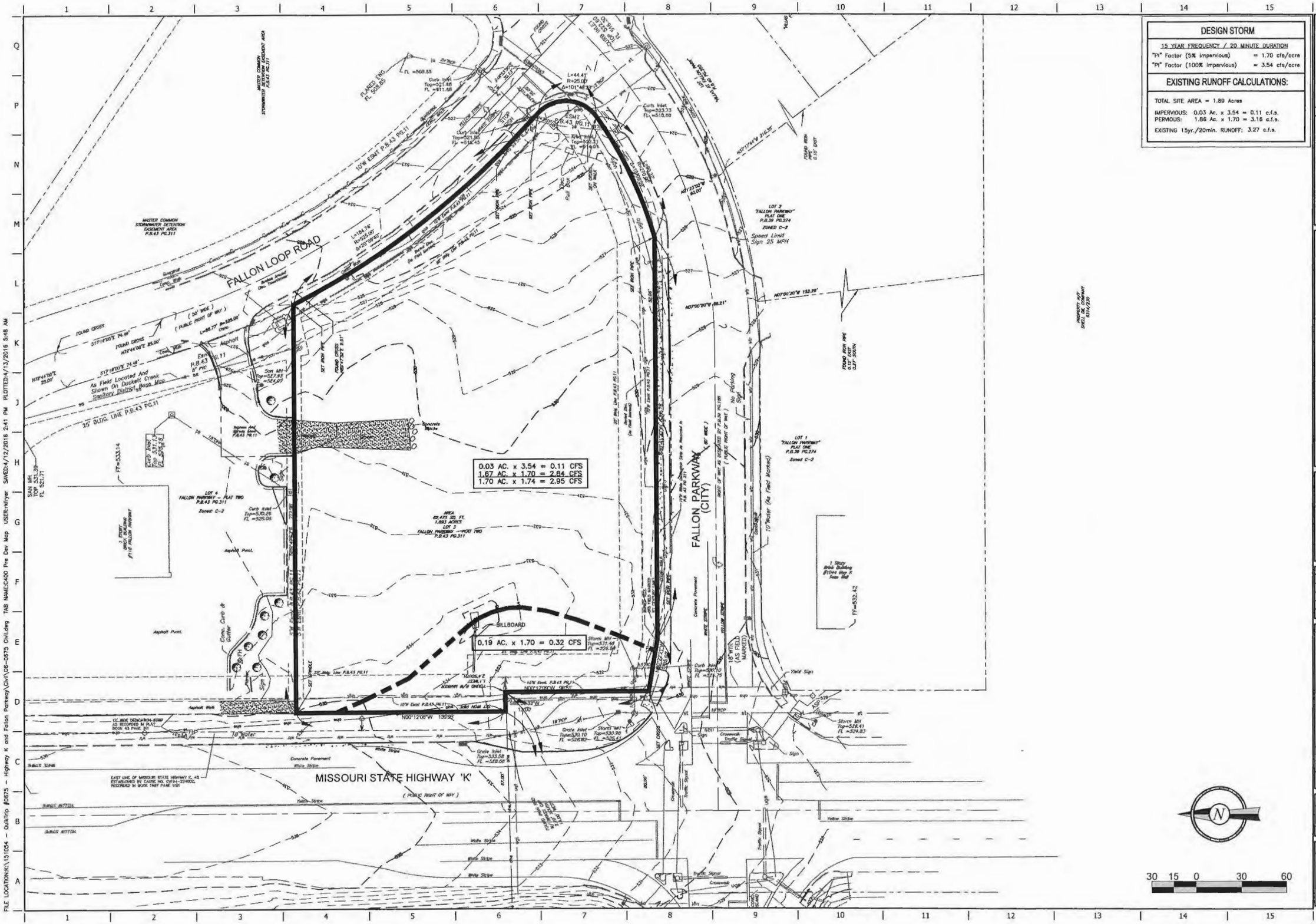
**EXHIBIT D**

**Pre-Developed Drainage Area Map**




| DESIGN STORM | |
|---|---|
| 15 YEAR FREQUENCY / 20 MINUTE DURATION | |
| "Pi" Factor (5% impervious) | = 1.70 cfs/acre |
| "Pi" Factor (100% impervious) | = 3.54 cfs/acre |

**EXISTING RUNOFF CALCULATIONS:**

TOTAL SITE AREA = 1.89 Acres

IMPERVIOUS: 0.03 Ac. x 3.54 = 0.11 c.f.s.
PERMOUS: 1.86 Ac. x 1.70 = 3.16 c.f.s.

EXISTING 15yr./20min. RUNOFF: 3.27 c.f.s.

MICHAEL JAMES VELLOFF NO. E-2000161862 PROFESSIONAL ENGINEER STATE OF MISSOURI REGISTERED

PROJECT NO.: 151054

NAME: MICHAEL J. VELLOFF
LICENSE NUMBER: E-2000161862
DISCIPLINE: CIVIL
CORPORATION AUTHORITY NUMBER: 001194

THE SEAL OF MICHAEL J. VELLOFF ON THIS DRAWING APPLIES ONLY TO THE CIVIL/SITE ENGINEERING SHOWN. IT DOES NOT APPLY, NOR IS ANY RESPONSIBILITY TAKEN FOR ENVIRONMENTAL, GEOTECHNICAL (INCLUDING BUT NOT LIMITED TO SLOPE STABILITY), STRUCTURAL, HVAC, PLUMBING, ELECTRICAL, FIRE PROTECTION, TRAFFIC ENGINEERING, SURVEYING (BOUNDARY AND TOPOGRAPHIC), OR ARCHITECTURAL (BUILDING OR LANDSCAPE).

# QuikTrip No. 0675

140 FALLON LOOP ROAD
O'FALLON, MISSOURI 63368



| | |
|---|---|
| PROTOTYPE: | P-86 |
| DIVISION: | 06 |
| VERSION: | 001 |
| DESIGNED BY: | RKF |
| DRAWN BY: | RKF |
| REVIEWED BY: | MJV |

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | ORIGINAL ISSUE DATE: 04-14-16 |

SHEET TITLE:
PRE-DEVELOPED DRAINAGE MAP

SHEET NUMBER:
C400

**EXHIBIT E**

**Post-Developed Drainage Area Map**

## PROPOSED STORM SEWER RUNOFF TABLE

| I.D. | TO STRUCTURE NO. | Total Area (ac.) | Impervious Area (ac.) | Pervious Area (ac.) | 15Yr./20Min. Composite Pi Factor (cfs/ac.) | 15Yr./20Min. Total Q (cfs) | 100Yr./20Min. Composite Pi Factor (cfs/ac.) | 100Yr./20Min. Total Q (cfs) |
|---|---|---|---|---|---|---|---|---|
| A | CI 1-8 | 0.07 | 0.07 | 0.000 | 3.540 | 0.248 | 4.770 | 0.334 |
| B | CI 1-9 | 0.07 | 0.07 | 0.000 | 3.540 | 0.248 | 4.770 | 0.334 |
| C | CI 1-11 | 0.17 | 0.17 | 0.000 | 3.540 | 0.602 | 4.770 | 0.811 |
| D | CI 1-11 | 0.36 | 0.32 | 0.040 | 3.338 | 1.201 | 4.494 | 1.618 |
| E | CI 1-7 | 0.11 | 0.10 | 0.010 | 3.373 | 0.371 | 4.545 | 0.500 |
| F | C 1-6 | 0.21 | 0.20 | 0.010 | 3.452 | 0.725 | 4.652 | 0.977 |
| G | CI 1-4 | 0.14 | 0.13 | 0.010 | 3.409 | 0.477 | 4.593 | 0.643 |
| H | CI 1-8 | 0.07 | 0.07 | 0.000 | 3.540 | 0.248 | 4.770 | 0.334 |
| I | CI 1-9 | 0.18 | 0.18 | 0.000 | 3.540 | 0.637 | 4.770 | 0.859 |
| J | CI 1-10 | 0.05 | 0.05 | 0.000 | 3.540 | 0.177 | 4.770 | 0.239 |
| K | EX.CI PKWY | 0.30 | 0.16 | 0.140 | 2.681 | 0.804 | 3.613 | 1.084 |
| L | EX AI | 0.16 | 0.00 | 0.160 | 1.700 | 0.272 | 2.290 | 0.366 |
| M | EX.CI LOOP | 0.41 | 0.21 | 0.200 | 2.842 | 1.083 | 3.560 | 1.460 |

(See Stormwater Management Facilities Report for Calculations)

= Drainage Area I.D.

FALLON LOOP ROAD

MISSOURI STATE HIGHWAY 'K'

FALLON PARKWAY (CITY)

CONNECT TO EXISTING UNDERGROUND CORE OF PULLBOX FOR CLEARANCE

MASTER COMMON STORMWATER DETENTION EASEMENT AREA P.B.43 Pg.311

PROPOSED GRADING EASEMENT

FFE 532.50
CLOSET FFE = 532.00
4" ROOF DOWNSPOUTS AT BACK OF BUILDING, 3" AT SIGN AND FRONT.

AREA 82,675 SQ. FT. 1.843 ACRES LOT 3 FALLON PARKWAY - PLAT TWO P.B.43 Pg.311

LOT 4 FALLON PARKWAY - PLAT TWO P.B.43 Pg.311 Zoned C-2

LOT 2 FALLON PARKWAY PLAT ONE P.B.38 Pg.374 ZONED C-2

LOT 1 FALLON PARKWAY PLAT ONE P.B.38 Pg.374 Zoned C-2

Speed Limit Sign 25 MPH

KEEP RIGHT SIGN

NO LEFT TURN SIGN

30 15 0 30 60

### DESIGN STORM

15 YEAR FREQUENCY / 20 MINUTE DURATION

"Pi" Factor (5% Impervious) = 1.70 cfs/acre
"Pi" Factor (100% Impervious) = 3.54 cfs/acre

100 YEAR FREQUENCY / 20 MINUTE DURATION

"Pi" Factor (5% Impervious) = 2.29 cfs/acre
"Pi" Factor (100% Impervious) = 4.77 cfs/acre

### EXISTING RUNOFF CALCULATIONS:

TOTAL SITE AREA = 1.89 Acres

IMPERVIOUS: 0.03 Ac. x 3.54 = 0.11 c.f.s.
PERVIOUS: 1.86 Ac. x 1.70 = 3.16 c.f.s.

EXISTING 15yr./20min. RUNOFF: 3.27 c.f.s.

### PROPOSED RUNOFF CALCULATIONS:

TOTAL SITE AREA = 1.89 Acres

IMPERVIOUS: 1.38 Ac. x 3.54 = 4.89 c.f.s.
PERVIOUS: 0.51 Ac. x 1.70 = 0.87 c.f.s.

PROPOSED 15yr./20min. RUNOFF: 5.76 c.f.s.

### DIFFERENTIAL RUNOFF CALCULATIONS:

TOTAL SITE AREA = 1.89 Acres

DIFFERENTIAL=PROPOSED-EXISTING=5.76-3.27=+2.49
NET INCREASE = 2.49 c.f.s.

SITE DETENTION HAS ALREADY BEEN PROVIDED WITH ORIGINAL DEVELOPMENT PLANS.

STATE OF MISSOURI
MICHAEL JAMES VELLOFF
NO. E-2000161862
REGISTERED PROFESSIONAL ENGINEER

PROJECT NO.: 151054

NAME: MICHAEL J. VELLOFF
LICENSE NUMBER: E-2000161862
DISCIPLINE: CIVIL
CORPORATION AUTHORITY NUMBER: 001194

THE SEAL OF MICHAEL J. VELLOFF ON THIS DRAWING APPLIES ONLY TO THE CIVIL/SITE ENGINEERING SHOWN. IT DOES NOT APPLY, NOR IS ANY RESPONSIBILITY TAKEN FOR ENVIRONMENTAL, GEOTECHNICAL (INCLUDING BUT NOT LIMITED TO SLOPE STABILITY), STRUCTURAL, HVAC, PLUMBING, ELECTRICAL, FIRE PROTECTION, TRAFFIC ENGINEERING, SURVEYING (BOUNDARY AND TOPOGRAPHIC), OR ARCHITECTURAL (BUILDING OR LANDSCAPE).

# QuikTrip No. 0675

140 FALLON LOOP ROAD
O'FALLON, MISSOURI 63368



PROTOTYPE: P-86
DIVISION: 05
VERSION: 001
DESIGNED BY: RKF
DRAWN BY: RKF
REVIEWED BY: MJV

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | ORIGINAL ISSUE DATE: 04-14-16 |

SHEET TITLE:
POST-DEVELOPED DRAINAGE MAP

SHEET NUMBER:
C401

FILE LOCATION:K:\151054 - QuikTrip #0675 - Highway K and Fallon Parkway\Civil\06-0675 Civil.dwg TAB NAME:C401 Post Dev Map USER:rkfryer SAVED:4/12/2016 2:41 PM PLOTTED:4/13/2016 5:48 AM

# STORM WATER MANAGEMENT FACILITIES REPORT: CALCULATIONS FOR

## QuikTrip Store #0675
## 140 Fallon Loop Road
## O'Fallon, Mo. 63368


PREPARED BY:

HEIDEMAN | ASSOCIATES, INC.
*A Zak Company*

**240 Larkin Williams Industrial Court**
**Fenton, Missouri 63026**
**P 636.492.3200**
**F 636.492.3202**


HAI #151054
4/14/16

**QuikTrip #675**
**140 Fallon Loop Road**
**Storm Water Management Facilities Report: Calculations**

## Table of Contents

## SECTION 1

**Project Site Data Summary**

**PROJECT SITE DATA:**

Location: 140 Fallon Loop Road
O'Fallon, MO 63368

Contact: QuikTrip Corporation, Gwen Keen (Real Estate Project Manager)
2255 Bluestone Drive, St. Charles, Missouri 63303
(636) 627-0003

Locator Number: 2-0069-A150-00-0003.0000000z

Area of Parcel: 1.893 acres:

Total Disturbed Area: 1.92 acres

Existing Site: Impervious Area ..... 0.03 ac. x 3.54 = 0.11 c.f.s.
Pervious Area ..... 1.86 ac. x 1.70 = 3.16 c.f.s.
Total Existing Runoff .....3.27 c.f.s.

Proposed Site: Impervious Area..... 1.38 ac. x 3.54 = 4.89 c.f.s.
Pervious Area ..... 0.51 ac. x 1.70 = 0.87 c.f.s.
Total Proposed Runoff .....5.76 c.f.s.

Differential Runoff: ..... 5.76 c.f.s. – 3.27 c.f.s. = +2.49 c.f.s.

Watershed: Dardenne Creek

Flood Protection (Qp): ..... 15yr./20min. differential runoff = +2.49 c.f.s.

Channel Protection (CPv):..... Overall development is less than 5 acres.

**PROJECT DESCRIPTION:**

QuikTrip Corporation will be reconstructing a 5,773 square convenient store and gas station located at 140 Fallon Loop Road in O'Fallon Missouri. A small developed portion of the site generally slopes to Highway K and is collected in an inlet and piped system near the intersection of Fallon Parkway and Highway K. The remaining portion of the site overland flows to the East of the site and is collected in an inlet and piped system near the intersection of Fallon Parkway and Fallon Loop Road. The drainage ultimately is collected in an existing open basin detention system on the East side of Fallon Loop Road. The proposed site drainage will maintain the existing drainage pattern. The total disturbed area associated with these improvements will be 1.92 acres. Water quality collected will be addressed for the disturbance by the installation of an off-line Contech CDS Water Quality unit.

**SECTION 2**

**Contech CDS Unit**
**Water Quality calculations**

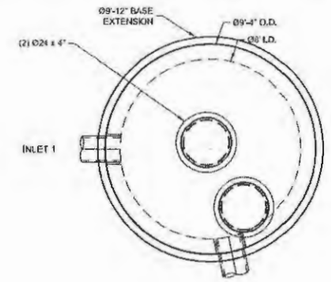
Project Name QuikTrip#675
Location: O'Fallon MO
Project No.: 151054
Structure No. 1-12
Prepared For: QuikTrip Corp
Prepared By: RKF

| | | | | | |
|---|---|---|---|---|---|
| Drainage Area | **1.43** | **acre** | Impervious Area | 1.36 | **acre** |
| | 62,291 | $ft^2$ | | 59,242 | $ft^2$ |
| | 1.43 | acre | | 1.36 | acre |
| | 0.00223438 | $mi^2$ | | 0.002125 | $mi^2$ |

| | | | |
|---|---|---|---|
| % Impervious | 95.1% | % Impervious Over-ride | 0 |

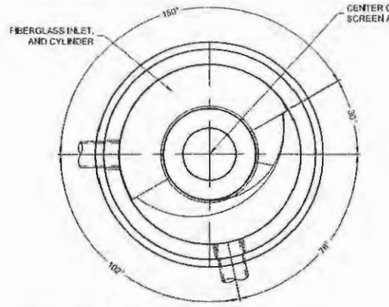
| | | |
|---|---|---|
| P | **1.14** | in |
| Rv | 0.906 | volumetric runoff coefficient |
| Qa | 1.03 | watershed inches |
| WQV | 5,361.1 | ft3 |
| | 0.123 | acre-ft |
| CN | 99.1 | |
| Tc | **6** | min |
| | 0.10 | hr |

| | | |
|---|---|---|
| Rainfall Type | **II** | |
| Potential Abstraction, "S" | 0.10 | inches |
| Initial Abstraction, "Ia" | 0.02 | inches |
| Treatment System | | Vortechs |
| Micron Rating | **110** | |
| qu | 1010.41 | |
| WQF | **2.33** | cfs |




**PLAN VIEW**

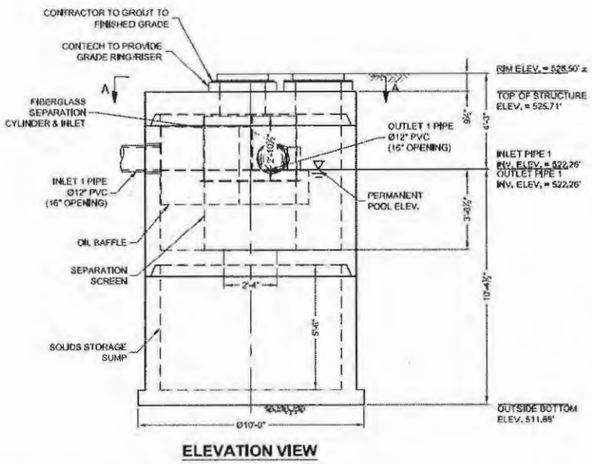
• INTERNAL COMPONENTS TO BE INSTALLED BY CONTECH ON SITE




**SECTION A-A**

MATERIAL LIST (PROVIDED BY CONTECH)

| COUNT | DESCRIPTION | INSTALLED BY |
|---|---|---|
| 1 | FIBERGLASS INLET AND CYLINDER | CONTECH |
| 1 | 2400 micron, 4' O.D. x 3.04' SEP. SCREEN | CONTECH |
| 1 | SEALANT FOR JOINTS (BY PRECASTER) | CONTRACTOR |
| 2 PLC | GRADE RINGS/RISERS | CONTRACTOR |
| 2 | Ø24" x 4" FRAME & COVER, EJ841600389, OR EQUIV. | CONTRACTOR |




**ELEVATION VIEW**

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE, www.ContechES.com
3. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. STRUCTURE SHALL MEET AASHTO HS-20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2', AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. IF REQUIRED, PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.
6. CDS STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C-478 AND AASHTO LOAD FACTOR DESIGN METHOD.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

STRUCTURE WEIGHT
APPROXIMATE HEAVIEST PICK = 23000 LBS.
STRUCTURE IS DELIVERED IN 3 PIECES

MAX FOOTPRINT = Ø9'-12"

CONTECH
CONTRACT
DRAWING

KIEN
LAYOUT 1A
4030-6-FGIS
1185 / KIEN10

CDS4030-8 - 539286-10
QUIKTRIP #675
OFALLON, MO
SITE DESIGNATION: #1-12

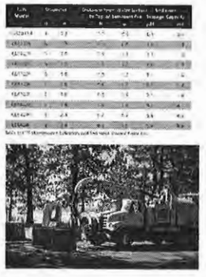
CONTECH ENGINEERED SOLUTIONS LLC
www.ContechES.com
800.338.1122
513.645.7000
513.645.7993 FAX

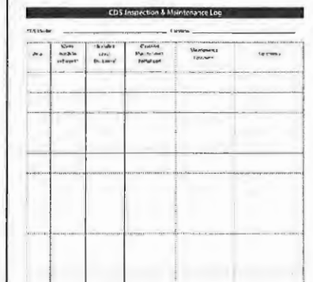
DATE: 03/21/16
SCALE: 1/4" = 1'-0"
DESIGNED:
DRAWN:
CHECKED:
APPROVED:
PROJECT No.: 539286
SEQUENCE No.: 10
SHEET: 1 OF 1

| MARK | DATE | REVISION DESCRIPTION | BY |
|---|---|---|---|
| | | | |

CONTECH

CDS® Inspection and Maintenance Guide





CDS Inspection & Maintenance Log

Project Name QuikTrip#675
Location: O'Fallon MO
Project No.: 151054
Structure No. 1-12
Prepared For: QuikTrip Corp
Prepared By: RKF

| | | | |
|---|---|---|---|
| Drainage Area | 1.43 acre | Impervious Area | 1.36 acre |
| | 62,291 ft² | | 59,242 ft² |
| | 1.43 acre | | 1.36 acre |
| | 0.00223438 mi² | | 0.002125 mi² |
| % Impervious | 95.1% | % Impervious Over-ride | 0 |
| P | 1.14 in | | |
| Rv | 0.906 volumetric runoff coefficient | | |
| Qa | 1.03 watershed inches | | |
| WQV | 5,361.1 ft3 | | |
| | 0.123 acre-ft | | |
| CN | 99.1 | | |
| Tc | 6 min | | |
| | 0.10 hr | | |
| Rainfall Type | II | | |
| Potential Abstraction, "S" | 0.10 inches | | |
| Initial Abstraction, "Ia" | 0.02 inches | | |
| Treatment System | Vortechs | | |
| Micron Rating | 110 | | |
| qu | 1010.41 | | |
| WQF | 2.33 cfs | | |

STATE OF MISSOURI
MICHAEL JAMES VELLOFF
NO. E-2000161862
REGISTERED PROFESSIONAL ENGINEER

PROJECT NO.: 151054
NAME: MICHAEL J. VELLOFF
LICENSE NUMBER: E-2000161862
DISCIPLINE: CIVIL
CORPORATION AUTHORITY NUMBER: 001194

THE SEAL OF MICHAEL J. VELLOFF ON THIS DRAWING APPLIES ONLY TO THE CIVIL/SITE ENGINEERING SHOWN. IT DOES NOT APPLY, NOR IS ANY RESPONSIBILITY TAKEN FOR ENVIRONMENTAL, GEOTECHNICAL (INCLUDING BUT NOT LIMITED TO SLOPE STABILITY), STRUCTURAL, HVAC, PLUMBING, ELECTRICAL, FIRE PROTECTION, TRAFFIC ENGINEERING, SURVEYING (BOUNDARY AND TOPOGRAPHIC), OR ARCHITECTURAL (BUILDING OR LANDSCAPE).

# QuikTrip No. 0675

140 FALLON LOOP ROAD
O'FALLON, MISSOURI 63368

QT



PROTOTYPE: P-86
DIVISION: 06
VERSION: 001
DESIGNED BY: RKF
DRAWN BY: RKF
REVIEWED BY: MJV

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | ORIGINAL ISSUE DATE: 04-14-16 |

SHEET TITLE:
WATER QUALITY DETAILS

SHEET NUMBER:
C301

FILE LOCATION=K:\151054 - QuikTrip #0675 - Highway K and Fallon Parkway\Civil\05-0675 Civil.dwg TAB NAME=C301 Water Quality Details USER=klyer SAVED=4/12/2016 2:41 PM PLOTTED=4/13/2016 5:49 AM

**SECTION 3**

**15 Year 20 Minute**
**Storm Sewer Hydraulics**

# Hydraflow HGL Computation Procedure



## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

# MSDReport



| Line No. | Line ID | Invert Dn (ft) | Invert Up (ft) | Line Size (in) | Line Length (ft) | Line Slope (%) | n-val Pipe | Flow Rate (cfs) | Capac Full (cfs) | Vel Ave (ft/s) | HGL Dn (ft) | HGL Up (ft) | Gnd/Rim El Dn (ft) | Gnd/Rim El Up (ft) | Hw (ft) | Rim-Hw (ft) | Defl Ang (Deg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ExCI1-1toExCI1-1A | 511.68 | 512.45 | 24 | 45.000 | 1.71 | 0.013 | 7.10 | 29.59 | 2.99 | 513.68 | 513.62 | 521.68 | 521.85 | 1.34 | 8.06 | 134.370 | |
| 2 | ExCI1-1AtoExAI1-1B | 512.45 | 514.01 | 24 | 17.000 | 9.18 | 0.013 | 6.02 | 68.52 | 3.65 | 513.79 | 514.88 j | 521.85 | 522.21 | 0.87 | 7.33 | -27.736 | |
| 3 | ExAI1-1BtoMH1-2 | 514.01 | 521.95 | 18 | 69.000 | 11.51 | 0.013 | 4.95 | 35.62 | 4.72 | 514.88 | 522.81 j | 522.21 | 526.25 | 0.86 | 3.44 | 58.336 | |
| 4 | MH1-2toMH1-3 | 521.95 | 523.78 | 18 | 21.000 | 8.71 | 0.013 | 4.95 | 31.00 | 4.76 | 522.81 | 524.64 | 526.25 | 527.50 | 1.20 | 2.52 | -17.148 | |
| 5 | MH1-3toCI1-4 | 522.50 | 523.60 | 15 | 47.000 | 2.34 | 0.013 | 1.58 | 9.88 | 1.29 | 524.98 | 525.01 | 527.50 | 528.12 | 1.44 | 3.08 | -16.801 | |
| 6 | CI1-4toCI1-5 | 523.60 | 525.26 | 15 | 37.000 | 4.49 | 0.013 | 1.10 | 13.68 | 2.01 | 525.04 | 525.67 j | 528.12 | 528.58 | 0.41 | 2.91 | 48.540 | |
| 7 | CI1-5toCI1-6 | 525.26 | 526.26 | 15 | 96.000 | 1.04 | 0.013 | 1.10 | 6.59 | 3.11 | 525.67 | 526.67 | 528.58 | 530.20 | 0.41 | 3.53 | 3.448 | |
| 8 | CI1-6toCI1-7 | 526.26 | 526.81 | 15 | 50.000 | 1.10 | 0.013 | 0.37 | 6.77 | 1.68 | 526.67 | 527.05 j | 530.20 | 530.60 | 0.24 | 3.55 | 22.430 | |
| 9 | ExAI1-1BtoExCI1-1C | 514.01 | 518.88 | 18 | 42.000 | 11.60 | 0.013 | 0.80 | 35.76 | 1.75 | 514.88 | 519.21 j | 522.21 | 523.73 | 0.33 | 4.52 | -10.946 | |
| 10 | MH1-3toCI1-8 | 522.50 | 522.76 | 15 | 26.000 | 1.00 | 0.013 | 3.37 | 6.46 | 2.75 | 524.98 | 525.05 | 527.50 | 529.95 | 2.39 | 4.80 | 82.037 | |
| 11 | CI1-8toCI1-9 | 522.76 | 524.48 | 15 | 172.000 | 1.00 | 0.013 | 2.87 | 6.46 | 2.54 | 525.15 | 525.47 | 529.95 | 529.75 | 1.16 | 4.11 | 30.778 | |
| 12 | CI1-9toCI1-10 | 524.48 | 525.08 | 15 | 60.000 | 1.00 | 0.013 | 1.98 | 6.46 | 2.69 | 525.64 | 525.64 j | 529.75 | 530.22 | 0.56 | 4.58 | -69.047 | |
| 13 | CI1-10toCI1-11 | 525.08 | 525.95 | 15 | 87.000 | 1.00 | 0.013 | 1.80 | 6.46 | 3.50 | 525.64 | 526.48 j | 530.22 | 530.00 | 0.53 | 3.52 | -13.216 | |

Project File: 15YearStormsystem1.stm | Number of lines: 13 | Date: 4/13/2016

NOTES: ** Critical depth

| Minor Loss (ft) | Known Q (cfs) | |
|---|---|---|
| 0.17 | 1.08 | |
| n/a | 0.27 | |
| n/a | 0.00 | |
| 0.35 | 0.00 | |
| 0.03 | 0.48 | |
| n/a | 0.00 | |
| 0.10 | 0.73 | |
| n/a | 0.37 | |
| n/a | 0.80 | |
| 0.10 | 0.50 | |
| 0.17 | 0.89 | |
| n/a | 0.18 | |
| n/a | 1.80 | |

| | | |
|---|---|---|
| Project File: 15YearStormsystem1.stm | Number of lines: 13 | Date: 4/13/2016 |
| NOTES: ** Critical depth | | |

# Hydraulic Grade Line Computations



| Line | Size | Q | Downstream | | | | | | | | Len | Upstream | | | | | | | | Check | | JL coeff | Minor loss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Invert elev | HGL elev | Depth | Area | Vel | Vel head | EGL elev | Sf | | Invert elev | HGL elev | Depth | Area | Vel | Vel head | EGL elev | Sf | Ave Sf | Enrgy loss | | |
| (1) | (in) (2) | (cfs) (3) | (ft) (4) | (ft) (5) | (ft) (6) | (sqft) (7) | (ft/s) (8) | (ft) (9) | (ft) (10) | (%) (11) | (ft) (12) | (ft) (13) | (ft) (14) | (ft) (15) | (sqft) (16) | (ft/s) (17) | (ft) (18) | (ft) (19) | (%) (20) | (%) (21) | (ft) (22) | (K) (23) | (ft) (24) |
| 1 | 24 | 7.10 | 511.68 | 513.68 | 2.00 | 3.14 | 2.26 | 0.08 | 513.76 | 0.099 | 45.000 | 512.45 | 513.62 | 1.17 | 1.91 | 3.72 | 0.22 | 513.83 | 0.236 | 0.168 | 0.075 | 0.78 | 0.17 |
| 2 | 24 | 6.02 | 512.45 | 513.79 | 1.34 | 1.31 | 2.70 | 0.33 | 514.12 | 0.000 | 17.000 | 514.01 | 514.88 j | 0.87** | 1.31 | 4.61 | 0.33 | 515.21 | 0.000 | 0.000 | n/a | 1.73 | n/a |
| 3 | 18 | 4.95 | 514.01 | 514.88 | 0.87 | 1.04 | 4.68 | 0.35 | 515.23 | 0.000 | 69.000 | 521.95 | 522.81 j | 0.86** | 1.04 | 4.76 | 0.35 | 523.16 | 0.000 | 0.000 | n/a | 0.34 | 0.12 |
| 4 | 18 | 4.95 | 521.95 | 522.81 | 0.86* | 1.04 | 4.76 | 0.35 | 523.16 | 0.000 | 21.000 | 523.78 | 524.64 | 0.86** | 1.04 | 4.76 | 0.35 | 524.99 | 0.000 | 0.000 | n/a | 0.99 | 0.35 |
| 5 | 15 | 1.58 | 522.50 | 524.98 | 1.25 | 1.23 | 1.29 | 0.03 | 525.01 | 0.060 | 47.000 | 523.60 | 525.01 | 1.25 | 1.23 | 1.29 | 0.03 | 525.04 | 0.060 | 0.060 | 0.028 | 1.18 | 0.03 |
| 6 | 15 | 1.10 | 523.60 | 525.04 | 1.25 | 0.35 | 0.90 | 0.01 | 525.05 | 0.029 | 37.000 | 525.26 | 525.67 j | 0.41** | 0.35 | 3.11 | 0.15 | 525.82 | 0.524 | 0.277 | n/a | 0.50 | 0.08 |
| 7 | 15 | 1.10 | 525.26 | 525.67 | 0.41* | 0.35 | 3.11 | 0.15 | 525.82 | 0.000 | 96.000 | 526.26 | 526.67 | 0.41** | 0.35 | 3.11 | 0.15 | 526.82 | 0.000 | 0.000 | n/a | 0.65 | 0.10 |
| 8 | 15 | 0.37 | 526.26 | 526.67 | 0.41 | 0.16 | 1.05 | 0.08 | 526.76 | 0.000 | 50.000 | 526.81 | 527.05 j | 0.24** | 0.16 | 2.30 | 0.08 | 527.13 | 0.000 | 0.000 | n/a | 1.00 | 0.08 |
| 9 | 18 | 0.80 | 514.01 | 514.88 | 0.87 | 0.29 | 0.76 | 0.12 | 514.99 | 0.000 | 42.000 | 518.85 | 519.21 j | 0.33** | 0.29 | 2.74 | 0.12 | 519.33 | 0.000 | 0.000 | n/a | 1.00 | 0.12 |
| 10 | 15 | 3.37 | 522.50 | 524.98 | 1.25 | 1.23 | 2.75 | 0.12 | 525.10 | 0.272 | 26.000 | 522.76 | 525.05 | 1.25 | 1.23 | 2.75 | 0.12 | 525.17 | 0.272 | 0.272 | 0.071 | 0.85 | 0.10 |
| 11 | 15 | 2.87 | 522.76 | 525.15 | 1.25 | 1.23 | 2.34 | 0.09 | 525.24 | 0.198 | 172.000 | 524.48 | 525.47 | 0.99 | 1.04 | 2.75 | 0.12 | 525.59 | 0.210 | 0.204 | 0.350 | 1.42 | 0.17 |
| 12 | 15 | 1.98 | 524.48 | 525.64 | 1.16 | 0.53 | 1.67 | 0.22 | 525.85 | 0.000 | 60.000 | 525.08 | 525.64 j | 0.56** | 0.53 | 3.72 | 0.22 | 525.86 | 0.000 | 0.000 | n/a | 0.50 | 0.11 |
| 13 | 15 | 1.80 | 525.08 | 525.64 | 0.56 | 0.50 | 3.38 | 0.20 | 525.84 | 0.000 | 87.000 | 525.95 | 526.48 j | 0.53** | 0.50 | 3.61 | 0.20 | 526.69 | 0.000 | 0.000 | n/a | 1.00 | 0.20 |

Project File: 15YearStormsystem1.stm | Number of lines: 13 | Run Date: 4/13/2016

Notes: * Crown depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

**SECTION 4**

**100 Year 20 Minute**
**Storm Sewer Hydraulics**

# Hydraflow HGL Computation Procedure



## General Procedure:

Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9)

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16)

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

# MSDReport



| Line No. | Line ID | Invert Dn (ft) | Invert Up (ft) | Line Size (in) | Line Length (ft) | Line Slope (%) | n-val Pipe | Flow Rate (cfs) | Capac Full (cfs) | Vel Ave (ft/s) | HGL Dn (ft) | HGL Up (ft) | Gnd/Rim El Dn (ft) | Gnd/Rim El Up (ft) | Hw (ft) | Rim-Hw (ft) | Defl Ang (Deg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ExCl1-1toExCl1-1A | 511.68 | 512.45 | 24 | 45.000 | 1.71 | 0.013 | 9.55 | 29.59 | 4.19 | 513.68 | 513.56 j | 521.68 | 521.85 | 1.45 | 7.95 | 134.370 |
| 2 | ExCl1-1AtoExAl1-1B | 512.45 | 514.01 | 24 | 17.000 | 9.18 | 0.013 | 8.09 | 68.52 | 4.19 | 513.90 | 515.02 j | 521.85 | 522.21 | 1.01 | 7.19 | -27.736 |
| 3 | ExAl1-1BtoMH1-2 | 514.01 | 521.95 | 18 | 69.000 | 11.51 | 0.013 | 6.64 | 35.62 | 5.28 | 515.02 | 522.95 j | 522.21 | 526.25 | 1.00 | 3.30 | 58.336 |
| 4 | MH1-2toMH1-3 | 521.95 | 523.78 | 18 | 21.000 | 8.71 | 0.013 | 6.64 | 31.00 | 5.33 | 522.95 | 524.78 | 526.25 | 527.50 | 1.43 | 2.29 | -17.148 |
| 5 | MH1-3toCl1-4 | 522.50 | 523.60 | 15 | 47.000 | 2.34 | 0.013 | 2.12 | 9.88 | 1.73 | 525.21 | 525.26 | 527.50 | 528.12 | 1.72 | 2.80 | -16.801 |
| 6 | Cl1-4toCl1-5 | 523.60 | 525.26 | 15 | 37.000 | 4.49 | 0.013 | 1.48 | 13.68 | 2.30 | 525.32 | 525.74 j | 528.12 | 528.58 | 0.48 | 2.84 | 48.540 |
| 7 | Cl1-5toCl1-6 | 525.26 | 526.26 | 15 | 96.000 | 1.04 | 0.013 | 1.48 | 6.59 | 3.40 | 525.74 | 526.74 | 528.58 | 530.20 | 0.48 | 3.46 | 3.448 |
| 8 | Cl1-6toCl1-7 | 526.26 | 526.81 | 15 | 50.000 | 1.10 | 0.013 | 0.50 | 6.77 | 1.82 | 526.74 | 527.09 j | 530.20 | 530.60 | 0.28 | 3.51 | 22.430 |
| 9 | ExAl1-1BtoExCl1-1C | 514.01 | 518.88 | 18 | 42.000 | 11.60 | 0.013 | 1.08 | 35.76 | 1.92 | 515.02 | 519.27 j | 522.21 | 523.73 | 0.39 | 4.46 | -10.946 |
| 10 | MH1-3toCl1-8 | 522.50 | 522.76 | 15 | 26.000 | 1.00 | 0.013 | 4.52 | 6.46 | 3.68 | 525.21 | 525.34 | 527.50 | 529.95 | 2.76 | 4.43 | 82.037 |
| 11 | Cl1-8toCl1-9 | 522.76 | 524.48 | 15 | 172.000 | 1.00 | 0.013 | 3.86 | 6.46 | 3.15 | 525.52 | 526.13 | 529.95 | 529.75 | 1.87 | 3.40 | 30.778 |
| 12 | Cl1-9toCl1-10 | 524.48 | 525.08 | 15 | 60.000 | 1.00 | 0.013 | 2.67 | 6.46 | 2.18 | 526.35 | 526.46 | 529.75 | 530.22 | 1.41 | 3.73 | -69.047 |
| 13 | Cl1-10toCl1-11 | 525.08 | 525.95 | 15 | 87.000 | 1.00 | 0.013 | 2.43 | 6.46 | 2.85 | 526.49 | 526.61 | 530.22 | 530.00 | 0.87 | 3.18 | -13.216 |

| | | |
|---|---|---|
| Project File: 100YearStormsystem1.stm | Number of lines: 13 | Date: 4/13/2016 |

NOTES: ** Critical depth

| Minor Loss (ft) | Known Q (cfs) | |
|---|---|---|
| n/a | 1.46 | |
| n/a | 0.37 | |
| n/a | 0.00 | |
| n/a | 0.00 | |
| 0.05 | 0.64 | |
| n/a | 0.00 | |
| 0.12 | 0.98 | |
| n/a | 0.50 | |
| n/a | 1.08 | |
| 0.18 | 0.66 | |
| 0.22 | 1.19 | |
| 0.04 | 0.24 | |
| 0.21 | 2.43 | |

| | | |
|---|---|---|
| Project File: 100YearStormsystem1.stm | Number of lines: 13 | Date: 4/13/2016 |

NOTES: ** Critical depth

# Hydraulic Grade Line Computations



| Line | Size | Q | Downstream | | | | | | | | Len | Upstream | | | | | | | | Check | | JL coeff | Minor loss |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Invert elev | HGL elev | Depth | Area | Vel | Vel head | EGL elev | Sf | | Invert elev | HGL elev | Depth | Area | Vel | Vel head | EGL elev | Sf | Ave Sf | Enrgy loss | | |
| (1) | (in) (2) | (cfs) (3) | (ft) (4) | (ft) (5) | (ft) (6) | (sqft) (7) | (ft/s) (8) | (ft) (9) | (ft) (10) | (%) (11) | (ft) (12) | (ft) (13) | (ft) (14) | (ft) (15) | (sqft) (16) | (ft/s) (17) | (ft) (18) | (ft) (19) | (%) (20) | (%) (21) | (ft) (22) | (K) (23) | (ft) (24) |
| 1 | 24 | 9.55 | 511.68 | 513.68 | 2.00 | 1.78 | 3.04 | 0.14 | 513.82 | 0.178 | 45.000 | 512.45 | 513.56 j | 1.11** | 1.79 | 5.34 | 0.44 | 514.00 | 0.507 | 0.343 | 0.154 | 0.78 | 0.35 |
| 2 | 24 | 8.09 | 512.45 | 513.90 | 1.45 | 1.59 | 3.30 | 0.40 | 514.31 | 0.000 | 17.000 | 514.01 | 515.02 j | 1.01** | 1.59 | 5.07 | 0.40 | 515.42 | 0.000 | 0.000 | n/a | 1.73 | n/a |
| 3 | 18 | 6.64 | 514.01 | 515.02 | 1.01 | 1.25 | 5.24 | 0.44 | 515.46 | 0.000 | 69.000 | 521.95 | 522.95 j | 1.00** | 1.25 | 5.33 | 0.44 | 523.39 | 0.000 | 0.000 | n/a | 0.34 | n/a |
| 4 | 18 | 6.64 | 521.95 | 522.95 | 1.00* | 1.25 | 5.33 | 0.44 | 523.39 | 0.000 | 21.000 | 523.78 | 524.78 | 1.00** | 1.25 | 5.33 | 0.44 | 525.22 | 0.000 | 0.000 | n/a | 0.99 | n/a |
| 5 | 15 | 2.12 | 522.50 | 525.21 | 1.25 | 1.23 | 1.73 | 0.05 | 525.26 | 0.108 | 47.000 | 523.60 | 525.26 | 1.25 | 1.23 | 1.73 | 0.05 | 525.31 | 0.108 | 0.108 | 0.051 | 1.18 | 0.05 |
| 6 | 15 | 1.48 | 523.60 | 525.32 | 1.25 | 0.44 | 1.21 | 0.02 | 525.34 | 0.053 | 37.000 | 525.26 | 525.74 j | 0.48** | 0.44 | 3.40 | 0.18 | 525.92 | 0.533 | 0.293 | n/a | 0.50 | 0.09 |
| 7 | 15 | 1.48 | 525.26 | 525.74 | 0.48* | 0.44 | 3.40 | 0.18 | 525.92 | 0.000 | 96.000 | 526.26 | 526.74 | 0.48** | 0.44 | 3.40 | 0.18 | 526.92 | 0.000 | 0.000 | n/a | 0.65 | 0.12 |
| 8 | 15 | 0.50 | 526.26 | 526.74 | 0.48 | 0.20 | 1.15 | 0.10 | 526.84 | 0.000 | 50.000 | 526.81 | 527.09 j | 0.28** | 0.20 | 2.50 | 0.10 | 527.18 | 0.000 | 0.000 | n/a | 1.00 | 0.10 |
| 9 | 18 | 1.08 | 514.01 | 515.02 | 1.01 | 0.36 | 0.85 | 0.14 | 515.16 | 0.000 | 42.000 | 518.88 | 519.27 j | 0.39** | 0.36 | 2.98 | 0.14 | 519.41 | 0.000 | 0.000 | n/a | 1.00 | 0.14 |
| 10 | 15 | 4.52 | 522.50 | 525.21 | 1.25 | 1.23 | 3.68 | 0.21 | 525.42 | 0.490 | 26.000 | 522.76 | 525.34 | 1.25 | 1.23 | 3.68 | 0.21 | 525.55 | 0.490 | 0.490 | 0.127 | 0.85 | 0.18 |
| 11 | 15 | 3.86 | 522.76 | 525.52 | 1.25 | 1.23 | 3.15 | 0.15 | 525.67 | 0.357 | 172.000 | 524.48 | 526.13 | 1.25 | 1.23 | 3.15 | 0.15 | 526.29 | 0.357 | 0.357 | 0.615 | 1.42 | 0.22 |
| 12 | 15 | 2.67 | 524.48 | 526.35 | 1.25 | 1.23 | 2.18 | 0.07 | 526.43 | 0.171 | 60.000 | 525.08 | 526.46 | 1.25 | 1.23 | 2.18 | 0.07 | 526.53 | 0.171 | 0.171 | 0.103 | 0.50 | 0.04 |
| 13 | 15 | 2.43 | 525.08 | 526.49 | 1.25 | 1.23 | 1.98 | 0.06 | 526.55 | 0.142 | 87.000 | 525.95 | 526.61 | 0.66 | 0.65 | 3.71 | 0.21 | 526.82 | 0.478 | 0.310 | 0.269 | 1.00 | 0.21 |

| | | |
|---|---|---|
| Project File: 100YearStormsystem1.stm | Number of lines: 13 | Run Date: 4/13/2016 |

Notes: * Crown depth assumed.; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

## SECTION 5

**Inlet Capacity Calculations**

# Inlet Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Single Combo Curb Inlet 1-4

**Combination Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = 2.48 |
| Throat Height (in) | = 0.44 |
| Grate Area (sqft) | = 1.50 |
| Grate Width (ft) | = 1.48 |
| Grate Length (ft) | = 2.48 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.010 |
| Slope, Sx (ft/ft) | = 0.010 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

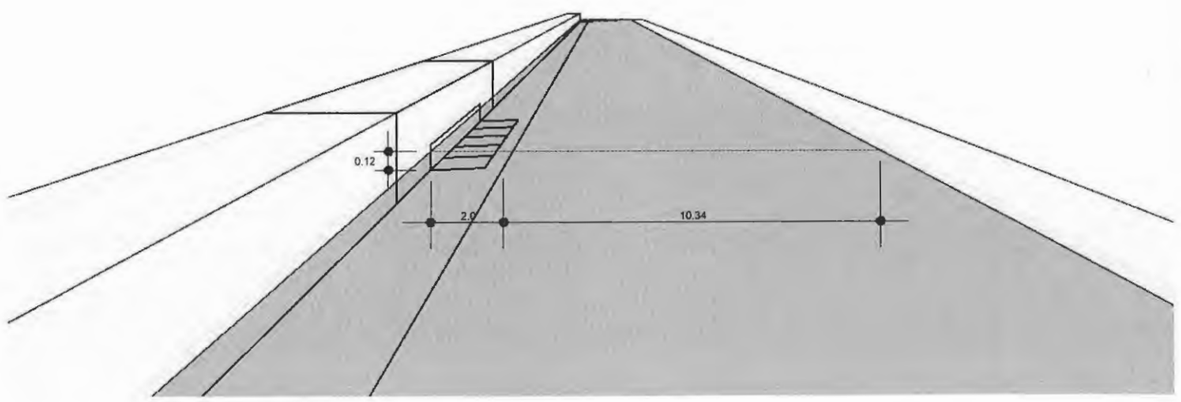
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 0.64 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 0.64 |
| Q Capt (cfs) | = 0.64 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 1.48 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 12.34 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet



# Inlet Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Single Combo Curb Inlet 1-7

**Combination Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = 2.48 |
| Throat Height (in) | = 0.44 |
| Grate Area (sqft) | = 1.50 |
| Grate Width (ft) | = 1.48 |
| Grate Length (ft) | = 2.48 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.010 |
| Slope, Sx (ft/ft) | = 0.010 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

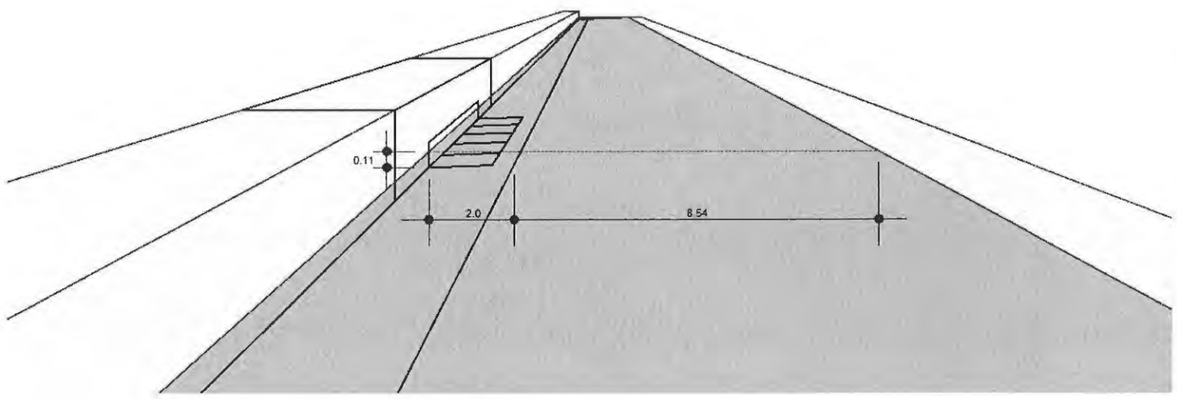
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 0.50 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 0.50 |
| Q Capt (cfs) | = 0.50 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 1.26 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 10.54 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet



# Inlet Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Single Combo Curb Inlet 1-8

**Combination Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = 2.48 |
| Throat Height (in) | = 0.44 |
| Grate Area (sqft) | = 1.50 |
| Grate Width (ft) | = 1.48 |
| Grate Length (ft) | = 2.48 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.010 |
| Slope, Sx (ft/ft) | = 0.010 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

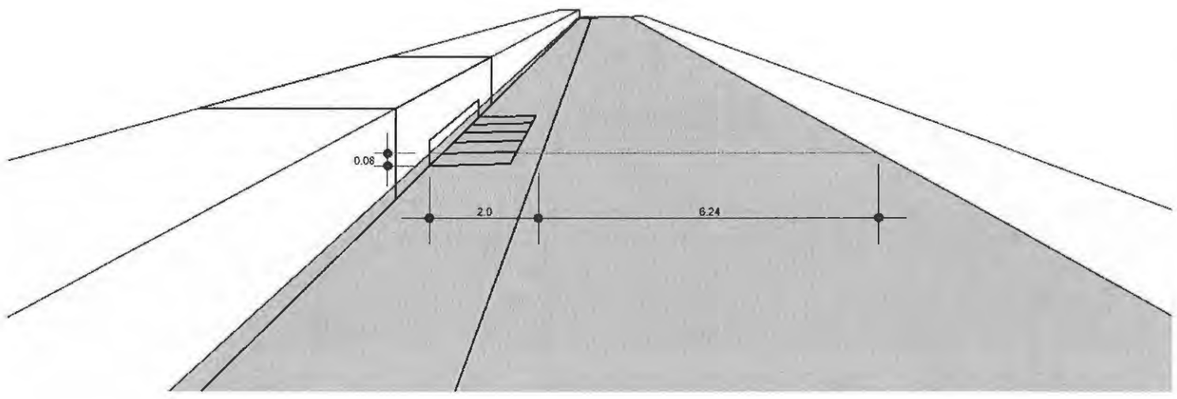
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 0.33 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 0.33 |
| Q Capt (cfs) | = 0.33 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 0.99 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 8.24 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet



# Inlet Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Single Combo Curb Inlet 1-9

**Combination Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = 2.48 |
| Throat Height (in) | = 0.44 |
| Grate Area (sqft) | = 1.50 |
| Grate Width (ft) | = 1.48 |
| Grate Length (ft) | = 2.48 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.010 |
| Slope, Sx (ft/ft) | = 0.010 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

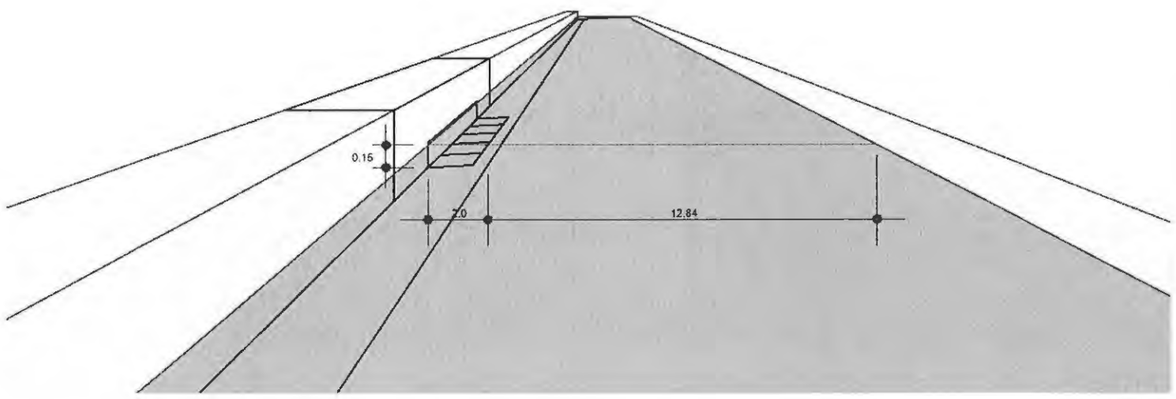
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 0.86 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 0.86 |
| Q Capt (cfs) | = 0.86 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 1.78 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 14.84 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet



# Inlet Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Single Combo Curb Inlet 1-10

**Combination Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = 2.48 |
| Throat Height (in) | = 0.44 |
| Grate Area (sqft) | = 1.50 |
| Grate Width (ft) | = 1.48 |
| Grate Length (ft) | = 2.48 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.010 |
| Slope, Sx (ft/ft) | = 0.010 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

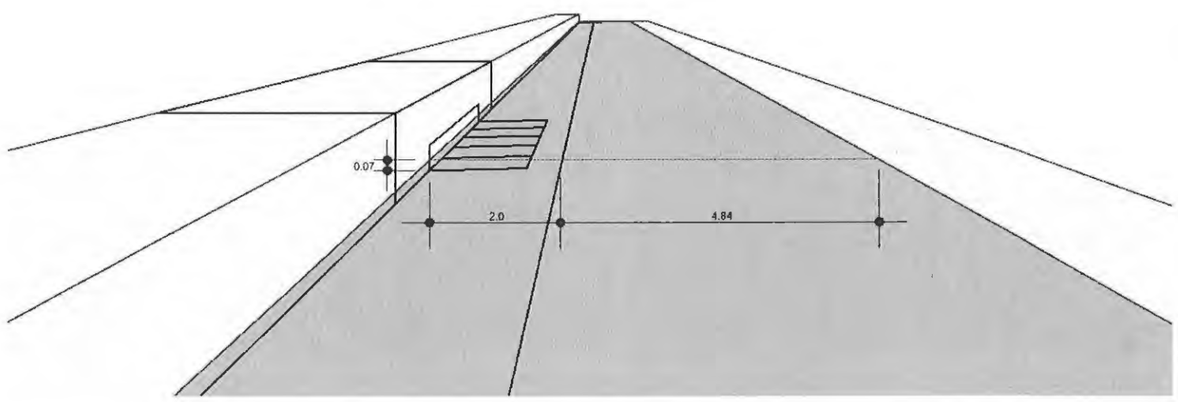
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 0.24 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 0.24 |
| Q Capt (cfs) | = 0.24 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 0.82 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 6.84 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet



# Inlet Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Single Combo Curb Inlet 1-11

**Combination Inlet**

| | |
|---|---|
| Location | = Sag |
| Curb Length (ft) | = 2.48 |
| Throat Height (in) | = 0.44 |
| Grate Area (sqft) | = 1.50 |
| Grate Width (ft) | = 1.48 |
| Grate Length (ft) | = 2.48 |

**Gutter**

| | |
|---|---|
| Slope, Sw (ft/ft) | = 0.010 |
| Slope, Sx (ft/ft) | = 0.010 |
| Local Depr (in) | = -0- |
| Gutter Width (ft) | = 2.00 |
| Gutter Slope (%) | = -0- |
| Gutter n-value | = -0- |

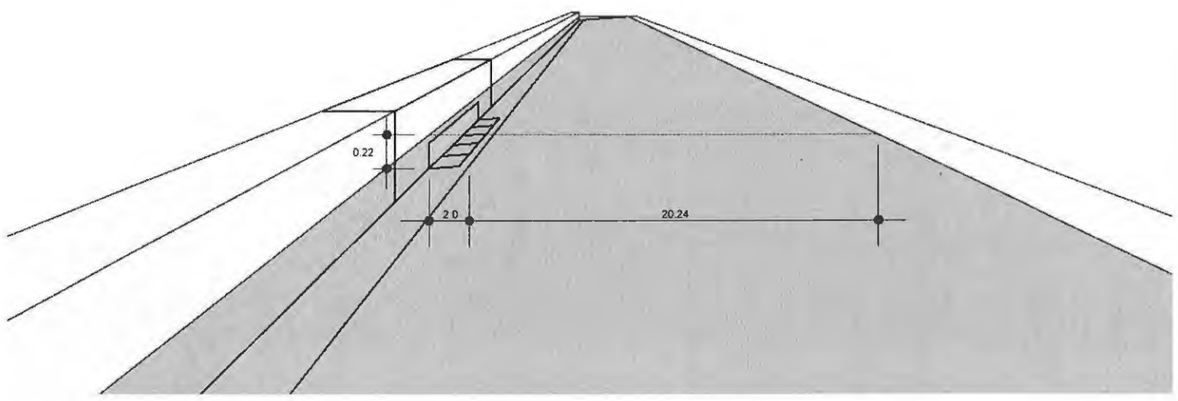
**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Q (cfs) | = 1.62 |

**Highlighted**

| | |
|---|---|
| Q Total (cfs) | = 1.62 |
| Q Capt (cfs) | = 1.62 |
| Q Bypass (cfs) | = -0- |
| Depth at Inlet (in) | = 2.67 |
| Efficiency (%) | = 100 |
| Gutter Spread (ft) | = 22.24 |
| Gutter Vel (ft/s) | = -0- |
| Bypass Spread (ft) | = -0- |
| Bypass Depth (in) | = -0- |

All dimensions in feet



## SECTION 6

**Flow Splitter Calculations**

# Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 13 2016

## Flow Splitter MH #1-3

| | |
|---|---|
| Invert Elev Dn (ft) | = 522.26 |
| Pipe Length (ft) | = 13.00 |
| Slope (%) | = 1.85 |
| Invert Elev Up (ft) | = 522.50 |
| Rise (in) | = 12.0 |
| Shape | = Circular |
| Span (in) | = 12.0 |
| No. Barrels | = 1 |
| n-Value | = 0.013 |
| Culvert Type | = Circular Concrete |
| Culvert Entrance | = Square edge w/headwall (C) |
| Coeff. K,M,c,Y,k | = 0.0098, 2, 0.0398, 0.67, 0.5 |

**Embankment**

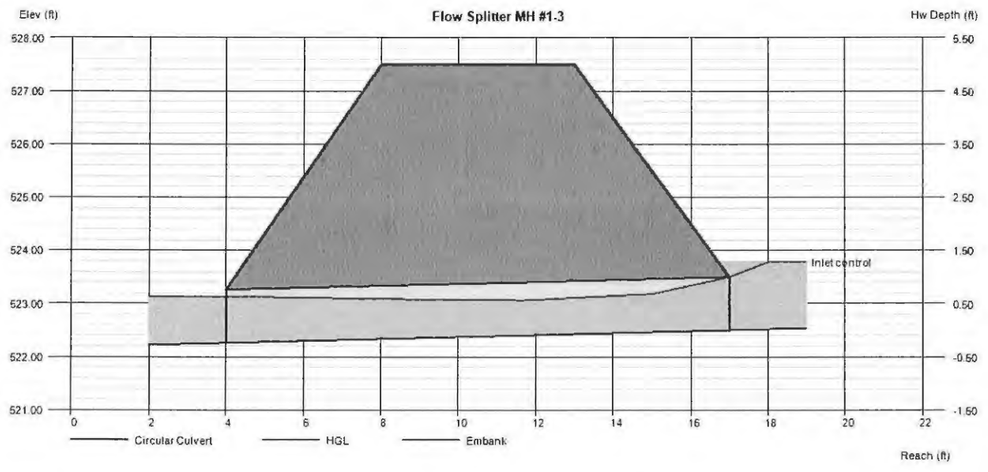
| | |
|---|---|
| Top Elevation (ft) | = 527.50 |
| Top Width (ft) | = 5.00 |
| Crest Width (ft) | = 0.00 |

**Calculations**

| | |
|---|---|
| Qmin (cfs) | = 3.10 |
| Qmax (cfs) | = 3.10 |
| Tailwater Elev (ft) | = (dc+D)/2 |

**Highlighted**

| | |
|---|---|
| Qtotal (cfs) | = 3.10 |
| Qpipe (cfs) | = 3.10 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 4.25 |
| Veloc Up (ft/s) | = 4.88 |
| HGL Dn (ft) | = 523.14 |
| HGL Up (ft) | = 523.25 |
| Hw Elev (ft) | = 523.78 |
| Hw/D (ft) | = 1.28 |
| Flow Regime | = Inlet Control |

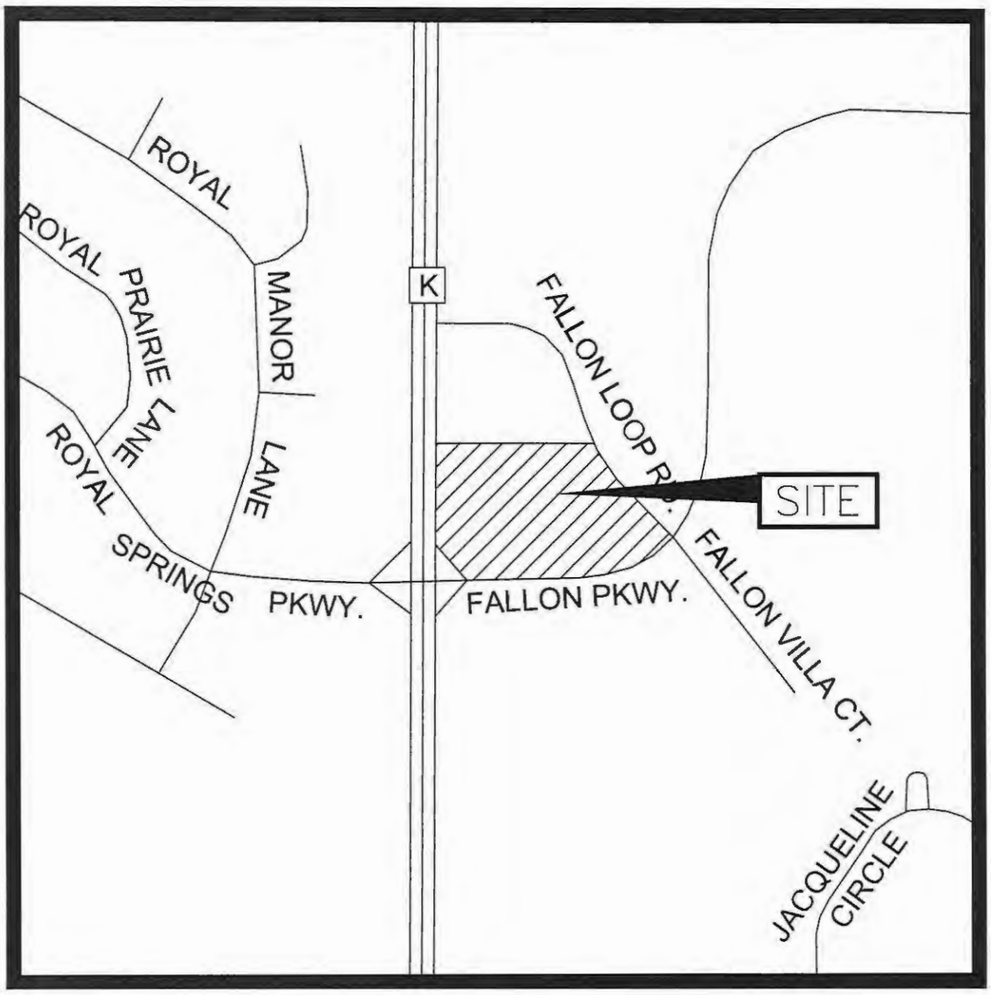


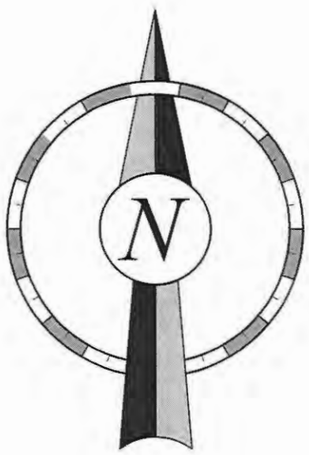
**SECTION 7**

**Supporting Data**

**EXHIBIT A**

**Site Location Map**



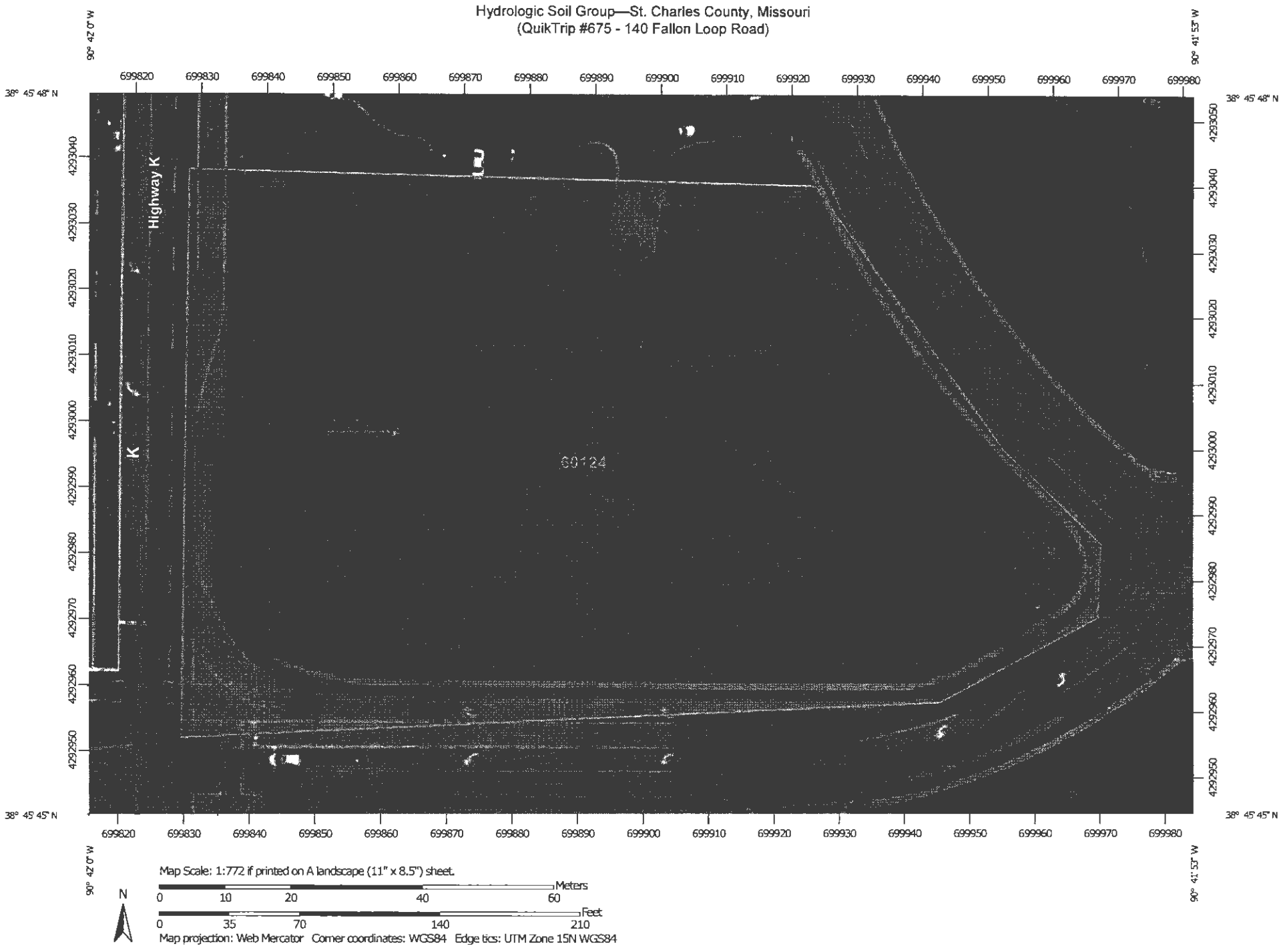




# Vicinity Map

Not to Scale

**EXHIBIT B**

**NRCS Hydrologic Soil Group**


90° 42' 0" W
90° 41' 53" W
38° 45' 48" N
38° 45' 45" N
699820
699830
699840
699850
699860
699870
699880
699890
699900
699910
699920
699930
699940
699950
699960
699970
699980
4293040
4293030
4293020
4293010
4293000
4292990
4292980
4292970
4292960
4292950
Highway K
K
60124
Map Scale: 1:772 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 10 20 40 60
Feet
0 35 70 140 210
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Lines**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Points**
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: St. Charles County, Missouri
Survey Area Data: Version 14, Sep 14, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 13, 2014—Jun 25, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Hydrologic Soil Group

| Hydrologic Soil Group— Summary by Map Unit — St. Charles County, Missouri (MO183) | | | | |
|---|---|---|---|---|
| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
| 60124 | Harvester-Urban land complex, 2 to 9 percent slopes | C | 2.5 | 100.0% |
| **Totals for Area of Interest** | | | **2.5** | **100.0%** |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

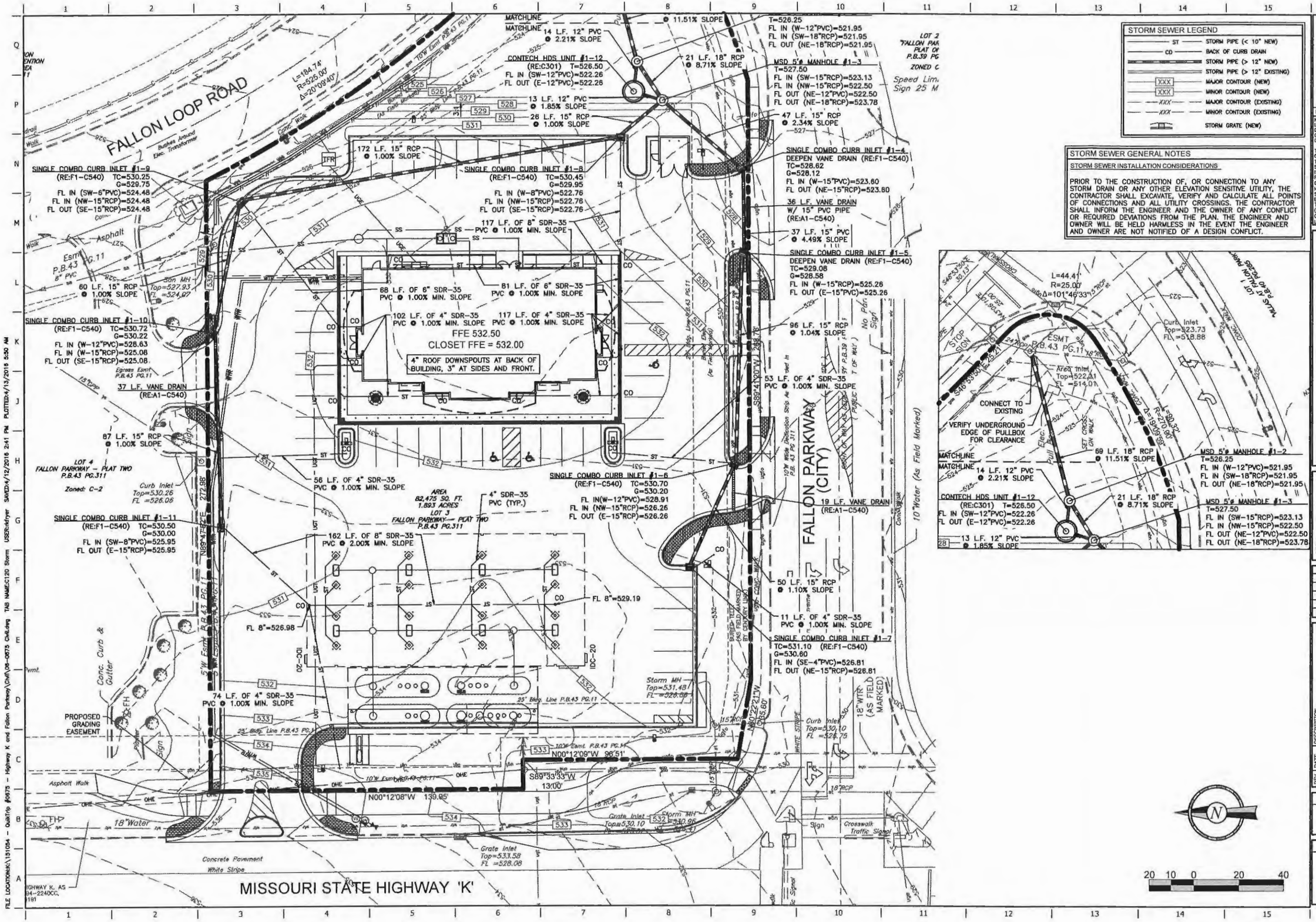
*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* *None Specified*

*Tie-break Rule:* Higher

**EXHIBIT C**

**WQ Facilities Construction Plans**




## STORM SEWER LEGEND

| | |
|---|---|
| ST | STORM PIPE (< 10" NEW) |
| CD | BACK OF CURB DRAIN |
| | STORM PIPE (> 12" NEW) |
| | STORM PIPE (> 12" EXISTING) |
| XXX | MAJOR CONTOUR (NEW) |
| XXX | MINOR CONTOUR (NEW) |
| XXX | MAJOR CONTOUR (EXISTING) |
| XXX | MINOR CONTOUR (EXISTING) |
| | STORM GRATE (NEW) |

## STORM SEWER GENERAL NOTES

STORM SEWER INSTALLATION CONSIDERATIONS

PRIOR TO THE CONSTRUCTION OF, OR CONNECTION TO ANY STORM DRAIN OR ANY OTHER ELEVATION SENSITIVE UTILITY, THE CONTRACTOR SHALL EXCAVATE, VERIFY AND CALCULATE ALL POINTS OF CONNECTIONS AND ALL UTILITY CROSSINGS. THE CONTRACTOR SHALL INFORM THE ENGINEER AND THE OWNER OF ANY CONFLICT OR REQUIRED DEVIATIONS FROM THE PLAN. THE ENGINEER AND OWNER WILL BE HELD HARMLESS IN THE EVENT THE ENGINEER AND OWNER ARE NOT NOTIFIED OF A DESIGN CONFLICT.

STATE OF MISSOURI
MICHAEL JAMES VELLOFF
NO. E-2000161862
REGISTERED PROFESSIONAL ENGINEER

PROJECT NO.: 151054

NAME: MICHAEL J. VELLOFF
LICENSE NUMBER: E-2000161862
DISCIPLINE: CIVIL
CORPORATION AUTHORITY NUMBER: 001194

THE SEAL OF MICHAEL J. VELLOFF ON THIS DRAWING APPLIES ONLY TO THE CIVIL/SITE ENGINEERING SHOWN. IT DOES NOT APPLY, NOR IS ANY RESPONSIBILITY TAKEN FOR, ENVIRONMENTAL, GEOTECHNICAL (INCLUDING BUT NOT LIMITED TO SLOPE STABILITY), STRUCTURAL, HVAC, PLUMBING, ELECTRICAL, FIRE PROTECTION, TRAFFIC ENGINEERING, SURVEYING (BOUNDARY AND TOPOGRAPHIC), OR ARCHITECTURAL (BUILDING OR LANDSCAPE).

# QuikTrip No. 0675

140 FALLON LOOP ROAD
O'FALLON, MISSOURI 63368

QT



PROTOTYPE: P-86
DIVISION: 06
VERSION: 001
DESIGNED BY: RKF
DRAWN BY: RKF
REVIEWED BY: MJV

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | ORIGINAL ISSUE DATE: 04-14-16 |

SHEET TITLE:
STORM SEWER PLAN

SHEET NUMBER:
C120

20 10 0 20 40

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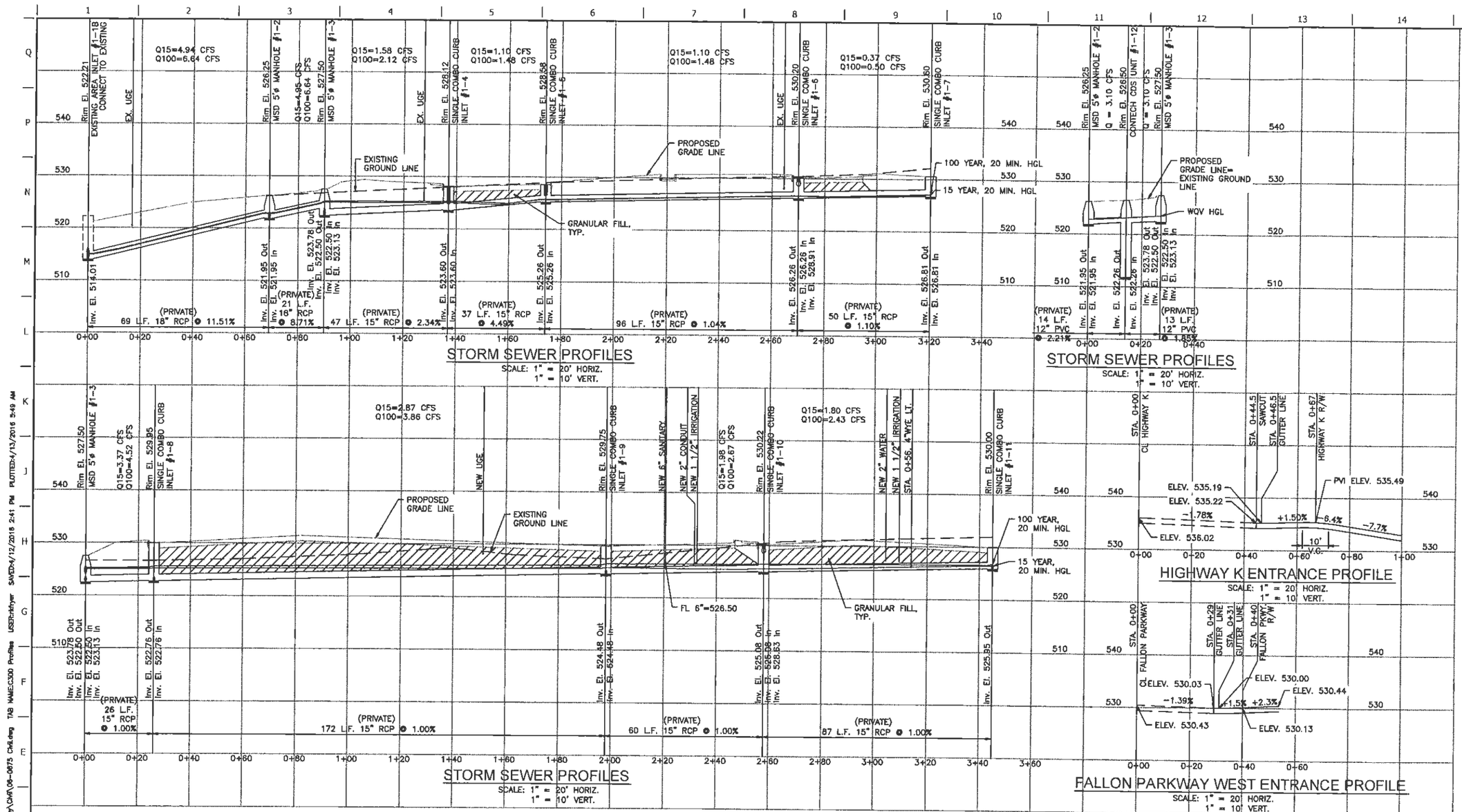


## STORM SEWER PROFILE GENERAL NOTES

STORM SEWER INSTALLATION CONSIDERATIONS

1. PRIOR TO THE CONSTRUCTION OF, OR CONNECTION TO ANY STORM DRAIN OR ANY OTHER ELEVATION SENSITIVE UTILITY, THE CONTRACTOR SHALL EXCAVATE, VERIFY AND CALCULATE ALL POINTS OF CONNECTIONS AND ALL UTILITY CROSSINGS. THE CONTRACTOR SHALL INFORM THE ENGINEER AND THE OWNER OF ANY CONFLICT OR REQUIRED DEVIATIONS FROM THE PLAN. THE ENGINEER AND OWNER WILL BE HELD HARMLESS IN THE EVENT THE ENGINEER AND OWNER ARE NOT NOTIFIED OF A DESIGN CONFLICT.
2. CONTRACTOR SHALL INSTALL NEW PIPE USING VERTICAL SHORING METHODS ACCEPTABLE TO OSHA LAWS AND REGULATIONS.
3. FOR SEWER PIPE (STORM, SANITARY AND COMBINED) WITH A DESIGN GRADE LESS THAN ONE PERCENT (1%), VERIFICATION OF THE PIPE GRADE WILL BE REQUIRED FOR EACH INSTALLED REACH OF SEWER, PRIOR TO ANY SURFACE RESTORATION OR INSTALLATION OF ANY SURFACE IMPROVEMENTS. THE CONTRACTOR'S FIELD SUPERVISOR WILL BE REQUIRED TO PROVIDE DAILY DOCUMENTATION VERIFYING THAT THE AS-BUILT PIPE GRADE MEETS THE DESIGN GRADE THROUGH THE SUBMITTAL OF SIGNED CUT SHEETS TO THE DISTRICT INSPECTOR UPON REQUEST.
4. THE CONTRACTOR WILL BE REQUIRED TO REMOVE AND REPLACE ANY SEWER REACH HAVING AN AS-BUILT GRADE FLATTER THAN THE DESIGN GRADE BY MORE THAN 0.1%. SEWERS WITH GRADES GREATER THAN THE DESIGN GRADE MAY BE LEFT IN PLACE PROVIDED NO OTHER SEWER GRADE IS REDUCED BY THIS VARIANCE IN THE AS-BUILT GRADE.
5. CITY ALSO RESERVES THE RIGHT TO REQUIRE THE CONTRACTOR TO REMOVE AND REPLACE ANY SEWER (AT ANY TIME PRIOR TO CONSTRUCTION APPROVAL) FOR WHICH THE AS-BUILT GRADE DOES NOT COMPLY WITH THE GRADE TOLERANCE STATED IN THE ABOVE PARAGRAPHS.
6. FIELD SURVEYED VERIFICATION MUST BE MADE UNDER THE DIRECTION OF THE LICENSED LAND SURVEYOR OR REGISTERED ENGINEER. THE SEWER CONTRACTOR SHALL BE RESPONSIBLE FOR ANY COST ASSOCIATED WITH THE FIELD VERIFICATION OF THE SEWER GRADE, OR REMOVAL AND REPLACEMENT OF THE SEWER PIPE OR ASSOCIATED APPURTENANCES.
7. TBR&R – THE REMOVAL AND REPLACEMENT, OR REHABILITATION OF THE EXISTING STRUCTURES WILL BE DETERMINED BY THE CITY FIELD INSPECTOR. IF THE STRUCTURE IS DETERMINED TO REMAIN IN PLACE THEN THE TOP SHALL BE ADJUSTED TO GRADE IF NEEDED.

## SEWER PIPE SPECIFICATIONS:

- P.V.C. = POLYVINYL CHLORIDE PIPE (ASTM D-3034, WALL THICKNESS SDR 35) FITTINGS: P.V.C., ASTM D-3034 SOLVENT CEMENT: ASTM D-2855 GASKETS AND SEALS: ELASTOMERIC, STANDARD TO THE MANUFACTURER
- A.D.S. = POLYPROPYLENE (ASTM F-2736 FOR 12"-30" ASTM F-2764 FOR 30"-60")(SANITITE HP)
- R.C.P. = REINFORCED CONCRETE PIPE, CLASS V (ASTM C-76)
- H.G.L. = HYDRAULIC GRADE LINE


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# QuikTrip No. 0675

140 FALLON LOOP ROAD
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| | |
|---|---|
| PROTOTYPE: | P-86 |
| DIVISION: | 06 |
| VERSION: | 001 |
| DESIGNED BY: | RKF |
| DRAWN BY: | RKF |
| REVIEWED BY: | MJV |

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | ORIGINAL ISSUE DATE: 04-14-16 |

SHEET TITLE:
STORM SEWER PROFILES

SHEET NUMBER:
C300


FILE LOCATION: K:\151054 - QuikTrip #0675 - Highway K and Fallon Parkway\Civil\06-0675 Civil.dwg TAB NAME: C300 Profiles USER: kfryer SAVED: 4/12/2016 2:41 PM PLOTTED: 4/13/2016 5:49 AM