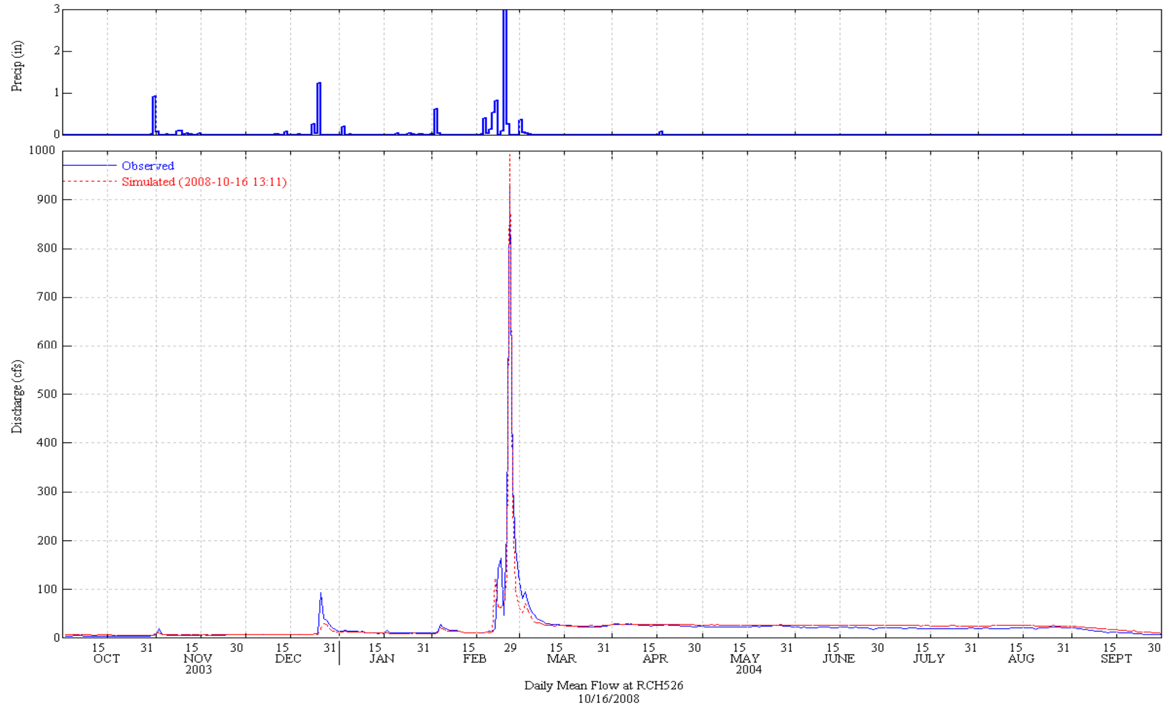

Figure 13 Simulated and Observed Daily Flow at Ab. Piru (WY 2004)

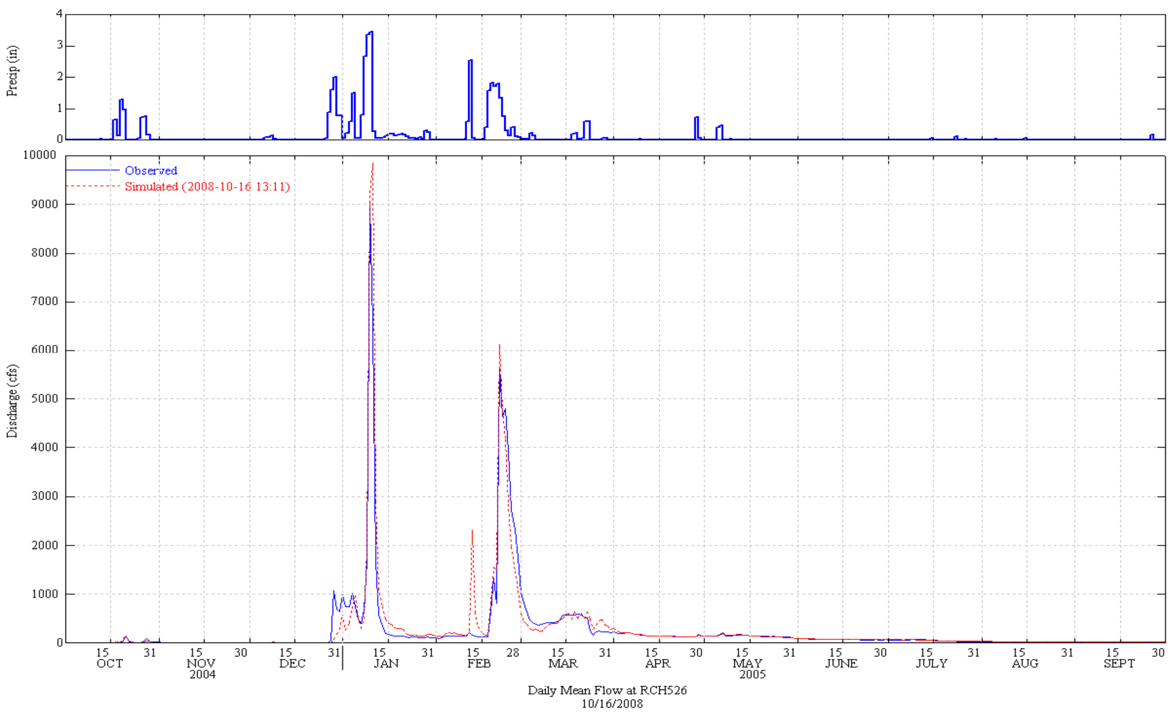

Figure 14 Simulated and Observed Daily Flow at Ab. Piru (WY 2005)

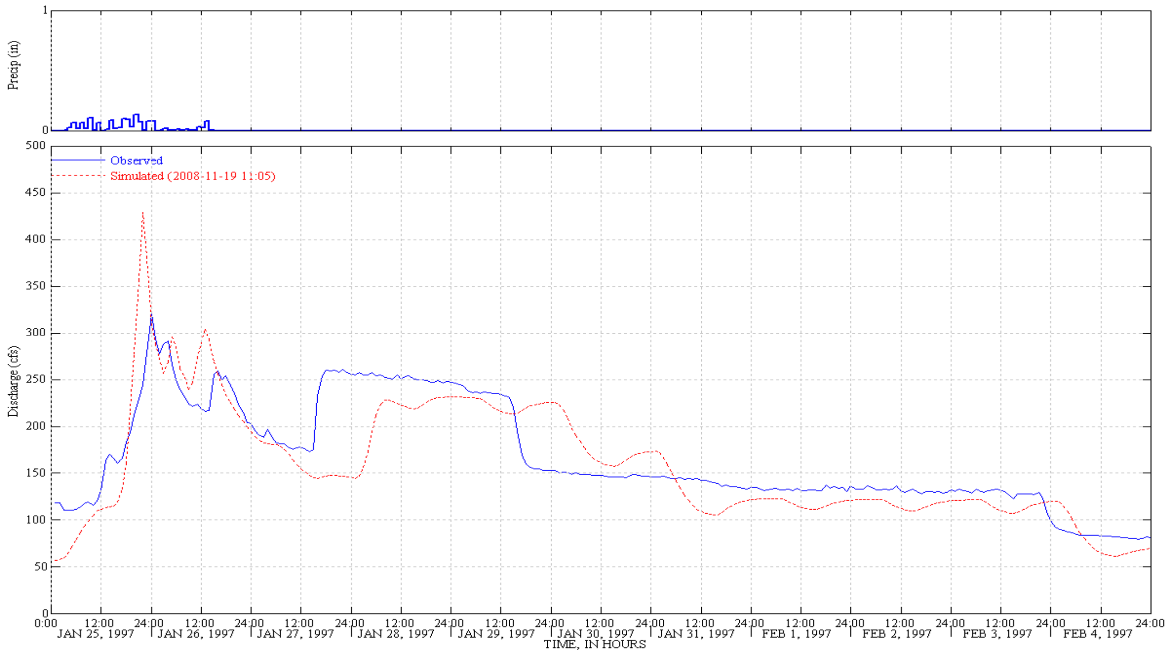

Figure 15 Simulated and Observed January 25, 1997 Storm Event

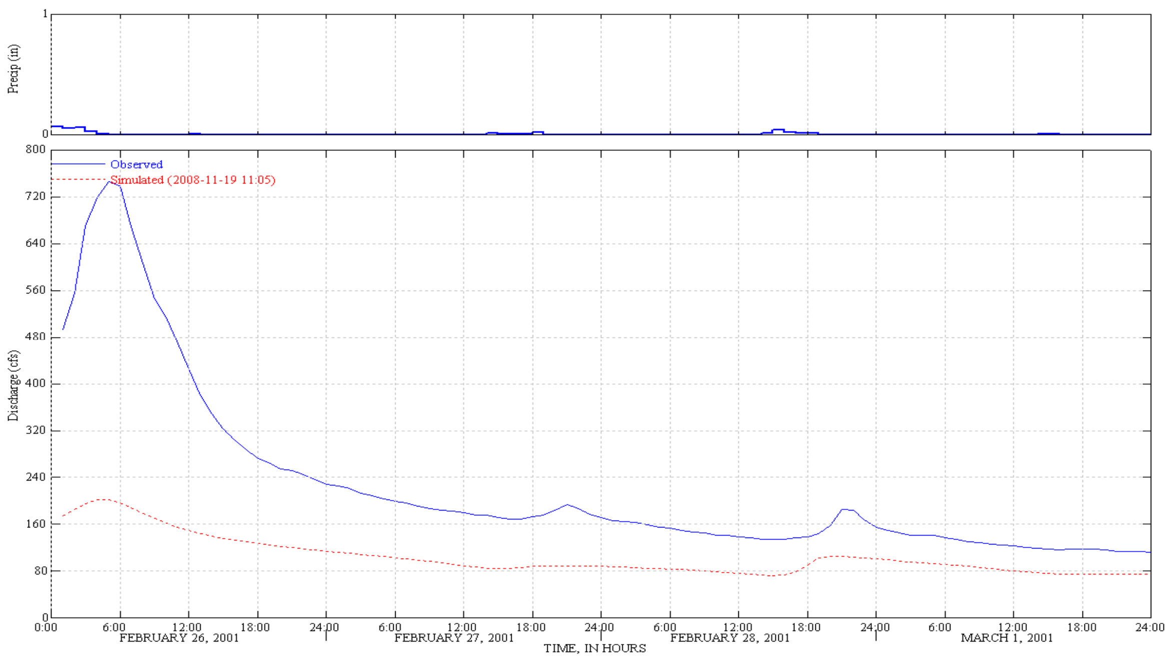

Figure 16 Simulated and Observed February 26, 2001 Storm Event

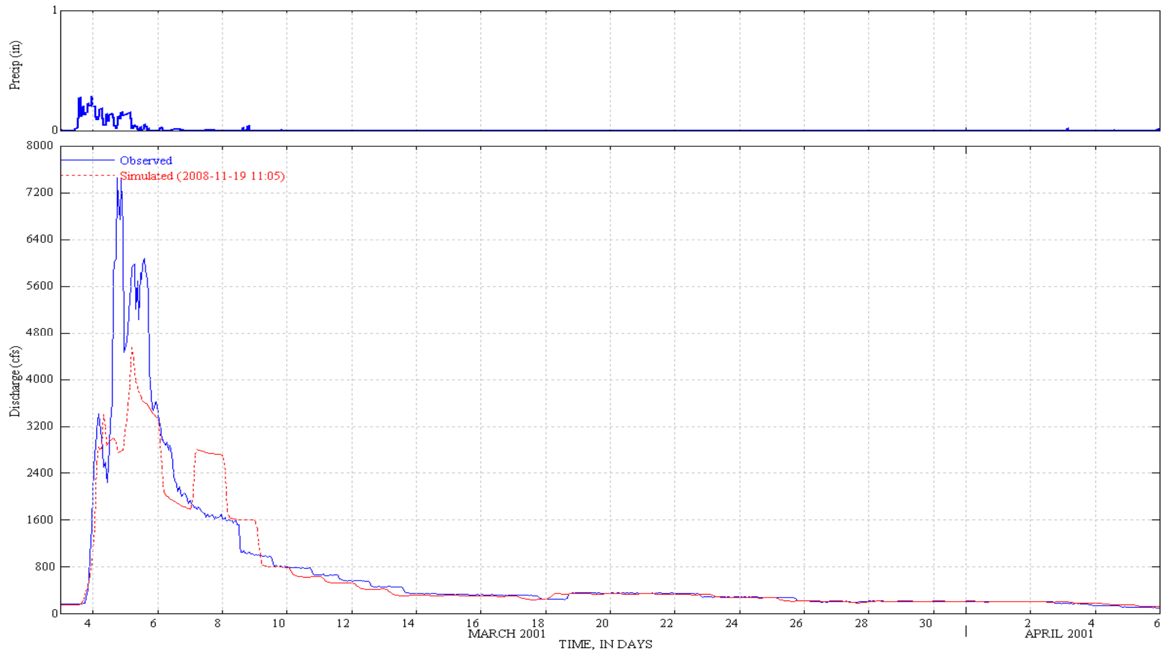

Figure 17 Simulated and Observed March 4, 2001 Storm Event

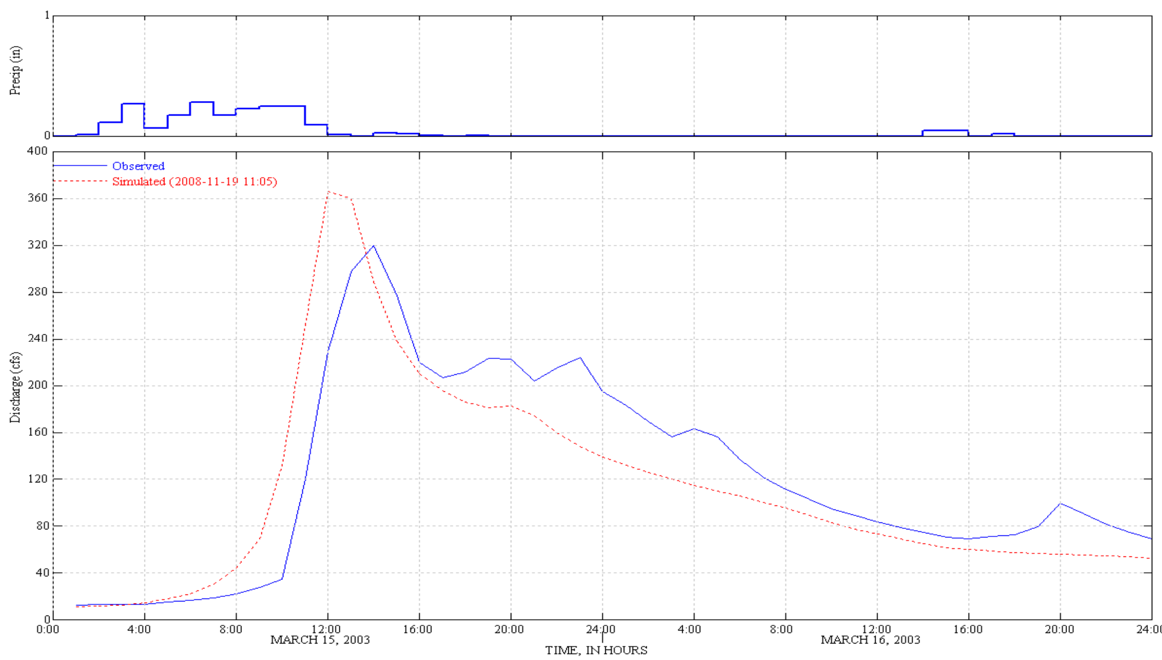

Figure 18 Simulated and Observed March 15, 2003 Storm Event

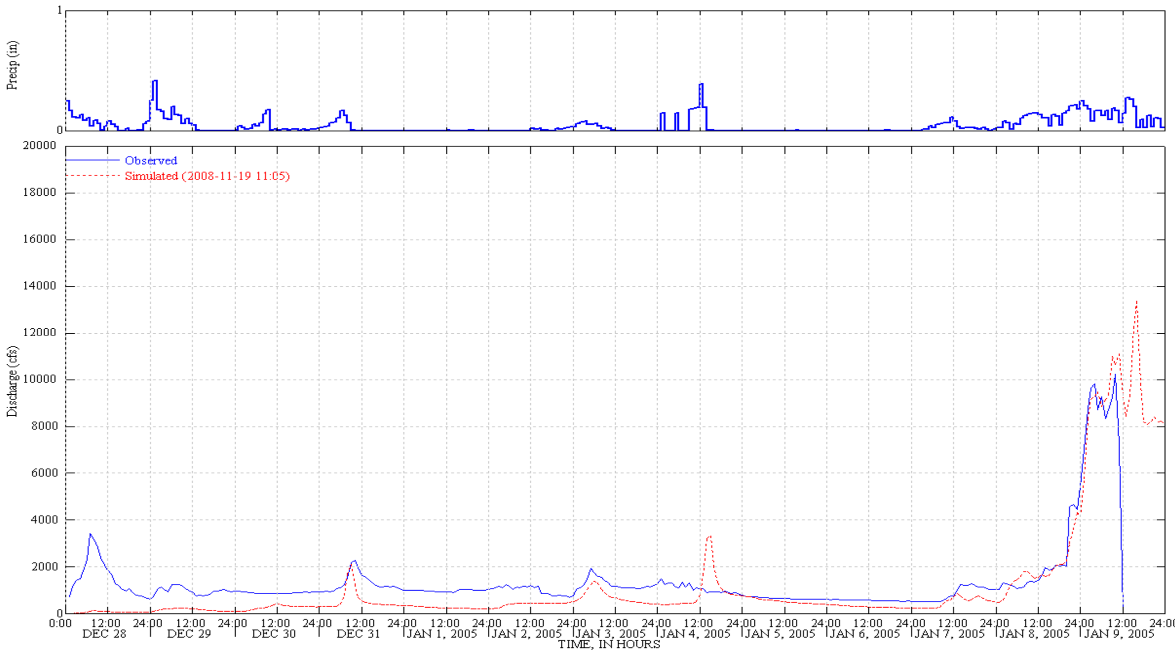

Figure 19 Simulated and Observed December 28, 2004 Storm Event

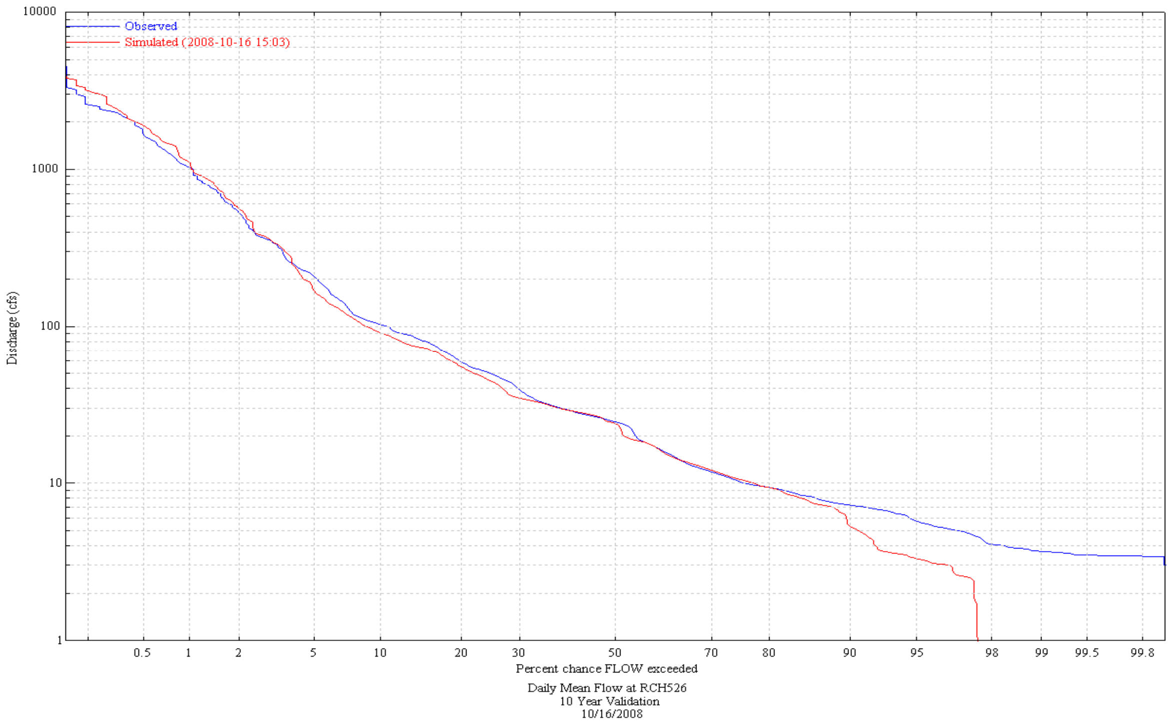

Figure 20 Simulated and Observed Daily Flow Duration Curve at Ab. Piru

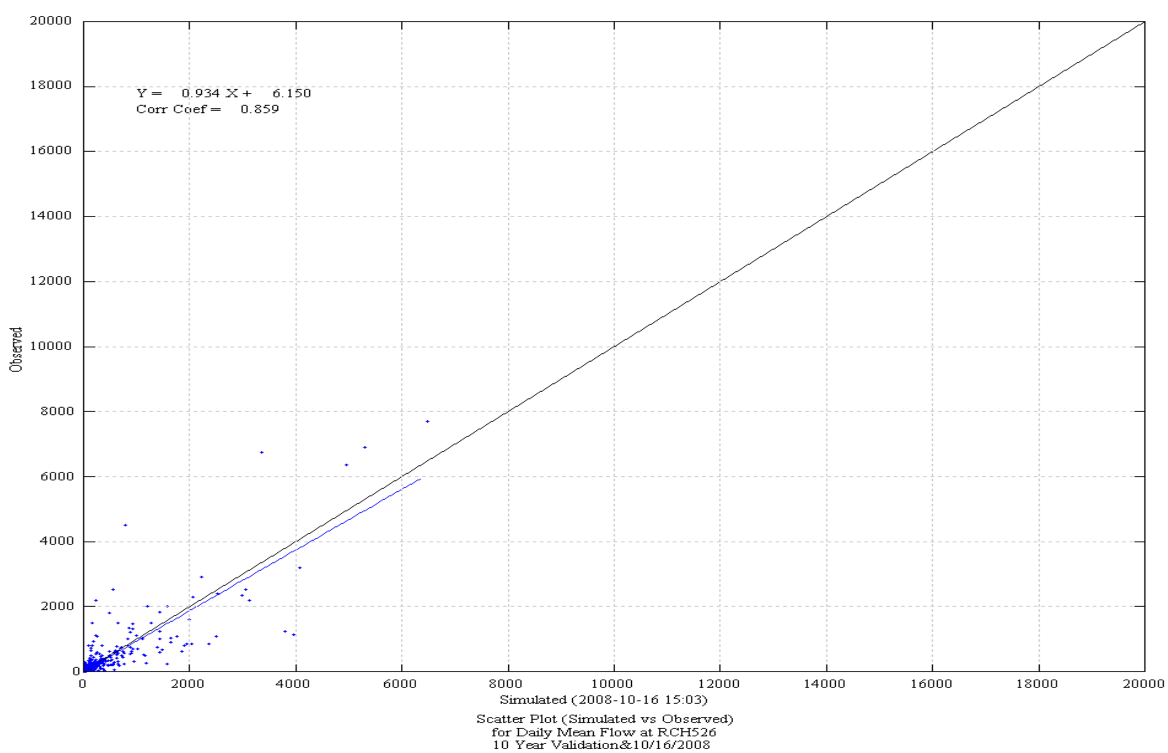

Figure 21 Daily Scatter Plot of Simulated versus Observed Flow at Ab. Piru

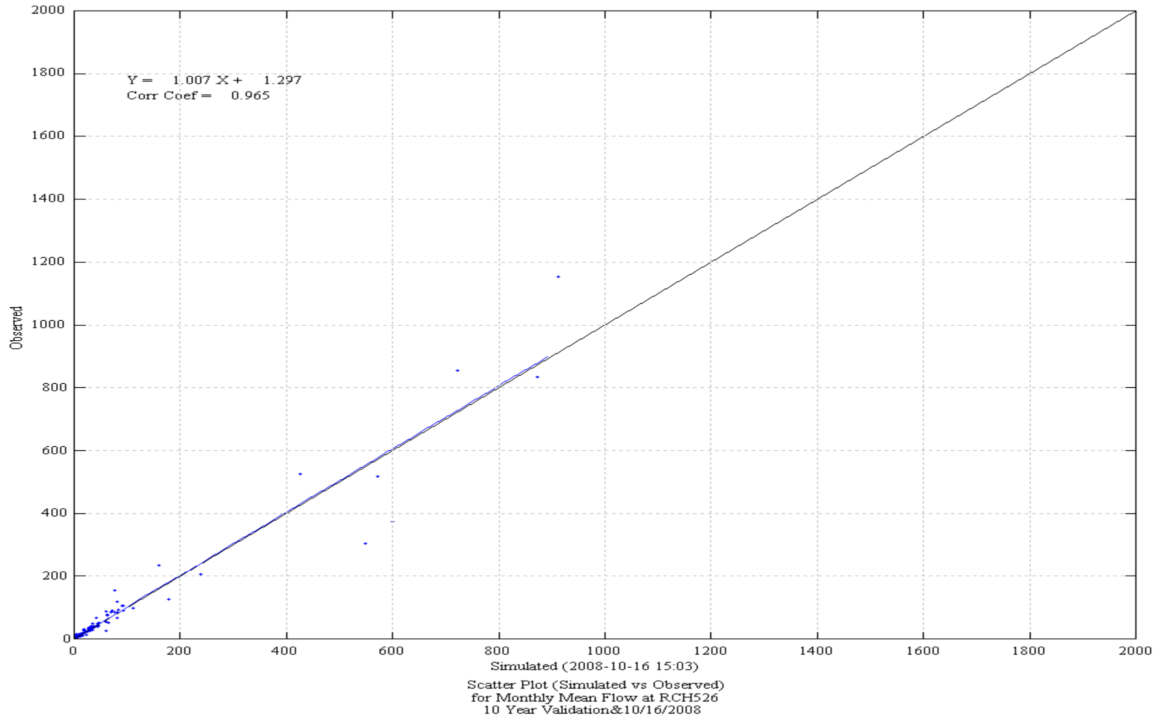

Figure 22 Monthly Scatter Plot of Simulated versus Observed Flow at Ab. Piru

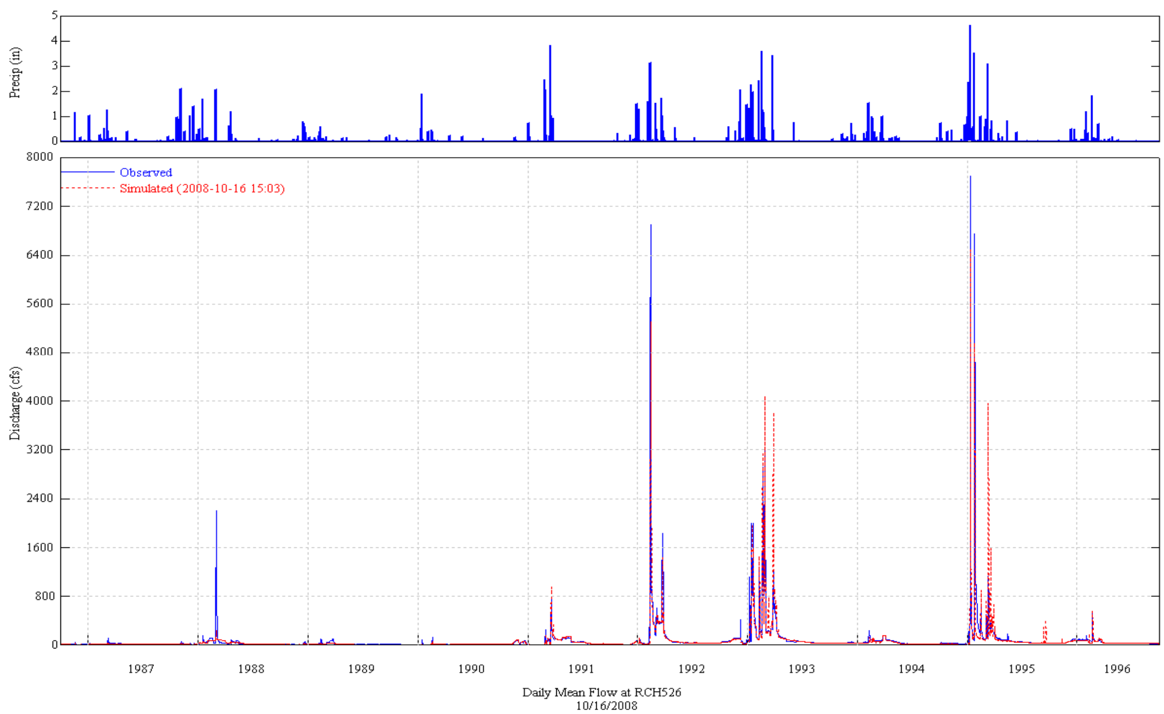

Figure 23 Simulated and Observed Daily Flow at Ab. Piru (WY 1987-1996)

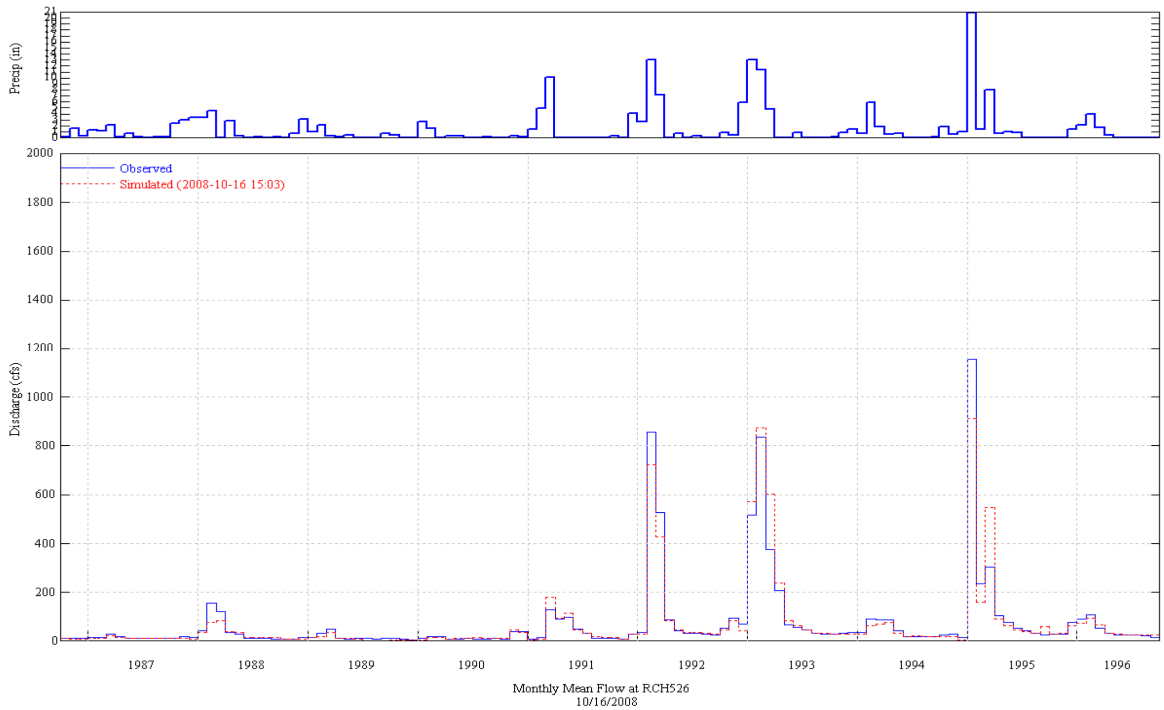

Figure 24 Simulated and Observed Monthly Flow at Ab. Piru (WY 1987-1996)

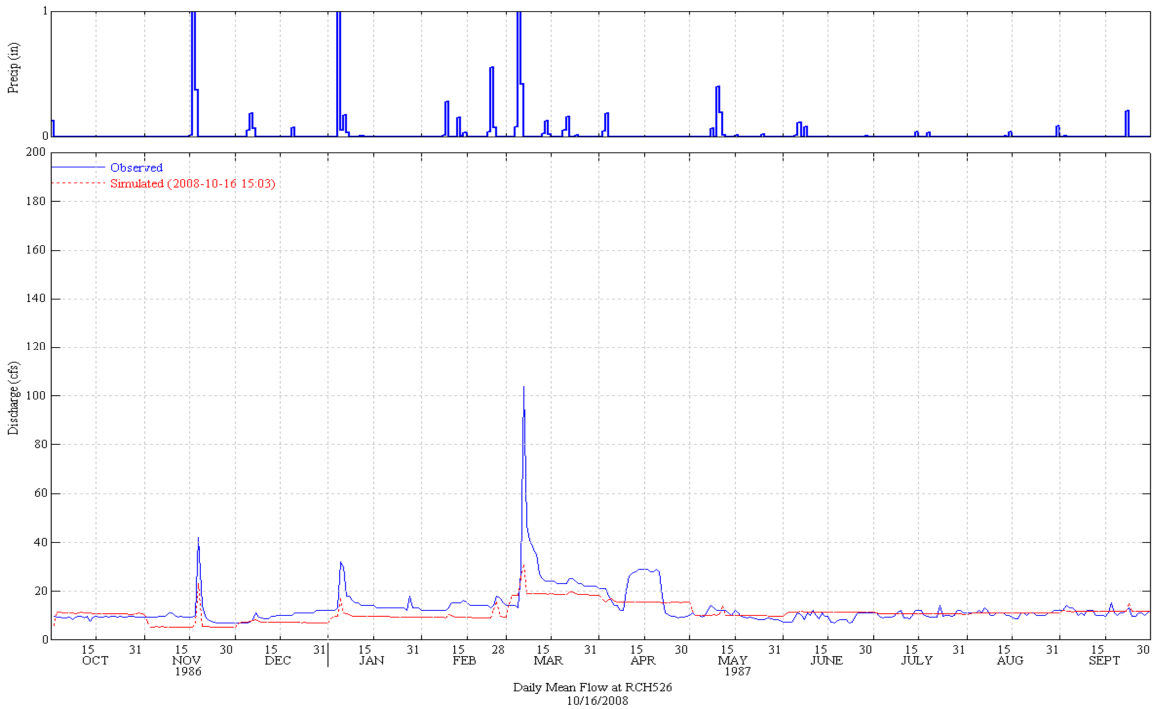

Figure 25 Simulated and Observed Daily Flow at Ab. Piru (WY 1987)

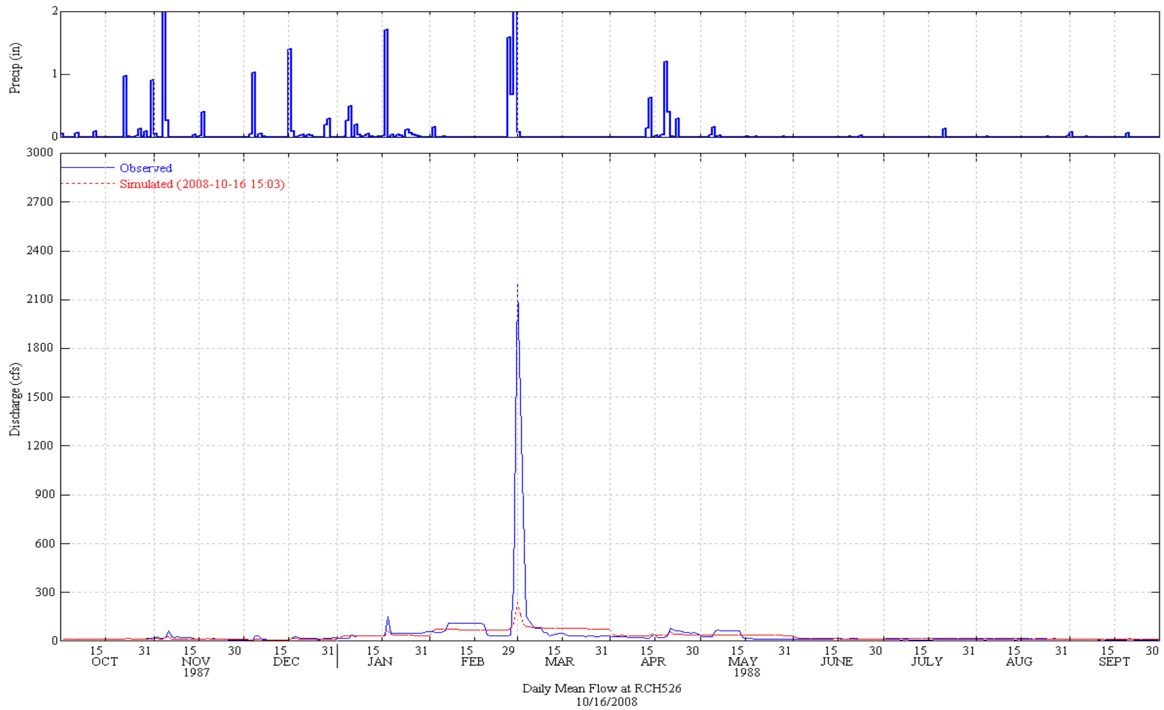

Figure 26 Simulated and Observed Daily Flow at Ab. Piru (WY 1988)

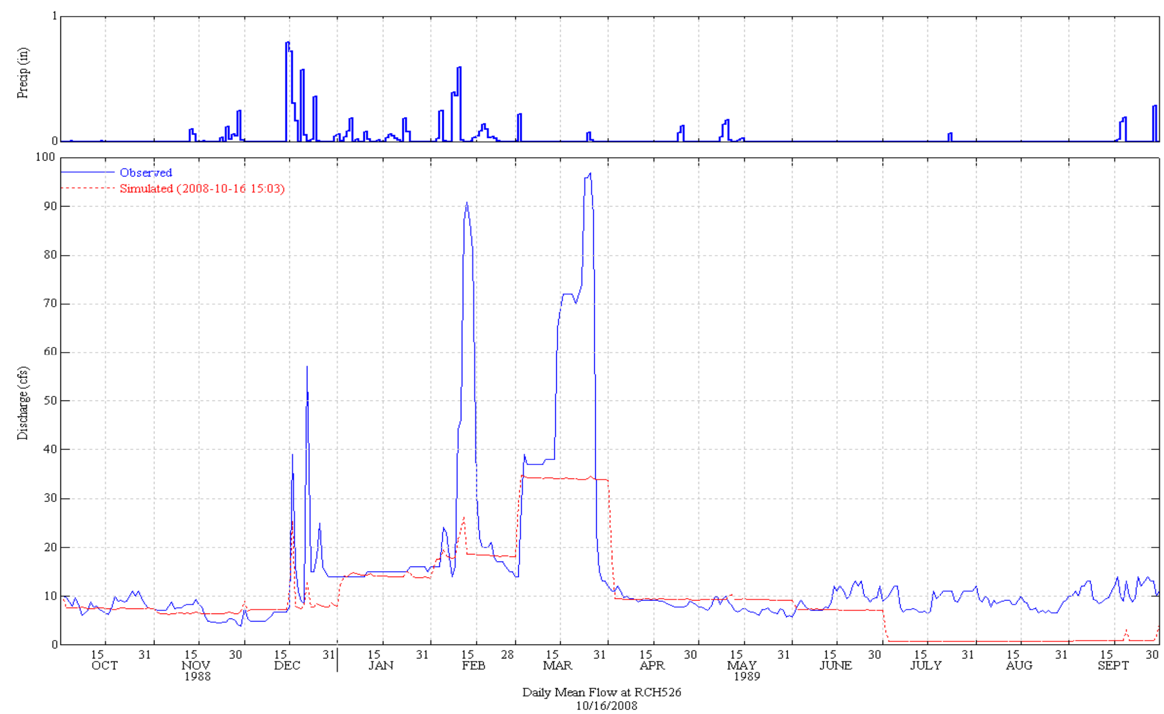

Figure 27 Simulated and Observed Daily Flow at Ab. Piru (WY 1989)

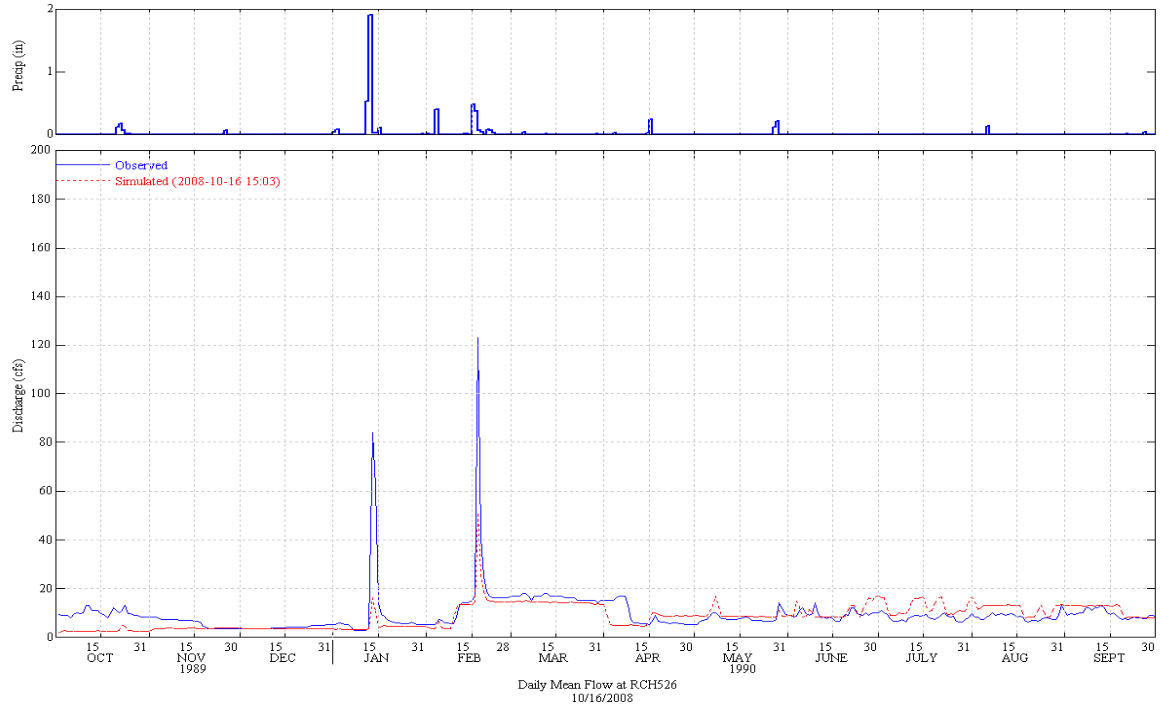

Figure 28 Simulated and Observed Daily Flow at Ab. Piru (WY 1990)

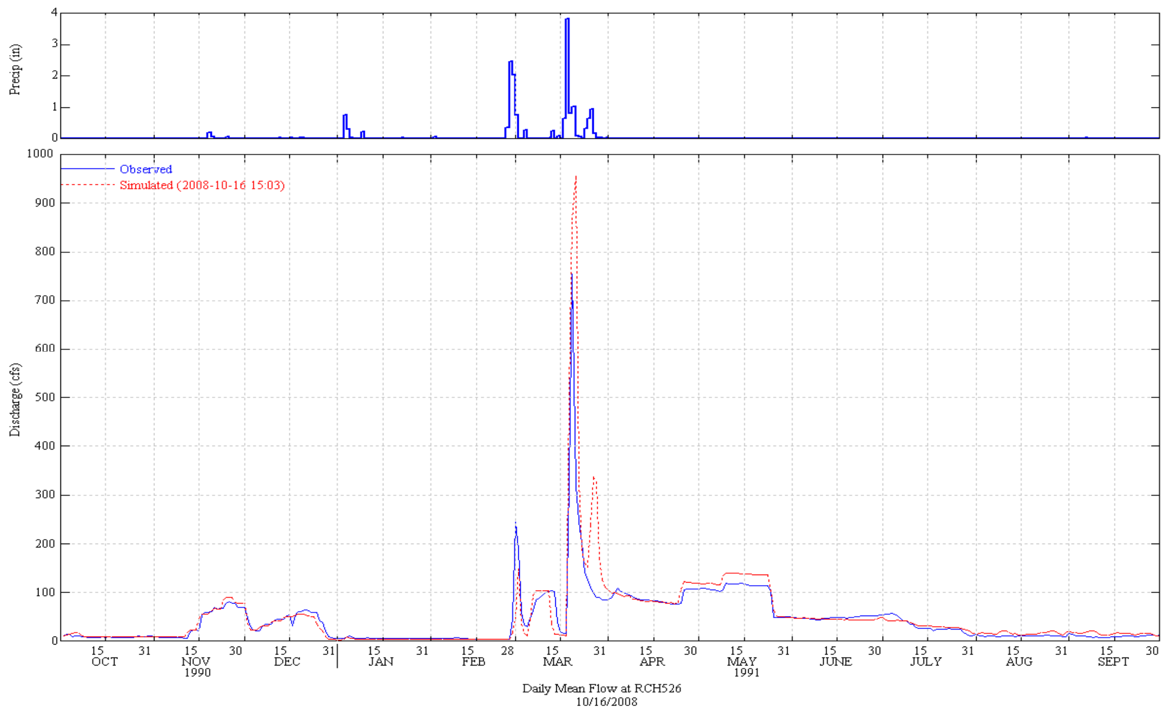

Figure 29 Simulated and Observed Daily Flow at Ab. Piru (WY 1991)

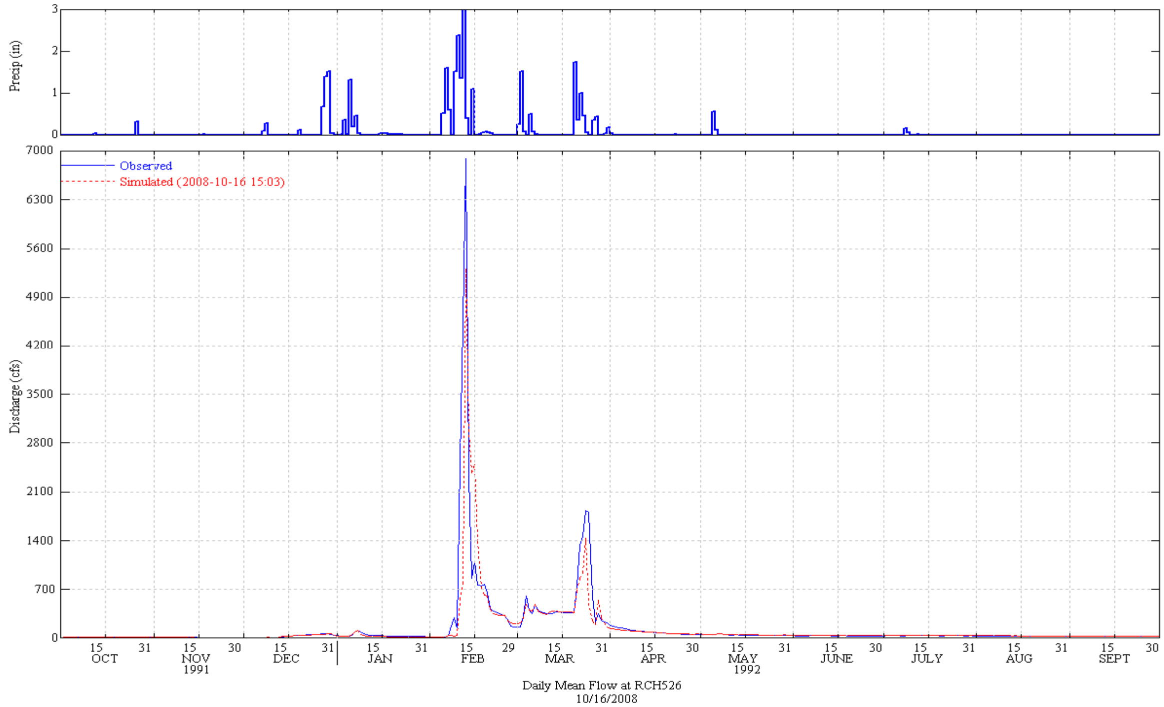

Figure 30 Simulated and Observed Daily Flow at Ab. Piru (WY 1992)

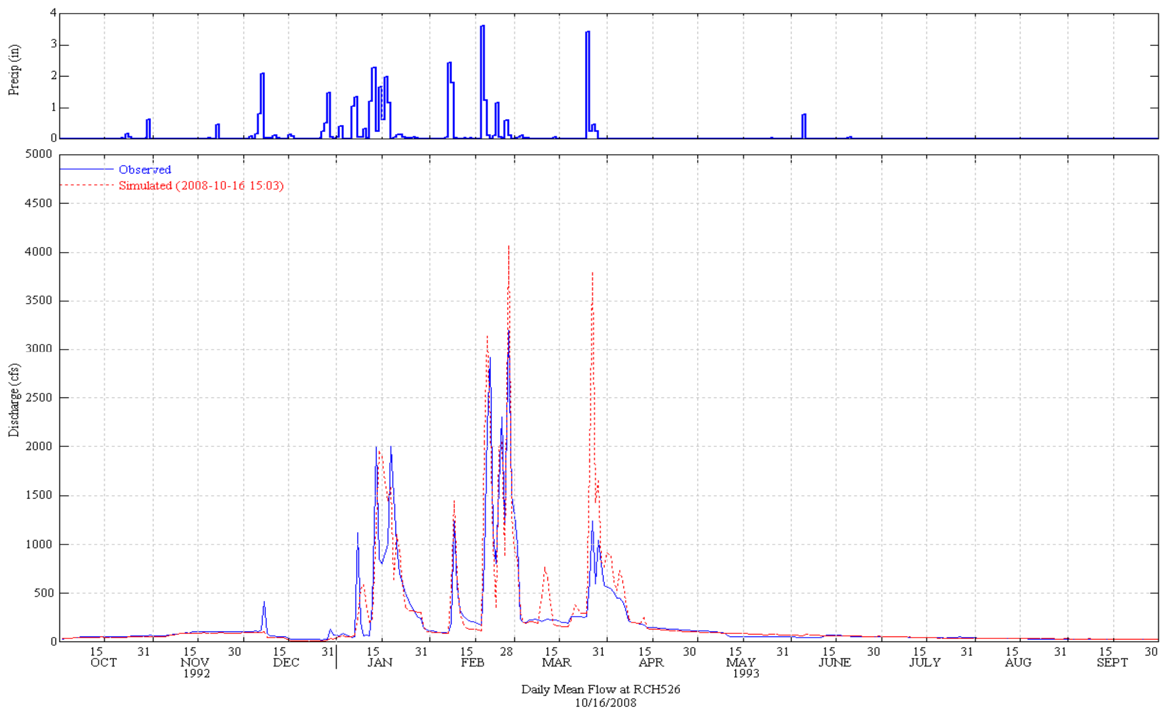

Figure 31 Simulated and Observed Daily Flow at Ab. Piru (WY 1993)

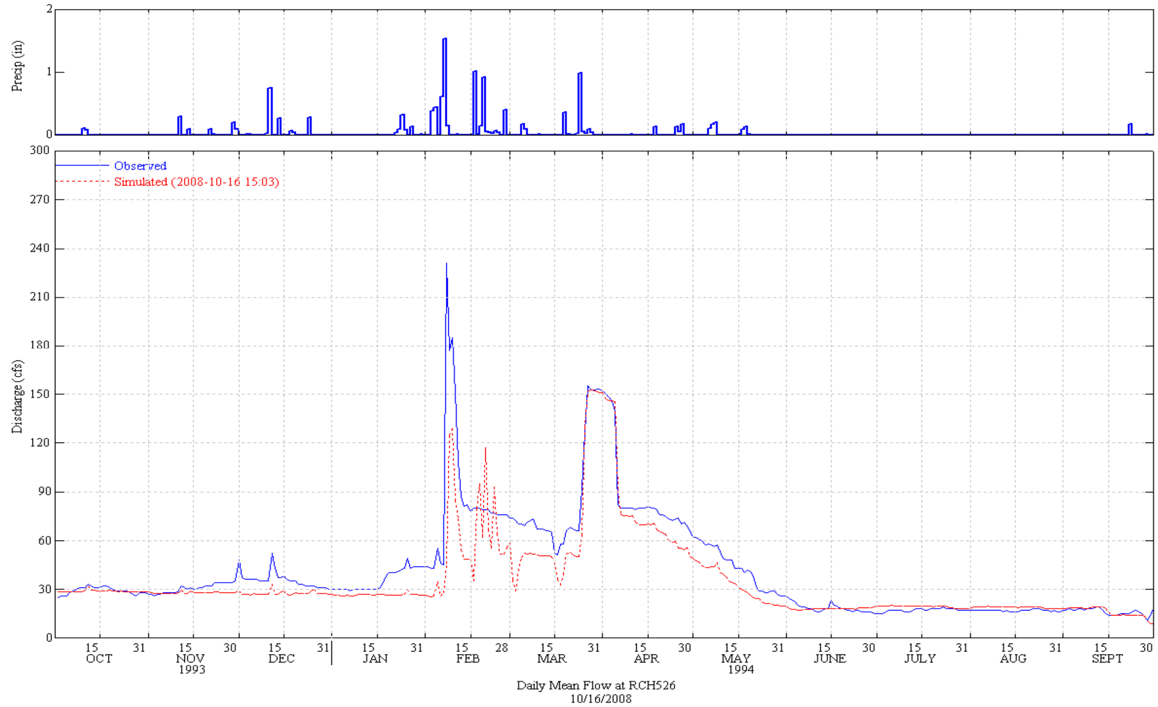

Figure 32 Simulated and Observed Daily Flow at Ab. Piru (WY 1994)

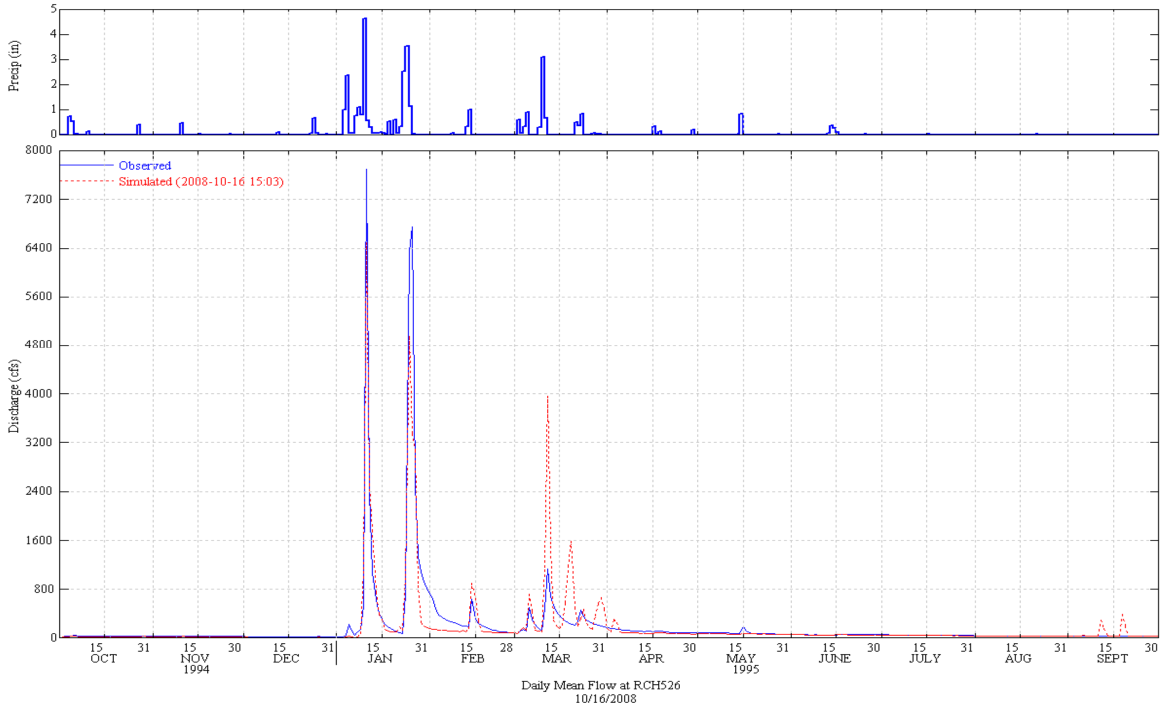

Figure 33 Simulated and Observed Daily Flow at Ab. Piru (WY 1995)

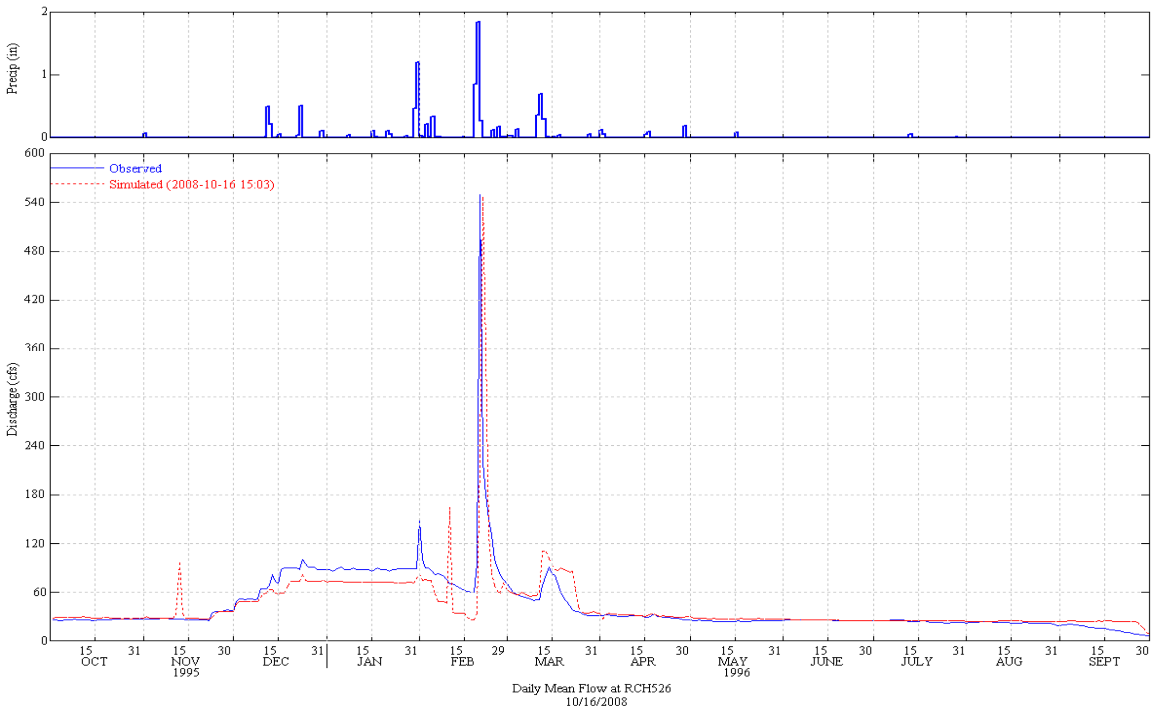

Figure 34 Simulated and Observed Daily Flow at Ab. Piru (WY 1996)

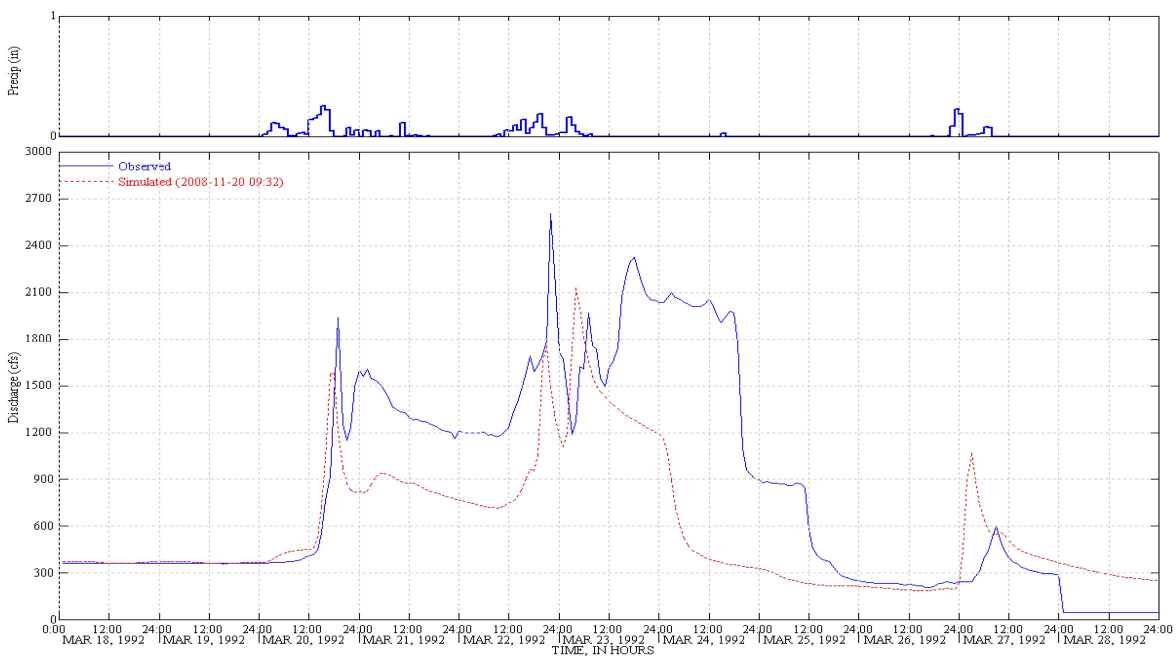

Figure 35 Simulated and Observed March 18, 1992 Storm Event

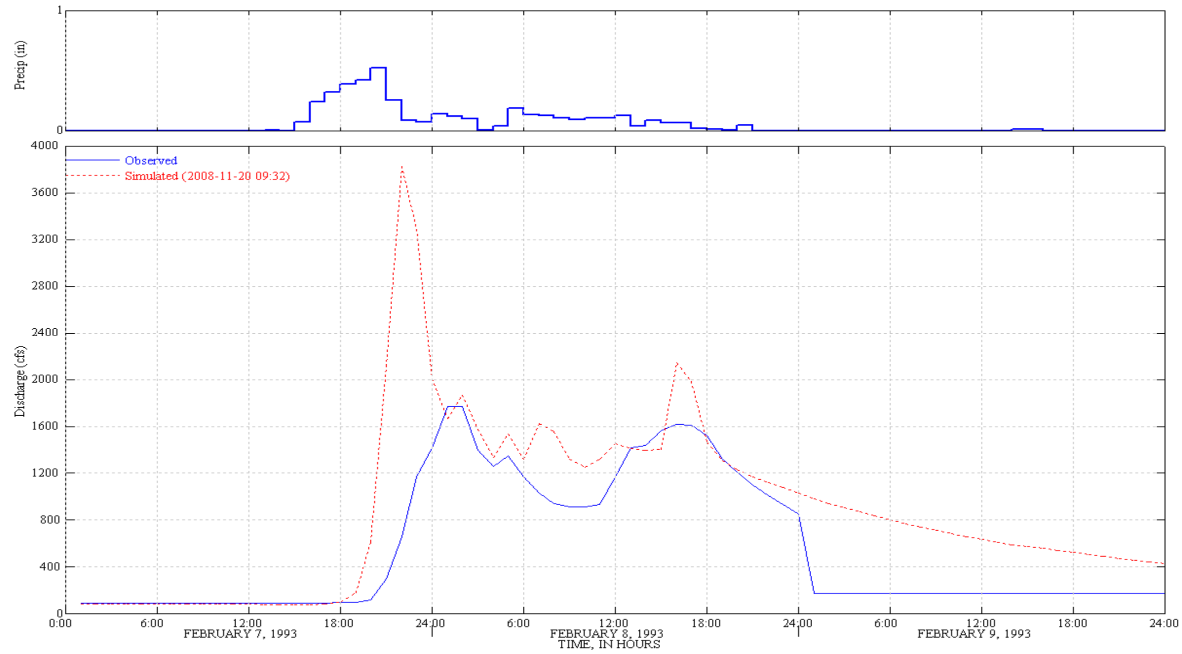

Figure 36 Simulated and Observed February 7, 1993 Storm Event

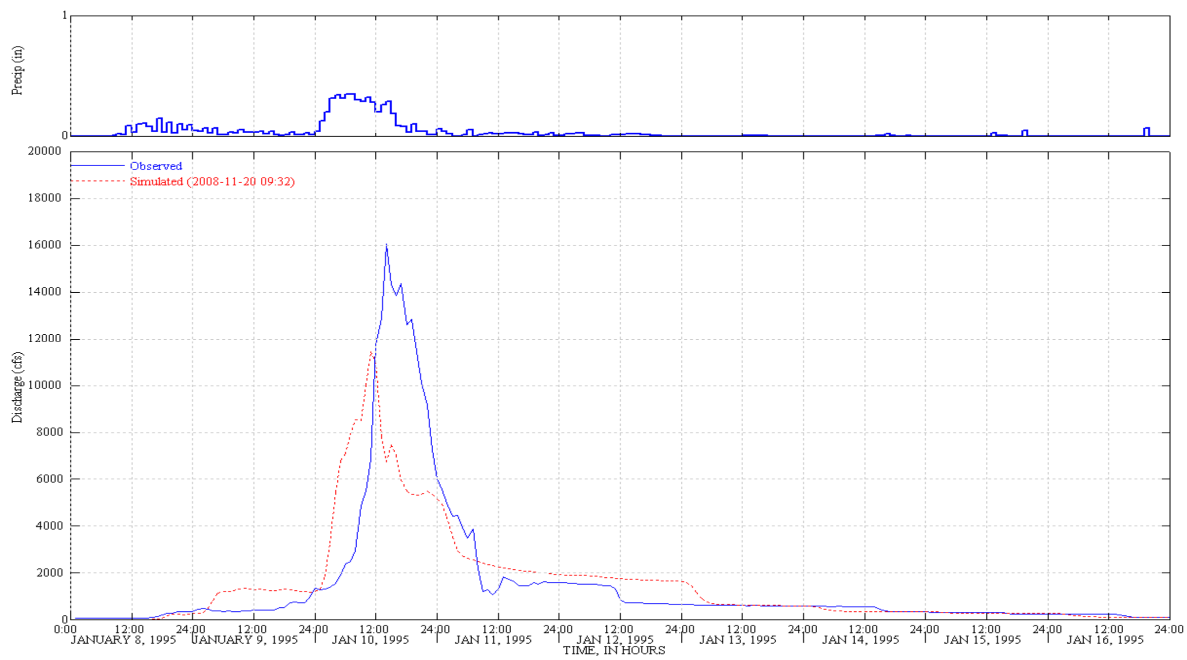

Figure 37 Simulated and Observed January 8, 1995 Storm Event

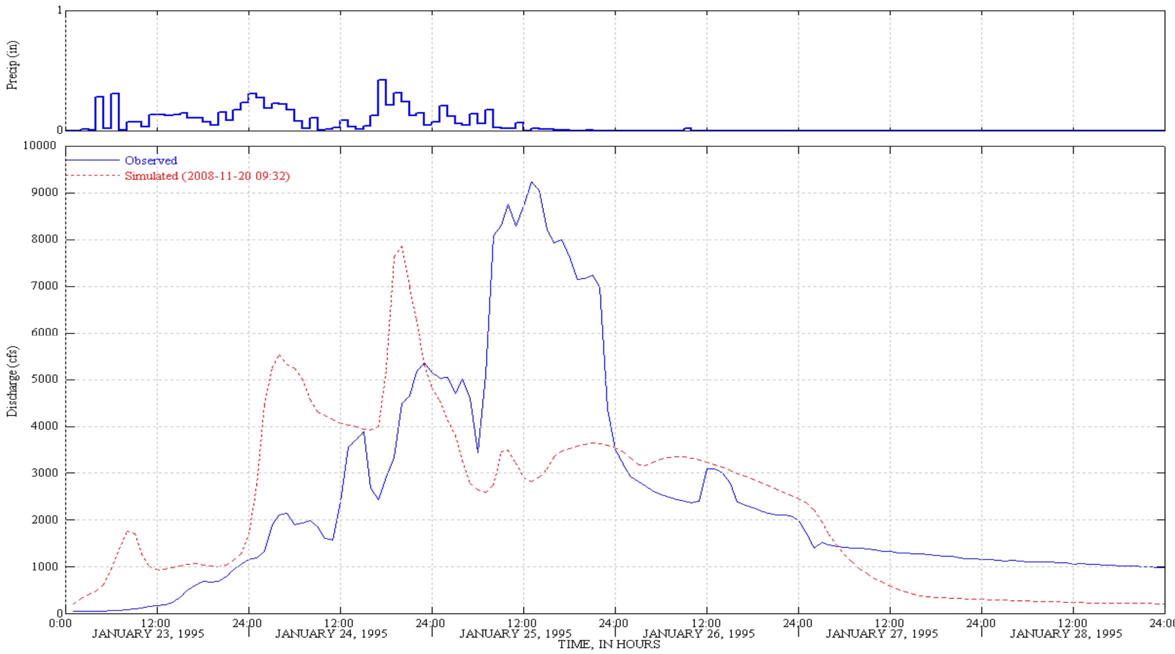

Figure 38 Simulated and Observed January 23, 1995 Storm Event

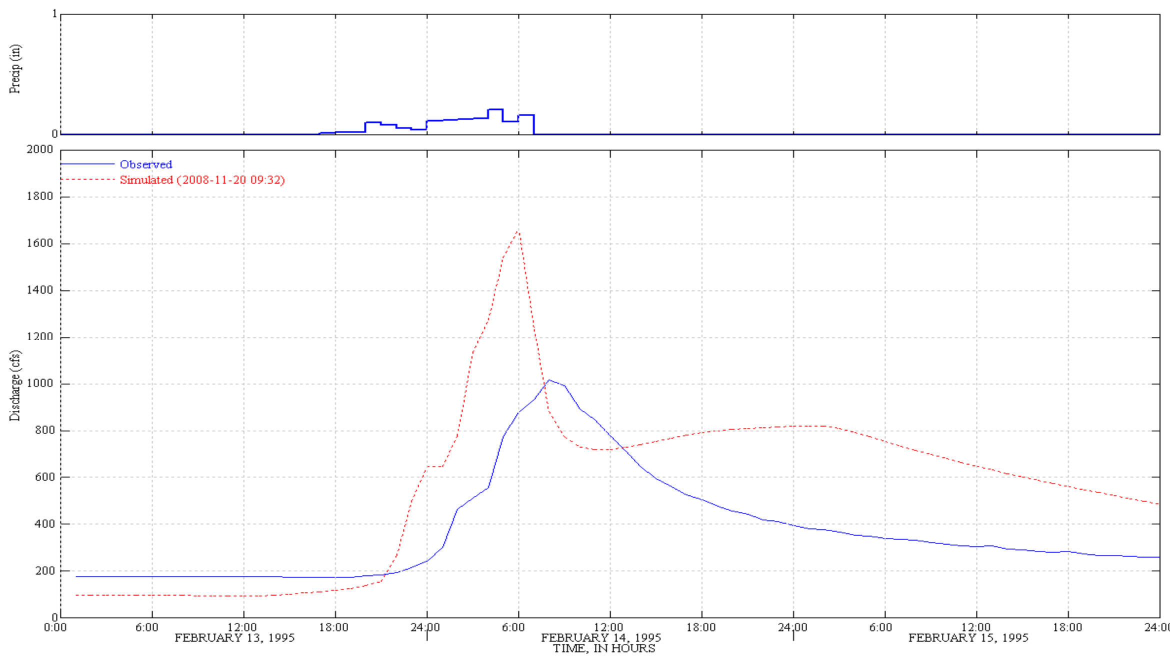

Figure 39 Simulated and Observed February 13, 1995 Storm Event

APPENDIX K

HYDROLOGY CALIBRATION / VALIDATION RESULTS FOR THE SANTA CLARA RIVER WATERSHED AT MONTALVO

Title Page

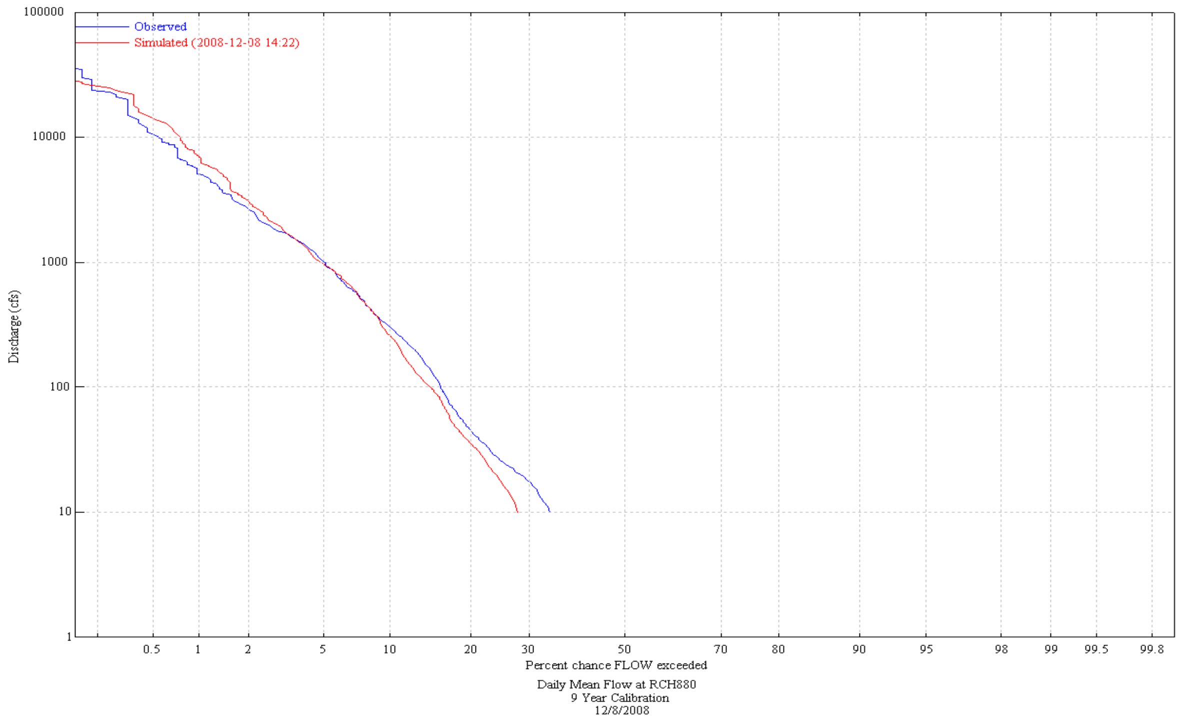

Figure 1 Simulated and Observed Daily Flow Duration Curve at Montalvo

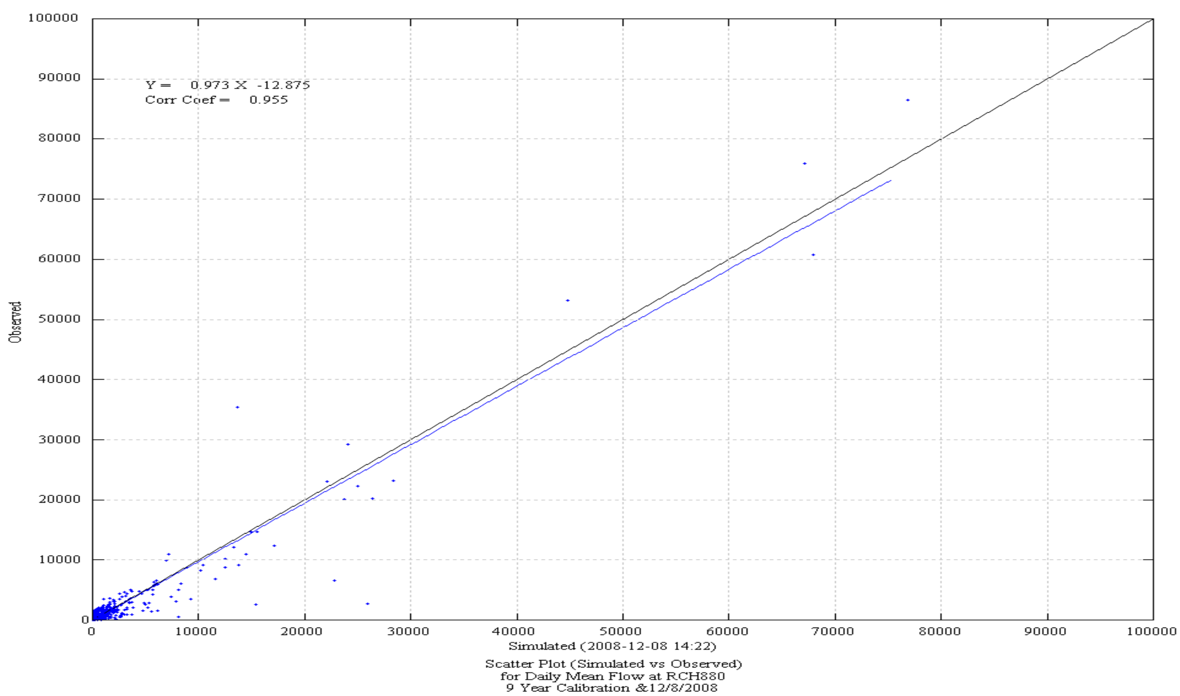

Figure 2 Daily Scatter Plot of Simulated versus Observed Flow at Montalvo

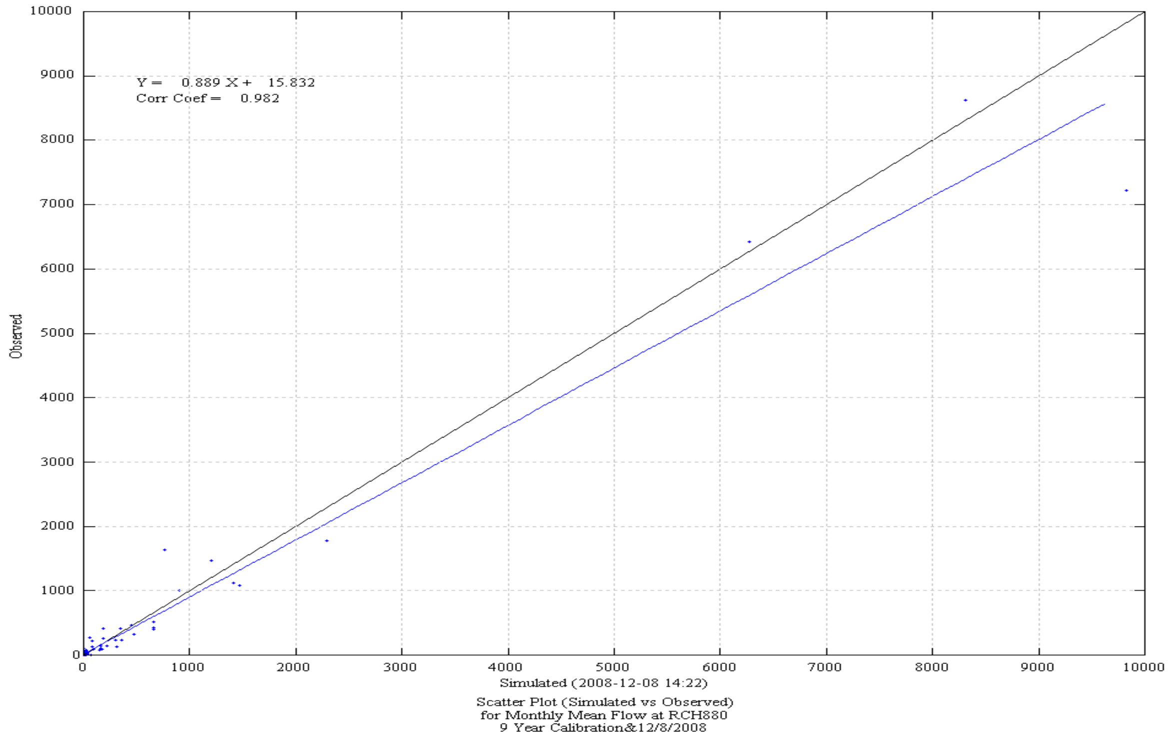

Figure 3 Monthly Scatter Plot of Simulated versus Observed Flow at Montalvo

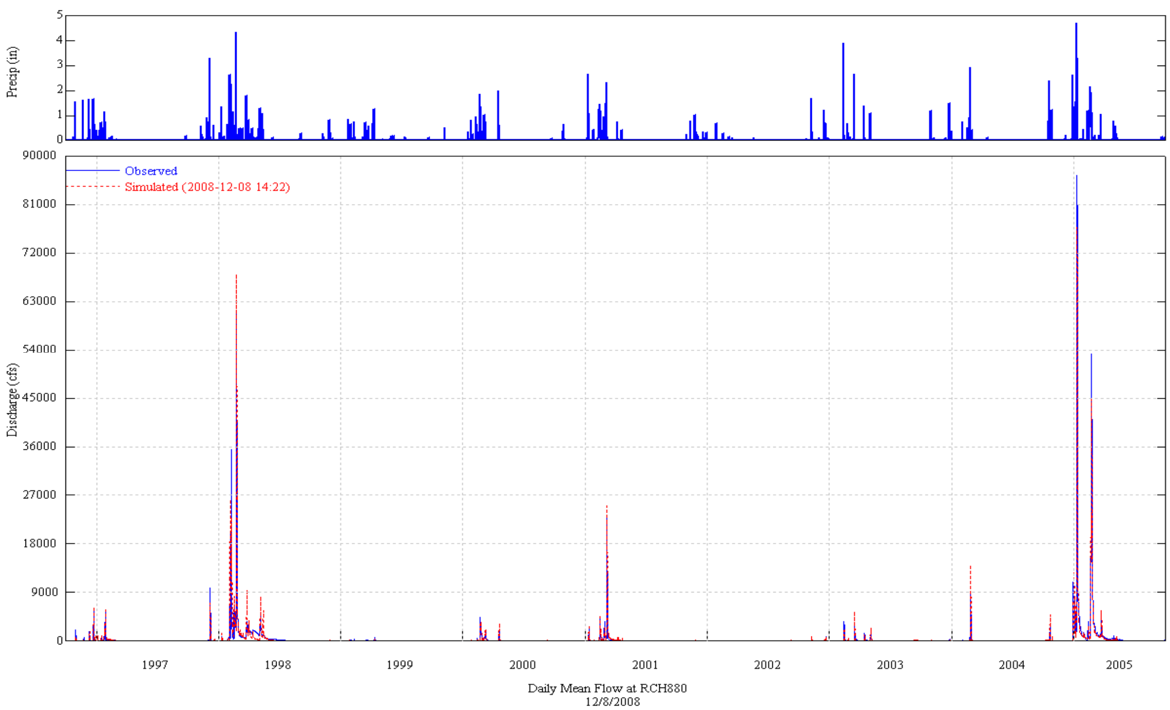

Figure 4 Simulated and Observed Daily Flow at Montalvo (WY 1997-2005)

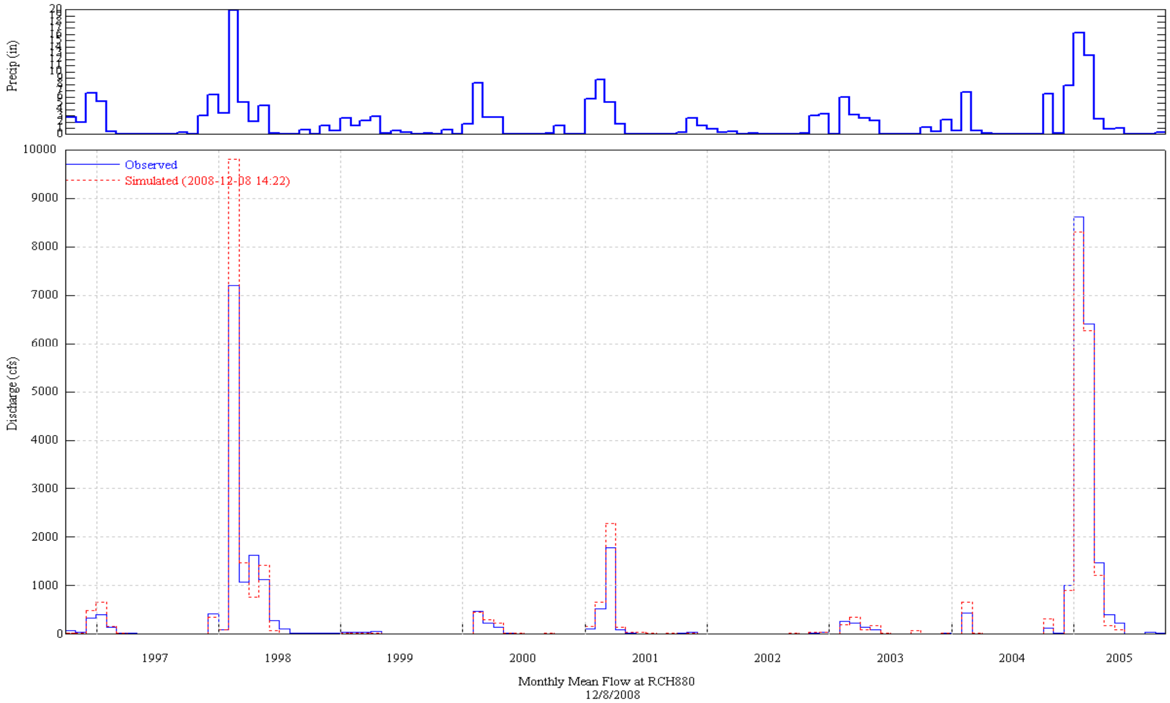

Figure 5 Simulated and Observed Monthly Flow at Montalvo (WY 1997-2005)

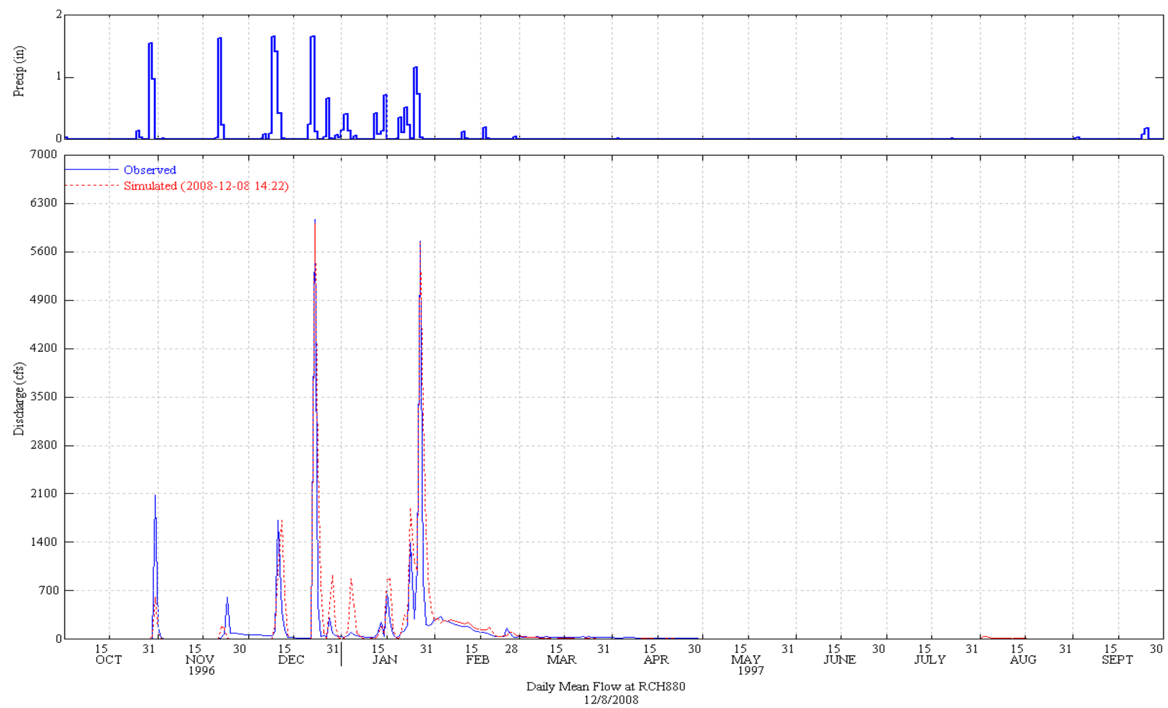

Figure 6 Simulated and Observed Daily Flow at Montalvo (WY 1997)

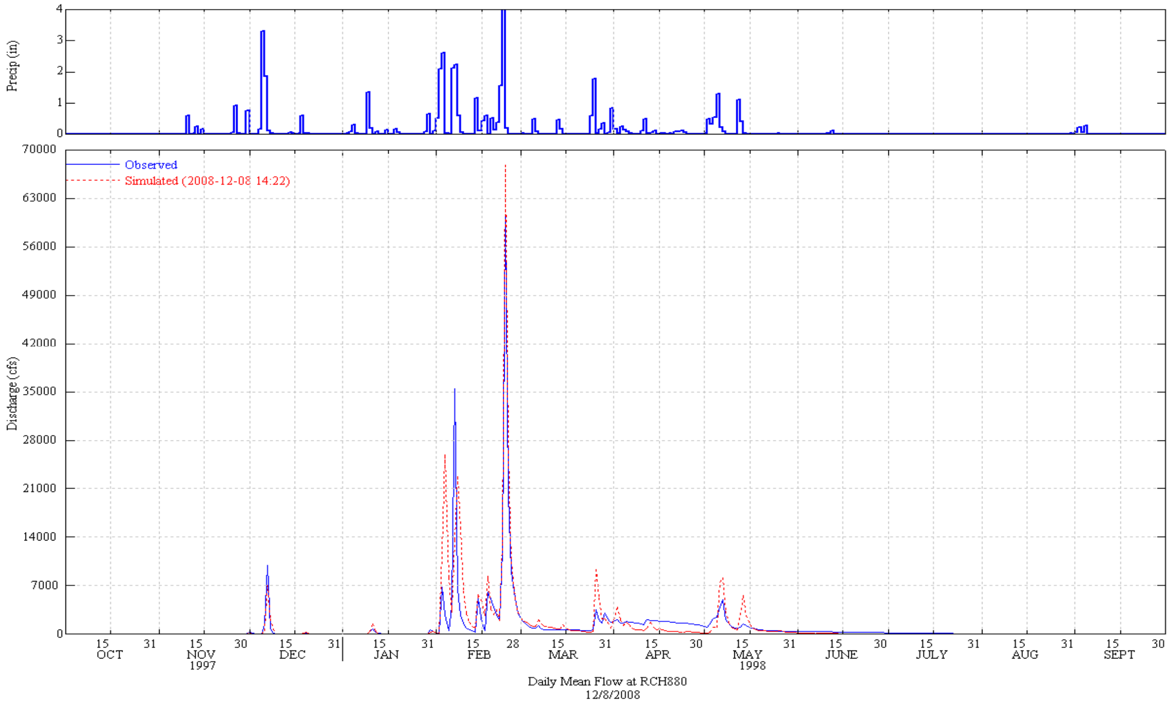

Figure 7 Simulated and Observed Daily Flow at Montalvo (WY 1998)

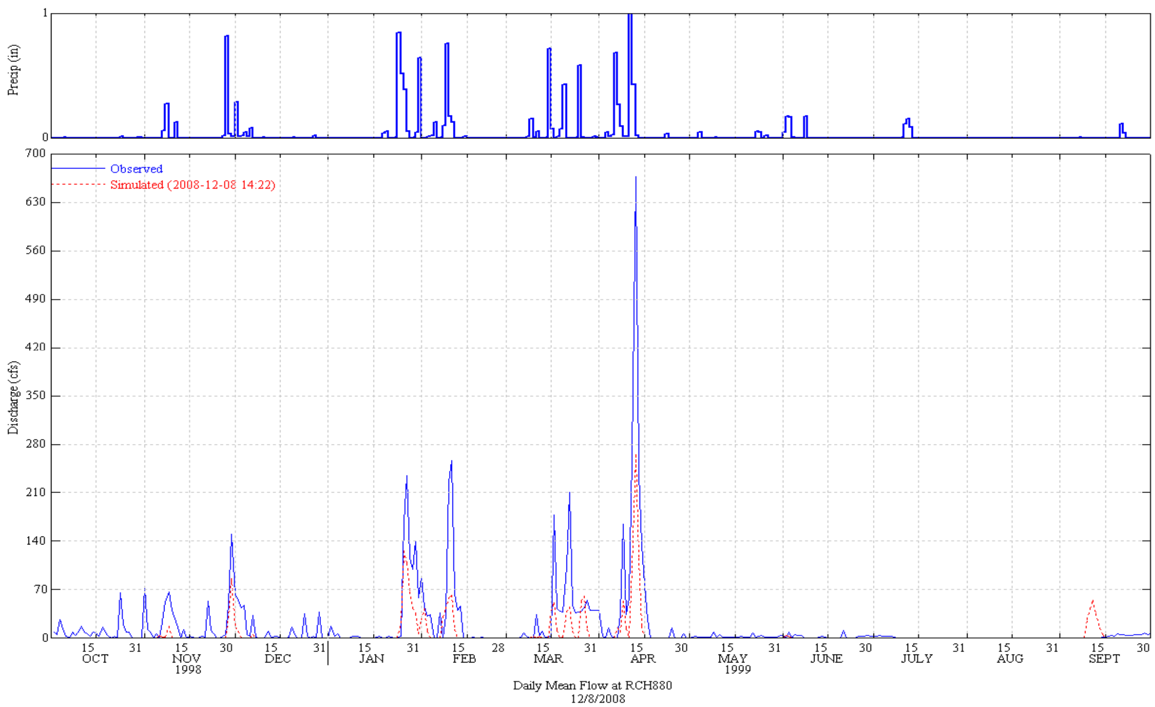

Figure 8 Simulated and Observed Daily Flow at Montalvo (WY 1999)

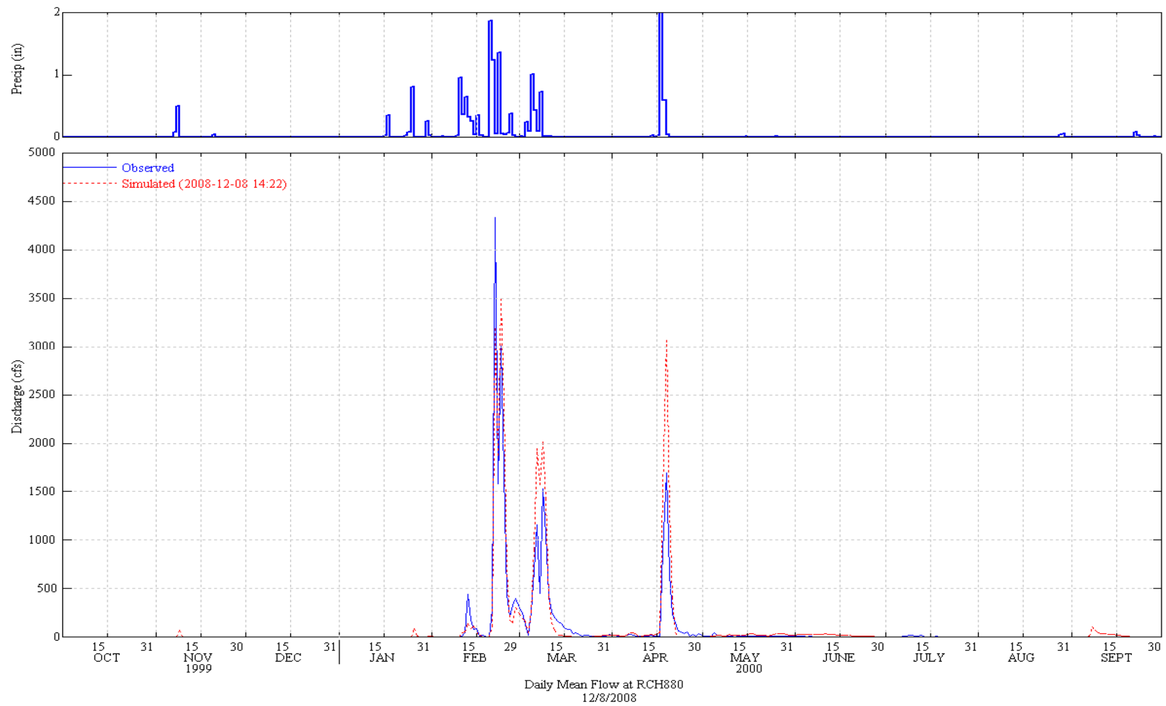

Figure 9 Simulated and Observed Daily Flow at Montalvo (WY 2000)

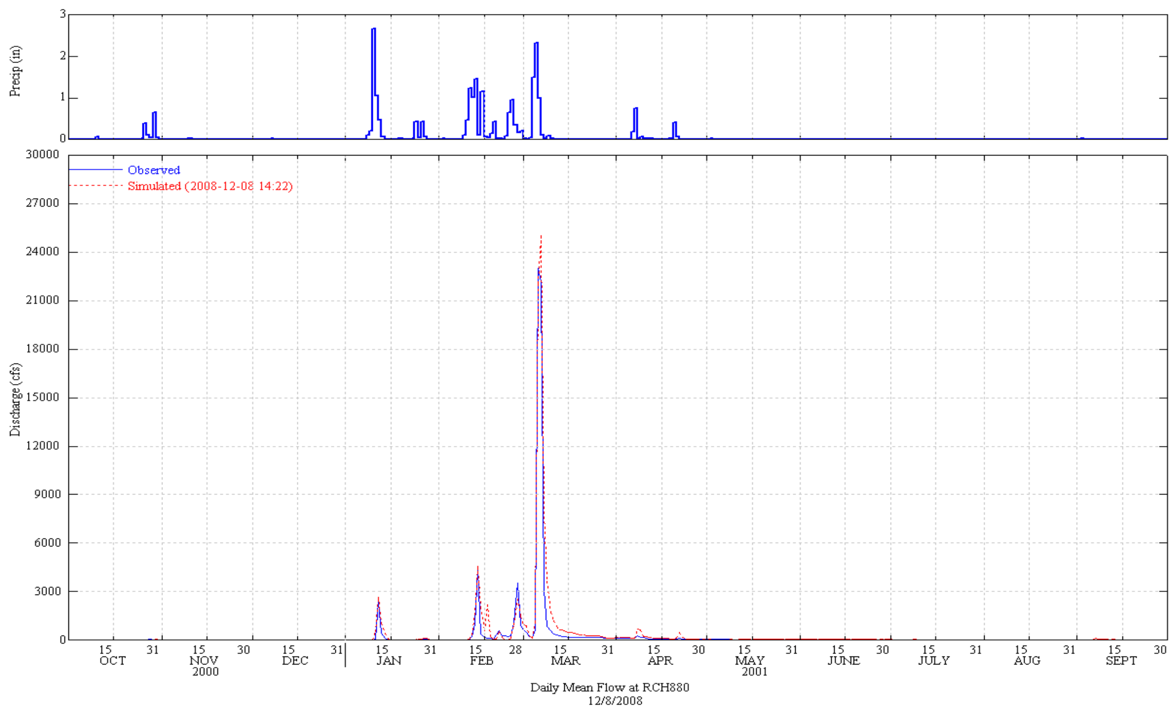

Figure 10 Simulated and Observed Daily Flow at Montalvo (WY 2001)

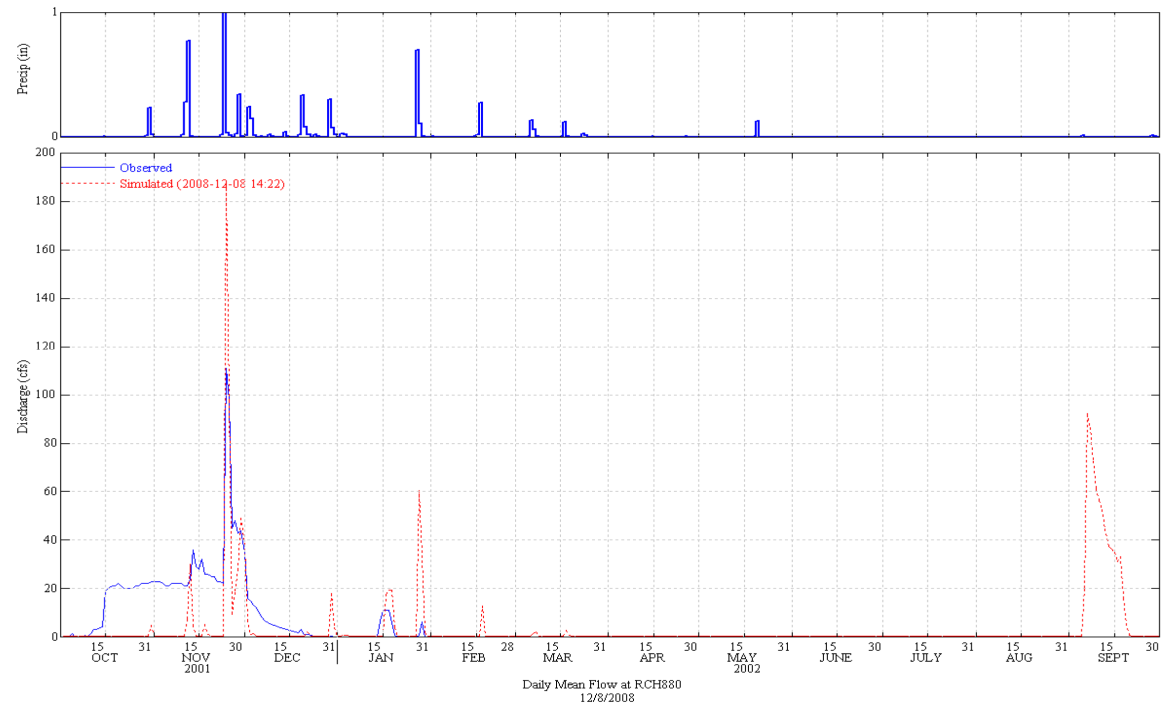

Figure 11 Simulated and Observed Daily Flow at Montalvo (WY 2002)

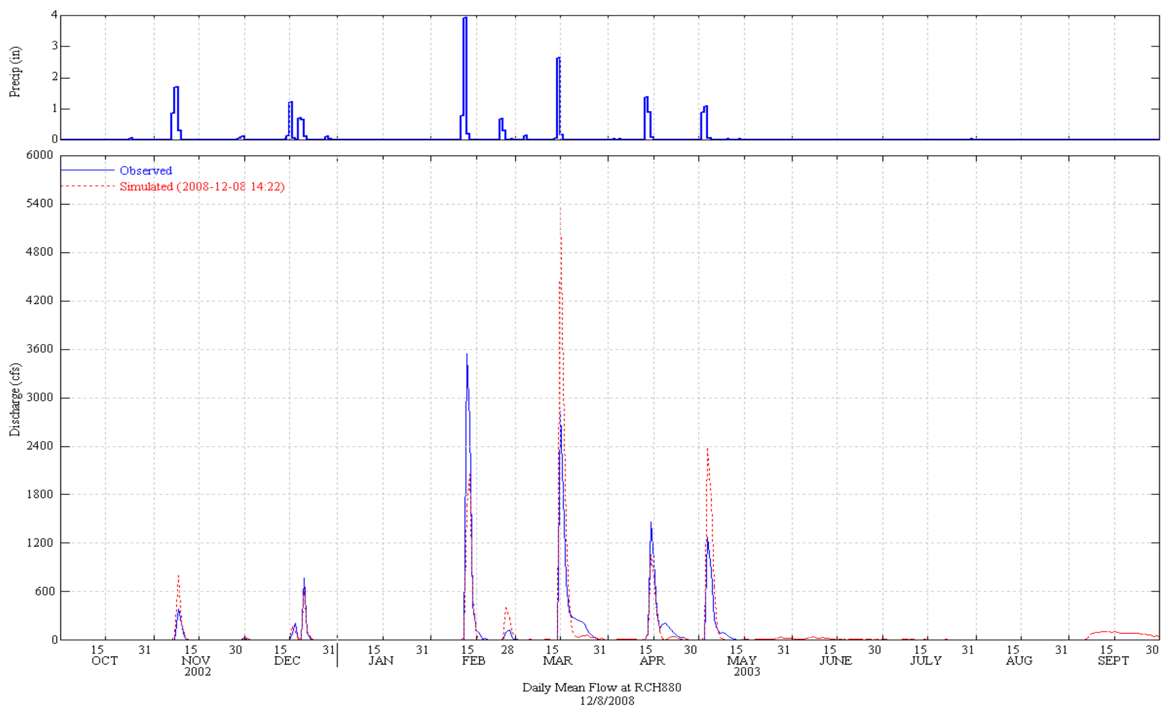

Figure 12 Simulated and Observed Daily Flow at Montalvo (WY 2003)

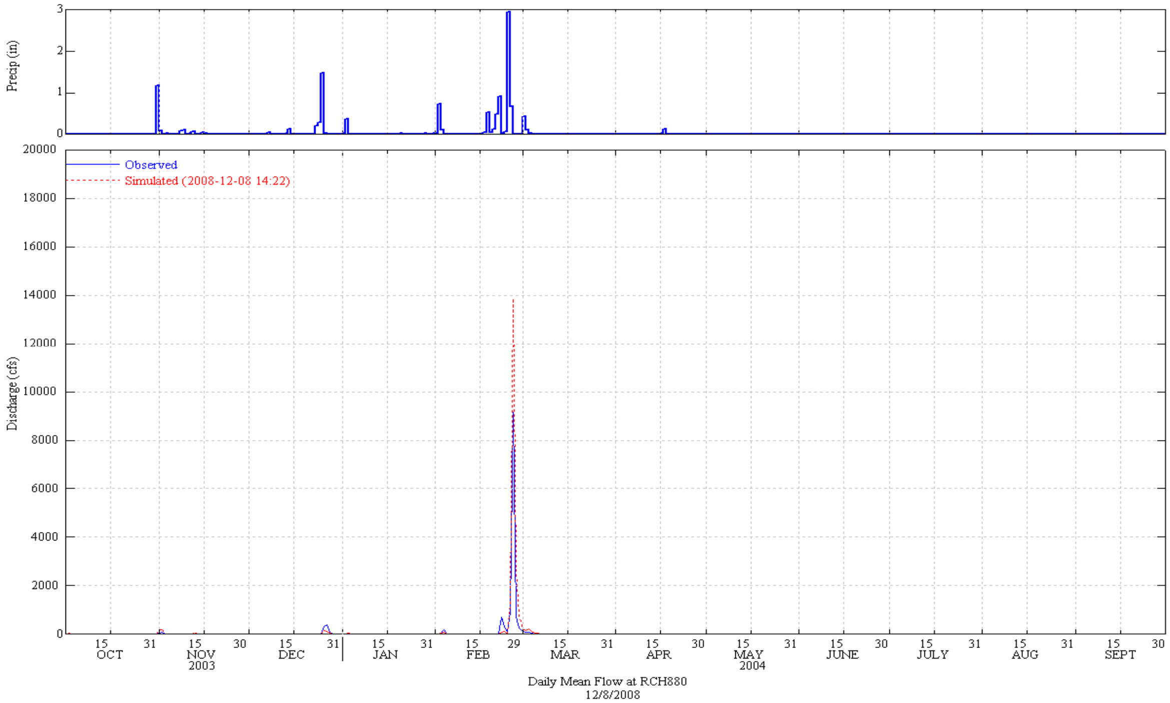

Figure 13 Simulated and Observed Daily Flow at Montalvo (WY 2004)

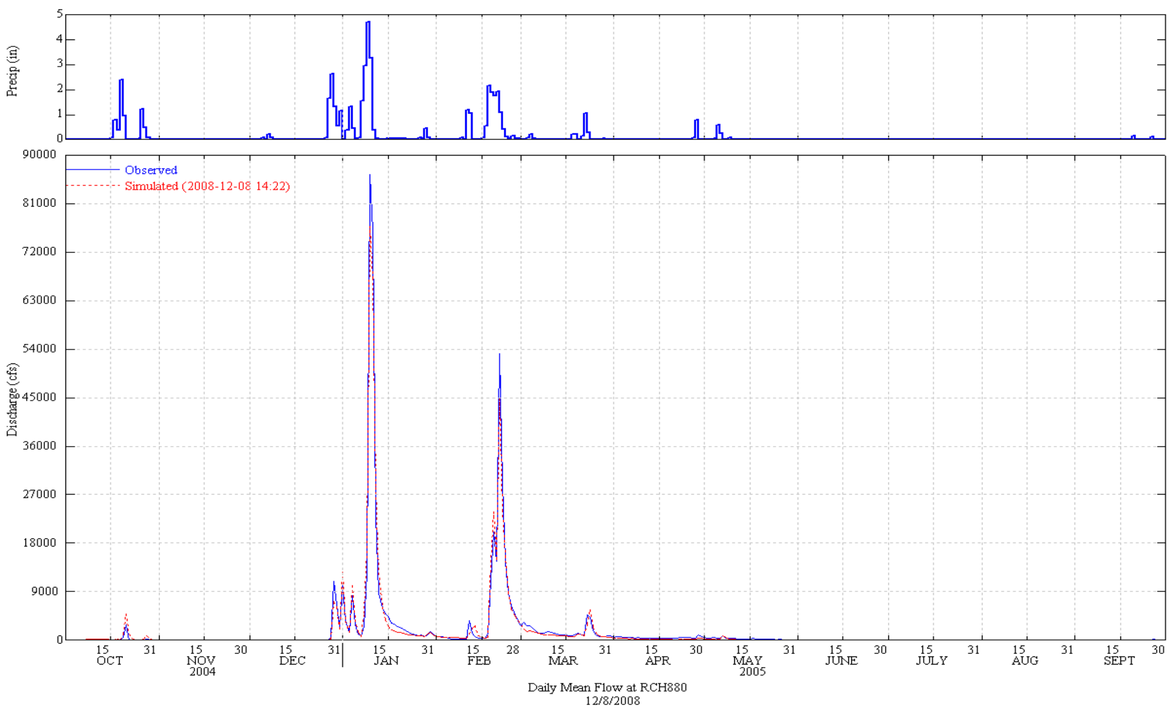

Figure 14 Simulated and Observed Daily Flow at Montalvo (WY 2005)

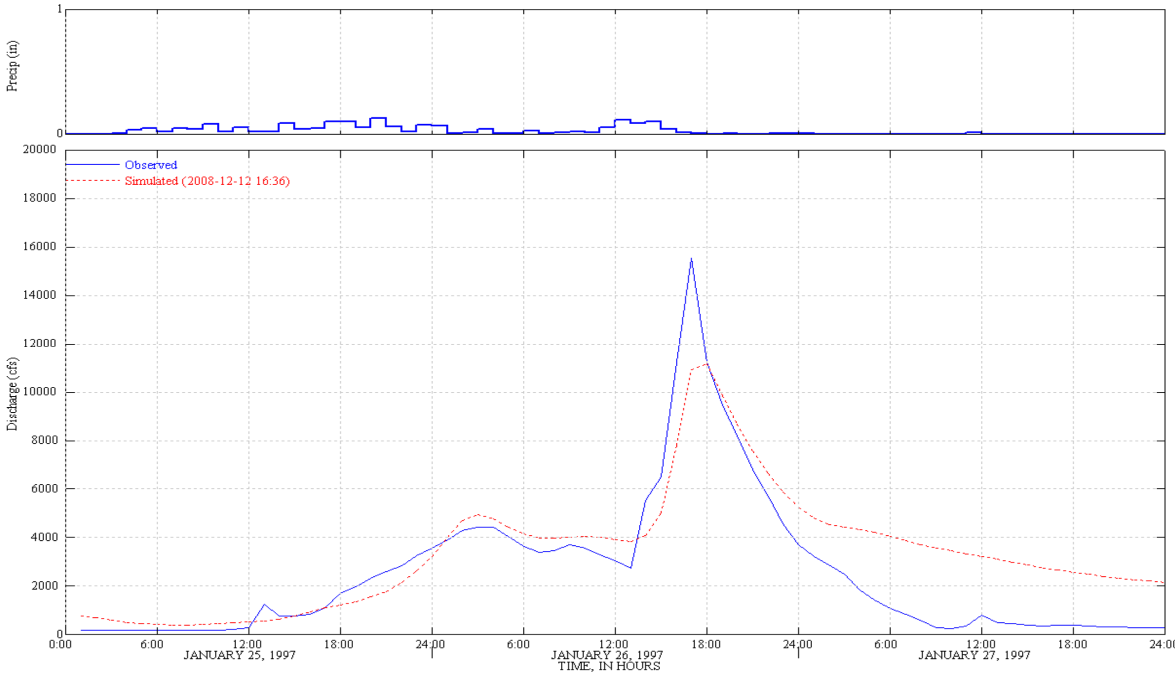

Figure 15 Simulated and Observed January 25-27, 1997 Storm Event

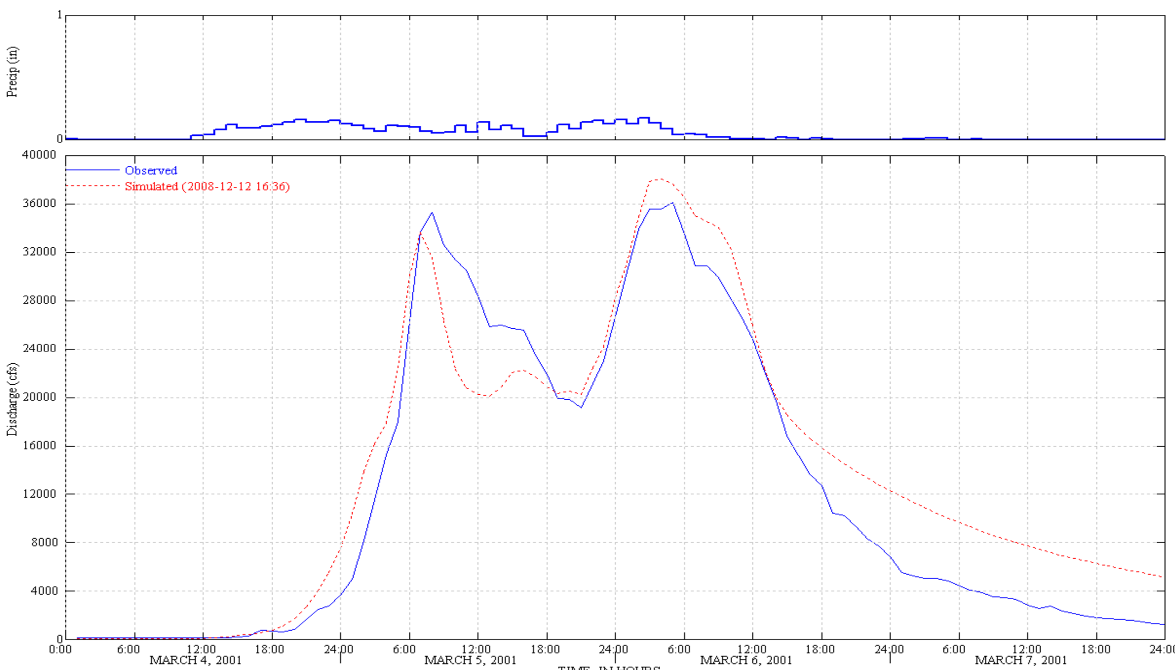

Figure 16 Simulated and Observed March 4-7, 2001 Storm Event

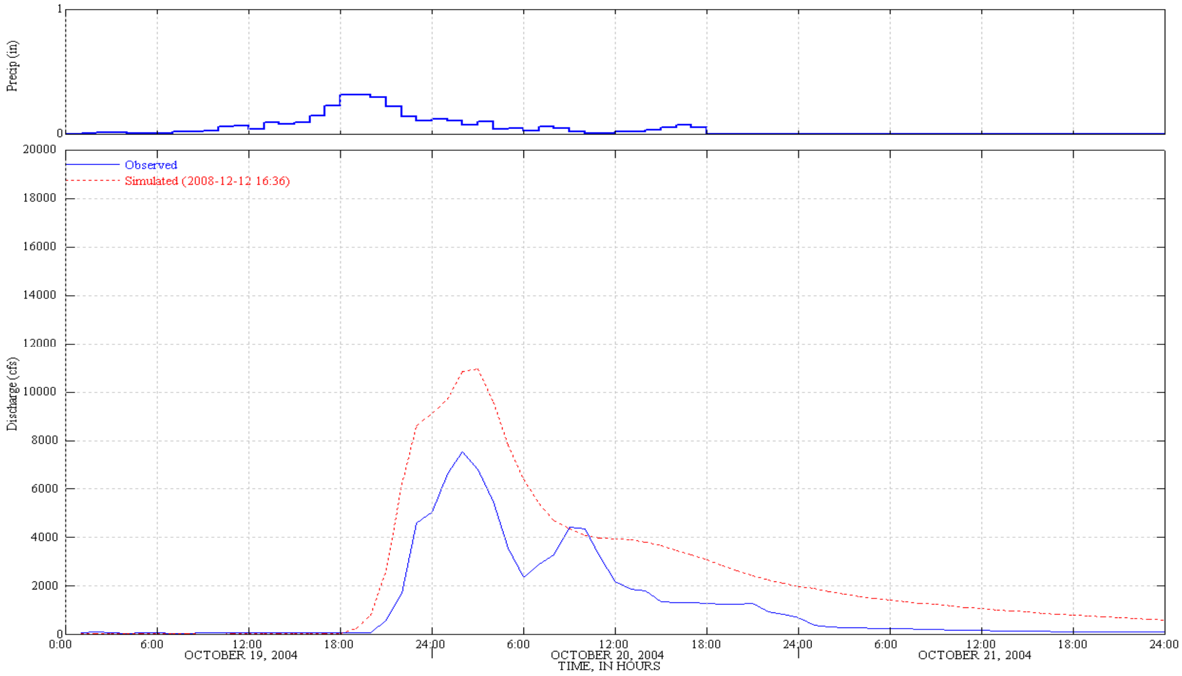

Figure 17 Simulated and Observed October 19-21, 2004 Storm Event

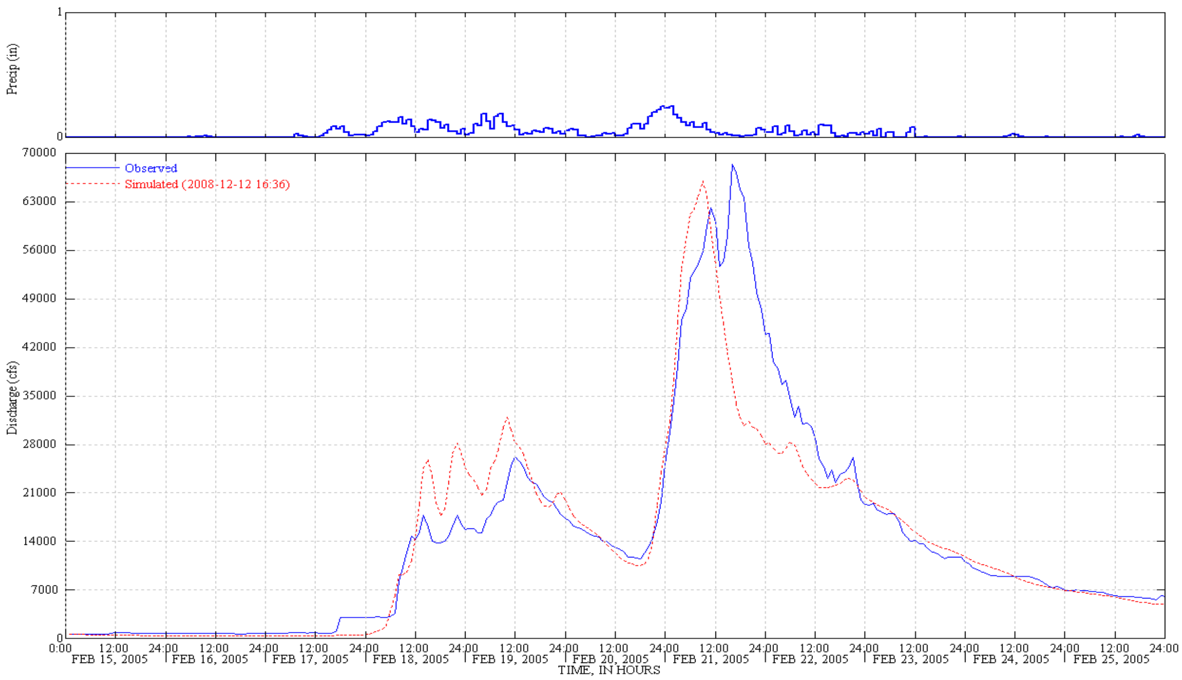

Figure 18 Simulated and Observed February 15-25, 2005 Storm Event

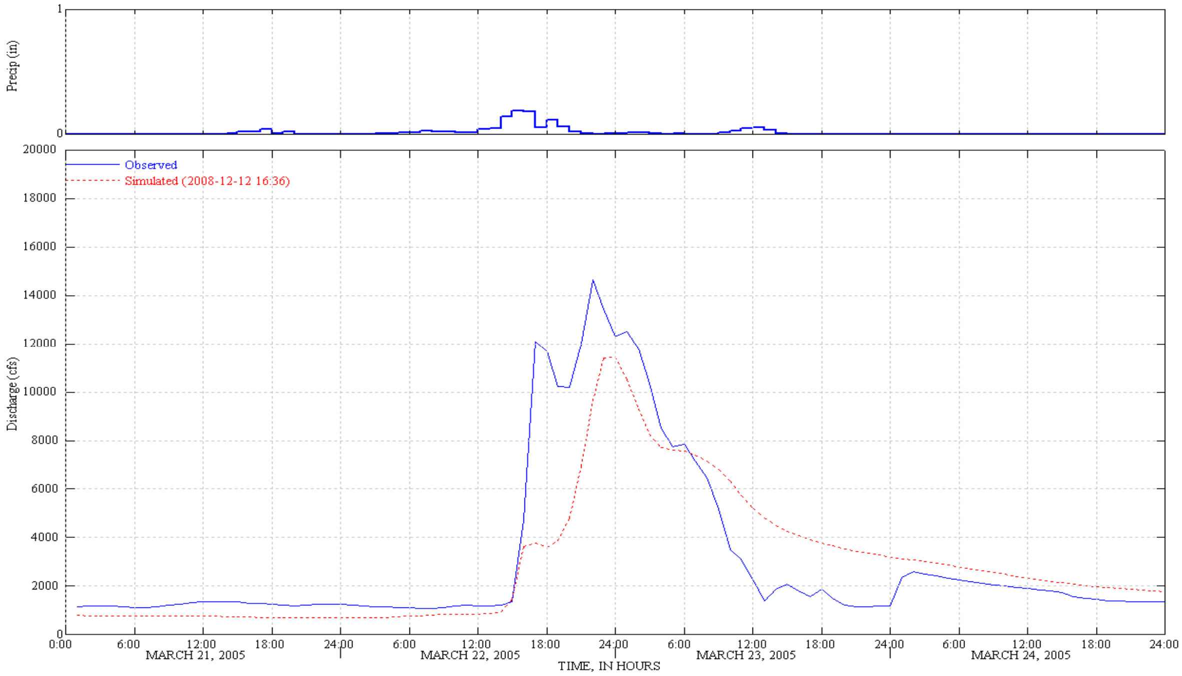

Figure 19 Simulated and Observed March 21-24, 2005 Storm Event

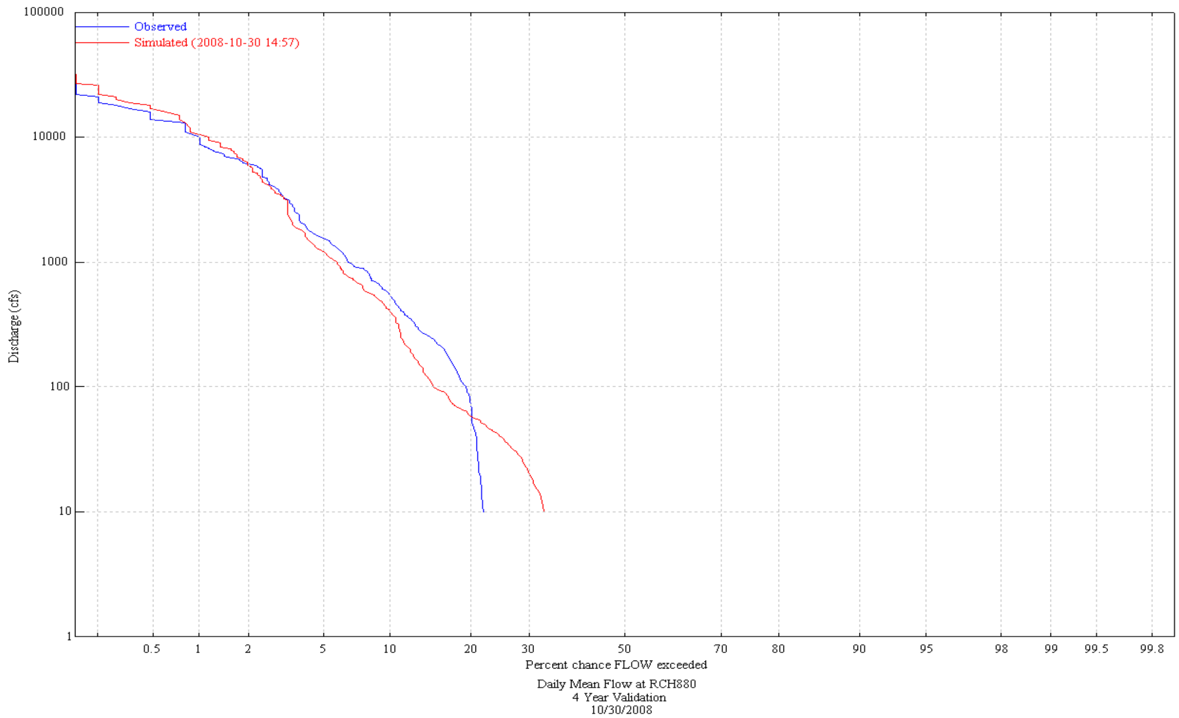

Figure 20 Simulated and Observed Daily Flow Duration Curve at Montalvo

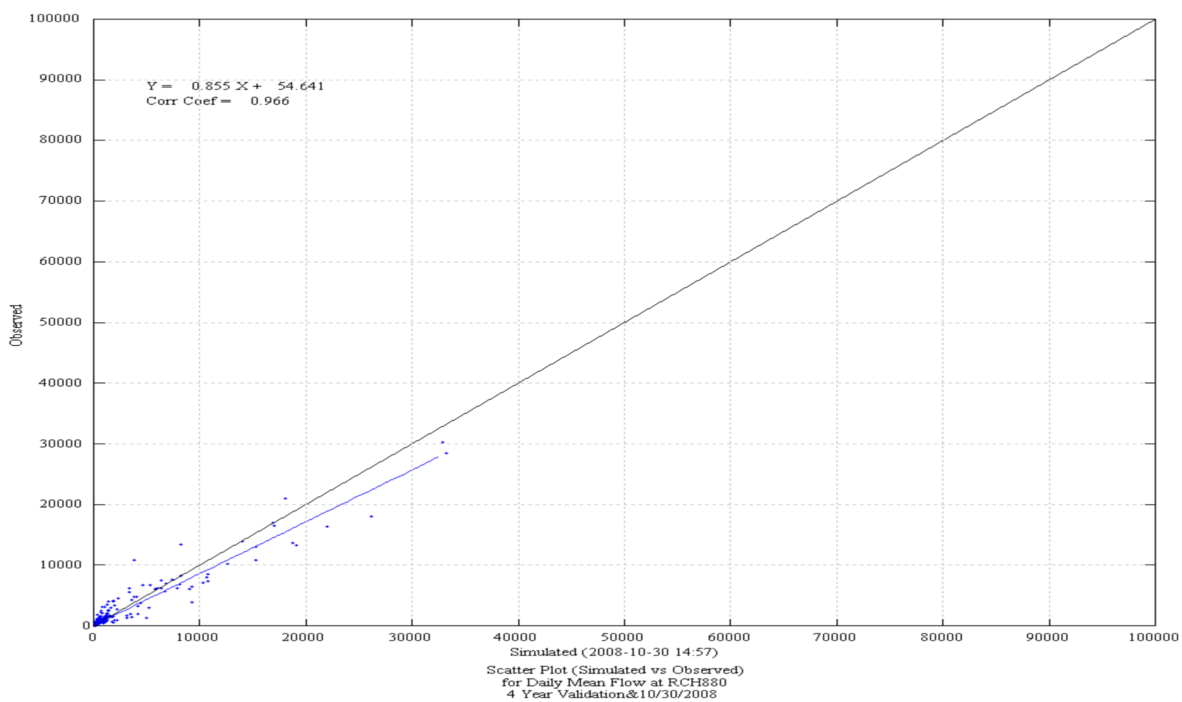

Figure 21 Daily Scatter Plot of Simulated versus Observed Flow at Montalvo

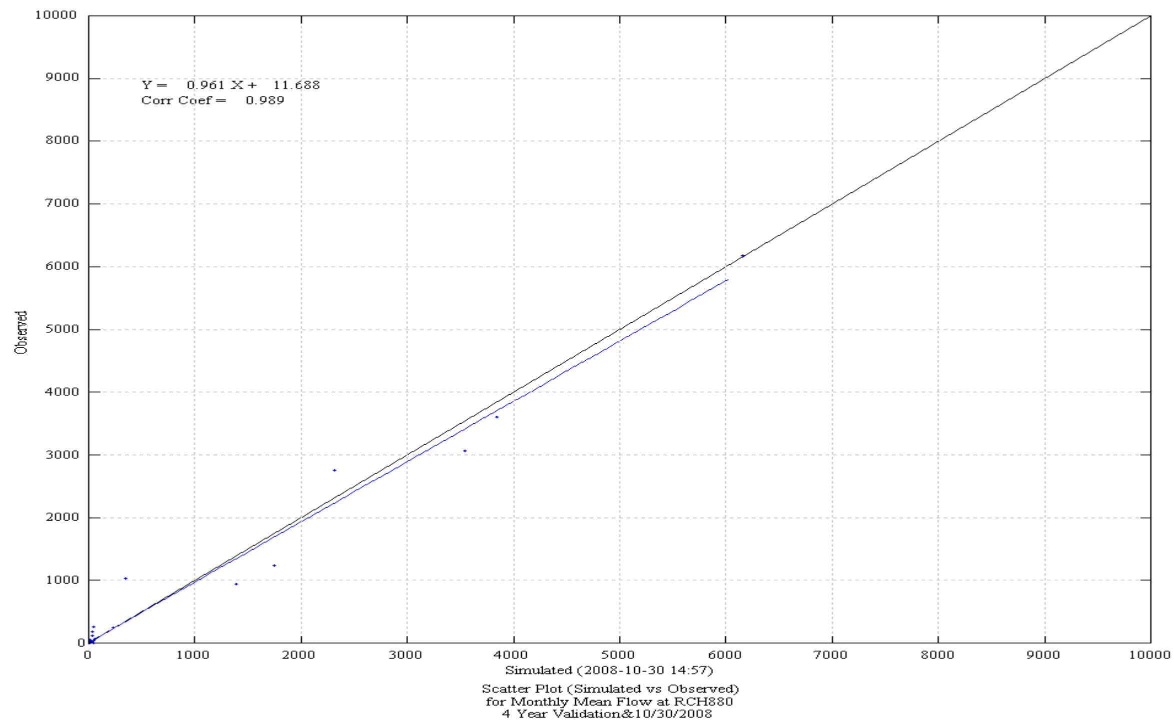

Figure 22 Monthly Scatter Plot of Simulated versus Observed Flow at Montalvo

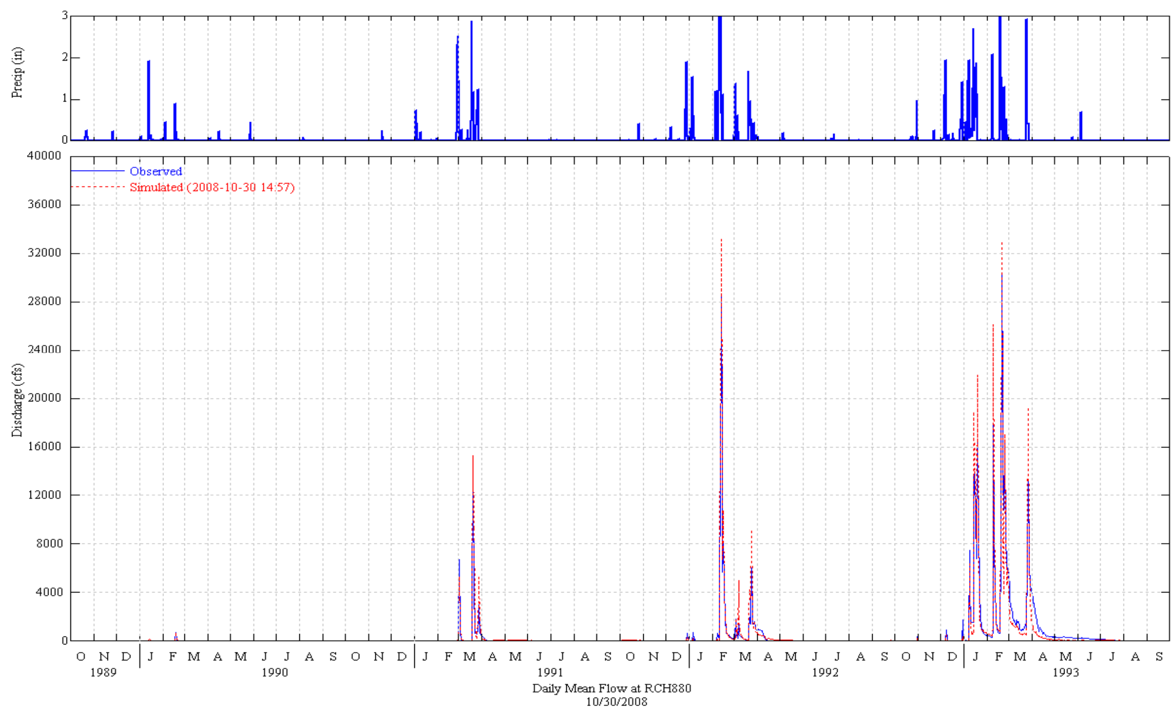

Figure 23 Simulated and Observed Daily Flow at Montalvo (WY 1990-1993)

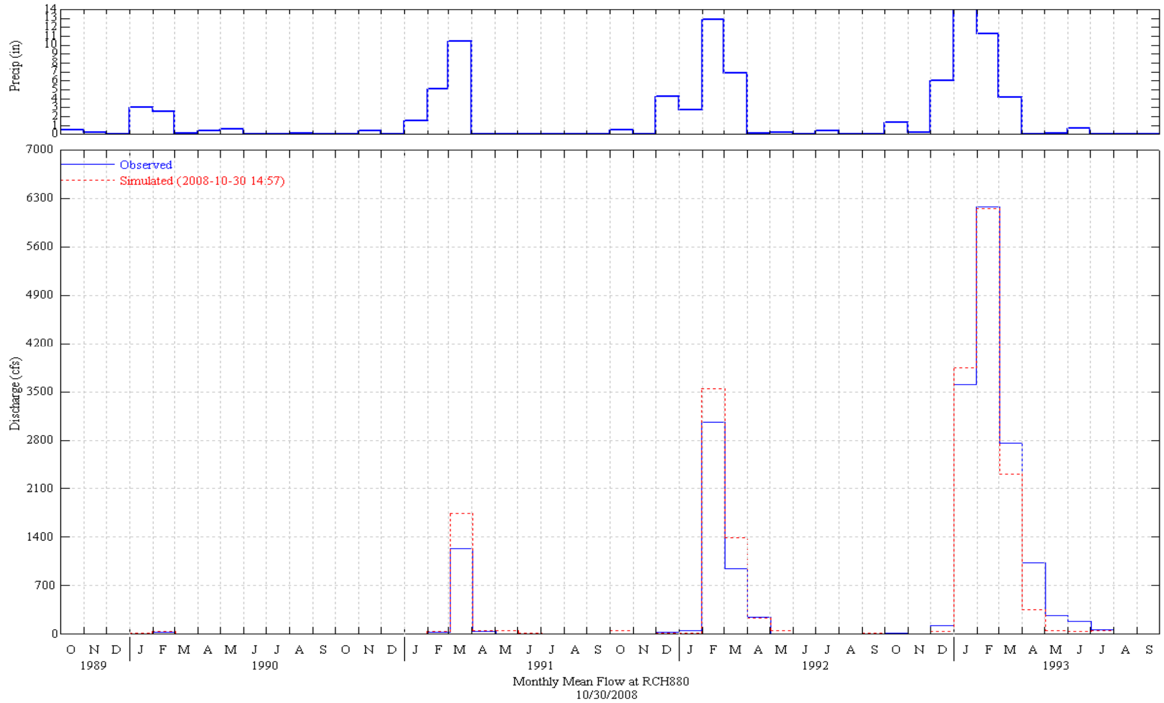

Figure 24 Simulated and Observed Monthly Flow at Montalvo (WY 1990-1993)

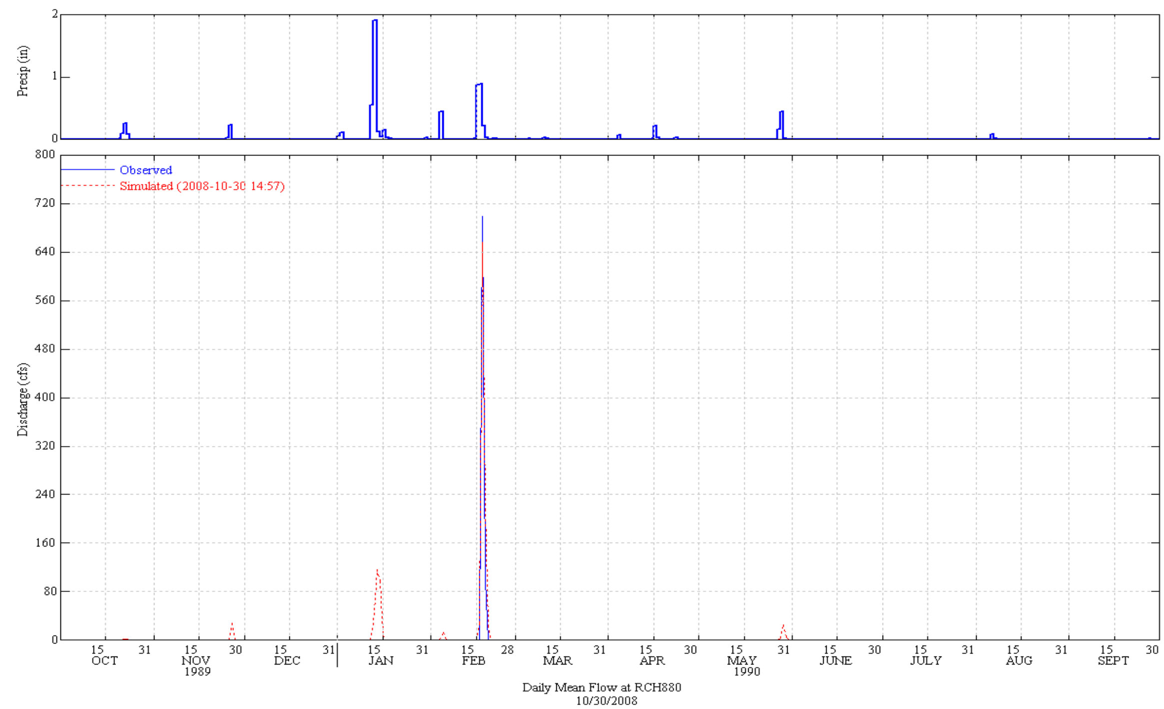

Figure 25 Simulated and Observed Daily Flow at Montalvo (WY 1990)

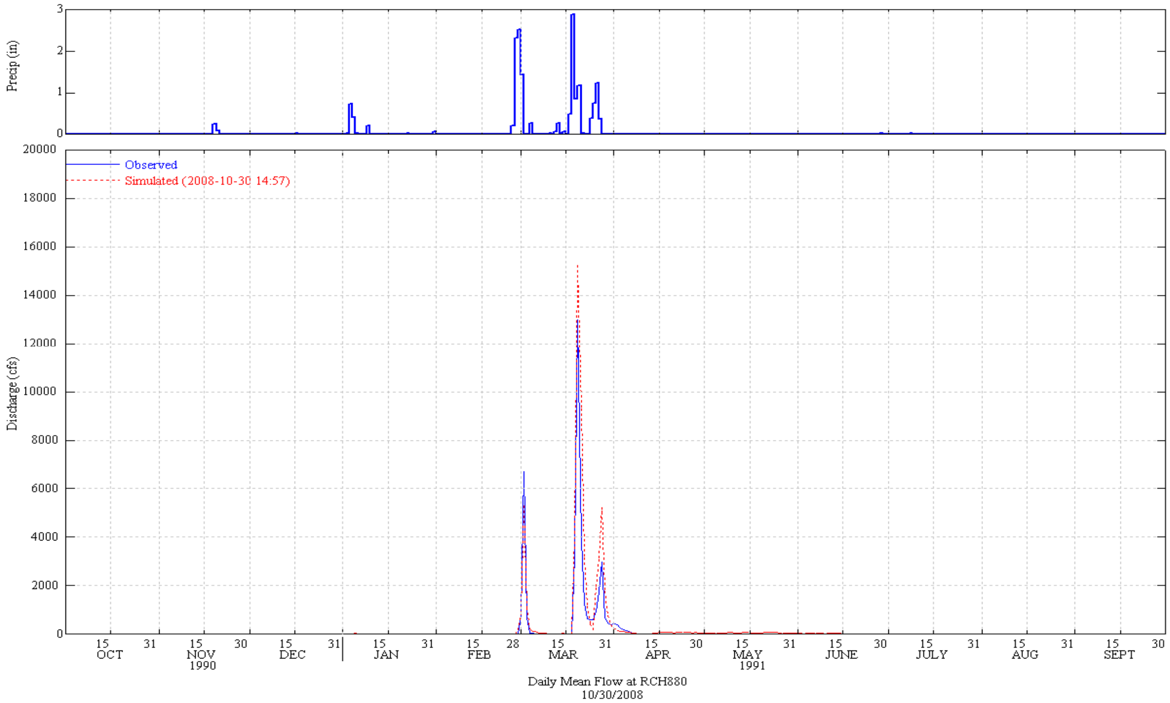

Figure 26 Simulated and Observed Daily Flow at Montalvo (WY 1991)

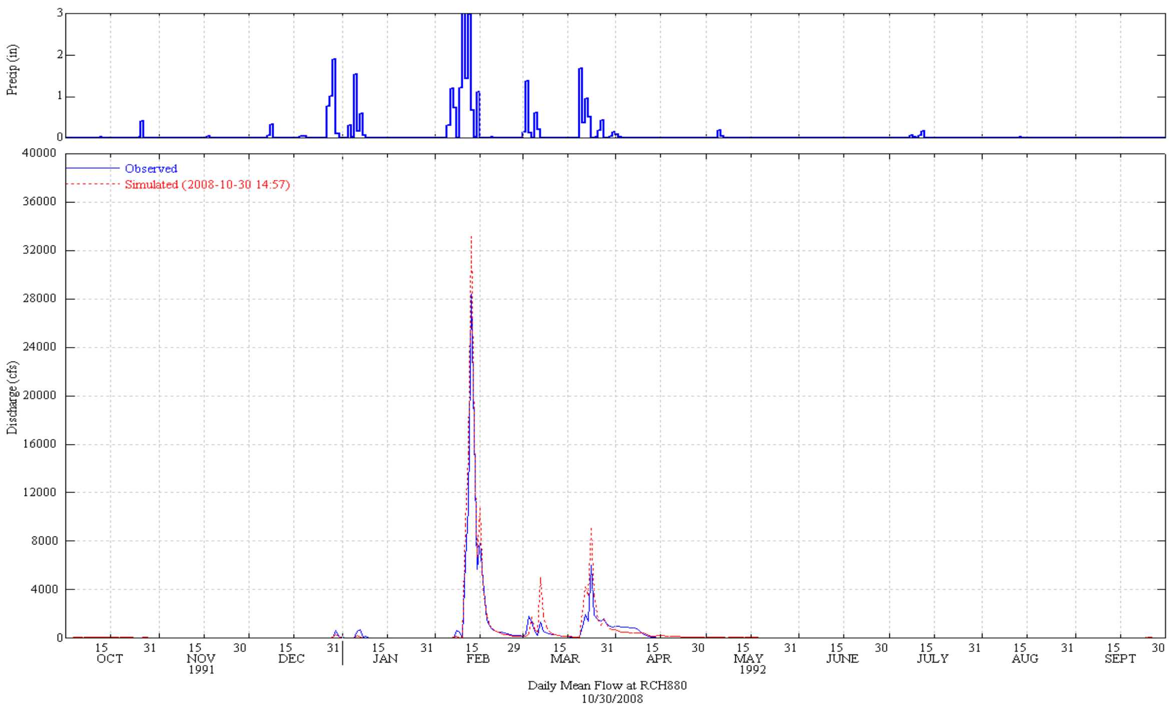

Figure 27 Simulated and Observed Daily Flow at Montalvo (WY 1992)

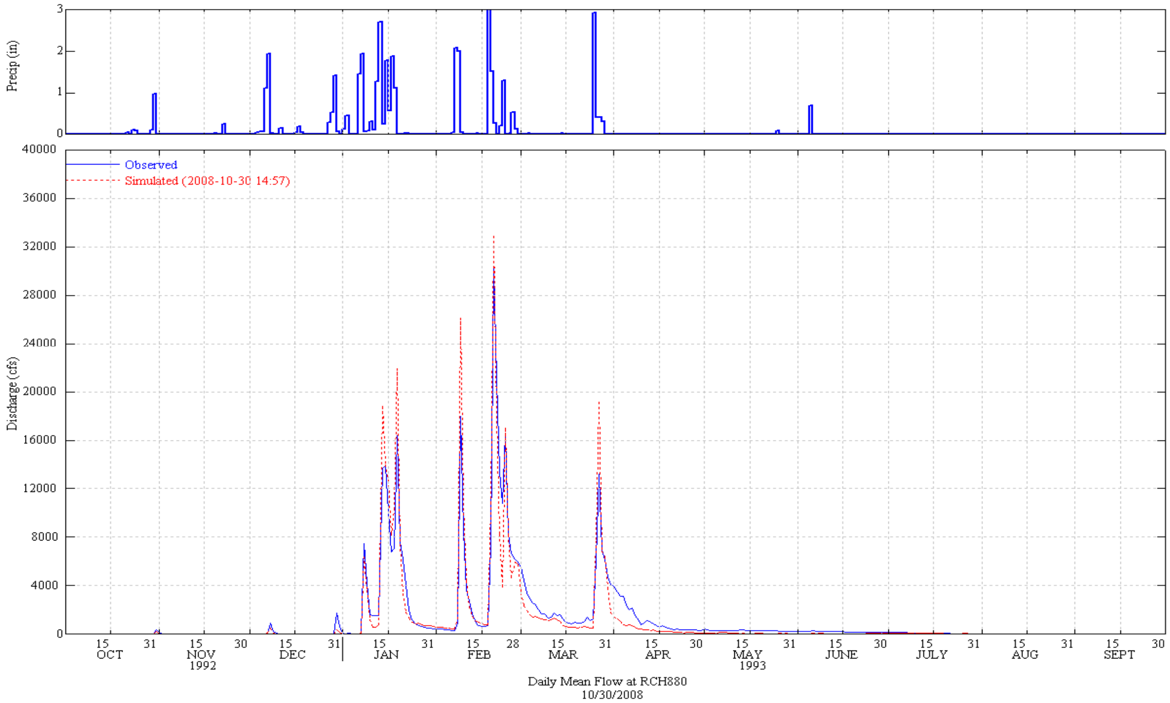

Figure 28 Simulated and Observed Daily Flow at Montalvo (WY 1993)

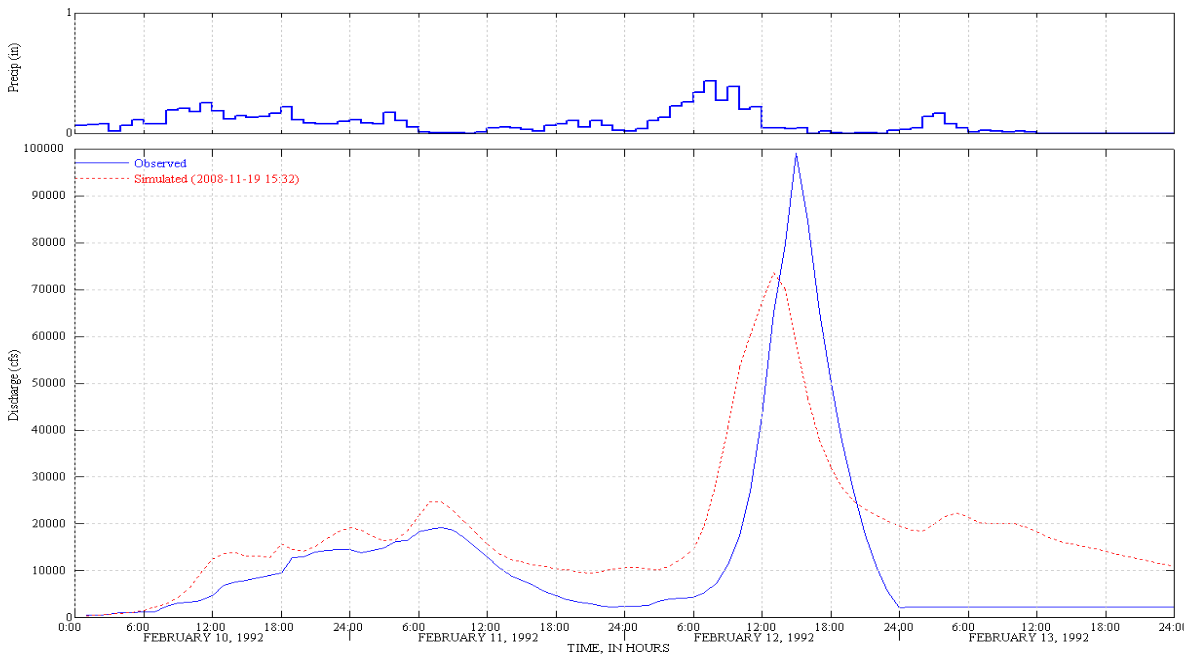

Figure 29 Simulated and Observed February 10-13, 1992 Storm Event

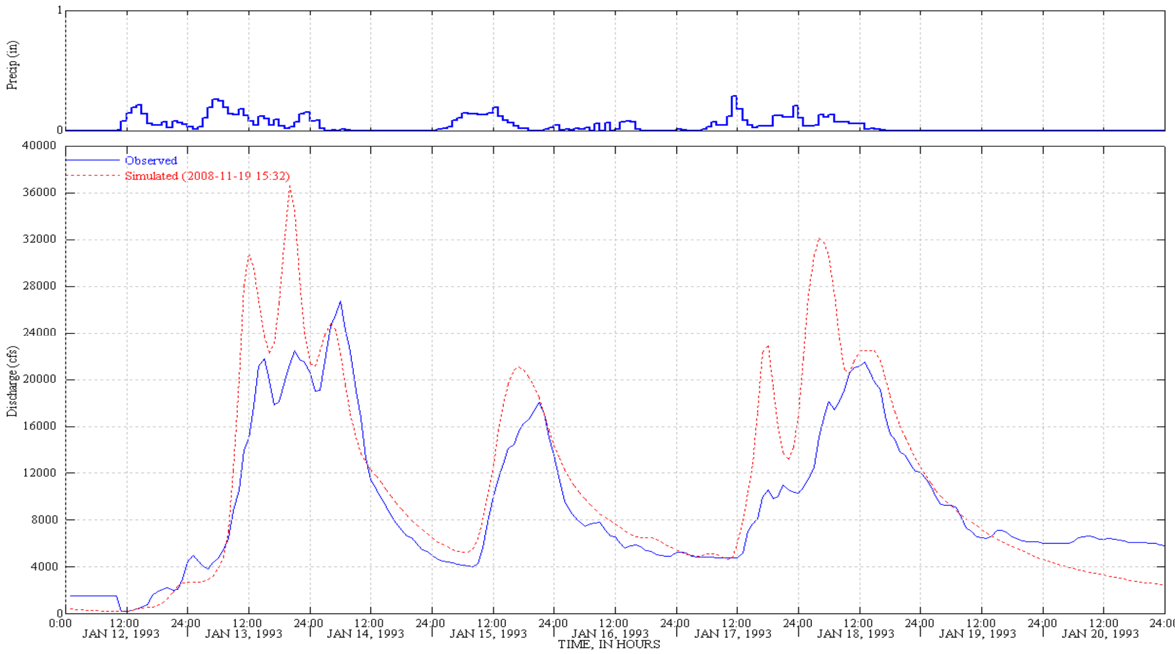

Figure 30 Simulated and Observed January 12-20, 1993 Storm Event

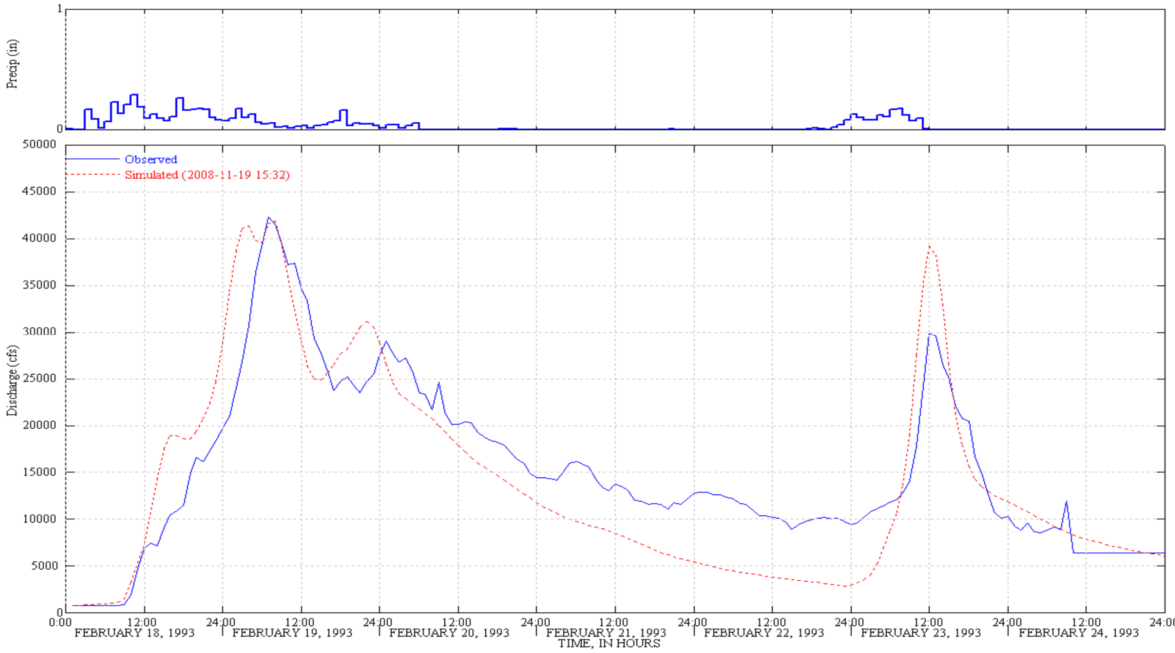

Figure 31 Simulated and Observed February 18-24, 1993 Storm Event

APPENDIX L - Ventura County Design Storm Results

Prepared by

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Ventura County Watershed Protection District

With assistance from
AQUA TERRA Consultants

Introduction

The calibrated Santa Clara HSPF model was used as the basis for generating design storm peaks and hydrographs for use in the hydraulic modeling portion of the study. The approach involved identifying a storm where saturation levels were very high across the model domain and then applying balanced design storm hyetographs for the 100-yr storm for each rain gage used in the HSPF model. The gaged tributaries with long-term records were used as calibration points in the modeling. The calibration was done by adjusting the rainfall factors (MFACTS in HSPF UCI – Users Control Input) applied to the rain data for each subarea and associated reach at the calibration points to establish corresponding rainfall factors that could then be applied to the ungaged tributaries. The HSPF model was then run with the appropriate rainfall distributions at 5-min timesteps for the storm of interest to provide 100-yr design storm peaks at the ungaged tributaries. The 100-yr peaks were converted to other return intervals of interest by using multipliers developed from flow frequency analyses of long-term Ventura County stream gages.

Balanced Storm Method for Developing Hyetographs

The Balanced Storm Method (also called alternating block) is a straightforward way of developing design storm hyetographs for the study following these steps:

1. Perform a frequency analysis of the rainfall data using the annual maxima data at the desired intervals ranging from 5-min to 24-hr. For Ventura County rain gages, a Pearson III model provided frequency results. For Los Angeles County, the Gumbel model provided the frequency results.

2. Plot the depth vs duration data on a log-log plot and fit a power equation trendline through the results.

3. Establish the desired rainfall duration.

4. Establish a duration interval that divides equally into an hour.

5. Tabulate the duration in increasing values of the interval.

6. Use equation from Step 2 to calculate the rainfall depth for each duration.

7. Calculate the incremental rainfall depth for each time period by subtracting the cumulative rainfall at the previous time step from the current time step.

8. If the sum of the incremental values is larger than the 24-hr depth from the frequency analysis, reduce the incremental values by a constant factor for each interval until the sum matches the 24-hr depth.

9. Distribute the incremental depth values. Use time blocks that correlate with the duration intervals. Assign the highest incremental depth to the central time block, and arrange the remaining incremental depth blocks in descending order, alternating between the upper and lower time blocks away from the central time block.

The resulting ordinates of the hyetographs for each rain gage were then used as input to the HSPF model. For rain gages that only have daily records, the 24-hr value resulting from a frequency analysis of the gage data was applied to the dimensionless distribution of an adjacent gage concluded to be a good surrogate for the gage of interest. Table 1 summarizes the rain data and surrogates used in the HSPF Design Storm Modeling.

HSPF Calibration- Approach and Results

The rainfall hyetographs developed from the data in the preceding section were entered into an HSPF submodel set up to provide design storm results for January 10, 2005. This day was selected as one of the wettest periods in recent history in the Santa Clara watershed as representing saturated conditions when a design storm could occur. The steps in preparing the submodel were as follows:

1. Run calibration HSPF UCI for entire SCR watershed to get state of system at beginning of analysis period for the design storm (end of day January 9, 2005). Extract initial state data from model output for appropriate locations for run of January 10 through 31, 2005.
2. Modify calibration UCI for storm simulation, 5-min timestep, initial storages, start time, rain data sets, adjusted rainfall factors incorporating original factors, areal reduction (AR) factors and 3rd factor used to match design storm peak from stream gage frequency analyses.
3. Run the modified UCI. Multiple runs were needed to implement the appropriate AR factors for each site; AR factor for all sites upstream of site of interest must be identical. For calibration sites – adjust factors to calibrate/match 100-yr peak flow within 2%
4. For ungaged sites, evaluate results from gaged locations and apply factors accordingly
5. Extract results for plotting using WDMUtil or GenScn (include observed flow, if available)

Figure 1 (below) provides the 24-hr storm duration AR factors used in the study from HEC-HMS model documentation.

Figure 1.

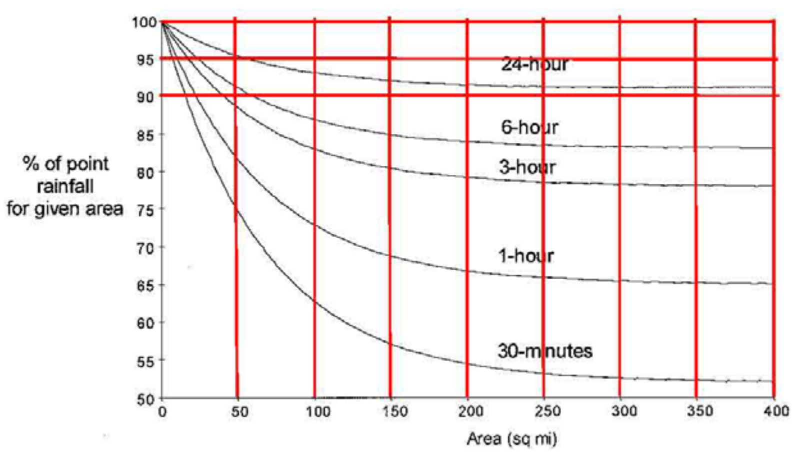


Table 1. Rainfall Gages Data Used in the HSPF Design Modeling

Rain Gage Number	HSPF Model Node	Gage Name	Analysis Type	Design Data Available	Gage Used for Hyetograph Distribution	100-yr 24-hr Depth (in)
Ventura County						
36	48	Piru Fire	Daily	24-hr depth	101	7.74
39	53	Fillmore-Rancho	Daily	24-hr depth	171	8.57
65	68	Upper Ojai Summit	Daily	24-hr depth	173	10.82
101	46	Piru Camulos	5-min	5-min Hyeto		7.46
152	61	Piedra Blanca	5-min	5-min Hyeto		11.79
160	50	Piru Temescal	Daily	24-hr depth	172	8.89
171	51	Fillmore Hatchery	5-min	5-min Hyeto		8.46
172	49	Piru Cyn	5-min	5-min Hyeto		9.21
173	67	Sta Paula Ferndale	5-min	5-min Hyeto		10.43
175	58	Saticoy Fire	5-min	5-min Hyeto		7.49
191	55	Moorpark Downing	5-min	5-min Hyeto		7.34
199	52	Fillmore Fire	Daily	24-hr depth	171	9.04
209	63	Lockwood Valley	5-min	5-min Hyeto		6.37
224	66	Sespe Westates	5-min	5-min Hyeto		12.94
225	60	Wheeler Cyn	5-min	5-min Hyeto		10.61
230	59	Vta Sexton Cyn	5-min	5-min Hyeto		8.98
238	56	S Mtn Shell	5-min	5-min Hyeto		9.10
242	47	Tripas Cyn	5-min	5-min Hyeto		8.33
245	57	Sta Paula UWCD	5-min	5-min Hyeto		7.96
250	54	Moorpark Happy Camp	5-min	5-min Hyeto		8.13
46910	62	NWS Pine Mtn	Daily	24-hr depth	152	12.00
46942	45	Piru Telemetry	Daily	None	101	na
Los Angeles County						
32 (04162)	36	Newhall Soledad	5-min	5-min Hyeto		8.42
120	33	Vincent Patrol Station	Daily	24-hr depth	261	3.81
125b	38	San Francisquito Cyn Power House	Daily	24-hr depth	372	6.34
128b	39	Elizabeth Lake - Warm Springs Camp	5-min	5-min Hyeto		8.63
252c	40	Castaic Lake	Daily	24-hr depth	372	5.47
261 (40014)	31	Acton Escondido Cyn	5-min	5-min Hyeto		4.61
277	41	Sawmill Mountain	Daily	24-hr depth	128b	8.32
372	37	San Francisquito Power House No. 2	5-min	5-min Hyeto		6.45
405b	34	Soledad Canyon	Daily	24-hr depth	261	6.99
409b	44	Pyramid Reservoir	Daily	24-hr depth	128b	7.55

Rain Gage Number	HSPF Model Node	Gage Name	Analysis Type	Design Data Available	Gage Used for Hyetograph Distribution	100-yr 24-hr Depth (in)
423c	32	Angeles Forest - Aliso Cyn.	Daily	24-hr depth	261	7.85
747	43	Sandberg	Daily	24-hr depth	128b	6.22
1005b	35	Mint Canyon Fire Station	Daily	24-hr depth	261	4.53
1263	42	Valencia Reclamation Plant		N-yr 1-day depths	VC101	6.49

For Ventura County, four relatively long-term stream gage records are available on tributaries that are considered suitable for calibration as follows in order from West to East: Santa Paula Creek, Sespe Creek at Wheeler, Sespe Creek at Fillmore, and Hopper Creek. There are additional gage records at Harmon Barranca, Ellsworth Barranca, and Pole Creek, each with about 30 yrs of annual peak flow data for use in frequency analyses. These data will be used for model validation along with the results of other tributary hydrology modeling. Table 2 summarizes the HSPF model results for the calibration points.

Table 2. HSPF Design Storm Model Results for Ventura County Calibration Sites

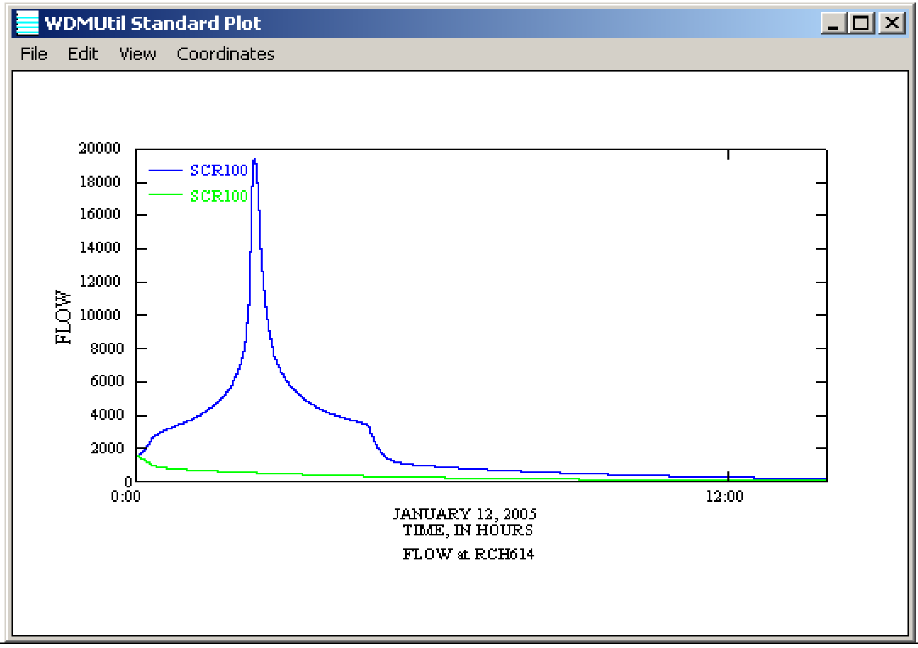
Location	Sespe-Fillmore	Sespe Wheeler	Hopper Creek	Santa Paula Creek	Average of Tribs <=50 sq mi
Area sq mi	251	50	23.6	40	
Number of Annual Stream Peaks	67	52	70	71	
FFA. Q100 cfs	135,000	31,500	19,200	38,800	
Q100/DA cfs/sqmi	537.8	630	813.6	970	
HSPF Q100 cfs	136,000	32,200	19,500	39,000	
Gage Rain with HSPF Factor (in)	NA	12	11.331	10.43	
Net Applied Rain (in)	NA	11.587	9.9	12.214	
% Applied Rain	NA	96.60%	87.30%	117.10%	100.30%
HSPF Rain Factor (Calibrated Model)	NA	1.07	0.9	1.07	
AR Factor	0.91	0.96	0.975	0.96	
Calib. Factor	1.025	0.94	1	1.14	
AR & Calib Factor	0.933	0.902	0.975	1.094	0.99
HSPF Area sq mi	254	52.5	25	39.9	
HSPF Q100/DA cfs/sq mi	535.5	613.9	781.4	977	

NA=Not calculated

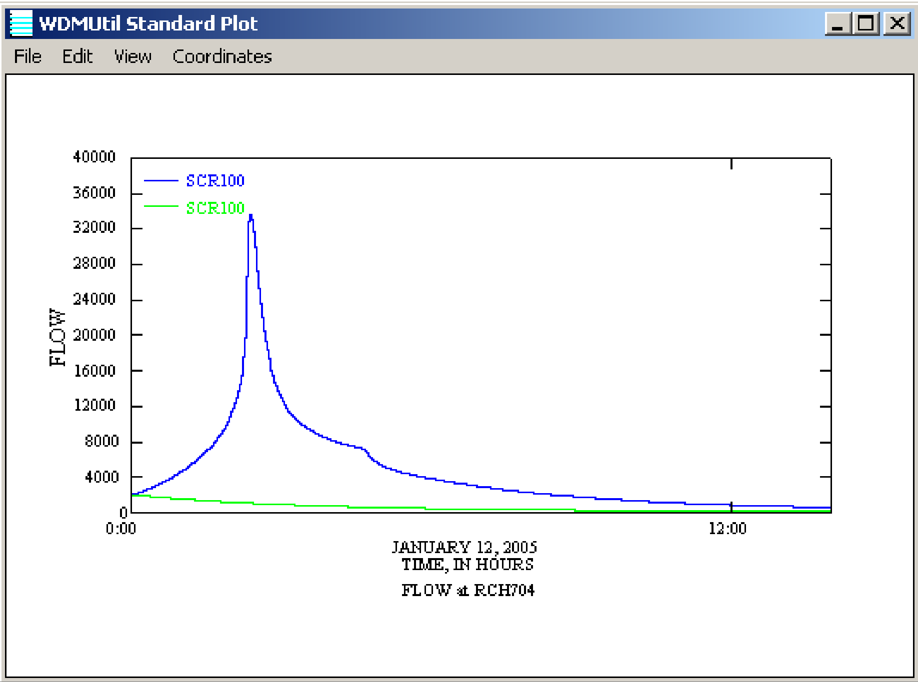
Because the ungaged tributaries to be studied with the HSPF model are less than 50 sq mi in area, only the results from the smaller 3 gaged tributaries were evaluated when choosing factors to apply to the ungaged tributaries. The weighted model rainfall and weighted applied rainfall after all factors were considered were calculated as part of the evaluation. The average percent applied rainfall to each watershed was about 100% for the three tributaries. The combined AR and calibration factors applied to the three tributaries ranged from 0.902 to 1.094, with an average of 0.99. In addition, the factors applied to the smallest watershed, Hopper Creek, were 0.975 and 1.0 for the AR and calibration factors. These results led to the conclusion that the combined AR and calibration factor to be applied to the ungaged tributaries is 1.0, and so HSPF design storm model results could be used directly without any further adjustment. Based on the range of the combined AR and calibration factor for the 3 tributaries, the uncertainty associated with the ungaged tributary results is expected to be on the order of 10%.

The following figures show the design storm results for the four gage tributaries evaluated in the HSPF model in Ventura County. The figures are output from the WDMutil program that is used with HSPF to extract and display model results from the .wdm file. SCR100 is the name of the underlying hydrology model file used in the tributary analyses. The blue lines represent the response of the watershed to the design rainfall while the green lines show the baseflow that would occur if no design storm rainfall was applied to the model after January 9, 2005.

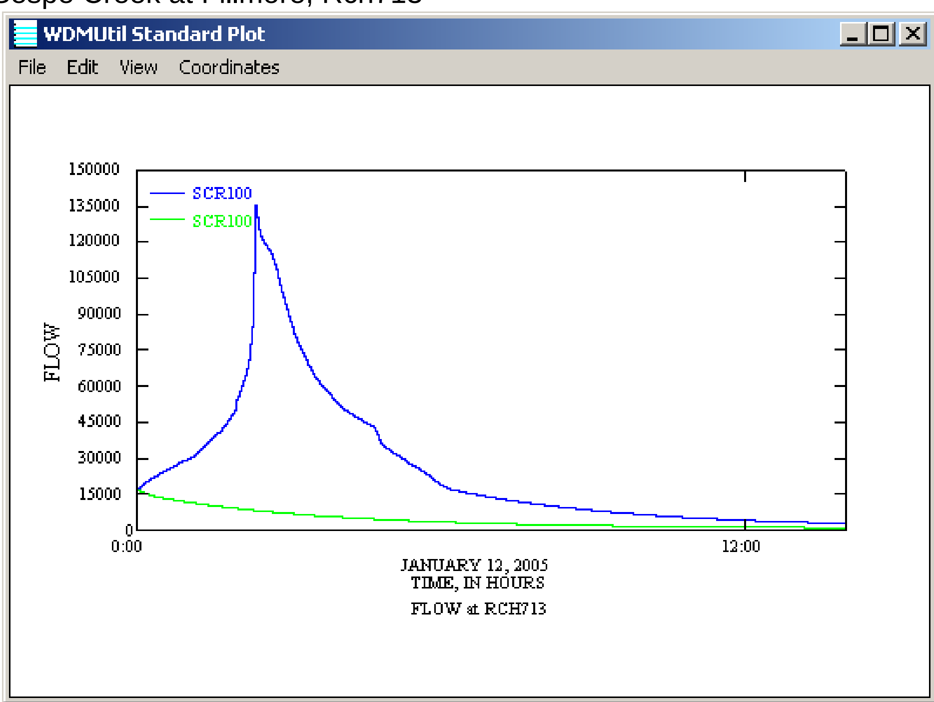
Hopper Creek Rch614



Sespe Creek at Wheeler Gorge, Rch704



Sespe Creek at Fillmore, Rch713



Santa Paula Creek Rch834

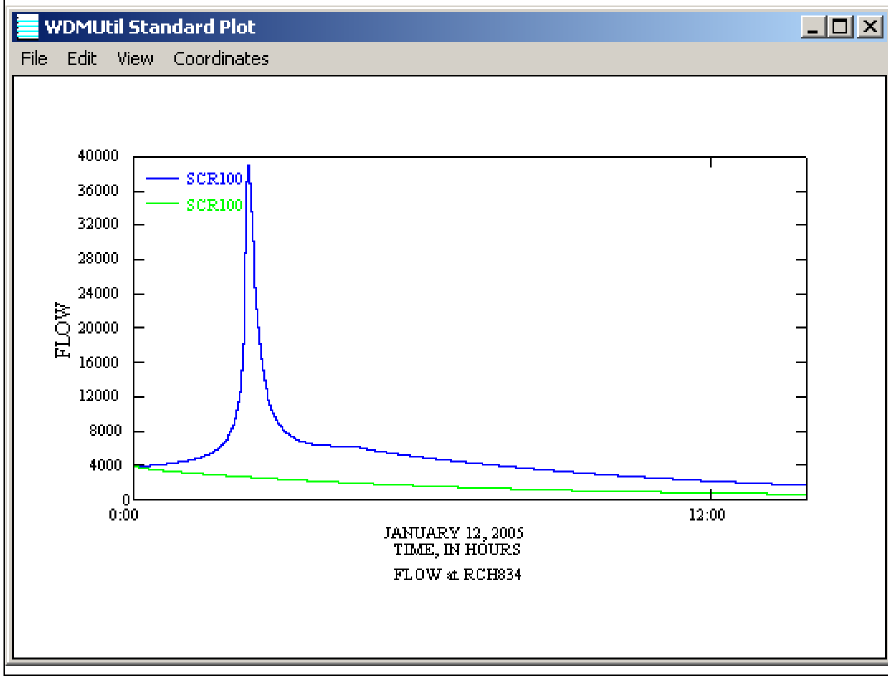


Figure 2. HSPF Design Storm Hydrographs for Ventura County Gage Sites

Sespe at Fillmore

The hydrographs in Figure 2 show that there is baseflow from the antecedent rainfall occurring prior to the end of January 9th that increases the design storm runoff. The baseflow is included in the design storm peak in this analysis because historical peaks often occur at the end of storms due to a relatively short burst of high intensity rain leading to a sharp spike in flow as seen in the historical data from January 10, 2005, which generated peaks with nearly 50-yr recurrence intervals in many streams. In addition, the parameters used across the model leading to baseflow did not vary widely and so similar baseflow conditions were expected in the ungaged tributaries.

Ungaged Tributary Results

Table 3 summarizes the results for the ungaged tributaries included in the analysis for Ventura County. Figure 3 shows the locations of the tributaries and SCR model reaches.

Table 3. HSPF Model Results for Ventura County Ungaged Sites

HSPF Reach #	Name	Drain. Area (sq mi)	HSPF Rain Factor	HSPF Q100 (cfs)	Q100/DA (cfs/ ac)	# Annual Peaks	FFA Q100 (cfs)	VCWPD Model Q100 (cfs)	FEMA08 Q100 /area (cfs/ac)
322	Salt Canyon	9.19	1	5,860	1.00	NA	NA	NA	NA
529	Piru Creek	435.93	1.1	NA	NA	NA	NA	42,000	0.147
631	Basolo Ditch	2.00	1.03	1,625	1.27	NA	NA	NA	1.27
634	Pole Creek	8.71	1.03	8,660	1.55	31	7,390	NA	1.27
641	Grimes Canyon	5.50	1	4,470	1.27	NA	NA	NA	1.27
801	Boulder Creek	6.22	1	4,710	1.18	NA	NA	NA	NA
821	Orcutt Canyon	4.80	1.07	5,300	1.73	NA	NA	NA	1.73
833	Sisar Creek	11.52	1.07	10,900	1.48	NA	NA	NA	NA
837	Fagan Cyn	5.07	1	4,550	1.40	NA	NA	2,100	NA
842	Adams Barranca	9.08	1	6,880	1.18	NA	NA	3,700	NA
844	Haines Barranca	3.49	1	2,950	1.32	NA	NA	NA	NA
852	Todd Barranca	9.43	1	6,650	1.10	NA	NA	NA	NA
853	Briggs Road Drain	1.25	1	1,230	1.54	NA	NA	935	NA
854	Cummings Road Drn	1.91	1	1,800	1.47	NA	NA	1,363	NA
862	Ellsworth Bar.	14.54	1	10,100	1.09	30	15,300	NA	1.73
874	Franklin Wason	4.95	1	3,950	1.25	NA	NA	NA	NA
881	El Rio Drain	1.40	1	1,050	1.17	NA	NA	1,050	1.17
882	Brown Barranca	3.20	1	2,720	1.33	NA	NA	2,323	NA
883	Harmon Barranca	5.77	1	4,630	1.25	33	1,980	NA	0.72
891	Patterson Rd Drain	1.40	1	1,450	1.62	NA	NA	1,450	1.62
604	Warring Canyon	1.28	1.1	2,420	2.97	NA	NA	1,425	NA
605	Warring & Real Canyons	2.14	1.1	2,960	2.16	NA	NA	2,026	NA
619	Fairview Canyon	0.87	1.03	1,330	2.39	NA	NA	NA	NA
806	Reimer Ditch	5.73	1	4,400	1.20	NA	NA	NA	NA
807	Bear Ck	2.22	1	3,030	2.13	NA	NA	NA	NA
809	O'Leary Creek	3.56	1	3,760	1.65	NA	NA	NA	NA
812	Balcom Canyon	4.92	0.94	4,590	1.46	NA	NA	NA	NA
822	Timber Canyon	4.32	0.94	5,030	2.41	NA	NA	NA	NA
838	Peck Rd Drn	1.24	0.94	1,830	2.30	NA	NA	1,604	NA
885	Sudden Barranca	1.18	0.94	1,370	1.81	NA	NA	1,470	NA
886	Clark Barranca	1.50	0.94	1,540	1.61	NA	NA	1,674	NA

NA=Not Available

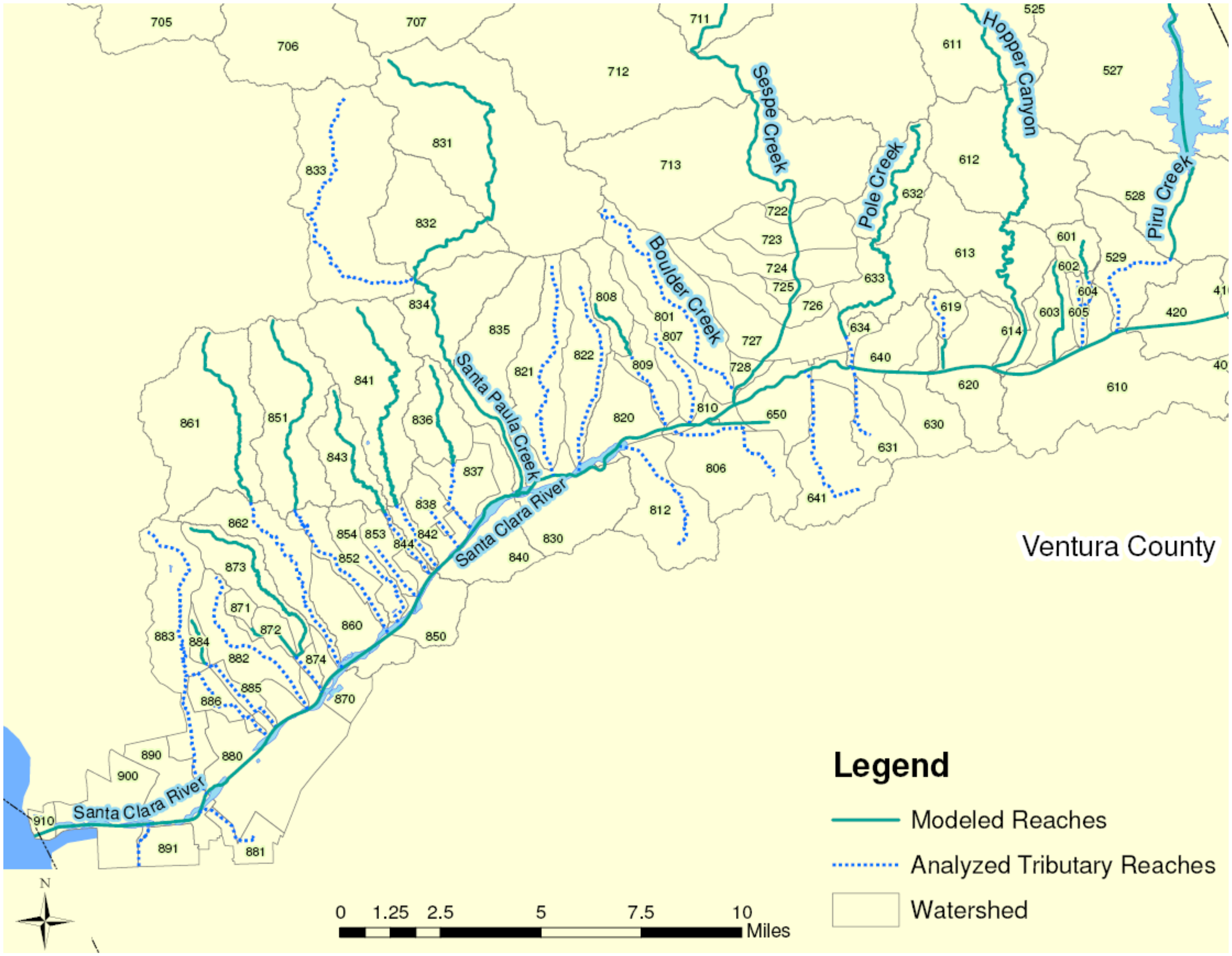
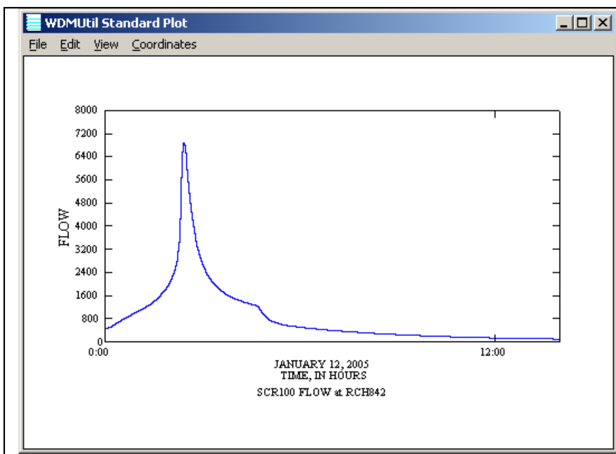


Figure 3. Tributary and SCR Model Reaches for Ventura County

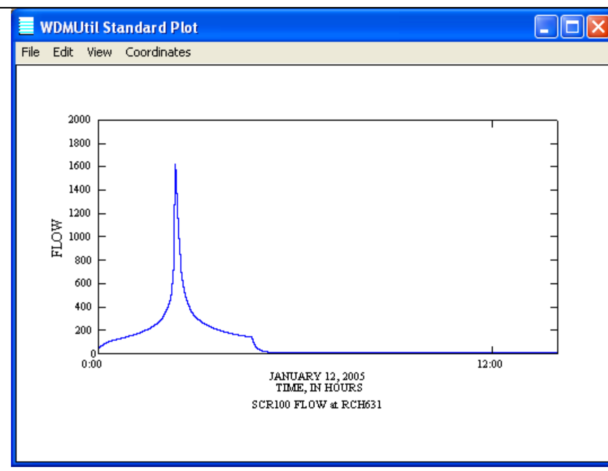
The results show that the HSPF Q100 peak/drainage area ratio in cfs/ac ranges from 0.99 to 2.97, which is reasonable based on modeling results from District hydrology models. The highest ratios are observed for the smaller watersheds with steep slopes and relatively high point rainfall. For the points where hydrology estimates were given to FEMA or available from flow frequency analyses, the following observations are made:

1. Basolo Ditch- the Q100 given to FEMA was based on the Q100 cfs/ac value from an analysis of the nearby Pole Creek gage. The HSPF model was calibrated to this value.
2. Pole Creek has a limited number of years for the flow frequency analysis and it is uncertain how the high sediment load from the watershed affects the gage measurements. The HSPF value is higher than the flow frequency result but well within the confidence limits provided by the frequency analysis.
3. Grimes Canyon- the Q100 given to FEMA was based on the Q100 cfs/ac value from an analysis of the nearby Pole Creek gage. The HSPF model was calibrated to this value.
4. Orcutt Canyon- the Q100 given to FEMA was based on the Q100 cfs/ac value from an analysis of the nearby Ellsworth Barranca gage. The HSPF model was calibrated to this value.
5. Ellsworth Barranca- The flow frequency analysis of the nearby Ellsworth Barranca gage yields relatively high results due to the short record length for the Ellsworth gage with three peaks in the record of about 10,000 cfs.
6. Harmon Barranca - The flow frequency analysis of the Harmon Barranca gage yields relatively low results due to the short record length. The computed Q100 from the frequency analysis is less than the historic peak of about 2,500 cfs measured in 1980. The HSPF model peak is more reasonable than the flow frequency result.

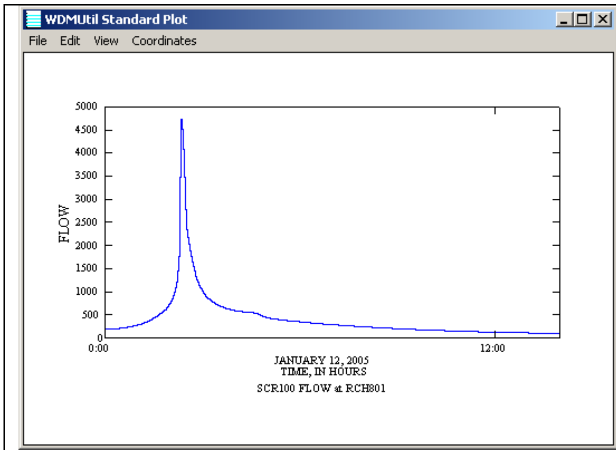
The following figures show the design storm peaks and hydrographs for the Ventura County tributaries included in this study.



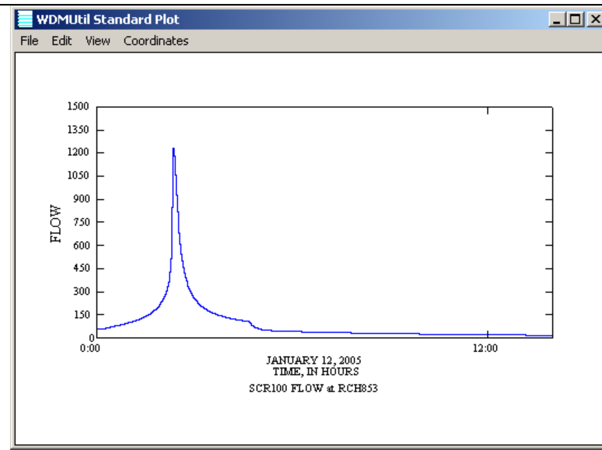
Adams Barranca Q100= 6,880 cfs



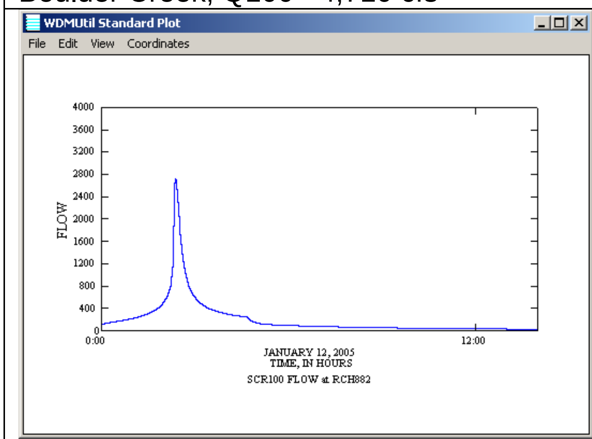
Basolo Ditch Q100=1,625 cfs



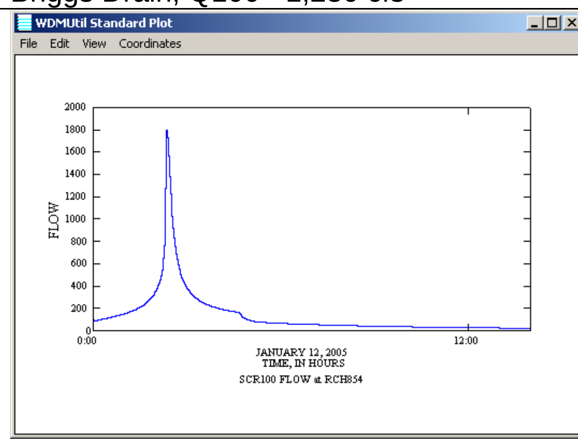
Boulder Creek, Q100= 4,710 cfs



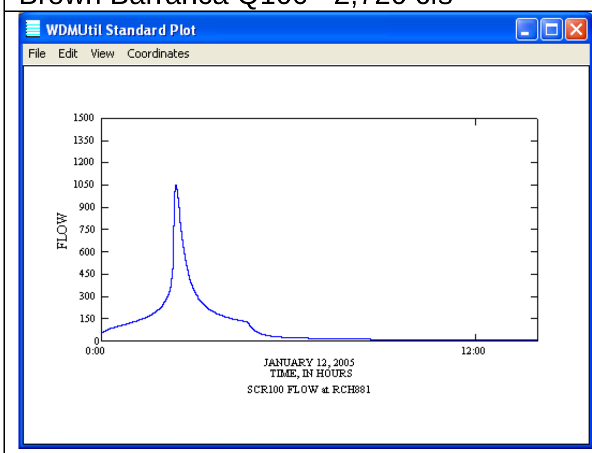
Briggs Drain, Q100= 1,230 cfs



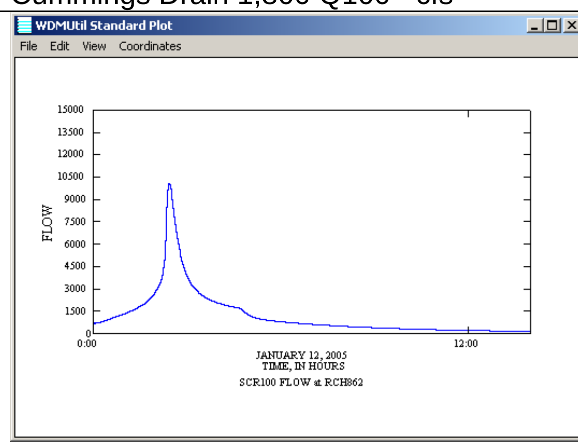
Brown Barranca Q100= 2,720 cfs



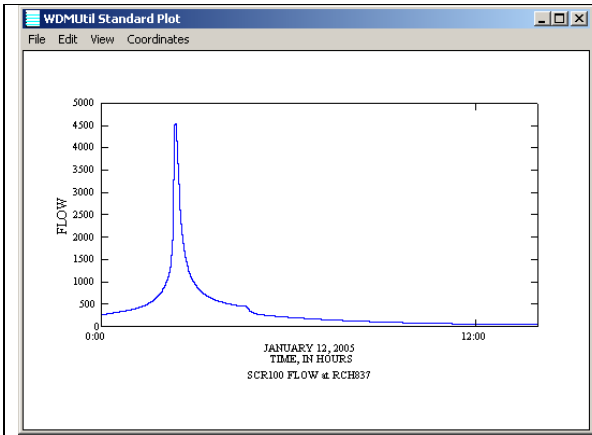
Cummings Drain 1,800 Q100= cfs



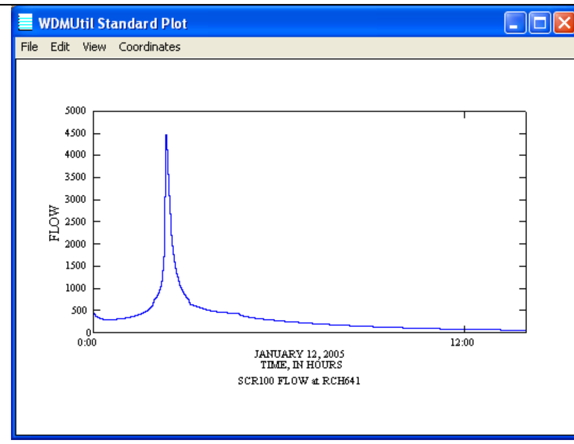
El Rio Drain Q100= 1,050 cfs



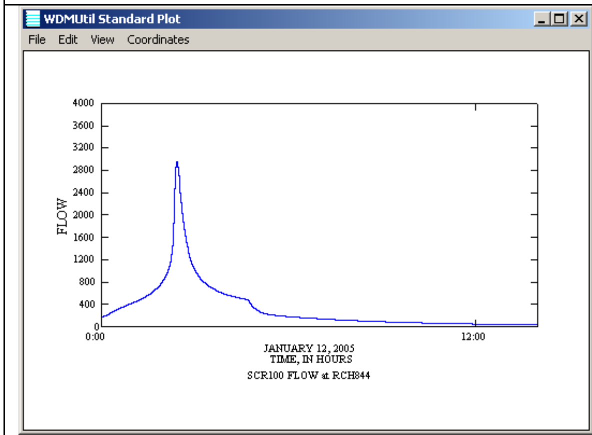
Ellsworth Barranca Q100= 10,100 cfs



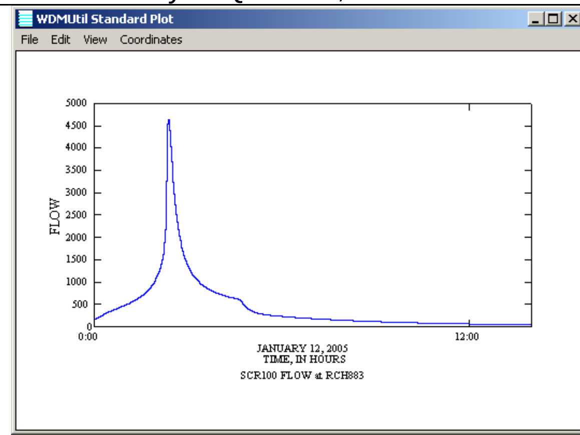
Fagan Canyon Q100= 4,550 cfs



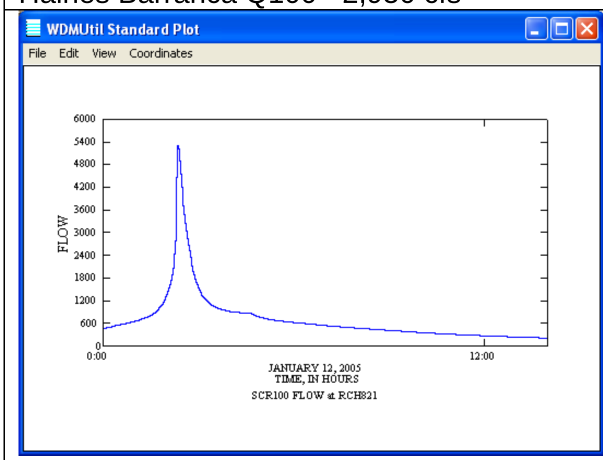
Grimes Canyon Q100= 4,470 cfs



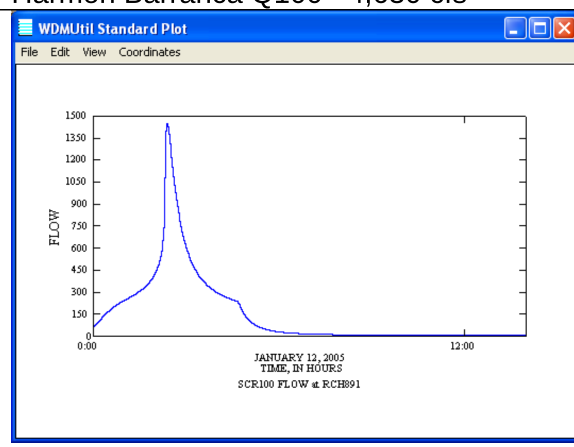
Haines Barranca Q100= 2,950 cfs



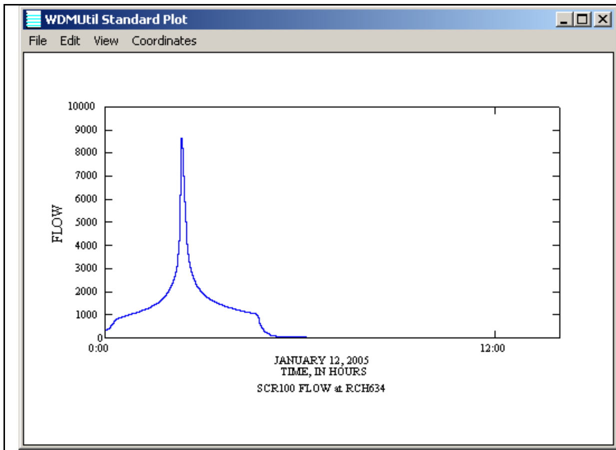
Harmon Barranca Q100= 4,630 cfs



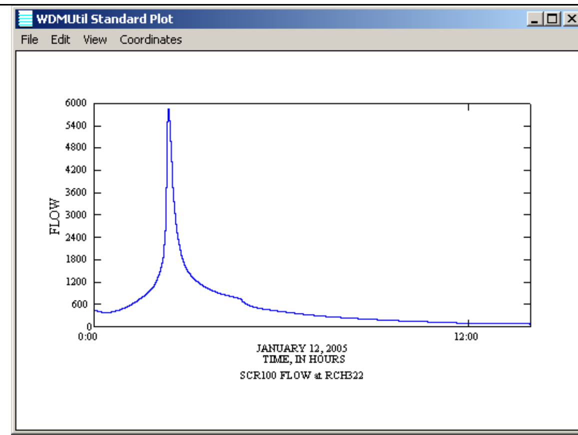
Orcutt Canyon Q100= 5,300 cfs



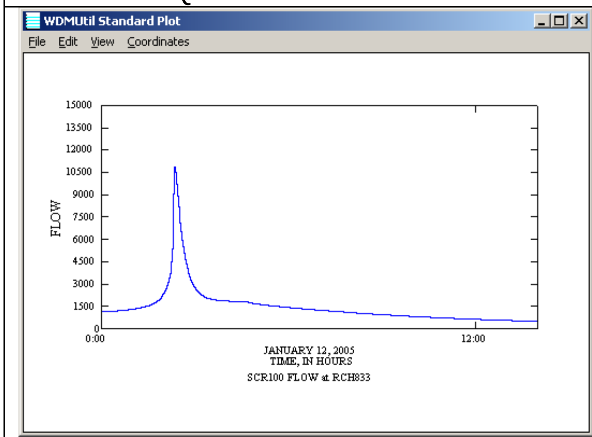
Patterson Drain; Victoria Ave Q100= 1,450 cfs



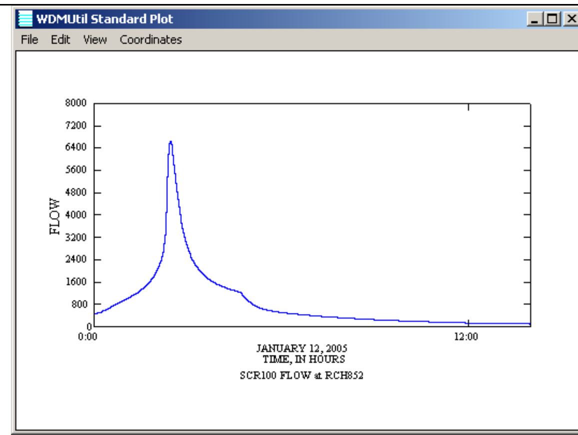
Pole Creek Q100= 8.660 cfs



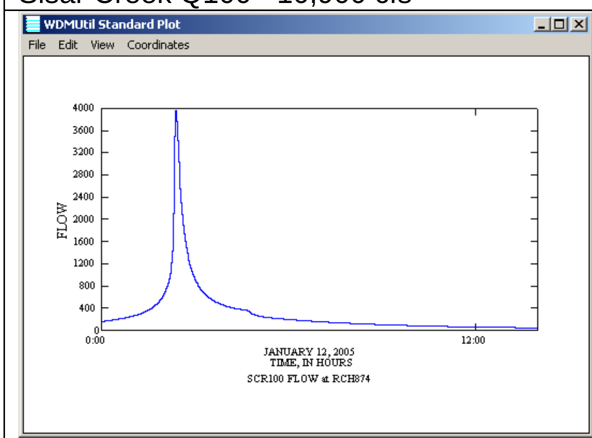
Salt Canyon nr County Line Q100= 5,860 cfs



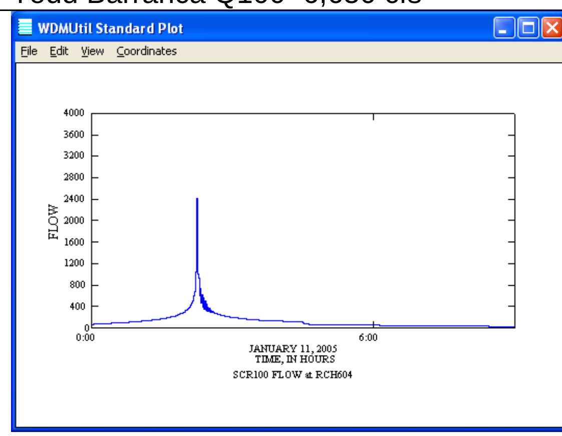
Sisar Creek Q100= 10,900 cfs



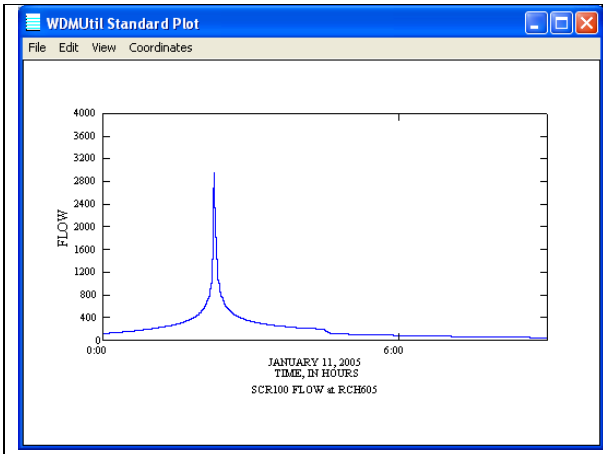
Todd Barranca Q100=6,650 cfs



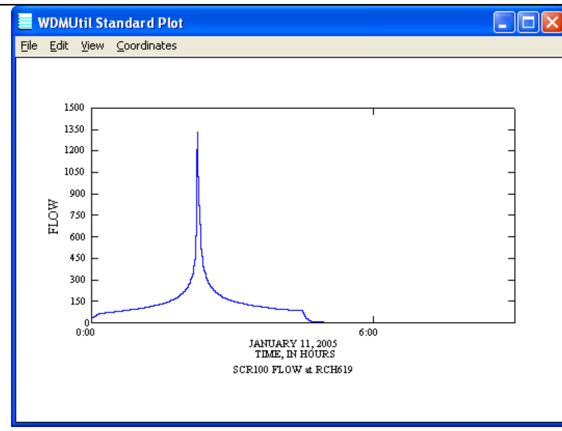
Franklin-Wasson Q100= 3,950 cfs



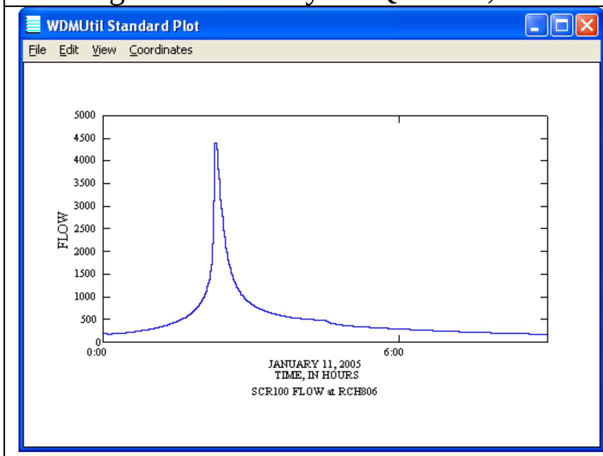
Warring Canyon Q100= 2,420 cfs



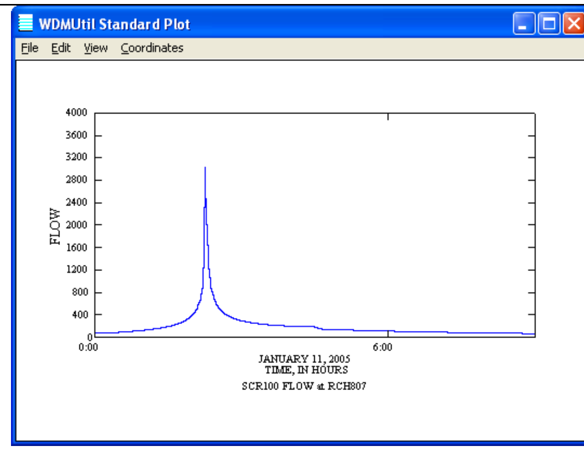
Warring and Real Canyons Q100= 2,960 cfs



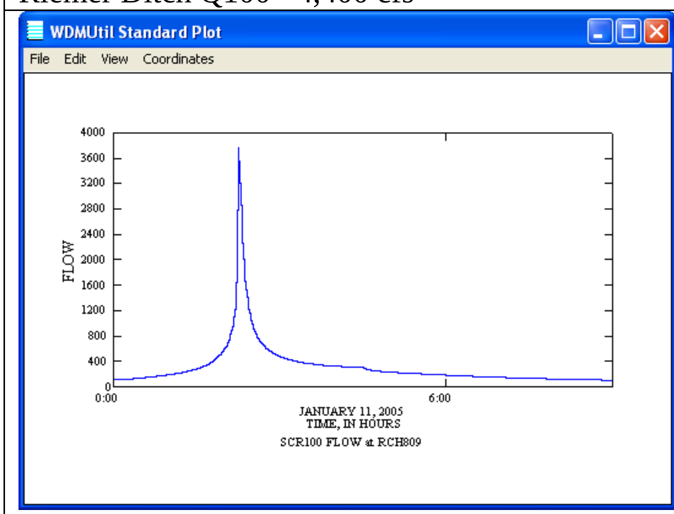
Fairview Canyon Q100= 1,330 cfs



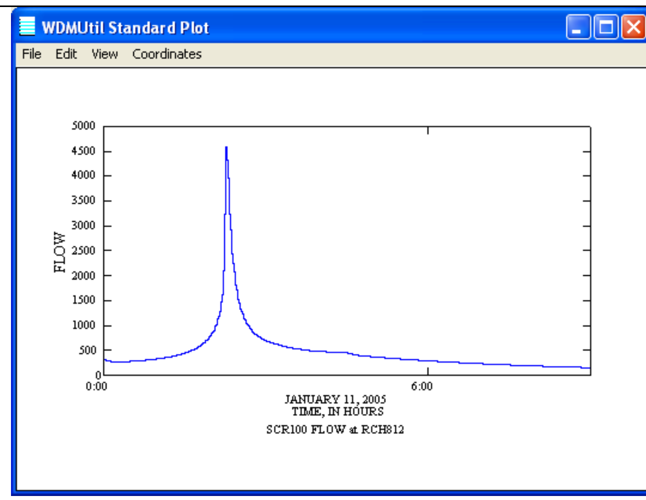
Riemer Ditch Q100= 4,400 cfs



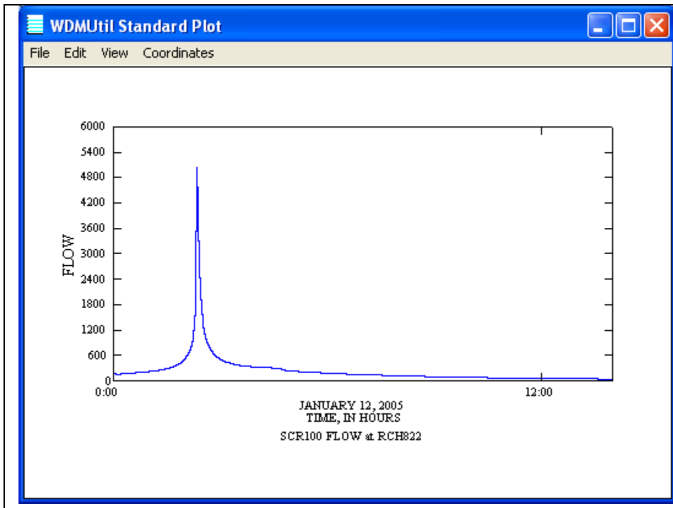
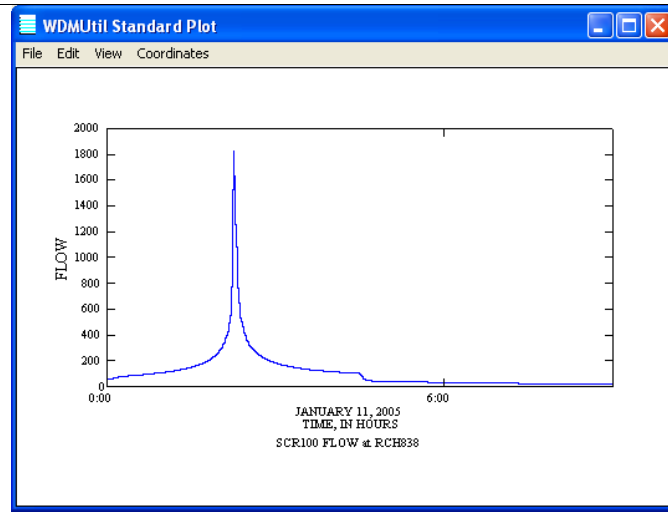
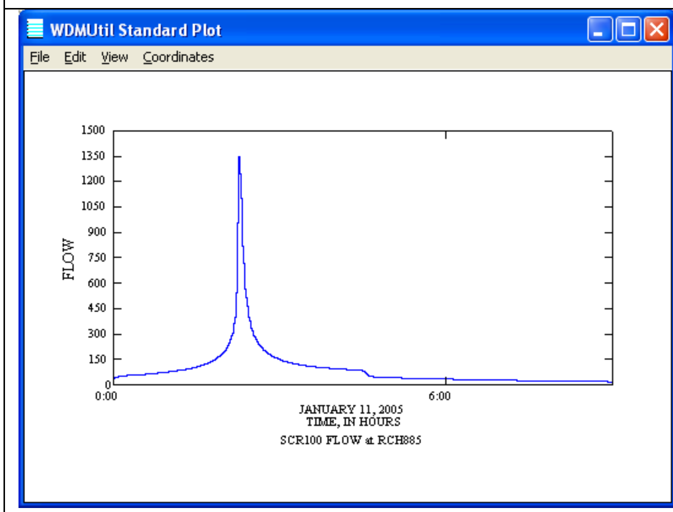
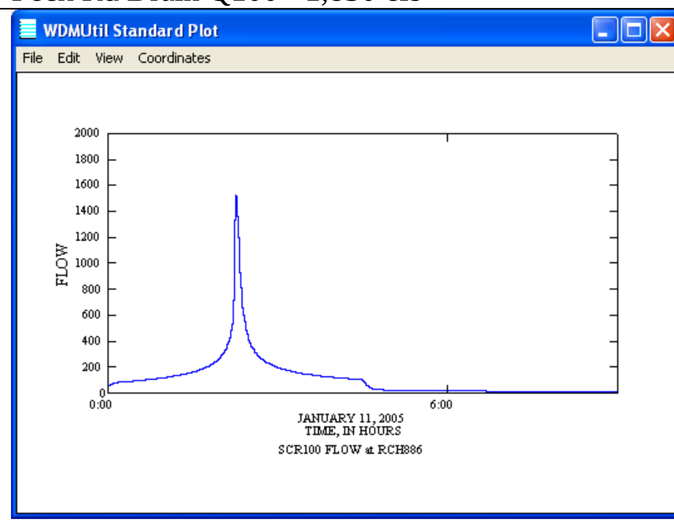
Bear Creek Q100= 3,030 cfs



O'Leary Creek Q100= 3,760 cfs



Balcom Cyn Q100= 4,590 cfs

 Timber Creek Q100= 5,030 cfs	 Peck Rd Drain Q100= 1,830 cfs
 Sudden Barranca Q100= 1,370 cfs	 Clark Barranca Q100= 1,540 cfs

Multipliers

It is likely that storms above the 50-yr level represent saturated conditions where most or all rain that falls on the land surface occurs as runoff. However, design storms at recurrence intervals less than 50-yrs represent various levels of saturation. It is difficult to quantify infiltration rates and available storage capacity for these storms. Because of this, it was decided to use the results of flow frequency analyses of Ventura County stream gages to develop design storm ratios that could be used to convert the Q100 results from the HSPF modeling to the other recurrence intervals of interest. The ratios from developed and undeveloped watershed used to develop the design storm ratios for this study are shown in the following table. The results show that for the 50-yr storm, the ratios of the 50-yr peak / 100-yr peak for the undeveloped watershed gages varied from 0.680 to 0.761 with a standard deviation of about 0.028. For developed watersheds, the ratios varied from 0.791 to 0.844 with a standard deviation of about 0.031. This is a relatively narrow range given the variation of size of the watersheds included in the data sets from 9.1 to 1,625 sq mi.

For this study, the intervals include the 2-, 5-, 10-, 50-, 200- and 500-yr events. The design storm peaks obtained from the HSPF model and converted to the other intervals are provided in Table 5. Because hydraulic modeling of the tributaries may require design storm discharges at points upstream from the locations provided in Table 5, it is recommended that the discharge transfer equations recommended in USGS WRI Report 94-4002 applicable to the South Coast Region of California be used to calculate the upstream flows using the design storm results. The equations relate design storm peak to area and mean annual precipitation, but since the mean annual precipitation does not vary much at the scale of the tributaries being evaluated, the primary factor in the equation is the area at the point of interest. The exponent on the area is about 0.80, which results in the peak discharge/unit area (cfs/ac) increasing as the area decreases. This is consistent with the conceptual model of rainfall and runoff in many hydrologic models in that smaller subareas can receive higher intensity rainfall from storm cells of limited size, leading to higher cfs/ac ratios for those areas.

Table 4. Ventura County Design Storm Ratios Based on Flow Frequency Analysis Results

Stream Gage Station, WPD Number	Yrs	Area sq mi	2 yr Ratio	5 yr Ratio	10 yr Ratio	25 yr Ratio	50 yr ratio	100 yr Ratio	200 Yr Ratio	500 yr Ratio
Undeveloped Watersheds										
VENTURA WATERSHED										
606 Santa Ana Cr. near Oak View	37	9.1	0.049	0.154	0.274	0.495	0.718	1.000	1.230	1.897
600 Coyote Cr. near Oak View	43	13.2	0.047	0.146	0.261	0.480	0.705	1.000	1.367	1.994
604 No. Fork Matilija Cr	72	15.6	0.048	0.158	0.281	0.507	0.727	1.000	1.324	1.842
605 San Antonio Cr. @ Casitas Spr.	55	51.2	0.039	0.126	0.233	0.448	0.683	1.000	1.416	2.160
608 Ventura Riv. near Ventura	73	187	0.032	0.127	0.245	0.474	0.707	1.000	1.349	1.913
SANTA CLARA WATERSHED										
707 Santa Clara @County Line	52	410	0.037	0.126	0.236	0.454	0.689	1.000	1.401	2.102
701 Hopper Cr. near Piru	70	23.6	0.048	0.148	0.264	0.482	0.708	1.000	1.359	1.974
709 Santa Paula Cr. near Santa Paula	71	40	0.032	0.116	0.222	0.440	0.680	1.000	1.402	2.168
711 Sespe Cr. near Wheeler Spr.	52	50	0.026	0.107	0.216	0.440	0.683	1.000	1.403	2.089
710 Sespe Cr. near Fillmore	63	251	0.062	0.190	0.324	0.549	0.756	1.000	1.274	1.681
708 Santa Clara Riv. @ Montalvo	68	1624	0.057	0.185	0.322	0.552	0.761	1.000	1.265	1.650
Average Ratio to 100 yr			0.043	0.144	0.262	0.484	0.711	1.000	1.345	1.952
Std Deviation			0.011	0.027	0.037	0.040	0.028	0.000	0.064	0.177
Historic District Multipliers			0.058	0.167	0.362	0.507	0.725	1.000	n/a	n/a
URBAN										
733 Oxnard West Drn.	35	3.2	0.231	0.423	0.560	0.739	0.871	1.000	1.129	1.293
833 Bus Canyon Drn..	35	4.9	0.199	0.357	0.484	0.670	0.827	1.000	1.185	1.462
830 Arroyo Conejo S Br	35	12.5	0.173	0.322	0.448	0.640	0.809	1.000	1.217	1.546
836 Arroyo Conejo	30	14.2	0.134	0.277	0.405	0.608	0.791	1.000	1.242	1.606
802 Arroyo Simi @ Royal Ave.	37	32.6	0.137	0.282	0.410	0.612	0.792	1.000	1.237	1.604
803 Arroyo Simi near Simi	63	71	0.124	0.318	0.476	0.688	0.844	1.000	1.139	1.500
Average Ratio to 100 yr			0.166	0.330	0.464	0.660	0.822	1.000	1.191	1.502
Std Deviation			0.042	0.054	0.057	0.050	0.031	-	0.049	0.117
Historic District Multipliers			0.133	0.375	0.567	0.692	0.833	1.000	n/a	n/a

Table 5 – Design Storm Peaks Using Watershed Multiplier Results

Watershed Name	Land Use	Storm Interval							
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Salt Canyon	Undev.	250	840	1,530	2,820	4,160	5,860	7,890	11,470
Basolo Ditch	Undev.	70	230	420	780	1,150	1,630	2,190	3,180
Grimes Canyon	Undev.	190	640	1,160	2,150	3,170	4,470	6,020	8,750
Boulder Creek	Undev.	200	680	1,230	2,270	3,340	4,710	6,340	9,220
Orcutt Canyon	Undev.	230	760	1,380	2,550	3,760	5,300	7,140	10,380
Sisar Creek	Undev.	470	1,560	2,840	5,250	7,740	10,900	14,680	21,340
Fagan Cyn	Undev.	200	650	1,190	2,190	3,230	4,550	6,130	8,910
Adams Barranca	Undev.	300	990	1,790	3,320	4,880	6,880	9,270	13,470
Haines Barranca	Undev.	130	420	770	1,420	2,090	2,950	3,970	5,780
Todd Barranca	Undev.	290	950	1,730	3,200	4,720	6,650	8,960	13,020
Briggs Road Drain	Undev.	50	180	320	590	870	1,230	1,660	2,410
Cummings Road Drain	Undev.	80	260	470	870	1,280	1,800	2,420	3,520
Ellsworth Bar.	Undev.	440	1,450	2,630	4,870	7,170	10,100	13,600	19,780
Franklin/Wason Barranca	Undev.	170	570	1,030	1,900	2,800	3,950	5,320	7,730
El Rio Drain	Dev.	170	340	490	690	860	1,050	1,250	1,580
Brown Barranca	Undev.	120	390	710	1,310	1,930	2,720	3,660	5,330
Harmon Barranca	Undev.	200	660	1,210	2,230	3,290	4,630	6,240	9,070
Patterson Rd Drain	Dev.	240	480	670	950	1,190	1,450	1,730	2,180
Warring Canyon	Undev.	100	350	630	1,170	1,720	2,420	3,260	4,740
Warring & Real Canyons	Undev.	130	420	770	1,430	2,100	2,960	3,990	5,800
Fairview Canyon	Undev.	60	190	350	640	940	1,330	1,790	2,600
Reimer Ditch	Undev.	190	630	1,150	2,120	3,120	4,400	5,930	8,620
Bear Ck	Undev.	130	430	790	1,460	2,150	3,030	4,080	5,930
O'Leary Creek	Undev.	160	540	980	1,810	2,670	3,760	5,060	7,360
Balcom Canyon	Undev.	200	660	1,200	2,210	3,260	4,590	6,180	8,990
Timber Canyon	Undev.	220	720	1,310	2,420	3,570	5,030	6,770	9,850
Peck Rd Drn	Dev.	300	600	850	1,200	1,500	1,830	2,180	2,750
Sudden Barranca	Undev.	60	200	360	660	970	1,370	1,840	2,680
Clark Barranca	Dev.	250	510	710	1,010	1,260	1,540	1,840	2,320

APPENDIX M – Los Angeles County Design Storm Results

Prepared by

R. Butler
Los Angeles County Department of Public Works

With assistance from
AQUA TERRA Consultants

Introduction

The calibrated Santa Clara HSPF model was used as the basis for generating design storm peaks and hydrographs for use in the hydraulic modeling portion of the study. The approach involved identifying a storm where saturation levels were very high across the model domain and then applying balanced design storm hyetographs for the 100-yr storm for each rain gage used in the HSPF model. The gaged tributaries with long-term records were used as calibration points in the modeling. The calibration was done by adjusting the rainfall factors (MFACTS in HSPF UCI – Users Control Input) applied to the rain data for each subarea and associated reach at the calibration points to establish corresponding rainfall factors that could then be applied to the ungaged tributaries. The HSPF model was then run with the appropriate rainfall distributions at 5-min timesteps for the storm of interest to provide 100-yr design storm peaks at the ungaged tributaries. The 100-yr peaks were converted to other return intervals of interest by using multipliers developed from flow frequency analyses of long-term Los Angeles County stream gages.

Balanced Storm Method for Developing Hyetographs

The Balanced Storm Method (also called alternating block) is a straightforward way of developing design storm hyetographs for the study following these steps:

1. Perform a frequency analysis of the rainfall data using the annual maxima data at the desired intervals ranging from 5-min to 24-hr. For Ventura County rain gages, a Pearson III model provided frequency results. For Los Angeles County, the Gumbel model provided the frequency results.
2. Plot the depth vs duration data on a log-log plot and fit a power equation trendline through the results.
3. Establish the desired rainfall duration.
4. Establish a duration interval that divides equally into an hour.
5. Tabulate the duration in increasing values of the interval.
6. Use equation from Step 2 to calculate the rainfall depth for each duration.
7. Calculate the incremental rainfall depth for each time period by subtracting the cumulative rainfall at the previous time step from the current time step.
8. If the sum of the incremental values is larger than the 24-hr depth from the frequency analysis, reduce the incremental values by a constant factor for each interval until the sum matches the 24-hr depth.

9. Distribute the incremental depth values. Use time blocks that correlate with the duration intervals. Assign the highest incremental depth to the central time block, and arrange the remaining incremental depth blocks in descending order, alternating between the upper and lower time blocks away from the central time block.

The resulting ordinates of the hyetographs for each rain gage were then used as input to the HSPF model. For rain gages that only have daily records, the 24-hr value resulting from a frequency analysis of the gage data was applied to the dimensionless distribution of an adjacent gage concluded to be a good surrogate for the gage of interest. Table 1 summarizes the rain data and surrogates used in the HSPF Design Storm Modeling.

HSPF Calibration- Approach and Results

The rainfall hyetographs developed from the data in the preceding section were entered into an HSPF submodel set up to provide design storm results for January 10, 2005. This day was selected as one of the wettest periods in recent history in the Santa Clara watershed as representing saturated conditions when a design storm could occur. The steps in preparing the submodel were as follows:

1. Run calibration HSPF UCI for entire SCR watershed to get state of system at beginning of analysis period for the design storm (end of day January 9, 2005). Extract initial state data from model output for appropriate locations for run of January 10 through 31, 2005.
2. Modify calibration UCI for storm simulation, 5-min timestep, initial storages, start time, rain data sets, and adjusted rainfall factors incorporating original factors, areal reduction (AR) factors and 3rd factor used to match design storm peak from stream gage frequency analyses.
3. Run the modified UCI. Multiple runs were needed to implement the appropriate AR factors for each site; AR factor for all sites upstream of site of interest must be identical. For calibration sites – adjust factors to calibrate/match 100-yr peak flow within 2%
4. For ungaged sites, evaluate results from gaged locations and apply factors accordingly
5. Extract results for plotting using WDMUtil or GenScn (include observed flow, if available)

Figure 1 (below) provides the 24-hr storm duration AR factors used in the study from HEC-HMS model documentation

Figure 1. HEC-HMS Aerial Reduction Factors

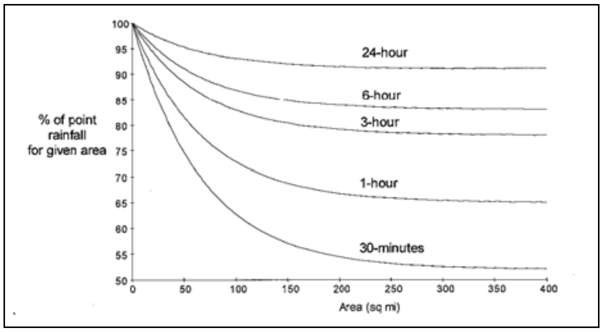


Table 1. Rainfall Gages Used in the HSPF Design Storm Modeling in Los Angeles County

Gage Number	HSPF Node ID	Station Name	Rain Data Type	Design Storm Data Provided	Assumed Gage Hyetograph	100-yr 24-hr Depth (in)
32 (04162)	36	Newhall Soledad	5-min	5-min Hyeto		8.42
120	33	Vincent Patrol Station		24-hr depths	261	3.81
125b	38	San Francisquito Cyn Power House		24-hr depths	372	6.34
128b	39	Elizabeth Lake - Warm Springs Camp	5-min	5-min Hyeto		8.63
252c	40	Castaic Lake		24-hr depths	372	5.47
261 (40014)	31	Acton Escondido Cyn	5-min	5-min Hyeto		4.61
277	41	Sawmill Mountain		24-hr depths	128b	8.32
372	37	San Francisquito Power House No. 2	5-min	5-min Hyeto		6.45
405b	34	Soledad Canyon		24-hr depths	261	6.99
409b	44	Pyramid Reservoir		24-hr depths	128b	7.55
423c	32	Angeles Forest - Aliso Cyn.		24-hr depths	261	7.85
747	43	Sandberg		24-hr depths	128b	6.22
1005b	35	Mint Canyon Fire Station		24-hr depths	261	4.53
1263	42	Valencia Reclamation Plant		24-hr depths	VC101	6.49

In Los Angeles County, four relatively long-term stream gage records are considered suitable for calibration. Three of the stream gage records are on the Santa Clara River, which from West to East are at the County line, Old Road/Interstate 5, and Lang Railroad Station. The last gage is located in the downstream portion of Aliso Canyon. Table 2 summarizes the HSPF model results for the calibration points.

Table 2. HSPF Design Storm Model Results for Los Angeles County Calibration Sites

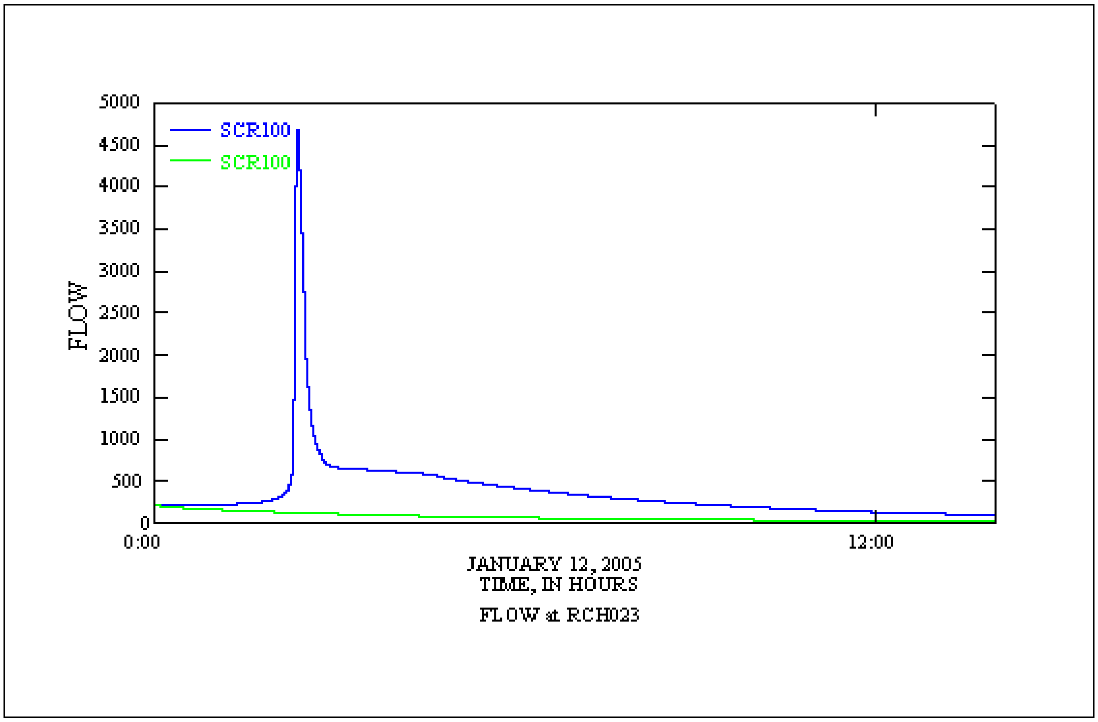
Location	SCR @ Aliso Canyon	SCR @ Lang RR Bridge	SCR @ Old Road/I-5	SCR @ County Line
Area (sq mi)	24	157	410	644
FFA Q100 (cfs)	4,720	19,600	52,300	66,600
Q100/Drainage Area (cfs/sq mi)	197	125	128	103
HSPF Q100 (cfs)	4,682	21,342	52,860	66,260
HSPF Rain Factor (Calibrated Model)	1.20	1.10	1.15	1.00
Aerial Reduction Factor	0.975	0.92	0.91	0.91
Calibration Factor	0.84	0.84	1.10	1.10
AR and Calibration Factor	0.82	0.77	1.00	1.00
HSPF Area (sq mi)	27	157	410	639
HSPF Q100/Drainage Area (cfs/sq mi)	176	136	129	104

The model was calibrated to match each gage's peak 100-year frequency flow rate from the flow frequency analysis. The flow frequency analysis was performed by Ventura County Watershed Protection District with the results for Aliso Canyon and the County Line being from the Santa Clara River 2006 Hydrology Update. A separate flow frequency analysis was computed using the station skew factors and was used for the results at the Lang and I-5 runoff gages. This analysis is included in the section titled, "Flood Frequency Analysis Results for the Lang Railroad Bridge and Old Road/I5 Runoff Gage" at the end of this appendix.

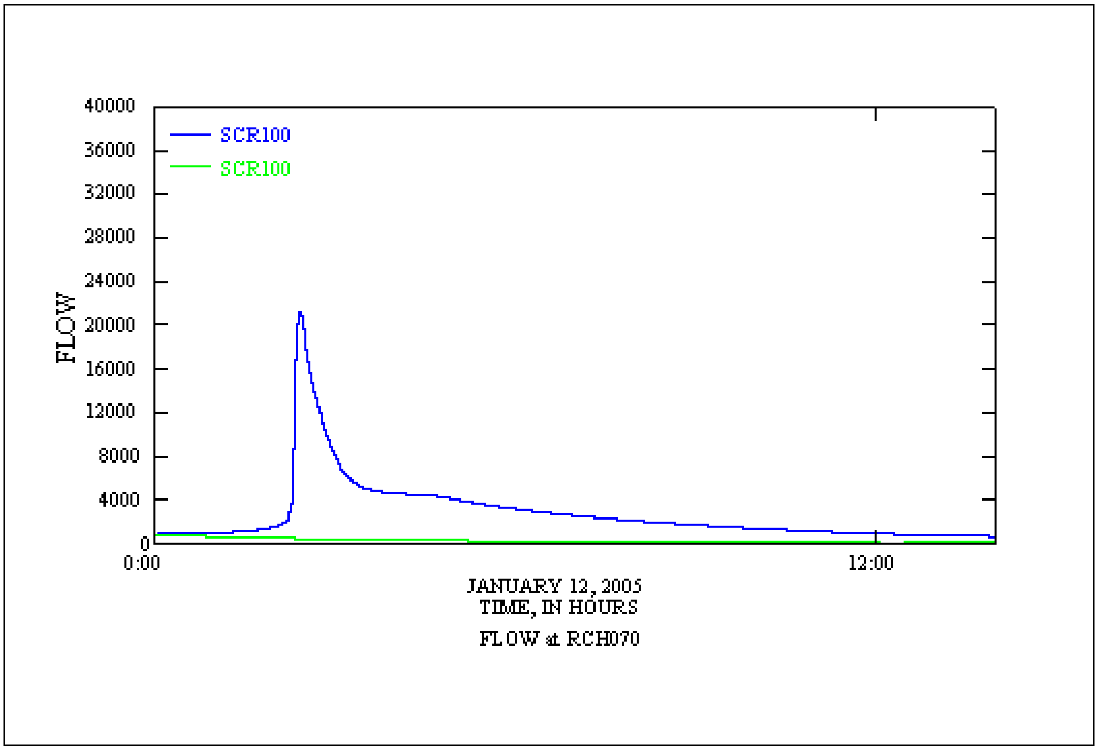
The calibration produced one model with different combined aerial reduction (AR) and calibration factors applied to the upper watershed than to the lower watershed. As shown in Table 2, the combined AR and calibration factors give a reduction of approximately 20 percent to the upper watershed rainfall and no adjustment to the lower watershed. This reduction factor is appropriate since the upper watershed receives 2.3 fewer inches of rainfall (average of rain gage depths) for the 100-year, 24-hour depth (see Table 1) than the lower watershed. Thus, this one calibrated HSPF model will be used for all of the tributaries on Los Angeles County side of the Santa Clara River watershed. Based on the range of 0.77 to 1.00 for the combined AR and calibration factors for the model, the uncertainty associated with the ungaged tributary results is expected to be on the order of 10%.

The following figures show the design storm results for the four gage tributaries evaluated in the HSPF model in Los Angeles County using output from the WDMUtil program. The plots show approximately 3 days of runoff starting from 00:00 hrs on January 10 through about midnight on January 12. SCR100 is the name of the underlying model file used to provide the hydrology results. The blue lines are the design storm peak runoff; the green lines are the baseflow that would occur if no design storm rainfall is applied to the model. Units of flow are cfs.

Figure 2. HSPF Design Storm Hydrographs for Los Angeles County Sites

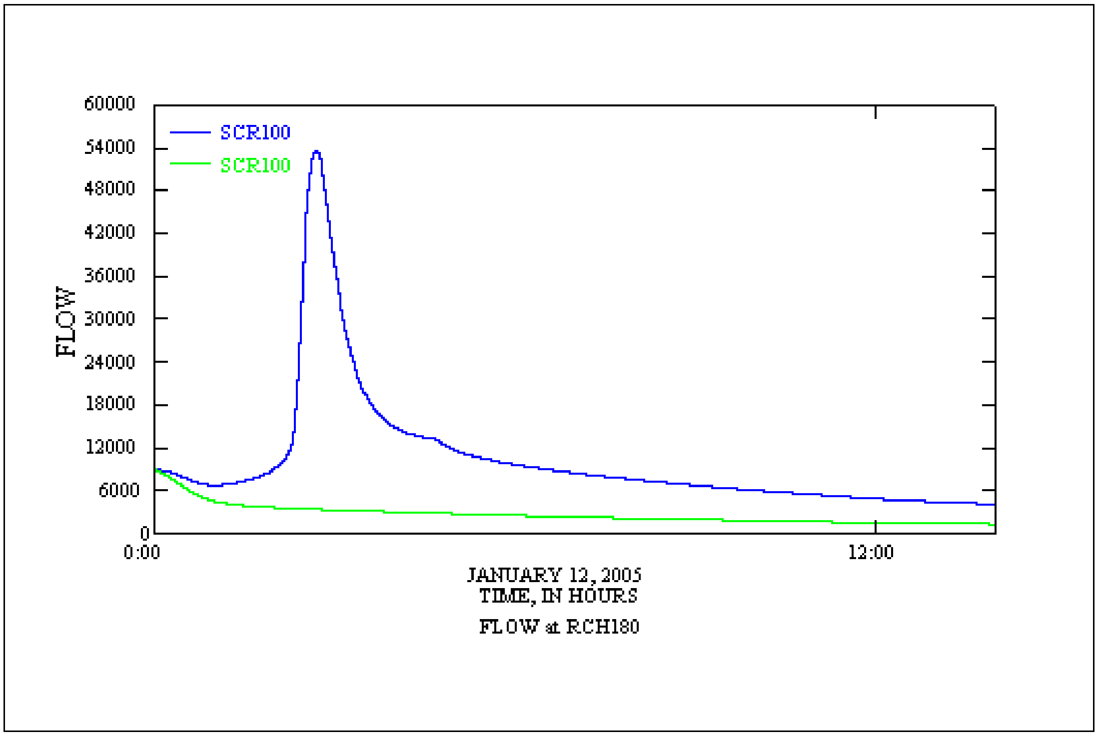


Aliso Canyon, Rch023

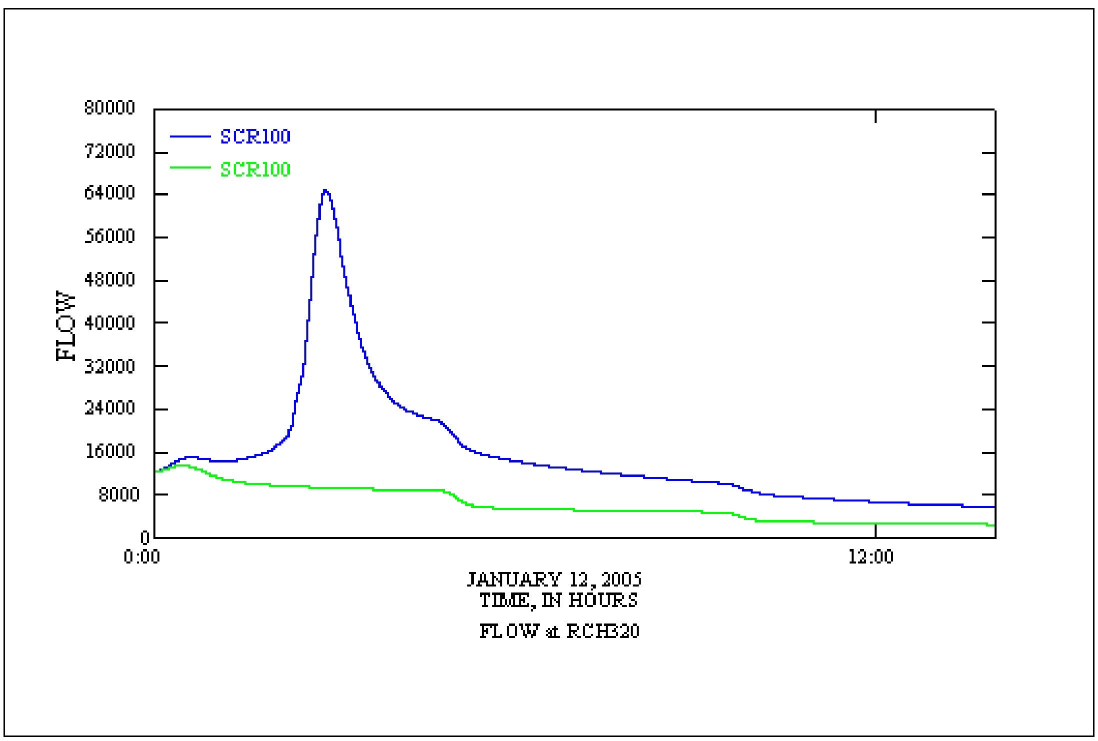


Santa Clara River at Lang Railroad Station Rch070

Figure 2 (Continued). HSPF Design Storm Hydrographs for Los Angeles County Sites



Santa Clara River at Interstate 5, Rch180



Santa Clara River at the County Line, Rch 320

The hydrographs in Figure 2 shows baseflow resulting from the rainfall occurring prior to the end of January 9th that increases the design storm peak runoff. The baseflow is included in this analysis because historical peaks often occur at the end of storms due to a relatively short burst of high intensity rain leading to a sharp spike in flow as seen in the historical data from January 10, 2005. In addition, the parameters used across the model leading to baseflow did not vary widely and so similar baseflow conditions were expected in the ungaged tributaries.

Ungaged Tributary Results

Table 3 summarizes the results for the ungaged tributaries included in the analysis for Los Angeles County. Figure 3 shows the locations of the tributaries and SCR Model reaches.

Table 3. HSPF Model Results for Los Angeles County Ungaged Sites

HSPF Reach #	Name	Cumulative Area (sq. mi)	HSPF Rain Factor	Combined AR and Design Adjustment	HSPF 100 (cfs)	Q100/DA (cfs/ac)
11	Soledad Canyon	9.03	1.20	0.82	2220	0.38
12	Trade Post	2.97	1.20	0.82	930	0.49
19	Acton Canyon (A)	4.62	1.20	0.82	1140	0.39
24	Red Rover Mine	2.40	1.20	0.82	720	0.47
26	Escondido Creek	12.98	1.20	0.82	2390	0.29
29	Acton Canyon 2 (B)	20.86	1.20	0.82	4080	0.31
63	Agua Dulce Canyon	29.52	1.15	0.77	3010	0.16
82	Iron Canyon	2.96	0.95	1.00	950	0.50
84	Sand Canyon	12.74	0.95	1.00	7940	0.97
85	Oak Spring Canyon	6.43	0.95	1.00	1140	0.28
86	Tick Canyon	5.67	0.95	1.00	1710	0.47
103	Mint Canyon	29.37	0.80	1.00	4260	0.23
121	Texas Canyon	10.99	0.80	1.00	3520	0.50
122	Vasquez Canyon	4.39	1.00	1.00	1420	0.51
123	Plum Canyon	3.17	1.00	1.00	1080	0.53
142	Haskell Canyon	9.76	0.80	1.00	3320	0.53
143	Bouquet Canyon	72.19	0.80	1.00	15700	0.34
147	Dry Canyon	9.48	0.80	1.00	3170	0.52
148	Towsley Canyon	5.83	0.80	1.00	2830	0.76
149	Lyon Canyon	1.50	0.80	1.00	690	0.72
156	Pico Canyon	6.93	0.80	1.00	1910	0.43
161	Newhall Creek	17.72	0.80	1.00	2480	0.22
164	Placerita Creek	9.53	0.80	1.00	2340	0.38
169	South Fork SCR	45.30	0.80	1.00	10840	0.37

Table 3 (Continued). HSPF Model Results for Los Angeles County Ungaged Sites

175	San Francisquito Cyn	49.10	0.85	1.00	13860	0.44
191	Lion Canyon	0.79	1.00	1.00	210	0.42
198	Violin Canyon	5.91	1.00	1.00	1980	0.52
203	Salt Creek	18.40	1.00	1.00	8110	0.69
206	Fish Creek	27.30	1.00	1.00	16970	0.97
207	Elderberry Canyon	2.50	1.00	1.00	2530	1.58
208	Necktie Canyon	2.10	1.00	1.00	2040	1.52
212	Elizabeth Lake Canyon	61.50	1.00	1.00	34070	0.87
214	Grasshopper Canyon	4.10	1.00	1.00	1460	0.56
218	Marple Canyon	10.50	1.00	1.00	3810	0.57
221	Charlie Canyon	9.90	0.80	1.00	2360	0.37
227	Hasley Canyon	7.40	1.00	1.00	750	0.16
228	Lower Castaic Creek	41.30	1.00	1.00	13540	0.51
302	San Martinez Chiquito Cyn	5.00	1.00	1.00	480	0.15
303	Long Canyon	1.54	1.00	1.00	260	0.26
304	San Martinez Grande Cyn	3.22	1.00	1.00	2310	1.12
312	Potrero Canyon	4.50	1.00	1.00	1930	0.67

The results, as shown above in Table 3, were in the expected range of flow per drainage area (Q100/DA) for the Santa Clara River watershed. The model Q100/DA is mostly between 0.2 and 0.6 cfs/ac, which compares well to other hydrology modeling results conducted for Los Angeles County watersheds by the Department of Public Works. The highest ratios are observed for mostly small watersheds with relatively high rainfall and high initial watershed and reach storage from the storm events leading up to the design storm. Similarly, the lowest ratios are in areas with relatively drier antecedent conditions and lower rainfall.

Figure 4 shows the design storm peaks and hydrographs for the Los Angeles County tributaries included in this study.

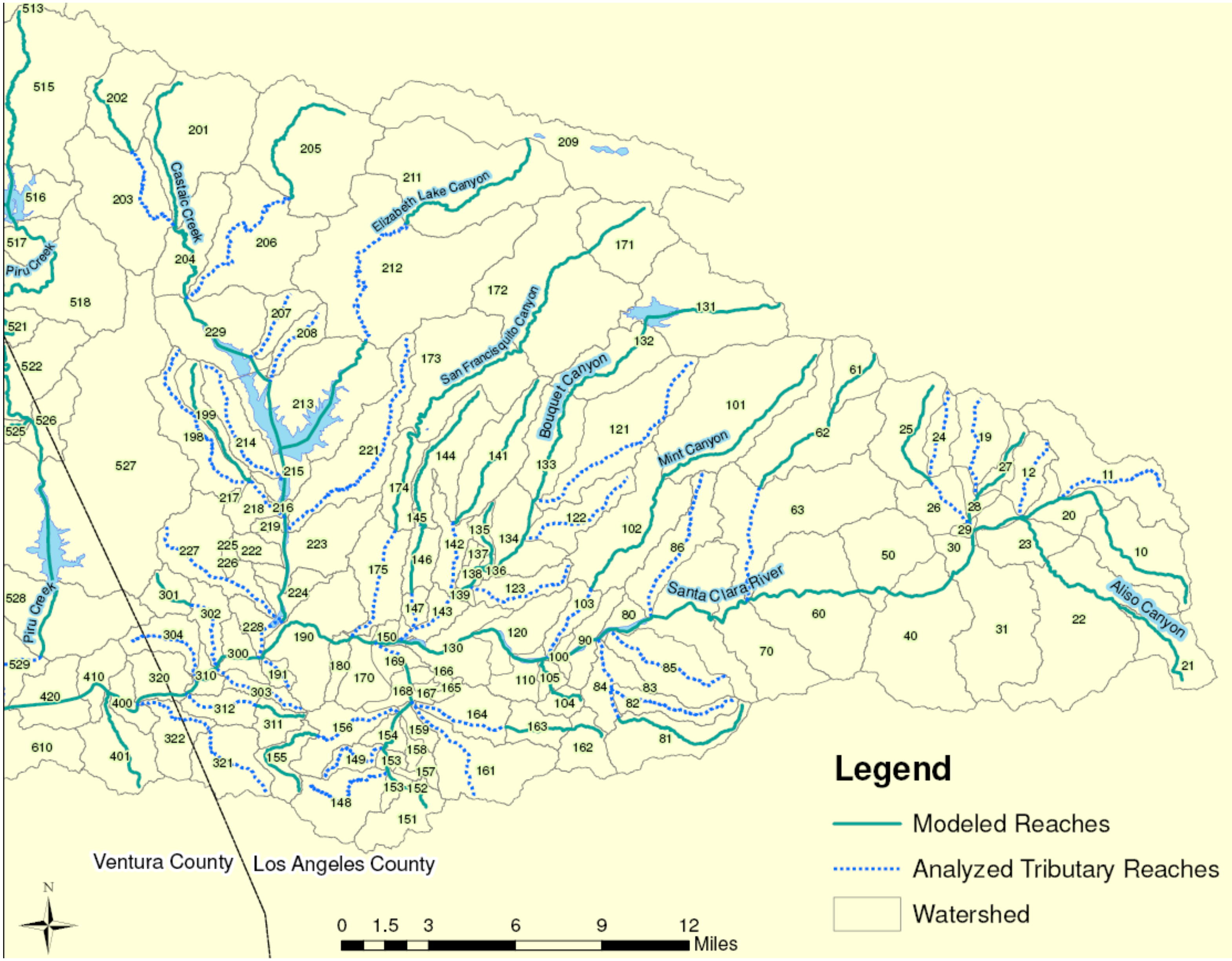
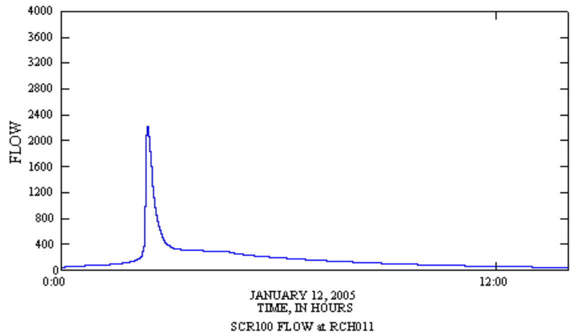
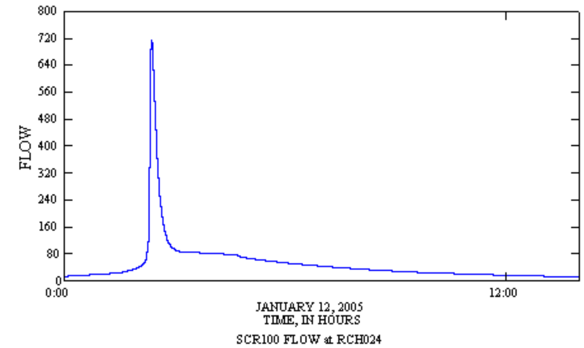


Figure 3. Tributary and SCR Model Reaches for Los Angeles County

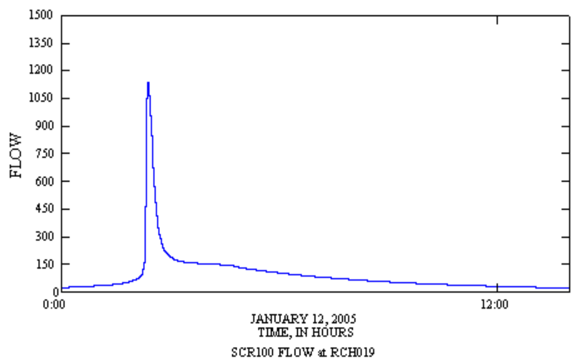
Figure 4. HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



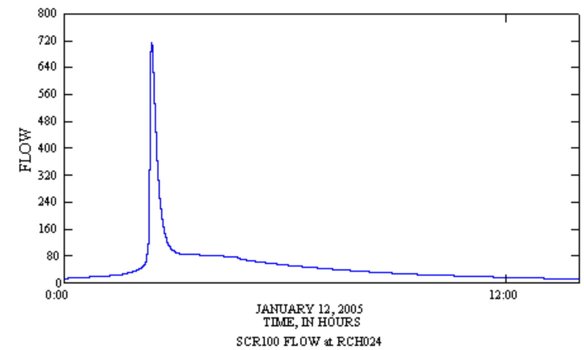
Soledad Canyon Q100= 2,220 cfs



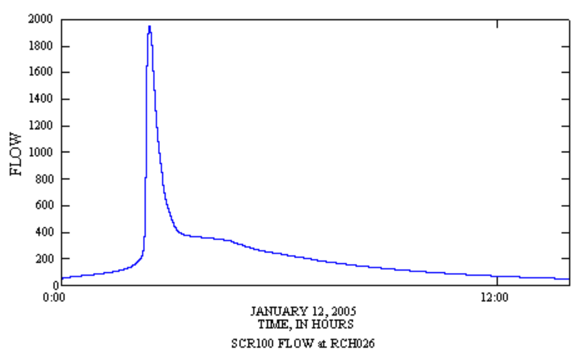
Trade Post Q100= 930 cfs



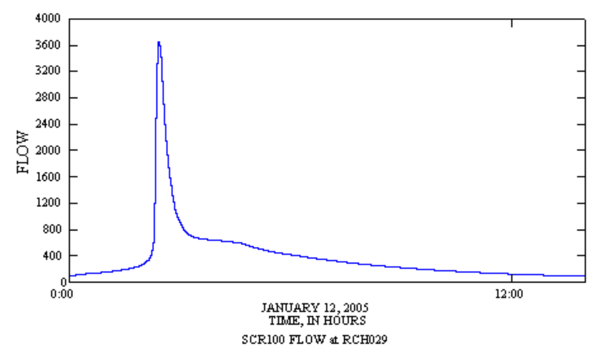
Acton Canyon (A), Q100= 1,140 cfs



Red Rover Mine, Q100= 720 cfs

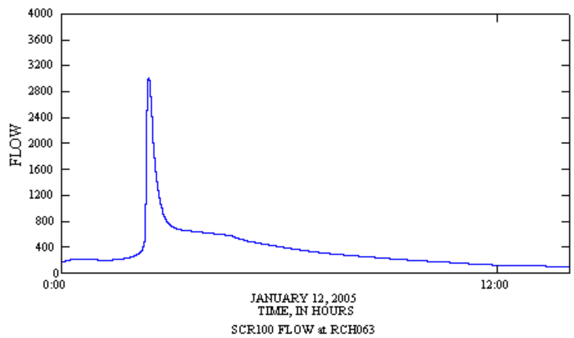


Escondido Creek Q100= 2,390 cfs

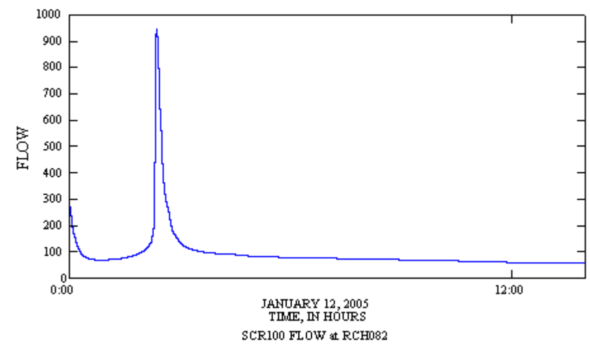


Acton Canyon 2 (B) Q100= 4,080 cfs

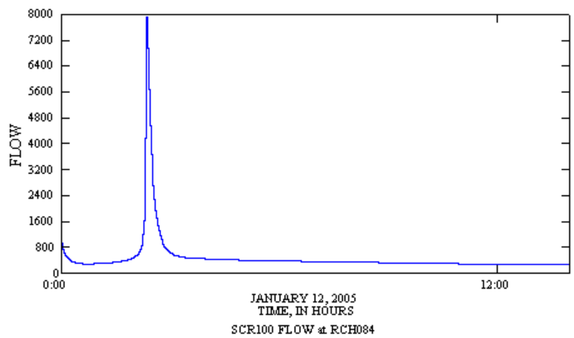
Figure 4 (Continued). HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



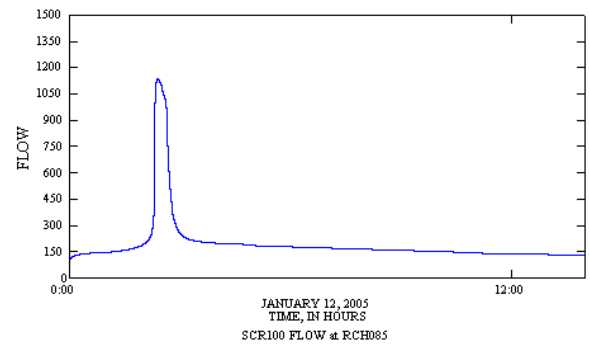
Agua Dulce Canyon Q100= 3,010 cfs



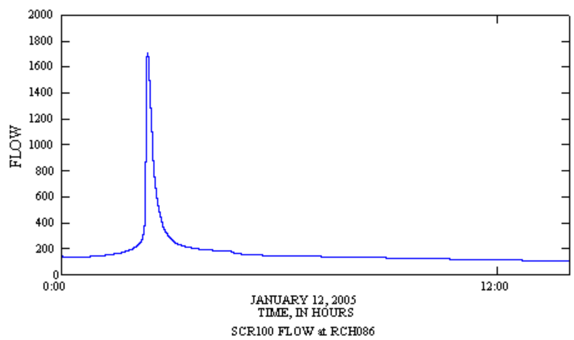
Iron Canyon Q100= 950 cfs



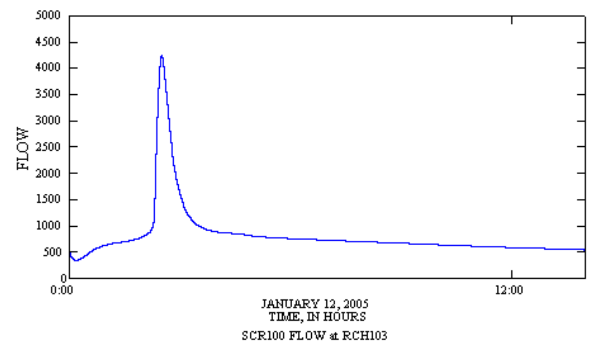
Sand Canyon Q100= 7,940 cfs



Oak Spring Canyon Q100= 1,140 cfs

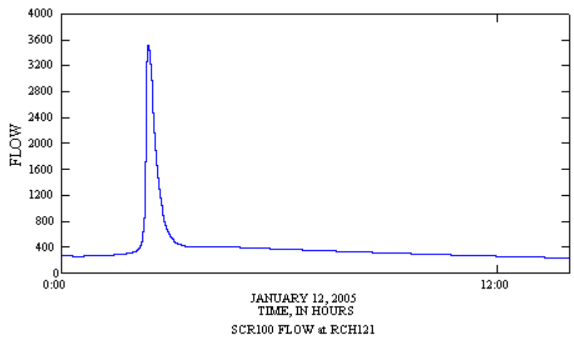


Tick Canyon Q100= 1,710 cfs

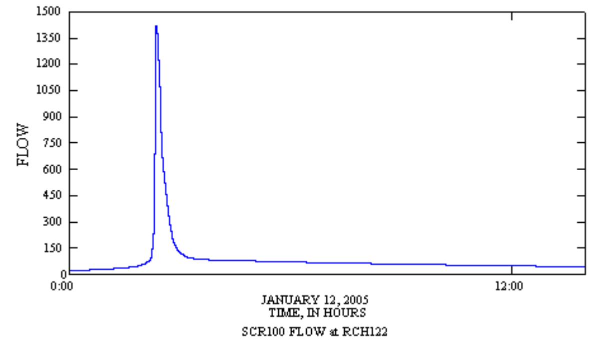


Mint Canyon Q100= 4,260 cfs

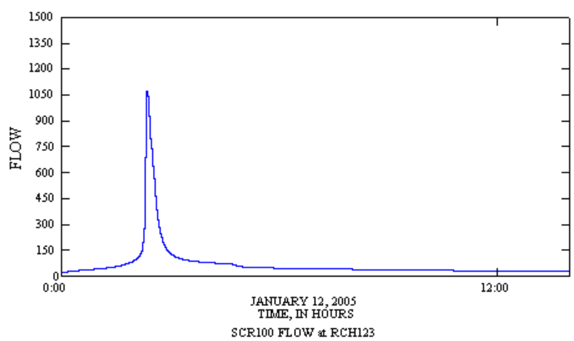
Figure 4 (Continued). HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



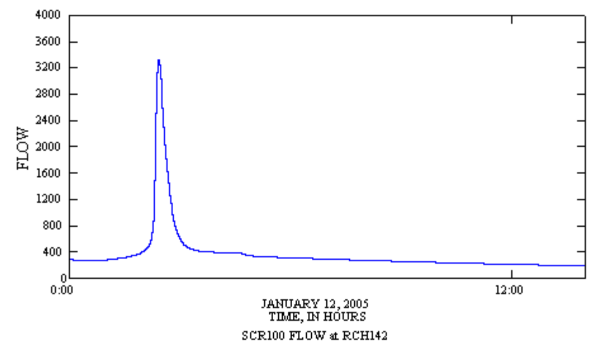
Texas Canyon Q100= 3,520 cfs



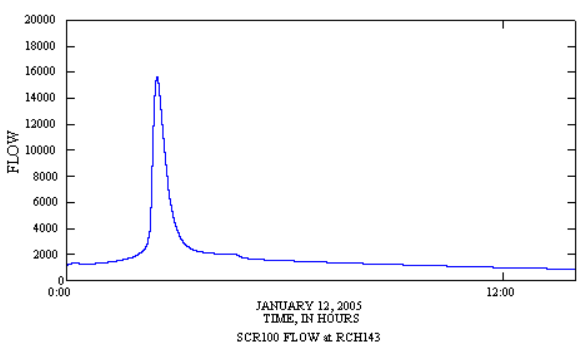
Vasquez Canyon Q100= 1,420 cfs



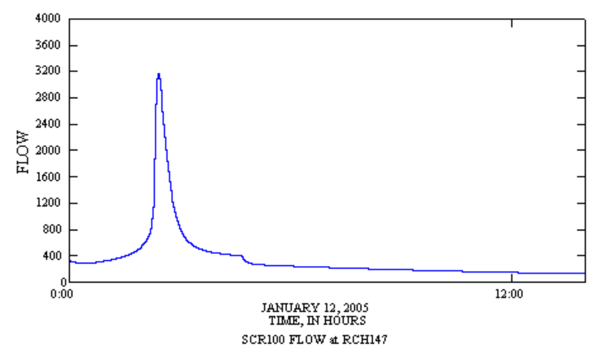
Plum Canyon Q100= 1,080 cfs



Haskell Canyon Q100= 3,320 cfs

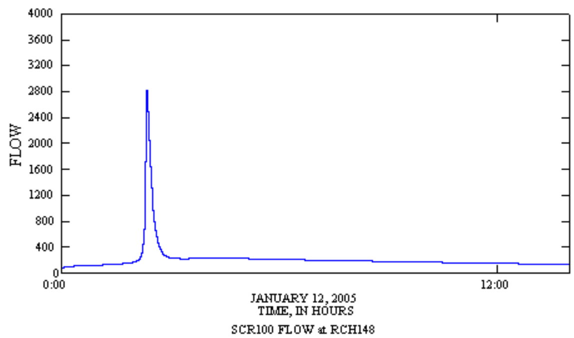


Bouquet Canyon Q100= 15,700 cfs

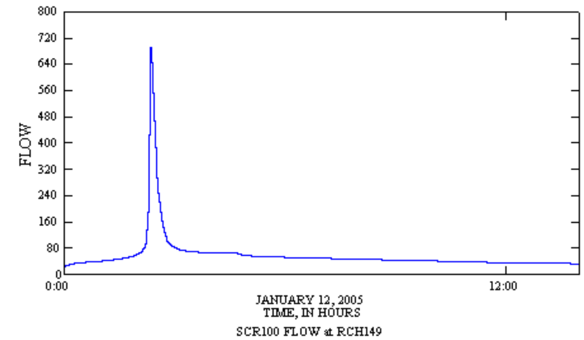


Dry Canyon Q100= 3,170 cfs

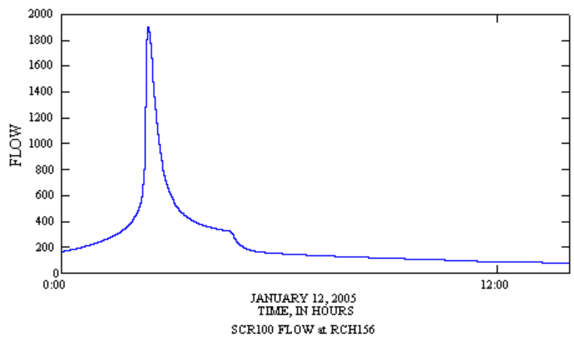
Figure 4 (Continued). HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



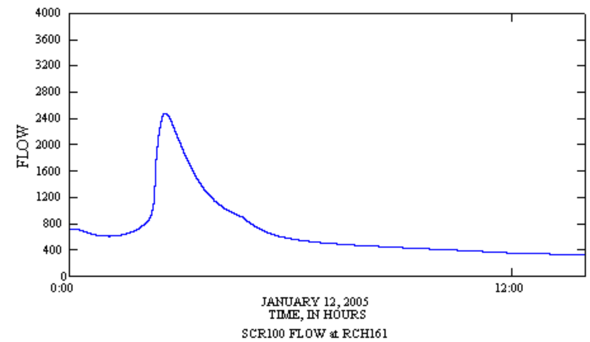
Towsley Canyon Q100= 2,830 cfs



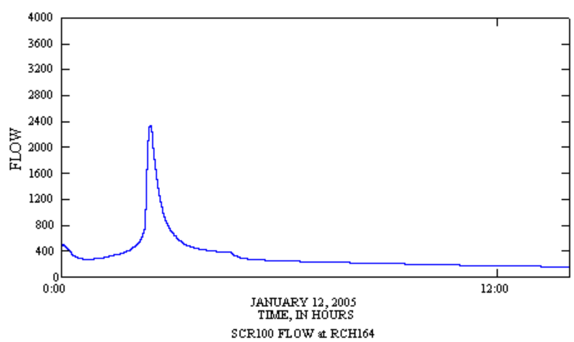
Lyon Canyon Q100= 690 cfs



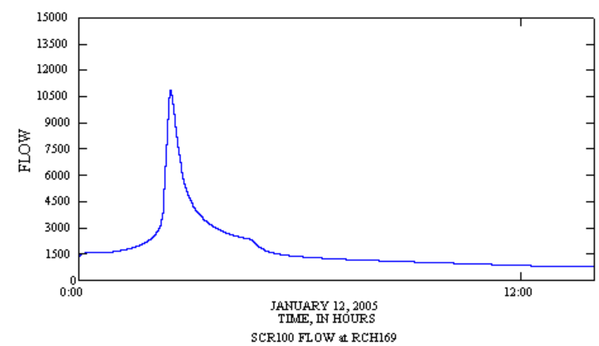
Pico Canyon Q100= 1,910 cfs



Newhall Creek Q100= 2,480 cfs

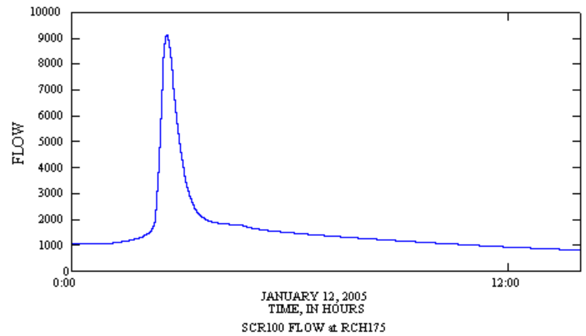


Placerita Creek Q100= 2,340 cfs

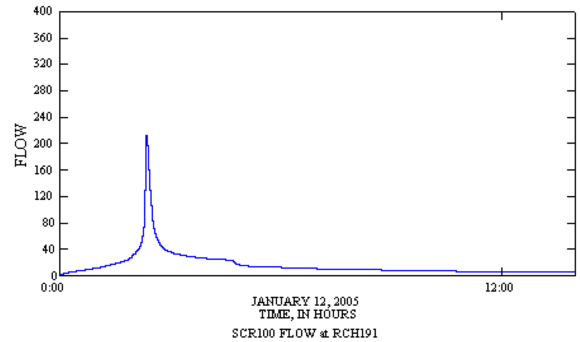


South Fork Santa Clara River Q100= 10,840 cfs

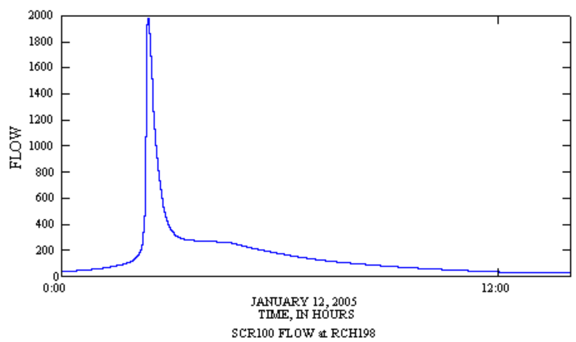
Figure 4 (Continued). HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



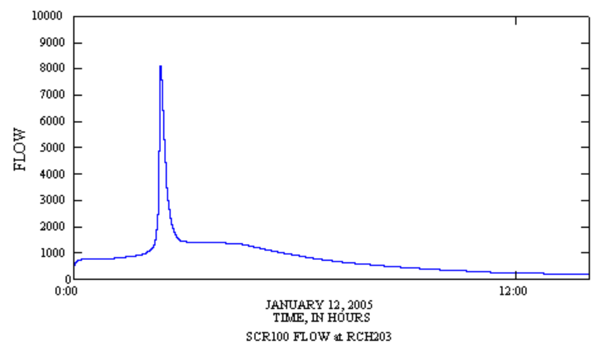
San Francisquito Canyon Q100= 13,860 cfs



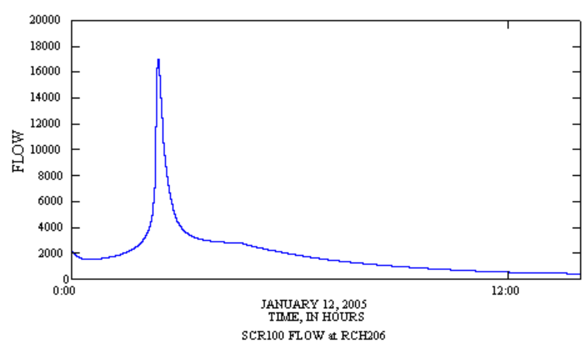
Lion Canyon Q100= 210 cfs



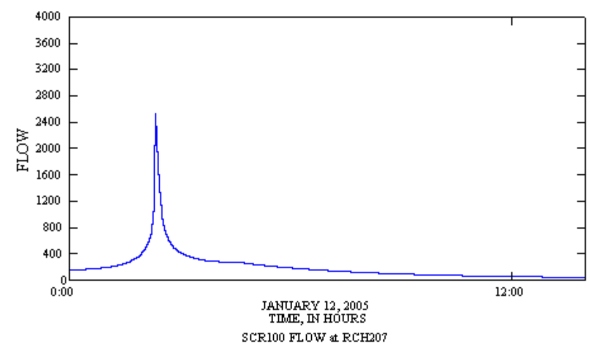
Violin Canyon Q100= 1,980 cfs



Salt Creek Q100= 8,110 cfs

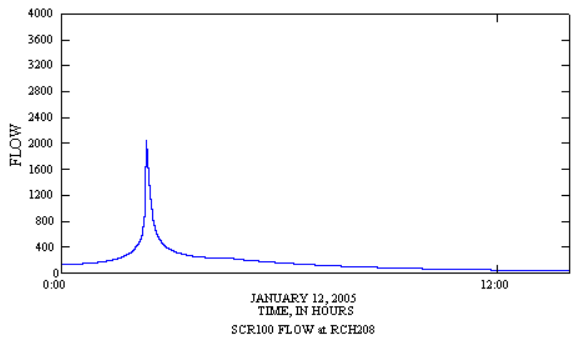


Fish Creek Q100= 16,970 cfs

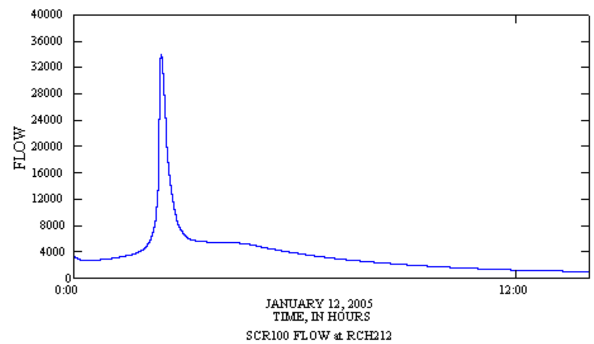


Elderberry Canyon Q100= 2,530 cfs

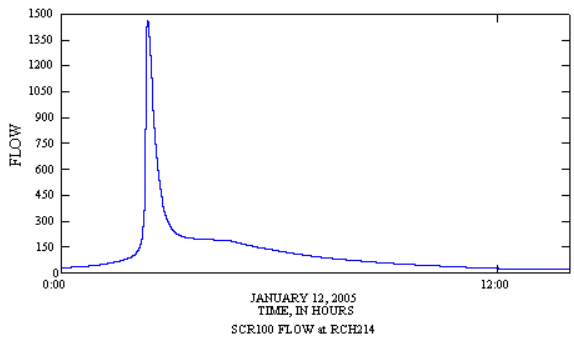
Figure 4 (Continued). HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



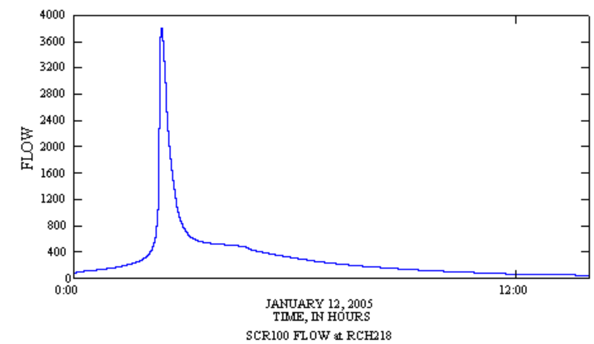
Necktie Canyon Q100= 2,040 cfs



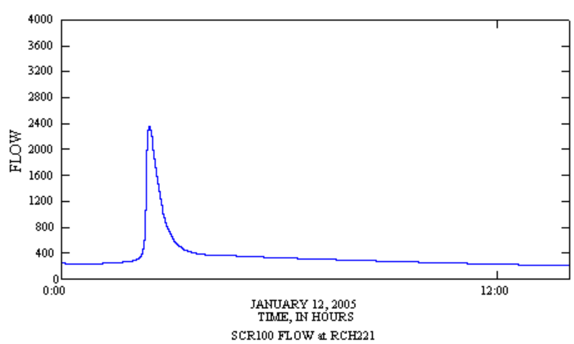
Elizabeth Lake Canyon Q100= 34,070 cfs



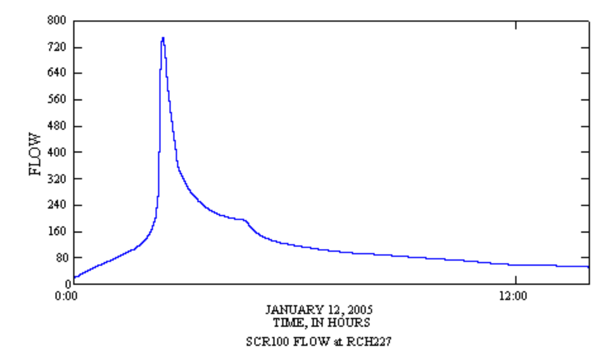
Grasshopper Canyon Q100= 1,460 cfs



Marple Canyon Q100= 3,810 cfs

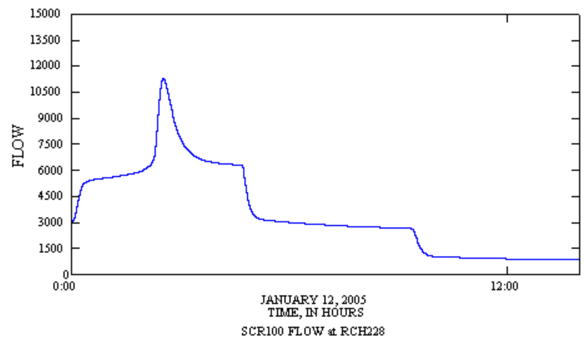


Charlie Canyon Q100= 2,360 cfs

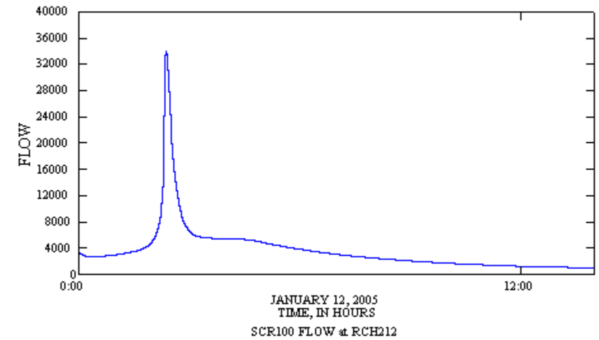


Hasley Canyon Q100= 750 cfs

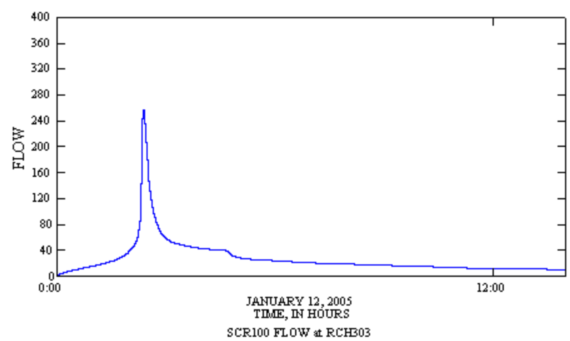
Figure 4 (Continued). HSPF Design Storm Hydrographs for Ungaged Tributaries in Los Angeles County



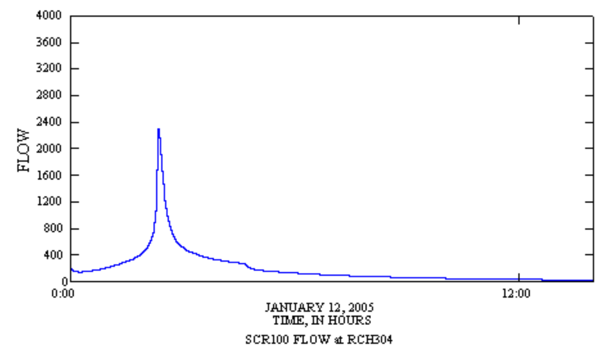
Lower Castaic Creek Q100= 13,540 cfs



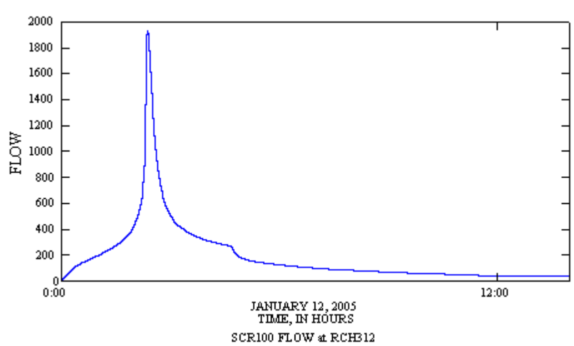
San Martinez Chiquito Canyon Q100= 480 cfs



Long Canyon Q100= 260 cfs



San Martinez Grande Canyon Q00= 2,310 cfs



Potrero Canyon Q100= 1,930 cfs

Multipliers

Storms above the 50-year storm frequency represent saturated conditions where most or all rain that falls on the land surface occurs as runoff. However, design storms at recurrence intervals less than 50-year frequencies represent various levels of saturation and quantifying infiltration rates and available storage capacity for these storms is difficult. Therefore the results of flow frequency analyses of Los Angeles County stream gages were used to develop discharge frequency multipliers. These multipliers (as shown in Table 4) represent each discharge frequency result divided by the 100-year frequency discharge at each calibration runoff gage. For each frequency discharge, the multipliers at three of the four calibration runoff gages were comparable and an average multiplier was calculated based on these gages. The results from the fourth gage, Lang Railroad Station, were disregarded for this analysis due to inconsistent discharge results from poor rainfall data. These multipliers are used to convert the Q100 results from the HSPF modeling to the other recurrence intervals of interest, including the 2-, 5-, 10-, 50-, 200- and 500-year frequency storm events.

Table 4. Discharge Frequency Multipliers for the Los Angeles County Tributaries

Name	Drainage Area (sq.mi)	Watershed Multiplier Results from Flow Frequency Analyses (cfs)							
Frequency Multipliers		0.035	0.117	0.221	0.374	0.675	1.000	1.434	2.218
Frequency Interval		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Soledad Canyon	9.03	80	260	490	830	1,500	2,220	3,180	4,920
Trade Post	2.97	30	110	210	350	630	930	1,330	2,060
Acton Canyon (A)	4.62	40	130	250	430	770	1,140	1,630	2,530
Red Rover Mine	2.40	30	80	160	270	490	720	1,030	1,600
Escondido Creek	12.98	80	280	530	890	1,610	2,390	3,430	5,300
Acton Canyon 2 (B)	20.86	140	480	900	1,530	2,750	4,080	5,850	9,050
Agua Dulce Canyon	29.52	110	350	670	1,130	2,030	3,010	4,320	6,680
Iron Canyon	2.96	30	110	210	360	640	950	1,360	2,110
Sand Canyon	12.74	280	930	1,750	2,970	5,360	7,940	11,390	17,610
Oak Spring Canyon	6.43	40	130	250	430	770	1,140	1,630	2,530
Tick Canyon	5.67	60	200	380	640	1,150	1,710	2,450	3,790
Mint Canyon	29.37	150	500	940	1,590	2,880	4,260	6,110	9,450
Texas Canyon	10.99	120	410	780	1,320	2,380	3,520	5,050	7,810
Vasquez Canyon	4.39	50	170	310	530	960	1,420	2,040	3,150
Plum Canyon	3.17	40	130	240	400	730	1,080	1,550	2,400

Table 4 (Continued). Discharge Frequency Multipliers for the Los Angeles County Tributaries

Haskell Canyon	9.76	120	390	730	1,240	2,240	3,320	4,760	7,360
Bouquet Canyon	72.19	550	1,840	3,470	5,870	10,600	15,700	22,510	34,820
Dry Canyon	9.48	110	370	700	1,190	2,140	3,170	4,550	7,030
Towsley Canyon	5.83	100	330	630	1,060	1,910	2,830	4,060	6,280
Lyon Canyon	1.50	20	80	150	260	470	690	990	1,530
Pico Canyon	6.93	70	220	420	710	1,290	1,910	2,740	4,240
Newhall Creek	17.72	90	290	550	930	1,670	2,480	3,560	5,500
Placerita Creek	9.53	80	270	520	880	1,580	2,340	3,360	5,190
South Fork SCR	45.30	380	1,270	2,400	4,050	7,320	10,840	15,540	24,040
San Francisquito Cyn	49.10	490	1,620	3,060	5,180	9,360	13,860	19,880	30,740
Lion Canyon	0.79	10	20	50	80	140	210	300	470
Violin Canyon	5.91	70	230	440	740	1,340	1,980	2,840	4,390
Salt Creek	18.40	280	950	1,790	3,030	5,470	8,110	11,630	17,990
Fish Creek	27.30	590	1,990	3,750	6,350	11,450	16,970	24,330	37,640
Elderberry Canyon	2.50	90	300	560	950	1,710	2,530	3,630	5,610
Necktie Canyon	2.10	70	240	450	760	1,380	2,040	2,930	4,520
Elizabeth Lake Canyon	61.50	1,190	3,990	7,530	12,740	23,000	34,070	48,860	75,570
Grasshopper Canyon	4.10	50	170	320	550	990	1,460	2,090	3,240
Marple Canyon	10.50	130	450	840	1,420	2,570	3,810	5,460	8,450
Charlie Canyon	9.90	80	280	520	880	1,590	2,360	3,380	5,230
Hasley Canyon	7.40	30	90	170	280	510	750	1,080	1,660
Lower Castaic Creek	41.30	470	1,580	2,990	5,060	9,140	13,540	19,420	30,030
San Martinez Chiquito Cyn	5.00	20	60	110	180	320	480	690	1,060
Long Canyon	1.54	10	30	60	100	180	260	370	580
San Martinez Grande Cyn	3.22	80	270	510	860	1,560	2,310	3,310	5,120
Potrero Canyon	4.50	70	230	430	720	1,300	1,930	2,770	4,280

Flood Frequency Analysis Results

Lang Railroad Bridge and Old Road/I5 Runoff Gages

Flood Frequency Analysis – Lang Railroad Station Runoff Gage

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************************************                    ************************************
 *         FFA                        *        *                                          *
 *   FLOOD FREQUENCY ANALYSIS         *        *   U.S. ARMY CORPS OF ENGINEERS           *
 *   PROGRAM DATE:  FEB 1995          *        *   THE HYDROLOGIC ENGINEERING CENTER      *
 *      VERSION:  3.1                 *        *   609 SECOND STREET                      *
 *   RUN  DATE   AND   TIME:          *        *   DAVIS, CALIFORNIA 95616                *
 *     10 JUL 08    10:13:16          *        *   (916) 756-1104                         *
 *                                    *        *                                          *
 ************************************                    ************************************



  INPUT FILE NAME: LAF93STN.TXT
 OUTPUT FILE NAME: LAF93STN.OUT



 **TITLE RECORD(S)**
 TT   FLOOD FLOW FREQUENCY PROGRAM - SANTA CLARA RIVER AT LANG RR STATION
 TT   PEAK VALUES FROM LA COUNTY
 TT   STATION SKEW -.07

 **STATION IDENTIFICATION**
 ID     F93 SANTA CLARA RIVER AT LANG RR STATION DA= 157SQMI REC BEGAN:1949

 **GENERALIZED SKEW**
     ISTN   GGMSE    SKEW
 GS    F93    .000    -.07

 **SYSTEMATIC EVENTS**
     30 EVENTS TO BE ANALYZED

 **END OF INPUT DATA**
 ED +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++



 ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ   FINAL RESULTS    ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

 -PLOTTING POSITIONS-   F93 SANTA CLARA RIVER AT LANG RR STATION D
 ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÑÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
 º     EVENTS ANALYZED     ³         ORDERED EVENTS         º
 º               FLOW      ³      WATER     FLOW   WEIBULL  º
 º MON DAY  YEAR     CFS   ³  RANK  YEAR      CFS    PLOT POS º
 ÇÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ¶
 º   0    0  1949       6.  ³    1   1968      5900.     3.23  º
 º   0    0  1950       2.  ³    2   1951      4200.     6.45  º
 º   0    0  1951    4200.  ³    3   1965      4040.     9.68  º
 º   0    0  1952      39.  ³    4   2004      2510.    12.90  º
 º   0    0  1953      29.  ³    5   1957      1260.    16.13  º
 º   0    0  1954       6.  ³    6   1972       953.    19.35  º
 º   0    0  1955       5.  ³    7   1970       620.    22.58  º
 º   0    0  1956       2.  ³    8   1960       500.    25.81  º
 º   0    0  1957    1260.  ³    9   1961       500.    29.03  º
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º  0   0  1958     40.  ³   10   1966      265.   32.26  º
º  0   0  1959      1.  ³  11   1973      264.   35.48  º
º  0   0  1960    500.  ³   12   1967      200.   38.71  º
º  0   0  1961    500.  ³   13   1969      200.   41.94  º
º  0   0  1962     60.  ³   14  2003       87.   45.16  º
º  0   0  1963     70.  ³   15   1971      79.   48.39  º
º  0   0  1964     35.  ³   16   1963      70.   51.61  º
º  0   0  1965   4040.  ³   17   1962       60.   54.84  º
º  0   0  1966    265.  ³   18   1974       59.   58.06  º
º  0   0  1967    200.  ³   19   1958       40.   61.29  º
º  0   0  1968   5900.  ³   20   1952       39.   64.52  º
º  0   0  1969    200.  ³   21   1976       38.   67.74  º
º  0   0  1970    620.  ³   22   1964       35.   70.97  º
º  0   0  1971     79.  ³   23   1953      29.   74.19  º
º  0   0  1972    953.  ³   24   1975       24.   77.42  º
º  0   0  1973    264.  ³   25   1954       6.   80.65  º
º  0   0  1974     59.  ³   26   1949      6.   83.87  º
º  0   0  1975     24.  ³   27   1955      5.   87.10  º
º  0   0  1976     38.  ³   28   1950      2.   90.32  º
º  0   0  2003     87.  ³   29   1956      2.   93.55  º
º  0   0  2004   2510.  ³   30   1959       1.   96.77  º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼


-OUTLIER TESTS  -
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
LOW OUTLIER TEST
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ


BASED ON  30 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.563

      0 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF       .2


ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
HIGH OUTLIER TEST
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ


BASED ON  30 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.563

     0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF   40823.
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ


-SKEW WEIGHTING -
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
BASED ON  30 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW =   .172
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW =   .302
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
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FINAL RESULTS

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-FREQUENCY CURVE-   F93 SANTA CLARA RIVER AT LANG RR STATION D
ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÑÍÍÍÍÍÍÍÍÍÍÍÍÍÍÑÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
º  COMPUTED   EXPECTED  ³  PERCENT  ³   CONFIDENCE LIMITS  º
º   CURVE   PROBABILITY ³   CHANCE  ³      .05       .95   º
º      FLOW IN CFS      ³ EXCEEDANCE ³    FLOW IN CFS      º
ÇÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ¶
º   64600.   122000.  ³      .2   ³  461000.    17100.  º
º   33700.    54800.  ³      .5   ³  204000.     9870.  º
º   19600.    28700.  ³     1.0   ³  104000.     6210.  º
º   10800.    14400.  ³     2.0   ³   49600.     3720.  º
º    4350.     5230.  ³     5.0   ³   16200.     1690.  º
º    1920.     2160.  ³    10.0   ³    6020.      822.  º
º     704.      748.  ³    20.0   ³    1830.      330.  º
º      99.       99.  ³    50.0   ³     205.       48.  º
º      13.       12.  ³    80.0   ³      28.        5.  º
º       4.        4.  ³    90.0   ³      11.        1.  º
º       2.        1.  ³    95.0   ³       5.        0.  º
º       0.        0.  ³    99.0   ³       1.        0.  º
ÌÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÏÍÍÍÍÍÍÍÍÍÍÍÍÍÍÏÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¹
º                  SYSTEMATIC STATISTICS                  º
ÇÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÂÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ¶
º LOG TRANSFORM: FLOW, CFS   ³    NUMBER OF EVENTS    º
ÇÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ¶
º MEAN              1.9788 ³ HISTORIC EVENTS       0 º
º STANDARD DEV      1.0269 ³ HIGH OUTLIERS         0 º
º COMPUTED SKEW     -.0704 ³ LOW OUTLIERS          0 º
º REGIONAL SKEW     -.0700 ³ ZERO OR MISSING       0 º
º ADOPTED SKEW      -.1000 ³ SYSTEMATIC EVENTS    30 º
ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÏÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
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++++++++++++++++++++++++
+ END OF RUN           +
+ NORMAL STOP IN FFA   +
++++++++++++++++++++++++
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Flood Frequency Analysis – I5 Runoff Gage

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 ************************************                                  ************************************
*          FFA                                   *          *
*    FLOOD FREQUENCY ANALYSIS                    *          *          U.S. ARMY CORPS OF ENGINEERS          *
*    PROGRAM DATE:  FEB 1995                     *          *          THE HYDROLOGIC ENGINEERING CENTER *
*       VERSION:  3.1                            *          *          609 SECOND STREET                     *
*    RUN  DATE   AND   TIME:                     *          *          DAVIS, CALIFORNIA 95616               *
*      10 JUL 08    10:33:48                     *          *          (916) 756-1104                        *
*                                                *          *
************************************                                   ************************************


 INPUT FILE NAME: I5NOUTST.TXT
OUTPUT FILE NAME: I5NOUTST.OUT



**TITLE RECORD(S)**
TT   FLOOD FLOW FREQUENCY PROGRAM - SANTA CLARA RIVER AT I-5
TT   STATION SKEW .2966 5 LOWEST FLOWS REMOVED

**STATION IDENTIFICATION**
ID    F92 SANTA CLARA RIVER AT I-5  DA= 410SQMI REC BEGAN:1931

**GENERALIZED SKEW**
    ISTN   GGMSE    SKEW
GS    F92    .000     .30

**SYSTEMATIC EVENTS**
    59 EVENTS TO BE ANALYZED

**END OF INPUT DATA**
ED ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++



ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ   FINAL RESULTS    ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

-PLOTTING POSITIONS-   F92 SANTA CLARA RIVER AT I-5  DA= 410SQMI
ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÑÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
º     EVENTS ANALYZED     ³          ORDERED EVENTS          º
º               FLOW  ³        WATER      FLOW   WEIBULL  º
º MON DAY  YEAR     CFS    ³  RANK  YEAR      CFS     PLOT POS º
ÇÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÅÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ¶
º   0   0  1931     2310.  ³    1   1969     31800.     1.67  º
º   0   0  1932     2090.  ³    2   1938     24000.     3.33  º
º   0   0  1933      618.  ³    3   1944     22200.     5.00  º
º   0   0  1934     3870.  ³    4   2005     20900.     6.67  º
º   0   0  1935      608.  ³    5   1998     19000.     8.33  º
º   0   0  1936      833.  ³    6   1943     15000.    10.00  º
º   0   0  1937     3410.  ³    7   1983     14925.    11.67  º
º   0   0  1938    24000.  ³    8   1966     11600.    13.33  º
º   0   0  1939     4620.  ³    9   2000      8770.    15.00  º
º   0   0  1940      676.  ³   10   1971      8150.    16.67  º
º   0   0  1941     5050.  ³   11   1952      7600.    18.33  º
```

					³					
º	0	0	1942	443.	³	12	2003	7290.	20.00	º
º	0	0	1943	15000.	³	13	2004	5900.	21.67	º
º	0	0	1944	22200.	³	14	1941	5050.	23.33	º
º	0	0	1945	317.	³	15	1973	4760.	25.00	º
º	0	0	1946	500.	³	16	1939	4620.	26.67	º
º	0	0	1947	1620.	³	17	1962	4250.	28.33	º
º	0	0	1948	350.	³	18	1934	3870.	30.00	º
º	0	0	1952	7600.	³	19	1958	3850.	31.67	º
º	0	0	1954	626.	³	20	1937	3410.	33.33	º
º	0	0	1955	746.	³	21	1979	3370.	35.00	º
º	0	0	1956	344.	³	22	1967	3000.	36.67	º
º	0	0	1957	1920.	³	23	1968	2810.	38.33	º
º	0	0	1958	3850.	³	24	1991	2750.	40.00	º
º	0	0	1959	1410.	³	25	1977	2510.	41.67	º
º	0	0	1960	151.	³	26	1974	2440.	43.33	º
º	0	0	1961	830.	³	27	1931	2310.	45.00	º
º	0	0	1962	4250.	³	28	1972	2200.	46.67	º
º	0	0	1963	1470.	³	29	1932	2090.	48.33	º
º	0	0	1964	860.	³	30	1997	2000.	50.00	º
º	0	0	1965	1260.	³	31	1957	1920.	51.67	º
º	0	0	1966	11600.	³	32	1985	1820.	53.33	º
º	0	0	1967	3000.	³	33	1947	1620.	55.00	º
º	0	0	1968	2810.	³	34	1999	1610.	56.67	º
º	0	0	1969	31800.	³	35	1963	1470.	58.33	º
º	0	0	1970	900.	³	36	1988	1450.	60.00	º
º	0	0	1971	8150.	³	37	1959	1410.	61.67	º
º	0	0	1972	2200.	³	38	1965	1260.	63.33	º
º	0	0	1973	4760.	³	39	1975	1120.	65.00	º
º	0	0	1974	2440.	³	40	1986	1050.	66.67	º
º	0	0	1975	1120.	³	41	1976	999.	68.33	º
º	0	0	1976	999.	³	42	1970	900.	70.00	º
º	0	0	1977	2510.	³	43	1989	876.	71.67	º
º	0	0	1979	3370.	³	44	1964	860.	73.33	º
º	0	0	1983	14925.	³	45	1936	833.	75.00	º
º	0	0	1985	1820.	³	46	1961	830.	76.67	º
º	0	0	1986	1050.	³	47	1955	746.	78.33	º
º	0	0	1987	444.	³	48	1940	676.	80.00	º
º	0	0	1988	1450.	³	49	1954	626.	81.67	º
º	0	0	1989	876.	³	50	1933	618.	83.33	º
º	0	0	1990	523.	³	51	1935	608.	85.00	º
º	0	0	1991	2750.	³	52	1990	523.	86.67	º
º	0	0	1997	2000.	³	53	1946	500.	88.33	º
º	0	0	1998	19000.	³	54	1987	444.	90.00	º
º	0	0	1999	1610.	³	55	1942	443.	91.67	º
º	0	0	2000	8770.	³	56	1948	350.	93.33	º
º	0	0	2003	7290.	³	57	1956	344.	95.00	º
º	0	0	2004	5900.	³	58	1945	317.	96.67	º
º	0	0	2005	20900.	³	59	1960	151.	98.33	º

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-OUTLIER TESTS -
ÄÄÄ
LOW OUTLIER TEST
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

BASED ON 59 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.831

0 LOW OUTLIER(S) IDENTIFIED BELOW TEST VALUE OF 62.8

ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
HIGH OUTLIER TEST
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

BASED ON 59 EVENTS, 10 PERCENT OUTLIER TEST VALUE K(N) = 2.831

0 HIGH OUTLIER(S) IDENTIFIED ABOVE TEST VALUE OF 74860.
ÄÄÄ

-SKEW WEIGHTING -
ÄÄÄ
BASED ON 59 EVENTS, MEAN-SQUARE ERROR OF STATION SKEW = .107
DEFAULT OR INPUT MEAN-SQUARE ERROR OF GENERALIZED SKEW = .302
ÄÄÄ

FINAL RESULTS

-FREQUENCY CURVE- F92 SANTA CLARA RIVER AT I-5 DA= 410SQMI

COMPUTED CURVE FLOW IN CFS	EXPECTED PROBABILITY FLOW IN CFS	PERCENT CHANCE EXCEEDANCE	CONFIDENCE LIMITS .05 FLOW IN CFS	CONFIDENCE LIMITS .95 FLOW IN CFS
125000.	159000.	.2	276000.	69300.
77300.	92200.	.5	157000.	45200.
52300.	59800.	1.0	99400.	32000.
34500.	38100.	2.0	61300.	22100.
18800.	19900.	5.0	30500.	12800.
11200.	11600.	10.0	16800.	7990.
6080.	6190.	20.0	8540.	4540.
2040.	2040.	50.0	2670.	1550.
746.	735.	80.0	999.	529.
456.	444.	90.0	633.	305.
310.	297.	95.0	444.	197.
156.	144.	99.0	240.	89.

SYSTEMATIC STATISTICS

LOG TRANSFORM: FLOW, CFS		NUMBER OF EVENTS	
MEAN	3.3360	HISTORIC EVENTS	0
STANDARD DEV	.5434	HIGH OUTLIERS	0
COMPUTED SKEW	.2966	LOW OUTLIERS	0
REGIONAL SKEW	.2966	ZERO OR MISSING	0
ADOPTED SKEW	.3000	SYSTEMATIC EVENTS	59

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+ END OF RUN +
+ NORMAL STOP IN FFA +
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