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Water System Hydraulic Analysis

Date: July 26, 2006

For: City of Fullerton
Building Department
Fullerton, CA

By: James H. Smith, P.E.
Manager, Public Works Dept.
Hunsaker & Associates

Project: **Amerige Court, Tract Nos. 17094 & 17097**

Hunsaker & Associates Irvine, Inc. (H&A) is pleased to submit the Water System Hydraulic Analysis for Amerige Court, Tract Nos. 17094 & 17097. This hydraulic analysis has been prepared to describe the proposed water for the aforementioned mixed-use development project in the City of Fullerton. The project lies within the jurisdiction of the City of Fullerton and their standards have been used for this report. Hydraulic models were prepared using Haestad Methods software to model various conditions the proposed water system would experience.

The goal of this hydraulic analysis is to evaluate the domestic water distribution systems for the proposed multi-family residential development of Tract Nos. 17094 & 17097, identifying the general location and size of the pipelines. The evaluation is based on existing and known conditions and should be re-evaluated if these conditions change or new information becomes available. Any interpretation of the information presented in this report should be referred to H&A to ensure the integrity of the results.

Project Location

Amerige Court, Tract Nos. 17094 & 17097, includes 131 proposed residential attached (Multi-Family) units and 31, 400 square feet of commercial development. The project is located in the City of Fullerton, on the North side of Commonwealth Avenue, to the West of Harbor Avenue. The general project location is shown on the included "Vicinity Map – Figure 1."

Summary of Findings

Water System

1. Water supply is provided by the City of Fullerton. The water system grid includes a 16-inch main in North Highland Avenue south of Commonwealth, changing into two 12-inch mains in Commonwealth Avenue and North Highland Avenue, north of Commonwealth. The Static Hydraulic Grade was assumed to be 336 feet based on a fire hydrant flow test on Commonwealth Avenue and North Highland Avenue, included in the appendix of this report.

2. The proposed onsite water system consists of 8-inch diameter mains. The proposed water system schematic is shown on the attached "Proposed Water System Model - Figure 2."

3. The pressure available from the existing water system is adequate to provide residual pressures greater than **20 psi during 2,625 gpm fire flows** as required by the City of Fullerton Fire Department. The minimum residual pressure experienced for the worst-case 2,625 gpm fire flow plus maximum

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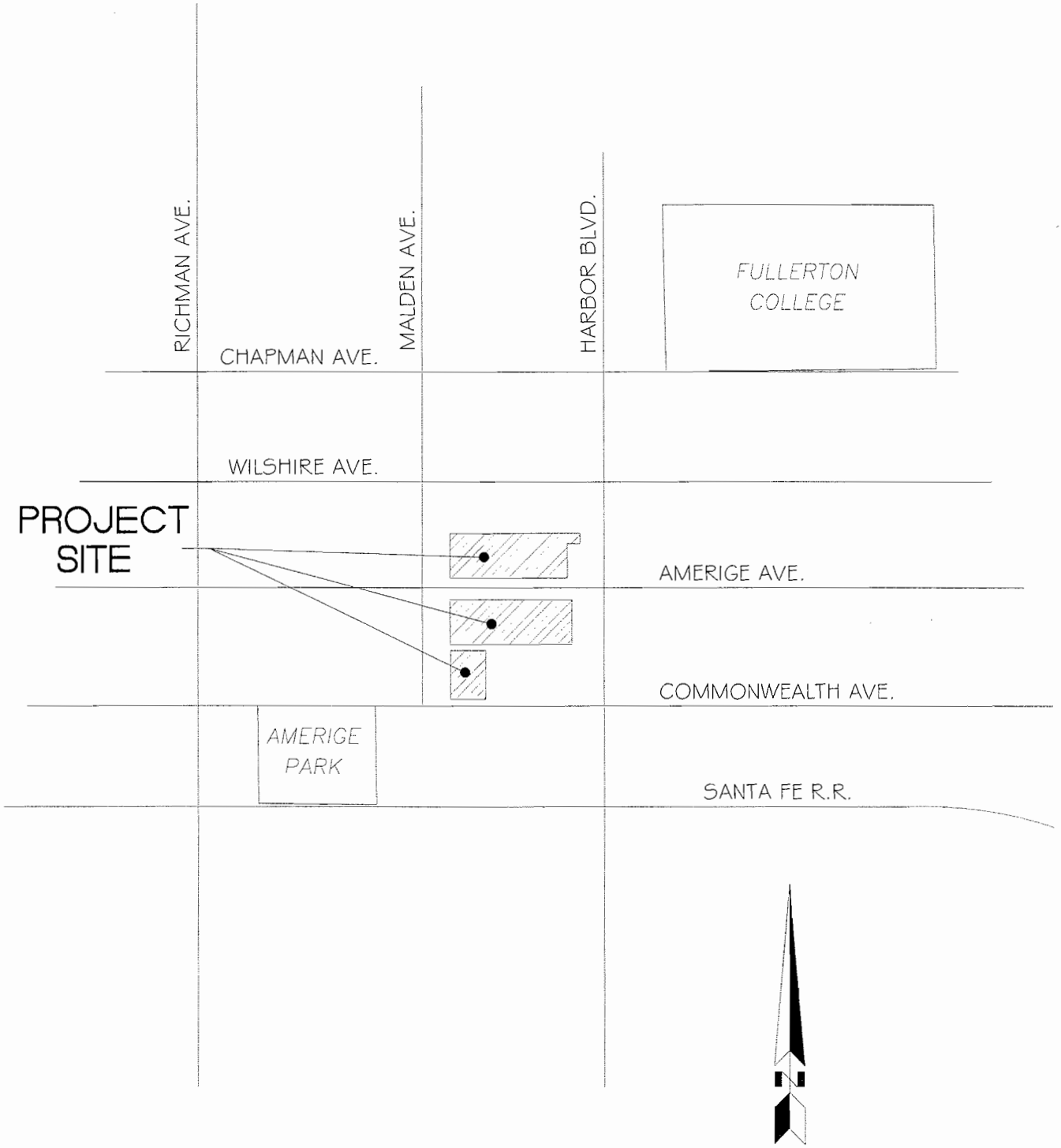

CITY OF FULLERTON

AMERIGE COURT, TRACT NOS. 17094 & 17097

VICINITY MAP

W.O. # 0344-51	DATE: 7-26-2006

FIGURE 1 OF 2

SCALE: 1" = 100'

LEGEND

- EXISTING 4-INCH WATER MAIN TO BE ABANDONED
- EXISTING WATER MAIN & PIPE NUMBER (8-INCH SIZE UNLESS NOTED ON PLAN)
- EXISTING 12-INCH WATER MAIN & PIPE NUMBER
- PROPOSED 8-INCH WATER MAIN & PIPE NUMBER
- JUNCTION NODE AND NUMBER
- LOCATION OF MODELED FIRE FLOW
- PROJECT SITE
- MODELED RESERVOIR

NOTE:

1. MODELED RESERVOIR IS LOCATED ON THE DISTRICTS WATER SYSTEM. THE STATIC HGL IS ASSUMED TO BE 336-FEET, BASED ON FIRE FLOW TEST.

100 50 0 100 200

GRAPHIC SCALE: 1" = 100'

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CITY OF FULLERTON
VINTAGE SQUARE- TRACTS NOS. 17094 & 17097
WATER SYSTEM MODEL

JOB NO. 0344-51 | DATE: 7-26-06

FIGURE 2 OF 2

day demands was **30 psi** at a calculated HGL of 230 feet at the flow test hydrant on Commonwealth Avenue.

4. The proposed water system provides greater than **40 psi** for all nodes during a domestic peak hour demand event as required by the City of Fullerton. The minimum pressure experienced was **75 psi** at a calculated HGL of 335 feet at the fire flow test hydrant on Commonwealth Avenue.

5. H&A estimated the flow constant "K" using Affinity Laws to determine the HGL of the water supply at static, peak hour, and maximum day plus 2,625 gpm fire flow demand. The flow constant for this water system is $K = Q/(H_F)^{0.54}$ where H_F in the measured head loss. The "K" value for the water system is estimated to be **239** based on the fire flow test provided by the City of Fullerton Fire Department.

6. The water demands for the proposed Tract Nos. 17094 & 17097 were based upon a previous H&A Water Master Plan for Amerige Heights in the City of Fullerton, dated October 2001. The average day domestic water demands are estimated to be 916 gpd/unit for residential attached developments. The following is the total water demands for Tract Nos. 17094 & 17097:

   - Tracts 17094 & 17097 - Average Day Demand (ADD)
     - Residential Attached – 131 DU's x 916 gpd/DU = 83 gpm
     - Commercial – 0.721 acres x 1200 gpd/acre = 0.60 gpm
     - Total Mixed Use = 84 gpm
   - Tracts 17094 & 17097 - Maximum Day Demand (MDD)
     - Total Mixed Use – MDD =1.46 x ADD = 123 gpm
   - Tracts 17094 & 17097 - Peak Hour Demand (PH)
     - Total Mixed Use – PH = 2 x MDD = 246 gpm

7. The water system for Tracts Nos. 17094 & 17097 was designed to meet all of the design criteria contained within the Uniform Fire Code.

Water System Analysis

The hydraulic analysis of Tract Nos. 17094 & 17097 was prepared using WaterCad v7.0 by Haestad Methods during steady state conditions. The plan layout of the model is located in the attached exhibit entitled "Proposed Water System Model – Figure 2." The water model was used to calculate the estimated pressures that will be experienced during static conditions, domestic peak hour flows, as well as maximum day plus 2,625 gpm fire flow at proposed fire hydrants locations within the tract.

Water Demands

The City of Fullerton Water Master Plan estimates domestic water consumption for residential attached (multi-family) and commercial development based upon duty factors. The domestic water demands were developed in accordance with the following criteria:

Residential Attached Demands (Multi-Family)

- Average Daily Demand (ADD) = 916 gpd/DU

Commercial Demands

- Average Day Demand (ADD) = 1200 gpd/acre

Peaking Factors

- Maximum Day Demand (MDD) = 1.46 x ADD
- Peak Hour Demand (PH) = 2 x MDD

A complete summary of the water demands for Tract Nos. 17094 & 17097 can be found in the Appendix of this report.

Fire Flows

Using Table A-III-A-1 in the Uniform Fire Code, the calculated required fire flow for a building with Type V Construction is 5,250 gpm. Per Fullerton Fire Marshall Julie Kunze, a 50 percent reduction in required fire flow is allowed for buildings with automatic sprinkler systems. The required fire flow is show in the following table:

Table 1 – Fire Flows Used for Model

Land Use	Fire Flow
Commercial	2,625 gpm

Fire Flow Test

A fire flow test was performed by the City of Fullerton Fire Department at a fire hydrant location on Commonwealth Avenue on the City of Fullerton water supply. The flow test results are located in the Appendix and the following is the data acquired from the flow and the calculated HGL's using Affinity laws:

Inland Empire Boulevard Test Hydrant

Static Pressure	81 psi
Residual Pressure	71 psi
Observed flow	1,300 gpm
Test Elevation	149 feet
Flow constant K	239
Static HGL	336 feet
Dynamic HGL	335 feet (desired flow = Peak Hour = 246 gpm)
Dynamic HGL	244 feet (desired flow = MDD+FF = 2,748 gpm)

Model Design Criteria

H&A has prepared hydraulic calculations for Tract Nos. 17094 & 17097 to demonstrate that the water system is capable of delivering the required flows at acceptable pressures, based on the City of Fullerton standards. The requirements are as follows:

- The minimum residual pressure at all nodes during maximum day demand + fire flow in the project shall be 20 psi.

- The minimum residual pressure at all nodes during peak hour flow in the project shall be 40 psi.
- Minimum pipeline size of 8-inches in diameter for proposed pipes.
- Pipe velocities shall not exceed 10 fps unless otherwise approved by the City of Fullerton.

Water Model Description

A pipe network was created from the existing and proposed water system. The network included enough pipes in the area of the project to represent actual water paths that would be experienced during domestic and fire flow demands. An existing fire hydrant labeled R-1 was used as the water source for the existing system. The HGL for R-1 in the water model was assumed to be 336 feet during static conditions, 335 feet for peak hour demands, and 244 feet for MDD plus 2,625 gpm fire flow demand.

The pipes in the model were drawn consistent with the existing and the proposed water system. The nodes were placed to facilitate the analysis required for this report.

In order to calculate the residual pressures and velocities during fire flows, the fire flows were split between two hydrants to simulate actual conditions and a model run was performed for the system. The test nodes represent fire hydrant locations or water main tees or crosses in the water system. The model results are for the worst-case scenarios. The test nodes were chosen at the most remote positions and highest elevations from the water source R-1. Using the City of Fullerton duty factors previously discussed in this report, the domestic demands were incorporated into the model by counting units and assigning flows to the nodes nearest to the proposed buildings.

The residual pressures and pipe velocities during a peak hour demand event were calculated applying the same technique used to apply demands to nodes in the fire flow model run. The peak hour demands were determined by multiplying the average day demand (ADD) by the peaking factors set forth by the City of Fullerton Water Master Plan.

The model run results are included in the Appendix and they provide the demand amounts at each node, pipeline sizes, and the hydraulic grade line elevation used for each model run.

Water System Results

Based on the results of the H&A water model, the pressure available from the existing water distribution system is adequate to provide the City of Fullerton's required flows at acceptable pressures. The residual pressures are estimated to be greater than 20 psi during MDD plus 2,625 gpm fire flows, as required, for the proposed mixed use development. The minimum residual pressure experienced during MDD plus 2,625 gpm fire flow conditions, was 30 psi. The proposed water system provides greater than 40 psi for all homes within Tract Nos. 17094 & 17097 during a peak hour demand event. The minimum residual pressure experienced during peak hour demands was 75 psi.

The following is a summary of the model calculations:

Table 2 - Summary of Fire Flow Model Run

Fire Flow Node(s)	Node Elevation (ft)	FF+MDD at Node(s) (gpm)	Node HGL (ft)	Residual Pressure (psi)
J-10	160	1,313	230	30
J-12	157	1,312	231	32

Table 3 – Summary of Peak Hour Model Run

Total Flow (gpm)	Minimum Residual Pressure (node) / (psi)	Maximum Velocity (pipe) / (ft/s)
246	J-9 / 75	P-40/ 0.74

In conclusion, Amerige Court Tract Nos. 17094 & 17097 shall meet the City of Fullerton standards based on the preceding summaries and attached calculations. Please feel free to contact Jim Smith (949) 458-5454 or Katrina Tabirara (949) 462-3810 at your earliest convenience regarding any questions or comments regarding this analysis.

JS:kt:hb
Enclosures
xc: Bill Harris, H&A
W.O. 0344-51
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Appendix

APPENDIX

FIRE HYDRANT FLOW TEST
&
HGL CALCULATIONS

HGL Calculation Based on Hydrant Test on Commonwealth and N. Highland (H31)				
Description	Desired Flow Q_F (gpm)	Dynamic Loss H_F (feet)*	Available HGL_F (feet)**	Test Run
Static	0	0.00	336	1
Peak Hour	246	1.05	335	2
MDD+2,625 gpm FF	2,748	91.65	244	3

* H_F is Static minus Residual (in feet) at Desired Flow

** HGL_F = Test Elevation + Static Pressure - H_F

Hydrant Test Data:

Orifice Dia	**2.5** in.	
Static Pressure	**81** psi	187 feet
Residual Pressure	**71** psi	164 feet
Pitot Reading	**60** psi	
Observed Flow	**1,300** gpm	
Test Elevation	**149** feet	

Affinity Equations:

$$K = \frac{Q_R}{H_R^{\wedge 0.54}}$$

$$H_F = \left(\frac{Q_F}{K}\right)^{\wedge 1.85}$$

- K is Affinity Constant
- Q_R is Test Flow
- Q_F is Desired Flow
- H_R is Static minus Residual (in feet) at Test Flow

Using Flow Test Values:

K = 239

Water Calcs

WATER SYSTEM MODEL RUN DATA

Scenario: Static
Steady State Analysis
H&A Junction Report

Label	Elevation (ft)	Demand (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	149.00	0.00	336.00	80.91
J-2	148.00	0.00	336.00	81.34
J-3	150.00	0.00	336.00	80.47
J-4	152.00	0.00	336.00	79.61
J-5	154.00	0.00	336.00	78.74
J-6	159.00	0.00	336.00	76.58
J-7	158.00	0.00	336.00	77.01
J-8	156.00	0.00	336.00	77.88
J-9	162.00	0.00	336.00	75.28
J-10	160.00	0.00	336.00	76.15
J-11	159.00	0.00	336.00	76.58
J-12	157.00	0.00	336.00	77.44
J-13	155.00	0.00	336.00	78.31
J-14	157.00	0.00	336.00	77.44
J-15	159.00	0.00	336.00	76.58
J-16	149.00	0.00	336.00	80.91
J-17	155.00	0.00	336.00	78.31
J-18	151.00	0.00	336.00	80.04
J-19	152.00	0.00	336.00	79.61
J-20	156.00	0.00	336.00	77.88
J-21	155.00	0.00	336.00	78.31
J-22	153.00	0.00	336.00	79.18
J-23	156.00	0.00	336.00	77.88
J-24	156.00	0.00	336.00	77.88
J-25	158.00	0.00	336.00	77.01
J-26	161.00	0.00	336.00	75.71

Scenario: Peak Hour
Steady State Analysis
H&A Junction Report

Label	Elevation (ft)	Demand (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	149.00	0.00	334.99	80.47
J-2	148.00	0.00	334.99	80.90
J-3	150.00	0.00	334.97	80.03
J-4	152.00	0.00	334.97	79.16
J-5	154.00	0.00	334.97	78.30
J-6	159.00	0.00	334.92	76.11
J-7	158.00	0.00	334.92	76.54
J-8	156.00	0.00	334.92	77.41
J-9	162.00	0.00	334.90	74.81
J-10	160.00	0.00	334.87	75.66
J-11	159.00	0.00	334.86	76.09
J-12	157.00	0.00	334.85	76.95
J-13	155.00	0.00	334.95	77.86
J-14	157.00	0.00	334.93	76.98
J-15	159.00	0.00	334.88	76.09
J-16	149.00	0.00	334.98	80.46
J-17	155.00	0.00	334.96	77.86
J-18	151.00	0.00	334.96	79.59
J-19	152.00	0.00	334.95	79.15
J-20	156.00	0.00	334.92	77.41
J-21	155.00	0.00	334.94	77.85
J-22	153.00	0.00	334.96	78.73
J-23	156.00	15.42	334.94	77.42
J-24	156.00	0.00	334.94	77.42
J-25	158.00	229.66	334.81	76.50
J-26	161.00	0.00	334.91	75.24

Scenario: Peak Hour
Steady State Analysis
H&A Pipe Report

Label	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpm)	Velocity (ft/s)	Upstream HGL (ft)	Downstream HGL (ft)	Headloss Gradient (ft/1000ft)	Pressure Pipe Headloss (ft)
P-5	53.00	12.0	130.0	Open	245.08	0.70	335.00	334.99	0.19	0.01
P-6	145.00	12.0	130.0	Open	90.69	0.26	334.99	334.99	0.03	0.00
P-8	179.00	12.0	130.0	Open	34.84	0.10	334.97	334.97	0.01	0.00
P-9	187.00	12.0	130.0	Open	25.90	0.07	334.97	334.97	0.00	0.00
P-11	187.00	8.0	130.0	Open	-6.22	0.04	334.92	334.92	0.00	0.00
P-12	659.00	4.0	130.0	Open	-8.93	0.23	334.92	334.97	0.09	0.06
P-14	179.00	8.0	130.0	Open	-2.71	0.02	334.92	334.92	0.00	0.00
P-16	270.00	6.0	130.0	Open	32.13	0.36	334.90	334.87	0.13	0.03
P-17	97.00	8.0	130.0	Open	32.13	0.21	334.87	334.86	0.03	0.00
P-19	206.00	8.0	130.0	Open	-113.40	0.72	334.85	334.92	0.32	0.07
P-22	293.00	8.0	130.0	Open	84.13	0.54	334.93	334.88	0.19	0.05
P-23	88.00	8.0	130.0	Open	84.13	0.54	334.88	334.86	0.19	0.02
P-25	298.00	12.0	130.0	Open	90.69	0.26	334.99	334.98	0.03	0.01
P-26	83.00	12.0	130.0	Open	90.69	0.26	334.98	334.97	0.03	0.00
P-27	125.00	6.0	130.0	Open	25.90	0.29	334.97	334.96	0.09	0.01
P-28	533.00	6.0	130.0	Open	25.90	0.29	334.96	334.92	0.09	0.05
P-29	123.00	8.0	130.0	Open	55.85	0.36	334.97	334.96	0.09	0.01
P-30	132.00	8.0	130.0	Open	55.85	0.36	334.96	334.95	0.09	0.01
P-31	403.00	8.0	130.0	Open	55.85	0.36	334.95	334.92	0.09	0.04
P-32	83.00	8.0	130.0	Open	-54.84	0.35	334.92	334.92	0.08	0.01
P-33	197.00	8.0	130.0	Open	-54.84	0.35	334.92	334.94	0.08	0.02
P-34	101.00	8.0	130.0	Open	-54.84	0.35	334.94	334.95	0.08	0.01
P-35	191.00	12.0	130.0	Open	-154.39	0.44	334.95	334.96	0.08	0.02
P-36	323.00	12.0	130.0	Open	-154.39	0.44	334.96	334.99	0.08	0.03
P-37	158.00	12.0	130.0	Open	99.55	0.28	334.95	334.94	0.04	0.01
P-38	102.00	12.0	130.0	Open	84.13	0.24	334.94	334.94	0.03	0.00
P-39	238.00	12.0	130.0	Open	84.13	0.24	334.94	334.93	0.03	0.01
P-40	163.00	8.0	130.0	Open	116.26	0.74	334.86	334.81	0.34	0.06
P-41	129.00	8.0	130.0	Open	-113.40	0.72	334.81	334.85	0.32	0.04
P-42	328.00	8.0	130.0	Open	32.13	0.21	334.92	334.91	0.03	0.01
P-43	170.00	8.0	130.0	Open	32.13	0.21	334.91	334.90	0.03	0.01

Scenario: Peak Hour
Steady State Analysis
H&A Reservoir Report

Label	Elevation (ft)	Outflow (gpm)	Calculated Hydraulic Grade (ft)
R-1	335.00	245.08	335.00

Scenario: MDD + 2,625 gpm FF
Steady State Analysis
H&A Junction Report

Label	Elevation (ft)	Demand (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
J-1	149.00	0.00	243.13	40.72
J-2	148.00	0.00	242.73	40.98
J-3	150.00	0.00	241.68	39.67
J-4	152.00	0.00	241.60	38.76
J-5	154.00	0.00	241.55	37.88
J-6	159.00	0.00	236.29	33.44
J-7	158.00	0.00	236.39	33.92
J-8	156.00	0.00	236.41	34.79
J-9	162.00	0.00	234.17	31.23
J-10	160.00	1,312.00	229.52	30.08
J-11	159.00	0.00	230.86	31.09
J-12	157.00	1,313.00	230.72	31.90
J-13	155.00	0.00	239.63	36.62
J-14	157.00	0.00	238.28	35.17
J-15	159.00	0.00	232.57	31.83
J-16	149.00	0.00	241.91	40.20
J-17	155.00	0.00	240.55	37.01
J-18	151.00	0.00	240.70	38.81
J-19	152.00	0.00	239.64	37.92
J-20	156.00	0.00	237.11	35.09
J-21	155.00	0.00	238.78	36.25
J-22	153.00	0.00	240.93	38.04
J-23	156.00	7.71	239.20	36.00
J-24	156.00	0.00	238.92	35.88
J-25	158.00	114.83	230.74	31.47
J-26	161.00	0.00	234.90	31.97

Scenario: MDD + 2,625 gpm FF
Steady State Analysis
H&A Pipe Report

Label	Length (ft)	Diameter (in)	Hazen-Williams C	Control Status	Discharge (gpm)	Velocity (ft/s)	Upstream HGL (ft)	Downstream HGL (ft)	Headloss Gradient (ft/1000ft)	Pressure Pipe Headloss (ft)
P-5	53.00	12.0	130.0	Open	2,747.54	7.79	244.00	243.13	16.48	0.87
P-6	145.00	12.0	130.0	Open	1,044.12	2.96	243.13	242.73	2.75	0.40
P-8	179.00	12.0	130.0	Open	403.07	1.14	241.68	241.60	0.47	0.08
P-9	187.00	12.0	130.0	Open	300.35	0.85	241.60	241.55	0.27	0.05
P-11	187.00	8.0	130.0	Open	-154.22	0.98	236.29	236.39	0.57	0.11
P-12	659.00	4.0	130.0	Open	-102.72	2.62	236.39	241.60	7.90	5.20
P-14	179.00	8.0	130.0	Open	51.50	0.33	236.41	236.39	0.08	0.01
P-16	270.00	6.0	130.0	Open	454.57	5.16	234.17	229.52	17.22	4.65
P-17	97.00	8.0	130.0	Open	-857.43	5.47	229.52	230.86	13.74	1.33
P-19	206.00	8.0	130.0	Open	-1,249.77	7.98	230.72	236.41	27.60	5.69
P-22	293.00	8.0	130.0	Open	1,035.49	6.61	238.28	232.57	19.48	5.71
P-23	88.00	8.0	130.0	Open	1,035.49	6.61	232.57	230.86	19.48	1.71
P-25	298.00	12.0	130.0	Open	1,044.12	2.96	242.73	241.91	2.75	0.82
P-26	83.00	12.0	130.0	Open	1,044.12	2.96	241.91	241.68	2.75	0.23
P-27	125.00	6.0	130.0	Open	300.35	3.41	241.55	240.55	7.99	1.00
P-28	533.00	6.0	130.0	Open	300.35	3.41	240.55	236.29	7.99	4.26
P-29	123.00	8.0	130.0	Open	641.05	4.09	241.68	240.70	8.02	0.99
P-30	132.00	8.0	130.0	Open	641.05	4.09	240.70	239.64	8.02	1.06
P-31	403.00	8.0	130.0	Open	641.05	4.09	239.64	236.41	8.02	3.23
P-32	83.00	8.0	130.0	Open	-660.21	4.21	236.41	237.11	8.47	0.70
P-33	197.00	8.0	130.0	Open	-660.21	4.21	237.11	238.78	8.47	1.67
P-34	101.00	8.0	130.0	Open	-660.21	4.21	238.78	239.63	8.47	0.86
P-35	191.00	12.0	130.0	Open	-1,703.42	4.83	239.63	240.93	6.80	1.30
P-36	323.00	12.0	130.0	Open	-1,703.42	4.83	240.93	243.13	6.80	2.20
P-37	158.00	12.0	130.0	Open	1,043.20	2.96	239.63	239.20	2.74	0.43
P-38	102.00	12.0	130.0	Open	1,035.49	2.94	239.20	238.92	2.70	0.28
P-39	238.00	12.0	130.0	Open	1,035.49	2.94	238.92	238.28	2.70	0.64
P-40	163.00	8.0	130.0	Open	178.06	1.14	230.86	230.74	0.75	0.12
P-41	129.00	8.0	130.0	Open	63.23	0.40	230.74	230.72	0.11	0.01
P-42	328.00	8.0	130.0	Open	454.57	2.90	236.29	234.90	4.24	1.39
P-43	170.00	8.0	130.0	Open	454.57	2.90	234.90	234.17	4.24	0.72

Scenario: MDD + 2,625 gpm FF
Steady State Analysis
H&A Reservoir Report

Label	Elevation (ft)	Outflow (gpm)	Calculated Hydraulic Grade (ft)
R-1	244.00	2,747.54	244.00