# Upper East Fork Cave Creek
# Campo Bello Drive Lateral

## Design Calculations

Prepared For:

**The Flood Control District of Maricopa County**

Registered Professional Engineer (Civil)
CERTIFICATE NO.
24332
JOHN V.
BERGHIAN
Date Signed 12-1-94
ARIZONA, U.S.A.

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Prepared By:

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December 1, 1994

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

DESIGN CALCULATIONS

Sht: ID-1
Job# 93041
By: K. SHORT
Date: 11-28-94
Chkd: JB
Date: 11-28-94

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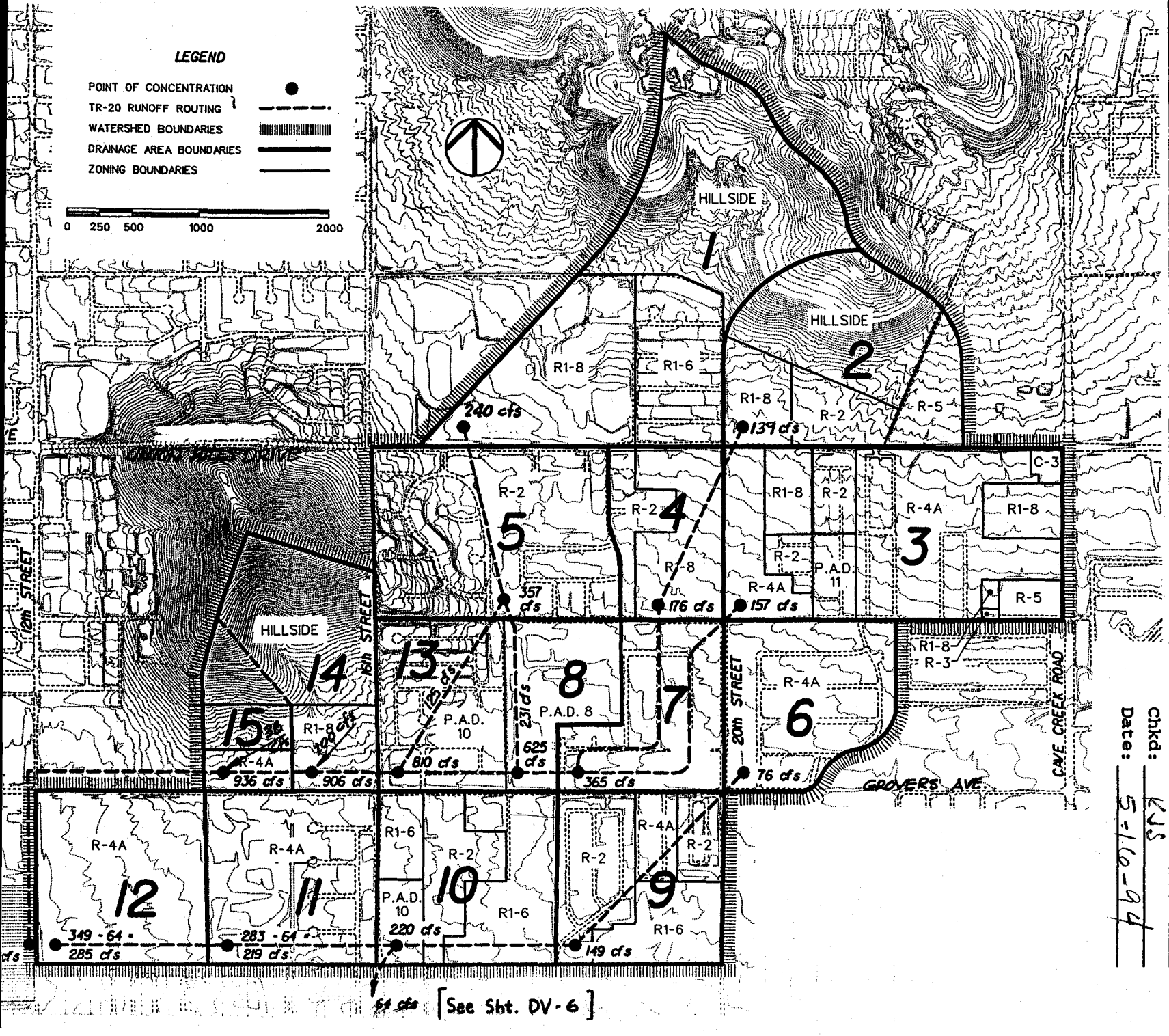



PROJECT ENGINEERING CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

DRAINAGE AREA MAP

Sht: DR-1
Job# 93041
By: JVB
Date: 5-10-94
Chkd: KJS
Date: 5-16-94

1

```
****************80-80 LIST OF INPUT DATA FOR TR-20 HYDROLOGY******************

JOB TR-20                                          SUMMARY  NOPLOTS
TITLE 000 CAMPOBELLO DRIVE LATERAL               DATE: 5-10-94
TITLE 000 JOB NUMBER:  93041                  FILENAME: CAMPO5.DAT
 5 RAINFL 1            .0208
 8          0.         .004       .008       .0130      .018
 8          .022       .026       .031       .035       .04
 8          .044       .048       .053       .057       .062
 8          .066       .071       .075       .080       .093
 8          .107       .120       .140       .170       .500
 8          .830       .860       .880       .893       .907
 8          .920       .924       .928       .933       .937
 8          .942       .947       .951       .956       .960
 8          .964       .969       .973       .978       .982
 8          .987       .991       .995       1.00       1.00
 9 ENDTBL
 2 XSECTN   001        1.0
 8                     29.75      0.         0.
 8                     30.50      1.         .7
 8                     30.75      9.4        4.2
 8                     31.00      39.2       11.
 8                     31.25      83.        18.8
 8                     31.50      148.       30.9
 8                     31.75      248.       49.6
 9 ENDTBL
 2 XSECTN   002        1.0
 8                     29.75      0.         0.
                       30.00      2.0        1.6
 8                     30.25      7.8        4.2
 8                     30.50      17.8       7.6
 8                     30.75      33.3       12.0
 8                     31.00      53.8       17.1
 8                     31.25      81.5       23.2
 8                     31.50      115.6      30.1
 8                     31.75      127.8      42.5
 9 ENDTBL
 6 RUNOFF 1 002       6 .084      91.        .15
 6 REACH  3 004   6   5 1400.     .045       1.66
 6 RUNOFF 1 004       7 .041      83.        .35
 6 ADDHYD 4 004   5 7 6
 6 REACH  3 007   6   7 2100.     .30        1.50
 6 RUNOFF 1 003       3 .123      85.        .54
 6 REACH  3 007   3   5 2400.     .30        1.50
 6 ADDHYD 4 007   5 7 6
 6 RUNOFF 1 007       5 .046      84.        .48
 6 ADDHYD 4 007   5 6 7
 6 REACH  3 008   7   3 400.      7.84       1.25
```

1

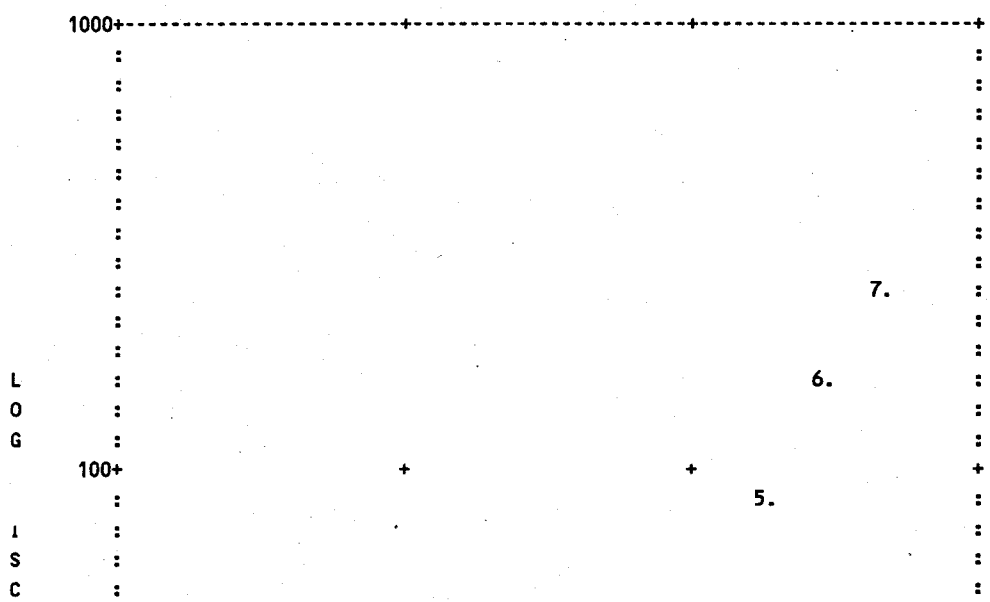
```
**********************80-80 LIST OF INPUT DATA (CONTINUED)**********************

 6 RUNOFF 1 001       6 .158      90.        .39
   REACH  3 005   6   5 1300.     7.06       1.25
 6 RUNOFF 1 005       7 .088      84.        .38
 6 ADDHYD 4 005   5 7 6
 6 DIVERT 6 001   6 1 2           1.         2.
 6 REACH  3 008   1   5 1300.     5.97       1.25
```

```
 6 ADDHYD 4 008   3 5 6
 6 RUNOFF 1 008       7 .036        84.         .48
 6 ADDHYD 4 008   6 7 4
 6 REACH  3 013   2   6 1600.       .82         1.47
   RUNOFF 1 013       7 .045        84.         .32
 o ADDHYD 4 013   6 7 5
 6 REACH  3 013   4   6 1000.       7.95        1.25
 6 ADDHYD 4 013   5 6 7
 6 REACH  3 014   7   5 650.        6.70        1.25
 6 RUNOFF 1 014       6 .060        94.         .28
 6 ADDHYD 4 014   5 6 7
 6 REACH  3 015   7   5 650.        9.17        1.25
 6 RUNOFF 1 015       6 .024        89.         .17
 6 ADDHYD 4 015   5 6 3
 6 RUNOFF 1 006       5 .054        86.         .37
 6 REACH  3 009   5   6 1850.       .31         1.50
 6 RUNOFF 1 009       7 .061        84.         .42
 6 ADDHYD 4 009   6 7 5
 6 REACH  3 010   5   7 1400.       .31         1.50
 6 RUNOFF 1 010       6 .065        84.         .69
 6 ADDHYD 4 010   6 7 5
 6 REACH  3 011   5   6 1800.       .26         1.60
 6 RUNOFF 1 011       7 .065        86.         .41
 6 ADDHYD 4 011   6 7 5
 6 REACH  3 012   5   6 1300.       .26         1.60
 6 RUNOFF 1 012       7 .063        86.         .38
 6 ADDHYD 4 012   6 7 2
   ENDATA
 7 INCREM 6           .08
 7 COMPUT 7 002   012              4.04        24.         1 2  01  01
   ENDCMP 1
   ENDJOB 2

0*******************************END OF 80-80 LIST*********************************
1
```

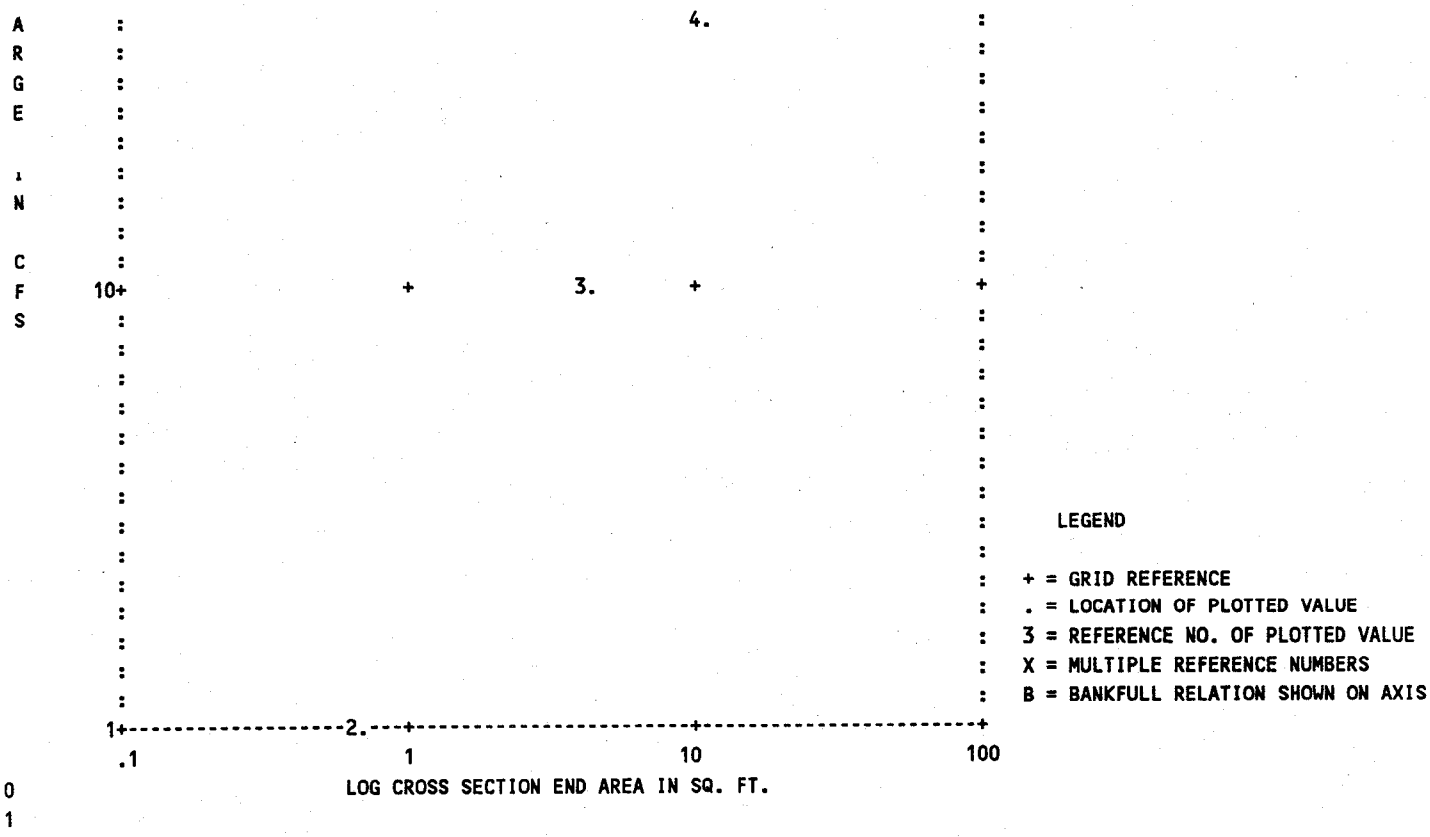
```
TR20 XEQ 05-12-94  10:58      CAMPOBELLO DRIVE LATERAL          DATE: 5-10-94                    JOB  1   PASS   1
     REV PC 09/83(.2)         JOB NUMBER:  93041              FILENAME: CAMPO5.DAT                          PAGE   1
```




CROSS SECTION 1 END AREA VS DISCHARGE

| REFERENCE NO'S | DISCHARGE (CFS) | END AREA (SQ.FT.) | M |
|---|---|---|---|
| 1 | .00 | .00 | 1.25 |
| 2 | 1.00 | .70 | 1.25 |
| 3 | 9.40 | 4.20 | 1.25 |
| 4 | 39.20 | 11.00 | 1.43 |
| 5 | 83.00 | 18.80 | 1.41 |
| 6 | 148.00 | 30.90 | 1.30 |
| 7 | 248.00 | 49.60 | 1.22 |

TR-3

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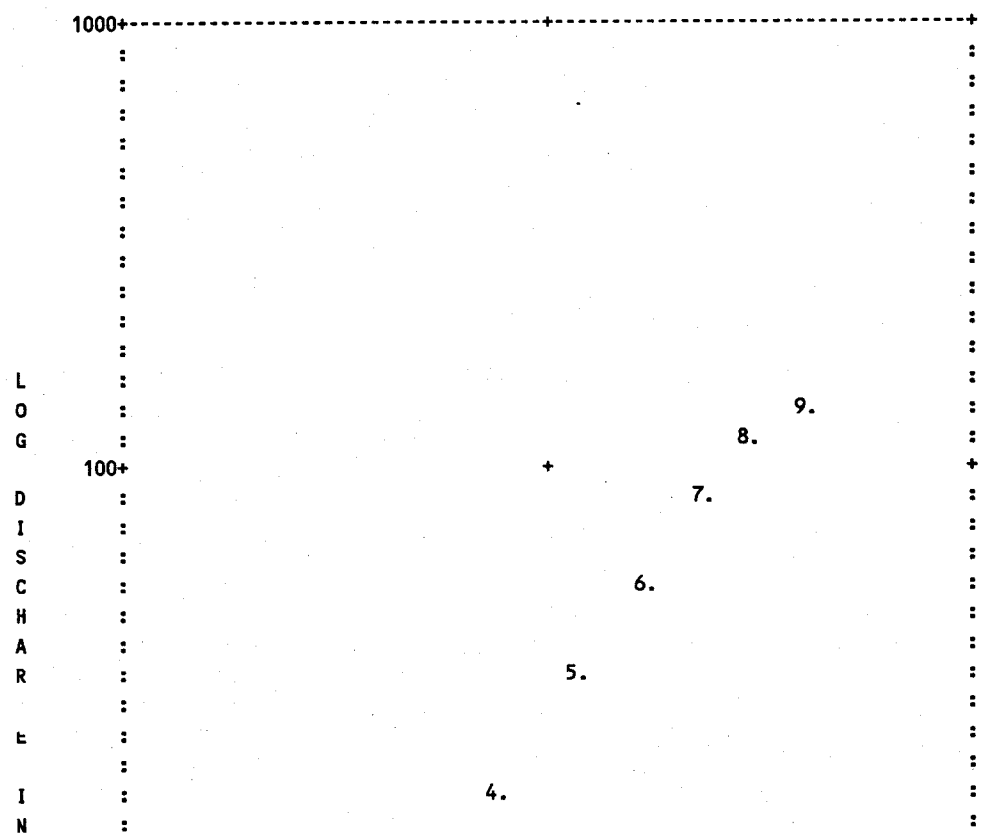


CROSS SECTION 2 END AREA VS DISCHARGE

| REFERENCE NO'S | DISCHARGE (CFS) | END AREA (SQ.FT.) | M |
|---|---|---|---|
| 1 | .00 | .00 | 1.41 |
| 2 | 2.00 | 1.60 | 1.41 |
| 3 | 7.80 | 4.20 | 1.41 |
| 4 | 17.80 | 7.60 | 1.40 |
| 5 | 33.30 | 12.00 | 1.39 |
| 6 | 53.80 | 17.10 | 1.37 |
| 7 | 81.50 | 23.20 | 1.37 |
| 8 | 115.60 | 30.10 | 1.36 |
| 9 | 127.80 | 42.50 | 1.26 |

TR-4

```
        :                                                                  :
C       :                                                                  :
F      10+                          +                                     +
S       :                                                                  :
        :                  3.                                              :
        :                                                                  :
        :                                                                  :
        :                                                                  :
        :                                                                  :
        :                                                                  :
        :                                                                  :
        :                                                                  :
        :                                                                  :
        :                                                                  :      LEGEND
        :                                                                  :
        :     2.                                                           :   + = GRID REFERENCE
        :                                                                  :   . = LOCATION OF PLOTTED VALUE
        :                                                                  :   3 = REFERENCE NO. OF PLOTTED VALUE
        :                                                                  :   X = MULTIPLE REFERENCE NUMBERS
        :                                                                  :   B = BANKFULL RELATION SHOWN ON AXIS
        :                                                                  :
       1+---------------------------------+---------------------------------+
        1                                 10                               100
0                        LOG CROSS SECTION END AREA IN SQ. FT.
```

```
EXECUTIVE CONTROL OPERATION INCREM                                                                    RECORD ID
+                                   MAIN TIME INCREMENT =   .08 HOURS


EXECUTIVE CONTROL OPERATION COMPUT                                                                    RECORD ID
+                                   FROM XSECTION   2
+                                                     TO XSECTION  12
        STARTING TIME =   .00    RAIN DEPTH =  4.04    RAIN DURATION= 24.00    RAIN TABLE NO.= 1    ANT. MOIST. COND= 2
        ALTERNATE NO.= 1         STORM NO.= 1    MAIN TIME INCREMENT =   .08 HOURS

     ***  WARNING  REACH   8 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH   5 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH   8 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH  13 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH  13 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH  14 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH  15 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***

     ***  WARNING  REACH  12 ATT-KIN COEFF.(C) GREATER THAN 0.667, CONSIDER REDUCING MAIN TIME INCREMENT  ***


EXECUTIVE CONTROL OPERATION ENDCMP                                                                    RECORD ID
+                                   COMPUTATIONS COMPLETED FOR PASS   1


EXECUTIVE CONTROL OPERATION ENDJOB                                                                    RECORD ID
1
```

SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

| SECTION/ STRUCTURE ID | STANDARD CONTROL OPERATION | DRAINAGE AREA (SQ MI) | RAIN TABLE # | ANTEC MOIST COND | MAIN TIME INCREM (HR) | PRECIPITATION BEGIN (HR) | PRECIPITATION AMOUNT (IN) | PRECIPITATION DURATION (HR) | RUNOFF AMOUNT (IN) | PEAK DISCHARGE ELEVATION (FT) | PEAK DISCHARGE TIME (HR) | PEAK DISCHARGE RATE (CFS) | PEAK DISCHARGE RATE (CSM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALTERNATE 1 STORM 1 | | | | | | | | | | | | | |
| + | | | | | | | | | | | | | |
| XSECTION 2 | RUNOFF | .08 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 3.05 | --- | 12.44 | 139.00 | 1654.8 |
| XSECTION 4 | REACH | .08 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 3.03 | --- | 12.70 | 129.76 | 1544.8 |
| XSECTION 4 | RUNOFF | .04 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.31 | --- | 12.49 | 53.40 | 1302.4 |
| XSECTION 4 | ADDHYD | .13 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.79 | --- | 12.55 | 175.94 | 1407.5 |
| XSECTION 7 | REACH | .13 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.79 | --- | 12.72 | 168.08 | 1344.6 |
| XSECTION 3 | RUNOFF | .12 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.47 | --- | 12.55 | 156.84 | 1275.2 |
| XSECTION 7 | REACH | .12 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.47 | --- | 12.71 | 146.26 | 1189.1 |
| XSECTION 7 | ADDHYD | .25 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.63 | --- | 12.72 | 314.33 | 1267.5 |
| XSECTION 7 | RUNOFF | .05 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.39 | --- | 12.53 | 58.94 | 1281.2 |
| XSECTION 7 | ADDHYD | .29 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.59 | --- | 12.66 | 365.28 | 1242.5 |
| XSECTION 8 | REACH | .29 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.59 | --- | 12.66 | 365.28 | 1242.5 |
| XSECTION 1 | RUNOFF | .16 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.94 | --- | 12.48 | 240.43 | 1521.7 |
| XSECTION 5 | REACH | .16 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.94 | --- | 12.48 | 240.43 | 1521.7 |
| XSECTION 5 | RUNOFF | .09 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.39 | --- | 12.50 | 116.44 | 1323.2 |
| XSECTION 5 | ADDHYD | .25 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.74 | --- | 12.49 | 356.73 | 1450.1 |
| XSECTION 1 | DIVERT | .25 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 1.27 | 31.71 | 12.49 | 231.00 | 939.0 |
| XSECTION 2 | DIVERT | .00 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 1.27 | 31.71 | 12.49 | 125.73 | ********** |
| XSECTION 8 | REACH | .25 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 1.27 | --- | 12.49 | 231.00 | 939.0 |
| XSECTION 8 | ADDHYD | .54 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 1.99 | --- | 12.55 | 579.16 | 1072.5 |
| XSECTION 8 | RUNOFF | .04 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.39 | --- | 12.53 | 46.12 | 1281.2 |
| XSECTION 8 | ADDHYD | .58 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.02 | --- | 12.55 | 625.23 | 1085.5 |
| XSECTION 13 | REACH | .00 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.02 | --- | 12.59 | 125.35 | ********** |
| XSECTION 13 | RUNOFF | .05 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.39 | --- | 12.48 | 60.82 | 1351.5 |
| XSECTION 13 | ADDHYD | .05 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 10.42 | --- | 12.50 | 185.11 | 4113.5 |
| XSECTION 13 | REACH | .58 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.02 | --- | 12.55 | 625.23 | 1085.5 |
| XSECTION 13 | ADDHYD | .62 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.62 | --- | 12.54 | 810.16 | 1304.6 |
| XSECTION 14 | REACH | .62 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.62 | --- | 12.54 | 810.16 | 1304.6 |
| XSECTION 14 | RUNOFF | .06 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 3.35 | --- | 12.44 | 99.68 | 1661.4 |
| XSECTION 14 | ADDHYD | .68 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.69 | --- | 12.53 | 906.17 | 1330.6 |
| XSECTION 15 | REACH | .68 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.69 | --- | 12.53 | 906.17 | 1330.6 |
| XSECTION 15 | RUNOFF | .02 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.86 | --- | 12.44 | 38.02 | 1584.0 |
| XSECTION 15 | ADDHYD | .71 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.69 | --- | 12.52 | 935.47 | 1326.9 |

1



SUMMARY TABLE 1 - SELECTED RESULTS OF STANDARD AND EXECUTIVE CONTROL INSTRUCTIONS IN THE ORDER PERFORMED
(A STAR(*) AFTER THE PEAK DISCHARGE TIME AND RATE (CFS) VALUES INDICATES A FLAT TOP HYDROGRAPH
A QUESTION MARK(?) INDICATES A HYDROGRAPH WITH PEAK AS LAST POINT.)

| SECTION/ STRUCTURE ID | STANDARD CONTROL OPERATION | DRAINAGE AREA (SQ MI) | RAIN TABLE # | ANTEC MOIST COND | MAIN TIME INCREM (HR) | PRECIPITATION BEGIN (HR) | PRECIPITATION AMOUNT (IN) | PRECIPITATION DURATION (HR) | RUNOFF AMOUNT (IN) | PEAK DISCHARGE ELEVATION (FT) | PEAK DISCHARGE TIME (HR) | PEAK DISCHARGE RATE (CFS) | PEAK DISCHARGE RATE (CSM) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALTERNATE 1 STORM 1 | | | | | | | | | | | | | |
| XSECTION 6 | RUNOFF | .05 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.57 | --- | 12.49 | 75.62 | 1400.3 |
| XSECTION 9 | REACH | .05 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.56 | --- | 12.63 | 71.49 | 1324.0 |
| XSECTION 9 | RUNOFF | .06 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.39 | --- | 12.52 | 79.59 | 1304.8 |
| XSECTION 9 | ADDHYD | .12 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.47 | --- | 12.55 | 149.05 | 1296.1 |
| XSECTION 10 | REACH | .12 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.47 | --- | 12.67 | 144.93 | 1260.3 |
| XSECTION 10 | RUNOFF | .06 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.39 | --- | 12.63 | 75.18 | 1156.7 |
| XSECTION 10 | ADDHYD | .18 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.44 | --- | 12.66 | 219.72 | 1220.7 |
| XSECTION 11 | REACH | .18 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.43 | --- | 12.78 | 215.56 | 1197.5 |
| XSECTION 11 | RUNOFF | .06 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.57 | --- | 12.50 | 89.50 | 1376.9 |
| XSECTION 11 | ADDHYD | .25 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.47 | --- | 12.63 | 283.25 | 1156.1 |
| XSECTION 12 | REACH | .25 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.46 | --- | 12.73 | 281.18 | 1147.7 |
| XSECTION 12 | RUNOFF | .06 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.57 | --- | 12.49 | 87.65 | 1391.3 |
| XSECTION 12 | ADDHYD | .31 | 1 | 2 | .08 | .0 | 4.04 | 24.00 | 2.49 | --- | 12.63 | 348.93 | 1132.9 |



MMARY TABLE 2 - SELECTED MODIFIED ATT-KIN REACH ROUTINGS IN ORDER OF STANDARD EXECUTIVE CONTROL INSTRUCTIONS
(A STAR(*) AFTER VOLUME ABOVE BASE(IN) INDICATES A HYDROGRAPH TRUNCATED AT A VALUE EXCEEDING BASE + 10% OF PEAK
A QUESTION MARK(?) AFTER COEFF.(C) INDICATES PARAMETERS OUTSIDE ACCEPTABLE LIMITS, SEE PREVIOUS WARNINGS)

| XSEC ID | REACH LENGTH (FT) | HYDROGRAPH INFORMATION INFLOW PEAK (CFS) | INFLOW TIME (HR) | OUTFLOW PEAK (CFS) | OUTFLOW TIME (HR) | OUTFLOW+ INTERV. PEAK (CFS) | OUTFLOW+ INTERV. TIME (HR) | BASE-FLOW (CFS) | ROUTING PARAMETERS VOLUME ABOVE BASE (IN) | MAIN TIME INCR (HR) | ITER-ATION # | Q AND A EQUATION COEFF (X) | Q AND A EQUATION POWER (M) | LENGTH FACTOR (K*) | PEAK RATIO Q/I (Q*) | S/Q @PEAK (K) (SEC) | ATT-KIN COEFF (C) | PEAK TRAVEL TIME STOR-AGE (HR) | PEAK TRAVEL TIME KINE-MATIC (HR) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALTERNATE 1 STORM 1 | | | | | | | | | | | | | | | | | | | |
| 4 | 1400 | 135 | 12.5 | 129 | 12.7 | 176 | 12.6 | 0 | 3.05 | .08 | 1 | .045 | 1.66 | .130 | .958 | 777 | .31 | .08 | .22 |
| 7 | 2100 | 176 | 12.6 | 168 | 12.7 | --- | --- | 0 | 2.79 | .08 | 1 | .300 | 1.50 | .077 | .955 | 558 | .41 | .16 | .16 |
| 7 | 2400 | 157 | 12.6 | 146 | 12.7 | 314 | 12.7 | 0 | 2.47 | .08 | 1 | .300 | 1.50 | .103 | .933 | 662 | .36 | .16 | .19 |
| 8 | 400 | 365 | 12.6 | 365 | 12.6 | --- | --- | 0 | 2.59 | .08 | 0 | 7.84 | 1.25 | .001 | 1.000 | 19 | 1.00? | .00 | .00 |
| 5 | 1300 | 240 | 12.5 | 240 | 12.5 | 357 | 12.5 | 0 | 2.94 | .08 | 0 | 7.06 | 1.25 | .008 | 1.000 | 73 | 1.00? | .00 | .00 |

```
                                                                                                                  5.97
+  8   1300     231  12.5     231  12.5                    0     1.27    .08    0        1.25   .014  1.000     84 1.00?   .00   .00
+                                          ---   ---
                                                                                                                  .820
   3   1600     126  12.5     125  12.6                    0      .00    .08    1        1.47   .015   .996    266  .70?   .08   .07
+                                          185  12.5
                                                                                                                  7.95
+ 13   1000     625  12.6     625  12.6                    0     2.02    .08    0        1.25   .004  1.000     42 1.00?   .00   .00
+                                          ---   ---
                                                                                                                  6.70
+ 14    650     809  12.6     809  12.6                    0     2.62    .08    0        1.25   .002  1.000     30 1.00?   .00   .00
+                                          901  12.6
                                                                                                                  9.17
+ 15    650     901  12.6     901  12.6                    0     2.69    .08    0        1.25   .002  1.000     23 1.00?   .00   .00
+                                          931  12.5

                                                                                                                  .310
+  9   1850      76  12.5      71  12.6                    0     2.57    .08    1        1.50   .106   .945    637  .37    .16   .18
+                                          149  12.6
                                                                                                                  .310
+ 10   1400     149  12.6     144  12.6                    0     2.47    .08    1        1.50   .047   .969    384  .55    .08   .11
+                                          220  12.6
                                                                                                                  .260
+ 11   1800     220  12.6     215  12.8                    0     2.44    .08    1        1.60   .033   .980    346  .59    .16   .10
+                                          283  12.6
                                                                                                                  .260
+ 12   1300     283  12.6     281  12.7                    0     2.47    .08    1        1.60   .015   .992    227  .78?   .08   .06
+                                          349  12.6
1
```



SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

| XSECTION/ STRUCTURE ID | DRAINAGE AREA (SQ MI) | STORM NUMBERS..... 1 |
|---|---|---|
| 0 XSECTION 1 | .25 | |
| + ALTERNATE 1 | | 231.00 |
| 0 XSECTION 2 | .00 | |
| + ALTERNATE 1 | | 125.73 |
| 0 XSECTION 3 | .12 | |
| + ALTERNATE 1 | | 156.84 |
| 0 XSECTION 4 | .13 | |
| + ALTERNATE 1 | | 175.94 |
| 0 XSECTION 5 | .25 | |
| + ALTERNATE 1 | | 356.73 |
| 0 XSECTION 6 | .05 | |
| ALTERNATE 1 | | 75.62 |
| 0 XSECTION 7 | .29 | |
| + ALTERNATE 1 | | 365.28 |

```
0 XSECTION    8          .58
+_____________________________
   ALTERNATE    1                  625.23
0 XSECTION    9          .12
 _____________________________
   ALTERNATE    1                  149.05
0 XSECTION   10          .18
+_____________________________
   ALTERNATE    1                  219.72
0 XSECTION   11          .25
+_____________________________
   ALTERNATE    1                  283.25
0 XSECTION   12          .31
+_____________________________
   ALTERNATE    1                  348.93
0 XSECTION   13          .62
+_____________________________
   ALTERNATE    1                  810.16
0 XSECTION   14          .68
+_____________________________
   ALTERNATE    1                  906.17
1
```



SUMMARY TABLE 3 - DISCHARGE (CFS) AT XSECTIONS AND STRUCTURES FOR ALL STORMS AND ALTERNATES

```
  ECTION/          DRAINAGE
 STRUCTURE           AREA       STORM NUMBERS..........
   ID              (SQ MI)            1

0 XSECTION   15          .71
+_____________________________
   ALTERNATE    1                  935.47
```

```
MAIN - UNEXPECTED RECORD FOUND(IGNORED) >>>                                                          <<<
1END OF  1 JOBS IN THIS RUN
```

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

COMPOSITE CURVE NUMBER
CALCULATIONS

Sht: CN-1
Job# 93041
By: JVB
Date: 5-10-94
Chkd: KJS
Date: 5-15-94

**Composite Curve Number**
**Campobello Drive Lateral**

JVB 5/15/94

| Sub Area | Total Area Acres | Total Area Sq. Miles | Area (Acres) - Type B Soil Cover Complex: C Cn=92 | R1-6 Cn=84 | R1-8 Cn=82 | R2 Cn=84 | R3 Cn=85 | R4, R5 Cn=86 | PAD Cn=84 | Hillside Cn=98 | Composite Cn Compt'd | Composite Cn USE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 101.0 | 0.158 | | 19.9 | 31.8 | | | | | 49.3 | 90.20 | 90 |
| 2 | 54.0 | 0.084 | | | 9.0 | 8.4 | | 9.0 | | 27.6 | 91.16 | 91 |
| 3 | 80.0 | 0.125 | 1.5 | | 12.1 | 8.2 | 0.3 | 52.9 | 5.0 | | 85.17 | 85 |
| 4 | 26.0 | 0.041 | | | 18.5 | 7.5 | | | | | 82.58 | 83 |
| 5 | 56.0 | 0.088 | | | | 56.0 | | | | | 84.00 | 84 |
| 6 | 35.0 | 0.055 | | | | | | 35.0 | | | 86.00 | 86 |
| 7 | 29.7 | 0.046 | | | | | | | 29.7 | | 84.00 | 84 |
| 8 | 23.1 | 0.036 | | | | | | | 23.1 | | 84.00 | 84 |
| 9 | 40.0 | 0.063 | | 12.5 | | 22.5 | | 5.0 | | | 84.25 | 84 |
| 10 | 40.0 | 0.063 | | 22.6 | | 12.0 | | | 5.4 | | 84.00 | 84 |
| 11 | 40.0 | 0.063 | | | | | | 40.0 | | | 86.00 | 86 |
| 12 | 40.0 | 0.063 | | | | | | 40.0 | | | 86.00 | 86 |
| 13 | 28.8 | 0.045 | | | | | | | 28.8 | | 84.00 | 84 |
| 14 | 38.4 | 0.060 | | | 9.7 | | | | | 28.7 | 93.96 | 94 |
| 15 | 15.6 | 0.024 | | | 5.2 | | | 5.2 | | 5.2 | 88.67 | 89 |

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: TC-1
By: KJS
Date: 05/25/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/25/94

Job No. 93041

Time of Concentration
Upland Method

| Area # | Hydraulic Length | Slope | Velocity | Tc |
|---|---|---|---|---|
| 1 | 3500 | 0.0794 | 2.50 | 0.39 |
| 2 | 1700 | 0.1247 | 3.20 | 0.15 |
| 3 | 2800 | 0.0100 | 1.45 | 0.54 |
| 4 | 1400 | 0.0143 | 1.10 | 0.35 |
| 5 | 1600 | 0.0063 | 1.16 | 0.38 |
| 6 | 1750 | 0.0080 | 1.31 | 0.37 |
| 7 | 2100 | 0.0067 | 1.22 | 0.48 |
| 8 | 1550 | 0.0097 | 0.89 | 0.48 |
| 9 | 1850 | 0.0070 | 1.23 | 0.42 |
| 10 | 1900 | 0.0074 | 0.77 | 0.69 |
| 11 | 1800 | 0.0072 | 1.23 | 0.41 |
| 12 | 1800 | 0.0083 | 1.31 | 0.38 |
| 13 | 1600 | 0.0094 | 1.39 | 0.32 |
| 14 | 2200 | 0.0636 | 2.20 | 0.28 |
| 15 | 1400 | 0.0657 | 2.30 | 0.17 |

PROJECT ENGINEERING
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3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

slopes used in time of concentration

Sht: TC-2
Job# 93041
By: K. SHORT
Date: 5-10-94
Chkd:
Date:

| DRAINAGE AREA | HYDRAULIC LENGTH | ELEVATION DROP | | | SLOPE |
|---|---|---|---|---|---|
| 1 | 3500 | 1720 | TO | 1442 | 0.0794 |
| 2 | 1700 | 1670 | TO | 1458 | 0.1247 |
| 3 | 2800 | 1470 | TO | 1442 | 0.0100 |
| 4 | 1400 | 1458 | TO | 1438 | 0.0143 |
| 5 | 1600 | 1450 | TO | 1432 | 0.0063 |
| 6 | 1750 | 1449 | TO | 1435 | 0.0080 |
| 7 | 2100 | 1438 | TO | 1424 | 0.0067 |
| 8 | 1550 | 1437 | TO | 1422 | 0.0097 |
| 9 | 1850 | 1435 | TO | 1422 | 0.0070 |
| 10 | 1900 | 1426 | TO | 1412 | 0.0074 |
| 11 | 1800 | 1416 | TO | 1403 | 0.0072 |
| 12 | 1800 | 1409 | TO | 1394 | 0.0083 |
| 13 | 1600 | 1432 | TO | 1417 | 0.0094 |
| 14 | 2200 | 1556 | TO | 1416 | 0.0636 |
| 15 | 1400 | 1504 | TO | 1412 | 0.0657 |

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

VELOCITIES FOR CALC. OF $T_c$

Sht: TC-3
Job# 93041
By: K. SHORT
Date: 5-10-94
Chkd:
Date:

| DRAINAGE AREA | SLOPE | CULTIVATED, STR. ROW OVERLAND FLOW, V * | PAVED AREA, V * | AVG. V |
|---|---|---|---|---|
| 1 | 0.0794 | 2.5 (100%) | — | 2.5 |
| 2 | 0.1247 | 3.2 (100%) | — | 3.2 |
| 3 | 0.0100 | 0.9 (50%) | 2.0 (50%) | 1.45 |
| 4 | 0.0143 | 1.1 (100%) | — | 1.1 |
| 5 | 0.0063 | 0.72 (50%) | 1.6 (50%) | 1.16 |
| 6 | 0.0080 | 0.81 (50%) | 1.8 (50%) | 1.31 |
| 7 | 0.0067 | 0.73 (50%) | 1.7 (50%) | 1.22 |
| 8 | 0.0097 | 0.89 (100%) | — | 0.89 |
| 9 | 0.0070 | 0.75 (50%) | 1.7 (50%) | 1.23 |
| 10 | 0.0074 | 0.77 (100%) | — | 0.77 |
| 11 | 0.0072 | 0.76 (50%) | 1.7 (50%) | 1.23 |
| 12 | 0.0083 | 0.82 (50%) | 1.8 (50%) | 1.31 |
| 13 | 0.0094 | 0.87 (50%) | 1.9 (50%) | 1.39 |
| 14 | 0.0636 | 2.2 (100%) | — | 2.2 |
| 15 | 0.0657 | 2.3 (100%) | — | 2.3 |

* FROM FIG. 8 VELOCITIES FOR UPLAND METHOD OF ESTIMATING $T_c$

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

CALC. OF $T_c$ — UPLAND METHOD

Sht: TC-4
Job# 93041
By: K SHORT
Date: 4-19-94
Chkd: JVB
Date: 4-20-94

UPLAND METHOD

$$T_c = \frac{l}{V}$$

$T_c$ = time of concentration, secs
$l$ = hydraulic flow length, ft
$V$ = velocity, fps (from FIG 8)

DRAINAGE AREA #1 :

$l$ = 3500 ft
$S$ = 0.0794 ⁄FT

using the slope in FIG 8 $V$ = 2.50 fps

$$T_c = \frac{3500 \text{ ft}}{2.50 \text{ fps}} = 1400 \text{ secs} \times \left(\frac{1 \text{ hr}}{3600 \text{ s}}\right)$$

$T_c$ = 0.39 hrs

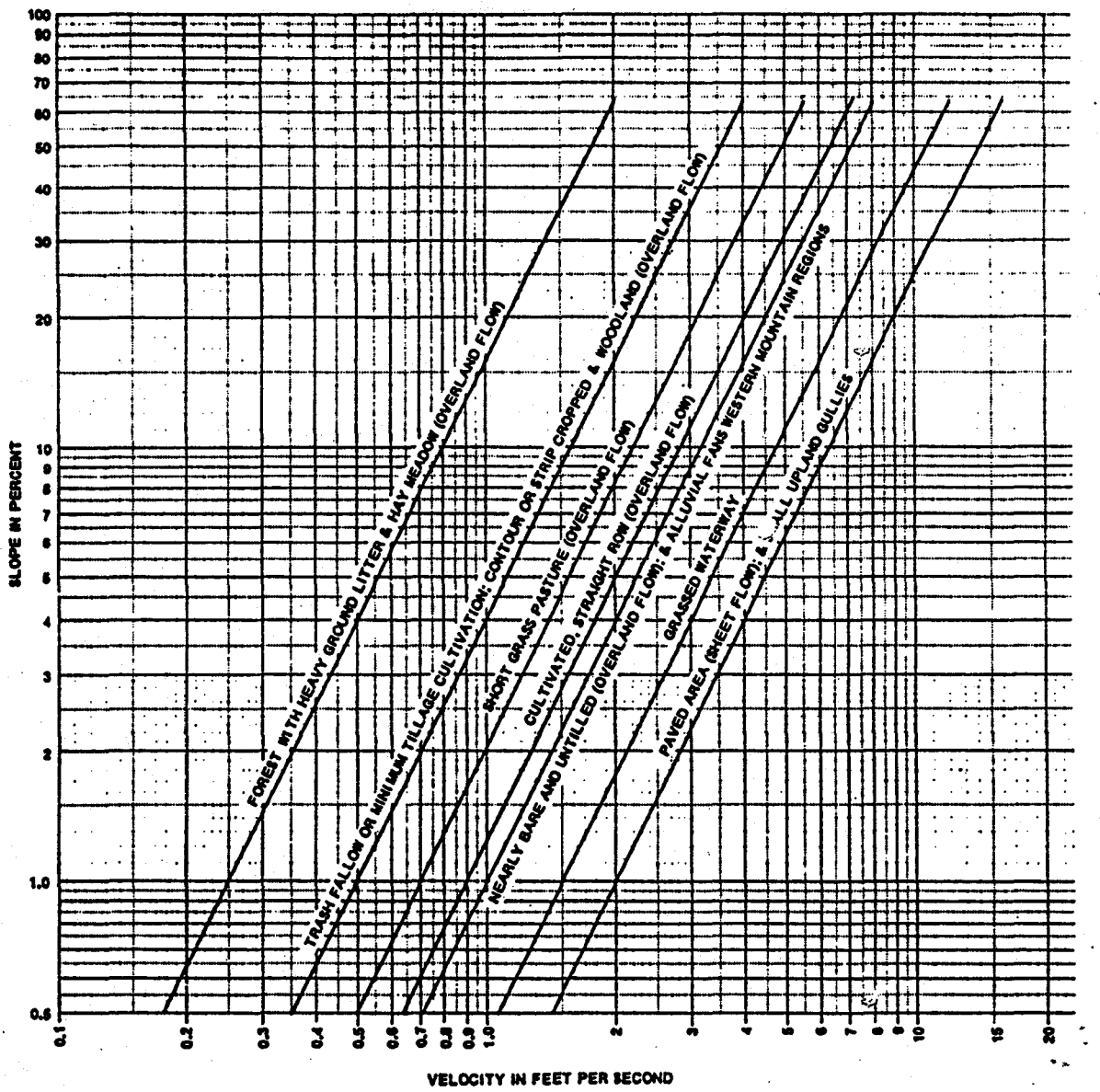
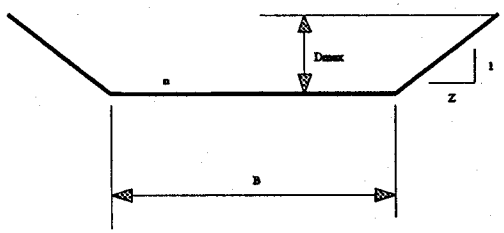



Figure 8. Velocities for upland method of estimating $T_c$

# CROSS-SECTIONS USED FOR DETERMINING "X" & "m" IN THE EQUATION Q=XA^m IN THE Att-Kin ROUTING PROCEDURE

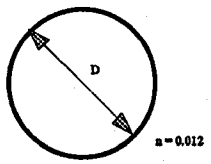



TRAPEZOIDAL CHANNEL

area, A = B*D + Z*D^2

X = 1.49*S^0.5 / (n*B^(2/3))

m = log[ A^(5 / 3)*(1 / (1 + (2*D / B)*(1 + Z^2)^0.5))^(2 / 3)] / log[ A ]



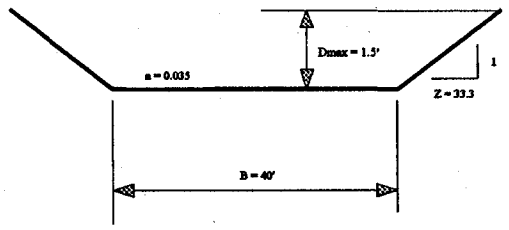

CONDUIT FLOW
(flow in storm drain)

X = 0.804*S^(1 / 2)*D^(1 / 6) / n

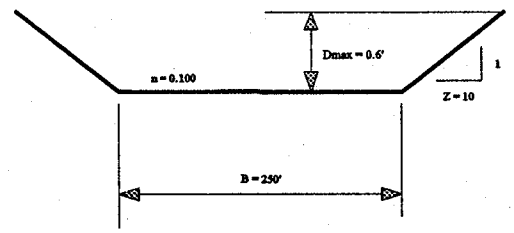
m = 5 / 4

AK-1

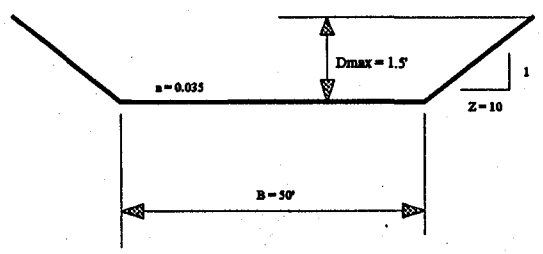
# CROSS-SECTIONS USED FOR DETERMINING "X" & "m" IN THE EQUATION Q=XA^m IN THE Att-Kin ROUTING PROCEDURE



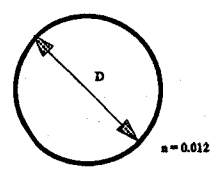

STREET OVERFLOW
(flow in excess of curb capacity)




OVERLAND FLOW
(natural desert)




CHANNEL FLOW
(man made channel)




CONDUIT FLOW
(flow in storm drain)

AK-2

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-3
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 4
50% overland flow (L = 3500')

| | | |
|---|---|---|
| Slope, S = | 0.0097 | ft/ft |
| Manning's n = | 0.1 | |
| Bottom Width, B = | 250 | ft |
| Max. Depth, D = | 0.6 | ft |
| Side Slope, Z = | 10 | ft/ft |
| Area = | 154 | ft^2 |
| X = | 0.037 | |
| m = | 1.66 | |
| Q = | 157.9 | cfs * |

50% street overflow

| | | |
|---|---|---|
| Slope, S = | 0.0097 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 40 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 33.3 | ft/ft |
| Area = | 135 | ft^2 |
| X = | 0.358 | |
| m = | 1.50 | |
| Q = | 552.1 | cfs * |
| **AVERAGE X =** | 0.20 | |
| **AVERAGE m =** | 1.58 | |

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-4
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 4
25% overland flow (L = 2400')

| | | |
|---|---|---|
| Slope, S = | 0.0067 | ft/ft |
| Manning's n = | 0.1 | |
| Bottom Width, B = | 250 | ft |
| Max. Depth, D = | 0.6 | ft |
| Side Slope, Z = | 10 | ft/ft |
| Area = | 154 | ft^2 |
| X = | 0.031 | |
| m = | 1.66 | |
| Q = | 131.2 | cfs * |

75% street overflow

| | | |
|---|---|---|
| Slope, S = | 0.0067 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 40 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 33.3 | ft/ft |
| Area = | 135 | ft^2 |
| X = | 0.298 | |
| m = | 1.50 | |
| Q = | 458.9 | cfs * |
| **AVERAGE X =** | 0.23 | |
| **AVERAGE m =** | 1.54 | |

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-5
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 5
pipe flow

Slope, S = 0.0070 ft/ft
Manning's n = 0.012
Pipe Diameter, D = 4 ft

Area = 12.57 ft^2
X = 7.06
m = 1.25

Q = 167.1 cfs *

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-6
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 7

pipe flow (L = 1300')

Slope, S = 0.005 ft/ft
Manning's n = 0.012
Pipe Diameter, D = 4 ft

Area = 12.57 ft^2
X = 5.97
m = 1.25

Q = 141.2 cfs *

pipe flow (L = 400')

Slope, S = 0.007 ft/ft
Manning's n = 0.012
Pipe Diameter, D = 7.5 ft

Area = 44.18 ft^2
X = 7.84
m = 1.25

Q = 893.3 cfs *

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-7
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 8
pipe flow (L = 650')

Slope, S = 0.009 ft/ft
Manning's n = 0.012
Pipe Diameter, D = 9 ft

Area = 63.62 ft^2
X = 9.17
m = 1.25

Q = 1647.0 cfs *

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-8
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 9
25% overland flow

| | | |
|---|---|---|
| Slope, S = | 0.007 | ft/ft |
| Manning's n = | 0.1 | |
| Bottom Width, B = | 250 | ft |
| Max. Depth, D = | 0.6 | ft |
| Side Slope, Z = | 10 | ft/ft |
| Area = | 154 | ft^2 |
| X = | 0.031 | |
| m = | 1.66 | |
| Q = | 134.1 | cfs * |

75% street overflow

| | | |
|---|---|---|
| Slope, S = | 0.007 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 40 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 33.3 | ft/ft |
| Area = | 135 | ft^2 |
| X = | 0.305 | |
| m = | 1.50 | |
| Q = | 469.0 | cfs * |
| **AVERAGE X =** | 0.24 | |
| **AVERAGE m =** | 1.54 | |

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-9
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 10
street overflow

| | | |
|---|---|---|
| Slope, S = | 0.0072 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 40 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 33.3 | ft/ft |
| Area = | 135 | ft^2 |
| X = | 0.31 | |
| m = | 1.50 | |
| Q = | 475.7 | cfs * |

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-10
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 11
street overflow

| | | |
|---|---|---|
| Slope, S = | 0.0069 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 40 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 33.3 | ft/ft |
| Area = | 135 | ft^2 |
| X = | 0.30 | |
| m = | 1.50 | |
| Q = | 465.6 | cfs * |

channel flow

| | | |
|---|---|---|
| Slope, S = | 0.0069 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 50 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 10 | ft/ft |
| Area = | 98 | ft^2 |
| X = | 0.26 | |
| m = | 1.60 | |
| Q = | 392.9 | cfs * |

**AVERAGE X =** 0.28
**AVERAGE m =** 1.55

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-11
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 12
channel flow

| | | |
|---|---|---|
| Slope, S = | 0.0069 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 50 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 10 | ft/ft |
| Area = | 98 | ft^2 |
| X = | 0.26 | |
| m = | 1.60 | |
| Q = | 392.9 | cfs * |

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-12
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 13
25% street overflow (L = 1600')

| | | |
|---|---|---|
| Slope, S = | 0.0094 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 40 | ft |
| Max. Depth, D = | 1.5 | ft |
| Side Slope, Z = | 33.3 | ft/ft |
| Area = | 135 | ft^2 |
| X = | 0.35 | |
| m = | 1.50 | |
| Q = | 543.5 | cfs * |

75% channel flow

| | | |
|---|---|---|
| Slope, S = | 0.0080 | ft/ft |
| Manning's n = | 0.035 | |
| Bottom Width, B = | 10 | ft |
| Max. Depth, D = | 2 | ft |
| Side Slope, Z = | 5 | ft/ft |
| Area = | 40 | ft^2 |
| X = | 0.82 | |
| m = | 1.47 | |
| Q = | 182.9 | cfs * |

**AVERAGE X =** 0.70
**AVERAGE m =** 1.47

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-13
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 13
pipe flow (L = 1000')

Slope, S = 0.0072 ft/ft
Manning's n = 0.012
Pipe Diameter, D = 7.5 ft

Area = 44.18 ft^2
X = 7.95
m = 1.25

Q = 905.9 cfs *

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: AK-14
By: KJS
Date: 05/11/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 05/11/94

Job No. 93041

Modified Attenuated-Kinematic Routing Procedure

AREA 14
pipe flow (L = 650')

| | | |
|---|---|---|
| Slope, S = | 0.005 | ft/ft |
| Manning's n = | 0.012 | |
| Pipe Diameter, D = | 8 | ft |
| Area = | 50.27 | ft^2 |
| X = | 6.70 | |
| m = | 1.25 | |
| Q = | 896.7 | cfs * |

* Values are compared against TR - 20 output for reasonable similarity of routing flow rate.

ATT-KIN - 3/14/94

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CAMPO BELLO DRIVE LATERAL

ATT-KIN ROUTING PROCEDURE

Sht: AK-15
Job# 93041
By: K. SHORT
Date: 4-19-94
Chkd: JVB
Date: 4-20-94

GENERALIZED CROSS-SECTIONS WERE DETERMINED FOR ROUTING. CONSTANTS WERE DETERMINED BY THE FOLLOWING EQNS. TAKEN FROM THE HEC-1 USER'S MANUAL:

TRAPEZOIDAL CHANNEL

$$x = \frac{1.49}{n} \times \frac{S^{0.5}}{B^{2/3}}$$

$$m = \frac{\log\left[A^{5/3}\left(\frac{1}{1+(2D/B)\sqrt{1+Z^2}}\right)^{2/3}\right]}{\log A}$$

$$A = BD + ZD^2$$

B = bottom width
D = max. depth
Z = side slope
n = Mannings coef.
S = slope

E.G. DRAINAGE AREA 4

$$x = \frac{1.49}{0.100} \times \frac{0.0097^{0.5}}{250^{2/3}} = 0.037$$

$$A = 250 \times 0.6 + 10 \times 0.6^2 = 153.6$$

$$m = \frac{\log\left[153.6^{5/3}\left(\frac{1}{1+(2\times 0.6/250)\sqrt{1+10^2}}\right)^{2/3}\right]}{\log 153.6} = 1.66$$

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CAMPO BELLO DRIVE LATERAL

ATT-KIN ROUTING PROCEDURE

Sht: AK-16
Job# 93041
By: K. SHORT
Date: 4-19-94
Chkd: JVB
Date: 4-20-94

CIRCULAR PIPE

$$X = \frac{0.804}{n} \times S^{0.5} D^{1/6}$$

$$m = 5/4$$

E.G. DRAINAGE AREA 7

$$X = \frac{0.804}{0.012} \times 0.005^{0.5} \times 4^{1/6} = 5.97$$

$$m = 5/4$$

IN SPECIAL CASES, THE ROUTING PATH IS COMPOSED OF two SEGMENTS. EACH SEGMENT being generalized by a different CROSS-SECTION. THESE SEGMENTS WERE APPROXIMATELY the SAME length. When this occurred an AVERAGE of the X and m COEFFICIENTS WERE USED.

This happened in REACHES in DRAINAGE AREAS 4, 11, and 13.

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CAMPO BELLO DRIVE LATERAL

Sht: AK-17
Job# 93041
By: K. SHORT
Date: 4-21-94
Chkd: JVB
Date: 4-22-94

DUE TO THE FACT THAT GENERALIZED CROSS-SECTIONS WERE USED THE AREA AND m COEFFICIENT CAN BE CALCULATED FOR ALL DRAINAGE AREAS SINCE THEY ONLY DEPEND ON CROSS-SECTION GEOMETRY.

STREET OVERFLOW (D.A. 4, 9, 10, 11, 13)

$B = 40'$ $D = 1.5'$ $Z = 33.3$

$A = 40 \times 1.5 + 33.3 \times 1.5^2 = 164.9$

$$m = \frac{\log\left[164.9^{5/3}\left(\frac{1}{1+(2\times1.5/40)\sqrt{1+33.3}}\right)^{2/3}\right]}{\log 164.9} = 1.50$$

CHANNEL FLOW (D.A. 11, 12, 13)

$B = 50'$ $D = 1.5'$ $Z = 10$

$A = 50 \times 1.5 + 10 \times 1.5^2 = 97.5$

$$m = \frac{\log\left[97.5^{5/3}\left(\frac{1}{1+(2\times1.5/50)\sqrt{1+10^2}}\right)^{2/3}\right]}{\log 97.5} = 1.60$$

OVERLAND FLOW (D.A. 4)

$B = 250'$ $D = 0.6'$ $Z = 10$

$A = 250 \times 0.6 + 10 \times 0.6^2 = 153.6$

$$m = \frac{\log\left[153.6^{5/3}\left(\frac{1}{1+(2\times0.6/250)\sqrt{1+10^2}}\right)^{2/3}\right]}{\log 153.6} = 1.66$$

PIPE FLOW (D.A. 5, 7, 8, 13, 14)

$m = 5/4$

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CAMPO BELLO DRIVE LATERAL

Sht: AK-18
Job# 93041
By: K. SHORT
Date: 4-21-94
Chkd: JVB
Date: 10/10/94

The x coefficient is dependant upon the cross-section geometry as well as the channel slope. Geometric eqns. are as follows:

TRAPEZOIDAL CHANNEL

$$X = \frac{1.49}{n} \cdot \frac{S^{0.5}}{B^{2/3}}$$

CIRCULAR CHANNEL

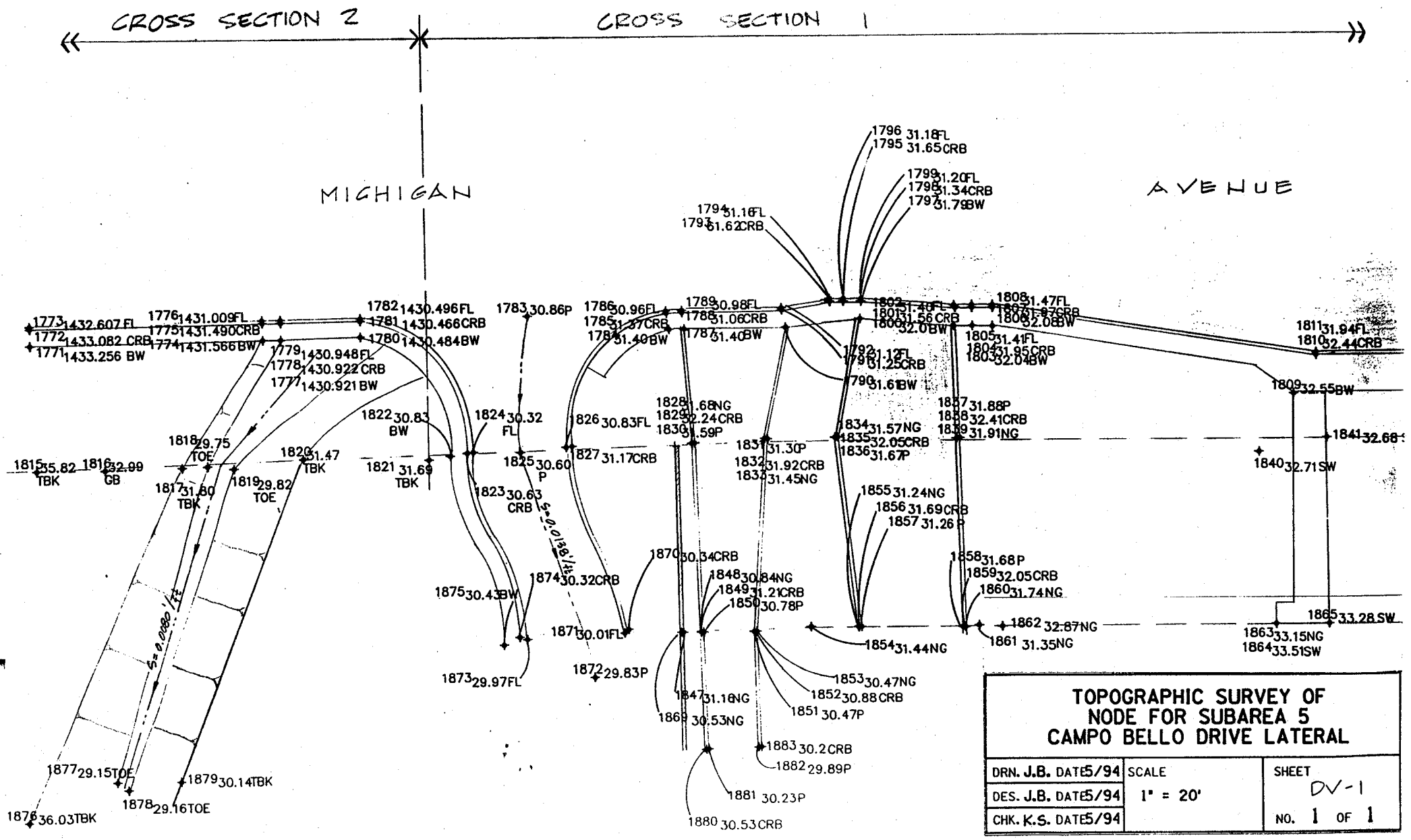
$$X = \frac{0.804}{n} \cdot S^{0.5} D^{1/6}$$

DRAINAGE AREA 4

$$X = \frac{1.49}{0.100} \cdot \frac{0.0097^{0.5}}{250^{2/3}} = 0.037$$ ✓ O.K.

DRAINAGE AREA 5

$$X = \frac{0.804}{0.012} \cdot 0.0070^{0.5} \times 4^{1/6} = 7.06$$ ✓ O.K.




| TOPOGRAPHIC SURVEY OF NODE FOR SUBAREA 5 CAMPO BELLO DRIVE LATERAL | | |
|---|---|---|
| DRN. J.B. DATE 5/94 | SCALE | SHEET |
| DES. J.B. DATE 5/94 | 1" = 20' | DV-1 |
| CHK. K.S. DATE 5/94 | | NO. 1 OF 1 |

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Phoenix, Arizona 85017 (602) 484-7691

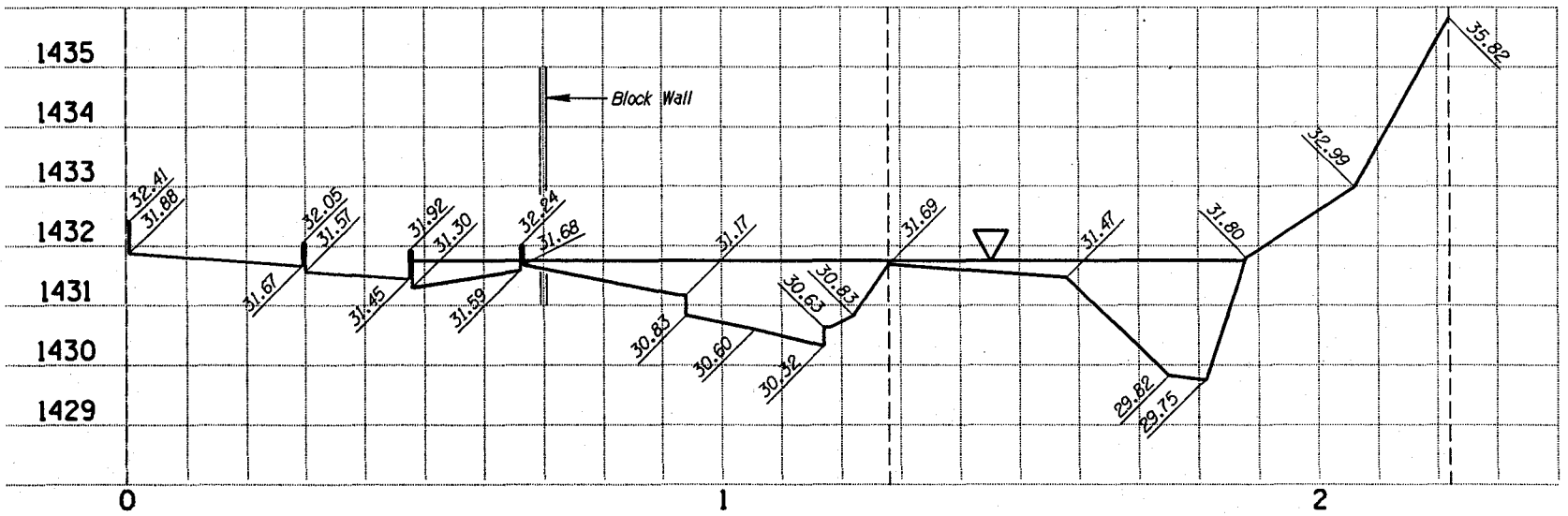
Amye Belle Drive Lateral

DIVERT @ 16th Way and Michigan

Sht: DV-2
Job #: 93041
By: JVB
Date: 4-22-94

| SECTION 1 | | |
|---|---|---|
| Elevation | Area (S.F.) | Wetted Perimeter |
| 1429.75 | 0 | 0.00' |
| 1430.00 | 0 | 0.00' |
| 1430.25 | 0 | 0.00' |
| 1430.50 | 0.67 | 7.58' |
| 1430.75 | 4.16 | 22.72' |
| 1431.00 | 11.04 | 29.69' |
| 1431.25 | 18.80 | 36.78' |
| 1431.50 | 30.90 | 53.48' |
| 1431.75 | 49.56 | 80.47' |

| SECTION 2 | | |
|---|---|---|
| Elevation | Area (S.F.) | Wetted Perimeter |
| 1429.75 | 0 | 0.00' |
| 1430.00 | 1.56 | 8.75' |
| 1430.25 | 4.17 | 12.23' |
| 1430.50 | 7.63 | 15.71' |
| 1430.75 | 11.95 | 19.18' |
| 1431.00 | 17.13 | 22.66' |
| 1431.25 | 23.17 | 26.14' |
| 1431.50 | 30.06 | 29.61' |
| 1431.75 | 42.50 | 60.26' |




Cross Section 1
S=0.0135'/ft
n=0.025

Cross Section 2
S=0.0080'/ft
n=0.035

LOOKING DOWNSTREAM

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PHOENIX, ARIZONA 85017

Campobello Drive Lateral

DIVERT @ 16th Way and Michigan
'n' Values

Sht: DV-3
Job# 93041
By: JVB
Date: 4-22-94
Chkd: KJS
Date: 5-2-94

XSECTION 1

78 LF PVMT @ n = 0.015
52 LF GROSS @ n = 0.035

130 LF

$$n \text{ weighted} = \frac{78(0.015) + 52(0.035)}{130} = \underline{\underline{0.023}} \longleftarrow \text{USE}$$

$$\text{Slope} = \frac{30.60 - 29.83}{56'} = \underline{\underline{0.0138}}\ '/ft$$

X SECTION 2

$n = \underline{\underline{0.035}} \longleftarrow$ USE

$$\text{Slope} = \frac{29.79 - 29.15}{80} = \underline{\underline{0.0080}}\ '/ft$$

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3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: DV-4
By: JVB
Date: 4/28/94

Project: Campo Bello Drive Lateral
DIVERT @ 16th Way and Michigan
Cross Section 1

Chkd: KJS
Date: 5-2-94

Job No. 93041

**Stage vs. Flow Rate**

Manning's Coefficient, n = 0.025
Channel Slope, S = 0.0135

| Water Surface Elev. | Channel X-Slope Area | P wet | Q cfs | V ft/s |
|---|---|---|---|---|
| 29.75 | 0 | 0 | ERR | ERR |
| 30.00 | 0 | 0 | ERR | ERR |
| 30.25 | 0 | 0 | ERR | ERR |
| 30.50 | 0.7 | 7.6 | 0.99 | 1.41 |
| 30.75 | 4.2 | 22.7 | 9.42 | 2.24 |
| 31.00 | 11 | 29.7 | 39.18 | 3.56 |
| 31.25 | 18.8 | 36.8 | 82.97 | 4.41 |
| 31.50 | 30.9 | 53.5 | 148.00 | 4.79 |
| 31.75 | 49.6 | 80.5 | 248.04 | 5.00 |
| | | | | |
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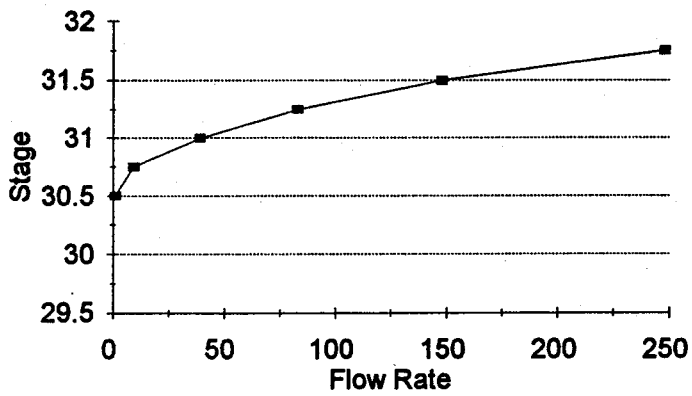
| | | | | |
| | | | | |

# RATING CURVE




RATING1 - 3/10/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: DV-5
By: JVB
Date: 4/28/94

Project: Campo Bello Drive Lateral
DIVERT @ 16th Way and Michigan
Cross Section 2

Chkd: KJS
Date: 5-2-94

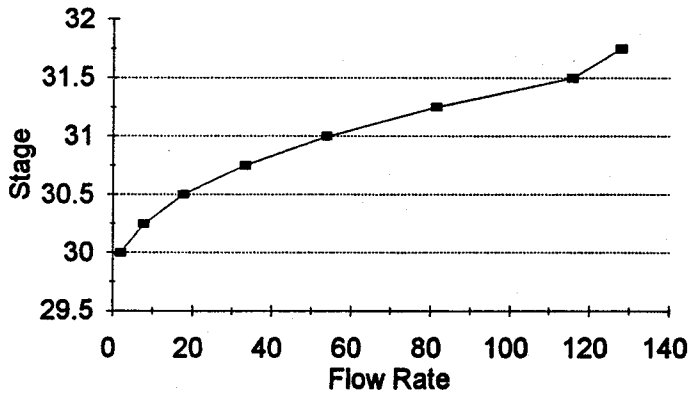
Job No. 93041

**Stage vs. Flow Rate**

Manning's Coefficient, n = 0.035
Channel Slope, S = 0.008

| Water Surface Elev. | Channel X-Slope Area | P wet | Q cfs | V ft/s |
|---|---|---|---|---|
| 29.75 | 0 | 0 | ERR | ERR |
| 30.00 | 1.6 | 8.8 | 1.95 | 1.22 |
| 30.25 | 4.2 | 12.2 | 7.83 | 1.87 |
| 30.50 | 7.6 | 15.7 | 17.79 | 2.34 |
| 30.75 | 12 | 19.2 | 33.31 | 2.78 |
| 31.00 | 17.1 | 22.7 | 53.76 | 3.14 |
| 31.25 | 23.2 | 26.1 | 81.45 | 3.51 |
| 31.50 | 30.1 | 29.6 | 115.59 | 3.84 |
| 31.75 | 42.5 | 60.3 | 127.82 | 3.01 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# RATING CURVE




RATING1 - 3/10/94

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CONSULTANTS, LTD.
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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

Diverted flow @ NODE #10.

Sht: DV-6
Job# 93041
By: K. SHORT
Date: 5-4-94
Chkd: JVB
Date: 5-4-94

The storm flow that travels thru the southern portion of sub areas 9 and 10 is decreased by two routes. The first of which is a 1 ft by 6 foot hole in the block wall boardering basin 10 to the south.

With the existing conditions water flow will accumulate in a pool directly in front of the relief hole in the block wall. Once this water level reaches a depth of around 1 foot it may flow to the west over a small berm.

The flow thru this hole was conservatively calculated by use of the oriface equation.

$q = 3H^{3/2}$ $\qquad$ $q = Q/B$

$Q = 3BH^{3/2}$
$= 3 \times 6 \times 1^{3/2}$
$= \underline{18 \text{ CFS}}$

The second route of flow diversion is thru the existing 2 year storm catch basins at 16th St. and Campo Bello Drive. These catch basins were used in calculating diverted flow due to the fact that flow was routed directely over these catch basins.

Again conservative calculations were done in determining the flow into these catch basins. The streets were only considered to be flowing full to the top of the gutters, and the basins were assumed to be clogged according to City of Phoenix Design standards.

These flows were 23 CFS, 8 CFS, and 15 CFS.

Therefore, the total flow diverted at Node 10:

18
23
8
15
64 CFS

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Phoenix, Arizona 85017

Sheet: DV-7
By: KJS
Date: 07/20/94

Project: Campo Bello Drive Lateral
16th St. & Campo Bello Dr. (West side of 16th)

Chkd: JVB
Date: 07/20/94

Existing Catch Basin
Type "M"

Sump Cond

| | | |
|---|---|---|
| Qa = | 220 | CFS |
| Length of curb opening = | 20 | FT |
| Height of curb opening = | 0.5 | FT |
| Depth @ curb(w/o depression) = | 0.5 | FT |
| Depth of depression = | 0.17 | FT |
| Width of depression = | 20 | FT |
| Depth at lip of curb opening, di = | 0.67 | |
| Effective head on center of oriface throat, do = | 0.46 | FT |

Operating as weir.

Flow into inlet, Q = 45.54 CFS

Flow used, Q = 22.77 CFS -> 50% Clogging Factor

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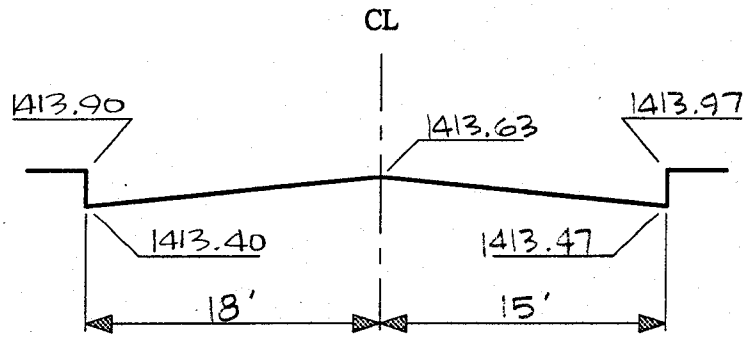
Sheet: DV-8
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral
CAMPO BELLO DRIVE & 16TH ST.

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = EXIST. CAMPO-SOUTH
Inlet Type = M-1, L=17'




LOOKING EAST

Street Slope = 0.0050

Water Elev = 1413.90
Area = 5.25
Wetted P = 15.43
Gutter Depth = 0.43
Qtot = N/A
Qa = 17.9 cfs

Qa/La = 0.31

$$La = \frac{17.9}{0.31} = 57.7$$

$$L/La = \frac{20}{57.7} = 0.35$$

Q/Qa = 0.54

$$Q = 0.8 \times 0.54 \times 17.9 = 7.7 \text{ cfs}$$

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

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Phoenix, Arizona 85017

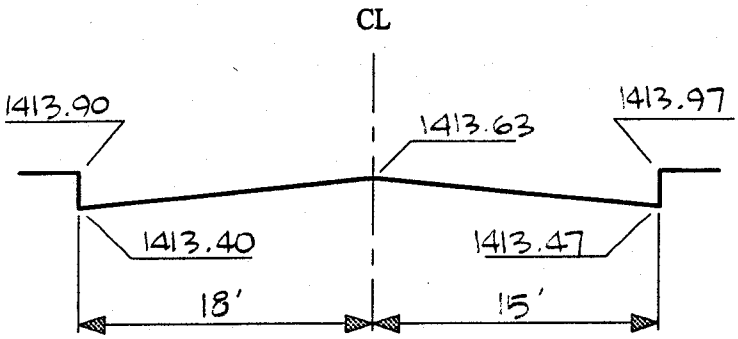
Sheet: DV-9
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral
CAMPO BELLO DRIVE & 16TH ST.

Chkd: JVB
Date: 07/07/94

Job No. 93041

EXIST.
Inlet Number = CAMPO - NORTH
Inlet Type = M-2, L = 17'




LOOKING EAST

Street Slope = 0.0050

Water Elev = 1413.90
Area = 6.93
Wetted P = 18.5
Gutter Depth = 0.5
Qtot = N/A
Qa = 25.2 cfs

Qa/La = 0.37

$$La = \frac{25.2}{0.37} = 68.1$$

$$L/La = \frac{37}{68.1} = 0.54$$

Q/Qa = 0.75

Q = 0.8 × 0.75 × 25.2 = 15.1 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

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Phoenix, Arizona 85017

Project: Campo Bello Drive Lateral

Flood Control District of Maricopa County

Rev:

Chkd: LMM

Date: 11/18/94

Sheet: HP - 1

By: KJS

Date: 11/18/94

## CIRCULAR PIPE

| Station | Dist. (ft) | Q (cfs) | Pipe Dia. (ft) | Area (sq-ft) | Velocity (fps) | Velocity Head | Ground Elev | Invert Elev | Soffit Elev | Wall Thick (in) | T/Pipe Elev | HGL Elev | EGL Elev | Cover Over Pipe | Cover Over HGL | Hydro Head | Slope of Pipe ('/ft) | SF ('/ft) | Slope of HGL ('/ft) | HL (ft) | Add. HL (ft) | Flowing Full? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1017.21 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1394.30 | 1378.40 | 1387.40 | 10 | 1388.23 | 1389.35 | 1392.71 | 6.07 | 4.95 | 10.95 | --- | --- | --- | --- | --- | --- |
| 1087.90 | 70.69 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1394.45 | 1378.44 | 1387.44 | 10 | 1388.27 | 1390.36 | 1393.72 | 6.18 | 4.09 | 11.92 | 0.0005 | 0.0048 | 0.0143 | 0.3384 | 0.67 | Yes |
| 1062.21 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1394.45 | 1378.44 | 1387.44 | 10 | 1388.27 | 1390.36 | 1393.72 | 6.18 | 4.09 | 11.92 | --- | --- | --- | --- | | --- |
| 1523.69 | 461.48 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1395.40 | 1378.68 | 1387.68 | 10 | 1388.51 | 1392.57 | 1395.93 | 6.89 | 2.83 | 13.89 | 0.0005 | 0.0048 | 0.0048 | 2.2094 | | Yes |
| 1523.69 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1395.40 | 1378.68 | 1387.68 | 10 | 1388.51 | 1392.57 | 1395.93 | 6.89 | 2.83 | 13.89 | --- | --- | --- | --- | | --- |
| 1624.75 | 101.06 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1395.67 | 1378.73 | 1387.73 | 10 | 1388.56 | 1393.08 | 1396.44 | 7.11 | 2.59 | 14.35 | 0.0005 | 0.0048 | 0.0051 | 0.4838 | 0.03 | Yes |
| 1624.50 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1395.67 | 1378.73 | 1387.73 | 10 | 1388.56 | 1393.08 | 1396.44 | 7.11 | 2.59 | 14.35 | --- | --- | --- | --- | | --- |
| 1725.56 | 101.06 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1395.82 | 1378.78 | 1387.78 | 10 | 1388.61 | 1393.60 | 1396.96 | 7.21 | 2.22 | 14.82 | 0.0005 | 0.0048 | 0.0051 | 0.4838 | 0.03 | Yes |
| 1725.32 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1395.82 | 1378.78 | 1387.78 | 10 | 1388.61 | 1393.60 | 1396.96 | 7.21 | 2.22 | 14.82 | --- | --- | --- | --- | | --- |
| 2230.00 | 504.68 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1397.01 | 1379.03 | 1388.03 | 10 | 1388.86 | 1396.01 | 1399.37 | 8.15 | 1.00 | 16.98 | 0.0005 | 0.0048 | 0.0048 | 2.4163 | | Yes |
| 2230.00 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1397.01 | 1379.03 | 1388.03 | 10 | 1388.86 | 1396.01 | 1399.37 | 8.15 | 1.00 | 16.98 | --- | --- | --- | --- | | --- |
| 2234.60 | 4.6 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1397.02 | 1379.03 | 1388.03 | 10 | 1388.86 | 1396.03 | 1399.40 | 8.16 | 0.99 | 17.00 | 0.0005 | 0.0048 | 0.0048 | 0.0220 | | Yes |
| 2234.60 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1397.02 | 1379.03 | 1388.03 | 10 | 1388.86 | 1396.03 | 1399.40 | 8.16 | 0.99 | 17.00 | --- | --- | --- | --- | | --- |
| 2312.94 | 78.34 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1397.33 | 1379.07 | 1388.07 | 10 | 1388.90 | 1397.01 | 1400.37 | 8.43 | 0.32 | 17.94 | 0.0005 | 0.0048 | 0.0124 | 0.3751 | 0.6 | Yes |

Notes: n = 0.012

* When conduit is not flowing full, then soffit elevation assumed to be HGL elevation (ie: conservative).

**PROJECT ENGINEERING CONSULTANTS, LTD.**

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Phoenix, Arizona 85017

Project: Campo Bello Drive Lateral

Flood Control District of Maricopa County

Rev:

Chkd: LMM

Date: 11/18/94

Sheet: HP - 2

By: KJS

Date: 11/18/94

## CIRCULAR PIPE

| Station | Dist. (ft) | Q (cfs) | Pipe Dia. (ft) | Area (sq-ft) | Velocity (fps) | Velocity Head | Ground Elev | Invert Elev | Soffit Elev | Wall Thick (in) | T/Pipe Elev | HGL Elev | EGL Elev | Cover Over Pipe | Cover Over HGL | Hydro Head | Slope of Pipe ('/ft) | SF ('/ft) | Slope of HGL ('/ft) | HL (ft) | Add. HL (ft) | Flowing Full? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2329.22 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1397.55 | 1379.07 | 1388.07 | 10 | 1388.90 | 1397.01 | 1400.37 | 8.65 | 0.54 | 17.94 | --- | --- | --- | --- | --- | --- |
| 2900.00 | 570.78 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1401.83 | 1384.21 | 1393.21 | 10 | 1394.04 | 1399.74 | 1403.10 | 7.79 | 2.09 | 15.53 | 0.0090 | 0.0048 | 0.0048 | 2.7327 | | Yes |
| 2900.00 | 0 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1401.83 | 1384.21 | 1393.21 | 10 | 1394.04 | 1399.74 | 1403.10 | 7.79 | 2.09 | 15.53 | --- | --- | --- | --- | | --- |
| 3540.00 | 640 | 936 | 9 | 63.62 | 14.7 | 3.36 | 1408.94 | 1389.97 | 1398.97 | 10 | 1399.80 | 1402.81 | 1406.17 | 9.14 | 6.13 | 12.84 | 0.0090 | 0.0048 | 0.0048 | 3.0641 | | Yes |
| 3540.00 | 0 | 906 | 9 | 63.62 | 14.2 | 3.15 | 1408.94 | 1389.97 | 1398.97 | 10 | 1399.80 | 1402.81 | 1405.96 | 9.14 | 6.13 | 12.84 | --- | --- | --- | --- | | --- |
| 4180.00 | 640 | 906 | 9 | 63.62 | 14.2 | 3.15 | 1413.26 | 1395.73 | 1404.73 | 10 | 1405.56 | 1405.68 | 1408.83 | 7.70 | 7.58 | 9.95 | 0.0090 | 0.0045 | 0.0045 | 2.8709 | | Yes |
| 4180.00 | 0 | 906 | 9 | 63.62 | 14.2 | 3.15 | 1413.26 | 1395.73 | 1404.73 | 10 | 1405.56 | 1405.68 | 1408.83 | 7.70 | 7.58 | 9.95 | --- | --- | --- | --- | | --- |
| 4840.00 | 660 | 906 | 9 | 63.62 | 14.2 | 3.15 | 1416.31 | 1399.03 | 1408.03 | 10 | 1408.86 | 1408.64 | 1411.79 | 7.45 | 7.67 | 9.61 | 0.0050 | 0.0045 | 0.0045 | 2.9606 | | Yes |
| 4840.00 | 0 | 906 | 8 | 50.27 | 18.0 | 5.04 | 1416.31 | 1400.03 | 1408.03 | 9 | 1408.78 | 1408.86 | 1413.90 | 7.53 | 7.45 | 8.83 | --- | --- | --- | --- | 0.22 | --- |
| 4856.94 | 16.94 | 906 | 8 | 50.27 | 18.0 | 5.04 | 1416.39 | 1400.15 | 1408.15 | 9 | 1408.90 | 1409.00 | 1414.05 | 7.49 | 7.39 | 8.85 | 0.0070 | 0.0084 | 0.0084 | 0.1424 | | Yes |
| 4856.65 | 0 | 906 | 8 | 50.27 | 18.0 | 5.04 | 1416.39 | 1400.15 | 1408.15 | 9 | 1408.90 | 1409.00 | 1414.05 | 7.49 | 7.39 | 8.85 | --- | --- | --- | --- | | --- |
| 4946.10 | 89.45 | 906 | 8 | 50.27 | 18.0 | 5.04 | 1416.84 | 1400.73 | 1408.73 | 9 | 1409.48 | 1410.20 | 1415.25 | 7.36 | 6.64 | 9.47 | 0.0070 | 0.0084 | 0.0134 | 0.7520 | 0.45 | Yes |
| 4943.50 | 0 | 906 | 8 | 50.27 | 18.0 | 5.04 | 1416.84 | 1400.73 | 1408.73 | 9 | 1409.48 | 1410.20 | 1415.25 | 7.36 | 6.64 | 9.47 | --- | --- | --- | --- | | --- |
| 5032.37 | 88.87 | 906 | 8 | 50.27 | 18.0 | 5.04 | 1417.10 | 1401.37 | 1409.37 | 9 | 1410.12 | 1411.40 | 1416.44 | 6.98 | 5.70 | 10.03 | 0.0070 | 0.0084 | 0.0135 | 0.7471 | 0.45 | Yes |

Notes: n = 0.012

* When conduit is not flowing full, then soffit elevation assumed to be HGL elevation (ie: conservative).

**PROJECT ENGINEERING CONSULTANTS, LTD.**

3130 N. 35th Avenue, Suite 1

Phoenix, Arizona 85017

Project: Campo Bello Drive Lateral

Flood Control District of Maricopa County

Rev:

Chkd: LMM

Date: 11/18/94

Sheet: HP - 3

By: KJS

Date: 11/18/94

CIRCULAR PIPE

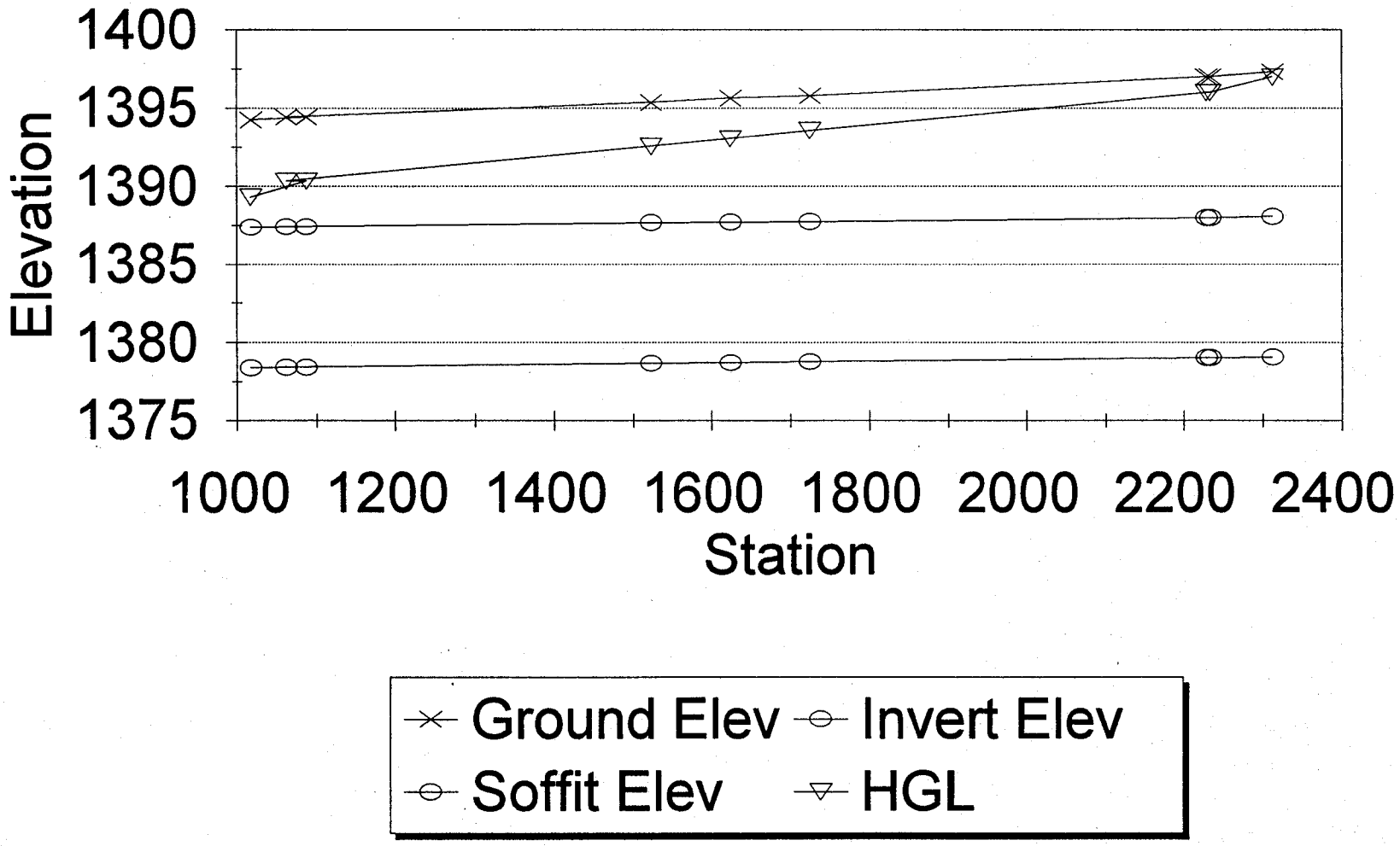
| Station | Dist. (ft) | Q (cfs) | Pipe Dia. (ft) | Area (sq-ft) | Velocity (fps) | Velocity Head | Ground Elev | Invert Elev | Soffit Elev | Wall Thick (in) | T/Pipe Elev | HGL Elev | EGL Elev | Cover Over Pipe | Cover Over HGL | Hydro Head | Slope of Pipe ('/ft) | SF ('/ft) | Slope of HGL ('/ft) | HL (ft) | Add. HL (ft) | Flowing Full? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5029.47 | 0 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1417.10 | 1401.37 | 1409.37 | 9 | 1410.12 | 1411.40 | 1415.43 | 6.98 | 5.7 | 10.03 | --- | --- | --- | --- | --- | --- |
| 5045.00 | 15.53 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1416.84 | 1401.47 | 1409.47 | 9 | 1410.22 | 1411.50 | 1415.54 | 6.62 | 5.34 | 10.03 | 0.0070 | 0.0067 | 0.0067 | 0.1044 | | Yes |
| 5045.00 | 0 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1416.84 | 1401.47 | 1409.47 | 9 | 1410.22 | 1411.50 | 1415.54 | 6.62 | 5.34 | 10.03 | --- | --- | --- | --- | | --- |
| 5360.00 | 315 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1418.82 | 1403.67 | 1411.67 | 9 | 1412.42 | 1413.62 | 1417.65 | 6.40 | 5.20 | 9.95 | 0.0070 | 0.0067 | 0.0067 | 2.1168 | | Yes |
| 5360.00 | 0 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1418.82 | 1403.67 | 1411.67 | 9 | 1412.42 | 1413.62 | 1417.65 | 6.40 | 5.20 | 9.95 | --- | --- | --- | --- | | --- |
| 5744.96 | 384.96 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1420.90 | 1404.82 | 1412.82 | 9 | 1413.57 | 1416.21 | 1420.24 | 7.33 | 4.69 | 11.39 | 0.0030 | 0.0067 | 0.0067 | 2.5869 | | Yes |
| 5744.96 | 0 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1420.90 | 1404.82 | 1412.82 | 9 | 1413.57 | 1416.21 | 1420.24 | 7.33 | 4.69 | 11.39 | --- | --- | --- | --- | | --- |
| 5822.44 | 77.48 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1421.00 | 1405.06 | 1413.06 | 9 | 1413.81 | 1416.81 | 1420.84 | 7.19 | 4.19 | 11.75 | 0.0030 | 0.0067 | 0.0078 | 0.5207 | 0.08 | Yes |
| 5822.37 | 0 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1421.00 | 1405.06 | 1413.06 | 9 | 1413.81 | 1416.81 | 1420.84 | 7.19 | 4.19 | 11.75 | --- | --- | --- | --- | | --- |
| 5896.09 | 73.72 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1421.14 | 1405.28 | 1413.28 | 9 | 1414.03 | 1417.38 | 1421.42 | 7.11 | 3.76 | 12.10 | 0.0030 | 0.0067 | 0.0078 | 0.4954 | 0.08 | Yes |
| 5896.00 | 0 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1421.14 | 1405.28 | 1413.28 | 9 | 1414.03 | 1417.38 | 1421.42 | 7.11 | 3.76 | 12.10 | --- | --- | --- | --- | | --- |
| 5899.76 | 3.76 | 810 | 8 | 50.27 | 16.1 | 4.03 | 1422.45 | 1405.29 | 1413.29 | 9 | 1414.04 | 1417.41 | 1421.44 | 8.41 | 5.04 | 12.12 | 0.0030 | 0.0067 | 0.0067 | 0.0253 | | Yes |
| 5899.76 | 0 | 365 | 7 | 38.48 | 9.5 | 1.40 | 1422.45 | 1405.29 | 1412.29 | 8 | 1412.96 | 1417.49 | 1418.89 | 9.49 | 4.96 | 12.20 | --- | --- | --- | --- | 0.08 | --- |
| 6208.00 | 308.24 | 365 | 7 | 38.48 | 9.5 | 1.40 | 1423.72 | 1406.21 | 1413.21 | 8 | 1413.88 | 1418.35 | 1419.74 | 9.84 | 5.37 | 12.14 | 0.0030 | 0.0028 | 0.0028 | 0.8574 | | Yes |

Notes: n = 0.012

* When conduit is not flowing full, then soffit elevation assumed to be HGL elevation (ie: conservative).

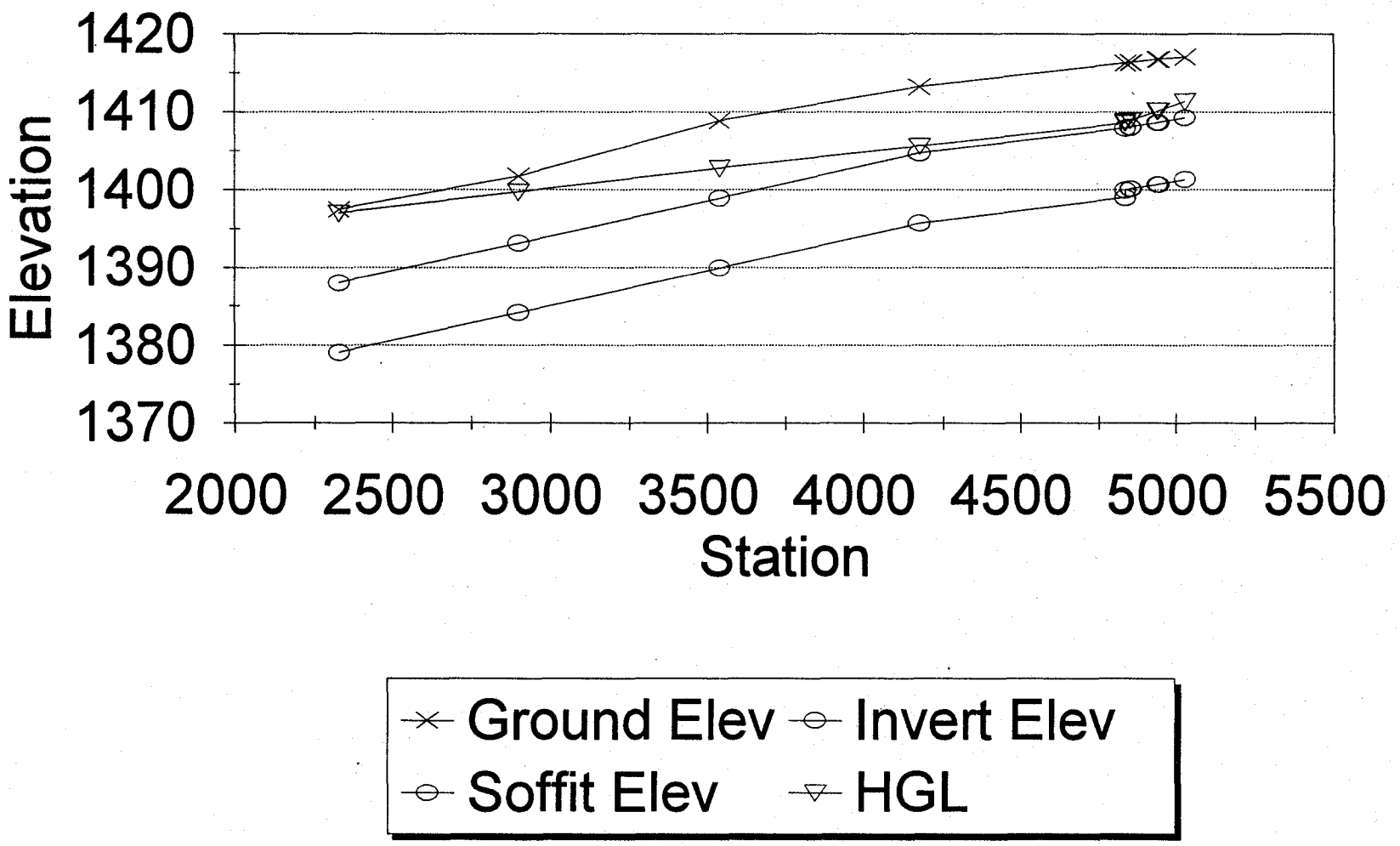
# Campo Bello Drive Lateral

## Graph of Hydraulic Properties



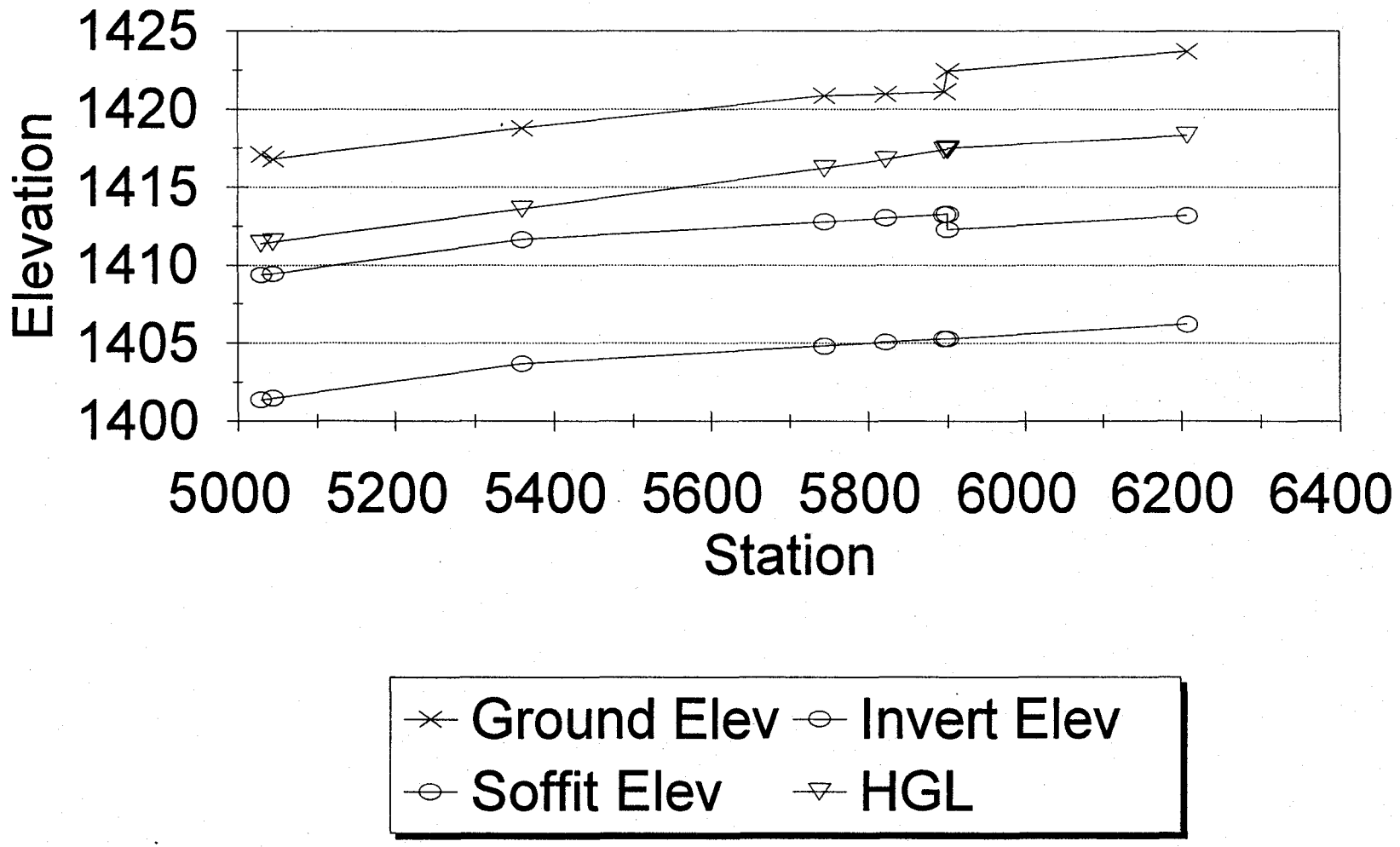
# Campo Bello Drive Lateral

## Graph of Hydraulic Properties



# Campo Bello Drive Lateral

## Graph of Hydraulic Properties



PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL
OUTLET INTO BASIN #5
HEAD LOSS

Sht: HL-1
Job# 93041
By: K. Short
Date: 4-26-94
Chkd: JVB
Date: 5-2-94

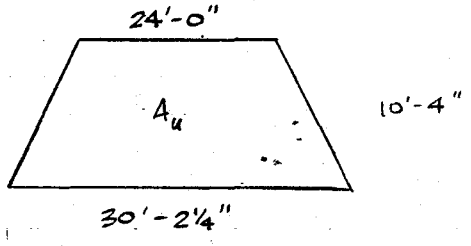
FROM THE MARICOPA COUNTY DRAINAGE DESIGN MANUAL

HEAD LOSS FOR TRASH RACKS : (pg. 4-94)

$$H_g = \left(\frac{2w + x}{x}\right)^{4/3} K_g \left[ V_u^2 / 2g \right] \sin \theta_g$$

$w$ = max. cross-sectional width of bars facing the flow, ft
$x$ = min. clear spacing between bars, ft
$K_g$ = dimensionless bar shape factor, equal to
- 2.42 - sharp edged rectangular bars
- 1.83 - rectangular bars w/ semi-circular upstream face
- 1.79 - circular bars
- 1.67 - rectangular bars w/ semi-circular up & downstream face

$V_u$ = Approach velocity, fps
$g$ = acceleration due to gravity, 32.2 ft/sec²
$\theta_g$ = angle of the grate with respect to the horizonal, degrees




$w = 1$ in $= 0.0833$ ft
$x = 4$ in $= 0.3333$ ft
$K_g = 1.79$
* $V_u = \frac{Q}{A_u} = \frac{936 + 349 - 64 - 1}{279.9} = 4.36$ cfs
$\theta_g = \sin(5.85/10.53) = 34.49°$

$$H_g = \left(\frac{2(0.0833) + 0.3333}{0.3333}\right)^{4/3} 1.79 \left[\frac{4.36^2}{64.4}\right] \sin 34.49°$$

$H_g = 0.51$

* 64 CFS DIVERTED SOUTH
1 CFS THRU 30" PIPE

$H.W.E._{100} = 1388.84$ from NBS Lowry report

$H.G.L. = 1388.84 + 0.51 = 1389.35$

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

HEAD LOSS IN BENDS

Sht: HL-2
Job# 93041
By: K SHORT
Date: 4-21-94
Chkd: JVB
Date: 5-2-94

STATION 10+48.5

DEFLECTION ANGLE, $\alpha$ = 90°
DIAMETER OF PIPE, D = 9'
RADIUS OF BEND, r = 45'

$$\frac{r}{D} = \frac{45}{9} = 5.0$$

FROM FIG. 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

LOSS COEF., $K_b = 0.20$

$$HL = K_b \frac{V^2}{2g} = 0.20 \times \frac{(14.71)^2}{2 \times 32.2} = 0.67$$

STATION 23+12.94

DEFLECTION ANGLE, $\alpha$ = 90°
DIAMETER OF PIPE, D = 9'
RADIUS OF BEND, r = 50'

$$\frac{r}{D} = \frac{50}{9} = 5.6$$

FROM FIG. 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

LOSS COEF., $K_b = 0.18$

$$HL = K_b \frac{V^2}{2g} = 0.18 \times \frac{(14.71)^2}{2 \times 32.2} = 0.60$$

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

HEAD LOSS IN BENDS

Sht: HL-3
Job# 93041
By: K SHORT
Date: 4-21-94
Chkd: JVB
Date: 5-2-94

STATION 16+24.75

DEFLECTION ANGLE, $\alpha = 6.81°$
DIAMETER OF PIPE, $D = 9'$
RADIUS OF BEND, $r = 850'$

$$\frac{r}{D} = \frac{850}{9} = 94.4$$

FROM FIG. 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

LOSS COEF. $K_b = 0.01$

$$HL = K_b \frac{V^2}{2g} = 0.01 \cdot \frac{(14.71)^2}{2 \times 32.2} = 0.03$$

STATION 17+25.56

PARAMETER IDENTICAL TO STATION 16+24.75

$\therefore HL = 0.03$

STATION 49+43.50

DEFLECTION ANGLE, $\alpha = 25.63°$
DIAMETER OF PIPE, $D = 8'$
RADIUS OF BEND, $r = 200'$

$$\frac{r}{D} = \frac{200}{8'} = 25$$

FROM FIG 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

LOSS COEF. $K_b = 0.09$

$$HL = K_b \frac{V^2}{2g} = 0.09 \cdot \frac{(18.02)^2}{2 \times 32.2} = 0.45$$

PROJECT ENGINEERING
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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

HEAD LOSS IN BENDS

Sht: HL-4
Job# 93041
By: K. SHORT
Date: 4-21-94
Chkd: JVB
Date: 5-2-94

STATION 50+29.47

DEFLECTION ANGLE, $\alpha = 25.46°$
DIAMETER OF PIPE, $D = 8'$
RADIUS OF BEND, $r = 200'$

$$\frac{r}{D} = \frac{200}{8} = 25$$

FROM FIG. 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

LOSS COEF. $K_b = 0.09$

$$HL = K_b \frac{V^2}{2g} = 0.09 \frac{(18.02)^2}{2 \times 32.2} = 0.45$$

STATION 58+22.37

DEFLECTION ANGLE, $\alpha = 4.44°$
DIAMETER OF PIPE, $D = 8'$
RADIUS OF BEND, $r = 1000'$

$$\frac{r}{D} = \frac{1000}{8} = 125$$

FROM FIG. 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

LOSS COEF. $K_b = 0.02$

$$HL = K_b \frac{V^2}{2g} = 0.02 \frac{(16.11)^2}{2 \times 32.2} = 0.08$$

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

HEAD LOSS IN BENDS

Sht: HL-5
Job# 93041
By: K. SHORT
Date: 5-19-94
Chkd: JVB
Date: 5-25-94

STATION 58+99.76

DEFLECTION ANGLE, $\alpha = 4.44°$
DIAMETER OF PIPE, $D = 8'$
RADIUS OF BEND, $r = 1000'$

$$\frac{r}{D} = \frac{1000}{8} = 125$$

FROM FIG. 4.16 IN THE MARICOPA COUNTY DESIGN MANUAL

loss coef. $K_b = 0.02$

$$HL = K_b \frac{V^2}{2g} = 0.02 \frac{(16.11)^2}{2 \cdot 32.2} = 0.08$$

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

HEAD LOSS DUE TO EXPANSION

Sht: HL-6
Job# 93041
By: K. SHORT
Date: 5-4-94
Chkd: JVB
Date: 5-4-94

FROM "APPLIED HYDRAULICS IN ENGINEERING", 2ND Ed., pg 109
head loss caused by EXPANSION, AS obtained from the energy equation: (sudden pipe EXPANSION)

$$H_{EXP} = \left[\frac{A}{A_a} - 1\right]^2 \frac{V^2}{2g} = \left[\left(\frac{D}{D_a}\right)^2 - 1\right]^2 \frac{V^2}{2g}$$

A = downstream
$A_a$ = upstream

STATION 48+40.00

8' DIA. TO 9' DIA

$$H_{EXP} = \left[\left(\frac{9}{8}\right)^2 - 1\right]^2 \frac{(14.24)^2}{2 \times 32.2} = 0.22$$

STATION 58+99.76

7' DIA TO 8' DIA

$$H_{EXP} = \left[\left(\frac{8}{7}\right)^2 - 1\right]^2 \frac{(16.11)^2}{2 \times 32.2} = 0.08$$

HL-7

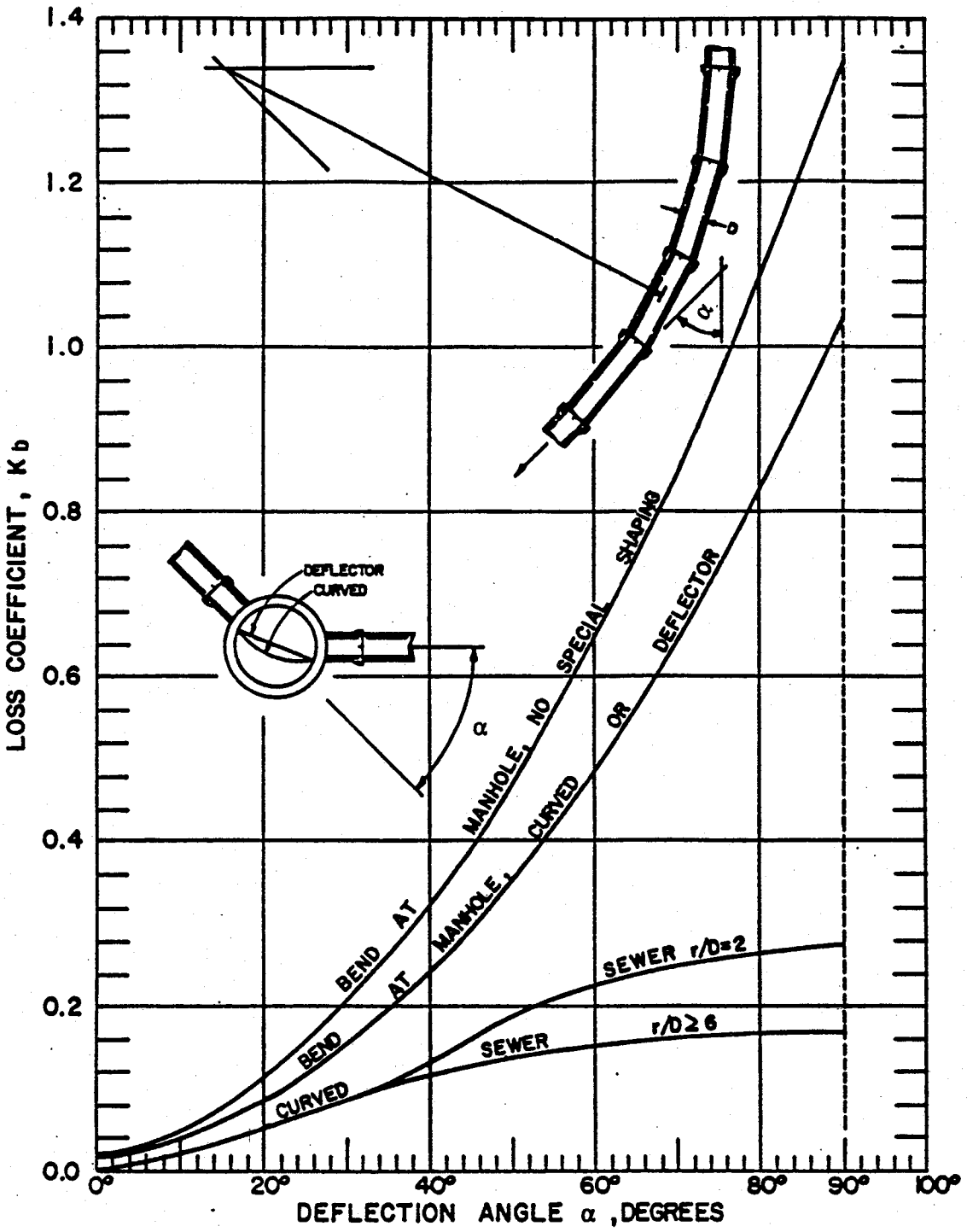


**Figure 4.16**
**Sewer Bend Loss Coefficient**
(University of Missouri 1958)

HL - 8

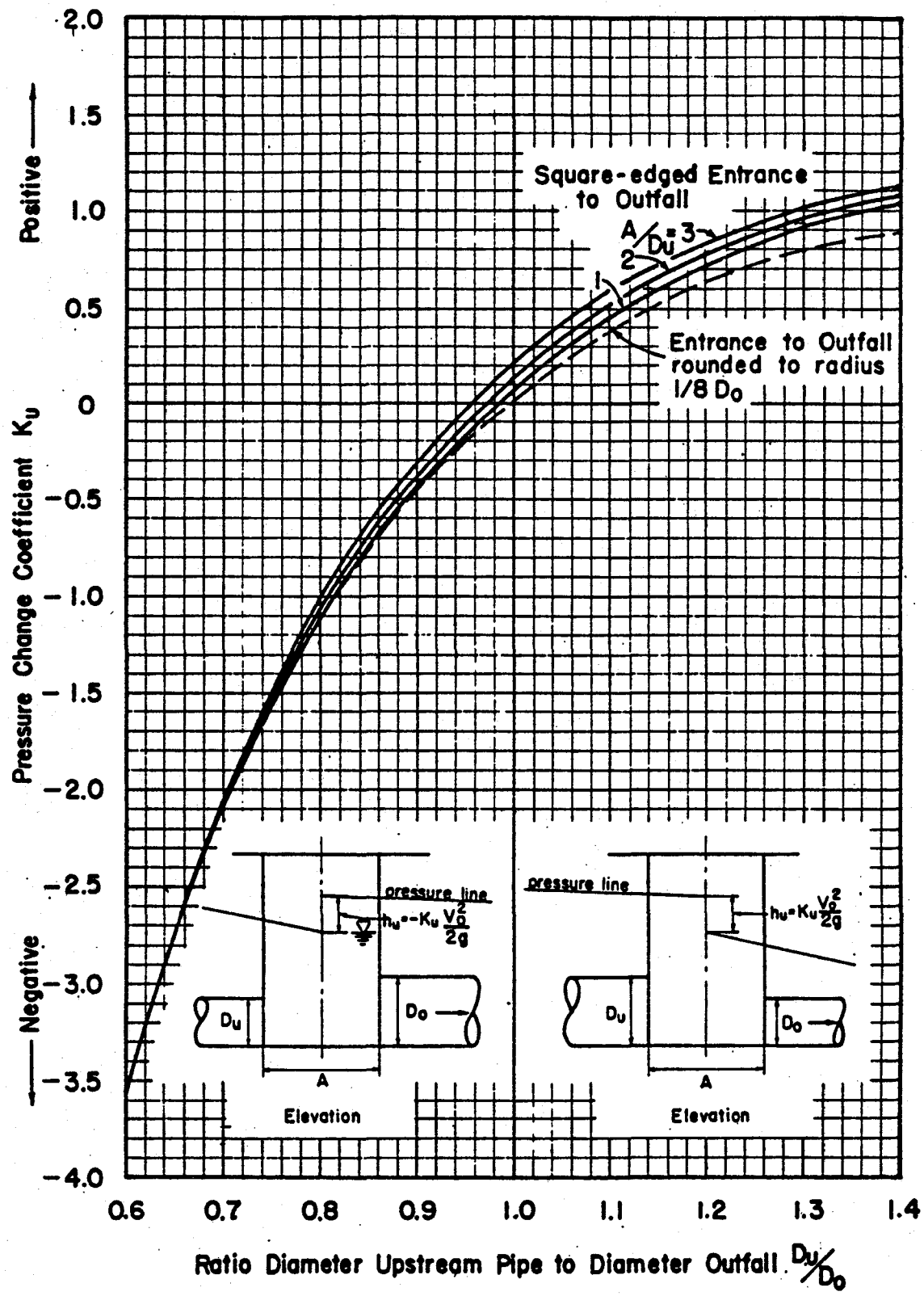


Figure 4.8
Flow Straight Through Any Manhole

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CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

STREET flow determination
– GROVERS AVE

Sht: CH-1
Job#: 93041
By: K. SHORT
Date: 7-15-94
Chkd: JVB
Date: 10-10-94

According to the TR-20 data, a peak flow of 365 cfs will be present at 18TH St. and GROVERS AVE. This flow will proceed to travel West on GROVERS. From survey information, this peak flow will produce a 0.70' depth above the back of the sidewalk to the South at sta 62+47.

Sta 62+47 is where water will need to start weiring over the sidewalk and into our proposed drainage channel.

WEIR EQN. $\frac{Q}{B} = 3H^{3/2}$ B = length of weir
H = depth of water

Due to the fact that the depth of water above the sidewalk is decreasing downstream as water is weired out of the street, trial and error will be utilized on the depth of water.

The control point for water flow in GROVERS AVE is at sta 58+73. According to survey information at this location only 60 cfs can be conveyed down GROVERS AVE without overtopping the bank and flowing into land to the South. Therefore, 305 cfs must be captured in the storm drain before this location.

This will be accomplished by the use of curb inlets at sta 59+70 and grates in sump in our drainage channel.

The curb openings will capture 13.0 cfs each. This leaves 279.0 cfs to be weired into the drainage channel and captured by the grated catch basins.

To prevent the channel from being designed for 279.0 cfs, two sump conditions were placed in the channel, dividing the weir flow.

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

STREET FLOW DETERMINATION
- GROVERS AVE

Sht: CH-2
Job# 93041
By: K SHORT
Date: 7-15-94
Chkd: JVB
Date: 10-10-94

This divider was placed at sta 61+73. Therefore,

$B = 6247 - 6173 = 74$ ft
assume $H = 0.65$ ft

$Q = 3H^{3/2}B = 3(0.65)^{3/2}\,74 = 116$ cfs into Channel 1

This would leave $365 - 116 = 249$ cfs in Grovers Ave. at sta 61+73. From survey information the depth above the back of the sidewalk would then be 0.65 ft. Therefore, our assumption of 0.6 ft is

The remainer of the weir flow is as follows:

$B = 6173 - 5989 = 184$ ft
assume $H = 0.43$ ft

$Q = 3(0.43)^{3/2}\,184 = 156$ cfs into Channel 2

This would leave $249 - 156 = 93$ cfs in Grovers Ave at sta 59+89. From survey information the depth above the back of the sidewalk would then be 0.21 ft. Average depth is 0.43 ft which is our assumption.

The two catch basins at sta 59+70 then get the storm flow down to:

$93 - 13.0 - 13.0 = 67.0$ cfs

This is close enough to the 60 cfs needed, since conservative assumptions were made.

ADOT standard grates LW1 or LB 1.2, have a capacity of 20.6 cfs with a 2.5 ft head. (2.5 feet is the depth of the drainage channel)

Channel 1 needs: $116 \text{ cfs} / 20.6 \text{ cfs/grate} = 6$ grates

Channel 2 needs: $156 \text{ cfs} / 20.6 \text{ cfs/grate} = 8$ grates

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CH-3
By: KJS
Date: 08/03/94

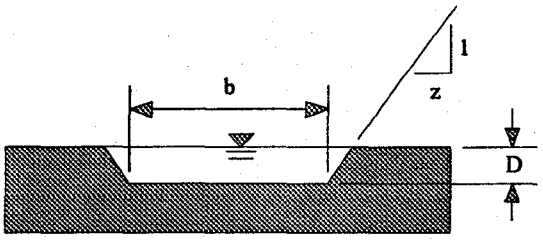
Project: Campo Bello Drive Lateral
17th & GROVERS CHANNEL

Chkd: JVB
Date: 08/03/94

Job No. 93041

Capacity of a Trapezoidal Channel

Diagram:




| | | |
|---|---|---|
| Q-design = | | cfs |
| S = | 0.005 | ft/ft |
| n = | 0.025 | |
| z = | 4 | |
| D = | 2 | ft |
| b = | 8 | ft |

| | | |
|---|---|---|
| A = | 32.00 | ft^2 |
| P = | 24.49 | ft |
| Rh = | 1.31 | ft |
| V = | 5.02 | fps |

Design Equations:

A = bD + z(D^2)
P = b + 2D(1 + z^2)^0.5
Rh = A/P
V = 1.486/n(Rh)^0.667(S)^0.5
Q = VA

Q-cap 161 cfs

Q-cap > Q-design and acceptable velocity for channel to be OK.

Notes:

TRAP1 - 3/11/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CH - 4
By: KJS
Date: 07/12/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/12/94

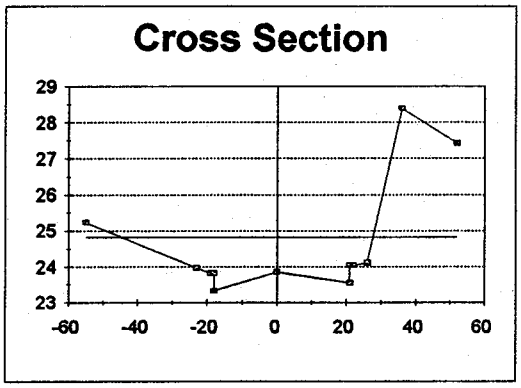
Job No. 93041

Sta = 62+82

Irregular channel
Flow value from
Manning's Eqn.

WSE = 24.815 Slope = 0.0067 n = 0.019

| Dist to CL | Elev | P | A |
|---|---|---|---|
| -55 | 25.24 | | |
| -23 | 23.97 | 21.31 | 9.00 |
| -19 | 23.83 | 4.00 | 3.66 |
| -18 | 23.83 | 1.00 | 0.99 |
| -18 | 23.33 | 0.50 | 0.00 |
| 0 | 23.87 | 18.01 | 21.87 |
| 21 | 23.55 | 21.00 | 23.21 |
| 21 | 24.05 | 0.50 | 0.00 |
| 22 | 24.05 | 1.00 | 0.77 |
| 26 | 24.12 | 4.00 | 2.92 |
| 36 | 28.38 | 1.77 | 0.57 |
| 52 | 27.42 | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 73.10 | 62.97 |




Q = 365 cfs

IRR - 4/28/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CH - 5
By: KJS
Date: 07/15/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/15/94

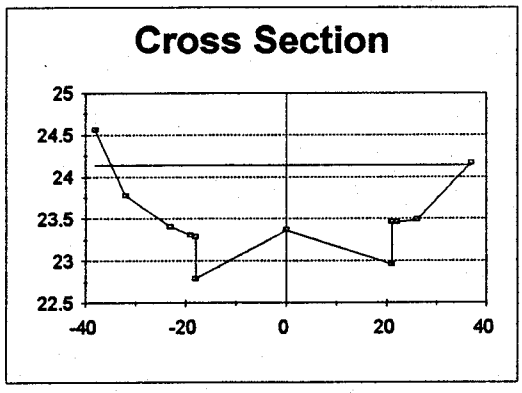
Job No. 93041

Sta = 61+73

Irregular channel
Flow value from
Manning's Eqn.

WSE = 24.14 Slope = 0.0046 n = 0.019

| Dist to CL | Elev | P | A |
|---|---|---|---|
| -38 | 24.56 | | |
| -32 | 23.78 | 2.79 | 0.50 |
| -23 | 23.41 | 9.01 | 4.91 |
| -19 | 23.31 | 4.00 | 3.12 |
| -18 | 23.29 | 1.00 | 0.84 |
| -18 | 22.79 | 0.50 | 0.00 |
| 0 | 23.37 | 18.01 | 19.08 |
| 21 | 22.96 | 21.00 | 20.47 |
| 21 | 23.46 | 0.50 | 0.00 |
| 22 | 23.46 | 1.00 | 0.68 |
| 26 | 23.49 | 4.00 | 2.66 |
| 37 | 24.17 | 10.53 | 3.42 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 72.35 | 55.68 |




Q = 248 cfs

IRR - 4/28/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CH-6
By: KJS
Date: 07/18/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/18/94

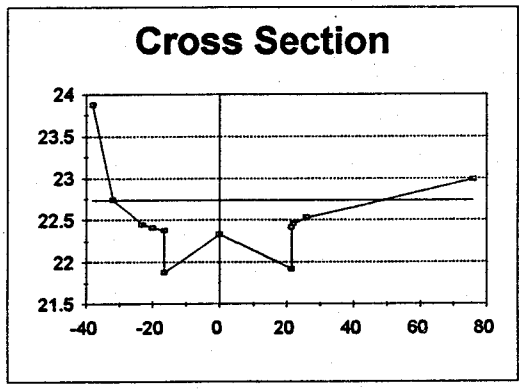
Job No. 93041

Sta = 59+73

Irregular channel
Flow value from
Manning's Eqn.

WSE = 22.74 Slope = 0.0051 n = 0.019

| Dist to CL | Elev | P | A |
|---|---|---|---|
| -38 | 23.87 | | |
| -32 | 22.74 | 0.00 | 0.00 |
| -23 | 22.45 | 9.00 | 1.30 |
| -20 | 22.41 | 3.00 | 0.93 |
| -16.5 | 22.38 | 3.50 | 1.21 |
| -16.5 | 21.88 | 0.50 | 0.00 |
| 0 | 22.33 | 16.51 | 10.48 |
| 21.5 | 21.92 | 21.50 | 13.22 |
| 21.5 | 22.42 | 0.50 | 0.00 |
| 22 | 22.46 | 0.50 | 0.15 |
| 26 | 22.53 | 4.00 | 0.98 |
| 76 | 22.99 | 22.83 | 2.40 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 81.84 | 30.67 |




Q = 89 cfs

IRR - 4/28/94

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CH-7
By: KJS
Date: 07/12/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/12/94

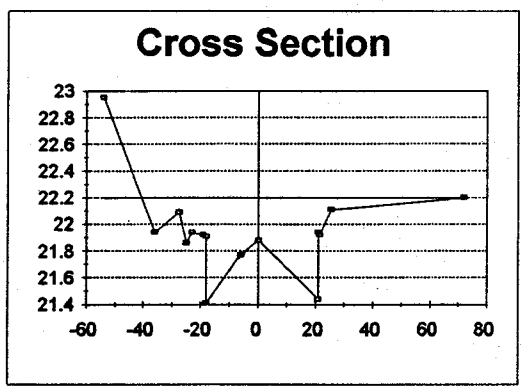
Job No. 93041

Sta = 58+73

Irregular channel
Flow value from
Manning's Eqn.

WSE = 22.2 Slope = 0.0045 n = 0.019

| Dist to CL | Elev | P | A |
|---|---|---|---|
| -54 | 22.95 | | |
| -36 | 21.94 | 4.64 | 0.60 |
| -27.5 | 22.09 | 8.50 | 1.57 |
| -25 | 21.86 | 2.51 | 0.56 |
| -23 | 21.94 | 2.00 | 0.60 |
| -19 | 21.92 | 4.00 | 1.08 |
| -18 | 21.91 | 1.00 | 0.28 |
| -18 | 21.41 | 0.50 | 0.00 |
| -6 | 21.77 | 12.01 | 7.32 |
| 0 | 21.88 | 6.00 | 2.25 |
| 21 | 21.44 | 21.00 | 11.34 |
| 21 | 21.94 | 0.50 | 0.00 |
| 21.5 | 21.92 | 0.50 | 0.13 |
| 25.5 | 22.11 | 4.00 | 0.74 |
| 72 | 22.2 | 46.50 | 2.09 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 0 | 0 |
| | | 113.67 | 28.58 |




Q = 60 cfs

IRR - 4/28/94

PROJECT ENGINEERING CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

DETERMINATION OF MANNING'S 'n' FOR STREET CAPACITY

Sht: CH-8
Job#: 93041
By: K. SHORT
Date: 7-18-94
Chkd: JVB
Date: 10-10-94

STA 62+82

BARE GROUND → 21.3 ft + 1.8 ft = 23.1 ft @ n = 0.025
PAVEMENT → 5.5 ft + 18 ft + 21 ft + 5.5 f = 50 ft @ n = 0.015

$$n_{WEIGHTED} = \frac{23.1(0.025) + 50(0.015)}{23.1 + 50} = 0.018 +$$

USE 0.019

$$SLOPE = \frac{1424.34 - 1423.87}{6352 - 6282} = 0.0065\ ^{\prime}/_{FT}$$

(SLOPE DETERMINED FROM ℄ SURVEY DATA UPSTREAM)

STA 61+73

BARE GROUND → 2.8 ft + 9 ft + 10.5 ft = 22.3 ft @ n = 0.025
PAVEMENT → 5.5 ft + 18 ft + 21 ft + 5.5 ft = 50 ft @ n = 0.015

$$n_{WEIGHTED} = \frac{22.3(0.025) + 50(0.015)}{22.3 + 50} = 0.018 +$$

USE 0.019

$$SLOPE = \frac{1423.87 - 1423.37}{6282 - 6173} = 0.0046\ ^{\prime}/ft$$

(SLOPE DETERMINED FROM ℄ SURVEY DATA UPSTREAM)

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

DETERMINATION OF MANNING'S 'n'
FOR STREET CAPACITY

Sht: CH-9
Job#: 93041
By: K SHORT
Date: 7-18-94
Chkd: JVB
Date: 10-10-94

STA 59+73

BARE GROUND → 9 ft + 22.8 ft = 31.8 ft @ n=0.025
PAVEMENT → 7 ft + 16.5 ft + 21.5 ft + 5 ft = 50 ft @ n=0.015

$$n_{WEIGHTED} = \frac{31.8(0.025) + 50(0.015)}{31.8 + 50} = 0.0189$$

USE 0.019

$$SLOPE = \frac{1422.84 - 1422.33}{6073 - 5973} = 0.0051 \ ^{\prime}/ft$$

(SLOPE DETERMINED FROM ℄ SURVEY DATA UPSTREAM)

STA 58+73

BARE GROUND → 17.6 ft + 46.5 ft = 64.1 ft @ n=0.025
PAVEMENT → 5.5 ft + 12 ft + 6 ft + 21 ft + 5 ft = 49.5 ft @ n=0.015

$$n_{WEIGHTED} = \frac{64.1(0.025) + 49.5(0.015)}{64.1 + 49.5} = 0.0206$$

DUE TO THE FACT THAT MOST OF THE BARE GROUND LENGTH IS OF VERY SHALLOW DEPTH, IT HAS BEEN IGNORED. A MORE CONSISTENT 'n' VALUE WAS USED.

USE 0.019

$$SLOPE = \frac{1422.33 - 1421.88}{5973 - 5873} = 0.0045 \ ^{\prime}/ft$$

(SLOPE DETERMINED FROM ℄ SURVEY DATA UPSTREAM)

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

CATCH BASIN DESIGN

Sht: CB-1
Job# 93041
By: K. SHORT
Date: 7-20-94
Chkd: JVB
Date: 10-10-94

## Catch Basin Methodology

Catch basin locations and sizes were designed to convey the 100-year storm runoff in the right-of-way cross section to the storm drain as quickly and completely as possible in a flow-by condition. The City of Phoenix storm drain design manual was used as the basis for this design.

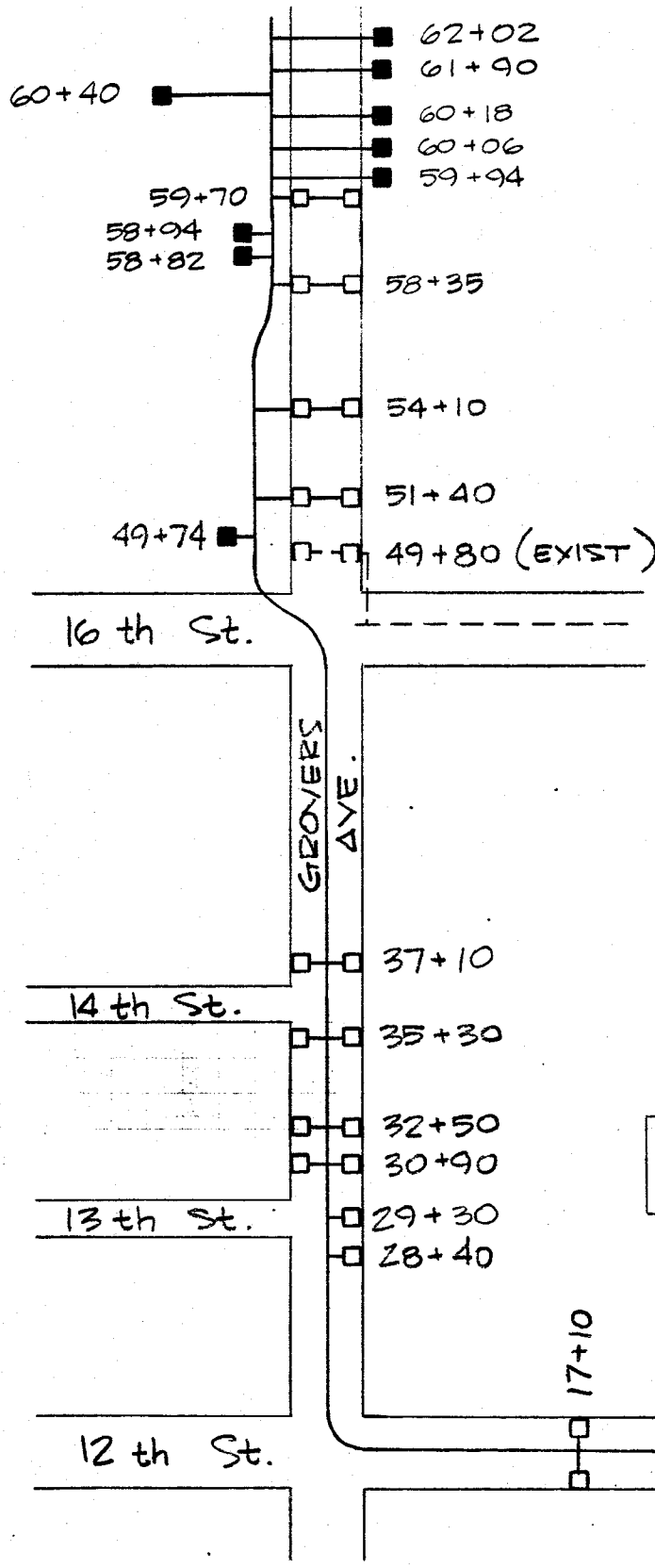
From the TR-20 output, design Q's were determined and water surface elevations were estimated using Mannings' equation. Starting at the upstream end of the storm drain reach at 18th Street and Grovers Avenue, sump-condition catch basins were placed south of Grovers Avenue to collect runoff that is contained within the right-of-way cross section and weirs over the south curb line. Runoff that does not weir over but remains within the pavement cross section is picked up by curb inlets along Grovers Avenue. These catch basins were designed in a flow-by condition, passing flows in excess of their capacity to other catch basins downstream. If the water surface elevations were determined to be above the curb, a gutter depth of 0.5 feet was conservatively assumed. Catch basins were placed until an acceptable flow-by remained which could be collected in the City of Phoenix two-year system.

Additional catch basins in sump conditions were placed north of Grovers Avenue to capture concentrated flows from the north. The Locations of these catch basins were determined by existing contours and flow paths. Capacities were designed for peak flow values in order to collect the entire flow value.

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

# CAMPO BELLO DRIVE LATERAL
## CATCH BASIN LOCATIONS

Sht: CB-2
Job# 93041
By: K. SHORT
Date: 7-20-94
Chkd: JVB
Date: 10-10-94




LEGEND

- CATCH BASIN (CURB INLET)
- CATCH BASIN (SUMP CONDITION)
- CITY OF PHOENIX (2-YR STORM DRAIN)

NORTH
NO SCALE

CATCH BASIN SCHEMATIC DIAGRAM

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-3
By: KJS
Date: 10/10/94

Project: Campo Bello Drive Lateral
summary of catch basins

Chkd: JVB
Date: 10/10/94

Job No. 93041

| Station | Inlet Position | Inlet Type | Req'd Depth | Provided Depth | Req'd Capacity | Provided Capacity | Conn. Pipe Dia. | Conn. Pipe Capacity | Flow By |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| 62+02.00 | Rt | N, 3 grates | 4.92 | 5 | 116 | 55.2 | 36" | 61.28 | 60.8 |
| 61+90.00 | Rt | N, 3 grates | 4.92 | 5 | 60.8 | 55.2 | 36" | 60.78 | 5.6 |
| | | | | | | | | | |
| 60+40.00 | Lt | N, 1 grate | 3.06 | 4 | * | 9.2 | 15" | 16.64 | 0 |
| | | | | | | | | | |
| 60+18.00 | Rt | N, 3 grates | 4.92 | 5 | 156 | 55.2 | 36" | 55.41 | 100.8 |
| 60+06.00 | Rt | N, 3 grates | 4.92 | 5 | 100.8 | 55.2 | 36" | 55.23 | 45.6 |
| 59+94.00 | Rt | N, 3 grates | 4.92 | 5 | 45.6 | 55.2 | 36" | 54.87 | 0 |
| | | | | | | | | | |
| 59+70.00 | Rt | M-2, L=17' | 3.92 | 4 | 93 | 13 | 18" | 17.91 | 80 |
| 59+70.00 | Lt | M-2, L=17' | 6.17 | 8 | 80 | 13 | 27" | 31.77 | 67 |
| | | | | | | | | | |
| 59+20.00 | Lt | Stubout | - | - | 231 | 150.5 | 48" | 150.5 | 80.5 |
| 58+82.00 | Lt | N, 3 grates | 3.32 | 8 | 80.5 | 55.2 | 30" | 45.86 | 34.64 |
| 58+94.00 | Lt | N, 3 grates | 3.32 | 8 | 34.64 | 55.2 | 30" | 45.86 | 0 |
| | | | | | | | | | |
| 58+35.00 | Rt | M-1, L=17' | 3.48 | 4 | 67 | 8.3 | 15" | 13.22 | 58.7 |
| 58+35.00 | Lt | M-1, L=17' | 5.69 | 8 | 58.7 | 8.3 | 21" | 23.97 | 50.4 |
| 54+10.00 | Rt | M-1, L=17' | 3.75 | 4 | 50.4 | 9.3 | 15" | 14.74 | 41.1 |
| 54+10.00 | Lt | M-1, L=17' | 6.91 | 8 | 41.1 | 9.3 | 21" | 25.79 | 31.8 |
| 51+40.00 | Rt | M-1, L=10' | 2.8 | 4 | 31.8 | 5 | 15" | 15.96 | 26.8 |
| 51+40.00 | Lt | M-1, L=10' | 4.68 | 8 | 26.8 | 5 | 15" | 17.40 | 21.8 |
| | | | | | | | | | |
| 49+74.00 | Lt | 10 grates | 6.81 | 8 | 125 | 130 | 48" | 176.36 | 0 |
| | | | | | | | | | |

* Catch basin is added to existing retention area, so there is no required capacity.

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-4
By: KJS
Date: 10/13/94

Project: Campo Bello Drive Lateral
summary of catch basins

Chkd: JVB
Date: 10/13/94

Job No. 93041

| Station | Inlet Position | Inlet Type | Req'd Depth | Provided Depth | Req'd Capacity | Provided Capacity | Conn. Pipe Dia. | Conn. Pipe Capacity | Flow By |
|---|---|---|---|---|---|---|---|---|---|
| 49+80.00 | Rt | M-1, L=10' | ? | ? | 21.8 | 4.5 | ? | ? | 17.3 |
| 49+80.00 | Lt | M-1, L=17' | ? | ? | 17.3 | 6.3 | ? | ? | 11 |
| 37+10.00 | Rt | M-2, L=17' | 4.67 | 8 | 38 | 12.1 | 15" | 17.32 | 25.9 |
| 37+15.00 | Lt | M-2, L=17' | 4.67 | 5 | 25.9 | 12.1 | 15" | 17.13 | 13.8 |
| 35+25.00 | Rt | M-2, L=17' | 4.21 | 8 | 113.8 | 10.8 | 15" | 17.67 | 103 |
| 35+30.00 | Lt | M-2, L=17' | 4.21 | 8 | 103 | 10.8 | 15" | 17.48 | 92.2 |
| 32+50.00 | Rt | M-2, L=17' | 5.44 | 8 | 92.2 | 14 | 15" | 17.04 | 78.2 |
| 32+55.00 | Lt | M-2, L=17' | 5.44 | 8 | 78.2 | 14 | 15" | 16.85 | 64.2 |
| 30+90.00 | Rt | M-2, L=17' | 4.45 | 8 | 64.2 | 11.5 | 15" | 13.58 | 52.7 |
| 30+95.00 | Lt | M-2, L=17' | 4.45 | 8 | 52.7 | 11.5 | 15" | 13.43 | 41.2 |
| 29+30.00 | Rt | M-1, L=17' | 3.25 | 8 | 41.2 | 8.9 | 18" | 11.67 | 32.3 |
| 28+40.00 | Rt | M-2, L=17' | 3.73 | 4 | 32.3 | 15.5 | 24" | 19.64 | 16.8 |
| 17+05.00 | Rt | M-2, L=17' | 3.08 | 4 | 16.8 | 6.6 | 15" | 9.63 | 10.2 |
| 17+10.00 | Lt | M-2, L=17' | 3.08 | 7 | 10.2 | 6.6 | 15" | 9.21 | 3.6 |

Catch Basins at Sta 49+80 is existing, therefore all data is not known or needed.

PROJECT ENGINEERING CONSULTANTS, LTD.

3130 N. 35th Avenue, Suite 1

Phoenix, Arizona 85017

Project: Campo Bello Drive Lateral
Connector Pipe Size
Determination

Rev: _____ Sheet: CB-5
Chkd: JVB By: KJS
Date: 10/13/94 Date: 10/13/94

| Inlet Position | Station | Q (cfs) | HGL Elev. | Top of Curb Elev. | Length (ft.) | Pipe Dia. (in.) | Velocity | Freeboard Elev. | Available Head | Head Loss | Extra Head | Calculated Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rt | 17+10 | 6.6 | 1393.52 | 1396.13 | 23 | 15 | 5.38 | 1394.97 | 1.45 | 0.13 | 1.32 | 9.02 |
| Lt | 17+10 | 6.6 | 1393.52 | 1396.13 | 14 | 15 | 5.38 | 1394.97 | 1.45 | 0.13 | 1.32 | 9.46 |
| Rt | 28+40 | 15.5 | 1399.45 | 1401.54 | 20 | 24 | 4.93 | 1400.38 | 0.93 | 0.11 | 0.82 | 19.37 |
| Lt | 29+30 | 8.9 | 1399.93 | 1402.16 | 19 | 18 | 5.04 | 1401.00 | 1.07 | 0.12 | 0.95 | 11.51 |
| Rt | 30+90 | 11.5 | 1400.65 | 1404.93 | 20 | 15 | 9.37 | 1403.77 | 3.12 | 0.41 | 2.71 | 13.15 |
| Lt | 30+90 | 11.5 | 1400.65 | 1404.93 | 17 | 15 | 9.37 | 1403.77 | 3.12 | 0.41 | 2.71 | 13.36 |
| Rt | 32+50 | 14 | 1401.42 | 1407.45 | 19 | 15 | 11.41 | 1406.29 | 4.87 | 0.61 | 4.26 | 16.57 |
| Lt | 32+50 | 14 | 1401.42 | 1407.45 | 17 | 15 | 11.41 | 1406.29 | 4.87 | 0.61 | 4.26 | 16.75 |
| Rt | 35+30 | 10.8 | 1402.76 | 1408.87 | 20 | 15 | 8.80 | 1407.71 | 4.95 | 0.36 | 4.59 | 17.10 |
| Lt | 35+30 | 10.8 | 1402.76 | 1408.87 | 17 | 15 | 8.80 | 1407.71 | 4.95 | 0.36 | 4.59 | 17.38 |
| Rt | 37+10 | 12.1 | 1403.53 | 1409.55 | 19 | 15 | 9.86 | 1408.39 | 4.86 | 0.45 | 4.41 | 16.85 |
| Lt | 37+10 | 12.1 | 1403.53 | 1409.55 | 18 | 15 | 9.86 | 1408.39 | 4.86 | 0.45 | 4.41 | 16.94 |
| | | | | | | 15 | 0.00 | -1.16 | -1.16 | 0.00 | -1.16 | ERR |
| | | | | | | 15 | 0.00 | -1.16 | -1.16 | 0.00 | -1.16 | ERR |
| | | | | | | 15 | 0.00 | -1.16 | -1.16 | 0.00 | -1.16 | ERR |

Notes:

PROJECT ENGINEERING CONSULTANTS, LTD.

3130 N. 35th Avenue, Suite 1

Phoenix, Arizona 85017

Project: Campo Bello Drive Lateral
Catch Basins in Series
Connector Pipe Design

Rev: _____
Chkd: JVB
Date: 10/10/94

Sheet: CB-6
By: KJS
Date: 10/10/94

| Inlet position | Station | Q in (cfs) | HGL Elev. | Top of Curb Elev. | Length (ft.) | Pipe Dia. (in.) | Velocity | Freeboard Elev. | Available Head | Hyd. Slope S | Head Loss | Extra Head (+) | Calc. Q | Req'd Depth of C.B. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rt | 59+70 | 13 | --- | 1422.44 | 42 | 18 | 7.36 | 1421.28 | 3.60 | 0.0130 | 1.81 | 1.79 | 19.66 | 3.92 |
| Lt | 59+70 | 13 | 1417.68 | 1422.40 | 10 | 27 | 6.54 | 1419.47 | 1.79 | 0.0060 | 1.06 | 0.74 | 37.76 | 6.17 |
| Rt | 58+35 | 8.3 | --- | 1421.83 | 42 | 15 | 6.76 | 1420.67 | 3.76 | 0.0141 | 1.66 | 2.10 | 13.55 | 3.48 |
| Lt | 58+35 | 8.3 | 1416.91 | 1421.84 | 10 | 21 | 6.90 | 1419.01 | 2.10 | 0.0094 | 1.20 | 0.90 | 24.49 | 5.69 |
| Rt | 54+10 | 9.3 | --- | 1419.66 | 42 | 15 | 7.58 | 1418.5 | 4.54 | 0.0177 | 2.08 | 2.46 | 14.87 | 3.75 |
| Lt | 54+10 | 9.3 | 1413.96 | 1420.19 | 14 | 21 | 7.73 | 1416.42 | 2.46 | 0.0117 | 1.56 | 0.90 | 26.06 | 6.91 |
| Rt | 51+40 | 5 | --- | 1418.37 | 42 | 15 | 4.07 | 1417.21 | 5.07 | 0.0051 | 0.60 | 4.47 | 16.07 | 2.80 |
| Lt | 51+40 | 5 | 1412.14 | 1418.49 | 14 | 15 | 8.15 | 1416.61 | 4.47 | 0.0204 | 1.83 | 2.64 | 17.44 | 4.68 |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

Notes:

PROJECT ENGINEERING CONSULTANTS, LTD.

3130 N. 35th Avenue, Suite 1

Phoenix, Arizona 85017

Project: Campo Bello Drive Lateral
Connector Pipe Sizing
Catch Basins in Sump

Rev: _____ Sheet: CB-7
Chkd: JVB By: KJS
Date: 10/10/94 Date: 10/10/94

| Inlet Number | Station | Q (cfs) | HGL Elev. | Top of Grate Elev. | Length (ft.) | Pipe Dia. (in.) | Velocity | Freeboard Elev. | Available Head | Head Loss | Extra Head | Calculated Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 * | 62+02 | 55.2 | 1418.33 | 1421.15 | 71 | 36 | 7.81 | 1421.15 | 2.82 | 0.28 | 2.54 | 71.44 |
| 2 * | 61+90 | 55.2 | 1418.30 | 1421.09 | 71 | 36 | 7.81 | 1421.09 | 2.79 | 0.28 | 2.51 | 71.01 |
| 3 | 60+40 | 9.2 | 1417.88 | 1423.80 | 26 | 15 | 7.50 | 1423.30 | 5.42 | 0.26 | 5.16 | 17.59 |
| 4 * | 60+18 | 55.2 | 1418.10 | 1420.18 | 71 | 36 | 7.81 | 1420.18 | 2.08 | 0.28 | 1.80 | 60.12 |
| 5 * | 60+06 | 55.2 | 1418.06 | 1420.13 | 71 | 36 | 7.81 | 1420.13 | 2.07 | 0.28 | 1.79 | 59.95 |
| 6 * | 59+94 | 55.2 | 1417.75 | 1420.07 | 70 | 36 | 7.81 | 1420.07 | 2.32 | 0.28 | 2.04 | 64.12 |
| 7 | 58+82 | 40.25 | 1417.27 | 1420.00 | 8 | 30 | 8.20 | 1419.50 | 2.23 | 0.31 | 1.92 | 48.66 |
| 8 | 58+94 | 40.25 | 1417.36 | 1420.00 | 8 | 30 | 8.20 | 1419.50 | 2.14 | 0.31 | 1.83 | 47.51 |
| 9 | 49+74 | 125 | 1410.65 | 1415.50 | 24 | 48 | 9.95 | 1415.00 | 4.35 | 0.46 | 3.89 | 174.73 |
| | | | | | | | | | | | | |
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Notes:

* 0.5' freeboard has been omitted due to constricting conditions caused from the 30" waterline

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

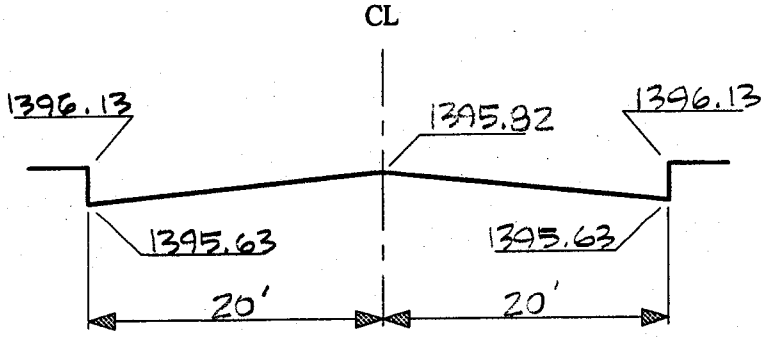
Sheet: CB-8
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 17+10 ± Rt & Lt.
Inlet Type = M-2, L=17'




LOOKING NORTH

Street Slope = 0.0038

Water Elev = 1395.93
Area = 8.2
Wetted P = 40.6
Gutter Depth = 0.30
Qtot = 17.2 cfs *
Qa = 8.6 cfs

* actual flow-by Q = 16.8 cfs
(from summary of C.B. sht.)

Qa/La = 0.21

$$La = \frac{8.6}{0.21} = 41.0$$

$$L/La = \frac{37}{41.0} = 0.90$$

Q/Qa = 0.96

$$Q = 0.8 \times 0.96 \times 8.6 = 6.6 \text{ cfs}$$

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

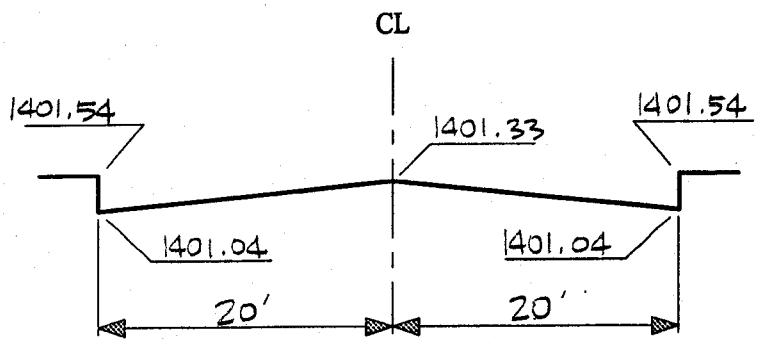
Sheet: CB-9
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 28+40 Rt.
Inlet Type = M-2, L = 17'




LOOKING EAST

Street Slope = 0.0062

Water Elev = 1401.54
Area = 14.2
Wetted P = 41.0
Gutter Depth = 0.5
Qtot = 54.6 cfs
Qa = 27.3 cfs

Qa/La = 0.37

$$La = \frac{27.3}{0.37} = 73.8$$

$$L/La = \frac{37}{73.8} = 0.50$$

Q/Qa = 0.71

Q = 0.8 × 0.71 × 27.3 = 15.5 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

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3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

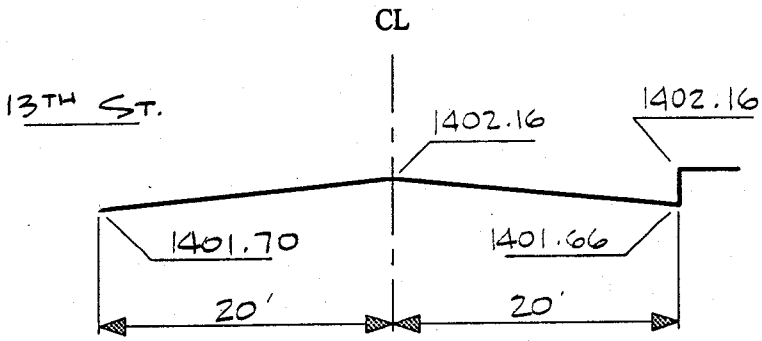
Sheet: CB-10
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 29+30 Rt.
Inlet Type = M-1, L=17'




LOOKING EAST

Street Slope = 0.0086

Water Elev = 1402.16
Area = 5.0
Wetted P = 20.5
Gutter Depth = 0.5
Qtot = N/A
Qa = 17.9 cfs

Qa/La = 0.37

$$La = \frac{17.9}{0.37} = 48.4$$

$$L/La = \frac{20}{48.4} = 0.41$$

Q/Qa = 0.62

Q = 0.8 × 0.62 × 17.9 = 8.9 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

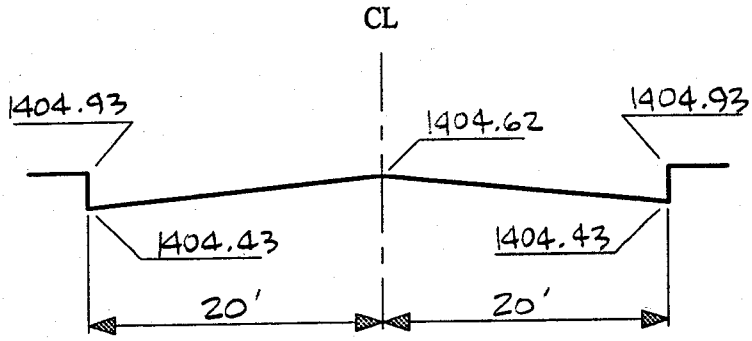
Sheet: CB-11
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 30+90± Rt & Lt.
Inlet Type = M-2, L=17'




LOOKING EAST

Street Slope = 0.0214

Water Elev = 1404.79
Area = 10.6
Wetted P = 40.7
Gutter Depth = 0.36
Qtot = 62.6 cfs *
Qa = 31.3 cfs
actual flow-by Q = 64.2 cfs
(from summary of G.B. sht.)

Qa/La = 0.25

$$La = \frac{31.3}{0.25} = 125.2$$

$$L/La = \frac{37}{125.2} = 0.30$$

Q/Qa = 0.46

Q = 0.8 × 0.46 × 31.3 = 11.5 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

**PROJECT ENGINEERING CONSULTANTS, LTD.**
2130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-12
By: KJS
Date: 07/19/94

Chkd: JVB
Date: 07/19/94

Project: Campo Bello Drive Lateral

Catch Basin Desig
Type "M"

Station 32+50 Rt & Lt

Flow-by Cond

| | | |
|---|---|---|
| Qa = | 20.8 | CFS |
| S = | 0.0116 | '/FT |
| n = | 0.015 | |
| x-Slope = | 0.0305 | '/FT |
| St. Width = | 40 | FT |
| z = | 32.79 | |
| z/n = | 2185.79 | |
| y = | 0.50 | FT |
| Spread = | 16.40 | FT |
| Dry Pvmt. = | 3.59545 | |
| L = | 37 | FT |
| a = | 2 | IN |
| a/y = | 0.33 | |
| Qa/La = | 0.37 | |
| La = | 56.30 | |
| L/La = | 0.66 | |
| Q/Qa = | 0.84 | |
| Q = | 14.03 | (Clogging factor = 0.8) |

Flow-by to next inlet = 6.77 CFS

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Sheet: CB-13
By: KJS
Date: 07/19/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/19/94

Catch Basin Desig
Type "M"

Station 35+30 Rt & Lt

Flow-by Cond

| | | |
|---|---|---|
| Qa = | 13.4 | CFS |
| S = | 0.0038 | '/FT |
| n = | 0.015 | |
| x-Slope = | 0.027 | '/FT |
| St. Width = | 40 | FT |
| z = | 37.04 | |
| z/n = | 2469.14 | |
| y = | 0.50 | FT |
| Spread = | 18.51 | FT |
| Dry Pvmt. = | 1.49384 | |
| L = | 37 | FT |
| a = | 2 | IN |
| a/y = | 0.33 | |
| Qa/La = | 0.37 | |
| La = | 36.33 | |
| L/La = | 1.02 | |
| Q/Qa = | 1.00 | |
| Q = | 10.77 | (Clogging factor = 0.8) |

Flow-by to next inlet = 2.63 CFS

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

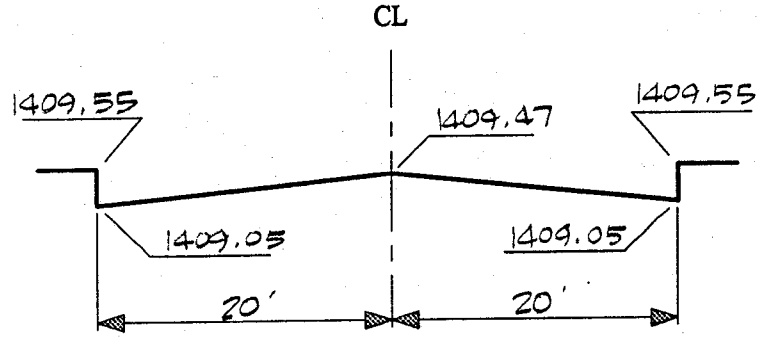
Sheet: CB-14
By: KJS
Date: 07/06/94

Chkd: JVB
Date: 07/07/94

Project: Campo Bello Drive Lateral

Job No. 93041

Inlet Number = 37+10± Rt & Lt
Inlet Type = M-2, L=17'




LOOKING EAST

Street Slope = 0.0040

Water Elev = 1409.55
Area = 11.6
Wetted P = 41.0
Gutter Depth = 0.5
Qtot = 31.3 cfs
Qa = 15.7 cfs

Qa/La = 0.37

$$La = \frac{15.7}{0.37} = 42.4$$

$$L/La = \frac{37}{42.4} = 0.87$$

Q/Qa = 0.96

Q = 0.8 × 0.96 × 15.7 = 12.1 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-15
By: KJS
Date: 07/18/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/18/94

Catch Basin Desig
Type "M"

Station 49+80 Rt

Flow-by Cond

| | | |
|---|---|---|
| Qa = | 10.9 | CFS |
| S = | 0.007 | '/FT |
| n = | 0.015 | |
| x-Slope = | 0.025 | '/FT |
| St. Width = | 40 | FT |
| z = | 40.00 | |
| z/n = | 2666.67 | |
| y = | 0.40 | FT |
| Spread = | 16.03 | FT |
| Dry Pvmt. = | 3.97381 | |
| L = | 13 | FT |
| a = | 2 | IN |
| a/y = | 0.42 | |
| Qa/La = | 0.29 | |
| La = | 38.23 | |
| L/La = | 0.34 | |
| Q/Qa = | 0.52 | |
| Q = | 4.54 | (Clogging factor = 0.8) |

Flow-by to next inlet = 6.36 CFS

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-16
By: KJS
Date: 07/18/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/18/94

Catch Basin Desig
Type "M"

Station 49+80 lt

Flow-by Cond

| | | |
|---|---|---|
| Qa = | 10.9 | CFS |
| S = | 0.007 | '/FT |
| n = | 0.015 | |
| x-Slope = | 0.025 | '/FT |
| St. Width = | 40 | FT |
| z = | 40.00 | |
| z/n = | 2666.67 | |
| y = | 0.40 | FT |
| Spread = | 16.03 | FT |
| Dry Pvmt. = | 3.97381 | |
| L = | 20 | FT |
| a = | 2 | IN |
| a/y = | 0.42 | |
| Qa/La = | 0.29 | |
| La = | 38.23 | |
| L/La = | 0.52 | |
| Q/Qa = | 0.72 | |
| Q = | 6.26 | (Clogging factor = 0.8) |

Flow-by to next inlet = 4.64 CFS

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

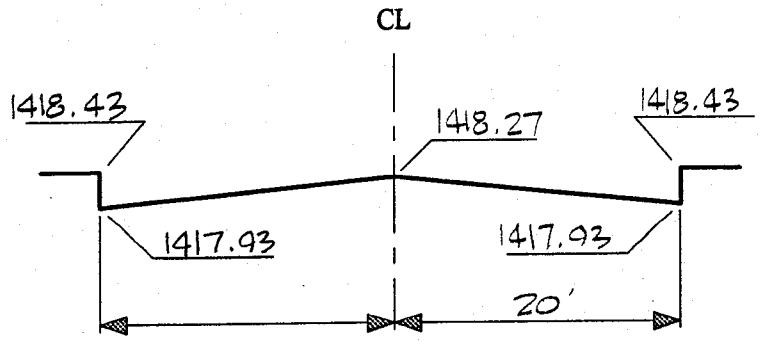
Sheet: CB-17
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 51+40± Rt & Lt
Inlet Type = M-1, L=10'




LOOKING EAST

Street Slope = 0.0069

Water Elev = 1418.35
Area = 10.0
Wetted P = 40.8
Gutter Depth = 0.42
Qtot = 32.2 cfs
Qa = 16.1 cfs

Qa/La = 0.30

$$La = \frac{16.1}{0.30} = 53.7$$

$$L/La = \frac{13}{53.7} = 0.24$$

Q/Qa = 0.39

Q = 0.8 × 0.39 × 16.1 = 5.0 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

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3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

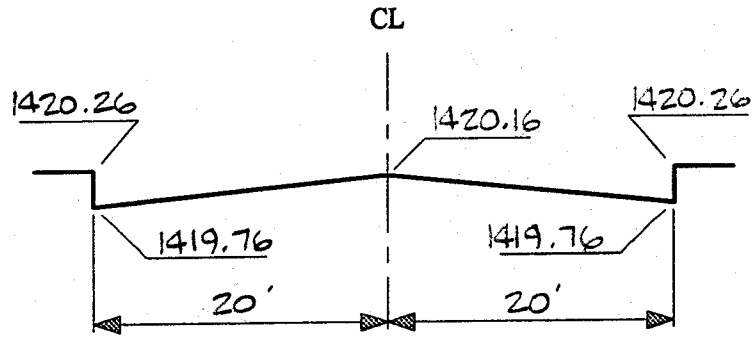
Sheet: CB - 18
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 54+10± Rt & Lt
Inlet Type = M-1, L = 17'




LOOKING EAST

Street Slope = 0.0068

Water Elev = 1420.26
Area = 12.0
Wetted P = 41.0
Gutter Depth = 0.5
Qtot = 43.2 cfs
Qa = 21.6 cfs

Qa/La = 0.37

$$La = \frac{21.6}{0.37} = 58.4$$

$$L/La = \frac{20}{58.4} = 0.34$$

Q/Qa = 0.54

$$Q = 0.8 \times 0.54 \times 21.6 = 9.3 \text{ cfs}$$

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1 - \left(1 - \frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2} - \left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2} - \left(\frac{a}{y}\right)^{5/2}}$$

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

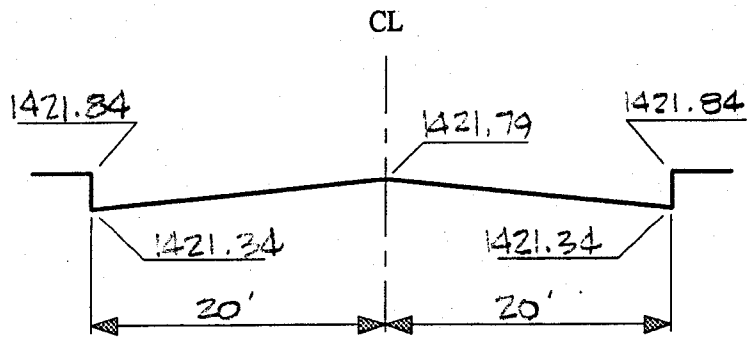
Sheet: CB-19
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 58+35 Rt & Lt.
Inlet Type = M-1, L = 17'




LOOKING EAST

Street Slope = 0.0039

Water Elev = 1421.84
Area = 11.0
Wetted P = 41.0
Gutter Depth = 0.5
Qtot = 28.3 cfs
Qa = 14.2 cfs

Qa/La = 0.37

$$La = \frac{14.2}{0.37} = 38.4$$

$$L/La = \frac{20}{38.4} = 0.52$$

Q/Qa = 0.73

Q = 0.8 × 0.73 × 14.2 = 8.3 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

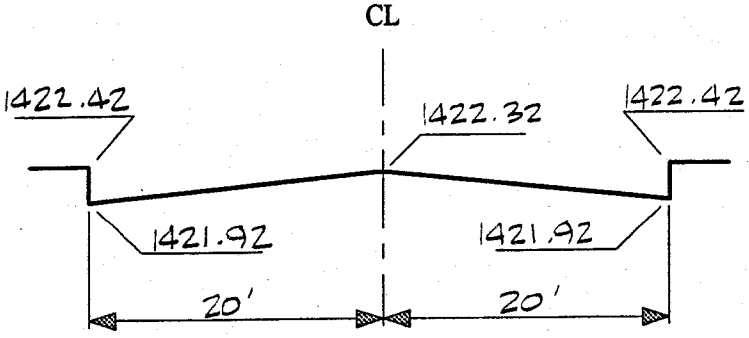
Sheet: CB-20
By: KJS
Date: 07/06/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/07/94

Job No. 93041

Inlet Number = 59+70± Rt & Lt
Inlet Type = M-2, L=17'




LOOKING EAST

Street Slope = 0.0045

Water Elev = 1422.42
Area = 12.0
Wetted P = 41.0
Gutter Depth = 0.5
Qtot = 35.2 cfs
Qa = 17.6 cfs

Qa/La = 0.37

$$La = \frac{17.6}{0.37} = 47.6$$

$$L/La = \frac{37}{47.6} = 0.78$$

Q/Qa = 0.92

Q = 0.8 × 0.92 × 17.6 = 13.0 cfs

$$Q_{tot} = \frac{1.486}{n} * A * R^{2/3} * S^{1/2}$$

$$Q_a = \frac{Q_{tot}}{2}$$

$$\frac{Q_a}{L_a} = 0.7 * (a+y)^{3/2} * \left[1-\left(1-\frac{y}{a+y}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}+1-\frac{L}{L_a}\right)^{5/2}}{\left(\frac{a}{y}+1\right)^{5/2}-\left(\frac{a}{y}\right)^{5/2}}$$

PROJECT ENGINEERING
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3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

EXPLANATION OF DIFFERENT CATCH BASIN METHODOLOGIES

Sht: CB-21
Job# 93041
By: K. SHORT
Date: 7-1-94
Chkd: JVB
Date: 10-10-94

The City of Phoenix, Storm Drain Design Manual was used to determine the capacity of catch basins. These capacities are directly proportional to the depth and amount of water flowing in the street.

The equation specified in the design manual for computing the street capacity is adapted from the Hydraulic Engineering Circular No. 12. The equation used is:

$$Q = 0.56 \left(\frac{Z}{n}\right) S^{1/2} Y^{8/3}$$

This is a modified form of the Mannings's Equation in which the resistance from the face of the curb is ignored.

This equation was used when flow depths were below the crown of the road. However, if full gutter depths were to submerge the crown of the road, the standard Mannings's Equation was used to calculate the street capacity.

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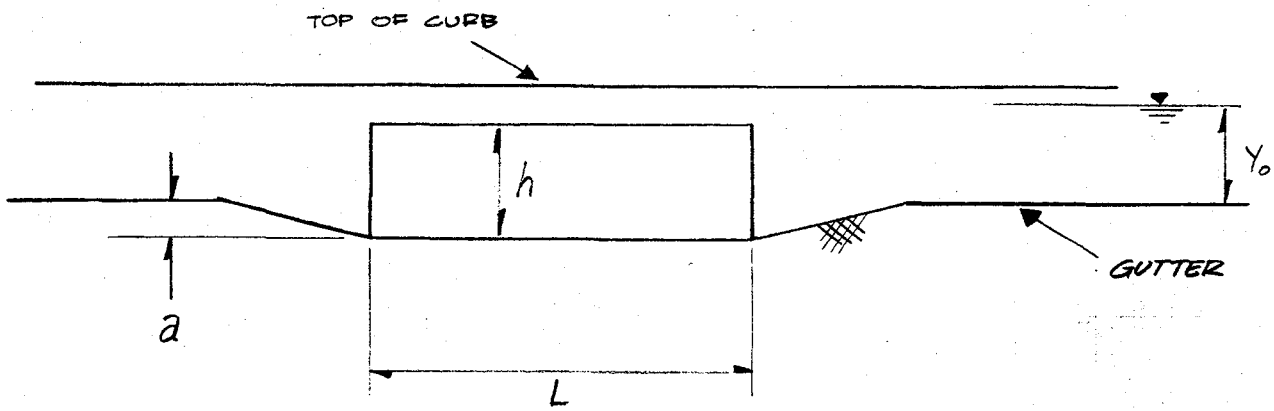
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

Sht: CB-22
Job# 93041
By: K. SHORT
Date: 7-6-94
Chkd: JVB
Date: 10-10-94




$a$ = depth of depression, ft
$h$ = height of curb-opening inlet, ft
$L$ = length of curb opening, ft
$Y_o$ = water depth at curb, measured from the normal cross slope, ft

Inlets in Sump condition :

If $Y_o \geq 1.4\,h$, inlet operates as an orifice

$$Q = 0.67\,hL\,(2gd_o)^{0.5} = 0.67\,A\left[2g\left(d_i - h/2\right)\right]^{0.5}$$

$d_o$ = effective head on the center of the orifice throat, ft
$A$ = clear area opening, $ft^2$
$d_i$ = depth at lip of curb opening, ft

Inlets in Flow-by condition :

$$\frac{Q_a}{L_a} = 0.7\,(a + Y_o)^{3/2}\left[1 - \left(1 - \frac{Y_o}{a + Y_o}\right)^{5/2}\right]$$

$$\frac{Q}{Q_a} = \frac{\left(a/Y_o + 1\right)^{5/2} - \left(a/Y_o + 1 - L/L_a\right)^{5/2}}{\left(a/Y_o + 1\right)^{5/2} - \left(a/Y_o\right)^{5/2}}$$

$Q_a$ = discharge in approach gutter, cfs
$L_a$ = required length of curb opening to intercept entire flow, ft
$Q$ = discharge intercepted by catch basin, cfs

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

EXAMPLE OF CATCH BASIN CAPACITY CALCULATIONS

Sht: CB-23
Job# 93041
By: K. SHORT
Date: 7-7-94
Chkd: JVB
Date: 10-10-94

STA 59+70

93 cfs is remaining from the design flow from summary of catch basins.

THIS VALUE OBVIOUSLY OVERTOPS THE CURBS, THEREFORE, A FULL GUTTER DEPTH OF 0.5 feet IS ASSUMED (CONSERVATIVE).

THIS W.S.E. OVERTOPS THE CROWN OF THE ROAD, THEREFORE, MANNING'S EQN. IS USED TO DETERMINE STREET FLOW AS EXPLAINED ON PG CB-21.

$$Q_{IN\ STREET} = \frac{1.486}{n} \times A \times R^{2/3} \times S^{1/2} = 35.2 \text{ cfs}$$

$$Q_{1/2\ STREET} = Q_{IN\ STREET} \div 2 = 17.6 \text{ cfs}$$

$$Q_a/L_a = 0.7(0.167 + 0.5)^{3/2}\left[1 - \left(1 - \frac{0.5}{0.167 + 0.5}\right)^{5/2}\right] = 0.37$$

$$L_a = \frac{Q_a}{Q_a/L_a} = \frac{17.6}{0.37} = 47.6$$

$$L/L_a = \frac{37}{47.6} = 0.78$$

$$Q/Q_a = \frac{\left(\frac{0.167}{0.5} + 1\right)^{5/2} - \left(\frac{0.167}{0.5} + 1 - 0.78\right)^{5/2}}{\left(\frac{0.167}{0.5} + 1\right)^{5/2} - \left(\frac{0.167}{0.5}\right)^{5/2}} = 0.92$$

$Q = 0.8 \times 0.92 \times 17.6 = 13.0$ cfs into catch basin w/ 20% clogging factor

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Phoenix, Arizona 85017

Sheet: CB-24
By: KJS
Date: 08/03/94

Project: Campo Bello Drive Lateral
grates in channel South of Grovers Ave.

Chkd: JVB
Date: 08/03/94

Catch Basin Design
Single Grate Capacity

Sump Cond.

| | | |
|---|---|---|
| Qa = | | CFS |
| Depth = | 2 | FT |
| Grate width = | 2 | '/FT |
| Grate length = | 3.33 | FT |
| Clear opening area = | 4.84 | SQ FT |
| Is curb against grate? | no | |
| Perimeter = | 10.66 | FT |
| Flow into grate, Q = | 36.78 | CFS |
| Adjusted flow by 50% = | 18.39 | CFS |

Grate operates as an orifice.

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3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-25
By: KJS
Date: 07/20/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/20/94

Station 60+40

Catch Basin Design
Single Grate Capacity

Sump Cond.

| | | |
|---|---|---|
| Qa = | | CFS |
| Depth = | 1 | FT |
| Grate width = | 2 | '/FT |
| Grate length = | 3.33 | FT |
| Clear opening area = | 4.84 | SQ FT |
| Is curb against grate? | no | |
| Perimeter = | 10.66 | FT |
| Flow into grate, Q = | 18.39 | CFS |
| Adjusted flow by 50% = | 9.19 | CFS |

Grate operates mostly as an orifice.

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Phoenix, Arizona 85017

Sheet: CB-26
By: KJS
Date: 08/03/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 08/03/94

Station 58+82 & 58+94

Catch Basin Design
Single Grate Capacity

Sump Cond.

| | | |
|---|---|---|
| Qa = | | CFS |
| Depth = | 2 | FT |
| Grate width = | 2 | '/FT |
| Grate length = | 3.33 | FT |
| Clear opening area = | 4.84 | SQ FT |
| Is curb against grate? | no | |
| Perimeter = | 10.66 | FT |
| Flow into grate, Q = | 36.78 | CFS |
| Adjusted flow by 50% = | 18.39 | CFS |

Grate operates as an orifice.

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-27
By: KJS
Date: 07/20/94

Project: Campo Bello Drive Lateral

Chkd: JVB
Date: 07/20/94

Station 49+74

Catch Basin Design
Single Grate Capacity

Sump Cond.

| | | |
|---|---|---|
| Qa = | | CFS |
| Depth = | 1.5 | FT |
| Grate width = | 2 | '/FT |
| Grate length = | 3.33 | FT |
| Clear opening area = | 4.84 | SQ FT |
| Is curb against grate? | no | |
| Perimeter = | 10.66 | FT |
| Flow into grate, Q = | 26.01 | CFS |
| Adjusted flow by 50% = | 13.00 | CFS |

Grate operates mostly as an orifice.

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

EXAMPLE OF GRATE IN SUMP CALCULATIONS

Sht: CB-28
Job# 93041
By: K. SHORT
Date: 7-21-94
Chkd: JVB
Date: 10-10-94

AT ALL LOCATIONS, THE DEPTH OF WATER ABOVE A CATCH BASIN IN SUMP IS AT LEAST 1 foot. THEREFORE, ONLY CURVE B WILL BE USED FROM PG. CB-29 TO DETERMINE THE CAPACITY OF GRATES. SINCE THIS GRAPH PROVIDE INFORMATION ON DISCHARGE PER SQUARE FOOT OF EFFECTIVE CLEAR OPENING, THE FLOW INTO THE CATCH BASIN IS DIRECTLY PROPORTIONAL TO THE CAPACITY OF ONE GRATE.

STA 62+02

depth of water over grate (d) = 2.0 feet
= depth of channel

from CURVE B discharge per sq. ft. of effective clear opening = 7.6 cfs/sq. ft.

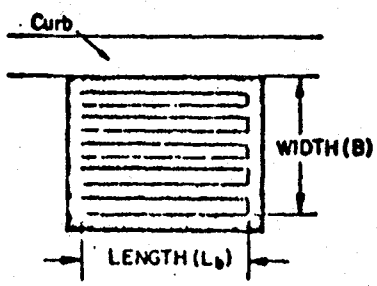
an ADOT standard grate LW or LB 1.2 has an effective clear opening area of 4.84 sq. ft.

7.60 cfs/sq.ft. × 4.84 sq. ft. = 36.78 cfs/grate

City of Phoenix standards call for 50% clogging

36.78 cfs/grate × 0.5 = 18.39 cfs/grate

∴ USE capacity = 18.4 cfs/grate

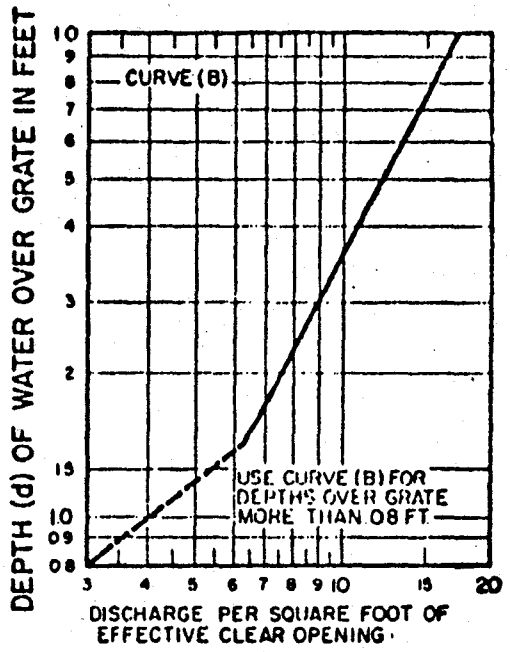


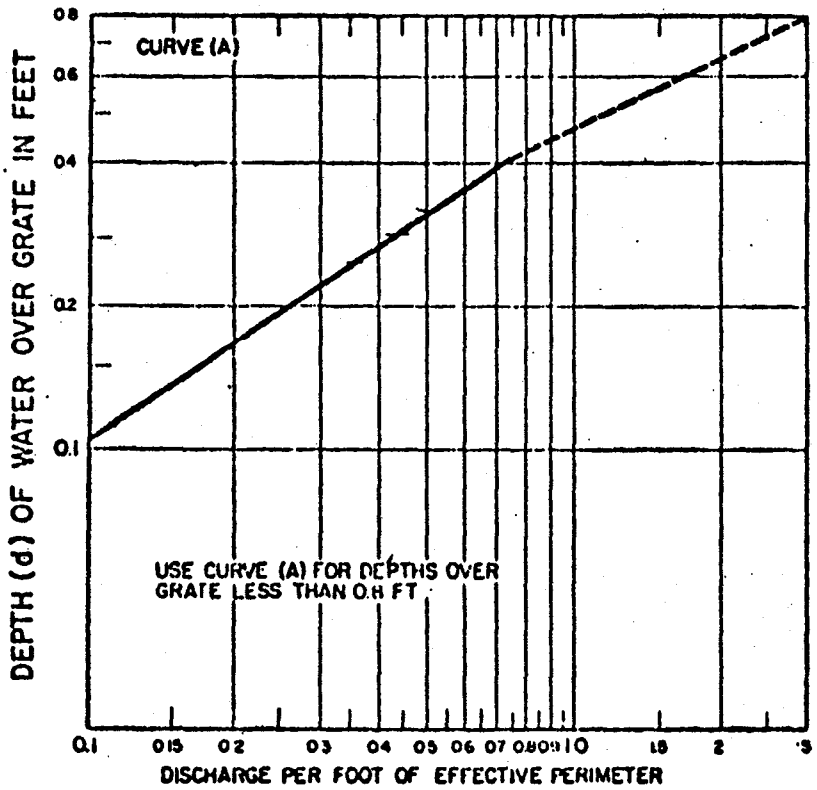

$P = 2B + L_b$

A = AREA OF CLEAR OPENING IN GRATE

TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB $P = 2(B + L_b)$




| TYPE | AREA | P |
|---|---|---|
| "F" | 5.43 | 11.1' |
| "E" | 3.1 | 5.8' |
| Grate for "D" | 4.6 | 7.6' |

BUREAU OF PUBLIC ROADS
REV. AUG. 1968

# HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

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PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

16TH ST CATCH BASIN
17TH WAY CATCH BASIN

Sht: CB-30
Job# 93041
By: K. SHORT
Date: 5-16-94
Chkd: JVB
Date: 5-27-94

STA. 49+74

DESIGN FLOW = 125 CFS FROM PG DR-1

USE LW OR LB 1.2 GRATES with 1.5' HEAD

→ 13.0 CFS / GRATE

$\frac{125 \text{ CFS}}{13 \text{ CFS/GRATE}} = 9.6$ GRATES USE 10 GRATES

STA 58+82 & 58+94

DESIGN FLOW 231 CFS FROM PG DR-1

150.5 CFS DESIGN FLOW FOR 4' S.D. IN 17TH WAY

THEREFORE 231 - 150.5 = 80.5 CFS must be coming thru block wall.

USE LW OR LB 1.2 grates with 2' HEAD

→ 18.4 CFS / GRATE

$\frac{80.5 \text{ CFS}}{18.4 \text{ CFS/GRATE}} = 4.4$ GRATES USE 6 grates

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Sheet: CB-31
By: KJS
Date: 10/10/94

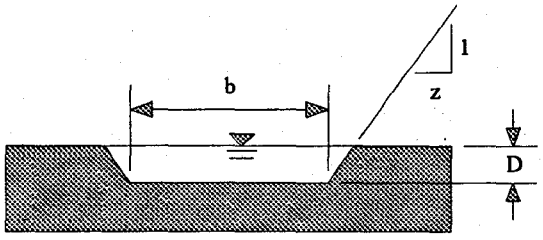
Project: Campo Bello Drive Lateral
16th and Grovers Channel

Chkd: JVB
Date: 10/10/94

Job No. 93041

Capacity of a Trapezoidal Channel

Diagram:




| | | | |
|---|---|---|---|
| Q-design | = | 125 | cfs |
| S | = | 0.01 | '/ft |
| n | = | 0.04 | |
| z | = | 4 | |
| D | = | 1.5 | ft |
| b | = | 35 | ft |

| | | | |
|---|---|---|---|
| A | = | 61.50 | ft^2 |
| P | = | 47.37 | ft |
| Rh | = | 1.30 | ft |
| V | = | 4.42 | fps |

Design Equations:

A = bD + z(D^2)
P = b + 2D(1 + z^2)^0.5
Rh = A/P
V = 1.486/n(Rh)^0.667(S)^0.5
Q = VA

Q-cap 272 cfs

Q-cap > Q-design and acceptable velocity for channel to be OK.

Notes:

TRAP1 - 3/11/94

Figure 4.42
Culvert Design Form

| Project: CAMPO BELLO DRIVE LATERAL | Station: | CULVERT DESIGN FORM |
|---|---|---|
| | Sheet ____ of ____ | Designer/Date: KJS / 5-4-94 |
| | | Reviewer/Date: ____ / ____ |

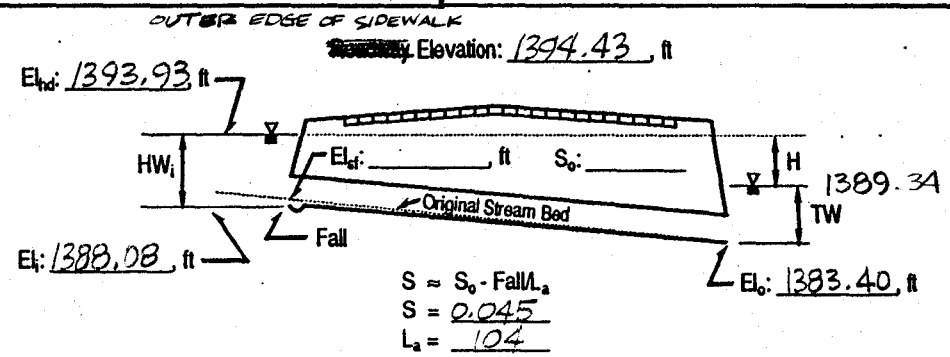
**Hydrological Data**

See Add'l shts

- ☐ Method: TR20
- ☐ Drainage Area: ____ ☐ Stream Slope: ____
- ☐ Channel Shape: ____
- ☐ Routing: ____ ☐ Other: ____

**Design Flows/Tailwater**

| R.I., years | Flow, cfs | TW, ft |
|---|---|---|
| 100 | 353-64 = 289 | 5.94 |




$S \approx S_o - Fall/L_a$
$S = 0.045$
$L_a = 104$

| Culvert Description: Material - Shape - Size - Entrance | Total Flow Q, cfs | Flow Per Barrel Q/N (1) | Headwater Calculations: Inlet Control: $HW_i/D$ (2) | $HW_i$ | Fall (3) | $EL_{hi}$ (4) | Outlet Control: TW (5) | $d_c$ | $\frac{d_c+D}{2}$ | $h_o$ (6) | $k_e$ | H (7) | $EL_{ho}$ (8) | Control Headwater Elevation | Outlet Velocity | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8'x4' CONCRETE BOX 30°-75° | 289 | 289 | 1.46 | 5.84 | 0 | 1393.92 | 5.94 | 3.43 | 3.72 | 5.94 | 0.4 | 2.21 | 1391.55 | 1393.92 | 9.03 | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

**Technical Footnotes:**

(1) Use Q/NB for box culverts.
(2) $HW_i/D$ = HW/D or $HW_f/D$ from design charts
(3) FALL ≐ $HW_i - (EL_{hd} - EL_{sf})$; Fall is zero for culverts on grade.
(4) $EL_{hi} = HW_i + EL_i$ (invert of inlet control section)
(5) TW based on downstream control or flow depth in channel.
(6) $h_o$ = TW or $(d_c + D)/2$ (whichever is greater).
(7) $H = \left[1 + k_e + (29n^2L)/R^{1.33}\right] V^2/2g$
(8) $EL_{ho} = EL_o + H + h_o$

**Subscript Definitions:**

a. approximate
f. culvert fact
hd. Design Headwater
hj. Headwater in inlet control
he. Headwater in outlet control
i. inlet control section
o. Outlet
sf. Streambed at culvert face
TW. Tailwater

**Comments / Discussion:**

$$d_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{(289/8)^2}{32.2}\right)^{1/3} = 3.43$$

$$R = \frac{A}{P_w} = \frac{8 \times 4}{16+8} = 1.33 \qquad V = \frac{Q}{A} = \frac{289}{32} = 9.03$$

**Culvert Barrel Selected:**

Size: 8'x4'
Shape: BOX
Material: CONCRETE n: 0.013
Entrance: 30°-75° WINGWALL FLARE

CV-1

CV-2

CURRENT DATE: 05-05-1994 FILE DATE: 03-09-1994
CURRENT TIME: 10:38:31 FILE NAME: BASIN5

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.1

| | SITE DATA | | | CULVERT SHAPE, MATERIAL, INLET | | | | |
|---|---|---|---|---|---|---|---|---|
| | INLET ELEV. (FT) | OUTLET ELEV. (FT) | CULVERT LENGTH (FT) | BARRELS / SHAPE / MATERIAL | SPAN (FT) | RISE (FT) | MANNING n | INLET TYPE |
| 1 | 1388.08 | 1383.40 | 104.11 | 1 RCB | 8.00 | 4.00 | .012 | CONVENTIONAL |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |

FILE: BASIN5 CULVERT HEADWATER ELEVATION (FT) DATE: 03-09-1994

| DISCHARGE | 1 | 2 | 3 | 4 | 5 | 6 | ROADWAY |
|---|---|---|---|---|---|---|---|
| 0 | 1389.24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.00 |
| 30 | 1389.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.22 |
| 60 | 1389.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.34 |
| 90 | 1390.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.45 |
| 120 | 1390.95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.54 |
| 150 | 1391.43 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.62 |
| 180 | 1391.89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.71 |
| 210 | 1392.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.78 |
| 240 | 1392.89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.85 |
| 270 | 1393.45 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.92 |
| 293 | 1393.91 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1394.98 |
| 352 | 1395.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

The above Q and HW are for a point above the roadway.

CV-3



DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

PERFORMANCE CURVE FOR CULVERT # 1 - 1 ( 8 BY 4 ) RCB

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

| DIS-CHARGE FLOW (cfs) | HEAD-WATER ELEV. (ft) | INLET CONTROL DEPTH (ft) | OUTLET CONTROL DEPTH (ft) | FLOW TYPE <F4> | NORMAL DEPTH (ft) | CRITICAL DEPTH (ft) | OUTLET VEL. (fps) | OUTLET DEPTH (ft) | TAILWATER VEL. (fps) | TAILWATER DEPTH (ft) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1389.24 | 0.00 | 1.16 | 0-NF | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.84 |
| 30 | 1389.26 | 1.12 | 1.18 | 1-S1f | 0.28 | 0.76 | 0.94 | 4.00 | 0.00 | 5.84 |
| 60 | 1389.85 | 1.77 | 1.77 | 1-S1f | 0.48 | 1.21 | 1.88 | 4.00 | 0.00 | 5.84 |
| 90 | 1390.43 | 2.35 | 2.35 | 1-S1f | 0.62 | 1.58 | 2.81 | 4.00 | 0.00 | 5.84 |
| 120 | 1390.95 | 2.87 | 2.87 | 1-S1f | 0.76 | 1.92 | 3.75 | 4.00 | 0.00 | 5.84 |
| 150 | 1391.43 | 3.35 | 3.35 | 1-S1f | 0.88 | 2.22 | 4.69 | 4.00 | 0.00 | 5.84 |
| 180 | 1391.89 | 3.81 | 3.81 | 1-S1f | 0.99 | 2.51 | 5.63 | 4.00 | 0.00 | 5.84 |
| 210 | 1392.38 | 4.30 | 4.30 | 1-S1f | 1.09 | 2.78 | 6.56 | 4.00 | 0.00 | 5.84 |
| 240 | 1392.89 | 4.81 | 4.81 | 1-S1f | 1.20 | 3.04 | 7.50 | 4.00 | 0.00 | 5.84 |
| 270 | 1393.45 | 5.37 | 5.37 | 1-S1f | 1.29 | 3.29 | 8.44 | 4.00 | 0.00 | 5.84 |
| 293 | 1393.91 | 5.83 | 5.83 | 1-S1f | 1.37 | 3.47 | 9.16 | 4.00 | 0.00 | 5.84 |

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

El. inlet face invert 1388.08 ft El. outlet invert 1383.40 ft

El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

***** SITE DATA ***** CULVERT INVERT **************

| | |
|---|---|
| INLET STATION (FT) | 2375.00 |
| INLET ELEVATION (FT) | 1388.08 |
| OUTLET STATION (FT) | 2271.00 |
| OUTLET ELEVATION (FT) | 1383.40 |
| NUMBER OF BARRELS | 1 |
| SLOPE (V-FT/H-FT) | 0.0450 |
| CULVERT LENGTH ALONG SLOPE (FT) | 104.11 |

***** CULVERT DATA SUMMARY ************************

| | |
|---|---|
| BARREL SHAPE | BOX |
| BARREL SPAN | 8.00 FT |
| BARREL RISE | 4.00 FT |
| BARREL MATERIAL | CONCRETE |
| BARREL MANNING'S N | 0.012 |
| INLET TYPE | CONVENTIONAL |
| INLET EDGE AND WALL | SQUARE EDGE (30-75 DEG. FLARE) |
| INLET DEPRESSION | NONE |

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

CV-4

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD TAILWATER DDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

CONSTANT WATER SURFACE ELEVATION
1389.24

DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDD ROADWAY OVERTOPPING DATA DDDDDDDDDDDDDDDDDDDDDDDDDDD
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

| | |
|---|---|
| ROADWAY SURFACE | PAVED |
| EMBANKMENT TOP WIDTH (FT) | 80.00 |
| CREST LENGTH (FT) | 100.00 |
| OVERTOPPING CREST ELEVATION (FT) | 1394.00 |

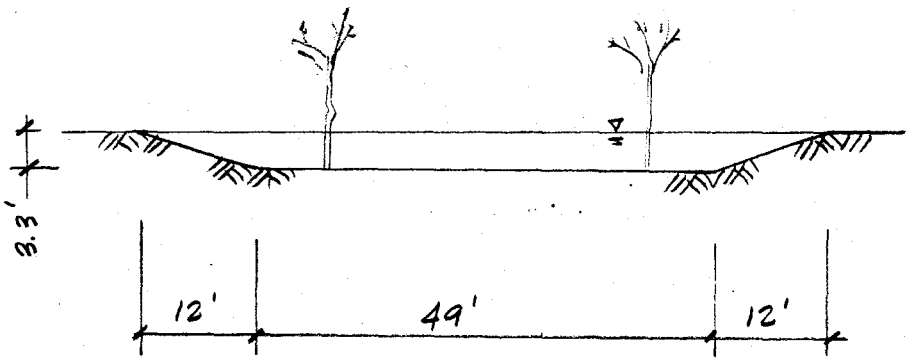
DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

Campo Bello Drive Lateral

Sht: MC-1
Job# 93041
By: JVB
Date: 5-20-94
Chkd: KS
Date: 5-25-94

Capacity of Exist. Landscaped Channel
South of Candle Creek Unit I




DESIGN

AREA(FT2)= 200.00
P-WET(FT)= 73.00
RH(FT)= 2.74
N= 0.0350
S(FT/FT)= 0.0036

---

Q(CFS)= 997.89
V(FPS)= 4.99

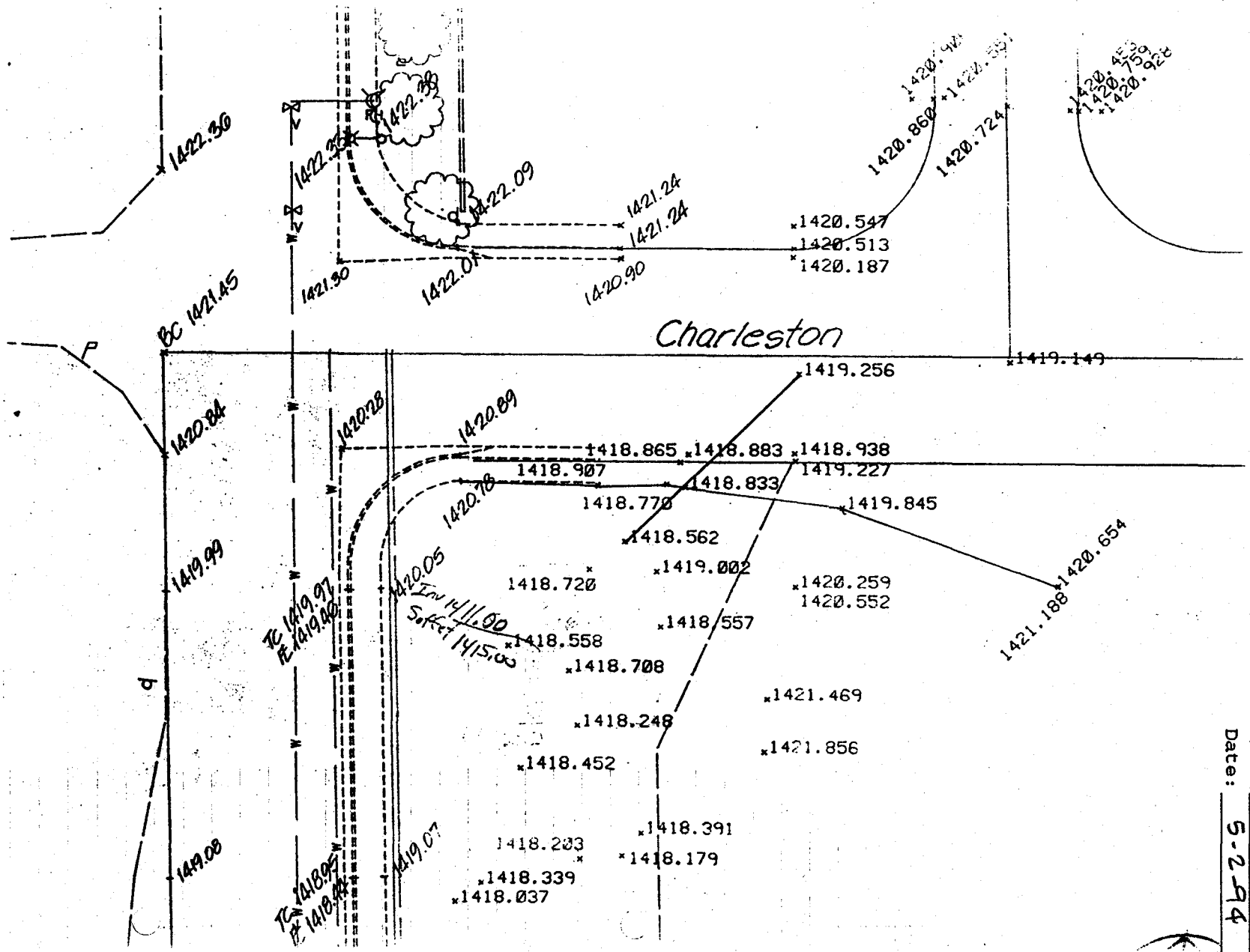
---

Based on PEC Survey:

$$S = \frac{2.9'}{800'} = 0.0036'/ft$$

$n = 0.035$ DG ground cover w/ accent cobbles. Trees planted approx 25' o.c. ea. side.

$Q = 285$ cfs $<$ 998 cfs ok ✓
(TR-20 Run)




**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

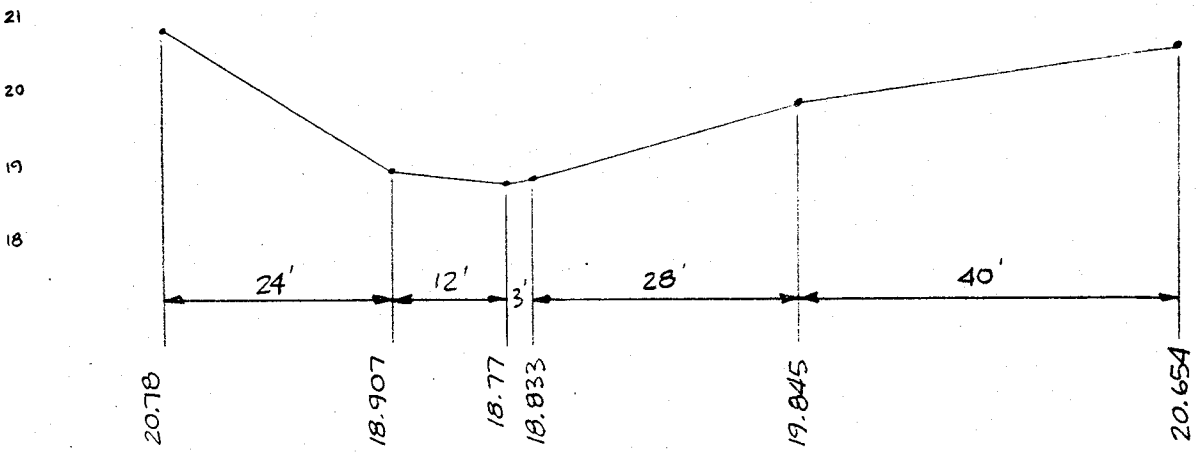
Campo Bello lateral
Charleston & 16th St.

Sht: MC-2
Job# 93041
By: KJS
Date: 5-2-94
Chkd: JVB
Date: 5-2-94

PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL
CHARLESTON & 16TH ST.

Sht: MC-3
Job# 93041
By: K. SHORT
Date: 3-24-94
Chkd: JVB
Date: 3-2-94




BROAD-CRESTED WEIR

$q = 3H^{3/2}$

H.W.E. = 20.654

H = 20.654 - 18.77 = 1.884
B = 22.38 + 12 + 3 + 28 + 40 = 105.38

B = A ÷ H = 99.9 ÷ 1.884 = 53.03

$q = 3 \times (1.884)^{3/2} = 7.76$

Q = q × B = 817.5 CFS

Q = 411.5 CFS

H.W.E. = 19.845

H = 19.845 - 18.77 = 1.075
B = 12.02 + 12 + 3 + 28 = 55.02

$q = 3 \times (1.075)^{3/2} = 3.34$

Q = q × B = 184.0 CFS

PROJECT ENGINEERING CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

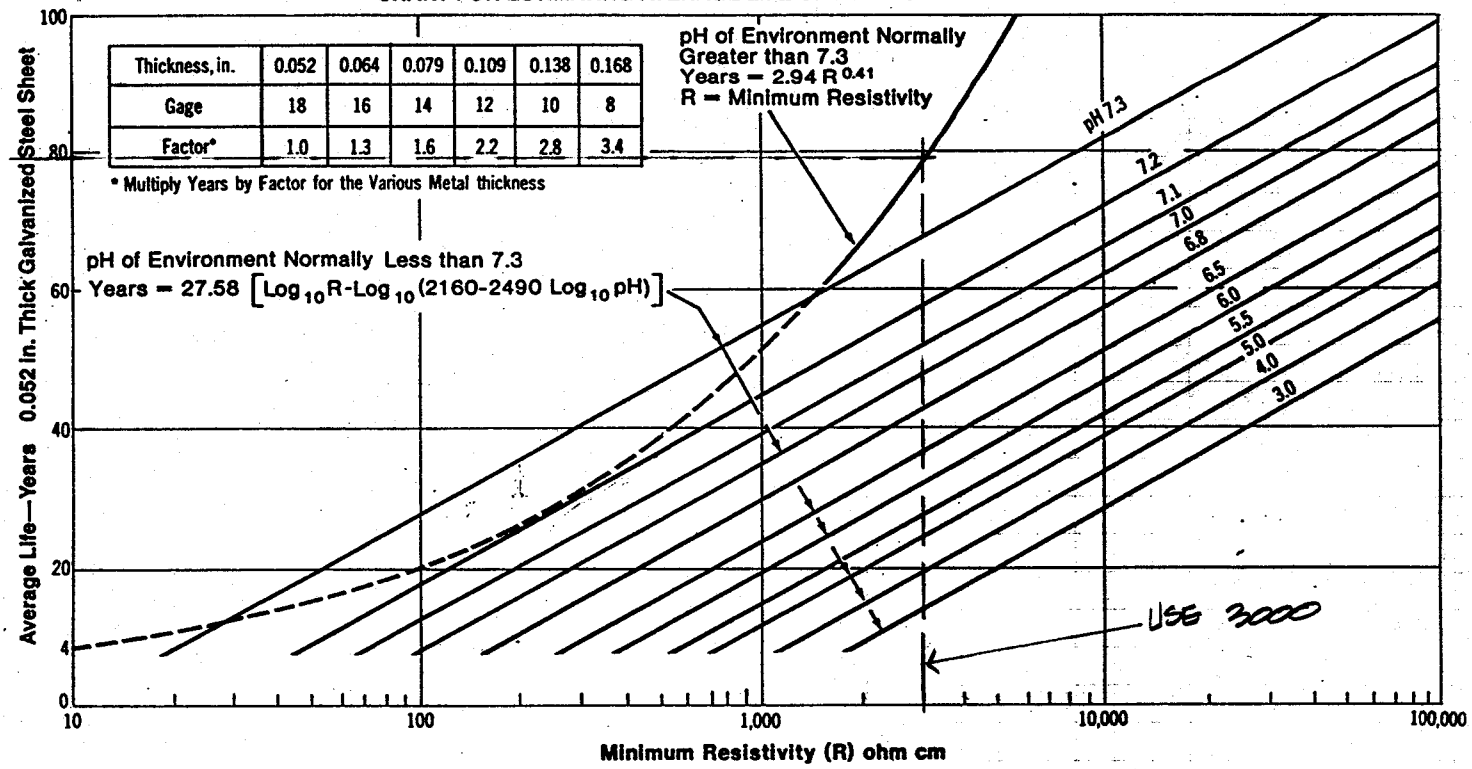
Campo Bello Drive Lateral

Durability for CMP Connector Pipes

Sht: MC-4
Job# 93041
By: JNB
Date: 9-15-94
Chkd: KJS
Date: 9-15-94



Figure 5-4
CHART FOR ESTIMATING AVERAGE LIFE OF PLAIN GALVANIZED CULVERTS




| Thickness, in. | 0.052 | 0.064 | 0.079 | 0.109 | 0.138 | 0.168 |
|---|---|---|---|---|---|---|
| Gage | 18 | 16 | 14 | 12 | 10 | 8 |
| Factor* | 1.0 | 1.3 | 1.6 | 2.2 | 2.8 | 3.4 |

* Multiply Years by Factor for the Various Metal thickness

Per Geotechnical Report, dated 8-31-94, Speedie and Associates, #9402848A:

Ph = 8.0
R = 2808 – 4213 ohm.cm (Moderate Degree of Corrosiveness)

Approx. Average Life (18 ga.) ≈ 80 years

∴ CMP ≥ 0.052 ok ✓

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Project : Campo Bello Drive Lateral
ASTM C 76 - Wall B

Rev :
Chkd : LMM
Date : 11/23/94

Sheet : MC-5
By : KJS
Date : 11/23/94

| STATION TO STATION | D Pipe I. D. (ft) | Bc Pipe O. D. (ft) | H Height of Cover, (ft) | H/Bc (ft/ft) | Rsd Assumed | P Projection Ratio | Rsd*P | Cc From Graph | Bc^2 (ft^2) | W Soil Unit Wt. (lbs/ft^3) | Wc (lbs/ft) | Wl (lbs/ft) | Bf Bedding Factor | Wc+Wl (lbs/ft) | Bf*D (ft) | F. S. | D 0.01 (lbs/ft/ft) | D 0.01 Round Up | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16+40 | | | | | | | | | | | | | | | | | | | |
| 16+52 | 9 | 10.67 | 7.3 | 0.68 | 0.7 | 1 | 0.7 | 0.78 | 113.849 | 140 | 12474.9 | 295.6 | 1.90 | 12770.5 | 17.10 | 1.0 | 746.8 | 750 | |
| 17+25 | 9 | 10.67 | 7.2 | 0.67 | 0.7 | 1 | 0.7 | 0.77 | 113.849 | 140 | 12280.8 | 301.5 | 1.90 | 12582.3 | 17.10 | 1.0 | 735.8 | 750 | |
| 20+00 | 9 | 10.67 | 7.8 | 0.73 | 0.7 | 1 | 0.7 | 0.54 | 113.849 | 140 | 8545.76 | 268.9 | 1.90 | 8814.64 | 17.10 | 1.0 | 515.5 | 750 | |
| 22+35 | 9 | 10.67 | 8.5 | 0.80 | 0.7 | 1 | 0.7 | 0.66 | 113.849 | 140 | 10557.1 | 237.1 | 1.90 | 10794.2 | 17.10 | 1.0 | 631.2 | 750 | |
| 23+29 | 9 | 10.67 | 8.5 | 0.80 | 0.7 | 1 | 0.7 | 0.66 | 113.849 | 140 | 10557.1 | 237.1 | 1.90 | 10794.2 | 17.10 | 1.0 | 631.2 | 750 | |
| 25+00 | 9 | 10.67 | 8.6 | 0.81 | 0.7 | 1 | 0.7 | 0.68 | 113.849 | 140 | 10844.4 | 233.1 | 1.90 | 11077.5 | 17.10 | 1.0 | 647.8 | 750 | |
| 27+00 | 9 | 10.67 | 8.3 | 0.78 | 0.7 | 1 | 0.7 | 0.63 | 113.849 | 140 | 9982.44 | 245.6 | 1.90 | 10228 | 17.10 | 1.0 | 598.1 | 750 | |
| 29+00 | 9 | 10.67 | 7.9 | 0.74 | 0.7 | 1 | 0.7 | 0.55 | 113.849 | 140 | 8833.09 | 264.0 | 1.90 | 9097.06 | 17.10 | 1.0 | 532.0 | 750 | |
| 30+80 | 9 | 10.67 | 9 | 0.84 | 0.7 | 1 | 0.7 | 0.75 | 113.849 | 140 | 11993.8 | 217.8 | 1.90 | 12211.6 | 17.10 | 1.0 | 714.1 | 750 | |
| 31+70 | 9 | 10.67 | 9.9 | 0.93 | 0.7 | 1 | 0.7 | 0.91 | 113.849 | 140 | 14579.8 | 188.4 | 1.90 | 14768.3 | 17.10 | 1.0 | 863.6 | 1000 | |
| 33+00 | 9 | 10.67 | 10.6 | 0.99 | 0.7 | 0.5 | 0.35 | 1.16 | 113.849 | 140 | 18461.2 | 169.5 | 1.90 | 18630.7 | 17.10 | 1.0 | 1089.5 | 1250 | |
| 34+20 | 9 | 10.67 | 10.2 | 0.96 | 0.7 | 0.5 | 0.35 | 1.09 | 113.849 | 140 | 17437.1 | 180.0 | 1.90 | 17617.1 | 17.10 | 1.0 | 1030.2 | 1250 | |
| 35+70 | 9 | 10.67 | 9.3 | 0.87 | 0.7 | 1 | 0.7 | 0.81 | 113.849 | 140 | 12855.8 | 207.3 | 1.90 | 13063.1 | 17.10 | 1.0 | 763.9 | 1000 | |
| 38+00 | 9 | 10.67 | 7.8 | 0.73 | 0.7 | 1 | 0.7 | 0.54 | 113.849 | 140 | 8545.76 | 268.9 | 1.90 | 8814.64 | 17.10 | 1.0 | 515.5 | 750 | |
| 40+00 | 9 | 10.67 | 7.8 | 0.73 | 0.7 | 1 | 0.7 | 0.54 | 113.849 | 140 | 8545.76 | 268.9 | 1.90 | 8814.64 | 17.10 | 1.0 | 515.5 | 750 | |
| 41+80 | 9 | 10.67 | 7.8 | 0.73 | 0.7 | 1 | 0.7 | 0.54 | 113.849 | 140 | 8545.76 | 268.9 | 1.90 | 8814.64 | 17.10 | 1.0 | 515.5 | 750 | |
| 43+00 | 9 | 10.67 | 8.1 | 0.76 | 0.7 | 1 | 0.7 | 0.59 | 113.849 | 140 | 9407.77 | 254.5 | 1.90 | 9662.3 | 17.10 | 1.0 | 565.0 | 750 | |
| 45+00 | 9 | 10.67 | 7.8 | 0.73 | 0.7 | 1 | 0.7 | 0.54 | 113.849 | 140 | 8545.76 | 268.9 | 1.90 | 8814.64 | 17.10 | 1.0 | 515.5 | 750 | |
| 47+00 | 9 | 10.67 | 7.2 | 0.67 | 0.7 | 1 | 0.7 | 0.77 | 113.849 | 140 | 12280.8 | 301.5 | 1.90 | 12582.3 | 17.10 | 1.0 | 735.8 | 750 | |
| 48+45 | 9 | 10.67 | 7.3 | 0.68 | 0.7 | 1 | 0.7 | 0.78 | 113.849 | 140 | 12474.9 | 295.6 | 1.90 | 12770.5 | 17.10 | 1.0 | 746.8 | 750 | |
| 48+57 | 8 | 9.5 | 7.3 | 0.77 | 0.7 | 1 | 0.7 | 0.89 | 90.25 | 140 | 11297 | 295.6 | 1.90 | 11592.6 | 15.20 | 1.0 | 762.7 | 1000 | |
| 50+29 | 8 | 9.5 | 7.4 | 0.78 | 0.7 | 1 | 0.7 | 0.91 | 90.25 | 140 | 11476.1 | 290.0 | 1.90 | 11766.1 | 15.20 | 1.0 | 774.1 | 1000 | |
| 52+00 | 8 | 9.5 | 7.2 | 0.76 | 0.7 | 1 | 0.7 | 0.88 | 90.25 | 140 | 11118.6 | 301.5 | 1.90 | 11420.1 | 15.20 | 1.0 | 751.3 | 1000 | |
| 53+60 | 8 | 9.5 | 7.4 | 0.78 | 0.7 | 1 | 0.7 | 0.91 | 90.25 | 140 | 11476.1 | 290.0 | 1.90 | 11766.1 | 15.20 | 1.0 | 774.1 | 1000 | |
| 56+00 | 8 | 9.5 | 7.3 | 0.77 | 0.7 | 1 | 0.7 | 0.89 | 90.25 | 140 | 11297 | 295.6 | 1.90 | 11592.6 | 15.20 | 1.0 | 762.7 | 1000 | |
| 58+00 | 8 | 9.5 | 7.4 | 0.78 | 0.7 | 1 | 0.7 | 0.91 | 90.25 | 140 | 11476.1 | 290.0 | 1.90 | 11766.1 | 15.20 | 1.0 | 774.1 | 1000 | |
| 59+02 | 8 | 9.5 | 8.8 | 0.93 | 0.7 | 1 | 0.7 | 0.91 | 90.25 | 140 | 11520.8 | 225.2 | 1.90 | 11746 | 15.20 | 1.0 | 772.8 | 1000 | |
| 59+14 | 7 | 8.33 | 8.9 | 1.07 | 0.7 | 1 | 0.7 | 1.19 | 69.3889 | 140 | 11513.2 | 221.5 | 1.90 | 11734.7 | 13.30 | 1.0 | 882.3 | 1000 | |
| 60+50 | 7 | 8.33 | 9 | 1.08 | 0.7 | 1 | 0.7 | 1.21 | 69.3889 | 140 | 11737.6 | 217.8 | 1.90 | 11955.3 | 13.30 | 1.0 | 898.9 | 1000 | |
| 62+08 | 7 | 8.33 | 9.7 | 1.16 | 0.7 | 1 | 0.7 | 1.37 | 69.3889 | 140 | 13307.8 | 194.4 | 1.90 | 13502.2 | 13.30 | 1.0 | 1015.2 | 1250 | |

Notes :

| Design Data (Provided by the City of Phoenix) | | |
|---|---|---|
| | Ku = 0.1924 | F. S. = 1.0 |
| For H<=10 | P = 1.0 | He/Bc = 1.7 |
| For H> 10, | P = 0.5 | He/Bc = 1.4 |

* Change in D-Load due to Bf transition

**PROJECT ENGINEERING CONSULTANTS, LTD.**
3130 N. 35th Avenue, Suite 1
Phoenix, Arizona 85017

Project : Campo Bello Drive Lateral
Connector Pipe D-Loads

Rev :
Chkd : LMM
Date : 11/23/94

Sheet : MC-6
By : KJS
Date : 11/23/94

| STATION | D Pipe I. D. (ft) | Bc Pipe O. D. (ft) | H Height of Cover, (ft) | H/Bc (ft/ft) | Rsd Assumed | P Projection Ratio | Rsd*P | Cc From Graph | Bc^2 (ft^2) | W Soil Unit Wt. (lbs/ft^3) | Wc (lbs/ft) | Wl (lbs/ft) | Bf Bedding Factor | Wc+Wl (lbs/ft) | Bf*D (ft) | F. S. | D 0.01 (lbs/ft/ft) | D 0.01 Round Up | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17+05.00 | 1.25 | 1.625 | 20 | 12.31 | 0.7 | 0.5 | 0.35 | 20.55 | 2.64063 | 140 | 7596.61 | 59.3 | 2.15 | 7655.88 | 2.69 | 1.0 | 2843.4 | 3000 | |
| 17+10.00 | 1.25 | 1.625 | 18 | 11.08 | 0.7 | 0.5 | 0.35 | 18.44 | 2.64063 | 140 | 6816.83 | 71.1 | 1.90 | 6887.92 | 2.38 | 1.0 | 2900.2 | 3000 | |
| 28+40.00 | 2 | 2.5 | 19 | 7.60 | 0.7 | 0.5 | 0.35 | 12.48 | 6.25 | 140 | 10920.6 | 64.8 | 1.90 | 10985.3 | 3.80 | 1.0 | 2890.9 | 3000 | |
| 29+30.00 | 1.5 | 1.917 | 19 | 9.91 | 0.7 | 0.5 | 0.35 | 16.44 | 3.67489 | 140 | 8459.06 | 64.8 | 1.90 | 8523.83 | 2.85 | 1.0 | 2990.8 | 3000 | |
| 30+90.00 | 1.25 | 1.625 | 24 | 14.77 | 0.7 | 0.5 | 0.35 | 24.77 | 2.64063 | 140 | 9156.18 | 43.0 | 2.15 | 9199.19 | 2.69 | 1.0 | 3418.3 | 3500 | |
| 30+95.00 | 1.25 | 1.625 | 21 | 12.92 | 0.7 | 0.5 | 0.35 | 21.60 | 2.64063 | 140 | 7986.51 | 54.4 | 2.15 | 8040.93 | 2.69 | 1.0 | 2986.8 | 3000 | |
| 32+50.00 | 1.25 | 1.625 | 26 | 16.00 | 0.7 | 0.5 | 0.35 | 26.88 | 2.64063 | 140 | 9935.97 | 37.3 | 2.15 | 9973.24 | 2.69 | 1.0 | 3706.6 | 3750 | |
| 32+55.00 | 1.25 | 1.625 | 24 | 14.77 | 0.7 | 0.5 | 0.35 | 24.77 | 2.64063 | 140 | 9156.18 | 43.0 | 2.15 | 9199.19 | 2.69 | 1.0 | 3418.3 | 3500 | |
| 35+25.00 | 1.25 | 1.625 | 24 | 14.77 | 0.7 | 0.5 | 0.35 | 24.77 | 2.64063 | 140 | 9156.18 | 43.0 | 2.15 | 9199.19 | 2.69 | 1.0 | 3418.3 | 3500 | |
| 35+30.00 | 1.25 | 1.625 | 22 | 13.54 | 0.7 | 0.5 | 0.35 | 22.66 | 2.64063 | 140 | 8376.4 | 50.2 | 2.15 | 8426.56 | 2.69 | 1.0 | 3130.5 | 3250 | |
| 37+10.00 | 1.25 | 1.625 | 22 | 13.54 | 0.7 | 0.5 | 0.35 | 22.66 | 2.64063 | 140 | 8376.4 | 50.2 | 2.15 | 8426.56 | 2.69 | 1.0 | 3130.5 | 3250 | |
| 37+15.00 | 1.25 | 1.625 | 20 | 12.31 | 0.7 | 0.5 | 0.35 | 20.55 | 2.64063 | 140 | 7596.61 | 59.3 | 2.15 | 7655.88 | 2.69 | 1.0 | 2843.4 | 3000 | |
| 49+04.64 | 4 | 4.833 | 20 | 4.14 | 0.7 | 0.5 | 0.35 | 6.55 | 23.3579 | 140 | 21412 | 59.3 | 1.90 | 21471.3 | 7.60 | 1.0 | 2825.2 | 3000 | |
| 49+74.00 | 4 | 4.833 | 17 | 3.52 | 0.7 | 0.5 | 0.35 | 5.48 | 23.3579 | 140 | 17933.2 | 78.4 | 1.90 | 18011.6 | 7.60 | 1.0 | 2369.9 | 2500 | 3000 * |
| 51+40.00 | 1.25 | 1.625 | 22 | 13.54 | 0.7 | 0.5 | 0.35 | 22.66 | 2.64063 | 140 | 8376.4 | 50.2 | 2.15 | 8426.56 | 2.69 | 1.0 | 3130.5 | 3250 | |
| 51+40.00 | 1.25 | 1.625 | 12 | 7.38 | 0.7 | 0.5 | 0.35 | 12.11 | 2.64063 | 140 | 4477.48 | 139.4 | 1.90 | 4616.83 | 2.38 | 1.0 | 1943.9 | 2000 | |
| 54+10.00 | 1.75 | 2.208 | 20 | 9.06 | 0.7 | 0.5 | 0.35 | 14.98 | 4.87526 | 140 | 10223.9 | 59.3 | 2.16 | 10283.2 | 3.77 | 1.0 | 2725.1 | 2750 | |
| 54+10.00 | 1.25 | 1.625 | 12 | 7.38 | 0.7 | 0.5 | 0.35 | 12.11 | 2.64063 | 140 | 4477.48 | 139.4 | 1.90 | 4616.83 | 2.38 | 1.0 | 1943.9 | 2000 | |
| 58+35.00 | 1.75 | 2.208 | 20 | 9.06 | 0.7 | 0.5 | 0.35 | 14.98 | 4.87526 | 140 | 10223.9 | 59.3 | 2.16 | 10283.2 | 3.77 | 1.0 | 2725.1 | 2750 | |
| 58+35.00 | 1.25 | 1.625 | 11 | 6.77 | 0.7 | 0.5 | 0.35 | 11.06 | 2.64063 | 140 | 4087.59 | 160.0 | 1.90 | 4247.57 | 2.38 | 1.0 | 1788.4 | 2000 | |
| 58+82.00 | 2.5 | 3.083 | 18 | 5.84 | 0.7 | 0.5 | 0.35 | 9.46 | 9.50489 | 140 | 12590.6 | 71.1 | 1.90 | 12661.6 | 4.75 | 1.0 | 2665.6 | 2750 | |
| 58+94.00 | 2.5 | 3.083 | 18 | 5.84 | 0.7 | 0.5 | 0.35 | 9.46 | 9.50489 | 140 | 12590.6 | 71.1 | 1.90 | 12661.6 | 4.75 | 1.0 | 2665.6 | 2750 | |
| 59+20.00 | 4 | 4.833 | 18 | 3.72 | 0.7 | 0.5 | 0.35 | 5.84 | 23.3579 | 140 | 19092.8 | 71.1 | 1.90 | 19163.9 | 7.60 | 1.0 | 2521.6 | 2750 | |
| 59+70.00 | 2.25 | 2.208 | 20 | 9.06 | 0.7 | 0.5 | 0.35 | 14.98 | 4.87526 | 140 | 10223.9 | 59.3 | 1.90 | 10283.2 | 4.28 | 1.0 | 2405.4 | 2500 | |
| 59+70.00 | 1.5 | 1.917 | 7 | 3.65 | 0.7 | 1 | 0.7 | 7.99 | 3.67489 | 140 | 4112.64 | 313.7 | 1.90 | 4426.29 | 2.85 | 1.0 | 1553.1 | 1750 | |
| 59+94.00 | 3 | 3.667 | 22 | 6.00 | 0.7 | 0.5 | 0.35 | 9.74 | 13.4469 | 140 | 18331.7 | 50.2 | 2.16 | 18381.8 | 6.48 | 1.0 | 2835.4 | 3000 | |
| 60+06.00 | 3 | 3.667 | 22 | 6.00 | 0.7 | 0.5 | 0.35 | 9.74 | 13.4469 | 140 | 18331.7 | 50.2 | 2.16 | 18381.8 | 6.48 | 1.0 | 2835.4 | 3000 | |
| 60+18.00 | 3 | 3.667 | 22 | 6.00 | 0.7 | 0.5 | 0.35 | 9.74 | 13.4469 | 140 | 18331.7 | 50.2 | 2.16 | 18381.8 | 6.48 | 1.0 | 2835.4 | 3000 | |
| 60+40.00 | 1.25 | 1.625 | 22 | 13.54 | 0.7 | 0.5 | 0.35 | 22.66 | 2.64063 | 140 | 8376.4 | 50.2 | 2.15 | 8426.56 | 2.69 | 1.0 | 3130.5 | 3250 | |
| 61+90.00 | 3 | 3.667 | 22 | 6.00 | 0.7 | 0.5 | 0.35 | 9.74 | 13.4469 | 140 | 18331.7 | 50.2 | 2.16 | 18381.8 | 6.48 | 1.0 | 2835.4 | 3000 | |
| 62+02.00 | 3 | 3.667 | 22 | 6.00 | 0.7 | 0.5 | 0.35 | 9.74 | 13.4469 | 140 | 18331.7 | 50.2 | 2.16 | 18381.8 | 6.48 | 1.0 | 2835.4 | 3000 | |

Notes :

| Design Data (Provided by the City of Phoenix) | | |
|---|---|---|
| | Ku = 0.1924 | F. S. = 1.0 |
| For H<=10 | P = 1.0 | He/Bc = 1.7 |
| For H> 10, | P = 0.5 | He/Bc = 1.4 |

* Change in D-Load due to Bf transition

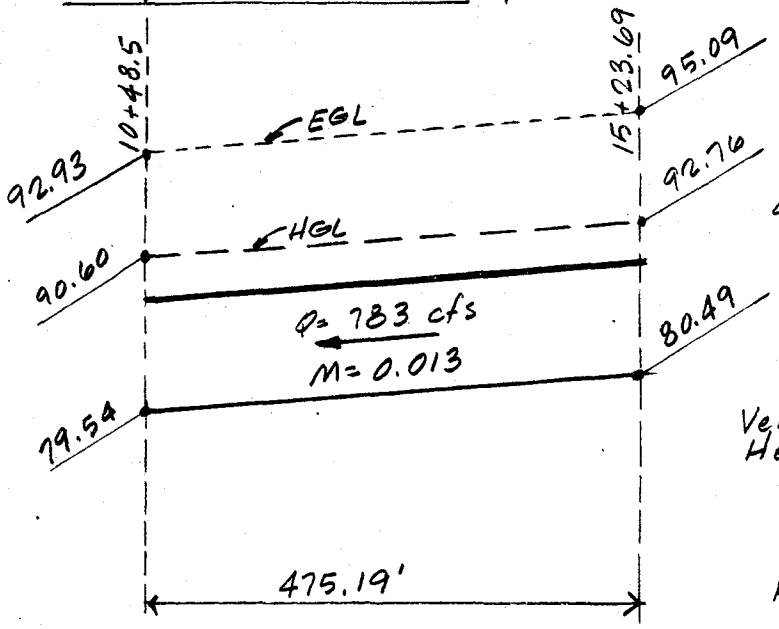
PROJECT ENGINEERING
CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO LATERAL

CHECK OF HYDRAULIC PROPERTIES
SPREADSHEET.

Sht: CK-1
Job# 93041
By: JVB
Date: 4-13-94
Chkd: KS
Date: 5-10-94

Single Barrel Box (8' x 8')




$$S = \frac{80.49 - 79.54}{475.19} = \underline{0.002}\ '/ft \checkmark$$

$$S_{HGL} = \frac{92.76 - 90.60}{475.19} = \underline{0.0045}\ '/ft \checkmark$$

$$V = \frac{Q}{A} = \frac{783}{8 \times 8} = \underline{12.2\ fps} \checkmark$$

$$\text{Vel. Head} = \frac{V^2}{2g} = \frac{(12.2)^2}{2(32.17)} = \underline{2.32\ ft} \checkmark$$

$$R_H = \frac{A}{P} = \frac{8 \times 8}{32} = \underline{2.0}$$

$$S_F = \left[\frac{Vn}{1.486 (R_H)^{2/3}}\right]^2$$

$$= \left[\frac{12.2\ (0.013)}{1.486\ (2.0)^{2/3}}\right]^2 = \underline{0.0045}\ '/cf \checkmark$$

$$H_L = S_F \times L = 0.0045\ (475.19) = 2.14$$

$$EGL = 92.93 + 2.14 = \underline{95.07'} \checkmark$$

$$HGL = EGL - \frac{V^2}{2g} = 95.07 - 2.32 = \underline{92.75'}$$

$$\text{Hydo. Head} = HGL - \text{Invert}$$
$$= 92.75 - 80.49 = \underline{12.26'} \checkmark$$

PROJECT ENGINEERING
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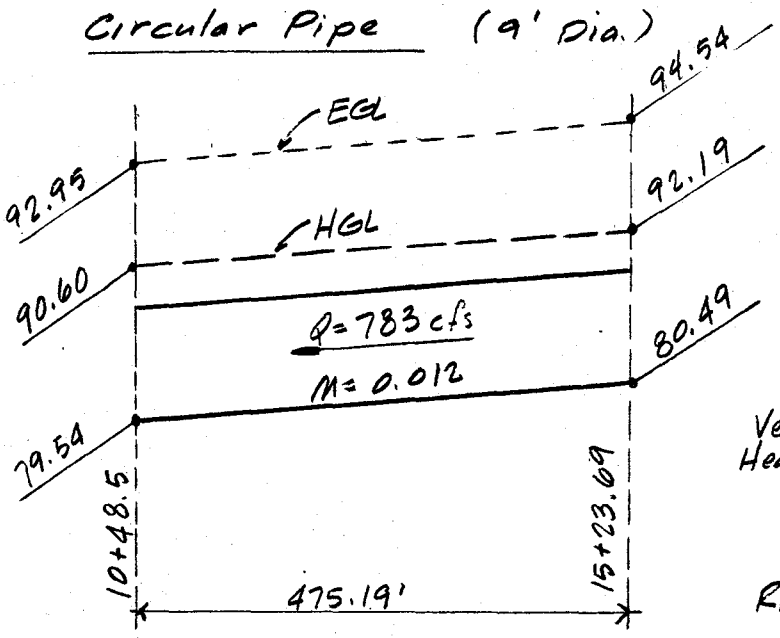
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DR. LATERAL

CHECK OF HYDRAULIC PROPERTIES
SPREADSHEAT

Sht: CK-2
Job# 93041
By: JVB
Date: 4-13-94
Chkd: KS
Date: 5-10-94

Circular Pipe (9' Dia.)




$S = \underline{0.002}\ '/ft$ ✓

$S_{HGL} = \dfrac{92.19 - 90.60}{475.19} = \underline{0.0033}$ ✓

$V = \dfrac{Q}{A} = \dfrac{783}{63.62} = \underline{12.3\ fps}$ ✓

$\text{Vel Head} = \dfrac{V^2}{2g} = \underline{2.35'}$ ✓

$R_H = \dfrac{A}{P} = \dfrac{63.62}{28.27} = 2.25$

$A = \dfrac{\pi D^2}{4} = 63.62\ ft^2$

$C = \pi D = 28.27\ ft$

$S_F = \left[\dfrac{Vn}{1.486\,(R_H)^{2/3}}\right]^2$

$= \left[\dfrac{12.3\,(0.012)}{1.486\,(2.25)^{2/3}}\right]^2 = \underline{0.0033}$ ✓

$H_L = S_F \times L = 0.0033\,(475.19) = 1.57$

$EGL = 92.93 + 1.57 = \underline{94.50}$ ✓

$HGL = EGL - \dfrac{V^2}{2g}$

$= 94.50 - 2.35 = \underline{92.15}$ ✓

$\text{Hydro Head} = HGL - Invert$

$= 92.15 - 80.49 = \underline{11.67'}$ ✓

PROJECT ENGINEERING CONSULTANTS, LTD.
3130 N. 35th AVENUE, SUITE 1
PHOENIX, ARIZONA 85017

CAMPO BELLO DRIVE LATERAL

CONNECTOR PIPES IN SERIES
CHECK OF SPREADSHEET

Sht: CK. 3
Job# 93041
By: K SHORT
Date: 5-19-94
Chkd: JVB
Date: 5-25-94

STATION 51+40

NEW M-1, L=10' (1) into M-1, L=10' (2) into 8' SD

$Q_1$ = 5 CFS
$Q_2$ = 5 CFS
TOTAL = 10 CFS

$T/C_1$ ELEV. = 1418.37
$T/C_2$ ELEV. = 1418.49
G = −0.08

$HGL_2$ ELEV. = 1412.14

CONNECTOR PIPE ① AS WITH ALL CONNECTOR PIPES MUST BE AT LEAST 15" DIA ACCORDING TO CITY OF PHOENIX STANDARDS.

Minimum depth for South C.B. 15" connector pipe

$$V_{①} = \frac{Q}{A} = \frac{5}{\pi/4\,(15/12)^2} = 4.07 \text{ fps}$$

$$V_1 = 1.16 + \frac{1.5(4.07)^2}{2\times 32.2} + \frac{15}{12} = 2.80 \longrightarrow$$ must be min. 4'-0" as per detail.

USE $V_1$ = 4'-0"

HEAD LOSS FOR ①

from Manning's Eqn. (flowing full) S = 0.0051

$$H_{①} = \frac{1.5(4.07)^2}{2\times 32.2} + (42\times 0.0051) = 0.60 \text{ ft.}$$

Minimum depth for North C.B. 15" connector pipe

$$V_{②} = \frac{Q}{A} = \frac{10}{\pi/4\,(15/12)^2} = 8.15 \text{ fps}$$

$$V_2 = 1.16 + \frac{1.5(8.15)^2}{2\times 32.2} + \frac{15}{12} + 0.60 - (-0.08) = 4.68'$$

USE $V_2$ = 4'-9"

HEAD loss for ②

from Manning's Eqn. (flowing full) S = 0.0204

$$H_{②} = \frac{1.5(8.15)^2}{2\times 32.2} + (14\times 0.0204) = 1.83 \text{ ft.}$$

Available head = 1418.37 − 1.16 − 1412.14 = 5.07
head loss = 0.60 + 1.83 = 2.43 → O.K.

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CAMPO BELLO DRIVE LATERAL

CONNECTOR PIPES IN SERIES

Sht: CK-4
Job# 93041
By: K. Short
Date: 5-20-94
Chkd: JVB
Date: 5-25-94

Station 54+10

NEW M-1, $L_1$=17' INTO ① M-1, $L_2$=17' into ② S.D.

$Q_1$ = 9.3 CFS
$Q_2$ = 9.3 CFS
TOTAL = 18.6 CFS

$T/C_1$ ELEV = 1419.66
$T/C_2$ ELEV = 1420.19
G = -0.53

$HGL_2$ ELEV = 1413.96

Connector pipe ① as with all connector pipes must be at least 15" dia according to City of Phoenix standards.

Minimum depth for South C.B. 15" connector pipe

$$V_① = \frac{Q}{A} = \frac{9.3}{\pi/4\,(15/12)^2} = 7.58 \text{ fps}$$

$$V_1 = 1.16 + \frac{1.5(7.58)^2}{2 \times 32.2} + \frac{15}{12} = 3.75' \longrightarrow$$ must be min 4'-0" as per detail

USE $V_1$ = 4'-0"

HEAD loss for ①

from Manning's Eqn. (flowing full) S = 0.0177

$$H_① = \frac{1.5(4.97)^2}{2 \times 32.2} + (42 \times 0.0177) = 2.08 \text{ ft.}$$

Minimum depth for North C.B. 21" connector pipe

$$V_② = \frac{Q}{A} = \frac{18.6}{\pi/4\,(21/12)^2} = 7.73 \text{ fps}$$

$$V_2 = 1.16 + \frac{1.5(7.73)^2}{2 \times 32.2} + \frac{21}{12} + 2.08 - (-0.53) = 6.91$$

USE $V_2$ = 7'-0"

HEAD loss for ②

from Manning's Eqn. (flowing full) S = 0.0117

$$H_② = \frac{1.5(7.73)^2}{2 \times 32.2} + (14 \times 0.0117) = 1.56 \text{ ft}$$

Available head = 1419.66 - 1.16 - 1413.96 = 4.54
head loss = 2.08 + 1.56 = 3.64 → O.K.

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CAMPO BELLO DRIVE LATERAL
SUMP TYPE CATCH BASIN

Sht: ST-1
Job# 93041
By: JVB
Date: 6-15-94
Chkd:
Date:

**JOB DESCRIPTION:**
Structural Design for Catch Basin
Sta. 49+74

**CLIENT:** Flood Control District of Maricopa County

**CODE:** AASHTO Standard Specs. for Highway Design

**ALLOWABLE STRESSES:**

Soil Bearing: $f_p$ = 2500 psf (Assumed)
Concrete: $f'_c$ = 3000 psi (Design); 3500 psi (Actual)
Reinforcing: Grade 60
Struct Steel: A36
Welding: E70 Electrodes

**LOADING:**

Vertical LL: HS20-44

Passive Earth: 200 pcf

Active Earth: 35 psf (Unrestrained at Top)
60 psf (Restrained at Top)

Hydrostatic: None (Exterior)
62.4 psf (Interior)

Backfill Soil Wt: 140 pcf (Assume ABC)

**TABLE OF CONTENTS:**

ST1 Cover
ST2 Design Sketch
ST3 Main Beam Design
ST4-5 Concrete Wall Design

Registered Professional Engineer (Structural)
CERTIFICATE NO. 20398
JOHN V. BERGHIAN
Date Signed 6-15-94
ARIZONA, U.S.A.

REV. 10-10-94

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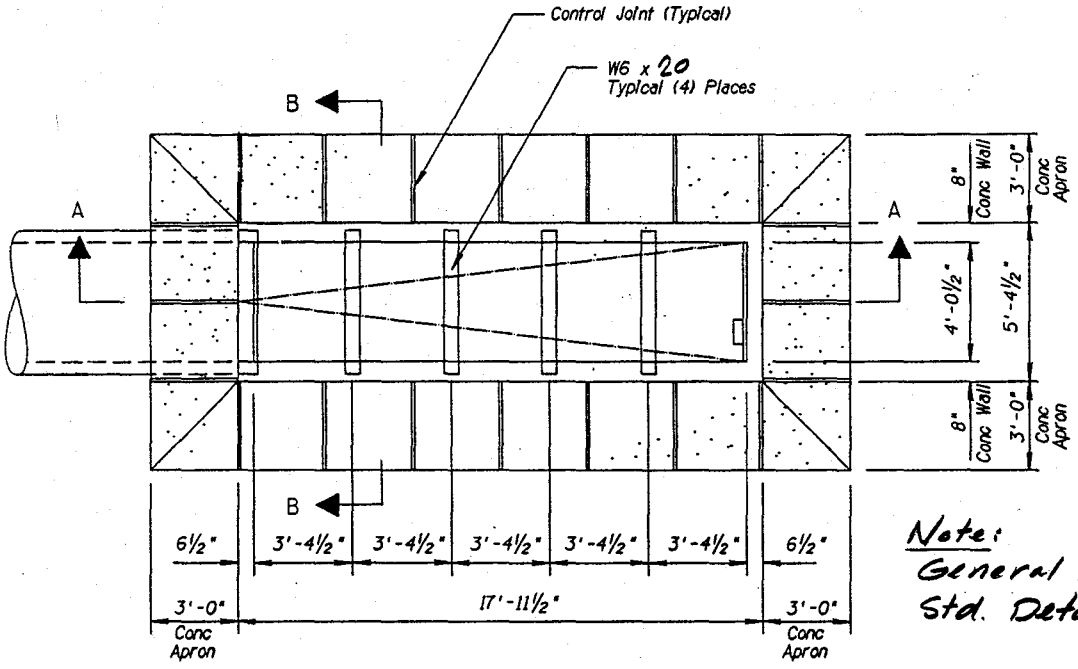
Campo Bello Drive Lateral

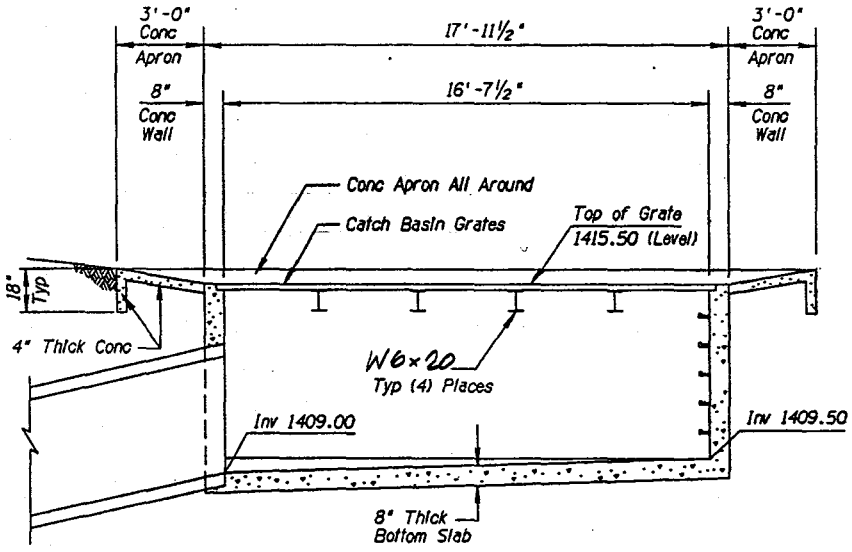
Design Sketch

Sht: ST-2
Job# 93041
By: JVB
Date: 6-15-94
Chkd:
Date:

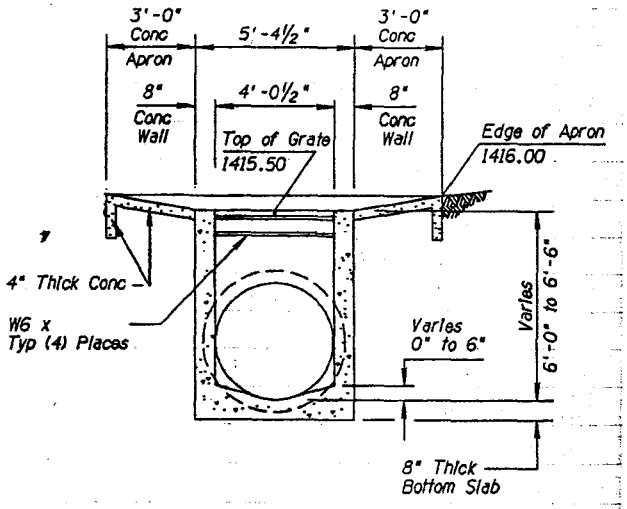



PLAN VIEW

Note:
General design per C.O.P.
Std. Detail P-1570




SECTION A-A




SECTION B-B

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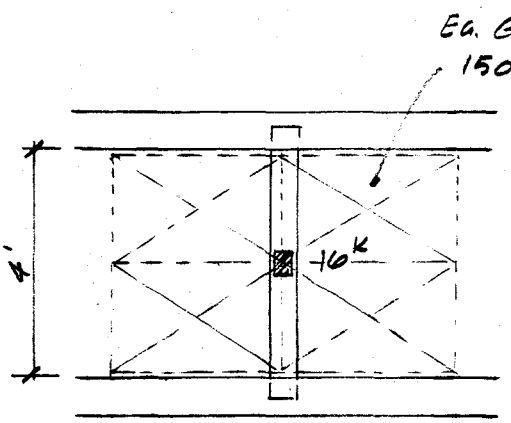
Campo Bello Drive Lateral

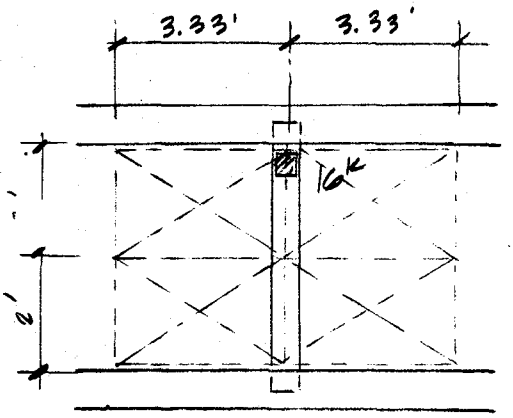
Main Beam Design
HS20-44 Loading

Sht: ST-3
Job# 93041
By: JVB
Date: 6-14-94
Chkd:
Date:




Load Case I

$$M_{MAX} = \frac{16.3\,(4)}{4} = \underline{\underline{16.3^{k'}}}$$




Load Case II

$$R_{MAX} = \underline{\underline{16.3^{k}}}$$

$$F_b = \frac{50 \times 10^6\, C_b}{S_{xc}} \left( \frac{I_{yc}}{l} \right) \sqrt{0.772 \frac{J}{I_{yc}} + 9.87 \left( \frac{d}{l} \right)^2} \leq \underline{\underline{0.55\, F_y}}$$

Use!

$F_b = \underline{\underline{19.8\ KSI}}$

$F_v = \underline{\underline{12.0\ KSI}}$

Per AASHTO Table 10.32.1 A

$$S_R = \frac{M}{F_b} = \frac{16.3\,(12)}{19.8} \times 1.30 = \underline{\underline{12.9\ in^3}}$$

Impact

$$A_R = \frac{V}{F_V} = \frac{16.3}{12.0} \times 1.30 = \underline{\underline{1.8\ in^2}}$$

Use: W6 x 20
A = 5.87
S = 13.4

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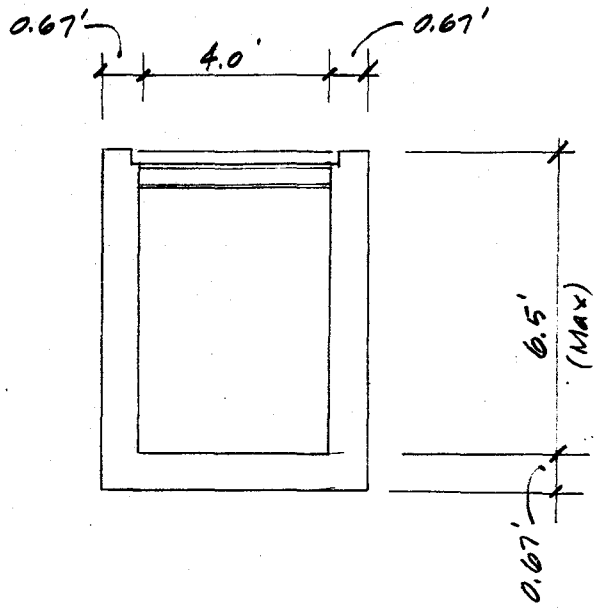
Concrete Wall Design

Sht: ST-4
Job# 93041
By: NB
Date: 6-14-94
Chkd:
Date:



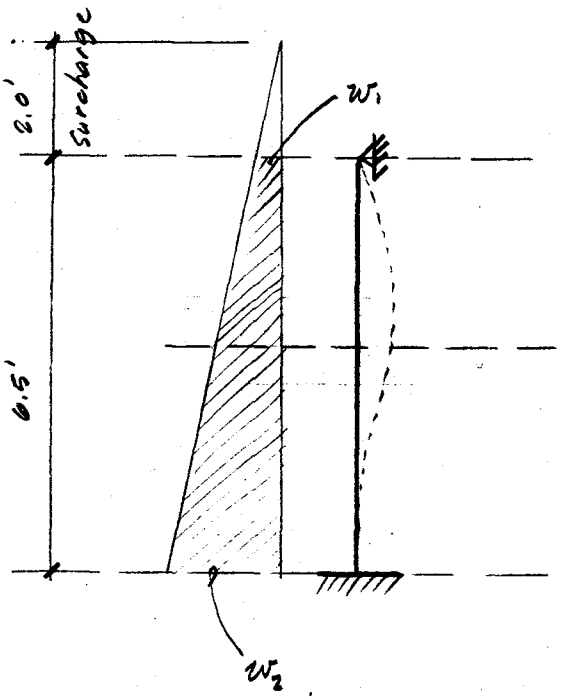

Design Assumptions

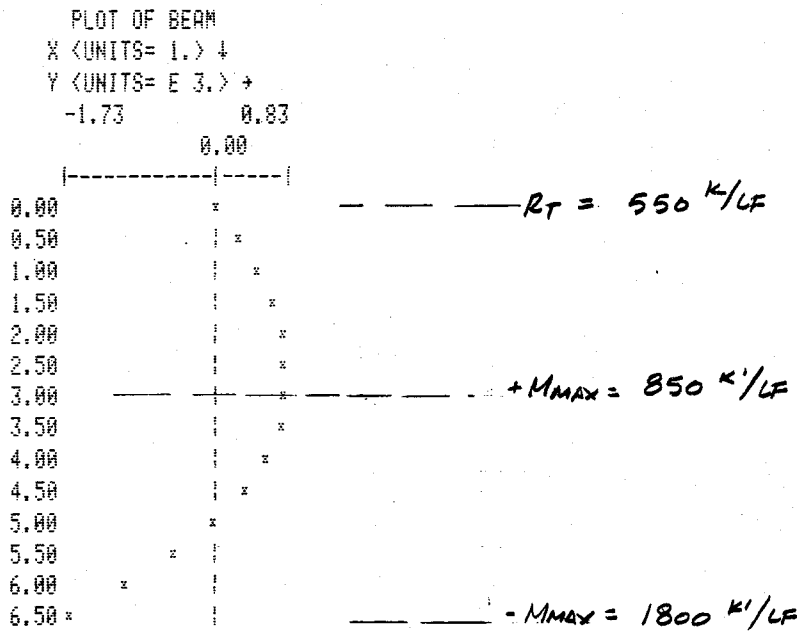
$\gamma_{active} = 60$ pcf (Restrained)

$w_1 = \gamma h = 60(2.0) = 120$ psf/LF

$w_2 = 120 + 60(6.5) = 510$ psf/LF

Analyze as Propped Beam



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Campo Bello Drive Lateral

Concrete Wall Design

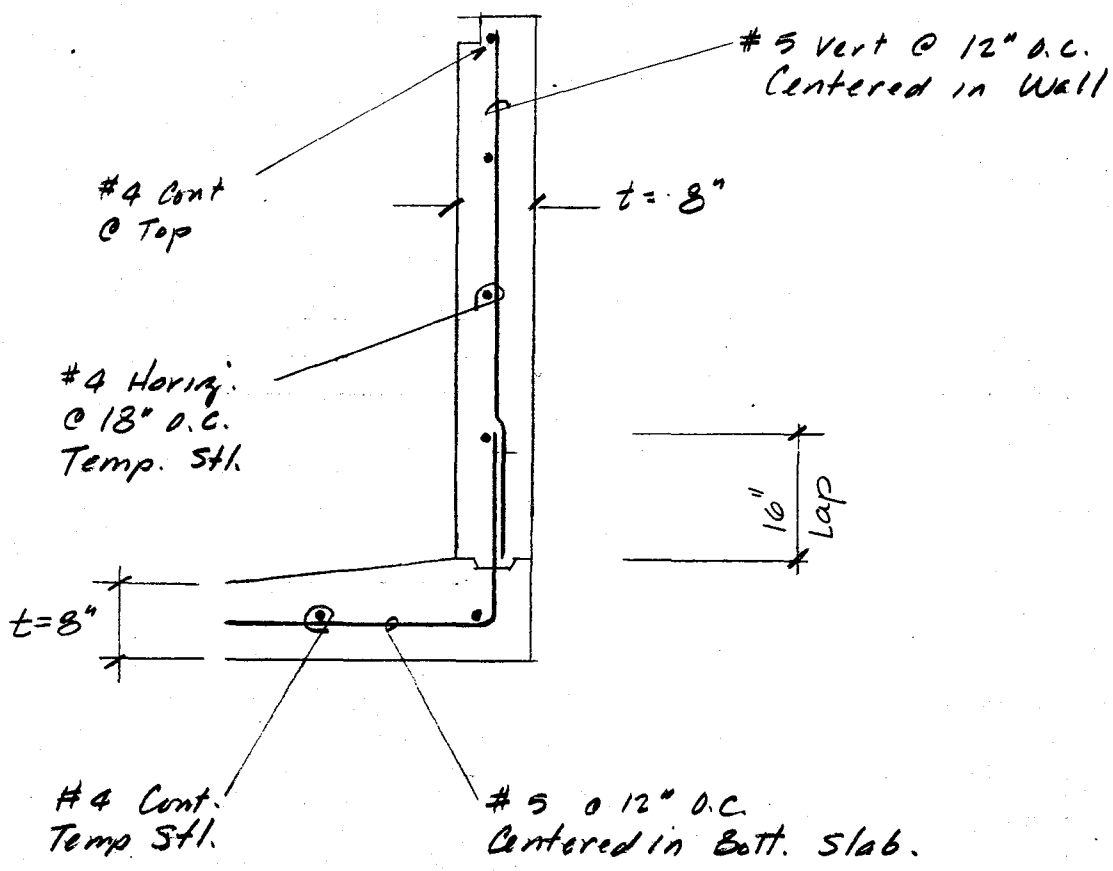
Sht: ST-5
Job# 93041
By: JVB
Date: 6-14-94
Chkd:
Date:

Vert. Reinf

(Assume Centered in wall)

$$A_s = \frac{M}{\phi d} = \frac{1.8}{1.76(4.0)} = \underline{0.26\ in^2/ft} \qquad \underline{\#5\ @\ 12"\ o.c.} \leftarrow$$

Horiz. Reinf.

(Temp Steel)

$$n = 0.125 \times 1.5 = \underline{0.20\ in^2/18"} \qquad \underline{\#4\ @\ 18"\ o.c.} \leftarrow$$