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December 3, 2019

State of New Mexico
Energy, Minerals, & Natural Resources Department
Mining & Minerals Division
Abandoned Mine Land Program
Wendell Chino Building
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Attn: Yeny Maestas

RE: Madrid Stormwater & Erosion Safety Project, Task Order #2
Evaluation of Existing Fire Suppression System and Proposed Changes

Weston Solutions, Inc. (Weston) reviewed record documents provided by the New Mexico Energy, Minerals, & Natural Resources Department (EMNRD) Mining & Minerals Division (MMD) Abandoned Mine Land (AML) Program for the Madrid, New Mexico fire suppression system and water pressure requirements of the Santa Fe Fire Department (SFFD) Fire Code. Weston's review and hydraulic analysis consisted of verifying findings published in the 2016 Preliminary Engineering Report (PER) prepared by Occam Engineers, Inc. (Occam) and investigating the potential risks of increasing the system pressures by relocating the water storage tank and increasing its storage capacity.

Based on the provided information, an EPANET hydraulic pipe network model was developed for system simulation of the Madrid fire suppression system water main. The system water pressure simulations were evaluated based on the current and proposed water tank location to assess the minimum flow and pressure requirements as well as the potential increases in delivered and static water pressures. A calculation summary package is provided as Attachment 1.

The proposed new water tank and new water main locations used for the EPANET model were taken from the PER. Other tank locations and pipeline alignments may be pursued without significantly affecting the results of Weston's hydraulic analysis as long as the overall water main pipeline length and the proposed maximum water surface elevation in the water storage tank are not significantly changed. Potential effects include:

- A significantly shorter water main pipeline will have less pressure loss due to friction, which will result in higher system pressures while the system is flowing.
- A significantly longer water main pipeline will have more pressure loss due to friction, which will result in lower system pressures while the system is flowing.
- A significantly higher maximum water surface elevation in the water storage tank will increase the hydrostatic pressure head on the system, which will result in higher system pressures while the system is flowing or static.
- A significantly lower maximum water surface elevation in the water storage tank will reduce the hydrostatic pressure head on the system, which will result in lower system pressures while the system is flowing and static.

The SFFD Fire Code defers to the International Code Council's (ICC) International Fire Code (IFC) for guidance regarding fire systems. The IFC does not provide minimum fire flow requirements, however the National Fire Protection Association's (NFPA) codes and standards for hydrant's general requirements do provide minimum standards. The requirements set forth in NFPA 1, Uniform Fire Code, states hydrant systems should be capable of supplying 1,000 gallon per minute (gpm) while maintaining a positive pressure of 20 pounds per square inch (psi).

Additionally, the Insurance Services Office (ISO) provides fire flow requirements based on the spacing between 1- and 2-story dwellings. For dwellings spaced 11 to 30 feet apart (which several homes in Madrid satisfy) a minimum flow rate of 1,000 gpm must be maintained for 1 hour. For larger non-sprinklered residential and commercial buildings, the minimum requirement is 1,000 gpm at 20 psi for 2 hours.

The PER states the hydrant at the lowest elevation in the fire system at the time of the report could not provide the required 1,000 gpm as stated in NFPA 1. It should be noted the system pressure was over 20 psi at the tested hydrant. Weston's EPANET model of the existing conditions system was in general agreement with the PER in that the system has sufficient pressure but cannot meet the minimum flow rate or duration requirements.

To deliver the required fire flow rate using only gravity flow, the water storage tank supplying the system will need to be larger. A new water storage tank with a capacity of at least 120,000 gallons (gal), and placed at least 39 feet higher in elevation than the existing tank will be required to deliver at least 1,000 gpm for 2 hours at a pressure of at least 20 psi.

The maximum calculated pressure for the existing and proposed system was 57 and 78 psi, respectively. Since maximum operating pressures for industry standard 8-inch PVC pressure pipe ranges from 93 to 160 psi (see Attachment 1), an increase in maximum system pressure to 78 psi should not result in adverse effects to the Madrid fire suppression system infrastructure.

If you have any questions regarding this analysis, please contact me at (505) 837-6524 or email me at sonny.cooper@westonsolutions.com.

DAVID J. COOPER
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PROFESSIONAL ENGINEER
12/3/19

Respectfully,
Weston Solutions, Inc.

David Cooper

David "Sonny" Cooper, P.E.
Project Manager

Attachments: ATTACHMENT 1 – Evaluation of Existing and Proposed Conditions of the Fire Suppression System

WESTON SOLUTIONS

CALCULATION COVER SHEET

PROJECT:	JOB NO.	CALC NO.	SHEET
Task Order 2 – Evaluation of Existing Fire Suppression System and Conceptual Designs for the Madrid Stormwater & Erosion Safety Project	15740.001.002	1	1 of 13

SUBJECT:	DISCIPLINE (Civil, Mech. Process, Elect.):
Evaluation of Existing and Proposed Conditions of the Fire Suppression System	Civil

PREPARED BY:	DATE:
Andrew Brenner, E.I.	December 3, 2019

CALCULATION STATUS	ISSUED FOR REVIEW	FINAL	CONFIRMED	SUPERSEDED	VOIDED
	☐	☒	☐	☐	☐

COMPUTER PROGRAMS USED:	☒ Yes ☐ No	DESCRIPTION/ VERSION: EPANET 2 and AutoCAD Civil 3D 2019

REFERENCE SPECIFICATIONS:	REFERENCE DRAWINGS:
City of Santa Fe Code Chapter XII, County of Santa Fe Ordinance 2018-8, International Fire Code, Uniform Fire Code	Fire Protection Improvements

SOURCES OF DATA:

City of Santa Fe. Chapter XII – Fire Prevention and Protection. Municode. October 2019.

County of Santa Fe. Ordinance No. 2018-8. December 2018.

International Code Council, Inc. 2015 International Fire Code. May 2014.

National Fire Protection Association. NFPA 1, Uniform Fire Code. August 2018.

Insurance Services Office, Inc. (ISO), *Guide for Determination of Needed Fire Flow*. 2014

Occam Engineers Inc. *Preliminary Engineering Report for the Community of Madrid, Santa Fe County, Fire Suppression System*. August 2016.

R.D. Barber, Consulting Engineer. *Fire Protection Improvements*, Santa Fe County, Fire Department, Madrid, New Mexico. 1998.

Santa Fe County Resolution No. 2012-88, *A Resolution Approving and Adopting Customer Service Policies for Water Customers of the Santa Fe County Water Utilities*, July 10, 2012

SUMMARY OF RESULTS:

The Madrid, New Mexico fire suppression water system needs to upgrade the current water storage tank to at least 120,000 gallons, and at a higher elevation to deliver at least 1,000 gallons per minute at 20 pounds per square inch for at least 2 hours from any of the fire hydrants on the system (See Section 7 for details).

RECORD OF REVISIONS

NO.	REASON FOR REVISION	TOTAL NO. OF SHEETS	LAST SHEET NO.	BY	CHECKED	APPROVED/ ACCEPTED	DATE
0	Issued for Review	12	12	AFB	DJC	--	11/22/2019
1	Final	13	13	AFB	DJC	DJC	12/3/2019

1. Objective

This calculation summary documents the hydraulic evaluation of the existing and proposed conditions of the fire suppression system in Madrid, New Mexico. The purpose of the evaluation is to estimate the current water pressures on the system and the change in pressures if a new water tank is installed.

2. Background

The New Mexico Energy, Minerals, & Natural Resources Department (EMNRD) Mining & Minerals Division (MMD) Abandoned Mine Land (AML) Program contracted Weston Solutions, Inc. (Weston) to evaluate the current and proposed changes to the Madrid fire suppression system using EPANET software. The AML Program is working with the community of Madrid to determine the potential need and location of a new water storage tank for fire suppression purposes. As-built record drawings of the current system (R.D. Barber, 1998) and the *Preliminary Engineering Report (PER) for the Community of Madrid, Santa Fe County, Fire Suppression System* (Occam, 2016) were provided to Weston by the AML Program.

The PER states the current system has an average pressure of 28 pounds per square inch (psi) at the fire hydrants. The hydrant with the lowest elevation has a maximum flow rate of 800 gallons per minute (gpm). A rate of 1,000 gpm at a pressure of 20 psi for two hours is required for the fire system to meet standards set forth in the Uniform Fire Code (Occam 2016). See Figure 1 for a system layout map (Figure 6 from the Occam 2016 PER).

3. Design Conditions

The County of Santa Fe and City of Santa Fe Fire Departments reference the International Code Council (ICC) International Fire Code (IFC). The IFC does not outline pressure requirements for hydrants, however the National Fire Protection Association (NFPA) codes do. NFPA 1, Uniform Fire Code, Section A.31.3.4.3.1 states that hydrant systems should be capable of supplying 1,000 gpm while maintaining a positive pressure of 20 psi.

The Insurance Services Office (ISO) flow rate requirements are determined by the spacing between 1- and 2-story dwellings. For dwellings spaced 11 to 30 feet apart (which several homes in Madrid satisfy) a minimum flow rate of 1,000 gpm must be maintained for 1 hour. For larger non-sprinklered residential and commercial buildings, the minimum requirement is 1,000 gpm at 20 psi for 2 hours.

4. Method of Calculation

- Develop current and proposed fire suppression water system models using EPANET 2.0 software developed by the U.S. Environmental Protection Agency (EPA) Water Supply and Water Resources Division.
- Evaluate the system pressures under existing conditions and proposed conditions for a 2-hour duration using a demand of 1,000 gpm for each fire hydrant.

- Determine if the existing and proposed system satisfies the requirements for 1,000 gpm at 20 psi for 2 hours.

5. Data and Assumptions

- The as-built record drawings do not provide geographic coordinates of the pipe network, therefore the pipe layouts in the EPANET model and the figures provided below were approximated and are meant to be schematic for this analysis. However, the pipe lengths and system components were taken from the as-built record drawings to accurately model the hydraulics of the system.
- The as-built record drawings do not provide pipe invert elevations, therefore all elevations were assumed be the ground surface elevation minus 4 feet.
- Ground surface elevations were based on digital elevation model (DEM) data provided by the AML Program.
- The proposed new water tank and water main location along NM-14 used for the EPANET model was taken from the PER (OCCAM 2016).
- Existing water storage tank volume: 100,000 gallons (gal)
- Proposed water storage tank volume (from PER): 125,000 gal
- Maximum demand for each fire hydrant: 1,000 gpm
- It was assumed that only one hydrant would be operated at a time for the analysis (a flow of 1,000 gpm will not be required by multiple hydrants simultaneously).
- Fire system main pipe size: 8-inch (in)
- Fire system branch pipe size: 6 in
- All pipes were modeled as SDR-26 polyvinyl chloride (PVC)
- Hazen-Williams Roughness Coefficient (C): 130 for PVC pipe, weathered
- Fittings and valves of the existing pipe network are unknown, therefore minor losses were not incorporated into the analysis.
- Pressure in the system was assumed to be from gravity only. Other means of increasing pressure in the system, such as pumps, were not included in this model.
- All fire hydrants modeled used the same numbering convention from the provided PER (Occam 2016).
- Hydrant 7, located at the fire station, is not connected to the current system. It is connected to a water tank at the fire station (Occam 2016).

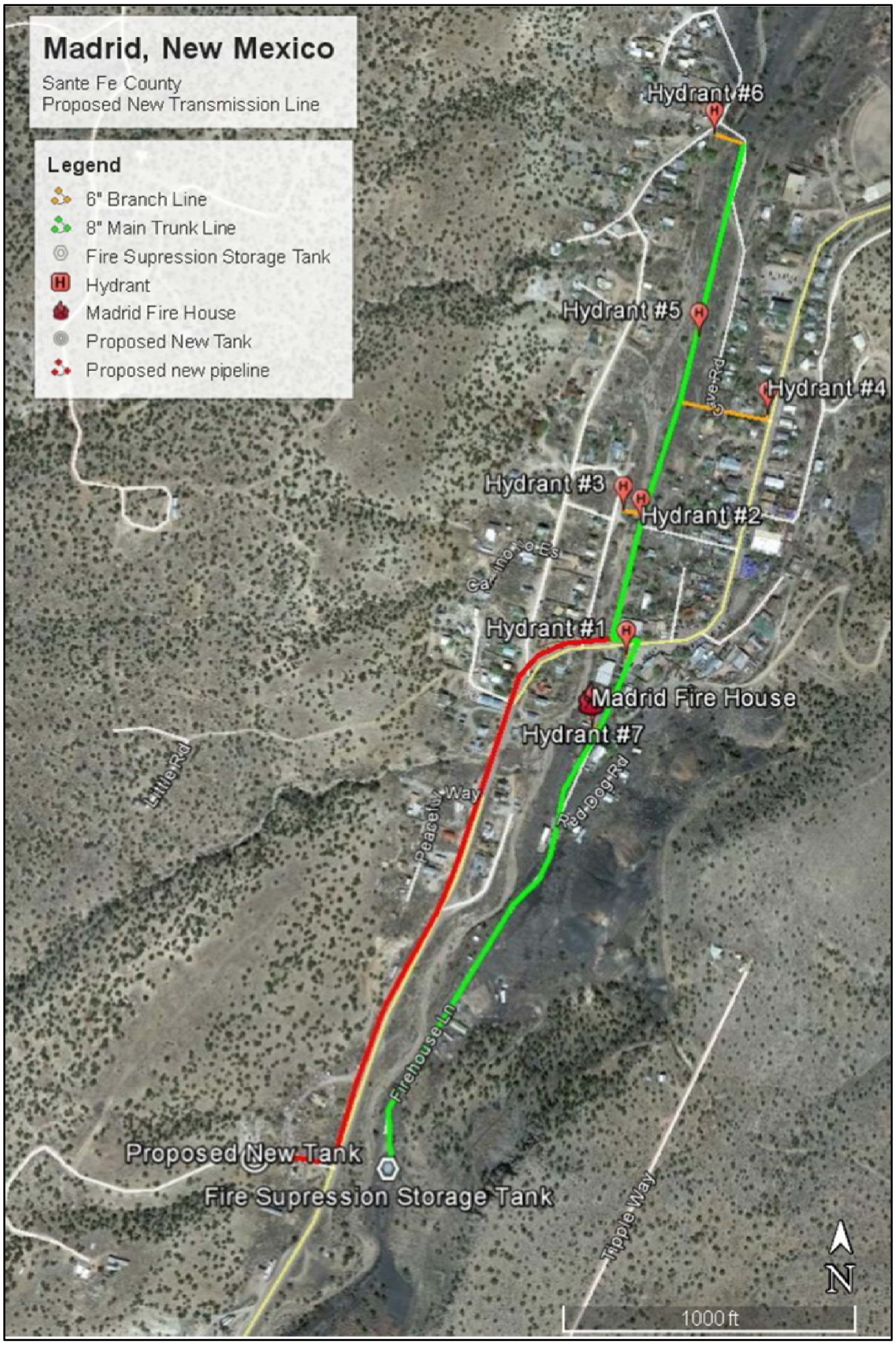

Figure 1: Layout of the Existing Fire Suppression system in Madrid, NM. (Figure 6 from Occam, 2016)

6. Calculation & Analysis

AutoCAD Civil3D 2019 (AutoCAD) was used to develop a layout of both the current and proposed system conditions and to estimate pipe network elevations using a digital elevation model (DEM) provided by the AML Program. The current system was drawn as described by the as-built drawings and the proposed system was approximated based on the layout from the PER (Occam 2016).

Figure 2 below illustrates the current fire suppression system pipe network and hydrant locations.

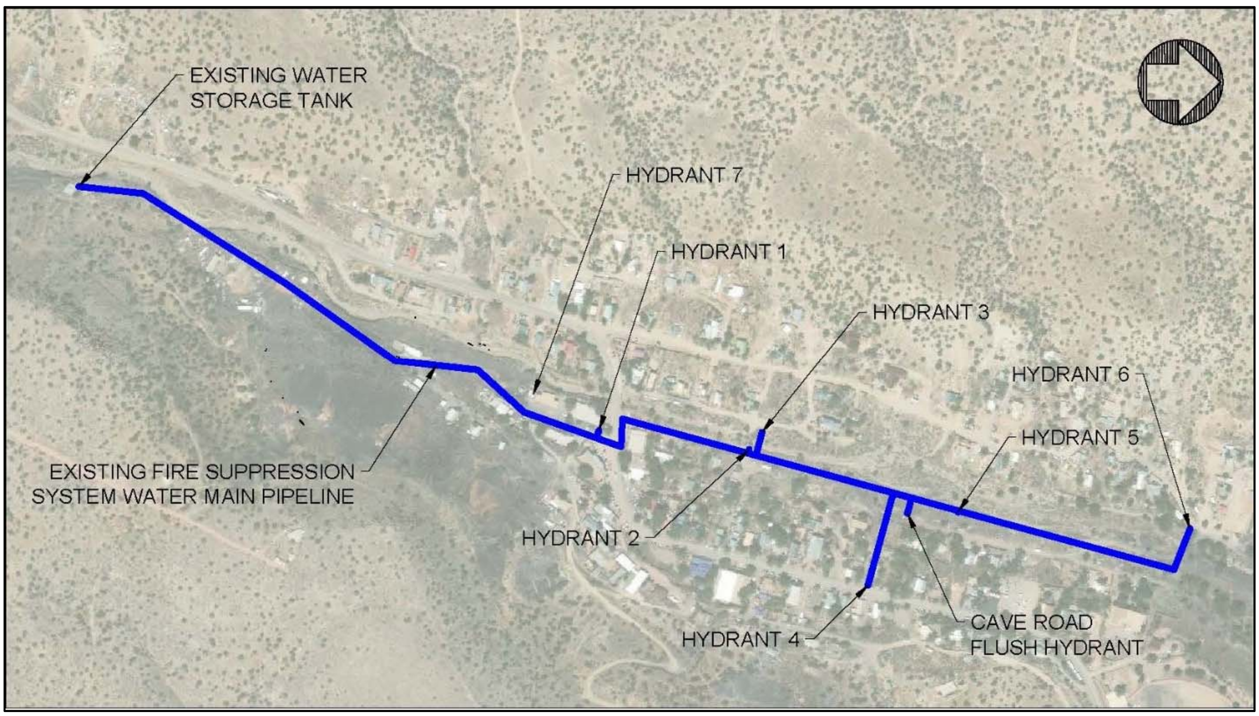

Figure 2: Current System Layout Overlain on Aerial Image in AutoCAD Civil 3D

Figure 3 below is a screenshot from EPANET of the existing system network corresponding to the layout in Figure 2.

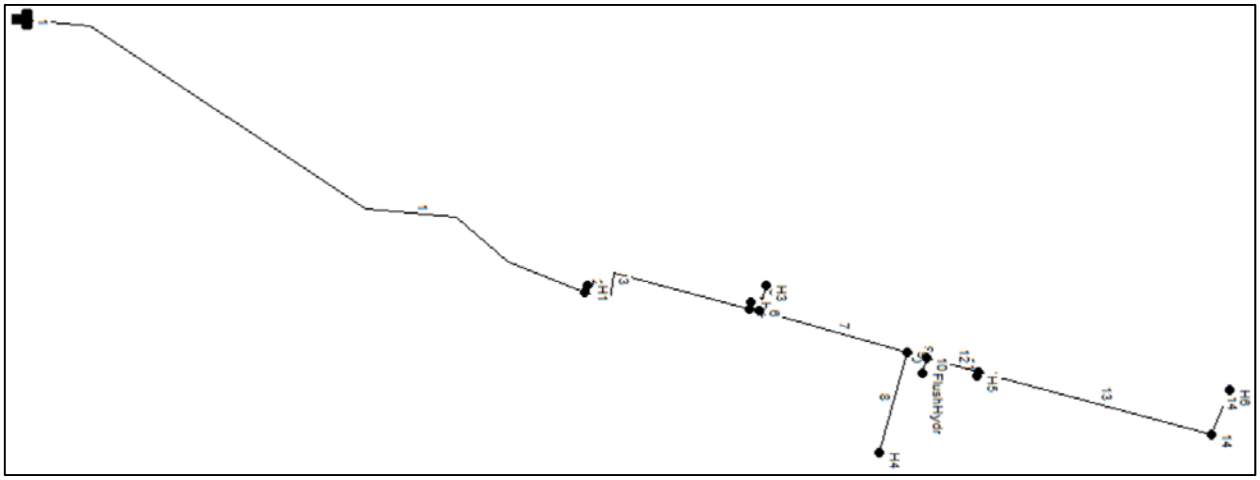

Figure 3: Current System Layout as Viewed in EPANET

The proposed system, as set forth in the PER states the new 8-inch PVC main will tie into the existing system where NM-14 crosses Madrid Arroyo on the west bank of the arroyo. The existing main would be cut and capped south of Hydrant 1. Figure 4 below illustrates that proposed layout.

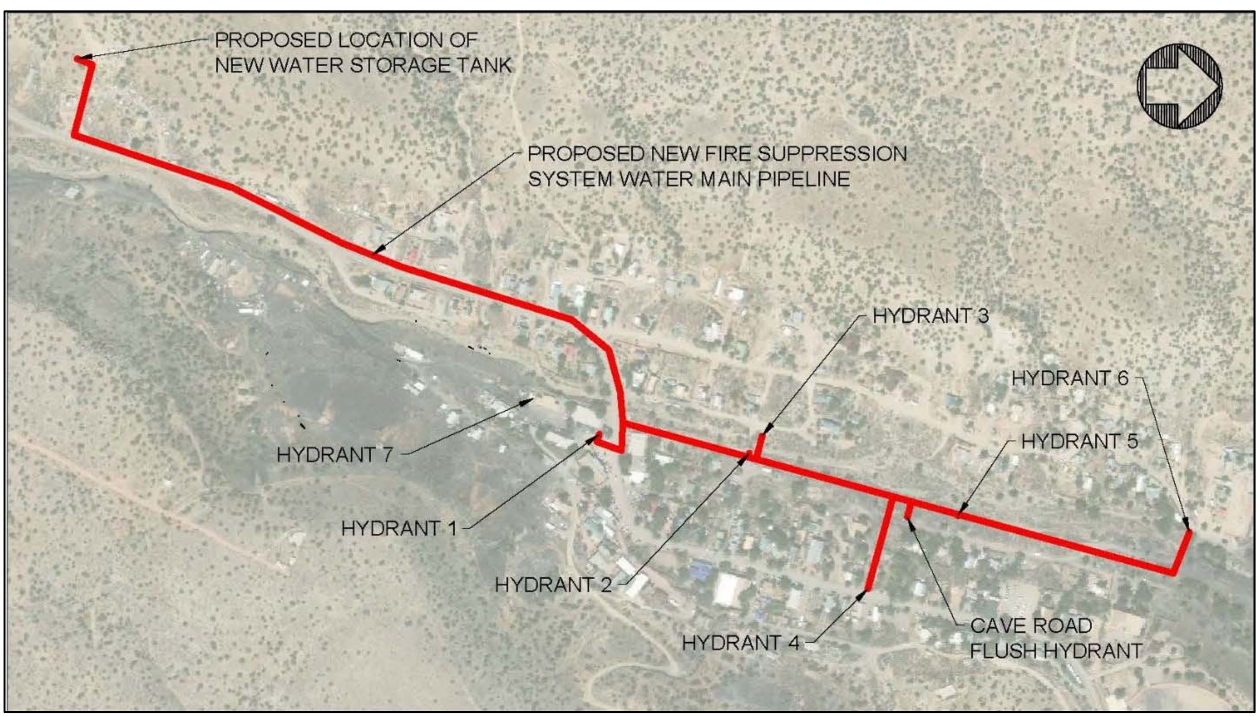

Figure 4: Proposed System Layout Overlain on Aerial Image in AutoCAD Civil 3D

Figure 5 below is a screen shot of the EPANET model of the proposed pipe network.

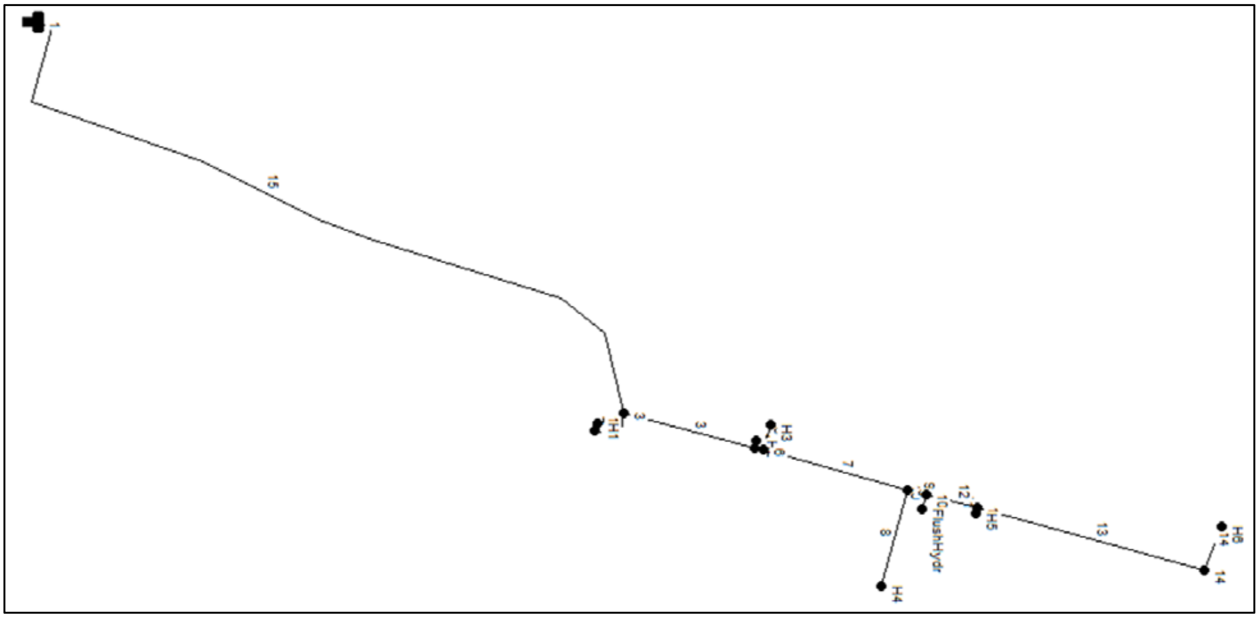

Figure 5: Proposed System Layout as Viewed in EPANET

The input elevations and pipe lengths into EPANET for both the existing and proposed system layouts are provided in Figures 6 and 7, respectively.

Network Table - Nodes

Node ID	Elevation ft
Junc 2	6021.95
Junc H1	6026.27
Junc 4	6009.21
Junc H2	6014
Junc 6	6007.88
Junc H3	6016.05
Junc H4	6003.99
Junc 9	5994.01
Junc 10	5991.93
Junc FlushHydr	5991.84
Junc 12	5986.49
Junc H5	5990.81
Junc 14	5969.05
Junc H6	5972.7
Tank 1	6086.59

Network Table - Links

Link ID	Length ft	Diameter in	Roughness
Pipe 1	2024	8	130
Pipe 2	10	6	130
Pipe 3	582.5	8	130
Pipe 4	10	6	130
Pipe 5	26.25	8	130
Pipe 6	92	6	130
Pipe 7	433.5	8	130
Pipe 8	340	6	130
Pipe 9	64	8	130
Pipe 10	50	6	130
Pipe 11	10	6	130
Pipe 12	152.71	8	130
Pipe 13	747.02	8	130
Pipe 14	129.77	8	130

Figure 6: EPANET Input Values – Existing System

Network Table - Nodes

Node ID	Elevation ft
Junc 2	6021.95
Junc H1	6026.27
Junc 4	6009.21
Junc H2	6014
Junc 6	6007.88
Junc H3	6016.05
Junc H4	6003.99
Junc 9	5994.01
Junc 10	5991.93
Junc FlushHydr	5991.84
Junc 12	5986.49
Junc H5	5990.81
Junc 14	5969.05
Junc H6	5972.7
Junc 3	6022.04
Tank 1	6126.09

Network Table - Links

Link ID	Length ft	Diameter in	Roughness
Pipe 2	10	6	130
Pipe 4	10	6	130
Pipe 5	26.25	8	130
Pipe 6	92	6	130
Pipe 7	433.5	8	130
Pipe 8	340	6	130
Pipe 9	64	8	130
Pipe 10	50	6	130
Pipe 11	10	6	130
Pipe 12	152.71	8	130
Pipe 13	747.02	8	130
Pipe 14	129.77	8	130
Pipe 1	131.57	8	130
Pipe 3	450.93	8	130
Pipe 15	2347.69	8	130

Figure 7: EPANET Input Values – Proposed System

EPANET uses the Hazen-Williams equation to calculate pipe velocities and employs the conservation of flow in an iterative process to hydraulically balance a pipe network model. The Hazen-Williams equation is as follows:

$$V = kCR^{0.63}S^{0.54}$$

V = velocity
k = conversion factor (1.318 for US customary units)
C = roughness coefficient
R = hydraulic radius
S = slope of the energy line

The PER recommends a 125,000 gallon water storage tank, which would provide the needed volume for 1,000 gpm for 2 hours. This sized tank was modeled at the elevation of the propose tank location to determine if such a configuration would provide the minimum flow requirements.

Flow demands were calculated at Hydrant 1 and Hydrant 6, the highest and lowest hydrants in the system, respectively. The minimum flow of 1,000 gpm was calculated, as well as lower flow rates if 1,000 gpm could not be achieved. Additionally, the static pressure scenarios were calculated for both the existing and proposed system layouts.

7. Results and Conclusions

The evaluation of the existing system agrees with the PER in that the existing 100,000 gallon water storage tank cannot provide the minimum water volume (120,000 gallons). The system can provide 1,000 gpm for at least an hour, but not at a pressure of at least 20 psi. See Figures 8 and 9 below for the model results of this run for Hydrants 1 and 6, respectively.

Network Table - Nodes at 1:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6054.82	14.24	0.00
Junc H1	1000.00	6054.07	12.05	0.00
Junc 4	0.00	6054.82	19.76	0.00
Junc H2	0.00	6054.82	17.69	0.00
Junc 6	0.00	6054.82	20.34	0.00
Junc H3	0.00	6054.82	16.80	0.00
Junc H4	0.00	6054.82	22.02	0.00
Junc 9	0.00	6054.82	26.35	0.00
Junc 10	0.00	6054.82	27.25	0.00
Junc FlushHydr	0.00	6054.82	27.29	0.00
Junc 12	0.00	6054.82	29.61	0.00
Junc H5	0.00	6054.82	27.73	0.00
Junc 14	0.00	6054.82	37.16	0.00
Junc H6	0.00	6054.82	35.58	0.00
Tank 1	-1000.03	6091.79	2.25	0.00

Figure 8: EPANET Results – Existing System at 1,000 gpm for 2 hours – Hydrant 1

Network Table - Nodes at 1:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6054.82	14.24	0.00
Junc H1	0.00	6054.82	12.37	0.00
Junc 4	0.00	6044.18	15.15	0.00
Junc H2	0.00	6044.18	13.08	0.00
Junc 6	0.00	6043.70	15.52	0.00
Junc H3	0.00	6043.70	11.98	0.00
Junc H4	0.00	6035.78	13.77	0.00
Junc 9	0.00	6035.78	18.10	0.00
Junc 10	0.00	6034.61	18.49	0.00
Junc FlushHydr	0.00	6034.61	18.53	0.00
Junc 12	0.00	6031.82	19.64	0.00
Junc H5	0.00	6031.82	17.77	0.00
Junc 14	0.00	6018.17	21.29	0.00
Junc H6	1000.00	6015.80	18.68	0.00
Tank 1	-1000.02	6091.79	2.25	0.00

Figure 9: EPANET Results – Existing System at 1,000 gpm for 2 hours – Hydrant 6

The existing system is capable of delivering approximately 735 gpm for 2 hours, but only the lower hydrants would achieve pressures greater than 20 psi. See Figures 10 and 11 below for the model results of this run for Hydrants 1 and 6, respectively.

Network Table - Nodes at 2:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6067.22	19.61	0.00
Junc H1	735.00	6066.80	17.56	0.00
Junc 4	0.00	6067.22	25.13	0.00
Junc H2	0.00	6067.22	23.06	0.00
Junc 6	0.00	6067.22	25.71	0.00
Junc H3	0.00	6067.22	22.17	0.00
Junc H4	0.00	6067.22	27.40	0.00
Junc 9	0.00	6067.22	31.72	0.00
Junc 10	0.00	6067.22	32.62	0.00
Junc FlushHydr	0.00	6067.22	32.66	0.00
Junc 12	0.00	6067.22	34.98	0.00
Junc H5	0.00	6067.22	33.11	0.00
Junc 14	0.00	6067.22	42.54	0.00
Junc H6	0.00	6067.22	40.95	0.00
Tank 1	-735.02	6088.12	0.66	0.00

Figure 10: EPANET Results – Existing System at 735 gpm for 2 hours – Hydrant 1

Network Table - Nodes at 2:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6067.22	19.61	0.00
Junc H1	0.00	6067.22	17.74	0.00
Junc 4	0.00	6061.20	22.53	0.00
Junc H2	0.00	6061.20	20.45	0.00
Junc 6	0.00	6060.93	22.99	0.00
Junc H3	0.00	6060.93	19.45	0.00
Junc H4	0.00	6056.45	22.73	0.00
Junc 9	0.00	6056.45	27.06	0.00
Junc 10	0.00	6055.79	27.67	0.00
Junc FlushHydr	0.00	6055.79	27.71	0.00
Junc 12	0.00	6054.21	29.34	0.00
Junc H5	0.00	6054.21	27.47	0.00
Junc 14	0.00	6046.50	33.56	0.00
Junc H6	735.00	6045.16	31.40	0.00
Tank 1	-735.03	6088.12	0.66	0.00

Figure 11: EPANET Results – Existing System at 735 gpm for 2 hours – Hydrant 6

The proposed system includes a 125,000 gallon water storage tank at an elevation approximately 39 feet higher than the current water storage tank. A 30-foot diameter, 24 foot tall round tank was used in the EPANET model. Figures 12 and 13 provide the output results of 1,000 gpm at 2 hours for Hydrants 1 and 6, respectively.

Network Table - Nodes at 2:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6082.11	26.07	0.00
Junc H1	1000.00	6081.37	23.87	0.00
Junc 4	0.00	6084.51	32.63	0.00
Junc H2	0.00	6084.51	30.55	0.00
Junc 6	0.00	6084.51	33.20	0.00
Junc H3	0.00	6084.51	29.66	0.00
Junc H4	0.00	6084.51	34.89	0.00
Junc 9	0.00	6084.51	39.21	0.00
Junc 10	0.00	6084.51	40.12	0.00
Junc FlushHydr	0.00	6084.51	40.15	0.00
Junc 12	0.00	6084.51	42.47	0.00
Junc H5	0.00	6084.51	40.60	0.00
Junc 14	0.00	6084.51	50.03	0.00
Junc H6	0.00	6084.51	48.45	0.00
Junc 3	0.00	6084.51	27.07	0.00
Tank 1	-1000.02	6127.40	0.57	0.00

Figure 12: EPANET Results – Proposed System at 1,000 gpm for 2 hours – Hydrant 1

Network Table - Nodes at 2:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6084.51	27.11	0.00
Junc H1	0.00	6084.51	25.24	0.00
Junc 4	0.00	6076.27	29.06	0.00
Junc H2	0.00	6076.27	26.98	0.00
Junc 6	0.00	6075.79	29.43	0.00
Junc H3	0.00	6075.79	25.89	0.00
Junc H4	0.00	6067.87	27.68	0.00
Junc 9	0.00	6067.87	32.01	0.00
Junc 10	0.00	6066.71	32.40	0.00
Junc FlushHydr	0.00	6066.71	32.44	0.00
Junc 12	0.00	6063.92	33.55	0.00
Junc H5	0.00	6063.92	31.68	0.00
Junc 14	0.00	6050.27	35.19	0.00
Junc H6	1000.00	6047.90	32.58	0.00
Junc 3	0.00	6084.51	27.07	0.00
Tank 1	-1000.03	6127.40	0.57	0.00

Figure 13: EPANET Results – Proposed System at 1,000 gpm for 2 hours – Hydrant 6

The last set of calculations were for the static pressure condition where no flow demands are present in the system and the water storage tank is full, exerting the maximum hydrostatic pressure on the pipe network. Figures 14 and 15 provide the output results of this scenario for the existing and proposed system, respectively.

Network Table - Nodes at 0:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6099.59	33.64	0.00
Junc H1	0.00	6099.59	31.77	0.00
Junc 4	0.00	6099.59	39.16	0.00
Junc H2	0.00	6099.59	37.09	0.00
Junc 6	0.00	6099.59	39.74	0.00
Junc H3	0.00	6099.59	36.20	0.00
Junc H4	0.00	6099.59	41.42	0.00
Junc 9	0.00	6099.59	45.75	0.00
Junc 10	0.00	6099.59	46.65	0.00
Junc FlushHydr	0.00	6099.59	46.69	0.00
Junc 12	0.00	6099.59	49.01	0.00
Junc H5	0.00	6099.59	47.13	0.00
Junc 14	0.00	6099.59	56.56	0.00
Junc H6	0.00	6099.59	54.98	0.00
Tank 1	-0.02	6099.59	5.63	0.00

Figure 14: EPANET Results – Existing System under Static Conditions

Network Table - Nodes at 2:00 Hrs

Node ID	Demand GPM	Head ft	Pressure psi	Quality
Junc 2	0.00	6150.09	55.52	0.00
Junc H1	0.00	6150.09	53.65	0.00
Junc 4	0.00	6150.09	61.04	0.00
Junc H2	0.00	6150.09	58.97	0.00
Junc 6	0.00	6150.09	61.62	0.00
Junc H3	0.00	6150.09	58.08	0.00
Junc H4	0.00	6150.09	63.31	0.00
Junc 9	0.00	6150.09	67.63	0.00
Junc 10	0.00	6150.09	68.53	0.00
Junc FlushHydr	0.00	6150.09	68.57	0.00
Junc 12	0.00	6150.09	70.89	0.00
Junc H5	0.00	6150.09	69.02	0.00
Junc 14	0.00	6150.09	78.44	0.00
Junc H6	0.00	6150.09	76.86	0.00
Junc 3	0.00	6150.09	55.48	0.00
Tank 1	-0.01	6150.09	10.40	0.00

Figure 15: EPANET Results – Proposed System under Static Conditions

It can be seen from the proposed water storage tank scenario that EPANET is calculating 1,000 gpm at greater than 20 psi for both hydrants for the entire 2-hour duration. The maximum pressures calculated for the existing and proposed systems were approximately 57 and 78 psi, respectively. Both occurred at Junction 14, the lowest point in the system (near the north end of Madrid Arroyo), for the static conditions scenario.

It is known that a portion of the system was repaired with 8-inch SDR-26 PVC pipe, which per ASTM D 2241, has a pressure rating of 160 psi. Per ASTM D 2466-06, 8-inch Schedule 40 PVC pipe has a maximum operating pressure of 93 psi. The typical recommended operating pressure for residential use is 40 to 60 psi, with pressure reducing valves recommended for pressures above 80 psi. Additionally, Section 8.2.A of Santa Fe County Resolution Number 2012-88, the Santa Fe County Water Utility shall deliver water pressure to service connections at 30 to 130 psi under “normal circumstances” (Santa Fe County, 2012). Based on this information, and assuming that the fire suppression system is constructed of PVC pressure pipe and fittings or other industry standard materials, an increase in system pressure to 78 psi is within normal water system pressure ranges, and should not result in adverse effects to the Madrid fire suppression system infrastructure.

The results of this analysis suggest that the current 100,000 gallon water storage tank in Madrid, NM is not sufficient to provide the volume and pressures to satisfy the minimum fire flow requirements. The results suggest that a new water storage tank with a volume of at least 120,000 gallons, and at least 39 feet higher in elevation than the existing water storage tank, will provide the minimum flow and pressure requirements for the currently installed fire hydrants in Madrid, NM.

8. References

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