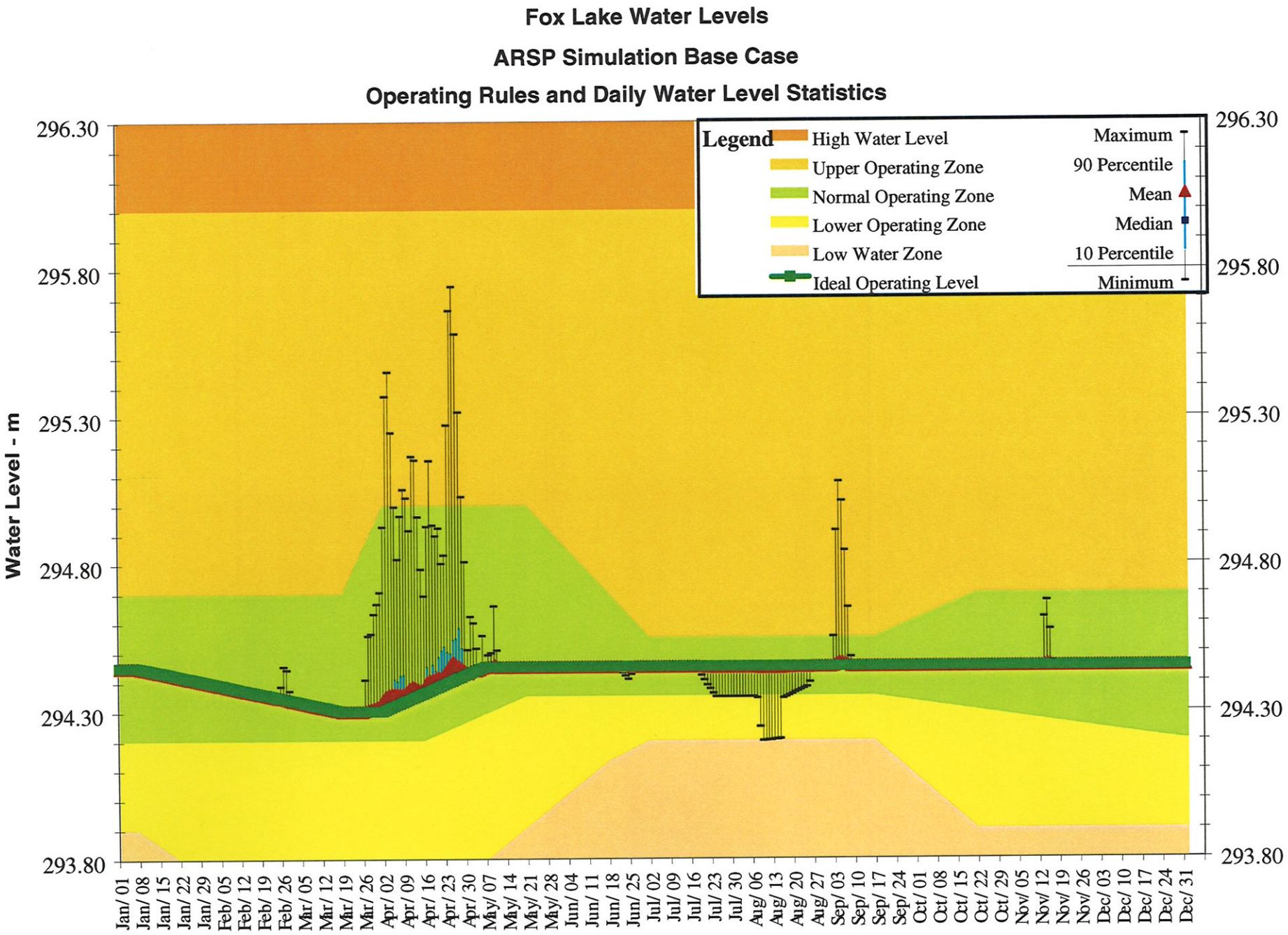
# Appendix F

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

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

# Fox Lake


Fox Lake Water Levels
ARSP Simulation Base Case
Operating Rules and Daily Water Level Statistics
Water Level - m
296.30
295.80
295.30
294.80
294.30
293.80
Legend
High Water Level
Upper Operating Zone
Normal Operating Zone
Lower Operating Zone
Low Water Zone
Ideal Operating Level
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
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

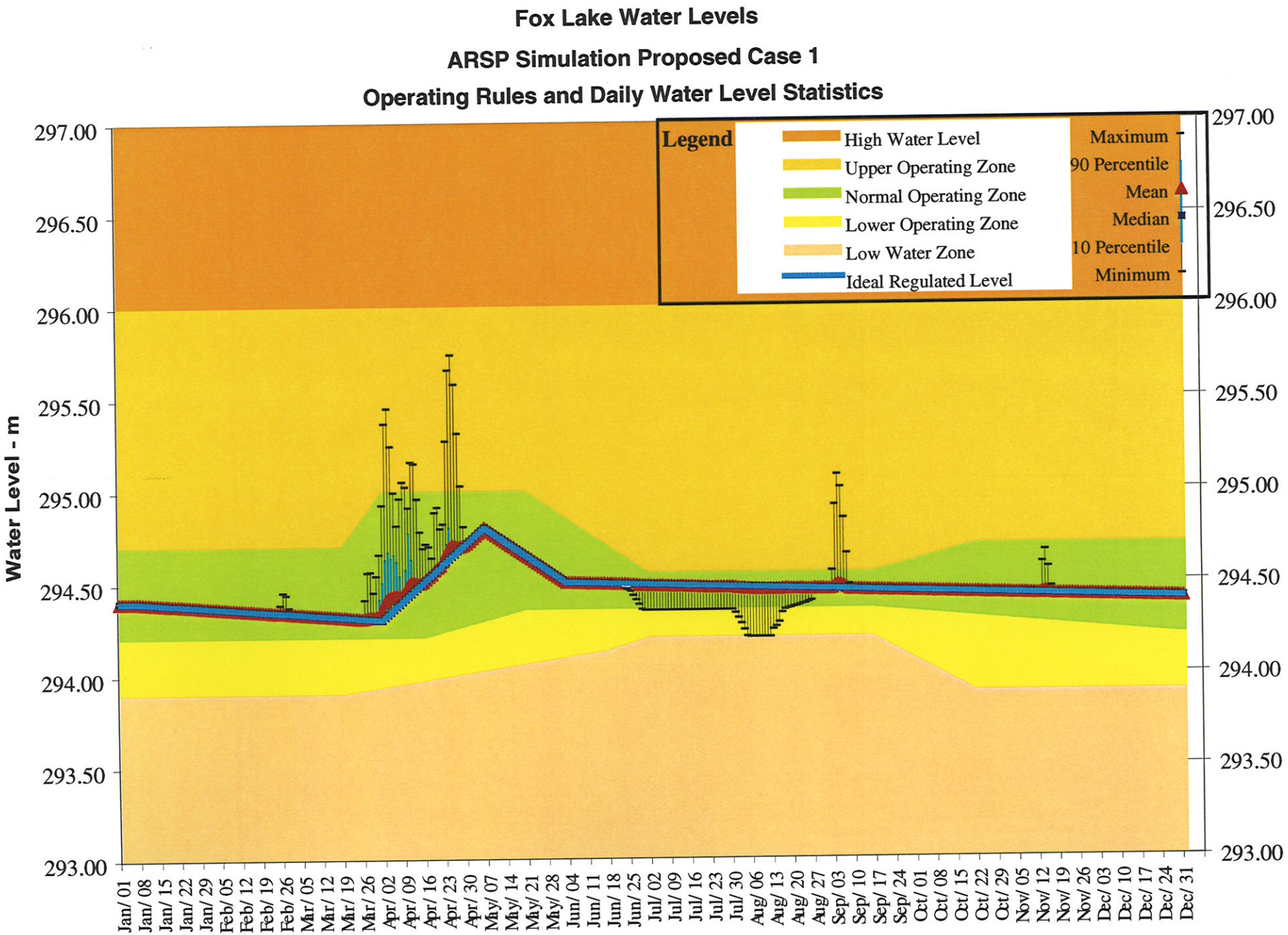
**Fox Lake Water Levels**
**ARSP Simulation Base Case**

| **Peak Water Levels** | |
|---|---|
| HWZ | 296 |
| No of Days in Exceedance | 0 |
| No of Years Exceeded | 0 |
| Maximum WL | 295.74 |

| **Time of spring peak levels before April 30** | |
|---|---|
| Percentile | 0.90 |
| Peak percentile WL | 294.58 |
| Date of peak | 27-Apr |
| | |
| Tolerance | 0 |
| Tolerated WL | 294.58 |
| Date tolerated exceeded | 27-Apr |

| **Summer recreation levels Jun-15 to Sep-30** | |
|---|---|
| *90 and 10 percentile range* | |
| Max 90% | 294.45 |
| Min 10% | 294.45 |
| Range | 0.00 |

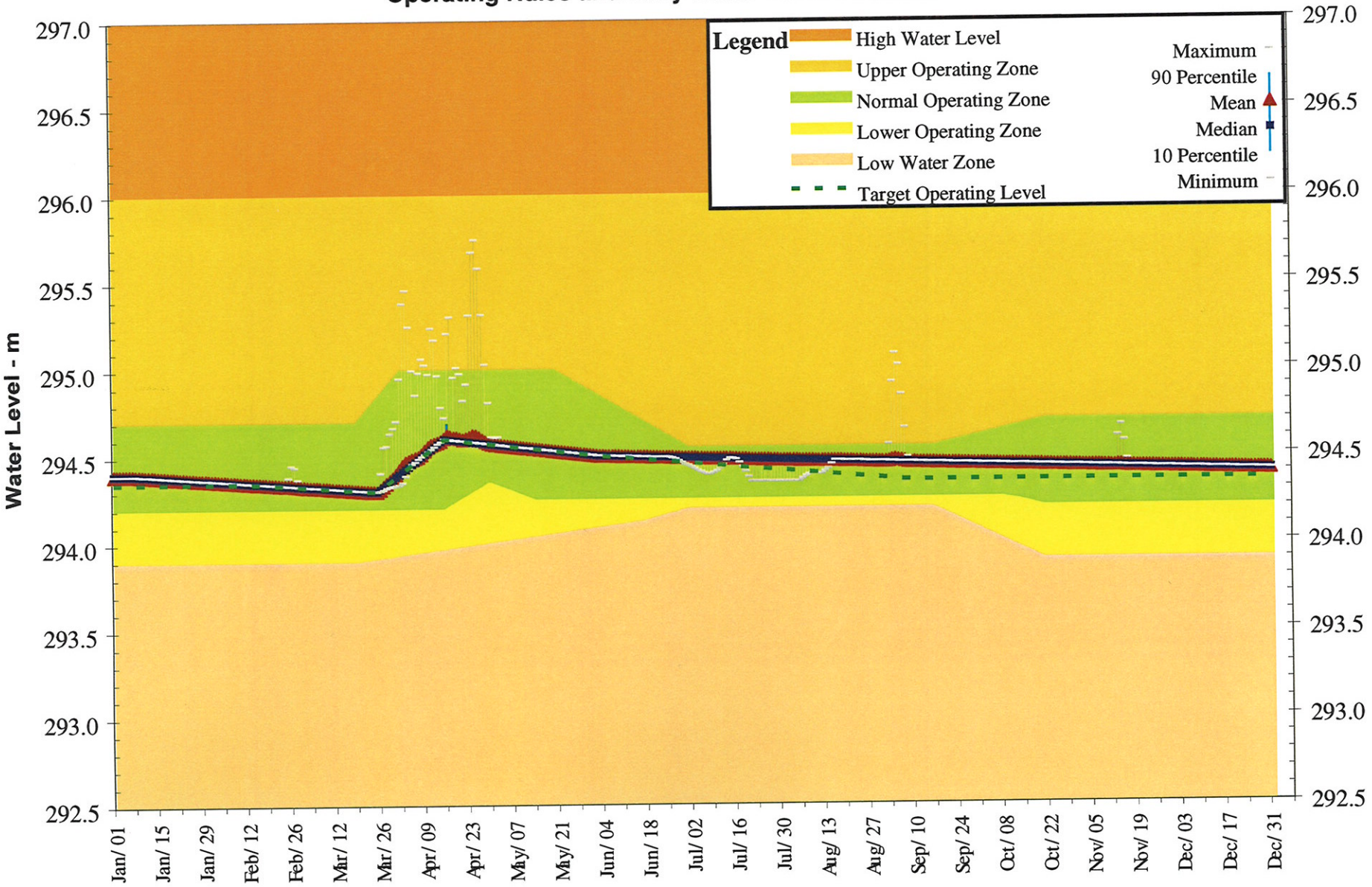
| *Median range* | |
|---|---|
| Max Median | 294.45 |
| Min Median | 294.45 |
| Range | 0.00 |


Fox Lake Water Levels
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
297.00
296.50
296.00
295.50
295.00
294.50
294.00
293.50
293.00
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

## Fox Lake Water Levels

## ARSP Simulation Case 2 - Rev. 1

## Operating Rules and Daily Water Level Statistics



**Fox Lake Water Levels**
**ARSP Simulation Case 2 - Rev. 1**

| **Peak Water Levels** | |
|---|---|
| HWZ | 296 |
| No of Days in Exceedance | 0 |
| No of Years Exceeded | 0 |
| Maximum WL | 295.75 |

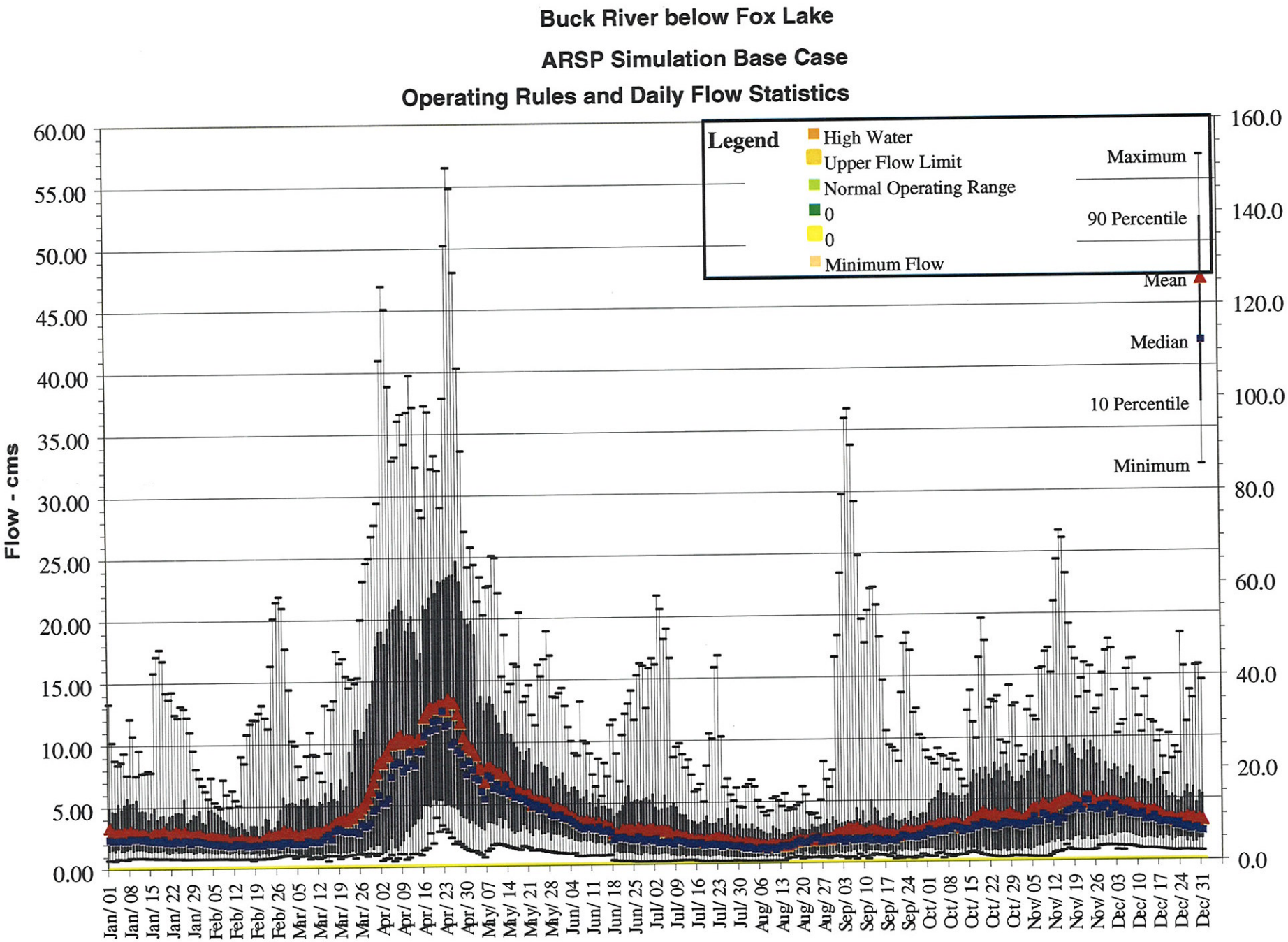
| **Time of spring peak levels before April 30** | |
|---|---|
| Percentile | 0.90 |
| Peak percentile WL | 294.69 |
| Date of peak | 16-Apr |
| | |
| Tolerance | 0 |
| Tolerated WL | 294.69 |
| Date tolerated exceeded | 16-Apr |

| **Summer recreation levels Jun-15 to Sep-30** | |
|---|---|
| *90 and 10 percentile range* | |
| Max 90% | 294.49 |
| Min 10% | 294.44 |
| Range | 0.05 |

| *Median range* | |
|---|---|
| Max Median | 294.49 |
| Min Median | 294.44 |
| Range | 0.05 |

**Spring Peak Water Level**

| | |
|---|---|
| Maximum - 50 yr Average | 294.75 |
| Date - 50 yr Average | 15/Apr |
| | |
| Summer Average Level | 294.47 |


Buck River below Fox Lake
ARSP Simulation Base Case
Operating Rules and Daily Flow Statistics
Legend
High Water
Upper Flow Limit
Normal Operating Range
0
0
Minimum Flow
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Flow - cms
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
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
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

Buck River below Fox Lake
ARSP Simulation Base Case
Daily Flows Model Results 1951 to 2000

**Walleye Spawning**

**Min Flow** 0 m³/s Achieved #N/A of time

**No of days above minumum flow**

*First half of season*

| | | |
|---|---|---|
| Min | 25 | days |
| Avg | 25 | days |
| Years Provided | 100% | |

*Last half of season*

| | | |
|---|---|---|
| Min | 24 | days |
| Avg | 24 | days |
| Years Provided | 100% | |

*For whole season*

| | | |
|---|---|---|
| Min | 49 | days |
| Avg | 49 | days |
| Years Provided | 100% | |

*From flow duration curve*

| % | Flow | | *No of days* | | % | *percentile peak flow* |
|---|---|---|---|---|---|---|
| 99% | 1.33 | m³/s | *min flow is achievd* | | 90% | |
| 95% | 2.27 | m³/s | 49 | days | 16 | m3/s |

**Summer Minimum 7-day Flow**

| | | | |
|---|---|---|---|
| | Maximum | 1.68 | m³/s |
| | Minimum | 0.21 | m³/s |
| 90% | Percentile | 1.34 | m³/s |
| 10% | Percentile | 0.43 | m³/s |
| | Median | 0.86 | m³/s |
| | Mean | 0.88 | m³/s |

**Maximum Flows**

Regulatory Flood Outflow

25 m³/s

No of years exceeded

23

**Minumum Flows**

*Min Daily flow*

0.21 m³/s

*7-day minimums*

| 2 -yr 7Q2 | 10 -yr 7Q10 | 20 -yr 7Q20 | return period |
|---|---|---|---|
| 0.80 | 0.43 | 0.38 | m³/s |

**Summer Fluctuations**

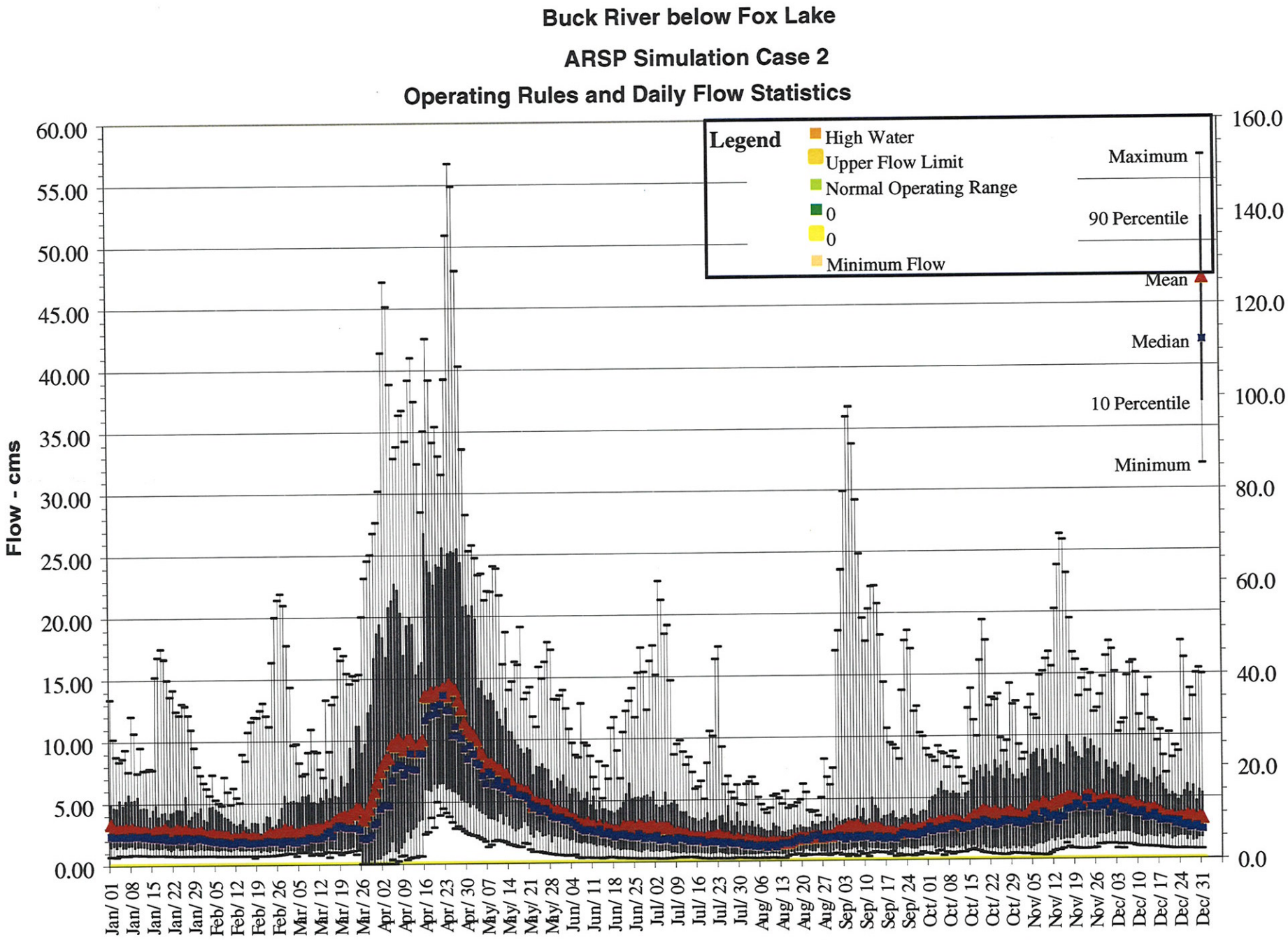
| Delta Flow | Average number of daily flow fluctuations per year | | |
|---|---|---|---|
| 1 | 12.28 | | |
| 3 | 1.56 | | |
| 5 | 0.40 | | |
| >0.845 | 15.56 | 0.5 | ratio of summer median |

**Water Usage**

| *Median Flow* | | *10% Percentile* | |
|---|---|---|---|
| summer m³/s | winter m³/s | summer m³/s | winter m³/s |
| 2.28 | 2.92 | 0.82 | 0.31 |

**Power Generation**

| | Quarter | | | | Annual | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | | |
| Flow | 3.01 | 6.90 | 2.07 | 3.86 | 3.96 | m³/s |


Buck River below Fox Lake
ARSP Simulation Case 2
Operating Rules and Daily Flow Statistics
Legend
High Water
Upper Flow Limit
Normal Operating Range
0
0
Minimum Flow
Maximum
90 Percentile
Mean
Median
10 Percentile
Minimum
Flow - cms
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
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
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

Buck River below Fox Lake
ARSP Simulation Case
2
Daily Flows Model Results 1951 to 2000

**Walleye Spawning**

**Min Flow** 0 m³/s Achieved #N/A of time

**No of days above minumum flow**

*First half of season*

| | | |
|---|---|---|
| Min | 25 | days |
| Avg | 25 | days |
| Years Provided | 100% | |

*Last half of season*

| | | |
|---|---|---|
| Min | 24 | days |
| Avg | 24 | days |
| Years Provided | 100% | |

*For whole season*

| | | |
|---|---|---|
| Min | 49 | days |
| Avg | 49 | days |
| Years Provided | 100% | |

*From flow duration curve*

| % | Flow | | *No of days* | | | |
|---|---|---|---|---|---|---|
| 99% | 1.18 | m³/s | *min flow is achievd* | | 90% | *percentile peak flow* |
| 95% | 2.21 | m³/s | 49 | days | 17 | m3/s |

**Summer Minimum 7-day Flow**

| | | | |
|---|---|---|---|
| | Maximum | 1.72 | m³/s |
| | Minimum | 0.25 | m³/s |
| 90% | Percentile | 1.38 | m³/s |
| 10% | Percentile | 0.47 | m³/s |
| | Median | 0.89 | m³/s |
| | Mean | 0.91 | m³/s |

**Maximum Flows**

| Regulatory Flood Outflow | | No of years exceeded |
|---|---|---|
| 25 | $m^3/s$ | 27 |

**Minumum Flows**

| *Min Daily flow* | | *7-day minimums* | | | |
|---|---|---|---|---|---|
| | | 2 | 10 | 20 | return period |
| | | -yr 7Q2 | -yr 7Q10 | -yr 7Q20 | |
| 0.00 | $m^3/s$ | 0.66 | 0.36 | 0.20 | $m^3/s$ |

**Summer Fluctuations**

| Delta Flow | Average number of daily flow fluctuations per year | | |
|---|---|---|---|
| 1 | 12.36 | | |
| 3 | 1.58 | | |
| 5 | 0.40 | | |
| >0.857 | 15.14 | 0.5 | ratio of summer median |

**Water Usage**

| *Median Flow* | | *10% Percentile* | |
|---|---|---|---|
| summer | winter | summer | winter |
| $m^3/s$ | $m^3/s$ | $m^3/s$ | $m^3/s$ |
| 2.25 | 2.87 | 0.85 | 0.00 |

**Power Generation**

| | Quarter | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Annual | |
| Flow | 2.91 | 6.94 | 2.11 | 3.89 | 3.96 | $m^3/s$ |