Simulation of CHEOPS Model to determine the Impacts of Inter Basin Transfer of Water for Concord Kannapolis from Catawba River Basin

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Division of Water Resources
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PURPOSE:

A study has been conducted to determine the impacts of Inter Basin Transfer [IBT] of water from Catawba River basin using a hydropower system simulation model CHEOPS. A brief description of the model, background input data and results are discussed in this report.

A. MODEL Background:

Computer Hydro- Electric Operations and Planning Software CHEOPS™ for Catawba River basin developed for Duke Power during the process of relicensing has been simulated to see the impacts of the water transferred as IBT from Catawba River basin. Duke Power contracted Devine Tarbell & Associates, Inc [DTA] to develop the CHEOPS and the 1st version was released to the stakeholders in January 2005. Since then it has gone through several major modifications along with addition of more features. The current version of the model is ***Catawba-Wateree CHEOPS Interface 8.3*** released in mid October 2005. There is no basin specific model report or user manual for ***Catawba -Wateree Cheops*** released by DTA. A generic report documented by DTA has been attached to Appendix –CD-2A [CHEOPS Generic Documentation.pdf.]

The following brief description of the model, data and analyses done for the simulation with IBT are provided based on the trainings given by Duke/DTA and working knowledge gathered during the last several months.

B. Model Description:

CHEOPS is designed for long term analysis of the effects of operational and physical changes made to the modeled hydro-system. It is not designed for real time scheduling.

The model is developed for Catawba – Wateree project. There are 11 hydroelectric reservoirs along the river in North Carolina and South Carolina operated by Duke Power. The names of the reservoirs and their project or plant names used in the model and also in the analysis from upstream to downstream are as follows:

	Reservoir Names	Project Names
1.	Lake James	Bridgewater [BW]
2.	Lake Rhodhiss	Rhodhiss [RH]
3.	Lake Hickory	Oxford [OX]
4.	Lake Lookout Shoals	Lookout Shoals [LS]
5.	Lake Norman	Cowan Ford [CF]
6.	Lake Mountain Island	Mountain Island [MI]
7.	Lake Wylie	Wylie [WY]
8.	Lake Fishing Creek	Fishing Creek [FC]
9.	Lake Great Falls/Dearborn	Great Falls [GF]
10.	Lake Rocky Creek/Cedar Creek	Rocky Creek [RC]
11.	Lake Wateree	Wateree [WA]

C. Background Data:

Table 1: Drainage Area of the sub basins [in sq-miles]

Project	Drainage Area (from ICD)
Bridgewater	380
Rhodhis	1,090
Oxford	1,310
Lookout Shoals	1,450
Cowans Ford	1,790
Mtn. Island	1,860
Wylie	3,020
Fishing Creek	3,810
Great Falls/Dearborn	4,100
Rocky Creek/Cedar Creek	4,360
Wateree	4,750

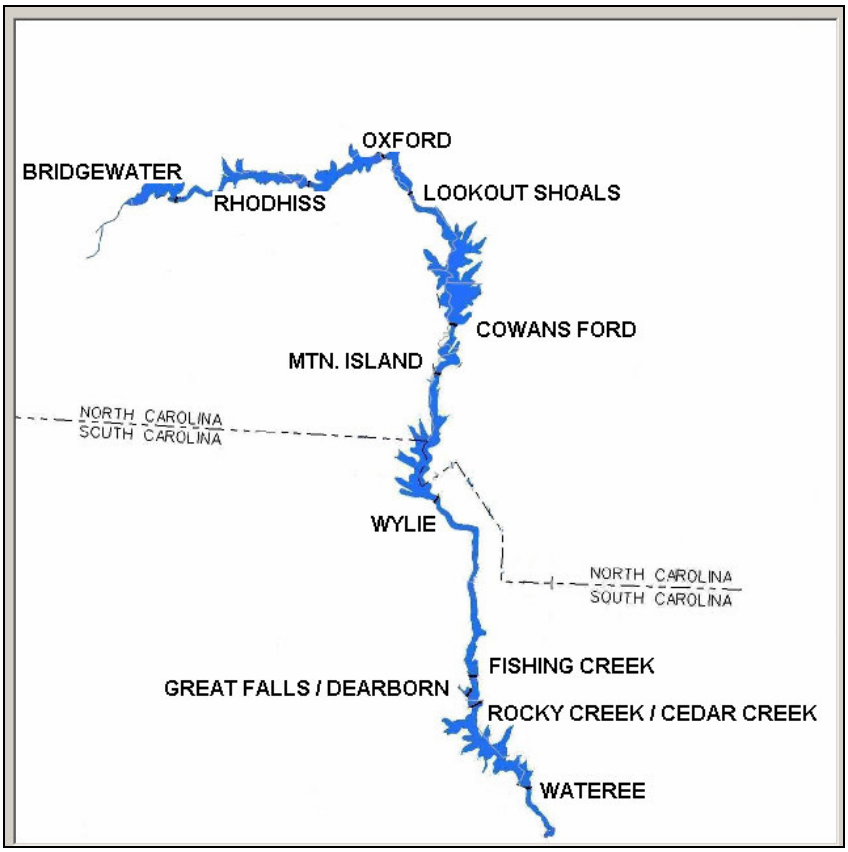

Figure 1: The schematic diagram of the river system [used in CHEOPS interface].

Table 2: Reservoir Sizes/Capacities

	Bridgewater	Rhodhiss	Oxford	Lookout shoals	Cowans Ford	Mtn Island	Wylie	Fishing Cr	Great Falls	Cedar Cr	Wateree	NUS
Full Pond Storage, ac-ft	280,076	46,357	126,990	25,043	1,067,396	59,618	233,618	39,953	5,025	17,690	256,196	
Critical Datum, ft	*61*	*89.4*	*94*	*74.9*	*90*	*94.3*	*92.6*	*95*	*87.2*	*80.3*	*88.5*	
Full Pond Elevation, ft	*1200*	*995.1*	*935*	*838.1*	*760*	*647.5*	*569.4*	*417.2*	*355.8*	*284.4*	*225.5*	
Critical Elevation, ft	*1161*	*984.5*	*929*	*813*	*750*	*641.8*	*562*	*412.2*	*343*	*264.7*	*214*	
Storage @ Critical Elevation, ac-ft	98,789	28,521	103,767	8,274	769,254	44,669	160,707	25,633	1,380	6,197	135,401	
Normal Usable Storage (NUS), ac-ft	**181,287**	**17,836**	**23,223**	**16,769**	**298,142**	**14,949**	**72,911**	**14,320**	**3,645**	**11,493**	**120,796**	**775,370**

Temporal Data:

The model simulates for the period from 01/01/1929 to 12/31/2003, 75 yrs of daily hydrological data. The input for hydrological data are in daily format; however the outputs are in daily for reservoir/river conditions and 15 min time steps for both hydro operation and reservoir conditions.

Inflow:

1. Inflow Estimation based on Historical Reservoir Operation

The inflows at the plant locations are not available. Therefore, DTA chose to use historical hydro generation data to convert to estimate inflows at the plant locations. See Appendix – CD-2B [example file: 01BW-1-18-05.xls]

2. Adjustments of Inflow Data

The inflows generated as above also generated numerous negative inflows. All reservoirs Itrib data has been adjusted to remove negatives by using USGS gage, NC runoff isohyets map and engineering judgments as appropriate with emphasis on trying to maintain the Mass Volume close to the Inflow Raw value generated in the 1st step. Minimum values to replace negatives were selected based on review of DA and runoff production based on the cfs/sq mi and using flow duration curves from unregulated gages. The adjusted Inflows were used as the inflow to the CHEOPS model to compare to historical Duke Generation numbers for each plant and system wide. In the next step it was refined based on generation comparison. The details of the procedure can be found in Appendix – CD-2C [Inflow ComparisonJce March10 Ralph charts.xls]

Evaporation/Rainfall:

In the model, daily evaporation coefficients were used to estimate evaporations from each reservoir, however rainfall data has not been included.

Water Withdrawal/Demand and corresponding Return Flows:

During the relicensing process a water supply study report was prepared by HDR in April 2005. In this report future water demand is projected for the next five decades. Duke's license will be renewed for the next 50 yrs starting from 2008. Therefore, 2008 water demand or withdrawal data is considered to be current demand.

In the water supply study report, return flows were also estimated and projected for the same time horizon. Return flows are not necessarily a function of the water withdrawals from each reservoir or to that specific watershed from where it was withdrawn. Rather these are the functions of withdrawals from different combinations of reservoirs. The projected return flow percents to a specific reservoir for different decades also vary. See Appendix – CD-2G [HDR Withdrawal_Return Flow.xls]

D. Model Flexibility/Functionality:

Model can be run for a varieties of physical, operational and generation settings for individual plants. The current condition with 2008 demand is called **Baseline** scenario. Any change to reflect operational condition proposed by the water user / interest groups with 2008 demand is called current licensed condition [which is **MG 08** in this analysis].

Currently the model is not run with routing options at each node as it takes up tremendous memory in the hard drive and also takes several days to run for the entire period of records.

There are options to vary the physical /or operational conditions such as future sedimentation effect or projected withdrawal effect over the period of records or just fix the sedimentation to current condition and change the withdrawal to any optional year of demand.

E. Model Enhancements:

Low Inflow Protocol [LIP]:

This new feature has been added to the model to comply with the established LIP adopted during the relicensing process to simulate operational constraints effectively. The purpose of the LIP was to establish procedures for reductions in water use during periods of low inflow to the Catawba-Wateree reservoir system. This LIP provides trigger points and procedures for how the Catawba-Wateree reservoir system will be operated as well as water withdrawal reduction measures for other water users during periods of low inflow (i.e., periods when there is not enough water flowing into the reservoirs to meet the normal water demands plus maintain lake levels within the normal ranges). The LIP was developed on the basis that all parties with interests in water quantity will share the responsibility to conserve the limited water supply. To find more details of the LIP report, refer to Appendix – CD-2D[CWRel_Attachement_G__(LIP)_07-15-05.pdf]]. The input data for LIP is in Appendix – CD-2F1 [LIP_Base.xls].

A modification has been added to the LIP data set after this analysis was started in November. For the purpose of keeping all analyses consistent, the old LIP data set was used. The new set has been used for the comparison with old set for one model scenario run. The data for the new LIP is in Appendix – CD-2F2 [New Lip_Base.xls].

Mutual Gains:

To meet the demands needed for municipalities or public use, to maintain recommended water levels at the reservoirs and rives within the normal ranges for a safe and sound ecosystem and seasonal public recreational activities, several scenarios were simulated by DTA to establish a demand schedule where all interested parties are benefited equally. This scenario is called Mutual Gain

Scenario [MG]. This scenario uses demands for municipal use for the year 2008. The current licensed condition is MG scenario which also includes operational constraint LIP. This scenario is modeled as "***MG 08"*** and is the base case for our comparison. For the details of the MG data refer to Appendix – CD-2E2 [Mututal Gain Data_9-16-05.PDF]

The NGOs also recommended increased flows for the streams. These increased flows were also modeled to see the ultimate effect of IBT. The tables for the modified increase flows recommended by the NGOs are in the Appendix – CD-2E1 [Modified MG_Increased ISF by NGOs.doc]

F. Modeling Assumptions for the IBT Runs:

Input Data:

The scenario **"MG 08"** is the base case. It considered all the baseline [current condition] operational, physical and generation conditions with one exception like sedimentation.

- Sedimentation: No gradual sedimentation over the decades was considered.
- LIP: Old LIP data set [version 9/27/2005] was used for all runs.
- MG operational constraints [version 9/2005] included
- Water Withdrawal: Several scenarios were simulated for water withdrawals with and without IBT from proposed source.
    1. Scenario **"MG 08**" – MG with 2008 demands.
    2. Scenario "**MG 08 CF**" – MG with 2008 demands considering IBT from Cowan Ford [Lake Norman].
    3. Scenario **"MG 35"** - MG with increased demands for 2035.
    4. Scenario **"MG 35 CF**" – MG with increased demand for 2035 considering IBT from Cowan Ford [Lake Norman].
    5. Scenario **"MG 35 MI**" – MG with increased demands for 2035 considering IBT from Mountain Island.
    6. Scenario **"MG 35 NGO"** – MG with 2035 demands considering increased instream flow requirements recommended by NGOs.
    7. Scenario **"MG 35 CF NGO**" – MG with 2035 demands and IBT from Cowan Ford considering increased instream flow requirements recommended by NGOs.
    8. Scenario **"MG 35 LIP**" – MG with 2035 demands considering new modified LIP [version November, 2005].
    9. Scenario **"MG 35 CF LIP**" – MG with 2035 demands and IBT from Cowan Ford considering new modified LIP [version November, 2005].

Variable transferable IBT quantities were modeled to see the impacts on the reservoir systems. The purpose was to analyze the impacts of

a. IBT quantities
b. IBT locations
c. IBT with increased instream flow requirements.

IBT Quantities and Distributions:

A maximum of 10 MGD from Cowan Ford in year 2008 was modeled. Then average 24 MGD from Cowan Ford and Mountain Island in year 2035 were modeled. The monthly distributions based on 2002 water use are as follows:

Table 3: IBT Monthly distribution

Distribution for	2035 IBT		2008 IBT	
Month	**MGD**	**AC-FT**	**MGD**	**AC-FT**
Jan	21.87	14.18	7.86	5.10
Feb	21.50	13.93	7.73	5.01
Mar	21.59	14.00	7.76	5.03
Apr	24.16	15.66	8.69	5.63
May	25.96	16.83	9.33	6.05
Jun	27.80	18.02	10.00	6.48
Jul	26.36	17.09	9.48	6.15
Aug	26.68	17.30	9.59	6.22
Sep	24.53	15.90	8.82	5.72
Oct	24.61	15.95	8.85	5.74
Nov	21.77	14.11	7.83	5.07
Dec	21.17	13.72	7.61	4.93
Avg	**24**	**15.56**	**8.63**	**5.59**

These monthly IBT amounts were added to 2008 and 2035 demands for scenario runs with IBT from Cowan Ford [Lake Norman] and Mountain Island and simulated as **"MG 08 CF**" and **"MG 35CF", "MG 35 MI", "MG 35 CF NGO".** The total monthly distributions of demands/withdrawals with and without IBT are:

Table 4: Total Monthly Distributions with and without IBT from Cowan Ford and Mountain Island

Withdrawals, ac-ft													
From	Demand Condition	January	February	March	April	May	June	July	August	September	October	November	December
Cowan Ford	2008	101	97	81	109	109	118	117	113	101	99	84	98
	2008 With IBT	106	102	86	114	114	123	122	118	106	104	89	103
	2035	189	184	169	209	216	233	229	217	195	191	172	183
	2035 With IBT	204	198	183	225	233	251	246	235	211	207	186	197
Mountain Island	2035	246	238	239	286	333	368	357	337	292	274	246	236
	2035 With IBT	260	252	253	302	350	386	374	354	308	290	260	250

G. Model Results:

Data Format:

As it was mentioned earlier, the inputs for hydrological data are in daily format. However the outputs are in daily for system wide reservoir/river conditions and 15 min time steps for both hydro operation and reservoir conditions. In this analysis only daily data was analyzed for convenience and faster processing.

The output results from the above eight model scenario runs are divided into 6 categories as it was processed to fulfill different purposes.

1. **LIP Summary** – System wide:
2. **Annual Duration of**
   - **Total Outflow** - at reservoir levels
   - **Elevations** - at reservoir levels
3. **Generation Summary** – at reservoir levels
4. **Performance Measure Sheets** – post processor to produce the performance criteria set by water user interests groups.
5. **Elevation and Storage Conditions** during Dry season including yr 2002 – at reservoirs levels.
6. **Haze Charts** – of Outflows and Lake Elevation at reservoir levels.

Under these categories, the results are summarized in three different groupings for comparison purposes to see:

A. **The impacts of IBT quantity on the system.**
B. **The impacts of the IBT locations.**
C. **The impacts of IBT along with new increased instream flow requirements recommended by the NGOs**.

And finally new set for

D. **Impacts of New Modified LIP**

Summary of Results:

The output results are summarized in several plots and tables in the following pages:

4. LIP Summary Plots:

A. Impacts of IBT Quantity

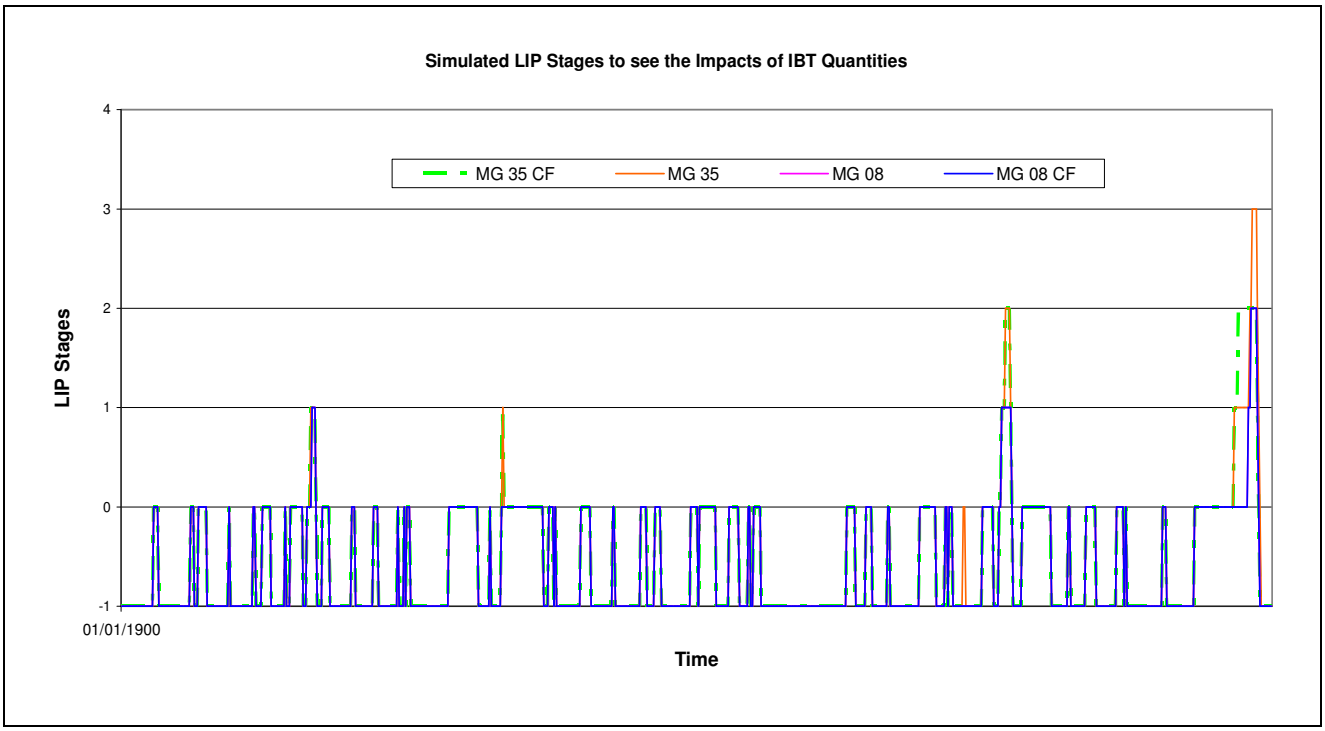

Figure 2: LIP Stages for Impacts of All IBT Quantities

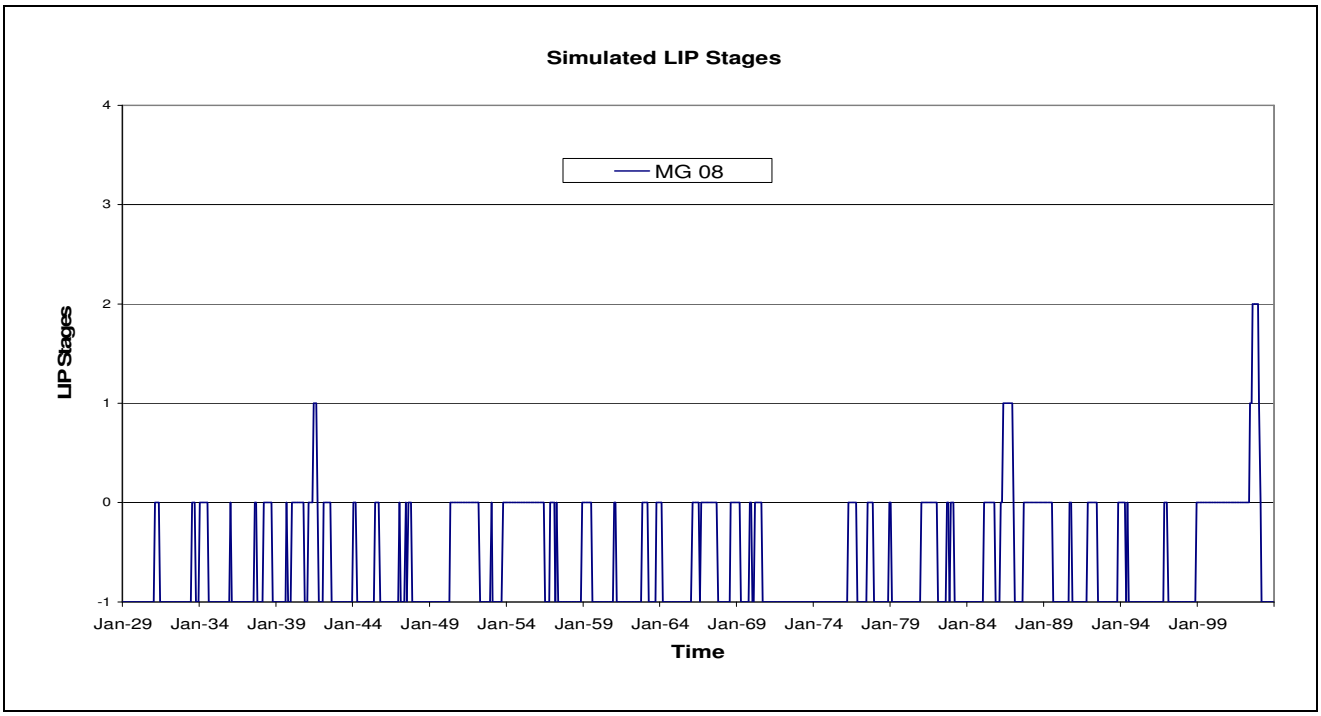

Figure 3: LIP Stages for Impacts of IBT Quantities for Scenario "MG 08"

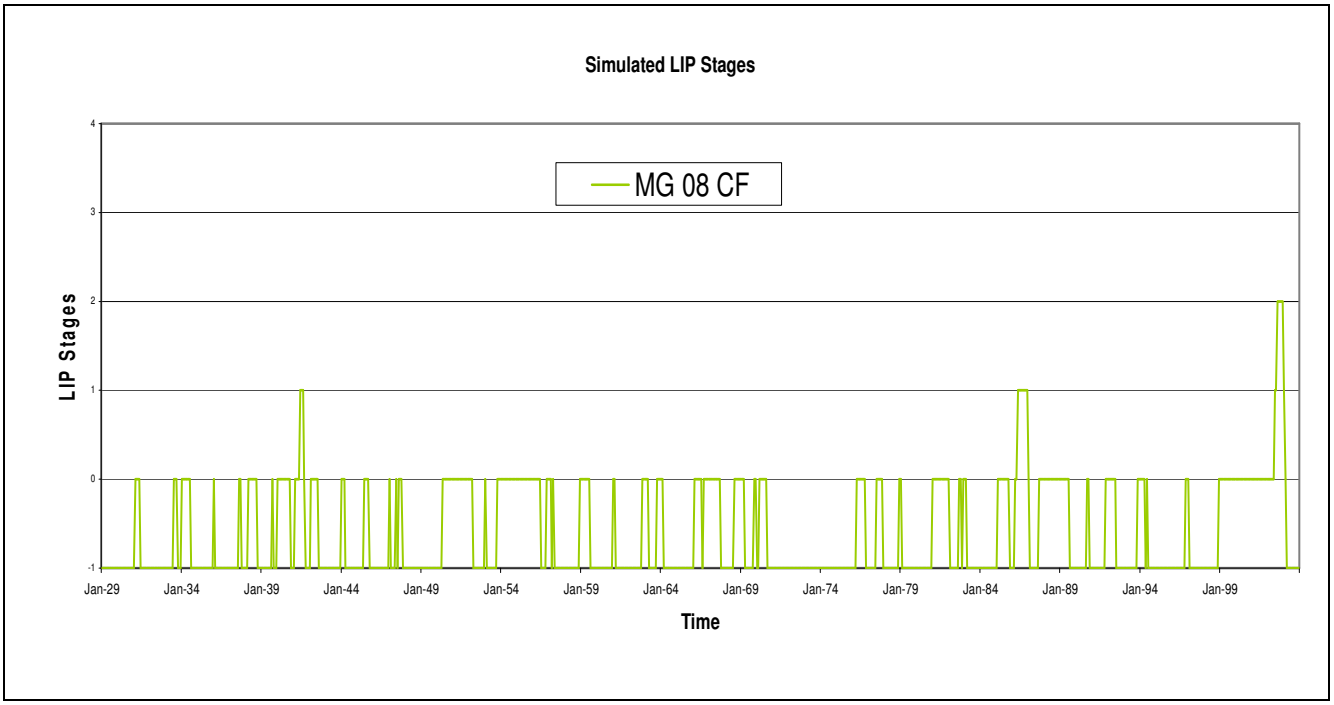

Figure 4: LIP Stages for Impacts of IBT Quantities for Scenario "MG 08 CF"

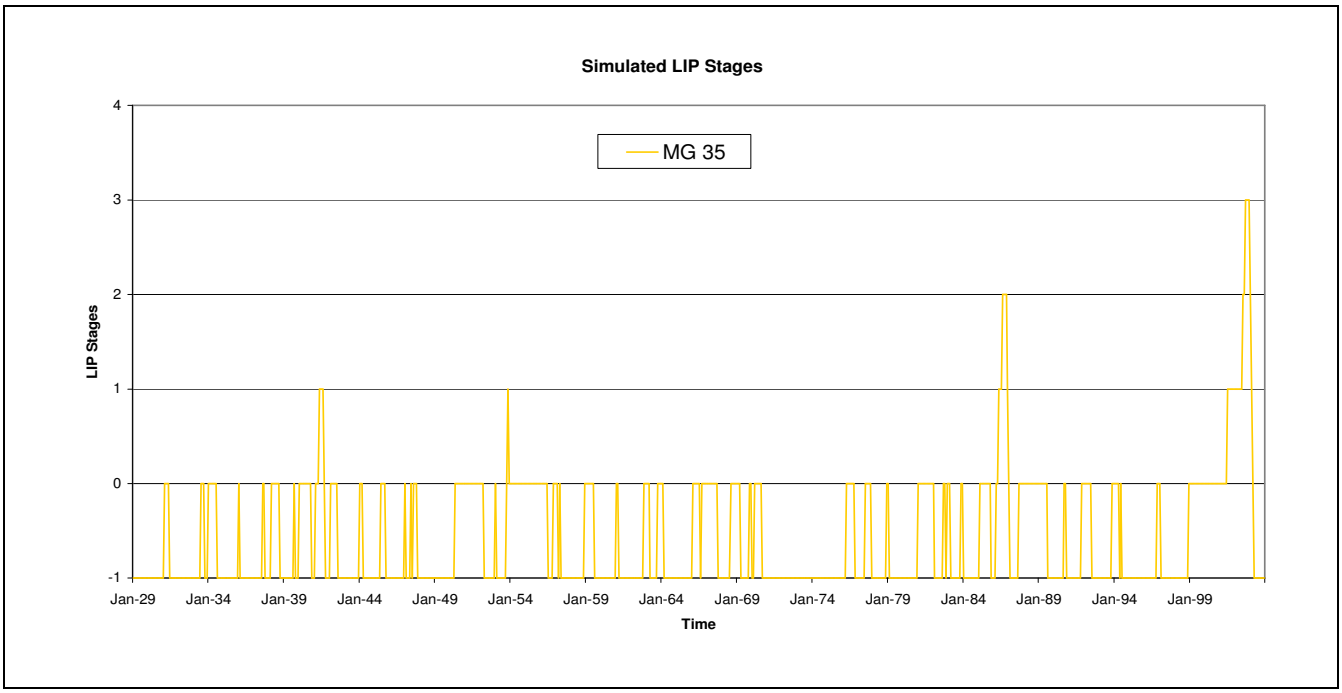

Figure 5: LIP Stages for Impacts of IBT Quantities for Scenario "MG 35"

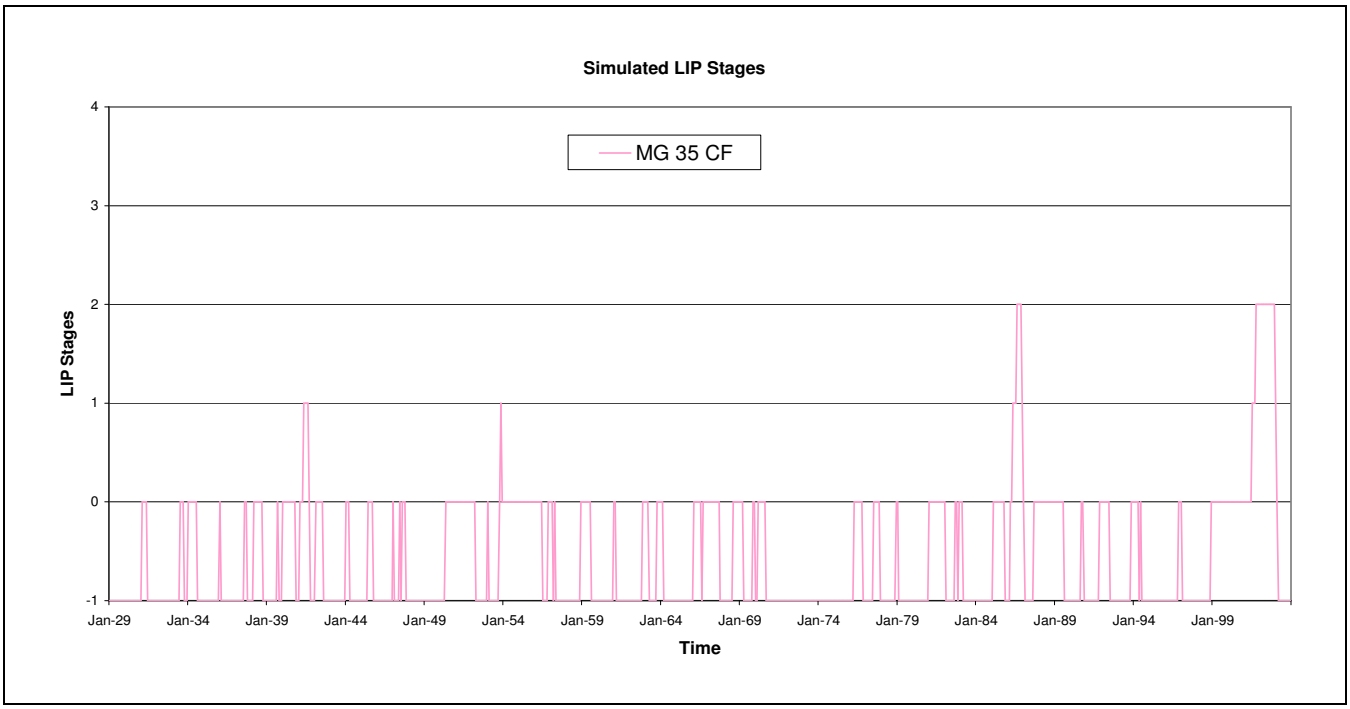

Figure 6: LIP Stages for Impacts of IBT Quantities for Scenario "MG 35 CF"

B. Impact of IBT Locations

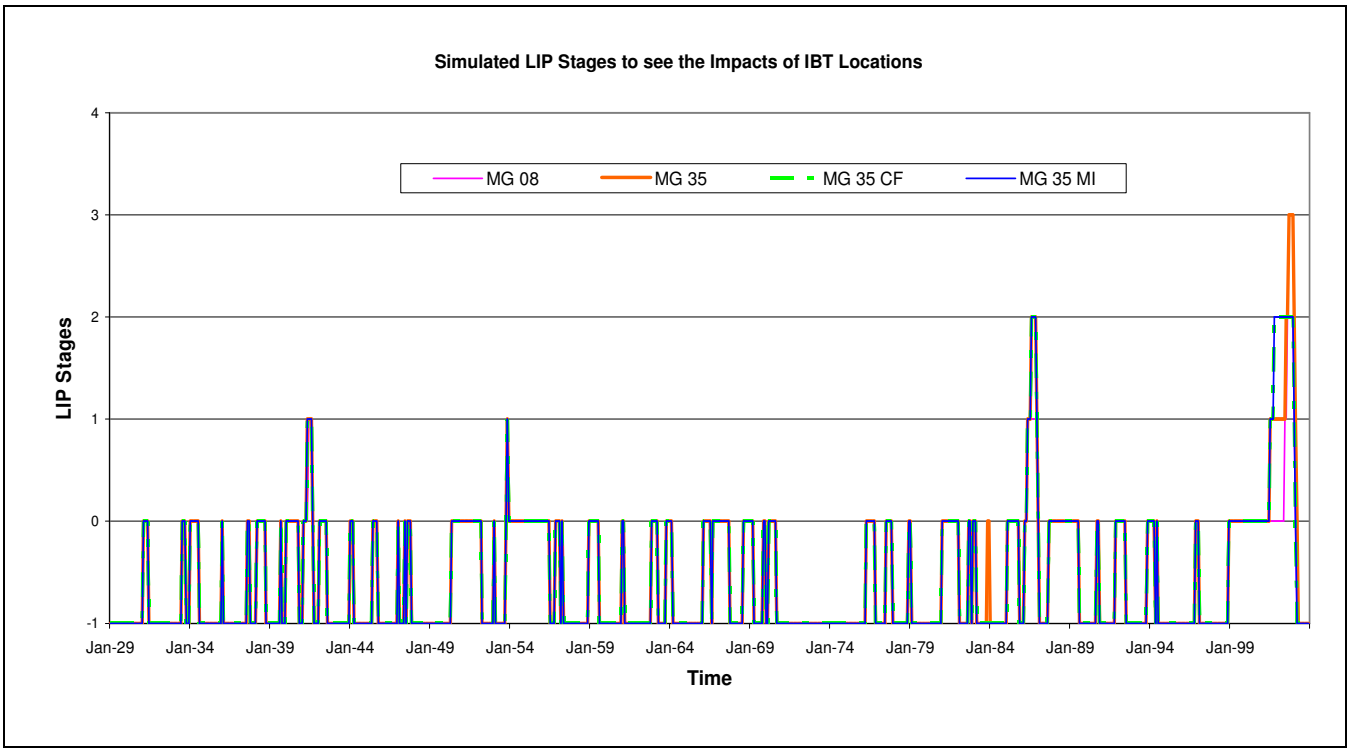

Figure 7: LIP Stages for Impacts of IBT Locations for all IBT Locations

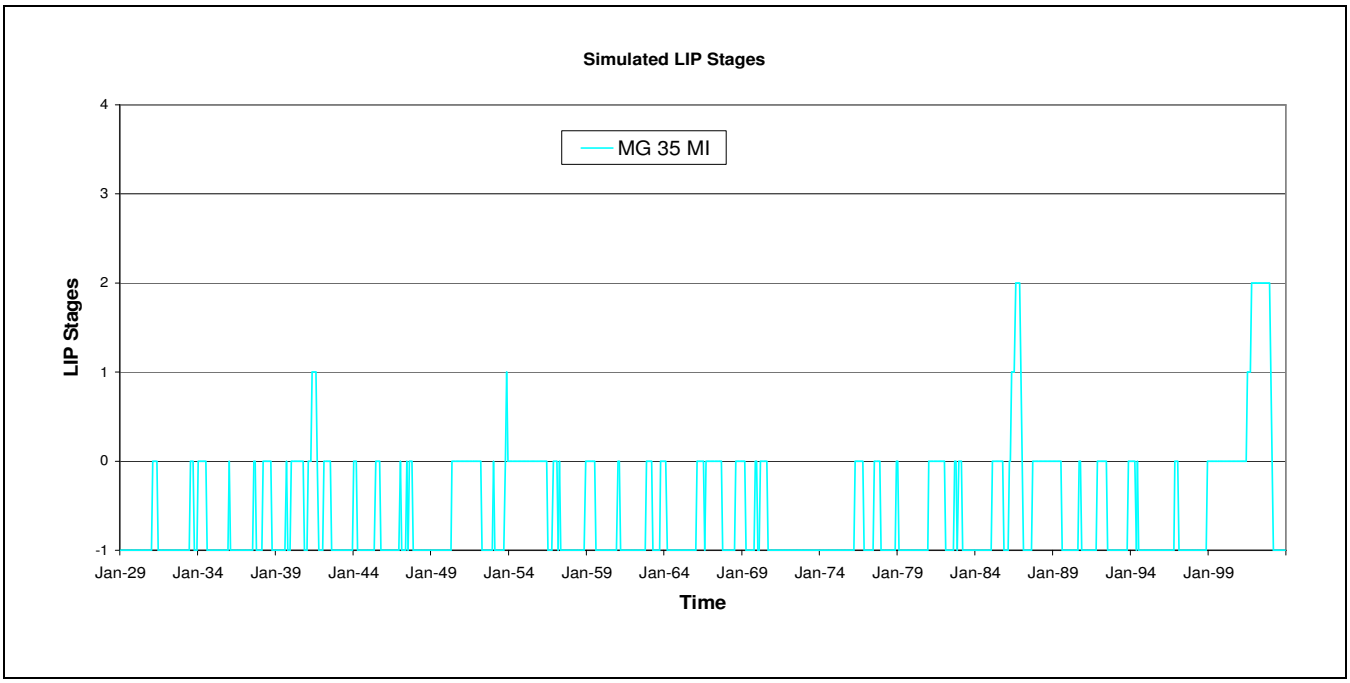

Figure 8: LIP Stages for Impacts of IBT Locations for Scenario "MG 35 MI"

C. Impacts of Increased Instream Flow Requirements

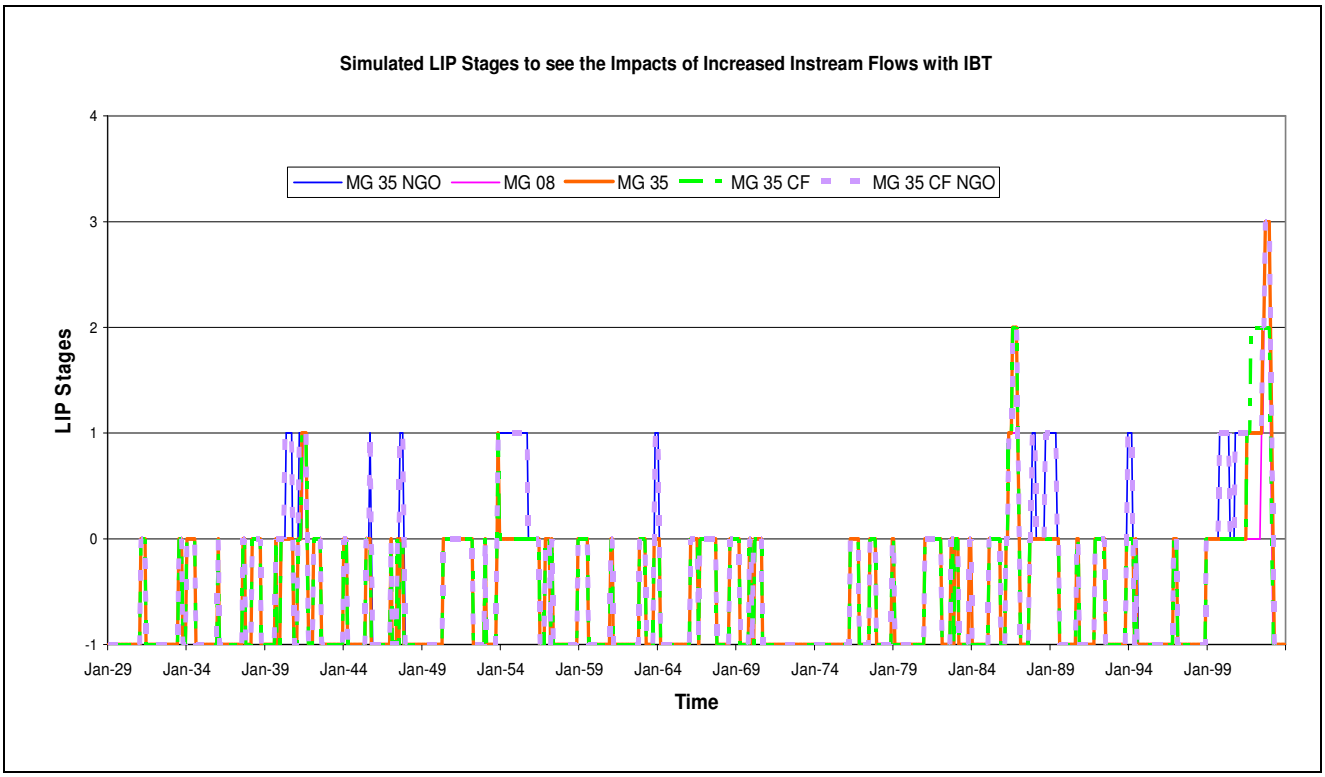

Figure 9: LIP Stages for Impacts of Increased Instream Flows with IBT"

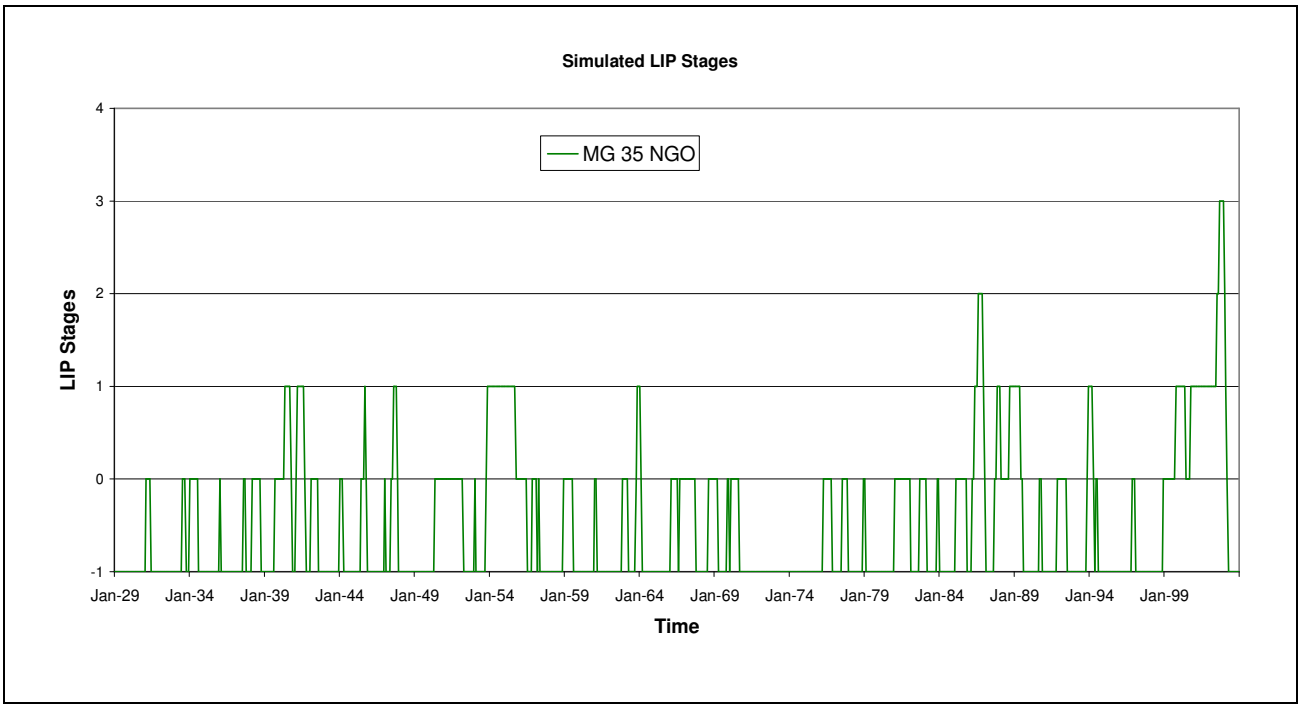

Figure 10: LIP Stages for Impacts of Increased Instream Flows for Scenario "MG 35 NGO"

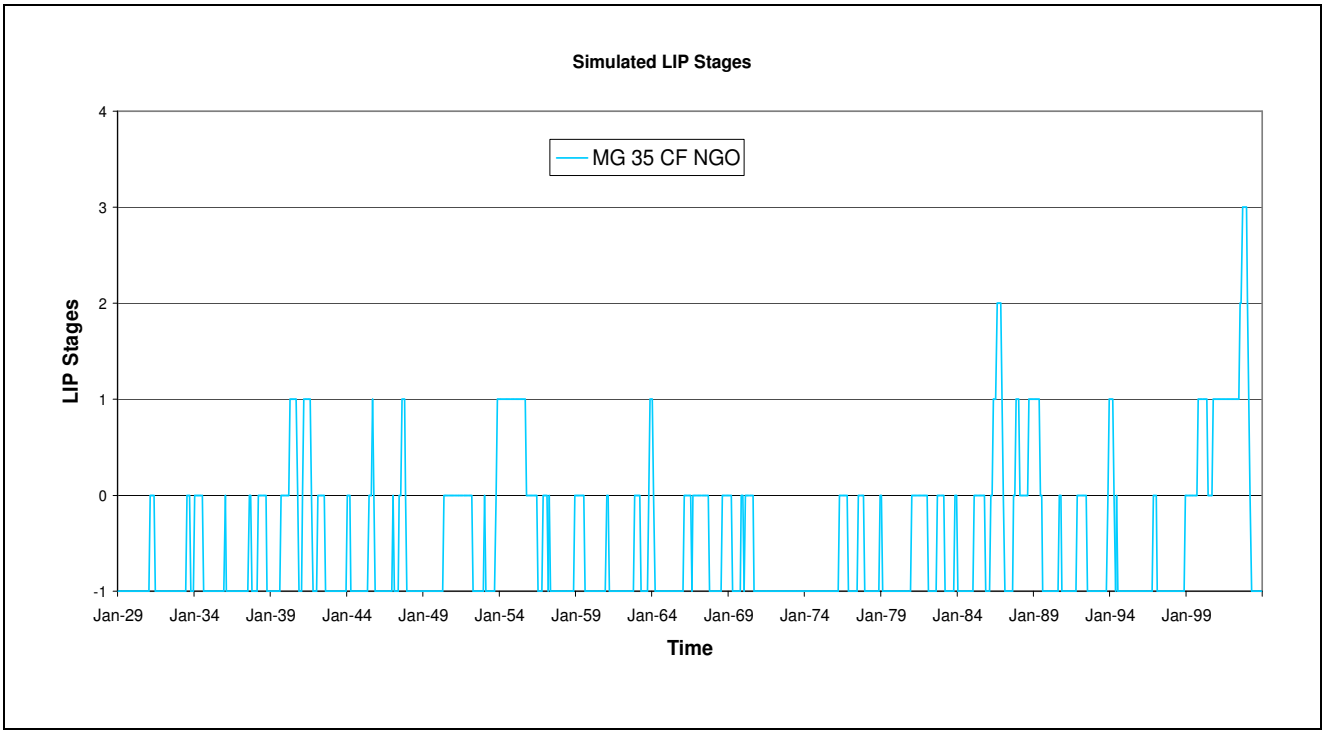

Figure 11: LIP for Impacts of Increased Instream Flows Stages for Scenario "MG 35 CF NGO"

2. LIP Summary Sheets:

A. Impacts of IBT Quantity

Table 5: LIP Summary for Impacts of IBT Quantities for MG 08

LIP Stage Summary for MG 08 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	576	64%
0	305	34%
1	14	2%
2	5	1%
3	0	0%
4	0	0%

Monthly LIP Stage Summary for MG 08 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	576	305	14	5	0	0
January	42	32	1	0	0	0
February	44	31	0	0	0	0
March	46	29	0	0	0	0
April	48	27	0	0	0	0
May	49	25	1	0	0	0
June	47	25	3	0	0	0
July	49	23	3	0	0	0
August	51	21	2	1	0	0
September	47	26	1	1	0	0
October	52	21	1	1	0	0
November	52	21	1	1	0	0
December	49	24	1	1	0	0

Table 6: LIP Summary for Impacts of IBT Quantities for MG 08 CF

LIP Stage Summary for MG 08 CF 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	576	64%
0	305	34%
1	14	2%
2	5	1%
3	0	0%
4	0	0%

Monthly LIP Stage Summary for MG 08 CF 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	576	305	14	5	0	0
January	42	32	1	0	0	0
February	44	31	0	0	0	0
March	46	29	0	0	0	0
April	48	27	0	0	0	0
May	49	25	1	0	0	0
June	47	25	3	0	0	0
July	49	23	3	0	0	0
August	51	21	2	1	0	0
September	47	26	1	1	0	0
October	52	21	1	1	0	0
November	52	21	1	1	0	0
December	49	24	1	1	0	0

Table 7: LIP Summary for Impacts of IBT Quantities for MG 35

LIP Stage Summary for MG 35 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	573	64%
0	294	33%
1	22	2%
2	7	1%
3	4	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	573	294	22	7	4	0
January	42	31	1	1	0	0
February	44	29	2	0	0	0
March	45	29	1	0	0	0
April	48	26	1	0	0	0
May	49	23	3	0	0	0
June	47	25	3	0	0	0
July	49	22	3	1	0	0
August	51	20	2	2	0	0
September	47	25	1	1	1	0
October	52	20	1	1	1	0
November	51	20	2	1	1	0
December	48	24	2	0	1	0

Table 8: LIP Summary for Impacts of IBT Quantities for MG 35 CF

LIP Stage Summary for MG 35 CF 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	576	64%
0	292	32%
1	13	1%
2	19	2%
3	0	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 CF 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	576	292	13	19	0	0
January	42	31	1	1	0	0
February	44	30	0	1	0	0
March	46	28	0	1	0	0
April	48	26	0	1	0	0
May	49	23	2	1	0	0
June	47	25	2	1	0	0
July	49	22	3	1	0	0
August	51	20	2	2	0	0
September	47	25	1	2	0	0
October	52	20	0	3	0	0
November	52	19	1	3	0	0
December	49	23	1	2	0	0

B. Impacts of IBT Locations

Table 9: LIP Summary for Impacts of IBT Locations for MG 35 MI

LIP Stage Summary for MG 35 MI 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	576	64%
0	292	32%
1	13	1%
2	19	2%
3	0	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 MI 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	576	292	13	19	0	0
January	42	31	1	1	0	0
February	44	30	0	1	0	0
March	46	28	0	1	0	0
April	48	26	0	1	0	0
May	49	23	2	1	0	0
June	47	25	2	1	0	0
July	49	22	3	1	0	0
August	51	20	2	2	0	0
September	47	25	1	2	0	0
October	52	20	0	3	0	0
November	52	19	1	3	0	0
December	49	23	1	2	0	0

C. Impacts of Increased Instream Flows with IBT

Table 10: LIP Summary for Impacts of Increased Instream Flows for MG 35 NGO

LIP Stage Summary for MG 35 NGO 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	564	63%
0	234	26%
1	91	10%
2	7	1%
3	4	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 NGO 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	564	234	91	7	4	0
January	42	23	9	1	0	0
February	43	24	8	0	0	0
March	45	22	8	0	0	0
April	48	20	7	0	0	0
May	49	17	9	0	0	0
June	47	21	7	0	0	0
July	47	21	6	1	0	0
August	51	16	6	2	0	0
September	47	19	7	1	1	0
October	50	17	6	1	1	0
November	48	17	8	1	1	0
December	47	17	10	0	1	0

Table 11: LIP Summary for Impacts of Increased Instream Flows for MG 35CF NGO

LIP Stage Summary for MG 35 CF NGO 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	565	63%
0	232	26%
1	92	10%
2	7	1%
3	4	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 CF NGO 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	565	232	92	7	4	0
January	42	23	9	1	0	0
February	43	24	8	0	0	0
March	45	22	8	0	0	0
April	48	19	8	0	0	0
May	49	17	9	0	0	0
June	47	21	7	0	0	0
July	48	20	6	1	0	0
August	51	16	6	2	0	0
September	47	19	7	1	1	0
October	50	17	6	1	1	0
November	48	17	8	1	1	0
December	47	17	10	0	1	0

3. Annual Duration of Total Outflows

1) Bridgewater

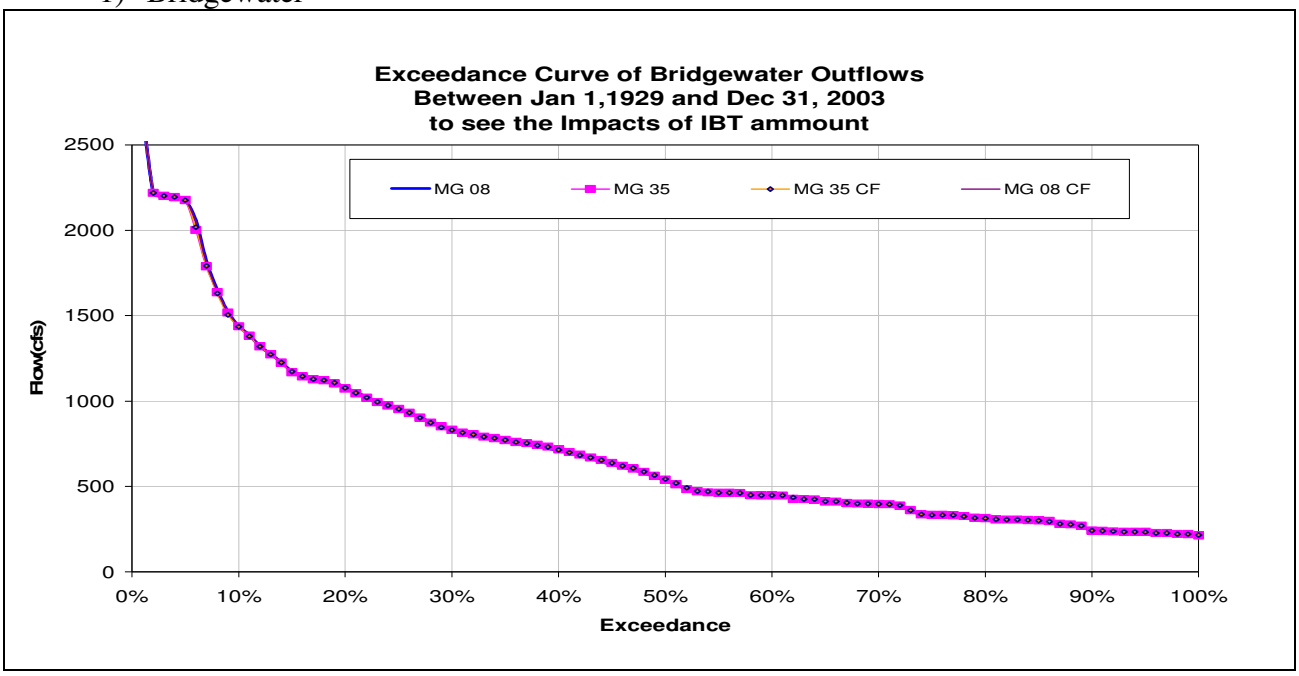

Figure 12: Outflow Duration plot of BW for Impacts of IBT Quantity

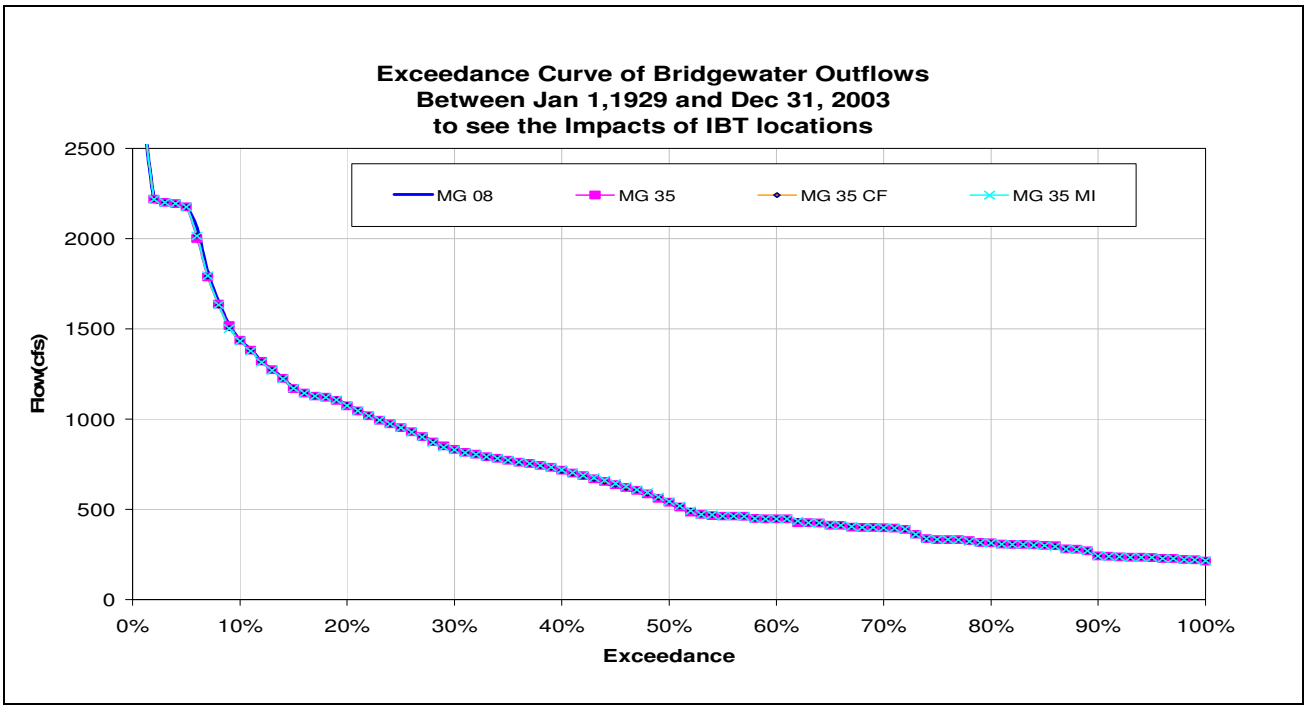

Figure 13: Outflow Duration plot of BW for Impacts of IBT Locations

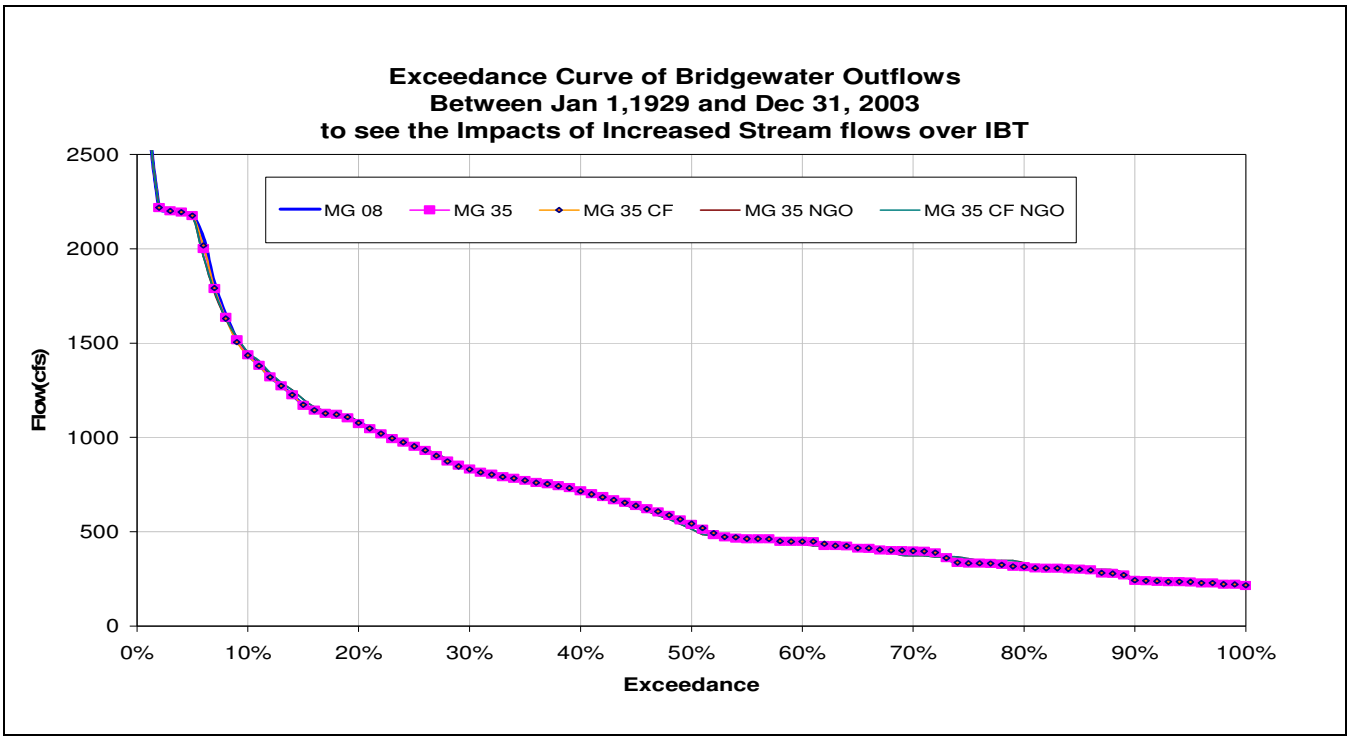

Figure 14: Outflow Duration plot of BW for Impacts of Increased Instream Flow Requirement with IBT

2) Rhodhiss

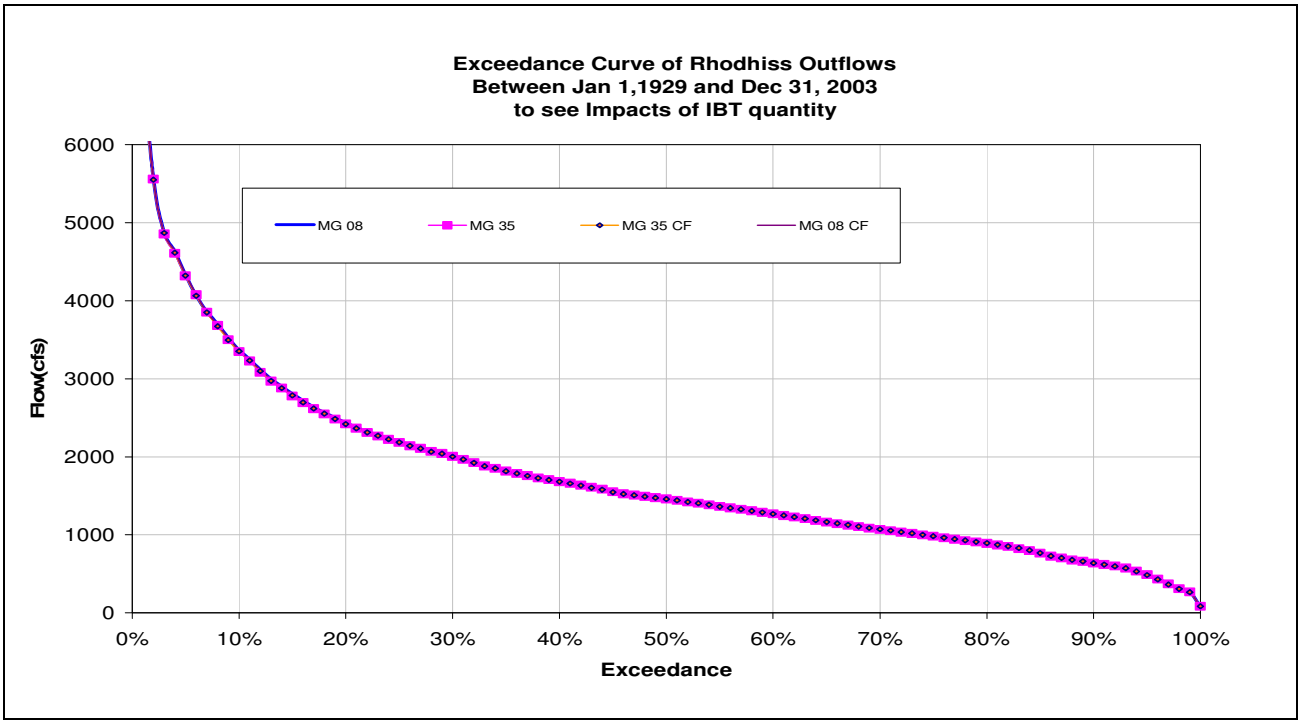

Figure 15: Outflow Duration plot of RH for Impacts of IBT Quantity

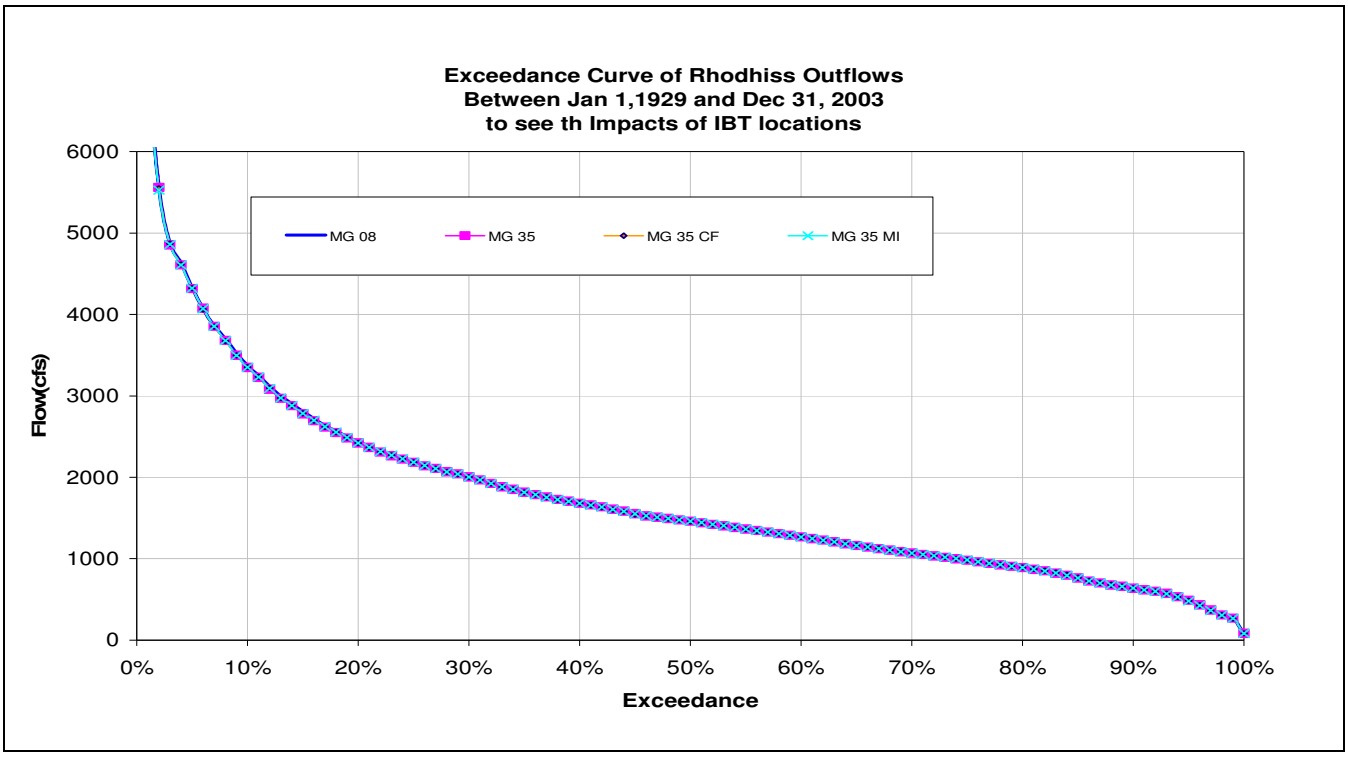

Figure 16: Outflow Duration plot of RH for Impacts of IBT Locations

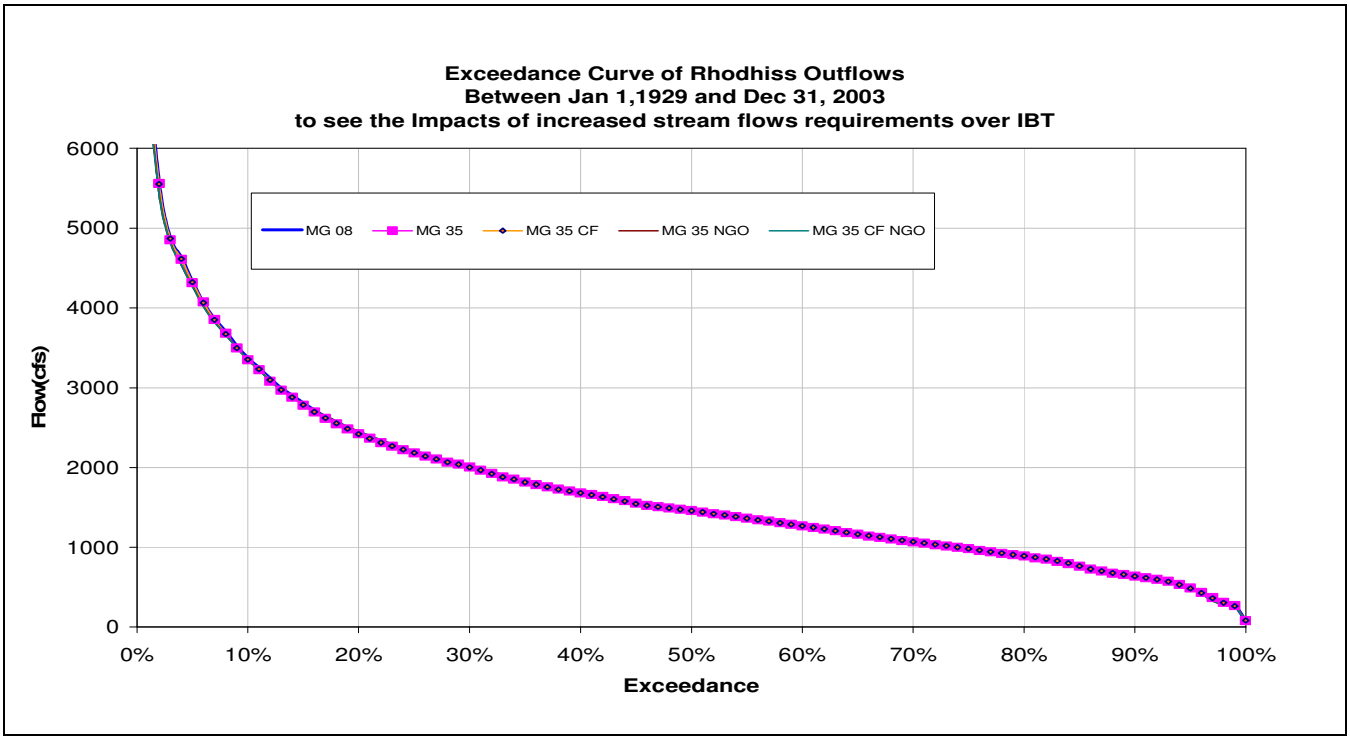

Figure 17: Outflow Duration plot of RH for Impacts of Increased Instream Flow Requirement with IBT

3) Oxford

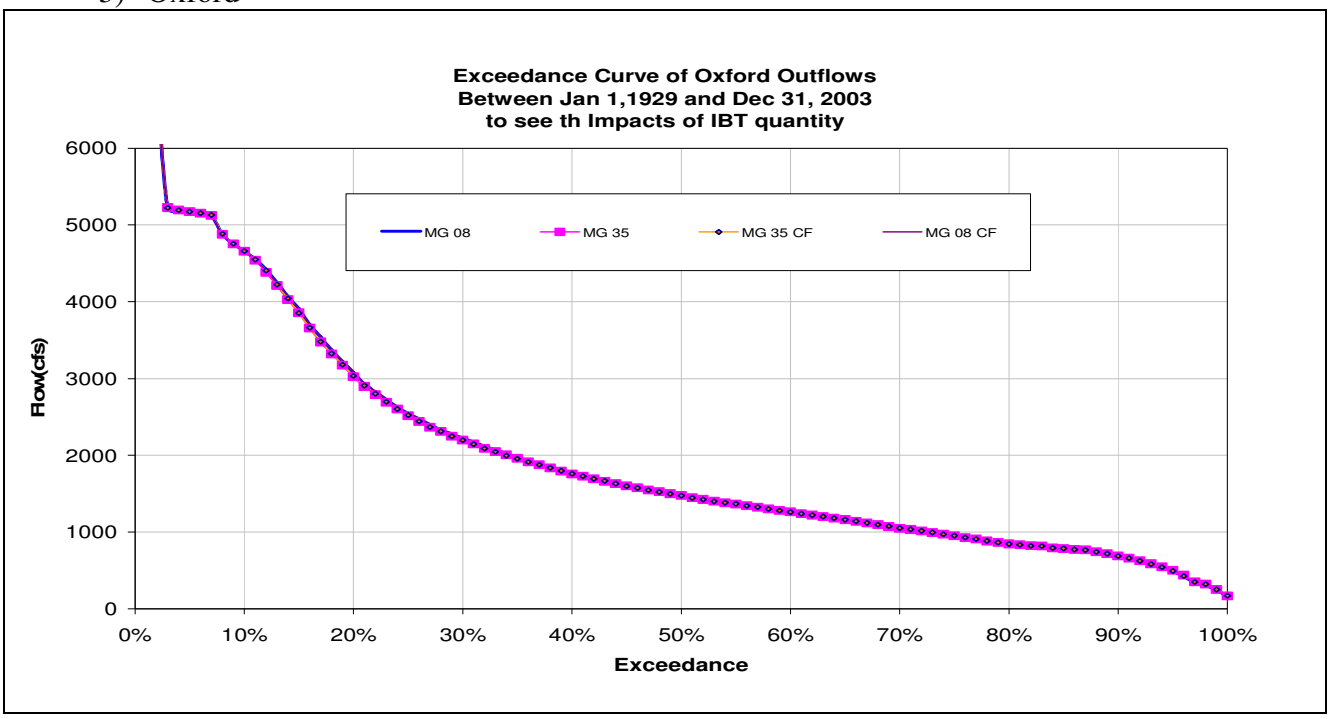

Figure 18: Outflow Duration plot of OX for Impacts of IBT Quantity

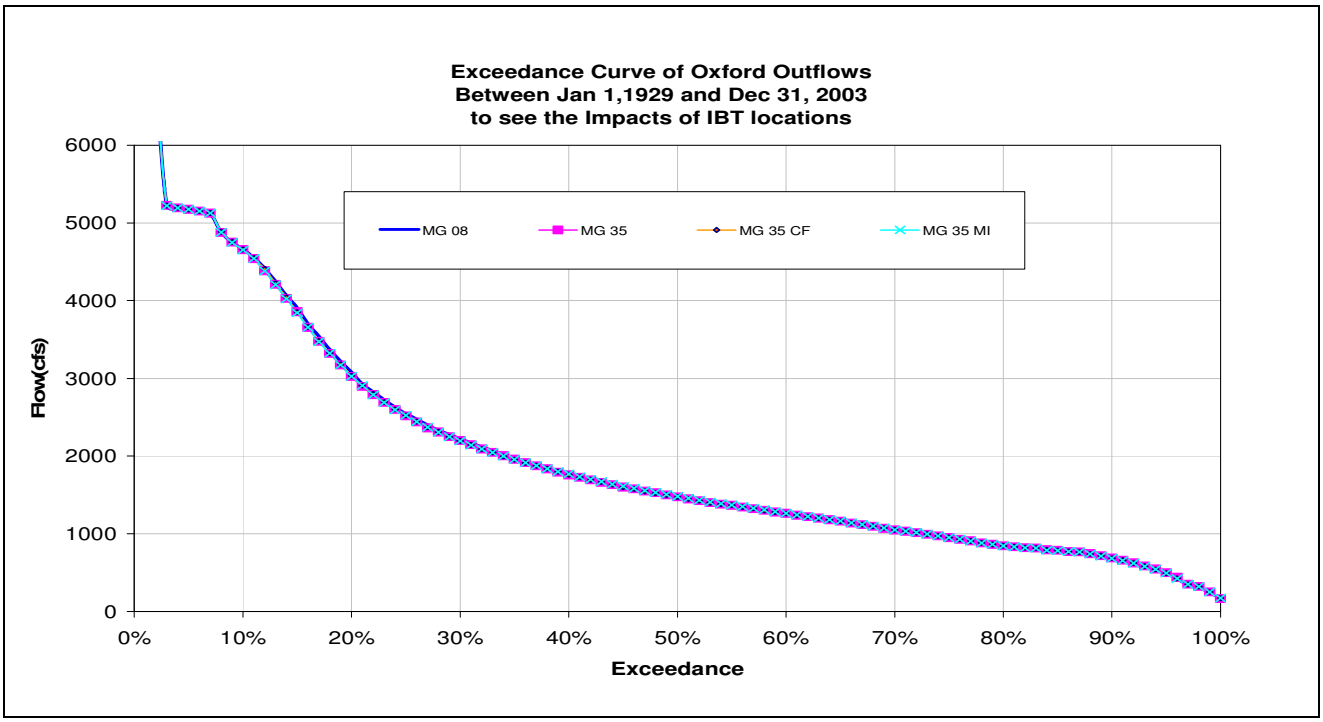

Figure 19: Outflow Duration plot of OX for Impacts of IBT Locations

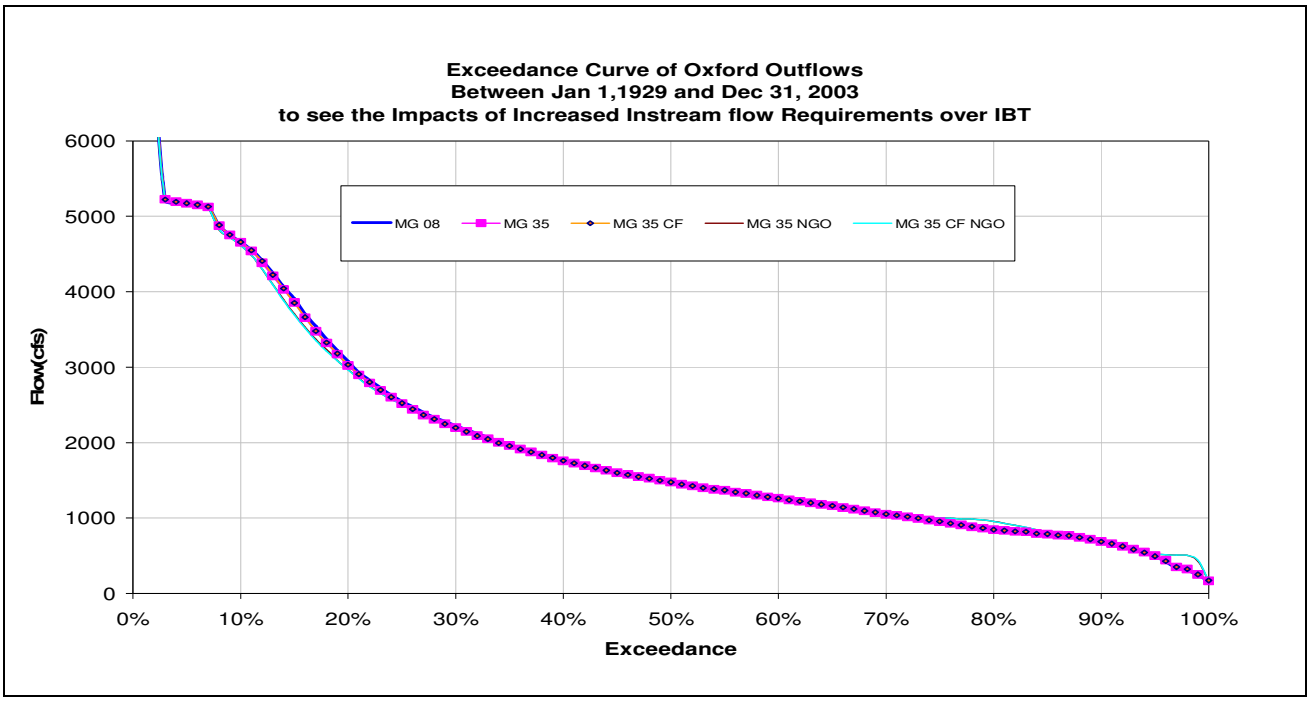

Figure 20: Outflow Duration plot of OX for Impacts of Increased Instream Flow Requirement with IBT

4) Lookout Shoals

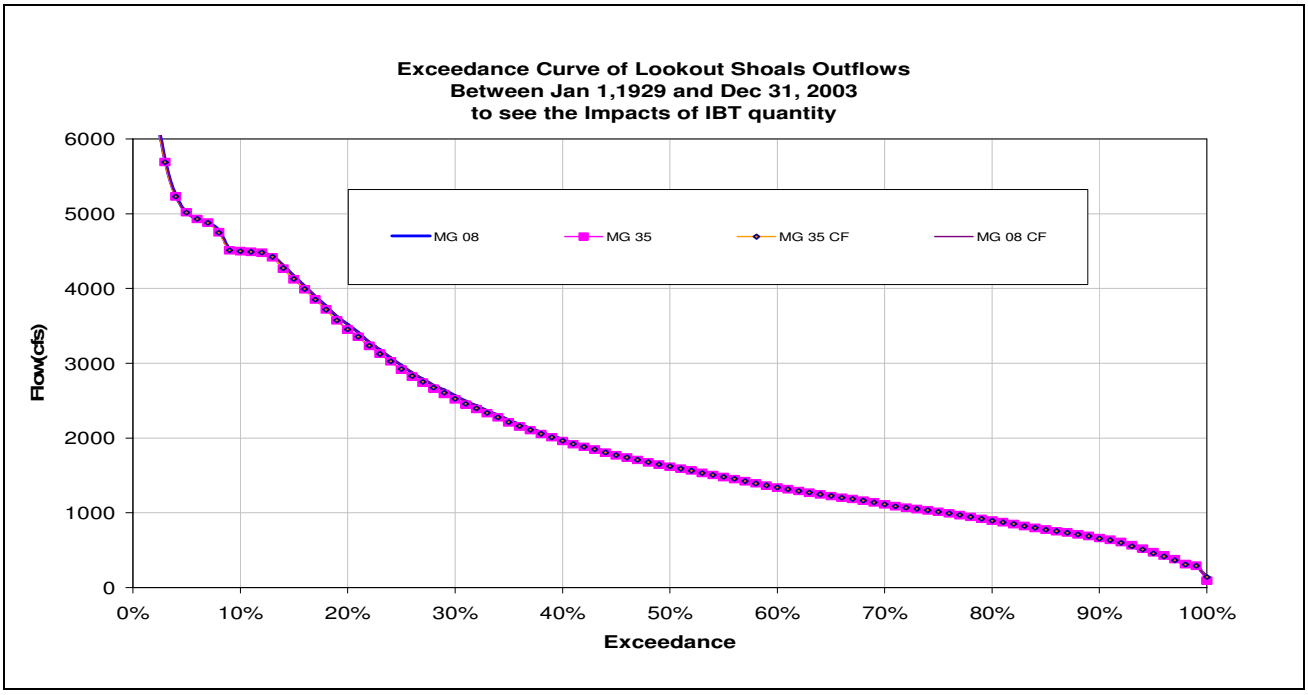

Figure 21: Outflow Duration plot of LS for Impacts of IBT Quantity

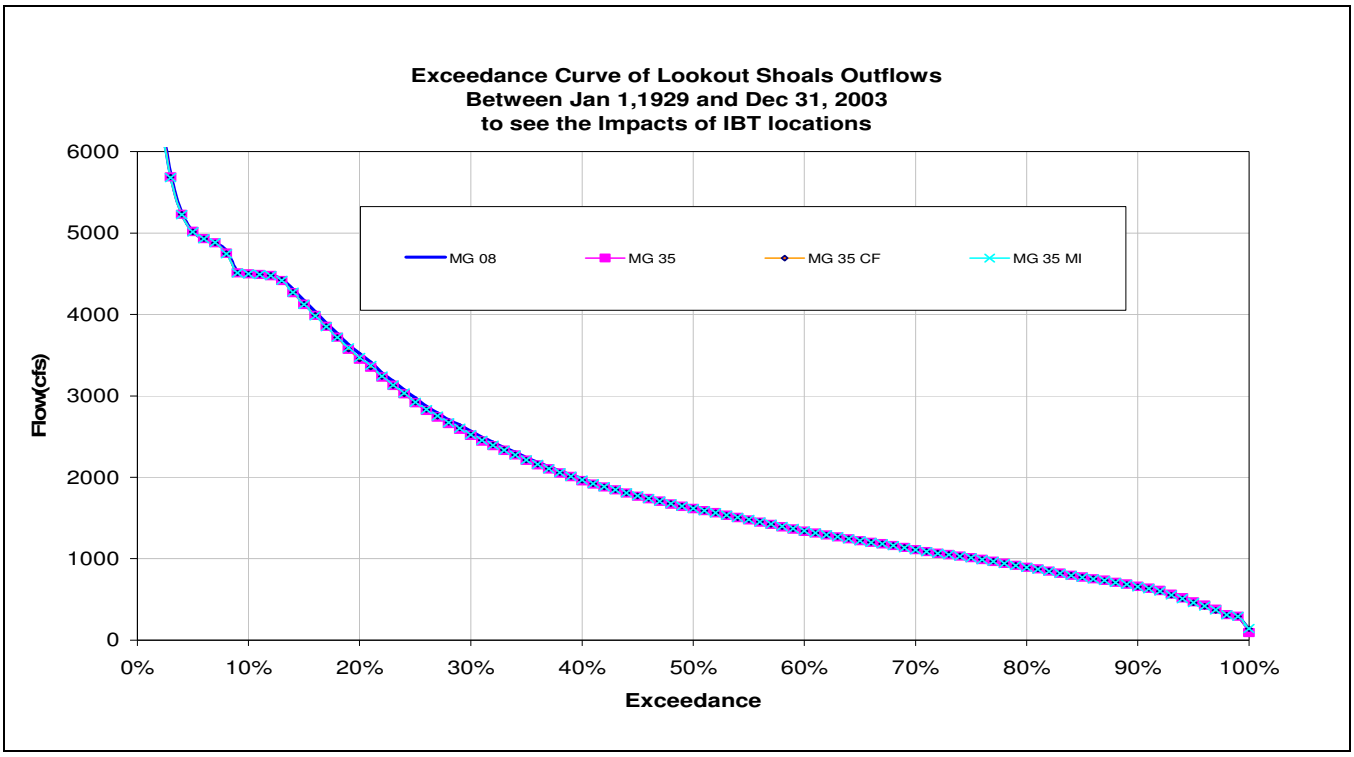

Figure 22: Outflow Duration plot of LS for Impacts of IBT Locations

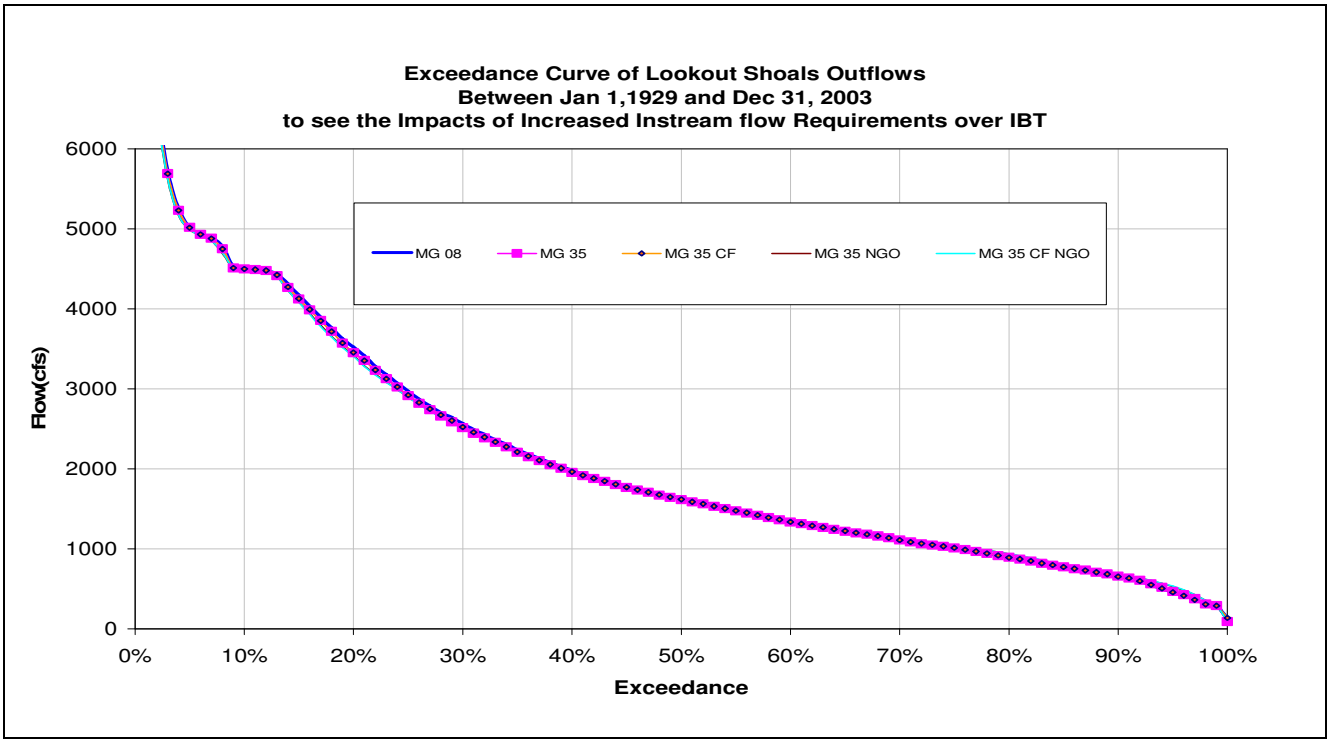

Figure 23: Outflow Duration plot of LS for Impacts of Increased Instream Flow Requirement with IBT

5) Cowan Ford

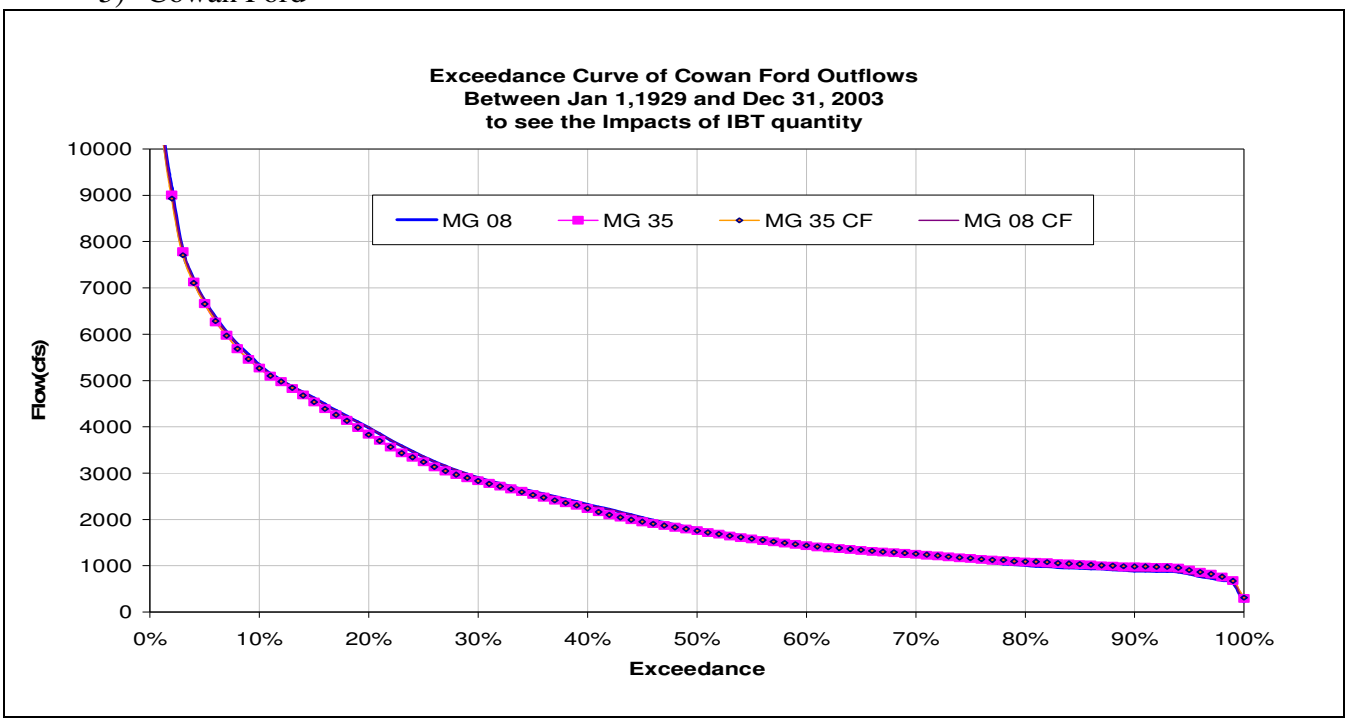

Figure 24: Outflow Duration plot of CF for Impacts of IBT Quantity

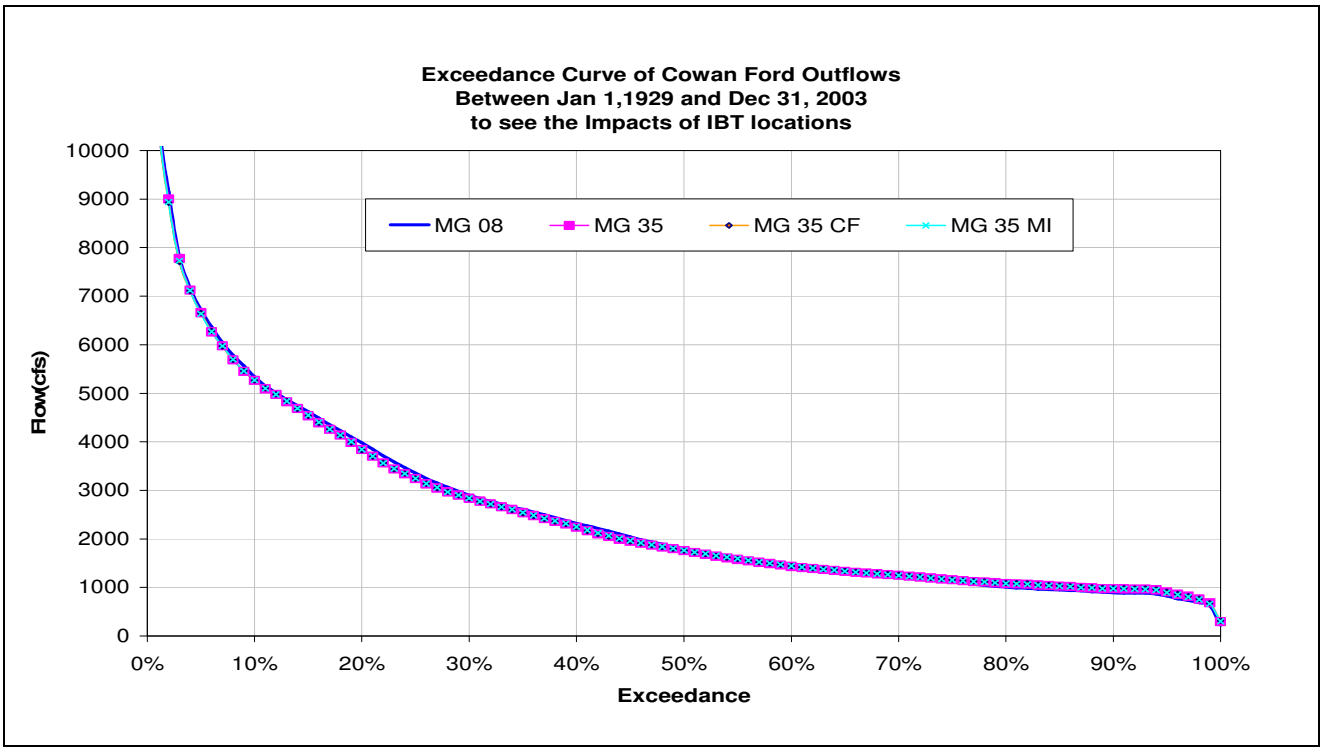

Figure 25: Outflow Duration plot of CF for Impacts of IBT Locations

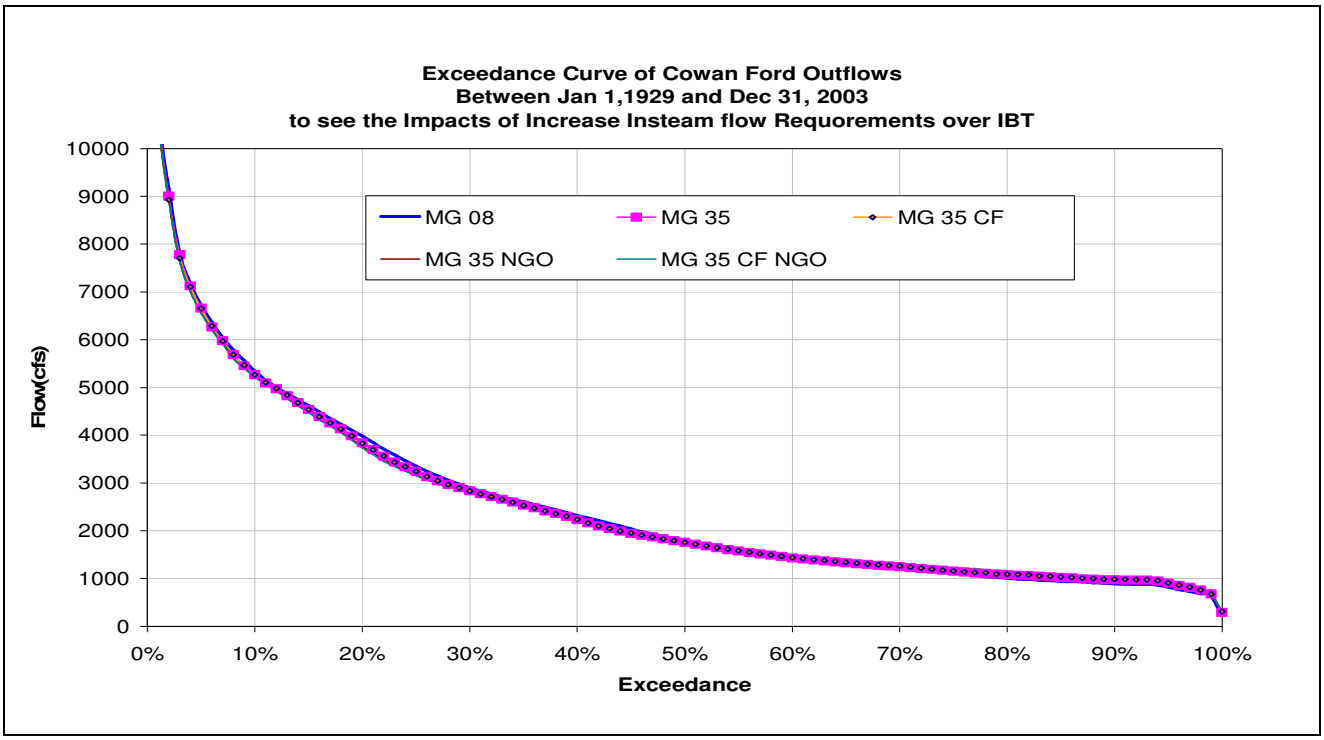

Figure 26: Outflow Duration plot of CF for Impacts of Increased Instream Flow Requirement with IBT

6) Mountain Island

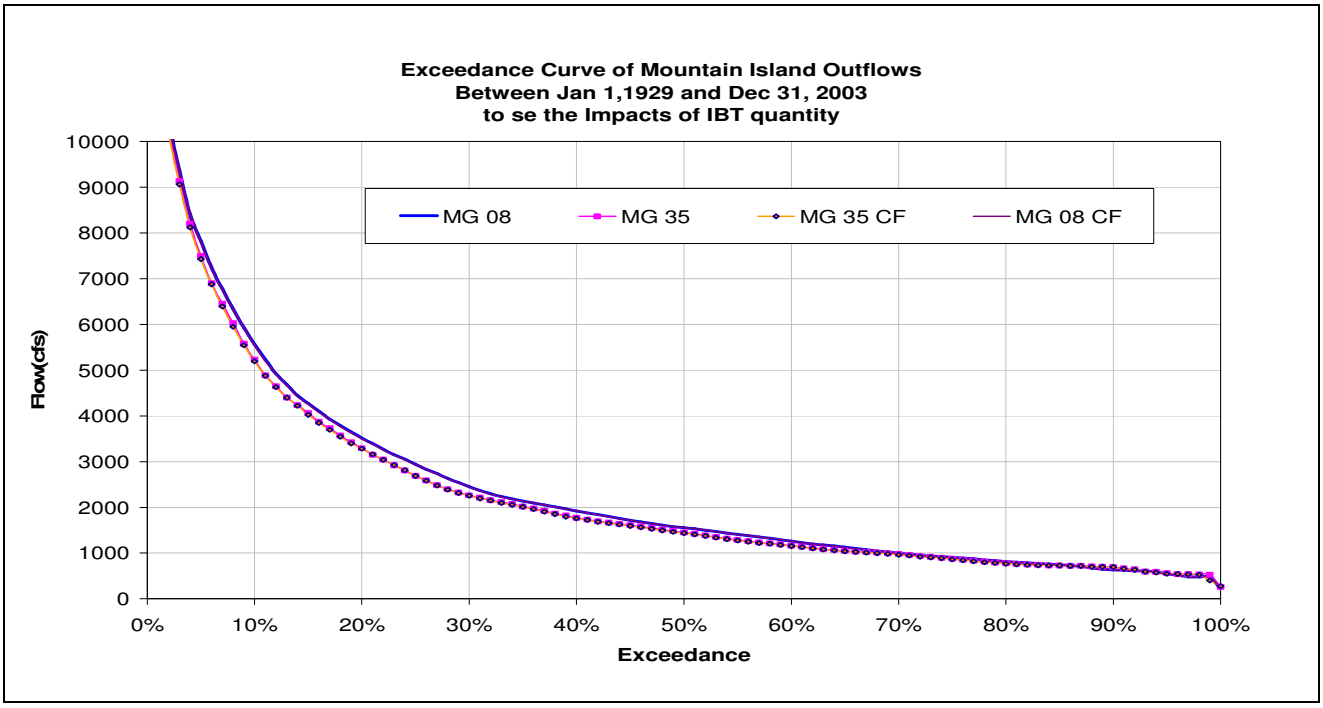

Figure 27: Outflow Duration plot of MI for Impacts of IBT Quantity

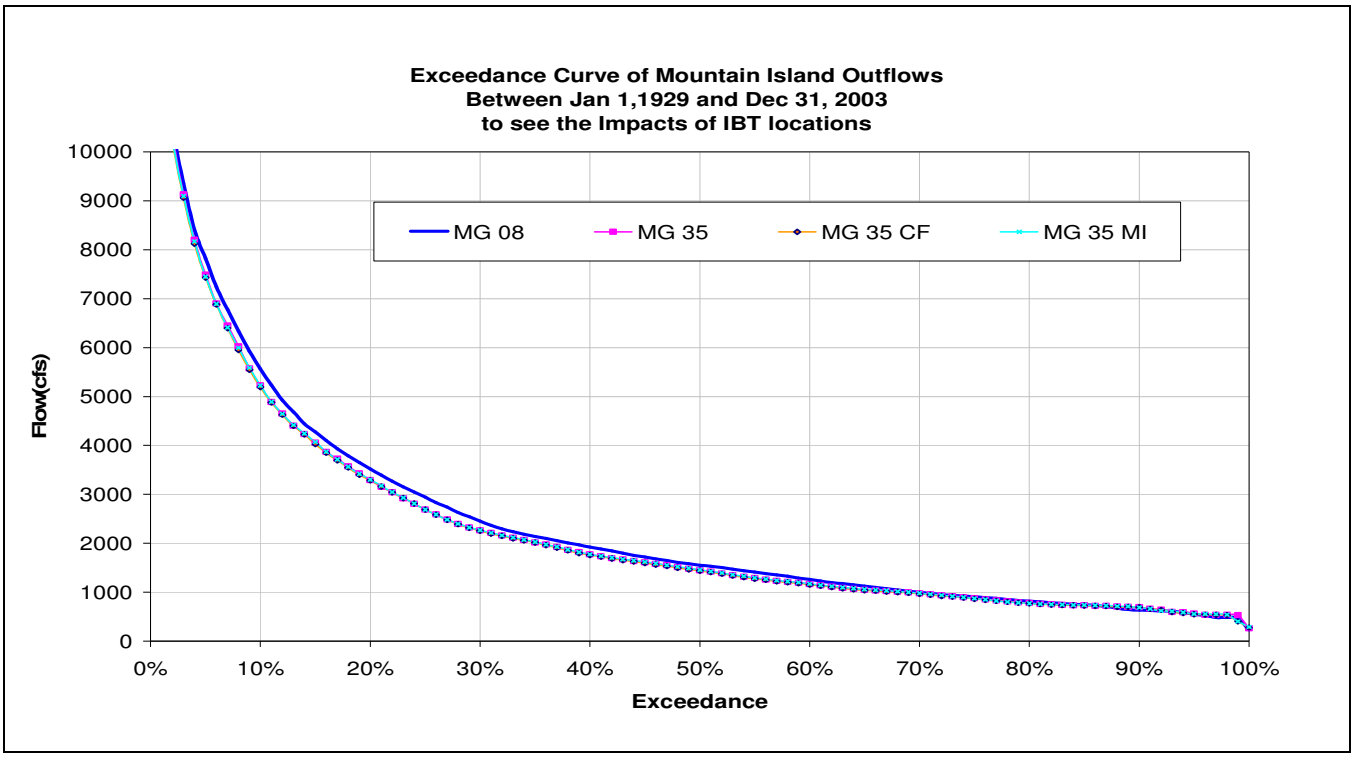

Figure 28: Outflow Duration plot of MI for Impacts of IBT Locations

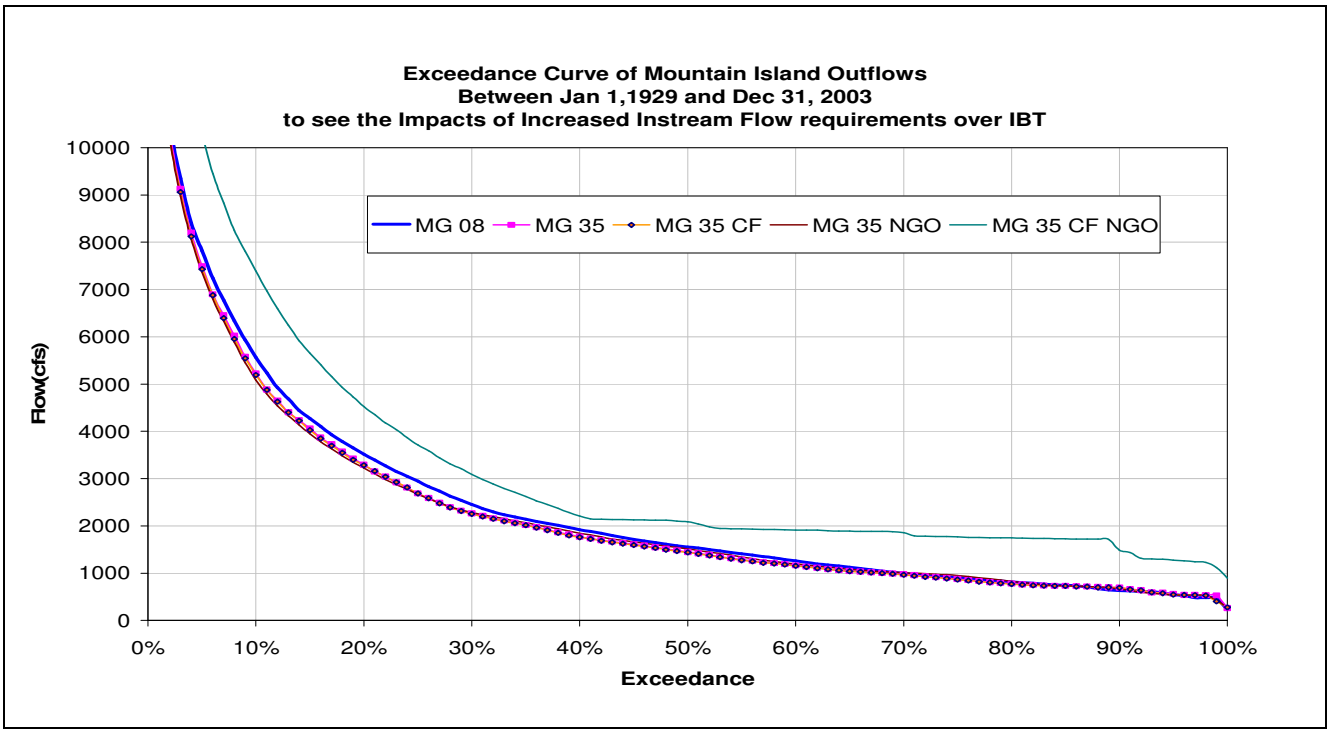

Figure 29: Outflow Duration plot of MI for Impacts of Increased Instream Flow Requirement with IBT

7) Wylie

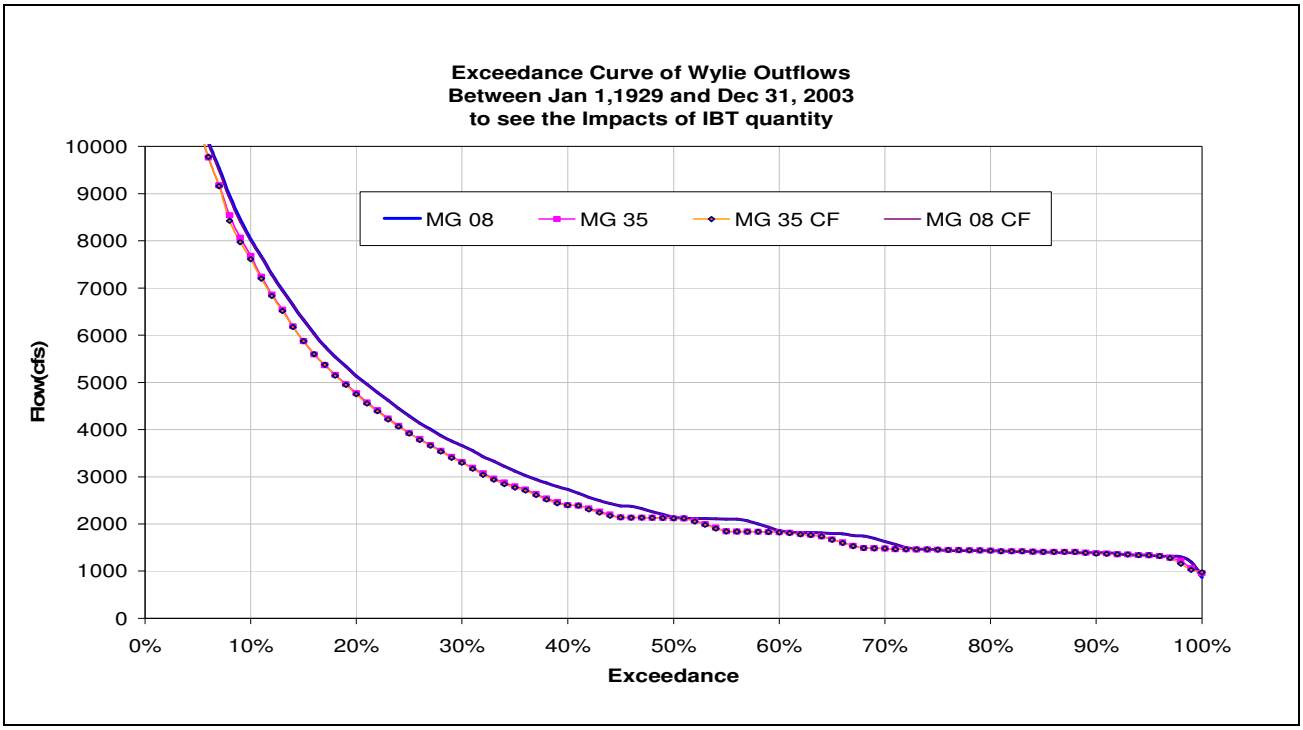

Figure 30: Outflow Duration plot of WY for Impacts of IBT Quantity

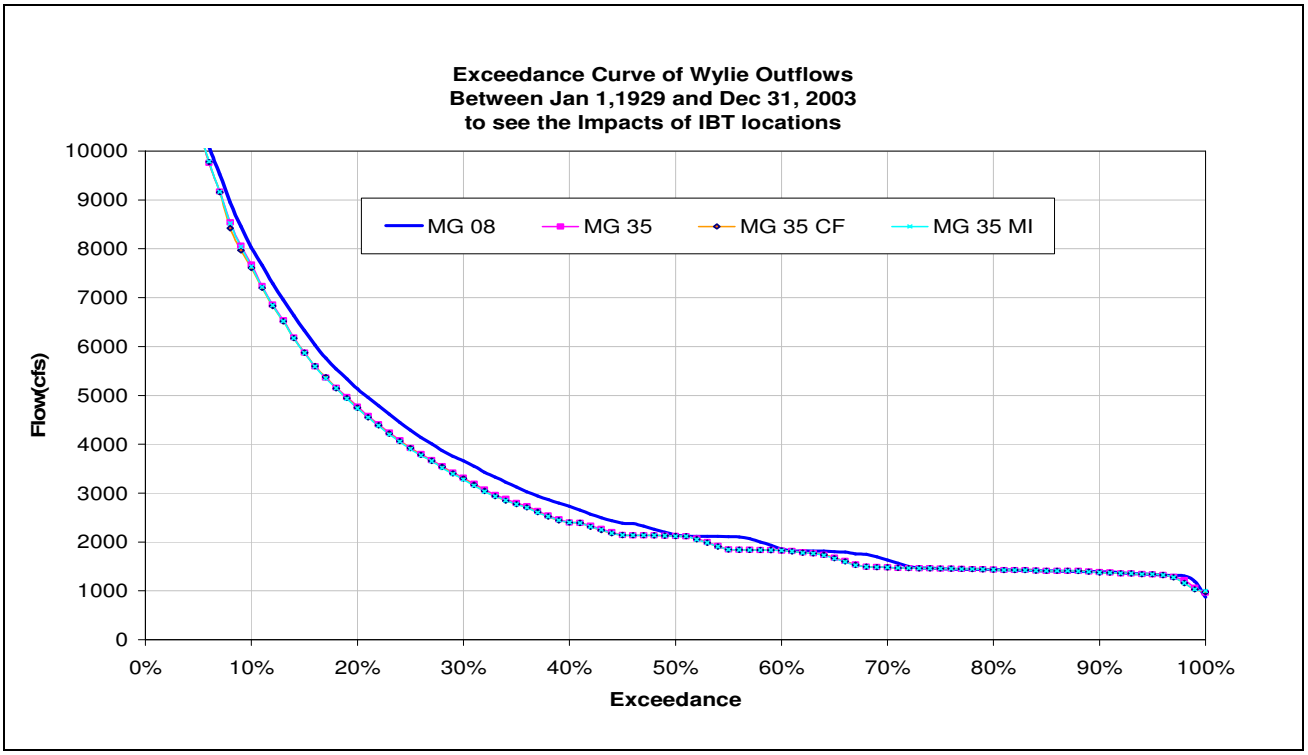

Figure 31: Outflow Duration plot of WY for Impacts of IBT Locations

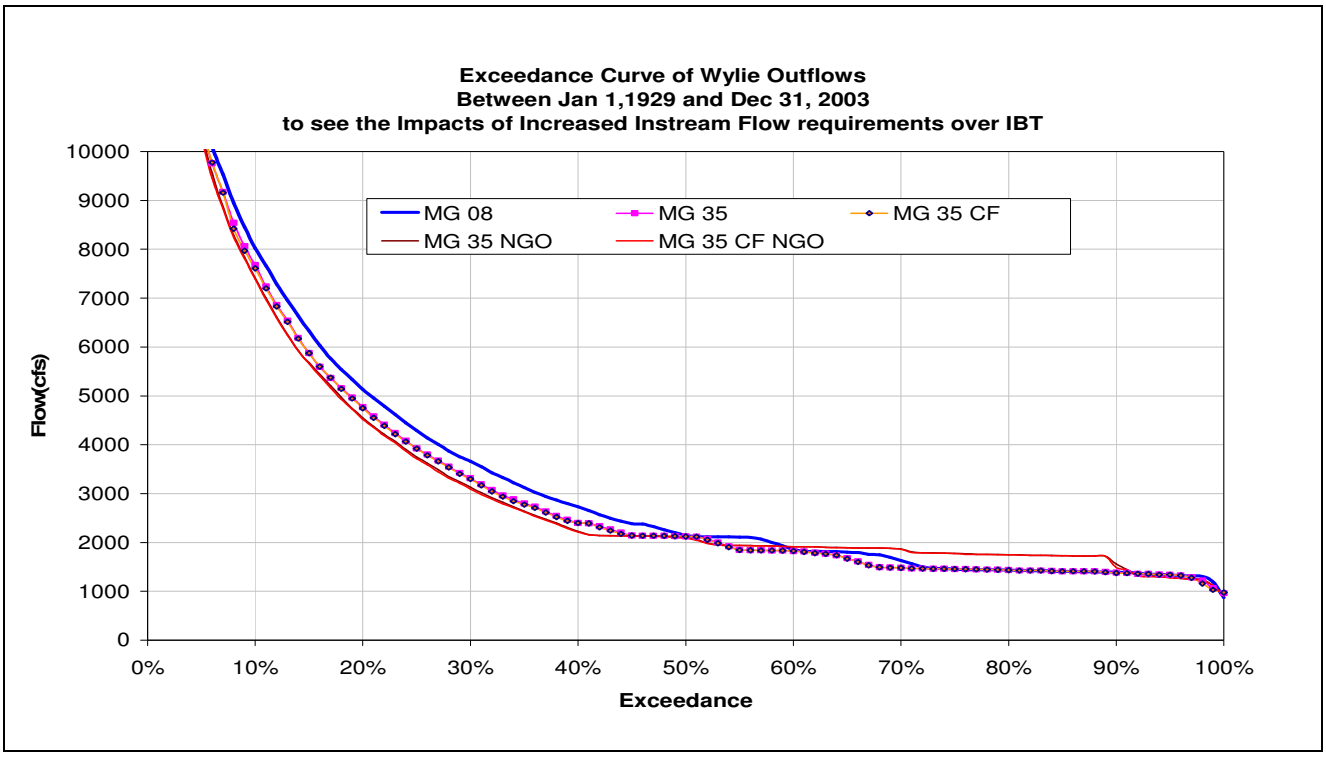

Figure 32: Outflow Duration plot of WY for Impacts of Increased Instream Flow Requirement with IBT

8) Fishing Creek

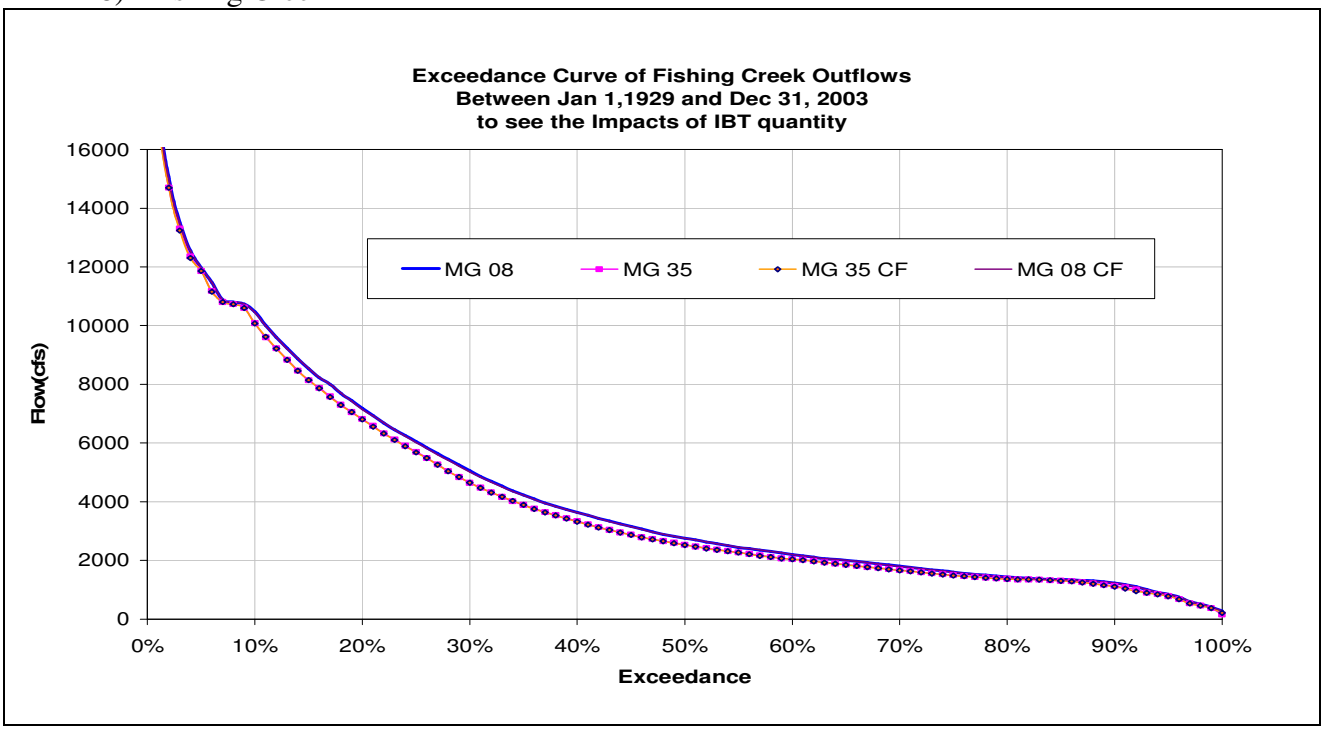

Figure 33: Outflow Duration plot of FC for Impacts of IBT Quantity

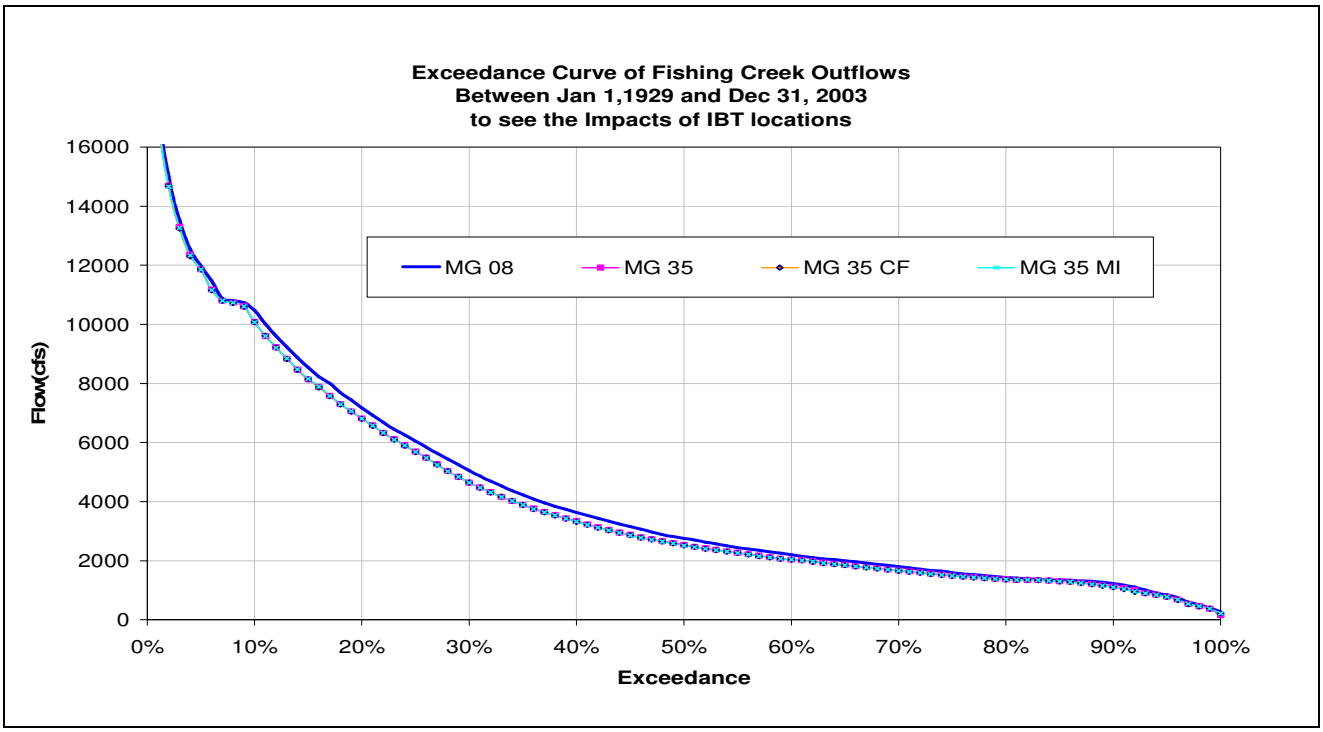

Figure 34: Outflow Duration plot of FC for Impacts of IBT Locations

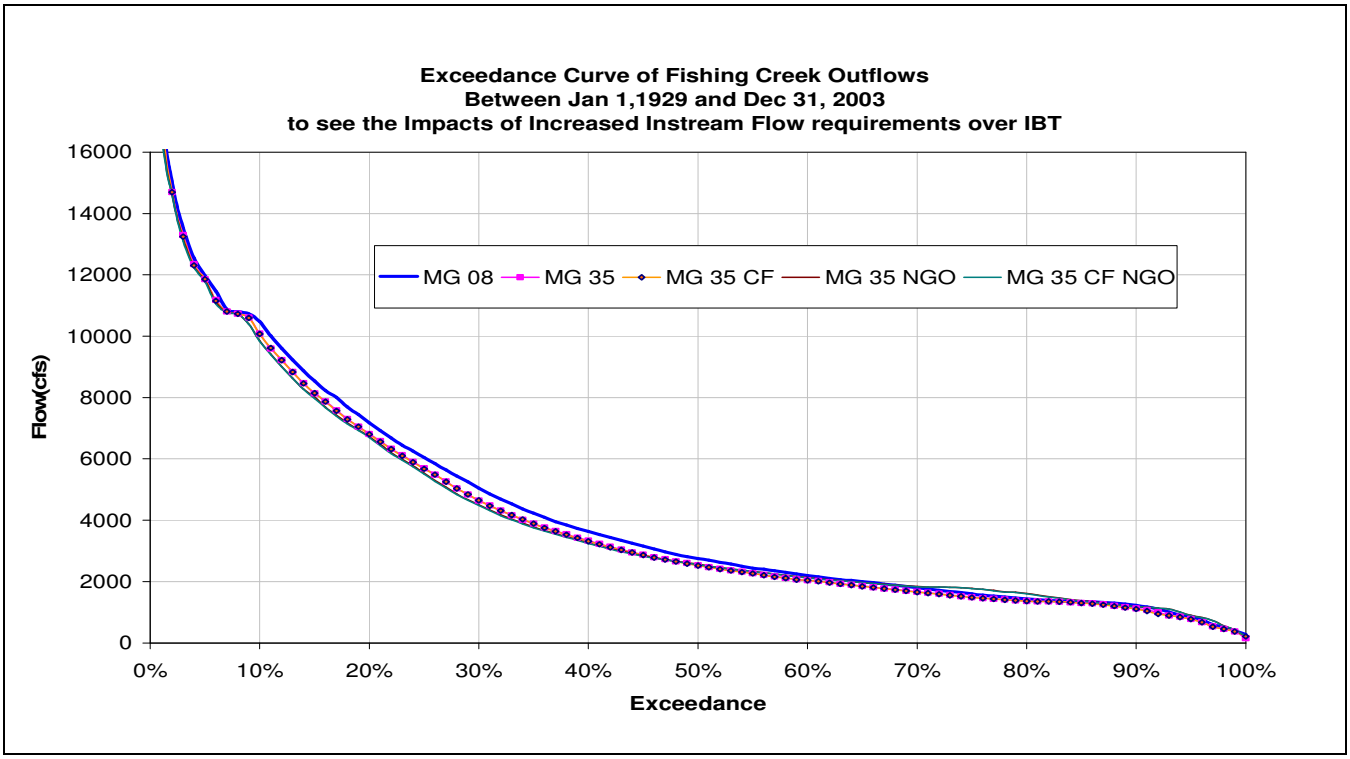

Figure 35: Outflow Duration plot of FC for Impacts of Increased Instream Flow Requirement with IBT

9) Great Falls

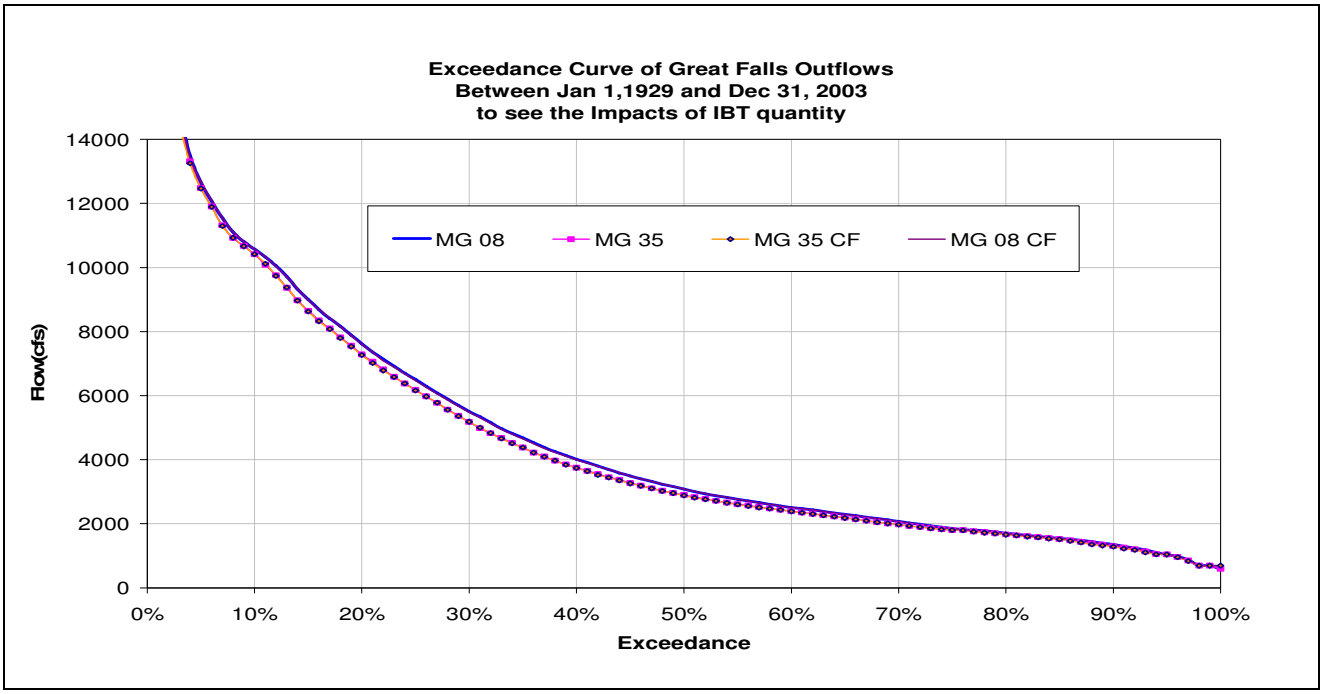

Figure 36: Outflow Duration plot of GF for Impacts of IBT Quantity

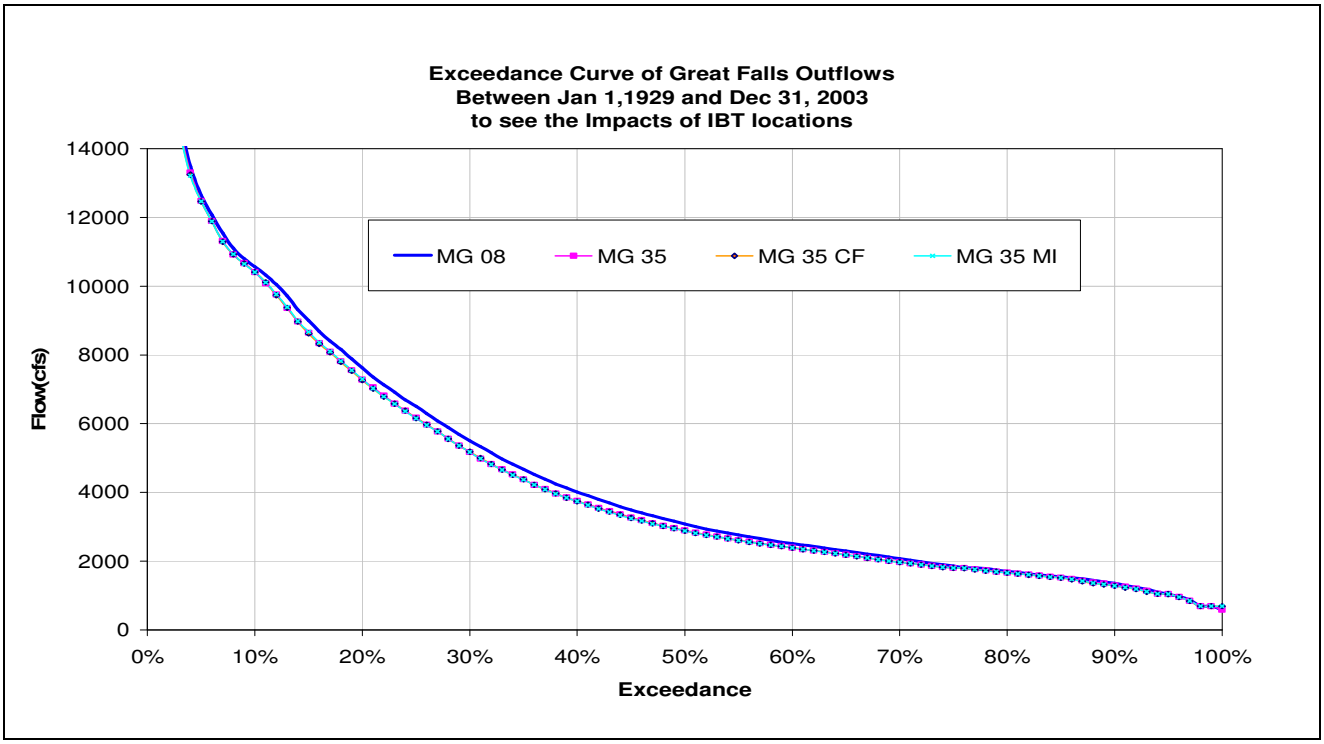

Figure 37: Outflow Duration plot of GF for Impacts of IBT Locations

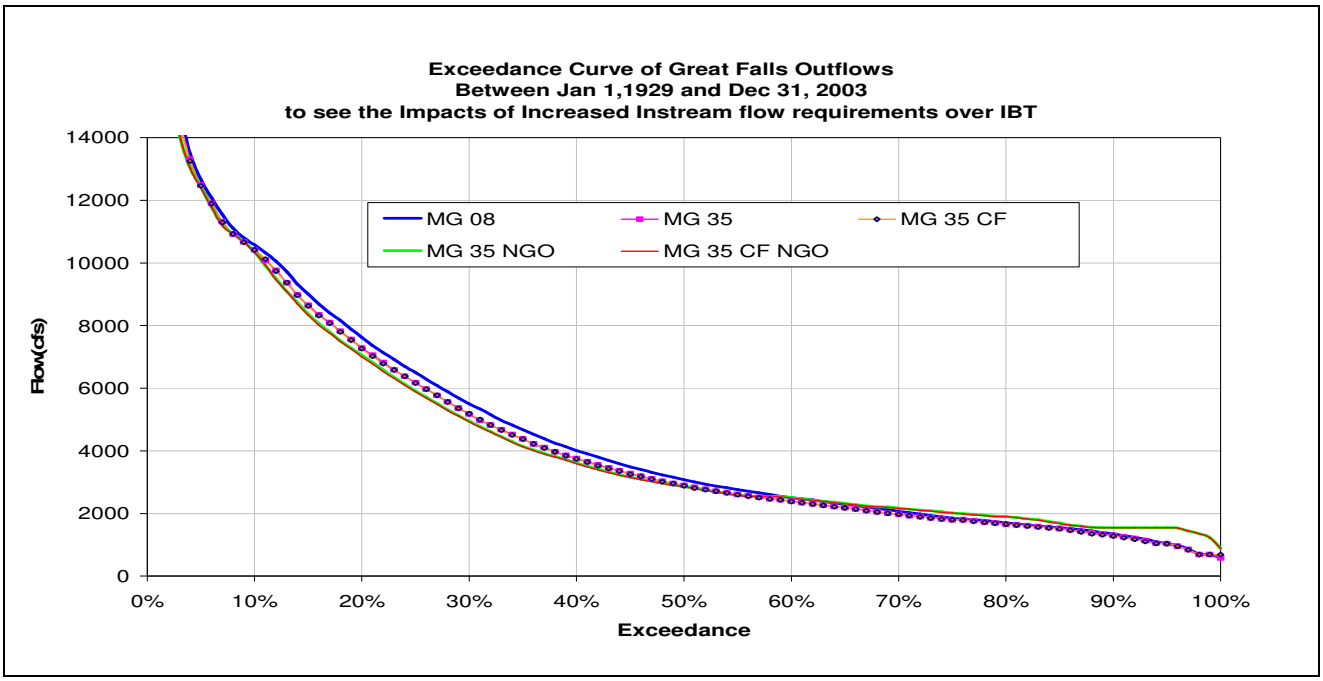

Figure 38: Outflow Duration plot of GF for Impacts of Increased Instream Flow Requirement with IBT

10) Rocky Creek

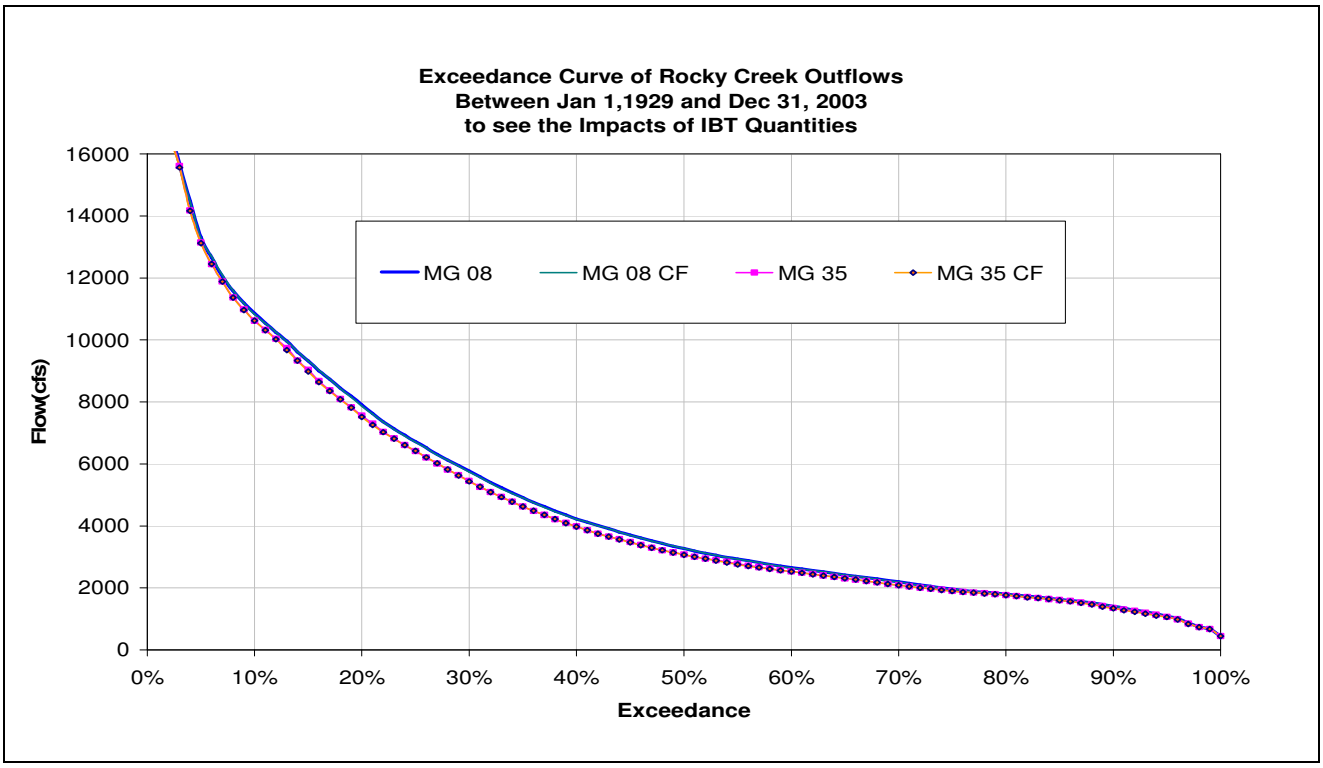

Figure 39: Outflow Duration plot of RC for Impacts of IBT Quantity

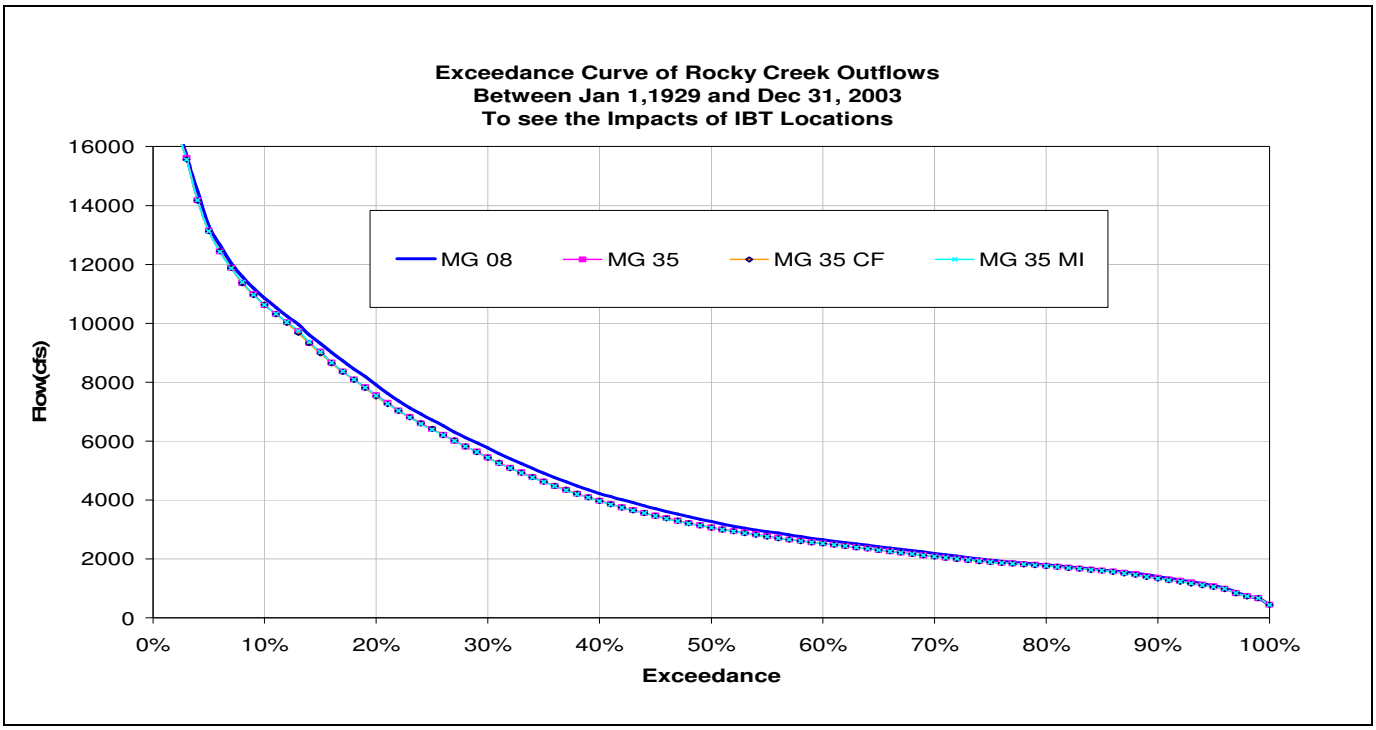

Figure 40: Outflow Duration plot of RC for Impacts of IBT Locations

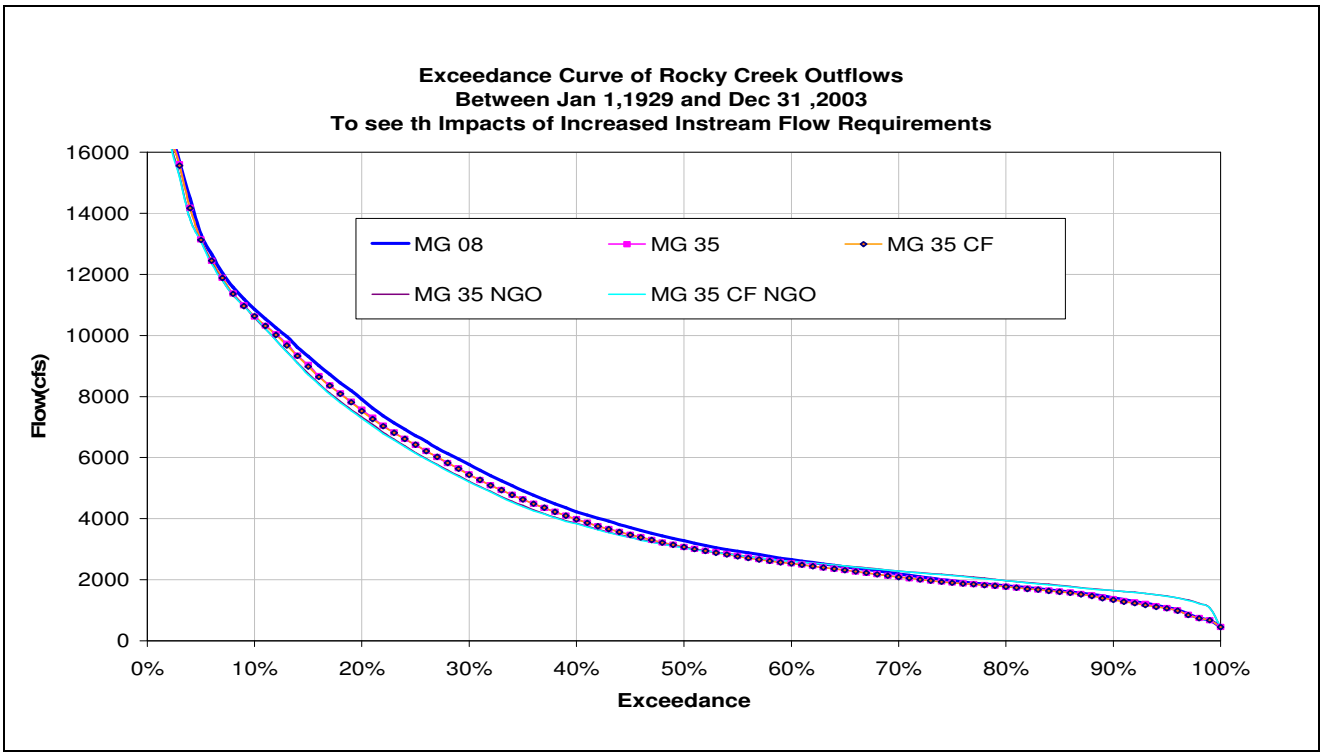

Figure 41: Outflow Duration plot of RC for Impacts of Increased Instream Flow Requirement with IBT

11) Wateree

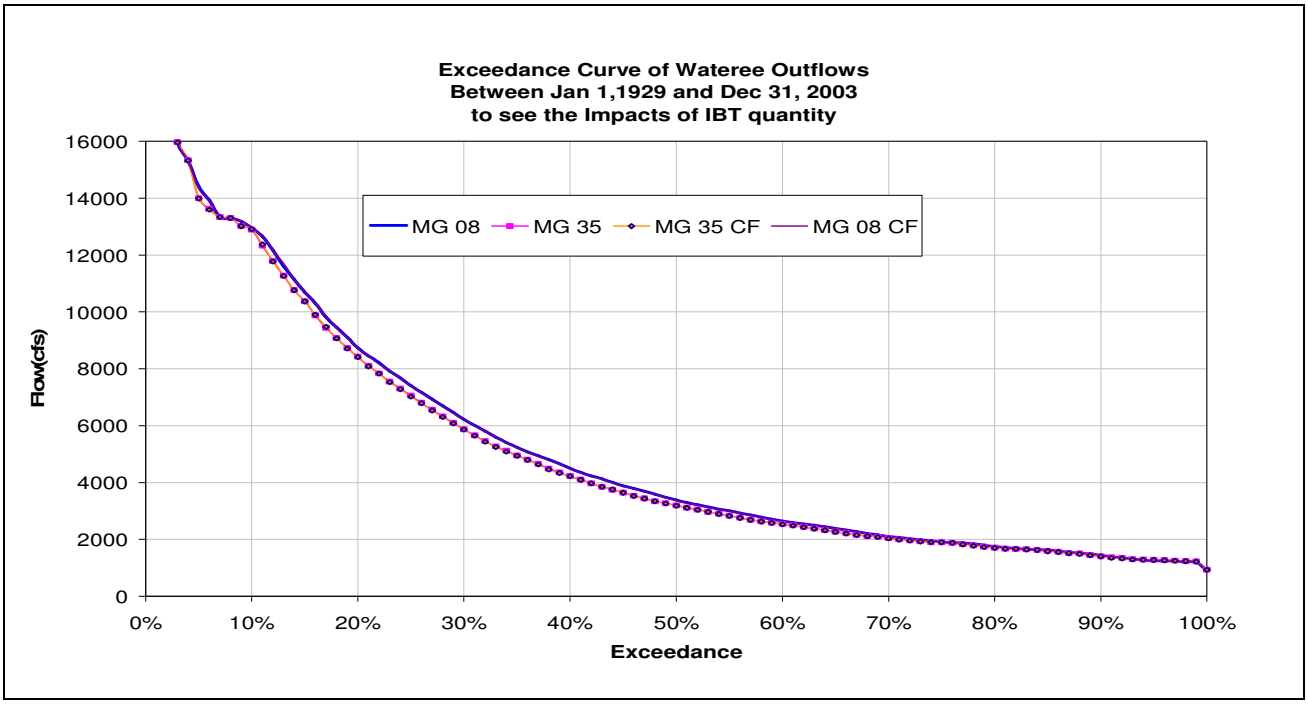

Figure 42: Outflow Duration plot of WA for Impacts of IBT Quantity

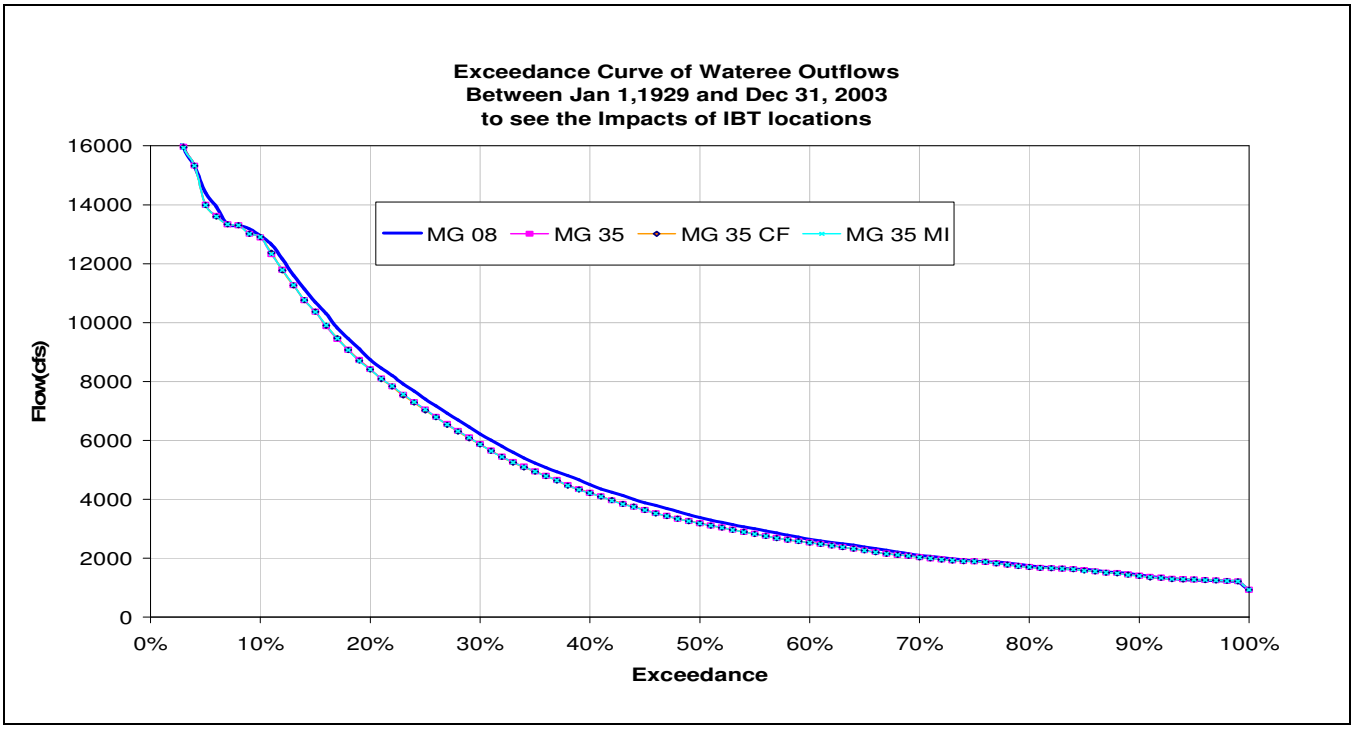

Figure 43: Outflow Duration plot of WA for Impacts of IBT Locations

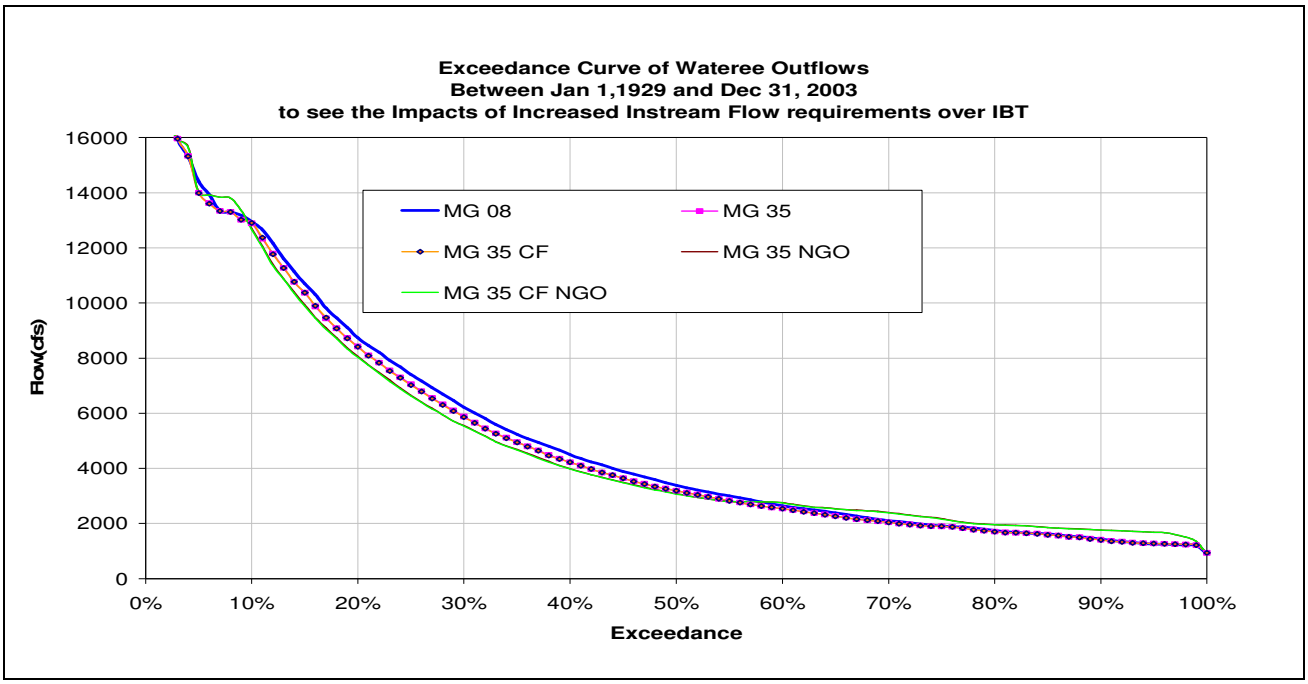

Figure 44: Outflow Duration plot of WA for Impacts of Increased Instream Flow Requirement with IBT

4. Annual Duration of Elevations at

1) Bridgewater

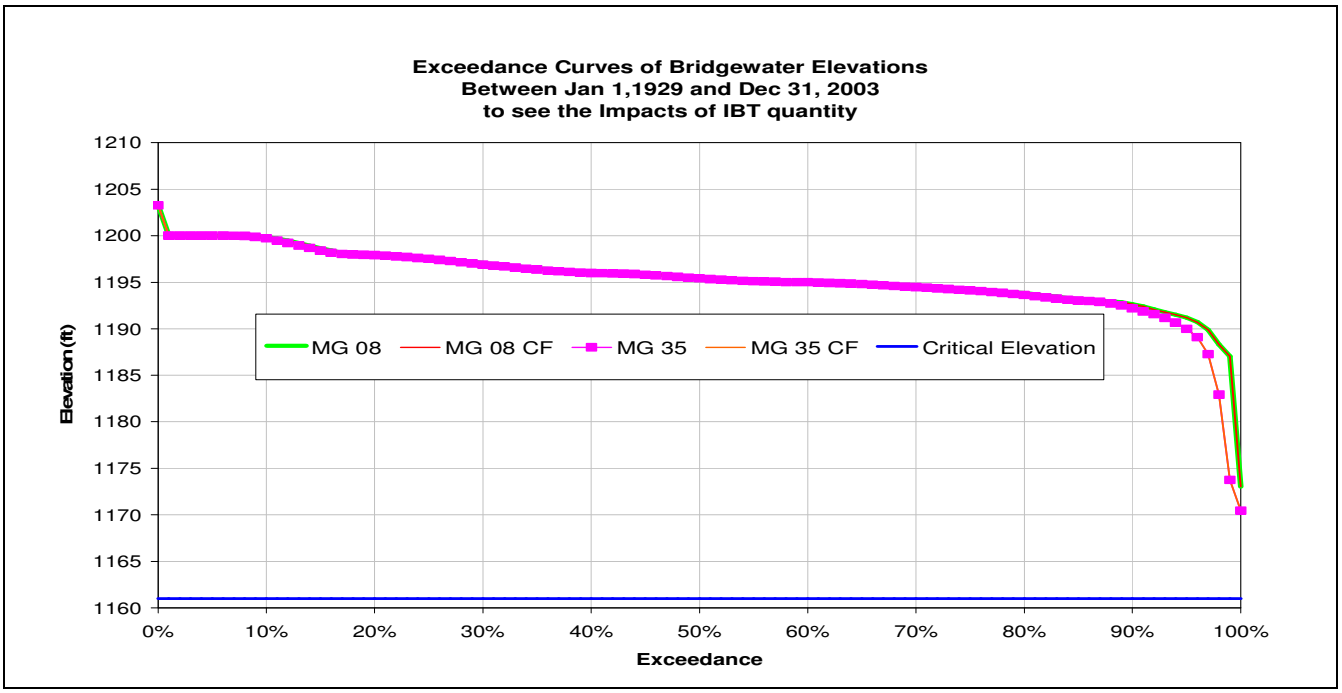

Figure 45: Elevation Duration plot of BW for Impacts of IBT Quantity

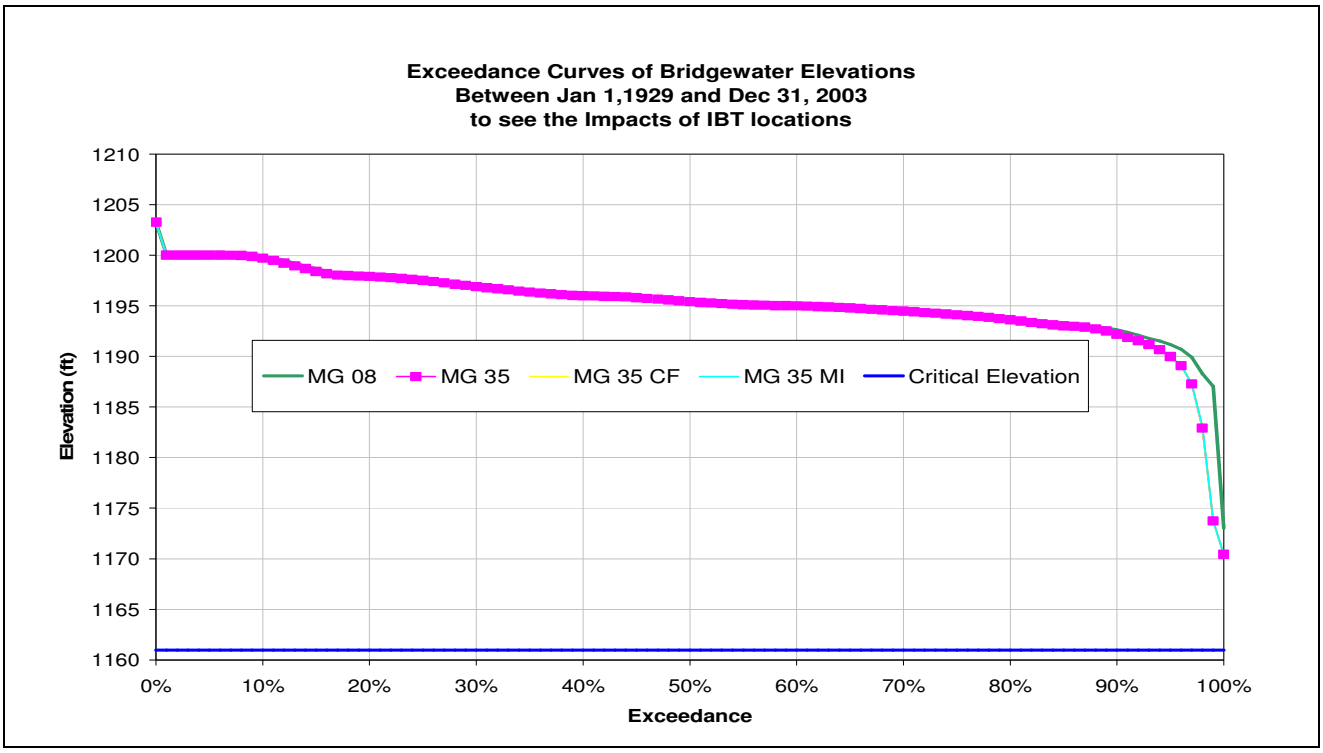

Figure 46: Elevation Duration plot of BW for Impacts of IBT Locations

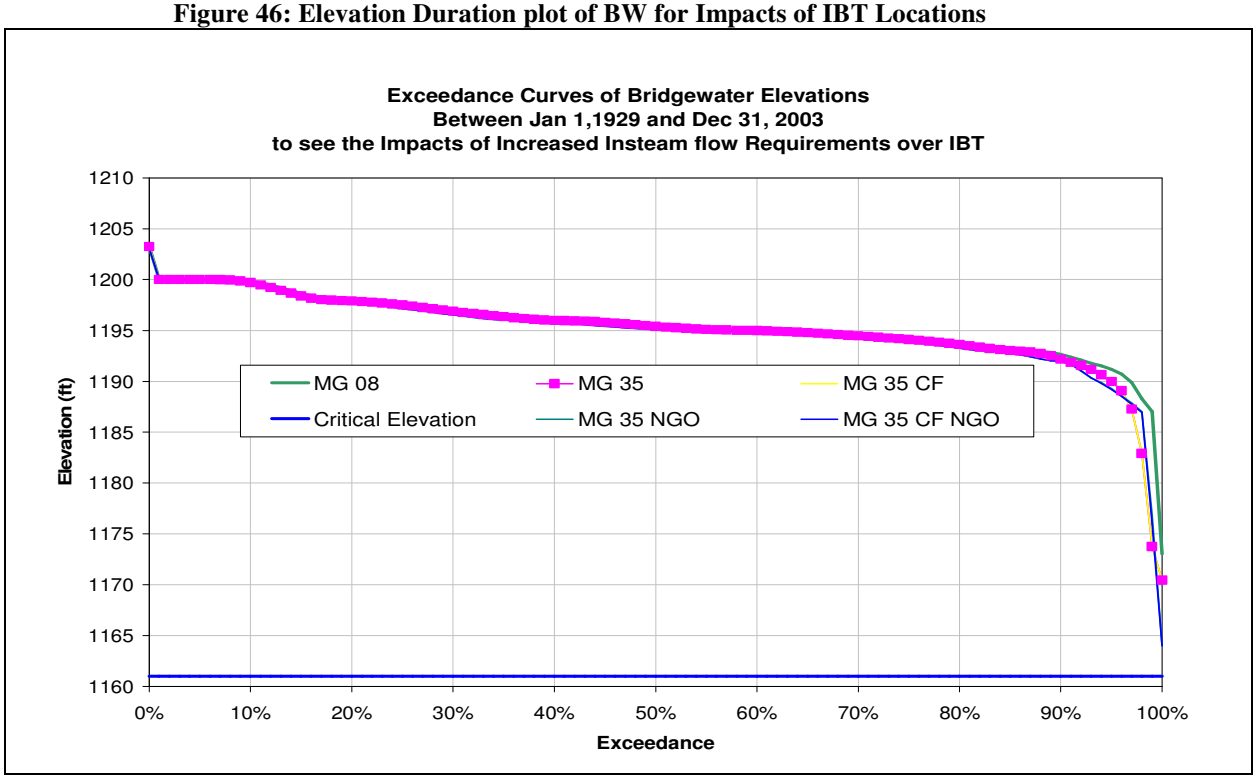

Figure 47: Elevation Duration plot of BW for Impacts of Increased Instream Flow Requirement with IBT

2) Rhodhiss

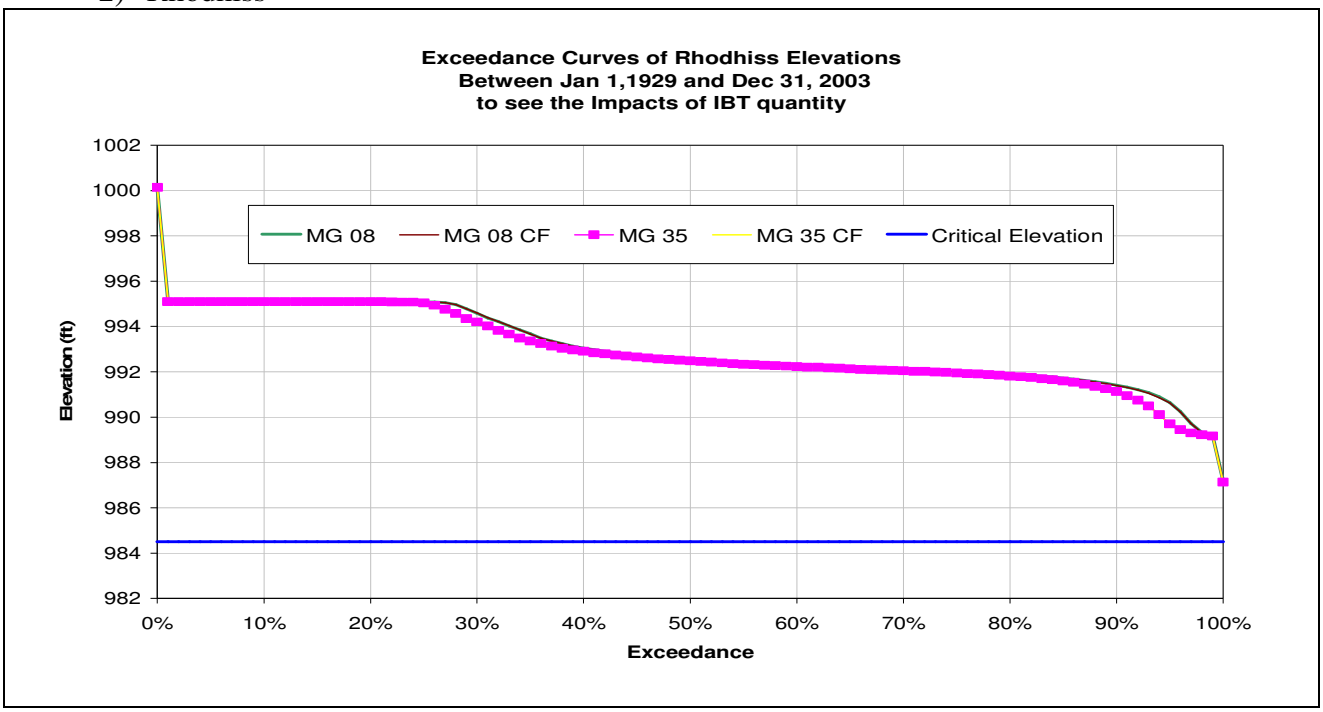

Figure 48: Elevation Duration plot of RH for Impacts of IBT Quantity

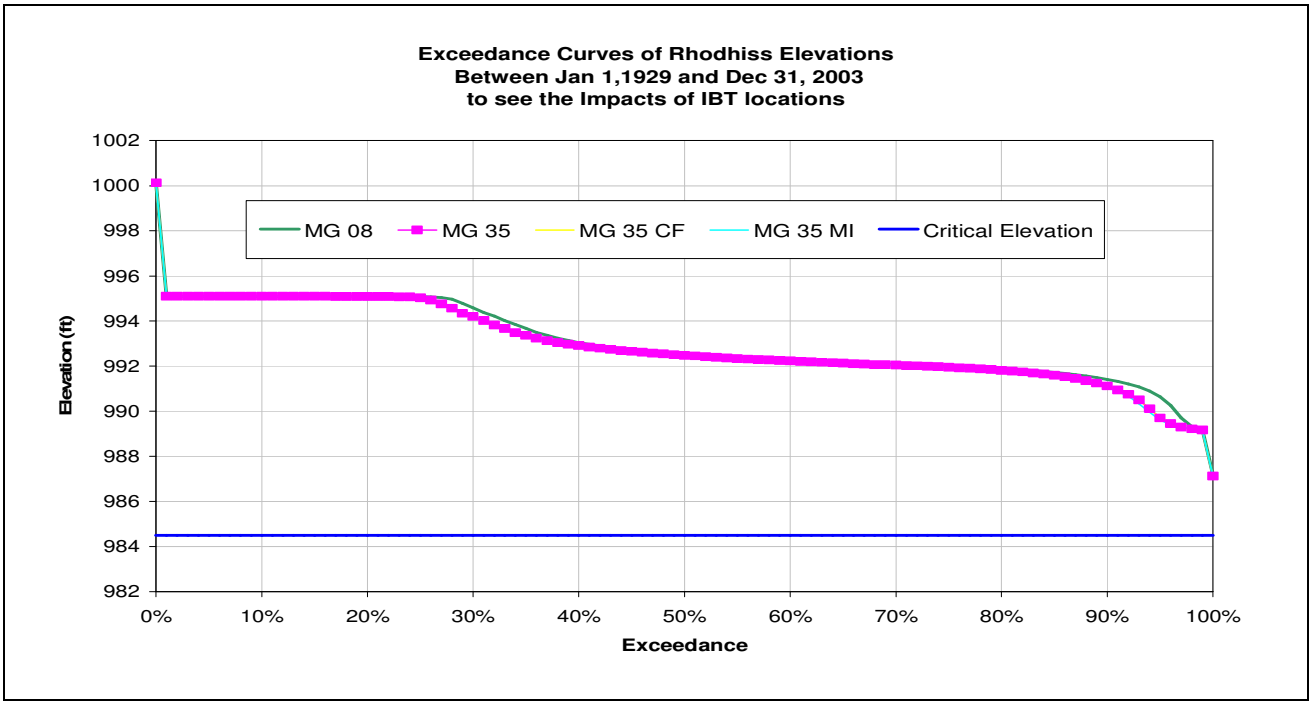

Figure 49: Elevation Duration plot of RH for Impacts of IBT Locations

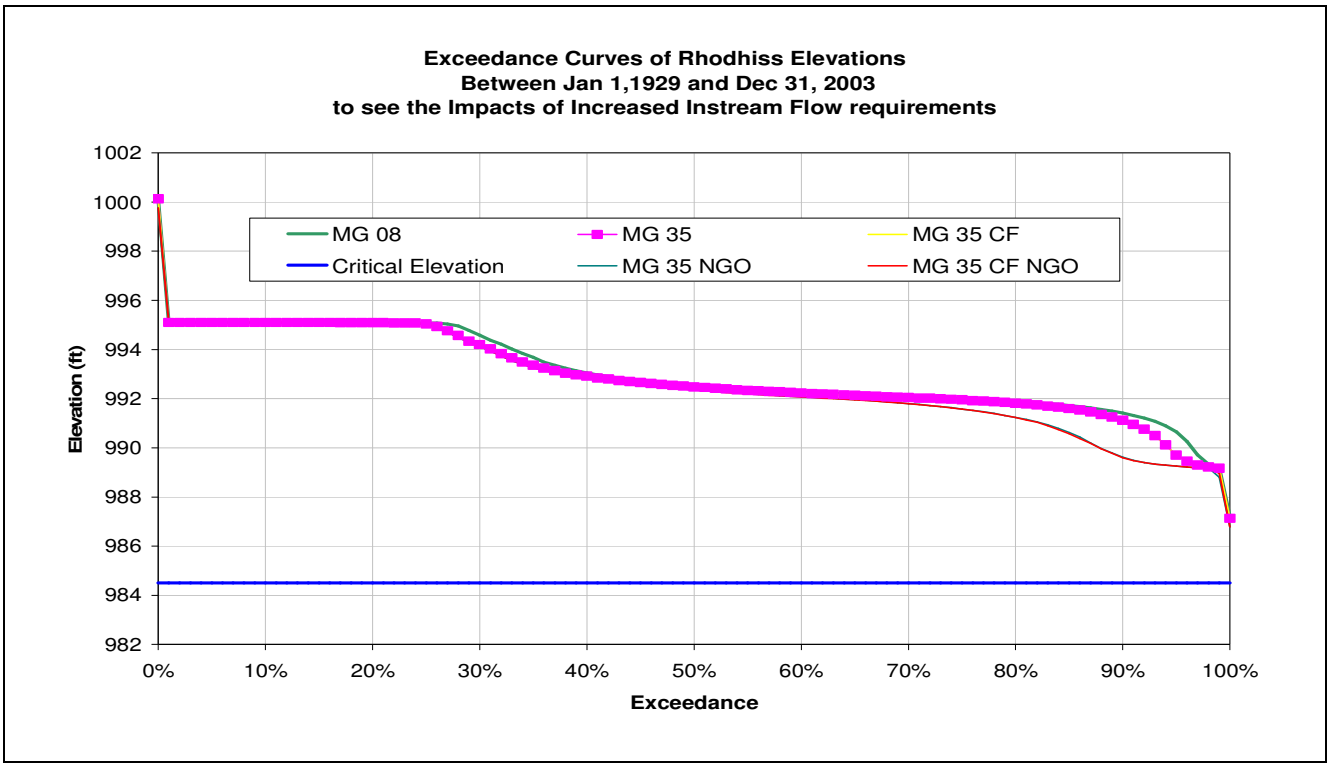

Figure 50: Elevation Duration plot of RH for Impacts of Increased Instream Flow Requirement with IBT

3) Oxford

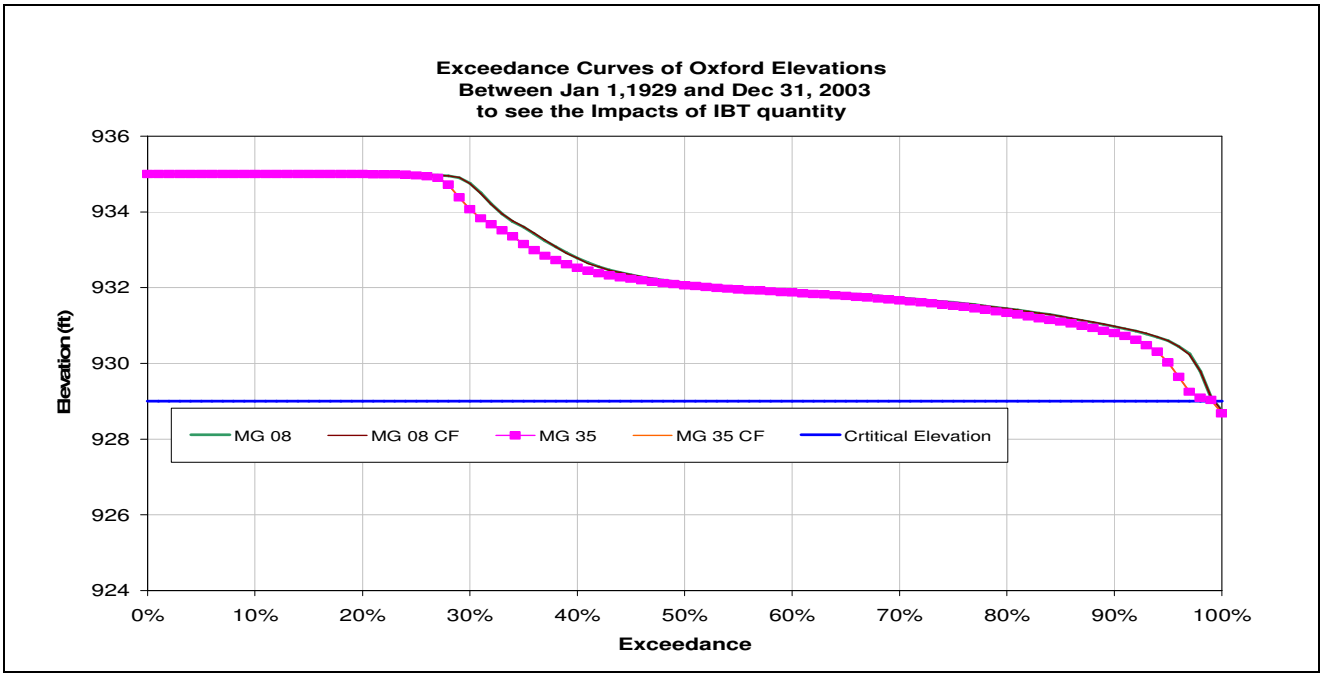

Figure 51: Elevation Duration plot of OX for Impacts of IBT Quantity

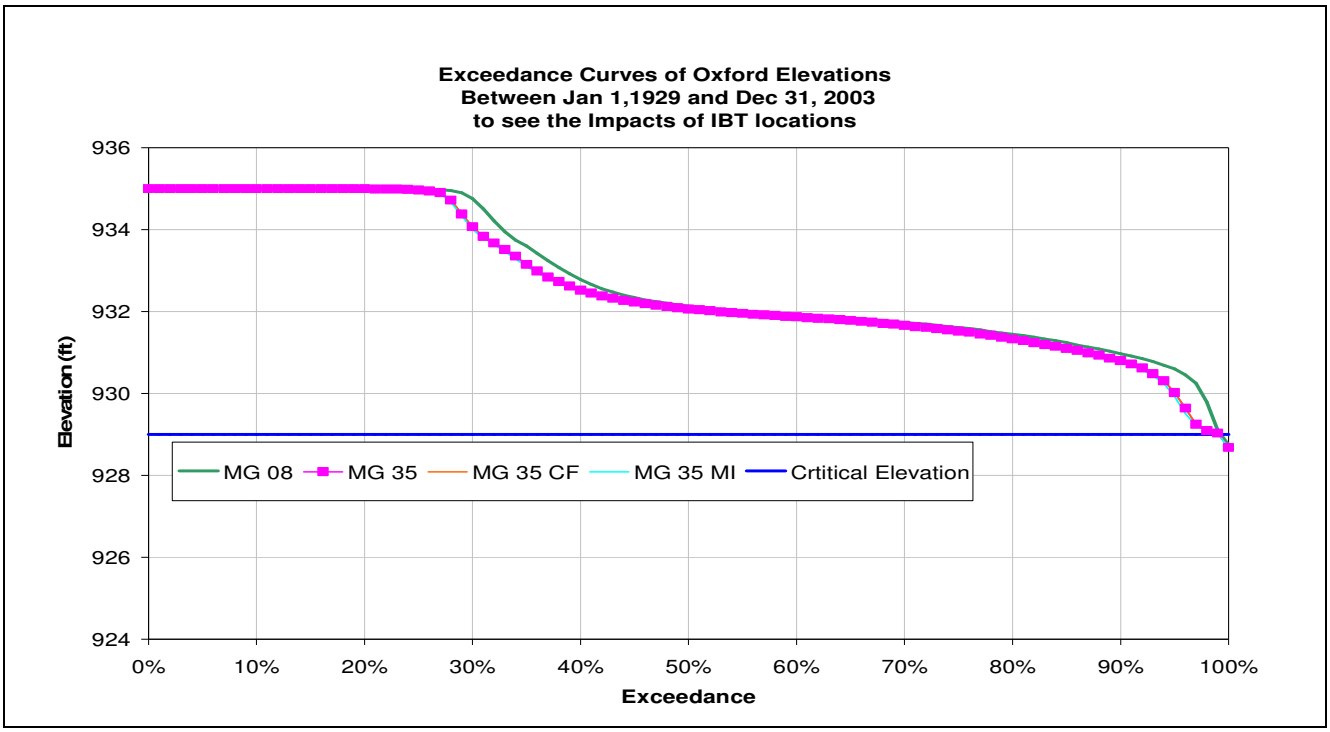

Figure 52: Elevation Duration plot of OX for Impacts of IBT Locations

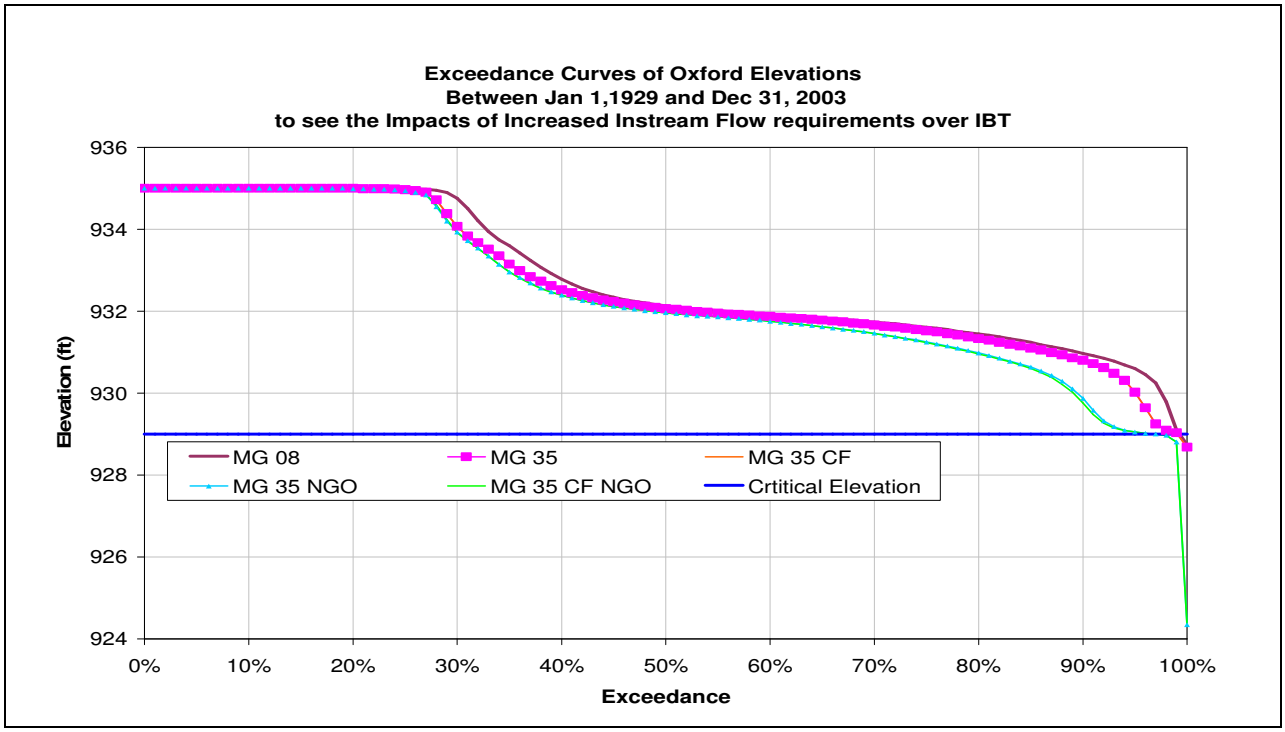

Figure 53: Elevation Duration plot of OX for Impacts of Increased Instream Flow Requirement with IBT

4) Lookout Shoals

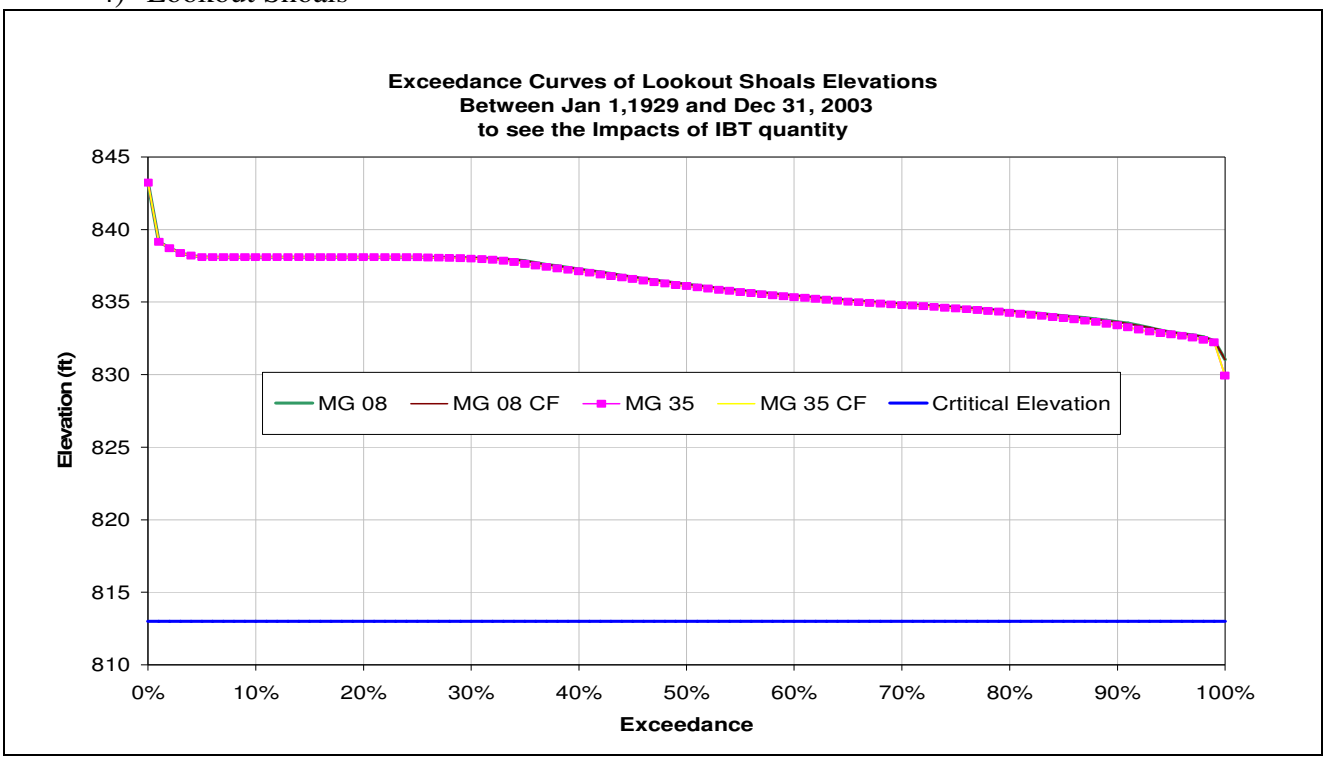

Figure 54: Elevation Duration plot of LS for Impacts of IBT Quantity

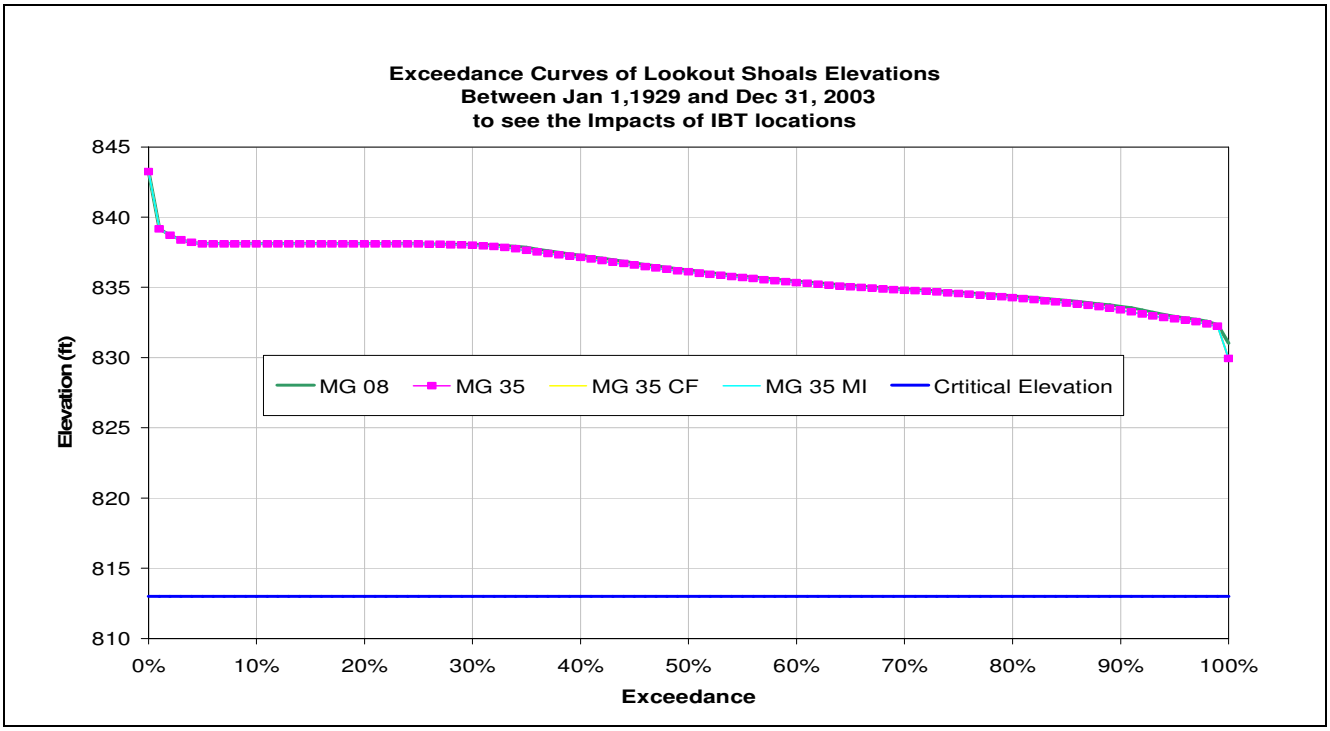

Figure 55: Elevation Duration plot of LS for Impacts of IBT Locations

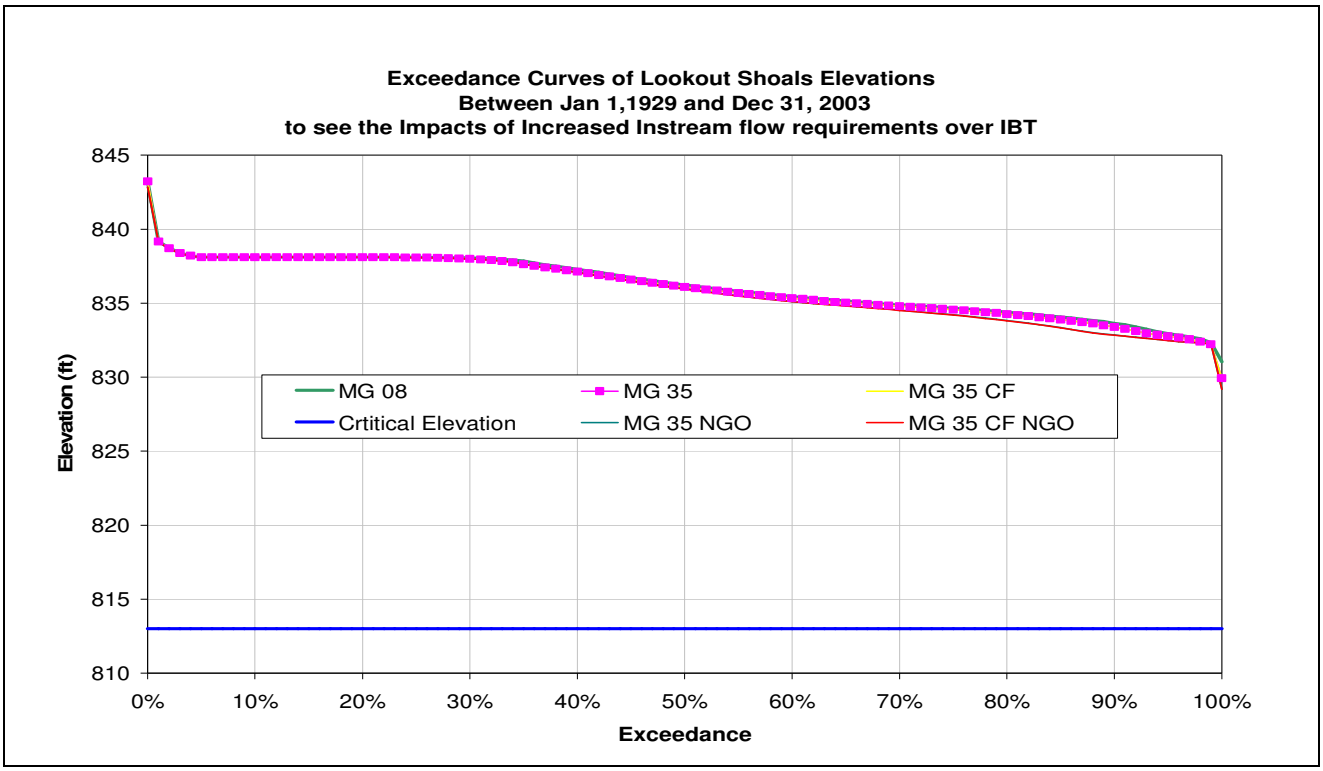

Figure 56: Elevation Duration plot of LS for Impacts of Increased Instream Flow Requirement with IBT

5) Cowan Ford

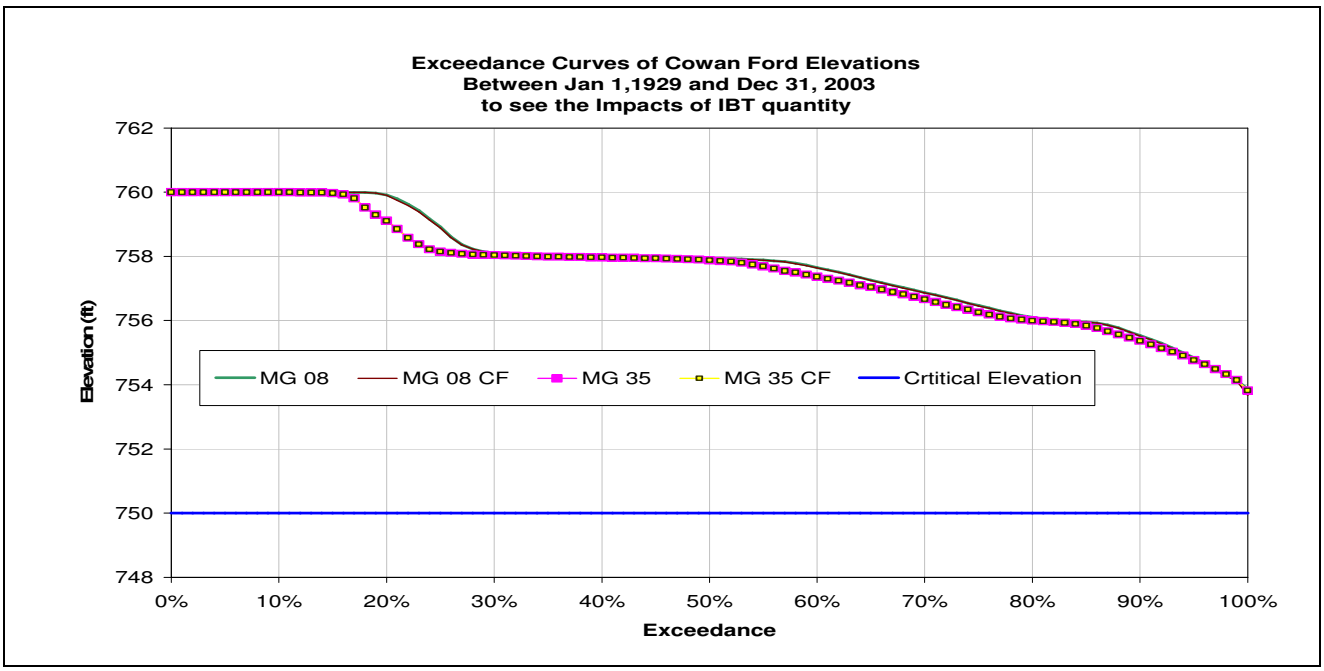

Figure 57: Elevation Duration plot of CF for Impacts of IBT Quantity

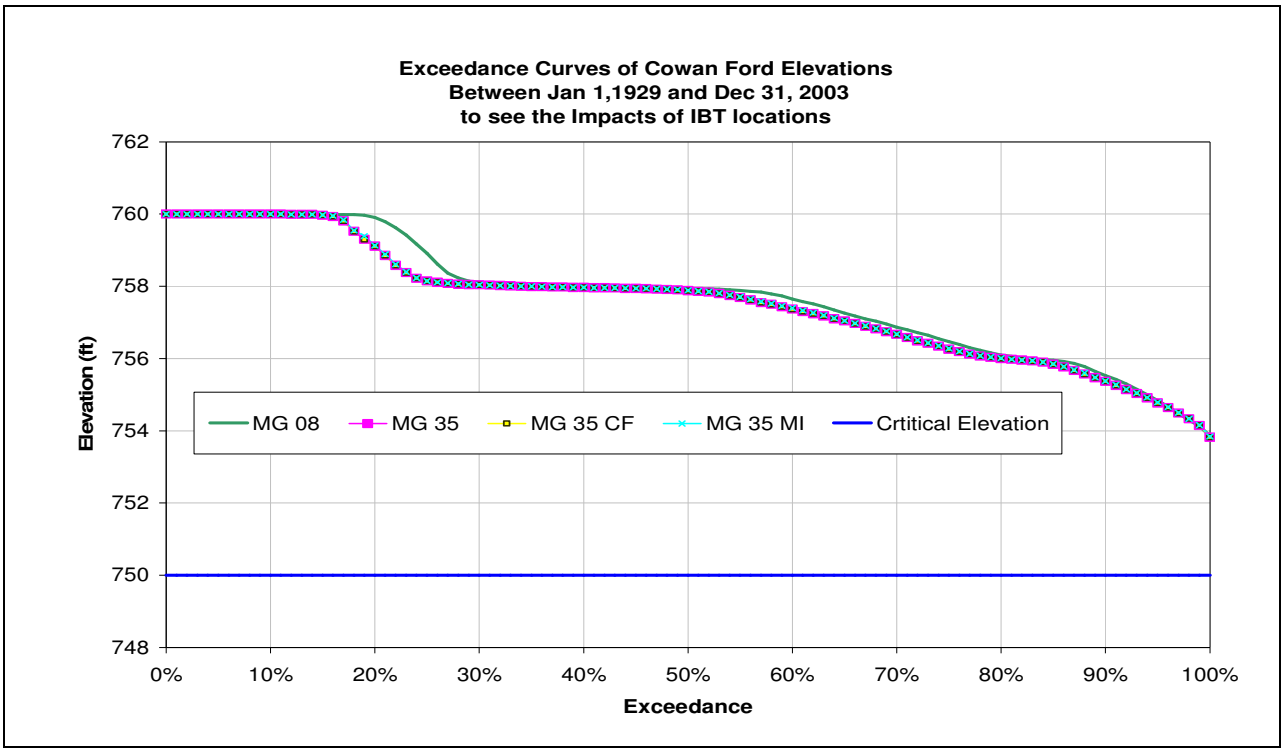

Figure 58: Elevation Duration plot of CF for Impacts of IBT Locations

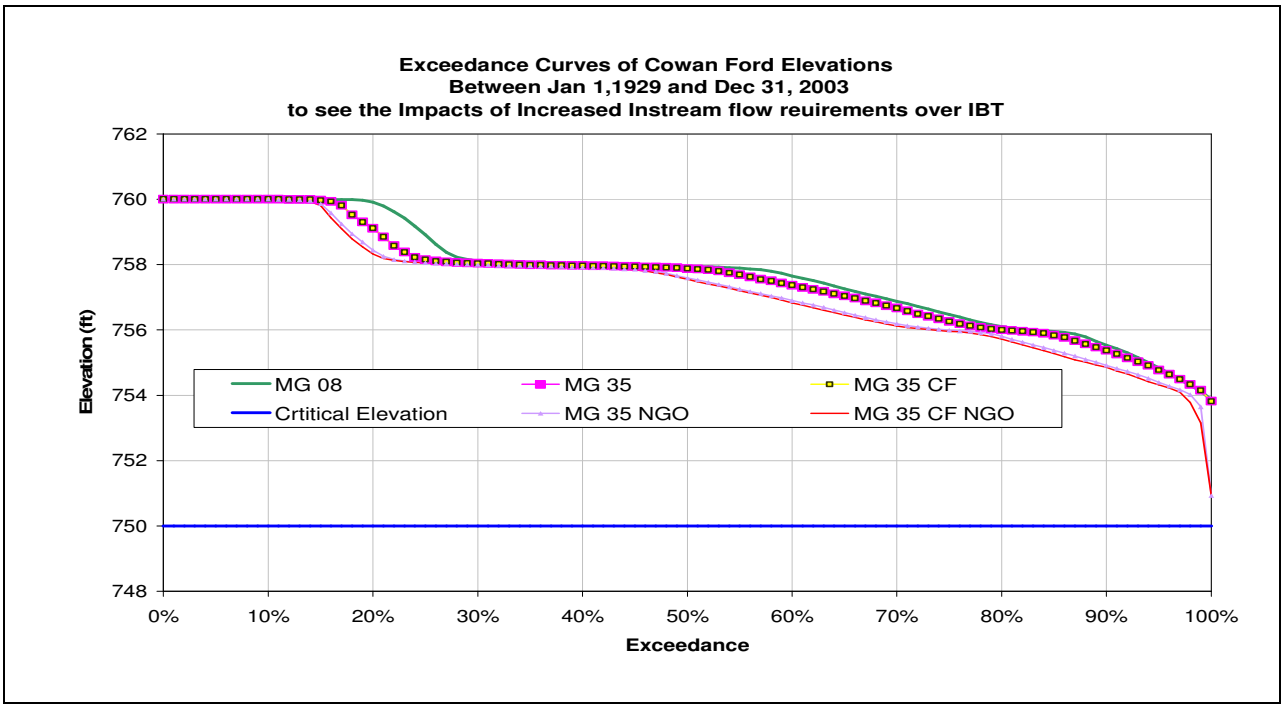

Figure 59: Elevation Duration plot of CF for Impacts of Increased Instream Flow Requirement with IBT

6) Mountain Island

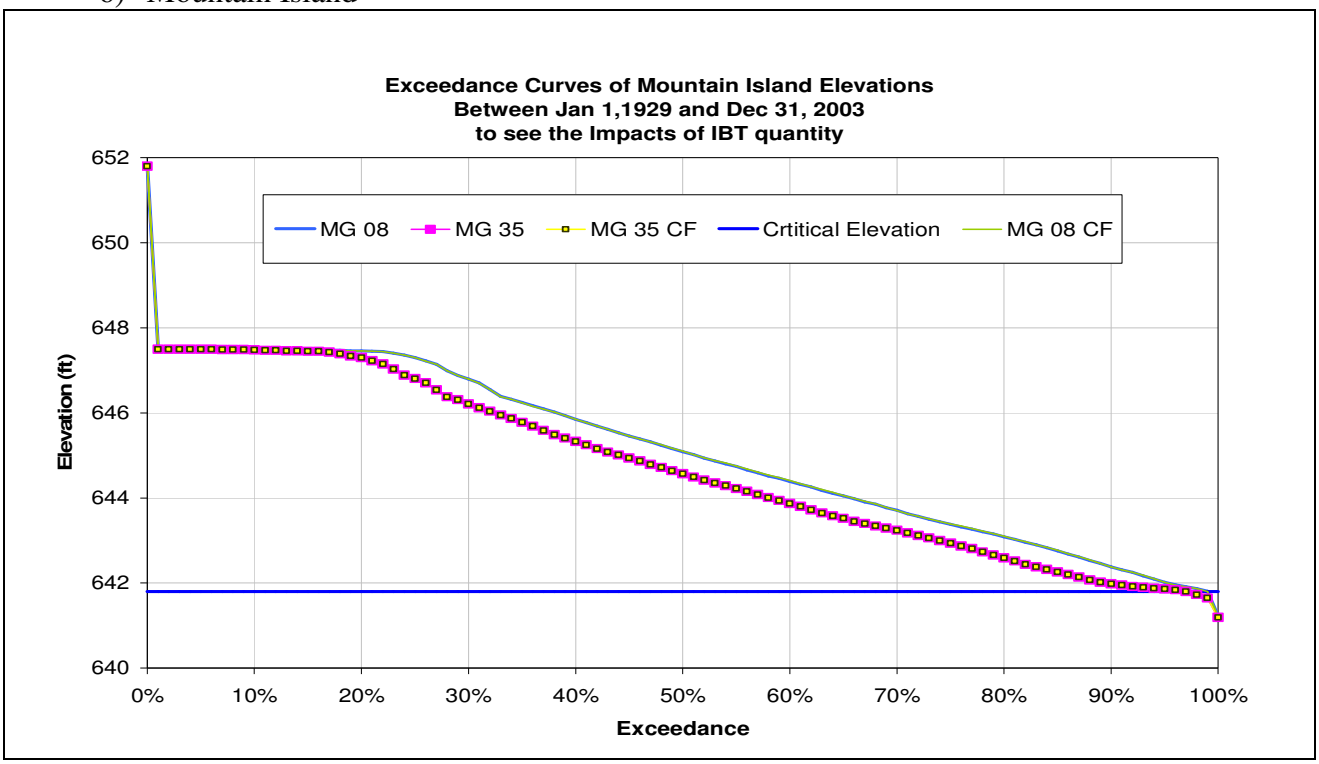

Figure 60: Elevation Duration plot of MI for Impacts of IBT Quantity

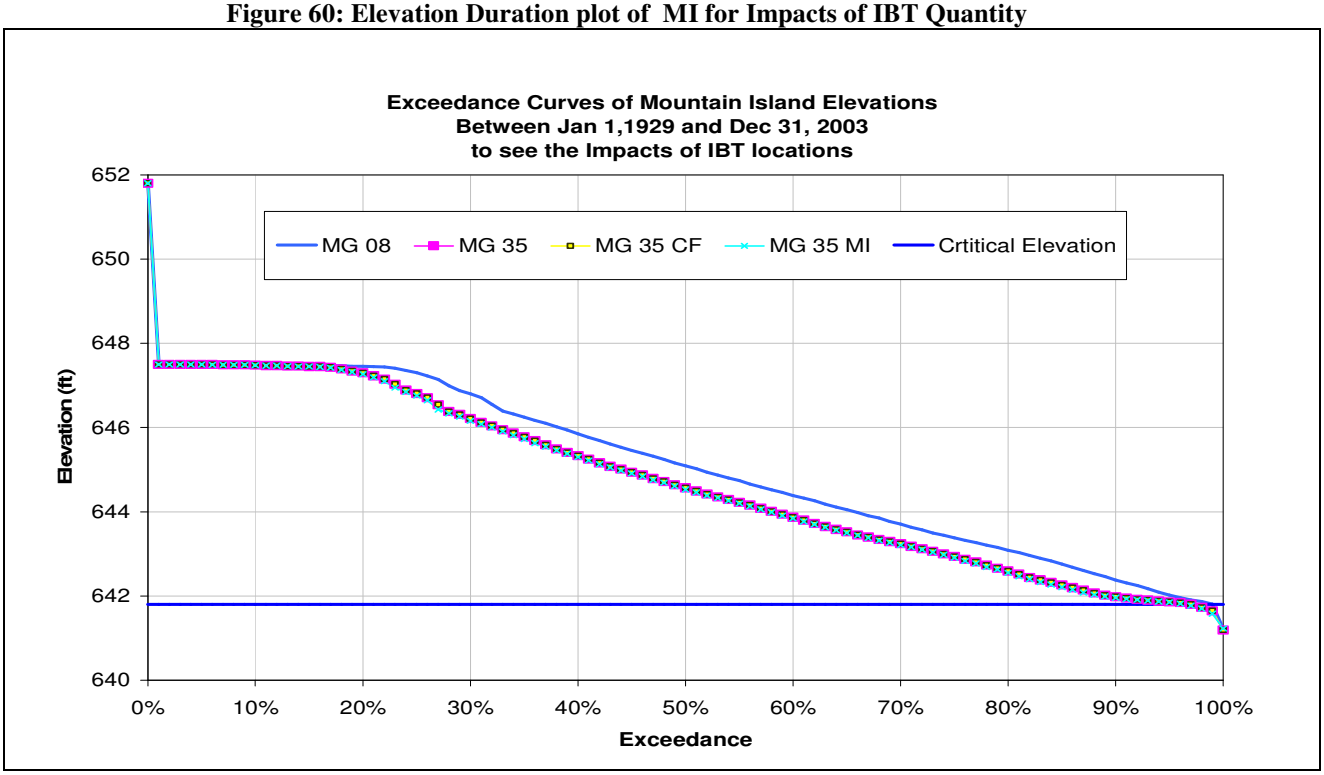

Figure 61: Elevation Duration plot of MI for Impacts of IBT Locations

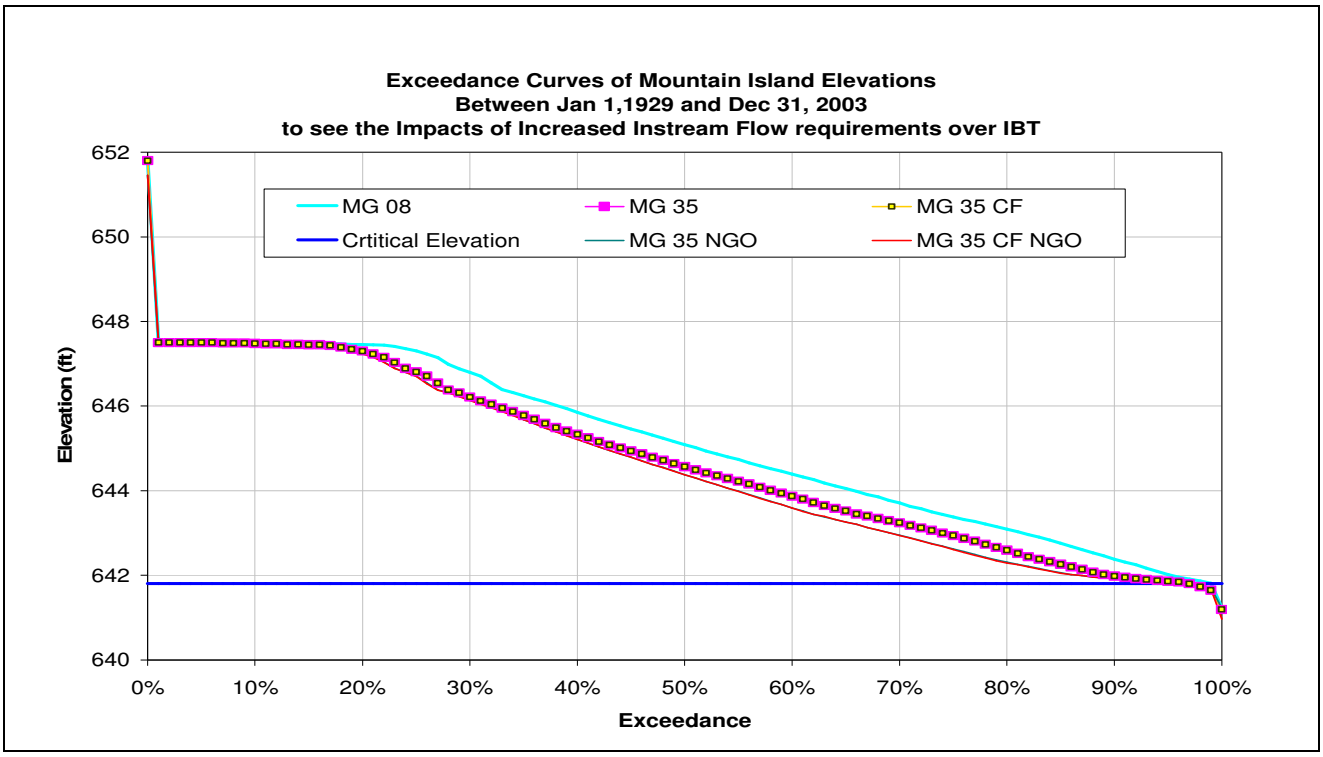

Figure 62: Elevation Duration plot of MI for Impacts of Increased Instream Flow Requirement with IBT

7) Wylie

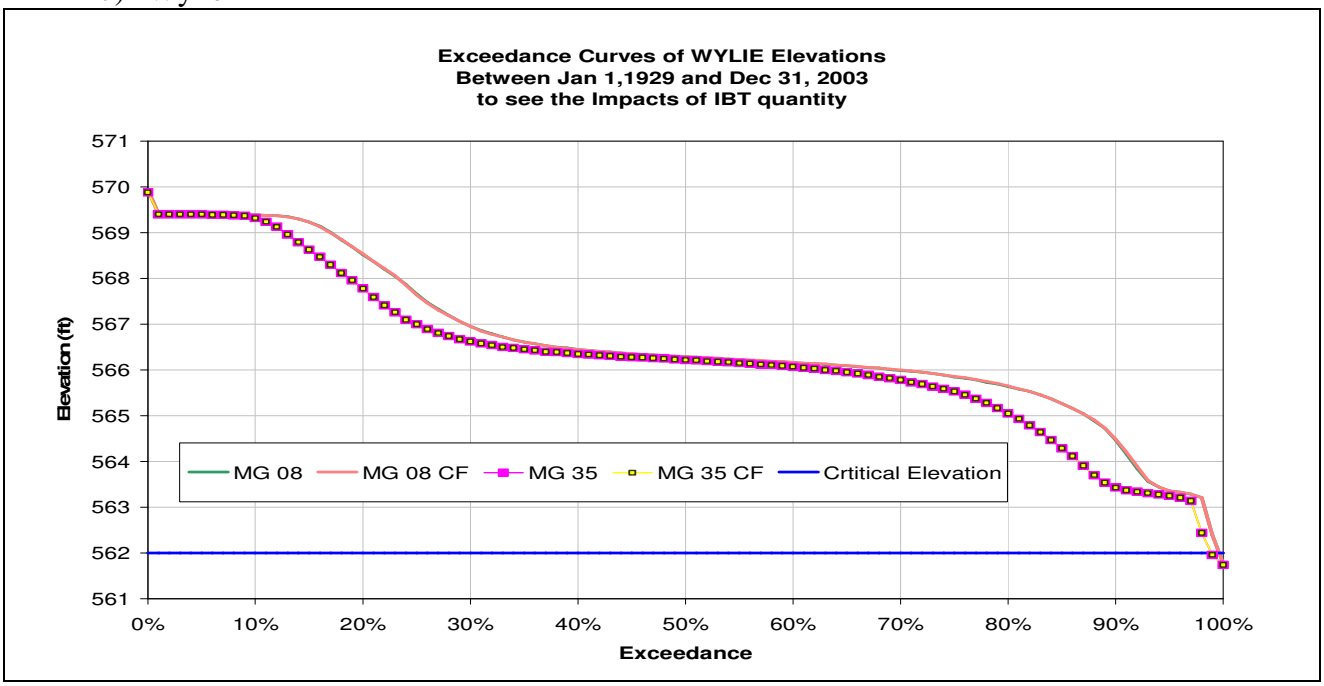

Figure 63: Elevation Duration plot of WY for Impacts of IBT Quantity

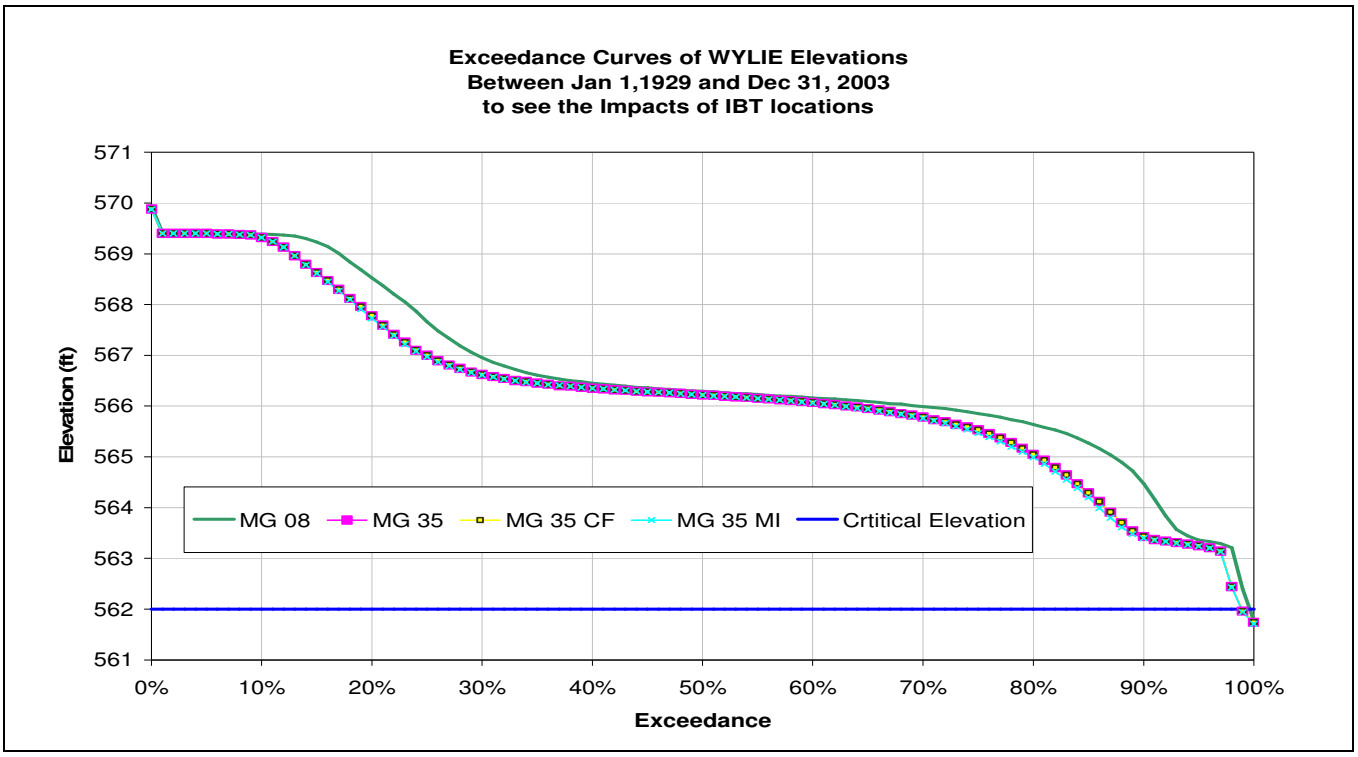

Figure 64: Elevation Duration plot of WY for Impacts of IBT Locations

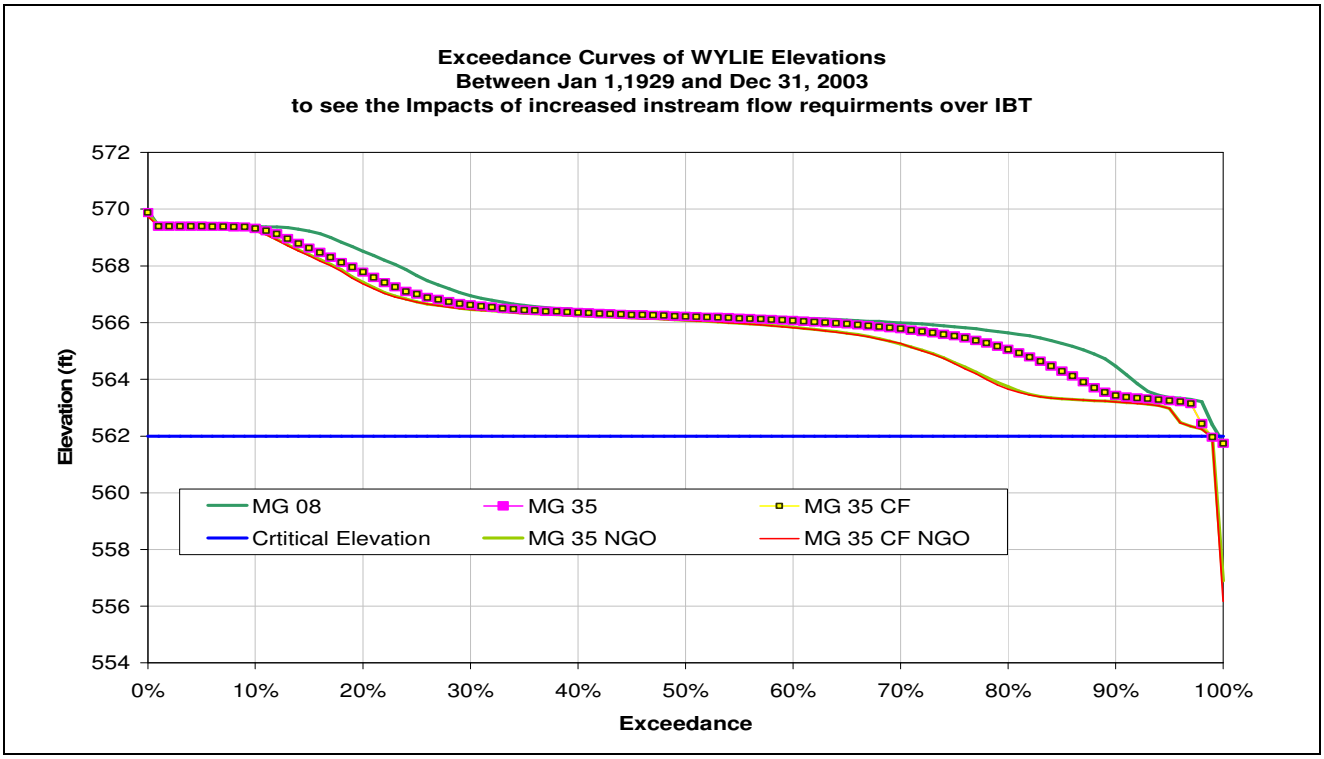

Figure 65: Elevation Duration plot of WY for Impacts of Increased Instream Flow Requirement with IBT

8) Fishing Creek

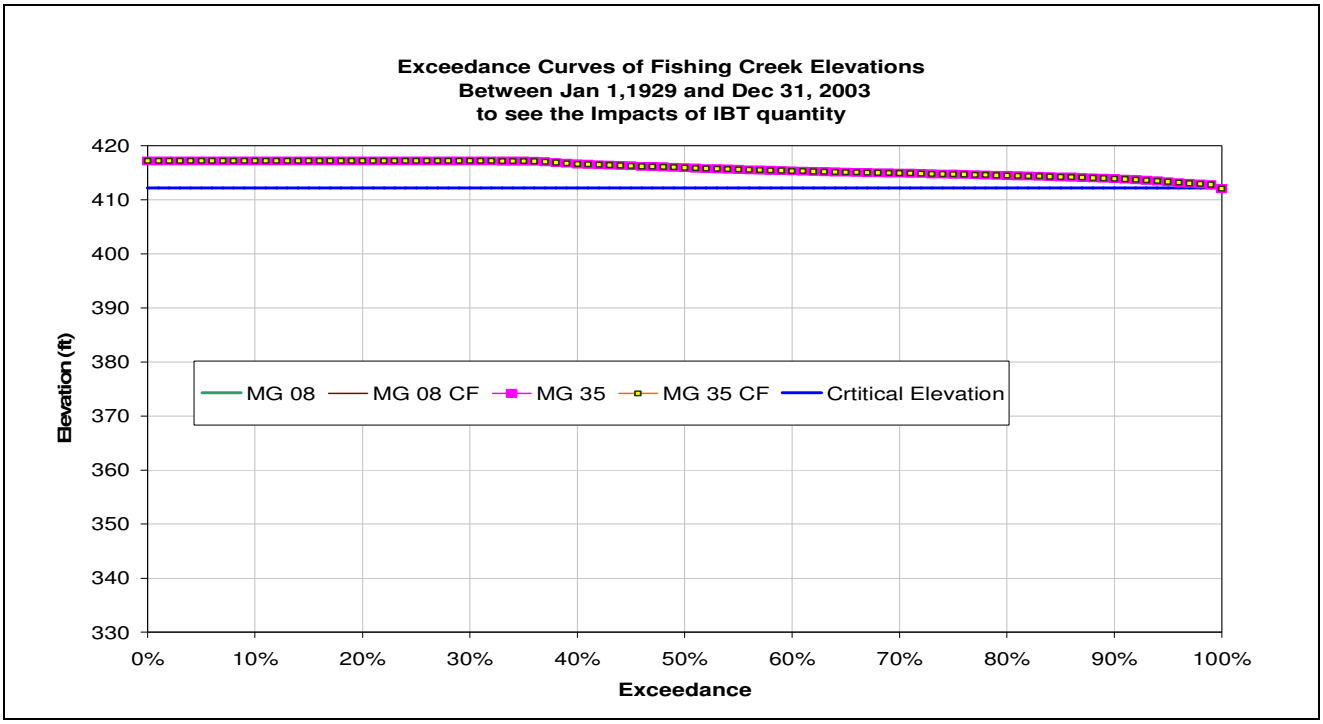

Figure 66: Elevation Duration plot of FC for Impacts of IBT Quantity

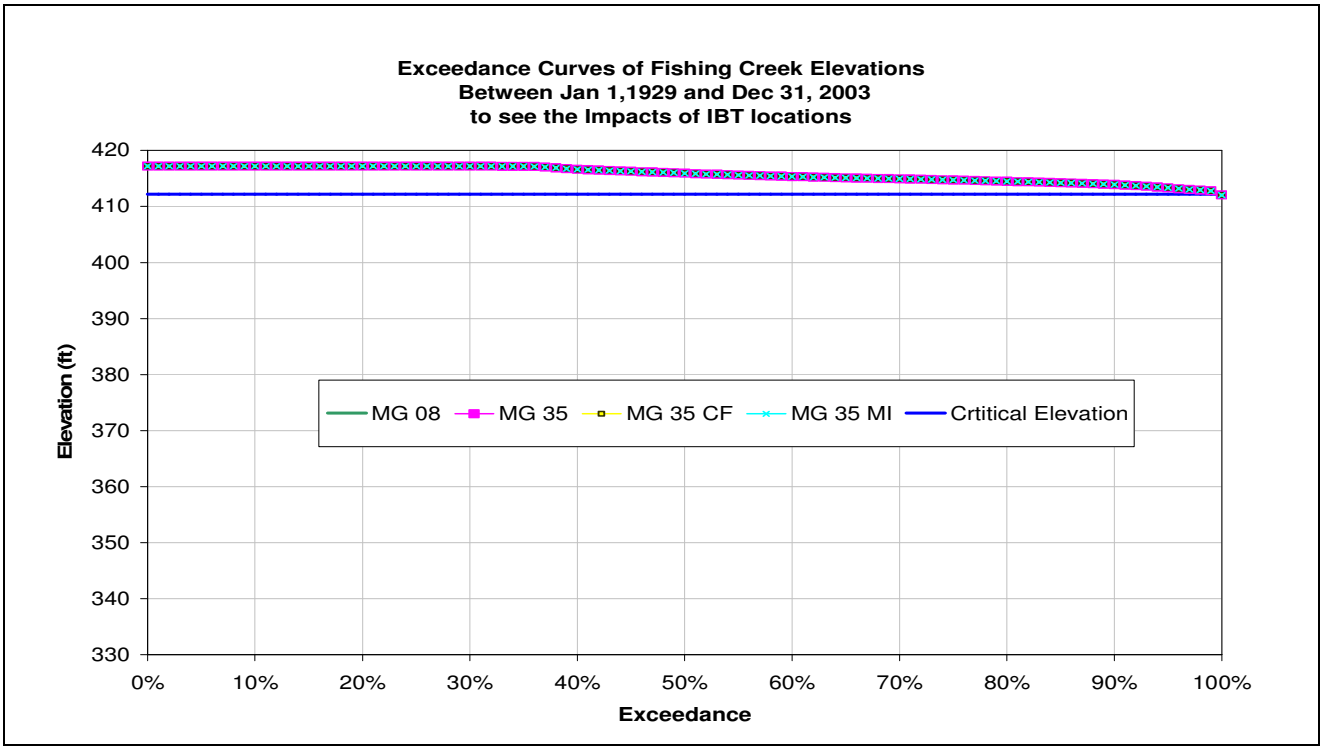

Figure 67: Elevation Duration plot of FC for Impacts of IBT Locations

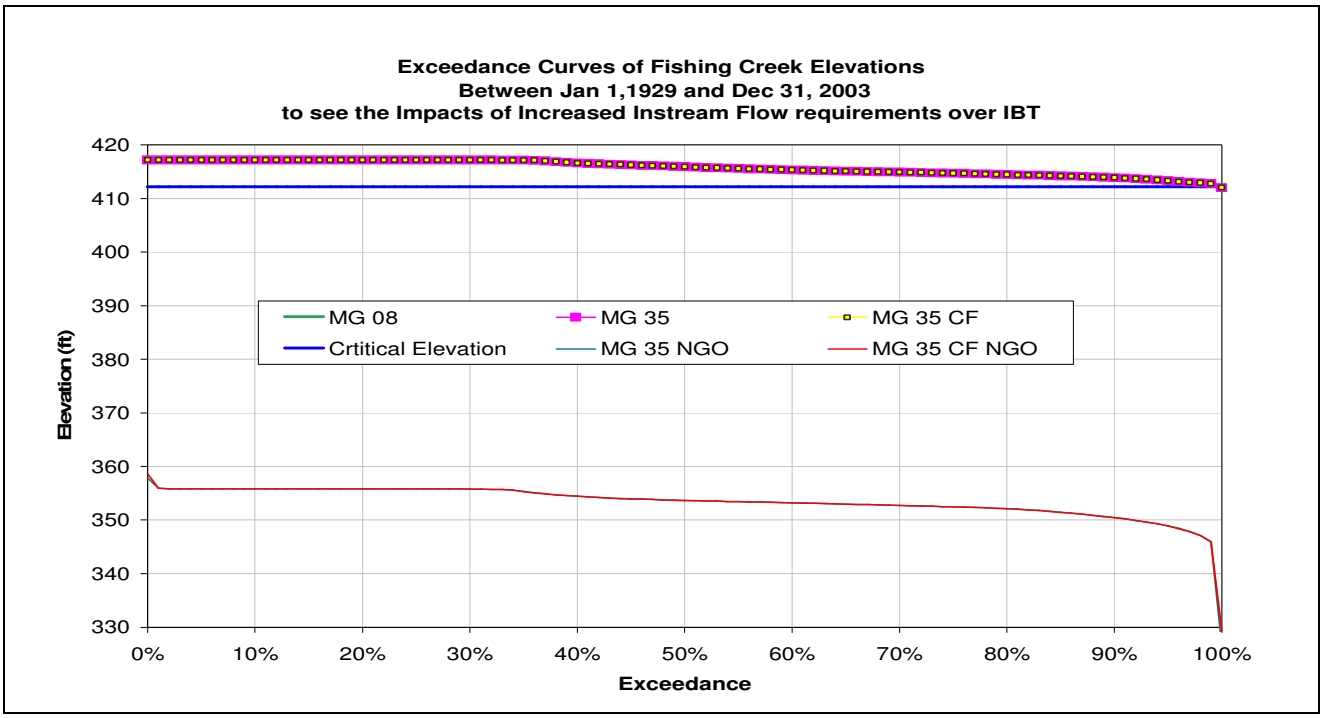

Figure 68: Elevation Duration plot of FC for Impacts of Increased Instream Flow Requirement with IBT

9) Great Falls

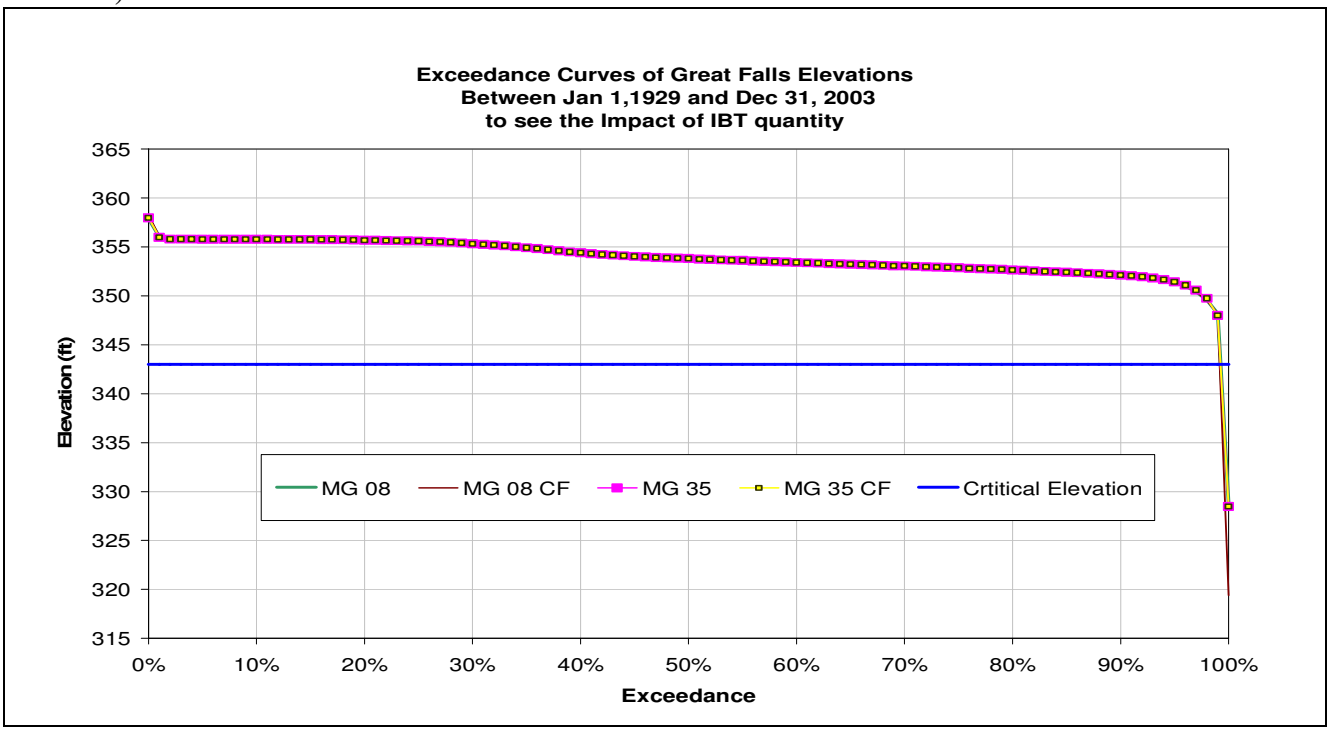

Figure 69: Elevation Duration plot of GF for Impacts of IBT Quantity

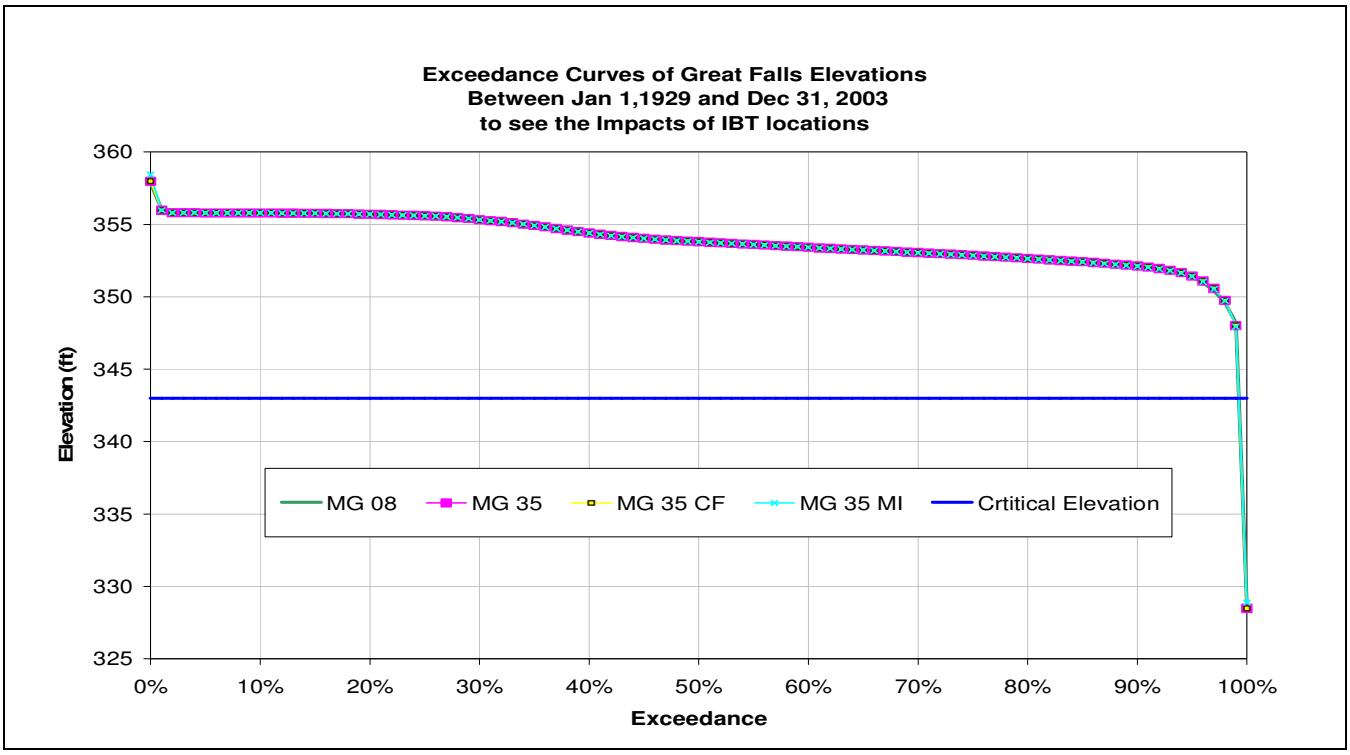

Figure 70: Elevation Duration plot of GF for Impacts of IBT Locations

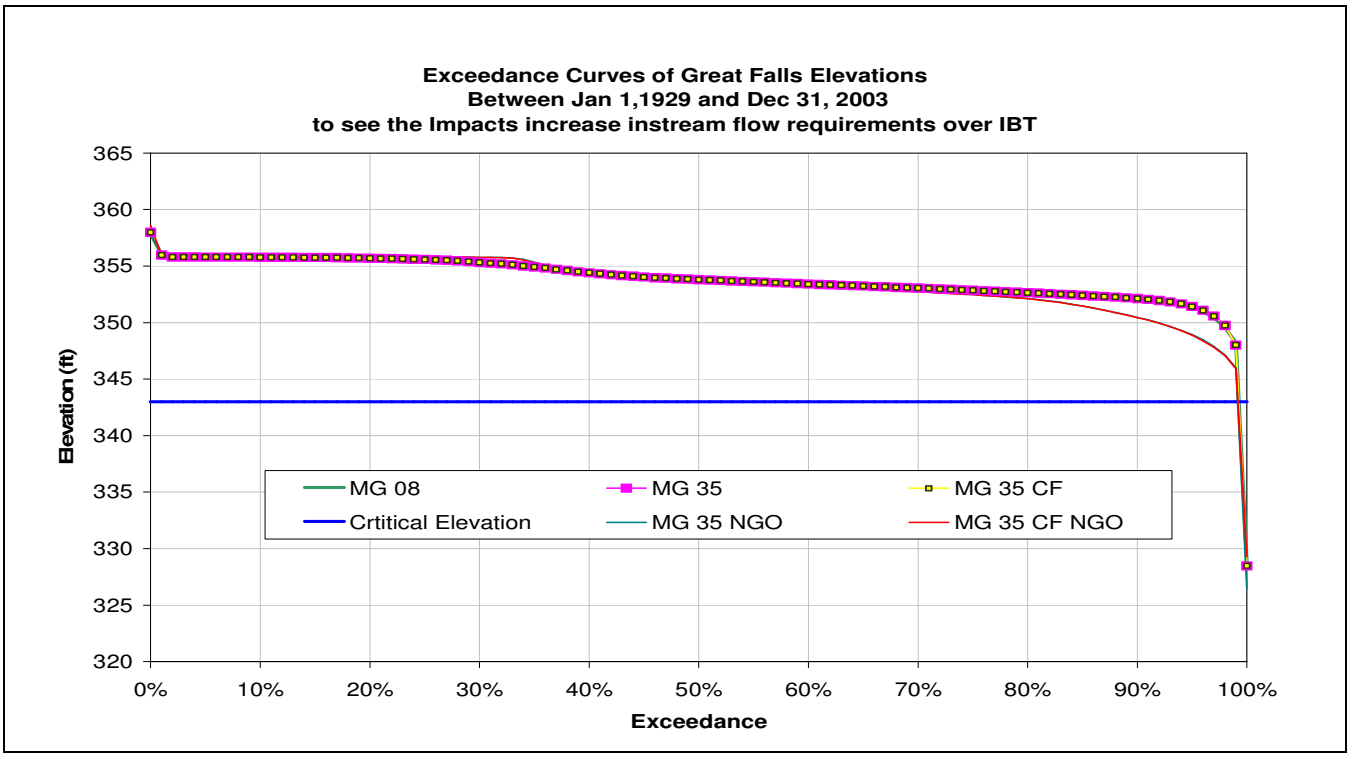

Figure 71: Elevation Duration plot of GF for Impacts of Increased Instream Flow Requirement with IBT

10) Rocky Creek

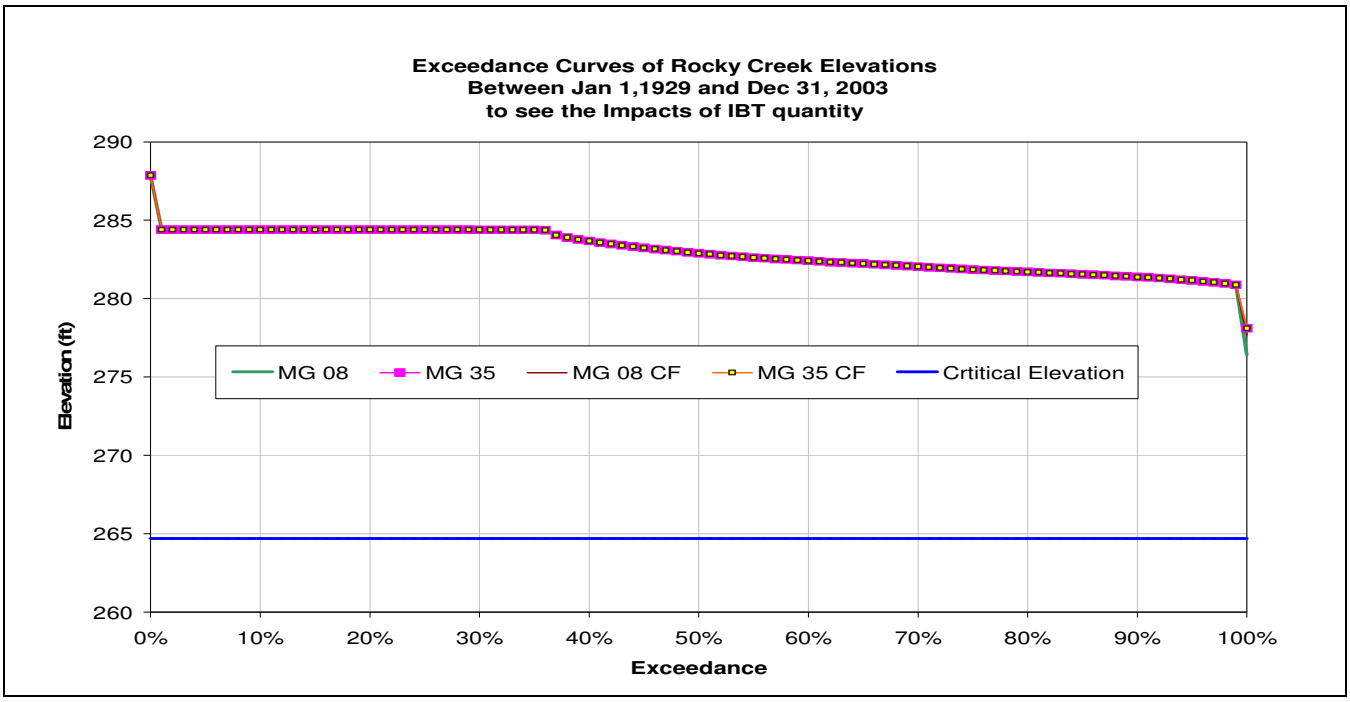

Figure 72: Elevation Duration plot of RC for Impacts of IBT Quantity

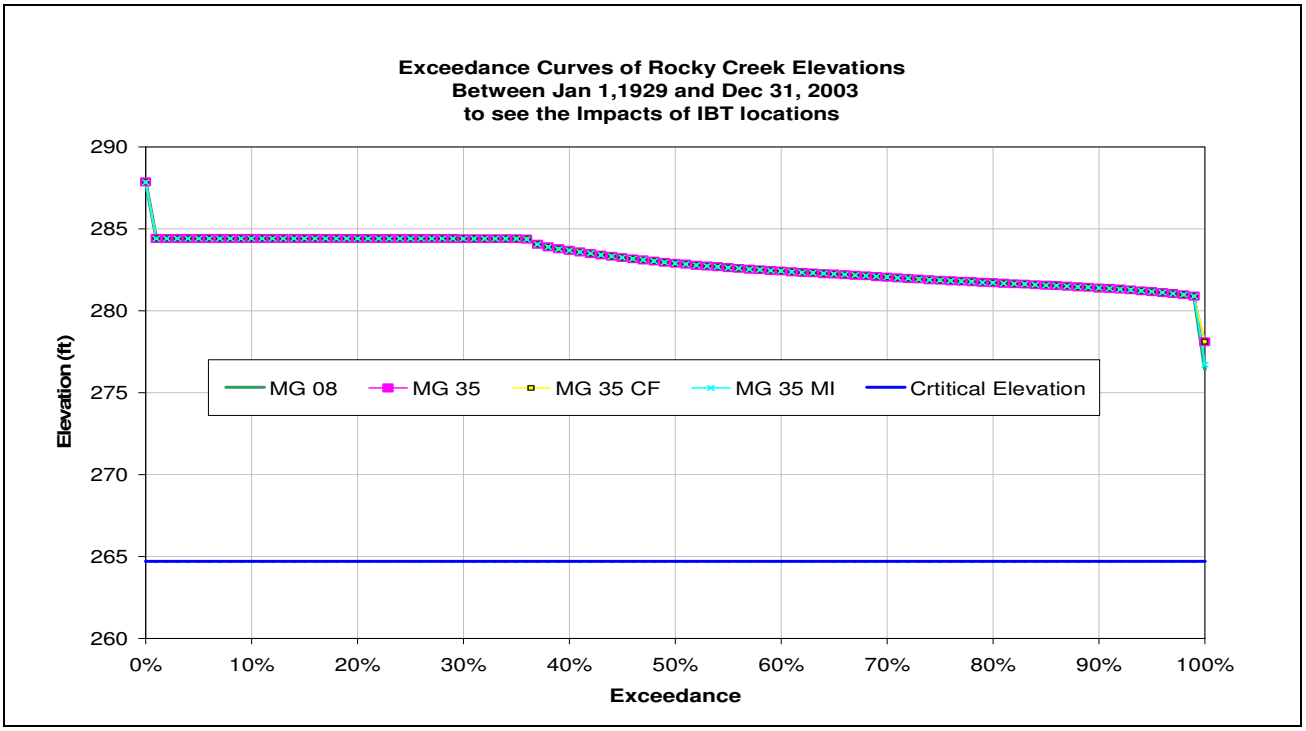

Figure 73: Elevation Duration plot of RC for Impacts of IBT Locations

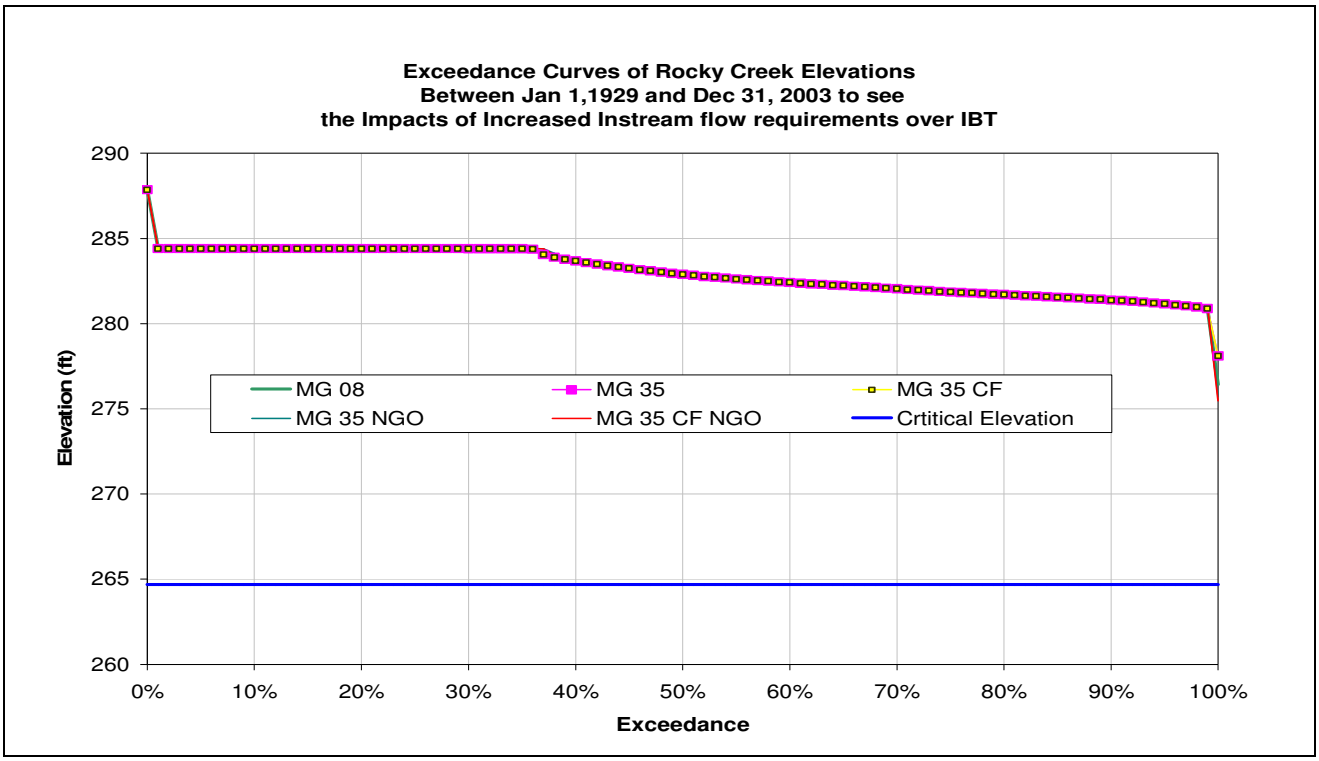

Figure 74: Elevation Duration plot of RC for Impacts of Increased Instream Flow Requirement with IBT

11) Wateree

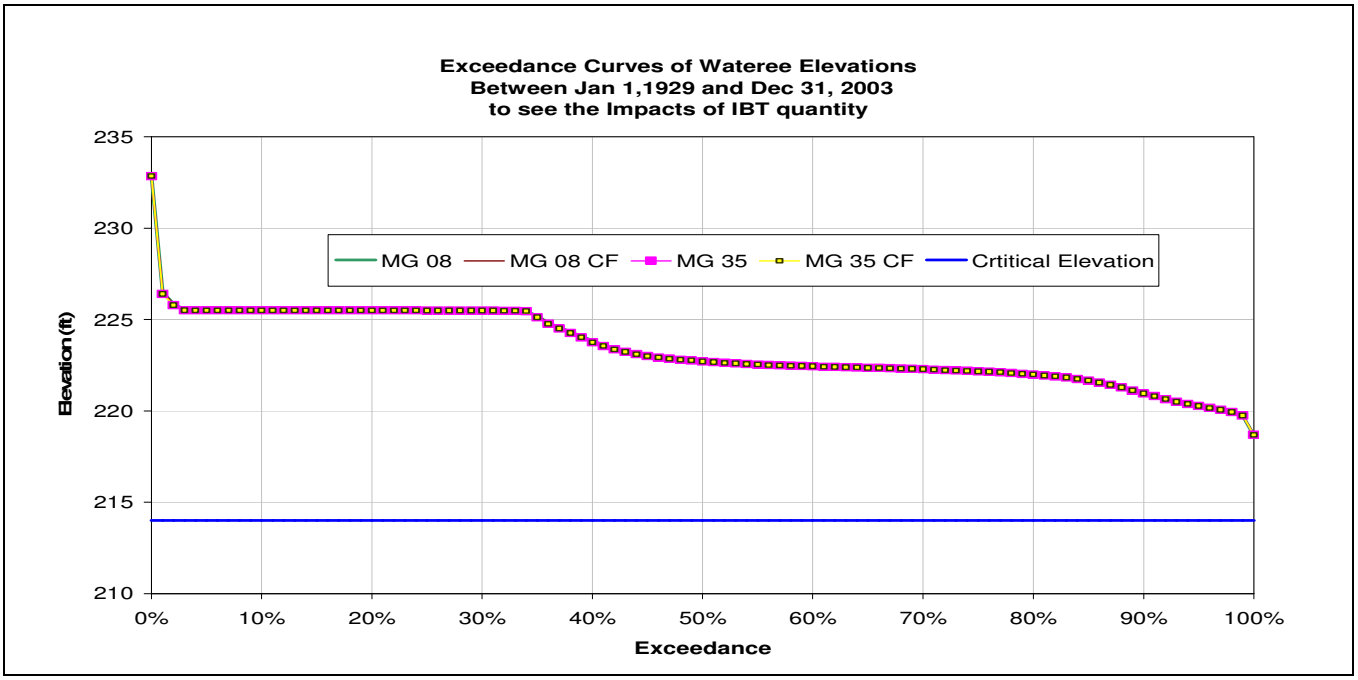

Figure 75: Elevation Duration plot of WA for Impacts of IBT Quantity

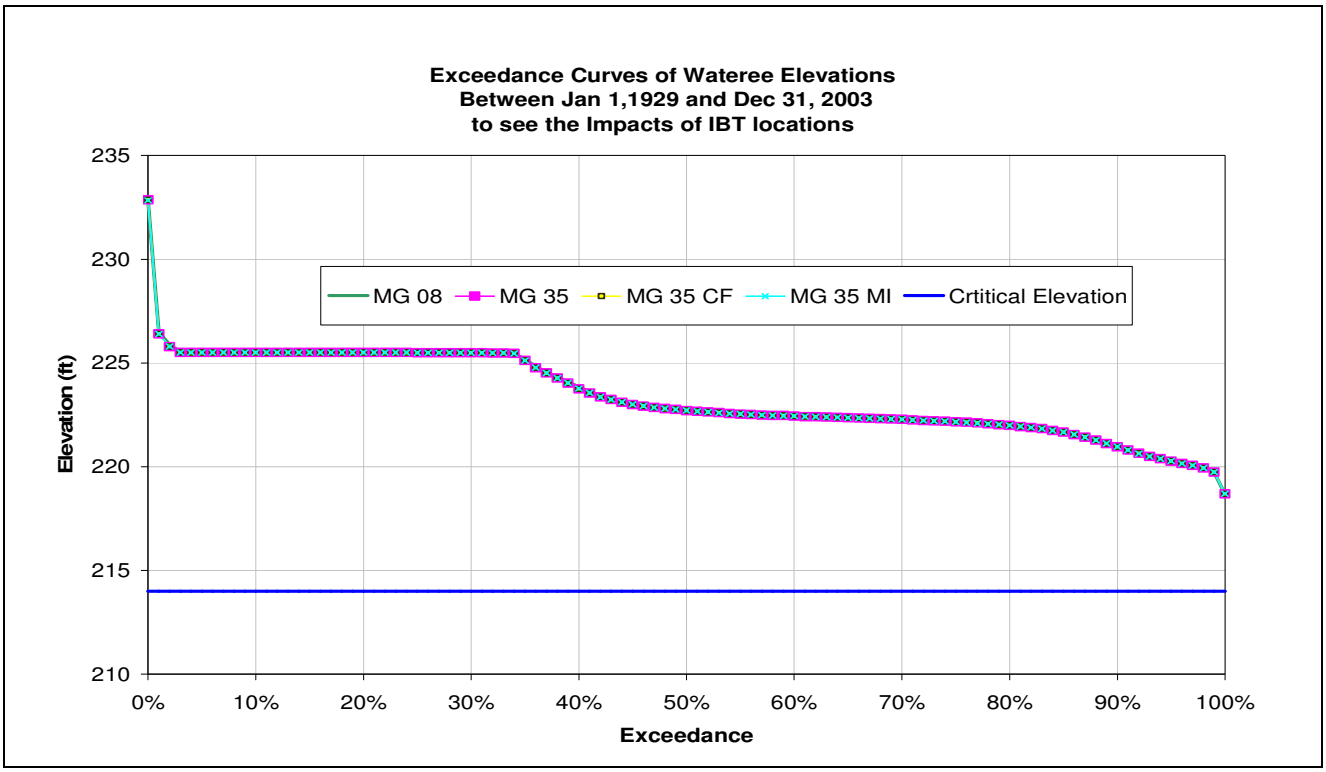

Figure 76: Elevation Duration plot of WA for Impacts of IBT Locations

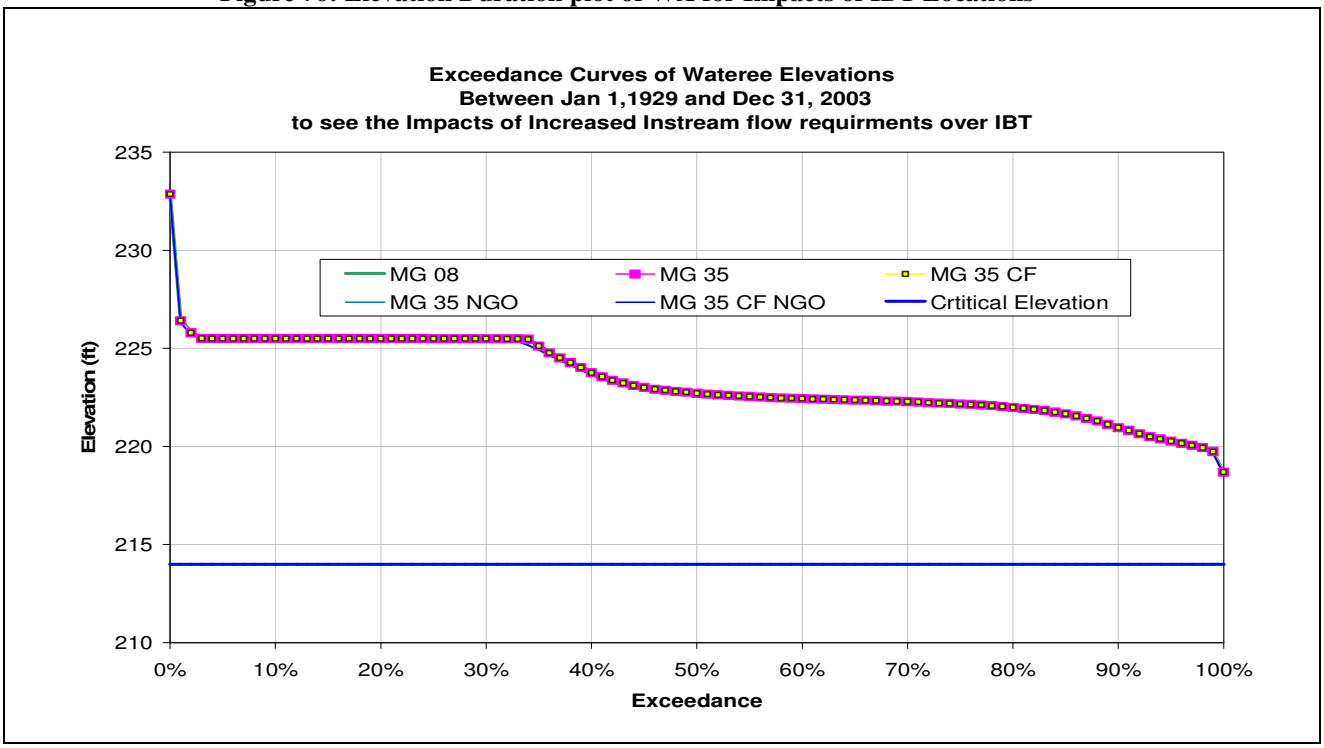

Figure 77: Elevation Duration plot of WA for Impacts of Increased Instream Flow Requirement with IBT

5. Generation Summary Plot

1) Bridgewater

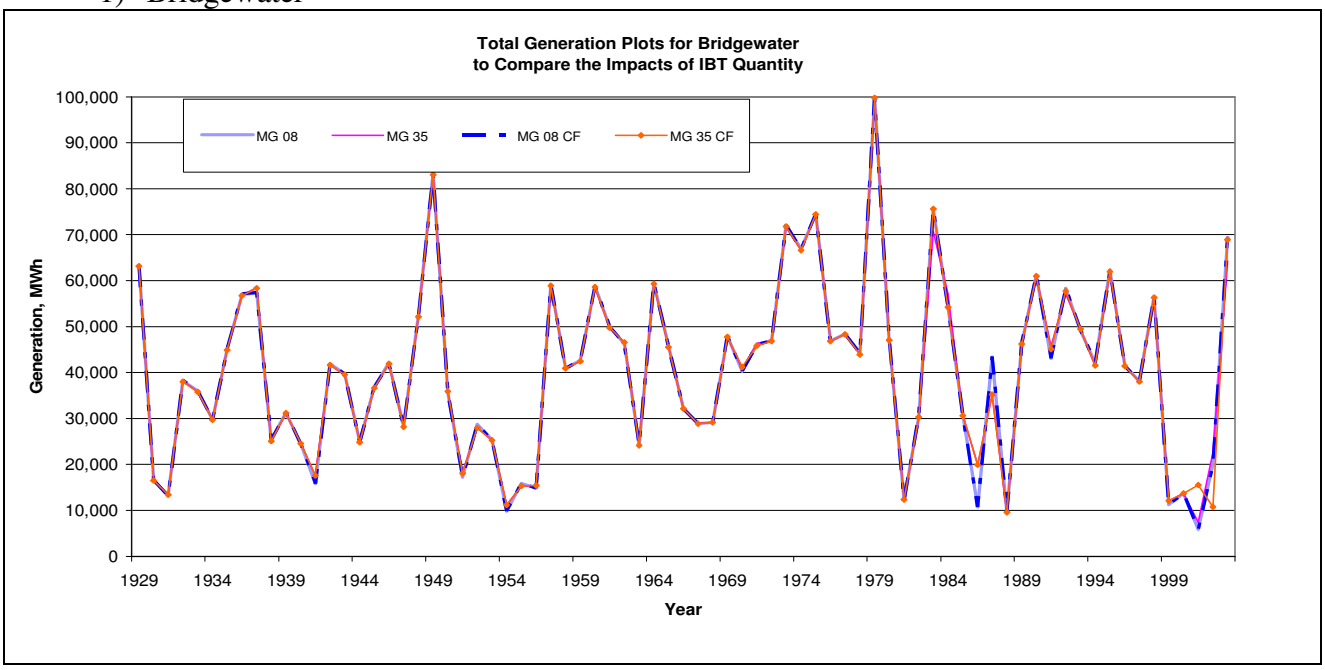

Figure 78: Annual Generation Plot of BW for Impacts of IBT Quantity

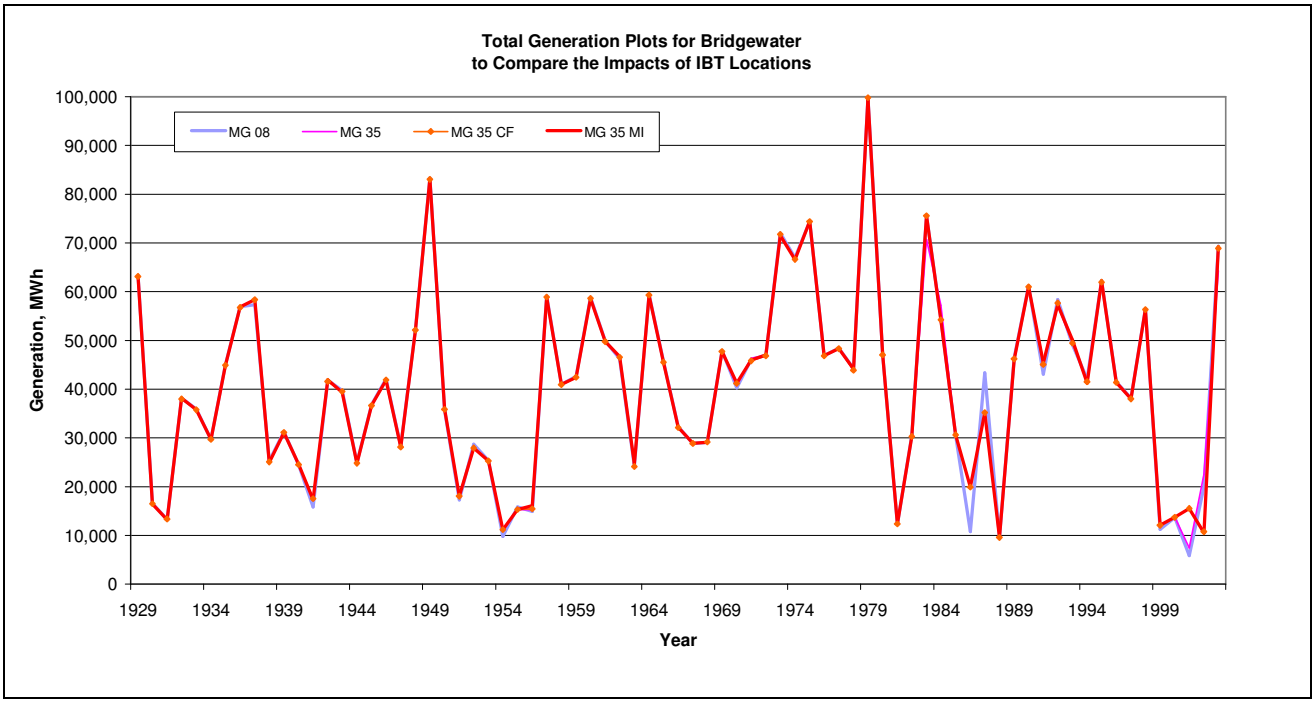

Figure 79: Annual Generation Plot of BW for Impacts of IBT Locations

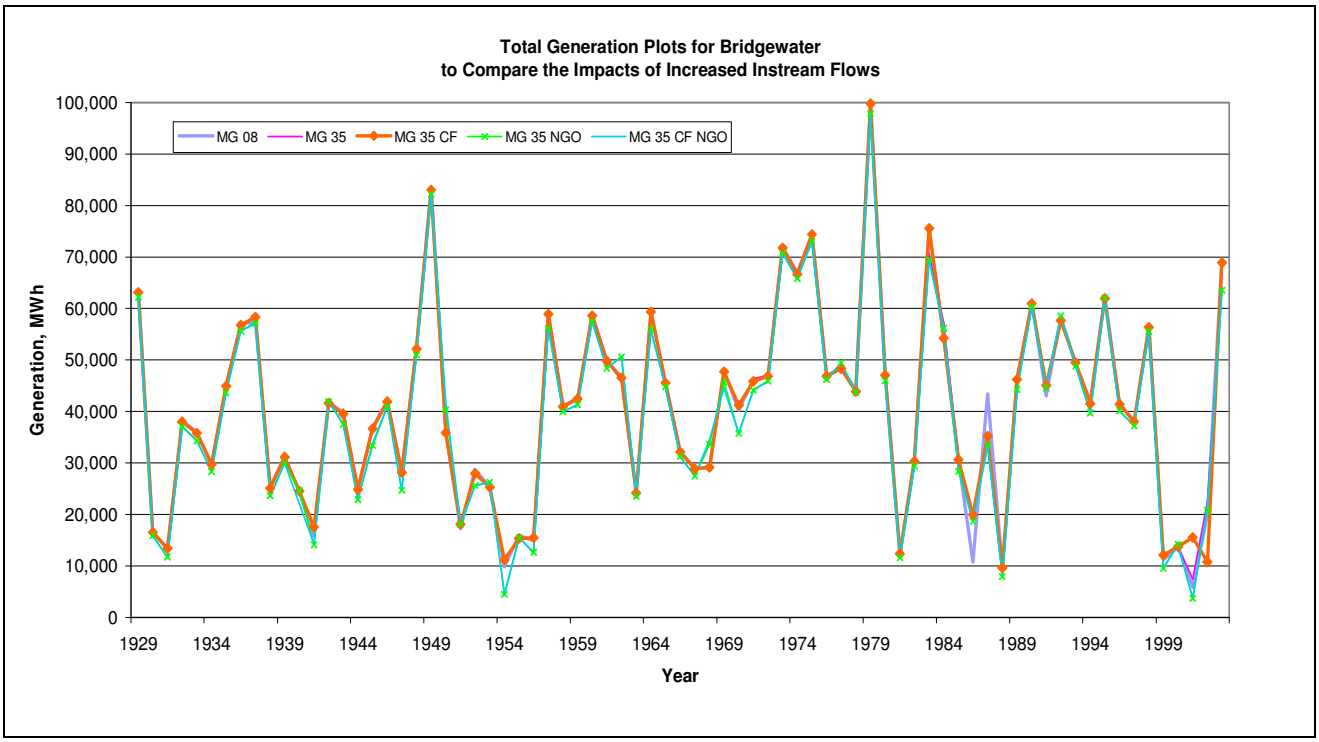

Figure 80: Annual Generation Plot of BW for Impacts of Increased Instream Flow Requirement with IBT

2) Rhodhiss

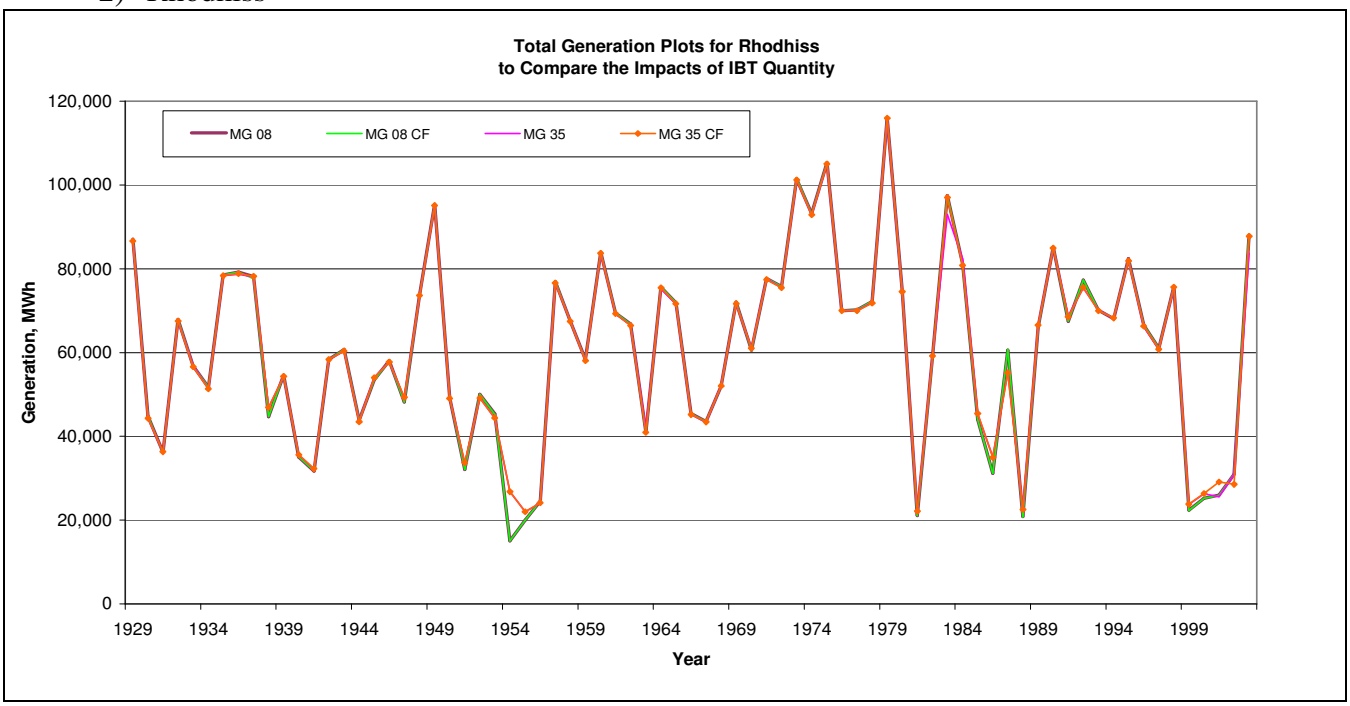

Figure 81: Annual Generation Plot of RH for Impacts of IBT Quantity

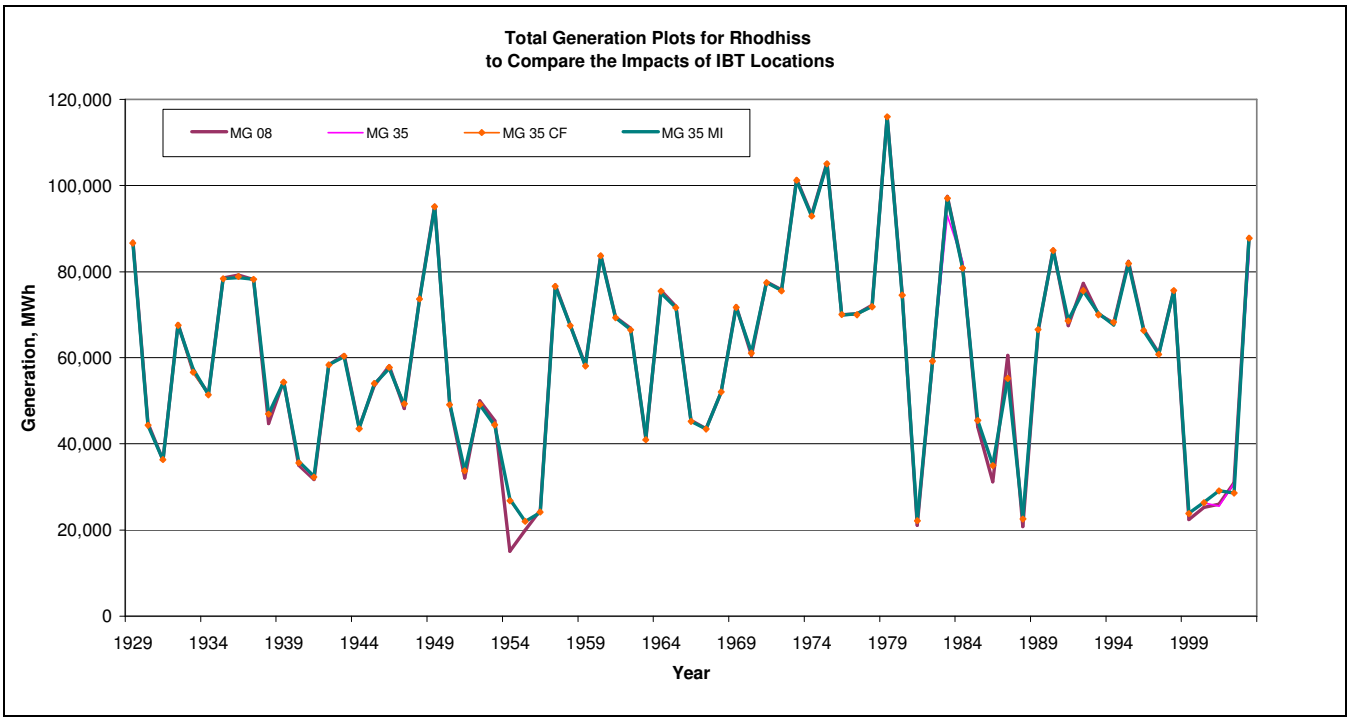

Figure 82: Annual Generation Plot of RH for Impacts of IBT Locations

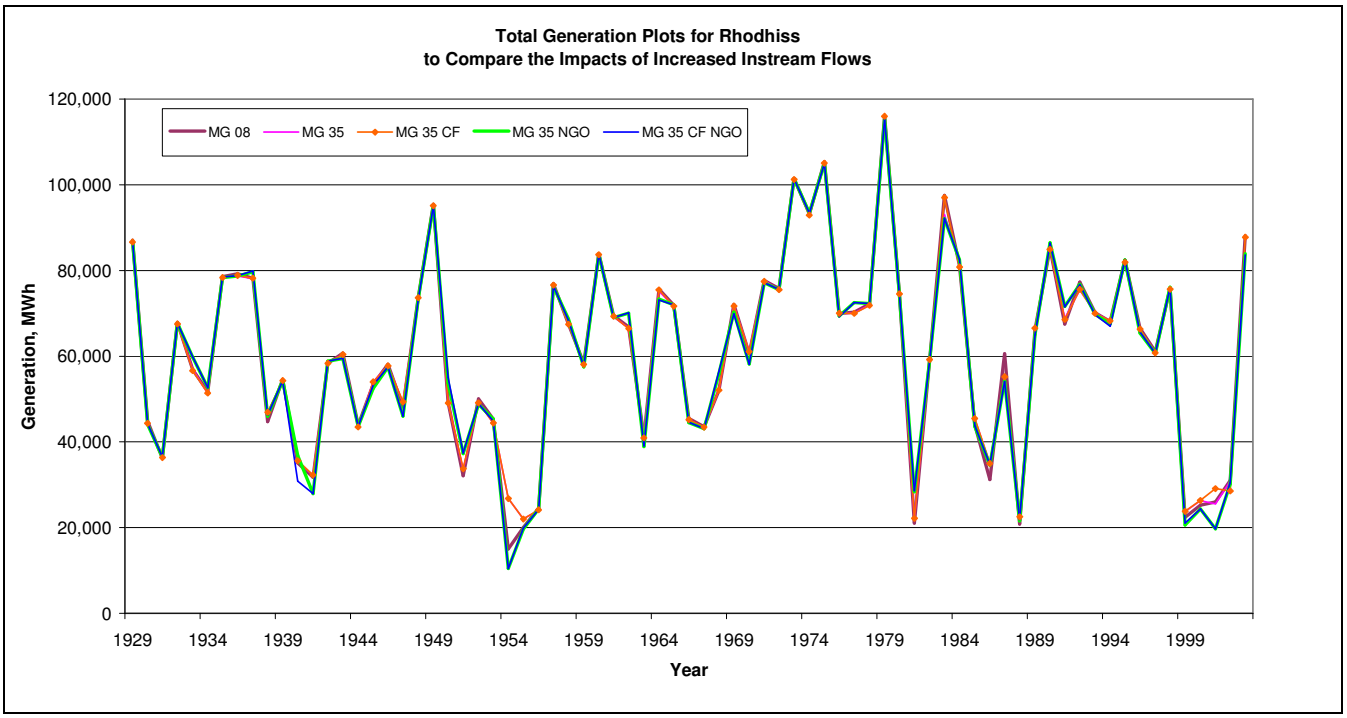

Figure 83: Annual Generation Plot of RH for Impacts of Increased Instream Flow Requirement with IBT

3) Oxford

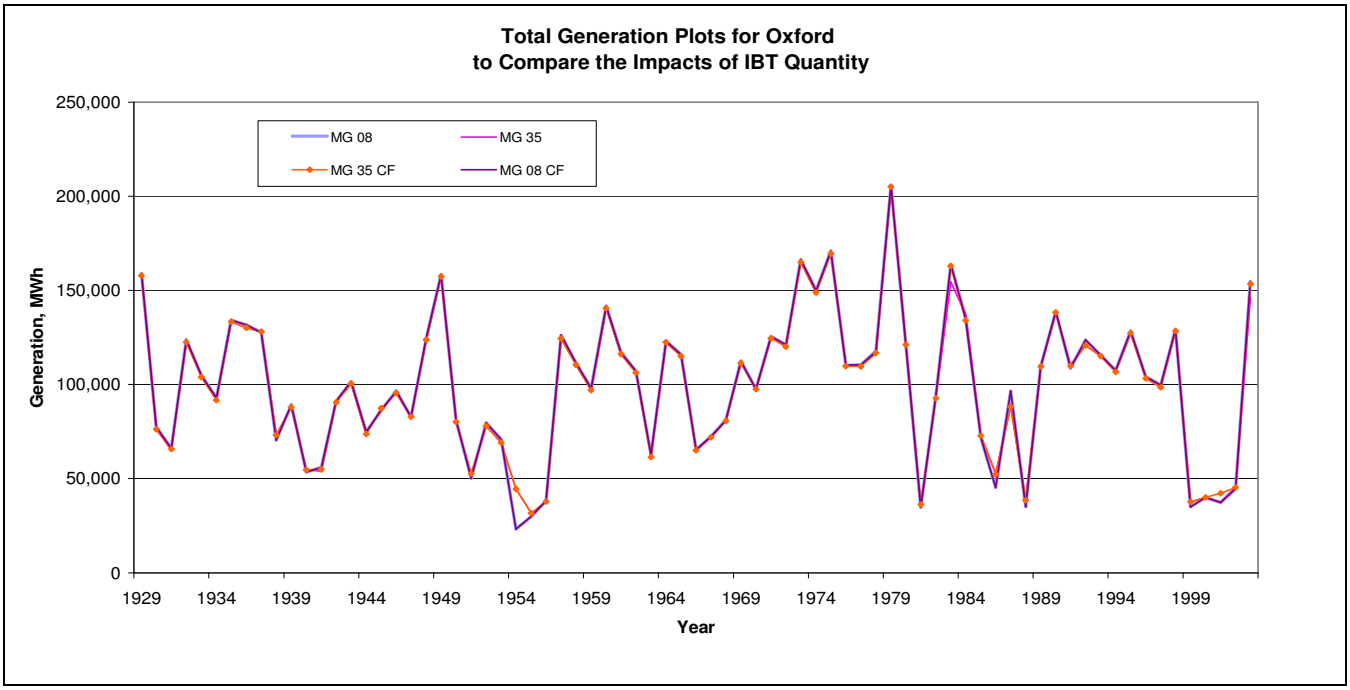

Figure 84: Annual Generation Plot of OX for Impacts of IBT Quantity

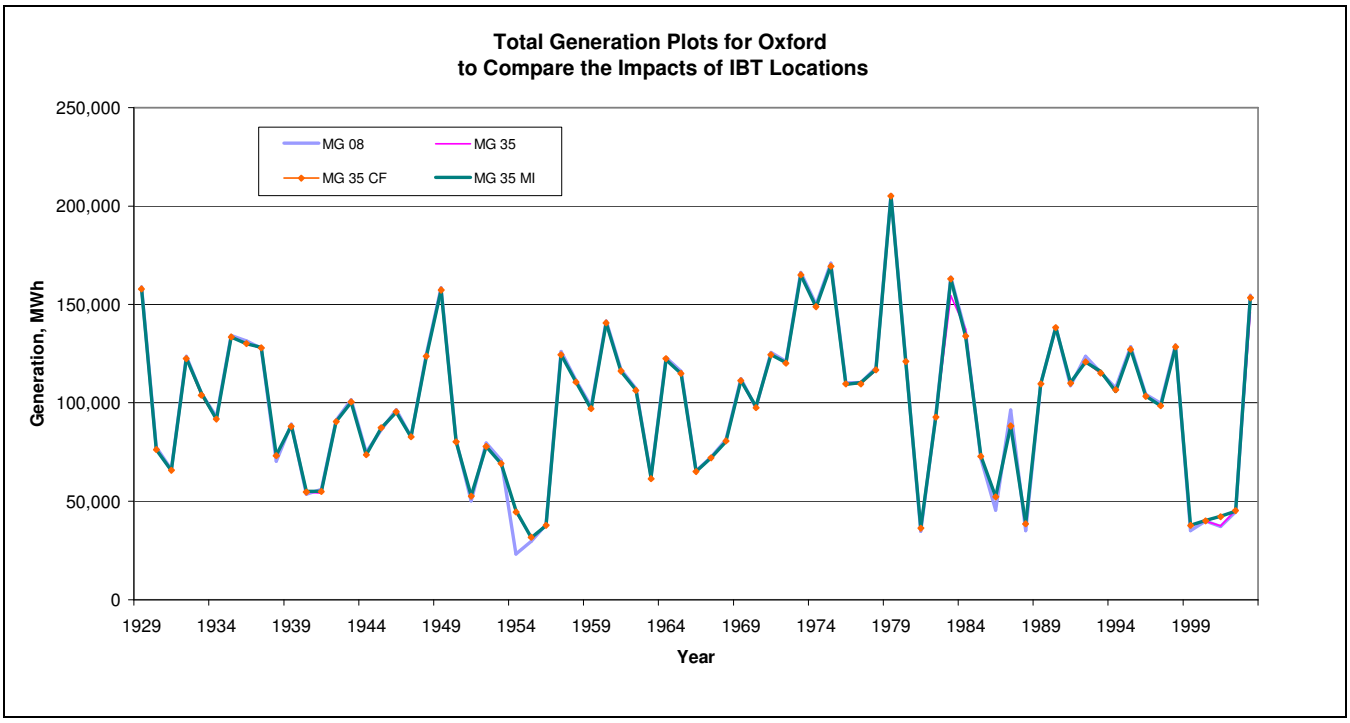

Figure 85: Annual Generation Plot of OX for Impacts of IBT Locations

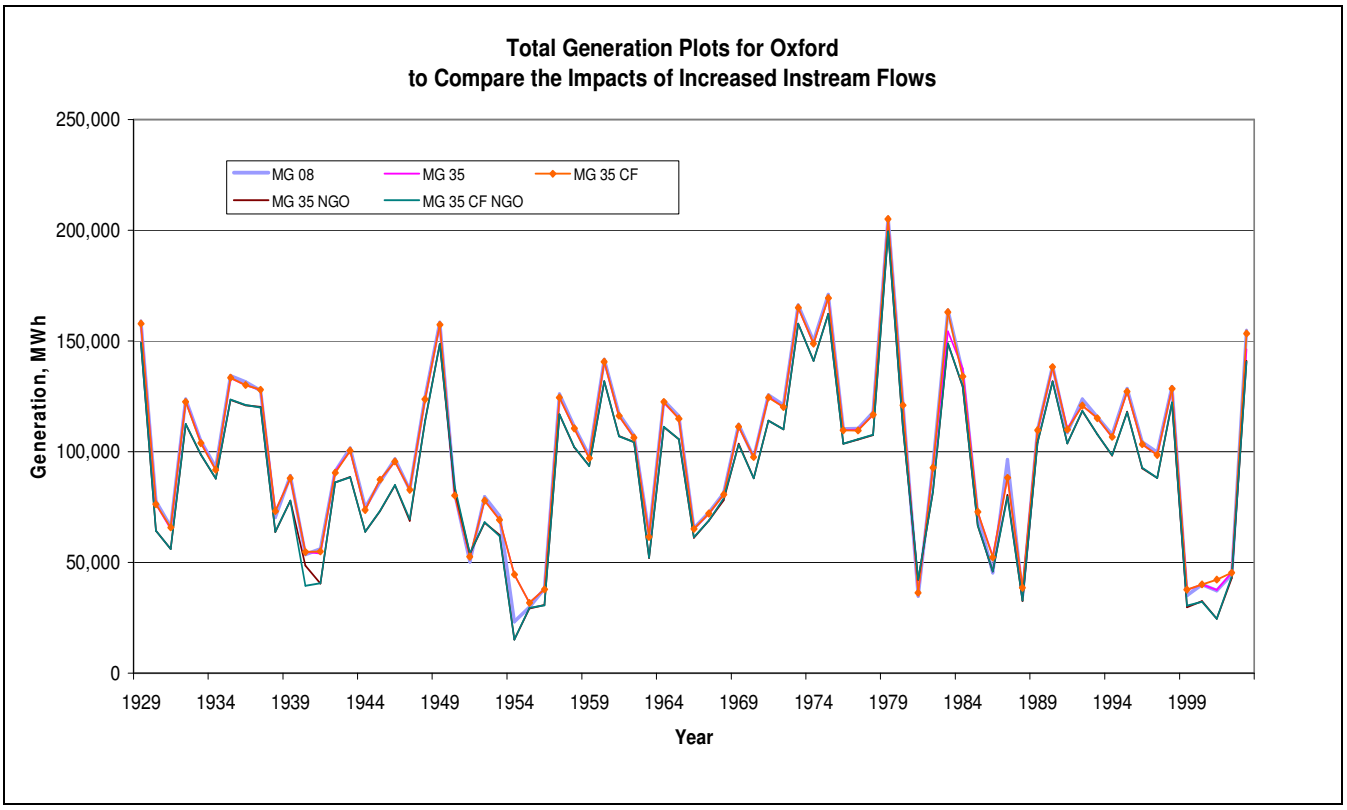

Figure 86: Annual Generation Plot of OX for Impacts of Increased Instream Flow Requirement with IBT

4) Lookout shoals

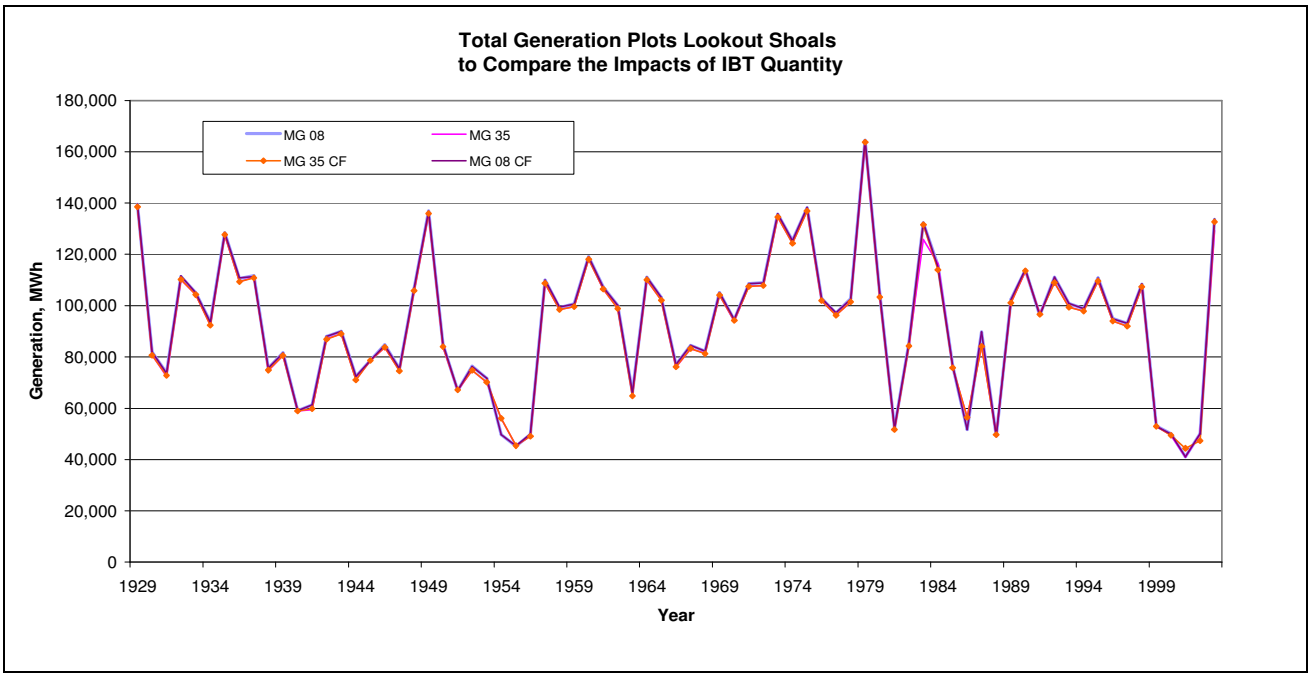

Figure 87: Annual Generation Plot of LS for Impacts of IBT Quantity

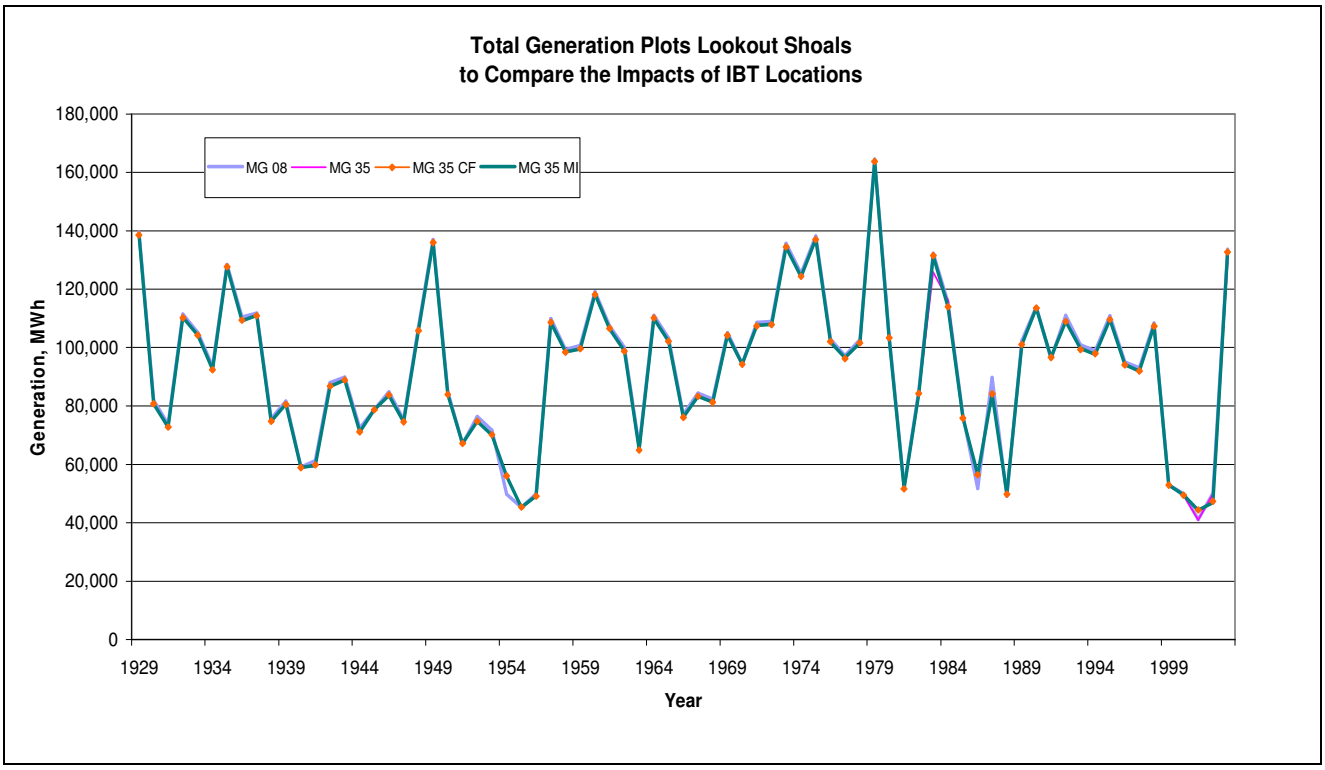

Figure 88: Annual Generation Plot of LS for Impacts of IBT Locations

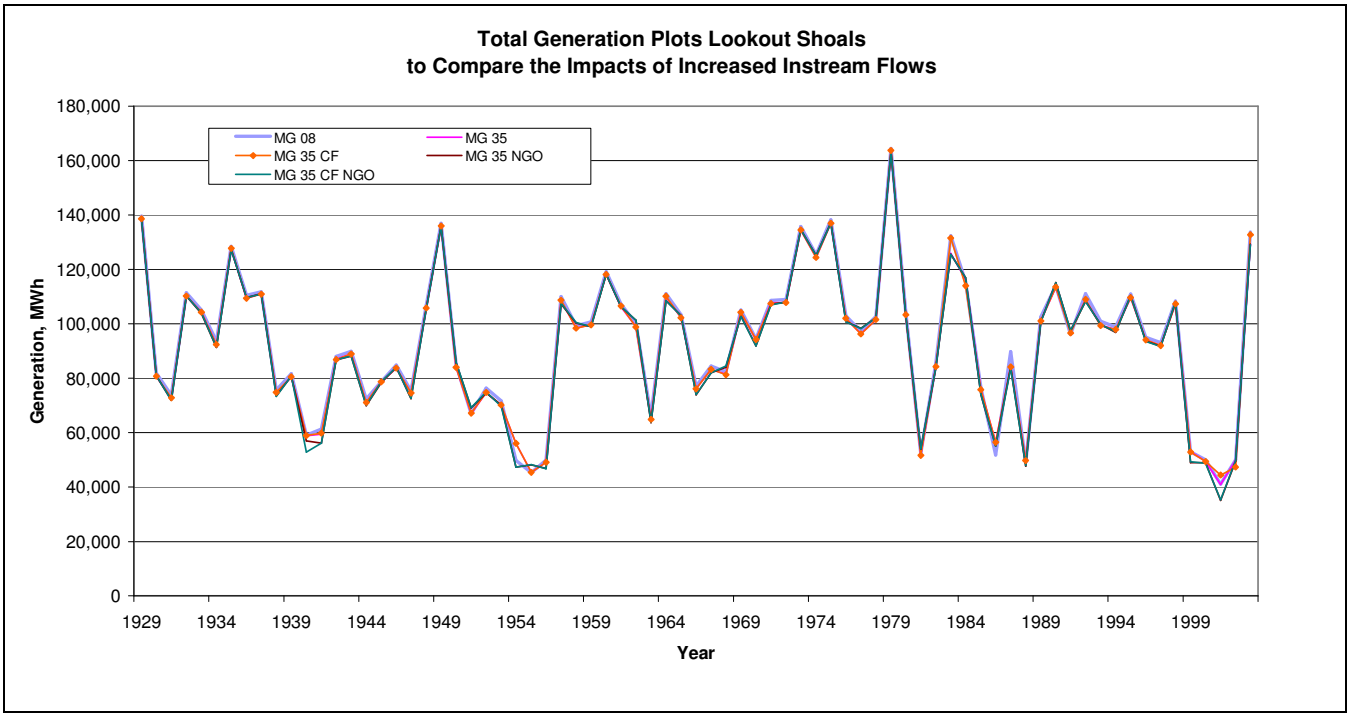

Figure 89: Annual Generation Plot of LS for Impacts of Increased Instream Flow Requirement with IBT

5) Cowan Ford

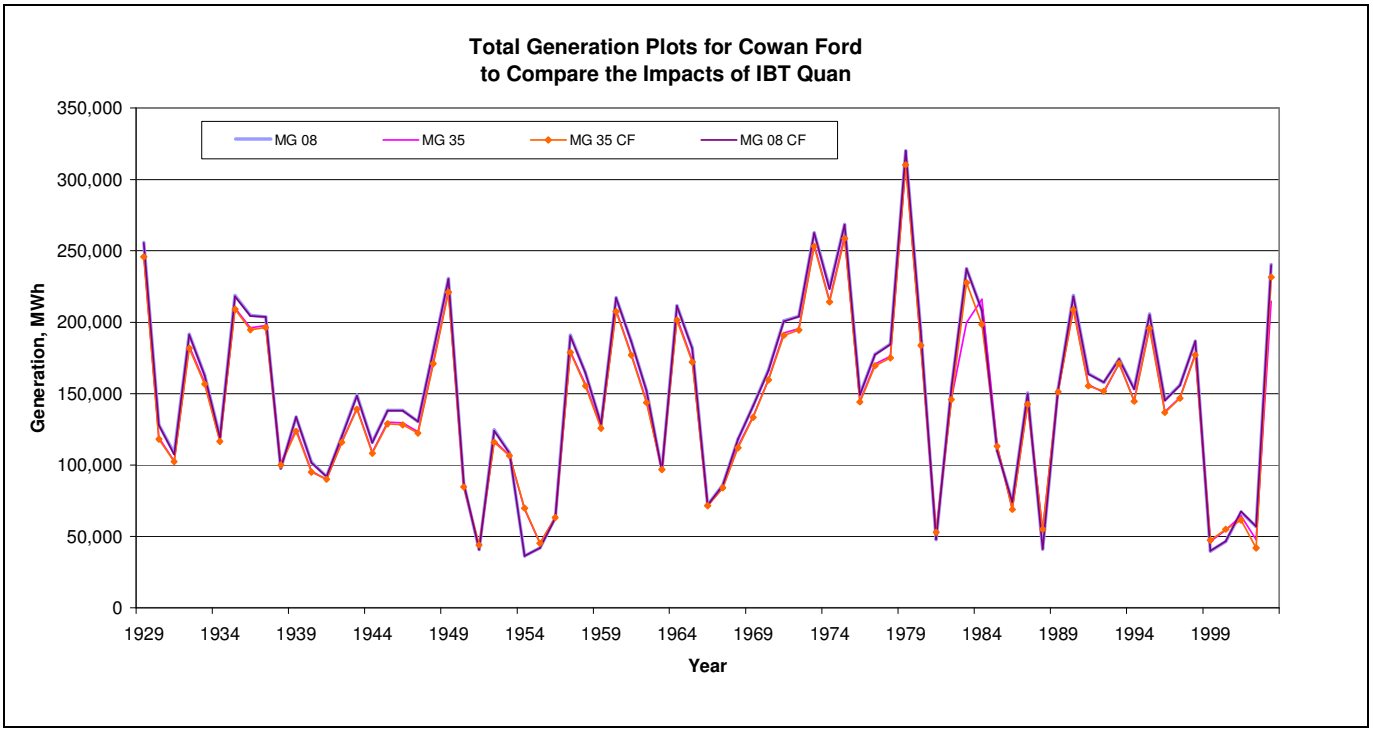

Figure 90: Annual Generation Plot of CF for Impacts of IBT Quantity

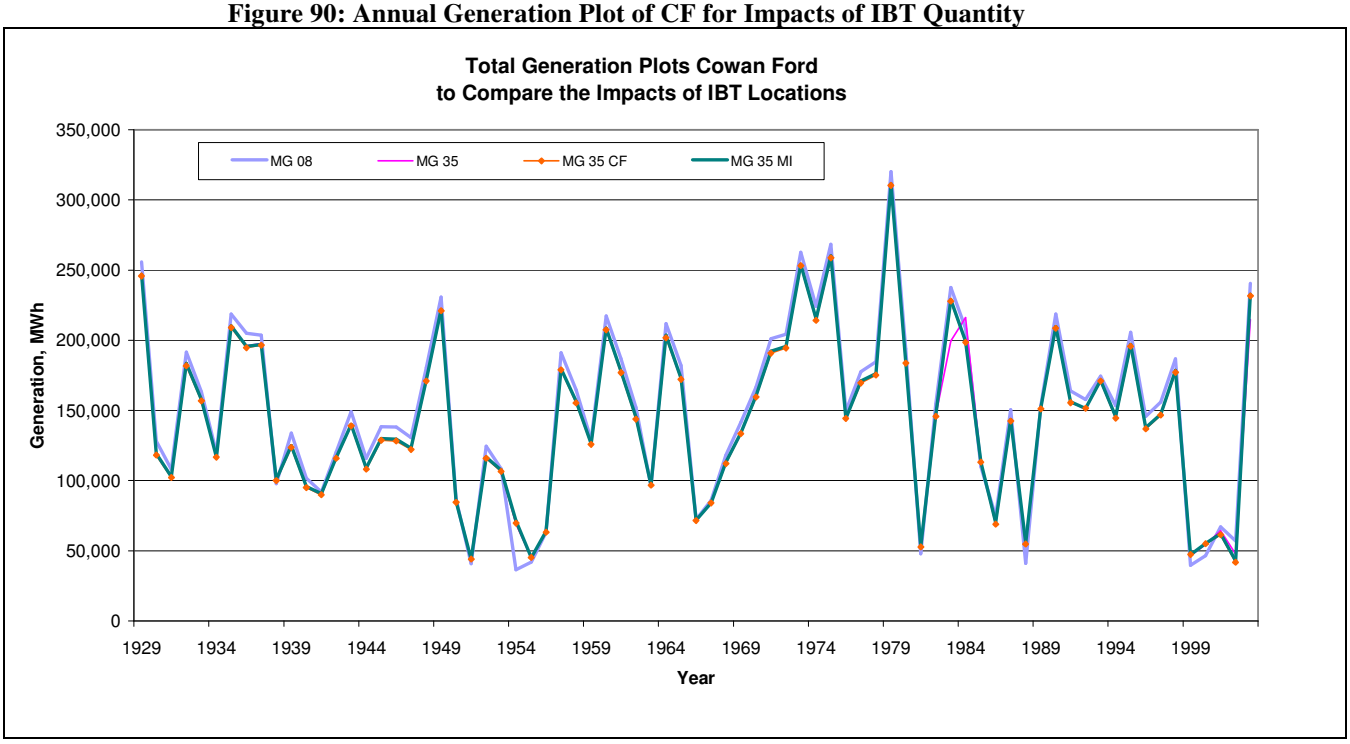

Figure 91: Annual Generation Plot of CF for Impacts of IBT Locations

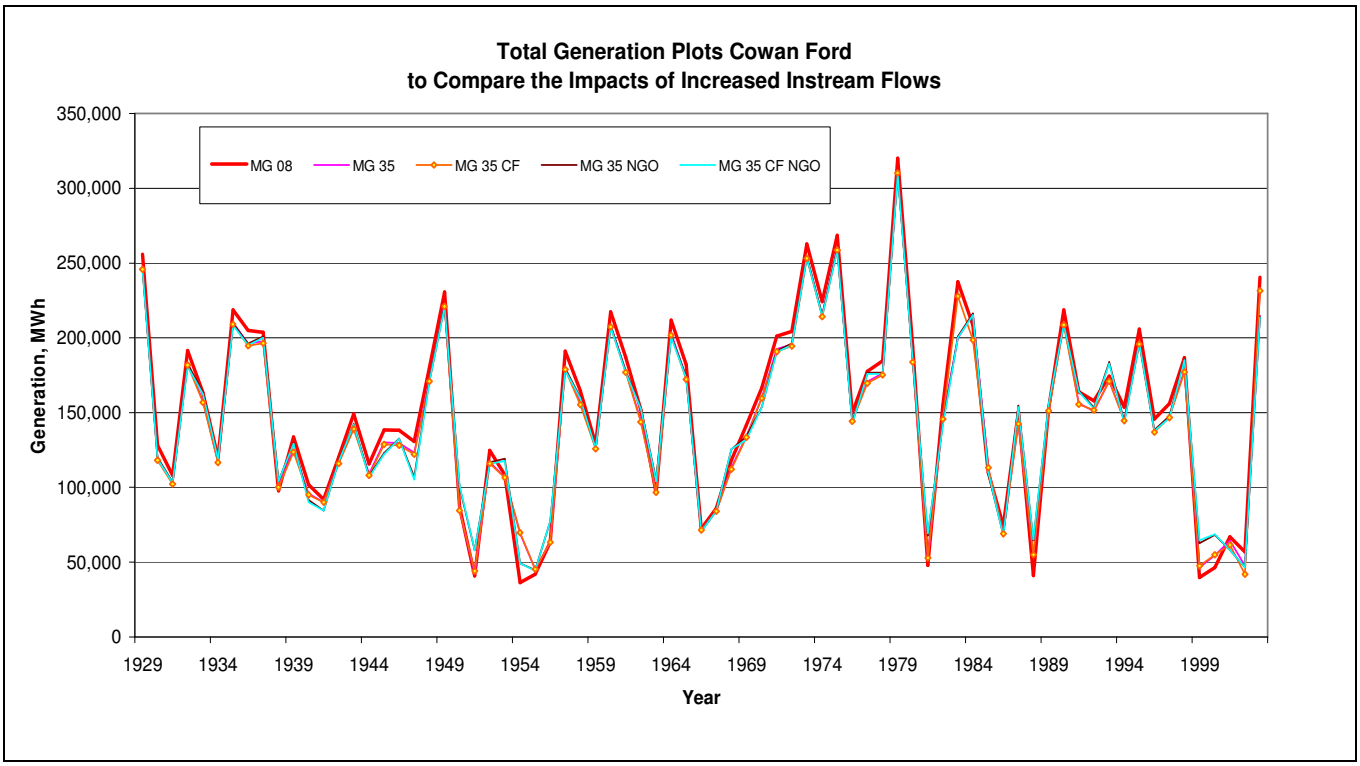

Figure 92: Annual Generation Plot of CF for Impacts of Increased Instream Flow Requirement with IBT

6) Mountain Island

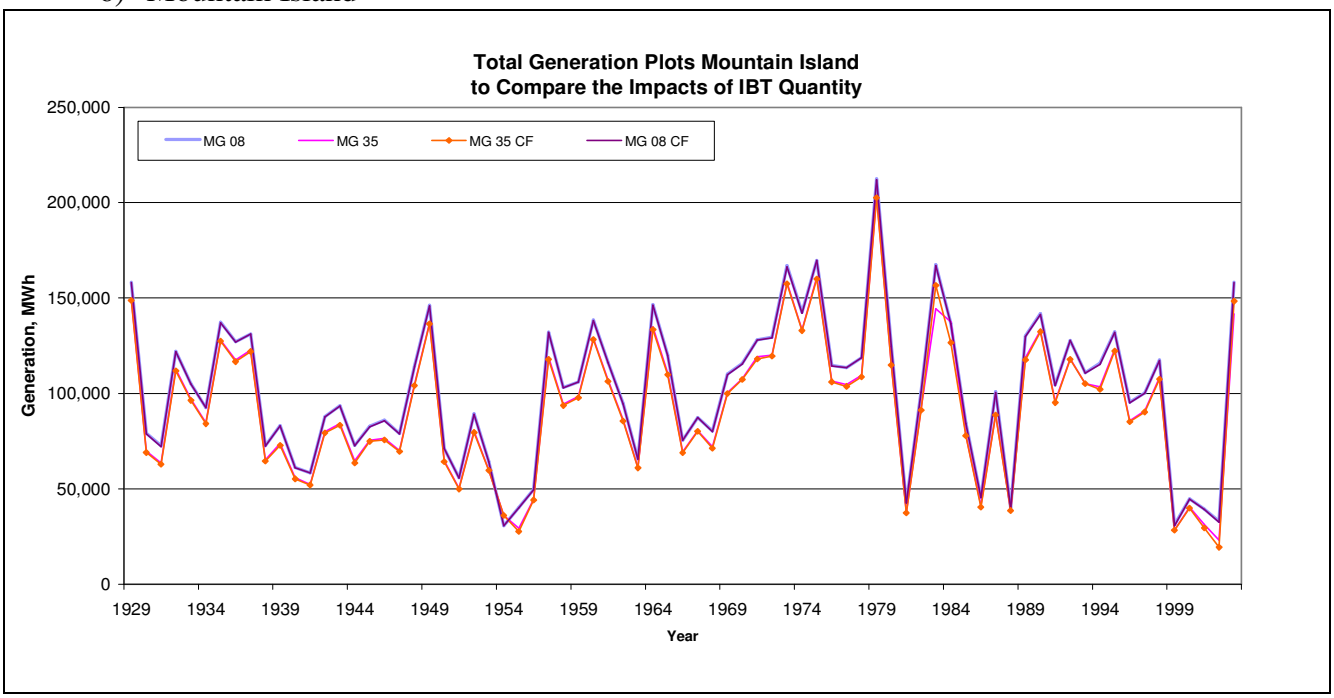

Figure 93: Annual Generation Plot of MI for Impacts of IBT Quantity

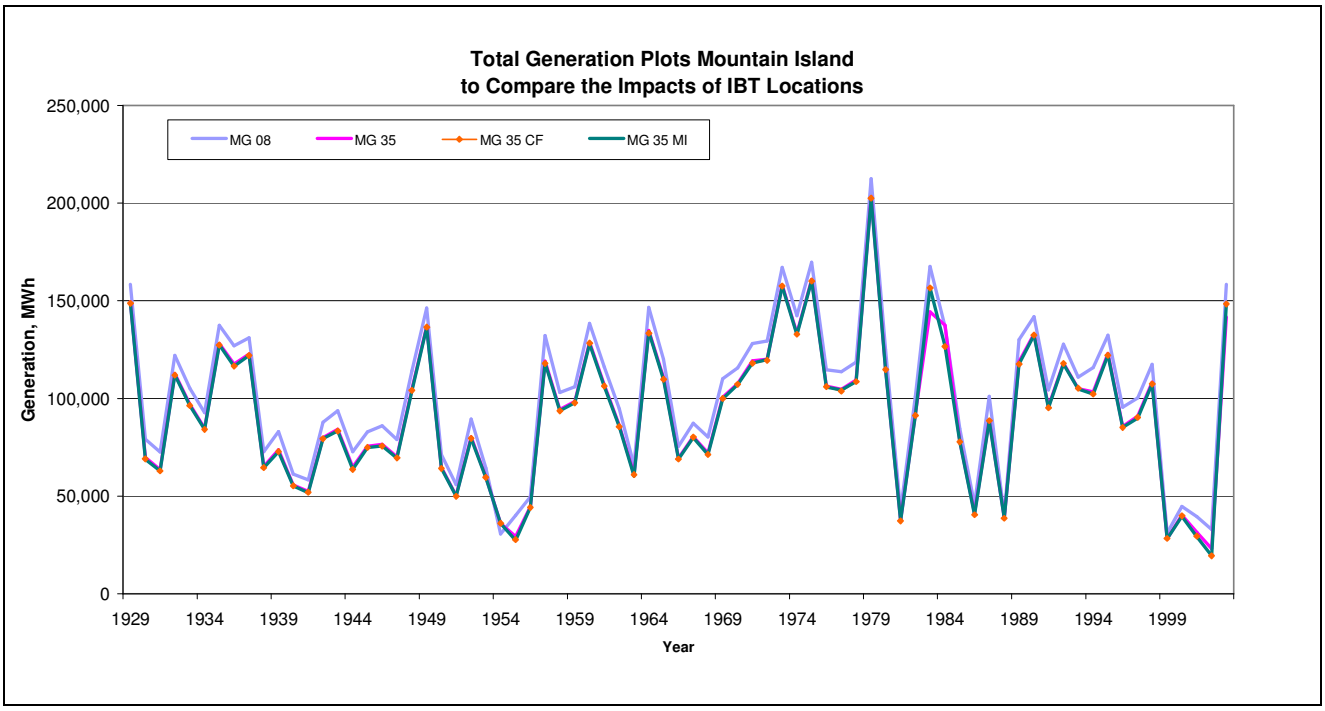

Figure 94: Annual Generation Plot of MI for Impacts of IBT Locations

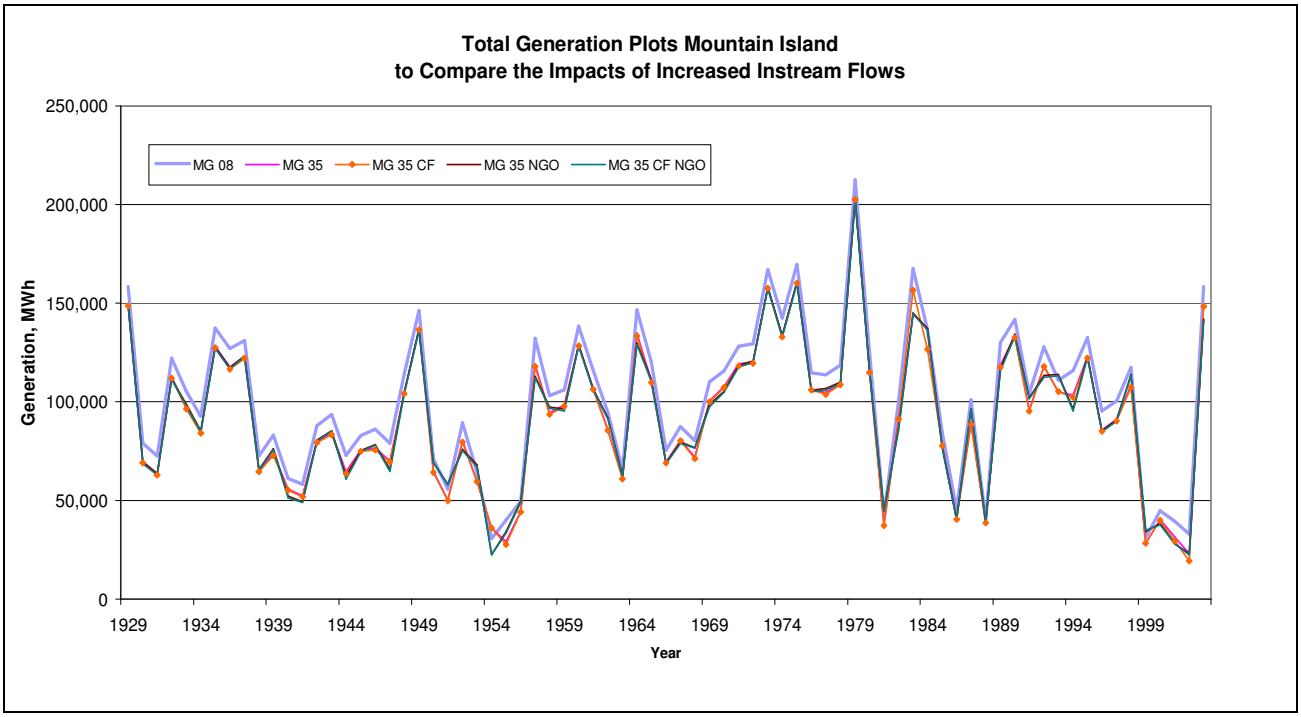

Figure 95: Annual Generation Plot of MI for Impacts of Increased Instream Flow Requirement with IBT

7) Wylie

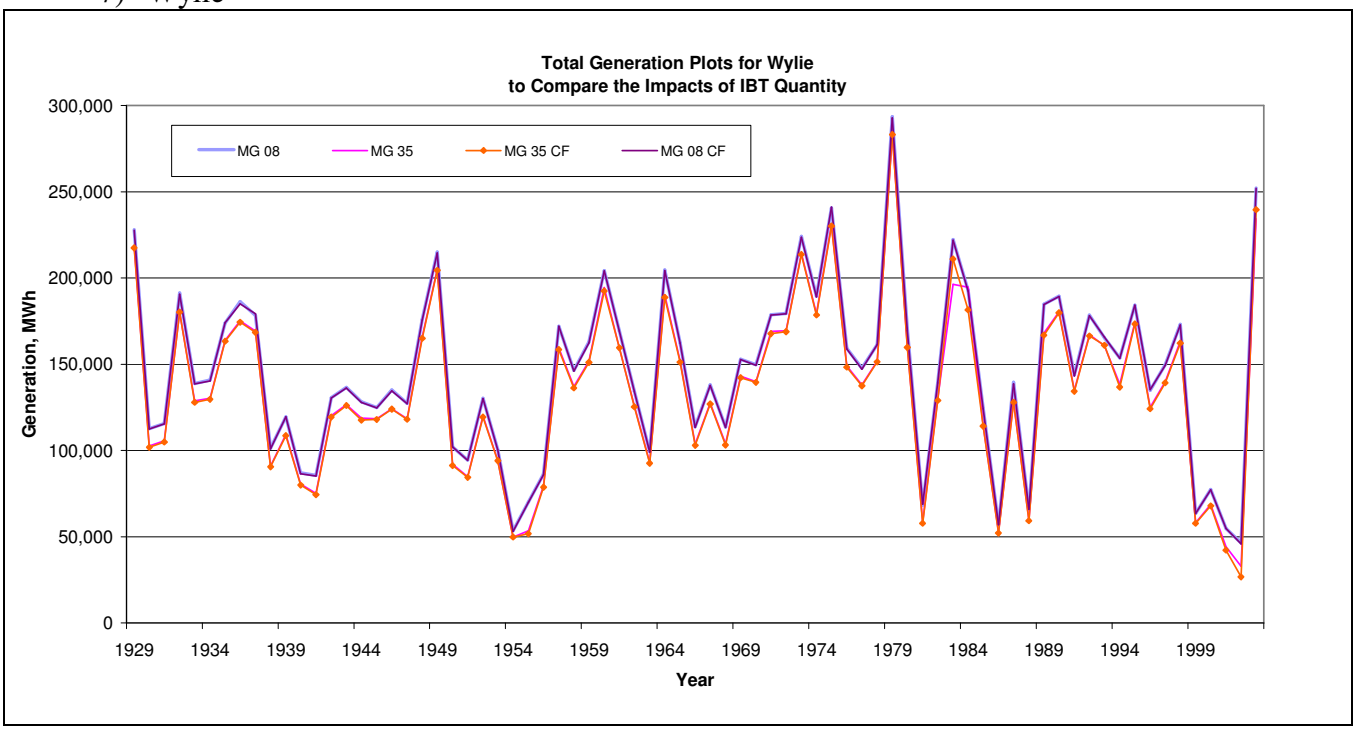

Figure 96: Annual Generation Plot of WY for Impacts of IBT Quantity

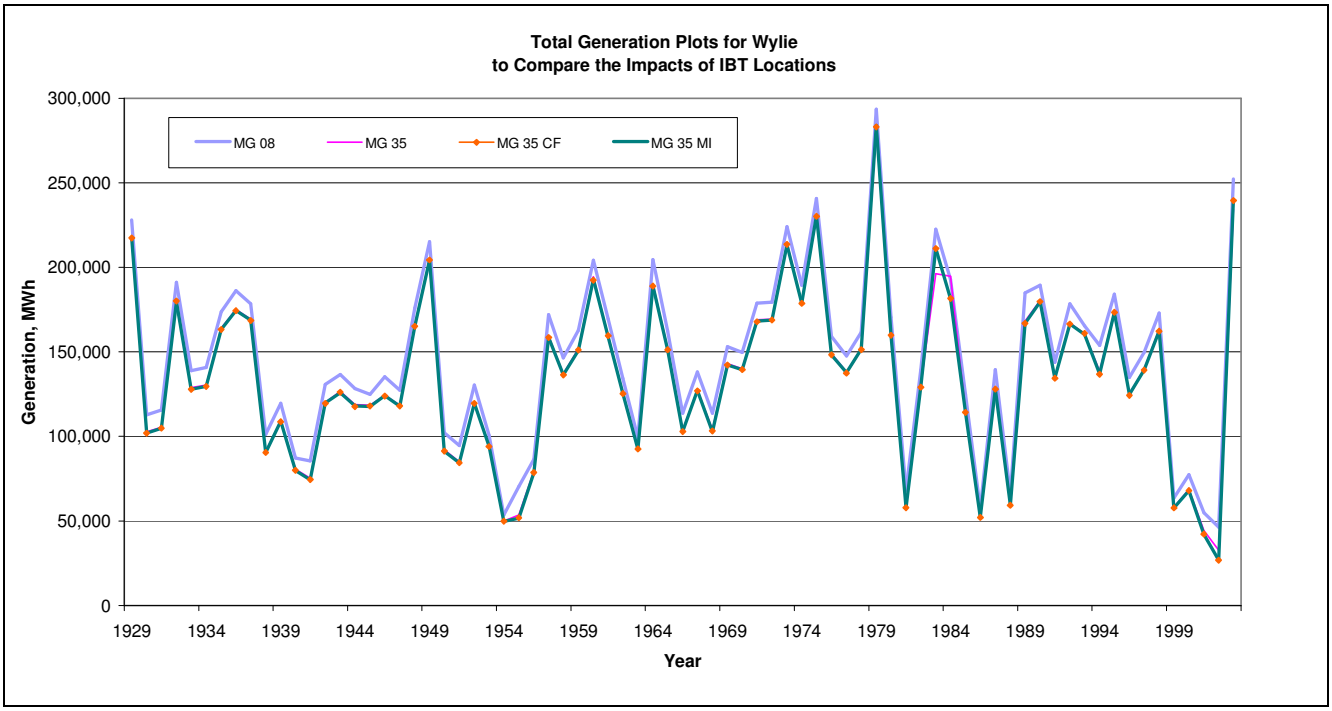

Figure 97: Annual Generation Plot of WY for Impacts of IBT Locations

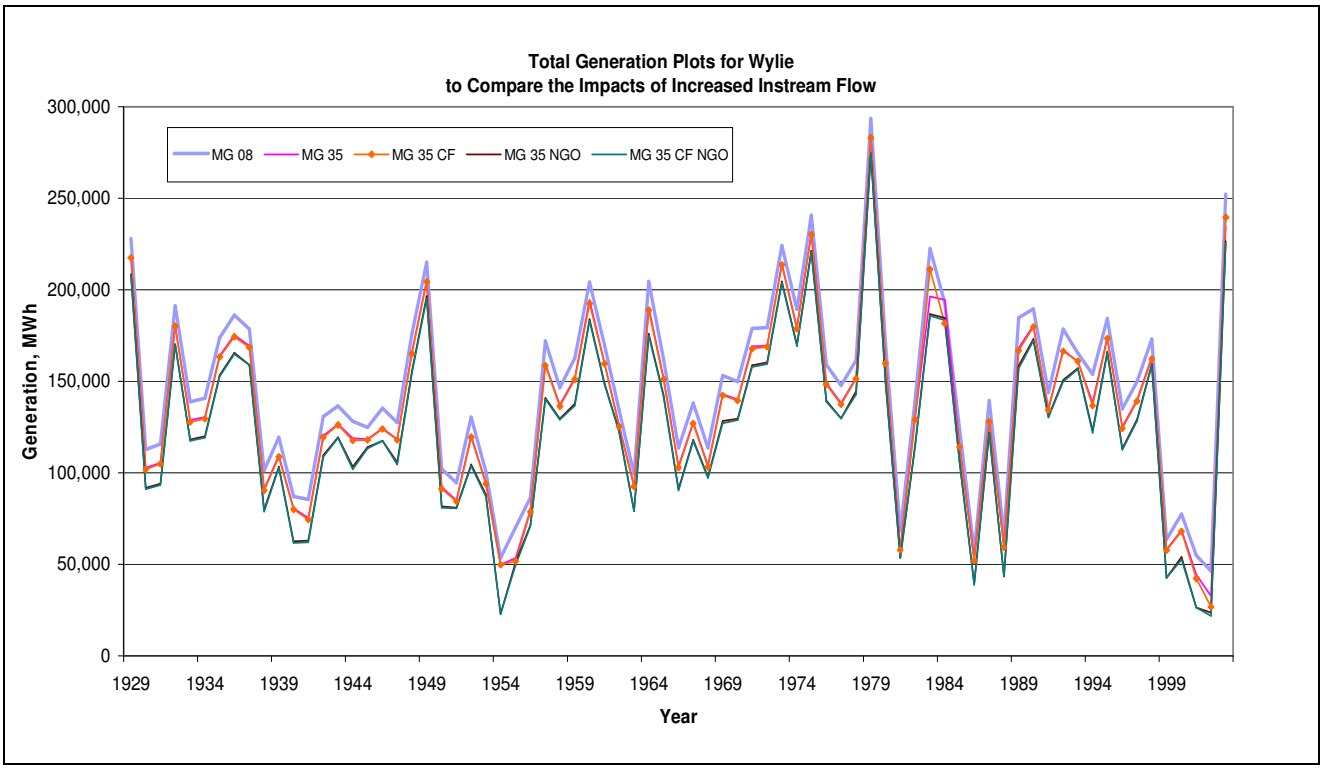

Figure 98: Annual Generation Plot of WY for Impacts of Increased Instream Flow Requirement with IBT

8) Fishing Creek

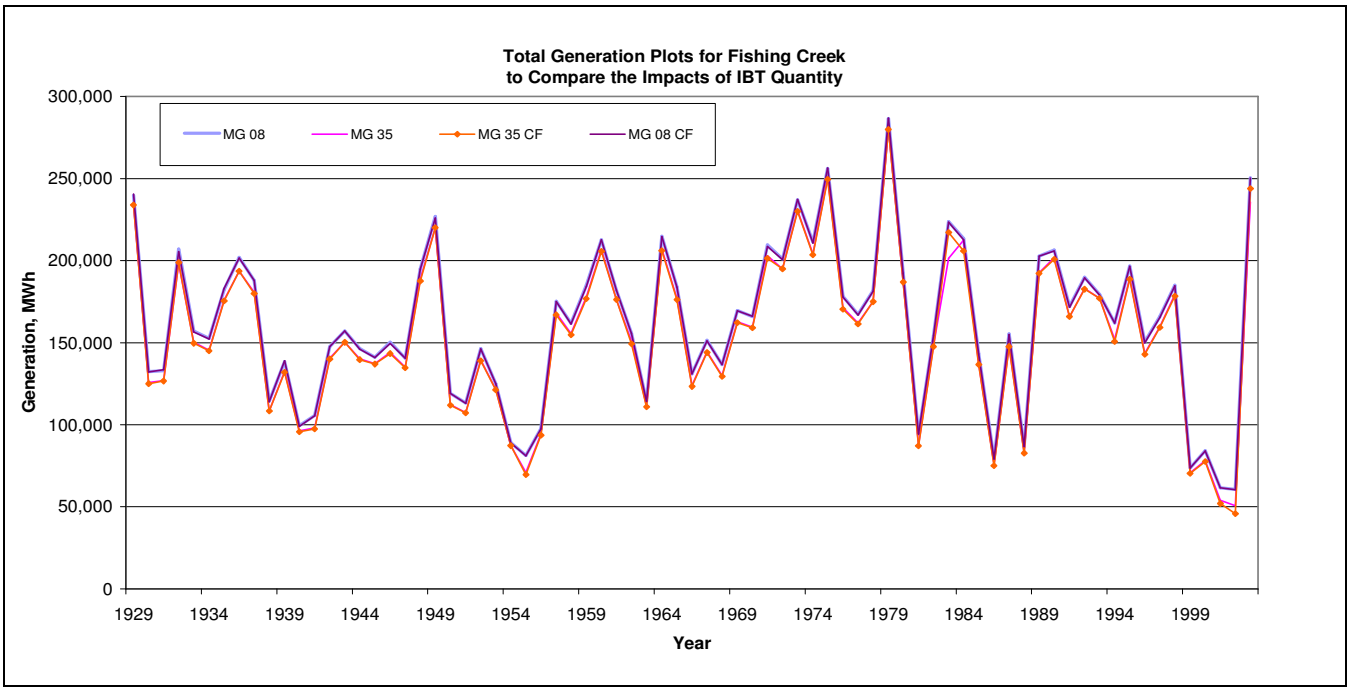

Figure 99: Annual Generation Plot of FC for Impacts of IBT Quantity

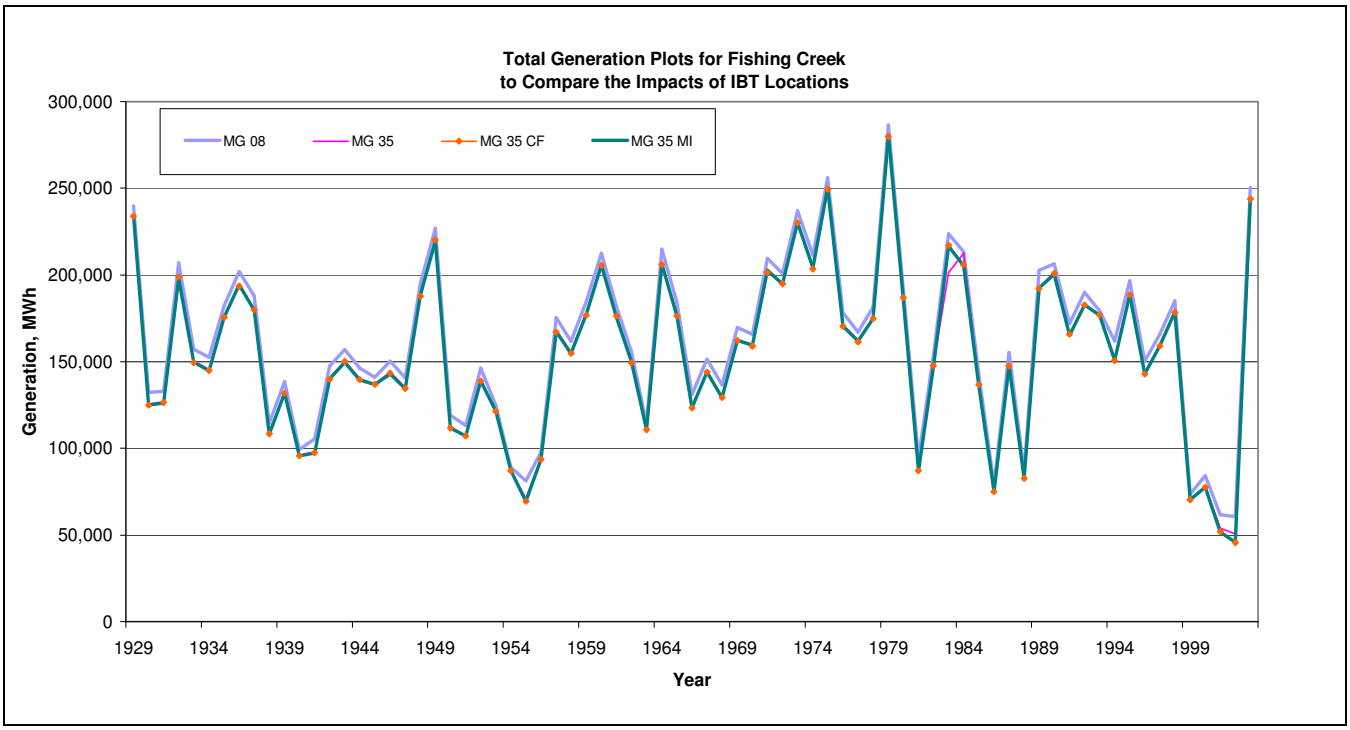

Figure 100: Annual Generation Plot of FC for Impacts of IBT Locations

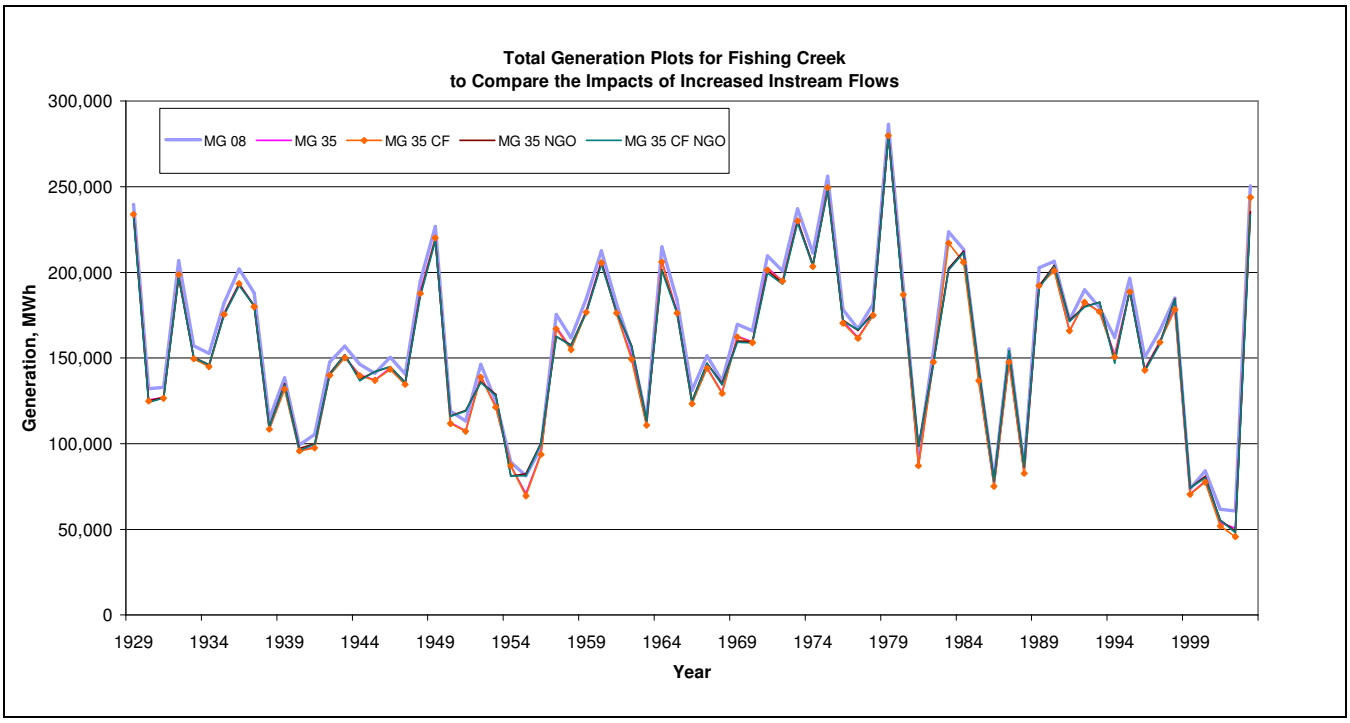

Figure 101: Annual Generation Plot of FC for Impacts of Increased Instream Flow Requirement with IBT

9) Great Falls

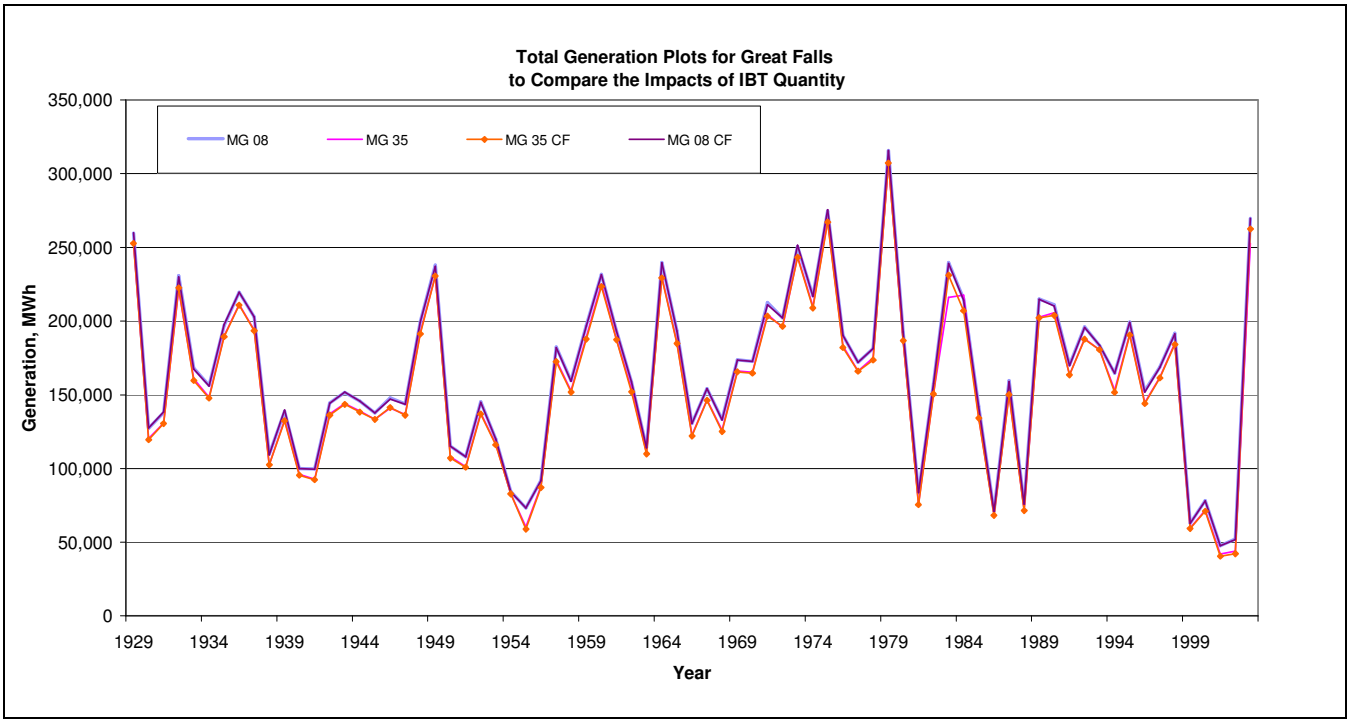

Figure 102: Annual Generation Plot of GF for Impacts of IBT Quantity

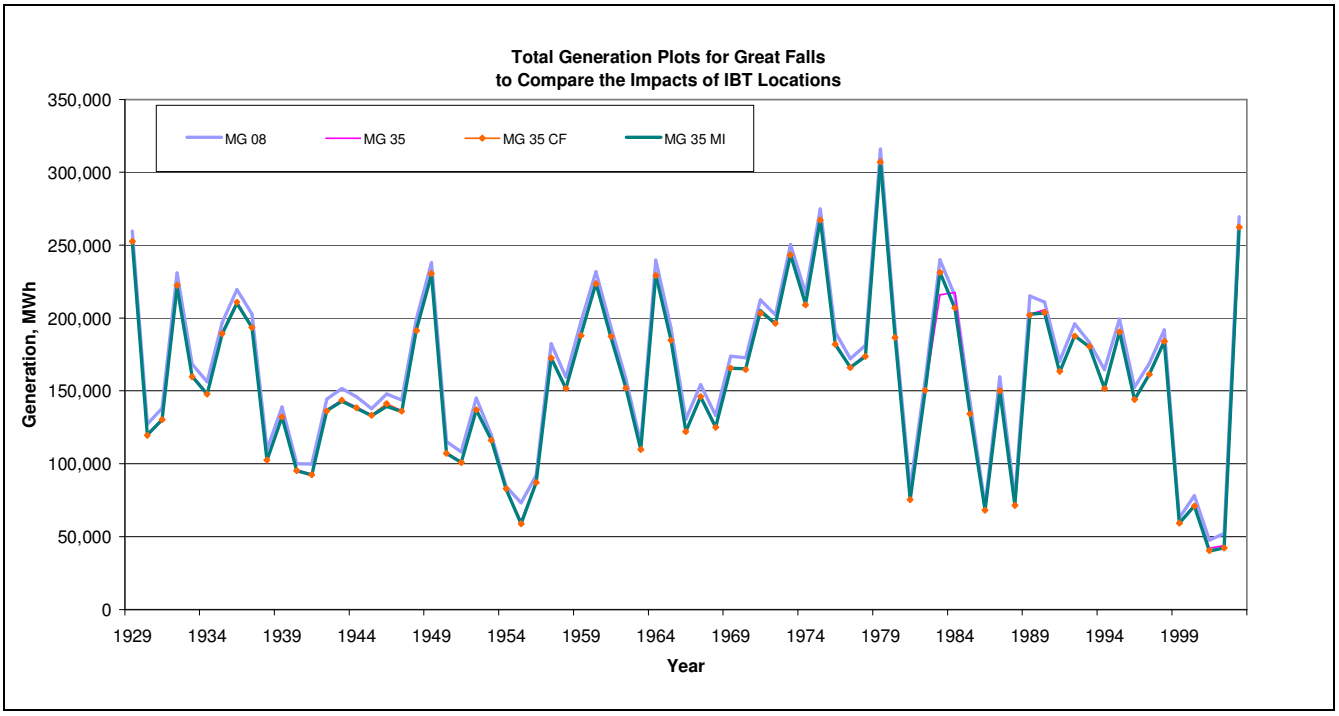

Figure 103: Annual Generation Plot of GF Impacts of IBT Locations

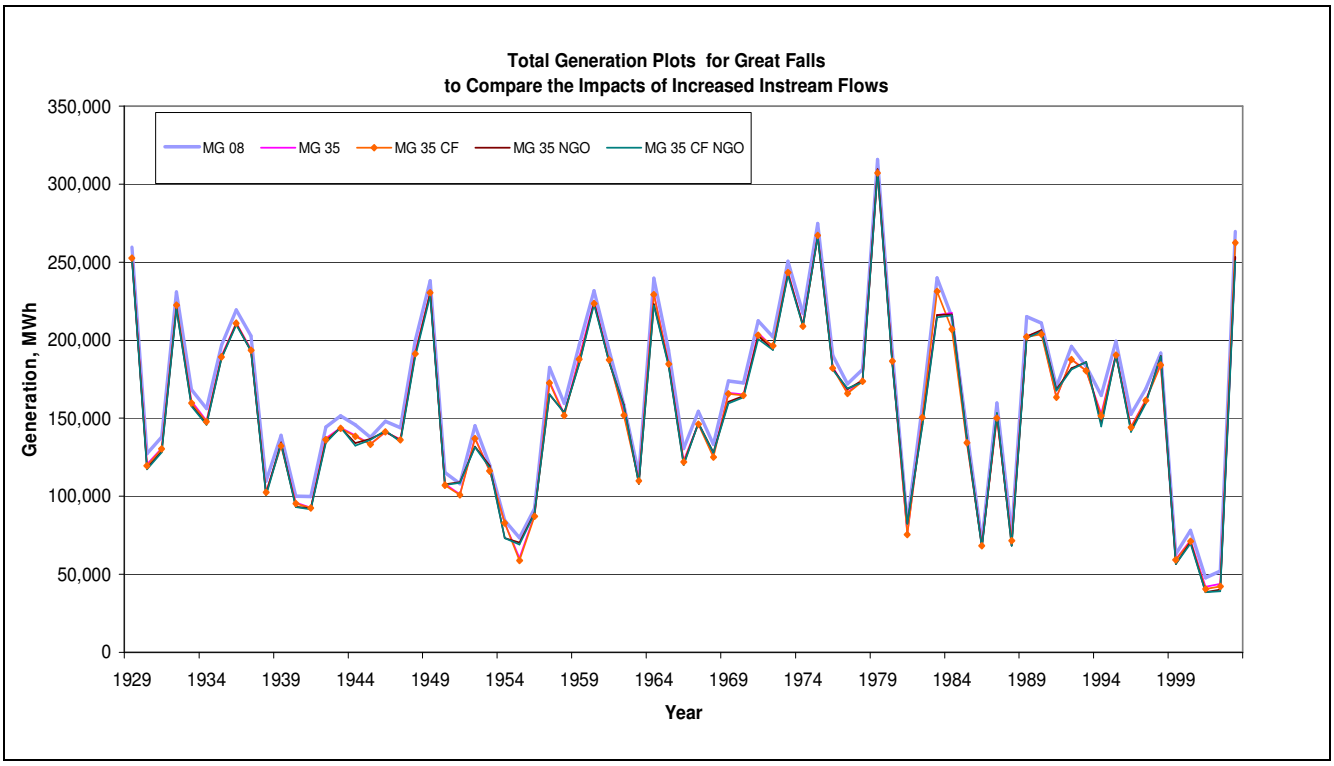

Figure 104: Annual Generation Plot of GF Impacts of Increased Instream Flow Requirement with IBT

10) Rocky Creek

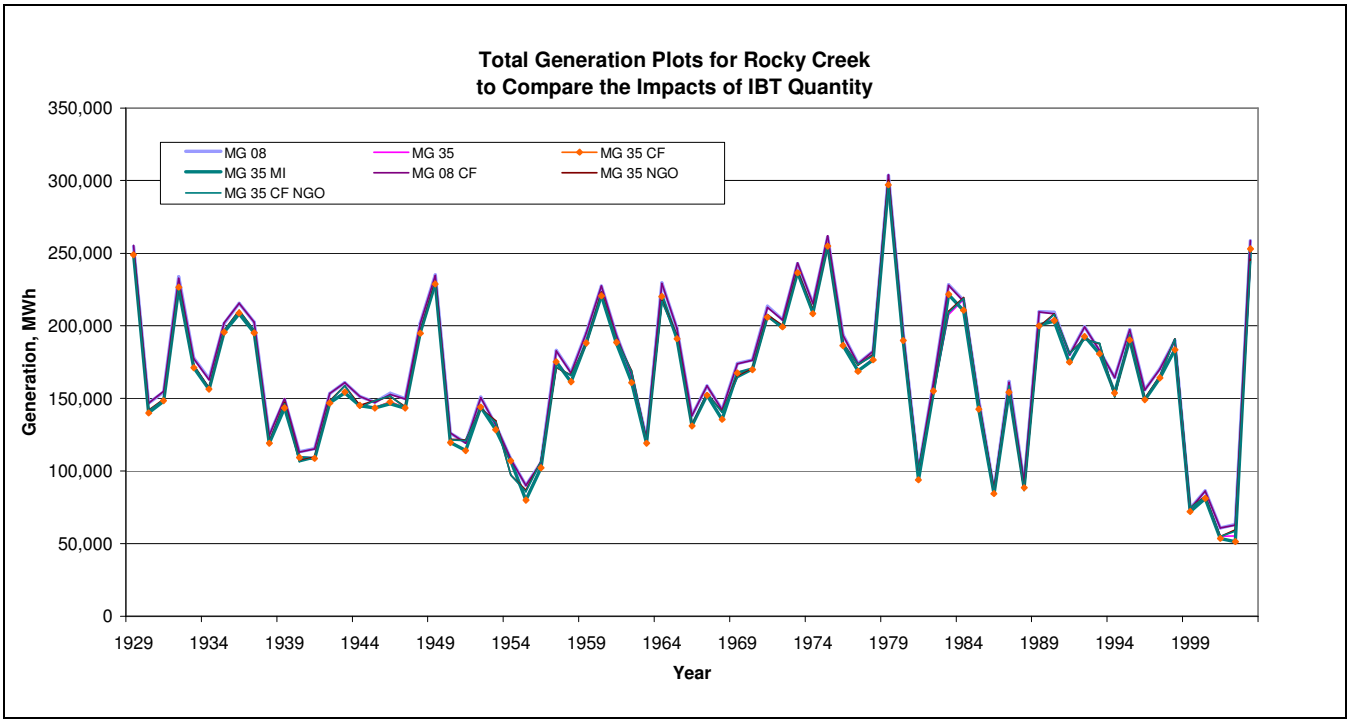

Figure 105: Annual Generation Plot of RCfor Impacts of IBT Quantity

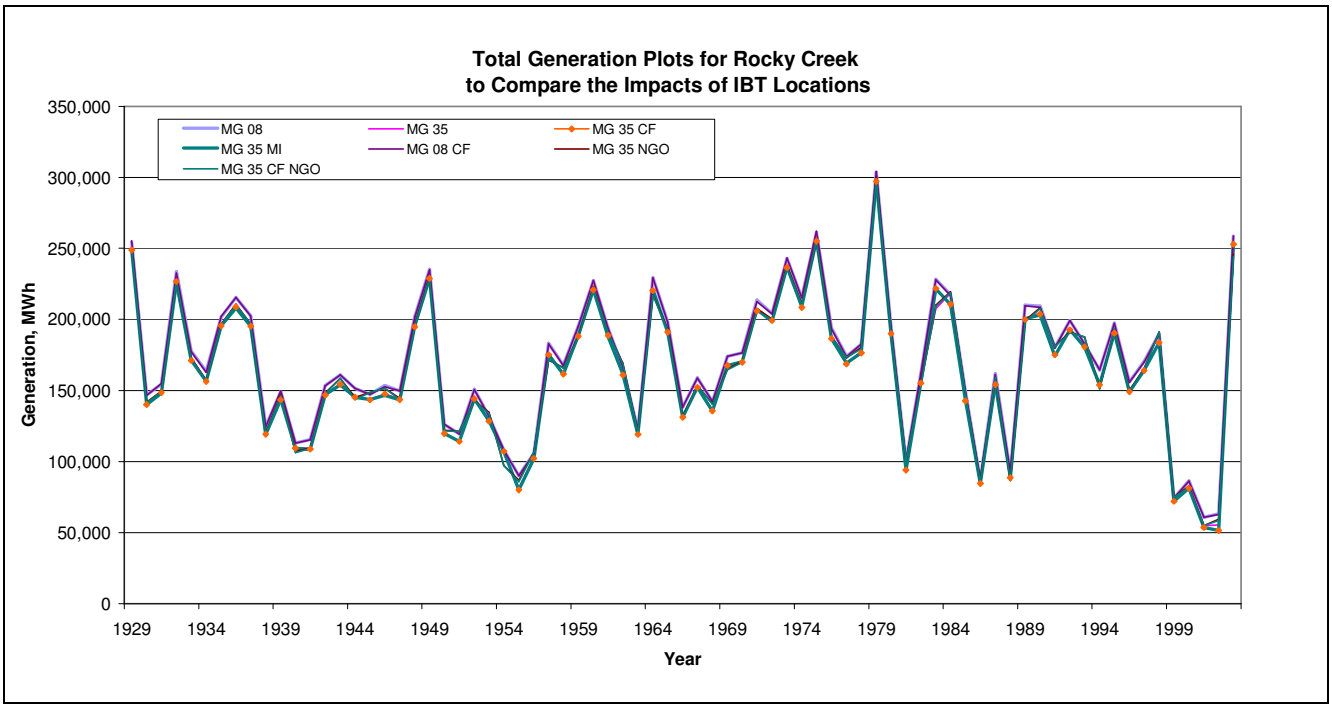

Figure 106: Annual Generation Plot of RC for Impacts of IBT Locations

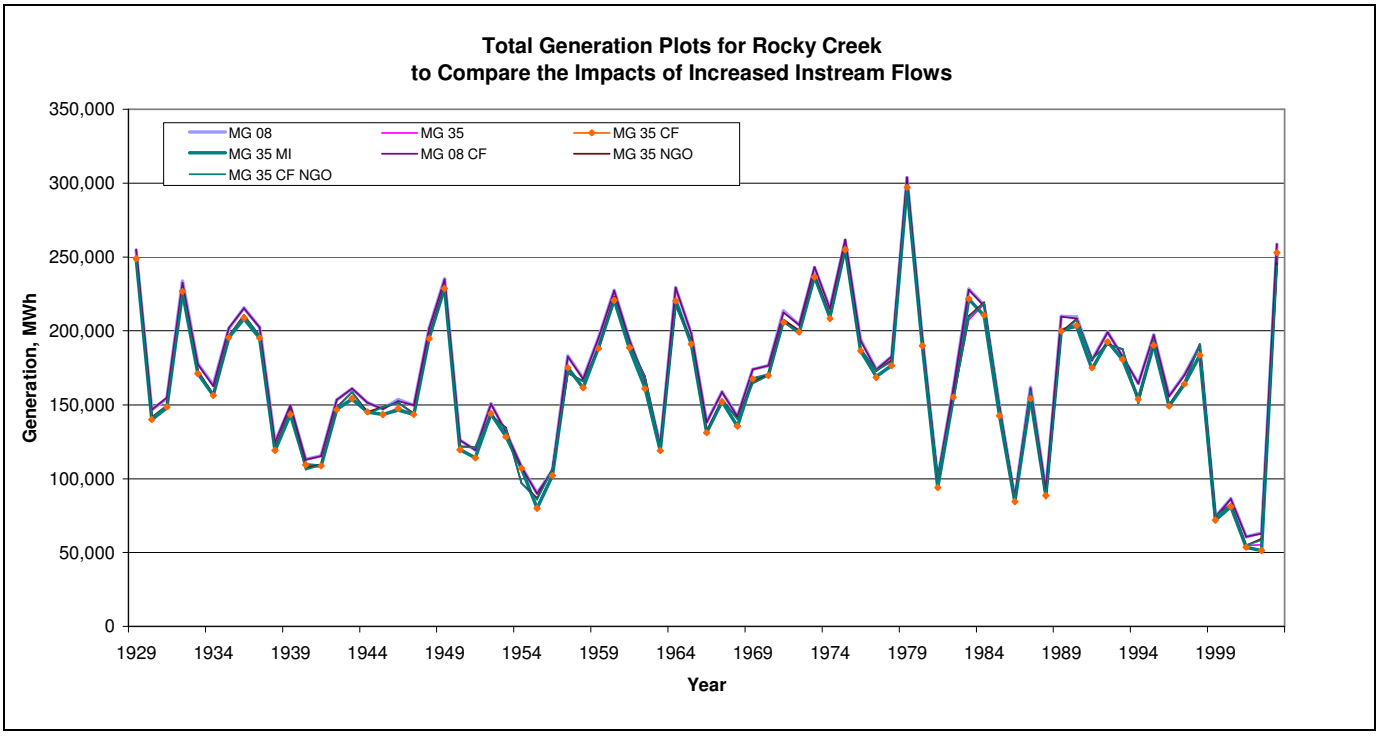

Figure 107: Annual Generation Plot of RC for Impacts of Increased Instream Flow Requirement with IBT

11) Wateree

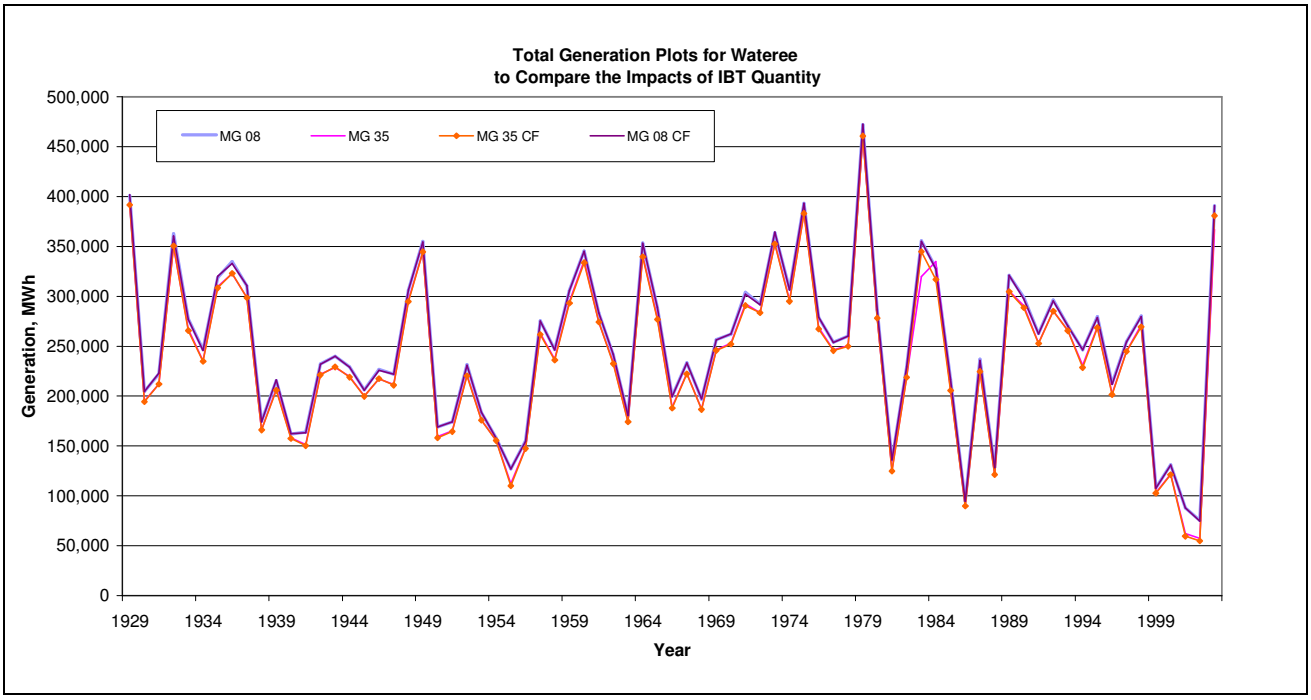

Figure 108: Annual Generation Plot of WA for Impacts of IBT Quantity

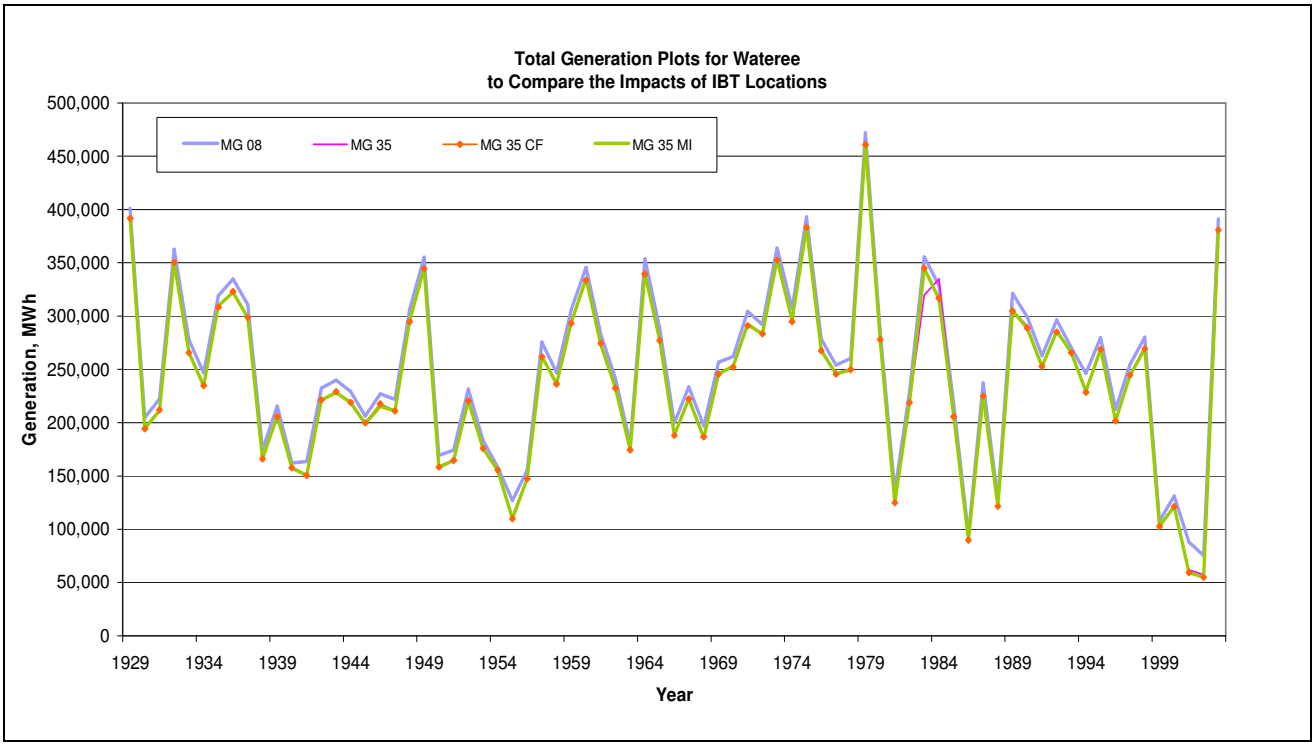

Figure 109: Annual Generation Plot of WA for Impacts of IBT Locations

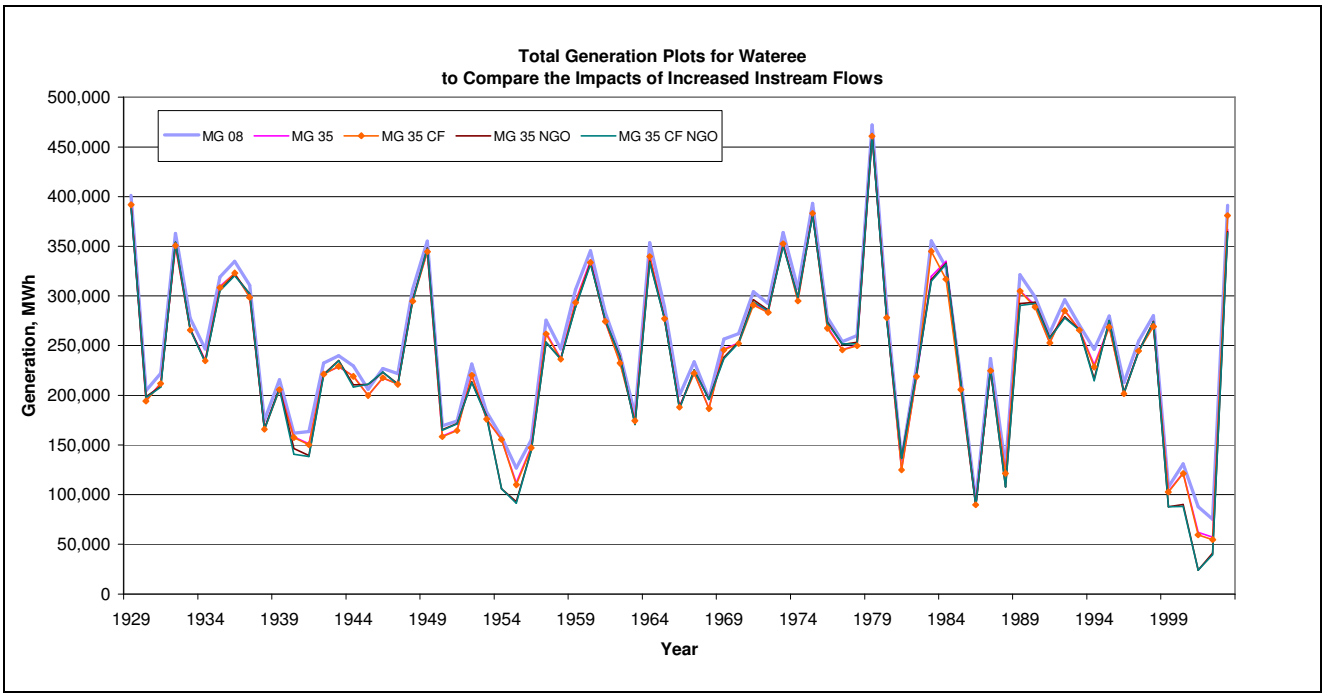

Figure 110: Annual Generation Plot of WA for Impacts of Increased Instream Flow Requirement with IBT

6. Generation Summary Table

Appendix – F [Generation Summary All.xls]

7. Performance Measure Sheets Table

Appendix – G [PMS- IBT.xls] contains the tables of performance measures for all 11 reservoirs and also the summary for the Catawba reservoir system.

The following 12 tables provide the same information for individual reservoirs.

Table 12 : Bridgewater Performances Sheet

Hydrology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
1													
5	Updated 06/01/05		Dates		MG 08	MG 08 CF	MG 35	MG 35 CF	MG 35 MI	MG 35 NGO	MG 35 CF NGO	MG 35 LIP	MG 35 CF LIP
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929-2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929-2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
7	Lake James (including the Catawba River Bypassed Reach, Paddy Creek Bypassed Reach and the Bridgewater Regulated River Reach)												
8	*Fish & Aquatic Interests*												
9	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	3,412	3,394	3,994	3,743	3,593	3,922	3,749	3,714	3,712
10		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	17,910	17,853	18,853	18,635	17,974	20,514	20,112	19,047	19,070
11		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	45,571	46,032	45,972	46,163	45,206	46,436	46,275	46,502	45,917
12	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	15%	15%	15%	14%	14%	16%	16%	15%	15%
13		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	22%	22%	21%	21%	21%	22%	23%	22%	21%
14		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	39%	38%	37%	37%	36%	36%	36%	37%	37%
15	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	21%	21%	20%	20%	19%	21%	21%	20%	20%
16		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	19%	19%	18%	18%	17%	17%	17%	18%	18%
17	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	108	108	111	111	112	119	119	109	109
23	*Recreation Interests*												
24	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 93.5 ft) during higher use months	01-Mar	31-Oct	30	30	34	34	34	35	35	30	32
25		Avg. days/yr lake level below critical level for public boat ramps (< 91.0 ft) (Note 3)	01-Jan	31-Dec	17	17	24	24	24	29	29	14	15
26	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<93.0 ft) (Note 4)	01-Jan	31-Dec	48	48	54	54	54	64	63	49	50
27	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	33%	33%	43%	36%	36%	43%	43%	21%	20%
32	*Water User Interests*												
33	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for hydro unit operation (≤ 61 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
35	Maximize low flows to maintain waste assimilation capacity of the regulated river reach.	Percent of days at or above approximate 7Q10 flow (148 cfs) released from the hydro development (RM 275.35) (Note 12)	01-Jan	31-Dec	76%	76%	76%	75%	75%	80%	80%	75%	74%
36		Lowest 7-day average flowrate (cfs) released from the hydro development (RM 275.35) for the evaluation period (Note 15)	01-Jan	31-Dec	110	110	110	110	110	125	125	100	101
37	*Other Interests*												
38	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 98.0 ft +/- 1 ft.)	01-Jan	31-Dec	18%	18%	17%	17%	17%	15%	15%	17%	17%
39		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 98.0 ft +/- 2 ft.)	01-Jan	31-Dec	42%	42%	40%	40%	40%	36%	36%	41%	41%
40		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 98.0 ft +/- 3 ft.)	01-Jan	31-Dec	62%	62%	60%	61%	60%	56%	56%	62%	61%
41	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	34%	34%	34%	34%	34%	30%	30%	34%	34%
42		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	51%	51%	49%	50%	49%	47%	47%	51%	50%
43		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	71%	71%	70%	70%	70%	68%	68%	70%	70%
44		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	18%	18%	19%	19%	19%	20%	20%	18%	18%
45	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	2,390	2,387	2,183	2,166	2,129	2,044	2,021	2,268	2,280
46		Days lake level at or above 103 ft	01-Jan	31-Dec	4	4	4	4	4	4	4	4	4

Table 13 : Rhodhiss Performances Sheet

ydrology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929 2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929 2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
50	Lake Rhodhiss												
51	*Fish & Aquatic Interests*												
52	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	13,060	13,153	14,341	14,535	15,384	15,085	15,260	14,151	14,371
53		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	37,955	37,910	41,333	41,675	42,634	45,123	45,044	40,525	41,133
54		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	64,855	64,796	69,623	69,993	70,800	71,809	72,028	69,274	69,738
55	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	34%	34%	33%	32%	32%	35%	35%	33%	32%
56		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	42%	42%	41%	40%	40%	43%	43%	41%	41%
57		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	70%	70%	69%	68%	67%	63%	63%	69%	68%
58	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	38%	38%	37%	36%	36%	35%	35%	36%	36%
59		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	41%	41%	40%	39%	39%	38%	38%	39%	39%
60	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	17	18	22	22	23	39	39	22	23
61	*Recreation Interests*												
62	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 94.0 ft) during higher use months	01-Mar	31-Oct	2	2	2	3	3	3	3	3	3
63		Avg. days/yr lake level below critical level for public boat ramps (< 90.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
64	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	161	162	167	169	170	186	186	169	169
65	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	15%	15%	15%	17%	17%	15%	15%	16%	17%
66	*Water User Interests*												
67	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest public water supply intake operation (≤ 89.4 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
68		Days at or below critical level for hydro unit operation (≤ 79.1 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
69	*Other Interests*												
70	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 97.0 ft +/- 1 ft.)	01-Jan	31-Dec	60%	60%	59%	59%	59%	52%	52%	59%	59%
71		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 97.0 ft +/- 2 ft.)	01-Jan	31-Dec	67%	67%	66%	67%	67%	61%	61%	66%	67%
72		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 97.0 ft +/- 3 ft.)	01-Jan	31-Dec	99%	99%	99%	99%	99%	99%	99%	99%	99%
73	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	58%	58%	57%	57%	57%	50%	50%	57%	57%
74		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	66%	66%	65%	66%	66%	60%	60%	65%	66%
75		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	99%	99%	99%	99%	99%	98%	99%	99%	99%
76		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%
77	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	7,680	7,695	7,259	7,123	7,081	7,126	7,146	7,226	7,097
78		Days lake level at or above 103 ft	01-Jan	31-Dec	16	16	15	15	15	16	15	15	15
79													

Table 14: Oxford Performance Sheet

Hydrology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929 2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929 2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
90	Lake Hickory (Including the Oxford Regulated River Reach)												
91	*Fish & Aquatic Interests*												
92	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	9,096	8,828	9,142	9,654	9,778	8,569	8,726	8,902	9,719
93		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	33,059	32,359	35,007	35,605	35,865	34,007	33,784	34,989	36,889
94		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	59,603	58,996	61,544	62,079	61,581	59,903	60,123	61,545	63,804
95	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	35%	35%	34%	33%	33%	36%	36%	34%	33%
96		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	42%	42%	41%	40%	40%	42%	42%	41%	40%
97		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	62%	62%	61%	60%	60%	58%	58%	61%	60%
98	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	38%	38%	35%	35%	34%	34%	34%	35%	34%
99		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	39%	39%	36%	36%	36%	35%	35%	36%	36%
90	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	21	21	26	26	27	39	40	26	27
91	Provide for aquatic habitat in the regulated river reach	Percent of hours at or above 400 cfs released from the hydro development (Note 16)	01-Jan	31-Dec	52%	52%	50%	50%	50%	96%	96%	50%	50%
92	Minimize days of critically low aquatic habitat in the regulated river reach	Avg. days/yr <= 250 cfs released from the hydro development (Note 16)	01-Jan	31-Dec	123	123	128	129	129	3	3	128	129
93	*Recreation Interests*												
94	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 94.0 ft) during higher use months	01-Mar	31-Oct	1	1	1	2	2	12	12	1	2
95		Avg. days/yr lake level below critical level for public boat ramps (< 91.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
96	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	181	182	190	191	192	204	204	192	193
97	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	14%	14%	14%	14%	14%	21%	21%	14%	14%
98	Maximize days/yr of boating opportunities in the regulated river reach	Avg. days/yr of daytime flows ≥ 2500, ≤ 5500 cfs released from the hydro development for at least 2 hrs/day during higher use months (Note 20)	01-Mar	31-Oct	164	164	167	168	167	150	150	167	167
99	*Water User Interests*												
100	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest public water supply intake operation (≤ 94 ft) (Note 3)	01-Jan	31-Dec	105	97	187	225	236	1,153	1,190	180	210
101		Days at or below critical level for hydro unit operation (≤ 73 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
102	Maximize low flows to maintain waste assimilation capacity of the regulated river reach.	Percent of days at or above approximate 7Q10 flow (374 cfs) released from the hydro development (RM 230) (Note 12)	01-Jan	31-Dec	99%	99%	99%	99%	99%	100%	100%	99%	98%
103		Lowest 7-day average flowrate (cfs) released from the hydro development (RM 230) for the evaluation period (Note 15)	01-Jan	31-Dec	200	200	165	165	165	267	267	148	148
104	*Other Interests*												
105	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 97.0 ft +/- 1 ft.)	01-Jan	31-Dec	55%	55%	55%	55%	55%	49%	49%	55%	55%
106		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 97.0 ft +/- 2 ft.)	01-Jan	31-Dec	66%	66%	66%	66%	66%	61%	61%	66%	66%
107		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 97.0 ft +/- 3 ft.)	01-Jan	31-Dec	100%	100%	100%	100%	100%	98%	98%	100%	100%
108	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	57%	57%	56%	57%	56%	51%	50%	57%	57%
109		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	65%	65%	65%	65%	65%	61%	60%	65%	65%
110		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	91%	91%	92%	92%	92%	92%	92%	92%	92%
111		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	2%	2%	0%	0%
112	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	7,422	7,425	6,961	6,809	6,771	6,496	6,549	6,928	6,803
113		Days at or above 43000 cfs released from the hydro development (Note 21)	01-Jan	31-Dec	1	1	1	1	1	0	0	1	1
114													

Table 15: Lookout Shoals Performance Sheet

rology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measure

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929-2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929-2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
115	Lookout Shoals Lake (including the Lookout Shoals Regulated River Reach)												
116	*Fish & Aquatic Interests*												
117	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	41,395	41,240	39,885	40,790	41,545	35,350	35,530	40,315	40,598
118		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	70,716	70,697	69,280	70,748	70,559	63,956	65,738	69,726	70,697
119		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	91,549	90,762	90,257	92,016	91,654	84,509	86,349	90,565	92,765
120	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	46%	46%	46%	46%	45%	46%	45%	46%	45%
121		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	56%	56%	57%	56%	56%	55%	55%	56%	56%
122		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	69%	69%	69%	69%	69%	66%	65%	69%	69%
123	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	51%	51%	50%	49%	49%	47%	47%	50%	49%
124		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	53%	53%	52%	52%	51%	50%	50%	51%	51%
125	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	35	36	39	39	39	49	50	39	39
126	Provide for aquatic habitat in the regulated river reach	Percent of hours at or above 400 cfs released from the hydro development (Note 16)	01-Jan	31-Dec	61%	61%	60%	60%	59%	63%	64%	60%	59%
127	Minimize days of critically low aquatic habitat in the regulated river reach	Avg. days/yr <= 250 cfs released from the hydro development (Note 16)	01-Jan	31-Dec	164	164	171	171	172	166	166	171	172
128	*Recreation Interests*												
129	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 92.0 ft) during higher use months	01-Mar	31-Oct	0	0	0	0	0	0	0	0	0
130		Avg. days/yr lake level below critical level for public boat ramps (< 91.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
131	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	150	150	155	156	157	165	167	156	156
132	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	10%	10%	14%	13%	13%	12%	10%	11%	13%
133	*Water User Interests*												
134	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest public water supply intake operation (≤ 74.9 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
135		Days at or below critical level for hydro unit operation (≤ 72.9 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
136	*Other Interests*												
137	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 97.0 ft +/- 1 ft.)	01-Jan	31-Dec	45%	44%	44%	44%	44%	38%	38%	44%	45%
138		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 97.0 ft +/- 2 ft.)	01-Jan	31-Dec	60%	60%	60%	60%	61%	56%	56%	60%	61%
139		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 97.0 ft +/- 3 ft.)	01-Jan	31-Dec	97%	97%	97%	97%	97%	97%	97%	97%	97%
140	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	41%	41%	41%	41%	41%	36%	36%	41%	41%
141		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	58%	58%	58%	57%	58%	53%	54%	58%	58%
142		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	96%	96%	96%	96%	96%	96%	96%	96%	96%
143		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%
144	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	9,419	9,400	8,944	8,882	8,859	8,629	8,632	8,891	8,798
145		Days lake level at or above 103 ft	01-Jan	31-Dec	43	43	43	44	44	42	43	43	43
146		Days at or above 19800 cfs released from the hydro development (Note 21)	01-Jan	31-Dec	50	49	50	51	50	49	51	50	51
147													

Table 16: Cowan Ford [Norman] Performance Sheet

drology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929 2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929 2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
148	Lake Norman												
149	*Fish & Aquatic Interests*												
150	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	2,075	2,074	1,983	2,087	2,058	2,000	1,987	1,949	2,078
151		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	3,672	3,674	3,401	3,480	3,714	3,387	3,374	3,397	3,690
152		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	5,423	5,403	5,049	5,162	5,246	5,761	5,588	5,035	5,079
153	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	28%	27%	25%	25%	25%	23%	23%	25%	25%
154		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	49%	48%	45%	45%	45%	39%	39%	45%	45%
155		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	81%	81%	80%	80%	81%	75%	74%	79%	80%
156	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	54%	54%	49%	49%	50%	43%	42%	49%	49%
157		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	41%	40%	36%	36%	36%	31%	30%	36%	36%
158	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	33	33	38	38	37	48	50	38	37
159	*Recreation Interests*												
160	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 96.0 ft) during higher use months	01-Mar	31-Oct	13	13	20	19	18	30	33	21	19
161		Avg. days/yr lake level below critical level for public boat ramps (< 91.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
162	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<95.0 ft) (Note 4)	01-Jan	31-Dec	23	23	29	26	25	41	45	29	26
163	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	15%	15%	17%	15%	15%	21%	21%	19%	15%
164	*Water User Interests*												
165	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest thermal power station operation (≤ 90 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
166		Days at or below critical level for shallowest public water supply intake operation (≤ 85 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
167		Days at or below critical level for shallowest industrial intake operation (≤ 75 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
168		Days at or below critical level for hydro unit operation (≤ 65 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
169	*Other Interests*												
170	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 98.0 ft +/- 1 ft.)	01-Jan	31-Dec	44%	45%	46%	46%	46%	42%	42%	46%	46%
171		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 98.0 ft +/- 2 ft.)	01-Jan	31-Dec	84%	84%	82%	82%	82%	76%	75%	81%	82%
172		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 98.0 ft +/- 3 ft.)	01-Jan	31-Dec	94%	94%	93%	94%	94%	90%	89%	93%	94%
173	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	69%	69%	71%	71%	71%	67%	66%	71%	71%
174		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	85%	85%	85%	86%	86%	84%	83%	85%	86%
175		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	89%	89%	90%	92%	91%	92%	92%	90%	92%
176		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%
177	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	5,021	5,006	4,057	3,895	3,964	3,537	3,401	3,978	3,893
178													

Table 17: Mountain Island Performance Sheet

ology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measure

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929 2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929 2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
179	Mt Island Lake (including the Mt Island Bypassed Reach)												
180	*Fish & Aquatic Interests*												
181	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	25,147	25,230	23,943	23,909	23,791	22,687	22,071	24,035	24,416
182		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	52,999	52,326	51,849	53,627	53,086	49,977	49,214	52,537	53,700
183		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	75,657	74,777	79,200	78,984	79,057	74,032	74,792	78,749	79,068
184	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	35%	35%	30%	29%	29%	32%	32%	30%	29%
185		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	47%	46%	41%	40%	39%	42%	42%	41%	40%
186		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	59%	59%	53%	52%	51%	53%	54%	53%	52%
187	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	41%	41%	35%	34%	33%	34%	34%	35%	34%
188		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	45%	45%	39%	39%	38%	37%	37%	39%	39%
189	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	55	55	67	68	69	75	75	67	68
190	*Recreation Interests*												
191	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 91.0 ft) during higher use months	01-Mar	31-Oct	0	0	0	0	0	0	0	0	0
192		Avg. days/yr lake level below critical level for public boat ramps (< 91.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
193	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<96.0 ft) (Note 4)	01-Jan	31-Dec	119	118	142	145	146	158	158	142	145
194	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	18%	18%	19%	19%	19%	19%	19%	20%	20%
195	*Water User Interests*												
196	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest thermal power station operation (≤ 94.3 ft) (Note 3)	01-Jan	31-Dec	590	589	1,542	1,695	1,892	1,872	1,939	1,615	1,759
197		Days at or below critical level for shallowest public water supply intake operation (≤ 88 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
198		Days at or below critical level for hydro unit operation (≤ 77.5 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
199	*Other Interests*												
200	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 96.0 ft +/- 1 ft.)	01-Jan	31-Dec	41%	41%	41%	42%	41%	39%	39%	41%	41%
201		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 96.0 ft +/- 2 ft.)	01-Jan	31-Dec	63%	63%	68%	68%	69%	70%	70%	68%	68%
202		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 96.0 ft +/- 3 ft.)	01-Jan	31-Dec	73%	73%	77%	78%	78%	79%	79%	77%	78%
203	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	37%	37%	37%	37%	37%	35%	35%	37%	37%
204		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	59%	59%	64%	64%	65%	65%	65%	64%	64%
205		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	70%	70%	75%	75%	76%	76%	76%	75%	75%
206		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	1%	1%	2%	2%	2%	1%	2%	2%	2%
207	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	4,398	4,402	3,262	3,121	3,122	2,970	2,849	3,211	3,125
208		Days lake level at or above 103 ft	01-Jan	31-Dec	17	17	16	16	16	16	16	15	16
209													

Table 18: Wylie Performance Sheet

Hydrology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929-2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929-2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
210	Lake Wylie (including the Wylie Regulated River Reach)												
211	*Fish & Aquatic Interests*												
212	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	3,027	3,181	3,713	3,605	3,688	3,192	3,279	3,583	3,573
213		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	21,413	20,976	24,264	23,589	23,653	23,062	22,680	23,752	23,093
214		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	54,656	53,991	58,651	58,494	58,339	59,080	59,829	58,470	57,189
215	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	23%	23%	20%	19%	19%	20%	19%	20%	19%
216		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	29%	29%	25%	25%	24%	26%	25%	25%	24%
217		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	46%	46%	41%	41%	41%	42%	42%	41%	40%
218	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	23%	23%	19%	19%	19%	19%	19%	19%	19%
219		Percent of time of lake levels >= 97 ft during the growing season	01-Apr	30-Sep	36%	36%	31%	31%	31%	31%	31%	31%	31%
220		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	27%	27%	23%	22%	22%	20%	20%	23%	22%
221	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	31	31	44	44	45	59	59	44	45
228	*Recreation Interests*												
229	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 95.5 ft) during higher use months	01-Mar	31-Oct	39	39	56	56	57	71	71	55	56
230		Avg. days/yr lake level below critical level for public boat ramps (< 92.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	1	1	0	0
231	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	224	224	240	242	242	257	258	240	242
232	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	18%	18%	18%	18%	18%	27%	29%	18%	18%
237	*Water User Interests*												
238	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest industrial intake operation (≤ 92.6 ft) (Note 3)	01-Jan	31-Dec	81	81	171	290	293	296	320	103	241
239		Days at or below critical level for shallowest public water supply intake operation (≤ 92 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	96	108	0	0
240		Days at or below critical level for shallowest thermal power station operation (≤ 90 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	27	46	0	0
241		Days at or below critical level for hydro unit operation (≤ 74 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
246	Maximize low flows to maintain waste assimilation capacity of the regulated river reach.	Percent of days at or above approximate 7Q10 flow (450 cfs) released from the hydro development (RM 139.63) (Note 12)	01-Jan	31-Dec	100%	100%	100%	100%	100%	100%	100%	100%	100%
247		Lowest 7-day average flowrate (cfs) released from the hydro development (RM 139.63) for the evaluation period (Note 15)	01-Jan	31-Dec	887	886	855	859	859	800	800	700	764
248	*Other Interests*												
249	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e., 97.0 ft +/- 1 ft.)	01-Jan	31-Dec	59%	59%	56%	57%	56%	50%	50%	56%	56%
250		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e., 97.0 ft +/- 2 ft.)	01-Jan	31-Dec	71%	71%	69%	69%	69%	63%	63%	69%	69%
251		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e., 97.0 ft +/- 3 ft.)	01-Jan	31-Dec	95%	95%	91%	91%	91%	84%	84%	91%	91%
252	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	59%	59%	55%	56%	55%	50%	50%	56%	56%
253		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	70%	70%	68%	69%	69%	62%	62%	68%	69%
254		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	95%	95%	91%	91%	91%	84%	84%	91%	91%
255		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	5%	5%	8%	8%	8%	14%	15%	8%	8%
256	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	2,954	2,943	2,289	2,178	2,188	1,990	1,948	2,289	2,205
257		Days at or above 39400 cfs at Node 1 (RM 139.63) (Note 21)	01-Jan	31-Dec									
258													

Table 19: Fishing Creek Performance Sheet

Hydrology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measu

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929 2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929 2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
259	Fishing Creek Reservoir												
260	*Fish & Aquatic Interests*												
261	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	29,540	29,054	29,576	29,128	29,132	29,807	29,137	28,699	28,992
262		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	57,822	57,380	57,019	57,367	57,456	57,444	58,135	57,124	57,143
263		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	75,663	75,154	75,036	75,237	75,305	75,395	76,097	75,023	74,915
264	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	49%	49%	49%	48%	48%	48%	48%	49%	49%
265		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	65%	65%	64%	64%	64%	62%	62%	64%	64%
266		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	82%	82%	82%	82%	82%	80%	80%	82%	82%
267	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	62%	62%	61%	61%	61%	59%	59%	61%	61%
268		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	65%	65%	65%	65%	65%	64%	64%	65%	65%
269	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	16	15	16	16	16	16	17	16	16
270	*Recreation Interests*												
271	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 95.0 ft) during higher use months	01-Mar	31-Oct	0	0	0	0	0	0	0	0	0
272		Avg. days/yr lake level below critical level for public boat ramps (< 93.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
273	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	93	94	92	93	92	96	98	93	92
274	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	18%	17%	18%	18%	18%	18%	18%	18%	18%
275	*Water User Interests*												
276	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest public water supply intake operation (≤ 95 ft) (Note 3)	01-Jan	31-Dec	14	10	11	9	7	13	16	10	6
277		Days at or below critical level for shallowest industrial intake operation (≤ 90.8 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
278		Days at or below critical level for hydro unit operation (≤ 77.9 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
279	*Other Interests*												
280	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 97.0 ft +/- 1 ft.)	01-Jan	31-Dec	51%	51%	51%	51%	51%	49%	49%	51%	51%
281		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 97.0 ft +/- 2 ft.)	01-Jan	31-Dec	98%	98%	97%	97%	97%	98%	97%	98%	98%
282		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 97.0 ft +/- 3 ft.)	01-Jan	31-Dec	100%	100%	100%	100%	100%	100%	100%	100%	100%
283	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	49%	49%	49%	49%	49%	47%	47%	49%	49%
284		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	98%	98%	97%	97%	97%	98%	97%	98%	98%
285		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	100%	100%	100%	100%	100%	100%	100%	100%	100%
286		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%
287	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	10,796	10,792	10,778	10,687	10,701	11,220	11,171	10,730	10,655
288													

Table 20: Great Falls Performance Sheet

/drology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929-2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929-2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
289	Great Falls-Dearborn Reservoir (including the Great Falls Long Bypassed Reach and the Great Falls Short Bypassed Reach)												
290	***Fish & Aquatic Interests***												
291	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	49,577	50,659	48,160	49,234	49,135	48,063	49,226	48,323	50,051
292		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	79,655	81,085	78,784	79,999	79,632	72,798	73,991	79,038	81,239
293		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	103,755	105,192	102,720	104,217	103,732	88,084	89,637	103,045	105,212
294	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	44%	44%	44%	43%	43%	44%	44%	44%	43%
295		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	57%	57%	57%	57%	57%	55%	55%	57%	56%
296		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	71%	71%	71%	71%	71%	66%	65%	71%	70%
297	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	56%	55%	56%	55%	55%	52%	52%	55%	55%
298		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	57%	57%	57%	57%	57%	56%	56%	57%	57%
299	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	28	28	27	27	28	50	50	27	28
300	***Recreation Interests***												
301	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 98.0 ft) during higher use months	01-Mar	31-Oct	151	151	151	152	152	152	153	152	153
302		Avg. days/yr lake level below critical level for public boat ramps (< 97.0 ft) (Note 3)	01-Jan	31-Dec	174	174	172	173	174	185	186	173	174
303	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<98.0 ft) (Note 4)	01-Jan	31-Dec	219	217	217	219	219	219	219	219	219
304	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	31%	31%	39%	46%	46%	49%	47%	35%	42%
305	***Water User Interests***												
306	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for hydro unit operation (≤ 97.2 ft) (Note 3)	01-Jan	31-Dec	182	179	173	169	180	466	451	177	168
307	***Other Interests***												
308	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 98.0 ft +/- 1 ft.)	01-Jan	31-Dec	65%	65%	65%	65%	65%	53%	53%	65%	65%
309		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 98.0 ft +/- 2 ft.)	01-Jan	31-Dec	81%	81%	81%	81%	81%	60%	60%	82%	82%
310		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 98.0 ft +/- 3 ft.)	01-Jan	31-Dec	99%	99%	99%	99%	99%	96%	96%	99%	99%
311	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	40%	40%	41%	41%	41%	30%	30%	42%	42%
312		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	68%	68%	68%	68%	68%	58%	57%	68%	68%
313		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	98%	98%	99%	98%	98%	96%	96%	99%	98%
314		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	1%	1%	1%	1%	1%	5%	5%	1%	1%
315	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	7,980	7,963	8,309	8,202	8,197	9,175	9,115	8,108	8,043
316		Days lake level at or above 103 ft	01-Jan	31-Dec	6	1	4	1	4	11	20	4	3
317													

Table 21: Rocky Creek [Cedar] Performance Sheet

drology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measur

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929-2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929-2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
318	Cedar Creek Reservoir												
319	*Fish & Aquatic Interests*												
320	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	28,938	29,529	28,622	28,569	28,702	27,155	27,348	28,673	28,267
321		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	55,691	55,915	55,344	55,343	55,872	54,432	54,715	55,543	54,855
322		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	76,182	76,103	75,818	76,417	76,923	74,647	75,123	76,031	76,253
323	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	48%	48%	48%	48%	48%	50%	49%	48%	48%
324		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	62%	62%	62%	62%	62%	65%	65%	62%	62%
325		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	83%	83%	83%	83%	83%	84%	83%	83%	83%
326	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	59%	59%	59%	59%	59%	63%	63%	59%	59%
327		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	61%	61%	61%	61%	61%	64%	64%	61%	61%
328	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	1	1	1	1	1	1	1	1	1
329	*Recreation Interests*												
330	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 98.5 ft) during higher use months	01-Mar	31-Oct	141	142	141	142	141	145	145	141	141
331		Avg. days/yr lake level below critical level for public boat ramps (< 96.0 ft) (Note 3)	01-Jan	31-Dec	3	3	3	3	2	3	2	3	3
332	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	109	110	109	109	110	119	120	109	109
333	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	7%	6%	7%	7%	6%	6%	6%	7%	6%
334	*Water User Interests*												
335	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for hydro unit operation (≤ 90.3 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
336	*Other Interests*												
337	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 98.0 ft +/- 1 ft.)	01-Jan	31-Dec	61%	61%	60%	61%	61%	61%	61%	61%	61%
338		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 98.0 ft +/- 2 ft.)	01-Jan	31-Dec	64%	64%	64%	64%	64%	63%	63%	64%	64%
339		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 98.0 ft +/- 3 ft.)	01-Jan	31-Dec	100%	100%	100%	100%	100%	100%	100%	100%	100%
340	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	53%	53%	53%	53%	53%	53%	53%	53%	53%
341		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	63%	63%	63%	63%	63%	62%	62%	63%	63%
342		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	100%	100%	100%	100%	100%	100%	100%	100%	100%
343		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%
344	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	11,401	11,388	11,432	11,376	11,367	11,980	11,906	11,381	11,359
345		Days lake level at or above 103 ft	01-Jan	31-Dec	3	3	3	3	3	3	3	3	3
346													

Table 22: Wateree Performance Sheet

ology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929-2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929-2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
347	Lake Wateree (including the Wateree Regulated River Reach)												
348	*Fish & Aquatic Interests*												
349	Minimize lake level variation during spawning season	Incidents of absolute lake level drops >=2 ft over 14 day-period (Note 13)	01-Mar	31-Jul	5,444	5,399	5,736	5,946	5,953	5,592	5,911	5,805	5,826
350		Incidents of absolute lake level drops >=1 ft over 14 day-period (Note 13)	01-Mar	31-Jul	24,105	24,158	22,900	23,072	23,020	21,006	21,037	22,858	22,544
351		Incidents of absolute lake level drops >=0.5 ft over 14 day-period (Note 13)	01-Mar	31-Jul	48,714	48,301	46,998	47,081	47,019	44,365	44,022	47,014	46,830
352	Maximize days of lake levels for fish spawning	Percent of time of lake levels >= 99 ft	01-Mar	31-Jul	39%	39%	39%	39%	39%	37%	37%	39%	39%
353		Percent of time of lake levels >= 98 ft	01-Mar	31-Jul	44%	44%	44%	44%	44%	42%	42%	44%	44%
354		Percent of time of lake levels >= 97 ft	01-Mar	31-Jul	66%	66%	65%	65%	65%	60%	60%	65%	65%
355	Maximize days of lake levels supporting littoral habitat	Percent of time of lake levels >= 98 ft during the growing season	01-Apr	30-Sep	39%	39%	39%	39%	39%	38%	38%	39%	39%
356		Percent of time of lake levels >= 98 ft	01-Jan	31-Dec	42%	42%	42%	41%	41%	41%	41%	42%	41%
357	Minimize days of littoral habitat loss	Incidents/yr of lake levels <= 96 ft for at least 2 consecutive days	01-Jan	31-Dec	25	25	26	26	26	27	27	26	26
365	*Recreation Interests*												
366	Minimize days/yr of restricted lake boat launching	Avg. days/yr lake level below critical level for highest public boat ramp (< 96.0 ft) during higher use months	01-Mar	31-Oct	4	4	5	5	5	6	6	5	5
367		Avg. days/yr lake level below critical level for public boat ramps (< 93.0 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
368	Minimize days/yr of potentially restricted dock access	Avg. days/yr lake level below lowest avg. monthly level in post-Cowans Ford era (<97.0 ft) (Note 4)	01-Jan	31-Dec	172	172	173	174	174	186	186	174	175
369	Minimize reservoir area with restricted lake navigation	Percent of the lake's full pond surface area that is not boatable when lake level is at the lowest average monthly elevation (Note 4)	01-Jan	31-Dec	11%	11%	11%	11%	11%	11%	11%	11%	11%
372	*Water User Interests*												
373	Minimize days of restricted operation at lake-located intakes	Days at or below critical level for shallowest public water supply intake operation (≤ 88.5 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
374		Days at or below critical level for hydro unit operation (≤ 74 ft) (Note 3)	01-Jan	31-Dec	0	0	0	0	0	0	0	0	0
376	Maximize low flows to maintain waste assimilation capacity of the regulated river reach.	Percent of days at or above approximate 7Q10 flow (528 cfs) released from the hydro development (RM 74.54) (Note 12)	01-Jan	31-Dec	76%	76%	76%	76%	76%	100%	100%	76%	76%
377		Lowest 7-day average flowrate (cfs) released from the hydro development (RM 74.54) for the evaluation period (Note 15)	01-Jan	31-Dec	989	989	980	947	947	903	903	985	960
379	*Other Interests*												
379	Maximize days of near "full pool" lake levels	Percent of days lake level within +/- 1 ft of existing maximum guide curve (i.e. 98.0 ft +/- 1 ft.)	01-Jan	31-Dec	47%	47%	47%	47%	47%	47%	47%	47%	47%
380		Percent of days lake level within +/- 2 ft of existing maximum guide curve (i.e. 98.0 ft +/- 2 ft.)	01-Jan	31-Dec	58%	57%	57%	58%	58%	57%	57%	57%	58%
381		Percent of days lake level within +/- 3 ft of existing maximum guide curve (i.e. 98.0 ft +/- 3 ft.)	01-Jan	31-Dec	97%	97%	98%	98%	98%	98%	98%	98%	98%
382	Maximize adherence to lake level target	Percent of days lake level within +/- 1 ft of target	01-Jan	31-Dec	56%	56%	56%	57%	57%	57%	57%	56%	57%
383		Percent of days lake level within +/- 2 ft of target	01-Jan	31-Dec	61%	61%	61%	61%	61%	62%	62%	61%	61%
384		Percent of days lake level within +/- 3 ft of target	01-Jan	31-Dec	86%	86%	86%	86%	86%	85%	86%	86%	86%
385		Percent of days lake level < Normal Minimum Elevation	01-Jan	31-Dec	0%	0%	0%	0%	0%	0%	0%	0%	0%
386	Minimize days of flooding of developed areas (Note 7)	Days lake level at or above 100 ft	01-Jan	31-Dec	7,958	7,942	8,060	7,994	7,997	8,617	8,616	8,052	8,023
387		Days lake level at or above 103 ft	01-Jan	31-Dec	41	42	43	40	40	42	41	44	40
388		Days at or above 35000 cfs at Node 2 (RM 71.1) (Note 21)	01-Jan	31-Dec									
389													

Table 23: Catawba Reservoir System Performance Sheet

Irology Condition / Period = _____

CHEOPS Performance Measures Evaluation Spreadsheet

Measures

	F	G	H	I	Y	Z	AA	AB	AC	AD	AE	AF	AG
6	Performance Measures	Criterion (Note 2)	Start	End	MG 08 (1929-2003)	MG 08 CF (1929-2003)	MG 35 (1929-2003)	MG 35 CF (1929 2003)	MG 35 MI (1929-2003)	MG 35 NGO (1929 2003)	MG 35 CF NGO (1929-2003)	MG 35 LIP (1929-2003)	MG 35 CF LIP (1929-2003)
390	Total Project Hydropower & Water Quantity Management												
391	Minimize risk of losing water storage inventory	Storage Index at or below 80% (Note 5)	01-Jan	31-Dec	604	604	644	650	651	675	680	645	646
392		Storage Index at or below 60% (Note 6)	01-Jan	31-Dec	54	53	72	70	72			64	63
393		Storage Index at or below 52% (Note 6)	01-Jan	31-Dec	3	4	6	5	5			4	1
394	Minimize inefficiencies in using water stored for	Percent of hydropower generation lost due to unplanned spills (Note 8)	01-Jan	31-Dec	3%	3%	3%	3%	3%			3%	3%
395		Percent of hydropower generation lost due to other non-power generation uses (Note 9)	01-Jan	31-Dec	9%	9%	10%	10%	10%			10%	10%
396	Maximize hydropower generation	Avg. MWH/yr of hydropower produced	01-Jan	31-Dec	1,433,281	1,431,684	1,378,569	1,375,795	1,376,759			1,379,050	1,375,934
397		Average equivalent # of homes per year that could be powered by the Hydro Project (Note 14)	01-Jan	31-Dec	108,582	108,461	104,437	104,227	104,300			104,473	104,237
398	Maximize hydropower value	Avg. hydro generation value in Normalized Dollars/yr (Note 10)	01-Jan	31-Dec	797,258	796,362	767,358	766,095	766,597			767,559	765,893

8. Elevation Condition in Dry Years

1) Bridgewater

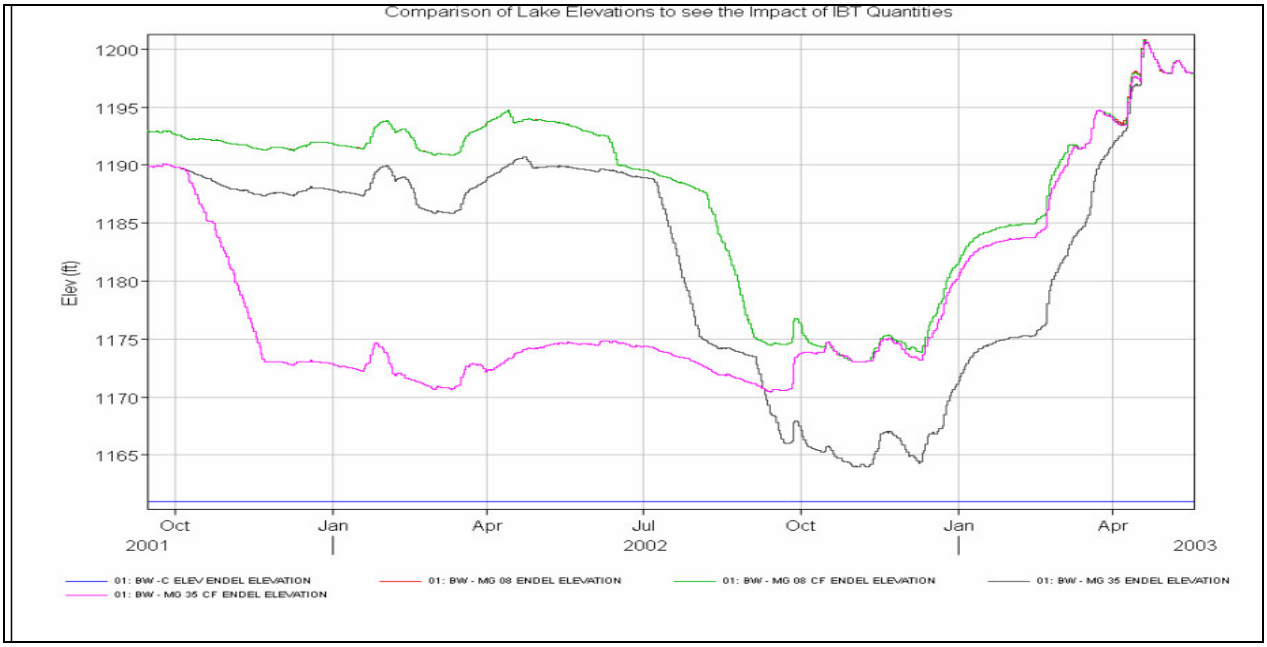

Figure 111: BW Elevations for Impacts of IBT Quantity on Elevation

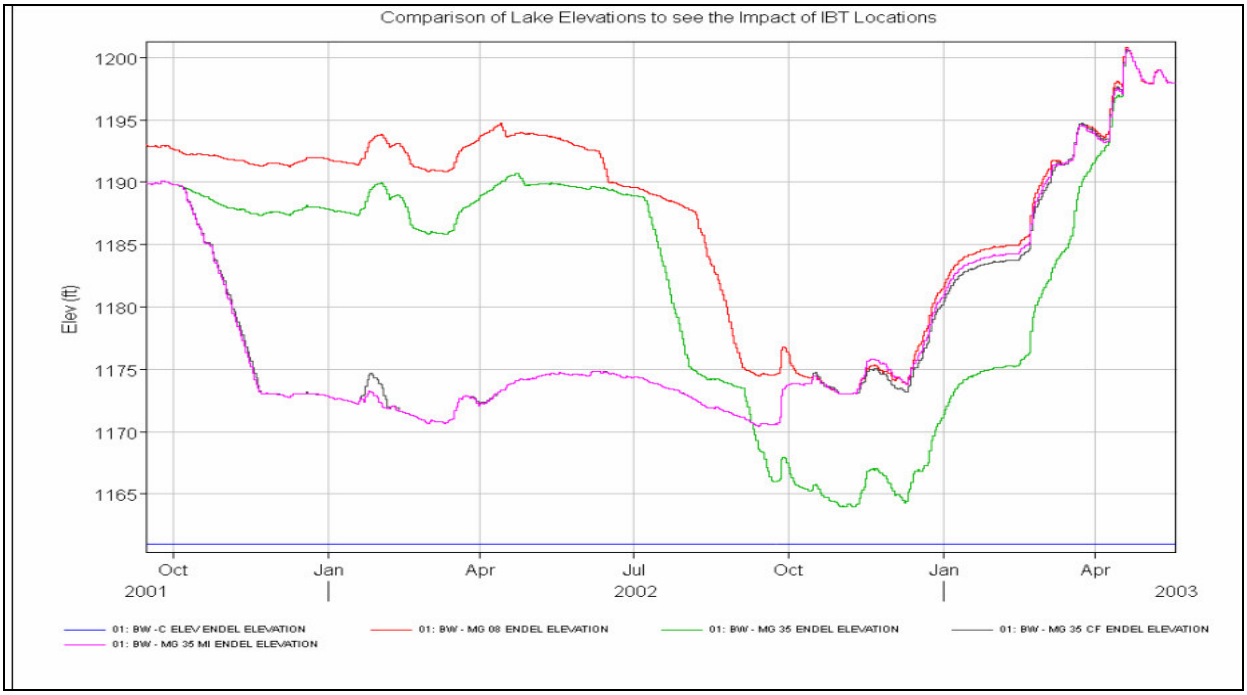

Figure 112: BW Elevations for Impacts of IBT Locations on Elevation

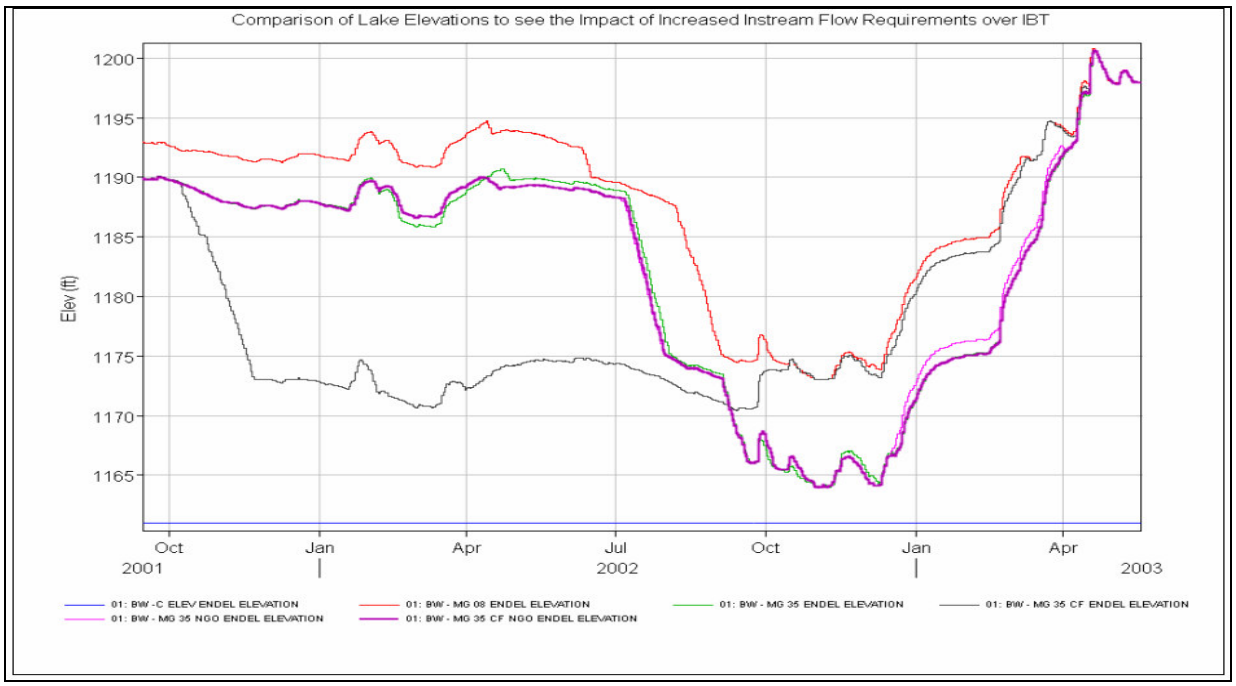

Figure 113: BW Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

2) Rhodhiss

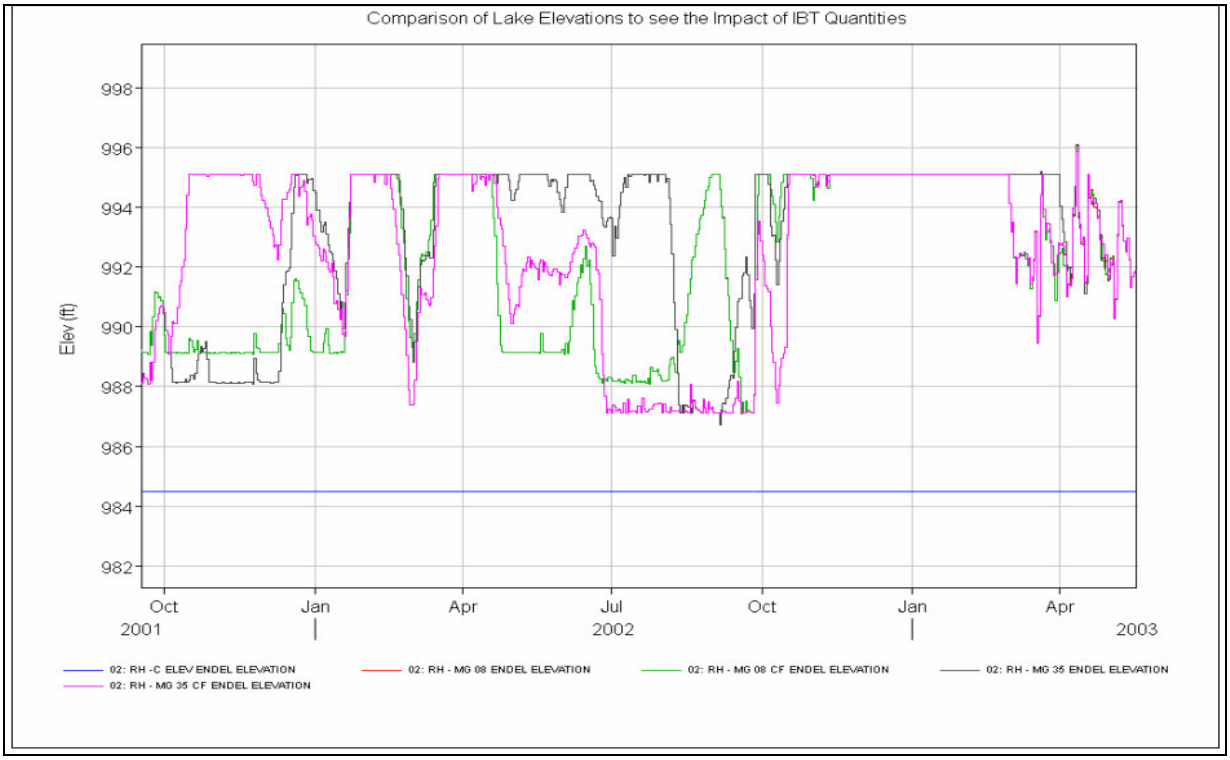

Figure 114: RH Elevations for Impacts of IBT Quantity on Elevation

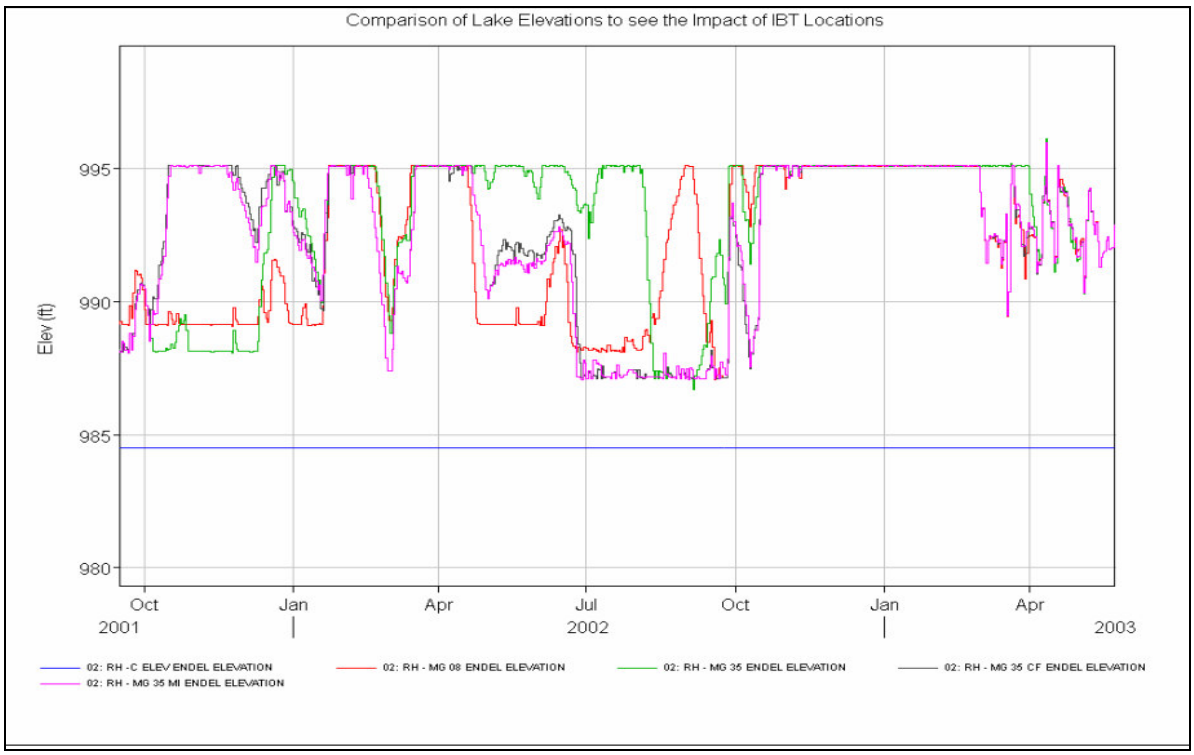

Figure 115: RH Elevations for Impacts of IBT Locations on Elevation

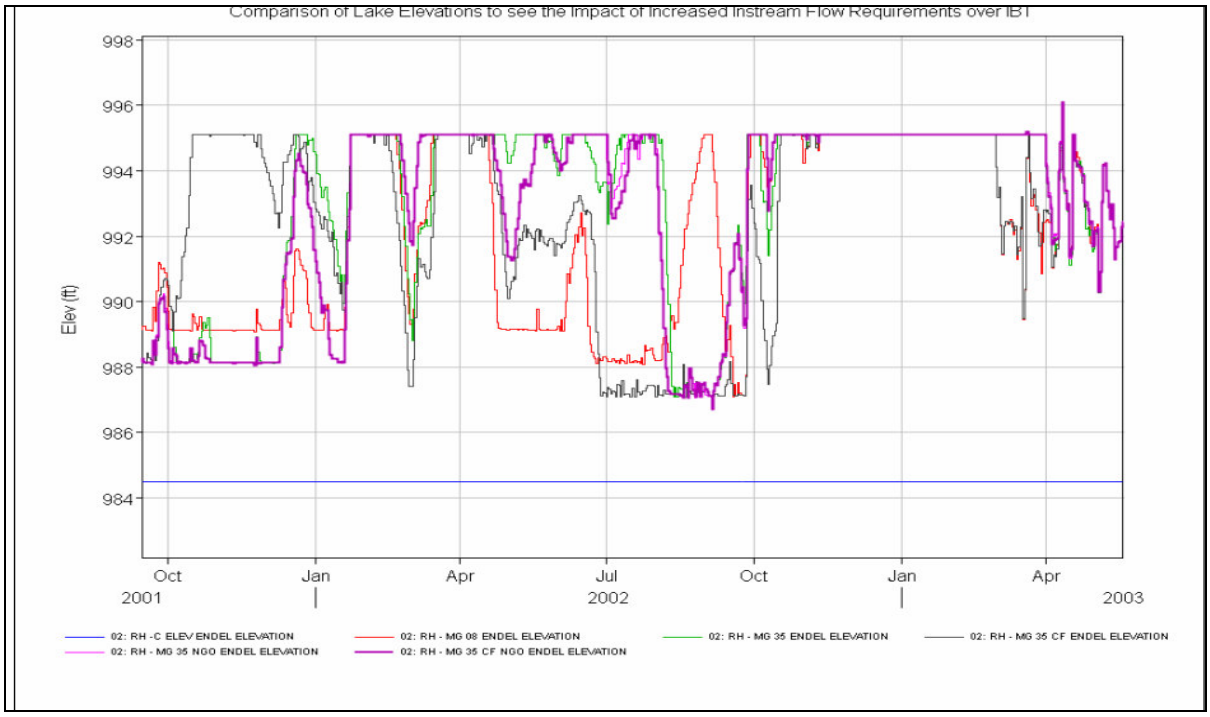

Figure 116: RH Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

3) Oxford

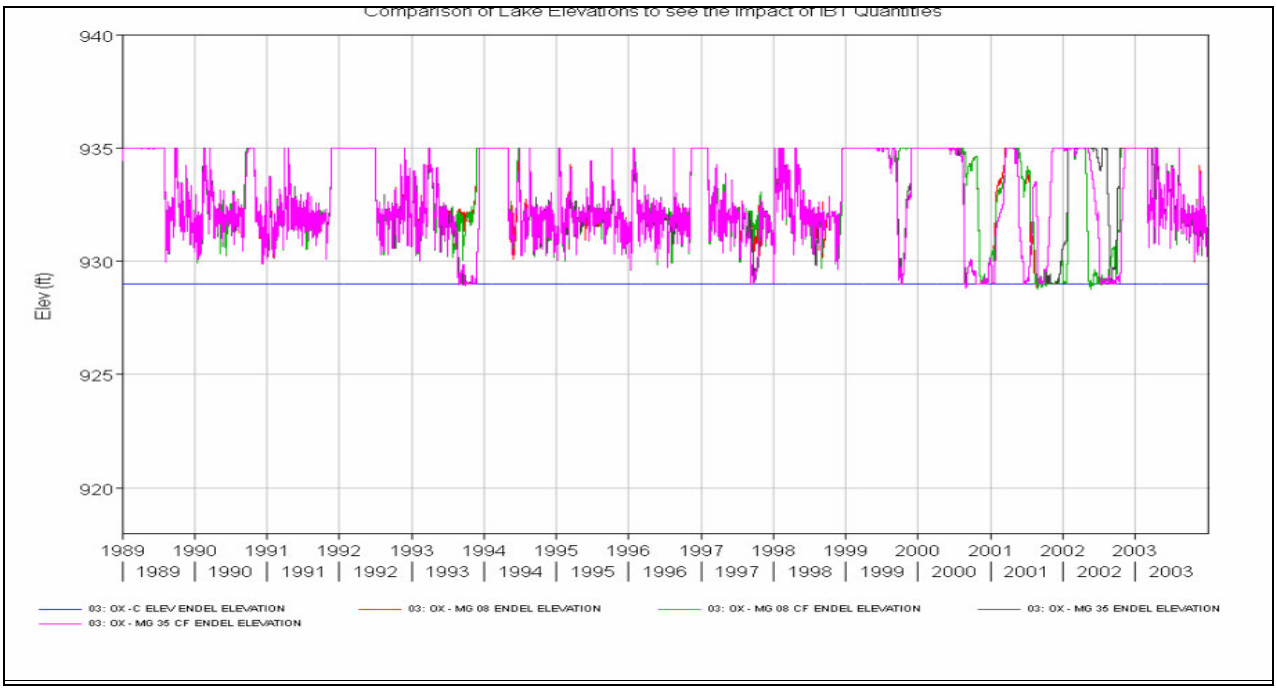

Figure 117: OX Elevations for Impacts of IBT Quantity on Elevation

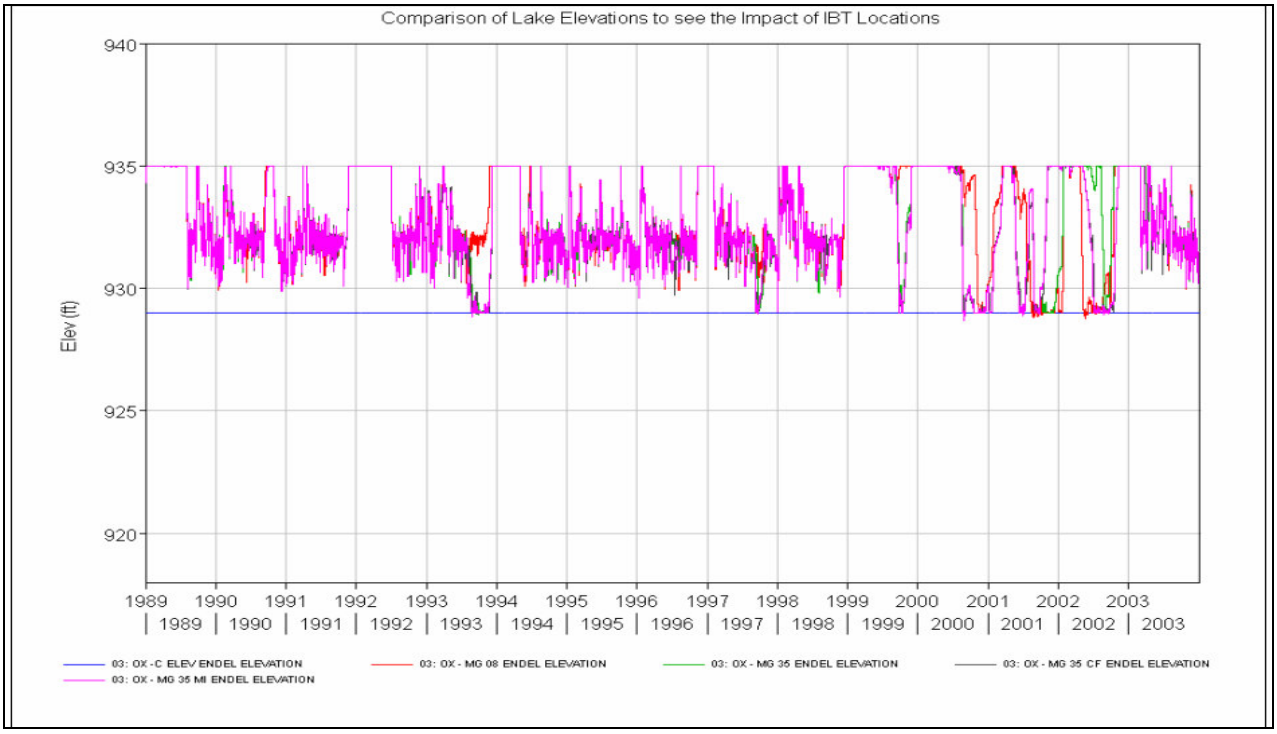

Figure 118: OX Elevations for Impacts of IBT Locations on Elevation

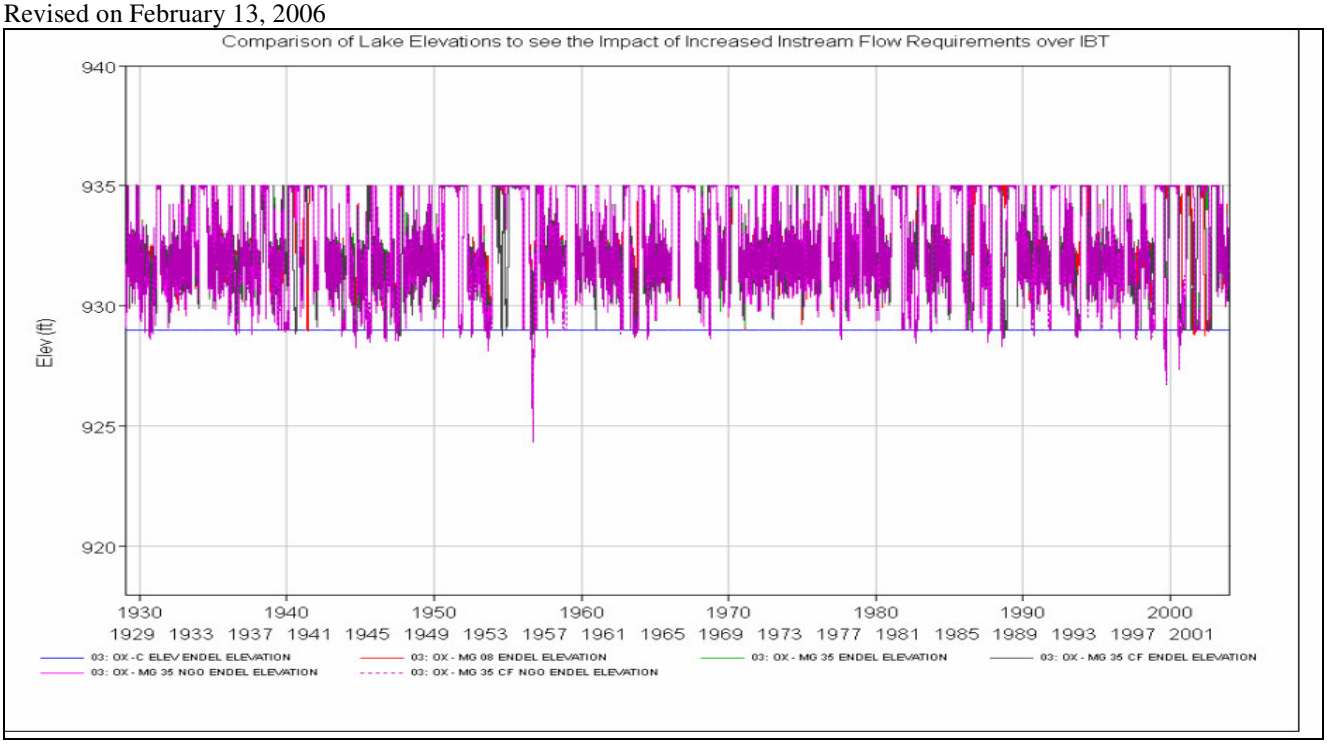

Figure 119: OX Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

4) Lookout shoals

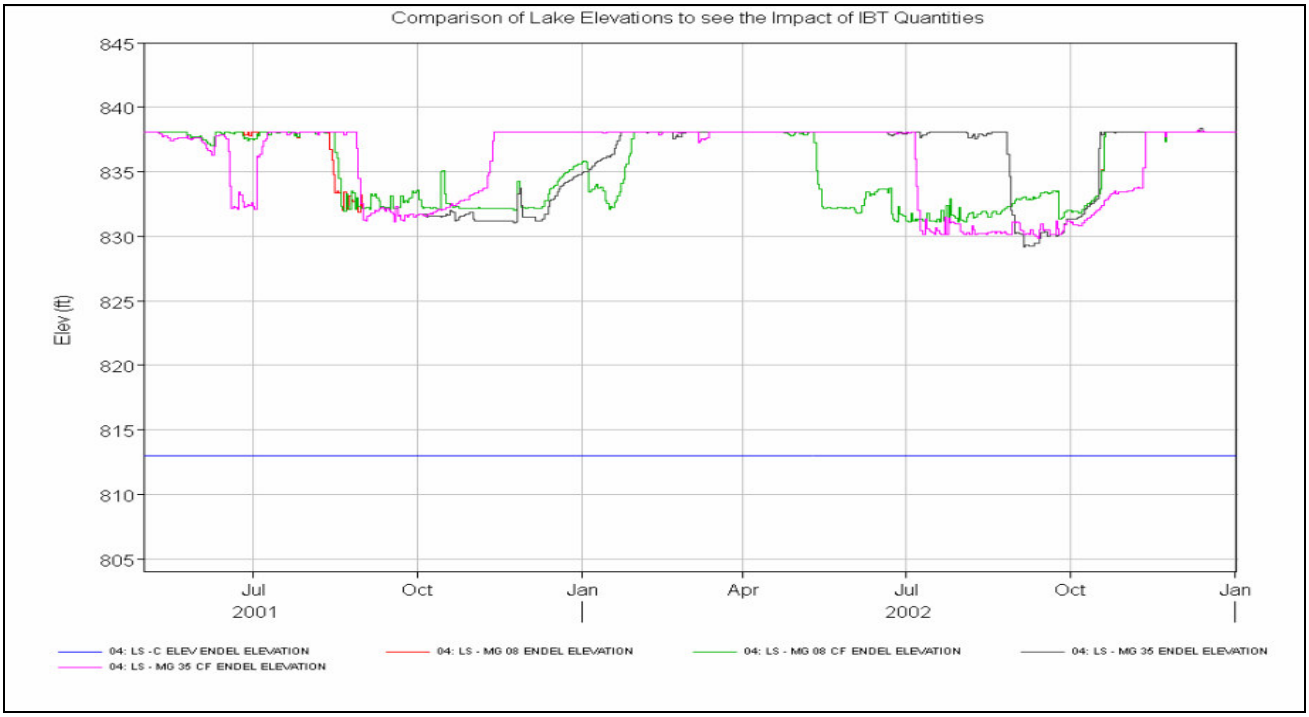

Figure 120: LS Elevations for Impacts of IBT Quantity on Elevation

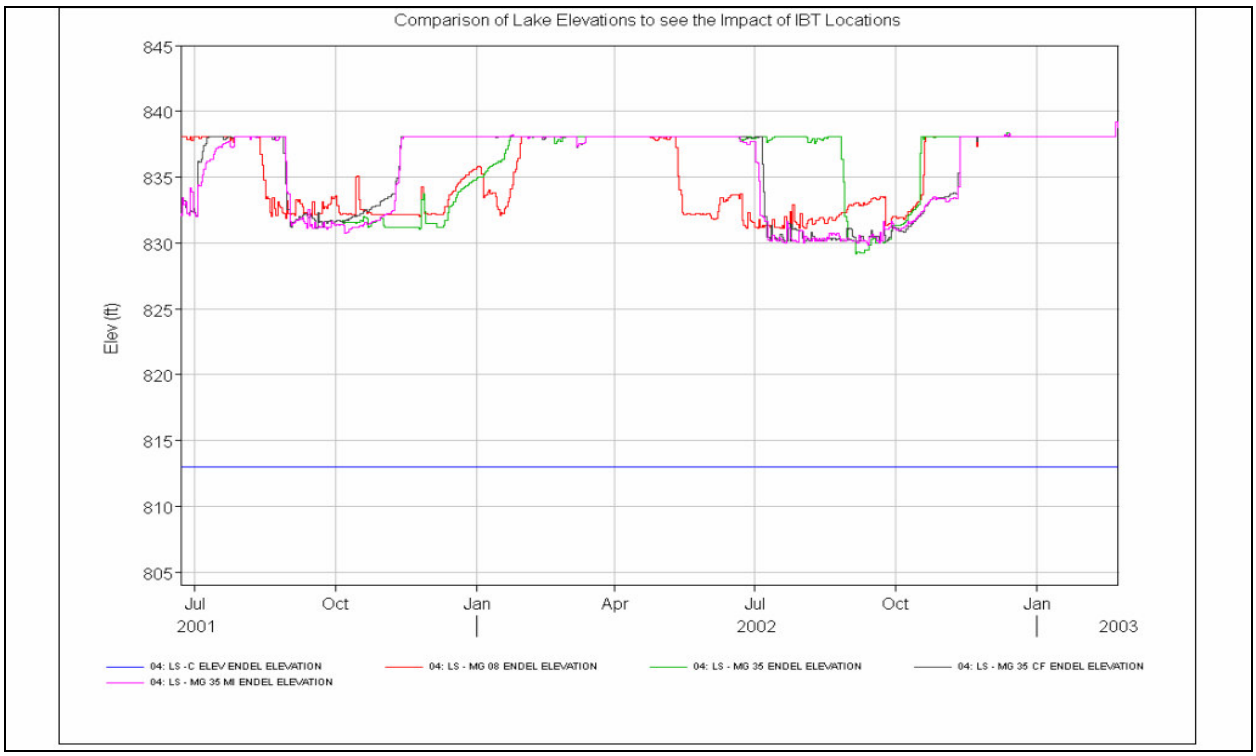

Figure 121: LS Elevations for Impacts of IBT Locations on Elevation

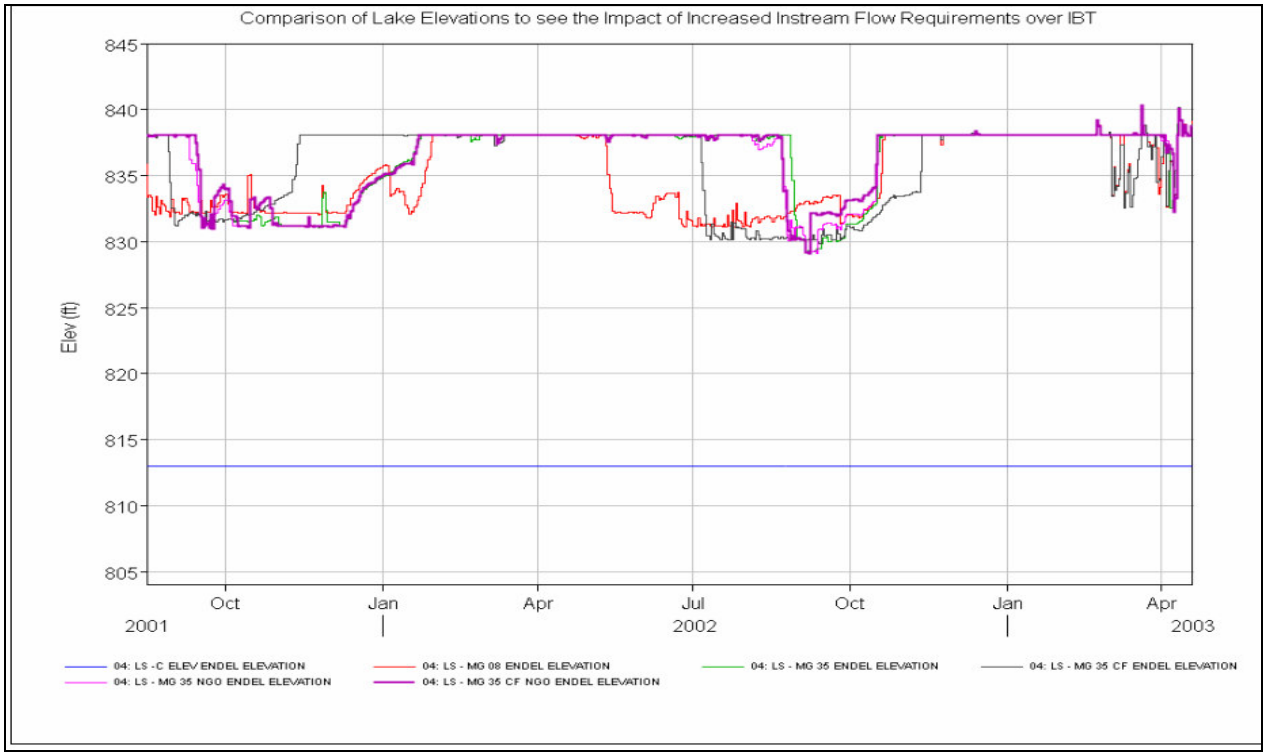

Figure 122: LS Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

5) Cowan Ford

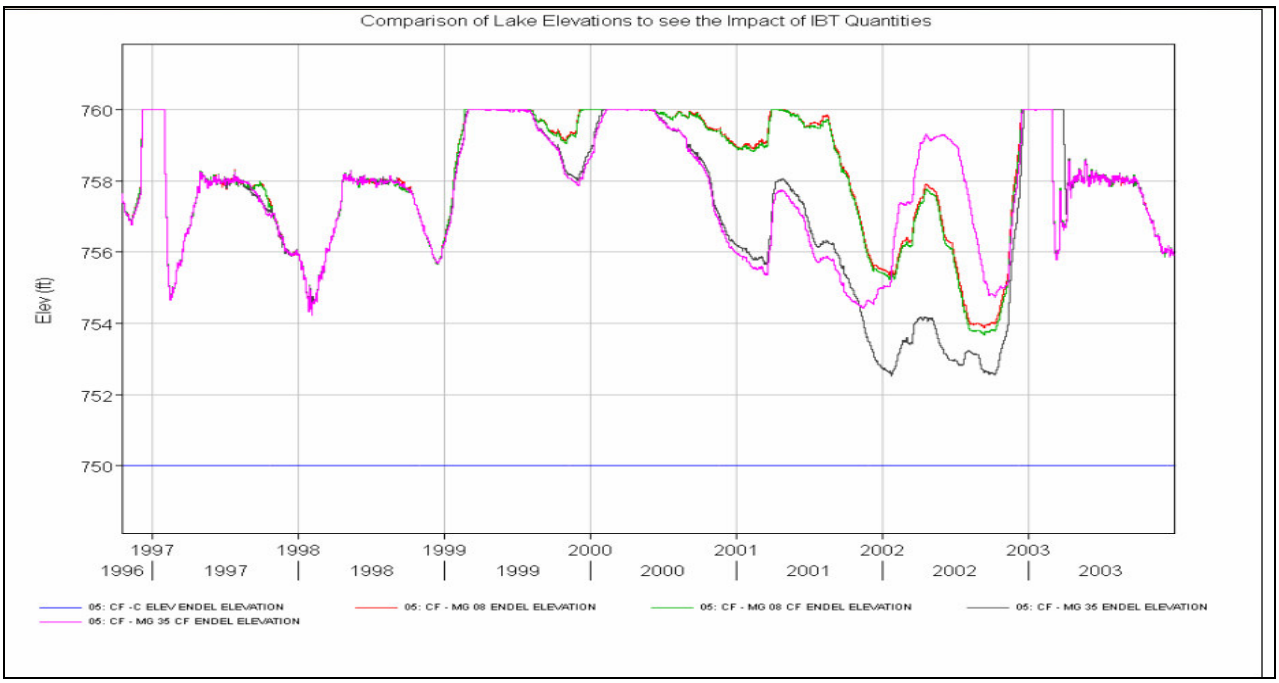

Figure 123: CF Elevations for Impacts of IBT Quantity on Elevation

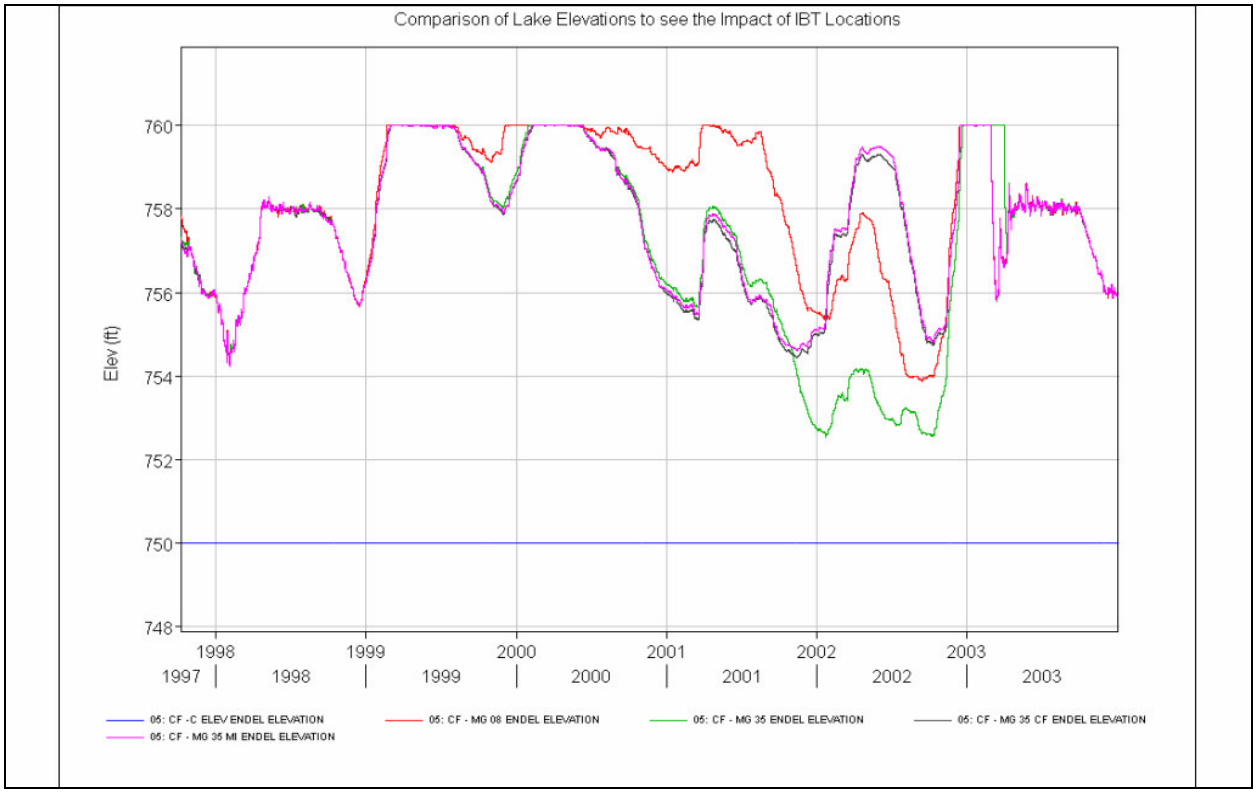

Figure 124: CF Elevations for Impacts of IBT Locations on Elevation

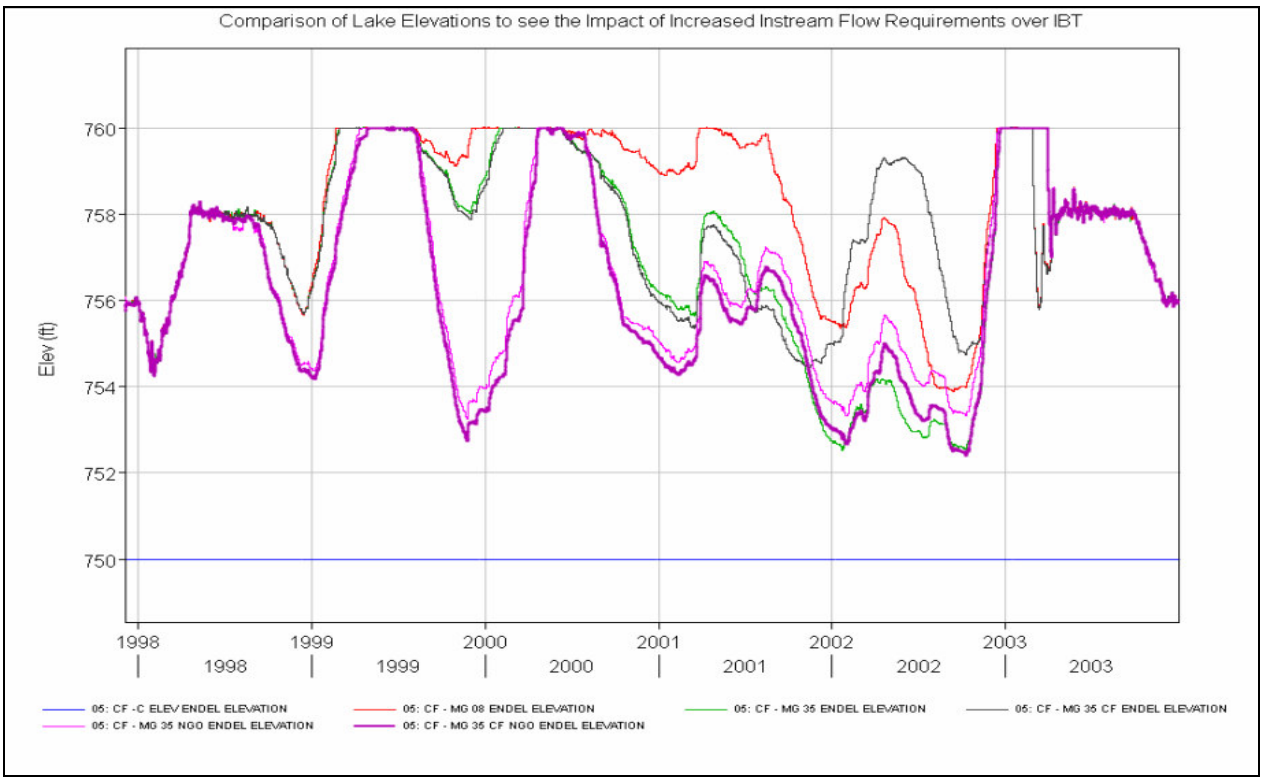

Figure 125: CF Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

6) Mountain Island

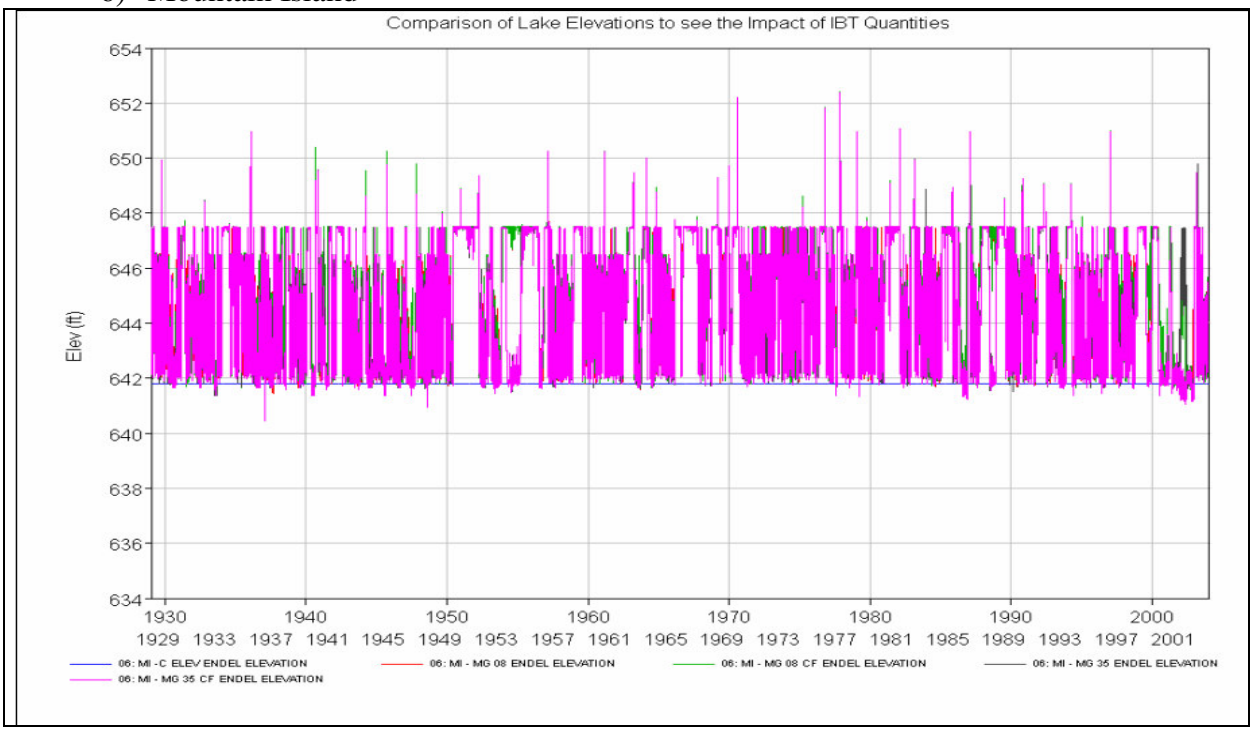

Figure 126: MI Elevations for Impacts of IBT Quantity on Elevation

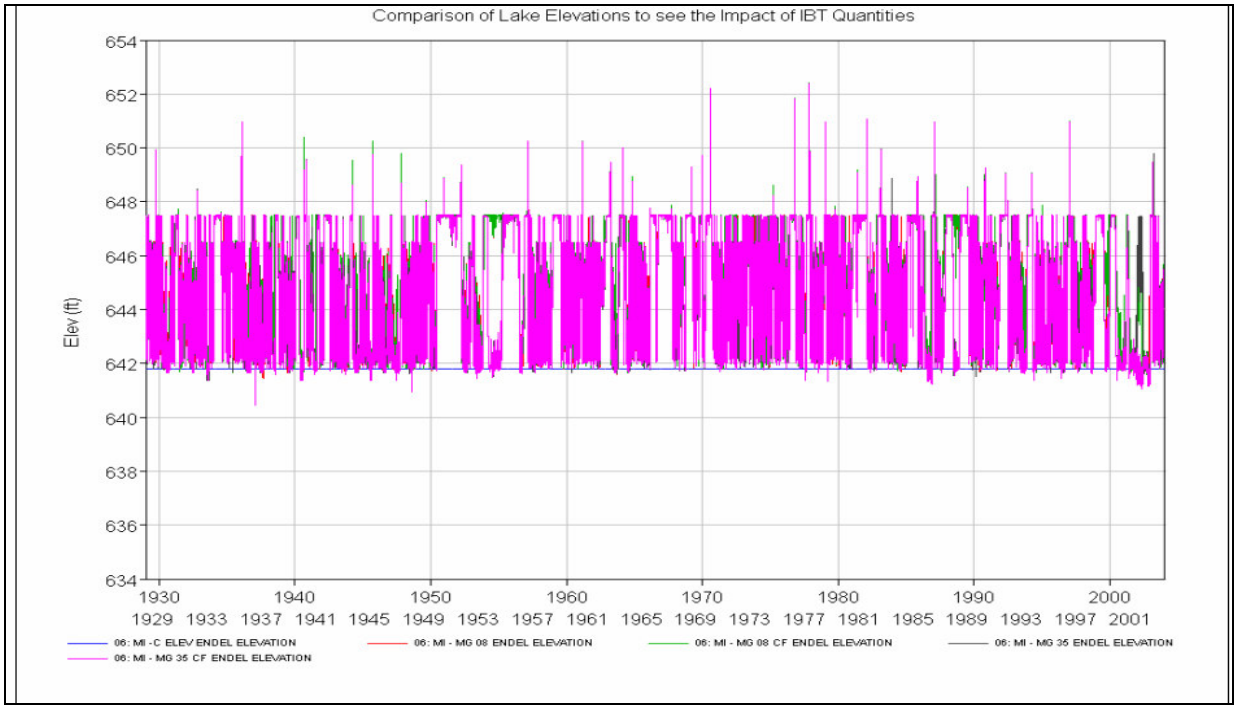

Figure 127: MI Elevations for Impacts of IBT Locations on Elevation

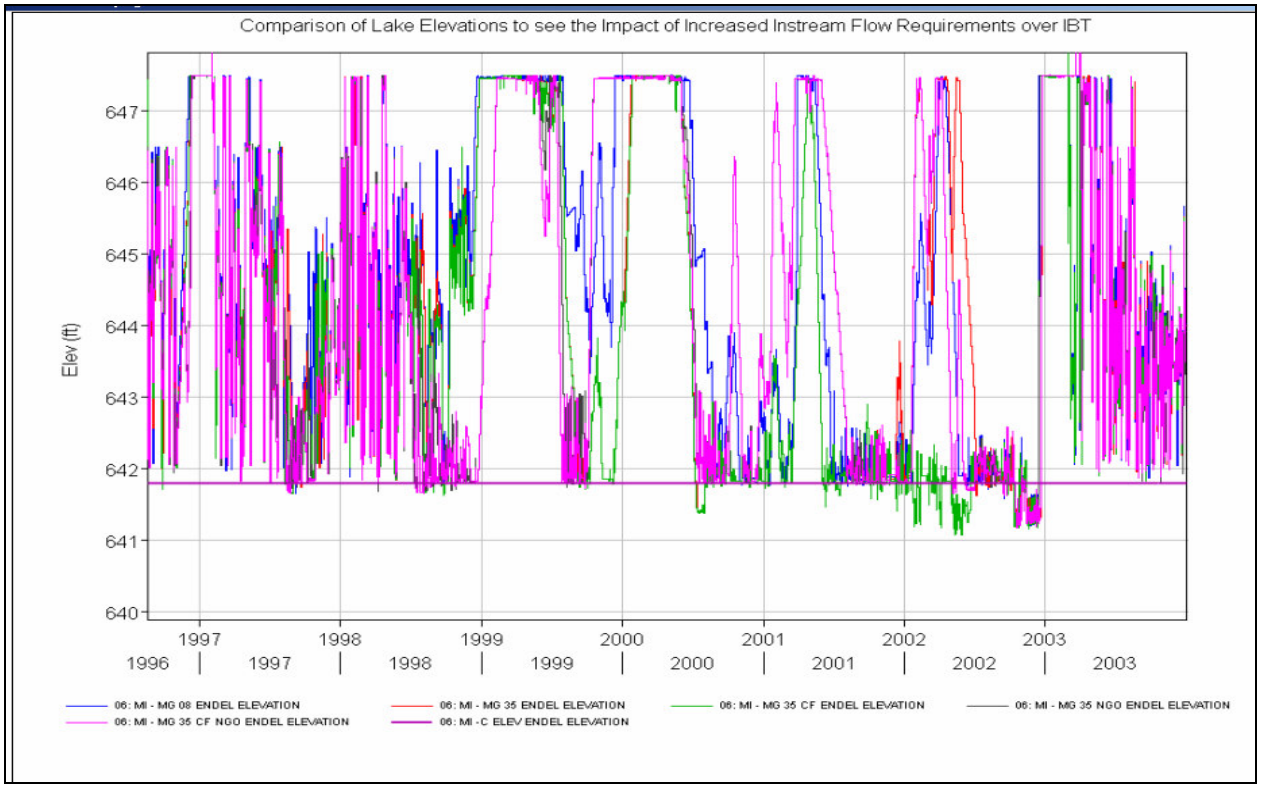

Figure 128: MI Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

7) Wylie

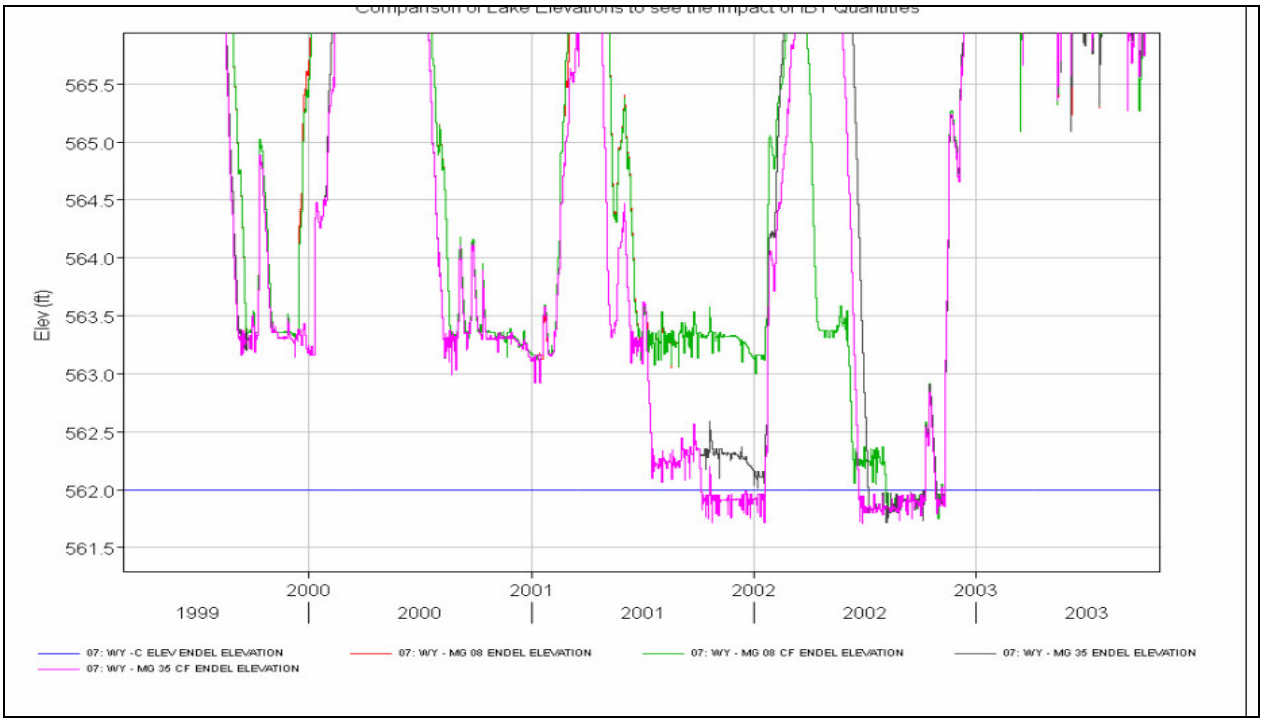

Figure 129: WY Elevations for Impacts of IBT Quantity on Elevation

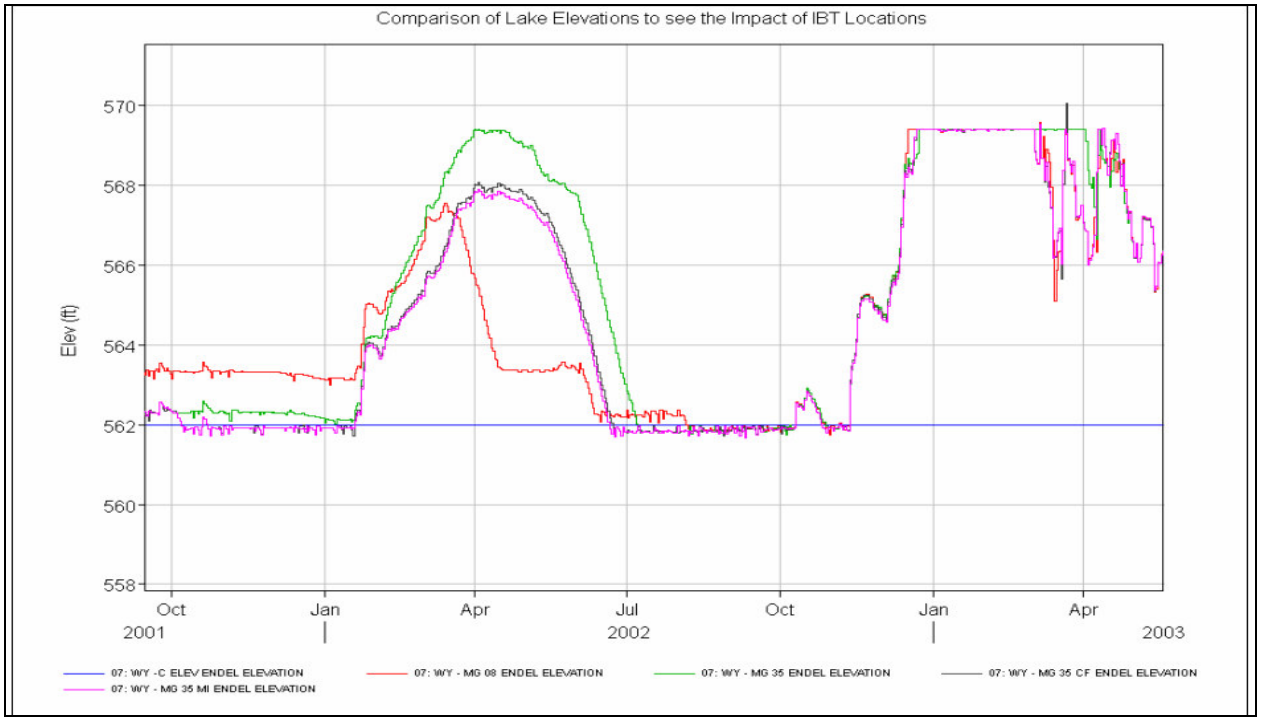

Figure 130: WY Elevations for Impacts of IBT Locations on Elevation

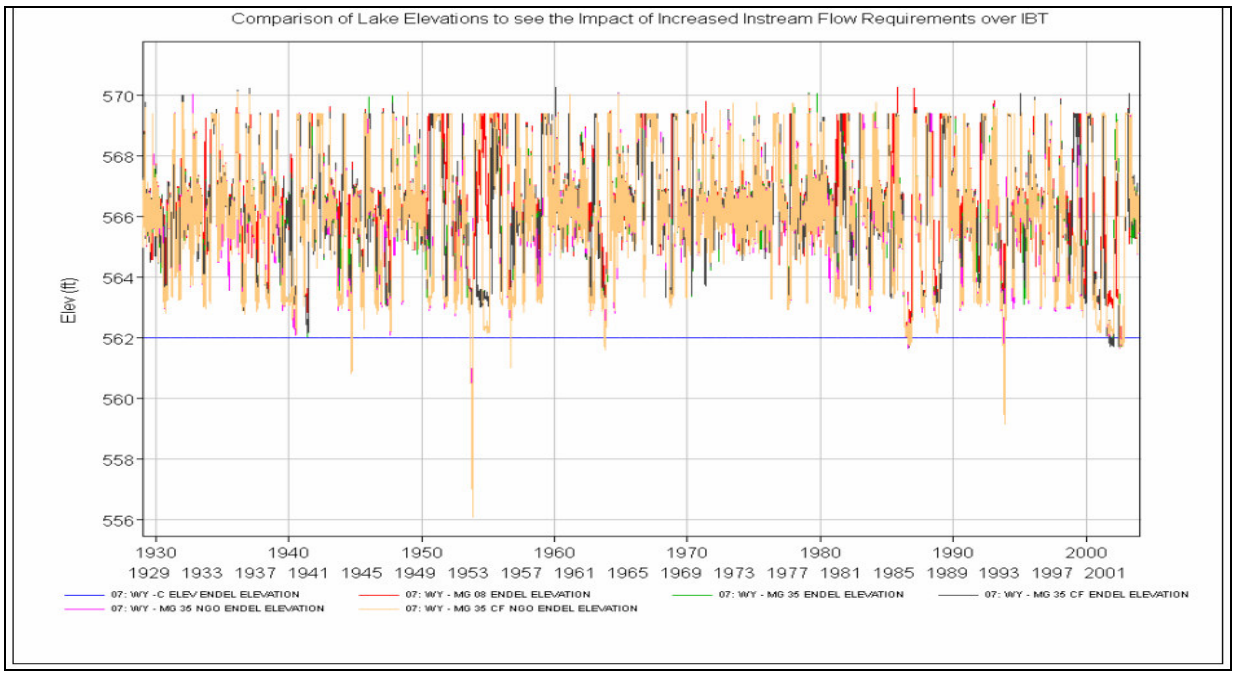

Figure 131: WY Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

8) Fishing Creek

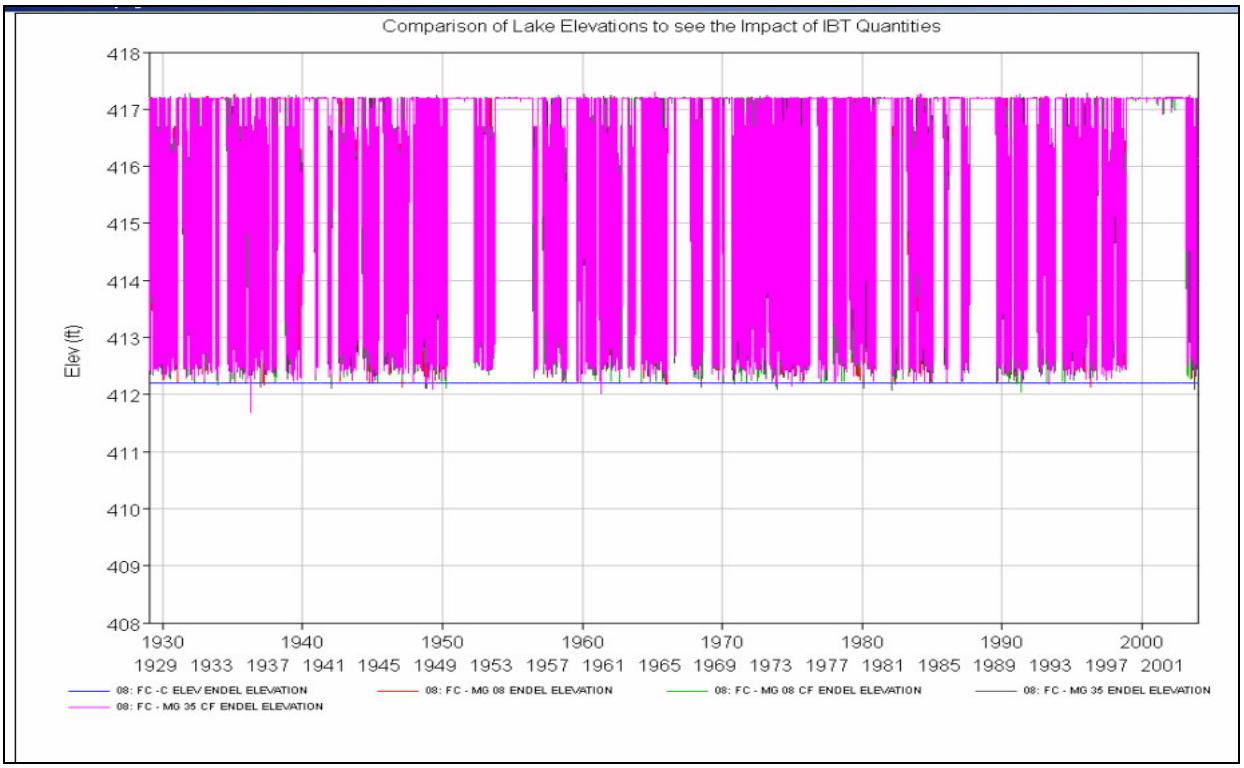

Figure 132: FC Elevations for Impacts of IBT Quantity on Elevation

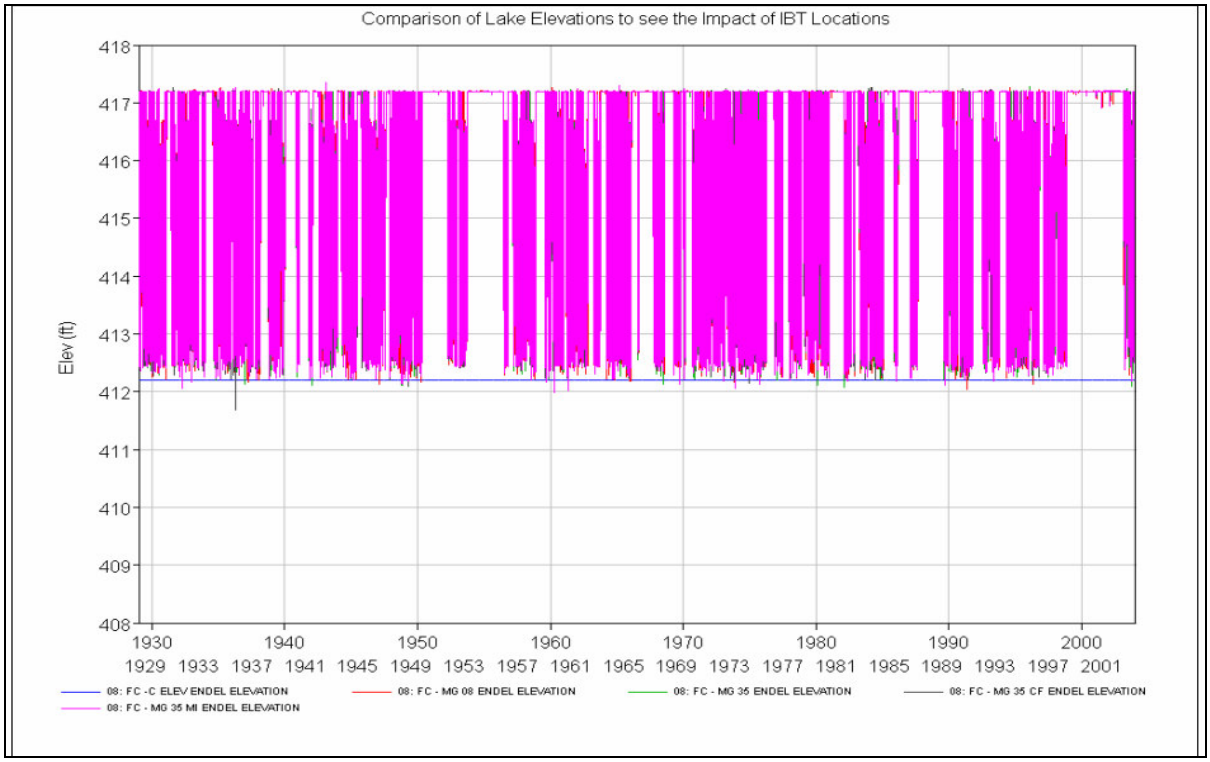

Figure 133: FC Elevations for Impacts of IBT Locations on Elevation

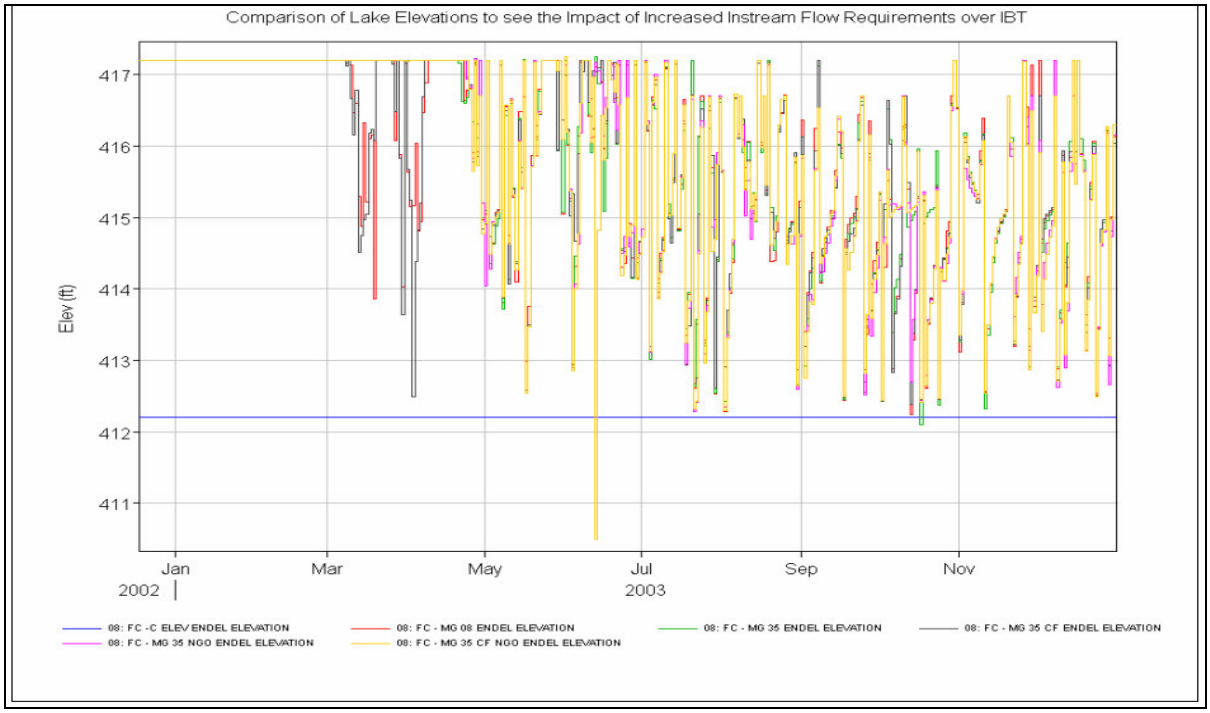

Figure 134: FC Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

9) Great Falls

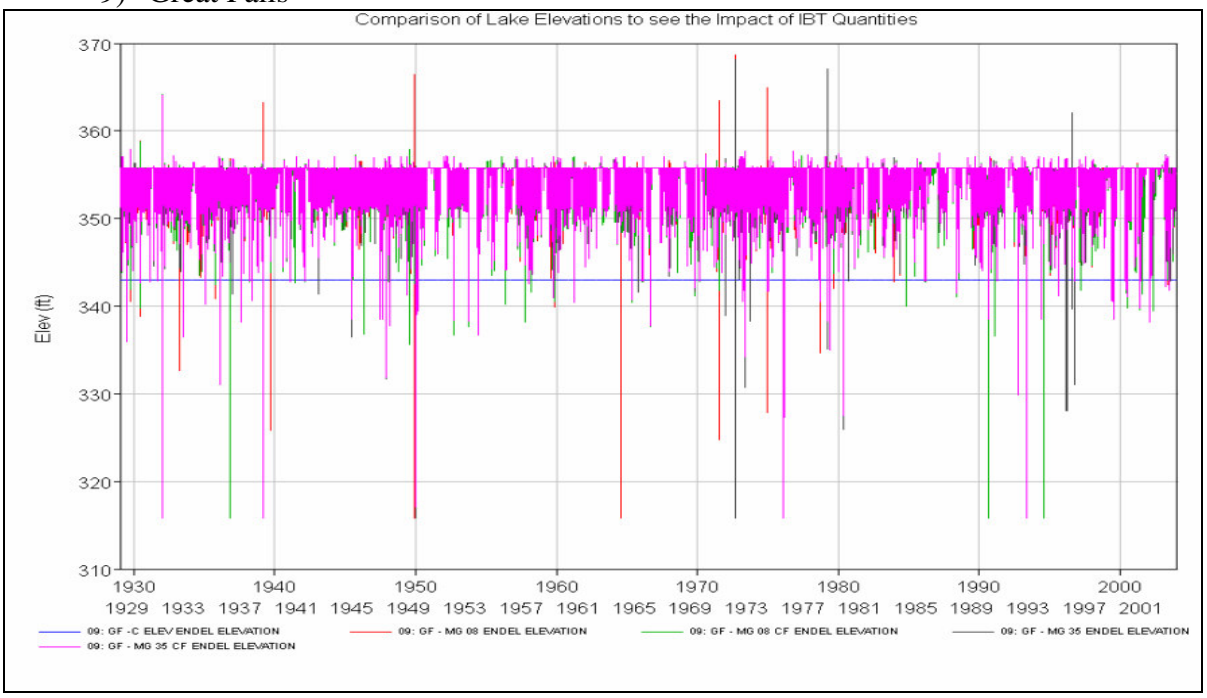

Figure 135: GF Elevations for Impacts of IBT Quantity on Elevation

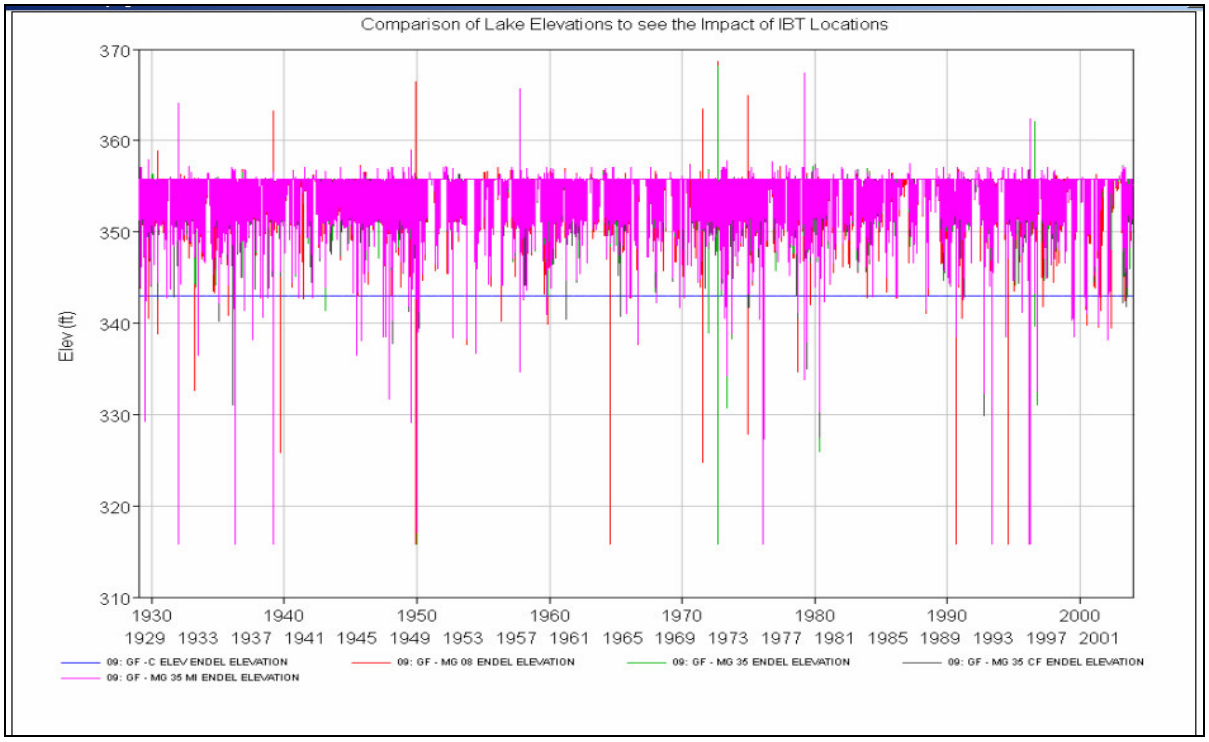

Figure 136: GF Elevations for Impacts of IBT Locations on Elevation

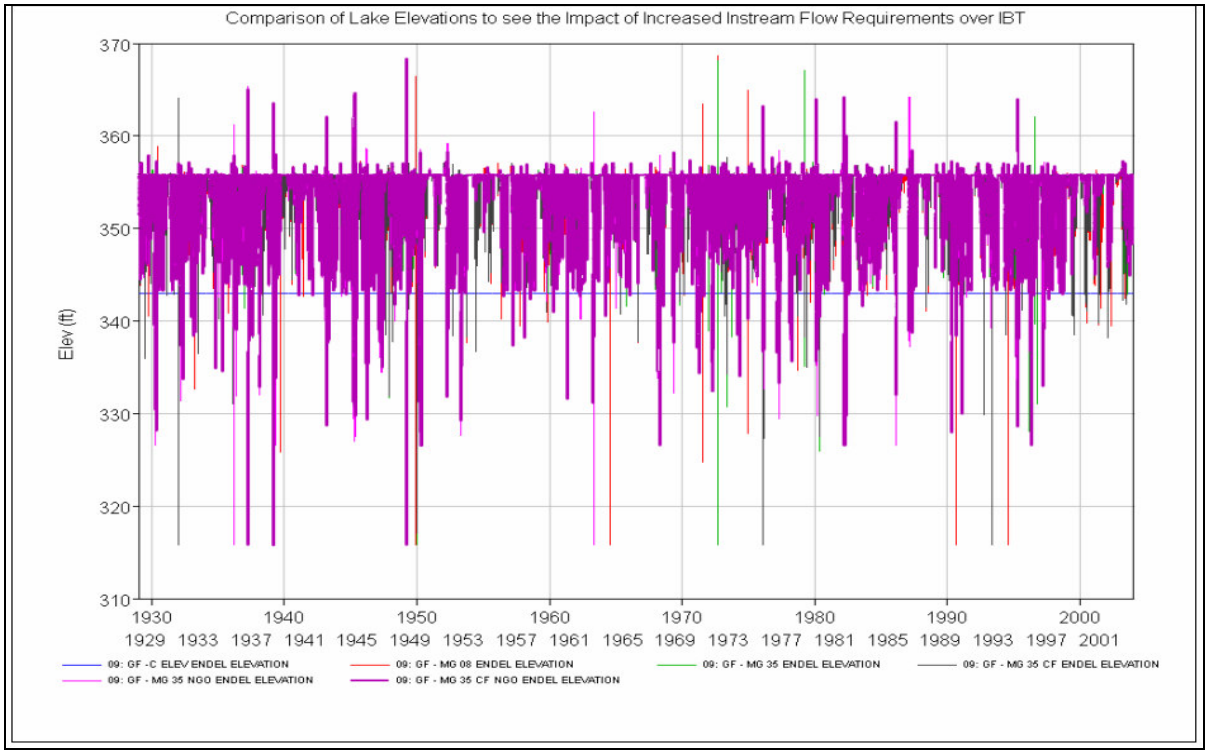

Figure 137: GF Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

10) Rocky Creek

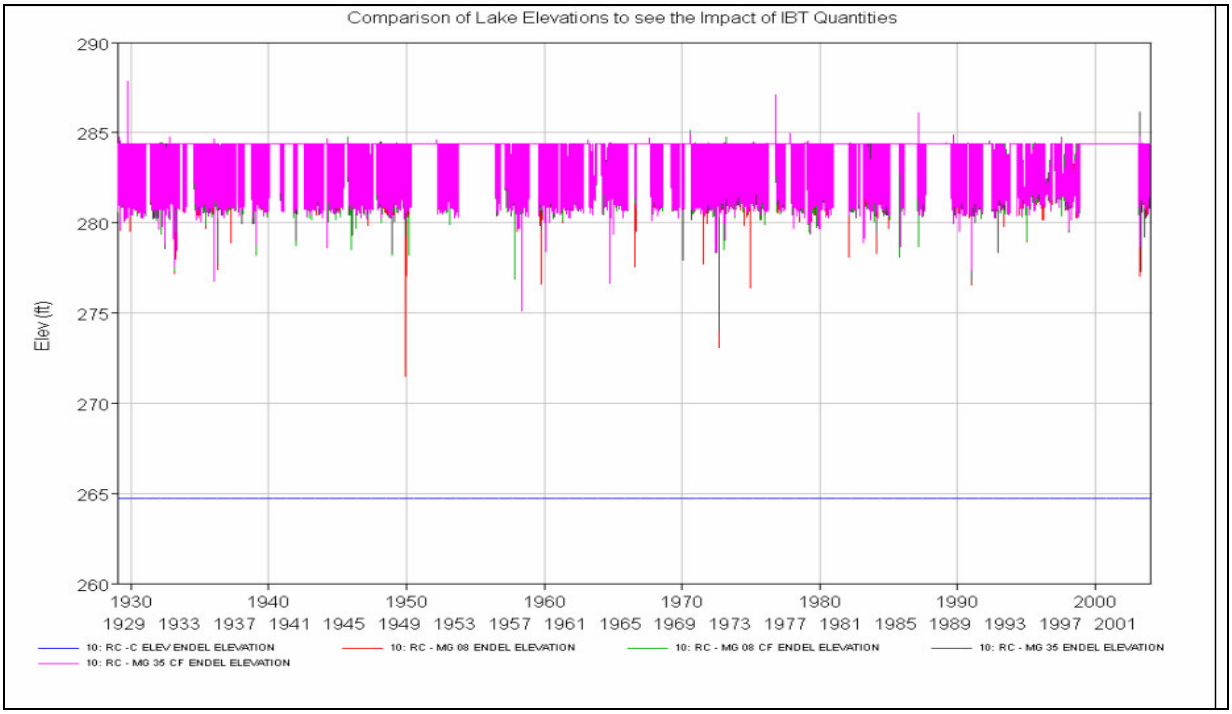

Figure 138: RC Elevations for Impacts of IBT Quantity on Elevation

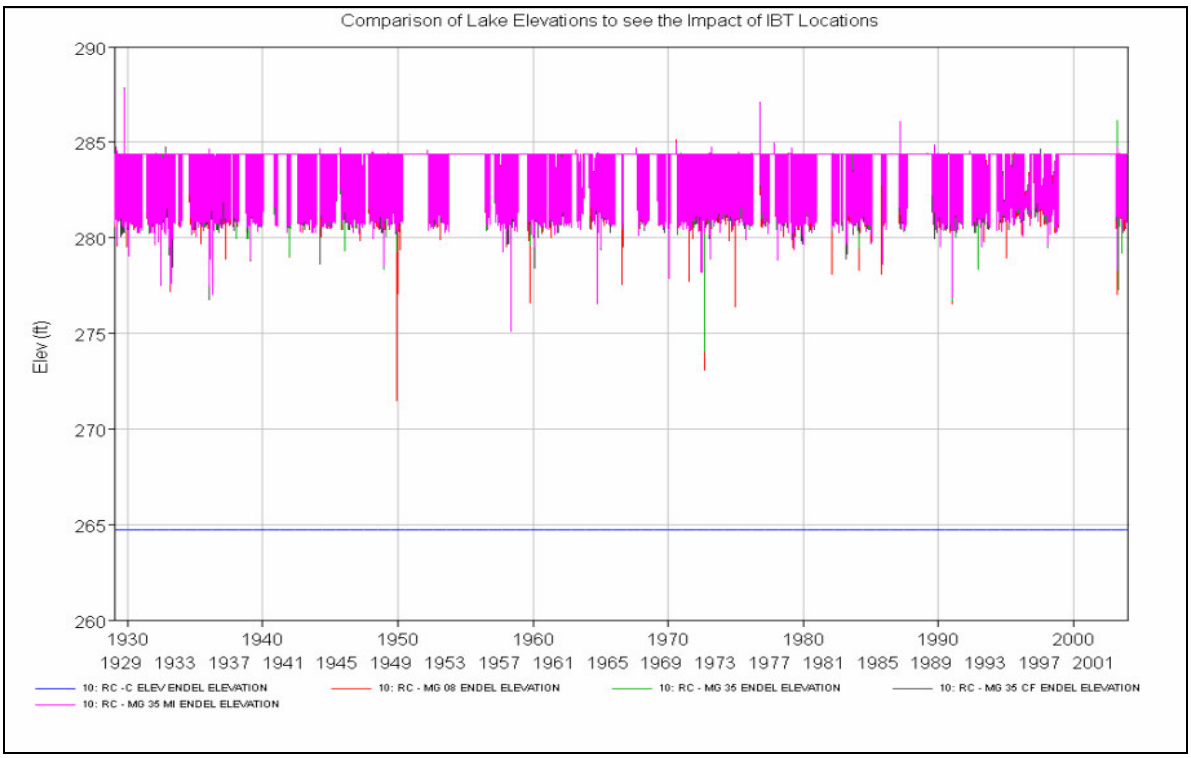

Figure 139: RC Elevations for Impacts of IBT Locations on Elevation

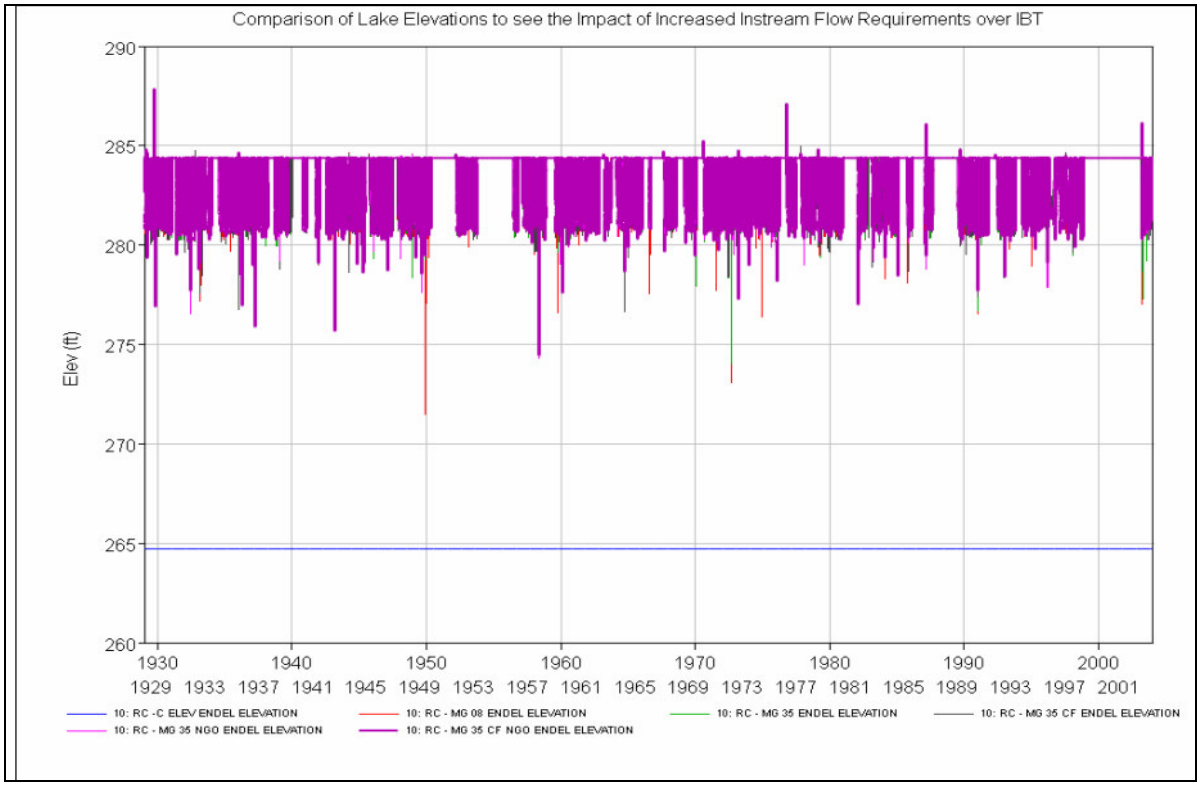

Figure 140: RC Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

11) Wateree

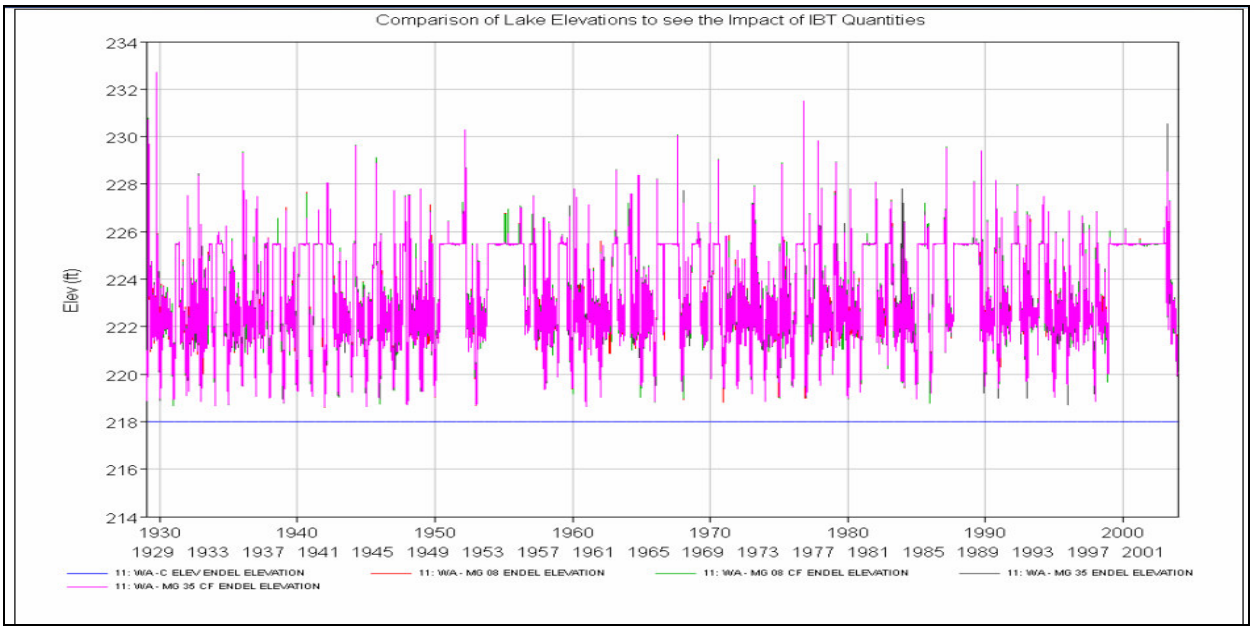

Figure 141: WA Elevations for Impacts of IBT Quantity on Elevation

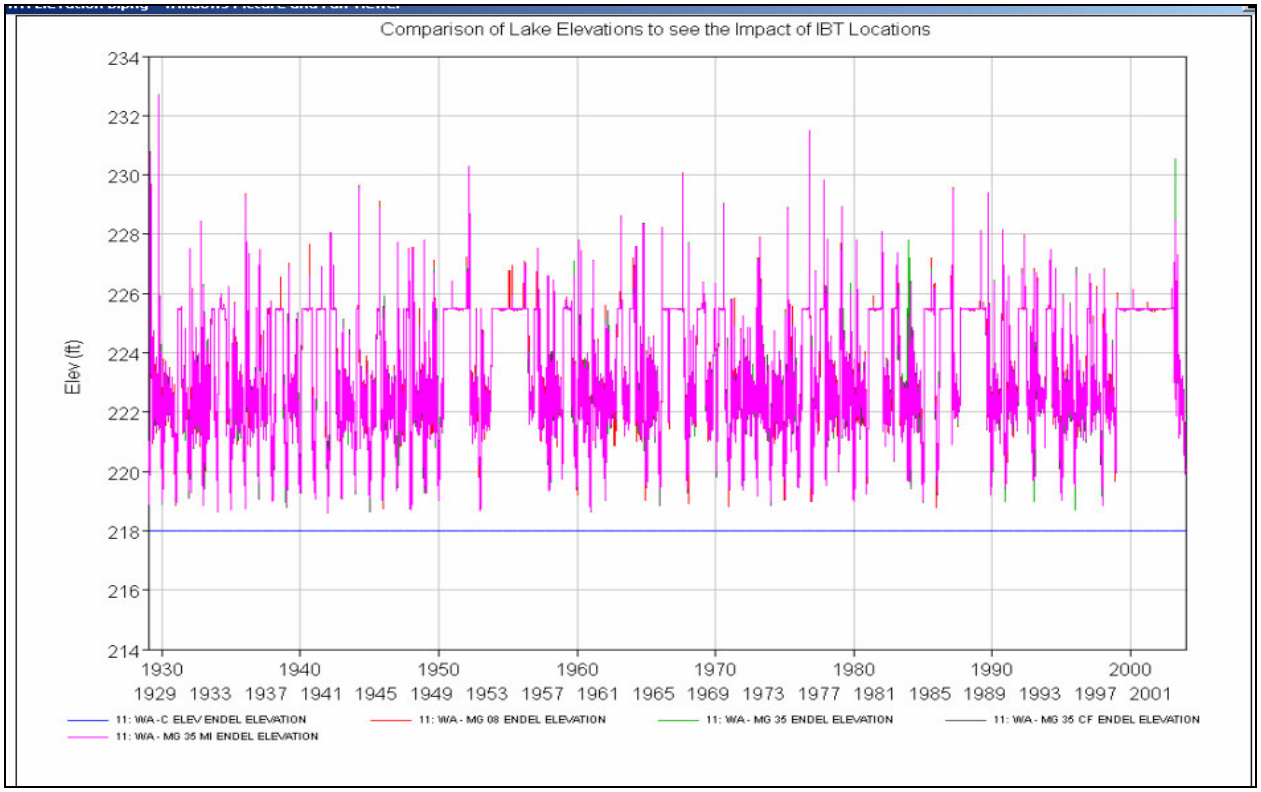

Figure 142: WA Elevations for Impacts of IBT Locations on Elevation

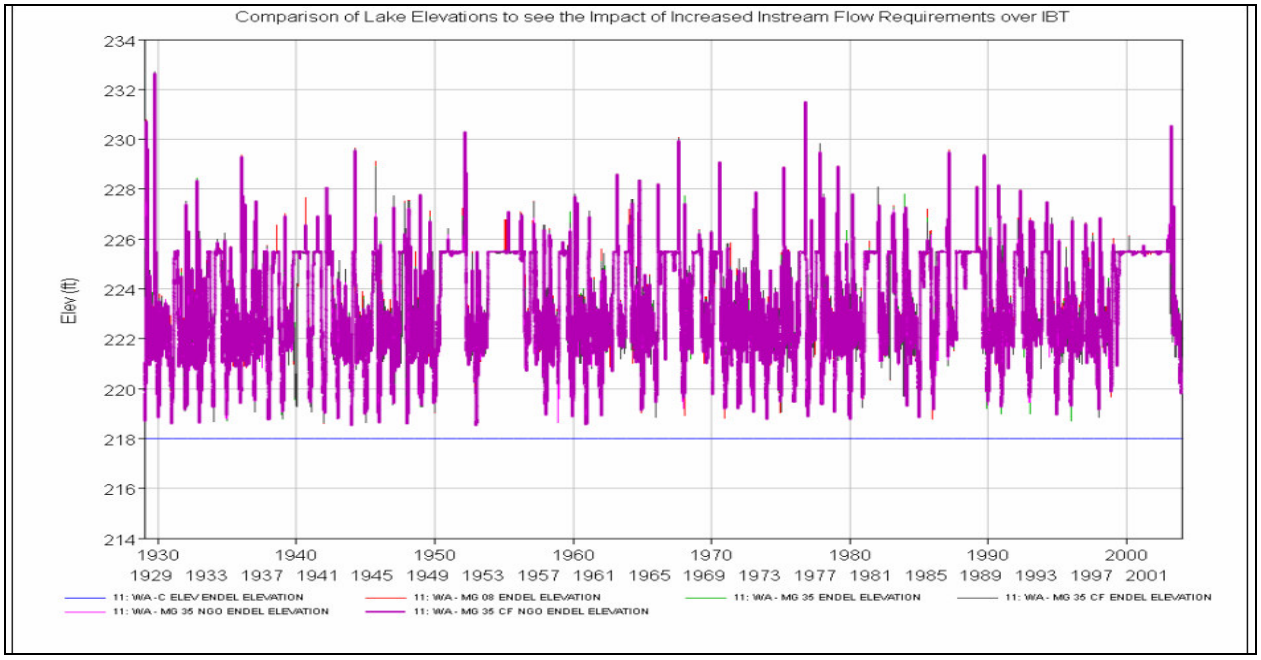

Figure 143: WA Elevations for Impacts of Increased Instream Flow Requirement with IBT on Elevation

9. Storage Condition in Dry Years

1) Bridgewater

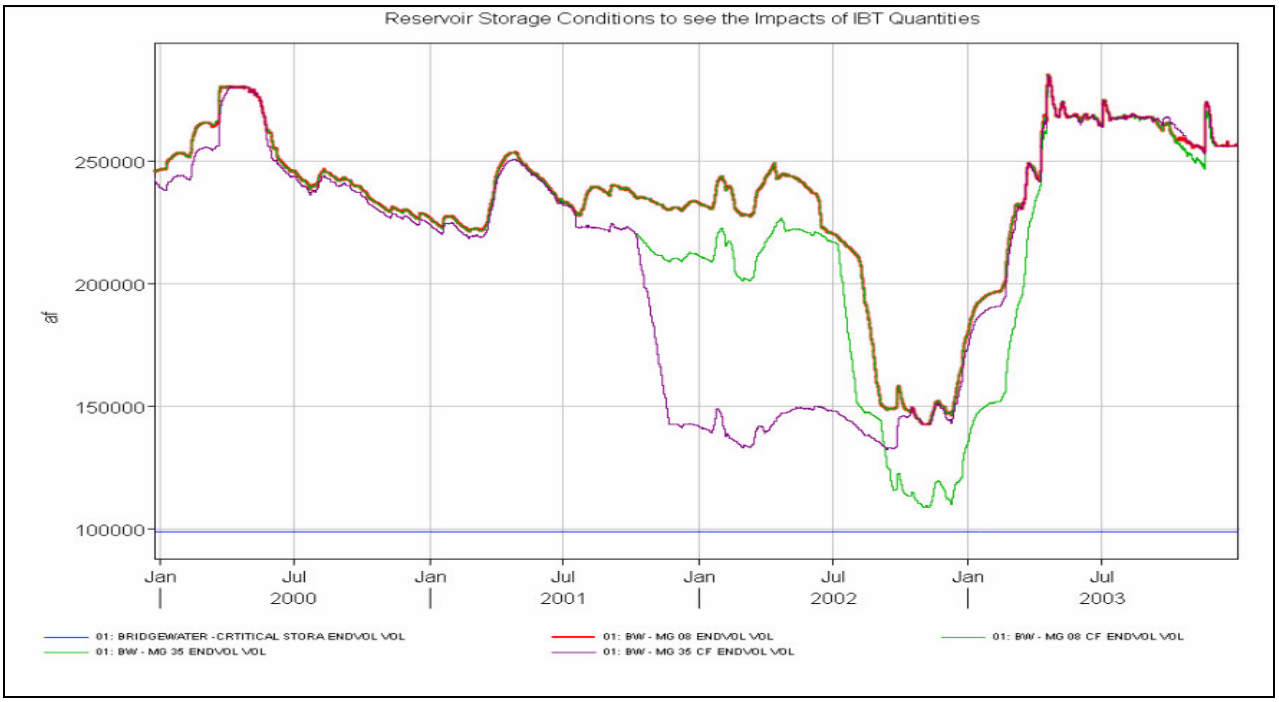

Figure 144: BW Storage for Impacts of IBT Quantity

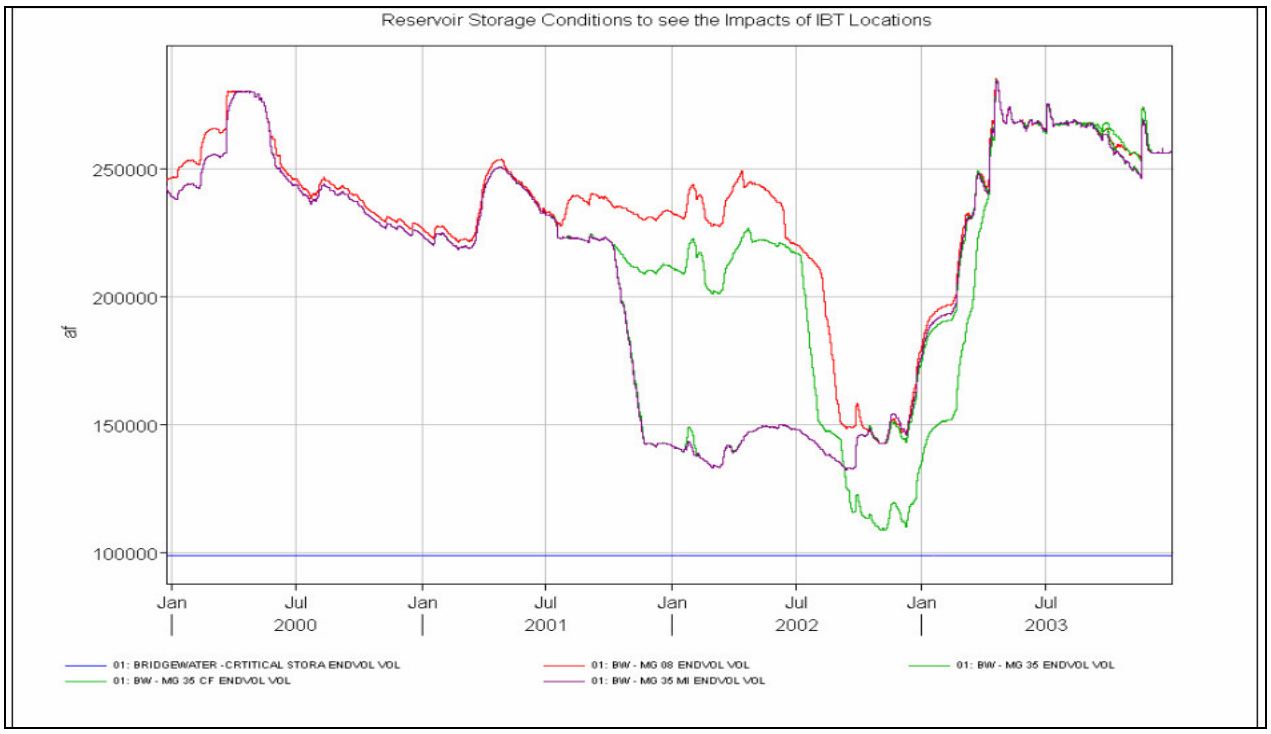

Figure 145: BW Storage for Impacts of IBT Locations

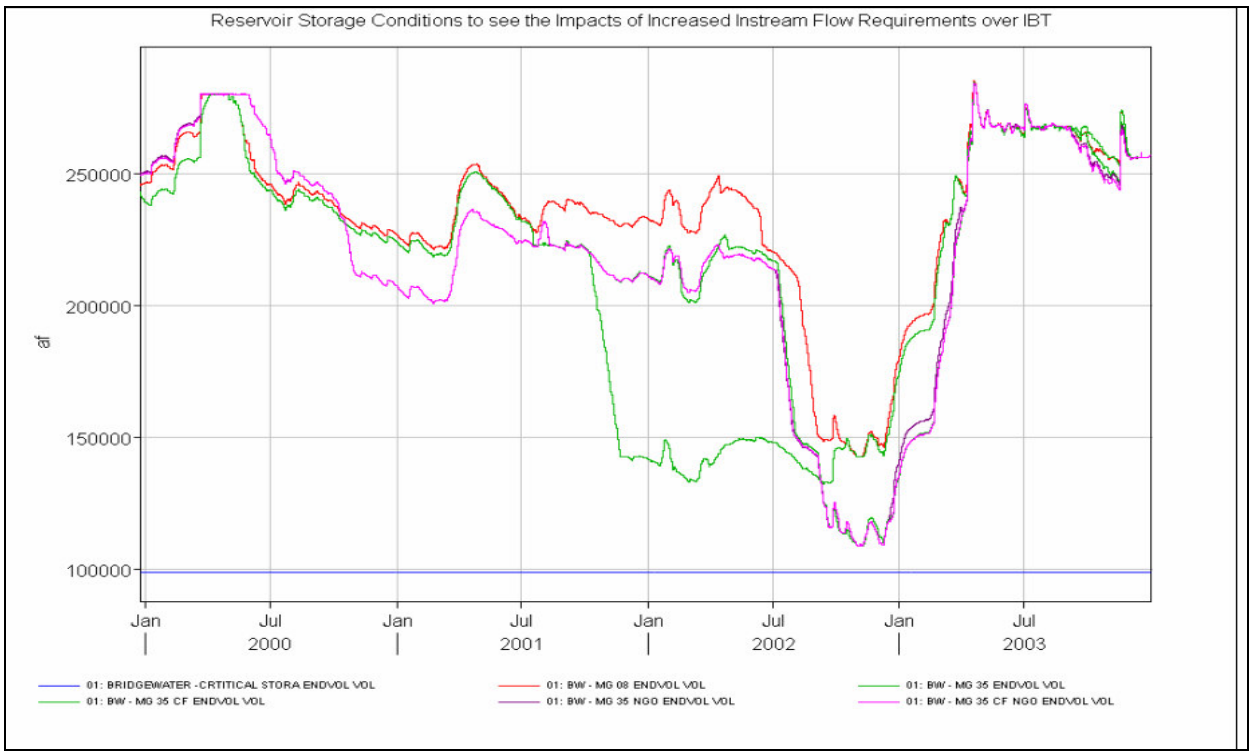

Figure 146: BW Storage for Impacts of Increased Instream Flow Requirement with IBT

2) Rhodhiss

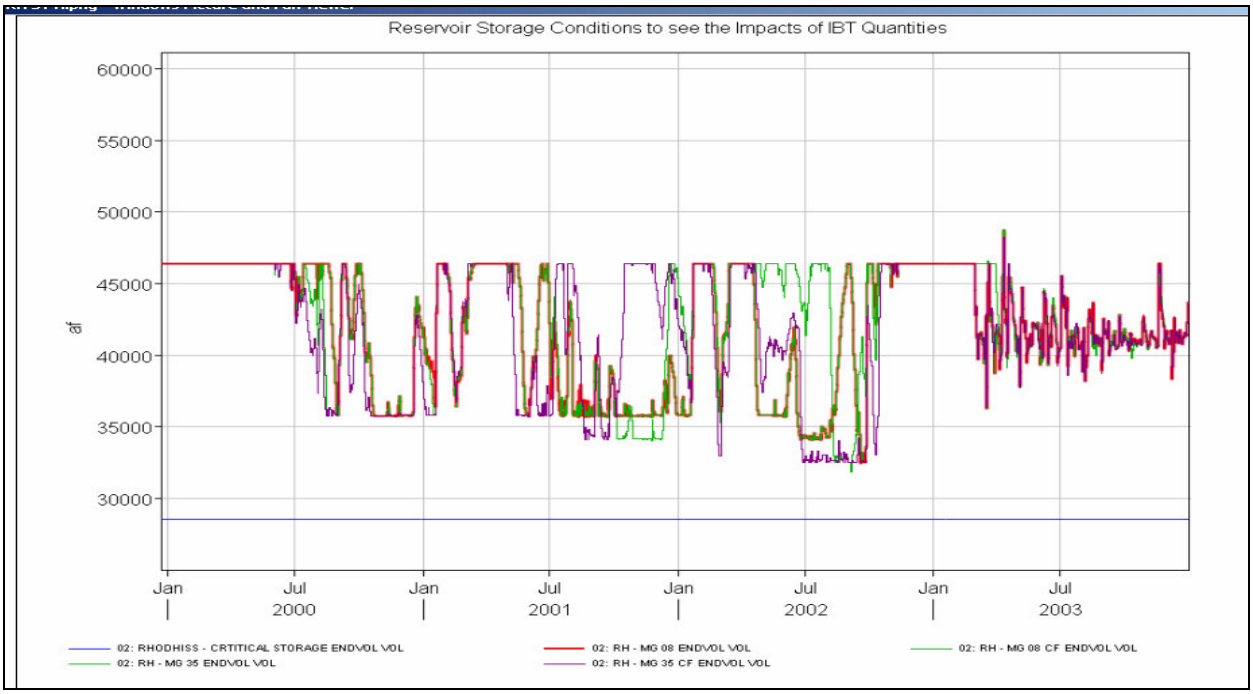

Figure 147: RH Storage for Impacts of IBT Quantity

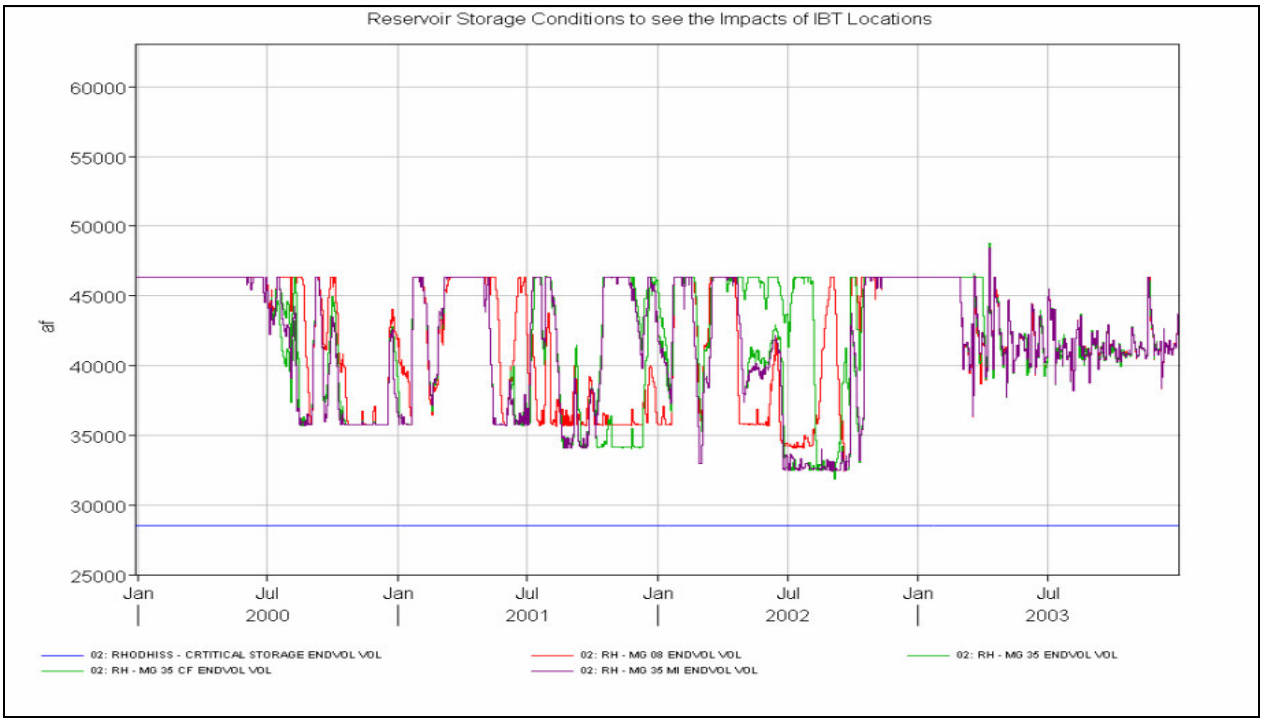

Figure 148: RH Storage for Impacts of IBT Locations

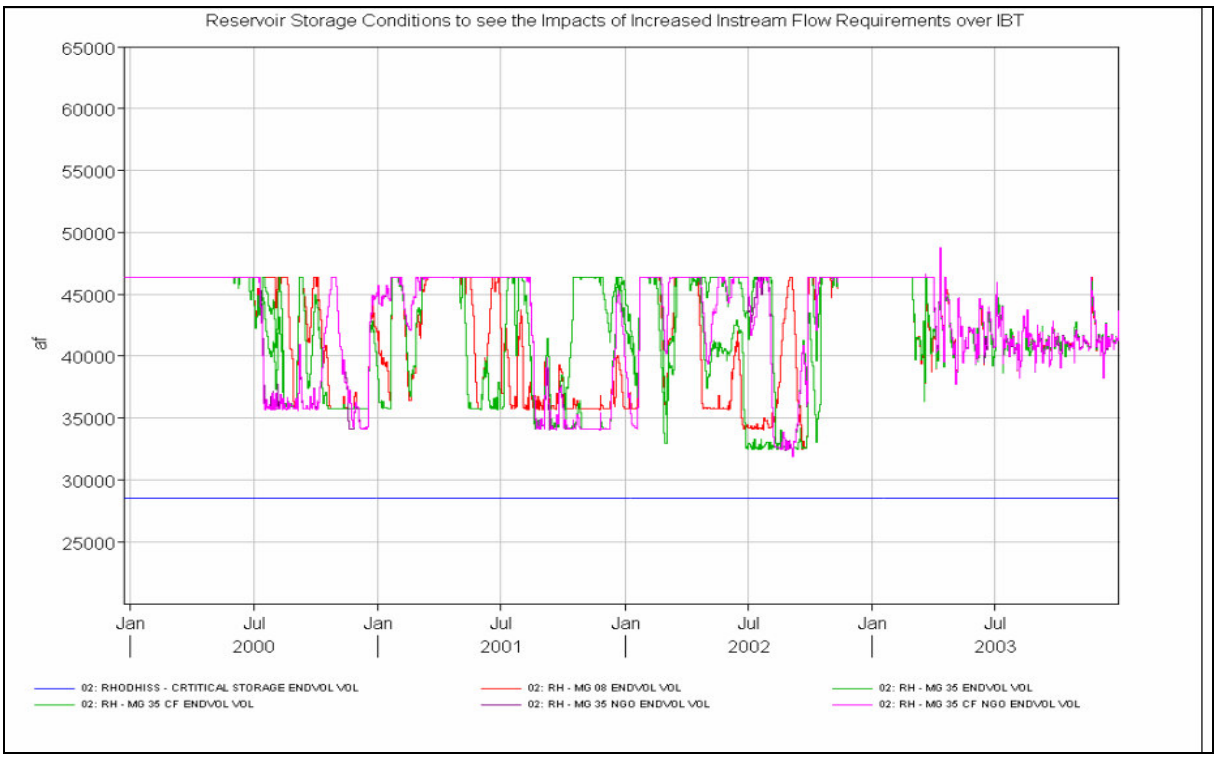

Figure 149: RH Storage for Impacts of Increased Instream Flow Requirement with IBT

3) Oxford

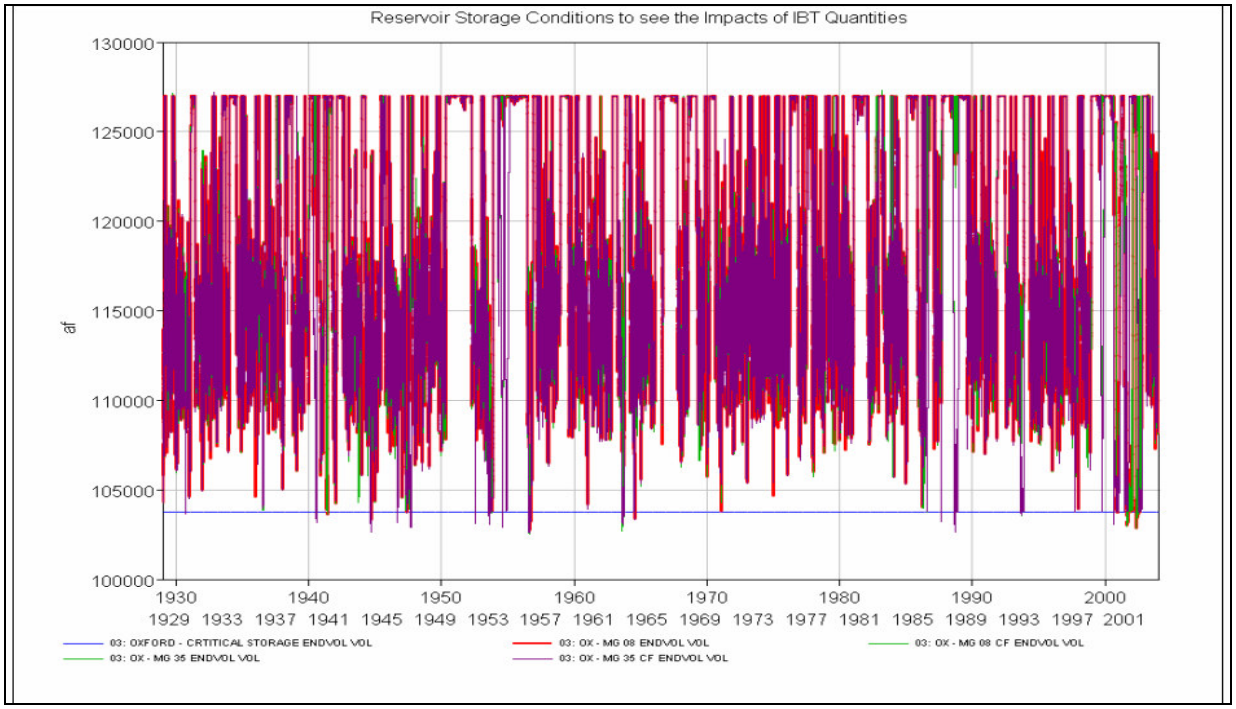

Figure 150: OX Storage for Impacts of IBT Quantity

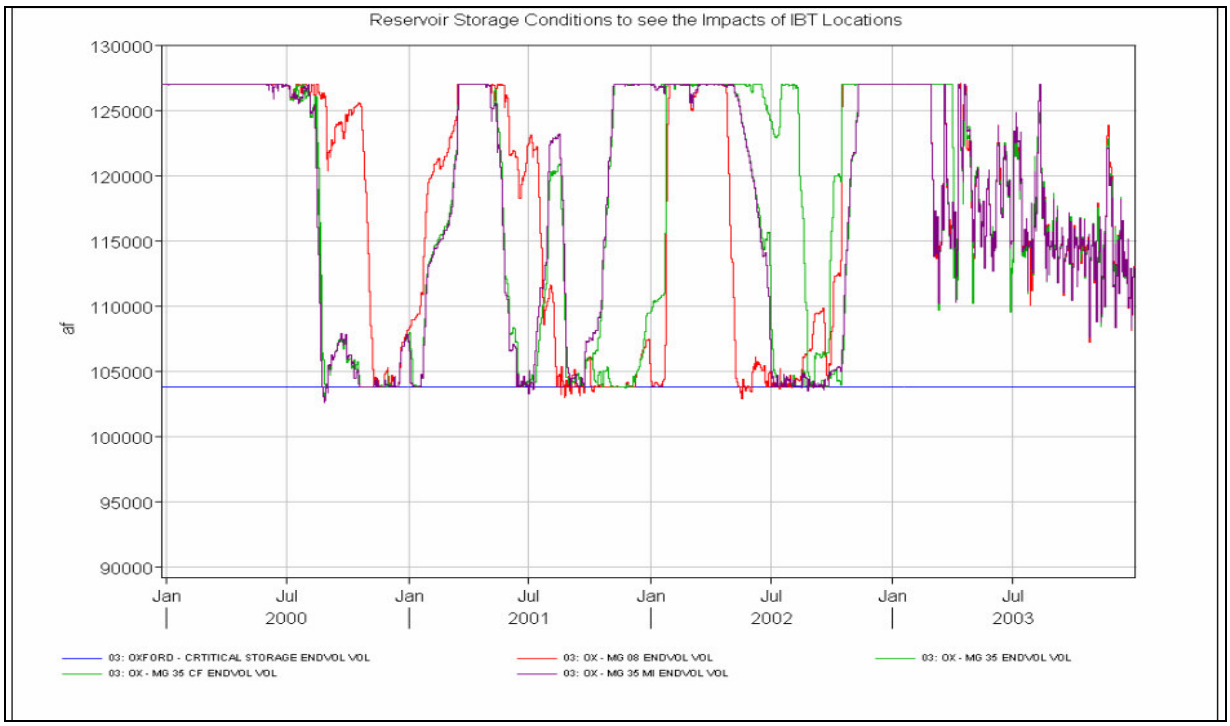

Figure 151: OX Storage for Impacts of IBT Locations

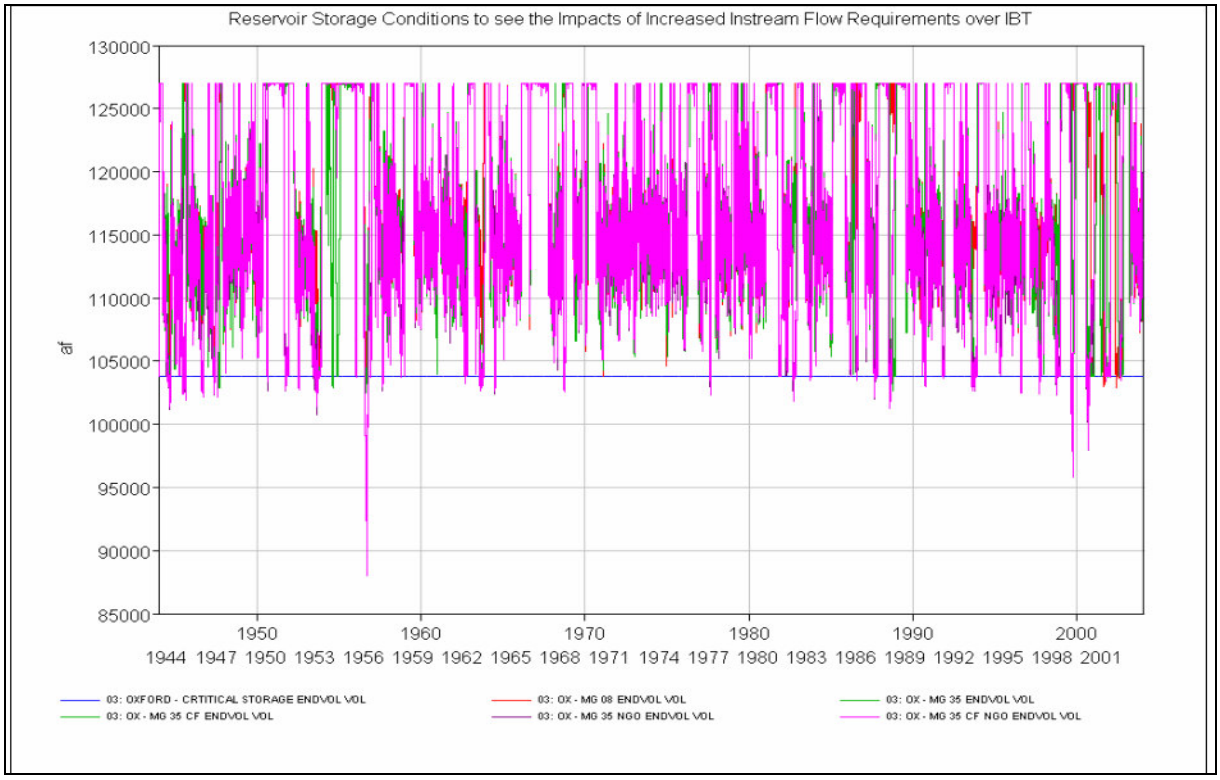

Figure 152: OX Storage for Impacts of Increased Instream Flow Requirement with IBT

4) Lookout shoals

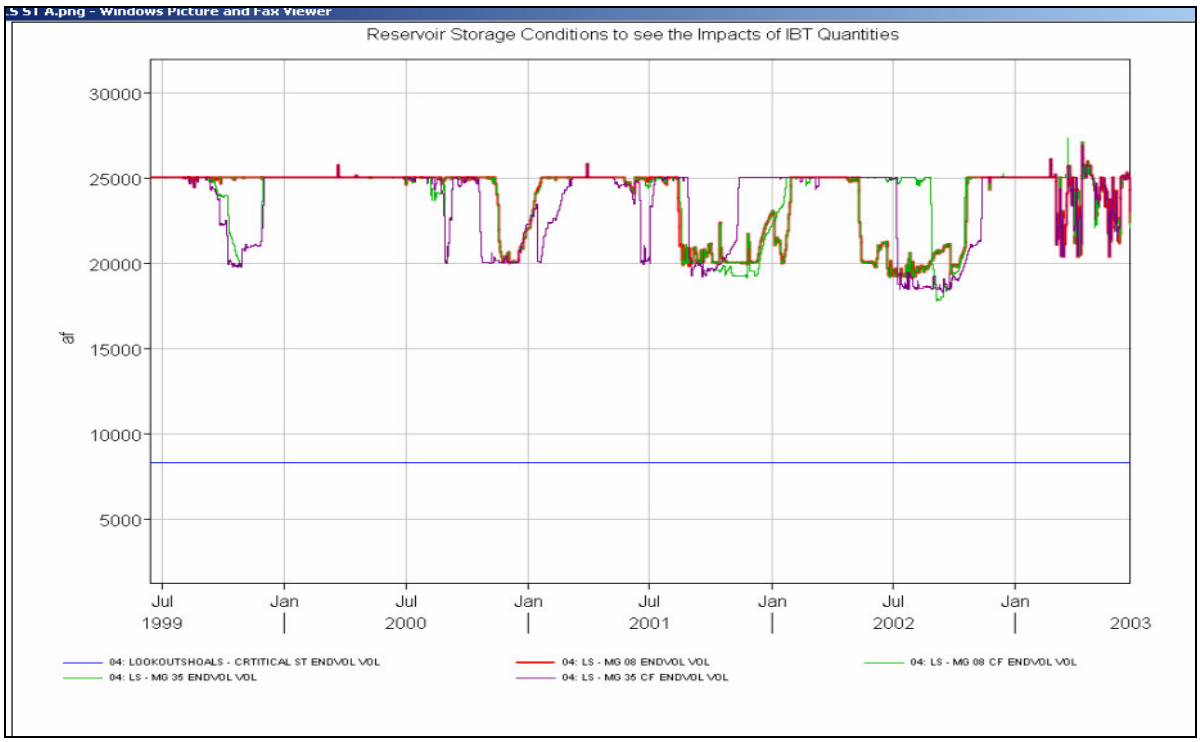

Figure 153: LS Storage for Impacts of IBT Quantity

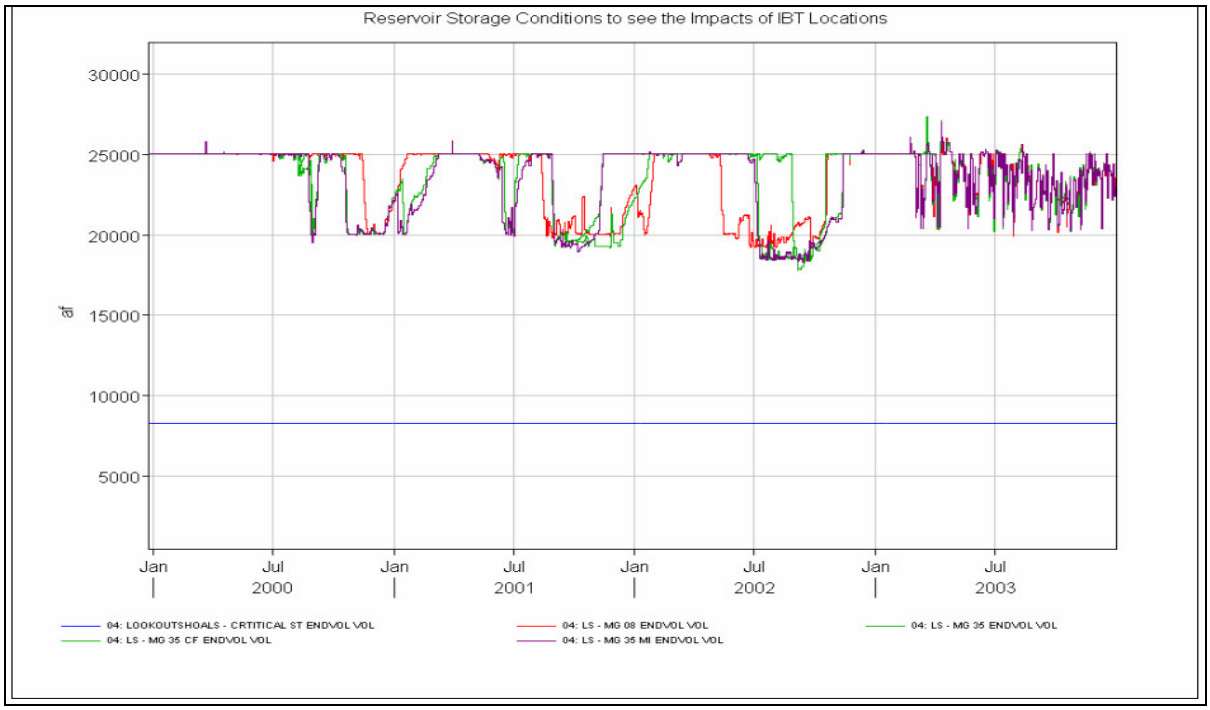

Figure 154: : LS Storage for Impacts of IBT Locations

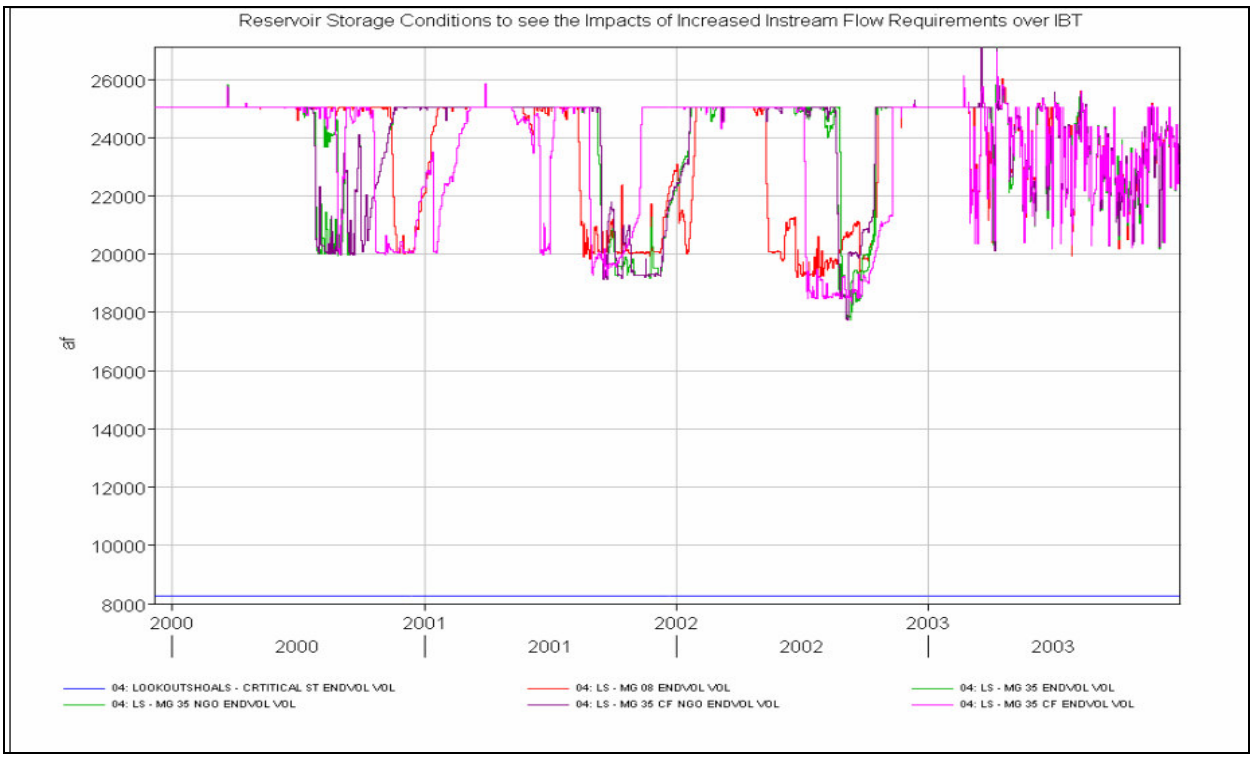

Figure 155: : LS Storage for Impacts of Increased Instream Flow Requirement with IBT

5) Cowan Ford

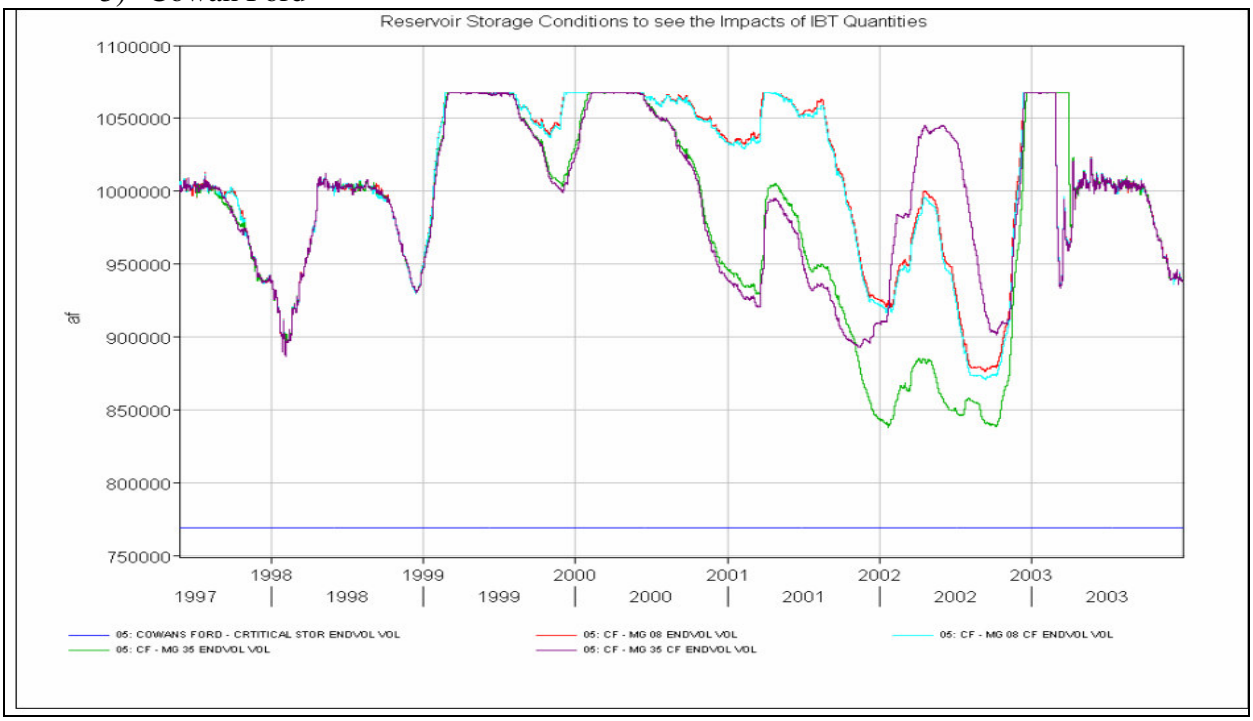

Figure 156: CF Storage for Impacts of IBT Quantity

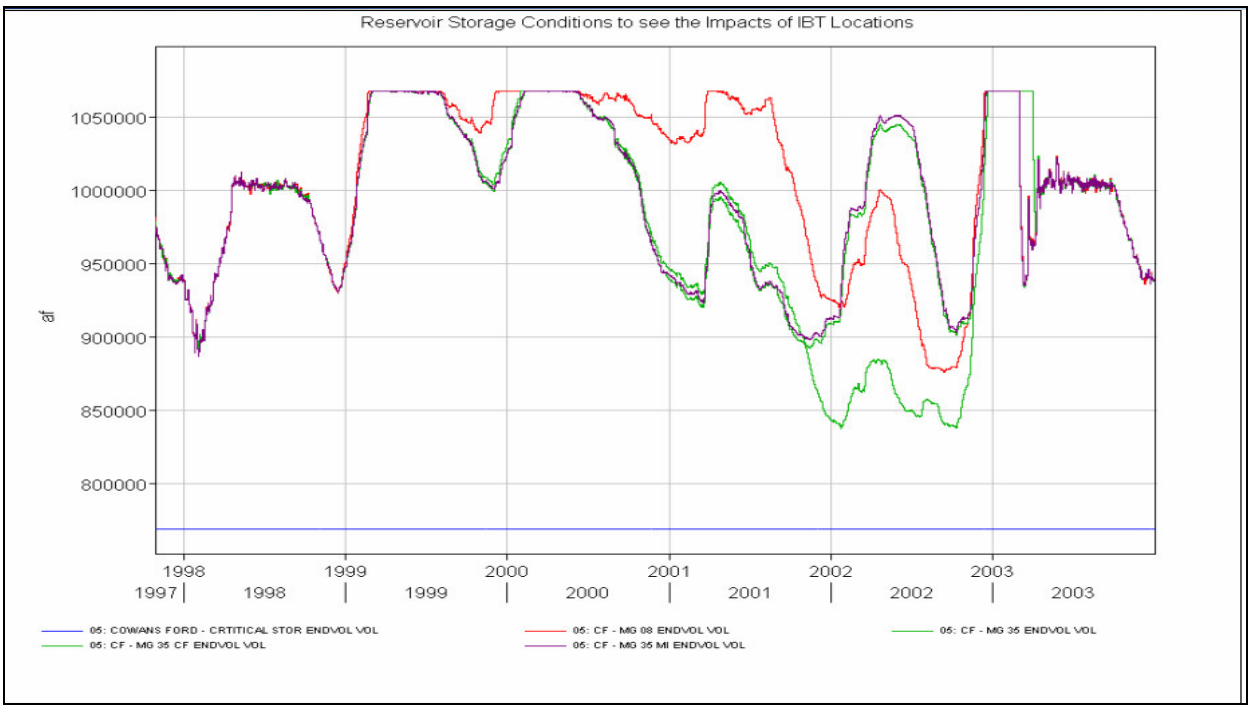

Figure 157: CF Storage for Impacts of IBT Locations

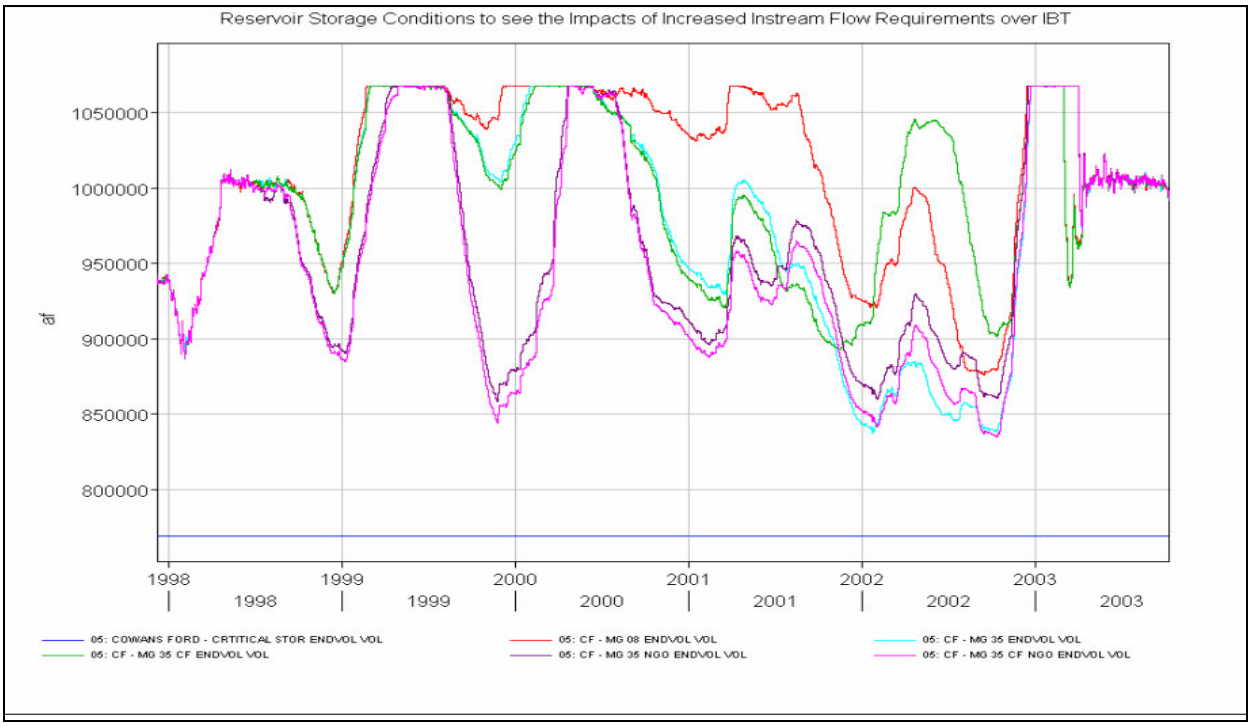

Figure 158: CF Storage for Impacts of Increased Instream Flow Requirement with IBT

6) Mountain Island

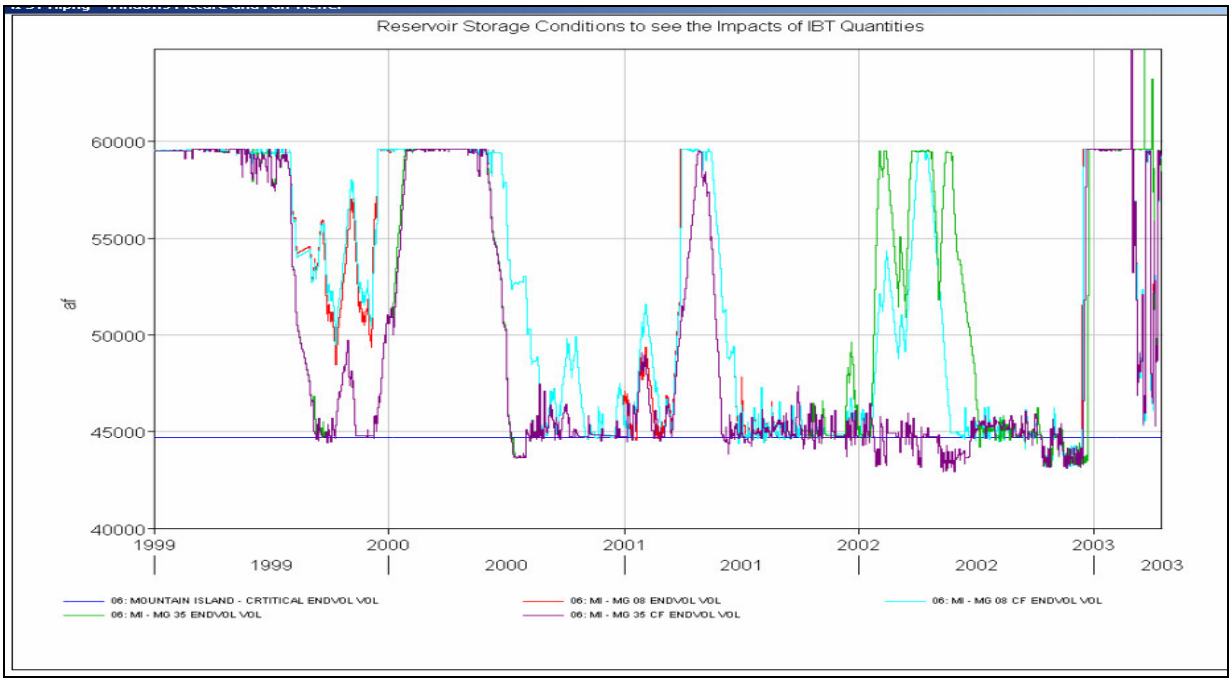

Figure 159: MI Storage for Impacts of IBT Quantity

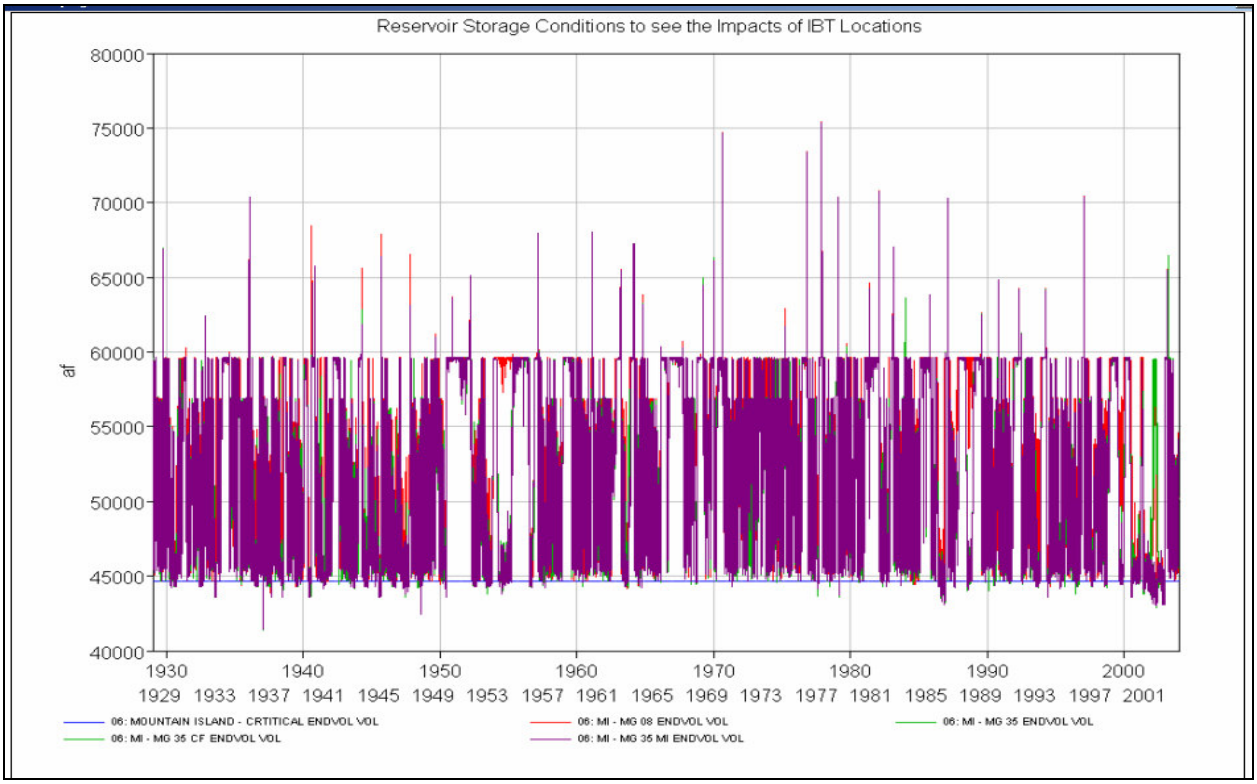

Figure 160: MI Storage for Impacts of IBT Locations

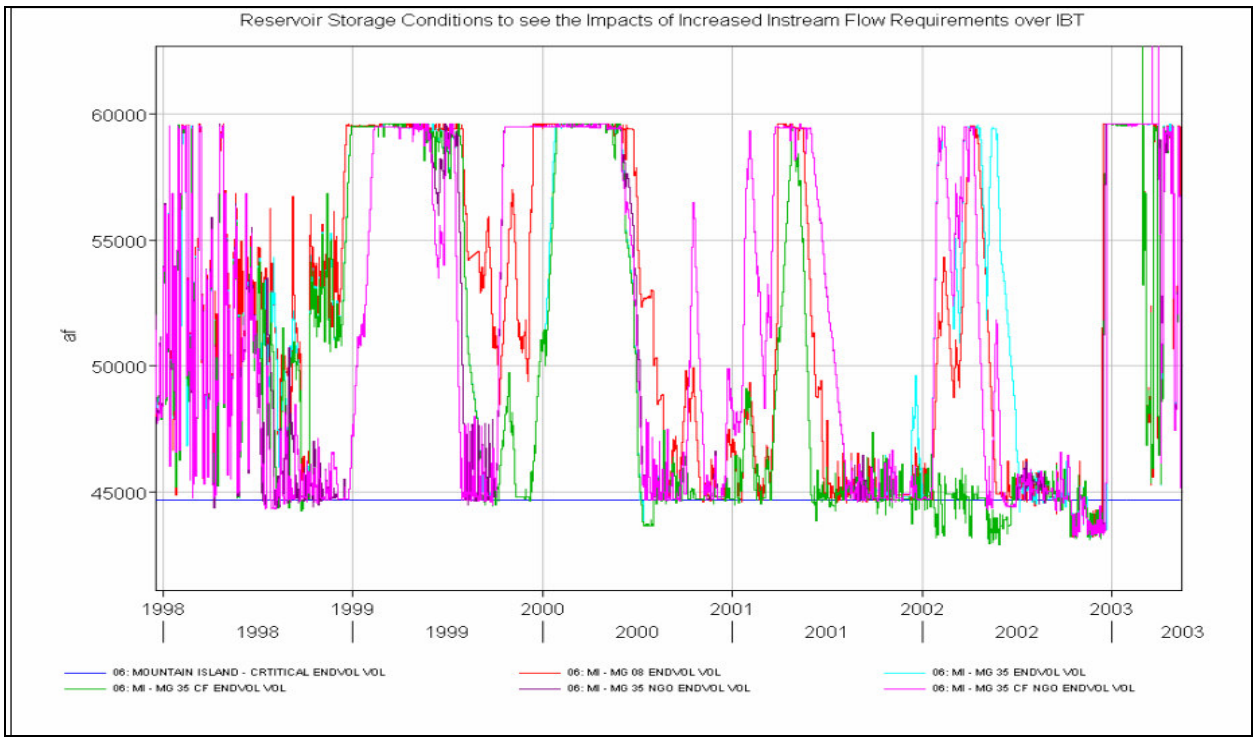

Figure 161: MI Storage for Impacts of Increased Instream Flow Requirement with IBT

7) Wylie

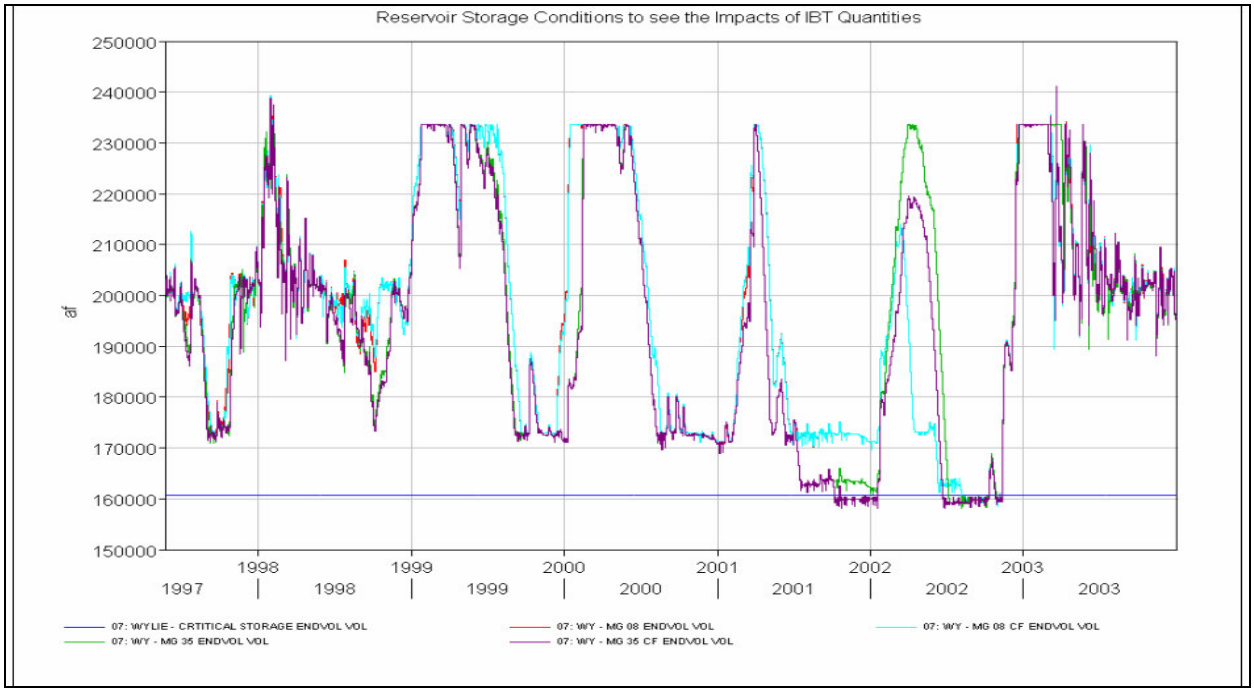

Figure 162: WY Storage for Impacts of IBT Quantity

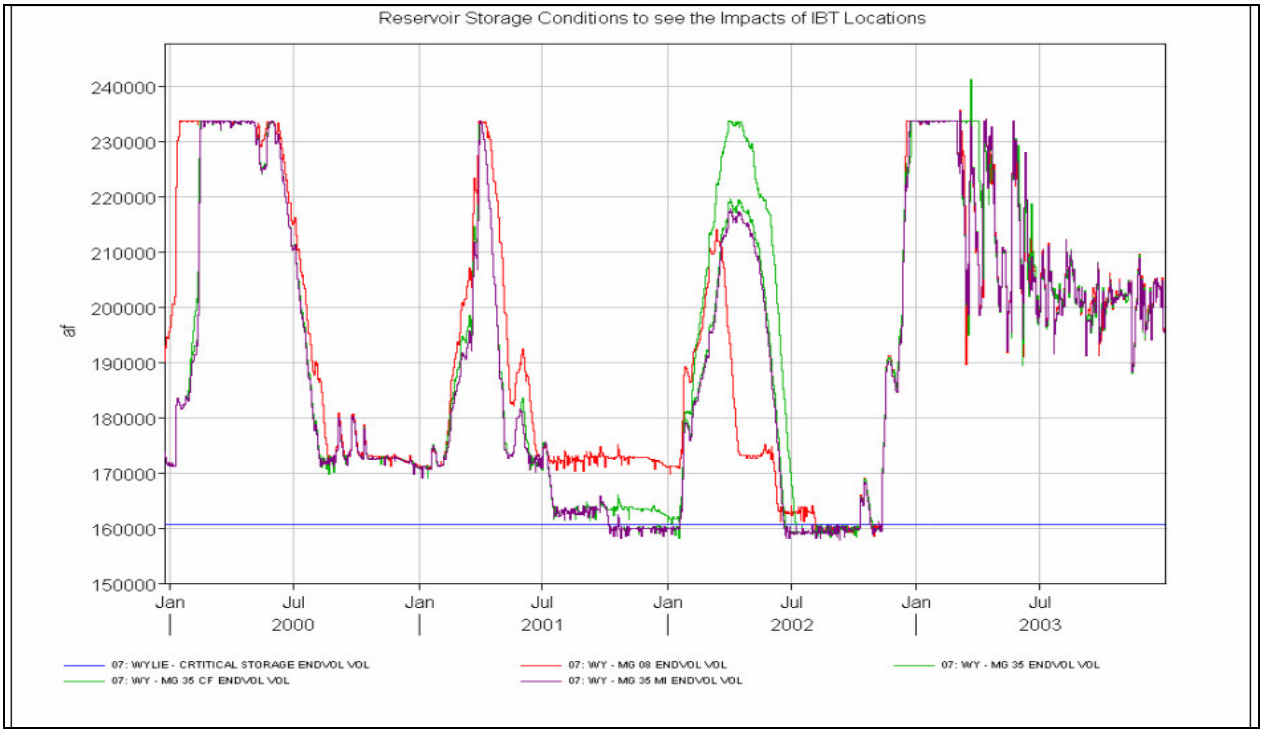

Figure 163: WY Storage for Impacts of IBT Locations

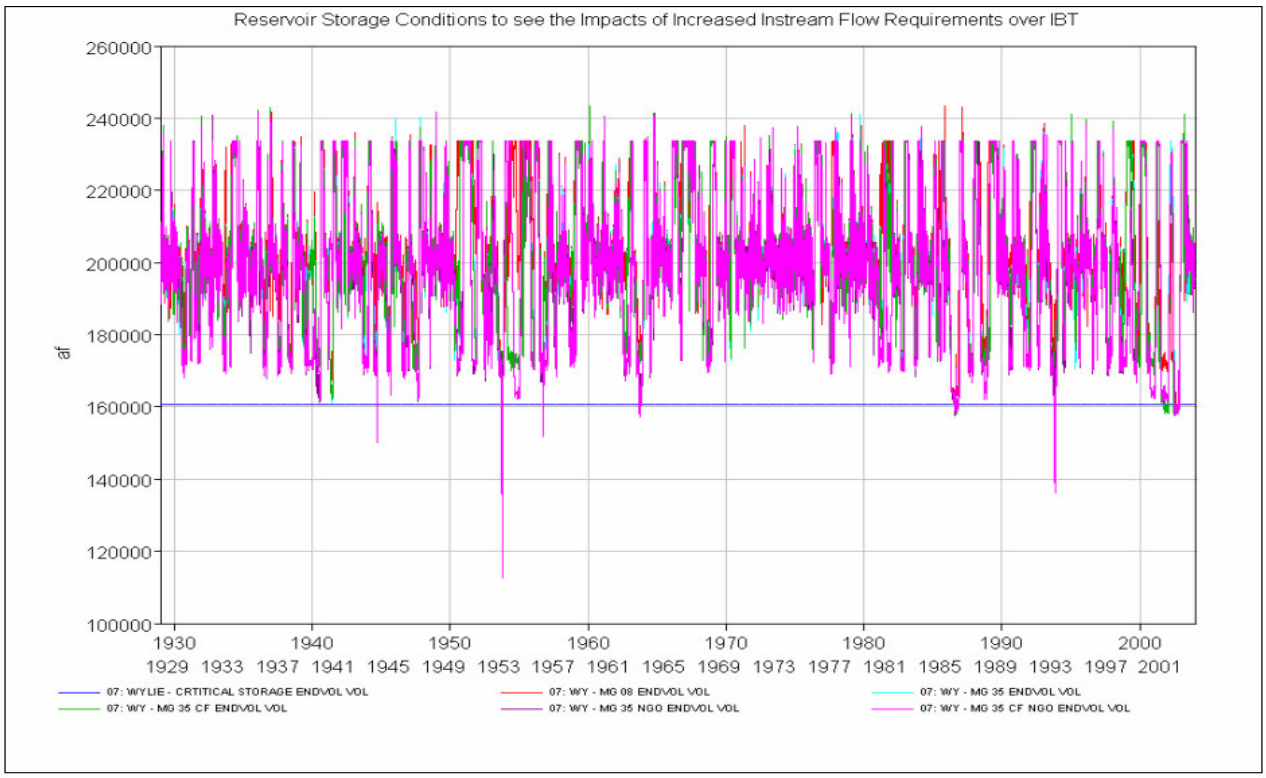

Figure 164: WY Storage for Impacts of Increased Instream Flow Requirement with IBT

8) Fishing Creek

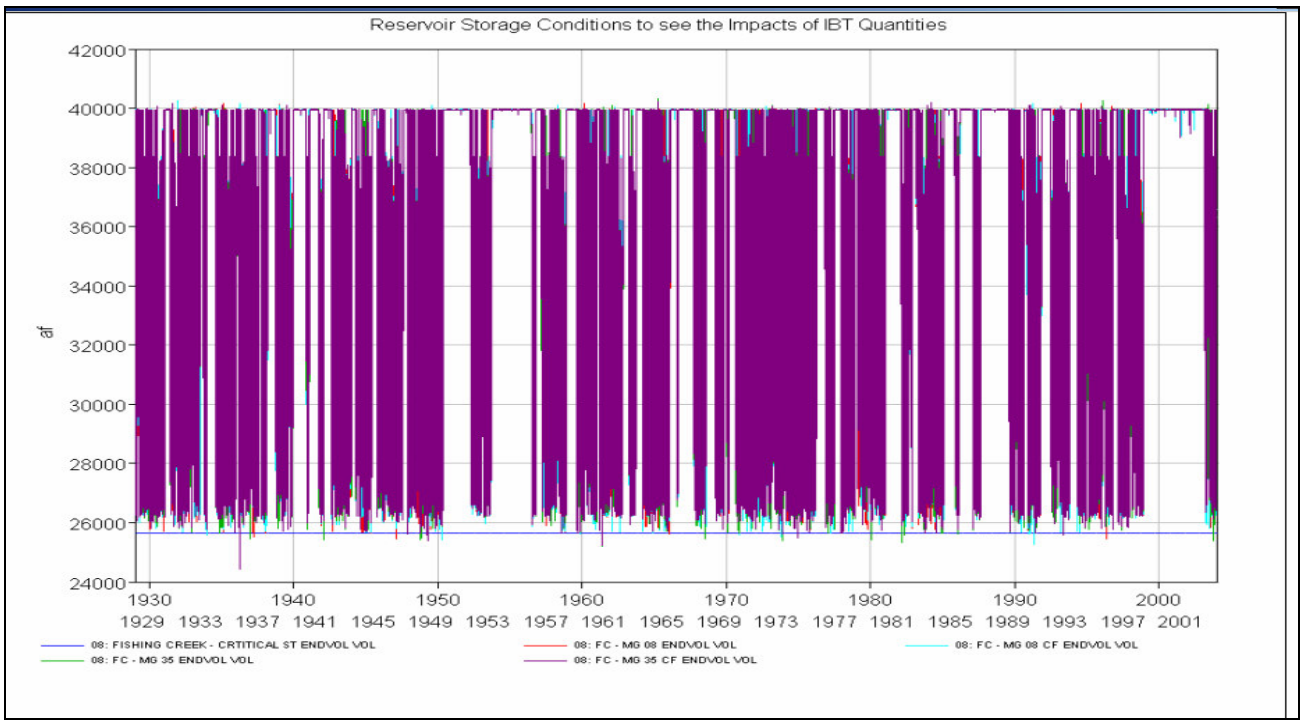

Figure 165: FC Storage for Impacts of IBT Quantity

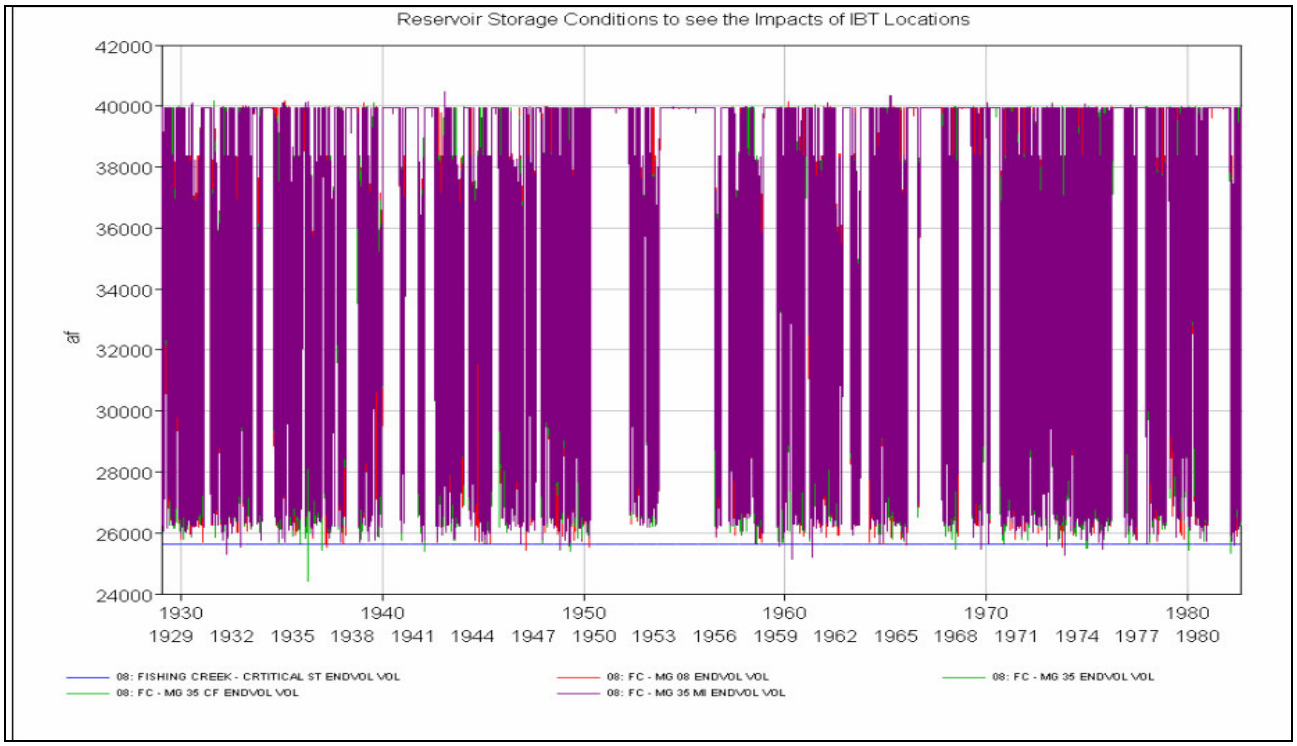

Figure 166: FC Storage for Impacts of IBT Locations

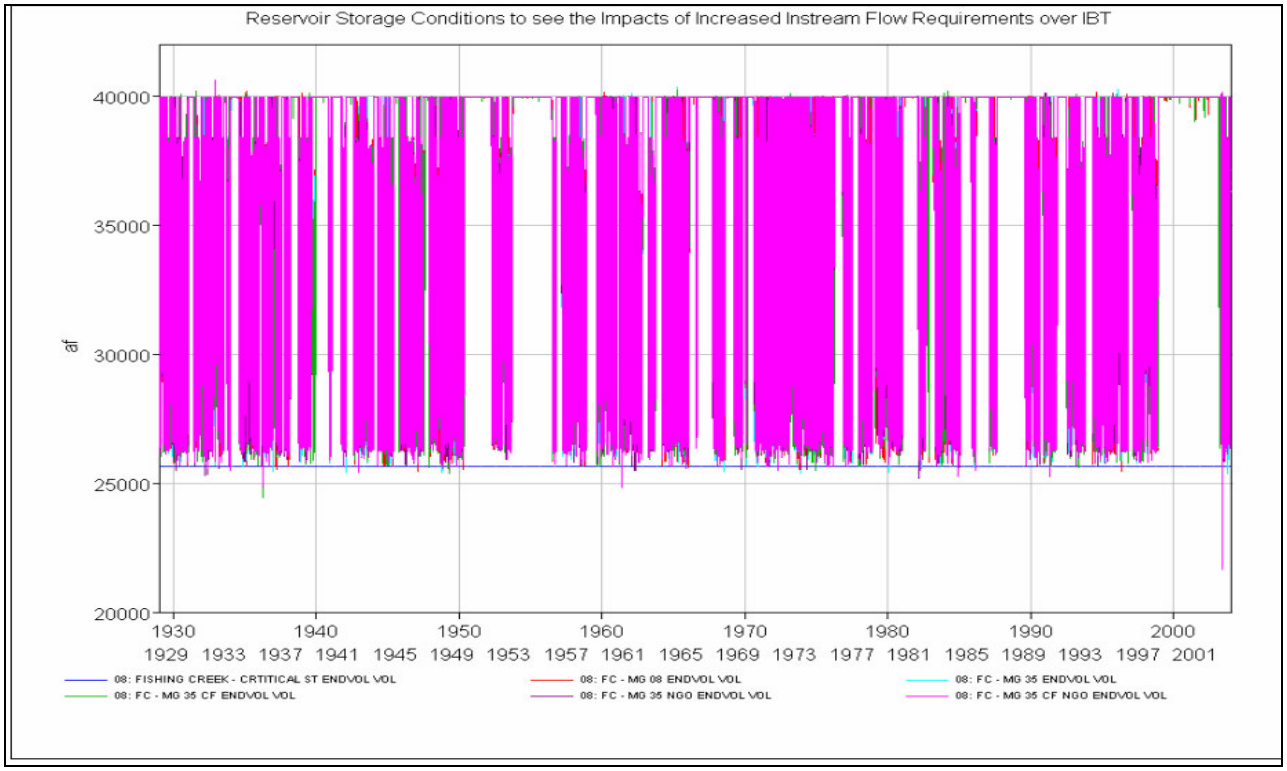

Figure 167: FC Storage for Impacts of Increased Instream Flow Requirement with IBT

9) Great Falls

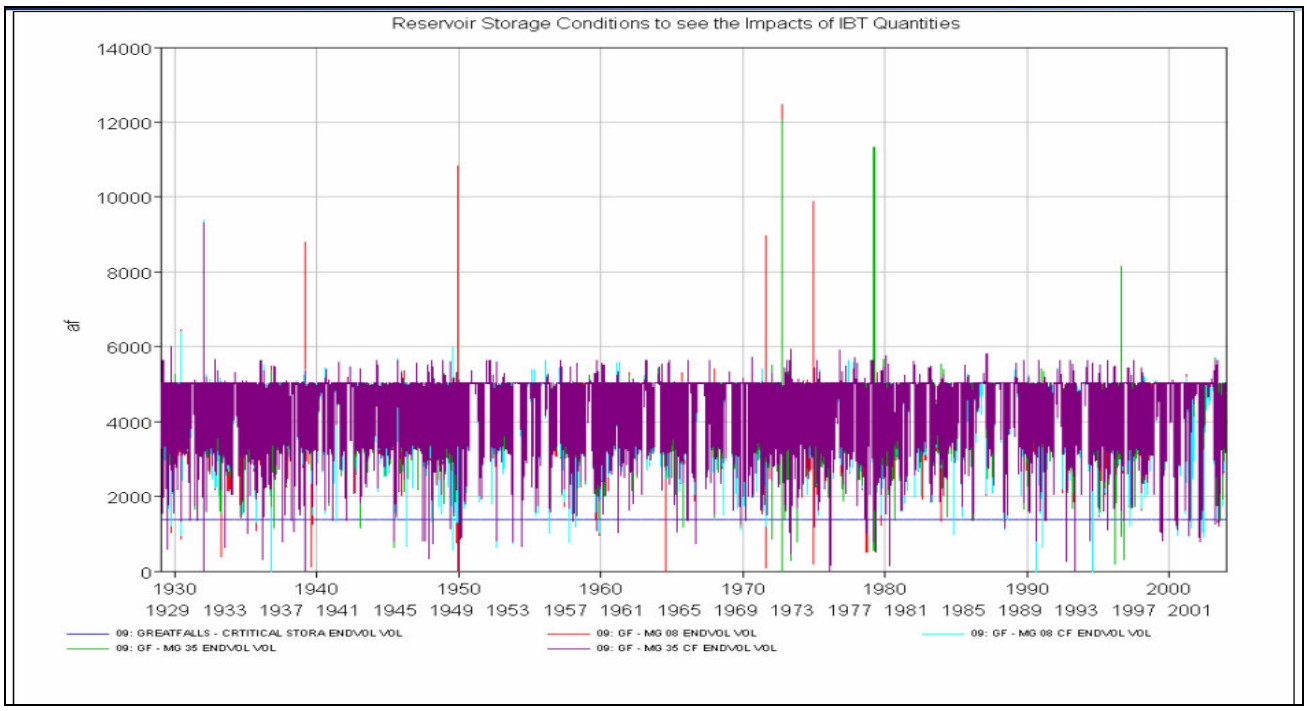

Figure 168: GF Storage for Impacts of IBT Quantity

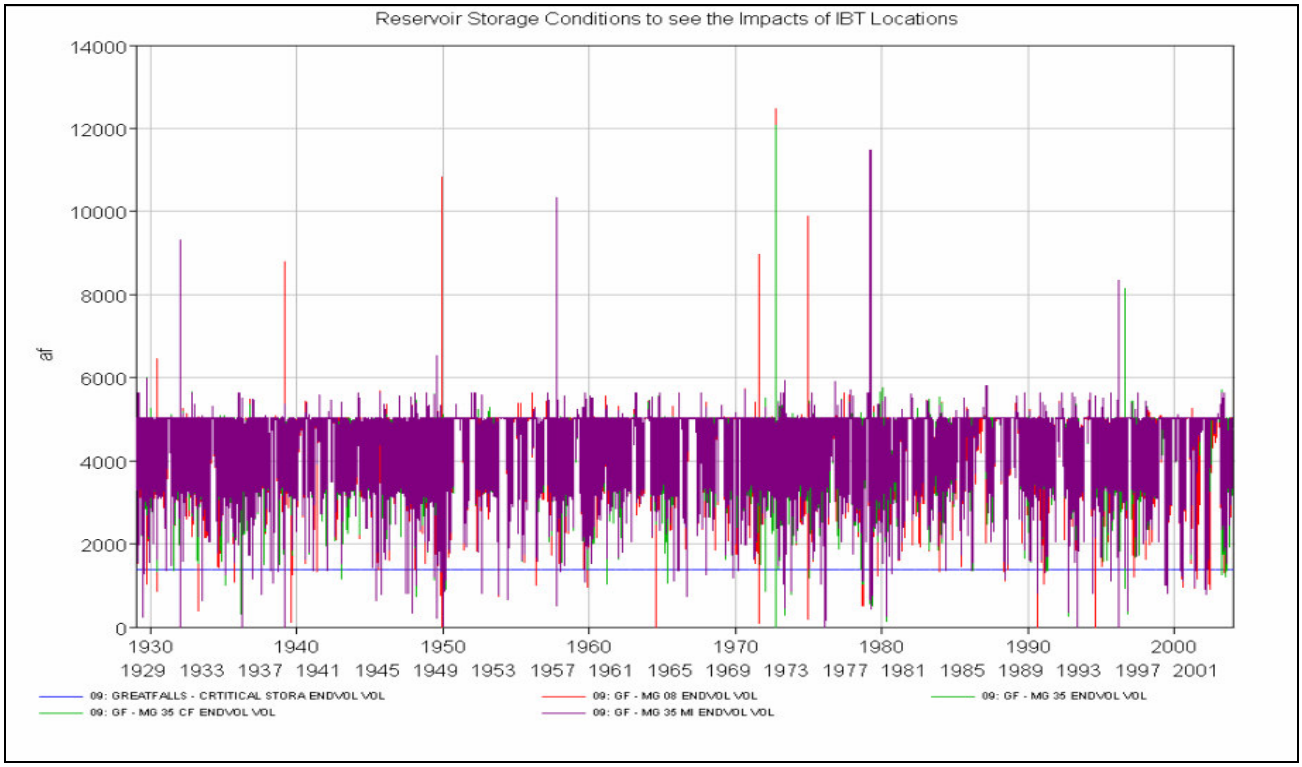

Figure 169: GF Storage for Impacts of IBT Locations

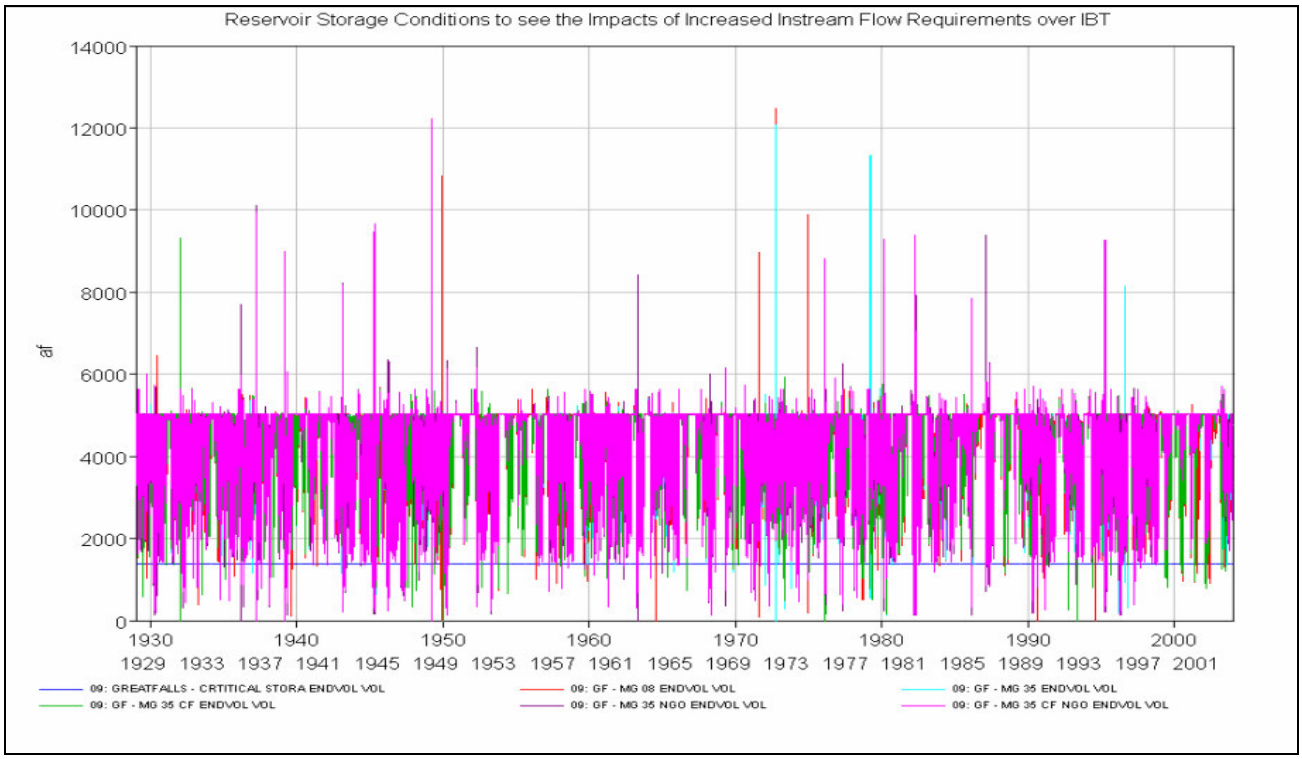

Figure 170: GF Storage for Impacts of Increased Instream Flow Requirement with IBT

10) Rocky Creek

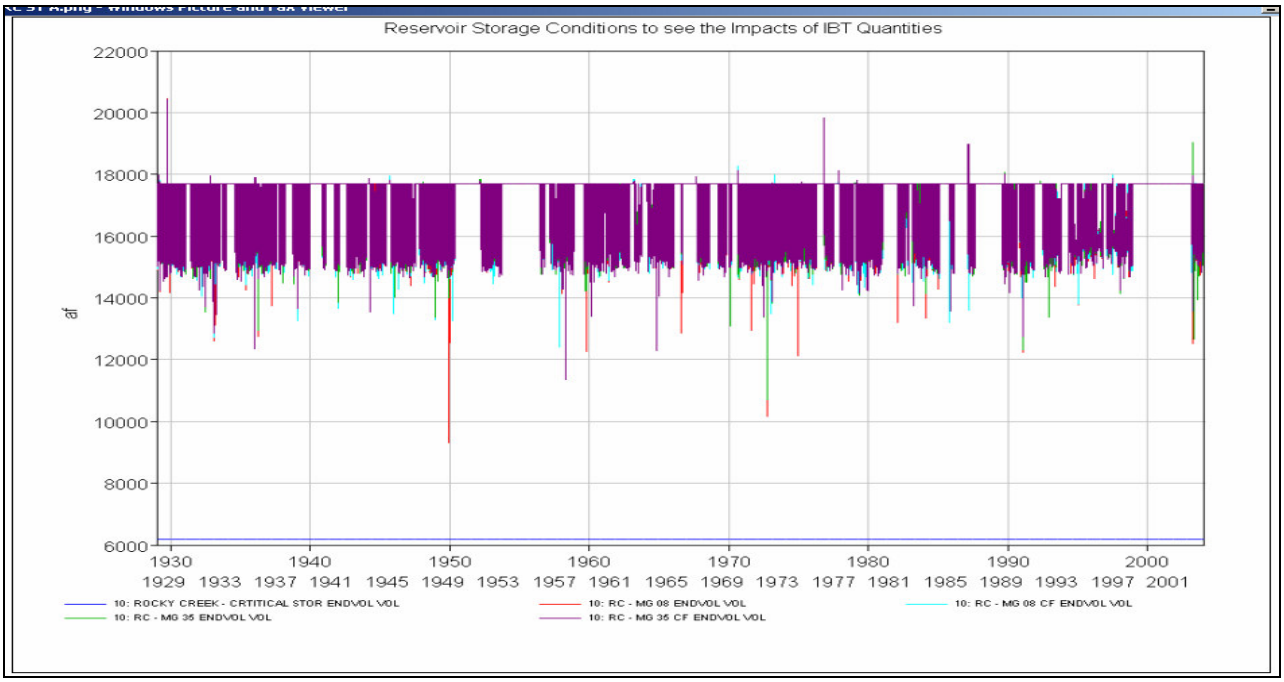

Figure 171: RC Storage for Impacts of IBT Quantity

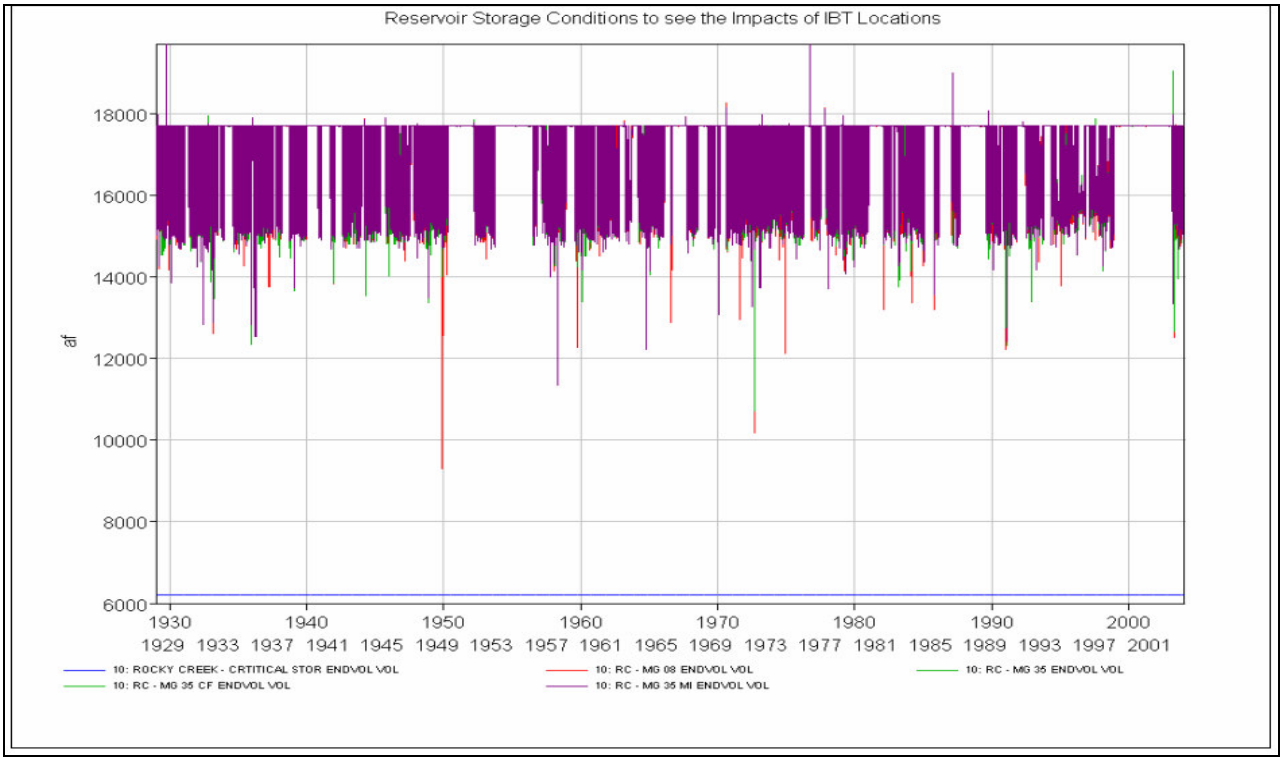

Figure 172: RC Storage for Impacts of IBT Locations

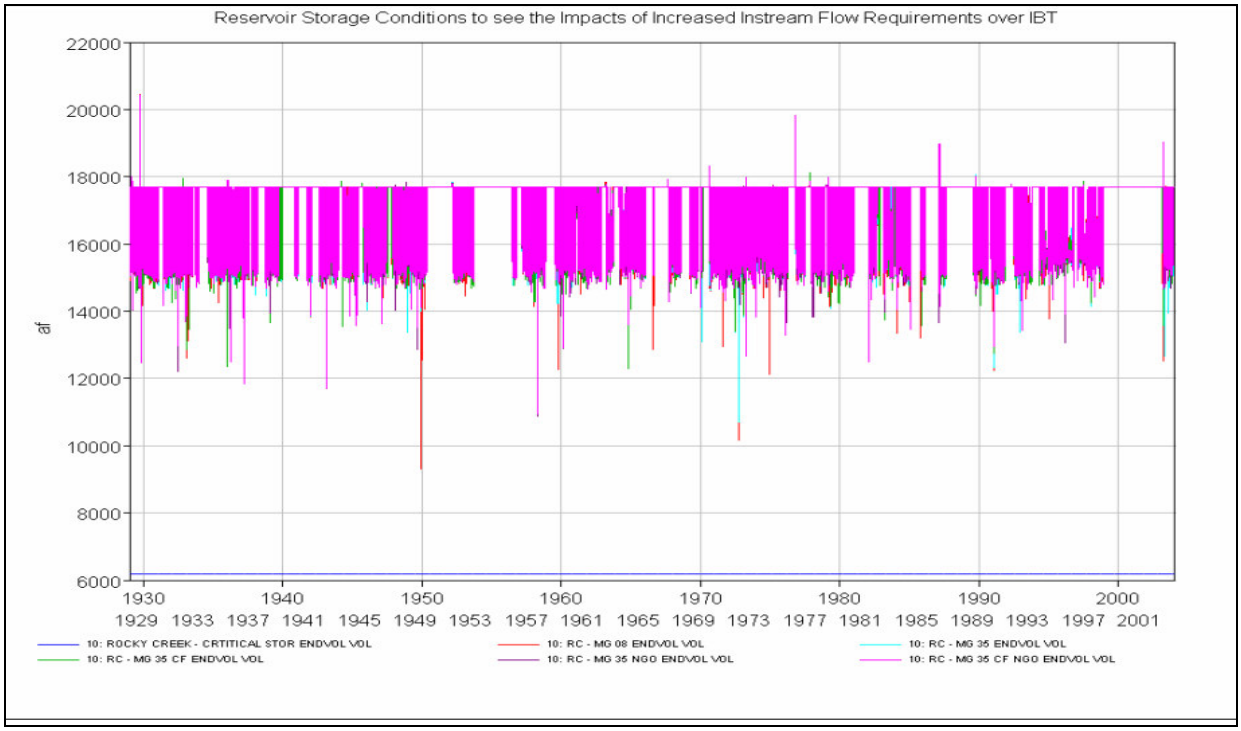

Figure 173: RC Storage for Impacts of Increased Instream Flow Requirement with IBT

11) Wateree

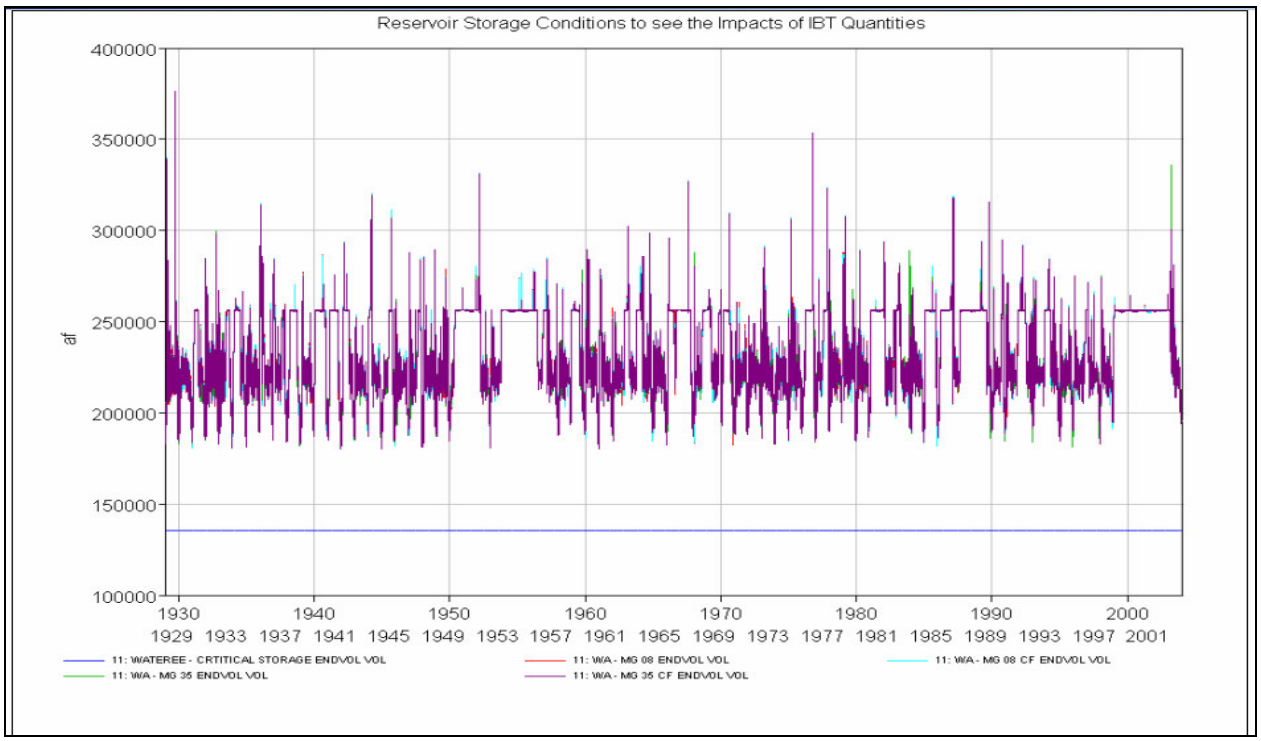

Figure 174: WA Storage for Impacts of IBT Quantity

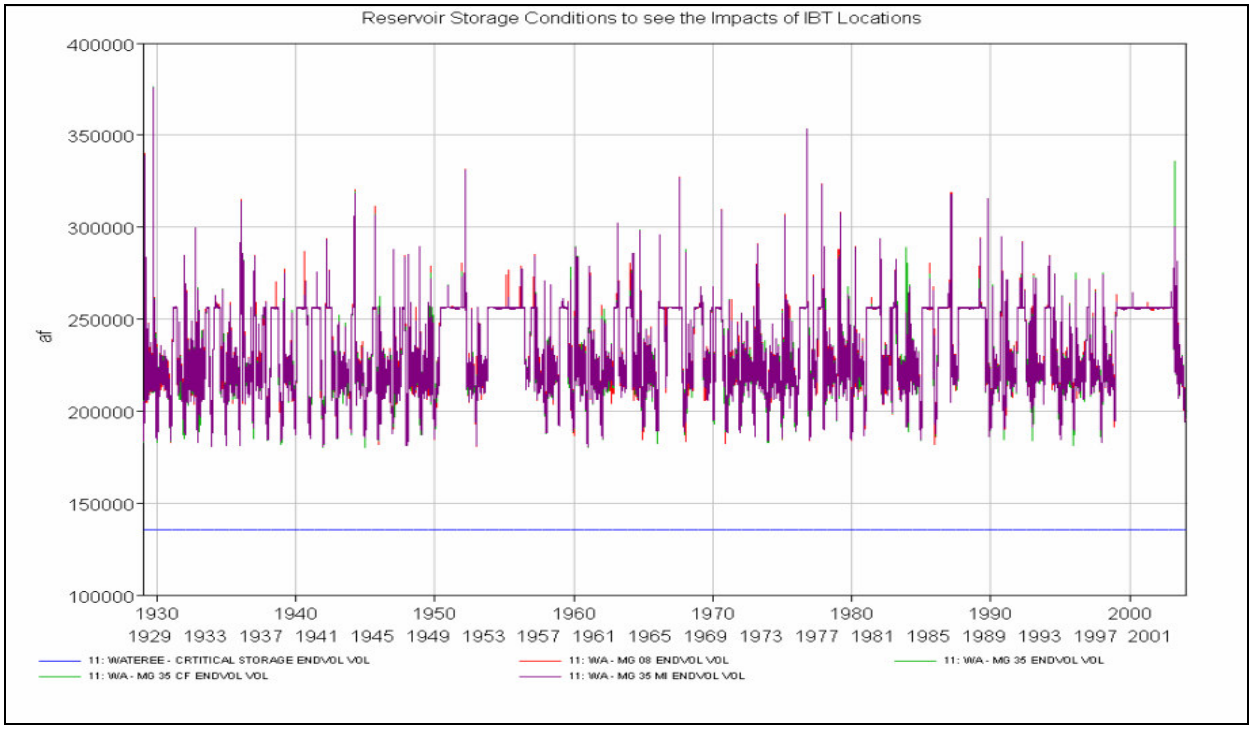

Figure 175: WA Storage for Impacts of IBT Locations

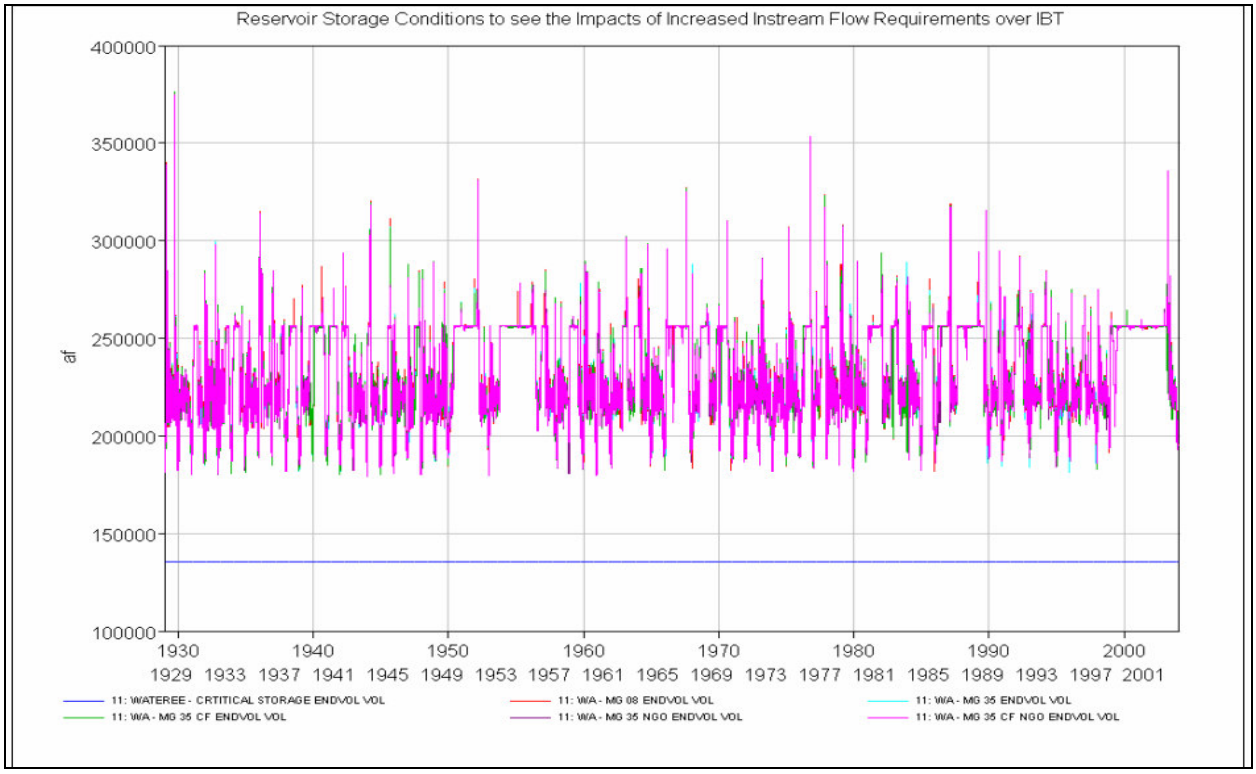

Figure 176: WA Storage for Impacts of Increased Instream Flow Requirement with IBT

10. Elevation Haze Charts:

1) Bridgewater

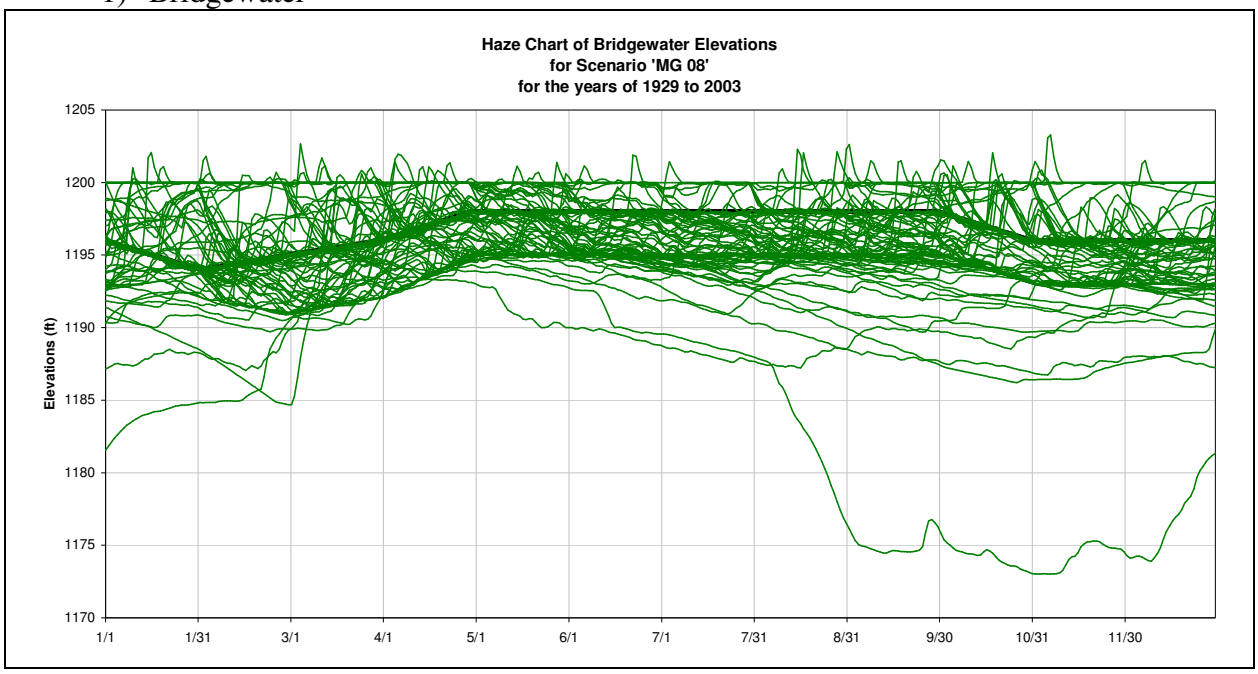

Figure 177: BW Elevation Haze Chart for MG 08

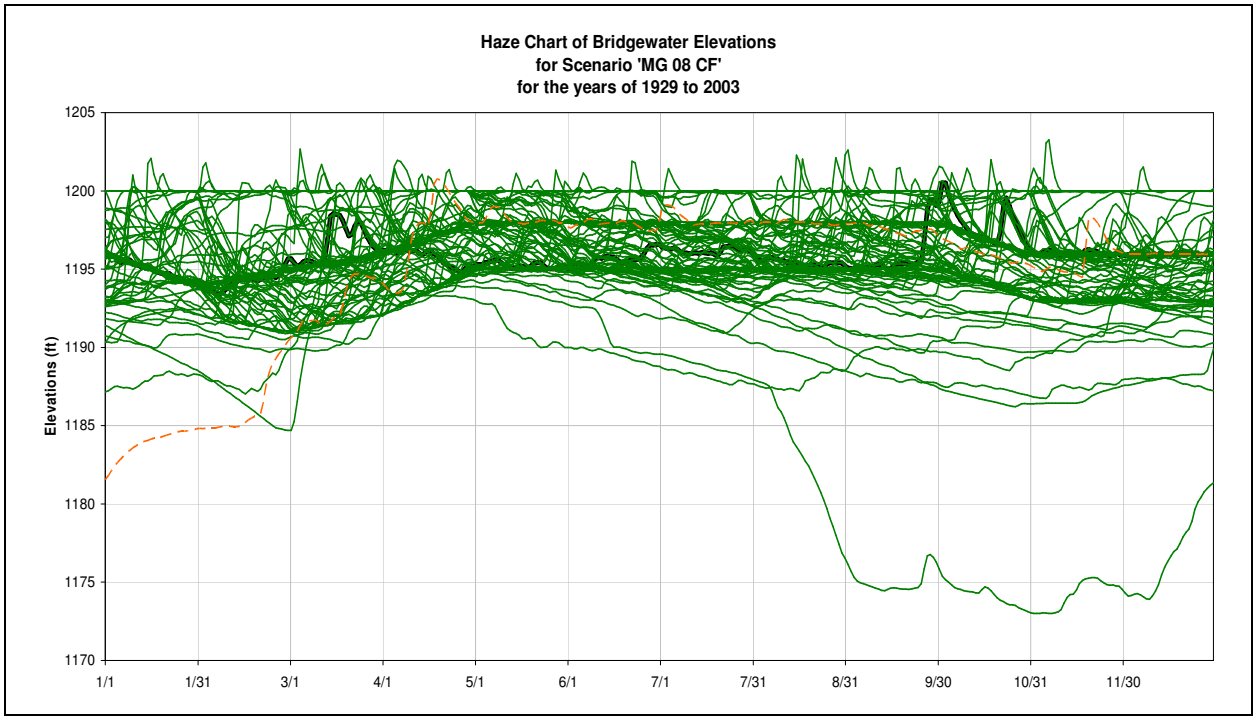

Figure 178: BW Elevation Haze Chart for MG 08 CF

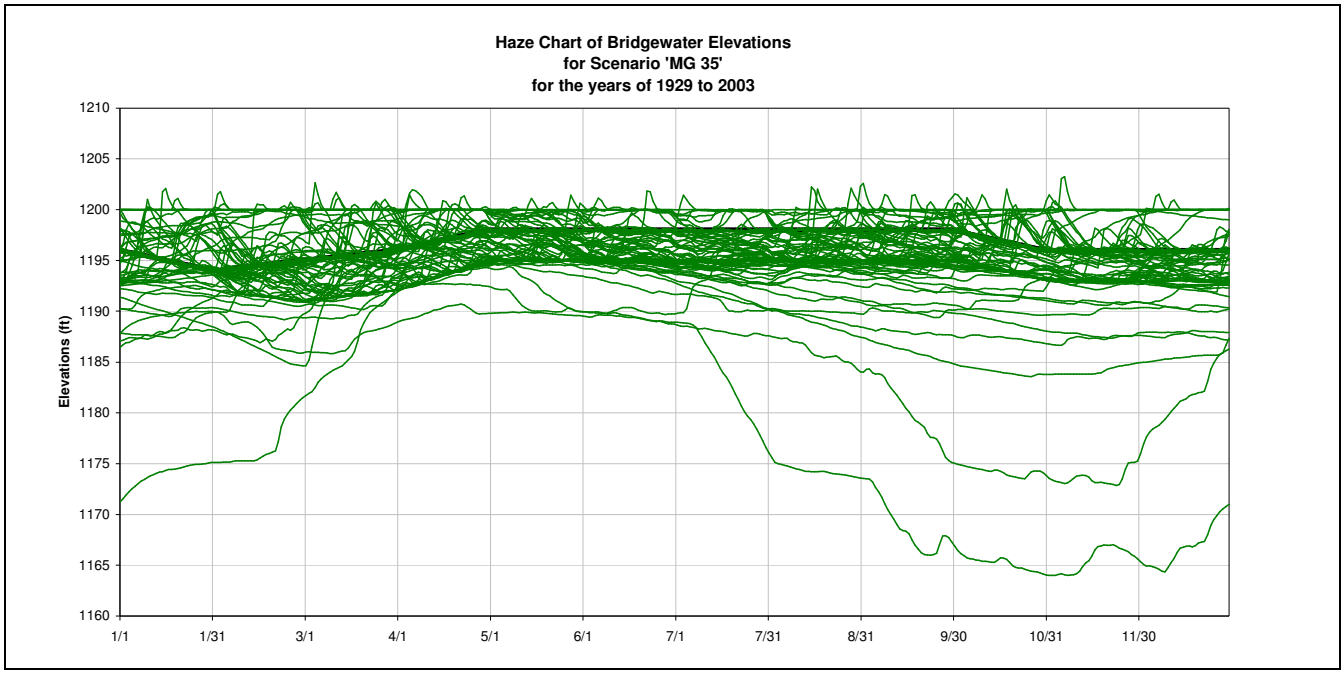

Figure 179 : BW Elevation Haze Chart for MG 35

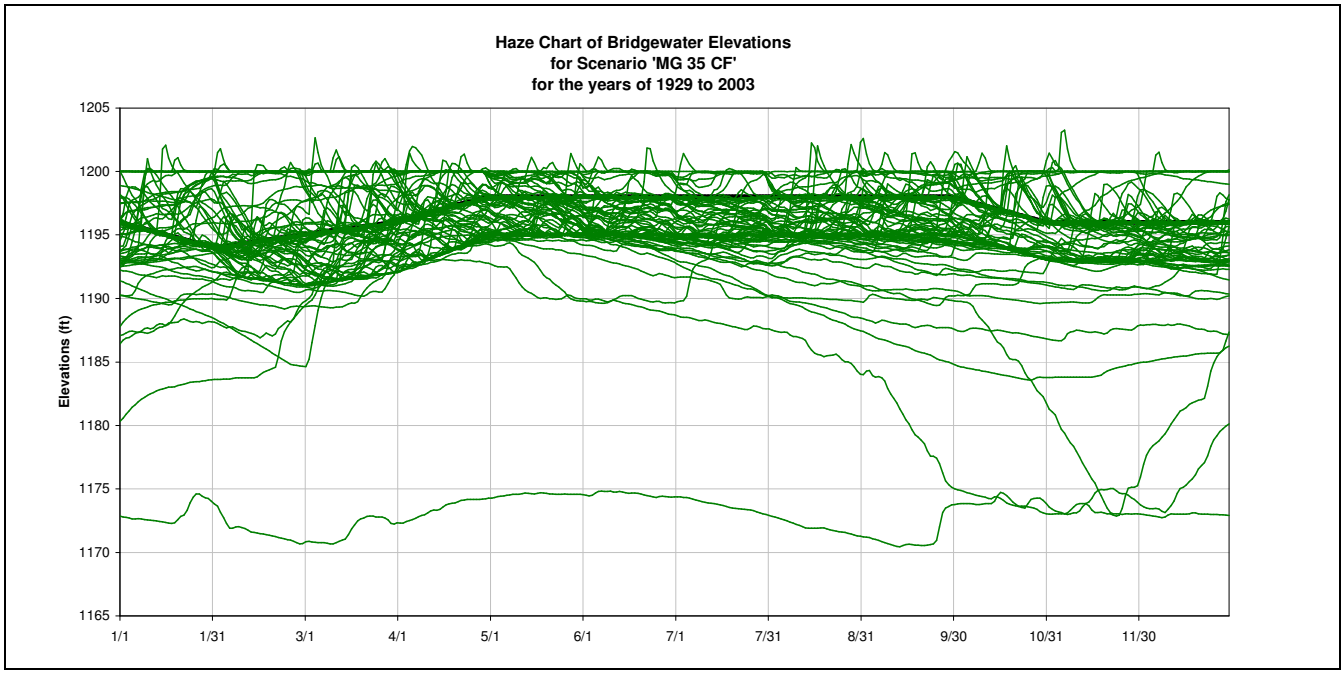

Figure 180: BW Elevation Haze Chart for MG 35 CF

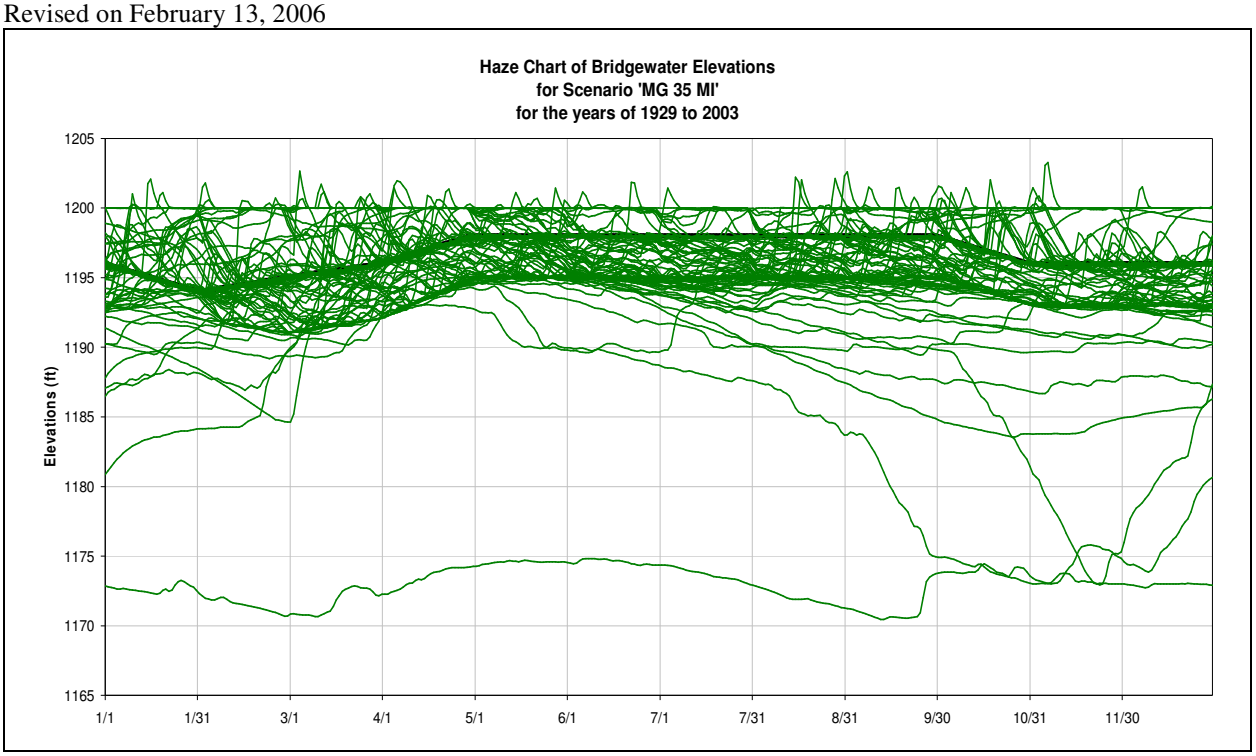

Figure 181: BW Elevation Haze Chart for MG 35 MI

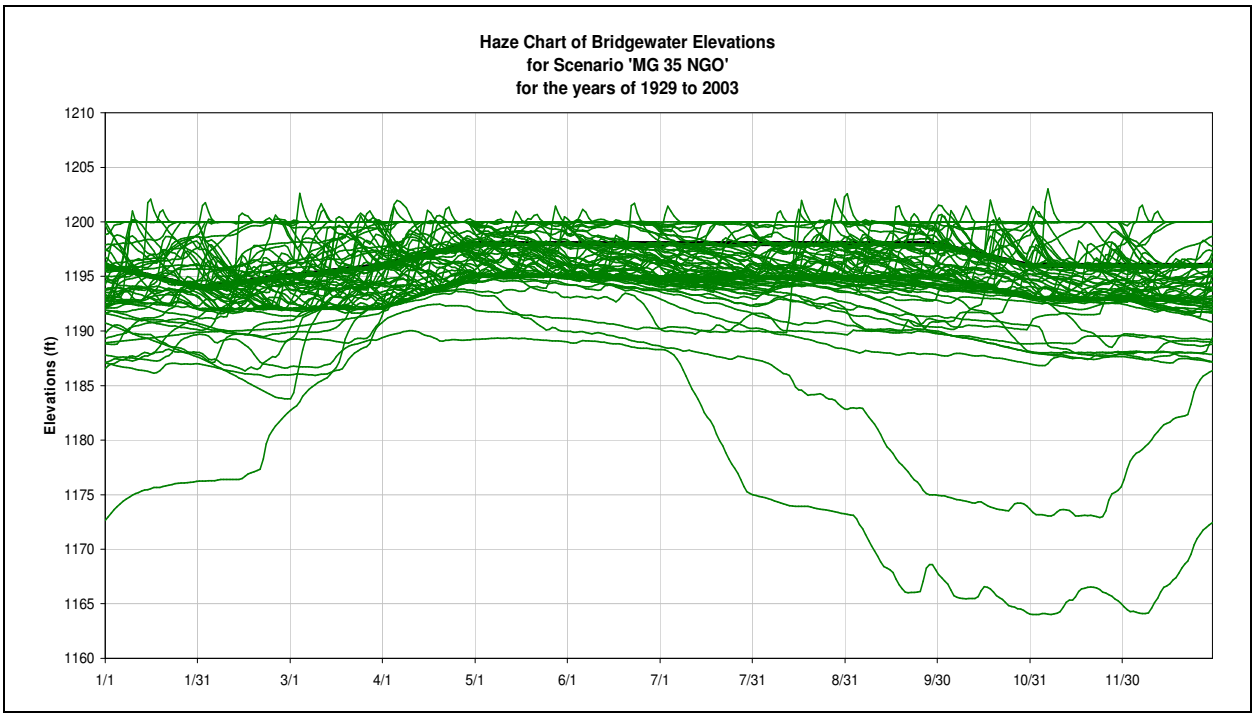

Figure 182: BW Elevation Haze Chart for MG 35 NGO

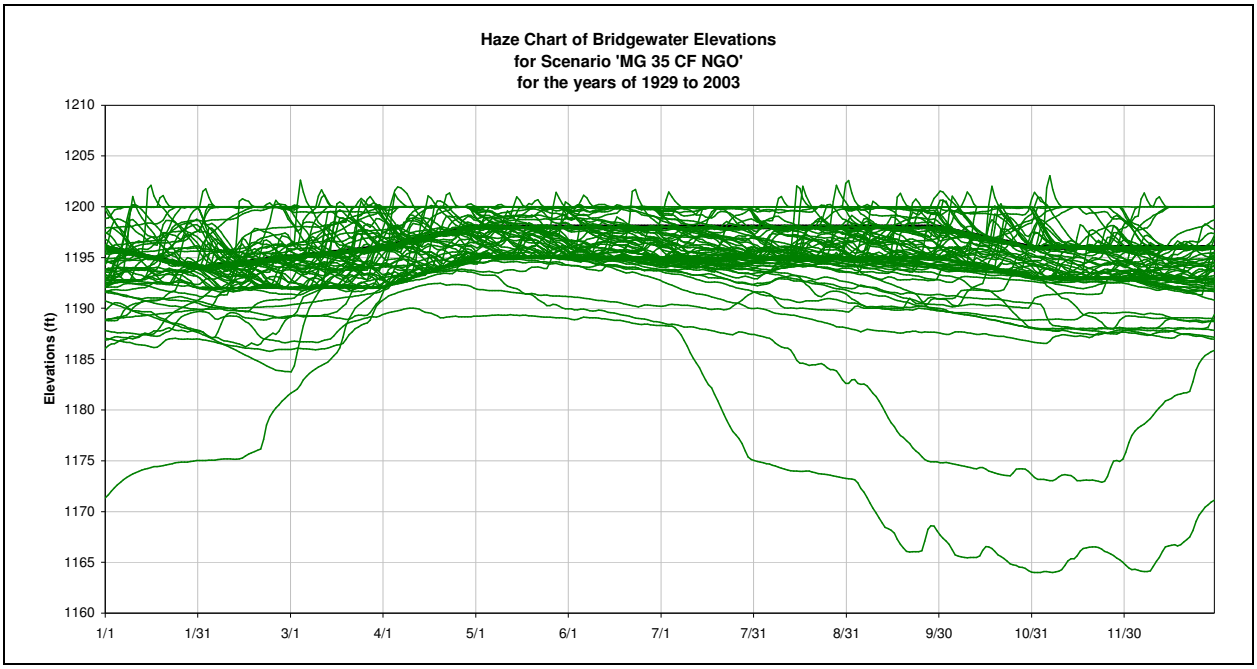

Figure 183: BW Elevation Haze Chart for MG 35 CF NGO

2) Rhodhiss

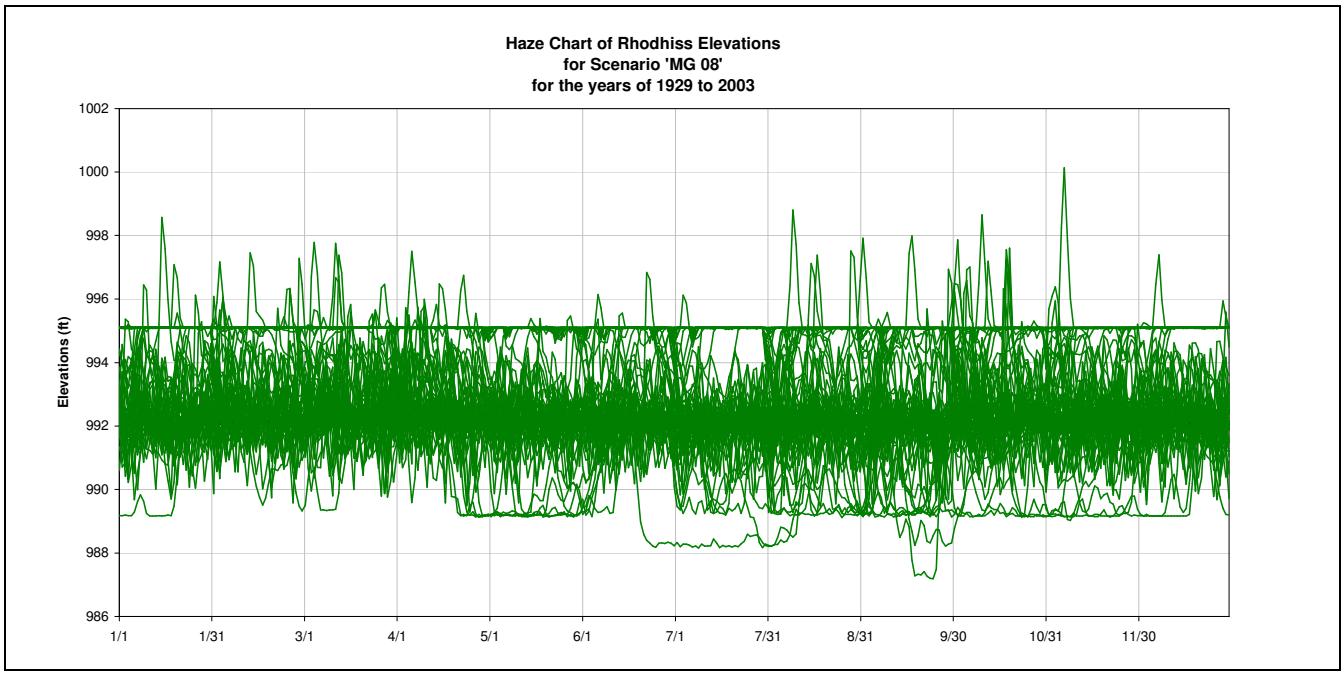

Figure 184: RH Elevation Haze Chart for MG 08

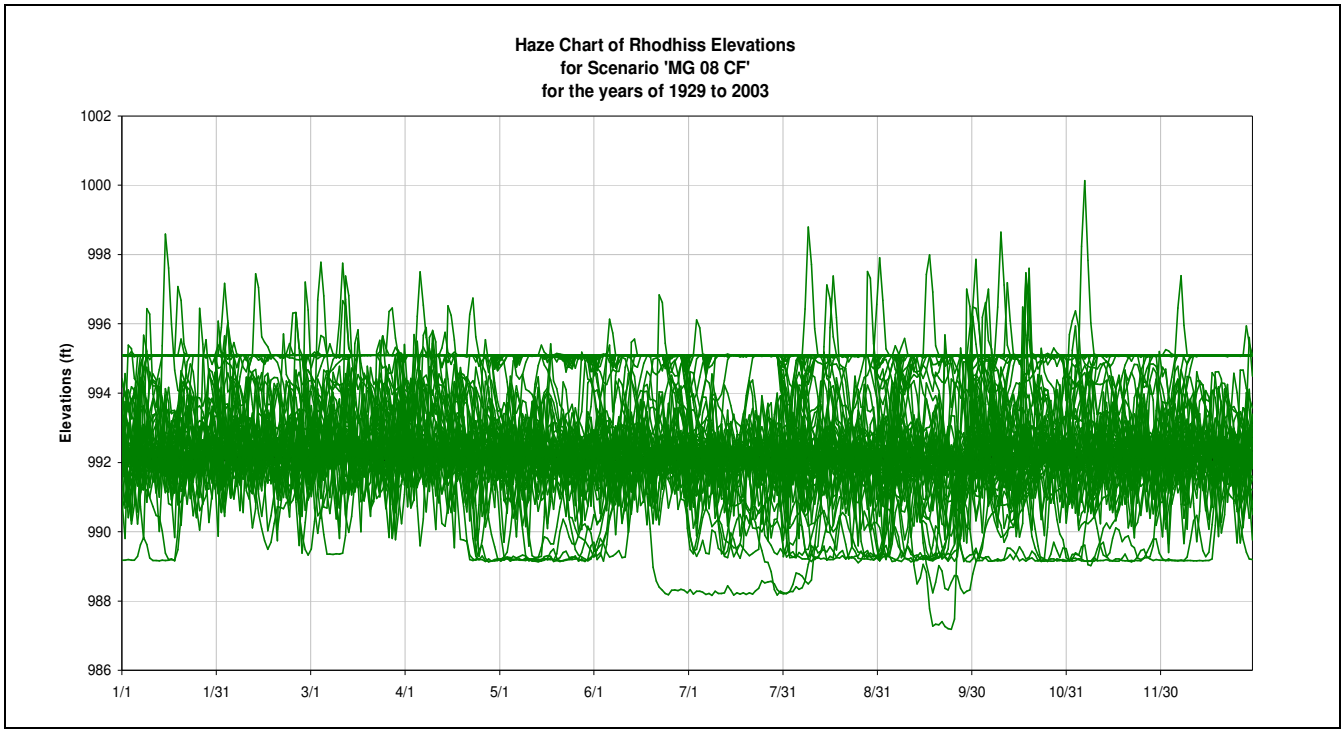

Figure 185: RH Elevation Haze Chart for MG 08 CF

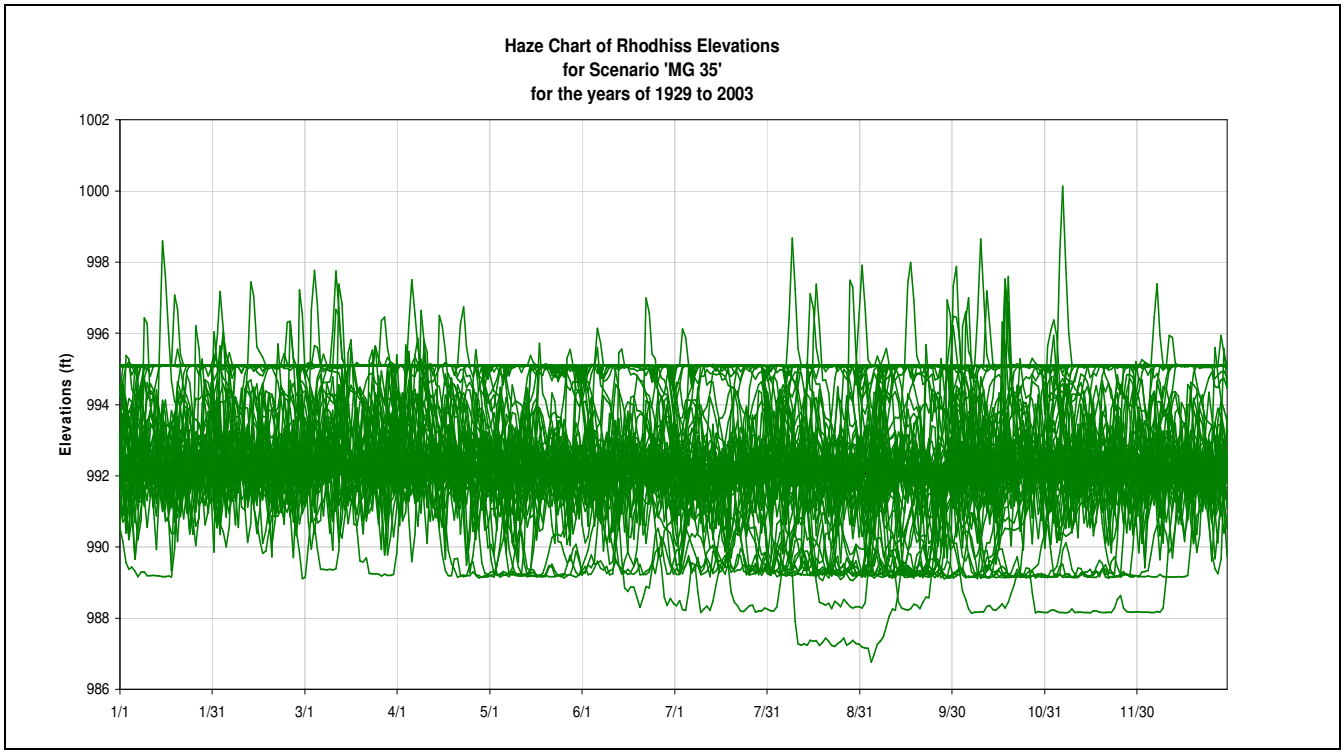

Figure 186: RH Elevation Haze Chart for MG 35

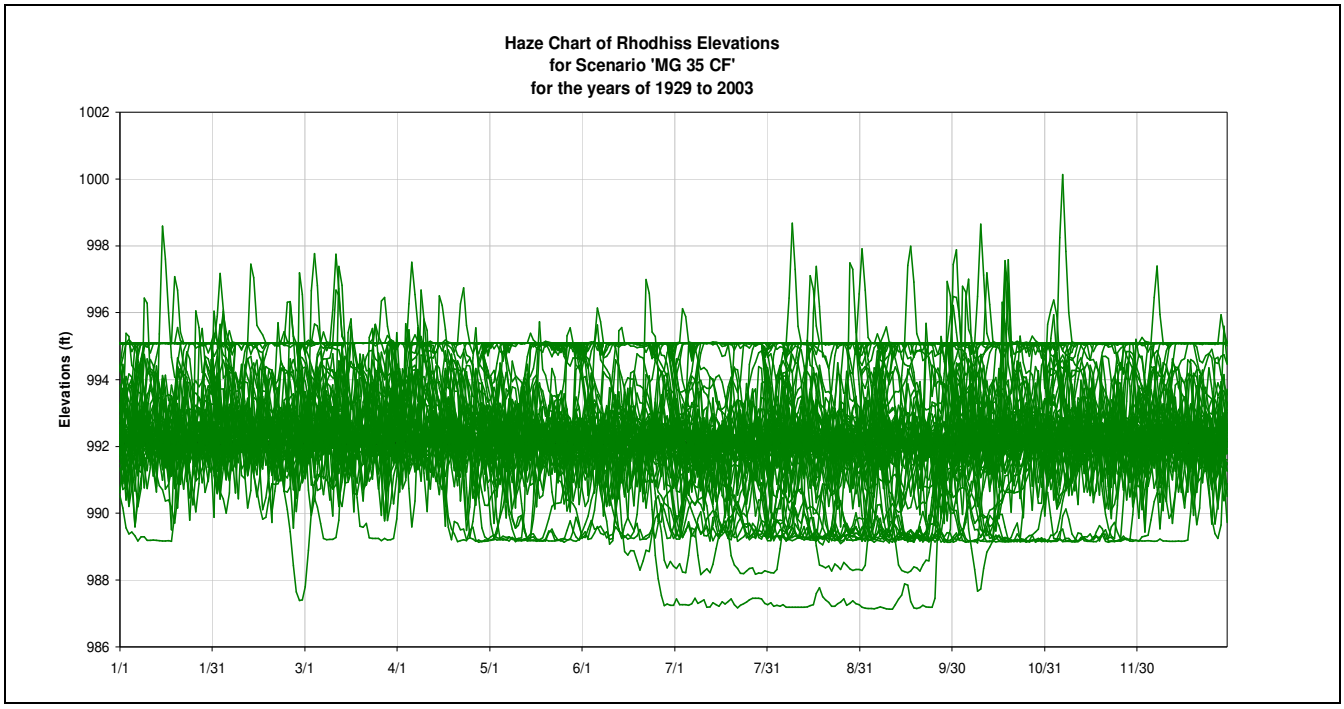

Figure 187: RH Elevation Haze Chart for MG 35 CF

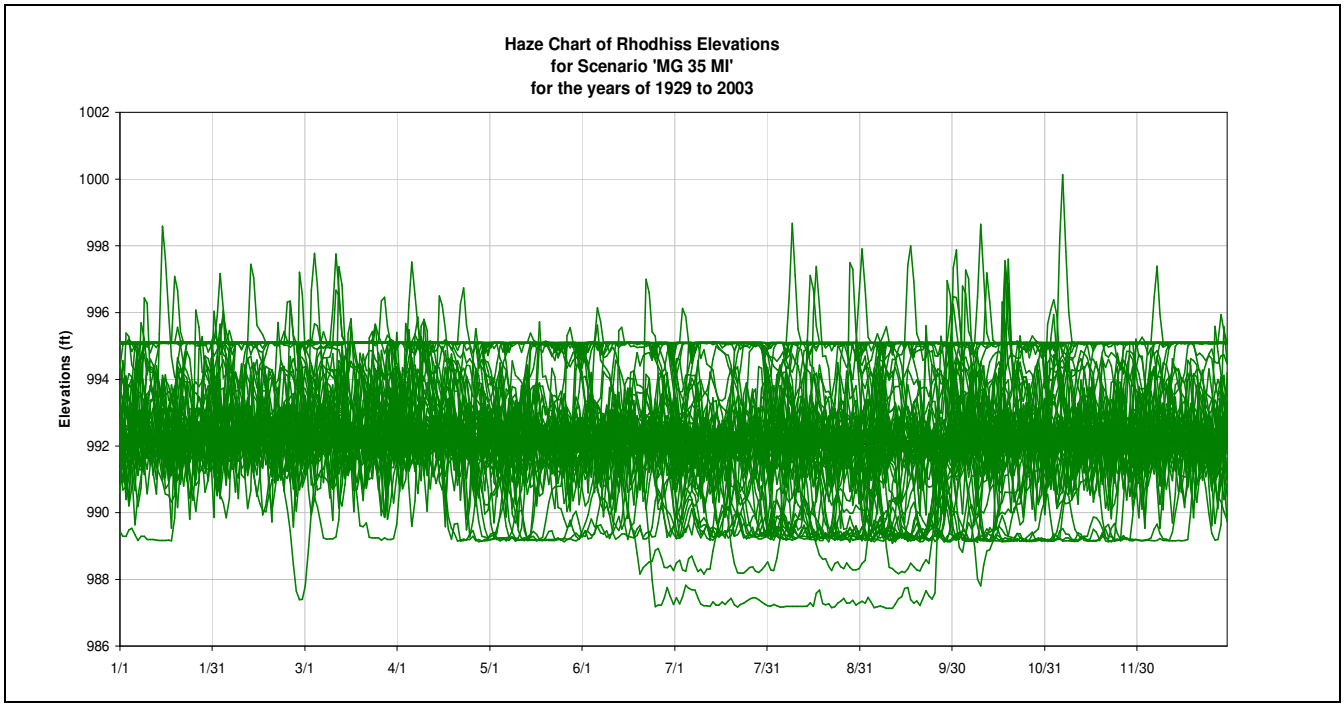

Figure 188: RH Elevation Haze Chart for MG 35 MI

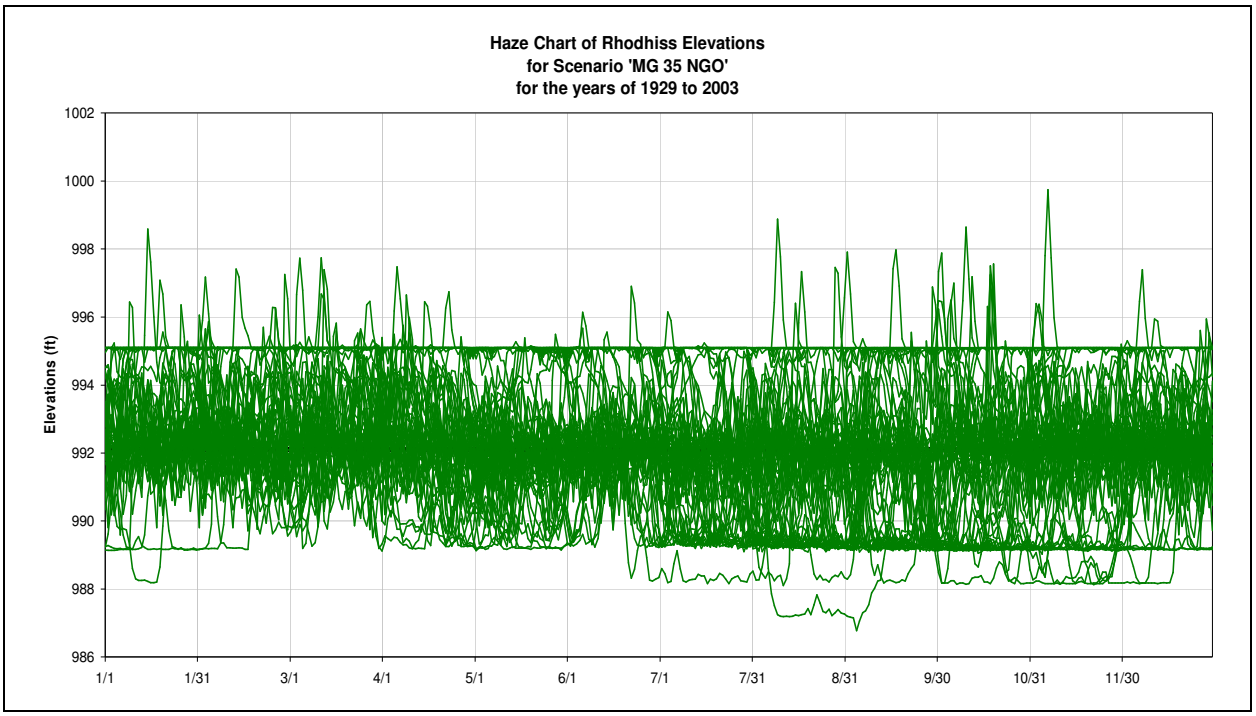

Figure 189: RH Elevation Haze Chart for MG 35 NGO

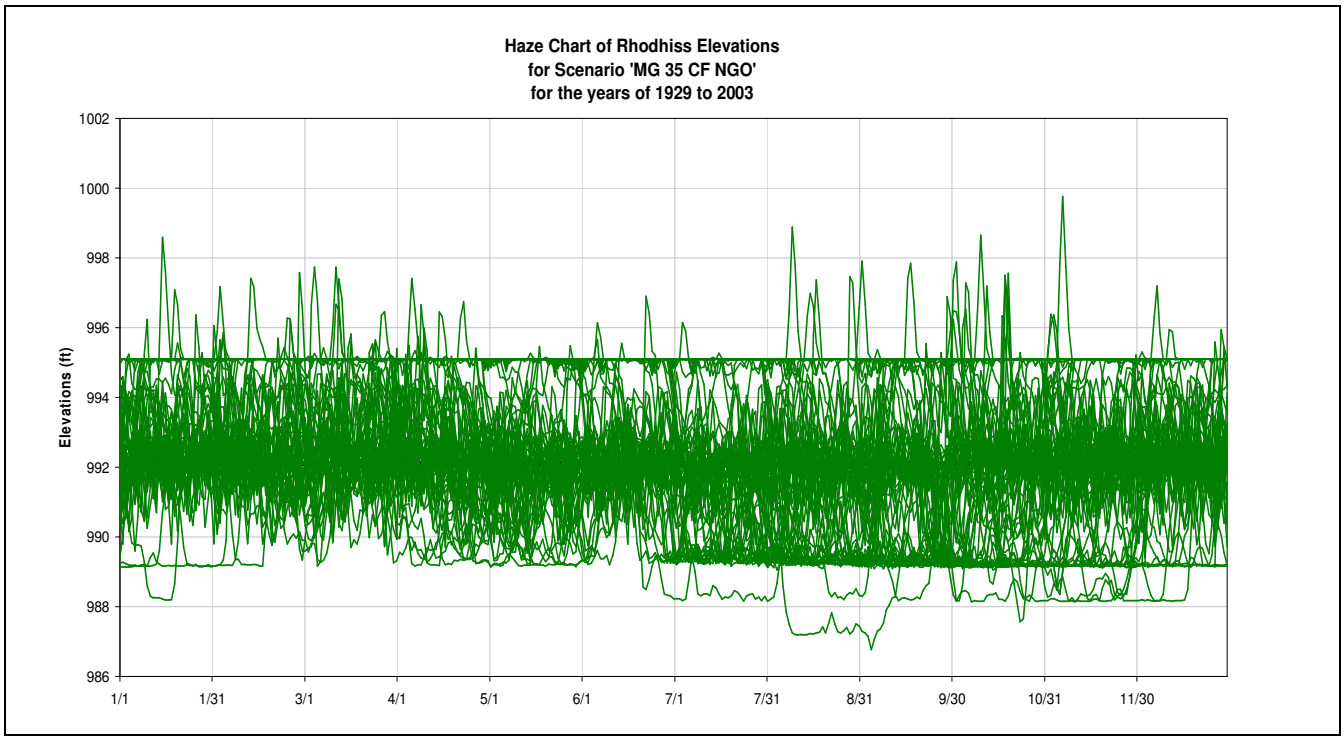

Figure 190: RH Elevation Haze Chart for MG 35 CF NGO

3) Oxford

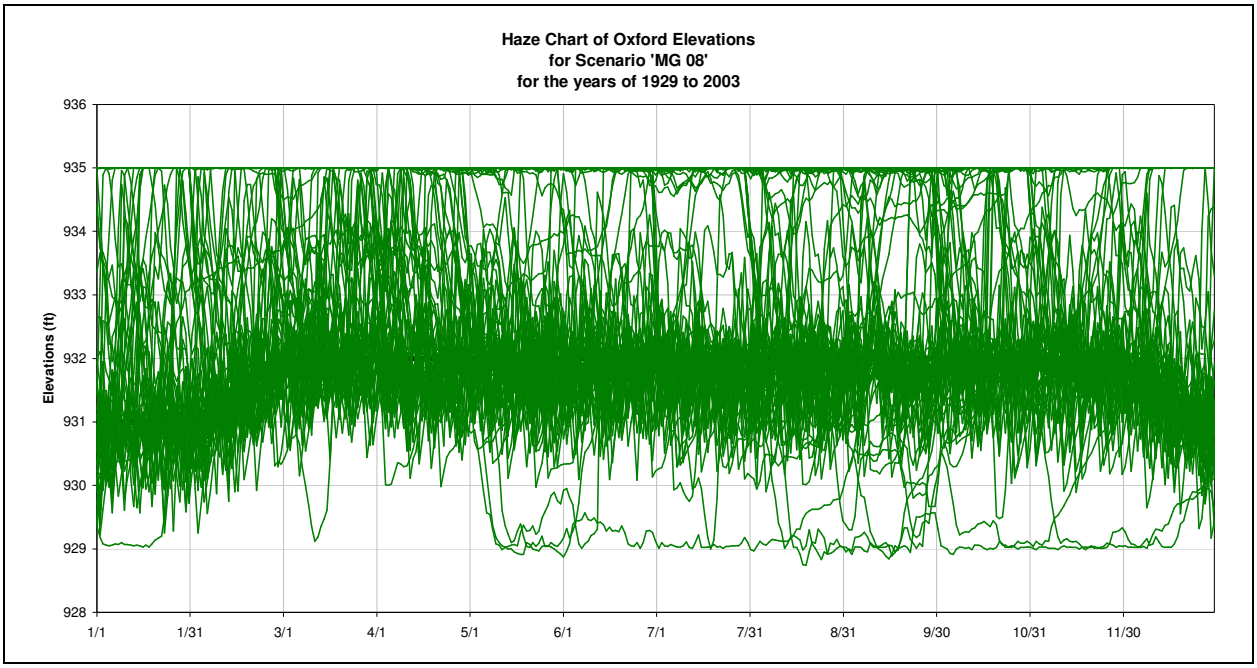

Figure 191: OX Elevation Haze Chart for MG 08

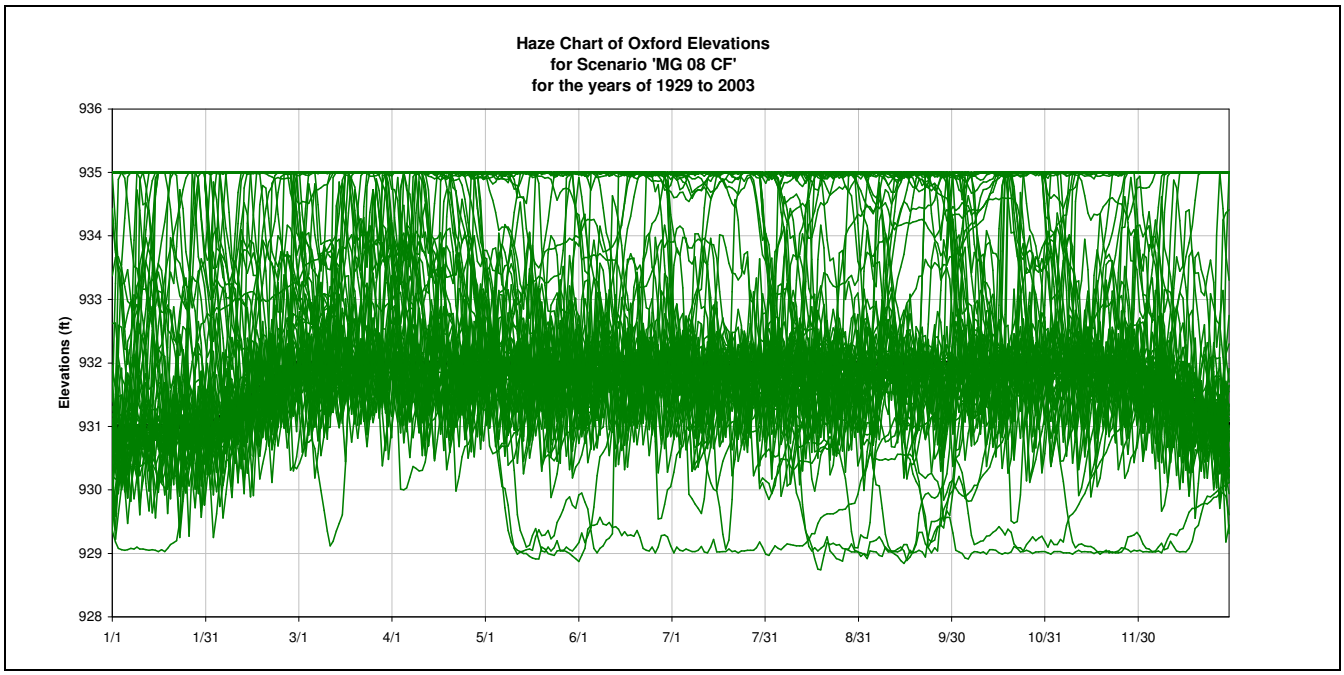

Figure 192: OX Elevation Haze Chart for MG 08 CF

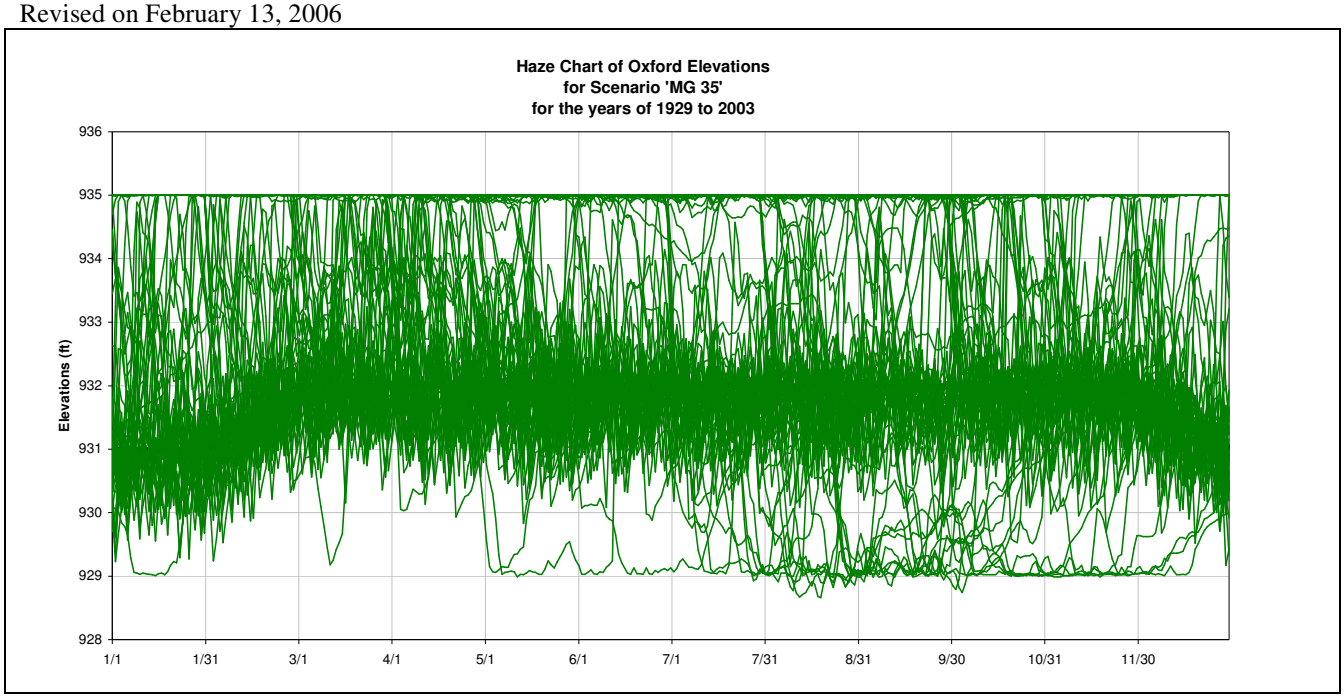

Figure 193: OX Elevation Haze Chart for MG 35

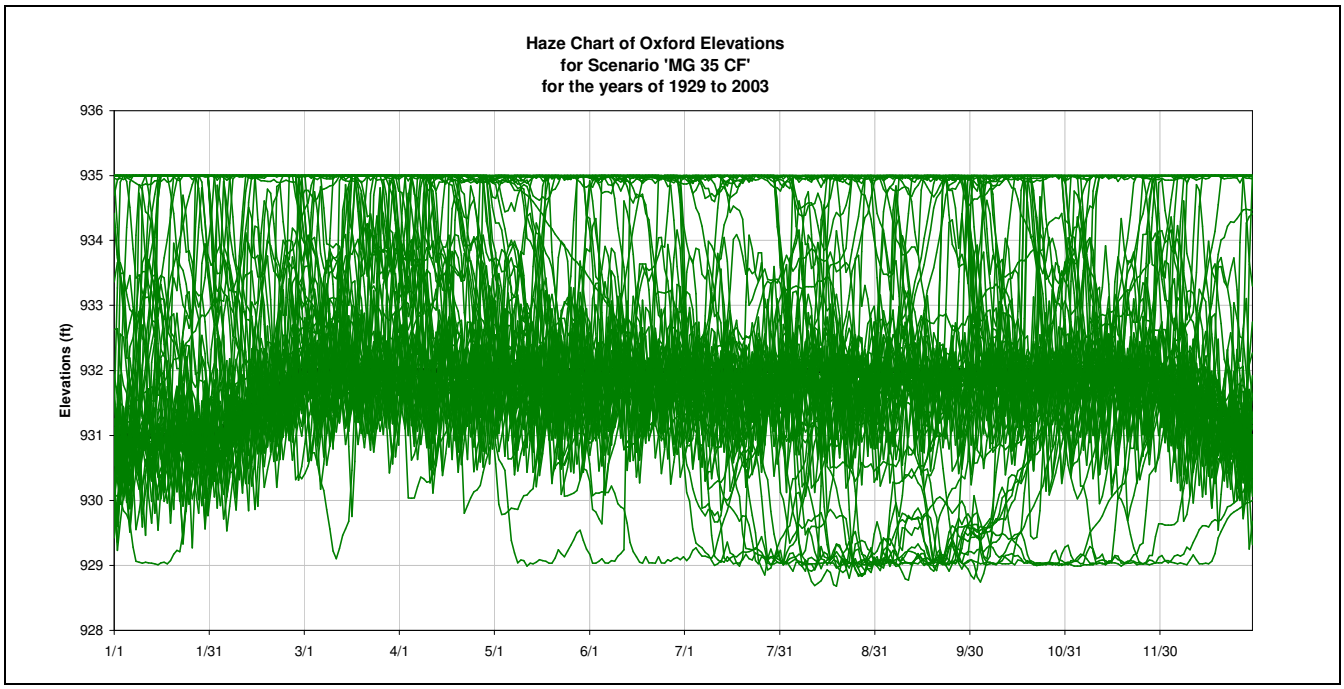

Figure 194: OX Elevation Haze Chart for MG 35 CF

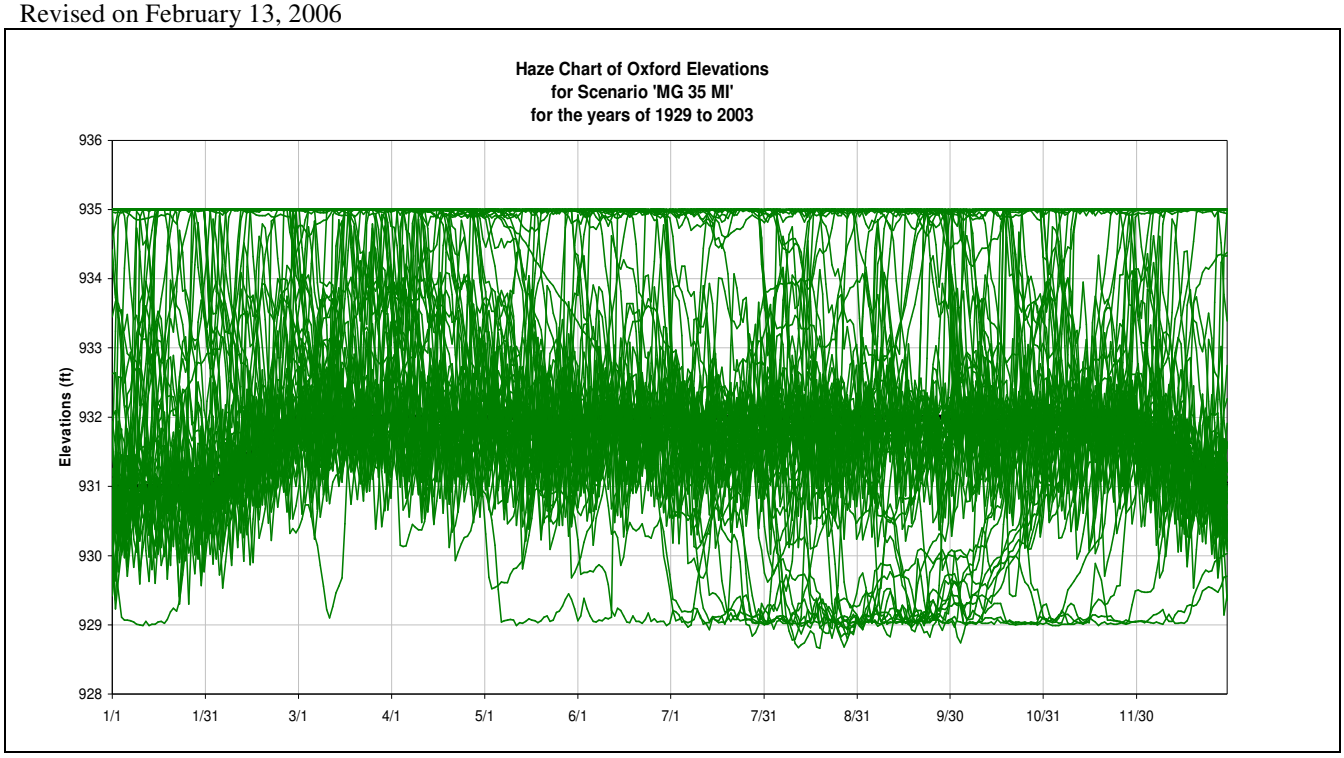

Figure 195: OX Elevation Haze Chart for MG 35 MI

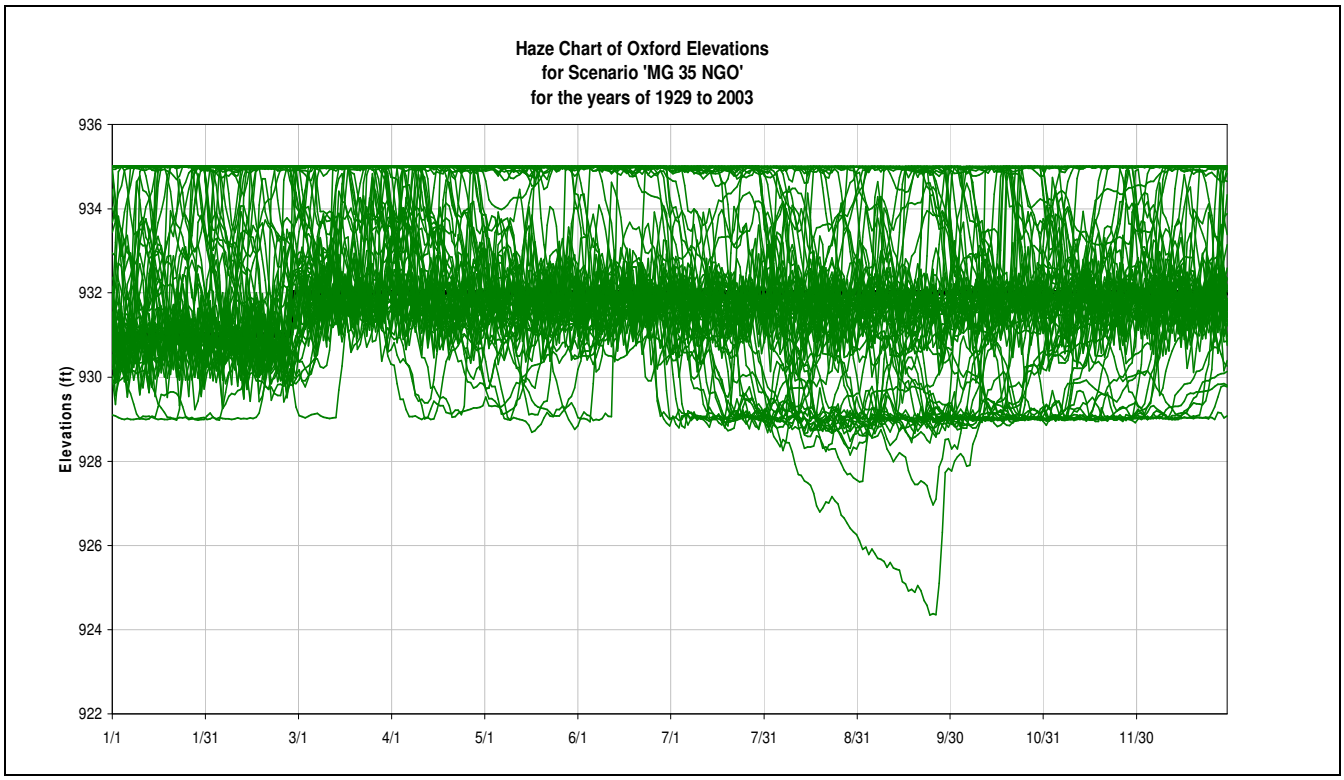

Figure 196: OX Elevation Haze Chart for MG 35 NGO

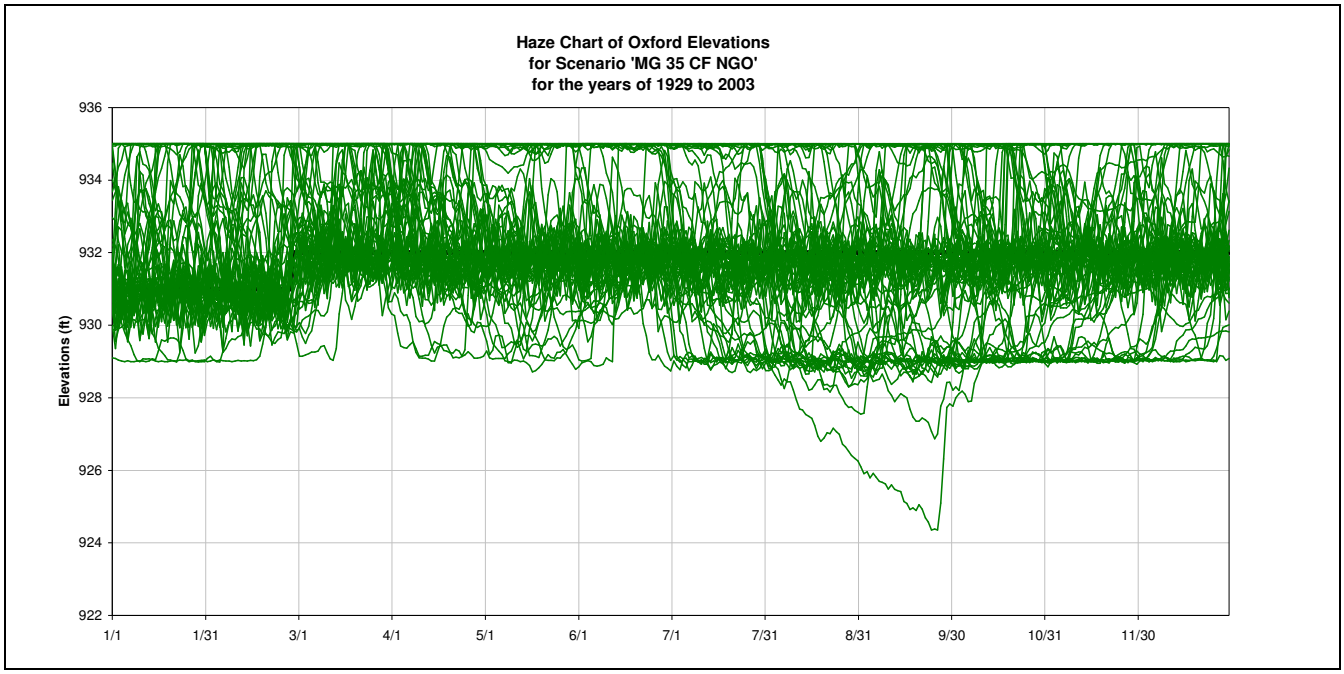

Figure 197: OX Elevation Haze Chart for MG 35 CF NGO

4) Lookout shoals

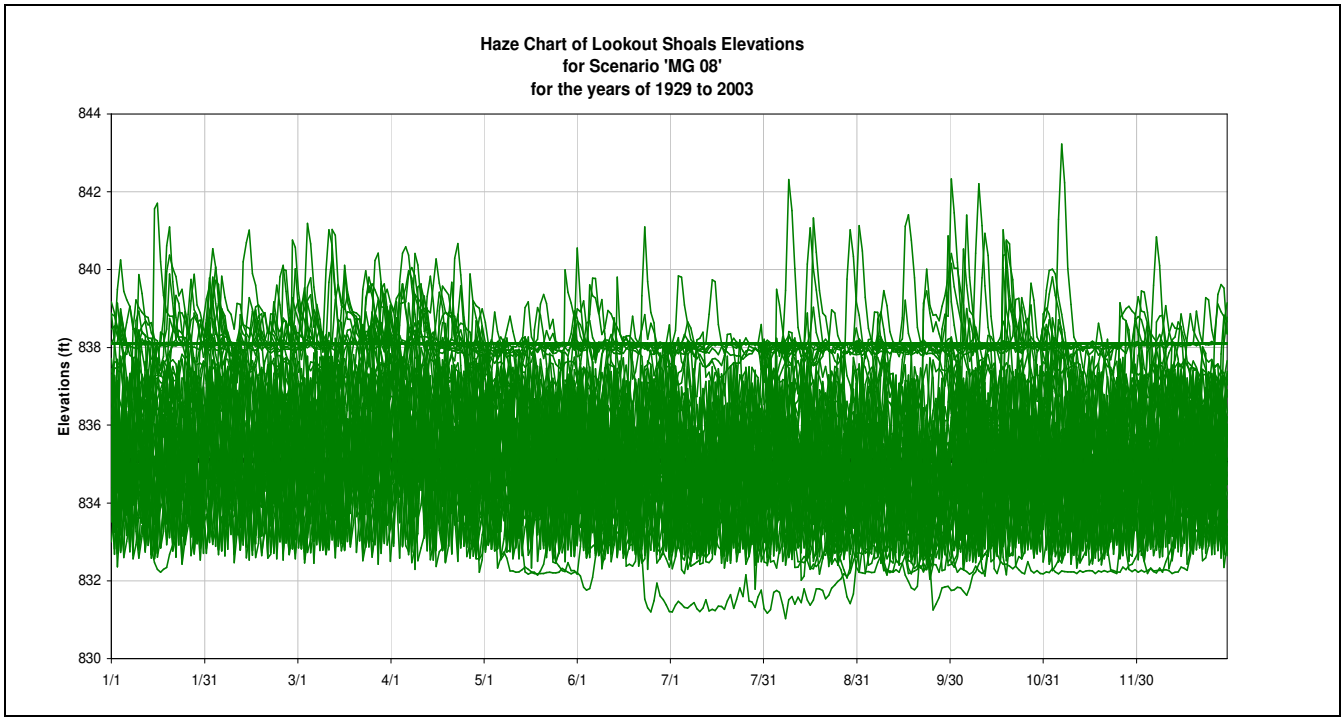

Figure 198: LS Elevation Haze Chart for MG 08

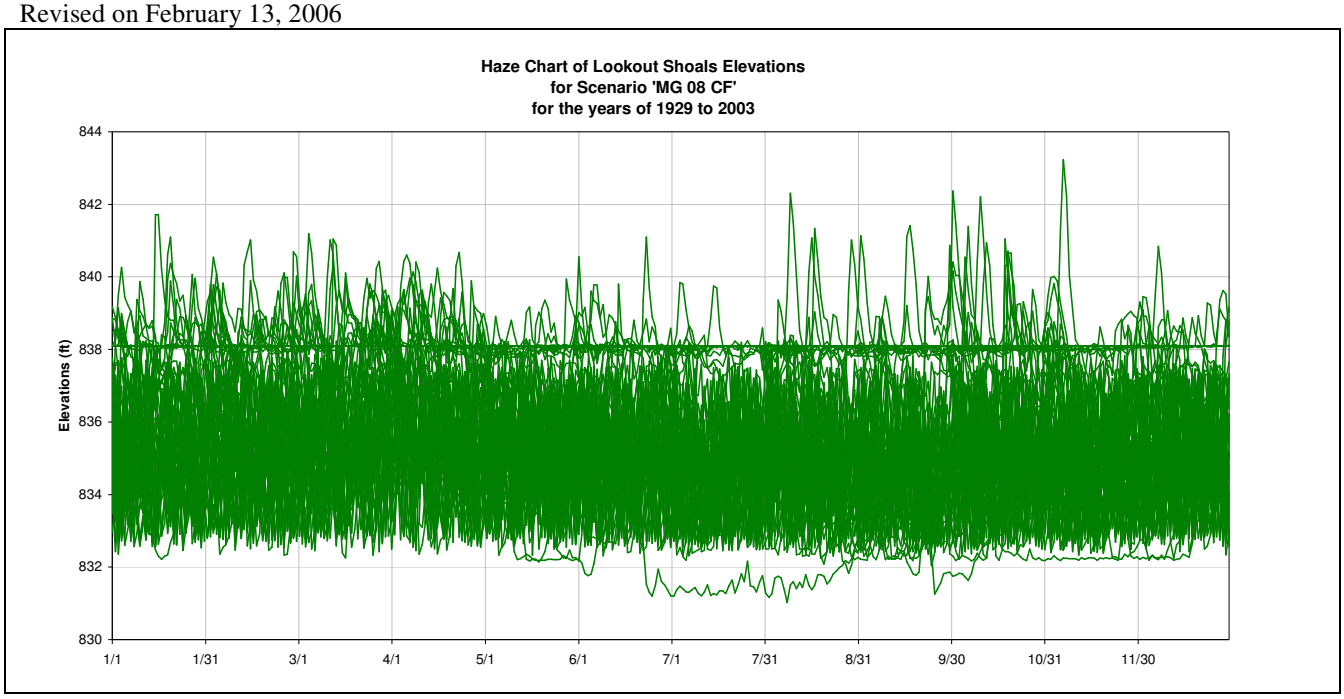

Figure 199: LS Elevation Haze Chart for MG 08 CF

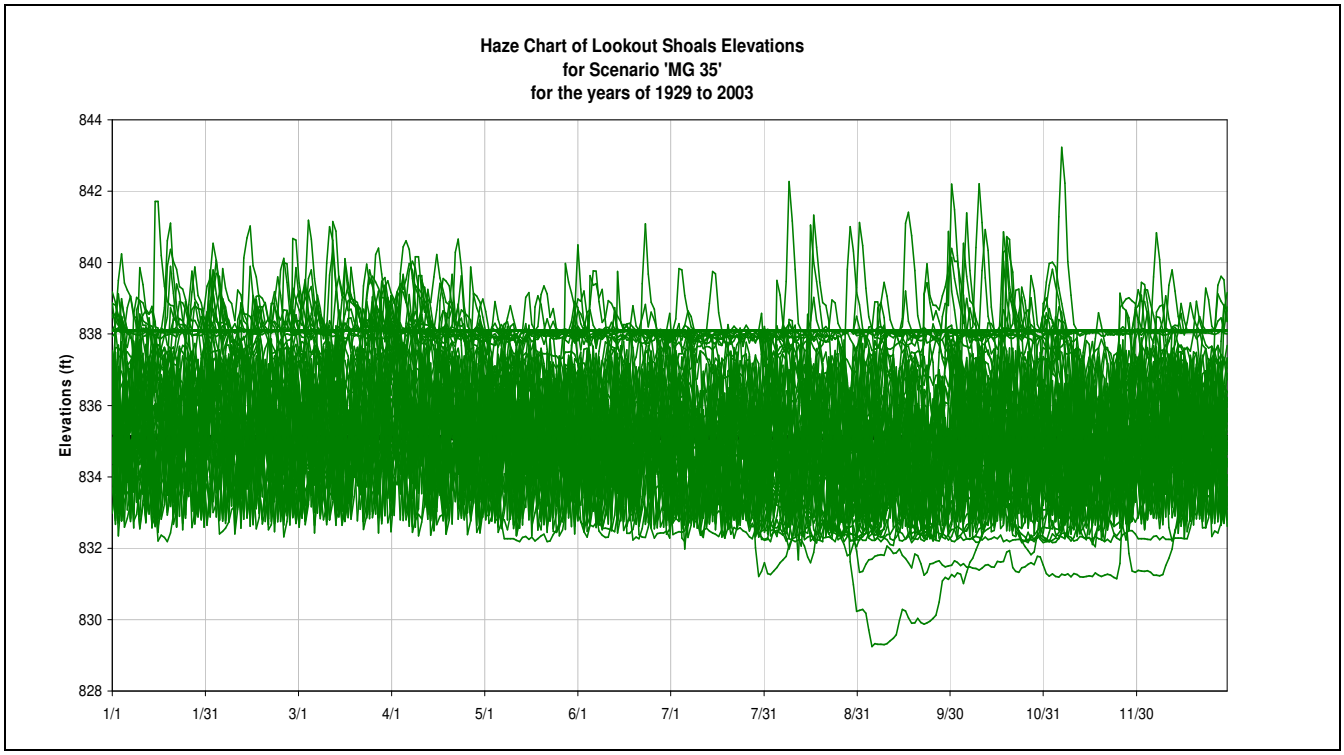

Figure 200: LS Elevation Haze Chart for MG 35

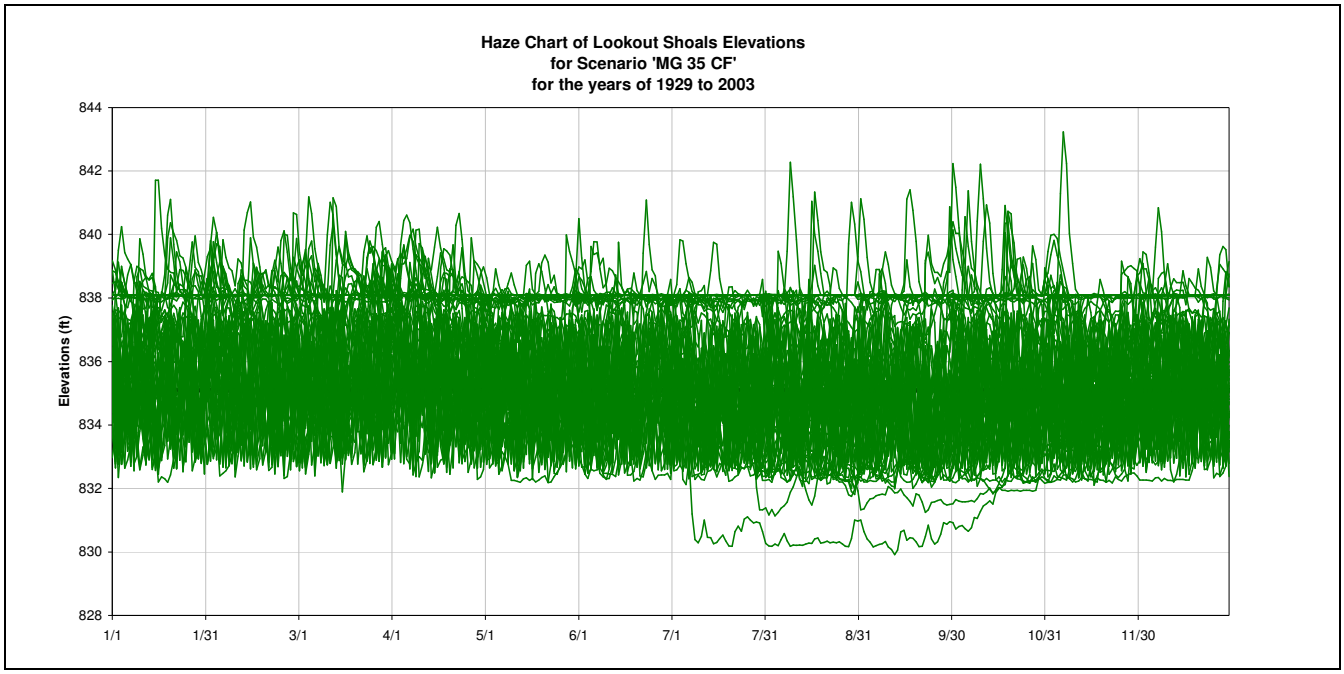

Figure 201: LS Elevation Haze Chart for MG 35 CF

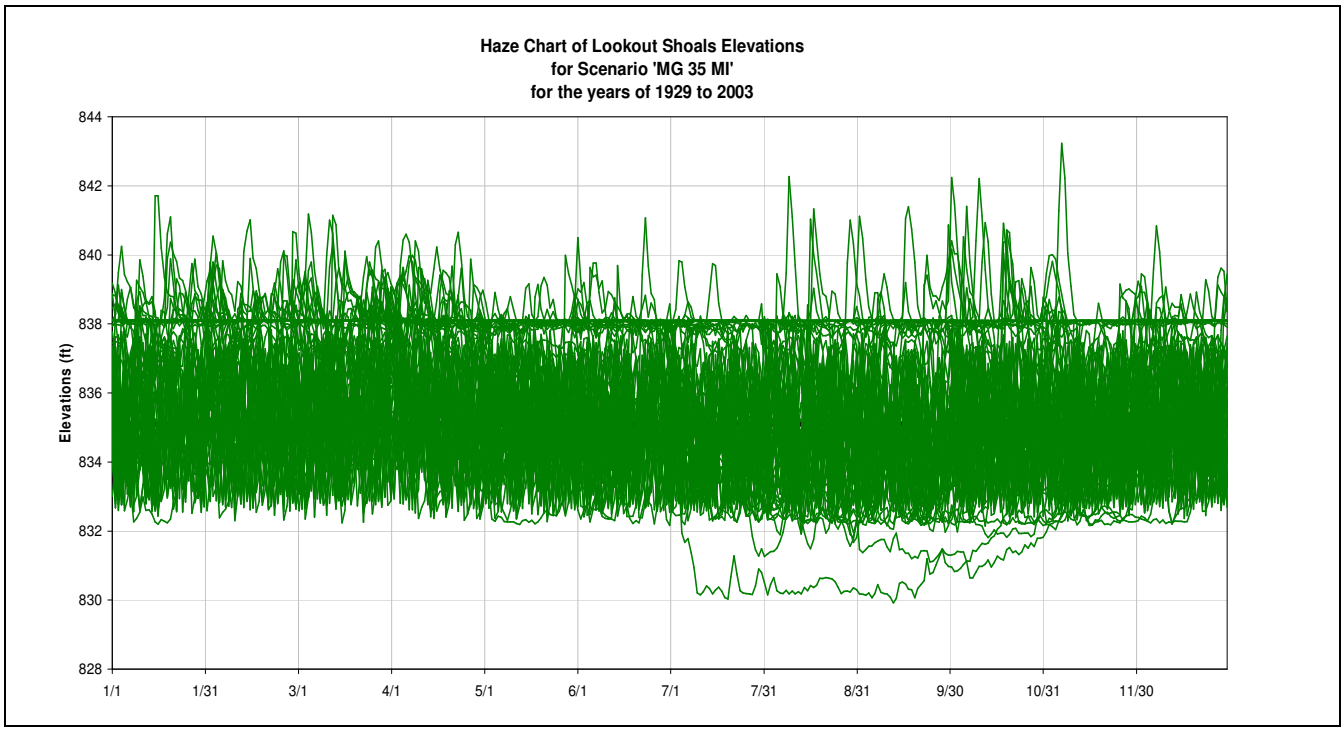

Figure 202: LS Elevation Haze Chart for MG 35 MI

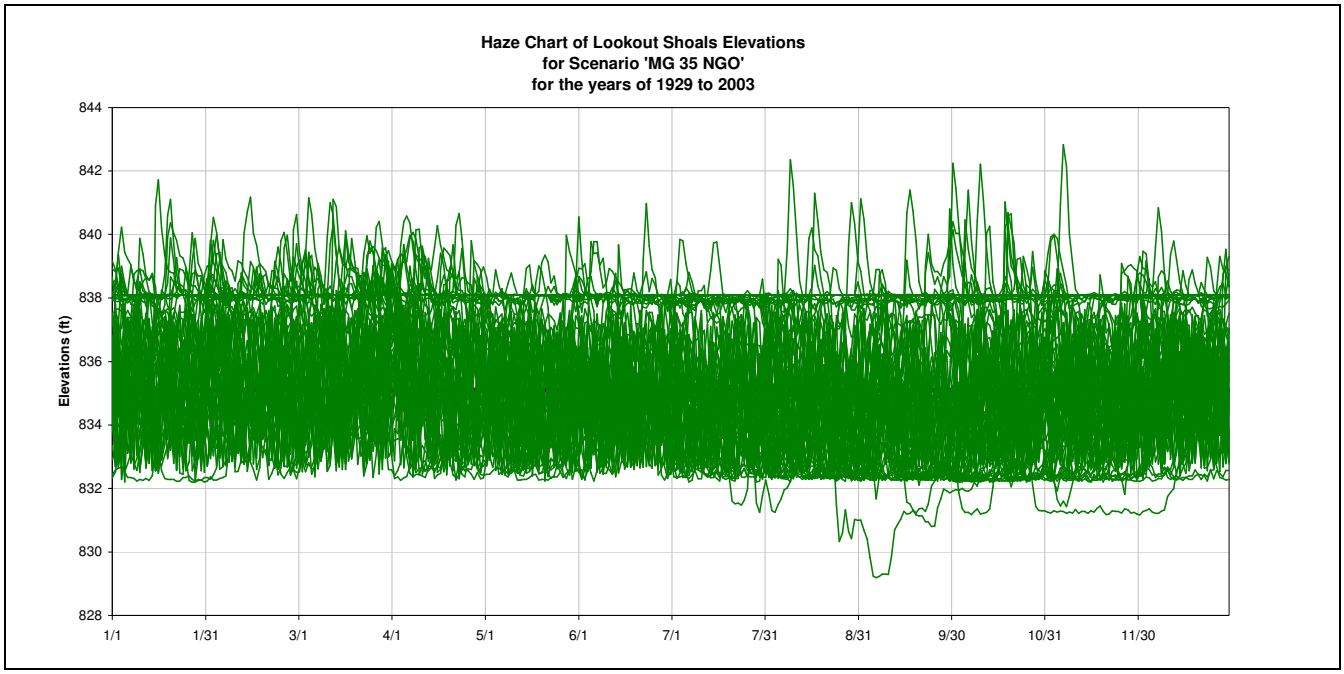

Figure 203: LS Elevation Haze Chart for MG 35 NGO

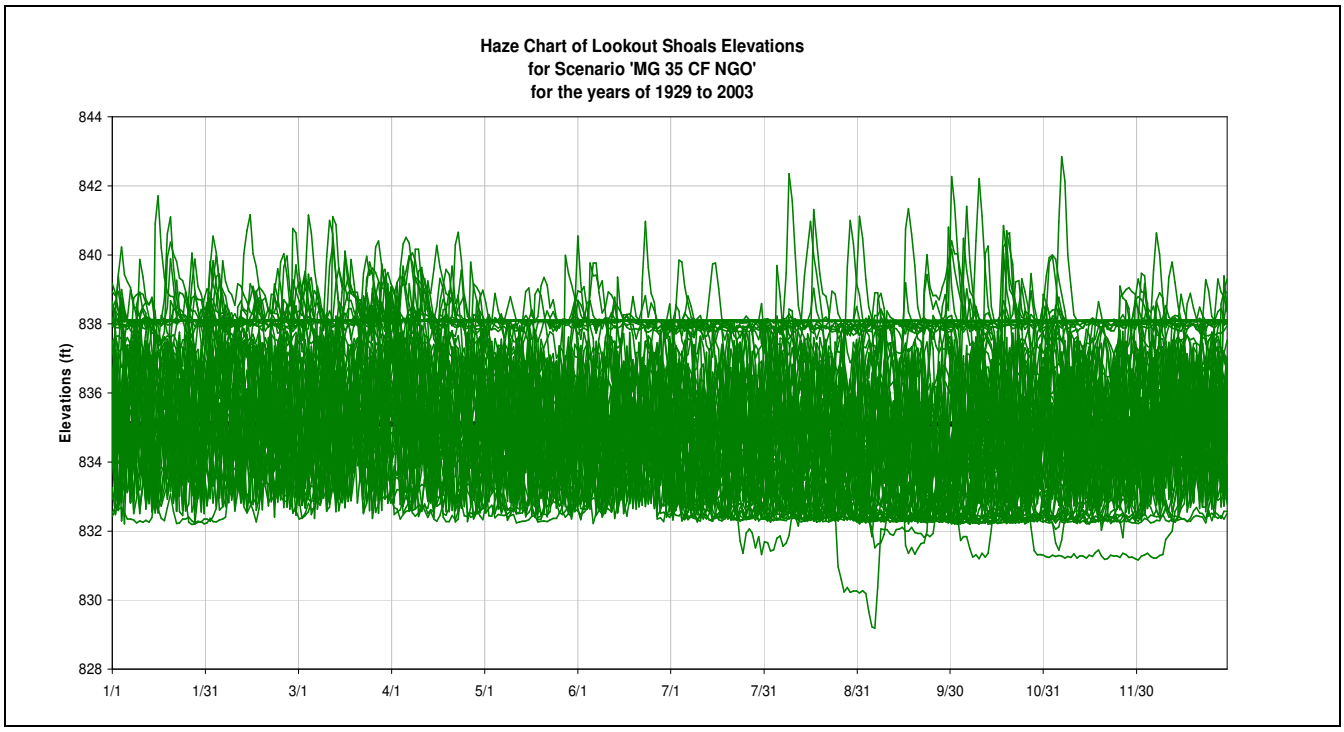

Figure 204: LS Elevation Haze Chart for MG 35 CF NGO

5) Cowan Ford

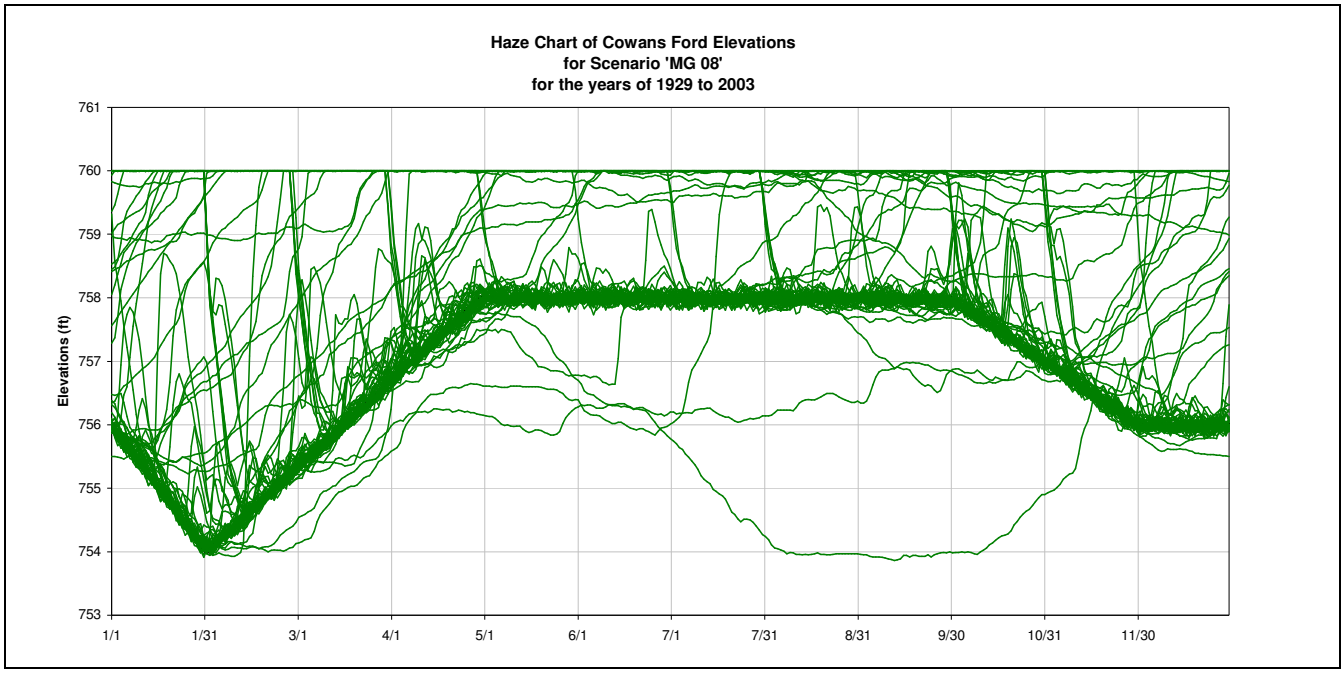

Figure 205: CF Elevation Haze Chart for MG 08

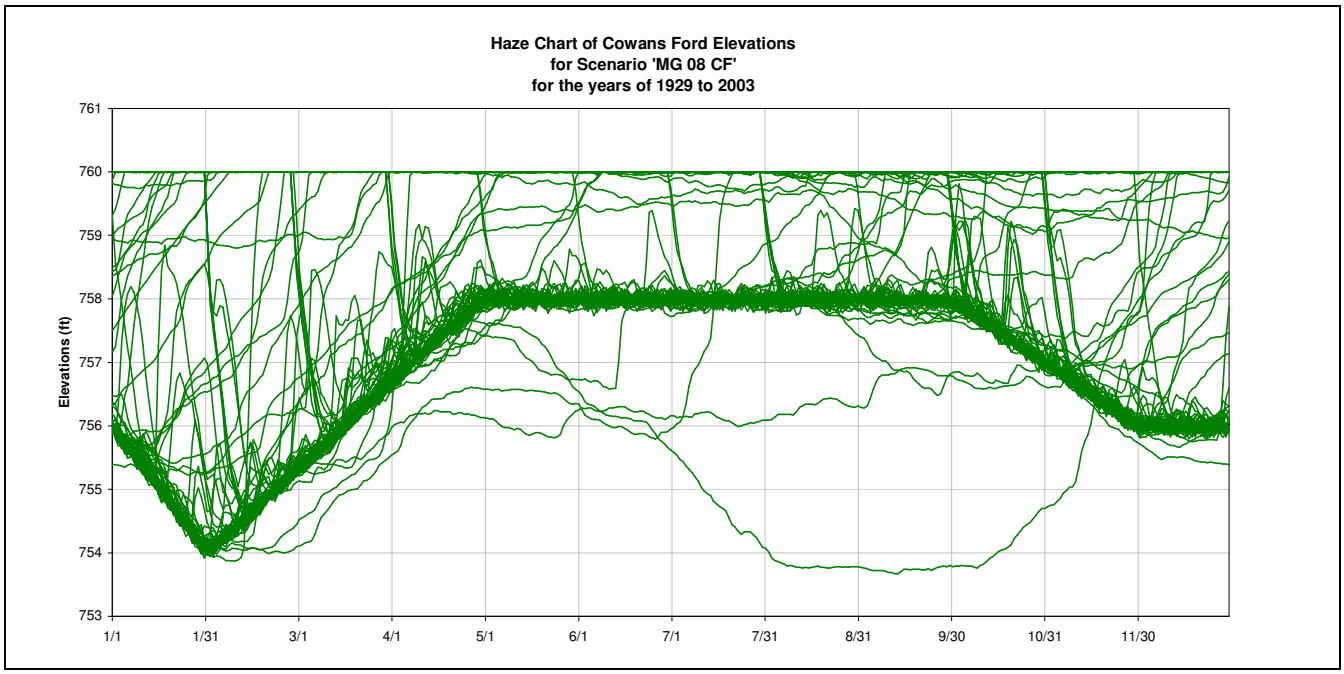

Figure 206: CF Elevation Haze Chart for MG 08 CF

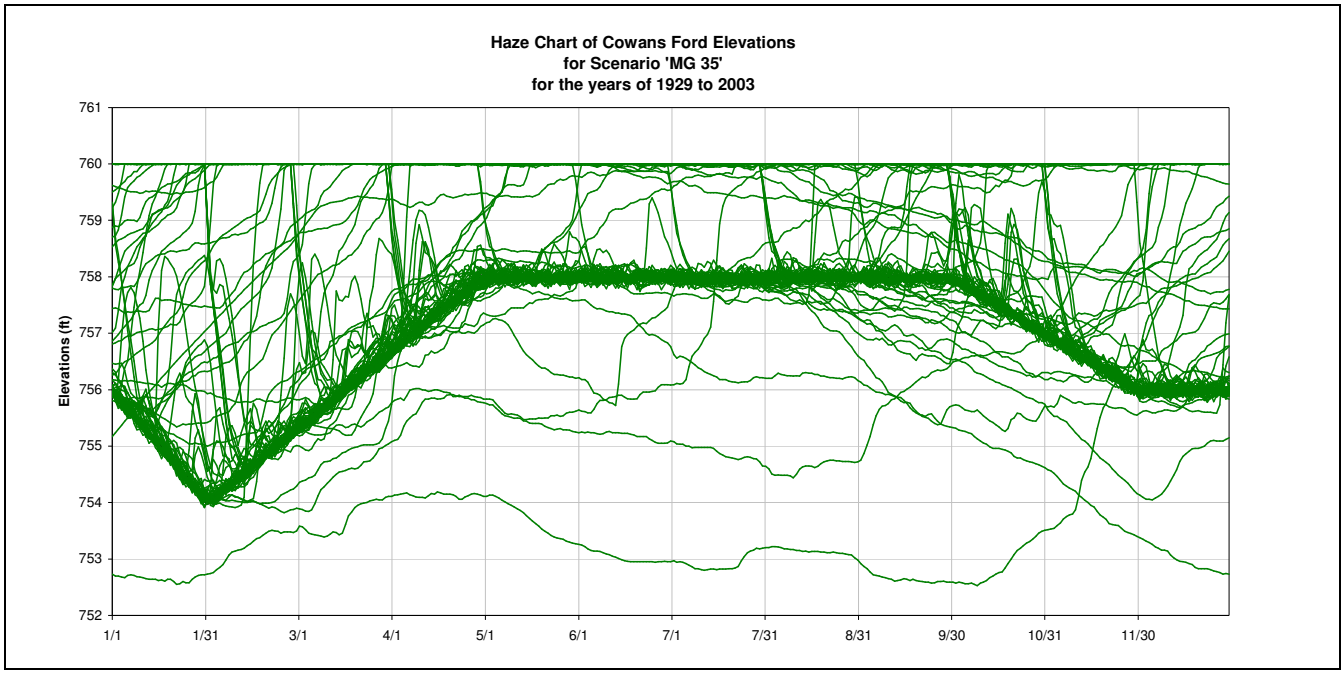

Figure 207: CF Elevation Haze Chart for MG 35

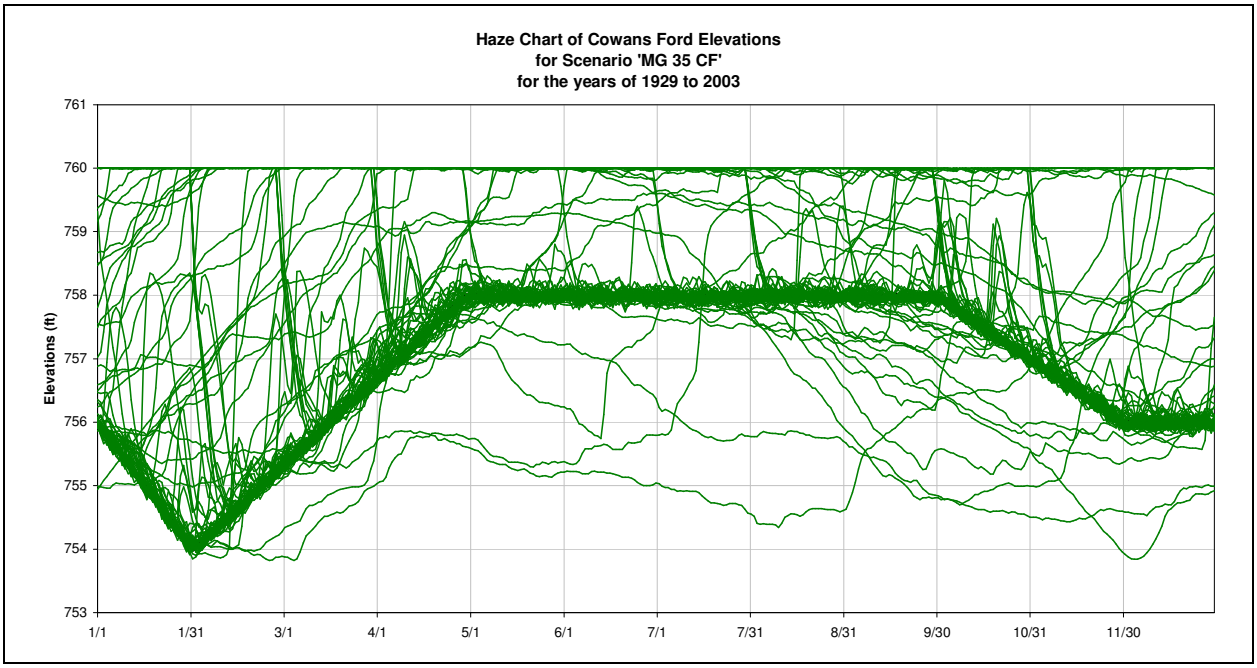

Figure 208: CF Elevation Haze Chart for MG 35 CF

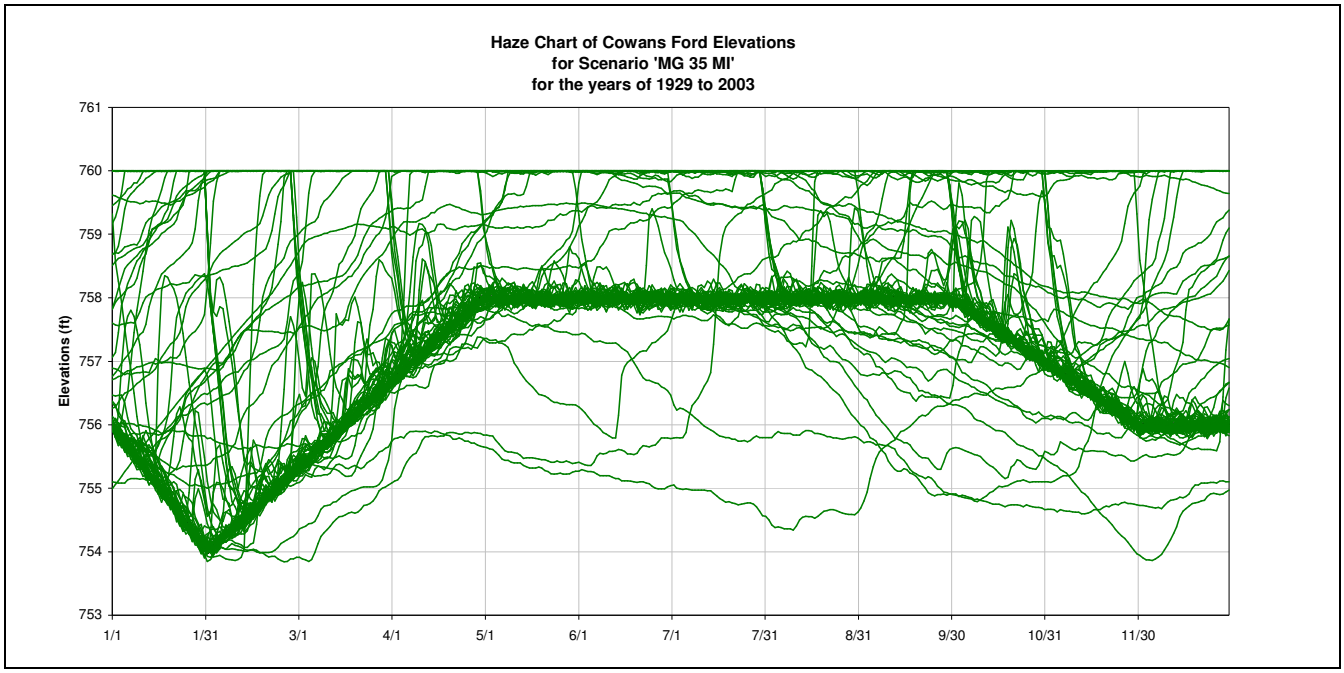

Figure 209: CF Elevation Haze Chart for MG 35 MI

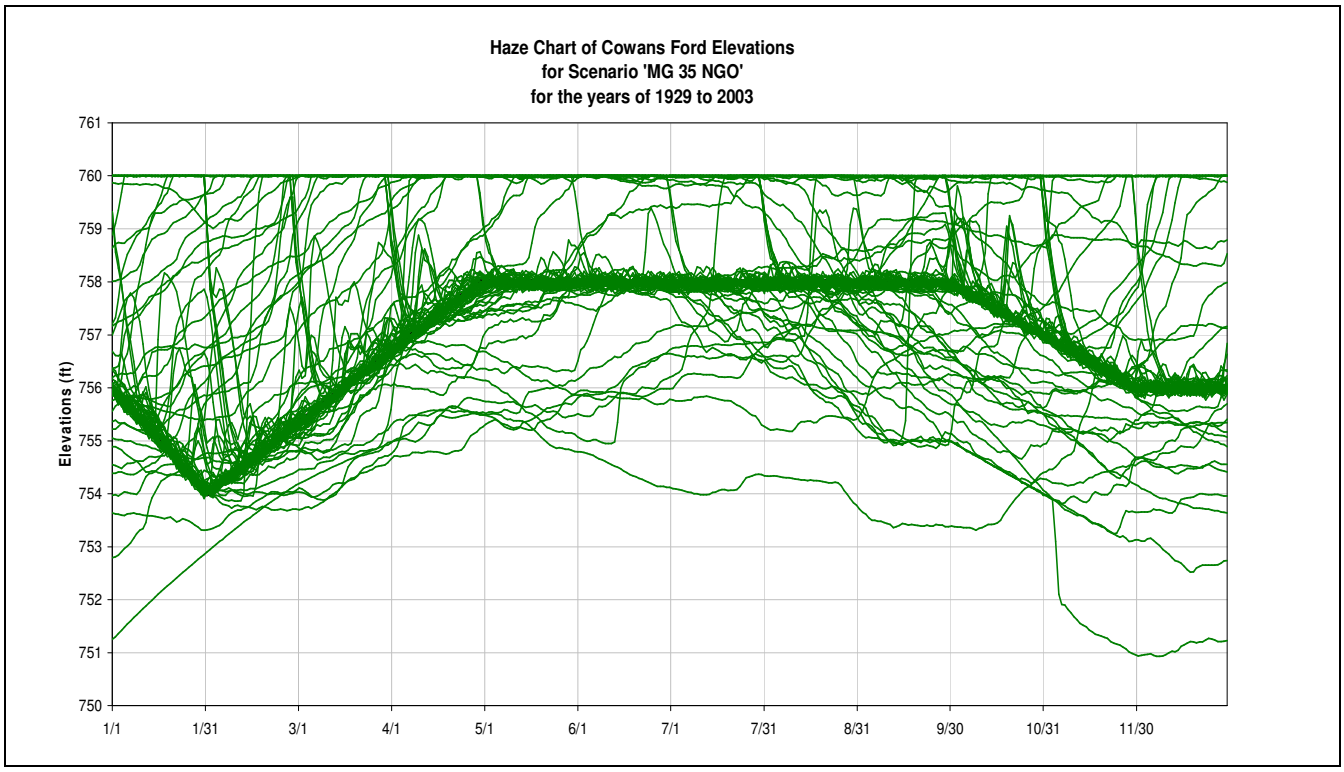

Figure 210: CF Elevation Haze Chart for MG 35 NGO

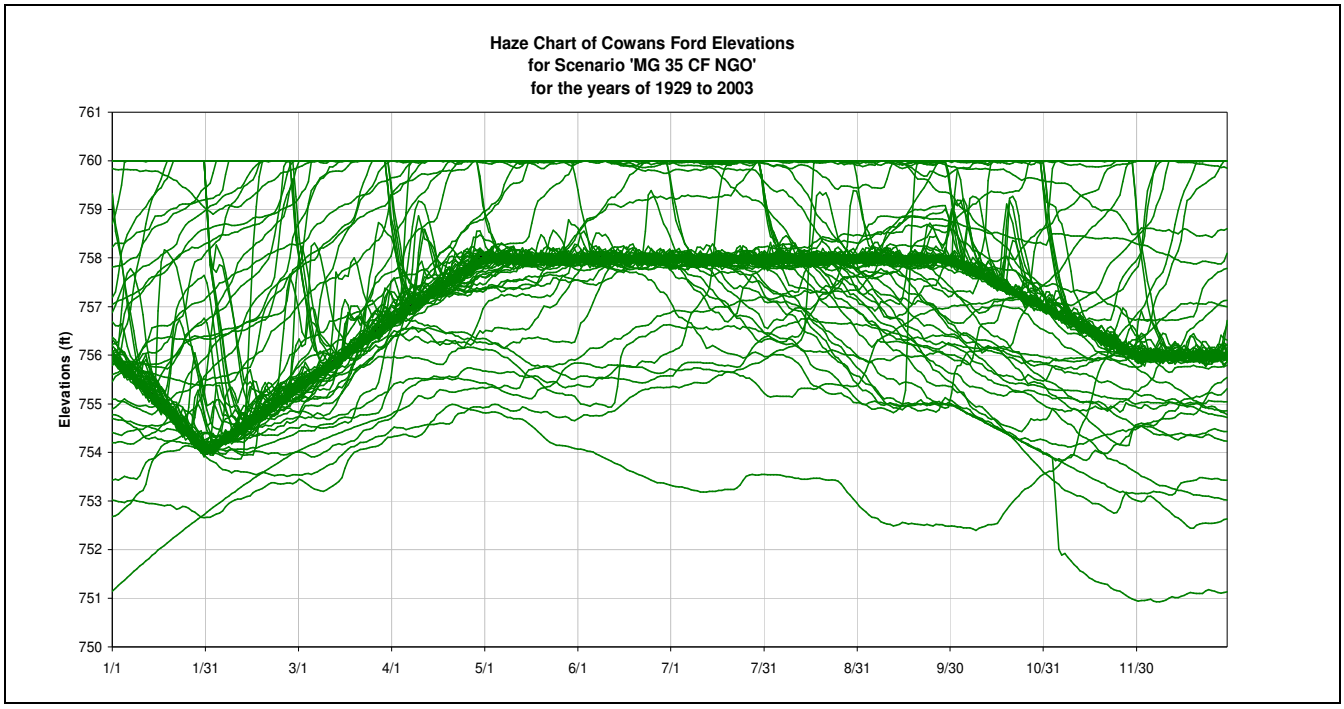

Figure 211: CF Elevation Haze Chart for MG 35 CF NGO

6) Mountain Island

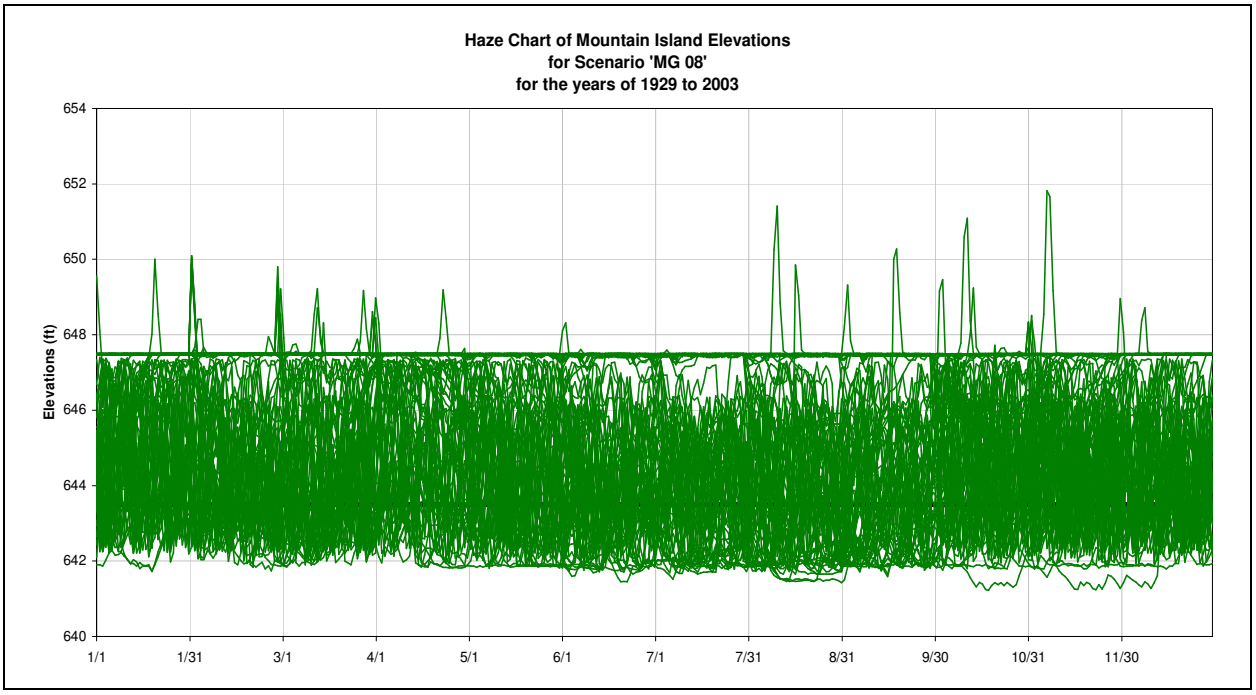

Figure 212: MI Elevation Haze Chart for MG 08

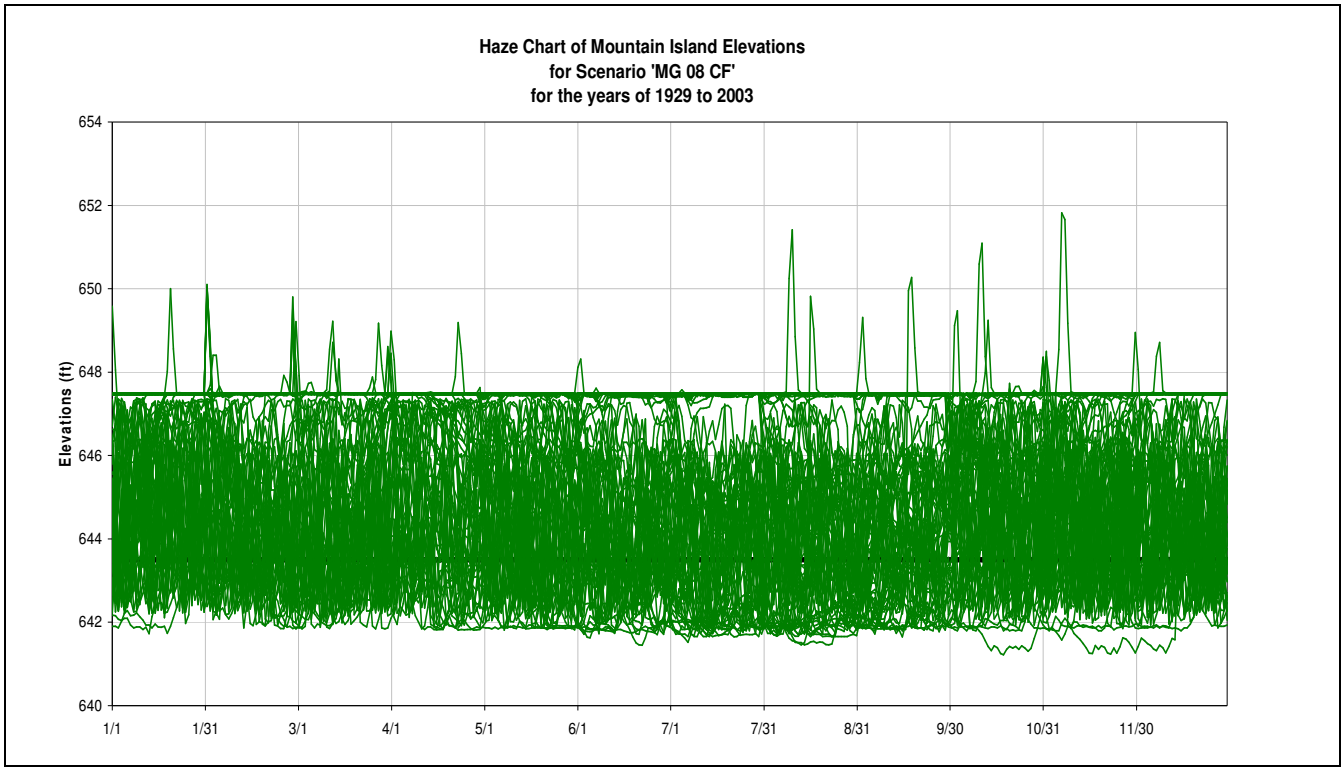

Figure 213: MI Elevation Haze Chart for MG 08 CF

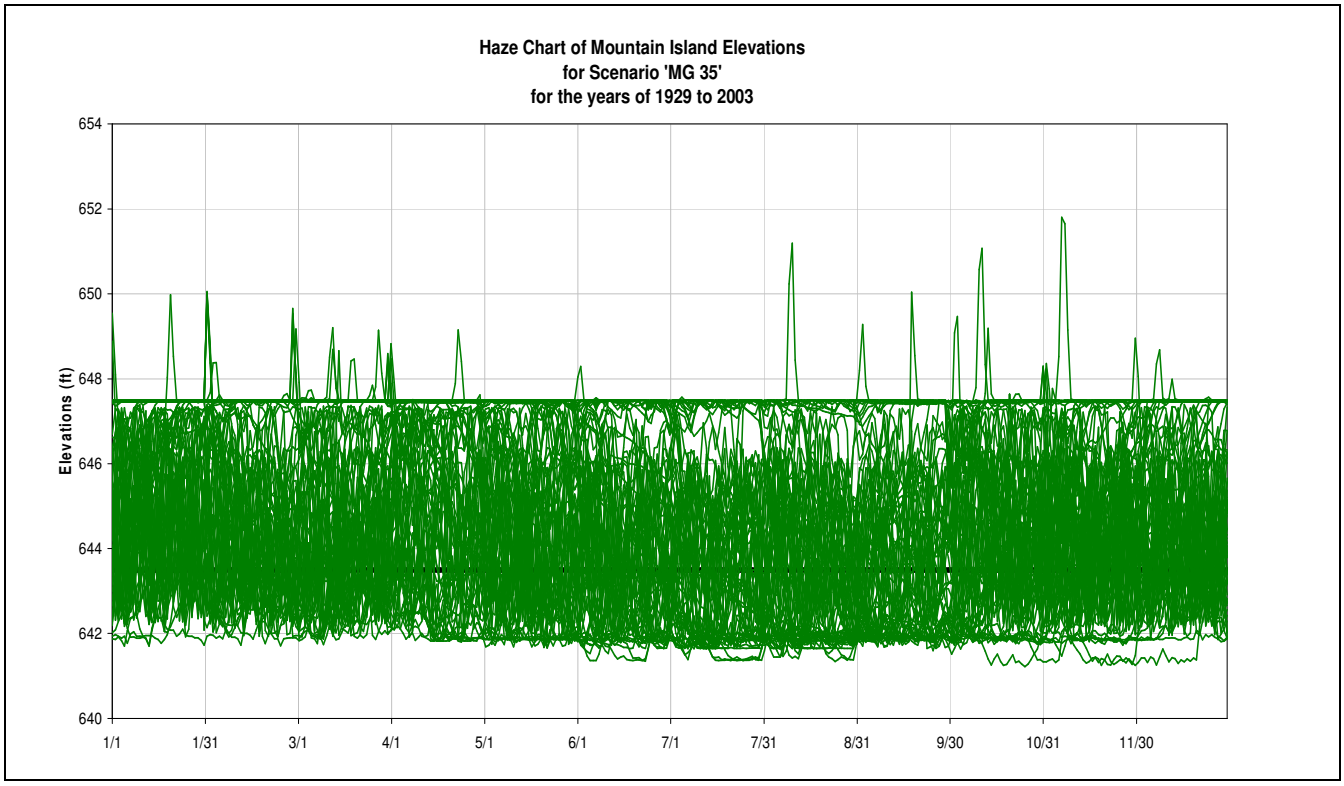

Figure 214: MOUNTAIN ISLAND chart for MG 35

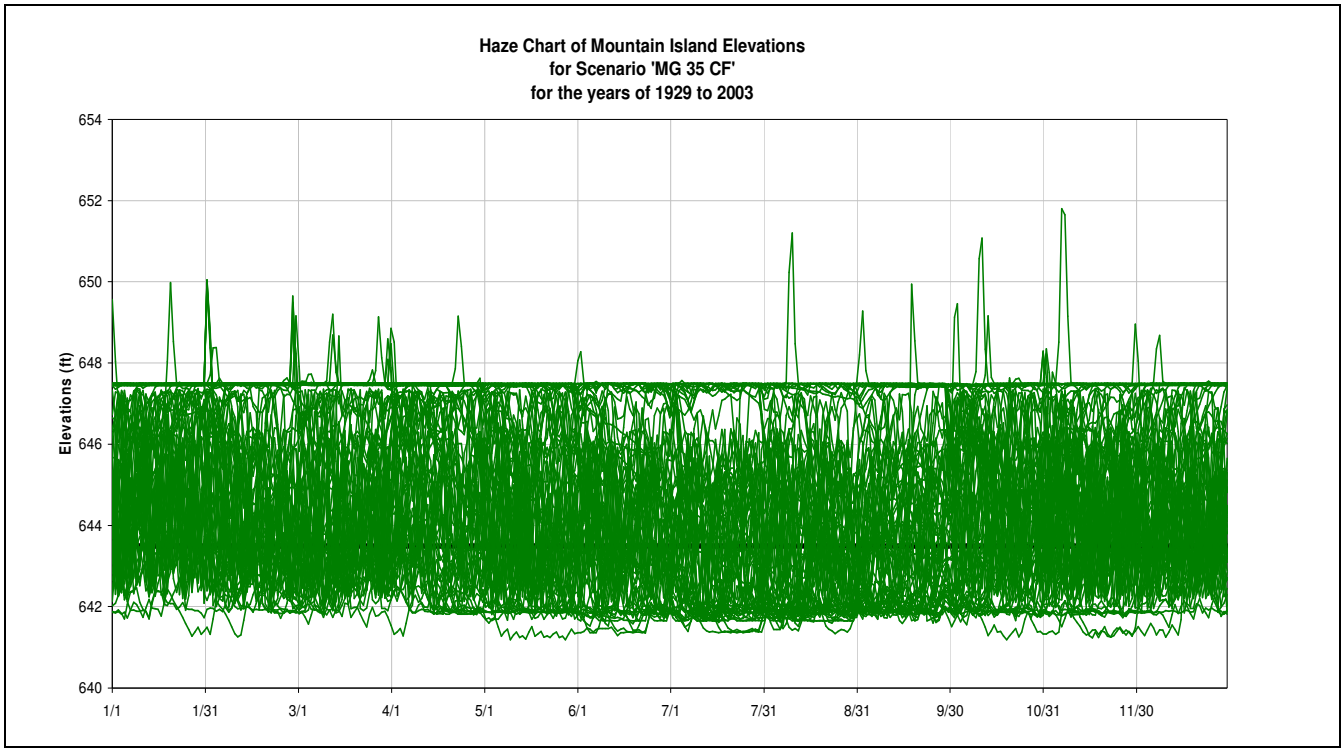

Figure 215: MOUNTAIN ISLAND chart for MG 35 CF

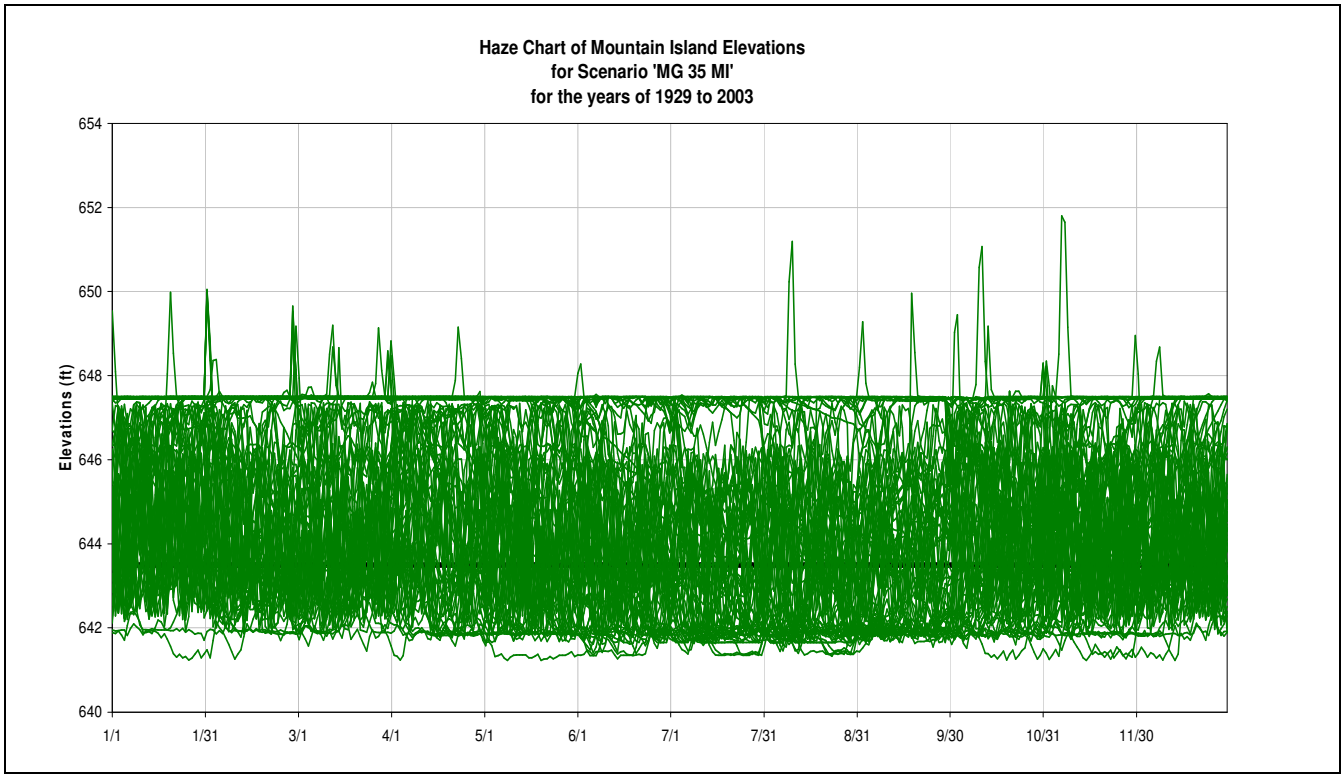

Figure 216: MOUNTAIN ISLAND chart for MG 35 MI

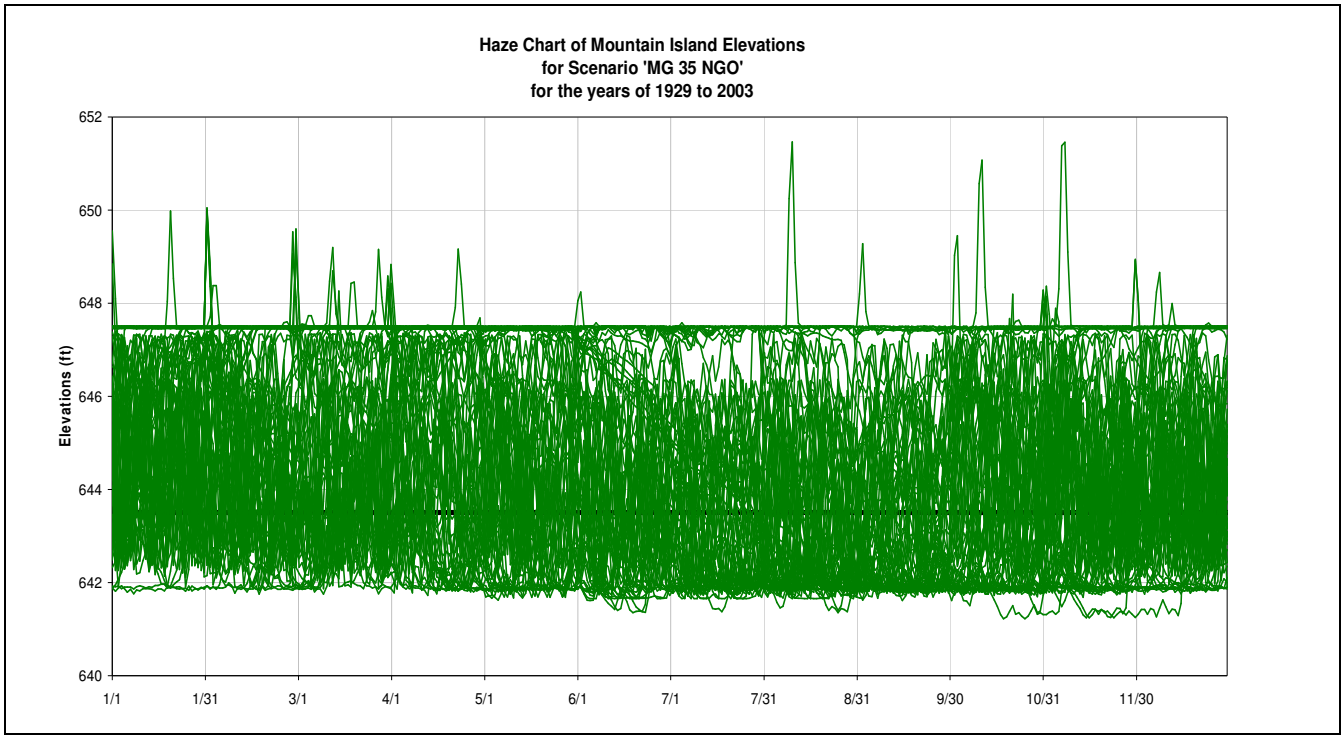

Figure 217: MOUNTAIN ISLAND chart for MG 35 NGO

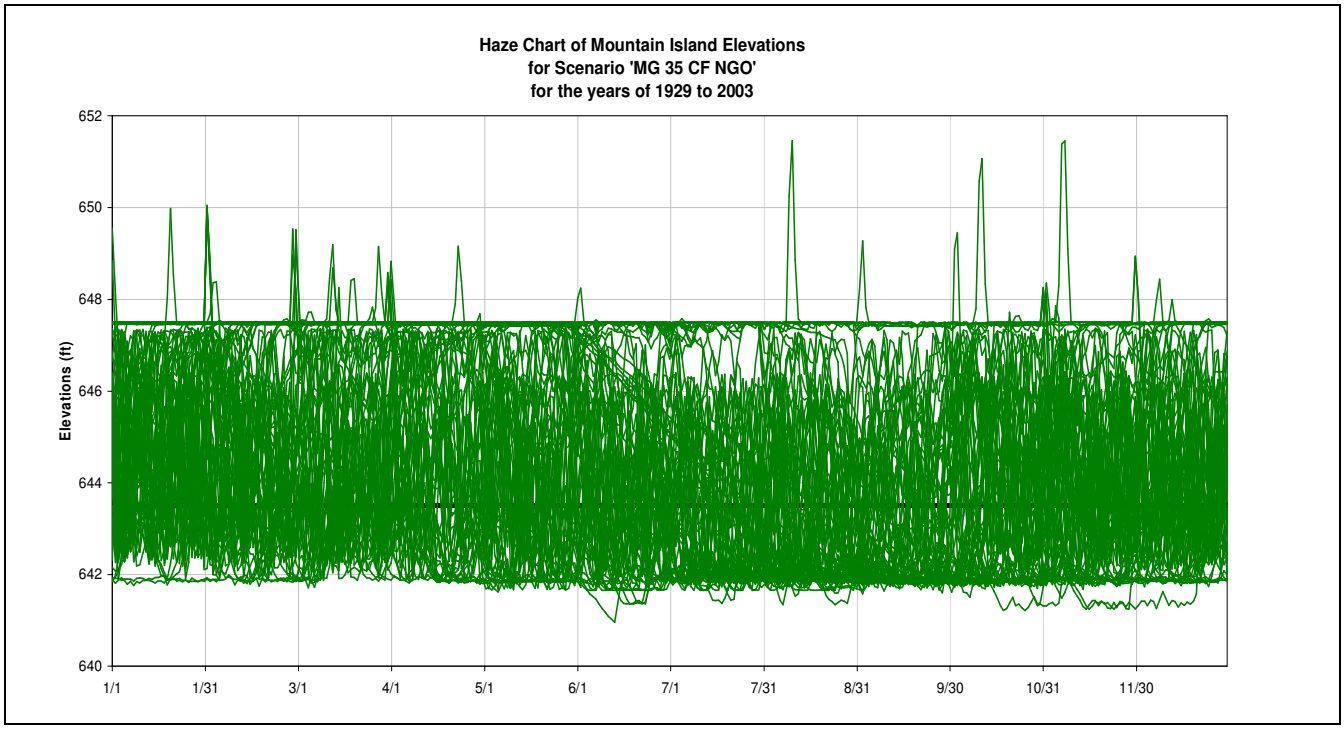

Figure 218: MI Elevation Haze Chart for MG 35

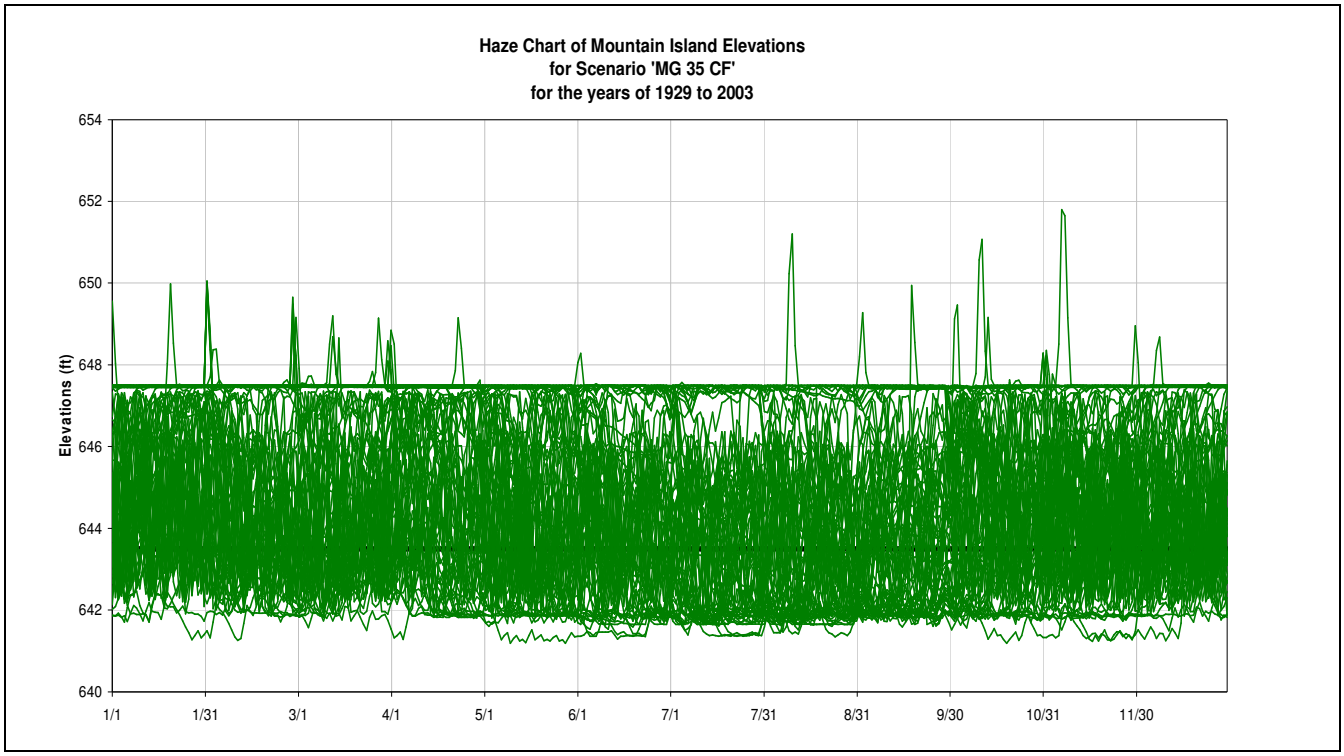

Figure 219: MI Elevation Haze Chart for MG 35 CF

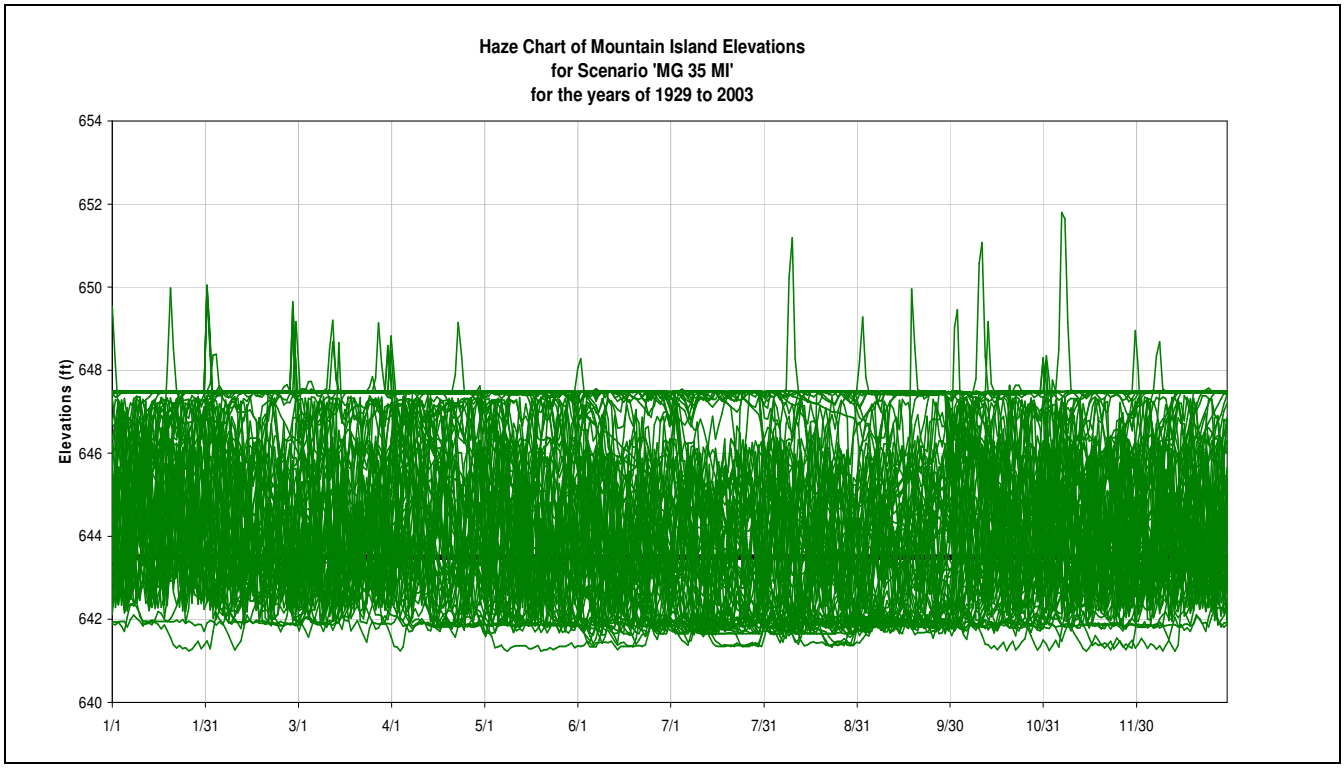

Figure 220: MI Elevation Haze Chart for MG 35 MI

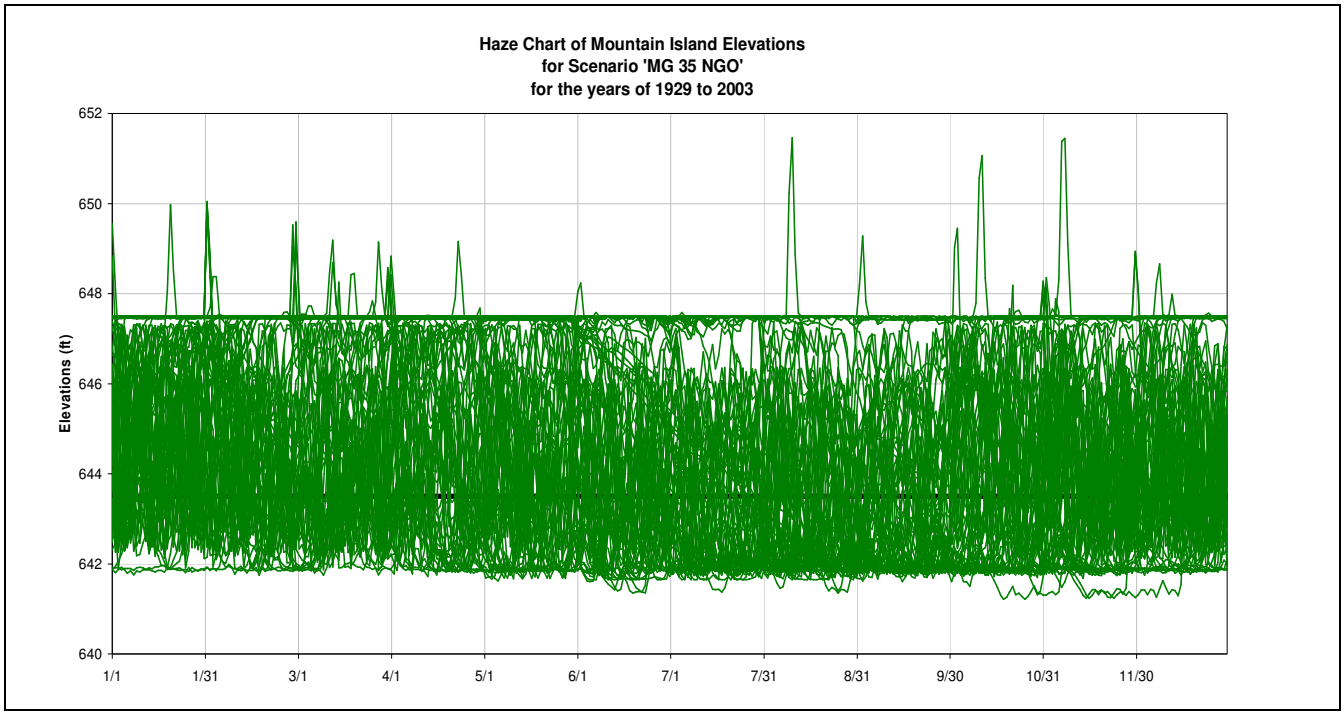

Figure 221: MI Elevation Haze Chart for MG 35 NGO

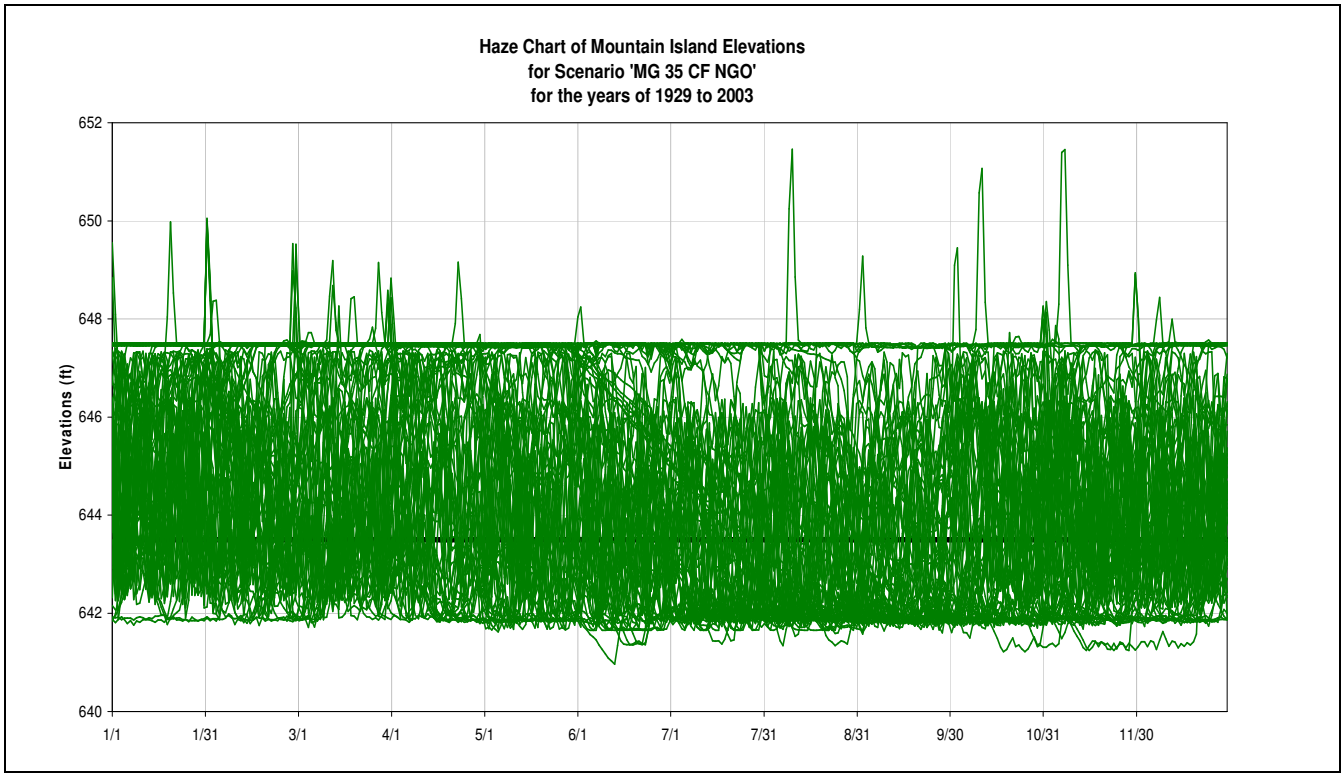

Figure 222: MI Elevation Haze Chart for MG 35 CF NGO

7) Wylie

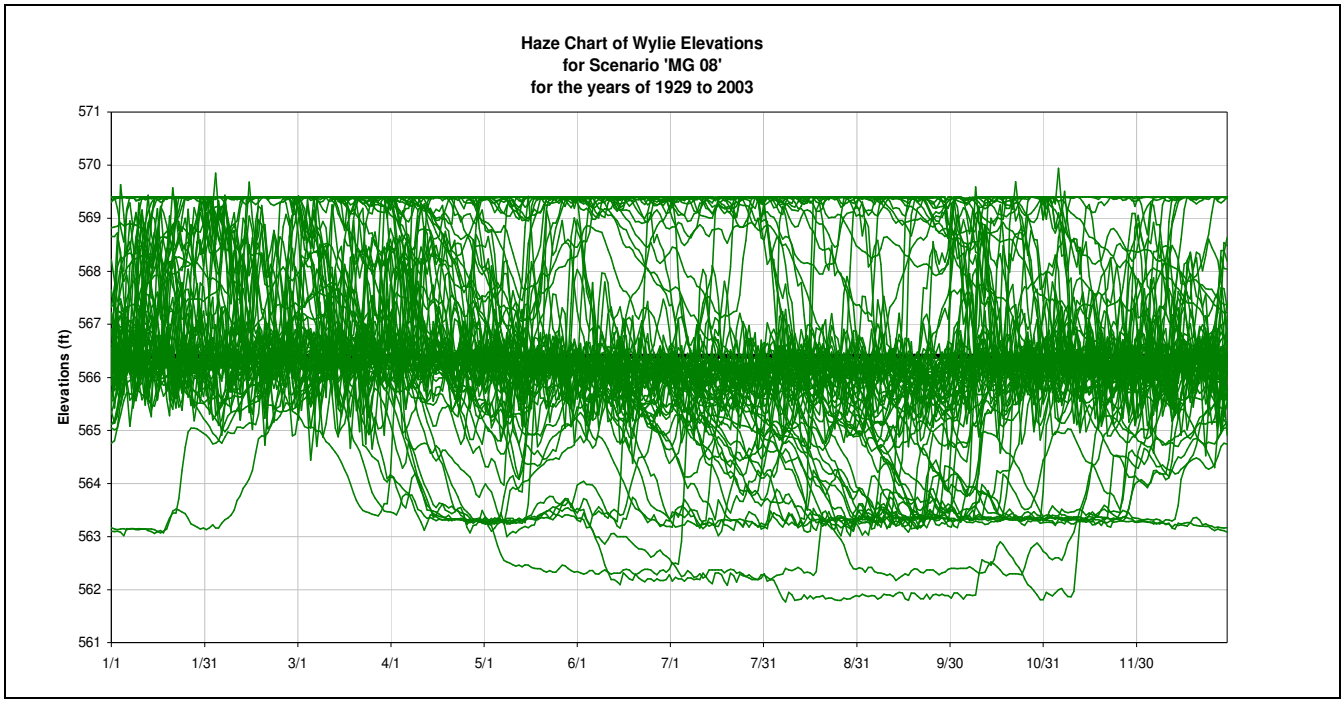

Figure 223: WY Elevation Haze Chart for MG 08

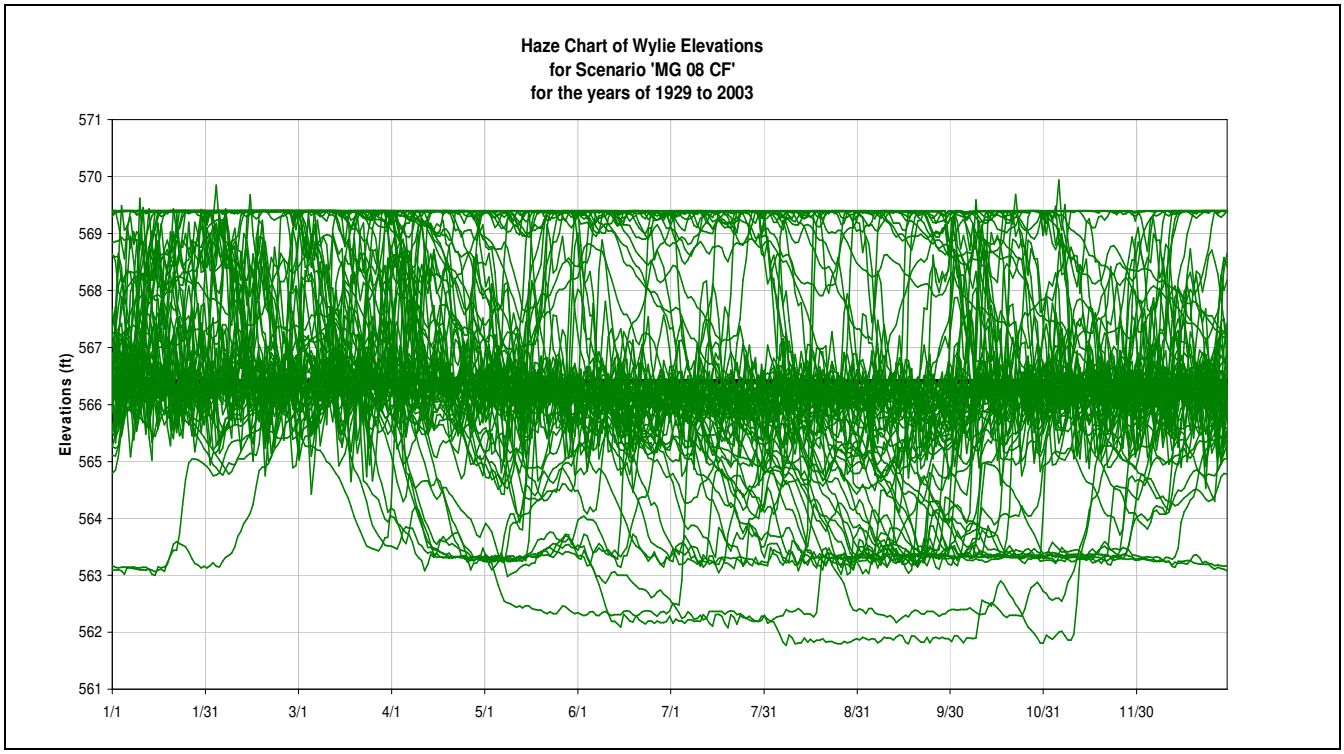

Figure 224: WY Elevation Haze Chart for MG 08 CF

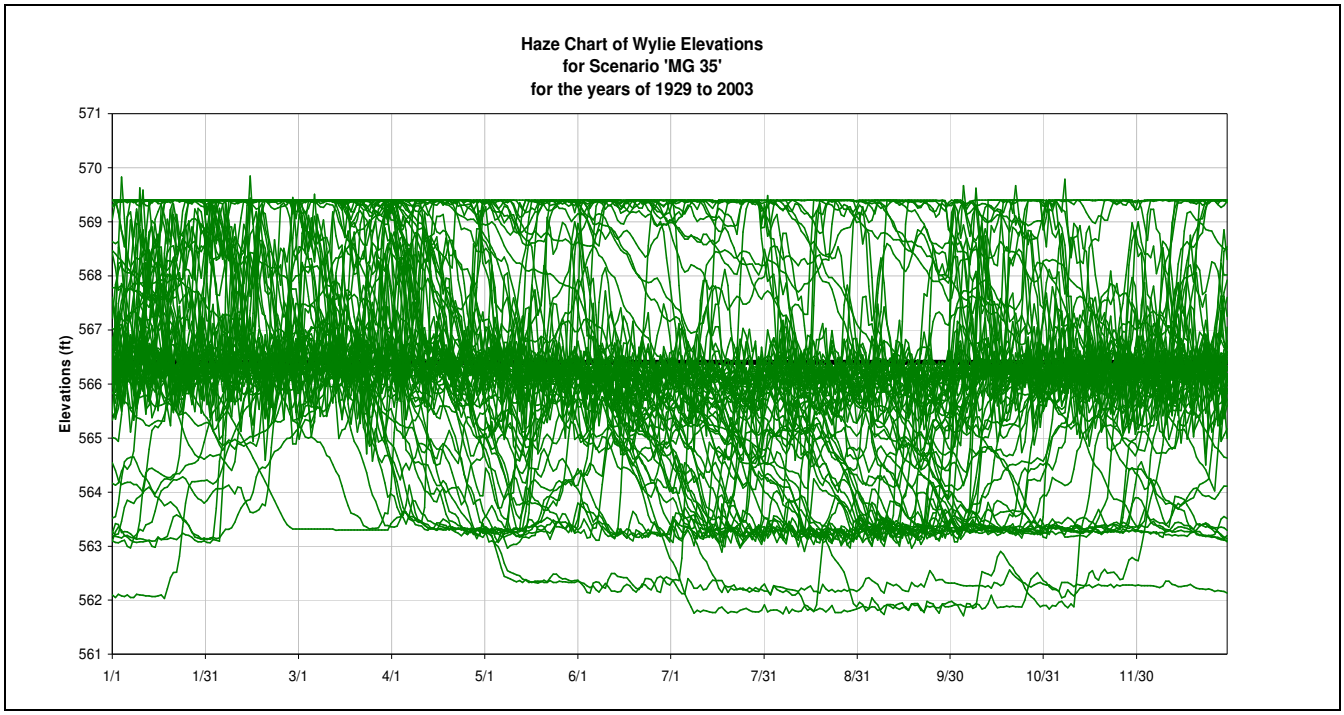

Figure 225: WY Elevation Haze Chart for MG 35

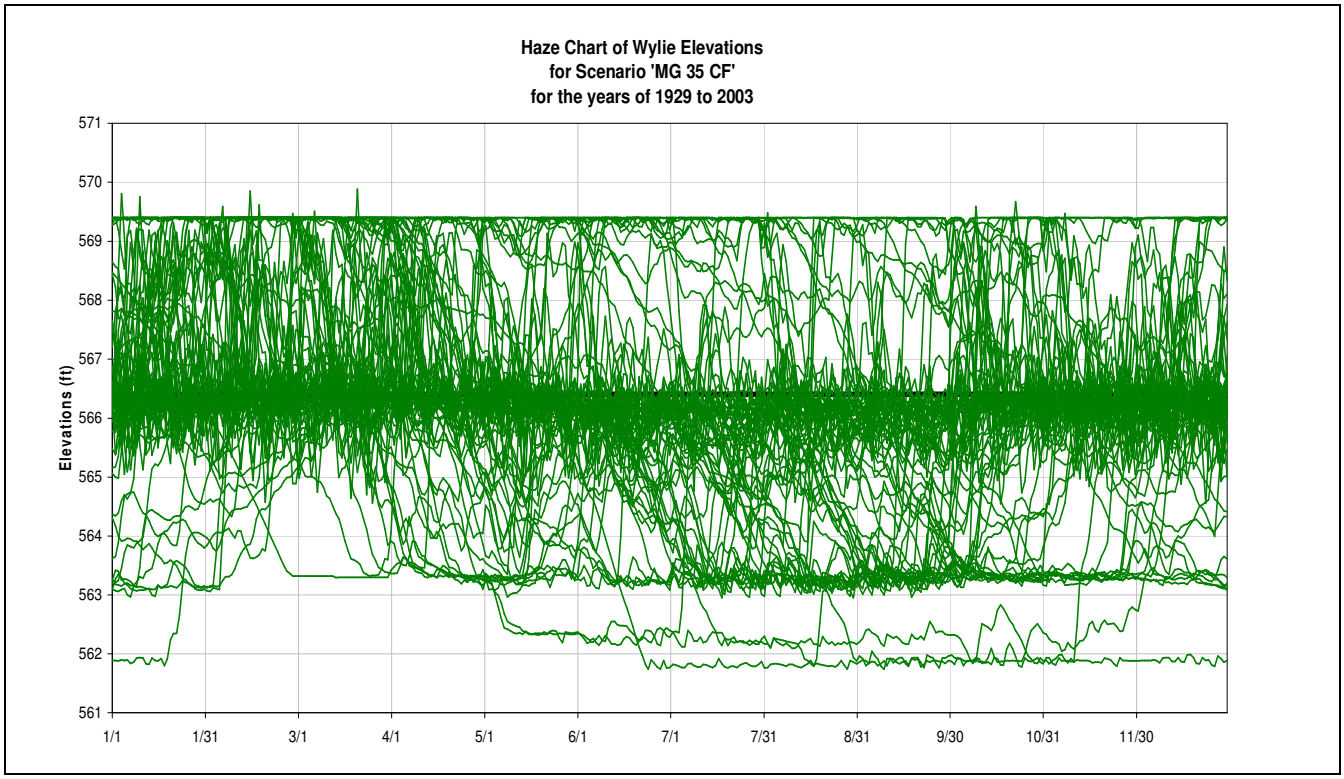

Figure 226: WY Elevation Haze Chart for MG 35 CF

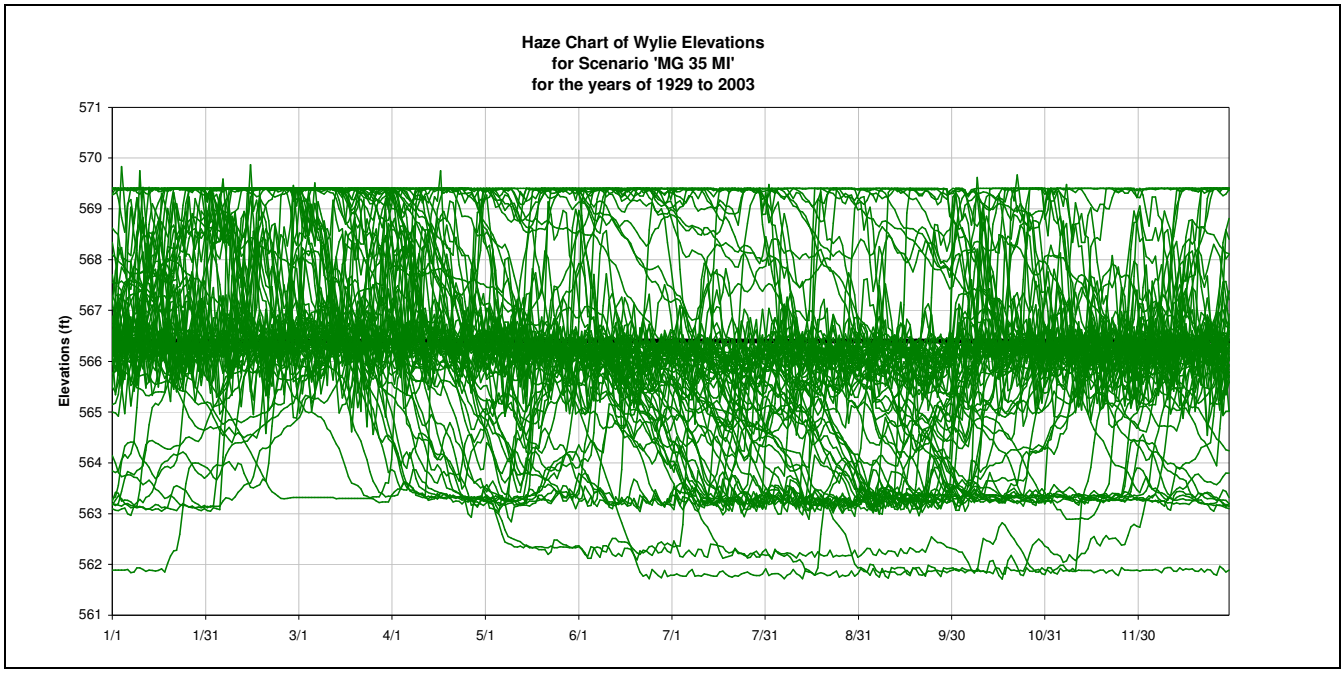

Figure 227: WY Elevation Haze Chart for MG 35 MI

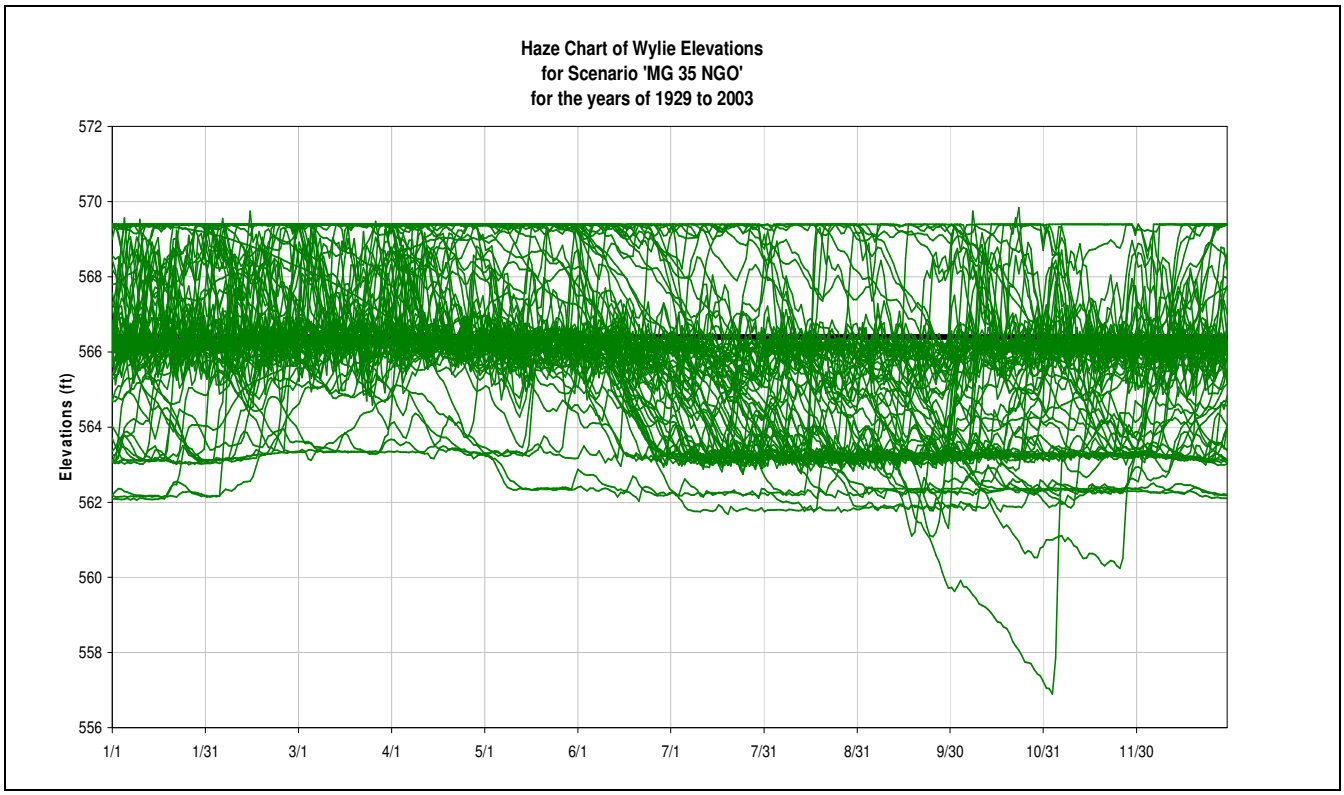

Figure 228: WY Elevation Haze Chart for MG 35 NGO

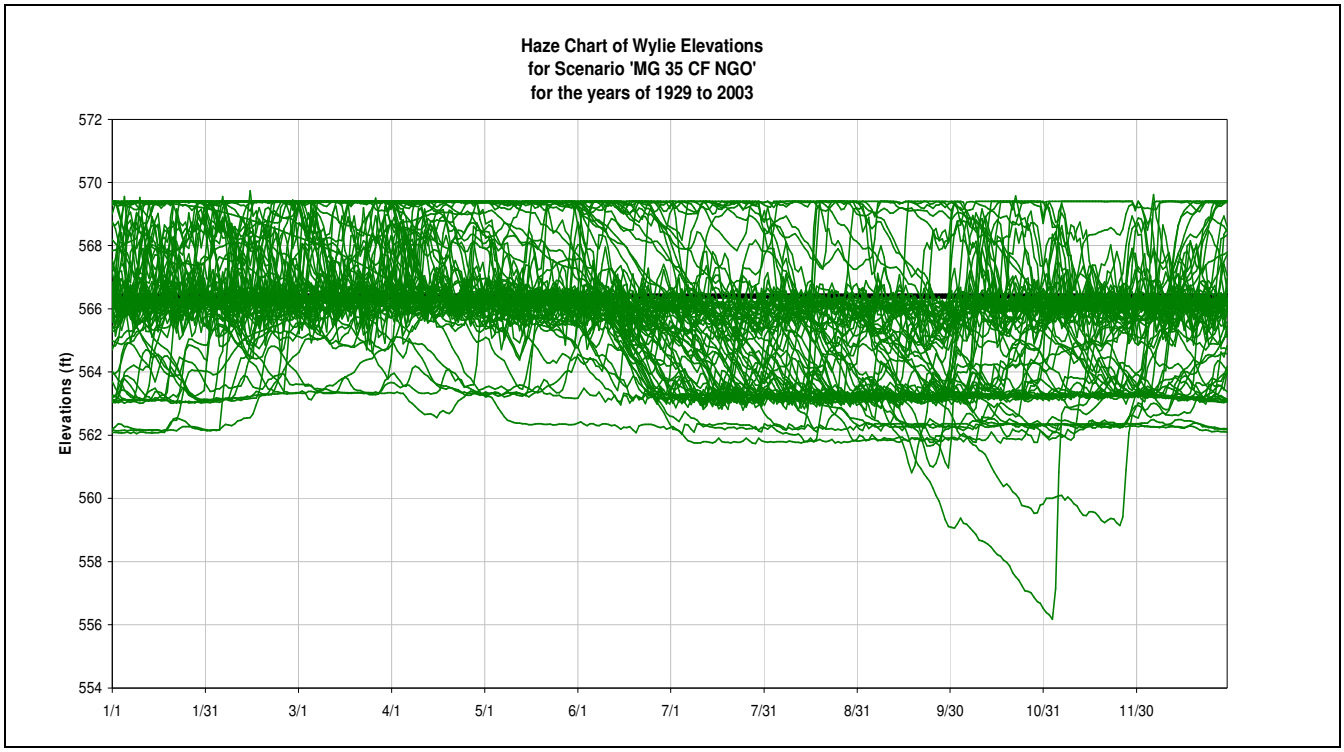

Figure 229: WY Elevation Haze Chart for MG 35 CF NGO

8) Fishing Creek

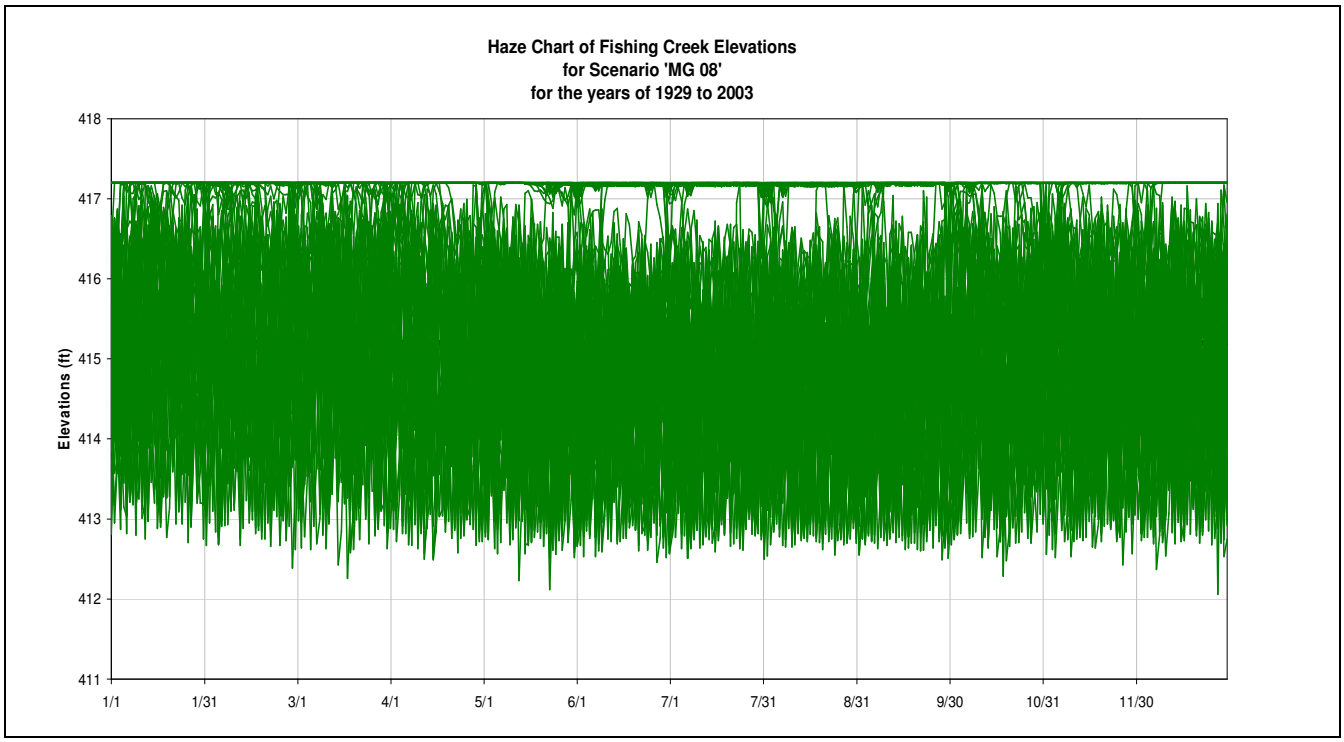

Figure 230: FC Elevation Haze Chart for MG 08

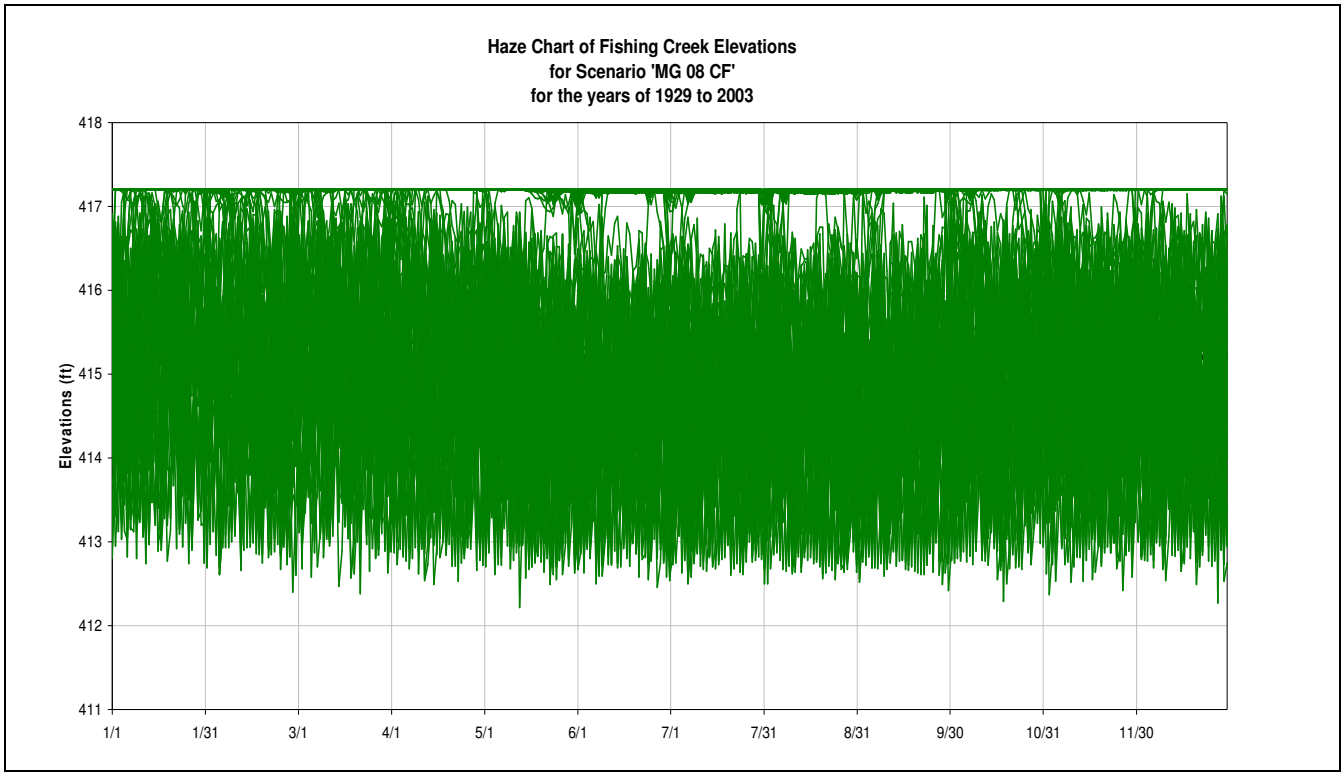

Figure 231: FC Elevation Haze Chart for MG 08 CF

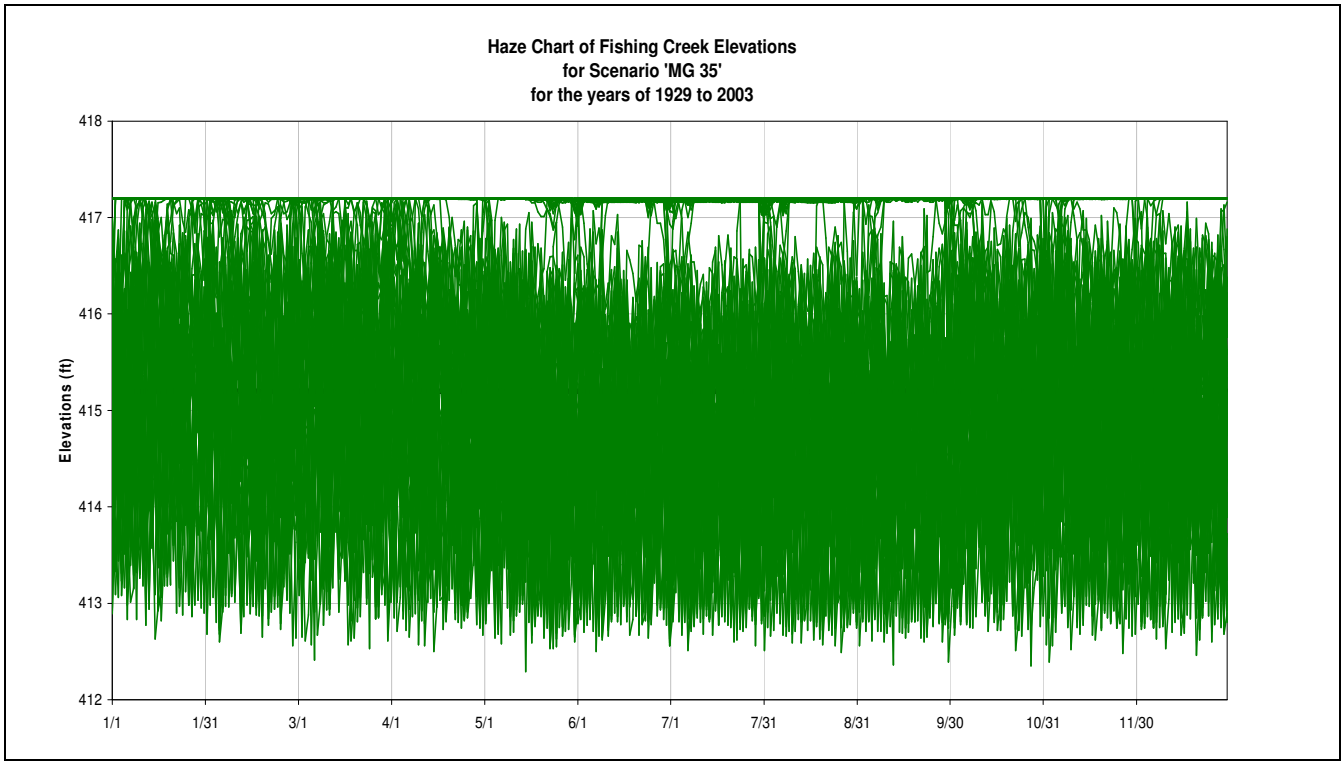

Figure 232: FISHING CREEK Chart for MG 35

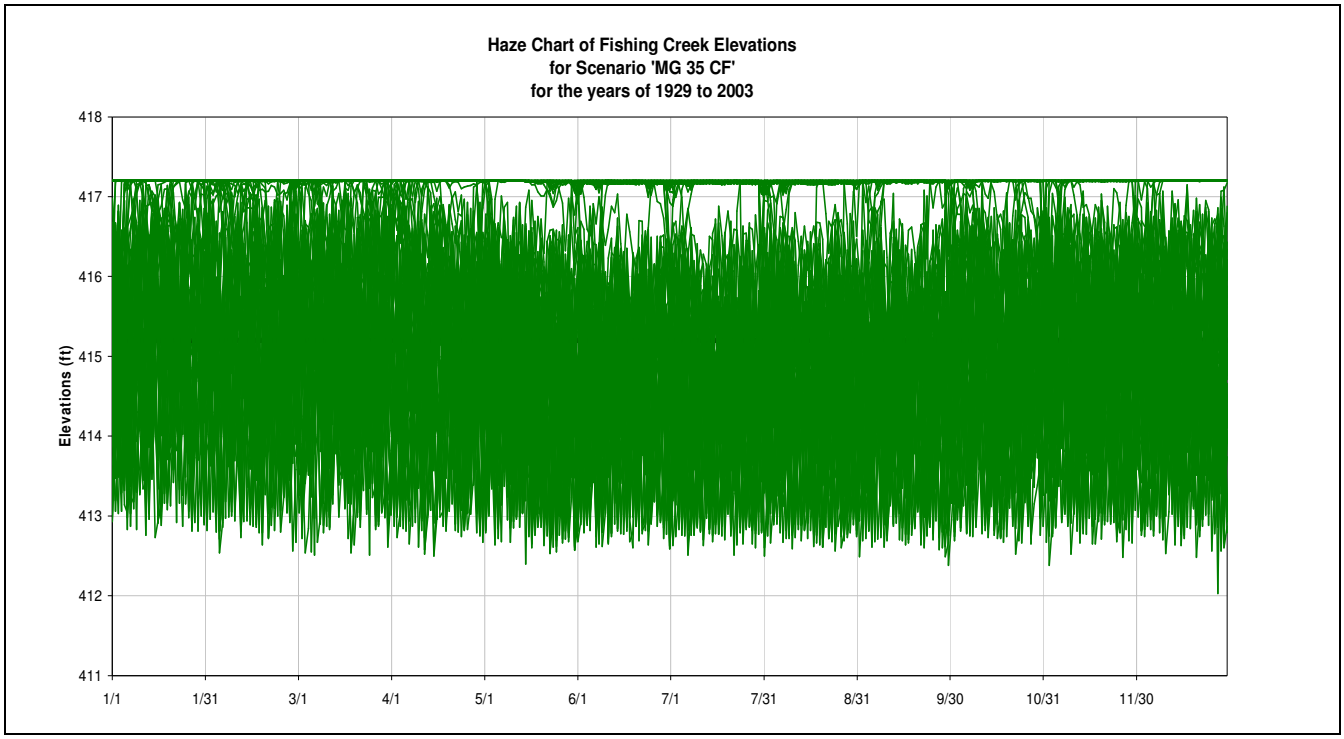

Figure 233: FISHING CREEK Chart for MG 35CF

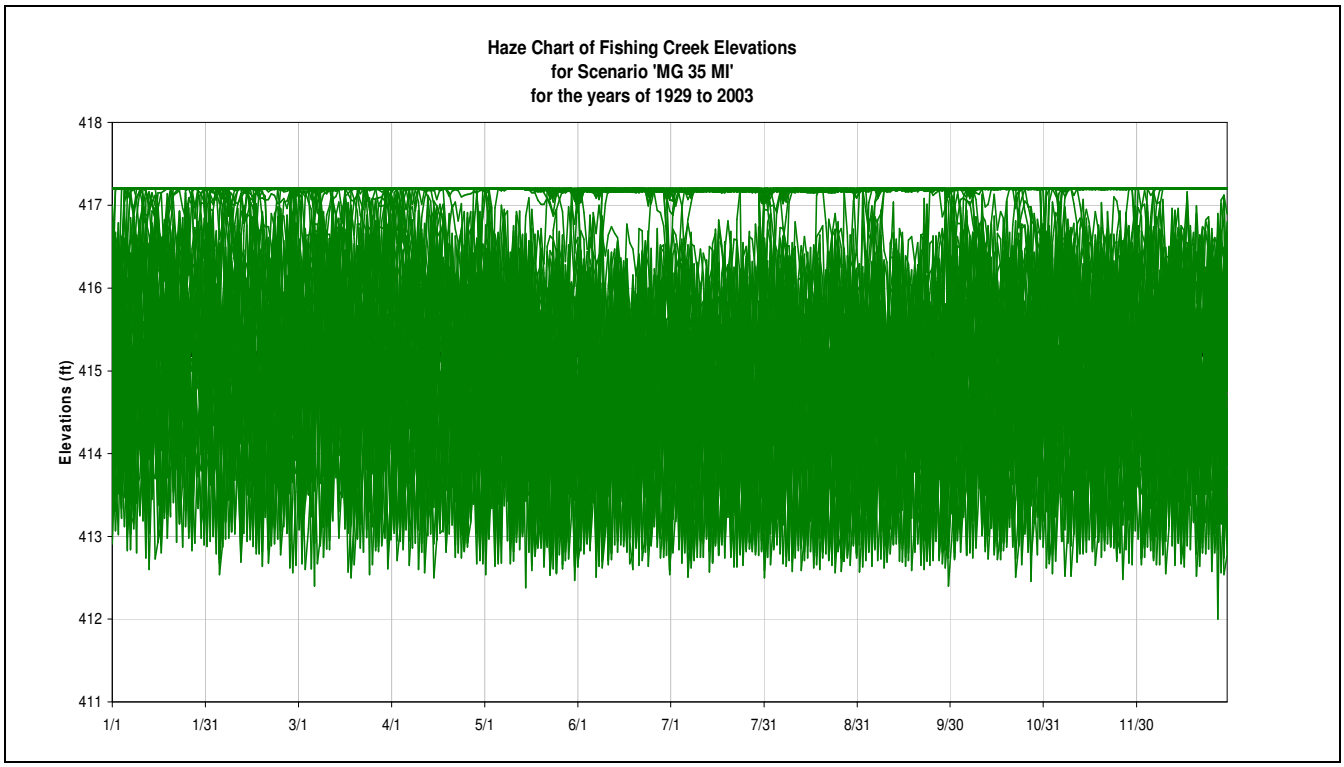

Figure 234: FISHING CREEK Chart for MG 35 MI

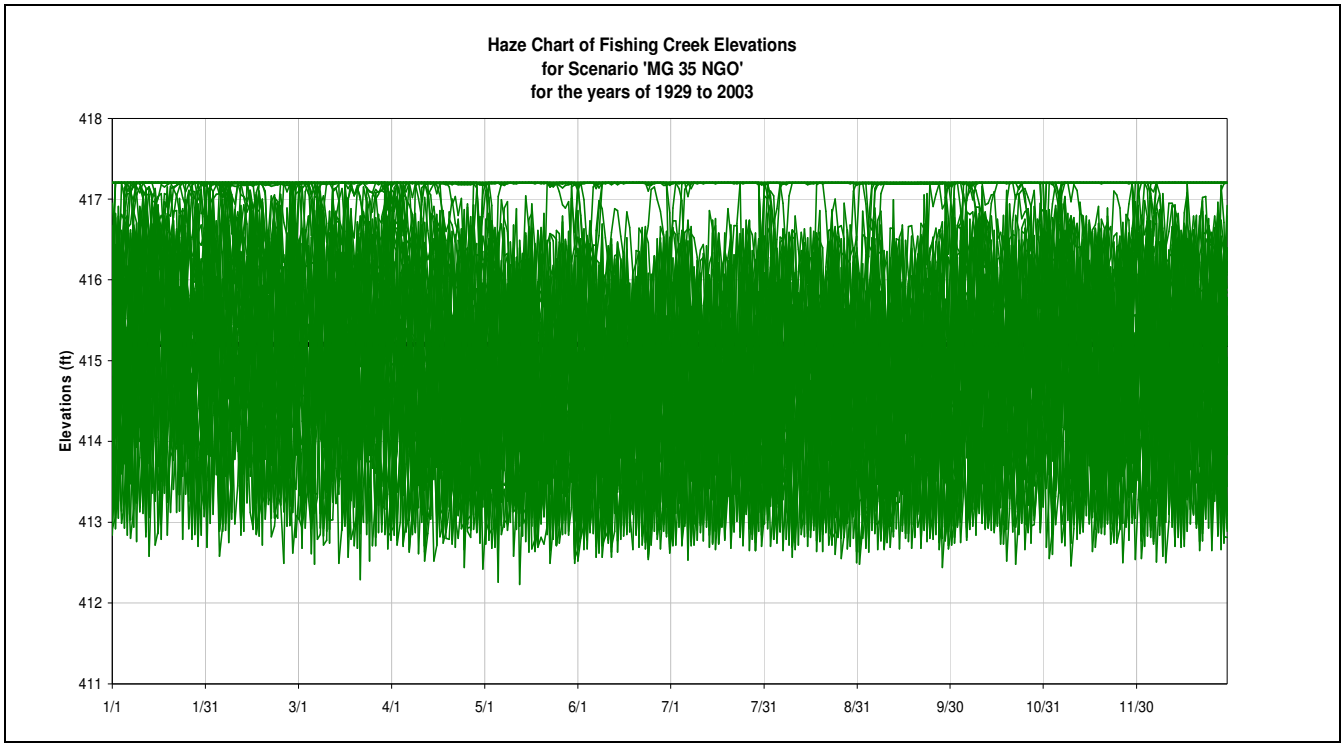

Figure 235: FISHING CREEK Chart for MG 35 NGO

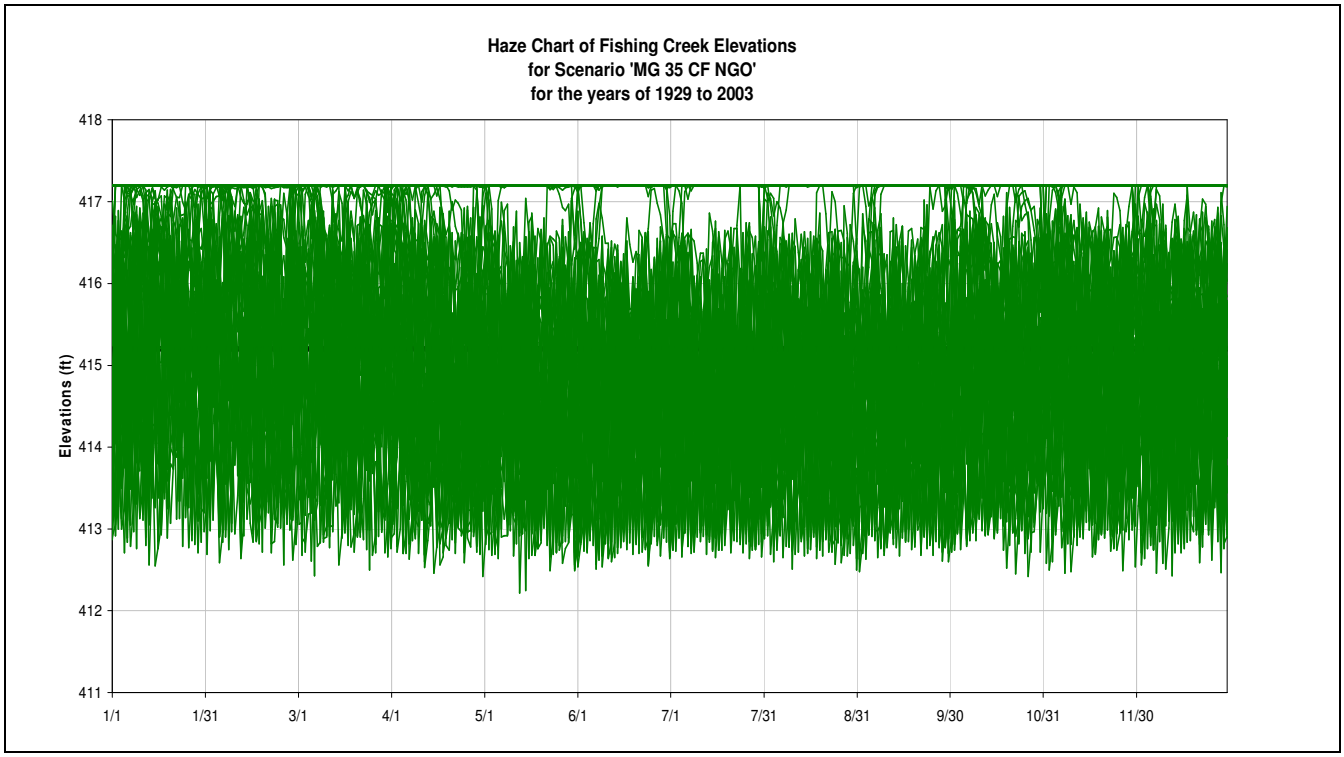

Figure 236: FC Elevation Haze Chart for MG 35

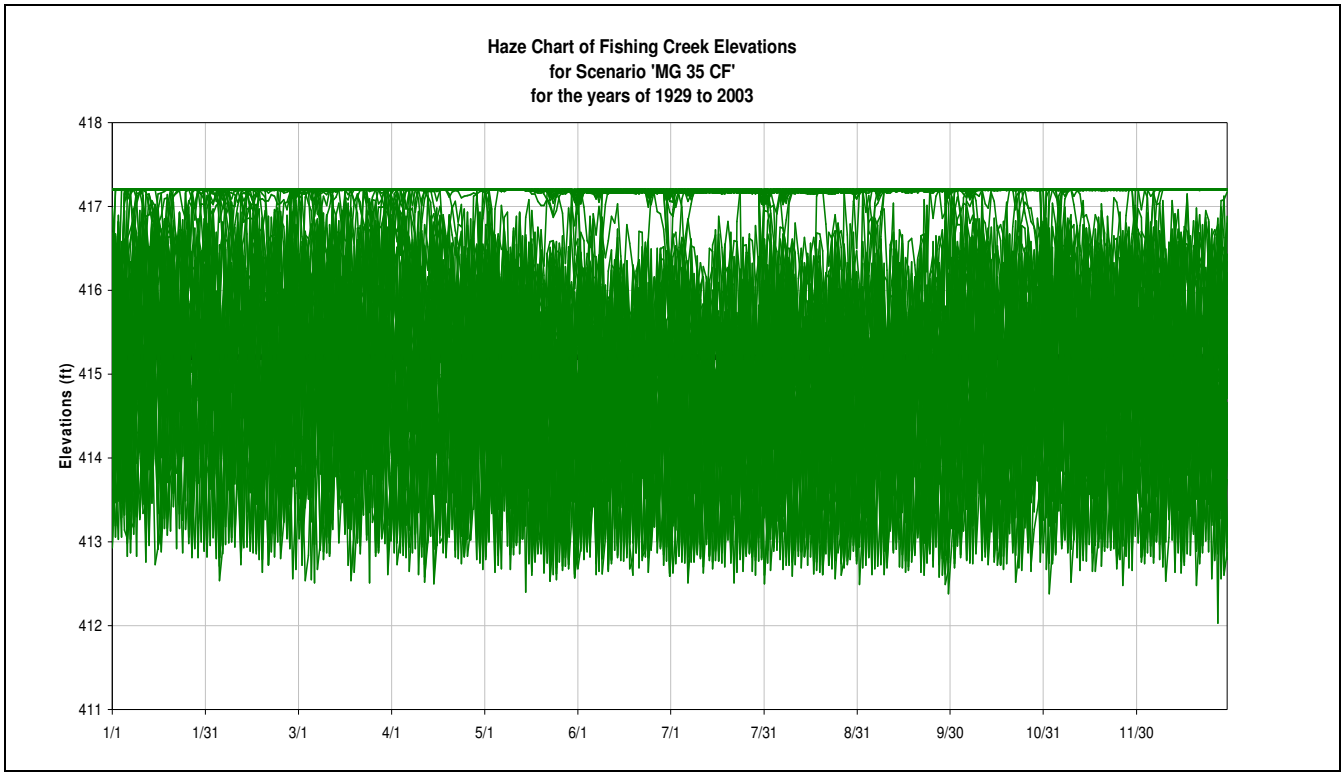

Figure 237: FC Elevation Haze Chart for MG 35CF

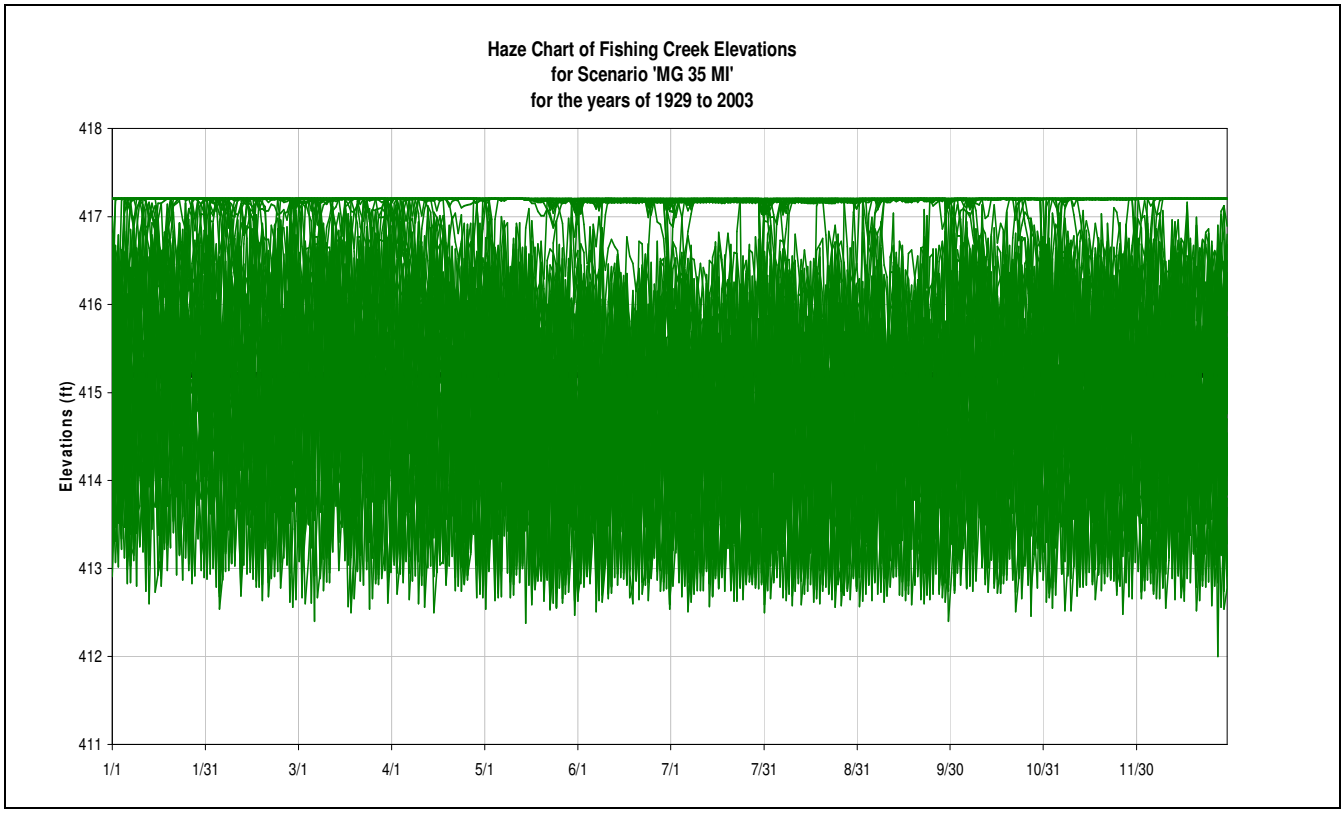

Figure 238: FC Elevation Haze Chart for MG 35 MI

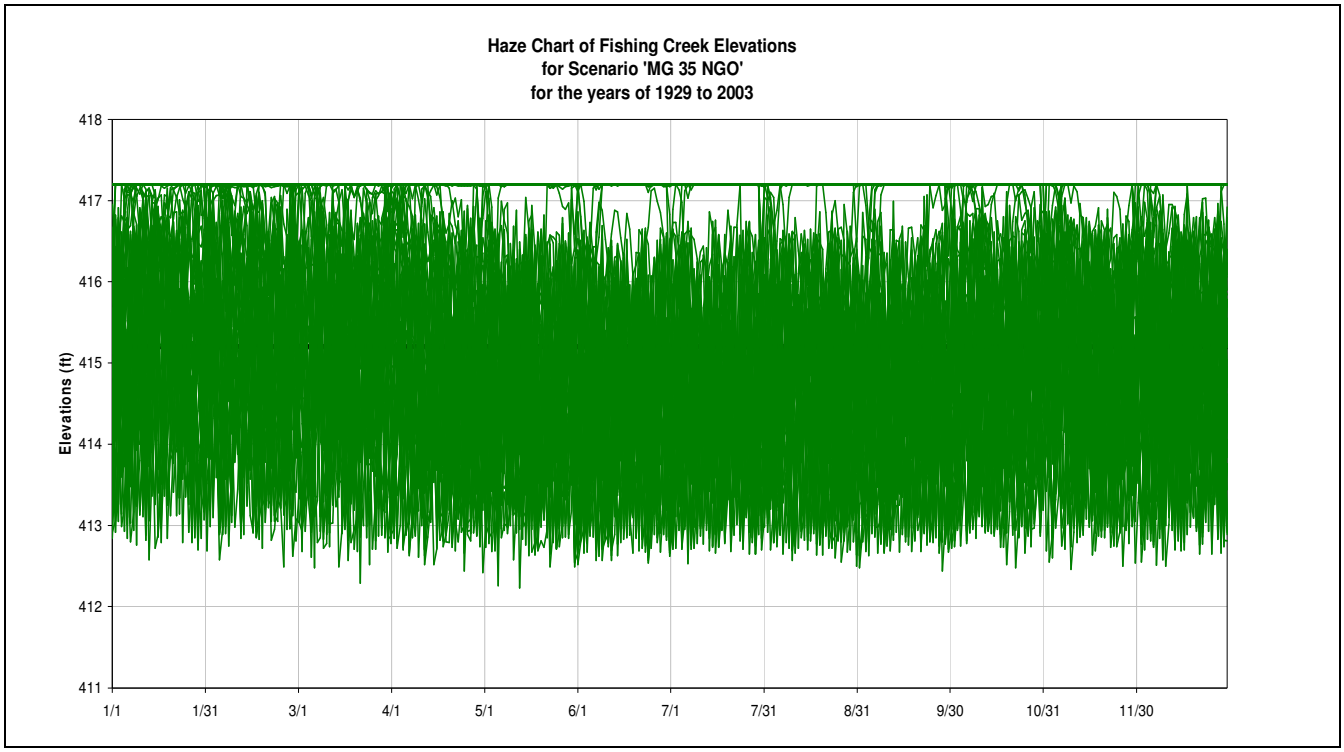

Figure 239: FC Elevation Haze Chart for MG 35 NGO

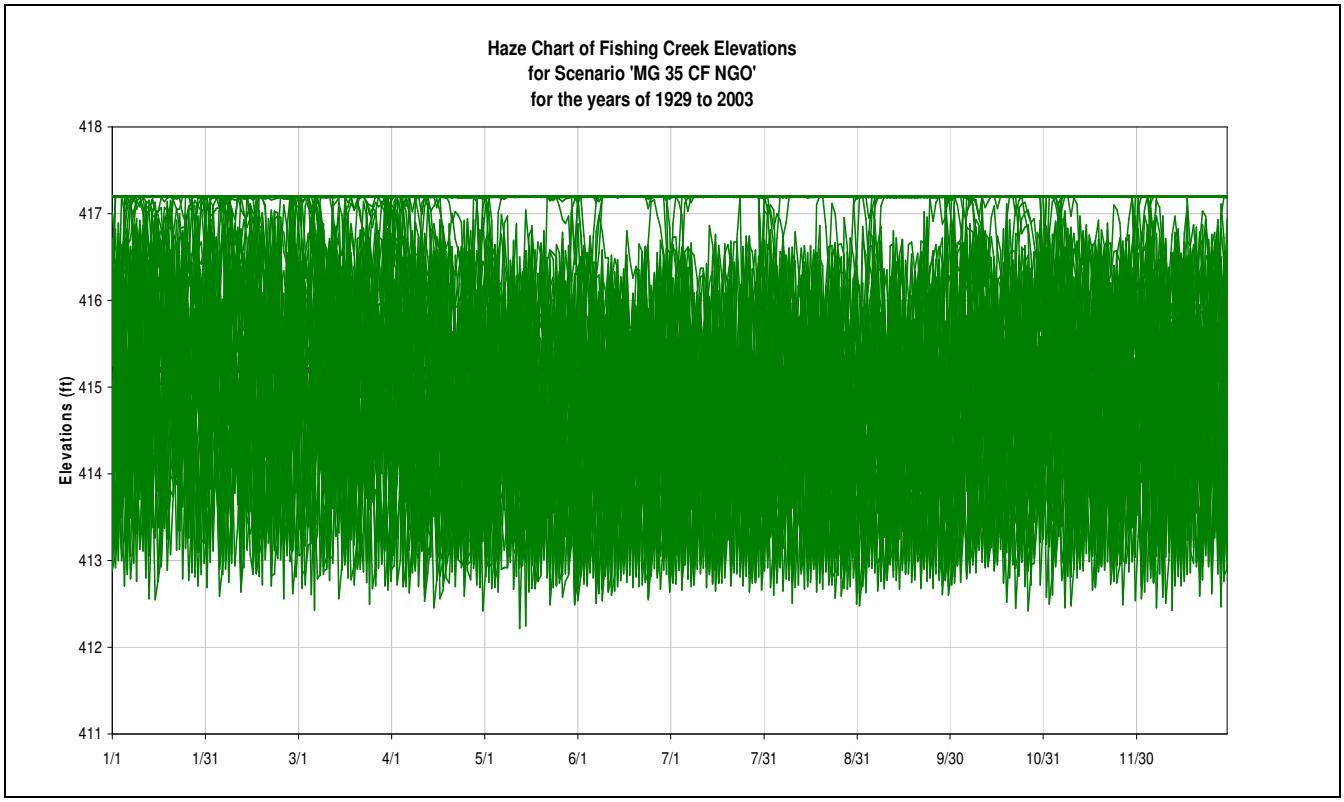

Figure 240: FC Elevation Haze Chart for MG 35 CF NGO

9) Great Falls

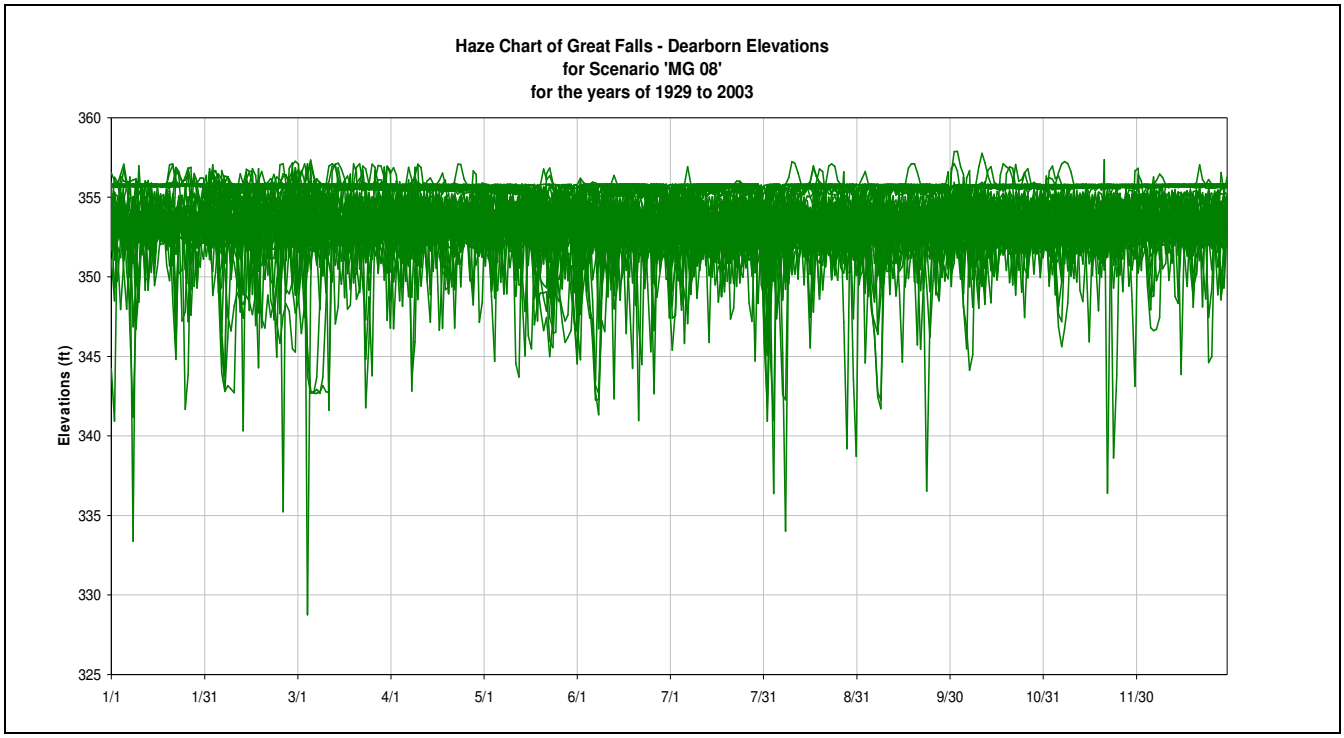

Figure 241: GF Elevation Haze Chart for MG 08

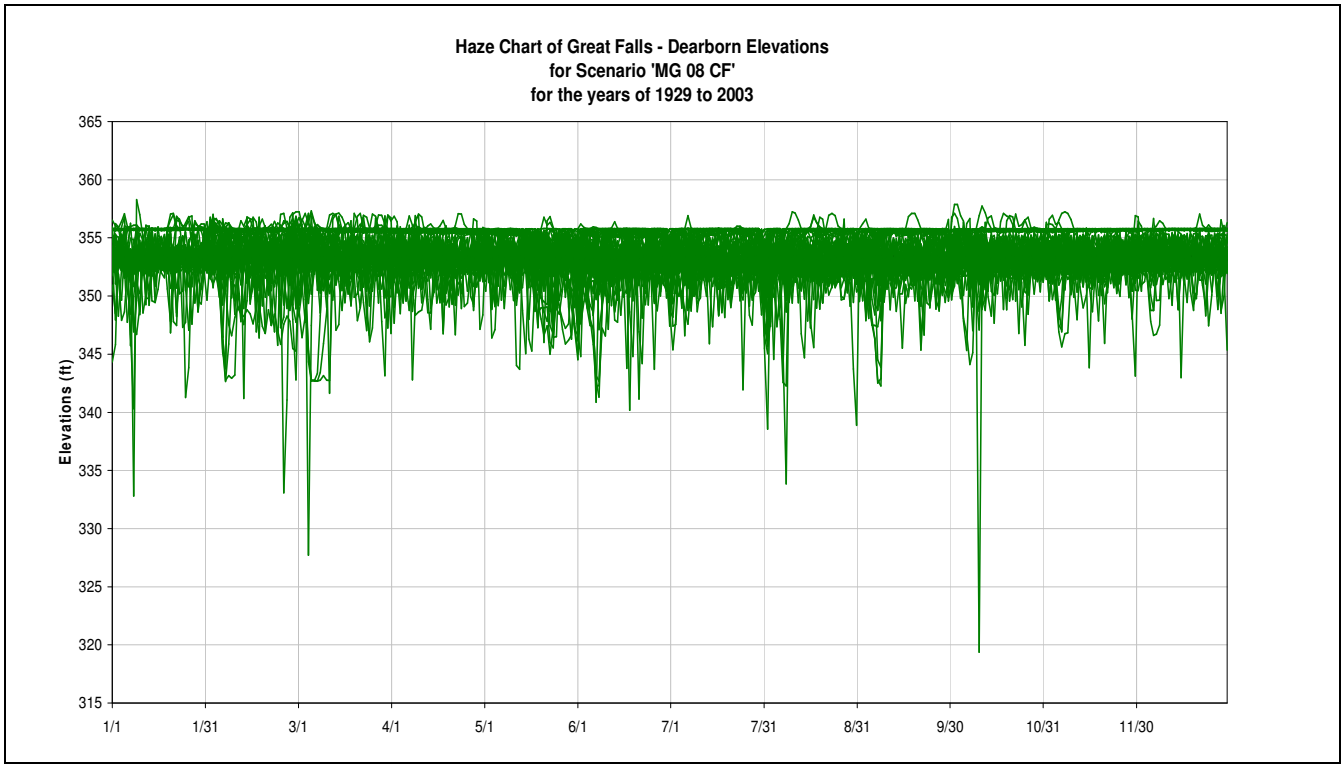

Figure 242: GF Elevation Haze Chart for MG 08 CF

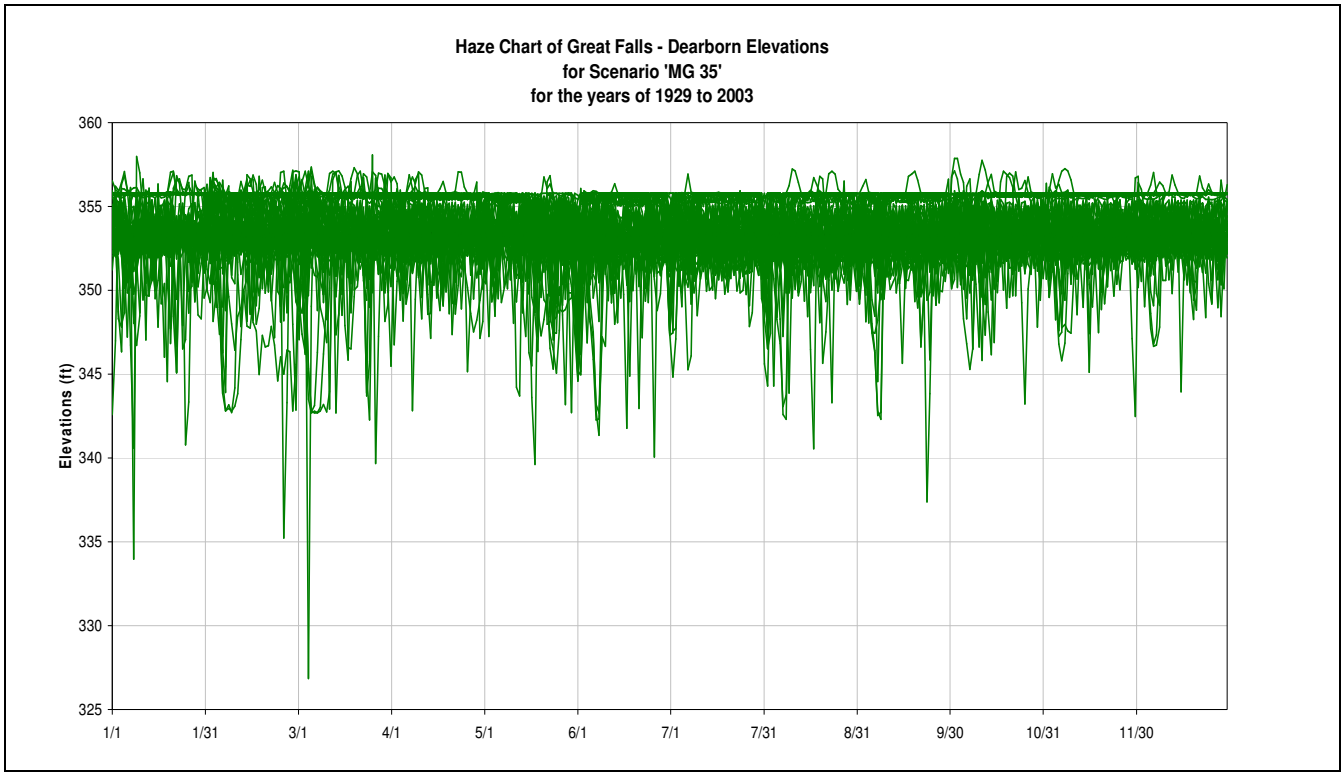

Figure 243: GF Elevation Haze Chart for MG 35

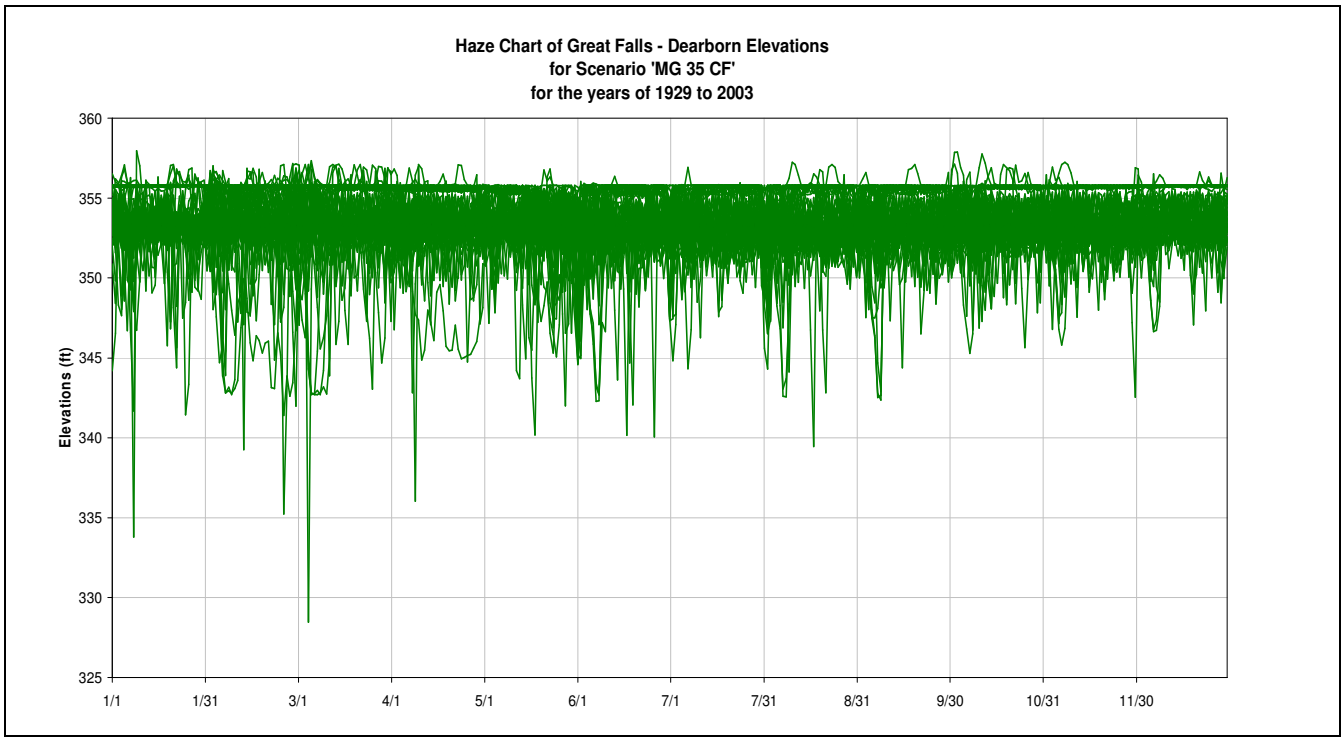

Figure 244: GF Elevation Haze Chart for MG 35 CF

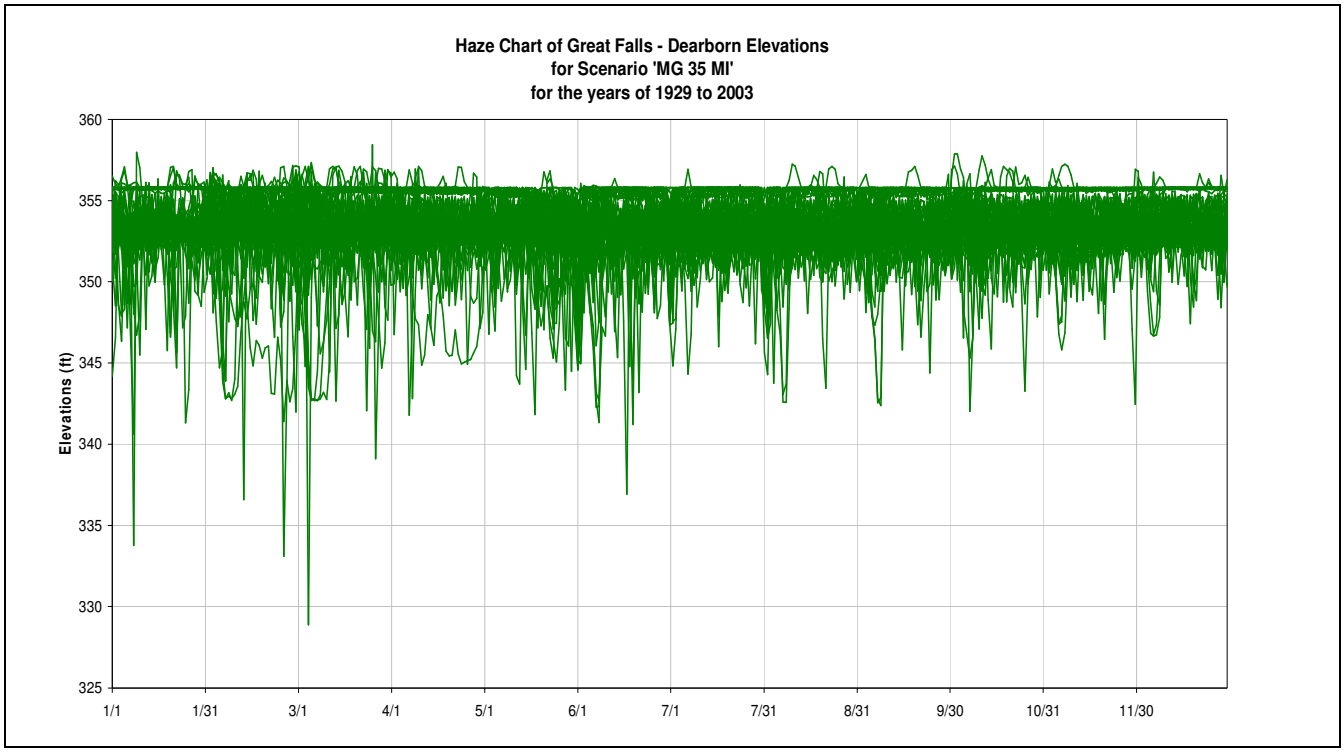

Figure 245: GF Elevation Haze Chart for MG 35 MI

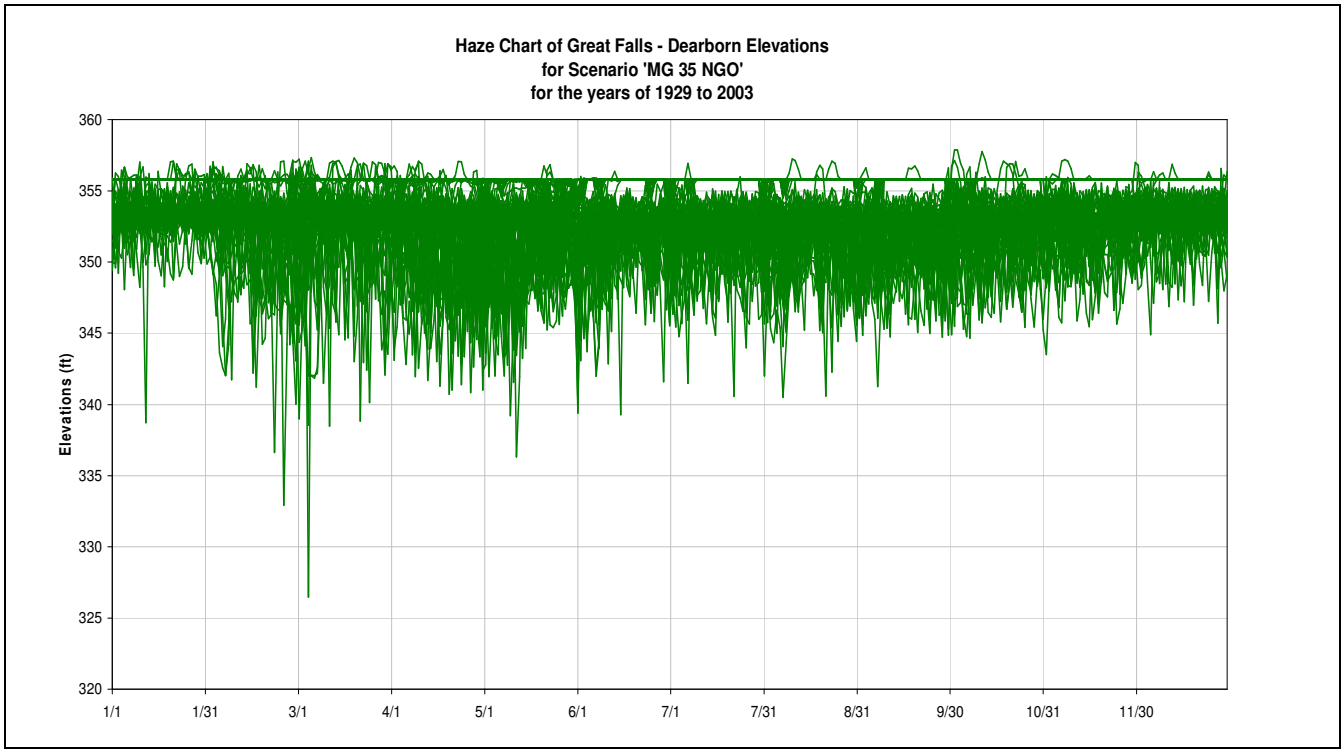

Figure 246: GF Elevation Haze Chart for MG 35 NGO

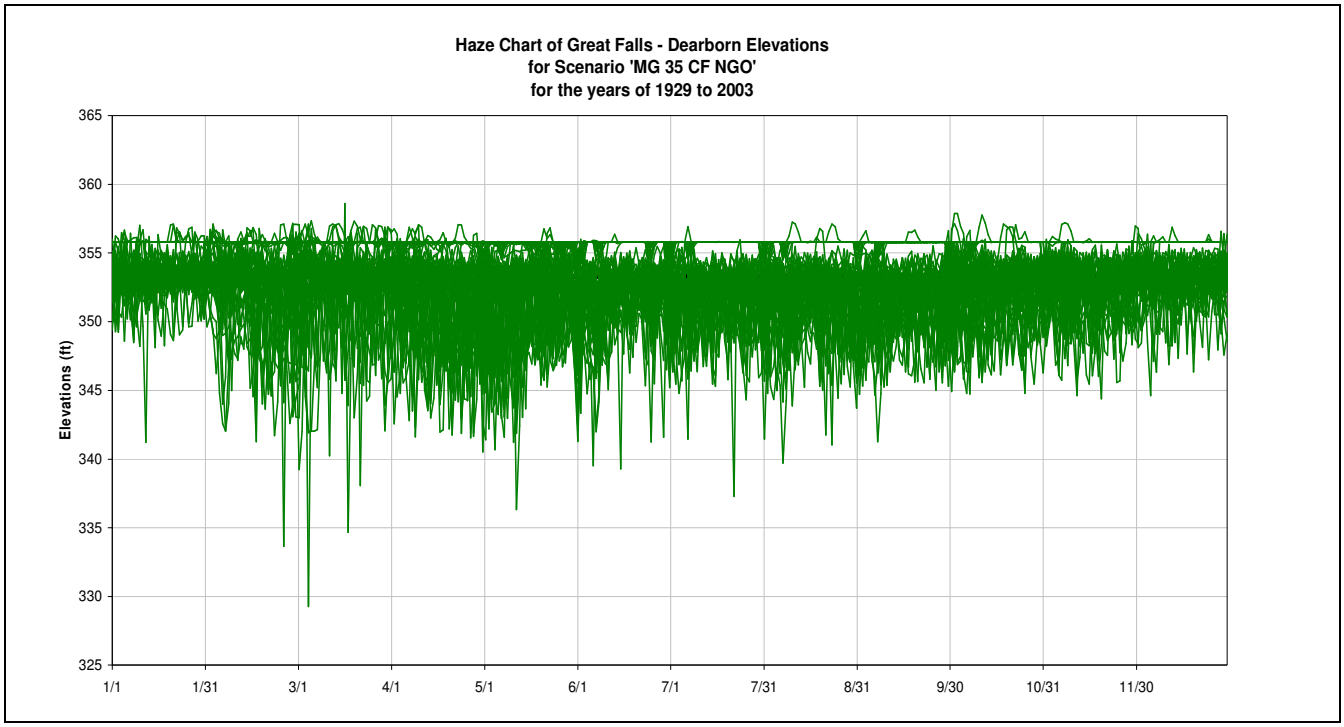

Figure 247: GF Elevation Haze Chart for MG 35 CF NGO

10) Rocky Creek

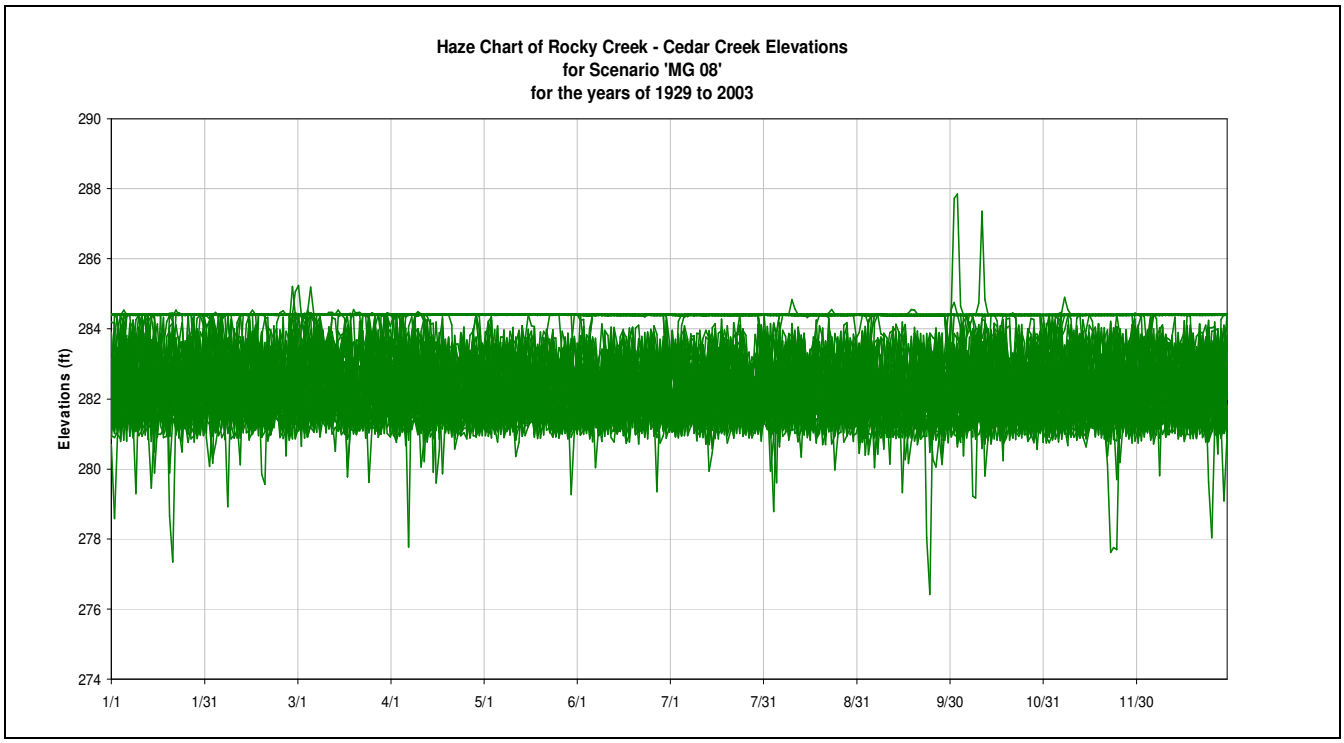

Figure 248: RC Elevation Haze Chart for MG 08

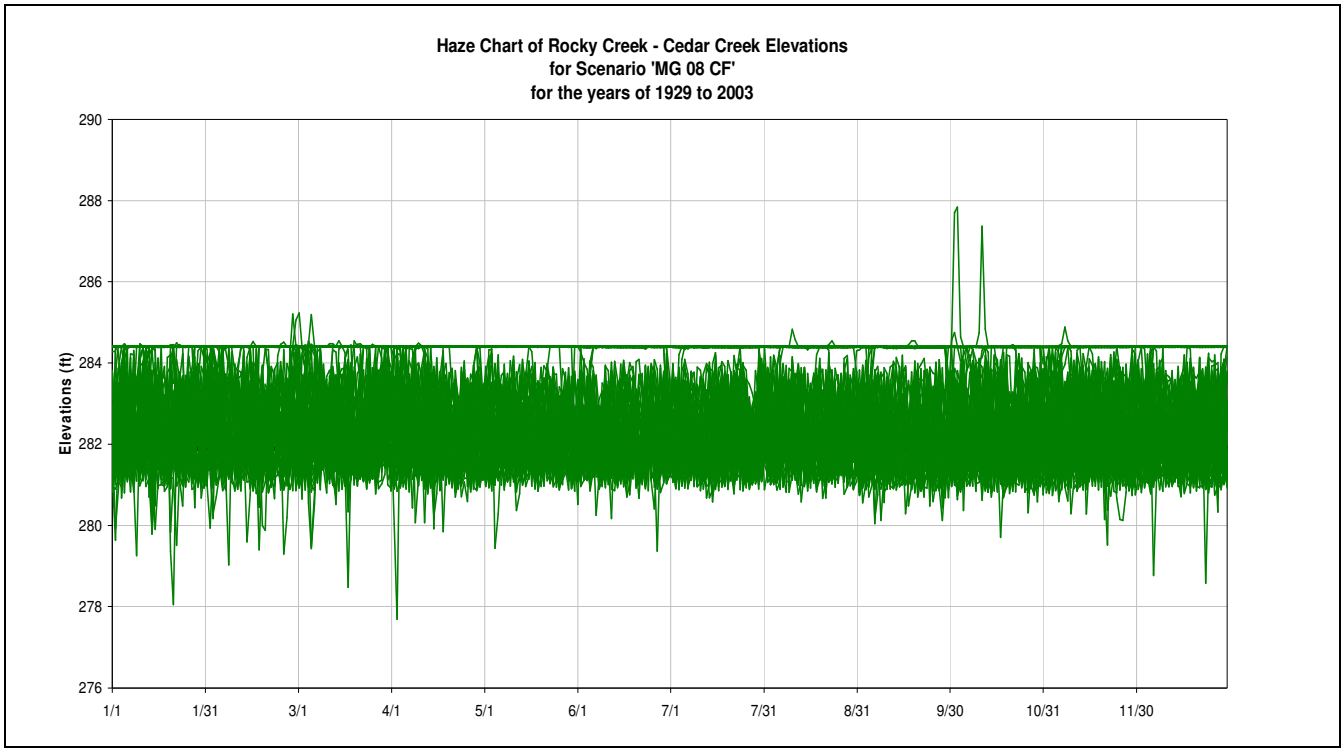

Figure 249: RC Elevation Haze Chart for MG 08 CF

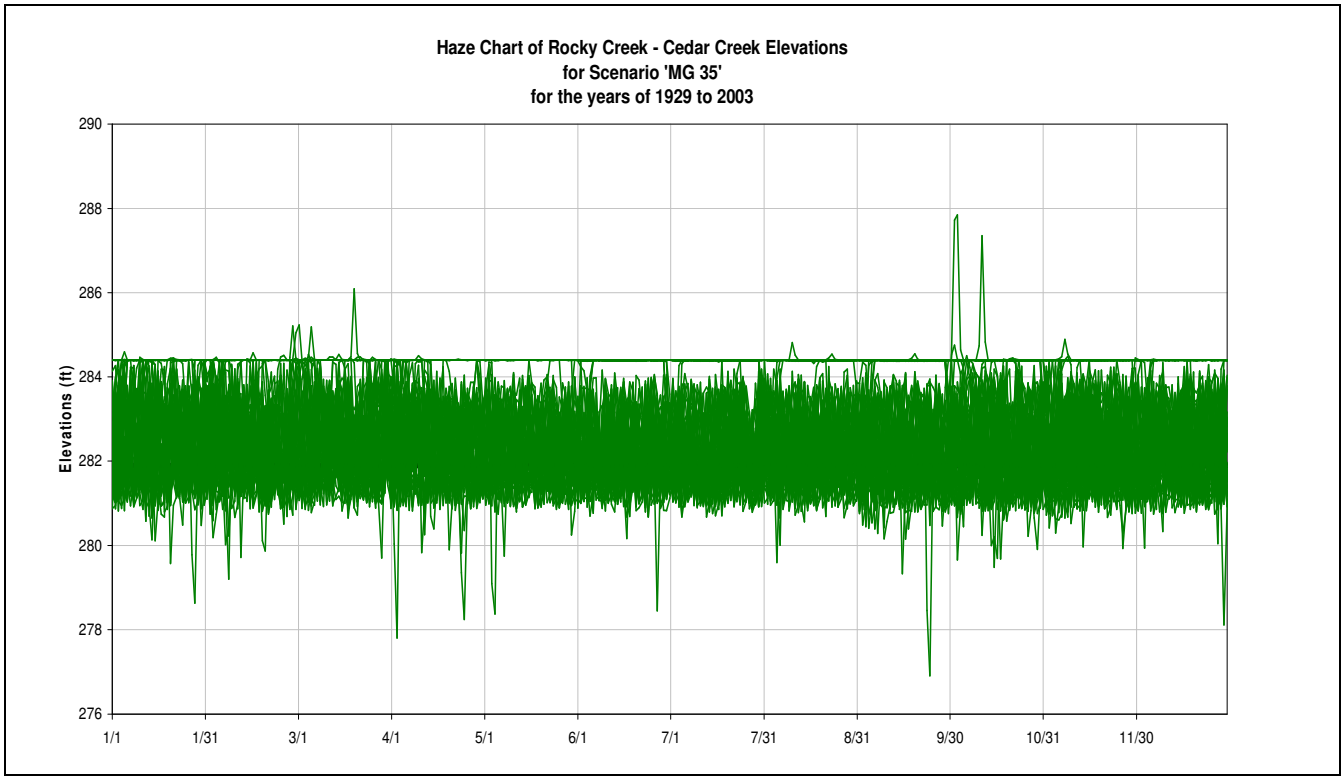

Figure 250: RC Elevation Haze Chart for MG 35

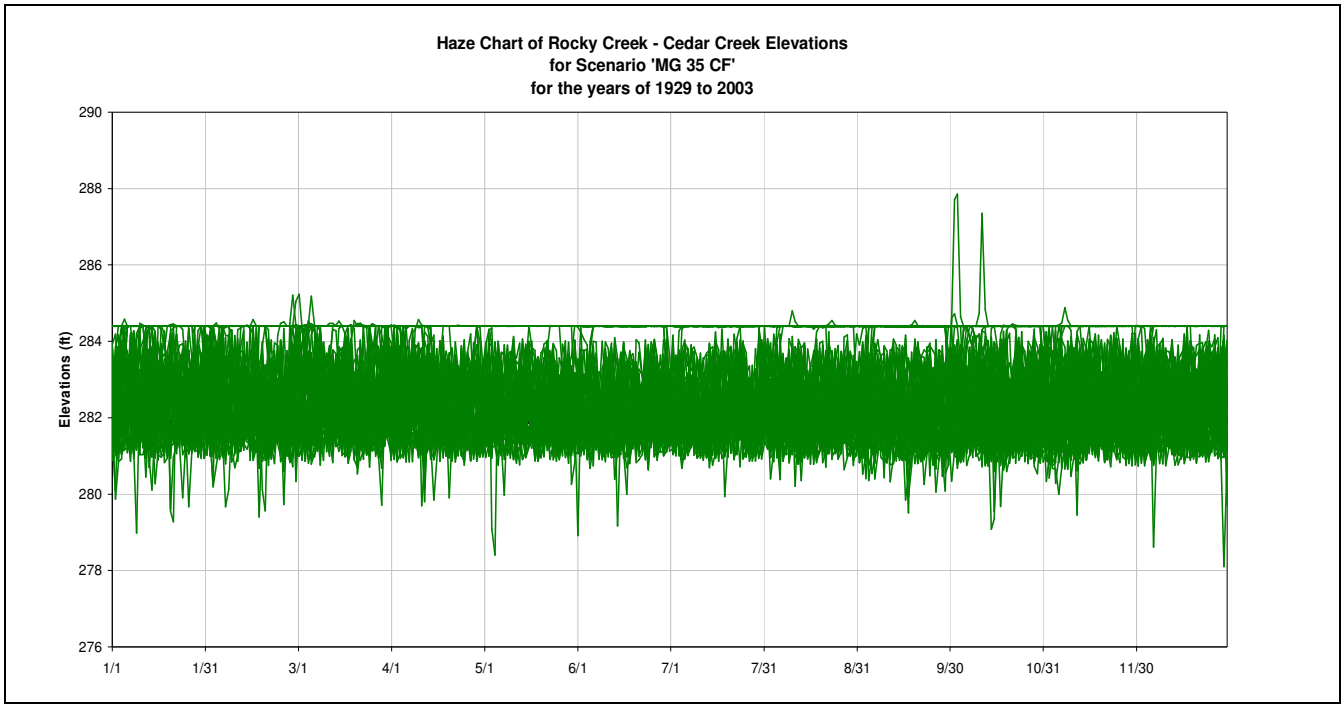

Figure 251: RC Elevation Haze Chart for MG 35 CF

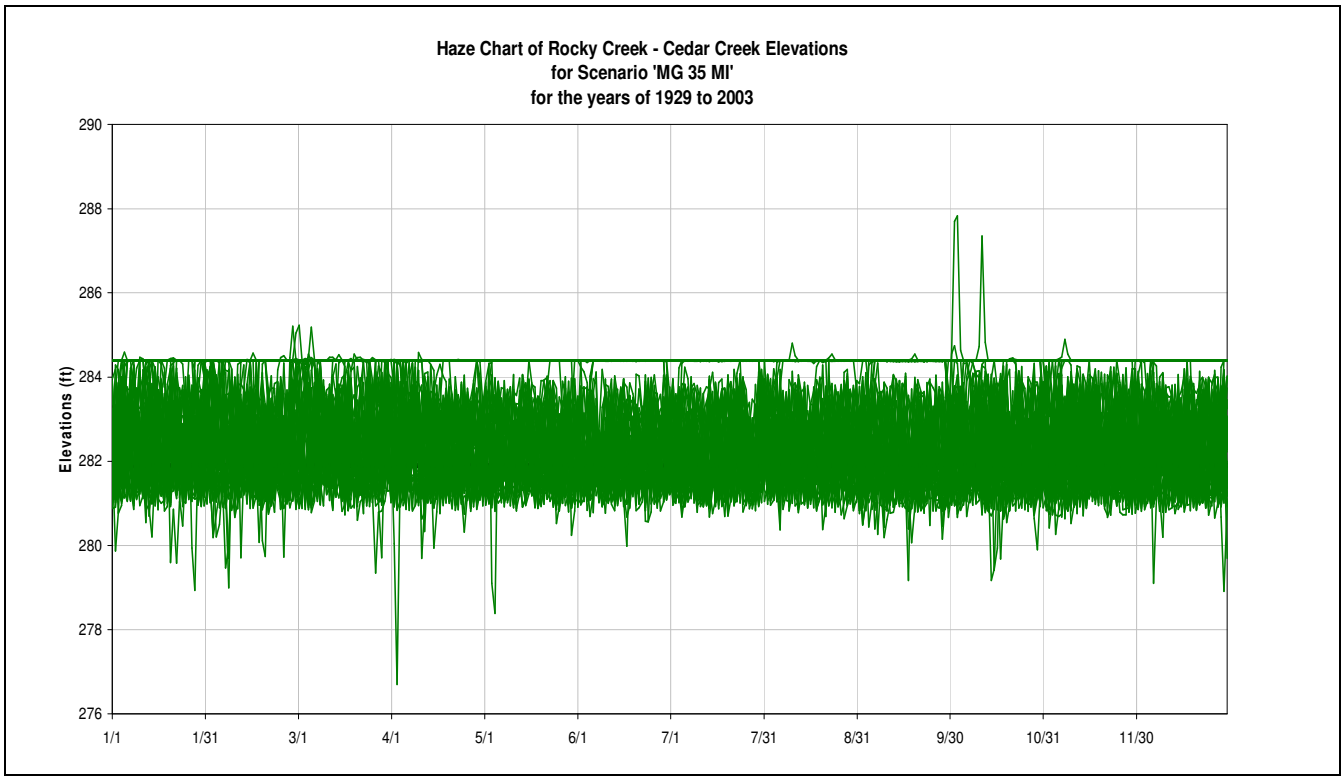

Figure 252: RC Elevation Haze Chart for MG 35 MI

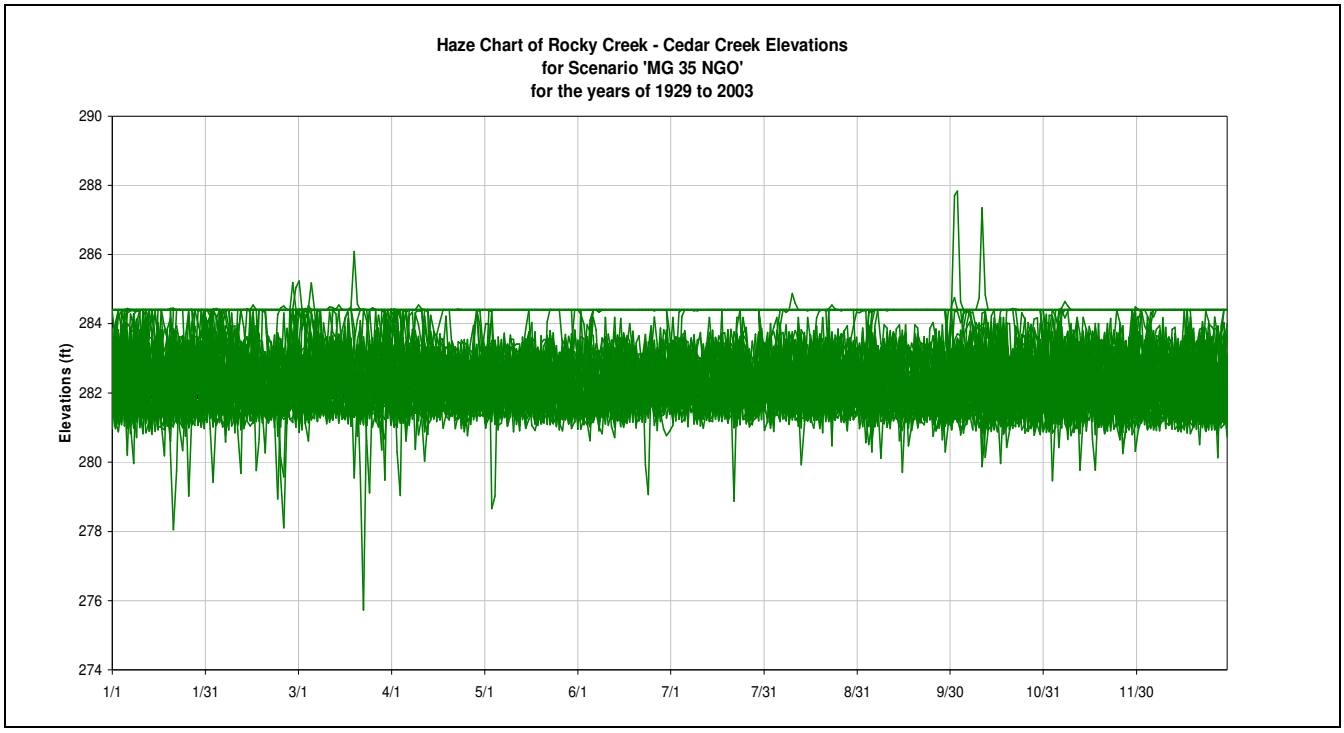

Figure 253: RC Elevation Haze Chart for MG 35 NGO

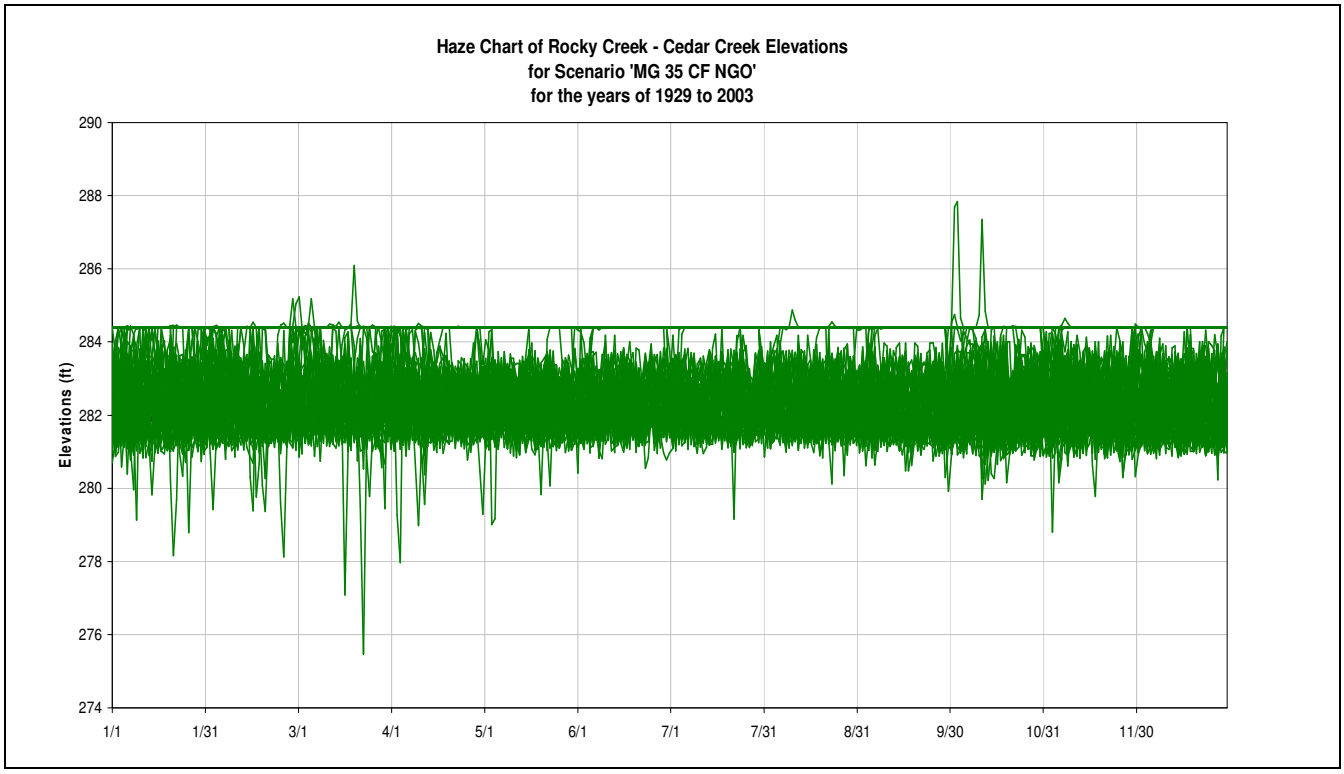

Figure 254: RC Elevation Haze Chart for MG 35 CF NGO

11) Wateree

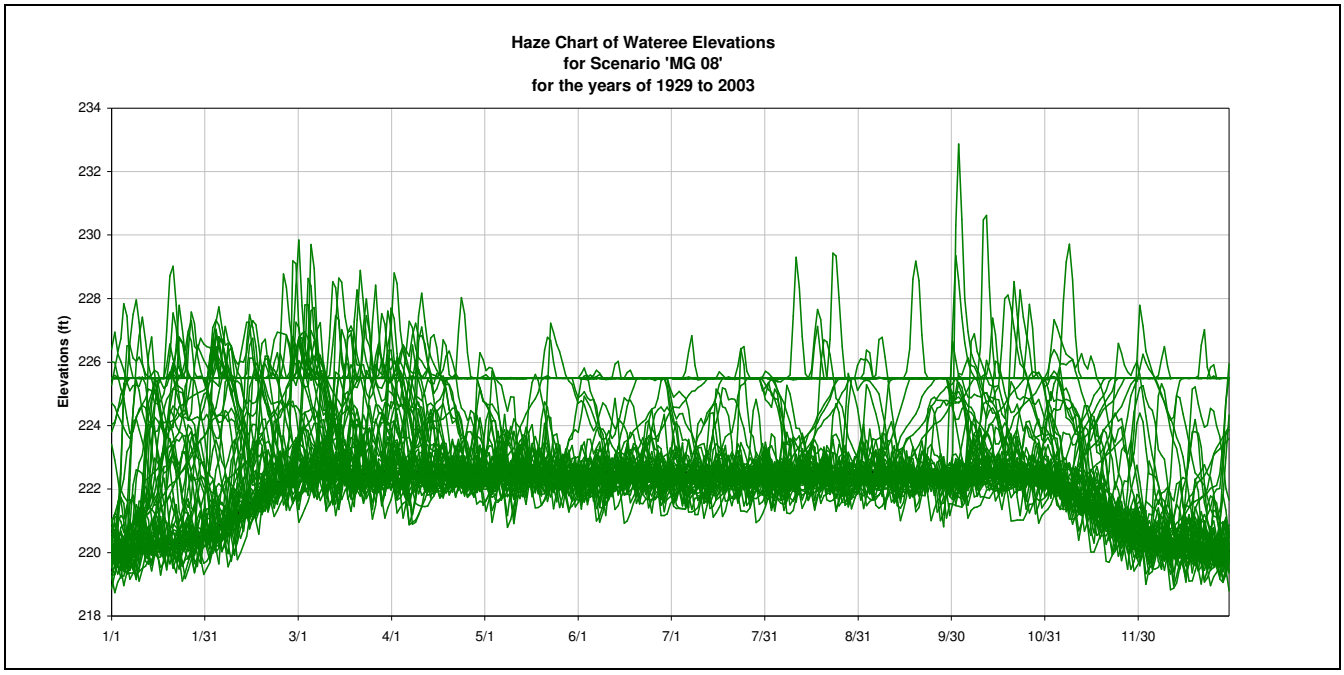

Figure 255: WA Elevation Haze Chart for MG 08

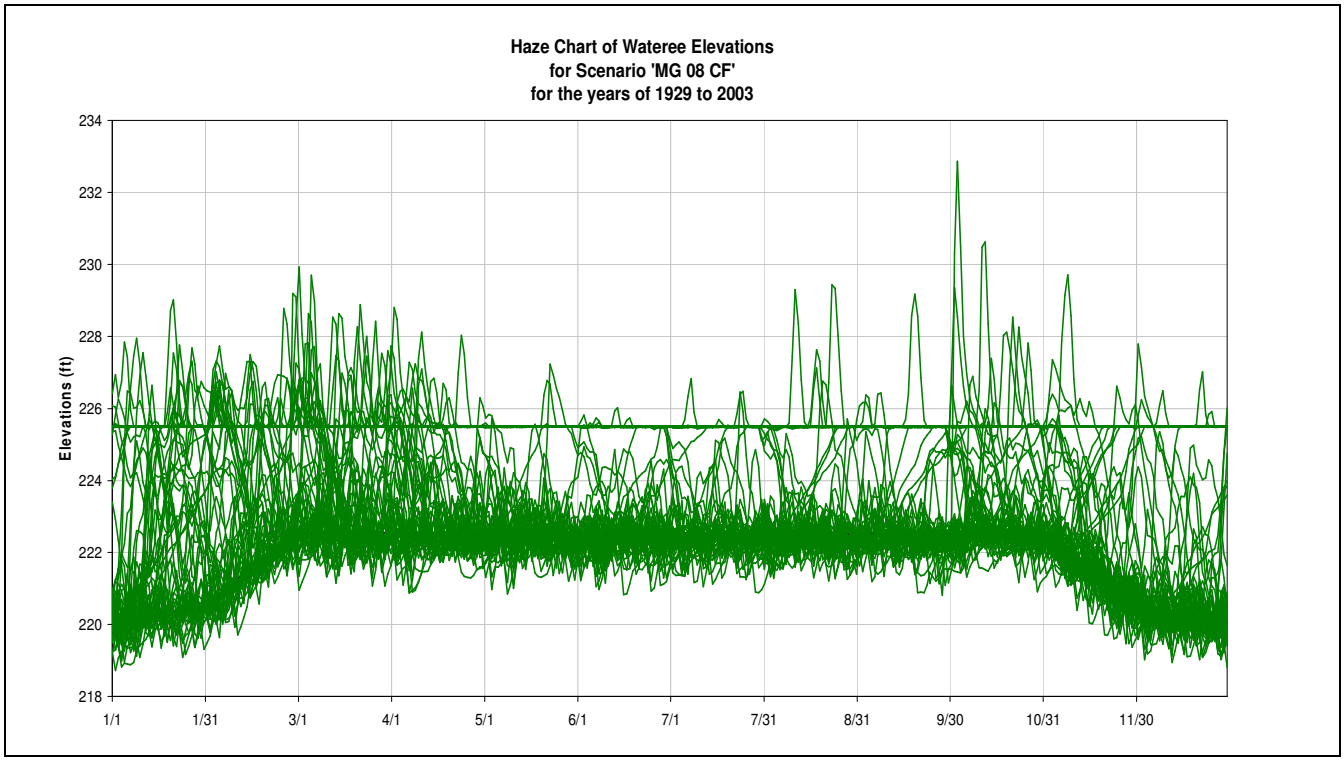

Figure 256: WA Elevation Haze Chart for MG CF

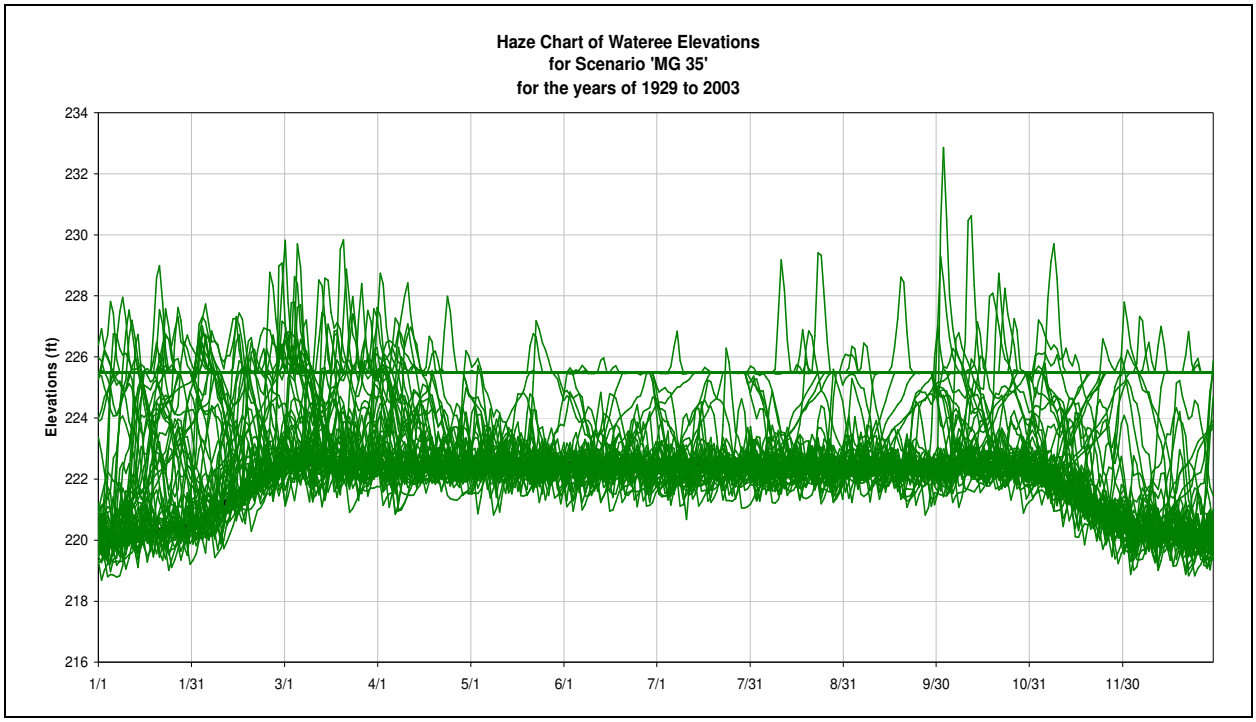

Figure 257: WA Elevation Haze Chart for MG 35

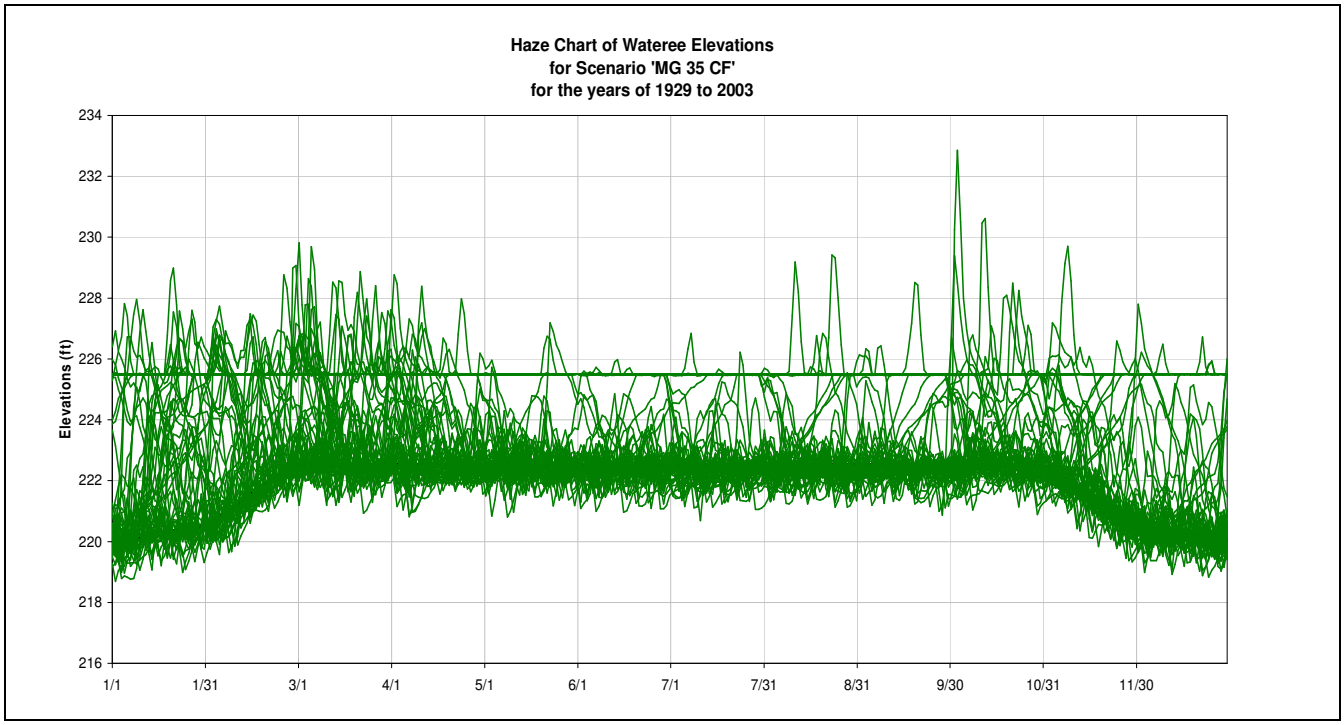

Figure 258: WA Elevation Haze Chart for MG 35 CF

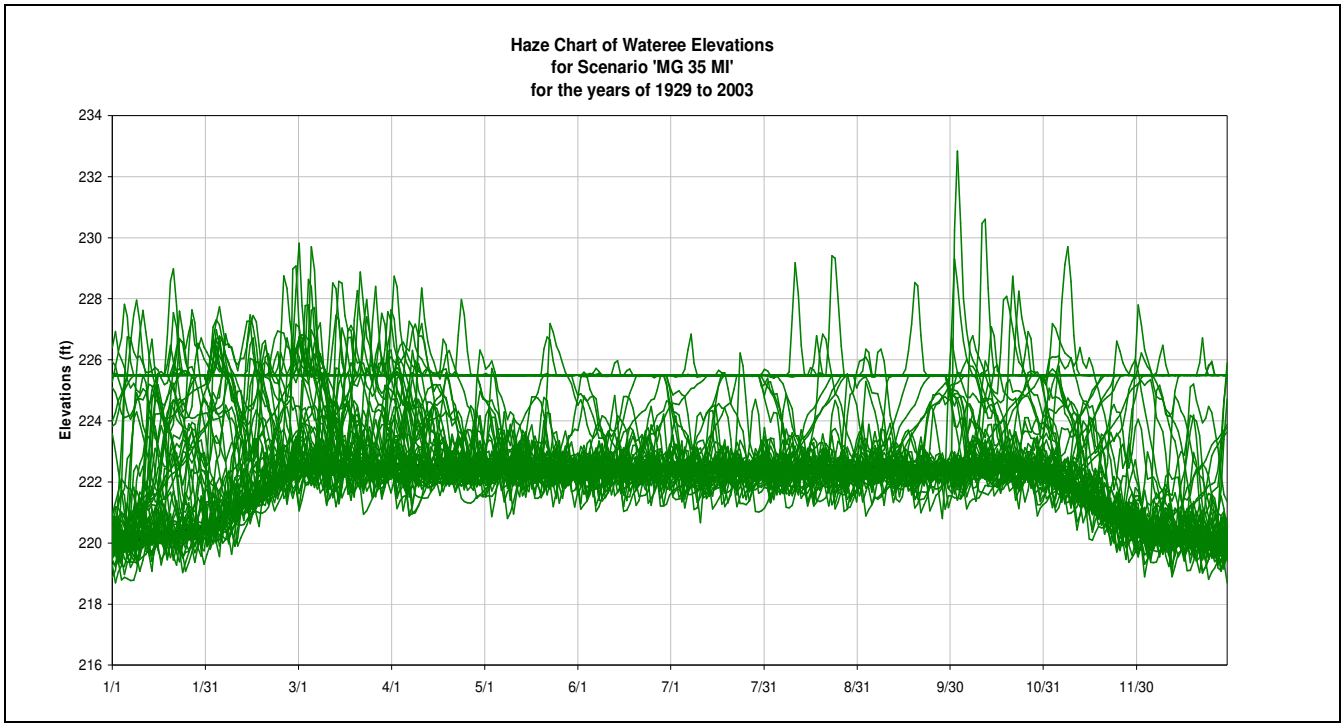

Figure 259: WA Elevation Haze Chart for MG 35 MI

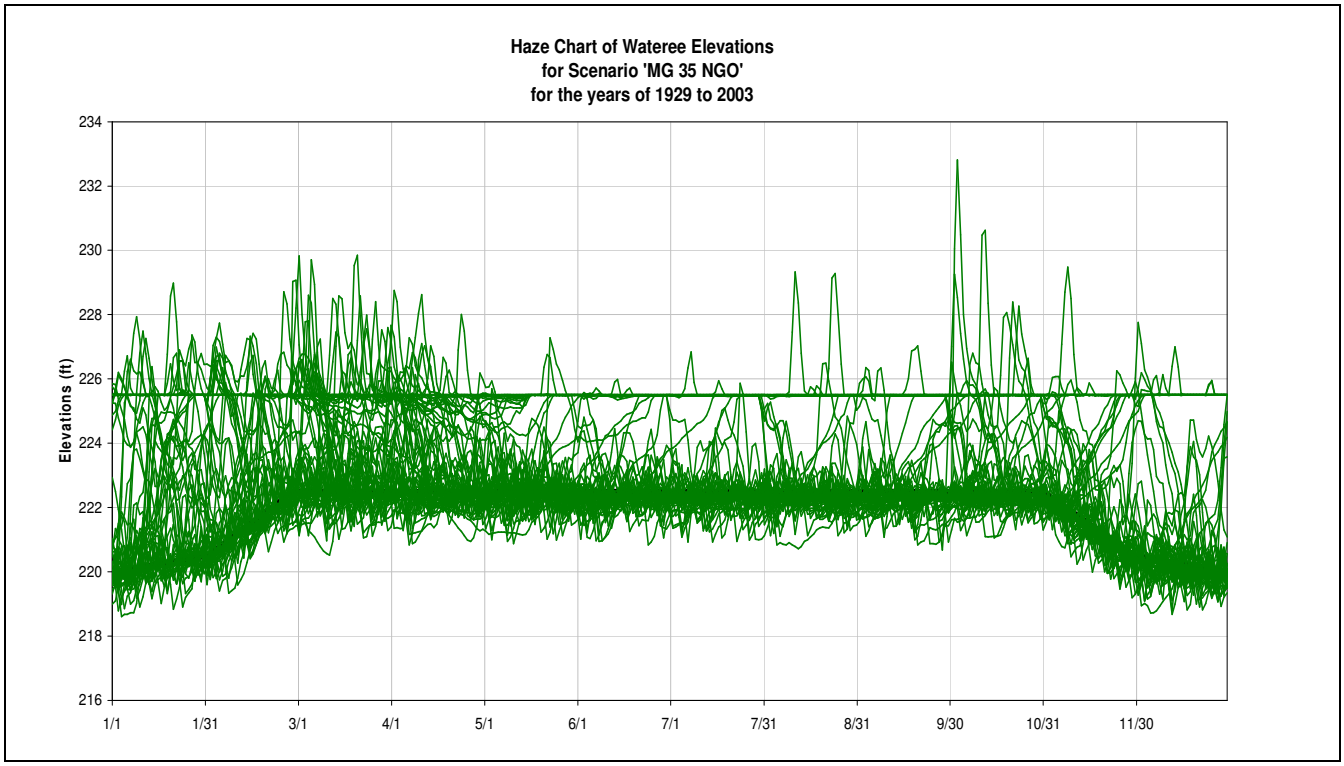

Figure 260: WA Elevation Haze Chart for MG 35 NGO

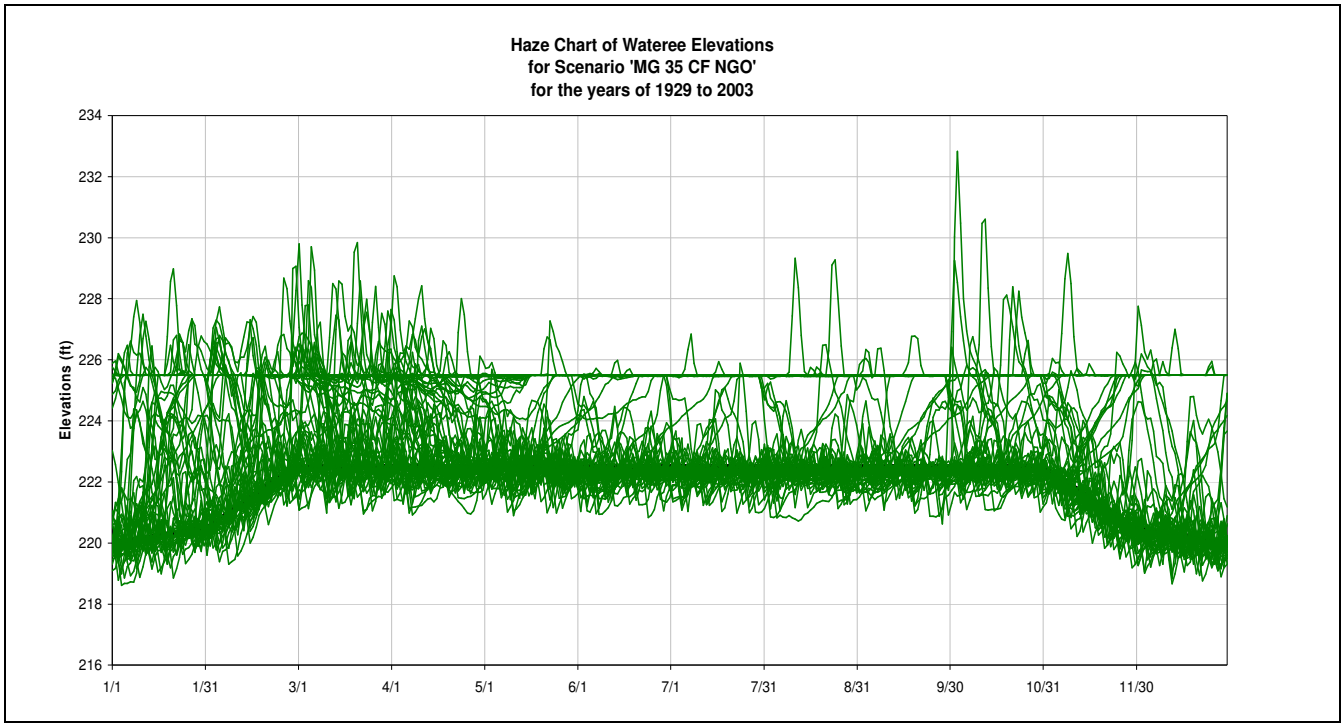

Figure 261: WA Elevation Haze Chart for MG 35 CF NGO

11. OUTFLOW HAZE CHARTS:

1) Bridgewtaer

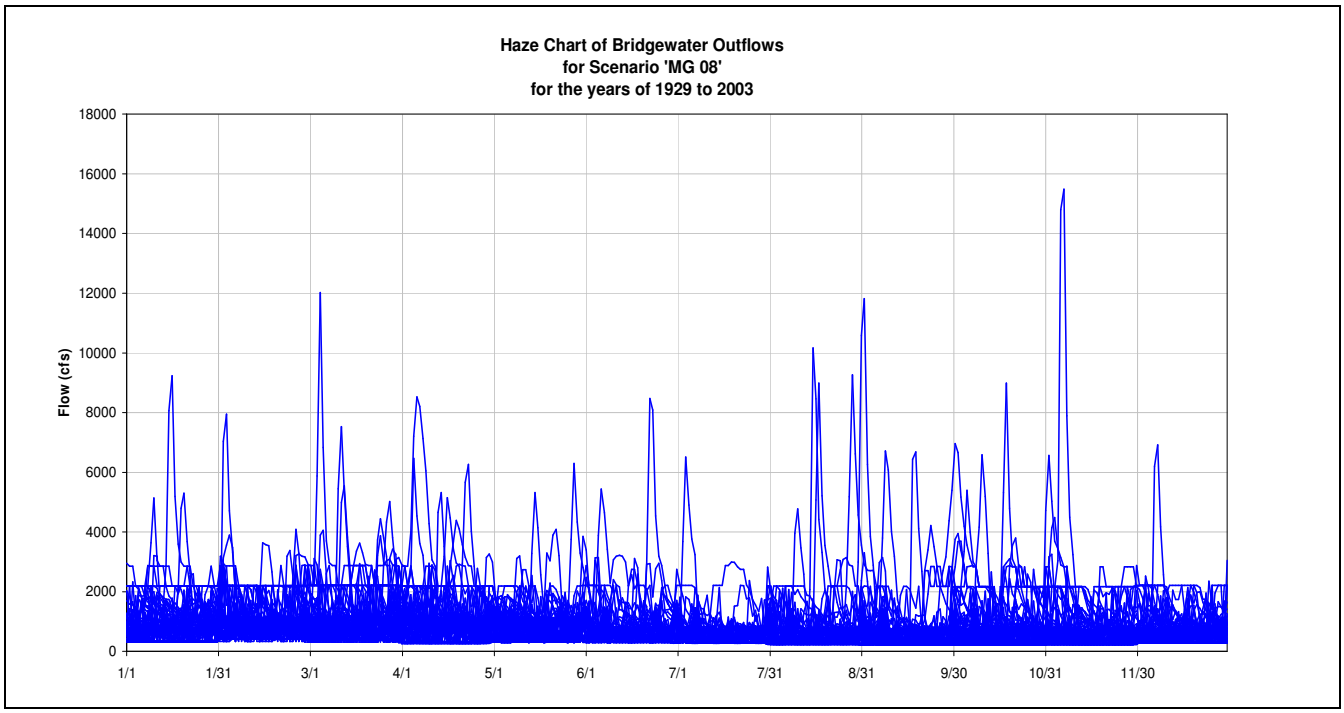

Figure 262: BW Outflow Haze Chart for MG 08

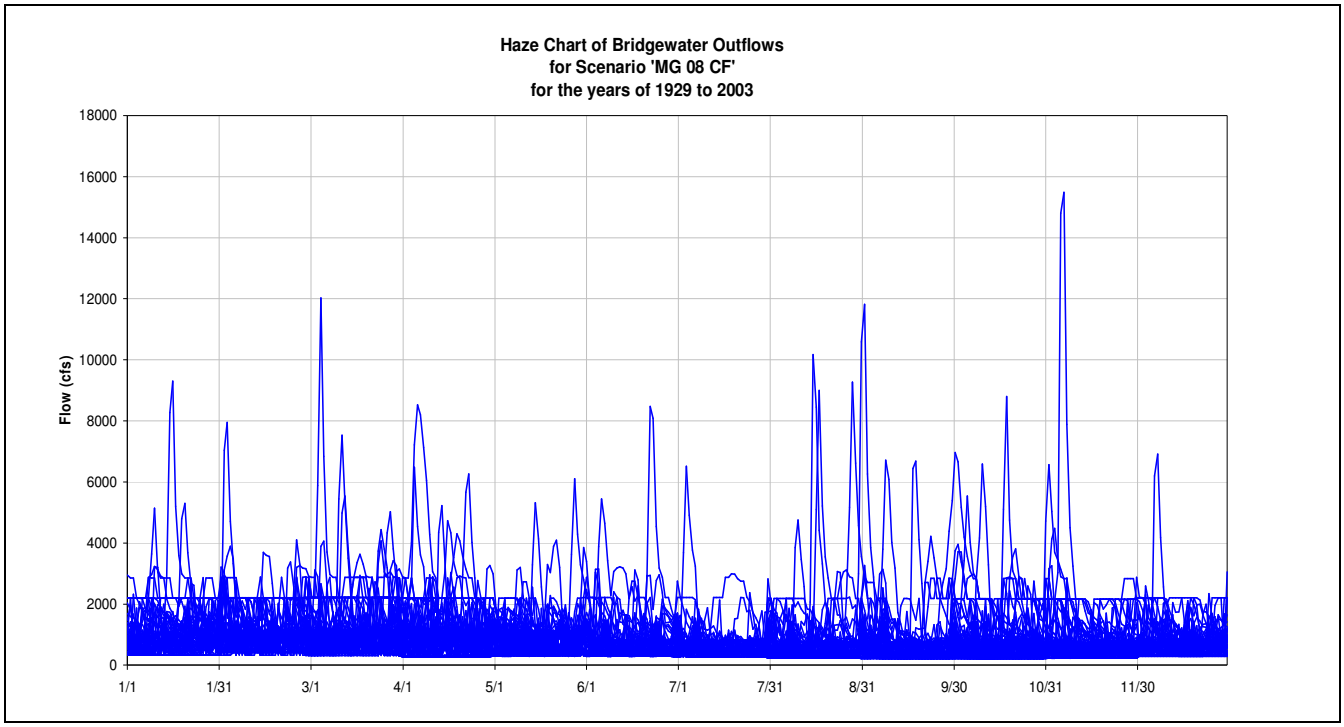

Figure 263: BW Outflow Haze Chart for MG 08 CF

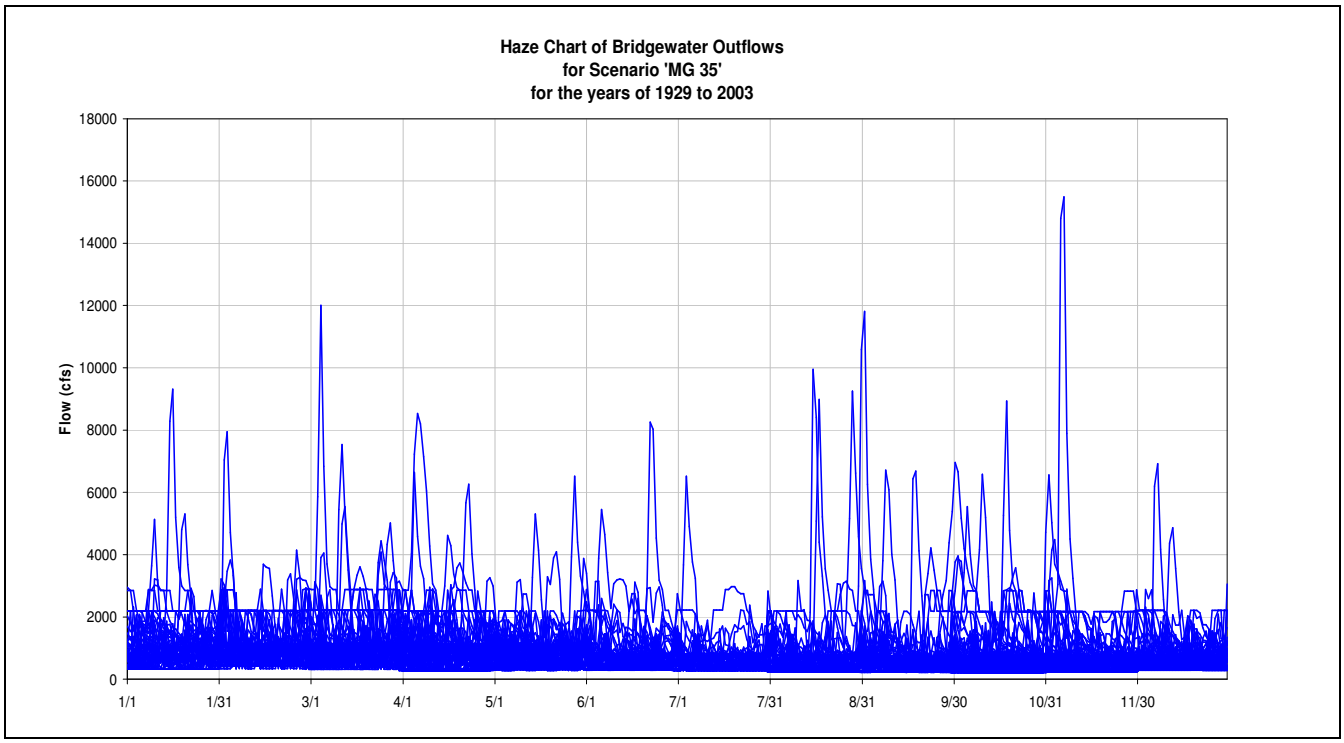

Figure 264: BRIDGEWATER Chart for 35

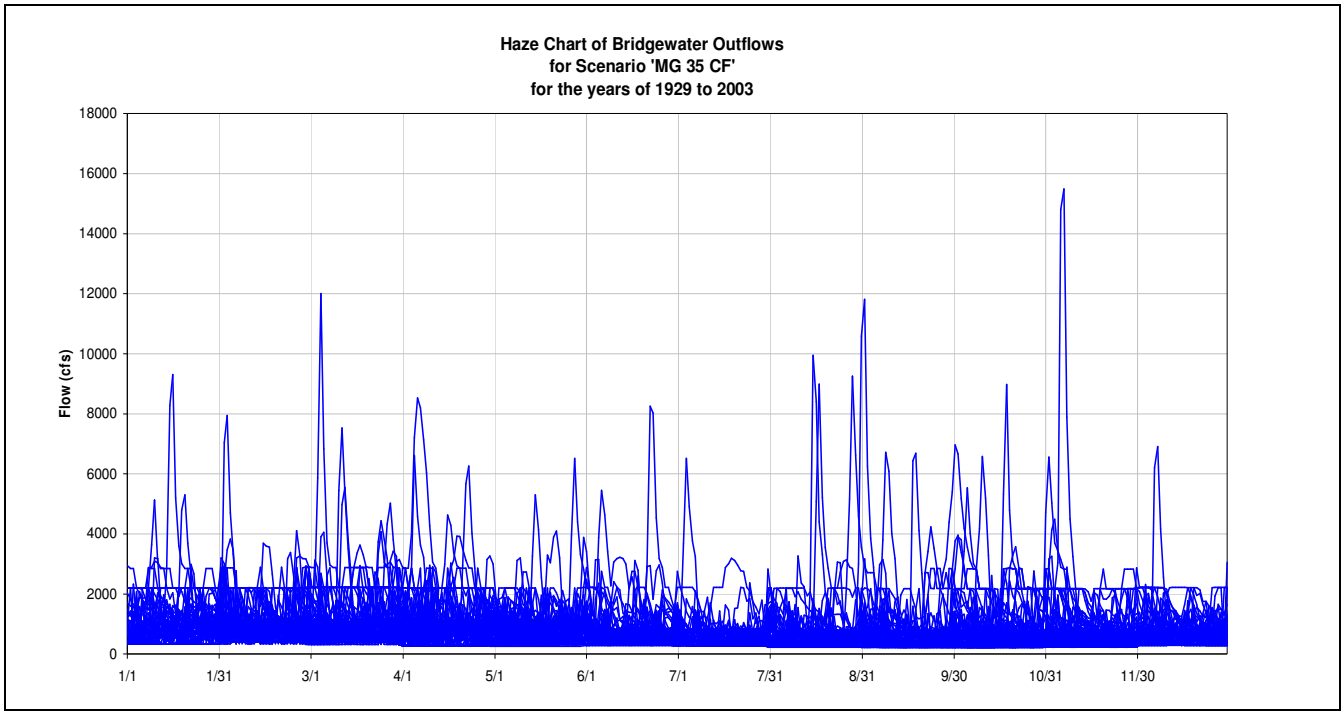

Figure 265: BRIDGEWATER Chart for 35 CF

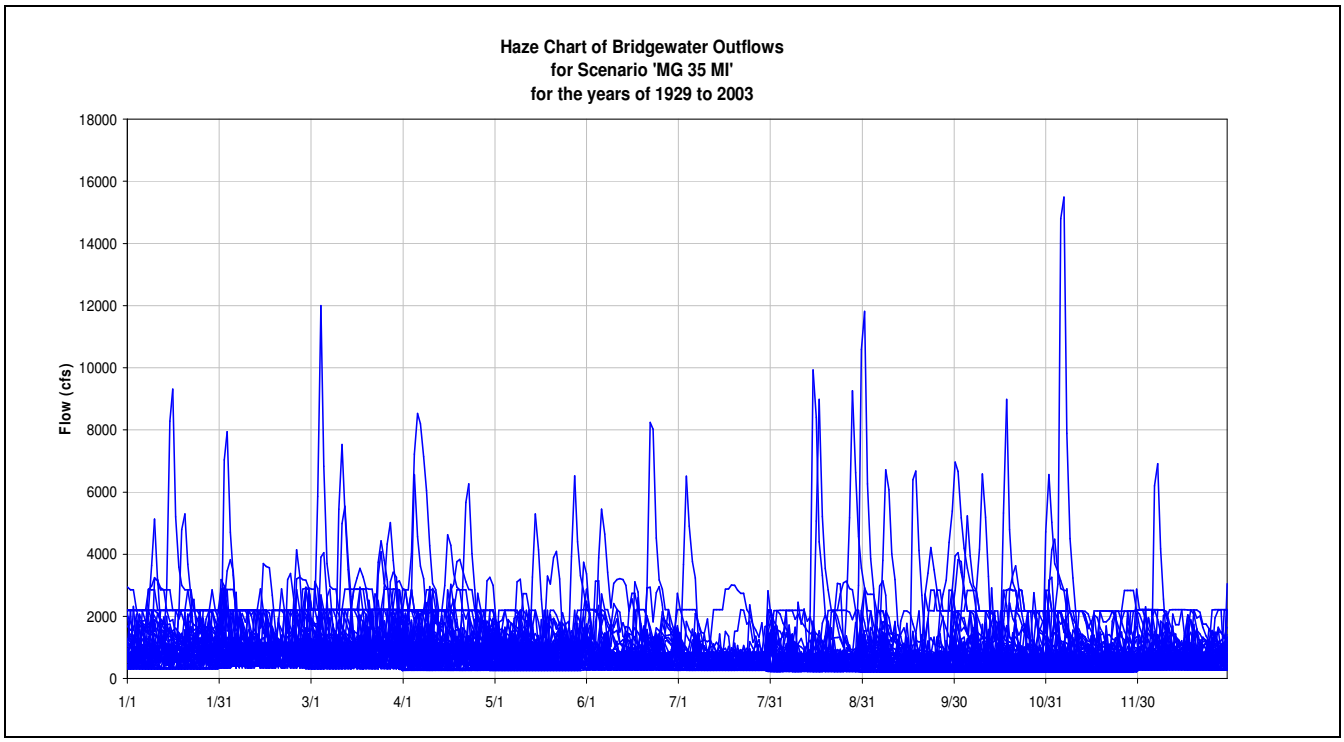

Figure 266: BRIDGEWATER Chart for 35 MI

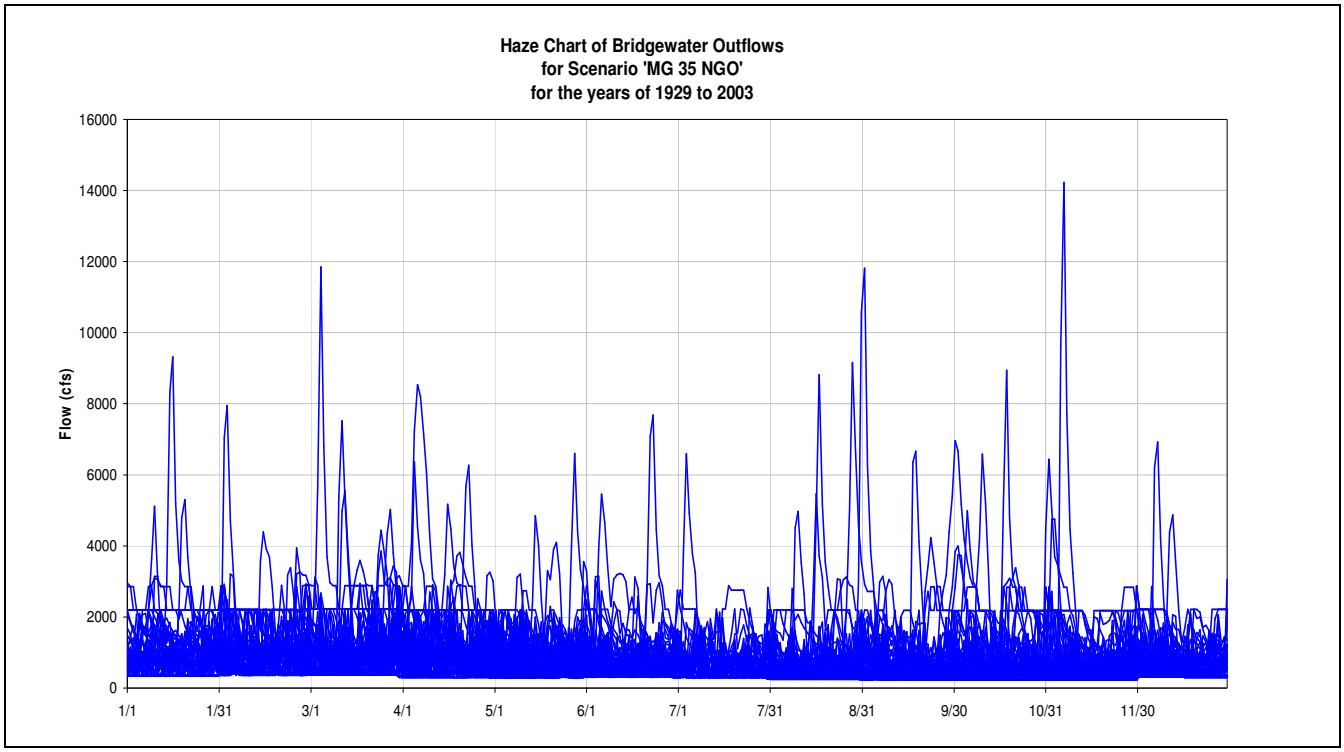

Figure 267: BRIDGEWATER Chart for 35 NGO

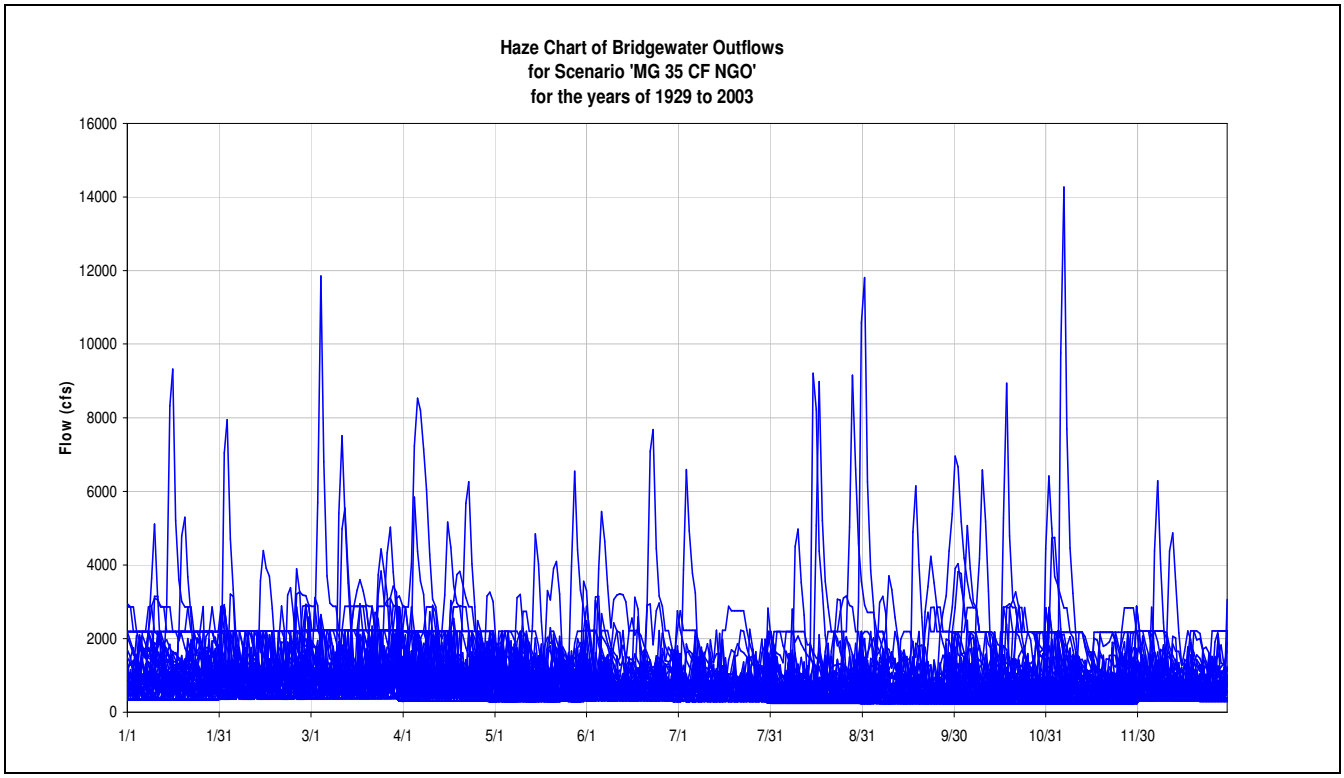

Figure 268: BW Outflow Haze Chart for MG 35

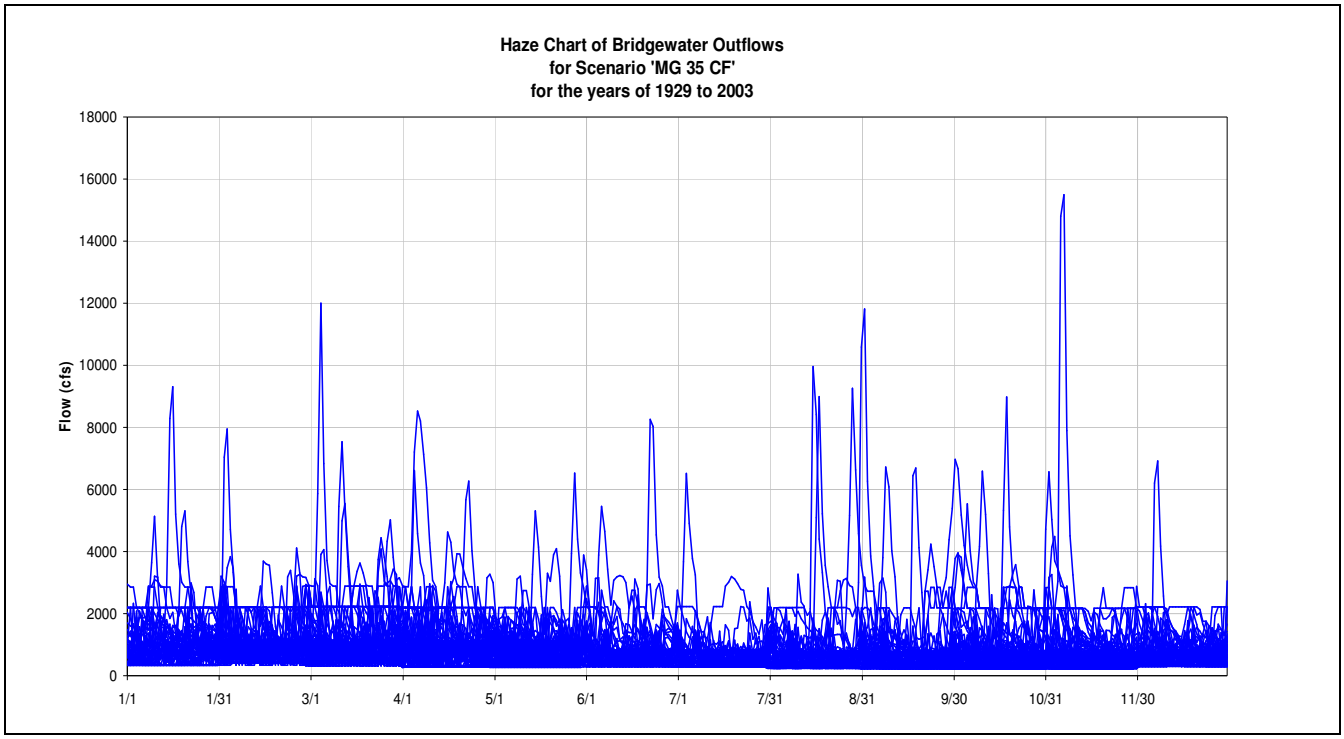

Figure 269: BW Outflow Haze Chart for MG 35 CF

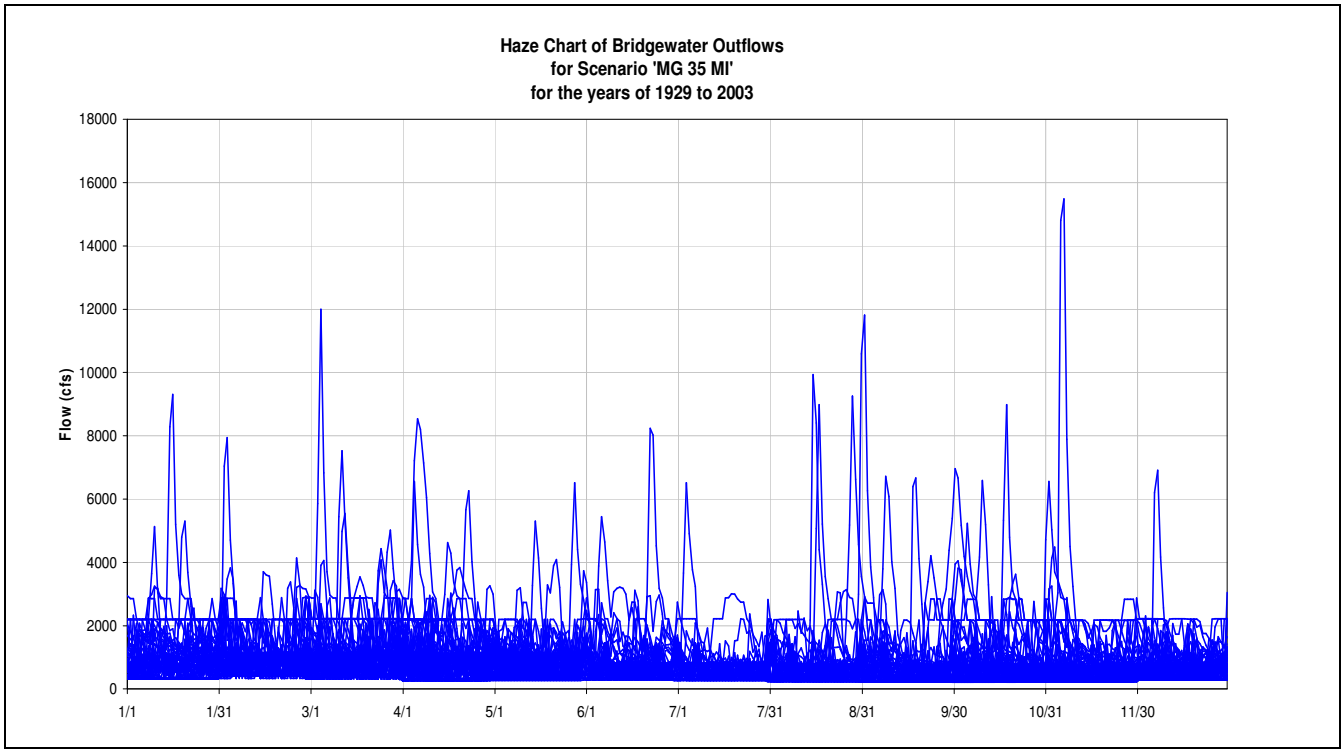

Figure 270: BW Outflow Haze Chart for MG 35 MI

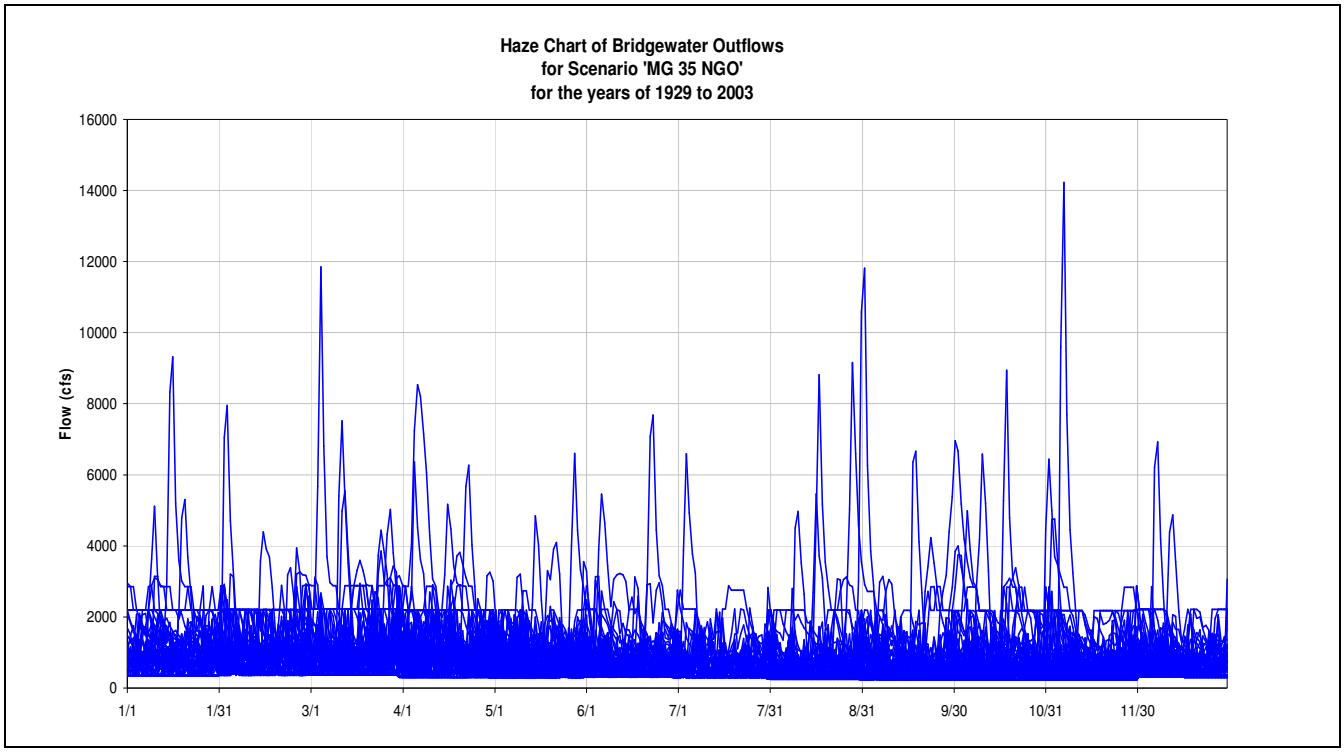

Figure 271: BW Outflow Haze Chart for MG 35 NGO

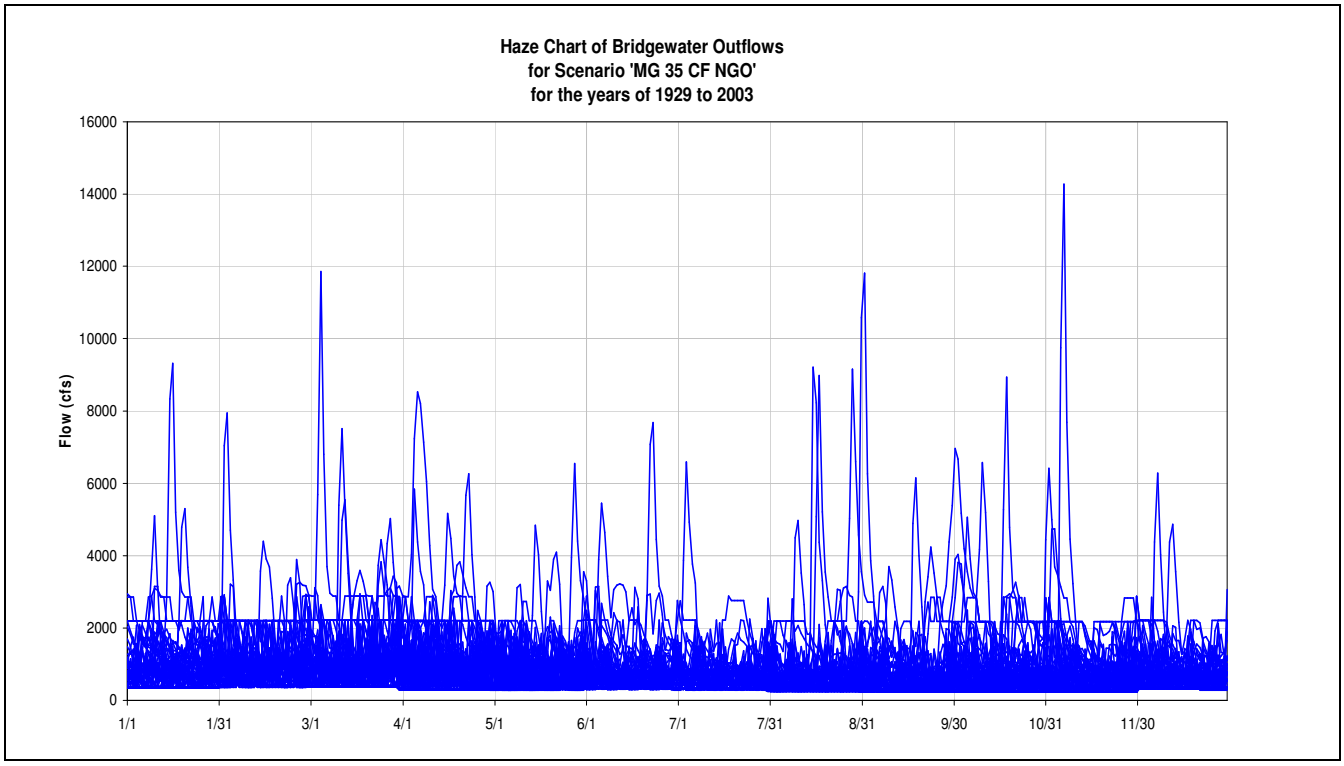

Figure 272: BW Outflow Haze Chart for MG 35 CF NGO

2) Rhodhiss

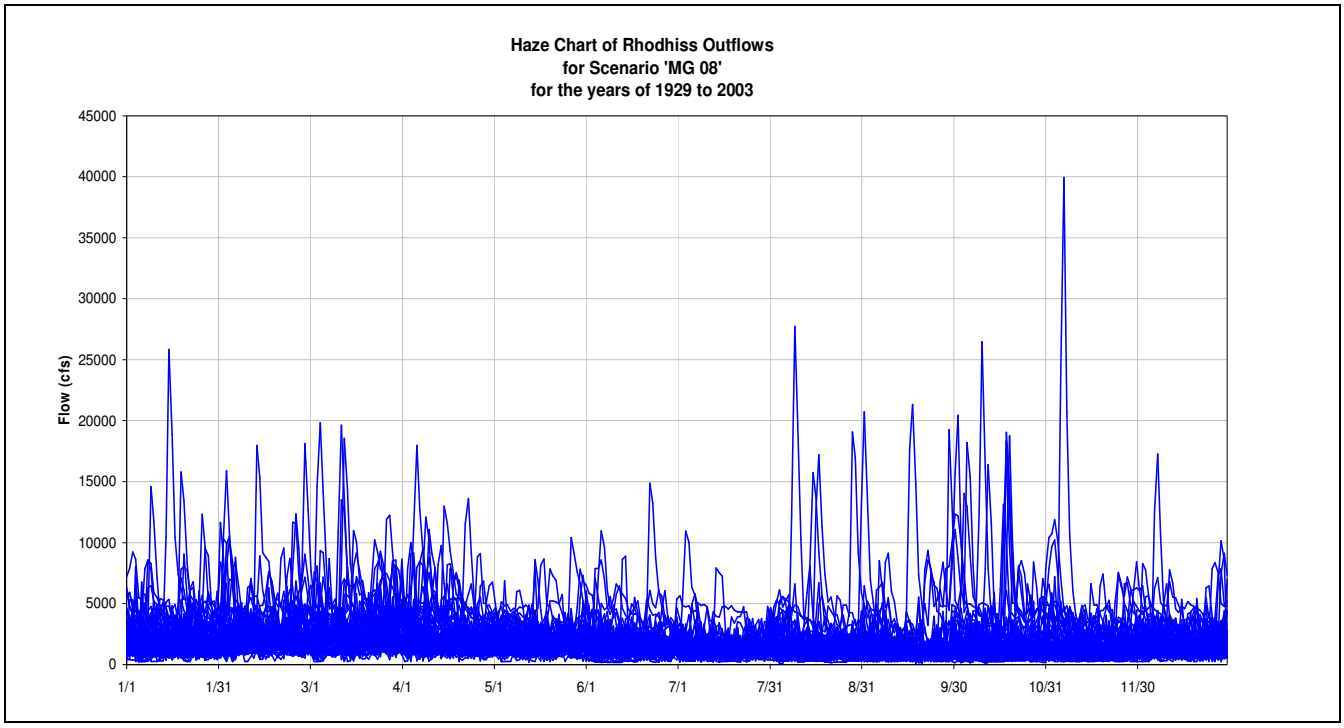

Figure 273: RH Outflow Haze Chart for MG 08

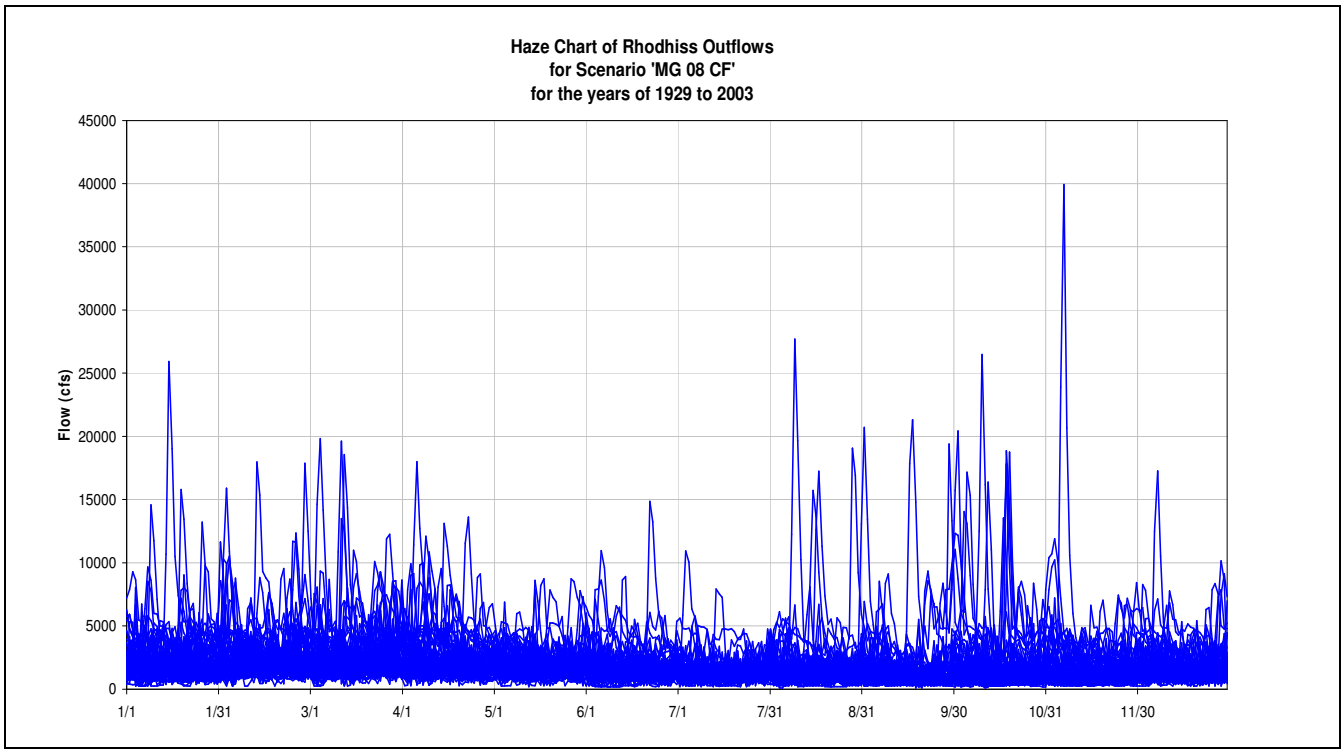

Figure 274: RH Outflow Haze Chart for MG 08 CF

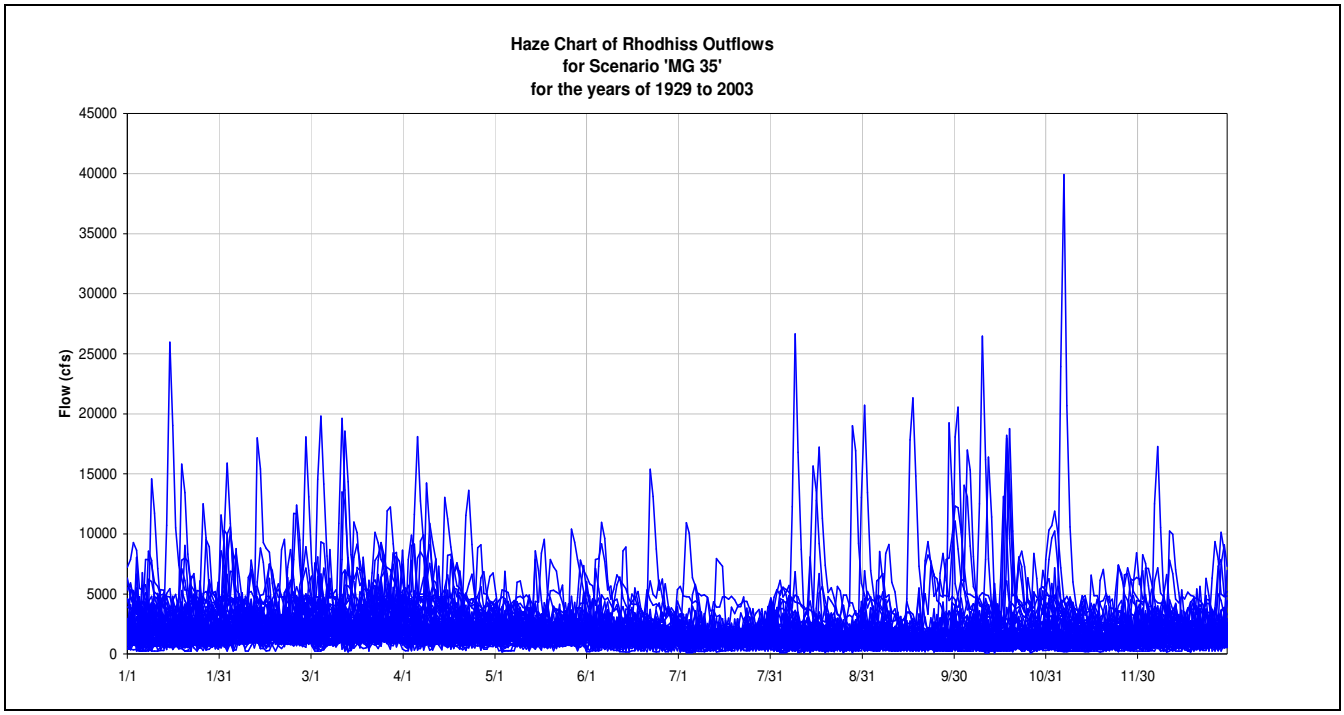

Figure 275: RH Outflow Haze Chart for MG 35

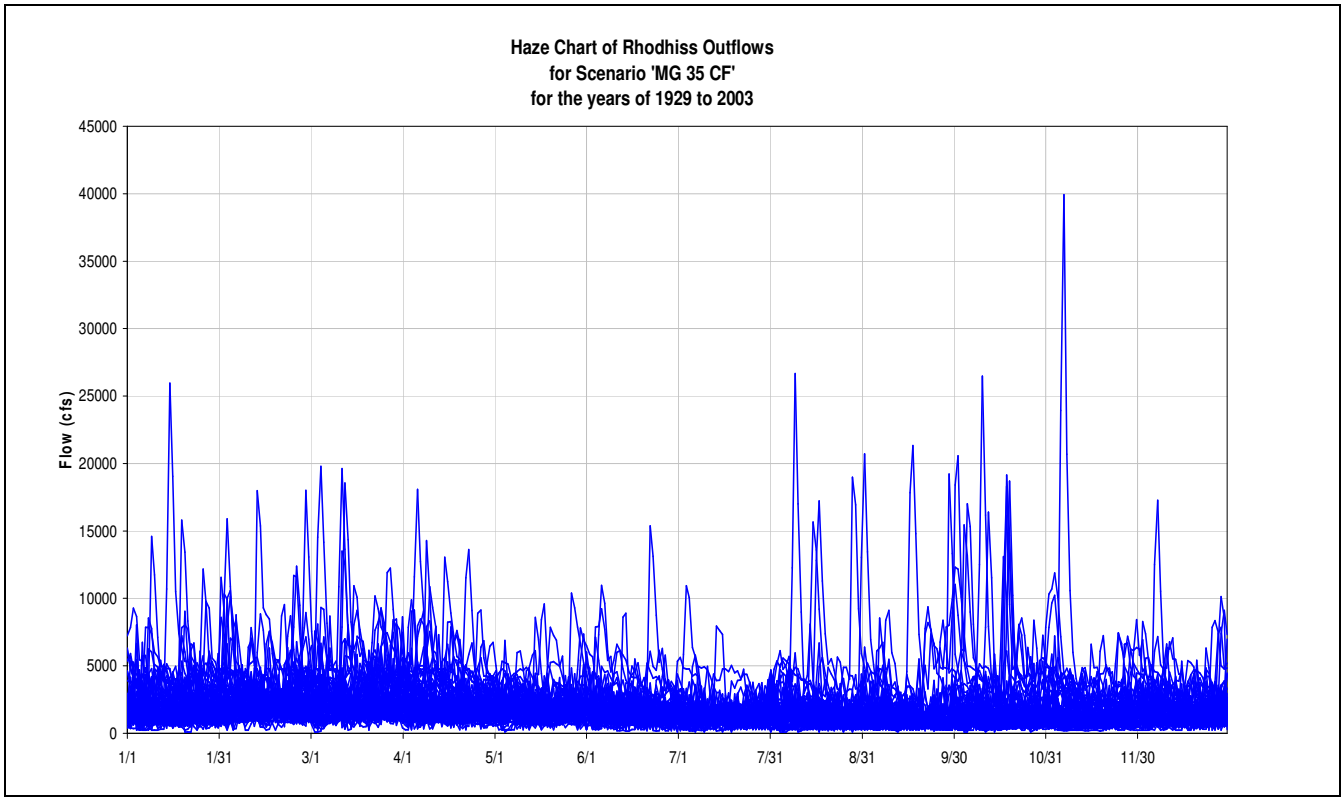

Figure 276: RH Outflow Haze Chart for MG 35 CF

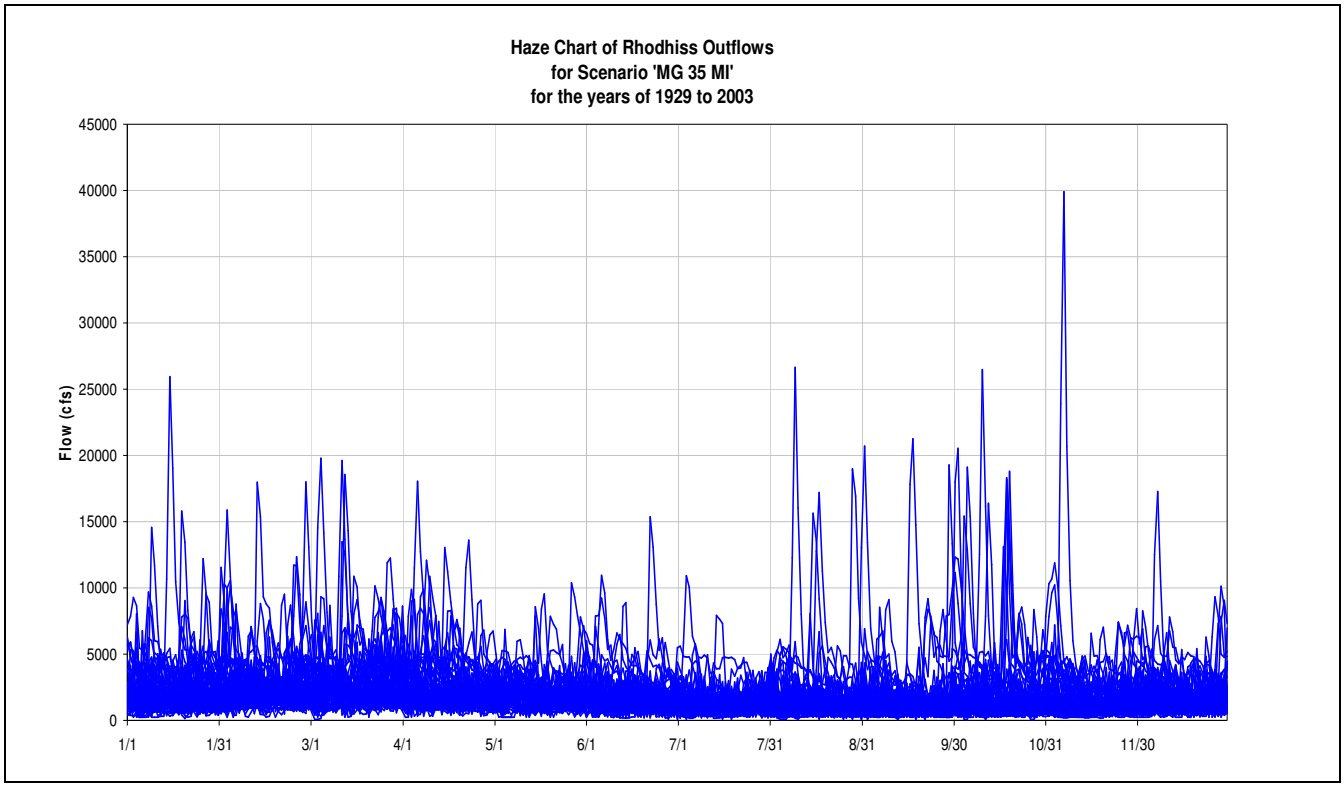

Figure 277: RH Outflow Haze Chart for MG 35 MI

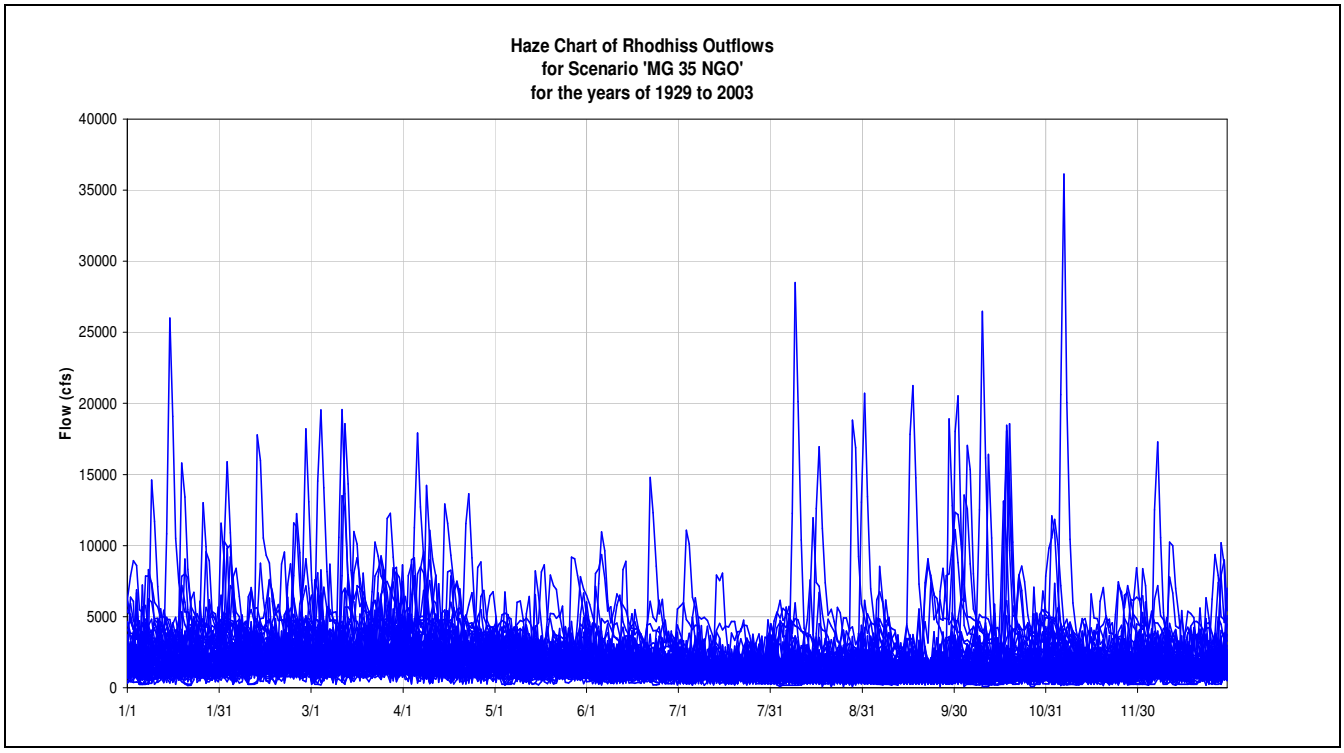

Figure 278: RH Outflow Haze Chart for MG 35 NGO

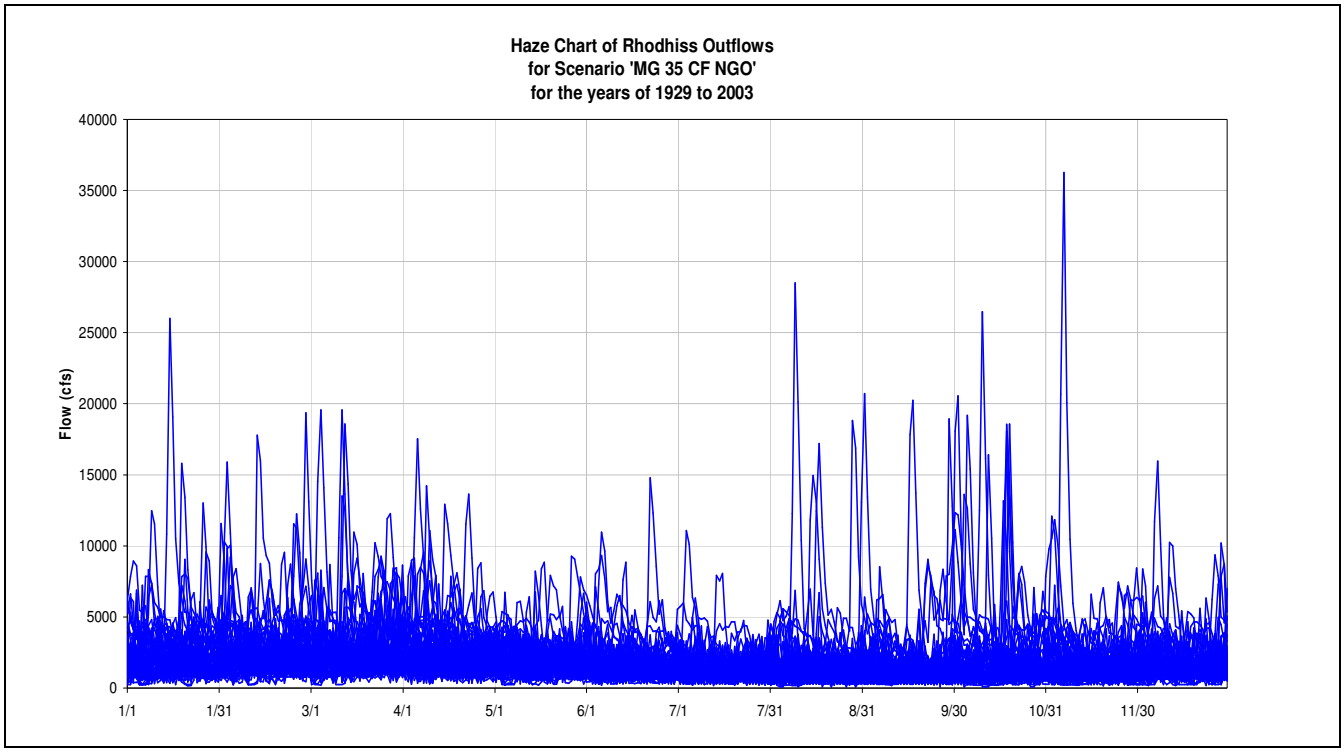

Figure 279: RH Outflow Haze Chart for MG 35 CF NGO

3) Oxford

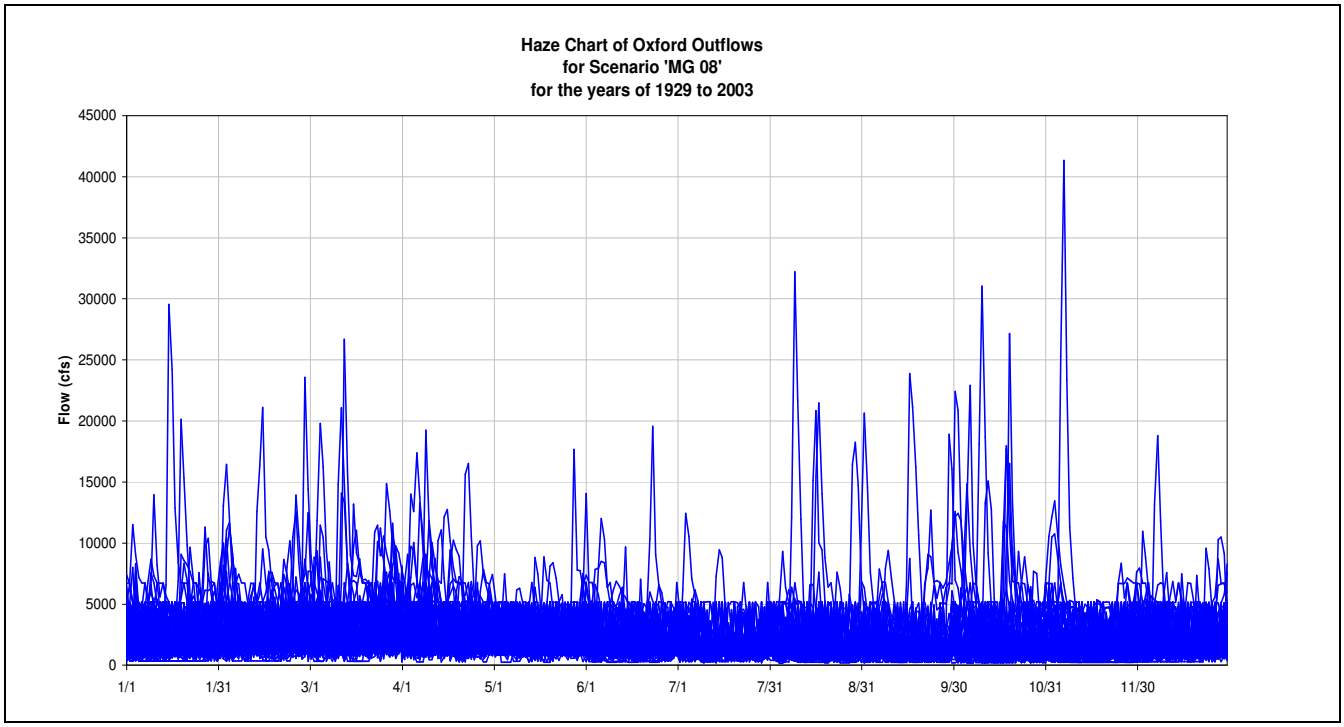

Figure 280: OX Outflow Haze Chart for MG 08

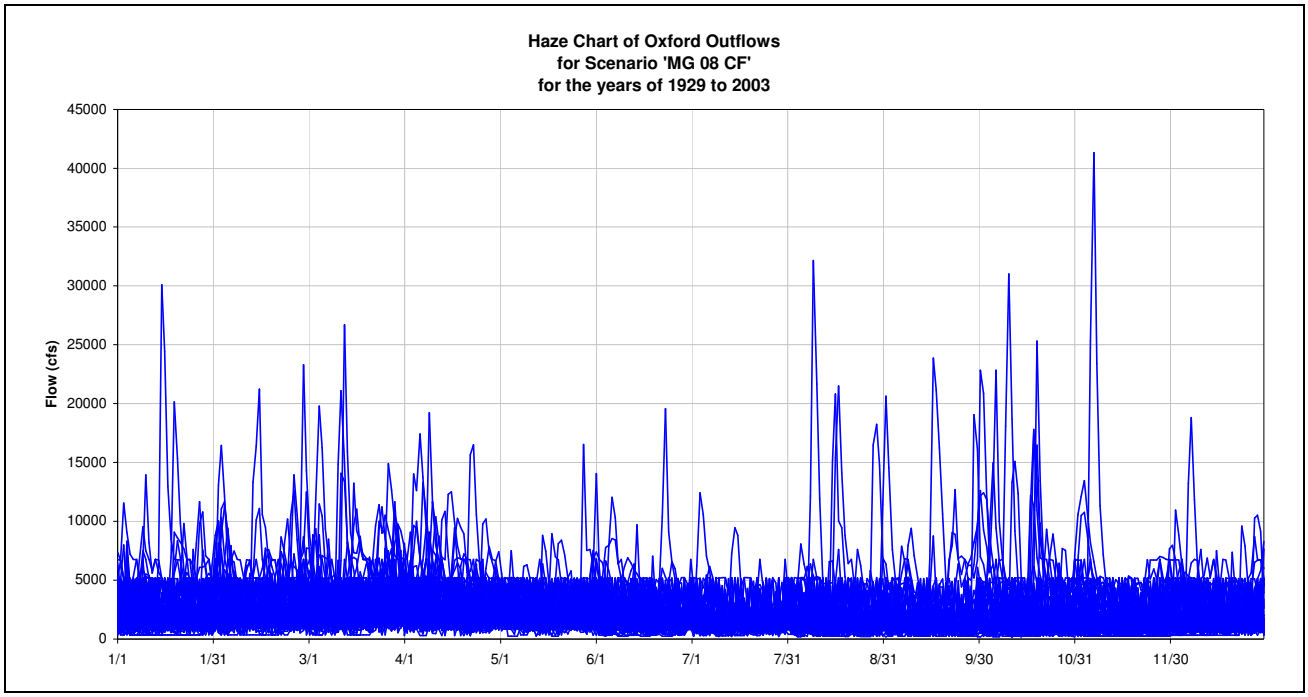

Figure 281: OX Outflow Haze Chart for MG 08 CF

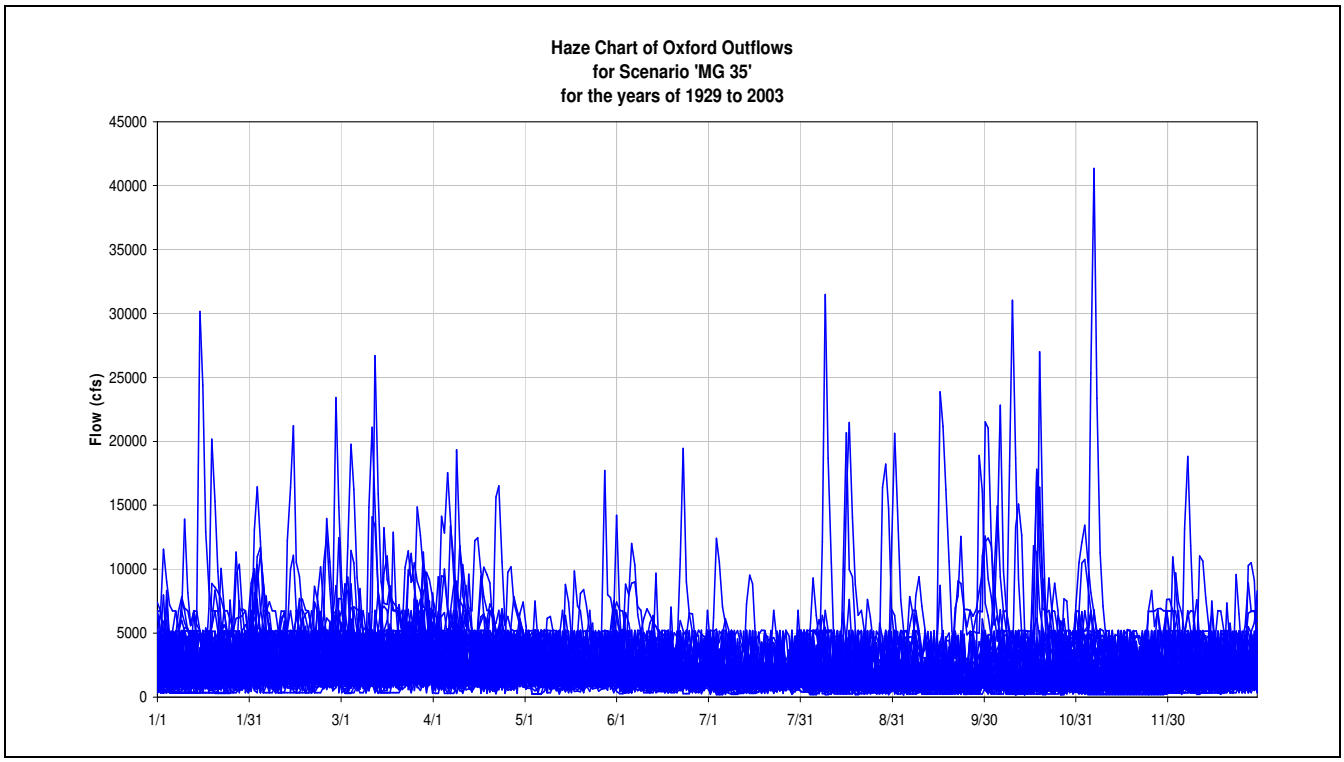

Figure 282: OX Outflow Haze Chart for MG 35

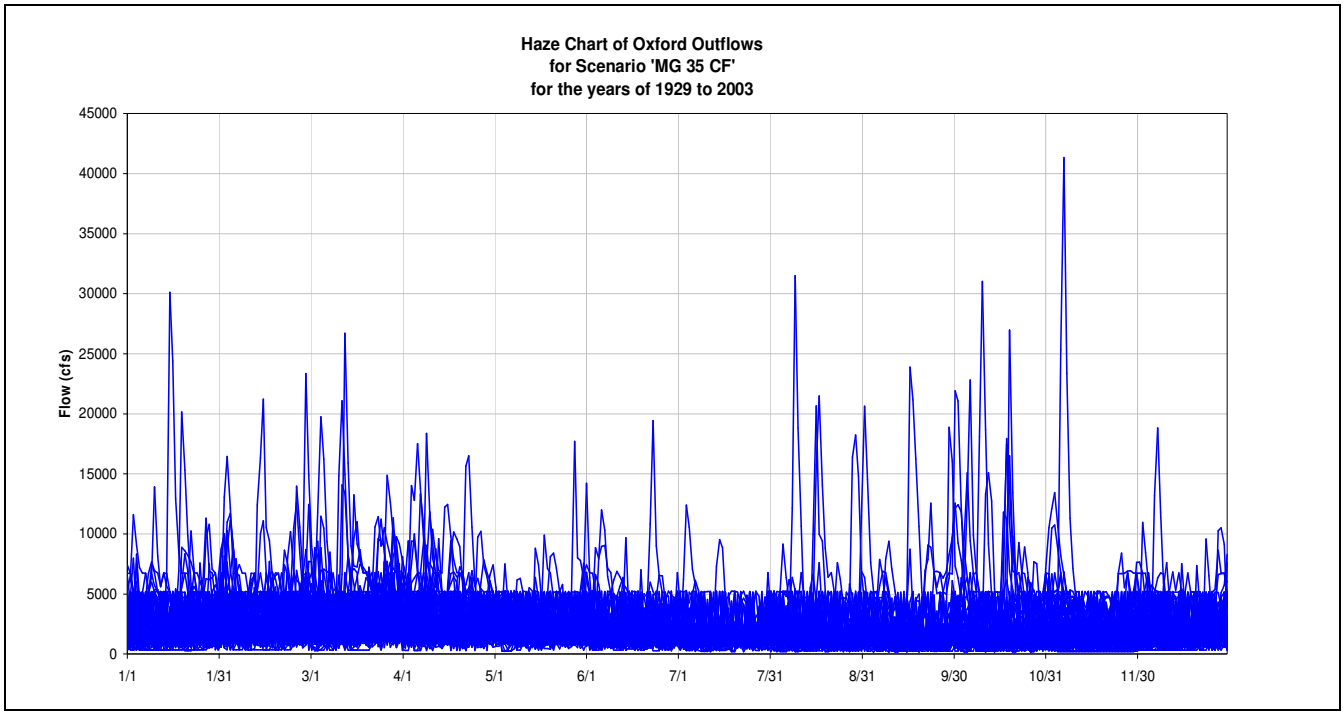

Figure 283: OX Outflow Haze Chart for MG 35 CF

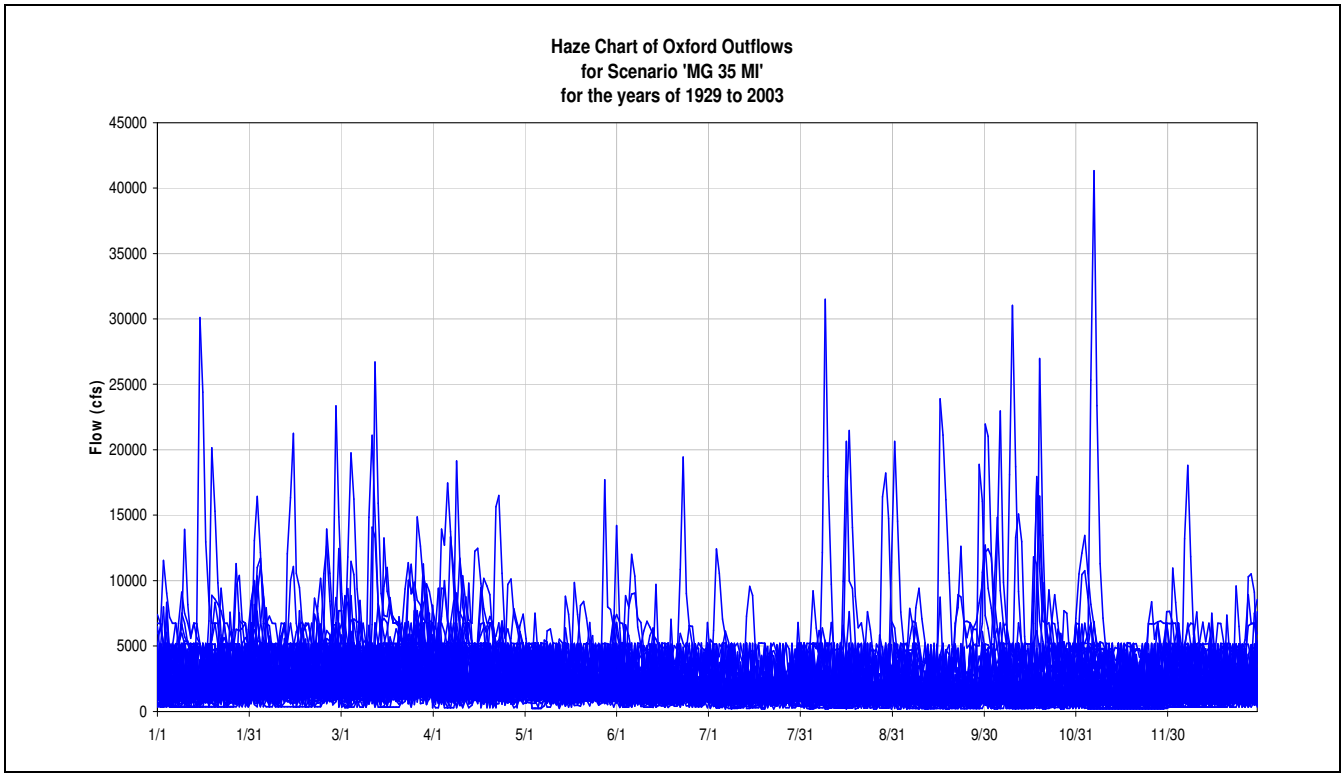

Figure 284: OX Outflow Haze Chart for MG 35 MI

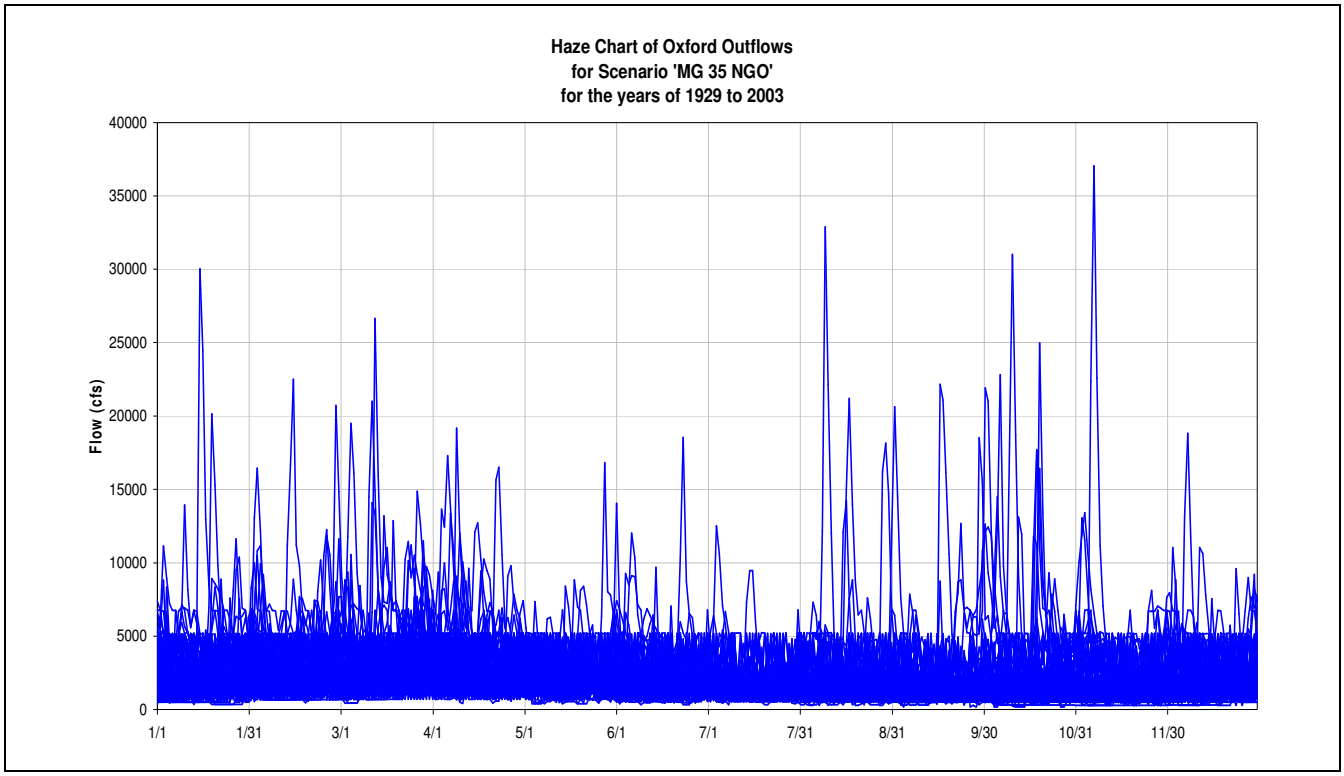

Figure 285: OX Outflow Haze Chart for MG 35 NGO

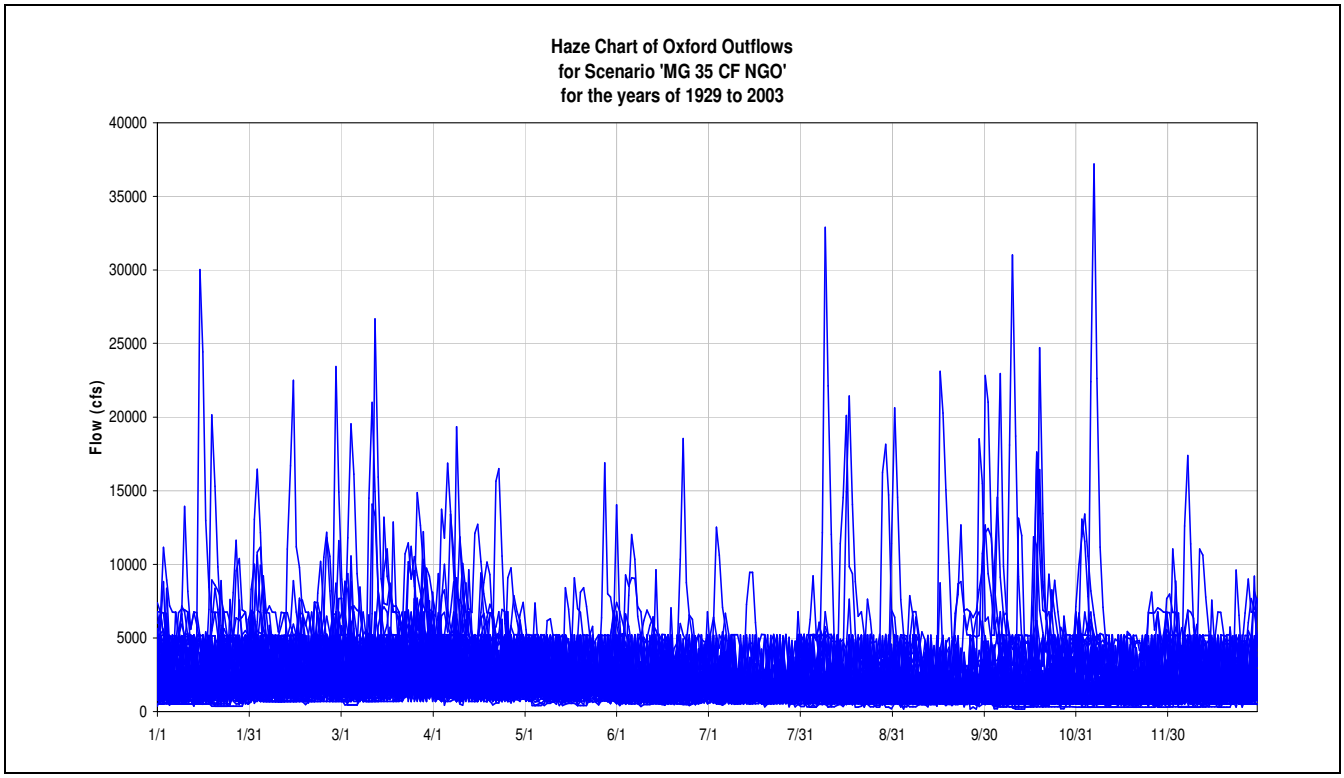

Figure 286: OX Outflow Haze Chart for MG 35 CF NGO

4) Lookout Shoals

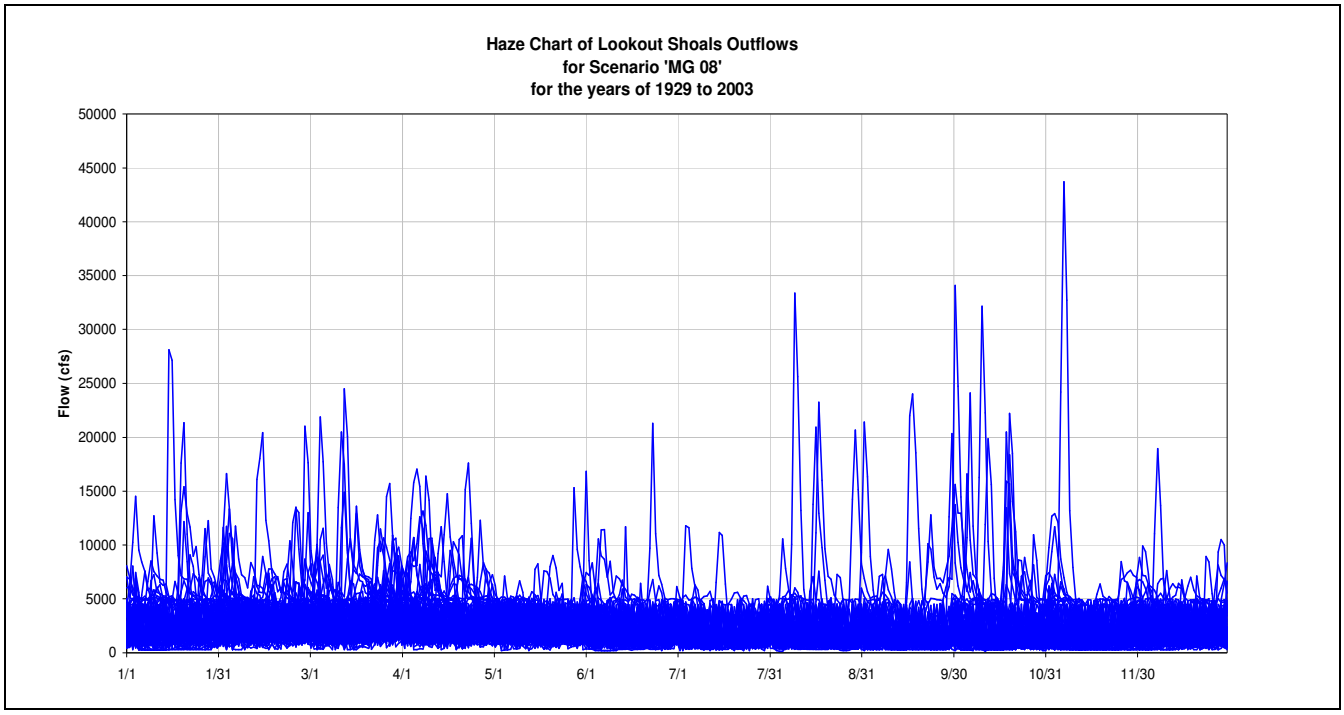

Figure 287: LS Outflow Haze Chart for MG 08

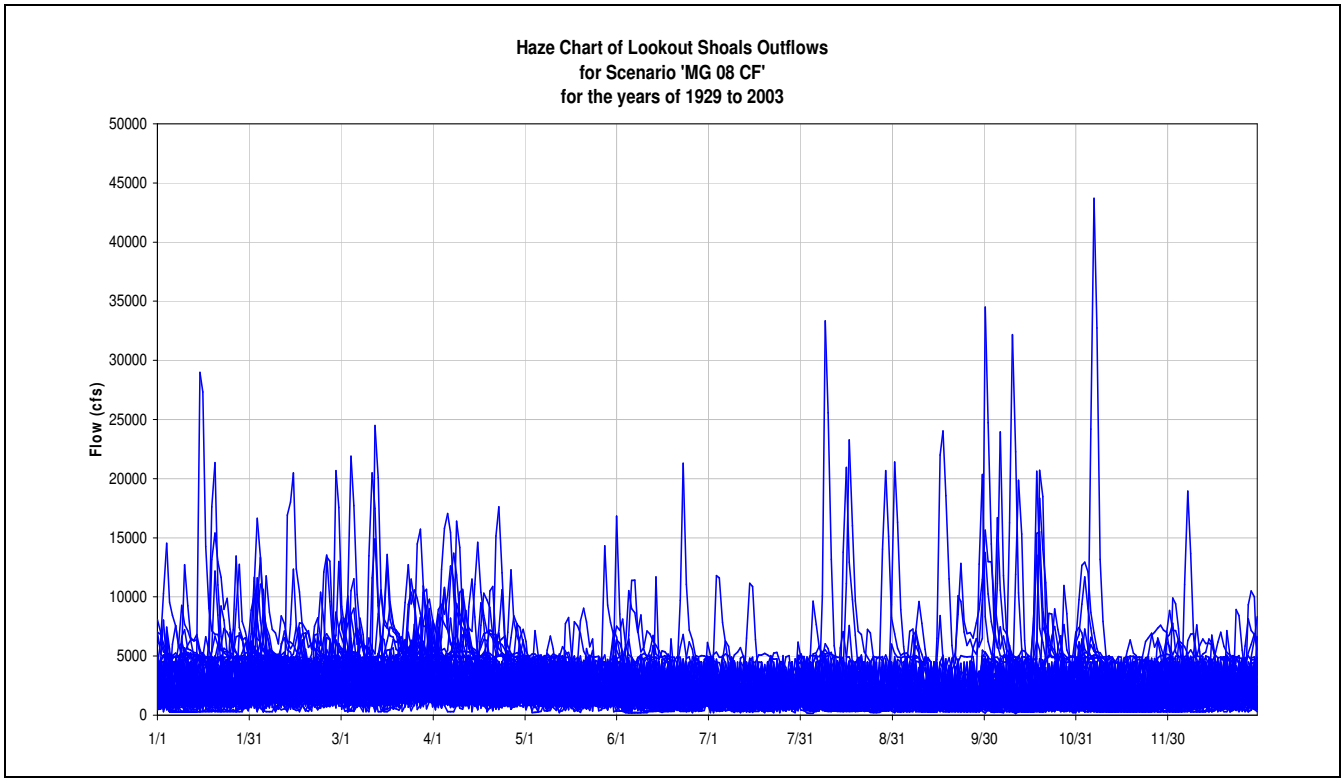

Figure 288: LS Outflow Haze Chart for MG 08 CF

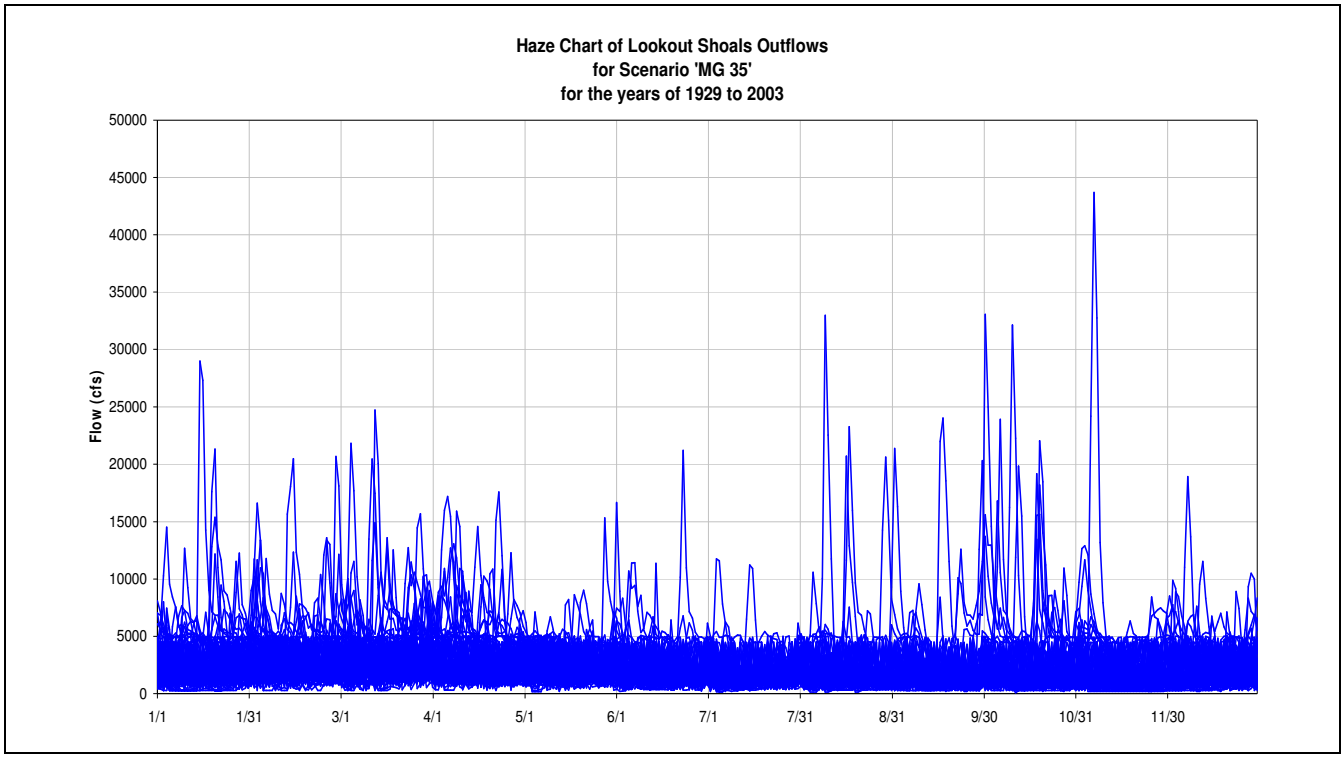

Figure 289: LS Outflow Haze Chart for MG 35

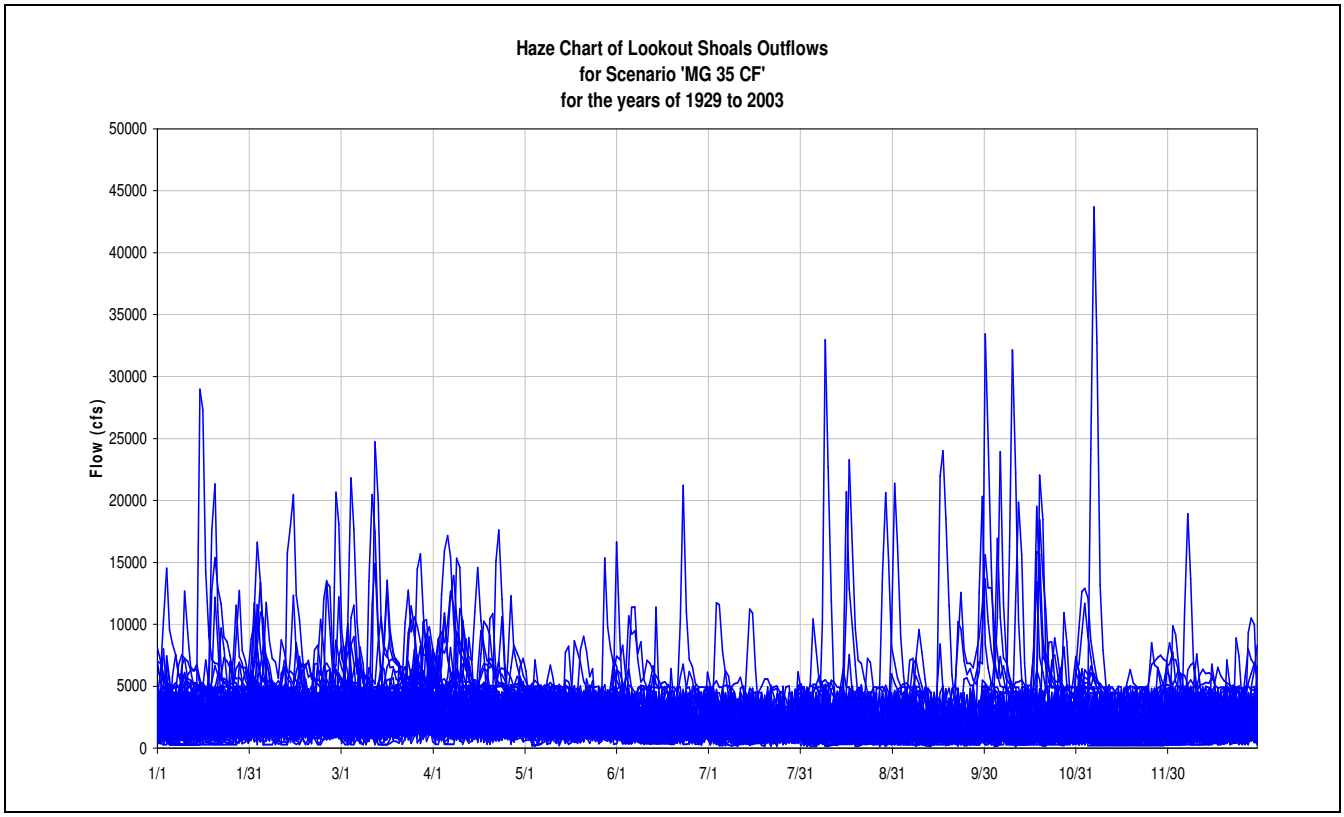

Figure 290: LS Outflow Haze Chart for MG 35 CF

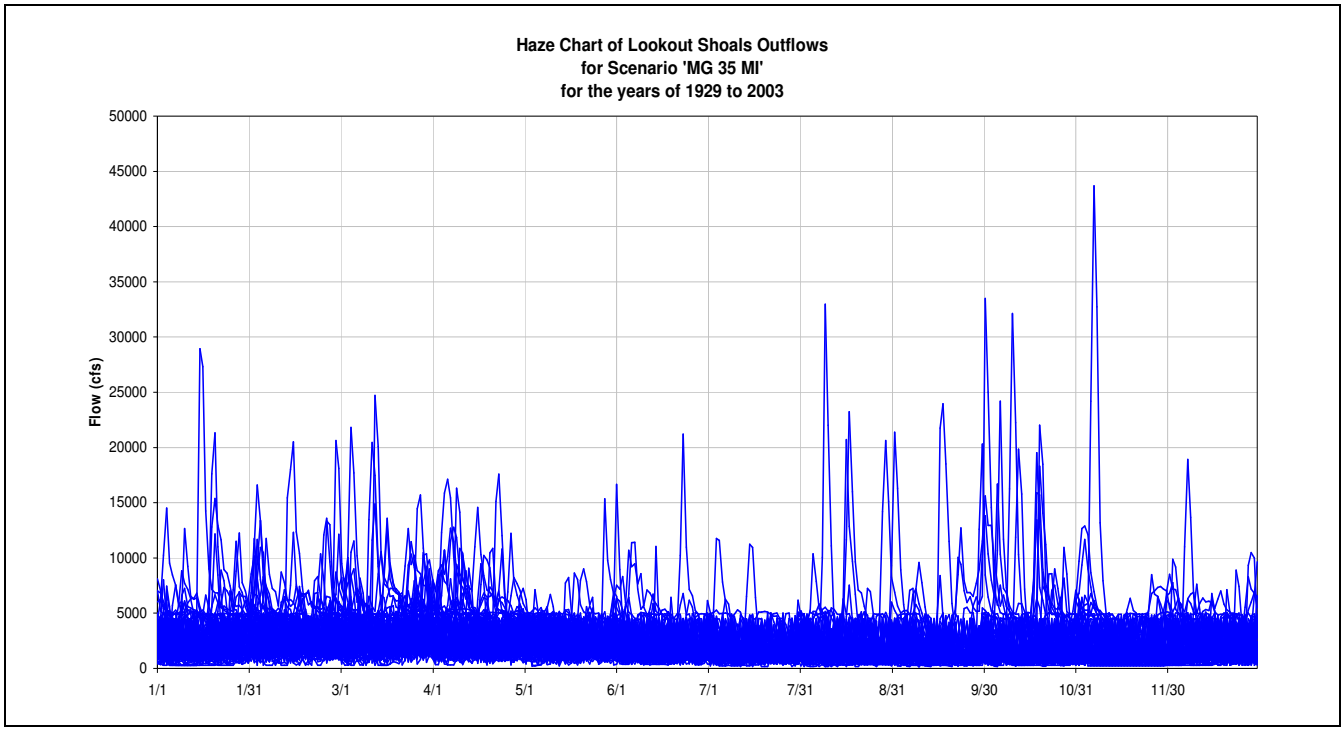

Figure 291: LS Outflow Haze Chart for MG 35 MI

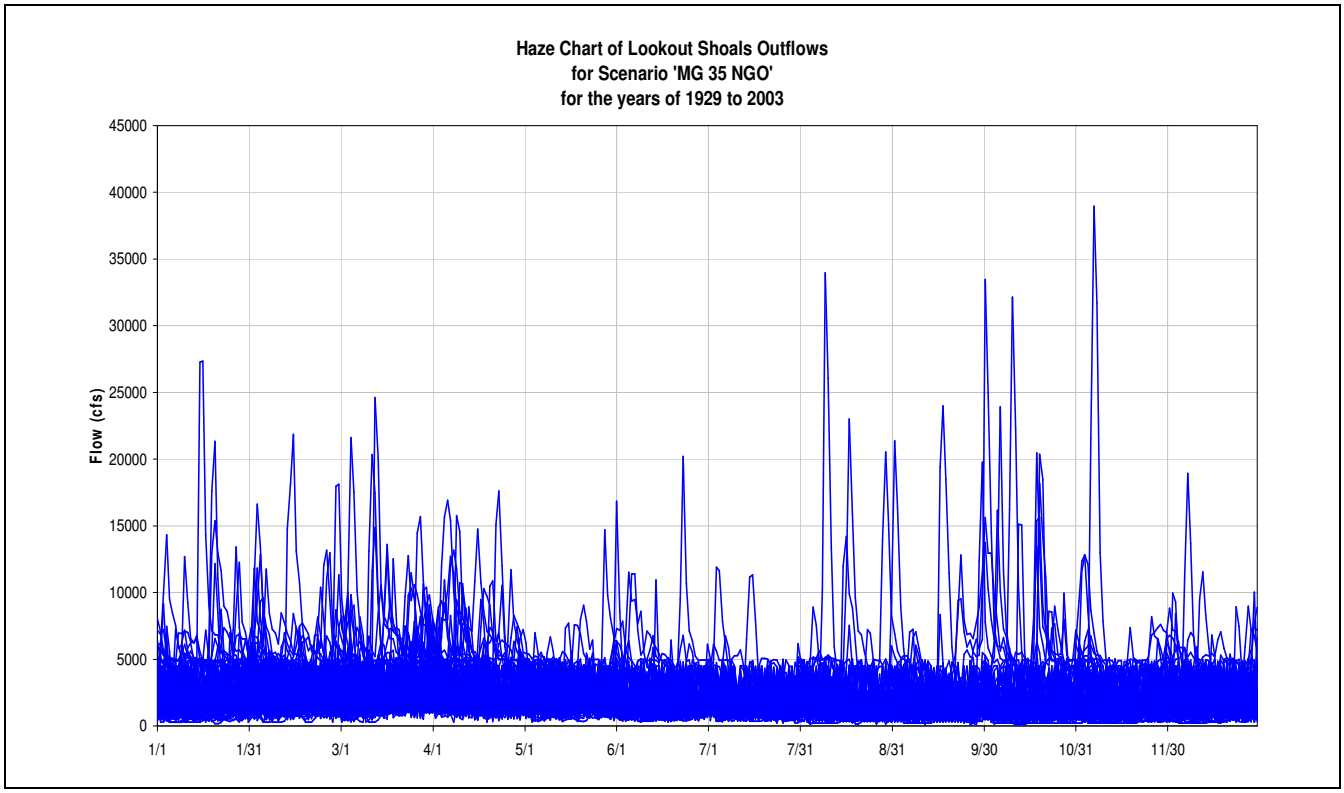

Figure 292: LS Outflow Haze Chart for MG 35 NGO

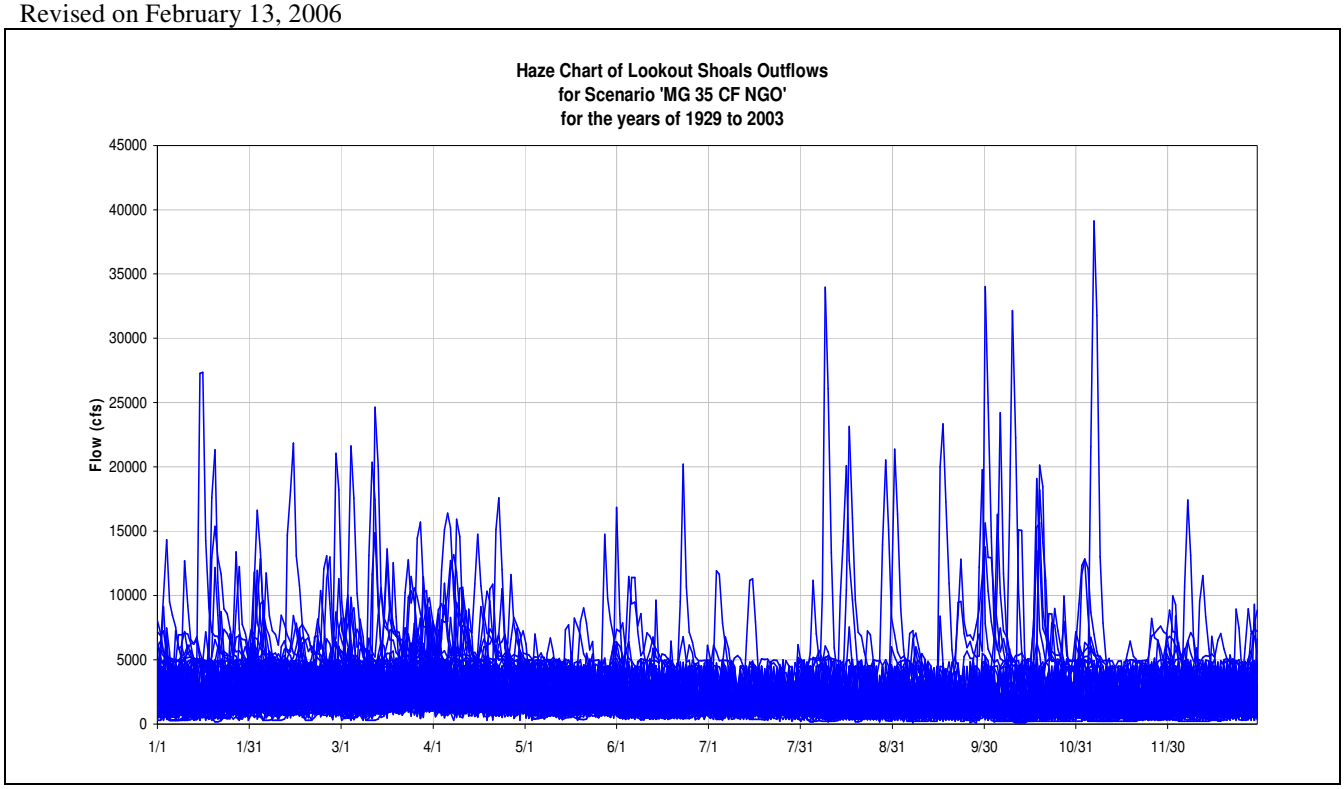

Figure 293: LS Outflow Haze Chart for MG 35 CF NGO

5) Cowan Ford

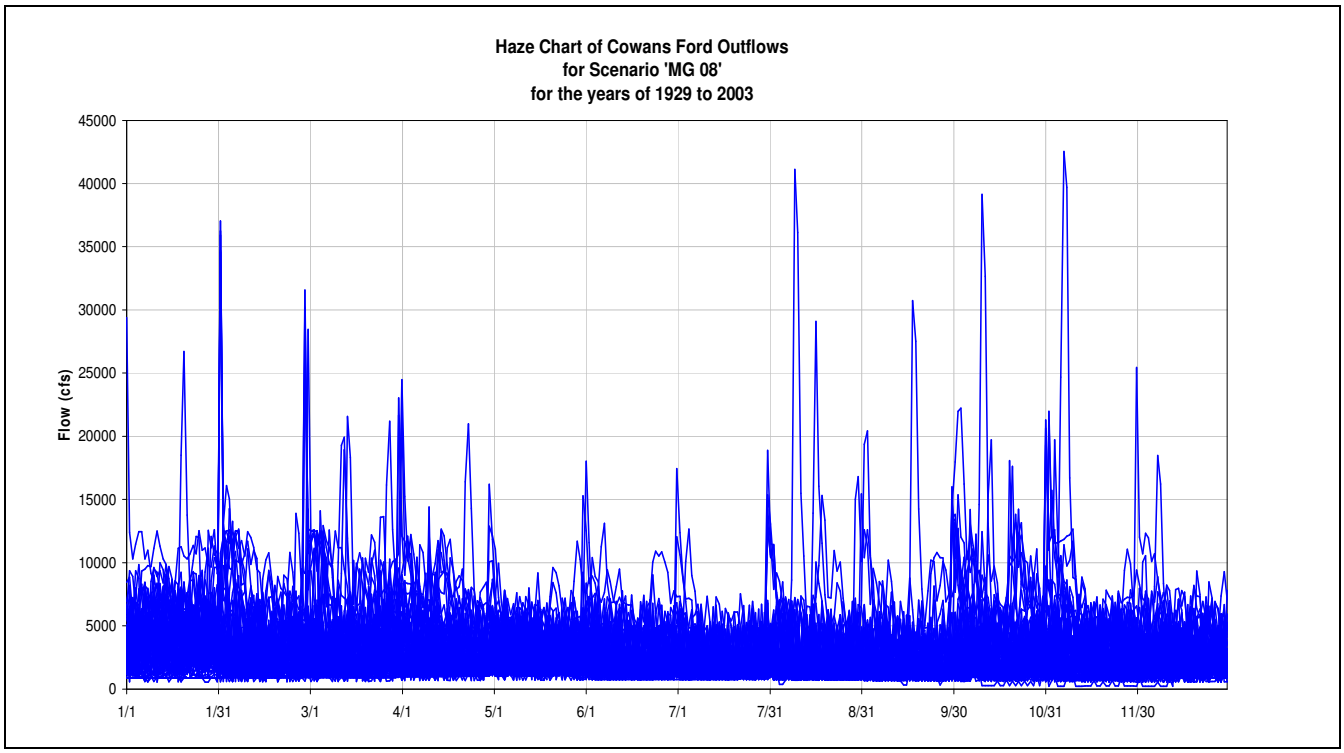

Figure 294: CF Outflow Haze Chart for MG 08

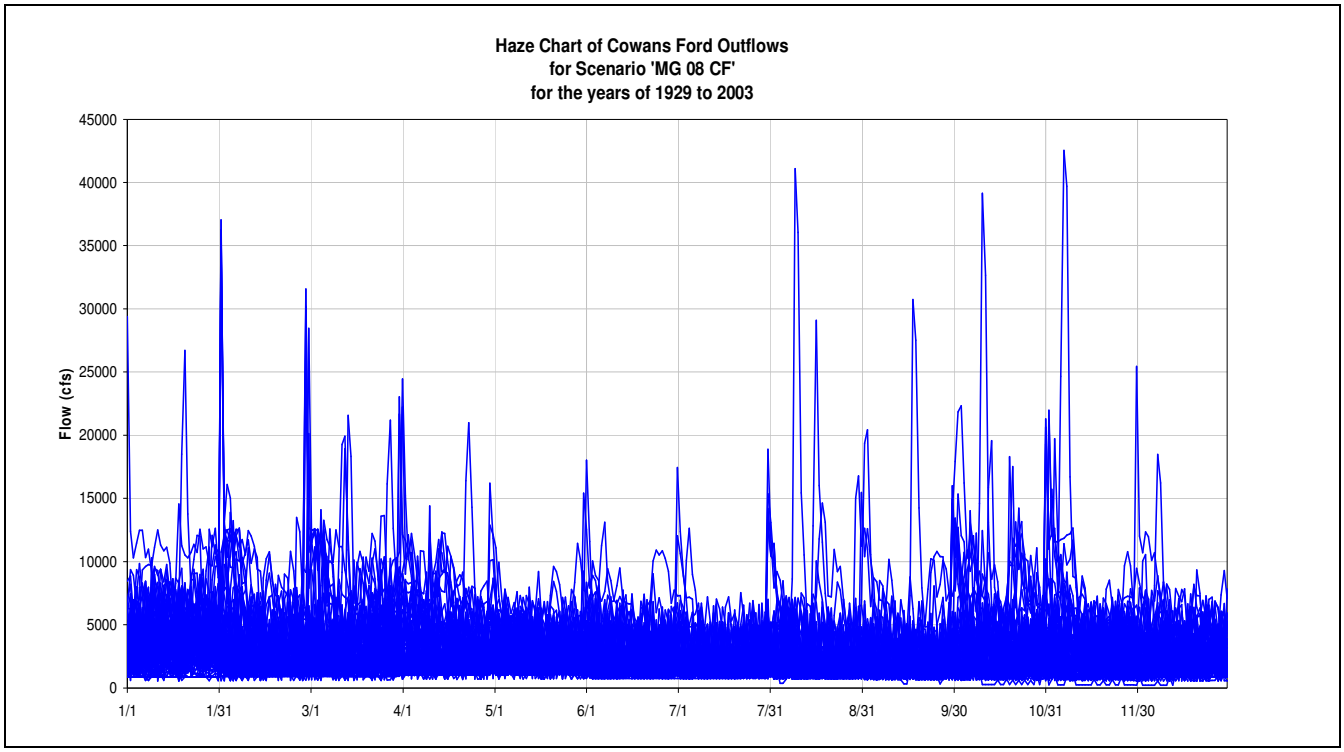

Figure 295: CF Outflow Haze Chart for MG 08 CF

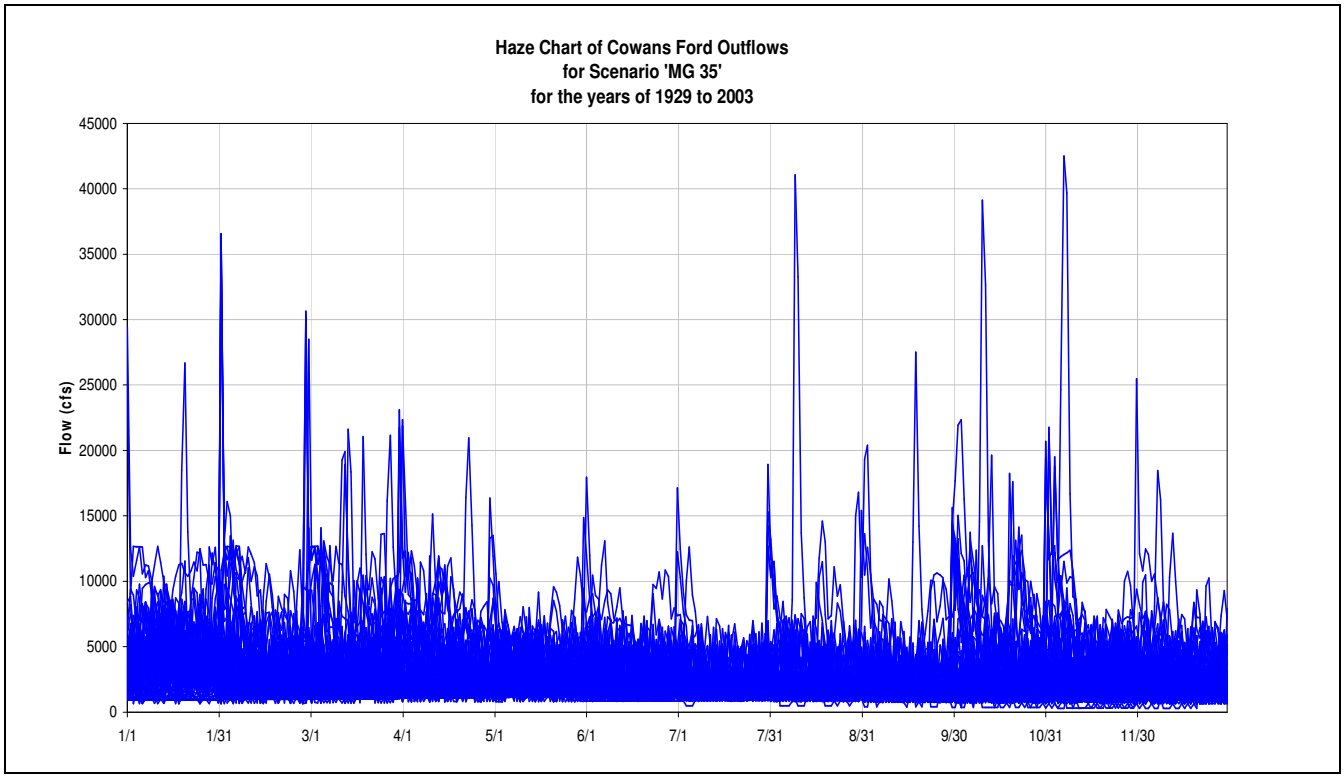

Figure 296: CF Outflow Haze Chart for MG 35

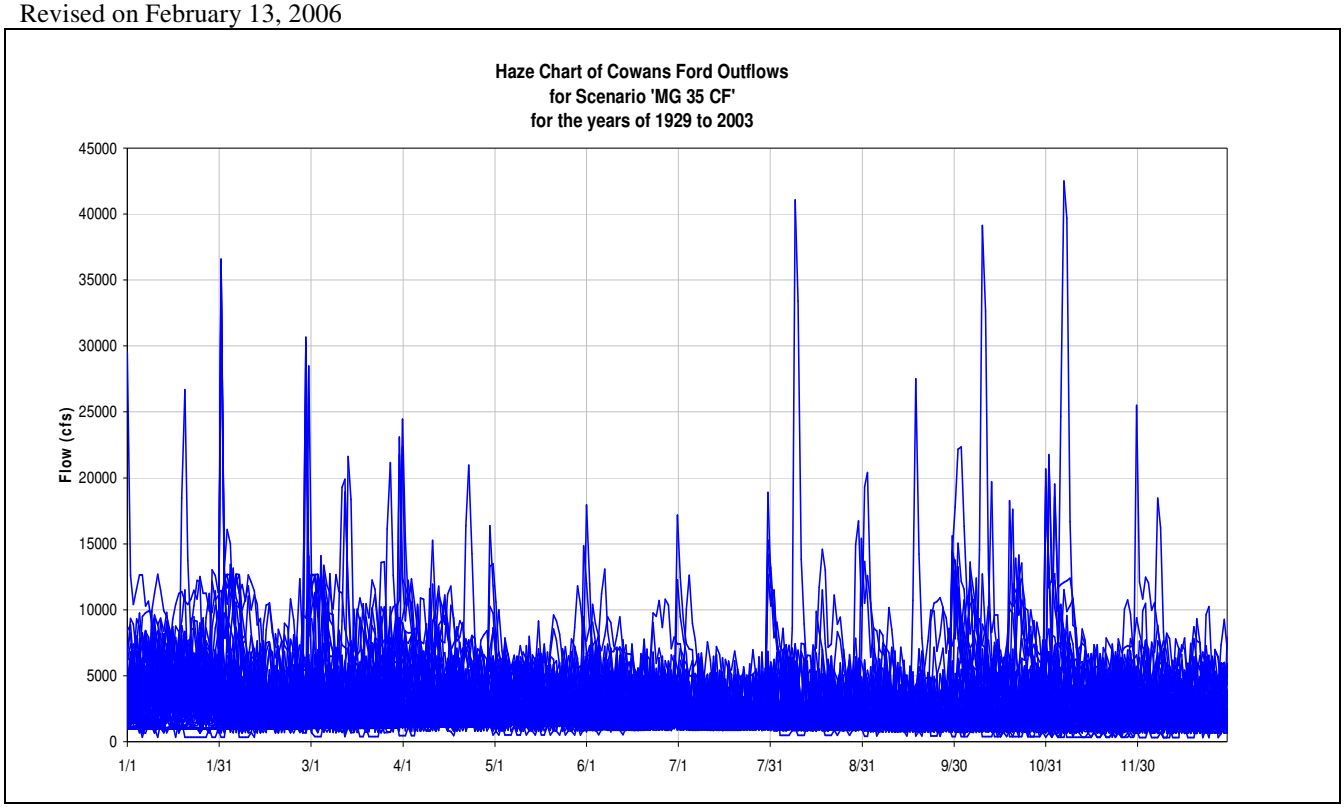

Figure 297: CF Outflow Haze Chart for MG 35 CF

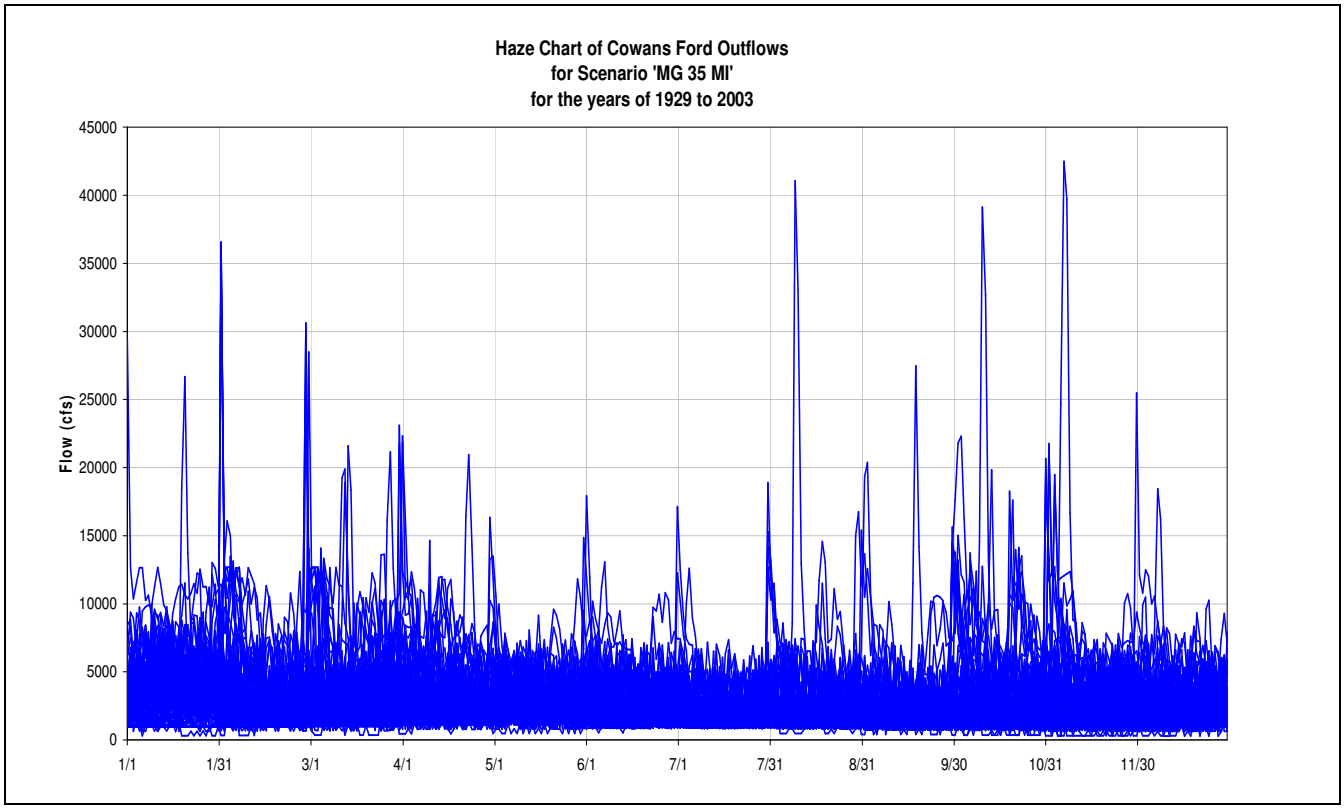

Figure 298: CF Outflow Haze Chart for MG 35 MI

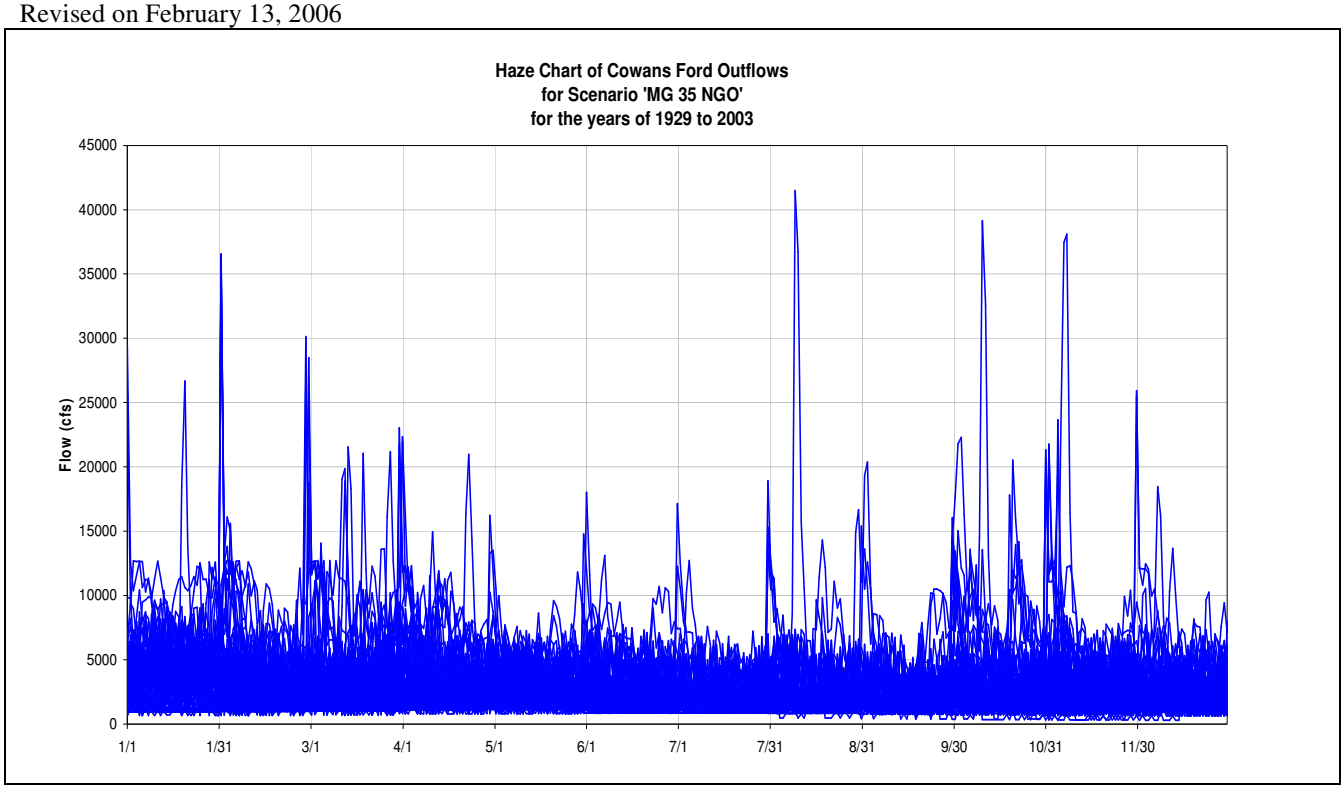

Figure 299: CF Outflow Haze Chart for MG 35 NGO

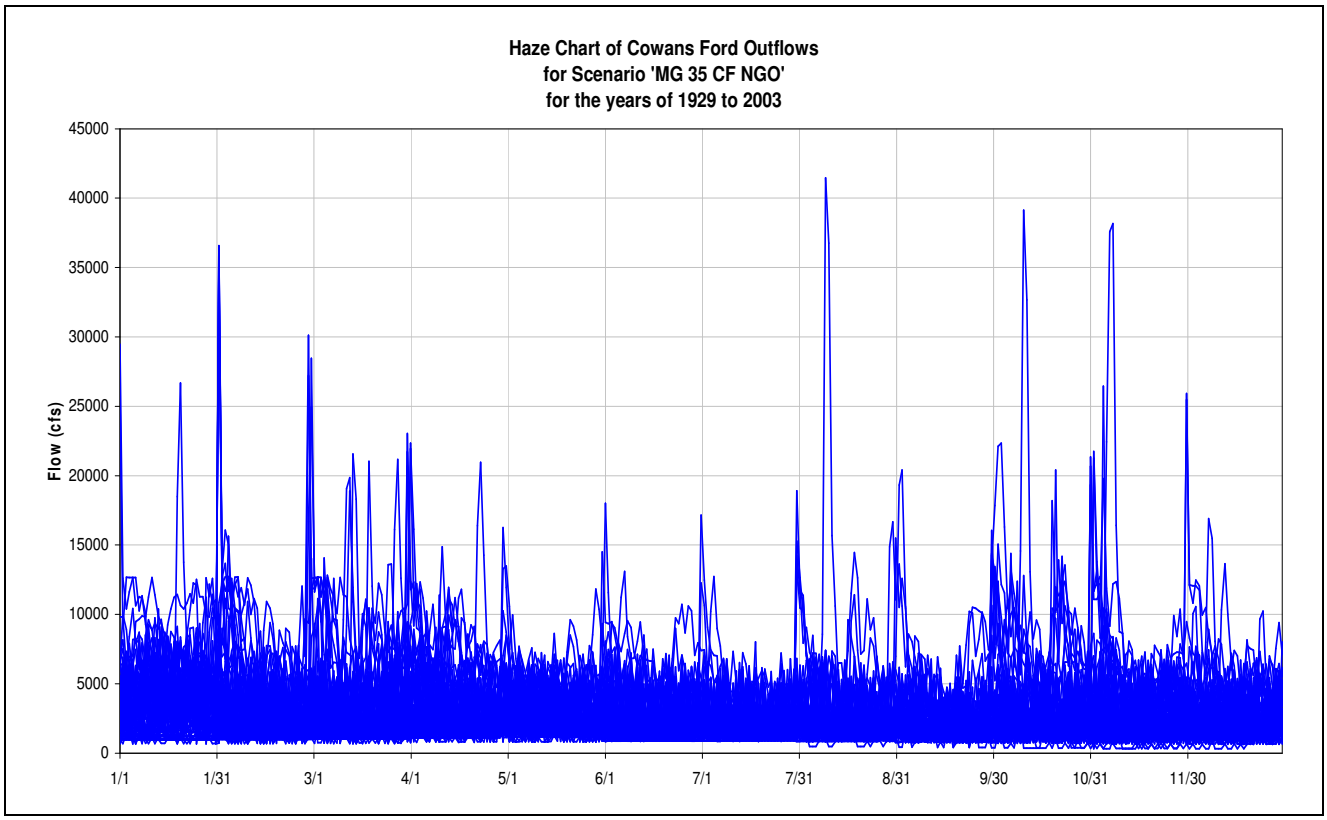

Figure 300: CF Outflow Haze Chart for MG 35 CF NGO

6) Mountain Island

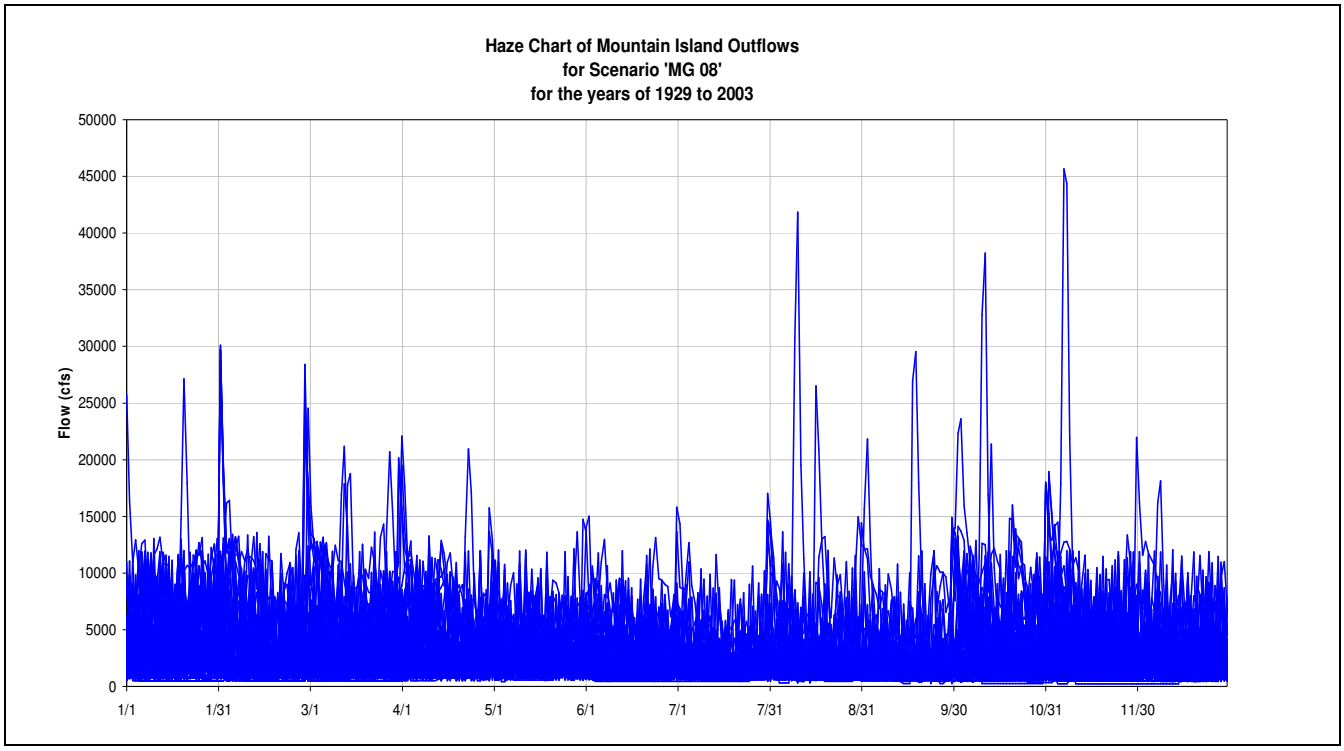

Figure 301: MI Outflow Haze Chart for MG 08

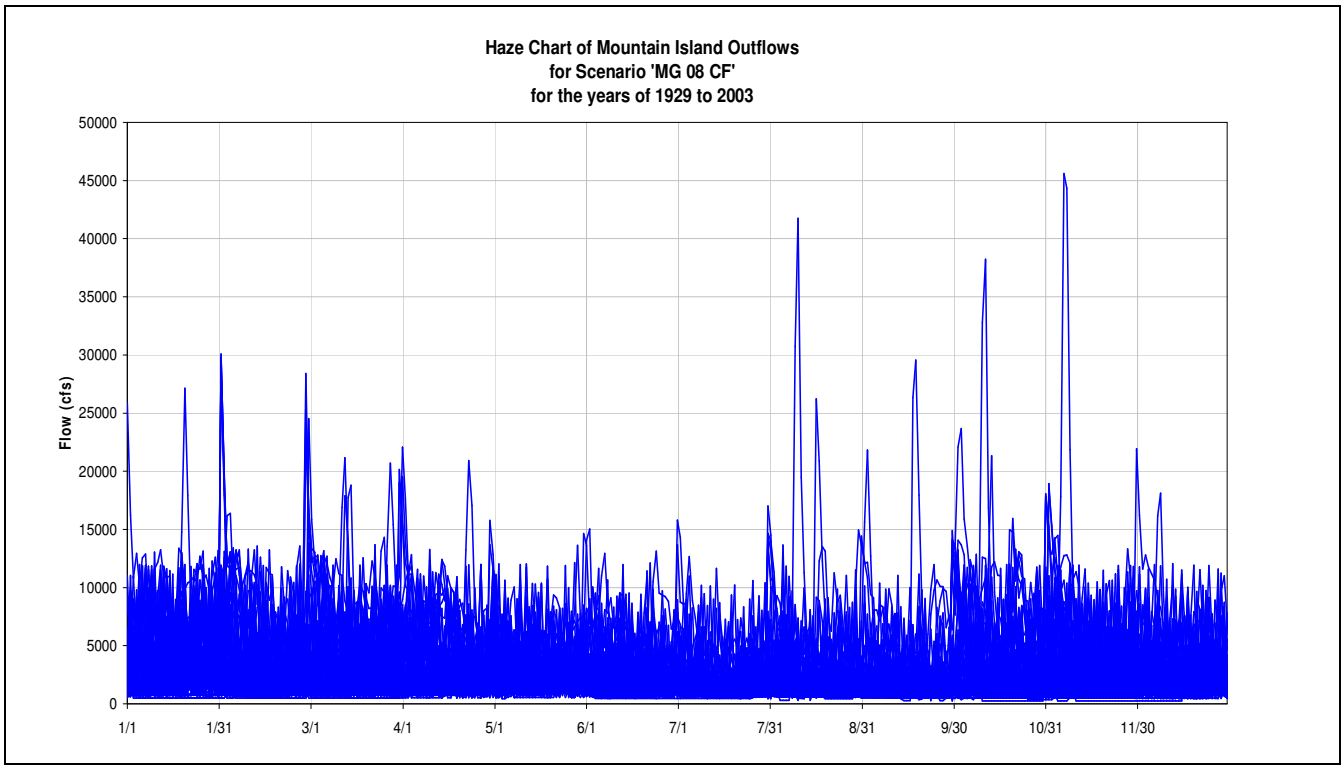

Figure 302: MI Outflow Haze Chart for MG 08 CF

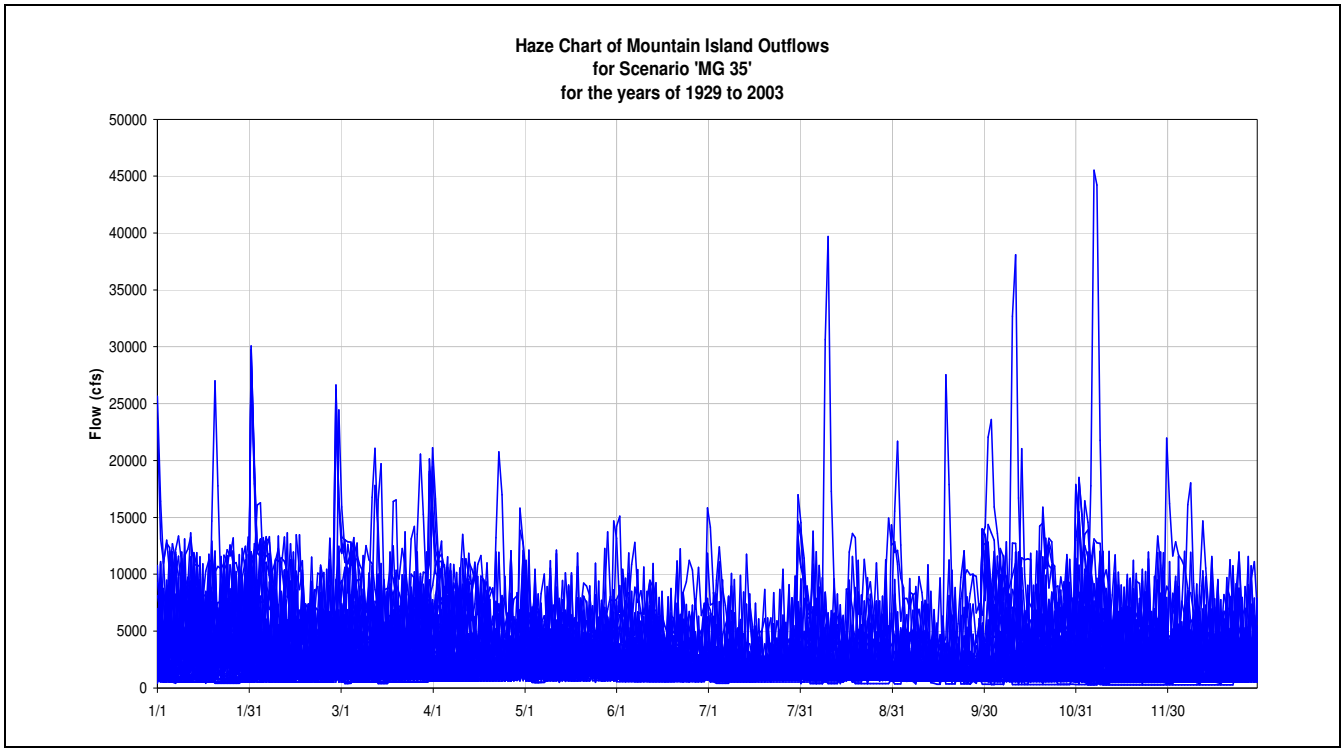

Figure 303: MI Outflow Haze Chart for MG 35

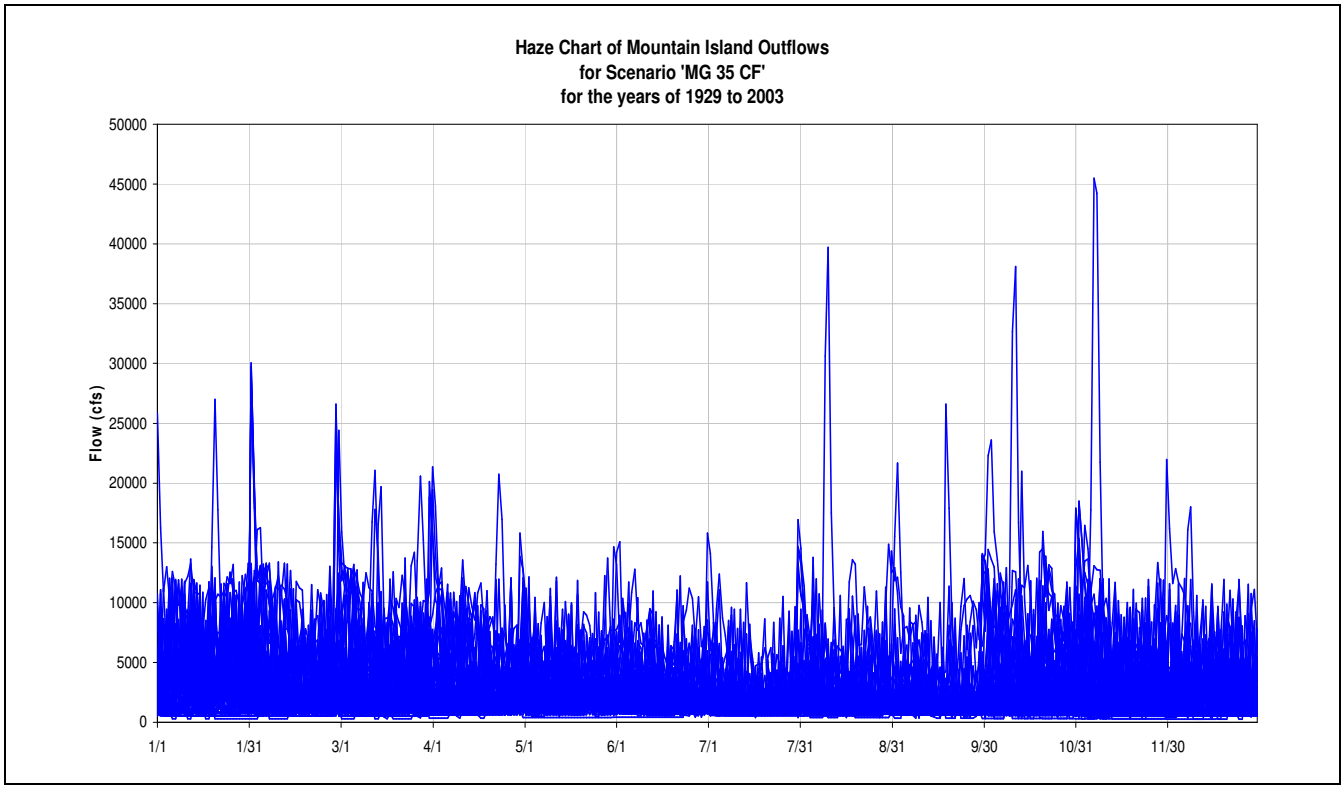

Figure 304: MI Outflow Haze Chart for MG 35 CF

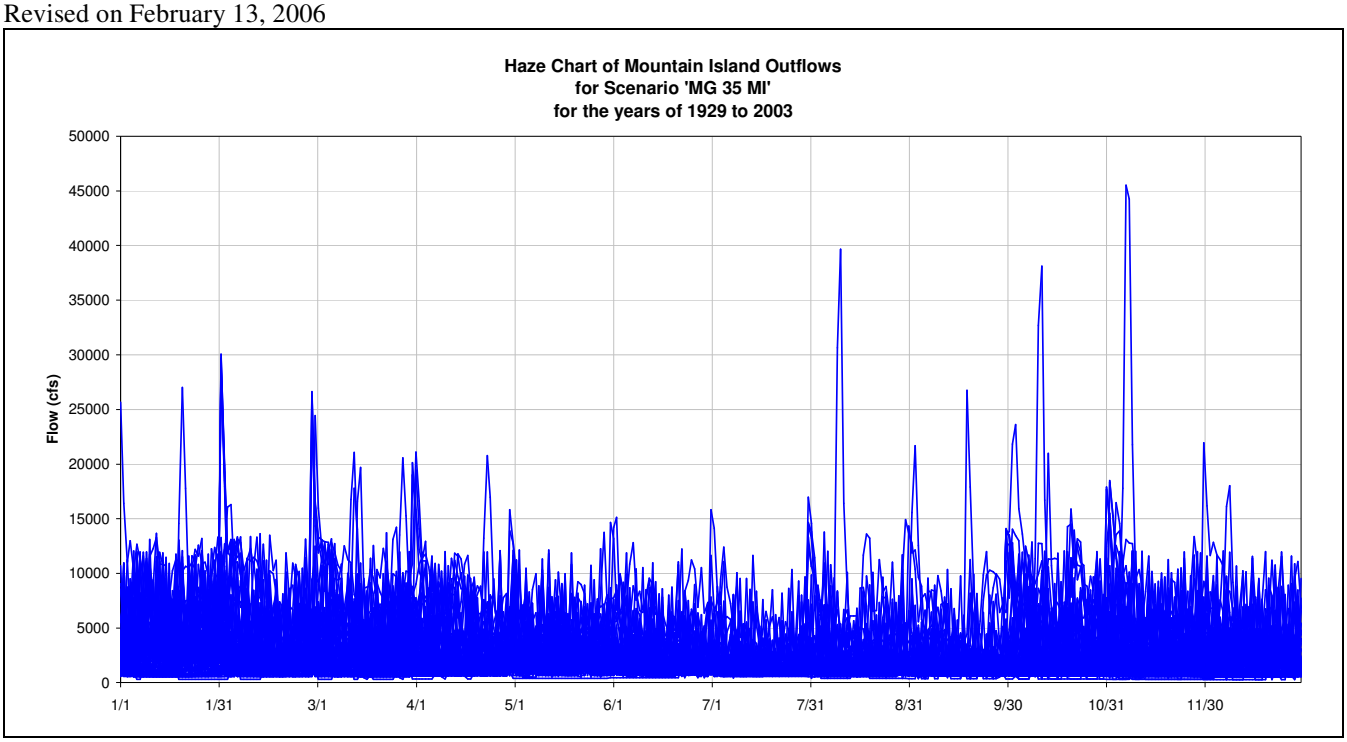

Figure 305: MI Outflow Haze Chart for MG 35 MI

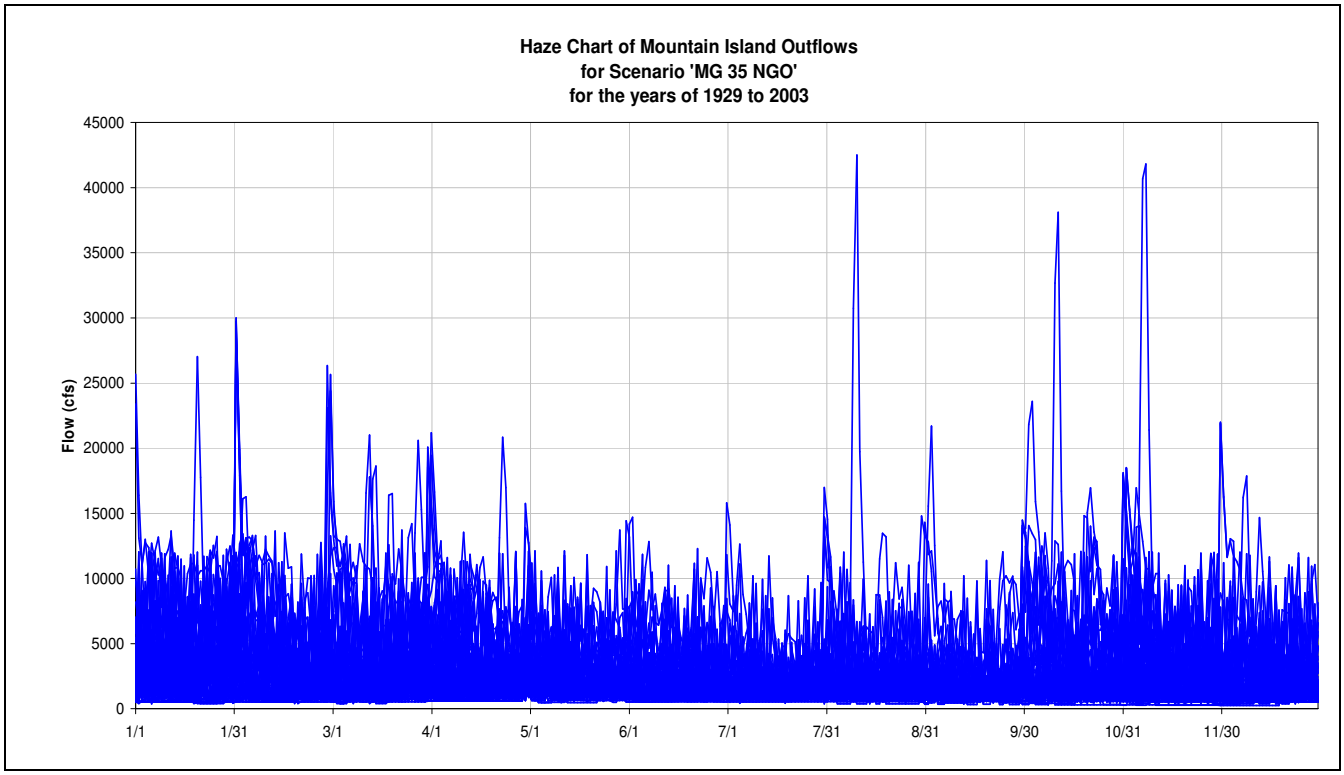

Figure 306: MI Outflow Haze Chart for MG 35 NGO

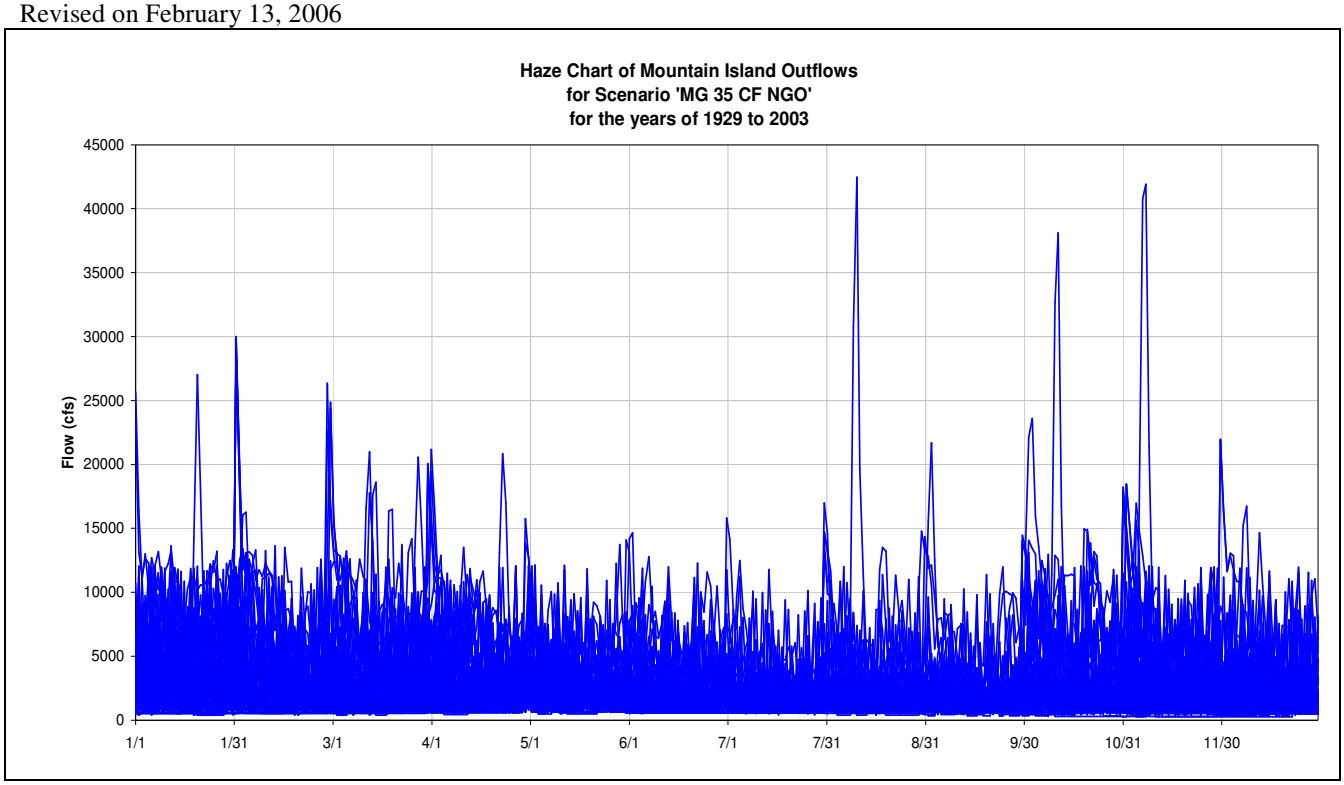

Figure 307: MI Outflow Haze Chart for MG 35 CF NGO

7) Wylie

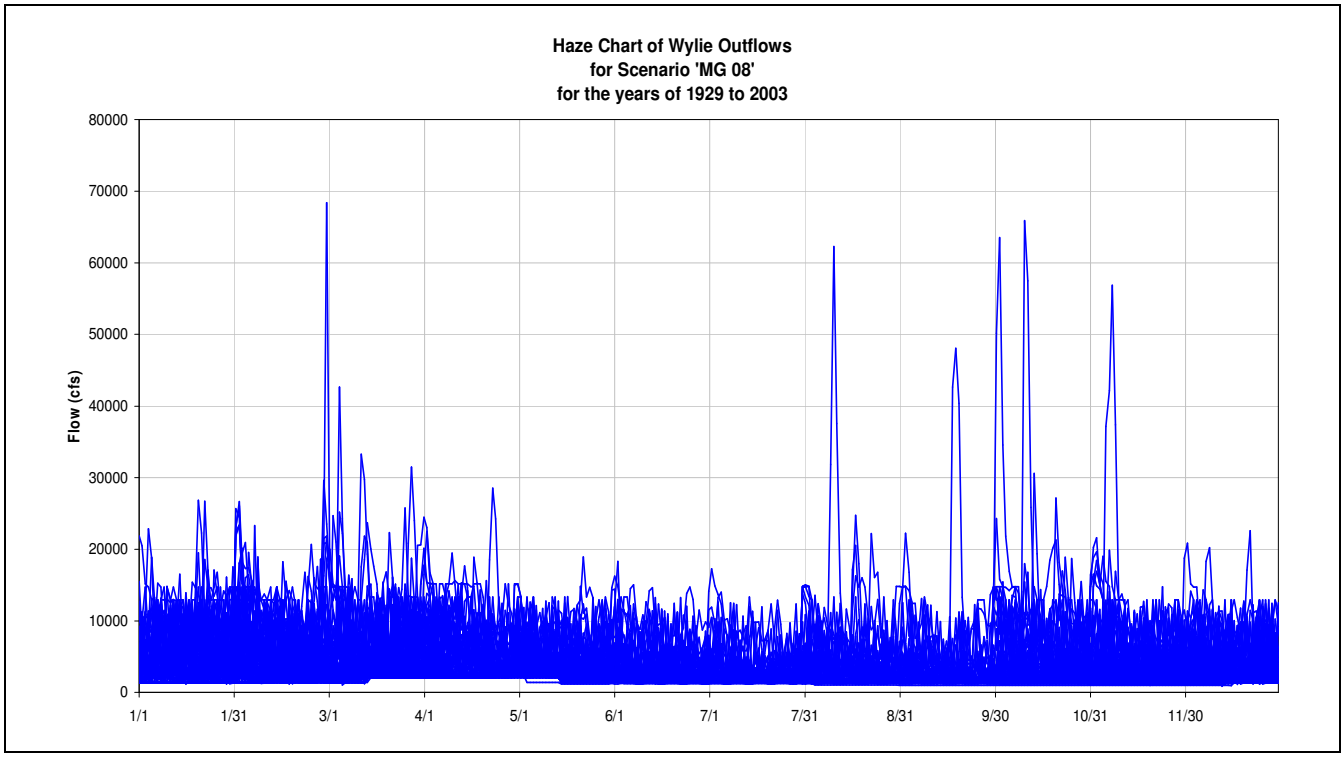

Figure 308: WY Outflow Haze Chart for MG 08

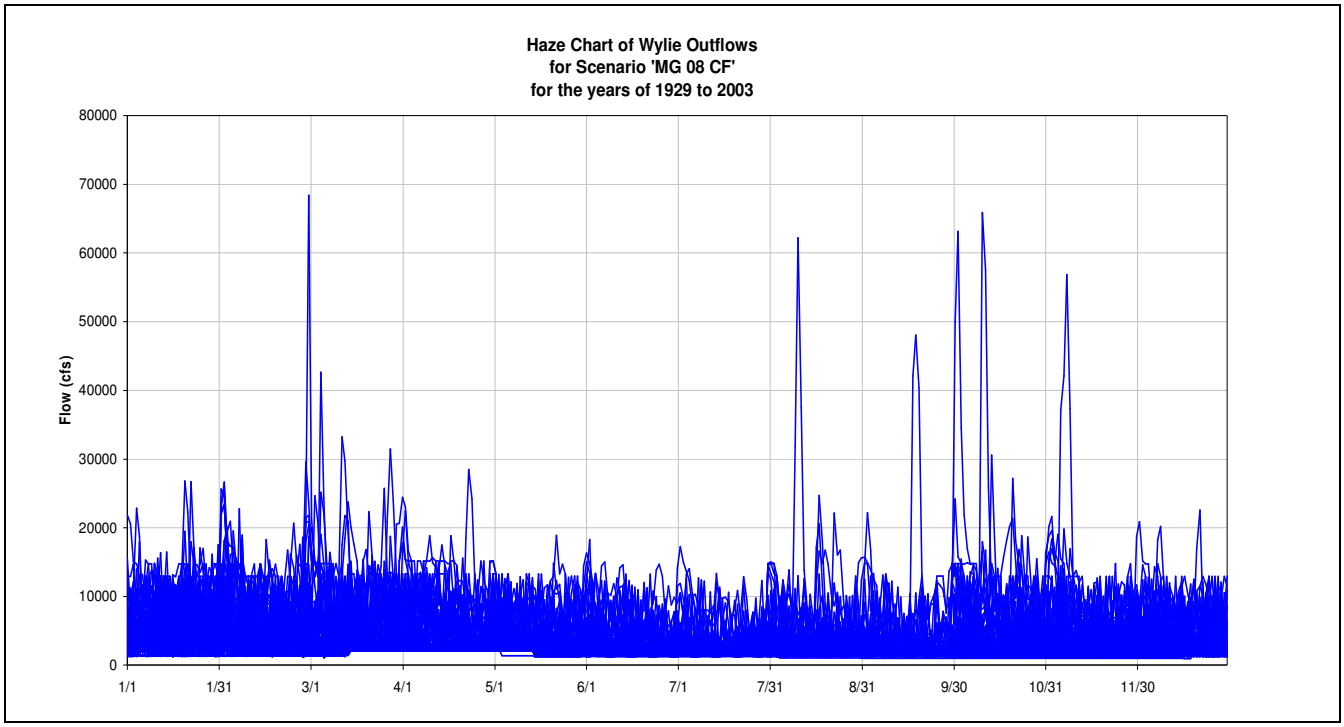

Figure 309: WY Outflow Haze Chart for MG 08 CF

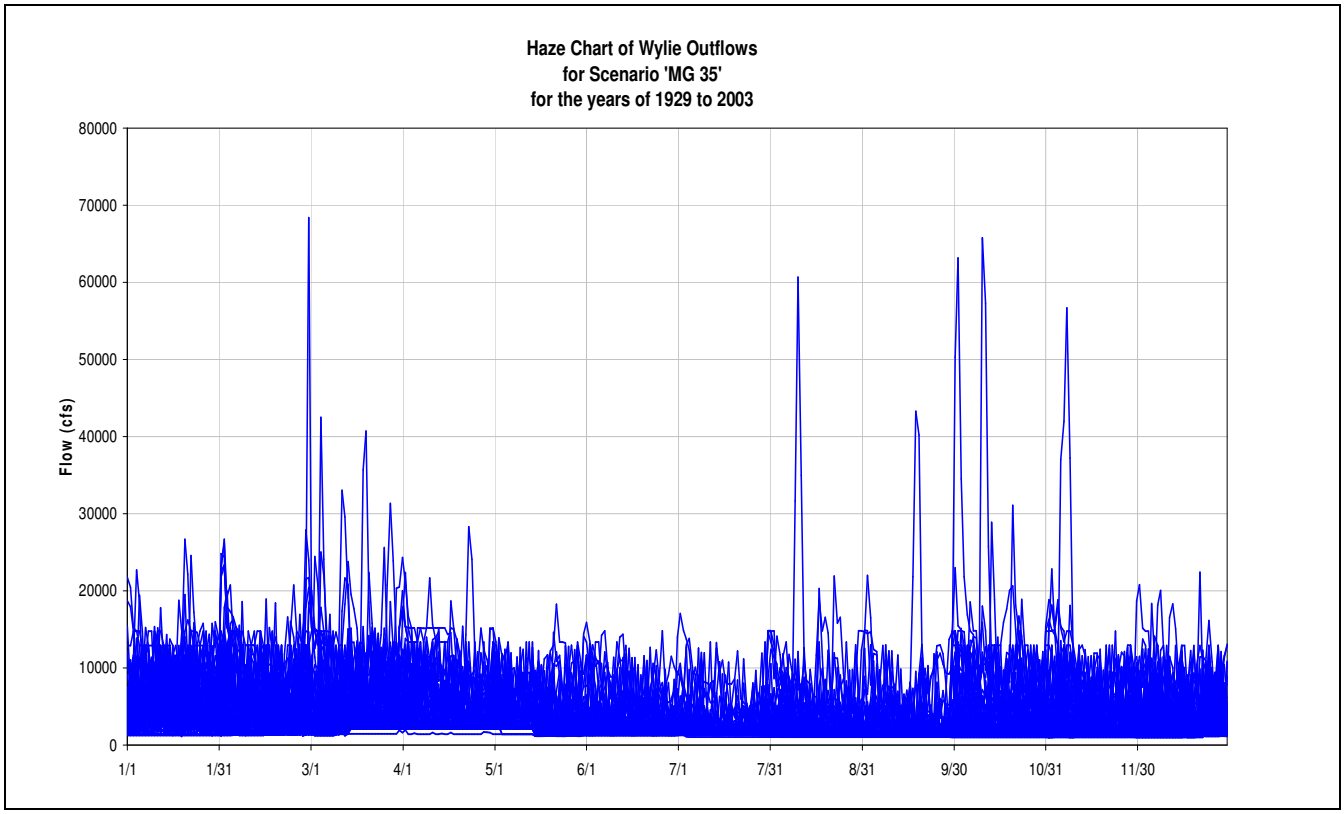

Figure 310: WY Outflow Haze Chart for for MG 35

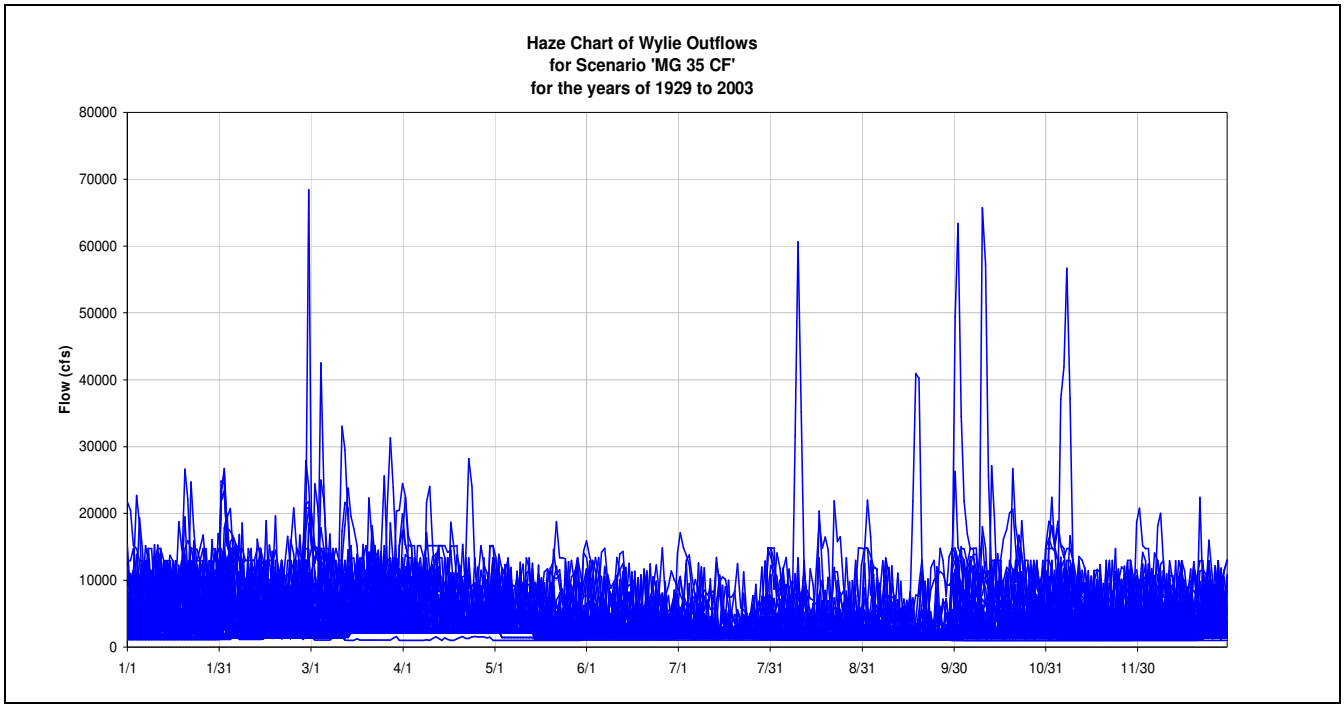

Figure 311: WY Outflow Haze Chart for MG 35 CF

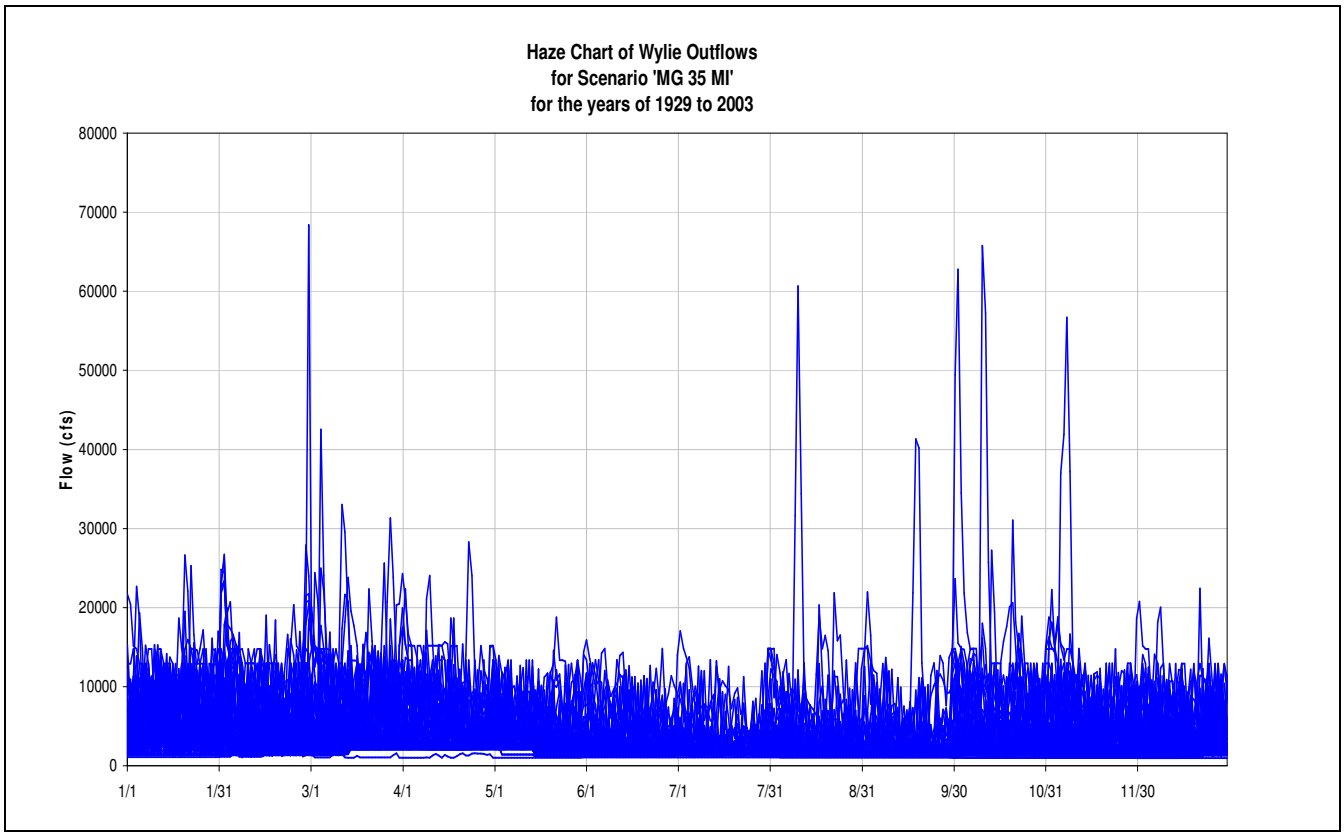

Figure 312: WY Outflow Haze Chart for MG 35 MI

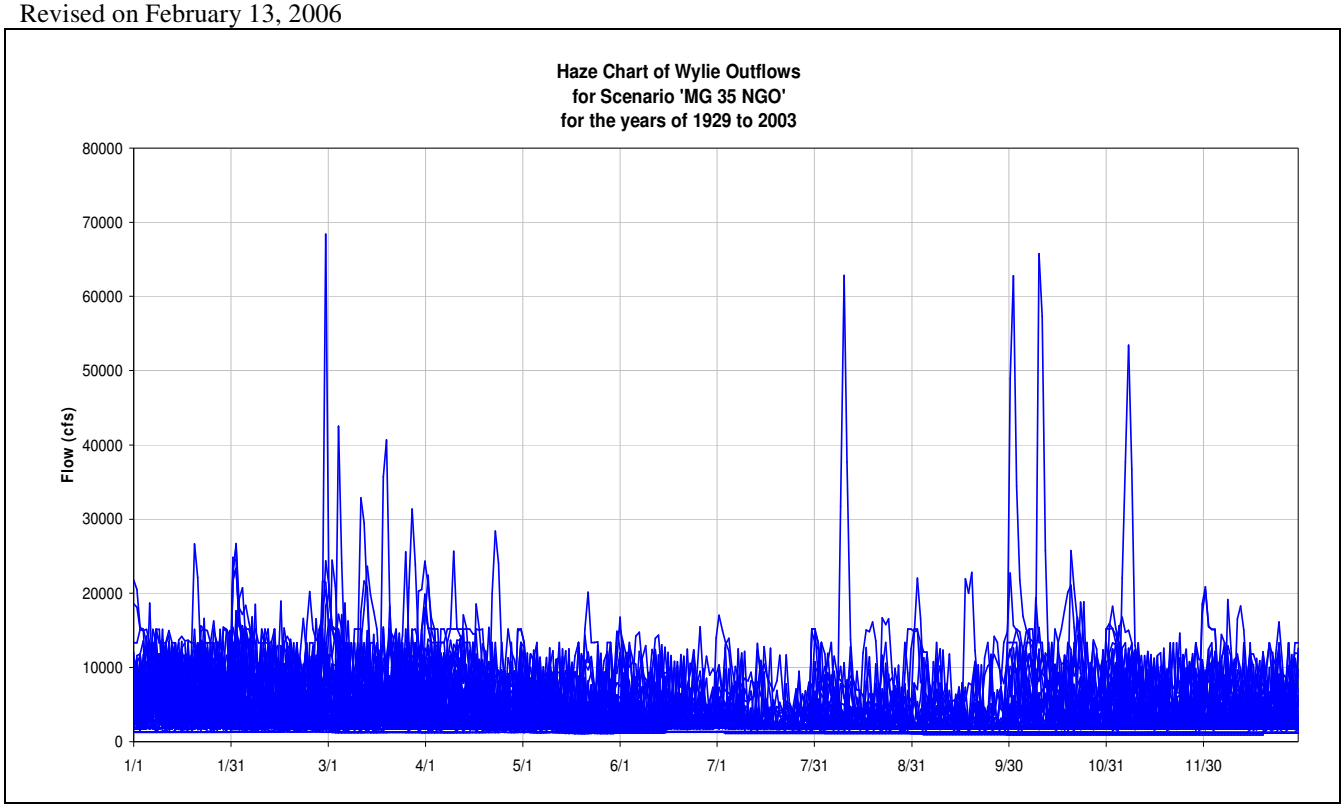

Figure 313: WY Outflow Haze Chart for MG 35 NGO

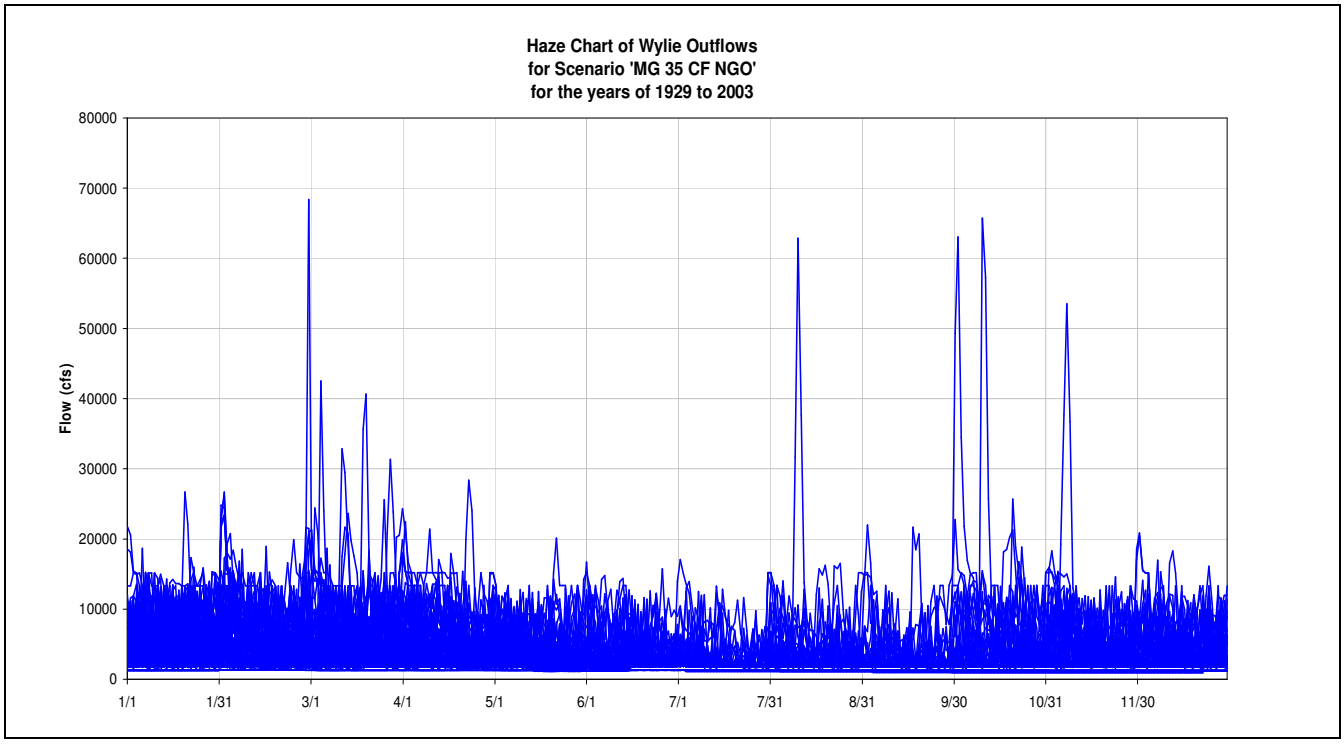

Figure 314: WY Outflow Haze Chart for MG 35 CF NGO

8) Fishing Creek

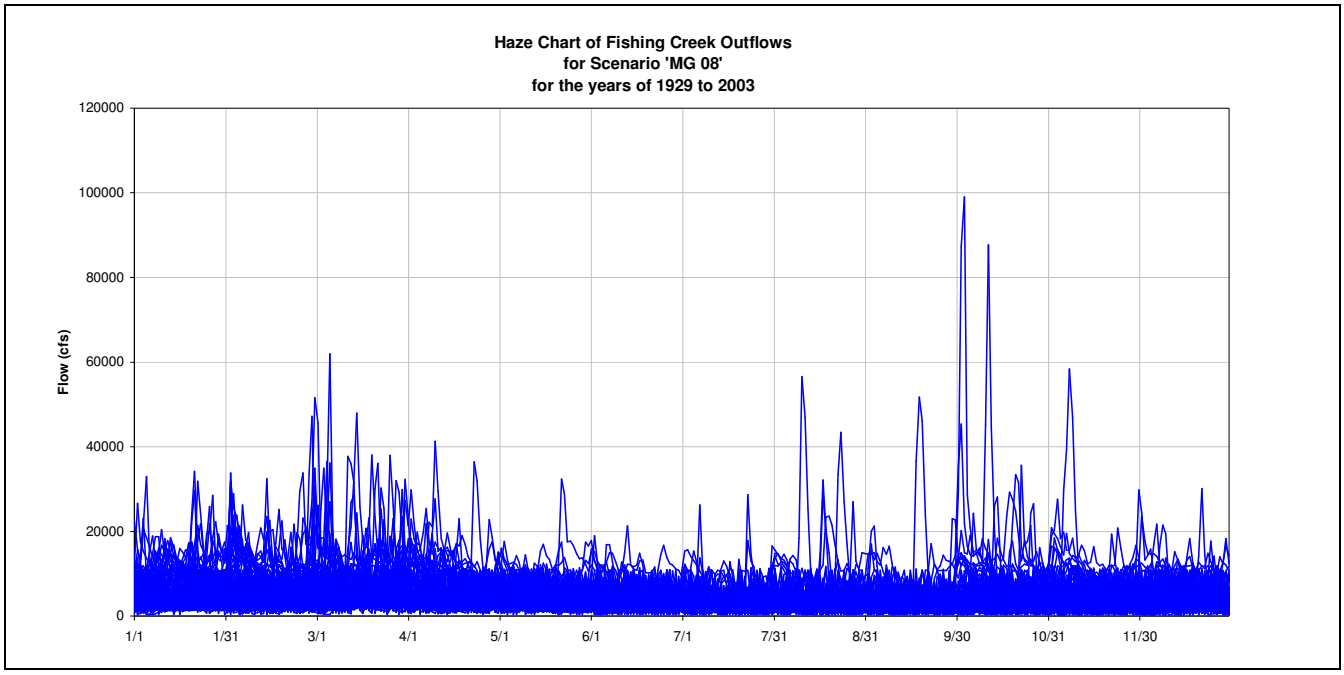

Figure 315: FC Outflow Haze Chart for MG 08

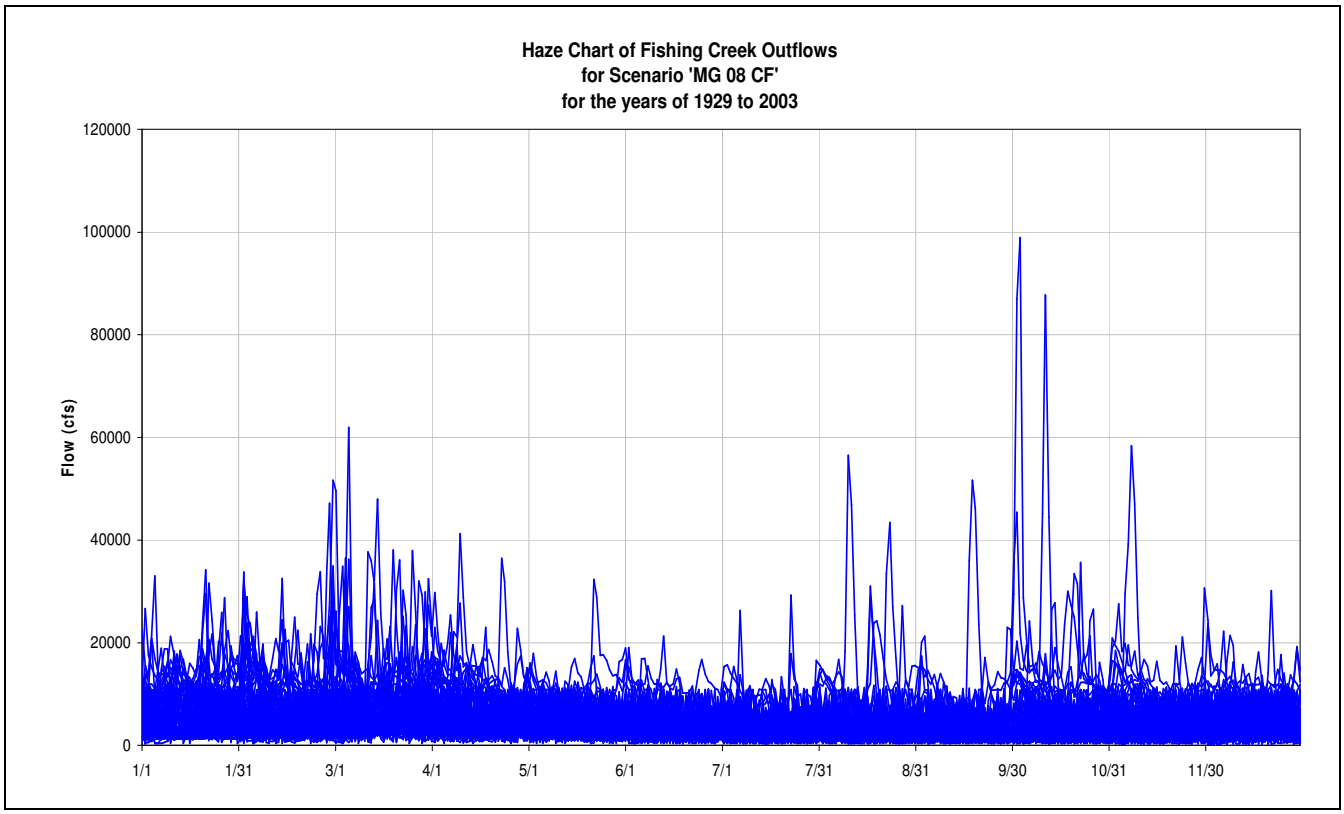

Figure 316: FC Outflow Haze Chart for MG 08 CF

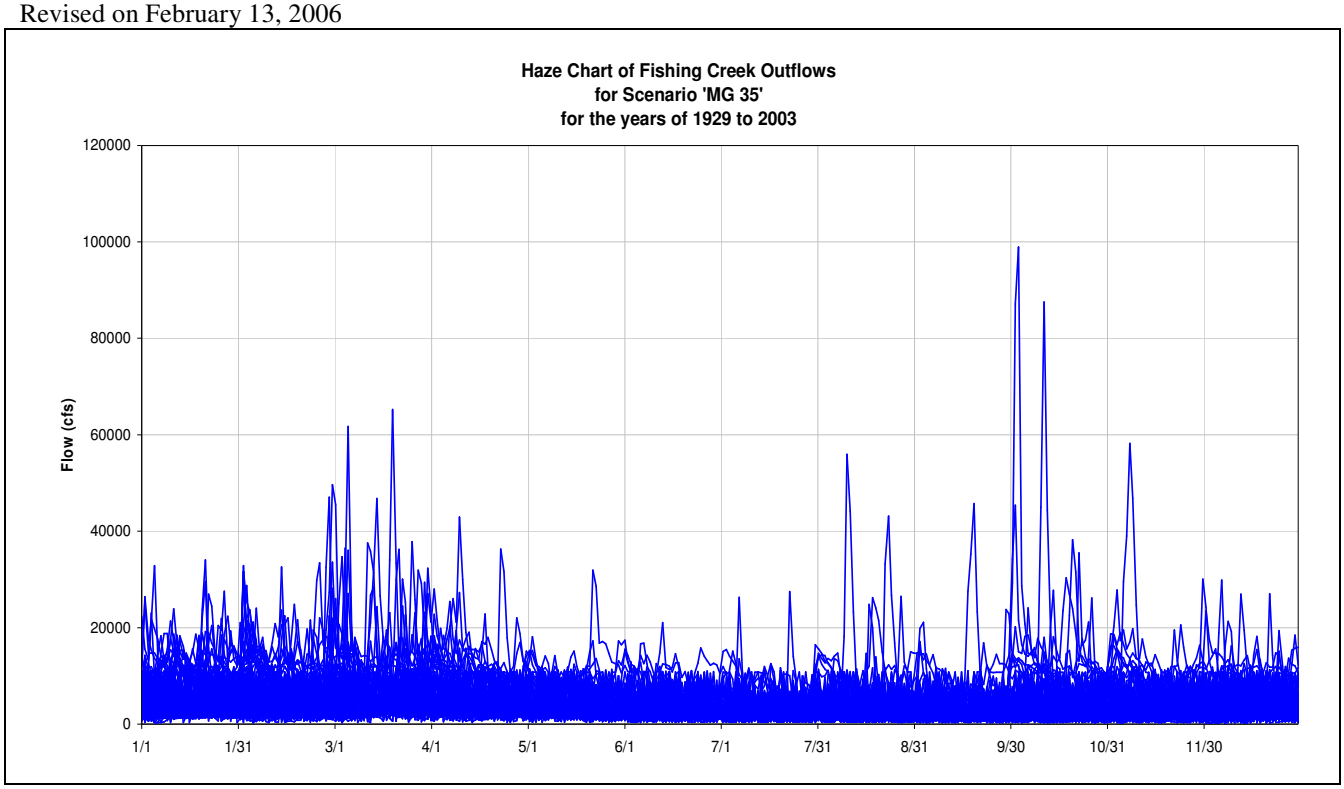

Figure 317: FC Outflow Haze Chart for MG 35

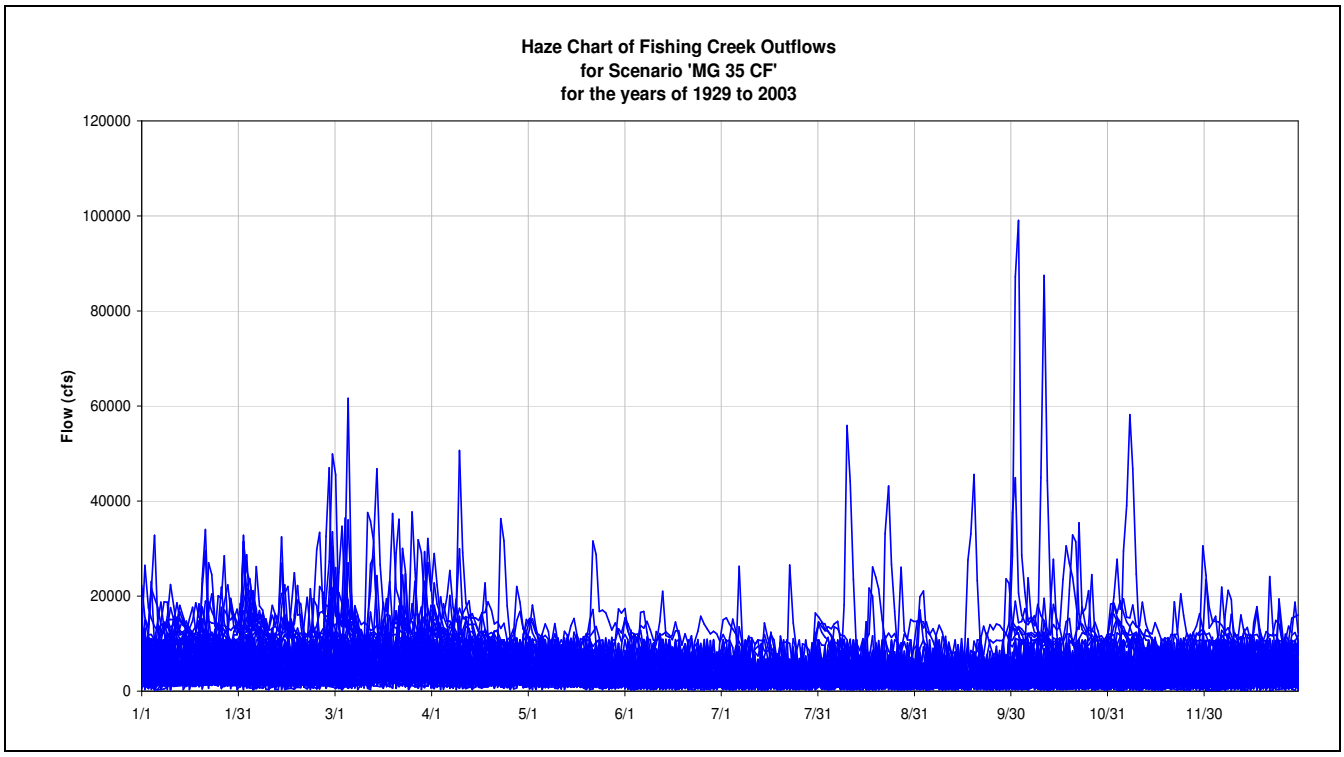

Figure 318: FC Outflow Haze Chart for MG 35 CF

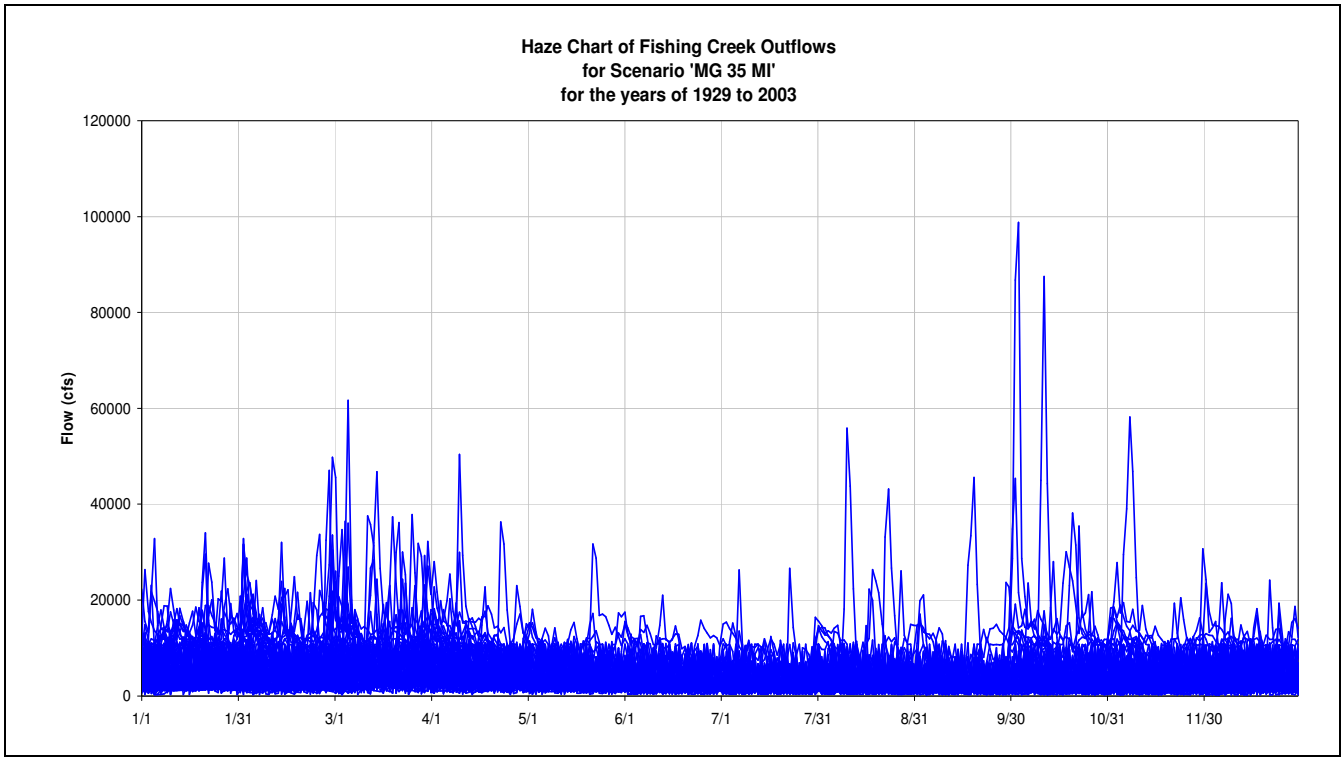

Figure 319: FC Outflow Haze Chart for MG 35 MI

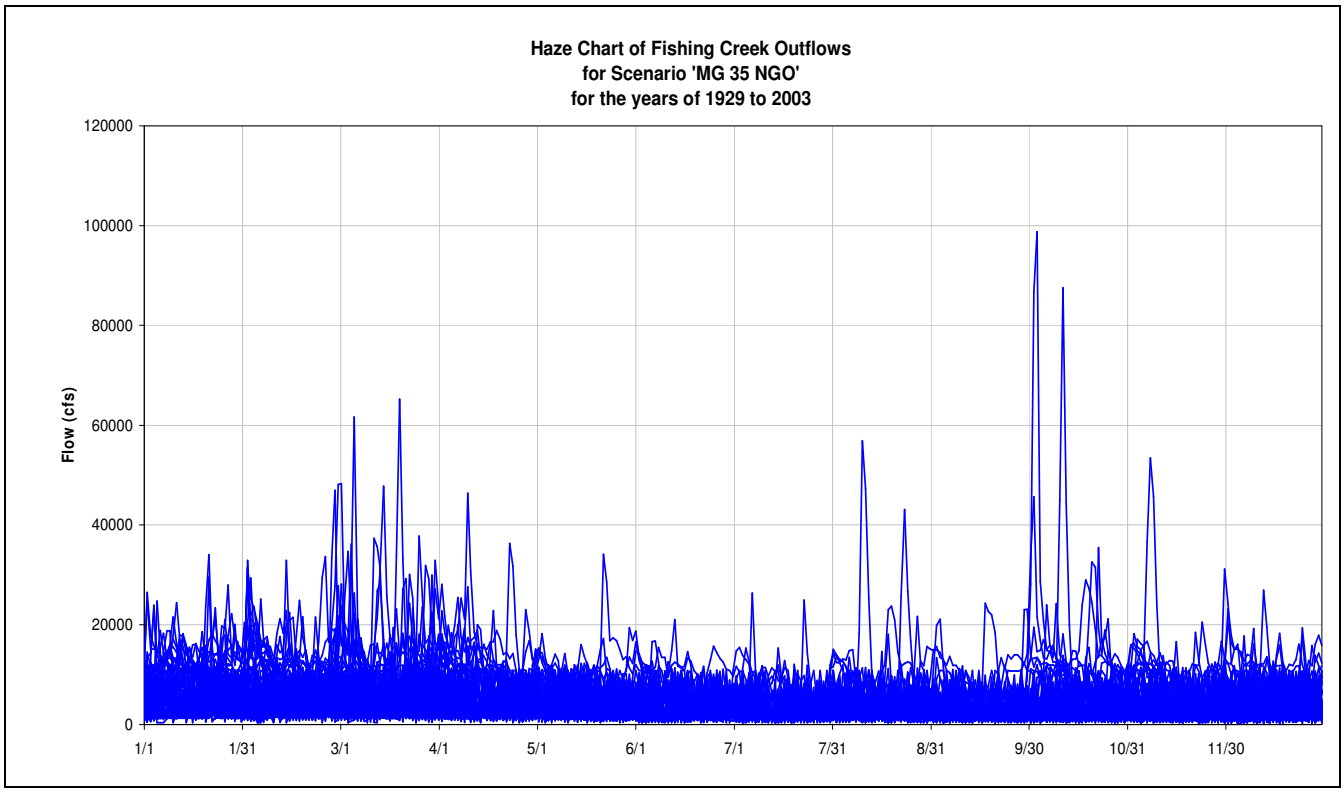

Figure 320: FC Outflow Haze Chart for MG 35 NGO

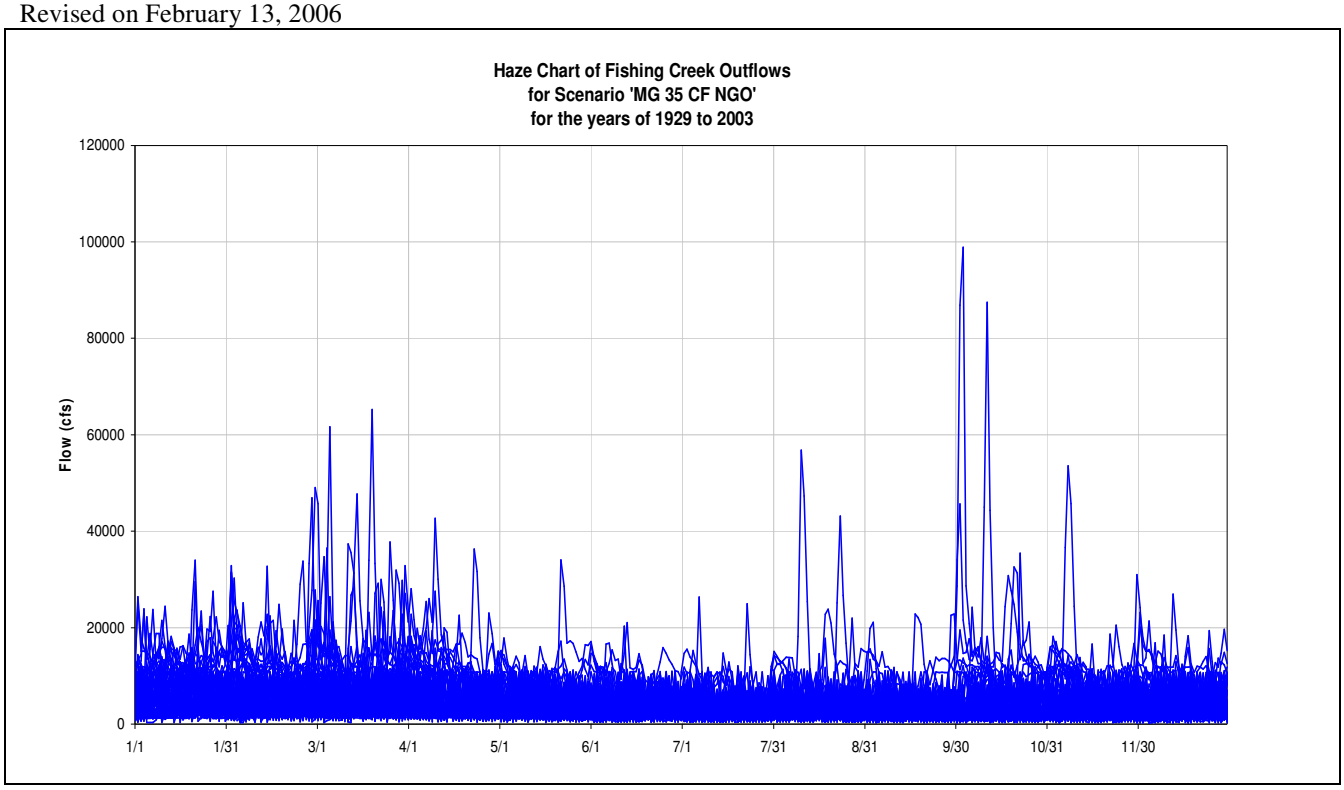

Figure 321: FC Outflow Haze Chart for MG 35 CF NGO

9) Great Falls

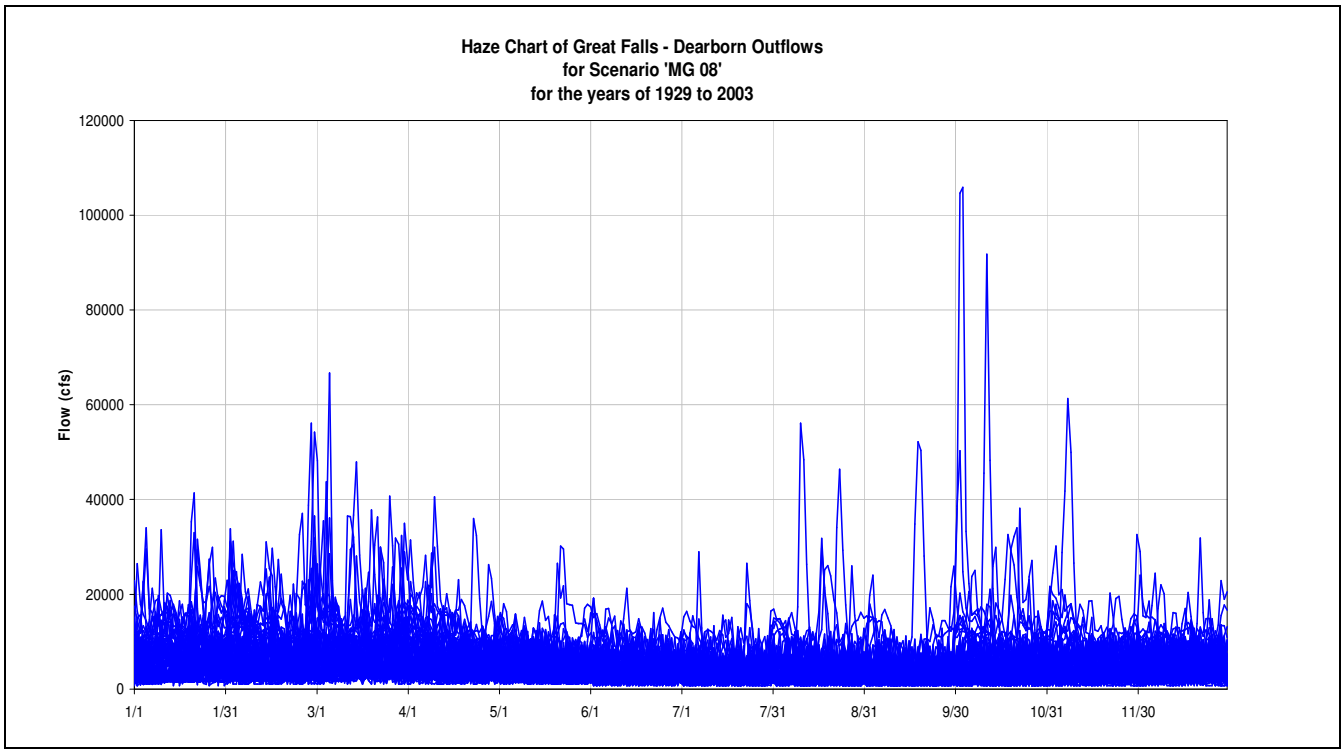

Figure 322: GF Outflow Haze Chart for MG 08

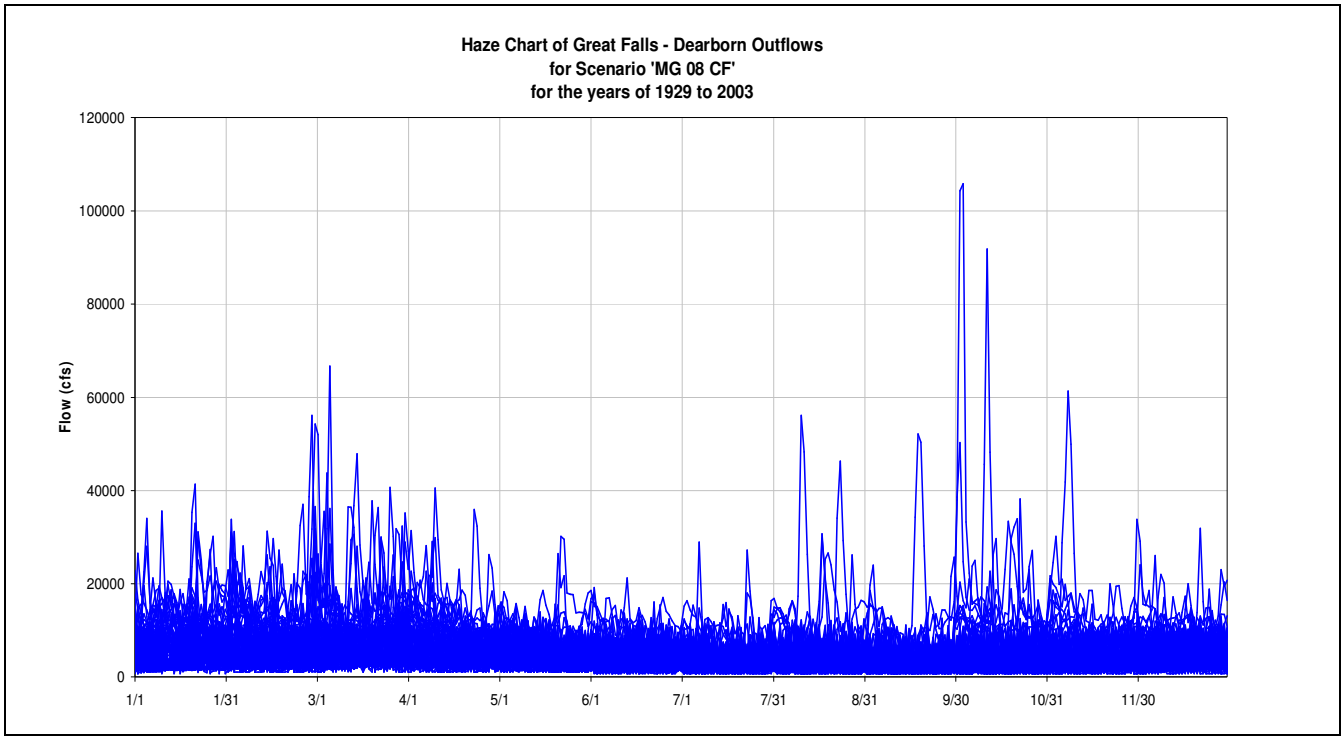

Figure 323: GF Outflow Haze Chart for MG 08 CF

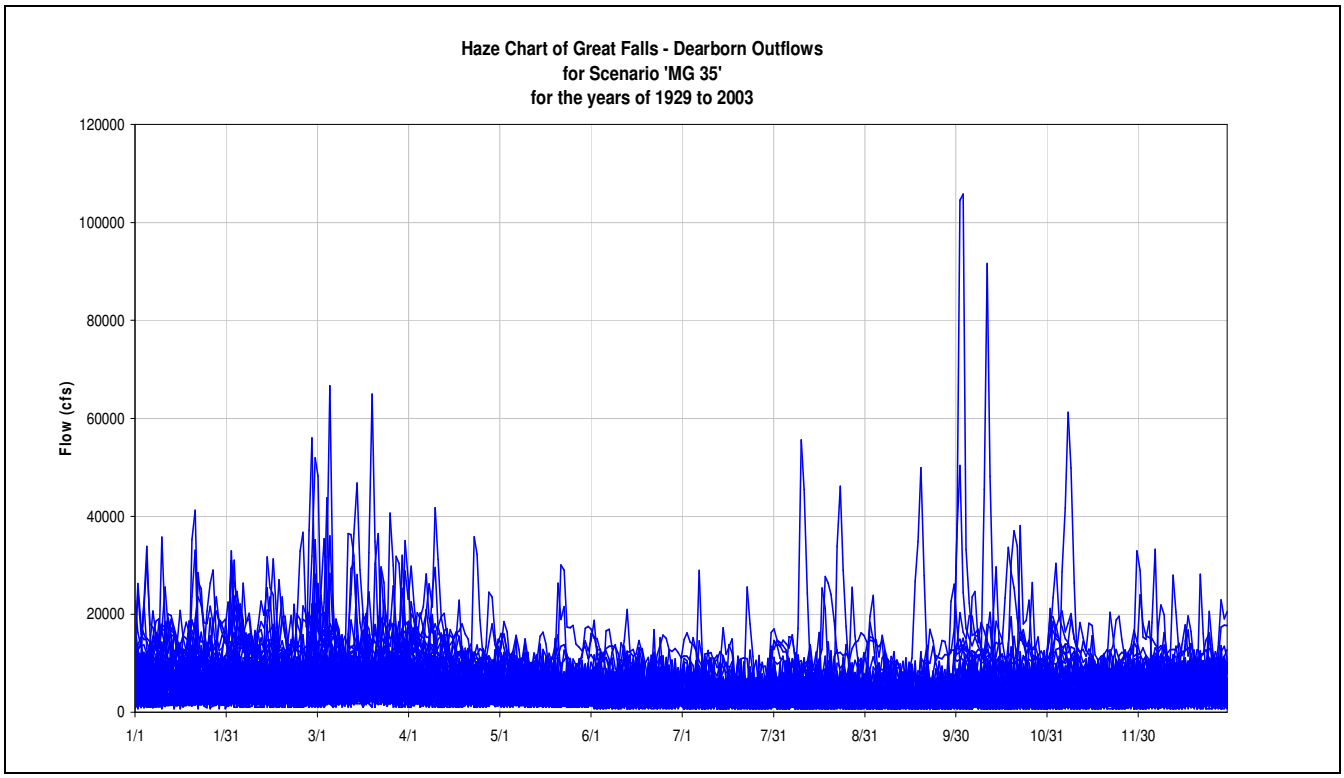

Figure 324: GF Outflow Haze Chart for MG 35

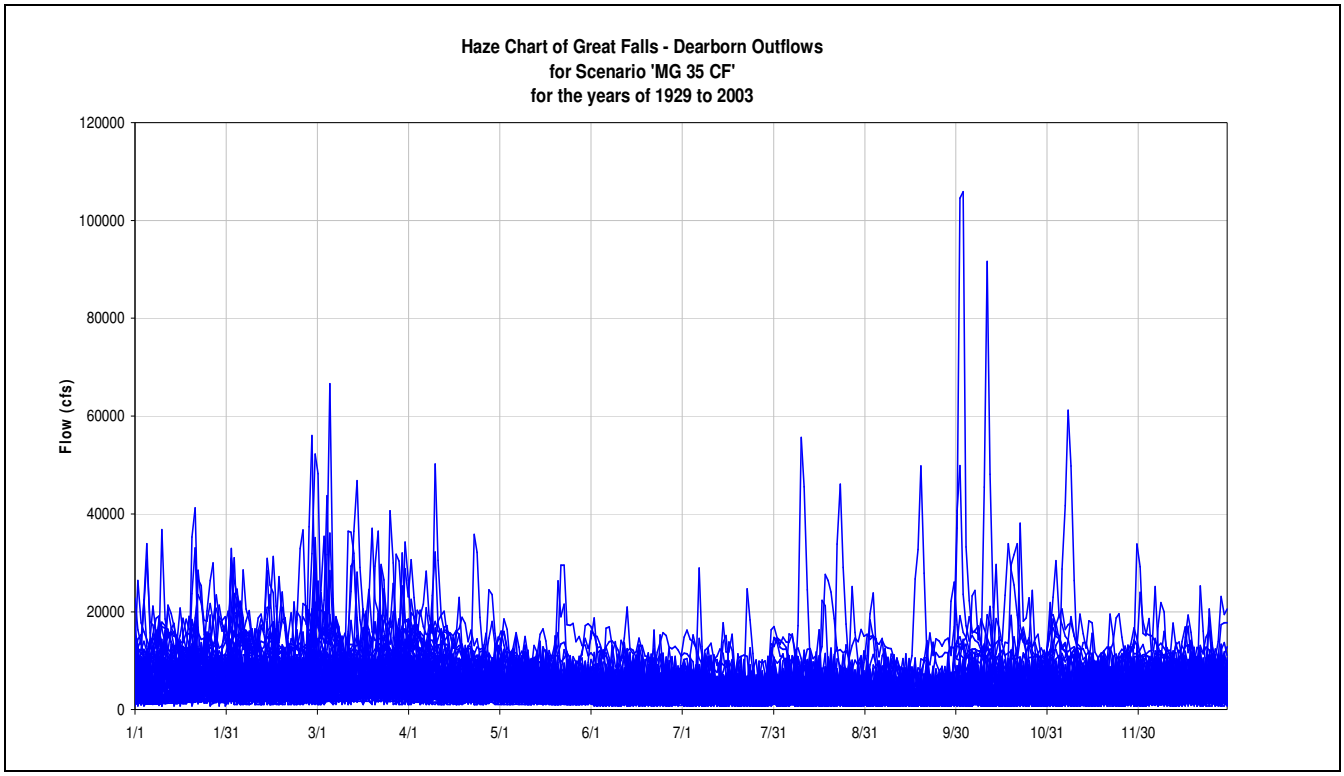

Figure 325: GF Outflow Haze Chart for MG 35 CF

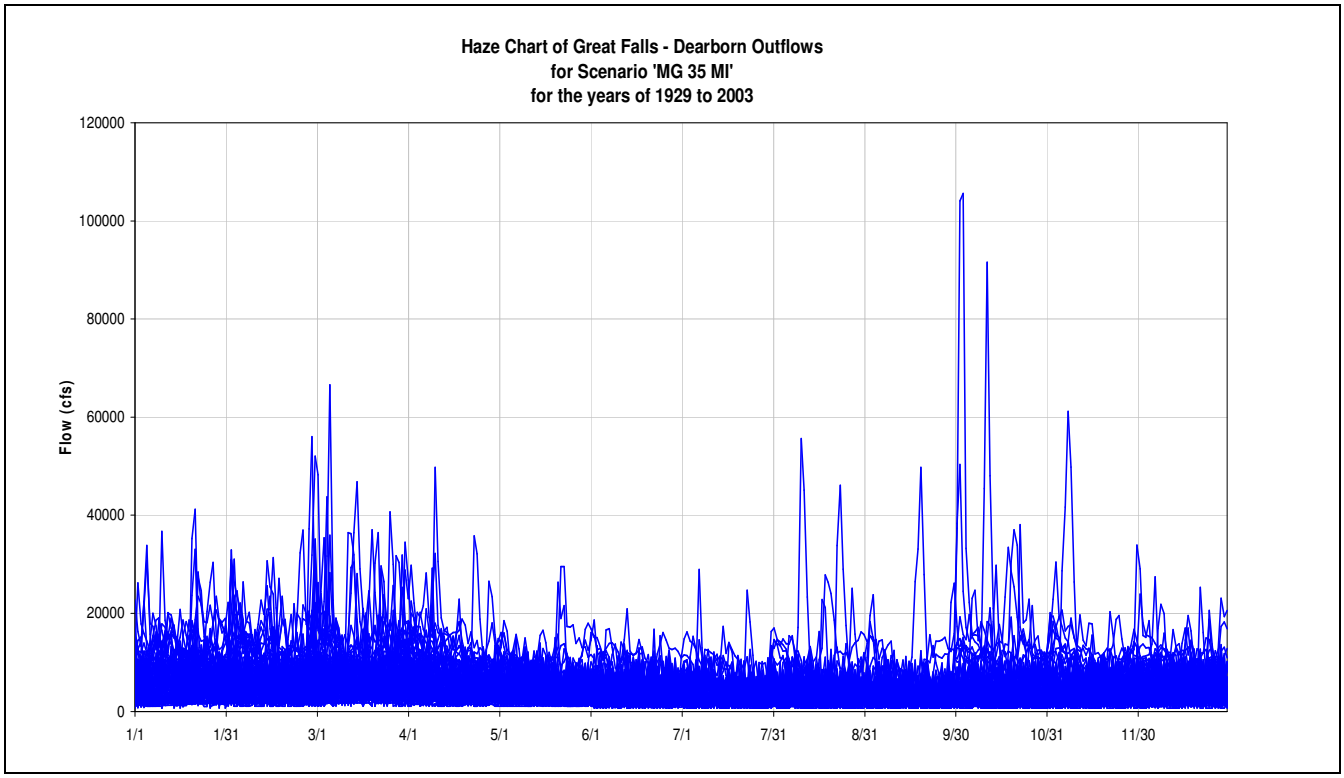

Figure 326: GF Outflow Haze Chart for MG 35 MI

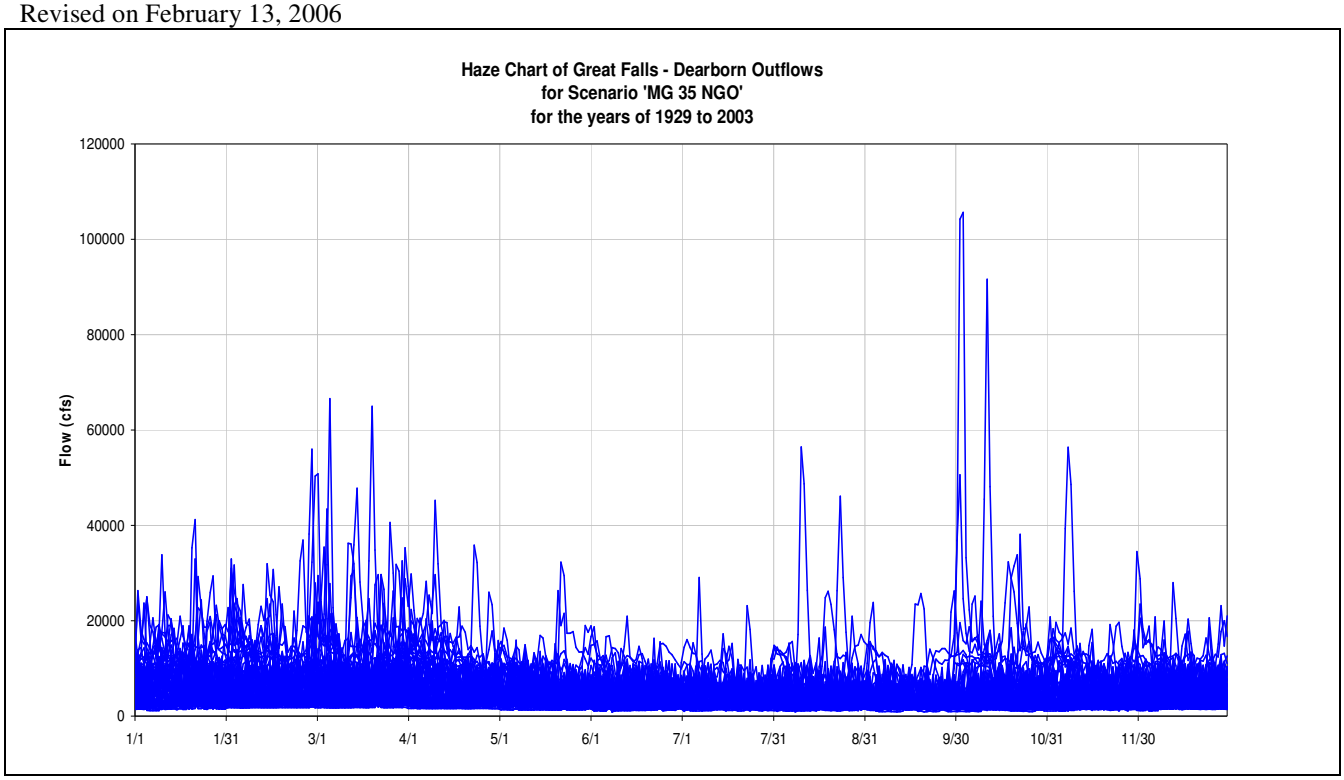

Figure 327: GF Outflow Haze Chart for MG 35 NGO

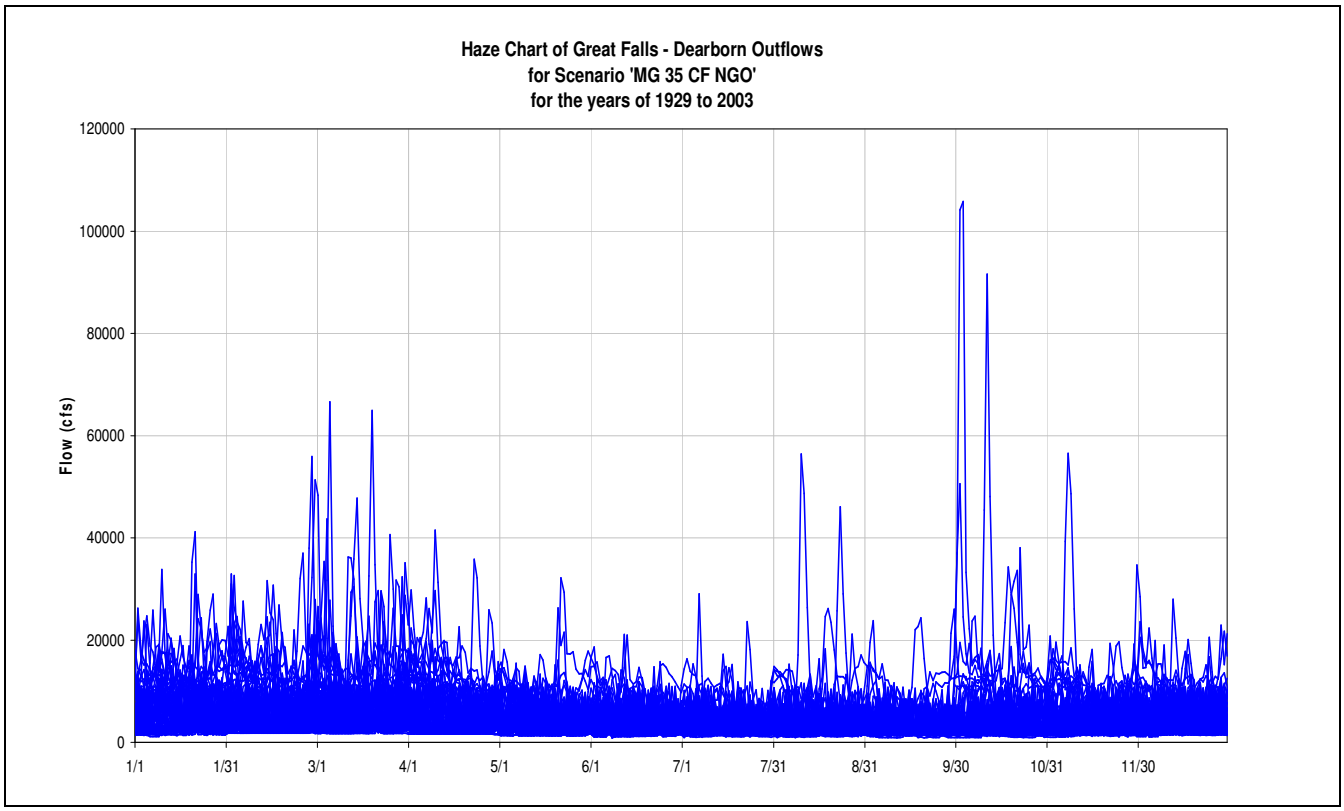

Figure 328: GF Outflow Haze Chart for MG 35 CF NGO

10) Rocky Creek

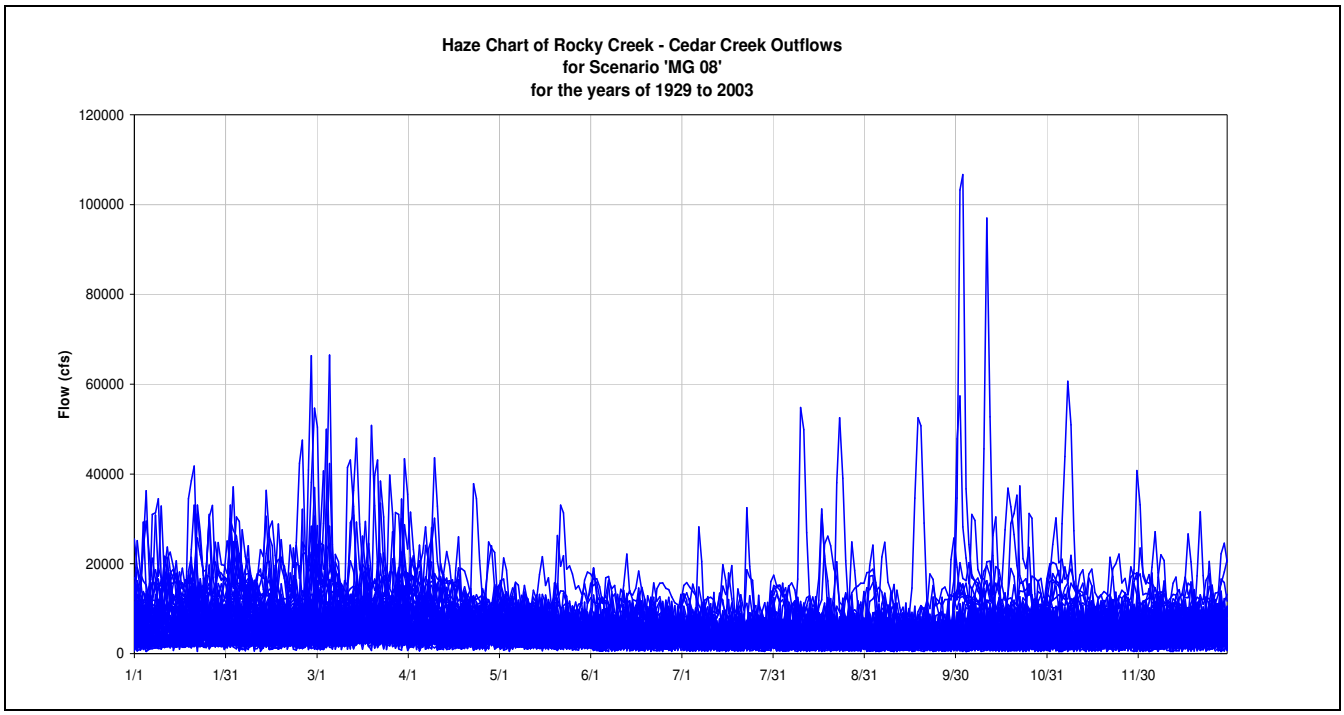

Figure 329: RC Outflow Haze Chart for MG 08

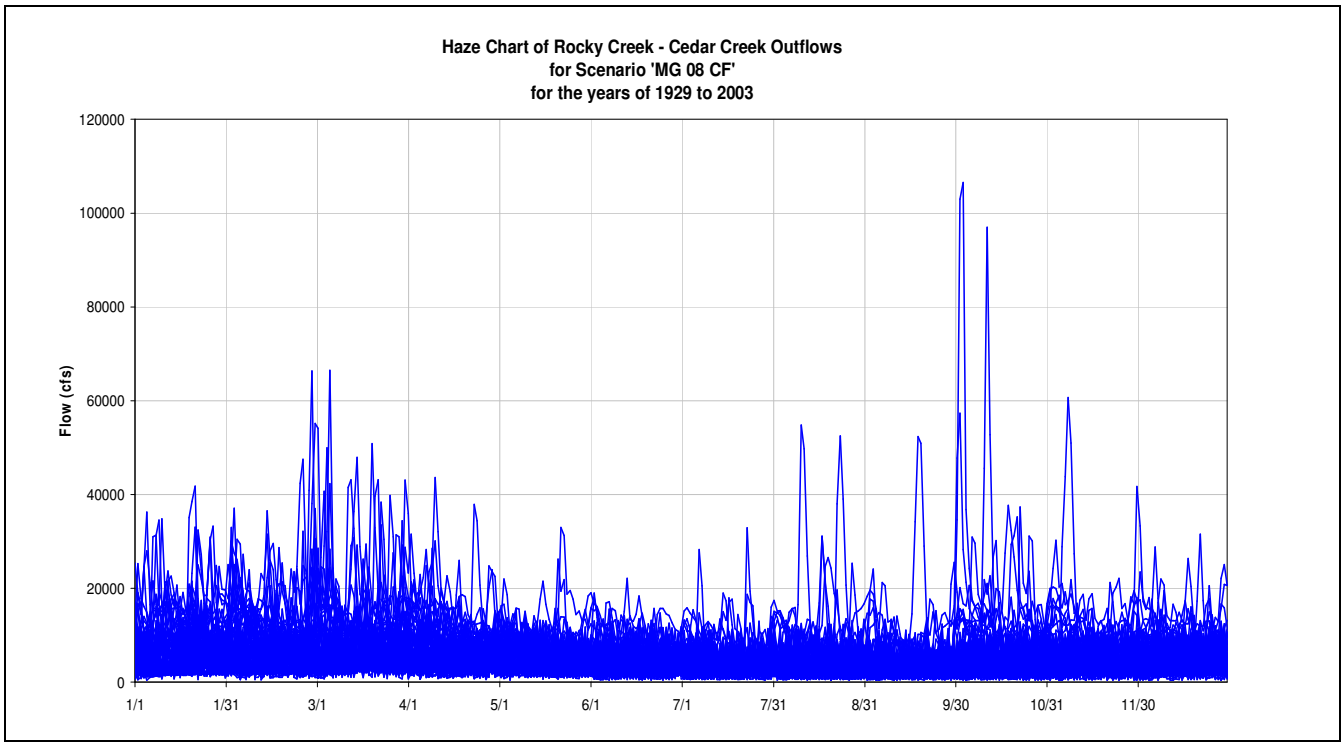

Figure 330: RC Outflow Haze Chart for MG 08 CF

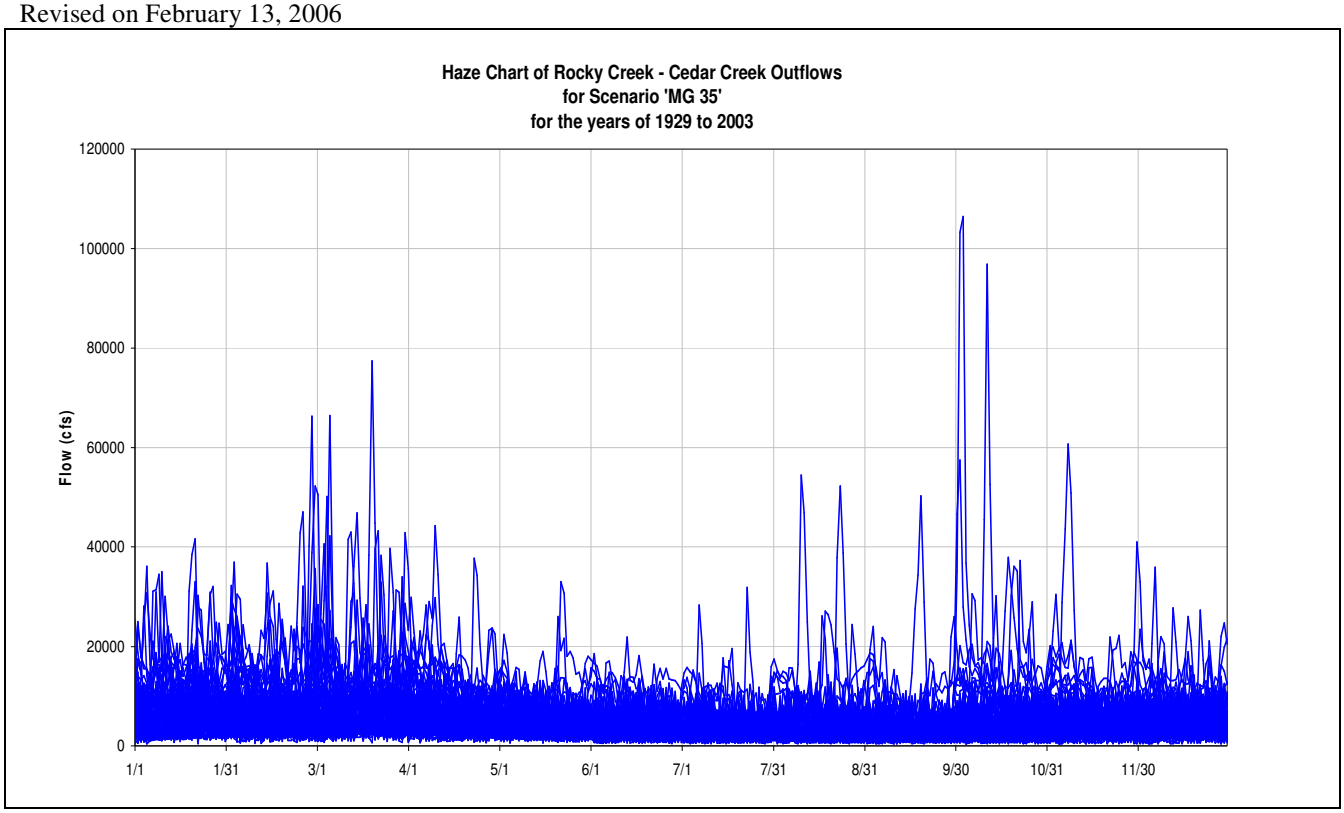

Figure 331: RC Outflow Haze Chart for MG 35

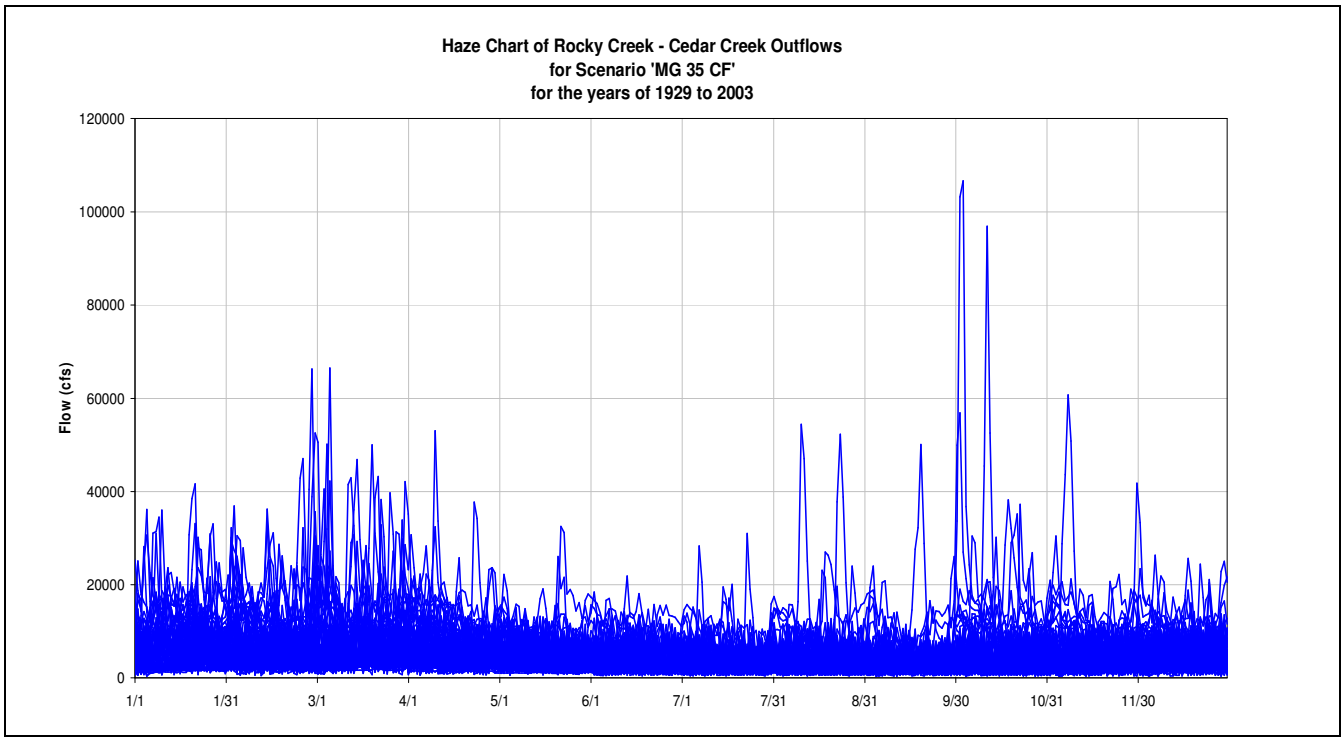

Figure 332: RC Outflow Haze Chart for MG 35 CF

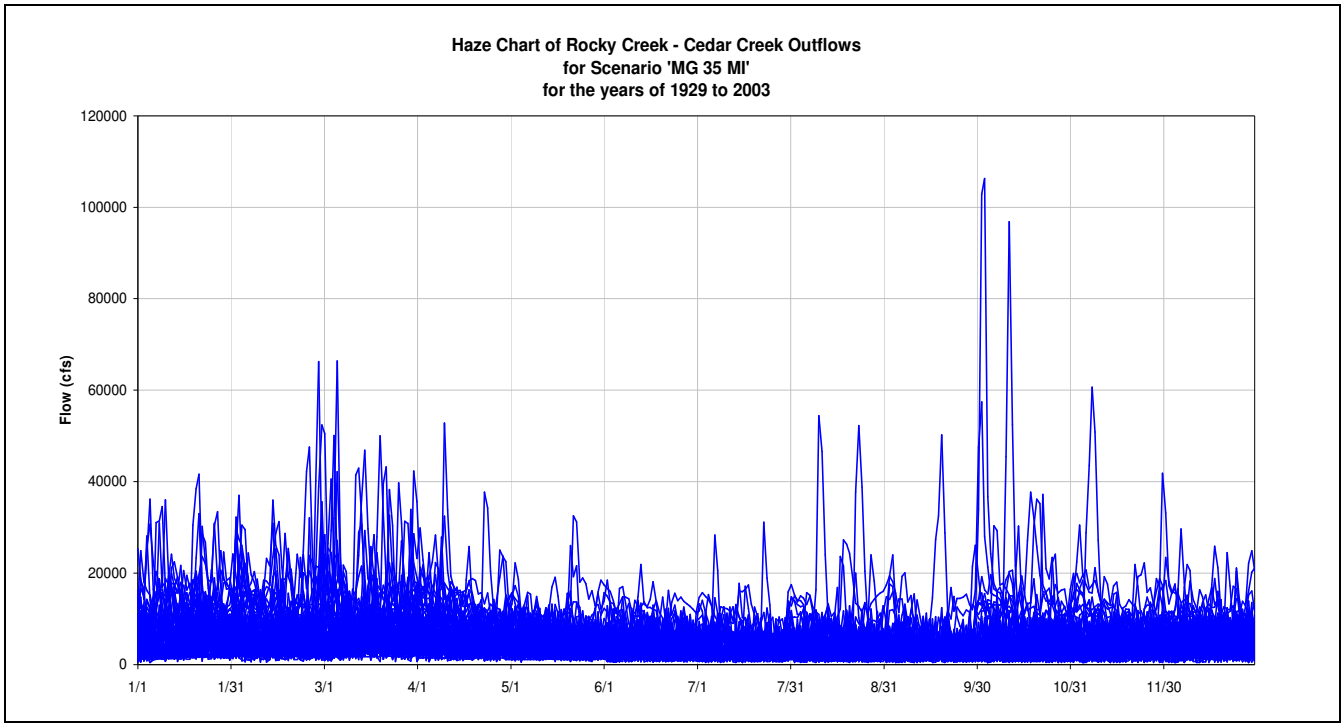

Figure 333: RC Outflow Haze Chart for MG 35 MI

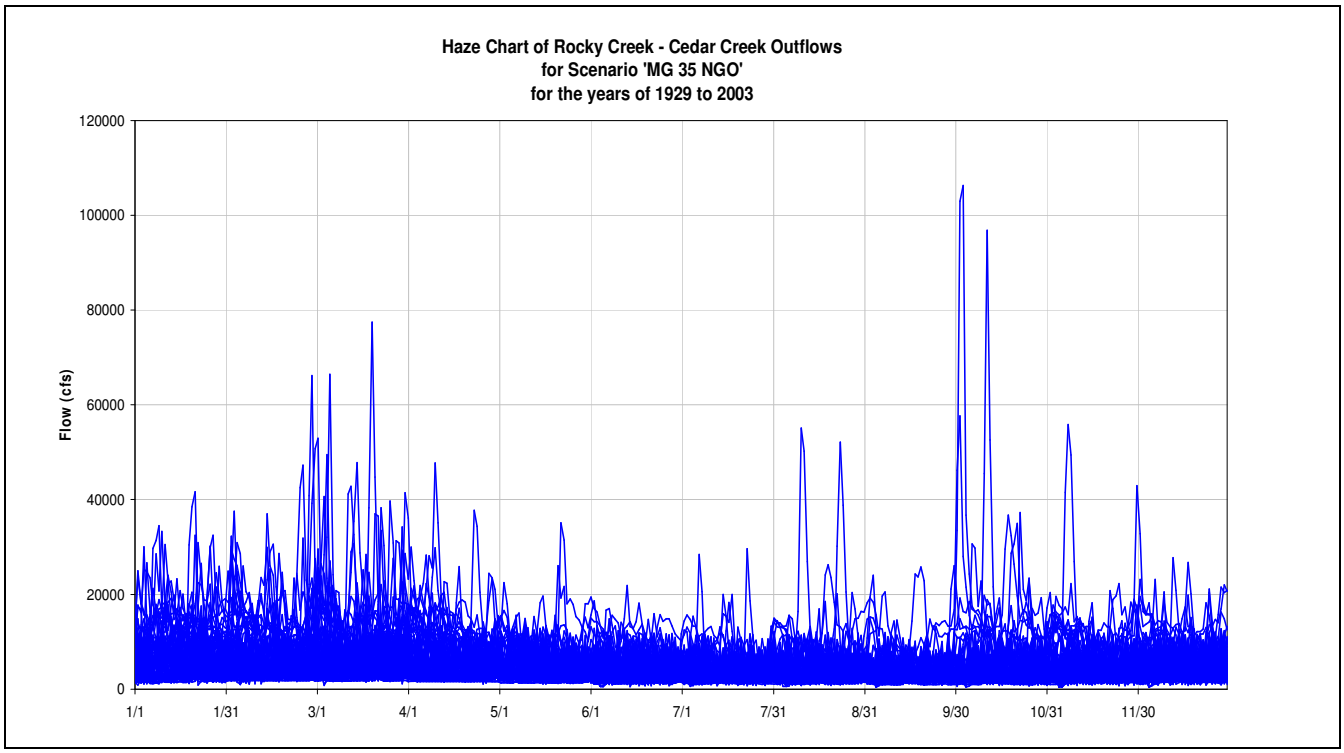

Figure 334: RC Outflow Haze Chart for MG 35 NGO

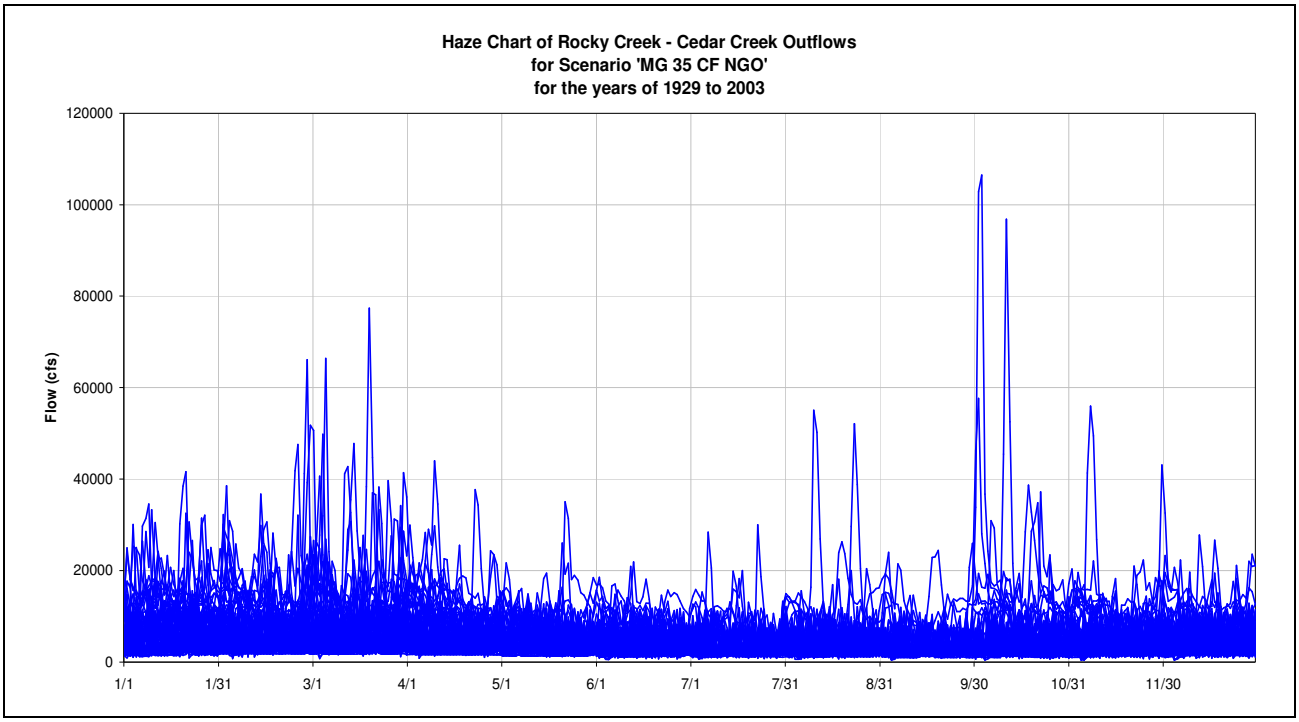

Figure 335: RC Outflow Haze Chart for MG 35 CF NGO

11) Watereee

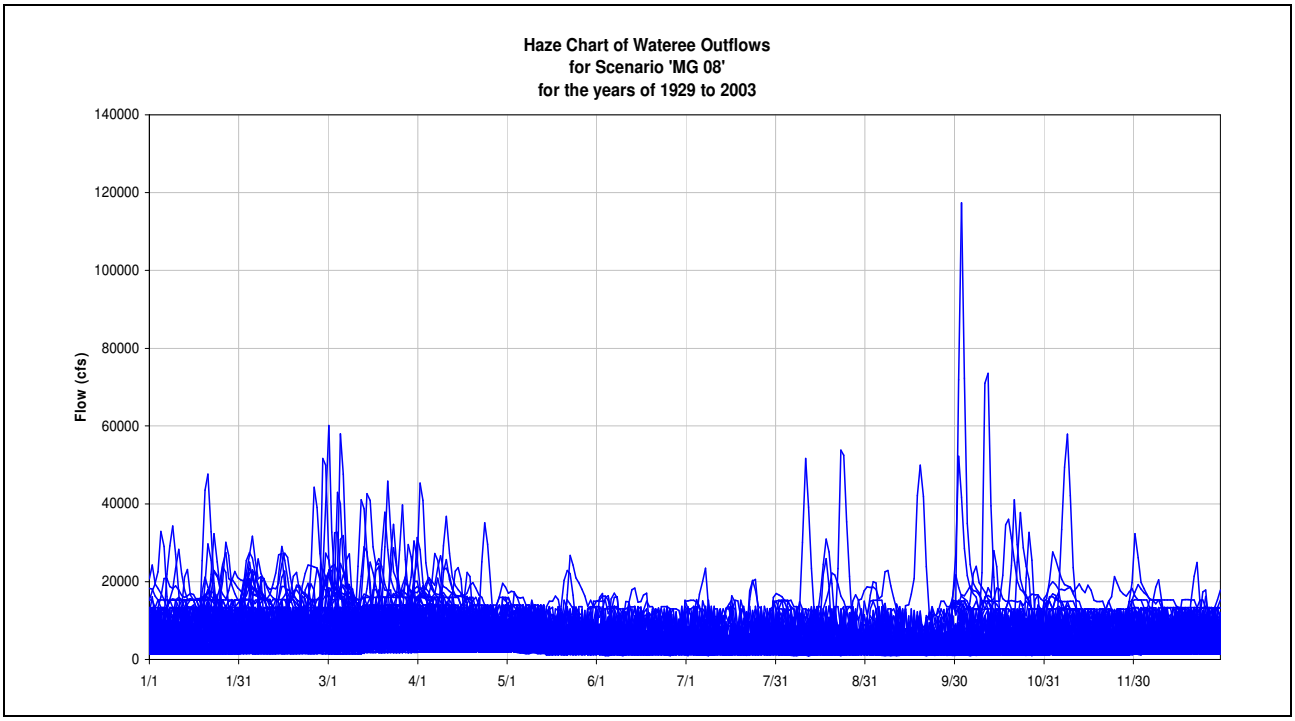

Figure 336: WA Outflow Haze Chart for MG 08

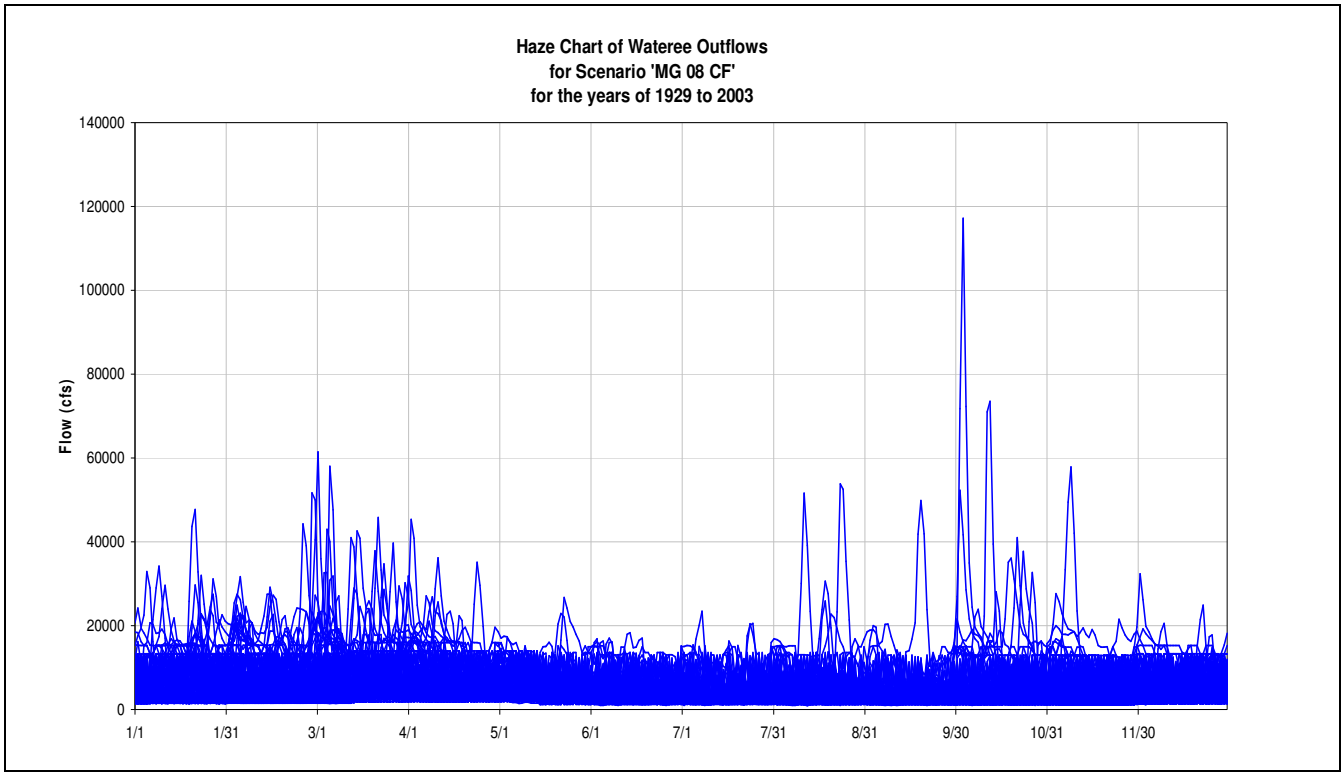

Figure 337: WA Outflow Haze Chart for MG 08 CF

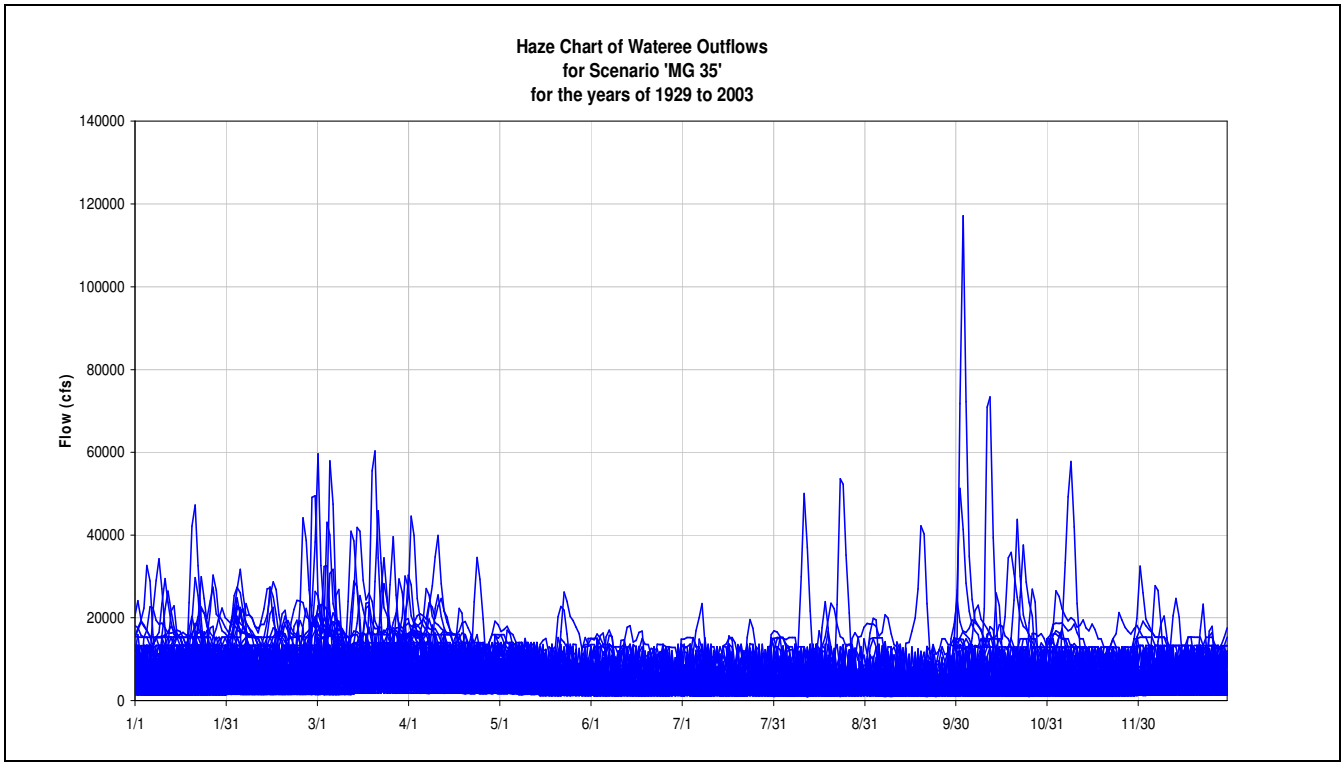

Figure 338: WA Outflow Haze Chart for MG 35

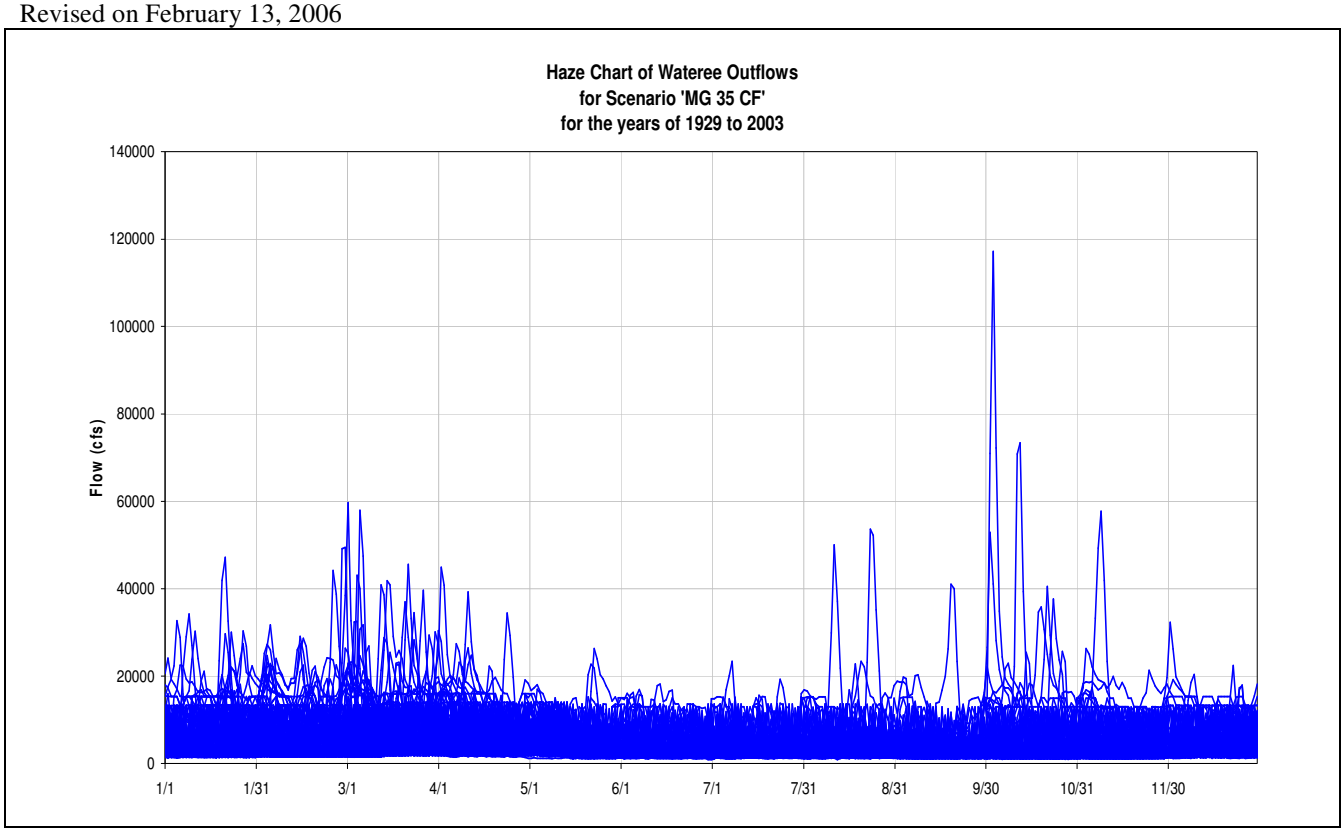

Figure 339: WA Outflow Haze Chart for MG 35 CF

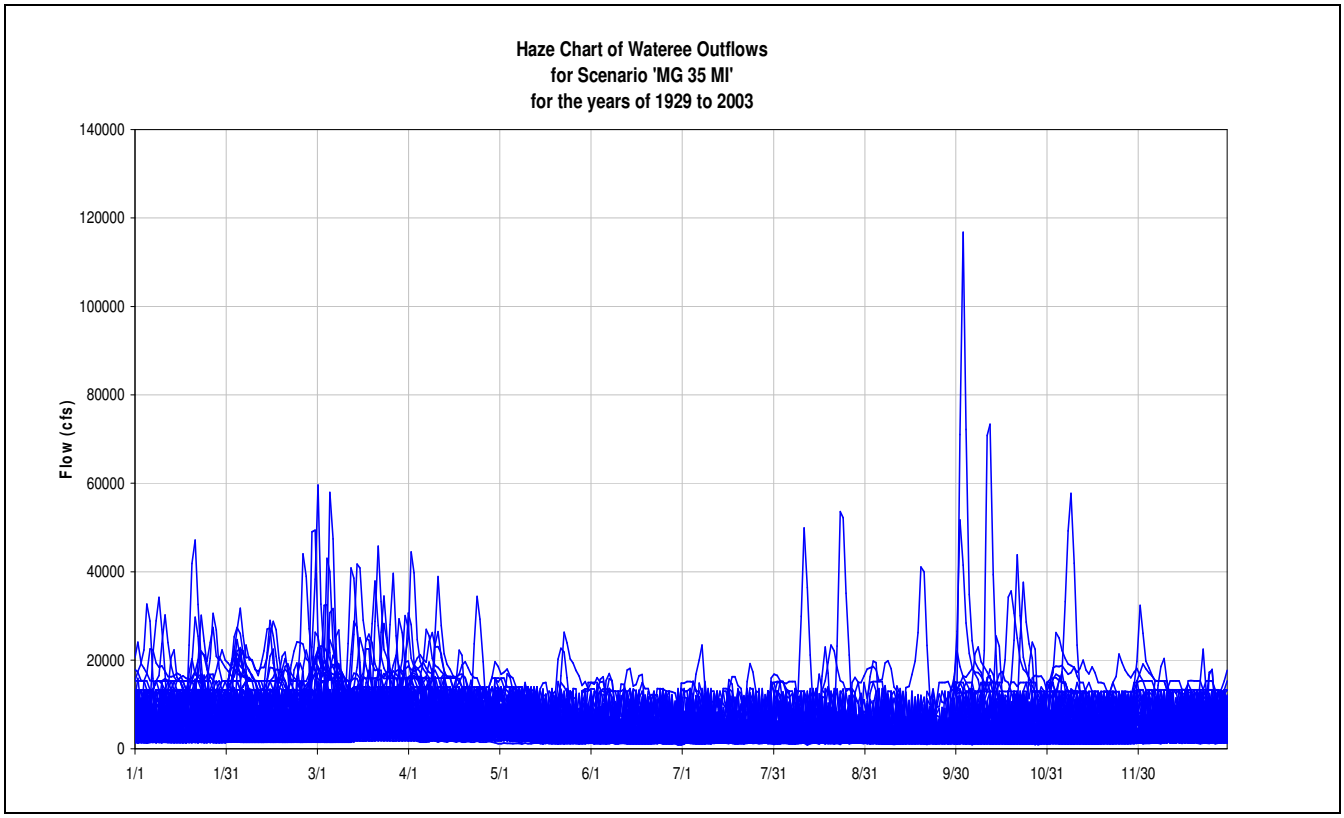

Figure 340: WA Outflow Haze Chart for MG 35 MI

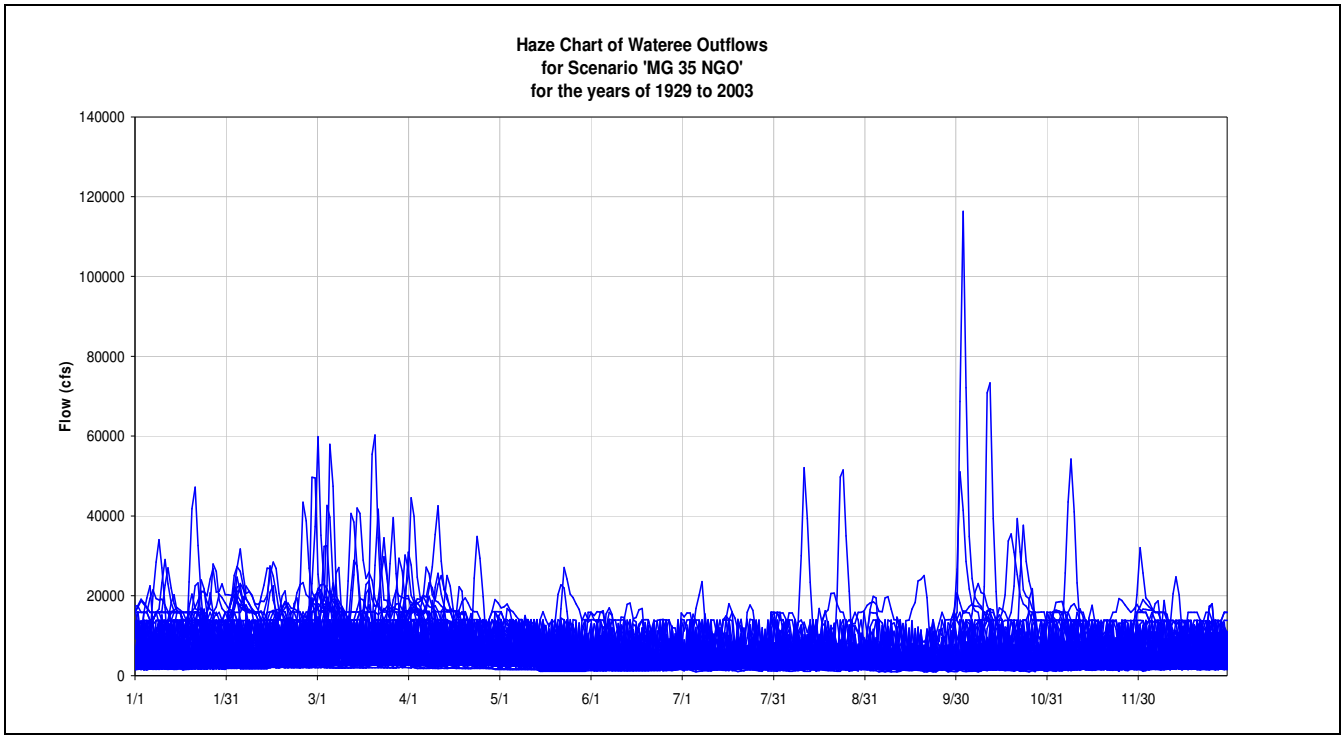

Figure 341: WA Outflow Haze Chart for MG 35 NGO

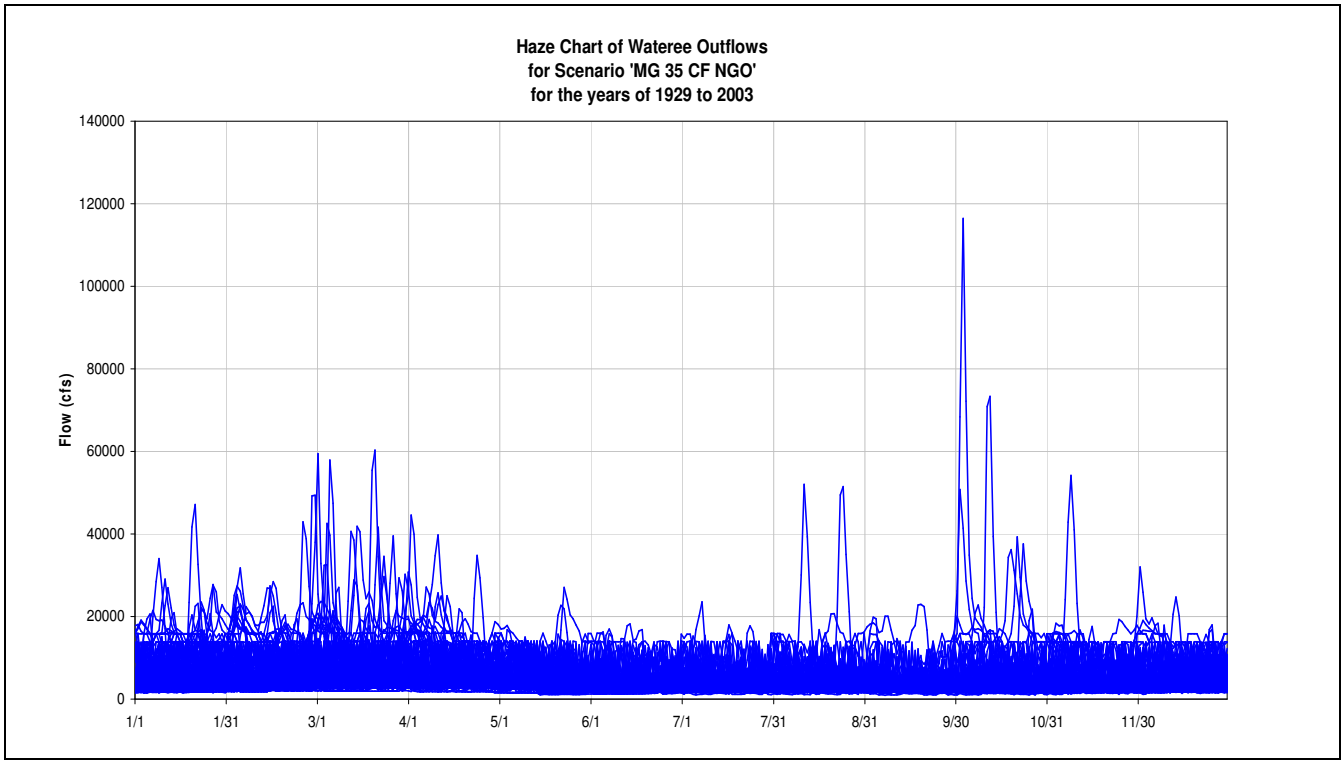

Figure 342: WA Outflow Haze Chart for MG 35 CF NGO

12. Impacts of NEW LIP data set:

This set of analyses was done to see the impacts of new LIP data set. The following charts and tables compare the old LIP vs the new LIP.

1. LIP Stages:

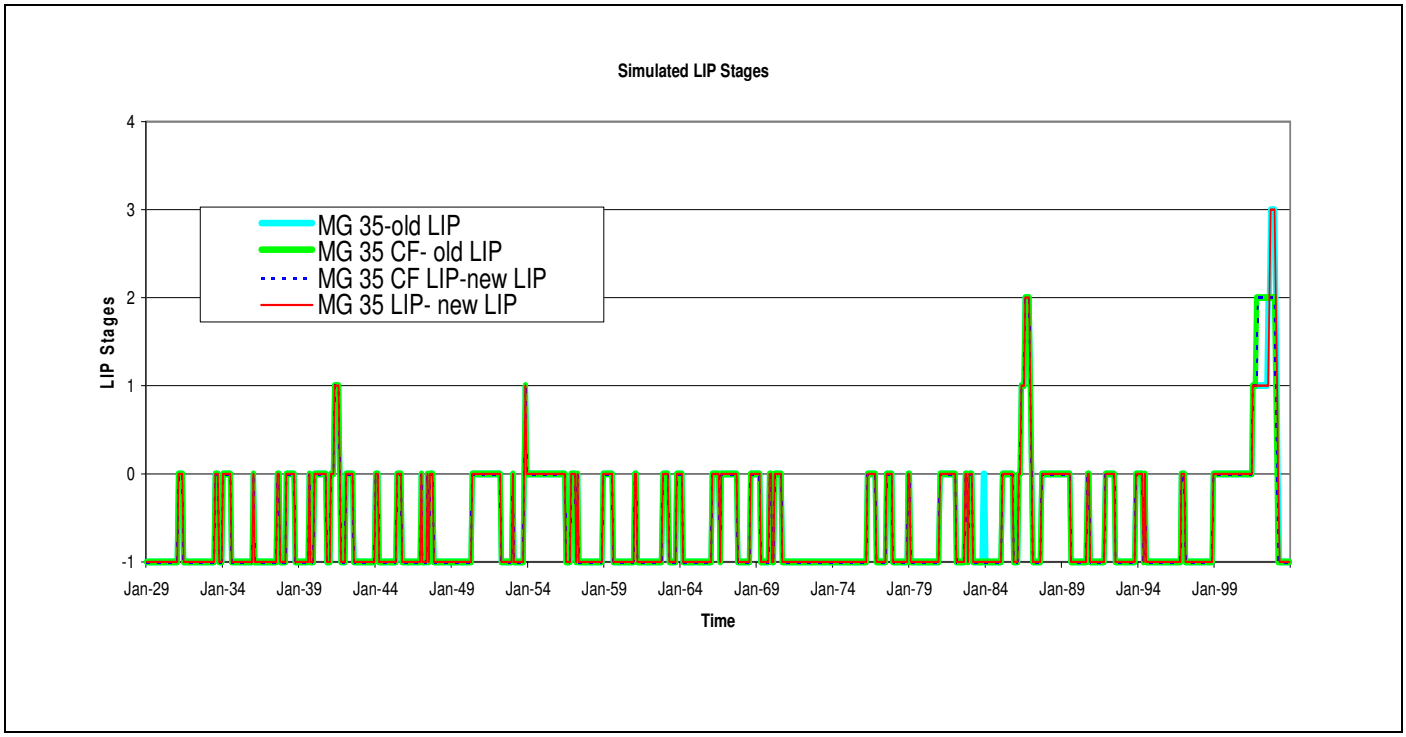

Figure 343: LIP Stages with new and old LIP data

2. LIP Summary:

Table 24 : LIP for MG 35 [old LIP]

LIP Stage Summary for MG 35 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	573	64%
0	294	33%
1	22	2%
2	7	1%
3	4	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	573	294	22	7	4	0
January	42	31	1	1	0	0
February	44	29	2	0	0	0
March	45	29	1	0	0	0
April	48	26	1	0	0	0
May	49	23	3	0	0	0
June	47	25	3	0	0	0
July	49	22	3	1	0	0
August	51	20	2	2	0	0
September	47	25	1	1	1	0
October	52	20	1	1	1	0
November	51	20	2	1	1	0
December	48	24	2	0	1	0

Table 25: LIP for MG 35 LIP [new LIP]

LIP Stage Summary for MG 35 LIP 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	575	64%
0	292	32%
1	23	3%
2	6	1%
3	4	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 LIP 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	575	292	23	6	4	0
January	42	31	1	1	0	0
February	44	29	2	0	0	0
March	45	29	1	0	0	0
April	48	26	1	0	0	0
May	49	23	3	0	0	0
June	47	25	3	0	0	0
July	49	22	4	0	0	0
August	51	20	2	2	0	0
September	47	25	1	1	1	0
October	52	20	1	1	1	0
November	52	19	2	1	1	0
December	49	23	2	0	1	0

Table 26 : LIP for MG 35 CF [old LIP]

LIP Stage Summary for MG 35 CF 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	576	64%
0	292	32%
1	13	1%
2	19	2%
3	0	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 CF 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	576	292	13	19	0	0
January	42	31	1	1	0	0
February	44	30	0	1	0	0
March	46	28	0	1	0	0
April	48	26	0	1	0	0
May	49	23	2	1	0	0
June	47	25	2	1	0	0
July	49	22	3	1	0	0
August	51	20	2	2	0	0
September	47	25	1	2	0	0
October	52	20	0	3	0	0
November	52	19	1	3	0	0
December	49	23	1	2	0	0

Table 27: LIP for MG 35 CF LIP [new LIP]

LIP Stage Summary for MG 35 CF LIP 1/1/1929 to 12/1/2003		
LIP Stage	**Number of Occurrences**	**Percent of Time**
-1	576	64%
0	292	32%
1	14	2%
2	18	2%
3	0	0%
4	0	0%

Monthly LIP Stage Summary for MG 35 CF LIP 1/1/1929 to 12/1/2003						
LIP Stage	**-1**	**0**	**1**	**2**	**3**	**4**
Total Number of Occurrences	576	292	14	18	0	0
January	42	31	1	1	0	0
February	44	30	0	1	0	0
March	46	28	0	1	0	0
April	48	26	0	1	0	0
May	49	23	2	1	0	0
June	47	25	2	1	0	0
July	49	22	3	1	0	0
August	51	20	2	2	0	0
September	47	25	1	2	0	0
October	52	20	1	2	0	0
November	52	19	1	3	0	0
December	49	23	1	2	0	0

3. Elevation Conditions during Dry Seasons:

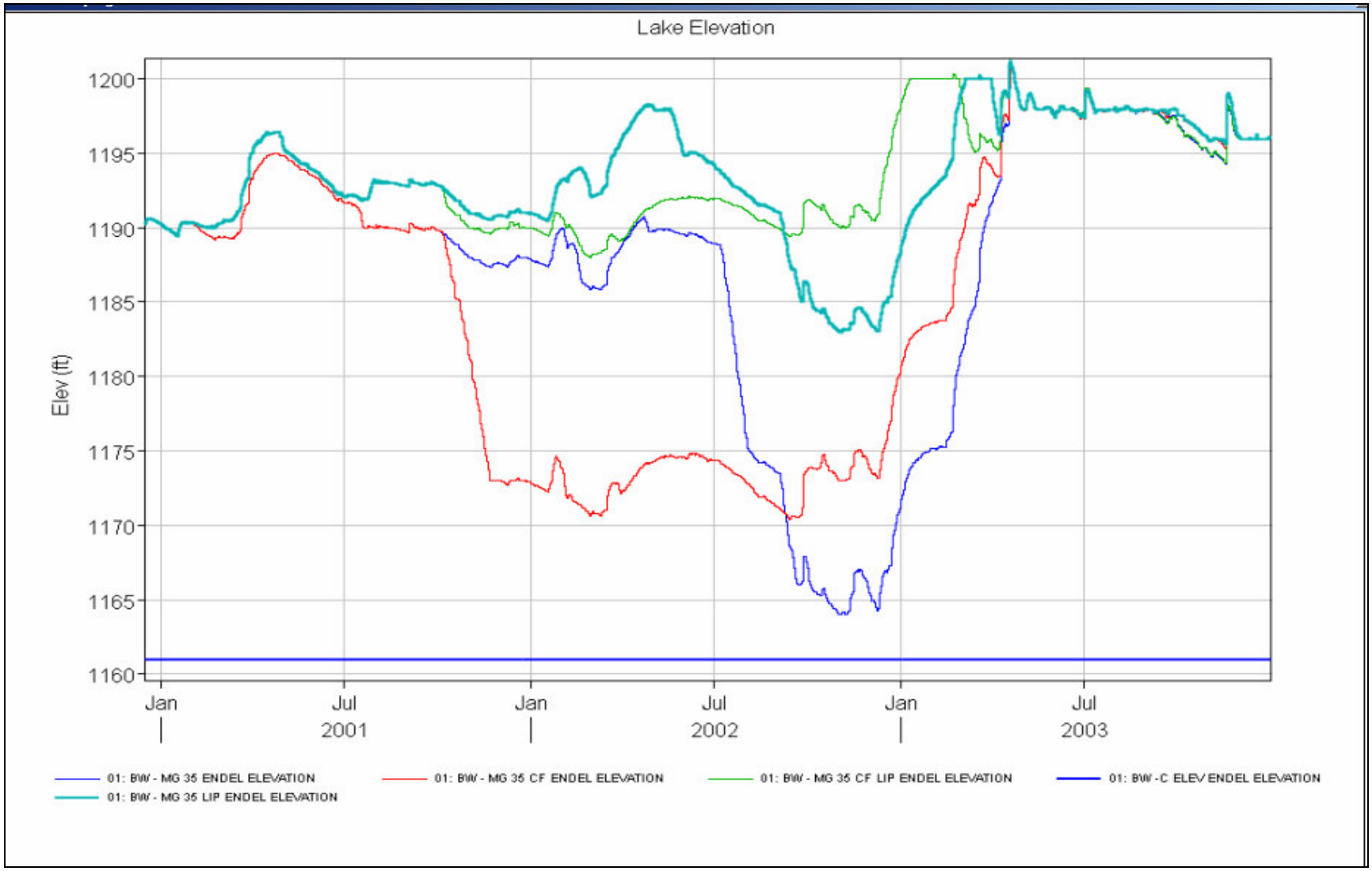

Figure 344: Bridgewater Elevations with New LIP

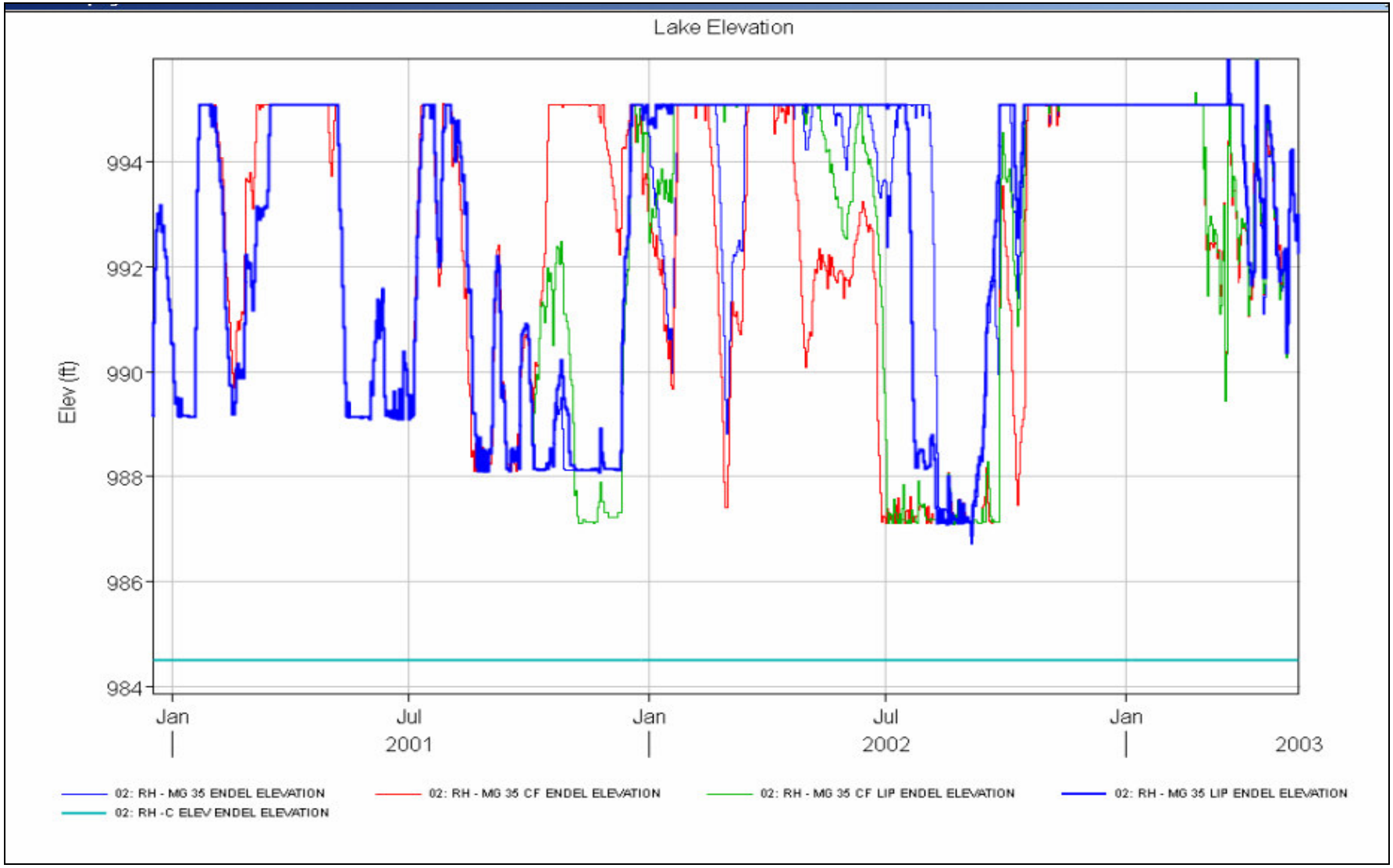

Figure 345: Rhodhiss Elevations with New LIP

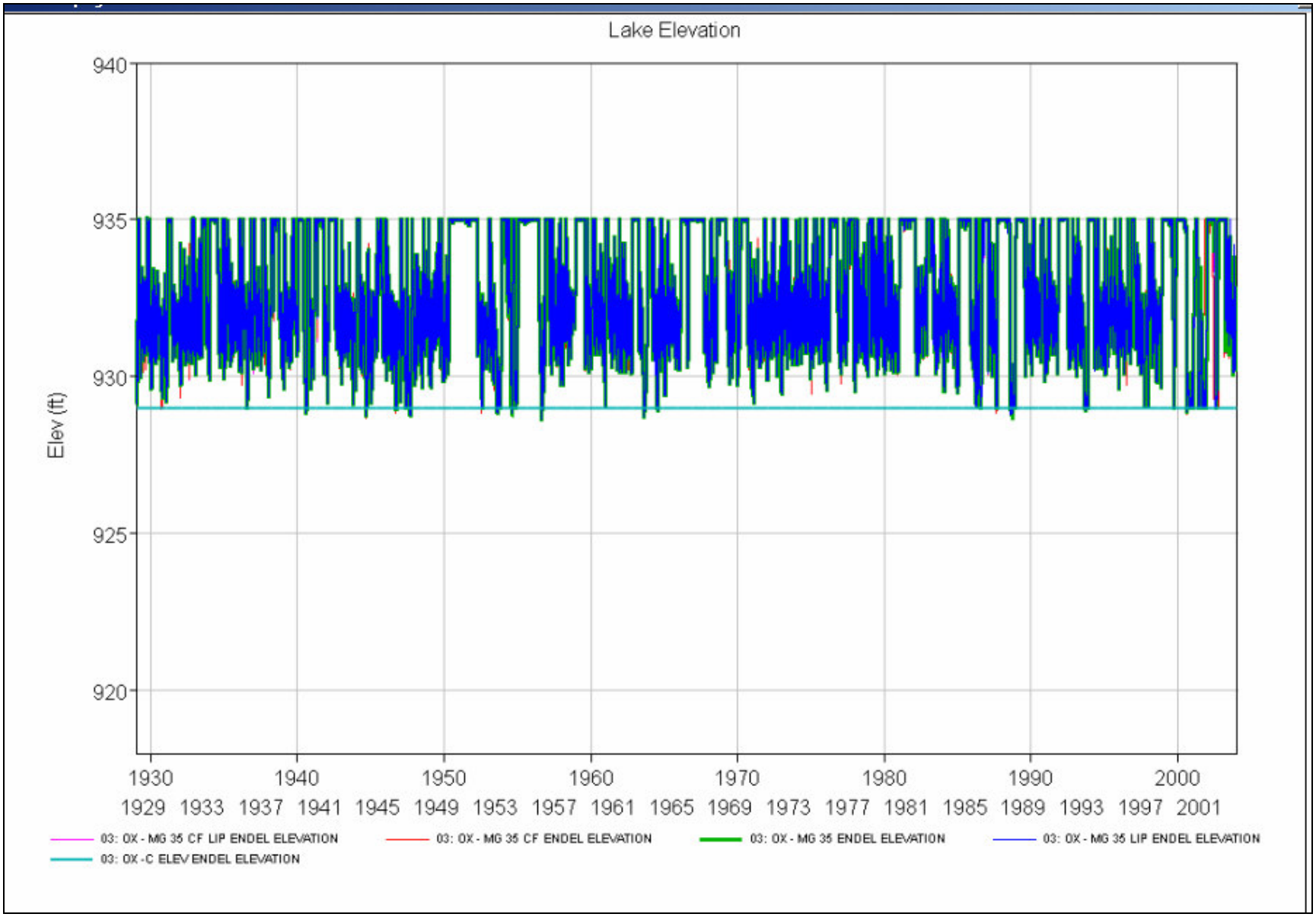

Figure 346: Oxford Elevations with New LIP

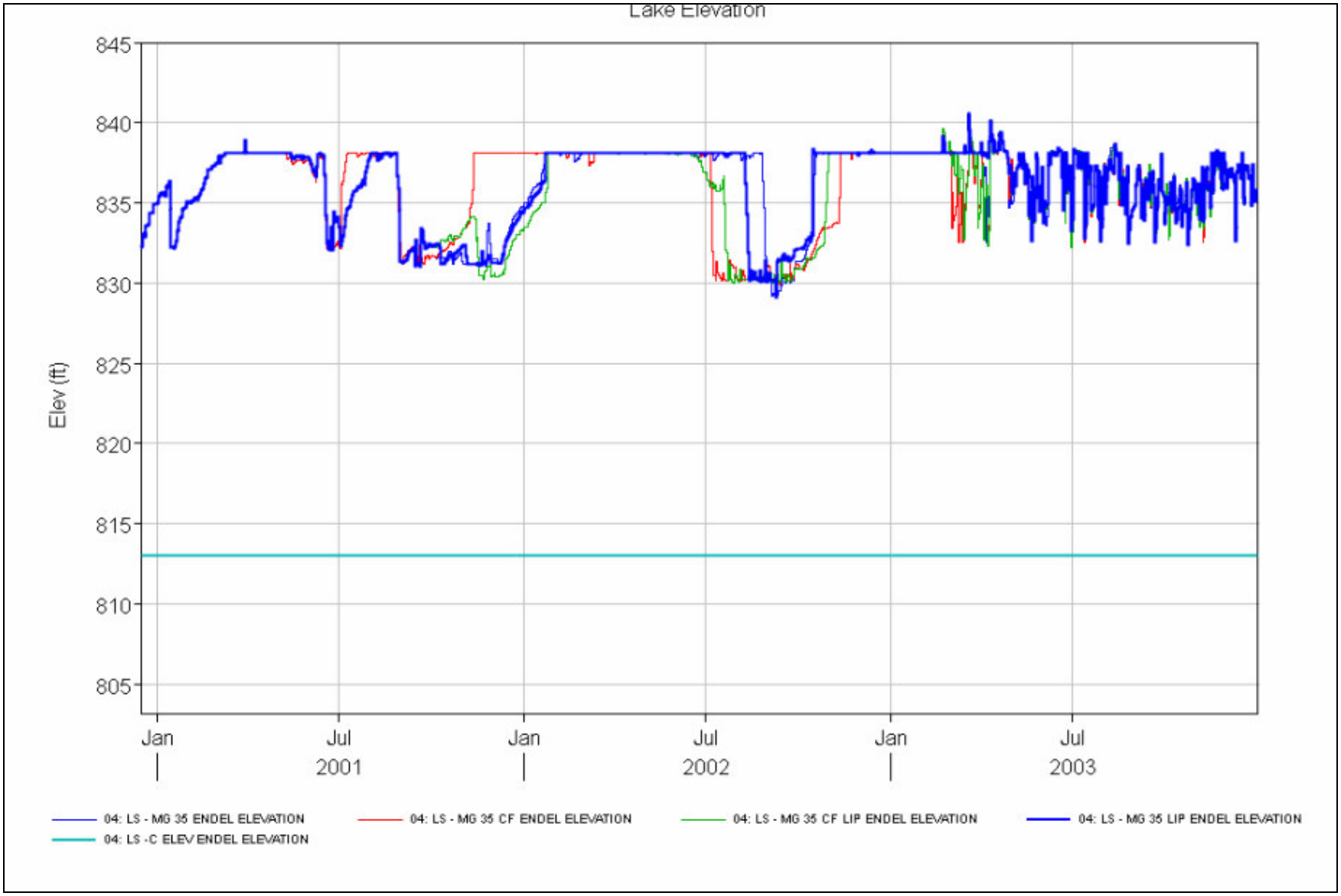

Figure 347: Lookout Shoals Elevations with New LIP

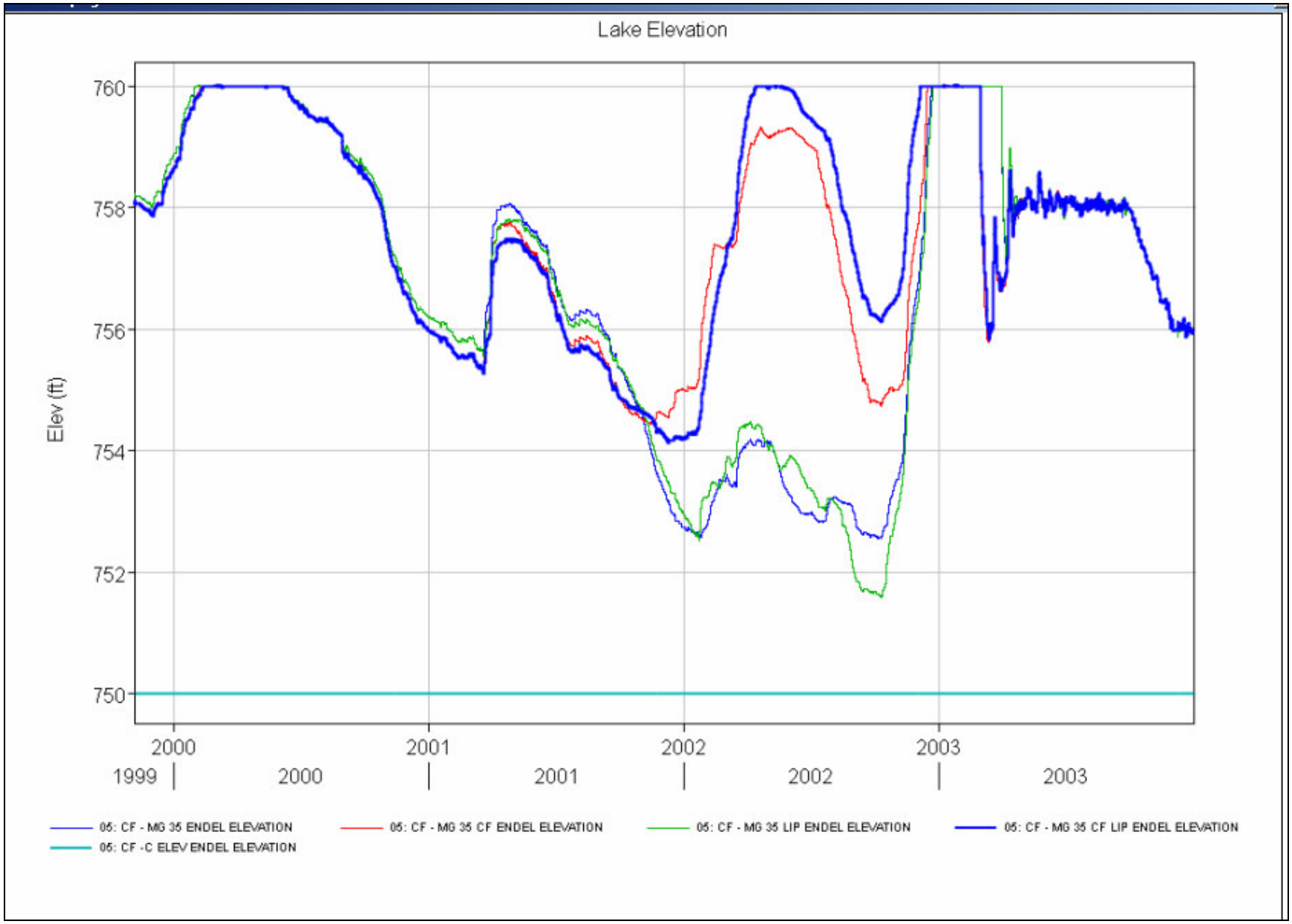

Figure 348: Cowan Ford Elevations with New LIP

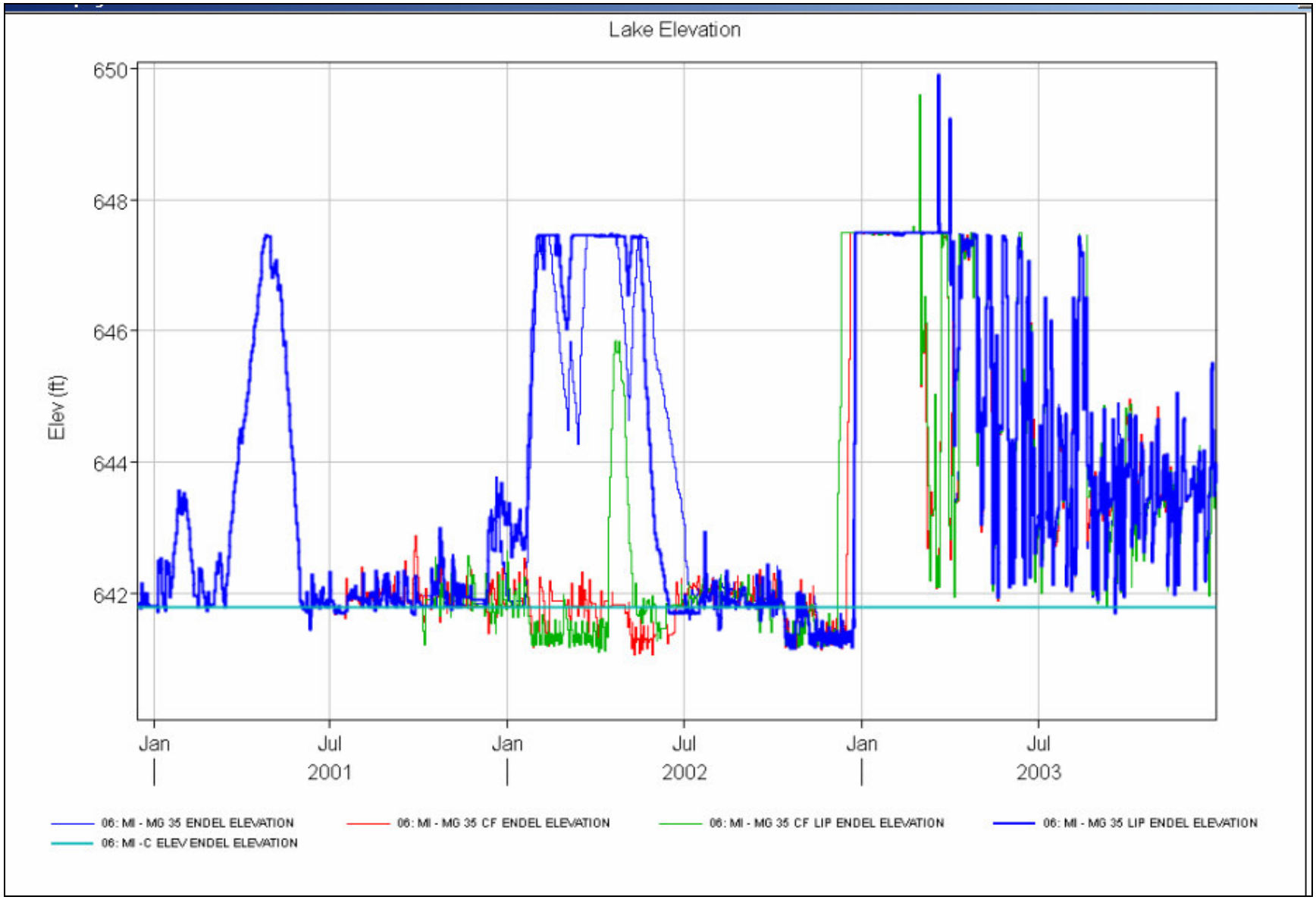

Figure 349: Mountain Island Elevations with New LIP

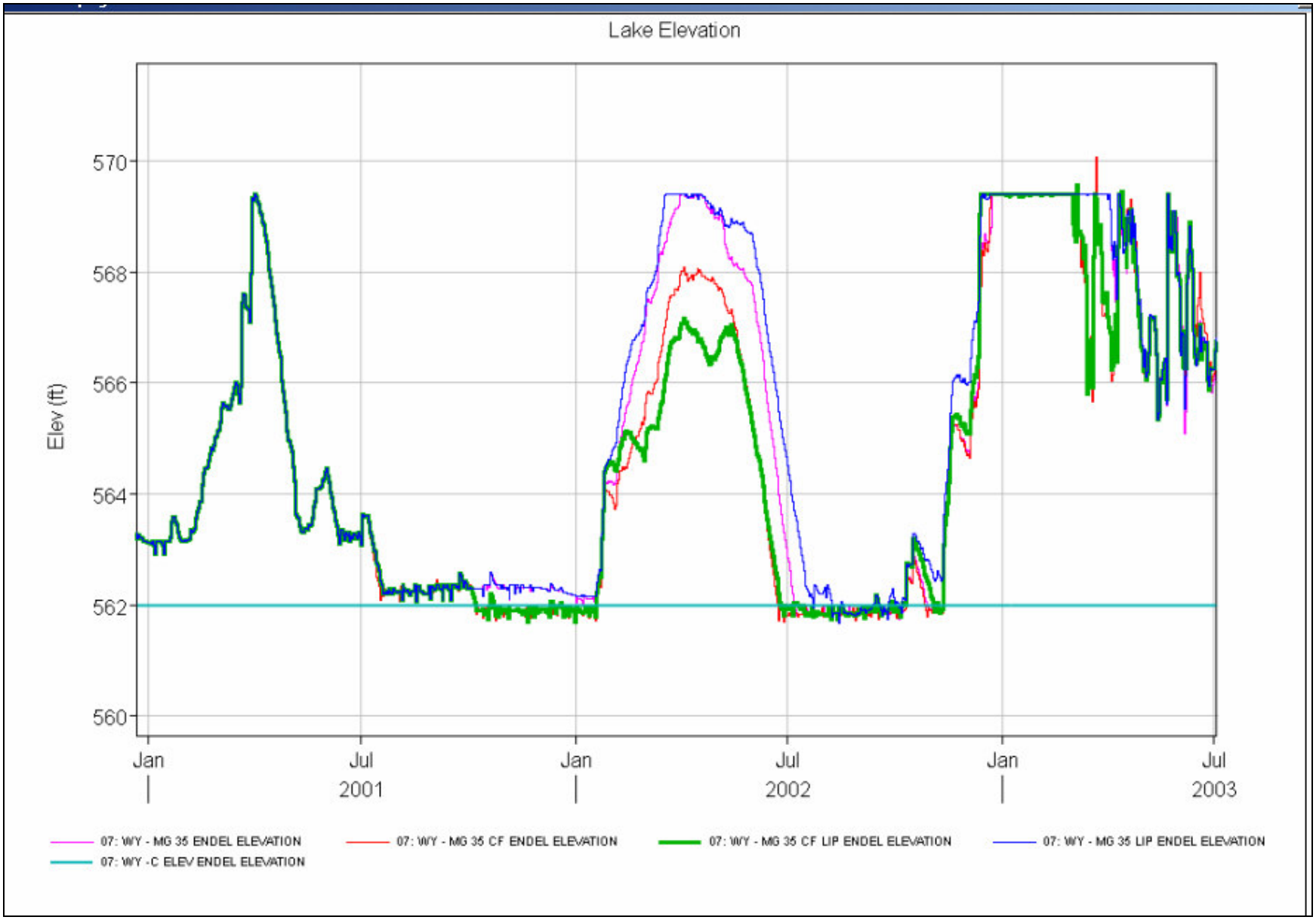

Figure 350: Wylie Elevations with New LIP

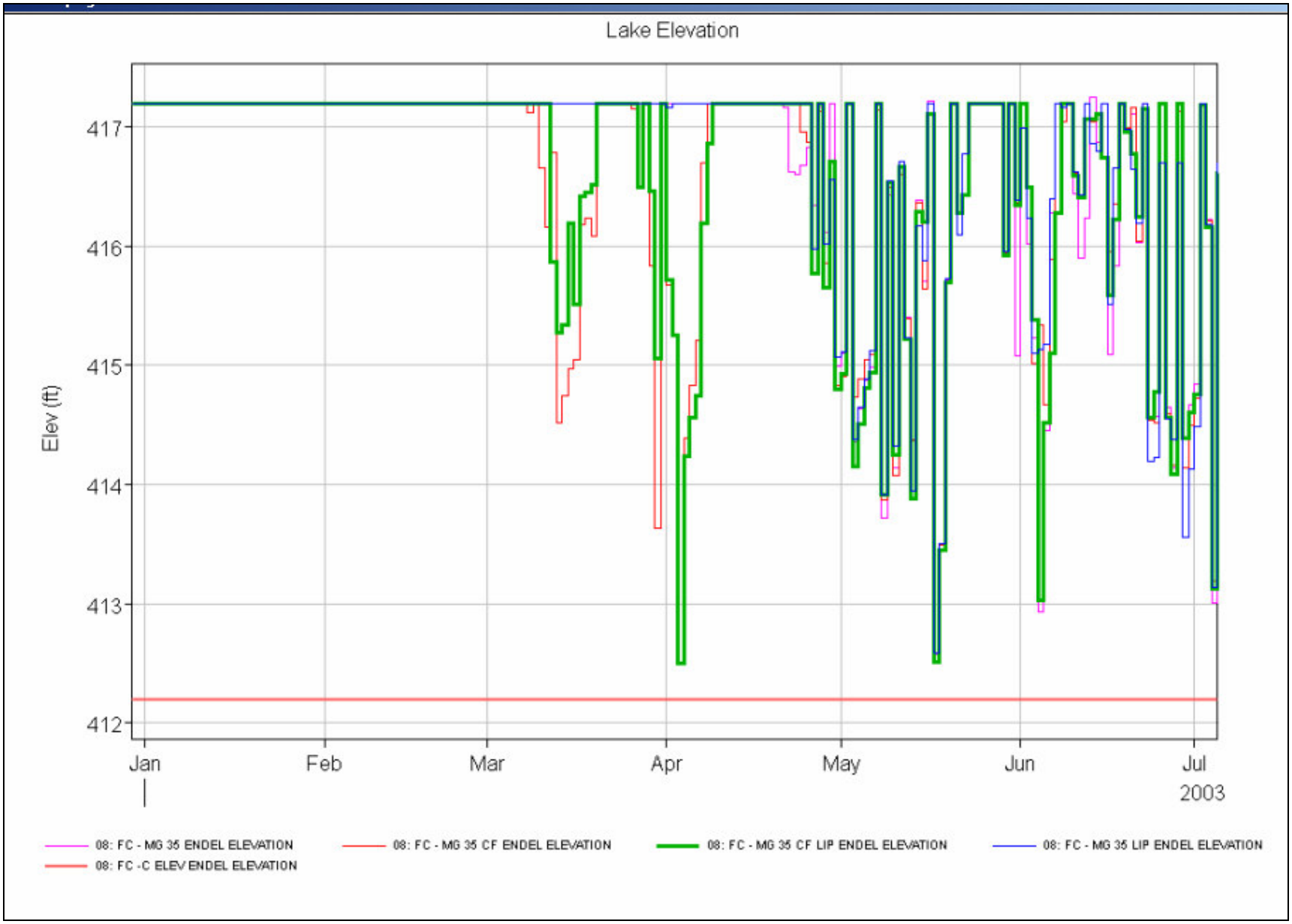

Figure 351: Fishing Creek Elevations with New LIP

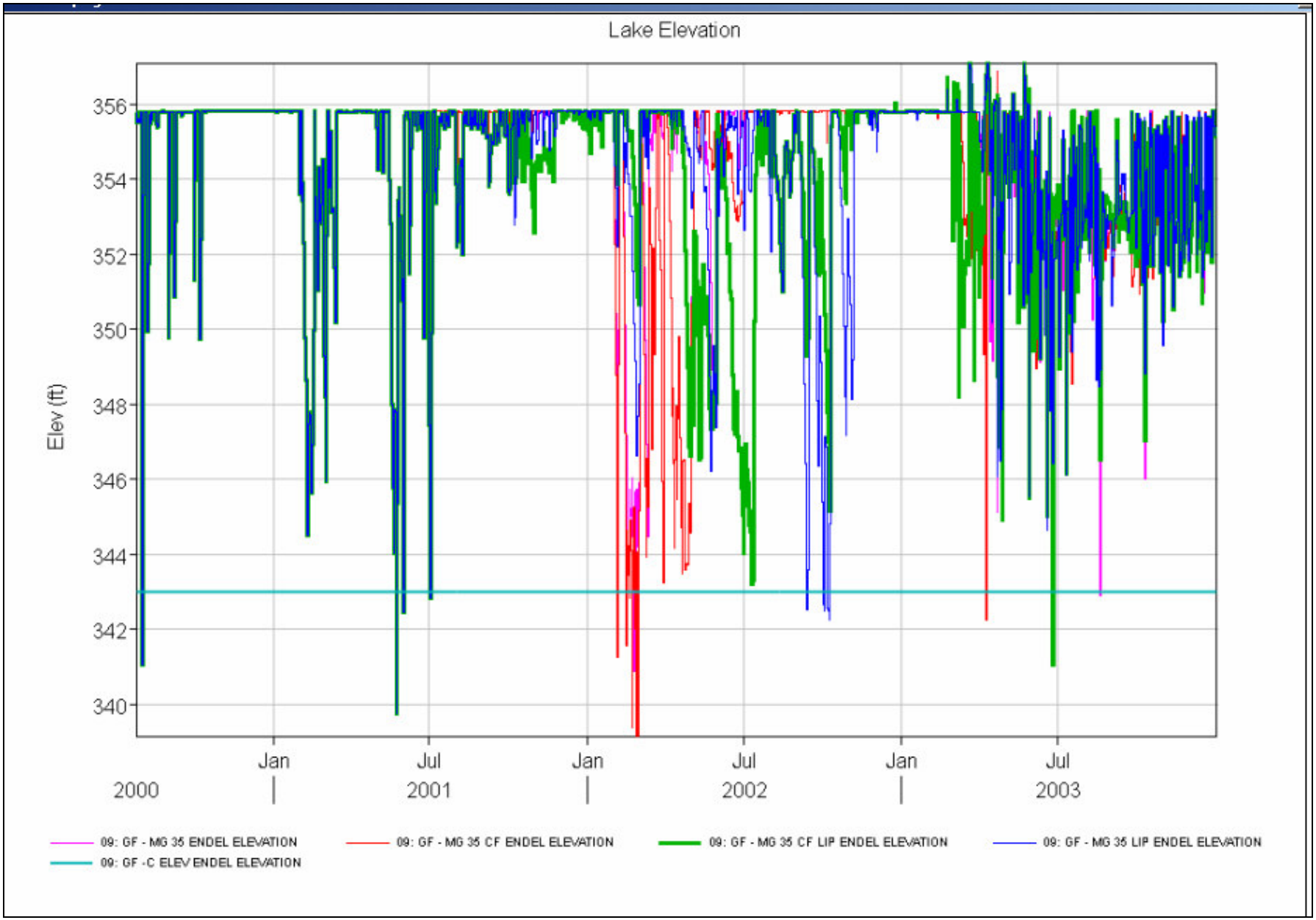

Figure 352: Great Falls Elevations with New LIP

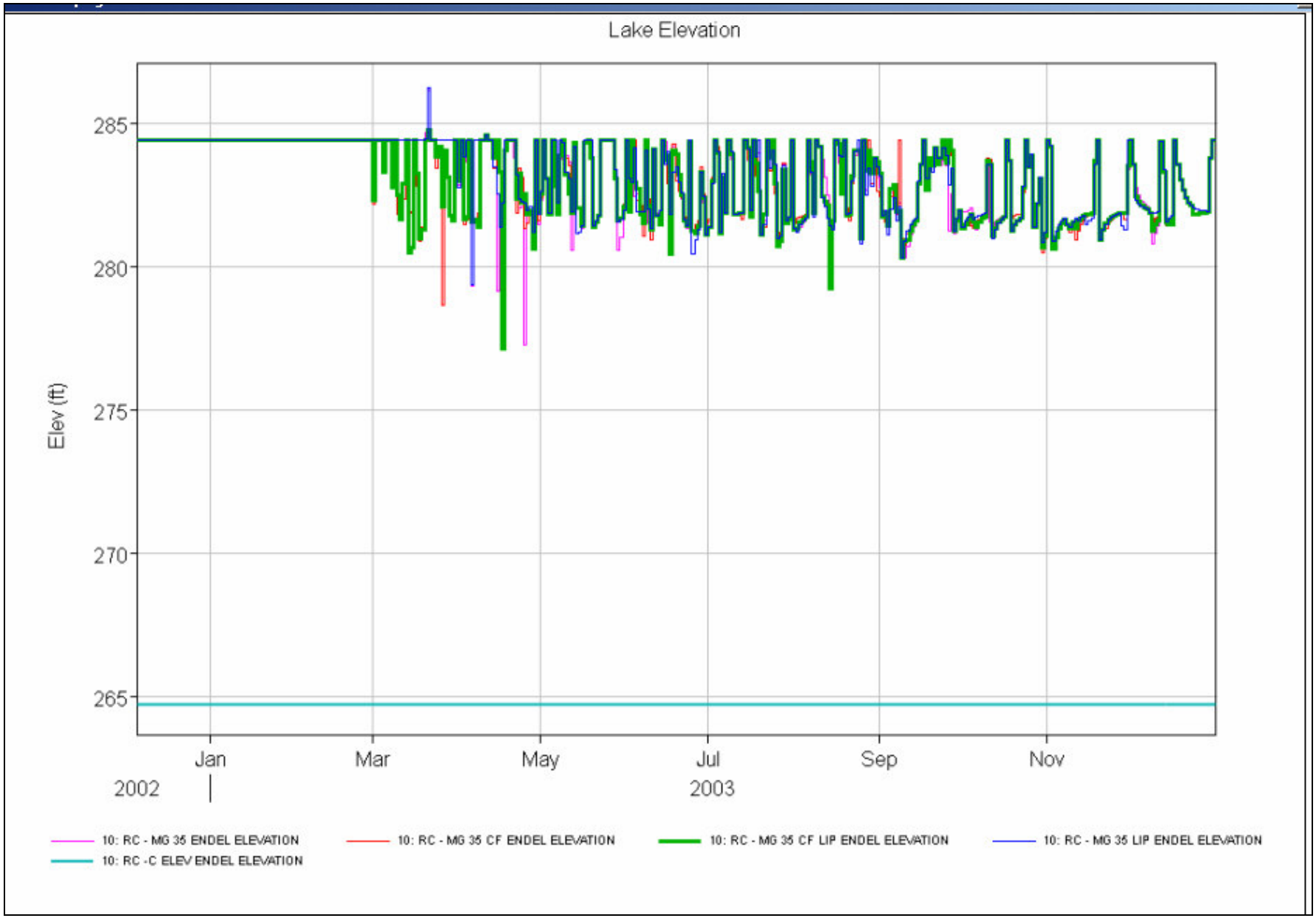

Figure 353: Rocky Creek Elevations with New LIP

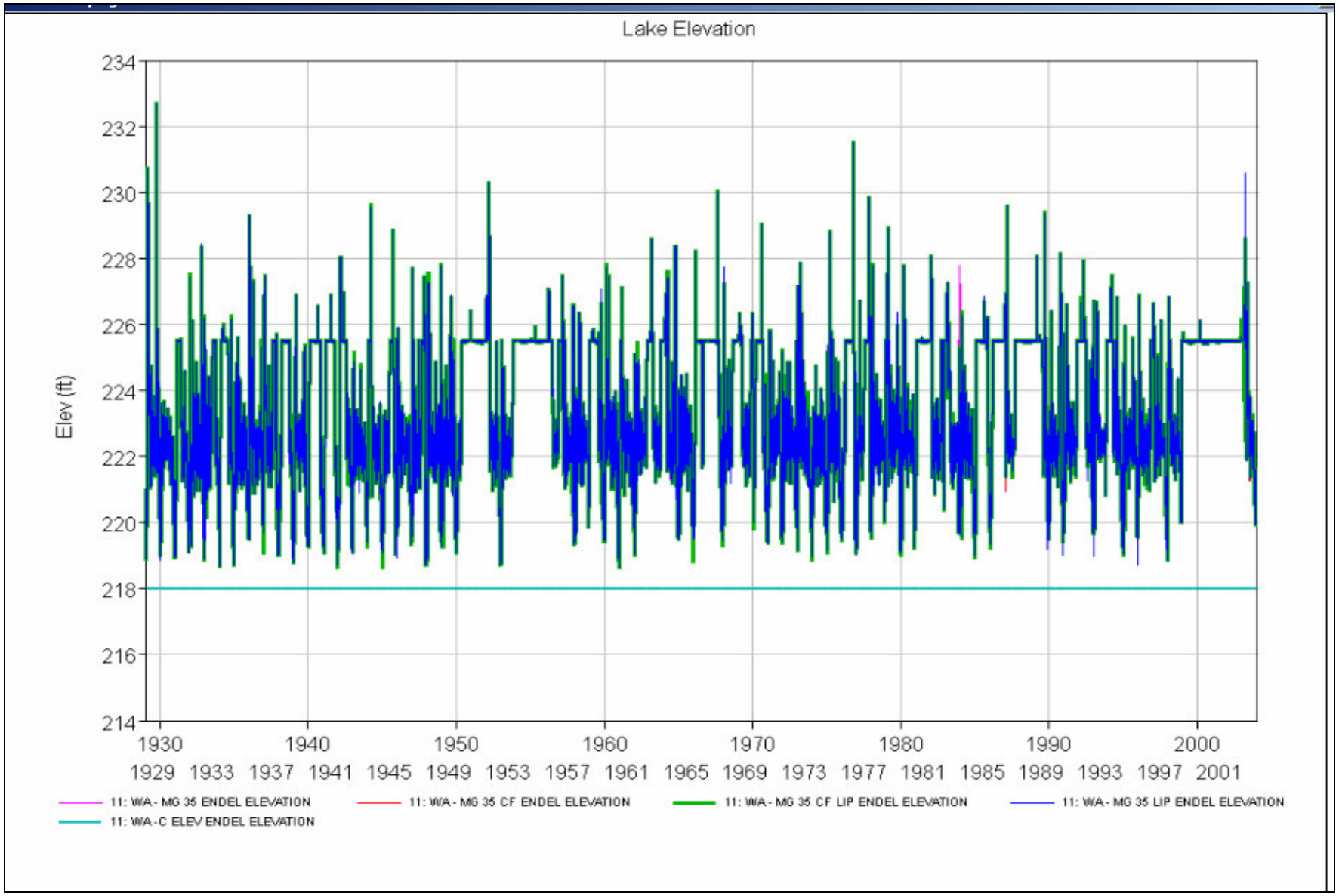

Figure 354: Wateree Elevations with New LIP

4. Storage Conditions during Dry Seasons:

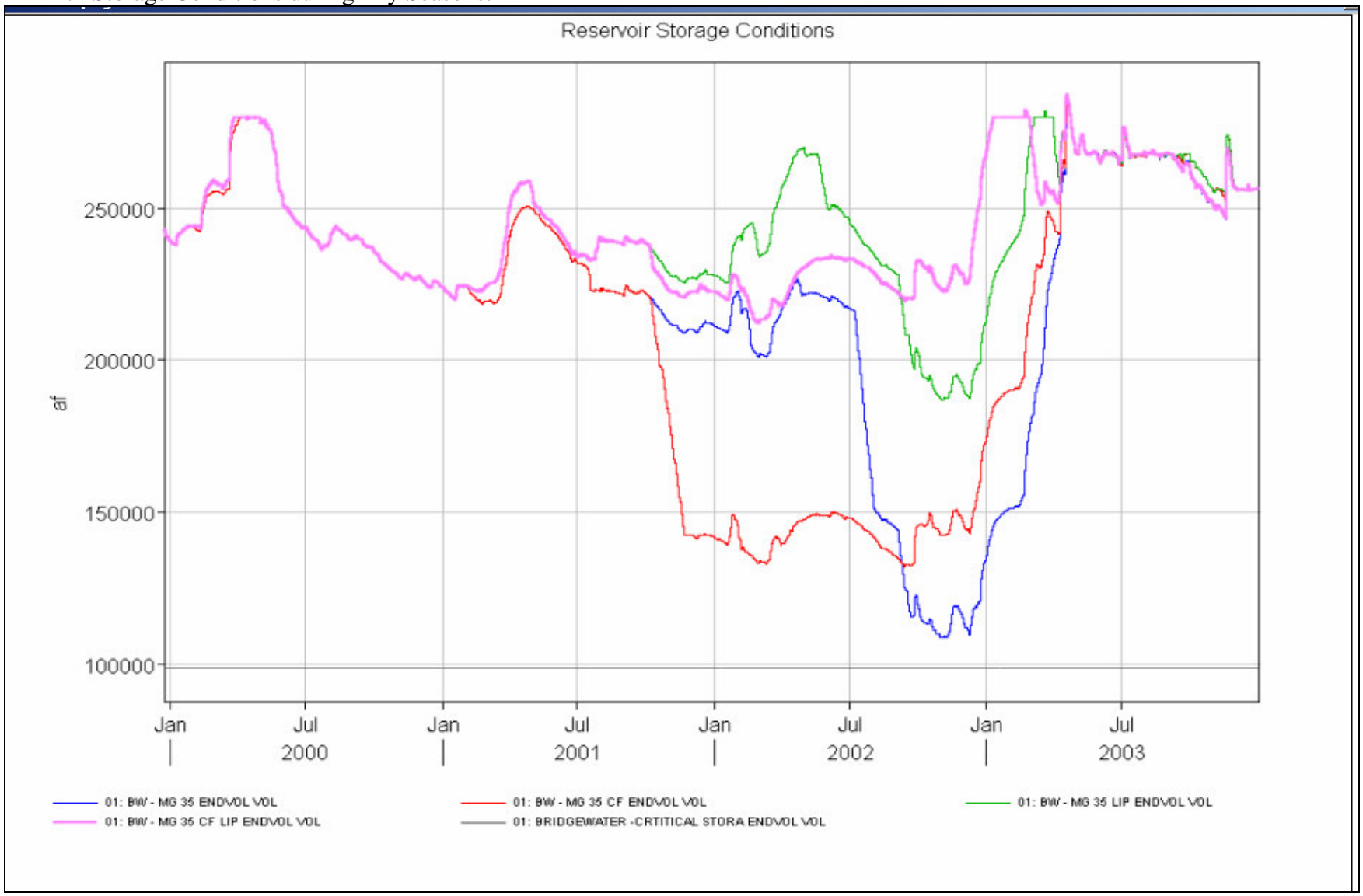

Figure 355: Bridgewater Storage with New LIP

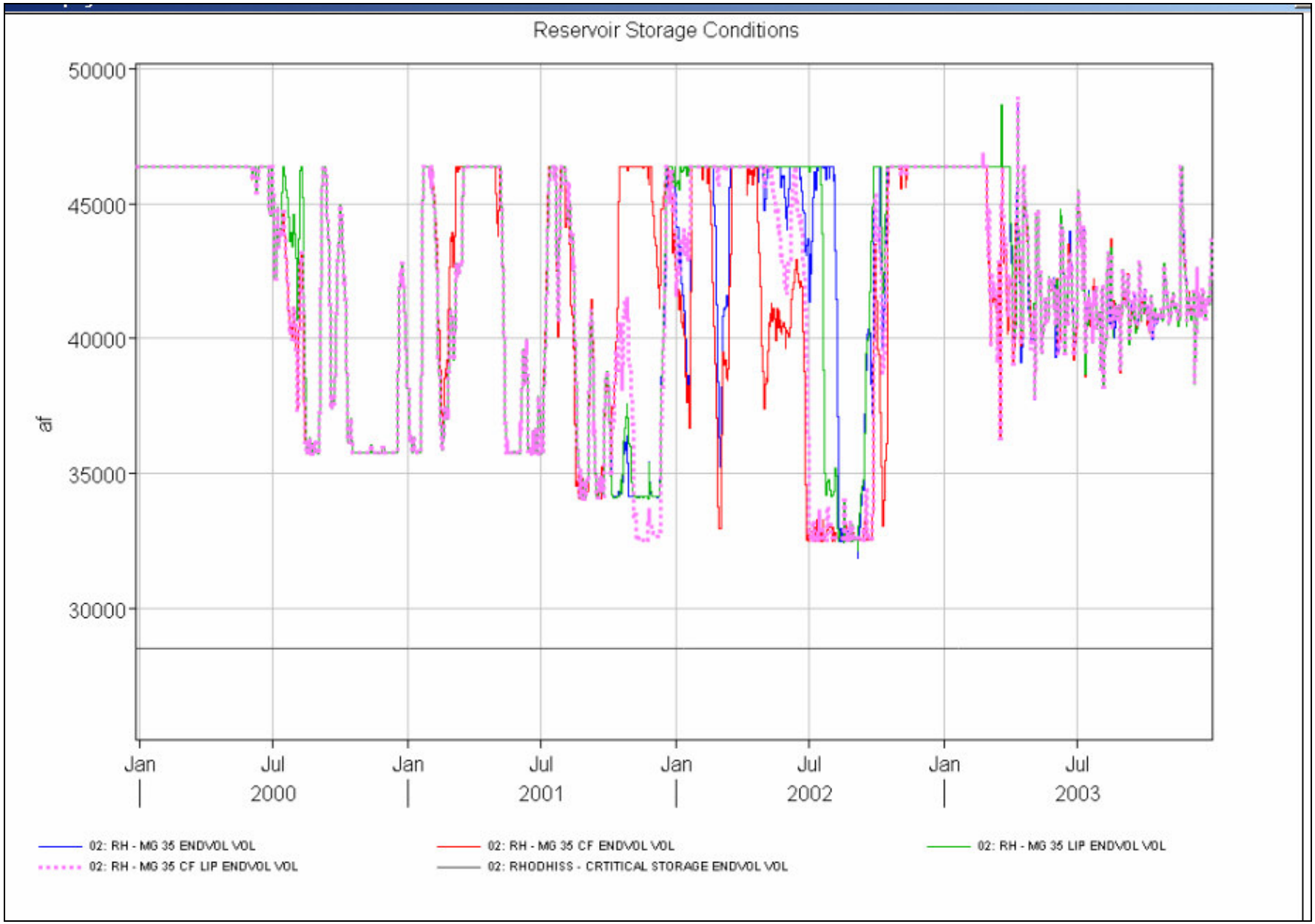

Figure 356: Rhodhiss Storage with New LIP

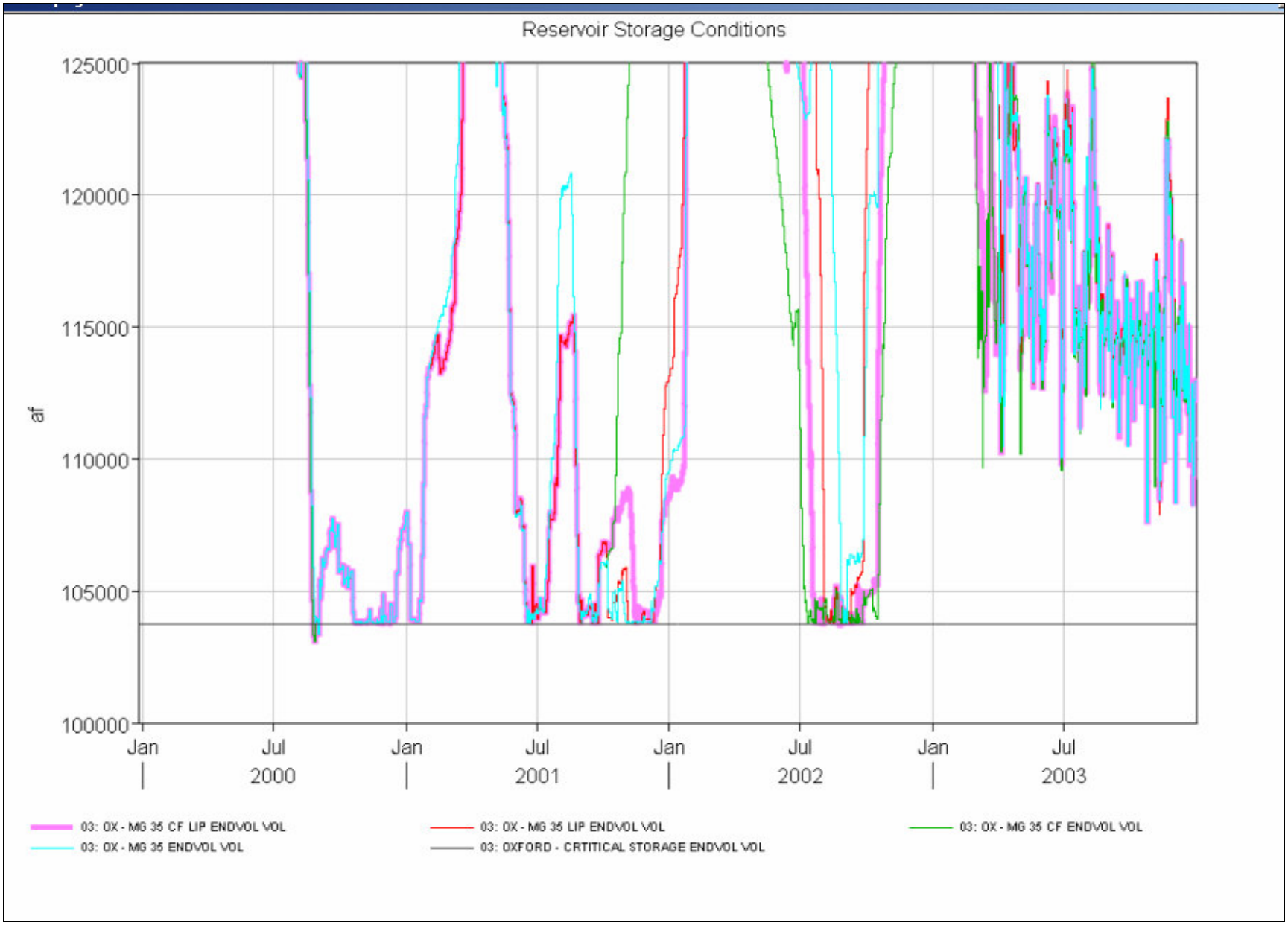

Figure 357: Oxford Storage with New LIP

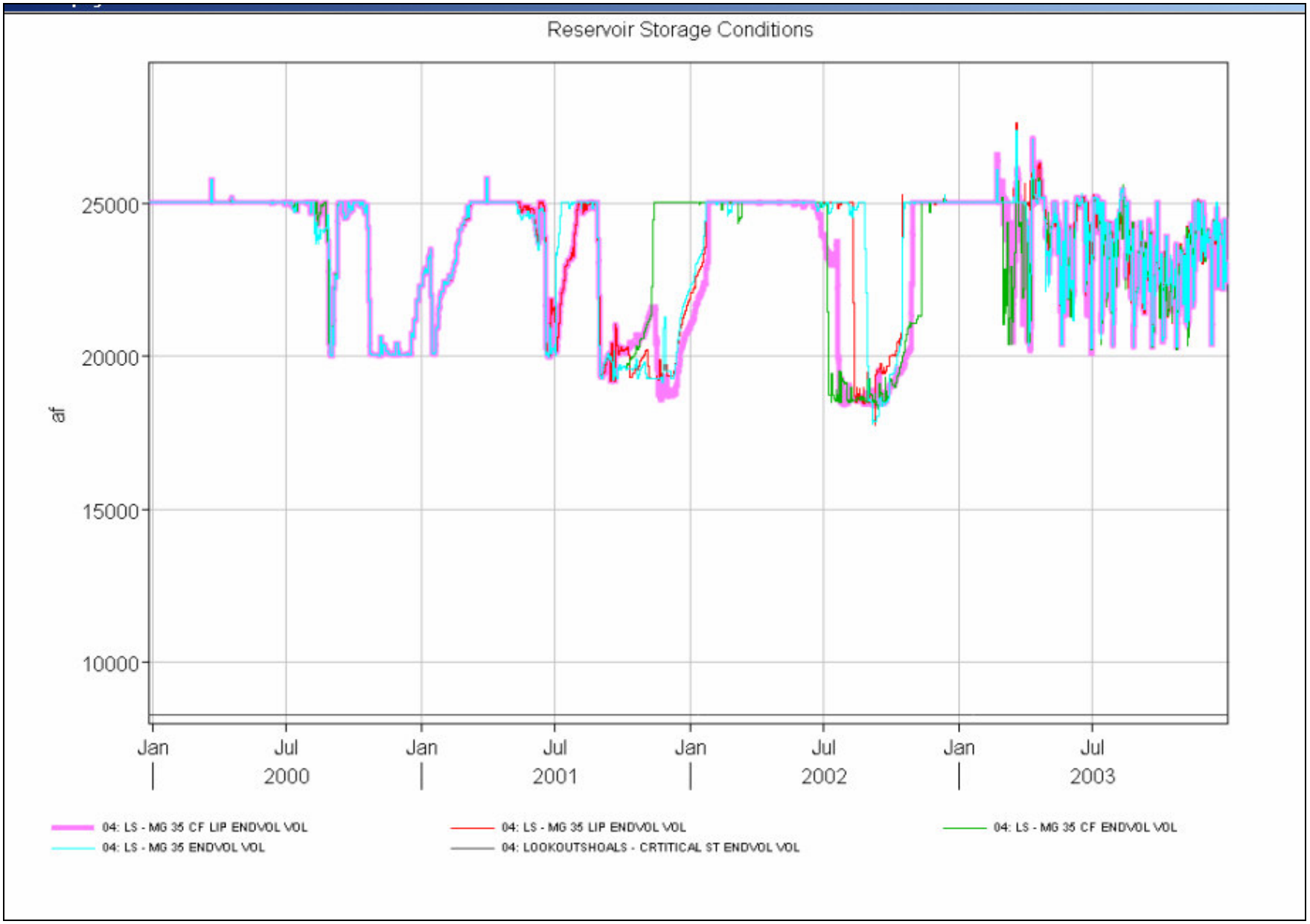

Figure 358: Lookout Shoals Storage with New LIP

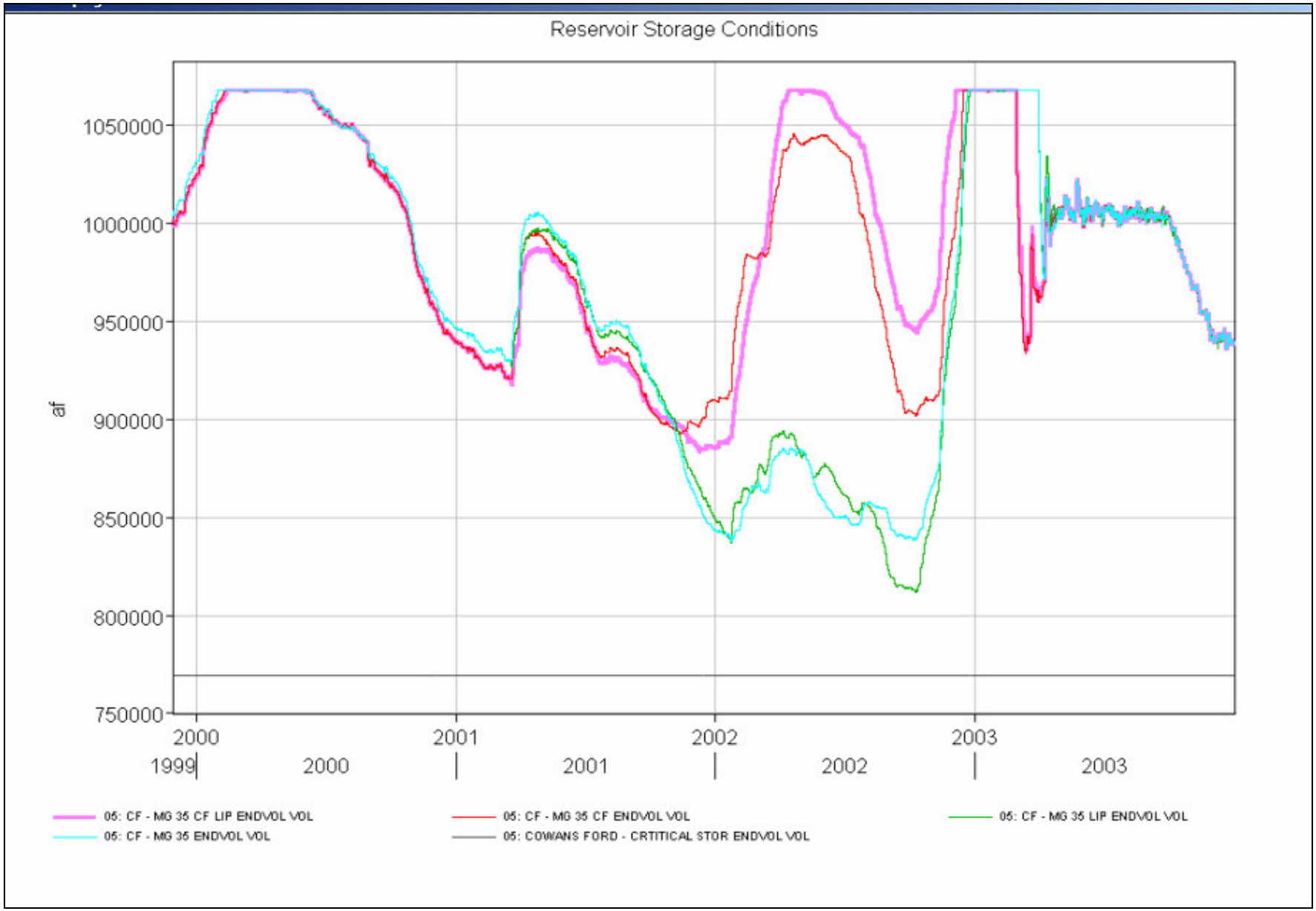

Figure 359: Cowan Ford Storage with New LIP

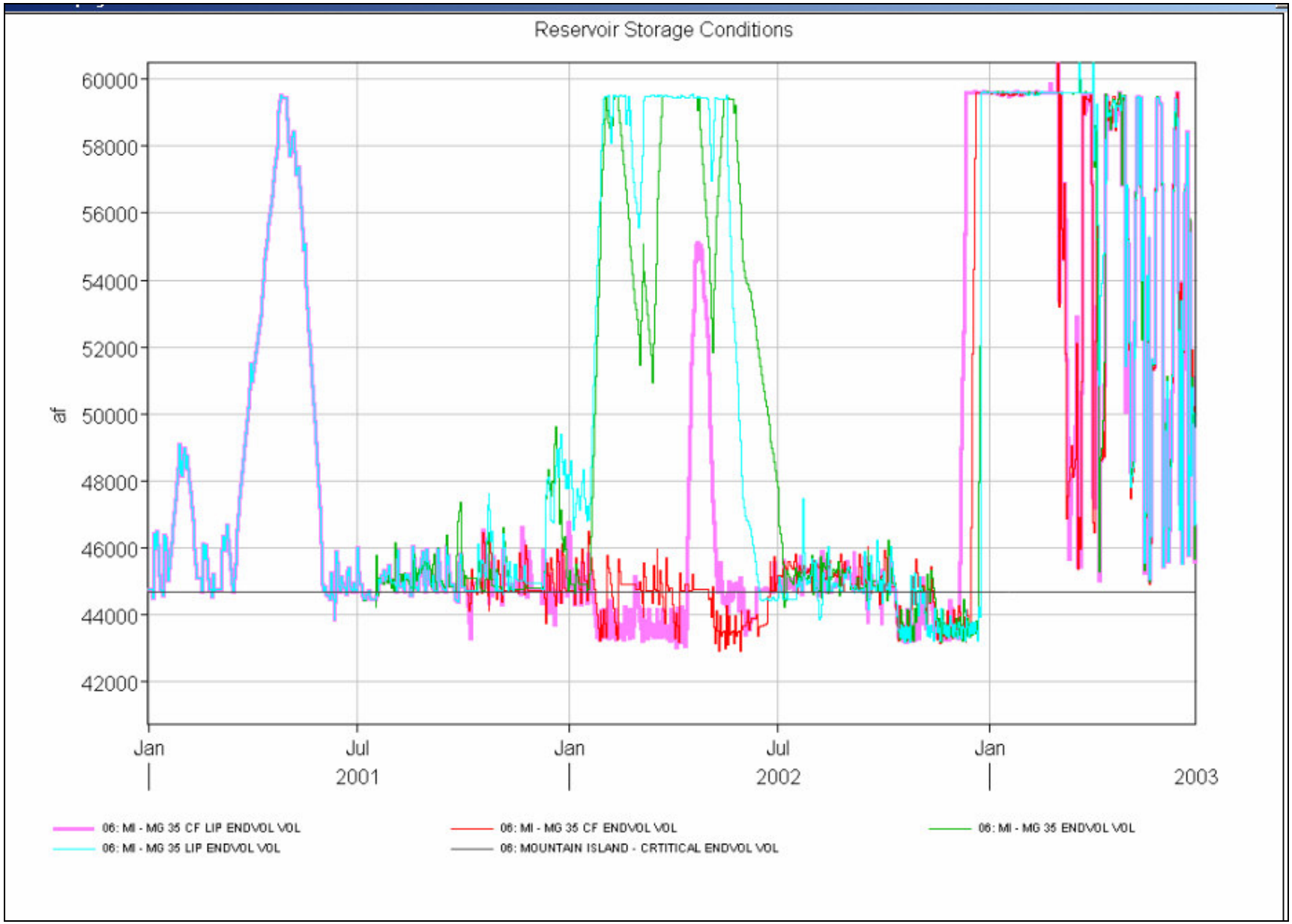

Figure 360: Mountain Island Storage with New LIP

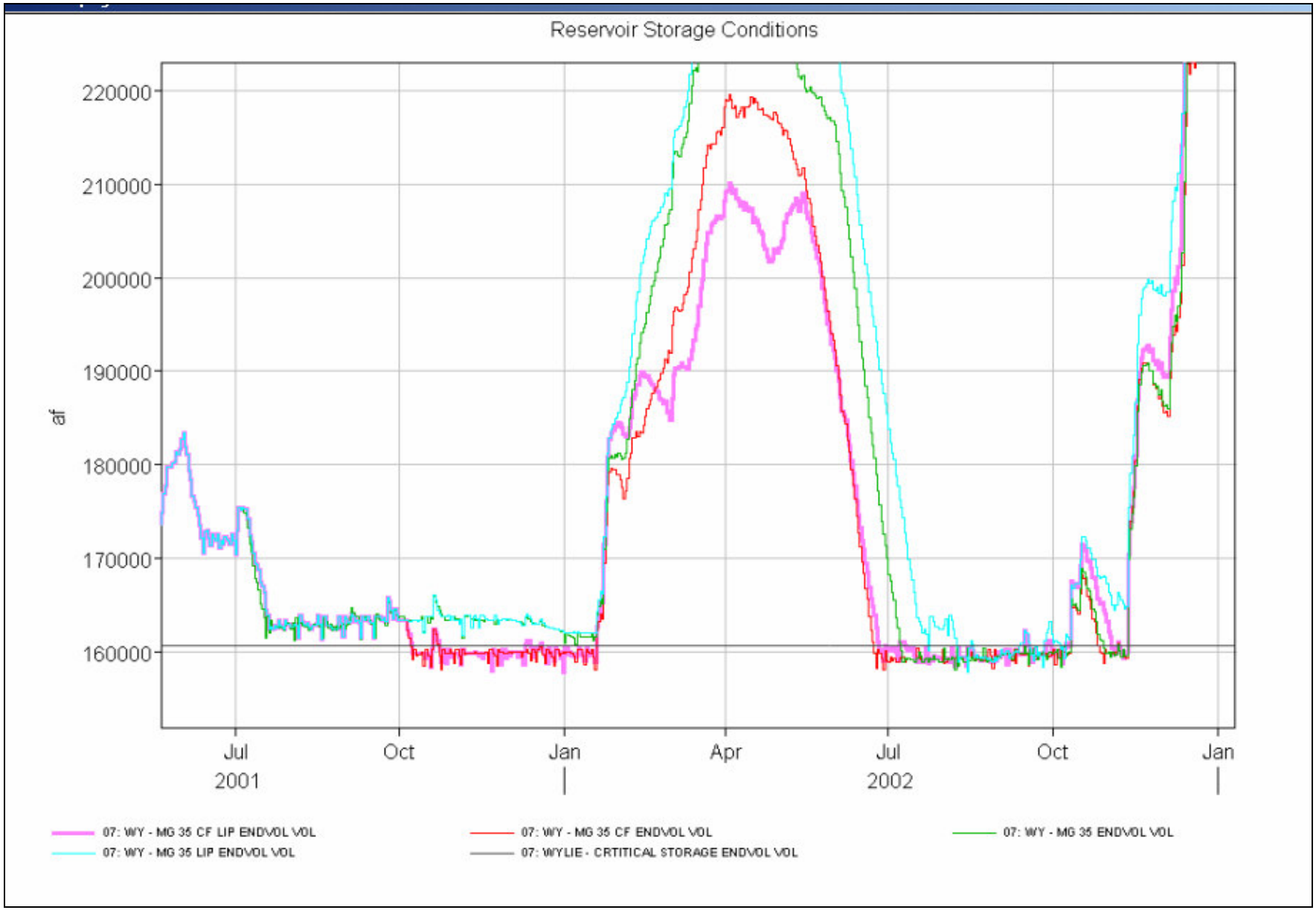

Figure 361: Wyile Storage with New LIP

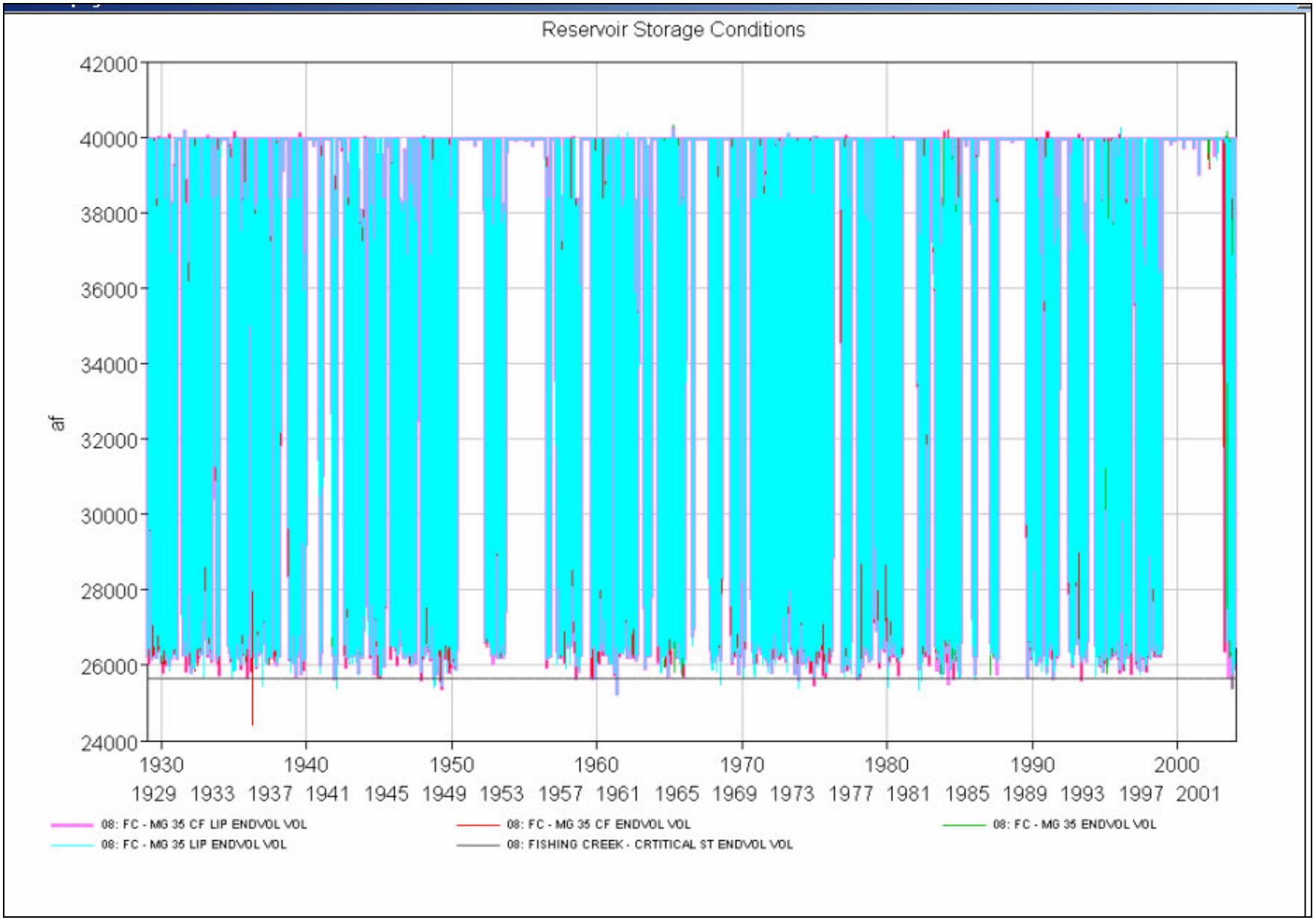

Figure 362: Fishing Creek Storage with New LIP

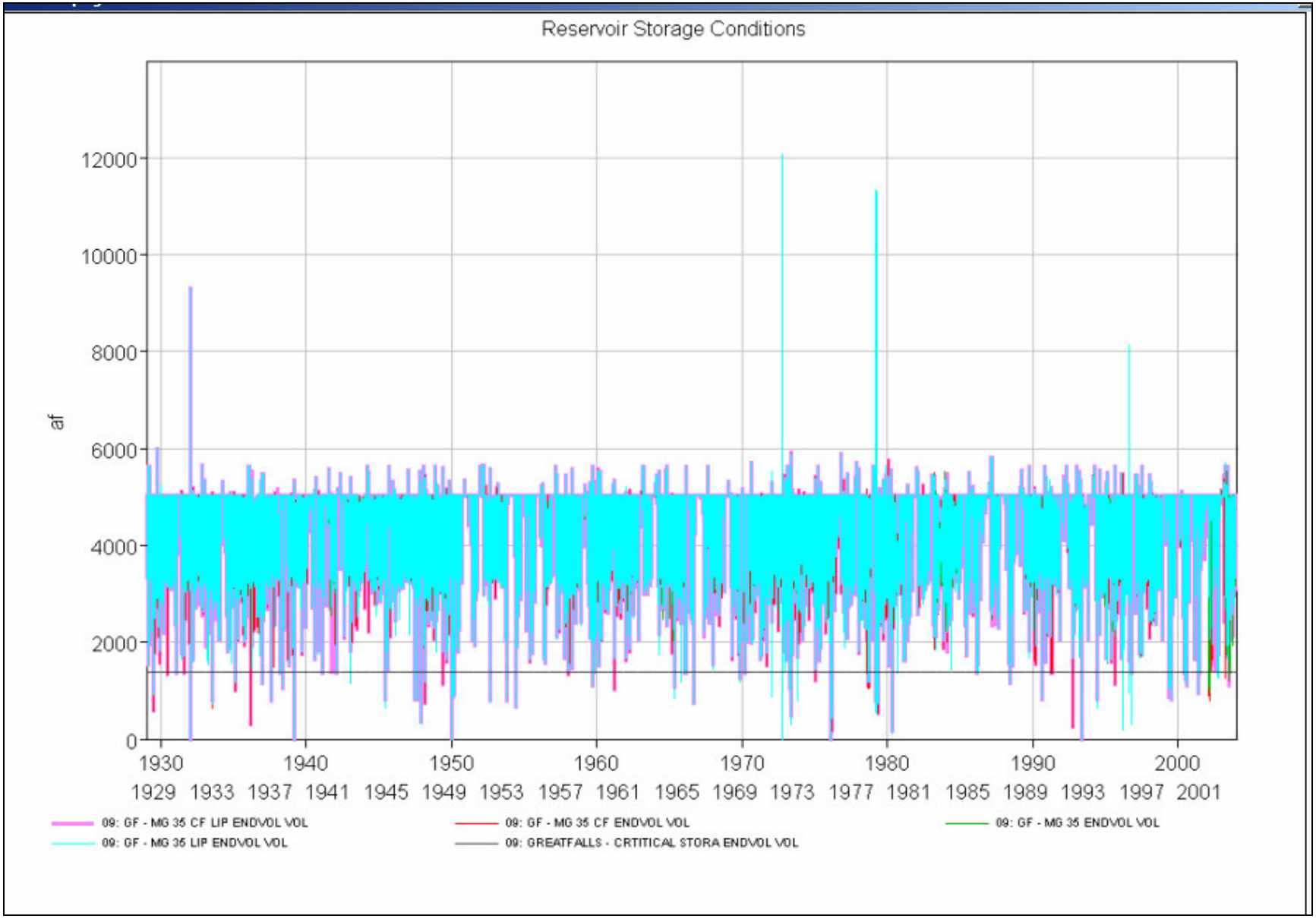

Figure 363: Great Falls Storage with New LIP

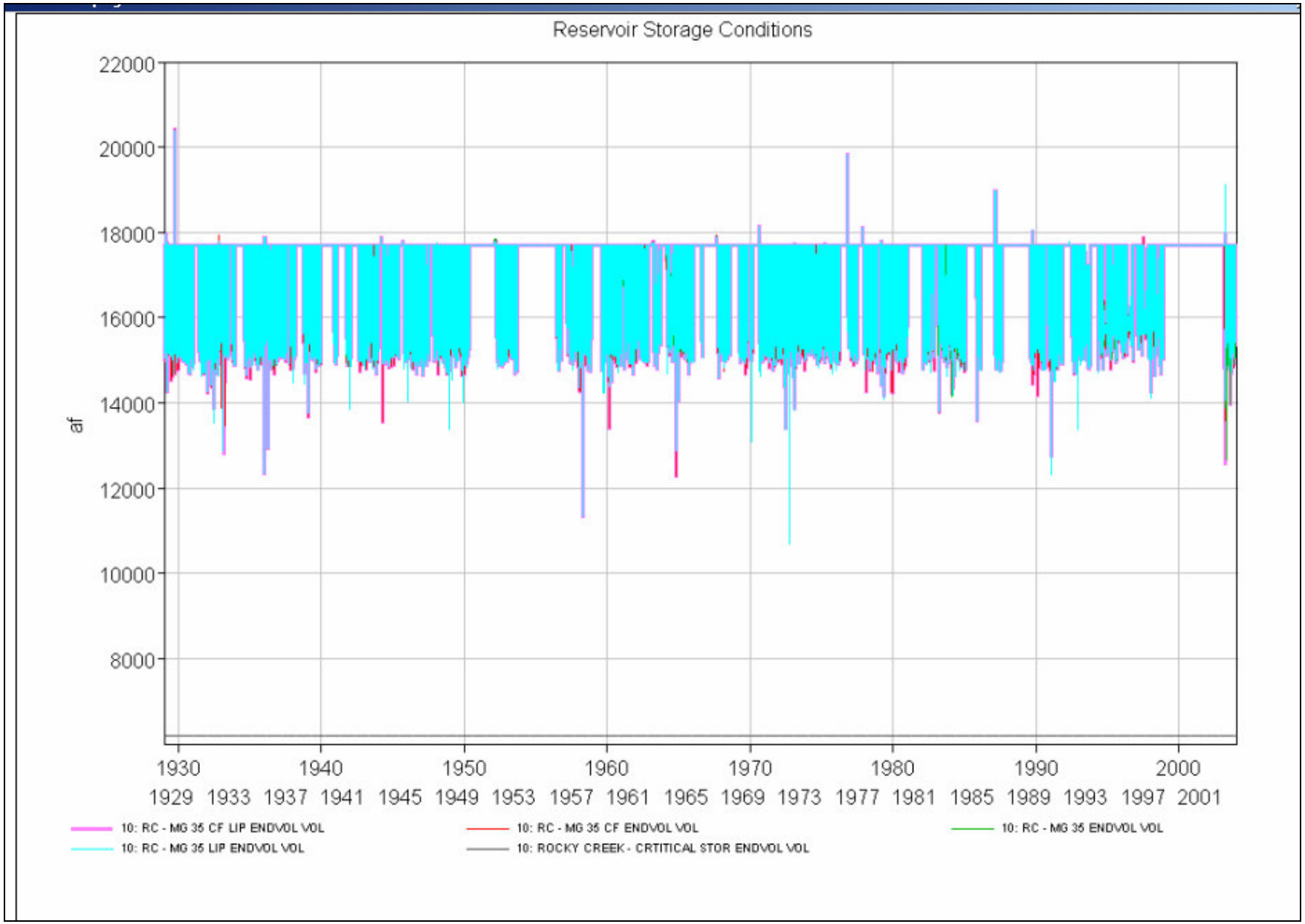

Figure 364: Rocky Creek Storage with New LIP

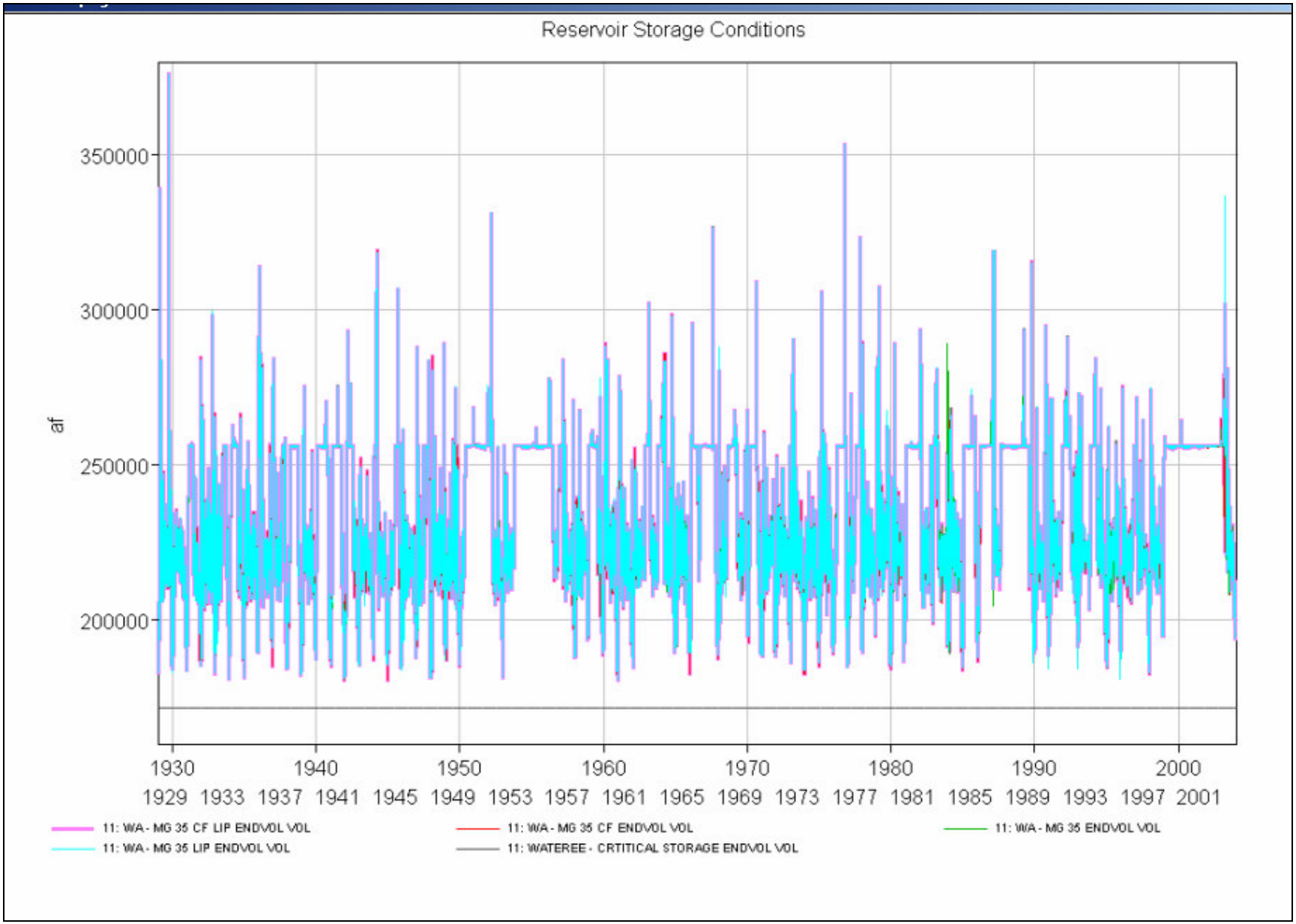

Figure 365: Wateree Storage with New LIP

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2. *Inflow ComparisonJce March10 Ralph charts.xls* received from Chris Ey, DTA
3. *CWRel Attachement G (LIP) 07-15-05.pdf* received from Duke Power.
4. *Water Supply Study Status Report Draft_rev050205.pdf* by HDR