DR06: 2

UNSER BOULEVARD DRAINAGE ANALYSIS
Sandoval County Line to Southern Boulevard

Prepared for

City of Rio Rancho, New Mexico

Prepared by

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June 23, 1992

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UNSER BOULEVARD DRAINAGE ANALYSIS

I. INTRODUCTION

The City of Rio Rancho is currently designing the extension of Unser Boulevard, located east of existing 20th Street from the Sandoval County Line north to the existing intersection of 20th Street and Southern Boulevard, a distance of approximately 1.6 miles. This report analyzes the drainage impacting this section of roadway, offers recommendations for structure sizing, conveyance and details cost estimates for the recommendations.

II. HYDROLOGIC ANALYSIS

The hydrologic model used for the analysis of Unser Boulevard was the March 1992 Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) version of HYMO (AHYMO). The analysis was performed for the 100 year, six hour design storm. The total precipitation for this storm is 2.3 inches. A 100 year return frequency event is the most commonly used storm for the design of conveyance structures under highways and is considered warranted for the Unser Boulevard project.

III. DRAINAGE BASINS AND EXISTING CONDITIONS

Drainage basins contributing runoff to the Unser Boulevard project were delineated and are shown on Figure 1 contained in the pocket in the back of the report.

The drainage basins are described as follows:

North of Southern Boulevard

Drainage basins contributing to the Unser Boulevard project are designated as U1, U2, U3 and U4 on Figure 1. Storm runoff from these areas is generally toward the east and south with slopes ranging from less than one percent to nearly four percent. The total area above Southern Boulevard that impacts the Unser Boulevard project is 1,930 acres.

Drainage basin U1, north of Idalia Road, is mostly undeveloped with sparse vegetative cover and highly erodible soil.

Drainage basins U2 and U3 are developed with mostly medium density single family residential with some high density multi-family residential areas. Landscaping throughout the developed areas of the basins is typically "southwestern" style, consisting of natural desert vegetation and rock. This type of land treatment has little effect on the natural runoff and erosion potential of the land.

Runoff from drainage basins U1 and U2 converge, through streets and a network of small channels, into the Lisbon Boulevard Channel. This channel has been graded from its natural state into a trapezoidal configuration with some lined sections, but is typically naturally lined. The longitudinal slope of the channel has been naturally stabilized due to a stratum of clay. The Lisbon Boulevard Channel passes under Southern Boulevard through an 8-foot rise by 11-foot span structural plate arch pipe, where it discharges into the unimproved west branch of the Black Arroyo.

There is a significant amount of erosion in the Black Arroyo below the arch pipe. The walls of the arroyo are unstabilized and are standing nearly vertical, with a depth of 12 to 15 feet.

Runoff from drainage basin U3 is conveyed through a series of small natural channels and developed street sections. Runoff is conveyed under Southern Boulevard via two 3-foot rise by 5-foot span corrugated metal pipe arches (CMPA's). These CMPA's discharge to a small natural channel that converges with the west branch of the Black Arroyo. The arroyo at this location is exhibiting similar erosion characteristics to the outfall of the Lisbon Channel.

Drainage basin U4, located on the northwest quadrant of Southern Boulevard and 20th Street, is currently undeveloped but is proposed to be developed into commercial property and some single family residential.

Drainage basin U4 currently collects in a small detention basin located at the northwest corner of the intersection of Southern Boulevard and 20th Street, overflows into the intersection of Southern Boulevard and 20th Street, then discharges into the Southern Boulevard channel east of 20th Street. The runoff then flows down Southern Boulevard to the intersection of Western Hills Drive. This results in flooding of the Western Hills Drive/Southern Boulevard intersection. The runoff ponds in this intersection until it overflows to the south down the right of way for 23rd Street. The water flows down this unimproved right of way until it reaches the Black Arroyo.

South of Southern Boulevard

Drainage basins south of Southern Boulevard that contribute runoff to the Unser Boulevard project are designated as L1, L2, L3, L4 and L6 on Figure 1. The area of these basins is approximately 1511 acres. These basins are presently undeveloped with the exception of some bladed roadways. Runoff is conveyed by overland flow into a network of natural finger arroyos. Flow is generally in the west to east direction, with ultimate discharge into the west branch of the Black Arroyo.

IV. ANTICIPATED DEVELOPED CONDITIONS

Development within the City of Rio Rancho has progressed at a brisk pace over the last few years. Although several of the drainage basins contributing runoff to the Unser Boulevard project are presently undeveloped or only partially developed, it is a reasonable expectation that the development will continue. Based on current development trends and existing zoning and platting, the assumed land uses are as follows:

Drainage basin U1-South of Idalia Road is currently developed with medium density single family residential. It is assumed that similar development will occur in the area north of Idalia Road.

Drainage basin U2-This basin is assumed to be completely developed with medium density single family residential.

Drainage basin U3-This basin is assumed to be completely developed with medium density single family residential with scattered high density multi-family residential and commercial along the north side of Southern Boulevard.

Drainage basin U4-This basin is currently undeveloped, but is assumed to be developed with commercial and high density residential under ultimate conditions.

Drainage basin L1-This basin is presently undeveloped, but has been platted and zoned for low density single family residential.

Drainage basin L2-This basin is presently undeveloped, but has been platted and zoned for low density single family residential. Some commercial development can be expected to occur along the south side of Southern Boulevard.

Drainage basin L3-It is anticipated that this basin will be developed entirely as commercial.

Drainage basin L4-This basin is presently undeveloped, but has been platted and zoned for low density single family residential.

Drainage basin L6-This basin is presently undeveloped, but has been platted and zoned for low density single family residential.

V. RESULTS OF THE HYDROLOGIC ANALYSES

Two hydrologic models were run for the Unser Boulevard drainage analysis. The first model was for the existing conditions and can be found in Appendix 1. The second model was for the ultimate developed condition and can be found in Appendix 2.

In the developed condition analysis, no detention was assumed to occur upstream of the Unser Boulevard project. This would allow for the design of conveyance structures under Unser Boulevard to be adequately sized on the worst case runoff flow rates.

Additionally, the Black Arroyo Detention Dams, currently under construction by AMAFCA, are designed to accept 100 year developed flow rates from the watershed.

As expected, the developed condition flow rates from the drainage basins is significantly higher than the flow rates under the existing conditions, particularly for the undeveloped areas south of Southern Boulevard. These flow rates are summarized in Table 1.

TABLE 1
COMPARISON OF DEVELOPED AND UNDEVELOPED CONDITION FLOW RATES

Drainage Area or Subarea	Existing 100 Year Flow Rates (cfs)	Developed 100 Year Flow Rates (cfs)
U1-1	24	176
U1-2	50	197
U1-3	70	276
U1-4	84	301
U1-5	78	105
U2	279	373
U3-1	200	327
U3-2	299	434
U4	196	480
L1	97	306
L2-1	79	227
L2-2	90	183
L3	41	296
L4-2	28	89
L6-1	100	289

Runoff from these basins is concentrated in six locations. These locations include three crossings of Southern Boulevard (at the existing 2-3' X 5' CMPA's, at 8'x 11' arch pipe at the Lisbon Channel and at the intersection of Southern and 20th Street), and three of the concentration points are located on the proposed alignment of Unser Boulevard (at the main crossing of the Black Arroyo, just south of the main arroyo crossing and at the County Line). Table 2 compares the developed flow rates versus the existing condition flow rates at these concentration points.

TABLE 2
SUMMARY OF ROUTED FLOWS AT THE CONCENTRATION POINTS

Location	Flow from Area	Ex. 100 Year Flows (cfs)	Dev. 100 Year Flows (cfs)
Southern, at Lisbon	U1, U2, U3-1	584	1504
Southern, at 3'x 5'arches	U3-2	298	434
Southern, at Unser	U4	196	480
Unser, at Black Arroyo	L1-L3, U1-U4	905	2845
Unser, south of Black Arroyo	L4-2	28	89
Unser, at County Line	L6-1	100	289

APPENDIX 1

EXISTING CONDITIONS

HYDROLOGIC ANALYSIS

VI. CONVEYANCE STRUCTURE SIZING

Conveyance structures were sized for both the existing flow rates and for the developed flow rates in order to do a cost comparison. The calculations and cost estimates for these structures are included in Appendices 3 and 4. The required structure sizes for the existing conditions and the developed conditions are summarized in Tables 3 and 4, respectively.

TABLE 3
SUMMARY OF REQUIRED STRUCTURE SIZES
EXISTING CONDITIONS

Location	Existing Flows (cfs)	Required Structure	Estimated Cost
Southern, at Lisbon	584	2-8'x 4' CBC	$ 55,550
Southern, at 3'x 5' arches	298	2-4'x 4' CBC	$ 40,000
Southern, at Unser	196	1-6'x 4' CBC	$ 25,500
Unser, at Black Arroyo	905	2-8'x 6' CBC	$ 84,900
Unser, south of Black Arroyo	28	1-24" RCP	$ 5,750
Unser, at County Line	100	1-48" RCP	$ 11,500

Subtotal of Conveyance Structure Construction $223,200

TABLE 4
SUMMARY OF REQUIRED STRUCTURE SIZES
DEVELOPED CONDITIONS

Location	Developed Flows (cfs)	Required Structure	Estimated Cost
Southern, at Lisbon	1504	5-8'x 4' CBC	$123,700
Southern, at 3'x 5' arches	434	3-4'x 4' CBC	$ 51,500
Southern, at Unser	480	3-4'x 4' CBC	$ 51,500
Unser, at Black Arroyo	2845	8-5'x 7' CBC	$227,100
Unser, south of Black Arroyo	89	1-48" RCP	$ 11,500
Unser, at County Line	289	1-8'x 4' CBC	$ 51,100

Subtotal of Conveyance Structure Construction $516,400

VII. PRELIMINARY CHANNEL SIZING

Drainage is currently routed through the watershed by natural arroyos that converge, either directly or indirectly, into a series of converging channels into the west branch of the Black Arroyo. The area of the drainage basins is platted, but easements for this network of arroyos are non-existent, are poorly defined, are of insufficient width to adequately convey flows, or are improperly aligned to with the existing alignment of the arroyos. While this condition does not directly impact the Unser Boulevard project, it is important to point out this information for future planning and development activities.

A preliminary analysis was completed to determine the size and configuration of the channels required to convey the flow that is discharged from the existing 3'x 5' CMPA's, the Lisbon Boulevard Channel, and the discharge from drainage basin U4 to the main arroyo crossing under Unser Boulevard at the Black Arroyo. The calculations for these channels are included in Appendix 5. Because of the steep slopes and the highly erosive soils in the area, it is recommended that velocities in unlined channels be limited to 2.5 feet per second (fps) or less.

There are two ways to protect the channel from erosion, by flattening the grade and thus reducing the velocity or by lining the channel and allowing for greater velocities. Flattening the grade of the channel results in a wide, shallow channel that requires drop structures to control the grade. The general rule of thumb for sizing drop structures is that the structure must be at least twice the height as the depth of water in the channel in order to effectively control the velocity. Grade control structures are usually constructed of wire enclosed riprap or gabions and are expensive.

Lining of the channel allows for the cross section to be reduced, with a narrower bottom width and steeper side slopes. Channel lining is also expensive, but allows for greater amounts of runoff to be conveyed in a smaller channel with higher velocities.

There is only one major conveyance channel that will need to be constructed with the Unser Boulevard project. This channel will be located on the west side of Unser, between Unser Boulevard and the existing 20th Street right of way. This channel will convey the flows from drainage basin U4, north of Southern Boulevard, and from basin L3, which currently sheet flows across the Unser right of way. Peak flow rates will range from 196 cfs in the existing condition to 480 cfs in the developed condition with unlimited construction. It is proposed that this channel be located in the excess right of way west of Unser Boulevard. The

channel configuration required is a 40 foot bottom width, 4:1 side slopes, depth of 2 to 3 feet with grade control structures if an unlined channel is used. In the event that an asphalt paved channel is used, the channel configuration can remain the same, but the grade control structures may be eliminated.

VIII. RECOMMENDATIONS

The following recommendations are offered for the drainage improvements associated with the construction of Unser Boulevard.

1. It is recommended that all structures and conveyance systems be sized for the 100 year return frequency storm. This is the most commonly accepted design for roadways within urban areas.

2. It is recommended that the City of Rio Rancho require that future development limit storm water discharge to existing flow rates. This will minimize the size of the structures under Unser Boulevard.

3. Two structures under Southern Boulevard will need to be replaced because of inadequate sizing, the existing 3'x 5' CMPA's that convey runoff from drainage basin U3-2 and the 8'x 11' arch pipe at the Lisbon Channel crossing. While these structures do not directly impact the Unser Boulevard construction, the drainage from the areas above Southern Boulevard does impact the Unser project. In the event that Southern Boulevard requires construction in the future, the conveyance structures should be replaced.

4. A new conveyance structure should be placed under Southern Boulevard at Unser Boulevard to convey the runoff from drainage basin U4. This structure will convey all of the runoff from basin U4 and will eliminate the flooding of the Southern Boulevard Channel and the Western Hills Drive/Southern Boulevard intersection.

5. One main crossing of the west branch of the Black Arroyo will be required under the Unser Boulevard right of way. The structure required for the developed flow conditions is a bank of eight 5'x7' box culverts.

6. Two smaller conveyance structures will be required under the Unser Boulevard right of way to convey the minor developed flows crossing Unser south of the main arroyo crossing. These structures are a 48 inch diameter pipe with headwalls and an 8'x4' box culvert located as shown on Figure 1.

7. The total estimated cost of the conveyance structures for the developed conditions runoff is $516,400.

8. It is recommended that the excess right of way west of the Unser Boulevard construction be utilized for an asphalt lined channel that will convey flow from drainage area U4 and intercept the overland flow that crosses Unser Boulevard from drainage basin L3.

9. Runoff from the Unser right of way proper should be intercepted in the west side channel discussed in Item 7 above. Minor runoff flows from the east side of the Unser Boulevard right of way will be intercepted in a small channel on the east side of the roadway that will discharge directly to the west branch of the Black Arroyo.

10. The City of Rio Rancho should consider channel lining or other erosion control measures for the existing channels in order to minimize the erosion and bank cutting that is occurring at the existing conveyance structure outfalls.

APPENDIX 2

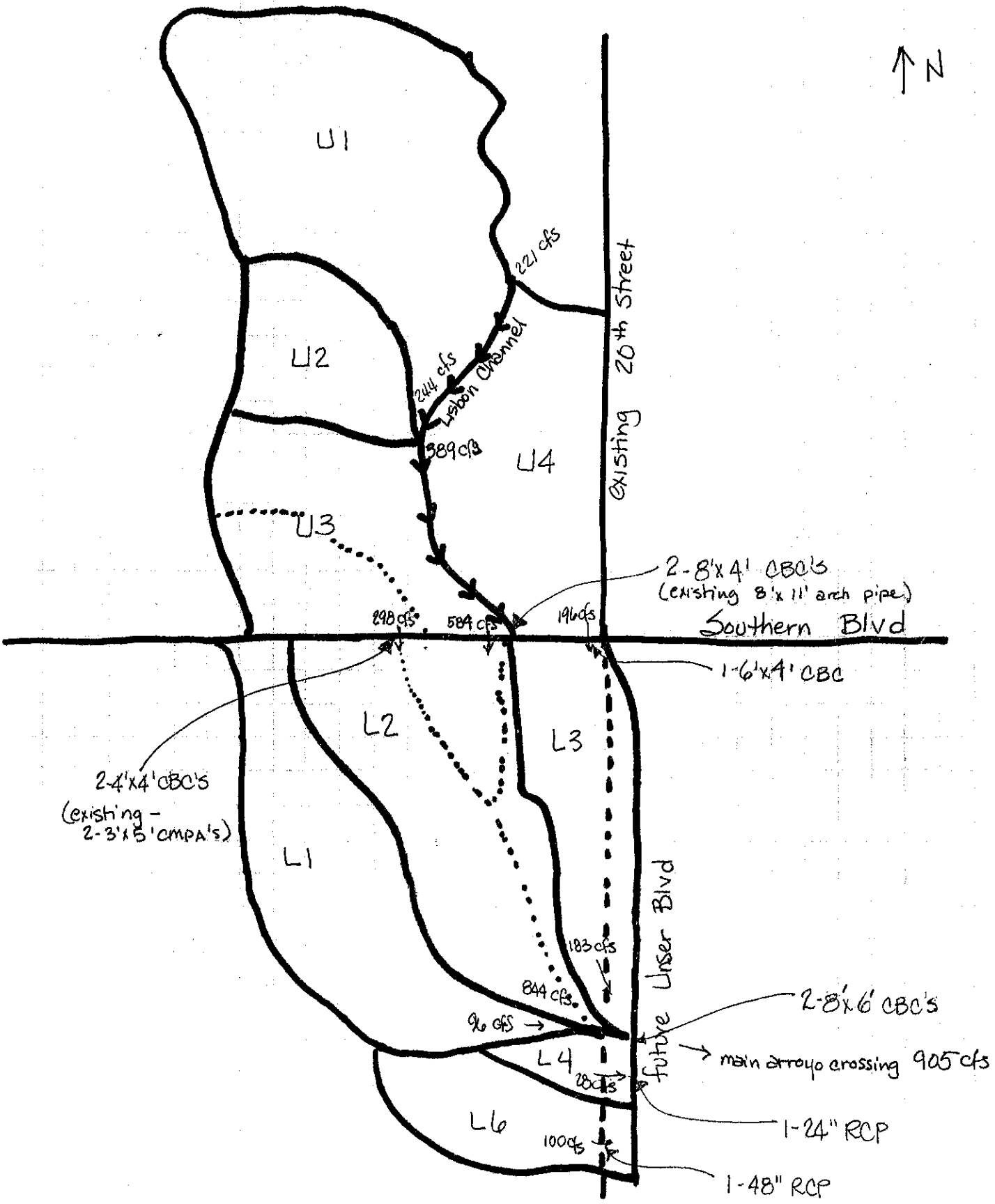
DEVELOPED CONDITIONS

HYDROLOGIC ANALYSIS

Gannett Fleming
ENGINEERS AND PLANNERS

SUBJECT | SHEET NO. | OF
JOB NO.
BY | DATE | CHKD. BY | DATE

Unser Blvd Drainage - Existing Conditions



AHYMO SUMMARY TABLE (AHYMO392) - AMAFCA VERSION OF HYMO - MARCH, 1992 RUN DATE (MON/DAY/YR) =06/01/1992
INPUT FILE = unserex.hy USER NO.= M_BURAK_.S92

COMMAND	HYDROGRAPH IDENTIFICATION	FROM ID NO.	TO ID NO.	AREA (SQ MI)	PEAK DISCHARGE (CFS)	RUNOFF VOLUME (AC-FT)	RUNOFF (INCHES)	TIME TO PEAK (HOURS)	CFS PER ACRE	NOTATION
*S	EXISTING CONDITIONS FOR 20TH STREET BETWEEN SOUTHERN AND COUNTY LINE									
RAINFALL	TYPE= 1									RAIN6= 2.300
*S	Subbasin No.U1-1									
COMPUTE	NM HYD	101.00	-	1	.13000	24.09	3.333	.48076	2.133	.290 PER IMP= .00
ROUTE		101.20	1	2	.13000	23.94	3.333	.48076	2.167	.288
*S	Subbasin No.U1-2									
COMPUTE	NM HYD	102.00	-	3	.22500	50.42	5.769	.48078	2.033	.350 PER IMP= .00
ADD HYD		102.10	2& 3	4	.35500	73.59	9.103	.48077	2.067	.324
ROUTE		102.20	4	5	.35500	68.32	9.103	.48077	2.267	.301
*S	Subbasin No.U1-3 Discharges into the top of the Lisbon Channel									
COMPUTE	NM HYD	103.00	-	1	.41520	69.57	10.644	.48067	2.300	.262 PER IMP= .00
*S	Total inflow to top of Lisbon Channel									
ADD HYD		103.10	5& 1	2	.77020	137.75	19.747	.48072	2.300	.279
ROUTE		103.20	2	3	.77020	137.57	19.746	.48071	2.300	.279
*S	Subbasin No.U1-4									
COMPUTE	NM HYD	104.00	-	4	.41250	83.68	12.317	.55987	2.333	.317 PER IMP= 4.00
ADD HYD		104.10	3& 4	5	1.18270	221.21	32.064	.50832	2.333	.292
ROUTE		104.20	5	6	1.18270	216.60	32.062	.50830	2.400	.286
*S	Subbasin No.U1-5									
COMPUTE	NM HYD	105.00	-	1	.11810	78.00	5.553	.88161	1.800	1.032 PER IMP= 20.00
ADD HYD		105.10	6& 1	2	1.30080	244.01	37.615	.54219	2.333	.293
*S	Subbasin No.U2									
COMPUTE	NM HYD	106.00	-	3	.41880	278.95	16.528	.73998	1.733	1.041 PER IMP= 13.00
ADD HYD		106.10	2& 3	4	1.71960	388.79	54.143	.59036	1.800	.353
ROUTE		106.20	4	5	1.71960	386.99	54.143	.59035	1.833	.352
*S	Subbasin No.U3-1 Drains along the Lisbon Channel to Southern Blvd									
COMPUTE	NM HYD	109.00	-	1	.34060	199.49	13.442	.73998	1.800	.915 PER IMP= 13.00
*S	Total in Lisbon Channel at Southern Boulevard									
ADD HYD		109.10	1& 5	2	2.06020	583.58	67.585	.61509	1.833	.443
ROUTE		109.20	2	3	2.06020	567.42	67.584	.61509	1.900	.430
*S	Subbasin No.U3-2 Drains to culvert under Southern Blvd									
COMPUTE	NM HYD	110.00	-	4	.31830	298.45	14.272	.84070	1.633	1.465 PER IMP= 18.00
ROUTE		110.20	4	5	.31830	270.73	14.272	.84070	1.733	1.329
ADD HYD		110.10	3& 5	6	2.37850	788.48	81.856	.64528	1.833	.518
*S	Subbasin No.L2-1 Drains to arroyo confluence south of Southern Blvd									
COMPUTE	NM HYD	111.00	-	1	.34600	78.77	8.872	.48078	2.067	.356 PER IMP= .00
*S	Total inflow to arroyo at confluence									
ADD HYD		111.10	6& 1	2	2.72450	853.82	90.728	.62439	1.833	.490
ROUTE		111.20	2	3	2.72450	761.05	90.727	.62438	2.000	.436
*S	Subbasin No.L2-2 Drains to crossing at Unser Blvd									
COMPUTE	NM HYD	112.00	-	4	.47400	89.62	12.153	.48073	2.200	.295 PER IMP= .00
*S	Inflow impacting Unser from the northern basins									
ADD HYD		112.10	3& 4	5	3.19850	843.78	102.880	.60309	2.033	.412
*S	Subbasin No.L1 Drains to crossing at Unser Blvd									
COMPUTE	NM HYD	113.00	-	6	.78100	96.48	20.005	.48028	2.633	.193 PER IMP= .00
*S	Inflow impacting Unser from the west basin at existing arroyo									
ADD HYD		113.10	5& 6	7	3.97950	905.44	122.885	.57899	2.033	.356
ROUTE		113.20	7	8	3.97950	884.98	122.883	.57898	2.133	.347
*S	Subbasin No.U4 Drains to Southern and Unser intersection									
COMPUTE	NM HYD	114.00	-	1	.63600	195.66	24.420	.71994	2.233	.481 PER IMP= 12.00
ROUTE		114.20	1	2	.63600	153.33	24.419	.71990	2.567	.377
*S	Subbasin No.L3 Drains across Unser in sheet flow condition									
COMPUTE	NM HYD	115.00	-	3	.20000	41.30	5.128	.48078	2.067	.323 PER IMP= .00
*S	Total sheet flow over Unser between Southern and arroyo crossing									
ADD HYD		115.10	2& 3	4	.83600	183.29	29.547	.66269	2.500	.343
ROUTE		115.20	4	5	.83600	164.60	29.546	.66266	2.767	.308
ADD HYD		115.30	8& 5	6	4.81550	972.84	152.429	.59351	2.200	.316
*S	Subbasin No.L4-1 Downstream of Unser, drains to Black Arroyo									
COMPUTE	NM HYD	116.00	-	1	.27300	52.88	7.000	.48075	2.167	.303 PER IMP= .00
ADD HYD		116.10	6& 1	2	5.08850	1025.56	159.428	.58746	2.200	.315
*S	Subbasin No.L4-2 Drains sheet flow to Unser									
COMPUTE	NM HYD	116.00	-	3	.06600	28.13	1.692	.48078	1.700	.666 PER IMP= .00
ROUTE		116.20	3	4	.06600	21.14	1.692	.48079	1.867	.500
ADD HYD		116.30	2& 4	5	5.15450	1038.82	161.121	.58609	2.200	.315
*S	Subbasin No.L6-1 Drains sheet flow to Unser									
COMPUTE	NM HYD	117.00	-	6	.49100	99.95	12.589	.48075	2.133	.318 PER IMP= .00
ROUTE		117.20	6	7	.49100	98.79	12.589	.48075	2.200	.314
ADD HYD		117.30	7& 5	8	5.64550	1137.62	173.710	.57693	2.200	.315
*S	Subbasin No.L6-2 Drains downstream of Unser to Black Arroyo									
COMPUTE	NM HYD	118.00	-	9	.06300	34.71	1.615	.48078	1.633	.861 PER IMP= .00
ADD HYD		118.10	8& 9	10	5.70850	1143.47	175.325	.57587	2.200	.313
FINISH										

```
**********************************************************************
*
*S     EXISTING CONDITIONS FOR 20TH STREET BETWEEN SOUTHERN AND COUNTY LINE
*                  INPUT FILE =  EXIST-20.HY
*                  100-YEAR, 6 HOUR DESIGN STORM
*                  MAY 22, 1992
**********************************************************************
**********************************************************************
*
*     6-Hour rainfall distribution based on NOAA Atlas 2 - Peak at 1.4 hr.
RAINFALL           TYPE=1
                   RAIN QTR= 0.0
                   RAIN ONE= 1.9
                   RAIN SIX= 2.3
                   RAIN DAY= 2.75
                   DT=.0333333
*
**********************************************************************
*S       Subbasin No.U1-1
*        Area = 83 acres
*        Length = 3,200 feet
*        Slope = 3.1 percent
*        Velocity = 1.8 fps
*        Time of Concentration = 0.49 hrs
*        Undeveloped
**********************************************************************
COMPUTE NM HYD     ID=1     HYD=101.0
                   DRAINAGE AREA = 0.13 SQ MI
                   SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                   TP=-0.74
                   RAIN=-1
PRINT HYD          ID=1      CODE=10
*
*
*     Route flow south in natural arroyo estimated as V-ditch with 10:1 slopes
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                   MIN ELEV=  0   MAX ELEV= 50
                   CH SLP=0.019  FP SLP=.019
                   N=.03          DIST=1000 FT
                   DIST     ELEV     DIST     ELEV     DIST     ELEV
                    0.0     50        500      0       1000      50
COMPUTE TRAVEL TIME  ID=2     REACH=1      NO VS=1
                   L=1600     SLP=.019
ROUTE              ID=2       HYD=101.2
                   INFLOW ID=1       DT=0.0
*
**********************************************************************
*S       Subbasin No.U1-2
*        Area = 144 acres
*        Length = 6,000 feet
*        Slope = 3.0 percent
*        Velocity = 1.7 fps
*        Time of Concentration = 0.980 hrs
*        Undeveloped
**********************************************************************
COMPUTE NM HYD     ID=3     HYD=102.0
                   DRAINAGE AREA = 0.225 SQ MI
                   SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                   TP=-0.65
                   RAIN=-1
PRINT HYD          ID=3      CODE=10
*
*       Combined runoff in the arroyo
ADD HYD             ID=4  HYD 102.1  ID=2  ID=3
PRINT HYD           ID=4      CODE=10
*
*     Route flow south in natural arroyo estimated as V-ditch with 20:1 slopes
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                   MIN ELEV=  0   MAX ELEV= 25
                   CH SLP=0.015  FP SLP=.015
                   N=.03          DIST=1000 FT
                   DIST     ELEV     DIST     ELEV     DIST     ELEV
                    0.0     25        500      0       1000      25
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                   L=2900     SLP=.015
ROUTE              ID=5       HYD=102.2
                   INFLOW ID=4       DT=0.0
*
**********************************************************************
*S      Subbasin No.U1-3  Discharges into the top of the Lisbon Channel
*        Area = 265.7 acres
*        Length = 8000 feet
*        Slope = 2.5 percent
*        Velocity = 1.6 fps
*        Time of Concentration = 1.390 hrs
*        Undeveloped
**********************************************************************
COMPUTE NM HYD     ID=1     HYD=103.0
```

```
                    DRAINAGE AREA = 0.4152 SQ MI
                    SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                    TP=-0.9260
                    RAIN=-1
PRINT HYD           ID=1      CODE=10
*
*S      Total inflow to top of Lisbon Channel
ADD HYD             ID=2  HYD 103.1  ID=5  ID=1
PRINT HYD           ID=2      CODE=10
*
*     Route flow south in Lisbon Channel concrete trap-channel, 10'bw and 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.015  FP SLP=.015
                    N=.015         DIST= 40 FT
                    DIST  ELEV     DIST  ELEV     DIST  ELEV   DIST  ELEV
                     0     10        20   0        30    0       40    10
COMPUTE TRAVEL TIME ID=3     REACH=1      NO VS=1
                    L=1800    SLP=.015
ROUTE               ID=3      HYD=103.2
                    INFLOW ID=2       DT=0.0
*
*
*******************************************************************************
*S      Subbasin No.U1-4
*       Area = 264.0 acres
*       Length = 8500 feet
*       Slope = 2.7 percent
*       Velocity = 1.7 fps
*       Time of Concentration = 1.390 hrs
*       80% Undeveloped, 20% Medium Density SFR
*******************************************************************************
COMPUTE NM HYD      ID=4     HYD=104.0
                    DRAINAGE AREA = 0.4125 SQ MI
                    SOIL PERCENTAGE  A = 88  B = 8  C = 0  D = 4
                    TP=-0.9260
                    RAIN=-1
PRINT HYD           ID=4      CODE=10
*
ADD HYD             ID=5  HYD 104.1  ID=3  ID=4
PRINT HYD           ID=5      CODE=10
*
*
*     Route flow south in Lisbon Channel concrete trap-channel, 10'bw and 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.003  FP SLP=.005
                    N=.015         DIST= 40 FT
                    DIST  ELEV     DIST  ELEV     DIST  ELEV   DIST  ELEV
                     0     10        20   0        30    0       40    10
COMPUTE TRAVEL TIME ID=6     REACH=1      NO VS=1
                    L=4000    SLP=.003
ROUTE               ID=6      HYD=104.2
                    INFLOW ID=5       DT=0.0
*
*
*******************************************************************************
*S      Subbasin No.U1-5
*       Area = 75.6 acres
*       Length = 5500 feet
*       Slope = 1.5 percent
*       Velocity = 2.5 fps
*       Time of Concentration = 0.611 hrs
*       Medium Density SFR
*******************************************************************************
COMPUTE NM HYD      ID=1     HYD=105.0
                    DRAINAGE AREA = 0.1181 SQ MI
                    SOIL PERCENTAGE  A = 40  B = 40  C = 0.0  D = 20
                    TP=-0.4074
                    RAIN=-1
PRINT HYD           ID=1      CODE=10
*
*
ADD HYD             ID=2  HYD 105.1  ID=6  ID=1
PRINT HYD           ID=2      CODE=10
*
*
*******************************************************************************
*S      Subbasin No.U2
*       Area = 268.0 acres
*       Length = 6500 feet
*       Slope = 3.0 percent
*       Velocity = 3.5 fps  (small upland gullies)
*       Time of Concentration = 0.516 hrs
*       35% Undeveloped, 65% Medium Density SFR
*******************************************************************************
COMPUTE NM HYD      ID=3     HYD=106.0
                    DRAINAGE AREA = 0.4188 SQ MI
```

```
                    SOIL PERCENTAGE  A = 61  B = 26  C = 0.0  D = 13
                    TP=-0.3439
                    RAIN=-1
PRINT HYD           ID=3      CODE=10
*
*       Combine runoff at Lisbon Channel
ADD HYD             ID=4  HYD 106.1  ID=2  ID=3
PRINT HYD           ID=4      CODE=10
*
*
*     Route flow south in Lisbon Channel to Southern Boulevard
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.028  FP SLP=.03
                    N=.015         DIST= 40 FT
                    DIST  ELEV     DIST  ELEV     DIST  ELEV   DIST  ELEV
                     0     10        20   0        30    0       40    10
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                    L=4000    SLP=.028
ROUTE               ID=5      HYD=106.2
                    INFLOW ID=4       DT=0.0
*
*
*******************************************************************************
*S      Subbasin No.U3-1  Drains along the Lisbon Channel to Southern Blvd
*       Area = 218.0 acres
*       Length = 8000 feet
*       Slope = 3.3 percent
*       Velocity = 3.7 fps  (small upland gullies)
*       Time of Concentration = 0.600 hrs
*       35% Undeveloped, 65% Medium Density SFR, commercial along Southern
*******************************************************************************
COMPUTE NM HYD      ID=1     HYD=109.0
                    DRAINAGE AREA = 0.3406 SQ MI
                    SOIL PERCENTAGE  A = 61  B = 26  C = 0  D = 13
                    TP=-0.4004
                    RAIN=-1
PRINT HYD           ID=1      CODE=10
*
*S      Total in Lisbon Channel at Southern Boulevard
ADD HYD             ID=2  HYD 109.1  ID=1  ID=5
PRINT HYD           ID=2      CODE=10
*
*     Route flow south in natural arroyo estimated as V-ditch with 10:1 slopes
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 50
                    CH SLP=0.02    FP SLP=.022
                    N=.03          DIST=1000 FT
                    DIST     ELEV     DIST     ELEV     DIST     ELEV
                     0.0     50        500      0       1000      50
COMPUTE TRAVEL TIME  ID=3     REACH=1      NO VS=1
                    L=2000    SLP=.02
ROUTE               ID=3      HYD=109.2
                    INFLOW ID=2       DT=0.0
*
*
*******************************************************************************
*S      Subbasin No.U3-2  Drains to culvert under Southern Blvd
*       Area = 203.7 acres
*       Length = 5600 feet
*       Slope = 3.9 percent
*       Velocity = 4.0 fps  (small upland gullies)
*       Time of Concentration = 0.389 hrs
*       10% Undeveloped, 90% Medium Density SFR, commercial along Southern
*******************************************************************************
COMPUTE NM HYD      ID=4     HYD=110.0
                    DRAINAGE AREA = 0.3183 SQ MI
                    SOIL PERCENTAGE  A = 46  B = 36  C = 0  D = 18
                    TP=-0.2593
                    RAIN=-1
PRINT HYD           ID=4      CODE=10
*
*     Route flow south in natural arroyo estimated as V-ditch with 10:1 slopes
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 50
                    CH SLP=0.025   FP SLP=.025
                    N=.03          DIST=1000 FT
                    DIST     ELEV     DIST     ELEV     DIST     ELEV
                     0.0     50        500      0       1000      50
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                    L=2600    SLP=.025
ROUTE               ID=5      HYD=110.2
                    INFLOW ID=4       DT=0.0
*
ADD HYD             ID=6  HYD 110.1  ID=3  ID=5
PRINT HYD           ID=6      CODE=10
*
*
```

```
*****************************************************************************
*S       Subbasin No.L2-1  Drains to arroyo confluence south of Southern Blvd
*        Area = 221.5 acres
*        Length = 7,000 feet
*        Slope = 3.7 percent
*        Velocity = 1.9 fps  (alluvial fans)
*        Time of Concentration = 1.023 hrs
*        Undeveloped
*****************************************************************************
COMPUTE NM HYD      ID=1     HYD=111.0
                    DRAINAGE AREA = 0.346 SQ MI
                    SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                    TP=-0.68
                    RAIN=-1
PRINT HYD           ID=1      CODE=10
*
*S      Total inflow to arroyo at confluence
ADD HYD             ID=2  HYD 111.1  ID=6  ID=1
PRINT HYD           ID=2      CODE=10
*
*
*     Route flow south in natural arroyo to crossing at 20th Street (Unser)
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 50
                    CH SLP=0.022   FP SLP=.025
                    N=.03          DIST=1000 FT
                    DIST     ELEV     DIST     ELEV     DIST     ELEV
                     0.0     50        500      0       1000      50
COMPUTE TRAVEL TIME ID=3     REACH=1      NO VS=1
                    L=5000    SLP=.022
ROUTE               ID=3      HYD=111.2
                    INFLOW ID=2       DT=0.0
*
*
*****************************************************************************
*S       Subbasin No.L2-2  Drains to crossing at Unser Blvd
*        Area = 303.6 acres
*        Length = 7,500 feet
*        Slope = 2.9 percent
*        Velocity = 1.7 fps  (alluvial fans)
*        Time of Concentration = 1.226 hrs
*        Undeveloped
*****************************************************************************
COMPUTE NM HYD      ID=4     HYD=112.0
                    DRAINAGE AREA = 0.474 SQ MI
                    SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                    TP=-0.82
                    RAIN=-1
PRINT HYD           ID=4      CODE=10
*
*S      Inflow impacting Unser from the northern basins
ADD HYD             ID=5  HYD 112.1  ID=3  ID=4
PRINT HYD           ID=5      CODE=10
*
*
*****************************************************************************
*S       Subbasin No.L1    Drains to crossing at Unser Blvd
*        Area = 500.0 acres
*        Length = 11,600 feet
*        Slope = 3.0 percent
*        Velocity = 1.7 fps  (alluvial fans)
*        Time of Concentration = 1.895 hrs
*        Undeveloped
*****************************************************************************
COMPUTE NM HYD      ID=6     HYD=113.0
                    DRAINAGE AREA = 0.781 SQ MI
                    SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                    TP=-1.26
                    RAIN=-1
PRINT HYD           ID=6      CODE=10
*
*S      Inflow impacting Unser from the west basin at existing arroyo
ADD HYD             ID=7  HYD 113.1  ID=5  ID=6
PRINT HYD           ID=7      CODE=10
*
*     Route flow southeast of Unser Blvd, V-ditch with 10:1 slopes
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 50
                    CH SLP=0.018   FP SLP=.018
                    N=.03          DIST=1000 FT
                    DIST     ELEV     DIST     ELEV     DIST     ELEV
                     0.0     50        500      0       1000      50
COMPUTE TRAVEL TIME ID=8     REACH=1      NO VS=1
                    L=2600    SLP=.025
ROUTE               ID=8      HYD=113.2
                    INFLOW ID=7       DT=0.0
*
*
```

```
**********************************************************************************
*S       Subbasin No.U4    Drains to Southern and Unser intersection
*        Area = 406.9 acres
*        Length = 8,800 feet
*        Slope = 0.6 percent
*        Velocity = 2.0 fps  (streets)
*        Time of Concentration = 1.222 hrs
*        40% Undeveloped, 60% Medium Density SFR
**********************************************************************************
COMPUTE NM HYD       ID=1     HYD=114.0
                     DRAINAGE AREA = 0.636 SQ MI
                     SOIL PERCENTAGE  A = 64  B = 24  C = 0  D = 12
                     TP=-0.815
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*
*     Route flow south as sheet flow to arroyo, est 100:1 v-ditch
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 5
                     CH SLP=0.018   FP SLP=.025
                     N=.03          DIST=1000 FT
                     DIST     ELEV     DIST     ELEV     DIST     ELEV
                      0.0      5        500      0        1000      5
COMPUTE TRAVEL TIME  ID=2     REACH=1      NO VS=1
                     L=5600    SLP=.018
ROUTE                ID=2      HYD=114.2
                     INFLOW ID=1       DT=0.0
*
*
**********************************************************************************
*S       Subbasin No.L3    Drains across Unser in sheet flow condition
*        Area = 128.0 acres
*        Length = 6,000 feet
*        Slope = 2.5 percent
*        Velocity = 1.6 fps  (alluvial fan)
*        Time of Concentration = 1.042 hrs
*        Undeveloped
**********************************************************************************
COMPUTE NM HYD       ID=3     HYD=115.0
                     DRAINAGE AREA = 0.200 SQ MI
                     SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                     TP=-0.694
                     RAIN=-1
PRINT HYD            ID=3      CODE=10
*
*S       Total sheet flow over Unser between Southern and arroyo crossing
ADD HYD              ID=4  HYD 115.1  ID=2  ID=3
PRINT HYD            ID=4      CODE=10
*
*     Route flow southeast as sheet flow to arroyo, est 100:1 v-ditch
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 5
                     CH SLP=0.018   FP SLP=.025
                     N=.03          DIST=1000 FT
                     DIST     ELEV     DIST     ELEV     DIST     ELEV
                      0.0      5        500      0        1000      5
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                     L=4000    SLP=.018
ROUTE                ID=5      HYD=115.2
                     INFLOW ID=4       DT=0.0
*
*       Add in flow from arroyo in west branch of Black Arroyo
ADD HYD              ID=6  HYD 115.3  ID=8  ID=5
PRINT HYD            ID=6      CODE=10
*
*
**********************************************************************************
*S       Subbasin No.L4-1    Downstream of Unser, drains to Black Arroyo
*        Area = 174.5 acres
*        Length = 6,300 feet
*        Slope = 2.1 percent
*        Velocity = 1.5 fps  (alluvial fan)
*        Time of Concentration = 1.167 hrs
*        Undeveloped
**********************************************************************************
COMPUTE NM HYD       ID=1     HYD=116.0
                     DRAINAGE AREA = 0.273 SQ MI
                     SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                     TP=-0.778
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*       Add in flow from arroyo in west branch of Black Arroyo
ADD HYD              ID=2  HYD 116.1  ID=6  ID=1
PRINT HYD            ID=2      CODE=10
*
*
```

```
**********************************************************************************
*S       Subbasin No.L4-2    Drains sheet flow to Unser
*        Area = 42.5 acres
*        Length = 2,800 feet
*        Slope = 2.9 percent
*        Velocity = 1.7 fps  (alluvial fan)
*        Time of Concentration = 0.458 hrs
*        Undeveloped
**********************************************************************************
COMPUTE NM HYD        ID=3     HYD=116.0
                      DRAINAGE AREA = 0.066 SQ MI
                      SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                      TP=-0.305
                      RAIN=-1
PRINT HYD             ID=3      CODE=10
*
*     Route flow southeast as sheet flow to arroyo, est 20:1 v-ditch
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                      MIN ELEV=  0   MAX ELEV= 5
                      CH SLP=0.021   FP SLP=.025
                      N=.03          DIST=1000 FT
                      DIST     ELEV     DIST     ELEV     DIST     ELEV
                       0.0      25       500      0        1000     25
COMPUTE TRAVEL TIME   ID=4     REACH=1      NO VS=1
                      L=2800    SLP=.021
ROUTE                 ID=4      HYD=116.2
                      INFLOW ID=3       DT=0.0
*
*        Add in flow from arroyo in west branch of Black Arroyo
ADD HYD               ID=5  HYD 116.3  ID=2  ID=4
PRINT HYD             ID=5      CODE=10
*
*
**********************************************************************************
*S       Subbasin No.L6-1    Drains sheet flow to Unser
*        Area = 313.9 acres
*        Length = 7,400 feet
*        Slope = 3.2 percent
*        Velocity = 1.8 fps  (alluvial fan)
*        Time of Concentration = 1.142 hrs
*        Undeveloped
**********************************************************************************
COMPUTE NM HYD        ID=6     HYD=117.0
                      DRAINAGE AREA = 0.491 SQ MI
                      SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                      TP=-0.761
                      RAIN=-1
PRINT HYD             ID=6      CODE=10
*
*     Route flow southeast as sheet flow to arroyo, est 20:1 v-ditch
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                      MIN ELEV=  0   MAX ELEV= 5
                      CH SLP=0.031   FP SLP=.031
                      N=.03          DIST=1000 FT
                      DIST     ELEV     DIST     ELEV     DIST     ELEV
                       0.0      25       500      0        1000     25
COMPUTE TRAVEL TIME   ID=7     REACH=1      NO VS=1
                      L=1600    SLP=.031
ROUTE                 ID=7      HYD=117.2
                      INFLOW ID=6       DT=0.0
*
*        Add in flow from arroyo in west branch of Black Arroyo
ADD HYD               ID=8  HYD 117.3  ID=7  ID=5
PRINT HYD             ID=8      CODE=10
*
*
**********************************************************************************
*S       Subbasin No.L6-2    Drains downstream of Unser to Black Arroyo
*        Area = 40.2 acres
*        Length = 2,000 feet
*        Slope = 2.5 percent
*        Velocity = 1.6 fps  (alluvial fan)
*        Time of Concentration = 0.347 hrs
*        Undeveloped
**********************************************************************************
COMPUTE NM HYD        ID=9     HYD=118.0
                      DRAINAGE AREA = 0.063 SQ MI
                      SOIL PERCENTAGE  A = 100  B = 0  C = 0  D = 0
                      TP=-0.232
                      RAIN=-1
PRINT HYD             ID=9      CODE=10
*
*        Total at West Branch Black Arroyo
ADD HYD               ID=10 HYD 118.1  ID=8  ID=9
PRINT HYD             ID=10     CODE=10
*
FINISH
```

Runoff from drainage basins U1 and U2 converge, through streets and a network of small channels, into the Lisbon Boulevard Channel. This channel has been graded from its natural state into a trapezoidal configuration with some lined sections, but is typically naturally lined. The longitudinal slope of the channel has been naturally stabilized due to a stratum of clay. The Lisbon Boulevard Channel passes under Southern Boulevard through an 8-foot rise by 11-foot span structural plate arch pipe, where it discharges into the unimproved west branch of the Black Arroyo.

There is a significant amount of erosion in the Black Arroyo below the arch pipe. The walls of the arroyo are unstabilized and are standing nearly vertical, with a depth of 12 to 15 feet.

Runoff from drainage basin U3 is conveyed through a series of small natural channels and developed street sections. Runoff is conveyed under Southern Boulevard via two 3-foot rise by 5-foot span corrugated metal pipe arches (CMPA's). These CMPA's discharge to a small natural channel that converges with the west branch of the Black Arroyo. The arroyo at this location is exhibiting similar erosion characteristics to the outfall of the Lisbon Channel.

Drainage basin U4, located on the northwest quadrant of Southern Boulevard and 20th Street, is currently undeveloped but is proposed to be developed into commercial property and some single family residential.

Drainage basin U4 currently collects in a small detention basin located at the northwest corner of the intersection of Southern Boulevard and 20th Street, overflows into the intersection of Southern Boulevard and 20th Street, then discharges into the Southern Boulevard channel east of 20th Street. The runoff then flows down Southern Boulevard to the intersection of Western Hills Drive. This results in flooding of the Western Hills Drive/Southern Boulevard intersection. The runoff ponds in this intersection until it overflows to the south down the right of way for 23rd Street. The water flows down this unimproved right of way until it reaches the Black Arroyo.

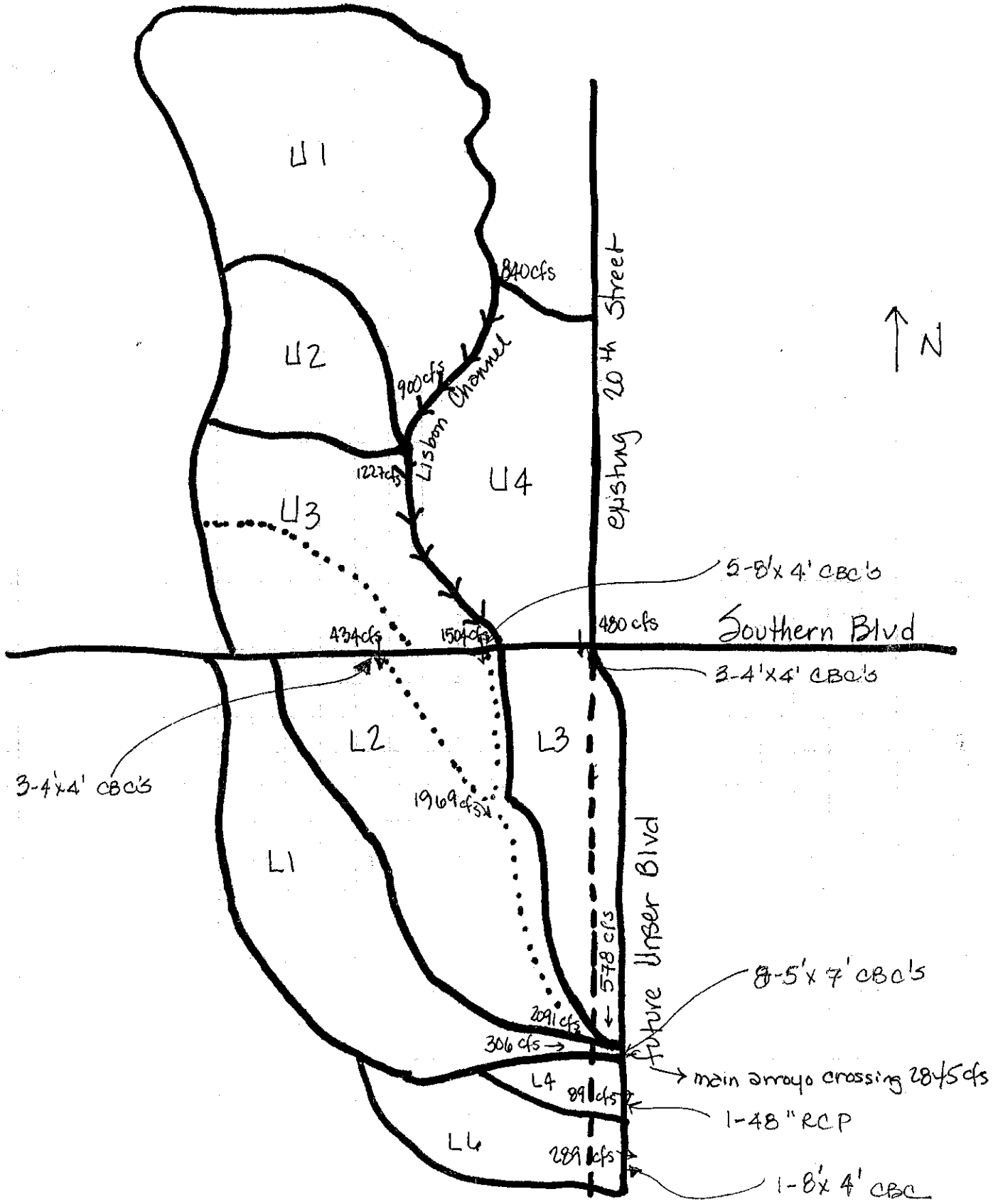
South of Southern Boulevard

Drainage basins south of Southern Boulevard that contribute runoff to the Unser Boulevard project are designated as L1, L2, L3, L4 and L6 on Figure 1. The area of these basins is approximately 1511 acres. These basins are presently undeveloped with the exception of some bladed roadways. Runoff is conveyed by overland flow into a network of natural finger arroyos. Flow is generally in the west to east direction, with ultimate discharge into the west branch of the Black Arroyo.

Gannett Fleming
ENGINEERS AND PLANNERS

SUBJECT | SHEET NO. | OF
JOB NO.
BY | DATE | CHKD. BY | DATE

Unser Blvd Drainage - Developed Conditions



AHYMO SUMMARY TABLE (AHYMO392) - AMAFCA VERSION OF HYMO - MARCH, 1992 RUN DATE (MON/DAY/YR) =06/01/1992
INPUT FILE = unserdev.hy USER NO.= M_BURAK_.S92

COMMAND	HYDROGRAPH IDENTIFICATION	FROM ID NO.	TO ID NO.	AREA (SQ MI)	PEAK DISCHARGE (CFS)	RUNOFF VOLUME (AC-FT)	RUNOFF (INCHES)	TIME TO PEAK (HOURS)	CFS PER ACRE	NOTATION
*S FULLY DEVELOPED CONDITIONS FOR 20TH STREET BETWEEN SOUTHERN AND COUNTY LINE										
RAINFALL TYPE= 1										RAIN6= 2.300
*S	Subbasin No.U1-1									
COMPUTE NM HYD	101.00	-	1	.13000	175.78	8.153	1.17594	1.600	2.113	PER IMP= 40.00
ROUTE	101.20	1	2	.13000	174.02	8.153	1.17594	1.600	2.092	
*S	Subbasin No.U1-2									
COMPUTE NM HYD	102.00	-	3	.22500	196.54	14.111	1.17594	1.800	1.365	PER IMP= 40.00
ADD HYD	102.10	2& 3	4	.35500	328.26	22.264	1.17594	1.700	1.445	
ROUTE	102.20	4	5	.35500	321.21	22.264	1.17594	1.733	1.414	
*S	Subbasin No.U1-3 Discharges into the top of the Lisbon Channel									
COMPUTE NM HYD	103.00	-	1	.41520	275.98	26.040	1.17594	2.033	1.039	PER IMP= 40.00
*S	Total inflow to top of Lisbon Channel									
ADD HYD	103.10	5& 1	2	.77020	540.95	48.304	1.17594	1.900	1.097	
ROUTE	103.20	2	3	.77020	540.35	48.304	1.17594	1.900	1.096	
*S	Subbasin No.U1-4									
COMPUTE NM HYD	104.00	-	4	.41250	300.83	25.871	1.17594	1.933	1.139	PER IMP= 40.00
ADD HYD	104.10	3& 4	5	1.18270	839.65	74.175	1.17594	1.933	1.109	
ROUTE	104.20	5	6	1.18270	815.56	74.175	1.17594	2.000	1.077	
*S	Subbasin No.U1-5									
COMPUTE NM HYD	105.00	-	1	.11810	104.88	7.407	1.17594	1.800	1.388	PER IMP= 40.00
ADD HYD	105.10	6& 1	2	1.30080	899.63	81.582	1.17594	1.967	1.081	
*S	Subbasin No.U2									
COMPUTE NM HYD	106.00	-	3	.41880	372.48	26.266	1.17594	1.800	1.390	PER IMP= 40.00
ADD HYD	106.10	2& 3	4	1.71960	1226.82	107.848	1.17594	1.933	1.115	
ROUTE	106.20	4	5	1.71960	1221.15	107.848	1.17594	1.967	1.110	
*S										
*S	Subbasin No.U3-1 Drains along the Lisbon Channel to Southern Blvd									
COMPUTE NM HYD	109.00	-	1	.34060	326.55	22.594	1.24377	1.800	1.498	PER IMP= 45.00
*S	Total in Lisbon Channel at Southern Boulevard (CULVERT HERE)									
ADD HYD	**109.10**	**1& 5**	**2**	**2.06020**	**1503.81**	**130.441**	**1.18715**	**1.933**	**1.141**	
ROUTE	109.20	2	3	2.06020	1504.07	130.441	1.18715	1.933	1.141	
*S										
*S	Subbasin No.U3-2 Drains to culvert under Southern Blvd (CULVERT HERE)									
COMPUTE NM HYD	**110.00**	-	**4**	**.31830**	**434.33**	**22.461**	**1.32310**	**1.633**	**2.132**	**PER IMP= 50.00**
ROUTE	110.20	4	5	.31830	428.30	22.461	1.32310	1.667	2.102	
ADD HYD	110.10	3& 5	6	2.37850	1750.90	152.902	1.20535	1.900	1.150	
*S	Subbasin No.L2-1 Drains to channel confluence south of Southern Blvd									
COMPUTE NM HYD	111.00	-	1	.34600	226.91	16.269	.88161	1.833	1.025	PER IMP= 20.00
*S	Total inflow to channel at confluence									
ADD HYD	111.10	6& 1	2	2.72450	1969.36	169.171	1.16423	1.900	1.129	
ROUTE	111.20	2	3	2.72450	1954.78	169.171	1.16423	1.933	1.121	
*S	Subbasin No.L2-2 Drains to crossing at Unser Blvd									
COMPUTE NM HYD	112.00	-	4	.47400	182.82	22.286	.88158	2.233	.603	PER IMP= 20.00
*S	Inflow impacting Unser from the northern basins									
ADD HYD	112.10	3& 4	5	3.19850	2091.13	191.457	1.12234	1.933	1.022	
*S	Subbasin No.L1 Drains to crossing at Unser Blvd									
COMPUTE NM HYD	113.00	-	6	.78100	306.42	36.721	.88159	2.233	.613	PER IMP= 20.00
*S	Inflow impacting Unser from the west basin at channel									
ADD HYD	113.10	5& 6	7	3.97950	2336.20	228.178	1.07510	1.967	.917	
*S	Subbasin No.U4 Southern and Unser intersection (PIPE CROSSING HERE)									
COMPUTE NM HYD	**114.00**	-	**1**	**.63600**	**480.09**	**54.863**	**1.61743**	**2.267**	**1.179**	**PER IMP= 70.00**
ROUTE	114.20	1	2	.63600	474.40	54.863	1.61743	2.333	1.165	
*S	Subbasin No.L3 Is collected along west side of Unser, taken south									
COMPUTE NM HYD	115.00	-	3	.20000	295.45	18.822	1.76459	1.733	2.308	PER IMP= 80.00
*S	Total flow along Unser between Southern and main channel									
ADD HYD	115.10	2& 3	4	.83600	577.59	73.685	1.65263	2.233	1.080	
*S										
*S	Inflow to CULVERT in main channel to west branch of Black Arroyo									
ADD HYD	**115.30**	**7& 4**	**5**	**4.81550**	**2845.09**	**301.864**	**1.17536**	**2.000**	**.923**	
*S	Subbasin No.L4-1 Downstream of Unser, drains to Black Arroyo									
COMPUTE NM HYD	116.00	-	1	.27300	192.99	12.836	.88161	1.767	1.105	PER IMP= 20.00
ADD HYD	116.10	5& 1	2	5.08850	2988.59	314.700	1.15960	1.967	.918	
ROUTE	116.20	2	3	5.08850	2988.82	314.700	1.15960	2.000	.918	
*S										
*S	Subbasin No.L4-2 Drains in streets to CULVERT under Unser									
COMPUTE NM HYD	**117.00**	-	**4**	**.06600**	**89.14**	**3.103**	**.88161**	**1.533**	**2.110**	**PER IMP= 20.00**
ROUTE	117.20	4	5	.06600	75.98	3.103	.88162	1.600	1.799	
ADD HYD	117.30	3& 5	6	5.15450	3010.09	317.803	1.15604	2.000	.912	
*S										
*S	Subbasin No.L6-1 Drains in streets to CULVERT under Unser									
COMPUTE NM HYD	**118.00**	-	**7**	**.49100**	**288.72**	**23.087**	**.88161**	**1.900**	**.919**	**PER IMP= 20.00**
ROUTE	118.20	7	8	.49100	288.39	23.087	.88162	1.900	.918	
ADD HYD	118.30	8& 6	9	5.64550	3286.76	340.889	1.13217	2.000	.910	
*S	Subbasin No.L6-2 Drains downstream of Unser to Black Arroyo									
COMPUTE NM HYD	119.00	-	10	.06300	101.19	2.962	.88161	1.500	2.510	PER IMP= 20.00
ADD HYD	119.10	9&10	11	5.70850	3300.55	343.852	1.12941	1.967	.903	
FINISH										

```
*****************************************************************************
*
*S FULLY DEVELOPED CONDITIONS FOR 20TH STREET BETWEEN SOUTHERN AND COUNTY LINE
*                    INPUT FILE =  UNSERDEV.HY
*                    100-YEAR, 6 HOUR DESIGN STORM
*                    MAY 29, 1992
*****************************************************************************
*****************************************************************************
*
*     6-Hour rainfall distribution based on NOAA Atlas 2 - Peak at 1.4 hr.
RAINFALL             TYPE=1
                     RAIN QTR= 0.0
                     RAIN ONE= 1.9
                     RAIN SIX= 2.3
                     RAIN DAY= 2.75
                     DT=.0333333
*
*****************************************************************************
*S       Subbasin No.U1-1
*        Area = 83 acres
*        Length = 3,840 feet  (add 20% over existing for street routing)
*        Slope = 2.6 percent
*        Velocity = 3.2 fps  (paved)
*        Time of Concentration = 0.33 hrs
*        Medium Density Single Family Residential (MDSFR) 4 units per acre
*****************************************************************************
COMPUTE NM HYD       ID=1     HYD=101.0
                     DRAINAGE AREA = 0.13 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 30  C = 0  D = 40
                     TP=-0.22
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*
*     Route flow south in concrete channel, B=10' with 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.019  FP SLP=.019
                     N=.015          DIST=  50 FT
                     DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                      0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=2     REACH=1      NO VS=1
                     L=1600    SLP=.019
ROUTE                ID=2      HYD=101.2
                     INFLOW ID=1       DT=0.0
*
*****************************************************************************
*S       Subbasin No.U1-2
*        Area = 144 acres
*        Length = 7,200 feet  (add 20% for street routing)
*        Slope = 2.5 percent
*        Velocity = 3.2 fps  (paved)
*        Time of Concentration = 0.625 hrs
*        Medium Density Single Family Residential (MDSFR)
*****************************************************************************
COMPUTE NM HYD       ID=3     HYD=102.0
                     DRAINAGE AREA = 0.225 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 30  C = 0  D = 40
                     TP=-0.42
                     RAIN=-1
PRINT HYD            ID=3      CODE=10
*
*       Combined runoff in the channel
ADD HYD              ID=4  HYD 102.1  ID=2  ID=3
PRINT HYD            ID=4      CODE=10
*
*
*     Route flow south in concrete channel, B=10' with 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.015  FP SLP=.015
                     N=.015          DIST=  50 FT
                     DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                      0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                     L=2900    SLP=.015
```

```
ROUTE                ID=5      HYD=102.2
                     INFLOW ID=4       DT=0.0
*
*******************************************************************************
*S      Subbasin No.U1-3  Discharges into the top of the Lisbon Channel
*        Area = 265.7 acres
*        Length = 9600 feet  (add 20% for street routing)
*        Slope = 2.0 percent
*        Velocity = 2.9 fps  (paved)
*        Time of Concentration = 0.920 hrs
*        Medium Density Single Family Residential (MDSFR)
*******************************************************************************
COMPUTE NM HYD       ID=1     HYD=103.0
                     DRAINAGE AREA = 0.4152 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 30  C = 0  D = 40
                     TP=-0.6130
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*S      Total inflow to top of Lisbon Channel
ADD HYD              ID=2  HYD 103.1  ID=5  ID=1
PRINT HYD            ID=2      CODE=10
*
*     Route flow south in Lisbon Channel concrete trap-channel, 10'bw and 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.015  FP SLP=.015
                     N=.015          DIST= 50 FT
                     DIST  ELEV     DIST  ELEV     DIST  ELEV   DIST  ELEV
                      0     10        30   0        40    0       50    10
COMPUTE TRAVEL TIME  ID=3     REACH=1      NO VS=1
                     L=1800    SLP=.015
ROUTE                ID=3      HYD=103.2
                     INFLOW ID=2       DT=0.0
*
*
*******************************************************************************
*S      Subbasin No.U1-4
*        Area = 264.0 acres
*        Length = 9350 feet  (add 10% for street routing)
*        Slope = 2.5 percent
*        Velocity = 3.2 fps  (paved)
*        Time of Concentration = 0.812 hrs
*        Medium Density Single Family Residential (MDSFR)
*******************************************************************************
COMPUTE NM HYD       ID=4     HYD=104.0
                     DRAINAGE AREA = 0.4125 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 30  C = 0  D = 40
                     TP=-0.541
                     RAIN=-1
PRINT HYD            ID=4      CODE=10
*
ADD HYD              ID=5  HYD 104.1  ID=3  ID=4
PRINT HYD            ID=5      CODE=10
*
*
*     Route flow south in Lisbon Channel concrete trap-channel, 10'bw and 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.003  FP SLP=.005
                     N=.015          DIST= 50 FT
                     DIST  ELEV     DIST  ELEV     DIST  ELEV   DIST  ELEV
                      0     10        30   0        40    0       50    10
COMPUTE TRAVEL TIME  ID=6     REACH=1      NO VS=1
                     L=4000    SLP=.003
ROUTE                ID=6      HYD=104.2
                     INFLOW ID=5       DT=0.0
*
*
*******************************************************************************
*S       Subbasin No.U1-5
*        Area = 75.6 acres
*        Length = 5500 feet
*        Slope = 1.5 percent
*        Velocity = 2.5 fps
*        Time of Concentration = 0.611 hrs
```

```
*        Medium Density Single Family Residential (MDSFR)
*******************************************************************************
COMPUTE NM HYD       ID=1     HYD=105.0
                     DRAINAGE AREA = 0.1181 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 30  C = 0.0  D = 40
                     TP=-0.4074
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*
ADD HYD              ID=2  HYD 105.1  ID=6  ID=1
PRINT HYD            ID=2      CODE=10
*
*
*******************************************************************************
*S       Subbasin No.U2
*        Area = 268.0 acres
*        Length = 7150 feet  (add 10% for street routing)
*        Slope = 2.7 percent
*        Velocity = 3.2 fps  (paved)
*        Time of Concentration = 0.621 hrs
*        Medium Density Single Family Residential (MDSFR)
*******************************************************************************
COMPUTE NM HYD       ID=3     HYD=106.0
                     DRAINAGE AREA = 0.4188 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 30  C = 0.0  D = 40
                     TP=-0.414
                     RAIN=-1
PRINT HYD            ID=3      CODE=10
*
*       Combine runoff at Lisbon Channel
ADD HYD               ID=4  HYD 106.1  ID=2  ID=3
PRINT HYD             ID=4      CODE=10
*
*
*     Route flow south in Lisbon Channel to Southern Boulevard
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.028  FP SLP=.03
                     N=.015          DIST= 50 FT
                     DIST  ELEV     DIST  ELEV     DIST  ELEV   DIST  ELEV
                      0     10        30   0        40    0       50    10
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                     L=4000    SLP=.028
ROUTE                ID=5      HYD=106.2
                     INFLOW ID=4       DT=0.0
*
*S
*******************************************************************************
*S      Subbasin No.U3-1  Drains along the Lisbon Channel to Southern Blvd
*        Area = 218.0 acres
*        Length = 8000 feet
*        Slope = 3.3 percent
*        Velocity = 3.7 fps  (paved)
*        Time of Concentration = 0.600 hrs
*        95% Medium Density SFR, 5% commercial (along Southern)
*******************************************************************************
COMPUTE NM HYD       ID=1     HYD=109.0
                     DRAINAGE AREA = 0.3406 SQ MI
                     SOIL PERCENTAGE  A = 30  B = 25  C = 0  D = 45
                     TP=-0.4004
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*S      Total in Lisbon Channel at Southern Boulevard  (CULVERT HERE)
ADD HYD               ID=2  HYD 109.1  ID=1  ID=5
PRINT HYD             ID=2      CODE=10
*
*     Route flow south in concrete channel, B=10' with 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.02   FP SLP=.02
                     N=.015          DIST=  50 FT
                     DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                      0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=3     REACH=1      NO VS=1
```

```
                    L=2000    SLP=.02
ROUTE               ID=3      HYD=109.2
                    INFLOW ID=2       DT=0.0
*
*S
*******************************************************************************
*S      Subbasin No.U3-2  Drains to culvert under Southern Blvd (CULVERT HERE)
*        Area = 203.7 acres
*        Length = 5600 feet
*        Slope = 3.9 percent
*        Velocity = 4.0 fps  (small upland gullies)
*        Time of Concentration = 0.389 hrs
*        90% Medium Density SFR, 10% commercial along Southern
*******************************************************************************
COMPUTE NM HYD      ID=4     HYD=110.0
                    DRAINAGE AREA = 0.3183 SQ MI
                    SOIL PERCENTAGE  A = 25  B = 25  C = 0  D = 50
                    TP=-0.2593
                    RAIN=-1
PRINT HYD           ID=4      CODE=10
*
*     Route flow south in concrete channel, B=10' with 2:1 Z
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.025  FP SLP=.025
                    N=.015         DIST=  50 FT
                    DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                     0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                    L=2600    SLP=.025
ROUTE               ID=5      HYD=110.2
                    INFLOW ID=4       DT=0.0
*
ADD HYD             ID=6  HYD 110.1  ID=3  ID=5
PRINT HYD           ID=6      CODE=10
*
*
*******************************************************************************
*S       Subbasin No.L2-1  Drains to channel confluence south of Southern Blvd
*        Area = 221.5 acres
*        Length = 8,400 feet (add 20% for street routing)
*        Slope = 3.1 percent
*        Velocity = 3.6 fps  (paved)
*        Time of Concentration = 0.648 hrs
*        Low Density Single Family Residential (LDSFR)  1.5 units per acre
*******************************************************************************
COMPUTE NM HYD      ID=1     HYD=111.0
                    DRAINAGE AREA = 0.346 SQ MI
                    SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                    TP=-0.432
                    RAIN=-1
PRINT HYD           ID=1      CODE=10
*
*S       Total inflow to channel at confluence
ADD HYD             ID=2  HYD 111.1  ID=6  ID=1
PRINT HYD           ID=2      CODE=10
*
*
*     Route flow south in concrete channel, to crossing at Unser
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.022  FP SLP=.022
                    N=.015         DIST=  50 FT
                    DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                     0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=3     REACH=1      NO VS=1
                    L=5000    SLP=.022
ROUTE               ID=3      HYD=111.2
                    INFLOW ID=2       DT=0.0
*
*
*******************************************************************************
*S       Subbasin No.L2-2  Drains to crossing at Unser Blvd
*        Area = 303.6 acres
*        Length = 7,500 feet
*        Slope = 2.9 percent
```

```
*       Velocity = 1.7 fps  (alluvial fans)
*       Time of Concentration = 1.226 hrs
*       Low Density Single Family Residential (LDSFR)
*****************************************************************************
COMPUTE NM HYD      ID=4     HYD=112.0
                    DRAINAGE AREA = 0.474 SQ MI
                    SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                    TP=-0.82
                    RAIN=-1
PRINT HYD           ID=4      CODE=10
*
*S      Inflow impacting Unser from the northern basins
ADD HYD             ID=5  HYD 112.1  ID=3  ID=4
PRINT HYD           ID=5      CODE=10
*
*
*****************************************************************************
*S      Subbasin No.L1    Drains to crossing at Unser Blvd
*       Area = 500.0 acres
*       Length = 13,900 feet (add 20% for street routing)
*       Slope = 2.5 percent
*       Velocity = 3.2 fps  (paved)
*       Time of Concentration = 1.207 hrs
*       Low Density Single Family Residential (LDSFR)
*****************************************************************************
COMPUTE NM HYD      ID=6     HYD=113.0
                    DRAINAGE AREA = 0.781 SQ MI
                    SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                    TP=-0.804
                    RAIN=-1
PRINT HYD           ID=6      CODE=10
*
*S      Inflow impacting Unser from the west basin at channel
ADD HYD             ID=7  HYD 113.1  ID=5  ID=6
PRINT HYD           ID=7      CODE=10
*
*
*****************************************************************************
*S      Subbasin No.U4    Southern and Unser intersection (PIPE CROSSING HERE)
*       Area = 406.9 acres
*       Length = 8,800 feet
*       Slope = 0.6 percent
*       Velocity = 2.0 fps  (streets)
*       Time of Concentration = 1.222 hrs
*       60% Medium Density SFR, 40% Commercial
*****************************************************************************
COMPUTE NM HYD      ID=1     HYD=114.0
                    DRAINAGE AREA = 0.636 SQ MI
                    SOIL PERCENTAGE  A = 15  B = 15  C = 0  D = 70
                    TP=-0.815
                    RAIN=-1
PRINT HYD           ID=1      CODE=10
*
*
*     Route flow south along Unser in concrete ditch to main channel
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.018  FP SLP=.025
                    N=.015          DIST=  50 FT
                    DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                     0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=2     REACH=1      NO VS=1
                    L=5600    SLP=.018
ROUTE               ID=2      HYD=114.2
                    INFLOW ID=1       DT=0.0
*
*
*****************************************************************************
*S      Subbasin No.L3    Is collected along west side of Unser, taken south
*       Area = 128.0 acres
*       Length = 6,000 feet
*       Slope = 2.5 percent
*       Velocity = 3.2 fps  (paved)
*       Time of Concentration = 0.521 hrs
*       20% Medium Density SFR, 80% Commercial
*****************************************************************************
```

```
COMPUTE NM HYD       ID=3     HYD=115.0
                     DRAINAGE AREA = 0.200 SQ MI
                     SOIL PERCENTAGE  A = 10  B = 10  C = 0  D = 80
                     TP=-0.347
                     RAIN=-1
PRINT HYD            ID=3      CODE=10
*
*S       Total flow along Unser between Southern and main channel
ADD HYD              ID=4  HYD 115.1  ID=2  ID=3
PRINT HYD            ID=4      CODE=10
*S
*S       Inflow to CULVERT in main channel to west branch of Black Arroyo
ADD HYD              ID=5  HYD 115.3  ID=7  ID=4
PRINT HYD            ID=5      CODE=10
*
*
*******************************************************************************
*S       Subbasin No.L4-1    Downstream of Unser, drains to Black Arroyo
*        Area = 174.5 acres
*        Length = 6,300 feet
*        Slope = 2.1 percent
*        Velocity = 3.0 fps  (paved)
*        Time of Concentration = 0.583 hrs
*        Low Density Single Family Residential (LDSFR)
*******************************************************************************
COMPUTE NM HYD       ID=1     HYD=116.0
                     DRAINAGE AREA = 0.273 SQ MI
                     SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                     TP=-0.389
                     RAIN=-1
PRINT HYD            ID=1      CODE=10
*
*        Add in flow from Unser culvert in west branch of Black Arroyo
ADD HYD              ID=2  HYD 116.1  ID=5  ID=1
PRINT HYD            ID=2      CODE=10
*
*     Route flow southeast to Black Arroyo channel
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.021  FP SLP=.025
                     N=.015         DIST=  50 FT
                     DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                      0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=3     REACH=1      NO VS=1
                     L=3000    SLP=.021
ROUTE                ID=3      HYD=116.2
                     INFLOW ID=2       DT=0.0
*
*
*S
*******************************************************************************
*S       Subbasin No.L4-2    Drains in streets to CULVERT under Unser
*        Area = 42.5 acres
*        Length = 2,800 feet
*        Slope = 2.9 percent
*        Velocity = 3.4 fps  (paved)
*        Time of Concentration = 0.229 hrs
*        Low Density Single Family Residential (LDSFR)
*******************************************************************************
COMPUTE NM HYD       ID=4     HYD=117.0
                     DRAINAGE AREA = 0.066 SQ MI
                     SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                     TP=-0.152
                     RAIN=-1
PRINT HYD            ID=4      CODE=10
*
*     Route flow southeast to Black Arroyo channel
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                     MIN ELEV=  0   MAX ELEV= 10
                     CH SLP=0.021  FP SLP=.025
                     N=.015         DIST=  50 FT
                     DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                      0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=5     REACH=1      NO VS=1
                     L=2800    SLP=.021
ROUTE                ID=5      HYD=117.2
```

```
                    INFLOW ID=4       DT=0.0
*
*       Add in flow from channel in west branch of Black Arroyo
ADD HYD             ID=6  HYD 117.3  ID=3  ID=5
PRINT HYD           ID=6      CODE=10
*
*S
**********************************************************************************
*S      Subbasin No.L6-1    Drains in streets to CULVERT under Unser
*       Area = 313.9 acres
*       Length = 8,880 feet (add 20% for street routing)
*       Slope = 2.7 percent
*       Velocity = 3.3 fps  (paved)
*       Time of Concentration = 0.741 hrs
*       Low Density Single Family Residential (LDSFR)
**********************************************************************************
COMPUTE NM HYD      ID=7     HYD=118.0
                    DRAINAGE AREA = 0.491 SQ MI
                    SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                    TP=-0.494
                    RAIN=-1
PRINT HYD           ID=7      CODE=10
*
*     Route flow southeast to Black Arroyo channel
COMPUTE RATING CURVE RC=1    VS NO=1     NO SEGS=1
                    MIN ELEV=  0   MAX ELEV= 10
                    CH SLP=0.031  FP SLP=.031
                    N=.015         DIST=  50 FT
                    DIST  ELEV   DIST  ELEV   DIST  ELEV  DIST  ELEV
                     0.0  10      20    0      30    0     50    10
COMPUTE TRAVEL TIME  ID=8     REACH=1      NO VS=1
                    L=1600    SLP=.031
ROUTE               ID=8      HYD=118.2
                    INFLOW ID=7       DT=0.0
*
*       Add in flow from channel in west branch of Black Arroyo
ADD HYD             ID=9  HYD 118.3  ID=8  ID=6
PRINT HYD           ID=9      CODE=10
*
*
**********************************************************************************
*S      Subbasin No.L6-2    Drains downstream of Unser to Black Arroyo
*       Area = 40.2 acres
*       Length = 2,000 feet
*       Slope = 2.5 percent
*       Velocity = 3.2 fps  (paved)
*       Time of Concentration = 0.174 hrs
*       Low Density Single Family Residential (LDSFR)
**********************************************************************************
COMPUTE NM HYD      ID=10    HYD=119.0
                    DRAINAGE AREA = 0.063 SQ MI
                    SOIL PERCENTAGE  A = 40  B = 40  C = 0  D = 20
                    TP=-0.116
                    RAIN=-1
PRINT HYD           ID=10     CODE=10
*
*       Total at West Branch Black Arroyo
ADD HYD             ID=11 HYD 119.1  ID=9  ID=10
PRINT HYD           ID=11     CODE=10
*
FINISH
```

APPENDIX 3

STRUCTURE SIZING AND COST ESTIMATES

EXISTING CONDITIONS

B O X C U L V E R T

Inlet control and outlet control parameters

Lisbon Channel at Southern, upstream detention

Box height	4.0 ft	INLET CTRL HWo:	
Box width	8.0 ft	tapered throat	5.22 ft
Number of boxes	2	45 degree bevels	5.87 ft
Slope	0.00300 ft/ft	sq edge headwall	6.38 ft
Manning's n	0.015	OUTLET CTRL HWo	5.56 ft
Culvert length	100 ft	Velocity	9.1 fps
Discharge	584 cfs	Critical depth	3.46 ft

B O X C U L V E R T

Inlet control and outlet control parameters

Basin U3-2 at Southern, upstream detention

Box height	4.0 ft	INLET CTRL HWo:	
Box width	4.0 ft	tapered throat	5.30 ft
Number of boxes	2	45 degree bevels	5.99 ft
Slope	0.00300 ft/ft	sq edge headwall	6.51 ft
Manning's n	0.015	OUTLET CTRL HWo	5.95 ft
Culvert length	100 ft	Velocity	9.3 fps
Discharge	298 cfs	Critical depth	3.51 ft

B O X C U L V E R T

Inlet control and outlet control parameters

Basin U4 at Southern and Unser, upstream detention

Box height	4.0 ft	INLET CTRL HWo:	
Box width	6.0 ft	tapered throat	4.83 ft
Number of boxes	1	45 degree bevels	5.30 ft
Slope	0.00300 ft/ft	sq edge headwall	5.74 ft
Manning's n	0.015	OUTLET CTRL HWo	5.08 ft
Culvert length	100 ft	Velocity	8.2 fps
Discharge	196 cfs	Critical depth	3.21 ft

B O X C U L V E R T

Inlet control and outlet control parameters

Main arroyo crossing at Unser

Box height	6.0 ft	INLET CTRL HWo:	
Box width	8.0 ft	tapered throat	6.95 ft
Number of boxes	2	45 degree bevels	7.55 ft
Slope	0.00300 ft/ft	sq edge headwall	8.18 ft
Manning's n	0.015	OUTLET CTRL HWo	7.11 ft
Culvert length	100 ft	Velocity	9.4 fps
Discharge	905 cfs	Critical depth	4.63 ft

P I P E C U L V E R T

Inlet control and outlet control parameters

Basin L4 crossing at Unser, upstream detention

Pipe diameter	24 in	INLET CTRL HWo:	
Number of pipes	1	beveled edge	4.17 ft
Slope	0.010 ft/ft	sq edge headwall	4.55 ft
Manning's n	0.012	thin edged proj	5.62 ft
Culvert length	100 ft	OUTLET CTRL HWo	4.08 ft
Discharge	28 cfs	velocity	8.9 fps
		critical depth	1.87 ft

B O X C U L V E R T

Inlet control and outlet control parameters

Basin L6 crossing at Unser, upstream detention

Box height	4.0 ft	INLET CTRL HWo:	
Box width	4.0 ft	tapered throat	4.02 ft
Number of boxes	1	45 degree bevels	4.26 ft
Slope	0.00300 ft/ft	sq edge headwall	4.60 ft
Manning's n	0.015	OUTLET CTRL HWo	4.17 ft
Culvert length	100 ft	Velocity	6.3 fps
Discharge	100 cfs	Critical depth	2.69 ft

P I P E C U L V E R T

Inlet control and outlet control parameters

Basin L6 crossing at Unser, upstream detention

Pipe diameter	48	in	INLET CTRL HWo:		
Number of pipes	1		beveled edge	4.94	ft
Slope	0.010	ft/ft	sq edge headwall	5.28	ft
Manning's n	0.012		thin edged proj	6.00	ft
Culvert length	100	ft	OUTLET CTRL HWo	4.36	ft
Discharge	100	cfs	velocity	8.0	fps
			critical depth	2.96	ft

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SUBJECT Cost estimates
Existing Conditions

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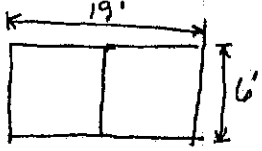
Calculate the estimated costs for the conveyance structures required for the existing conditions flow rates.

Structure #1 - Southern at Lisbon Channel, 2-8'x4' CBC req'd

Calculate structural concrete req'd, assume 1' thick walls, roof & floor.



$(19 \times 6) - (4 \times 8)2 = 50$ sf/LF
$= 1.9$ CY/LF

assume length = 75'
total CY req'd = $75(1.9) = 143$ CY

143 CY x \$300/CY = \$42,900

add cost of riprap blanket below structure, estimate 40' long, 2' thick 40' x 2' x 30' wide = 2400 cf = 89 CY → use 90 CY

90 CY x \$60/CY = \$5400 use 15% contingencies

total cost = $(42,900 + 5400)1.15$ = \$55,545 use \$55,550

Structure #2 - Southern at existing CMPA's, 2-4'x4' CBC's req'd

Concrete calculations $(11 \times 6) - (4 \times 4)2 = 34$ sf/lf = 1.3 CY/LF
assume length = 75'
total CY req'd = $75(1.3) = 97.5$ CY use 98 CY
98 x \$300/CY = \$29,400

use riprap outfall similar in cost to Structure #1

total cost = $(29,400 + 5400)(1.15) = 40,020$ use \$40,000

Structure #3 - Southern at Unser, 1-4'x4' CBC req'd.

Concrete calculations (6x6) - (4x4) = 20 SF/LF
= .75 CY/LF

Total volume (.75) 75' = 56 CY

56 CY x $300/CY = $16,800

Add riprap outfall at $5400

Total cost = (16,800 + 5,400) 1.15 = $25,530 use $25,500

Structure #4 - Unser at main arroyo, 2-8'x6' CBC's req'd

Concrete volume: (19 x 8) - (6 x 8)2 = 56 SF/LF
= 2.1 CY/LF

Length assumed to be 100'
Volume = 2.1 x 100 = 210 CY
210 x $300/CY = $63,000

Use riprap protection at outfall - assume twice the size as previous, so cost is $10,800

Total cost = (63,000 + 10,800) 1.15 = $84,870 use $84,900

Structure #5 - Unser, South of Black Arroyo, 24" rcp req'd

24" pipe - 100' @ $30/LF = 3000
Add headwalls 2 @ $1000 = 2000
Total cost = (3000 + 2000) 1.15 = $5,750

Structure #6 - Unser at County Line, 48" RCP req'd

48" pipe - 100' @ $60/LF = $6000
Add headwalls - 2 @ $2000 = 4000
Total cost = (6000 + 4000) 1.15 = 11,500

APPENDIX 4

STRUCTURE SIZING AND COST ESTIMATES

DEVELOPED CONDITIONS

B O X C U L V E R T

Inlet control and outlet control parameters

Lisbon channel at Southern

Box height	4.0	ft	INLET CTRL HWo:		
Box width	8.0	ft	tapered throat	5.34	ft
Number of boxes	5		45 degree bevels	6.04	ft
Slope	0.00300	ft/ft	sq edge headwall	6.57	ft
Manning's n	0.015		OUTLET CTRL HWo	5.72	ft
Culvert length	100	ft	Velocity	9.4	fps
Discharge	1504	cfs	Critical depth	3.53	ft

B O X C U L V E R T

Inlet control and outlet control parameters

Basin U3-2 at Southern

Box height	4.0	ft	INLET CTRL HWo:		
Box width	4.0	ft	tapered throat	5.19	ft
Number of boxes	3		45 degree bevels	5.82	ft
Slope	0.00300	ft/ft	sq edge headwall	6.32	ft
Manning's n	0.015		OUTLET CTRL HWo	5.77	ft
Culvert length	100	ft	Velocity	9.0	fps
Discharge	434	cfs	Critical depth	3.44	ft

B O X C U L V E R T

Inlet control and outlet control parameters

Basin U4 at Southern and Unser

Box height	4.0	ft	INLET CTRL HWo:		
Box width	4.0	ft	tapered throat	5.58	ft
Number of boxes	3		45 degree bevels	6.43	ft
Slope	0.00300	ft/ft	sq edge headwall	7.01	ft
Manning's n	0.015		OUTLET CTRL HWo	6.41	ft
Culvert length	100	ft	Velocity	10.0	fps
Discharge	480	cfs	Critical depth	3.68	ft

B O X C U L V E R T

Inlet control and outlet control parameters

Main arroyo crossing at Unser

Box height	6.0	ft	INLET CTRL HWo:		
Box width	8.0	ft	tapered throat	7.18	ft
Number of boxes	6		45 degree bevels	7.87	ft
Slope	0.02000	ft/ft	sq edge headwall	8.52	ft
Manning's n	0.015		OUTLET CTRL HWo	5.69	ft
Culvert length	100	ft	Velocity	9.9	fps
Discharge	2845	cfs	Critical depth	4.78	ft

B O X C U L V E R T

Inlet control and outlet control parameters

Main Arroyo Crossing at Unser Boulevard

Box height	7.0 ft			
Box width	5.0 ft		INLET CTRL HWo:	
Number of boxes	8		tapered throat	8.10 ft
Slope	0.00300 ft/ft		45 degree bevels	8.80 ft
Manning's n	0.015		sq edge headwall	9.52 ft
Culvert length	100 ft		OUTLET CTRL HWo	8.45 ft
Discharge	2845 cfs		Velocity	10.2 fps
			Critical depth	5.40 ft

Note: 5' x 7' structures examined to accommodate trail crossings.

P I P E C U L V E R T

Inlet control and outlet control parameters

Basin L4-2 crossing at Unser

Pipe diameter	48 in	INLET CTRL HWo:	
Number of pipes	1	beveled edge	4.51 ft
Slope	0.020 ft/ft	sq edge headwall	4.80 ft
Manning's n	0.015	thin edged proj	5.37 ft
Culvert length	100 ft	OUTLET CTRL HWo	3.12 ft
Discharge	90 cfs	velocity	7.2 fps
		critical depth	2.81 ft

B O X C U L V E R T

Inlet control and outlet control parameters

Basin L6-1 crossing at Unser

Box height	4.0 ft	INLET CTRL HWo:	
Box width	8.0 ft	tapered throat	5.20 ft
Number of boxes	1	45 degree bevels	5.83 ft
Slope	0.02000 ft/ft	sq edge headwall	6.34 ft
Manning's n	0.015	OUTLET CTRL HWo	3.82 ft
Culvert length	100 ft	Velocity	9.1 fps
Discharge	290 cfs	Critical depth	3.44 ft

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SUBJECT Developed Conditions Cost Estimate | SHEET NO. 1 OF
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Structure #1 - Southern at Lisbon Channel, 5-8'x 4' CBC's

Concrete required - (6x46) - (4x8)5 = 116 sf/LF
= 4.3 CY/LF

Assume length = 75'

Concrete required = 75 x 4.3 = 323 CY

Cost = 323 x $300/CY = $96,900

Add riprap blanket at outfall, estimate 40' long, 2' thick
Volume = 60x40x2 = 178 CY
178 CY x $60/CY = 10,680

Total cost = (96900+10680) 1.15 = $123,717 use $123,700

Structure #2 - Southern at existing CMPA's, 3-4'x4' CBC's req'd

Concrete required = (16x6) - (4x4)3 = 48 sf/LF
= 1.8 CY/LF

Volume = 1.8 x 75' = 135 CY

Cost = 135 x $300 = $40,500

Riprap - 40'x2'x24' = 71 CY
Cost = 71 x $60 = $4,260

Total cost = (40500+4260) 1.15 = $51,474 use $51,500

Structure #3 - Southern at Unser

Same as Structure #2

Structure #4 – Unser at main arroyo – 6-6'x8' CBC's req'd

Concrete required = (8x55) - (6x8)6 = 152 sy/LF
= 5.6 CY/LF

Length = 100'
Volume = 5.6 x 100 = 560 CY
Cost = 560 x $300 = $168,000

Do revised cost p. 3 for 5'x7' culverts

Riprap blanket = 60' x 2' x 70' = 8400 cf = 311 cy
Cost = 311 x $60/cy = $18,660

Total cost = (168,000 + 18,660) 1.15 = $214,659
use $214,700

Structure #5 - Unser, south of main arroyo, 48" RCP req'd

Same as Structure #6 under existing conditions

Structure #6 - Unser at County Line, 1-8'x4' CBC req'd

from existing conditions calculations for Structure #2
use 1.3 CY/LF

Volume = 1.3 x 100 = 130 cy

Cost = 130 x 300 = $39,000

Add riprap blanket @ $5400

Total Cost = (39000 + 5400) 1.15 = 51,060
use $51,100

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SUBJECT

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Structure # 4

Because of proposed trail crossing under Unser Blvd. at the Black Arroyo, need to examine the cost of

8 - 5' x 7' box culverts under Unser.

Concrete req'd = (49' x 9') - (5x7)8 = 161 SY / LF
= 5.96 CY / LF

Length = 100'

Volume = 5.96 x 100 = 596 CY

Cost = 596 CY x 300 = $178,800

Riprap blanket = 8400 CF = 311 CY
Cost = 311 x 60/CY = 18660

Total Cost = (18,660 + 178,800) 1.15 = $227,079

use $227,100

APPENDIX 5
PRELIMINARY CHANNEL SIZING

LISBON CHANNEL EXTENSION TO UNSER BLVD. ARROYO CROSSING

T R A P E Z O I D A L C H A N N E L

Normal depth and critical depth parameters

Drainage from Lisbon Channel, upstream detention

Input variables:		Output variables:	
Discharge	584 cfs	Normal depth	3.44 ft
Channel slope	0.00075 ft/ft	Normal velocity	3.16 fps
Manning's n	0.025	Froude number	0.34
Bottom width	40 ft	Critical depth	1.77 ft
Left side slope	4 H:1	Critical velocity	7.01 fps
Right side slope	4 H:1	Critical slope	0.008
		Superelevation	0.00 ft
Curve Radius	10000 ft	Freeboard (COA)	2.12 ft
		Channel Depth	5.56 ft

Note: Freeboard = (2+0.025(velocity)(depth)^(1/3))

Comments:
Upstream detention will limit flow to existing conditions
Channel configuration for this flow rate: 40' bottom width, 4:1 sideslopes
Grade control structures, min 7' high would be required to flatten channel slope.
Velocities still >2.5 fps, so some erosion would occur.

T R A P E Z O I D A L C H A N N E L

Normal depth and critical depth parameters

Drainage from Lisbon Channel, Unlimited discharge

Input variables:		Output variables:	
Discharge	1504 cfs	Normal depth	8.30 ft
Channel slope	0.00075 ft/ft	Normal velocity	4.95 fps
Manning's n	0.025	Froude number	0.37
Bottom width	20 ft	Critical depth	4.75 ft
Left side slope	2 H:1	Critical velocity	10.73 fps
Right side slope	2 H:1	Critical slope	0.006
		Superelevation	0.01 ft
Curve Radius	10000 ft	Freeboard (COA)	2.25 ft
		Channel Depth	10.56 ft

Note: Freeboard = (2+0.025(velocity)(depth)^(1/3))

Comments:
For unlimited discharge, lined channel would be required.
No configuration of unlined channel was considered reasonable.

BASIN U3-2 EXTENSION TO UNSER BLVD. ARROYO CROSSING

TRAPEZOIDAL CHANNEL

Normal depth and critical depth parameters

Drainage from basin U3-2, upstream detention

Input variables:		Output variables:	
Discharge	298 cfs	Normal depth	2.99 ft
Channel slope	0.00100 ft/ft	Normal velocity	3.12 fps
Manning's n	0.025	Froude number	0.37
Bottom width	20 ft	Critical depth	1.69 ft
Left side slope	4 H:1	Critical velocity	6.59 fps
Right side slope	4 H:1	Critical slope	0.008
		Superelevation	0.00 ft
Curve Radius	10000 ft	Freeboard (COA)	2.11 ft
		Channel Depth	5.10 ft

Note: Freeboard = (2+0.025(velocity)(depth)^(1/3))

Comments:

Upstream detention will limit flow to existing conditions

Channel configuration for this flow rate: 20' bottom width, 4:1 sideslopes

Grade control structures req'd, min 6' high

Velocities > 2.5 fps, so some erosion would occur

TRAPEZOIDAL CHANNEL

Normal depth and critical depth parameters

Drainage from basin U3-2, unlimited discharge

Input variables:		Output variables:	
Discharge	434 cfs	Normal depth	3.09 ft
Channel slope	0.00100 ft/ft	Normal velocity	3.32 fps
Manning's n	0.025	Froude number	0.38
Bottom width	30 ft	Critical depth	1.73 ft
Left side slope	4 H:1	Critical velocity	6.79 fps
Right side slope	4 H:1	Critical slope	0.008
		Superelevation	0.00 ft
Curve Radius	10000 ft	Freeboard (COA)	2.12 ft
		Channel Depth	5.21 ft

Note: Freeboard = (2+0.025(velocity)(depth)^(1/3))

Comments:

For unlimited discharge, an unlined channel is marginally acceptable.

Channel configuration would be 30' bottom width, 4:1 sideslopes,

Grade control structures min 6.5' high

Velocities > 2.5 fps, erosion would still occur

CHANNEL ON THE WEST SIDE OF UNSER BLVD.

UNLINED CHANNEL CONFIGURATION

TRAPEZOIDAL CHANNEL

Normal depth and critical depth parameters

Drainage from basin U4 to main crossing, upstream detention

Input variables:		Output variables:	
Discharge	196 cfs	Normal depth	1.72 ft
Channel slope	0.00100 ft/ft	Normal velocity	2.43 fps
Manning's n	0.025	Froude number	0.35
Bottom width	40 ft	Critical depth	0.88 ft
Left side slope	4 H:1	Critical velocity	5.12 fps
Right side slope	4 H:1	Critical slope	0.010
		Superelevation	0.00 ft
Curve Radius	10000 ft	Freeboard (COA)	2.07 ft
		Channel Depth	3.79 ft

Note: Freeboard = (2+0.025(velocity)(depth)^(1/3))

TRAPEZOIDAL CHANNEL

Normal depth and critical depth parameters

Drainage from basin U4 to main crossing

Input variables:		Output variables:	
Discharge	480 cfs	Normal depth	2.85 ft
Channel slope	0.00100 ft/ft	Normal velocity	3.28 fps
Manning's n	0.025	Froude number	0.38
Bottom width	40 ft	Critical depth	1.57 ft
Left side slope	4 H:1	Critical velocity	6.61 fps
Right side slope	4 H:1	Critical slope	0.008
		Superelevation	0.00 ft
Curve Radius	10000 ft	Freeboard (COA)	2.12 ft
		Channel Depth	4.97 ft

Note: Freeboard = (2+0.025(velocity)(depth)^(1/3))