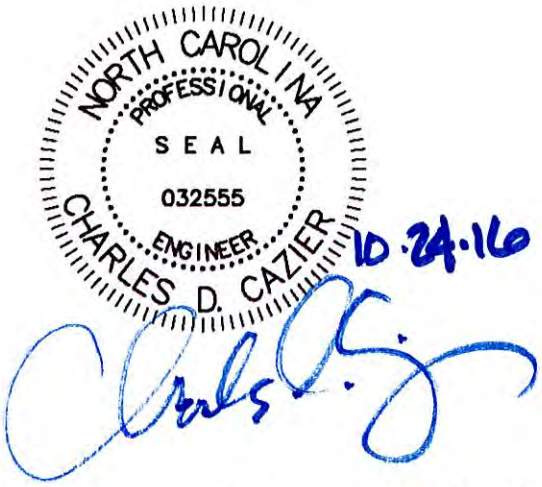
# CALCULATIONS

for

# Family Fare Market St.

CITY OF WILMINGTON
NORTH CAROLINA

October 2016




**Prepared By:**

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Final SW Calcs
SWP 2017017
4/4/2017
RAC

PN 2015-049

| Total Drainage Area | |
|---|---|
| sq. ft. | acres |
| 54,450 | 1.25 |

| Impervious Area | | | |
|---|---|---|---|
| Land Use | | sq. ft. | acres |
| buildings | | 4,500 | 0.10 |
| parking/asphalt | | 25,814 | 0.59 |
| Sidewalks | | 947 | 0.02 |
| Future/Outparcel | | 4,504 | 0.10 |
| | Total | 35,765 | 0.82 |

% impervious = 0.657
= 65.7%
say 66.0%

Stormwater Calculations:

Time of Concentration:

Hydraulic Length (L) = 600 ft.
change in Height (H) = 2 ft.
$T_C = (L^3/H)^{.385} / 128$
= 9.68 min.

Flow for 10 year, 24 hour Storm ($Q_{10}$):

$Q_{PRE} = (C_{PRE}) \times (I_{10}) \times (Area)$
= 1.81 cfs
$Q_{POST} = (C_{POST}) \times (I_{10}) \times (Area)$
= 6.33 cfs

$C_{PRE}$ = 0.2
$C_{POST}$ = (% imp.)(.95)+(1-% imp.)(.2)
= 0.7
$I_{10}$ = 7.23 in/hr

Detention Pond Design:

Pond Size:

| | Elevation (ft.) | Surface Area (sq. ft.) |
|---|---|---|
| Normal Pool | 26.00 | 3,521 |
| Flood Pool | 27.25 | 4,621 |
| Top of Bank | 29.50 | 4,621 |
| Bottom of Pool | 21.50 | 1,739 |

Provided Storage Volume:

Vol. = [(Normal pool SA + Flood Pool SA) / 2]
x (F.P. elev. - N.P. elev.)
= 5,089 cu. ft.

State Volume Required for Storage of first 1.5" of runoff:

Rv = .05+ .009(% imp)
= 0.641157
V= (Design rainfall)(Rv)(Drainage Area)
= 4,364 cu. ft.

State Surface Area Requirement at normal pool:

Pond side slopes = 3 :1
Depth below N.P. = 3.66 ft.
SA/DA = 0.0632
(Chart for 90% TSS Removal for Wet Detention Pond without Vegetative Filter)
Required SA = (SA/DA) x (Total Drainage Area)
= 3,441 sq. ft.

Average Depth Calculation:

d= [0.25 x (1+ BVS SA/NP SA)] + [((BVS SA +Btm SA)/2)x(D/BVS SA)]
= 3.66 ft

*Bottom of Veg Shelf whole pond= 1,947.00 sf*

Main Pond Volume:

| | | |
|---|---|---|
| Bottom SA = | 1,240 sq. ft. | el 21.50 |
| Btm Veg Shelf SA = | 1,947 sq. ft. | el 25.50 |
| Normal Pool SA = | 2,662 sq. ft. | el 26.00 |

Vol. = [(NP SA + BVS SA) / 2] x (NP el. - BVS el.)+[(Bottom. SA + BVS SA) / 2] x (Bottom. el. - BVS el.)
= 7,526 cu. ft.

Forebay Volume:

| | | |
|---|---|---|
| Bottom SA = | 499 sq. ft. | el 23.00 |
| Normal Pool SA = | 859 sq. ft. | el 26.00 |

Vol. = [(NP SA + BVS SA) / 2] x (NP el. - BVS el.)+[(Bottom. SA + BVS SA) / 2] x (Bottom. el. - BVS el.)
= 2,037 cu. ft.

Forebay:

Required Volume

Vol. = 20% of Pond Volume (MPV + FV)
= 1,913 cu. ft.

Provided Volume

Vol. =
= 2,037 cu. ft.

Outlet Structure Design:

* Additional flow from Ground Water Table= 0 cfs

Flow for 2-day drawdown:

for Required Volume
Q = (Required Vol. / 172,800 sec.)+Gw flow
= 0.025 cfs

Flow for 5-day drawdown:

for Required Volume
Q = (Required Vol. / 432,000 sec)+Gw flow
= 0.010 cfs

Required Area of Pipe for 2-day drawdown:

A = Q / [Cd x SQRT(2 x g x h)]
Cd = 0.6
g = 32.2 ft./s$^2$
h = (F.P. elev.- N.P. elev.) /3
= 0.416667 ft.
A = 0.0081 sq. ft.

Required Area of Pipe for 5-day drawdown:

A = Q / [Cd x SQRT(2 x g x h)]
Cd = 0.6
g = 32.2 ft./s$^2$
h = (F.P. elev. - N.P. elev.) / 3
= 0.416667 ft.
A = 0.0033 sq. ft.

Diameter of Pipe for 2-day drawdown:

DIA. = SQRT[(A x 4) / pi]
= 0.1017 ft.
= 1.22 in.

*Use: 1" diameter pipe

Drawdown time 1" pipe = 3.53 days

Diameter of Pipe for 5-day drawdown:

DIA. = SQRT[(A x 4) / pi]
= 0.0643 ft.
= 0.77 in.

## WATERSHED DATA

**BEFORE DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.2 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (2YR) | 5.88 IN/HR |

**Qa = 1.47 CFS**

Qa = PRE-DEVELOPED PEAK DISCHARGE

**AFTER DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.7 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (2YR) | 5.88 IN/HR |

**Qp = 5.15 CFS**

Qp = POST-DEVELOPED PEAK DISCHARGE

**COMPUTE DEPTH OF RUNOFF**

P = 4.5 **INCHES** 2yr, 24hr PRECIPITATION
CN = 88

S = (1000/CN)-10
S = 1.36

Depth (D) = (P-0.2S)^2/(P+0.8S)
D = 3.20 IN - 2yr, 24hr RUNOFF DEPTH

**SET VOLUME AND COMPUTE TIME TO PEAK**

Tp = [(43.5)(D)(Area)] / Qp
Tp = 33.78 MINUTES

Storage Volume Req'd = (Qp-Qa)*Tp*1.39*60
= 10,353 cu. ft.

**CALCULATE Ks AND b**

SET NORMAL ELEVATION AT = 26.00 feet

| CONTOUR | CONTOUR AREA (sq ft) | INCR VOL (cu ft) | S ACCUM VOL (cu ft) | Z STAGE (ft) | ln S | ln Z | Z est (ft) |
|---|---|---|---|---|---|---|---|
| 26.00 | 5,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27.00 | 7,286 | 6,375 | 6,375 | 1.0 | 8.7601 | 0 | 1.00 |
| 28.00 | 7,970 | 7,628 | 14,003 | 2.0 | 9.5470 | 0.6931 | 1.99 |
| 29.00 | 8,711 | 8,341 | 22,344 | 3.0 | 10.0143 | 1.0986 | 3.00 |
| 30.00 | 9,508 | 9,110 | 31,453 | 4.0 | 10.3562 | 1.3863 | 4.05 |
| 31.00 | | | 31,453 | 5.0 | 10.3562 | 1.6094 | 4.05 |
| 32.00 | | | 31,453 | 6.0 | 10.3562 | 1.7918 | 4.05 |
| 33.00 | | | 31,453 | 7.0 | 10.3562 | 1.9459 | 4.05 |

Regression Output:
**==> Ks = 6368**
**b = 1.14**

X Coefficient 8.76

**CHAINSAW METHOD FOR RISER BARREL ROUTING**

**STORM DATA**

| | |
|---|---|
| Qa = | 1.47 cfs |
| Qp = | 5.15 cfs |
| Tp = | 33.8 min |
| dT = | 2 min |

* *Infiltration rate* = 0 *in/hr*

**BASIN DATA**

| | |
|---|---|
| Ks = | 6368 |
| b = | 1.14 |
| Zo = | 26.00 ft |
| Normal water elev = | 26.00 ft |
| Box Weir Length = | 10 ft |
| Cw = | 3.0 |
| Zcr = | 28.80 ft |
| Dd = | 15 in |
| Cd = | 0.59 |
| Zi = | 26.00 ft |

| | |
|---|---|
| **Peak Outflow =** | 0.74 cfs |
| Peak Stage = | 27.74 ft |
| Maximum Storage = | 11,966 cu ft |

Control Holes:

| | | |
|---|---|---|
| State Orifice: | Dia = | 1.00 in |
| | Inv = | 26.00 ft |
| Weir: | L = | 4 in |
| | Inv = | 27.25 ft |

| Time (min) | Inflow (cfs) | Storage (cu ft) | Stage (ft) | Outflow (cfs) | W Riser (cfs) | Barrel (cfs) | Orifice (cfs) | City Weir (cfs) | IFStore (cu ft) | Infiltrate (cf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0 | 26.00 | 0.00 | 0 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 2 | 0.0 | 0 | 26.00 | 0 | 0.00 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 4 | 0.2 | 5 | 26.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 5.3 | 0.0 |
| 6 | 0.4 | 26 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 26.4 | 0.0 |
| 8 | 0.7 | 73 | 26.02 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 73.2 | 0.0 |
| 10 | 1.0 | 155 | 26.04 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 154.7 | 0.0 |
| 12 | 1.4 | 279 | 26.06 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 278.7 | 0.0 |
| 14 | 1.9 | 451 | 26.10 | 0.01 | 0.00 | 0.1 | 0.01 | 0.00 | 451.4 | 0.0 |
| 16 | 2.4 | 677 | 26.14 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 677.4 | 0.0 |
| 18 | 2.8 | 960 | 26.19 | 0.01 | 0.00 | 0.3 | 0.01 | 0.00 | 959.6 | 0.0 |
| 20 | 3.3 | 1299 | 26.25 | 0.01 | 0.00 | 0.4 | 0.01 | 0.00 | 1298.9 | 0.0 |
| 22 | 3.7 | 1694 | 26.31 | 0.01 | 0.00 | 0.6 | 0.01 | 0.00 | 1694.3 | 0.0 |
| 24 | 4.2 | 2143 | 26.38 | 0.02 | 0.00 | 0.8 | 0.02 | 0.00 | 2142.6 | 0.0 |
| 26 | 4.5 | 2639 | 26.46 | 0.02 | 0.00 | 1.0 | 0.02 | 0.00 | 2639.1 | 0.0 |
| 28 | 4.8 | 3177 | 26.54 | 0.02 | 0.00 | 1.3 | 0.02 | 0.00 | 3177.1 | 0.0 |
| 30 | 5.0 | 3749 | 26.63 | 0.02 | 0.00 | 1.6 | 0.02 | 0.00 | 3748.8 | 0.0 |
| 32 | 5.1 | 4345 | 26.72 | 0.02 | 0.00 | 2.0 | 0.02 | 0.00 | 4345.0 | 0.0 |
| 34 | 5.1 | 4956 | 26.80 | 0.02 | 0.00 | 2.4 | 0.02 | 0.00 | 4955.6 | 0.0 |
| 36 | 5.1 | 5570 | 26.89 | 0.02 | 0.00 | 2.8 | 0.02 | 0.00 | 5570.3 | 0.0 |
| 38 | 4.9 | 6178 | 26.97 | 0.02 | 0.00 | 3.2 | 0.02 | 0.00 | 6178.2 | 0.0 |
| 40 | 4.7 | 6769 | 27.05 | 0.03 | 0.00 | 3.6 | 0.03 | 0.00 | 6769.2 | 0.0 |
| 42 | 4.4 | 7333 | 27.13 | 0.03 | 0.00 | 4.0 | 0.03 | 0.00 | 7333.2 | 0.0 |
| 44 | 4.1 | 7861 | 27.20 | 0.03 | 0.00 | 4.3 | 0.03 | 0.00 | 7861.5 | 0.0 |
| 46 | 3.8 | 8351 | 27.27 | 0.04 | 0.00 | 4.7 | 0.03 | 0.01 | 8350.9 | 0.0 |
| 48 | 3.5 | 8803 | 27.33 | 0.09 | 0.00 | 4.9 | 0.03 | 0.06 | 8803.0 | 0.0 |
| 50 | 3.3 | 9215 | 27.38 | 0.16 | 0.00 | 5.0 | 0.03 | 0.13 | 9215.0 | 0.0 |
| 52 | 3.0 | 9587 | 27.43 | 0.23 | 0.00 | 5.2 | 0.03 | 0.20 | 9587.4 | 0.0 |
| 54 | 2.8 | 9922 | 27.47 | 0.31 | 0.00 | 5.3 | 0.03 | 0.28 | 9921.5 | 0.0 |
| 56 | 2.6 | 10219 | 27.51 | 0.39 | 0.00 | 5.5 | 0.03 | 0.36 | 10219.5 | 0.0 |
| 58 | 2.4 | 10483 | 27.55 | 0.46 | 0.00 | 5.6 | 0.03 | 0.43 | 10483.4 | 0.0 |
| 60 | 2.2 | 10716 | 27.58 | 0.53 | 0.00 | 5.7 | 0.03 | 0.49 | 10715.8 | 0.0 |
| 62 | 2.1 | 10919 | 27.60 | 0.57 | 0.00 | 5.7 | 0.03 | 0.54 | 10918.8 | 0.0 |
| 64 | 1.9 | 11097 | 27.63 | 0.60 | 0.00 | 5.8 | 0.03 | 0.57 | 11097.1 | 0.0 |
| 66 | 1.8 | 11253 | 27.65 | 0.63 | 0.00 | 5.9 | 0.03 | 0.59 | 11253.3 | 0.0 |
| 68 | 1.6 | 11389 | 27.66 | 0.65 | 0.00 | 5.9 | 0.03 | 0.62 | 11389.4 | 0.0 |
| 70 | 1.5 | 11507 | 27.68 | 0.67 | 0.00 | 6.0 | 0.03 | 0.63 | 11507.2 | 0.0 |
| 72 | 1.4 | 11608 | 27.69 | 0.68 | 0.00 | 6.0 | 0.03 | 0.65 | 11608.3 | 0.0 |
| 74 | 1.3 | 11694 | 27.70 | 0.70 | 0.00 | 6.0 | 0.03 | 0.66 | 11694.0 | 0.0 |
| 76 | 1.2 | 11766 | 27.71 | 0.71 | 0.00 | 6.1 | 0.03 | 0.67 | 11765.8 | 0.0 |
| 78 | 1.1 | 11825 | 27.72 | 0.72 | 0.00 | 6.1 | 0.03 | 0.68 | 11824.8 | 0.0 |
| 80 | 1.0 | 11872 | 27.73 | 0.72 | 0.00 | 6.1 | 0.03 | 0.69 | 11872.2 | 0.0 |
| 82 | 1.0 | 11909 | 27.73 | 0.73 | 0.00 | 6.1 | 0.03 | 0.69 | 11908.8 | 0.0 |
| 84 | 0.9 | 11936 | 27.73 | 0.73 | 0.00 | 6.1 | 0.03 | 0.70 | 11935.7 | 0.0 |
| 86 | 0.8 | 11954 | 27.74 | 0.73 | 0.00 | 6.1 | 0.03 | 0.70 | 11953.7 | 0.0 |
| 88 | 0.8 | 11964 | 27.74 | 0.73 | 0.00 | 6.1 | 0.03 | 0.70 | 11963.5 | 0.0 |
| 90 | 0.7 | 11966 | 27.74 | 0.74 | 0.00 | 6.1 | 0.03 | 0.70 | 11966.0 | 0.0 |
| 92 | 0.6 | 11962 | 27.74 | 0.73 | 0.00 | 6.1 | 0.03 | 0.70 | 11961.6 | 0.0 |
| 94 | 0.6 | 11951 | 27.74 | 0.73 | 0.00 | 6.1 | 0.03 | 0.70 | 11951.2 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 0.6 | 11935 | 27.73 | 0.73 | 0.00 | 6.1 | 0.03 | 0.70 | 11935.1 | 0.0 |
| 98 | 0.5 | 11914 | 27.73 | 0.73 | 0.00 | 6.1 | 0.03 | 0.69 | 11914.0 | 0.0 |
| 100 | 0.5 | 11888 | 27.73 | 0.72 | 0.00 | 6.1 | 0.03 | 0.69 | 11888.3 | 0.0 |
| 102 | 0.4 | 11858 | 27.72 | 0.72 | 0.00 | 6.1 | 0.03 | 0.69 | 11858.5 | 0.0 |
| 104 | 0.4 | 11825 | 27.72 | 0.72 | 0.00 | 6.1 | 0.03 | 0.68 | 11824.9 | 0.0 |
| 106 | 0.4 | 11788 | 27.72 | 0.71 | 0.00 | 6.1 | 0.03 | 0.68 | 11788.1 | 0.0 |
| 108 | 0.3 | 11748 | 27.71 | 0.70 | 0.00 | 6.0 | 0.03 | 0.67 | 11748.2 | 0.0 |
| 110 | 0.3 | 11706 | 27.71 | 0.70 | 0.00 | 6.0 | 0.03 | 0.66 | 11705.7 | 0.0 |
| 112 | 0.3 | 11661 | 27.70 | 0.69 | 0.00 | 6.0 | 0.03 | 0.66 | 11660.8 | 0.0 |
| 114 | 0.3 | 11614 | 27.69 | 0.68 | 0.00 | 6.0 | 0.03 | 0.65 | 11613.9 | 0.0 |
| 116 | 0.3 | 11565 | 27.69 | 0.68 | 0.00 | 6.0 | 0.03 | 0.64 | 11565.1 | 0.0 |
| 118 | 0.2 | 11515 | 27.68 | 0.67 | 0.00 | 6.0 | 0.03 | 0.64 | 11514.8 | 0.0 |
| 120 | 0.2 | 11463 | 27.67 | 0.66 | 0.00 | 5.9 | 0.03 | 0.63 | 11463.1 | 0.0 |
| 122 | 0.2 | 11410 | 27.67 | 0.65 | 0.00 | 5.9 | 0.03 | 0.62 | 11410.2 | 0.0 |
| 124 | 0.2 | 11356 | 27.66 | 0.64 | 0.00 | 5.9 | 0.03 | 0.61 | 11356.4 | 0.0 |
| 126 | 0.2 | 11302 | 27.65 | 0.63 | 0.00 | 5.9 | 0.03 | 0.60 | 11301.9 | 0.0 |
| 128 | 0.2 | 11247 | 27.65 | 0.63 | 0.00 | 5.9 | 0.03 | 0.59 | 11246.7 | 0.0 |
| 130 | 0.1 | 11191 | 27.64 | 0.62 | 0.00 | 5.8 | 0.03 | 0.58 | 11191.0 | 0.0 |
| 132 | 0.1 | 11135 | 27.63 | 0.61 | 0.00 | 5.8 | 0.03 | 0.57 | 11135.1 | 0.0 |
| 134 | 0.1 | 11079 | 27.62 | 0.60 | 0.00 | 5.8 | 0.03 | 0.56 | 11078.9 | 0.0 |
| 136 | 0.1 | 11023 | 27.62 | 0.59 | 0.00 | 5.8 | 0.03 | 0.55 | 11022.7 | 0.0 |
| 138 | 0.1 | 10967 | 27.61 | 0.58 | 0.00 | 5.8 | 0.03 | 0.54 | 10966.6 | 0.0 |
| 140 | 0.1 | 10911 | 27.60 | 0.57 | 0.00 | 5.7 | 0.03 | 0.53 | 10910.6 | 0.0 |
| 142 | 0.1 | 10855 | 27.60 | 0.56 | 0.00 | 5.7 | 0.03 | 0.52 | 10854.9 | 0.0 |
| 144 | 0.1 | 10799 | 27.59 | 0.55 | 0.00 | 5.7 | 0.03 | 0.51 | 10799.5 | 0.0 |
| 146 | 0.1 | 10745 | 27.58 | 0.54 | 0.00 | 5.7 | 0.03 | 0.50 | 10744.5 | 0.0 |
| 148 | 0.1 | 10690 | 27.57 | 0.52 | 0.00 | 5.7 | 0.03 | 0.49 | 10690.1 | 0.0 |
| 150 | 0.1 | 10637 | 27.57 | 0.50 | 0.00 | 5.6 | 0.03 | 0.47 | 10636.8 | 0.0 |
| 152 | 0.1 | 10585 | 27.56 | 0.49 | 0.00 | 5.6 | 0.03 | 0.46 | 10584.7 | 0.0 |
| 154 | 0.1 | 10534 | 27.55 | 0.47 | 0.00 | 5.6 | 0.03 | 0.44 | 10533.8 | 0.0 |
| 156 | 0.1 | 10484 | 27.55 | 0.46 | 0.00 | 5.6 | 0.03 | 0.43 | 10484.0 | 0.0 |
| 158 | 0.1 | 10435 | 27.54 | 0.45 | 0.00 | 5.6 | 0.03 | 0.41 | 10435.4 | 0.0 |
| 160 | 0.0 | 10388 | 27.54 | 0.43 | 0.00 | 5.5 | 0.03 | 0.40 | 10388.0 | 0.0 |
| 162 | 0.0 | 10342 | 27.53 | 0.42 | 0.00 | 5.5 | 0.03 | 0.39 | 10341.6 | 0.0 |
| 164 | 0.0 | 10296 | 27.52 | 0.41 | 0.00 | 5.5 | 0.03 | 0.38 | 10296.4 | 0.0 |
| 166 | 0.0 | 10252 | 27.52 | 0.40 | 0.00 | 5.5 | 0.03 | 0.37 | 10252.2 | 0.0 |
| 168 | 0.0 | 10209 | 27.51 | 0.39 | 0.00 | 5.5 | 0.03 | 0.35 | 10209.2 | 0.0 |
| 170 | 0.0 | 10167 | 27.51 | 0.37 | 0.00 | 5.4 | 0.03 | 0.34 | 10167.1 | 0.0 |
| 172 | 0.0 | 10126 | 27.50 | 0.36 | 0.00 | 5.4 | 0.03 | 0.33 | 10126.1 | 0.0 |
| 174 | 0.0 | 10086 | 27.50 | 0.35 | 0.00 | 5.4 | 0.03 | 0.32 | 10086.0 | 0.0 |
| 176 | 0.0 | 10047 | 27.49 | 0.34 | 0.00 | 5.4 | 0.03 | 0.31 | 10046.9 | 0.0 |
| 178 | 0.0 | 10009 | 27.49 | 0.33 | 0.00 | 5.4 | 0.03 | 0.30 | 10008.8 | 0.0 |
| 180 | 0.0 | 9972 | 27.48 | 0.32 | 0.00 | 5.4 | 0.03 | 0.29 | 9971.6 | 0.0 |
| 182 | 0.0 | 9935 | 27.48 | 0.32 | 0.00 | 5.4 | 0.03 | 0.28 | 9935.4 | 0.0 |
| 184 | 0.0 | 9900 | 27.47 | 0.31 | 0.00 | 5.3 | 0.03 | 0.28 | 9900.0 | 0.0 |
| 186 | 0.0 | 9865 | 27.47 | 0.30 | 0.00 | 5.3 | 0.03 | 0.27 | 9865.4 | 0.0 |
| 188 | 0.0 | 9832 | 27.46 | 0.29 | 0.00 | 5.3 | 0.03 | 0.26 | 9831.7 | 0.0 |
| 190 | 0.0 | 9799 | 27.46 | 0.28 | 0.00 | 5.3 | 0.03 | 0.25 | 9798.8 | 0.0 |
| 192 | 0.0 | 9767 | 27.45 | 0.27 | 0.00 | 5.3 | 0.03 | 0.24 | 9766.8 | 0.0 |
| 194 | 0.0 | 9735 | 27.45 | 0.27 | 0.00 | 5.3 | 0.03 | 0.24 | 9735.5 | 0.0 |
| 196 | 0.0 | 9705 | 27.45 | 0.26 | 0.00 | 5.3 | 0.03 | 0.23 | 9704.9 | 0.0 |
| 198 | 0.0 | 9675 | 27.44 | 0.25 | 0.00 | 5.2 | 0.03 | 0.22 | 9675.1 | 0.0 |
| 200 | 0.0 | 9646 | 27.44 | 0.25 | 0.00 | 5.2 | 0.03 | 0.22 | 9646.0 | 0.0 |
| 202 | 0.0 | 9618 | 27.44 | 0.24 | 0.00 | 5.2 | 0.03 | 0.21 | 9617.6 | 0.0 |
| 204 | 0.0 | 9590 | 27.43 | 0.23 | 0.00 | 5.2 | 0.03 | 0.20 | 9589.9 | 0.0 |

## WATERSHED DATA

**BEFORE DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.2 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (10YR) | 7.23 IN/HR |

**Qa = 1.81 CFS**

Qa = PRE-DEVELOPED PEAK DISCHARGE

**AFTER DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.7 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (10YR) | 7.23 IN/HR |

**Qp = 6.33 CFS**

Qp = POST-DEVELOPED PEAK DISCHARGE

**COMPUTE DEPTH OF RUNOFF**

P = 7 INCHES 10yr, 24hr PRECIPITATION
CN = 88

S = (1000/CN)-10
S = 1.36

Depth (D) = (P-0.2S)^2/(P+0.8S)
D = 5.59 IN - 10yr, 24hr RUNOFF DEPTH

**SET VOLUME AND COMPUTE TIME TO PEAK**

Tp = [(43.5)(D)(Area)] / Qp
Tp = 48.08 MINUTES

Storage Volume Req'd = (Qp-Qa)*Tp*1.39*60
= 18,118 cu. ft.

**CALCULATE Ks AND b**

SET NORMAL ELEVATION AT = 26.00 feet

| CONTOUR | CONTOUR AREA (sq ft) | INCR VOL (cu ft) | S ACCUM VOL (cu ft) | Z STAGE (ft) | ln S | ln Z | Z est (ft) |
|---|---|---|---|---|---|---|---|
| 26.00 | 5,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27.00 | 7,286 | 6,375 | 6,375 | 1.0 | 8.7601 | 0 | 1.00 |
| 28.00 | 7,970 | 7,628 | 14,003 | 2.0 | 9.5470 | 0.6931 | 1.99 |
| 29.00 | 8,711 | 8,341 | 22,344 | 3.0 | 10.0143 | 1.0986 | 3.00 |
| 30.00 | 9,508 | 9,110 | 31,453 | 4.0 | 10.3562 | 1.3863 | 4.05 |
| 31.00 | | | 31,453 | 5.0 | 10.3562 | 1.6094 | 4.05 |
| 32.00 | | | 31,453 | 6.0 | 10.3562 | 1.7918 | 4.05 |
| 33.00 | | | 31,453 | 7.0 | 10.3562 | 1.9459 | 4.05 |

Regression Output:
**==> Ks = 6368**
**b = 1.14**

X Coefficient 8.76

**CHAINSAW METHOD FOR RISER BARREL ROUTING**

**STORM DATA**

| | | | |
|---|---|---|---|
| Qa = | 1.81 cfs | * *Infiltration rate* = | 0 *in/hr* |
| Qp = | 6.33 cfs | | |
| Tp = | 48.1 min | | |
| dT = | 2 min | | |

**BASIN DATA**

| | | | |
|---|---|---|---|
| Ks = | 6368 | | |
| b = | 1.14 | | |
| Zo = | 26.00 ft | | |
| Normal water elev = | 26.00 ft | | |
| | | **Peak Outflow =** | 1.34 cfs |
| Box Weir Length = | 10 ft | Peak Stage = | 28.53 ft |
| Cw = | 3.0 | Maximum Storage = | 18,322 cu ft |
| Zcr = | 28.80 ft | Control Holes: | |
| | | State Orifice: Dia = | 1.00 in |
| Dd = | 15 in | Inv = | 26.00 ft |
| Cd = | 0.59 | Weir: L = | 4 in |
| Zi = | 26.00 ft | Inv = | 27.25 ft |

| Time (min) | Inflow (cfs) | Storage (cu ft) | Stage (ft) | Outflow (cfs) | W Riser (cfs) | Barrel (cfs) | Orifice (cfs) | City Weir (cfs) | IFStore (cu ft) | Infiltrate (cf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0 | 26.00 | 0.00 | 0 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 2 | 0.0 | 0 | 26.00 | 0 | 0.00 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 4 | 0.1 | 3 | 26.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 3.2 | 0.0 |
| 6 | 0.2 | 16 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 16.1 | 0.0 |
| 8 | 0.4 | 45 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 44.9 | 0.0 |
| 10 | 0.7 | 96 | 26.03 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 95.6 | 0.0 |
| 12 | 0.9 | 174 | 26.04 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 173.7 | 0.0 |
| 14 | 1.2 | 284 | 26.07 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 284.3 | 0.0 |
| 16 | 1.6 | 432 | 26.09 | 0.01 | 0.00 | 0.1 | 0.01 | 0.00 | 431.9 | 0.0 |
| 18 | 1.9 | 620 | 26.13 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 620.4 | 0.0 |
| 20 | 2.3 | 853 | 26.17 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 853.2 | 0.0 |
| 22 | 2.7 | 1133 | 26.22 | 0.01 | 0.00 | 0.3 | 0.01 | 0.00 | 1132.6 | 0.0 |
| 24 | 3.2 | 1460 | 26.28 | 0.01 | 0.00 | 0.5 | 0.01 | 0.00 | 1460.5 | 0.0 |
| 26 | 3.6 | 1838 | 26.34 | 0.01 | 0.00 | 0.6 | 0.01 | 0.00 | 1837.6 | 0.0 |
| 28 | 4.0 | 2264 | 26.40 | 0.02 | 0.00 | 0.8 | 0.02 | 0.00 | 2264.0 | 0.0 |
| 30 | 4.4 | 2739 | 26.48 | 0.02 | 0.00 | 1.1 | 0.02 | 0.00 | 2738.9 | 0.0 |
| 32 | 4.7 | 3261 | 26.56 | 0.02 | 0.00 | 1.4 | 0.02 | 0.00 | 3260.6 | 0.0 |
| 34 | 5.1 | 3827 | 26.64 | 0.02 | 0.00 | 1.7 | 0.02 | 0.00 | 3826.7 | 0.0 |
| 36 | 5.4 | 4434 | 26.73 | 0.02 | 0.00 | 2.0 | 0.02 | 0.00 | 4433.8 | 0.0 |
| 38 | 5.7 | 5078 | 26.82 | 0.02 | 0.00 | 2.4 | 0.02 | 0.00 | 5078.2 | 0.0 |
| 40 | 5.9 | 5755 | 26.92 | 0.02 | 0.00 | 2.9 | 0.02 | 0.00 | 5755.3 | 0.0 |
| 42 | 6.1 | 6460 | 27.01 | 0.03 | 0.00 | 3.4 | 0.03 | 0.00 | 6459.9 | 0.0 |
| 44 | 6.2 | 7186 | 27.11 | 0.03 | 0.00 | 3.9 | 0.03 | 0.00 | 7186.5 | 0.0 |
| 46 | 6.3 | 7929 | 27.21 | 0.03 | 0.00 | 4.4 | 0.03 | 0.00 | 7929.0 | 0.0 |
| 48 | 6.3 | 8681 | 27.31 | 0.07 | 0.00 | 4.8 | 0.03 | 0.04 | 8681.4 | 0.0 |
| 50 | 6.3 | 9432 | 27.41 | 0.20 | 0.00 | 5.1 | 0.03 | 0.17 | 9432.1 | 0.0 |
| 52 | 6.2 | 10164 | 27.51 | 0.37 | 0.00 | 5.4 | 0.03 | 0.34 | 10164.3 | 0.0 |
| 54 | 6.1 | 10866 | 27.60 | 0.56 | 0.00 | 5.7 | 0.03 | 0.53 | 10866.2 | 0.0 |
| 56 | 5.9 | 11530 | 27.68 | 0.67 | 0.00 | 6.0 | 0.03 | 0.64 | 11530.3 | 0.0 |
| 58 | 5.7 | 12159 | 27.76 | 0.76 | 0.00 | 6.2 | 0.03 | 0.73 | 12159.1 | 0.0 |
| 60 | 5.4 | 12750 | 27.84 | 0.84 | 0.00 | 6.4 | 0.03 | 0.80 | 12749.8 | 0.0 |
| 62 | 5.1 | 13299 | 27.91 | 0.90 | 0.00 | 6.6 | 0.04 | 0.87 | 13299.0 | 0.0 |
| 64 | 4.9 | 13807 | 27.97 | 0.96 | 0.00 | 6.7 | 0.04 | 0.92 | 13807.0 | 0.0 |
| 66 | 4.6 | 14276 | 28.03 | 1.00 | 0.00 | 6.9 | 0.04 | 0.97 | 14275.9 | 0.0 |
| 68 | 4.4 | 14708 | 28.08 | 1.05 | 0.00 | 7.0 | 0.04 | 1.01 | 14708.4 | 0.0 |
| 70 | 4.1 | 15107 | 28.13 | 1.08 | 0.00 | 7.1 | 0.04 | 1.05 | 15106.7 | 0.0 |
| 72 | 3.9 | 15473 | 28.18 | 1.12 | 0.00 | 7.2 | 0.04 | 1.08 | 15472.9 | 0.0 |
| 74 | 3.7 | 15809 | 28.22 | 1.15 | 0.00 | 7.3 | 0.04 | 1.11 | 15809.1 | 0.0 |
| 76 | 3.5 | 16117 | 28.26 | 1.17 | 0.00 | 7.4 | 0.04 | 1.13 | 16117.0 | 0.0 |
| 78 | 3.3 | 16398 | 28.29 | 1.20 | 0.00 | 7.5 | 0.04 | 1.16 | 16398.2 | 0.0 |
| 80 | 3.2 | 16655 | 28.32 | 1.22 | 0.00 | 7.6 | 0.04 | 1.18 | 16654.5 | 0.0 |
| 82 | 3.0 | 16887 | 28.35 | 1.24 | 0.00 | 7.6 | 0.04 | 1.20 | 16887.2 | 0.0 |
| 84 | 2.8 | 17098 | 28.38 | 1.25 | 0.00 | 7.7 | 0.04 | 1.21 | 17097.8 | 0.0 |
| 86 | 2.7 | 17287 | 28.40 | 1.27 | 0.00 | 7.7 | 0.04 | 1.23 | 17287.5 | 0.0 |
| 88 | 2.5 | 17458 | 28.42 | 1.28 | 0.00 | 7.8 | 0.04 | 1.24 | 17457.5 | 0.0 |
| 90 | 2.4 | 17609 | 28.44 | 1.29 | 0.00 | 7.8 | 0.04 | 1.25 | 17609.0 | 0.0 |
| 92 | 2.3 | 17743 | 28.46 | 1.30 | 0.00 | 7.8 | 0.04 | 1.26 | 17743.1 | 0.0 |
| 94 | 2.2 | 17861 | 28.47 | 1.31 | 0.00 | 7.9 | 0.04 | 1.27 | 17860.8 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 2.0 | 17963 | 28.48 | 1.32 | 0.00 | 7.9 | 0.04 | 1.28 | 17963.0 | 0.0 |
| 98 | 1.9 | 18051 | 28.49 | 1.32 | 0.00 | 7.9 | 0.04 | 1.28 | 18050.6 | 0.0 |
| 100 | 1.8 | 18125 | 28.50 | 1.33 | 0.00 | 7.9 | 0.04 | 1.29 | 18124.5 | 0.0 |
| 102 | 1.7 | 18186 | 28.51 | 1.33 | 0.00 | 8.0 | 0.04 | 1.29 | 18185.5 | 0.0 |
| 104 | 1.6 | 18234 | 28.51 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18234.4 | 0.0 |
| 106 | 1.6 | 18272 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18271.9 | 0.0 |
| 108 | 1.5 | 18299 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18298.6 | 0.0 |
| 110 | 1.4 | 18315 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18315.2 | 0.0 |
| 112 | 1.3 | 18322 | 28.53 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18322.3 | 0.0 |
| 114 | 1.3 | 18321 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18320.5 | 0.0 |
| 116 | 1.2 | 18310 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18310.3 | 0.0 |
| 118 | 1.1 | 18292 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18292.3 | 0.0 |
| 120 | 1.1 | 18267 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18286.9 | 0.0 |
| 122 | 1.0 | 18235 | 28.51 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18234.5 | 0.0 |
| 124 | 1.0 | 18196 | 28.51 | 1.33 | 0.00 | 8.0 | 0.04 | 1.29 | 18195.7 | 0.0 |
| 126 | 0.9 | 18151 | 28.50 | 1.33 | 0.00 | 8.0 | 0.04 | 1.29 | 18150.8 | 0.0 |
| 128 | 0.9 | 18100 | 28.50 | 1.33 | 0.00 | 7.9 | 0.04 | 1.29 | 18100.3 | 0.0 |
| 130 | 0.8 | 18044 | 28.49 | 1.32 | 0.00 | 7.9 | 0.04 | 1.28 | 18044.4 | 0.0 |
| 132 | 0.8 | 17984 | 28.48 | 1.32 | 0.00 | 7.9 | 0.04 | 1.28 | 17983.6 | 0.0 |
| 134 | 0.7 | 17918 | 28.48 | 1.31 | 0.00 | 7.9 | 0.04 | 1.27 | 17918.1 | 0.0 |
| 136 | 0.7 | 17848 | 28.47 | 1.31 | 0.00 | 7.9 | 0.04 | 1.27 | 17848.4 | 0.0 |
| 138 | 0.7 | 17775 | 28.46 | 1.30 | 0.00 | 7.9 | 0.04 | 1.26 | 17774.6 | 0.0 |
| 140 | 0.6 | 17697 | 28.45 | 1.30 | 0.00 | 7.8 | 0.04 | 1.26 | 17697.1 | 0.0 |
| 142 | 0.6 | 17616 | 28.44 | 1.29 | 0.00 | 7.8 | 0.04 | 1.25 | 17616.2 | 0.0 |
| 144 | 0.6 | 17532 | 28.43 | 1.29 | 0.00 | 7.8 | 0.04 | 1.25 | 17532.0 | 0.0 |
| 146 | 0.5 | 17445 | 28.42 | 1.28 | 0.00 | 7.8 | 0.04 | 1.24 | 17444.9 | 0.0 |
| 148 | 0.5 | 17355 | 28.41 | 1.27 | 0.00 | 7.7 | 0.04 | 1.23 | 17355.0 | 0.0 |
| 150 | 0.5 | 17263 | 28.40 | 1.26 | 0.00 | 7.7 | 0.04 | 1.23 | 17262.6 | 0.0 |
| 152 | 0.5 | 17168 | 28.39 | 1.26 | 0.00 | 7.7 | 0.04 | 1.22 | 17167.9 | 0.0 |
| 154 | 0.4 | 17071 | 28.37 | 1.25 | 0.00 | 7.7 | 0.04 | 1.21 | 17071.1 | 0.0 |
| 156 | 0.4 | 16972 | 28.36 | 1.24 | 0.00 | 7.6 | 0.04 | 1.20 | 16972.3 | 0.0 |
| 158 | 0.4 | 16872 | 28.35 | 1.23 | 0.00 | 7.6 | 0.04 | 1.19 | 16871.8 | 0.0 |
| 160 | 0.4 | 16770 | 28.34 | 1.23 | 0.00 | 7.6 | 0.04 | 1.19 | 16769.6 | 0.0 |
| 162 | 0.3 | 16666 | 28.32 | 1.22 | 0.00 | 7.6 | 0.04 | 1.18 | 16666.1 | 0.0 |
| 164 | 0.3 | 16561 | 28.31 | 1.21 | 0.00 | 7.5 | 0.04 | 1.17 | 16561.2 | 0.0 |
| 166 | 0.3 | 16455 | 28.30 | 1.20 | 0.00 | 7.5 | 0.04 | 1.16 | 16455.1 | 0.0 |
| 168 | 0.3 | 16348 | 28.28 | 1.19 | 0.00 | 7.5 | 0.04 | 1.15 | 16348.1 | 0.0 |
| 170 | 0.3 | 16240 | 28.27 | 1.18 | 0.00 | 7.4 | 0.04 | 1.14 | 16240.1 | 0.0 |
| 172 | 0.3 | 16131 | 28.26 | 1.17 | 0.00 | 7.4 | 0.04 | 1.14 | 16131.4 | 0.0 |
| 174 | 0.2 | 16022 | 28.24 | 1.16 | 0.00 | 7.4 | 0.04 | 1.13 | 16022.0 | 0.0 |
| 176 | 0.2 | 15912 | 28.23 | 1.16 | 0.00 | 7.4 | 0.04 | 1.12 | 15912.1 | 0.0 |
| 178 | 0.2 | 15802 | 28.22 | 1.15 | 0.00 | 7.3 | 0.04 | 1.11 | 15801.7 | 0.0 |
| 180 | 0.2 | 15891 | 28.20 | 1.14 | 0.00 | 7.3 | 0.04 | 1.10 | 15691.0 | 0.0 |
| 182 | 0.2 | 15580 | 28.19 | 1.13 | 0.00 | 7.3 | 0.04 | 1.09 | 15580.0 | 0.0 |
| 184 | 0.2 | 15469 | 28.18 | 1.12 | 0.00 | 7.2 | 0.04 | 1.08 | 15468.8 | 0.0 |
| 186 | 0.2 | 15358 | 28.16 | 1.11 | 0.00 | 7.2 | 0.04 | 1.07 | 15357.6 | 0.0 |
| 188 | 0.2 | 15246 | 28.15 | 1.10 | 0.00 | 7.2 | 0.04 | 1.06 | 15246.3 | 0.0 |
| 190 | 0.2 | 15135 | 28.14 | 1.09 | 0.00 | 7.1 | 0.04 | 1.05 | 15135.1 | 0.0 |
| 192 | 0.2 | 15024 | 28.12 | 1.08 | 0.00 | 7.1 | 0.04 | 1.04 | 15024.0 | 0.0 |
| 194 | 0.1 | 14913 | 28.11 | 1.07 | 0.00 | 7.1 | 0.04 | 1.03 | 14913.2 | 0.0 |
| 196 | 0.1 | 14803 | 28.09 | 1.06 | 0.00 | 7.0 | 0.04 | 1.02 | 14802.6 | 0.0 |
| 198 | 0.1 | 14692 | 28.08 | 1.05 | 0.00 | 7.0 | 0.04 | 1.01 | 14692.3 | 0.0 |
| 200 | 0.1 | 14582 | 28.07 | 1.03 | 0.00 | 7.0 | 0.04 | 1.00 | 14582.5 | 0.0 |
| 202 | 0.1 | 14473 | 28.05 | 1.02 | 0.00 | 6.9 | 0.04 | 0.99 | 14473.1 | 0.0 |
| 204 | 0.1 | 14364 | 28.04 | 1.01 | 0.00 | 6.9 | 0.04 | 0.98 | 14364.1 | 0.0 |

## WATERSHED DATA

**BEFORE DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.2 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (25YR) | 8.15 IN/HR |

**Qa = 2.04 CFS**

Qa = PRE-DEVELOPED PEAK DISCHARGE

**AFTER DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.7 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (25YR) | 8.15 IN/HR |

**Qp = 7.13 CFS**

Qp = POST-DEVELOPED PEAK DISCHARGE

**COMPUTE DEPTH OF RUNOFF**

P = 8.05 INCHES 25yr, 24hr PRECIPITATION
CN = 88

S = (1000/CN)-10
S = 1.36

Depth (D) = (P-0.2S)^2/(P+0.8S)
D = 6.62 IN - 25yr, 24hr RUNOFF DEPTH

**SET VOLUME AND COMPUTE TIME TO PEAK**

Tp = [(43.5)(D)(Area)] / Qp
Tp = 50.45 MINUTES

Storage Volume Req'd = (Qp-Qa)*Tp*1.39*60
= 21,434 cu. ft.

**CALCULATE Ks AND b**

SET NORMAL ELEVATION AT = 26.00 feet

| CONTOUR | CONTOUR AREA (sq ft) | INCR VOL (cu ft) | S ACCUM VOL (cu ft) | Z STAGE (ft) | ln S | ln Z | Z est (ft) |
|---|---|---|---|---|---|---|---|
| 26.00 | 5,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27.00 | 7,286 | 6,375 | 6,375 | 1.0 | 8.7601 | 0 | 1.00 |
| 28.00 | 7,970 | 7,628 | 14,003 | 2.0 | 9.5470 | 0.6931 | 1.99 |
| 29.00 | 8,711 | 8,341 | 22,344 | 3.0 | 10.0143 | 1.0986 | 3.00 |
| 30.00 | 9,508 | 9,110 | 31,453 | 4.0 | 10.3562 | 1.3863 | 4.05 |
| 31.00 | | | 31,453 | 5.0 | 10.3562 | 1.6094 | 4.05 |
| 32.00 | | | 31,453 | 6.0 | 10.3562 | 1.7918 | 4.05 |
| 33.00 | | | 31,453 | 7.0 | 10.3562 | 1.9459 | 4.05 |

Regression Output:
**==> Ks = 6368**
**b = 1.14**

X Coefficient 8.76

**CHAINSAW METHOD FOR RISER BARREL ROUTING**

**STORM DATA**

| | | | |
|---|---|---|---|
| Qa = | 2.04 | cfs | |
| Qp = | 7.13 | cfs | * *Infiltration rate* = 0 *in/hr* |
| Tp = | 50.5 | min | |
| dT = | 2 | min | |

**BASIN DATA**

| | | | |
|---|---|---|---|
| Ks = | 6368 | | |
| b = | 1.14 | | |
| Zo = | 26.00 | ft | |
| Normal water elev = | 26.00 | ft | |
| | | | **Peak Outflow =** 1.89 cfs |
| Box Weir Length = | 10 | ft | Peak Stage = 28.85 ft |
| Cw = | 3.0 | | Maximum Storage = 21,058 cu ft |
| Zcr = | 28.80 | ft | Control Holes: |
| | | | State Orifice: Dia = 1.00 in |
| Dd = | 15 | in | Inv = 26.00 ft |
| Cd = | 0.59 | | Weir: L = 4 in |
| Zi = | 26.00 | ft | Inv = 27.25 ft |

| Time (min) | Inflow (cfs) | Storage (cu ft) | Stage (ft) | Outflow (cfs) | W Riser (cfs) | Barrel (cfs) | Orifice (cfs) | City Weir (cfs) | IFStore (cu ft) | Infiltrate (cf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0 | 26.00 | 0.00 | 0 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 2 | 0.0 | 0 | 26.00 | 0 | 0.00 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 4 | 0.1 | 3 | 26.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 3.3 | 0.0 |
| 6 | 0.2 | 17 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 16.5 | 0.0 |
| 8 | 0.4 | 46 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 46.0 | 0.0 |
| 10 | 0.7 | 98 | 26.03 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 98.0 | 0.0 |
| 12 | 0.9 | 178 | 26.04 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 178.2 | 0.0 |
| 14 | 1.3 | 292 | 26.07 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 291.9 | 0.0 |
| 16 | 1.6 | 444 | 26.10 | 0.01 | 0.00 | 0.1 | 0.01 | 0.00 | 444.0 | 0.0 |
| 18 | 2.0 | 639 | 26.13 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 638.6 | 0.0 |
| 20 | 2.4 | 879 | 26.18 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 879.4 | 0.0 |
| 22 | 2.9 | 1169 | 26.23 | 0.01 | 0.00 | 0.4 | 0.01 | 0.00 | 1169.4 | 0.0 |
| 24 | 3.3 | 1510 | 26.28 | 0.01 | 0.00 | 0.5 | 0.01 | 0.00 | 1510.5 | 0.0 |
| 26 | 3.7 | 1904 | 26.35 | 0.01 | 0.00 | 0.7 | 0.01 | 0.00 | 1904.2 | 0.0 |
| 28 | 4.2 | 2351 | 26.42 | 0.02 | 0.00 | 0.9 | 0.02 | 0.00 | 2350.9 | 0.0 |
| 30 | 4.6 | 2850 | 26.49 | 0.02 | 0.00 | 1.1 | 0.02 | 0.00 | 2850.4 | 0.0 |
| 32 | 5.0 | 3402 | 26.58 | 0.02 | 0.00 | 1.4 | 0.02 | 0.00 | 3401.5 | 0.0 |
| 34 | 5.4 | 4002 | 26.67 | 0.02 | 0.00 | 1.8 | 0.02 | 0.00 | 4002.3 | 0.0 |
| 36 | 5.8 | 4650 | 26.76 | 0.02 | 0.00 | 2.2 | 0.02 | 0.00 | 4650.0 | 0.0 |
| 38 | 6.1 | 5341 | 26.86 | 0.02 | 0.00 | 2.6 | 0.02 | 0.00 | 5341.2 | 0.0 |
| 40 | 6.4 | 6072 | 26.96 | 0.02 | 0.00 | 3.1 | 0.02 | 0.00 | 6071.8 | 0.0 |
| 42 | 6.6 | 6837 | 27.06 | 0.03 | 0.00 | 3.6 | 0.03 | 0.00 | 6837.1 | 0.0 |
| 44 | 6.8 | 7632 | 27.17 | 0.03 | 0.00 | 4.2 | 0.03 | 0.00 | 7631.8 | 0.0 |
| 46 | 7.0 | 8450 | 27.28 | 0.04 | 0.00 | 4.7 | 0.03 | 0.01 | 8450.2 | 0.0 |
| 48 | 7.1 | 9284 | 27.39 | 0.17 | 0.00 | 5.1 | 0.03 | 0.14 | 9284.4 | 0.0 |
| 50 | 7.1 | 10115 | 27.50 | 0.36 | 0.00 | 5.4 | 0.03 | 0.33 | 10114.7 | 0.0 |
| 52 | 7.1 | 10927 | 27.61 | 0.57 | 0.00 | 5.7 | 0.03 | 0.54 | 10927.0 | 0.0 |
| 54 | 7.0 | 11712 | 27.71 | 0.70 | 0.00 | 6.0 | 0.03 | 0.67 | 11712.4 | 0.0 |
| 56 | 6.9 | 12474 | 27.80 | 0.80 | 0.00 | 6.3 | 0.03 | 0.77 | 12473.9 | 0.0 |
| 58 | 6.7 | 13208 | 27.90 | 0.89 | 0.00 | 6.5 | 0.04 | 0.86 | 13208.0 | 0.0 |
| 60 | 6.5 | 13910 | 27.98 | 0.97 | 0.00 | 6.8 | 0.04 | 0.93 | 13910.5 | 0.0 |
| 62 | 6.2 | 14577 | 28.07 | 1.03 | 0.00 | 7.0 | 0.04 | 1.00 | 14576.7 | 0.0 |
| 64 | 5.9 | 15202 | 28.14 | 1.09 | 0.00 | 7.1 | 0.04 | 1.06 | 15202.5 | 0.0 |
| 66 | 5.7 | 15785 | 28.22 | 1.14 | 0.00 | 7.3 | 0.04 | 1.11 | 15785.3 | 0.0 |
| 68 | 5.4 | 16326 | 28.28 | 1.19 | 0.00 | 7.5 | 0.04 | 1.15 | 16326.1 | 0.0 |
| 70 | 5.1 | 16827 | 28.34 | 1.23 | 0.00 | 7.6 | 0.04 | 1.19 | 16827.3 | 0.0 |
| 72 | 4.8 | 17291 | 28.40 | 1.27 | 0.00 | 7.7 | 0.04 | 1.23 | 17291.4 | 0.0 |
| 74 | 4.6 | 17720 | 28.45 | 1.30 | 0.00 | 7.8 | 0.04 | 1.26 | 17720.3 | 0.0 |
| 76 | 4.4 | 18116 | 28.50 | 1.33 | 0.00 | 7.9 | 0.04 | 1.29 | 18116.2 | 0.0 |
| 78 | 4.1 | 18481 | 28.54 | 1.35 | 0.00 | 8.0 | 0.04 | 1.31 | 18480.8 | 0.0 |
| 80 | 3.9 | 18816 | 28.58 | 1.38 | 0.00 | 8.1 | 0.04 | 1.34 | 18816.0 | 0.0 |
| 82 | 3.7 | 19123 | 28.62 | 1.40 | 0.00 | 8.2 | 0.04 | 1.36 | 19123.3 | 0.0 |
| 84 | 3.6 | 19404 | 28.66 | 1.42 | 0.00 | 8.3 | 0.04 | 1.38 | 19404.3 | 0.0 |
| 86 | 3.4 | 19660 | 28.69 | 1.44 | 0.00 | 8.3 | 0.04 | 1.39 | 19660.5 | 0.0 |
| 88 | 3.2 | 19893 | 28.71 | 1.45 | 0.00 | 8.4 | 0.04 | 1.41 | 19893.2 | 0.0 |
| 90 | 3.0 | 20104 | 28.74 | 1.47 | 0.00 | 8.4 | 0.04 | 1.42 | 20103.7 | 0.0 |
| 92 | 2.9 | 20293 | 28.76 | 1.48 | 0.00 | 8.5 | 0.04 | 1.44 | 20293.2 | 0.0 |
| 94 | 2.7 | 20463 | 28.78 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20462.9 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 2.6 | 20614 | 28.80 | 1.50 | 0.00 | 8.6 | 0.04 | 1.46 | 20613.8 | 0.0 |
| 98 | 2.5 | 20747 | 28.82 | 1.57 | 0.06 | 8.6 | 0.04 | 1.46 | 20747.1 | 0.0 |
| 100 | 2.4 | 20856 | 28.83 | 1.66 | 0.15 | 8.6 | 0.04 | 1.47 | 20856.5 | 0.0 |
| 102 | 2.2 | 20940 | 28.84 | 1.75 | 0.23 | 8.6 | 0.04 | 1.48 | 20939.7 | 0.0 |
| 104 | 2.1 | 20998 | 28.85 | 1.81 | 0.29 | 8.6 | 0.04 | 1.48 | 20998.3 | 0.0 |
| 106 | 2.0 | 21035 | 28.85 | 1.86 | 0.34 | 8.7 | 0.04 | 1.48 | 21035.3 | 0.0 |
| 108 | 1.9 | 21054 | 28.85 | 1.88 | 0.36 | 8.7 | 0.04 | 1.48 | 21054.0 | 0.0 |
| 110 | 1.8 | 21058 | 28.85 | 1.89 | 0.36 | 8.7 | 0.04 | 1.48 | 21057.7 | 0.0 |
| 112 | 1.7 | 21049 | 28.85 | 1.88 | 0.35 | 8.7 | 0.04 | 1.48 | 21049.3 | 0.0 |
| 114 | 1.6 | 21031 | 28.85 | 1.86 | 0.33 | 8.7 | 0.04 | 1.48 | 21031.3 | 0.0 |
| 116 | 1.6 | 21006 | 28.85 | 1.82 | 0.30 | 8.6 | 0.04 | 1.48 | 21005.5 | 0.0 |
| 118 | 1.5 | 20974 | 28.84 | 1.79 | 0.26 | 8.6 | 0.04 | 1.48 | 20973.7 | 0.0 |
| 120 | 1.4 | 20937 | 28.84 | 1.74 | 0.22 | 8.6 | 0.04 | 1.48 | 20937.0 | 0.0 |
| 122 | 1.3 | 20896 | 28.83 | 1.70 | 0.18 | 8.6 | 0.04 | 1.47 | 20896.5 | 0.0 |
| 124 | 1.3 | 20853 | 28.83 | 1.66 | 0.14 | 8.6 | 0.04 | 1.47 | 20852.7 | 0.0 |
| 126 | 1.2 | 20806 | 28.82 | 1.61 | 0.10 | 8.6 | 0.04 | 1.47 | 20806.1 | 0.0 |
| 128 | 1.1 | 20757 | 28.82 | 1.57 | 0.07 | 8.6 | 0.04 | 1.46 | 20757.0 | 0.0 |
| 130 | 1.1 | 20705 | 28.81 | 1.54 | 0.03 | 8.6 | 0.04 | 1.46 | 20705.4 | 0.0 |
| 132 | 1.0 | 20651 | 28.80 | 1.51 | 0.01 | 8.6 | 0.04 | 1.46 | 20651.3 | 0.0 |
| 134 | 1.0 | 20594 | 28.80 | 1.50 | 0.00 | 8.6 | 0.04 | 1.45 | 20594.0 | 0.0 |
| 136 | 0.9 | 20532 | 28.79 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20531.9 | 0.0 |
| 138 | 0.9 | 20464 | 28.78 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20464.4 | 0.0 |
| 140 | 0.8 | 20392 | 28.77 | 1.48 | 0.00 | 8.5 | 0.04 | 1.44 | 20391.8 | 0.0 |
| 142 | 0.8 | 20314 | 28.76 | 1.48 | 0.00 | 8.5 | 0.04 | 1.44 | 20314.5 | 0.0 |
| 144 | 0.8 | 20233 | 28.75 | 1.47 | 0.00 | 8.5 | 0.04 | 1.43 | 20232.7 | 0.0 |
| 146 | 0.7 | 20147 | 28.74 | 1.47 | 0.00 | 8.4 | 0.04 | 1.43 | 20146.7 | 0.0 |
| 148 | 0.7 | 20057 | 28.73 | 1.46 | 0.00 | 8.4 | 0.04 | 1.42 | 20056.8 | 0.0 |
| 150 | 0.6 | 19963 | 28.72 | 1.46 | 0.00 | 8.4 | 0.04 | 1.41 | 19963.3 | 0.0 |
| 152 | 0.6 | 19866 | 28.71 | 1.45 | 0.00 | 8.4 | 0.04 | 1.41 | 19866.4 | 0.0 |
| 154 | 0.6 | 19766 | 28.70 | 1.44 | 0.00 | 8.4 | 0.04 | 1.40 | 19766.4 | 0.0 |
| 156 | 0.6 | 19663 | 28.69 | 1.44 | 0.00 | 8.3 | 0.04 | 1.39 | 19663.4 | 0.0 |
| 158 | 0.5 | 19558 | 28.67 | 1.43 | 0.00 | 8.3 | 0.04 | 1.39 | 19557.8 | 0.0 |
| 160 | 0.5 | 19450 | 28.66 | 1.42 | 0.00 | 8.3 | 0.04 | 1.38 | 19449.6 | 0.0 |
| 162 | 0.5 | 19339 | 28.65 | 1.41 | 0.00 | 8.3 | 0.04 | 1.37 | 19339.1 | 0.0 |
| 164 | 0.5 | 19227 | 28.63 | 1.41 | 0.00 | 8.2 | 0.04 | 1.37 | 19226.5 | 0.0 |
| 166 | 0.4 | 19112 | 28.62 | 1.40 | 0.00 | 8.2 | 0.04 | 1.36 | 19112.0 | 0.0 |
| 168 | 0.4 | 18996 | 28.61 | 1.39 | 0.00 | 8.2 | 0.04 | 1.35 | 18995.6 | 0.0 |
| 170 | 0.4 | 18878 | 28.59 | 1.38 | 0.00 | 8.1 | 0.04 | 1.34 | 18877.7 | 0.0 |
| 172 | 0.4 | 18758 | 28.58 | 1.37 | 0.00 | 8.1 | 0.04 | 1.33 | 18758.2 | 0.0 |
| 174 | 0.3 | 18637 | 28.56 | 1.37 | 0.00 | 8.1 | 0.04 | 1.33 | 18637.5 | 0.0 |
| 176 | 0.3 | 18515 | 28.55 | 1.36 | 0.00 | 8.0 | 0.04 | 1.32 | 18515.5 | 0.0 |
| 178 | 0.3 | 18392 | 28.53 | 1.35 | 0.00 | 8.0 | 0.04 | 1.31 | 18392.4 | 0.0 |
| 180 | 0.3 | 18268 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18268.4 | 0.0 |
| 182 | 0.3 | 18144 | 28.50 | 1.33 | 0.00 | 8.0 | 0.04 | 1.29 | 18143.6 | 0.0 |
| 184 | 0.3 | 18018 | 28.49 | 1.32 | 0.00 | 7.9 | 0.04 | 1.28 | 18018.1 | 0.0 |
| 186 | 0.3 | 17892 | 28.47 | 1.31 | 0.00 | 7.9 | 0.04 | 1.27 | 17891.9 | 0.0 |
| 188 | 0.2 | 17765 | 28.46 | 1.30 | 0.00 | 7.9 | 0.04 | 1.26 | 17765.3 | 0.0 |
| 190 | 0.2 | 17638 | 28.44 | 1.29 | 0.00 | 7.8 | 0.04 | 1.25 | 17638.2 | 0.0 |
| 192 | 0.2 | 17511 | 28.43 | 1.28 | 0.00 | 7.8 | 0.04 | 1.24 | 17510.8 | 0.0 |
| 194 | 0.2 | 17383 | 28.41 | 1.27 | 0.00 | 7.8 | 0.04 | 1.23 | 17383.1 | 0.0 |
| 196 | 0.2 | 17255 | 28.40 | 1.26 | 0.00 | 7.7 | 0.04 | 1.22 | 17255.3 | 0.0 |
| 198 | 0.2 | 17127 | 28.38 | 1.25 | 0.00 | 7.7 | 0.04 | 1.21 | 17127.4 | 0.0 |
| 200 | 0.2 | 17000 | 28.36 | 1.24 | 0.00 | 7.7 | 0.04 | 1.20 | 16999.5 | 0.0 |
| 202 | 0.2 | 16872 | 28.35 | 1.23 | 0.00 | 7.6 | 0.04 | 1.19 | 16871.7 | 0.0 |
| 204 | 0.2 | 16744 | 28.33 | 1.22 | 0.00 | 7.6 | 0.04 | 1.18 | 16744.0 | 0.0 |

## WATERSHED DATA

**BEFORE DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.2 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (50 YR) | 8.87 IN/HR |

**Qa = 2.22 CFS**

Qa = PRE-DEVELOPED PEAK DISCHARGE

**AFTER DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.7 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (50 YR) | 8.87 IN/HR |

**Qp = 7.76 CFS**

Qp = POST-DEVELOPED PEAK DISCHARGE

**COMPUTE DEPTH OF RUNOFF**

P = 9 INCHES 50yr, 24hr PRECIPITATION
CN = 88

S = (1000/CN)-10
S = 1.36

Depth (D) = (P-0.2S)^2/(P+0.8S)
D = 7.55 IN - 50yr, 24hr RUNOFF DEPTH

**SET VOLUME AND COMPUTE TIME TO PEAK**

Tp = [(43.5)(D)(Area)] / Qp
Tp = 52.88 MINUTES

Storage Volume Req'd = (Qp-Qa)*Tp*1.39*60
= 24,449 cu. ft.

**CALCULATE Ks AND b**

SET NORMAL ELEVATION AT = 26.00 feet

| CONTOUR | CONTOUR AREA (sq ft) | INCR VOL (cu ft) | S ACCUM VOL (cu ft) | Z STAGE (ft) | ln S | ln Z | Z est (ft) |
|---|---|---|---|---|---|---|---|
| 26.00 | 5,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27.00 | 7,286 | 6,375 | 6,375 | 1.0 | 8.7601 | 0 | 1.00 |
| 28.00 | 7,970 | 7,628 | 14,003 | 2.0 | 9.5470 | 0.6931 | 1.99 |
| 29.00 | 8,711 | 8,341 | 22,344 | 3.0 | 10.0143 | 1.0986 | 3.00 |
| 30.00 | 9,508 | 9,110 | 31,453 | 4.0 | 10.3562 | 1.3863 | 4.05 |
| 31.00 | | | 31,453 | 5.0 | 10.3562 | 1.6094 | 4.05 |
| 32.00 | | | 31,453 | 6.0 | 10.3562 | 1.7918 | 4.05 |
| 33.00 | | | 31,453 | 7.0 | 10.3562 | 1.9459 | 4.05 |

Regression Output:
**==> Ks = 6368**
**b = 1.14**

X Coefficient 6.76

**CHAINSAW METHOD FOR RISER BARREL ROUTING**

**STORM DATA**

| | | | |
|---|---|---|---|
| Qa = | 2.22 cfs | | |
| Qp = | 7.76 cfs | * *Infiltration rate* = | 0 *in/hr* |
| Tp = | 52.9 min | | |
| dT = | 2 min | | |

**BASIN DATA**

| | | | | |
|---|---|---|---|---|
| Ks = | 6368 | | | |
| b = | 1.14 | | | |
| Zo = | 26.00 ft | | | |
| Normal water elev = | 26.00 ft | | | |
| | | **Peak Outflow =** | 3.33 cfs | |
| Box Weir Length = | 10 ft | Peak Stage = | 28.95 ft | |
| Cw = | 3.0 | Maximum Storage = | 21,886 cu ft | |
| Zcr = | 28.80 ft | Control Holes: | | |
| | | State Qrifice: Dia = | 1.00 in | |
| Dd = | 15 in | Inv = | 26.00 ft | |
| Cd = | 0.59 | Weir: L = | 4.00 in | |
| Zi = | 26.00 ft | Inv = | 27.25 ft | |

| Time (min) | Inflow (cfs) | Storage (cu ft) | Stage (ft) | Outflow (cfs) | W Riser (cfs) | Barrel (cfs) | Orifice (cfs) | City Weir (cfs) | IFStore (cu ft) | Infiltrate (cf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0 | 26.00 | 0.00 | 0 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 2 | 0.0 | 0 | 26.00 | 0 | 0.00 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 4 | 0.1 | 3 | 26.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 3.3 | 0.0 |
| 6 | 0.2 | 16 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 16.4 | 0.0 |
| 8 | 0.4 | 46 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 45.6 | 0.0 |
| 10 | 0.7 | 97 | 26.03 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 97.2 | 0.0 |
| 12 | 0.9 | 177 | 26.04 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 176.9 | 0.0 |
| 14 | 1.3 | 290 | 26.07 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 290.1 | 0.0 |
| 16 | 1.6 | 442 | 26.10 | 0.01 | 0.00 | 0.1 | 0.01 | 0.00 | 441.6 | 0.0 |
| 18 | 2.0 | 636 | 26.13 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 635.9 | 0.0 |
| 20 | 2.4 | 877 | 26.18 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 876.8 | 0.0 |
| 22 | 2.9 | 1167 | 26.23 | 0.01 | 0.00 | 0.4 | 0.01 | 0.00 | 1167.5 | 0.0 |
| 24 | 3.3 | 1510 | 26.28 | 0.01 | 0.00 | 0.5 | 0.01 | 0.00 | 1510.4 | 0.0 |
| 26 | 3.8 | 1907 | 26.35 | 0.01 | 0.00 | 0.7 | 0.01 | 0.00 | 1907.3 | 0.0 |
| 28 | 4.2 | 2359 | 26.42 | 0.02 | 0.00 | 0.9 | 0.02 | 0.00 | 2359.1 | 0.0 |
| 30 | 4.7 | 2866 | 26.50 | 0.02 | 0.00 | 1.2 | 0.02 | 0.00 | 2865.9 | 0.0 |
| 32 | 5.1 | 3427 | 26.58 | 0.02 | 0.00 | 1.5 | 0.02 | 0.00 | 3427.3 | 0.0 |
| 34 | 5.6 | 4042 | 26.67 | 0.02 | 0.00 | 1.8 | 0.02 | 0.00 | 4041.7 | 0.0 |
| 36 | 6.0 | 4707 | 26.77 | 0.02 | 0.00 | 2.2 | 0.02 | 0.00 | 4707.1 | 0.0 |
| 38 | 6.3 | 5421 | 26.87 | 0.02 | 0.00 | 2.7 | 0.02 | 0.00 | 5420.6 | 0.0 |
| 40 | 6.7 | 6179 | 26.97 | 0.02 | 0.00 | 3.2 | 0.02 | 0.00 | 6178.8 | 0.0 |
| 42 | 7.0 | 6977 | 27.08 | 0.03 | 0.00 | 3.7 | 0.03 | 0.00 | 6977.3 | 0.0 |
| 44 | 7.2 | 7812 | 27.20 | 0.03 | 0.00 | 4.3 | 0.03 | 0.00 | 7811.6 | 0.0 |
| 46 | 7.4 | 8676 | 27.31 | 0.07 | 0.00 | 4.8 | 0.03 | 0.04 | 8676.3 | 0.0 |
| 48 | 7.6 | 9561 | 27.43 | 0.23 | 0.00 | 5.2 | 0.03 | 0.20 | 9561.0 | 0.0 |
| 50 | 7.7 | 10446 | 27.54 | 0.45 | 0.00 | 5.6 | 0.03 | 0.42 | 10445.5 | 0.0 |
| 52 | 7.8 | 11316 | 27.66 | 0.64 | 0.00 | 5.9 | 0.03 | 0.60 | 11316.2 | 0.0 |
| 54 | 7.8 | 12170 | 27.76 | 0.76 | 0.00 | 6.2 | 0.03 | 0.73 | 12170.4 | 0.0 |
| 56 | 7.7 | 13009 | 27.87 | 0.87 | 0.00 | 6.5 | 0.03 | 0.83 | 13009.1 | 0.0 |
| 58 | 7.6 | 13828 | 27.97 | 0.96 | 0.00 | 6.7 | 0.04 | 0.92 | 13828.3 | 0.0 |
| 60 | 7.4 | 14623 | 28.07 | 1.04 | 0.00 | 7.0 | 0.04 | 1.00 | 14623.2 | 0.0 |
| 62 | 7.2 | 15389 | 28.17 | 1.11 | 0.00 | 7.2 | 0.04 | 1.07 | 15388.8 | 0.0 |
| 64 | 6.9 | 16120 | 28.26 | 1.17 | 0.00 | 7.4 | 0.04 | 1.13 | 16120.3 | 0.0 |
| 66 | 6.6 | 16813 | 28.34 | 1.23 | 0.00 | 7.6 | 0.04 | 1.19 | 16813.0 | 0.0 |
| 68 | 6.3 | 17462 | 28.42 | 1.28 | 0.00 | 7.8 | 0.04 | 1.24 | 17462.3 | 0.0 |
| 70 | 6.0 | 18068 | 28.49 | 1.33 | 0.00 | 7.9 | 0.04 | 1.28 | 18068.4 | 0.0 |
| 72 | 5.7 | 18633 | 28.56 | 1.37 | 0.00 | 8.1 | 0.04 | 1.32 | 18632.5 | 0.0 |
| 74 | 5.5 | 19157 | 28.63 | 1.40 | 0.00 | 8.2 | 0.04 | 1.36 | 19157.1 | 0.0 |
| 76 | 5.2 | 19644 | 28.68 | 1.44 | 0.00 | 8.3 | 0.04 | 1.39 | 19644.3 | 0.0 |
| 78 | 5.0 | 20096 | 28.74 | 1.47 | 0.00 | 8.4 | 0.04 | 1.42 | 20096.0 | 0.0 |
| 80 | 4.7 | 20514 | 28.79 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20514.3 | 0.0 |
| 82 | 4.5 | 20901 | 28.83 | 1.70 | 0.19 | 8.6 | 0.04 | 1.47 | 20900.8 | 0.0 |
| 84 | 4.3 | 21235 | 28.87 | 2.14 | 0.60 | 8.7 | 0.04 | 1.49 | 21234.7 | 0.0 |
| 86 | 4.1 | 21491 | 28.90 | 2.56 | 1.01 | 8.8 | 0.04 | 1.51 | 21490.9 | 0.0 |
| 88 | 3.9 | 21672 | 28.93 | 2.90 | 1.33 | 8.8 | 0.04 | 1.52 | 21671.7 | 0.0 |
| 90 | 3.7 | 21789 | 28.94 | 3.13 | 1.56 | 8.8 | 0.04 | 1.53 | 21788.7 | 0.0 |
| 92 | 3.5 | 21855 | 28.95 | 3.27 | 1.69 | 8.8 | 0.04 | 1.53 | 21855.4 | 0.0 |
| 94 | 3.3 | 21884 | 28.95 | 3.33 | 1.75 | 8.8 | 0.04 | 1.53 | 21884.3 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 3.2 | 21886 | 28.95 | 3.33 | 1.76 | 8.8 | 0.04 | 1.53 | 21885.6 | 0.0 |
| 98 | 3.0 | 21867 | 28.95 | 3.29 | 1.72 | 8.8 | 0.04 | 1.53 | 21867.4 | 0.0 |
| 100 | 2.9 | 21836 | 28.94 | 3.23 | 1.65 | 8.8 | 0.04 | 1.53 | 21835.5 | 0.0 |
| 102 | 2.7 | 21794 | 28.94 | 3.14 | 1.57 | 8.8 | 0.04 | 1.53 | 21794.2 | 0.0 |
| 104 | 2.6 | 21747 | 28.93 | 3.04 | 1.48 | 8.8 | 0.04 | 1.52 | 21746.5 | 0.0 |
| 106 | 2.5 | 21695 | 28.93 | 2.94 | 1.38 | 8.8 | 0.04 | 1.52 | 21694.7 | 0.0 |
| 108 | 2.4 | 21640 | 28.92 | 2.84 | 1.27 | 8.8 | 0.04 | 1.52 | 21640.2 | 0.0 |
| 110 | 2.3 | 21584 | 28.92 | 2.73 | 1.17 | 8.8 | 0.04 | 1.51 | 21584.1 | 0.0 |
| 112 | 2.1 | 21527 | 28.91 | 2.62 | 1.07 | 8.8 | 0.04 | 1.51 | 21527.1 | 0.0 |
| 114 | 2.0 | 21470 | 28.90 | 2.52 | 0.97 | 8.8 | 0.04 | 1.51 | 21469.7 | 0.0 |
| 116 | 1.9 | 21412 | 28.89 | 2.42 | 0.87 | 8.7 | 0.04 | 1.50 | 21412.2 | 0.0 |
| 118 | 1.9 | 21355 | 28.89 | 2.33 | 0.78 | 8.7 | 0.04 | 1.50 | 21354.9 | 0.0 |
| 120 | 1.8 | 21298 | 28.88 | 2.23 | 0.69 | 8.7 | 0.04 | 1.50 | 21298.0 | 0.0 |
| 122 | 1.7 | 21241 | 28.87 | 2.15 | 0.61 | 8.7 | 0.04 | 1.49 | 21241.4 | 0.0 |
| 124 | 1.6 | 21185 | 28.87 | 2.06 | 0.53 | 8.7 | 0.04 | 1.49 | 21185.1 | 0.0 |
| 126 | 1.5 | 21129 | 28.86 | 1.98 | 0.45 | 8.7 | 0.04 | 1.49 | 21129.3 | 0.0 |
| 128 | 1.4 | 21074 | 28.85 | 1.91 | 0.38 | 8.7 | 0.04 | 1.48 | 21073.7 | 0.0 |
| 130 | 1.4 | 21018 | 28.85 | 1.84 | 0.32 | 8.6 | 0.04 | 1.48 | 21018.3 | 0.0 |
| 132 | 1.3 | 20963 | 28.84 | 1.77 | 0.25 | 8.6 | 0.04 | 1.48 | 20963.1 | 0.0 |
| 134 | 1.2 | 20908 | 28.83 | 1.71 | 0.20 | 8.6 | 0.04 | 1.47 | 20907.8 | 0.0 |
| 136 | 1.2 | 20852 | 28.83 | 1.66 | 0.14 | 8.6 | 0.04 | 1.47 | 20852.3 | 0.0 |
| 138 | 1.1 | 20796 | 28.82 | 1.61 | 0.10 | 8.6 | 0.04 | 1.47 | 20796.4 | 0.0 |
| 140 | 1.1 | 20740 | 28.81 | 1.56 | 0.05 | 8.6 | 0.04 | 1.46 | 20739.7 | 0.0 |
| 142 | 1.0 | 20682 | 28.81 | 1.52 | 0.02 | 8.6 | 0.04 | 1.46 | 20681.8 | 0.0 |
| 144 | 1.0 | 20622 | 28.80 | 1.50 | 0.00 | 8.6 | 0.04 | 1.46 | 20622.1 | 0.0 |
| 146 | 0.9 | 20559 | 28.79 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20559.4 | 0.0 |
| 148 | 0.9 | 20492 | 28.79 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20491.7 | 0.0 |
| 150 | 0.8 | 20419 | 28.78 | 1.49 | 0.00 | 8.5 | 0.04 | 1.44 | 20419.1 | 0.0 |
| 152 | 0.8 | 20342 | 28.77 | 1.48 | 0.00 | 8.5 | 0.04 | 1.44 | 20342.0 | 0.0 |
| 154 | 0.8 | 20261 | 28.76 | 1.48 | 0.00 | 8.5 | 0.04 | 1.43 | 20260.6 | 0.0 |
| 156 | 0.7 | 20175 | 28.75 | 1.47 | 0.00 | 8.5 | 0.04 | 1.43 | 20175.2 | 0.0 |
| 158 | 0.7 | 20086 | 28.74 | 1.46 | 0.00 | 8.4 | 0.04 | 1.42 | 20086.1 | 0.0 |
| 160 | 0.7 | 19993 | 28.73 | 1.46 | 0.00 | 8.4 | 0.04 | 1.42 | 19993.5 | 0.0 |
| 162 | 0.6 | 19898 | 28.71 | 1.45 | 0.00 | 8.4 | 0.04 | 1.41 | 19897.6 | 0.0 |
| 164 | 0.6 | 19799 | 28.70 | 1.45 | 0.00 | 8.4 | 0.04 | 1.40 | 19798.7 | 0.0 |
| 166 | 0.6 | 19697 | 28.69 | 1.44 | 0.00 | 8.3 | 0.04 | 1.40 | 19697.0 | 0.0 |
| 168 | 0.5 | 19593 | 28.68 | 1.43 | 0.00 | 8.3 | 0.04 | 1.39 | 19592.6 | 0.0 |
| 170 | 0.5 | 19486 | 28.67 | 1.42 | 0.00 | 8.3 | 0.04 | 1.38 | 19485.8 | 0.0 |
| 172 | 0.5 | 19377 | 28.65 | 1.42 | 0.00 | 8.3 | 0.04 | 1.38 | 19376.7 | 0.0 |
| 174 | 0.5 | 19266 | 28.64 | 1.41 | 0.00 | 8.2 | 0.04 | 1.37 | 19265.6 | 0.0 |
| 176 | 0.4 | 19153 | 28.63 | 1.40 | 0.00 | 8.2 | 0.04 | 1.36 | 19152.5 | 0.0 |
| 178 | 0.4 | 19038 | 28.61 | 1.39 | 0.00 | 8.2 | 0.04 | 1.35 | 19037.7 | 0.0 |
| 180 | 0.4 | 18921 | 28.60 | 1.39 | 0.00 | 8.1 | 0.04 | 1.34 | 18921.2 | 0.0 |
| 182 | 0.4 | 18803 | 28.58 | 1.38 | 0.00 | 8.1 | 0.04 | 1.34 | 18803.3 | 0.0 |
| 184 | 0.4 | 18684 | 28.57 | 1.37 | 0.00 | 8.1 | 0.04 | 1.33 | 18684.1 | 0.0 |
| 186 | 0.3 | 18564 | 28.55 | 1.36 | 0.00 | 8.1 | 0.04 | 1.32 | 18563.6 | 0.0 |
| 188 | 0.3 | 18442 | 28.54 | 1.35 | 0.00 | 8.0 | 0.04 | 1.31 | 18442.1 | 0.0 |
| 190 | 0.3 | 18320 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18319.6 | 0.0 |
| 192 | 0.3 | 18196 | 28.51 | 1.33 | 0.00 | 8.0 | 0.04 | 1.29 | 18196.2 | 0.0 |
| 194 | 0.3 | 18072 | 28.49 | 1.33 | 0.00 | 7.9 | 0.04 | 1.29 | 18072.1 | 0.0 |
| 196 | 0.3 | 17947 | 28.48 | 1.32 | 0.00 | 7.9 | 0.04 | 1.28 | 17947.4 | 0.0 |
| 198 | 0.3 | 17822 | 28.46 | 1.31 | 0.00 | 7.9 | 0.04 | 1.27 | 17822.1 | 0.0 |
| 200 | 0.2 | 17696 | 28.45 | 1.30 | 0.00 | 7.8 | 0.04 | 1.26 | 17696.3 | 0.0 |
| 202 | 0.2 | 17570 | 28.43 | 1.29 | 0.00 | 7.8 | 0.04 | 1.25 | 17570.2 | 0.0 |
| 204 | 0.2 | 17444 | 28.42 | 1.28 | 0.00 | 7.8 | 0.04 | 1.24 | 17443.8 | 0.0 |

## WATERSHED DATA

**BEFORE DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.2 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (50 YR) | 8.87 IN/HR |

**Qa = 2.22 CFS**

Qa = PRE-DEVELOPED PEAK DISCHARGE

**AFTER DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.7 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (50 YR) | 8.87 IN/HR |

**Qp = 7.76 CFS**

Qp = POST-DEVELOPED PEAK DISCHARGE

**COMPUTE DEPTH OF RUNOFF**

P = 9 INCHES 50yr, 24hr PRECIPITATION
CN = 88

S = (1000/CN)-10
S = 1.36

Depth (D) = (P-0.2S)^2/(P+0.8S)
D = 7.55 IN - 50yr, 24hr RUNOFF DEPTH

**SET VOLUME AND COMPUTE TIME TO PEAK**

Tp = [(43.5)(D)(Area)] / Qp
Tp = 52.88 MINUTES

Storage Volume Req'd = (Qp-Qa)*Tp*1.39*60
= 24,449 cu. ft.

**CALCULATE Ks AND b**

SET NORMAL ELEVATION AT = 26.00 feet

| CONTOUR | CONTOUR AREA (sq ft) | INCR VOL (cu ft) | S ACCUM VOL (cu ft) | Z STAGE (ft) | ln S | ln Z | Z est (ft) |
|---|---|---|---|---|---|---|---|
| 26.00 | 5,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27.00 | 7,286 | 6,375 | 6,375 | 1.0 | 8.7601 | 0 | 1.00 |
| 28.00 | 7,970 | 7,628 | 14,003 | 2.0 | 9.5470 | 0.6931 | 1.99 |
| 29.00 | 8,711 | 8,341 | 22,344 | 3.0 | 10.0143 | 1.0986 | 3.00 |
| 30.00 | 9,508 | 9,110 | 31,453 | 4.0 | 10.3562 | 1.3863 | 4.05 |
| 31.00 | | | 31,453 | 5.0 | 10.3562 | 1.6094 | 4.05 |
| 32.00 | | | 31,453 | 6.0 | 10.3562 | 1.7918 | 4.05 |
| 33.00 | | | 31,453 | 7.0 | 10.3562 | 1.9459 | 4.05 |

Regression Output:
**==> Ks = 6368**
**b = 1.14**

X Coefficient 8.76

**CHAINSAW METHOD FOR RISER BARREL ROUTING**

**STORM DATA**

| | | | |
|---|---|---|---|
| Qa = | 2.22 cfs | | |
| Qp = | 7.76 cfs | * *Infiltration rate* = | 0 *in/hr* |
| Tp = | 52.9 min | | |
| dT = | 2 min | | |

**BASIN DATA**

| | | | | |
|---|---|---|---|---|
| Ks = | 6368 | | | |
| b = | 1.14 | | | |
| Zo = | 26.00 ft | | | |
| Normal water elev = | 26.00 ft | | | |
| | | **Peak Outflow =** | **3.43** | cfs |
| Box Weir Length = | 0 ft | Peak Stage = | 29.46 | ft |
| Cw = | 3.0 | Maximum Storage = | 26,240 | cu ft |
| Zcr = | 28.80 ft | Control Holes: | | |
| | | State Qrifice: Dia = | 0.00 | in |
| Dd = | 15 in | Inv = | 26.00 | ft |
| Cd = | 0.59 | Weir: L = | 360.00 | in |
| Zi = | 26.00 ft | Inv = | 29.40 | ft |

| Time (min) | Inflow (cfs) | Storage (cu ft) | Stage (ft) | Outflow (cfs) | W Riser (cfs) | Barrel (cfs) | Orifice (cfs) | City Weir (cfs) | IFStore (cu ft) | Infiltrate (cf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0 | 26.00 | 0.00 | 0 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 2 | 0.0 | 0 | 26.00 | 0 | 0.00 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 4 | 0.1 | 3 | 26.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 3.3 | 0.0 |
| 6 | 0.2 | 16 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 16.4 | 0.0 |
| 8 | 0.4 | 46 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 45.6 | 0.0 |
| 10 | 0.7 | 97 | 26.03 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 97.3 | 0.0 |
| 12 | 0.9 | 177 | 26.04 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 177.0 | 0.0 |
| 14 | 1.3 | 290 | 26.07 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 290.5 | 0.0 |
| 16 | 1.6 | 442 | 26.10 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 442.5 | 0.0 |
| 18 | 2.0 | 637 | 26.13 | 0.00 | 0.00 | 0.2 | 0.00 | 0.00 | 637.5 | 0.0 |
| 20 | 2.4 | 879 | 26.18 | 0.00 | 0.00 | 0.2 | 0.00 | 0.00 | 879.3 | 0.0 |
| 22 | 2.9 | 1171 | 26.23 | 0.00 | 0.00 | 0.4 | 0.00 | 0.00 | 1171.1 | 0.0 |
| 24 | 3.3 | 1515 | 26.28 | 0.00 | 0.00 | 0.5 | 0.00 | 0.00 | 1515.4 | 0.0 |
| 26 | 3.8 | 1914 | 26.35 | 0.00 | 0.00 | 0.7 | 0.00 | 0.00 | 1913.8 | 0.0 |
| 28 | 4.2 | 2367 | 26.42 | 0.00 | 0.00 | 0.9 | 0.00 | 0.00 | 2367.3 | 0.0 |
| 30 | 4.7 | 2876 | 26.50 | 0.00 | 0.00 | 1.2 | 0.00 | 0.00 | 2876.0 | 0.0 |
| 32 | 5.1 | 3439 | 26.58 | 0.00 | 0.00 | 1.5 | 0.00 | 0.00 | 3439.5 | 0.0 |
| 34 | 5.6 | 4056 | 26.67 | 0.00 | 0.00 | 1.8 | 0.00 | 0.00 | 4056.2 | 0.0 |
| 36 | 6.0 | 4724 | 26.77 | 0.00 | 0.00 | 2.2 | 0.00 | 0.00 | 4724.0 | 0.0 |
| 38 | 6.3 | 5440 | 26.87 | 0.00 | 0.00 | 2.7 | 0.00 | 0.00 | 5440.2 | 0.0 |
| 40 | 6.7 | 6201 | 26.98 | 0.00 | 0.00 | 3.2 | 0.00 | 0.00 | 6201.1 | 0.0 |
| 42 | 7.0 | 7003 | 27.09 | 0.00 | 0.00 | 3.7 | 0.00 | 0.00 | 7002.7 | 0.0 |
| 44 | 7.2 | 7840 | 27.20 | 0.00 | 0.00 | 4.3 | 0.00 | 0.00 | 7840.1 | 0.0 |
| 46 | 7.4 | 8708 | 27.32 | 0.00 | 0.00 | 4.8 | 0.00 | 0.00 | 8708.1 | 0.0 |
| 48 | 7.6 | 9601 | 27.43 | 0.00 | 0.00 | 5.2 | 0.00 | 0.00 | 9601.1 | 0.0 |
| 50 | 7.7 | 10513 | 27.55 | 0.00 | 0.00 | 5.6 | 0.00 | 0.00 | 10513.0 | 0.0 |
| 52 | 7.8 | 11438 | 27.67 | 0.00 | 0.00 | 5.9 | 0.00 | 0.00 | 11437.5 | 0.0 |
| 54 | 7.8 | 12368 | 27.79 | 0.00 | 0.00 | 6.3 | 0.00 | 0.00 | 12368.3 | 0.0 |
| 56 | 7.7 | 13299 | 27.91 | 0.00 | 0.00 | 6.6 | 0.00 | 0.00 | 13298.6 | 0.0 |
| 58 | 7.6 | 14222 | 28.02 | 0.00 | 0.00 | 6.9 | 0.00 | 0.00 | 14222.0 | 0.0 |
| 60 | 7.4 | 15132 | 28.14 | 0.00 | 0.00 | 7.1 | 0.00 | 0.00 | 15131.9 | 0.0 |
| 62 | 7.2 | 16022 | 28.25 | 0.00 | 0.00 | 7.4 | 0.00 | 0.00 | 16022.2 | 0.0 |
| 64 | 6.9 | 16887 | 28.35 | 0.00 | 0.00 | 7.6 | 0.00 | 0.00 | 16886.9 | 0.0 |
| 66 | 6.6 | 17720 | 28.45 | 0.00 | 0.00 | 7.8 | 0.00 | 0.00 | 17720.3 | 0.0 |
| 68 | 6.3 | 18517 | 28.55 | 0.00 | 0.00 | 8.0 | 0.00 | 0.00 | 18517.2 | 0.0 |
| 70 | 6.0 | 19277 | 28.64 | 0.00 | 0.00 | 8.2 | 0.00 | 0.00 | 19276.8 | 0.0 |
| 72 | 5.7 | 20000 | 28.73 | 0.00 | 0.00 | 8.4 | 0.00 | 0.00 | 20000.0 | 0.0 |
| 74 | 5.5 | 20688 | 28.81 | 0.00 | 0.00 | 8.6 | 0.00 | 0.00 | 20688.5 | 0.0 |
| 76 | 5.2 | 21344 | 28.89 | 0.00 | 0.00 | 8.7 | 0.00 | 0.00 | 21343.9 | 0.0 |
| 78 | 5.0 | 21968 | 28.96 | 0.00 | 0.00 | 8.9 | 0.00 | 0.00 | 21967.9 | 0.0 |
| 80 | 4.7 | 22562 | 29.03 | 0.00 | 0.00 | 9.0 | 0.00 | 0.00 | 22561.9 | 0.0 |
| 82 | 4.5 | 23127 | 29.10 | 0.00 | 0.00 | 9.1 | 0.00 | 0.00 | 23127.5 | 0.0 |
| 84 | 4.3 | 23666 | 29.16 | 0.00 | 0.00 | 9.2 | 0.00 | 0.00 | 23665.9 | 0.0 |
| 86 | 4.1 | 24179 | 29.22 | 0.00 | 0.00 | 9.3 | 0.00 | 0.00 | 24178.5 | 0.0 |
| 88 | 3.9 | 24667 | 29.28 | 0.00 | 0.00 | 9.4 | 0.00 | 0.00 | 24666.5 | 0.0 |
| 90 | 3.7 | 25131 | 29.33 | 0.00 | 0.00 | 9.5 | 0.00 | 0.00 | 25131.1 | 0.0 |
| 92 | 3.5 | 25573 | 29.38 | 0.00 | 0.00 | 9.6 | 0.00 | 0.00 | 25573.4 | 0.0 |
| 94 | 3.3 | 25994 | 29.43 | 1.29 | 0.00 | 9.7 | 0.00 | 1.29 | 25994.4 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 3.2 | 26240 | 29.46 | 3.43 | 0.00 | 9.8 | 0.00 | 3.43 | 26240.0 | 0.0 |
| 98 | 3.0 | 26210 | 29.46 | 3.13 | 0.00 | 9.8 | 0.00 | 3.13 | 26209.9 | 0.0 |
| 100 | 2.9 | 26197 | 29.45 | 3.01 | 0.00 | 9.8 | 0.00 | 3.01 | 26197.1 | 0.0 |
| 102 | 2.7 | 26182 | 29.45 | 2.86 | 0.00 | 9.8 | 0.00 | 2.86 | 26181.7 | 0.0 |
| 104 | 2.6 | 26167 | 29.45 | 2.73 | 0.00 | 9.8 | 0.00 | 2.73 | 26167.3 | 0.0 |
| 106 | 2.5 | 26153 | 29.45 | 2.60 | 0.00 | 9.7 | 0.00 | 2.60 | 26153.3 | 0.0 |
| 108 | 2.4 | 26140 | 29.45 | 2.48 | 0.00 | 9.7 | 0.00 | 2.48 | 26139.7 | 0.0 |
| 110 | 2.3 | 26127 | 29.45 | 2.36 | 0.00 | 9.7 | 0.00 | 2.36 | 26126.6 | 0.0 |
| 112 | 2.1 | 26114 | 29.44 | 2.25 | 0.00 | 9.7 | 0.00 | 2.25 | 26113.8 | 0.0 |
| 114 | 2.0 | 26102 | 29.44 | 2.14 | 0.00 | 9.7 | 0.00 | 2.14 | 26101.5 | 0.0 |
| 116 | 1.9 | 26090 | 29.44 | 2.04 | 0.00 | 9.7 | 0.00 | 2.04 | 26089.6 | 0.0 |
| 118 | 1.9 | 26078 | 29.44 | 1.94 | 0.00 | 9.7 | 0.00 | 1.94 | 26078.1 | 0.0 |
| 120 | 1.8 | 26067 | 29.44 | 1.85 | 0.00 | 9.7 | 0.00 | 1.85 | 26066.9 | 0.0 |
| 122 | 1.7 | 26056 | 29.44 | 1.77 | 0.00 | 9.7 | 0.00 | 1.77 | 26056.1 | 0.0 |
| 124 | 1.6 | 26046 | 29.44 | 1.68 | 0.00 | 9.7 | 0.00 | 1.68 | 26045.7 | 0.0 |
| 126 | 1.5 | 26036 | 29.44 | 1.60 | 0.00 | 9.7 | 0.00 | 1.60 | 26035.5 | 0.0 |
| 128 | 1.4 | 26026 | 29.43 | 1.53 | 0.00 | 9.7 | 0.00 | 1.53 | 26025.7 | 0.0 |
| 130 | 1.4 | 26016 | 29.43 | 1.46 | 0.00 | 9.7 | 0.00 | 1.46 | 26016.3 | 0.0 |
| 132 | 1.3 | 26007 | 29.43 | 1.39 | 0.00 | 9.7 | 0.00 | 1.39 | 26007.1 | 0.0 |
| 134 | 1.2 | 25998 | 29.43 | 1.32 | 0.00 | 9.7 | 0.00 | 1.32 | 25998.2 | 0.0 |
| 136 | 1.2 | 25990 | 29.43 | 1.26 | 0.00 | 9.7 | 0.00 | 1.26 | 25989.6 | 0.0 |
| 138 | 1.1 | 25981 | 29.43 | 1.20 | 0.00 | 9.7 | 0.00 | 1.20 | 25981.3 | 0.0 |
| 140 | 1.1 | 25973 | 29.43 | 1.14 | 0.00 | 9.7 | 0.00 | 1.14 | 25973.2 | 0.0 |
| 142 | 1.0 | 25965 | 29.43 | 1.09 | 0.00 | 9.7 | 0.00 | 1.09 | 25965.4 | 0.0 |
| 144 | 1.0 | 25958 | 29.43 | 1.04 | 0.00 | 9.7 | 0.00 | 1.04 | 25957.8 | 0.0 |
| 146 | 0.9 | 25951 | 29.43 | 0.99 | 0.00 | 9.7 | 0.00 | 0.99 | 25950.5 | 0.0 |
| 148 | 0.9 | 25943 | 29.43 | 0.94 | 0.00 | 9.7 | 0.00 | 0.94 | 25943.5 | 0.0 |
| 150 | 0.8 | 25937 | 29.42 | 0.90 | 0.00 | 9.7 | 0.00 | 0.90 | 25936.6 | 0.0 |
| 152 | 0.8 | 25930 | 29.42 | 0.86 | 0.00 | 9.7 | 0.00 | 0.86 | 25930.0 | 0.0 |
| 154 | 0.8 | 25924 | 29.42 | 0.82 | 0.00 | 9.7 | 0.00 | 0.82 | 25923.5 | 0.0 |
| 156 | 0.7 | 25917 | 29.42 | 0.78 | 0.00 | 9.7 | 0.00 | 0.78 | 25917.3 | 0.0 |
| 158 | 0.7 | 25911 | 29.42 | 0.74 | 0.00 | 9.7 | 0.00 | 0.74 | 25911.3 | 0.0 |
| 160 | 0.7 | 25905 | 29.42 | 0.71 | 0.00 | 9.7 | 0.00 | 0.71 | 25905.5 | 0.0 |
| 162 | 0.6 | 25900 | 29.42 | 0.67 | 0.00 | 9.7 | 0.00 | 0.67 | 25899.8 | 0.0 |
| 164 | 0.6 | 25894 | 29.42 | 0.64 | 0.00 | 9.7 | 0.00 | 0.64 | 25894.4 | 0.0 |
| 166 | 0.6 | 25889 | 29.42 | 0.61 | 0.00 | 9.7 | 0.00 | 0.61 | 25889.1 | 0.0 |
| 168 | 0.5 | 25884 | 29.42 | 0.58 | 0.00 | 9.7 | 0.00 | 0.58 | 25884.0 | 0.0 |
| 170 | 0.5 | 25879 | 29.42 | 0.56 | 0.00 | 9.7 | 0.00 | 0.56 | 25879.0 | 0.0 |
| 172 | 0.5 | 25874 | 29.42 | 0.53 | 0.00 | 9.7 | 0.00 | 0.53 | 25874.2 | 0.0 |
| 174 | 0.5 | 25870 | 29.42 | 0.50 | 0.00 | 9.7 | 0.00 | 0.50 | 25869.6 | 0.0 |
| 176 | 0.4 | 25865 | 29.42 | 0.48 | 0.00 | 9.7 | 0.00 | 0.48 | 25865.1 | 0.0 |
| 178 | 0.4 | 25861 | 29.42 | 0.46 | 0.00 | 9.7 | 0.00 | 0.46 | 25860.7 | 0.0 |
| 180 | 0.4 | 25857 | 29.42 | 0.44 | 0.00 | 9.7 | 0.00 | 0.44 | 25856.5 | 0.0 |
| 182 | 0.4 | 25852 | 29.41 | 0.42 | 0.00 | 9.7 | 0.00 | 0.42 | 25852.4 | 0.0 |
| 184 | 0.4 | 25848 | 29.41 | 0.40 | 0.00 | 9.7 | 0.00 | 0.40 | 25848.5 | 0.0 |
| 186 | 0.3 | 25845 | 29.41 | 0.38 | 0.00 | 9.7 | 0.00 | 0.38 | 25844.7 | 0.0 |
| 188 | 0.3 | 25841 | 29.41 | 0.36 | 0.00 | 9.7 | 0.00 | 0.36 | 25841.0 | 0.0 |
| 190 | 0.3 | 25837 | 29.41 | 0.34 | 0.00 | 9.7 | 0.00 | 0.34 | 25837.4 | 0.0 |
| 192 | 0.3 | 25834 | 29.41 | 0.33 | 0.00 | 9.7 | 0.00 | 0.33 | 25833.9 | 0.0 |
| 194 | 0.3 | 25831 | 29.41 | 0.31 | 0.00 | 9.7 | 0.00 | 0.31 | 25830.6 | 0.0 |
| 196 | 0.3 | 25827 | 29.41 | 0.30 | 0.00 | 9.7 | 0.00 | 0.30 | 25827.3 | 0.0 |
| 198 | 0.3 | 25824 | 29.41 | 0.28 | 0.00 | 9.7 | 0.00 | 0.28 | 25824.2 | 0.0 |
| 200 | 0.2 | 25821 | 29.41 | 0.27 | 0.00 | 9.7 | 0.00 | 0.27 | 25821.1 | 0.0 |
| 202 | 0.2 | 25818 | 29.41 | 0.26 | 0.00 | 9.7 | 0.00 | 0.26 | 25818.1 | 0.0 |
| 204 | 0.2 | 25815 | 29.41 | 0.25 | 0.00 | 9.7 | 0.00 | 0.25 | 25815.3 | 0.0 |

## WATERSHED DATA

**BEFORE DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.2 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (100YR) | 9.60 IN/HR |

**Qa = 2.40 CFS**

Qa = PRE-DEVELOPED PEAK DISCHARGE

**AFTER DEVELOPMENT**

| | |
|---|---|
| WATERSHED AREA | 1.25 ACRES |
| HYDRAULIC LENGTH | 280 FT |
| CHANGE IN HEIGHT | 3 FT |
| RUNOFF COEF. 'C' | 0.7 |
| TIME OF CONCENTR | 5.00 MIN |
| INTENSITY (100YR) | 9.60 IN/HR |

**Qp = 8.40 CFS**

Qp = POST-DEVELOPED PEAK DISCHARGE

**COMPUTE DEPTH OF RUNOFF**

P = 10 INCHES 100yr, 24hr PRECIPITATION
CN = 88

S = (1000/CN)-10
S = 1.36

Depth (D) = (P-0.2S)^2/(P+0.8S)
D = 8.53 IN - 100yr, 24hr RUNOFF DEPTH

**SET VOLUME AND COMPUTE TIME TO PEAK**

Tp = [(43.5)(D)(Area)] / Qp
Tp = 55.22 MINUTES

Storage Volume Req'd = (Qp-Qa)*Tp*1.39*60
= 27,635 cu. ft.

**CALCULATE Ks AND b**

SET NORMAL ELEVATION AT = 26.00 feet

| CONTOUR | CONTOUR AREA (sq ft) | INCR VOL (cu ft) | S ACCUM VOL (cu ft) | Z STAGE (ft) | ln S | ln Z | Z est (ft) |
|---|---|---|---|---|---|---|---|
| 26.00 | 5,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27.00 | 7,286 | 6,375 | 6,375 | 1.0 | 8.7601 | 0 | 1.00 |
| 28.00 | 7,970 | 7,628 | 14,003 | 2.0 | 9.5470 | 0.6931 | 1.99 |
| 29.00 | 8,711 | 8,341 | 22,344 | 3.0 | 10.0143 | 1.0986 | 3.00 |
| 30.00 | 9,508 | 9,110 | 31,453 | 4.0 | 10.3562 | 1.3863 | 4.05 |
| 31.00 | | | 31,453 | 5.0 | 10.3562 | 1.6094 | 4.05 |
| 32.00 | | | 31,453 | 6.0 | 10.3562 | 1.7918 | 4.05 |
| 33.00 | | | 31,453 | 7.0 | 10.3562 | 1.9459 | 4.05 |

Regression Output:
**==> Ks = 6368**
**b = 1.14**

X Coefficient 8.76

**CHAINSAW METHOD FOR RISER BARREL ROUTING**

**STORM DATA**

| | |
|---|---|
| Qa = | 2.40 cfs |
| Qp = | 8.40 cfs |
| Tp = | 55.2 min |
| dT = | 2 min |

* ***Infiltration rate =*** 0 ***in/hr***

**BASIN DATA**

| | |
|---|---|
| Ks = | 6368 |
| b = | 1.14 |
| Zo = | 26.00 ft |
| Normal water elev = | 26.00 ft |
| Box Weir Length = | 10 ft |
| Cw = | 3.0 |
| Zcr = | 28.80 ft |
| Dd = | 15 in |
| Cd = | 0.59 |
| Zi = | 26.00 ft |

| | |
|---|---|
| **Peak Outflow =** | 4.67 cfs |
| Peak Stage = | 29.02 ft |
| Maximum Storage = | 22,460 cu ft |

Control Holes:

| | | |
|---|---|---|
| State Orifice: | Dia = | 1.00 in |
| | Inv = | 26.00 ft |
| Weir: | L = | 4 in |
| | Inv = | 27.25 ft |

| Time (min) | Inflow (cfs) | Storage (cu ft) | Stage (ft) | Outflow (cfs) | W Riser (cfs) | Barrel (cfs) | Orifice (cfs) | City Weir (cfs) | IFStore (cu ft) | Infiltrate (cf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0 | 26.00 | 0.00 | 0 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 2 | 0.0 | 0 | 26.00 | 0 | 0.00 | 0 | 0 | 0.00 | 0.0 | 0.0 |
| 4 | 0.1 | 3 | 26.00 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 3.3 | 0.0 |
| 6 | 0.2 | 16 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 16.2 | 0.0 |
| 8 | 0.4 | 45 | 26.01 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 45.3 | 0.0 |
| 10 | 0.7 | 97 | 26.03 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 96.6 | 0.0 |
| 12 | 0.9 | 176 | 26.04 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 | 175.8 | 0.0 |
| 14 | 1.3 | 289 | 26.07 | 0.00 | 0.00 | 0.1 | 0.00 | 0.00 | 288.5 | 0.0 |
| 16 | 1.6 | 440 | 26.10 | 0.01 | 0.00 | 0.1 | 0.01 | 0.00 | 439.7 | 0.0 |
| 18 | 2.0 | 634 | 26.13 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 633.7 | 0.0 |
| 20 | 2.4 | 875 | 26.18 | 0.01 | 0.00 | 0.2 | 0.01 | 0.00 | 874.7 | 0.0 |
| 22 | 2.9 | 1166 | 26.23 | 0.01 | 0.00 | 0.4 | 0.01 | 0.00 | 1166.1 | 0.0 |
| 24 | 3.3 | 1511 | 26.28 | 0.01 | 0.00 | 0.5 | 0.01 | 0.00 | 1510.5 | 0.0 |
| 26 | 3.8 | 1910 | 26.35 | 0.01 | 0.00 | 0.7 | 0.01 | 0.00 | 1910.2 | 0.0 |
| 28 | 4.3 | 2366 | 26.42 | 0.02 | 0.00 | 0.9 | 0.02 | 0.00 | 2366.3 | 0.0 |
| 30 | 4.8 | 2880 | 26.50 | 0.02 | 0.00 | 1.2 | 0.02 | 0.00 | 2879.5 | 0.0 |
| 32 | 5.2 | 3450 | 26.58 | 0.02 | 0.00 | 1.5 | 0.02 | 0.00 | 3449.7 | 0.0 |
| 34 | 5.7 | 4076 | 26.68 | 0.02 | 0.00 | 1.8 | 0.02 | 0.00 | 4075.9 | 0.0 |
| 36 | 6.1 | 4757 | 26.77 | 0.02 | 0.00 | 2.2 | 0.02 | 0.00 | 4756.5 | 0.0 |
| 38 | 6.5 | 5489 | 26.88 | 0.02 | 0.00 | 2.7 | 0.02 | 0.00 | 5489.3 | 0.0 |
| 40 | 6.9 | 6271 | 26.99 | 0.03 | 0.00 | 3.2 | 0.03 | 0.00 | 6271.3 | 0.0 |
| 42 | 7.3 | 7099 | 27.10 | 0.03 | 0.00 | 3.8 | 0.03 | 0.00 | 7098.8 | 0.0 |
| 44 | 7.6 | 7968 | 27.22 | 0.03 | 0.00 | 4.4 | 0.03 | 0.00 | 7967.6 | 0.0 |
| 46 | 7.8 | 8873 | 27.34 | 0.10 | 0.00 | 4.9 | 0.03 | 0.07 | 8872.9 | 0.0 |
| 48 | 8.1 | 9801 | 27.46 | 0.28 | 0.00 | 5.3 | 0.03 | 0.25 | 9801.4 | 0.0 |
| 50 | 8.2 | 10733 | 27.58 | 0.53 | 0.00 | 5.7 | 0.03 | 0.50 | 10733.5 | 0.0 |
| 52 | 8.3 | 11656 | 27.70 | 0.69 | 0.00 | 6.0 | 0.03 | 0.66 | 11655.6 | 0.0 |
| 54 | 8.4 | 12572 | 27.82 | 0.82 | 0.00 | 6.3 | 0.03 | 0.78 | 12572.3 | 0.0 |
| 56 | 8.4 | 13481 | 27.93 | 0.92 | 0.00 | 6.6 | 0.04 | 0.89 | 13481.2 | 0.0 |
| 58 | 8.3 | 14378 | 28.04 | 1.01 | 0.00 | 6.9 | 0.04 | 0.98 | 14378.1 | 0.0 |
| 60 | 8.2 | 15258 | 28.15 | 1.10 | 0.00 | 7.2 | 0.04 | 1.06 | 15258.0 | 0.0 |
| 62 | 8.1 | 16116 | 28.26 | 1.17 | 0.00 | 7.4 | 0.04 | 1.13 | 16115.8 | 0.0 |
| 64 | 7.9 | 16946 | 28.36 | 1.24 | 0.00 | 7.6 | 0.04 | 1.20 | 16946.1 | 0.0 |
| 66 | 7.6 | 17744 | 28.46 | 1.30 | 0.00 | 7.8 | 0.04 | 1.26 | 17743.8 | 0.0 |
| 68 | 7.3 | 18504 | 28.55 | 1.36 | 0.00 | 8.0 | 0.04 | 1.32 | 18503.9 | 0.0 |
| 70 | 7.0 | 19222 | 28.63 | 1.41 | 0.00 | 8.2 | 0.04 | 1.37 | 19221.8 | 0.0 |
| 72 | 6.7 | 19895 | 28.71 | 1.45 | 0.00 | 8.4 | 0.04 | 1.41 | 19895.0 | 0.0 |
| 74 | 6.4 | 20524 | 28.79 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20524.1 | 0.0 |
| 76 | 6.1 | 21111 | 28.86 | 1.96 | 0.43 | 8.7 | 0.04 | 1.49 | 21111.3 | 0.0 |
| 78 | 5.8 | 21607 | 28.92 | 2.77 | 1.21 | 8.8 | 0.04 | 1.52 | 21607.2 | 0.0 |
| 80 | 5.5 | 21972 | 28.96 | 3.52 | 1.94 | 8.9 | 0.04 | 1.54 | 21972.0 | 0.0 |
| 82 | 5.3 | 22215 | 28.99 | 4.07 | 2.48 | 8.9 | 0.04 | 1.55 | 22215.2 | 0.0 |
| 84 | 5.0 | 22361 | 29.01 | 4.43 | 2.82 | 9.0 | 0.04 | 1.56 | 22361.1 | 0.0 |
| 86 | 4.8 | 22435 | 29.02 | 4.61 | 3.00 | 9.0 | 0.04 | 1.56 | 22435.5 | 0.0 |
| 88 | 4.6 | 22460 | 29.02 | 4.67 | 3.06 | 9.0 | 0.04 | 1.57 | 22459.7 | 0.0 |
| 90 | 4.4 | 22450 | 29.02 | 4.65 | 3.04 | 9.0 | 0.04 | 1.57 | 22450.1 | 0.0 |
| 92 | 4.2 | 22418 | 29.01 | 4.57 | 2.96 | 9.0 | 0.04 | 1.56 | 22418.0 | 0.0 |
| 94 | 4.0 | 22371 | 29.01 | 4.45 | 2.85 | 9.0 | 0.04 | 1.56 | 22371.4 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 96 | 3.8 | 22316 | 29.00 | 4.32 | 2.71 | 8.9 | 0.04 | 1.56 | 22315.7 | 0.0 |
| 98 | 3.6 | 22254 | 28.99 | 4.17 | 2.57 | 8.9 | 0.04 | 1.55 | 22254.4 | 0.0 |
| 100 | 3.5 | 22190 | 28.99 | 4.01 | 2.42 | 8.9 | 0.04 | 1.55 | 22189.9 | 0.0 |
| 102 | 3.3 | 22124 | 28.98 | 3.86 | 2.27 | 8.9 | 0.04 | 1.55 | 22123.8 | 0.0 |
| 104 | 3.2 | 22057 | 28.97 | 3.71 | 2.12 | 8.9 | 0.04 | 1.54 | 22057.0 | 0.0 |
| 106 | 3.0 | 21990 | 28.96 | 3.56 | 1.98 | 8.9 | 0.04 | 1.54 | 21990.3 | 0.0 |
| 108 | 2.9 | 21924 | 28.96 | 3.41 | 1.84 | 8.9 | 0.04 | 1.54 | 21924.1 | 0.0 |
| 110 | 2.7 | 21859 | 28.95 | 3.27 | 1.70 | 8.8 | 0.04 | 1.53 | 21858.6 | 0.0 |
| 112 | 2.6 | 21794 | 28.94 | 3.14 | 1.57 | 8.8 | 0.04 | 1.53 | 21793.9 | 0.0 |
| 114 | 2.5 | 21730 | 28.93 | 3.01 | 1.44 | 8.8 | 0.04 | 1.52 | 21730.3 | 0.0 |
| 116 | 2.4 | 21668 | 28.92 | 2.89 | 1.33 | 8.8 | 0.04 | 1.52 | 21667.8 | 0.0 |
| 118 | 2.3 | 21606 | 28.92 | 2.77 | 1.21 | 8.8 | 0.04 | 1.52 | 21606.2 | 0.0 |
| 120 | 2.2 | 21546 | 28.91 | 2.66 | 1.10 | 8.8 | 0.04 | 1.51 | 21545.7 | 0.0 |
| 122 | 2.1 | 21486 | 28.90 | 2.55 | 1.00 | 8.8 | 0.04 | 1.51 | 21486.2 | 0.0 |
| 124 | 2.0 | 21428 | 28.90 | 2.45 | 0.90 | 8.7 | 0.04 | 1.51 | 21427.7 | 0.0 |
| 126 | 1.9 | 21370 | 28.89 | 2.35 | 0.81 | 8.7 | 0.04 | 1.50 | 21370.0 | 0.0 |
| 128 | 1.8 | 21313 | 28.88 | 2.26 | 0.72 | 8.7 | 0.04 | 1.50 | 21313.2 | 0.0 |
| 130 | 1.7 | 21257 | 28.88 | 2.17 | 0.63 | 8.7 | 0.04 | 1.50 | 21257.1 | 0.0 |
| 132 | 1.6 | 21202 | 28.87 | 2.09 | 0.55 | 8.7 | 0.04 | 1.49 | 21201.6 | 0.0 |
| 134 | 1.6 | 21147 | 28.86 | 2.01 | 0.48 | 8.7 | 0.04 | 1.49 | 21146.8 | 0.0 |
| 136 | 1.5 | 21092 | 28.86 | 1.93 | 0.41 | 8.7 | 0.04 | 1.49 | 21092.4 | 0.0 |
| 138 | 1.4 | 21038 | 28.85 | 1.86 | 0.34 | 8.7 | 0.04 | 1.48 | 21038.4 | 0.0 |
| 140 | 1.4 | 20985 | 28.84 | 1.80 | 0.28 | 8.6 | 0.04 | 1.48 | 20984.6 | 0.0 |
| 142 | 1.3 | 20931 | 28.84 | 1.74 | 0.22 | 8.6 | 0.04 | 1.48 | 20930.8 | 0.0 |
| 144 | 1.2 | 20877 | 28.83 | 1.68 | 0.17 | 8.6 | 0.04 | 1.47 | 20877.0 | 0.0 |
| 146 | 1.2 | 20823 | 28.82 | 1.63 | 0.12 | 8.6 | 0.04 | 1.47 | 20822.9 | 0.0 |
| 148 | 1.1 | 20768 | 28.82 | 1.58 | 0.07 | 8.6 | 0.04 | 1.47 | 20768.2 | 0.0 |
| 150 | 1.1 | 20713 | 28.81 | 1.54 | 0.04 | 8.6 | 0.04 | 1.46 | 20712.6 | 0.0 |
| 152 | 1.0 | 20656 | 28.80 | 1.51 | 0.01 | 8.6 | 0.04 | 1.46 | 20655.6 | 0.0 |
| 154 | 1.0 | 20596 | 28.80 | 1.50 | 0.00 | 8.6 | 0.04 | 1.45 | 20596.5 | 0.0 |
| 156 | 0.9 | 20533 | 28.79 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20533.4 | 0.0 |
| 158 | 0.9 | 20465 | 28.78 | 1.49 | 0.00 | 8.5 | 0.04 | 1.45 | 20465.4 | 0.0 |
| 160 | 0.8 | 20393 | 28.77 | 1.48 | 0.00 | 8.5 | 0.04 | 1.44 | 20392.8 | 0.0 |
| 162 | 0.8 | 20316 | 28.76 | 1.48 | 0.00 | 8.5 | 0.04 | 1.44 | 20315.9 | 0.0 |
| 164 | 0.8 | 20235 | 28.75 | 1.47 | 0.00 | 8.5 | 0.04 | 1.43 | 20235.0 | 0.0 |
| 166 | 0.7 | 20150 | 28.74 | 1.47 | 0.00 | 8.4 | 0.04 | 1.43 | 20150.2 | 0.0 |
| 168 | 0.7 | 20062 | 28.73 | 1.46 | 0.00 | 8.4 | 0.04 | 1.42 | 20061.8 | 0.0 |
| 170 | 0.7 | 19970 | 28.72 | 1.46 | 0.00 | 8.4 | 0.04 | 1.41 | 19970.1 | 0.0 |
| 172 | 0.6 | 19875 | 28.71 | 1.45 | 0.00 | 8.4 | 0.04 | 1.41 | 19875.3 | 0.0 |
| 174 | 0.6 | 19778 | 28.70 | 1.44 | 0.00 | 8.4 | 0.04 | 1.40 | 19777.5 | 0.0 |
| 176 | 0.6 | 19677 | 28.69 | 1.44 | 0.00 | 8.3 | 0.04 | 1.40 | 19677.1 | 0.0 |
| 178 | 0.6 | 19574 | 28.68 | 1.43 | 0.00 | 8.3 | 0.04 | 1.39 | 19574.0 | 0.0 |
| 180 | 0.5 | 19469 | 28.66 | 1.42 | 0.00 | 8.3 | 0.04 | 1.38 | 19468.6 | 0.0 |
| 182 | 0.5 | 19361 | 28.65 | 1.42 | 0.00 | 8.3 | 0.04 | 1.37 | 19361.0 | 0.0 |
| 184 | 0.5 | 19251 | 28.64 | 1.41 | 0.00 | 8.2 | 0.04 | 1.37 | 19251.4 | 0.0 |
| 186 | 0.5 | 19140 | 28.62 | 1.40 | 0.00 | 8.2 | 0.04 | 1.36 | 19139.9 | 0.0 |
| 188 | 0.4 | 19027 | 28.61 | 1.39 | 0.00 | 8.2 | 0.04 | 1.35 | 19026.6 | 0.0 |
| 190 | 0.4 | 18912 | 28.60 | 1.39 | 0.00 | 8.1 | 0.04 | 1.34 | 18911.8 | 0.0 |
| 192 | 0.4 | 18795 | 28.58 | 1.38 | 0.00 | 8.1 | 0.04 | 1.34 | 18795.5 | 0.0 |
| 194 | 0.4 | 18678 | 28.57 | 1.37 | 0.00 | 8.1 | 0.04 | 1.33 | 18677.9 | 0.0 |
| 196 | 0.4 | 18559 | 28.55 | 1.36 | 0.00 | 8.1 | 0.04 | 1.32 | 18559.1 | 0.0 |
| 198 | 0.3 | 18439 | 28.54 | 1.35 | 0.00 | 8.0 | 0.04 | 1.31 | 18439.2 | 0.0 |
| 200 | 0.3 | 18318 | 28.52 | 1.34 | 0.00 | 8.0 | 0.04 | 1.30 | 18318.3 | 0.0 |
| 202 | 0.3 | 18197 | 28.51 | 1.33 | 0.00 | 8.0 | 0.04 | 1.29 | 18196.6 | 0.0 |
| 204 | 0.3 | 18074 | 28.50 | 1.33 | 0.00 | 7.9 | 0.04 | 1.29 | 18074.1 | 0.0 |

1/4/2017
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Family Fare Market St.
10Yr Drainage Calculations

| LOCATION | | AREA | | RUNOFF | RAIN | FLOW | PIPE DATA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FROM | TO | SUB TOTAL (Acre) | TOTAL (Acre) | COEFF. C | INT. I (in/hr) | Q=CIA (C.F.S. REQ'D) | TYPE | N | LENGTH (ft) | S % | SIZE (in) | VEL. (fps) | Q AVAIL. (cfs) | HI INV. | LOW INV. | ELEV. HEAD (ft) | | RIM ELEV. (ft) | STRUCTURE HEIGHT (ft) |
| Curb Inlet No 1 | Manhole No 1 | 0.22 | 0.22 | 0.90 | 7.23 | **1.43** | RCP | 0.013 | 59 | 0.85% | 15 | 1.2 | **5.96** | 27.50 | 27.00 | 0.50 | - | 30.50 | 3.0 |
| Manhole No 1 | Manhole No 2 | 0.00 | 0.22 | 0.90 | 7.23 | **1.43** | RCP | 0.013 | 34 | 1.47% | 15 | 1.2 | **7.85** | 27.00 | 26.50 | 0.50 | - | 31.35 | 4.4 |
| Manhole No 2 | Curb Inlet No 2 | 0.00 | 0.22 | 0.90 | 7.23 | **1.43** | RCP | 0.013 | 61 | 0.82% | 15 | 1.2 | **5.86** | 26.50 | 26.00 | 0.50 | - | 30.75 | 4.3 |
| Curb Inlet No 2 | Curb Inlet No 3 | 0.46 | 0.77 | 0.90 | 7.23 | **5.01** | RCP | 0.013 | 100 | 0.50% | 18 | 2.8 | **7.45** | 26.00 | 25.50 | 0.50 | - | 29.00 | 3.0 |
| Curb Inlet No 3 | Basin Forebay | 0.02 | 0.79 | 0.90 | 7.23 | **5.14** | PVC | 0.009 | 17 | 2.94% | 18 | 2.9 | **26.09** | 25.50 | 25.00 | 0.50 | - | 29.00 | 3.5 |
| | | | | | | | | | | | | | | | | | | | |
| Curb Inlet No 4 | Curb Inlet No 3 | 0.09 | 0.09 | 0.90 | 7.23 | **0.59** | RCP | 0.013 | 30 | 1.67% | 15 | 0.5 | **8.36** | 26.00 | 25.50 | 0.50 | - | 29.00 | 3.0 |

*Energy Dissipator Sizing*

*Required Zone 1 for a 18"*
4.5' x 6' x 12"

*Minimum Provided Zone 1 18"*
5' x 10' x 18"

*Required Zone 1 for a 24"*
6' x 8' x 12"

*Minimum Provided Zone 1 24"*
10' x 15' x 18"

*Required Zone 1 for a 30"*
7.5' x 10' x 18"

*Minimum Provided Zone 1 30"*
10' x 15' x 18"

*Required Zone 1 for a 36"*
9' x 12' x 18"

*Minimum Provided Zone 1 36"*
10' x 15' x 18"

*Required Zone 2 for a 42"*
10.5' x 21' x 18"

*Minimum Provided Zone 2 42"*
15' x 25' x 18"

Family Fare Market St
10Yr HGL Calculations



| LOCATION | | Outlet | Do | Qo | | | Head Losses | | | | Inlet | Rim |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FROM | TO | WS ELEV | (in) | | LENGTH (ft) | Hf | Hc | He | Hb | Ht | WS ELEV | Elev |
| Pond | Curb Inlet No 3 | 28.53 | 18 | 5.14 | 17 | 0.03 | | | | | 28.56 | 29.00 |
| Curb Inlet No 3 | Curb Inlet No 2 | 28.56 | 18 | 5.01 | 97 | 0.16 | | | | | 28.72 | 29.00 |
| Curb Inlet No 2 | SDMH No 2 | 28.72 | 15 | 1.43 | 61 | 0.02 | | | | | 28.74 | 30.75 |
| SDMH No 2 | SDMH No 1 | 28.74 | 15 | 1.43 | 34 | 0.01 | | | | | 28.75 | 31.35 |
| SDMH No 1 | Curb Inlet No 1 | 28.75 | 15 | 1.43 | 59 | 0.02 | | | | | 28.77 | 30.50 |
| | | | | | | | | | | | | |
| Curb Inlet No 3 | Curb Inlet No 4 | 28.56 | 15 | 0.59 | 30 | 0.00 | | | | | 28.56 | 29.00 |

12/2/2016
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# Family Fare Market St.
## 10Yr Drainage Calculations
## (w/ Drainage from Future Outparcel Allocated to Curb Inlet No 1)

| LOCATION | | AREA | | RUNOFF | RAIN | FLOW | PIPE DATA | | | | | | | | | | RIM | STRUCTURE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FROM | TO | SUB TOTAL (Acre) | TOTAL (Acre) | COEFF. C | INT. I (in/hr) | Q=CIA (C.F.S. REQ'D) | TYPE | N | LENGTH (ft) | S % | SIZE (in) | VEL. (fps) | Q AVAIL. (cfs) | HI INV. | LOW INV. | ELEV. HEAD (ft) | ELEV. (ft) | HEIGHT (ft) |
| Curb Inlet No 1 | Manhole No 1 | 0.32 | 0.32 | 0.90 | 7.23 | **2.08** | RCP | 0.013 | 59 | 0.85% | 15 | 1.7 | **5.96** | 27.50 | 27.00 | 0.50 | 30.50 | 3.0 |
| Manhole No 1 | Manhole No 2 | 0.00 | 0.32 | 0.90 | 7.23 | **2.08** | RCP | 0.013 | 34 | 1.47% | 15 | 1.7 | **7.85** | 27.00 | 26.50 | 0.50 | 30.50 | 3.5 |
| Manhole No 2 | Curb Inlet No 2 | 0.00 | 0.32 | 0.90 | 7.23 | **2.08** | RCP | 0.013 | 61 | 0.82% | 15 | 1.7 | **5.86** | 26.50 | 26.00 | 0.50 | 29.70 | 3.2 |
| Curb Inlet No 2 | Curb Inlet No 3 | 0.41 | 0.87 | 0.90 | 7.23 | **5.66** | RCP | 0.013 | 100 | 0.50% | 18 | 3.2 | **7.45** | 26.00 | 25.50 | 0.50 | 29.00 | 3.0 |
| Curb Inlet No 3 | Basin Forebay | 0.02 | 0.89 | 0.90 | 7.23 | **5.79** | PVC | 0.009 | 17 | 2.94% | 18 | 3.3 | **26.09** | 25.50 | 25.00 | 0.50 | 29.00 | 3.5 |
| | | | | | | | | | | | | | | | | | | |
| Curb Inlet No 4 | Curb Inlet No 3 | 0.14 | 0.14 | 0.90 | 7.23 | **0.91** | RCP | 0.013 | 30 | 1.67% | 15 | 0.7 | **8.36** | 26.00 | 25.50 | 0.50 | 29.00 | 3.0 |

*Energy Dissipator Sizing*

*Required Zone 1 for a 18"*
4.5' x 6' x 12"

*Minimum Provided Zone 1 18"*
5' x 10' x 18"

*Required Zone 1 for a 24"*
6' x 8' x 12"

*Minimum Provided Zone 1 24"*
10' x 15' x 18"

*Required Zone 1 for a 30"*
7.5' x 10' x 18"

*Minimum Provided Zone 1 30"*
10' x 15' x 18"

*Required Zone 1 for a 36"*
9' x 12' x 18"

*Minimum Provided Zone 1 36"*
10' x 15' x 18"

*Required Zone 2 for a 42"*
10.5' x 21' x 18"

*Minimum Provided Zone 2 42"*
15' x 25' x 18"

1/4/2017
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Family Fare Market St.
50Yr Drainage Calculations

| LOCATION | | AREA | | RUNOFF | RAIN | FLOW | PIPE DATA | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FROM | TO | SUB TOTAL (Acre) | TOTAL (Acre) | COEFF. C | INT. I (in/hr) | Q=CIA (C.F.S. REQ'D) | TYPE | N | LENGTH (ft) | S % | SIZE (in) | VEL. (fps) | Q AVAIL. (cfs) | HI INV. | LOW INV. | ELEV. HEAD (ft) | |
| Curb Inlet No 1 | Manhole No 1 | 0.22 | 0.22 | 0.90 | 8.87 | 1.76 | RCP | 0.013 | 59 | 0.85% | 15 | 1.4 | **5.96** | 27.50 | 27.00 | 0.50 | - |
| Manhole No 1 | Manhole No 2 | 0.00 | 0.22 | 0.90 | 8.87 | 1.76 | RCP | 0.013 | 34 | 1.47% | 15 | 1.4 | **7.85** | 27.00 | 26.50 | 0.50 | - |
| Manhole No 2 | Curb Inlet No 2 | 0.00 | 0.22 | 0.90 | 8.87 | 1.76 | RCP | 0.013 | 61 | 0.82% | 15 | 1.4 | **5.86** | 26.50 | 26.00 | 0.50 | - |
| Curb Inlet No 2 | Curb Inlet No 3 | 0.46 | 0.77 | 0.90 | 8.87 | 6.15 | RCP | 0.013 | 100 | 0.50% | 18 | 3.5 | **7.45** | 26.00 | 25.50 | 0.50 | - |
| Curb Inlet No 3 | Basin Forebay | 0.02 | 0.79 | 0.90 | 8.87 | 6.31 | PVC | 0.009 | 17 | 2.94% | 18 | 3.6 | **26.09** | 25.50 | 25.00 | 0.50 | - |
| | | | | | | | | | | | | | | | | | |
| Curb Inlet No 4 | Curb Inlet No 3 | 0.09 | 0.09 | 0.90 | 8.87 | 0.72 | RCP | 0.013 | 30 | 1.67% | 15 | 0.6 | **8.36** | 26.00 | 25.50 | 0.50 | - |

| RIM ELEV. (ft) | STRUCTURE HEIGHT (ft) |
|---|---|
| 30.50 | 3.0 |
| 31.35 | 4.4 |
| 30.75 | 4.3 |
| 29.00 | 3.0 |
| 29.00 | 3.5 |
| | |
| 29.00 | 3.0 |

*Energy Dissipator Sizing*

*Required Zone 1 for a 18"*
4.5' x 6' x 12"

*Minimum Provided Zone 1 18"*
5' x 10' x 18"

*Required Zone 1 for a 24"*
6' x 8' x 12"

*Minimum Provided Zone 1 24"*
10' x 15' x 18"

*Required Zone 1 for a 30"*
7.5' x 10' x 18"

*Minimum Provided Zone 1 30"*
10' x 15' x 18"

*Required Zone 1 for a 36"*
9' x 12' x 18"

*Minimum Provided Zone 1 36"*
10' x 15' x 18"

*Required Zone 2 for a 42"*
10.5' x 21' x 18"

*Minimum Provided Zone 2 42"*
15' x 25' x 18"

Family Fare Market St
50Yr HGL Calculations



| LOCATION | | Outlet | Do | Qo | | | Head Losses | | | | Inlet | Rim |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FROM | TO | WS ELEV | (in) | | LENGTH (ft) | Hf | Hc | He | Hb | Ht | WS ELEV | Elev |
| Pond | Curb Inlet No 3 | 28.95 | 18 | 6.31 | 17 | 0.04 | | | | | 28.99 | 29.00 |
| Curb Inlet No 3 | Curb Inlet No 2 | 28.99 | 18 | 6.15 | 97 | 0.24 | | | | | 29.24 | 29.00 |
| Curb Inlet No 2 | SDMH No 2 | 29.24 | 15 | 1.76 | 61 | 0.03 | | | | | 29.27 | 30.75 |
| SDMH No 2 | SDMH No 1 | 29.27 | 15 | 1.76 | 34 | 0.02 | | | | | 29.29 | 31.35 |
| SDMH No 1 | Curb Inlet No 1 | 29.29 | 15 | 1.76 | 59 | 0.03 | | | | | 29.32 | 30.50 |
| | | | | | | | | | | | | |
| Curb Inlet No 3 | Curb Inlet No 4 | 28.99 | 15 | 0.72 | 30 | 0.00 | | | | | 29.00 | 29.00 |

RFTS

*Soils Engineering and Testing Services*

September 14, 2016

Intracoastal Engineering, PLLC
5725 Oleander Drive, Unit E-7
Wilmington, North Carolina 28403

Attention: Mr. Charles Cazier, P.E.

Reference: Report of Subsurface Exploration
Proposed Family Fare Store
6 South 11th Street
Wilmington, North Carolina
RFTS Project No. 1407-16

Dear Mr. Cazier:

RFTS has recently completed an exploration of subsurface conditions within the area of a proposed Family Fare store to be located at 6 South 11th Street in Wilmington, North Carolina. This letter serves as the report of our work. We present herein our understanding of the relevant project information, a description of our field activities, our findings, and recommendations relating to foundation support for the building, earth support of slabs-on-grade, pavement section design, and earthwork operations during construction.

## PROJECT INFORMATION

Our understanding of the relevant project information is based on our conversations with you and our review of a September 6, 2016 email from Mr. Bill Easterling, P.E. of Gardner & McDaniel, PA.

The project site is located at the southwest corner of 11th and Market Streets in Wilmington, North Carolina. Proposed construction consists of a single-story commercial building of approximately 3,200 square feet with a concrete slab-on-grade floor, a steel-frame superstructure, and brick or stone veneer exterior walls. Individual column loads will be less than 20 kips, and wall loads will be less than 1 kip per lineal foot. Floor live loading will not exceed 125 pounds per square foot. We assume that the store will have adjacent bituminous pavement parking and drives and that these pavements will accommodate traffic and loading conditions typical of this kind of commercial facility.

## DESCRIPTION OF EXPLORATION ACTIVITIES

In order to obtain subsurface data to form the basis for our recommendations, two soil borings were advanced at the approximate locations shown in Figure 1 to depths below site grade of 34 feet (Boring B-1) and 30 feet (Boring B-2) using a trailer-mounted rotary drilling rig. Soil samples were recovered and Standard Penetration (SPT) Testing was conducted at routine depth intervals in general accordance with the procedures set forth in ASTM D1586. The locations of the borings were determined in the field by pacing and estimating distances from known site features and should be considered only as accurate as the limitations implied by these methods.

At the completion of drilling, standing water levels in the boreholes were determined and recorded. The use of drilling fluid in the wash-boring techniques used for our exploration can result in standing water levels in the boreholes at variance with and less accurate than watertable levels obtained by other methods, such as the installation and reading of peizometers.

The soil samples obtained in the field were delivered by the drillers to the undersigned authors of this report who classified them in general accordance with the Unified Soil Classification System (USCS) as set forth in ASTM D2487 using the visual/manual procedures set forth in ASTM 2488. The boring logs included with this report were then prepared based on those classifications and the drillers' field logs.

## FINDINGS

The findings of our subsurface exploration are based on the conditions discovered in our soil borings as detailed in the boring logs and soil profiles and on our observations while on site. We summarize them as follows:

### Site Description

The site is a relatively flat vacant lot with ground elevations ranging from approximately +29 to +31 feet MSL. The property has no trees or significant ground vegetation and no above-ground structures; however, the presence of concrete slabs in some areas suggests a history of development.

### Regional Geology

The project site lies within the southeastern portion of the Outer Coastal Plain Physiographic Province of North Carolina. The Outer Coastal Plain, as described by David R. Soller and Hugh H. Mills in The Geology of the Carolinas (1991), is the eastern portion of the Coastal Plain where constructional topography is evident or dominant. The Inner Coastal Plain begins at the Fall Line and narrows northerly, and is considered to be

an area of erosional topography. According to Horton and Zullo in The Geology of the Carolinas (1991), the Coastal Plain is comprised of a seaward thickening wedge of post-Triassic, primarily unconsolidated, siliciclastic sediments and carbonate rocks that extend from the Fall Line to the continental shelf break. Coastal Plain sediments were deposited in a number of different environments including but not limited to, off-shore marine, near-shore marine, lagoonal, and deltaic. The eustatic rise and fall of sea level has resulted in numerous sedimentary packages of transgressive and regressive sequences deposited throughout the Coastal Plain. In New Hanover County, the pre-Mesozoic crystalline basement rock, onto which the Coastal Plain was deposited, lies approximately 500 meters below MSL.

## Subsurface Conditions

The two borings advanced for this exploration encountered distinctly different subsurface conditions. These conditions are detailed in the boring logs appended to this report. We summarize them as follows:

**Boring B-1.** Judging from the presence of brick and wood debris in the recovered SPT samples, the soils in the upper 21 feet below grade in this boring appear to constitute fill soils. They consist primarily of interbedded clean and silty sands (USCS Soil Groups 'SP', 'SP-SM', and 'SM'), with the exception of a layer of high-plasticity clay (Group 'CH') occurring between 13 and 17 feet below grade. These apparent fill soils occur in an *in-situ* condition ranging from very loose/very soft to medium dense.

From a depth of 21 feet to the completed boring depth of 34 feet, the soils as sampled appear to be native and consist of very loose clean and clayey sands ('SP', 'SC') extending to a depth of 33 feet and terminating in hard marine limestone.

**Boring B-2.** In this boring the soils in the upper 6 feet appear to constitute fill for the same reasons indicated above; they consist of loose to medium dense clean sands ('SP'). From 6 feet to 12 feet, the boring encountered soft and very soft organic silt ('OH'). This was underlain to a depth of 16 feet by medium dense clean sand ('SP'). No soil was recovered in the split-spoon sampler in the SPT test conducted from 18.5 to 20.0 feet; however, the encountered material exhibited a penetration resistance indicative of loose sand or firm clay. From a depth of approximately 23 feet to the completed boring depth of 30 feet, weathered marine limestone was encountered. The hardness of this rock increased with depth and exhibited a penetration resistance in excess of 100 blows per foot at the termination depth of the boring.

## Groundwater

Standing water levels recorded in both boreholes at the completion of drilling were 3 feet below site grade. As noted above, these observed levels can be influenced by the

presence of drilling fluid in wash borings. Groundwater levels may vary with seasonal fluctuations in precipitation and will be higher after periods of prolonged or heavy rainfall. The silty texture of the soils at a depth of five feet in both borings suggests that the groundwater may be a perched condition.

## RECOMMENDATIONS

Our analysis and recommendations herein have been developed in accordance with standards of practice generally accepted within geotechnical engineering practice in this region and at the time of the preparation of this report. No other warranty, express or implied, is made. Inasmuch as subsurface conditions can and do vary significantly between the locations of borings, it is entirely possible that conditions not contemplated within our analysis and recommendations may be discovered during the course of construction. In this event, we will be pleased to revisit our recommendations and expand or modify them. Our recommendations are predicated upon our understanding of the proposed construction as set forth under the heading Project Information in this report. Any features of the actual design or construction of the project which may be at variance with the assumptions set forth therein should be brought to our attention so that we may revise or expand our recommendations as appropriate.

### Site Preparation

Site preparation should be initiated by stripping the construction area of turf and topsoil, demolishing and removing the existing concrete slabs where they occur within the area of the proposed building and adjacent pavements, and excavating and removing any underground features of previous construction (footings, utility pipes, etc.). The resulting excavations should then be backfilled to grade with controlled structural fill as defined below under **Earthwork Operations**.

After the above work has been completed, the site should be proofrolled with a heavy vibratory roller to identify areas of soft or yielding soil and to densify the soils disturbed during stripping and demolition. Areas exhibiting pumping, rutting, or other excessive displacement of the subgrade should be excavated to firm material and backfilled to grade with controlled structural fill.

### Earthwork Operations

All fill required to raise the site to its final subgrade elevations and all backfill within undercut areas should consist of controlled structural fill. In the context of this report "controlled structural fill" shall mean a relatively clean sand (USCS Soil Group 'SP', 'SW'. 'SP-SM', or 'SP-SC') placed in loose lifts not exceeding 8 inches in thickness and compacted to a minimum of 98 percent of the maximum dry density as determined by the Standard Proctor Method (ASTM D698).

The soils occurring in the upper three feet on site should generally be suitable for re-use as controlled structural fill, although it may be necessary to remove embedded construction debris where it occurs in the upper foot of the prepared subgrade.

Due to the existing perched water condition on site, soil compaction operations may be adversely affected after periods of prolonged or heavy rainfall. If the exposed soils are observed to pump under the compaction roller during proofrolling or compaction of fill, it may be necessary to delay the placement of additional lifts until pore pressures have subsided and the subgrade has stabilized.

## Foundation Support

Due to the presence of very soft organic soils in the depth interval from 6 to 12 feet in Boring B-2, it is our opinion that it will not be feasible to support the proposed building on shallow spread footings without extensive subgrade repair. While a shallow foundation bearing in the upper two to three feet below site grade would not experience bearing capacity failure, there would be unacceptably large differential foundation settlements due to consolidation of the organic silt in those areas where it occurs beneath the building.

Settlement due to a compressible soil layer is sometimes dealt with by placing a soil surcharge mound over the building area and leaving it in place for a period of time to induce the undesirable consolidation in advance of construction. In this case, however, we believe the long-term secondary consolidation typical of organic soils could not be induced within a reasonable period of time. Accordingly, we recommend the implementation of one of the following two options to provide support for the proposed building:

### Option A—Undercutting and Backfilling

Under this option, an area extending at least five feet beyond the footprint of the building would be undercut to a depth of 12 feet below site grade and backfilled with controlled structural fill as defined above under **Earthwork Operations**. The building could then be supported on a shallow foundation designed for a net allowable bearing pressure of 2,000 psf. Footings bearing in properly placed, and compacted controlled structural fill, and sized for the loading conditions outlined above under **Project Information** should experience total settlements no greater than 1 inch and differential settlements no greater than ½ inch. It would likely be necessary to provide continuous dewatering of the undercut excavation in order to effectively compact the controlled fill in place.

**Option B—Deep Foundation Support**

Under this option, the building would be supported on a deep foundation consisting of either helical piers or round timber piles. For either mode of support, the bearing depth could be expected to range from 30 to 35 feet below site grade.

For a timber pile foundation, the piles should be driven using a single- or double-acting mechanical hammer with a minimum rated energy of 15,000 foot-pounds. To avoid damage to the piles during installation, the site of each pile should be pre-augered to a depth of 15 to 17 feet so as to penetrate any embedded construction debris. Piles should be driven continuously until they exhibit a penetration resistance (in blows per foot or inches per blow) derived from a suitable dynamic formula incorporating a factor of safety of at least 2.0. We would be pleased to provide a driving resistance criterion for pile installation once the driving hammer for the project has been selected. Properly installed timber piles bearing in the weathered limestone in which our borings were terminated should develop working loads in compression of 15 to 20 tons.

If helical piers are employed for deep support of the foundation, they should be installed using hydraulic equipment furnished with a means of registering the torque resistance encountered at take-up (pressure gauge or shear pins). The torque resistance should be related to the axial capacity of the piers by either: (a) an established torque resistance/axial capacity relationship, or (b) a torque resistance/axial capacity relationship established by load testing on site. We estimate that properly installed helical piers will develop axial capacities of 30 kips in compression when advanced into the weathered limestone in which our borings terminated.

**Slabs-on-Grade**

Concrete floor slabs may be designed for a modulus of subgrade reaction (k) of 125 pci. All interior slabs should be furnished with a polymer vapor barrier and should be underlain by at least 4 inches of free-draining granular material. This should consist of a relatively clean sand with less than 7 percent silt fines and no clay.

**Bituminous Pavement**

We have not conducted a California Bearing Ratio (CBR) test of the near-surface subgrade soils on this site. However, based on our experience with similar soils, we believe an estimated CBR value of 12 would be appropriate for purposes of design on this project where the subgrade soils will consist of either controlled structural fill or the prepared and compacted native soils occurring in the upper three feet on site. For a project of this type, where traffic consists primarily of POV's and occasional heavy-axle

delivery vehicles, a pavement section consisting of 2 inches of bituminous pavement surface course over 6 inches of crushed aggregate base course is generally appropriate for the subgrade conditions encountered on this site.

It is essential to the performance of any bituminous pavement that the pavement section and the upper two feet of the underlying soils be furnished with effective and permanent subgrade drainage. We recommend that the shallow perched water condition on this site be addressed through the installation of subdrains beneath the pavement that are effective in maintaining a vertical separation of at least two feet between the water level in the soil and the bottom of the aggregate base course.

## INFILTRATION TESTING AND SHWT ESTIMATES

Infiltration testing, and seasonal high watertable estimates were performed at two locations identified by you. The purpose of this testing was to provide soil parameters for stormwater infiltration design.

Seasonal High Watertable Estimates

Hand auger borings were advanced at two locations to depths of approximately 4 to 5 feet below the existing ground surface in the areas proposed by the civil designer for infiltration structures. The encountered soils were logged and visually classified by depth and a Munsell Soil Color Chart was used to determine the hue, value, and chroma of the visually distinct soil layers. Our soil logs are presented in Table 1.

SHWT-1

Soils encountered in our boring consisted of interbedded fine sands with some construction debris (USCS Soil Group "SP") in the upper 38 inches below the existing ground surface. Below the depth of 30 inches and continuing to the boring termination depth of 45 inches, silty sand with some debris and organics (USCS Soil Groups "SM") were encountered. No distinct zones of soil cementation were encountered in the profile. Based on our experience with similar soils and comparisons of the soil coloration to the Munsell Chart, it is our opinion that a perched seasonal high water table level occurs approximately 25 inches below the existing the ground surface. A measurement made 1 hour after augering indicate depths to standing water in the borehole of 25 inches below the existing ground surface.

SHWT-2

Soils encountered in our boring consisted of interbedded fine sands with some construction debris (USCS Soil Group "SP") in the upper 60 inches below the existing ground surface. Below the depth of 60 inches and continuing to the boring termination depth of 65 inches, sand with silt and burnt wood (USCS Soil Groups "SM") were encountered. No distinct zones of soil cementation were encountered in the profile. Based on our experience with similar soils and comparisons of the soil coloration to the Munsell Chart, it is our opinion the seasonal high water table level occurs approximately 51 inches below the existing the ground surface. A measurement made 1 hour after augering indicate depths to standing water in the borehole of 60 inches below the existing ground surface.

Infiltration Testing

Infiltration testing was performed using a model 2800 Guclph Permeameter which is a constant-head device which operates on the Mariotte siphon principle and is referenced in ASTM D-5126. The permeameter is used to determine field saturated hydraulic conductivity in centimeters per second for soil at a specified depth. This testing involves advancing a borehole to the desired infiltration depth and introducing water at a constant head to determine the steady state flow rate from which the hydraulic conductivity can be calculated.

Our testing was performed approximately 27 inches below the existing ground surface at the location identified as SHWT-2. No infiltration testing was performed at SHWT-1 due to a perched shallow water condition. The results of our permeameter testing are presented in Table 2.

Based on the results of our field testing and soil classifications at the test location, we offer the following recommendations for stormwater infiltration design:

At the test location SHWT-2 it is our opinion that in order to achieve the steady state flow rate obtained during our testing; the areas of infiltration galleries or other infiltration structures should introduce stormwater at approximately 27 inches below the existing ground surface elevation. For purposes of sizing the structures we recommend an ultimate application rate of 2.0 inches per hour. These recommendations should be reviewed by appropriate regulatory authorities before finalizing the details of any civil design.

**CLOSURE**

RFTS appreciates the opportunity to be of service to you on this project. If you should have questions or if we may be of additional assistance, please do not hesitate to contact us.

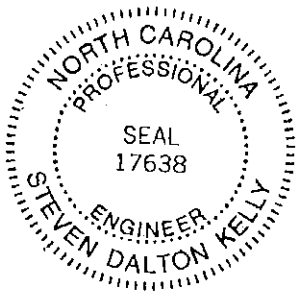
Sincerely,

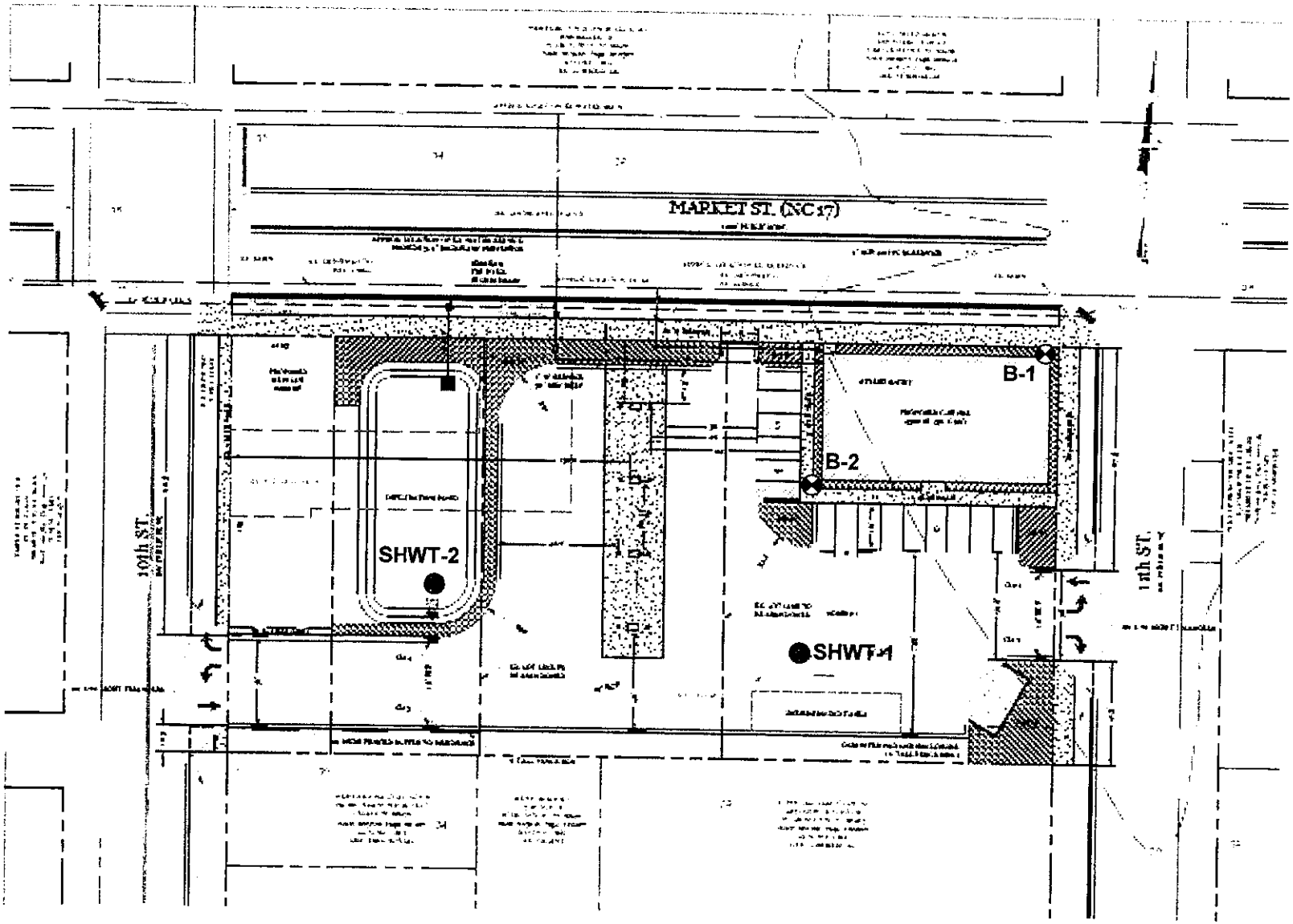
**RFTS, PLLC**

David L. Winstead
Field Operations Manager

Steven D. Kelly, P.E.
Senior Geotechnical Engineer
NC Registration No. 17638

DLW:SDK/sdk
Attachments






**Legend**

- APPROXIMATE BORING LOCATION
- APPROXIMATE SHWT LOCATION

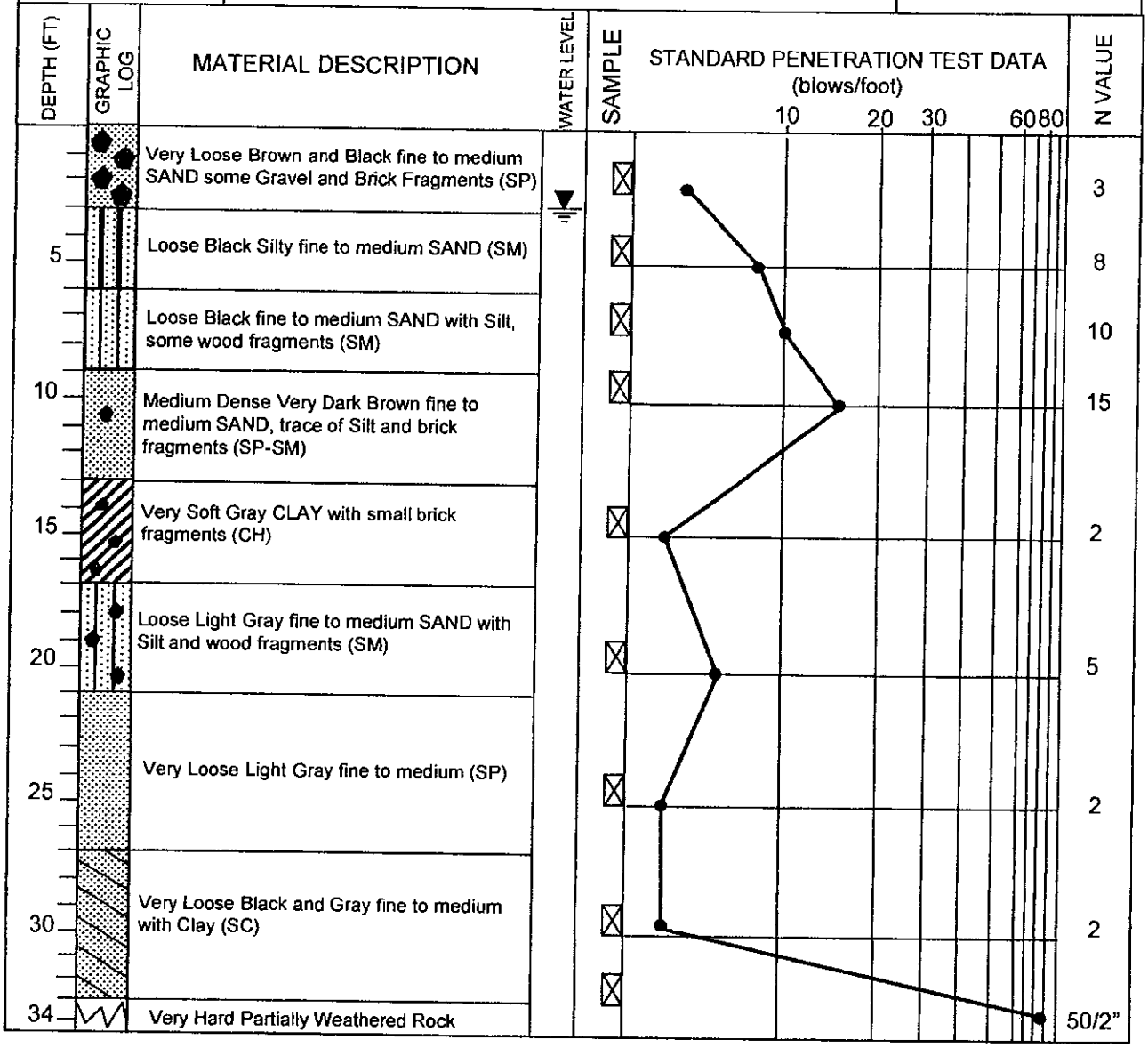
RFTS
Soils Engineering and Testing Services

SOIL BORINGS AND INFILTRATION TESTING LAYOUT
PROPOSED FAMILY FARE STORE
6 SOUTH 11TH STREET
WILMINGTON, NORTH CAROLINA
PROJECT NO. 1407-16

**FIGURE 1**
**DRAWING NOT TO SCALE**
**DATE: 9/14/16**
**SKETCH: DLW**
**REVIEW: SDK**

RFTS, PLLC
761 Sloop Pointe Lane
Kure Beach, North Carolina 28449
Office: 910-470-7450

| BORING B-1 | PROJECT: PROPOSED FAMILY FARE<br>6 SOUTH 11TH STREET<br>WILMINGTON, NORTH CAROLINA | JOB NO.<br>1407-16 |
|---|---|---|




**Boring terminated at 34 feet.**

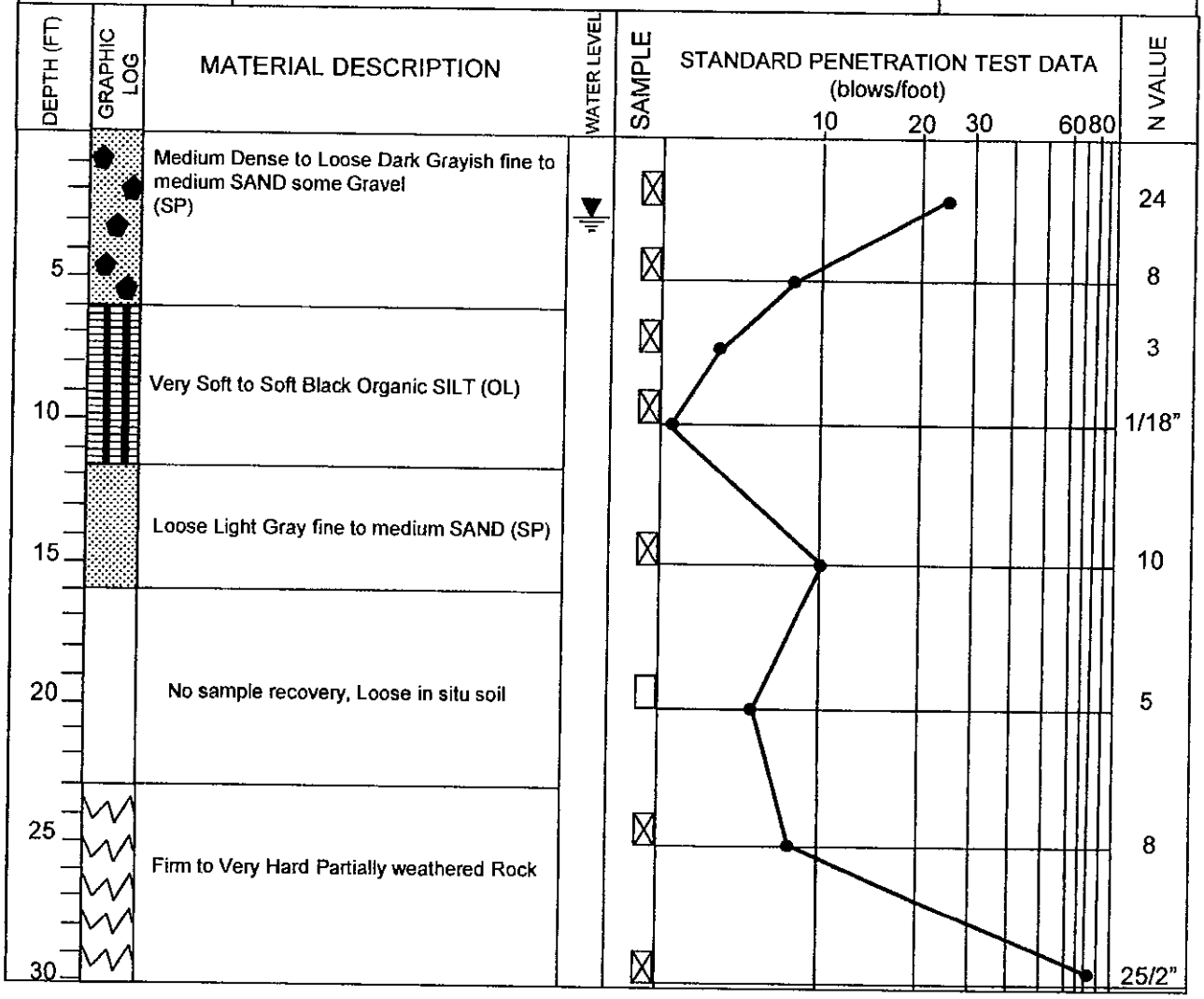
1. Boring, sampling and penetration test data in general accordance with ASTM D-1586.
2. Water level is at time of exploration and will vary.
3. Stratification and groundwater depth are not exact.
4. WOH = Weight Of Hammer.

| | |
|---|---|
| DATE DRILLED: 9/1/16 | ELEVATION: UNKNOWN |
| DRILLING METHOD: WASH BORING | BORING DEPTH: 34 FEET |
| LOGGED BY: D. WINSTEAD | WATER LEVEL: 3 FEET |
| DRILLER: CAROLINA DRILLING | DRILL RIG: ATV 45 |


RFTS Soils Engineering and Testing Services

761 Sloop Pointe Lane
Kure Beach, North Carolina 28449
Phone (910) 470-7450
www.rftspllc.com

| BORING B-2 | **PROJECT:** PROPOSED FAMILY FARE<br>6 SOUTH 11TH STREET<br>WILMINGTON, NORTH CAROLINA | **JOB NO.**<br>1407-16 |
|---|---|---|




**Boring terminated at 26.5 feet.**

1. Boring, sampling and penetration test data in general accordance with ASTM D-1586.
2. Water level is at time of exploration and will vary.
3. Stratification and groundwater depth are not exact.
4. WOH = Weight Of Hammer.

| | |
|---|---|
| DATE DRILLED: 9/1/16 | ELEVATION: UNKNOWN |
| DRILLING METHOD: WASH BORING | BORING DEPTH: 26.5 FEET |
| LOGGED BY: D. WINSTEAD | WATER LEVEL: 3 FEET |
| DRILLER: CAROLINA DRILLING | DRILL RIG: ATV 45 |


RFTS Soils Engineering and Testing Services

761 Sloop Pointe Lane
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Phone (910) 470-7450
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Table 1
Munsell Soil Classifications
Proposed Family Fare
6 South 11th Street
Wilmington, North Carolina
RFTS Project No. 1407-16

| Loc | Soil Description | Hue | Value | Chroma | Depth (in.) | Comments |
|---|---|---|---|---|---|---|
| 1 | Topsoil | - | - | - | 0-5 | |
| | Very Dark Grayish Brown fine SAND with small brick debris | 10YR | 3 | 2 | 5-25 | |
| | Yellowish Brown fine SAND | 10YR | 5 | 6 | 25-30 | **Perched SHWT/$H_2O$@ 25"** |
| | Yellowish Brown fine SAND | 10YR | 5 | 4 | 30-35 | |
| | Gray fine SAND | 10YR | 6 | 1 | 35-38 | |
| | Black Silty SAND with brick debris | 10YR | 2 | 1 | 38-45 | |
| | | | | | | |
| 2 | Topsoil | - | - | - | 0-4 | |
| | Pale Olive fine SAND | 5Y | 6 | 3 | 4-35 | |
| | Brownish Yellow fine SAND with small debris | 10YR | 6 | 6 | 35-51 | |
| | Yellowish Brown fine SAND | 10YR | 5 | 4 | 51-60 | **SHWT@51"** |
| | Black fine SAND with some Silt and burnt wood | 10YR | 2 | 1 | 60-65 | **$H_2O$@60"** |

Table 2
Guelph Permeameter Test Results
Proposed Family Fare
6 South 11th Street
Wilmington, North Carolina
RFTS Project No. 1407-16

| Location | 2 |
|---|---|
| Depth (in.) | 27 |
| $H_1$ (cm) | 5 |
| $R_1$ (cm/min) | 13.6 |
| $R_{1S}$ (cm/sec) | 0.230 |
| $H_2$ (cm) | 10 |
| $R_2$ (cm/min) | 17.6 |
| $R_{2S}$ (cm/sec) | 0.293 |
| $K_{fs}$ (cm/sec) | $1.43 \times 10^{-3}$ |
| **$K_{fs}$ (in/hr)** | **2.0** |

Definition of Terms

$R_{1,2}$ – Established 3 or more constant rate of water level change (cm/min)
$R_{1S,\,2S}$ – Calculated steady state flow rates (cm/sec)
$H_{1,2}$ – Maintained Head of $H_2O$ (cm)
$K_{fs}$ – Calculated field saturated hydraulic conductivity (cm/sec)
Depth – Depth of well hole (in.)
Location – Test location identification number
Note: Diameter of well is 3.0 cm.

01/04/17 PN 2015-049

# *Stormwater Narrative*

Family Fare (Market St.)
Wilmington, NC

The Project Site for the Family Fare (Market St.) is a 1.25 acre tract located on the South side of Market St. between 10th and 11th Streets in Wilmington, NC. The proposed plan is to subdivide the existing parcel into (2) lots with the main parcel being developed and an outparcel established for future development. Much of the existing site is covered with either asphalt or concrete slabs. These existing impervious surfaces are identified to be removed in order for the site to be redeveloped. The proposed improvements will consist of a convenience store (4,500 s.f.), associated parking and access drive (25,814 s.f.), sidewalks (947 s.f.), and an allotment for future development of the outparcel (4,504 s.f.). The total proposed onsite impervious is 35,765 s.f. resulting in 66% impervious for the total tract.

Development of the site will disturb approximately 1.29 acres which includes the proposed driveway connections required for access to the developed site. Runoff from the site will be treated by (2) on-site wet detention basins that were sized to provide volume and surface area required to meet the 1.5" storage requirement and the 25yr Pre-Post Peak development rate. The total drainage area flowing to these basins is 54,450 s.f. The routed discharge from these basins will be piped into the City of Wilmington stormwater network that eventually releases runoff into Burnt Mill Creek, classification C;SW 18-74-63-2.