Ballentine Associates, P.A.

Fire Flow Analysis

For

Brookside at Fieldstone
Chatham County, North Carolina

(PIN: 9766-20-6324)

Prepared by:

Ballentine Associates, P.A.
Consulting Engineers
221 Providence Road
Chapel Hill, NC 27514
(919) 929-0481

BA Project # 113022.00

NORTH CAROLINA PROFESSIONAL SEAL 026127 ENGINEER GEORGE J. RETSCHLE
13APR16

APPROVED BY CHATHAM COUNTY UTILITIES
4/18/16

Issue Dates	Description
13 Apr 2016	Chatham County Public Utilities & Water Division

Project Overview:

Brookside at Fieldstone is a residential subdivision project including the extension of the existing Fieldstone Lane and water main to serve 13 new single family lots. The site is located to the east of the existing Fieldstone neighborhood, which is off of Mann's Chapel Road.

The water main project will include an approximately 1,700 linear feet extension of the existing 8-inch ductile iron water main extension, as shown on the attached Utility Plan prepared by Ballentine Associates. There will be four new 6-inch fire hydrant services and thirteen domestic water meters; one for each new lot. The 8-inch water main will terminate at the southern end of the new culdesac with a 2" blow-off assembly as per Chatham County standards and specifications.

Hydrant Flow Test:

A hydrant flow test was performed by Chatham County Public Utilities & Water Division personnel, utilizing two existing hydrants: the gauge hydrant near the entrance to the Fieldstone neighborhood, and the flow hydrant near the Fieldstone Lane culdesac. Refer to the attached hydrant flow test report and map for additional information.

Water Demands & Fire Flow Requirements:

The cumulative peak domestic demand for the fully developed 13 lots has been calculated to be 200 gpm, irrigation peak demand has been estimated to be 120 gpm, and the minimum fire flow required for a fire hydrant is 500 gpm per Chatham County & NCDEQ requirements. The total required flow for the new water system has been calculated to be 820 gpm. Refer to the attached calculations for additional information.

Analysis:

A spreadsheet based on the Hazen-Williams formula was used to calculate the head losses that will occur between the test flow hydrant location and the proposed hydrants on site. The spreadsheet accounts for pressure loss due to static losses and friction, and minor losses in the proposed piping. Separate scenarios were evaluated to determine the "worst case" calculation of pressure loss through the system from the test hydrant to each of the proposed new hydrants.

A total flow of 820 gpm (500 gpm fire flow + 320 gpm domestic/irrigation) was assumed in all scenarios. Hydrant #2 was determined to be the "worst case" scenario based on the pressure loss at the node (See attached Utility Plan for the Hydrant #2 node location.) 820 gpm @ 51 psi was determined to be available at Hydrant #2.

Results/Conclusions:

The attached calculations provided at each node (proposed new hydrants) confirm that peak domestic demand and required fire flow can be met for this project with the worst case scenario being at hydrant #2 where 820 gpm will be available at 51 psi.

Appendix:

- Hydrant Flow Test Report & Map (provided by Chatham County)
- Utility Plan (11”x17”) showing proposed water system.
- Fire Flow Q20 Calculation
- Fire Flow Calculations
- System Performance Curve
- Equivalent Pipe Length Tables

Chatham County Public Utilities & Water Division

FIRE FLOW TEST DATA

964 East Street, Suite 205, Pittsboro, NC 27312

Phone: 919-542-8270 Fax: 919-542-8282

Project: Brookside at Fieldstone

Address:

Location of Hydrants : Intersection of Manns Chapel Rd./Fieldstone Ln. (test hydrant), End of Fieldstone Ln. (flow hydrant)

Test No.	Location of Hydrants	Time			C	Dia. (in.)	Residual Hydrant		Flow Hydrant			
		Date	Time	Day			Static (psi)	Residual (psi)	Static (psi)	Pitot (psi)	Observed (gpm)	Calculated (gpm) at 20 psi
1	Along Fieldstone Ln.	3/18/2016	1:15 PM	Fri.	0.90	2.50	74	54	70	25	839	1,434

The formula used to compute the discharge Q in gpm for these measurements is:

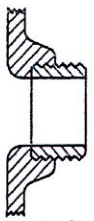
$$Q = 29.83cd^2(p)^{1/2}$$

c = is the coefficient of discharge

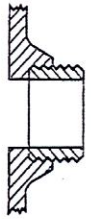
d = is the diameter of the outlet in inches

p = is the velocity pressure in psi

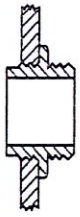
If stream straightners are being utilized, a "c" of 0.95 is suggested unless the coefficient of the tube is known.



Outlet smooth and rounded coef. 0.90



Outlet square and sharp coef. 0.80



Outlet square and projecting into barrel coef. 0.70

The formula which is generally used to compute the discharge at the specified residual pressure or for any desired pressure drop is:

$$Q_r = Q_f \times \frac{Hr^{0.54}}{H_f^{0.54}}$$

Q_r = is the flow available at desired pressure

Q_f = is the flow during test

H_r = is the pressure drop to desired residual pressure

H_f = is the pressure drop during test

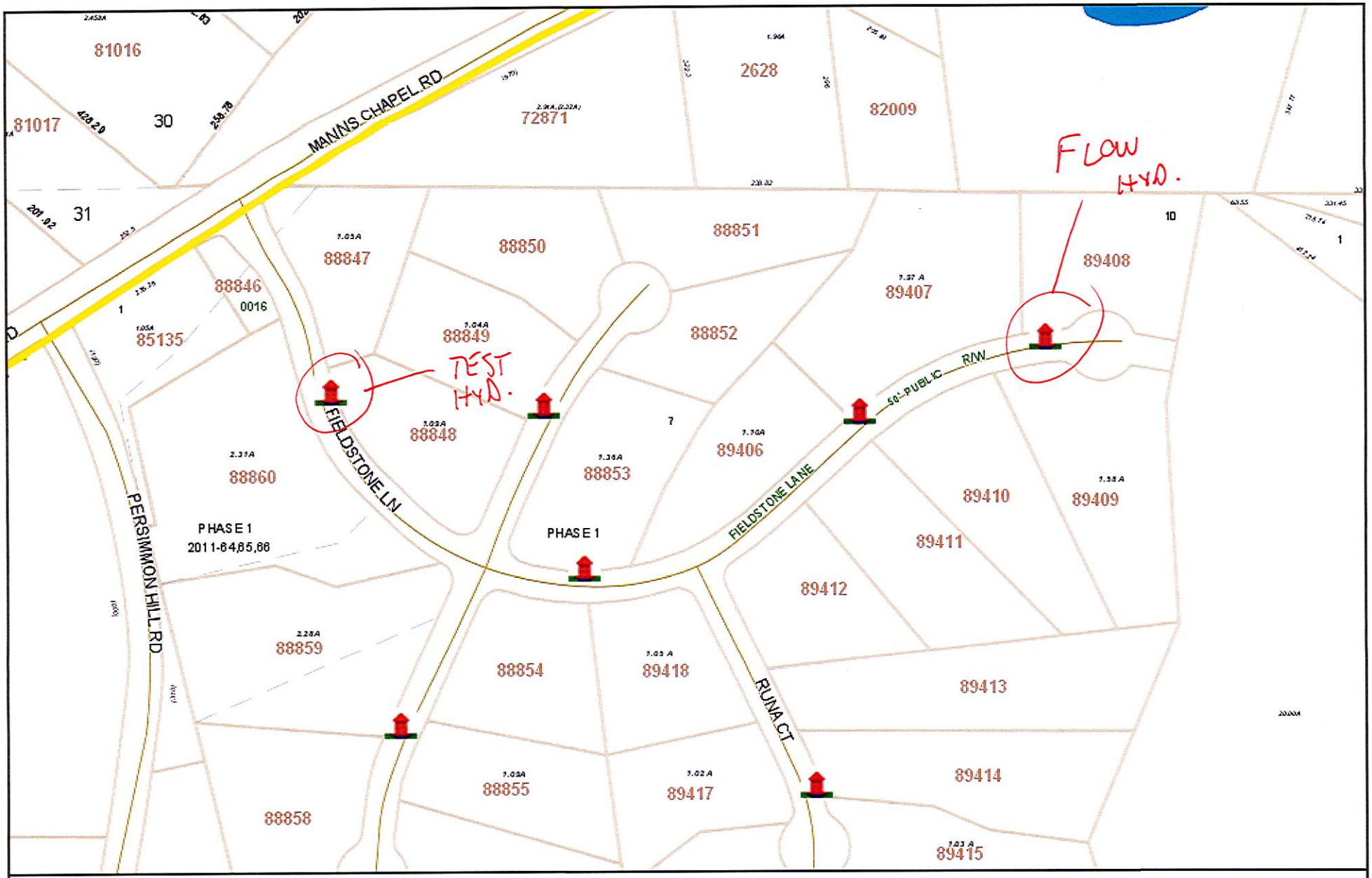
Larry Bridges

TESTING AND CALCULATIONS CHECKED

Larry Bridges, Public Utilities Director

3/21/16

DATE

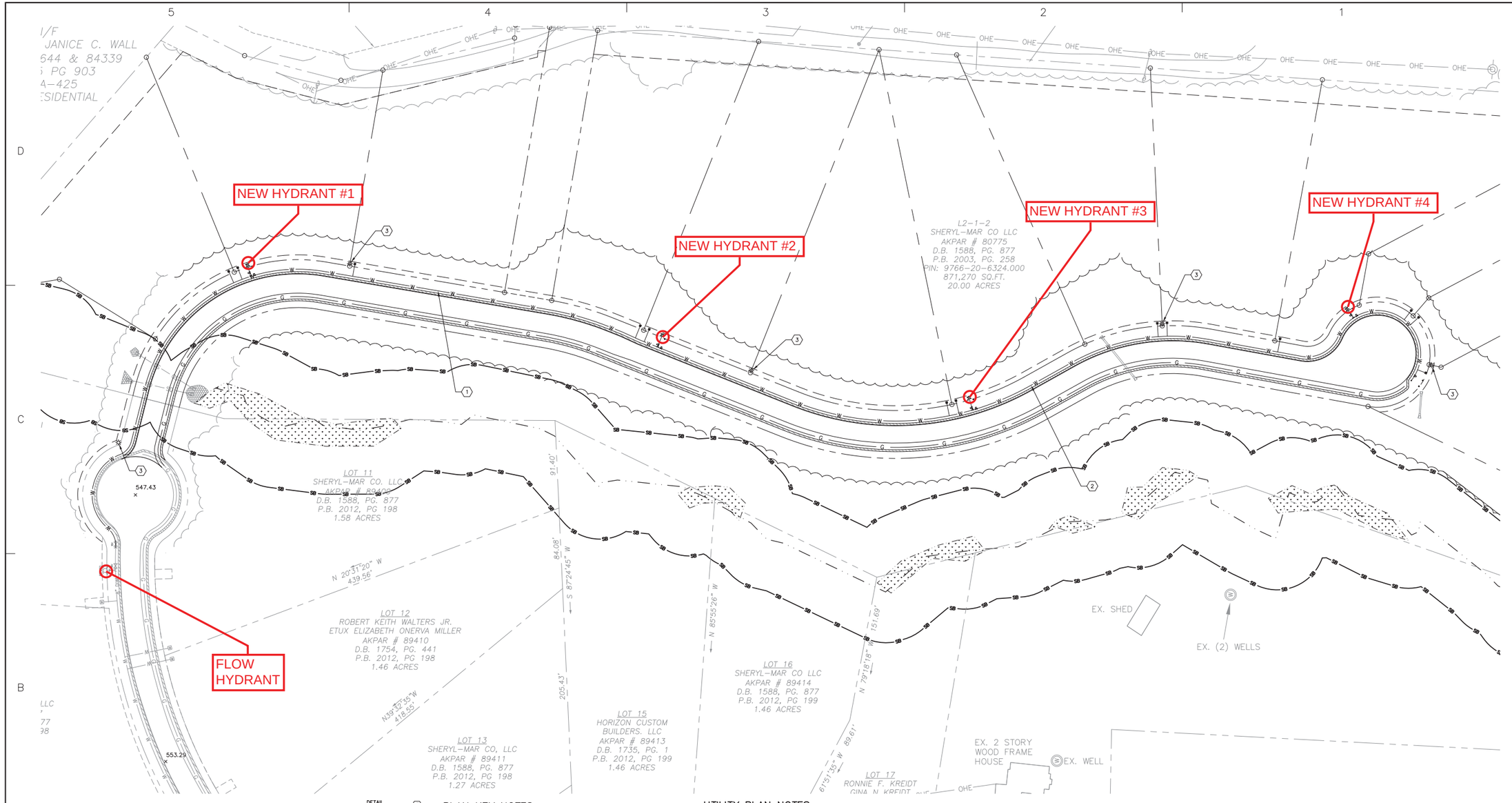


CHATHAM COUNTY, NC

Property Map

Disclaimer:
The data provided on this map are prepared for the inventory of real property found within Chatham County, NC and are compiled from recorded plats, deeds, and other public records and data. This data is for informational purposes only and should not be substituted for a true title search, property appraisal, survey, or for zoning verification.

One Inch = 200 Feet



DETAIL REFERENCE

A3 C1102 / C3 C1102

A3 C1103 / B3 C1103

PLAN KEY NOTES

1. WATER MAIN PLAN & PROFILE – NORTH
2. WATER MAIN PLAN & PROFILE – SOUTH
3. STREET LIGHT

UTILITY PLAN NOTES

1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH CHATHAM COUNTY AND NCDEQ REQUIREMENTS, STANDARDS AND SPECIFICATIONS.
2. CONTRACTOR SHALL LOCATE ALL EXISTING UTILITIES (PRIVATE AND PUBLIC) AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES OR CONFLICTS. CONTRACTOR SHALL PROTECT ALL EXISTING UTILITIES DURING CONSTRUCTION.
3. WATER UTILITIES:
   - 3.1. ALL WATER UTILITIES SHALL BE PER CHATHAM COUNTY PUBLIC WATER STANDARD SPECIFICATIONS AND DETAILS.
   - 3.2. CONTRACTOR SHALL SUBMIT PRODUCT DATA FOR WATER MAIN PIPES, FITTINGS AND APPURTENANCES.
   - 3.3. MINIMUM UTILITY VERTICAL SEPARATION DISTANCES: STORM SEWER AND WATER – 18"
4. ELECTRICAL:
   - 4.1. CONTRACTOR SHALL CONTACT ERVIN SUMMERS WITH DUKE ENERGY AT (336) 634-4633 TO COORDINATE ELECTRICAL SERVICE LINES.
     - 4.1.1. ELECTRICAL SUBCONTRACTOR SHALL PROVIDE TRENCHING, BACKFILLING AND COMPACTING FOR ALL ELECTRICAL CONDUITS.
     - 4.1.2. ELECTRICAL SUBCONTRACTOR SHALL PROVIDE CONCRETE TRANSFORMER PAD(S) IN ACCORDANCE WITH LOCAL REQUIREMENTS. ACTUAL PAD SIZE MAY VARY CONTINGENT ON FINAL TRANSFORMER SIZE SELECTED BY POWER COMPANY.
     - 4.1.3. ELECTRICAL SUBCONTRACTOR TO PROVIDE AND INSTALL SCH 40 PVC CONDUIT(S) UNDER ROADWAY AS NEEDED. MINIMUM DEPTH OF PRIMARY AND SECONDARY CONDUITS/CABLING SHALL BE MIN. 30" OR AS REQUIRED BY POWER COMPANY, WHICHEVER IS GREATER.
5. GAS:
   - 5.1. GAS SERVICE TO BE DESIGNED, SIZED & INSTALLED BY GAS COMPANY. CONTACT WARREN DUNCAN WITH PSNC AT (919) 367-2715 FOR COORDINATION.
6. TELECOM:
   - 6.1. AT&T: SARAH BITTING – (919) 918-4132.

DRAWING LEGEND

SYMBOL/ABBREVIATION EXISTING	PROPOSED	DESCRIPTION
		FIRE HYDRANT
		WATER VALVE
		VALVE MARKER POST
W		WATER METER
		UTILITY POLE
		STREET LIGHT
W	W	WATER LINE
G	G	GAS LINE
SD		STORM DRAIN PIPE
OHE		OVERHEAD UTILITY LINE
		UNDERGROUND UTILITY CORRIDOR
		PROPERTY LINE
		RIGHT-OF-WAY LINE
× 550.00		BENCH MARK

NC GRID NAD 83

UTILITY PLAN

50 0 25 50 100

(GRAPHIC SCALE IN FEET)

REVIEW DRAWING NOT FOR CONSTRUCTION

BALLENTINE ASSOCIATES, P.A.
221 PROVIDENCE ROAD, CHAPEL HILL, N.C. 27514
(919) 929 - 5448 (919) 489 - 4789

Ballentine Associates, P.A. CORPORATE SEAL C328 NORTH CAROLINA Chapel Hill

NORTH CAROLINA PROFESSIONAL SEAL 027271 ENGINEER GEORGE J. RETSCHLE

DATE	REVISIONS	NUM

OWNER INFORMATION
SHERYL-MAR CO. LLC.
87 NORWOOD ROAD
CHAPEL HILL, NC 27516

OWNERS REPRESENTATIVE:
JIM HODGIN
PH. 910-210-0920
FAX
EMAIL jimhodgin@hotmail.com

DATE	ISSUED
25 MAR 16	TO SHERYL-MAR
12 APR 16	CHATHAM UTILITIES & NCDOT

BROOKSIDE AT FIELDSTONE

CHATHAM COUNTY, NORTH CAROLINA

CONSTRUCTION DRAWINGS

JOB NUMBER:	113022.00
DATE:	25 MAR 2016
SCALE:	AS NOTED
DRAWN BY:	DBB
REVIEWED BY:	GJR

SHEET
C1101

N:\Projects\113022.00 Fieldstone Phase 2\1_Dwg\BIM Model Files\C1100-Utility-Fieldstone Ph1.dwg, 4/12/2016 7:55:06 PM, davidb

Fire Flow Q20 Calculation

Ballentine Associates, P.A.
Consulting Engineers
221 Providence Road
Chapel Hill, NC 27514
(919) 929-0481 fax 489-2803

Project: Brookside at Fieldstone
Project Number: 113022.00
Client Brookside at Fieldstone
Date: 11-Apr-2016

Hydrant Flow Test Data: (See attached Hydrant Flow Test Report.)

Flow Hydrant Location: Fieldstone Lane Culdesac
Gauge Hydrant Location: Near Entrance to Fieldstone Subd.

Static Conditions

Static Pressure = 74.00 psi
To convert to feet of static head: (x 144 sqin/sqft) / (62.4 lb/ft)
Static Head (S) = 170.77 ft

Static Flow = 0.00 gpm

Residual Conditions

Residual Pressure = 54.00 psi
To convert to feet of residual head: (x 144 sqin/sqft) / (62.4 lb/ft)
Residual Head (R) = 124.62 ft

Residual Flow (Qr) = 839.00 gpm

Baseline Conditions

Baseline Pressure = 20.00 psi
To convert to feet of baseline head: (x 144 sqin/sqft) / (62.4 lb/ft)
Baseline Head (R20) = 46.15 ft

Baseline Flow at 20 psi (Q20) = 1434.49 gpm
To determine Q20, solve for Hazen Williams Equation below.

Hazen Williams Equation

Q20 = Qr x [((S - R20)^.54) / ((S - R)^.54)]

Qr: 839.00 gpm
S: 170.77 ft
R20: 46.15 ft
R: 124.62 ft

Solving the above equation for Q20 using above data yields the following result.

Baseline Flow at 20 psi: **(Q20) = 1434.49 gpm**

Fire Flow Analysis Calculations
4/13/2016

Project: Brookside at Fieldstone
Proj. Number: 113022.00
Client: Sheryl-Mar LLC.
Node: **Hydrant #1**

Ballentine Associates, P.A.
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221 Providence Road
Chapel Hill, NC 27514
(919) 929-0481 fax 489-2803

Water System Data

Flow (gpm)	Pressure (ft)	Pressure (psi)	
0	170.9	74	*Static Pressure*
839	124.7	54	*Residual Pressure*
1434.49	46.2	20	*Note: This is the calculated Q_{20} flow*

MINIMUM FIRE FLOW at 20 psi
Per Chatham County/NCDEQ: 500 gpm

FIRE FLOW REQUIREMENT: 500 gpm
DOMESTIC FLOW REQUIREMENT: 200 gpm — approximately 15 gpm (75% of meter capacity) per lot
IRRIGATION FLOW REQUIREMENT: 120 gpm — 40 gpm/meter (assuming 3 lots in use at a time)

TOTAL FLOW FOR CALCULATIONS: 820 gpm

Head Losses in Pipe

Static Headloss

Static Head = Δ Elevation

Elevation of Pipe @ Test Flow Node (Ground Elev minus 3 ft) = 547 ft NGVD
Nozzle Elevation @ New Fire Hydrant = 552 ft NGVD

Static Head (h_S) = 5 ft

Minor Losses (Equivalent Lengths)

PIPE SIZE 6-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	15	0	0
45° Elbow, flanged	4.5	0	0
Tee-through, flanged	3.1	0	0
Gate Valve, flanged	2.6	2	5.2
		SUM =	**5**

PIPE SIZE 16-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	39	0	0
45° Elbow, flanged	13	0	0
Tee-through, flanged	6.5	0	0
Gate Valve, flanged	3	0	0
		SUM =	**0**

PIPE SIZE 8-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	20	1	20
45° Elbow, flanged	6.3	2	12.6
Tee-through, flanged	3.9	0	0
Gate Valve, flanged	2.7	1	2.7
		SUM =	**35.3**

Fire Flow Analysis Calculations
4/13/2016

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Client: Sheryl-Mar LLC.
Node: **Hydrant #1**

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Friction Loss

Hazen-Williams Formula $h_f = \frac{L * (4.73*Q_{gpm}^{1.85})}{(C^{1.85} * d^{4.87})}$

PIPE SIZE	6-in	8-in	16-in
Pipe Length	24	370 ft	0
Equiv Length	5	35.3	0
total	29.2	405.3	0
C	100	100	100
diameter	6-in	8-in	16-in
Q (GPM)	820	820	820
h_f =	1.10	3.76	0.00

TOTAL h_f = 4.86

Total Headloss

$H_{L(feet)} = h_S + h_f$ = 5.00 + 4.86

$H_{L(feet)}$ = 10 ft

$H_{L(psi)} = h_{L(feet)}$ / (144 sq inches/SF) * (62.4 lb/ft)

$H_{L(psi)}$ = 10 / (144 si/SF) * (62.4 lb/ft)

TOTAL H_L = 4 psi

From the System Performance Curve, the pressure at a flow of 820 gpm = 55 psi (127 ft)

Starting Pressure = 55 psi
Pressure loss due to friction and minor losses = 4 psi
Residual Pressure with a 820 gpm flow = 51 psi

this system satisfies the minimum fire flow requirements.

Fire Flow Analysis Calculations
4/13/2016

Project: Brookside at Fieldstone
Proj. Number: 113022.00
Client: Sheryl-Mar LLC.
Node: **Hydrant #2**

Ballentine Associates, P.A.
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221 Providence Road
Chapel Hill, NC 27514
(919) 929-0481 fax 489-2803

Water System Data

Flow (gpm)	Pressure (ft)	Pressure (psi)	
0	170.9	74	*Static Pressure*
839	124.7	54	*Residual Pressure*
1434.49	46.2	20	*Note: This is the calculated Q_{20} flow*

MINIMUM FIRE FLOW at 20 psi
Per Chatham County/NCDEQ: 500 gpm

FIRE FLOW REQUIREMENT: 500 gpm
DOMESTIC FLOW REQUIREMENT: 200 gpm — approximately 15 gpm (75% of meter capacity) per lot
IRRIGATION FLOW REQUIREMENT: 120 gpm — 40 gpm/meter (assuming 3 lots in use at a time)

TOTAL FLOW FOR CALCULATIONS: 820 gpm

Head Losses in Pipe

Static Headloss

Static Head = Δ Elevation

Elevation of Pipe @ Flow Test Node (Ground Elev minus 3 ft) = 547 ft NGVD
Nozzle Elevation @ New Fire Hydrant = 549 ft NGVD

Static Head (h_S) = 2 ft

Minor Losses (Equivalent Lengths)

PIPE SIZE 6-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	15	0	0
45° Elbow, flanged	4.5	0	0
Tee-through, flanged	3.1	0	0
Gate Valve, flanged	2.6	2	5.2
		SUM =	**5**

PIPE SIZE 16-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	39	0	0
45° Elbow, flanged	13	0	0
Tee-through, flanged	6.5	0	0
Gate Valve, flanged	3	0	0
		SUM =	**0**

PIPE SIZE 8-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	20	1	20
45° Elbow, flanged	6.3	4	25.2
Tee-through, flanged	3.9	1	3.9
Gate Valve, flanged	2.7	2	5.4
		SUM =	**54.5**

Fire Flow Analysis Calculations
4/13/2016

Project: Brookside at Fieldstone
Proj. Number: 113022.00
Client: Sheryl-Mar LLC.
Node: **Hydrant #2**

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Friction Loss

Hazen-Williams Formula $h_f = \frac{L * (4.73*Q_{gpm}^{1.85})}{(C^{1.85} * d^{4.87})}$

PIPE SIZE	6-in	8-in	16-in
Pipe Length	24	800 ft	0
Equiv Length	5	54.5	0
total	29.2	854.5	0
C	100	100	100
diameter	6-in	8-in	16-in
Q (GPM)	820	820	820
h_f =	1.10	7.93	0.00
TOTAL h_f =	**9.03**		

Total Headloss

$H_{L(feet)} = h_S + h_f =$ 2.00 + 9.03

$H_{L(feet)}$ = **11** **ft**

$H_{L(psi)} = h_{L(feet)}$ / (144 sq inches/SF) * (62.4 lb/ft)

$H_{L(psi)} =$ 11 / (144 si/SF) * (62.4 lb/ft)

TOTAL H_L = **5** **psi**

From the System Performance Curve, the pressure at a flow of 820 gpm = 55 psi (127 ft)

Starting Pressure = 55 psi
Pressure loss due to friction and minor losses = 5 psi
Residual Pressure with a 820 gpm flow = 50 psi

this system satisfies the minimum fire flow requirements.

Fire Flow Analysis Calculations
4/13/2016

Project: Brookside at Fieldstone
Proj. Number: 113022.00
Client: Sheryl-Mar LLC.
Node: **Hydrant #3**

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Chapel Hill, NC 27514
(919) 929-0481 fax 489-2803

Water System Data

Flow (gpm)	Pressure (ft)	Pressure (psi)	
0	170.9	74	*Static Pressure*
839	124.7	54	*Residual Pressure*
1434.49	46.2	20	*Note: This is the calculated Q_{20} flow*

MINIMUM FIRE FLOW at 20 psi
Per Chatham County/NCDEQ: 500 gpm

FIRE FLOW REQUIREMENT: 500 gpm
DOMESTIC FLOW REQUIREMENT: 200 gpm — approximately 15 gpm (75% of meter capacity) per lot
IRRIGATION FLOW REQUIREMENT: 120 gpm — 40 gpm/meter (assuming 3 lots in use at a time)

TOTAL FLOW FOR CALCULATIONS: 820 gpm

Head Losses in Pipe

Static Headloss

Static Head = Δ Elevation

Elevation of Pipe @ Flow Test Node (Ground Elev minus 3 ft) = 547 ft NGVD
Nozzle Elevation @ New Fire Hydrant = 539 ft NGVD

Static Head (h_S) = -8 ft

Minor Losses (Equivalent Lengths)

PIPE SIZE 6-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	15	0	0
45° Elbow, flanged	4.5	0	0
Tee-through, flanged	3.1	0	0
Gate Valve, flanged	2.6	2	5.2
		SUM =	**5**

PIPE SIZE 16-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	39	0	0
45° Elbow, flanged	13	0	0
Tee-through, flanged	6.5	0	0
Gate Valve, flanged	3	0	0
		SUM =	**0**

PIPE SIZE 8-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	20	1	20
45° Elbow, flanged	6.3	6	37.8
Tee-through, flanged	3.9	2	7.8
Gate Valve, flanged	2.7	3	8.1
		SUM =	**73.7**

Fire Flow Analysis Calculations
4/13/2016

Project: Brookside at Fieldstone
Proj. Number: 113022.00
Client: Sheryl-Mar LLC.
Node: **Hydrant #3**

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Friction Loss

Hazen-Williams Formula $h_f = \frac{L * (4.73*Q_{gpm}^{1.85})}{(C^{1.85} * d^{4.87})}$

PIPE SIZE	6-in	8-in	16-in
Pipe Length	24	1150 ft	0
Equiv Length	5	73.7	0
total	29.2	1223.7	0
C	100	100	100
diameter	6-in	8-in	16-in
Q (GPM)	820	820	820
h_f =	1.10	11.35	0.00

TOTAL h_f = 12.45

Total Headloss

$H_{L(feet)} = h_S + h_f =$ (8.00) + 12.45

$H_{L(feet)}$ = 4 ft

$H_{L(psi)} = h_{L(feet)}$ / (144 sq inches/SF) * (62.4 lb/ft)

$H_{L(psi)}$ = 4 / (144 si/SF) * (62.4 lb/ft)

TOTAL H_L = 2 psi

From the System Performance Curve, the pressure at a flow of 820 gpm = 55 psi (127 ft)

Starting Pressure = 55 psi
Pressure loss due to friction and minor losses = 2 psi
Residual Pressure with a 820 gpm flow = 53 psi

this system satisfies the minimum fire flow requirements.

Fire Flow Analysis Calculations
4/13/2016

Project: Brookside at Fieldstone
Proj. Number: 113022.00
Client: Sheryl-Mar LLC.
Node: **Hydrant #3**

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Water System Data

Flow (gpm)	Pressure (ft)	Pressure (psi)	
0	170.9	74	*Static Pressure*
839	124.7	54	*Residual Pressure*
1434.49	46.2	20	*Note: This is the calculated Q_{20} flow*

MINIMUM FIRE FLOW at 20 psi
Per Chatham County/NCDEQ: 500 gpm

FIRE FLOW REQUIREMENT: 500 gpm
DOMESTIC FLOW REQUIREMENT: 200 gpm — approximately 15 gpm (75% of meter capacity) per lot
IRRIGATION FLOW REQUIREMENT: 120 gpm — 40 gpm/meter (assuming 3 lots in use at a time)

TOTAL FLOW FOR CALCULATIONS: 820 gpm

Head Losses in Pipe

Static Headloss

Static Head = Δ Elevation

Elevation of Pipe @ Flow Test Node (Ground Elev minus 3 ft) = 547 ft NGVD
Nozzle Elevation @ New Fire Hydrant = 535 ft NGVD

Static Head (h_S) = -12 ft

Minor Losses (Equivalent Lengths)

PIPE SIZE 6-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	15	0	0
45° Elbow, flanged	4.5	0	0
Tee-through, flanged	3.1	0	0
Gate Valve, flanged	2.6	2	5.2
		SUM =	**5**

PIPE SIZE 16-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	39	0	0
45° Elbow, flanged	13	0	0
Tee-through, flanged	6.5	0	0
Gate Valve, flanged	3	0	0
		SUM =	**0**

PIPE SIZE 8-in

Fitting Type	Eq Len	Qty	Total
Tee-branch, flanged	20	1	20
45° Elbow, flanged	6.3	8	50.4
Tee-through, flanged	3.9	3	11.7
Gate Valve, flanged	2.7	4	10.8
		SUM =	**92.9**

Fire Flow Analysis Calculations
4/13/2016

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Client: Sheryl-Mar LLC.
Node: **Hydrant #3**

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Friction Loss

Hazen-Williams Formula $h_f = \frac{L * (4.73*Q_{gpm}^{1.85})}{(C^{1.85} * d^{4.87})}$

PIPE SIZE	6-in	8-in	16-in
Pipe Length	24	1600 ft	0
Equiv Length	5	92.9	0
total	29.2	1692.9	0
C	100	100	100
diameter	6-in	8-in	16-in
Q (GPM)	820	820	820
h_f =	1.10	15.70	0.00

TOTAL h_f = 16.80

Total Headloss

$H_{L(feet)} = h_S + h_f =$ (12.00) + 16.80

$H_{L(feet)}$ = 5 ft

$H_{L(psi)} = h_{L(feet)}$ / (144 sq inches/SF) * (62.4 lb/ft)

$H_{L(psi)}$ = 5 / (144 si/SF) * (62.4 lb/ft)

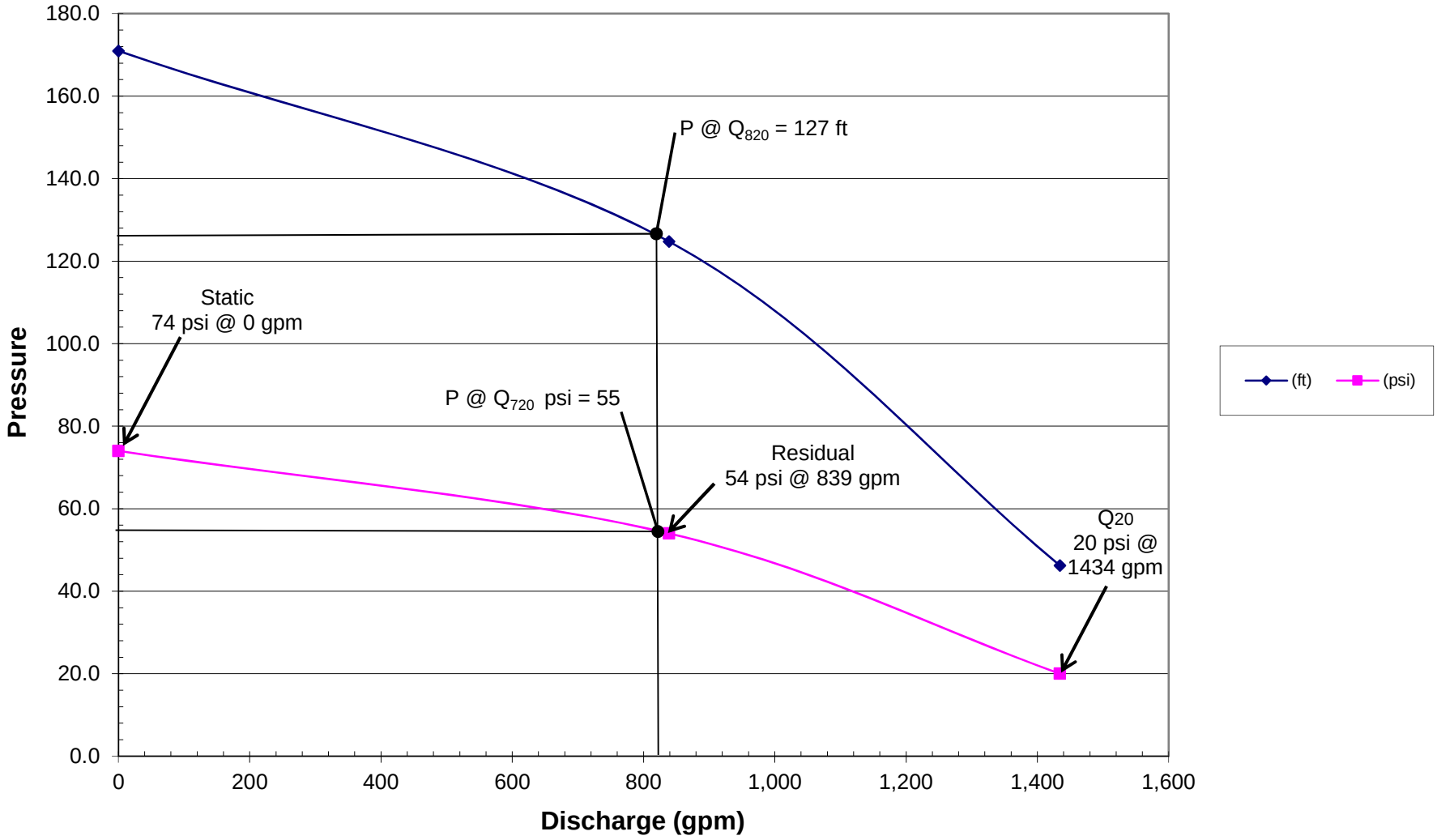
TOTAL H_L = 2 psi

From the System Performance Curve, the pressure at a flow of 820 gpm = 55 psi (127 ft)

Starting Pressure = 55 psi
Pressure loss due to friction and minor losses = 2 psi
Residual Pressure with a 820 gpm flow = 53 psi

this system satisfies the minimum fire flow requirements.

System Performance Curve



Equivalent Length of STEEL Straight Pipe for Various Fittings in feet, turbulent flow only

	Pipe Size, Inches													
FITTINGS	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**
90° Elbow, screwed	5.2	8.5	11	13										
90° Elbow, flanged	1.6	3.1	4.4	5.9	7.3	8.9	12	14	17	18	21	23	25	30
45° Elbow, screwed	1.3	2.7	4.0	5.5										
45° Elbow, flanged	0.8	1.7	2.6	3.5	4.5	5.6	7.7	9	11	13	15	16	18	22
Tee-branch, screwed	6.6	12.0	17.0	21.0										
Tee-branch, flanged	3.3	6.6	9.4	12	15	18	24	30	34	37	43	47	52	62
Tee-through, screwed	3.2	7.7	12	17										
Tee-through, flanged	1.0	1.8	2.2	2.8	3.3	3.8	4.7	5.2	6.0	6.4	7.2	7.6	8.2	9.6
Coupling, screwed	0.3	0.5	0.5	0.7										
Globe Valve, screwed	29	54	79	110										
Globe Valve, flanged	45	70	94	120	150	190	260	310	390					
Swing Check Valve, screwed	11	19	27	38										
Swing Check Valve, flanged	7.2	17	27	38	50	63	90	120	140					
Gate Valve, screwed	0.8	1.5	1.9	2.5										
Gate Valve, flanged		2.6	2.8	2.9	3.1	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Bell Inlet, Steel	0.2	0.4	0.7	1.0	1.3	1.6	2.3	2.9	3.5	4.0	4.7	5.3	6.1	7.6
Square Inlet, Steel	1.3	3.1	6.7	9.5	13	16	23	29	35	40	47	53	61	76
Re-entrant, Steel	3.6	8.5	13	19	25	32	45	58	70	80	95	110	120	150

Civil Engineering Reference Manual, 8th Edition, 2001 Appendix 17.D

Equivalent Length of CAST IRON Straight Pipe for Various Fittings in feet, turbulent flow only

	Pipe Size, Inches													
FITTINGS	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**
90° Elbow, screwed			9	11										
90° Elbow, flanged			3.6	4.8		7.2	10	12	15	17	19	22	24	28
45° Elbow, screwed			3.3	4.5										
45° Elbow, flanged			2.1	2.9		4.5	6.3	8	10	12	13	15	17	20
Tee-branch, screwed			14	17										
Tee-branch, flanged			7.7	10		15	20	25	30	35	39	44	49	57
Tee-through, screwed			10	14										
Tee-through, flanged			1.9	2.2		3.1	3.9	4.6	5.2	5.9	6.5	7.2	7.7	8.8
Coupling, screwed			0.44	0.52										
Globe Valve, screwed			65	86										
Globe Valve, flanged			77	99		150	210	270	330					
Swing Check Valve, screwed			22	31										
Swing Check Valve, flanged			22	31		52	74	98	120					
Gate Valve, screwed			1.6	2.0										
Gate Valve, flanged	0.0		2.3	2.4		2.6	2.7	2.8	2.9	2.9	3.0	3.0	3.0	3.0
Bell Inlet, Steel	2.0		0.55	0.77		1.3	1.9	2.4	3.0	3.6	4.3	5.0	5.7	7.0
Square Inlet, Steel			5.5	7.7		13	19	24	30	36	43	50	57	70
Re-entrant, Steel			11	15		26	37	49	61	73	86	100	110	140

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Equivalent Length of PVC Straight Pipe for Various Fittings in feet, turbulent flow only

24	370													
FITTINGS	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**
90° Elbow	2.6	5.2	7.7	10.1	12.6	15.2	20.0	25.1	29.8	32.8	37.5	42.2	47.0	56.6
45° Elbow	1.4	2.8	4.1	5.4	6.7	8.1	10.6	13.4	15.9	17.5	20.0	22.5	25.1	30.2
Tee-branch flow	5.3	10.3	15.3	20.1	25.2	30.3	39.9	50.1	59.7	65.6	75.0	84.4	94.1	113.0
Tee-through flow	1.8	3.5	5.1	6.7	8.4	10.1	13.3	16.7	19.9	21.8	25.0	28.1	31.4	37.7
Globe Valve, full open	29.7	58.6	86.9	114	143	172	226	284	338	372	425	478	533	641
Swing Check Valve, full open	8.7	17.2	25.5	33.6	42.1	50.5	33.3	41.8	49.7	54.7	62.5	70.3	78.4	94.3
Gate Valve, full open	0.7	1.4	2.0	2.7	3.4	4.0	5.3	6.7	8.0	8.8	10.0	16.9	12.5	15.1

Handbook of PVC Pipe, 4th Edition, 2001 Table 9.1