AGENDA
City of Lucas
City Council Hydraulic Modeling Workshop
September 30, 2021
6:00 PM
City Hall Council Chambers
and by Live Streaming Video
665 Country Club Road – Lucas, Texas

Notice is hereby given that a workshop meeting of the Lucas City Council will be held on Thursday, September 30, 2021, beginning at 6:00 pm at Lucas City Hall, 665 Country Club Road, Lucas, Texas at which time the following agenda will be discussed, but no official business will be transacted during this meeting.

If you would like to watch the meeting live, go to the City's live streaming link at https://www.lucastexas.us/live-streaming-videos/. This meeting will not be offered through Zoom.

Call to Order

- Roll Call
- Determination of Quorum
- Reminder to turn off or silence cell phones
- Pledge of Allegiance

Regular Agenda

1. Presentation by Birkhoff, Hendricks & Carter LLP regarding the hydraulic model of the City's existing water distribution system and discuss the 2020 Lucas Water Master Plan.

2. Adjournment.

Certification

I do hereby certify that the above notice was posted in accordance with the Texas Open Meetings Act on the bulletin board at Lucas City Hall, 665 Country Club Road, Lucas, Texas and on the City's website at www.lucastexas.us on or before 5:00 p.m. on September 23, 2021.

Stacy Henderson, City Secretary

In compliance with the American with Disabilities Act, the City of Lucas will provide for reasonable accommodations for persons attending public meetings at City Hall. Requests for accommodations or interpretive services should be directed to City Secretary Stacy Henderson at 972.912.1211 or by email at shenderson@lucastexas.us at least 48 hours prior to the meeting.

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS

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MATT HICKEY, P.E.
ANDREW MATA, JR., P.E.

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CRAIG M. KERKHOFF, P.E.
JUSTIN R. IVY, P.E.
JULIAN T. LE, P.E.
COOPER E. REINBOLD, P.E.

September 22, 2021

Ms. Joni Clarke
City Manager
City of Lucas, Texas
665 Country Club Road
Lucas, TX 75002

Re: Existing System Hydraulic Modeling Report

Dear Ms. Clarke:

In accordance with the engineering services agreement with the City of Lucas dated November 4, 2020, Birkhoff, Hendricks & Carter, LLP (BHC) has prepared a fully functional hydraulic model of the City of Lucas existing water distribution system. Utilizing this model and water system data provided by the City, BHC has evaluated the water distribution immediate needs.

This letter report presents a summary of hydraulic model methodology, data provided by the City and used in the model, and the existing system immediate needs evaluation and recommendations.

EXISTING HYDRAULIC MODEL DEVELOPMENT AND RESOURCES

Existing System Pipe Network

The existing system hydraulic model pipe network was created from existing water system mapping provided by the city. Water pipe sizes, configuration and connectivity were applied the Collin County Parcel Map which form basis of the pipe network. Pipe lengths are determined from this network. Pipe friction factors were applied to the hydraulic model utilizing normal industry standards. The pipe network was originally intended to only include pipe sizes 8-inchs and larger. However, once BHC started the modeling process, it became apparent that smaller pipes must be included to complete the pipe network. We believe all know water lines in the City's water distribution system are included in the hydraulic model.

They hydraulic system node elevations were determined from 2-foot contours secured by BHC from the North Central Texas Council of Governments DFW Map Service Center.

Existing System Pressure Planes

The City of Lucas existing water system is reported to operate using two separate and distinct pressure planes. The City referred to these pressure plans as the "High Pressure Zone" and "Low Pressure Zone". For this hydraulic study, BHC refers to these pressure plans as:

792 Service Area (High Zone)

723 Service Area (Low Zone)

The City reported these zones were at one time "interconnected" with a series of pressure regulating valves, with the 792 Service Area providing water supply across the pressure boundary divide through these devices when system demands and pressures required. Through our review and several interviews with current City Staff, it was reported these pressure regulating valves are inoperable and that the two service areas are completely separated using a series of closed valves along the pressure boundary divide. The existing system hydraulic map that accompanies this report shows the now current service area (pressure) boundary divide as reported by the city and utilized by BHC in the existing system hydraulic model. The existing system hydraulic model is configured so that the 792 and 723 Service Areas operate separate and distinct.

Pump Station and Ground Storage Reservoirs

Pump Station locations and layout including ground storage tank capacities and levels, were determined from available record drawings of the McGarity Pump and new North Pump Station. Existing pump sizes and pump performance curves were obtained using submittal data for the North Pump Station; and name plate data from the pumps at the McGarity Pump Station. BHC performed field verification of the pump station configuration and pump data. The pump station hydraulic model schematics and information are detailed on the Existing System Hydraulic Map and summarized in Table 1 below:

Table 1 – Existing System Pump Station and Ground Storage Capacities

McGarity Pump Station (792 Service Area)

Pump Bulding One (old)		
	Pump 1	1,100 gpm at 160 TDH
	Pump 2	1,100 pgm at 160 TDH
Pump Building Two (newer)		
	Pump 1	750 gpm @ 190 TDH
	Pump 2	750 gpm @ 190 TDH
	Pump 3	750 gpm @ 190 TDH
Ground Storage Reservoirs		
	GSR 1	200,000 gallons
	GSR2	350,000 gallons

North Pump Station (723 Service Area)

Pump Building One (old)		
	Pump 1	900 pgm at 200 TDH
	Pump 2	900 pgm at 200 TDH
	Pump 3	900 pgm at 200 TDH
Pump Building Two (new)		
	Pump 1	900 pgm at 200 TDH
	Pump 2	900 pgm at 200 TDH
	Pump 3	900 pgm at 200 TDH
	Pump 4	900 pgm at 200 TDH
	Pump 5	900 pgm at 200 TDH
Ground Storage Reserviors		
	GSR 1	500,000 gallons
	GSR2	750,000 gallons

Elevated Storage Tanks

The city was not able to provide any construction record data for either of the two existing elevated storage tanks in the system. To include these critical infrastructure elements in the hydraulic model, we relied on information obtained from a previous water system master plan report prepared by Freese and Nichols dated April 10, 2006. The existing system hydraulic model includes these two elevated tanks configured as shown in Table 2 below:

Table 2 – Existing System Elevated Storage Tanks

McGarity Elevated Tank (792 Service Area)

Capacity	300,000 gallons
High Water Level	792 MSL
Head Range	32.5 Feet

Winningkoff Elevated Tank (723 Service Area)

Capacity	300,000 gallons
High Water Level	723 MSL
Head Range	32.0 Feet

Existing System Hydraulic Demands

To determine the existing system hydraulic demands for the maximum day, maximum hour and minimum hour conditions, and the development of a 72-hour diurnal demand curve for use in the model, the City of Lucas was expected to provide the following data for the months of January, July, and August 2019 (or 2020 if available):

i. Hourly Pumping Records at both the McGarity and North Pump Station
ii. Hourly Elevated Storage Tank Levels (McGarity and Winningkoff)
iii. Hourly Ground Storage Tank Levels (McGarity and North Pump Station)
iv. NTMWD Water Supply Meter Data (McGarity and North Pump Station)
v. Wholesale customer meters and any unique water demand customers known within the distribution system
vi. Water customer monthly retail billing records

The due to reported SCADA system problems, the city was not able to provide any of the data listed above, other than item vi. monthly retail billing records. Therefore, to develop the existing water system hydraulic model demands, BHC used the monthly billing data and developed unit demands as outlined in Tables 3 through 7 below. These demands are utilized in the existing system hydraulic model.

Again, because the City was not able to provide the necessary data for a complete existing system demand evaluation, the 72-hour diurnal demand curve developed by BHC for the City of Parker was utilized for the existing system hydraulic model as shown in Figure 1.

Table 3 – City of Lucas Monthly Water Billing Record Summary

3a-Lucas Monthly Billing Records Summary

Month and Year	Residential (GAL)	Commercial (GAL)	Total Consumption (GAL)	Residential (MG)	Commercial (MG)	Total Consumption (MG)
July 2018	71,485,300	3,209,600	74,694,900	71.49	3.21	74.69
August 2018	82,320,000	4,283,000	86,603,000	82.32	4.28	86.60
January 2019	20,667,400	1,525,600	22,193,000	20.67	1.53	22.19
July 2019	44,223,900	1,820,800	46,044,700	44.22	1.82	46.04
August 2019	91,004,000	4,331,800	95,335,800	91.00	4.33	95.34

Note: Assumes raw data
is per 100 gallons

3b-Max Day per Capita

Month and Year	Monthly Residential (GAL)	Average Day Residential (GAL)	Max Day Residential Demands (GAL)*	Estimated 2019 Population	Max Day per Capita Rate (gpcd)
July 2018	71,485,300	2,305,977	5,764,944	8,067	715
August 2018	82,320,000	2,655,484	6,638,710	8,067	823
July 2019	44,223,900	1,426,577	3,566,444	8,067	442
August 2019	91,004,000	2,935,613	7,339,032	8,067	910

*Used Max Daily Demand Factor of 2.5

3c -Avg Day per Capita

Month and Year	Monthly Residential (GAL)	Average Day Residential (GAL)	Estimated 2019 Population	Avg Day per Capita Rate (gpcd)
January 2019	20,667,400	666,690	8,067	83

3d-Population Calculation

# of Residential Meters (2019)	Meter to Population Factor	Estimated Population
2569	3.14	8,067

Table 4 – Existing System Unit Demands

CITY OF LUCAS EXISTING DEMAND RATES

Land Use	Residential		Non-Residential		
	Max Day Per Capita g.p.c.d.	Max Hour Per Capita g.p.c.d.	Max Day Per Acre g.p.a.d.	Max Hour Per Acre g.p.a.d.	Peak Factor
Single Family Residential - Rural	495	891			1.80
Single Family Residential - Estate	495	891			
Single Family Residential - Low Density	495	891			
Single Family Residential - High Density	495	891			
Estate Development District	495	891			
Manufactured Housing	495	891			
Commercial			1,500	2,700	
Village Center			1,500	2,700	
Public/Semi-Public			1,500	2,700	
Park/Open Space			0	0	

Table 5 – Water Distribution Existing System Model Demands

CITY OF LUCAS
2020 WATER DISTRIBUTION SYSTEM SUMMARY

Land Use	Residential			Non-Residential			Total Demand	
	Population	Max Day Demand (MGD)	Max Hour Demand (MGD)	Area (Ac)	Max Day Demand (MGD)	Max Hour Demand (MGD)	Max Day Demand (MGD)	Max Hour Demand (MGD)
Single Family Residential - Rural	5,268	2.608	4.694				2.608	4.694
Single Family Residential - Estate	1,317	0.652	1.173				0.652	1.173
Single Family Residential - Low Density	1,372	0.679	1.222				0.679	1.222
Single Family Residential - High Density	0	0.000	0.000				0.000	0.000
Estate Development District	60	0.030	0.053				0.030	0.053
Manufactured Housing	50	0.025	0.045				0.025	0.045
Residential Totals	**8,067**						**3.993**	**7.188**
Commercial				164.94	0.247	0.445	0.247	0.445
Village Center				11.16	0.017	0.030	0.017	0.030
Public/Semi-Public				27.95	0.042	0.075	0.042	0.075
Park/Open Space				403.73	0.000	0.000	0.000	0.000
Non-Residential Totals				**607.78**			**0.306**	**0.551**
Totals							**4.299**	**7.739**

Min Hour Demand (MGD): 2.322

Table 6 – 723 Service Area Existing System Model Demands

CITY OF LUCAS
2020 723 SERVICE AREA SUMMARY

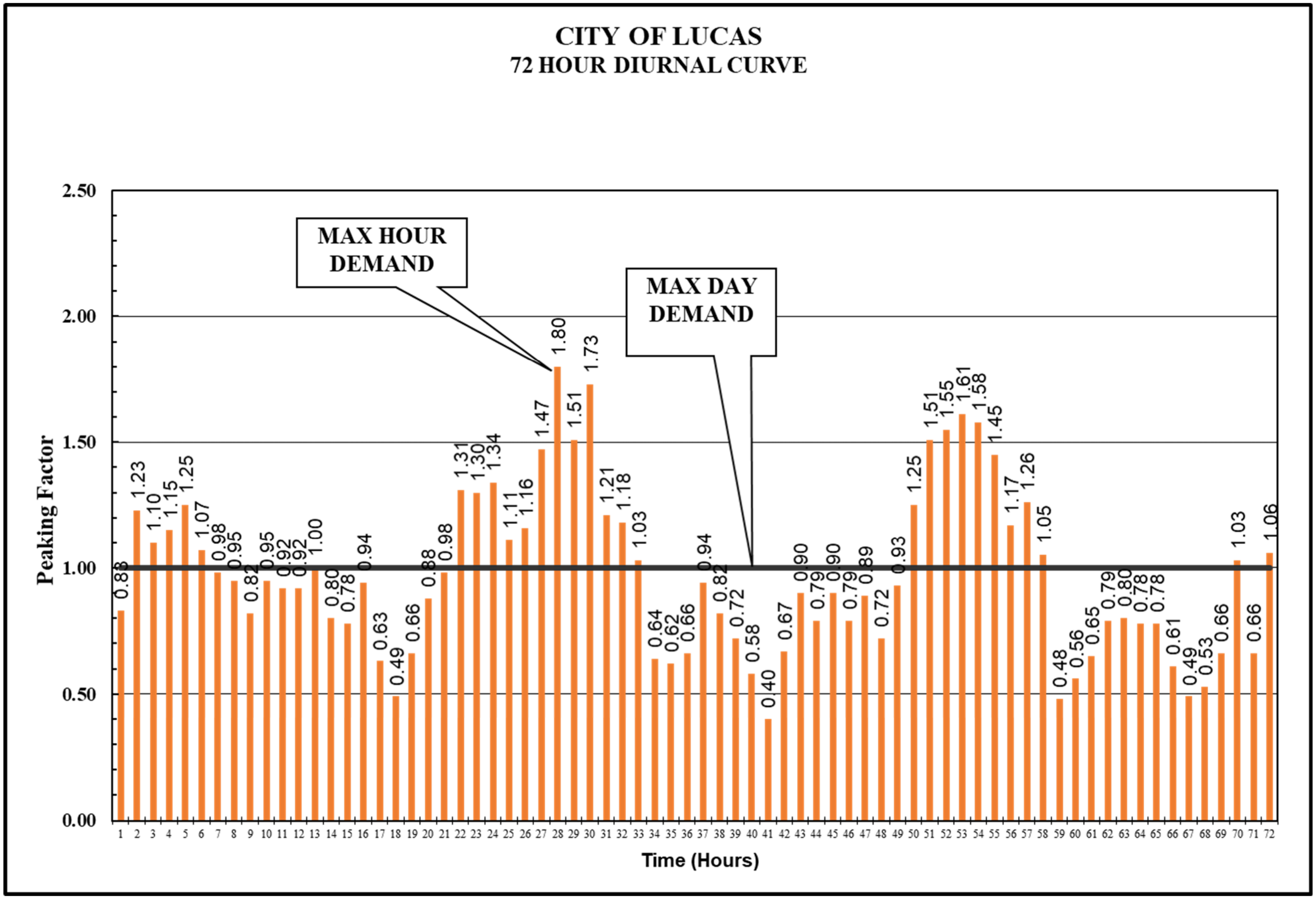
Land Use	Residential			Non-Residential			Total Demand	
	Population	Max Day Demand (MGD)	Max Hour Demand (MGD)	Area (Ac)	Max Day Demand (MGD)	Max Hour Demand (MGD)	Max Day Demand (MGD)	Max Hour Demand (MGD)
Single Family Residential - Rural	3,972	1.966	3.539				1.966	3.539
Single Family Residential - Estate	563	0.279	0.502				0.279	0.502
Single Family Residential - Low Density	771	0.382	0.687				0.382	0.687
Single Family Residential - High Density	-	0.000	0.000				0.000	0.000
Estate Development District	-	0.000	0.000				0.000	0.000
Manufactured Housing	50	0.025	0.045				0.025	0.045
Commercial				32.21	0.048	0.087	0.048	0.087
Village Center				0.00	0.000	0.000	0.000	0.000
Public/Semi-Public				10.94	0.016	0.030	0.016	0.030
Park/Open Space				403.73	0.000	0.000	0.000	0.000
Totals	**5,356**	**2.651**	**4.772**	**446.89**	**0.065**	**0.117**	**2.716**	**4.889**

Table 7 -792 Service Area Existing System Model Demands

CITY OF LUCAS
2020 792 SERVICE AREA SUMMARY

Land Use	Residential			Non-Residential			Total Demand	
	Population	Max Day Demand (MGD)	Max Hour Demand (MGD)	Area (Ac)	Max Day Demand (MGD)	Max Hour Demand (MGD)	Max Day Demand (MGD)	Max Hour Demand (MGD)
Single Family Residential - Rural	1,296.00	0.642	1.155				0.642	1.155
Single Family Residential - Estate	754.00	0.373	0.672				0.373	0.672
Single Family Residential - Low Density	601.00	0.297	0.535				0.297	0.535
Single Family Residential - High Density	-	0.000	0.000				0.000	0.000
Estate Development District	60.00	0.030	0.053				0.030	0.053
Manufactured Housing	-	0.000	0.000				0.000	0.000
Commercial				132.73	0.199	0.358	0.199	0.358
Village Center				11.16	0.017	0.030	0.017	0.030
Public/Semi-Public				17.00	0.026	0.046	0.026	0.046
Park/Open Space				0.00	0.000	0.000	0.000	0.000
Totals	**2,711**	**1.342**	**2.416**	**160.89**	**0.241**	**0.434**	**1.583**	**2.850**

Figure 1 – 72 Hour Diurnal Curve



EXISTING SYSTEM HYDRAULIC EVALUATION

1) Low and High Pressure Areas

As described above, the existing water distribution system is believed to be operated in two separate and distinct pressure boundary service areas. The "High Zone" service area has an established high-water level in the existing McGarity Elevated tank of 792 MSL. The "Low Zone" service area has an established high-water level in the existing Winningkoff Elevated Tank pf 723 MSL. The high-water level in the elevated tanks establish the operating pressures within each service area.

a) Existing Service Area Pressure Evaluation (See **Exhibits A and B** attached hereto)

792 Service Area

Based on BHC understanding of the pump operation sequencing at the McGarity Pump Station, we found no particular instance of either high pressure (over 90 psi) or low pressure (under 40 psi) throughout the 72-hour extended period simulation within the 792 Service Area.

723 Service Area

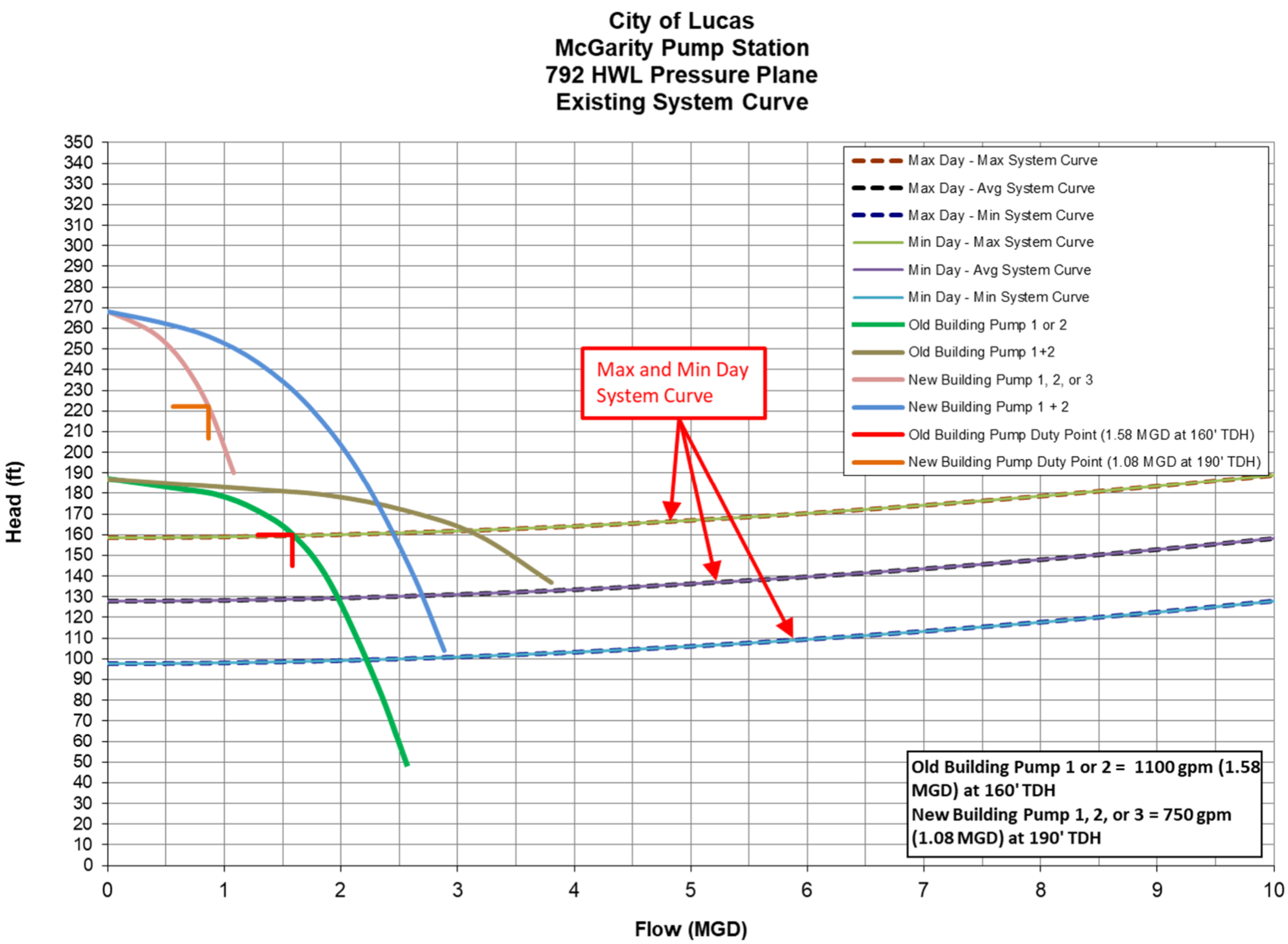
Based on BHC understanding of the pump operation sequencing at the new North Pump Station (we took the old pump station out of service in the hydraulic model), we noted several instances of both high pressure (over 90 psi) and low pressure (under 40 psi) throughout the 72-hour extended period simulation within the 723 Service Area. The low-pressure areas are represented by the red contour lines (40 psi and less) on Exhibit A. The high-pressure areas are represented by the red contour lines (90 psi and over) on Exhibit B.

2) Pump Station System Curves and Pump Performance Curves

Though not a specific scope item for evaluation (and not something we expected to find), during our existing system hydraulic model runs, we continued to get a warning at both the McGarity and North Pump Stations that the pumps are "operating out of range". This means the pump performance curves input into the model are not crossing the hydraulic system curve without being "extended" beyond there normal and designed operating point.

To illustrate the situation, using the existing system hydraulic model, we created a system curve for both the McGarity and North Pump Station, and imposed the existing pump performance curves. **Figure 2** shows the McGarity Pump Station (792 Service Area) pump and system curves, and **Figure 3** shows the North Pump Station (723 Service Area) pump and system curves.

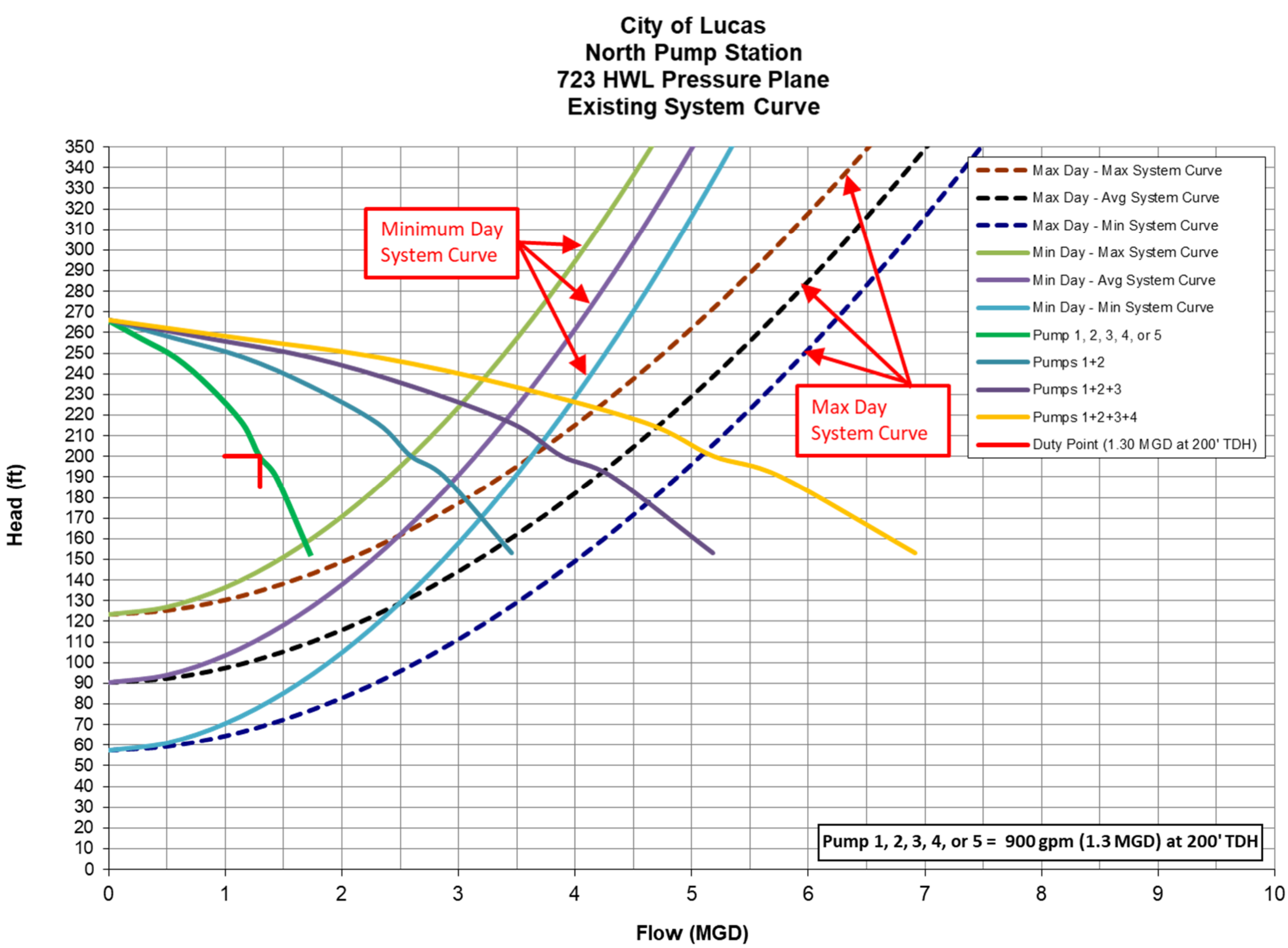
Figure 2 – McGarity Pump Station Existing System Curve



The solid color green line either Pump 1 or Pump 2 on the "Old Pump Building". The red angle mark is the point of desirable operation for the pump(s). Notice the green pump curve crosses the system curve(s) at or near the most efficient operating point. This seems consistent with the City's operators reports that they prefer to use the pumps in the old pump building.

The light brown line represents the pumps in the new pump building. Notice the pump curve does not cross the system curve. This indicates these pumps, when running alone (if that ever occurs) are running "off the curve" or "to far right" on the curve. This condition, if it is occurring, can be the cause of the pumps operating inefficiently, can cause the pumps to cavitate and wear out the impelled quickly, and can cause the motors to pull more amps than designed to do.

Figure 3 – North Pump Station Existing System Curve



The situation is more pronounced at the North Pump Station. Notice the solid green line is barely touching the system curve during the highest head condition (Minimum Hour Demand, EST nearly full). Based on this evaluation, the pumps are most likely not operating at or near its point of best efficiency. As the water distribution system expands and grows (especially in the 723 Service Area), this problem may become more noticeable.

We recommend the City operating staff keep a close watch on the pumps and motors at both pump stations and look for any signs of cavitation or unusually high amp draws.

IMMEDIATE NEEDS RECOMMENDATION

1) Texas Commission on Environmental Quality (TCEQ) Requirements

The TCEQ Chapter 290 Rules and Regulations for Public Water System provides for minimum capacities for water supply, pumping capacity, and total storage capacity (ground storage and elevated storage). These TECQ requirements are the ***minimum*** capacities required for public water systems. These minimums are designed to provide a safe drinking water system. They generally do not consider robust landscape irrigation nor fire flow demands necessary to meet the needs of adequate fire protection. requirements. For that reason, in this hydraulic evaluation, BHC utilizes actual system demands as experienced by the City of Lucas and has provided capacity recommendations that meet the needs of the City's actual patterns of use during a severe test of the system; and provide for strong and reliable fire flow capabilities during extreme system demands.

Tables 8a and 8b below summarizes the City of Lucas existing system capacities in both the 792 and 723 Service Area, provides a comparison to the TCEQ minimum system requirements and BHC's recommendations for water supply and pumping, elevated storage and ground storage capacities.

Table 8a – Existing System Pumping Recommendations

Service Area	Population Served	Estimated Number of Connections	TCEQ Min. Pumping (0.6-gpm/Conn.)	BHC Pumping Recommdation	Total Existing Pumping
723 Service Area	5,356	1,706	1.47 MGD	3.41 MGD	5.20 MGD
792 Service Area	2,711	863	0.75 MGD	1.94 MGD	3.74 MGD
System Totals	**8,067**	**2569**	**2.22 MGD**	**5.35 MGD**	**8.94 MGD**

Table 8b – Existing System Storage Recommendations

Service Area	Population Served	Estimated Number of Connections	TCEQ Min. Volume Elev. Storage	BHC Elevated Storage Recommendation	Total Existing Elev. Storage	BHC Ground Storage Recommendation	Total Existing Ground Storage
723 Service Area	5,356	1,706	0.34 MGD	0.68 MG	0.30 MG	0.85 MG	1.25 MG
792 Service Area	2,711	863	0.17 MGD	0.39 MG	0.30 MG	0.50 MG	0.55 MG
System Totals	**8,067**	**2569**	**0.51 MGD**	**1.07 MG**	**0.60 MG**	**1.35 MG**	**1.80 MG**

2) System Pressures, Service Area Divide, and Elevated Storage Tank Recommendations

a) Phase 1 Existing System Improvements Recommendation

i) Elevated Storage Tank Recommendation

As indicated in Table 8a and 8b, while the 723 Service Area has adequate pumping and ground storage capacities, based on our estimate of service connections in the 723 Service Area, additional elevated storage is recommended. Along with input from City Staff, BHC evaluated several potential elevated storage sites and ran numerous hydraulic model scenarios to determine the best suited site ***hydraulically***. On this basis we recommend a new 0.5 MG elevated storage tank located on the currently owned City of Lucas 0.89-acre, Tract 22 in the Jas Lovejoy Survey Abstract 538 (CAD Parcel ID 1214545). The recommended site is shown on the Existing System Hydraulic Model Map accompanying this report.

While this site provides the best hydraulic solution and can be implemented with minimum immediate changes to the distribution system and pressure boundary divide, two (2) other sites along Stinson Road, south of West Lucas Road were considered and will function adequately in the 723 Service Area. These sites are shown as the 1st and 2nd alternate tank sites on the Existing System Hydraulic Map.

ii) Water Distribution System Improvements

To help "balance" the operation of the recommended 0.5 MG elevated tank with the smaller capacity 0.3 MG Winningkoff elevated tank in this Phase 1 improvements, we recommend the City consider closing the 12-inch water line connection at Estates Parkway to the 12" water line in Country Club Road (Model Pipe P2121) and the 12" water line connection in W. Blondy

Jhune Road to the 12” water line in Country Club Rod (Model Pipe P2117), and creating a new water line loop (proposed pipe P2240).

Phase I system improvements are more specifically shown on **Exhibit C - Phase I Improvements** expected to reduce or eliminate the regions of low and high pressures currently experienced in the 723 Service Area. **Exhibit D – Phase I Improvements Low Pressure Areas and Exhibit E – Phase I Improvements High Pressure Areas** graphically show the anticipated results of these improvements.

Our opinion of probable construction cost for these Phase I system improvements recommendations is in the range of **$4.0 million**. Our itemized opinion of cost is included in the Appendix to this letter report.

b) Phase 2 Existing System Improvements Recommendation
   i) 792/723 Service Area Boundary Adjustment

   While the Phase I improvements address the immediate needs of the existing water distribution system and provide some relief to high- and low-pressure areas, they do not adequately address all the high pressure areas and the new 723 Service Area elevated storage tank is not “balanced” with the existing elevated tank.

   The proposed Phase 2 System Improvements mitigate this situation by adjusting the 792/723 Service Area Boundary Line. The recommended boundary line adjustment and associated water distribution system improvements are shown on Exhibit F -Phase 2 Improvements. The cyan color line is the current Service Area Boundary Line, and the magenta-colored dashed line is the recommended Service Area Boundary location.

   The hydraulic model results with these recommended improvements provide a more consistent and stable pressure gradient across the 723 Service Area throughout the 72-hour extended period simulation and improve the balance between the existing 0.30 MG Winningkoff elevated tank and the proposed 0.5 MG elevated tank.

Our opinion of probable construction cost for the recommended Phase 2 improvements is in the range of $**6.5 million**. Our itemized opinion of cost is included in the Appendix to this letter report.

SUPPLEMENTAL LONG-TERM RECOMMENDATIONS

Our scope of services on this project was to construct an existing system hydraulic model, evaluate the existing system and provide "immediate needs" recommendations. We believe our computer hydraulic model, this report and accompanying existing system hydraulic map accomplished the task. While working through this task, and as we discovered more about your water distribution system, we note other "Supplemental Recommendations" below:

Supplemental Recommendation No. 1

Our scope of services does not include development of a "Water System Master Plan". While the City of Lucas may be at or near its expected build-out condition, a Water System Master Plan is still an important and valuable tool in for planning for future water supply needs and addressing the needs of future developments as they are considered or occur.

Supplemental Recommendation No. 2

During our site visit to the North Pump Station and subsequent discussions with City Staff, we pointed out the need to make sure the North Texas Municipal Water District (NTMWD) is aware of the City's water supply needs and specifically what long-term supply needs are required at each pump station. We were told that the NTMWD "restricts" the flow to the North Pump Station and is a better position to deliver more water to the McGarity Pump Station.

This statement, if true, is counter-intuitive to the apparent pervious planning efforts for the system. The McGarity Pump Station serves a much smaller service area (792) than the North Pump Station; it is appropriately smaller than the North Pump Station, and it has less ground storage capacity than the North Pump Station. The City recently expanded (significantly) the capacity of the North Pump Station apparently to meet the needs of anticipated growth in the 792 Service Area.

If not already in progress, we recommend the City coordinate with the NTMWD and discuss your long-term water supply needs and plans for delivery at each of the two pump stations. If the NTMWD will not (or cannot) deliver the required water supply to the North Pump Station, then another look at the long-term needs of the City's Water Distribution System is in order.

We trust the hydraulic model of the City's existing water distribution system; the accompanying existing system hydraulic model map and this letter report meets your expectations and fulfills our obligations under the terms of our professional services agreement. We are available to discuss this project further at your convenience.

Sincerely,

Gary C. Hendricks, P.E., R.P.L.S.

Attachments/Accompaniments

2020 Existing Water Distribution System Hydraulic Model Map (Full Scale)

Exhibit A – Existing System Low Pressure Area Contour Map

Exhibit B – Existing System High Pressure Area Contour Map

Exhibit C – Phase 1 Recommended System Improvements

Exhibit D – Phase 1 Low Pressure Area Contour Map

Exhibit E– Phase 1 High Pressure Area Contour Map

Exhibit F- Phase 2 Recommended System Improvements

Exhibit G – Phase 2 Low Pressure Area Contour Map

Exhibit H -Phase 2 High Pressure Area Contour Map

Exhibit I – 2020 Water Distribution System
Existing System Hydraulic Model Map (Separate Document)

Appendix

Phase 1 and Phase 2 Itemized Opinion of Probable Cost

City of Lucas
Existing System Hydraulic Model Report

Existing Water Distribution System Hydraulic Map
EXHIBITS A – I

Exhibit A – Existing System Low Pressure Area Contour Map

Exhibit B – Existing System High Pressure Area Contour Map

Exhibit C – Phase 1 Recommended System Improvements

Exhibit D – Phase 1 Low Pressure Area Contour Map

Exhibit E– Phase 1 High Pressure Area Contour Map

Exhibit F- Phase 2 Recommended System Improvements

Exhibit G – Phase 2 Low Pressure Area Contour Map

Exhibit H - Phase 2 High Pressure Area Contour Map

Exhibit I – 2020 Water Distribution System Existing System Hydraulic Model Map (Separate Document)

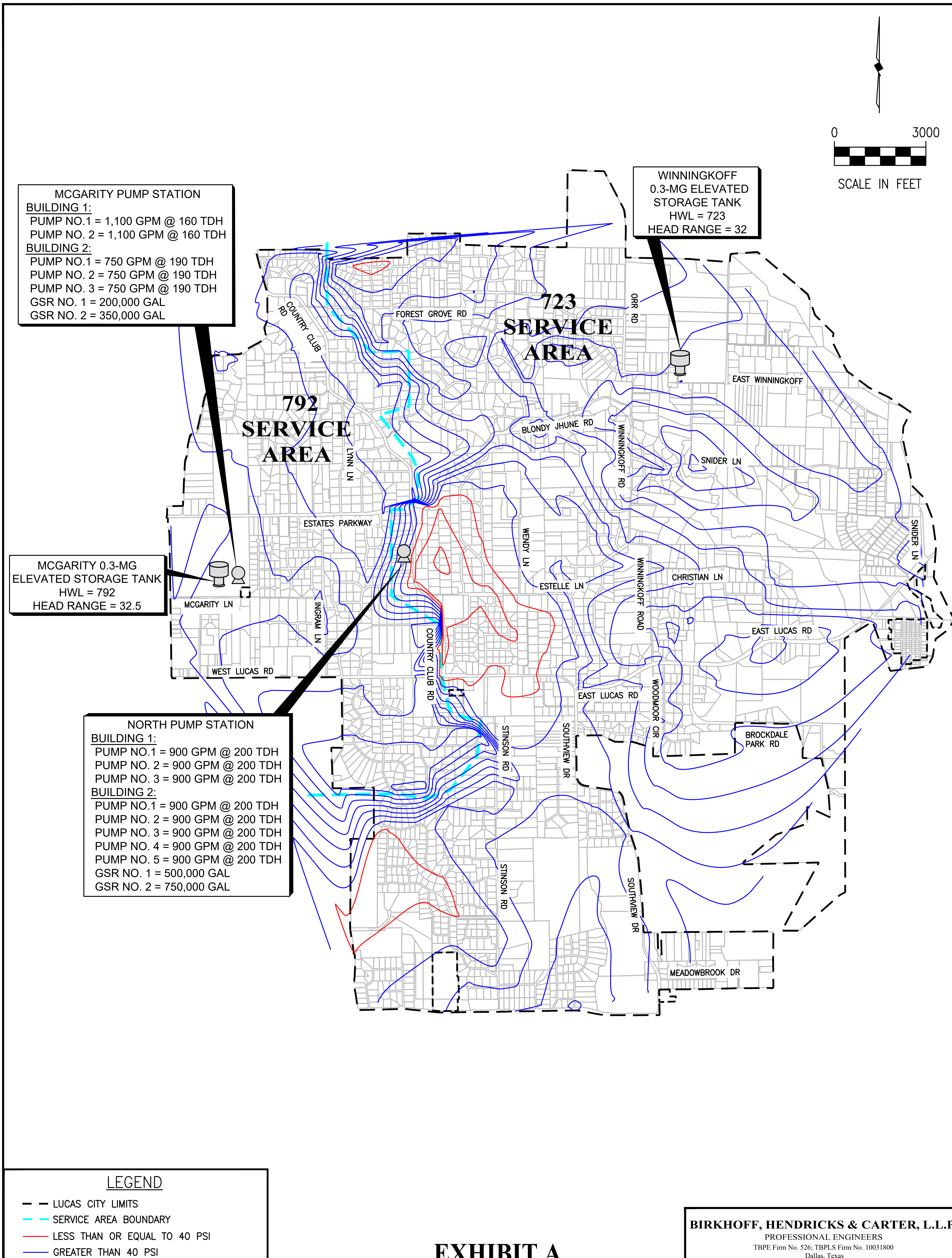


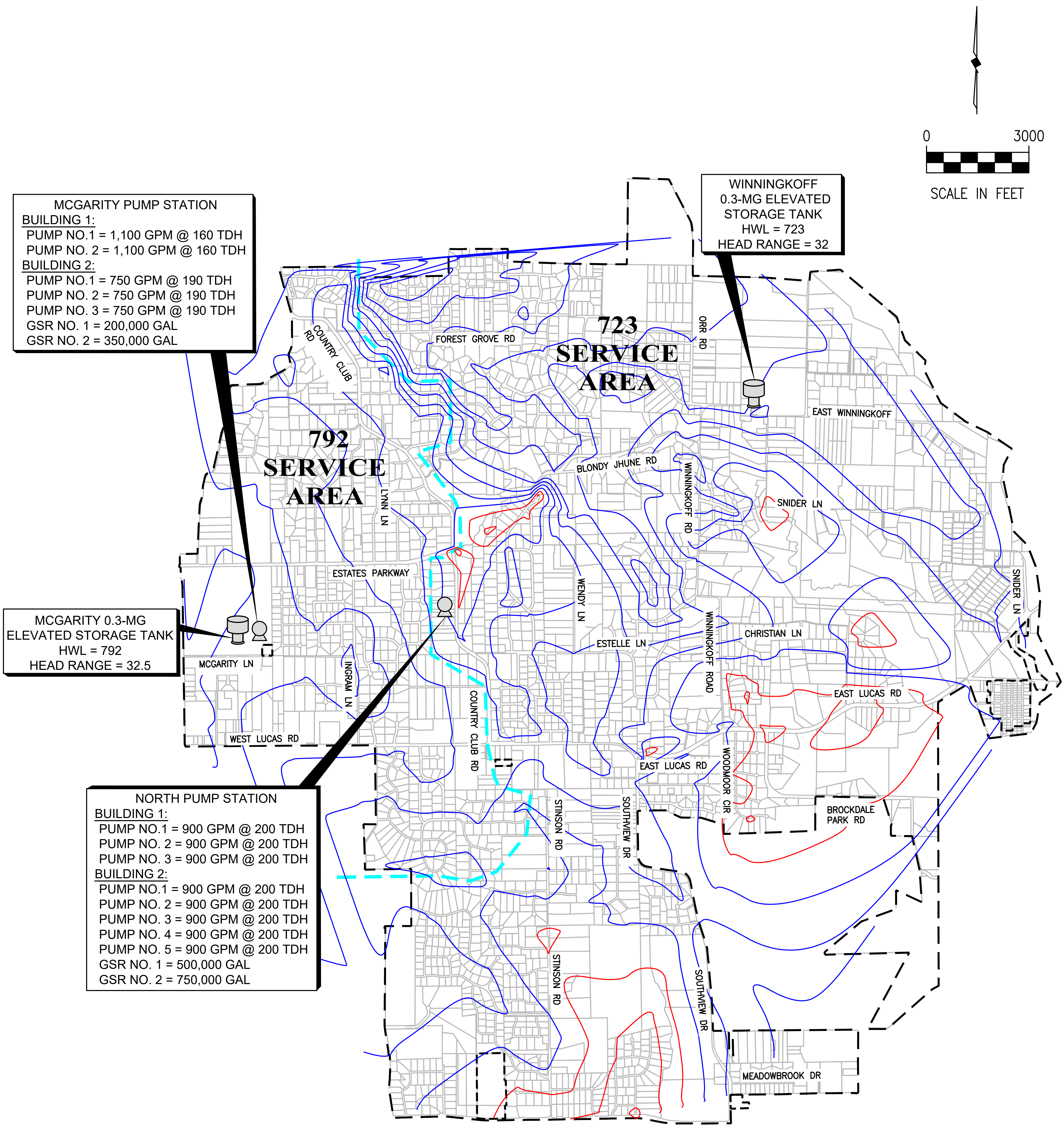
EXHIBIT A

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

Lucas

EXISTING WATER DISTRIBUTION SYSTEM
BASED ON EXISTING MAXIMUM DAY DEMANDS
LOW PRESSURE AREAS

JUNE 2021



LEGEND

- LUCAS CITY LIMITS
- SERVICE AREA BOUNDARY
- GREATER THAN OR EQUAL TO 90 PSI
- LESS THAN 90 PSI

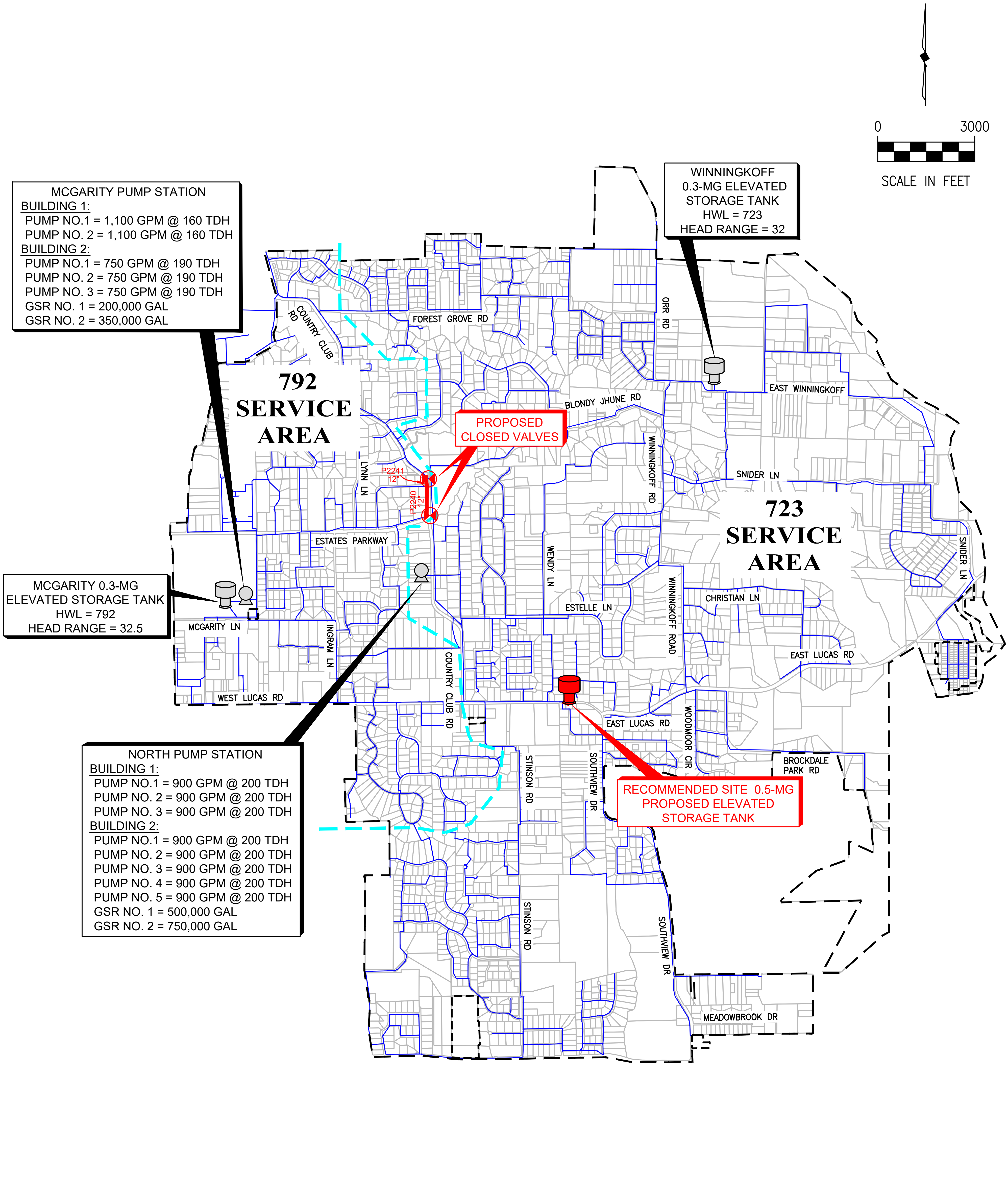
EXHIBIT B

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

Lucas

EXISTING WATER DISTRIBUTION SYSTEM BASED ON EXISTING MAXIMUM DAY DEMANDS HIGH PRESSURE AREAS

JUNE 2021



LEGEND

- LUCAS CITY LIMITS
- EXISTING WATER LINE
- PROPOSED WATER LINE
- PROPOSED CLOSED VALVE

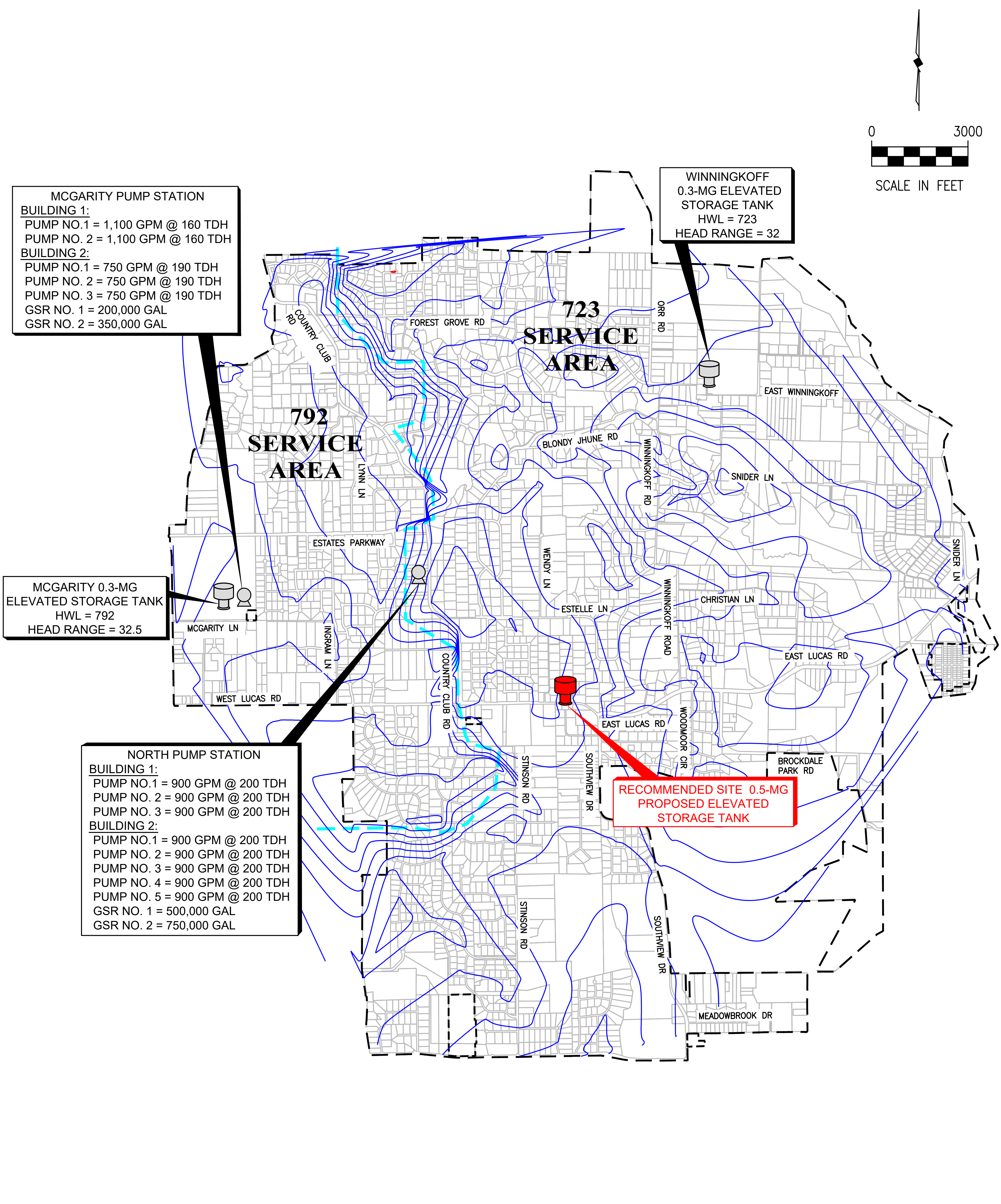
EXHIBIT C

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

Lucas

PHASE 1 IMPROVEMENTS
PROPOSED 0.5 MG ELEVATED STORAGE TANK AND PARALLEL 12-INCH WATER LINE

JUNE 2021



LEGEND

- LUCAS CITY LIMITS
- SERVICE AREA BOUNDARY
- LESS THAN OR EQUAL TO 40 PSI
- GREATER THAN 40 PSI

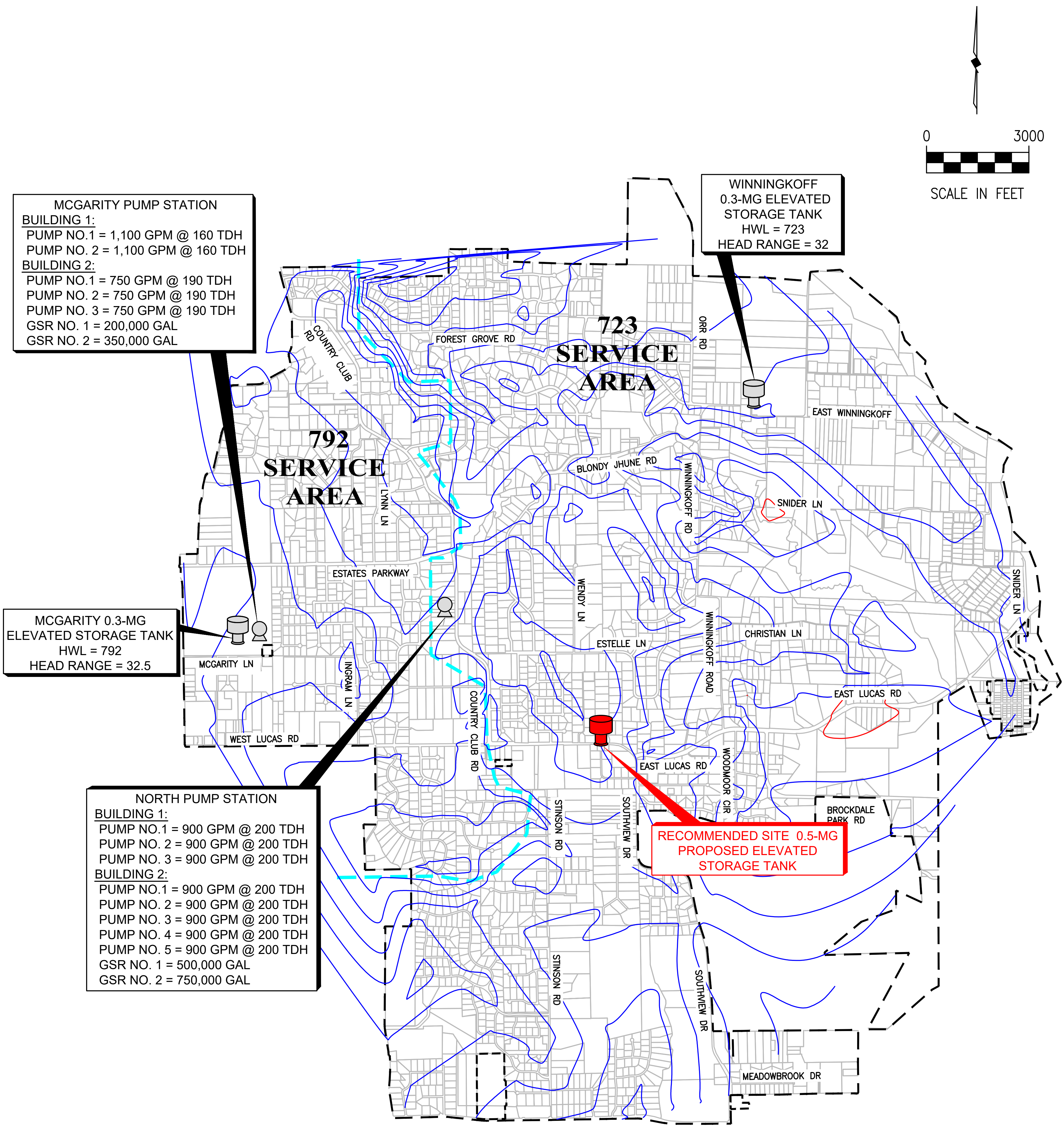
EXHIBIT D

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

Lucas

PHASE 1 IMPROVEMENTS
LOW PRESSURE AREAS

JUNE 2021



LEGEND

- LUCAS CITY LIMITS
- SERVICE AREA BOUNDARY
- GREATER THAN OR EQUAL TO 90 PSI
- LESS THAN 90 PSI

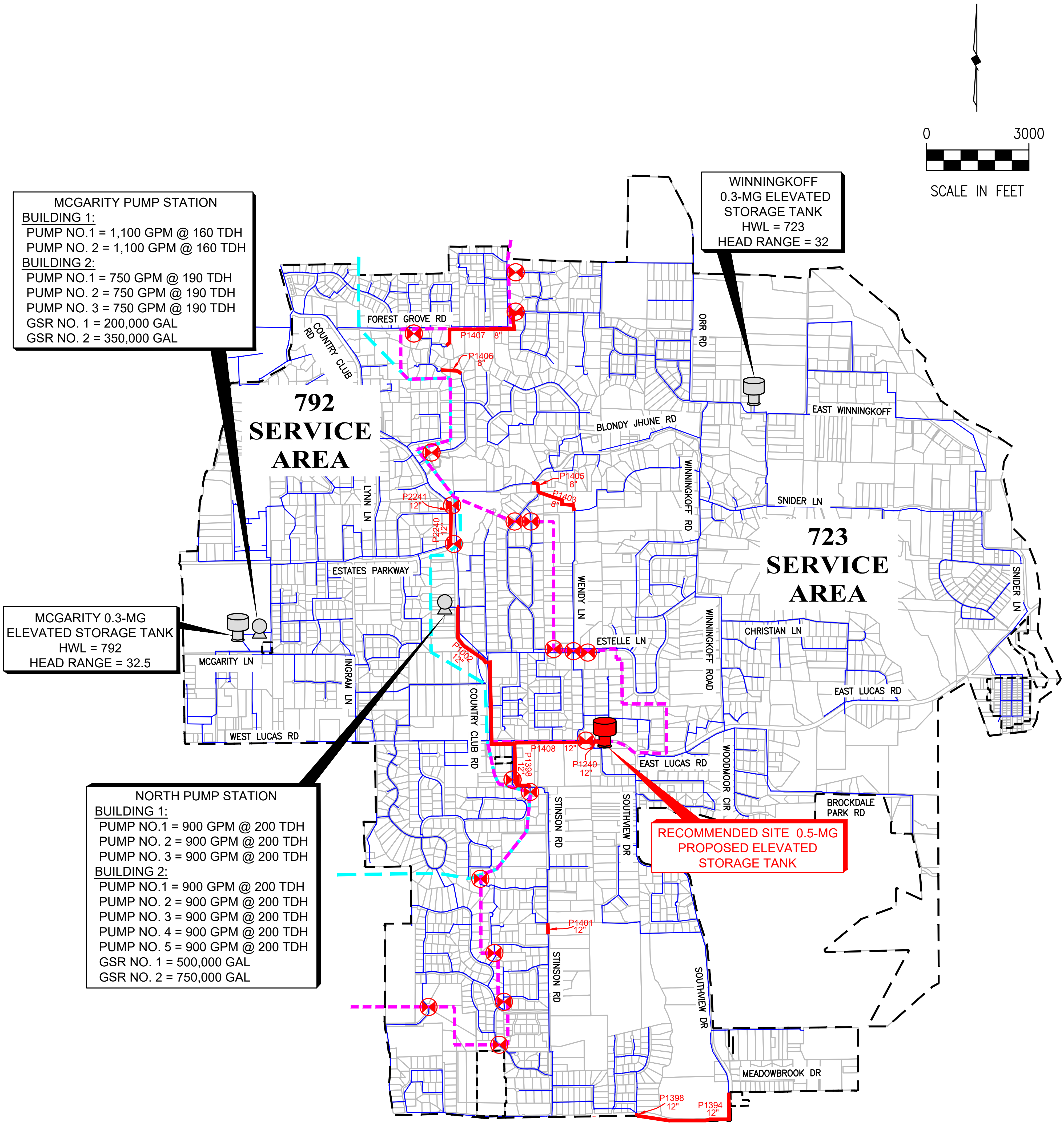
EXHIBIT E

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

Lucas

PHASE 1 IMPROVEMENTS
HIGH PRESSURE AREAS

JUNE 2021



LEGEND

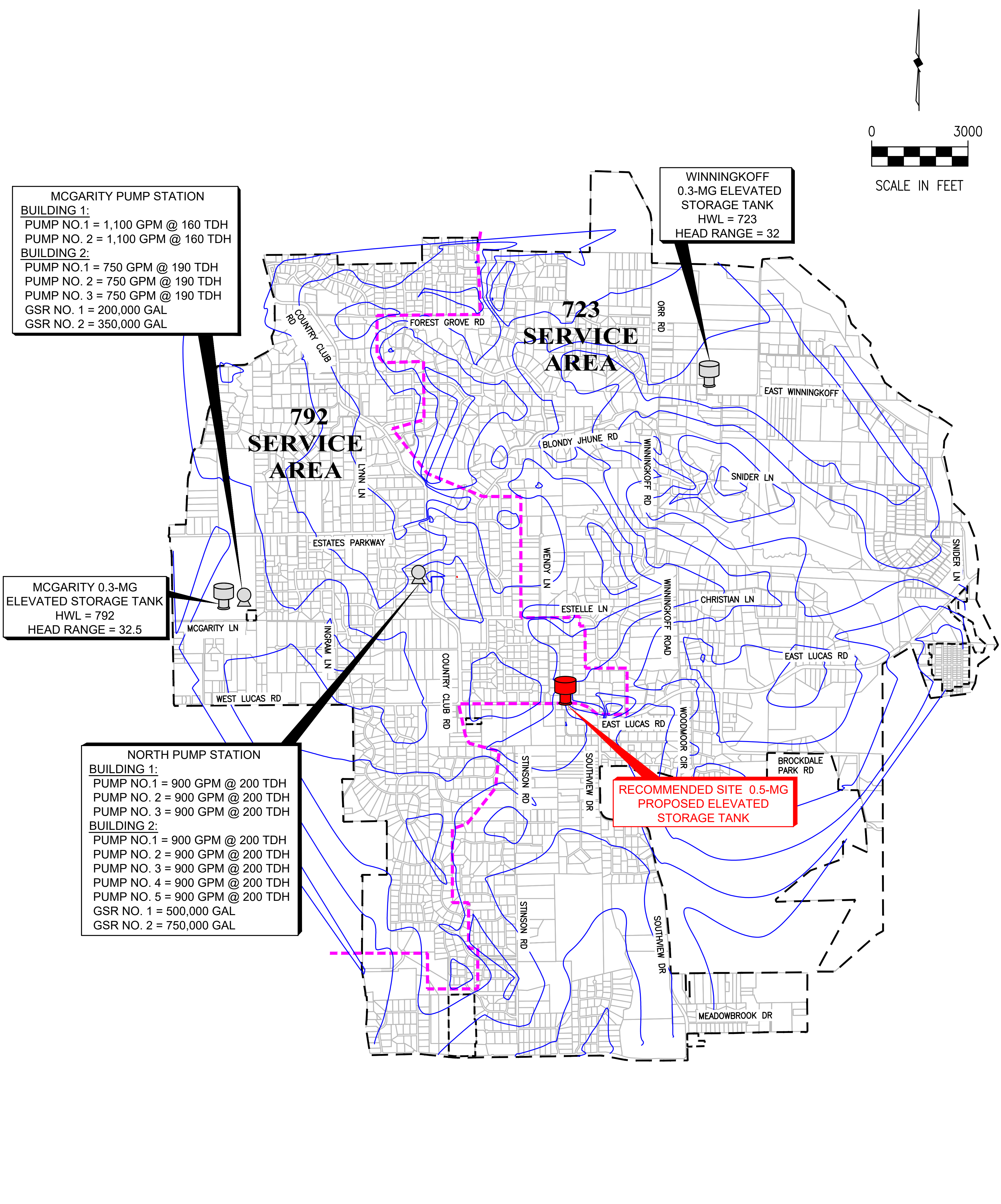
- LUCAS CITY LIMITS
- EXISTING WATER LINE
- PROPOSED WATER LINE
- PROPOSED CLOSED VALVE

EXHIBIT F

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

PHASE 2 IMPROVEMENTS
PROPOSED SERVICE AREA ADJUSTMENT
AND WATER LINES

JUNE 2021



LEGEND

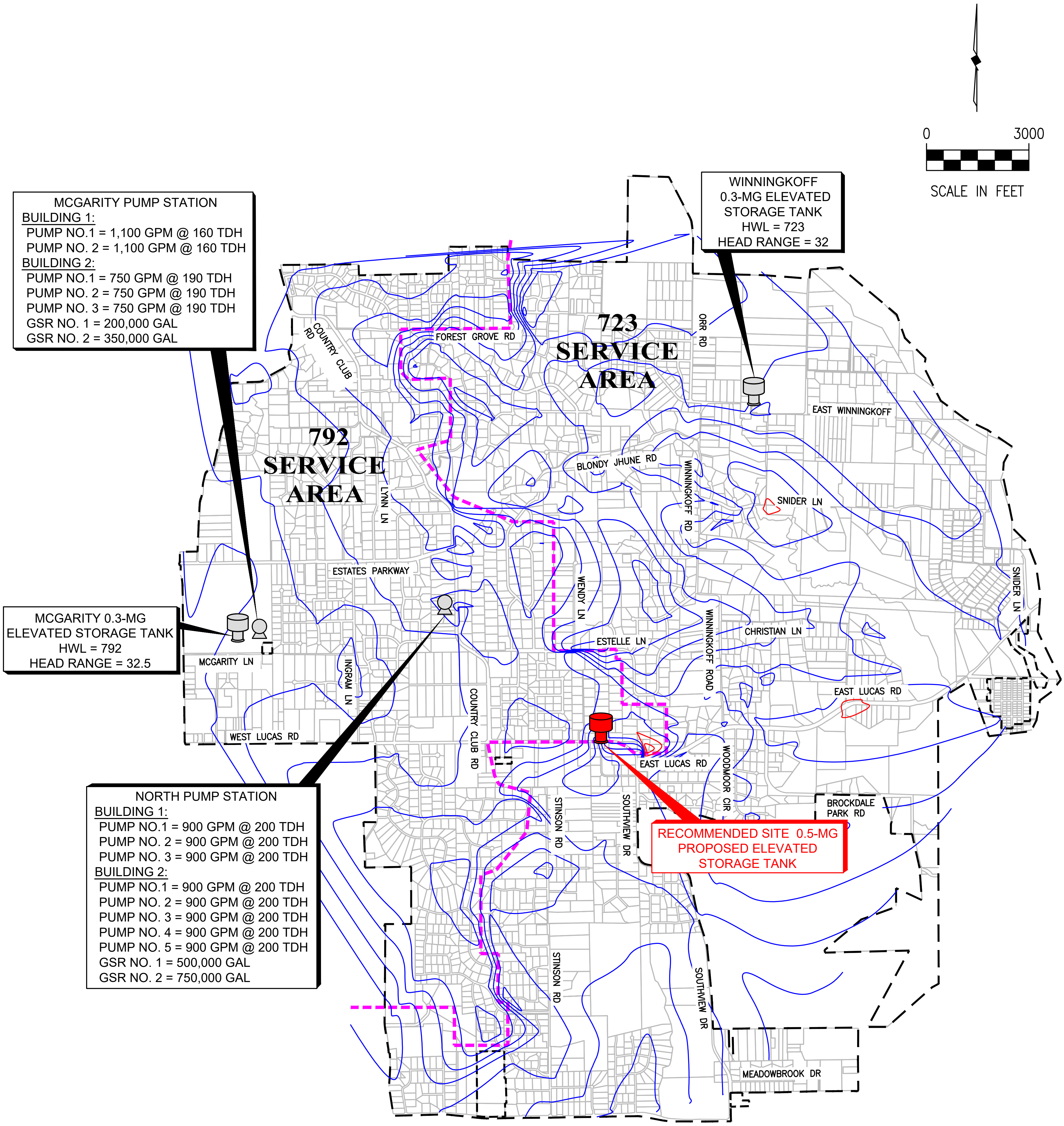
- LUCAS CITY LIMITS
- PROPOSED SERVICE AREA BOUNDARY
- LESS THAN OR EQUAL TO 40 PSI
- GREATER THAN 40 PSI

EXHIBIT G

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

PHASE 2 IMPROVEMENTS
LOW PRESSURE AREAS

JUNE 2021



LEGEND

- LUCAS CITY LIMITS
- PROPOSED SERVICE AREA BOUNDARY
- GREATER THAN OR EQUAL TO 90 PSI
- LESS THAN 90 PSI

EXHIBIT H

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm No. 526; TBPLS Firm No. 10031800
Dallas, Texas

Lucas

PHASE 2 IMPROVEMENTS
HIGH PRESSURE AREAS

JUNE 2021

City of Lucas

Existing System Hydraulic Model Report

APPENDIX

Phase 1 and Phase 2 Itemized Opinion of Cost

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm 526

Project No. 2020142

Client: City of Lucas
Date: 9/21/2021
Project: 2020 Existing Water Model Evaluation
Phase 1 - CIP (Proposed 0.5 MG Composite EST & Parallel 12-Inch Water Line)
By: GCH & JTL

ENGINEER'S OPINION OF CONSTRUCTION COST

Item No.	Description	Quantity	Unit	Price	Amount
1	Mobilization, Site Preparation, Bonds & Insurance	1	L.S.	$ 100,000.00	$ 100,000.00
2	Construct 0.5-MG Composite Elevated Steel Water Storage Tank (Reinforced Concrete Column & 0.5-MG Welded Steel Tank) in accordance with AWWA Standard D107-10 including all Instrumentation, Controls, Tank Piping, Containment System for Exterior Blasting and Painting (including Painted Logo), Dehumidification System & appurtenances	1	L.S.	$1,500,000.00	$ 1,500,000.00
3	Tank Mixing System	1	L.S.	$ 150,000.00	$ 150,000.00
4	Tank & Site Electrical Components	1	L.S.	$ 150,000.00	$ 150,000.00
5	Connect EST Instrumentation to SCADA System	1	L.S.	$ 25,000.00	$ 25,000.00
6	Tank Logos	3	Ea	$ 5,000.00	$ 15,000.00
7	12-Inch Waterline	100	L.F.	$ 200.00	$ 20,000.00
8	Connect to Existing Water Line	1	L.S.	$ 2,000.00	$ 2,000.00
9	8-Inch Thick Reinforced Concrete Driveway	250	S.Y.	$ 90.00	$ 22,500.00
10	4-Inch Thick Reinforced Concrete Sidewalks	150	S.Y.	$ 55.00	$ 8,250.00
11	Earthwork & Site Grading	1	L.S.	$ 40,000.00	$ 40,000.00
12	Drainage Infrastructure	1	L.S.	$ 50,000.00	$ 50,000.00
13	8-Foot Security Fence & Gate	1	L.S.	$ 80,000.00	$ 80,000.00
14	Site Security & Logo Lighting	1	L.S.	$ 100,000.00	$ 100,000.00
15	Site Turf & Landscape Features	1	L.S.	$ 75,000.00	$ 75,000.00
16	Site Irrigation System	1	L.S.	$ 25,000.00	$ 25,000.00
17	Stormwater Pollution Prevention Plan & Erosion Control	1	L.S.	$ 5,000.00	$ 5,000.00
	Subtotal:				**$ 2,367,750.00**
	Contingencies and Miscellaneous Items	20.0%			$ 473,600.00
	Proposed 2.0 MG Elevated Storage Tank Total:				**$ 2,841,350.00**

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
TBPE Firm 526

Project No. 2020142

Client: City of Lucas **Date:** 9/21/2021
Project: 2020 Existing Water Model Evaluation
Phase 1 - CIP (Proposed 0.5 MG Composite EST & Parallel 12-Inch Water Line) **By:** GCH & JTL

ENGINEER'S OPINION OF CONSTRUCTION COST

Item No.	Description	Quantity	Unit	Price	Amount
Prop. 24-inch Water Transmission Main, 18-inch, 16-inch, and 12-inch Water Lines					
18	Furnish & Install 12-inch Water Line	1,100	L.F.	$ 200.00	$ 220,000.00
19	Trench Safety Plan and Implementation	1,100	L.F.	$ 5.00	$ 5,500.00
20	Erosion Control Plan and Implementation	1	L.S.	$ 5,000.00	$ 5,000.00
21	Surface Restoration (Pavement, Sod, or Hydromulch)	3,000	S.Y	$ 15.00	$ 45,000.00
22	Traffic Control Plan and Implementation	1	L.S.	$ 5,000.00	$ 5,000.00
	Subtotal:				**$ 280,500.00**
	Contingencies and Miscellaneous Items	20.0%			$ 56,100.00
	Proposed Water Line Total:				**$ 336,600.00**
	Construction Total:				**$ 3,177,950.00**
	Professional Fees including: Engineering, Surveying, Bidding, Construction Admin., Easement Doc Preparation; Geotechnical Evaluations	15%			$476,693
	Land Rights Acquisition (1 Acre parcel)	1.0	Acre	$ 100,000.00	$100,000
	Land Rights Acquisition (20-ft Permanent Easement):	0.51	Ac.	$ 30,000.00	$ 15,151.52
	Materials Testing & Quality Control	2.5%			$ 79,400.00
	Specialized Inspection Services	2.0%			$ 63,600.00
	Project Total:				**$ 3,912,794.02**
				USE:	**$ 4,000,000.00**

BIRKHOFF, HENDRICKS & CARTER, L.L.P.

PROFESSIONAL ENGINEERS

Texas Firm F526

Project No. 2020-142

Client: City of Lucas

Date: 9/21/2021

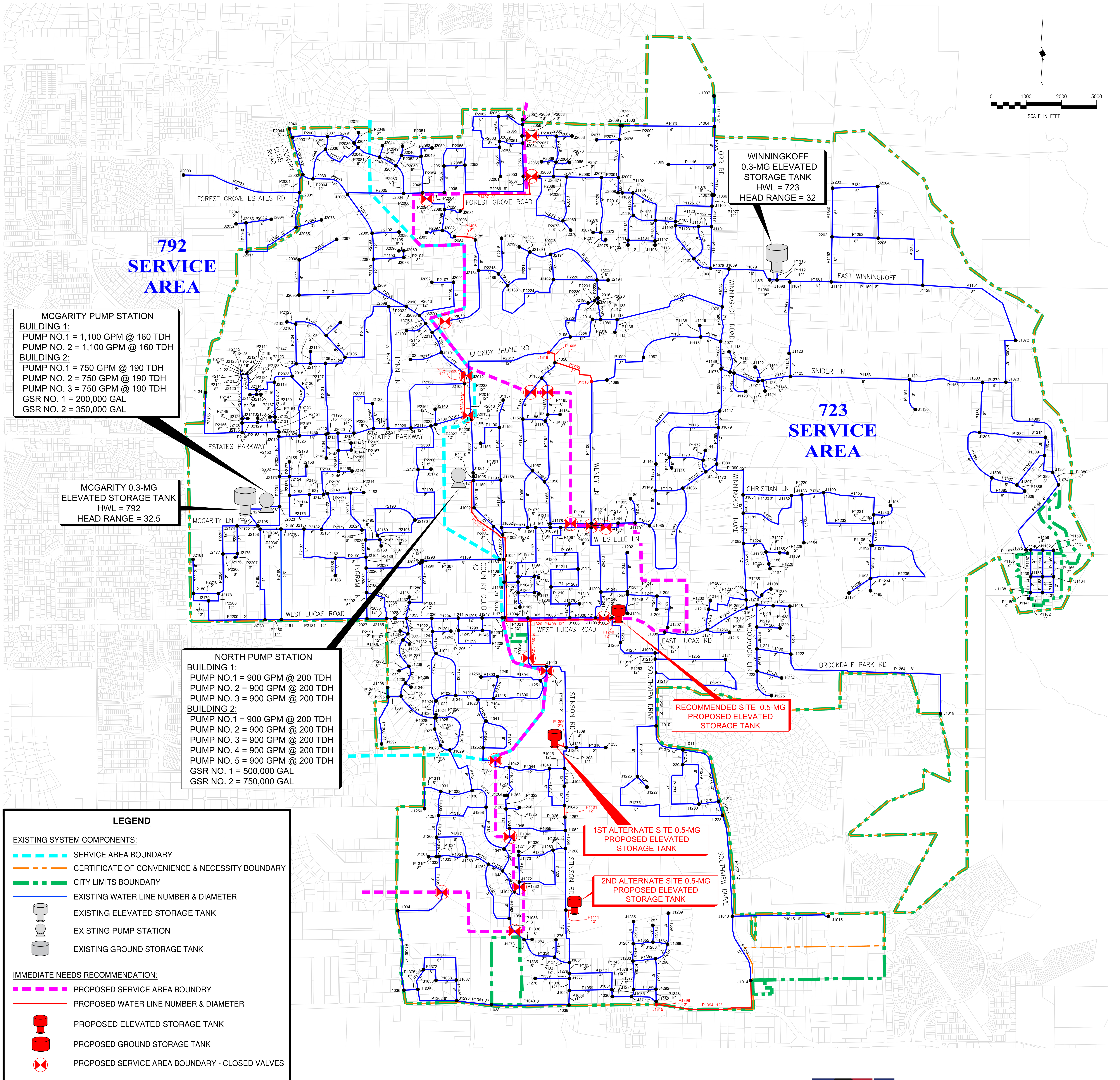
Project: 2020 Existing Water Model Evaluation

Phase 2 CIP (Proposed Service Area Adjustment & Water Line Improvements)

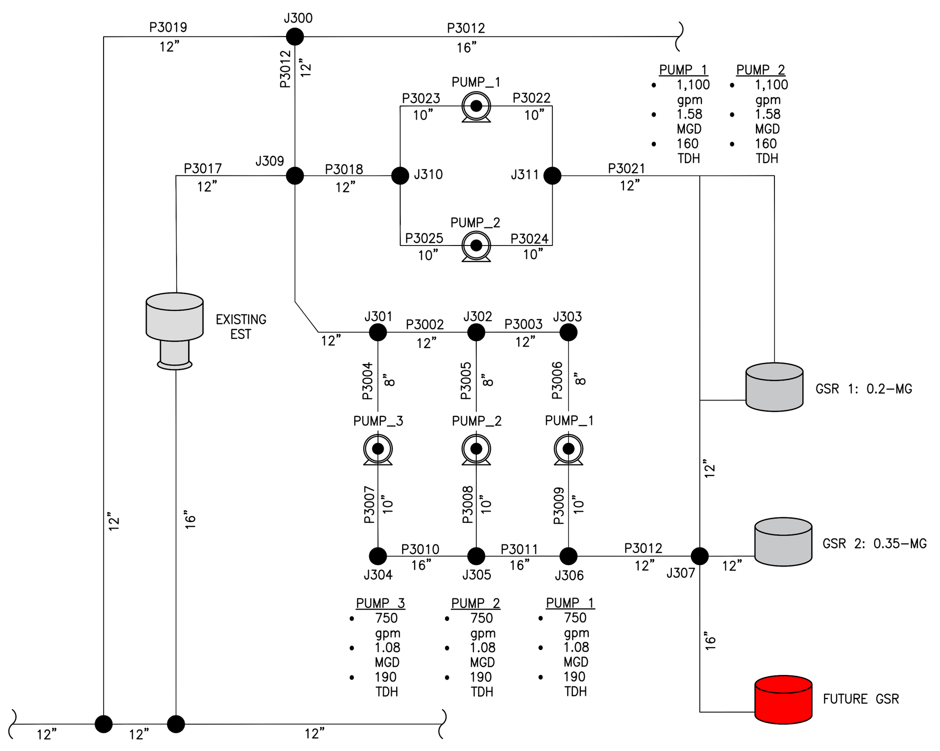
By: GCH & JTL

ENGINEER'S OPINION OF PROBABLE PROJECT COST

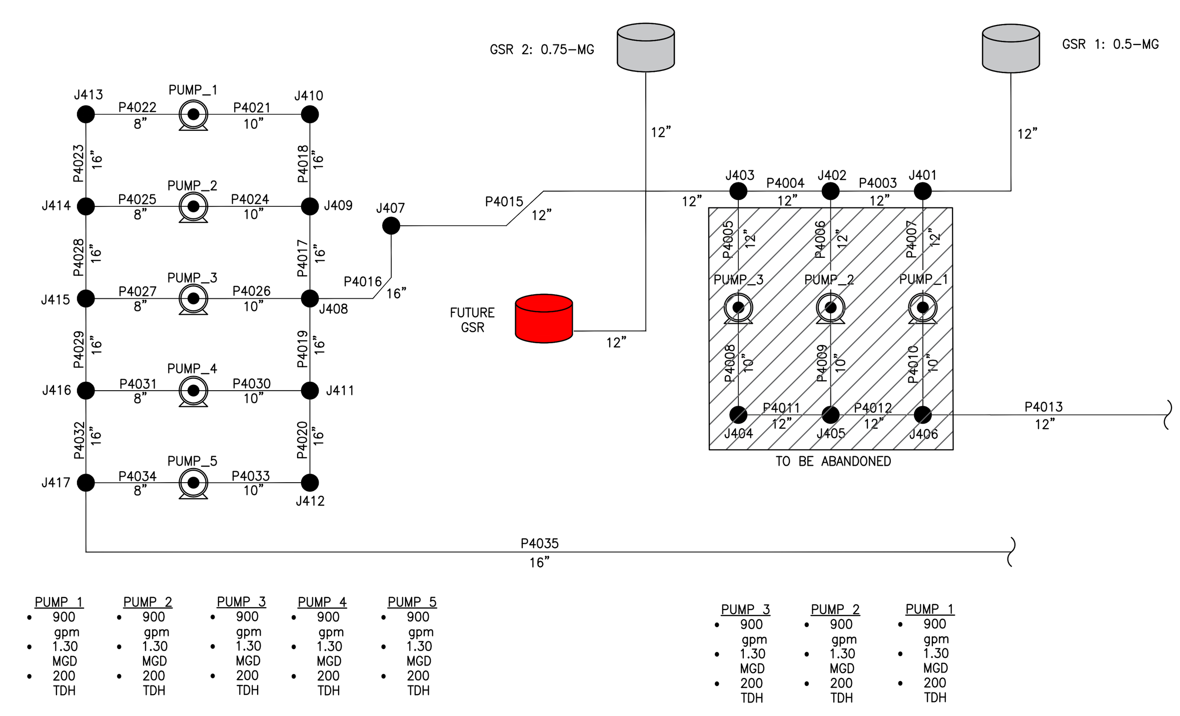
Item No.	Description	Quantity	Unit	Price	Amount
1	Furnish & Install 12-inch Water Line	13,200	L.F.	$ 200.00	$ 2,640,000.00
2	Furnish & Install 8-inch Water Line	5,500	L.F.	$ 180.00	$ 990,000.00
3	Trench Safety Plan and Implementation	18,700	L.F.	$ 5.00	$ 93,500.00
4	Erosion Control Plan and Implementation	1	L.S.	$ 30,000.00	$ 30,000.00
5	Surface Restoration (Pavement, Sod, or Hydromulch)	42,000	S.Y	$ 15.00	$ 630,000.00
6	Traffic Control Plan and Implementation	1	L.S.	$ 30,000.00	$ 30,000.00
	Construction Subtotal:				**$ 4,413,500.00**
	Contingencies and Miscellaneous Items:	20%			$ 882,700.00
	Subtotal:				**$ 5,296,200.00**
	Land Rights Acquisition (20-ft Permanent Easement):	8.59	Ac.	$ 30,000.00	**$ 257,575.76**
	Professional Fees including: Engineering, Surveying, Bidding, Construction Admin., Easement Doc Preparation; Geotechnical Evaluations	15%			**$ 794,430.00**
	Quality Control & Construction Materials Testing:	2.5%			**$ 132,405.00**
	Project Total:				**$ 6,480,610.76**
	Project Budget:			**USE:**	**$ 6,500,000.00**



MCGARITY PUMP STATION



NORTH PUMP STATION



2020 WATER DISTRIBUTION SYSTEM EXISTING SYSTEM HYDRAULIC MODEL MAP AND IMMEDIATE NEEDS RECOMMENDATIONS

BIRKHOFF, HENDRICKS & CARTER, L.L.P.
PROFESSIONAL ENGINEERS
Dallas, Texas
TPBE FIRM NO. 526
June 2021