Appendix B.3:
Surface Water Modeling Calculations for EIS

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Zavoral Mining and Reclamation Project

Surface Water Modeling Calculations for EIS

References:

1. Carnelian-Marine-St. Croix Watershed District (CMSWD) Rules Adopted March 1, 2010.
2. CMSWD Watershed Management Plan, 2010, Appendix A: Land and Natural Resource Inventory.
3. Soil Conservation Service, 1986, Urban Hydrology for Small Watersheds, TR-55.
4. XP, 2011, Stormwater Management Model V2011.

Sheet 1

- Scope
- Existing Conditions
- Watershed areas from CAD

Sheet 2

- Time of concentration calculations for internally drained areas(2-yr, 10-yr, 100-yr, 24-hr)

Sheet 3

- Time of concentration calculations for off-site discharge (2-yr, 10-yr, and 100-yr, 24-hr)

Sheet 4

- Storage calculations for existing conditions and post reclamation (100-yr, 24-hr)
- Storage results from XPSWMM for existing conditions

Sheet 5

- Storage results from XPSWMM for post reclamation
- Peak flow results from XPSWMM for existing conditions, during construction, and post reclamation

Appendix A – XPSWMM results

Scope:

Model Complete Zavoral Mining Site for 2-yr, 10-yr, and 100-yr storm events for pre-construction, during construction, and post-construction events, calculating runoff and storage.

Existing Conditions

Total Site Storage = 126,000 cu yds.

Total Area = 63.6 acres

24-hr Rainfall from CMSCWD Watershed Management Plan Land & Natural Resource Inventory:

2-yr	2.8”
10-yr	4.2”
100-yr	5.9”

Total Watershed internally drained = 52.0 acres
Zavoral Stream Watershed (North) = 4.58 acres
Middle Stream Watershed = 1.04 acres
South Stream Watershed = 5.97

Majority of soils are Hydrologic Soil Group A according the USDA NRCS Soil Data Survey. According to CMSCWD Rules Adopted 3-1-2010 Curve Number for HSG A is 30. However, since the site was previously mined, it can be considered post-development which according to 2.5.3 (d) of CMSCWD Rules should be shifted down ½ a classification. So, averaging HSG A (30) and HSG B (58) the curve number used is 44.

According to TR-55 n-value is short prairie grass = 0.15.

All time of concentration calculations based on TR-55.

All Watersheds and Pits (depression areas) based on EIS Figures 26 – 30.

Time of Concentration Calcs used in XPSWMM for Existing Conditions

Based on eight internal storage areas, the following time of concentration values are calculated:

2-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
1	340	0.12	0.121212	12.31878	12.43999
2	1535	0.04	6.432292	19.11685	25.54914
3	1037	0.03	4.386905	21.44825	25.83515
4	292	0.04		19.11685	19.11685
5	874	0.05	2.657407	17.48446	20.14187
6	926	0.03	3.72619	21.44825	25.17444
7	391	0.08	0.32971	14.48786	14.81757
8	432	0.1	0.44	13.25074	13.69074

10-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
1	340	0.12	0.121212	10.05824	10.17946
2	1535	0.04	6.432292	15.60884	22.04113
3	1037	0.03	4.386905	17.51242	21.89932
4	292	0.04		15.60884	15.60884
5	874	0.05	2.657407	14.276	16.93341
6	926	0.03	3.72619	17.51242	21.23861
7	391	0.08	0.32971	11.82929	12.159
8	432	0.1	0.44	10.81919	11.25919

100-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
1	340	0.12	0.121212	8.486347	8.607559
2	1535	0.04	6.432292	13.1695	19.60179
3	1037	0.03	4.386905	14.77559	19.16249
4	292	0.04		13.1695	13.1695
5	874	0.05	2.657407	12.04496	14.70237
6	926	0.03	3.72619	14.77559	18.50178
7	391	0.08	0.32971	9.980615	10.31033
8	432	0.1	0.44	9.128371	9.568371

Off-site drainage time of concentration calculations are also calculated:

2-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
North	600	0.03	1.785714	21.44825	23.23396
Middle	100	0.03		8.906248	8.906248
South	770	0.03	2.797619	21.44825	24.24587

10-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
North	600	0.03	1.785714	17.51242	19.29813
Middle	100	0.03		7.271921	7.271921
South	770	0.03	2.797619	17.51242	20.31004

100-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
North	600	0.03	1.785714	14.77559	16.5613
Middle	100	0.03		6.135469	6.135469
South	770	0.03	2.797619	14.77559	17.57321

<u>Time of Concentration Calcs Used in XPSWMM for Post Reclamation</u>

2-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
1	219	0.05		13.59285149	13.59285149
2	631	0.08	1.199275362	11.26322031	12.46249567
3	175	0.03		16.67439449	16.67439449
4	230	0.009		26.98991831	26.98991831
5	1014	0.006	29.75	31.74227674	61.49227674

10-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
1	219	0.05		11.09851677	11.09851677
2	631	0.08	1.199275362	9.196380873	10.39565624
3	175	0.03		13.61458609	13.61458609
4	230	0.009		22.03717602	22.03717602
5	1014	0.006	29.75	25.91746043	55.66746043

100-yr

WS	Length (ft)	Slope (ft/ft)	T(conc) (min)	T(sheet) (min)	T(total) (min)
1	219	0.05		9.364046938	9.364046938
2	631	0.08	1.199275362	9.980614947	11.17989031
3	175	0.03		9.600154643	9.600154643
4	230	0.009		19.33666427	19.33666427
5	1014	0.006	29.75	28.12760765	57.87760765

Storage Calcs in acres used in XPSWMM

Existing

Depth (ft)	Pit #1	Pit #2	Pit #3	Pit #4	Pit #5	Pit #6	Pit #7	Pit #8
0	0.04	0.04	0.03	0.01	0.14	0.45	0.01	0.04
2	0.42	0.21	0.06	0.13	0.24	0.95	0.16	0.11
4	0.8	0.76	0.11	1.01	0.48	1.87	0.27	0.19
6	1.03	1.64	0.49	1.71		2.68		
8	1.2	2.67	0.90	2.26		3.87		
10	1.36	4.28		2.72				
12	1.51			3.07				

Post

Depth(ft)	Pit #1	Pit #2	Pit #3	Pit #4	Pit #5
1	.11	.17	.58	.29	.71
2	.48	.82		.86	2.91
3					9.29
4					17.20

Storage Calculation Depths for 100-yr event

Existing

Pit #	Bottom Elev (ft)	Max Stage 100yr (ft)	100-yr water depth (ft)
1	868	869.163	1.163
2	856	859.444	3.444
3	860	864.442	4.442
4	866	868.357	2.357
5	884	887.285	3.285
6	854	854.383	0.383
7	850	851.504	1.504
8	880	881.22	1.22

Post

Pit #	Bottom Elev (ft)	Max Stage 100yr (ft)	100-yr water depth (ft)
1	866	866.591	0.591
2	857	858.267	1.267
3	861	861.768	0.768
4	857	857.402	0.402
5	851	852.163	1.163

Peak Flow Runoff Results

Peak Flows (cfs)		2-yr	10-yr	100-yr
Existing	North WS	0.0	0.1	2.2
	Middle WS	0.0	0.0	0.8
	South WS	0.0	0.2	2.7
During	North WS	0.0	0.0	0.7
	Middle WS	0.0	0.0	0.8
	South WS	0.0	0.1	1.5
Post	North WS	0.0	0.0	0.6
	Middle WS	0.0	0.0	0.0
	South WS	0.0	0.0	0.0

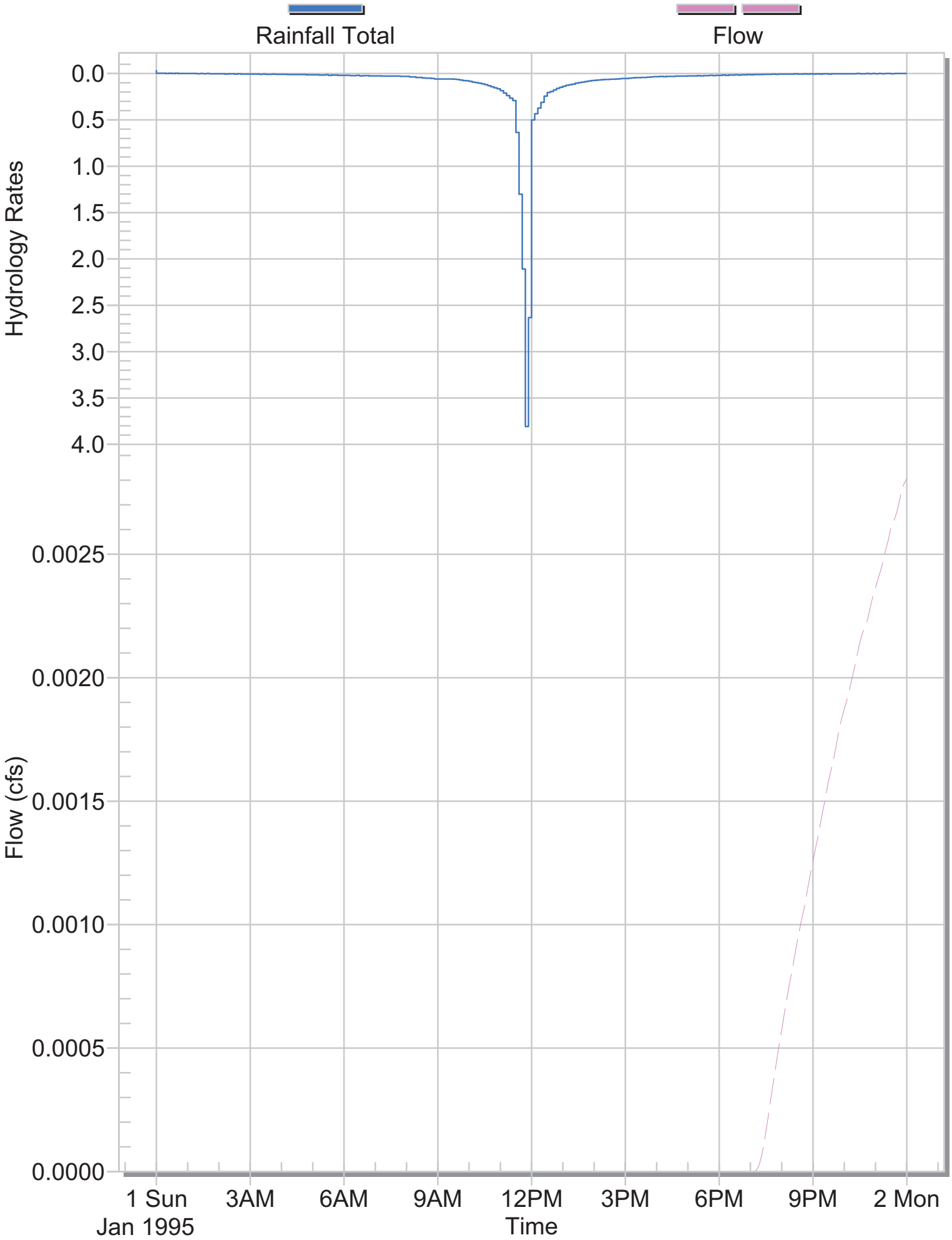
Appendix A

XPSWMM Results

Node - North WS

Existing 2-yr

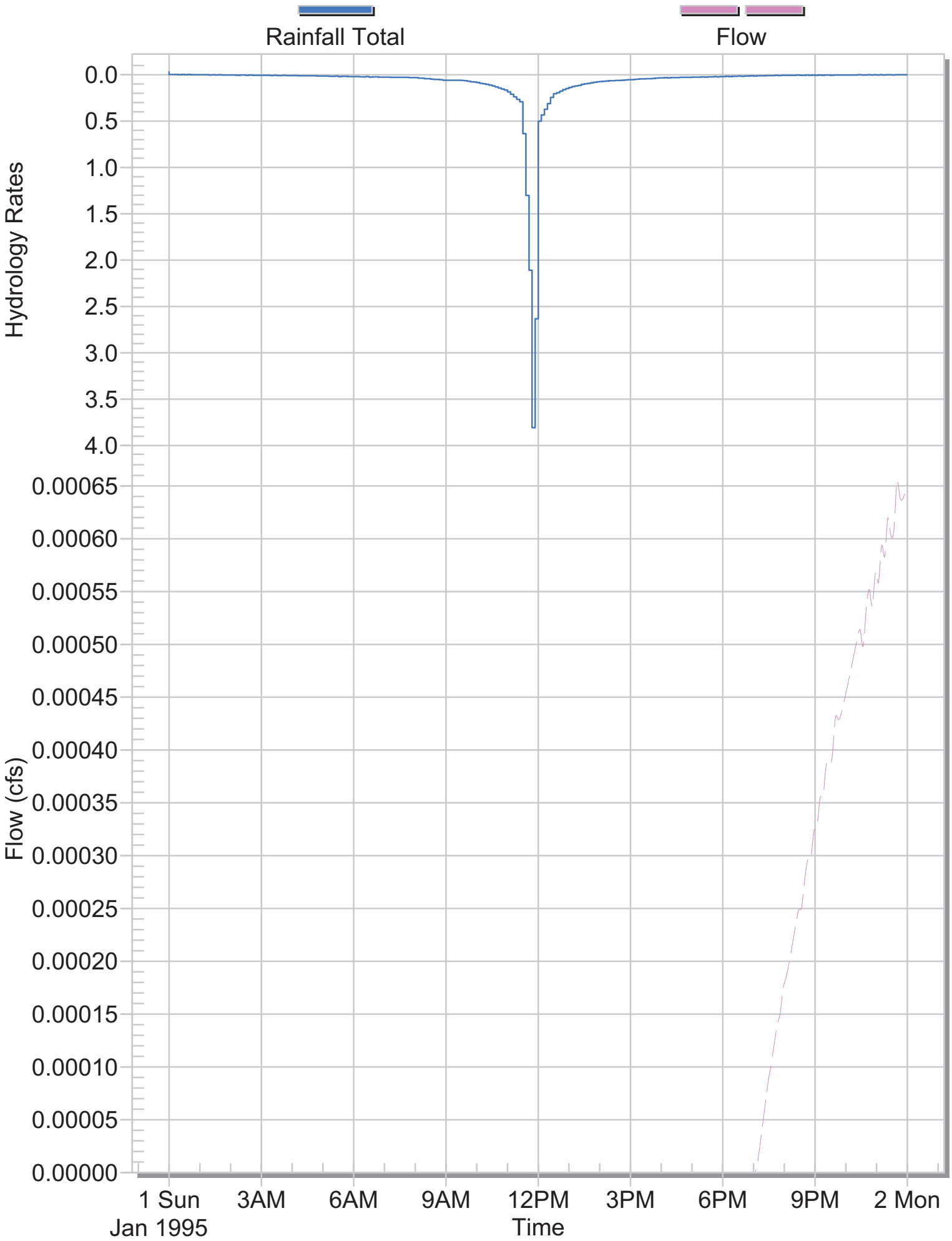
[Max Flow = 0.0028]



Node - Mid WS

Existing 2-yr

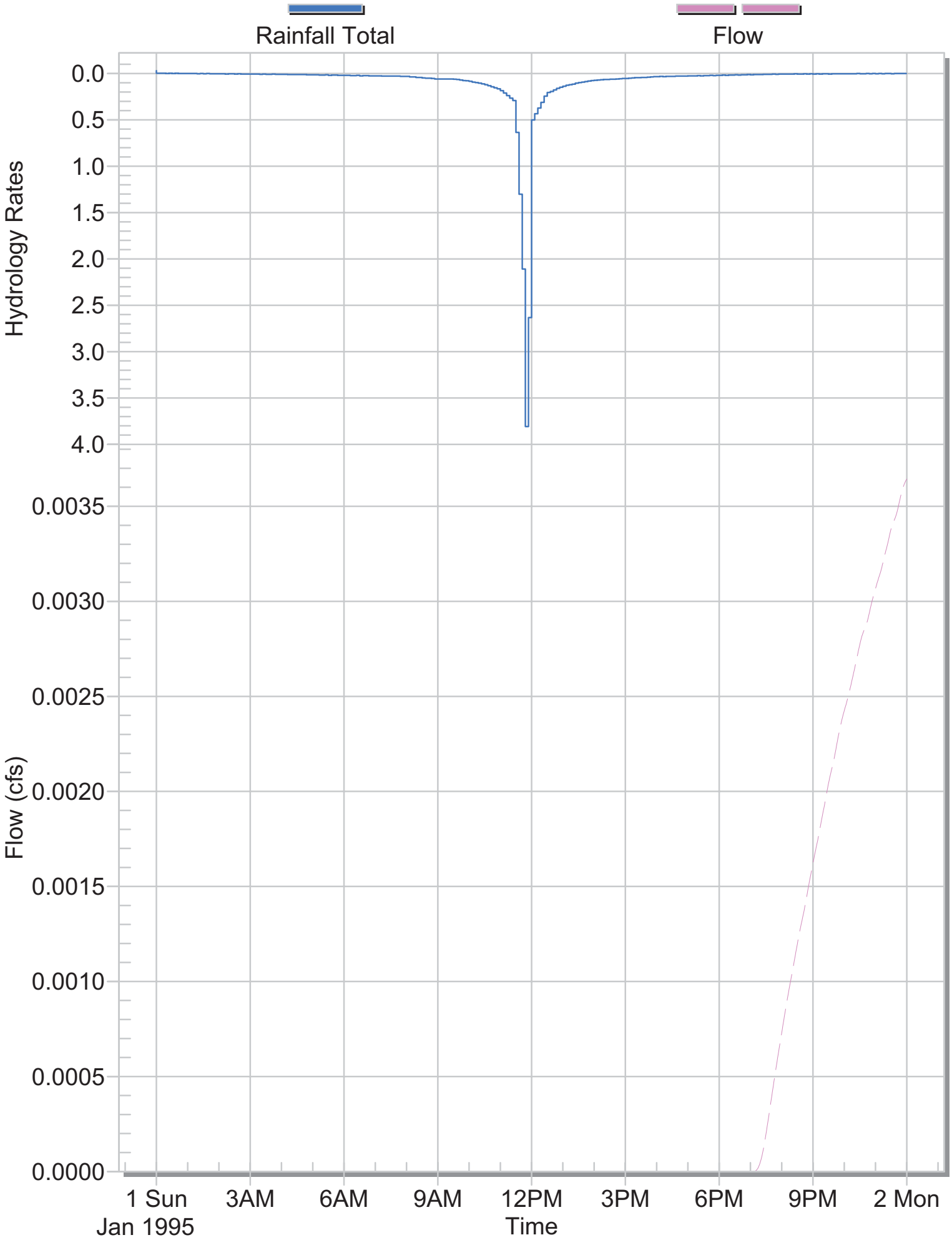
[Max Flow = 0.0007]



Node - South WS

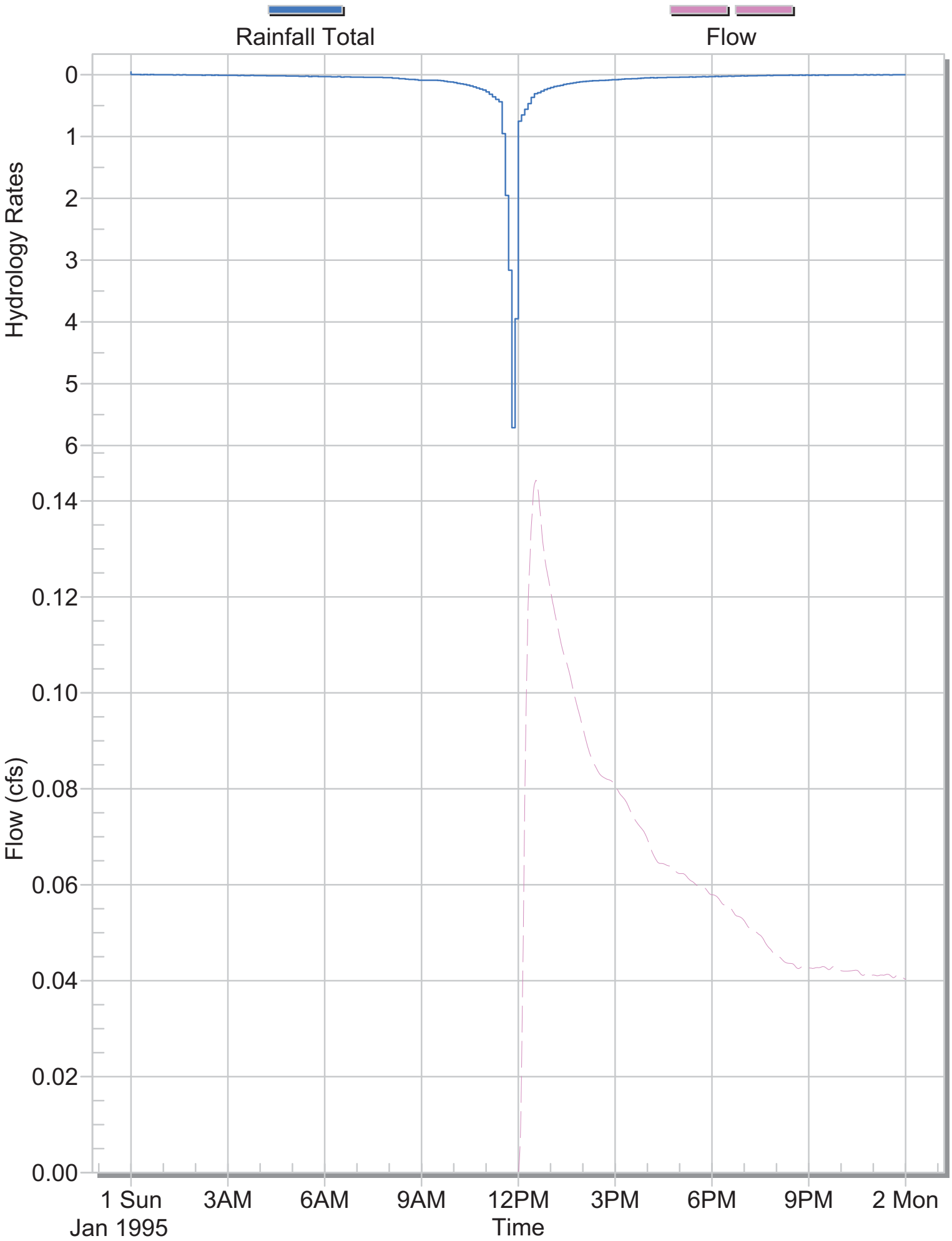
Existing 2-yr

[Max Flow = 0.0036]



Node - North WS Existing 10-yr

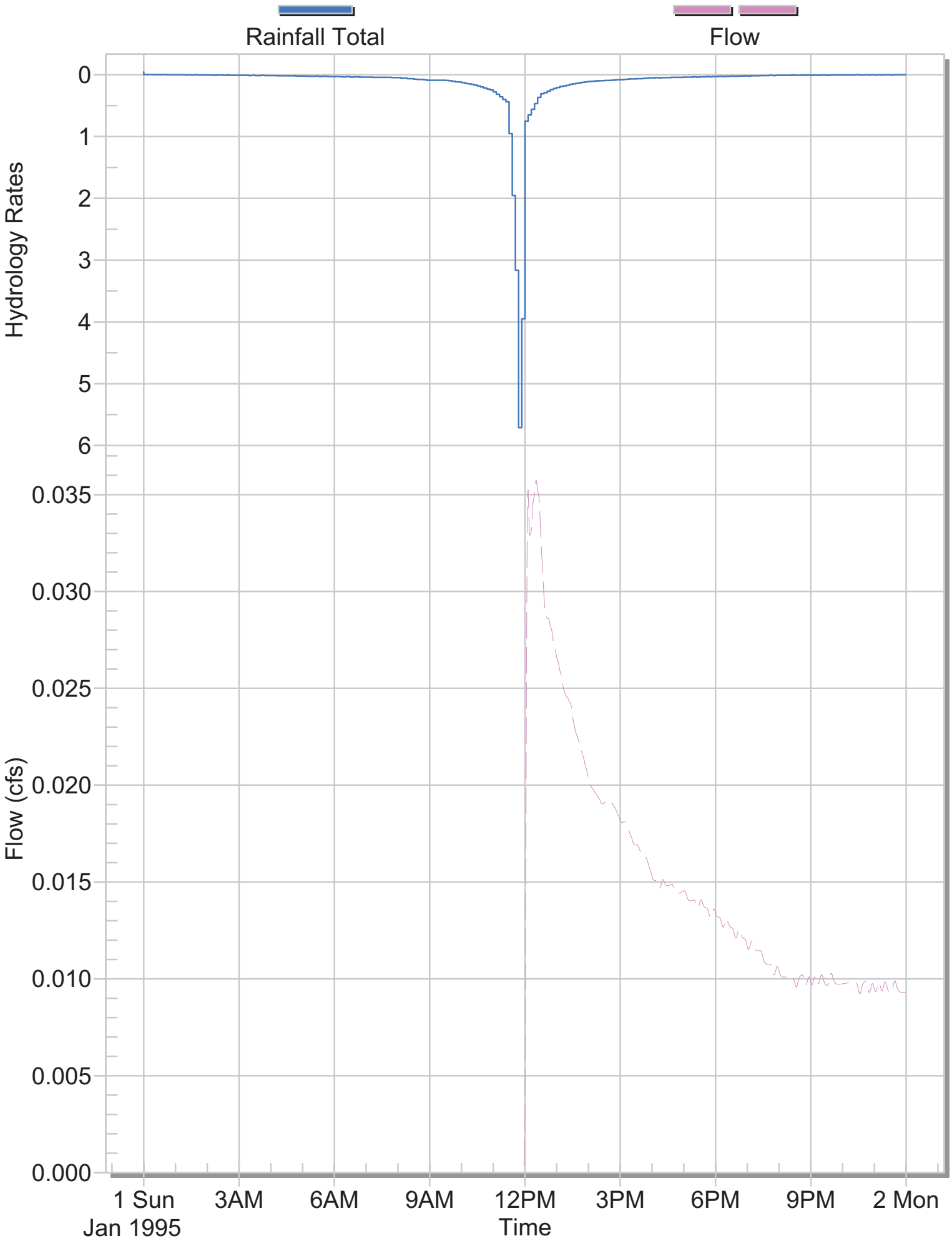
[Max Flow = 0.1443]



Node - Mid WS

Existing 10-yr

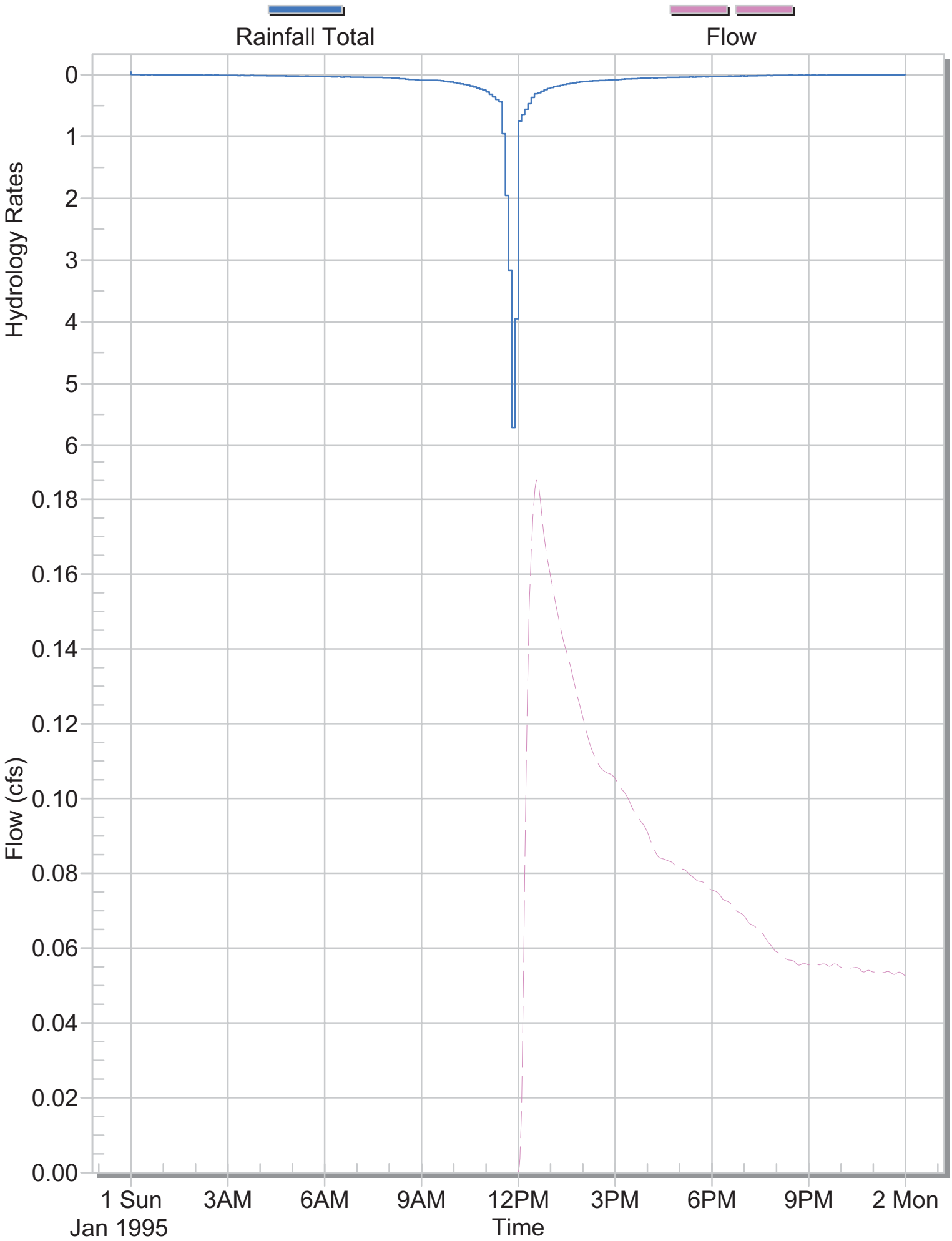
[Max Flow = 0.0357]



Node - South WS

Existing 10-yr

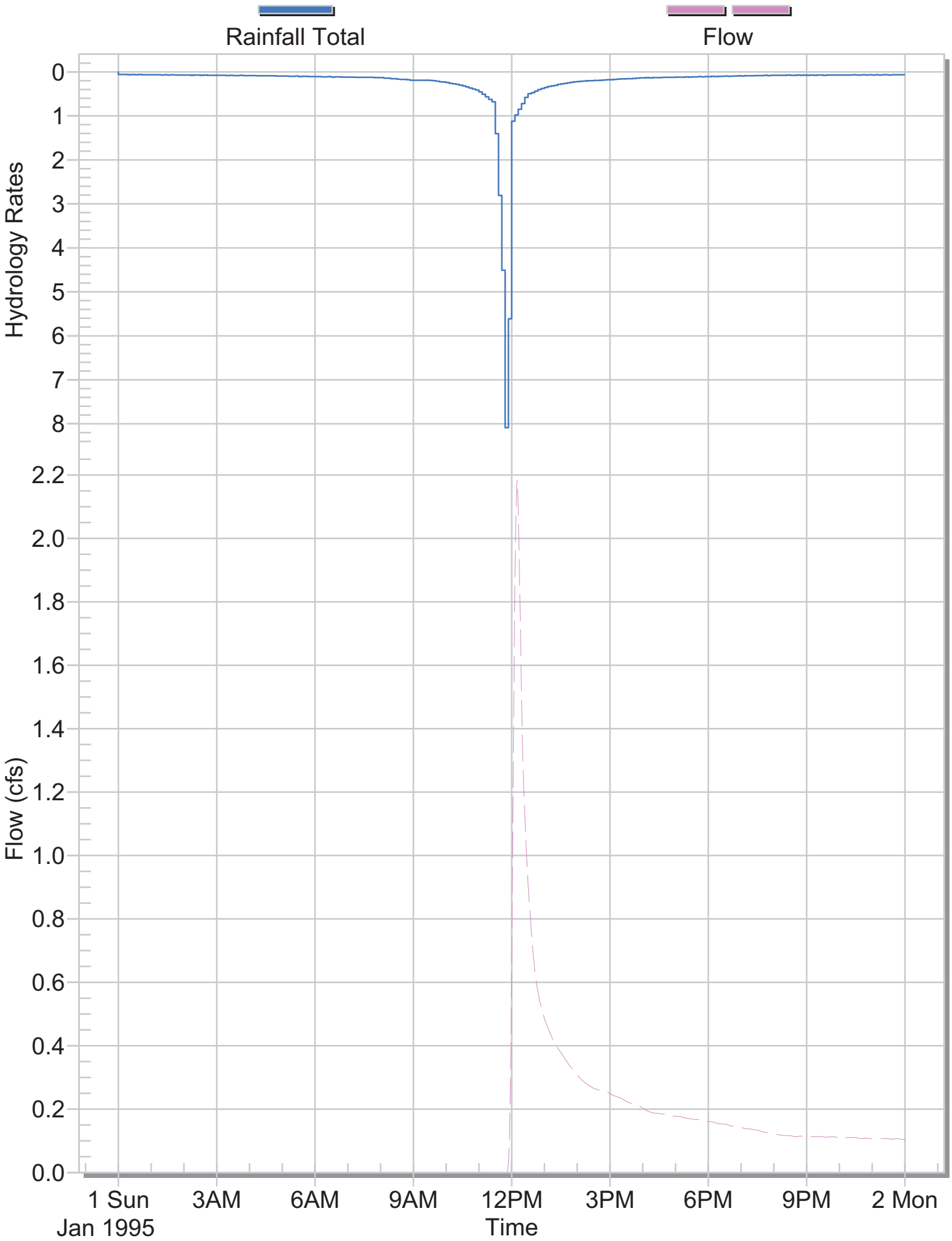
[Max Flow = 0.1851]



Node - North WS

Existing 100-yr

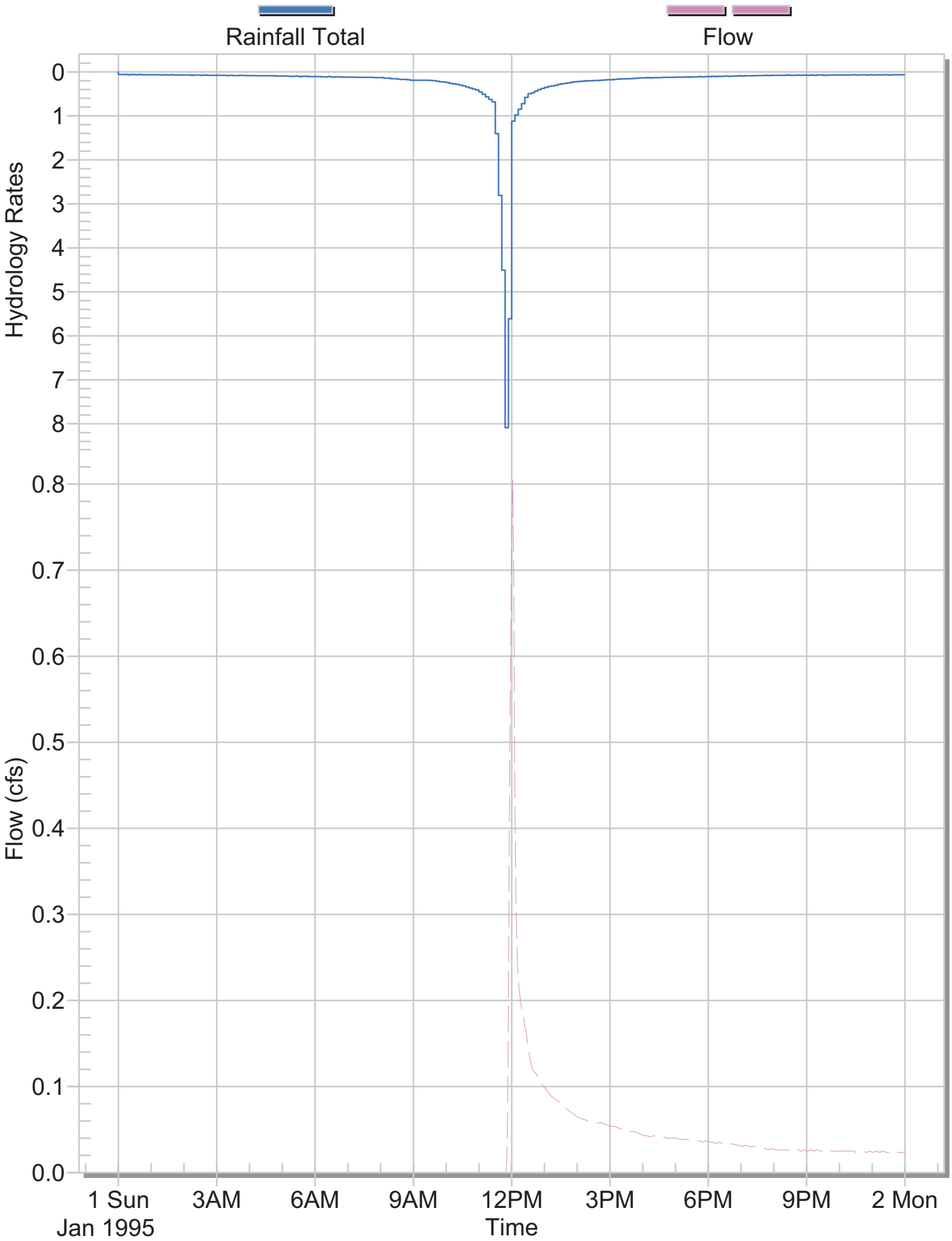
[Max Flow = 2.1838]



Node - Mid WS

Existing 100-yr

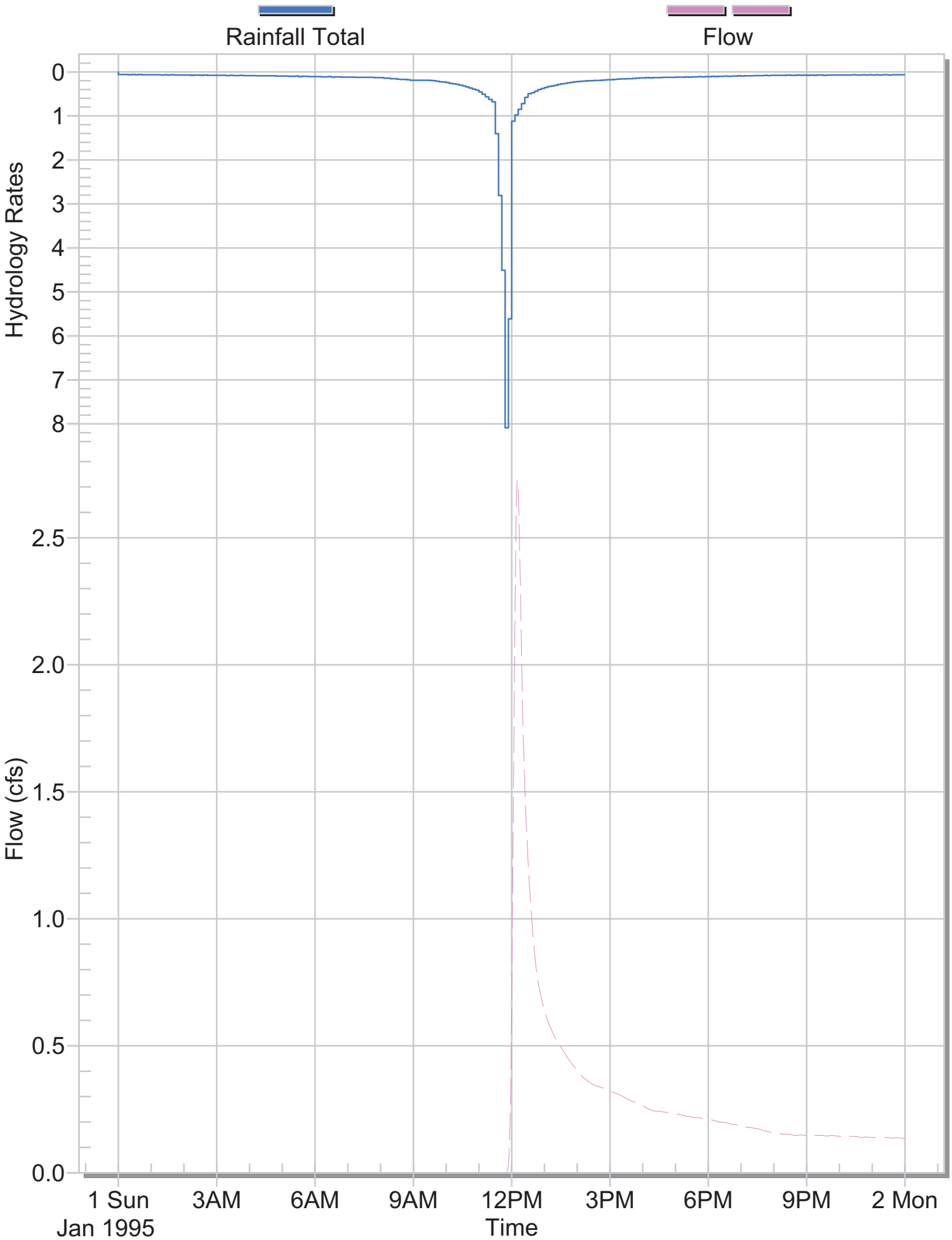
[Max Flow = 0.8046]



Node - South WS

Existing 100-yr

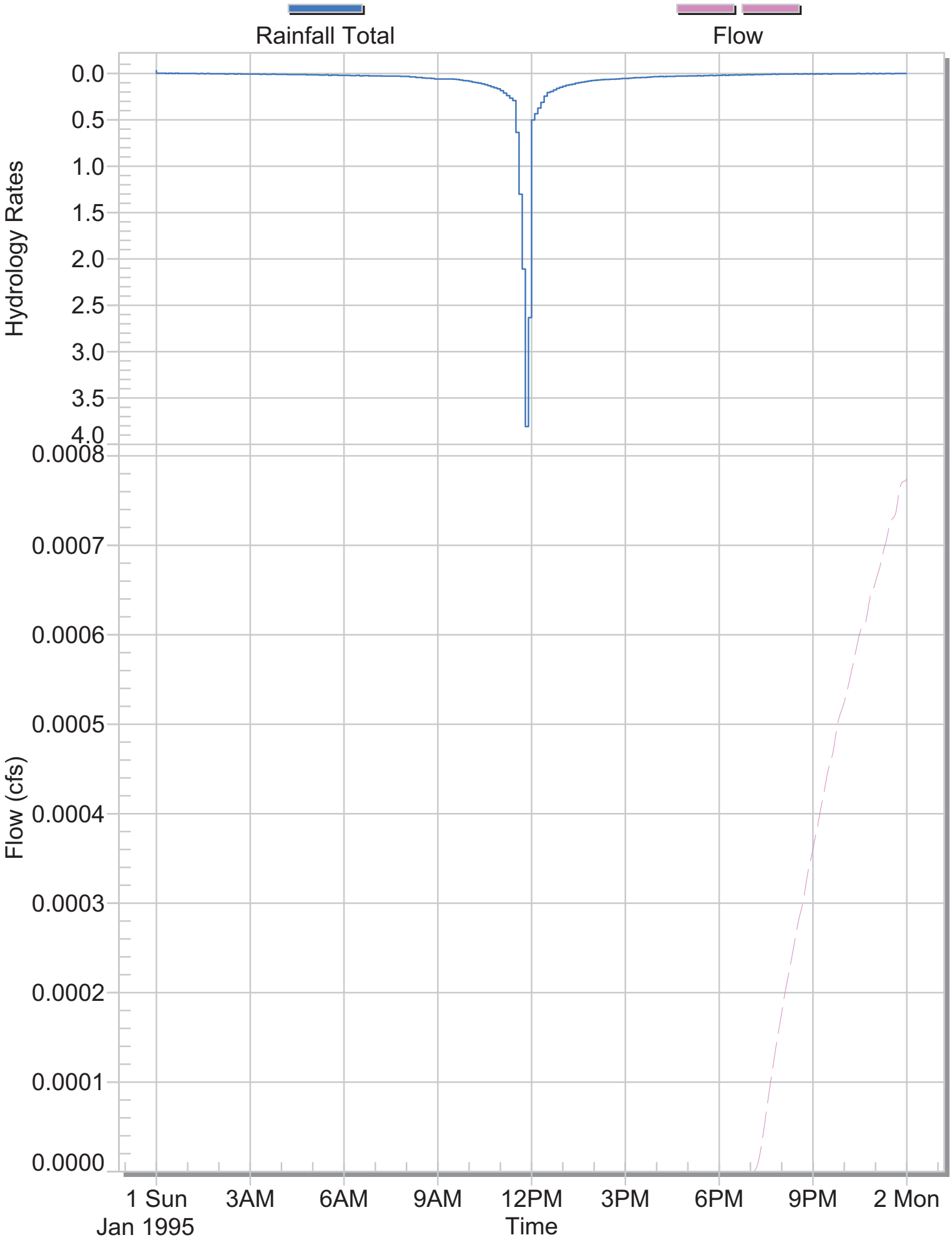
[Max Flow = 2.7266]



Node - North WS

During 2-yr

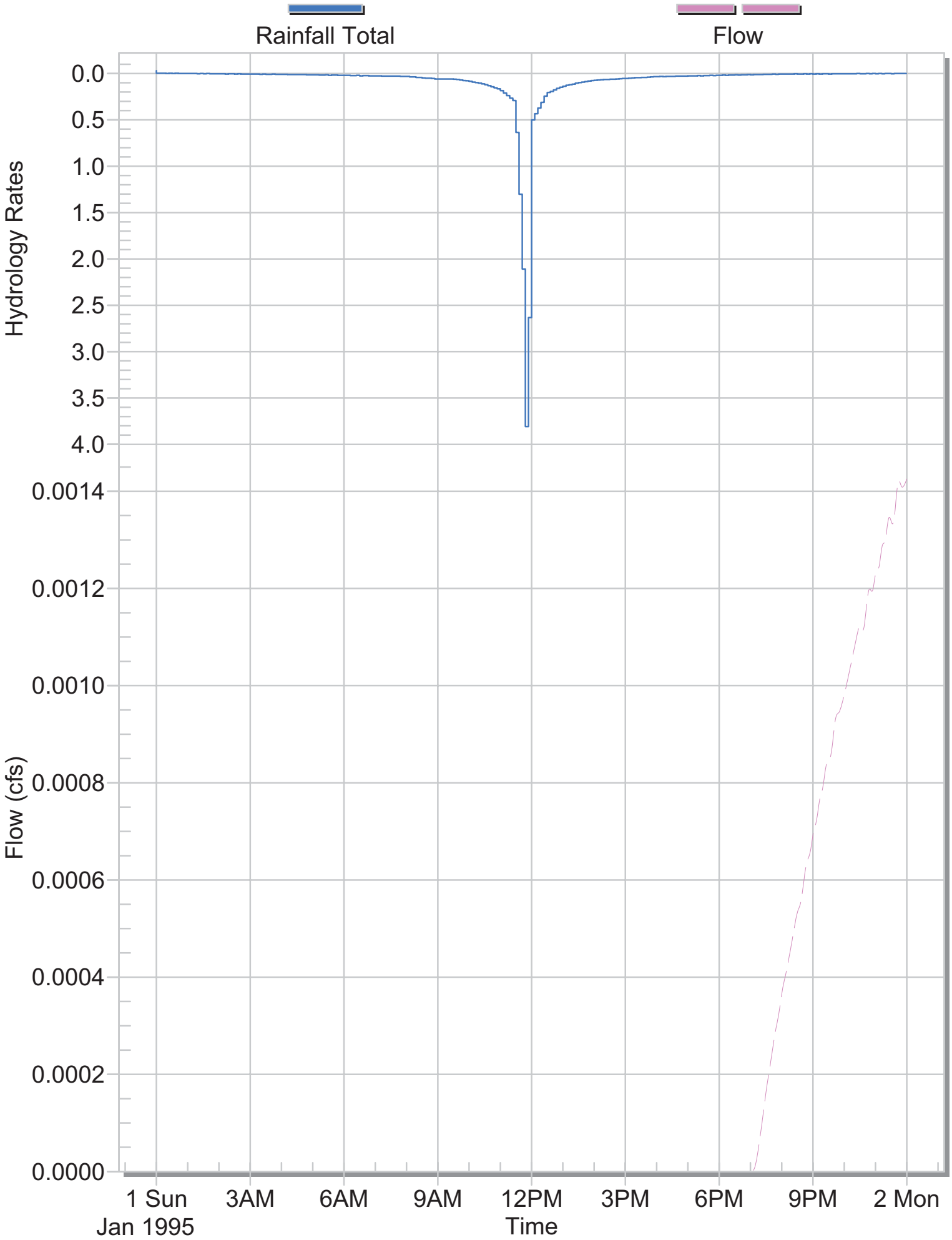
[Max Flow = 0.0008]



Node - South WS

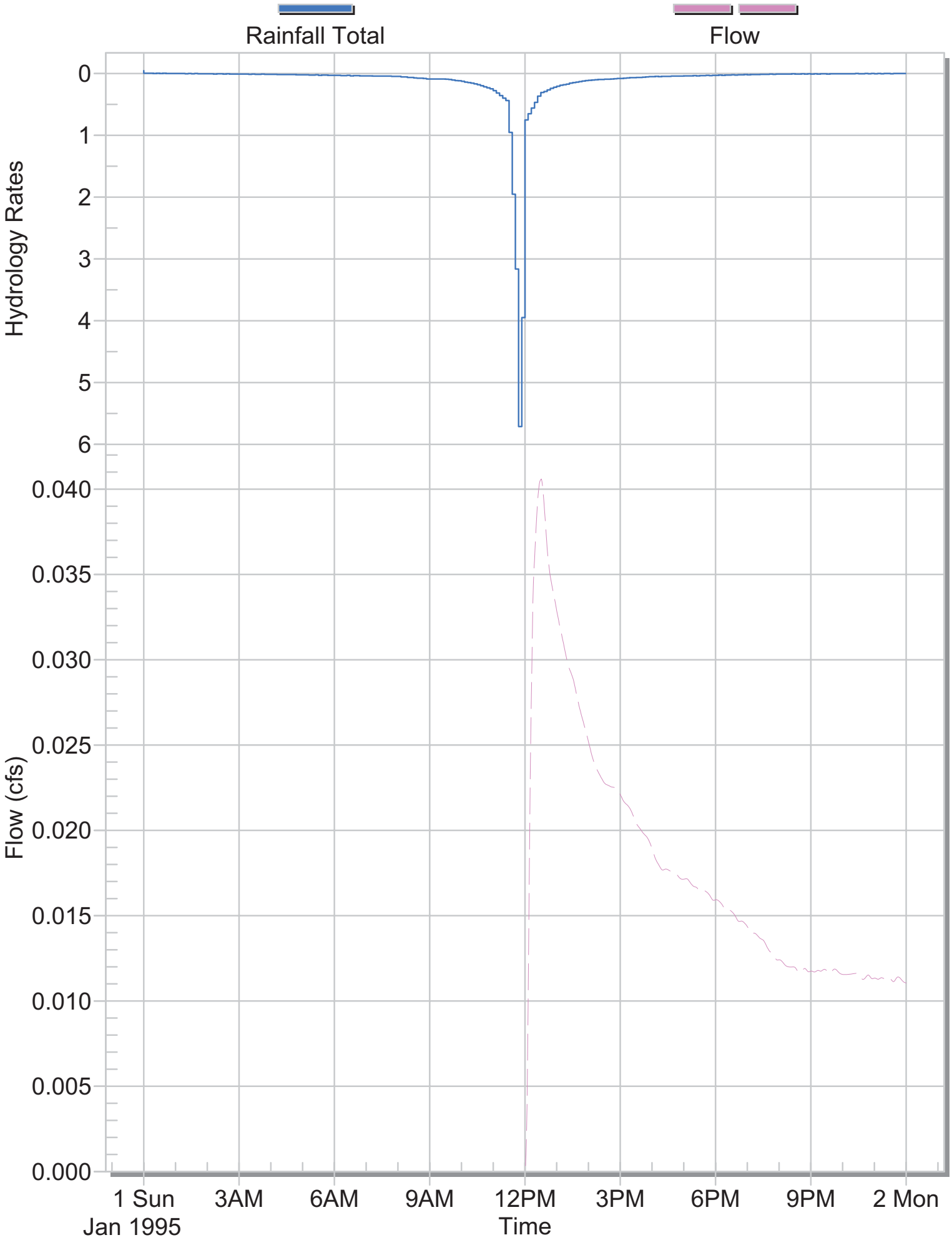
During 2-yr

[Max Flow = 0.0014]



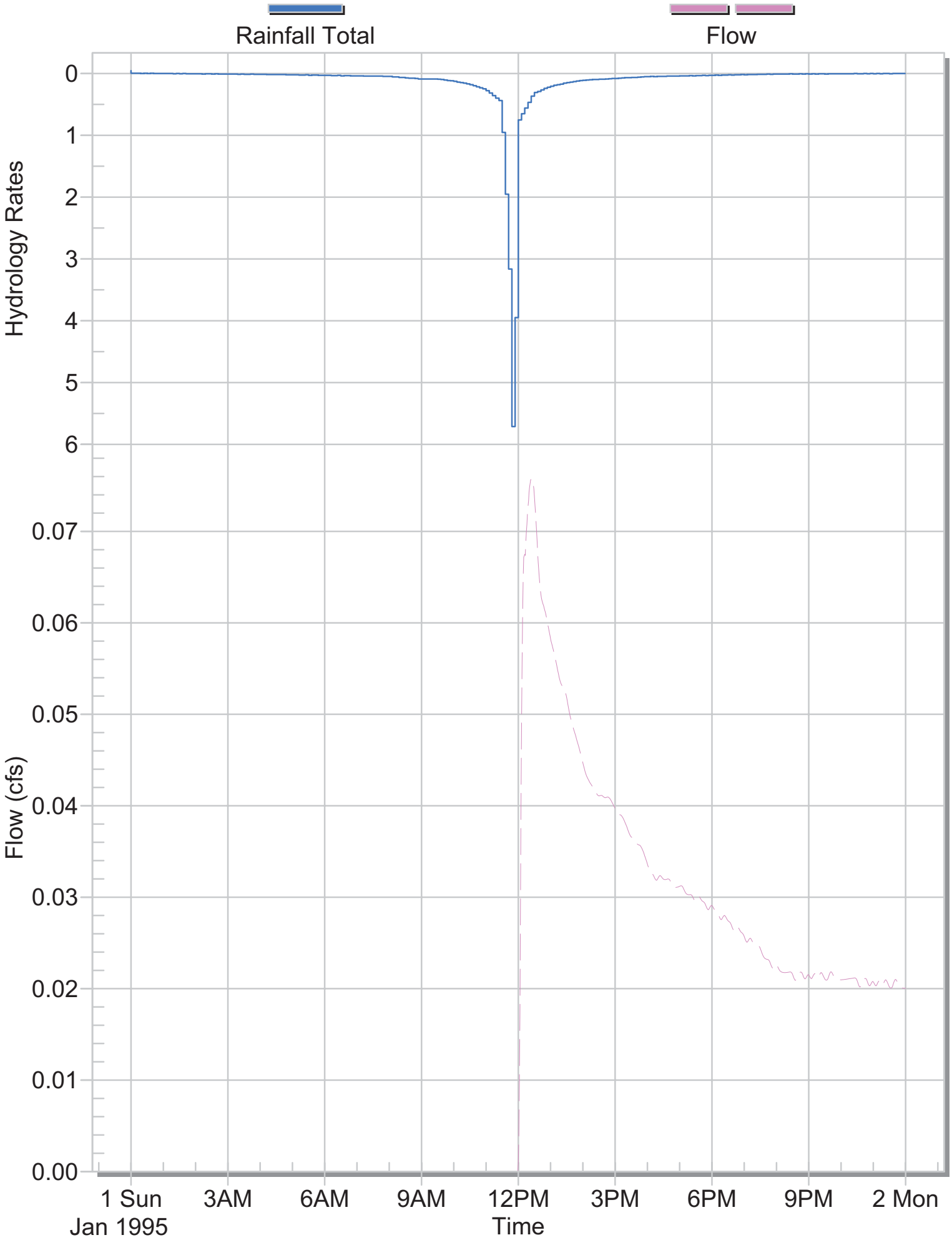
Node - North WS During 10-yr

[Max Flow = 0.0406]



Node - South WS During 10-yr

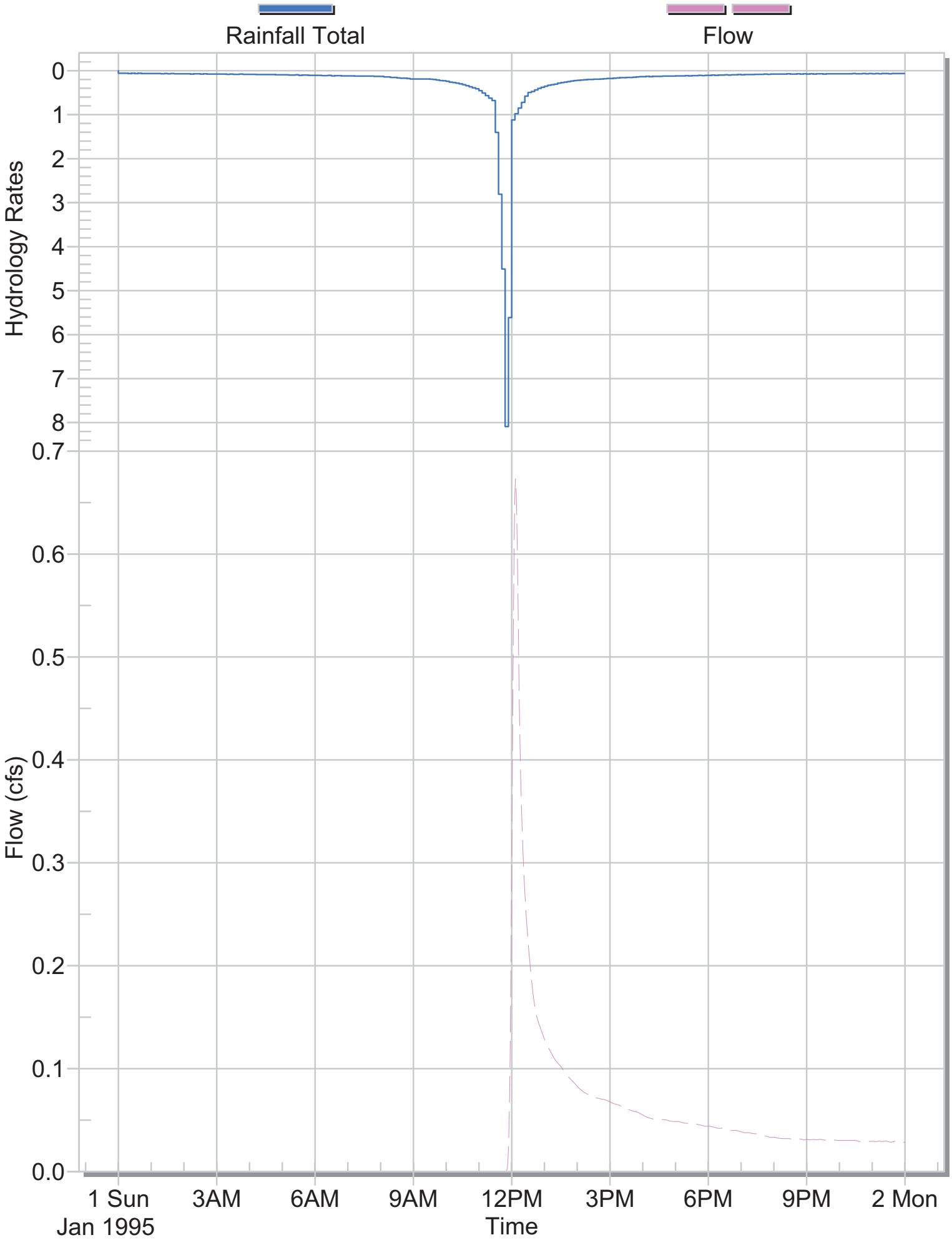
[Max Flow = 0.0757]



Node - North WS

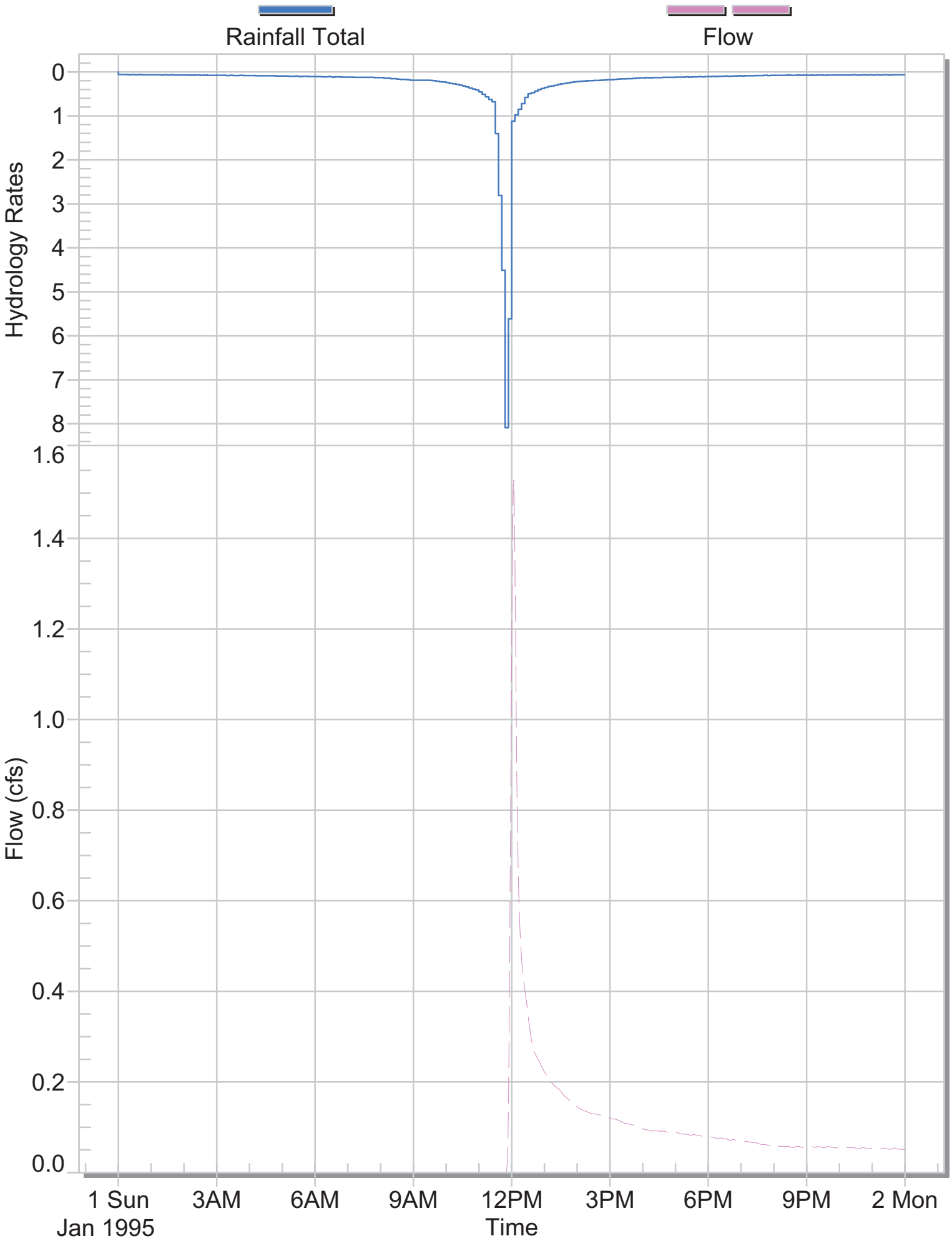
During 100-yr

[Max Flow = 0.6730]



Node - South WS During 100-yr

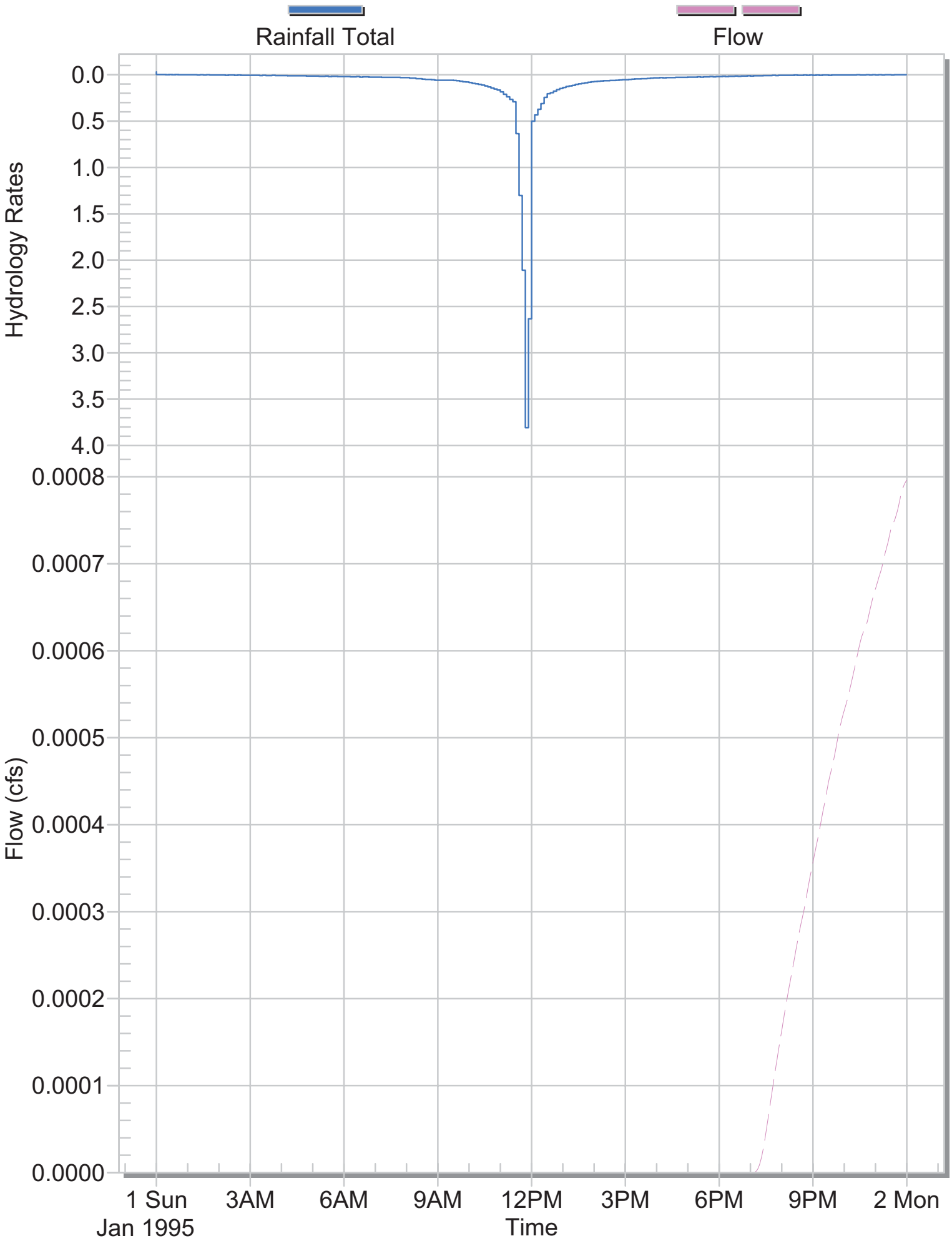
[Max Flow = 1.5285]



Node - North WS

Post 2-yr

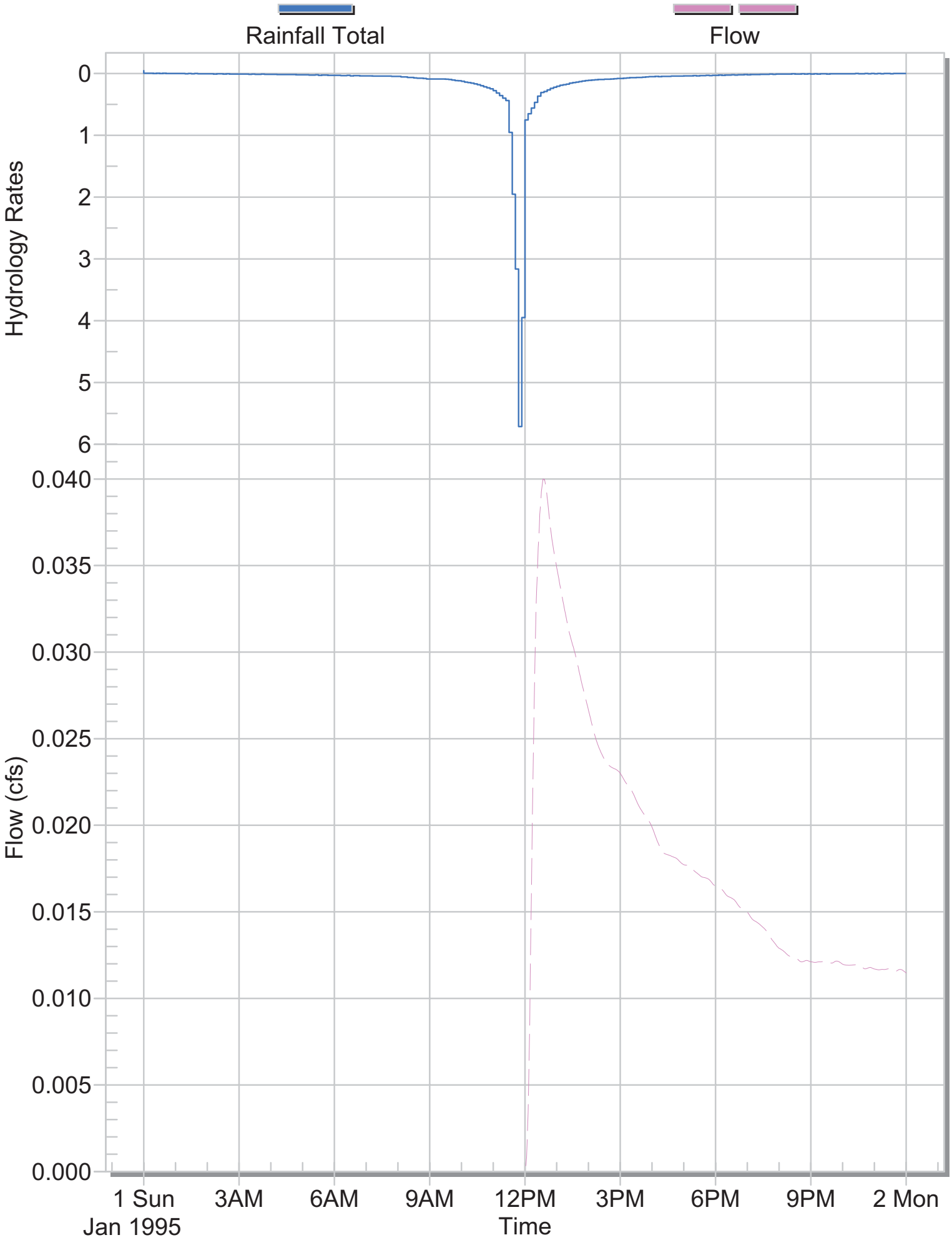
[Max Flow = 0.0008]



Node - North WS

Post 10-yr

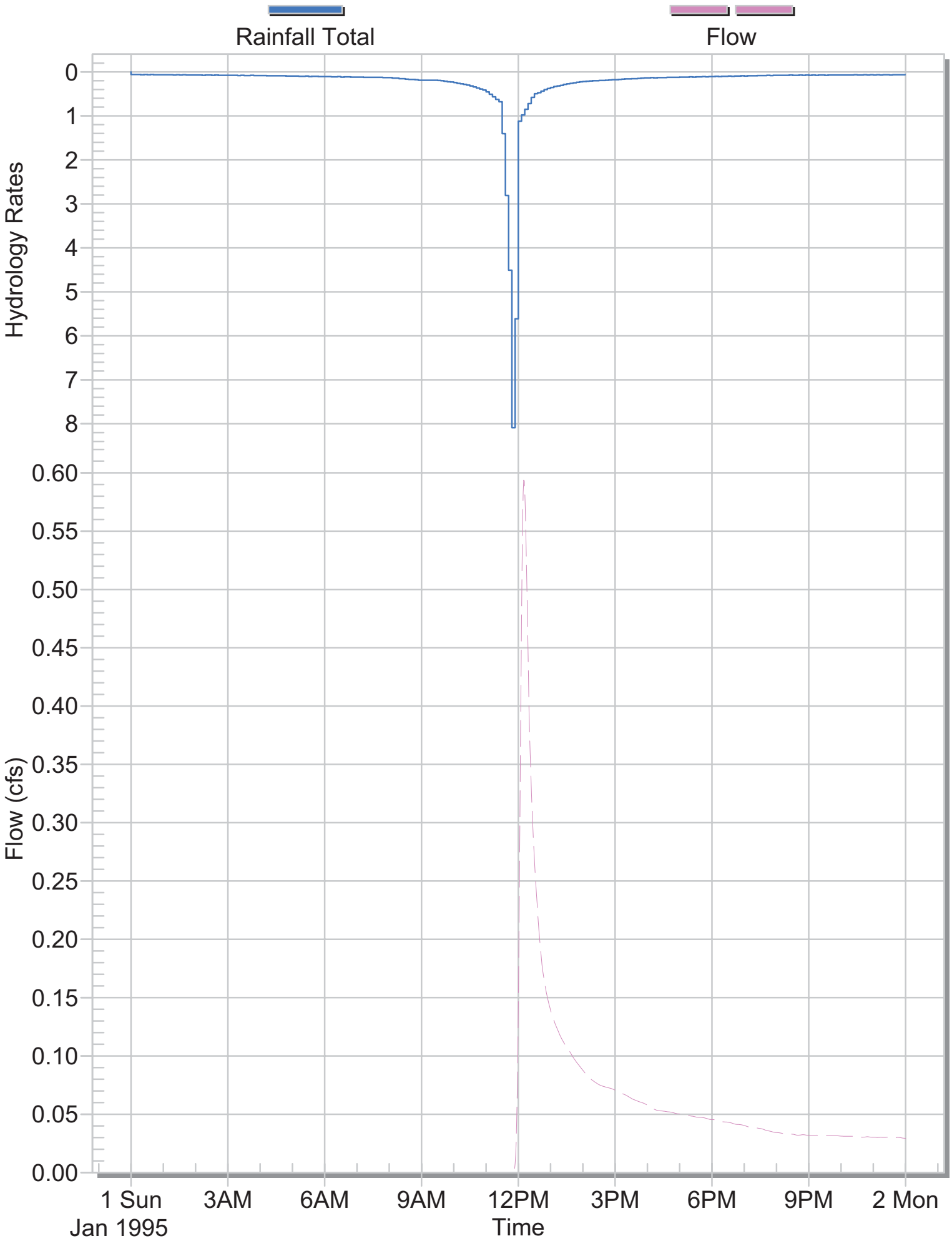
[Max Flow = 0.0400]



Node - North WS

Post 100-yr

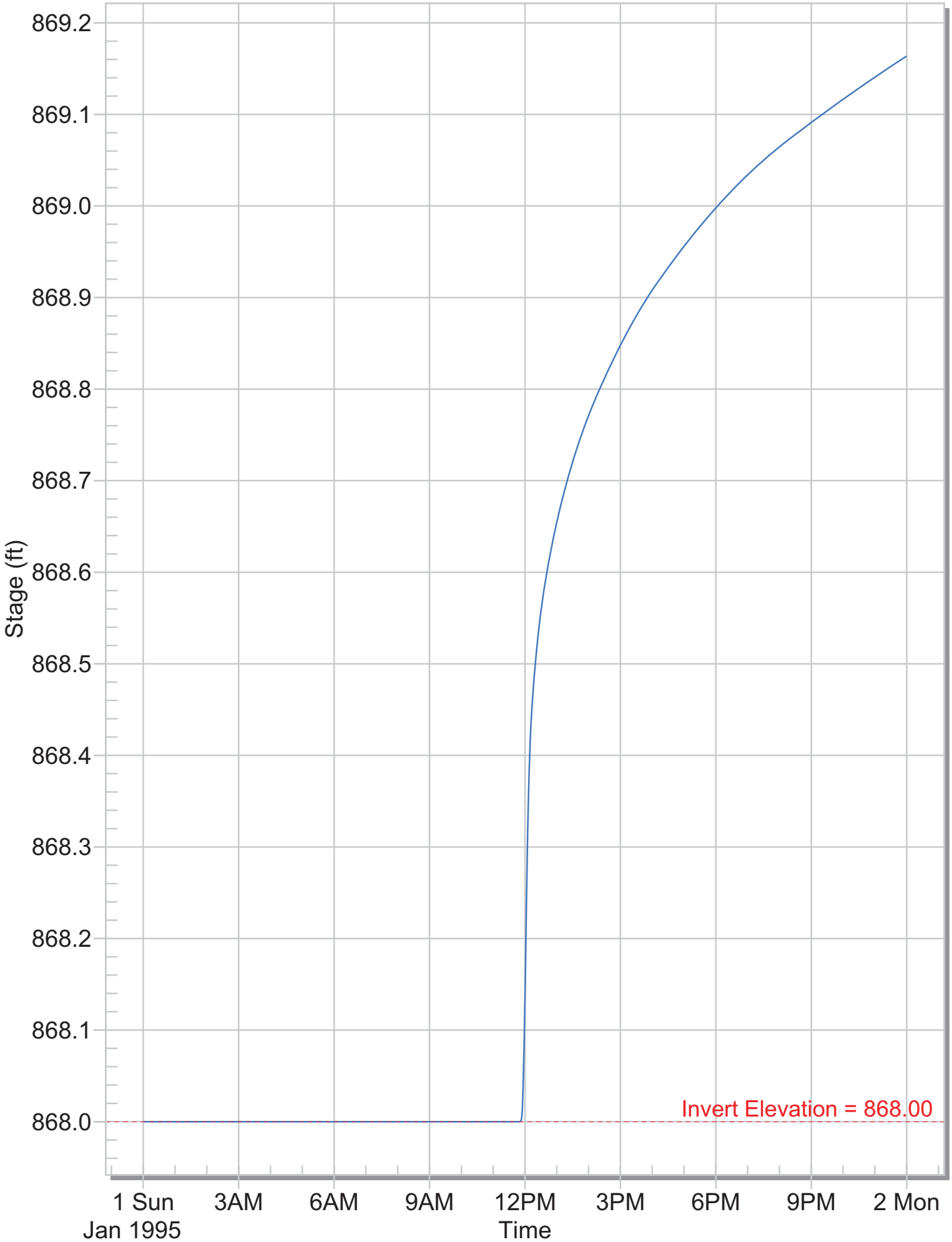
[Max Flow = 0.5937]



Node - Pit 1

Existing 100-yr

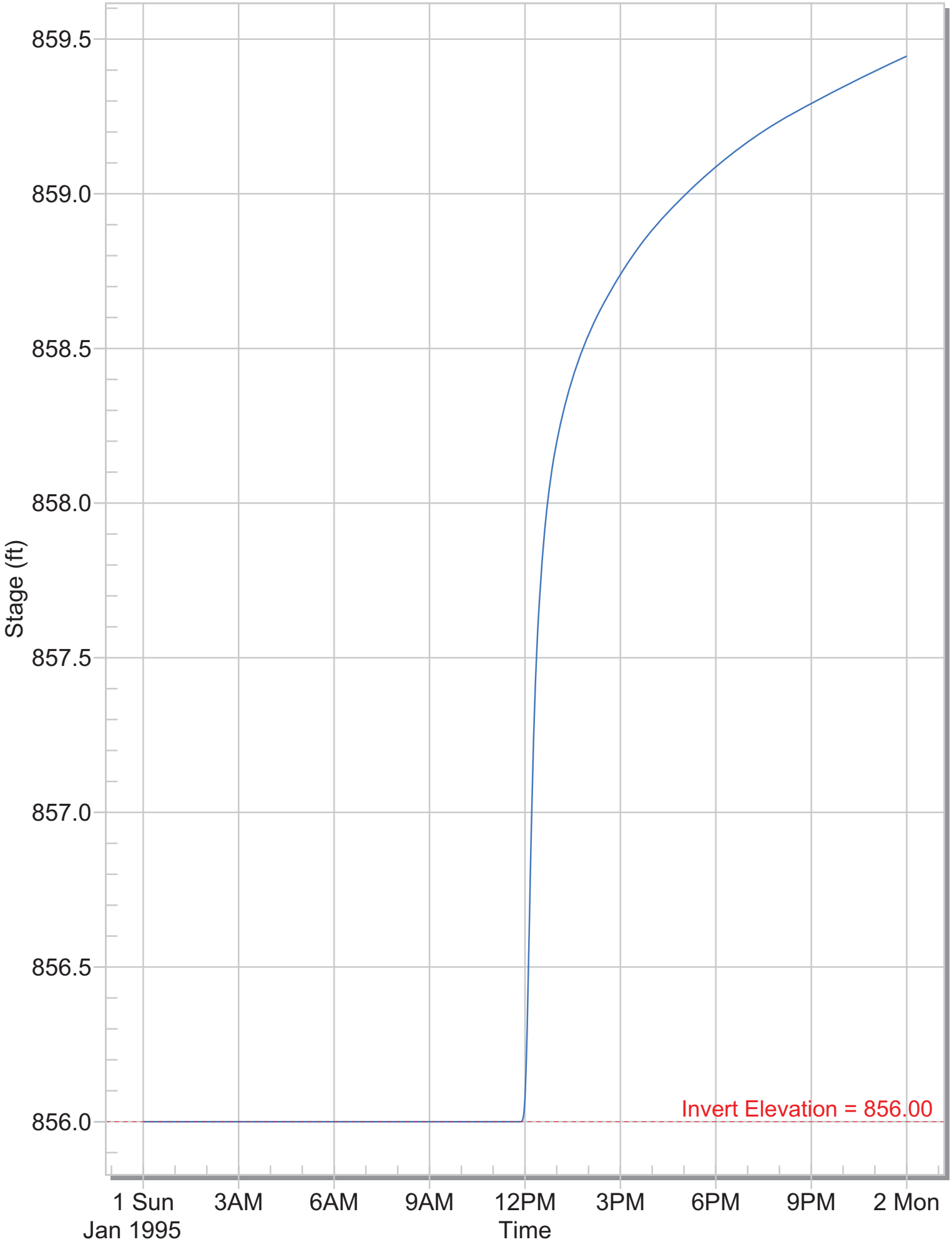
[Max Stage = 869.163]



Node - Pit 2

Existing 100-yr

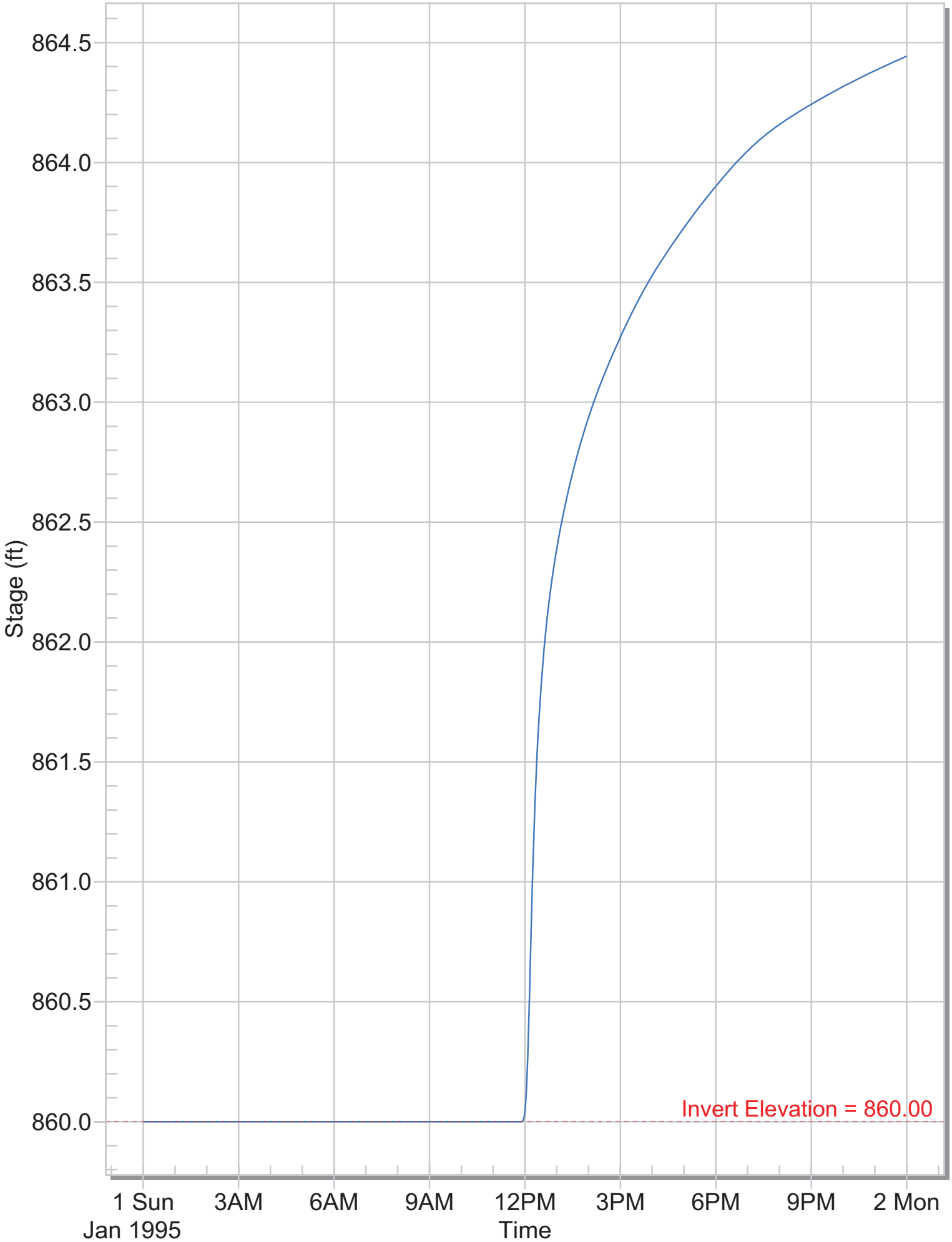
[Max Stage = 859.444]



Node - Pit 3

Existing 100-yr

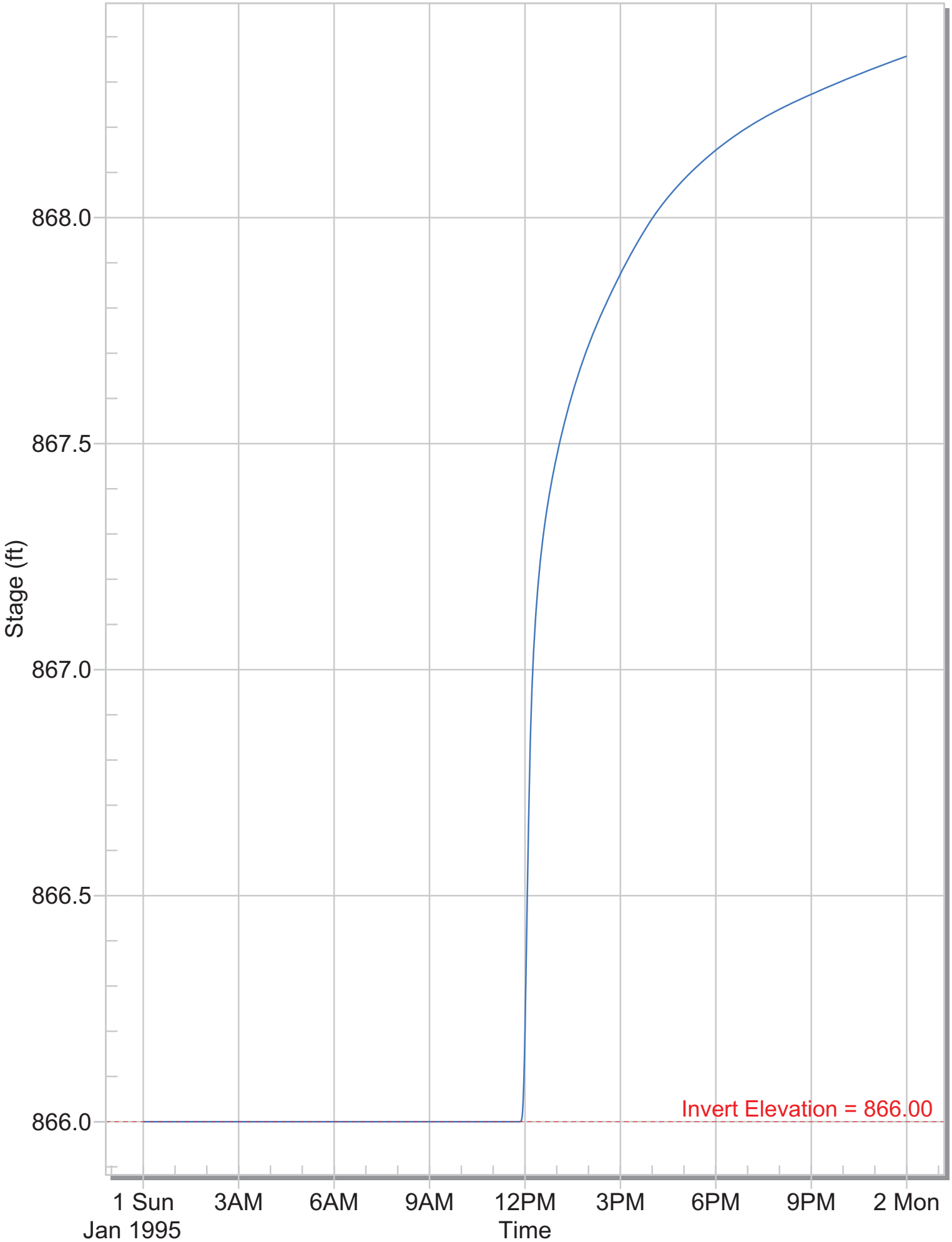
[Max Stage = 864.442]



Node - Pit 4

Existing 100-yr

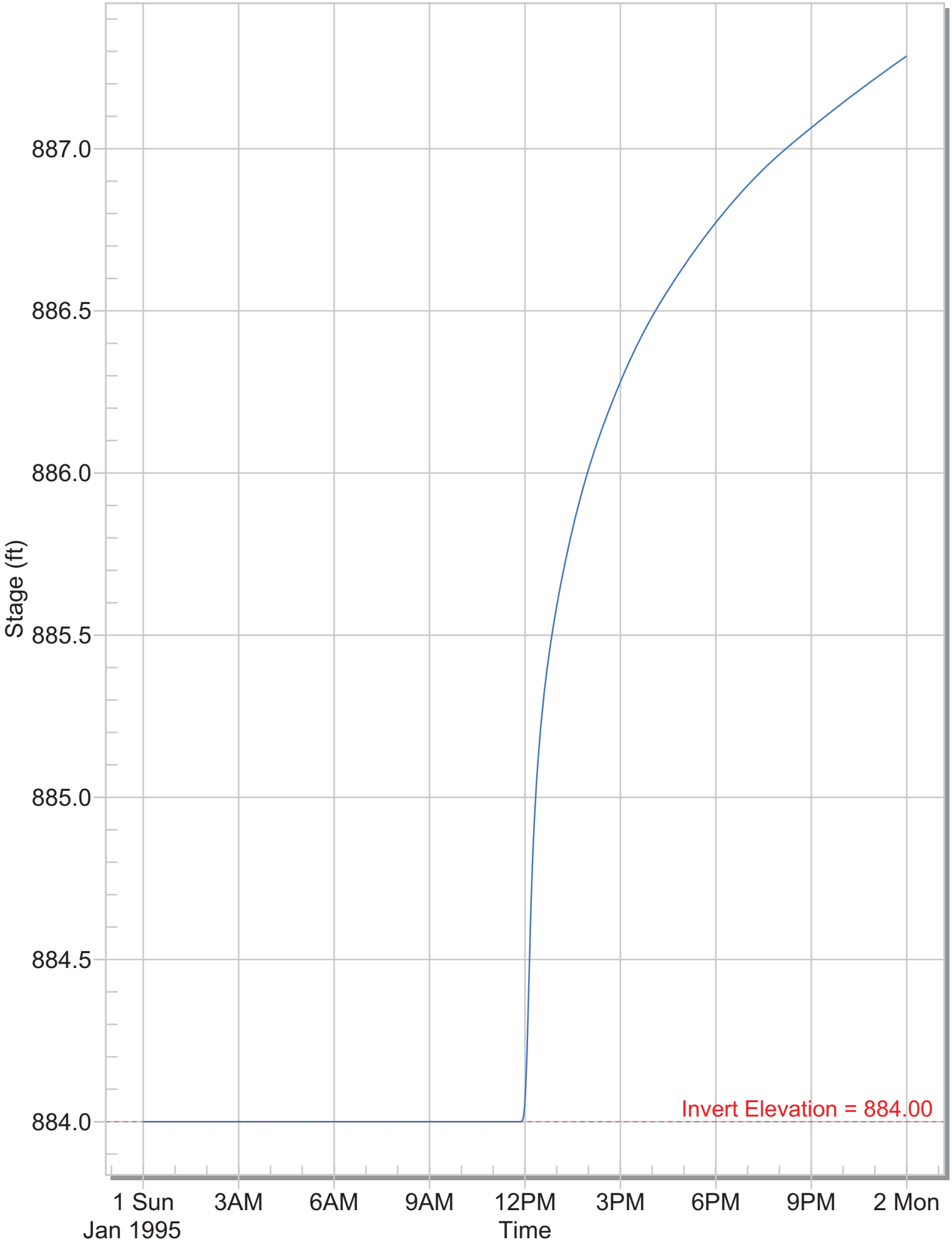
[Max Stage = 868.357]

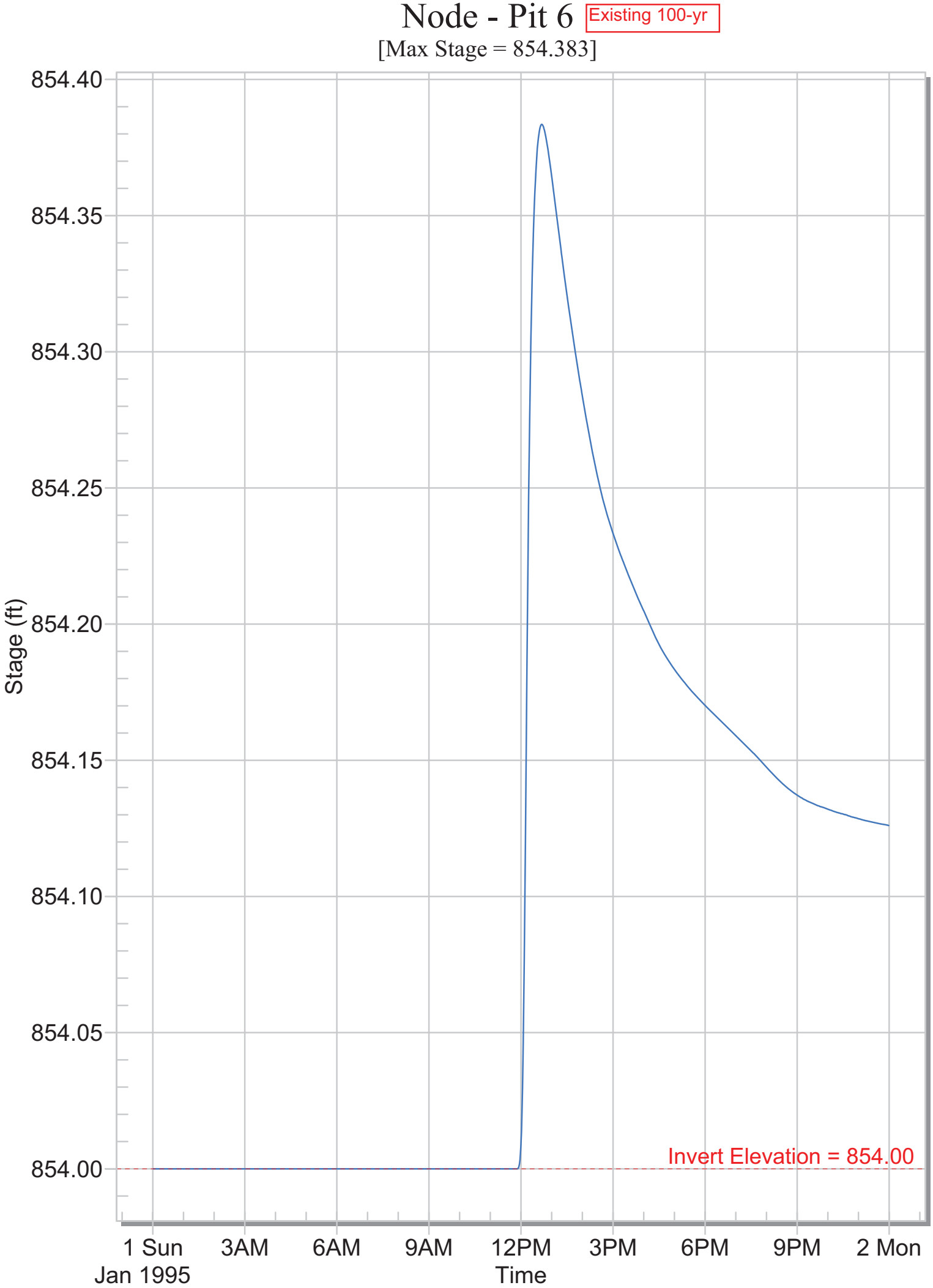


Node - Pit 5

Existing 100-yr

[Max Stage = 887.285]

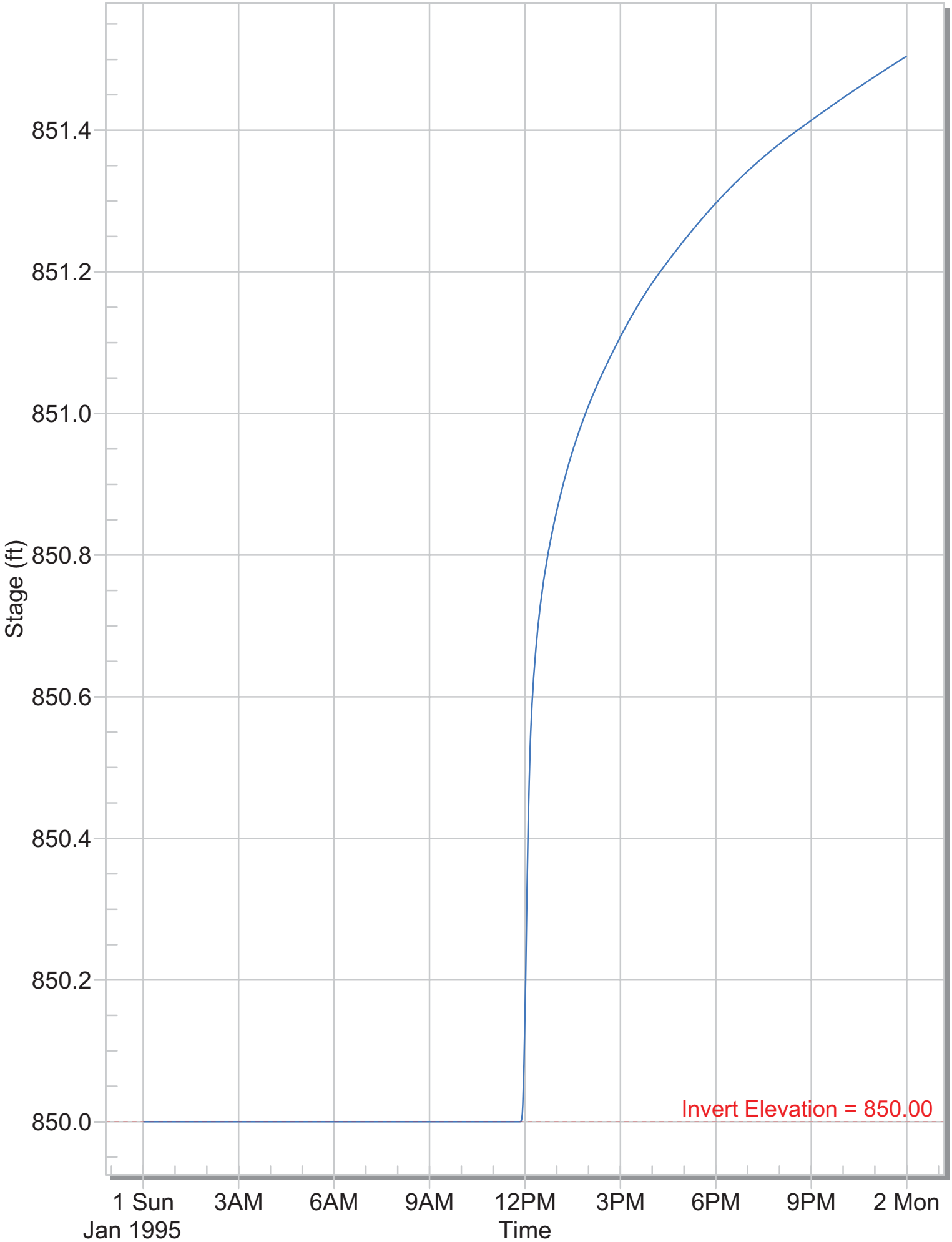



Node - Pit 6
Existing 100-yr
[Max Stage = 854.383]
854.40
854.35
854.30
854.25
854.20
854.15
854.10
854.05
854.00
Stage (ft)
Invert Elevation = 854.00
1 Sun
Jan 1995
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
Time

Node - Pit 7

Existing 100-yr

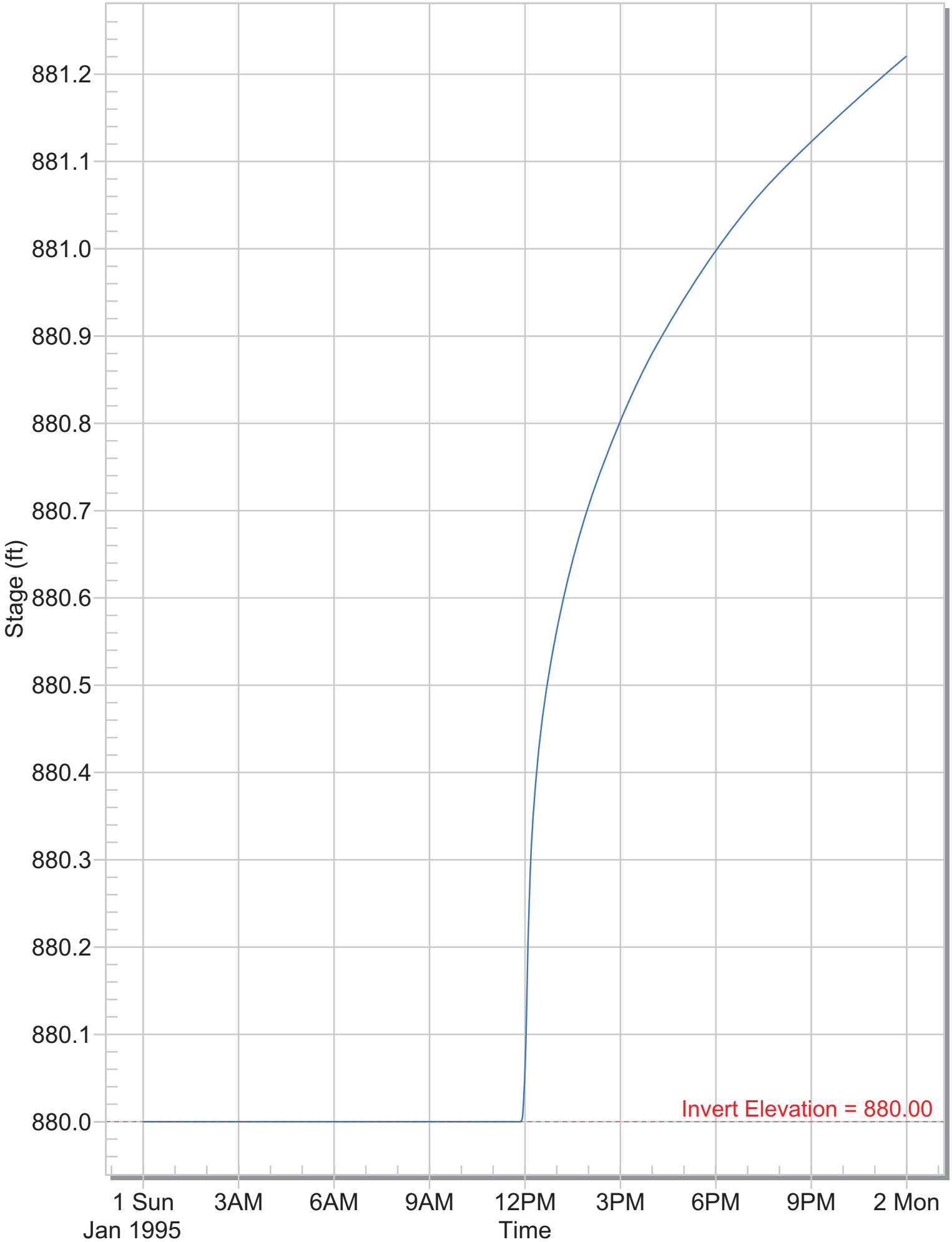
[Max Stage = 851.504]



Node - Pit 8

Existing 100-yr

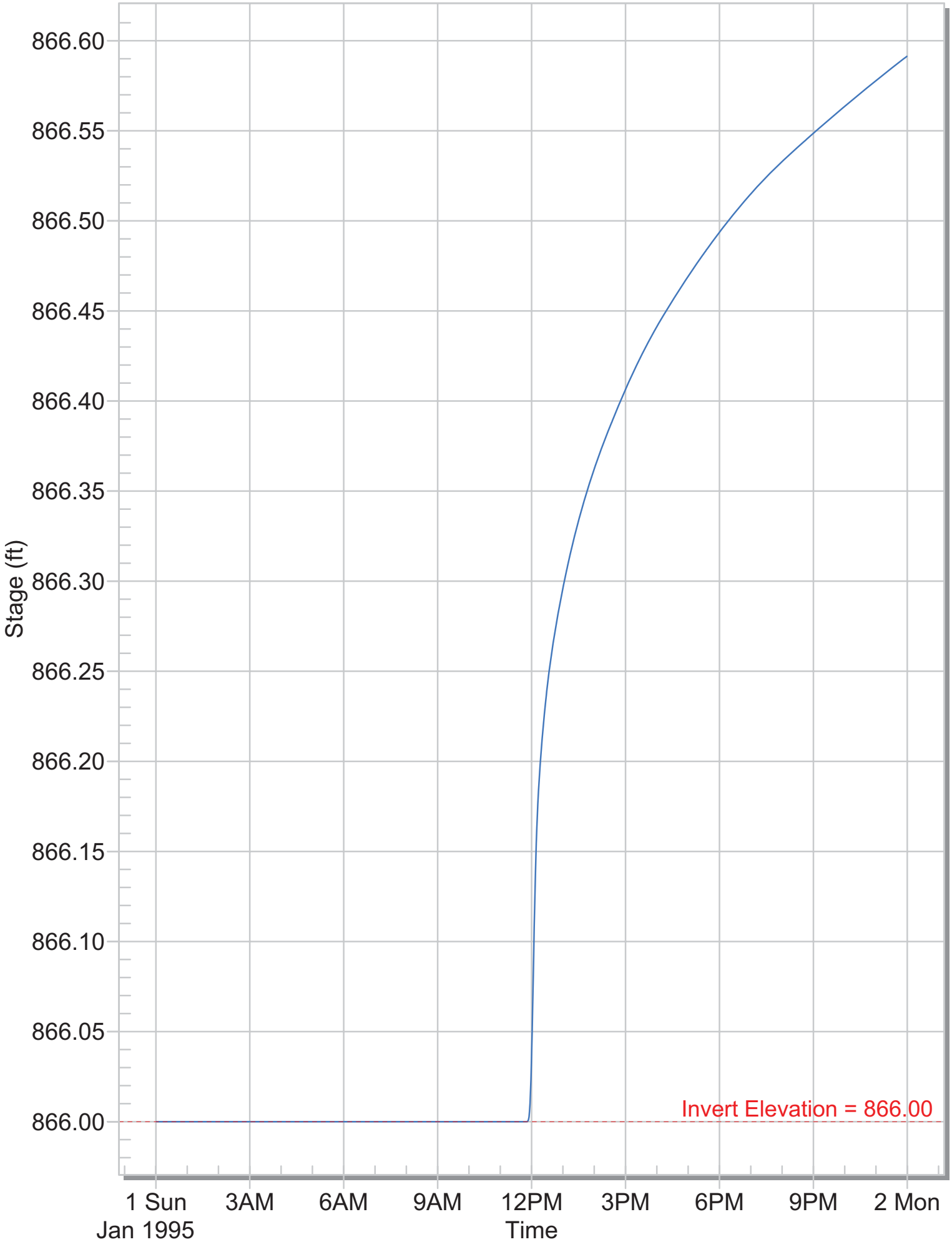
[Max Stage = 881.220]



Node - Pit 1

Post 100-yr

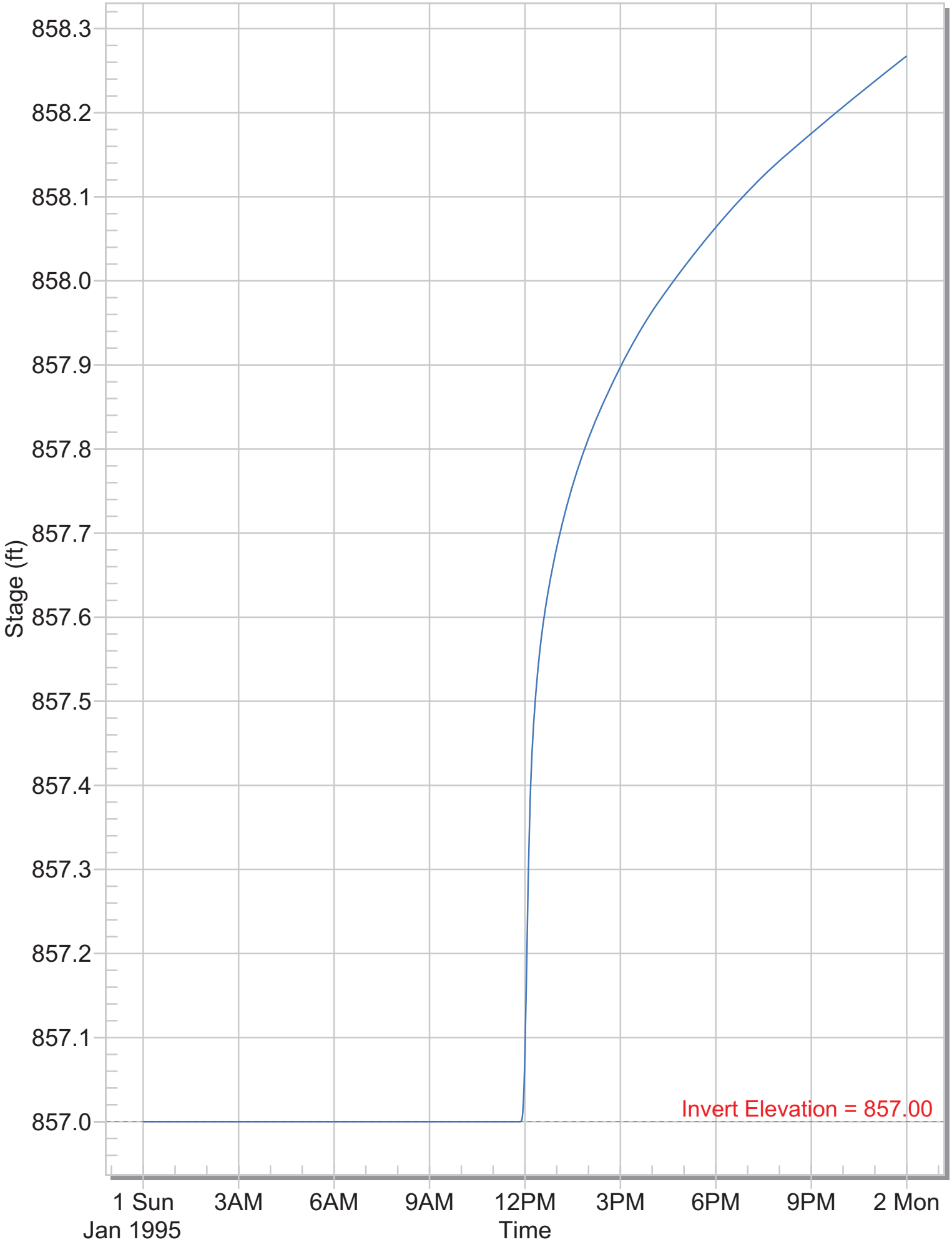
[Max Stage = 866.591]



Node - Pit 2

Post 100-yr

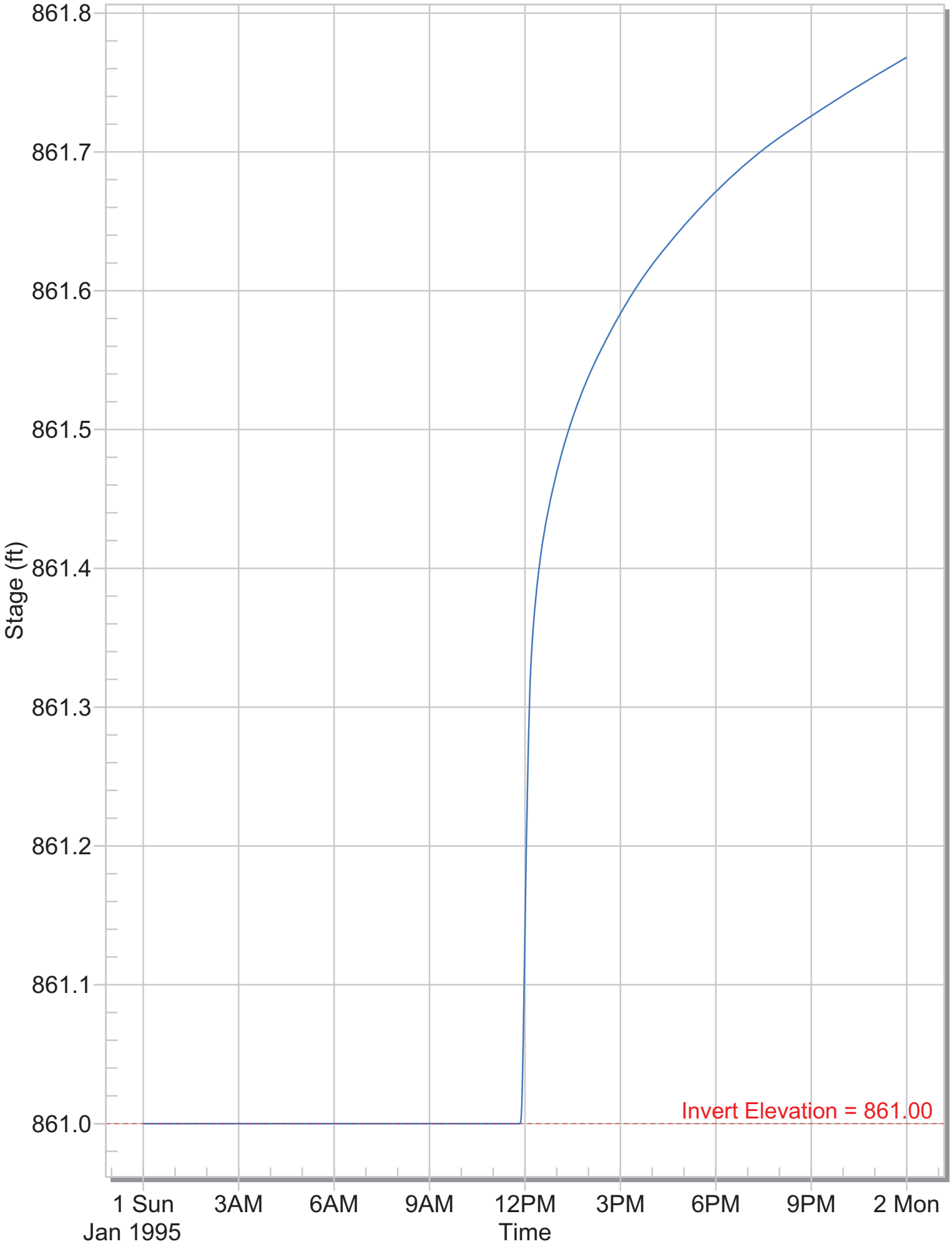
[Max Stage = 858.267]

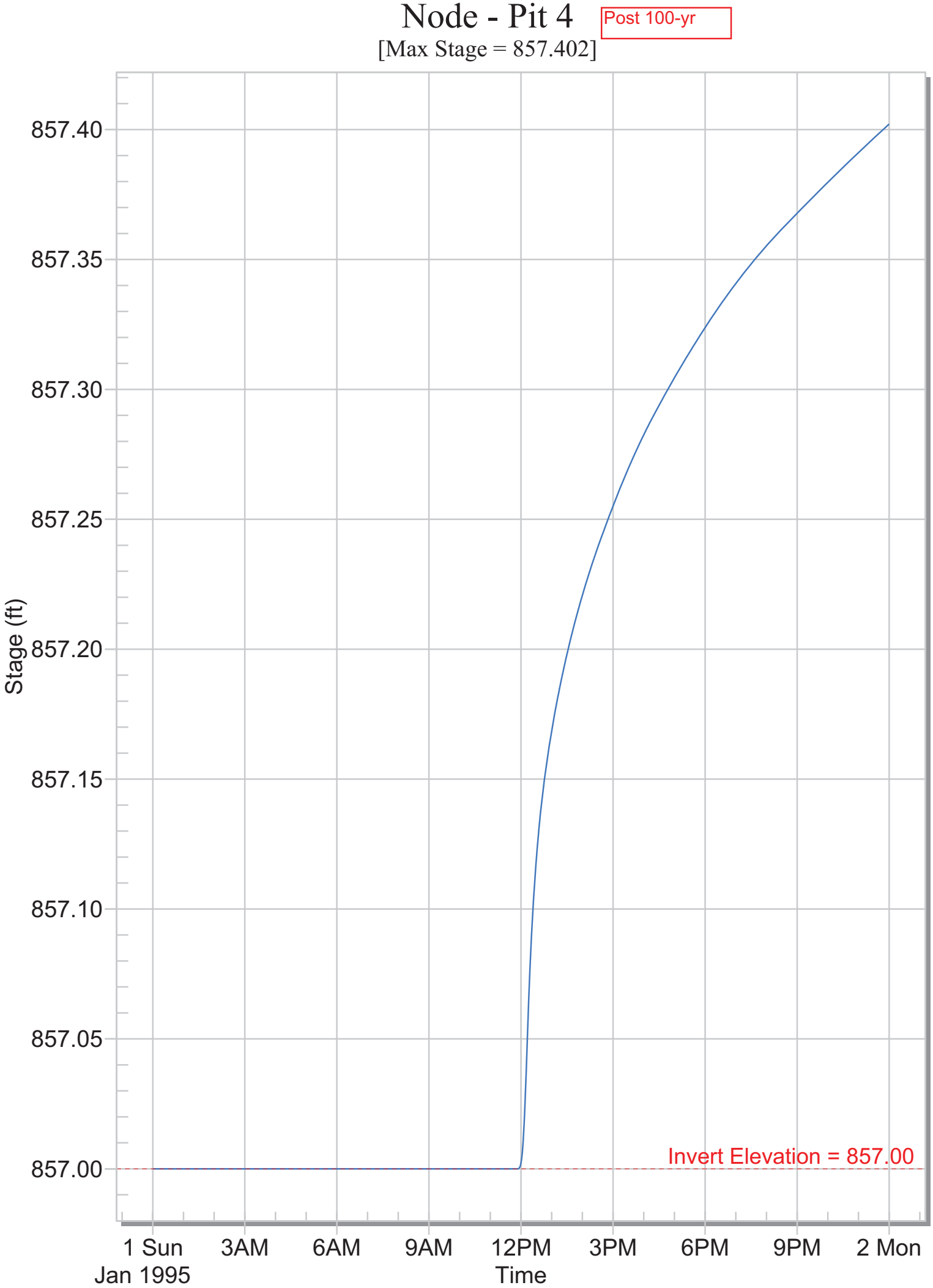


Node - Pit 3

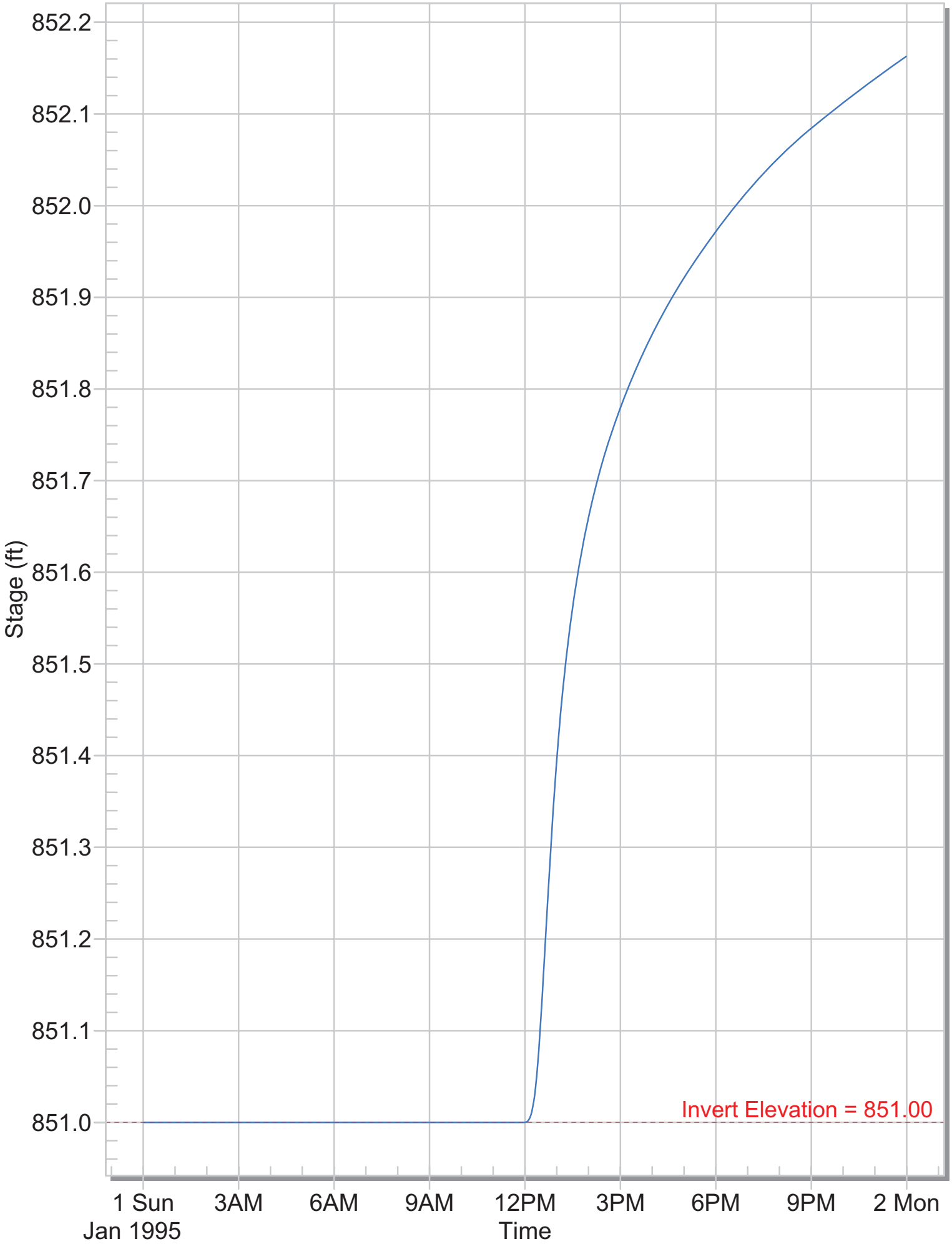
Post 100-yr

[Max Stage = 861.768]




Node - Pit 4
Post 100-yr
[Max Stage = 857.402]
857.40
857.35
857.30
857.25
857.20
857.15
857.10
857.05
857.00
Stage (ft)
Invert Elevation = 857.00
1 Sun
Jan 1995
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Mon
Time

Node - Pit 5

Post 100-yr

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