Design Data Report
Final Submittal

October 2005

Bethany Home/Grand Canal Flood Control Project

Bethany Home Outfall Channel – Reach C

83rd Avenue to 73rd Avenue

Project No. 2004C 055, PCN No. 620 03 32

Prepared for:
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TABLE OF CONTENTS

HYDROLOGY

CHANNEL GEOMETRY

HYDRAULICS

TRAFFIC CONTROL

UTILITY POTHOLE DATA

RIGHT OF WAY

STRUCTURAL CALCULATIONS

QUANTITY AND COST CALCULATIONS

CHANNEL GEOMETRY

BETHANY HOME OUTFALL CHANNEL CENTERLINE GEOMETRY
REACH-C 90% SUBMITTAL

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            Project Name: BETHANY HOME OUTFALL CHANNEL
             Description: REACH "C" 90% Geometry
Horizontal Alignment Name: 300rev
             Description:
                   Style: centerline
            Input Factor: 1.00
                                          STATION      NORTHING       EASTING

Element: Linear
            POB (        )            120+30.73    918072.580    603062.577
             PC (        )            120+39.86    918072.536    603071.706
        Tangent Direction:       S 89^43'17" E
           Tangent Length:                9.129

Element: Circular
             PC (        )            120+39.86    918072.536    603071.706
             PI (        )            121+93.83    918071.787    603225.675
             CC (        )                         917772.539    603070.248
             PT (        )            123+24.37    917946.257    603314.833
                  Radius:               300.000
                   Delta:            54^20'13" Right
  Degree of Curvature(Arc):          19^05'55"
                  Length:               284.508
                 Tangent:               153.971
                   Chord:               273.965
          Middle Ordinate:               33.100
                 External:               37.205
        Tangent Direction:       S 89^43'17" E
         Radial Direction:       S  0^16'43" W
          Chord Direction:       S 62^33'11" E
         Radial Direction:       S 54^36'56" W
        Tangent Direction:       S 35^23'04" E

Element: Linear
             PT (        )            123+24.37    917946.257    603314.833
             PC (        )            124+67.04    917829.941    603397.447
        Tangent Direction:       S 35^23'04" E
           Tangent Length:               142.669

Element: Circular
             PC (        )            124+67.04    917829.941    603397.447
             PI (        )            124+76.57    917822.166    603402.970
             CC (        )                         917656.223    603152.862
             PT (        )            124+86.10    917814.055    603407.987
                  Radius:               300.000
                   Delta:             3^38'30" Right
  Degree of Curvature(Arc):          19^05'55"
                  Length:                19.068
                 Tangent:                 9.537
                   Chord:                19.065
          Middle Ordinate:                 0.151
                 External:                 0.152
        Tangent Direction:       S 35^23'04" E
         Radial Direction:       S 54^36'56" W
          Chord Direction:       S 33^33'49" E
         Radial Direction:       S 58^15'26" W
        Tangent Direction:       S 31^44'34" E

Element: Linear
             PT (        )            124+86.10    917814.055    603407.987
             PC (        )            128+13.40    917535.719    603580.178
        Tangent Direction:       S 31^44'34" E
           Tangent Length:               327.293

Element: Circular
             PC (        )            128+13.40    917535.719    603580.178
             PI (        )            128+22.93    917527.609    603585.196
             CC (        )                         917693.551    603835.304
             PT (        )            128+32.46    917519.833    603590.718
                  Radius:               300.000
                   Delta:             3^38'30" Left
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  Degree of Curvature(Arc):          19^05'55"
                    Length:             19.068
                   Tangent:              9.537
                     Chord:             19.064
            Middle Ordinate:              0.151
                  External:               0.152
          Tangent Direction:      S 31^44'34" E
           Radial Direction:      S 58^15'26" W
            Chord Direction:      S 33^33'49" E
           Radial Direction:      S 54^36'56" W
          Tangent Direction:      S 35^23'04" E

Element: Linear
               PT (        )          128+32.46    917519.833    603590.718
               PC (        )          128+72.24    917487.405    603613.751
          Tangent Direction:      S 35^23'04" E
             Tangent Length:             39.776

Element: Circular
               PC (        )          128+72.24    917487.405    603613.751
               PI (        )          128+90.71    917472.347    603624.445
               CC (        )                       917661.122    603858.336
               PT (        )          129+09.13    917458.716    603636.906
                     Radius:            300.000
                      Delta:           7^02'44" Left
  Degree of Curvature(Arc):          19^05'55"
                    Length:             36.891
                   Tangent:             18.469
                     Chord:             36.867
            Middle Ordinate:              0.567
                  External:               0.568
          Tangent Direction:      S 35^23'04" E
           Radial Direction:      S 54^36'56" W
            Chord Direction:      S 38^54'26" E
           Radial Direction:      S 47^34'12" W
          Tangent Direction:      S 42^25'48" E

Element: Linear
               PT (        )          129+09.13    917458.716    603636.906
               PI (        )          147+86.32    916073.156    604903.427
          Tangent Direction:      S 42^25'48" E
             Tangent Length:           1877.193

Element: Linear
               PI (        )          147+86.32    916073.156    604903.427
               PI (        )          152+52.64    915733.167    605222.575
          Tangent Direction:      S 43^11'21" E
             Tangent Length:            466.313

Element: Linear
               PI (        )          152+52.64    915733.167    605222.575
               PC (        )          154+24.38    915610.663    605342.937
          Tangent Direction:      S 44^29'41" E
             Tangent Length:            171.739

Element: Circular
               PC (        )          154+24.38    915610.663    605342.937
               PI (        )          154+62.00    915583.822    605369.310
               CC (        )                       915400.410    605128.943
               PT (        )          154+99.24    915551.299    605388.236
                     Radius:            300.000
                      Delta:          14^17'55" Right
  Degree of Curvature(Arc):          19^05'55"
                    Length:             74.868
                   Tangent:             37.629
                     Chord:             74.673
            Middle Ordinate:              2.332
                  External:               2.351
          Tangent Direction:      S 44^29'41" E
           Radial Direction:      S 45^30'19" W
            Chord Direction:      S 37^20'44" E
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          Radial Direction:      S 59^48'14" W
         Tangent Direction:      S 30^11'46" E

Element: Linear
              PT (        )          154+99.24    915551.299    605388.236
              PC (        )          155+19.49    915533.800    605398.419
         Tangent Direction:      S 30^11'46" E
            Tangent Length:             20.246

Element: Circular
              PC (        )          155+19.49    915533.800    605398.419
              PI (        )          155+50.00    915507.427    605413.766
              CC (        )                       915684.688    605657.711
              PT (        )          155+80.31    915484.684    605434.108
                    Radius:            300.000
                     Delta:          11^36'55" Left
  Degree of Curvature(Arc):          19^05'55"
                    Length:             60.817
                   Tangent:             30.513
                     Chord:             60.713
           Middle Ordinate:              1.540
                  External:              1.548
         Tangent Direction:      S 30^11'46" E
          Radial Direction:      S 59^48'14" W
           Chord Direction:      S 36^00'14" E
          Radial Direction:      S 48^11'19" W
         Tangent Direction:      S 41^48'41" E

Element: Linear
              PT (        )          155+80.31    915484.684    605434.108
              PI (        )          156+11.93    915461.116    605455.189
         Tangent Direction:      S 41^48'41" E
            Tangent Length:             31.620

Element: Linear
              PI (        )          156+11.93    915461.116    605455.189
              PC (        )          162+94.51    914957.283    605915.704
         Tangent Direction:      S 42^25'41" E
            Tangent Length:            682.584

Element: Circular
              PC (        )          162+94.51    914957.283    605915.704
              PI (        )          163+15.35    914941.899    605929.765
              CC (        )                       915159.008    606136.403
              PT (        )          163+36.13    914928.615    605945.825
                    Radius:            299.000
                     Delta:           7^58'30" Left
  Degree of Curvature(Arc):          19^09'45"
                    Length:             41.617
                   Tangent:             20.842
                     Chord:             41.584
           Middle Ordinate:              0.724
                  External:              0.726
         Tangent Direction:      S 42^25'41" E
          Radial Direction:      S 47^34'19" W
           Chord Direction:      S 46^24'56" E
          Radial Direction:      S 39^35'49" W
         Tangent Direction:      S 50^24'11" E

Element: Linear
              PT (        )          163+36.13    914928.615    605945.825
              PC (        )          163+66.42    914909.308    605969.165
         Tangent Direction:      S 50^24'11" E
            Tangent Length:             30.290

Element: Circular
              PC (        )          163+66.42    914909.308    605969.165
              PI (        )          163+87.36    914895.958    605985.304
              CC (        )                       914677.374    605777.312
              PT (        )          164+08.24    914880.502    605999.439
                    Radius:            301.000
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                    Delta:          7^57'39" Right
  Degree of Curvature(Arc):        19^02'07"
                  Length:             41.822
                 Tangent:             20.945
                   Chord:             41.789
          Middle Ordinate:              0.726
                 External:              0.728
        Tangent Direction:      S 50^24'11" E
         Radial Direction:      S 39^35'49" W
          Chord Direction:      S 46^25'21" E
         Radial Direction:      S 47^33'29" W
        Tangent Direction:      S 42^26'31" E

Element: Linear
             PT (        )          164+08.24    914880.502    605999.439
             PI (        )          179+29.89    913757.583    607026.314
        Tangent Direction:      S 42^26'31" E
           Tangent Length:           1521.650

Element: Linear
             PI (        )          179+29.89    913757.583    607026.314
             PI (        )          184+12.24    913403.453    607353.804
        Tangent Direction:      S 42^45'42" E
           Tangent Length:            482.347

Element: Linear
             PI (        )          184+12.24    913403.453    607353.804
             PI (        )          186+43.96    913221.892    607497.794
        Tangent Direction:      S 38^25'01" E
           Tangent Length:            231.727

Element: Linear
             PI (        )          186+43.96    913221.892    607497.794
             PI (        )          190+56.54    912937.920    607797.095
        Tangent Direction:      S 46^30'20" E
           Tangent Length:            412.579

Element: Linear
             PI (        )          190+56.54    912937.920    607797.095
             PI (        )          191+59.65    912855.839    607859.494
        Tangent Direction:      S 37^14'32" E
           Tangent Length:            103.106

Element: Linear
             PI (        )          191+59.65    912855.839    607859.494
             PC (        )          196+55.80    912490.210    608194.880
        Tangent Direction:      S 42^31'47" E
           Tangent Length:            496.154

Element: Circular
             PC (        )          196+55.80    912490.210    608194.880
             PI (        )          196+76.48    912474.974    608208.855
             CC (        )                       912693.001    608415.958
            PRC (        )          196+97.09    912461.799    608224.788
                  Radius:             300.000
                   Delta:           7^53'05" Left
  Degree of Curvature(Arc):        19^05'55"
                  Length:             41.284
                 Tangent:             20.674
                   Chord:             41.251
          Middle Ordinate:              0.710
                 External:              0.712
        Tangent Direction:      S 42^31'47" E
         Radial Direction:      S 47^28'13" W
          Chord Direction:      S 46^28'19" E
         Radial Direction:      S 39^35'09" W
        Tangent Direction:      S 50^24'51" E

Elements are not coincident

Element: Circular
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            PRC (        )          196+97.09    912460.899    608225.877
             PI (        )          197+19.64    912446.529    608243.257
             CC (        )                       912229.697    608034.708
             PT (        )          197+42.10    912429.721    608258.293
                   Radius:            300.000
                    Delta:           8^35'52" Right
  Degree of Curvature(Arc):          19^05'55"
                   Length:             45.018
                  Tangent:             22.551
                    Chord:             44.976
           Middle Ordinate:              0.844
                  External:              0.846
         Tangent Direction:      S 50^24'51" E
          Radial Direction:      S 39^35'09" W
           Chord Direction:      S 46^06'55" E
          Radial Direction:      S 48^11'01" W
         Tangent Direction:      S 41^48'59" E

Element: Linear
             PT (        )          197+42.10    912429.721    608258.293
             PI (        )          199+27.22    912291.759    608381.716
         Tangent Direction:      S 41^48'59" E
            Tangent Length:            185.113

Element: Linear
             PI (        )          199+27.22    912291.759    608381.716
             PI (        )          200+21.76    912219.744    608442.973
         Tangent Direction:      S 40^23'05" E
            Tangent Length:             94.544

Element: Linear
             PI (        )          200+21.76    912219.744    608442.973
             PC (        )          201+18.14    912148.719    608508.124
         Tangent Direction:      S 42^31'47" E
            Tangent Length:             96.380

Element: Circular
             PC (        )          201+18.14    912148.719    608508.124
             PI (        )          201+45.89    912128.268    608526.882
             CC (        )                       912216.316    608581.816
             PT (        )          201+72.28    912120.409    608553.497
                   Radius:            100.000
                    Delta:          31^01'10" Left
  Degree of Curvature(Arc):          57^17'45"
                   Length:             54.139
                  Tangent:             27.751
                    Chord:             53.481
           Middle Ordinate:              3.642
                  External:              3.779
         Tangent Direction:      S 42^31'47" E
          Radial Direction:      S 47^28'13" W
           Chord Direction:      S 58^02'22" E
          Radial Direction:      S 16^27'03" W
         Tangent Direction:      S 73^32'57" E

Element: Linear
             PT (        )          201+72.28    912120.409    608553.497
             PC (        )          202+18.91    912107.204    608598.219
         Tangent Direction:      S 73^32'57" E
            Tangent Length:             46.631

Element: Circular
             PC (        )          202+18.91    912107.204    608598.219
             PI (        )          202+67.09    912093.562    608644.420
             CC (        )                       911963.344    608555.740
             PT (        )          203+12.14    912055.569    608674.039
                   Radius:            150.000
                    Delta:          35^36'34" Right
  Degree of Curvature(Arc):          38^11'50"
                   Length:             93.225
                  Tangent:             48.173
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Chord:	91.732
Middle Ordinate:	7.184
External:	7.546
Tangent Direction:	S 73^32'57" E
Radial Direction:	S 16^27'03" W
Chord Direction:	S 55^44'40" E
Radial Direction:	S 52^03'37" W
Tangent Direction:	S 37^56'23" E

HYDROLOGY

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MEMORANDUM

To:	**C. Scott Vogel, P.E.**	Date:	**Monday, February 28, 2005**
From:	**Alan B. Morrice, P.E.**	Subject:	**Bethany Home Outfall Channel - Reach B & C Hydrologic Modeling Refinements for Mainline**

I. INTRODUCTION

Since the completion of the Bethany Home / Grand Canal Flood Control Project (BH/GC FCP) Pre-Design Study, several hydrologic parameters were examined and refined with the final design of Phase 2 of the Bethany Home Outfall Channel (BHOC) and the Conditional Letter of Map Revision (CLOMR). Modifications were also made to the hydrologic model by DMJM+HARRIS in conjunction with the hydrology and concept drainage report for the TSA/Cardinals Multipurpose facility which also included improvements associated with the new Glendale Arena. Since that time, refinements have been made to the hydrologic model in conjunction with the continuing design efforts for the BHOC Reaches B and C.

II. ADDITIONAL DESIGN / CONCENTRATION POINT

The previous hydrologic model generally used the same discharge rate for the entire Reach C. Since Reach C is comprised of almost entirely all reinforced concrete box culvert and the costs are relatively high, efforts were made to refine the hydrologic model to try and help that situation. An additional combination point was created near Missourri Avenue within the hydrologic model. The previous model's combination point added three hydrographs (R1421W, RET14E and R1421S) before combining with runoff of the Bethany Home Outfall Channel (BHOC). The revised model combines two of the hydrographs (R1421W and RET14E) with runoff from the BHOC and then separately combines the third hydrograph (R1421S) with BHOC runoff. This refinement allowed 3,300 lineal feet of box culvert to be designed for a discharge that was approximately 110 cfs less.

III. MARYVALE DETENTION BASIN – STAGE / STORAGE / DISCHARGE RELATIONSHIPS

With revisions made to the Maryvale detention basin design since the pre-design and CLOMR, the hydrologic model had to be updated to reflect current design information. These revisions or design refinements affected both storage and discharge relationships with stage or water surface elevation. The storage volumes calculated were similar to those reflected in the previous model although slightly less at lower elevations and slightly higher at higher elevations.

The relationship of discharge with elevation also had to be evaluated. With the aid of CulvertMaster software, the headwater of the downstream culvert was used to establish the tailwater condition for the upstream (75th Avenue to Camelback Road) culvert. This process took several iterations to establish conditions that were similar to those reflected in the HEC-RAS model. Once this new headwater to discharge relationship was developed, it was input into the hydrologic model for the Maryvale Detention Basin reservoir routing.

IV. HYDROLOGIC MODELING RESULTS

The table below presents the results of the most recent hydrologic model for the entire BHOC project due to the refinements associated with Reach B and C final designs.

Location	Concentration Point	100-Year Peak Flow (cfs)
Indian School Road	RDC1B	344
67th Avenue	C@DC1	974
Maryvale Detention basin Inflow	C@DC2	1,598
Maryvale Detention basin Outflow	GCDCo	1,083
75th Avenue	C@DC3A	1,369
Missouri Avenue	C@DC3B	1,479
83rd Avenue	C@DC4	2,893
91st Avenue	CBH5	3,101
95th Avenue	CBH5-2	3,122
Loop 101	CBHAF2	4,469
New River	C8-21W	4,524

The peak flows in the lower reach is slightly higher than those presented in the hydrologic model submitted with the CLOMR however it will have a minimal effect on the 100-year water surface. The floodplain delineation shown in the CLOMR was based upon a water surface coinciding with the top of banks. Therefore, those higher discharges will have no effect on the floodplain limits.

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	2 COMBINED AT									
+		CBH83	1498.	13.33	978.	313.	107.	37.34		
	HYDROGRAPH AT									
+		RDC1B	344.	13.83	99.	25.	8.	34.80		
	ROUTED TO									
+		RDC1B	343.	13.92	99.	25.	8.	34.80		
	HYDROGRAPH AT									
+		RDC1	667.	13.67	226.	63.	21.	40.90		
	2 COMBINED AT									
+		C@DC1	974.	13.67	318.	86.	29.	43.25		
	HYDROGRAPH AT									
+		RGCDC2	687.	13.25	299.	93.	31.	37.08		
	2 COMBINED AT									
+		C@DC2	1598.	13.67	613.	178.	59.	43.25		
	ROUTED TO									
+		GCDCo	1083.	14.33	614.	178.	60.	43.25		
	ROUTED TO									
+		RDC2-3	1082.	14.42	614.	178.	60.	43.25		
	HYDROGRAPH AT									
+		RDC3A	470.	13.33	183.	50.	17.	41.03		
	2 COMBINED AT									
+		C@DC3A	1369.	13.67	775.	222.	74.	50.96		
	HYDROGRAPH AT									
+		RDC3B	127.	13.33	40.	10.	3.	41.03		
	2 COMBINED AT									
+		C@DC3B	1479.	13.50	811.	232.	77.	50.96		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	RDC3-4	1479.	13.58	811.	232.	77.	50.96		
+	2 COMBINED AT	C@DC4	2893.	13.33	1746.	534.	181.	50.96		
+	DIVERSION TO	D83BH	0.	13.33	0.	0.	0.	50.96		
+	HYDROGRAPH AT	DBH83	2893.	13.33	1745.	534.	181.	50.96		
+	ROUTED TO	RBH12A	2892.	13.42	1745.	534.	181.	50.96		
+	ROUTED TO	RBH12B	2879.	13.50	1743.	533.	181.	50.96		
+	ROUTED TO	RBH12C	2874.	13.58	1741.	533.	181.	50.96		
+	HYDROGRAPH AT	SGA8S	126.	13.00	47.	12.	4.	34.46		
+	ROUTED TO	R1021S	119.	13.33	47.	12.	4.	34.46		
+	HYDROGRAPH AT	10-21	586.	12.58	160.	45.	15.	.98		
+	DIVERSION TO	D1021R	410.	12.58	81.	21.	7.	.98		
+	HYDROGRAPH AT	RET10	312.	13.50	84.	24.	8.	.98		
+	HYDROGRAPH AT	S83FW	83.	13.25	39.	10.	3.	34.87		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	R1021W	77.	13.58	39.	10.	3.	34.87		
+	3 COMBINED AT	C10-21	309.	13.83	144.	39.	13.	43.32		
+	DIVERSION TO	D1021W	133.	13.83	62.	17.	6.	43.32		
+	HYDROGRAPH AT	D1021S	176.	13.83	82.	22.	7.	43.32		
+	ROUTED TO	D91det	88.	15.25	63.	20.	7.	43.32		
+	HYDROGRAPH AT	D91GA	327.	13.17	145.	36.	12.	34.46		
+	ROUTED TO	R91G	320.	13.33	145.	36.	12.	34.46		
+	HYDROGRAPH AT	D1021W	133.	13.83	62.	17.	6.	43.32		
+	2 COMBINED AT	C91D	421.	13.33	200.	51.	17.	43.32		
+	DIVERSION TO	S91DW	180.	13.33	85.	21.	7.	43.32		
+	HYDROGRAPH AT	S91DS	241.	13.33	115.	30.	10.	43.32		
+	ROUTED TO	R91H	236.	13.50	114.	30.	10.	43.32		
+	3 COMBINED AT	CBH5	3101.	13.67	1874.	572.	194.	57.17		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	DIVERSION TO	SBH7S	0.	13.50	0.	0.	0.	57.17		
+	HYDROGRAPH AT	SBH7W	3101.	13.67	1874.	572.	194.	57.17		
+	DIVERSION TO	D91BH	0.	.00	0.	0.	0.	57.17		
+	HYDROGRAPH AT	DBH91	3101.	13.67	1874.	572.	194.	57.17		
+	ROUTED TO	RBH13A	3102.	13.67	1874.	572.	194.	57.17		
+	HYDROGRAPH AT	9-21S4	52.	12.33	12.	3.	1.	.07		
+	2 COMBINED AT	CBH5-1	3112.	13.67	1879.	574.	195.	57.24		
+	ROUTED TO	RBH13B	3106.	13.75	1878.	574.	195.	57.24		
+	HYDROGRAPH AT	9-21S3	226.	12.17	41.	14.	5.	.15		
+	DIVERSION TO	D921R3	0.	.00	0.	0.	0.	.15		
+	HYDROGRAPH AT	RET9S3	226.	12.17	41.	14.	5.	.15		
+	2 COMBINED AT	CBH5-2	3122.	13.75	1891.	586.	199.	57.39		
+	ROUTED TO	RBH13C	3113.	13.75	1890.	586.	199.	57.39		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	9-21S2	222.	12.08	33.	12.	4.	.12		
+	DIVERSION TO	D921R2	0.	.00	0.	0.	0.	.12		
+	HYDROGRAPH AT	RET9S2	222.	12.08	33.	12.	4.	.12		
+	2 COMBINED AT	CBH5-3	3124.	13.75	1898.	595.	202.	57.51		
+	HYDROGRAPH AT	SGA9S	0.	.00	0.	0.	0.	35.26		
+	ROUTED TO	R921S	0.	.00	0.	0.	0.	35.26		
+	HYDROGRAPH AT	9-21NE	417.	12.25	82.	26.	9.	.45		
+	DIVERSION TO	D921NR	205.	12.25	38.	11.	4.	.45		
+	HYDROGRAPH AT	RET9NE	212.	12.25	46.	15.	5.	.45		
+	HYDROGRAPH AT	S91DW	180.	13.33	85.	21.	7.	43.32		
+	ROUTED TO	R921W	177.	13.58	85.	21.	7.	43.32		
+	3 COMBINED AT	C9-21N	212.	13.50	122.	35.	12.	44.56		
+	HYDROGRAPH AT	DGAAFS	1316.	13.33	824.	317.	127.	35.26		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	ROUTED TO									
+		RAF2	1312.	13.42	823.	317.	127.	35.26		
	2 COMBINED AT									
+		CAFA	1466.	13.42	907.	341.	136.	45.82		
	ROUTED TO									
+		RAF3	1465.	13.50	906.	341.	136.	45.82		
	HYDROGRAPH AT									
+		9-21S1	112.	12.08	14.	5.	2.	.06		
	2 COMBINED AT									
+		CBHAF1	1469.	13.50	909.	343.	137.	45.88		
	2 COMBINED AT									
+		CBHAF2	4469.	13.67	2775.	913.	337.	58.90		
	HYDROGRAPH AT									
+		9-21W	31.	12.83	13.	4.	1.	.11		
	DIVERSION TO									
+		S99AW	31.	12.83	13.	4.	1.	.11		
	HYDROGRAPH AT									
+		S99AS	0.	12.42	0.	0.	0.	.11		
	ROUTED TO									
+		R99C	0.	12.92	0.	0.	0.	.11		
	2 COMBINED AT									
+		CBH6	4469.	13.67	2775.	913.	337.	59.01		
	DIVERSION TO									
+		D99BH	0.	.00	0.	0.	0.	59.01		
	HYDROGRAPH AT									
+		DBH99	4468.	13.67	2775.	913.	337.	59.01		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	ROUTED TO	RBH14	4461.	13.67	2774.	913.	337.	59.01		
+	HYDROGRAPH AT	8-21E	216.	12.58	55.	14.	5.	.51		
+	HYDROGRAPH AT	S99AW	31.	12.83	13.	4.	1.	.11		
+	ROUTED TO	R821EW	30.	13.25	13.	4.	1.	.11		
+	2 COMBINED AT	C8-21E	216.	12.58	66.	17.	6.	46.01		
+	DIVERSION TO	D821EW	105.	12.67	32.	8.	3.	46.01		
+	HYDROGRAPH AT	D821ES	82.	12.67	25.	6.	2.	46.01		
+	2 COMBINED AT	CBH7	4500.	13.67	2790.	918.	338.	59.51		
+	HYDROGRAPH AT	8-21W	173.	12.42	34.	9.	3.	.27		
+	2 COMBINED AT	C8-21W	4524.	13.67	2803.	925.	341.	59.79		
+	HYDROGRAPH AT	D821EW	105.	12.67	32.	8.	3.	46.01		
+	ROUTED TO	RES8N	0.	19.08	0.	0.	0.	46.01		
+	3 COMBINED AT	NULL5	8880.	13.58	5194.	1641.	585.	1.00		

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	2 COMBINED AT									
+		NULL5A	9847.	13.58	5753.	1798.	638.	1.00		

*** NORMAL END OF HEC-1 ***

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MEMORANDUM

To:	**Jeff R. Minch, P.E.**	Date:	**Tuesday, December 7, 2004**
From:	**Alan B. Morrice, P.E.**	Subject:	**Bethany Home Outfall Channel - Reach B & C Hydrologic Calculations for Local Inflows**

I. INTRODUCTION

Since the completion of the Bethany Home / Grand Canal Flood Control Project (BH/GC FCP) Pre-Design Study, several hydrologic parameters were examined and refined with the final design of Phase 2 of the Bethany Home Outfall Channel (BHOC) and the Conditional Letter of Map Revision (CLOMR). The refined hydrologic (HEC-1) model developed for the CLOMR submittal reflected overall final design conditions for the entire BHOC project. For the remaining phases of final design, the comprehensive hydrologic model has to be integrated with more detailed local drainage area delineations so that the peak flows for each individual inflow location to the BHOC can be estimated. Since most of these smaller local drainage areas are less than 160 acres, the Rational Method was utilized in combination with the results of the HEC-1 model.

II. LOCAL SUB-BASIN RUNOFF ESTIMATION

To aid in the delineation of the numerous local sub-basins adjacent to BHOC - Reaches B & C, topographic mapping that was available was acquired. The available mapping included the detailed mapping along the project corridor combined with the aerial mapping from the Maryvale Area Drainage Master Study (ADMS). Since this mapping did not reflect current development conditions, it was supplemented with property lines as shown on County assessor maps and with field reconnaissance. For Reach B, from Camelback Road to 67th Avenue, seven drainage basins were delineated corresponding to each inflow location to the BHOC. For Reach C, from 83rd Avenue to 75th Avenue, thirteen local sub-basins were delineated which corresponded to each of the BHOC inflow locations. These local individual sub-basins ranged in size from 1.2 to 114 acres. The land use for both reaches was predominantly medium density residential. Peak flow rates were calculated with the Rational Method using the Flood Control District of Maricopa County's (FCDMC) Drainage Design Management System for Windows (DDMSW) software. Peak flow rates were calculated for each local sub-basin for various frequency storms. However, the 100-year storm is of primary importance for this project. Where no additional flow was diverted in these basins from outlying watersheds, these local peak flow values will be used for design.

III. DIVERTED RUNOFF FROM OUTER WATERSHEDS

As presented in the final hydrologic model for the BHOC CLOMR submittal, diversions from streets frequently occurred at arterial intersections and also at mid-mile locations. The street diversions occurring at the mid-mile

locations represented the accumulative diversions along that entire length of street within that particular sub-basin. One task of this project was to use the hydrologic model results and to distribute the diverted flow into components so that it could be combined with the runoff from the various smaller local sub-basins. At some locations, such as at known low points, it was not necessary to distribute the diverted flow along the roadway segment. For this project, these street diversions were integrated with the local sub-basin runoff in various manners based upon the conditions present in the field. Each of the street diversion distribution techniques shall be discussed individually.

Reach C

Along Bethany Home Road, between 83rd and 75th Avenues, the hydrologic model presented a peak flow of 133 cfs that is diverted south while the remaining (532 cfs) is routed west. The southern diversion combines with runoff from the local sub-basin C10. A future storm drain is proposed which will also convey 802 cfs to the west into the BHOC.

Along 75th Avenue, between Bethany Home and Camelback Roads, runoff is primarily contained within the road right-of-way until it approaches the southern portion of the segment where it overflows to the west into the Glendale Park at a low point in the road. The low point occurs since 75th Avenue rises over the Grand Canal near Camelback Road. The hydrologic model reflects a peak discharge of 339 cfs that is diverted west at this location.

Reach B

Along Camelback Road, between 75th Avenue and 67th Avenue, the hydrologic model depicts a peak discharge of 239 cfs that is diverted south. The distribution of this flow along Camelback and into the local sub-basins was done in the same manner as the ADMS, primarily based upon the right-of-way width of the intersecting residential and collector streets.

Along 67th Avenue, between Camelback Road and the Grand Canal, a similar condition exists as with 75th Avenue where a low point occurs north of the canal. However, due to the relative grades of the intersecting streets, some runoff is diverted west prior to reaching the low point north of the Grand Canal. The hydrologic model indicates that 144 cfs is diverted south onto 67th Avenue at Camelback Road and a total of 523 cfs is diverted west between Camelback Road and the canal. As mentioned earlier, the majority of this runoff that is diverted west will occur at the low point. For the purposes of this study, it was assumed that the upper basin diversion would be consistent with the rating in the ADMS for the discharge (144 cfs) which is approximately 49 percent. Also, it was assumed that the runoff that is diverted west will generally be replaced with an equitable amount of runoff coming from the east as we continue south. The remaining diverted runoff for this segment (239 cfs) will discharge west at the low point north of the Grand Canal.

IV. COMBINED TOTAL RUNOFF TO BHOC

The peak flows presented in the hydrologic model for the two main sub-basins which include the local drainage basins for Reaches B and C (24-21N and 14-21E) were reviewed. It was noticed that the runoff for each of these sub-basin combination points, C2421N and C1421E, were significantly lower than the simple addition of the peak flow rates that were combined. This is due to the timing of the peaks of the hydrographs in that they differed by over an hour. For each of these sub-basins, the ratio of the concentration point peak flow to the sum of the combined peak flow was calculated. These ratios were 0.59 and 0.76 for basins 24-21N (Reach B) and 14-21E (Reach C), respectively. These same ratios, for their respective reaches, were applied to the combined flows that involved local sub-basins and diverted street flows. This reduced peak was compared to both the

local basin peak and the diverted peak flow and whichever of the three values was greatest is recommended for design. The following table presents the selected final peak discharges. The Drainage Basin Maps enclosed with this memorandum presents the various local sub-basins as well as concentration points for the combined discharges.

Sub Basin	**Concentration Point**	**100-Year Peak Flow** (cfs)
Street	CP1	532
Storm Drain (future)	CP2	802
C02		12
C04		41
C06		37
C08		8
	CP3	234
C12		34
C14		33
C16		128
C18		37
C20		40
C22		64
C24		7
C26		29
C28		13
	CP4	339
Street	CP5	187
Storm Drain (future)	CP6	501
	CP7	92
	CP8	83
	CP9A	374
	CP10	153
	CP9B	520
B08		24
B10		24
	CP11	239

Sub-basin peak flows do not reflect any combination with diverted street flow from outlying watersheds. Concentration point CP9B is the combination of CP9A and CP10 and was only calculated as a potential scenario for design purposes.

For locations along the project where very minimal drainage areas were involved although some flow interception was necessary, peak flow rates were not calculated. For these locations, engineering judgment was utilized for appropriate inlet sizing.

Flood Control District of Maricopa County
BHOC_B_C - Bethany Home Outfall Channel - Reaches B & C

Sub Basin Data - Rational Method

 12/6/2004

Sub Basin	Sub Basin Parameters					Return Period (Years)					
	Area (acres)	Length (ft)	Slope (ft/ft)	Kb		2	5	10	25	50	100
C02	2.30	480	0.0042	0.075	**Q (cfs)**	3	5	6	8	10	12
C04	9.50	1,190	0.0029	0.063	**Q (cfs)**	9	15	19	26	34	41
C06	8.90	1,010	0.0026	0.067	**Q (cfs)**	9	14	17	25	31	37
C08	1.90	600	0.0017	0.076	**Q (cfs)**	2	3	4	5	7	8
C10	55.40	3,300	0.0029	0.053	**Q (cfs)**	37	62	77	113	144	175
C12	7.40	1,180	0.0051	0.068	**Q (cfs)**	9	13	16	22	28	34
C14	6.60	890	0.0058	0.069	**Q (cfs)**	9	13	16	22	28	33
C16	86.00	4,660	0.0019	0.074	**Q (cfs)**	26	43	56	80	108	128
C18	9.70	1,820	0.0038	0.066	**Q (cfs)**	9	13	17	24	31	37
C20	10.40	1,700	0.0035	0.066	**Q (cfs)**	9	15	18	26	33	40
C22	16.40	1,630	0.0034	0.063	**Q (cfs)**	15	23	30	41	54	64
C24	1.20	400	0.0083	0.079	**Q (cfs)**	2	3	4	5	6	7
C26	5.60	730	0.0066	0.070	**Q (cfs)**	8	12	14	20	25	29
C28	6.40	635	0.0157	0.130	**Q (cfs)**	4	5	6	9	11	13
B02	24.80	1,670	0.0027	0.061	**Q (cfs)**	21	34	42	61	77	92
B04	25.10	2,190	0.0029	0.073	**Q (cfs)**	18	28	36	53	68	83
B06	114.20	3,960	0.0038	0.052	**Q (cfs)**	74	126	156	230	294	361

* Non default value

Sub Basin Data - Rational Method

Sub Basin	Sub Basin Parameters					Return Period (Years)					
	Area (acres)	Length (ft)	Slope (ft/ft)	Kb		2	5	10	25	50	100
B07	31.80	2,060	0.0035	0.059	**Q (cfs)**	27	43	54	78	99	118
B67	146.00	3,960	0.0038	0.050	**Q (cfs)**	104	161	209	294	376	467
B08	6.70	1,640	0.0026	0.069	**Q (cfs)**	5	9	11	15	20	24
B10	5.90	875	0.0019	0.069	**Q (cfs)**	6	9	12	16	20	24
B12	4.30	470	0.0070	0.071	**Q (cfs)**	7	10	12	17	21	25

Flood Control District of Maricopa County
BHOC_B_C - Bethany Home Outfall Channel - Reaches B & C

Land Use Data Rational Method

 12/6/2004

Sub Basin ID	Land Use Code	Area	Area Pct (%)	C10 Value	Kb Type	Kb
C02	M.D.R.	2.320	100.0	0.65	Low	0.08
C04	M.D.R.	8.000	84.3	0.65	Low	0.07
	IND	1.490	15.7	0.72	Min	0.04
C06	M.D.R.	8.940	100.0	0.65	Low	0.07
C08	M.D.R.	1.890	100.0	0.65	Low	0.08
C10	M.D.R.	46.400	83.8	0.65	Low	0.06
	IND	8.970	16.2	0.72	Min	0.03
C12	M.D.R.	7.400	100.0	0.65	Low	0.07
C14	M.D.R.	6.550	100.0	0.65	Low	0.07
C16	M.D.R.	59.400	69.1	0.65	Low	0.06
	ROWCROP	26.580	30.9	0.16	Hi	0.11
C18	M.D.R.	9.660	100.0	0.65	Low	0.07
C20	M.D.R.	10.380	100.0	0.65	Low	0.07
C22	M.D.R.	16.350	100.0	0.65	Low	0.06
C24	M.D.R.	1.210	100.0	0.65	Low	0.08
C26	M.D.R.	5.570	100.0	0.65	Low	0.07
C28	PARK	6.380	100.0	0.25	Hi	0.13
B02	M.D.R.	24.810	100.0	0.65	Low	0.06
B04	M.D.R.	9.770	39.0	0.65	Low	0.07
	M.F.R.	12.850	51.3	0.75	Low	0.07
	PARK	2.430	9.7	0.25	Hi	0.14
B06	M.F.R.	1.250	1.1	0.75	Low	0.08
	COMM	0.680	0.6	0.76	Min	0.04
	M.D.R.	112.300	98.3	0.65	Low	0.05

* Custom Value (not default value)

Land Use Data Rational Method

Sub Basin ID	Land Use Code	Area	Area Pct (%)	C10 Value	Kb Type	Kb
B07	M.D.R.	31.800	100.0	0.65	Low	0.06
B67	M.F.R.	1.250	0.9	0.75	Low	0.08
	COMM	0.680	0.5	0.76	Min	0.04
	M.D.R.	144.100	98.7	0.65	Low	0.05
B08	M.D.R.	6.690	100.0	0.65	Low	0.07
B10	M.D.R.	5.910	100.0	0.65	Low	0.07
B12	M.D.R.	4.310	100.0	0.65	Low	0.07

Bethany Home Outfall Channel - Reaches B & C

Flood Control District of Maricopa County

Peak Flow Summary

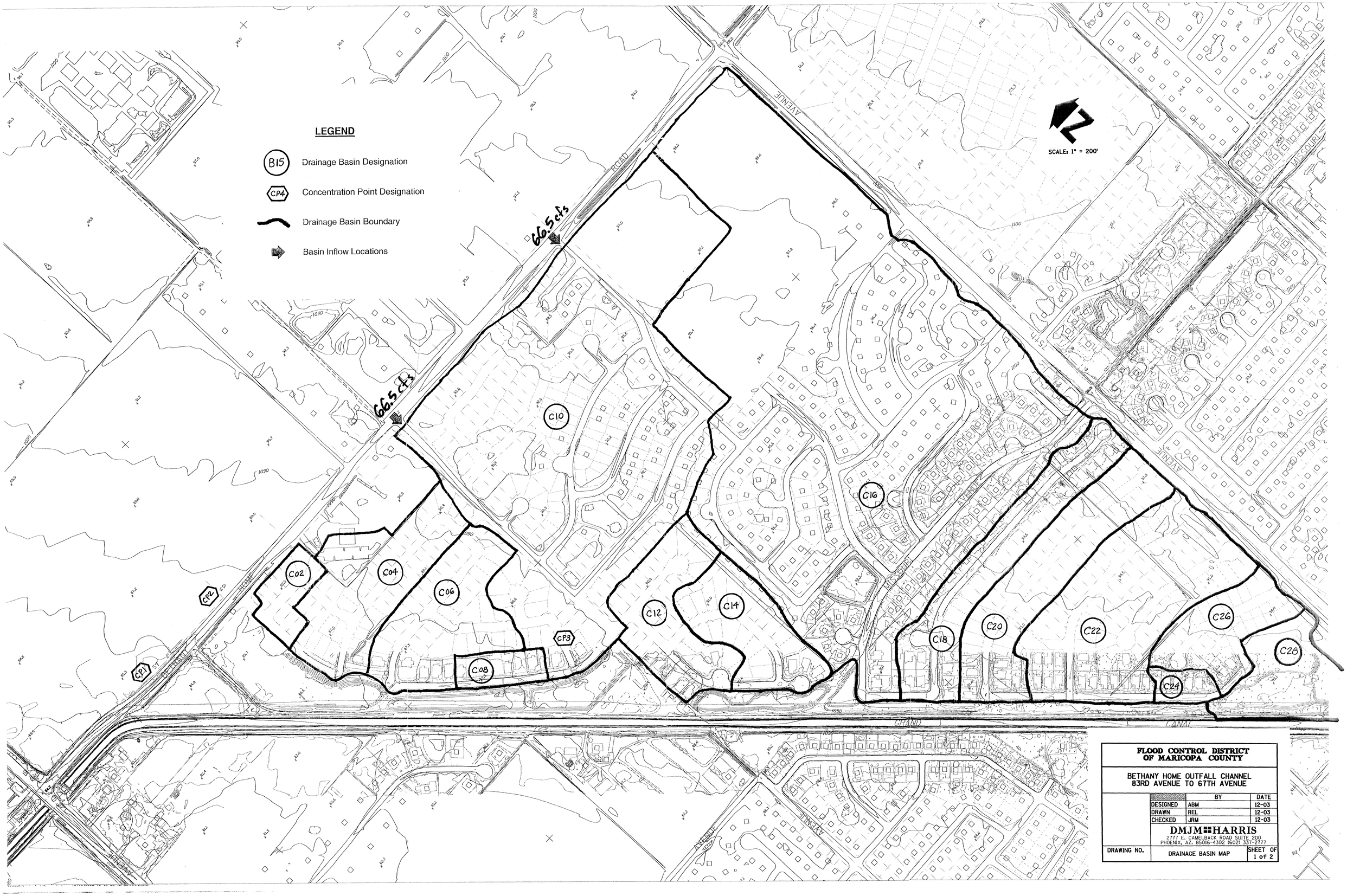
Sub Basin	Concentration Point	Area (acres)	Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)	HEC-1 Diverted Basin Inflow * (cfs)	Subtotal (cfs)	Reduction Factor	Combined 100 Year Peak Flow (cfs)	Selected 100-Year Peak Flow (cfs)
Street	CP1									532*
Storm Drain	CP2									802*
C02		2.30	3	6	12					12
C04		9.50	9	19	41					41
C06		8.90	9	17	37					37
C08		1.90	2	4	8					8
C10		55.40	37	77	175					175
	CP3				175	133	308	0.76	234	234
C12		7.40	9	16	34					34
C14		6.60	9	16	33					33
C16		86.00	26	56	128					128
C18		9.70	9	17	37					37
C20		10.40	9	18	40					40
C22		16.40	15	30	64					64
C24		1.20	2	4	7					7
C26		5.60	8	14	29					29
C28		6.40	4	6	13					13
C26+C28		12.00	12	20	42					42
	CP4									339*
Street	CP5									187*
Storm Drain	CP6									501*
B02		24.80	21	42	92					92
	CP7				92	54.3	146	0.59	86	92
B04		25.10	18	36	83					83
	CP8				83	54.3	137	0.59	81	83
B06		114.20	74	156	361					361
	CP9A				361	272.8	634	0.59	374	374
B07		31.80	27	54	118					118
	CP10				118	141.8	260	0.59	153	153
B6 + B7		146.00	104	209	467					467
	CP9B***				467	413.9	881	0.59	520	520
B08		6.70	5	11	24					24
B10		5.90	6	12	24					24
B12		4.30	7	12	25					25
	CP11				25	239.4	264	0.59	156	239**

Note: The selected 100-Year Peak Flow is the highest of either the Rational sub-basin flow (Q_{100}), the Diverted Basin Flow, or the Combined Peak Flow.

* Peak Flow Rates as presented in the CLOMR hydrologic (HEC-1) model.

** Flow may spill into BHOC right-of-way prior to reaching the road low point.

*** CP9B is the combination of CP10 and CP9A assuming all flows reach the low point at 71st Avenue.



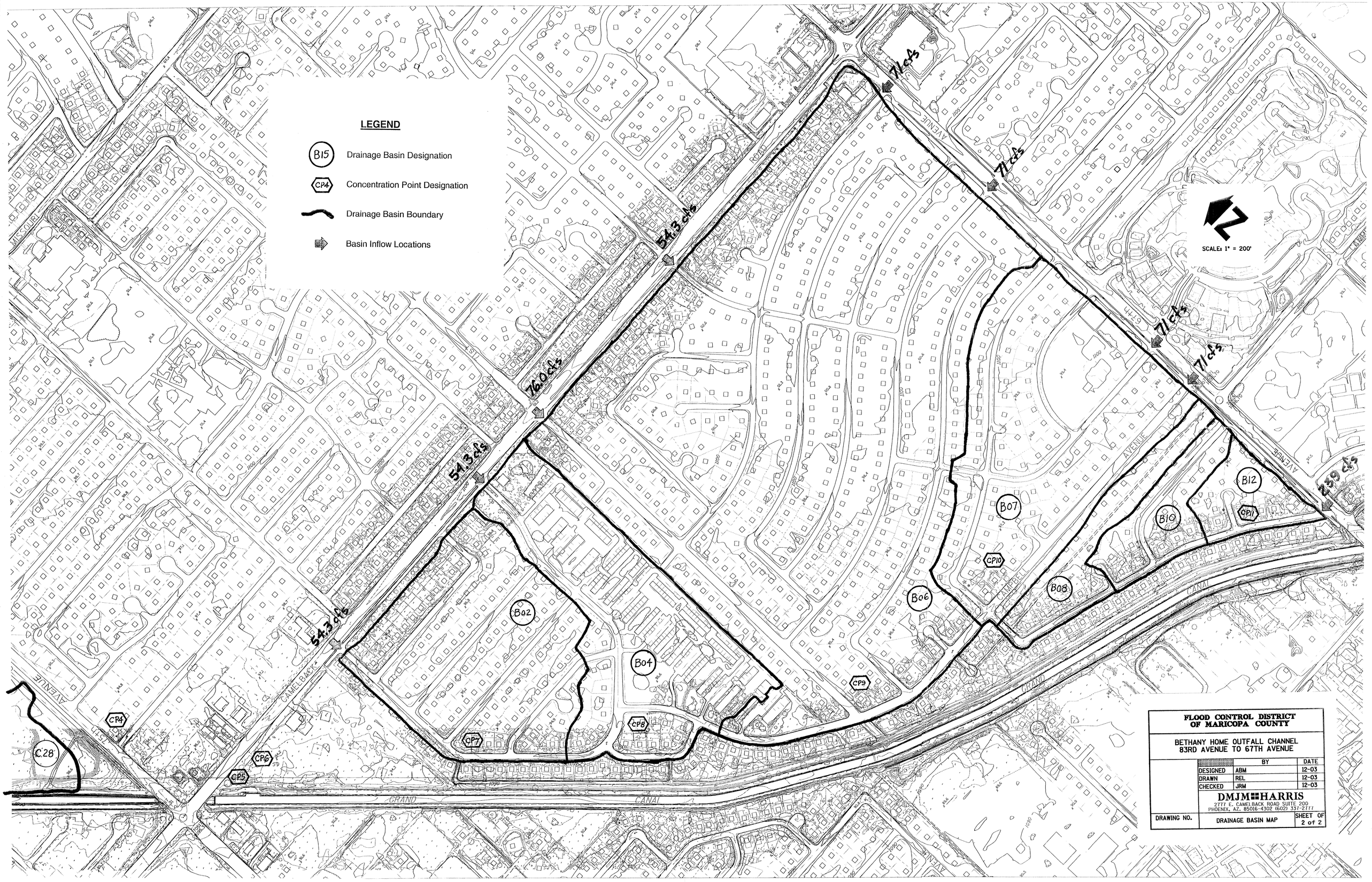
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

BETHANY HOME OUTFALL CHANNEL
83RD AVENUE TO 67TH AVENUE

	BY	DATE
DESIGNED	ABM	12-03
DRAWN	REL	12-03
CHECKED	JRM	12-03

DMJM HARRIS
2777 E. CAMELBACK ROAD SUITE 200
PHOENIX, AZ. 85016-4302 (602) 337-2777

DRAWING NO. | DRAINAGE BASIN MAP | SHEET OF 1 of 2


LEGEND
B15 Drainage Basin Designation
CP4 Concentration Point Designation
Drainage Basin Boundary
Basin Inflow Locations
SCALE: 1" = 200'
71 cfs
71 cfs
71 cfs
71 cfs
54.3 cfs
76.0 cfs
54.3 cfs
54.3 cfs
239 cfs
B02
B04
B06
B07
B08
B10
B12
CP4
CP5
CP6
CP7
CP8
CP9
CP10
CP11
C28
AVENUE
MISSOURI
CAMELBACK
CAMPBELL
GRAND
CANAL
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
BETHANY HOME OUTFALL CHANNEL
83RD AVENUE TO 67TH AVENUE
BY
DATE
DESIGNED ABM 12-03
DRAWN REL 12-03
CHECKED JRM 12-03
DMJM HARRIS
2777 E. CAMELBACK ROAD SUITE 200
PHOENIX, AZ. 85016-4302 (602) 337-2777
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DRAINAGE BASIN MAP
SHEET OF
2 of 2

HYDRAULICS

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MEMORANDUM

To:	**C. Scott Vogel, P.E.**	Date:	**Monday, February 28, 2005**
From:	**Alan B. Morrice, P.E.**	Subject:	**Bethany Home Outfall Channel - Reach B & C Hydraulic Modeling**

I. INTRODUCTION

Since the completion of the Bethany Home / Grand Canal Flood Control Project (BH/GC FCP) Pre-Design Study, several modifications were made to the proposed floodplain improvements with the final design of Phase 2 of the Bethany Home Outfall Channel (BHOC) and the Conditional Letter of Map Revision (CLOMR). Similarly, further modifications or design refinements occurred with the final design of Reaches B and C. These modifications required that revisions be made to the hydraulic (HEC-RAS) model.

II. UPDATED DISCHARGES

As presented in the mainline hydrologic modeling memorandum, peak discharges along the Bethany Home Outfall Channel (BHOC) were revised to reflect design refinements to the Maryvale Detention Basin. The design refinements included a new stage – storage relationship due to the revised grading of the detention basin. The stage – discharge relationship of the detention basin, due to design refinements to the box culvert under Camelback Road, was also modified. These revisions resulted in lower peak discharges for the majority of Reaches B and C. Along the Maryvale Detention Basin, inflow discharges were prorated based upon the local hydrologic calculations and applied to the HEC-1 discharges. The updated discharges at key concentration points were input into the hydraulic (HEC-RAS) model.

The peak discharges along Reaches B and C decreased. The peak flows in Reach A are slightly higher than those presented in the hydrologic model submitted with the CLOMR however it has a minimal effect on the 100-year water surface (increase of approximately 0.05 feet). The floodplain delineation shown in the CLOMR was based upon a water surface coinciding with the top of banks. Therefore, the slightly higher discharges will have no effect on the proposed floodplain limits.

III. MODIFICATIONS TO REACH B

The majority of Reach B is comprised of the Maryvale Detention Basin. A detailed grading plan was developed for the Maryvale Detention Basin that incorporated a meandering low channel, undulating side slopes and a muli-use trail system. Since differing from the basin configuration that was presented with the CLOMR, it was necessary to update the hydraulic model for these design refinements. Numerous cross-sections were input into the HEC-RAS model to reflect the refined basin grading.

Two new culvert crossings within the Maryvale Detention Basin were also included in the hydraulic model. These culverts provide for crossings of the muli-use trail near 71st and 73rd Avenues. The trail crossing near 73rd Avenue consists of a 2 – 12' x 10' RCB culvert and the trail crossing near 73rd Avenue has a 3 – 10' x 8' RCB

culvert. Each of these culverts were input into the HEC-RAS model. Output from the updated model is enclosed with this memorandum.

As a result of the design refinements to the Maryvale Detention Basin and the Camelback Road culvert, the 100-year peak discharge was lowered from 1,145 to 1,083 cfs. Correspondingly, the 100-year water surface in the detention basin was lowered by 0.25 to 0.6 feet across its length.

IV. MODIFICATIONS TO REACH C

Within Reach C, the profile was lowered in an effort to minimize relocations of existing utilities within 75th Avenue and Camelback Road. The hydraulic model presented with the CLOMR included a 2 – 10' x 8' RCB for the majority of Reach C. As part of the structural alternative evaluation, several different culvert configurations that were relatively equal hydraulically were investigated. As a result of that evaluation a 2 – 9' x 9' RCB is recommended to be utilized for the majority of Reach C. The box culvert under 75th Avenue and Camelback Road is a 2 – 8' x 7' RCB that has a few angle points that caused some minor losses. The hydraulic model was revised to include these culvert modifications. Enclosed is output from the updated HEC-RAS hydraulic model.

HEC-RAS Plan: ReachC100_BF River: BHOC FCP Reach: Reach C - 100% Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach C - 100%	1415	PF 1	4469.00	1048.64	1056.66	1054.38	1057.63	0.000668	7.90	565.54	91.32	0.56
Reach C - 100%	1526	PF 1	3124.00	1048.81	1057.43		1057.80	0.000226	4.86	642.40	95.00	0.33
Reach C - 100%	1573	PF 1	3124.00	1048.81	1057.42		1057.82	0.000254	5.09	614.17	92.71	0.35
Reach C - 100%	1588		Bridge									
Reach C - 100%	1603	PF 1	3124.00	1048.81	1057.77	1053.53	1058.14	0.000221	4.86	643.28	93.61	0.33
Reach C - 100%	1741	PF 1	3124.00	1049.22	1058.05		1058.18	0.000091	2.86	1093.70	186.72	0.21
Reach C - 100%	1800	PF 1	3124.00	1049.28	1058.06		1058.19	0.000368	2.94	1061.31	192.32	0.22
Reach C - 100%	2000	PF 1	3124.00	1049.50	1058.13		1058.26	0.000337	2.88	1086.04	190.75	0.21
Reach C - 100%	2200	PF 1	3124.00	1049.74	1058.20		1058.34	0.000415	2.93	1066.39	194.05	0.22
Reach C - 100%	2400	PF 1	3124.00	1049.97	1058.28		1058.43	0.000463	3.09	1010.59	184.14	0.23
Reach C - 100%	2600	PF 1	3124.00	1050.19	1058.38		1058.52	0.000479	3.07	1016.60	191.52	0.24
Reach C - 100%	2800	PF 1	3124.00	1050.42	1058.47		1058.63	0.000517	3.15	991.06	190.37	0.24
Reach C - 100%	3000	PF 1	3124.00	1050.64	1058.57		1058.74	0.000557	3.24	962.86	187.10	0.25
Reach C - 100%	3200	PF 1	3124.00	1050.88	1058.68		1058.85	0.000586	3.32	939.64	182.99	0.26
Reach C - 100%	3400	PF 1	3124.00	1051.10	1058.79		1058.96	0.000517	3.29	948.83	187.72	0.26
Reach C - 100%	3600	PF 1	3124.00	1051.33	1058.89		1059.08	0.000635	3.51	890.61	187.46	0.28
Reach C - 100%	3800	PF 1	3124.00	1051.56	1059.01		1059.21	0.000619	3.56	877.87	177.25	0.28
Reach C - 100%	4000	PF 1	3124.00	1051.79	1059.14		1059.35	0.000716	3.69	846.93	180.43	0.30
Reach C - 100%	4200	PF 1	3124.00	1052.02	1059.28		1059.49	0.000678	3.63	861.16	180.76	0.29
Reach C - 100%	4400	PF 1	3124.00	1052.20	1059.41		1059.64	0.000742	3.80	821.96	171.89	0.31
Reach C - 100%	4600	PF 1	3124.00	1052.47	1059.57		1059.81	0.000950	3.91	799.03	167.08	0.32
Reach C - 100%	4800	PF 1	3124.00	1052.70	1059.73		1060.08	0.001492	4.74	658.61	144.25	0.39
Reach C - 100%	5000	PF 1	3124.00	1052.85	1060.06		1060.33	0.001033	4.16	751.30	152.11	0.33
Reach C - 100%	5200	PF 1	3124.00	1053.16	1060.27		1060.56	0.001225	4.34	720.06	155.78	0.36
Reach C - 100%	5330	PF 1	3124.00	1053.30	1060.43		1060.71	0.001075	4.24	736.78	149.46	0.34
Reach C - 100%	5400	PF 1	3124.00	1053.46	1060.42		1060.85	0.001666	5.24	596.13	121.46	0.42
Reach C - 100%	5450	PF 1	3124.00	1053.57	1060.35		1061.02	0.002223	6.54	477.35	99.46	0.53
Reach C - 100%	5482	PF 1	3101.00	1053.57	1060.48		1061.06	0.000524	6.09	509.33	102.18	0.48
Reach C - 100%	5591		Bridge									
Reach C - 100%	5592	PF 1	3101.00	1053.97	1060.98	1058.46	1061.50	0.000454	5.82	533.10	102.69	0.45
Reach C - 100%	5633	PF 1	3101.00	1055.49	1060.44	1060.15	1061.78	0.002019	9.31	333.08	98.47	0.89
Reach C - 100%	5730	PF 1	3101.00	1055.77	1061.24		1062.10	0.004027	7.41	418.75	114.34	0.68
Reach C - 100%	5800	PF 1	3101.00	1055.83	1061.74		1062.35	0.002694	6.25	495.98	129.05	0.56
Reach C - 100%	6000	PF 1	3101.00	1055.99	1062.31		1062.83	0.002116	5.82	532.40	128.88	0.51
Reach C - 100%	6200	PF 1	3101.00	1056.15	1062.80		1063.21	0.001582	5.11	606.39	143.50	0.44
Reach C - 100%	6400	PF 1	3101.00	1056.31	1063.10		1063.53	0.001552	5.22	593.87	133.87	0.44
Reach C - 100%	6600	PF 1	3101.00	1056.44	1063.37		1063.88	0.001736	5.77	537.06	112.84	0.47
Reach C - 100%	6800	PF 1	2893.00	1056.63	1063.79		1064.20	0.001290	5.12	565.22	113.76	0.40
Reach C - 100%	7000	PF 1	2893.00	1056.79	1064.05		1064.45	0.001239	5.06	571.88	113.56	0.40

HEC-RAS Plan: ReachC100_BF River: BHOC FCP Reach: Reach C - 100% Profile: PF 1 (Continued)

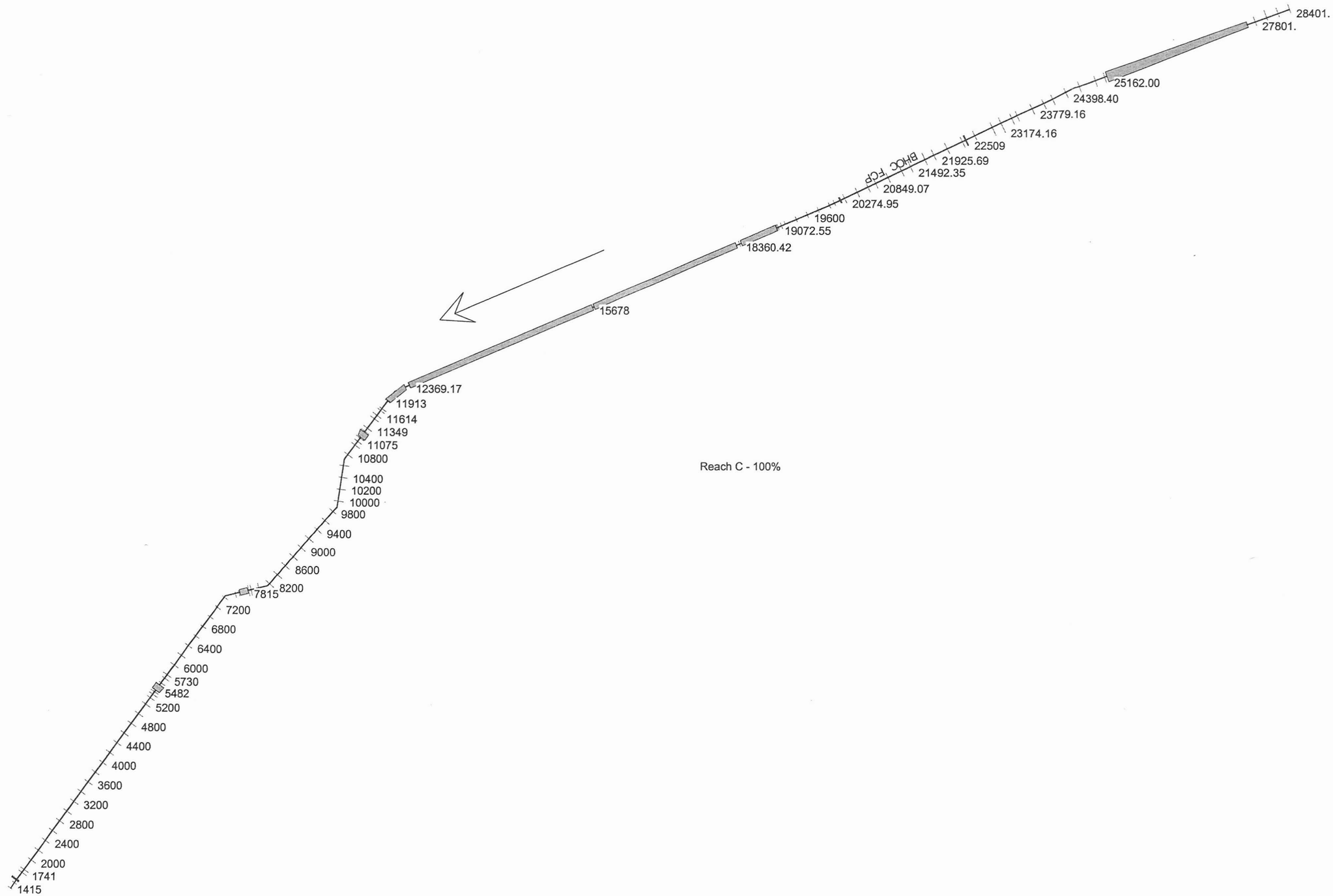
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach C - 100%	7200	PF 1	2893.00	1056.90	1064.31		1064.69	0.001166	4.94	585.07	114.76	0.39
Reach C - 100%	7400	PF 1	2893.00	1057.11	1064.55		1064.92	0.001122	4.88	593.24	115.48	0.38
Reach C - 100%	7600	PF 1	2893.00	1057.27	1064.75		1065.17	0.001210	5.18	558.12	104.28	0.39
Reach C - 100%	7660	PF 1	2893.00	1057.29	1064.79		1065.26	0.001319	5.53	523.40	94.18	0.41
Reach C - 100%	7676.4	PF 1	2893.00	1058.11	1064.63		1065.36	0.002013	6.86	421.47	64.62	0.47
Reach C - 100%	7815		Culvert									
Reach C - 100%	7816.7	PF 1	2893.00	1058.05	1066.02	1062.00	1066.51	0.000309	5.62	514.81	64.61	0.35
Reach C - 100%	7828.7	PF 1	2893.00	1059.89	1067.39		1067.77	0.000386	4.96	583.60	128.28	0.41
Reach C - 100%	7872	PF 1	2893.00	1059.96	1067.41		1067.80	0.001395	5.01	577.60	127.68	0.41
Reach C - 100%	8000	PF 1	2893.00	1060.16	1067.63		1067.98	0.001331	4.77	605.92	139.31	0.40
Reach C - 100%	8200	PF 1	2893.00	1060.46	1067.93		1068.23	0.001111	4.35	664.63	153.88	0.37
Reach C - 100%	8400	PF 1	2893.00	1060.76	1068.11		1068.55	0.001758	5.33	542.59	130.06	0.46
Reach C - 100%	8600	PF 1	2893.00	1061.06	1068.59		1069.02	0.003331	5.26	550.16	118.23	0.43
Reach C - 100%	8800	PF 1	2893.00	1061.36	1069.25		1069.64	0.002842	5.02	576.48	117.83	0.40
Reach C - 100%	9000	PF 1	2893.00	1061.66	1069.85		1070.09	0.001710	3.90	741.21	151.66	0.31
Reach C - 100%	9200	PF 1	2893.00	1062.00	1070.19		1070.46	0.001960	4.18	692.42	141.97	0.33
Reach C - 100%	9400	PF 1	2893.00	1062.27	1070.58		1070.86	0.001985	4.25	681.15	136.71	0.34
Reach C - 100%	9600	PF 1	2893.00	1062.57	1070.99		1071.23	0.001693	3.93	736.26	148.00	0.31
Reach C - 100%	9800	PF 1	2893.00	1062.87	1071.33		1071.58	0.001759	4.03	718.26	142.58	0.32
Reach C - 100%	10000	PF 1	2893.00	1063.17	1071.68		1071.93	0.001702	3.99	725.36	142.90	0.31
Reach C - 100%	10200	PF 1	2893.00	1063.47	1072.02		1072.27	0.001714	4.02	720.45	141.24	0.31
Reach C - 100%	10400	PF 1	2893.00	1063.77	1072.36		1072.62	0.001739	4.06	712.58	138.53	0.32
Reach C - 100%	10600	PF 1	2893.00	1064.07	1072.70		1072.97	0.001755	4.12	702.22	134.62	0.32
Reach C - 100%	10800	PF 1	2893.00	1064.38	1073.06		1073.33	0.001840	4.17	694.43	135.45	0.32
Reach C - 100%	11000	PF 1	2893.00	1064.68	1073.41		1073.72	0.001944	4.43	652.39	120.23	0.34
Reach C - 100%	11075	PF 1	2893.00	1064.79	1073.59		1073.86	0.001660	4.13	700.06	128.13	0.31
Reach C - 100%	11144	PF 1	2893.00	1064.89	1073.64		1074.03	0.002418	5.04	573.64	102.13	0.37
Reach C - 100%	11160	PF 1	2893.00	1064.92	1073.65		1074.05	0.000310	5.08	569.00	101.63	0.38
Reach C - 100%	11265		Bridge									
Reach C - 100%	11266	PF 1	2893.00	1065.08	1073.83	1070.24	1074.21	0.000285	4.94	585.74	102.40	0.36
Reach C - 100%	11281	PF 1	2893.00	1065.10	1073.84		1074.21	0.000285	4.93	587.31	102.93	0.36
Reach C - 100%	11349	PF 1	2893.00	1065.19	1073.97		1074.26	0.001823	4.31	670.50	122.98	0.33
Reach C - 100%	11542	PF 1	2893.00	1065.49	1074.31		1074.65	0.002066	4.70	615.47	108.45	0.35
Reach C - 100%	11614	PF 1	2893.00	1065.60	1074.44		1074.82	0.002210	4.90	590.47	102.37	0.36
Reach C - 100%	11715	PF 1	2893.00	1065.75	1074.72		1075.08	0.003105	4.80	602.93	103.13	0.35
Reach C - 100%	11755	PF 1	2893.00	1066.40	1073.43	1072.74	1076.03	0.027718	12.93	223.68	31.81	0.86
Reach C - 100%	11913	PF 1	2893.00	1066.72	1074.79		1076.74	0.001546	11.19	258.46	32.03	0.69
Reach C - 100%	12036		Culvert									
Reach C - 100%	12299.17	PF 1	2893.00	1067.04	1077.35	1073.42	1078.56	0.000515	8.81	328.43	31.86	0.48

HEC-RAS Plan: ReachC100_BF River: BHOC FCP Reach: Reach C - 100% Profile: PF 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach C - 100%	12369.17	PF 1	1479.00	1067.12	1077.91	1072.66	1078.64	0.000400	6.85	215.88	20.02	0.37
Reach C - 100%	13900		Culvert									
Reach C - 100%	15678	PF 1	1479.00	1070.95	1084.32	1076.66	1084.85	0.000263	5.82	254.16	19.02	0.28
Reach C - 100%	16852		Culvert									
Reach C - 100%	18305.01	PF 1	1369.00	1073.96	1088.73	1079.23	1089.06	0.000152	4.63	295.51	20.02	0.21
Reach C - 100%	18360.42	PF 1	1369.00	1074.02	1088.80		1089.27	0.000249	5.52	247.93	16.79	0.25
Reach C - 100%	18554		Culvert									
Reach C - 100%	19056.54	PF 1	1083.00	1074.82	1091.11	1079.89	1091.35	0.000123	3.96	273.28	16.79	0.17
Reach C - 100%	19072.55	PF 1	1083.00	1074.84	1091.03	1080.55	1091.39	0.000210	4.77	226.86	14.02	0.21
Reach C - 100%	19134.60	PF 1	784.00	1081.04	1090.95		1091.45	0.000371	5.65	138.84	14.02	0.32
Reach C - 100%	19200	PF 1	784.00	1081.10	1090.97		1091.47	0.000375	5.67	138.32	14.02	0.32
Reach C - 100%	19400	PF 1	784.00	1081.30	1091.04		1091.55	0.000388	5.75	136.45	14.02	0.32
Reach C - 100%	19600	PF 1	784.00	1081.50	1091.11		1091.64	0.000402	5.82	134.62	14.02	0.33
Reach C - 100%	19800	PF 1	784.00	1081.70	1091.18		1091.72	0.000416	5.90	132.82	14.02	0.34
Reach C - 100%	20000	PF 1	784.00	1081.90	1091.54		1091.80	0.000151	4.06	192.92	20.02	0.23
Reach C - 100%	20090	PF 1	784.00	1081.99	1091.60		1091.82	0.000119	3.71	211.54	22.02	0.21
Reach C - 100%	20189.03	PF 1	784.00	1082.08	1091.71		1091.83	0.000058	2.81	279.35	29.02	0.16
Reach C - 100%	20190		Culvert									
Reach C - 100%	20209.03	PF 1	784.00	1082.10	1091.73	1085.25	1091.86	0.000065	2.90	269.90	29.02	0.17
Reach C - 100%	20274.95	PF 1	744.00	1082.16	1091.85		1091.88	0.000046	1.27	587.12	102.10	0.09
Reach C - 100%	20509.35	PF 1	744.00	1082.40	1091.87		1091.89	0.000095	1.23	606.06	116.32	0.09
Reach C - 100%	20707.35	PF 1	744.00	1082.59	1091.89		1091.91	0.000070	1.11	672.15	120.06	0.08
Reach C - 100%	20849.07	PF 1	744.00	1082.72	1091.90		1091.92	0.000057	1.04	715.52	119.94	0.08
Reach C - 100%	21080.27	PF 1	744.00	1082.93	1091.91		1091.93	0.000078	1.13	656.11	121.93	0.09
Reach C - 100%	21329.35	PF 1	708.00	1083.17	1091.93		1091.96	0.000112	1.28	551.29	111.91	0.10
Reach C - 100%	21492.35	PF 1	708.00	1083.32	1091.96		1091.97	0.000055	0.91	774.16	153.95	0.07
Reach C - 100%	21759	PF 1	708.00	1083.50	1091.97		1091.98	0.000042	0.81	871.56	168.35	0.06
Reach C - 100%	21925.69	PF 1	708.00	1083.73	1091.97		1092.00	0.000128	1.33	534.18	114.14	0.11
Reach C - 100%	22169.35	PF 1	708.00	1083.95	1092.00		1092.03	0.000145	1.41	502.55	107.55	0.11
Reach C - 100%	22439.16	PF 1	708.00	1084.20	1092.04		1092.07	0.000144	1.47	483.00	96.16	0.12
Reach C - 100%	22491	PF 1	459.00	1084.26	1092.07		1092.08	0.000064	0.98	468.56	93.42	0.08
Reach C - 100%	22503		Culvert									
Reach C - 100%	22509	PF 1	459.00	1084.27	1092.14	1086.42	1092.16	0.000009	0.97	471.42	94.11	0.08
Reach C - 100%	22664.16	PF 1	459.00	1084.41	1092.14		1092.16	0.000083	1.00	459.08	107.88	0.09
Reach C - 100%	22994.16	PF 1	459.00	1084.72	1092.17		1092.17	0.000012	0.44	1034.51	198.55	0.03
Reach C - 100%	23174.16	PF 1	459.00	1084.89	1092.17		1092.17	0.000007	0.34	1358.79	263.47	0.03
Reach C - 100%	23406.16	PF 1	459.00	1085.11	1092.16		1092.18	0.000072	0.93	495.44	117.68	0.08
Reach C - 100%	23504.16	PF 1	459.00	1085.20	1092.17		1092.19	0.000120	1.13	404.53	104.24	0.10
Reach C - 100%	23779.16	PF 1	459.00	1085.46	1092.20		1092.23	0.000149	1.24	371.35	99.11	0.11

HEC-RAS Plan: ReachC100_BF River: BHOC FCP Reach: Reach C - 100% Profile: PF 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach C - 100%	23989.16	PF 1	459.00	1085.66	1092.23		1092.25	0.000078	0.98	466.59	107.46	0.08
Reach C - 100%	24154.41	PF 1	459.00	1085.81	1092.25		1092.27	0.000136	1.20	382.41	99.63	0.11
Reach C - 100%	24398.40	PF 1	459.00	1086.04	1092.28		1092.30	0.000098	1.06	431.59	105.15	0.09
Reach C - 100%	24659.16	PF 1	459.00	1086.29	1092.31		1092.33	0.000171	1.30	351.88	95.77	0.12
Reach C - 100%	24948.83	PF 1	459.00	1086.56	1092.36		1092.41	0.000396	1.89	242.73	70.58	0.18
Reach C - 100%	25120.02	PF 1	344.00	1086.74	1092.44		1092.47	0.000241	1.46	235.63	69.60	0.14
Reach C - 100%	25162.00	PF 1	344.00	1086.80	1092.45		1092.48	0.000251	1.48	232.14	69.11	0.14
Reach C - 100%	26400		Culvert									
Reach C - 100%	27671.	PF 1	344.00	1088.90	1095.65	1092.74	1096.26	0.000871	6.29	54.71	8.21	0.43
Reach C - 100%	27801.	PF 1	344.00	1086.00	1096.32		1096.33	0.000002	0.23	1488.84	213.87	0.02
Reach C - 100%	28001.	PF 1	344.00	1086.00	1096.33		1096.33	0.000000	0.12	2830.27	366.14	0.01
Reach C - 100%	28201.	PF 1	344.00	1086.00	1096.33		1096.33	0.000001	0.18	1895.21	254.80	0.01
Reach C - 100%	28401.	PF 1	344.00	1086.38	1096.33		1096.33	0.000001	0.19	1847.96	253.97	0.01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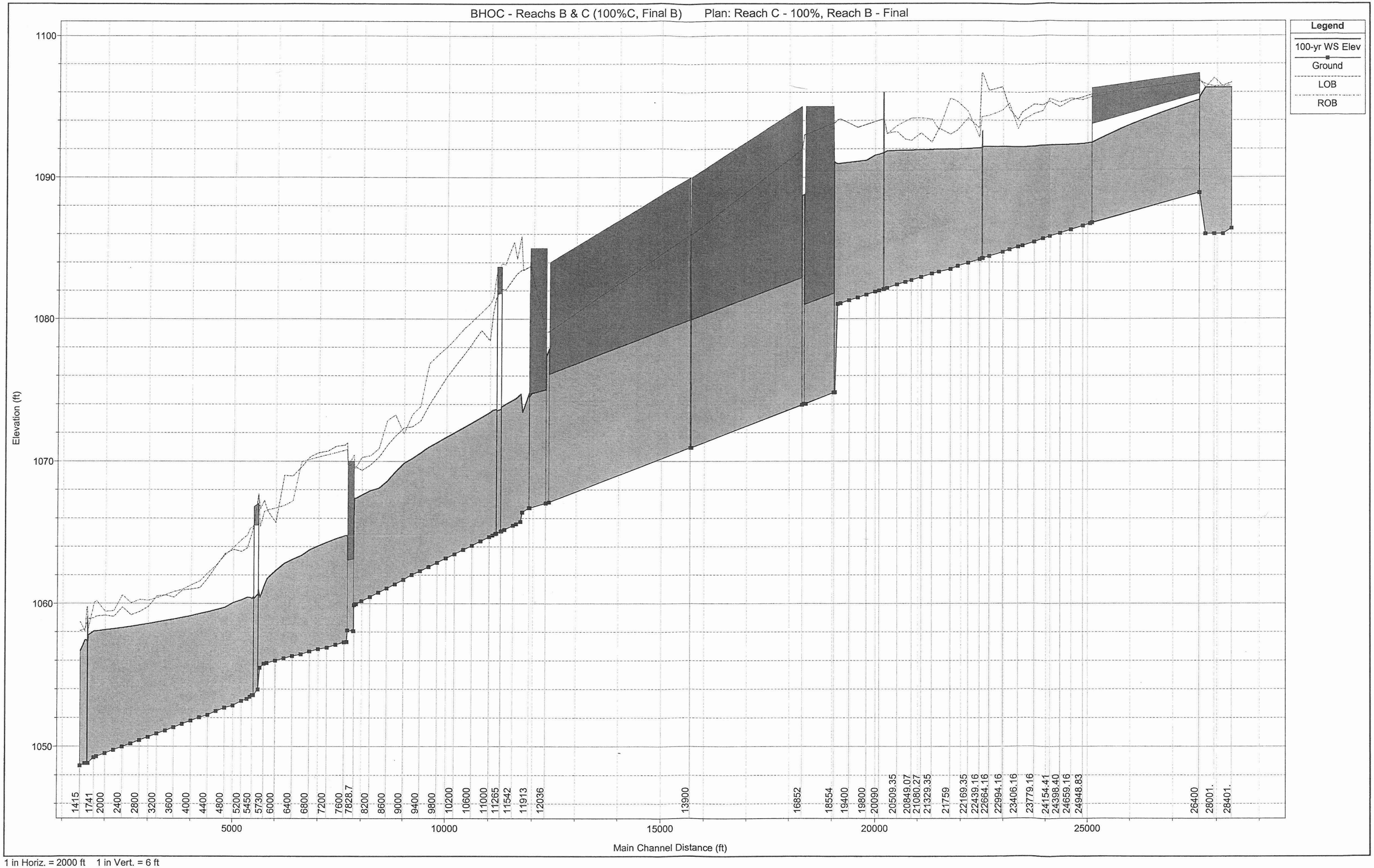
Reach C - 100%



1 in Horiz. = 2000 ft 1 in Vert. = 6 ft

Bethany Home Outfall Channel - Reach B

Maryvale Detention Basin Inflow Spilways

Design Point / Drainage Basin	100-yr. Peak Flow Rate	Weir Crest Bottom Width	Equivalent Weir Crest Length	Planter Obstruction Width	Net Effective Weir Length	Initial Head	Inlet Interception	Adjusted Head	Aprox. Avg. Crest Elevation	100-yr. Water Surface Elevation	Pavement Reconstruction Required	Spillway Type
	(cfs)	(ft.)	(ft.)	(ft.)	(ft.)	(ft.)	(cfs)	(ft.)				
CP7	92	20	26	0	26	1.09	N/A	1.09	1092.54	1093.63	No	Concrete
CP8	83	20	26	0	26	1.02	8.7	0.95	1092.18	1093.13	No	Conlock
CP9	374	110	117	12	105	1.10	9.0	1.08	1092.31	1093.39	Yes	Conlock
CP10B	100	64	72	3	69	0.60	6.7	0.58	1093.68	1094.26	Yes	Conlock
CP10A	53	33	41	3	38	0.59	6.6	0.54	1094.92	1095.46	No	Conlock
B08	24	20	26	0	26	0.45	5.7	0.37	1093.70	1094.07	No	Conlock
B10	24	20	26	0	26	0.45	5.7	0.37	1094.40	1094.77	No	Conlock
B12	25	20	26	0	26	0.46	5.8	0.38	1094.90	1095.28	No	Conlock
CP11	239	125	132	9	123	0.73	7.4	0.69	1095.01	1095.70	Yes	Conlock

Note:

- Supplemental survey information was used in addition to the topographic mapping to establish existing and proposed crest elevations.
- Head requirements and corresponding water surface elevations were developed using the broad crested weir equation: $Q = 3.1\ L\ H^{1.5}$.
- Inlet interception is based upon a grate with a clear opening area (A) of 3.2 sq. ft.; $Q = .67A(CF)(64.4H)^{0.5}$, where the clogging factor (CF is 0.5).

Bethany Home Outfall Channel

Reach C Side Flow Inlets

Design Point / Drainage Basin	Design Discharge (cfs)	Inlet A - MAG Type G						Inlet B - MAG Std. 540-2 (EF-1)						Outlet Pipe(s)		
		Perimeter (L.F.)	Clear Area (S.F.)	# of Grates	Weir Head Required (Feet)	Orifice Head Required (Feet)	Design Head Required (Feet)	Perimeter (L.F.)	Clear Area (S.F.)	# of Grates	Weir Head Required (Feet)	Orifice Head Required (Feet)	Design Head Required (Feet)	Pipe Diameter (Inches)	Inlet Control HW (Feet)	Minimum Slope (%)
C02 + 5	17	14.25	6.636	2	0.66	0.92	0.92							24	2.48	0.56
C04 + C06	78	4.75						22.41	18.64	4	1.34	2.45	2.45	48	4.20	0.30
C08 + 3	11	9.5	3.318	1	0.64	1.54	1.54							18	2.55	0.10
C10	24	4.75						14.54	9.32	2	0.81	0.93	0.93	24	3.54	1.13
CP3A	210	4.75						46.04	46.60	10	1.60	2.84	2.84	2 - 54	4.95	0.29
C12	14	9.5	3.318	1	0.75	2.49	2.49							24	N / A	2.26
C14A	3	9.5	3.318	1	0.27	0.11	0.27							24	N / A	1.04
C14B	13	9.5	3.318	1	0.72	2.15	2.15							18	3.08	1.54
C16A	96	4.75						26.35	23.30	5	1.38	2.38	2.38	2 - 36	3.93	0.52
C16B	27.5	4.75						14.54	9.32	2	0.89	1.22	1.22	30	N / A	0.61
C18	32.5	4.75						18.48	13.98	3	0.85	0.76	0.85	30	3.50	0.63
C20	35.5	4.75						18.48	13.98	3	0.90	0.90	0.90	30	3.75	0.75
C22	59.5	4.75						22.41	18.64	4	1.12	1.43	1.43	36	4.80	0.80
C26 + C28	42	4.75						14.54	9.32	2	1.18	2.84	2.84	30	4.63	1.05

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C02 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formul
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.025	
Channel Slope	,200000	ft/ft
Left Side Slope	50.00	H : V
Right Side Slope	4.00	H : V
Discharge	3.20	cfs

Results		
Depth	0.16	ft
Flow Area	0.7	ft²
Wetted Perim	8.47	ft
Top Width	8.45	ft
Critical Depth	0.24	ft
Critical Slope	0.018403	ft/ft
Velocity	4.84	ft/s
Velocity Head	0.36	ft
Specific Energ	0.52	ft
Froude Numb	3.05	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C04 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.021	
Channel Slope	.080000	ft/ft
Left Side Slope	80.00	H : V
Right Side Slope	80.00	H : V
Discharge	23.50	cfs

Results		
Depth	0.24	ft
Flow Area	4.8	ft²
Wetted Perim	39.07	ft
Top Width	39.07	ft
Critical Depth	0.35	ft
Critical Slope	0.011507	ft/ft
Velocity	4.93	ft/s
Velocity Head	0.38	ft
Specific Energ	0.62	ft
Froude Numb	2.49	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C06 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	
Channel Slope	.110000	ft/ft
Left Side Slope	75.00	H : V
Right Side Slope	75.00	H : V
Discharge	19.50	cfs

Results		
Depth	0.23	ft
Flow Area	4.0	ft²
Wetted Perim	34.66	ft
Top Width	34.65	ft
Critical Depth	0.33	ft
Critical Slope	0.015289	ft/ft
Velocity	4.87	ft/s
Velocity Head	0.37	ft
Specific Energ	0.60	ft
Froude Numb	2.53	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C08 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	
Channel Slope	,250000	ft/ft
Left Side Slope	75.00	H : V
Right Side Slope	75.00	H : V
Discharge	5.60	cfs

Results		
Depth	0.12	ft
Flow Area	1.2	ft²
Wetted Perim	18.61	ft
Top Width	18.61	ft
Critical Depth	0.20	ft
Critical Slope	0.017949	ft/ft
Velocity	4.85	ft/s
Velocity Head	0.37	ft
Specific Energ	0.49	ft
Froude Numb	3.43	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	CP3 - Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.030000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	100.00	H : V
Discharge	210.00	cfs

Results		
Depth	0.89	ft
Flow Area	42.0	ft²
Wetted Perim	94.45	ft
Top Width	94.37	ft
Critical Depth	1.00	ft
Critical Slope	0.016567	ft/ft
Velocity	5.00	ft/s
Velocity Head	0.39	ft
Specific Energ	1.28	ft
Froude Numb	1.32	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	CP3A Overflow Alternate
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.018000	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	60.00	ft
Discharge	210.00	cfs

Results		
Depth	0.67	ft
Flow Area	42.6	ft²
Wetted Perim	66.86	ft
Top Width	66.73	ft
Critical Depth	0.71	ft
Critical Slope	0.015009	ft/ft
Velocity	4.93	ft/s
Velocity Head	0.38	ft
Specific Energ	1.05	ft
Froude Numb	1.09	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	CP3A Overflow Alternate
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.024000	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	75.00	ft
Discharge	210.00	cfs

Results		
Depth	0.54	ft
Flow Area	42.2	ft²
Wetted Perim	80.53	ft
Top Width	80.42	ft
Critical Depth	0.62	ft
Critical Slope	0.015657	ft/ft
Velocity	4.98	ft/s
Velocity Head	0.39	ft
Specific Energ	0.93	ft
Froude Numb	1.21	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	CP3A Overflow Alternate
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.034000	ft/ft
Left Side Slope	6.00	H : V
Right Side Slope	6.00	H : V
Bottom Width	100.00	ft
Discharge	210.00	cfs

Results		
Depth	0.41	ft
Flow Area	42.2	ft²
Wetted Perim	105.01	ft
Top Width	104.94	ft
Critical Depth	0.51	ft
Critical Slope	0.016604	ft/ft
Velocity	4.97	ft/s
Velocity Head	0.38	ft
Specific Energ	0.80	ft
Froude Numb	1.38	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	CP3A Overflow Alternate
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.010000	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	30.00	ft
Discharge	210.00	cfs

Results		
Depth	1.18	ft
Flow Area	42.2	ft²
Wetted Perim	42.00	ft
Top Width	41.77	ft
Critical Depth	1.08	ft
Critical Slope	0.013493	ft/ft
Velocity	4.97	ft/s
Velocity Head	0.38	ft
Specific Energ	1.56	ft
Froude Numb	0.87	
Flow Type	Subcritical	

Worksheet
Worksheet for Irregular Channel

Project Description	
Worksheet	San Miguel Avenue Capacity
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	002300	ft/ft
Water Surface Elev	0.50	ft

Options	
Current Roughness Methc	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin	Horton's Method

Results		
Mannings Coeffic	0.016	
Elevation Range	.00 to 2.50	
Discharge	24.34	cfs
Flow Area	11.6	ft²
Wetted Perimete	35.83	ft
Top Width	35.50	ft
Actual Depth	0.50	ft
Critical Elevation	0.42	ft
Critical Slope	0.006020	ft/ft
Velocity	2.10	ft/s
Velocity Head	0.07	ft
Specific Energy	0.57	ft
Froude Number	0.65	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
-0+38	-0+18	0.030
-0+18	0+18	0.016
0+18	0+22	0.020

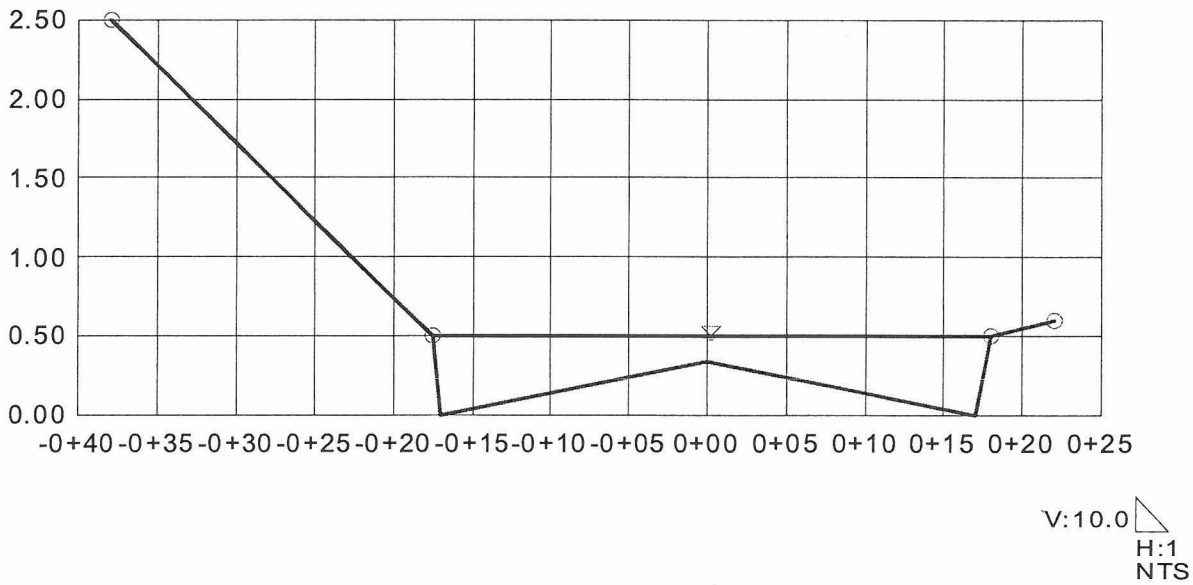
Natural Channel Points

Station (ft)	Elevation (ft)
-0+38	2.50
-0+18	0.50
-0+17	0.00
0+00	0.34
0+17	0.00
0+18	0.50
0+22	0.60

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	San Miguel Avenue Capacity
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficie	0.016	
Channel Slope	0.002300	ft/ft
Water Surface Elev	0.50	ft
Elevation Range	.00 to 2.50	
Discharge	24.34	cfs



Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C10 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.024	
Channel Slope	,130000	ft/ft
Left Side Slope	75.00	H : V
Right Side Slope	75.00	H : V
Discharge	15.20	cfs

Results		
Depth	0.20	ft
Flow Area	3.1	ft²
Wetted Perim	30.60	ft
Top Width	30.60	ft
Critical Depth	0.30	ft
Critical Slope	0.015706	ft/ft
Velocity	4.87	ft/s
Velocity Head	0.37	ft
Specific Energ	0.57	ft
Froude Numb	2.69	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C12 Overflow Spillway
Flow Element	Triangular Channe
Method	Manning's Formul
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	,200000	ft/ft
Left Side Slope	75.00	H : V
Right Side Slope	75.00	H : V
Discharge	14.00	cfs

Results		
Depth	0.20	ft
Flow Area	2.9	ft²
Wetted Perim	29.75	ft
Top Width	29.74	ft
Critical Depth	0.29	ft
Critical Slope	0.024803	ft/ft
Velocity	4.75	ft/s
Velocity Head	0.35	ft
Specific Energ	0.55	ft
Froude Numb	2.66	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	C14 Overflow Spillway
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.090000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	12.00	ft
Discharge	13.00	cfs

Results		
Depth	0.21	ft
Flow Area	2.6	ft²
Wetted Perim	13.69	ft
Top Width	13.64	ft
Critical Depth	0.32	ft
Critical Slope	0.019972	ft/ft
Velocity	4.95	ft/s
Velocity Head	0.38	ft
Specific Energ	0.59	ft
Froude Numb	1.99	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	C16A Overflow Spillway
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.022000	ft/ft
Left Side Slope	5.00	H : V
Right Side Slope	5.00	H : V
Bottom Width	30.00	ft
Discharge	101.00	cfs

Results		
Depth	0.61	ft
Flow Area	20.3	ft²
Wetted Perim	36.25	ft
Top Width	36.13	ft
Critical Depth	0.68	ft
Critical Slope	0.015485	ft/ft
Velocity	4.99	ft/s
Velocity Head	0.39	ft
Specific Energ	1.00	ft
Froude Numb	1.17	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C16B Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.140000	ft/ft
Left Side Slope	75.00	H : V
Right Side Slope	75.00	H : V
Discharge	27.50	cfs

Results		
Depth	0.27	ft
Flow Area	5.6	ft²
Wetted Perim	40.97	ft
Top Width	40.97	ft
Critical Depth	0.38	ft
Critical Slope	0.022757	ft/ft
Velocity	4.91	ft/s
Velocity Head	0.38	ft
Specific Energ	0.65	ft
Froude Numb	2.34	
Flow Type	Supercritical	

Worksheet
Worksheet for Irregular Channel

Project Description	
Worksheet	Missouri Avenue Flow Capacity
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Channel Slope	.004000	ft/ft
Water Surface Elev.	0.50	ft

Options	
Current Roughness Methc	ved Lotter's Method
Open Channel Weighting	ved Lotter's Method
Closed Channel Weightin	Horton's Method

Results		
Mannings Coeffic	0.016	
Elevation Range	.00 to 2.50	
Discharge	32.10	cfs
Flow Area	11.6	ft²
Wetted Perimeter	35.83	ft
Top Width	35.50	ft
Actual Depth	0.50	ft
Critical Elevation	0.47	ft
Critical Slope	0.005673	ft/ft
Velocity	2.77	ft/s
Velocity Head	0.12	ft
Specific Energy	0.62	ft
Froude Number	0.85	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
-0+38	-0+18	0.030
-0+18	0+18	0.016
0+18	0+22	0.020

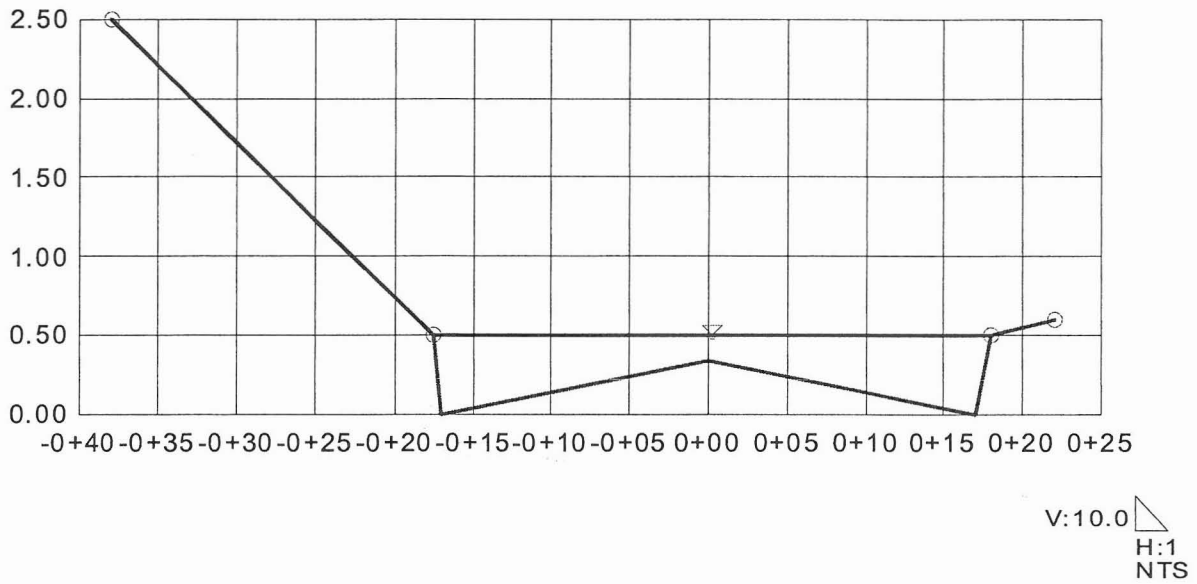
Natural Channel Points

Station (ft)	Elevation (ft)
-0+38	2.50
-0+18	0.50
-0+17	0.00
0+00	0.34
0+17	0.00
0+18	0.50
0+22	0.60

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	Missouri Avenue Flow Capacity
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficie	0.016	
Channel Slope	0.004000	ft/ft
Water Surface Elev	0.50	ft
Elevation Range	.00 to 2.50	
Discharge	32.10	cfs



Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C18 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	,200000	ft/ft
Left Side Slope	150.00	H : V
Right Side Slope	150.00	H : V
Discharge	32.50	cfs

Results		
Depth	0.21	ft
Flow Area	6.6	ft²
Wetted Perim	62.97	ft
Top Width	62.97	ft
Critical Depth	0.31	ft
Critical Slope	0.024317	ft/ft
Velocity	4.92	ft/s
Velocity Head	0.38	ft
Specific Energ	0.59	ft
Froude Numb	2.68	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C20 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	,190000	ft/ft
Left Side Slope	150.00	H : V
Right Side Slope	150.00	H : V
Discharge	35.50	cfs

Results		
Depth	0.22	ft
Flow Area	7.2	ft²
Wetted Perim	65.62	ft
Top Width	65.61	ft
Critical Depth	0.32	ft
Critical Slope	0.024024	ft/ft
Velocity	4.95	ft/s
Velocity Head	0.38	ft
Specific Energ	0.60	ft
Froude Numb	2.64	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C22 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.160000	ft/ft
Left Side Slope	200.00	H : V
Right Side Slope	200.00	H : V
Discharge	59.50	cfs

Results		
Depth	0.25	ft
Flow Area	12.1	ft²
Wetted Perim	98.51	ft
Top Width	98.51	ft
Critical Depth	0.35	ft
Critical Slope	0.023437	ft/ft
Velocity	4.90	ft/s
Velocity Head	0.37	ft
Specific Energ	0.62	ft
Froude Numb	2.46	
Flow Type	Supercritical	

Worksheet
Worksheet for Triangular Channel

Project Description	
Worksheet	C26 Overflow Spillway
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.180000	ft/ft
Left Side Slope	100.00	H : V
Right Side Slope	100.00	H : V
Discharge	27.00	cfs

Results		
Depth	0.23	ft
Flow Area	5.4	ft²
Wetted Perim	46.46	ft
Top Width	46.46	ft
Critical Depth	0.34	ft
Critical Slope	0.023594	ft/ft
Velocity	5.00	ft/s
Velocity Head	0.39	ft
Specific Energ	0.62	ft
Froude Numb	2.59	
Flow Type	Supercritical	

Worksheet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	75th Ave. Overflow
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.200000	ft/ft
Left Side Slope	300.00	H : V
Right Side Slope	300.00	H : V
Bottom Width	50.00	ft
Discharge	173.00	cfs

Results		
Depth	0.23	ft
Flow Area	28.0	ft²
Wetted Perim	190.05	ft
Top Width	190.05	ft
Critical Depth	0.39	ft
Critical Slope	0.021485	ft/ft
Velocity	6.17	ft/s
Velocity Head	0.59	ft
Specific Energ	0.83	ft
Froude Numb	2.84	
Flow Type	Supercritical	

Access Barrier Computations		
Rack Data		
Panel Width (in) =	33.25	
Bar Dia (in) =	0.25	
Bar Spacing C_L to C_L (in) =	5.5	
Open Area Space Between Bars (in) =	5.25	
# of Spaces =	6	
Panel Spacing (in) =	5.25	
Total Pan. Width Incl. Space Bet. Panels (in) =	38.5	Assumes 1/2 space on each end
Open Width Per Panel W_P (ft) =	3.0625	
Culvert Data		
# Cells =	2	
Culvert Span S (ft) =	12	
Culvert Rise H (ft) =	10	
Wall Thickness (in) =	13	
Top Slab Thickness T (in) =	12.5	
Area Box Culvert A_B (ft^2) =	240	
Overall Culvert Width =	25.08	
Design Flow Q (cfs) =	784	
Panel Sizing Calculations		
Rack/Culvert Open Area Ratio =	**1.98**	
Required Rack Open Area A_R (ft^2) =	475.2	
Clogging Factor =	**0.5**	
Rack Open Area w/Clogging Factor Applied A_{RC} (ft^2) =	237.6	
# Panel/Culvert (includes space between panels) =	7.8	8.0
Tot. Open Width for All Panels $W_{PT} = W_P$ * # Panels (ft) =	24.5	
Panel Length $L = A_R/W_{PT}$ (ft) =	19.40	
Installation Height $H_I = H + (T - 4")/12$ (ft) =	10.71	
~ Installation Length from Culvert (ft) =	16.17	
~ Angle of Panel to Channel Bottom θ (degrees) =	33.5	
Head Loss Calculations		
Gravitational Constant g (ft/s^2) =	32.2	
Velocity Between Racks $Vg = Q/A_{RC}$ (ft/s) =	3.3	
Approach velocity in Channel (from HEC-RAS) Va (ft/s) =	3.2	
$Hg = 1.5[Vg^2 - Va^2]/2g$ (ft) =	0.01	

Culvert Designer/Analyzer Report
Glendale Park Trail Crossing (2 - 6 x 5 RCB) W/ low TW

Analysis Component			
Storm Event	Design	Discharge	256.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	256.00 cfs	Check Discharge	256.00 cfs

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	256.00 cfs	Bottom Elevation	1,087.27 ft
Depth	2.23 ft	Velocity	4.79 ft/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-6 x 5 ft Box	256.00 cfs	1,091.29 ft	9.22 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Glendale Park Trail Crossing (2 - 6 x 5 RCB) W/ low TW

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	1,091.29	ft	Discharge	256.00	cfs
Inlet Control HW Elev.	1,091.29	ft	Tailwater Elevation	1,089.50	ft
Outlet Control HW Elev.	1,091.20	ft	Control Type	Inlet Control	
Headwater Depth/Height	0.79				

Grades					
Upstream Invert	1,087.33	ft	Downstream Invert	1,087.27	ft
Length	12.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.31	ft
Slope Type	Steep		Normal Depth	2.24	ft
Flow Regime	Supercritical		Critical Depth	2.42	ft
Velocity Downstream	9.22	ft/s	Critical Slope	0.004035	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 5 ft		Rise	5.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,091.20	ft	Upstream Velocity Head	1.21	ft
Ke	0.20		Entrance Loss	0.24	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,091.29	ft	Flow Control	Unsubmerged	
Inlet Type	headwall w 3/4 inch chamfers		Area Full	60.0	ft^2
K	0.51500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	1	
C	0.03750		Equation Form	2	
Y	0.79000				

Culvert Designer/Analyzer Report
Glendale Park Trail Crossing (2 - 6 x 5 RCB) W/ high TW

Analysis Component			
Storm Event	Design	Discharge	256.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	256.00 cfs	Check Discharge	256.00 cfs

Tailwater properties: Trapezoidal Channel

Tailwater conditions for Design Storm.			
Discharge	256.00 cfs	Bottom Elevation	1,089.12 ft
Depth	2.23 ft	Velocity	4.79 ft/s

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-6 x 5 ft Box	256.00 cfs	1,091.88 ft	5.22 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
Glendale Park Trail Crossing (2 - 6 x 5 RCB) W/ high TW

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev:	1,091.88	ft	Discharge	256.00	cfs
Inlet Control HW Elev.	1,091.35	ft	Tailwater Elevation	1,091.35	ft
Outlet Control HW Elev.	1,091.88	ft	Control Type	Outlet Control	
Headwater Depth/Height	0.91				

Grades					
Upstream Invert	1,087.33	ft	Downstream Invert	1,087.27	ft
Length	12.00	ft	Constructed Slope	0.005000	ft/ft

Hydraulic Profile					
Profile	S1		Depth, Downstream	4.08	ft
Slope Type	Steep		Normal Depth	2.24	ft
Flow Regime	Subcritical		Critical Depth	2.42	ft
Velocity Downstream	5.22	ft/s	Critical Slope	0.004035	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	6.00	ft
Section Size	6 x 5 ft		Rise	5.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	1,091.88	ft	Upstream Velocity Head	0.44	ft
Ke	0.20		Entrance Loss	0.09	ft

Inlet Control Properties					
Inlet Control HW Elev.	1,091.35	ft	Flow Control	N/A	
Inlet Type	headwall w 3/4 inch chamfers		Area Full	60.0	ft^2
K	0.51500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	1	
C	0.03750		Equation Form	2	
Y	0.79000				

75th Avenue Overflow Channel
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	75th Ave. Overflow Channel
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Channel Slope	.009000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	37.00	ft
Discharge	256.00	cfs

Results		
Depth	1.23	ft
Flow Area	51.4	ft²
Wetted Perim	47.11	ft
Top Width	46.81	ft
Critical Depth	1.10	ft
Critical Slope	0.013259	ft/ft
Velocity	4.98	ft/s
Velocity Head	0.39	ft
Specific Energ	1.61	ft
Froude Numb	0.84	
Flow Type	Subcritical	

75th Avenue Storm Drain -1
Worksheet for Circular Channel

Project Description	
Worksheet	75th Avenue Storm Dr
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.013	
Channel Slope	004000	ft/ft
Diameter	48.0	in
Discharge	83.00	cfs

Results		
Depth	3.01	ft
Flow Area	10.1	ft²
Wetted Perime	8.39	ft
Top Width	0.00	ft
Critical Depth	2.76	ft
Percent Full	75.1	%
Critical Slope	0.004943	ft/ft
Velocity	8.20	ft/s
Velocity Head	1.04	ft
Specific Energ	4.05	ft
Froude Numbe	0.84	
Maximum Disc	97.72	cfs
Discharge Full	90.84	cfs
Slope Full	0.003339	ft/ft
Flow Type	Subcritical	

75th Avenue Storm Drain - 2
Worksheet for Circular Channel

Project Description	
Worksheet	75th Avenue Storm Dr
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Slope

Input Data		
Mannings Coeffic	).013	
Diameter	30.0	in
Discharge	63.00	cfs

Results		
Channel Slope	023594	ft/ft
Depth	2.50	ft
Flow Area	4.9	ft²
Wetted Perime	12.57	ft
Top Width	0.00	ft
Critical Depth	2.41	ft
Percent Full	100.0	%
Critical Slope	020636	ft/ft
Velocity	12.83	ft/s
Velocity Head	2.56	ft
Specific Energ	5.06	ft
Froude Numbe	0.00	
Maximum Disc	67.77	cfs
Discharge Full	63.00	cfs
Slope Full	023594	ft/ft
Flow Type	N/A	

75th Avenue Storm Drain - 3
Worksheet for Circular Channel

Project Description	
Worksheet	75th Avenue Storm Dr
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Slope

Input Data		
Mannings Coeffic	).013	
Diameter	24.0	in
Discharge	21.00	cfs

Results		
Channel Slope	008618	ft/ft
Depth	2.00	ft
Flow Area	3.1	ft²
Wetted Perime	12.57	ft
Top Width	0.00	ft
Critical Depth	1.64	ft
Percent Full	100.0	%
Critical Slope	008593	ft/ft
Velocity	6.68	ft/s
Velocity Head	0.69	ft
Specific Energ	2.69	ft
Froude Numbe	0.00	
Maximum Disc	22.59	cfs
Discharge Full	21.00	cfs
Slope Full	008618	ft/ft
Flow Type	N/A	

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL	JOB NO. 6063	SHEET of
		DESIGNED BY G.H.A.	DATE 3/15/05
SUBJECT: FLOWMASTER CALCS FOR 18" EXIST. & 30" NEW S.D. PIPES		CHECKED BY	DATE

▶ FLOW MASTER WAS USED TO FIND FLOW THROUGH THE EXIST. 18" DIA PIPE. THE SLOPE WAS FOUND FROM → CALBCK ROAD IMPROVEMENTS - 73RD TO 75TH AVE AS BUILTS PG # 15430 & 15484)

$$S = 0.39/112' = 0.0035\ FT/FT\ (0.35\%)$$

FLOWMASTER INPUTS:

$n = 0.013$ ← CONC. LINED CHANNEL

$S = 0.35\%$

$D = 18"$

SOLVED FOR Q;

$$\boxed{Q_1 = 6.21\ CFS}$$

▶ A COMBINATION OF Q_1 PLUS Q FOUND FROM THE (1/2 ROAD @ CROWN OVERTOP CALCS) WHICH WAS 30.65 CFS, WAS USED TO DESIGN THE SLOPE FOR A NEW 30" PIPE (FROM THE 24' CATCH BASIN TO THE BHOC):

$$6.21 + 30.65 = 36.86 \cong 37\ CFS$$

▶ FLOWMASTER WAS USED WITH THE FOLLOWING INPUTS:

$n = 0.013$

$D = 30"$

$Q = 37\ CFS$

SOLVED FOR SLOPE

$S = 0.82\% \cong 0.9\%$ CONSERVATIVE SLOPE IS 1%

NEW 30" S.D. PIPE (FROM 24' CATCH BASIN TO BHOC AT CAMELBACK RD.)
Worksheet for Circular Channel

Project Description	
Worksheet	new 30" s.d. pipe
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Slope

Input Data	
Mannings Coefficient	0.013
Diameter	30.0 in
Discharge	37.00 cfs

Results	
Channel Slope	0.008138 ft/ft
Depth	2.50 ft
Flow Area	4.9 ft²
Wetted Perimeter	4.71 ft
Top Width	0.00 ft
Critical Depth	2.06 ft
Percent Full	100.0 %
Critical Slope	0.008061 ft/ft
Velocity	7.54 ft/s
Velocity Head	0.88 ft
Specific Energy	3.38 ft
Froude Number	0.00
Maximum Discharge	39.80 cfs
Discharge Full	37.00 cfs
Slope Full	0.008138 ft/ft
Flow Type	N/A

EXIST. 18" STORM DRAIN PIPE (24' CATCH BASIN TO BHOC AT CMLBK RD.)
Worksheet for Circular Channel

Project Description	
Worksheet	EXIST 18 IN S.D. PIPE
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data	
Mannings Coefficient	0.013
Channel Slope	0.003500 ft/ft
Diameter	18.0 in

Results	
Depth	1.50 ft
Discharge	6.21 cfs
Flow Area	1.8 ft²
Wetted Perimeter	4.71 ft
Top Width	0.00 ft
Critical Depth	0.96 ft
Percent Full	100.0 %
Critical Slope	0.006333 ft/ft
Velocity	3.52 ft/s
Velocity Head	0.19 ft
Specific Energy	1.69 ft
Froude Number	0.00
Maximum Discharge	6.68 cfs
Discharge Full	6.21 cfs
Slope Full	0.003500 ft/ft
Flow Type	N/A

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL	JOB NO. 6063	SHEET of
		DESIGNED BY G.H.A.	DATE 3/15/05
SUBJECT: 1/2 OF CAMELBACK RD INLET CALC.S		CHECKED BY	DATE

- FLOW ALONG 1/2 OF CAMELBACK ROAD {N. RETAINING WALL TO CROWN OF ROADWAY} WAS FOUND TO BE:

$$Q = 30.65 \text{ CFS}$$

- THE "BROAD CRESTED WEIR FORMULA" IS USED TO CALCULATE THE <u>LENGTH</u> OF INLET NEEDED:

$$Q = 3 \cdot L \cdot H^{1.5} \quad \text{(EQ. 1)}$$

- THE HEIGHT WAS FOUND BY TAKING THE DIFFERENCE OF THE HIGH POINT OF THE GUTTER @ THE NORTH SIDE OF CAMELBACK ROAD AND THE LOW POINT OF THE CATCH BASIN AS SHOWN:

$$1095.9 - 1095.33 = \boxed{0.57'} \quad \therefore H = 0.57'$$

- USING EQ. 1, SOLVE FOR $L = ?$

$$Q = 30.65 \text{ CFS}, \quad H = 0.57'$$

$$30.65 \text{ CFS} = 3 \cdot L \cdot 0.57^{1.5}$$

$$L = 23.74' \cong \boxed{24'}$$

BHOC-1/2 OF CAMELBACK ROAD
Worksheet for Irregular Channel

Project Description	
Worksheet	BHOC C/S (A)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Channel Slope	0.002500 ft/ft
Water Surface Elevation	1,096.41 ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.017
Elevation Range	1,095.67 to 1,103.17
Discharge	28.09 cfs
Flow Area	13.6 ft²
Wetted Perimeter	42.55 ft
Top Width	42.19 ft
Actual Depth	0.74 ft
Critical Elevation	1,096.31 ft
Critical Slope	0.006552 ft/ft
Velocity	2.06 ft/s
Velocity Head	0.07 ft
Specific Energy	1,096.48 ft
Froude Number	0.64
Flow Type	Subcritical

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+21	0.030
0+21	0+61	0.016

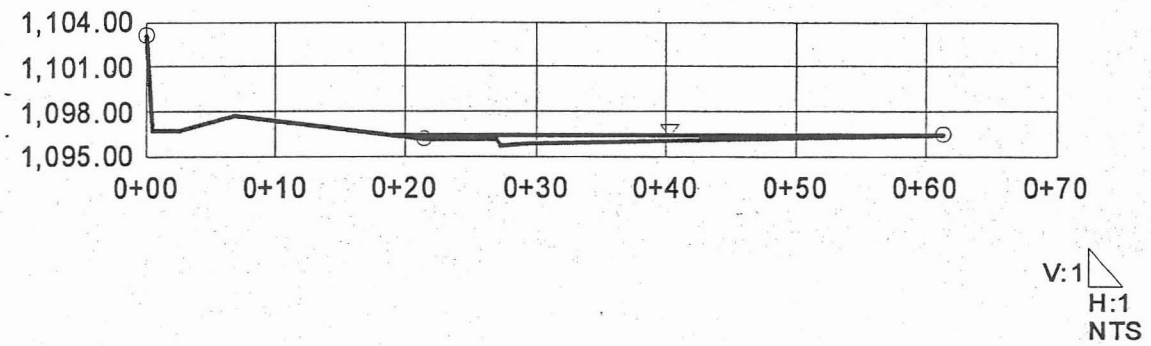
Natural Channel Points

Station (ft)	Elevation (ft)
0+00	1,103.17
0+01	1,096.73
0+03	1,096.73
0+07	1,097.70
0+21	1,096.17
0+27	1,096.17
0+27	1,095.67
0+29	1,095.75
0+61	1,096.41

BHOC-1/2 OF CAMELBACK ROAD
Cross Section for Irregular Channel

Project Description	
Worksheet	BHOC C/S (A)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data	
Mannings Coefficient	0.017
Channel Slope	0.002500 ft/ft
Water Surface Elevation	1,096.41 ft
Elevation Range	1,095.67 to 1,103.17
Discharge	28.09 cfs



BHOC-1/2 OF CAMELBACK ROAD
Worksheet for Irregular Channel

Project Description	
Worksheet	BHOC C/S (B)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data	
Channel Slope	0.002500 ft/ft
Water Surface Elevation	1,096.26 ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results	
Mannings Coefficient	0.017
Elevation Range	1,095.54 to 1,102.47
Discharge	30.65 cfs
Flow Area	14.4 ft²
Wetted Perimeter	42.50 ft
Top Width	42.10 ft
Actual Depth	0.72 ft
Critical Elevation	1,096.15 ft
Critical Slope	0.006453 ft/ft
Velocity	2.13 ft/s
Velocity Head	0.07 ft
Specific Energy	1,096.33 ft
Froude Number	0.64
Flow Type	Subcritical

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+04	0.030
0+04	0+44	0.016

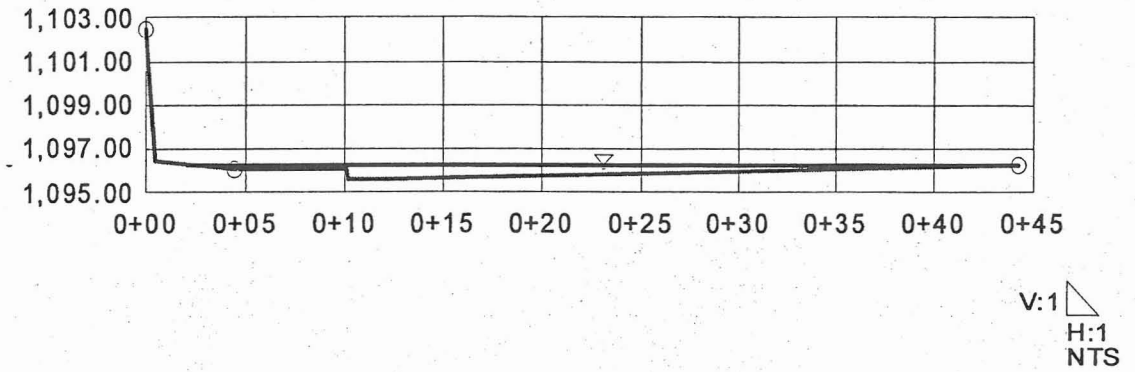
Natural Channel Points

Station (ft)	Elevation (ft)
0+00	1,102.47
0+01	1,096.41
0+04	1,096.04
0+10	1,096.04
0+10	1,095.54
0+12	1,095.54
0+44	1,096.26

BHOC-1/2 OF CAMELBACK ROAD
Cross Section for Irregular Channel

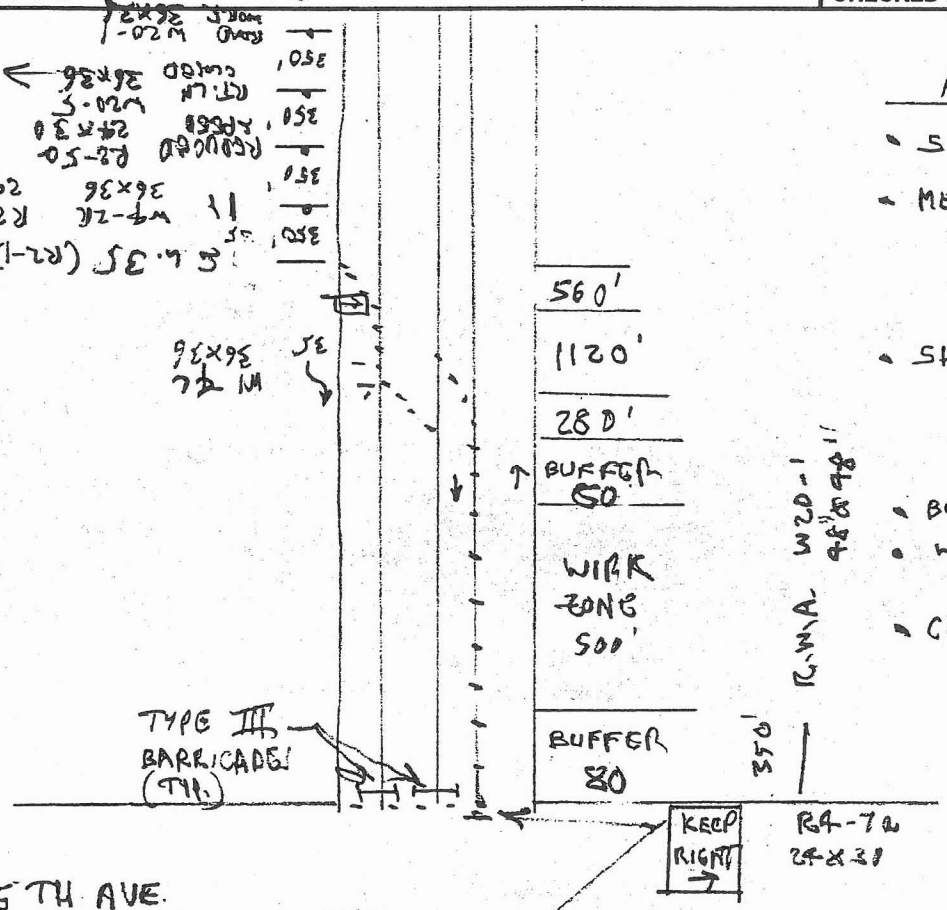
Project Description	
Worksheet	BHOC C/S (B)
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data	
Mannings Coefficient	0.017
Channel Slope	0.002500 ft/ft
Water Surface Elevation	1,096.26 ft
Elevation Range	1,095.54 to 1,102.47
Discharge	30.65 cfs



TRAFFIC CONTROL

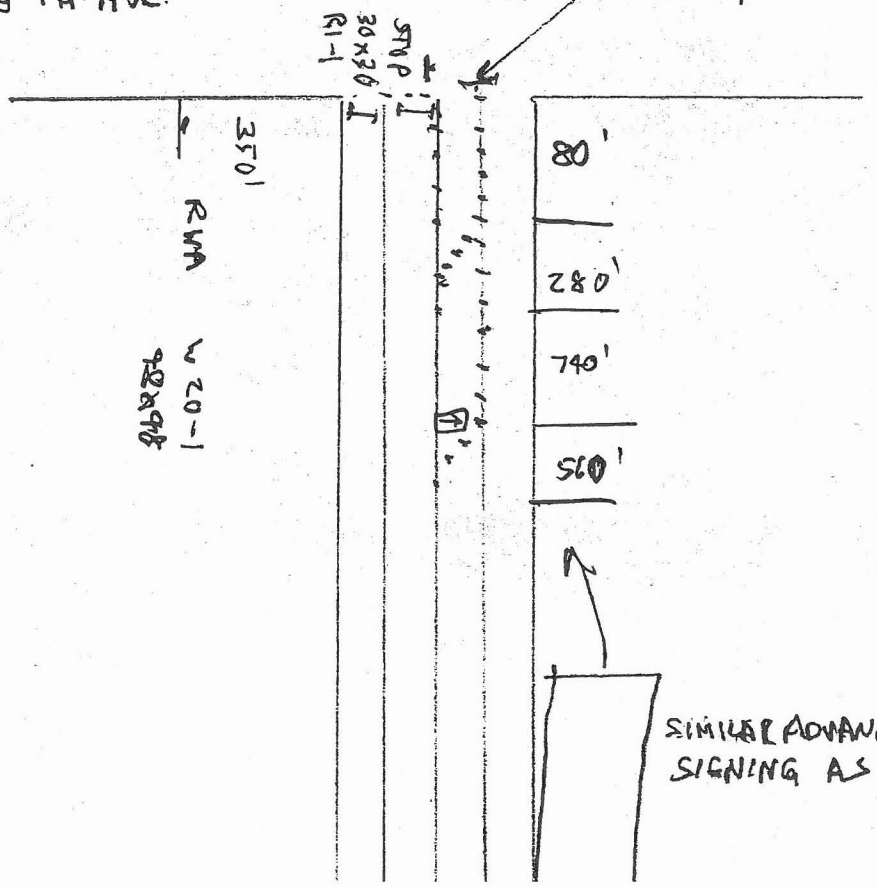
DMJM HARRIS	PROJECT: BHOC	JOB NO.	SHEET 1 of 3
		DESIGNED BY JJP	DATE 2/18/04
SUBJECT: TYP TRAFFIC CONTROL PER PHASE		CHECKED BY JAB	DATE 2/18/04



ASSUMPTIONS

- S = 45 MPH W = 12'
- MERGE TAPER (L) = WS = 45·12 = 540 USE 560
- SHIFT TAPER = $\frac{WS}{2}$ = 270 USE 280
- BUFFER ZONE = 80'
- WORK ZONE = 500'
- CONSTRUCTION DURATION 90 DAYS

75TH AVE.



SIMILAR ADVANCE SIGNING AS W/B

DMJM HARRIS	PROJECT: BHOC	JOB NO.	SHEET 2 of 3
		DESIGNED BY JJP	DATE 2/18/04
SUBJECT: QUANTITIES PER PHASE		CHECKED BY	DATE

PER PHASE

VERTICAL PANEL = 560 @ 40' x 1 = 14
1120 @ 80' x 1 = 14
280 @ 40 x 2 = 14
660 @ 80 x 1 = 17
AT INTERSECTION USE 8
80 @ 40 x 2 = 4
280 @ 90 x 2 = 14
740 @ 80 x 1 = 10
560 @ 40 x 1 = 14

TOTAL = 109 x 90 DAY = 9810 EA-DAY

TYPE 'C' WARNING LIGHTS = 109 EA x 90 DAY = 9810

ARROW BOARD = 2 EA x 90 DAY = 180

TEMP SIGN (< 10 SF) = R1-1 (30x30) @ 1 EA
R2-5a (24x30) @ 2 EA
R2-1 (24x30) @ 2 EA
W4-2 (36x36) @ 2 EA
R4-7a (24x30) @ 2 EA
W1-4 (36x36) @ 1 EA
W20-1 (36x36) @ 2 EA
W20-5 (36x36) @ 2 EA

14 EA x 90 DY = 1260 EA-DAY

TYPE 'A' WARNING LIGHTS = 14 x 90 = 1260 EA-DY

RIGID STAND = 14 x 90 = 1260 EA-DY

TYPE III BARRICADES = 4 x 90 = 360 EA-DY

DMJM HARRIS	PROJECT: BHOC	JOB NO.	SHEET 3 of 3
		DESIGNED BY	DATE 2/18/04
SUBJECT: TOTAL QUANTITIES		CHECKED BY	DATE

ASSUMPTIONS

- EACH PHASE WILL HAVE SAME QUANTITIES
- 4 PHASES

PHASE 1 CLOSE W/B CAMELBACK
" 2 CLOSE E/B CAMELBACK
" 3 CLOSE N/B 75TH AVE
" 4 CLOSE S/B 75TH AVE

QUANTITIES

	PH 1	PH 2	PH 3	PH 4	TOTAL	UNIT COST	TOTAL COST
BARRICADE (TY. II VERT. PANEL)	9810	9810	9810	9810	39240	0.50	19620
PORTABL SIGN STAND RIGID	1260	1260	1260	1260	5040	1.00	5040
WARNING LIGHT (TYPE A)	1260	1260	1260	1260	5040	0.25	1260
WARNING LIGHT (TYPE C)	9810	9810	9810	9810	39240	0.70	27468
TEMP SIGN (< 10SF)	1260	1260	1260	1260	5040	1.50	7560
BARRICADES (TYPE III)	360	360	360	360	1440	10.00	14400

TOTAL 75,348

UTILITY DATA

Testhole Data Summary

AZTEC
www.aztec.us

Date: 3/14/2005

Project Number: AZ03191-003

Project Name: Bethany Home Outfall Channel

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42014
JOSEPH R.
DAVIS
Date Signed
ARIZONA, U.S.A.

TH #	Location	Date of Excavation	Utility Owner	Utility Size	Utility Description	Coordinates		Ground Elevation	Top Elevation	Bottom Elevation	Depth of Cover	Comments
						Northing	Easting					
1	78th Drive and San Juan Avenue	3/14/2005	Qwest Local Network	None	None	0.00	0.00	0.00	0.00	0.00	0.00	Dug in the requested location and no facility was found. No utility in the requested location per QLN Bluestake Locator.
2	79th Avenue and Grand Canal	3/14/2005	Salt River Project	None	None	0.00	0.00	0.00	0.00	0.00	0.00	Dug in the requested location and no facility was found. No utility in the requested location per SRP Bluestake Locator.
3	78th Drive and San Juan Avenue	3/9/2005	Salt River Project	Three 2.38"	PVC	916084.11	604883.57	1089.76	1085.03	1084.83	4.73	0
4	77th Lane and Missouri Avenue	3/9/2005	Salt River Project	Three 2.38"	PVC	915460.00	605434.51	1090.13	1085.93	1085.73	4.20	0
5	77th Lane and Missouri Avenue	3/9/2005	Salt River Project	Three 2.38"	PVC	915413.62	605498.26	1090.05	1084.80	1084.42	5.25	0
6	77th Lane and Denton Lane	3/9/2005	Salt River Project	Six 2.38"	PVC	915311.25	605570.67	1090.59	1086.37	1085.80	4.22	0
7	77th Lane and Denton Lane	3/9/2005	Salt River Project	Six 2.38"	PVC	915230.80	605667.05	1090.35	1086.15	1085.66	4.20	0
8	77th Lane and Denton Lane	3/10/2005	Salt River Project	Two 2.38"	PVC	915144.48	605746.17	1090.62	1085.60	1085.40	5.02	0
9	77th Lane and Denton Lane	3/9/2005	Salt River Project	Six 2.38"	PVC	915058.77	605802.01	1090.61	1085.87	1085.58	4.74	0
10	77th Lane and Vermont Avenue	3/9/2005	Salt River Project	3"	PVC	914938.57	605933.74	1091.34	1086.75	1086.46	4.59	0
11	77th Lane and Vermont Avenue	3/9/2005	Salt River Project	Six 2.38"	PVC	914905.96	605940.86	1091.41	1086.93	1086.49	4.48	0
12	77th Lane and Georgia Avenue	3/9/2005	Salt River Project	Three 2.38"	PVC	914748.74	606121.19	1090.75	1086.56	1086.33	4.19	0
13	77th Lane and Georgia Avenue	3/9/2005	Salt River Project	Four 2.38"	PVC	914741.15	606126.89	1090.74	1086.53	1086.31	4.21	0
14	75th Avenue and Camelback Road	3/8/2005	Southwest Gas	4"	Steel w/ Coating	913271.21	607462.55	1095.55	1090.56	1090.18	4.99	0
15	75th Avenue and Camelback Road	3/8/2005	City of Glendale Water	12"	DIP	913252.64	607477.38	1096.17	1092.25	1091.15	3.92	0
16	75th Avenue and Camelback Road	3/8/2005	Salt River Project	36" Wide	Concrete Duct	913235.17	607469.00	1096.13	1088.44	1085.73	7.69	0
17	75th Avenue and Camelback Road	3/8/2005	Salt River Project	36" Wide	Concrete Duct	913235.40	607491.08	1096.55	1089.27	1086.15	7.28	0
18	75th Avenue and Camelback Road	3/8/2005	Salt River Project	36" Wide	Concrete Duct	913235.59	607504.33	1096.48	1090.42	1086.98	6.06	0
19	75th Avenue and Camelback Road	3/10/2005	Qwest Local Network	2"	PE	913206.96	607532.65	1096.62	1093.64	1093.47	2.98	0
20	75th Avenue and Camelback Road	3/10/2005	Qwest Local Network	2"	PE	913167.21	607533.42	1096.83	1094.32	1094.15	2.51	0

Testhole Data Summary

AZTEC
www.aztec.us

Date: 3/14/2005

Project Number: AZ03191-003

Project Name: Bethany Home Outfall Channel

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42014
JOSEPH R.
DAVIS
Date Signed
ARIZONA, U.S.A.

TH #	Location	Date of Excavation	Utility Owner	Utility Size	Utility Description	Coordinates		Ground Elevation	Top Elevation	Bottom Elevation	Depth of Cover	Comments
						Northing	Easting					
21	75th Avenue and Camelback Road	3/10/2005	City of Glendale Water	12"	ACP	913032.66	607696.43	1095.85	1090.64	1089.48	5.21	0
22	75th Avenue and Camelback Road	3/10/2005	City of Glendale Storm Drain	18"	RCP	913039.73	607753.24	1095.67	1094.07	1092.15	1.60	0
23	75th Avenue and Camelback Road	3/10/2005	City of Phoenix Water	8"	ACP	912991.60	607741.45	1096.05	1092.01	1091.25	4.04	0
24	75th Avenue and Camelback Road	3/9/2005	Southwest Gas	4"	Steel	912985.50	607746.58	1096.00	1090.65	1090.27	5.35	0
25	75th Avenue and Camelback Road	3/14/2005	Qwest Local Network	None	None	0.00	0.00	0.00	0.00	0.00	0.00	Dug in the requested location and no facility was found. No utility in the requested location per QLN Bluestake Locator.
26	75th Avenue and Camelback Road	3/9/2005	City of Phoenix Water	16"	CIP	912961.58	607773.59	1096.93	1087.73	1086.40	9.20	0

TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	1	SUE Crew	D. Harmon
Date Dug	3/14/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	78th Drive and San Juan Avenue		

LOCATION PLAN - NOT TO SCALE

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42014
JOSEPH R.
DAVIS
Date Signed
ARIZONA, U.S.A.

SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR None

CROSS SECTION - NOT TO SCALE

FACING _____

SURFACE ELEVATION _____ WIDTH/O.D. _____

TOP ELEVATION 0 _____ TOP DEPTH (FEET)

BOTTOM ELEVATION 0 _____ BOTTOM (FEET)

COORDINATES: NORTHING _____ EASTING _____

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE None TYPE None FACILITY OWNER Qwest Local Network

REMARKS:

Dug in the requested location and no facility was found. No utility in the requested location per QLN Bluestake Locator.

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	2	SUE Crew	D. Harmon
Date Dug	3/14/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	79th Avenue and Grand Canal		

LOCATION PLAN - NOT TO SCALE

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42014
JOSEPH R.
DAVIS
Date Signed
ARIZONA, U.S.A.

SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR None

CROSS SECTION - NOT TO SCALE

FACING

SURFACE ELEVATION

WIDTH/O.D.

TOP ELEVATION 0 TOP DEPTH (FEET)

BOTTOM ELEVATION 0 BOTTOM (FEET)

COORDINATES: NORTHING EASTING

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE None TYPE None FACILITY OWNER Salt River Project

REMARKS:

Dug in the requested location and no facility was found. No utility in the requested location per SRP Bluestake Locator.

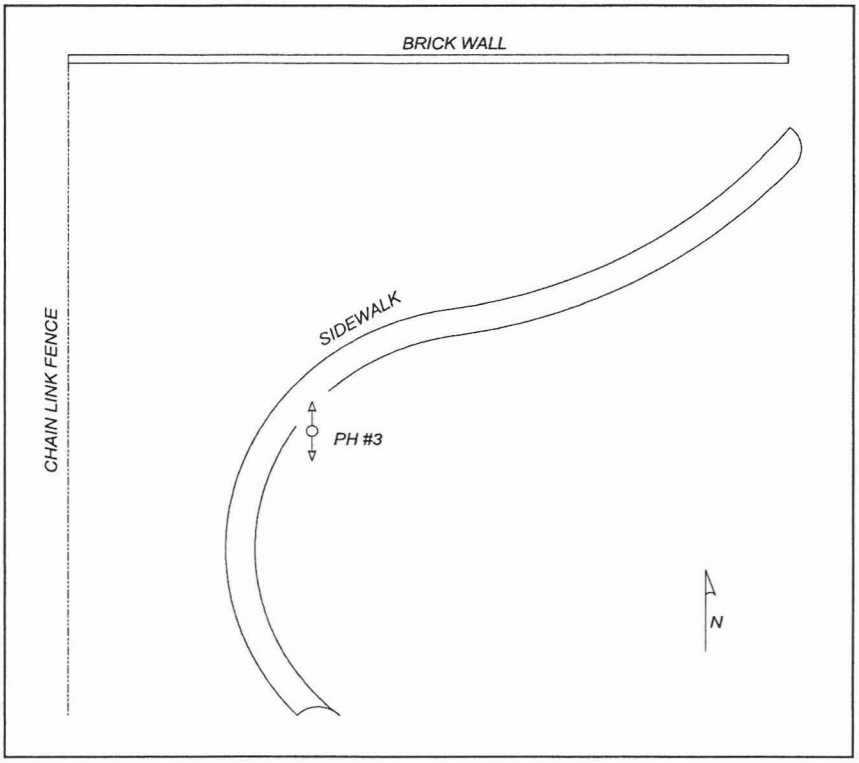
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	3	SUE Crew	J. Brandt
Date Dug	3/9/2005	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	78th Drive and San Juan Avenue		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR Red

CROSS SECTION - NOT TO SCALE

FACING North

SURFACE ELEVATION	1089.76	WIDTH/O.D. 10"		
TOP ELEVATION	1085.03		4.73	TOP DEPTH (FEET)
BOTTOM ELEVATION	1084.83		4.93	BOTTOM (FEET)

COORDINATES: NORTHING 916084.11 EASTING 604883.57

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Three 2.38" TYPE PVC FACILITY OWNER Salt River Project

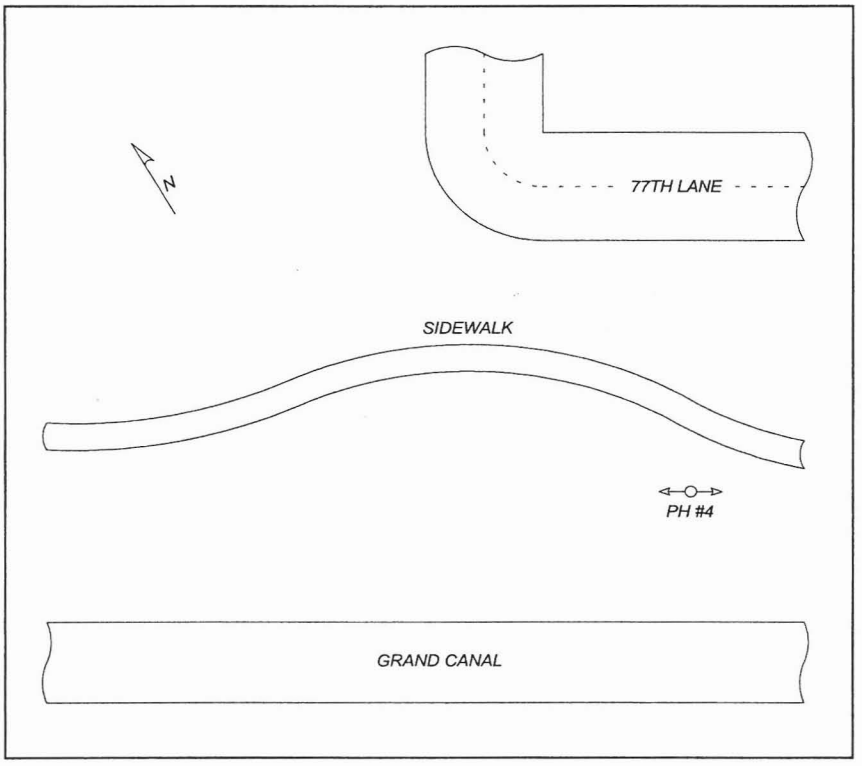
REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

Test Hole #	4	AZTEC www.aztec.us	SUE Crew	J. Brandt
Date Dug	3/9/2005		Truck #	710
Client Project #	BHOC	4561 East McDowell Road, Phoenix, AZ 85008-4504	City	Glendale
Project #	AZ03191-003	Tel. (602)458-0402 Fax. (602)458-9359	County	Maricopa
Location	77th Lane and Missouri Avenue			

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: West SURFACE ELEVATION: 1090.13 WIDTH/O.D.: 10" TOP ELEVATION: 1085.93 TOP DEPTH (FEET): 4.2 BOTTOM ELEVATION: 1085.73 BOTTOM (FEET): 4.4
RIBBON COLOR: Red	

COORDINATES: NORTHING 915460 EASTING 605434.51

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Three 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

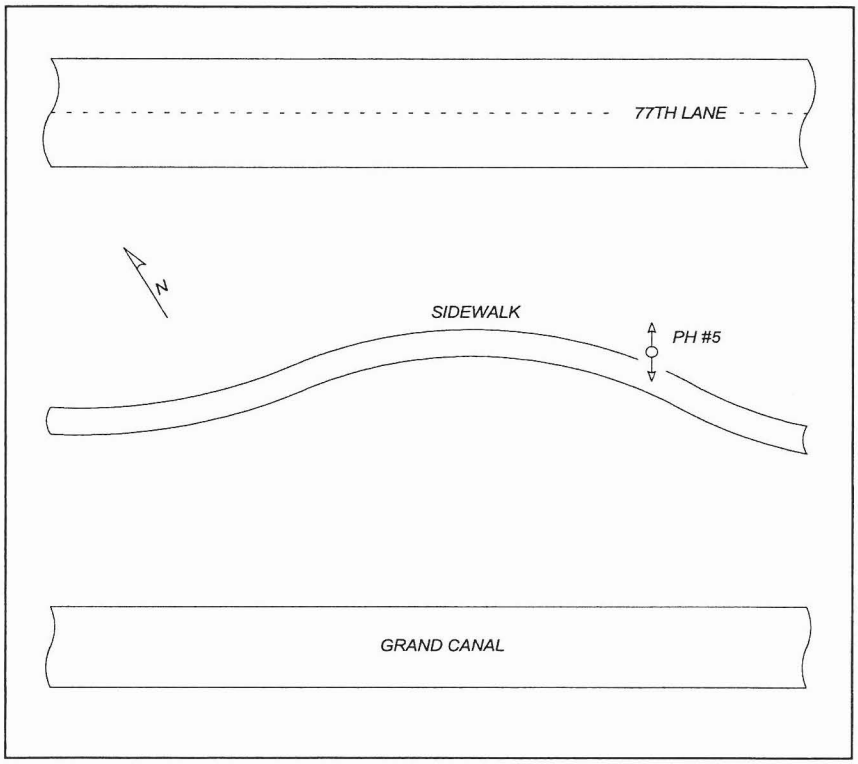
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	5	SUE Crew	J. Brandt
Date Dug	3/9/2005	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Missouri Avenue		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: North SURFACE ELEVATION: 1090.05 WIDTH/O.D.: 7" TOP ELEVATION: 1084.8 — TOP DEPTH (FEET): 5.25 BOTTOM ELEVATION: 1084.42 — BOTTOM (FEET): 5.63
RIBBON COLOR: Red	

COORDINATES: NORTHING 915413.62 EASTING 605498.26

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Three 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

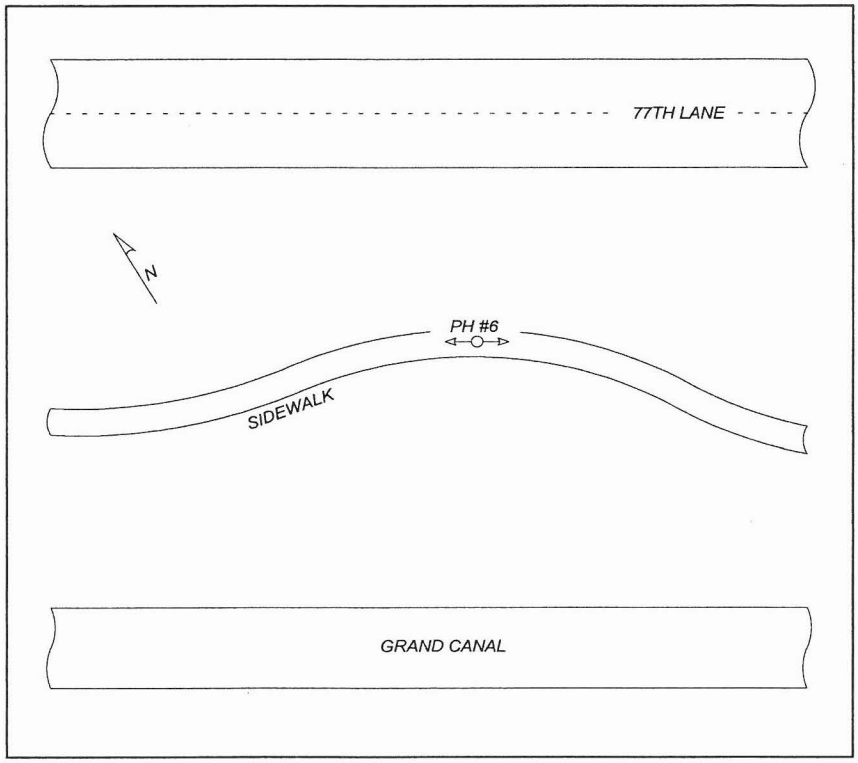
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

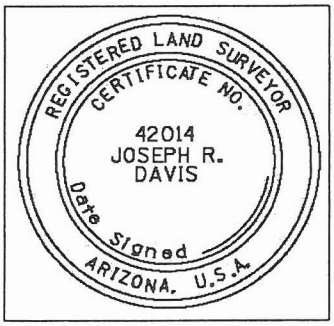
TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	6	SUE Crew	J. Brandt
Date Dug	3/9/2005	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Denton Lane		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Red

CROSS SECTION - NOT TO SCALE

FACING: West

SURFACE ELEVATION	1090.59	WIDTH/O.D. 11"	
TOP ELEVATION	1086.37	4.22	TOP DEPTH (FEET)
BOTTOM ELEVATION	1085.8	4.79	BOTTOM (FEET)

COORDINATES: NORTHING 915311.25 EASTING 605570.67

PAVING THICKNESS 4" PAVING TYPE Concrete SOIL CONDITION GP

SIZE Six 2.38" TYPE PVC FACILITY OWNER Salt River Project

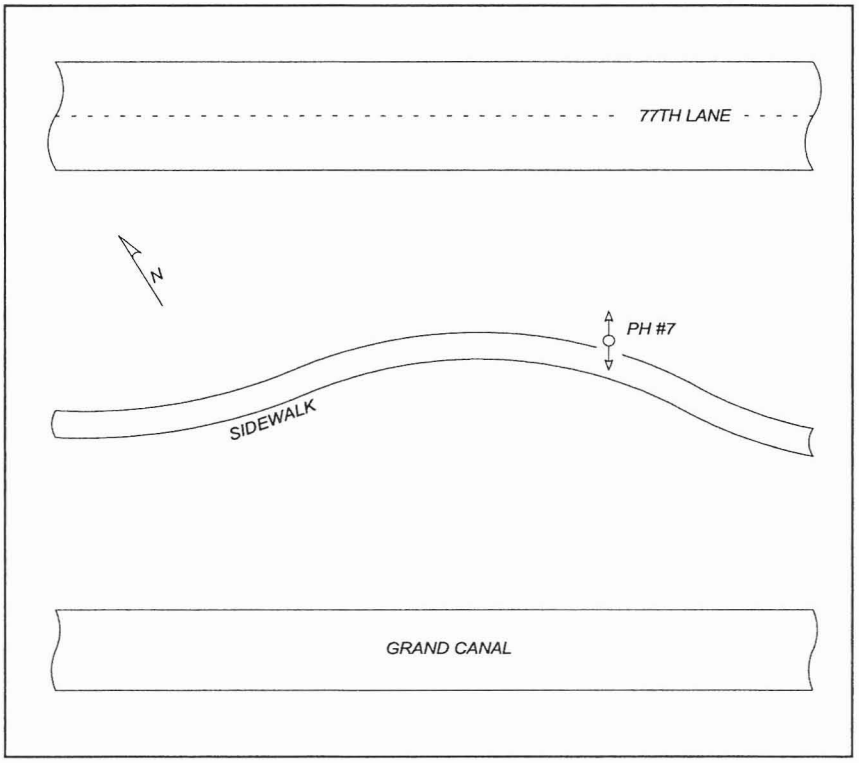
REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

Test Hole #	7	AZTEC www.aztec.us	SUE Crew	J. Brandt
Date Dug	3/9/2005		Truck #	710
Client Project #	BHOC	4561 East McDowell Road, Phoenix, AZ 85008-4504	City	Glendale
Project #	AZ03191-003	Tel. (602)458-0402 Fax. (602)458-9359	County	Maricopa
Location	77th Lane and Denton Lane			

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: North SURFACE ELEVATION: 1090.35 WIDTH/O.D.: 12" TOP ELEVATION: 1086.15 — 4.2 TOP DEPTH (FEET) BOTTOM ELEVATION: 1085.66 — 4.69 BOTTOM (FEET)
RIBBON COLOR: Red	

COORDINATES: NORTHING 915230.8 EASTING 605667.05

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Six 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

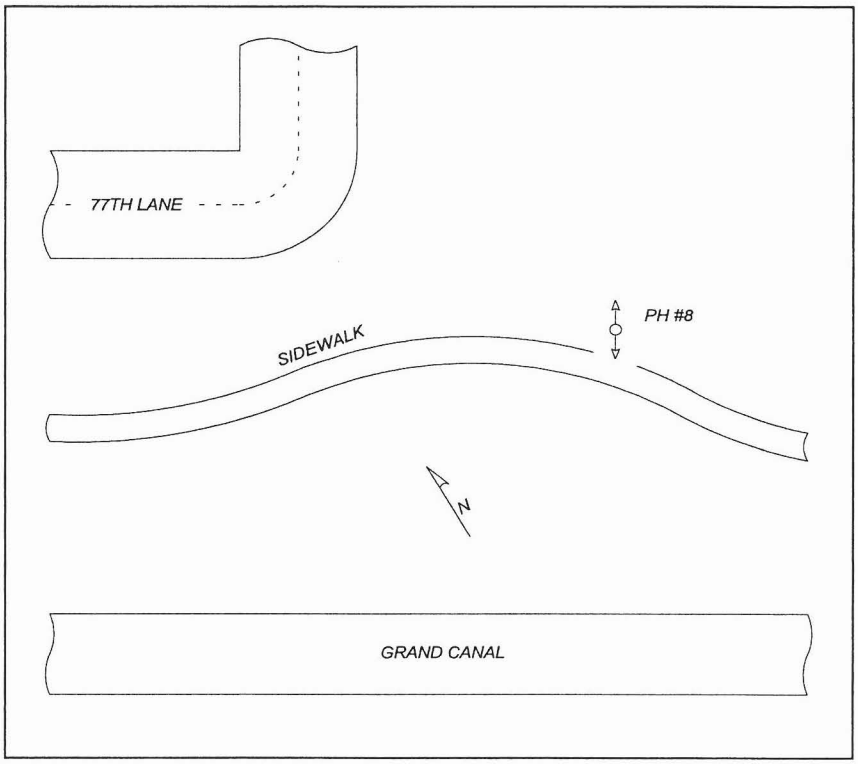
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	8	SUE Crew	J. Stroud
Date Dug	3/10/2005	Truck #	8276
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Denton Lane		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: East SURFACE ELEVATION: 1090.62 WIDTH/O.D.: 8" TOP ELEVATION: 1085.6 — TOP DEPTH (FEET): 5.02 BOTTOM ELEVATION: 1085.4 — BOTTOM (FEET): 5.22
RIBBON COLOR: Red	

COORDINATES: NORTHING 915144.48 EASTING 605746.17

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Two 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

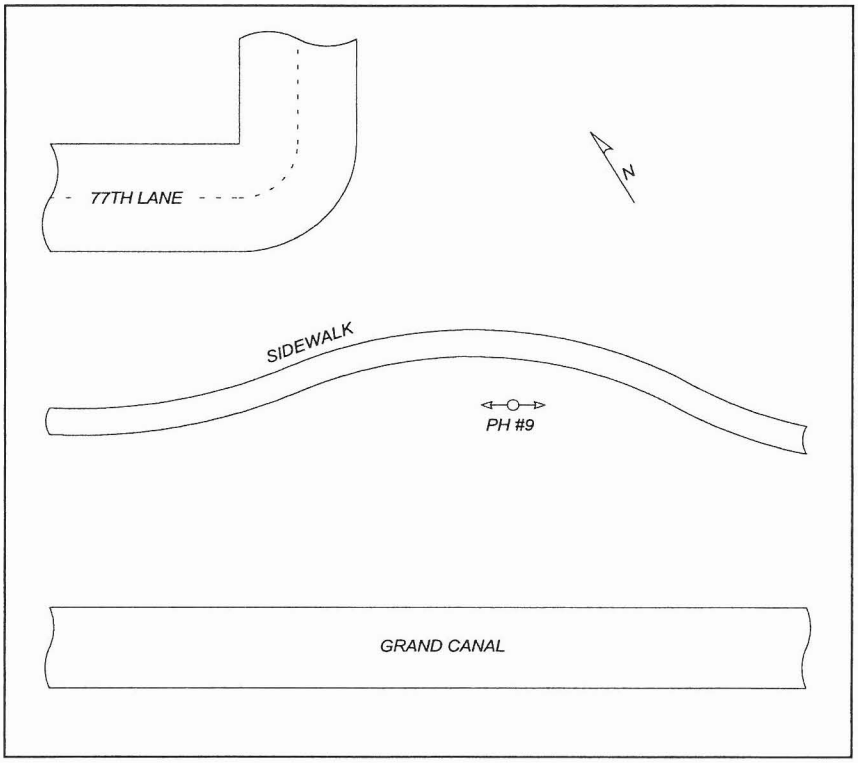
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	9	SUE Crew	J. Stroud
Date Dug	3/9/2005	Truck #	8276
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Denton Lane		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: North SURFACE ELEVATION: 1090.61 WIDTH/O.D.: 18" TOP ELEVATION: 1085.87 — 4.74 TOP DEPTH (FEET) BOTTOM ELEVATION: 1085.58 — 5.03 BOTTOM (FEET)
RIBBON COLOR: Red	

COORDINATES: NORTHING 915058.77 EASTING 605802.01

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Six 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

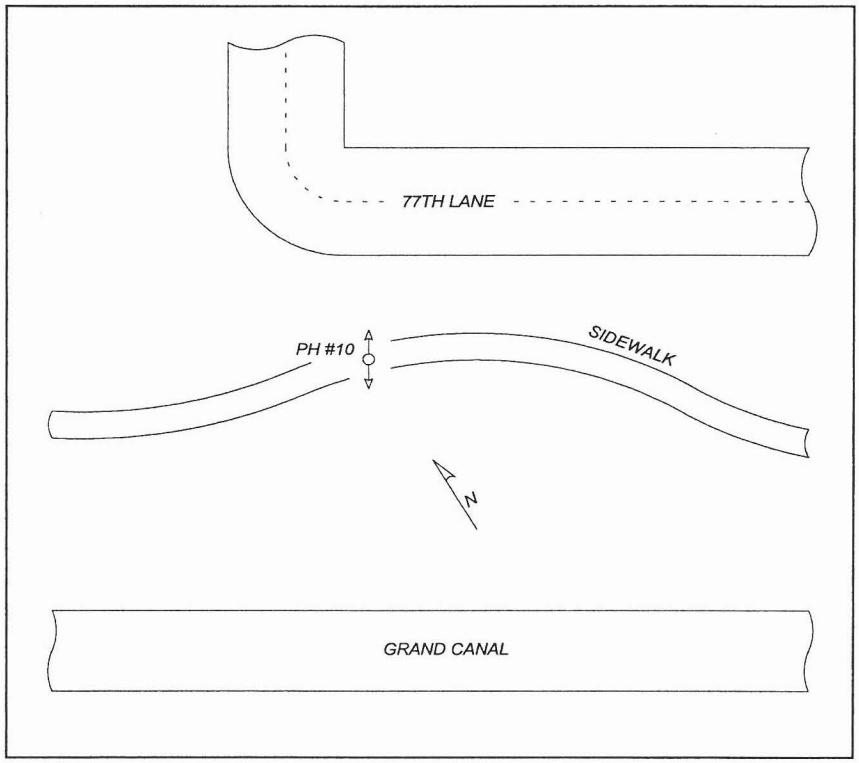
TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10	SUE Crew	J. Stroud
Date Dug	3/9/2005	Truck #	8276
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Vermont Avenue		

LOCATION PLAN - NOT TO SCALE



REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42014
JOSEPH R.
DAVIS
Date Signed
ARIZONA, U.S.A.

SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: East SURFACE ELEVATION: 1091.34 WIDTH/O.D.: 3.5" TOP ELEVATION: 1086.75 — TOP DEPTH (FEET): 4.59 BOTTOM ELEVATION: 1086.46 — BOTTOM (FEET): 4.88
RIBBON COLOR: Red	

COORDINATES: NORTHING 914938.57 EASTING 605933.74

PAVING THICKNESS 4" PAVING TYPE Concrete SOIL CONDITION GP

SIZE 3" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

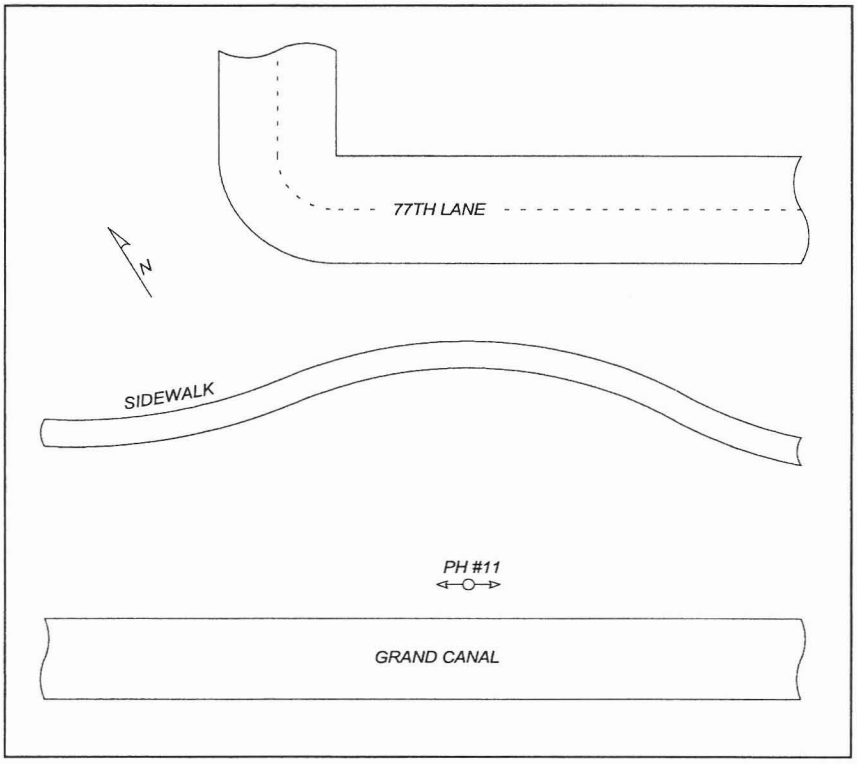
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	11	SUE Crew	J. Stroud
Date Dug	3/9/2005	Truck #	8247
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Vermont Avenue		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: North SURFACE ELEVATION: 1091.41 WIDTH/O.D.: 22" TOP ELEVATION: 1086.93 — TOP DEPTH (FEET): 4.48 BOTTOM ELEVATION: 1086.49 — BOTTOM (FEET): 4.92
RIBBON COLOR: Red	

COORDINATES: NORTHING 914905.96 EASTING 605940.86

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Six 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

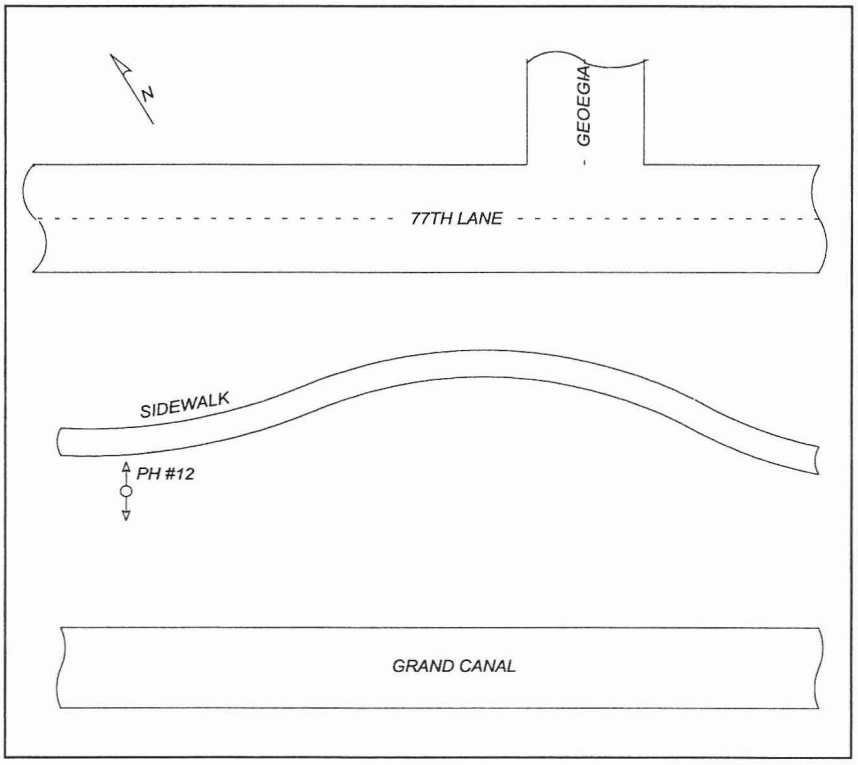
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	12	SUE Crew	J. Stroud
Date Dug	3/9/2005	Truck #	8247
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Georgia Avenue		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK
NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87
RIBBON COLOR: Red

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1090.75	WIDTH/O.D. 12"	
TOP ELEVATION	1086.56		4.19 TOP DEPTH (FEET)
BOTTOM ELEVATION	1086.33		4.42 BOTTOM (FEET)

COORDINATES: NORTHING 914748.74 EASTING 606121.19

PAVING THICKNESS: None PAVING TYPE: None SOIL CONDITION: GP

SIZE: Three 2.38" TYPE: PVC FACILITY OWNER: Salt River Project

REMARKS:

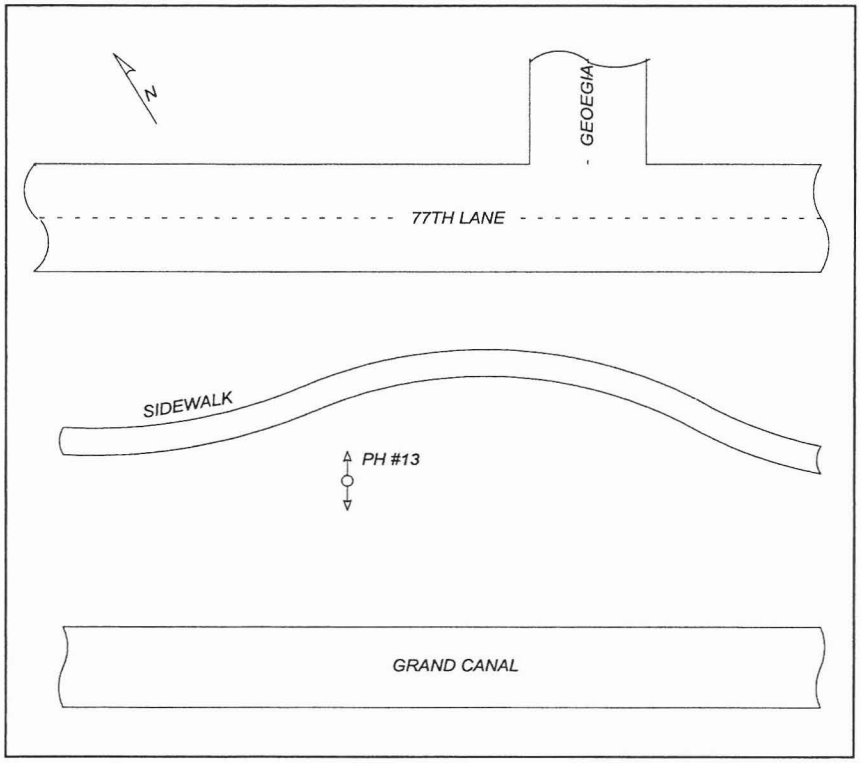
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	13	SUE Crew	J. Stroud
Date Dug	3/9/2005	Truck #	8247
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	77th Lane and Georgia Avenue		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: East SURFACE ELEVATION: 1090.74 WIDTH/O.D.: 18" TOP ELEVATION: 1086.53 — TOP DEPTH (FEET): 4.21 BOTTOM ELEVATION: 1086.31 — BOTTOM (FEET): 4.43
RIBBON COLOR: Red	

COORDINATES: NORTHING 914741.15 EASTING 606126.89

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE Four 2.38" TYPE PVC FACILITY OWNER Salt River Project

REMARKS:

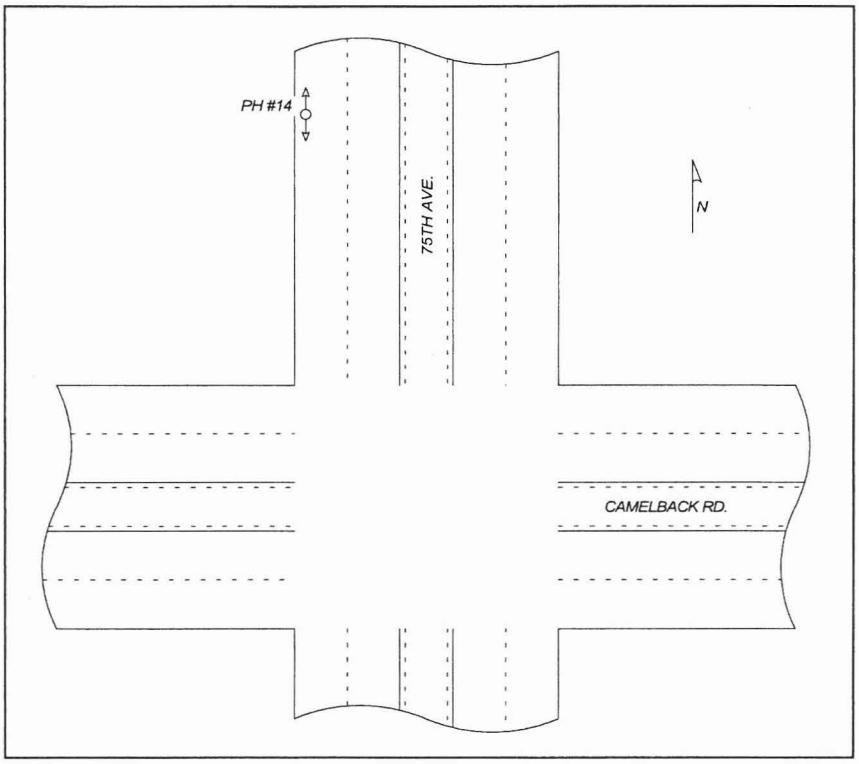
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	14	SUE Crew	C. Nowlin
Date Dug	3/8/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Yellow

CROSS SECTION - NOT TO SCALE

FACING: North

SURFACE ELEVATION	1095.55	WIDTH/O.D. 4.5"	
TOP ELEVATION	1090.56		4.99 TOP DEPTH (FEET)
BOTTOM ELEVATION	1090.18		5.37 BOTTOM (FEET)

COORDINATES: NORTHING 913271.21 EASTING 607462.55

PAVING THICKNESS 18" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 4" TYPE Steel w/ Coating FACILITY OWNER Southwest Gas

REMARKS:

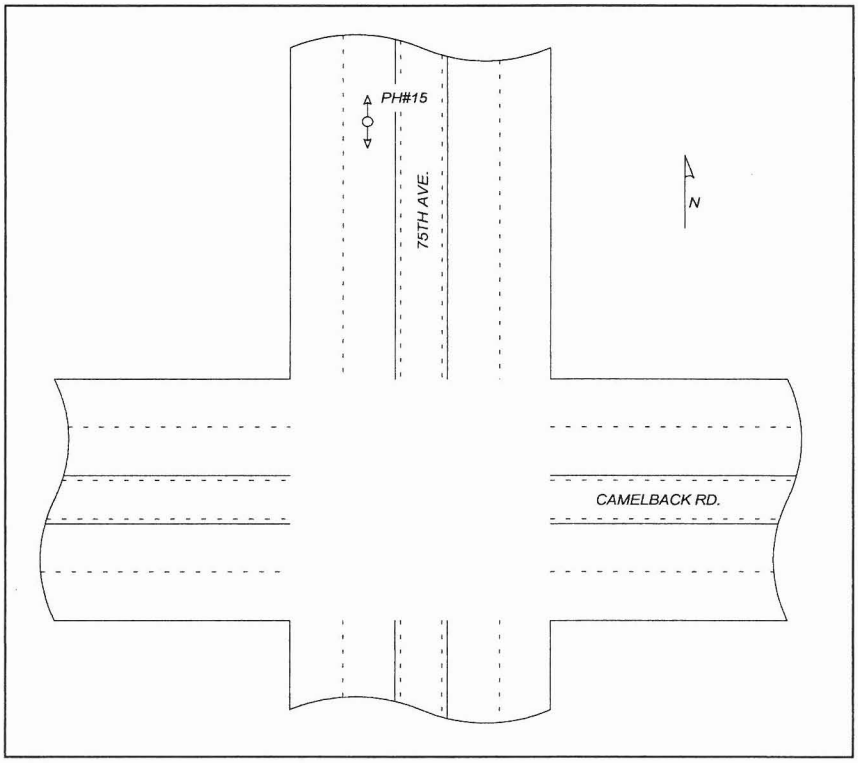
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	15	SUE Crew	C. Nowlin
Date Dug	3/8/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR Blue

CROSS SECTION - NOT TO SCALE

FACING North

SURFACE ELEVATION	1096.17	WIDTH/O.D. 13.2"	
TOP ELEVATION	1092.25		3.92 TOP DEPTH (FEET)
BOTTOM ELEVATION	1091.15		5.02 BOTTOM (FEET)

COORDINATES: NORTHING 913252.64 EASTING 607477.38

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION Slurry

SIZE 12" TYPE DIP FACILITY OWNER City of Glendale Water

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

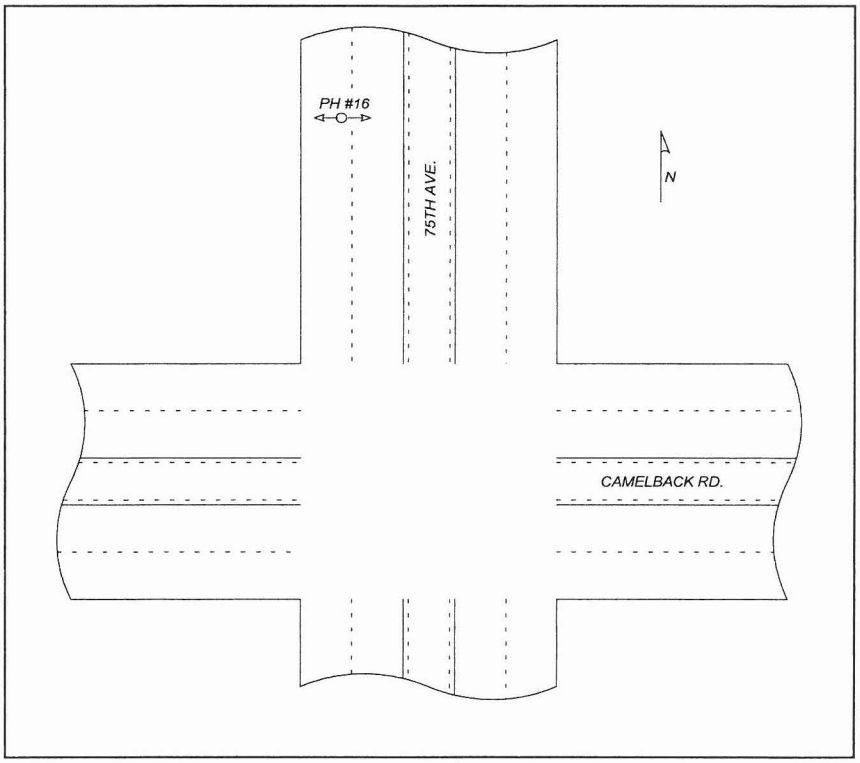
TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	16	SUE Crew	C. Nowlin
Date Dug	3/8/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: East SURFACE ELEVATION: 1096.13 WIDTH/O.D.: 36" TOP ELEVATION: 1088.44 — TOP DEPTH (FEET): 7.69 BOTTOM ELEVATION: 1085.73 — BOTTOM (FEET): 10.4
RIBBON COLOR: Red	

COORDINATES: NORTHING 913235.17 EASTING 607469

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 36" Wide TYPE Concrete Duct FACILITY OWNER Salt River Project

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

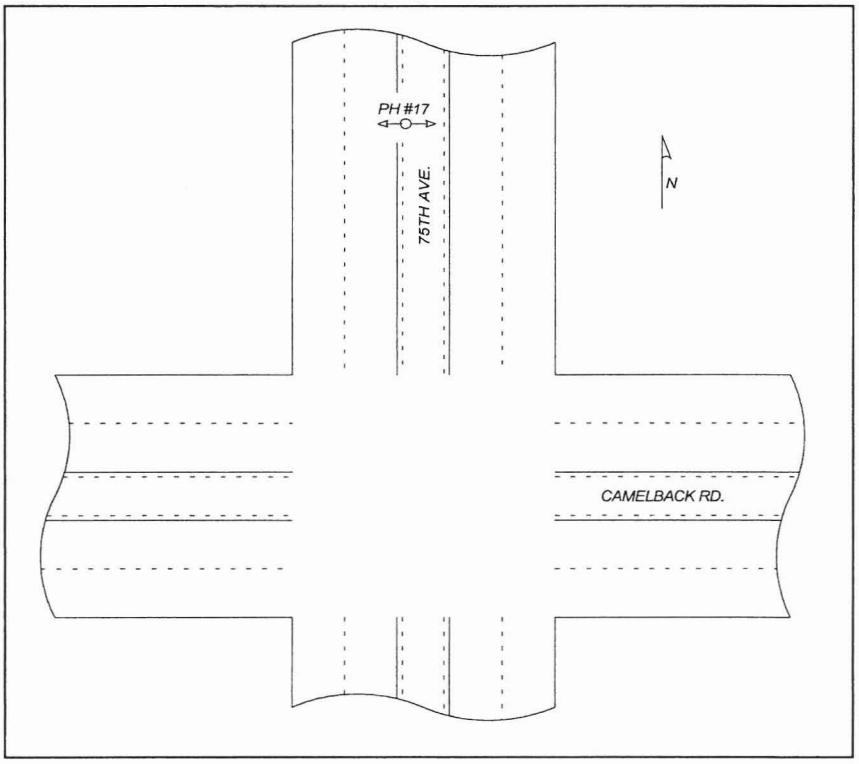
TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	17	SUE Crew	C. Nowlin
Date Dug	3/8/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Red

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1096.55	WIDTH/O.D. 36"	
TOP ELEVATION	1089.27		7.28 TOP DEPTH (FEET)
BOTTOM ELEVATION	1086.15		10.4 BOTTOM (FEET)

COORDINATES: NORTHING 913235.4 EASTING 607491.08

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 36" Wide TYPE Concrete Duct FACILITY OWNER Salt River Project

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

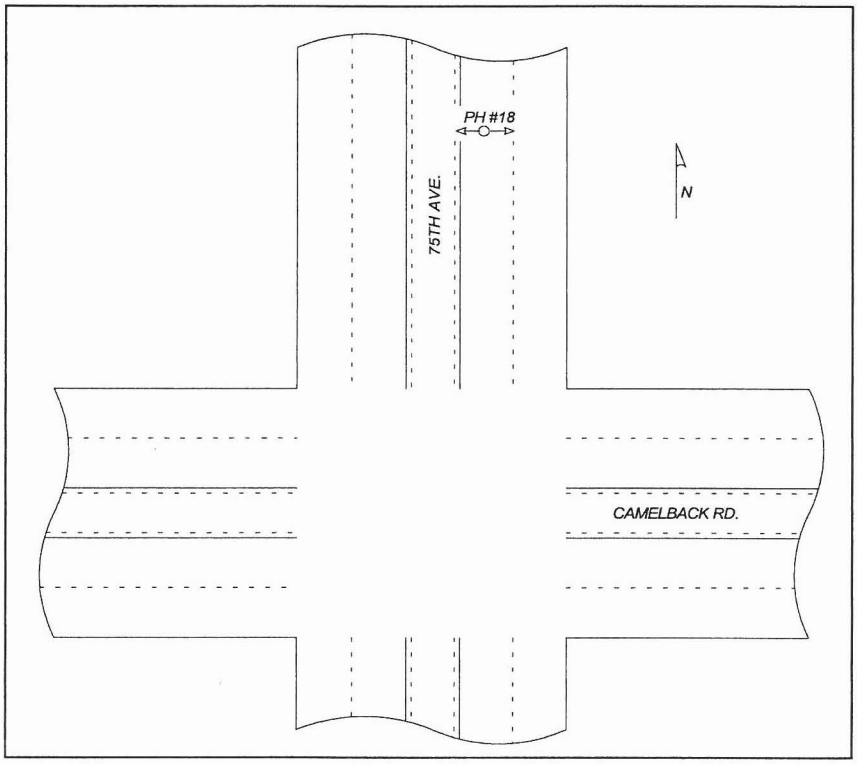
TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	18	SUE Crew	C. Nowlin
Date Dug	3/8/2005	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Red

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1096.48	WIDTH/O.D. 36"	
TOP ELEVATION	1090.42		6.06 TOP DEPTH (FEET)
BOTTOM ELEVATION	1086.98		9.5 BOTTOM (FEET)

COORDINATES: NORTHING 913235.59 EASTING 607504.33

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 36" Wide TYPE Concrete Duct FACILITY OWNER Salt River Project

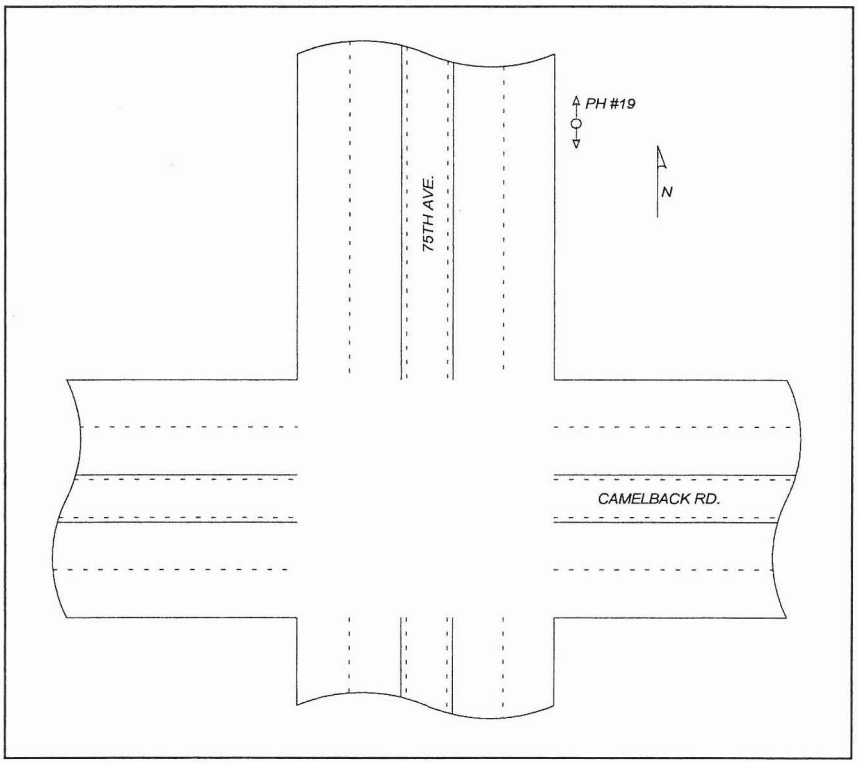
REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

Test Hole #	19	AZTEC www.aztec.us	SUE Crew	J. Stroud
Date Dug	3/10/2005		Truck #	8276
Client Project #	BHOC	4561 East McDowell Road, Phoenix, AZ 85008-4504	City	Glendale
Project #	AZ03191-003	Tel. (602)458-0402 Fax. (602)458-9359	County	Maricopa
Location	75th Avenue and Camelback Road			

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK
NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87
RIBBON COLOR Orange

CROSS SECTION - NOT TO SCALE

FACING North

SURFACE ELEVATION	1096.62	WIDTH/O.D. 2"		
TOP ELEVATION	1093.64		2.98	TOP DEPTH (FEET)
BOTTOM ELEVATION	1093.47		3.15	BOTTOM (FEET)

COORDINATES: NORTHING 913206.96 EASTING 607532.65

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE 2" TYPE PE FACILITY OWNER Qwest Local Network

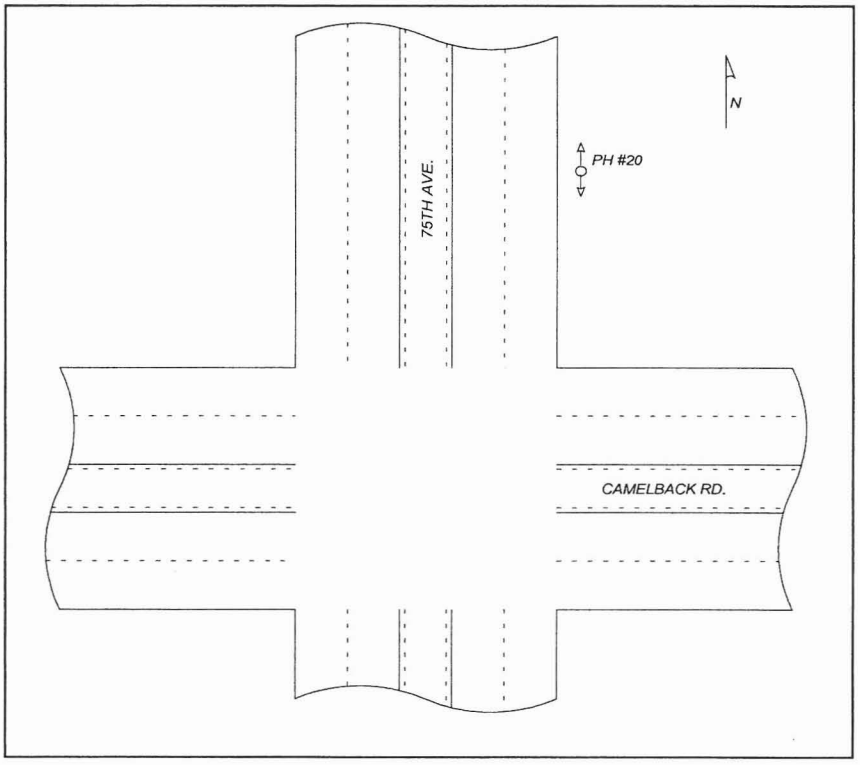
REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

Test Hole #	20	AZTEC www.aztec.us	SUE Crew	J. Stroud
Date Dug	3/10/2005		Truck #	8276
Client Project #	BHOC	4561 East McDowell Road, Phoenix, AZ 85008-4504	City	Glendale
Project #	AZ03191-003	Tel. (602)458-0402 Fax. (602)458-9359	County	Maricopa
Location	75th Avenue and Camelback Road			

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
NGVD 29 1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD NORTHING: 913930.26 EASTING: 606585.11 ELEVATION: 1092.87	FACING: North SURFACE ELEVATION: 1096.83 WIDTH/O.D.: 2" TOP ELEVATION: 1094.32 — TOP DEPTH (FEET): 2.51 BOTTOM ELEVATION: 1094.15 — BOTTOM (FEET): 2.68
RIBBON COLOR: Orange	

COORDINATES: NORTHING 913167.21 EASTING 607533.42

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE 2" TYPE PE FACILITY OWNER Qwest Local Network

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

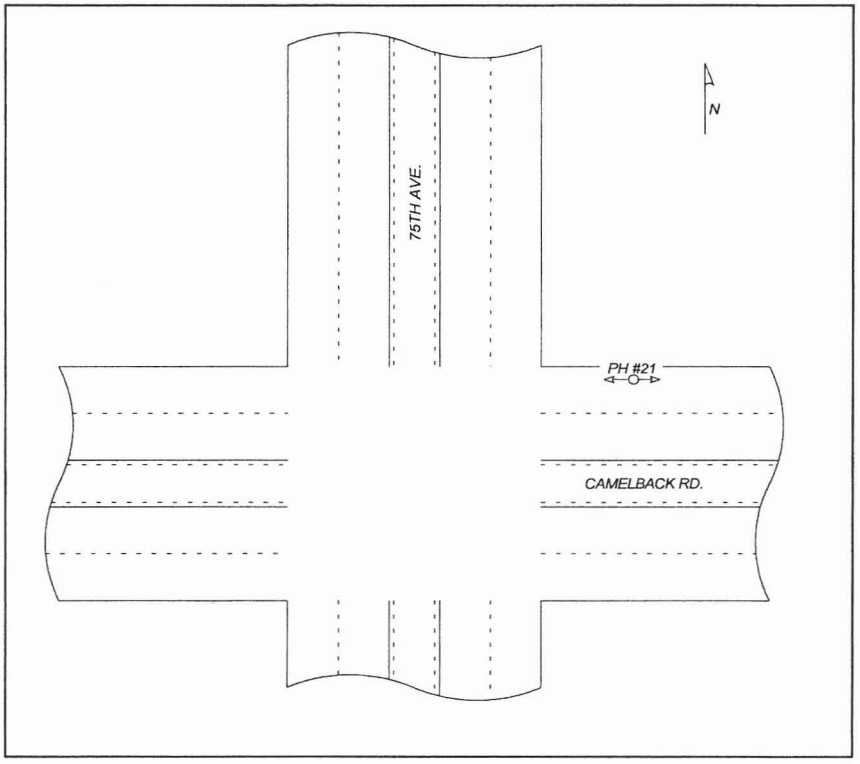
TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	21	SUE Crew	J. Stroud
Date Dug	3/10/2005	Truck #	8276
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Blue

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1095.85	WIDTH/O.D. 13.92"	
TOP ELEVATION	1090.64		5.21 TOP DEPTH (FEET)
BOTTOM ELEVATION	1089.48		6.37 BOTTOM (FEET)

COORDINATES: NORTHING 913032.66 EASTING 607696.43

PAVING THICKNESS 5" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 12" TYPE ACP FACILITY OWNER City of Glendale Water

REMARKS:

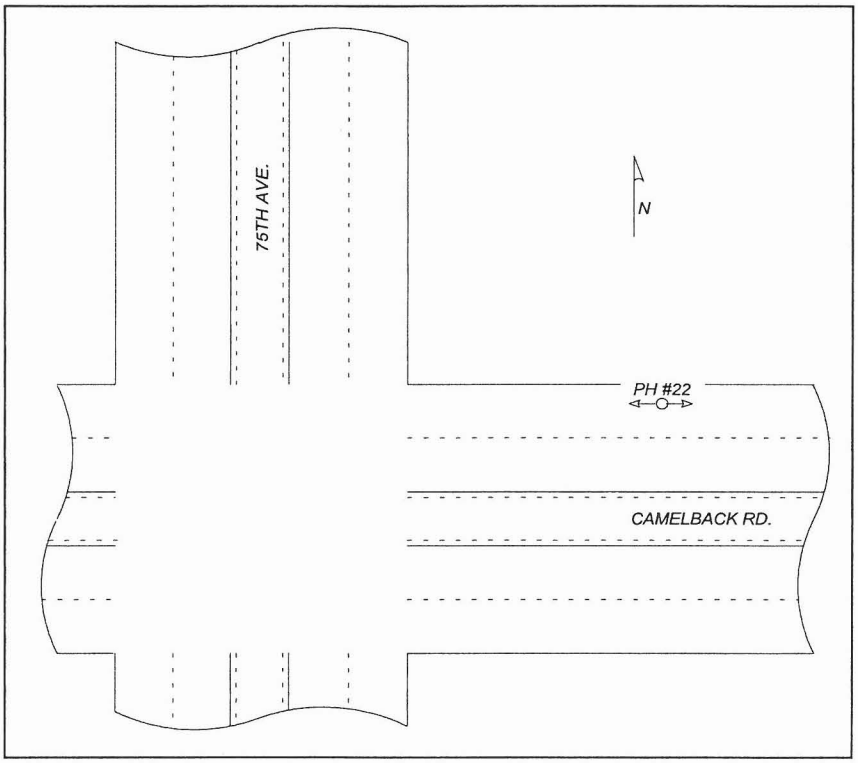
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

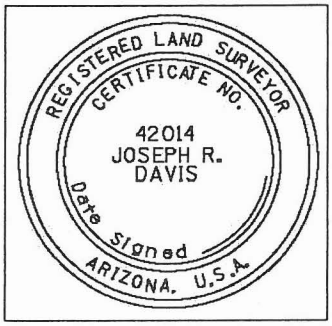
TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	22	SUE Crew	J. Brandt
Date Dug	3/10/2005	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Blue

CROSS SECTION - NOT TO SCALE

FACING: West

SURFACE ELEVATION	1095.67	WIDTH/O.D. 23"	
TOP ELEVATION	1094.07		1.6 TOP DEPTH (FEET)
BOTTOM ELEVATION	1092.15		3.52 BOTTOM (FEET)

COORDINATES: NORTHING 913039.73 EASTING 607753.24

PAVING THICKNESS 5" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 18" TYPE RCP FACILITY OWNER City of Glendale Storm Drain

REMARKS:

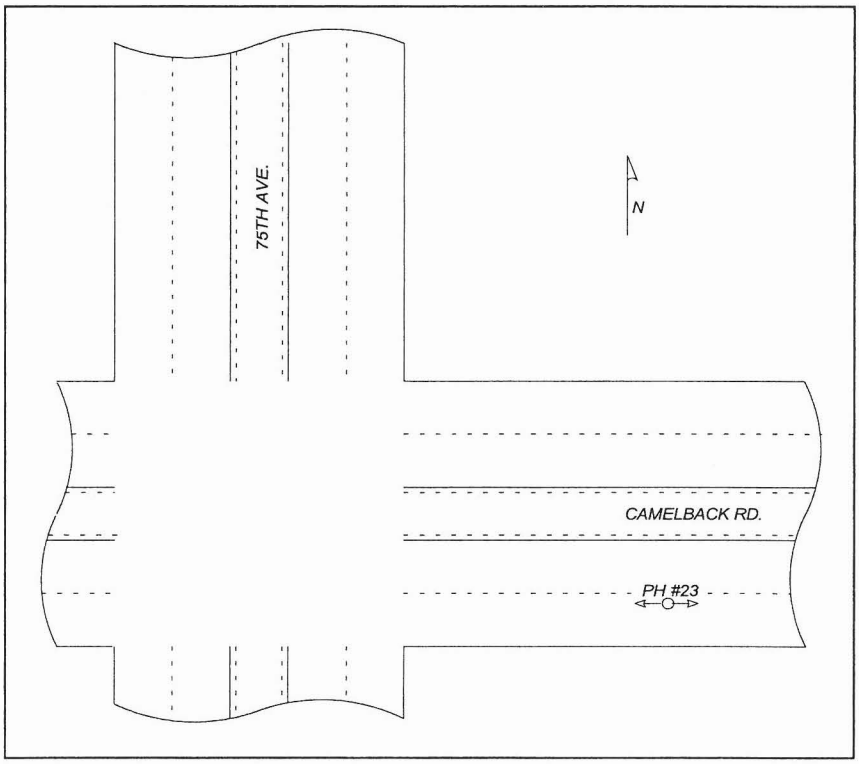
PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us
4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	23	SUE Crew	J. Brandt
Date Dug	3/10/2005	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE



SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Blue

CROSS SECTION - NOT TO SCALE

FACING: West

SURFACE ELEVATION	1096.05	WIDTH/O.D. 9.11"	
TOP ELEVATION	1092.01		4.04 TOP DEPTH (FEET)
BOTTOM ELEVATION	1091.25		4.8 BOTTOM (FEET)

COORDINATES: NORTHING 912991.6 EASTING 607741.45

PAVING THICKNESS 6" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 8" TYPE ACP FACILITY OWNER City of Phoenix Water

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

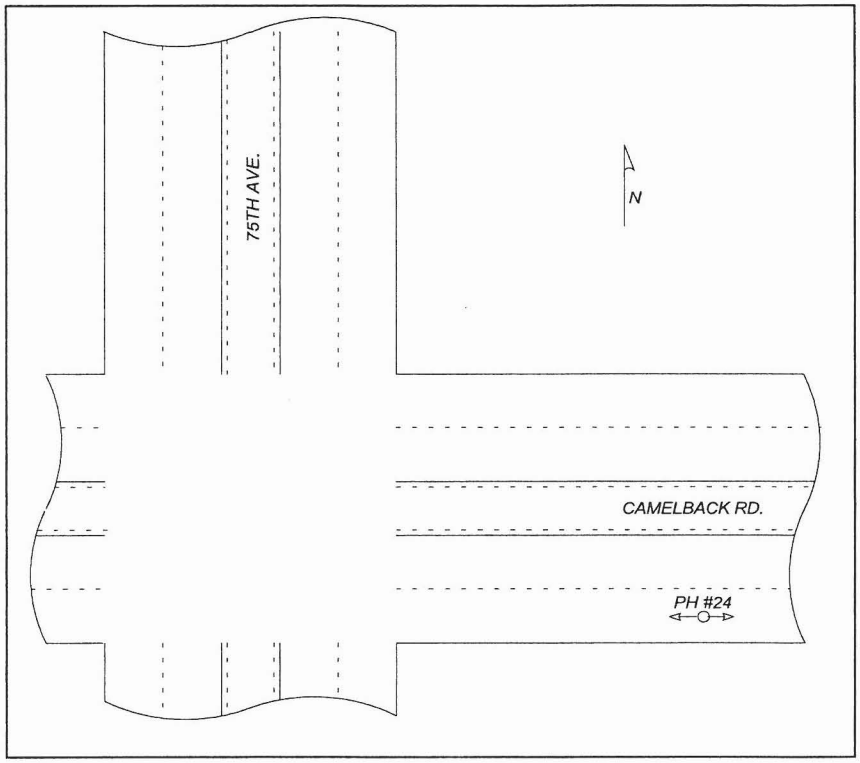
TEST HOLE DATA REPORT

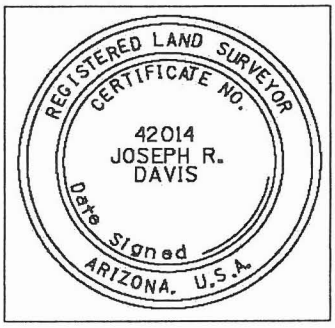
AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	24	SUE Crew	J. Brandt
Date Dug	3/9/2005	Truck #	9218
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Yellow

CROSS SECTION - NOT TO SCALE

FACING: West

SURFACE ELEVATION	1096	WIDTH/O.D. 4.5"	
TOP ELEVATION	1090.65		5.35 TOP DEPTH (FEET)
BOTTOM ELEVATION	1090.27		5.73 BOTTOM (FEET)

COORDINATES: NORTHING 912985.5 EASTING 607746.58

PAVING THICKNESS 6" PAVING TYPE Asphalt SOIL CONDITION GP

SIZE 4" TYPE Steel FACILITY OWNER Southwest Gas

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

TEST HOLE DATA REPORT

AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	25	SUE Crew	D. Harmon
Date Dug	3/14/2005	Truck #	929
Client Project #	BHOC	City	Glendale
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
42014
JOSEPH R.
DAVIS
Date Signed
ARIZONA, U.S.A.

SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR None

CROSS SECTION - NOT TO SCALE

FACING

SURFACE ELEVATION

WIDTH/O.D.

TOP ELEVATION 0 TOP DEPTH (FEET)

BOTTOM ELEVATION 0 BOTTOM (FEET)

COORDINATES: NORTHING EASTING

PAVING THICKNESS None PAVING TYPE None SOIL CONDITION GP

SIZE None TYPE None FACILITY OWNER Qwest Local Network

REMARKS:

Dug in the requested location and no facility was found. No utility in the requested location per QLN Bluestake Locator.

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

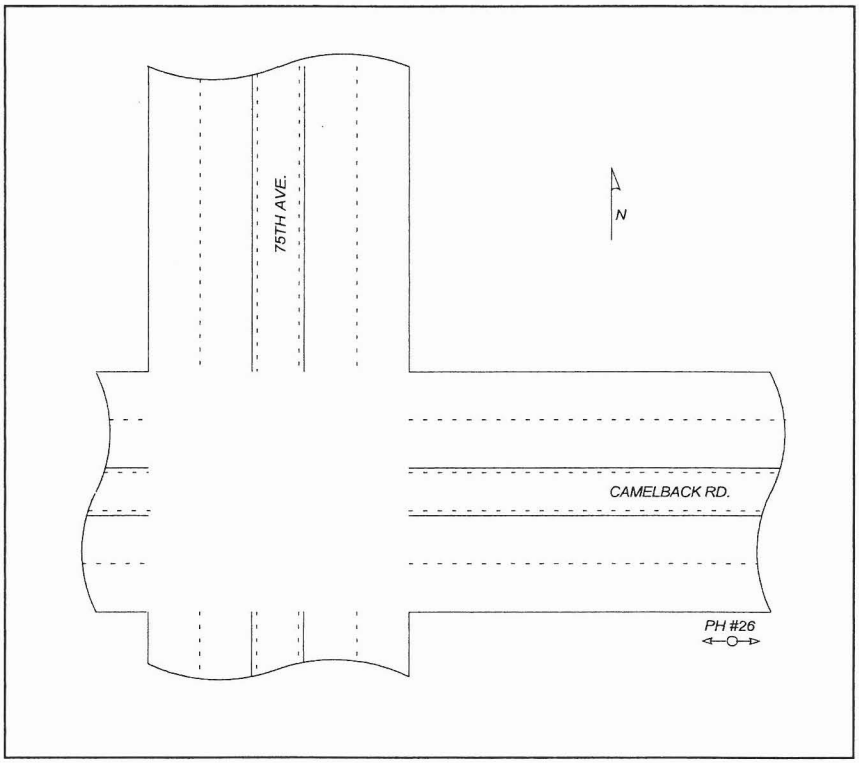
TEST HOLE DATA REPORT

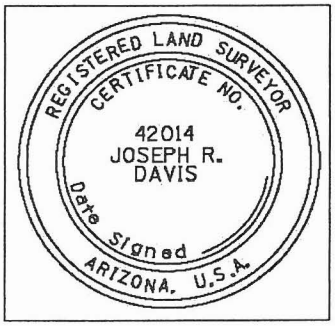
AZTEC
www.aztec.us

4561 East McDowell Road, Phoenix, AZ 85008-4504
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	26	SUE Crew	J. Brandt
Date Dug	3/9/2005	Truck #	710
Client Project #	BHOC	City	Phoenix
Project #	AZ03191-003	County	Maricopa
Location	75th Avenue and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

NGVD 29
1/2" REBAR 0.20 MILES N/W OF 75TH AVENUE & CAMELBACK ROAD
NORTHING: 913930.26
EASTING: 606585.11
ELEVATION: 1092.87

RIBBON COLOR: Blue

CROSS SECTION - NOT TO SCALE

FACING: West

SURFACE ELEVATION	1096.93	WIDTH/O.D. 17.8"	
TOP ELEVATION	1087.73		9.2 TOP DEPTH (FEET)
BOTTOM ELEVATION	1086.4		10.53 BOTTOM (FEET)

COORDINATES: NORTHING 912961.58 EASTING 607773.59

PAVING THICKNESS: None PAVING TYPE: None SOIL CONDITION: GP

SIZE: 16" TYPE: CIP FACILITY OWNER: City of Phoenix Water

REMARKS:

PREPARED BY: Marie Jubie CHECKED BY: Bryan Frye

AZTEC ENGINEERING

Testhole Data Summary

Date: 2/6/2004

Project Number: AZ03191

Project Name: Bethany Home Outfall Channel

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
16542
ROBERT O.
GOFDNIA
Date Signed
ARIZONA, U.S.A.

TH #	Location	Date of Excavation	Utility Owner	Utility Size	Utility Description	Coordinates		Ground Elevation	Top Elevation	Bottom Elevation	Depth of Cover
						Northing	Easting				
10001	75th Ave. and Camelback.	2/5/2004	City of Glendale	36" x 48"	Slurry Encasement	913236.19	607478.10	1096.35	1095.93	1091.84	0.42
10002	75th Ave. and Camelback Road	2/5/2004	City of Glendale	15"	RCP	913224.69	607487.00	1096.69	1081.69	1080.07	15.00
10003	75th Ave and Camelback Road	2/5/2004	City of Glendale	18"	VCP	913202.11	607507.06	1096.75	1085.80	1084.14	10.95
10005	75th Ave. and Camelback Road	2/4/2004	City of Glendale	12"	ACP	913186.28	607520.20	1096.60	1088.88	1087.72	7.72
10006	75th Av. And Camelback Road	2/4/2004	Qwest Communications	4"	PVC	913184.20	607522.44	1096.61	1089.96	1089.38	6.65
10007	75th Ave. and Camelback Road	2/5/2004	City of Glendale	12"	ACP	913189.74	607516.88	1096.63	1088.71	1087.55	7.92
10008	75th Ave. and Camelback Road	2/4/2004	City of Glendale	12"	ACP	913032.27	607663.09	1095.78	1091.21	1090.05	4.57
10011	75th Ave. and Camelback Road	2/4/2004	City of Glendale	8"	ACP	912990.63	607702.00	1096.09	1092.46	1091.67	3.63
10012	75th Ave. and Camelback Road	2/4/2004	City of Glendale	16"	DIP	912961.95	607730.84	1096.48	1086.70	1085.22	9.78
10013	75th Ave. and Camelback Road	2/6/2004	Salt River Project	.5"	Ground wire	913057.57	607638.50	1096.38	1095.36	1095.32	1.02
10014	75th Ave. and Camelback Road	2/5/2004	Salt River Project	36" x 22"	Slurry Encasement	913235.34	607478.45	1096.44	1088.79	1086.86	7.65
10015	75th Ave. and Camelback Road	2/4/2004	City of Glendale	48"	RCP	912979.68	607758.21	1095.95	1089.36	1084.55	6.59

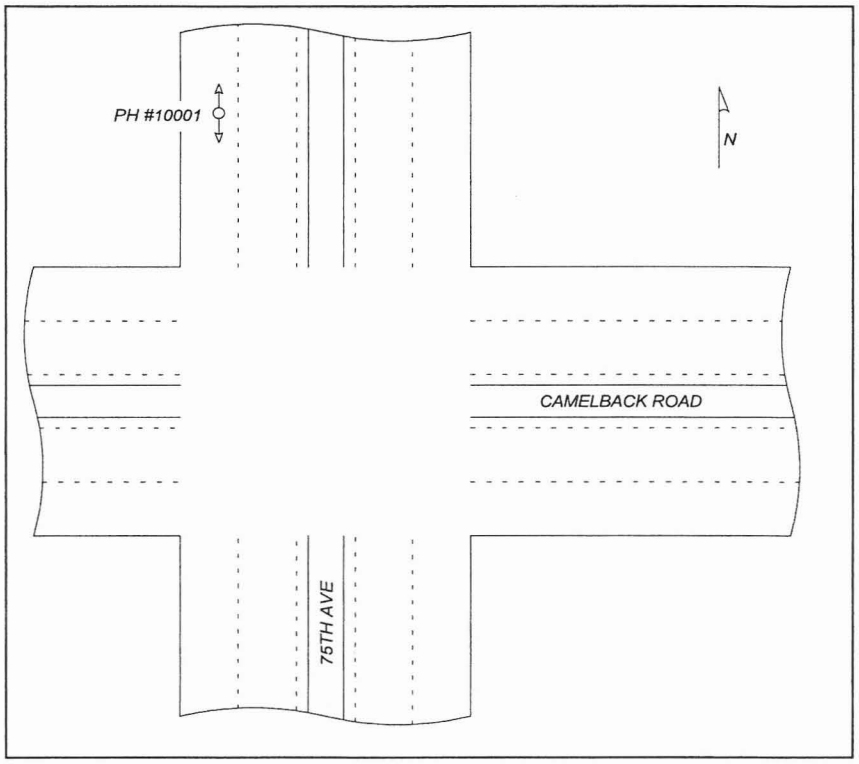
TEST HOLE DATA REPORT

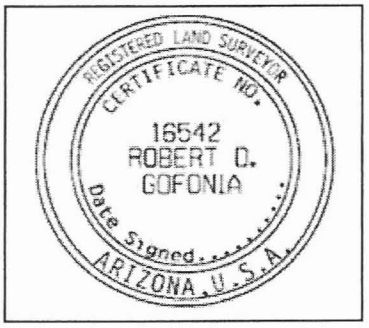
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10001	SUE Crew	J. Cherry
Date Dug	2/5/2004	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback.		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR: Blue

CROSS SECTION - NOT TO SCALE

FACING: North

SURFACE ELEVATION	1096.35	WIDTH/O.D. 36"	
TOP ELEVATION	1095.93		0.42 TOP DEPTH
BOTTOM ELEVATION	1091.84		4.51 BOTTOM

COORDINATES: NORTHING 913236.19 EASTING 607478.10

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION Sand & Rock (Soft)

SIZE 36" x 48" TYPE Slurry Encasement FACILITY OWNER City of Glendale

REMARKS: This is a 12" water line encased in slurry.

PREPARED BY: A. Mehler CHECKED BY:

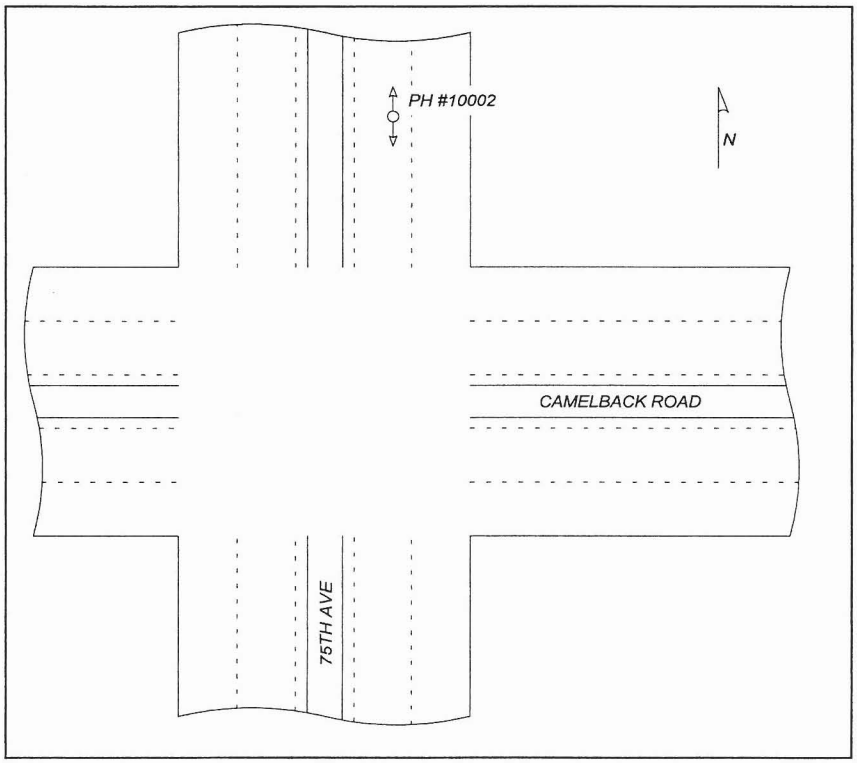
TEST HOLE DATA REPORT

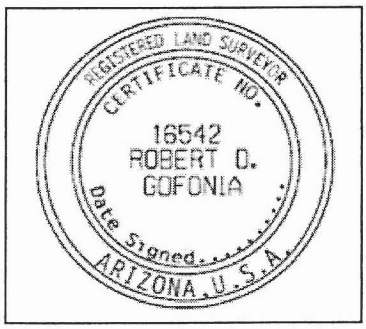
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10002	SUE Crew	J. Cherry
Date Dug	2/5/2004	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
609 913003.6377 North 607482.6763 East 1095.32 Elevation Found brass cap in a hand hole Southwest Corner Section 13, T2N R1E 75th Ave. and Camelback Road.	FACING: North SURFACE ELEVATION: 1096.69 WIDTH/O.D.: 19.5" TOP ELEVATION: 1081.69 — 15.00 TOP DEPTH BOTTOM ELEVATION: 1080.07 — 16.62 BOTTOM
RIBBON COLOR: Green	

COORDINATES: NORTHING 913224.69 EASTING 607487.00

PAVING THICKNESS 5" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 15" TYPE RCP FACILITY OWNER City of Glendale

REMARKS: This is a Gity of Glendale Storm Drain.

PREPARED BY: A. Mehler CHECKED BY:

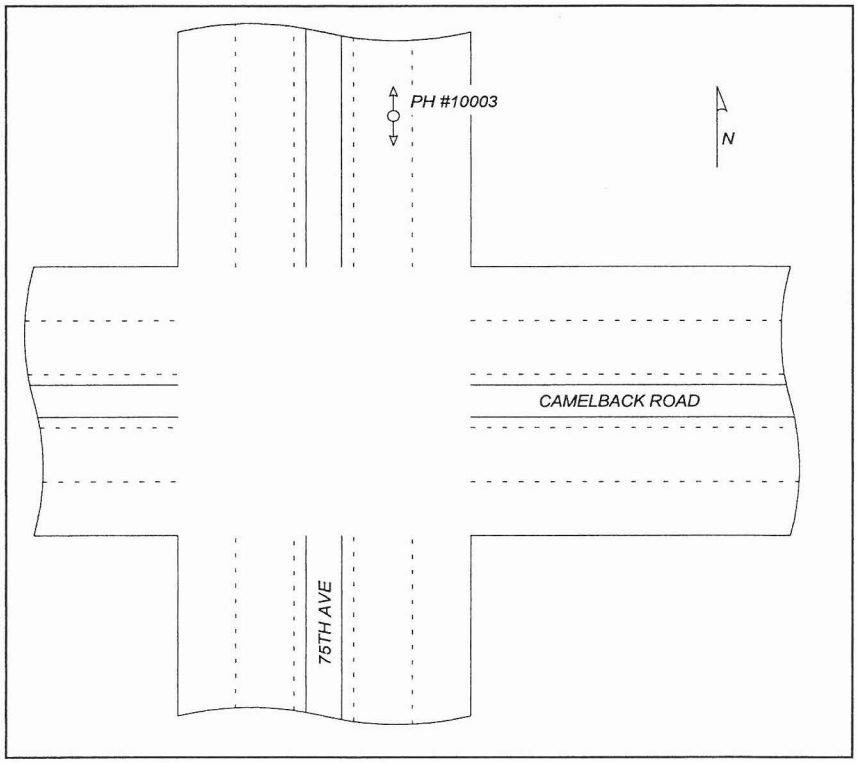
TEST HOLE DATA REPORT

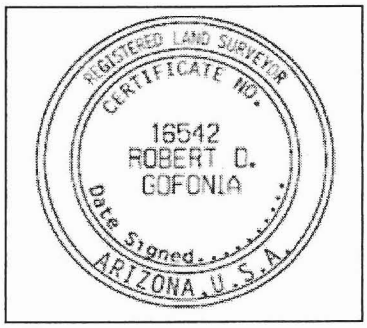
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10003	SUE Crew	J. Cherry
Date Dug	2/5/2004	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR: Green

CROSS SECTION - NOT TO SCALE

FACING: North

SURFACE ELEVATION	1096.75	WIDTH/O.D. 20"		
TOP ELEVATION	1085.8		10.95	TOP DEPTH
BOTTOM ELEVATION	1084.14		12.61	BOTTOM

COORDINATES: NORTHING 913202.11 EASTING 607507.06

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 18" TYPE VCP FACILITY OWNER City of Glendale

REMARKS: This is a City of Glendale sanitary sewer.

PREPARED BY: A. Mehler CHECKED BY:

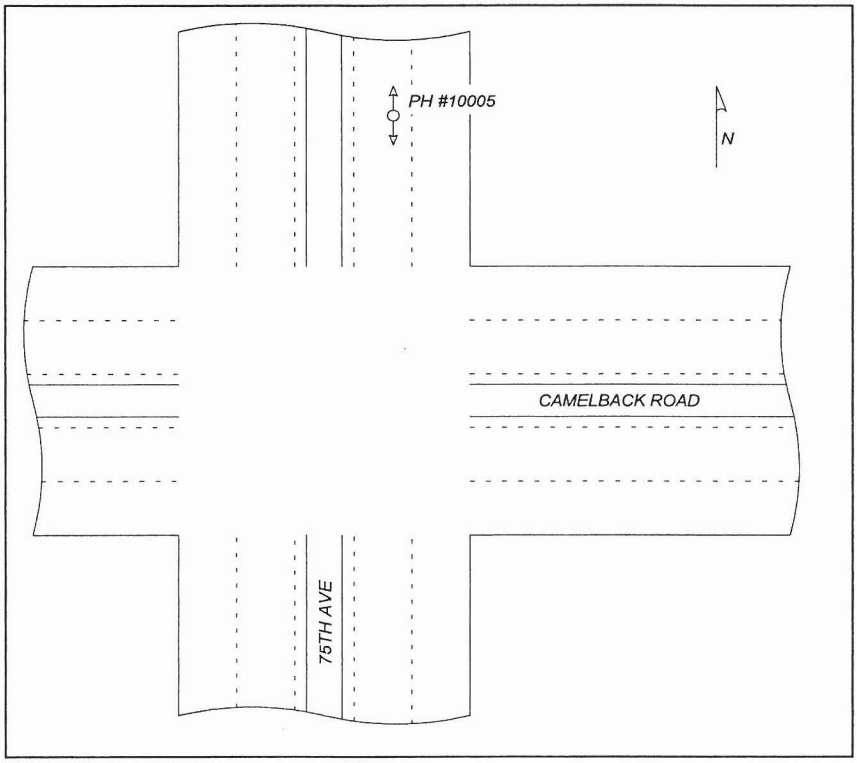
TEST HOLE DATA REPORT

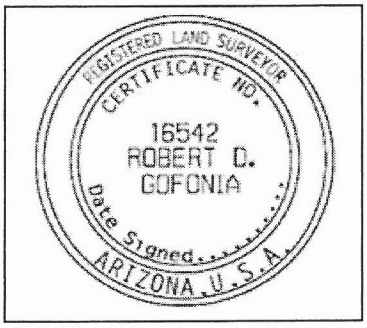
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10005	SUE Crew	J. Cherry
Date Dug	2/4/2004	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
609 913003.6377 North 607482.6763 East 1095.32 Elevation Found brass cap in a hand hole Southwest Corner Section 13, T2N R1E 75th Ave. and Camelback Road.	FACING: North SURFACE ELEVATION: 1096.6 WIDTH/O.D.: 13.92" TOP ELEVATION: 1088.88 — 7.72 TOP DEPTH BOTTOM ELEVATION: 1087.72 — 8.88 BOTTOM
RIBBON COLOR: Blue	

COORDINATES: NORTHING 913186.28 EASTING 607520.20

PAVING THICKNESS 5" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 12" TYPE ACP FACILITY OWNER City of Glendale

REMARKS:

PREPARED BY: A. Mehler CHECKED BY:

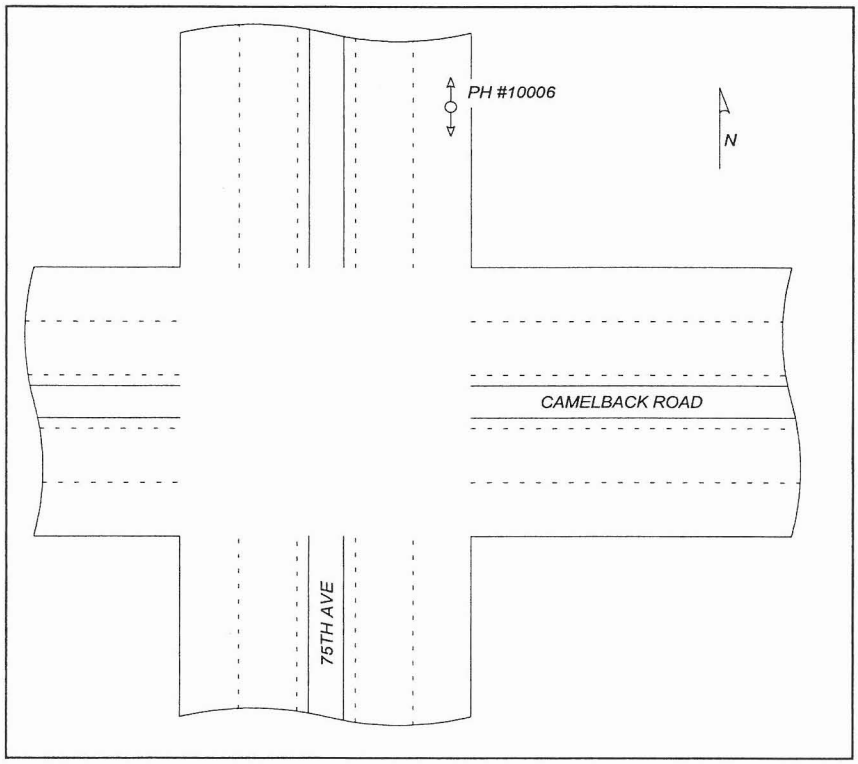
TEST HOLE DATA REPORT

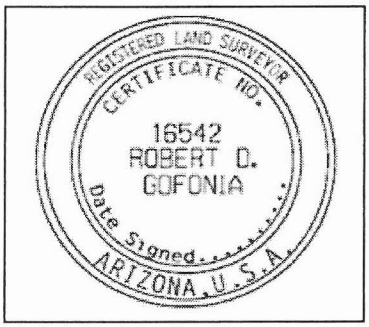
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10006	SUE Crew	J. Cherry
Date Dug	2/4/2004	Truck #	8565
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Av. And Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR: Orange

CROSS SECTION - NOT TO SCALE

FACING: North

SURFACE ELEVATION	1096.61	WIDTH/O.D. 20"		
TOP ELEVATION	1089.96		6.65	TOP DEPTH
BOTTOM ELEVATION	1089.38		7.23	BOTTOM

COORDINATES: NORTHING 913184.20 EASTING 607522.44

PAVING THICKNESS 5" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 4" TYPE PVC FACILITY OWNER Qwest Communications

REMARKS: Found four 4" PVC conduits.

PREPARED BY: A. Mehler CHECKED BY:

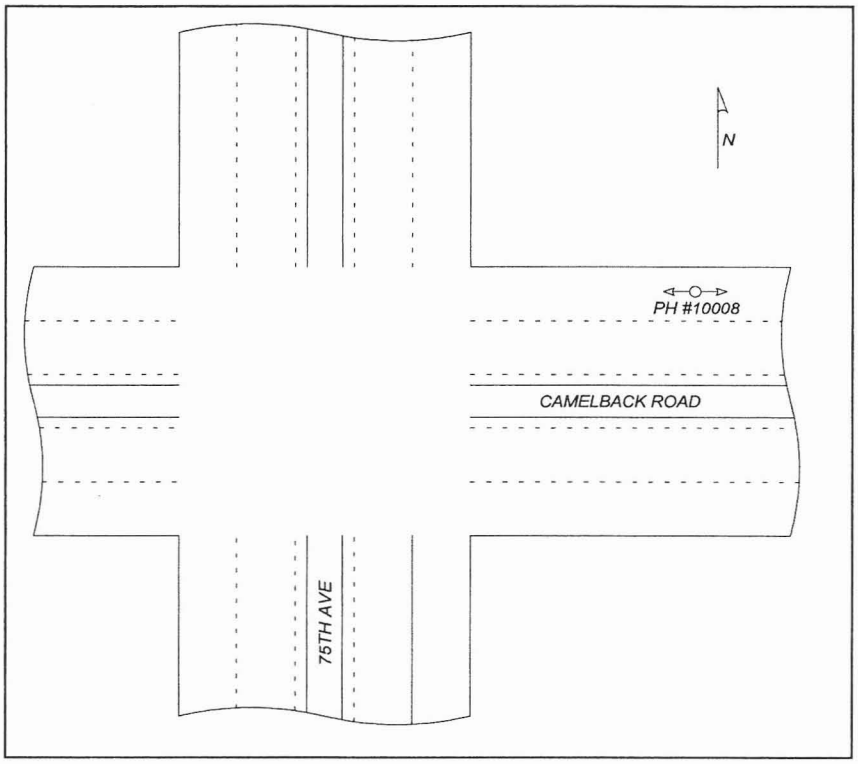
TEST HOLE DATA REPORT

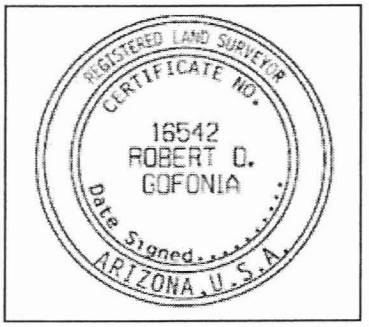
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10007	SUE Crew	J. Chery
Date Dug	2/5/2004	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR: Blue

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1096.63	WIDTH/O.D. 13.92	
TOP ELEVATION	1088.71		7.92 TOP DEPTH
BOTTOM ELEVATION	1087.55		9.08 BOTTOM

COORDINATES: NORTHING 913189.74 EASTING 607516.88

PAVING THICKNESS 5" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 12" TYPE ACP FACILITY OWNER City of Glendale

REMARKS:

PREPARED BY: A. Mehler CHECKED BY:

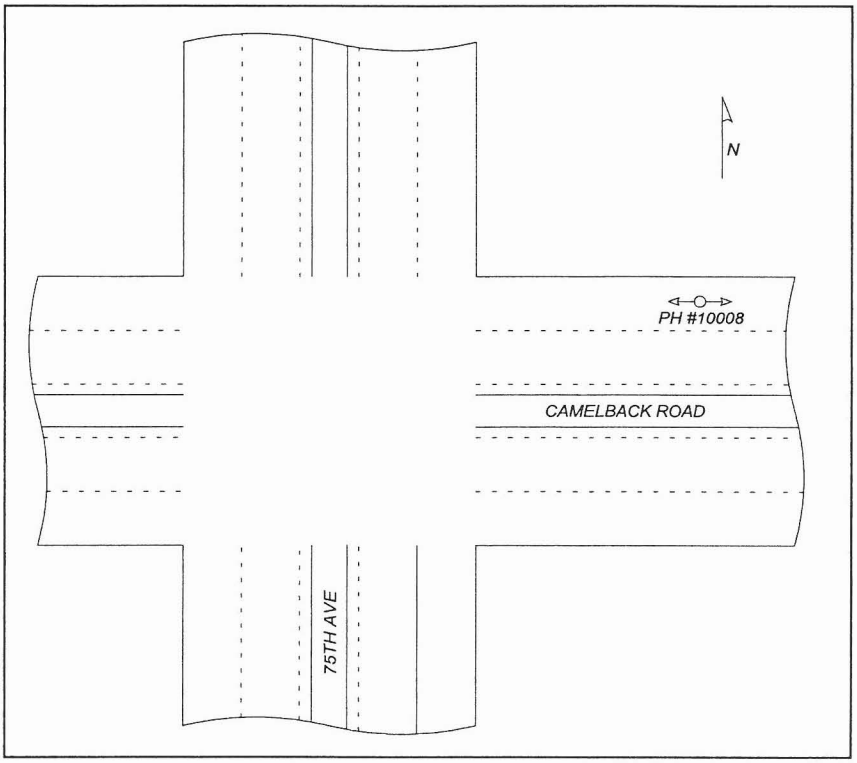
TEST HOLE DATA REPORT

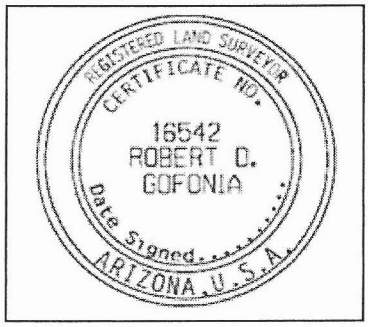
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10008	SUE Crew	D. Harmon
Date Dug	2/4/2004	Truck #	929
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR Blue

CROSS SECTION - NOT TO SCALE

FACING East

SURFACE ELEVATION	1095.78	WIDTH/O.D. 13.92"	
TOP ELEVATION	1091.21		4.57 TOP DEPTH
BOTTOM ELEVATION	1090.05		5.73 BOTTOM

COORDINATES: NORTHING 913032.27 EASTING 607663.09

PAVING THICKNESS 8" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 12" TYPE ACP FACILITY OWNER City of Glendale

REMARKS:

PREPARED BY: A. Mehler CHECKED BY:

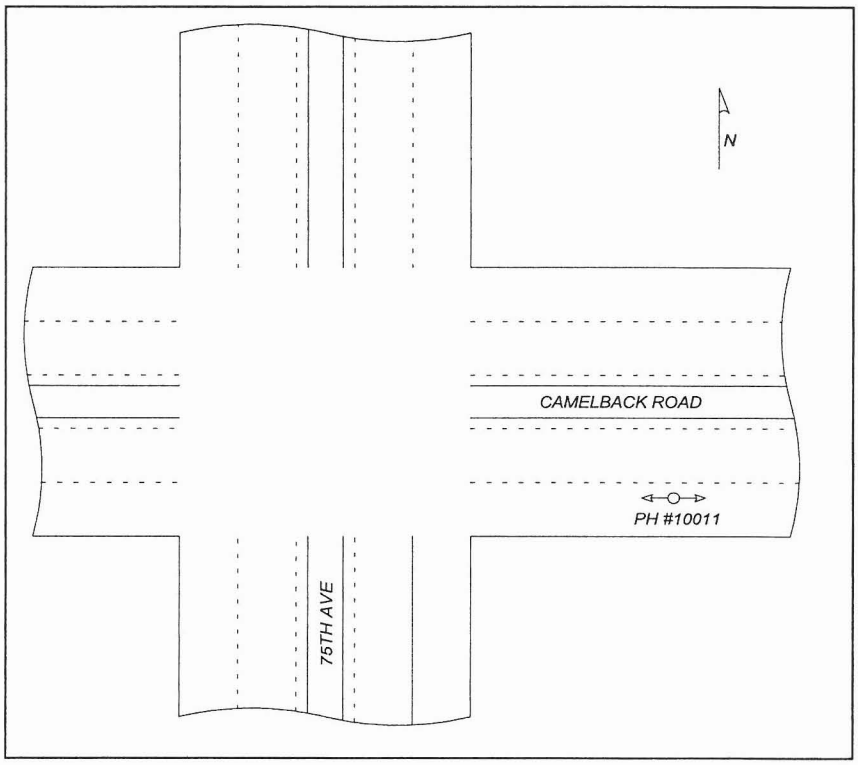
TEST HOLE DATA REPORT

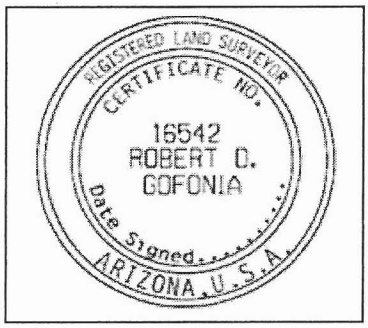
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10011	SUE Crew	D. Harmon
Date Dug	2/4/2004	Truck #	929
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK
609 913003.6377 North 607482.6763 East 1095.32 Elevation Found brass cap in a hand hole Southwest Corner Section 13, T2N R1E 75th Ave. and Camelback Road.
RIBBON COLOR Blue

CROSS SECTION - NOT TO SCALE

FACING East

SURFACE ELEVATION	1096.09	WIDTH/O.D. 9.57	
TOP ELEVATION	1092.46		3.63 TOP DEPTH
BOTTOM ELEVATION	1091.67		4.42 BOTTOM

COORDINATES: NORTHING 912990.63 EASTING 607702.00

PAVING THICKNESS 6" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 8" TYPE ACP FACILITY OWNER City of Glendale

REMARKS:

PREPARED BY: A. Mehler CHECKED BY:

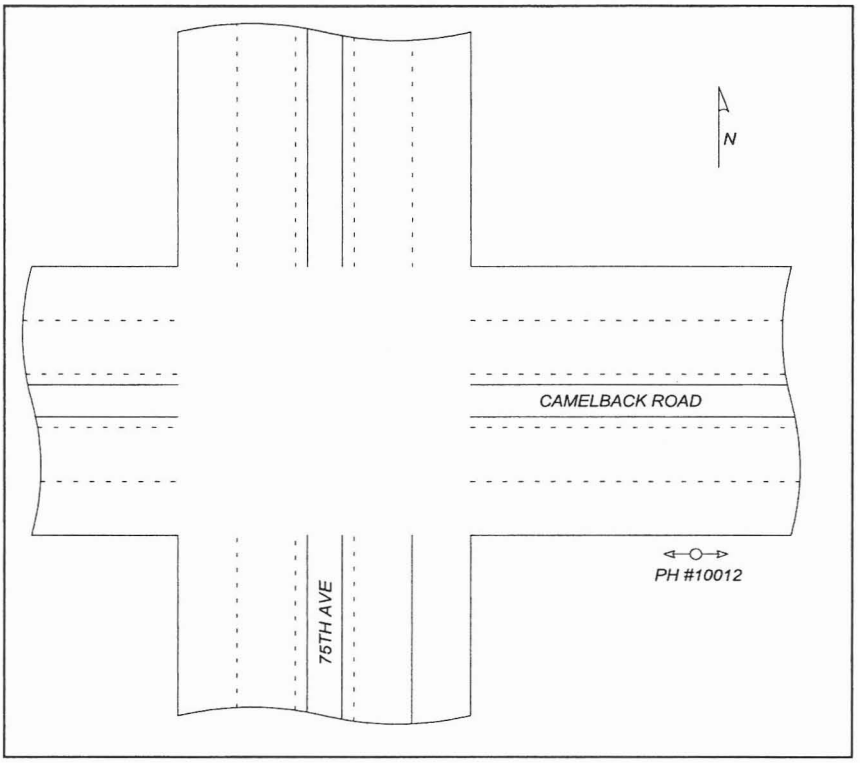
TEST HOLE DATA REPORT

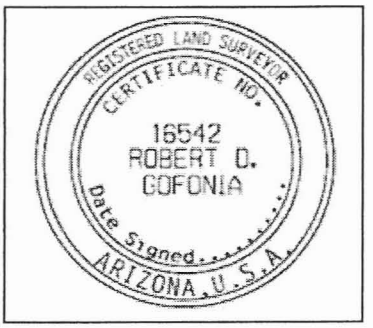
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10012	SUE Crew	D. Harmon
Date Dug	2/4/2004	Truck #	929
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK	CROSS SECTION - NOT TO SCALE
609 913003.6377 North 607482.6763 East 1095.32 Elevation Found brass cap in a hand hole Southwest Corner Section 13, T2N R1E 75th Ave. and Camelback Road.	FACING: East SURFACE ELEVATION: 1096.48 WIDTH/O.D.: 17.8" TOP ELEVATION: 1086.7 — TOP DEPTH: 9.78 BOTTOM ELEVATION: 1085.22 — BOTTOM: 11.26
RIBBON COLOR: Blue	

COORDINATES: NORTHING 912961.95 EASTING 607730.84

PAVING THICKNESS _____ PAVING TYPE Dirt SOIL CONDITION Sand and Rocks (soft)

SIZE 16" TYPE DIP FACILITY OWNER City of Glendale

REMARKS:

PREPARED BY: A. Mehler CHECKED BY:

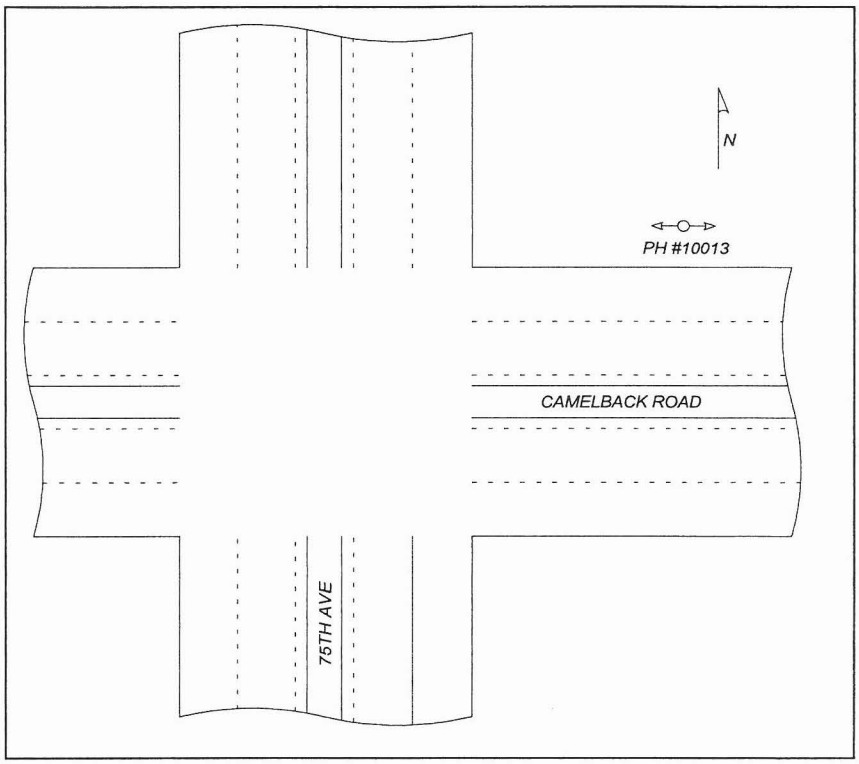
TEST HOLE DATA REPORT

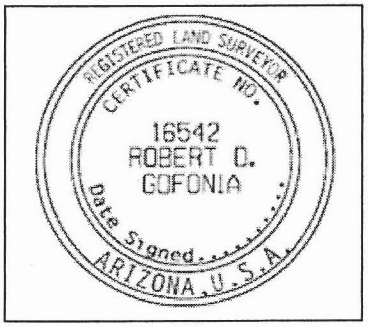
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10013	SUE Crew	D. Harmon
Date Dug	2/6/2004	Truck #	929
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR Red

CROSS SECTION - NOT TO SCALE

FACING East

SURFACE ELEVATION	1096.38	WIDTH/O.D. .5"		
TOP ELEVATION	1095.36		1.02	TOP DEPTH
BOTTOM ELEVATION	1095.32		1.06	BOTTOM

COORDINATES: NORTHING 913057.57 EASTING 607638.50

PAVING THICKNESS _____ PAVING TYPE Dirt SOIL CONDITION Sand and Rocks (soft)

SIZE .5" TYPE Ground wire FACILITY OWNER Salt River Project

REMARKS: Found a copper ground wire.

PREPARED BY: A. Mehler CHECKED BY:

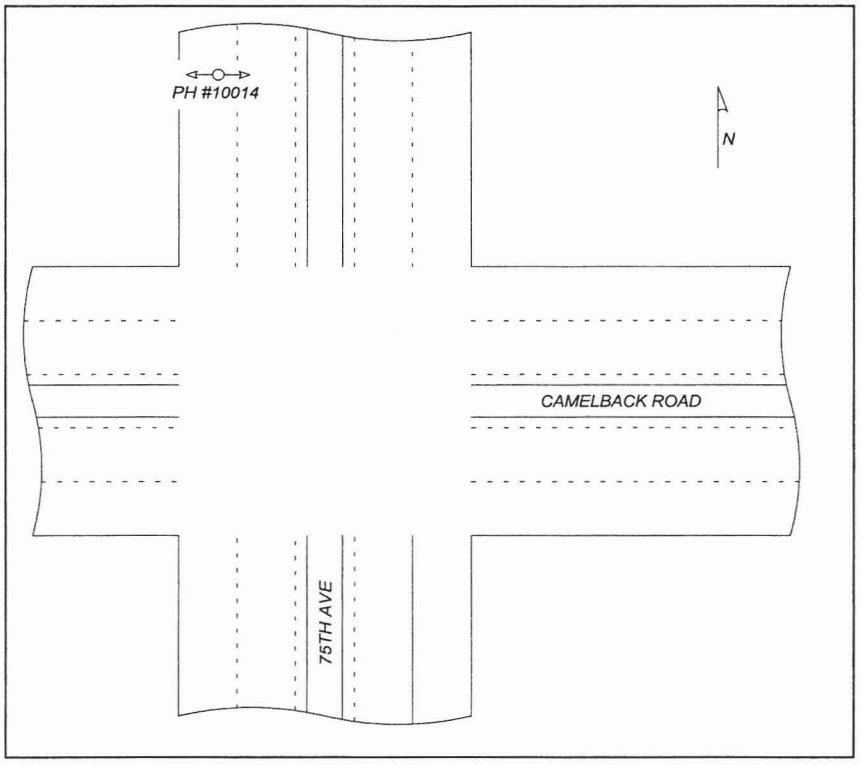
TEST HOLE DATA REPORT

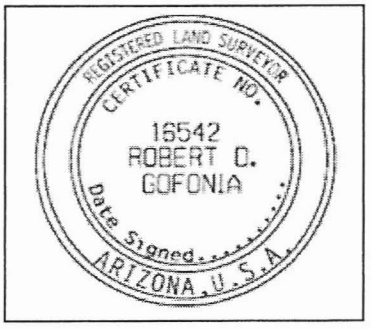
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10014	SUE Crew	J. Cherry
Date Dug	2/5/2004	Truck #	710
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR: Red

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1096.44	WIDTH/O.D. 36"	
TOP ELEVATION	1088.79		7.65 TOP DEPTH
BOTTOM ELEVATION	1086.86		9.58 BOTTOM

COORDINATES: NORTHING 913235.34 EASTING 607478.45

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 36" x 22" TYPE Slurry Encasement FACILITY OWNER Salt River Project

REMARKS:

PREPARED BY: CHECKED BY:

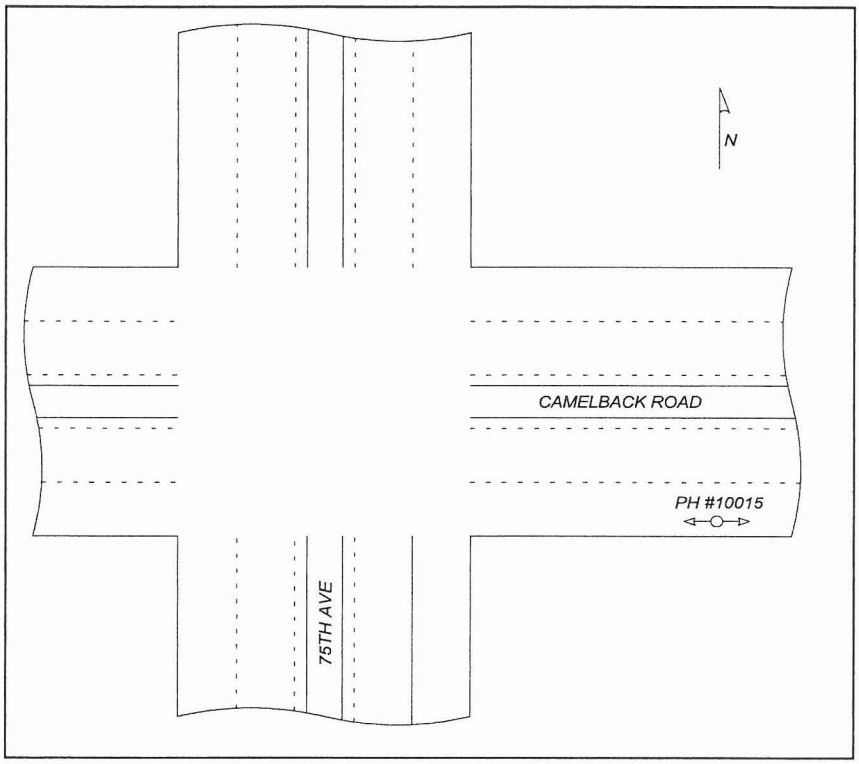
TEST HOLE DATA REPORT

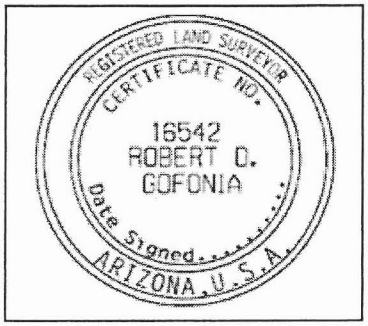
AZTEC ENGINEERING

3747 East Grove, Phoenix, AZ 85040-3982
Tel. (602)458-0402 Fax. (602)458-9359

Test Hole #	10015	SUE Crew	D. Harmon
Date Dug	2/4/2004	Truck #	929
Client Project #	BHOC	City	Glendale
Project #	AZ03191	County	Maricopa
Location	75th Ave. and Camelback Road		

LOCATION PLAN - NOT TO SCALE





SITE BENCHMARK

609
913003.6377 North
607482.6763 East
1095.32 Elevation
Found brass cap in a hand hole
Southwest Corner Section 13, T2N R1E
75th Ave. and Camelback Road.

RIBBON COLOR: Green

CROSS SECTION - NOT TO SCALE

FACING: East

SURFACE ELEVATION	1095.95	WIDTH/O.D. 58"	
TOP ELEVATION	1089.36		6.59 TOP DEPTH
BOTTOM ELEVATION	1084.55		11.40 BOTTOM

COORDINATES: NORTHING 912979.68 EASTING 607758.21

PAVING THICKNESS 4" PAVING TYPE Asphalt SOIL CONDITION Sand and Rocks (soft)

SIZE 48" TYPE RCP FACILITY OWNER City of Glendale

REMARKS: This is a City of Glendale sanitary sewer.

PREPARED BY: CHECKED BY:

PROJECT: BHOC Reach C

MANNINGS FLOW CALCULATIONS FOR CIRCULAR PIPES

DMJM Harris

GRAVITY FLOW IN CIRCULAR PIPES

INPUT PERAMETERS

CALCULATIONS NOTES:

83rd Avenue Sewer Siphon: Pipe size for minimum flow condition. Minimum flow condition = 0.340 MGD.

Peak Velocity	9	fps
Minimum Velocity	2	fps
Enter "Q" (GPD)	558,720	GPD
Enter Mannings "n"	0.013	
Enter Slope (ft/ft)	0.0021	ft/ft
Enter pipe diam. "D" (in)	15	in.

GO!

RESET d/D

FLOW/VELOCITY/DEPTH RESULTS

Full Capacity Velocity=	2.41	fps
Full Capacity Flow=	2.96	cfs
Flow Velocity=	2.09	fps
Flow=	0.86	cfs
Q/Q_{full}=	0.29	
V/V_{full}=	0.87	
Flow depth	5.55	in.
Flow depth	0.46	ft
depth/Diameter (d/D)	0.37	

CALCULATION DATA

Q	=	0.8646	CFS			
Q	=	0.388	1000 GPM			
Q	=	0.55872	MGD			
		Peak Flow		**Full Capacity**		
D	=	1.25	ft.	1.25	ft.	
D/2	=	0.625	ft.	0.625	ft.	
d	=	0.46268912	ft.	1.25	ft.	
θ	=	0.65404374	rad.	1.570796327	rad.	
X-sec. area "a"	=	0.41300792	s.f.	1.22718463	s.f.	
Wetted perimeter	=	1.63510934	ft.	3.926990817	ft.	
Hydraulic radius "r"	=	0.25258734	ft.	0.3125	ft.	
1,912,981	GPD capacity			558,642	GPD peak	
558,720	GPD required			558,720	GPD required	
29%	Capcity utilization			100.0%	<Should be 100%	

CALCULATION SUMMARY RESULTS

Sufficient Capacity?	Yes
Correct d/D?	Yes
Min Vel OK?	Yes
Peak Vel OK?	Yes
Acceptable Design?	**Yes-Congratulations!**

SIPHON UNDER BHOC CULVERT

		15" (MGD)		8" (MGD)		(CFS)	
Q Max =		0.558720	+	0.02016	=	0.896	
Q Min =		0.2448000	+	0.00864	=	0.392	
Use siphon size at	6 in.	@ Q Max		Velocity	=	4.56	ft/sec
Use siphon size at	6 in.	@ Q Min		Velocity	=	2.00	ft/sec

60
8

Memorandum

To: Jeff Minch, P.E.
From: Dave Prinzhorn
Date: November 10, 2004

Re: BHOC Wastewater Flow Measurement at Grand Canal and Missouri Avenue

This Memorandum presents the findings of wastewater flow measurements conducted in October of 2004 for a section of 15" diameter wastewater collection pipeline located at the SRP Grand Canal and Missouri Avenue alignment.

Arizona Engineering Company installed an Isco 4210 Ultrasonic Wastewater Flow Meter into a manhole on the north side of the SRP Grand Canal. The pipeline in the manhole was a 15" diameter VCP with an as-built pipe slope of 0.00335 ft/ft. Due to turbulence observed in the wastewater flow stream, a Mannings "N" value of 0.014 was used for calibration of the Isco Flow Meter.

Basic pipeline information is provided as follows:

Rim = 90.27	Upstream Invert: 16.1' D	74.14	73.21	0.47'
Rim = 92.87	Downstream Invert: 19.37' D (0.61')	73.50	72.74	
	Pipeline Reach Length:	191 feet		
	Pipeline Slope:	0.00335 ft/ft *((74.14 -73.50) / 191 feet)*		
	Maximum pipeline capacity:	3.47 CFS (1557.44 GPM)		
	Pipeline Flow Velocity when Full:	2.83 FPS		

Pipeline Water Depth Observed at Time of Meter Placement:	3.75 inches
Calculated Q at Time of Meter Placement:	224 GPM

On October 22, 2004 an Isco 4210 Ultrasonic Wastewater Flow Meter was set in Manhole # 9 adjacent to the SRP Grand Canal. The sensor head was set two feet above the water level and the unit was flow calibrated to match the flow passing through the pipe at the time of placement and calibration (3.75 inches water depth, 224.4 GPM). Over the next several days, the pipeline water depth and flows were measured and the results are presented as follows:

	Add:		GPM +8"	GPM	= GPD
Low Flow Range:		90 – 250 GPM	170	176	253,440
Average Flow Range:	10 gpm	225 – 330 GPM	277.5 GPM	288	414,720
Maximum Flow Range:		350 – 425 GPM	388	402	578,880

No excessive diurnal peaks were observed in the meter printout log. The maximum flow depth recorded was 5.37 inches. This equates to a d/D ratio of 0.358 or a pipeline running approximately 1/3 full.

425+10 = 435 GPM
= 0.626 MGD

Fields: Qmax @ ½ full, use 15" pipe → 1.05 MGD capacity
@ .8 full, use 12" pipe

Siphon:
Qmax @ 16", 0.579 MGD, V=
Qmin @ 16", 93 GPM, V=
.134 MGD

Gravity Flow Equivalent Design Option (Manning's Equations)

For equivalency purposes, using a 10" diameter PVC pipeline placed at the minimum allowable slope allowed by ADEQ of 0.0024 ft/ft, 425 GPM would flow at about 2.23 FPS with a d/D depth of 0.73 (about ¾ full). Proper sewer design requires that a minimum velocity of 2 to 3 FPS at least once each day be provided by the maximum daily flow.

Siphon Pipeline Design Option (Hazen-Williams Equations)

The potential design of a sewer siphon would require an 8" diameter pipeline calculated with a Mannings "N" value of 0.014 or a Hazen-Williams "C" value of 100. An 8" diameter sewer siphon at 425 GPM would perform at 2.75 FPS velocity with a head loss of approximately 6.4 feet/1000 feet of pipe.

Summary

The 15" diameter pipeline crossing the Grand Canal could be downsized (if no future upstream expansion is planned) to a 10" diameter gravity pipeline or an 8" diameter sewer siphon.

For design purposes, a minimum flow of 90 GPM should be used and a maximum flow of 425 GPM should be used. Diurnal conditions are fairly uniform with no excessive peaks.

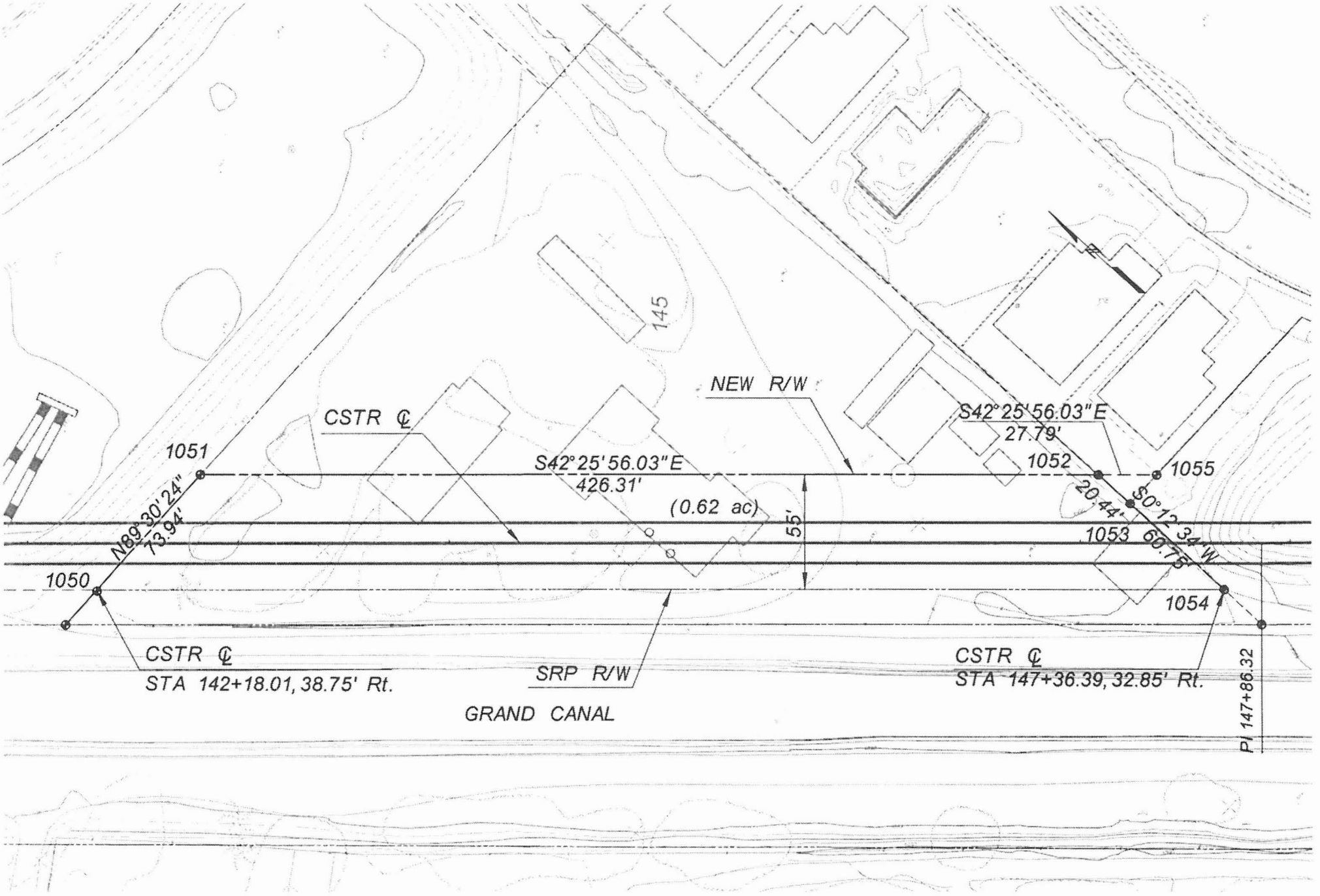
Any redesign of the sewer pipeline should be carefully coordinated with City of Glendale officials.

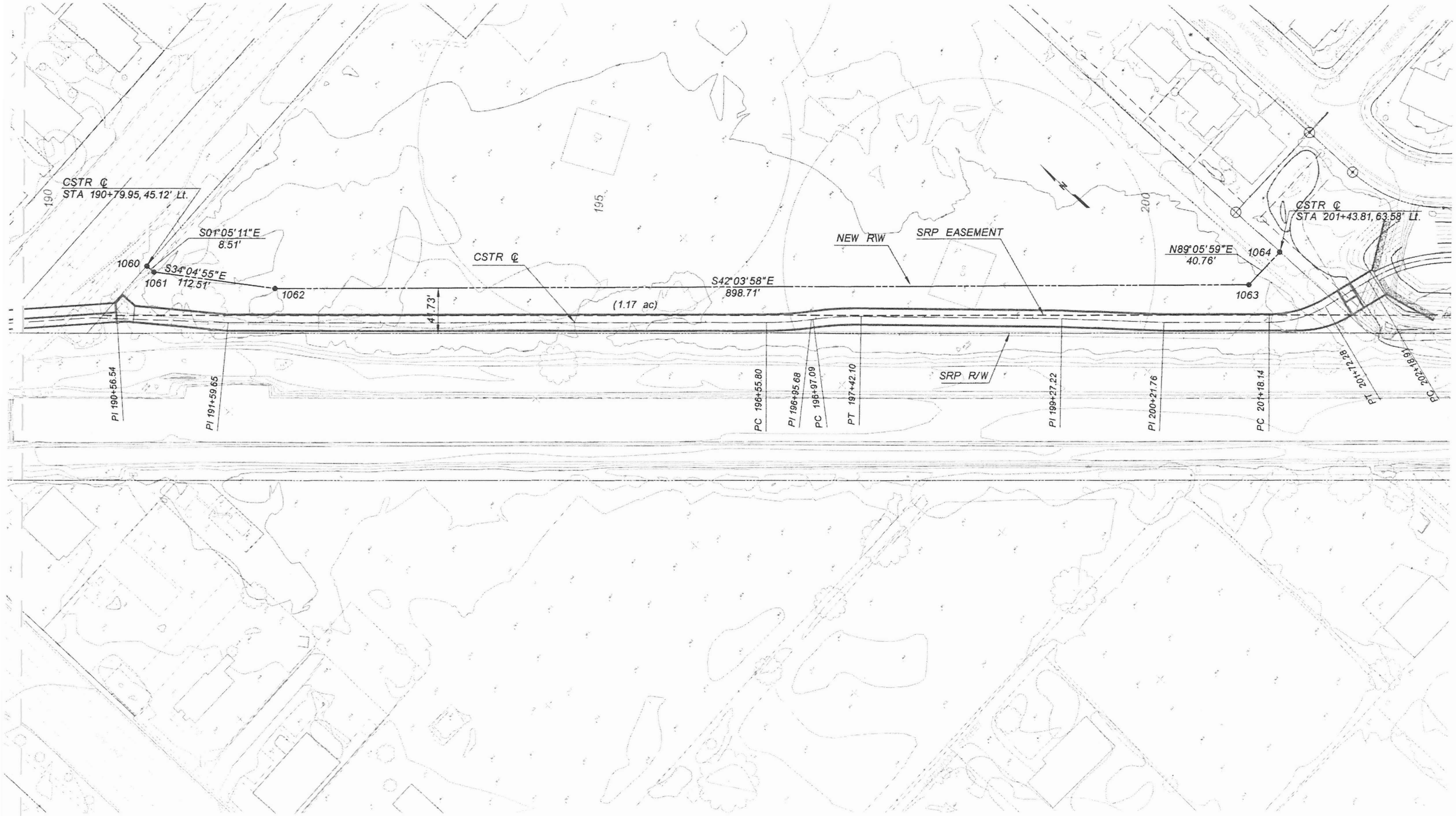
MANNING

CALIBRATION SETPOINTS

WASTEWATER COLLECTION PIPING EVALUATION					10-Nov-04	
PIPELINE REACH:	1	(#)				
PIPELINE DIAMETER:	15.00	(INCHES)				
PIPELINE LENGTH:	191.00	(FEET)				
PIPELINE SLOPE:	0.003351	(FT./FT.)				
PIPELINE AVG. 'Q':	0.50	(CFS)	224.415GPM			
AVG. FLOW DEPTH:	0.25	(d/D)			AVG Ca:	0.150091
AVG. FLOW VELOCITY:	2.13	(fps)			AVG K':	0.061930
					PEAK Ca:	0.420684
PIPELINE PEAK 'Q':	2.06	(CFS)			PEAK K':	0.254657
PEAK FLOW DEPTH:	0.53	(d/D)				
PEAK FLOW VELOCITY:	3.13	(fps)			AVG PIPE AREA:	0.2345
					PEAK PIPE AREA:	0.6573
	323,157.60	GPD				

RIGHT OF WAY


145
NEW R/W
CSTR ℄
S42°25'56.03"E
27.79'
1051
S42°25'56.03"E
426.31'
1052
1055
N89°30'24"
73.94'
(0.62 ac)
20.44'
S0°12'34"W
60.75'
55'
1053
1050
1054
CSTR ℄
STA 142+18.01, 38.75' Rt.
SRP R/W
CSTR ℄
STA 147+36.39, 32.85' Rt.
GRAND CANAL
PI 147+86.32


CSTR ℄
STA 190+79.95, 45.12' Lt.
S01°05'11"E
8.51'
1060
S34°04'55"E
1061 112.51'
1062
CSTR ℄
4.73'
(1.17 ac)
S42°03'58"E
898.71'
NEW R\W
SRP EASEMENT
N89°05'59"E
40.76'
1064
1063
CSTR ℄
STA 201+43.81, 63.58' Lt.
SRP R/W
190
195
200
PI 190+56.54
PI 191+59.65
PC 196+55.80
PI 196+95.68
PC 196+97.09
PT 197+42.10
PI 199+27.22
PI 200+21.76
PC 201+18.14
PT 201+72.28
PC 202+18.91

Bethany Home Outfall Channel Reach "C" Pre-Final

Proposed Right of Way Points

Point	Northing	Easting	Station	Offset
1050	916466.49	604491.39	142+18.01	38.75' Rt
1051	916467.32	604587.58	142+82.29	32.81' Lt
1052	916152.67	604875.22	147+08.60	32.82' Lt
1053	916132.23	604875.14	147+23.64	18.98' Lt
1054	916047.09	604874.83	147+86.27	38.69' Rt
1055	916132.16	604893.96	147+36.39	32.82' Lt

Point	Northing	Easting	Station	Offset
1060	912946.59	607847.18	190+79.95	45.12' Lt
1061	912938.08	607847.36	190+86.83	40.12' Lt
1062	912845.64	607911.49	192+02.32	31.43' Lt
1063	912185.52	608521.34	201+00.00	34.62' Lt
1064	912185.68	608562.11	201+43.81	63.58' Lt

```
#######################################################
#
# BHOC Right of Way File 83rd Avenue - 67th Avenue
#
# GJJ 01/20/2003
#
# filename: n:/6063/Design/row/ROW.ics
#######################################################
del c   (1-10000)

del fig [1-10000]

a p !SCLN_e



# Survey Control Points provided by Aztec Engineering
# Survey Report For BETHANY HOME OUTFALL CHANNEL FCD 2003C010
# BHOC REACH B AND C SURVEY CONTROL POINTS, From Excel Spreadsheet Table for DMJM_grnd
# Email from Al Reece To Bill Clemans dated January 21, 2004



S
    315 918230.3091 602274.1073                 # SE Cor, Sec 10, 83rd Ave & Bethany Home Rd
    608 915638.1723 607488.0889 1098.55     # E 1/4 Cor Sec 14, T2N R1E, 75th Ave & Missouri Ave
    609 913003.6377 607482.6763 1095.32     # SW Cor Sec 13, T2N R1E, 75th AVE & Camelback Rd
    611 910474.6835 612756.9620 1098.54     # W 1/4 Cor Sec 19, T2N R2E, 67th Ave & Campbell Rd
    614 907828.7791 612738.7540 1091.11     # SW Cor Sec 19, T2N R2E, 67th Ave & Indian School Rd
    1204    915589.6427 602256.0139         # E 1/4 Cor Sec 15, 83rd Ave & Missouri Ave
    1205    920849.7315 602277.6420         # E 1/4 Cor Sec 10, 83rd Ave & Lincoln Dr
    4628    913061.5186 610128.9690 1100.45     # S 1/4 Cor Sec 13, 71st Ave & Camelback Rd
    4629    913058.6299 609997.9110 1101.02     # Monument, 71st ave and camelback Rd



#############################################################
# Survey Control Points are taken from Colins Pina
# Bethany Home Outfall Channel Phase II Results Of Survey
# Dated 5/03/00
#############################################################


S     2 918251.9588 604883.0649 # N 1/4 COr Sec 14
    100 918272.60   607493.34   # NE COR SEC 14, 75th Ave & Bethany Home Rd
    101 918231.17   602274.29   # NW COR SEC 14, 83rd Ave & Bethany Home Rd
    104 915638.2347 607487.9369 # E 1/4 COR SEC 14, 75th Ave & Missouri
    111 913122.55   612774.73   # SE COR SEC 13, 67th Ave & Camelback Rd
    112 913063.02   610129.07   # S 1/4 COR SEC 13, 71st Ave & Camelback Rd
    113 913004.92   607482.91   # SW COR SEC 13, 75th Ave & Camelback Rd
    115 909125.81   610106.84   # 1/16 SEC 24, On 71st Ave
    116 909153.25   612747.93   # 1/16 SEC 24, On 67th Ave
    117 910476.38   612757.14   # E 1/4 COR SEC 24, 67th Ave & Campbell Rd
    119 907830.62   612739.08   # SE COR SEC 24, 67th Ave & Indian School Rd
    5354    910438.31   610114.36   # CENTER SEC 24, 71st Ave & Campbell Rd



#############################################################
# Survey Control Points are taken from Collins Pina
# Bethany Home Outfall Channel Phase II Results Of Survey
# Dated 5/03/00
# Coordinates Shifted Per Instructions Of Al Reece(Aztec) Dec 31, 2003
# NOrthing is shifted -1.0953'
# Easting is Shifted -.0931'
# The following points reflect the updated coordinates
# Changed Point Numbers by adding a 1 + Original Collins Pina NUmber
#############################################################

S     12    918250.8635 604882.9718 # N 1/4 COr Sec 14
    1100    918271.5047 607493.2469 # NE COR SEC 14, 75th Ave & Bethany Home Rd
    1101    918230.0747 602274.1969 # NW COR SEC 14, 83rd Ave & Bethany Home Rd
    1104    915638.2347 607487.9369 # E 1/4 COR SEC 14, 75th Ave & Missouri
    1111    913121.4547 612774.6369 # SE COR SEC 13, 67th Ave & Camelback Rd
    1112    913061.9247 610128.9769 # S 1/4 COR SEC 13, 71st Ave & Camelback Rd
    1113    913003.8247 607482.8169 # SW COR SEC 13, 75th Ave & Camelback Rd
    1115    909124.7147 610106.7469 # 1/16 SEC 24, On 71st Ave
    1116    909152.1547 612747.8369 # 1/16 SEC 24, On 67th Ave
    1117    910475.2847 612757.0469 # E 1/4 COR SEC 24, 67th Ave & Campbell Rd
    1119    907829.5247 612738.9869 # SE COR SEC 24, 67th Ave & Indian School Rd
```

```
    15354   910437.2147 610114.2669 # CENTER SEC 24, 71st Ave & Campbell Rd


########################################
#                                      #
#   CREATE SECTION LINE FIGURES        #
#                                      #
########################################


# SECTION LINES RUNNING WEST-EAST
# Section Lines are based on Aztec's Points and the Original Collin's-Pina Points

S F 100 (315 2 100) # BETHANY HOME ROAD
F D [100]*BETHANY HOME ROAD

S F 200 (1204 608) # MISSOURI AVENUE
F D [200]*MISSOURI AVENUE

S F 300 (609 4628) 609 1000 # CAMELBACK ROAD
F D [300]*CAMELBACK ROAD

S F 400 (5354 611) # CAMPBELL ROAD
F D [400]*CAMPBELL ROAD

S F 500 (115 116) # HEATHERBRAE DRIVE
F D [500]*HEATHERBRAE DRIVE


# SECTION LINES RUNNING NORTH-SOUTH
# Section Lines are based on Aztec's Points and the Original Collin's-Pina Points

S F 1100 (1204 315 1205)  # 83RD AVENUE
F D [1100]*83RD AVENUE

S F 1200 (609 608 100) 609 1000 # 75TH AVENUE
F D [1200]*75TH AVENUE

S F 1300 (115 5354 4628) # 71ST AVENUE
F D [1300]*71ST AVENUE

S F 1400 (614 611) # 67TH AVENUE
F D [1400]*67TH AVENUE


L C (2 100 101 104 111 112 113 115 116 117 119
     315 608 609 611 614 1204 1205 4628 4629 5354))

I D (315 2)
    (2 100)
    (1204 608)
    (609 4628)
    (5354 611)
    (115 116)
    (1204 315)
    (315 1205)
    (609 608)
    (608 100)
    (115 5354)
    (5354 4628)
    (614 611)


a p !XRW_e

# Set ROW Along South Side of Canal
# ROW Started at Point #101, Intersection of 83rd Ave and Bethany Home Road
# All ROW Was set based off Collins Pina Shifted Points to maintain consistency

L DI   1101 800 S00-21-29W   36.61
    800 801 S00-21-29W    7.29
    801 802 S89-18-25E  489.92  # Set Iron ROd w/cap #22755
    802 803 S47-15-01E  270.31  # Found 1/2" Iron Rod(Bent)
    803 804 S42-11-13E 1038.55  # Found Iron Rod w/Salt River Project Aluminum Cap
    804 805 S42-11-13E  653.89  # Set Iron ROd w/cap #22755
    805 806 S42-11-13E 1050.00  # Found Iron Rod w/Salt River Project Aluminum Cap
    806 807 S43-58-13E  103.98  # (#80) Set Iron ROd w/cap #22755
    807 808 S43-58-13E  372.56  # Found 1/2" Iron Rod
    808 809 S61-10-05E    7.30  # Found Iron Rod w/Salt River Project Aluminum Cap
    809 810 S42-25-41E 1038.49  # Set Iron ROd w/cap #22755
```

```
DI I    811 1113 (A 1113 1104) 810 S42-25-41E   # Set PK w/cap #22755, Point 113 Int 75th & Camelback
    812 1113 (A 1113 1112) 811 S40-05-10E   # Found PK Nail

L DI    812 813 S42-31-51E 2271.03  # Found Iron Rod w/Salt River Project Aluminum Cap
    813 814 S42-34-10E  513.60  # Found Iron Rod w/Salt River Project Aluminum Cap
    814 815 S57-05-14E  780.89  # Found 1/2" Iron Rod

DI I    816 5354 (A 15354 1112) 815 S47-05-47E  # Found Iron Rod w/Salt River Project Aluminum Cap
    817 5354 (A 15354 1117) 816 S57-00-39E    # Set Iron ROd w/cap #22755

L DI    817 818 S57-00-39E   43.14  # Found Iron Rod w/Salt River Project Aluminum Cap
    818 819 S66-15-42E  573.64  # Set Iron ROd w/cap #22755
    819 820 S72-48-55E 1155.67  # Nothing Set
    820 821 S60-01-36E  674.13      # Nothing Set

DI I    822 1116 (A 1116 1117) 821 S52-19-06E   # Set PK w/cap #22755

L DI    822 823 (A 822 1117) 32.86  # Set PK w/cap #22755
    823 824 S44-53-07E  209.90  # Found Iron Rod w/Salt River Project Aluminum Cap


S F 800 (800 801 802 803 804 805 806 807 808 809
         810 811 812 813 814 815 816 817 818 819
         820 821 822 823 824) # Southern CAP ROW
F D [800]*SOUTHERN CAP ROW


L C (800 801 802 803 804 805 806 807 808 809
     810 811 812 813 814 815 816 817 818 819
     820 821 822 823 824)


I D (800 801)
    (801 802)
    (802 803)
    (803 804)
    (804 805)
    (805 806)
    (806 807)
    (807 808)
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    (809 810)
    (810 811)
    (811 812)
    (812 813)
    (813 814)
    (814 815)
    (815 816)
    (816 817)
    (817 818)
    (818 819)
    (819 820)
    (820 821)
    (821 822)
    (822 823)
    (823 824)


# Set ROW Along North Side of Canal
# ROW Started at Point #101, Intersection of 83rd Ave and Bethany Home Road
# All ROW Was set based off Collins Pina Shifted Points to maintain consistency

L DI   1101 900 N00-04-48W   65.51  # Set PK w/cap #22755
       1101 901 N00-04-48W   55.00  # Set PK w/cap #22755
    901 902 N89-50-06E  333.85  # Found 1/2" Iron Rod(Bent)
    902 903 S85-01-32E  158.88  # Found 1/2" Iron Rod(Bent)
    903 904 S70-57-05E  114.65  # Found 3/4" Iron Rebar
    904 905 S42-25-48E 2964.48  # Found Iron Rod w/Salt River Project Aluminum Cap
    905 906 S42-47-33E  584.93  # Found Iron Rod w/Salt River Project Aluminum Cap
    906 907 N89-27-51E   11.59  # Found Iron Rod w/Salt River Project Aluminum Cap


DI I    908 1113 (A 1113 1104) 907 S42-25-41E   # Set PK w/cap #22755
    909 1113 (A 1113 1112) 908 S47-41-21E   # Set PK w/cap #22755
```

```
L DI    909 910 S42-31-51E 1268.08  # Set Iron Rod w/cap #22755
    910 911 S42-31-51E  919.57  # Set Iron Rod w/cap #22755
    911 912 S42-47-18E  485.70  # Found 3/4" Iron Pipe
    912 913 S56-52-22E  717.34  # Set Iron Rod w/cap #22755
    913 914 S56-52-22E  142.33  # Set Iron Rod w/cap #22755
    914 915 S66-16-06E  316.12  # Set Iron Rod w/cap #22755
    915 916 S66-16-06E  298.41  # Set Iron Rod w/cap #22755
    916 917 S72-49-53E 1278.45  # Set Iron Rod w/cap #22755
    917 918 S60-06-09E  320.79  # Found Iron Rod w/Salt River Project Aluminum Cap


DI I    919 1117 (A 1117 1116) 918 S52-19-43E   # Set PK w/cap #22755

L DI    919 920 (A 1117 1116)  30.79    # Set PK w/cap #22755
    920 921 S49-09-04E   85.62  # Set Iron Rod w/cap #22755
    921 922 N00-23-47E   29.76  # Found 1-1/2" Iron Pipe
    922 923 S48-49-54E   83.60  # Found Iron Rod w/Salt River Project Aluminum Cap
    923 924 S41-17-02E  122.72  # Found Iron Rod w/Salt River Project Aluminum Cap




S F 900 (900 901 902 903 904 905 906 907 908 909
         910 911 912 913 914 915 916 917 918 919
         920 921 922 923 924) # Southern CAP ROW
F D [900]*SOUTHERN CAP ROW


L C (900 901 902 903 904 905 906 907 908 909
     910 911 912 913 914 915 916 917 918 919
     920 921 922 923 924)



I D (900 901)
    (901 902)
    (902 903)
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    (908 909)
    (909 910)
    (910 911)
    (911 912)
    (912 913)
    (913 914)
    (914 915)
    (915 916)
    (916 917)
    (917 918)
    (918 919)
    (919 920)
    (920 921)
    (921 922)
    (922 923)
    (923 924)



# BHOC Reach B & C Construction Centerline
# By wjc 01/23/04
del c   (20000-39999)
del fig [20000-39999]
ap  !centerline

s   20000   918076.3769 602273.1360 *POB
    30000   918071.9367 603197.3579 *PI
    30002   917458.4246 603633.1075 *PI
    20005   916071.1247 604901.2190 *PI
    30004   915684.0146 605259.5929 *PI
    30006   915632.7643 605298.8622 *PI
    20010   915586.3613 605341.8206 *PI
    20011   915460.4455 605454.4470 *PI
    30008   914974.5304 605898.5850 *PI
    30010   914921.3578 605960.7338 *PI
```
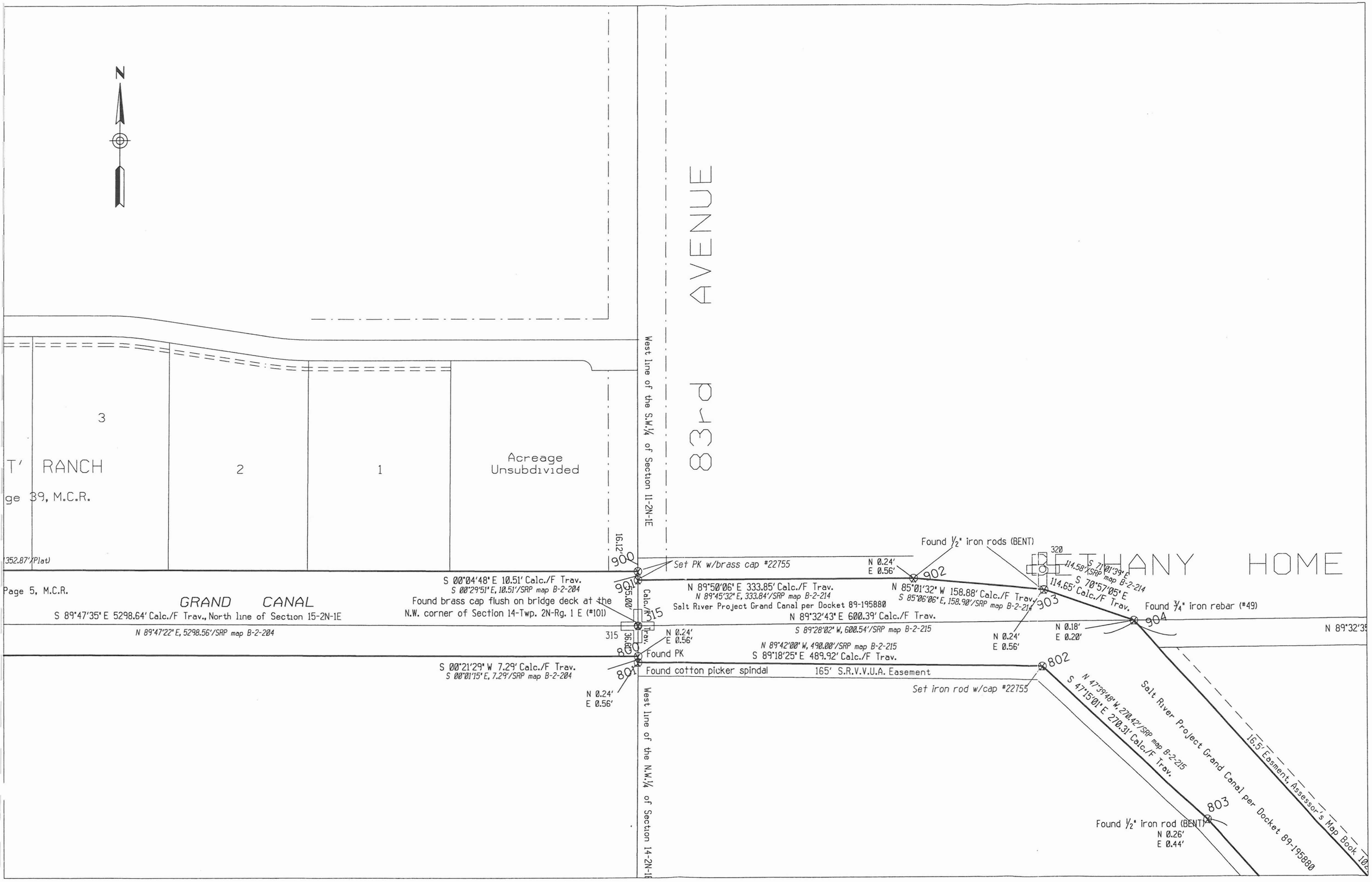
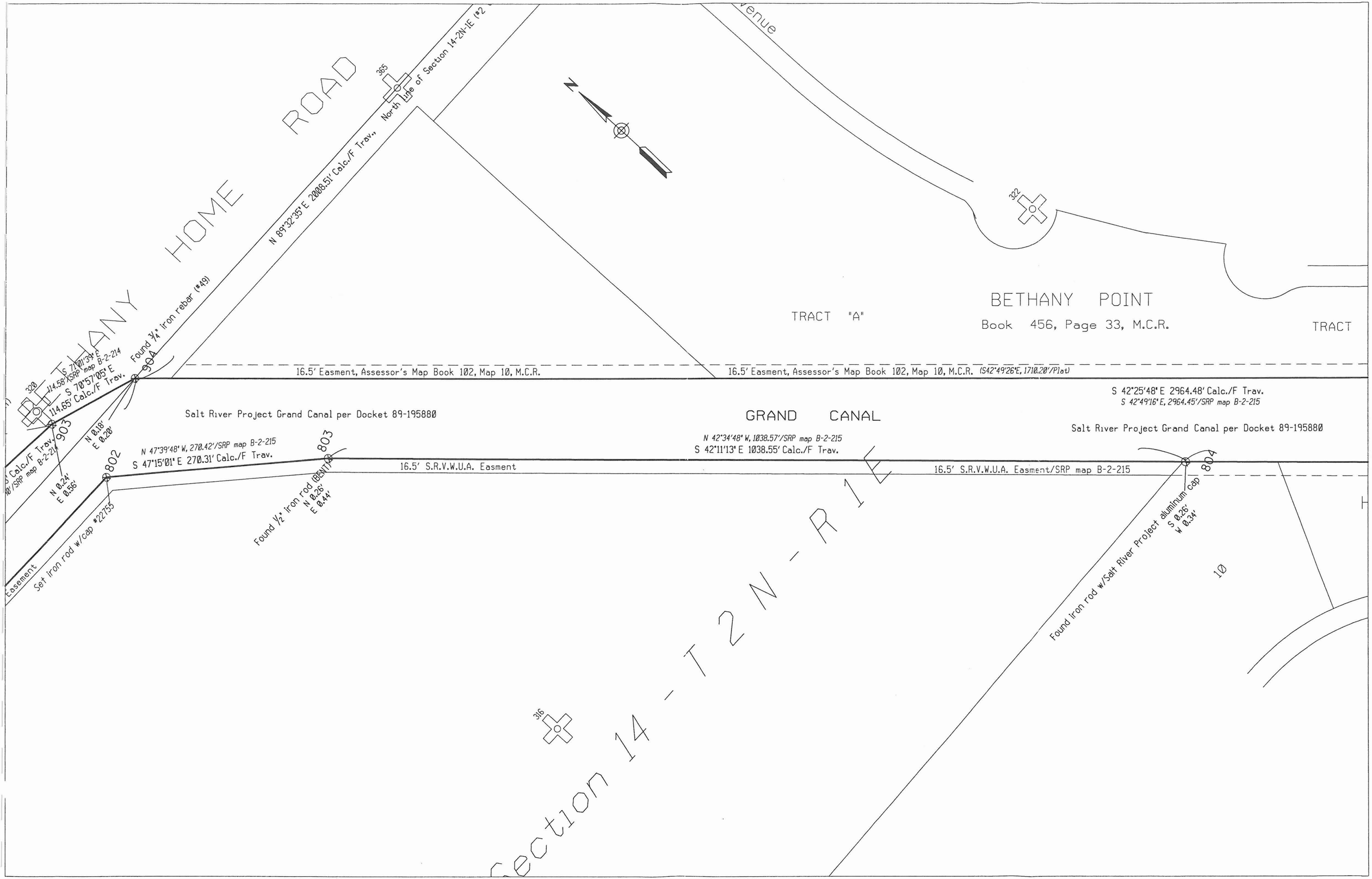

```
    30012   913347.2915 607399.4679 *PI
    30014   913278.3581 607437.7094 *PI
    30016   912920.7293 607765.3946 *PI
    30018   912868.0922 607847.7437 *PI
    30020   912258.3718 608407.0534 *PI
    20026   912138.9628 608588.6112 *PI
    30022   911100.6947 609536.2130 *PI
    30024   910577.1544 610321.7174 *PI
    30026   910282.5868 611089.2897 *PI
    30028   909975.8318 612121.7806 *PI
    20035   909636.0093 612582.5632 *PI
    30030   909468.7923 612719.0979 *PI
    20038   909441.6960 612749.8347 *POE\PI\PC


f c 20000 30000 30002 20001 30001 20002 250.00
    30000 30002 20005 20003 30003 20004 300.00
    20005 30004 30006 20006 30005 20007 300.00
    30004 30006 20010 20008 30007 20009 300.00
    20011 30008 30010 20012 30009 20013 300.00
    30008 30010 30012 20014 30011 20015 300.00
    30010 30012 30014 20016 30013 20017 300.00
    30012 30014 30016 20018 30015 20019 300.00
    30014 30016 30018 20020 30017 20021 300.00
    30016 30018 30020 20022 30019 20023 300.00
    30018 30020 20026 20024 30021 20025 300.00
    20026 30022 30024 20027 30023 20028 1500.00
    30022 30024 30026 20029 30025 20030 1500.00
    30024 30026 30028 20031 30027 20032 2500.00
    30026 30028 20035 20033 30029 20034 1500.00
    20035 30030 20038 20036 30031 20037 500.00

s f 20000  (20000 20001 C30001R 20002 20003 C30003L 20004 20005
        20006 C30005R 20007 20008 C30007L 20009 20010 20011 20012 C30009L
                20013 20014 C30011R 20015 20016 C30013R 20017 20018 C30015L 20019
            20020 C30017L 20021 20022 C30019R 20023 20024 C30021L 20025 20026
        20027 C30023L 20028 20029 C30025L 20030 20031 C30027L 20032 20033
        C30029R 20034 20035 20036 C30031L 20037) 20000 11121.23

f d [20000]*BHOC B_C Channel

f f i   31000 20000 200 20009
    31001 20000 1200 20019
    31002 20000 300 20020
    31003 20000 1300 20029
    31004 20000 400 20030

se a    20000
s a o   (31000)
    (31001)
    (31002)
    (31003)
    (31004)

se a    1200
s a o   (31001)
se a    300
s a o   (31002)

i d (614 20037 611)


# Points where Channel Intersects 75th Ave & Camelback Road


# 75th Avenue, Point # 1201

F F I   1201 20000 1200


# Camelback Road, Point # 301

F F I    301 20000 300
```


N
T' RANCH
ge 39, M.C.R.
3
2
1
Acreage
Unsubdivided
352.87'/Plat
Page 5, M.C.R.
GRAND CANAL
S 89°47'35" E 5298.64' Calc./F Trav., North line of Section 15-2N-1E
N 89°47'22" E, 5298.56'/SRP map B-2-204
S 00°04'48" E 10.51' Calc./F Trav.
S 00°29'51" E, 10.51'/SRP map B-2-204
Found brass cap flush on bridge deck at the
N.W. corner of Section 14-Twp. 2N-Rg. 1 E (#101)
S 00°21'29" W 7.29' Calc./F Trav.
S 00°01'15" E, 7.29'/SRP map B-2-204
N 0.24'
E 0.56'
Found PK
West line of the S.W.¼ of Section 11-2N-1E
West line of the N.W.¼ of Section 14-2N-1E
16.12'
900
901
315
801
Set PK w/brass cap #22755
N 89°50'06" E 333.85' Calc./F Trav.
N 89°45'32" E, 333.84'/SRP map B-2-214
Salt River Project Grand Canal per Docket 89-195880
N 89°32'43" E 600.39' Calc./F Trav.
S 89°28'02" W, 600.54'/SRP map B-2-215
N 89°42'00" W, 490.00'/SRP map B-2-215
S 89°18'25" E 489.92' Calc./F Trav.
Found cotton picker spindal
165' S.R.V.V.U.A. Easement
Found ½" iron rods (BENT)
N 85°01'32" W 158.88' Calc./F Trav.
S 85°06'06" E, 158.90'/SRP map B-2-214
S 71°01'39" E
S 70°57'05" E
114.58' (SRP map B-2-214
114.65' Calc./F Trav.
Found ¾" iron rebar (#49)
N 0.18'
E 0.20'
Set iron rod w/cap #22755
N 47°39'48" W, 270.42'/SRP map B-2-215
S 47°15'01" E 270.31' Calc./F Trav.
Found ½" iron rod (BENT)
N 0.26'
E 0.44'
902
903
904
802
803
320
BETHANY HOME
83rd AVENUE
Salt River Project Grand Canal per Docket 89-195880
16.5' Easment, Assessor's Map Book 10
N 89°32'35


venue
365
North Line of Section 14-2N-1E (#2
N 89°32'35" E 2008.51' Calc./F Trav.,
ROAD
HOME
BETHANY
Found 3/4" iron rebar (#49)
S 71°01'39" E
114.58' ASRP map B-2-214
S 70°57'05" E
114.65' Calc./F Trav.
320
903
N 0.18'
E 0.20'
N 0.24'
E 0.56'
802
Set iron rod w/cap #22755
N
322
TRACT "A"
BETHANY POINT
Book 456, Page 33, M.C.R.
TRACT
16.5' Easment, Assessor's Map Book 102, Map 10, M.C.R.
16.5' Easment, Assessor's Map Book 102, Map 10, M.C.R. (S42°49'26"E, 1710.20'/Plat)
Salt River Project Grand Canal per Docket 89-195880
GRAND CANAL
S 42°25'48" E 2964.48' Calc./F Trav.
S 42°49'16" E, 2964.45'/SRP map B-2-215
Salt River Project Grand Canal per Docket 89-195880
N 47°39'48" W, 270.42'/SRP map B-2-215
S 47°15'01" E 270.31' Calc./F Trav.
803
Found 1/2" iron rod (BENT)
N 0.26'
E 0.44'
16.5' S.R.V.W.U.A. Easment
N 42°34'48" W, 1038.57'/SRP map B-2-215
S 42°11'13" E 1038.55' Calc./F Trav.
16.5' S.R.V.W.U.A. Easment/SRP map B-2-215
804
Found iron rod w/Salt River Project aluminum cap
S 0.26'
W 0.34'
10
316
Section 14 - T2N - R1E

BETHANY POINT

Book 456, Page 33, M.C.R.

San Miguel Avenue

BETHANY POINT

Book 456, Page 33, M.C.R.

TRACT "A"

TRACT "A"

East line of the N.W. 1/4 of Section 14-2N-1E

N 00°12'55"E 2204.14' Calc./F Trav. to N 1/4 corner of Section 14-2N-1E (#50 to #2)

(#50)

905

16.5' S.R.V.W.U.A. Easement (Assesor's Book 102, Map 10

(S42°49'26"E, 1710.20'/Plat)

16.5' Easment, Assessor's Map Book 102, Map 10, M.C.R.

S 42°25'48" E 2964.48' Calc./F Trav.

S 42°49'16" E, 2964.45'/SRP map B-2-215

Salt River Project Grand Canal per Docket 89-195880

GRAND CANAL

N 42°34'48" W, 1046.65'/SRP map B-2-215

N 42°11'13" W 1050.00' Calc./F Trav.

Found iron rod w/Salt River Project aluminum cap

N 0.00'

E 0.10'

806

S 43°58'13"

103.98' Calc./F

N 44°21'47" W, 103.

SRP map B-2-

(N42°36'00"W, 653.64'/Plat)

N 42°34'58" W, 653.90'/SRP map B-2-215

S 42°11'13" E 653.89' Calc./F Trav.

805

16.5' S.R.V.W.U.A. Easement

HOMESTEAD ESTATES

11

12

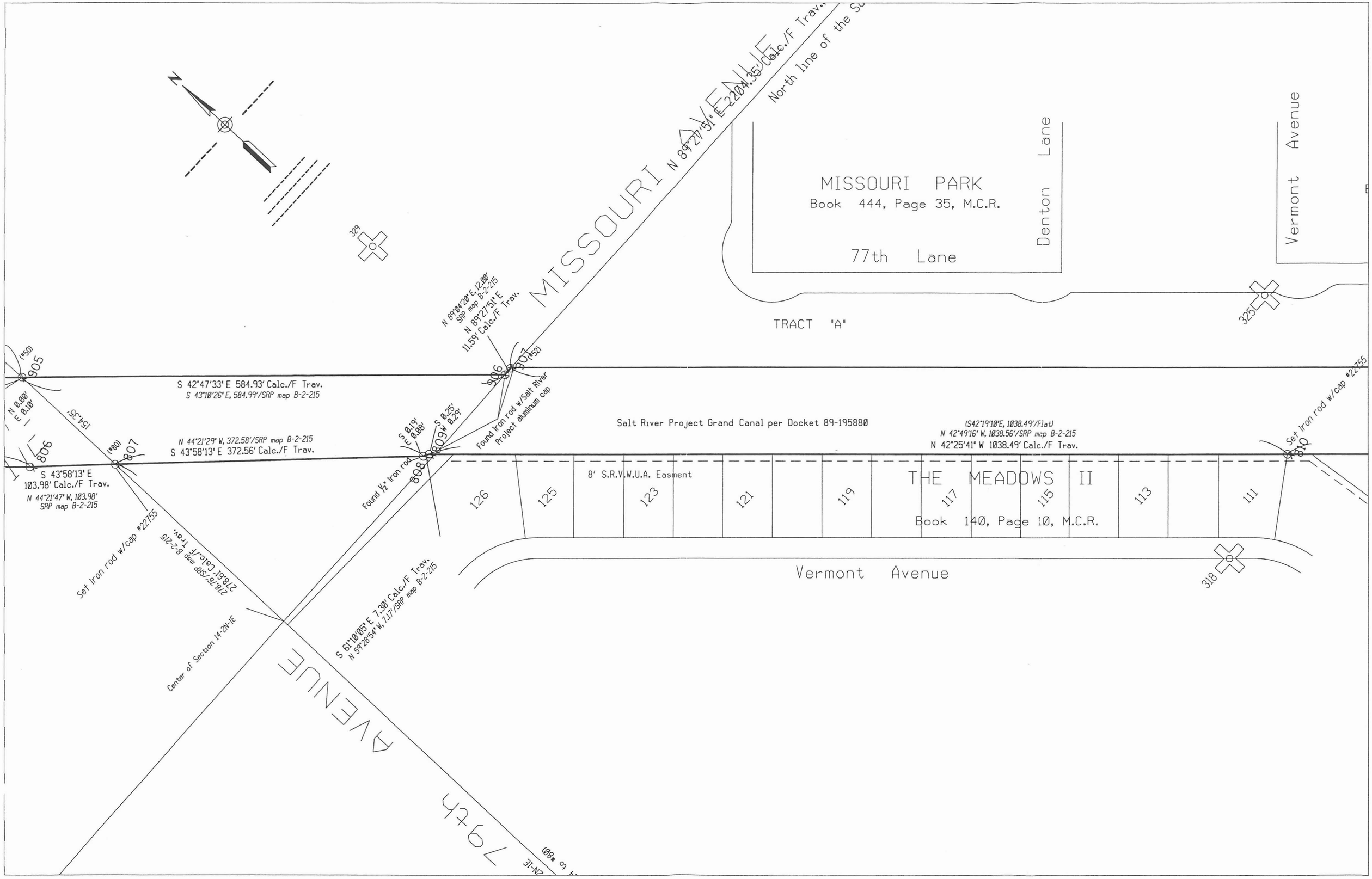
Book 208, Page 5, M.C.R.

Set iron rod w/cap #22755

Montebello Avenue

317

Section 14 - T 2 N - R


N
MISSOURI AVENUE
N 89°27'51" E 2204.35' Calc./F Trav.
North line of the Sa
MISSOURI PARK
Book 444, Page 35, M.C.R.
Denton Lane
77th Lane
Vermont Avenue
TRACT "A"
329
325
318
N 89°04'20" E, 12.00' SRP map B-2-215
N 89°27'51" E 11.59' Calc./F Trav.
905
(#50)
906
907
(#52)
S 42°47'33" E 584.93' Calc./F Trav.
S 43°10'26" E, 584.99'/SRP map B-2-215
N 0.00' E 0.18'
154.35'
808
(#80)
807
N 44°21'29" W, 372.58'/SRP map B-2-215
S 43°58'13" E 372.56' Calc./F Trav.
S 0.19' E 0.08'
S 0.25' W 0.29'
Found iron rod w/Salt River Project aluminum cap
Salt River Project Grand Canal per Docket 89-195880
(S42°19'10"E, 1038.49'/Flat)
N 42°49'16" W, 1038.56'/SRP map B-2-215
N 42°25'41" W 1038.49' Calc./F Trav.
Set iron rod w/cap #22755
810
S 43°58'13" E 103.98' Calc./F Trav.
N 44°21'47" W, 103.98' SRP map B-2-215
Found ½" iron rod
8' S.R.V.W.U.A. Easment
THE MEADOWS II
Book 140, Page 10, M.C.R.
126
125
123
121
119
117
115
113
111
Vermont Avenue
Set iron rod w/cap #22755
218.61' Calc./F Trav.
218.76'/SRP map B-2-215
S 61°10'05" E 7.30' Calc./F Trav.
N 59°28'54" W, 7.17'/SRP map B-2-215
Center of Section 14-2N-1E
79th AVENUE

Vermont Avenue

MISSOURI PARK
Book 444, Page 35, M.C.R.

77th Lane

Georgia Avenue

MISSOURI PARK
Book 444, Page 35, M.C.R.

77th Lane

75th L

MISSOU
Book 444,

TRACT "A"

TRACT "A"

TRAC

327

on rod w/cap #2755

S 42°25'41" E 3258.99' Calc./F Trav.
S 42°49'16" E, 3259.29'/SRP map B-2-215
(N42°32'40"W, 3259.39'/Plat)

GRAND CANAL

N 42°49'16" W, 2435.27'/SRP map B-2-215
S 42°25'41" E 2435.39' Calc./F Trav.

T2N - R1E

MISSOURI PARK

Book 444, Page 35, M.C.R.

TRACT "A"

75th AVENUE

N 00°06'41" E 2426.90' Calc./F Trav., to the East 1/4 corner of

N 88°44'32" E 2423.70' Calc./F Trav., to the South 1/4 corne

Twp. 2

N

358

330

319

S 42°25'41" E 3258.99' Calc./F Trav.
S 42°49'16" E, 3259.29'/SRP map B-2-215
(N42°32'40"W, 3259.39'/Plat)

GRAND CANAL

N 42°49'16" W, 2435.27'/SRP map B-2-215
S 42°25'41" E 2435.09' Calc./F Trav.

N 41°41'49" W, 2271.02'/SRP map B-2-212
S 42°31'51" E 2271.03' Calc./F Trav.

1201 (#53) 908

Set PK w/cap #22755

301.03' Calc./F Trav.
S 47°41'42" E

Set PK w/cap #22755

301 (#54) 309

S00°06'41"W, 154.76' Calc./F Trav.

S88°44'32"W, 179.40' Calc./F Trav.

311 312

Set PK w/cap #22755

609

Found PK nail
N 0.12'
W 0.09'

CAMELBACK ROAD

N 40°05'10" W
67.99' Calc./F Trav.

N 00°06'41" E 52.76' Calc./F Trav.

Found brass cap in hand hole @
S.E. corner of Section 14-2N-1E (#113)

N 88°44'32" E 43.69'
Calc./F Trav.

South line of the S.E. 1/4 of Section 14-2N-1E
N 89°23'15" E 2619.72' Calc./F Trav. (#114 to # 113)

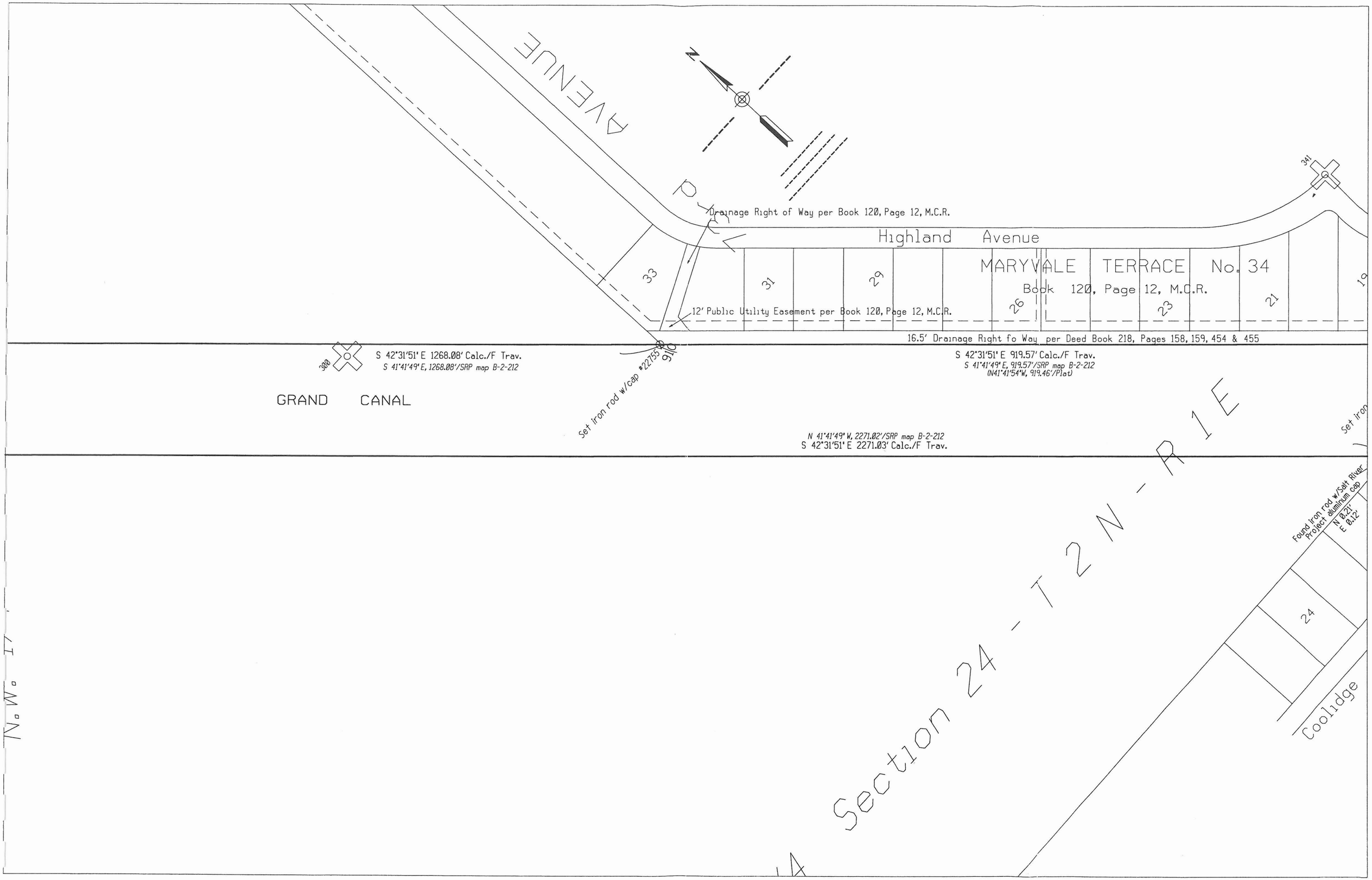
23 - Twp. 2N - Rg. 1E

24

N.W. 1/4 Section

West line N.W. 1/4 of Section 24-2N-1E

East line NE. 1/4 of Section 23-2N-1E


AVENUE
Drainage Right of Way per Book 120, Page 12, M.C.R.
Highland Avenue
MARYVALE TERRACE No. 34
Book 120, Page 12, M.C.R.
33
31
29
26
23
21
12' Public Utility Easement per Book 120, Page 12, M.C.R.
16.5' Drainage Right fo Way per Deed Book 218, Pages 158, 159, 454 & 455
S 42°31'51" E 1268.08' Calc./F Trav.
S 41°41'49" E, 1268.08'/SRP map B-2-212
S 42°31'51" E 919.57' Calc./F Trav.
S 41°41'49" E, 919.57'/SRP map B-2-212
(N41°41'54"W, 919.46'/Plat)
GRAND CANAL
Set iron rod w/cap #22755
N 41°41'49" W, 2271.02'/SRP map B-2-212
S 42°31'51" E 2271.03' Calc./F Trav.
Section 24 - T 2 N - R 1 E
Found iron rod w/Salt River Project aluminum cap
N 0.21'
E 0.12'
24
Coolidge

STRUCTURAL CALCULATIONS

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 2
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

$w_{conc} := 150\frac{lbf}{ft^3}$ $ksf := 1000\frac{lbf}{ft^2}$ $ksi := 1000psi$ $kips := 1000lbf$ $psf := 1\frac{lbf}{ft^2}$

$plf := \frac{lbf}{ft}$

Design Data & Loads

Assume 24" from top of culvert to top of opening with 18 feet of fill (approximate 18 feet of fill max for 8x7). Utilize T-beam behavior.

$opening_{clear} := 24in$ $n := 9$

$b_y := opening_{clear}$ $b_y = 24.00in$

$d_{ytop} := b_y - 2\cdot in - \frac{1}{2}\cdot(1)\,in - \frac{5}{8}in - 1in$ $d_{ytop} = 19.88\,in$

Same reinforcement top and bottom - assume 1 layer of #8 bars with #5 bar wrapping around - add 1" for placement of #8 away from curve in #5 sitrrup

$f_c := 3500psi$

$f_y := 60000psi$

Flexural Design

Design the opening for the worst fill condition of the two box culverts -- design for the 8 x 7 culvert

$opening := 8ft$ $slabthick := 9in$ $fill := 18ft$ $backfill := 120pcf$

$trib_{width} := \frac{1}{2}\cdot(9in + 8ft + 9in + 8ft + 9in)$ $trib_{width} = 9.13\,ft$

Per AASHTO 8.10.1

$b_z := \min\left(trib_{width}, \frac{opening}{4}, 12\cdot slabthick\right)$ $b_z = 2.00\,ft$ $web := 9in$

$w_{soil} := 1.25\cdot 10.86\frac{kips}{ft}$ from box culvert anaylsis plus 25% $w_{soil} = 13.57\frac{kips}{ft}$ Uniform dead weight of soil

Double the concrete weight to include the "soil reaction" from below the culvert for the bottom lintel design.

$w_{concrete} := 2\cdot w_{conc}\cdot\left[trib_{width}\cdot 9in + \left(opening_{clear} - slabthick\right)\cdot 9in\right]$ $w_{concrete} = 2.33\frac{kips}{ft}$ Uniform dead weight of concrete

Also, from box culvert analysis:

$w_{live} := 0\frac{kips}{ft}$ (if fill is high, the live load is insignificant) $w_{live} = 0.00\frac{kips}{ft}$ Uniform live load

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 3
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

T - Beam Section Properties

Wide portion

$flangewidth := trib_{width}$ $flangethickness := 9in$ $webdepth := b_y - flangethickness$ $webwidth := web$

$areaweb := webwidth \cdot webdepth$ $areaweb = 135.00\,in^2$

$areaflange := flangewidth \cdot flangethickness$ $areaflange = 985.50\,in^2$

$Area := areaweb + areaflange$ $Area = 1121\,in^2$

$$I_{basic} := \frac{flangewidth \cdot flangethickness^3}{12} + \frac{webwidth \cdot webdepth^3}{12}$$

$$centroidtop := \frac{\frac{flangethickness}{2} \cdot (areaflange) + \left(\frac{webdepth}{2} + flangethickness\right) \cdot (areaweb)}{Area}$$

$centroidbottom := webdepth + flangethickness - centroidtop$

$centroidtop = 5.95\,in$

$centroidbottom = 18.05\,in$ tension face depth

$$I_{total} := I_{basic} + (areaflange) \cdot \left(centroidtop - \frac{flangethickness}{2}\right)^2 + areaweb \cdot \left[centroidtop - \left(flangethickness + \frac{webdepth}{2}\right)\right]^2$$

$I_{total} = 26281\,in^4$

Section modulus for section (for cracking moment calculations)

$$S_{cr} := \frac{I_{total}}{centroidbottom}$$ $S_{cr} = 1456\,in^3$

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 4
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

Ultimate & Service Moments - **Positive Moment**

Using fixed-fixed conditions...

$M_{stop} := (w_{soil} + w_{concrete} + w_{live}) \cdot \frac{opening^2}{24}$ $\quad M_{stop} = 42.42\,kips \cdot ft$ Positive service level moment

$M_{ultpos} := 1.3 \cdot \left[(w_{soil} + w_{concrete} + 1.67 w_{live}) \cdot \frac{opening^2}{24} \right]$ $\quad M_{ultpos} = 55.15\,kips \cdot ft$ Factored positive moment

Try 2 - #8s

$A_{stop} := 2 \cdot 0.79 in^2$ $\quad A_{stop} = 1.58\,in^2$

$a_{top} := \frac{A_{stop} \cdot f_y}{0.85 \cdot f_c \cdot b_z}$ $\quad a_{top} = 1.33\,in$ < top flange thickness = 9 inches

$\Phi M_{ntop} := 0.9 \cdot A_{stop} \cdot f_y \cdot \left(d_{ytop} - \frac{a_{top}}{2} \right)$ $\quad \Phi M_{ntop} = 136.59\,kips \cdot ft$

$if(\Phi M_{ntop} > M_{ultpos}, "ok", "NO\ GOOD!!!") = "ok"$

Per AASHTO 8.17.1, **one** of these two conditions should be "ok":

Cracking Moment

$M_{cr} := 7.5 \cdot \left(\sqrt{\frac{f_c}{psi}} \cdot psi \right) \cdot S_{cr}$ $\quad M_{cr} = 53.82\,kips \cdot ft$

$if(\Phi M_{ntop} > 1.2 \cdot M_{cr}, "ok", "NO\ GOOD!!!") = "ok"$

$if(\Phi M_{ntop} > 1.33 \cdot M_{ultpos}, "ok", "NO\ GOOD!!!") = "ok"$

Design meets minimum cracking requirements - ok per AASHTO 8.17.1.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 5
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

Serviceability Checks (AASHTO 8.16.8.4)

$ntop := 2$ Number of bars per layer

$d_{ctop} := \min[(b_y - d_{ytop}), 2in]$ $d_{ctop} = 2.00\,in$ $A_{top} := \frac{2 \cdot d_{ctop} \cdot web}{ntop}$ $A_{top} = 18.00\,in^2$

$$f_{stop} := \min\left[0.6 \cdot f_y, \frac{170 \cdot \frac{kips}{in}}{(d_{ctop} \cdot A_{top})^{\frac{1}{3}}}\right]$$ $f_{stop} = 36000.00\,psi$

$$\rho top := \frac{A_{stop}}{b_z \cdot d_{ytop}}$$

$$k := \left[2 \cdot \rho top \cdot n + (\rho top \cdot n)^2\right]^{0.5} - \rho top \cdot n$$ $j := 1 - \frac{k}{3}$ $k = 0.22$ $j = 0.93$

$$f_{sactualtop} := \frac{M_{stop}}{A_{stop} \cdot j \cdot d_{ytop}}$$ $f_{sactualtop} = 17471\,psi$ $if(f_{sactualtop} < f_{stop}, "ok", "no good") = "ok"$

Minimum and Maximum Reinforcement Checks

$$\rho_{top} := \frac{A_{stop}}{b_z \cdot d_{ytop}}$$

$$\beta_1 := 0.85 - \max\left[\frac{0.05}{1000psi} \cdot (f_c - 4000psi), 0\right]$$ $\beta_1 = 0.85000$

$$\rho balanced := \frac{0.85 \cdot \beta_1 \cdot f_c}{f_y} \cdot \left(\frac{87000psi}{87000psi + f_y}\right)$$ $\rho balanced = 0.02494$

$\rho_{top} = 0.00331$ < $0.75 \cdot \rho balanced = 0.01871$

Provide 2-#8 bars top and bottom at opening and extend a minimum distance of ld beyond face of support = 3'-0".

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 6
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

Shear Design

$V_{ult} := 1.3(w_{soil} + w_{concrete} + w_{live}) \cdot \left(\frac{opening}{2} - d_{ytop}\right)$ $\boxed{V_{ult} = 48.47\,kips}$

Compute the capacity of the concrete alone.

$\Phi V_c := 0.85\left[2 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot (d_{ytop}) \cdot web\right]$

$\Phi V_c = 17.99\,kips$

Steel is required for shear!!

Check Vs limit per AASHTO 8.16.6.3.9

$\Phi V_{scheck} := 0.85\left[8 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot ((d_{ytop})) \cdot web\right]$ $\Phi V_{scheck} = 71.96\,kips$

$if(\Phi V_{scheck} > V_{ult} - \Phi V_c, "OK", "NO\ GOOD!") = "OK"$

Compute the minimum area of steel required on a per foot basis...

$V_{needed} := V_{ult} - \Phi V_c$ $V_{needed} = 30.48\,kips$

$A_{vneeded} := \frac{V_{needed} \cdot 1\,in}{0.85 \cdot f_y \cdot (d_{ytop})}$ $\boxed{A_{vneeded} = 0.03\,in^2}$ Area needed per foot.

Provide #4 sitrrups. Check minimum stirrup spacing per AASHTO 8.19.3.

$min_{stirrupspacing} := if\left[(V_{ult} - \Phi V_c) < 4 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot (d_{ytop}) \cdot web, min\left(24in, \frac{d_{ytop}}{2}\right), 0.5 \cdot min\left(24in, \frac{d_{ytop}}{2}\right)\right]$

$min_{stirrupspacing} = 9.94\,in$ **say 9 inches**

Provide #4 stirrups @ 9 inches on center. This would provide 0.53 in^2/ft.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 7
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

Ultimate & Service Moments - **Negative Moment**

Using fixed-fixed conditions...

$d_{ybot} := b_y - 2in - \frac{5}{8}in - \frac{1}{2}\cdot(1in)$ $\quad d_{ybot} = 20.88in$

$M_{sbot} := (w_{soil} + w_{concrete} + w_{live})\cdot\frac{opening^2}{12}$ $\quad M_{sbot} = 84.85kips\cdot ft$ Negative service level moment

$M_{ultneg} := 1.3\cdot\left[(w_{soil} + w_{concrete} + 1.67w_{live})\cdot\frac{opening^2}{12}\right]$ $\quad M_{ultneg} = 110.30kips\cdot ft$ Factored negative moment

Try 2 - #8s

$A_{sbot} := 2\cdot 0.79in^2$ $\quad A_{sbot} = 1.58in^2$

$a_{bot} := \frac{A_{sbot}\cdot f_y}{0.85\cdot f_c\cdot web}$ $\quad a_{bot} = 3.54in$

$\Phi M_{nbot} := 0.9\cdot A_{sbot}\cdot f_y\cdot\left(d_{ybot} - \frac{a_{bot}}{2}\right)$ $\quad \Phi M_{nbot} = 135.83kips\cdot ft$

$if(\Phi M_{nbot} > M_{ultneg}, "ok", "NO GOOD!!!") = "ok"$

Per AASHTO 8.17.1, **one** of these two conditions should be "ok":

Cracking Moment

$M_{cr} := 7.5\cdot\left(\sqrt{\frac{f_c}{psi}}\cdot psi\right)\cdot S_{cr}$ $\quad M_{cr} = 53.82kips\cdot ft$

$if(\Phi M_{nbot} > 1.2\cdot M_{cr}, "ok", "NO GOOD!!!") = "ok"$

$if(\Phi M_{nbot} > 1.33\cdot M_{ultneg}, "ok", "NO GOOD!!!") = "NO GOOD!!!"$

Design meets minimum cracking requirements - ok per AASHTO 8.17.1.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 8
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (8x7 culvert - 18' fill)		CHECKED BY: IBK	DATE 8-05

Serviceability Checks (AASHTO 8.16.8.4)

$nbot := 2$ Number of bars per layer

$d_{cbot} := \min[(b_y - d_{ybot}), 2in]$ $d_{cbot} = 2.00\,in$ $A_{bot} := \frac{2 \cdot d_{cbot} \cdot web}{nbot}$ $A_{bot} = 18.00\,in^2$

$f_{sbot} := \min\left[0.6 \cdot f_y, \frac{170 \cdot \frac{kips}{in}}{(d_{cbot} \cdot A_{bot})^{\frac{1}{3}}}\right]$ $f_{sbot} = 36000.00\,psi$

$\rho bot := \frac{A_{sbot}}{b_z \cdot d_{ybot}}$

$k := \left[2 \cdot \rho bot \cdot n + (\rho bot \cdot n)^2\right]^{0.5} - \rho bot \cdot n$ $j := 1 - \frac{k}{3}$ $k = 0.21$ $j = 0.93$

$f_{sactualbot} := \frac{M_{sbot}}{A_{sbot} \cdot j \cdot d_{ybot}}$ $f_{sactualbot} = 33213\,psi$ $\text{if}(f_{sactualbot} < f_{sbot}, \text{"ok"}, \text{"no good"}) = \text{"ok"}$

Minimum and Maximum Reinforcement Checks

$\rho bot := \frac{A_{sbot}}{b_z \cdot d_{ybot}}$

$\beta_1 := 0.85 - \max\left[\frac{0.05}{1000psi} \cdot (f_c - 4000psi), 0\right]$ $\beta_1 = 0.85000$

$\rho balanced := \frac{0.85 \cdot \beta_1 \cdot f_c}{f_y} \cdot \left(\frac{87000psi}{87000psi + f_y}\right)$ $\rho balanced = 0.02494$

$\rho bot = 0.00315$ < $0.75 \cdot \rho balanced = 0.01871$

Provide 2-#8 bars top and bottom at top and bottom slabs and extend a minimum distance of ld beyond face of support = 3'-0".

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 2
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

$w_{conc} := 150\frac{lbf}{ft^3}$ $ksf := 1000\frac{lbf}{ft^2}$ $ksi := 1000psi$ $kips := 1000lbf$ $psf := 1\frac{lbf}{ft^2}$

$plf := \frac{lbf}{ft}$

Design Data & Loads

The worst case, an 8x7 culvert with 18' of fill, was designed. Check the 9x9 culvert design with 2 feet of fill - utilize the same reinforcement detailing. See calculation S-7.00, revision 1.

$opening_{clear} := 24in$ $n := 9$

$b_y := opening_{clear}$ $b_y = 24.00in$

$d_{ytop} := b_y - 2\cdot in - \frac{1}{2}\cdot(1)\,in - \frac{5}{8}in - 1in$ $d_{ytop} = 19.88in$

Same reinforcement top and bottom - assume 1 layer of #8 bars with #5 bar wrapping around - add 1" for placement of #8 away from curve in #5 sitrrup

$f_c := 3500psi$

$f_y := 60000psi$

Flexural Design

$opening := 8ft$ $slabthick := 9in$ $fill := 2ft$ $backfill := 120pcf$

$trib_{width} := \frac{1}{2}\cdot(9in + 9ft + 9in + 9ft + 9in)$ $trib_{width} = 10.13\,ft$

Per AASHTO 8.10.1

$b_z := \min\left(trib_{width}, \frac{opening}{4}, 12\cdot slabthick\right)$ $b_z = 2.00\,ft$ $web := 9in$

$w_{soil} := 1.25\cdot 1.11\frac{kips}{ft}$ from box culvert anaylsis plus 25% $w_{soil} = 1.39\frac{kips}{ft}$ Uniform dead weight of soil

Double the concrete weight to include the "soil reaction" from below the culvert for the bottom lintel design.

$w_{concrete} := 2\cdot w_{conc}\cdot\left[trib_{width}\cdot 9in + \left(opening_{clear} - slabthick\right)\cdot 9in\right]$ $w_{concrete} = 2.56\frac{kips}{ft}$ Uniform dead weight of concrete

Also, from box culvert analysis:

$w_{live} := 1.43\frac{kips}{ft}$ $w_{live} = 1.43\frac{kips}{ft}$ Uniform live load

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 3
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

T - Beam Section Properties

Wide portion

$flangewidth := trib_{width}$ $flangethickness := 9in$ $webdepth := b_y - flangethickness$ $webwidth := web$

$areaweb := webwidth \cdot webdepth$ $areaweb = 135.00\,in^2$

$areaflange := flangewidth \cdot flangethickness$ $areaflange = 1093.50\,in^2$

$Area := areaweb + areaflange$ $\boxed{Area = 1229\,in^2}$

$$I_{basic} := \frac{flangewidth \cdot flangethickness^3}{12} + \frac{webwidth \cdot webdepth^3}{12}$$

$$centroidtop := \frac{\frac{flangethickness}{2} \cdot (areaflange) + \left(\frac{webdepth}{2} + flangethickness\right) \cdot (areaweb)}{Area}$$

$centroidbottom := webdepth + flangethickness - centroidtop$

$centroidtop = 5.82\,in$

$centroidbottom = 18.18\,in$ tension face depth

$$I_{total} := I_{basic} + (areaflange) \cdot \left(centroidtop - \frac{flangethickness}{2}\right)^2 + areaweb \cdot \left[centroidtop - \left(flangethickness + \frac{webdepth}{2}\right)\right]^2$$

$\boxed{I_{total} = 27216\,in^4}$

Section modulus for section (for cracking moment calculations)

$$S_{cr} := \frac{I_{total}}{centroidbottom}$$ $\boxed{S_{cr} = 1497\,in^3}$

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 4
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

Ultimate & Service Moments - **Positive Moment**

Using fixed-fixed conditions...

$M_{stop} := (w_{soil} + w_{concrete} + w_{live}) \cdot \frac{opening^2}{24}$ $\quad M_{stop} = 14.34\,kips \cdot ft$ Positive service level moment

$M_{ultpos} := 1.3 \cdot \left[(w_{soil} + w_{concrete} + 1.67 w_{live}) \cdot \frac{opening^2}{24} \right]$ $\quad M_{ultpos} = 21.96\,kips \cdot ft$ Factored positive moment

Try 2 - #8s

$A_{stop} := 2 \cdot 0.79 in^2$ $\quad A_{stop} = 1.58\,in^2$

$a_{top} := \frac{A_{stop} \cdot f_y}{0.85 \cdot f_c \cdot b_z}$ $\quad a_{top} = 1.33\,in$ < top flange thickness = 9 inches

$\Phi M_{ntop} := 0.9 \cdot A_{stop} \cdot f_y \cdot \left(d_{ytop} - \frac{a_{top}}{2} \right)$ $\quad \Phi M_{ntop} = 136.59\,kips \cdot ft$

$if(\Phi M_{ntop} > M_{ultpos}, "ok", "NO\ GOOD!!!") = "ok"$

Per AASHTO 8.17.1, **one** of these two conditions should be "ok":

Cracking Moment

$M_{cr} := 7.5 \cdot \left(\sqrt{\frac{f_c}{psi}} \cdot psi \right) \cdot S_{cr}$ $\quad M_{cr} = 55.35\,kips \cdot ft$

$if(\Phi M_{ntop} > 1.2 \cdot M_{cr}, "ok", "NO\ GOOD!!!") = "ok"$

$if(\Phi M_{ntop} > 1.33 \cdot M_{ultpos}, "ok", "NO\ GOOD!!!") = "ok"$

Design meets minimum cracking requirements - ok per AASHTO 8.17.1.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 5
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

Serviceability Checks (AASHTO 8.16.8.4)

$ntop := 2$ Number of bars per layer

$d_{ctop} := \min[(b_y - d_{ytop}), 2in]$ $d_{ctop} = 2.00\,in$ $A_{top} := \frac{2 \cdot d_{ctop} \cdot web}{ntop}$ $A_{top} = 18.00\,in^2$

$$f_{stop} := \min\left[0.6 \cdot f_y, \frac{170 \cdot \frac{kips}{in}}{(d_{ctop} \cdot A_{top})^{\frac{1}{3}}}\right]$$ $f_{stop} = 36000.00\,psi$

$$\rho top := \frac{A_{stop}}{b_z \cdot d_{ytop}}$$

$$k := \left[2 \cdot \rho top \cdot n + (\rho top \cdot n)^2\right]^{0.5} - \rho top \cdot n$$ $j := 1 - \frac{k}{3}$ $k = 0.22$ $j = 0.93$

$$f_{sactualtop} := \frac{M_{stop}}{A_{stop} \cdot j \cdot d_{ytop}}$$ $f_{sactualtop} = 5905\,psi$ $if(f_{sactualtop} < f_{stop}, "ok", "no\ good") = "ok"$

Minimum and Maximum Reinforcement Checks

$$\rho_{top} := \frac{A_{stop}}{b_z \cdot d_{ytop}}$$

$$\beta_1 := 0.85 - \max\left[\frac{0.05}{1000psi} \cdot (f_c - 4000psi), 0\right]$$ $\beta_1 = 0.85000$

$$\rho balanced := \frac{0.85 \cdot \beta_1 \cdot f_c}{f_y} \cdot \left(\frac{87000psi}{87000psi + f_y}\right)$$ $\rho balanced = 0.02494$

$\rho_{top} = 0.00331$ < $0.75 \cdot \rho balanced = 0.01871$

Provide 2-#8 bars top and bottom at opening and extend a minimum distance of ld beyond face of support = 3'-0".

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 6
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

Shear Design

$V_{ult} := 1.3(w_{soil} + w_{concrete} + w_{live}) \cdot \left(\frac{opening}{2} - d_{ytop}\right)$ $\boxed{V_{ult} = 16.38\,kips}$

Compute the capacity of the concrete alone.

$\Phi V_c := 0.85\left[2 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot (d_{ytop}) \cdot web\right]$

$\Phi V_c = 17.99\,kips$

Steel is required for shear!!

Check Vs limit per AASHTO 8.16.6.3.9

$\Phi V_{scheck} := 0.85\left[8 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot ((d_{ytop})) \cdot web\right]$ $\Phi V_{scheck} = 71.96\,kips$

$if(\Phi V_{scheck} > V_{ult} - \Phi V_c, "OK", "NO\ GOOD!") = "OK"$

Compute the minimum area of steel required on a per foot basis...

$V_{needed} := V_{ult} - \Phi V_c$ $V_{needed} = -1.61\,kips$

$A_{vneeded} := \frac{V_{needed} \cdot 12in}{0.85 \cdot f_y \cdot (d_{ytop})}$ $\boxed{A_{vneeded} = -0.02\,in^2}$ Area needed per foot.

Provide #4 sitrrups. Check minimum stirrup spacing per AASHTO 8.19.3.

$max_{stirrupspacing} := if\left[(V_{ult} - \Phi V_c) < 4 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot (d_{ytop}) \cdot web, \min\left(24in, \frac{d_{ytop}}{2}\right), 0.5 \cdot \min\left(24in, \frac{d_{ytop}}{2}\right)\right]$

$max_{stirrupspacing} = 9.94\,in$ **say 9 inches**

Provide #4 stirrups @ 9 inches on center. This would provide 0.53 in^2/ft.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 7
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

Ultimate & Service Moments - **Negative Moment**

Using fixed-fixed conditions...

$d_{ybot} := b_y - 2in - \frac{5}{8}in - \frac{1}{2}\cdot(1in)$ $\quad d_{ybot} = 20.88\,in$

$M_{sbot} := (w_{soil} + w_{concrete} + w_{live})\cdot\frac{opening^2}{12}$ $\quad M_{sbot} = 28.68\,kips\cdot ft$ Negative service level moment

$M_{ultneg} := 1.3\cdot\left[(w_{soil} + w_{concrete} + 1.67w_{live})\cdot\frac{opening^2}{12}\right]$ $\quad M_{ultneg} = 43.92\,kips\cdot ft$ Factored negative moment

Try 2 - #8s

$A_{sbot} := 2\cdot 0.79in^2$ $\quad A_{sbot} = 1.58\,in^2$

$a_{bot} := \frac{A_{sbot}\cdot f_y}{0.85\cdot f_c\cdot web}$ $\quad a_{bot} = 3.54\,in$

$\Phi M_{nbot} := 0.9\cdot A_{sbot}\cdot f_y\cdot\left(d_{ybot} - \frac{a_{bot}}{2}\right)$ $\quad \Phi M_{nbot} = 135.83\,kips\cdot ft$

$if(\Phi M_{nbot} > M_{ultneg}, "ok", "NO\ GOOD!!!") = "ok"$

Per AASHTO 8.17.1, **one** of these two conditions should be "ok":

Cracking Moment

$M_{cr} := 7.5\cdot\left(\sqrt{\frac{f_c}{psi}}\cdot psi\right)\cdot S_{cr}$ $\quad M_{cr} = 55.35\,kips\cdot ft$

$if(\Phi M_{nbot} > 1.2\cdot M_{cr}, "ok", "NO\ GOOD!!!") = "ok"$

$if(\Phi M_{nbot} > 1.33\cdot M_{ultneg}, "ok", "NO\ GOOD!!!") = "ok"$

Design meets minimum cracking requirements - ok per AASHTO 8.17.1.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 8
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 2' fill)		CHECKED BY: IBK	DATE 8-05

Serviceability Checks (AASHTO 8.16.8.4)

$nbot := 2$ Number of bars per layer

$d_{cbot} := \min[(b_y - d_{ybot}), 2in]$ $d_{cbot} = 2.00\,in$ $A_{bot} := \frac{2 \cdot d_{cbot} \cdot web}{nbot}$ $A_{bot} = 18.00\,in^2$

$$f_{sbot} := \min\left[0.6 \cdot f_y, \frac{170 \cdot \frac{kips}{in}}{(d_{cbot} \cdot A_{bot})^{\frac{1}{3}}}\right]$$ $f_{sbot} = 36000.00\,psi$

$$\rho bot := \frac{A_{sbot}}{b_z \cdot d_{ybot}}$$

$k := \left[2 \cdot \rho bot \cdot n + (\rho bot \cdot n)^2\right]^{0.5} - \rho bot \cdot n$ $j := 1 - \frac{k}{3}$ $k = 0.21$ $j = 0.93$

$f_{sactualbot} := \frac{M_{sbot}}{A_{sbot} \cdot j \cdot d_{ybot}}$ $f_{sactualbot} = 11225\,psi$ $if(f_{sactualbot} < f_{sbot}, "ok", "no\ good") = "ok"$

Minimum and Maximum Reinforcement Checks

$$\rho bot := \frac{A_{sbot}}{b_z \cdot d_{ybot}}$$

$\beta_1 := 0.85 - \max\left[\frac{0.05}{1000psi} \cdot (f_c - 4000psi), 0\right]$ $\beta_1 = 0.85000$

$\rho balanced := \frac{0.85 \cdot \beta_1 \cdot f_c}{f_y} \cdot \left(\frac{87000psi}{87000psi + f_y}\right)$ $\rho balanced = 0.02494$

$\rho bot = 0.00315$ < $0.75 \cdot \rho balanced = 0.01871$

Provide 2-#8 bars top and bottom at top and bottom slabs and extend a minimum distance of ld beyond face of support = 3'-0".

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 9
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 10' fill)		CHECKED BY: IBK	DATE 8-05

$w_{conc} := 150\frac{lbf}{ft^3}$ $\quad ksf := 1000\frac{lbf}{ft^2}$ $\quad ksi := 1000psi$ $\quad kips := 1000lbf$ $\quad psf := 1\frac{lbf}{ft^2}$

$plf := \frac{lbf}{ft}$

Design Data & Loads

The worst case, an 8x7 culvert with 18' of fill, was designed. Check the 9x9 culvert design with 10 feet of fill - utilize the same reinforcement detailing. See calculation S-7.00, revision 1.

$opening_{clear} := 24in$ $\quad n := 9$

$b_y := opening_{clear}$ $\quad b_y = 24.00in$

$d_{ytop} := b_y - 2\cdot in - \frac{1}{2}\cdot(1)\,in - \frac{5}{8}in - 1in$ $\quad d_{ytop} = 19.88in$

Same reinforcement top and bottom - assume 1 layer of #8 bars with #5 bar wrapping around - add 1" for placement of #8 away from curve in #5 sitrrup

$f_c := 3500psi$

$f_y := 60000psi$

Flexural Design

$opening := 8ft$ $\quad slabthick := 9in$ $\quad fill := 10ft$ $\quad backfill := 120pcf$

$trib_{width} := \frac{1}{2}\cdot(9in + 9ft + 9in + 9ft + 9in)$ $\quad trib_{width} = 10.13\,ft$

Per AASHTO 8.10.1

$b_z := \min\left(trib_{width}, \frac{opening}{4}, 12\cdot slabthick\right)$ $\quad b_z = 2.00\,ft$ $\quad web := 9in$

$w_{soil} := 1.25\cdot 6.5\frac{kips}{ft}$ from box culvert anaylsis plus 25% $\quad w_{soil} = 8.13\frac{kips}{ft}$ Uniform dead weight of soil

Double the concrete weight to include the "soil reaction" from below the culvert for the bottom lintel design.

$w_{concrete} := 2\cdot w_{conc}\cdot\left[trib_{width}\cdot 9in + \left(opening_{clear} - slabthick\right)\cdot 9in\right]$ $\quad w_{concrete} = 2.56\frac{kips}{ft}$ Uniform dead weight of concrete

Also, from box culvert analysis:

$w_{live} := 0\frac{kips}{ft}$ live load is relatively insignificant at 10 feet of fill $\quad w_{live} = 0.00\frac{kips}{ft}$ Uniform live load

T - Beam Section Properties

Wide portion

$flangewidth := trib_{width}$ $flangethickness := 9in$ $webdepth := b_y - flangethickness$ $webwidth := web$

$areaweb := webwidth \cdot webdepth$ $areaweb = 135.00\,in^2$

$areaflange := flangewidth \cdot flangethickness$ $areaflange = 1093.50\,in^2$

$Area := areaweb + areaflange$ $\boxed{Area = 1229\,in^2}$

$$I_{basic} := \frac{flangewidth \cdot flangethickness^3}{12} + \frac{webwidth \cdot webdepth^3}{12}$$

$$centroidtop := \frac{\frac{flangethickness}{2} \cdot (areaflange) + \left(\frac{webdepth}{2} + flangethickness\right) \cdot (areaweb)}{Area}$$

$centroidbottom := webdepth + flangethickness - centroidtop$

$centroidtop = 5.82\,in$

$centroidbottom = 18.18\,in$ tension face depth

$$I_{total} := I_{basic} + (areaflange) \cdot \left(centroidtop - \frac{flangethickness}{2}\right)^2 + areaweb \cdot \left[centroidtop - \left(flangethickness + \frac{webdepth}{2}\right)\right]^2$$

$\boxed{I_{total} = 27216\,in^4}$

Section modulus for section (for cracking moment calculations)

$$S_{cr} := \frac{I_{total}}{centroidbottom}$$ $\boxed{S_{cr} = 1497\,in^3}$

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 11
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 10' fill)		CHECKED BY: IBK	DATE 8-05

Ultimate & Service Moments - **Positive Moment**

Using fixed-fixed conditions...

$M_{stop} := (w_{soil} + w_{concrete} + w_{live}) \cdot \frac{opening^2}{24}$ $\quad M_{stop} = 28.49\,kips \cdot ft$ Positive service level moment

$M_{ultpos} := 1.3 \cdot \left[(w_{soil} + w_{concrete} + 1.67 w_{live}) \cdot \frac{opening^2}{24} \right]$ $\quad M_{ultpos} = 37.04\,kips \cdot ft$ Factored positive moment

Try 2 - #8s

$A_{stop} := 2 \cdot 0.79 in^2$ $\quad A_{stop} = 1.58\,in^2$

$a_{top} := \frac{A_{stop} \cdot f_y}{0.85 \cdot f_c \cdot b_z}$ $\quad a_{top} = 1.33\,in$ < top flange thickness = 9 inches

$\Phi M_{ntop} := 0.9 \cdot A_{stop} \cdot f_y \cdot \left(d_{ytop} - \frac{a_{top}}{2} \right)$ $\quad \Phi M_{ntop} = 136.59\,kips \cdot ft$

$if(\Phi M_{ntop} > M_{ultpos}, "ok", "NO\ GOOD!!!") = "ok"$

Per AASHTO 8.17.1, **one** of these two conditions should be "ok":

Cracking Moment

$M_{cr} := 7.5 \cdot \left(\sqrt{\frac{f_c}{psi}} \cdot psi \right) \cdot S_{cr}$ $\quad M_{cr} = 55.35\,kips \cdot ft$

$if(\Phi M_{ntop} > 1.2 \cdot M_{cr}, "ok", "NO\ GOOD!!!") = "ok"$

$if(\Phi M_{ntop} > 1.33 \cdot M_{ultpos}, "ok", "NO\ GOOD!!!") = "ok"$

Design meets minimum cracking requirements - ok per AASHTO 8.17.1.

Serviceability Checks (AASHTO 8.16.8.4)

$ntop := 2$ Number of bars per layer

$d_{ctop} := \min[(b_y - d_{ytop}), 2in]$ $d_{ctop} = 2.00\,in$ $A_{top} := \frac{2 \cdot d_{ctop} \cdot web}{ntop}$ $A_{top} = 18.00\,in^2$

$$f_{stop} := \min\left[0.6 \cdot f_y, \frac{170 \cdot \frac{kips}{in}}{(d_{ctop} \cdot A_{top})^{\frac{1}{3}}}\right]$$ $f_{stop} = 36000.00\,psi$

$$\rho top := \frac{A_{stop}}{b_z \cdot d_{ytop}}$$

$$k := \left[2 \cdot \rho top \cdot n + (\rho top \cdot n)^2\right]^{0.5} - \rho top \cdot n$$ $j := 1 - \frac{k}{3}$ $k = 0.22$ $j = 0.93$

$$f_{sactualtop} := \frac{M_{stop}}{A_{stop} \cdot j \cdot d_{ytop}}$$ $f_{sactualtop} = 11733\,psi$ $if(f_{sactualtop} < f_{stop}, "ok", "no\ good") = "ok"$

Minimum and Maximum Reinforcement Checks

$$\rho_{top} := \frac{A_{stop}}{b_z \cdot d_{ytop}}$$

$$\beta_1 := 0.85 - \max\left[\frac{0.05}{1000psi} \cdot (f_c - 4000psi), 0\right]$$ $\beta_1 = 0.85000$

$$\rho_{balanced} := \frac{0.85 \cdot \beta_1 \cdot f_c}{f_y} \cdot \left(\frac{87000psi}{87000psi + f_y}\right)$$ $\rho_{balanced} = 0.02494$

$\rho_{top} = 0.00331$ < $0.75 \cdot \rho_{balanced} = 0.01871$

Provide 2-#8 bars top and bottom at opening and extend a minimum distance of ld beyond face of support = 3'-0".

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 13
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 10' fill)		CHECKED BY: IBK	DATE 8-05

Shear Design

$V_{ult} := 1.3(w_{soil} + w_{concrete} + w_{live}) \cdot \left(\frac{opening}{2} - d_{ytop}\right)$ $\boxed{V_{ult} = 32.55\,kips}$

Compute the capacity of the concrete alone.

$\Phi V_c := 0.85\left[2 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot (d_{ytop}) \cdot web\right]$

$\Phi V_c = 17.99\,kips$

Steel is required for shear!!

Check Vs limit per AASHTO 8.16.6.3.9

$\Phi V_{scheck} := 0.85\left[8 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot ((d_{ytop})) \cdot web\right]$ $\Phi V_{scheck} = 71.96\,kips$

$if(\Phi V_{scheck} > V_{ult} - \Phi V_c, "OK", "NO\ GOOD!") = "OK"$

Compute the minimum area of steel required on a per foot basis...

$V_{needed} := V_{ult} - \Phi V_c$ $V_{needed} = 14.56\,kips$

$A_{vneeded} := \frac{V_{needed} \cdot 12in}{0.85 \cdot f_y \cdot (d_{ytop})}$ $\boxed{A_{vneeded} = 0.17\,in^2}$ Area needed per foot.

Provide #4 sitrrups. Check minimum stirrup spacing per AASHTO 8.19.3.

$max_{stirrupspacing} := if\left[(V_{ult} - \Phi V_c) < 4 \cdot \left(\sqrt{psi \cdot f_c}\right) \cdot (d_{ytop}) \cdot web, \min\left(24in, \frac{d_{ytop}}{2}\right), 0.5 \cdot \min\left(24in, \frac{d_{ytop}}{2}\right)\right]$

$max_{stirrupspacing} = 9.94\,in$ **say 9 inches**

Provide #4 stirrups @ 9 inches on center. This would provide 0.53 in^2/ft.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 14
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 10' fill)		CHECKED BY: IBK	DATE 8-05

Ultimate & Service Moments - **Negative Moment**

Using fixed-fixed conditions...

$d_{ybot} := b_y - 2in - \frac{5}{8}in - \frac{1}{2}\cdot(1in)$ $\quad d_{ybot} = 20.88in$

$M_{sbot} := (w_{soil} + w_{concrete} + w_{live})\cdot\frac{opening^2}{12}$ $\quad M_{sbot} = 56.98kips\cdot ft$ Negative service level moment

$M_{ultneg} := 1.3\cdot\left[(w_{soil} + w_{concrete} + 1.67w_{live})\cdot\frac{opening^2}{12}\right]$ $\quad M_{ultneg} = 74.08kips\cdot ft$ Factored negative moment

Try 2 - #8s

$A_{sbot} := 2\cdot 0.79in^2$ $\quad A_{sbot} = 1.58in^2$

$a_{bot} := \frac{A_{sbot}\cdot f_y}{0.85\cdot f_c\cdot web}$ $\quad a_{bot} = 3.54in$

$\Phi M_{nbot} := 0.9\cdot A_{sbot}\cdot f_y\cdot\left(d_{ybot} - \frac{a_{bot}}{2}\right)$ $\quad \Phi M_{nbot} = 135.83kips\cdot ft$

$if(\Phi M_{nbot} > M_{ultneg}, "ok", "NO GOOD!!!") = "ok"$

Per AASHTO 8.17.1, **one** of these two conditions should be "ok":

Cracking Moment

$M_{cr} := 7.5\cdot\left(\sqrt{\frac{f_c}{psi}}\cdot psi\right)\cdot S_{cr}$ $\quad M_{cr} = 55.35kips\cdot ft$

$if(\Phi M_{nbot} > 1.2\cdot M_{cr}, "ok", "NO GOOD!!!") = "ok"$

$if(\Phi M_{nbot} > 1.33\cdot M_{ultneg}, "ok", "NO GOOD!!!") = "ok"$

Design meets minimum cracking requirements - ok per AASHTO 8.17.1.

DMJM HARRIS | AECOM	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 15
		DESIGNED BY: CAL	DATE 8-05
SUBJECT: Equalizer Wall Calculation (9x9 culvert - 10' fill)		CHECKED BY: IBK	DATE 8-05

Serviceability Checks (AASHTO 8.16.8.4)

$nbot := 2$ Number of bars per layer

$d_{cbot} := \min[(b_y - d_{ybot}), 2in]$ $d_{cbot} = 2.00\,in$ $A_{bot} := \frac{2 \cdot d_{cbot} \cdot web}{nbot}$ $A_{bot} = 18.00\,in^2$

$$f_{sbot} := \min\left[0.6 \cdot f_y, \frac{170 \cdot \frac{kips}{in}}{(d_{cbot} \cdot A_{bot})^{\frac{1}{3}}}\right]$$ $f_{sbot} = 36000.00\,psi$

$$\rho bot := \frac{A_{sbot}}{b_z \cdot d_{ybot}}$$

$$k := \left[2 \cdot \rho bot \cdot n + (\rho bot \cdot n)^2\right]^{0.5} - \rho bot \cdot n \qquad j := 1 - \frac{k}{3} \qquad k = 0.21 \qquad j = 0.93$$

$$f_{sactualbot} := \frac{M_{sbot}}{A_{sbot} \cdot j \cdot d_{ybot}}$$ $f_{sactualbot} = 22305\,psi$ $if(f_{sactualbot} < f_{sbot}, "ok", "no\ good") = "ok"$

Minimum and Maximum Reinforcement Checks

$$\rho bot := \frac{A_{sbot}}{b_z \cdot d_{ybot}}$$

$$\beta_1 := 0.85 - \max\left[\frac{0.05}{1000psi} \cdot (f_c - 4000psi), 0\right] \qquad \beta_1 = 0.85000$$

$$\rho balanced := \frac{0.85 \cdot \beta_1 \cdot f_c}{f_y} \cdot \left(\frac{87000psi}{87000psi + f_y}\right) \qquad \rho balanced = 0.02494$$

$\rho bot = 0.00315$ < $0.75 \cdot \rho balanced = 0.01871$

Provide 2-#8 bars top and bottom at top and bottom slabs and extend a minimum distance of ld beyond face of support = 3'-0".

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

DESIGN CRITERIA

STRUCTURE DESCRIPTION: 2 - 9 x 9 CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERT

DESIGN SPECIFICATIONS: AASHTO SEVENTEENTH EDITION, ADOT BRIDGE GROUP BRIDGE PRACTICE GUIDELINES, ADOT REINFORCED CONCRETE BOX CULVERT MANUAL

DESIGN LOADS:

LIVE LOAD:	HS20 - 44
EARTH PRESSURES:	120 PCF VERT & 30 PCF HORIZ
OR	120 PCF VERT & 60 PCF HORIZ

DESIGN STRESSES: f'c = 3500 psi
fy = 60 ksi

DESIGN METHOD : ULTIMATE STRENGTH DESIGN
GROUP X : 1.3 [D + E + 1.67 (L+I)]

ASSUMED MEMBER THICKNESSES:

ROOF = 9 in.
INVERT = 10.5 in.
EXT WALL = 9 in.
INT WALL = 9 in.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

PRESSURES:

DEAD LOAD:

ROOF: 0.75 * 0.15 kcf = 0.11 ksf

INVERT:

WALLS: $\frac{.15 * [2(9) + 1(9)](9)/12}{(2(9) + [2(9) + 1(9)]/12}$ = 0.15 ksf

ROOF: = 0.11 ksf

0.26 ksf

EARTH :

ROOF: 2 * 0.12 kcf = 0.24 ksf

INVERT: = 0.24 ksf

WALLS:

LOADING 1, 30 pcf

pt : [2 + 2 + .5 * 9 / 12] * 0.03 = 0.13 ksf

ΔP : [9 + .5 (9 + 10.5) / 12] * 0.03 = 0.29 ksf

LOADING 2, 60 pcf

pt : 0.13 (60 / 30) = 0.26 ksf

ΔP : 0.29 (60 / 30) = 0.59 ksf

LIVE LOAD:

ROOF: PER AASHTO 6.4, WHEEL LOADS SHALL BE PLACED ON ROOF SLAB AND DISTRIBUTED IN ACCORDANCE WITH AASHTO 3.24.3, CASE B

IMPACT: = 20 %

WHEEL LOAD: = HS20

E' = 4 + 0.06 (S) = 4.54

INVERT: TRUCK LOADS DISTRIBUTED OVER 14' LANE

WHEEL LOAD: = VARIES

MEMBER LENGTHS:

ROOF & INVERT : 9 + 9 / 12 = 9.75 ft

WALLS : 9 + .5 * (9 + 10.5) / 12 = 9.81 ft

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

SHEAR DESIGN:

REQUIRED DEPTH

$\phi vc > V_U / bd$

$d_{REQ'D} > V_U / b\ \phi vc$

ROOF:

$\phi vc = \phi [\ 2.14 \sqrt{f'c} + 4600\ \rho\ (Vu\ d / Mu)\ ]$

$= 147.9$ psi

$V_U = 2$ kips

$M_U = 2.6$ ft-kips

$d_{REQ'D} = 1.1$ in $<= 6.6$ in OK

INVERT:

$\phi vc = \phi [\ 2.14 \sqrt{f'c} + 4600\ \rho\ (Vu\ d / Mu)\ ]$

$= 173.9$ psi

$V_U = 5.4$ kips

$M_U = 2.7$ ft-kips

$d_{REQ'D} = 2.6$ in $<= 7.1$ in OK

WALL:

$\phi vc = \phi [\ 1.9 \sqrt{f'c} + 2500\ \rho\ (Vu\ d / Mu)\ ]$

$= 126.7$ psi

$V_U = 3.7$ kips

$M_U = 4$ ft-kips

$d_{REQ'D} = 2.5$ in $<= 6.6$ in OK

MOMENT DESIGN:

ROOF:

+ MOMENT

Mu = 17.19 ft-kips
d = 7.13 in
F = 0.0508
Ku = 338.6
au = 4.2
As = 0.58 sq in

- MOMENT

@ EXT WALL

Mu = 9.14 ft-kips
d = 6.63 in
F = 0.0439
Ku = 208.2
au = 4.3
As = 0.32 sq in

@ INT WALL

Mu = 12.74 ft-kips
d = 6.63 in
F = 0.0439
Ku = 290.3
au = 4.2
As = 0.45 sq in

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

MOMENT DESIGN (CONT):

INVERT:

+ MOMENT

Mu = 6.66 ft-kips
d = 8.13 in
F = 0.066
Ku = 100.9
au = 4.4
As = 0.19 sq in

- MOMENT

@ EXT WALL

Mu = 6.21 ft-kips
d = 7.13 in
F = 0.0508
Ku = 122.4
au = 4.4
As = 0.2 sq in

@ INT WALL

Mu = 12.08 ft-kips
d = 7.13 in
F = 0.0508
Ku = 237.9
au = 4.3
As = 0.4 sq in

WALL:

+ MOMENT

Mu = 3.8 ft-kips
d = 6.63 in
F = 0.0439
Ku = 86.5
au = 4.4
As = 0.13 sq in

- MOMENT

@ SUPPORT

Mu = 10.52 ft-kips
d = 6.63 ft-kips
F = 0.0439
Ku = 239.8
au = 4.3
As = 0.37 sq in

@ MIDSPAN

Mu = 0.91 ft-kips
d = 6.63 in
F = 0.0439
Ku = 20.8
au = 4.5
As = 0.03 sq in

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 2/05

ROOF SLAB

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	0.21	2.01	3.31	-1.10	3.36		0.44	1.19	1.39	0.00	0.00	
0.98	-0.17	0.97	2.07	-2.62	1.18		0.33	0.95	1.15	0.00	0.00	
1.95	-0.44	0.15	1.06	-4.12	0.00		0.22	0.72	0.92	0.00	0.00	
2.93	-0.61	-0.43	0.28	-5.58	0.34		0.11	0.48	0.69	0.00	0.00	
3.90	-0.66	-0.79	-0.27	-6.64	0.80		0.01	0.25	0.45	0.00	0.00	
4.88	-0.62	-0.92	-0.60	-6.97	1.26		-0.10	0.02	0.22	0.00	0.00	
5.85	-0.46	-0.83	-0.70	-6.59	1.71		-0.21	-0.22	-0.02	0.00	0.00	
6.83	-0.20	-0.50	-0.56	-5.61	2.17		-0.32	-0.45	-0.25	0.00	0.00	
7.80	0.17	0.05	-0.21	-4.05	2.63		-0.43	-0.69	-0.48	0.00	0.00	
8.78	0.65	0.84	0.38	-2.01	3.11		-0.54	-0.92	-0.72	0.00	0.00	
9.75	1.23	1.85	1.20	0.00	4.02		-0.65	-1.15	-0.95	0.00	0.00	
9.75	1.23	1.85	1.20	0.00	4.02		0.65	1.15	0.95	0.00	0.00	
10.73	0.65	0.84	0.38	-2.01	3.11		0.54	0.92	0.72	0.00	0.00	
11.70	0.17	0.05	-0.21	-4.05	2.63		0.43	0.69	0.48	0.00	0.00	
12.68	-0.20	-0.50	-0.56	-5.61	2.17		0.32	0.45	0.25	0.00	0.00	
13.65	-0.46	-0.83	-0.70	-6.59	1.71		0.21	0.22	0.02	0.00	0.00	
14.63	-0.62	-0.92	-0.60	-7.00	1.26		0.10	-0.02	-0.22	0.00	0.00	
15.60	-0.66	-0.79	-0.27	-6.70	0.80		-0.01	-0.25	-0.45	0.00	0.00	
16.58	-0.61	-0.43	0.28	-5.62	0.34		-0.11	-0.48	-0.69	0.00	0.00	
17.55	-0.44	0.15	1.06	-4.12	0.00		-0.22	-0.72	-0.92	0.00	0.00	
18.53	-0.17	0.97	2.07	-2.62	1.19		-0.33	-0.95	-1.15	0.00	0.00	
19.50	0.21	2.01	3.31	-1.03	3.46		-0.44	-1.19	-1.39	0.00	0.00	

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 2/05

FLOOR SLAB

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	-0.59	-2.28	-4.20	0.73	-0.88		-1.05	-1.23	-1.52	0.00	-0.93	
0.98	0.31	-1.20	-2.83	1.10	-0.17		-0.79	-0.99	-1.29	0.00	-0.71	
1.95	0.96	-0.34	-1.69	1.53	0.00		-0.54	-0.76	-1.06	0.00	-0.49	
2.93	1.36	0.28	-0.77	1.74	0.00		-0.28	-0.53	-0.82	0.00	-0.27	
3.90	1.51	0.68	-0.08	1.76	0.00		-0.03	-0.29	-0.59	0.12	-0.05	
4.88	1.41	0.85	0.38	1.57	0.00		0.23	-0.06	-0.35	0.33	0.00	
5.85	1.06	0.80	0.61	1.17	0.00		0.48	0.18	-0.12	0.55	0.00	
6.83	0.47	0.51	0.61	0.56	-0.02		0.74	0.41	0.11	0.77	0.00	
7.80	-0.38	0.00	0.38	0.00	-0.52		1.00	0.64	0.35	0.99	0.00	
8.78	-1.48	-0.74	-0.07	0.00	-1.57		1.25	0.88	0.58	1.21	0.00	
9.75	-2.82	-1.71	-0.75	0.00	-2.85		1.51	1.11	0.82	1.43	0.00	
9.75	-2.82	-1.71	-0.75	0.00	-2.85		-1.51	-1.11	-0.82	0.00	-1.43	
10.73	-1.48	-0.74	-0.07	0.00	-1.57		-1.25	-0.88	-0.58	0.00	-1.21	
11.70	-0.38	0.00	0.38	0.00	-0.52		-1.00	-0.64	-0.35	0.00	-0.99	
12.68	0.47	0.51	0.61	0.57	0.00		-0.74	-0.41	-0.11	0.00	-0.77	
13.65	1.06	0.80	0.61	1.18	0.00		-0.48	-0.18	0.12	0.00	-0.55	
14.63	1.41	0.85	0.38	1.57	0.00		-0.23	0.06	0.35	0.00	-0.33	
15.60	1.51	0.68	-0.08	1.76	0.00		0.03	0.29	0.59	0.04	-0.12	
16.58	1.36	0.28	-0.77	1.74	0.00		0.28	0.53	0.82	0.26	-0.01	
17.55	0.96	-0.34	-1.69	1.53	0.00		0.54	0.76	1.06	0.48	0.00	
18.53	0.31	-1.20	-2.83	1.10	-0.17		0.79	0.99	1.29	0.70	0.00	
19.50	-0.59	-2.28	-4.20	0.82	-0.81		1.05	1.23	1.52	0.92	0.00	

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 2/05

WALLS

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	0.59	2.28	4.20	-0.73	0.88		0.04	1.63	3.30	-0.42	0.20	
0.98	0.55	0.88	1.36	-0.32	0.68		0.04	1.23	2.50	-0.42	0.20	
1.96	0.52	-0.14	-0.72	0.00	0.49		0.04	0.86	1.75	-0.42	0.20	
2.94	0.48	-0.81	-2.09	0.00	0.62		0.04	0.51	1.06	-0.42	0.20	
3.93	0.44	-1.16	-2.81	-0.07	0.97		0.04	0.20	0.43	-0.42	0.20	
4.91	0.40	-1.20	-2.94	-0.23	1.32		0.04	-0.09	-0.15	-0.42	0.20	
5.89	0.36	-0.98	-2.54	-0.39	1.72		0.04	-0.35	-0.67	-0.42	0.20	
6.87	0.33	-0.52	-1.65	-0.55	2.13		0.04	-0.58	-1.13	-0.42	0.20	
7.85	0.29	0.15	-0.35	-0.71	2.54		0.04	-0.78	-1.53	-0.42	0.20	
8.83	0.25	1.00	1.33	-0.90	2.95		0.04	-0.95	-1.87	-0.42	0.20	
9.81	0.21	2.01	3.31	-1.10	3.36		0.04	-1.10	-2.16	-0.42	0.20	

DMJM HARRIS

Box_Culvert.xls - Results

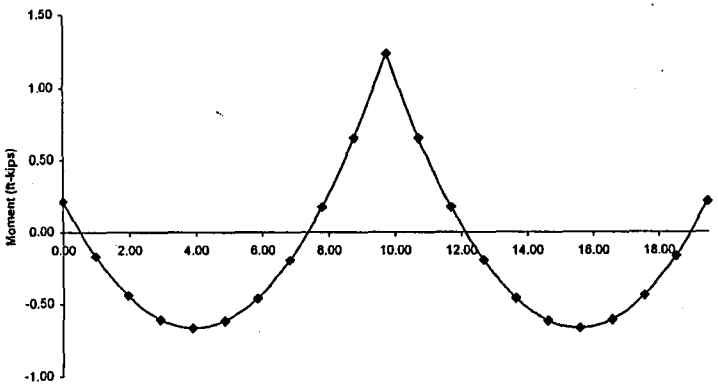
Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 2/05

MOMENT ENVELOPES

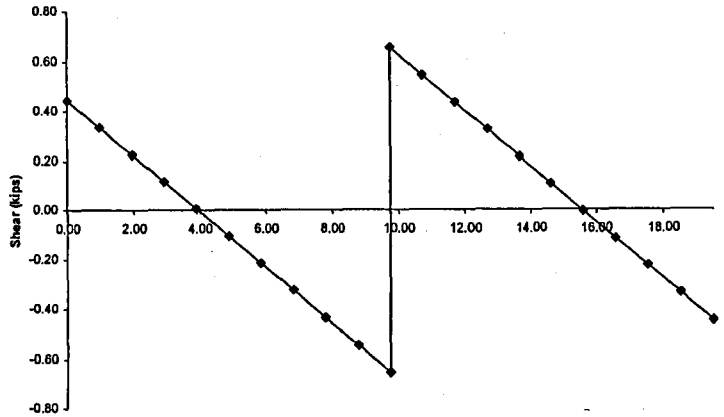
ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
11.87	0.49	-8.14	-2.16	8.15	2.16
5.04	-4.65	-3.64	1.22	3.97	1.17
0.81	-9.32	-0.95	4.11	1.54	-0.26
0.32	-13.47	0.76	5.92	0.91	-2.10
0.52	-16.32	1.85	6.66	1.17	-3.23
1.15	-17.13	2.32	6.36	1.83	-3.80
2.22	-15.99	2.17	4.97	2.93	-3.66
3.81	-13.17	1.24	2.61	4.37	-2.91
6.00	-8.84	-1.62	0.00	6.08	-1.61
8.68	-3.02	-6.29	-2.01	8.45	-0.33
12.74	3.15	-12.08	-4.65	11.87	0.50
12.74	3.15	-12.08	-4.65		
8.68	-3.02	-6.29	-2.01		
6.00	-8.84	-1.62	0.00		
3.81	-13.17	1.26	2.64		
2.22	-15.99	2.17	4.98		
1.15	-17.19	2.32	6.36		
0.52	-16.44	1.85	6.66		
0.32	-13.56	0.76	5.92		
0.81	-9.32	-0.95	4.11		
5.05	-4.65	-3.64	1.22		
12.09	0.66	-7.99	-1.96		

SHEAR ENVELOPES

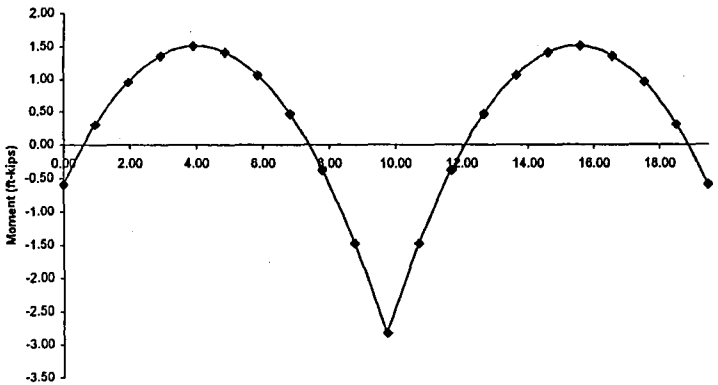
ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
2.38	2.12	-4.98	-3.35	4.78	1.27
1.93	1.67	-3.87	-2.71	3.74	0.75
1.49	1.23	-2.75	-2.07	2.76	0.26
1.04	0.78	-2.02	-1.05	1.87	-0.19
0.59	0.33	-0.91	-0.16	1.04	-0.60
0.15	-0.11	-0.16	0.95	0.37	-1.05
-0.30	-0.56	0.47	2.06	0.03	-1.72
-0.75	-1.01	1.11	3.18	-0.27	-2.32
-1.19	-1.45	1.75	4.29	-0.53	-2.84
-1.64	-1.90	2.38	5.41	-0.75	-3.29
-2.09	-2.35	3.02	6.52	-0.94	-3.66
2.35	2.09	-6.52	-3.02		
1.90	1.64	-5.41	-2.38		
1.45	1.19	-4.29	-1.75		
1.01	0.75	-3.18	-1.11		
0.56	0.30	-2.06	-0.47		
0.11	-0.15	-0.95	0.16		
-0.33	-0.59	0.15	0.89		
-0.78	-1.04	1.03	2.00		
-1.23	-1.49	2.07	2.73		
-1.67	-1.93	2.71	3.85		
-2.12	-2.38	3.35	4.96		



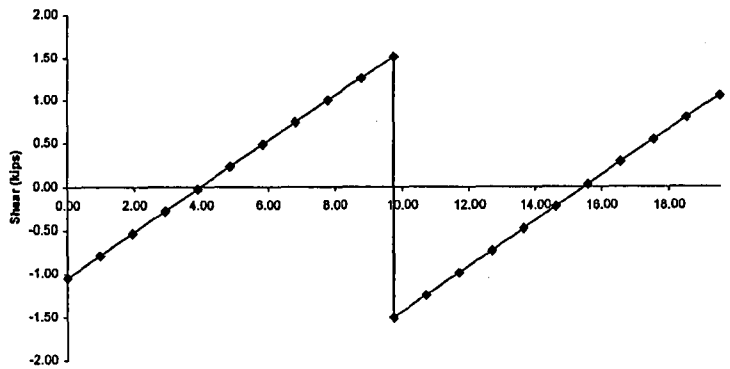
Roof Dead Load Moments



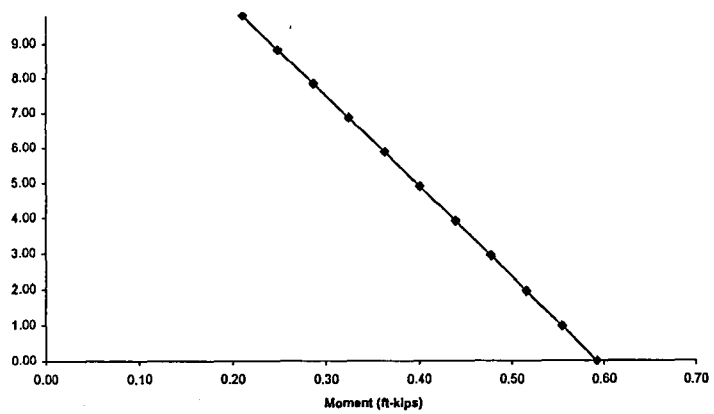
Roof Dead Load Shears



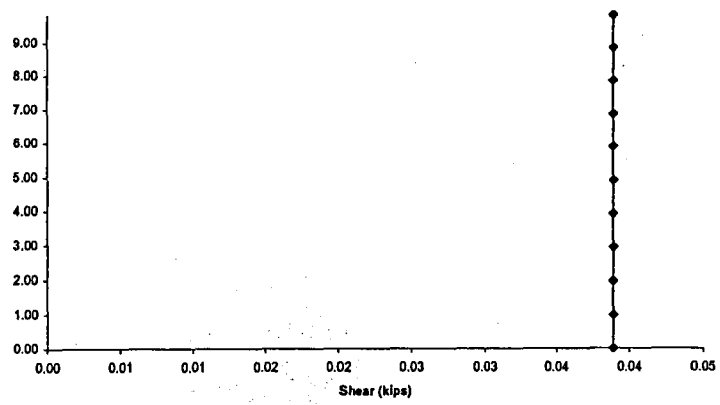
Floor Dead Load Moments



Floor Dead Load Shears



Wall Dead Load Moments



Wall Dead Load Shears

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

JOB NO. 6063

SHEET

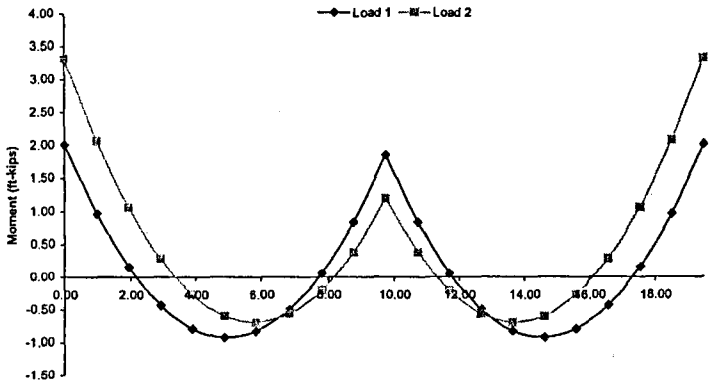
DESIGNED BY: CAL

DATE 1-05

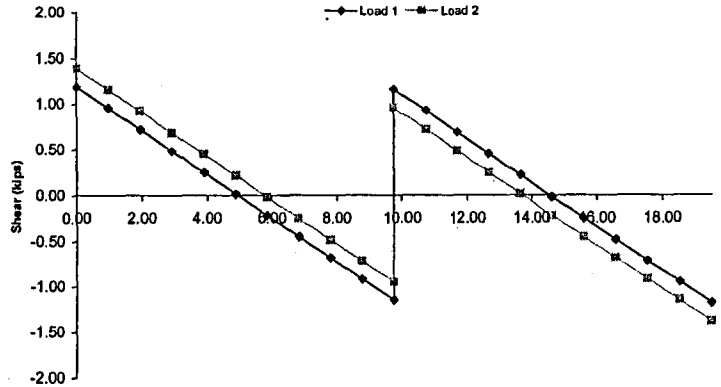
CHECKED BY: SEO

DATE 2-05

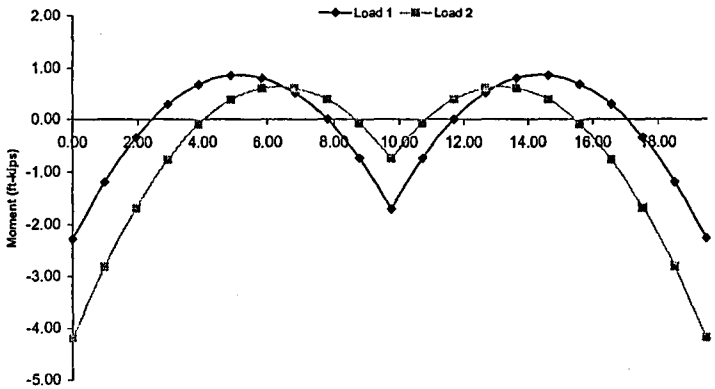
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT



Roof Earth Load Moments



Roof Earth Load Shears



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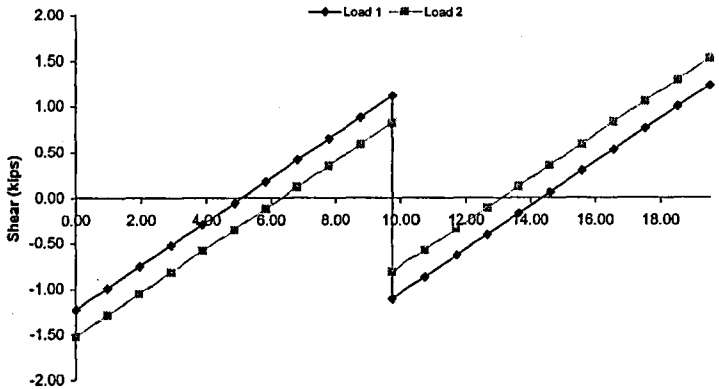
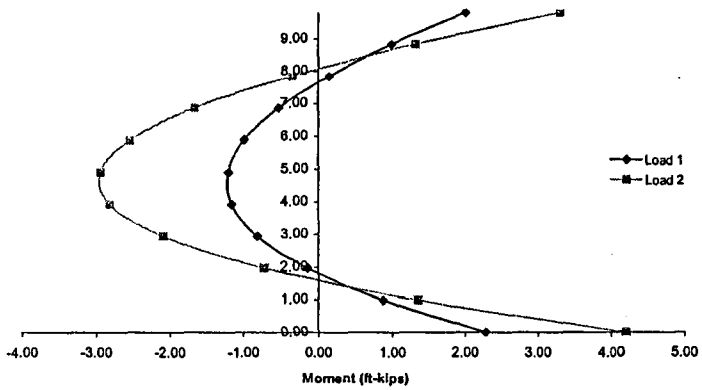
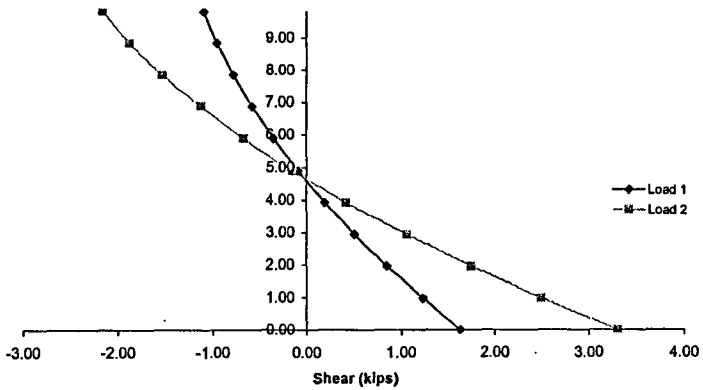


Floor Earth Load Shears



Wall Earth Load Moments



Wall Earth Load Shears

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

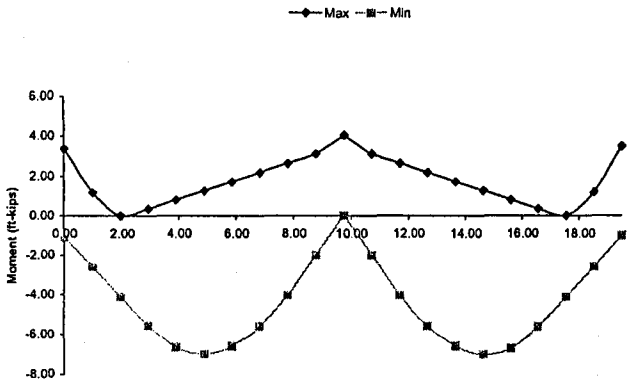
JOB NO. 6063

SHEET

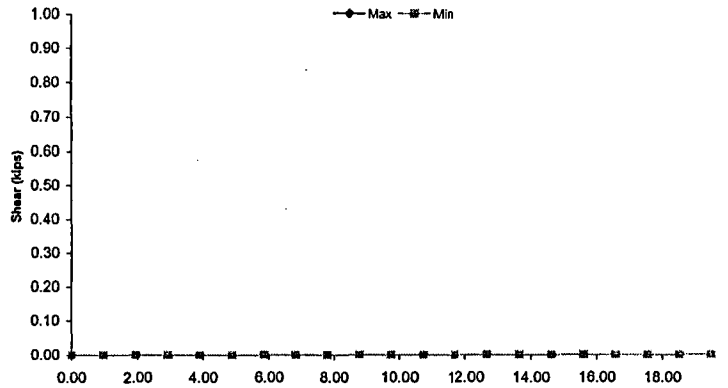
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT

DESIGNED BY: CAL DATE 1-05

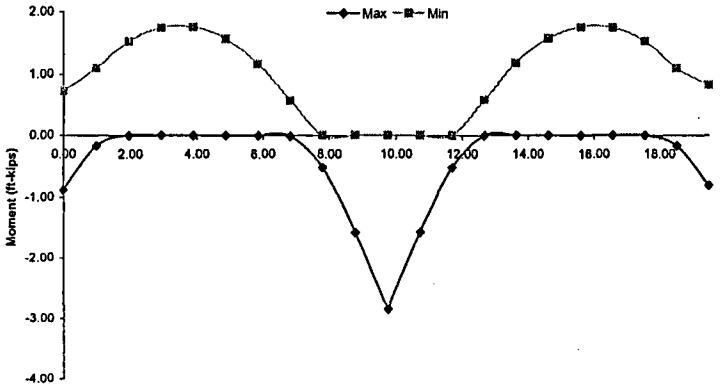
CHECKED BY: SEO DATE 2-05



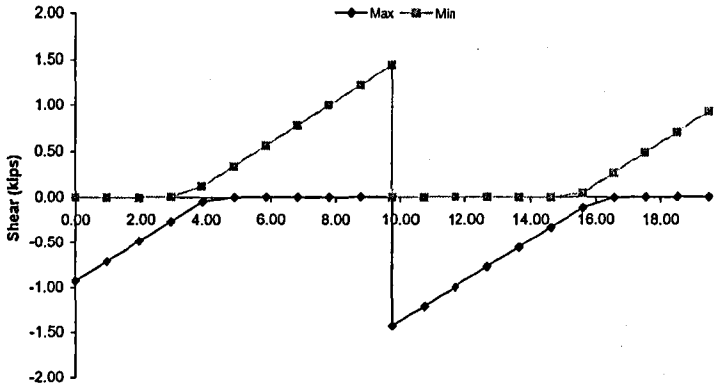
Roof Live Load Moments



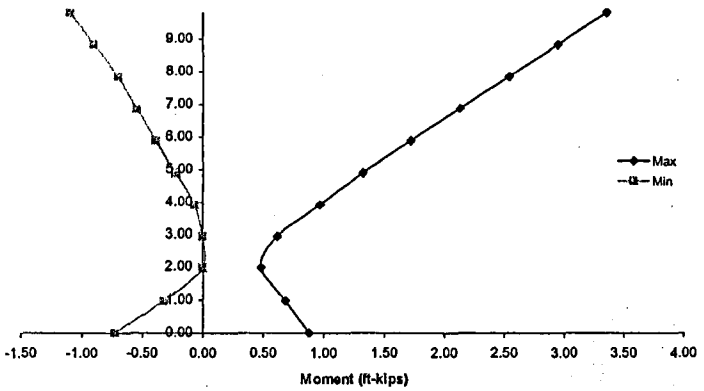
Roof Live Load Shears



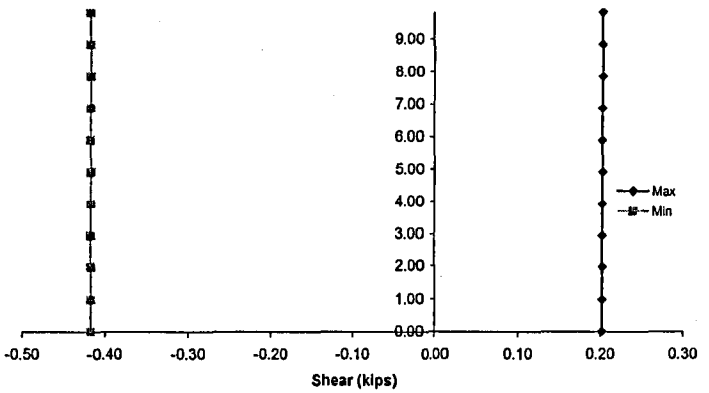
Floor Live Load Moments



Floor Live Load Shears



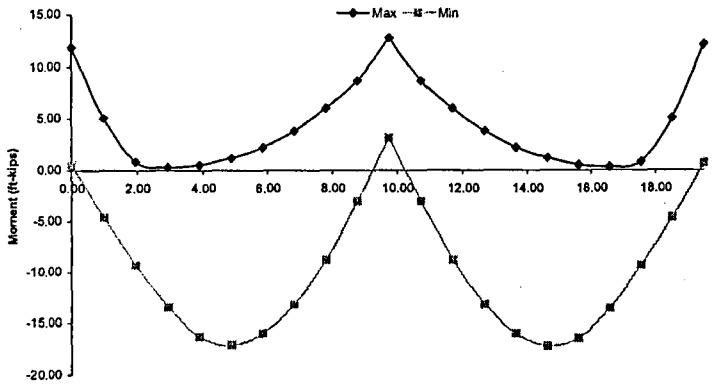
Wall Live Load Moments



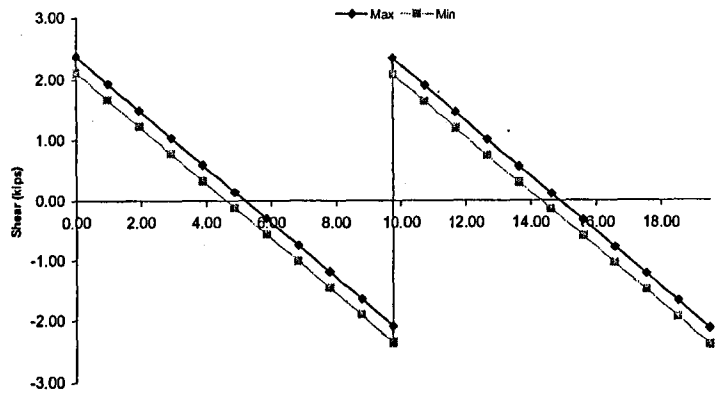
Wall Live Load Shears

DMJM HARRIS

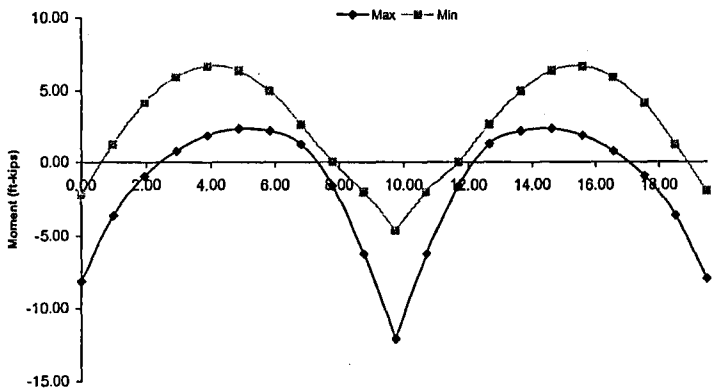
PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C		JOB NO. 6063	SHEET
	DESIGNED BY: CAL	DATE 1-05	
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT	CHECKED BY: SEO	DATE 2-05	



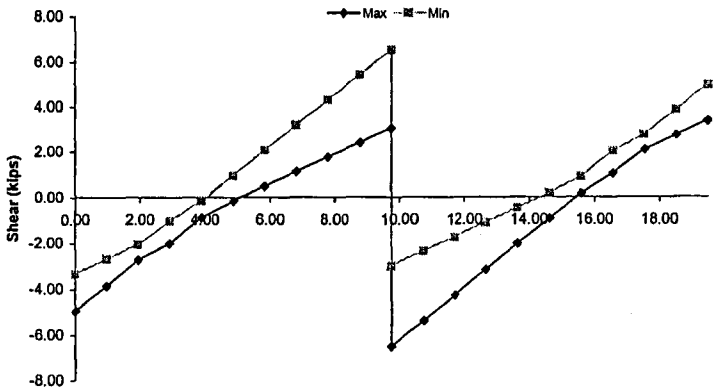
Roof Moment Envelope



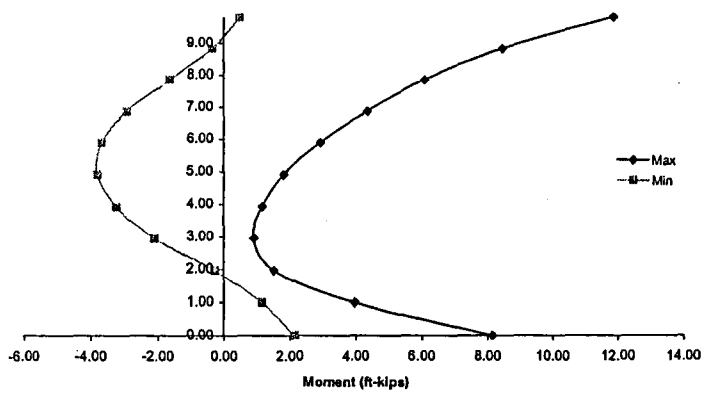
Roof Shear Envelope



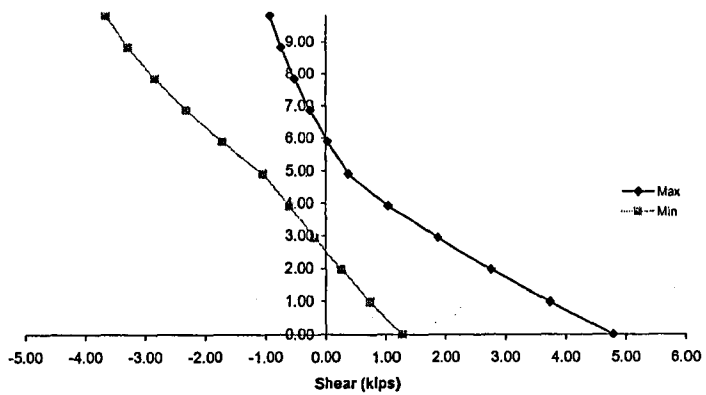
Floor Moment Envelope



Floor Shear Envelope



Wall Moment Envelope



Wall Shear Envelope

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

JOB NO. 6063

SHEET

SUBJECT: 9X9 DOUBLE CELL BOX CULVERT

DESIGNED BY: CAL DATE 1-05

CHECKED BY: SEO DATE 2-05

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 2-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

DESIGN CRITERIA

STRUCTURE DESCRIPTION: 2 - 9 x 9 CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERT

DESIGN SPECIFICATIONS: AASHTO SEVENTEENTH EDITION, ADOT BRIDGE GROUP BRIDGE PRACTICE GUIDELINES, ADOT REINFORCED CONCRETE BOX CULVERT MANUAL

DESIGN LOADS:

LIVE LOAD:	HS20 - 44
EARTH PRESSURES:	120 PCF VERT & 30 PCF HORIZ
OR	120 PCF VERT & 60 PCF HORIZ

DESIGN STRESSES: f'c = 3500 psi
fy = 60 ksi

DESIGN METHOD : ULTIMATE STRENGTH DESIGN
GROUP X : 1.3 [D + E + 1.67 (L+I)]

ASSUMED MEMBER THICKNESSES:

ROOF = 9 in.
INVERT = 10.5 in.
EXT WALL = 9 in.
INT WALL = 9 in.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 2-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

PRESSURES:

DEAD LOAD:

ROOF: 0.75 * 0.15 kcf = 0.11 ksf

INVERT:

WALLS: $\frac{.15 * [2(9) + 1(9)](9)/12}{(2(9) + [2(9) + 1(9)]/12}$ = 0.15 ksf

ROOF: = 0.11 ksf

0.26 ksf

EARTH :

ROOF: 10 * 0.12 kcf = 1.20 ksf

INVERT: = 1.20 ksf

WALLS:

LOADING 1, 30 pcf

pt : [10 + 2 + .5 * 9 / 12] * 0.03 = 0.37 ksf

ΔP : [9 + .5 (9 + 10.5) / 12] * 0.03 = 0.29 ksf

LOADING 2, 60 pcf

pt : 0.37 (60 / 30) = 0.74 ksf

ΔP : 0.29 (60 / 30) = 0.59 ksf

LIVE LOAD:

ROOF: PER AASHTO 6.4, LIVE LOADS UNIFORMLY DISTRIBUTED

IMPACT: = 0 %

WHEEL LOAD: = 0.2 ksf

INVERT: PER AASHTO 6.4, LIVE LOADS UNIFORMLY DISTRIBUTED

WHEEL LOAD: = 0.2 ksf

MEMBER LENGTHS:

ROOF & INVERT : 9 + 9 / 12 = 9.75 ft

WALLS : 9 + .5 * (9 + 10.5) / 12 = 9.81 ft

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 2-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

SHEAR DESIGN:

REQUIRED DEPTH

$\phi vc > V_U / bd$

$d_{REQ'D} > V_U / b\ \phi vc$

ROOF:

$\phi vc = \phi [2.14 \sqrt{f'c} + 4600 \rho (Vu\ d / Mu)]$

$= 151.2$ psi

$V_U = 9.6$ kips

$M_U = 10.9$ ft-kips

$d_{REQ'D} = 5.3$ in < = 6.6 in OK

INVERT:

$\phi vc = \phi [2.14 \sqrt{f'c} + 4600 \rho (Vu\ d / Mu)]$

$= 149.2$ psi

$V_U = 10.7$ kips

$M_U = 13.3$ ft-kips

$d_{REQ'D} = 6$ in < = 7.1 in OK

WALL:

$\phi vc = \phi [1.9 \sqrt{f'c} + 2500 \rho (Vu\ d / Mu)]$

$= 127.2$ psi

$V_U = 5.7$ kips

$M_U = 5.8$ ft-kips

$d_{REQ'D} = 3.7$ in < = 6.6 in OK

MOMENT DESIGN:

ROOF:

+ MOMENT

Mu = 10.43 ft-kips
d = 7.13 in
F = 0.0508
Ku = 205.5
au = 4.3
As = 0.34 sq in

- MOMENT
@ EXT WALL

Mu = 9.15 ft-kips
d = 6.63 in
F = 0.0439
Ku = 208.5
au = 4.3
As = 0.32 sq in

@ INT WALL

Mu = 20.64 ft-kips
d = 6.63 in
F = 0.0439
Ku = 470.2
au = 4.1
As = 0.77 sq in

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 2-05
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

MOMENT DESIGN (CONT):

INVERT:

+ MOMENT

Mu = 9.58 ft-kips
d = 8.13 in
F = 0.066
Ku = 145.2
au = 4.4
As = 0.27 sq in

- MOMENT
@ EXT WALL

Mu = 9.01 ft-kips
d = 7.13 in
F = 0.0508
Ku = 177.4
au = 4.4
As = 0.29 sq in

@ INT WALL

Mu = 18.76 ft-kips
d = 7.13 in
F = 0.0508
Ku = 369.5
au = 4.2
As = 0.63 sq in

WALL:

+ MOMENT

Mu = 4.43 ft-kips
d = 6.63 in
F = 0.0439
Ku = 101.0
au = 4.4
As = 0.15 sq in

- MOMENT
@ SUPPORT

Mu = 10.48 ft-kips
d = 6.63 ft-kips
F = 0.0439
Ku = 238.9
au = 4.3
As = 0.37 sq in

@ MIDSPAN

Mu = 0.74 ft-kips
d = 6.63 in
F = 0.0439
Ku = 16.9
au = 4.5
As = 0.02 sq in

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 1/05

ROOF SLAB

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	0.21	6.05	8.56			0.58	0.44	5.32	5.70			0.81
0.98	-0.17	1.43	3.57			-0.11	0.33	4.15	4.53			0.61
1.95	-0.44	-2.04	-0.28			-0.62	0.22	2.98	3.36			0.42
2.93	-0.61	-4.37	-2.99			-0.94	0.11	1.81	2.19			0.23
3.90	-0.66	-5.57	-4.56			-1.07	0.01	0.64	1.02			0.04
4.88	-0.62	-5.62	-4.99			-1.02	-0.10	-0.53	-0.15			-0.15
5.85	-0.46	-4.53	-4.28			-0.78	-0.21	-1.70	-1.32			-0.34
6.83	-0.20	-2.30	-2.42			-0.35	-0.32	-2.87	-2.49			-0.53
7.80	0.17	1.07	0.57			0.26	-0.43	-4.04	-3.66			-0.72
8.78	0.65	5.58	4.70			1.06	-0.54	-5.21	-4.83			-0.91
9.75	1.23	11.24	9.98			2.04	-0.65	-6.38	-6.00			-1.11
9.75	1.23	11.24	9.98			2.04	0.65	6.38	6.00			1.11
10.73	0.65	5.58	4.70			1.06	0.54	5.21	4.83			0.91
11.70	0.17	1.07	0.57			0.26	0.43	4.04	3.66			0.72
12.68	-0.20	-2.30	-2.42			-0.35	0.32	2.87	2.49			0.53
13.65	-0.46	-4.53	-4.28			-0.78	0.21	1.70	1.32			0.34
14.63	-0.62	-5.62	-4.99			-1.02	0.10	0.53	0.15			0.15
15.60	-0.66	-5.57	-4.56			-1.07	-0.01	-0.64	-1.02			-0.04
16.58	-0.61	-4.37	-2.99			-0.94	-0.11	-1.81	-2.19			-0.23
17.55	-0.44	-2.04	-0.28			-0.62	-0.22	-2.98	-3.36			-0.42
18.53	-0.17	1.43	3.57			-0.11	-0.33	-4.15	-4.53			-0.61
19.50	0.21	6.05	8.56			0.58	-0.44	-5.32	-5.70			-0.81

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
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FLOOR SLAB

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	-0.59	-5.31	-8.78			-0.30	-1.05	-5.20	-5.74			-0.76
0.98	0.31	-0.80	-3.75			0.35	-0.79	-4.03	-4.57			-0.57
1.95	0.96	2.56	0.13			0.81	-0.54	-2.86	-3.40			-0.38
2.93	1.36	4.78	2.87			1.09	-0.28	-1.69	-2.23			-0.19
3.90	1.51	5.86	4.47			1.18	-0.03	-0.52	-1.06			0.00
4.88	1.41	5.80	4.94			1.09	0.23	0.65	0.11			0.19
5.85	1.06	4.60	4.26			0.81	0.48	1.82	1.28			0.38
6.83	0.47	2.26	2.44			0.34	0.74	2.99	2.45			0.57
7.80	-0.38	-1.22	-0.53			-0.31	1.00	4.16	3.62			0.77
8.78	-1.48	-5.84	-4.63			-1.15	1.25	5.33	4.79			0.96
9.75	-2.82	-11.61	-9.87			-2.18	1.51	6.50	5.96			1.15
9.75	-2.82	-11.61	-9.87			-2.18	-1.51	-6.50	-5.96			-1.15
10.73	-1.48	-5.84	-4.63			-1.15	-1.25	-5.33	-4.79			-0.96
11.70	-0.38	-1.22	-0.53			-0.31	-1.00	-4.16	-3.62			-0.77
12.68	0.47	2.26	2.44			0.34	-0.74	-2.99	-2.45			-0.57
13.65	1.06	4.60	4.26			0.81	-0.48	-1.82	-1.28			-0.38
14.63	1.41	5.80	4.94			1.09	-0.23	-0.65	-0.11			-0.19
15.60	1.51	5.86	4.47			1.18	0.03	0.52	1.06			0.00
16.58	1.36	4.78	2.87			1.09	0.28	1.69	2.23			0.19
17.55	0.96	2.56	0.13			0.81	0.54	2.86	3.40			0.38
18.53	0.31	-0.80	-3.75			0.35	0.79	4.03	4.57			0.57
19.50	-0.59	-5.31	-8.78			-0.30	1.05	5.20	5.74			0.76

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
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WALLS

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	0.59	5.31	8.78			0.30	0.04	2.71	5.59			-0.03
0.98	0.55	2.96	3.92			0.33	0.04	2.07	4.31			-0.03
1.96	0.52	1.23	0.29			0.35	0.04	1.46	3.09			-0.03
2.94	0.48	0.09	-2.17			0.38	0.04	0.88	1.93			-0.03
3.93	0.44	-0.50	-3.52			0.41	0.04	0.33	0.83			-0.03
4.91	0.40	-0.56	-3.81			0.44	0.04	-0.20	-0.22			-0.03
5.89	0.36	-0.13	-3.11			0.47	0.04	-0.69	-1.21			-0.03
6.87	0.33	0.78	-1.46			0.49	0.04	-1.16	-2.14			-0.03
7.85	0.29	2.13	1.07			0.52	0.04	-1.59	-3.01			-0.03
8.83	0.25	3.90	4.43			0.55	0.04	-2.00	-3.83			-0.03
9.81	0.21	6.05	8.56			0.58	0.04	-2.38	-4.58			-0.03

DMJM HARRIS

Box_Culvert.xls - Results

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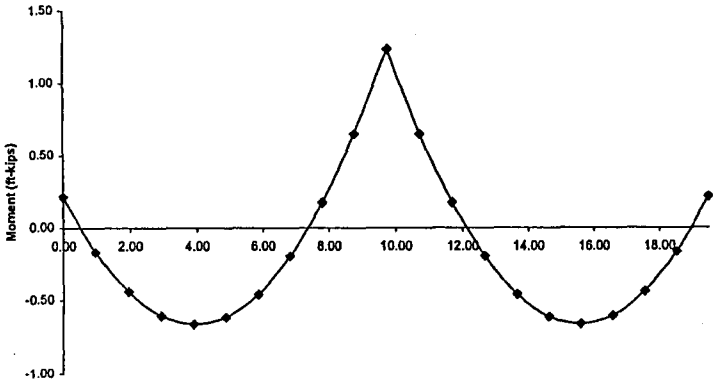
MOMENT ENVELOPES

ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
12.65	8.13	-12.18	-8.32	12.83	7.67
4.42	1.39	-3.72	-0.64	6.53	4.57
-0.94	-4.57	3.18	4.57	3.05	1.05
-4.68	-8.51	7.87	7.98	1.57	-2.20
-6.79	-10.43	10.35	9.58	0.81	-4.00
-7.29	-10.32	10.62	9.38	0.74	-4.43
-6.16	-8.18	8.67	7.37	1.32	-3.57
-3.25	-4.18	4.29	3.77	2.51	-1.48
2.18	0.96	-2.08	-1.86	4.28	1.76
10.39	6.96	-9.52	-10.44	7.27	5.39
20.64	14.57	-18.76	-21.23	12.65	8.13
20.64	14.57	-18.76	-21.23		
10.39	6.96	-9.52	-10.44		
2.18	0.96	-2.08	-1.86		
-3.25	-4.18	4.29	3.77		
-6.16	-8.18	8.67	7.37		
-7.29	-10.32	10.62	9.38		
-6.79	-10.43	10.35	9.58		
-4.68	-8.51	7.87	7.98		
-0.94	-4.57	3.18	4.57		
4.42	1.39	-3.72	-0.64		
12.65	8.13	-12.18	-8.32		

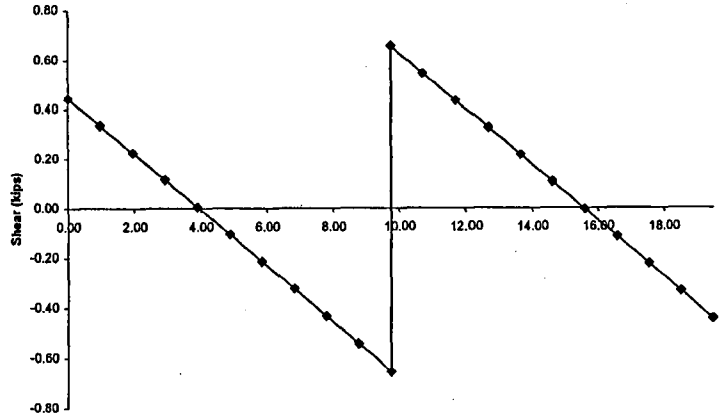
SHEAR ENVELOPES

ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
9.74	7.49	-8.83	-9.79	7.32	3.51
7.66	5.83	-6.97	-7.52	5.66	2.68
5.58	4.16	-5.12	-5.25	4.07	1.89
3.51	2.50	-3.26	-2.98	2.56	1.13
1.43	0.84	-1.41	-0.72	1.13	0.41
-0.33	-1.15	0.86	1.14	-0.20	-0.29
-1.99	-3.23	3.13	2.99	-0.85	-1.58
-3.65	-5.31	5.40	4.84	-1.45	-2.79
-5.32	-7.39	7.67	6.70	-2.02	-3.92
-6.98	-9.47	9.94	8.55	-2.55	-4.98
-8.64	-11.55	12.20	10.41	-3.04	-5.97
11.55	8.64	-10.41	-12.20		
9.47	6.98	-8.55	-9.94		
7.39	5.32	-6.70	-7.67		
5.31	3.65	-4.84	-5.40		
3.23	1.99	-2.99	-3.13		
1.15	0.33	-1.14	-0.86		
-0.84	-1.43	0.72	1.41		
-2.50	-3.51	2.98	3.26		
-4.16	-5.58	5.25	5.12		
-5.83	-7.66	7.52	6.97		
-7.49	-9.74	9.79	8.83		

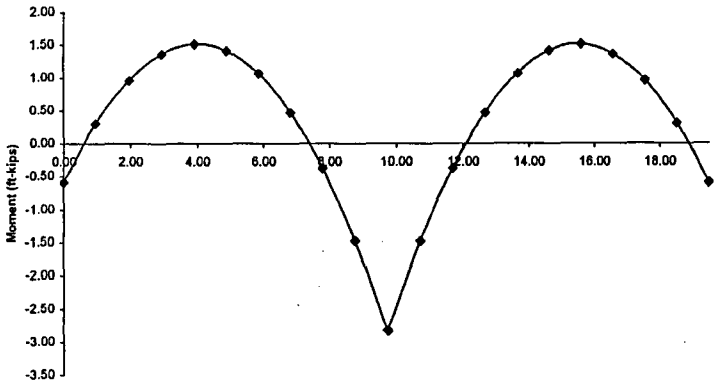
DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT		DESIGNED BY: CAL	DATE 2-05
		CHECKED BY: SEO	DATE 2-05



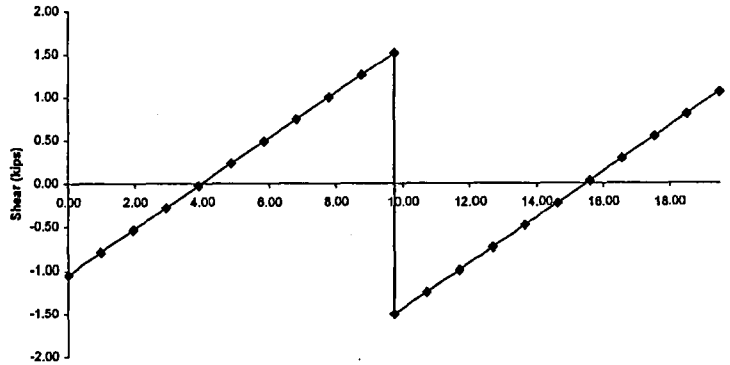
Roof Dead Load Moments



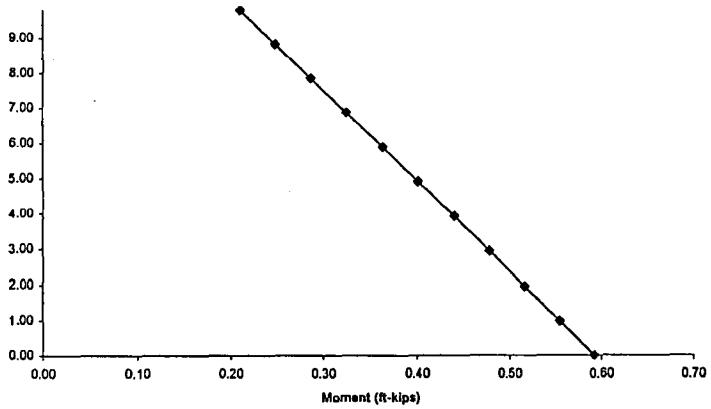
Roof Dead Load Shears



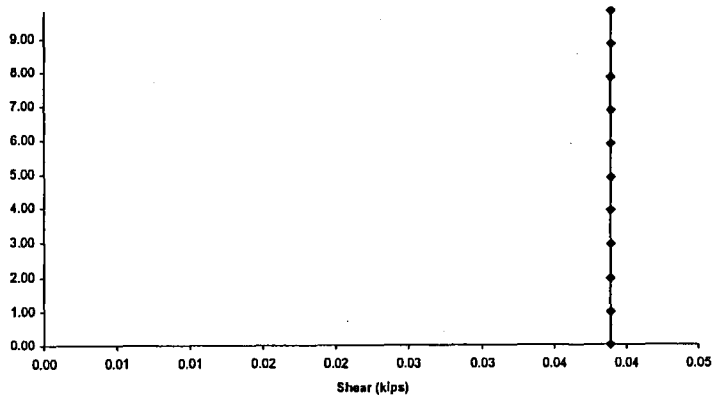
Floor Dead Load Moments



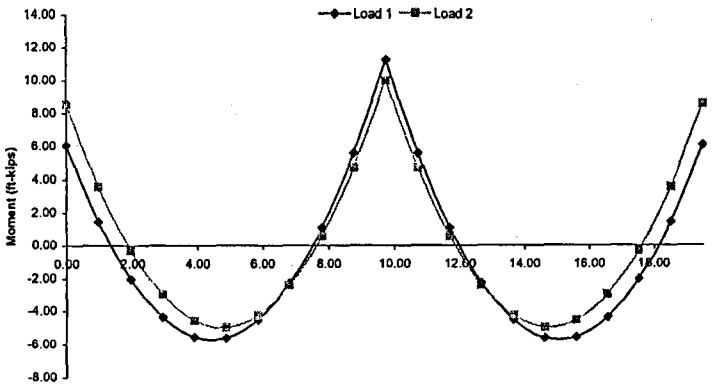
Floor Dead Load Shears



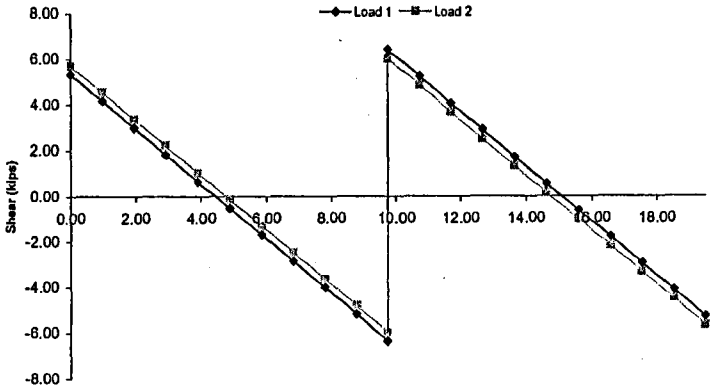
Wall Dead Load Moments



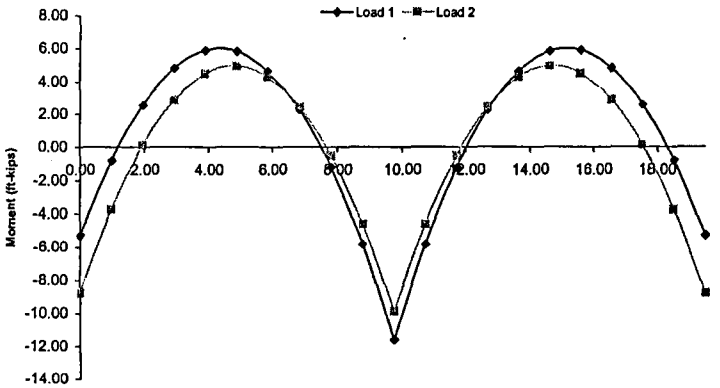
Wall Dead Load Shears



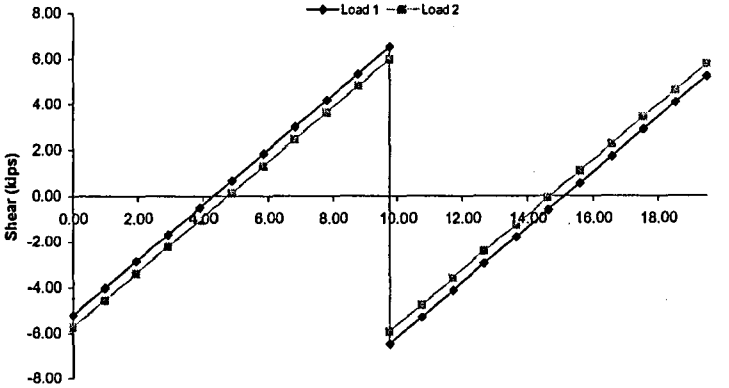
Roof Earth Load Moments



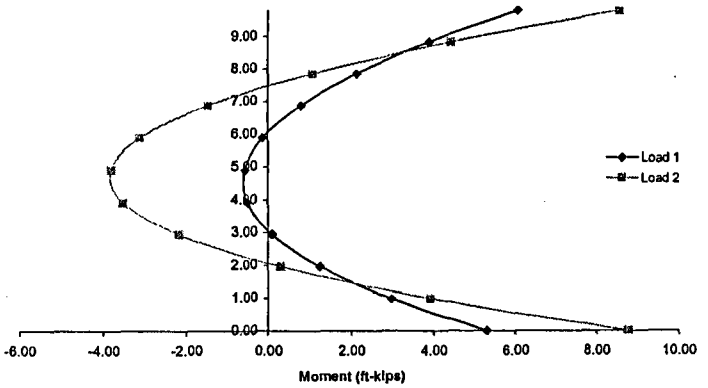
Roof Earth Load Shears



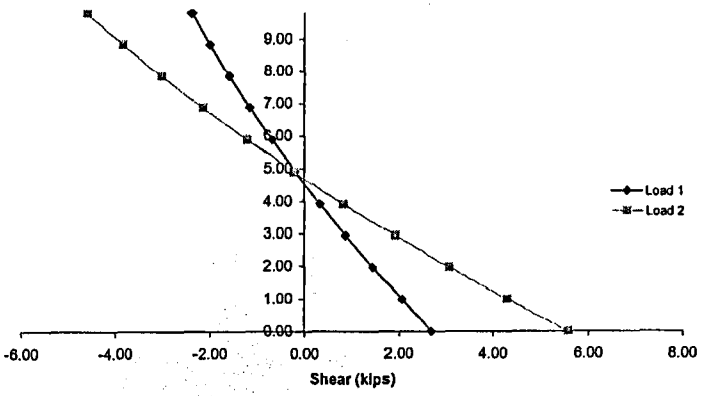
Floor Earth Load Moments



Floor Earth Load Shears



Wall Earth Load Moments



Wall Earth Load Shears

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

JOB NO. 6063

SHEET

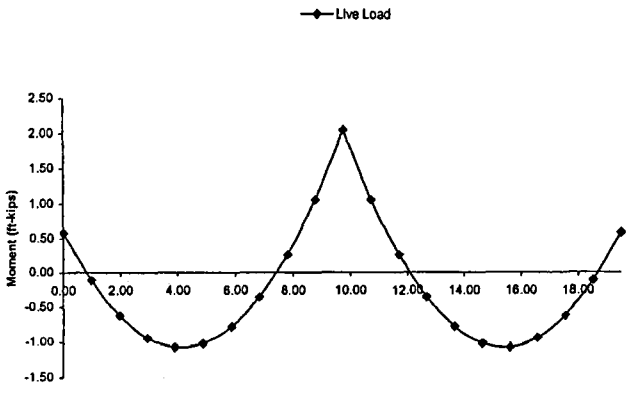
DESIGNED BY: CAL

DATE 2-05

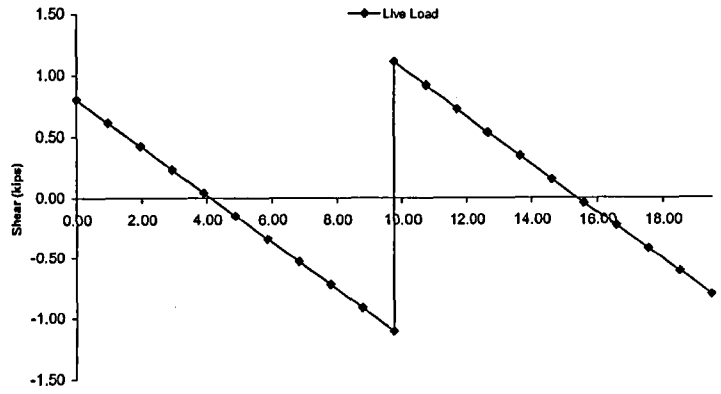
CHECKED BY: SEO

DATE 2-05

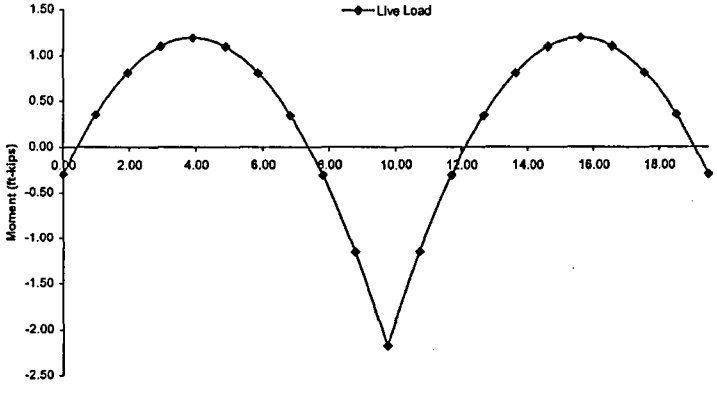
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT



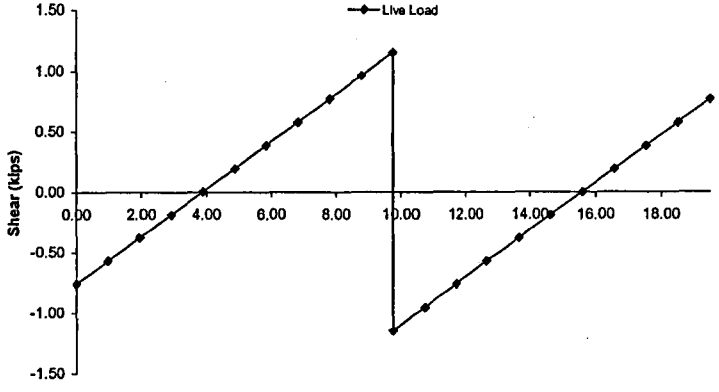
Roof Live Load Moments



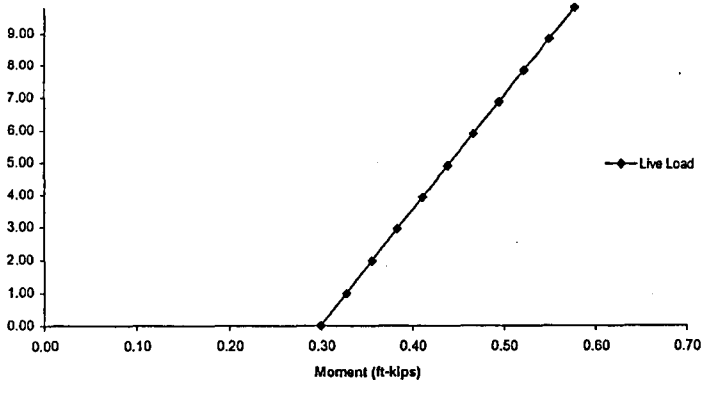
Roof Live Load Shears



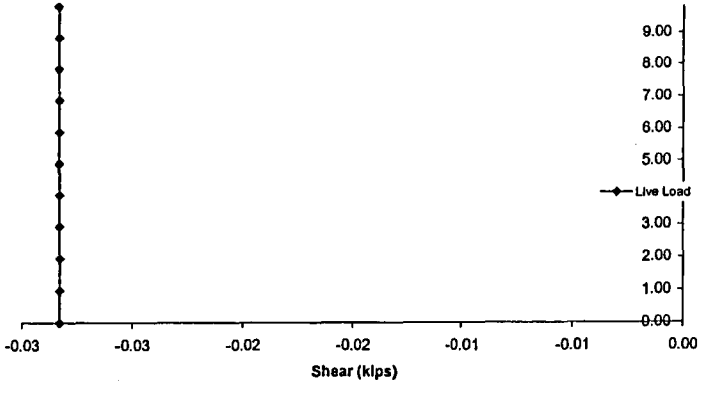
Floor Live Load Moments



Floor Live Load Shears



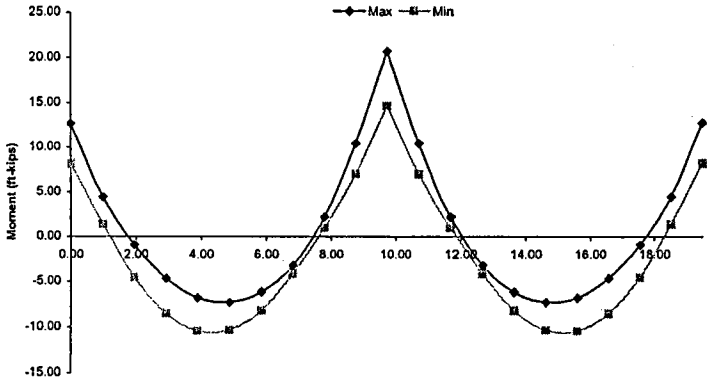
Wall Live Load Moments



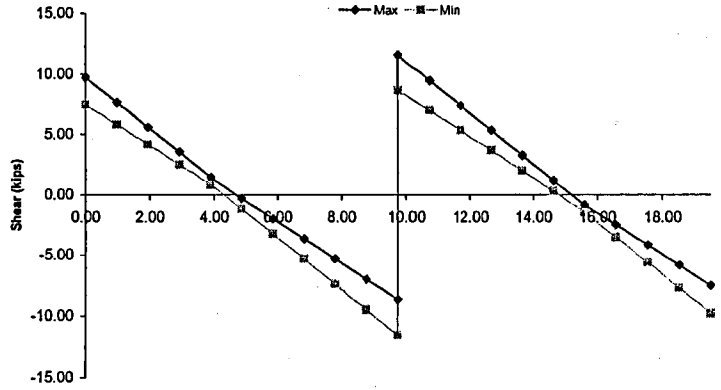
Wall Live Load Shears

DMJM HARRIS

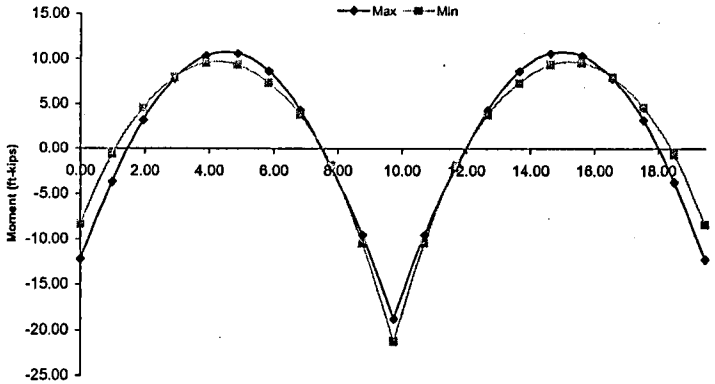
PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C		JOB NO. 6063	SHEET
	DESIGNED BY: CAL	DATE 2-05	
SUBJECT: 9X9 DOUBLE CELL BOX CULVERT	CHECKED BY: SEO	DATE 2-05	



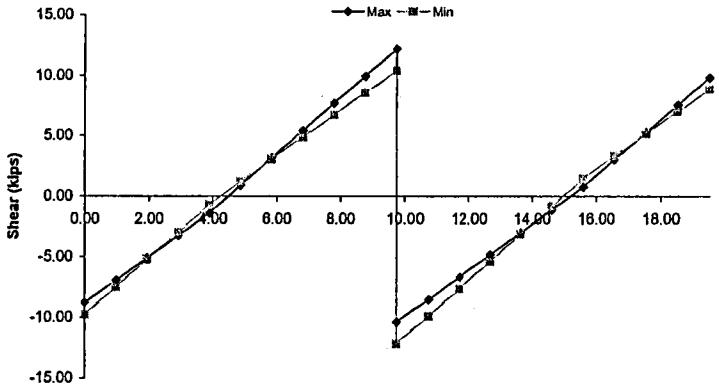
Roof Moment Envelope



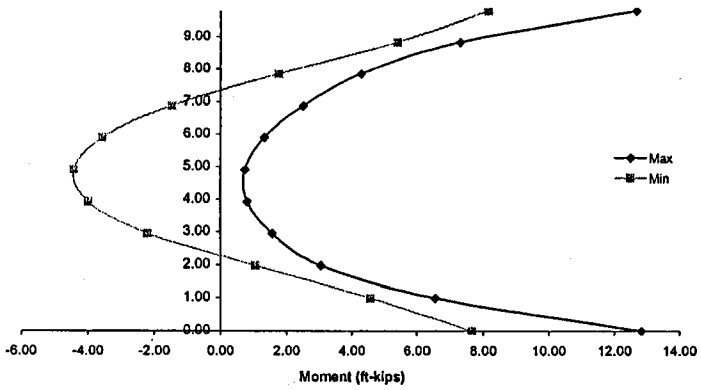
Roof Shear Envelope



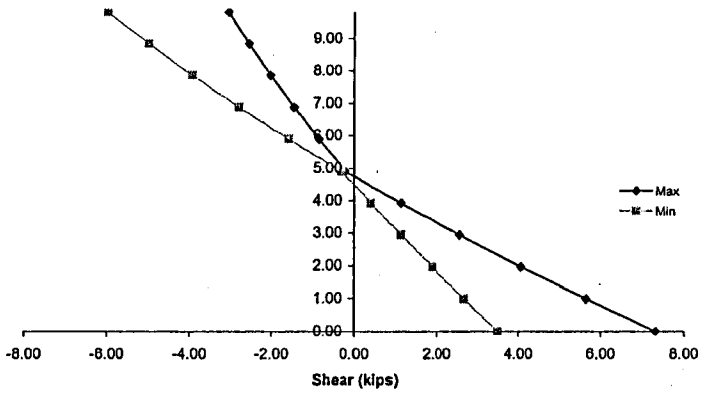
Floor Moment Envelope



Floor Shear Envelope



Wall Moment Envelope



Wall Shear Envelope

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

JOB NO. 6063

SHEET

DESIGNED BY : CAL

DATE 2-05

CHECKED BY: SEO

DATE 2-05

SUBJECT: 9X9 DOUBLE CELL BOX CULVERT

DMJM HARRIS	PROJECT: Bethany Home Outfall Channel - Reach B & C	JOB NO. 6063.0018	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9x9 Double Cell Box Culvert		CHECKED BY: SEO	DATE 1-05

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad psf := \frac{lbf}{ft^2}$

$wconc := 150pcf$ weight of concrete

Per comments received from the Maricopa Flood Control District, investigate positive moment cutoff of reinforcement in the top slab. Also, investigate moment cutoff for alternating bars in the walls as needed. Floor slab reinforcement, as commented by the District, will utilize a mirror-image of the top slab reinforcement - check that this reinforcement pattern works for the floor slab.

As already calculated:

Roof maximum positive moment requires 0.60 in^2/ft (2' of fill controls) **use #5 @ 6"**
Roof maximum negative moment (at interior wall) requires 0.74 in^2/ft (10' of fill controls) **use #6 @ 6"**

By inspection, roof moments control over invert moments.

Wall maximum moment requires 0.38 in^2/ft at the supports (2' of fill controls) **use #5 @ 6"** - midspan and positive moments are controlled by minimum temperature and shrinkage requirements.

Utilize LFD design

$f_c := 3500psi$ $\quad f_y := 60000psi$ $\quad b := 12in$

$d_{wallandroof5} := 9in - 2in - \frac{1}{2}\cdot\left(\frac{5}{8}in\right)$ $\quad d_{wallandroof5} = 6.69\,in$

$d_{wallandroof6} := 9in - 2in - \frac{1}{2}\cdot\left(\frac{6}{8}in\right)$ $\quad d_{wallandroof6} = 6.62\,in$

DMJM HARRIS	PROJECT: Bethany Home Outfall Channel - Reach B & C	JOB NO. 6063.0018	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9x9 Double Cell Box Culvert		CHECKED BY: SEO	DATE 1-05

Calculate moment capacity of #6 @ 12" and determine cutoff location for negative steel.

$A_{check} := 0.44in^2$

$a := \frac{A_{check} \cdot f_y}{0.85 \cdot f_c \cdot b}$ $\quad a = 0.74\,in$

$\Phi M_n := 0.9 \cdot A_{check} \cdot f_y \cdot \left(d_{wallandroof6} - \frac{a}{2}\right)$ $\quad \Phi M_n = 12.39\,kips \cdot ft$

Based on the moment envelope diagrams, #6 @ 6" could be terminated approximately 0.8' away from support.

$barextend := \max\left(15 \cdot \frac{6}{8}\,in, d_{wallandroof6}, \frac{1}{20} \cdot 9ft\right)$ $\quad barextend = 11.25\,in$

$l_d := \frac{\frac{0.04 \cdot 0.44in^2 \cdot f_y}{psi \cdot in}}{\sqrt{\frac{f_c}{psi}}}$ $\quad l_d = 17.85\,in$

Based on the development length needed and the length of bar that needs to extend beyond the point where reinforcement is not needed, provide a **5'-0" long bar @ 12" alternating with a # 6 bar that extends to a hooked bar at the corners (1'-6" lap). At this location, the negative moment does not control.**

DMJM HARRIS	PROJECT: Bethany Home Outfall Channel - Reach B & C	JOB NO. 6063.0018	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 9x9 Double Cell Box Culvert		CHECKED BY: SEO	DATE 1-05

Calculate moment capacity of #5 @ 12" and determine cutoff location for positive steel.

$A_{check} := 0.31 in^2$

$a := \frac{A_{check} \cdot f_y}{0.85 \cdot f_c \cdot b}$ $\quad a = 0.52 in$

$\Phi M_n := 0.9 \cdot A_{check} \cdot f_y \cdot \left(d_{wallandroof5} - \frac{a}{2}\right)$ $\quad \Phi M_n = 8.97 kips \cdot ft$

Based on the moment envelope diagrams, #5 @ 6" could be terminated at 1.88' away from exterior wall and 1.95' away from interior wall.

$barextend := \max\left(15 \cdot \frac{5}{8} in, d_{wallandroof5}, \frac{1}{20} \cdot 9ft\right)$ $\quad barextend = 9.38 in$

$l_d := \frac{\frac{0.04 \cdot 0.31 in^2 \cdot f_y}{psi \cdot in}}{\sqrt{\frac{f_c}{psi}}}$ $\quad l_d = 12.58 in$

Based on this, the bar could be terminated 0.8' +/- away from CL exterior wall. Therefore, terminate the bar 0'-5" away from face of wall. For the interior wall, the bar could be terminated approx 0.90' away from CL (or 6" away from face of wall) The bar can be 8'-1".
Make the bar 8'-2" long and space it 0'-5" away from the face of wall.

For wall steel, this same moment capacity could be terminated less than 10" away from support. **Utilize 3'-0" hooks on into wall and slab.**

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

DESIGN CRITERIA

STRUCTURE DESCRIPTION: 2 - 8 x 7 CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERT

DESIGN SPECIFICATIONS: AASHTO SEVENTEENTH EDITION, ADOT BRIDGE GROUP BRIDGE PRACTICE GUIDELINES, ADOT REINFORCED CONCRETE BOX CULVERT MANUAL

DESIGN LOADS:

LIVE LOAD:	HS20 - 44
EARTH PRESSURES:	120 PCF VERT & 30 PCF HORIZ
OR	120 PCF VERT & 60 PCF HORIZ

DESIGN STRESSES: f'c = 3500 psi
fy = 60 ksi

DESIGN METHOD : ULTIMATE STRENGTH DESIGN
GROUP X : 1.3 [D + E + 1.67 (L+I)]

ASSUMED MEMBER THICKNESSES:

ROOF = 9 in.
INVERT = 11 in.
EXT WALL = 9 in.
INT WALL = 9 in.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

PRESSURES:

DEAD LOAD:

ROOF: 0.75 * 0.15 kcf = 0.11 ksf

INVERT:

WALLS: $\frac{.15 * [2(9) + 1(9)](7)/12}{(2(8) + [2(9) + 1(9)]/12}$ = 0.13 ksf

ROOF: = 0.11 ksf

0.24 ksf

EARTH :

ROOF: 18 * 0.12 kcf = 2.16 ksf

INVERT: = 2.16 ksf

WALLS:

LOADING 1, 30 pcf

pt : [18 + 2 + .5 * 9 / 12] * 0.03 = 0.61 ksf

ΔP : [7 + .5 (9 + 11) / 12] * 0.03 = 0.24 ksf

LOADING 2, 60 pcf

pt : 0.61 (60 / 30) = 1.22 ksf

ΔP : 0.24 (60 / 30) = 0.47 ksf

LIVE LOAD:

ROOF: PER AASHTO 6.4, LIVE LOAD EFFECTS MAY BE NEGLECTED

IMPACT: = 0 %

WHEEL LOAD: = 0 ksf

INVERT: PER AASHTO 6.4, LIVE LOAD EFFECTS MAY BE NEGLECTED

WHEEL LOAD: = 0 ksf

MEMBER LENGTHS:

ROOF & INVERT : 8 + 9 / 12 = 8.75 ft

WALLS : 7 + .5 * (9 + 11) / 12 = 7.83 ft

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

SHEAR DESIGN:

REQUIRED DEPTH

$\phi vc > V_U / bd$

$d_{REQ'D} > V_U / b\ \phi vc$

ROOF:

$\phi vc = \phi [\ 2.14 \sqrt{f'c} + 4600\ \rho\ (Vu\ d / Mu)\ ]$

$= 156$ psi

$V_U = 11.7$ kips

$M_U = 11.1$ ft-kips

$d_{REQ'D} = 6.2$ in $<= 6.6$ in OK

INVERT:

$\phi vc = \phi [\ 2.14 \sqrt{f'c} + 4600\ \rho\ (Vu\ d / Mu)\ ]$

$= 146.6$ psi

$V_U = 12.6$ kips

$M_U = 17.8$ ft-kips

$d_{REQ'D} = 7.2$ in $<= 7.6$ in OK

WALL:

$\phi vc = \phi [\ 1.9 \sqrt{f'c} + 2500\ \rho\ (Vu\ d / Mu)\ ]$

$= 124.4$ psi

$V_U = 5.7$ kips

$M_U = 7.3$ ft-kips

$d_{REQ'D} = 3.8$ in $<= 6.6$ in OK

MOMENT DESIGN:

ROOF:

+ MOMENT

Mu = 11.67 ft-kips
d = 7.13 in
F = 0.0508
Ku = 230.0
au = 4.3
As = 0.38 sq in

- MOMENT

@ EXT WALL

Mu = 8.93 ft-kips
d = 6.63 in
F = 0.0439
Ku = 203.4
au = 4.3
As = 0.31 sq in

@ INT WALL

Mu = 23.07 ft-kips
d = 6.63 in
F = 0.0439
Ku = 525.7
au = 4.0
As = 0.87 sq in

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 2-05

MOMENT DESIGN (CONT):

INVERT:

+ MOMENT

Mu = 13.64 ft-kips
d = 8.63 in
F = 0.0744
Ku = 183.4
au = 4.3
As = 0.36 sq in

- MOMENT

@ EXT WALL

Mu = 7.43 ft-kips
d = 7.63 in
F = 0.0581
Ku = 127.8
au = 4.4
As = 0.22 sq in

@ INT WALL

Mu = 26.02 ft-kips
d = 7.63 in
F = 0.0581
Ku = 447.5
au = 4.1
As = 0.84 sq in

WALL:

+ MOMENT

Mu = 2.03 ft-kips
d = 6.63 in
F = 0.0439
Ku = 46.2
au = 4.5
As = 0.07 sq in

- MOMENT

@ SUPPORT

Mu = 10.61 ft-kips
d = 6.63 ft-kips
F = 0.0439
Ku = 241.8
au = 4.3
As = 0.37 sq in

@ MIDSPAN

Mu = 1.75 ft-kips
d = 6.63 in
F = 0.0439
Ku = 39.9
au = 4.5
As = 0.06 sq in

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1-05
Checked By: SEO
Date: 2-05

ROOF SLAB

	MOMENTS				SHEARS			
Location	DL	EL1	EL2	LL	DL	EL1	EL2	LL
0.00	0.22	7.78	9.94	0.00	0.41	8.42	8.79	0.00
0.88	-0.10	1.24	3.07	0.00	0.31	6.53	6.90	0.00
1.75	-0.32	-3.65	-2.14	0.00	0.21	4.64	5.01	0.00
2.63	-0.46	-6.88	-5.70	0.00	0.11	2.75	3.12	0.00
3.50	-0.52	-8.46	-7.60	0.00	0.01	0.86	1.23	0.00
4.38	-0.48	-8.39	-7.85	0.00	-0.09	-1.03	-0.66	0.00
5.25	-0.37	-6.66	-6.45	0.00	-0.18	-2.92	-2.55	0.00
6.13	-0.16	-3.28	-3.39	0.00	-0.28	-4.81	-4.44	0.00
7.00	0.13	1.75	1.32	0.00	-0.38	-6.70	-6.33	0.00
7.88	0.51	8.44	7.68	0.00	-0.48	-8.59	-8.22	0.00
8.75	0.97	16.78	15.70	0.00	-0.58	-10.48	-10.11	0.00
8.75	0.97	16.78	15.70	0.00	0.58	10.48	10.11	0.00
9.63	0.51	8.44	7.68	0.00	0.48	8.59	8.22	0.00
10.50	0.13	1.75	1.32	0.00	0.38	6.70	6.33	0.00
11.38	-0.16	-3.28	-3.39	0.00	0.28	4.81	4.44	0.00
12.25	-0.37	-6.66	-6.45	0.00	0.18	2.92	2.55	0.00
13.13	-0.48	-8.39	-7.85	0.00	0.09	1.03	0.66	0.00
14.00	-0.52	-8.46	-7.60	0.00	-0.01	-0.86	-1.23	0.00
14.88	-0.46	-6.88	-5.70	0.00	-0.11	-2.75	-3.12	0.00
15.75	-0.32	-3.65	-2.14	0.00	-0.21	-4.64	-5.01	0.00
16.63	-0.10	1.24	3.07	0.00	-0.31	-6.53	-6.90	0.00
17.50	0.22	7.78	9.94	0.00	-0.41	-8.42	-8.79	0.00

DMJM HARRIS

Box_Culvert.xls - Results

Designed By:___CAL____
Date:__1-05_____
Checked By:___SEO____
Date:__2-05_____

FLOOR SLAB

	MOMENTS				SHEARS			
Location	DL	EL1	EL2	LL	DL	EL1	EL2	LL
0.00	-0.41	-5.54	-8.67	0.00	-0.86	-8.04	-8.57	0.00
0.88	0.25	0.67	-2.00	0.00	-0.65	-6.15	-6.68	0.00
1.75	0.73	5.22	3.02	0.00	-0.44	-4.26	-4.79	0.00
2.63	1.02	8.12	6.39	0.00	-0.23	-2.37	-2.90	0.00
3.50	1.13	9.36	8.11	0.00	-0.02	-0.48	-1.01	0.00
4.38	1.05	8.95	8.17	0.00	0.19	1.41	0.88	0.00
5.25	0.79	6.89	6.57	0.00	0.41	3.30	2.77	0.00
6.13	0.34	3.17	3.33	0.00	0.62	5.19	4.66	0.00
7.00	-0.29	-2.20	-1.57	0.00	0.83	7.08	6.55	0.00
7.88	-1.11	-9.22	-8.13	0.00	1.04	8.97	8.44	0.00
8.75	-2.11	-17.90	-16.34	0.00	1.25	10.86	10.33	0.00
8.75	-2.11	-17.90	-16.34	0.00	-1.25	-10.86	-10.33	0.00
9.63	-1.11	-9.22	-8.13	0.00	-1.04	-8.97	-8.44	0.00
10.50	-0.29	-2.20	-1.57	0.00	-0.83	-7.08	-6.55	0.00
11.38	0.34	3.17	3.33	0.00	-0.62	-5.19	-4.66	0.00
12.25	0.79	6.89	6.57	0.00	-0.41	-3.30	-2.77	0.00
13.13	1.05	8.95	8.17	0.00	-0.19	-1.41	-0.88	0.00
14.00	1.13	9.36	8.11	0.00	0.02	0.48	1.01	0.00
14.88	1.02	8.12	6.39	0.00	0.23	2.37	2.90	0.00
15.75	0.73	5.22	3.02	0.00	0.44	4.26	4.79	0.00
16.63	0.25	0.67	-2.00	0.00	0.65	6.15	6.68	0.00
17.50	-0.41	-5.54	-8.67	0.00	0.86	8.04	8.57	0.00

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1-05
Checked By: SEO
Date: 2-05

WALLS

	MOMENTS				SHEARS			
Location	DL	EL1	EL2	LL	DL	EL1	EL2	LL
0.00	0.41	5.54	8.67	0.00	0.03	2.72	5.85	0.00
0.78	0.39	3.67	4.60	0.00	0.03	2.07	4.55	0.00
1.57	0.37	2.30	1.54	0.00	0.03	1.43	3.28	0.00
2.35	0.35	1.42	-0.54	0.00	0.03	0.82	2.04	0.00
3.13	0.33	1.01	-1.67	0.00	0.03	0.22	0.84	0.00
3.92	0.31	1.07	-1.87	0.00	0.03	-0.36	-0.32	0.00
4.70	0.29	1.58	-1.18	0.00	0.03	-0.92	-1.44	0.00
5.48	0.27	2.52	0.37	0.00	0.03	-1.47	-2.52	0.00
6.27	0.25	3.87	2.76	0.00	0.03	-1.99	-3.57	0.00
7.05	0.23	5.63	5.96	0.00	0.03	-2.50	-4.59	0.00
7.83	0.22	7.78	9.94	0.00	0.03	-2.99	-5.56	0.00

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1-05
Checked By: SEO
Date: 2-05

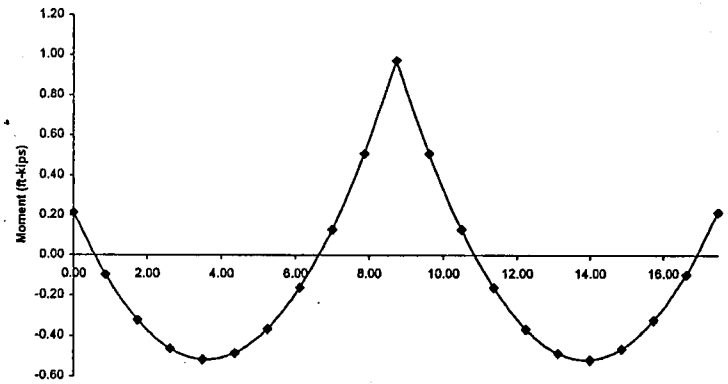
MOMENT ENVELOPES

ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
13.20	10.40	-11.81	-7.74	11.81	7.74
3.87	1.49	-2.27	1.19	6.49	5.27
-3.20	-5.16	4.88	7.73	3.47	2.49
-8.01	-9.55	9.64	11.88	2.30	-0.24
-10.55	-11.67	12.01	13.64	1.75	-1.73
-10.84	-11.54	11.99	13.01	1.80	-2.03
-8.86	-9.14	9.58	9.98	2.43	-1.16
-4.48	-4.62	4.57	4.77	3.63	0.84
2.44	1.88	-3.23	-2.42	5.37	3.92
11.63	10.65	-13.43	-12.00	8.06	7.63
23.07	21.67	-26.02	-23.98	13.20	10.40
23.07	21.67	-26.02	-23.98		
11.63	10.65	-13.43	-12.00		
2.44	1.88	-3.23	-2.42		
-4.48	-4.62	4.57	4.77		
-8.86	-9.14	9.58	9.98		
-10.84	-11.54	11.99	13.01		
-10.55	-11.67	12.01	13.64		
-8.01	-9.55	9.64	11.88		
-3.20	-5.16	4.88	7.73		
3.87	1.49	-2.27	1.19		
13.20	10.40	-11.81	-7.74		

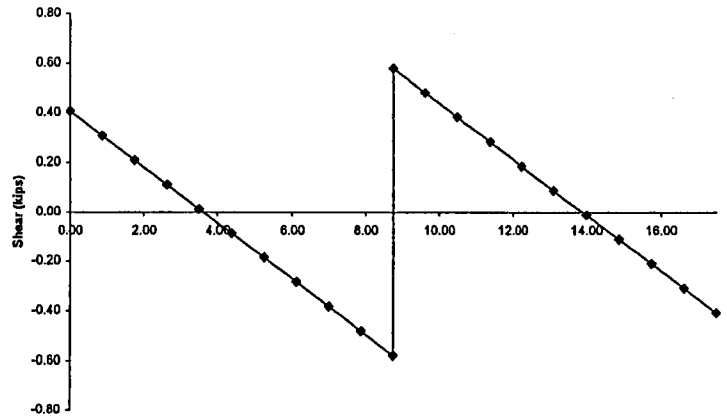
SHEAR ENVELOPES

ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
11.96	11.48	-12.27	-11.57	7.64	3.57
9.37	8.89	-9.54	-8.84	5.94	2.72
6.79	6.31	-6.81	-6.11	4.29	1.89
4.20	3.72	-4.07	-3.38	2.69	1.09
1.62	1.14	-1.34	-0.64	1.13	0.31
-0.97	-1.45	1.39	2.09	-0.38	-0.44
-3.55	-4.03	4.12	4.82	-1.17	-1.84
-6.14	-6.62	6.86	7.55	-1.88	-3.25
-8.72	-9.20	9.59	10.29	-2.56	-4.61
-11.31	-11.79	12.32	13.02	-3.22	-5.93
-13.89	-14.37	15.05	15.75	-3.85	-7.20
14.37	13.89	-15.75	-15.05		
11.79	11.31	-13.02	-12.32		
9.20	8.72	-10.29	-9.59		
6.62	6.14	-7.55	-6.86		
4.03	3.55	-4.82	-4.12		
1.45	0.97	-2.09	-1.39		
-1.14	-1.62	0.64	1.34		
-3.72	-4.20	3.38	4.07		
-6.31	-6.79	6.11	6.81		
-8.89	-9.37	8.84	9.54		
-11.48	-11.96	11.57	12.27		

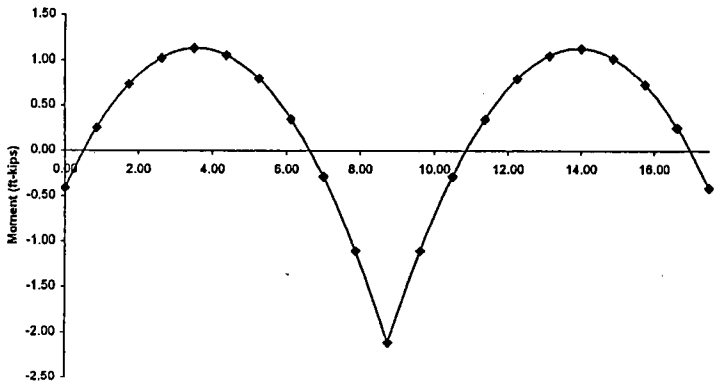
DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		DESIGNED BY: CAL	DATE 1-05
		CHECKED BY: SEO	DATE 2-05



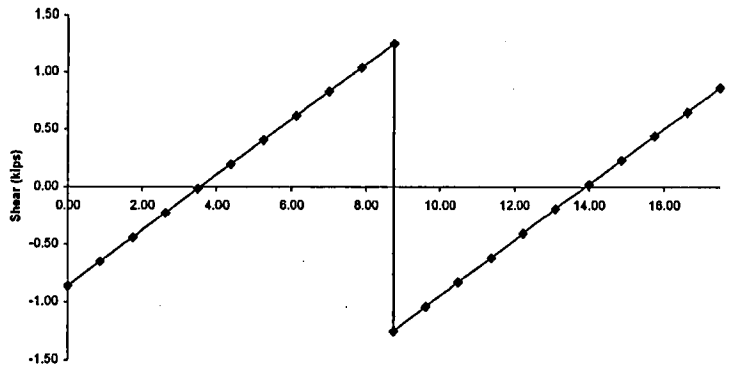
Roof Dead Load Moments



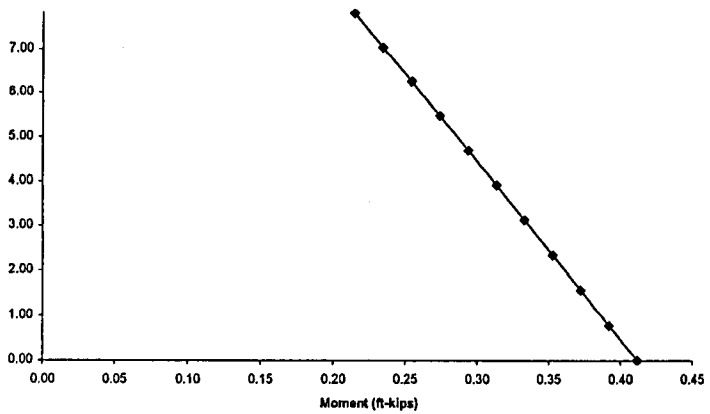
Roof Dead Load Shears



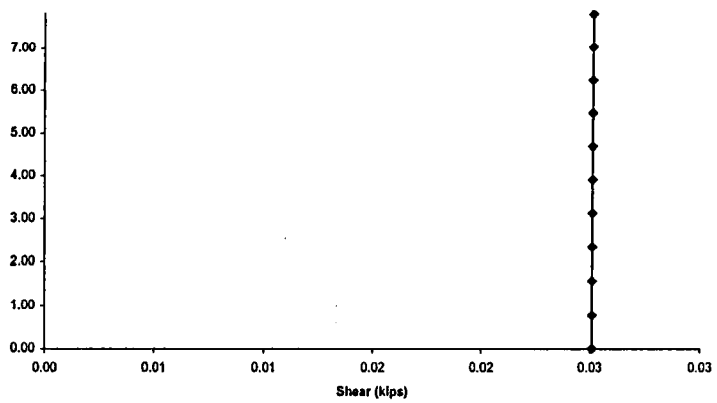
Floor Dead Load Moments



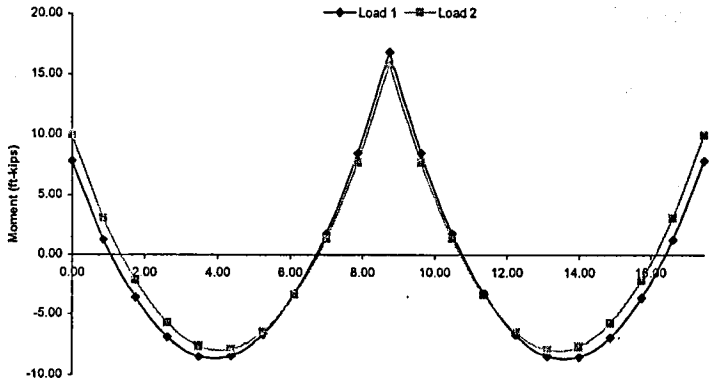
Floor Dead Load Shears



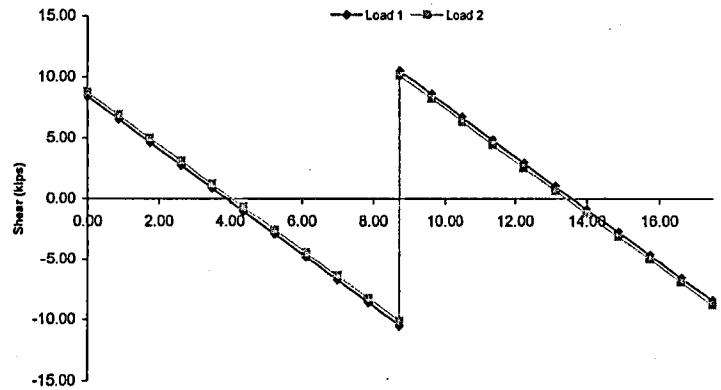
Wall Dead Load Moments



Wall Dead Load Shears



Roof Earth Load Moments



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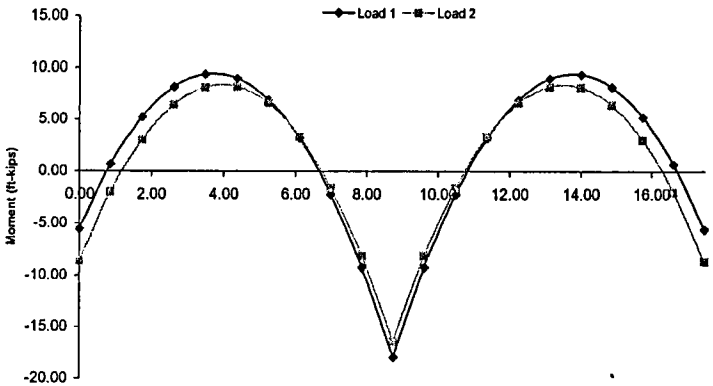

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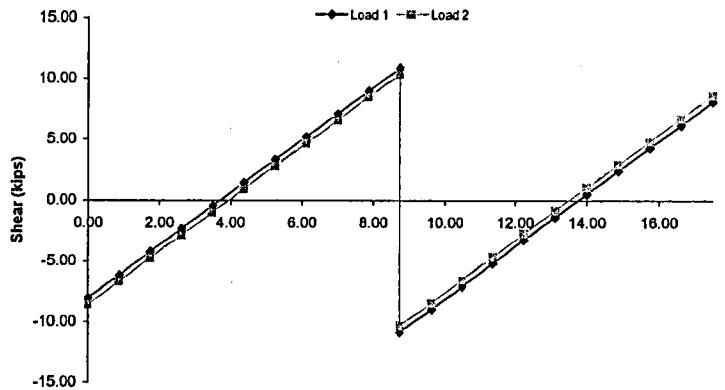

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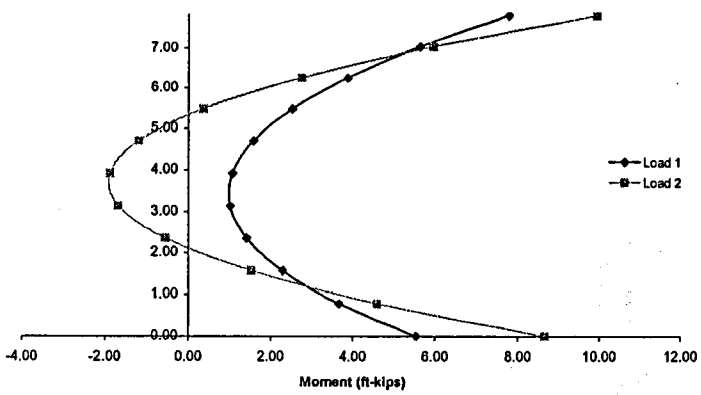
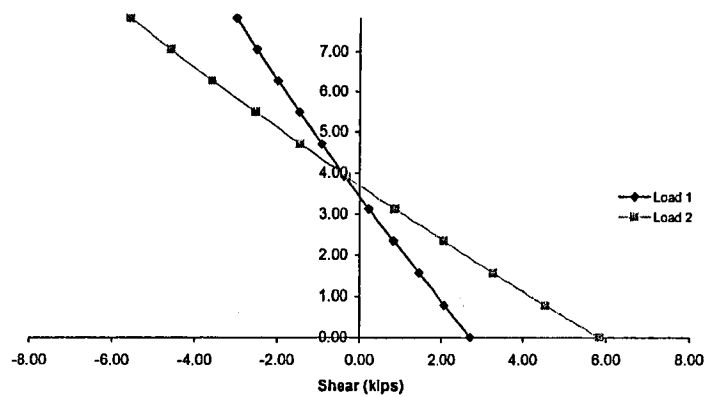


Wall Earth Load Moments



Wall Earth Load Shears

DMJM HARRIS

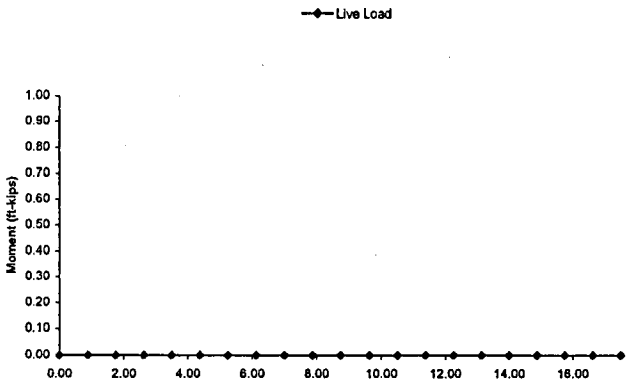
PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

SUBJECT: 8X7 DOUBLE CELL BOX CULVERT

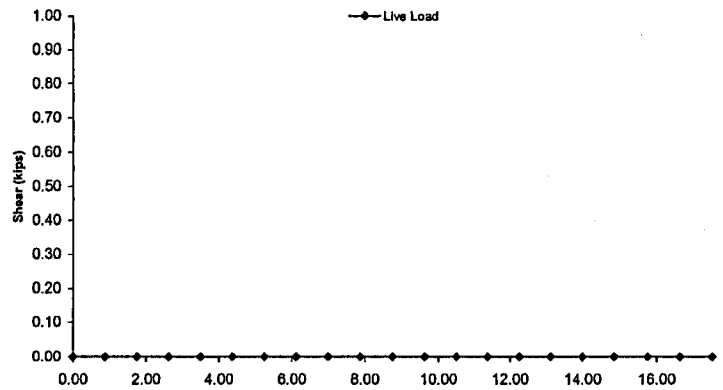
JOB NO.	SHEET
6063	

DESIGNED BY:	DATE
CAL	1-05

CHECKED BY:	DATE
SEO	2-05



Roof Live Load Moments



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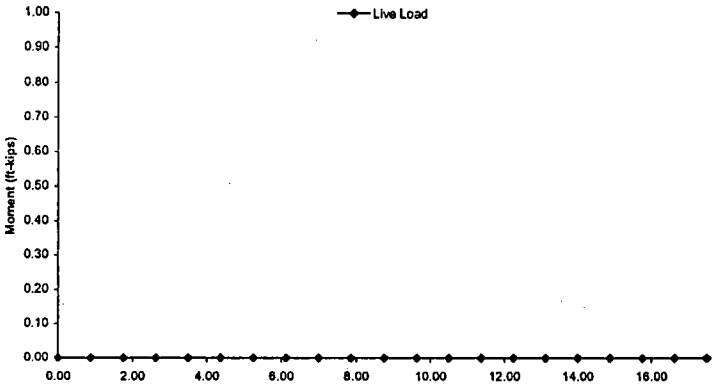

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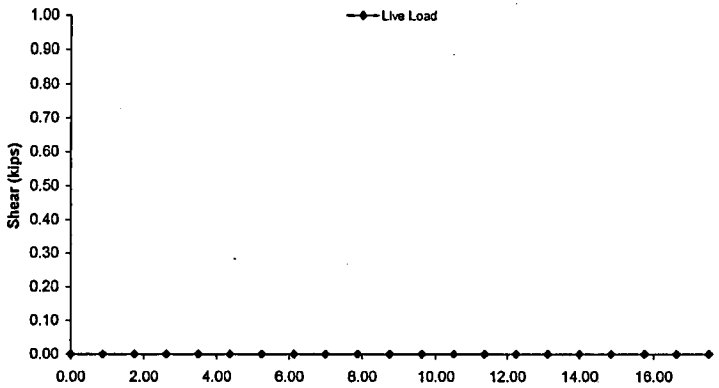
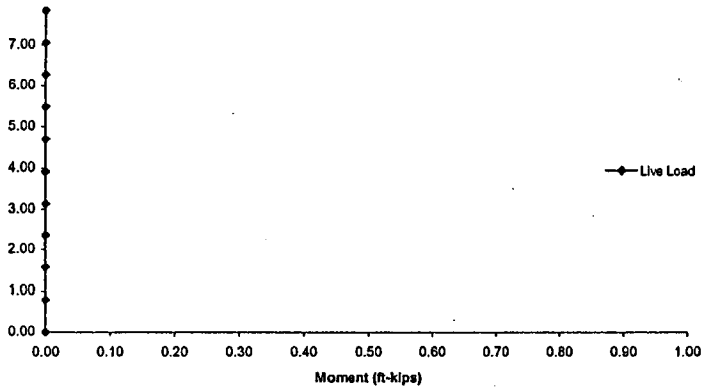
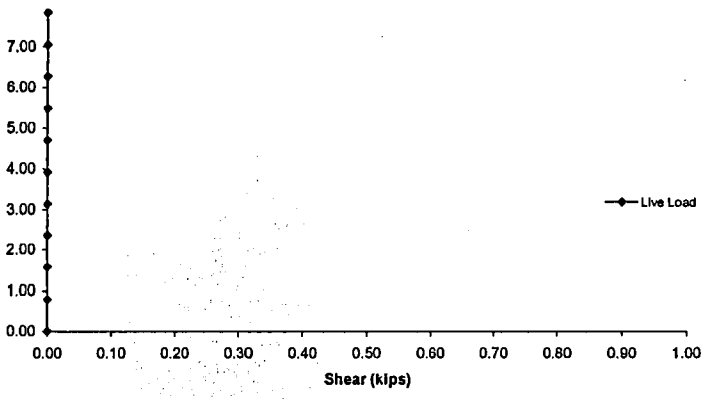


Floor Live Load Shears



Wall Live Load Moments



Wall Live Load Shears

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

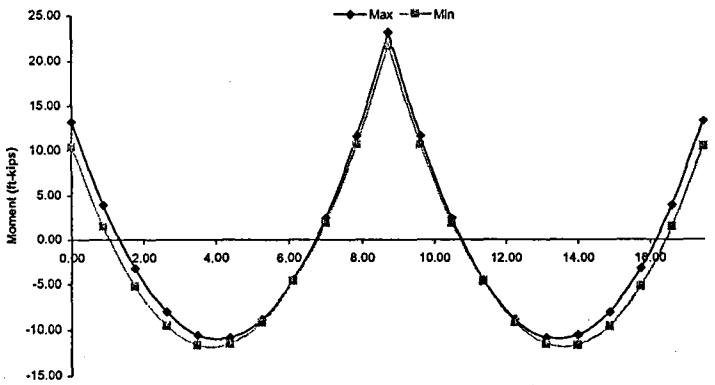
JOB NO. 6063

SHEET

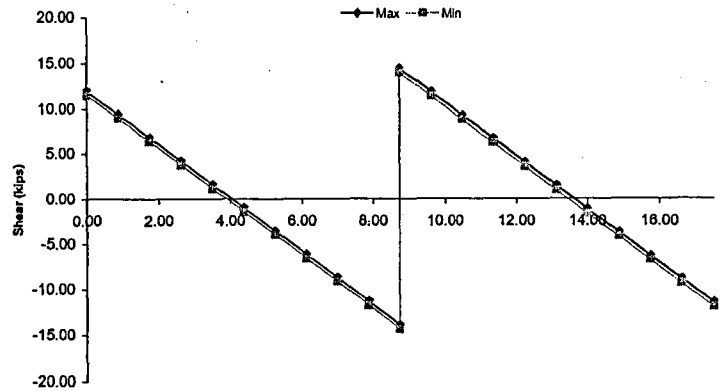
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT

DESIGNED BY: CAL DATE 1-05

CHECKED BY: SEO DATE 2-05



Roof Moment Envelope



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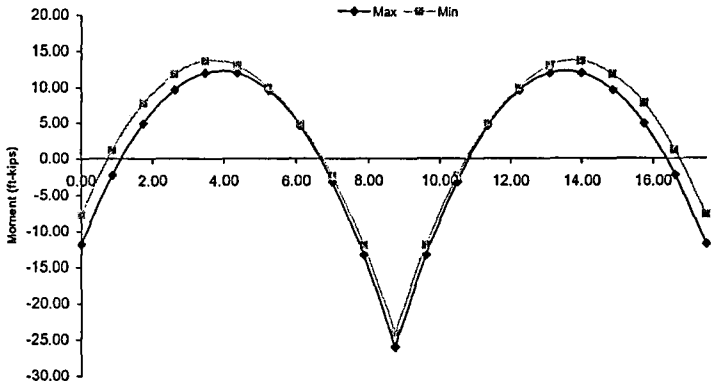

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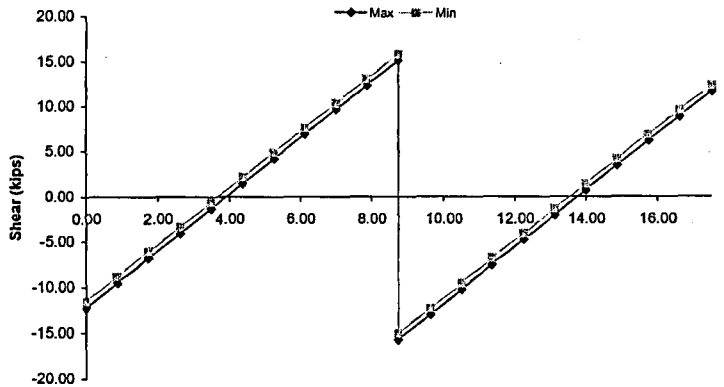
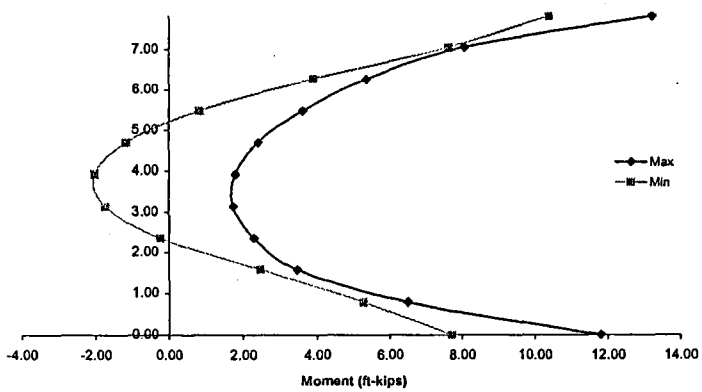
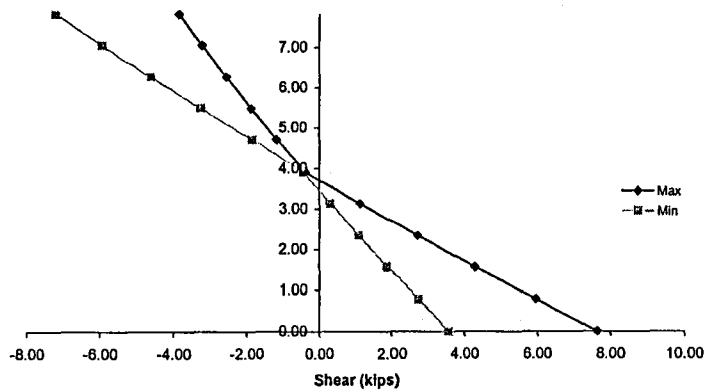


Floor Shear Envelope



Wall Moment Envelope



Wall Shear Envelope

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C		JOB NO. 6063	SHEET
	DESIGNED BY: CAL	DATE 1-05	
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT	CHECKED BY: SEO	DATE 2-05	

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 1-05

DESIGN CRITERIA

STRUCTURE DESCRIPTION: 2 - 8 x 7 CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERT

DESIGN SPECIFICATIONS: AASHTO SEVENTEENTH EDITION, ADOT BRIDGE GROUP BRIDGE PRACTICE GUIDELINES, ADOT REINFORCED CONCRETE BOX CULVERT MANUAL

DESIGN LOADS:

LIVE LOAD: HS20 - 44

EARTH PRESSURES: 120 PCF VERT & 30 PCF HORIZ

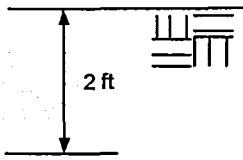
OR 120 PCF VERT & 60 PCF HORIZ

DESIGN STRESSES: f'c = 3500 psi

fy = 60 ksi

DESIGN METHOD : ULTIMATE STRENGTH DESIGN

GROUP X : 1.3 [D + E + 1.67 (L+I)]



ASSUMED MEMBER THICKNESSES:

ROOF = 9 in.

INVERT = 11 in.

EXT WALL = 9 in.

INT WALL = 9 in.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 1-05

PRESSURES:

DEAD LOAD:

ROOF: 0.75 * 0.15 kcf = 0.11 ksf

INVERT:

WALLS: $\frac{.15 * [2(9) + 1(9)](7)/12}{(2(8) + [2(9) + 1(9)]/12}$ = 0.13 ksf

ROOF: = 0.11 ksf

0.24 ksf

EARTH :

ROOF: 2 * 0.12 kcf = 0.24 ksf

INVERT: = 0.24 ksf

WALLS:

LOADING 1, 30 pcf

pt : [2 + 2 + .5 * 9 / 12] * 0.03 = 0.13 ksf

ΔP : [7 + .5 (9 + 11) / 12] * 0.03 = 0.24 ksf

LOADING 2, 60 pcf

pt : 0.13 (60 / 30) = 0.26 ksf

ΔP : 0.24 (60 / 30) = 0.47 ksf

LIVE LOAD:

ROOF: PER AASHTO 6.4, WHEEL LOADS SHALL BE PLACED ON ROOF SLAB AND DISTRIBUTED IN ACCORDANCE WITH AASHTO 3.24.3, CASE B

IMPACT: = 20 %

WHEEL LOAD: = HS20

E' = 4 + 0.06 (S) = 4.48

INVERT: TRUCK LOADS DISTRIBUTED OVER 14' LANE

WHEEL LOAD: = VARIES

MEMBER LENGTHS:

ROOF & INVERT : 8 + 9 / 12 = 8.75 ft

WALLS : 7 + .5 * (9 + 11) / 12 = 7.83 ft

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 1-05

SHEAR DESIGN:

REQUIRED DEPTH

$\phi vc > V_U / bd$

$d_{REQ'D} > V_U / b\ \phi vc$

ROOF:

$\phi vc = \phi [2.14 \sqrt{f'c} + 4600 \rho (Vu\ d / Mu)]$

$= 157.4$ psi

$V_U = 1.7$ kips

$M_U = 1.6$ ft-kips

$d_{REQ'D} = 0.9$ in < = 6.6 in OK

INVERT:

$\phi vc = \phi [2.14 \sqrt{f'c} + 4600 \rho (Vu\ d / Mu)]$

$= 157.4$ psi

$V_U = 5$ kips

$M_U = 4.5$ ft-kips

$d_{REQ'D} = 2.6$ in < = 7.6 in OK

WALL:

$\phi vc = \phi [1.9 \sqrt{f'c} + 2500 \rho (Vu\ d / Mu)]$

$= 118.3$ psi

$V_U = 2.8$ kips

$M_U = 7.4$ ft-kips

$d_{REQ'D} = 2$ in < = 6.6 in OK

MOMENT DESIGN:

ROOF:

+ MOMENT

Mu = 15.34 ft-kips
d = 7.13 in
F = 0.0508
Ku = 302.2
au = 4.2
As = 0.51 sq in

- MOMENT

@ EXT WALL

Mu = 7.31 ft-kips
d = 6.63 in
F = 0.0439
Ku = 166.6
au = 4.4
As = 0.25 sq in

@ INT WALL

Mu = 10.32 ft-kips
d = 6.63 in
F = 0.0439
Ku = 235.1
au = 4.3
As = 0.36 sq in

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		CHECKED BY: SEO	DATE 1-05

MOMENT DESIGN (CONT):

INVERT:

+ MOMENT

Mu = 6.09 ft-kips
d = 8.63 in
F = 0.0744
Ku = 81.9
au = 4.4
As = 0.16 sq in

- MOMENT
@ EXT WALL

Mu = 3.66 ft-kips
d = 7.63 in
F = 0.0581
Ku = 63.0
au = 4.5
As = 0.11 sq in

@ INT WALL

Mu = 10.33 ft-kips
d = 7.63 in
F = 0.0581
Ku = 177.8
au = 4.3
As = 0.31 sq in

WALL:

+ MOMENT

Mu = 2.15 ft-kips
d = 6.63 in
F = 0.0439
Ku = 49.1
au = 4.5
As = 0.07 sq in

- MOMENT
@ SUPPORT

Mu = 8.99 ft-kips
d = 6.63 ft-kips
F = 0.0439
Ku = 204.8
au = 4.3
As = 0.31 sq in

@ MIDSPAN

Mu = 1.3 ft-kips
d = 6.63 in
F = 0.0439
Ku = 29.5
au = 4.5
As = 0.04 sq in

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 1/05

ROOF SLAB

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	0.22	1.33	2.03	-0.97	3.33		0.41	1.02	1.14	0.00	0.00	
0.88	-0.10	0.53	1.13	-2.17	1.23		0.31	0.81	0.93	0.00	0.00	
1.75	-0.32	-0.08	0.41	-3.61	0.02		0.21	0.60	0.72	0.00	0.00	
2.63	-0.46	-0.51	-0.12	-4.98	0.28		0.11	0.39	0.51	0.00	0.00	
3.50	-0.52	-0.75	-0.47	-6.00	0.70		0.01	0.18	0.30	0.00	0.00	
4.38	-0.48	-0.82	-0.64	-6.29	1.11		-0.09	-0.03	0.09	0.00	0.00	
5.25	-0.37	-0.69	-0.62	-5.94	1.53		-0.18	-0.24	-0.12	0.00	0.00	
6.13	-0.16	-0.39	-0.42	-5.08	1.94		-0.28	-0.45	-0.33	0.00	0.00	
7.00	0.13	0.10	-0.04	-3.68	2.36		-0.38	-0.66	-0.54	0.00	0.00	
7.88	0.51	0.78	0.53	-1.82	2.78		-0.48	-0.87	-0.75	0.00	0.00	
8.75	0.97	1.63	1.28	0.00	3.19		-0.58	-1.08	-0.96	0.00	0.00	
8.75	0.97	1.63	1.28	0.00	3.19		0.58	1.08	0.96	0.00	0.00	
9.63	0.51	0.78	0.53	-1.82	2.78		0.48	0.87	0.75	0.00	0.00	
10.50	0.13	0.10	-0.04	-3.68	2.36		0.38	0.66	0.54	0.00	0.00	
11.38	-0.16	-0.39	-0.42	-5.08	1.94		0.28	0.45	0.33	0.00	0.00	
12.25	-0.37	-0.69	-0.62	-5.94	1.53		0.18	0.24	0.12	0.00	0.00	
13.13	-0.48	-0.82	-0.64	-6.29	1.11		0.09	0.03	-0.09	0.00	0.00	
14.00	-0.52	-0.75	-0.47	-6.03	0.70		-0.01	-0.18	-0.30	0.00	0.00	
14.88	-0.46	-0.51	-0.12	-4.99	0.28		-0.11	-0.39	-0.51	0.00	0.00	
15.75	-0.32	-0.08	0.41	-3.61	0.02		-0.21	-0.60	-0.72	0.00	0.00	
16.63	-0.10	0.53	1.13	-2.17	1.23		-0.31	-0.81	-0.93	0.00	0.00	
17.50	0.22	1.33	2.03	-0.97	3.34		-0.41	-1.02	-1.14	0.00	0.00	

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 1/05

FLOOR SLAB

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	-0.41	-1.38	-2.48	0.82	-0.72		-0.86	-1.02	-1.21	0.00	-0.91	
0.88	0.25	-0.57	-1.51	1.12	-0.16		-0.65	-0.81	-1.00	0.00	-0.69	
1.75	0.73	0.05	-0.73	1.50	0.00		-0.44	-0.60	-0.79	0.00	-0.47	
2.63	1.02	0.48	-0.13	1.68	0.00		-0.23	-0.39	-0.58	0.02	-0.25	
3.50	1.13	0.74	0.29	1.68	0.00		-0.02	-0.18	-0.37	0.13	-0.04	
4.38	1.05	0.80	0.53	1.48	0.00		0.19	0.03	-0.16	0.34	0.00	
5.25	0.79	0.69	0.58	1.10	0.00		0.41	0.24	0.05	0.56	0.00	
6.13	0.34	0.39	0.45	0.52	-0.03		0.62	0.45	0.26	0.78	0.00	
7.00	-0.29	-0.09	0.13	0.00	-0.49		0.83	0.66	0.47	1.00	0.00	
7.88	-1.11	-0.76	-0.37	0.00	-1.40		1.04	0.87	0.68	1.22	0.00	
8.75	-2.11	-1.61	-1.06	0.00	-2.53		1.25	1.08	0.89	1.44	0.00	
8.75	-2.11	-1.61	-1.06	0.00	-2.53		-1.25	-1.08	-0.89	0.00	-1.44	
9.63	-1.11	-0.76	-0.37	0.00	-1.40		-1.04	-0.87	-0.68	0.00	-1.22	
10.50	-0.29	-0.09	0.13	0.00	-0.49		-0.83	-0.66	-0.47	0.00	-1.00	
11.38	0.34	0.39	0.45	0.53	-0.03		-0.62	-0.45	-0.26	0.00	-0.78	
12.25	0.79	0.69	0.58	1.11	0.00		-0.41	-0.24	-0.05	0.00	-0.56	
13.13	1.05	0.80	0.53	1.49	0.00		-0.19	-0.03	0.16	0.00	-0.34	
14.00	1.13	0.74	0.29	1.69	0.00		0.02	0.18	0.37	0.04	-0.13	
14.88	1.02	0.48	-0.13	1.69	0.00		0.23	0.39	0.58	0.24	-0.02	
15.75	0.73	0.05	-0.73	1.50	0.00		0.44	0.60	0.79	0.46	0.00	
16.63	0.25	-0.57	-1.51	1.12	-0.16		0.65	0.81	1.00	0.68	0.00	
17.50	-0.41	-1.38	-2.48	0.83	-0.64		0.86	1.02	1.21	0.90	0.00	

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
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Checked By: SEO
Date: 1/05

WALLS

	MOMENTS						SHEARS					
Location	DL	EL1	EL2	LL Min	LL Max	LL	DL	EL1	EL2	LL Min	LL Max	LL
0.00	0.41	1.38	2.48	-0.82	0.73		0.03	1.13	2.31	-0.53	0.20	
0.78	0.39	0.60	0.89	-0.41	0.57		0.03	0.86	1.76	-0.53	0.20	
1.57	0.37	0.03	-0.28	0.00	0.41		0.03	0.60	1.24	-0.53	0.20	
2.35	0.35	-0.34	-1.06	0.00	0.59		0.03	0.36	0.76	-0.53	0.20	
3.13	0.33	-0.53	-1.48	-0.07	0.97		0.03	0.13	0.31	-0.53	0.20	
3.92	0.31	-0.56	-1.56	-0.22	1.35		0.03	-0.07	-0.10	-0.53	0.20	
4.70	0.29	-0.43	-1.33	-0.37	1.73		0.03	-0.26	-0.47	-0.53	0.20	
5.48	0.27	-0.16	-0.84	-0.52	2.11		0.03	-0.42	-0.80	-0.53	0.20	
6.27	0.25	0.23	-0.09	-0.67	2.50		0.03	-0.57	-1.10	-0.53	0.20	
7.05	0.23	0.73	0.88	-0.82	2.92		0.03	-0.70	-1.36	-0.53	0.20	
7.83	0.22	1.33	2.03	-0.97	3.33		0.03	-0.82	-1.58	-0.53	0.20	

DMJM HARRIS

Box_Culvert.xls - Results

Designed By: CAL
Date: 1/05
Checked By: SEO
Date: 1/05

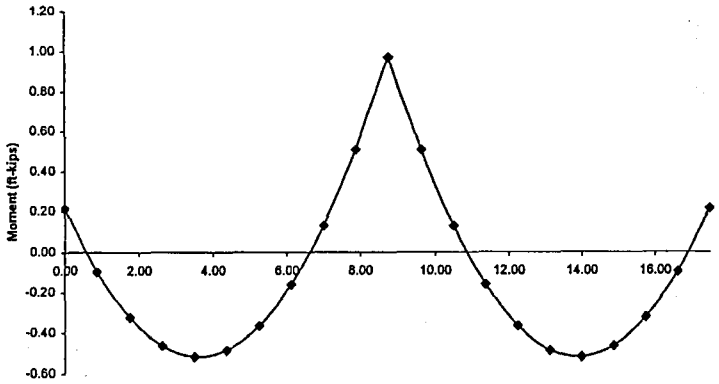
MOMENT ENVELOPES

ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
10.16	-0.09	-5.33	-0.54	5.34	0.53
4.01	-4.15	-1.99	2.01	2.90	0.40
0.16	-8.36	0.00	4.26	1.42	0.12
-0.15	-12.08	1.17	5.62	1.30	-0.92
0.23	-14.69	1.85	6.08	1.85	-1.64
0.95	-15.34	2.06	5.64	2.61	-2.09
2.03	-14.28	1.78	4.31	3.58	-2.15
3.51	-11.78	0.89	2.15	4.73	-1.85
5.43	-7.87	-1.56	-0.21	6.06	-1.23
7.69	-2.61	-5.46	-1.92	7.78	-0.51
10.32	2.92	-10.33	-4.11	10.15	-0.09
10.32	2.92	-10.33	-4.11		
7.69	-2.61	-5.46	-1.92		
5.43	-7.87	-1.56	-0.21		
3.51	-11.78	0.89	2.18		
2.03	-14.28	1.78	4.33		
0.95	-15.34	2.06	5.66		
0.23	-14.74	1.85	6.09		
-0.15	-12.10	1.17	5.63		
0.16	-8.36	0.00	4.27		
4.01	-4.15	-1.99	2.01		
10.17	-0.09	-5.16	-0.53		

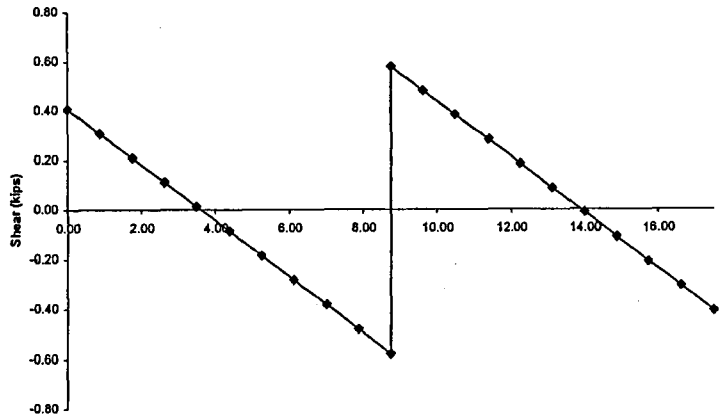
SHEAR ENVELOPES

ROOF		FLOOR		WALLS	
Max	Min	Max	Min	Max	Min
2.00	1.85	-4.43	-2.70	3.47	0.35
1.60	1.45	-3.41	-2.15	2.75	-0.01
1.20	1.05	-2.38	-1.60	2.08	-0.34
0.80	0.64	-1.60	-0.76	1.45	-0.66
0.40	0.24	-0.59	0.03	0.87	-0.95
0.00	-0.16	0.04	1.03	0.37	-1.24
-0.40	-0.56	0.59	2.05	0.13	-1.73
-0.80	-0.96	1.14	3.08	-0.08	-2.16
-1.20	-1.36	1.68	4.10	-0.28	-2.55
-1.60	-1.76	2.23	5.12	-0.45	-2.89
-2.00	-2.16	2.78	6.15	-0.59	-3.18
2.16	2.00	-6.15	-2.78		
1.76	1.60	-5.12	-2.23		
1.36	1.20	-4.10	-1.68		
0.96	0.80	-3.08	-1.14		
0.56	0.40	-2.05	-0.59		
0.16	0.00	-1.03	-0.04		
-0.24	-0.40	-0.03	0.59		
-0.64	-0.80	0.76	1.58		
-1.05	-1.20	1.60	2.36		
-1.45	-1.60	2.15	3.38		
-1.85	-2.00	2.70	4.40		

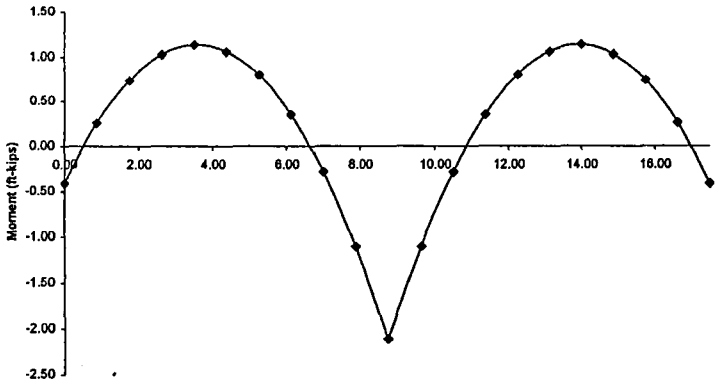
DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C	JOB NO. 6063	SHEET
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT		DESIGNED BY: CAL	DATE 1-05
		CHECKED BY: SEO	DATE 1-05



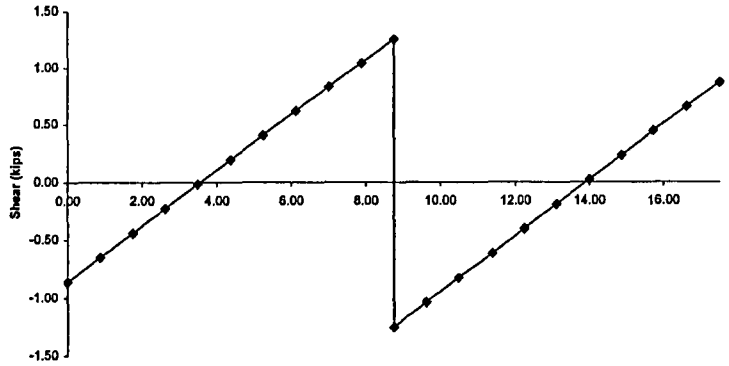
Roof Dead Load Moments



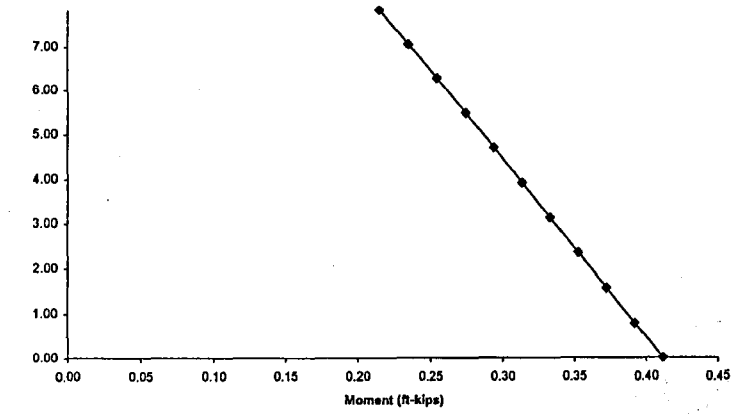
Roof Dead Load Shears



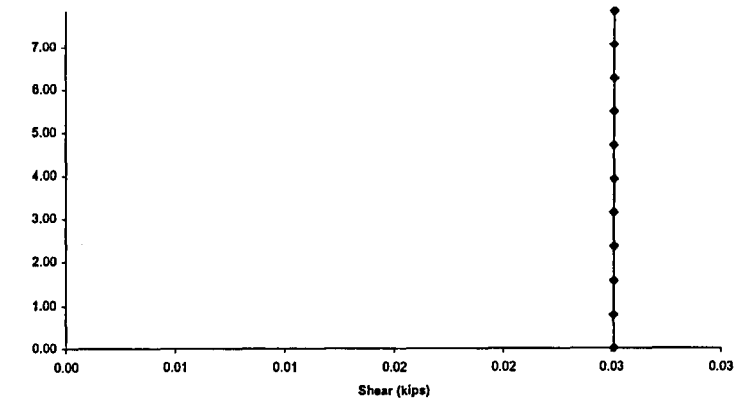
Floor Dead Load Moments



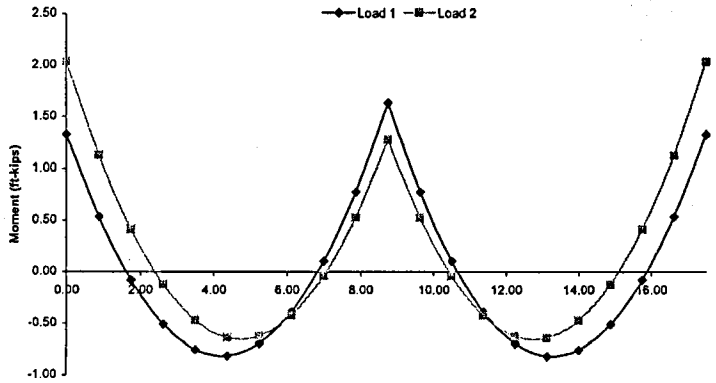
Floor Dead Load Shears



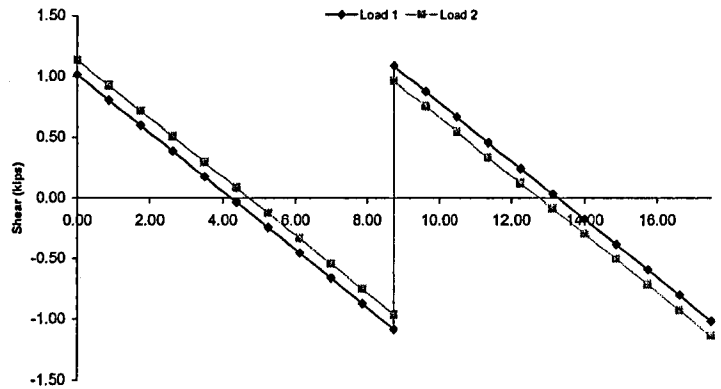
Wall Dead Load Moments



Wall Dead Load Shears



Roof Earth Load Moments



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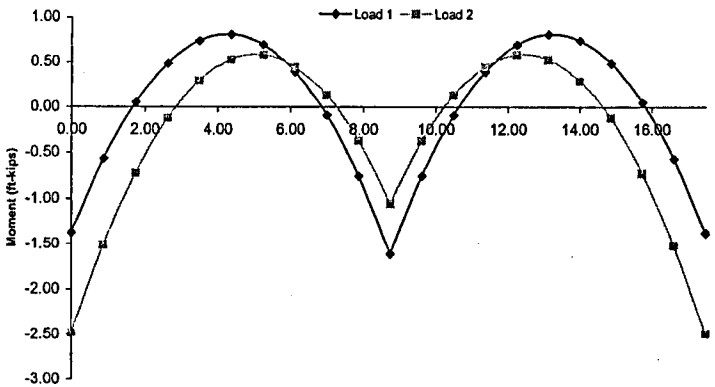
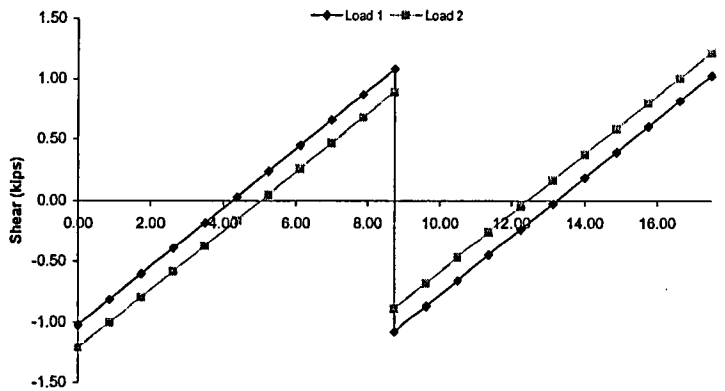


Floor Earth Load Moments



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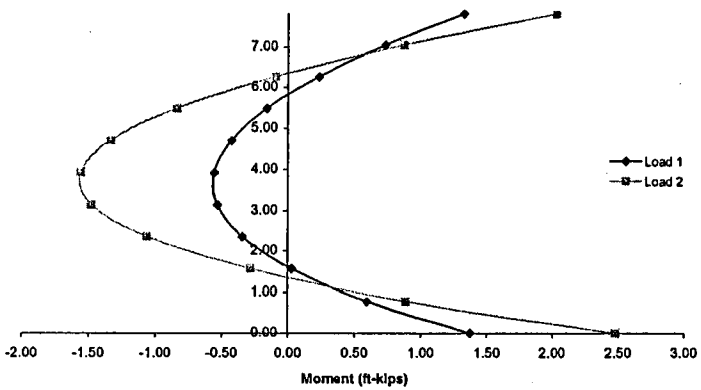
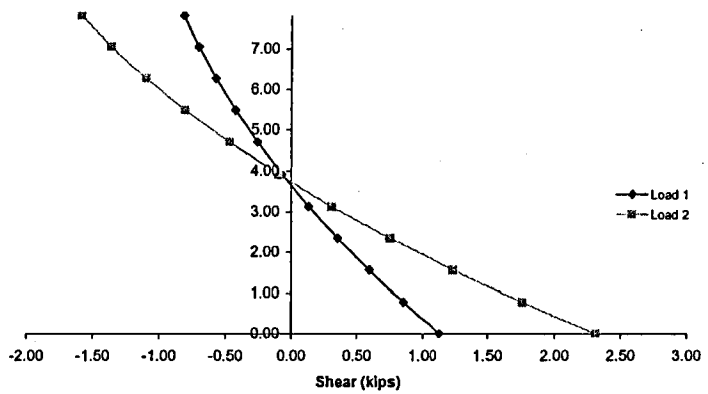


Wall Earth Load Moments



Wall Earth Load Shears

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

SUBJECT: 8X7 DOUBLE CELL BOX CULVERT

JOB NO. 6063

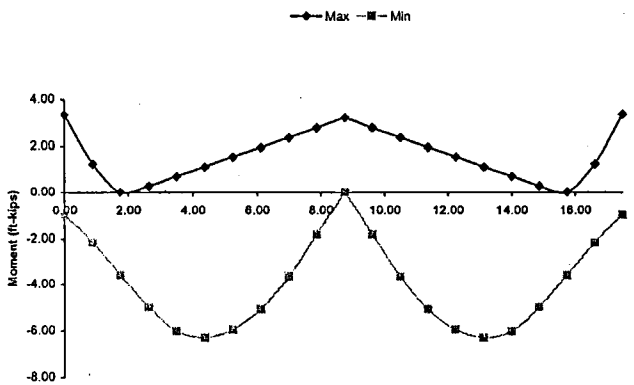
DESIGNED BY: CAL

DATE 1-05

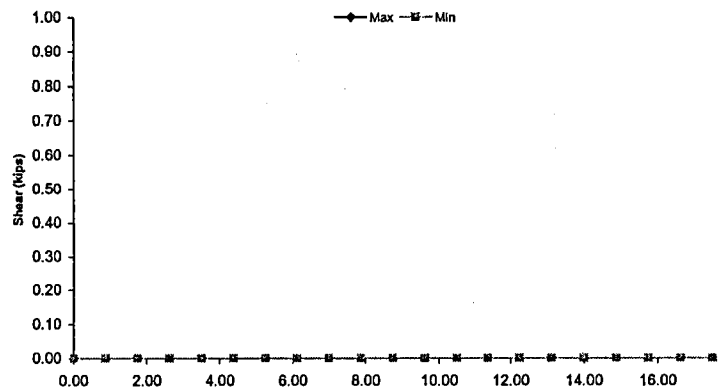
CHECKED BY: SEO

DATE 1-05

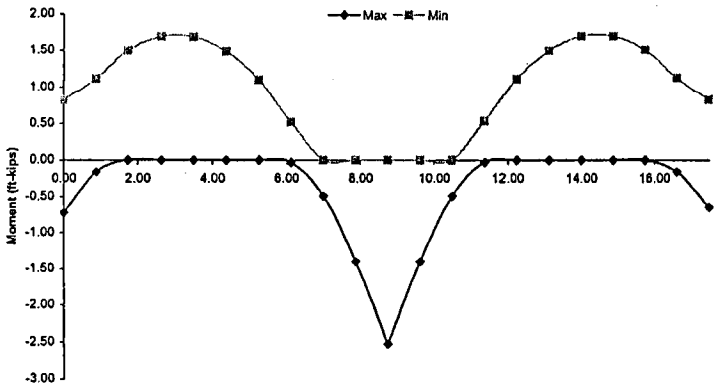
SHEET



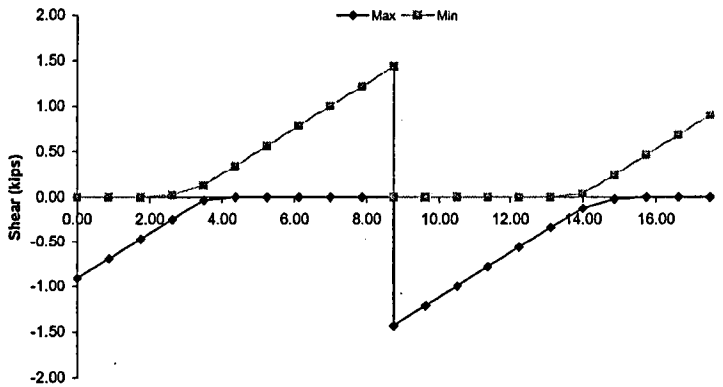
Roof Live Load Moments



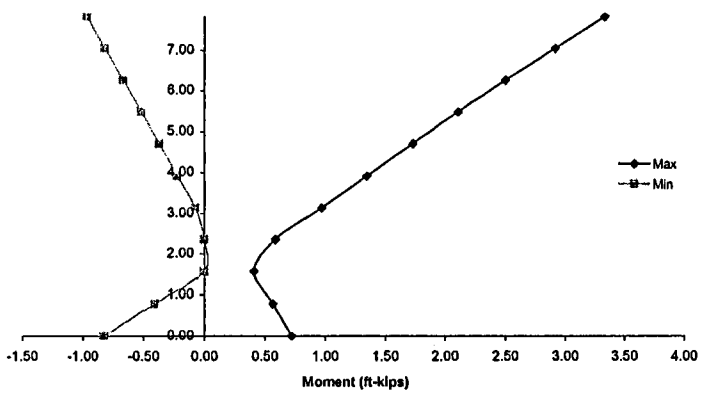
Roof Live Load Shears



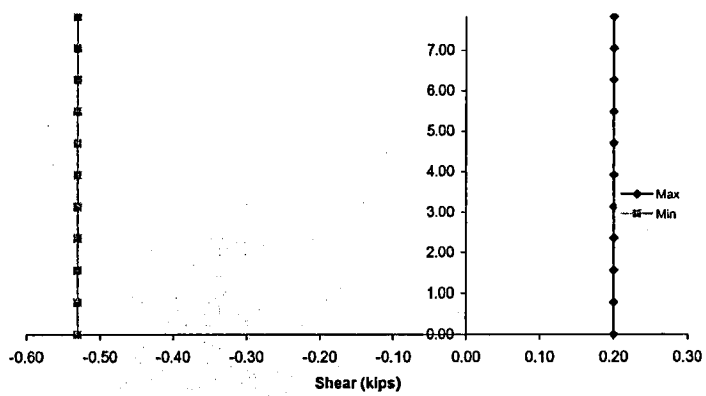
Floor Live Load Moments



Floor Live Load Shears



Wall Live Load Moments



Wall Live Load Shears

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

JOB NO. 6063

SHEET

DESIGNED BY: CAL

DATE 1-05

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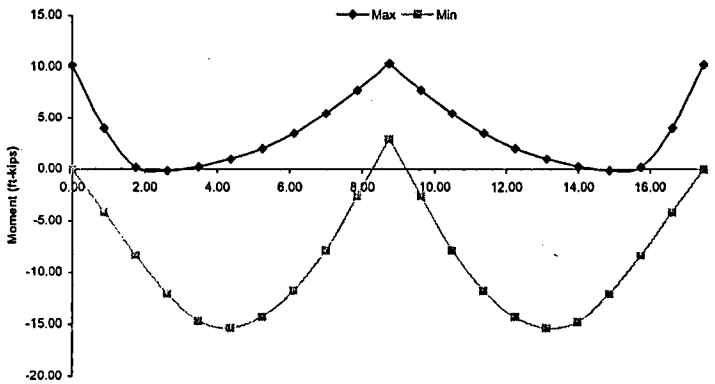
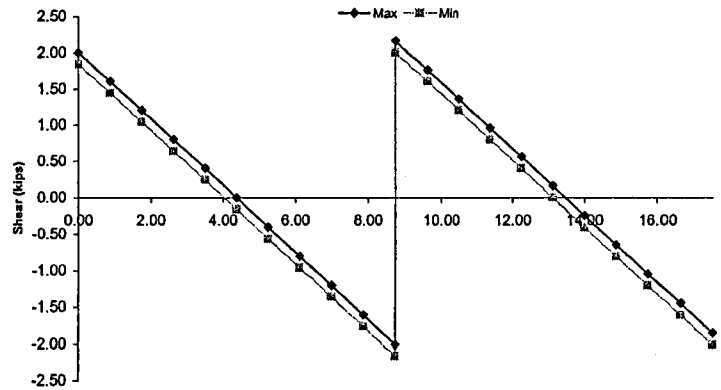
DATE 1-05

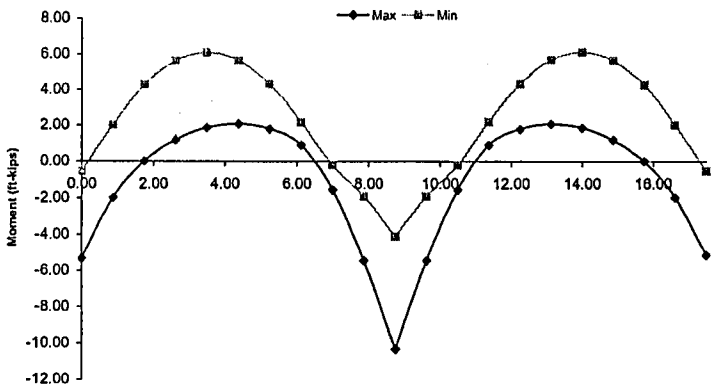
SUBJECT: 8X7 DOUBLE CELL BOX CULVERT



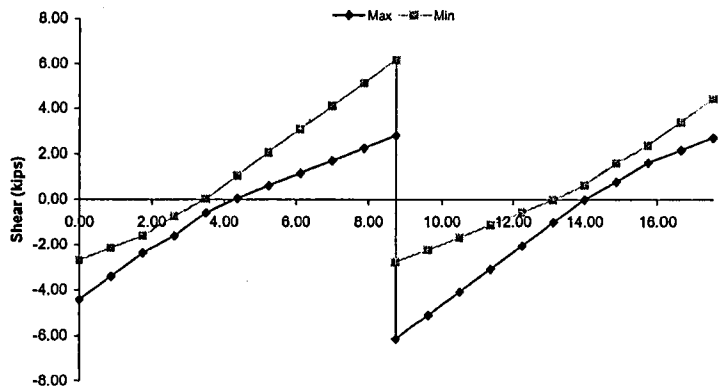
Roof Moment Envelope



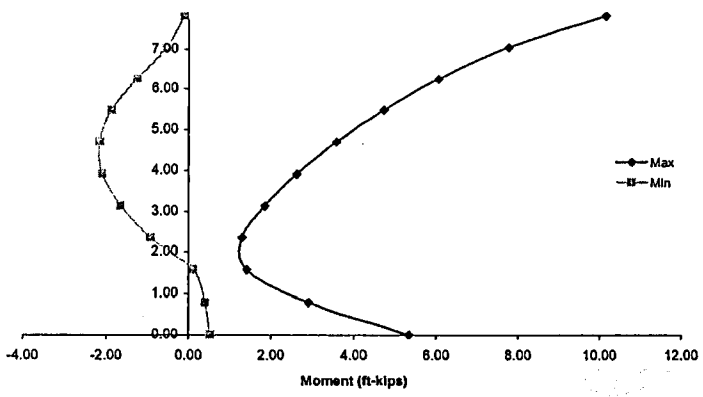
Roof Shear Envelope



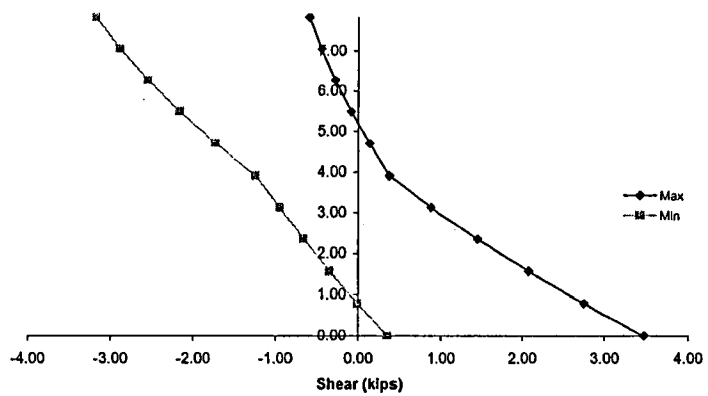
Floor Moment Envelope



Floor Shear Envelope



Wall Moment Envelope



Wall Shear Envelope

DMJM HARRIS

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH B & C

JOB NO. 6063

SHEET

DESIGNED BY: CAL

DATE 1-05

CHECKED BY: SEO

DATE 1-05

SUBJECT: 8X7 DOUBLE CELL BOX CULVERT

DMJM HARRIS	PROJECT: Bethany Home Outfall Channel - Reach B & C	JOB NO. 6063.0018	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8x7 Double Cell Box Culvert		CHECKED BY: SEO	DATE 1-05

General Unit Definitions

$kips := 1000lbf$ $\quad pcf := \frac{lbf}{ft^3}$ $\quad CY := 27ft^3$ $\quad lf := ft$

$kcf := 1000pcf$ $\quad ksi := 1000psi$ $\quad sqft := ft^2$ $\quad psf := \frac{lbf}{ft^2}$

$wconc := 150pcf$ weight of concrete

Per comments received from the Maricopa Flood Control District, investigate positive moment cutoff of reinforcement in the top slab. Also, investigate moment cutoff for alternating bars in the walls as needed. Floor slab reinforcement, as commented by the District, will utilize a mirror-image of the top slab reinforcement - check that this reinforcement pattern works for the floor slab.

As already calculated:

Roof maximum positive moment requires 0.39 in^2/ft **use #5 @ 9" - however, use #5 @ 6" and alternate w/ #5 @ 12"**
Roof maximum negative moment requires 0.88 in^2/ft **use #6 @ 6"**

By inspection, roof moments control over invert moments.

Wall maximum moment requires 0.37 in^2/ft at the supports **use #5 @ 6"** - midspan and positive moments are controlled by minimum temperature and shrinkage requirements.

Utilize LFD design

$f_c := 3500psi$ $\quad f_y := 60000psi$ $\quad b := 12in$

$d_{wallandroof5} := 9in - 2in - \frac{1}{2}\cdot\left(\frac{5}{8}in\right)$ $\quad d_{wallandroof5} = 6.69\,in$

$d_{wallandroof6} := 9in - 2in - \frac{1}{2}\cdot\left(\frac{6}{8}in\right)$ $\quad d_{wallandroof6} = 6.62\,in$

DMJM HARRIS	PROJECT: Bethany Home Outfall Channel - Reach B & C	JOB NO. 6063.0018	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8x7 Double Cell Box Culvert		CHECKED BY: SEO	DATE 1-05

Calculate moment capacity of #6 @ 12" and determine cutoff location for negative steel.

$A_{check} := 0.44in^2$

$a := \frac{A_{check} \cdot f_y}{0.85 \cdot f_c \cdot b}$ $\quad a = 0.74\,in$

$\Phi M_n := 0.9 \cdot A_{check} \cdot f_y \cdot \left(d_{wallandroof6} - \frac{a}{2}\right)$ $\quad \Phi M_n = 12.39\,kips \cdot ft$

Based on the moment envelope diagrams, #6 @ 6" could be terminated at 0.87' away from support.

$barextend := \max\left(15 \cdot \frac{6}{8}\,in, d_{wallandroof6}, \frac{1}{20} \cdot 8ft\right)$ $\quad barextend = 11.25\,in$

$l_d := \frac{\frac{0.04 \cdot 0.44in^2 \cdot f_y}{psi \cdot in}}{\sqrt{\frac{f_c}{psi}}}$ $\quad l_d = 17.85\,in$

Based on the development length needed and the length of bar that needs to extend beyond the point where reinforcement is not needed, provide a **5'-6" long bar @ 12" alternating with a # 6 bar that extends to a hooked bar at the corners (1'-6" lap). At this location, the negative moment does not control.**

DMJM HARRIS	PROJECT: Bethany Home Outfall Channel - Reach B & C	JOB NO. 6063.0018	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: 8x7 Double Cell Box Culvert		CHECKED BY: SEO	DATE 1-05

Calculate moment capacity of #5 @ 12" and determine cutoff location for positive steel.

$A_{check} := 0.31 in^2$

$a := \frac{A_{check} \cdot f_y}{0.85 \cdot f_c \cdot b}$ $\quad a = 0.52 in$

$\Phi M_n := 0.9 \cdot A_{check} \cdot f_y \cdot \left(d_{wallandroof5} - \frac{a}{2}\right)$ $\quad \Phi M_n = 8.97 kips \cdot ft$

Based on the moment envelope diagrams, #5 @ 6" could be terminated at 2.47' away from exterior wall and 3.46' away from interior wall.

$barextend := \max\left(15 \cdot \frac{5}{8} in, d_{wallandroof5}, \frac{1}{20} \cdot 8ft\right)$ $\quad barextend = 9.38 in$

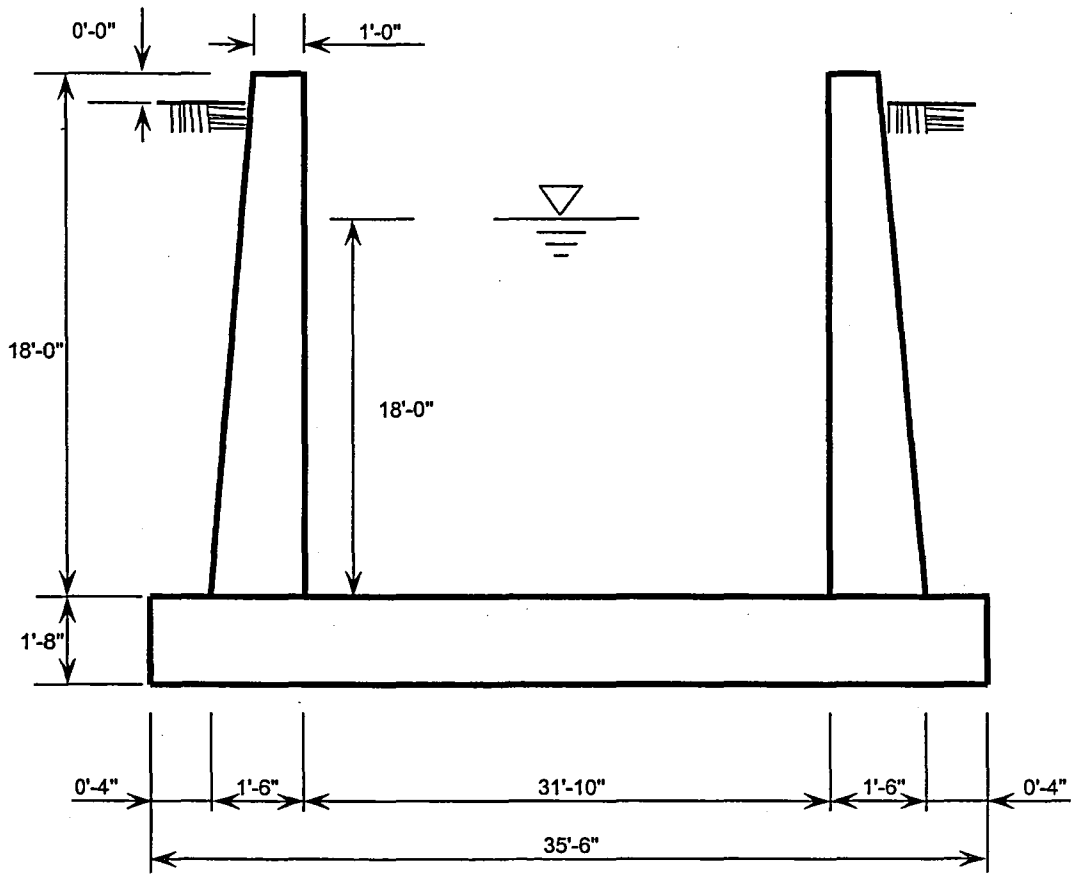
$l_d := \frac{\frac{0.04 \cdot 0.31 in^2 \cdot f_y}{psi \cdot in}}{\sqrt{\frac{f_c}{psi}}}$ $\quad l_d = 12.58 in$

Based on this, the bar could be terminated 1.42' +/- away from CL exterior wall. Therefore, terminate the bar 1'-3" away from face of wall. For the interior wall, the bar could be terminated approx 2.41' away from CL (approx 2'-5"). The bar can be 5'-0".
Make the bar 5'-6" long and space it 1'-3" away from the face of wall.

For wall steel, this same moment capacity could be terminated less than 10" away from support. **Utilize 3'-0" hooks on into wall and slab.**

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

83rd AVE RECTANGULAR CHANNEL



DESIGN CRITERIA

DESIGN IN ACCORDANCE WITH AASHTO LOAD FACTOR DESIGN

SOIL PARAMETERS:

γ = 120 pcf
σa = 35 pcf
qa = 3.5 ksf

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

83rd AVE RECTANGULAR CHANNEL

CANTILEVER WALL DESIGN

TRY A 18" CONC WALL

f'c = 3500 psi
Fy = 60 ksi

EARTH LOADING

Mu = 1.69 [1 / 6 (35 pcf) (18'-0") ^ 3 + 1 / 2 (2'-0") (35 pcf) (18'-0") ^ 2]
= 70.9 ft-kips

F = 0.237
Ku = 299.32
au = 4.2317
As = 1.09 in^2
As min = 0.42 in^2
As max = 3.46 in^2
As provide = 1.04 in^2

∴ **SEE TABLE FOR BAR SELECTION AND PATTERN**

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

83rd AVE RECTANGULAR CHANNEL

HYDROSTATIC LOADING (conservatively use water pressure minus active pressure)

Mu = 1.3 [1 / 6 (62.4 pcf - 35 pcf) (18'-0") ^ 3]
= 31.8 ft-kips

F = 0.237
Ku = 134.2303
au = 4.3839
As = 0.47 in^2
As min = 0.42 in^2
As max = 3.46 in^2
As provide = 0.47 in^2 ∴ **USE #7 @ 12" o/c**

SHEAR

V = 1.3 [1 / 2 (62.4 pcf) (18'-0") ^ 2]
= 11.1 kips

Vc = Φ 2 SQRT(f'c) bd = 18.58 kips > Vu ∴ OK

Results

WALLS

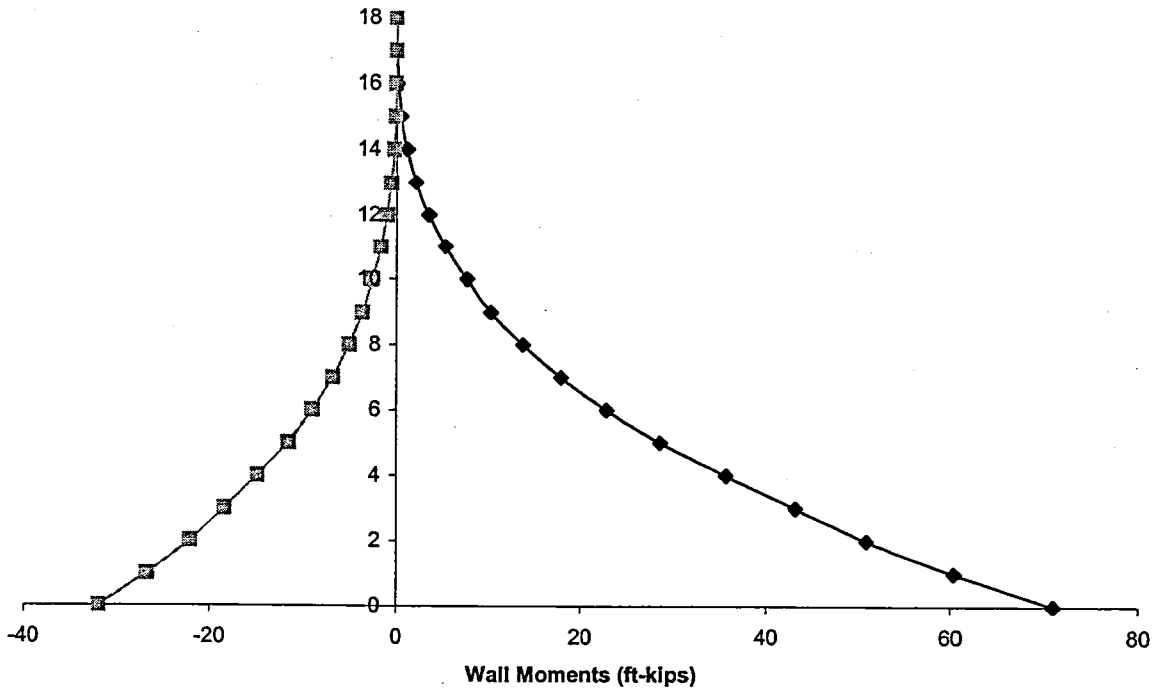
Location	MOMENTS E	MOMENTS SF	SHEAR
0	70.9491927	-31.8168229	11.1275938
1	60.388	-26.7	10.0037438
2	50.922	-22.1	8.93904375
3	43.155	-18.4	8.01503038
4	35.621	-14.9	7.06370122
5	28.497	-11.6	6.09984375
6	22.816	-9.0	5.27174375
7	17.934	-6.9	4.50279375
8	13.791	-5.1	3.79299375
9	10.328	-3.6	3.14234375
10	7.701	-2.6	2.59787622
11	5.376	-1.7	2.06059705
12	3.560	-1.0	1.58246788
13	2.192	-0.6	1.16348872
14	1.213	-0.3	0.80365955
15	0.565	-0.1	0.50298038
16	0.187	0.0	0.26145122
17	0.022	0.0	0.07907205
18	0.000	0.0	0.01006372

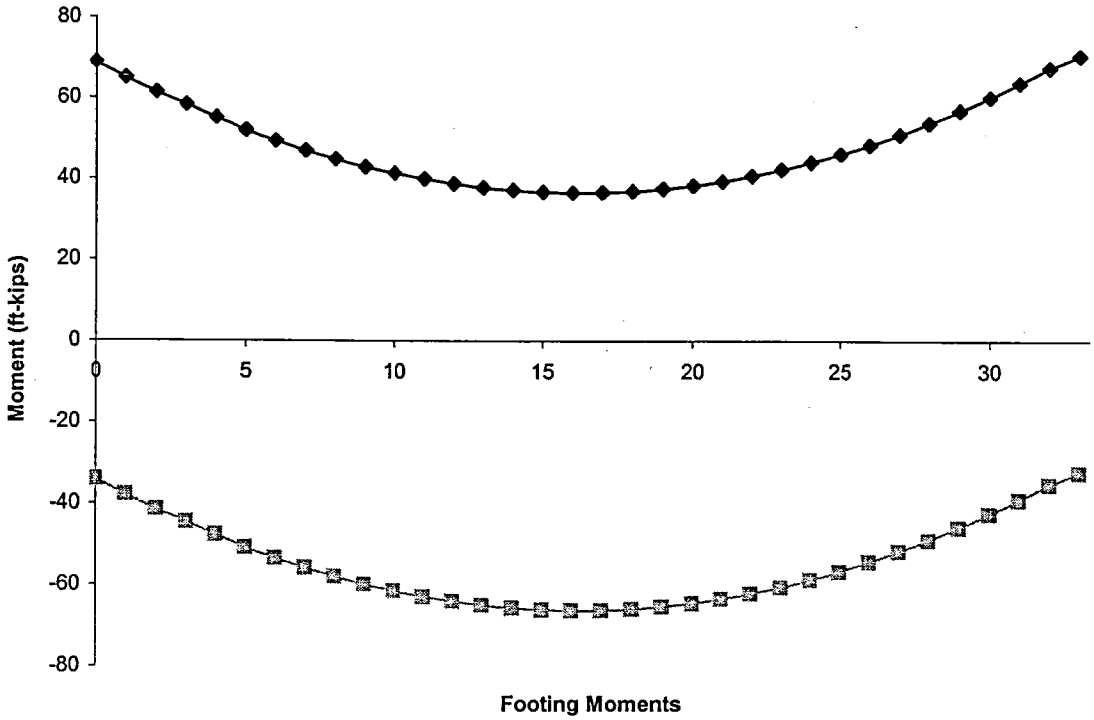
FOOTING

Location	MOMENTS E	MOMENTS SF
0	68.9202314	-33.8457842
1	65.0476962	-37.7
2	61.4223441	-41.3
3	58.3162482	-44.4
4	55.1646637	-47.6
5	52.0293864	-50.7
6	49.3927667	-53.4
7	47.00333	-55.8
8	44.8610765	-57.9
9	42.9660061	-59.8
10	41.4460017	-61.3
11	40.0246989	-62.7
12	38.8505792	-63.9
13	37.9236426	-64.8
14	37.243889	-65.5
15	36.8113186	-66.0
16	36.6259313	-66.1
17	36.6877271	-66.1
18	36.996706	-65.8
19	37.6103723	-65.2
20	38.434316	-64.3
21	39.5054428	-63.3
22	40.8237526	-61.9
23	42.3892456	-60.4
24	44.2019217	-58.6
25	46.2617808	-56.5
26	48.5688231	-54.2
27	51.1230484	-51.6
28	53.9244569	-48.8415587
29	56.9730485	-45.7929672
30	60.2688231	-42.4971925
31	63.8117809	-38.9542348
32	67.6019217	-35.1640939
33	70.6067413	-32.1592744

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN		CHECKED BY: SEO	DATE 2-05

MOMENT ENVELOPES





DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

Outside Face Wall Cut-Offs - Earth Load Only

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	70.95	1.50	15.6	1.04	1.75	69.03	15.97	2.38	2.00	28.50	41.98	31.00	126.34	#7 @ 12";#6 @ 12" (say ok - 2.7% overstress quickly diminished within an inch of top of footing)
1.00	60.39	1.47	15.3	1.04	1.75	67.47	15.68	2.38	2.00	28.50	35.73	26.96	109.88	#7 @ 12";#6 @ 12"
2.00	50.92	1.44	15.0	1.04	1.75	65.91	15.38	2.38	2.00	28.50	30.13	23.24	94.72	#7 @ 12";#6 @ 12"
3.00	43.16	1.42	14.6	1.04	1.75	64.35	15.09	2.38	2.00	28.50	25.54	20.15	82.10	#7 @ 12";#6 @ 12"
4.00	35.62	1.39	14.3	1.04	1.75	62.79	14.79	2.38	2.00	28.50	21.08	17.02	69.35	#7 @ 12";#6 @ 12"
5.00	28.50	1.36	14.0	1.04	1.75	61.23	14.49	2.38	2.00	28.50	16.86	13.94	56.80	#7 @ 12";#6 @ 12"
6.00	22.82	1.33	13.6	0.44	0.74	26.25	14.20	2.38	1.00	57.00	13.50	27.02	138.75	#6 @ 12"
7.00	17.93	1.31	13.3	0.31	0.52	18.18	13.90	2.38	1.00	57.00	10.61	30.90	158.68	#5 @ 12"
8.00	13.79	1.28	13.0	0.31	0.52	17.71	13.61	2.38	1.00	57.00	8.16	24.38	125.16	#5 @ 12"
9.00	10.33	1.25	12.6	0.31	0.52	17.25	13.31	2.38	1.00	57.00	6.11	18.74	96.21	#5 @ 12"
10.00	7.70	1.22	12.3	0.31	0.52	16.78	13.02	2.38	1.00	57.00	4.56	14.35	73.68	#5 @ 12"
11.00	5.38	1.19	12.0	0.31	0.52	16.32	12.72	2.38	1.00	57.00	3.18	10.30	52.88	#5 @ 12"
12.00	3.56	1.17	11.6	0.31	0.52	15.85	12.42	2.38	1.00	57.00	2.11	7.01	36.01	#5 @ 12"
13.00	2.19	1.14	11.3	0.31	0.52	15.39	12.13	2.38	1.00	57.00	1.30	4.45	22.83	#5 @ 12"
14.00	1.21	1.11	11.0	0.31	0.52	14.92	11.83	2.38	1.00	57.00	0.72	2.54	13.02	#5 @ 12"
15.00	0.56	1.08	10.6	0.31	0.52	14.46	11.54	2.38	1.00	57.00	0.33	1.22	6.25	#5 @ 12"
16.00	0.19	1.06	10.3	0.31	0.52	13.99	11.24	2.38	1.00	57.00	0.11	0.42	2.14	#5 @ 12"
17.00	0.02	1.03	10.0	0.31	0.52	13.53	10.94	2.38	1.00	57.00	0.01	0.05	0.26	#5 @ 12"
18.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.01	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	10.8
5	0.625	9.375	15.63	10.8
6	0.75	11.25	15.63	10.8
7	0.875	13.125	15.63	10.8
8	1	15	15.63	10.8
9	1.128	16.92	15.63	10.8

Summary

For #7@12", extend hook to 7.5' beyond top of footing or say 9'-0" even (from bottom of footing)
For #6@12", extend hook to 8.5' beyond top of footing, or say 10'-0" even.
Utilize #5 @ 12" to lap into #6 @ 12".

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6053	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

Bottom Slab Reinforcement Cut-Offs

L feet	Moment kip-ft	Bim Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Fla thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check: dc	# of bars per foot	A	Mc	fs (max 36 ksi)	z < 1707	Comments
0.00	68.92	0	68.92	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	40.78	26.30	145.80	#7 @ 12"; #6 @ 12"
1.00	68.92	-0.038649215	68.88	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	40.78	26.29	145.72	#7 @ 12"; #6 @ 12"
2.00	68.92	-0.293193718	68.63	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	40.61	26.18	145.18	#7 @ 12"; #6 @ 12"
3.00	68.92	-0.989528797	67.93	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	40.20	27.90	143.70	#7 @ 12"; #6 @ 12"
4.00	68.92	-2.345548741	66.57	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	39.39	27.34	140.84	#7 @ 12"; #6 @ 12"
5.00	68.92	-4.581151837	64.34	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	38.07	26.42	136.11	#7 @ 12"; #6 @ 12"
6.00	68.92	-7.916230375	61.00	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	36.10	25.05	129.05	#7 @ 12"; #6 @ 12"
7.00	68.92	-12.57068064	56.35	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	33.34	23.14	119.20	#7 @ 12"; #6 @ 12"
8.00	68.92	-18.76439793	50.16	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	29.68	20.60	106.10	#7 @ 12"; #6 @ 12"
9.00	68.92	-26.71727751	42.20	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	24.87	17.33	89.26	#7 @ 12"; #6 @ 12"
10.00	68.92	-36.6492147	32.27	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	19.10	13.25	68.27	#7 @ 12"; #6 @ 12"
11.00	68.92	-48.78010476	20.14	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	11.92	19.55	126.68	#6 @ 12"
12.00	68.92	-63.329643	5.59	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	3.31	5.43	35.22	#6 @ 12"
13.00	68.92	-80.51832469	0.00	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	0.00			#6 @ 12"
14.00	68.92	-100.5854451	0.00	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	0.00			#6 @ 12"
15.00	68.92	-123.8810998	0.00	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	0.00			#6 @ 12"

(1) Utilize a triangular distribution of zero at wall to allowable bearing pressure at wall CL, Minimum moment = 0.

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	10.8
5	0.625	9.375	16.63	10.8
6	0.75	11.25	16.63	10.8
7	0.875	13.125	16.63	10.8
8	1	15	16.63	10.8
9	1.128	16.92	16.63	10.8

Summary

For # 7 @ 12", extend hook to 10'-0" + 1'-6" wall + 1'-5" extension = 13'-0".
For # 6 @ 12", extend hook 4'-0" and provide a class C lap = 1.7 * ld = 30.3", say 2'-7" lap on both sides.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

Inside Face Wall Cut-Offs - Hydrostatic - Earth (Conservative)

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	31.82	1.50	15.6	0.62	1.04	42.14	15.97	2.38	2.00	28.50	26.51	32.84	133.85	#5 @ 12"; #5 @ 12"
1.00	30.05	1.47	15.3	0.62	1.04	41.21	15.68	2.38	2.00	28.50	25.04	31.69	129.17	#5 @ 12"; #5 @ 12"
2.00	28.28	1.44	15.0	0.62	1.04	40.28	15.38	2.38	2.00	28.50	23.57	30.50	124.28	#5 @ 12"; #5 @ 12"
3.00	26.51	1.42	14.6	0.62	1.04	39.35	15.09	2.38	2.00	28.50	22.10	29.24	119.17	#5 @ 12"; #5 @ 12"
4.00	24.75	1.39	14.3	0.62	1.04	38.42	14.79	2.38	2.00	28.50	20.62	27.93	113.82	#5 @ 12"; #5 @ 12"
5.00	22.98	1.36	14.0	0.62	1.04	37.49	14.49	2.38	2.00	28.50	19.15	26.55	108.21	#5 @ 12"; #5 @ 12"
6.00	21.21	1.33	13.6	0.62	1.04	36.56	14.20	2.38	2.00	28.50	17.68	25.11	102.33	#5 @ 12"; #5 @ 12"
7.00	19.44	1.31	13.3	0.62	1.04	35.63	13.90	2.38	2.00	28.50	16.20	23.59	96.15	#5 @ 12"; #5 @ 12"
8.00	17.68	1.28	13.0	0.62	1.04	34.70	13.61	2.38	2.00	28.50	14.73	22.00	89.66	#5 @ 12"; #5 @ 12"
9.00	15.91	1.25	12.6	0.62	1.04	33.77	13.31	2.38	2.00	28.50	13.26	20.32	82.83	#5 @ 12"; #5 @ 12"
10.00	14.14	1.22	12.3	0.62	1.04	32.84	13.02	2.38	2.00	28.50	11.78	18.56	75.62	#5 @ 12"; #5 @ 12"
11.00	12.37	1.19	12.0	0.62	1.04	31.91	12.72	2.38	2.00	28.50	10.31	16.69	68.01	#5 @ 12"; #5 @ 12"
12.00	10.61	1.17	11.6	0.31	0.52	15.85	12.42	2.38	1.00	57.00	8.84	29.43	151.11	#5 @ 12"
13.00	8.84	1.14	11.3	0.31	0.52	15.39	12.13	2.38	1.00	57.00	7.37	25.25	129.64	#5 @ 12"
14.00	7.07	1.11	11.0	0.31	0.52	14.92	11.83	2.38	1.00	57.00	5.89	20.81	106.87	#5 @ 12"
15.00	5.30	1.08	10.6	0.31	0.52	14.46	11.54	2.38	1.00	57.00	4.42	16.10	82.66	#5 @ 12"
16.00	3.54	1.06	10.3	0.31	0.52	13.99	11.24	2.38	1.00	57.00	2.95	11.08	56.89	#5 @ 12"
17.00	1.77	1.03	10.0	0.31	0.52	13.53	10.94	2.38	1.00	57.00	1.47	5.73	29.40	#5 @ 12"
18.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.00	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	10.8
5	0.625	9.375	15.63	10.8
6	0.75	11.25	15.63	10.8
7	0.875	13.125	15.63	10.8
8	1	15	15.63	10.8
9	1.128	16.92	15.63	10.8

Summary

For #5 @ 12", make bar 13'-6" long - lap w/ dowel bar = 1.7 * 15" = say 2'-6" lap.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 83rd Avenue		CHECKED BY: SEO	DATE 2-05

Top Slab Reinforcement Cut-Offs (Hydrostatic - Active Earth Pressure)

L feet	Moment kip-ft	Bim Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Fig thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check: de	# of bars per foot	A	Ms	fs (max 36 ksi)	g < 170?	Comments
0.00	31.82	0	31.82	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	16.63	16.12	93.33	#6 @ 12"; #5 @ 12"
1.00	31.82	-1.303337698	30.51	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	16.06	17.35	89.51	#6 @ 12"; #5 @ 12"
2.00	31.82	-5.176701571	26.64	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	15.76	15.17	78.15	#6 @ 12"; #5 @ 12"
3.00	31.82	-11.5651176	20.25	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	11.98	11.53	59.41	#6 @ 12"; #5 @ 12"
4.00	31.82	-20.41361256	11.40	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	6.75	15.71	101.96	#5 @ 12"
5.00	31.82	-31.60721204	0.15	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.09	0.21	1.34	#5 @ 12"
6.00	31.82	-45.27084241	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
7.00	31.82	-61.16982984	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
8.00	31.82	-79.30890052	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
9.00	31.82	-99.63318062	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
10.00	31.82	-122.0876963	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
11.00	31.82	-146.8174738	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
12.00	31.82	-173.1675393	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
13.00	31.82	-201.6525188	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
14.00	31.82	-232.1046387	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
15.00	31.82	-264.3697251	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"

(1) Utilize a triangular distribution of maximum allowable bearing pressure at wall to zero at wall CL. Minimum moment = 0. Recall that unit weight of water is less than soil removed - ignore contribution since earth treatment is still conservative.

Bar Cutoff Extension Table

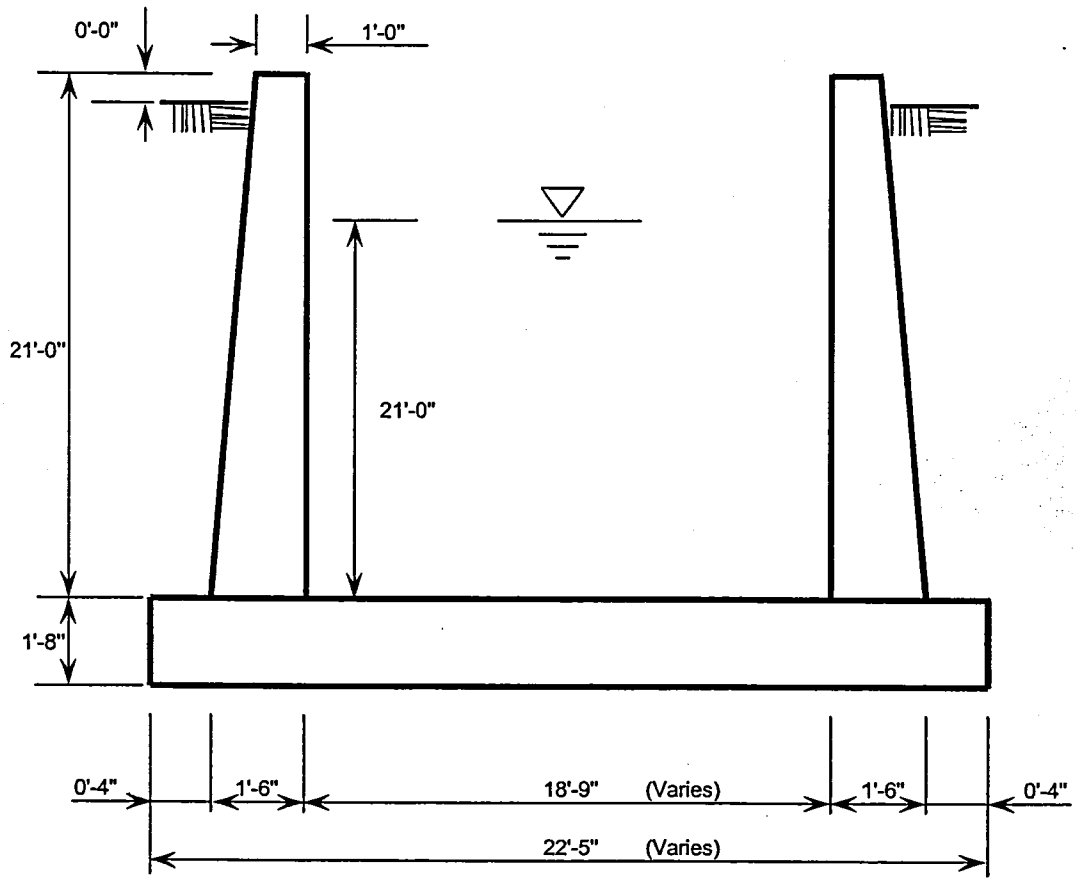
Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	10.8
5	0.625	9.375	16.63	10.8
6	0.75	11.25	16.63	10.8
7	0.875	13.125	16.63	10.8
8	1	15	16.63	10.8
9	1.128	16.92	16.63	10.8

Summary

Hook # 6 bar to develop moment - terminate # 6 bar 4'-6" away from wall, minimum, or 4" + 1.8' + 4.8' = 6'-4" long
Hook #5 bar and run full length.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY: SEO	DATE 2-05

75TH AVENUE RECTANGULAR CHANNEL



DESIGN CRITERIA

DESIGN IN ACCORDANCE WITH AASHTO LOAD FACTOR DESIGN

SOIL PARAMETERS:

γ = 120 pcf
σa = 35 pcf
qa = 2.5 ksf

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		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY: SEO	DATE 2-05

75TH AVENUE RECTANGULAR CHANNEL

CANTILEVER WALL DESIGN

TRY A 18" CONC WALL

f'c = 3500 psi
Fy = 60 ksi

EARTH LOADING

Mu = 1.69 [1 / 6 (35 pcf) (21'-0") ^ 3 + 1 / 2 (2'-0") (35 pcf) (21'-0") ^ 2]
= 109.8 ft-kips

F = 0.2378
Ku = 461.75
au = 4.0697
As = 1.75 in^2
As min = 0.42 in^2
As max = 3.46 in^2
As provide = 1.79 in^2

∴ **See Table For Selected Reinforcement**

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY: SEO	DATE 2-05

75TH AVENUE RECTANGULAR CHANNEL

HYDROSTATIC LOADING (conservatively use water pressure minus active pressure)

Mu = 1.3 [1 / 6 (62.4 pcf - 35 pcf) (21'-0") ^ 3]
= 51.1 ft-kips

F = 0.2378
Ku = 215.1075
au = 4.3107
As = 0.77 in^2
As min = 0.42 in^2
As max = 3.46 in^2
As provide = 0.93 in^2 ∴ **See Table For Selected Reinforcement**

SHEAR

V = 1.3 [1 / 2 (62.4 pcf) (21'-0") ^ 2]
= 14.9 kips

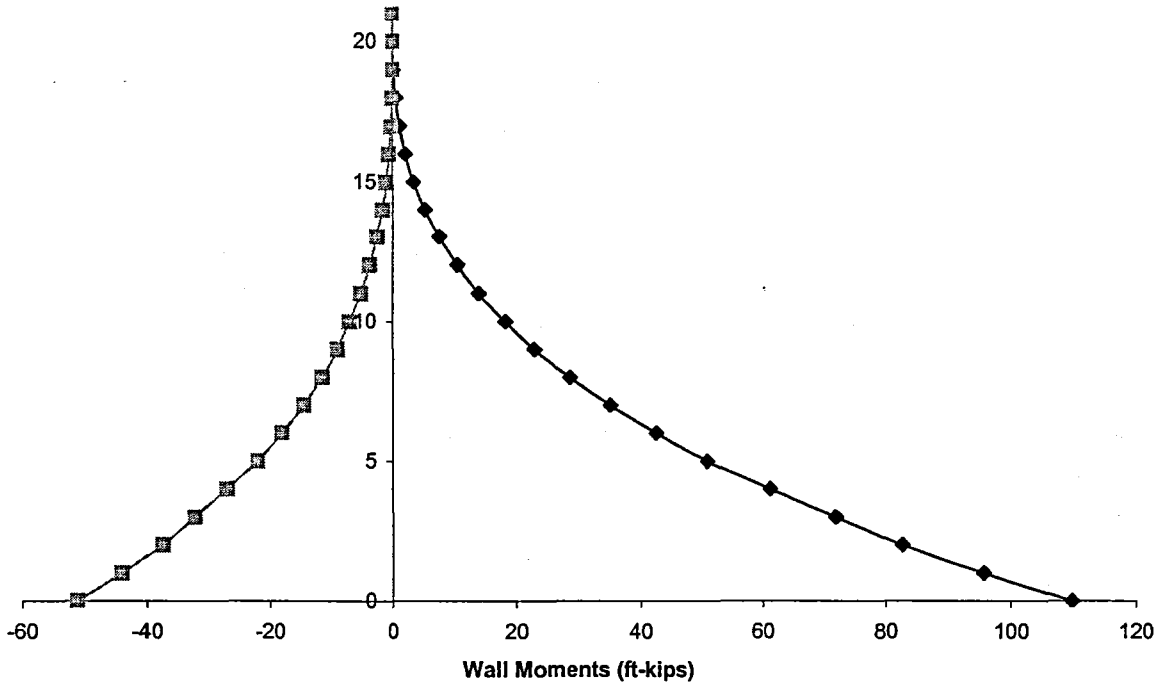
Vc = Φ 2 SQRT(f'c) bd = 18.61 kips > Vu ∴ OK

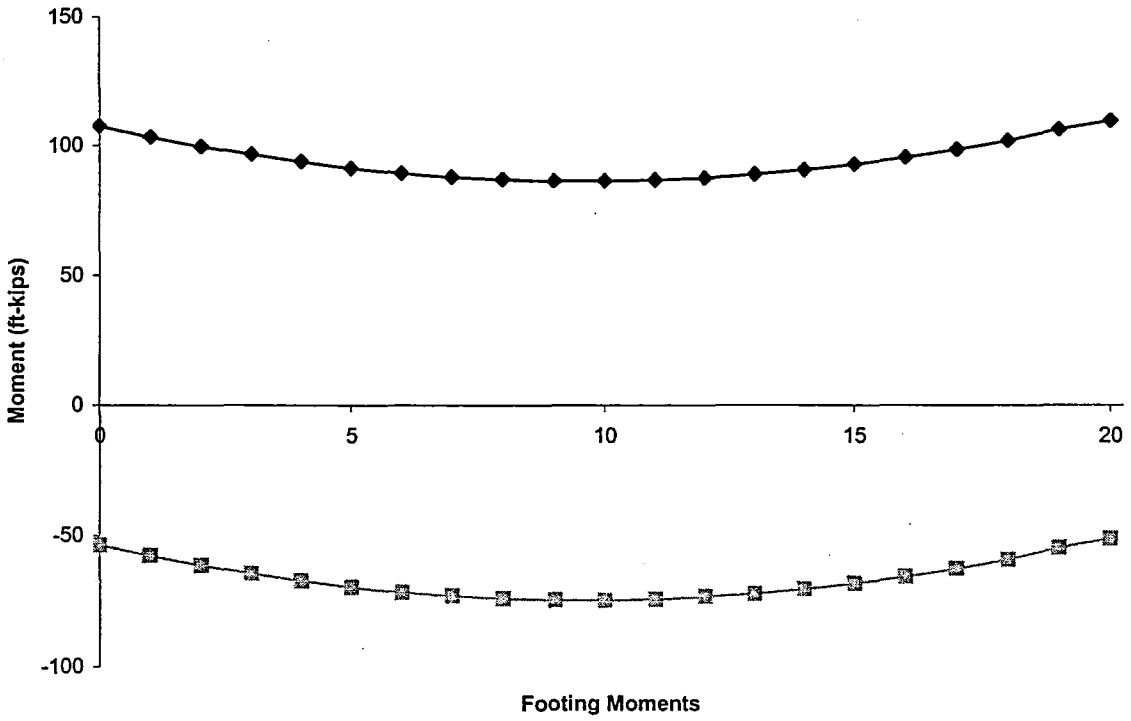
Results

	WALLS				FOOTING	
	MOMENTS		SHEAR		MOMENTS	
Location	E	SF		Location	E	SF
0	109.788561	-51.1451254	14.8540438	0	107.533647	-53.4000395
1	95.590	-44.0	13.5527438	1	103.366338	-57.6
2	82.663	-37.6	12.3105938	2	99.6557199	-61.3
3	71.881	-32.3	11.2239179	3	96.6555108	-64.3
4	61.226	-27.1	10.0951387	4	93.8202181	-67.1
5	50.922	-22.1	8.93904375	5	91.2640145	-69.7
6	42.491	-18.1	7.93349375	6	89.3801623	-71.6
7	35.035	-14.6	6.98709375	7	87.9530015	-73.0
8	28.497	-11.6	6.09984375	8	86.9825322	-74.0
9	22.816	-9.0	5.27174375	9	86.4687543	-74.5
10	18.311	-7.0	4.56461372	10	86.398982	-74.5
11	14.109	-5.2	3.84988455	11	86.7605294	-74.2
12	10.592	-3.8	3.19430538	12	87.5787682	-73.4
13	7.701	-2.6	2.59787622	13	88.8536985	-72.1
14	5.376	-1.7	2.06059705	14	90.5853203	-70.3
15	3.560	-1.0	1.58246788	15	92.7736335	-68.2
16	2.192	-0.6	1.16348872	16	95.4186381	-65.5
17	1.213	-0.3	0.80365955	17	98.5203342	-62.4
18	0.565	-0.1	0.50298038	18	102.078722	-58.9
19	0.166	0.0	0.24399375	19	106.449005	-54.5
20	0.016	0.0	0.06654375	20	109.788561	-51.1
21	0.000	0.0	3.3623E-15			

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN		CHECKED BY: SEO	DATE 2-05

MOMENT ENVELOPES





DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY: SEO	DATE 2-05

Outside Face Wall Cut-Offs - Earth Load Only

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	109.79	1.50	15.6	1.79	3.01	113.74	15.97	2.38	2.00	28.50	64.96	27.87	113.59	#9 @ 12";#8 @ 12"
1.00	95.59	1.48	15.3	1.79	3.01	111.44	15.72	2.38	2.00	28.50	56.56	24.72	100.74	#9 @ 12";#8 @ 12"
2.00	82.66	1.45	15.1	1.79	3.01	109.14	15.47	2.38	2.00	28.50	48.91	21.78	88.77	#9 @ 12";#8 @ 12"
3.00	71.88	1.43	14.8	1.79	3.01	106.84	15.21	2.38	2.00	28.50	42.53	19.31	78.69	#9 @ 12";#8 @ 12"
4.00	61.23	1.40	14.5	1.10	1.85	67.11	14.96	2.38	2.00	28.50	36.23	27.29	111.22	#8 @ 12";#5 @ 12"
5.00	50.92	1.38	14.2	1.10	1.85	65.70	14.71	2.38	2.00	28.50	30.13	23.15	94.36	#8 @ 12";#5 @ 12"
6.00	42.49	1.36	13.9	1.10	1.85	64.28	14.45	2.38	2.00	28.50	25.14	19.72	80.35	#8 @ 12";#5 @ 12"
7.00	35.04	1.33	13.6	1.10	1.85	62.87	14.20	2.38	2.00	28.50	20.73	16.60	67.64	#8 @ 12";#5 @ 12"
8.00	28.50	1.31	13.3	1.10	1.85	61.45	13.95	2.38	2.00	28.50	16.86	13.79	56.20	#8 @ 12";#5 @ 12"
9.00	22.82	1.29	13.1	1.10	1.85	60.04	13.69	2.38	2.00	28.50	13.50	11.28	45.98	#8 @ 12";#5 @ 12"
10.00	18.31	1.26	12.8	1.10	1.85	58.63	13.44	2.38	2.00	28.50	10.84	9.26	37.73	#8 @ 12";#5 @ 12"
11.00	14.11	1.24	12.5	0.31	0.52	17.05	13.18	2.38	1.00	57.00	8.35	25.89	132.94	#5 @ 12"
12.00	10.59	1.21	12.2	0.31	0.52	16.65	12.93	2.38	1.00	57.00	6.27	19.89	102.14	#5 @ 12"
13.00	7.70	1.19	11.9	0.31	0.52	16.25	12.68	2.38	1.00	57.00	4.56	14.81	76.04	#5 @ 12"
14.00	5.38	1.17	11.6	0.31	0.52	15.85	12.42	2.38	1.00	57.00	3.18	10.59	54.39	#5 @ 12"
15.00	3.56	1.14	11.3	0.31	0.52	15.45	12.17	2.38	1.00	57.00	2.11	7.19	36.92	#5 @ 12"
16.00	2.19	1.12	11.1	0.31	0.52	15.06	11.92	2.38	1.00	57.00	1.30	4.54	23.32	#5 @ 12"
17.00	1.21	1.10	10.8	0.31	0.52	14.66	11.66	2.38	1.00	57.00	0.72	2.58	13.25	#5 @ 12"
18.00	0.56	1.07	10.5	0.31	0.52	14.26	11.41	2.38	1.00	57.00	0.33	1.23	6.34	#5 @ 12"
19.00	0.17	1.05	10.2	0.31	0.52	13.86	11.16	2.38	1.00	57.00	0.10	0.37	1.92	#5 @ 12"
20.00	0.02	1.02	9.9	0.31	0.52	13.46	10.90	2.38	1.00	57.00	0.01	0.04	0.19	#5 @ 12"
21.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.00	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	12.6
5	0.625	9.375	15.63	12.6
6	0.75	11.25	15.63	12.6
7	0.875	13.125	15.63	12.6
8	1	15	15.63	12.6
9	1.128	16.92	15.63	12.6

Summary

For #9@12", extend hook ~~to 4.5' beyond top of footing or say~~ 7'-0" even (from bottom of footing)

For #8@12", extend hook ~~to 11.5' beyond top of footing or~~ say ~~12'-0"~~ 14'-0" even (from bottom of footing)

Utilize # 5 @ 12" to lap into short leg of # 9 @ 12" (use class C lap = 2'-6")

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY GEO	DATE 2-05

Bottom Slab Reinforcement Cut-Offs

L feet	Moment kip-ft	Bim Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Fts thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check: de	# of bars per foot	A	Ms	fs (max 36 ksi)	z < 1707	Comments
0.00	107.53	0	107.53	1.67	16.6	1.79	3.01	121.80	17.75	3.38	2	40.50	63.63	25.86	132.17	#9 @ 12"; # 8 @ 12"
1.00	107.53	-0.666666669	107.44	1.67	16.6	1.79	3.01	121.80	17.75	3.38	2	40.50	63.58	25.84	132.08	#9 @ 12"; # 8 @ 12"
2.00	107.53	-0.711111111	106.82	1.67	16.6	1.79	3.01	121.80	17.75	3.38	2	40.50	63.21	25.49	131.29	#9 @ 12"; # 8 @ 12"
3.00	107.53	-2.4	105.13	1.67	16.6	1.79	3.01	121.80	17.75	3.38	2	40.50	62.21	25.09	129.22	#9 @ 12"; # 8 @ 12"
4.00	107.53	-5.688888889	101.84	1.67	16.6	1.79	3.01	121.80	17.75	3.38	2	40.50	60.26	24.30	125.18	#9 @ 12"; # 8 @ 12"
5.00	107.53	-11.11111111	96.42	1.67	16.6	1.44	2.42	99.89	17.75	3.38	2	40.50	57.05	20.60	147.32	#9 @ 12"; # 8 @ 12"
6.00	107.53	-19.2	88.33	1.67	16.6	1.44	2.42	99.89	17.75	3.38	2	40.50	52.27	26.20	134.96	#9 @ 12"; # 6 @ 12"
7.00	107.53	-30.48888889	77.04	1.67	16.6	1.44	2.42	99.89	17.75	3.38	2	40.50	45.59	22.85	117.71	#9 @ 12"; # 6 @ 12"
8.00	107.53	-45.51111111	62.02	1.67	16.6	1.44	2.42	99.89	17.75	3.38	2	40.50	36.70	18.40	94.78	#9 @ 12"; # 6 @ 12"
9.00	107.53	-64.8	42.73	1.67	16.6	1.44	2.42	99.89	17.75	3.38	2	40.50	25.29	12.67	65.28	#9 @ 12"; # 6 @ 12"

(1) Utilize a triangular distribution of zero at wall to allowable bearing pressure at wall CL. Minimum moment = 0.

Bar Cutoff Extension Table

Bar Siz	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	12.6
5	0.625	9.375	16.63	12.6
6	0.75	11.25	16.63	12.6
7	0.875	13.125	16.63	12.6
8	1	15	16.63	12.6
9	1.128	16.92	16.63	12.6

Summary

For # 9 @ 12", provide 5'-6" hook.
For # 8 @ 12", provide 5'-6" hook and class C lap of 3'-8" for #8 reinforcement.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY: SEO	DATE 2-05

Interior Face Wall Cut-Offs - Hydrostatic - Earth Load (Conservative)

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	51.15	1.50	15.6	0.93	1.56	62.12	15.97	2.38	3.00	19.00	42.62	35.20	125.30	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
1.00	48.71	1.48	15.3	0.93	1.56	60.92	15.72	2.38	3.00	19.00	40.59	34.14	121.56	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
2.00	46.27	1.45	15.1	0.93	1.56	59.73	15.47	2.38	3.00	19.00	38.56	33.05	117.67	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
3.00	43.84	1.43	14.8	0.93	1.56	58.53	15.21	2.38	3.00	19.00	36.53	31.92	113.64	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
4.00	41.40	1.40	14.5	0.93	1.56	57.34	14.96	2.38	3.00	19.00	34.50	30.74	109.44	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
5.00	38.97	1.38	14.2	0.93	1.56	56.14	14.71	2.38	3.00	19.00	32.47	29.52	105.08	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
6.00	36.53	1.36	13.9	0.93	1.56	54.95	14.45	2.38	3.00	19.00	30.44	28.24	100.53	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
7.00	34.10	1.33	13.6	0.93	1.56	53.75	14.20	2.38	3.00	19.00	28.41	26.91	95.80	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
8.00	31.66	1.31	13.3	0.93	1.56	52.55	13.95	2.38	3.00	19.00	26.38	25.52	90.86	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
9.00	29.23	1.29	13.1	0.93	1.56	51.36	13.69	2.38	3.00	19.00	24.35	24.07	85.71	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
10.00	26.79	1.26	12.8	0.62	1.04	34.17	13.44	2.38	2.00	28.50	22.33	33.84	137.92	#5 @ 12"; #5 @ 12"
11.00	24.35	1.24	12.5	0.62	1.04	33.37	13.18	2.38	2.00	28.50	20.30	31.47	128.25	#5 @ 12"; #5 @ 12"
12.00	21.92	1.21	12.2	0.62	1.04	32.57	12.93	2.38	2.00	28.50	18.27	28.99	118.13	#5 @ 12"; #5 @ 12"
13.00	19.48	1.19	11.9	0.62	1.04	31.78	12.68	2.38	2.00	28.50	16.24	26.38	107.52	#5 @ 12"; #5 @ 12"
14.00	17.05	1.17	11.6	0.62	1.04	30.98	12.42	2.38	2.00	28.50	14.21	23.65	96.40	#5 @ 12"; #5 @ 12"
15.00	14.61	1.14	11.3	0.62	1.04	30.18	12.17	2.38	2.00	28.50	12.18	20.79	84.71	#5 @ 12"; #5 @ 12"
16.00	12.18	1.12	11.1	0.62	1.04	29.39	11.92	2.38	2.00	28.50	10.15	17.77	72.41	#5 @ 12"; #5 @ 12"
17.00	9.74	1.10	10.8	0.31	0.52	14.66	11.66	2.38	1.00	57.00	8.12	29.18	149.85	#5 @ 12"
18.00	7.31	1.07	10.5	0.31	0.52	14.26	11.41	2.38	1.00	57.00	6.09	22.49	115.45	#5 @ 12"
19.00	0.17	1.05	10.2	0.31	0.52	13.86	11.16	2.38	1.00	57.00	0.14	0.53	2.70	#5 @ 12"
20.00	0.02	1.02	9.9	0.31	0.52	13.46	10.90	2.38	1.00	57.00	0.01	0.05	0.27	#5 @ 12"
21.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.00	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	12.6
5	0.625	9.375	15.63	12.6
6	0.75	11.25	15.63	12.6
7	0.875	13.125	15.63	12.6
8	1	15	15.63	12.6
9	1.128	16.92	15.63	12.6

Summary

Although the design calls for #5 @ 4", it is based on a conservative treatment of hydrostatic and soil pressures. Provide #5 @ 6" and terminate every other bar approximately at mid-height of wall.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET -
		DESIGNED BY: CAL	DATE 1-05
SUBJECT U-SHAPE CHANNEL DESIGN - 75TH AVENUE		CHECKED BY: BEO	DATE 2-05

Top Slab Reinforcement Cut-Offs (Hydrostatic - Active Earth Pressure)

L feet	Moment kip-ft	Bns Slab Moment* earth (1) kip-ft	Design Moment kips-ft	Fin Thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.3 Mcr Moment Check	Crack Control Check: de	# of bars per foot	A	Ms	fs (max 36 ksi)	z < 170?	Comments
0.00	51.15	0	51.15	1.67	16.6	0.75	1.26	83.96	17.75	3.38	2	40.50	30.26	28.13	150.03	#6 @ 12"; #5 @ 12"
1.00	51.15	-0.926388889	50.22	1.67	16.6	0.75	1.26	83.96	17.75	3.38	2	40.50	29.72	26.60	147.31	#6 @ 12"; #5 @ 12"
2.00	51.15	-3.681111111	47.46	1.67	16.6	0.75	1.26	83.96	17.75	3.38	2	40.50	28.10	27.04	139.29	#6 @ 12"; #5 @ 12"
3.00	51.15	-8.1375	43.01	1.67	16.6	0.75	1.26	83.96	17.75	3.38	2	40.50	25.45	24.49	126.18	#6 @ 12"; #5 @ 12"
4.00	51.15	-14.28888889	36.86	1.67	16.6	0.75	1.26	83.96	17.75	3.38	1	81.00	21.81	20.99	136.22	#5 @ 12"
5.00	51.15	-22.04861111	29.10	1.67	16.6	0.75	1.26	83.96	17.75	3.38	1	81.00	17.22	16.57	107.54	#5 @ 12"
6.00	51.15	-31.35	19.80	1.67	16.6	0.75	1.26	83.96	17.75	3.38	1	81.00	11.71	11.27	73.16	#5 @ 12"
7.00	51.15	-42.12938889	9.02	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	9.34	12.43	80.64	#5 @ 12"
8.00	51.15	-54.31111111	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
9.00	51.15	-67.8375	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"

(1) Utilize a triangular distribution of maximum allowable bearing pressure at wall to zero at wall CL. Minimum moment = 0. Recall that unit weight of water is less than soil removed - ignore contribution since earth treatment is still conservative.

Bar Cutoff Extension Table

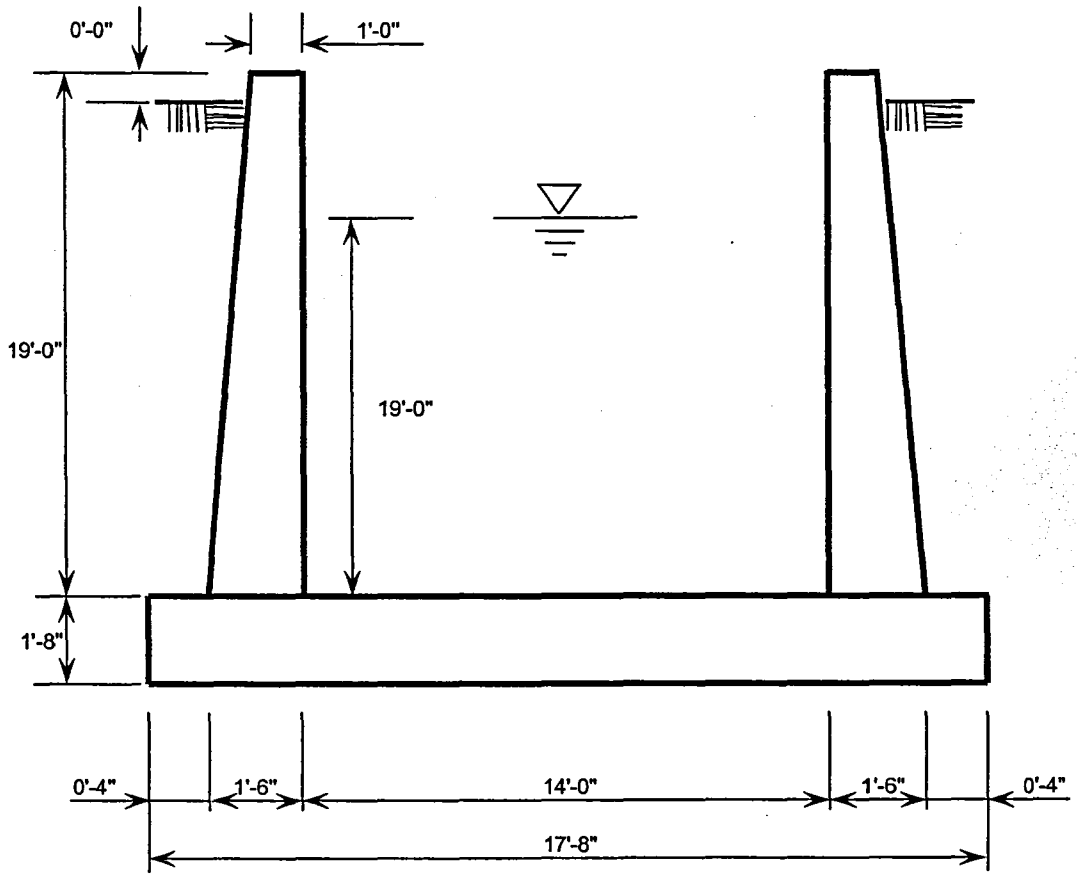
Bar Siz	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	12.8
5	0.625	9.375	16.63	12.8
6	0.75	11.25	16.63	12.8
7	0.875	13.125	16.63	12.8
8	1	15	16.63	12.8
9	1.128	16.92	16.63	12.8

Summary

Hook both bars. Provide #6 @ 12" w/ 5'-6" long leg.
Provide # 5 @ 12"

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 19' high		CHECKED BY: SEO	DATE 2-05

CAMELBACK 19' HIGH RECTANGULAR CHANNEL



DESIGN CRITERIA

DESIGN IN ACCORDANCE WITH AASHTO LOAD FACTOR DESIGN

SOIL PARAMETERS:

γ = 120 pcf
σa = 35 pcf
qa = 2 ksf

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 19' high		CHECKED BY: SEO	DATE 2-05

CAMELBACK 19' HIGH RECTANGULAR CHANNEL

CANTILEVER WALL DESIGN

TRY A 18" CONC WALL

f'c = 3500 psi
Fy = 60 ksi

EARTH LOADING

Mu = 1.69 [1 / 6 (35 pcf) (19'-0") ^ 3 + 1 / 2 (2'-0") (35 pcf) (19'-0") ^ 2]
= 82.7 ft-kips

F = 0.2373
Ku = 348.35
au = 4.1842
As = 1.28 in^2
As min = 0.42 in^2
As max = 3.46 in^2
As provide = 1.2 in^2 ∴ **USE #7 @ 6" o/c (See Table)**

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 19' high		CHECKED BY: SEO	DATE 2-05

CAMELBACK 19' HIGH RECTANGULAR CHANNEL

HYDROSTATIC LOADING (conservatively use water pressure minus active pressure)

Mu = 1.3 [1 / 6 (62.4 pcf - 35 pcf) (19'-0") ^ 3]
= 37.6 ft-kips

F = 0.2373
Ku = 158.4006
au = 4.3623
As = 0.56 in^2
As min = 0.42 in^2
As max = 3.46 in^2
As provide = 0.93 in^2 ∴ **USE #5 @ 4" o/c (HOWEVER, Please See Bottom Of Table)**

SHEAR

V = 1.3 [1 / 2 (62.4 pcf) (19'-0") ^ 2]
= 12.3 kips

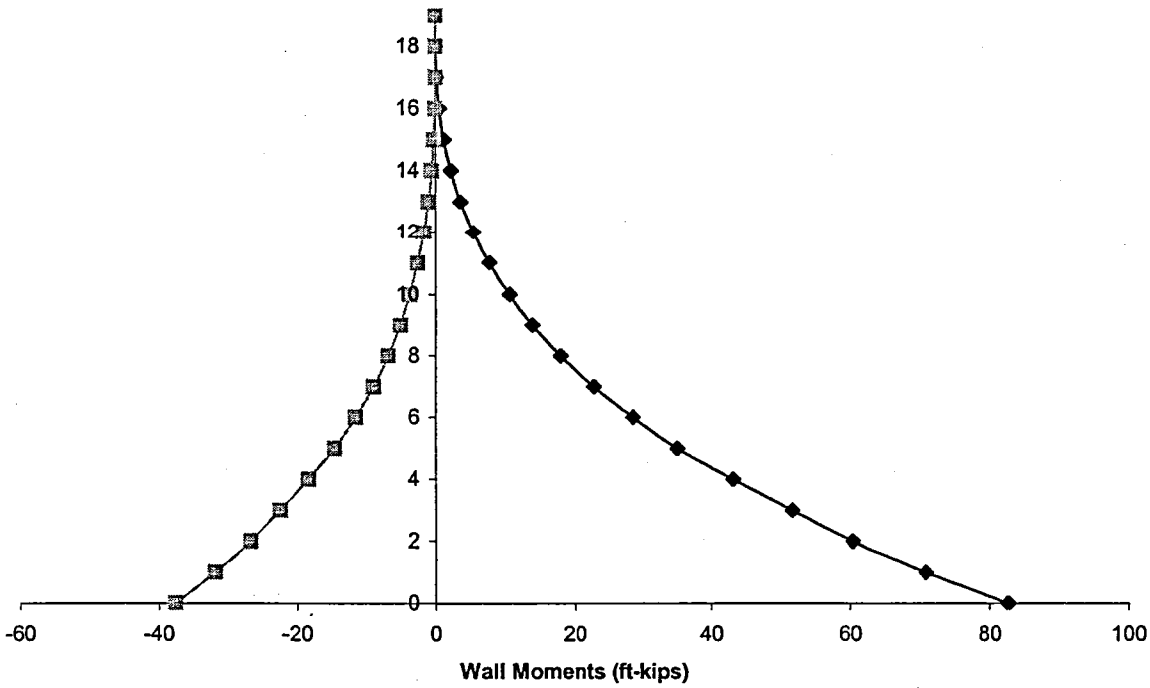
Vc = Φ 2 SQRT(f'c) bd = 18.59 kips > Vu ∴ **OK**

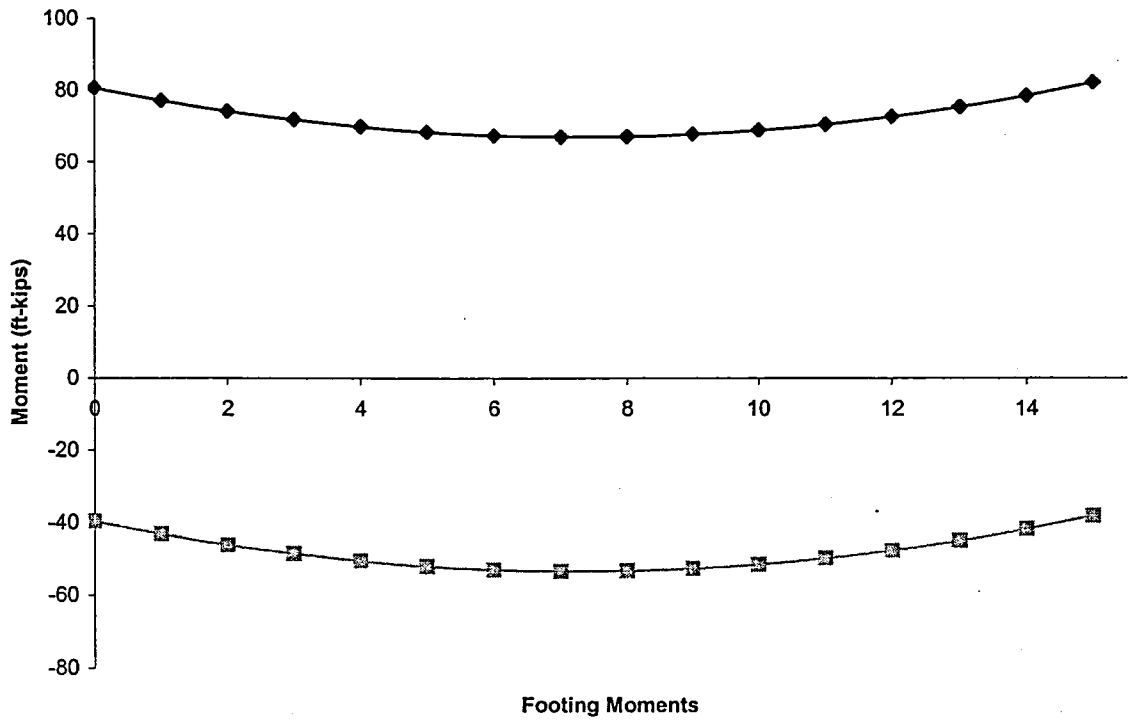
Results

	WALLS				FOOTING	
	MOMENTS		SHEAR		MOMENTS	
Location	E	SF		Location	E	SF
0	82.6633573	-37.5887471	12.3105938	0	80.6972606	-39.5548438
1	70.949	-31.8	11.1275938	1	77.1582865	-43.1
2	60.388	-26.7	10.0037438	2	74.1436049	-46.1
3	51.671	-22.5	9.02550955	3	71.8407232	-48.4
4	43.155	-18.4	8.01503038	4	69.8309354	-50.4
5	35.035	-14.6	6.98709375	5	68.2453148	-52.0
6	28.497	-11.6	6.09984375	6	67.327803	-52.9
7	22.816	-9.0	5.27174375	7	66.9345837	-53.3
8	17.934	-6.9	4.50279375	8	67.0656568	-53.2
9	13.791	-5.1	3.79299375	9	67.7210224	-52.5
10	10.592	-3.8	3.19430538	10	68.7823505	-51.5
11	7.701	-2.6	2.59787622	11	70.4426099	-49.8
12	5.376	-1.7	2.06059705	12	72.6271618	-47.6
13	3.560	-1.0	1.58246788	13	75.3360062	-44.9
14	2.192	-0.6	1.16348872	14	78.569143	-41.7
15	1.213	-0.3	0.80365955	15	82.3265722	-37.9
16	0.565	-0.1	0.50298038			
17	0.187	0.0	0.26145122			
18	0.022	0.0	0.07907205			
19	0.000	0.0	0.01006372			

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN		CHECKED BY: SEO	DATE 2-05

MOMENT ENVELOPES





DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 19' high		CHECKED BY: SEO	2-05

11.71
0.333333333 78.75666667

Outside Face Wall Cut-Offs - Earth Load Only

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	82.66	1.50	15.6	1.20	2.02	78.93	15.97	2.38	2.00	28.50	48.91	31.30	127.58	#7 @ 12";#7 @ 12" (say ok; moment diminishes 4" away from top of footing - slight overstress @ interface)
1.00	70.95	1.47	15.3	1.20	2.02	77.22	15.69	2.38	2.00	28.50	41.98	27.42	111.78	#7 @ 12";#7 @ 12"
2.00	60.39	1.45	15.0	1.20	2.02	75.52	15.41	2.38	2.00	28.50	35.73	23.83	97.12	#7 @ 12";#7 @ 12"
3.00	51.67	1.42	14.7	1.20	2.02	73.81	15.13	2.38	2.00	28.50	30.57	20.83	84.89	#7 @ 12";#7 @ 12"
4.00	43.16	1.39	14.4	1.20	2.02	72.11	14.85	2.38	2.00	28.50	25.54	17.78	72.46	#7 @ 12";#7 @ 12"
5.00	35.04	1.37	14.0	0.60	1.01	36.56	14.57	2.38	1.00	57.00	20.73	29.52	151.57	#7 @ 12"
6.00	28.50	1.34	13.7	0.60	1.01	35.71	14.29	2.38	1.00	57.00	16.86	24.56	126.11	#7 @ 12"
7.00	22.82	1.32	13.4	0.60	1.01	34.86	14.01	2.38	1.00	57.00	13.50	20.13	103.35	#7 @ 12"
8.00	17.93	1.29	13.1	0.60	1.01	34.01	13.73	2.38	1.00	57.00	10.61	16.20	83.19	#7 @ 12"
9.00	13.79	1.26	12.8	0.31	0.52	17.47	13.45	2.38	1.00	57.00	8.16	24.71	126.88	#5 @ 12"
10.00	10.59	1.24	12.5	0.31	0.52	17.03	13.17	2.38	1.00	57.00	6.27	19.46	99.92	#5 @ 12"
11.00	7.70	1.21	12.2	0.31	0.52	16.59	12.89	2.38	1.00	57.00	4.56	14.52	74.53	#5 @ 12"
12.00	5.38	1.18	11.8	0.31	0.52	16.15	12.61	2.38	1.00	57.00	3.18	10.40	53.42	#5 @ 12"
13.00	3.56	1.16	11.5	0.31	0.52	15.71	12.33	2.38	1.00	57.00	2.11	7.08	36.34	#5 @ 12"
14.00	2.19	1.13	11.2	0.31	0.52	15.27	12.05	2.38	1.00	57.00	1.30	4.48	23.01	#5 @ 12"
15.00	1.21	1.11	10.9	0.31	0.52	14.83	11.77	2.38	1.00	57.00	0.72	2.55	13.10	#5 @ 12"
16.00	0.56	1.08	10.6	0.31	0.52	14.39	11.49	2.38	1.00	57.00	0.33	1.22	6.28	#5 @ 12"
17.00	0.19	1.05	10.3	0.31	0.52	13.94	11.21	2.38	1.00	57.00	0.11	0.42	2.15	#5 @ 12"
18.00	0.02	1.03	9.9	0.31	0.52	13.50	10.93	2.38	1.00	57.00	0.01	0.05	0.26	#5 @ 12"
19.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.01	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	11.4
5	0.625	9.375	15.63	11.4
6	0.75	11.25	15.63	11.4
7	0.875	13.125	15.63	11.4
8	1	15	15.63	11.4
9	1.128	16.92	15.63	11.4

Summary

For #7@12", extend hook to 5.5' beyond top of footing or say 8'-0" even (from bottom of footing)
For #7@12", extend hook to 10.5' beyond top of footing, or say 12'-0" even.
Utilize #5 @ 12" to lap into #7 @ 12".

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Cameback 19' High		CHECKED BY: SEQ	DATE 2-05

Bottom Slab Reinforcement Cut-Offs

L feet	Moment kip-ft	Sim Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Fte thickness feet	d inches	* As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check: dc	# of bars per foot	A	Ms	fs (max 36 ksi)	z < 170?	Comments
0.00	80.70	0	80.70	1.67	16.6	1.20	2.02	84.33	17.75	3.38	2	40.50	47.75	26.72	147.95	#7 @ 12"; #7 @ 12"
1.00	80.70	-0.047619048	80.65	1.67	16.6	1.20	2.02	84.33	17.75	3.38	2	40.50	47.72	26.70	147.86	#7 @ 12"; #7 @ 12"
2.00	80.70	-0.380952381	80.32	1.67	16.6	1.20	2.02	84.33	17.75	3.38	2	40.50	47.52	26.59	147.25	#7 @ 12"; #7 @ 12"
3.00	80.70	-1.285714286	79.41	1.67	16.6	1.20	2.02	84.33	17.75	3.38	2	40.50	46.99	26.28	145.59	#7 @ 12"; #7 @ 12"
4.00	80.70	-3.047619048	77.65	1.67	16.6	1.20	2.02	84.33	17.75	3.38	2	40.50	45.95	27.64	142.36	#7 @ 12"; #7 @ 12"
5.00	80.70	-5.952380952	74.74	1.67	16.6	1.20	2.02	84.33	17.75	3.38	2	40.50	44.23	26.60	137.04	#7 @ 12"; #7 @ 12"
6.00	80.70	-10.28571429	70.41	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	41.68	28.82	148.95	#7 @ 12"; #6 @ 12"
7.00	80.70	-16.33333333	64.36	1.67	16.6	1.04	1.75	73.71	17.75	3.38	2	40.50	38.09	26.42	136.19	#7 @ 12"; #6 @ 12"

(1) Utilize a triangular distribution of zero at wall to allowable bearing pressure at wall CL. Minimum moment = 0.

Bar Cutoff Extension Table

Bar Siz	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	11.4
5	0.625	9.375	16.63	11.4
6	0.75	11.25	16.63	11.4
7	0.875	13.125	16.63	11.4
8	1	15	16.63	11.4
9	1.128	16.92	16.63	11.4

Summary

For # 7 @ 12", extend hook to 6'-0" + 1'-6" wall + 1'-5" extension = 8'-0" and lap 3'-6" into #6 bars.
For other # 7 @ 12", extend hook 3'-6" and provide a class C lap = 3'-6" on both sides.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	1-05
SUBJECT:	U-SHAPE CHANNEL DESIGN - Camelback 19' high	CHECKED BY: SEO	2-05

Inside Face Wall Cut-Offs - Hydrostatic - Earth (Conservative)

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	37.59	1.50	15.6	0.93	1.56	62.12	15.97	2.38	3.00	19.00	31.32	25.87	92.09	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
1.00	35.61	1.47	15.3	0.93	1.56	60.80	15.69	2.38	3.00	19.00	29.68	25.01	89.04	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
2.00	33.63	1.45	15.0	0.93	1.56	59.48	15.41	2.38	2.00	28.50	28.03	24.12	98.30	# 5 @ 12"; # 5 @ 12"; # 5 @ 12"
3.00	31.65	1.42	14.7	0.62	1.04	39.50	15.13	2.38	2.00	28.50	26.38	34.78	141.76	#6 @ 12"; #5 @ 12"
4.00	29.68	1.39	14.4	0.62	1.04	38.62	14.85	2.38	2.00	28.50	24.73	33.33	135.82	#5 @ 12"; #5 @ 12"
5.00	27.70	1.37	14.0	0.62	1.04	37.73	14.57	2.38	2.00	28.50	23.08	31.80	129.61	#5 @ 12"; #5 @ 12"
6.00	25.72	1.34	13.7	0.62	1.04	36.85	14.29	2.38	2.00	28.50	21.43	30.21	123.12	#5 @ 12"; #5 @ 12"
7.00	23.74	1.32	13.4	0.62	1.04	35.97	14.01	2.38	2.00	28.50	19.78	28.54	116.33	#5 @ 12"; #5 @ 12"
8.00	21.76	1.29	13.1	0.62	1.04	35.09	13.73	2.38	2.00	28.50	18.13	26.80	109.20	#5 @ 12"; #5 @ 12"
9.00	19.78	1.26	12.8	0.62	1.04	34.21	13.45	2.38	2.00	28.50	16.49	24.96	101.73	#5 @ 12"; #5 @ 12"
10.00	17.81	1.24	12.5	0.62	1.04	33.33	13.17	2.38	2.00	28.50	14.84	23.04	93.88	#5 @ 12"; #5 @ 12"
11.00	15.83	1.21	12.2	0.62	1.04	32.45	12.89	2.38	2.00	28.50	13.19	21.01	85.61	#5 @ 12"; #5 @ 12"
12.00	13.85	1.18	11.8	0.62	1.04	31.57	12.61	2.38	2.00	28.50	11.54	18.87	76.91	#5 @ 12"; #5 @ 12"
13.00	11.87	1.16	11.5	0.62	1.04	30.69	12.33	2.38	2.00	28.50	9.89	16.62	67.73	#5 @ 12"; #5 @ 12"
14.00	9.89	1.13	11.2	0.31	0.52	15.27	12.05	2.38	1.00	57.00	8.24	28.48	146.23	#5 @ 12"
15.00	7.91	1.11	10.9	0.31	0.52	14.83	11.77	2.38	1.00	57.00	6.59	23.44	120.38	#5 @ 12"
16.00	5.94	1.08	10.6	0.31	0.52	14.39	11.49	2.38	1.00	57.00	4.95	18.11	92.98	#5 @ 12"
17.00	3.96	1.05	10.3	0.31	0.52	13.94	11.21	2.38	1.00	57.00	3.30	12.44	63.90	#5 @ 12"
18.00	1.98	1.03	9.9	0.31	0.52	13.50	10.93	2.38	1.00	57.00	1.65	6.42	32.96	#5 @ 12"
19.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.01	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	11.4
5	0.625	9.375	15.63	11.4
6	0.75	11.25	15.63	11.4
7	0.875	13.125	15.63	11.4
8	1	15	15.63	11.4
9	1.128	16.92	15.63	11.4

Summary

Although the design calls for the provision of #5 @ 4" at the base, this is based on a conservative. Provide #5 @ 6" maximum and terminate every other bar towards the top of wall.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO 6053	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Cameiback 19' high		CHECKED BY: SEO	DATE 2-05

Top Slab Reinforcement Cut-Offs (Hydrostatic - Active Earth Pressure)

L feet	Moment kip-ft	Bim Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Fla thickness feet	d inches	As provided	s inches	Moment Capacity Provided	1.2 Mor Moment Check	Crack Control Check de	# of bars per foot	A	Ms	fs (max 36 ksi)	z < 1707	Comments
0.00	37.59	0	37.59	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	22.24	21.41	110.26	#6 @ 12"; #5 @ 12"
1.00	37.59	-0.738095238	36.85	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	21.81	20.99	108.10	#6 @ 12"; #5 @ 12"
2.00	37.59	-2.904761905	34.68	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	20.52	19.75	101.74	#6 @ 12"; #5 @ 12"
3.00	37.59	-6.428571429	31.16	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	18.44	17.74	91.41	#6 @ 12"; #5 @ 12"
4.00	37.59	-11.23809524	26.35	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	15.59	15.01	77.30	#6 @ 12"; #5 @ 12"
5.00	37.59	-17.26190476	20.33	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	12.03	11.58	59.63	#6 @ 12"; #5 @ 12"
6.00	37.59	-24.42857143	13.16	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	7.78	7.49	38.60	#6 @ 12"; #5 @ 12"
7.00	37.59	-32.86666667	4.92	1.67	16.6	0.75	1.26	63.98	17.75	3.38	2	40.50	2.91	2.80	14.44	#6 @ 12"; #5 @ 12"

(1) Utilize a triangular distribution of maximum allowable bearing pressure at wall to zero at wall CL. Minimum moment = 0. Recall that unit weight of water is less than soil removed - ignore contribution since earth treatment is still conservative.

Bar Cutoff Extension Table

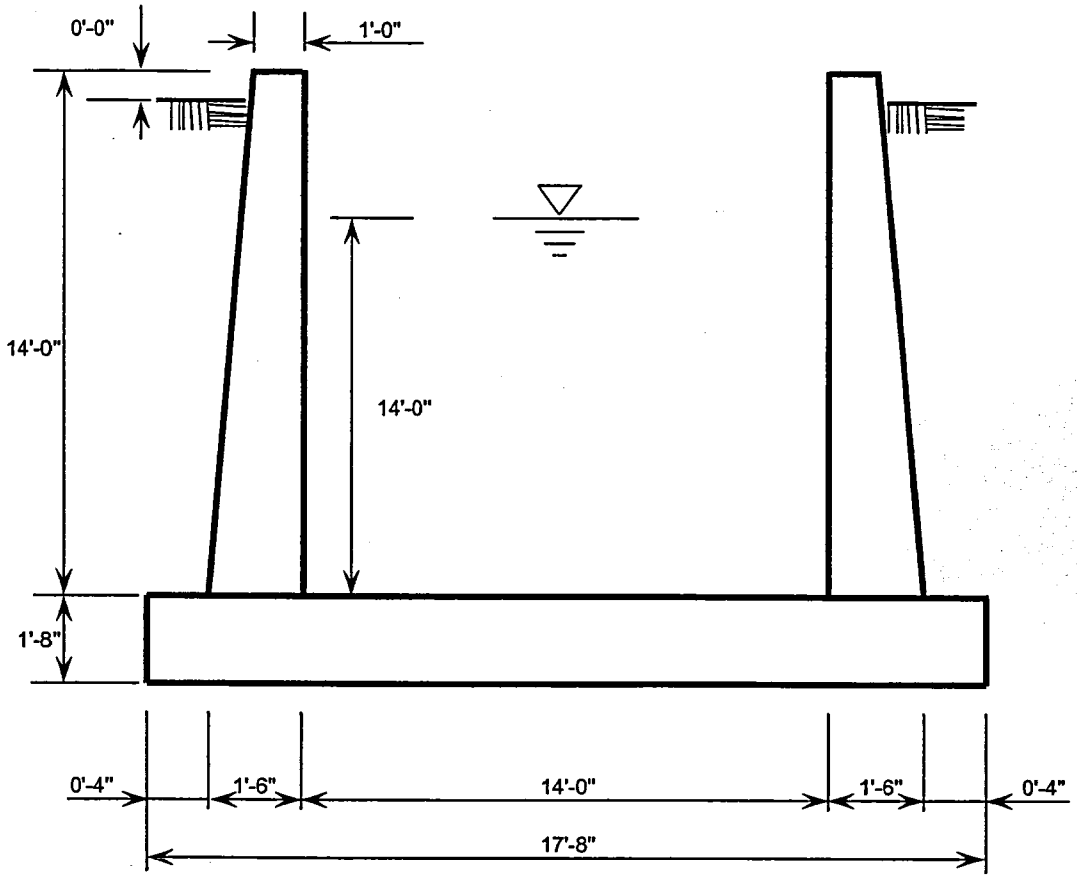
Bar Siz	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	11.4
5	0.625	9.375	16.63	11.4
6	0.75	11.25	16.63	11.4
7	0.875	13.125	16.63	11.4
8	1	15	16.63	11.4
9	1.128	16.92	16.63	11.4

Summary

Hook bars to develop moment - run both bars full length.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high/73rd Ave		CHECKED BY: SEO	DATE 2-05

CAMELBACK 14' HIGH/73rd Ave RECTANGULAR CHANNEL



DESIGN CRITERIA

DESIGN IN ACCORDANCE WITH AASHTO LOAD FACTOR DESIGN

SOIL PARAMETERS:

γ = 120 pcf
σa = 35 pcf
qa = 2 ksf

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high/73rd Ave		CHECKED BY: SEO	DATE 2-05

CAMELBACK 14' HIGH/73rd Ave RECTANGULAR CHANNEL

CANTILEVER WALL DESIGN

TRY A 18" CONC WALL

f'c = 3500 psi
Fy = 60 ksi

EARTH LOADING

Mu = 1.69 [1 / 6 (35 pcf) (14'-0") ^ 3 + 1 / 2 (2'-0") (35 pcf) (14'-0") ^ 2]
= 35 ft-kips

F = 0.2356
Ku = 148.73
au = 4.3709
As = 0.52 in^2
As min = 0.42 in^2
As max = 3.45 in^2
As provide = 0.75 in^2

∴ **See Table For Selected Reinforcement.**

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high/73rd Ave		CHECKED BY: SEO	DATE 2-05

CAMELBACK 14' HIGH/73rd Ave RECTANGULAR CHANNEL

HYDROSTATIC LOADING (conservatively use water pressure minus active pressure)

Mu = 1.3 [1 / 6 (62.4 pcf - 35 pcf) (14'-0") ^ 3]
= 14.6 ft-kips

F = 0.2356
Ku = 62.0052
au = 4.4471
As = 0.21 in^2
As min = 0.42 in^2
As max = 3.45 in^2
As provide = 0.62 in^2

∴ **See Table For Selected Reinforcement.**

SHEAR

V = 1.3 [1 / 2 (62.4 pcf) (14'-0") ^ 2]
= 7 kips

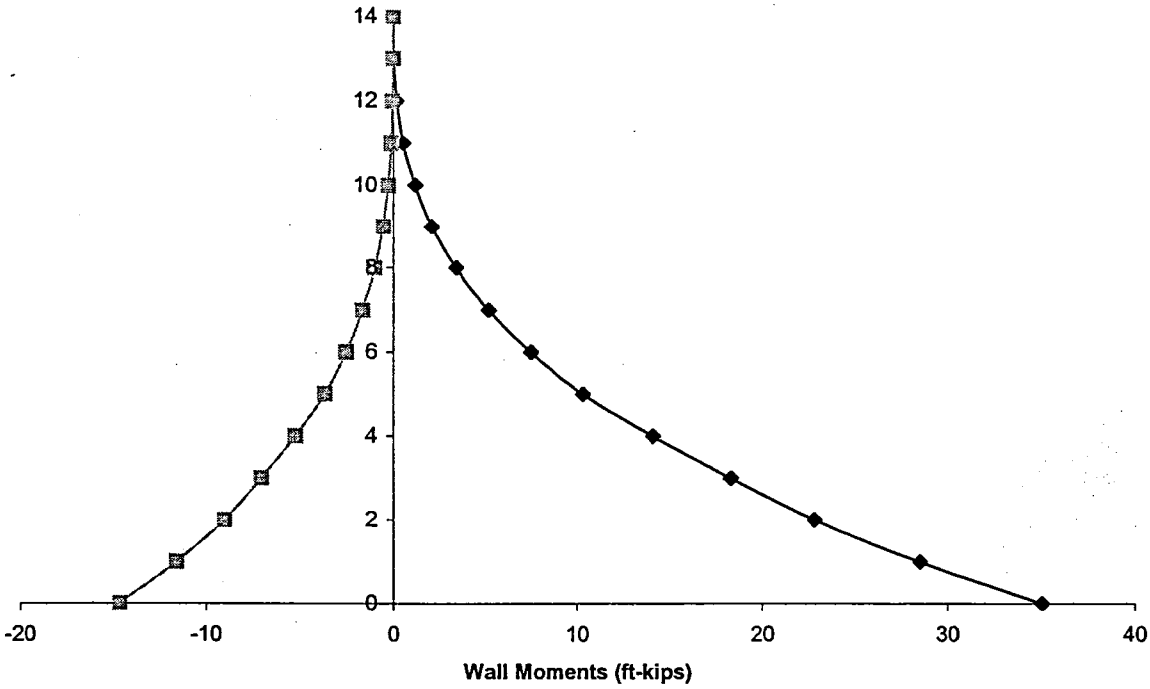
Vc = Φ 2 SQRT(f'c) bd = 18.52 kips > Vu ∴ OK

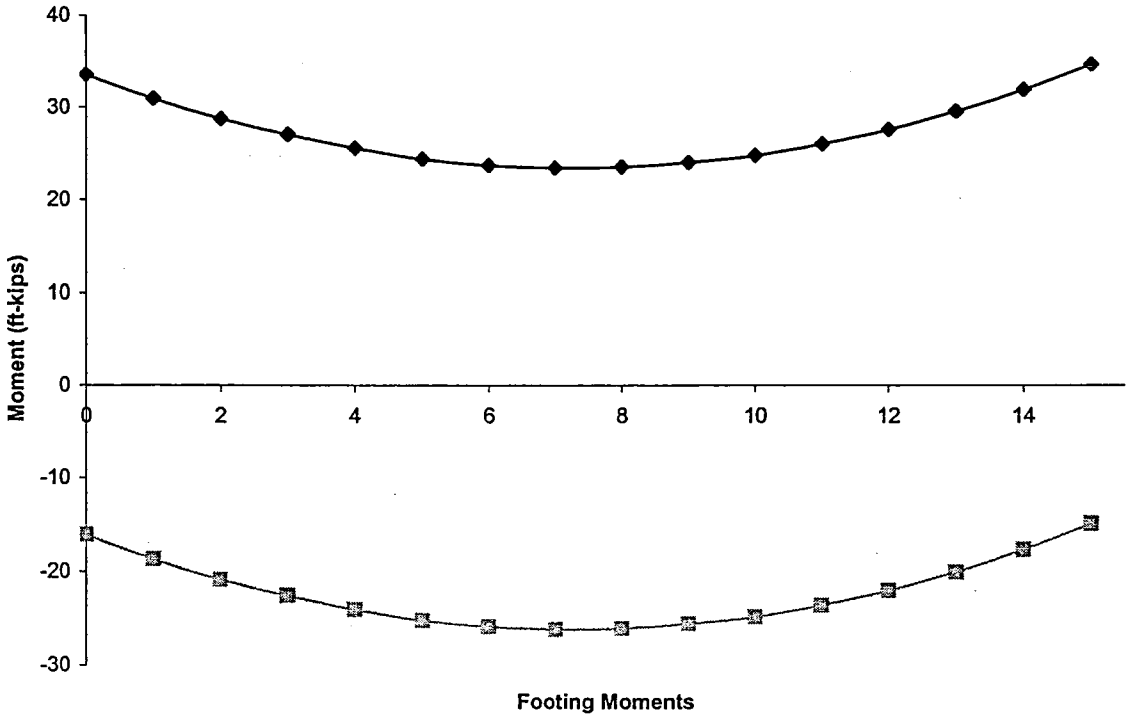
Results

WALLS				FOOTING		
	MOMENTS		SHEAR		MOMENTS	
Location	E	SF		Location	E	SF
0	35.0352844	-14.6064263	6.98709375	0	33.5865815	-16.0551291
1	28.497	-11.6	6.09984375	1	30.9789165	-18.7
2	22.816	-9.0	5.27174375	2	28.7575721	-20.9
3	18.311	-7.0	4.56461372	3	27.0607119	-22.6
4	14.109	-5.2	3.84988455	4	25.5798156	-24.1
5	10.328	-3.6	3.14234375	5	24.4114636	-25.2
6	7.486	-2.5	2.55084375	6	23.7354023	-25.9
7	5.206	-1.6	2.01849375	7	23.4456617	-26.2
8	3.429	-1.0	1.54529375	8	23.5422419	-26.1
9	2.096	-0.5	1.13124375	9	24.0251429	-25.6
10	1.213	-0.3	0.80365955	10	24.8071741	-24.8
11	0.565	-0.1	0.50298038	11	26.0305232	-23.6
12	0.187	0.0	0.26145122	12	27.640193	-22.0
13	0.022	0.0	0.07907205	13	29.6361835	-20.0
14	0.000	0.0	0.01006372	14	32.0184949	-17.6
				15	34.7871269	-14.9

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN		CHECKED BY: SEO	DATE 2-05

MOMENT ENVELOPES





DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high/73rd Ave		CHECKED BY: SEO	DATE 2-05

Outside Face Wall Cut-Offs - Earth Load Only

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	35.04	1.50	15.6	0.75	1.26	50.61	15.97	2.38	2.00	28.50	20.73	21.23	86.51	#6 @ 12";#5 @ 12"
1.00	28.50	1.46	15.2	0.75	1.26	49.16	15.59	2.38	2.00	28.50	16.88	17.75	72.35	#6 @ 12";#5 @ 12"
2.00	22.82	1.43	14.8	0.75	1.26	47.71	15.21	2.38	2.00	28.50	13.50	14.63	59.61	#6 @ 12";#5 @ 12"
3.00	18.31	1.39	14.3	0.31	0.52	19.64	14.83	2.38	1.00	57.00	10.84	29.25	150.19	#5 @ 12"
4.00	14.11	1.36	13.9	0.31	0.52	19.04	14.45	2.38	1.00	57.00	8.35	23.23	119.29	#5 @ 12"
5.00	10.33	1.32	13.5	0.31	0.52	18.44	14.07	2.38	1.00	57.00	6.11	17.55	90.09	#5 @ 12"
6.00	7.49	1.29	13.1	0.31	0.52	17.85	13.69	2.38	1.00	57.00	4.43	13.14	67.45	#5 @ 12"
7.00	5.21	1.25	12.6	0.31	0.52	17.25	13.31	2.38	1.00	57.00	3.08	9.45	48.50	#5 @ 12"
8.00	3.43	1.21	12.2	0.31	0.52	16.65	12.93	2.38	1.00	57.00	2.03	6.44	33.07	#5 @ 12"
9.00	2.10	1.18	11.8	0.31	0.52	16.05	12.55	2.38	1.00	57.00	1.24	4.08	20.95	#5 @ 12"
10.00	1.21	1.14	11.3	0.31	0.52	15.45	12.17	2.38	1.00	57.00	0.72	2.45	12.58	#5 @ 12"
11.00	0.56	1.11	10.9	0.31	0.52	14.86	11.79	2.38	1.00	57.00	0.33	1.19	6.09	#5 @ 12"
12.00	0.19	1.07	10.5	0.31	0.52	14.26	11.41	2.38	1.00	57.00	0.11	0.41	2.10	#5 @ 12"
13.00	0.02	1.04	10.1	0.31	0.52	13.66	11.03	2.38	1.00	57.00	0.01	0.05	0.26	#5 @ 12"
14.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.01	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	8.4
5	0.625	9.375	15.63	8.4
6	0.75	11.25	15.63	8.4
7	0.875	13.125	15.63	8.4
8	1	15	15.63	8.4
9	1.128	16.92	15.63	8.4

Summary

For #6@12", extend hook to 4.5' beyond top of footing or say 6'-0" even (from bottom of footing)
For #5@12", extend hook to top of wall.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 5053	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high73rd Ave		CHECKED BY: SEO	DATE 2-05

Bottom Slab Reinforcement Cut-Offs

L feet	Moment kip-ft	Bim Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Fla thickness feet	d inches	As provided	s inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check: da	# of bars per foot	A	Ms	fs (max 36 ksi)	z < 170?	Comments
0.00	33.59	0	33.59	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	19.87	19.13	98.52	#6 @ 12", #5 @ 12"
1.00	33.59	-0.047619048	33.54	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	19.83	19.10	98.38	#6 @ 12", #5 @ 12"
2.00	33.59	-0.380952381	33.21	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	19.65	18.91	97.41	#6 @ 12", #5 @ 12"
3.00	33.59	-1.285714286	32.30	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	19.11	18.39	94.75	#6 @ 12", #5 @ 12"
4.00	33.59	-3.047619048	30.54	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	18.07	17.39	89.58	#6 @ 12", #5 @ 12"
5.00	33.59	-5.952380952	27.63	1.67	16.6	0.75	1.26	53.98	17.75	3.38	2	40.50	16.35	15.74	81.06	#6 @ 12", #5 @ 12"
6.00	33.59	-10.28571429	23.30	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	13.78	22.62	146.78	#6 @ 12"
7.00	33.59	-16.33333333	17.26	1.67	16.6	0.44	0.74	32.19	17.75	3.38	1	81.00	10.21	16.75	108.69	#6 @ 12"

(1) Utilize a triangular distribution of zero at wall to allowable bearing pressure at wall CL. Minimum moment = 0.

Bar Cutoff Extension Table

Bar Siz	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	8.4
5	0.625	9.375	16.63	8.4
6	0.75	11.25	16.63	8.4
7	0.875	13.125	16.63	8.4
8	1	15	16.63	8.4
9	1.128	16.92	16.63	8.4

Summary

For # 5@ 12", extend hook to 6'-0" + 1'-6" wall + 1'-5" extension = 8'-11".
For # 6 @ 12", extend hook 4'-0" and provide a class C lap = 1.7 * ld = 30.3", say 2'-7" lap on both sides.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 6063	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high/73rd Ave		CHECKED BY: SEO	DATE 2-05

Inside Face Wall Cut-Offs - Hydrostatic - Earth (Conservative)

height feet	Moment kip-ft	Wall thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check dc	# of bars	A	Ms	fs	z < 170?	Comments
0.00	14.61	1.50	15.6	0.62	1.04	42.14	15.97	2.38	2.00	28.50	12.17	15.08	61.45	#5 @ 12"; #5 @ 12"
1.00	13.56	1.46	15.2	0.62	1.04	40.94	15.59	2.38	2.00	28.50	11.30	14.40	58.67	#5 @ 12"; #5 @ 12"
2.00	12.52	1.43	14.8	0.62	1.04	39.75	15.21	2.38	2.00	28.50	10.43	13.67	55.73	#5 @ 12"; #5 @ 12"
3.00	11.48	1.39	14.3	0.62	1.04	38.55	14.83	2.38	2.00	28.50	9.56	12.91	52.61	#5 @ 12"; #5 @ 12"
4.00	10.43	1.36	13.9	0.31	0.52	19.04	14.45	2.38	1.00	57.00	8.69	24.19	124.23	#5 @ 12"
5.00	9.39	1.32	13.5	0.31	0.52	18.44	14.07	2.38	1.00	57.00	7.82	22.47	115.36	#5 @ 12"
6.00	8.35	1.29	13.1	0.31	0.52	17.85	13.69	2.38	1.00	57.00	6.96	20.63	105.91	#5 @ 12"
7.00	7.30	1.25	12.6	0.31	0.52	17.25	13.31	2.38	1.00	57.00	6.09	18.66	95.81	#5 @ 12"
8.00	6.26	1.21	12.2	0.31	0.52	16.65	12.93	2.38	1.00	57.00	5.22	16.56	85.01	#5 @ 12"
9.00	5.22	1.18	11.8	0.31	0.52	16.05	12.55	2.38	1.00	57.00	4.35	14.30	73.42	#5 @ 12"
10.00	4.17	1.14	11.3	0.31	0.52	15.45	12.17	2.38	1.00	57.00	3.48	11.87	60.96	#5 @ 12"
11.00	3.13	1.11	10.9	0.31	0.52	14.86	11.79	2.38	1.00	57.00	2.61	9.25	47.51	#5 @ 12"
12.00	2.09	1.07	10.5	0.31	0.52	14.26	11.41	2.38	1.00	57.00	1.74	6.42	32.97	#5 @ 12"
13.00	1.04	1.04	10.1	0.31	0.52	13.66	11.03	2.38	1.00	57.00	0.87	3.35	17.19	#5 @ 12"
14.00	0.00	1.00	9.6	0.31	0.52	13.06	10.65	2.38	1.00	57.00	0.00	0.00	0.00	#5 @ 12"

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	15.63	8.4
5	0.625	9.375	15.63	8.4
6	0.75	11.25	15.63	8.4
7	0.875	13.125	15.63	8.4
8	1	15	15.63	8.4
9	1.128	16.92	15.63	8.4

Summary

For #5 @ 12", make bar 4'-6" long - lap w/ dowel bar = 1.7 * 12.5" = 21", say 2'-0" lap.
Utilize #5 @ 12" (class C lap reduced by 0.31/0.62 only) say 1'-0" lap into #5.

DMJM HARRIS	PROJECT: BETHANY HOME OUTFALL CHANNEL REACH C	JOB NO. 8053	SHEET
		DESIGNED BY: CAL	DATE 1-05
SUBJECT: U-SHAPE CHANNEL DESIGN - Camelback 14' high/73rd Ave		CHECKED BY: SEO	DATE 2-05

Top Slab Reinforcement Cut-Offs (Hydrostatic - Active Earth Pressure)

L feet	Moment kip-ft	Btm Slab Moment * earth (1) kip-ft	Design Moment kips-ft	Flg thickness feet	d inches	As provided	a inches	Moment Capacity Provided	1.2 Mcr Moment Check	Crack Control Check: do	# of bars per foot	A	Mc	fs (max 38 ksi)	z < 1707	Comments
0.00	14.61	0	14.61	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	8.64	20.12	130.81	#5 @ 12"
1.00	14.61	-0.736095238	13.87	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	8.21	19.11	124.01	#5 @ 12"
2.00	14.61	-2.904761905	11.70	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	6.92	16.12	104.63	#5 @ 12"
3.00	14.61	-6.428571429	8.18	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	4.84	11.27	73.12	#5 @ 12"
4.00	14.61	-11.23809524	3.37	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	1.99	4.64	30.12	#5 @ 12"
5.00	14.61	-17.26190476	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
6.00	14.61	-24.42857143	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"
7.00	14.61	-32.96666667	0.00	1.67	16.6	0.31	0.52	22.83	17.75	3.38	1	81.00	0.00			#5 @ 12"

(1) Utilize a triangular distribution of maximum allowable bearing pressure at wall to zero at wall CL. Minimum moment = 0. Recall that unit weight of water is less than soil removed - ignore contribution since earth treatment is still conservative.

Bar Cutoff Extension Table

Bar Size	Bar diameter	15 * bar diameter	Maximum d	S/20
4	0.5	7.5	16.63	8.4
5	0.625	9.375	16.63	8.4
6	0.75	11.25	16.63	8.4
7	0.875	13.125	16.63	8.4
8	1	15	16.63	8.4
9	1.128	16.92	16.63	8.4

Summary

Provide # 5 @ 12", utilize standard hooks at ends.

QUANTITY AND COST CALCULATIONS

BETHANY HOME OUTFALL CHANNEL
REACH C - 83rd Avenue to 73rd Avenue

FCD Contract No. 2004C055
PCN No. 620 03 32
October 2005

Pre-final Construction Cost Estimate

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST NUMBERS	EXTENDED AMOUNT
105-1	PARTNERING ALLOWANCE	LS	1	$ 25,000.00	$ 25,000.00
107-1	AZPDES/SWPPP PERMITS	LS	1	$ 7,500.00	$ 7,500.00
107-2	PUBLIC INFORMATION AND NOTIFICATION (ALLOWANCE)	LS	1	$ 50,000.00	$ 50,000.00
107-3	PROJECT SIGNS ALLOWANCE	LS	1	$ 5,000.00	$ 5,000.00
107-4	WATER MANAGEMENT	LS	1	$ 40,000.00	$ 40,000.00
202-1	MOBILIZATION	LS	1	$ 410,656.00	$ 410,656.00
211-1	FILL CONSTRUCTION	CY	80,139	$ 8.00	$ 641,112.00
336-1	PAVEMENT REPLACEMENT (75TH AVENUE AND CAMELBACK ROAD)	SY	859	$ 24.00	$ 20,616.00
336-2	PAVEMENT PLACEMENT (81ST AVENUE DRIVEWAY)	SY	896	$ 20.00	$ 17,920.00
336-3	PAVEMENT PLACEMENT (75TH AVENUE PARKING LOT)	SY	2,000	$ 20.00	$ 40,000.00
340-1	CONCRETE SIDEWALK	SF	1,561	$ 2.75	$ 4,292.75
340-2	CONCRETE CURB AND GUTTER (MAG DETAIL 220, TYPE A)	LF	1,298	$ 10.00	$ 12,980.00
340-3	CONCRETE VALLEY GUTTER (MAG DETAIL 240)	LF	350	$ 7.50	$ 2,625.00
340-4	CONCRETE PEDESTRIAN TRAIL (PRIMARY)	SF	70,750	$ 5.00	$ 353,750.00
340-5	CONCRETE PEDESTRIAN TRAIL (SECONDARY)	SF	6,109	$ 7.00	$ 42,763.00
340-6	CONCRETE DRIVEWAY WING TYPE	SF	200	$ 10.00	$ 2,000.00
340-7	CONCRETE DRIVEWAY RETURN TYPE	SF	113	$ 10.00	$ 1,130.00
350-1	REMOVE ASPHALT CONCRETE PAVEMENT	SY	859	$ 2.25	$ 1,932.75
350-2	REMOVE CONCRETE CURB AND GUTTER	LF	545	$ 4.00	$ 2,180.00
350-3	REMOVE CONCRETE SIDEWALK/PEDESTRIAN TRAIL	SF	61,011	$ 1.20	$ 73,213.20
350-4	REMOVE CONCRETE CHANNEL LINING	SF	1,461	$ 5.00	$ 7,305.00
350-5	REMOVE EXIST WATER PIPE	LF	387	$ 10.00	$ 3,870.00
350-6	DECOMISSION DRYWELL	EA	19	$ 800.00	$ 15,200.00
350-7	MISCELLANEOUS REMOVAL OF EXISTING IMPROVEMENTS	LS	1	$ 33,400.00	$ 33,400.00
401-1	75TH AVENUE TRAFFIC CONTROL	LS	1	$ 35,000.00	$ 35,000.00
401-2	CAMELBACK ROAD TRAFFIC CONTROL	LS	1	$ 35,000.00	$ 35,000.00
401-3	MISCELLANEOUS TRAFFIC CONTROL	LS	1	$ 20,000.00	$ 20,000.00
420-1	6' CHAIN LINK FENCE, MAG STD DTL 160	LF	1,063	$ 7.00	$ 7,441.00
421-1	WELL SITE AND SUBSTATION CONSTRUCTION	LS	1	$ 120,000.00	$ 120,000.00
430-1	TREES (24" BOX)	EA	469	$ 225.00	$ 105,525.00
430-2	TREES (15 GALLON)	EA	568	$ 75.00	$ 42,600.00
430-3	SHRUBS (1 GALLON)	EA	1,136	$ 6.00	$ 6,816.00
430-4	SHRUBS (5 GALLON)	EA	1,931	$ 16.00	$ 30,896.00
430-5	BOULDERS	EA	212	$ 150.00	$ 31,800.00
430-6	TURF (HYDROSEED)	SF	506,890	$ .12	$ 60,826.80
430-7	DECOMPOSED GRANITE	SF	477,909	$ .30	$ 143,372.70
430-8	CONCRETE HEADER	LF	6,369	$ 8.00	$ 50,952.00
430-9	HARDSCAPE ELEMENTS	LS	1	$ 156,800.00	$ 156,800.00
430-10	SITE AMENITIES	LS	1	$ 215,800.00	$ 215,800.00
430-11	4" STABILIZED DECOMPOSED GRANITE	SF	38,738	$ 1.50	$ 58,107.00
430-12	12" CONCRETE HEADER	LF	344	$ 12.00	$ 4,128.00
430-13	POST AND RAIL FENCE	LF	985	$ 11.00	$ 10,835.00
440-1	IRRIGATION DISTRIBUTION SYSTEM	LS	1	$ 319,500.00	$ 319,500.00
479-1	LIGHTING	LS	1	$ 192,200.00	$ 192,200.00
505-1	RCBC 1, 2-9x9	LF	5,838	$ 1,215.00	$ 7,093,170.00
505-2	RCBC 2, 2-8x7	LF	717	$ 2,000.00	$ 1,434,000.00
505-3	75TH AVENUE RECTANGULAR CHANNEL	LF	56	$ 3,035.00	$ 169,960.00
505-4	CAMELBACK RECTANGULAR CHANNEL	LF	1,062	$ 1,280.00	$ 1,359,360.00
505-5	73RD AVENUE 2-12X10 RCBC TRANSITION	LS	1	$ 245,200.00	$ 245,200.00
505-6	75TH AVENUE PEDESTRIAN TRAIL CROSSING	LS	1	$ 86,400.00	$ 86,400.00
505-7	CONCRETE LOW-FLOW CHANNEL (DETAIL D2)	LF	50	$ 60.00	$ 3,000.00
505-8	CONCRETE CHANNEL LINING	SF	2,257	$ 35.00	$ 78,995.00
505-9	CONCRETE PAINTING	LS	1	$ 25,000.00	$ 25,000.00
505-10	CATCH BASINS (DETAIL D4)	EA	20	$ 2,800.00	$ 56,000.00
505-11	CATCH BASINS, MAG DTL 532	EA	3	$ 3,600.00	$ 10,800.00
505-12	CATCH BASINS, MAG DTL 530	EA	1	$ 4,200.00	$ 4,200.00
505-13	GLENDALE EAST JUNCTION STRUCTURE	EA	1	$ 56,420.00	$ 56,420.00
505-14	GLENDALE WEST JUNCTION STRUCTURE	EA	1	$ 56,550.00	$ 56,550.00
505-15	GLENDALE NORTH JUNCTION STRUCTURE	EA	1	$ 61,000.00	$ 61,000.00
505-16	GLENDALE SOUTH JUNCTION STRUCTURE	EA	1	$ 43,530.00	$ 43,530.00
602-1	24" STEEL PIPE, BORED AND JACKED	L.F.	378	$ 760.00	$ 287,280.00
609-1	WELL CLOSURE	EA	1	$ 12,000.00	$ 12,000.00
610-1	3/4" WATER LINE SERVICE FOR PARK NODES	EA	5	$ 1,700.00	$ 8,500.00
610-2	FIRE HYDRANT RELOCATION	EA	1	$ 800.00	$ 800.00
610-3	GATE VALVE (12")	EA	2	$ 1,500.00	$ 3,000.00
610-4	DUCTILE IRON PIPE (12")	LF	337	$ 70.00	$ 23,590.00
610-5	DUCTILE IRON PIPE (8")	LF	50	$ 50.00	$ 2,500.00
610-6	REMOVE AND REPLACE EXISTING 12" DIP	EA	1	$ 11,000.00	$ 11,000.00
615-1	BYPASS PUMPING GLENDALE SANITARY SEWERS IN THE VICINITY OF 75TH AVE. & CAMELBACK RD.	L.S.	1	$ 452,000.00	$ 452,000.00
615-2	CHEMICAL ADD. FOR ODOR CONTROL - ALLOWANCE	Day	60	$ 270.00	$ 16,200.00
615-3	GLENDALE REMOVE EXISTING VCP (18")	L.F.	46	$ 17.00	$ 782.00
615-4	GLENDALE LINED REINFORCED CONC. PIPE (48")	L.F.	55	$ 310.00	$ 17,050.00
615-5	GLENDALE VITRIFIED CLAY PIPE (8")	L.F.	857	$ 40.00	$ 34,280.00
615-6	GLENDALE REMOVE EXISTING LINED RCP (42") AND REPLACE WITH LINED RCP (48") WEST OF SRP CANAL--ALLOWA	L.F.	200	$ 320.00	$ 64,000.00
615-7	REMOVE EXISTING GLENDALE SANITARY SEWER (48") AND BACKFILL TRENCH	L.F.	94	$ 20.00	$ 1,880.00
615-8	FILL THREE EXISTING DUCTILE IRON PIPES (24")	L.S.	1	$ 10,500.00	$ 10,500.00
615-9	ABANDON GLENDALE WEST JUNCTION STRUCTURE	L.S.	1	$ 3,000.00	$ 3,000.00
615-10	DEMOLISH GLENDALE EAST JUNCTION STRUCTURE	L.S.	1	$ 5,000.00	$ 5,000.00
615-11	FILL GLENDALE EXISTING VCP SEWER (24")	L.S.	1	$ 4,100.00	$ 4,100.00
615-12	REMOVE EXISTING 18" VCP SEWER AND REPLACE WITH LINED DUCTILE IRON PIPE SEWER (18")	L.F.	52	$ 135.00	$ 7,020.00
615-13	REMOVE EXISTING 48" LINED RCP AND REPLACE WITH LINED RCP SEWER (48")	L.F.	110	$ 320.00	$ 35,200.00
615-14	BYPASS PUMPING GLENDALE SANITARY SEWERS IN THE VICINITY OF BHOC REACH C STA. 154 +00	L.S.	1	$ 120,000.00	$ 120,000.00
615-15	GLENDALE VITRIFIED CLAY PIPE SEWER (15")	L.F.	150	$ 55.00	$ 8,250.00
615-16	GLENDALE LINED DUCTILE IRON PIPE W/ RESTRAINED JTS. (8")	L.F.	248	$ 110.00	$ 27,280.00
615-17	GLENDALE LINED DUCTILE IRON PIPE AIR JUMPER (6")	L.F.	83	$ 85.00	$ 7,055.00
618-1	12-INCH RGRCP, CLASS III	LF	37	$ 55.00	$ 2,035.00
618-2	15-INCH RGRCP, CLASS III	LF	8	$ 60.00	$ 480.00
618-3	18-INCH RGRCP, CLASS III	LF	316	$ 65.00	$ 20,540.00
618-4	24-INCH RGRCP, CLASS III	LF	333	$ 75.00	$ 24,975.00
618-5	30-INCH RGRCP, CLASS III	LF	136	$ 85.00	$ 11,560.00
618-6	36-INCH RGRCP, CLASS III	LF	74	$ 100.00	$ 7,400.00
618-7	48-INCH RGRCP, CLASS III	LF	252	$ 120.00	$ 30,240.00
618-8	54-INCH RGRCP, CLASS III	LF	127	$ 150.00	$ 19,050.00
618-9	102-INCH RGRCP, CLASS III	LF	10	$ 300.00	$ 3,000.00
618-10	SRP IRRIGATION CONSTRUCTION	LS	1	$ 60,000.00	$ 60,000.00
625-1	STORM DRAIN MANHOLE MAG DTL 520, 521 AND 522	EA	2	$ 4,000.00	$ 8,000.00
625-2	*ITEM NOT USED*				
625-3	STORM DRAIN MANHOLE (DETAIL S-8.02)	EA	26	$ 3,500.00	$ 91,000.00
625-4	GLENDALE SANITARY SEWER MANHOLE (5' DIAMETER)	EA	11	$ 6,600.00	$ 72,600.00
625-5	GLENDALE SANITARY SEWER MANHOLE (6' DIAMETER)	EA	2	$ 6,800.00	$ 13,600.00
625-6	GLENDALE SANITARY SEWER MANHOLE (7' OR 8' DIAMETER)	EA	1	$ 7,000.00	$ 7,000.00
625-7	GLENDALE EXISTING MANHOLE REHABILITATION	EA	3	$ 4,000.00	$ 12,000.00
				Subtotal (w/o Mob.)	$ 15,275,521.20
				Estimated Total Contract Construction Cost	$ 15,686,177.20

QUANTITY ESTIMATE

Bethany Home Outfall Channel
Reach C - Pre-Final
83rd Avenue to 73rd Avenue
FCD No. 2004C055

QUANTITY SUMMARY

ITEM NO.	ITEM DESCRIPTION	UNIT	SHEET NUMBERS																								TOTAL QUANTITY
			C-2.01	C-2.02	C-2.03	C-2.04	C-2.05	C-2.06	C-2.07	C-2.08	C-2.09	C-3.01	C-4.01	C-4.07	C-6.02	C-6.03	L-2.01	L-2.02	L-2.03	L-2.04	L-2.05	L-2.06	L-2.07	L-2.08	L-2.09	NODES	U-1.02	
211-1	FILL CONSTRUCTION	CY																										80,139
336-1	PAVEMENT REPLACEMENT (75TH AVENUE AND CAMELBACK ROAD)	SY													412	447												859
336-2	PAVEMENT PLACEMENT (81ST AVENUE DRIVEWAY)	SY											896															896
336-3	PAVEMENT PLACEMENT (75TH AVENUE PARKING LOT)	SY												2000														2,000
340-1	CONCRETE SIDEWALK	SF			496										960	105												1,561
340-2	CONCRETE CURB AND GUTTER (MAG DETAIL 220, TYPE A)	LF			101									937	153	107												1,298
340-3	CONCRETE VALLEY GUTTER (MAG DETAIL 240)	LF												350														350
340-4	CONCRETE PEDESTRIAN TRAIL (PRIMARY)	SF	4080	7080	9200	10470	10110	10660	6780	7180	5190																	70,750
340-5	CONCRETE PEDESTRIAN TRAIL (SECONDARY)	SF			1940	1480	1120	600	369		600																	6,109
340-6	CONCRETE DRIVEWAY WING TYPE	SF														200												200
340-7	CONCRETE DRIVEWAY RETURN TYPE	SF														113												113
350-1	REMOVE ASPHALT CONCRETE PAVEMENT	SY													412	447												859
350-2	REMOVE CONCRETE CURB AND GUTTER	LF			101								104	80	153	107												545
350-3	REMOVE CONCRETE SIDEWALK/PEDESTRIAN TRAIL	SF	3668	5877	5230	9684	10773	10287	13661						960	871												61,011
350-4	REMOVE CONCRETE CHANNEL LINING	SF		674	337								450															1,461
350-5	REMOVE EXIST WATER PIPE	LF																									387	387
350-6	DECOMISSION DRYWELL	EA	2	5	3	4	2	2			1																	19
350-7	MISCELLANEOUS REMOVAL OF EXISTING IMPROVEMENTS	LS		1																								1
401-1	75TH AVENUE TRAFFIC CONTROL	LS																										1
401-2	CAMELBACK ROAD TRAFFIC CONTROL	LS																										1
401-3	MISCELLANEOUS TRAFFIC CONTROL	LS																										1
420-1	6' CHAIN LINK FENCE, MAG STD DTL 160	LF								618	445																	1,063
421-1	WELL SITE AND SUBSTATION CONSTRUCTION	LS																										1
430-1	TREES (24" BOX)	EA															52	66	60	62	71	36	63	33	25	1		469
430-2	TREES (15 GALLON)	EA															89	85	71	50	24	87	157	0	0	5		568
430-3	SHRUBS (1 GALLON)	EA															25	268	328	251	54	48	121	0	0	41		1,136
430-4	SHRUBS (5 GALLON)	EA															349	256	332	295	78	151	436	0	0	34		1,931
430-5	BOULDERS	EA															55	21	26	54	20	14	22	0	0			212
430-6	TURF (HYDROSEED)	SF															35681	69843	87205	68772	43320	42298	159771	0	0			506,890
430-7	DECOMPOSED GRANITE	SF															129298	71968	71406	45699	19229	35788	82915	12277	9329			477,909
430-8	6" CONCRETE HEADER	LF															1858	1160	1317	810	0	200	1002	0	0	22		6,369
430-9	HARDSCAPE ELEMENTS	LS															1											1
430-10	SITE AMENITIES	LS															1											1
430-11	4" STABILIZED DECOMPOSED GRANITE	SF															35765	2973										38,738
430-12	12" CONCRETE HEADER	LF																								344		344
430-13	POST AND RAIL FENCE	LF															823	162										985
440-1	IRRIGATION DISTRIBUTION SYSTEM	LS																										1
479-1	LIGHTING	LS																										1
505-1	RCBC 1, 2-9x9	LF	233	1000	1000	1000	1000	1000	605																			5,838
505-2	RCBC 2, 2-8x7	LF							340	357	20																	717
505-3	75TH AVENUE RECTANGULAR CHANNEL	LF							56																			56
505-4	CAMELBACK RECTANGULAR CHANNEL	LF								644	418																	1,062
505-5	73RD AVENUE 2-12X10 RCBC TRANSITION	LS									1																	1
505-6	75TH AVENUE PEDESTRIAN TRAIL CROSSING	LS									1																	1
505-7	CONCRETE LOW-FLOW CHANNEL (DETAIL D2)	LF									50																	50
505-8	CONCRETE CHANNEL LINING	SF		1290	442								525															2,257
509-9	CONCRETE PAINTING	LS																										1
505-10	CATCH BASINS (DETAIL D4)	EA	2	2	2	5	4	3	2																			20
505-11	CATCH BASINS, MAG DTL 532	EA								1		2																3
505-12	CATCH BASINS, MAG DTL 530	EA												1														1
609-1	WELL CLOSURE	EA								1																		1
610-1	3/4" WATER LINE SERVICE FOR PARK NODES	EA															1		1	2		1						5
610-2	FIRE HYDRANT RELOCATION	EA																									1	1
610-3	GATE VALVE (12")	EA																									2	2
610-4	LINED DUCTILE IRON PIPE (12")	LF																									337	337
610-5	LINED DUCTILE IRON PIPE (8")	LF																									50	50
610-6	REMOVE AND REPLACE EXISTING 12" DIP	EA																									1	1
618-1	12-INCH RGRCP, CLASS III	LF				18			19																			37
618-2	15-INCH RGRCP, CLASS III	LF							8																			8
618-3	18-INCH RGRCP, CLASS III	LF	11	11		23	32	77	14	10		12		126														316
618-4	24-INCH RGRCP, CLASS III	LF	45		58	129		18				83																333
618-5	30-INCH RGRCP, CLASS III	LF				23	20	43		25		25																136
618-6	36-INCH RGRCP, CLASS III	LF				69	5																					74
618-7	48-INCH RGRCP, CLASS III	LF		32								220																252
618-8	54-INCH RGRCP, CLASS III	LF			127																							127
618-9	102-INCH RGRCP, CLASS III	LF								10																		10
618-10	SRP IRRIGATION CONSTRUCTION	LS																										1
625-1	STORM DRAIN MANHOLE MAG DTL 520, 521 AND 522	EA						1				1																2
625-2	"ITEM NOT USED"																											
625-3	STORM DRAIN MANHOLE (DETAIL S-8.03)	EA		4	6	4	4	4	2	2																		26

DMJM HARRIS	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 1
		DESIGNED BY: SEO	DATE 3-05
SUBJECT: Take-Off		CHECKED BY: CAL	DATE

location: 2-9x9 rcbc **Length: 5838 ft** **Cost**

Structure Excavation						
Width	Height		Excavation volume			
23.91	15		78849.87			
			0			
			78849.87		788498.667	
Shoring		(1200)(23)	27600	@ $16	441600	
Structural Backfill						
wall						
length	height		Backfill volume			
5838	11		14510.22			
			0			
			14510.22		290204.444	
Concrete						
CSA	Length		RCBC volume			
54.1292	5936		11900.4			
			0			
			11900.4		3808129.55	
Reinforcing Steel			2078618		1558963.5	1766825.3
Total Cost					$7,095,258	

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DMJM HARRIS	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 1
		DESIGNED BY: SEO	DATE 3-05
SUBJECT: Take-Off		CHECKED BY: CAL	DATE

location: ***2-8x7 rcbc*** **Length: 696 ft** **Cost**

Structure Excavation						
Width	Height		Excavation volume			
21.91	24		13554.99			
			0			
			13554.99		135549.87	
Shoring		(24+24)(696)	33408	@ $16	534528	
Structural Backfill						
wall length	wall height		Backfill volume			
696	10		1546.667			
			0			
			1546.667		30933.333	
Concrete						
CSA	Length		RCBC volume			
43.5827	696		1123.465			
			0			
			1123.465		505559.32	
Reinforcing Steel			215323		161492.25	183024.55
Total Cost					$1,389,595	

Unit Cost= $1,997

DMJM HARRIS	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 1
		DESIGNED BY: SEO	DATE 10-05
SUBJECT: Take-Off		CHECKED BY: CAL	DATE

location: 75th Avenue Pedestrian Pipe Arch

				Cost
Structure Excavation				
Width	Height		Excavation volume	
15.5	2	RCBC	15.69519	
15.5	10	Cut-Off Walls	5.740741	
7	4	(Retaining Walls)	164.7541	
6.5	4	(Retaining Walls)	28.09926	
8.67	4	(Retaining Walls)	63.75982	
			278.0491	2780.491
Structural Backfill				
wall length	height		Backfill volume	
13.67	6.5	RCBC	19.74556	
158.87	5	(Retaining Walls)	88.26111	
29.18	4	(Retaining Walls)	12.96889	
49.64	8	(Retaining Walls)	44.12444	
			165.1	3302
Concrete				
CSA	Length		Concrete volume	
1.32	14	(RCBC)	18.48	
0.372	158.87	(Retaining Walls)	59.09964	
0.323	29.18	(Retaining Walls)	9.42514	
0.561	49.64	(Retaining Walls)	27.84804	
10	15.5	(cut-off wall)	5.740741	
0.66	15.5	(Headwall)	0.378889	
			120.9724	38711.18
Reinforcing Steel			11221	9537.85
Arched Railing			107	21400
Safety Railing			164.06	10663.9
Rustication			650.15	650.15
Total Cost				$86,395
Painting			814.21	407.105

DMJM HARRIS	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 1
		DESIGNED BY: SEO	DATE 10-05
SUBJECT: Take-Off		CHECKED BY: CAL	DATE

location: ***75th Avenue Rectang*** **Length: 55.4 ft** **Cost**

Structure Excavation			Excavation	
Width	Height		volume	
24.45	21.35		1071.082	
			0	
			1071.082	10710.82
Structural Backfill				
wall			Backfill	
length	height		volume	
55.4	21.35		262.8422	
20.25	9.8		44.1	
18.25	11.93		48.38278	
			355.325	7106.5
Concrete			Concrete	
CSA	Length		volume	
84.77	55.4	(Rt Wall)	173.9355	
77	55.4	(Lt Wall)	157.9926	
12.66	38.5	(Headwall)	18.05222	
			349.9803	111993.7
Reinforcing Steel			35205	29924.25
Steel Picket Fence			149.3	9704.5
Rustication			443.2	443.2
Total Cost				$169,883
Painting			2501.703	1125.766

DMJM HARRIS	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 1
		DESIGNED BY: SEO	DATE 10-05
SUBJECT: Take-Off		CHECKED BY: CAL	DATE

location: Camelback Rectangular Channel & Transition

			Cost
Sta 190+56.54 to Sta 190+72.55	16 ft		
Sta 190+72.55 to Sta 191+34.60	62.05 ft		
Sta 191+34.60 to Sta 201+18.14	983.54 ft		
	1061.59		
Structure Excavation			
Width / Height	Excavation volume		
23.67 / 20.23	283.7595		
20.67 / 17.23	818.4719		
20.67 / 14.17	10669.37		
	11771.6		117715.9679
Structural Backfill			
wall length / height	Backfill volume		
16 / 20.23	71.92889		
62.05 / 17.23	237.5826		
983.54 / 14.17	3097.058		
	3406.57		68131.39244
Concrete			
CSA / Length	Concrete volume		
80.85 / 16	47.91111	(Channel)	
68.56 / 62.05	157.561	(Channel)	
60.9 / 983.54	2218.429	(Channel)	
12.69 / 18.25	8.5775	(Headwall)	
	2432.479		778393.203
Reinforcing Steel	309535		263104.75
Steel Picket Fence	2141.43		139192.95
Rustication	8492.72		8492.72
Total Cost			$1,375,031
Painting	29453.77		13254.19695

DMJM HARRIS	PROJECT: BHOC Reach C	JOB NO. 6063	SHEET 1
		DESIGNED BY: SEO	DATE 10-05
SUBJECT: Take-Off		CHECKED BY: CAL	DATE

location: 73rd Avenue 2-12x10

				Cost
Sta 201+18.14 to Sta 201+89.02 (Channel)			70.88 ft	
Sta 201+89.02 to Sta 202+03.02 (rcbc)			14 ft	
Sta 202+03.02 to Sta 202+27.04 (Channel)			24.02 ft	
(Inlet Walls)			97 ft	
Structure Excavation			Excavation	
Width	Height		volume	
26.08	14.17		970.1466	
31.5	14.17		628.534	
11	6	Retaining Walls	237.1111	
			1835.792	18357.92
Structural Backfill				
wall			Backfill	
length	height		volume	
70.88	14.17		223.1932	
38.02	14.17		119.7208	
97	9		97	
			439.914	8798.28
Concrete			Concrete	
CSA	Length		volume	
69.93	70.88	(Channel)	183.5792	
3.523	14	(rcbc)	1.826741	
79.02	24.02	(Channel)	70.29853	
0.409	33	(Inlet Walls)	13.497	
0.676	32	(Inlet Walls)	21.632	
0.958	32	(Inlet Walls)	30.656	
5	25	(cut-off wall/curb)	4.62963	
12.69	18.25	(Headwall)	8.5775	
			334.6966	107102.9
Reinforcing Steel			94193	80064.05
Steel Picket Fence			168.76	10969.4
Safety Railing			172.04	11182.6
Access Barrier			1	7500
Rustication			1147.2	1147.2
Total Cost				$245,122
Painting			1717.65	858.825

Bethany Home Outfall Channel - Reach C

Summary of Catch Basins and Laterals

CATCH BASINS							PIPES							QUANTITIES			Cost		
BASIN STATION (FT.)	OFFSET LEFT (FT.)	CATCH BASIN TYPE	NUMBER OF GRATES	BASIN WIDTH X (FT.)	GRATE ELEVATION (FT.)	BASIN INV. ELEV. (FT.)	LENGTHS L1 (FT.)	LENGTHS L2 (FT.)	DIAMETERS D1 (IN.)	DIAMETERS D2 (IN.)	OUTLET STATION (FT.)	OFFSET LEFT (FT.)	OUTLET INV. ELEV. (FT.)	CONCRETE WALLS (C.F.)	CONCRETE FLOOR (C.F.)	CONCRETE TOTAL (C.Y.)	UNIT COST ($)	EXTENSION ($)	
123+74.31	170.60	A	2	8.08	1081.10	1076.10	6	N/A	18	N/A	123+62.34	167.75	1073.46	67.20	26.91	3.49	$675.00	$2,360	1
123+97.24	92.07	A	2	8.08	1080.64	1076.66	41	N/A	24	N/A	123+52.12	100.71	1073.66	53.49	26.91	2.98	$675.00	$2,010	2
130+65.10	40.32	B	4	12.33	1085.00	1077.30	32	N/A	48	N/A	130+51.74	9.38	1069.91	157.39	53.39	7.81	$675.00	$5,270	3
132+40.81	21.48	A	1	5.71	1083.00	1078.45	11	N/A	18	N/A	132+35.56	9.38	1074.62	46.74	19.00	2.43	$675.00	$1,650	4
140+95.35	64.75	B	2	8.33	1085.20	1080.16	58	N/A	24	N/A	140+72.85	9.38	1075.09	76.14	36.07	4.16	$675.00	$2,810	5
142+19.34	66.10	B	10	24.33	1084.80	1078.35	67/60	N/A	2-54	N/A	141+81.66	9.38	1070.35	235.04	105.35	12.61	$675.00	$8,510	6
148+21.58	27.52	A	1	5.71	1087.00	1083.00	16	42	30	24	148+12.81	9.38	1075.43	41.09	19.00	2.23	$675.00	$1,510	7
151+50.26	24.80	A	1	5.71	1087.00	1083.50	15	56	24	24	151+45.50	9.38	1076.31	35.96	19.00	2.04	$675.00	$1,380	8
152+22.97	25.40	A	1	5.71	1087.63	1083.05	23	N/A	18	N/A	152+16.30	9.38	1076.90	47.05	19.00	2.45	$675.00	$1,660	9
155+04.14	44.62	B	5	14.33	1087.79	1082.36	35/34	N/A	2 - 36	N/A	154+96.50	9.38	1073.32	125.47	62.05	6.95	$675.00	$4,690	10
155+98.74	25.01	B	2	8.33	1086.41	1082.41	23	18	30	12	155+80.50	9.38	1076.33	60.43	36.07	3.57	$675.00	$2,420	11
157+28	19.86	B	3	10.33	1087.75	1082.75	11	N/A	30	N/A	157+20.80	9.38	1076.48	88.87	44.73	4.95	$675.00	$3,340	12
160+74.86	18.40	B	3	10.33	1088.00	1082.75	9	N/A	30	N/A	160+70.00	9.38	1076.88	93.31	44.73	5.11	$675.00	$3,460	13
163+94.40	14.30	A	1	5.71	1089.00	1086.00	5	N/A	18	N/A	163+90.00	9.38	1078.25	30.82	19.00	1.85	$675.00	$1,250	14
166+13.94	14.27	B	4	12.33	1089.00	1082.70	5	N/A	36	N/A	166+10.00	9.38	1075.00	128.77	53.39	6.75	$675.00	$4,560	15
168+44.33	18.20	A	1	5.71	1089.30	1086.30	9	N/A	18	N/A	168+38.70	9.38	1078.76	30.82	19.00	1.85	$675.00	$1,250	16
174+31.81	19.88	A	1	5.71	1089.00	1086.00	11	N/A	18	N/A	174+24.00	9.38	1079.44	30.82	19.00	1.85	$675.00	$1,250	17
176+57.23	47.39	B	2	8.33	1092.40	1088.40	43	N/A	30	N/A	176+34.00	9.38	1078.68	60.43	36.07	3.57	$675.00	$2,420	18
183+63.46	16.97	A	1	5.71	1086.00	1079.87	5	N/A	18	N/A	183+63.38	16.00	1078.52	62.98	19.00	3.04	$675.00	$2,050	19
184+03.55	109.00	A	1	5.71	1090.89	1086.90	11	N/A	18	N/A	183+91.82	109.52	1089.23	40.99	19.00	2.22	$675.00	$1,500	20
																	SUM	$55,350	$2,768

BHOC Reach C 100%
Project # 6063

QNTYS

	Sheets C-4.01-4.09								
	C.4.01	**C.4.02**	**C.4.03**	**C.4.04**	**C.4.05**	**C.4.06**	**C.4.07**	**C.4.08**	**C.4.09**
Cut(CY)	3760.5	507.6	650.8	513.4	685	632.6	2714.7	560.6	1791.6
Fill(CY)	11068.7	7748.9	8328	7726.7	963.8	2791.9	40786.6	261	426.2
NET(CY)	-7308.2	-7241.3	-7677.2	-7213.3	-278.8	-2159.3	-38071.9	299.6	1365.4

Excavations qntys for BHOC per sheet									
Cut(Cf)	50122.8	215156.25	215156.25	215156.25	215156.25	215156.25	206867.2	220949.94	136660.48
Cut(CY)	1856.4	7968.75	7968.75	7968.75	7968.75	7968.75	7661.748	8183.3311	5061.4993

Cut/Fill Qntys to appear on sheets C-4.01-4.09									
Cut(CY)	5616.9	8476.35	8619.55	8482.15	8653.75	8601.35	10376.45	8743.9311	6853.0993
Fill(CY)	11068.7	7748.9	8328	7726.7	963.8	2791.9	40786.6	261	426.2
NET(CY)	-5451.8	727.45	291.55	755.45	7689.95	5809.45	-30410.2	8482.9311	6426.8993
STATUS	BORROW	WASTE	WASTE	WASTE	WASTE	WASTE	BORROW	WASTE	WASTE

Total Qntys (CY)	
Total Cut	74423.529
Total Fill	80101.8
Net	-5678.271
	BORROW

Item No.	Description	Unit	Quantity	Unit Cost	Amount
440 - 1	Irrigation Distribution System	LS	1	$319,456.25	$319,456.25
					319,456.25

440 - 1	Master Valve	EA	6	$750.00	$4,500.00
440 - 1	Gate Valve (4")	EA	19	$500.00	$9,500.00
440 2	Gate Valve (2-1/2")	EA	2	$250.00	$500.00
440 3	Gate Valve (1-1/4")	EA	0	$150.00	$0.00
440 - 4	Gate Valve (1")	EA	3	$125.00	$375.00
440 5	Quick Coupler	EA	7	$125.00	$875.00
440 6	Controller	EA	3	$7,500.00	$22,500.00
440 7	Control Valve (Bubbler) (1")	EA	2	$125.00	$250.00
440 - 8	Control Valve (Drip) (1")	EA	47	$175.00	$8,225.00
440 - 9	Control Valve (Turf) (2")	EA	71	$200.00	$14,200.00
440 - 10	Emitters	EA	1,600	$15.00	$24,000.00
440 11	Bubbler	EA	58	$15.00	$870.00
440 - 12	Rotor Sprinkler (40'-60')	EA	238	$120.00	$28,560.00
440 - 13	Rotor Sprinkler (25'-40')	EA	220	$70.00	$15,400.00
440 - 14	Pipe (PVC)(3/4") Class 200 Emitter Lateral	LF	41,350	$1.15	$47,552.50
440 15	Pipe (PVC)(3/4") Class 200 Bubbler Lateral	LF	1,225	$1.15	$1,408.75
440 - 16	Pipe (PVC) Class 200 Turf Lateral	LF	18,600	$2.75	$51,150.00
440 17	Pipe (PVC)(1") Sch. 40 Mainline	LF	520	$1.50	$780.00
440 - 18	Pipe (PVC)(1-1/4") Sch. 40 Mainline	LF	360	$1.75	$630.00
440 19	Pipe (PVC)(2") Sch. 40 Mainline	LF	955	$2.25	$2,148.75
440 20	Pipe (PVC)(2-1/2") Sch. 40 Mainline	LF	425	$2.75	$1,168.75
440 - 21	Pipe (PVC)(4") Class 200	LF	10,465	$6.50	$68,022.50
440 - 22	Pipe Sleeve	LF	1,500	$12.50	$18,750.00
440 - 23	End Caps	EA	259	$10.00	$2,590.00
				TOTAL:	$319,456.25

PROJECT: BETHANY HOME OUTFALL CHANNEL - REACH C

BY: KELLY 02-10-05

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

DMJM+HARRIS NO. 6063

SUBJECT: COST ESTIMATE WORKSHEET (100% DESIGN) - LANDSCAPE ARCHITECTURE - MAIN TRAIL

ITEM NO.	DESCRIPTION NEW CONSTRUCTION	QTY	UNIT	UNIT COST	TOTAL
	MISC. EARTH GRADING & BERMS (No Pay Item) ?	9,400	SF	$0.00	$0.00
	FINE GRADING (No Pay Item)	998,136	SF	$0.00	$0.00
430-1	TREES (24" BOX)	509	EA	$200.00	$101,800.00
430-2	TREES (15 GALLON)	530	EA	$70.00	$37,100.00
430-3	SHRUBS (5 GALLON)	1,942	EA	$16.00	$31,072.00
430-4	GROUNDCOVER (1 GALLON)	1,136	EA	$6.00	$6,816.00
430-5	BOULDERS	212	EA	$140.00	$29,680.00
430-6	TURF (HYDROSEED)	506,890	SF	$0.10	$50,689.00
430-7	DECOMPOSED GRANITE (PLANTING AREAS)	477,909	SF	$0.25	$119,477.25
430-8	6" CONCRETE HEADER	6,347	LF	$7.00	$44,429.00
430-11	STABILIZED DECOMPOSED GRANITE	38,738	SF	$1.40	$54,233.20
430-12	12" CONCRETE HEADER	344	LF	$12.00	$4,128.00
430-11	CEDAR POST AND RAIL FENCE	1,005	LF	$11.00	$11,055.00
	SUBTOTAL				$490,479.45
430-9	HARDSCAPE ELEMENTS				
A	TRAIL MILE MARKERS	6	EA	$500.00	$3,000.00
B	CONCRETE PAVING (Does not include the secondary path conc. through the nodes)	13,284	SF	$2.50	$33,210.00
C	COLORED CONCRETE PAVING	5,467	SF	$7.00	$38,269.00
D	INTERLOCKING CONCRETE PAVERS	5,121	SF	$7.00	$35,847.00
E	VEHICLE ACCESS RAMP (Neighborhood Nodes only)	4	EA	$2,000.00	$8,000.00
F	STAMPED COLORED CONCRETE BANDS (Includes all secondary paths to primary path intersections)	53	SF	$7.00	$371.00
G	12" CONCRETE HEADER	344	LF	$22.00	$7,568.00
H	TUBULAR STEEL SAFETY RAILING (All nodes + ped crossings)	470	LF	$50.00	$23,500.00
I	ENTRY PLAZA RETAINING WALL	232	SF	$30.00	$6,960.00
J	PUMP STATION ENCLOSURE (CMU walls, T.S. Gate, C.L. Fence Cover)	0	SF	$20.00	$0.00
	SUBTOTAL				$156,725.00
430-10	SITE AMENITIES				
A	PARK BENCH	26	EA	$1,350.00	$35,100.00
B	CONCRETE SEAT PODS	0	EA	$600.00	$0.00
C	PICNIC TABLE	8	EA	$1,150.00	$9,200.00
D	BARBECUE GRILL	8	EA	$260.00	$2,080.00
E	BICYCLE LOOPS	25	EA	$125.00	$3,125.00
F	DRINKING FOUNTAIN (including BFP, QC and sump)	7	EA	$4,375.00	$30,625.00
G	PARK SIGN - N.I.C.	4	EA	$0.00	$0.00
H	WARNING SIGN - N.I.C.	4	EA	$0.00	$0.00
I	REMOVEABLE BOLLARDS (All nodes and equestrian parking lot)	11	EA	$400.00	$4,400.00
J	TRASH RECEPTACLES	10	EA	$440.00	$4,400.00
K	SHADE RAMADA	8	EA	$15,000.00	$120,000.00
L	CONCRETE BOLLARDS	17	EA	$400.00	$6,800.00
	SUBTOTAL				$215,730.00
$0.00	**#VALUE!**	**$0.00**	**$0.00**	**$0.00**	**$862,934.45**

BHOC Lighting Estimate

	E-2.01	E-2.02	E-2.03	E-2.04	E-2.05	E-2.06	E-2.07	Total	Unit Cost	Total
3.25" Square Pole - 24 foot	4	7	9	9	6	7	10	52	$ 800.00	$ 41,600.00
3.25" Square Pole - 35 foot	4						4	8	$ 1,200.00	$ 9,600.00
Pole Foundation	8	7	9	9	6	7	14	60	$ 600.00	$ 36,000.00
100-Watt HID	4	7	9	9	6	7	10	52	$ 100.00	$ 5,200.00
250-Watt HID	4						4	8	$ 250.00	$ 2,000.00
2" PVC								9700	$ 5.00	$ 48,500.00
Pull Box	10	10	11	13	6	8	19	77	$ 200.00	$ 15,400.00
Conductors								1	$ 30,000.00	$ 30,000.00
Service Pedestal				1				1	$ 2,500.00	$ 2,500.00
Modify Service		1				1		2	$ 500.00	$ 1,000.00
100-Watt Ramada Light		1	1	2				4	$ 100.00	$ 400.00

Total $ 192,200.00