

RECLAMATION

Managing Water in the West

Yellowtail Dam & Bighorn Lake Operation Rule Curves

Billings, MT
April 2, 2009

PROGRESS to DATE

- **Proposed Modified Reservoir Elevation Targets**
- **Developed Method to Forecast Winter Gains**
- **Developed Procedure for Setting Winter Release**
- **Developed and Evaluated Reservoir Rule Curves for use during Spring Runoff Season**
- **Evaluating raising top of joint use pool**

Bighorn Lake Winter Release Criteria

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Forecasted Nov. – Mar. Inflow

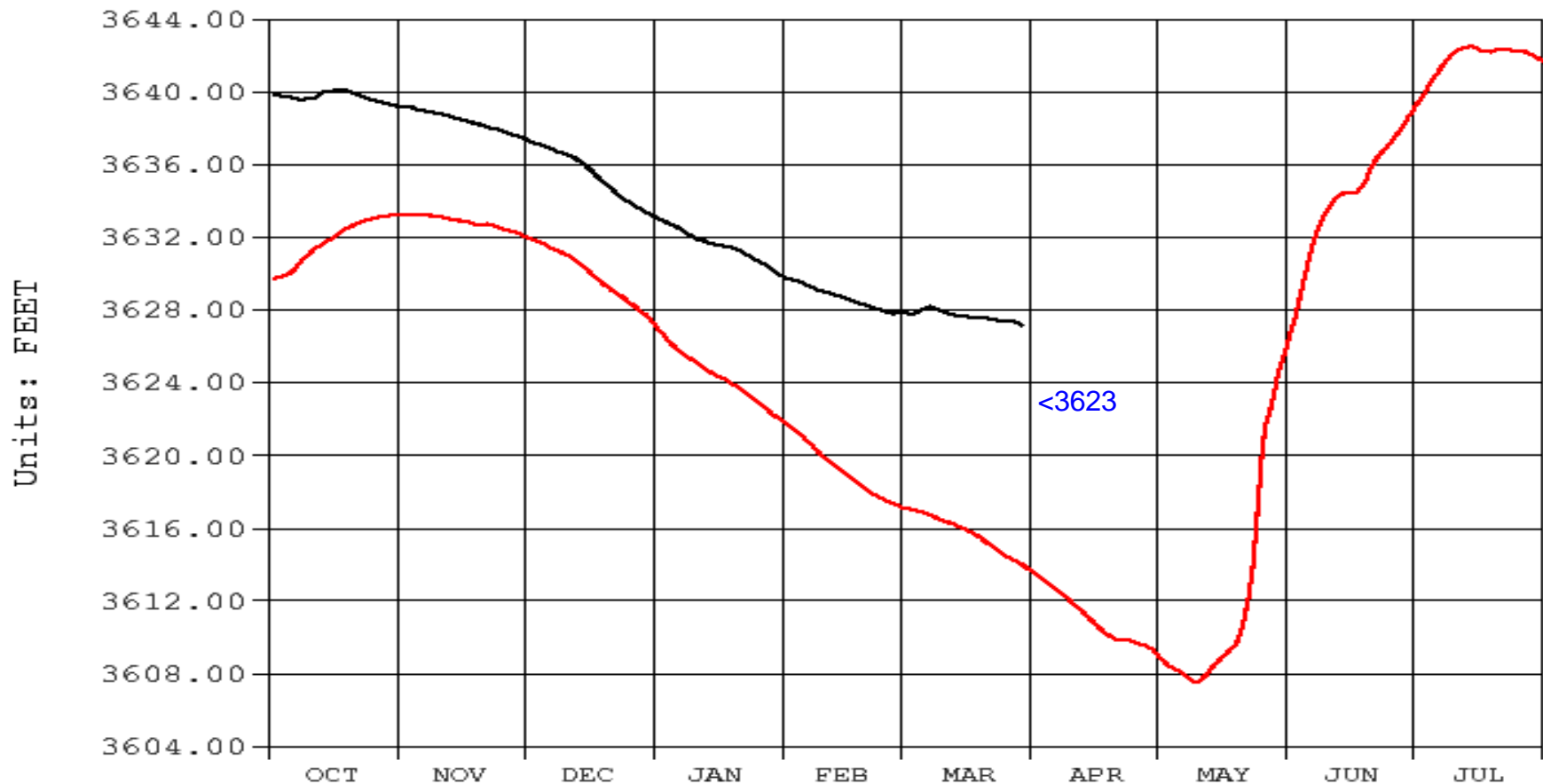
	Forecasted	Acre-feet Actual	Forecast % of Actual
2009 WRC	560,600	580,000	97%
2009 AOP	529,700	580,000	91%
2008 WRC	382,600	382,600	100%
2008 AOP	376,700	382,600	98%

Bighorn Lake Winter Release

	River Release	End of March Lake Elevation
2009		
New Procedure	2546 cfs	3623 ft
Actual	2450 cfs	3627 ft
Difference	-96 cfs	+4 ft

Reservoir Elevation 2009 vs 2008

Archive Data From 1-OCT Through 31-JUL
Plotted 03/30/2009 13:21



BHR
FB

Bighorn Lake (Yellowtail), Bighorn River near Fort Smith, MT
Reservoir Forebay Elevation (feet)

2009 2008

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RULE CURVE OPERATIONS

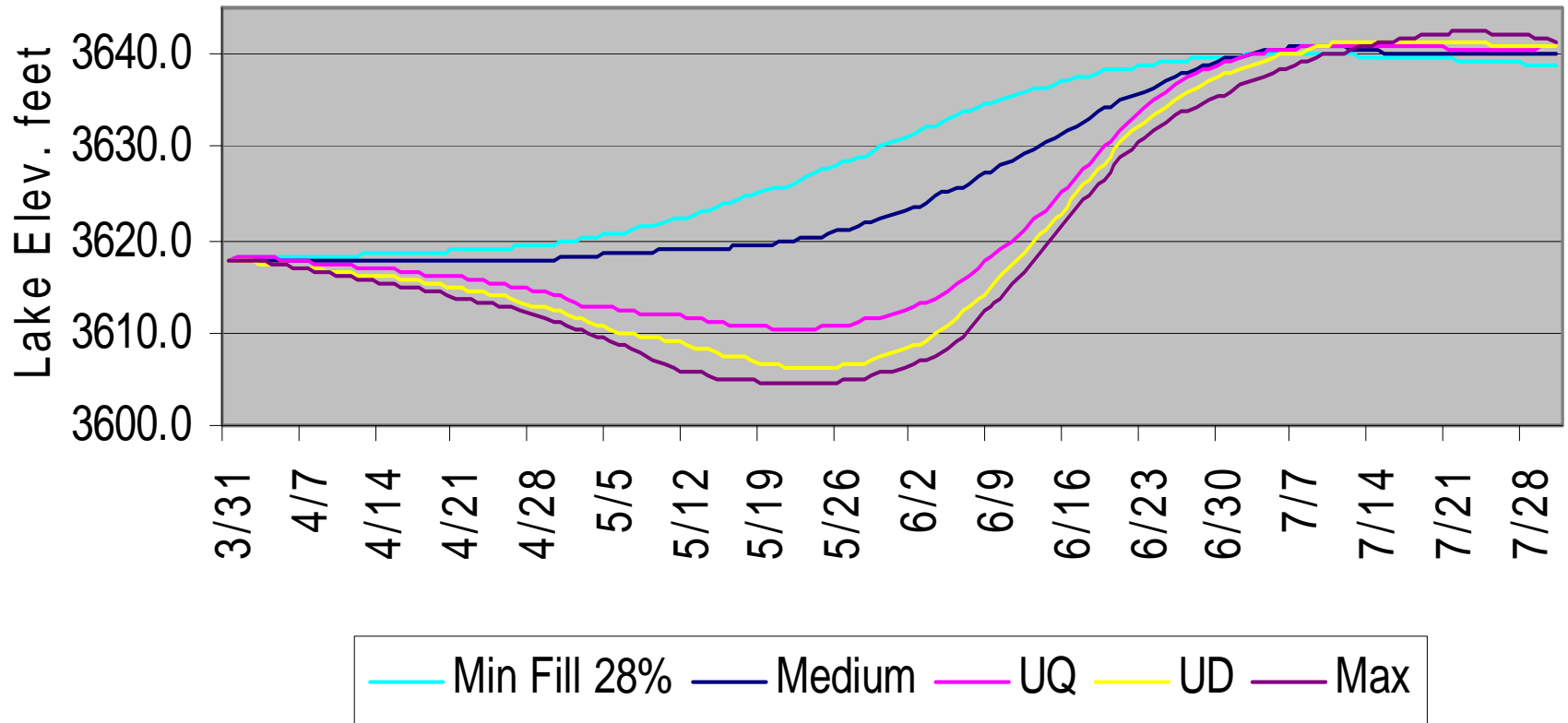
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Progress Since Last Meeting

- Refined Rule Curves based on Earlier evaluations
- Evaluated all 42 years of record using Refined Rule Curves
- Developed Modified set of Rule Curves based on raising top of joint use pool elevation
- Corps currently evaluating raising the top of joint use pool elevation

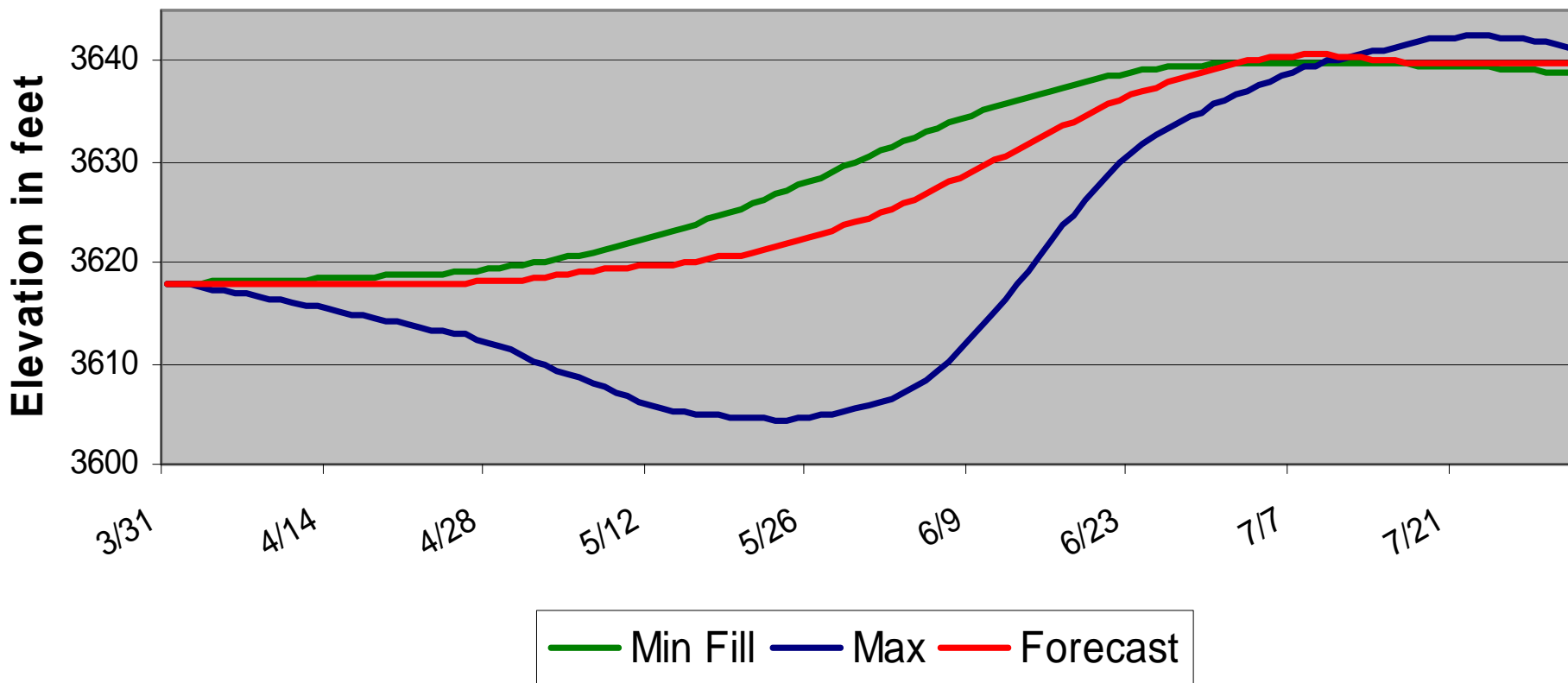
Rule Curve with 3640 top of joint use

Bighorn Lake Rule Curves



Forecast 90% 2009 1,003,100 af

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves

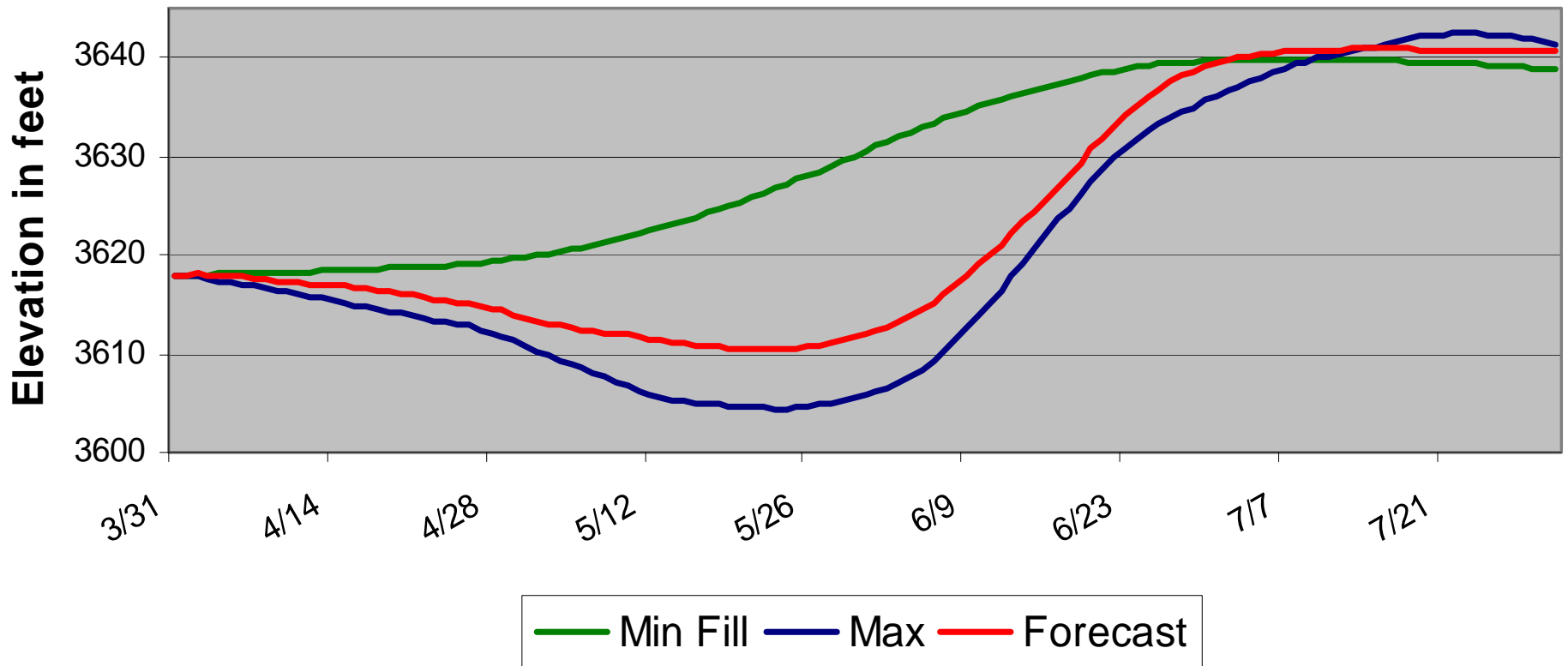


Forecast 137%

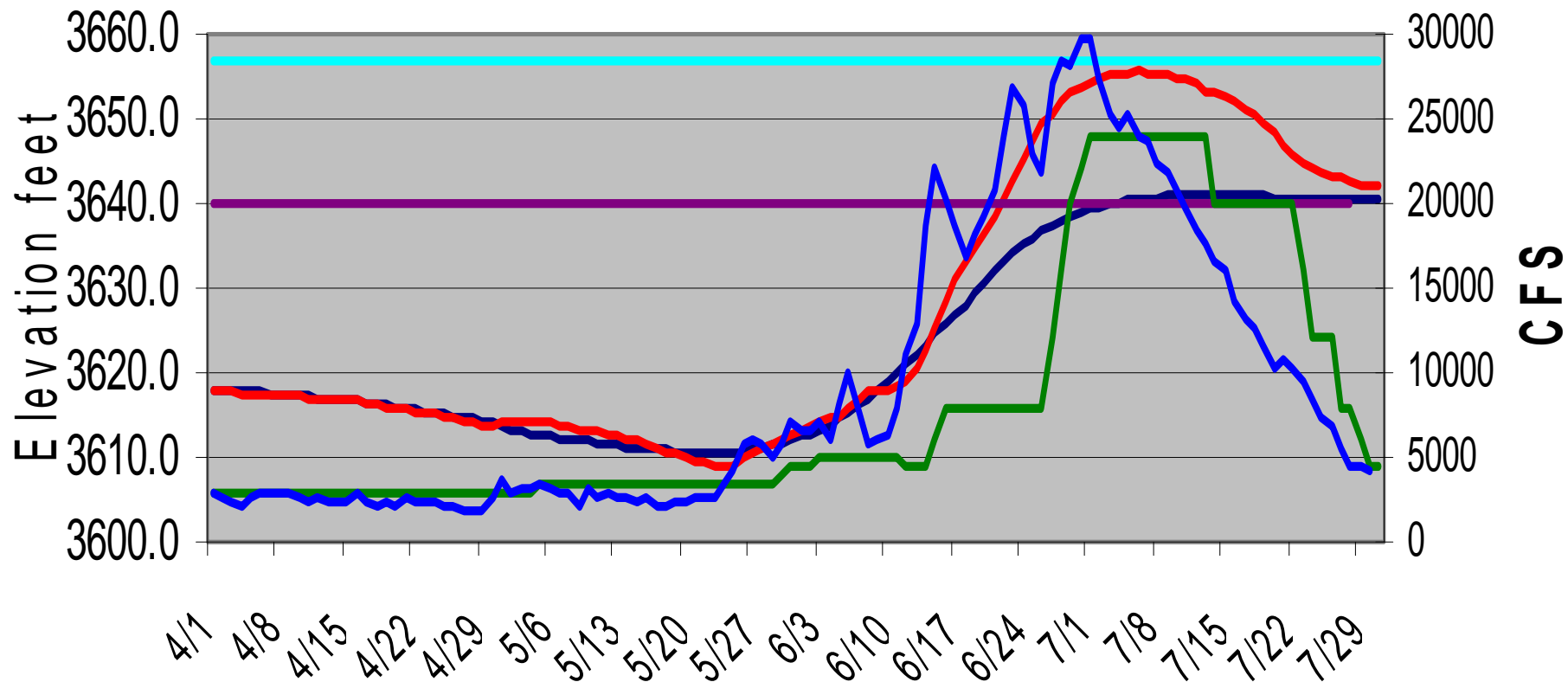
1967

Actual 200%

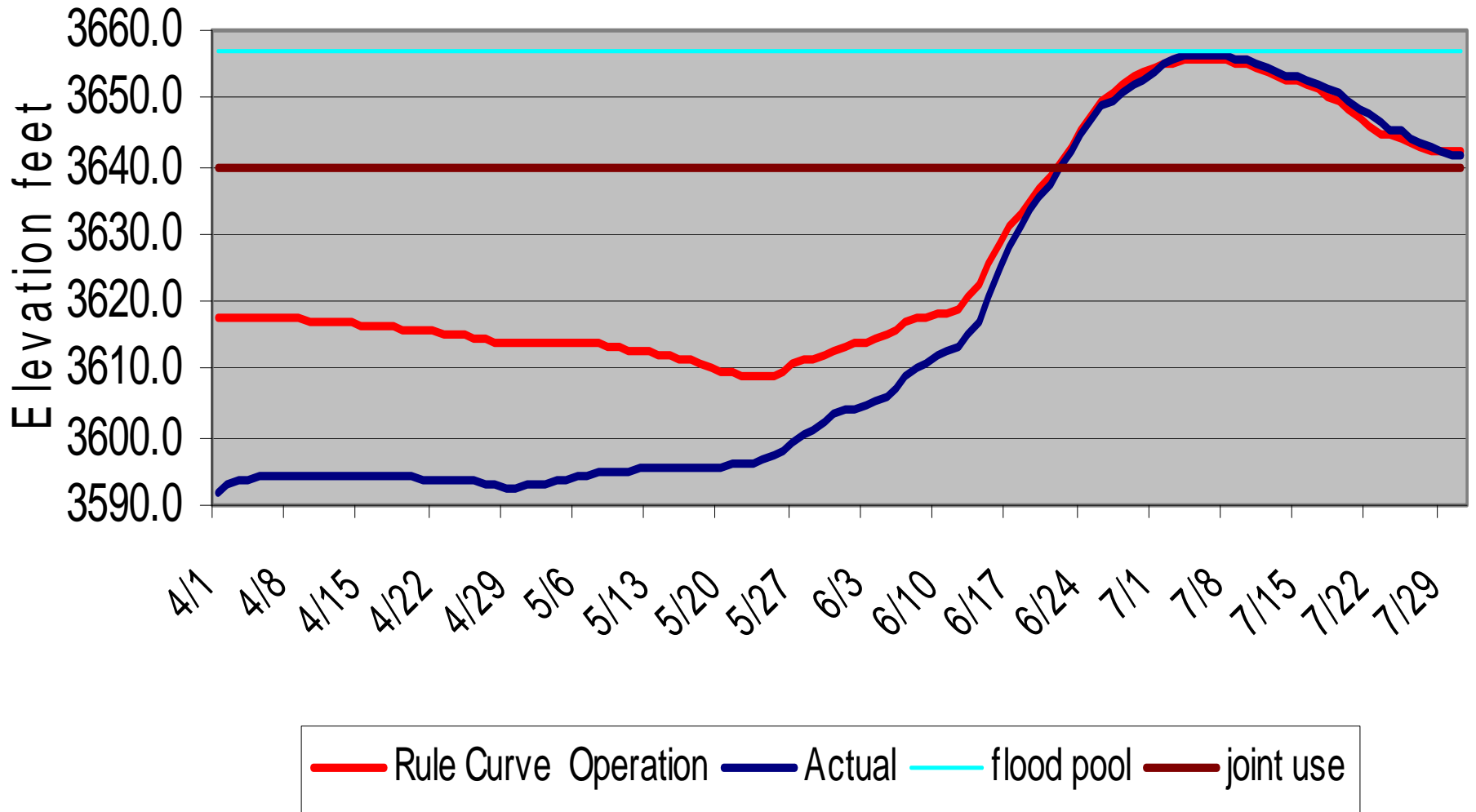
1967 Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



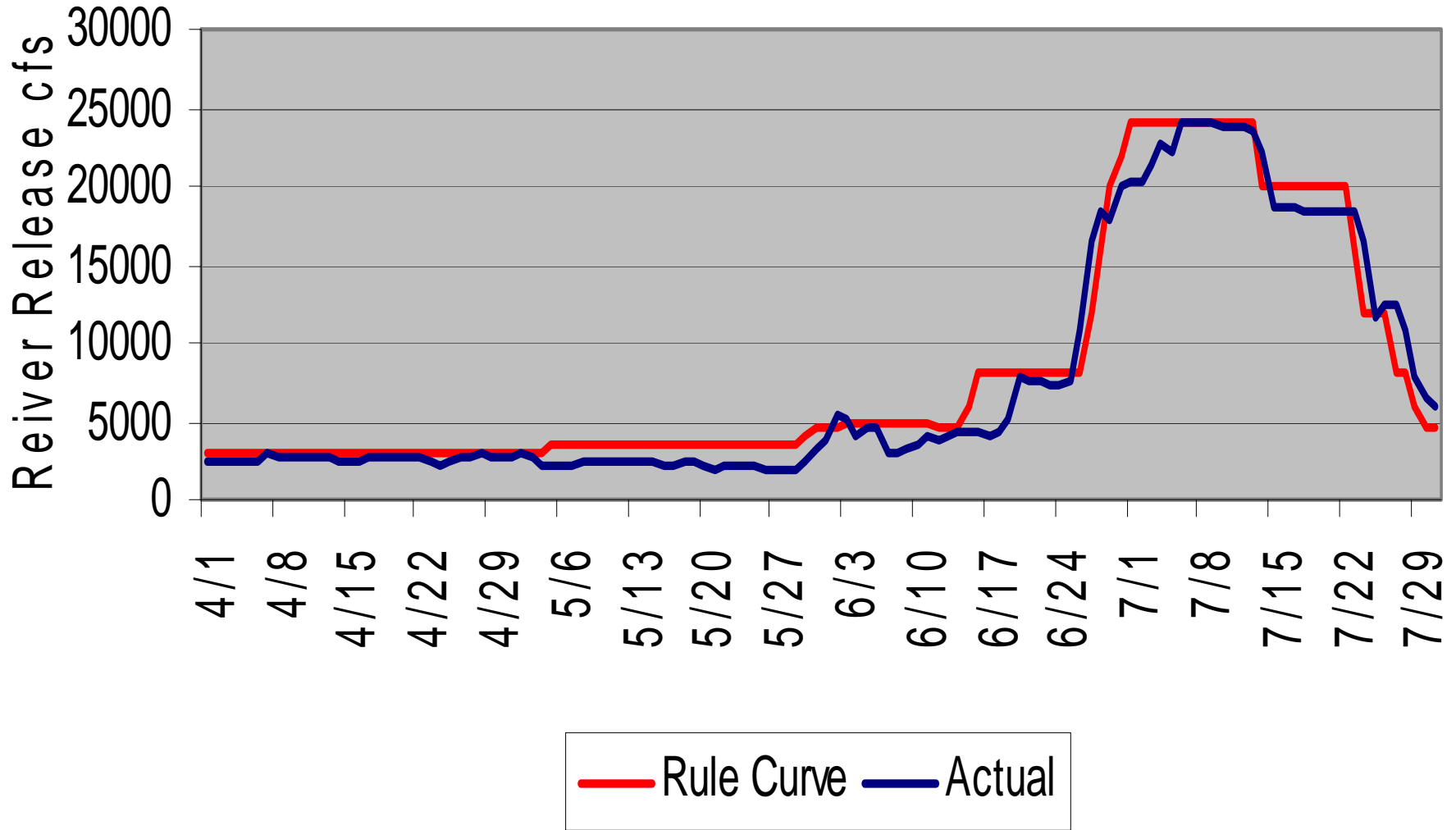
Bighorn Lake Operations 1967



Bighorn Lake Rule Curve Operation vs Actual 1967



Bighorn Lake - Rule Curve vs Actual 1967

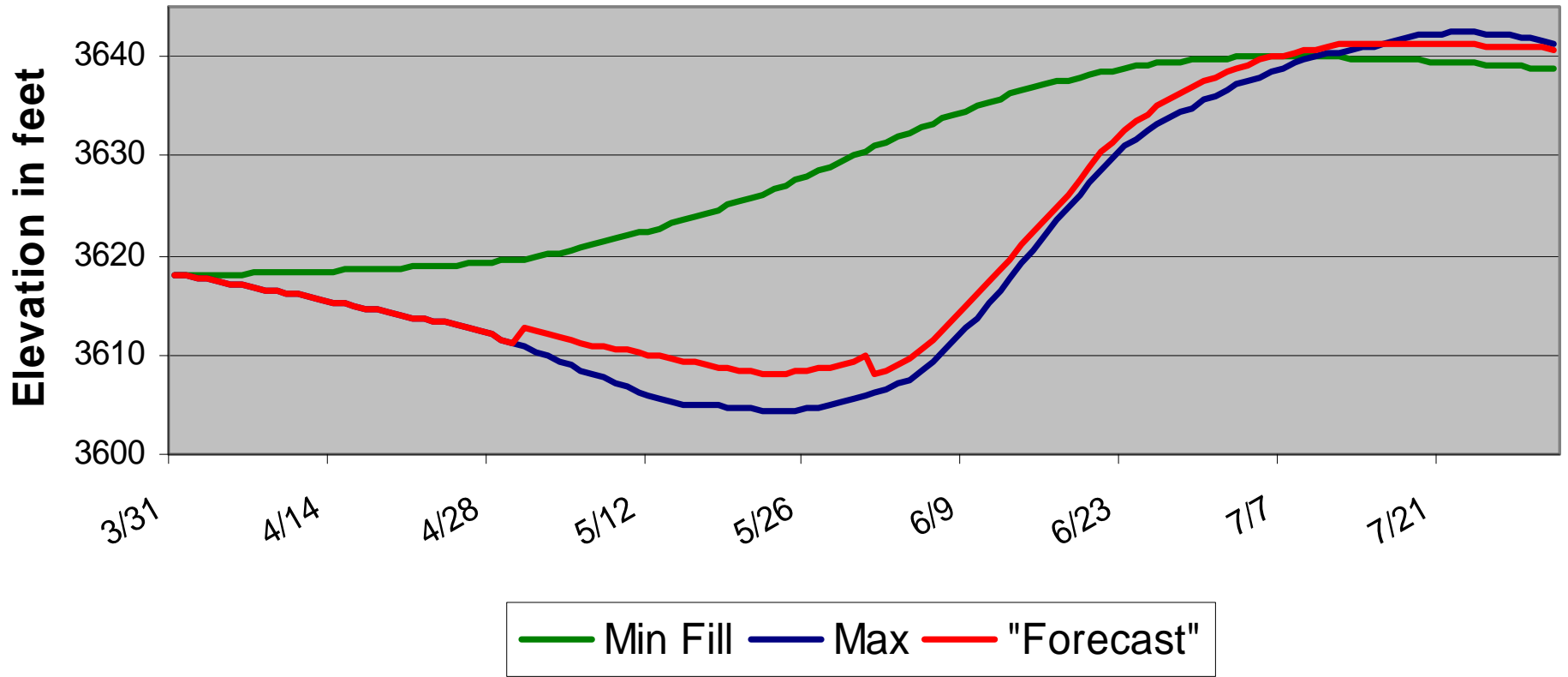


Forecast 183%

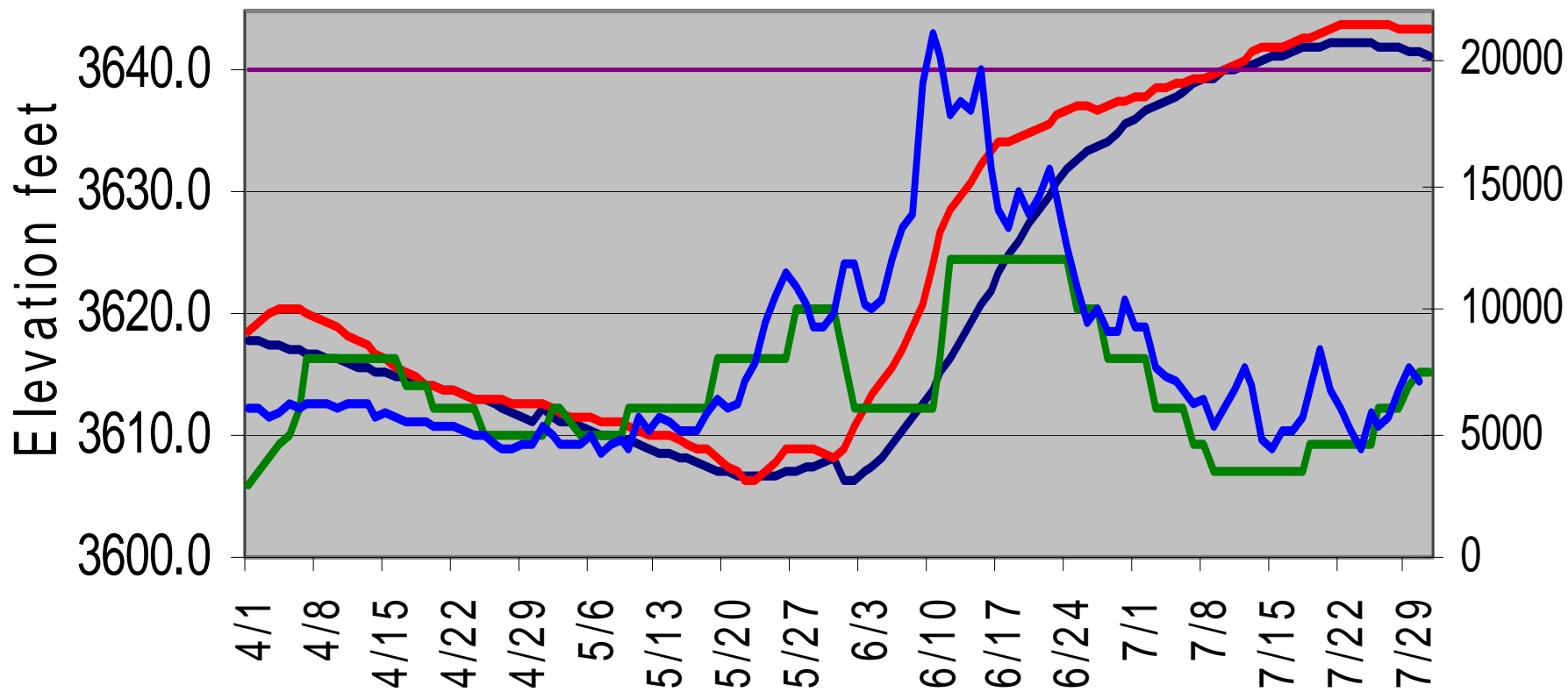
1997

Actual 173%

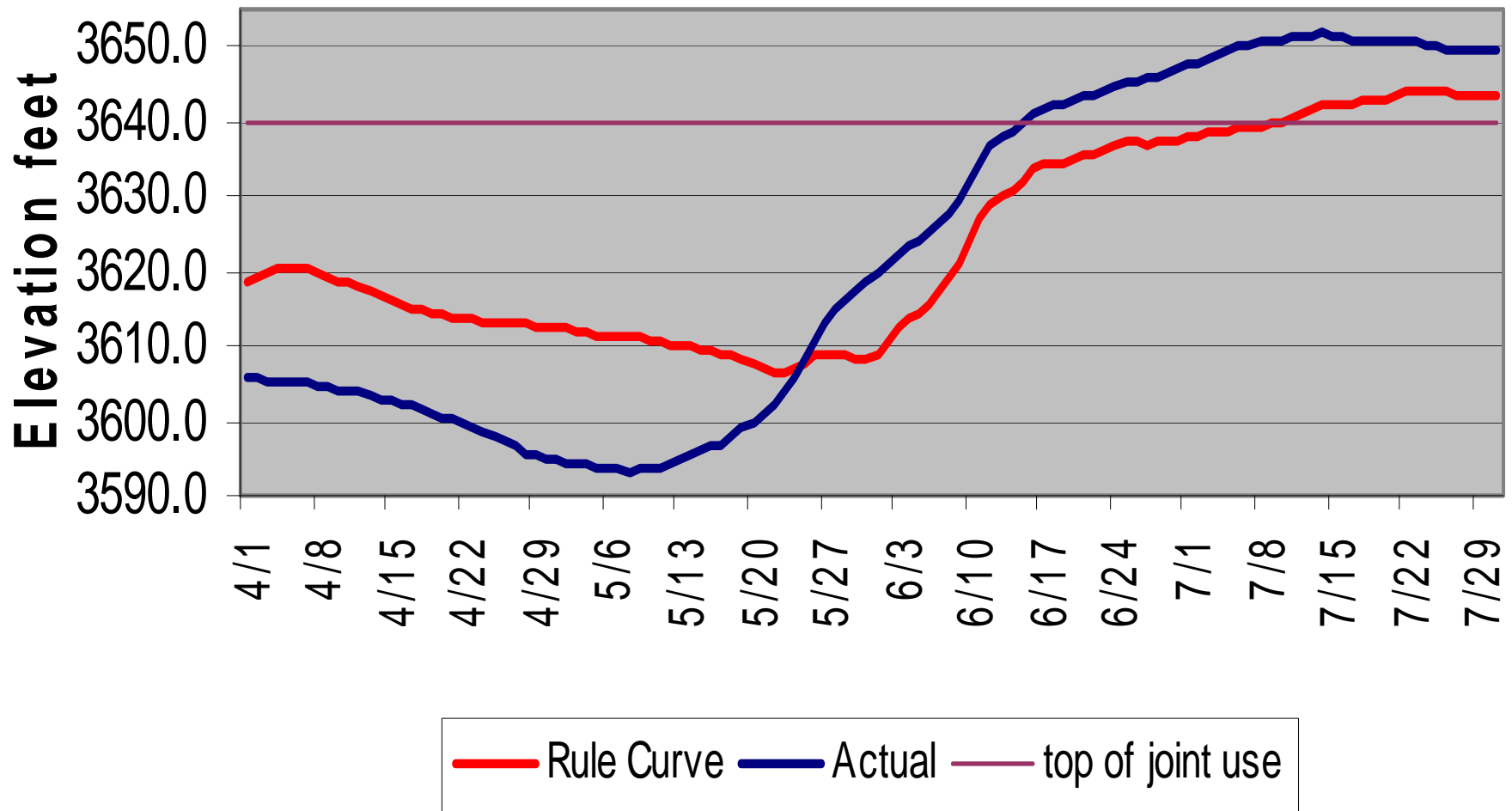
Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



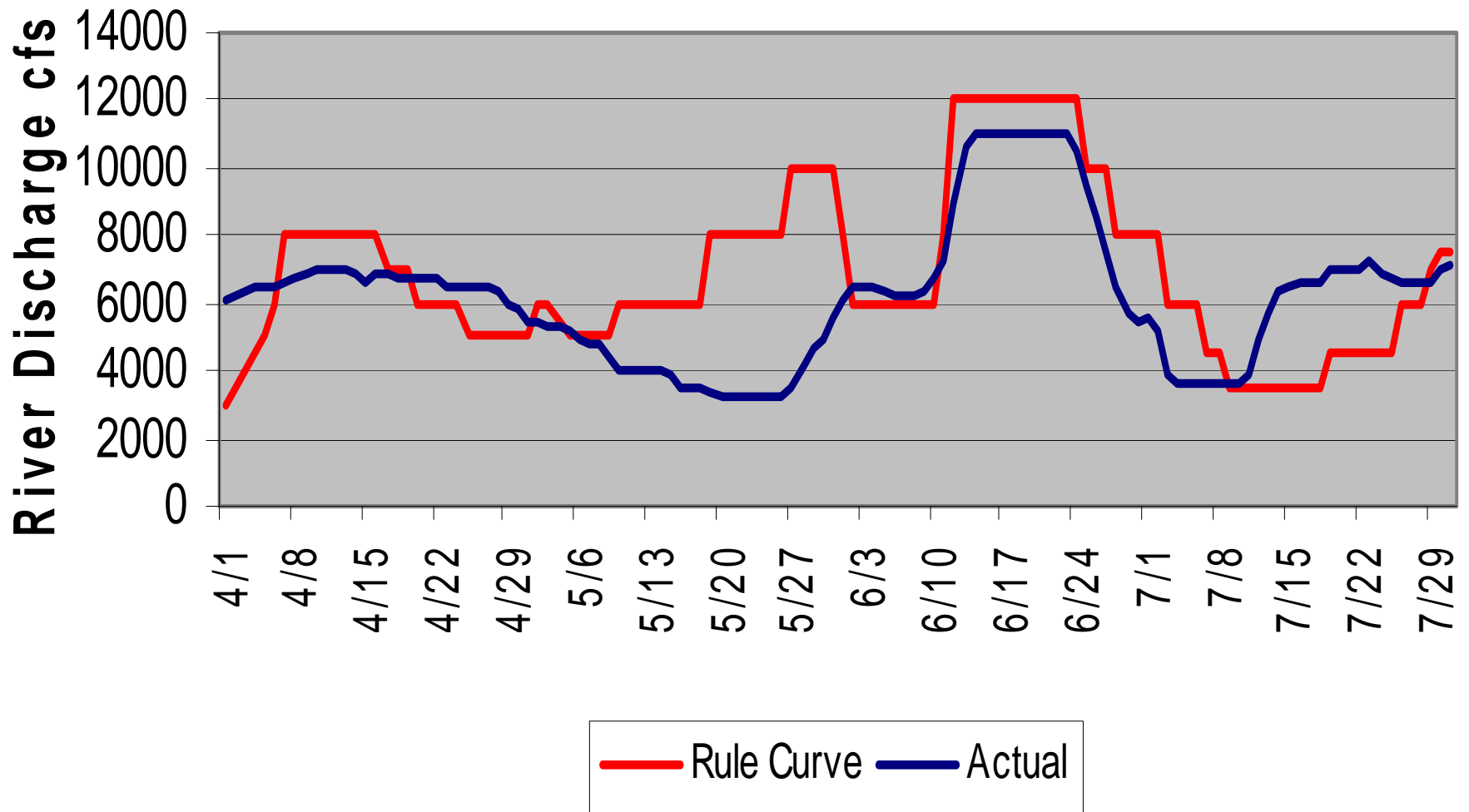
Bighorn Lake Operations 1997



Bighorn Lake - Rule Curve vs Actual 1997

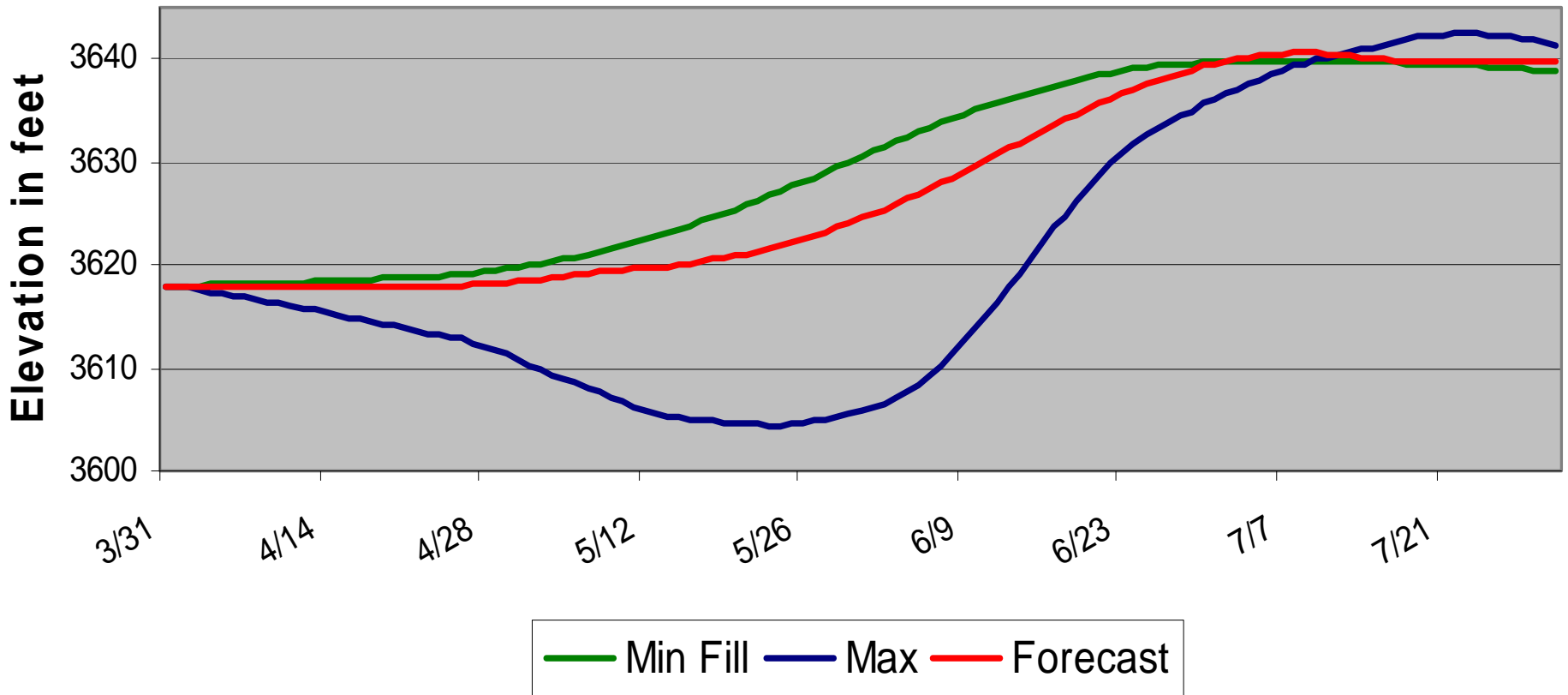


Bighorn Lake - Rule Curve vs Actual 1997

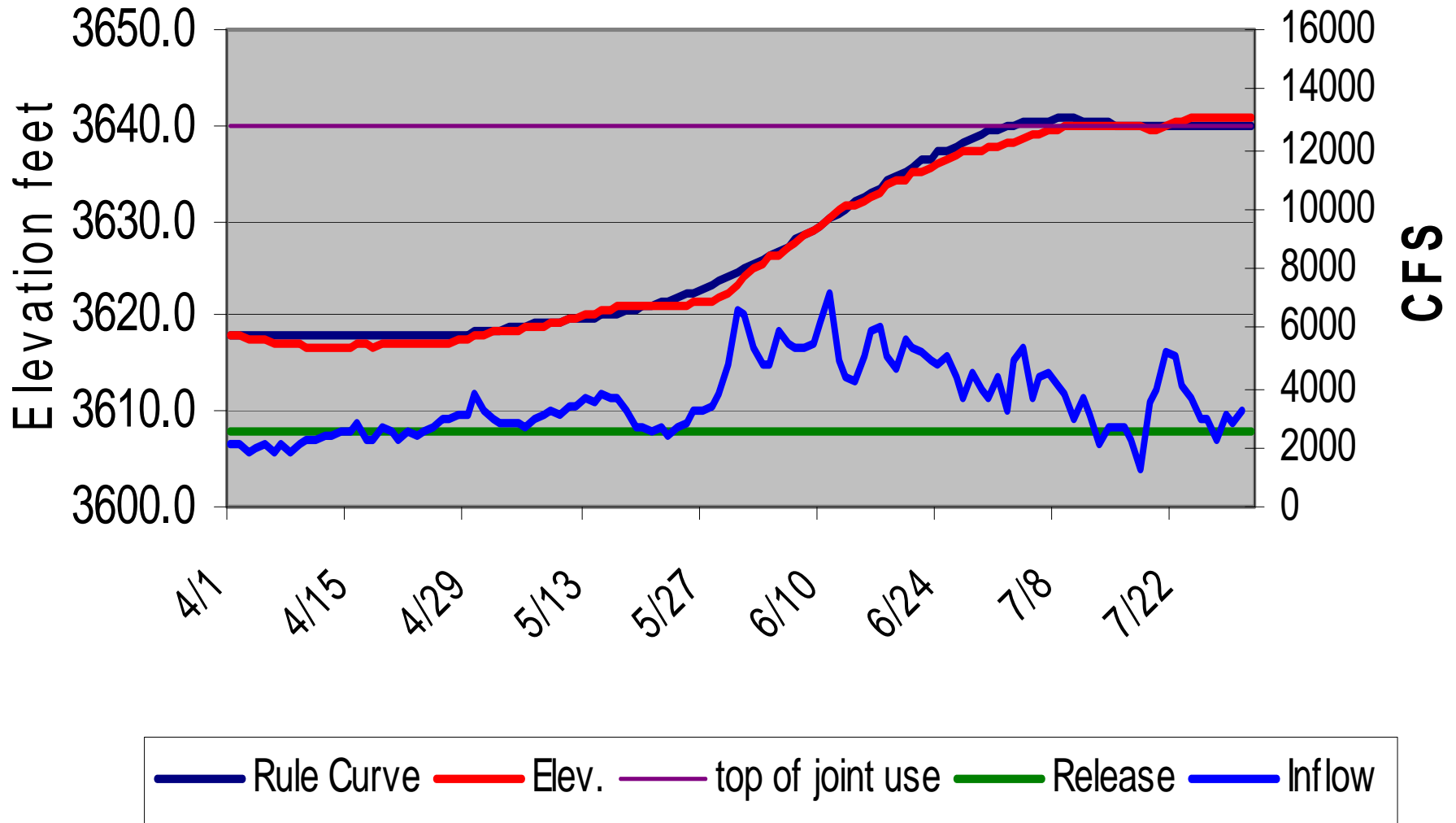


Forecast 88% 1990 Actual 77%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves

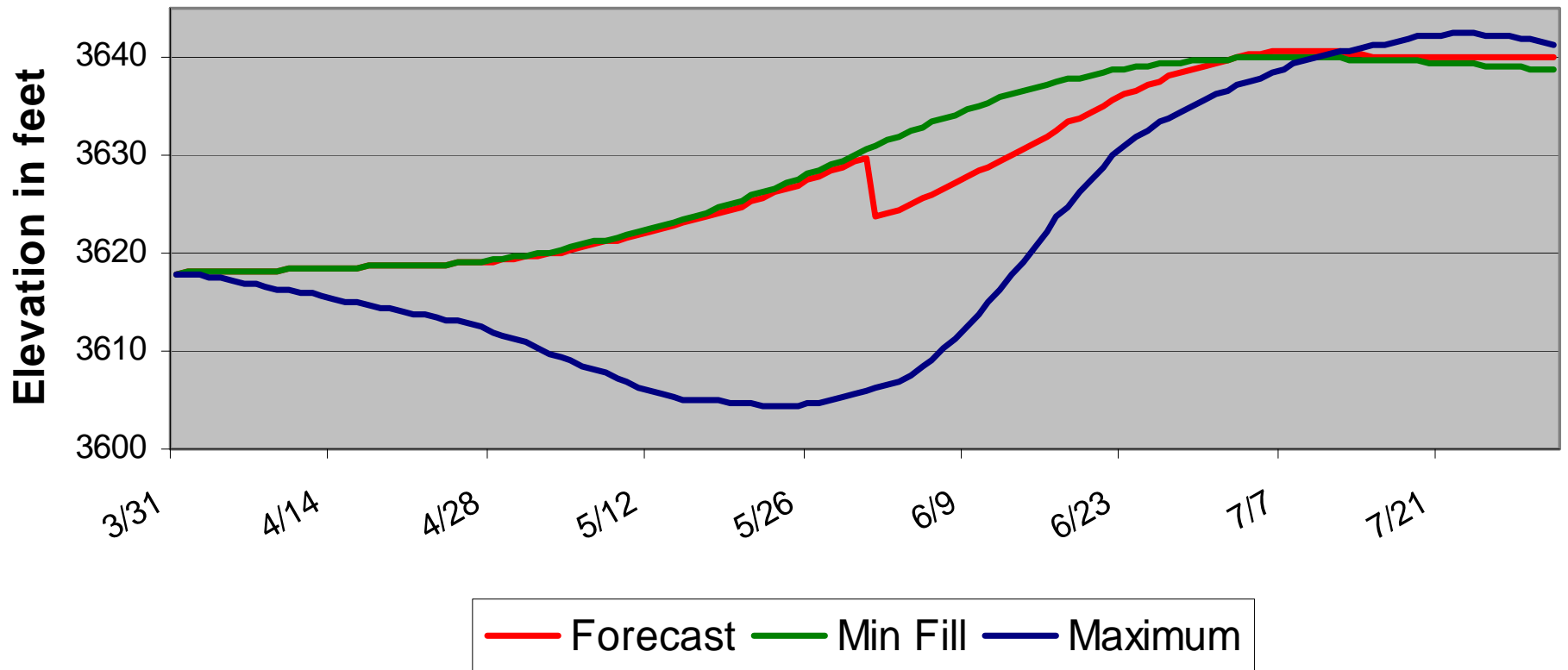


Bighorn Lake Operations 1990

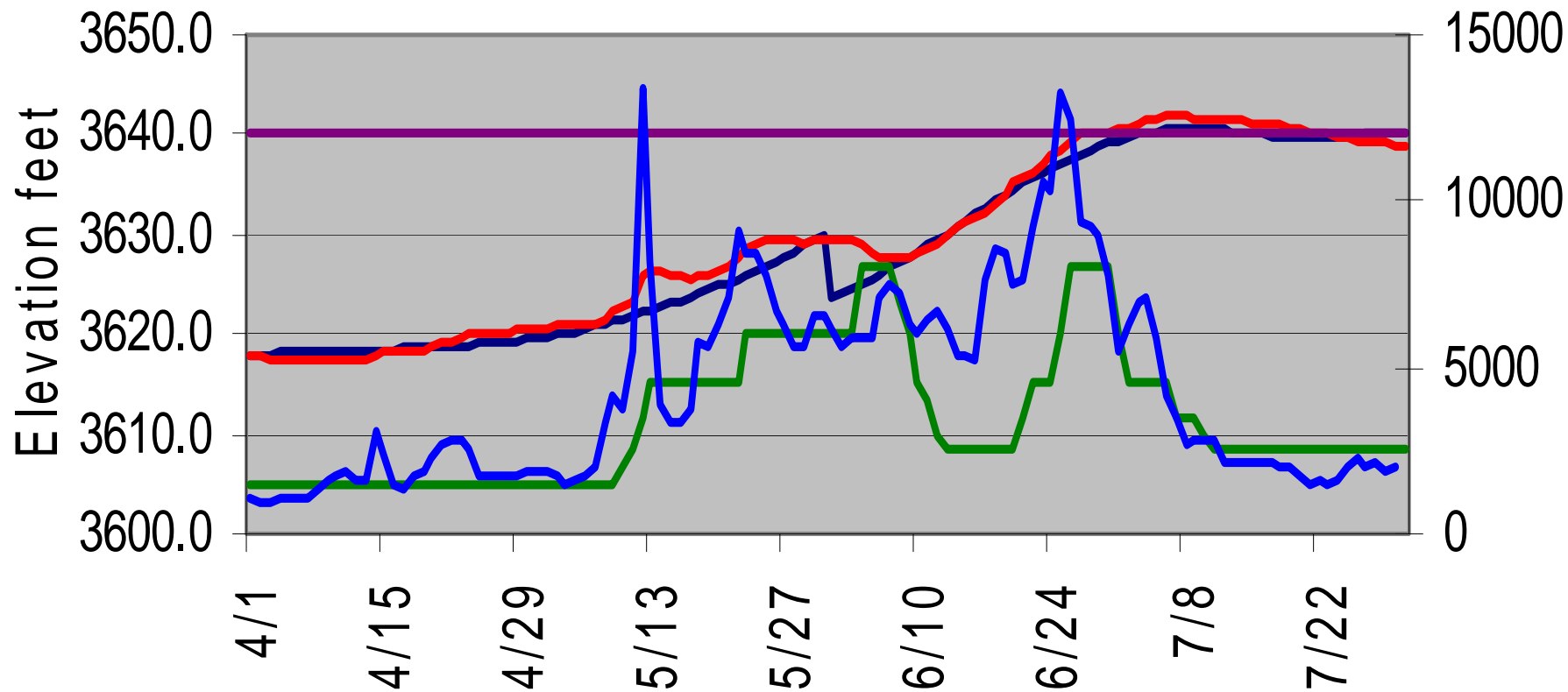


Forecast 64% 2005 Actual 94%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



Bighorn Lake Operations 2005



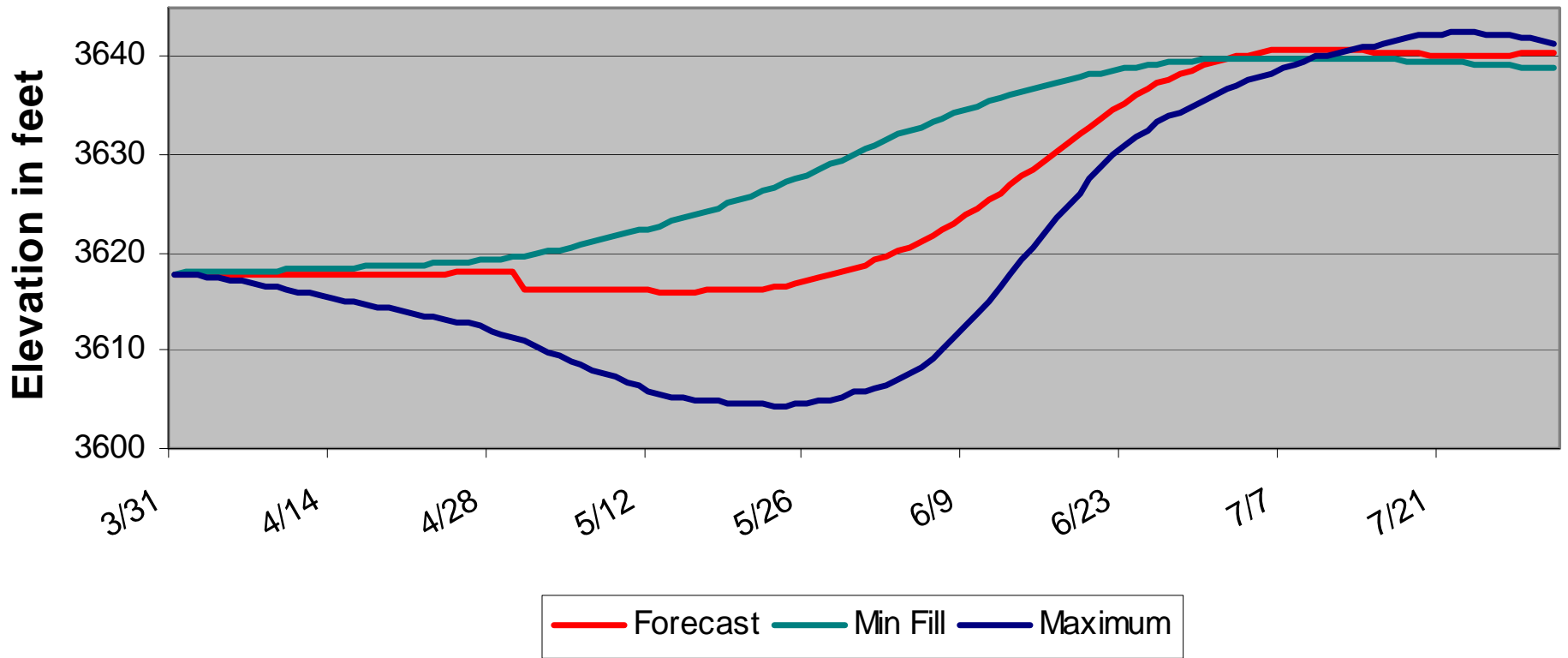
— Rule Curve — Elev. — top of joint use — Release — Inflow

Forecast 90%

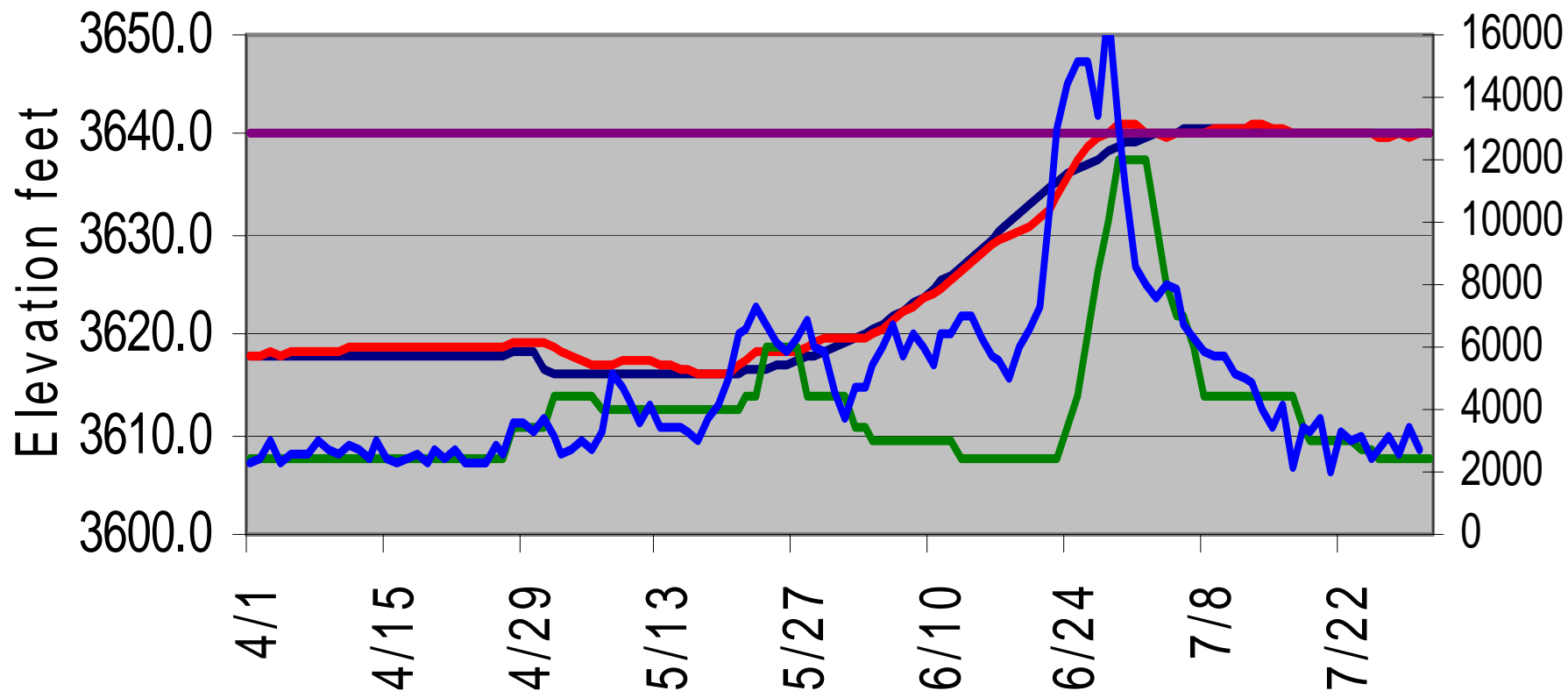
1970

Actual 107%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



Bighorn Lake Operations 1970



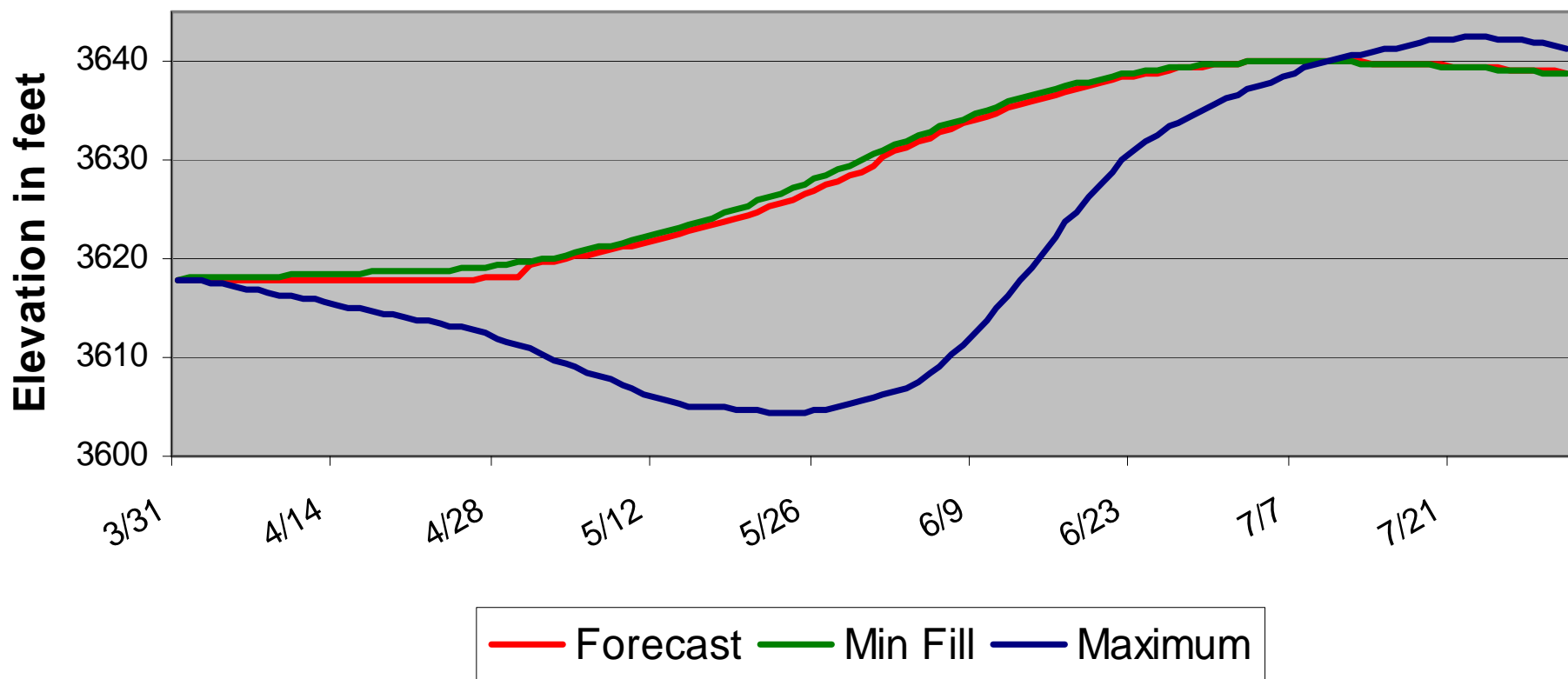
— Rule Curve — Elev. — top of joint use — Release — Inflow

Forecast 91%

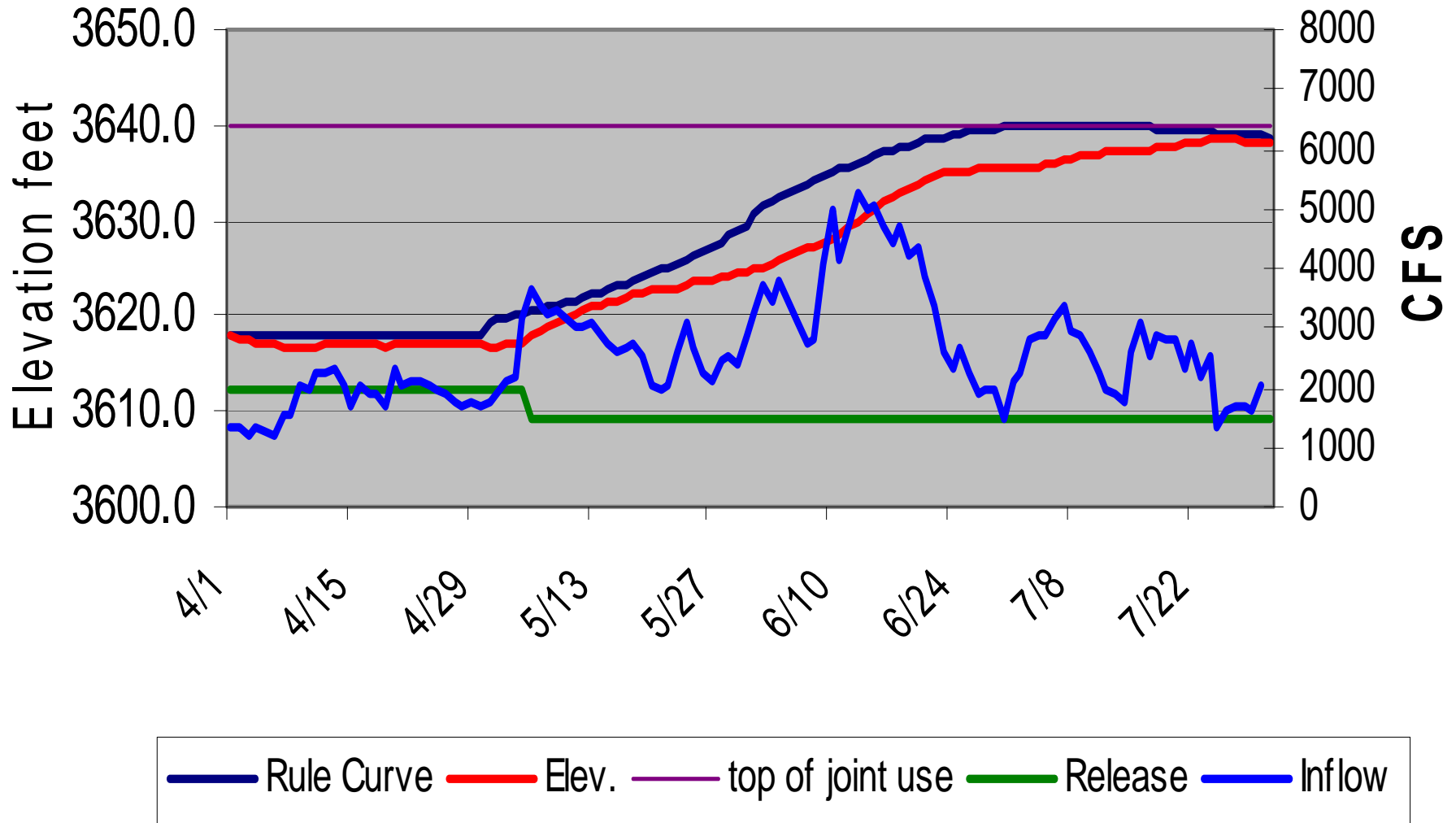
1989

Actual 55%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



Bighorn Lake Operations 1989

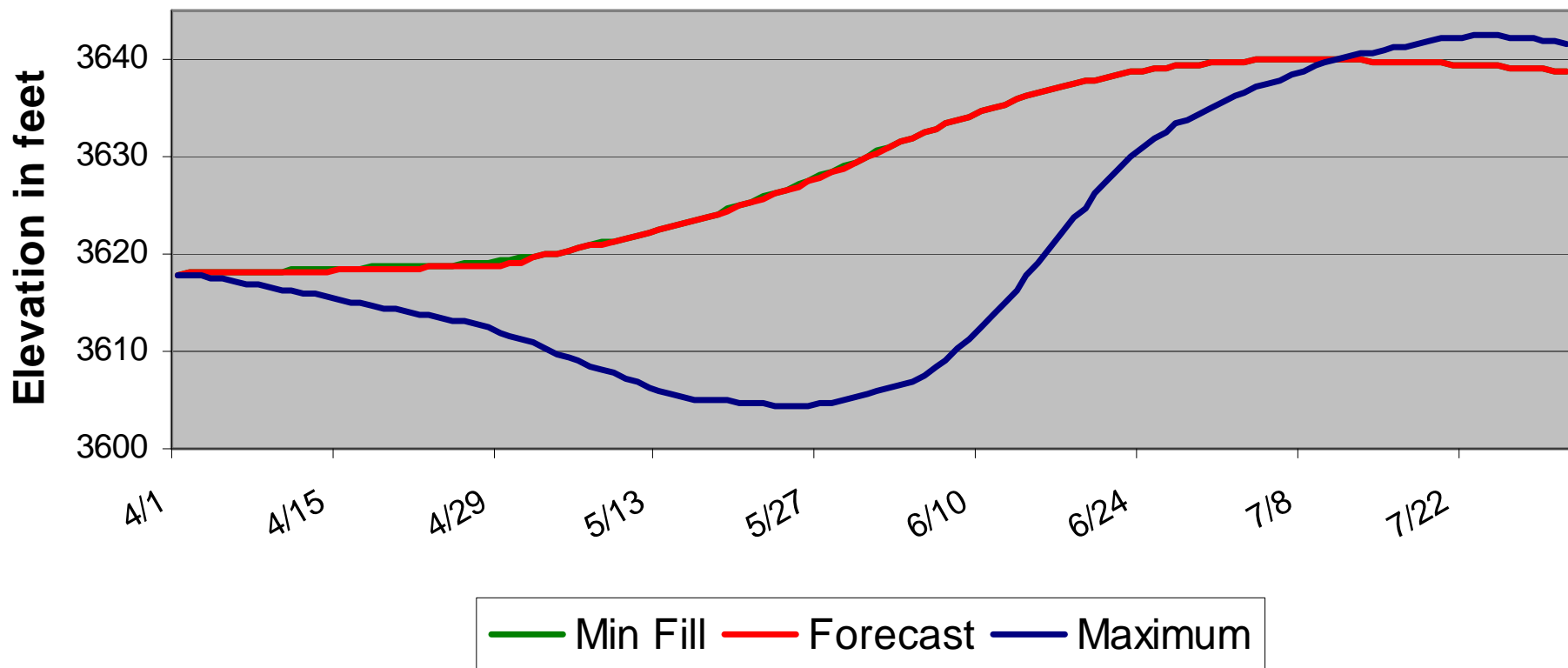


Forecast 71%

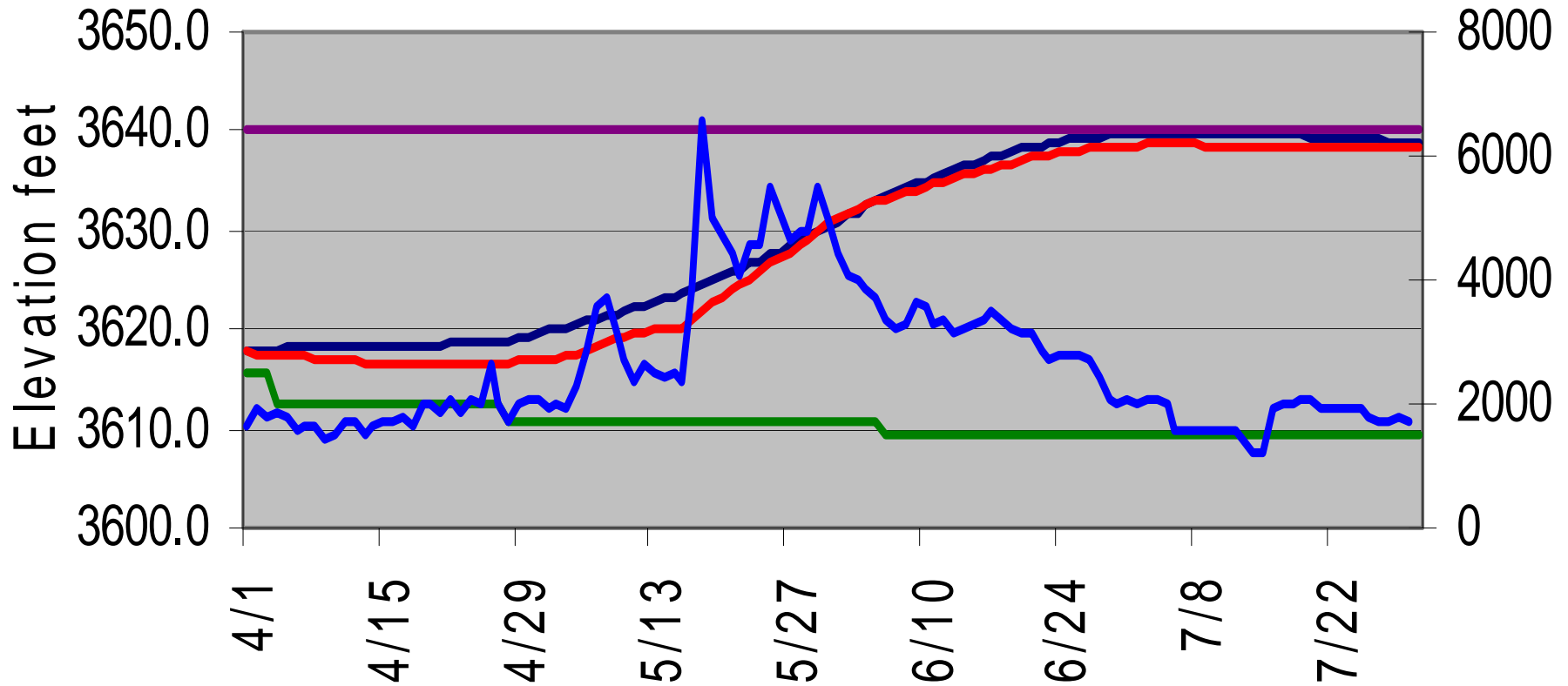
2000

Actual 57%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



Bighorn Lake Operations 2000



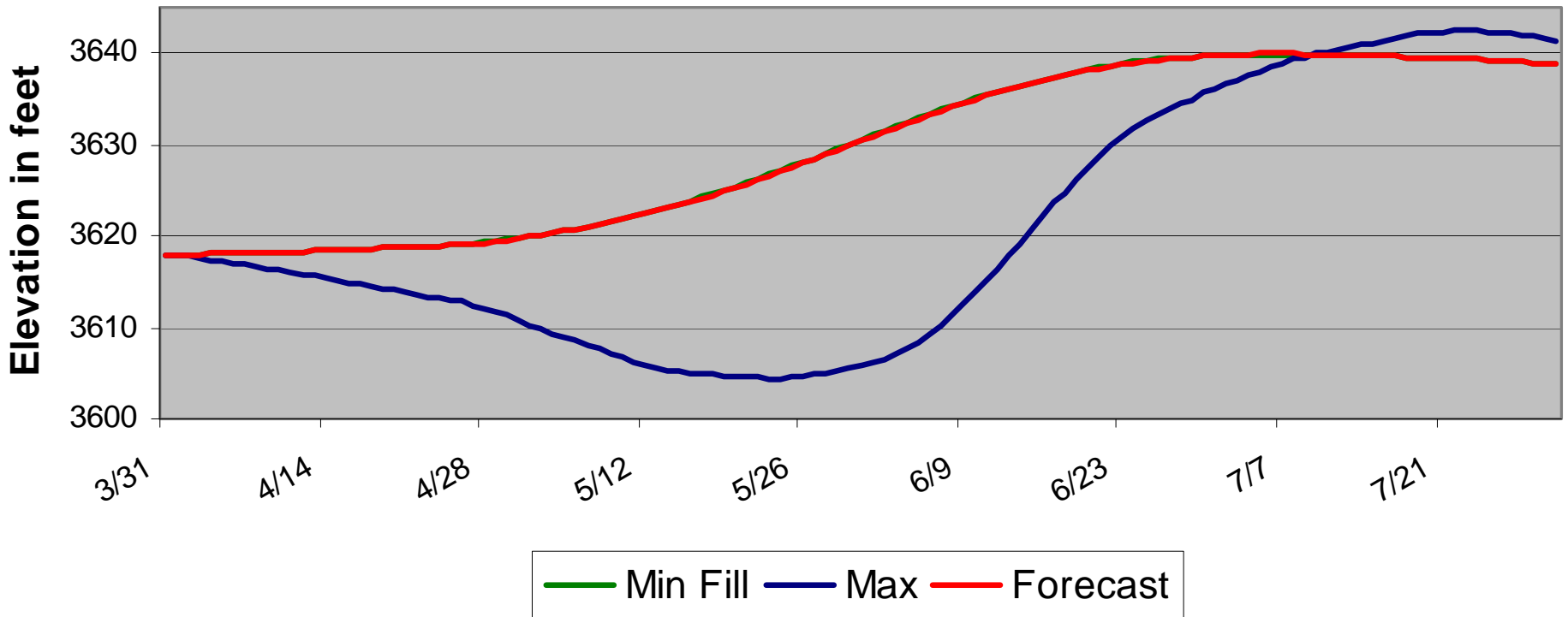
— Rule Curve — Elev. — top of joint use — Release — Inflow

Forecast 64%

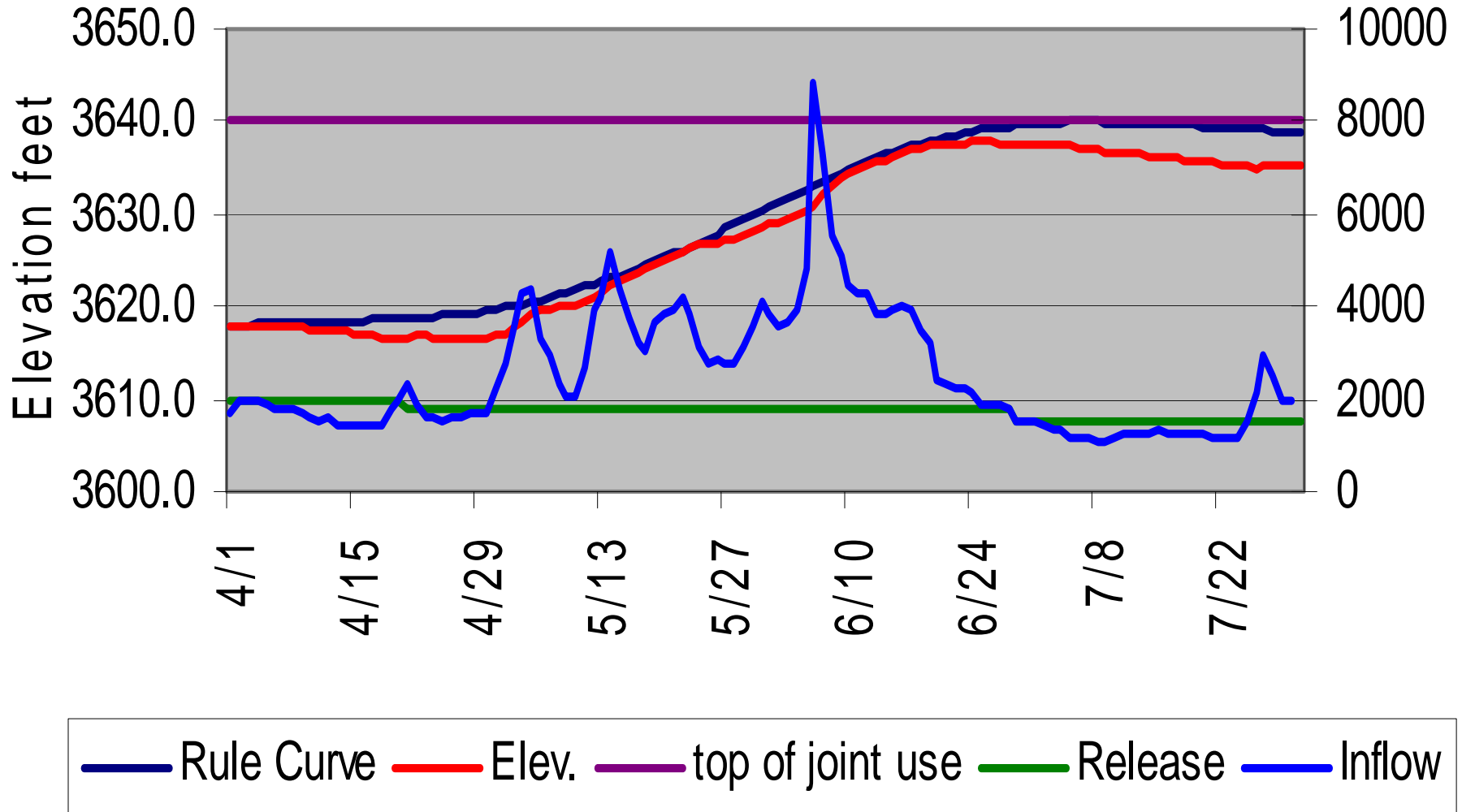
2007

Actual 54%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



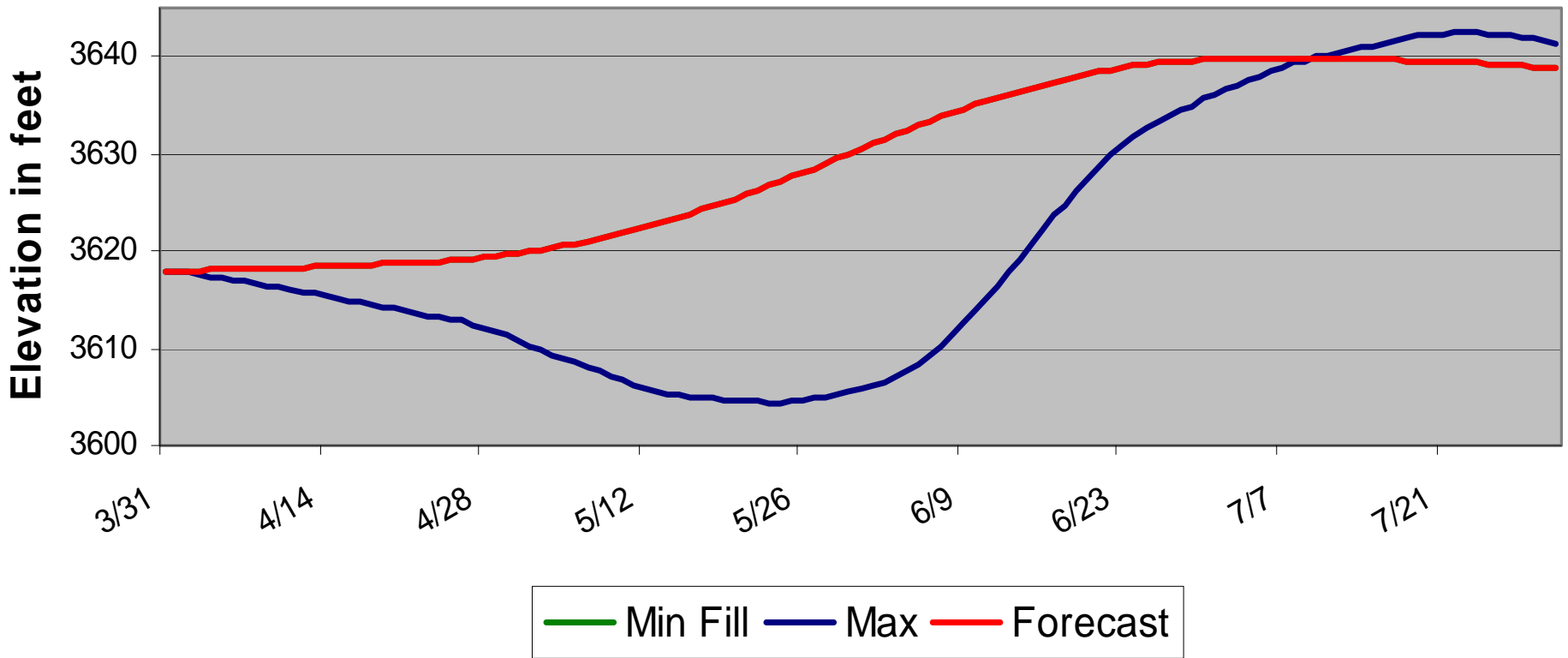
Bighorn Lake Operations 2007



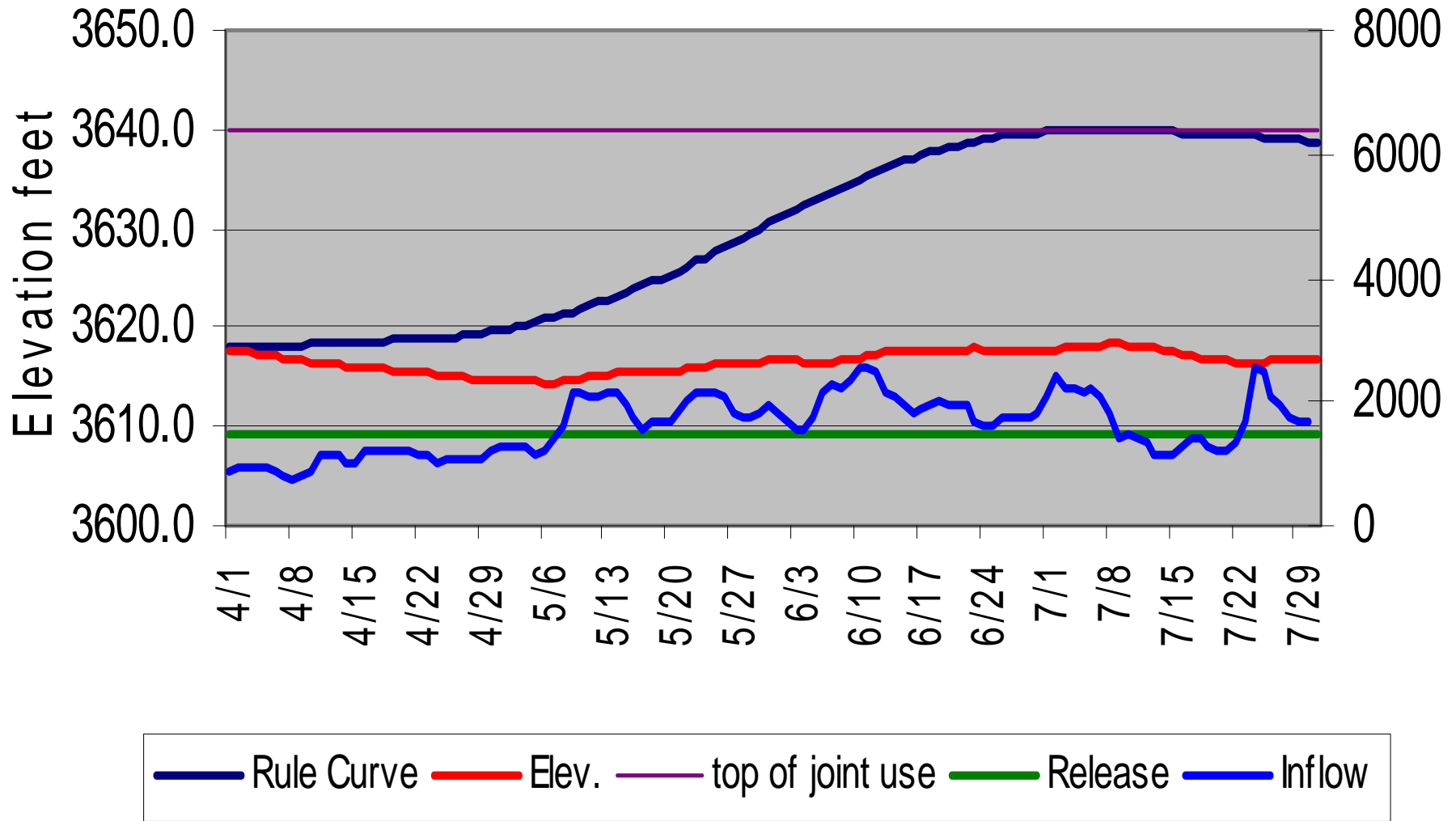
Forecast 50% 2004

Actual 35%

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



Bighorn Lake Operations 2004



DIFFICULT YEARS

- Early Runoff -Years with early warm weather. This occurred in 1977, 1985, 1988 & 1994.
- Late Runoff - Years with cool spring weather. This occurred in 1969, 1995, 1998 & 2008

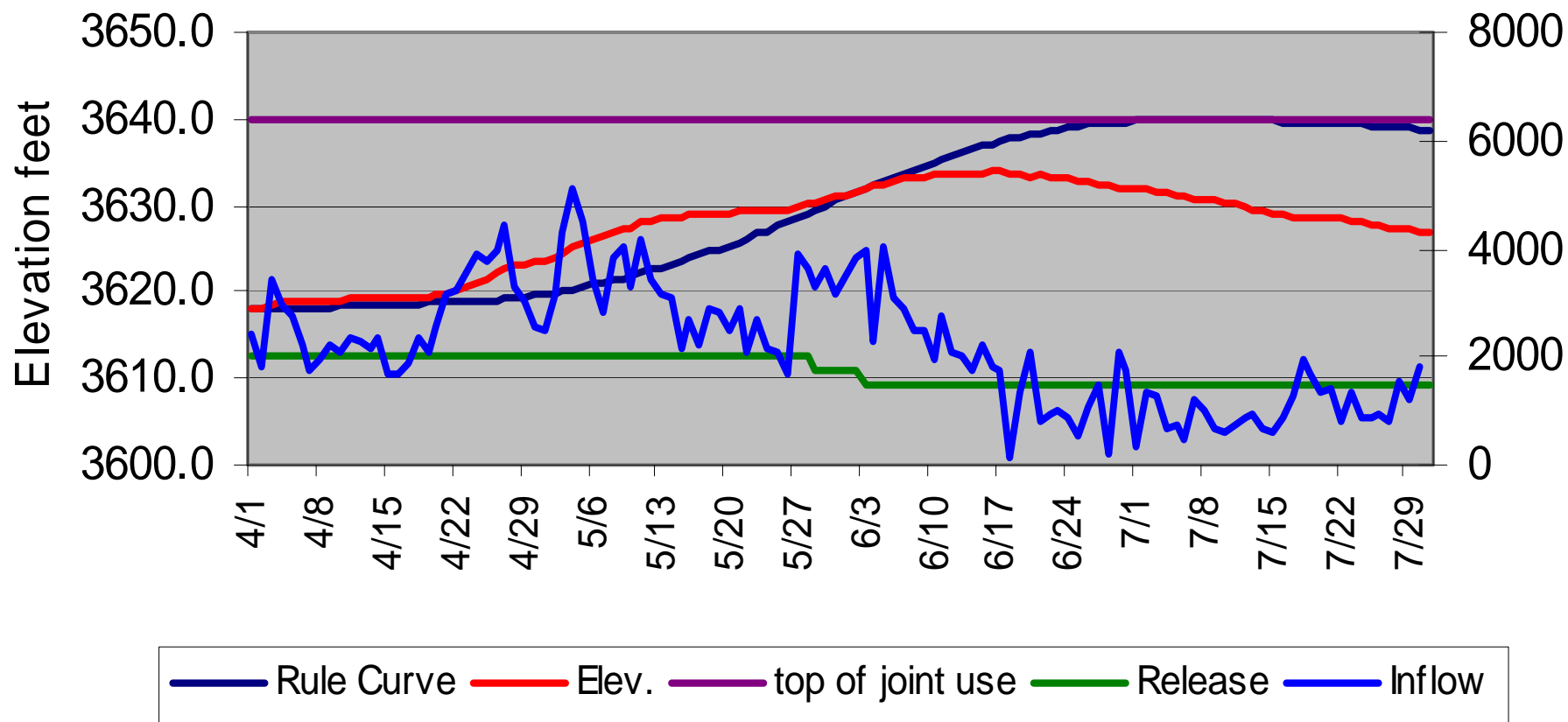
EARLY RUNOFF

1977 & 1988

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Forecast 60% 1977 Actual 49%

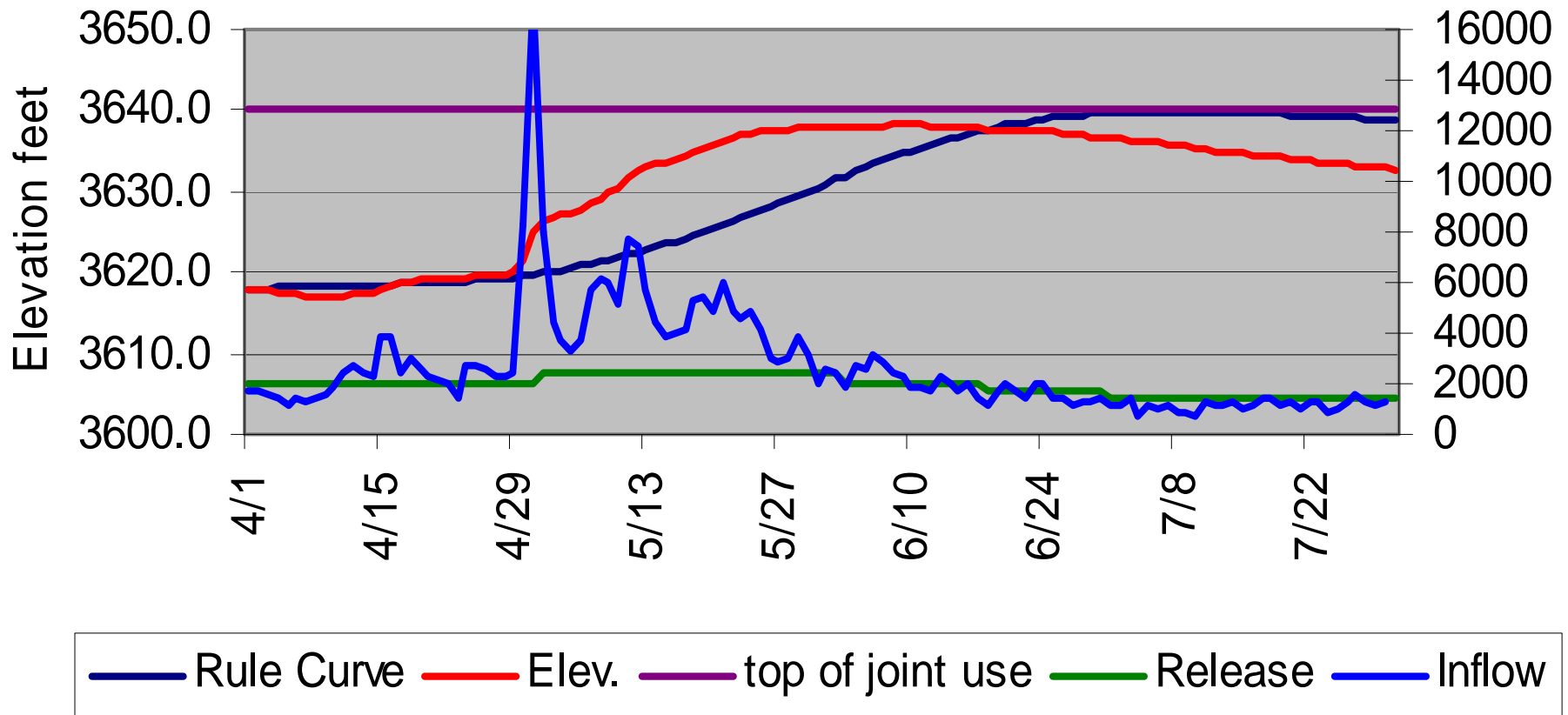
Bighorn Lake Operations 1977



Forecast 44% 1988

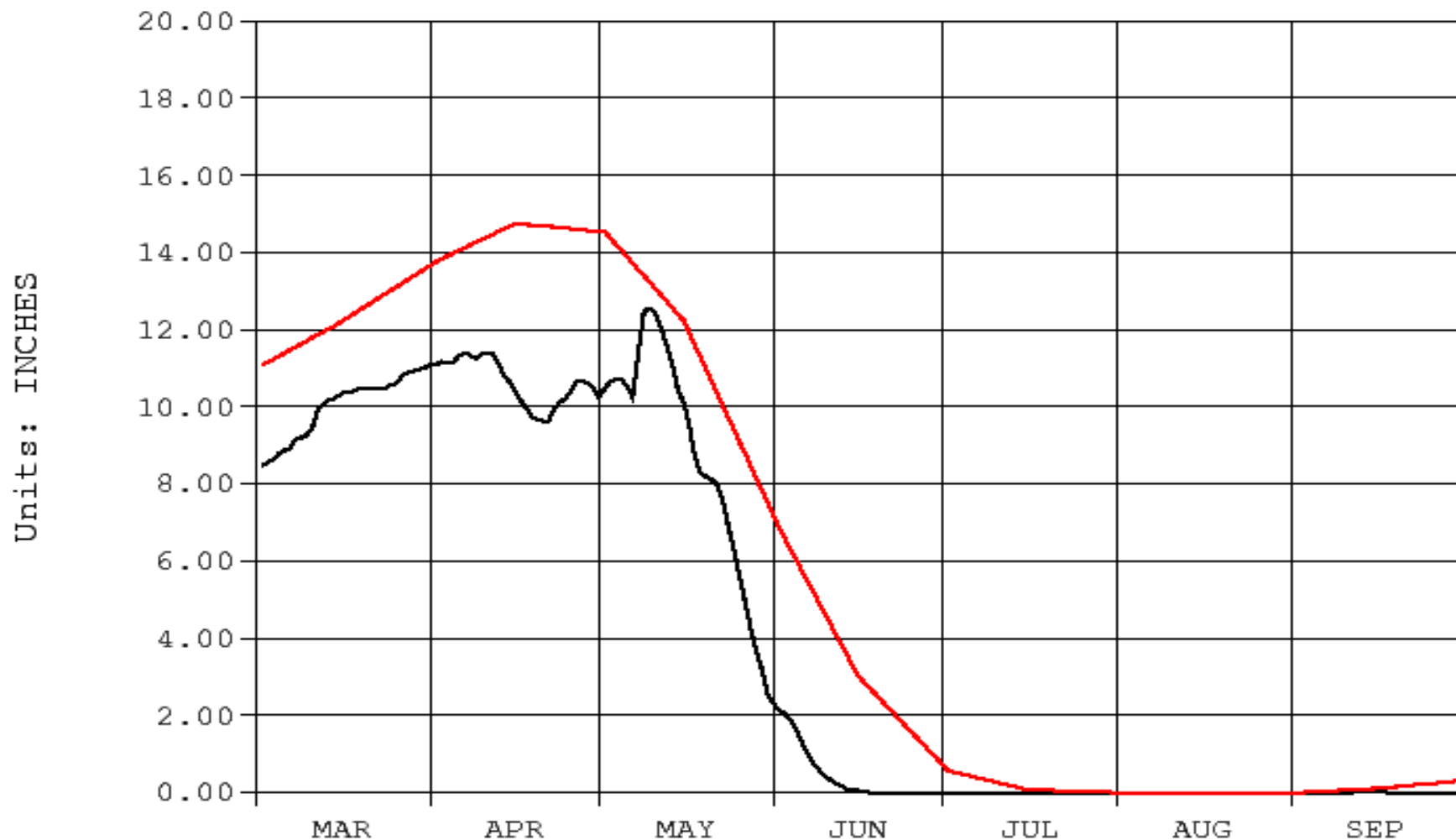
Actual 58%

Bighorn Lake Operations 1988



Archive Data From 1-MAR Through 30-SEP

Plotted 03/24/2009 14:48



BHR Bighorn Lake (Yellowtail), Bighorn River near Fort Smith, MT

SE Snow Water Equivalent (inches)

1988

SE_AVG Snow Water Equivalent Average (inches)

2008

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LATE RUNOFF

1969 & 2008

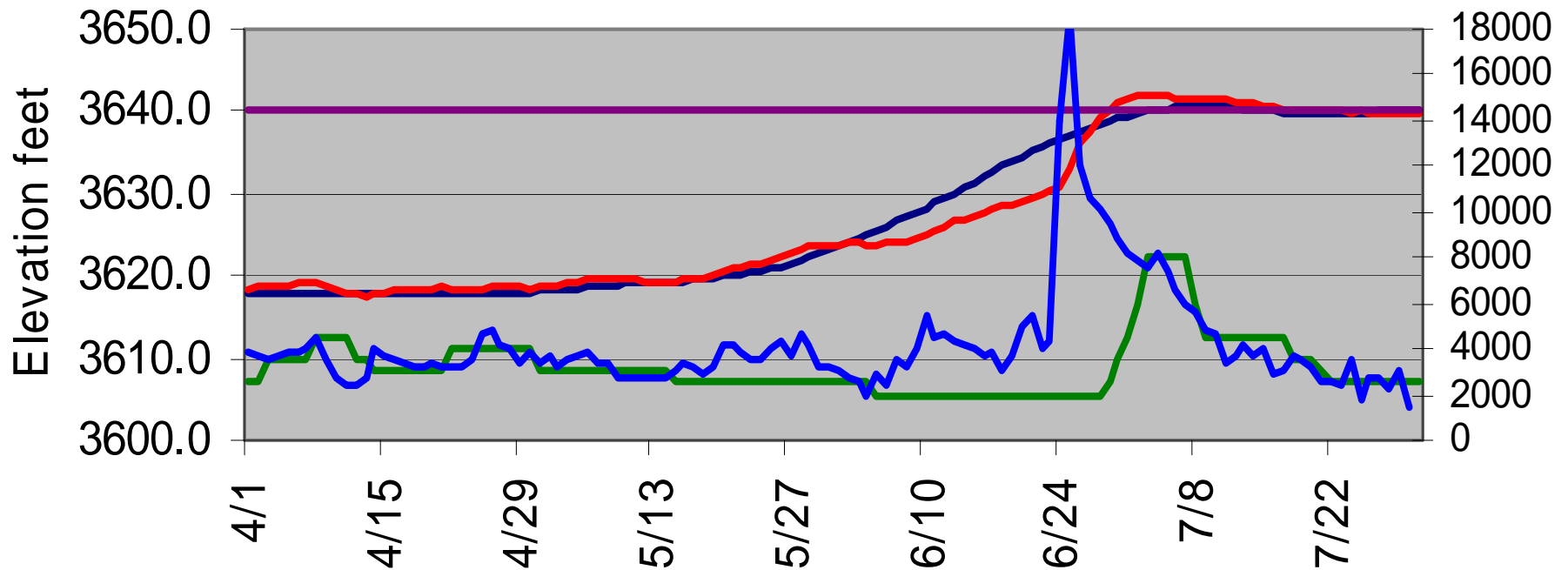
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Forecast 93%

1969

Actual 90%

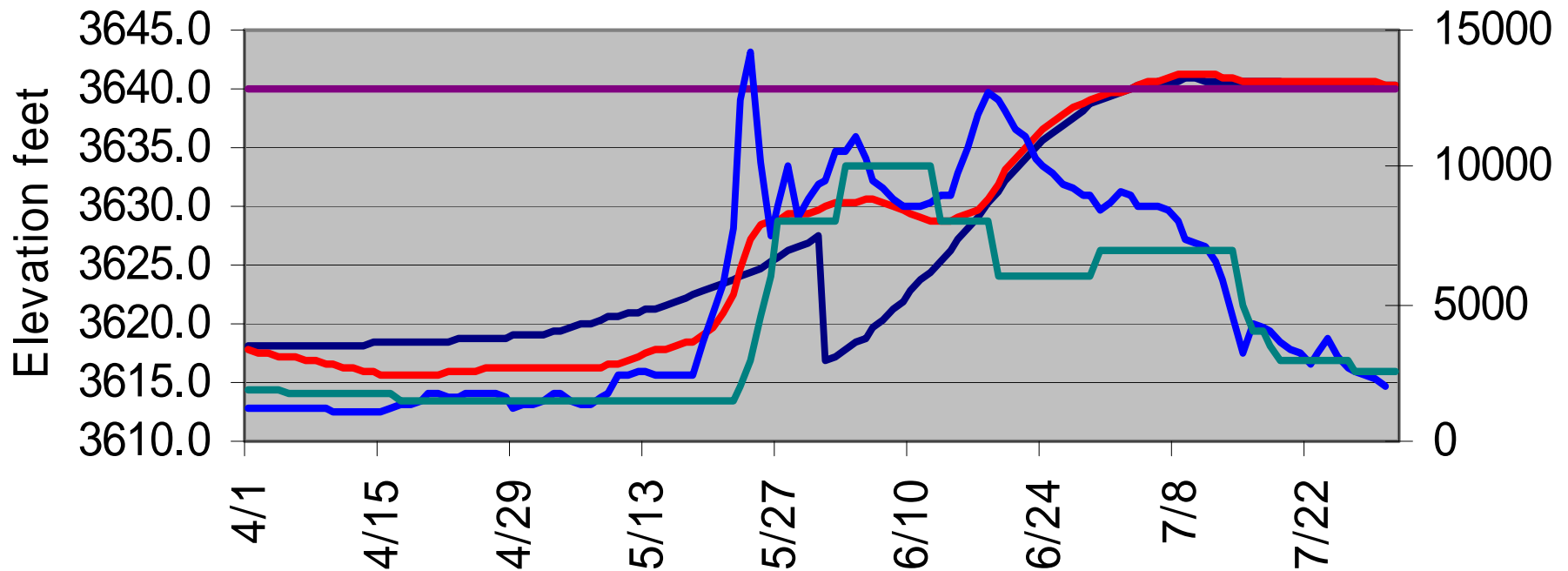
Bighorn Lake Operations 1969



— Rule Curve — Elev. — top of joint use — Release — Inflow

Forecast 72% 2008 Actual 115%

Bighorn Lake Operations 2008



— Rule Curve — Elev. — top of joint use — Inflow — Release

Rule Curve Operations Statistical Results

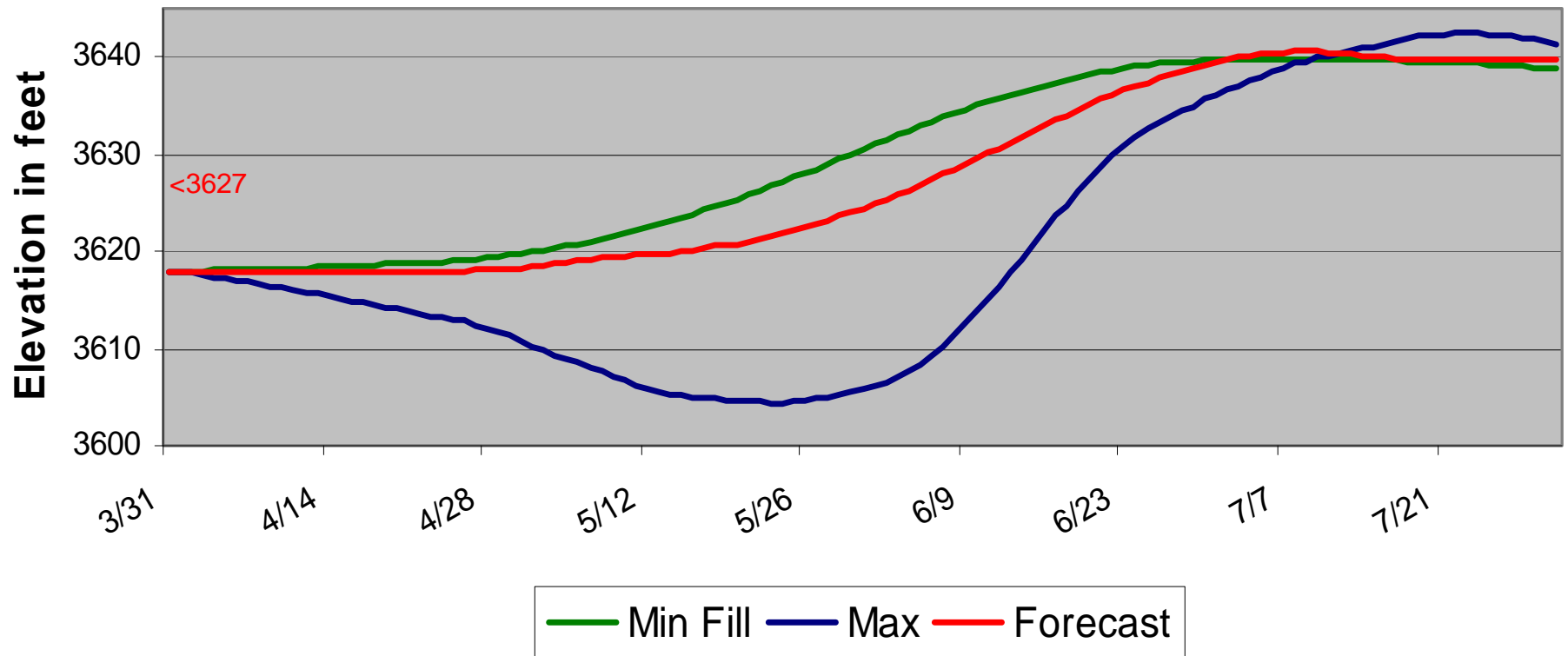
	Historic	Rule Curve	Gain
Fill to 3638 or >	71%	79%	+8%
May 31 3620 or >	45%	62%	+17%
River Release April-July			
2500 cfs or >	25%	40%	+15%
2000 cfs or >	40%	62%	+22%
1500 cfs or >	93%	100%	+ 7%

**2009
LOOKING AHEAD**

RECLAMATION

Forecast 90% 2009 Actual ??

Bighorn Lake Elevation for Forecast A-J Inflow with Rule Curves



SUMMARY

MODIFIED RESERVOIR TARGETS

<u>Date</u>	<u>Previous</u>	<u>Current Proposed</u>	<u>Raise Joint Use Pool</u>
Oct 31	3635	3638	3642?
Mar 31	3605-14	3618	3625?
July 31	3640	3640	3645?

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Discussion & Questions

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