Distribution System Hydraulic Modeling

American Water Works Association

2011 PNWS-AWWA Annual Conference
Boise, Idaho
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Previous Limitations of Hydraulic Modeling

- Incomplete physical data/demands
- Skeletonized systems
- Very approximate elevations
- Limited computational ability
- Numerical input/output
- Limited ability to diagnose
- Need?

Sharpening Your Tool

- Updating physical data
- System demands/distribution
- Diurnal demand patterns & EPS
- System controls & operating schemes (e.g. winter vs summer)
- Calibration

Hydraulic Analysis

- Modeling Scenarios
- Documentation!
- Analysis
- Evaluation/Interpretation of Results
- Selection of Preferred Alternatives
- Prioritization

Notes, assumptions and changes to the hydraulic model:

- 10/09/09: Saved "July_2009_Base" model to "October_2009" filename, prior to updating model per Additional Hydraulic Model Update and System Analysis Scope
- 10/9/09: 660/580 zone minor update
- 10/09/09: updated 424 Tank bottom elevation to 392.41 and max level (37.59' depth, for 430' max level) per survey data sent 09/28/09. There still may be uncertainty about elevation datum and/or max elev.
- 10/13/09: Demand updates – demand scenarios are being updated per the Scope. 2008 demand (purchased water) summary reported on SPU spreadsheet is used for the existing Average Day Demand. 2008 MDD is calculated though, using the 2.20 multiplier previously determined.
- 10/15/09: Analysis should be conducted in **flow control mode**, since that is what the District will operate in, for peak demands.
    - BS1 (2700 nominal, but use 2050 gpm from telemetry) & BS2: (2700 nominal but use 2300 gpm from telemetry) (1 pump) each during MDD.
    - SS1 & SS3: use 400 gpm to 492 zone only (not 424, which is supplied by new SS2 supply via 424 Tank)
    - Flow rates confirmed by Mike's 10/19 email
- 10/16/09: per meeting yesterday, assume the 25th Avenue project improvements are in the model for the existing conditions analysis, including; 12" - 25th Avenue pipeline; replacement of 6" bottleneck in Perkins Way (east of PRV-8) with 8" pipe; 8" piping in 18th Avenue, from PRV-8 to 18th & NE 190th; SS2 to 424 reservoir (reservoir is now listed tentatively as 432 overflow); connection of NE 184th Pl piping to new 25th Avenue 424 zone piping & removal of PRV-9; setting PRV-5 to 45 psi and using 2" line in PRV-5 as a bypass to trickle 15 gpm from 580 zone directly to 424/392 zone; setting PRV-2 & PRV-4 to fire flow only.
- 10/29/09: 184th Place cul-de-sac piping will remain on 492 zone connection, with PRV-9 in place.
- 10/29/09: 10 operational/range for 424 tank is reasonable – (so set as bottom of equalizing/operational range for analyses).
- 10/30/09: Deleted hydrant flow in model, for node J492-1018. Per meeting yesterday, the hydrant has been removed from that location. (is the piping still there?)
- 11/3/09: nodes are not showing up in the 215 zone, when color coded for Fire_DEM, because the model cannot solve for those nodes.
- 11/9/09: pressure zone consolidation analysis was performed for the 300 and 215 zones. Two different hydraulic gradients were analyzed, attempting to combine the two zones into one. A 268' nominal HGL was tried first; pressures at the shoreline are up to 105 psi. one pipe rerouting and two PRV relocation projects would provide for 40 psi min (nominal) pressures at the highest elevation locations in the proposed combined zone. A 256' nominal HGL was also tried, keeping high pressures at the shoreline no higher than 100 psi, but an additional, low (less than 40 psi nominal) pressure area emerges using a 256' HGL.

Kitsap MIKE Urban model
File Naming Convention

Simulation ID	Scenario ID	Hot Start	Model file name	Description
ExistWetImp ExistWetWeather ExistAvgAnnual		ExistWetImpHot WetHotStart ExistAvgHotStart	Kitsap_Ex_Imp.mup Kitsap_Ex_Imp.mup Kitsap_Ex_Imp.mup	
FutAvgAnnual FutPeakDay		FutAvgAnnualHot FutPeakDayHot	Kitsap_Future.mup Kitsap_Future.mup	includes existing scenario improvements includes existing scenario improvements
FutPeakDayNI		FutPeakDayNIHot	Kitsap_Fut_No_Imp.mup	future peak day with existing system/no improvements
FutPeakDayIMP2		FutPeakDayIMP2HOT	Kitsap_Fut_Imp.mup	iterate on improvements to resolve future peak day flows
FutPeakDayIMP5		FutPeakDayIMP5HOT	Kitsap_Fut_Imp.mdb	Modify 'IMP2' run: increase siphon capacity, but keep 'IMP2' results, for comparison
FutPeakDayIMP6		FutPeakDayIMP6HOT	Kitsap_Fut_Imp0109.mup	Update 'IMP5' run: update Lemolo siphon; other pumping improvements
FutPeakDayIMP4		FutPeakDayIMP4HOT	Kitsap_Fut_NoSiphon.mup	modify Kitsap_Fut_Imp.mup - so that siphon low point=outfall, resolving siphon surcharge, to identify upstream
Lemolo		LemoloHOT	Kitsap_Fut_Imp_Lemolo.mup	Modify Kitsap_Fut_Imp0109 to analyze Lemolo options, namely bypassing LS-16
ExistNI		ExistNIHOT	Kitsap_Ex_NI.mup	ModifyKitsap_Ex_03.mdb to update the Lemolo siphon
FutPeakDayIMP7		FutPeakDayIMP7HOT	Kitsap_Fut_Imp0509.mup	Update 'Kitsap_Fut_Imp0109.mup: add imp #19, 20; This is the up to date future model (including improvements)
ExistALT		ExistALTHOT	Kitsap_Ex_ALT.mup	Modify Kitsap_Ex_NI.mdb for alternate improvements (1/2 depth pipe criteria)
FutLemoloPeakDayNI		FutLemoloPeakDayNIHot	Lemolo_Fut_No_Imp.mup	Modify Kitsap_Fut_No_Imp.mup for north flow to WWTP only. Examine future Lemolo flows
ExLemoloPeakDayNI		ExLemoloPeakDayNIHot	Lemolo_Exist_NI.mup	Modify Kitsap_Ex_NI.mup for north flow to WWTP only. Examine existing Lemolo flows
FutALT		FutALTHOT	Kitsap_Fut_ALT.mup	Modify Kitsap_Fut_No_Imp.mup to analyze alternate siphon improvements & phasing: 1st interim improvement
FutALT2		FutALT2HOT		2nd interim improvement
ExLS16Bypass		ExLS16BypassHOT	Lemolo_Exist_LS16Bypass.mup	Modify Lemolo_Exist_NI to analyze impacts of LS16 bypass to LS67.
ExLemoloPeakTempNI		.... HOT		
				modify Lemolo_Exist_NI.mup, turning LS16 & LS67 into free discharges
LemFutLS16Bypass		...HOT	Lemolo_Fut_LS16Bypass	Modify Lemolo_Fut_No_Imp.mup. The only improvement is bypassing LS16 (& LS67)
LemFutLS16BypassLS67Free		... HOT	.. .. ..16BypassLS67Free	update ↑ - LS67 = free discharge

5/29/2009

C:\Kitsap\MIKEUrban\File naming convention.xls

Why Invest In This?

- Technological advances make it possible
- Evolving regulatory environment
- Know what's happening in your system
- Increase efficiency
  - Efficient/properly prioritized CIP
  - Optimize system operations
  - Optimize system configuration
- Save $$$

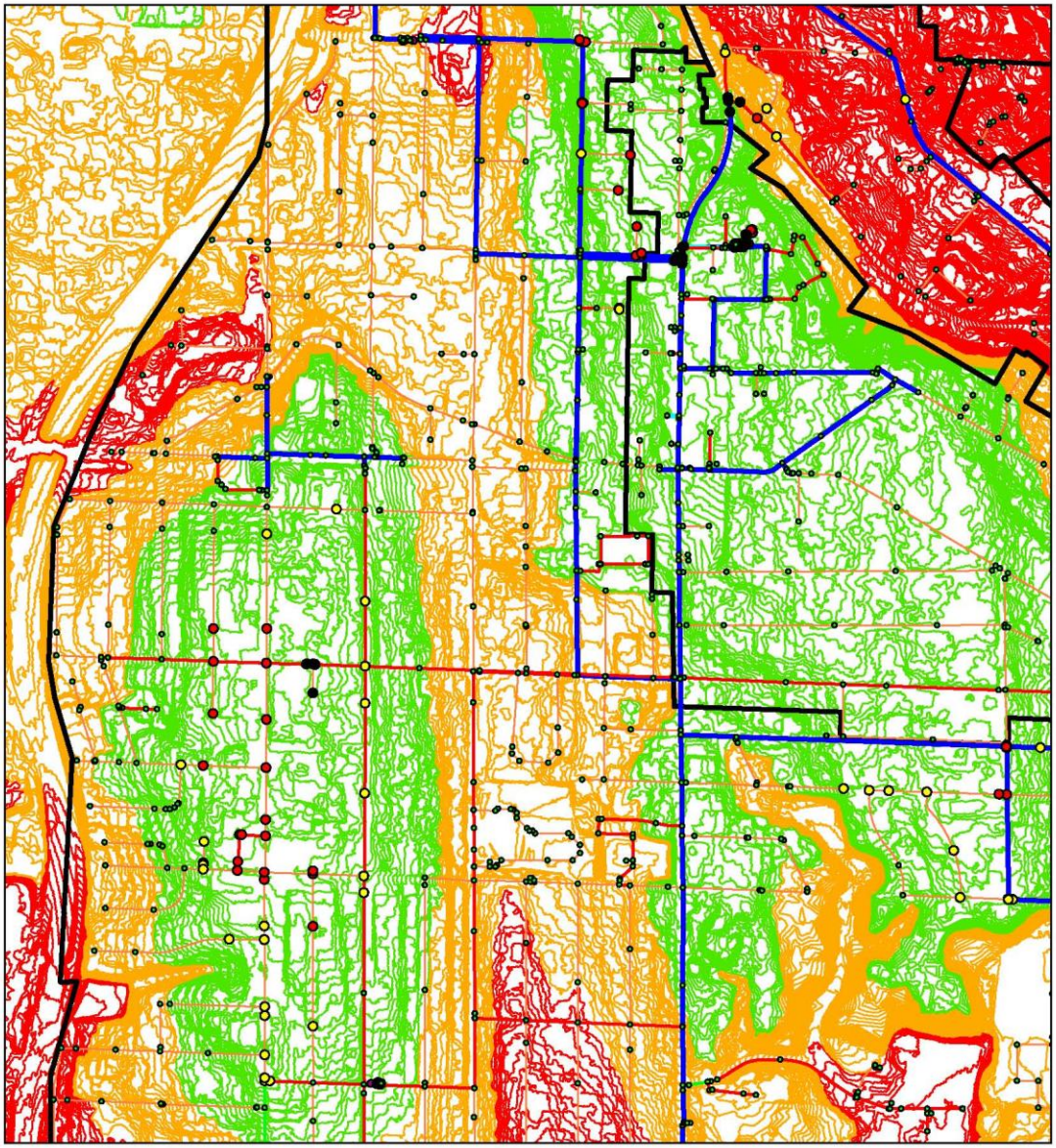
Pressure Rezone Analysis
Pressure Ranges for 615' HGL

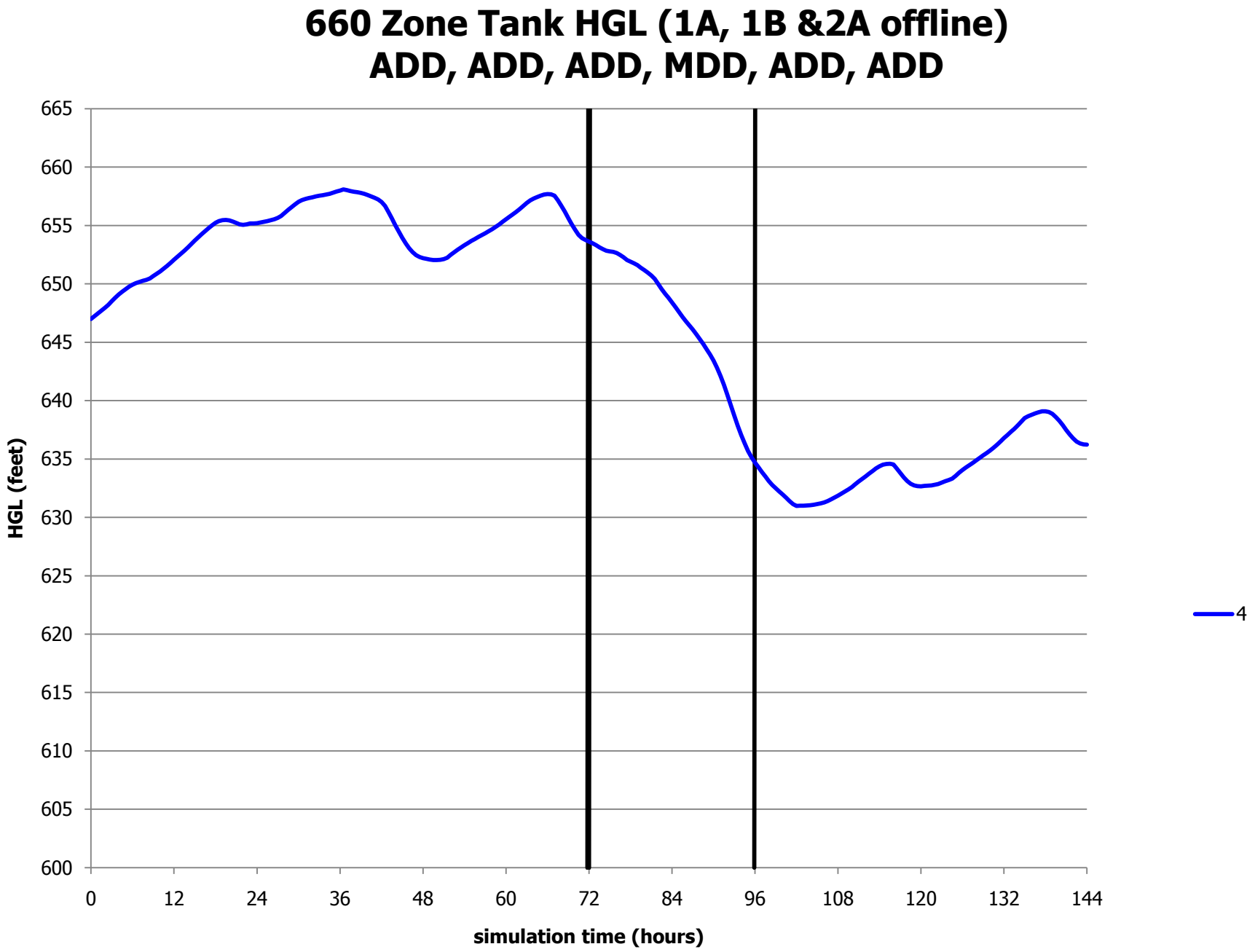
Pressure Zone Boundary

Pipe DIAMETER
- 6"
- 8"
- 10"
- 12"
- > 12"

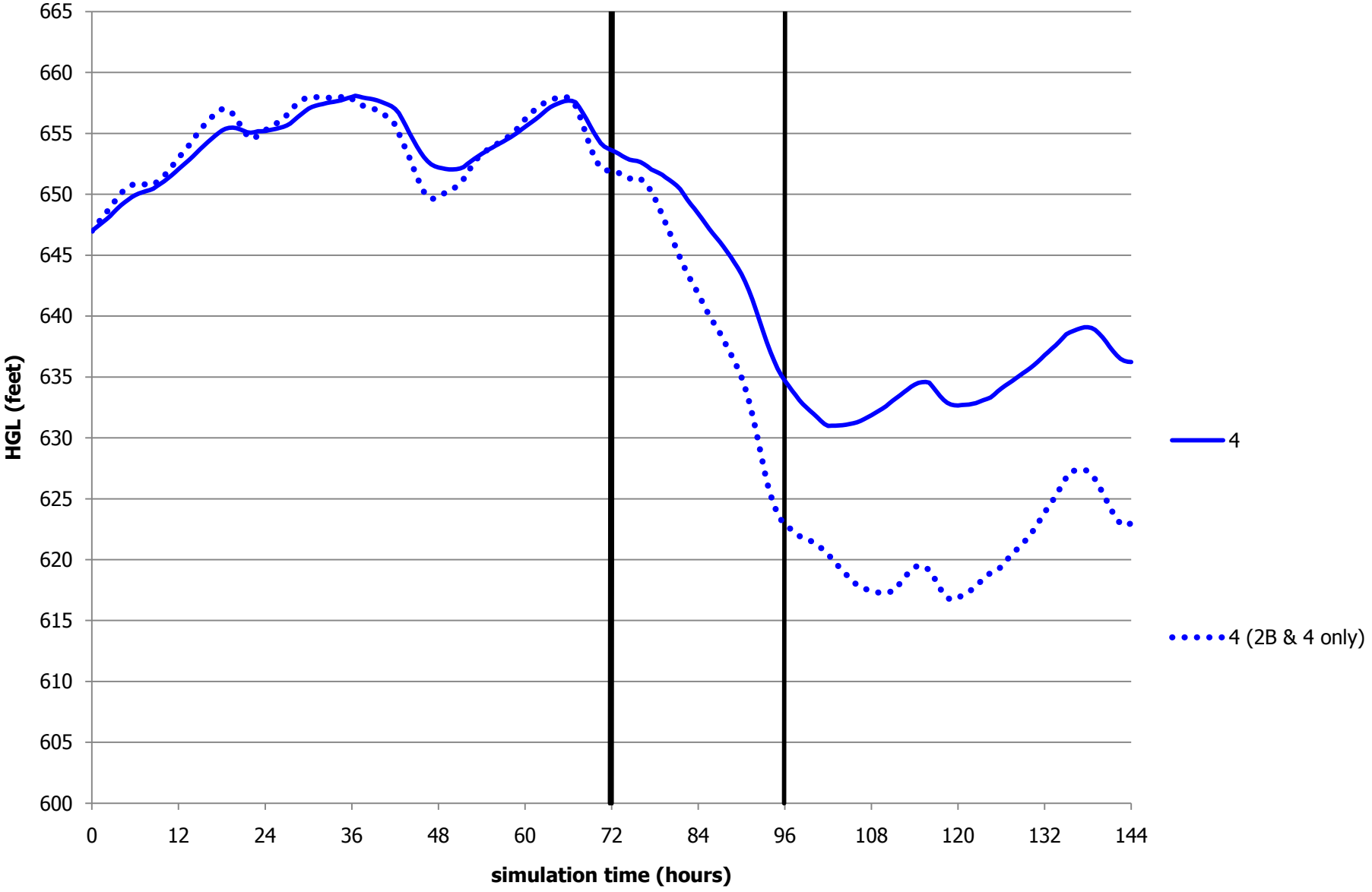
Existing Junction PRESSURE
- Less than 35
- 35~40
- 40~45
- Greater than 45

Topo Contour/ Pressure Range
- > 100 psi
- 80 - 100 psi
- 40 - 80 psi
- 30 - 40 psi
- < 30 psi

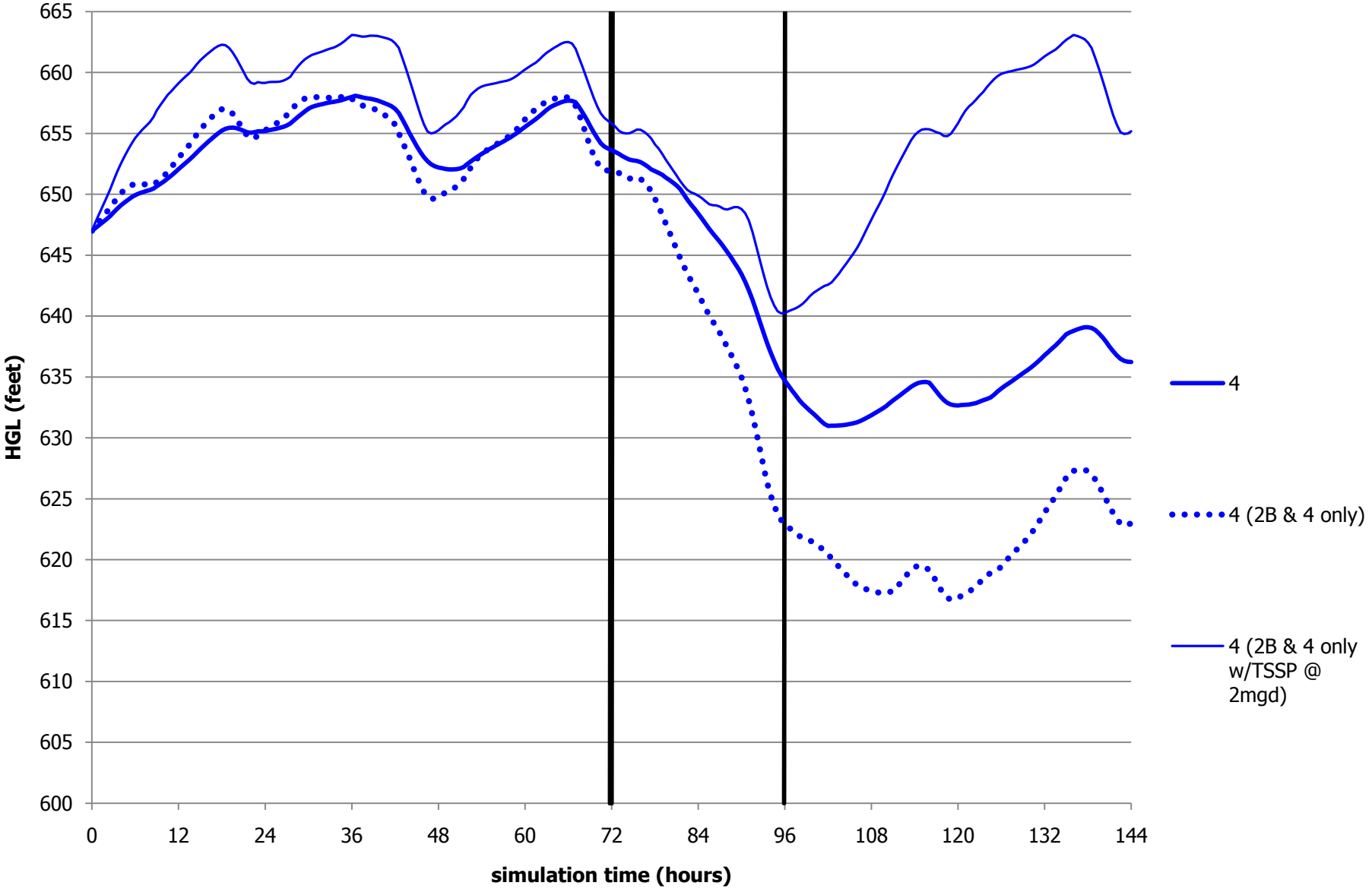


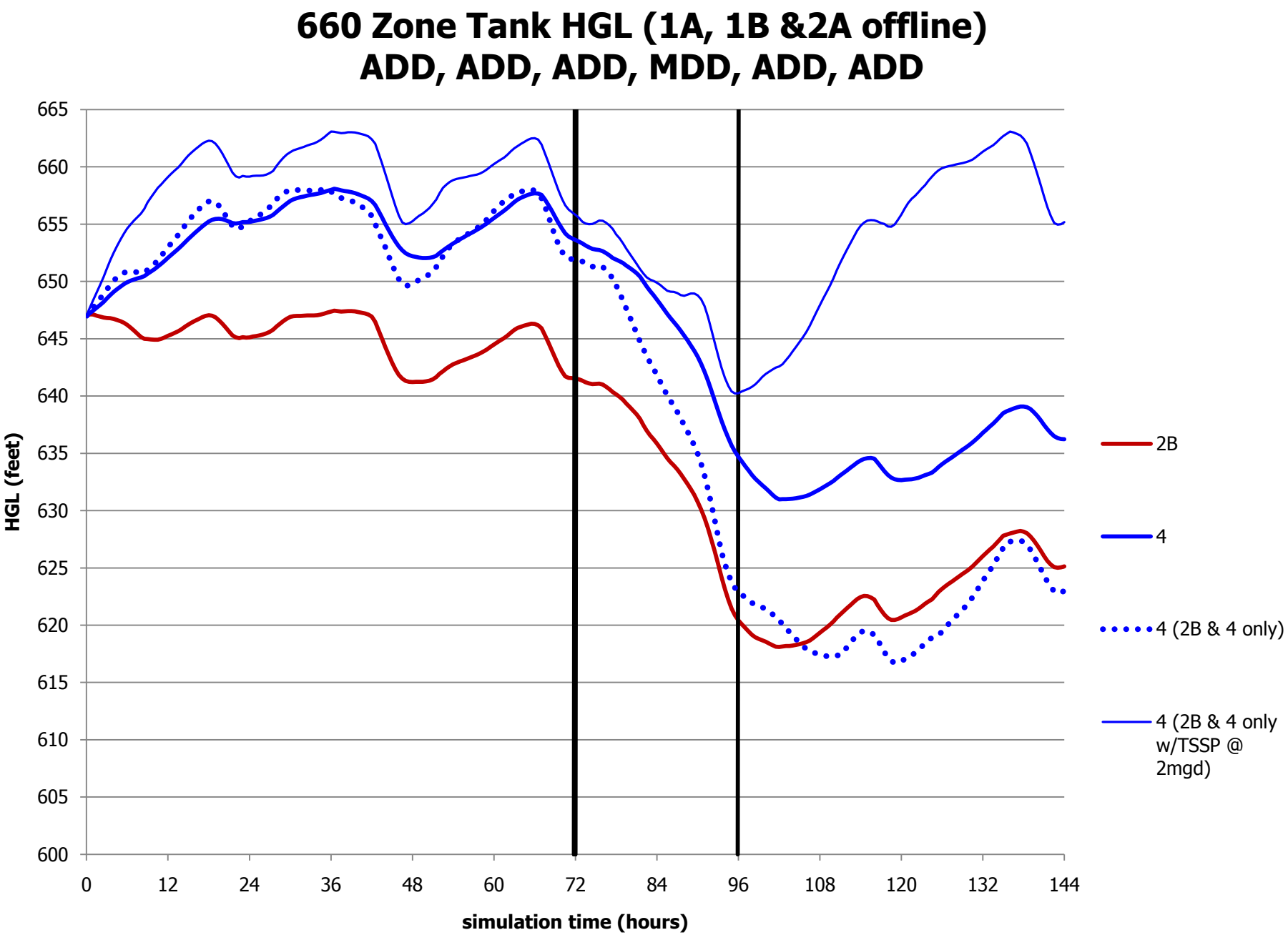

660 Zone Tank HGL (1A, 1B &2A offline)
ADD, ADD, ADD, MDD, ADD, ADD
HGL (feet)
665
660
655
650
645
640
635
630
625
620
615
610
605
600
0
12
24
36
48
60
72
84
96
108
120
132
144
simulation time (hours)
4

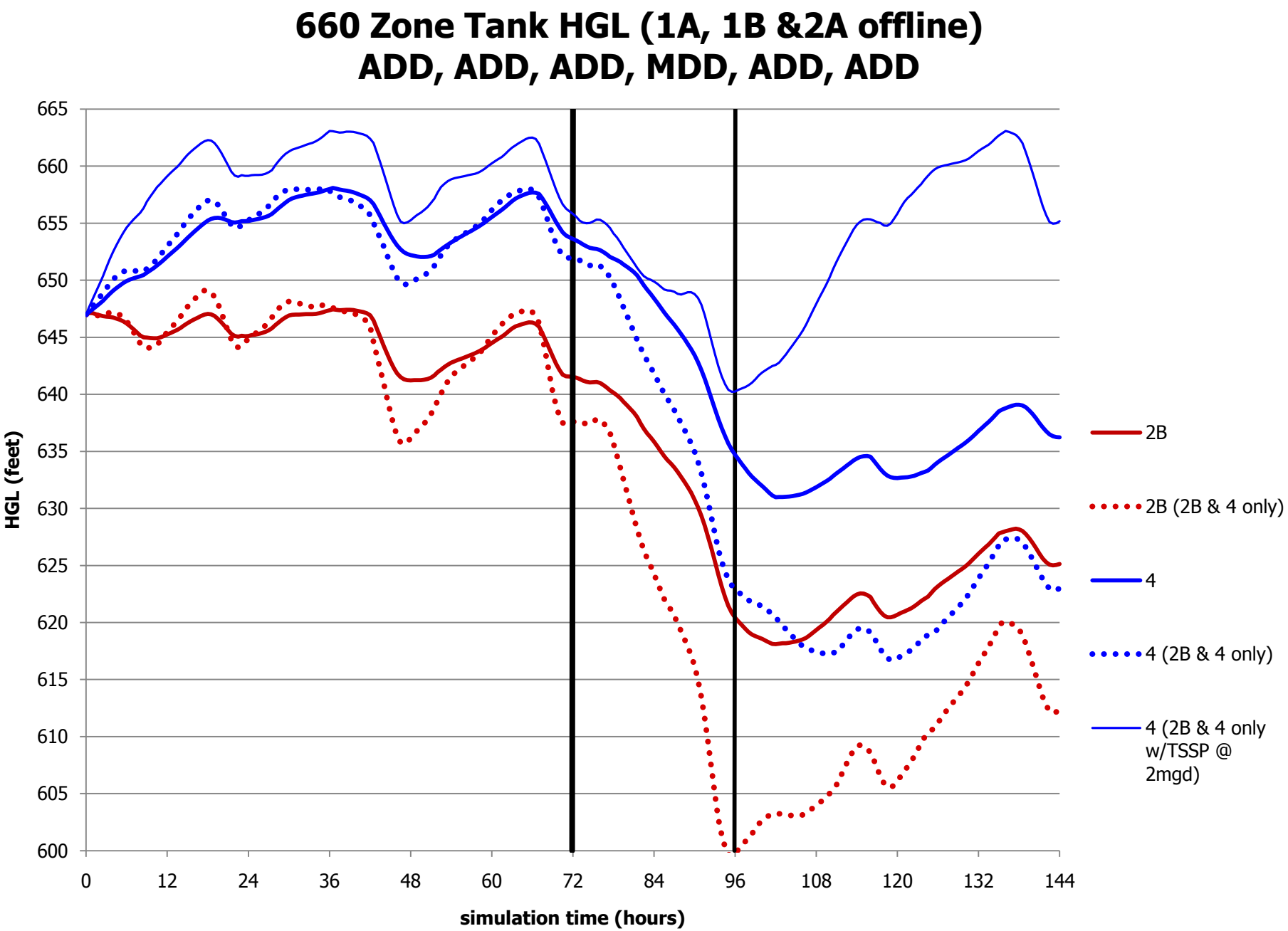
660 Zone Tank HGL (1A, 1B &2A offline)
ADD, ADD, ADD, MDD, ADD, ADD

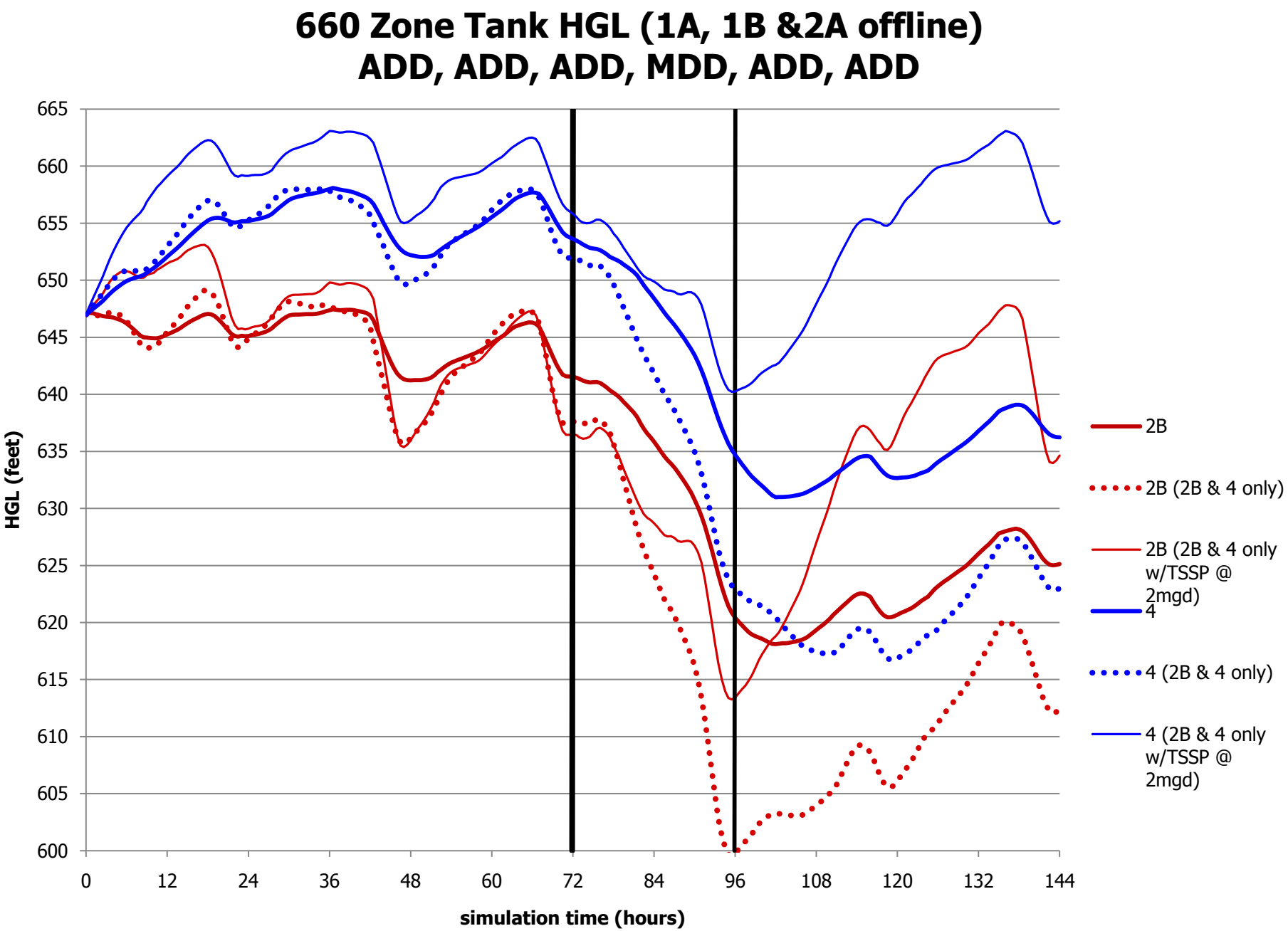


660 Zone Tank HGL (1A, 1B &2A offline)
ADD, ADD, ADD, MDD, ADD, ADD

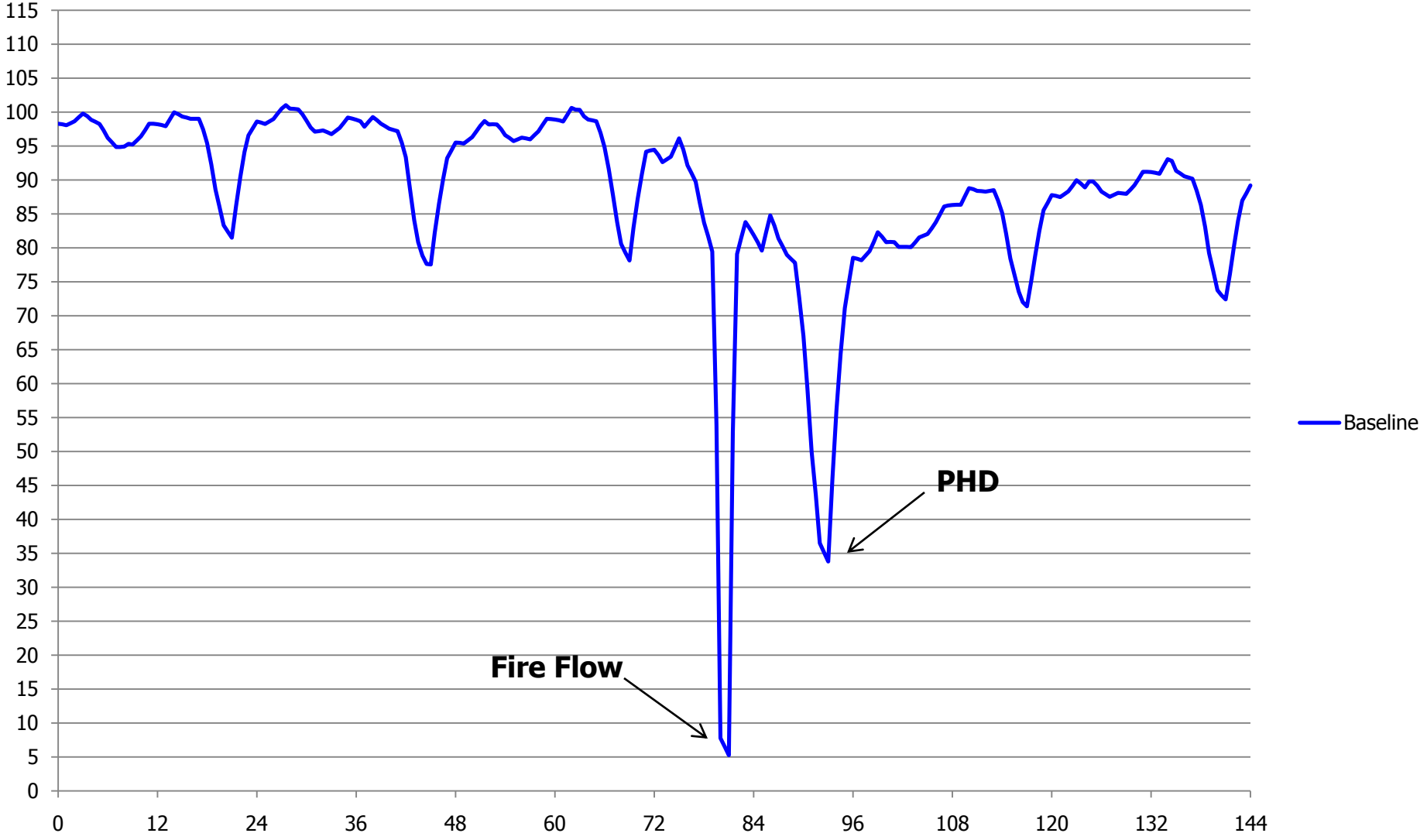



660 Zone Tank HGL (1A, 1B &2A offline)
ADD, ADD, ADD, MDD, ADD, ADD
HGL (feet)
665
660
655
650
645
640
635
630
625
620
615
610
605
600
0
12
24
36
48
60
72
84
96
108
120
132
144
simulation time (hours)
2B
4
4 (2B & 4 only)
4 (2B & 4 only w/TSSP @ 2mgd)

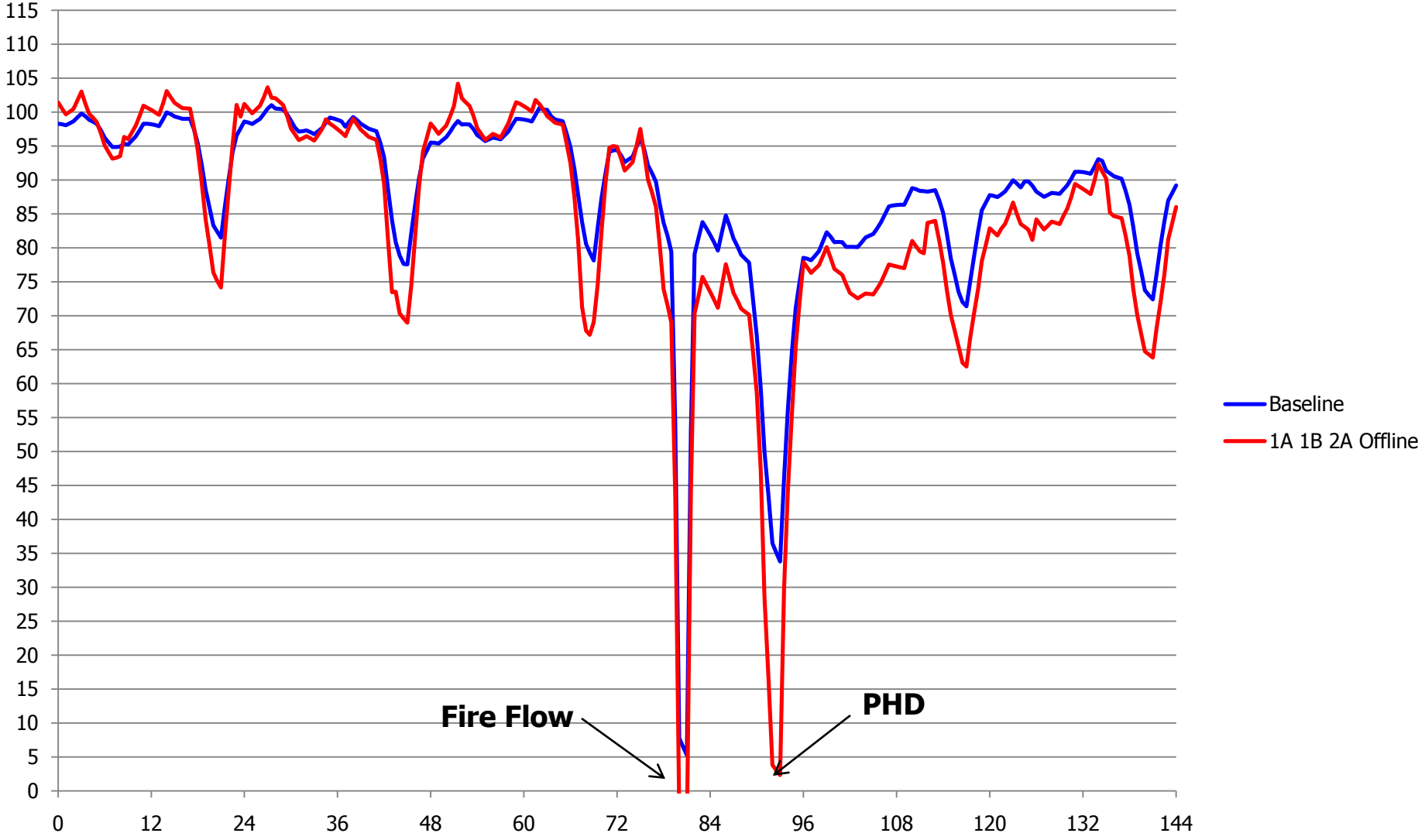

660 Zone Tank HGL (1A, 1B &2A offline)
ADD, ADD, ADD, MDD, ADD, ADD
HGL (feet)
665
660
655
650
645
640
635
630
625
620
615
610
605
600
0
12
24
36
48
60
72
84
96
108
120
132
144
simulation time (hours)
2B
2B (2B & 4 only)
4
4 (2B & 4 only)
4 (2B & 4 only w/TSSP @ 2mgd)


660 Zone Tank HGL (1A, 1B &2A offline)
ADD, ADD, ADD, MDD, ADD, ADD
HGL (feet)
665
660
655
650
645
640
635
630
625
620
615
610
605
600
0
12
24
36
48
60
72
84
96
108
120
132
144
simulation time (hours)
2B
2B (2B & 4 only)
2B (2B & 4 only w/TSSP @ 2mgd)
4
4 (2B & 4 only)
4 (2B & 4 only w/TSSP @ 2mgd)

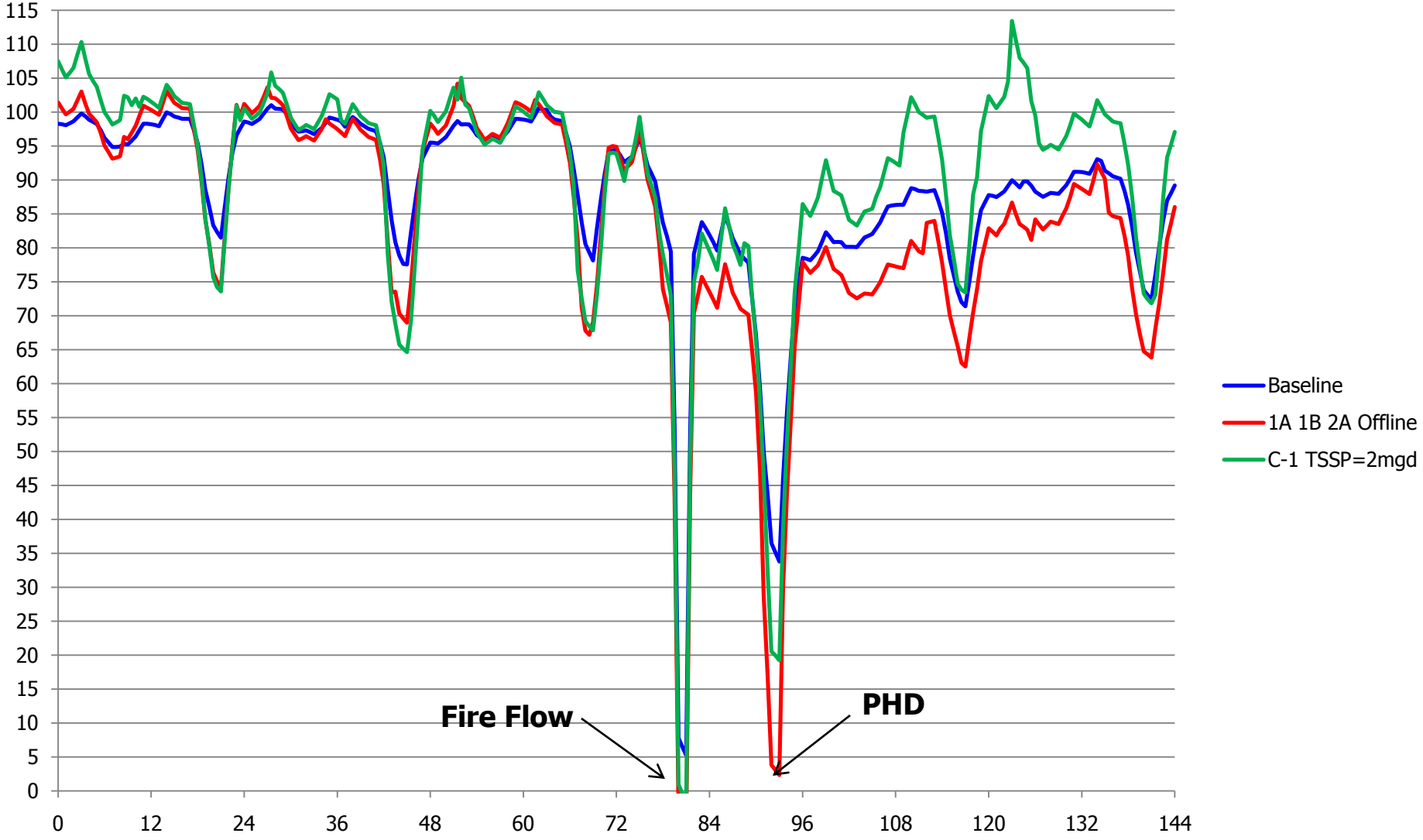
Pressure in Southwest 660 Zone: 1,000 gpm Fire Flow

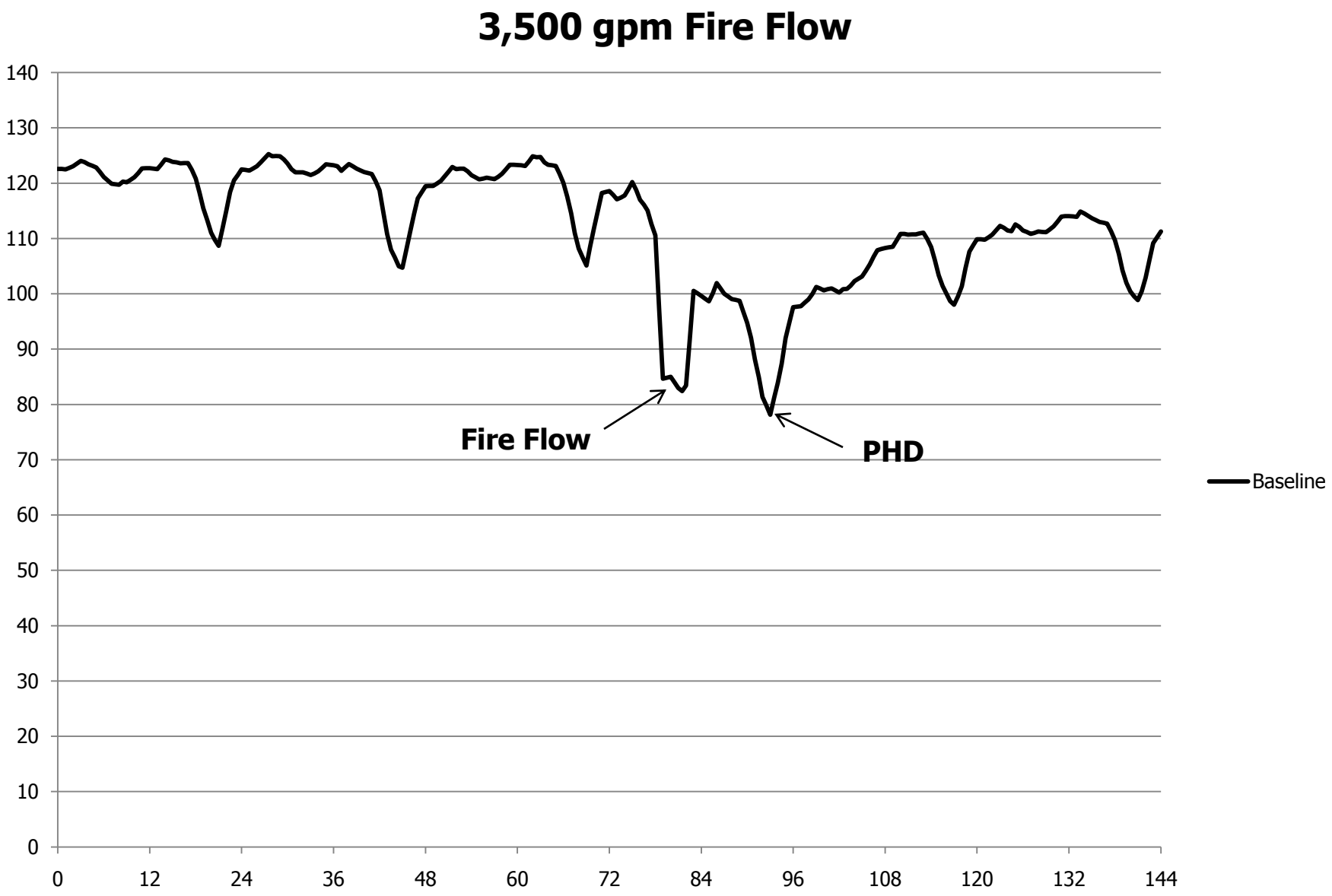


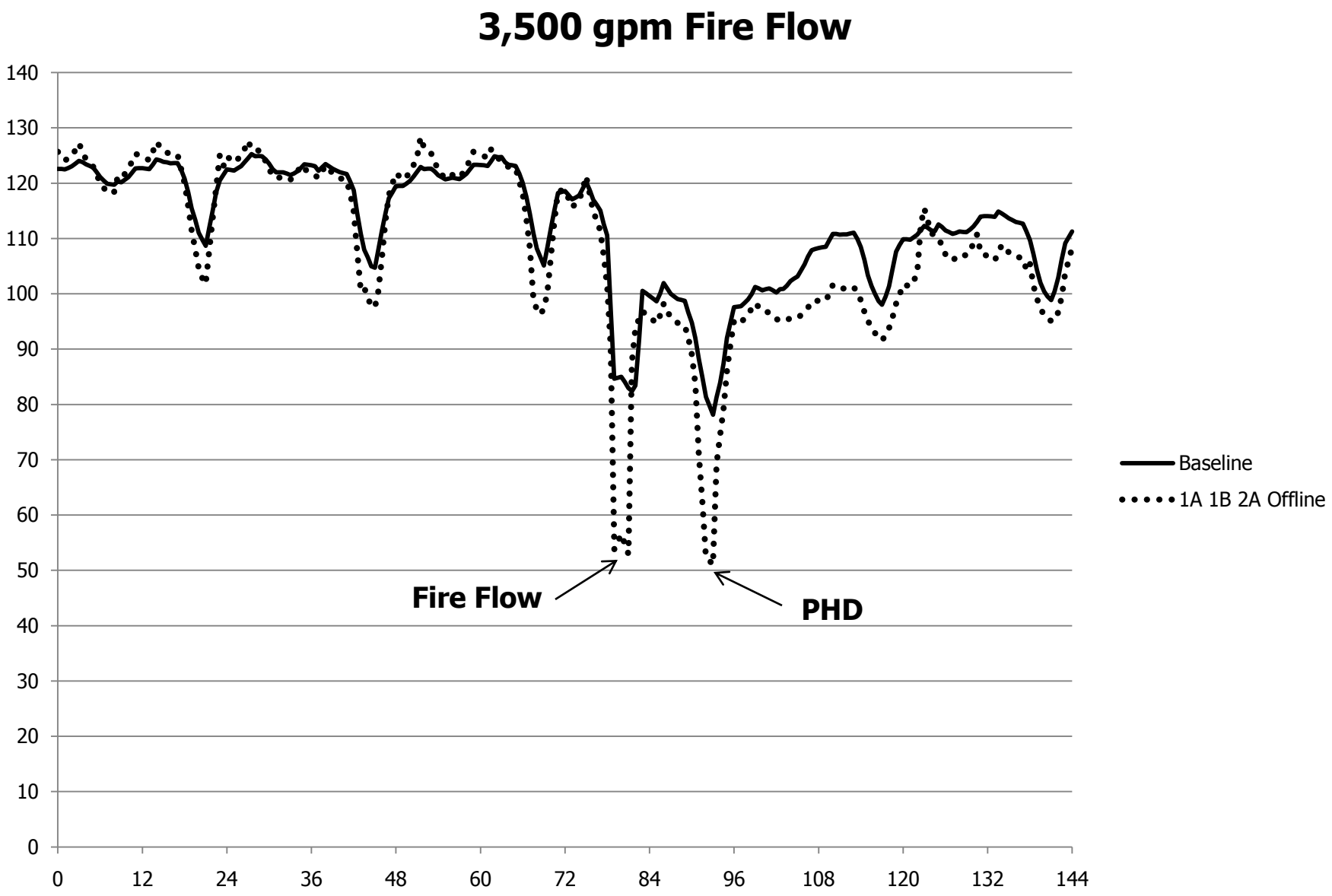
Pressure in Southwest 660 Zone: 1,000 gpm Fire Flow

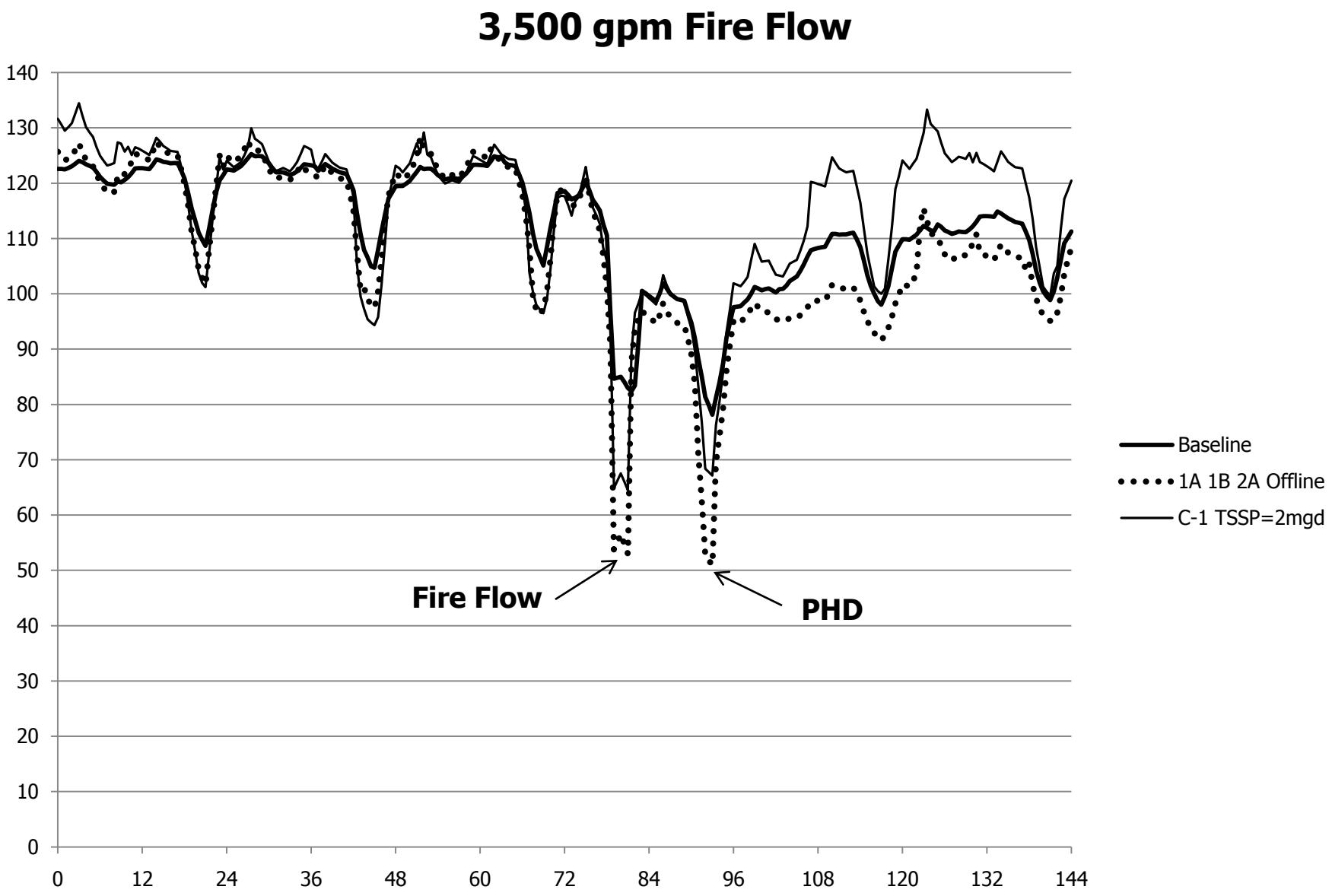


Pressure in Southwest 660 Zone: 1,000 gpm Fire Flow




3,500 gpm Fire Flow
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
12
24
36
48
60
72
84
96
108
120
132
144
Fire Flow
PHD
Baseline


3,500 gpm Fire Flow
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
12
24
36
48
60
72
84
96
108
120
132
144
Fire Flow
PHD
Baseline
1A 1B 2A Offline

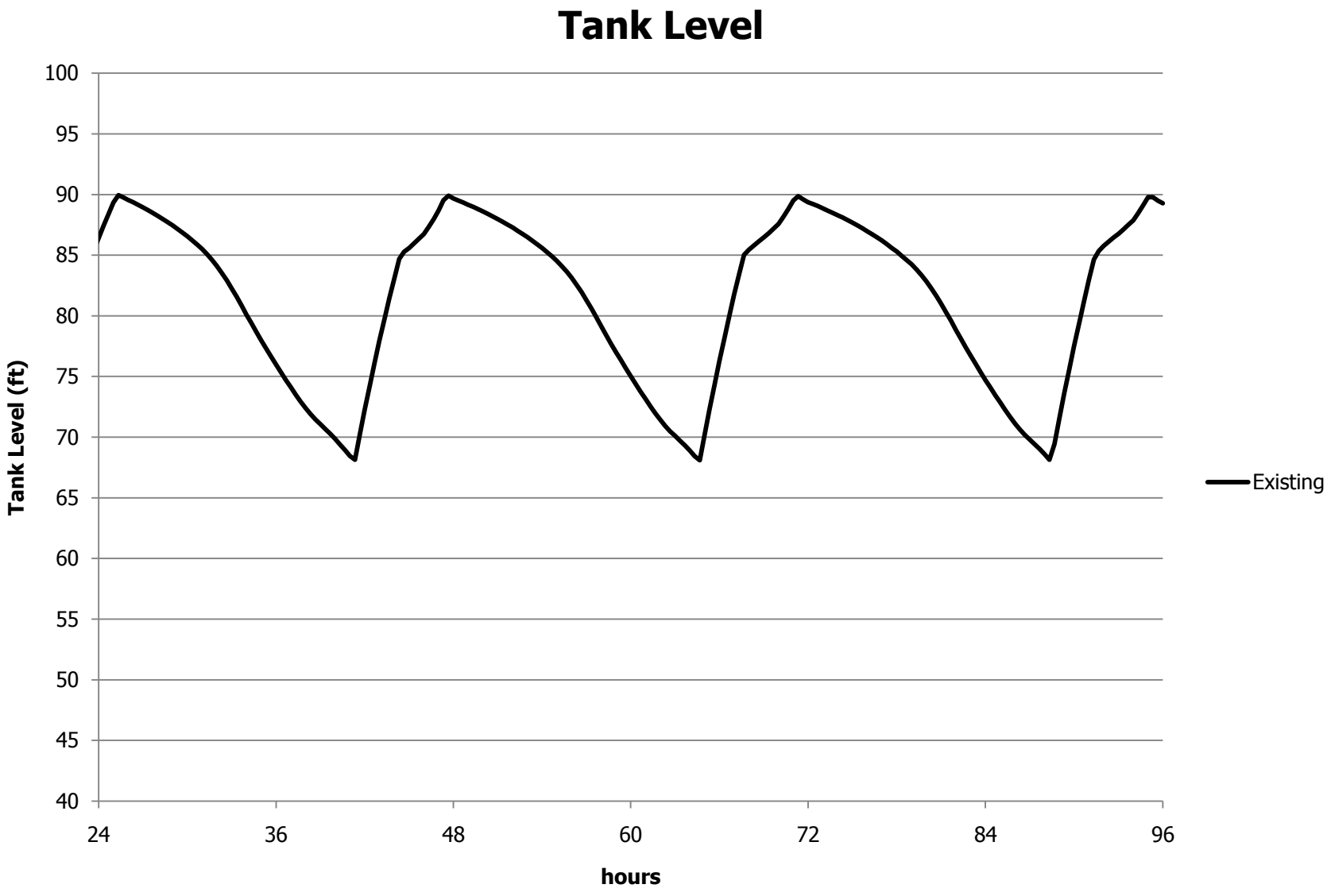

3,500 gpm Fire Flow
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
12
24
36
48
60
72
84
96
108
120
132
144
Fire Flow
PHD
Baseline
1A 1B 2A Offline
C-1 TSSP=2mgd

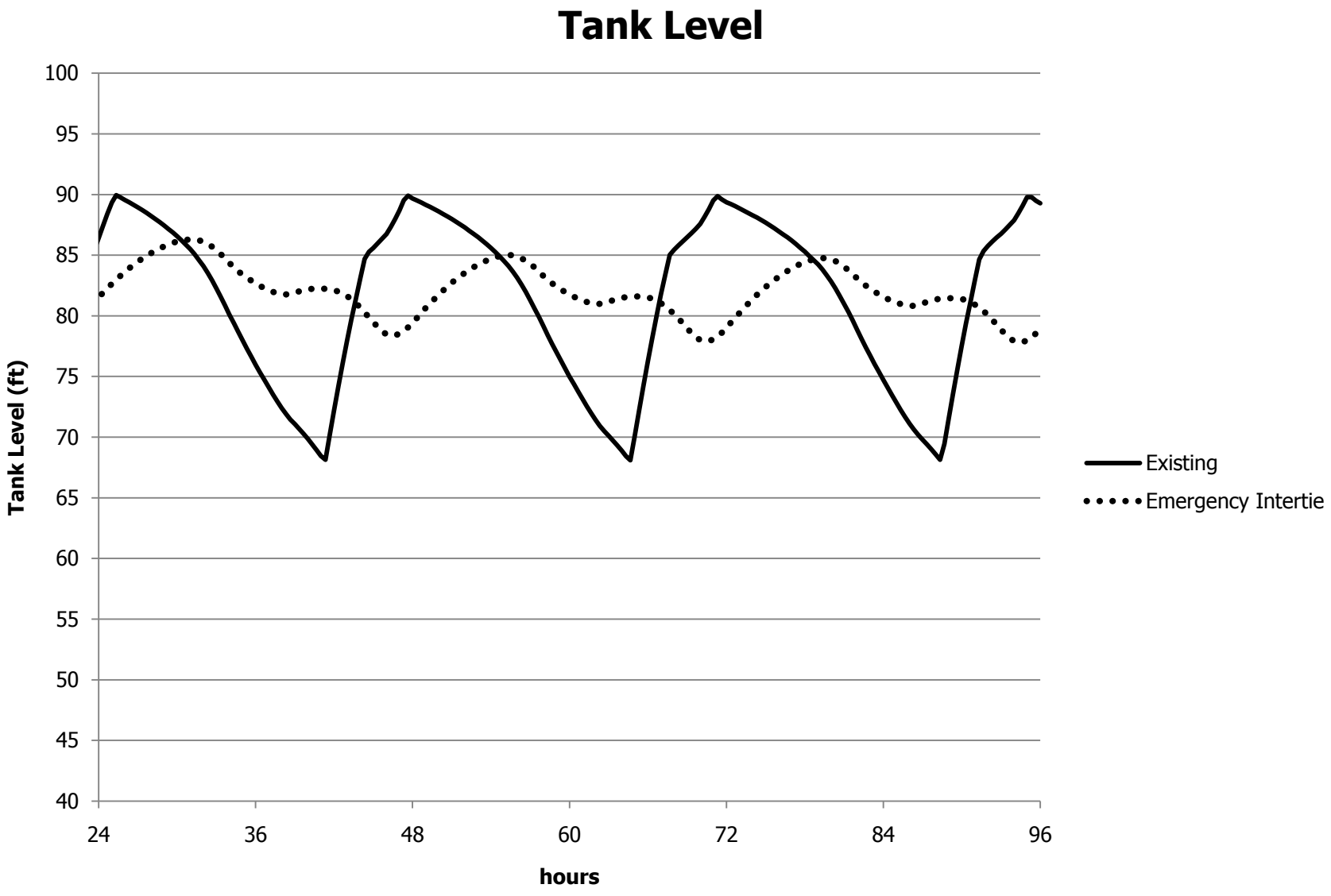
MDD + 3000 gpm Fire Flow
Tank Level
Level (ft)
63
62
61
60
59
58
57
56
55
54
53
0
4
8
12
16
20
24
28
32
36
Hour of Day
level
fire flow

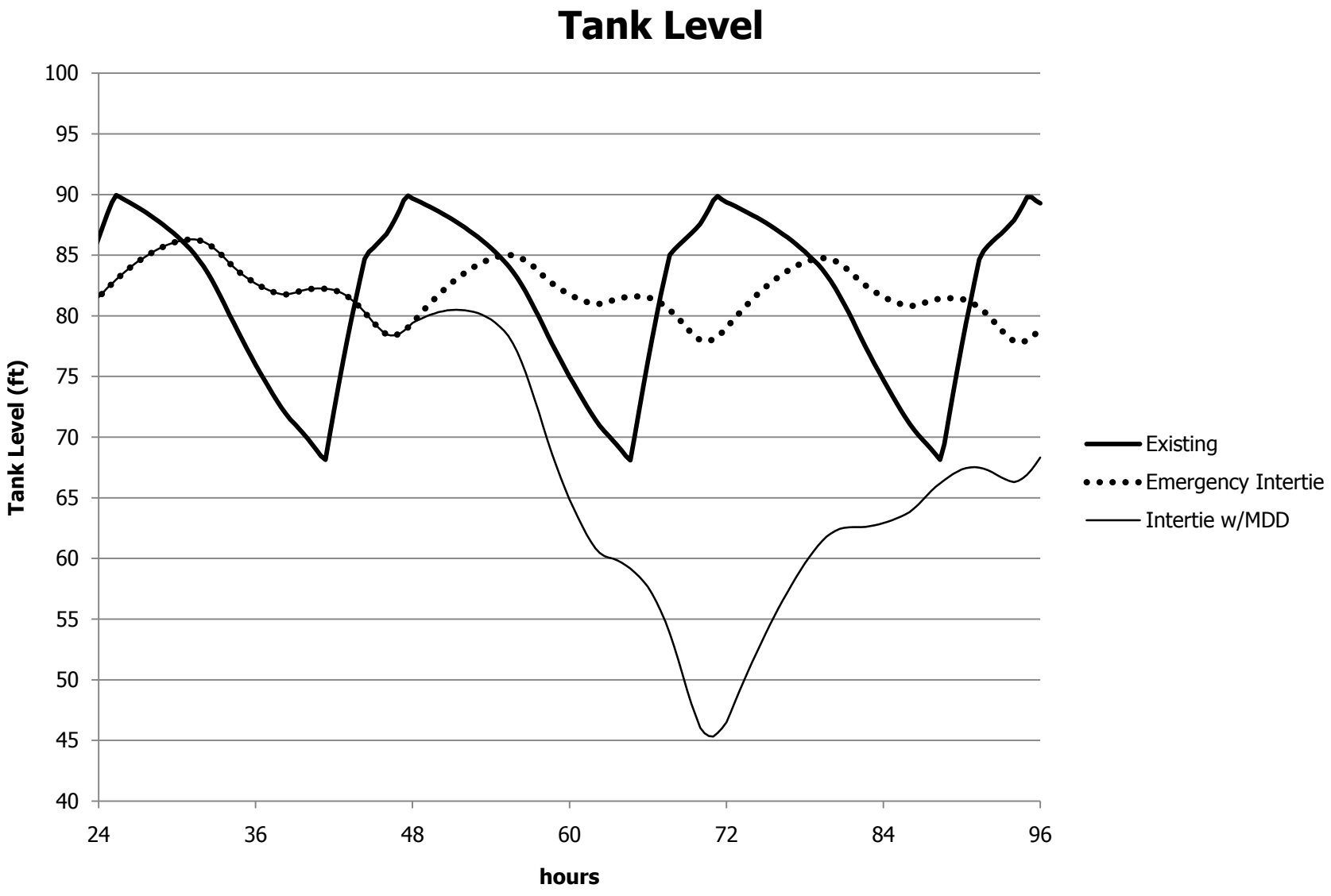
MDD + 3000 gpm Fire Flow
Tank Level
Level (ft)
63
62
61
60
59
58
57
56
55
54
53
0
4
8
12
16
20
24
28
32
36
Hour of Day
level
FF Level
fire flow

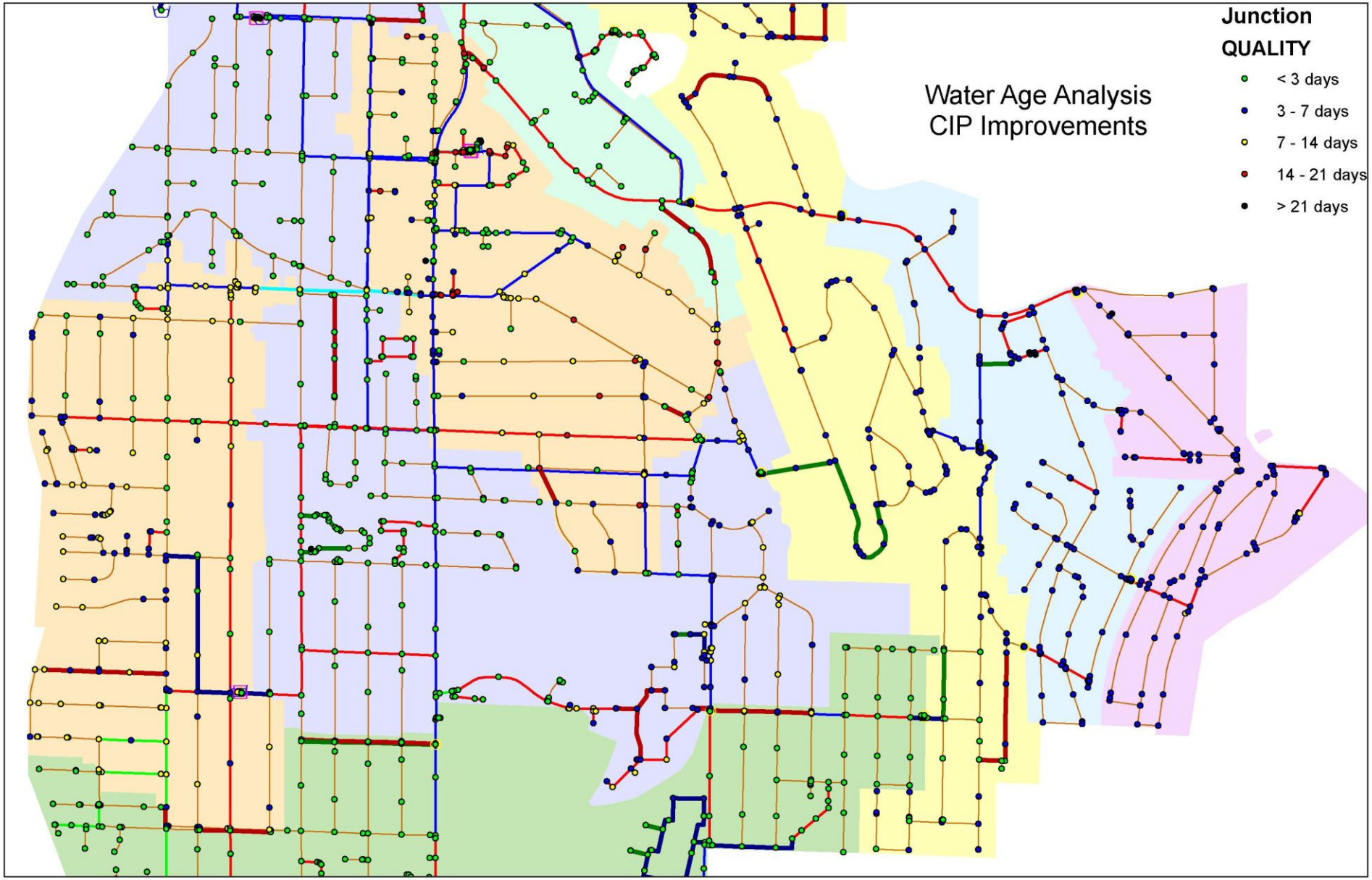
Emergency Response Planning

- What happens to system pressures?
- Can you fill your tanks?
- Can you deliver fire flow?
- What operational changes are necessary during an emergency condition?

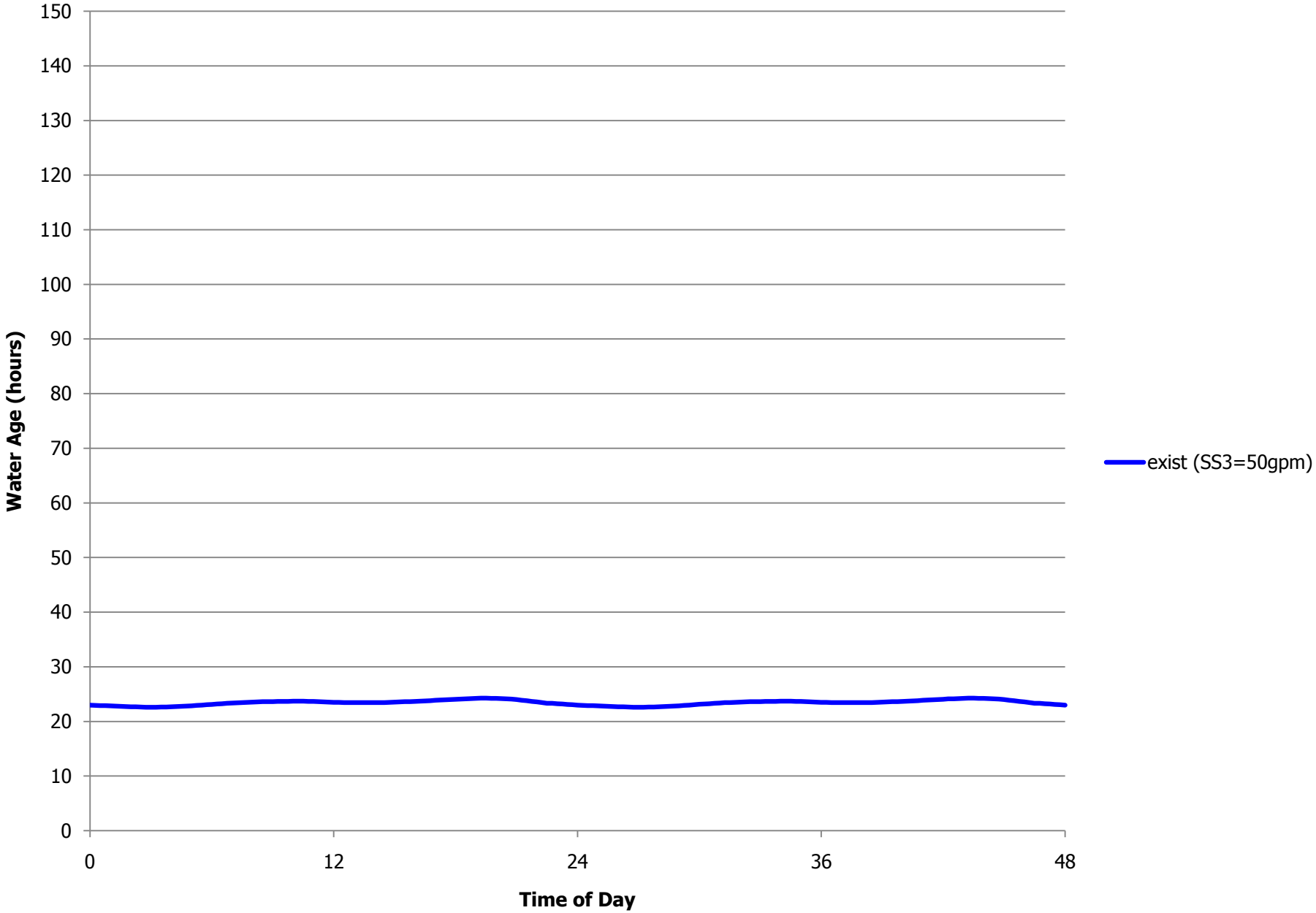

Tank Level
100
95
90
85
80
75
70
65
60
55
50
45
40
Tank Level (ft)
24
36
48
60
72
84
96
hours
Existing


Tank Level
100
95
90
85
80
75
70
65
60
55
50
45
40
Tank Level (ft)
24
36
48
60
72
84
96
hours
Existing
Emergency Intertie

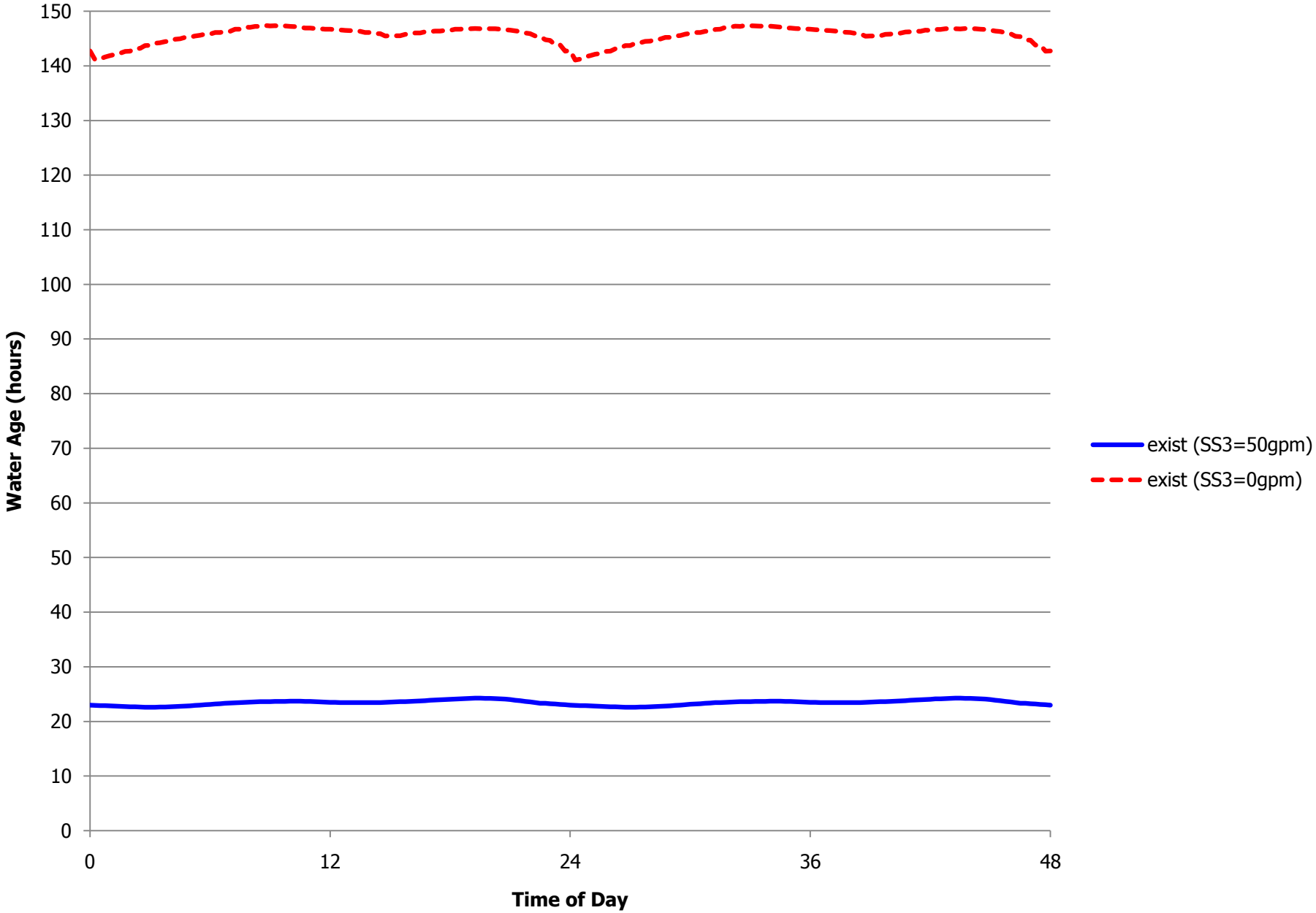

Tank Level
100
95
90
85
80
75
70
65
60
55
50
45
40
Tank Level (ft)
24
36
48
60
72
84
96
hours
Existing
Emergency Intertie
Intertie w/MDD


Water Age Analysis
CIP Improvements
Junction
QUALITY
< 3 days
3 - 7 days
7 - 14 days
14 - 21 days
> 21 days

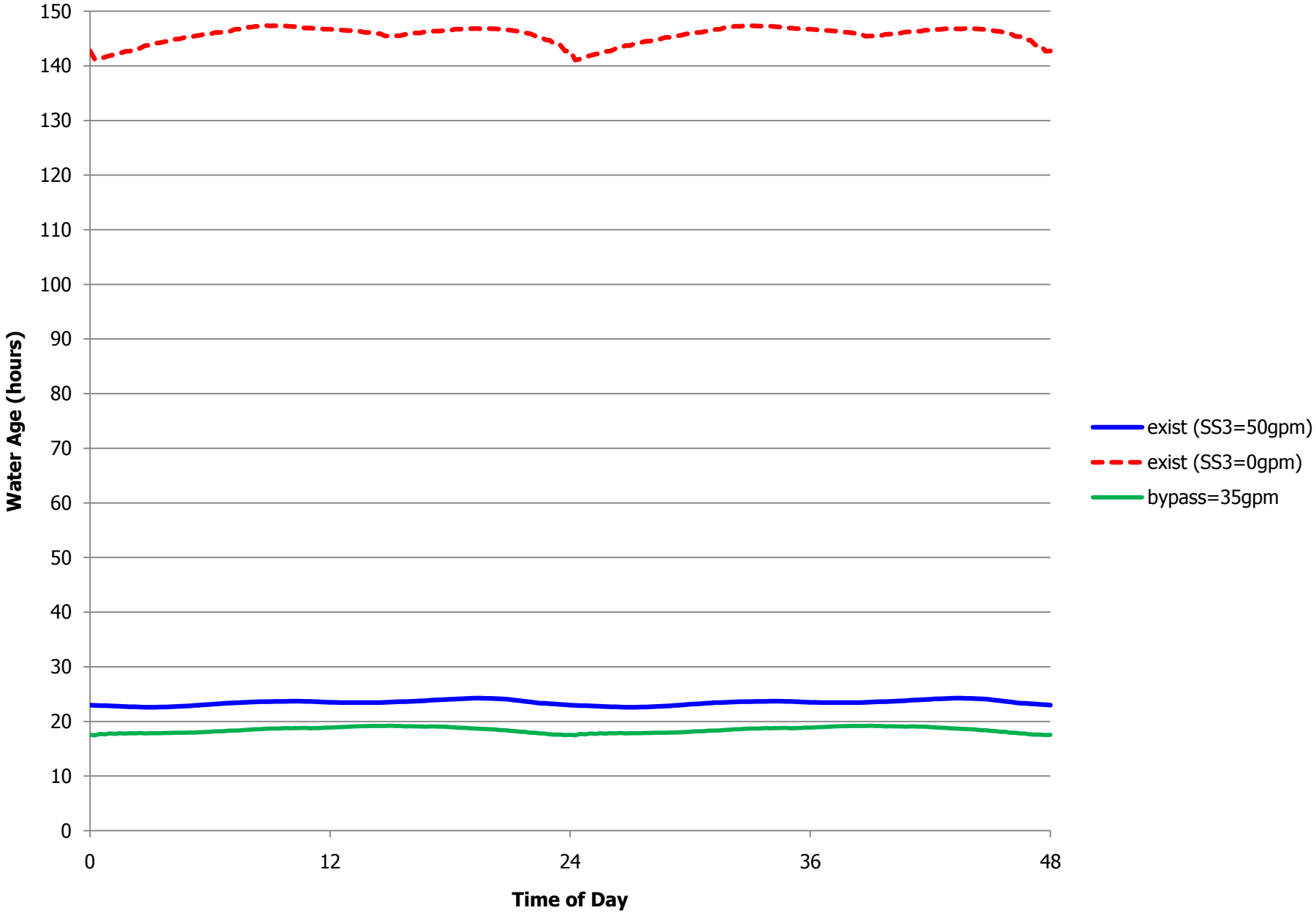
Water Age @ J1634 (20255 37th Ave NE - 502 Zone)



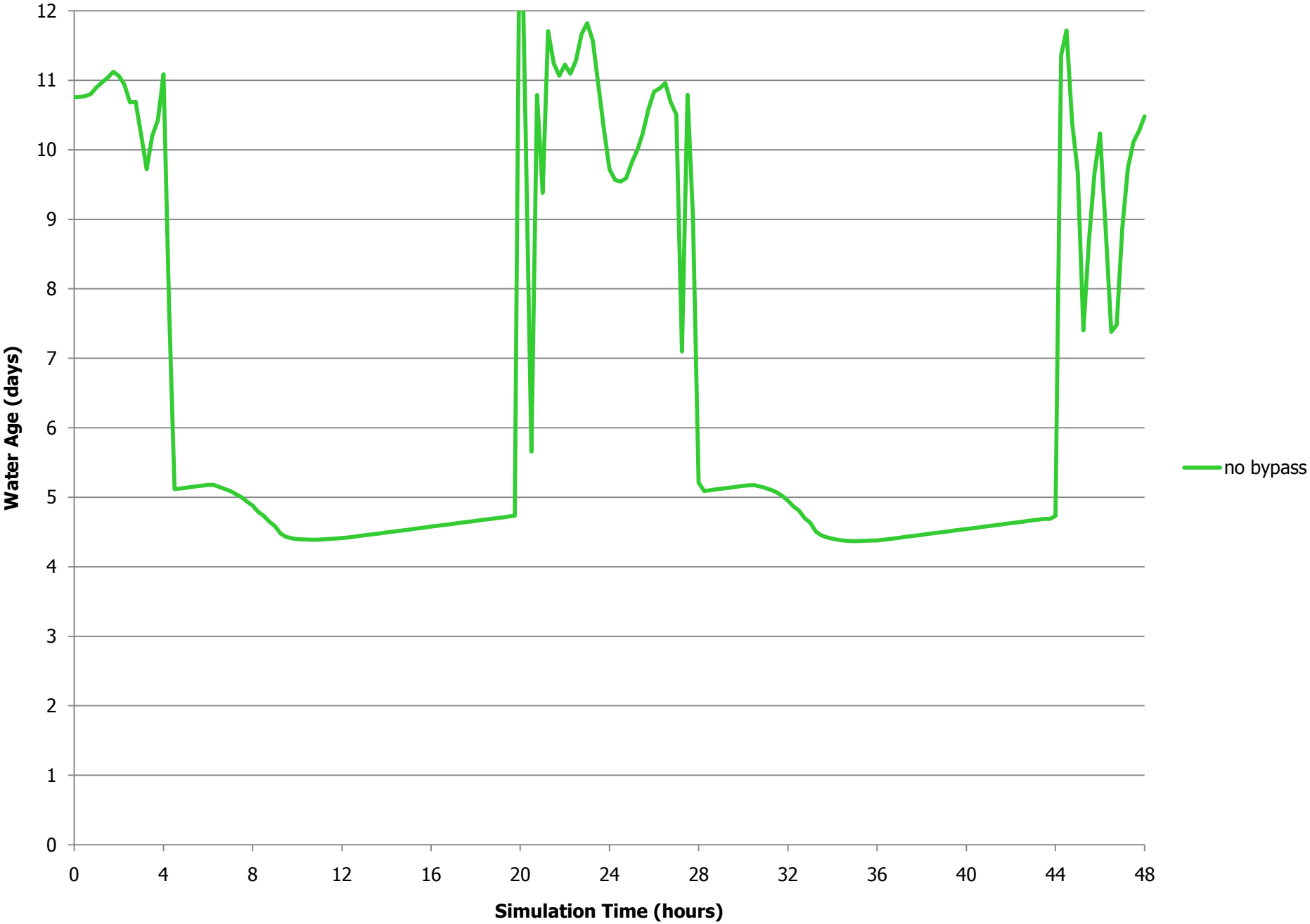
Water Age @ J1634 (20255 37th Ave NE - 502 Zone)

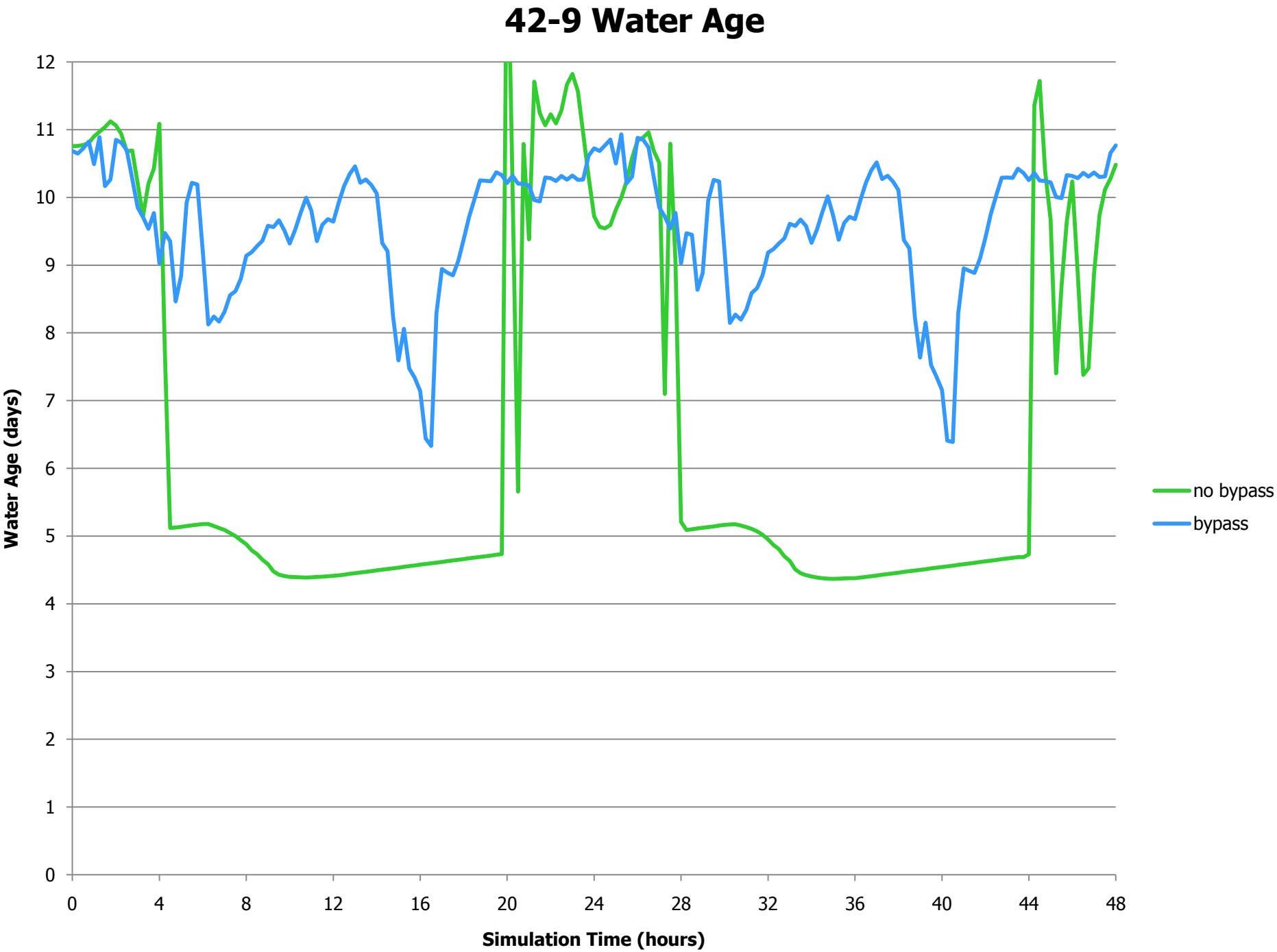


Water Age @ J1634 (20255 37th Ave NE - 502 Zone)

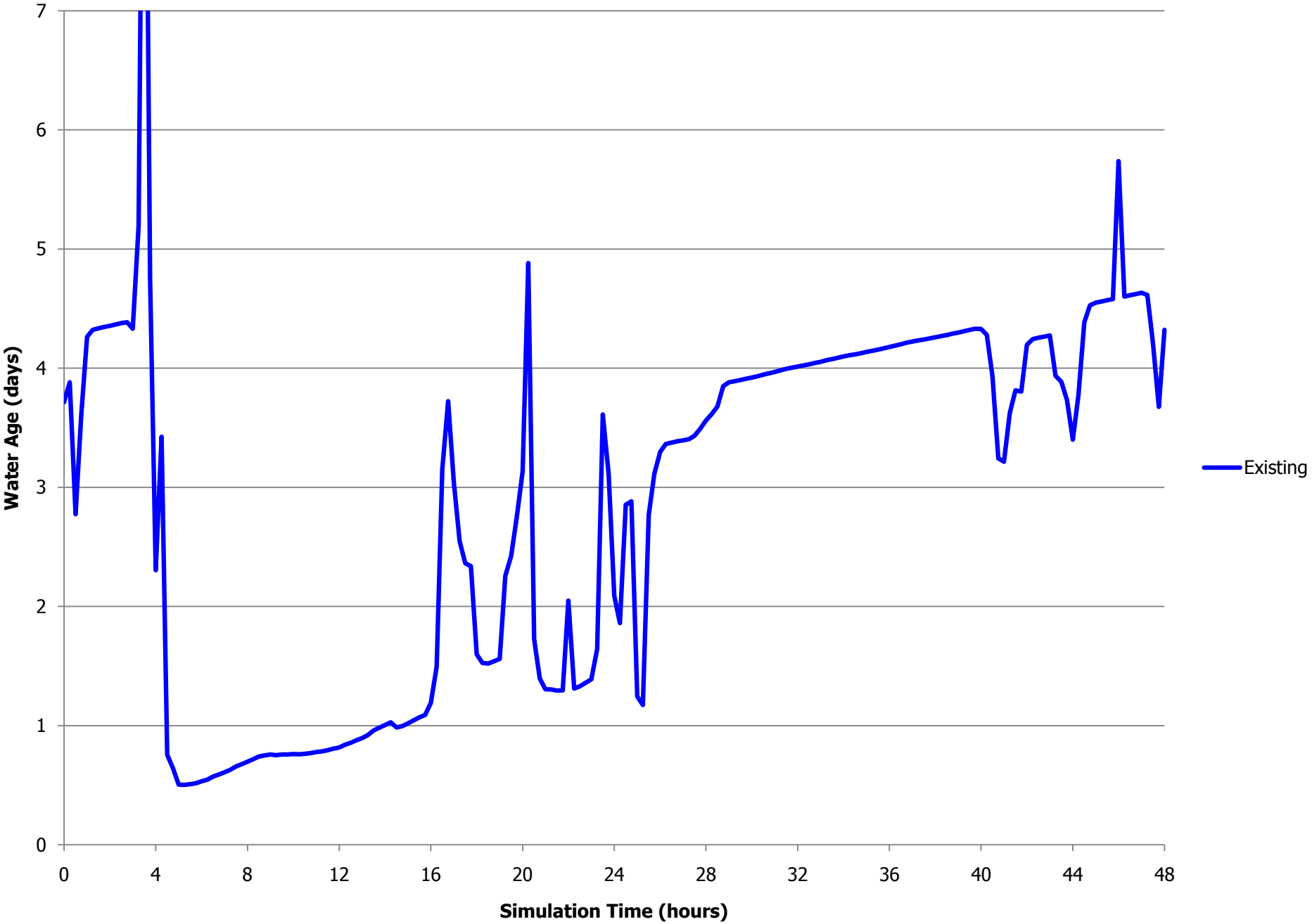


42-9 Water Age

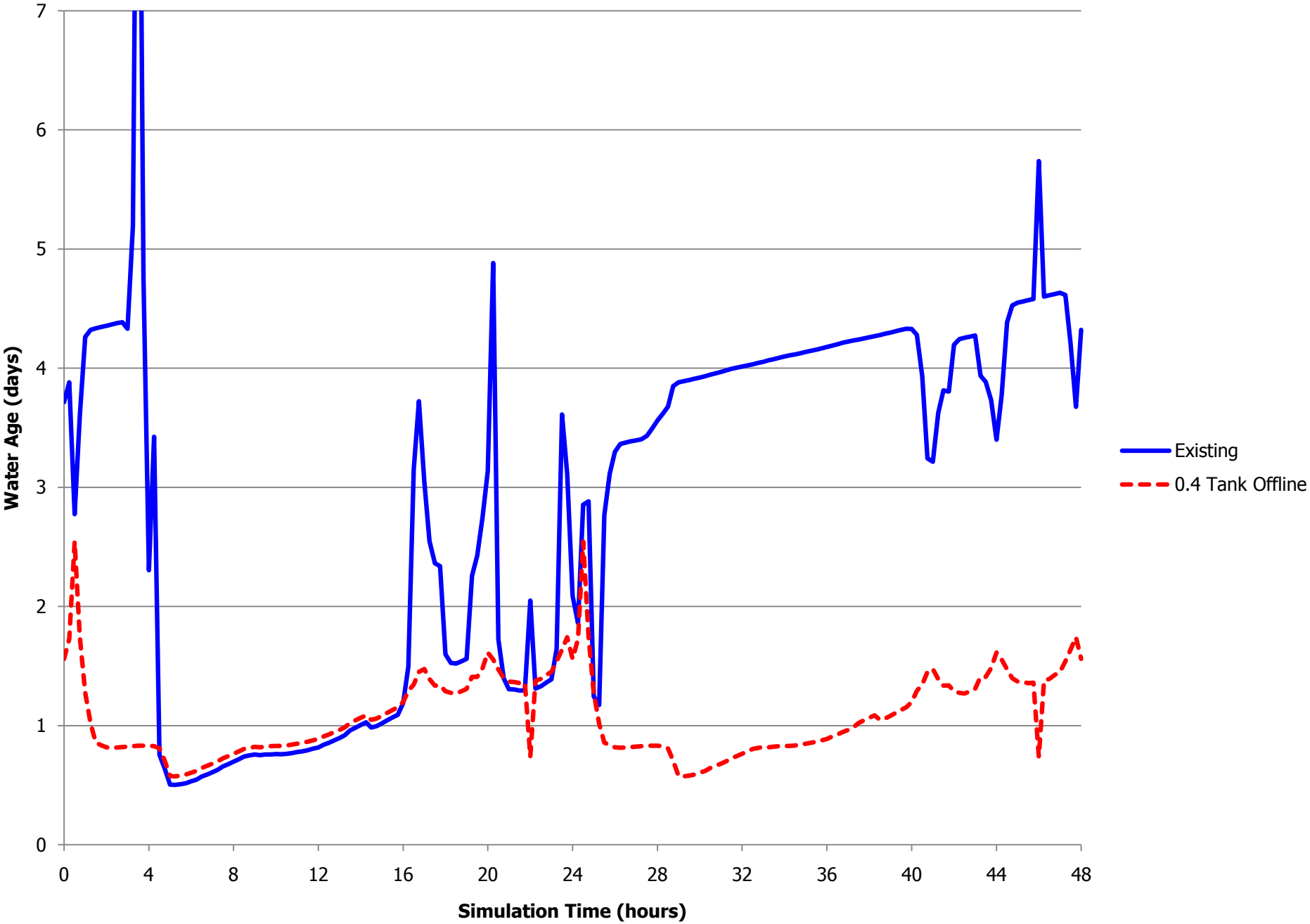



42-9 Water Age
Water Age (days)
Simulation Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
4
8
12
16
20
24
28
32
36
40
44
48
no bypass
bypass

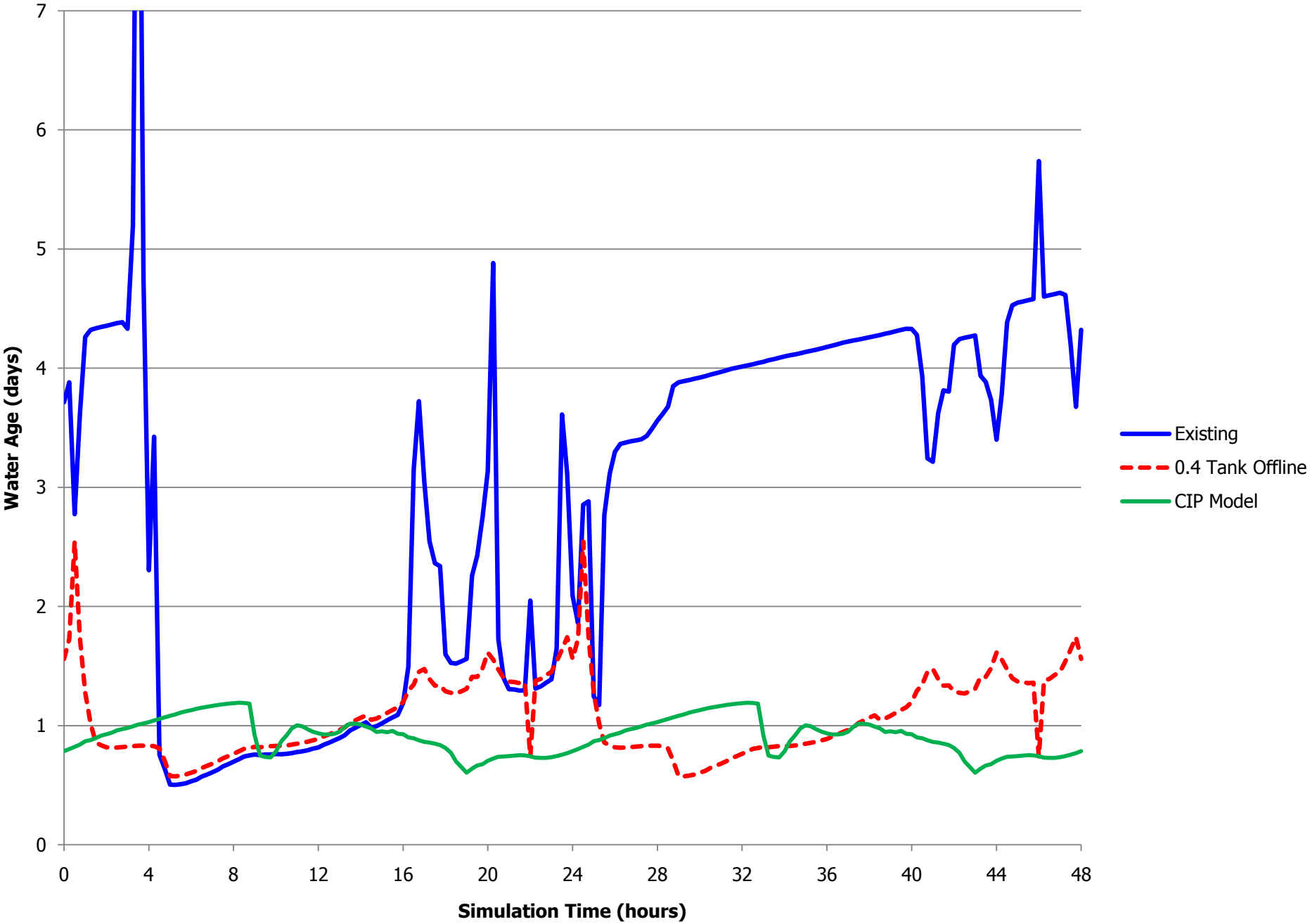
Water Age @ J1665 (20030 Ballinger Way NE - 502 Zone)



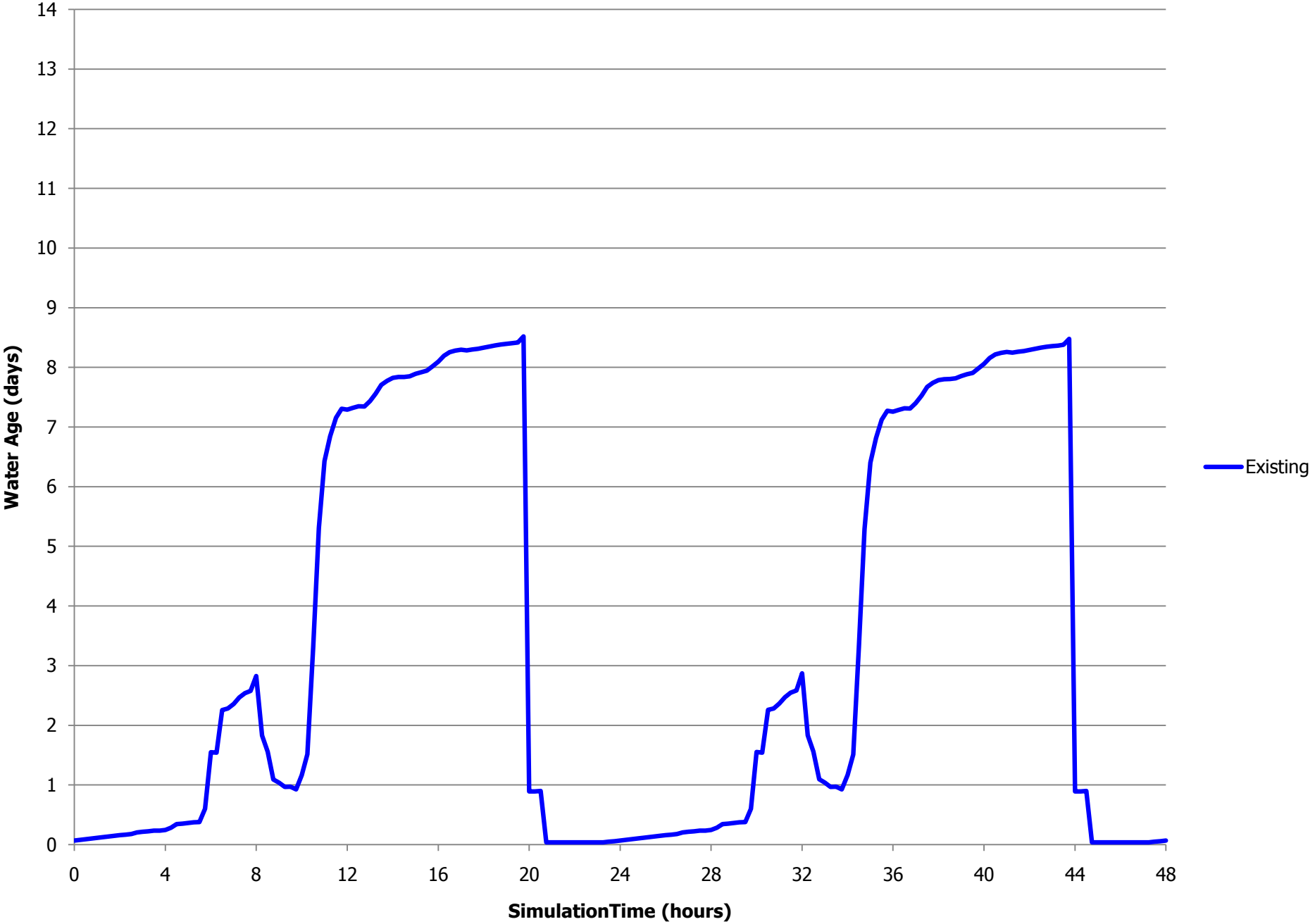
Water Age @ J1665 (20030 Ballinger Way NE - 502 Zone)

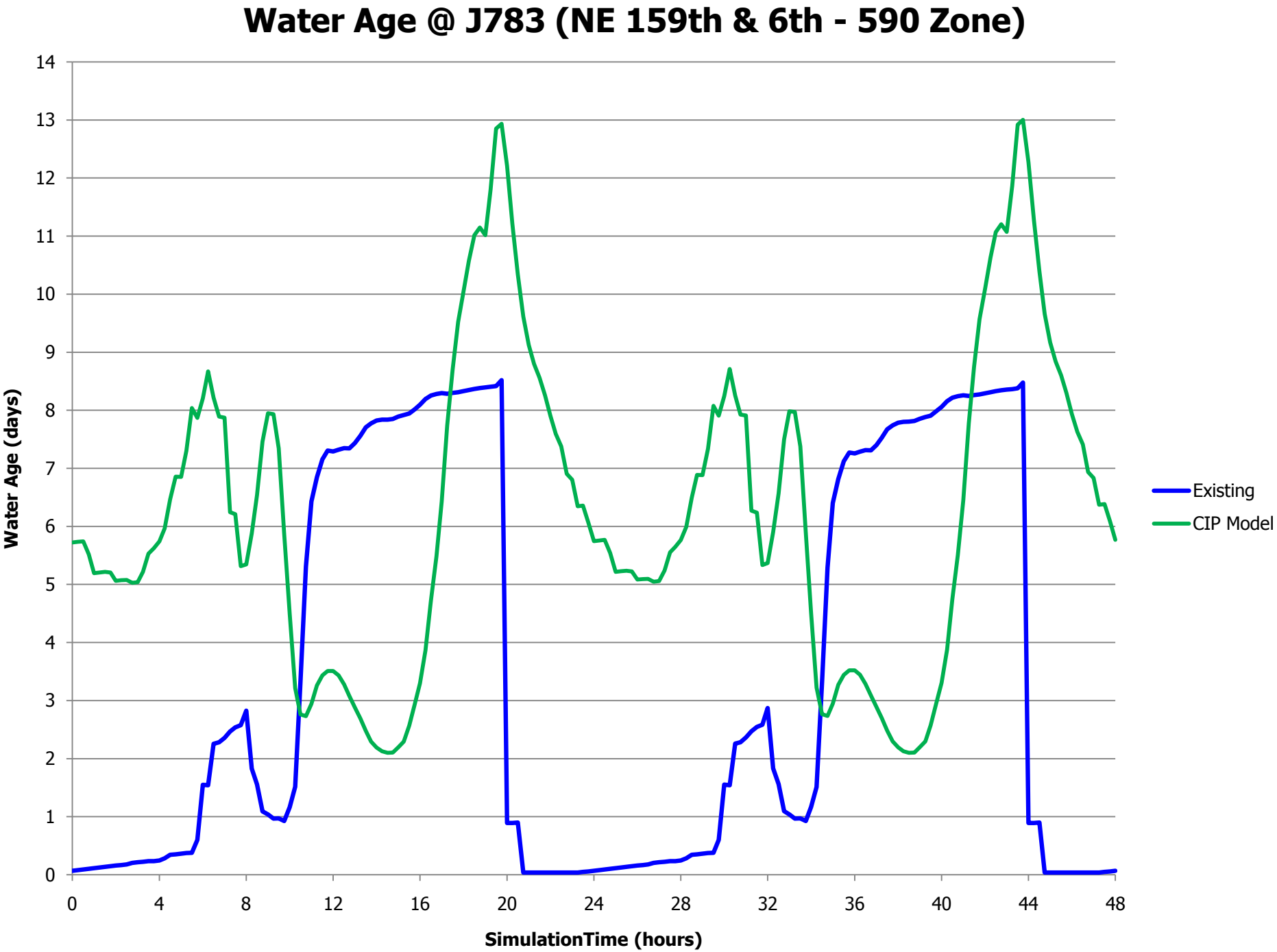


Water Age @ J1665 (20030 Ballinger Way NE - 502 Zone)



Water Age @ J783 (NE 159th & 6th - 590 Zone)

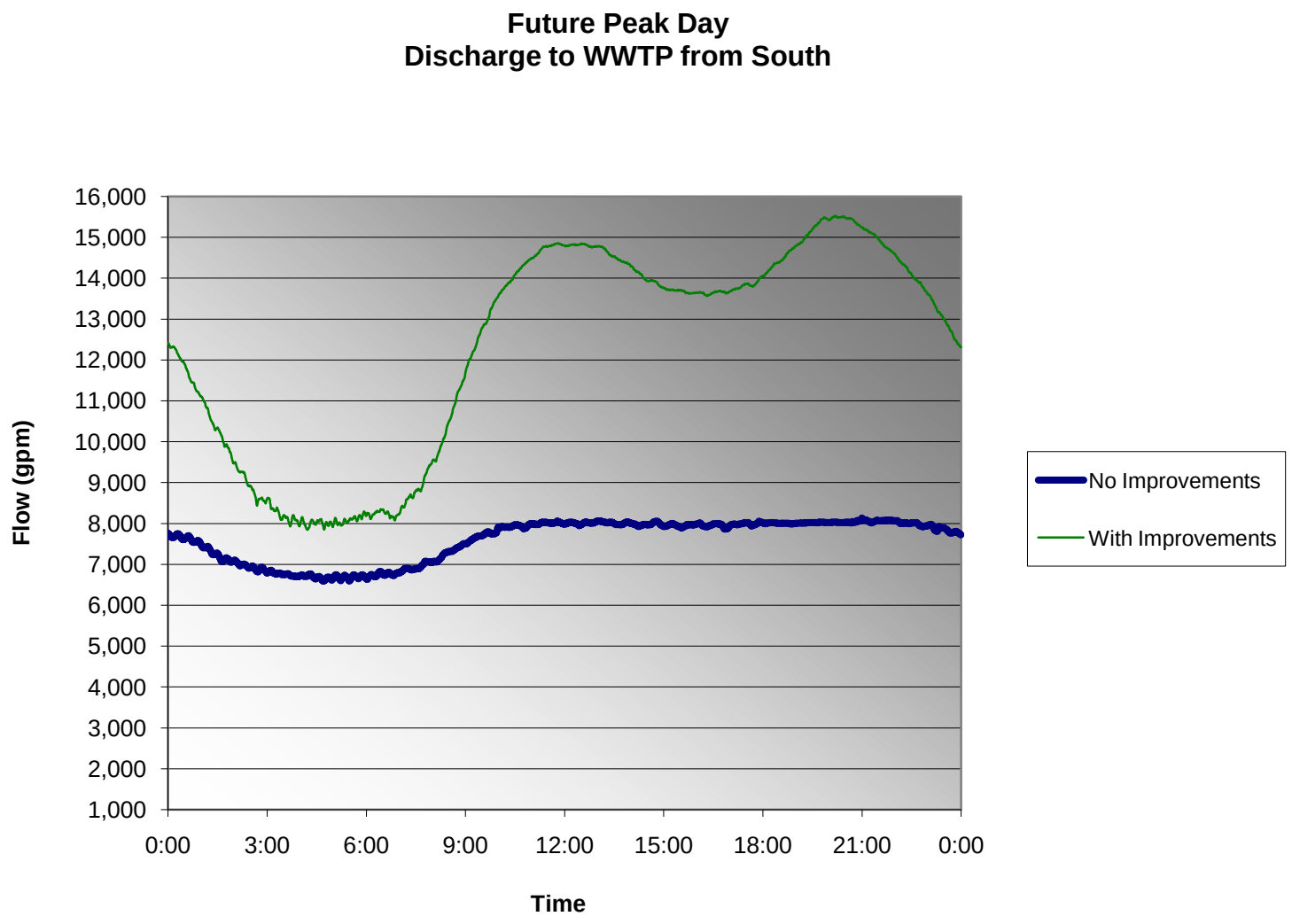


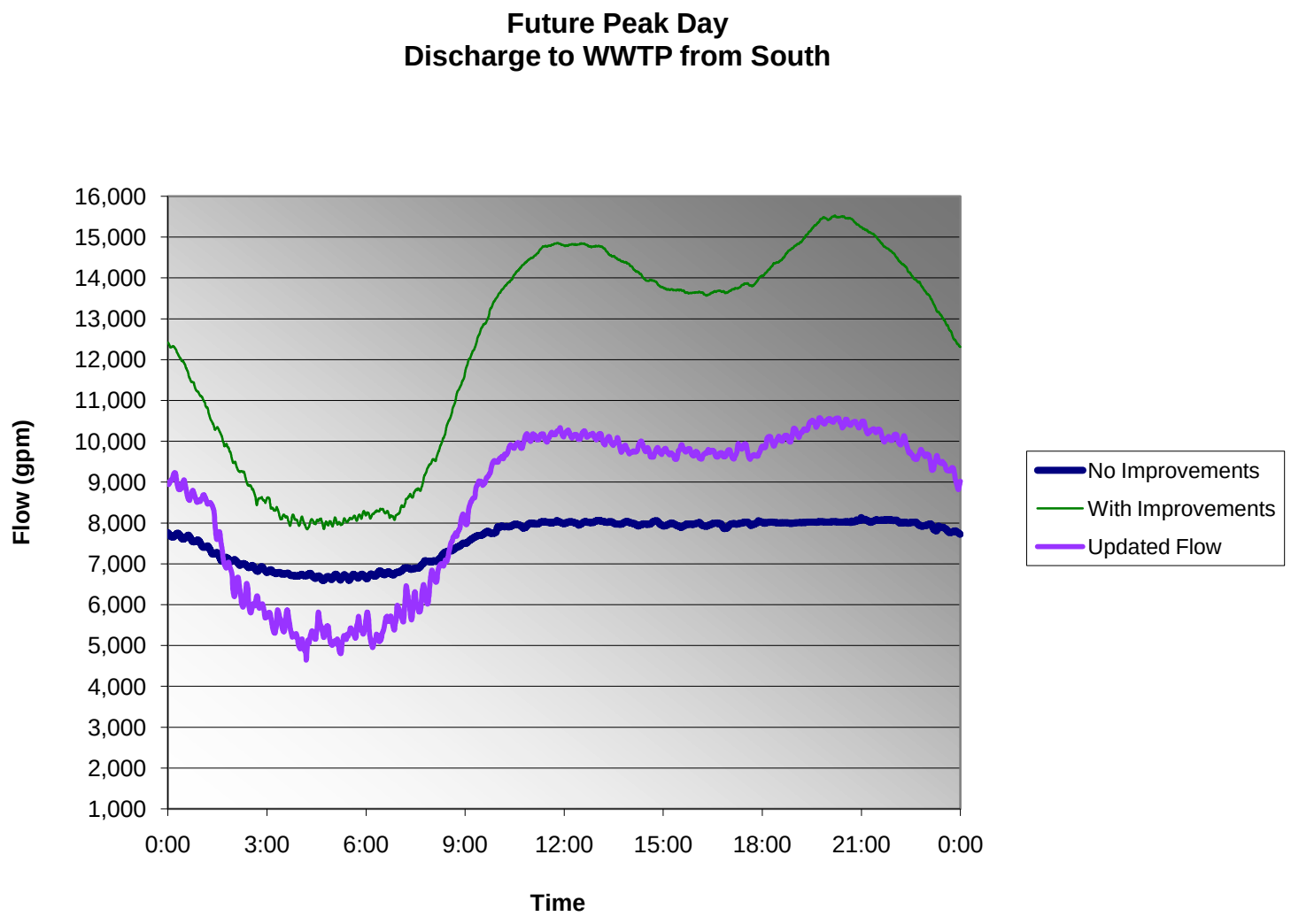

Water Age @ J783 (NE 159th & 6th - 590 Zone)
Water Age (days)
SimulationTime (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
4
8
12
16
20
24
28
32
36
40
44
48
Existing
CIP Model

Trends:

- RTC
- Balancing conflicting goals
- Sustainability
- Adapting to climate change
- Security
- Future capabilities

Questions???


Future Peak Day
Discharge to WWTP from South
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
Flow (gpm)
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time
No Improvements
With Improvements


Future Peak Day
Discharge to WWTP from South
Flow (gpm)
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0:00
3:00
6:00
9:00
12:00
15:00
18:00
21:00
0:00
Time
No Improvements
With Improvements
Updated Flow