MISSOURI PUBLIC SERVICE COMMISSION

RATE CASE WR-2021-0177

WATER SYSTEM EVALUATION

FOR

CARRIAGE OAKS ESTATES

STONE COUNTY, MISSOURI

OWNER

CARL R. MILLS WATER SERVICE

170 FALLING LEAF COURT

BRANSON WEST, MISSOURI 65737

ROZELL ENGINEERING COMPANY

ENGINEERING SECTION INC., PC

2404 STATE HIGHWAY 248, SUITE 4

BRANSON, MISSOURI 65616

STATE OF MISSOURI
WAYNE DIEBOLD
NUMBER E-22744
REGISTERED PROFESSIONAL ENGINEER
1-28-22

WAYNE DIEBOLD, P.E. #22744

JANUARY 28, 2022

WO# 15756EW

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I. INTRODUCTION:

This one volume report is for the purpose of evaluating the existing water system that serves Carriage Oaks Estates in Stone County, Missouri. The owner and operator of the existing water system is the Carl R. Mills Water Service, 170 Falling Leaf Court, Branson West, Missouri, 65737, Mr. Robert Sykes, Manager. The subdivision is located approximately three miles southeast of Kimberling City, Missouri. The site can be accessed by traveling north and east from Kimberling City on M.S.H.D. No. 13 approximately 1.7 miles to M.S.H.D. No. "DD". From there travel approximately 4.5 miles south and east on M.S.H.D. No. "DD" to the service road entrance located on the east side of the highway. The well house and water storage tank site are located approximately 120 feet to the north of the service road entrance.

II. FIELD SURVEY:

This is an existing subdivision being served by a well and water system that was originally approved under Review No. 52270-98 and issued PWS ID No. MO5031247. Due to the fact that the water system never reached the threshold of serving at least 25 individuals a minimum of 60 days out of the year or 15 service connections, the Missouri Department of Natural Resources (MDNR) has not been regulating the system. This system is, however, being regulated by the Missouri Public Service Commission (Commission) as a result of Case No. WA-2018-0370. The water supply system was originally designed to serve 55 residential lots. Two of those lots have been combined reducing the total number of lots to 54. Water mains are in place to serve 31 existing lots, including seven existing homes. An engineering report had been submitted to the MDNR under Review No. 53224-03 for an expansion of the water system to serve 33 additional lots. Actually, these lots were part of the original planned 55 lots and the engineering report was filed in order to get MDNR approval for the extension of the water mains as they exist today.

The information contained in this report, concerning the existing water system, is based on a site meeting with Mr. Robert Sykes and Mr. David Lott, President of Carriage Oaks Estates HOA, on December 20, 2021 and the best available information to the engineer.

The existing water system consists of a six inch diameter deep well drilled to a depth of 810 feet with 580 feet of steel casing equipped with a 15 HP submersible pump which can provide 80 gpm. The well discharges through a master meter and then into a 35,000 gallon ground level storage tank. The system has the ability to be chlorinated with the chlorine solution tank and chemical feed pump located in a separate enclosure attached to the well house. Water flows through a separate suction line from the storage tank through two 7.5 horsepower high service pumps that discharge into the main water line. The water system is set up to run on a 45 psi to 65 psi cycle. At 45 psi each high service pump can deliver 130 gpm. At 65 psi each pump can deliver 93 gpm. The on and off operation of the high service pumps is controlled by a pressure switch and the pumps are set up to alternate. There are six 119 gallon, gross volume, bladder type pressure tanks manifolded into the main discharge line to help maintain pressure on the system. Based on a 45 psi to 65 psi cycle, each bladder tank would have a drawdown volume of 31.5 gallons resulting in a total drawdown volume of 189 gallons. The high service pumps discharge into a three inch diameter steel pipe manifold which transitions down to a two inch diameter PVC water line for approximately eight feet before being enlarged to a four inch diameter water main before exiting the well house. The existing water distribution system consists entirely of four inch diameter pipe.

III. SYSTEM ANALYSIS:

Based on a conversation with, and subsequent information provided by, Mr. David Roos with the Missouri Public Service Commission, it appears that the main concern with the system is in regards to being able to provide adequate amounts of water and reasonable pressures where irrigation is concerned. More to the point is the concern that the section of two inch diameter pipe in the well house, located between the three inch diameter high service pump manifold and the four inch diameter water line exiting the well house, is creating this problem, or at a minimum, is exacerbating it. At the site meeting with Mr. Sykes and Mr. Lott, on December 20, 2021, it was decided that the best course of action, regardless of the results of the system analysis, would be to replace the two inch diameter section of pipe with a four inch diameter piece.

The current water demand based on the seven existing homes, including irrigation, would be as follows:

7 lots x 3 people/home x 100 gpcd	=	2,100 gpd
	=	87.5 gph
	=	1.45 gpm
Peak Daily Demand: 2,100 gpd x 2	=	4,200 gpd
	=	175 gph
	=	2.92 gpm
Peak Hourly Demand: 87.5 gph x 10	=	875 gph
	=	14.58 gpm

Assume an irrigation rate of 12 gpm per lot:

7 lots x 12 gpm	=	84 gpm

Based on the calculations presented above, the peak hourly rate for the existing seven homes, with irrigation, would be 98.58 gpm. In regards to the system being able to provide the required amount of water it is assumed that, on average, each irrigation system would operate for a period of two hours. At this rate, 11,820 gallons of water would have been used. The storage tank has a capacity of 35,000 gallons. The well pump can provide 80 gpm into the storage tank. The difference between the usage rate of 98.58 gpm and the well pump rate of 80 gpm is 18.5 gpm which would equate to 2,230 gallons over a two hour period. There would be more than sufficient water available in the storage tank under these conditions. The high service pumps can provide 130 gpm at a pressure of 45 psi, which is the pressure setting at which one of the pumps is turned on. As the pump discharges water into the system at the 130 gpm rate, the system pressure will rise until a pressure of 65 psi is achieved and the pump would shut off. As the pressure in the system rises, the high service pumping rate will decline to 93 gpm before shut off occurs. If the demand on the system remains high enough, then the high service pump would continue to operate since the 65 psi cutoff pressure had not been achieved and would be pumping at a rate higher than 93 gpm because of the lower system pressure. If the cutoff pressure was achieved, then the high service pump would cease to operate. As soon as the pressure dropped back to the 45 psi (pump on) pressure the second high service pump would be engaged and the pumping rate would start at the 130 gpm. Based on this information, the high service pumps should be more than adequate to provide the required flow for peak flow plus irrigation for the seven existing homes.

In regards to the matter of replacing the two inch diameter section of pipe with a four inch diameter piece, the following calculations have been provided as a comparison for velocity and headloss:

Existing 2" diameter SCH 80 PVC water main:

Nominal Inside Diameter: 1.913 inches
Area: 0.01996 sq. ft.
Peak Hourly Flow plus Irrigation for 7 homes = 98.58 gpm (0.22 cfs)

Velocity = Flow/Area: 0.22 cfs/0.01996 sq.ft. = 11.02 feet/sec > 4 feet/sec

Headloss in 2" PVC SCH 80 pipe:

$$h_f = .2083 \frac{(100)^{1.85}}{(130)^{1.85}} \times \frac{(q)^{1.85}}{(1.913)^{4.87}}$$

$$h_f = (.00544430)\,(98.58)^{1.85} = 26.57 \text{ ft/100 ft.}$$

Total Headloss in 2" PVC SCH 80 pipe with a length of 8 feet:

$$\frac{26.57 \text{ ft.}}{100 \text{ ft.}} \times 8 \text{ ft.} = 2.13 \text{ ft.}$$

$$\frac{2.13 \text{ ft. of headloss}}{2.31 \text{ ft. per 1 psi}} = 0.92 \text{ psi of headloss}$$

Proposed 4" diameter SCH 80 PVC water main:

Nominal Inside Diameter: 3.786 inches
Area: 0.07818 sq. ft.
Peak Hourly Flow plus Irrigation for 7 homes = 98.58 gpm (0.22 cfs)

Velocity = Flow/Area: 0.22 cfs/0.07818 sq.ft. = 2.8 feet/sec < 4 feet/sec

Headloss in 4" PVC SCH 80 pipe:

$$h_f = .2083 \frac{(100)^{1.85}}{(130)^{1.85}} \times \frac{(q)^{1.85}}{(3.786)^{4.87}}$$

$$h_f = (.00019595)\,(98.58)^{1.85} = 0.96 \text{ ft/100 ft.}$$

Total Headloss in 4" PVC SCH 80 pipe with a length of 8 feet:

$$\frac{0.96 \text{ ft.}}{100 \text{ ft.}} \times 8 \text{ ft.} = 0.08 \text{ ft.}$$

$$\frac{0.08 \text{ ft. of headloss}}{2.31 \text{ ft. per 1 psi}} = 0.03 \text{ psi of headloss}$$

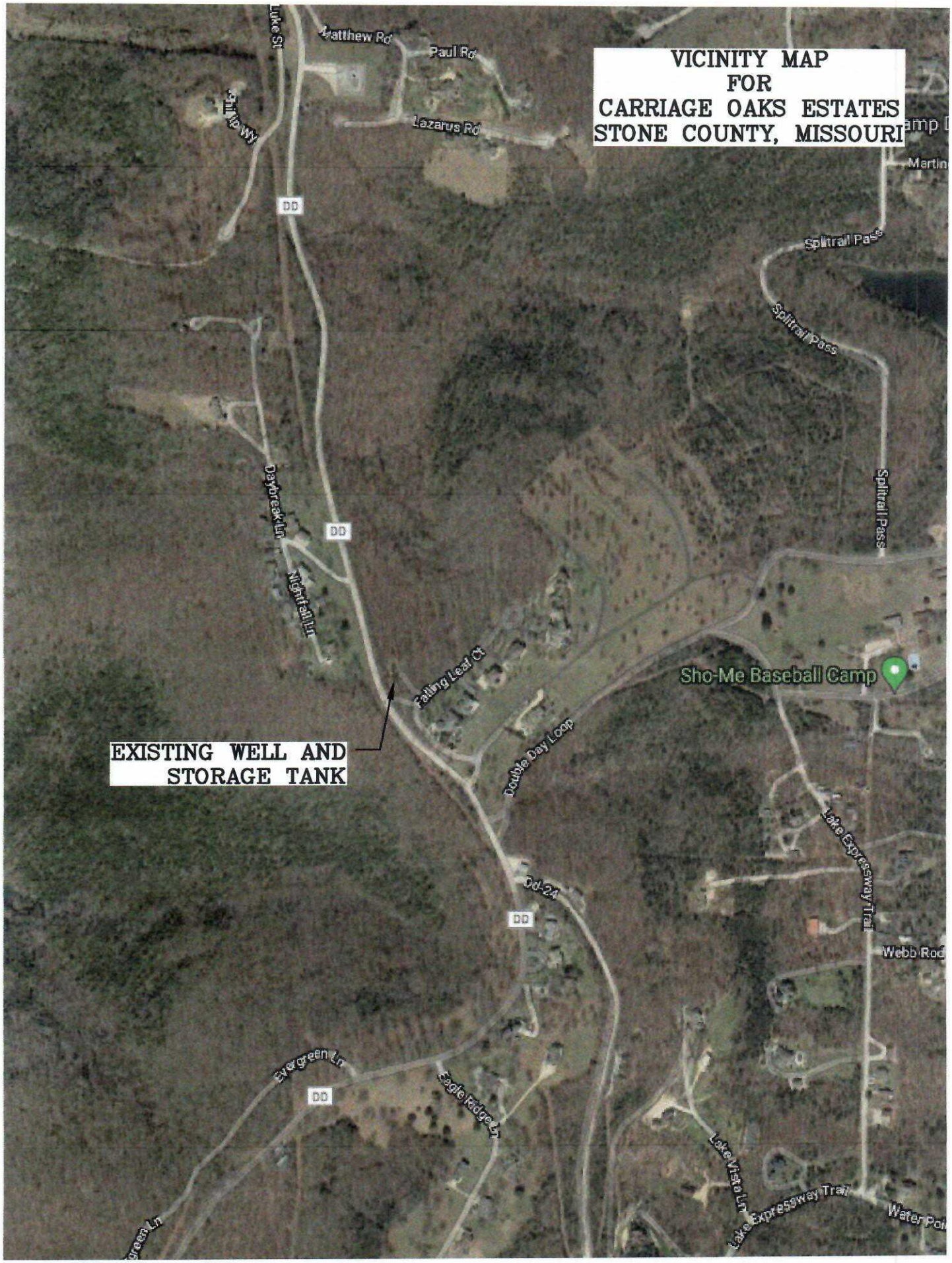
IV. CONCLUSIONS AND RECOMMENDATIONS:

Based on the calculations presented in this report, it appears that the existing two inch diameter pipe does not significantly reduce the pressure in the distribution system based on the peak flow plus irrigation for the seven existing homes. This is basically due to the fact that this section of pipe is only eight feet in length. However, the velocity of 11.2 feet per second in the PVC pipe is generally unacceptable and certainly could lead to damaging it internally if this condition persisted over a long period of time. The high velocity may also lead to cavitation where the smaller two inch pipe connects to the four inch pipe due to the sudden enlargement. With these items in mind, it is recommended that the two inch diameter section of pipe be replaced with a four inch diameter piece. The four inch diameter pipe will be capable of carrying substantially more water at a velocity that falls within normally accepted ranges with the headloss through this section of pipe being very low.

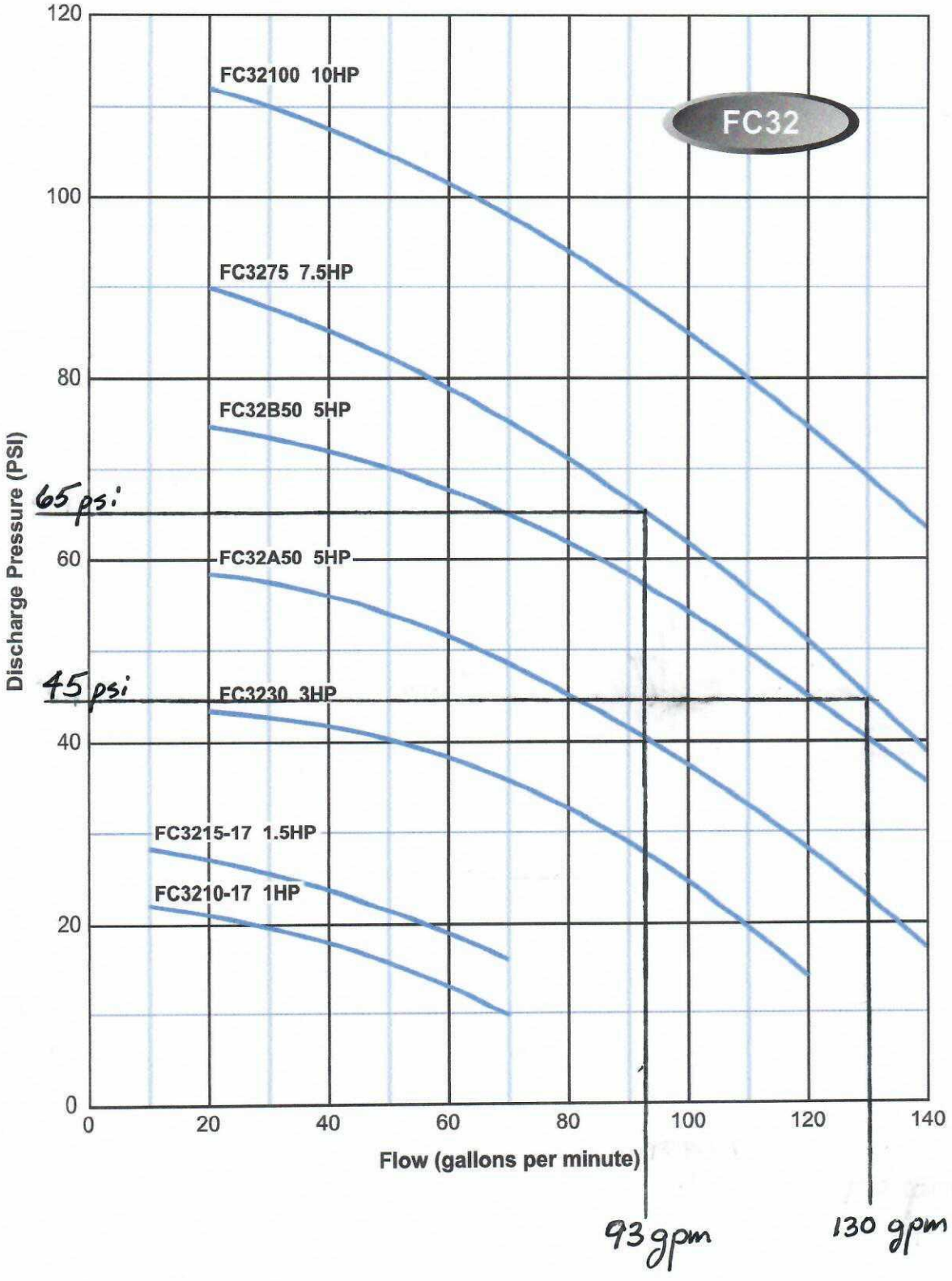
In regards to domestic water, the system appears to have adequate pumping capacity from both the high service pumps and the well pump as well as adequate storage capacity to serve not only the existing seven homes but all of the 55 lots it was designed to serve. The existing four inch diameter mains should also be adequate to serve all of the proposed 55 lots with domestic water. The real issue with this system is the load that is put on it from the irrigation systems. Most rural systems of this type are not designed to handle large quantities of irrigation due to their tendency to require high flowrates and a lot of storage. In this instance, the system appears to have sufficient storage, pumping capabilities, and distribution main sizes to handle the irrigation so long as the number and size of the irrigation systems does not get too large. One way to reduce the demand on the system, due to irrigation, is to implement a watering schedule for the residents that allows for the irrigation systems to be operated on alternate days and at varying times. This would allow the peak hourly demand plus irrigation to be reduced from the 98.58 gpm calculated in this report to a level that causes less headloss in the system and therefore better delivery pressures. This type of watering schedule will probably be even more important in the future as more homes are built and additional irrigation systems are installed.

Another area of concern has been the flushing of the water mains. The Carl R. Mills Water Service has a flushing program in place, a copy of which has been included in the appendices of this report. As the system is expanded in the future, additional flushing assemblies may need to be installed and the flushing procedures may need to be modified.

APPENDICES

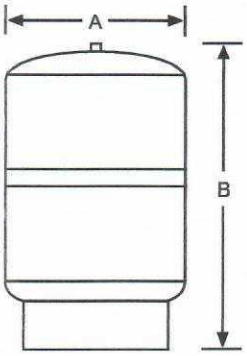

VICINITY MAP
FOR
CARRIAGE OAKS ESTATES
STONE COUNTY, MISSOURI
Luke St
Matthew Rd
Paul Rd
Lazarus Rd
DD
Splitrail Pass
Daybreak Ln
Nightfall Ln
Falling Leaf Ct
Sho-Me Baseball Camp
EXISTING WELL AND
STORAGE TANK
Double Day Loop
Mo-24
Mo Expressway Trail
Webb Rod
Evergreen Ln
Eagle Ridge Ln
Lake Vista Ln
Lake Expressway Trail

FC32 SERIES GROUP CURVES



CHAMPION

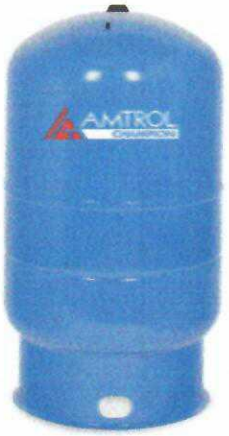
Champion precharged well tanks deliver reliable performance at an affordable price. All feature 125 PSI working pressure, Stainless Steel connection, Fresh Water Turbulator™ and a 5-year limited warranty. Made in the USA at our ISO 9001:2015 certified facilities, Champion well tanks are an outstanding value.



Specifications

Model Number	Tank Volume (Gallons)	Max. Accept. Volume (Gallons)	A Diameter (Inches)	B Height (Inches)	System Connection NPTF (Inches)	System Drawdown (Gallons)			Shipping Weight (lbs.)
						30/50 PSI	40/60 PSI	50/70 PSI	
CH-14	14	11.3	15	25	1	4.8	4.1	3.3	22
CH-20	20	11.4	15	32	1	6.8	5.9	4.7	28
CH-26	26	11.4	15	39	1	8.8	7.6	6.1	34
CH-32	32	11.2	15	47	1	10.9	9.4	7.6	40
CH-34	34	34.0	22	30	1¼	11.6	10.0	8.0	50
CH-44	44	33.9	22	36	1¼	15.0	12.9	10.4	57
CH-62	62	34.1	22	47	1¼	21.1	18.2	14.6	75
CH-81	81	33.2	22	57	1¼	27.5	23.8	19.1	92
CH-86	86	46.4	26	47	1¼	29.2	25.3	20.3	99
CH-119	119	46.4	26	62	1¼	40.5	35.0	28.1	133

Stainless Steel System Connection with Fresh Water Turbulator™
Maximum Operating Temperature: 200°F. Factory Pre-Charge: 38 PSI. Maximum Working Pressure: 125 PSI.



Sizing

Pump Discharge Rate GPM (Approx.)	Pumps Up To 3/4 hp & 1 Minute Run Time			Pumps Over 3/4 hp & 2 Minute Run Time		
	30/50 PSI	40/60 PSI	50/70 PSI	30/50 PSI	40/60 PSI	50/70 PSI
5	CH-20	CH-20	CH-20	CH-34	CH-34	CH-44
7	CH-26	CH-32	CH-32	CH-44	CH-62	CH-62
10	CH-34	CH-34	CH-44	CH-62	CH-81	CH-86
12	CH-44	CH-44	CH-62	CH-81	CH-81	CH-119
15	CH-44	CH-62	CH-62	CH-86	CH-119	CH-119
20	CH-62	CH-81	CH-86	CH-119	CH-81 (2)	CH-86 (2)
25	CH-81	CH-86	CH-119	CH-81 (2)	CH-86 (2)	CH-119 (2)
30	CH-86	CH-119	CH-119	CH-86 (2)	CH-119 (2)	CH-86 (3)
35	CH-119	CH-119	CH-81 (2)	CH-119 (2)	CH-119 (2)	CH-119 (3)
40	CH-119	CH-81 (2)	CH-86 (2)	CH-119 (2)	CH-86 (3)	CH-119 (3)

Larger Tank = Fewer Cycles for Longer Tank and Pump Life

WORTHINGTON INDUSTRIES
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T: 800.426.8765 **www.amtrol.com**

Turbulator LOW-LEAD NSF NSF/ANSI 61 NAF COMPLIANT national ground water association WATER SYSTEMS COUNCIL MADE IN USA

MC 7080 (01/19)

Carl R. Mills Water Service
Water Main Flushing Procedure

Purpose:

The purpose of this procedure is to provide a safe and effective method for periodic flushing of the water main at the Carriage Oaks Estates Subdivision. This purpose will be achieved by notifying the Customers of the water main flushing and maintaining a minimum of 20 psi. water pressure throughout the entire distribution system during flushing.

Customer Notification:

Customers will be notified no later than three (3) days prior to the day of the scheduled flushing by either telephone, e-mail or written notice.

Flushing Procedure:

Two personnel, with each person having either cell phone or portable two-way radio are required to flush the water main.

One person will be located at the air relief valve which is at the highest point of the water main. The air relief valve is in a below grade valve box on Lot 1 facing Highway DD. Inside the valve box is a shutoff valve, a pressure gage for reading water pressure, and the air relief valve. The assigned personnel will monitor the pressure gage before, during and after the flushing.

The second person will be at the flushing valve located at the end of the water main.

The personnel will establish two way communication before starting the water main flush.

The person at the flush valve will slowly open the flush valve while the person at the air relief valve tells the valve operator the current water pressure. Flushing will stop when the system pressure approaches 20 psi. Flushing may resume once system pressure is above 25 psi.

Occurance:

Water main flushing will be scheduled at approximate 6-month intervals during the spring and fall months.