Appendix F

Option Development Process
ARSP Modeling and Analysis
of Lake Levels and River Flows

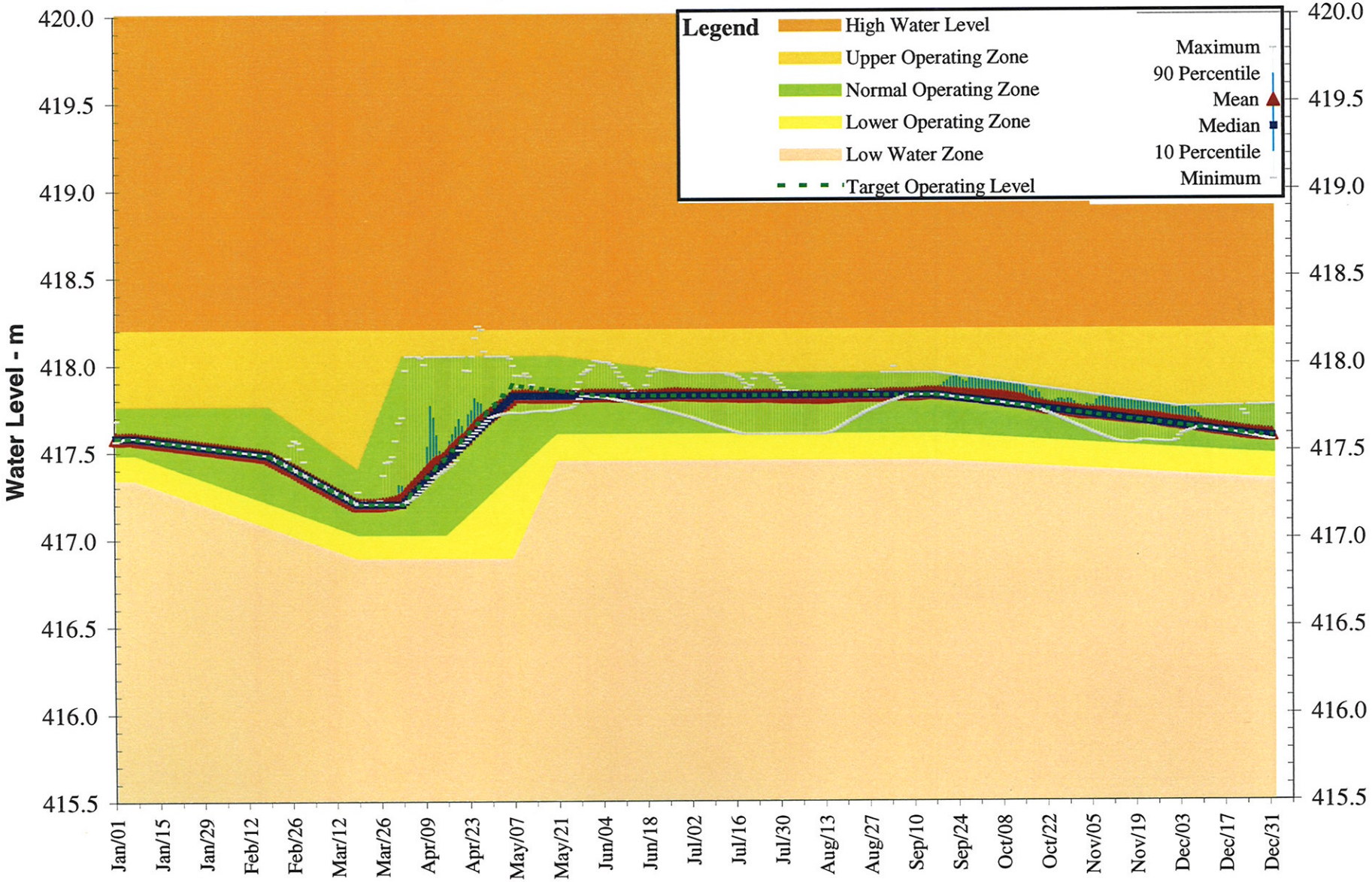
- **ARSP Base Case**
- **ARSP Case One**
- **ARSP Case Two**

Canoe, Smoke, Tea Lakes

Canoe, Smoke, and Tea Lakes Water

ARSP Simulation Base Case

Operating Rules and Daily Water Level Statistics



Canoe, Smoke, and Tea Lakes Water Levels
ARSP Simulation Base Case

Peak Water Levels	
HWZ	418.2
No of Days in Exceedance	2
No of Years Exceeded	1
Maximum WL	418.22

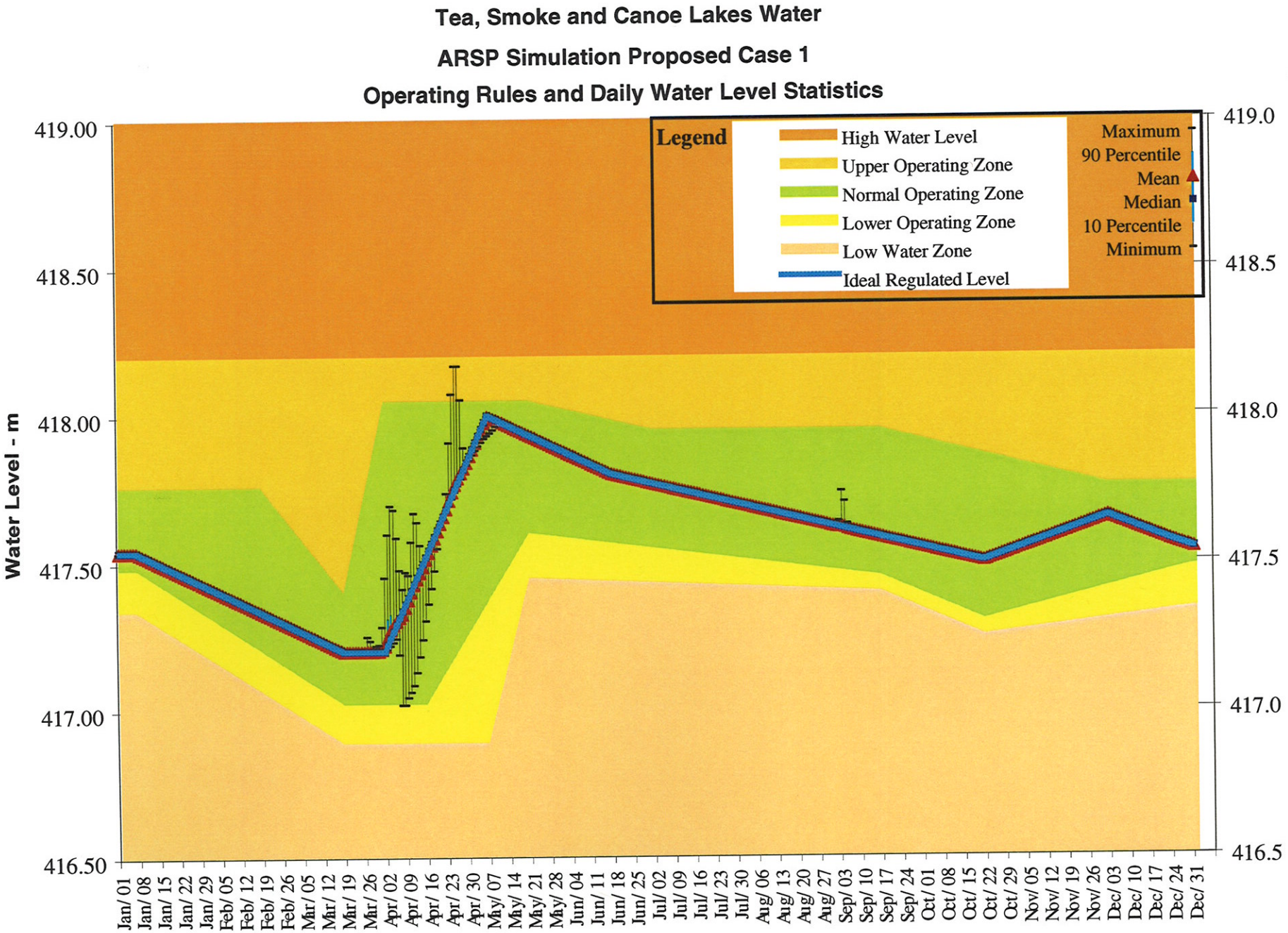
Time of spring peak levels before April 30	
Percentile	0.90
Peak percentile WL	417.81
Date of peak	24-Apr
Tolerance	0
Tolerated WL	417.81
Date tolerated exceeded	24-Apr

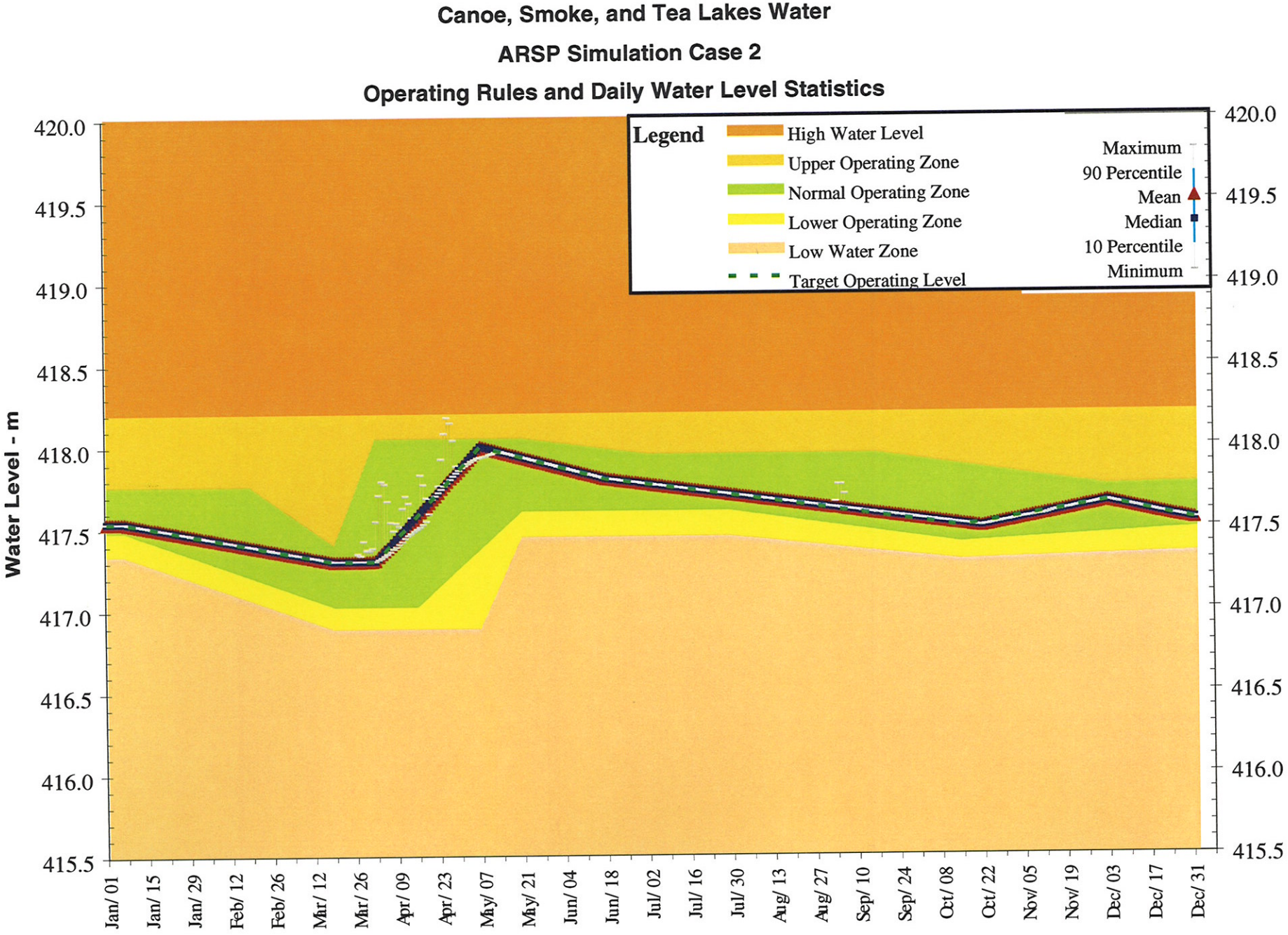
Summer recreation levels Jun-15 to Sep-30	
90 and 10 percentile range	
Max 90%	417.93
Min 10%	417.78
Range	0.14

Median range	
Max Median	417.82
Min Median	417.79
Range	0.03

Spring Peak Water Level

Maximum - 50 yr Average	417.87
Date - 50 yr Average	6/May
Summer Average Level	417.82


Tea, Smoke and Canoe Lakes Water
ARSP Simulation Proposed Case 1
Operating Rules and Daily Water Level Statistics
Legend
High Water Level
Upper Operating Zone
Normal Operating Zone
Lower Operating Zone
Low Water Zone
Ideal Regulated Level
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Water Level - m
419.00
418.50
418.00
417.50
417.00
416.50
419.0
418.5
418.0
417.5
417.0
416.5
Jan/ 01
Jan/ 08
Jan/ 15
Jan/ 22
Jan/ 29
Feb/ 05
Feb/ 12
Feb/ 19
Feb/ 26
Mar/ 05
Mar/ 12
Mar/ 19
Mar/ 26
Apr/ 02
Apr/ 09
Apr/ 16
Apr/ 23
Apr/ 30
May/ 07
May/ 14
May/ 21
May/ 28
Jun/ 04
Jun/ 11
Jun/ 18
Jun/ 25
Jul/ 02
Jul/ 09
Jul/ 16
Jul/ 23
Jul/ 30
Aug/ 06
Aug/ 13
Aug/ 20
Aug/ 27
Sep/ 03
Sep/ 10
Sep/ 17
Sep/ 24
Oct/ 01
Oct/ 08
Oct/ 15
Oct/ 22
Oct/ 29
Nov/ 05
Nov/ 12
Nov/ 19
Nov/ 26
Dec/ 03
Dec/ 10
Dec/ 17
Dec/ 24
Dec/ 31


Canoe, Smoke, and Tea Lakes Water
ARSP Simulation Case 2
Operating Rules and Daily Water Level Statistics
Legend
High Water Level
Upper Operating Zone
Normal Operating Zone
Lower Operating Zone
Low Water Zone
Target Operating Level
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Water Level - m
420.0
419.5
419.0
418.5
418.0
417.5
417.0
416.5
416.0
415.5
Jan/ 01
Jan/ 15
Jan/ 29
Feb/ 12
Feb/ 26
Mar/ 12
Mar/ 26
Apr/ 09
Apr/ 23
May/ 07
May/ 21
Jun/ 04
Jun/ 18
Jul/ 02
Jul/ 16
Jul/ 30
Aug/ 13
Aug/ 27
Sep/ 10
Sep/ 24
Oct/ 08
Oct/ 22
Nov/ 05
Nov/ 19
Dec/ 03
Dec/ 17
Dec/ 31

Canoe, Smoke, and Tea Lakes Water Levels
ARSP Simulation Case 2

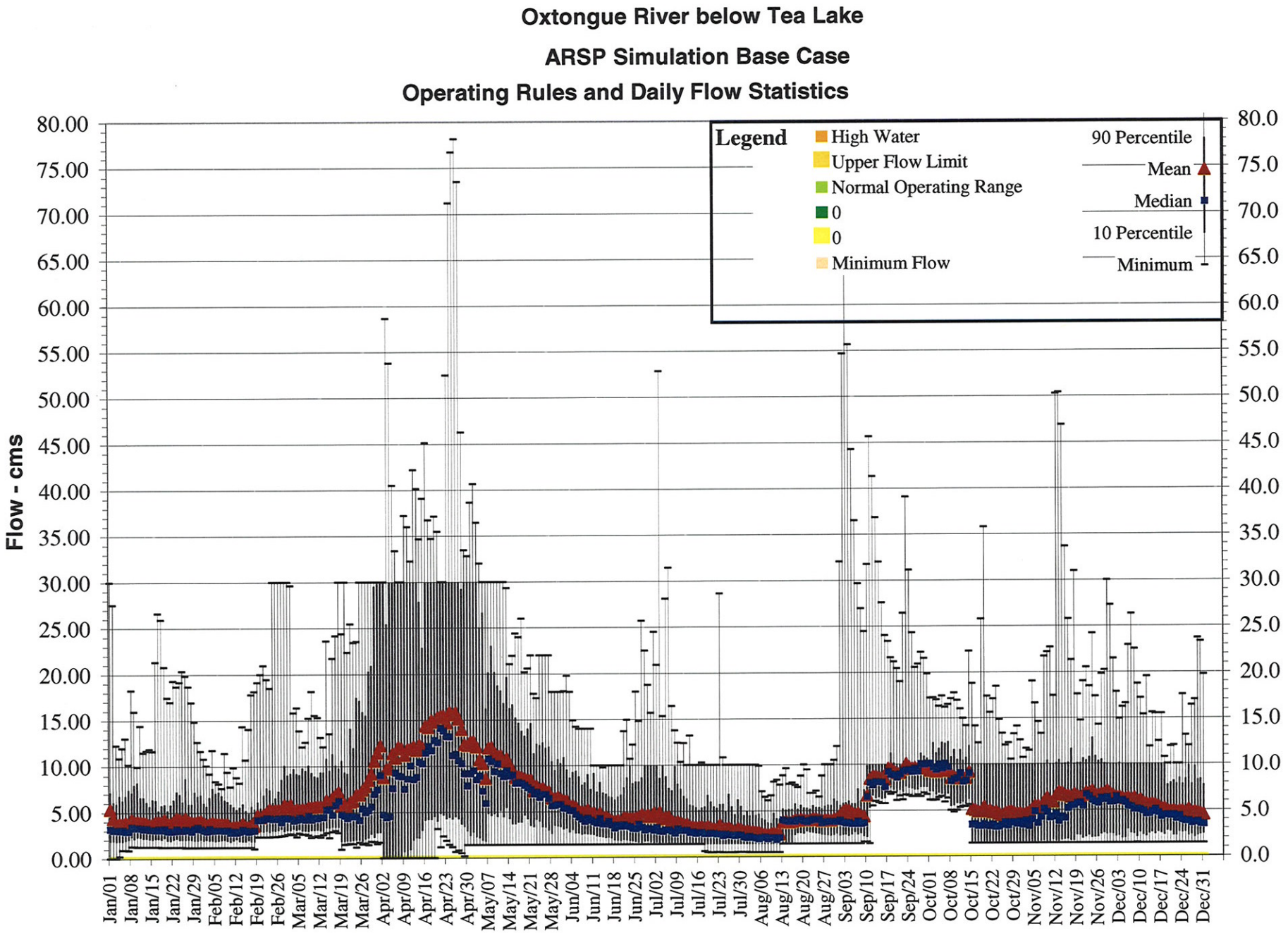
Peak Water Levels	
HWZ	418.2
No of Days in Exceedance	0
No of Years Exceeded	0
Maximum WL	418.18

Time of spring peak levels before April 30	
Percentile	0.90
Peak percentile WL	417.88
Date of peak	30-Apr
Tolerance	0
Tolerated WL	417.88
Date tolerated exceeded	30-Apr

Summer recreation levels Jun-15 to Sep-30	
90 and 10 percentile range	
Max 90%	417.81
Min 10%	417.55
Range	0.26

Median range	
Max Median	417.81
Min Median	417.55
Range	0.26

Spring Peak Water Level	
Maximum - 50 yr Average	418.00
Date - 50 yr Average	6/May
Summer Average Level	417.71


Oxtongue River below Tea Lake
ARSP Simulation Base Case
Operating Rules and Daily Flow Statistics
Flow - cms
Legend
High Water
Upper Flow Limit
Normal Operating Range
0
0
Minimum Flow
90 Percentile
Mean
Median
10 Percentile
Minimum
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Jan/01
Jan/08
Jan/15
Jan/22
Jan/29
Feb/05
Feb/12
Feb/19
Feb/26
Mar/05
Mar/12
Mar/19
Mar/26
Apr/02
Apr/09
Apr/16
Apr/23
Apr/30
May/07
May/14
May/21
May/28
Jun/04
Jun/11
Jun/18
Jun/25
Jul/02
Jul/09
Jul/16
Jul/23
Jul/30
Aug/06
Aug/13
Aug/20
Aug/27
Sep/03
Sep/10
Sep/17
Sep/24
Oct/01
Oct/08
Oct/15
Oct/22
Oct/29
Nov/05
Nov/12
Nov/19
Nov/26
Dec/03
Dec/10
Dec/17
Dec/24
Dec/31

Flow Evaluation

Yellow cells indicate values that can be changed for analysis

Oxtongue River below Tea Lake
ARSP Simulation Base Case
Daily Flows Model Results 1951 to 2000

Walleye Spawning

Min Flow **0** m³/s Achieved 100% of time

No of days above minumum flow

First half of season		*Last half of season*		*For whole season*	
Min	21 days	Min	24 days	Min	45 days
Avg	24.88 days	Avg	24 days	Avg	48.88 days
Years Provided	96%	Years Provided	100%	Years Provided	96%

From flow duration curve

%	Flow	
99%	1.40	m³/s
95%	2.16	m³/s

No of days min flow is achievd 45 days

90% *percentile peak flow* 23 m3/s

Summer Minimum 7-day Flow

	Maximum	3.65 m³/s
	Minimum	0.47 m³/s
90%	Percentile	2.74 m³/s
10%	Percentile	1.40 m³/s
	Median	1.84 m³/s
	Mean	1.93 m³/s

Maximum Flows

Regulatory Flood Outflow — No of years exceeded — Maximum Daily Flow

130 m³/s	0	78.16 m³/s

Minumum Flows

Min Daily flow	*7-day minimums*			
0.00 m³/s	2	10	20	return period
	-yr 7Q2	-yr 7Q10	-yr 7Q20	
	1.40	0.15	0.00 m³/s	

Summer Fluctuations

Delta Flow	Average number of daily flow fluctuations per year		
1	18.92		
3	3.90		
5	1.10		
>1.80525	8.62	0.5	ratio of summer median

Water Usage

Median Flow		*10% Percentile*	
summer m³/s	winter m³/s	summer m³/s	winter m³/s
4.59	4.32	1.65	0.00

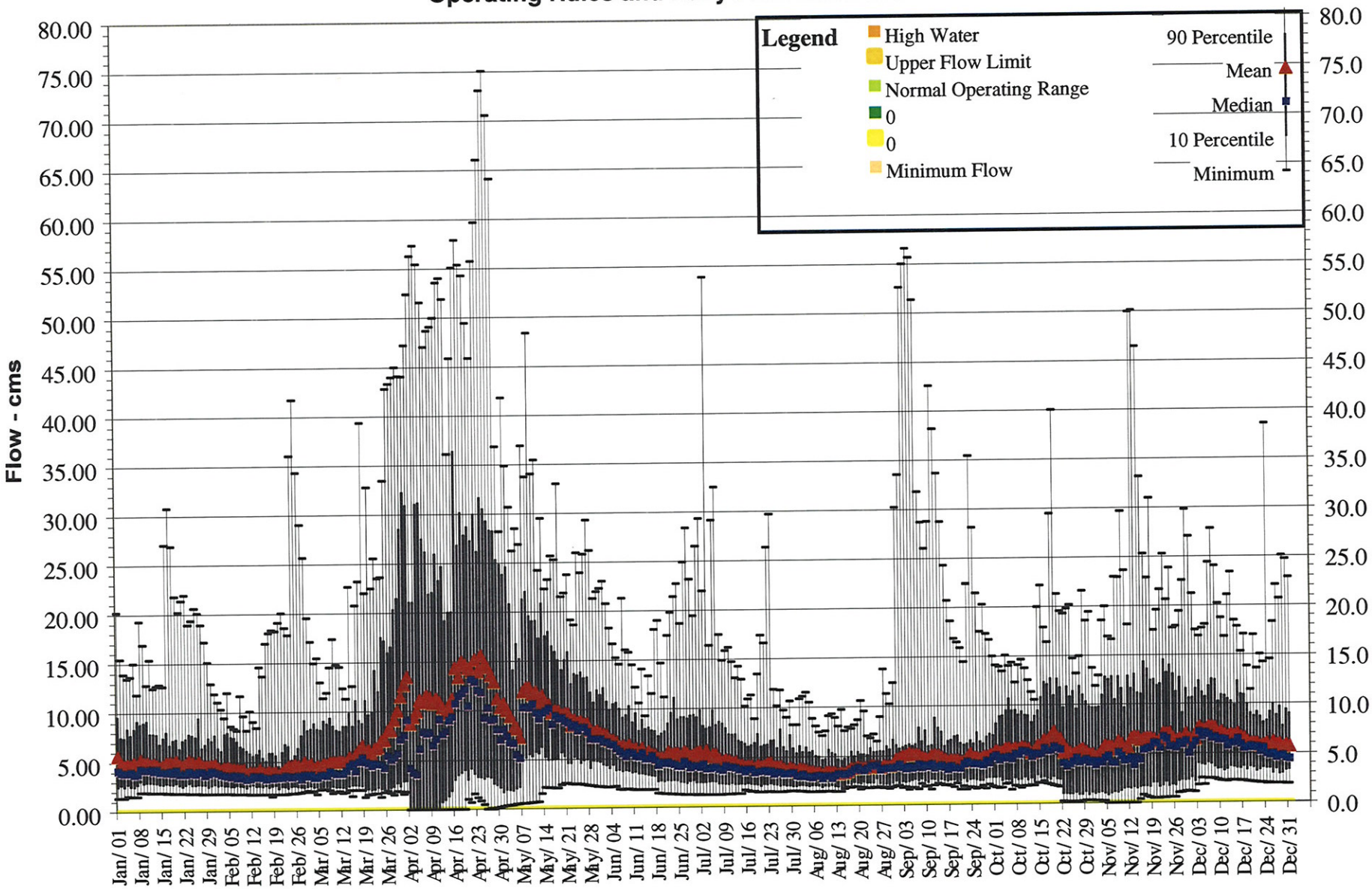
Power Generation

	Quarter				
	1	2	3	4	Annual
Flow	4.91	8.95	4.85	6.10	6.20 m³/s

Oxtongue River below Tea Lake

ARSP Simulation Case 2

Operating Rules and Daily Flow Statistics



Flow Evaluation

Yellow cells indicate values that can be changed for analysis

Oxtongue River below Tea Lake
ARSP Simulation Case
2
Daily Flows Model Results 1951 to 2000

Walleye Spawning

Min Flow 0 m³/s Achieved 100% of time

No of days above minumum flow

First half of season

Min	14	days
Avg	24.62	days
Years Provided	94%	

Last half of season

Min	24	days
Avg	24	days
Years Provided	100%	

For whole season

Min	38	days
Avg	48.62	days
Years Provided	94%	

From flow duration curve

%	Flow		*No of days*		*percentile peak*
99%	0.50	m³/s	*min flow is achievd*		90% *flow*
95%	2.42	m³/s	38	days	21 m3/s

Summer Minimum 7-day Flow

	Maximum	3.70	m³/s
	Minimum	1.24	m³/s
90%	Percentile	3.26	m³/s
10%	Percentile	1.78	m³/s
	Median	2.47	m³/s
	Mean	2.50	m³/s

Maximum Flows

Regulatory Flood Outflow		No of years exceeded	Maximum Daily Flow	
130	m³/s	0	75.06	m³/s

Minumum Flows

Min Daily flow		*7-day minimums*			
		2	10	20	return period
		-yr 7Q2	-yr 7Q10	-yr 7Q20	
0.00	m³/s	1.48	0.00	0.00	m³/s

Summer Fluctuations

Delta Flow	Average number of daily flow fluctuations per year		
1	22.02		
3	4.18		
5	1.38		
>1.83675	10.02	0.5	ratio of summer median

Water Usage

Median Flow		*10% Percentile*	
summer	winter	summer	winter
m³/s	m³/s	m³/s	m³/s
4.40	4.61	2.28	0.00

Power Generation

	Quarter					
	1	2	3	4	Annual	
Flow	5.13	9.26	4.29	6.15	6.20	m³/s