Lyon Boulevard Storm Drain

Engineering Design Report

Prepared for

AMAFCA

Prepared by

WILSON & COMPANY
ENGINEERS & ARCHITECTS
2600 The American Rd, SE
Suite 100
Rio Rancho, NM 87124

RECEIVED
AUG 2 0 2004
HYDROLOGY SECTION

FINAL SUBMITTAL VERSION

August 20, 2004

I, Mario G. Juarez-Infante, P.E., do hereby certify that this document was prepared by me or under my direction, and is true and correct to the best of my knowledge and belief and that I am a duly registered Professional Engineer under the laws of the State of New Mexico.

Mario G. Juarez-Infante, P.E.
NMPE No. 15340

MARIO G. JUAREZ-INFANTE
NEW MEXICO
15340
LICENSED PROFESSIONAL ENGINEER

Date 8/20/04

I. INTRODUCTION

The Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) has retained WCEA to prepare design services for the Lyon's Boulevard storm drain, between Irving Boulevard and Paradise Boulevard. The project is located in Northwest Albuquerque, New Mexico (see Figure 1). A previous study completed in January 2003 by Bohannan Huston Inc. (BHI), is the primary basis for the hydrological model employed in this report. The BHI models have been modified for use for this project to include more detailed information and update for current proposed systems.

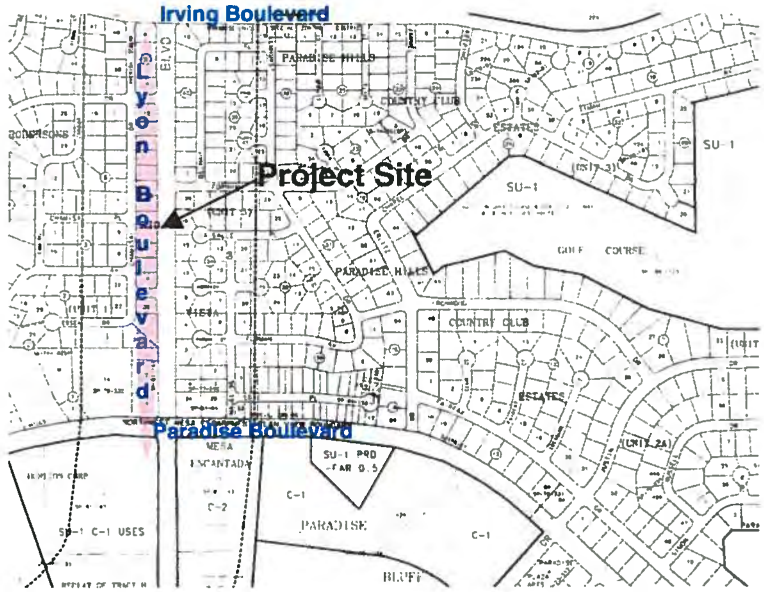


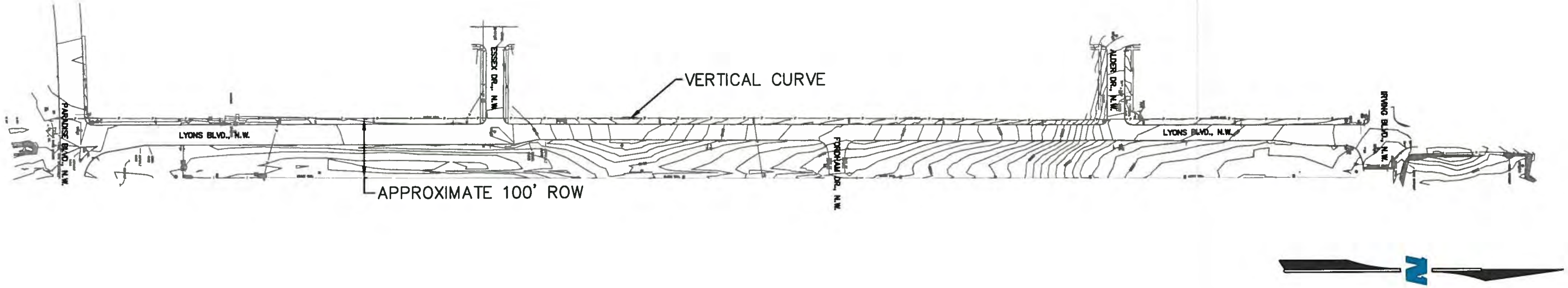
Figure 1: Zone Atlas B-11-Z

Lyon's Boulevard storm drain is being studied to accommodate 100_{year} design runoff from future Westside development and to alleviate a portion of the volumetric runoff, which drains to the Piedras Marcadas Dam. This report analyzes the project limits topography; subsurface geotechnical conditions, and provides conceptual design of a proposed 90-inch storm drain that will extend approximately 2450 ft. Upstream, at intersection of Paradise Boulevard/Lyon Boulevard Intersection, the storm drain system will provide a junction manhole with a 60-inch diameter stub-out to the south and a 72-inch diameter stub-out to the west. A temporary cattle guard inlet is proposed on the west stub-out to capture Paradise Boulevard flows. These proposed improvements will allow the elimination of the existing rock channel located south of Paradise Boulevard. A detailed basalt profile, which includes depths to the top and (where applicable) the bottom of basalt, at 100-foot intervals was determined and is illustrated in Exhibit B. Conceptual design for storm water quality treatment measures are included near the connection to the existing 72-inch storm drain, located immediately north of Lyon Boulevard/Irving Boulevard Intersection.

II. SITE DESCRIPTION

The storm drain corridor is approximately 2450-ft, within apparent 100-ft Right-of-Way, measured from existing fence to fence. The project corridor is intersected by three residential streets, in order from north to south, which are; Alder Drive NW, Fordham Drive NW, and Essex Drive NW (See Exhibit A). Approximately 1360-ft south of Irving Boulevard, a sharp vertical crest curve divides the topographic slope to drain north and south.

Downstream, the 90-inch diameter storm drain ties into an existing 72-inch storm drain, which out falls to the Calabacillas Arroyo. Main line laterals and curb inlets, located immediately adjacent to the intersection of Alder Drive NW and Essex Drive NW, are proposed to capture upstream runoff.



PLAN

SYMBOL LEGEND

- CONTROL POINT
- WATER VALVE
- TRAFFIC SIGN
- SEWER MANHOLE
- TELEPHONE MANHOLE
- WATER MANHOLE
- SIGNAL LIGHT JUNCTION BOX
- TRAFFIC SIGNAL LIGHT
- TRAFFIC SIGNAL LIGHT W/MAST ARM
- LIGHT
- WATER METER
- ELECTRIC METER
- POWER POLE
- TV PEDESTAL
- TELEPHONE PEDESTAL
- SANITARY CLEAN-OUT
- ELECTRIC BOX
- HEATING AND AIR CONDITIONING UNIT
- OVERHEAD POWER LINES
- WOOD FENCE

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

WILSON & COMPANY
2600 THE AMERICAN ROAD S.E.
SUITE 100
RIO RANCHO, NEW MEXICO
87124
(505) 896-8021

LYON BOULEVARD STORM DRAIN

EXHIBIT A
TOPOGRAPHIC SURVEY

REVISIONS	NO.	DATE	REMARKS	BY

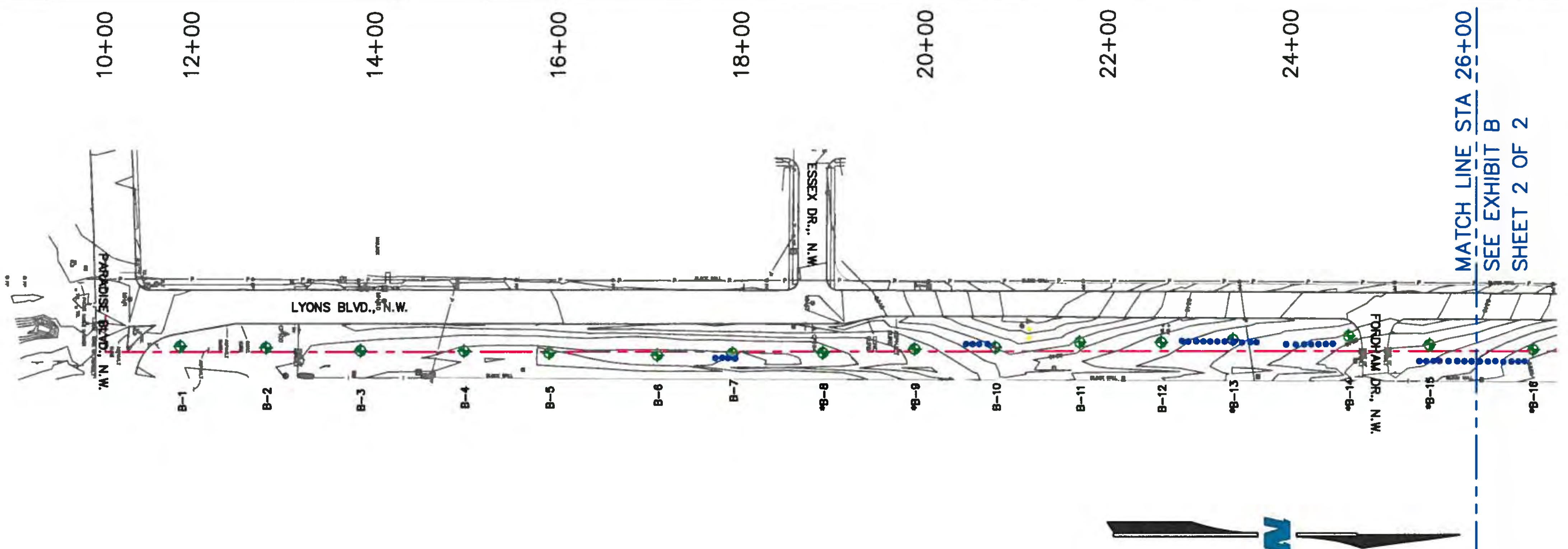
DESIGN MJI	WCEA NO. X4218037	DATE AUG 2004	
DRAWN JEL	PROJECT NO. N/A	SHEET NO. 1 OF 1	
CHECK MJI			

III. BASALT PROFILE

AMEC Earth and Environmental, Inc. conducted a subsurface field investigation along the proposed Lyon Boulevard storm drain alignment. Twenty-six (26) exploration borings were drilled along the proposed alignment, on approximately 100-foot centers to depths ranging from 8-feet to 25-feet below existing grade utilizing an Ingersoll-Rand air rotary drill rig.

Initial basalt bores were plotted on a plan & profile. The AMAFCA-WCEA team reviewed the approximate top and bottom of basalt profile on Friday, July 30, 2004. At the conclusion of the basalt review, the team determined to conduct additional top of basalt exploration using a case of 590 Super M Backhoe. Fieldwork was completed between August 9 – 10, 2004. Top of basalt exploration was limited to the 15-foot backhoe excavation depth. The top of basalt grades was surveyed at 10-foot centers. Field information supplements the AMEC geotechnical study.

A copy of the completed Basalt exploration report is presented in Appendix A. Exhibit D superimposes the Basalt profile with the proposed 90-inch storm drain profile. In general, south of Irving Boulevard, the storm drain lies immediately below or near the bottom of the Basalt profile. As the storm drain extends north of Irving Boulevard, the system is situated within the basalt profile. The former condition presents a more complex construction project because the installation of pipe is exposed to cantilevered rock, which presents difficulty with backfilling requirements.

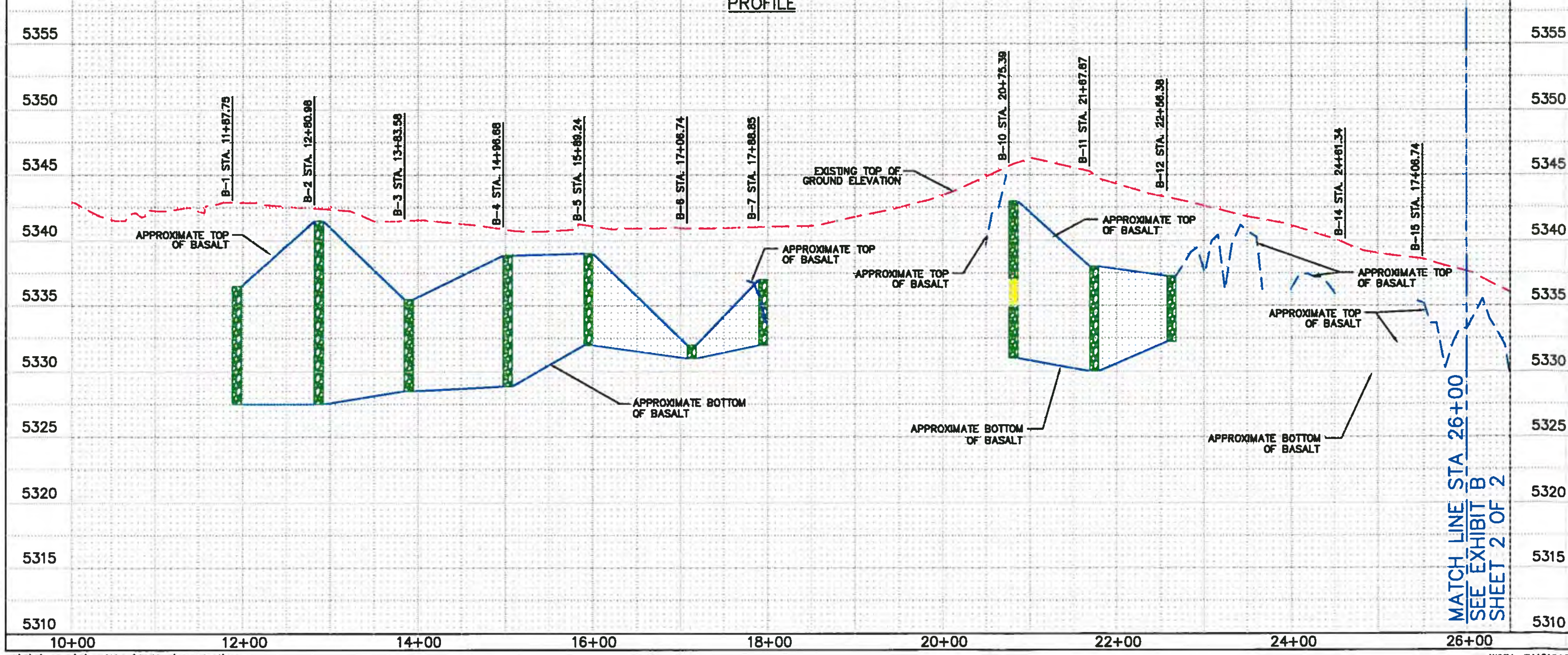


LYON BOULEVARD

PLAN

SCALE:
HORIZ: 1" = 150'
VERT: 1" = 10'

PROFILE



X:\P\P\ OR T:\P\ X1218XXX\FILE.DWG\XX-XX-98\XXX

WCEA #X4218037
AUG 2004

LEGEND

(green pattern)	BASALT
(yellow pattern)	SILTY SAND
(green diamond)	BORE NUMBER BASED ON SUPPLEMENT OF AMEC
*B-8	NO BASALT ENCOUNTERED
(blue dot)	BORE NUMBER BASED ON SUPPLEMENT OF WCEA
(solid line)	TOP OF BASALT BASED ON SUPPLEMENT OF AMEC
(dashed line)	TOP OF BASALT BASED ON SUPPLEMENT OF WCEA

GEOTECHNICAL REFERENCE:
GEOTECHNICAL ENGINEERING STUDY
LYON BOULEVARD STORM DRAIN
ALBUQUERQUE, NEW MEXICO
BY AMEC EARTH & ENVIRONMENTAL, INC.
JULY 28, 2004.

MICRO-FILM INFORMATION

AS-BUILT INFORMATION

BENCH MARKS
ACS 11-B11
ELEVATION=5348.50 (NAVD88)

SURVEY INFORMATION
NO.	BY	DATE

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

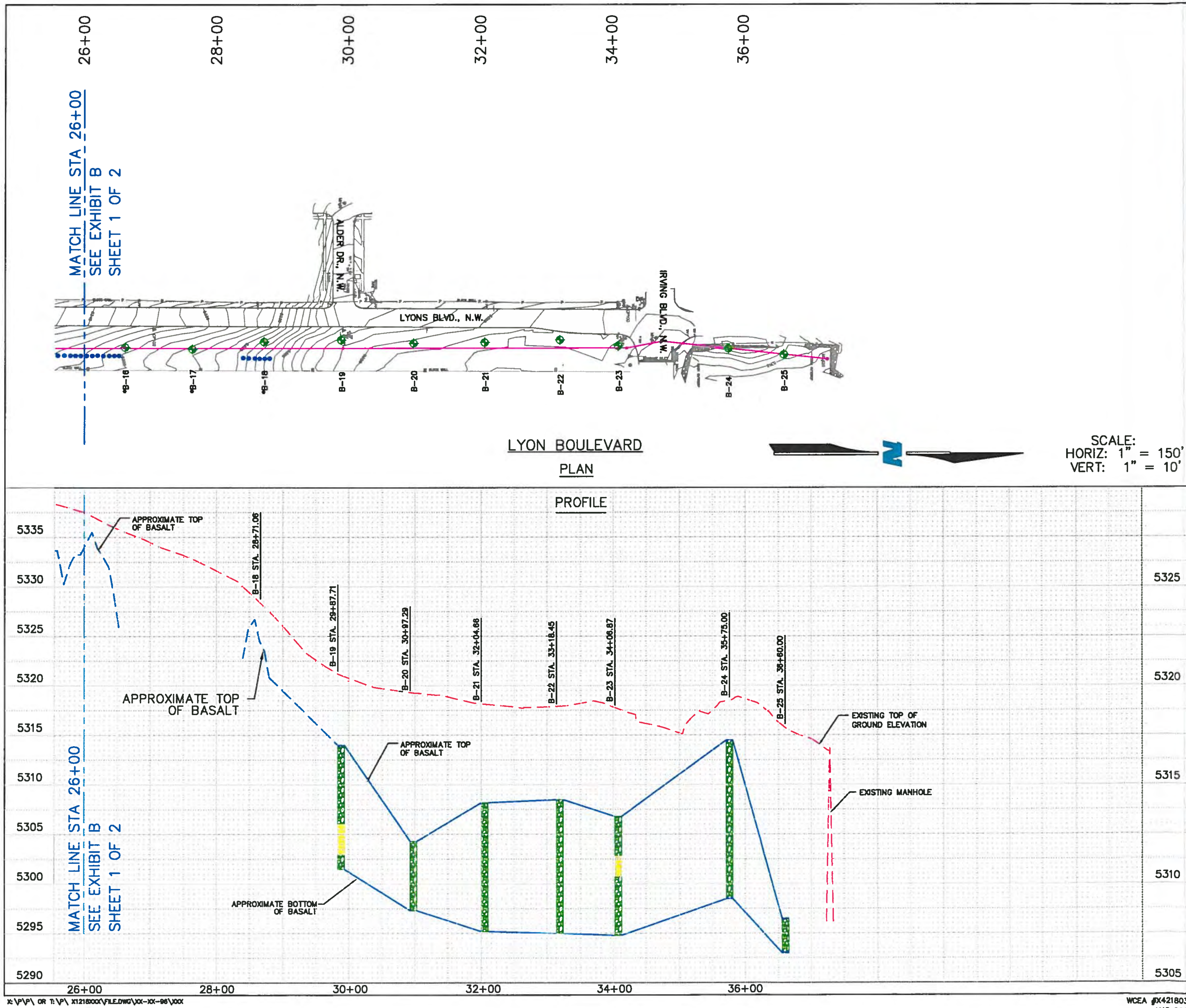
WILSON & COMPANY
2600 THE AMERICAN ROAD S.E.
SUITE 100
RIO RANCHO, NEW MEXICO
87124
(505) 898-8021

LYON BOULEVARD STORM DRAIN

EXHIBIT B
BASALT PROFILE

REVISIONS	NO.	DATE	REMARKS	BY

DESIGN	MJI	WCEA NO. X4218037	DATE AUG 2004
DRAWN	JEL	PROJECT NO. N/A	SHEET NO. 1 OF 2
CHECK	MJI		



LEGEND

- BASALT
- SILTY SAND
- BORE NUMBER BASED ON SUPPLEMENT OF AMEC
- *B-8 NO BASALT ENCOUNTERED
- BORE NUMBER BASED ON SUPPLEMENT OF WCEA
- TOP OF BASALT BASED ON SUPPLEMENT OF AMEC
- TOP OF BASALT BASED ON SUPPLEMENT OF WCEA

GEOTECHNICAL REFERENCE:
GEOTECHNICAL ENGINEERING STUDY
LYON BOULEVARD STORM DRAIN
ALBUQUERQUE, NEW MEXICO
BY AMEC EARTH & ENVIRONMENTAL, INC.
JULY 28, 2004.

MICRO-FILM INFORMATION
RECORDED BY
NO.
DATE

AS-BUILT INFORMATION
CONTRACTOR
WORK STAKED BY / DATE
FIELD VERIFICATION BY / DATE
INSPECTOR'S ACCEPTANCE BY / DATE
DRAWINGS CORRECTED BY / DATE

BENCH MARKS
ACS 11-B11
ELEVATION=5348.50 (NAVD88)

SURVEY INFORMATION

NO.	BY	DATE

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

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LYON BOULEVARD STORM DRAIN

EXHIBIT B

BASALT PROFILE

REVISIONS	NO.	DATE	REMARKS	BY

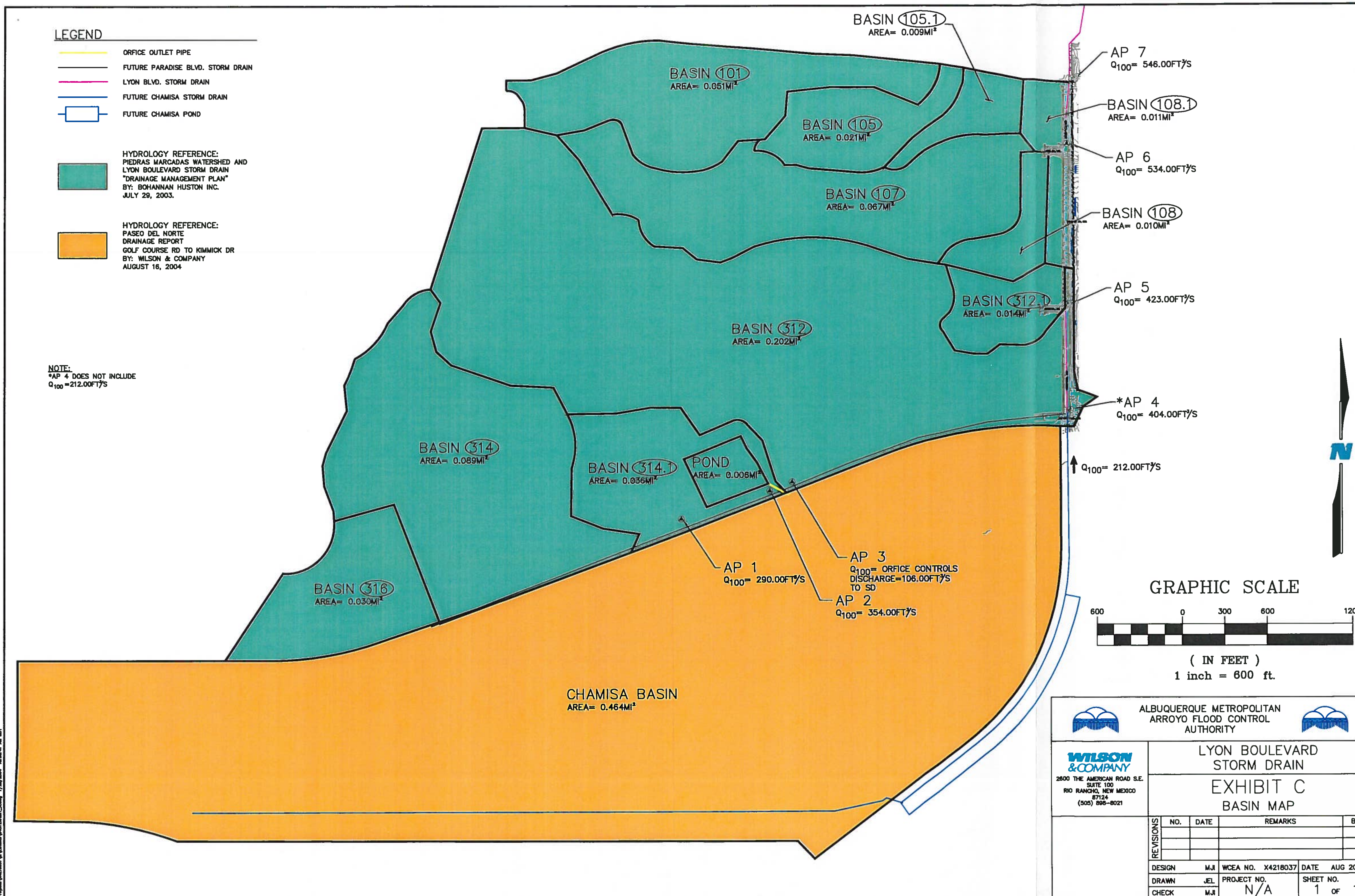
DESIGN	MJI	WCEA NO. X4218037	DATE AUG 2004
DRAWN	JEL	PROJECT NO. N/A	SHEET NO. 2 OF 2
CHECK	MJI		

IV. HYDROLOGY

The basic hydrology for this report was provided by AMAFCA. Hydrologic model was previously completed as part of the *Piedras Marcadas Watershed and Lyon Boulevard Storm Drainage Management Plan, dated July 29, 2003*, by Bohannan Huston Inc. (hereinafter Reference 1).

An AHYMO summary report (taken from Appendix A, Reference 1) is included in Appendix B. Appendix D, includes a copy of Plate 1, Exhibit 1 *Drainage Basin Map Unser Blvd.(Lyon Blvd.)/Paradise Blvd. Storm Drain April – 2000* and a copy of Exhibit 6, Option #4 storm drain, which summarize storm drain flows. Peak flows were captured at those locations, recommend in Exhibit 6.

Plate 1, Exhibit 1, peak flows were extracted and summarized in Exhibit C, in this report. Exhibit C illustrates the contributing watershed for the proposed Lyon Boulevard Storm Drain, which is discussed in greater detail in Reference 1, Section II. The total peak flow conveyed to the existing 72-inch storm drain and discharged into the Calabacillas Arroyo is 760 ft^3/s.



ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

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LYON BOULEVARD STORM DRAIN

EXHIBIT C

BASIN MAP

REVISIONS	NO.	DATE	REMARKS	BY

DESIGN MJI	WCEA NO. X4218037	DATE AUG 2004	
DRAWN JEL	PROJECT NO. N/A	SHEET NO. 1 OF 1	
CHECK MJI			

V. HYDRAULICS

a. Street Capacities

This report evaluates area drain inlets at the intersections of Irving Boulevard, Alder Drive NW, Essex Drive NW, and Paradise Boulevard, upstream (west) of Lyon Boulevard to convey existing flows to the Lyon storm drain. A half street section capacity of Lyon Boulevard is also analyzed based on future 2 to 4 lane roadway conversion and anticipated roadway typical.

Street hydraulic analysis is based on the DPM, Section 22.3, subsection E. Existing Street capacities are analyzed approximately 100 feet upstream of each respective intersection and recommendations for inlet locations are provided. The following street hydraulic design criteria is employed:

a. Manning's roughness coefficient is 0.017
b. Conjugate and/or sequent depth in the 100_{year} design event may not exceed 0.2 feet above curb height and shall be contained within the street Right-of-Way.
c. The product of the depth times the velocity may not exceed 6.5 in any location in any street in the 10_{year} design storm.

Irving Boulevard

Irving Boulevard is a collector road, approximately 42'-0" wide (measured Face-to-Face of Curb at west leg). As-built record drawings, dated February 1995, prepared by Community Sciences Corporation provide details and inlet capacity for the existing cattle guard at Irving Boulevard/Lyon Boulevard Intersection (see Figure 2). The modified cattle guard has an existing capacity, Q_{100} = 418.6 ft^3/s. (Refer to Appendix D, Sheet 20A of 23).

Figure 2: Standing east looking west along Irving Boulevard/Lyon Boulevard Intersection.

The existing upstream watersheds discharging peak flow to the modified cattle guard include: Basin 101, Basin 105, Basin 105.1, Basin 107, Basin 108, and Basin 108.1. Installation of the proposed storm drain system, will intercept peak runoff upstream of each roadway intersection throughout the project corridor. A storm drain will be sized and stubbed out along Irving Boulevard, immediately west of Lyon Boulevard, to allow for future extension. Basin 101, Basin

105, and Basin 105.1, located upstream of Irving Boulevard/Lyon Boulevard Intersection, may be captured by combination curb inlets along Irving Boulevard and tied to the Lyon Boulevard Storm Drain.

In the interim condition, the existing modified cattle guard inlet may be left in place, and no installation of curb inlets are required upstream of the Intersection.

Alder Drive NW
Alder Drive NW is a local residential street, approximately 31'-0" wide (measured Face-to-Face of Curb). Street longitudinal slope is approximately 2.61% and has no crown. The existing street capacity has been determined to be 218.3 ft^3/s. The existing upstream watershed is subdivided into three sub-basins; Basin 107, Basin 108, and Basin 108.1. The total watershed area is approximately 0.088 mi^2. However, only a portion of the entire watershed runoff may be logically intercepted along Alder Drive. Therefore, a storm drain will be sized and stubbed out along Alder Drive, immediately west of Lyon Boulevard, to allow for future extension. Basin 108 and approximately 1/3 of Basin 108.1, located immediately upstream of Alder Drive/Lyon Boulevard Intersection, may be captured by combination curb inlets along Alder Drive and tied to the Lyon Boulevard Storm Drain. This peak discharge rate is Q_{100} = 31.79 ft^3/s. In a 100_{year} storm event, Alder Drive NW may flow to a depth H = 0.21 ft.

Essex Drive NW
Essex Drive NW is a local residential street, approximately 33'-0" wide (measured Face-to-Face of Curb). Street longitudinal slope is approximately 1% and has no crown. The existing street capacity has been determined to be 144.1 ft^3/s. The upstream watershed is identified as BASIN 312.1, and has a peak discharge rate, Q_{100} = 32.56 ft^3/s. In a 100_{year} storm event, Essex Drive NW may flow to a depth H = 0.27 ft.

Paradise Boulevard NW
Paradise Boulevard NW is a minor arterial street, approximately 45'-0" wide (measured Face-to-Face of Curb). Presently, Paradise Boulevard is a half street section, with future lanes to be added along the south right-of-way. Street longitudinal slope is approximately 1.17% and has no crown. The existing street capacity has been determined to be 258 ft^3/s. The upstream watershed is comprised of sub-basins 312, 313N, 314, 314.1, and 316 (see Exhibit 'C'). The total water shed area is approximately 0.439 mi^2 and has a peak flow rate, Q_{100} = 403.02 ft^3/s. Future expansion of Paradise Boulevard drainage system will capture and convey flow via underground storm drain. In a 100_{year} storm event, the existing Paradise Boulevard will over top the curb.

Lyon Boulevard

Lyon Boulevard is a Major Arterial road, approximately 36'-0" wide (measured Face-to-Face of Curb). The roadway topography is divided by a crest vertical curve, located approximately midway along the project corridor. Existing street capacities of the current half-street section were analyzed for both the segments north and south of the crest vertical curve. The north segment slopes towards Irving Boulevard at an average grade of 1.13%. The existing half-street capacity is Q_{100} = 27.23 ft^3/s.

The south segment is further subdivided into two smaller basins. The segment between Essex Drive NW and the crest vertical curve is a low point in the roadway, which ultimately ponds water; therefore the existing street inundation area is not determined. The segment between Essex Drive NW and Paradise Boulevard slopes in a southerly direction at an average grade of 0.29%. The existing half-street capacity is Q_{100} = 12.86 ft^3/s.

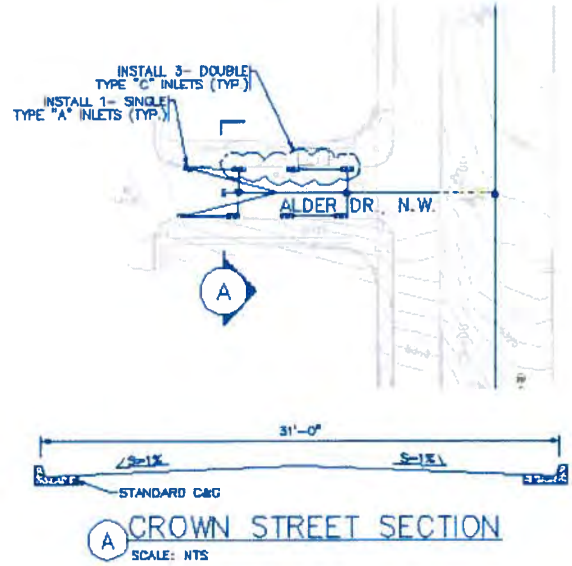


Figure 3: Alder Drive Drainage Improvements

b. CUB INLET ANALYSIS

City standard catch basins "Type A, C, and Cattle Guard" single and combination inlets are analyzed within this report. The curb opening type inlets are preferred; because debris accumulation and offset lost capacity due to grate clogging is limited.

"Type A" basins are recommended along Essex Drive NW and Alder Drive NW, because a battery of inlets will be required within these street segments. A minimum of 25' between curb transitions is required for compliance with the City's DPM.

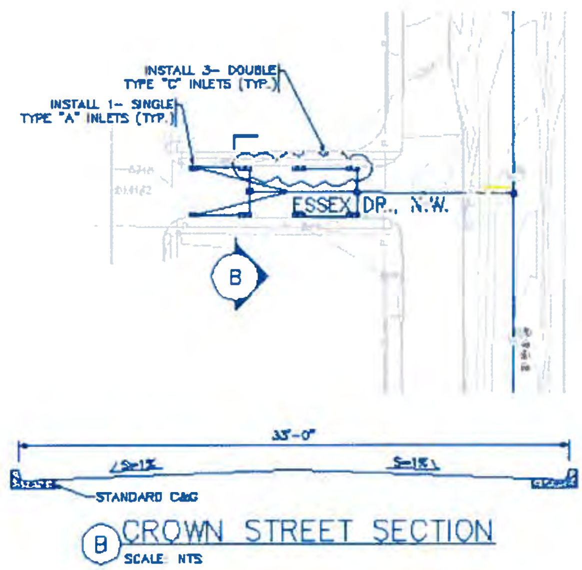


Figure 4: Essex Drive Drainage Improvements

Alder Drive NW

Installation of combination curb inlets along Alder Drive NW is recommended because Alder Drive NW T-intersects Lyon Boulevard, a Major Arterial roadway. Transportation safety, primarily friction factors associated with breaking distance and intersection sight distance, merit capturing surface runoff, minimizing depth of street flows, and maintaining optimal driving lane conditions.

A recommendation to crown Alder Drive and install 1 single Type 'A' inlet upstream followed by 3-double Type 'C' inlets on each side of Alder Drive NW is illustrated in Figure 3. Proposed street capacities and inlet capacity computations are provided in Appendix C.

Essex Drive NW

This report recommends installation of combination curb inlets along Essex Drive NW because Essex Drive NW T-intersects Lyon Boulevard, a Major Arterial roadway. Transportation safety, primarily friction factors associated with breaking distance and intersection sight distance, merit capturing surface runoff, minimizing depth of street flows, and maintaining optimal driving lane conditions.

A recommendation to crown Essex Drive and install 1 single Type 'A' inlet upstream followed by 3-double Type 'C' inlets on each side of Essex Drive NW as illustrated in Figure 4. Proposed street capacities and inlet capacity computations are provided in Appendix C.

Paradise Boulevard NW

The Piedras Marcadas Watershed and Lyon Storm Drain DMP identifies the need for future underground storm drain extension, west of Paradise Boulevard/Lyon Boulevard Intersection. This report recommends installation of a temporary cattle guard inlet within the west leg of the Intersection, in the interim condition. Installation of the cattle guard inlet will maximize captured surface flows, until Paradise Boulevard Storm drain can be designed and constructed. Figure 5 shows location of future inlet.

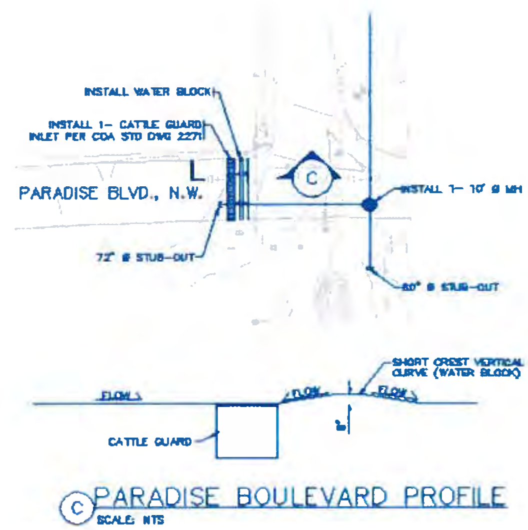


Figure 5: Location of cattle guard inlet

Lyon Boulevard NW

Local Right-of-Way drainage within Lyon Boulevard is topographically divided by crest vertical curve, as discussed in the previous section. The north roadway segment is comprised of approximately 2/3 of Basin 108.1, which translates to a peak discharge of Q_{100} = 17.06 ft^3/s. Assuming a future four-lane roadway section, the peak flow conveyed by half-street is 8.53 ft^3/s. Therefore, a single type 'C' inlet preceded by a type 'A' inlet, south of Irving Boulevard/Lyon Boulevard intersection, is recommended.

The south roadway segment is has a similar peak discharge of Q_{100} = 17.06 ft^3/s. However, the vertical profile south of the crest vertical curve has a low point between the crest vertical curve and Essex Drive NW. A type 'C' inlet is recommended at the low point location for nuisance flows. South of Essex Drive NW the approximate peak flow conveyed by the roadway is 2/3(8.53 ft^3/s), or 5.69 ft^3/s. Therefore, single type 'A' inlet north of Paradise Boulevard/Lyon Boulevard intersection, is recommended.

c. Storm Drain Hydraulic Analysis

Hydraflow Sewers by Intelisolve 2003, Version 10.0 was used to perform a hydraulic grade line analysis. Hydraflow uses the energy-based Standard Step method when computing the hydraulic profile. This methodology is an iterative procedure that applies Bernoulli's energy equation between the downstream and upstream ends of each line in the system. Manning's equation is used to determine head losses due to pipe friction. The greatest benefit to using this method is that a solution can always be found regardless of the flow regime. This method makes no assumptions as to the depth of flow and is only accepted when the energy equation has balanced.

The main storm drain alignment originates at the intersection of Paradise Boulevard/Lyon Boulevard Intersection, provides two future stub-outs (east and west), and extends north, past the Intersection of Irving Boulevard/Lyon Boulevard and connects to an existing 72-inch RCP. The contributing watershed is illustrated in Exhibit C. The storm drain may be constructed on the eastern half of the existing Lyon Boulevard Right-of-Way, away from existing driving lanes, vehicular traffic, and pedestrians.

The Lyon Boulevard Storm Drain invert elevations are primarily constrained by sub-basins 311 N, 311 S, and 8, located south of the project, illustrated on Exhibit C. The *Piedras Marcadas Watershed and Lyon Boulevard Storm Drainage Management Plan* constrains peak discharge to Q_{100} = 212 ft^3/s. Following a meeting on Tuesday, August 10, 2004 with Tierra West Engineer Vincent Carrica, P.E., it was confirmed that a 60" ∅ storm drain stub-out is required south of Paradise Boulevard/Lyon Boulevard Intersection, in order to accommodate Q_{100} = 212 ft^3/s. Tierra West's 60" ∅ storm drain is presently designed at a pipe grade S = 0.37%, and ties into an invert elevation of 5320.00, at the south end of the Lyon Boulevard Storm Drain (see Exhibit D and Appendix E "Conceptual Design").

A 72" ∅ storm drain stub-out is recommended west of Paradise Boulevard/Lyon Boulevard Intersection, to accommodate future Paradise Boulevard storm drain. Underground storm drain is sized to convey approximately Q_{100} = 404 ft^3/s. Hydraulic analysis is provided in Appendix C.

Junction Losses

The Classical Method is used to predict minor losses at pipe entrances, exits, bends, and junctions. The head loss is the product of the minor loss coefficient, K, and the difference between the upstream and downstream velocity heads:

$$h_L = K \left| \frac{V_2^2 - V_1^2}{2g} \right|$$

Where h_L is head loss due to minor losses (ft), K is the minor loss coefficient, V is the velocity of flow (ft/s), and g is the gravitational acceleration constant (32.2 ft/s^2).

Locations where Tee manholes are used in conjunction with bends, the pipe node are modeled as a bend. This situation occurs immediately south of Irving Boulevard/Lyon Boulevard Intersection, where the 90-inch storm drain steers around the existing traffic signals and cattle guard. The bend loss coefficient, K, may be computed as:

$$K = 0.25\sqrt{\theta/90^\circ} = 0.25\,(16.3^\circ/90^\circ)^{0.5} = 0.106$$

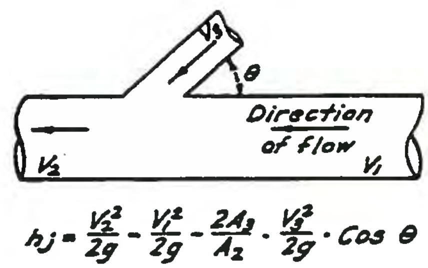


Figure 6: COA DPM, Section 22, page 22-99, *Pressure flow Junction Losses*

The manhole junction losses, where the 90-inch storm drain has an incoming 48-inch line, within the Intersection of Irving Boulevard/Lyon Boulevard, is a special case of pressure flow. If $A_1 = A_2$; at incoming junction line is at $\theta = 90^\circ$, then the junction loss coefficient (k) may be computed by the following equation shown in Figure 6;

$$h_j = ((17.29\text{ft/s})^2/2g) - ((17.16\text{ft/s})^2/2g) - 0 = 0.06\text{ft}$$

Contraction Losses

The minor loss coefficient for the contraction from 90" to 72" diameter pipe, north of Irving Boulevard, depends on the relative abruptness of the transition, flow velocity, and pipe diameters. Table 4.14, American Iron and Steel Institute *Modern Sewer Design 4th Edition*, is used to estimate the sudden contraction losses employed in the model. A contraction coefficient, K_T = 0.1225.

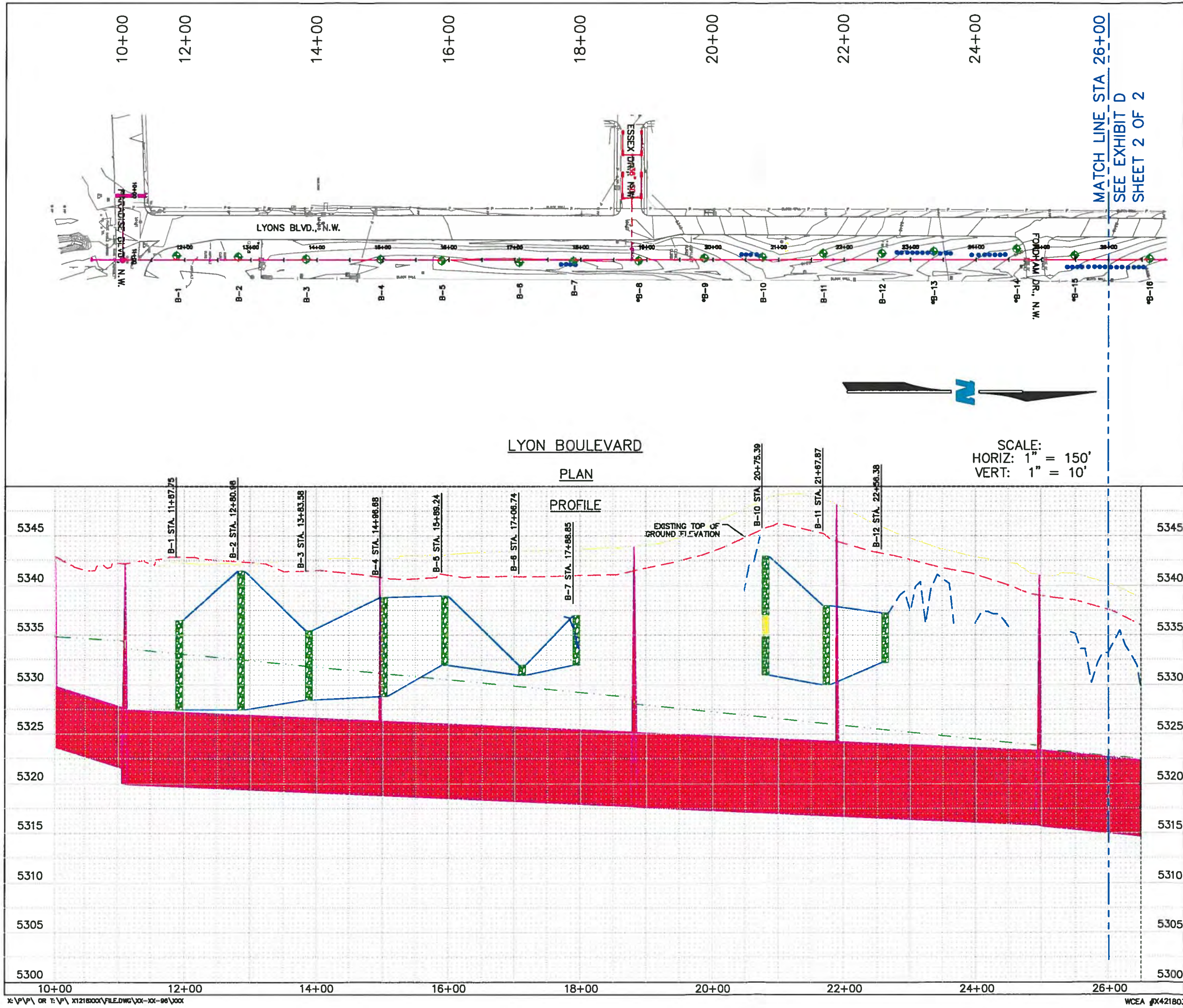
Table 4.14 Values of K_3 for Determining Loss of Head Due to Sudden Contraction From the Formula $H_3 = K_3(V_2^2/2g)$ [7]

d_2/d_1 = Ratio of Larger Pipe to Smaller Pipe V_2 = Velocity in Smaller Pipe

d_2/d_1	Velocity, V_2, in Meters Per Second (feet per second)												
	0.6 (2.0)	0.9 (3.0)	1.2 (4.0)	1.5 (5.0)	1.8 (6.0)	2.1 (7.0)	2.4 (8.0)	3.0 (10)	3.6 (12)	4.5 (15)	6.0 (20)	9.0 (30)	12.0 (40)
1.1	03	04	04	.04	04	04	04	04	.04	04	.05	.05	.06
1.2	07	07	07	07	07	07	07	.08	08	08	.09	10	.11
1.4	17	17	17	.17	.17	17	17	.18	18	18	18	19	.20
1.6	26	.26	.26	26	26	26	26	.26	.26	25	25	.25	.24
1.8	34	34	.34	34	.34	34	.33	.33	32	.32	.31	.29	.27
2.0	.38	38	.37	.37	37	37	.36	.36	.35	.34	33	.31	.29
2.2	.40	40	.40	39	.39	39	.39	.38	.37	.37	.35	.33	.30
2.5	.42	.42	.42	41	.41	41	.40	.40	39	.38	.37	.34	.31
3.0	44	.44	44	.43	.43	.43	.42	42	.41	40	39	.36	.33
4.0	.47	.46	46	.46	.45	45	.45	.44	.43	42	41	.37	.34
5.0	.48	.48	47	47	.47	46	46	.45	45	.44	.42	.38	35
10.0	49	.48	48	48	48	47	47	.46	46	.45	43	.40	36
∞	.49	49	48	48	48	47	.47	47	.46	.45	.44	.41	38

Reference: American Iron & Steel Institute, *Modern Sewer Design, 4th Edition*, 1999.

Water Quality Structure
WCEA has reviewed the project for location and type of water quality structure. It is our recommendation that the treatment for water quality be sized to accommodate the first 0.25 inches of runoff from the contributing drainage basins. We will look at both commercial and WCEA designed off line structures to provide treatment. If desired a small constructed wetland may be tied with a water quality manhole to provide additional treatment for fecal coliform along with floatable and sediment removal. These facilities should be located within the AMAFCA properties; possibly between the Calabacillas Arroyo and Irving Boulevard. The Water Quality Structure could also provide additional capacity if the flows are pulled off at the location were the 90-inch pipe intersects with the smaller 72-inch line.



LEGEND

- BASALT
- SILTY SAND
- BORE NUMBER BASED ON SUPPLEMENT OF AMEC
- BORE NUMBER BASED ON SUPPLEMENT OF WCEA
- TOP OF BASALT BASED ON SUPPLEMANT OF AMEC
- TOP OF BASALT BASED ON SUPPLEMANT OF WCEA
- PROPOSED STORM DRAIN
- PROPOSED STORM DRAIN MANHOLE

GEOTECHNICAL REFERENCE:
GEOTECHNICAL ENGINEERING STUDY
LYON BOULEVARD STORM DRAIN
ALBUQUERQUE , NEW MEXICO
BY AMEC EARTH & ENVIRONMENTAL, INC.
JULY 28, 2004.

MICRO-FILM INFORMATION	
RECORDED BY	
NO.	DATE

AS-BUILT INFORMATION			
CONTRACTOR			
WORK STAKED BY	DATE	INSPECTOR'S ACCEPTANCE BY	DATE
FIELD VERIFICATION BY	DATE	DRAWINGS CORRECTED BY	DATE

BENCH MARKS
ACS 11-B11
ELEVATION=5348.50 (NAVD88)

SURVEY INFORMATION		
NO.	BY	DATE

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

WILSON & COMPANY
2600 THE AMERICAN ROAD S.E.
SUITE 100
RIO RANCHO, NEW MEXICO
87124
(505) 898-8021

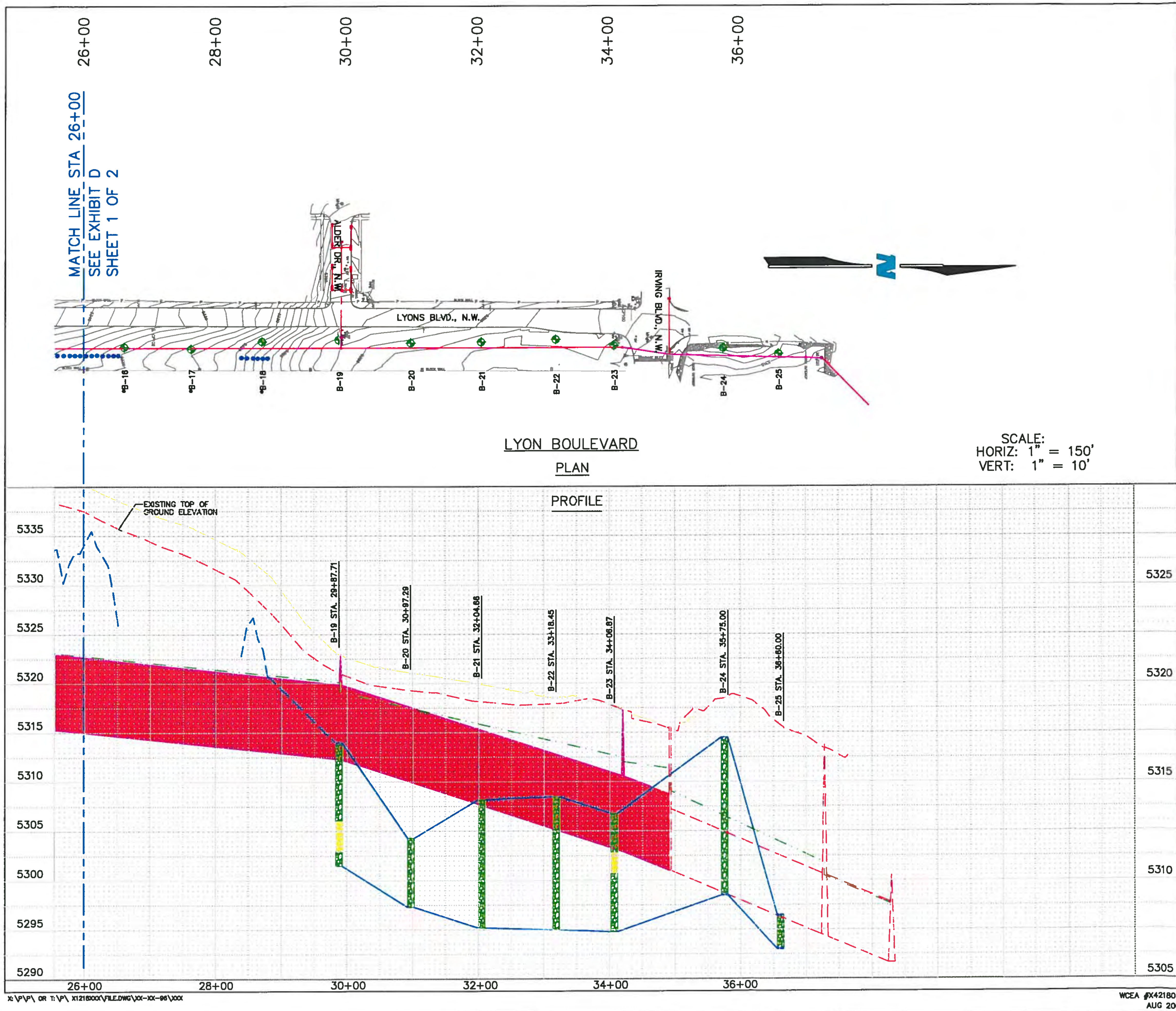
LYON BOULEVARD STORM DRAIN

EXHIBIT D

SD/BASALT PROFILE COMPARISON

REVISIONS			
NO.	DATE	REMARKS	BY

DESIGN	MJI	WCEA NO. X4218037	DATE AUG 2004
DRAWN	JEL	PROJECT NO.	SHEET NO.
CHECK	MJI	N/A	1 OF 2



LEGEND

- BASALT
- SILTY SAND
- BORE NUMBER BASED ON SUPPLEMENT OF AMEC
- BORE NUMBER BASED ON SUPPLEMENT OF WCEA
- TOP OF BASALT BASED ON SUPPLEMANT OF AMEC
- TOP OF BASALT BASED ON SUPPLEMANT OF WCEA
- PROPOSED STORM DRAIN
- PROPOSED STORM DRAIN MANHOLE
- EXISTING STORM DRAIN MANHOLE

GEOTECHNICAL REFERENCE:
GEOTECHNICAL ENGINEERING STUDY
LYON BOULEVARD STORM DRAIN
ALBUQUERQUE, NEW MEXICO
BY AMEC EARTH & ENVIRONMENTAL, INC.
JULY 28, 2004.

MICRO-FILM INFORMATION — RECORDED BY / NO. / DATE

AS-BUILT INFORMATION — CONTRACTOR / WORK STAKED BY / FIELD VERIFICATION BY / DATE / INSPECTOR'S ACCEPTANCE BY / DRAWINGS CORRECTED BY / DATE

BENCH MARKS — ACS 11-B11 ELEVATION=5348.50 (NAVD88)

SURVEY INFORMATION — NO. / BY / DATE

ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY

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87124
(505) 896-8021

LYON BOULEVARD STORM DRAIN

EXHIBIT D

SD/BASALT PROFILE COMPARISON

REVISIONS NO.	DATE	REMARKS	BY

DESIGN	MJ	WCEA NO. X4218037	DATE AUG 2004
DRAWN	JEL	PROJECT NO. N/A	SHEET NO. 2 OF 2
CHECK	MJ		

VII. SUMMARY & RECOMMENDATIONS

The storm drain vertical alignment grade proposed, balances the depth of storm drain north of Paradise Boulevard/Lyon Boulevard Intersection, while maintaining the hydraulic grade line below the future roadway grade.

The conceptual level cost estimate prepared, is itemized, based on design topographic survey and recent bid tabs unit prices. The approximate cost for construction is $4.55 Million (which excludes NMGRT). This cost is comparable to those cost originally prepared in the Piedras Marcadas study. The increase in cost from $3.337 M (Piedras Marcadas study) and $4.55 M is due to the rock excavation cost considered in this report. The previous study did not consider rock excavation cost. Reader is advised that excavation cost is based on a limited study of the existing basalt profile; rock excavation quantities may increase based on a more detailed basalt study.

If unit pricing is to be used for rock excavation, then this report recommends that a more detailed study of the existing basalt profile, prior to preliminary design, be completed. Sub-surface utility engineering for 3-D mapping of utilities, material, and location is also recommended to minimize utility conflicts and disruptions during construction.

VIII. REFERENCES

1. American Iron and Steel Institute, *Modern Sewer Design, 3rd Edition*, 1995.

2. Bohannan Huston, Inc., *Piedras Marcadas Watershed and Lyon Boulevard Storm Drain Drainage Management Plan*, July 29, 2003.

3. City of Albuquerque, *Development Process Manual, Volume II – Design Criteria*, 2003 Revision.

4. Haestad Durrans, Stormwater Conveyance Modeling and Design, 1st Edition, 2003.

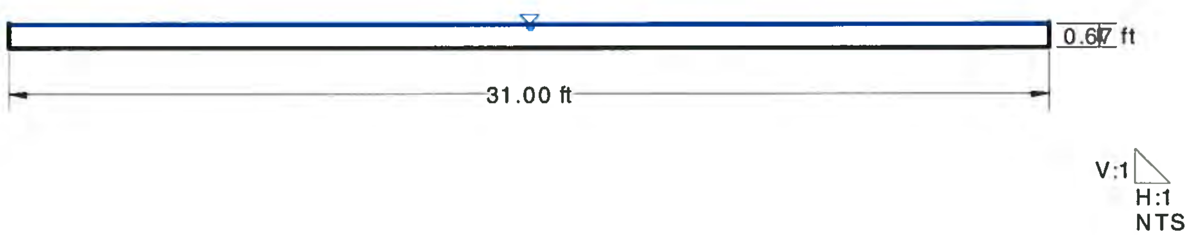
5. HydraFlow Storm Sewers 2003, *User's Manual*, Version 10.0.

6. Wilson & Company, Inc., E&A, *Paseo Del Norte Drainage Report, Golf Course to Kimmick Drive*, August 16, 2004.

Cross Section
Cross Section for Rectangular Channel

Project Description	
Worksheet	Alder Drive NW (Ex. Cap
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

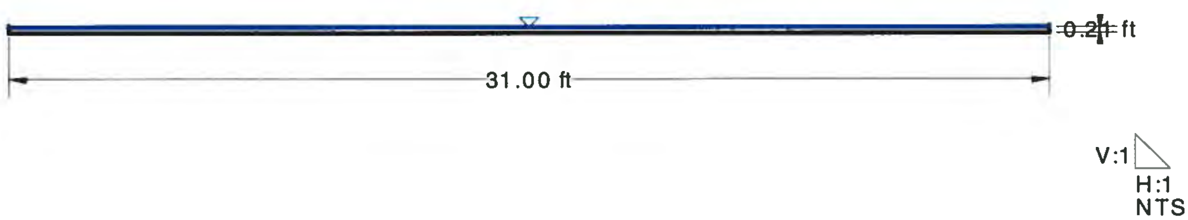
Section Data		
Mannings Coeffic	0.017	
Slope	026087	ft/ft
Depth	0.67	ft
Bottom Width	31.00	ft
Discharge	218.27	cfs



Cross Section
Cross Section for Rectangular Channel

Project Description	
Worksheet	Alder Drive NW (Ex Flow
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coeffic	0.017	
Slope	026087	ft/ft
Depth	0.21	ft
Bottom Width	31.00	ft
Discharge	31.79	cfs



Cross Section
Cross Section for Rectangular Channel

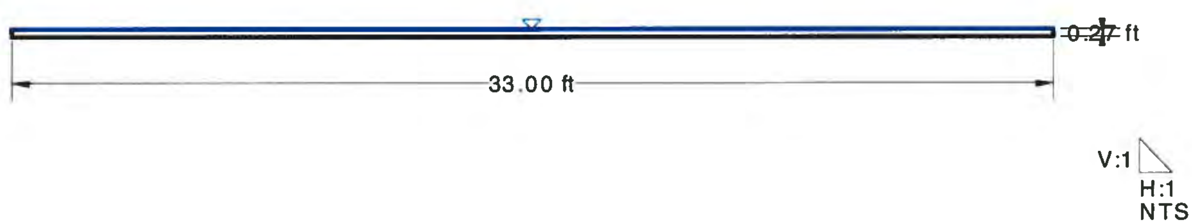
Project Description	
Worksheet	Essex Drive NW (Ex. Ca
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coeffic	0.017	
Slope	010000	ft/ft
Depth	0.67	ft
Bottom Width	33.00	ft
Discharge	144.10	cfs

Cross Section
Cross Section for Rectangular Channel

Project Description	
Worksheet	Essex Drive NW (Ex Flov
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Depth

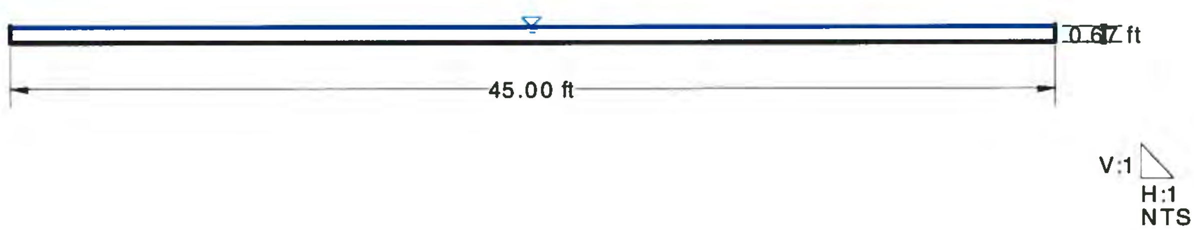
Section Data		
Mannings Coeffic	0.017	
Slope	010000	ft/ft
Depth	0.27	ft
Bottom Width	33.00	ft
Discharge	32.56	cfs



Cross Section
Cross Section for Rectangular Channel

Project Description	
Worksheet	Paradise Boulevard NW (Ex. (
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Discharge

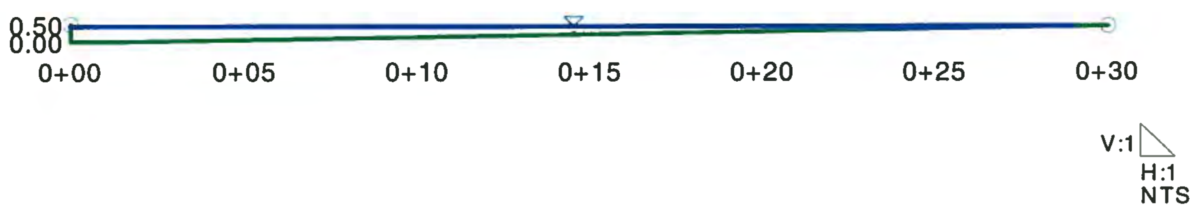
Section Data		
Mannings Coeffic	0.017	
Slope	017000	ft/ft
Depth	0.67	ft
Bottom Width	45.00	ft
Discharge	258.00	cfs



Existing Lyon Blvd. Half-Street Section (North of Crest)
Cross Section for Gutter Section

Project Description	
Worksheet	North Lyon Boulevard Half Street
Type	Gutter Section
Solve For	Discharge

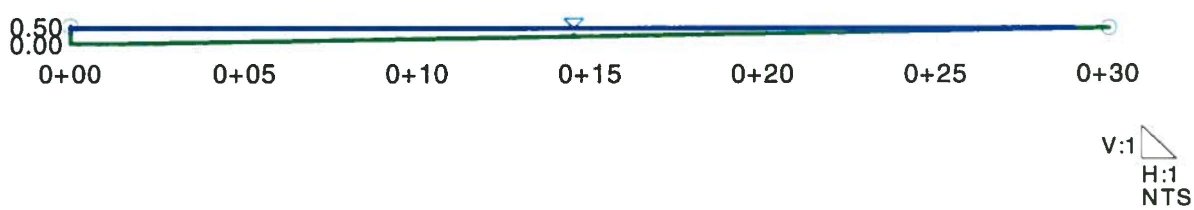
Section Data		
Slope	012994	ft/ft
Discharge	27.23	cfs
Gutter Width	1.50	ft
Gutter Cross Slo|	025000	ft/ft
Road Cross Slop	015000	ft/ft
Spread	29.00	ft
Mannings Coeffic	0.017	



Existing Lyon Blvd. Half-Steet Section (South of Crest)
Cross Section for Gutter Section

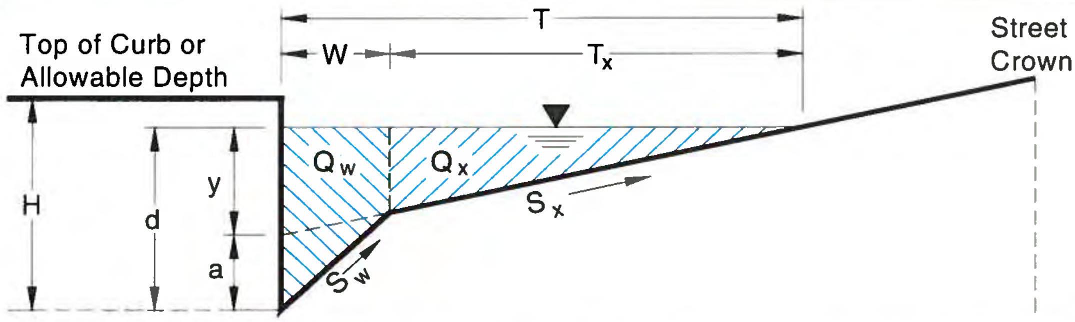
Project Description	
Worksheet	South Lyon Boulevard Half Stree
Type	Gutter Section
Solve For	Discharge

Section Data		
Slope	002899	ft/ft
Discharge	12.86	cfs
Gutter Width	1.50	ft
Gutter Cross Slo|	025000	ft/ft
Road Cross Slop	015000	ft/ft
Spread	29.00	ft
Mannings Coeffic	0.017	



GUTTER CONVEYANCE CAPACITY

Project = Lyon Boulevard Storm Drain Project
Inlet ID = Alder Drive NW

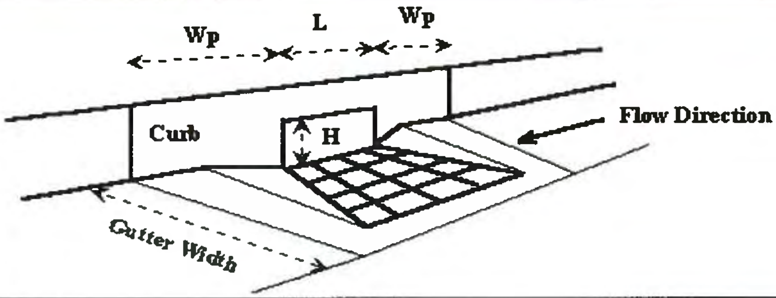


Street Geometry (Input)			
Design Discharge in the Gutter	Q_o =	**6.5**	**cfs**
Gutter Width (Cannot Be Less Than Any Grate Width)	W =	2.00	ft
Gutter Depression, if Composite Gutter	a =	4.3	inches
Street Transverse Slope	S_x =	0.0100	ft/ft
Street Longitudinal Slope	S_o =	0.0260	ft/ft
Manning's Roughness	n =	0.017	
Gutter Conveyance Geometry			
Gutter Cross Slope	S_w =	0.1871	ft/ft
Water Spread Width	T =	14.6	ft
Water Depth without Gutter Depression	y =	1.8	inches
Water Depth with a Gutter Depression	d =	6.0	inches
Gutter Conveyance Calculations by HEC-22 Method			
Spread for Side Flow on the Street (T - W)	T_x =	12.6	ft
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	2.1	cfs
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_o =	0.67	
Discharge within the Gutter Section W	Q_w =	4.4	cfs
Total Flow Rate by HEC-22 Method	Q_T =	**6.5**	**cfs**
Equivalent Street Transverse Slope	S_e =	0.1290	ft/ft
Flow Area	A_s =	1.4	sq ft
Flow Velocity	V_s =	4.6	fps
V_s*d product	**V_s*d =**	**2.3**	**ft^2/s**

NOTE: V_s*d product should be less than 6.0 for minor event and less than 8.0 for major event.

COMBINATION INLET ON A GRADE

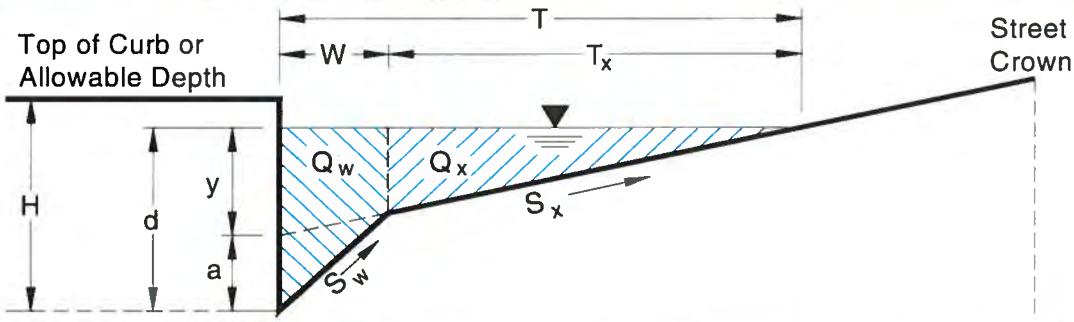
Project: Lyon Boulevard Storm Drain Project
Inlet ID: Alder Drive NW



Design Information (Input)			
Type of Grate	Type =	Bar P-1-7/8	
Length of a Single Unit Grate	L_o =	6.67	ft
Width of a Unit Grate (cannot be greater than W from *Street Hy*)	W_o =	2.00	ft
Clogging Factor for a Single Unit Grate (typical value = 0.5)	C_o-G =	0.50	
Clogging Factor for a Single Unit Curb Opening (typical value = 0.1)	C_o-C =	0.10	
Local Depression, if any (not part of upstream Composite Gutter)	a_{local} =	2.8	inches
Total Number of Units in the Combination Inlet	No =	1	
Grate Analysis (Calculated)			
Design Discharge on the Street (from *Street Hy*)	**Q_o =**	**6.5**	**cfs**
Water Depth for Design Condition	Y_d =	8.8	inches
Total Length of Inlet Grate & Curb Opening	L =	6.67	ft
Ratio of Grate Flow to Design Flow E_o	E_o =	0.67	
Flow Velocity Vs (from *Street Hy*)	V_s =	4.56	fps
Spash-over Velocity V_o: Check Against Flow Velocity V_s	V_o is:	greater than Vs	
Under No-Clogging Condition			
Interception Rate of Gutter Flow	R_f =	1.00	
Interception Rate of Side Flow Rx (from *Street Hy*)	R_x =	0.88	
Interception Capacity	Q_i =	6.2	cfs
Under Clogging Condition			
Clogging Coefficient for Multiple-unit Grate Inlet	Coef =	1.00	
Clogging Factor for Multiple-unit Grate Inlet	Clog =	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	3.34	ft
Interception Rate of Side Flow Rx (from *Street Hy*)	R_x =	0.59	
Actual Interception Capacity	**Q_a =**	**5.6**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening)	**Q_{curb} =**	**0.9**	**cfs**
Curb Opening Analysis (Calculated)			
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.2060	ft/ft
Required Length L_T to Have 100% Interception	L_T =	5.65	ft
Clogging Coefficient	Coef =	1.00	
Clogging Factor for Multiple-unit Curb Opening Inlet	Clog =	0.10	
Effective (Unclogged) Length	L_e =	5.65	ft
Under No-Clogging Condition			
Effective Length of Curb Opening Inlet (must be $\leq L_T$)	L =	5.65	ft
Interception Capacity	Q_i =	0.4	cfs
Under Clogging Condition			
Actual Interception Capacity	**Q_a =**	**0.4**	**cfs**
Carry-Over Flow = Q_{curb}-Q_a =	**Q_b =**	**0.5**	**cfs**
Capture Percentage = Q_a/Q_o =	**C% =**	**92.3**	**%**

GUTTER CONVEYANCE CAPACITY

Project = **Lyon Boulevard Storm Drain Project**
Inlet ID = **Essex Drive NW**



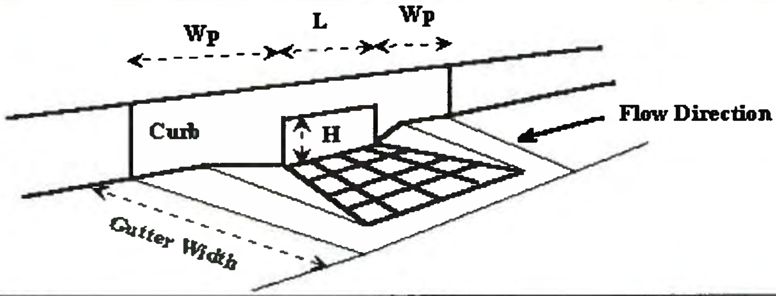
Street Geometry (Input)			
Design Discharge in the Gutter	**Q_o =**	**4.9**	**cfs**
Gutter Width (Cannot Be Less Than Any Grate Width)	W =	2.00	ft
Gutter Depression, if Composite Gutter	a =	4.3	inches
Street Transverse Slope	S_x =	0.0100	ft/ft
Street Longitudinal Slope	S_o =	0.0100	ft/ft
Manning's Roughness	n =	0.017	

Gutter Conveyance Geometry			
Gutter Cross Slope	S_w =	0.1871	ft/ft
Water Spread Width	T =	16.5	ft
Water Depth without Gutter Depression	y =	2.0	inches
Water Depth with a Gutter Depression	d =	6.2	inches
Gutter Conveyance Calculations by HEC-22 Method			
Spread for Side Flow on the Street (T - W)	T_x =	14.5	ft
Discharge outside the Gutter Section W, carried in Section T_x	Q_x =	1.9	cfs
Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)	E_o =	0.61	
Discharge within the Gutter Section W	Q_w =	3.0	cfs
Total Flow Rate by HEC-22 Method	**Q_T =**	**4.9**	**cfs**
Equivalent Street Transverse Slope	S_e =	0.1174	ft/ft
Flow Area	A_s =	1.7	sq ft
Flow Velocity	V_s =	2.8	fps
V_s*d product	**V_s*d =**	**1.5**	**ft^2/s**

NOTE: V_s*d product should be less than 6.0 for minor event and less than 8.0 for major event.

COMBINATION INLET ON A GRADE

Project: Lyon Boulevard Storm Drain Project
Inlet ID: Essex Drive NW



Design Information (Input)			
Type of Grate	Type =	Bar P-1-7/8	
Length of a Single Unit Grate	L_o =	6.67	ft
Width of a Unit Grate (cannot be greater than W from *Street Hy*)	W_o =	2.00	ft
Clogging Factor for a Single Unit Grate (typical value = 0.5)	C_o-G =	0.50	
Clogging Factor for a Single Unit Curb Opening (typical value = 0.1)	C_o-C =	0.10	
Local Depression, if any (not part of upstream Composite Gutter)	a_{local} =	2.8	inches
Total Number of Units in the Combination Inlet	No =	1	
Grate Analysis (Calculated)			
Design Discharge on the Street (from *Street Hy*)	Q_o =	**4.9**	**cfs**
Water Depth for Design Condition	Y_d =	9.0	inches
Total Length of Inlet Grate & Curb Opening	L =	6.67	ft
Ratio of Grate Flow to Design Flow E_o	E_o =	0.61	
Flow Velocity Vs (from *Street Hy*)	V_s =	2.84	fps
Spash-over Velocity V_o: Check Against Flow Velocity V_s	V_o is:	greater than Vs	
Under No-Clogging Condition			
Interception Rate of Gutter Flow	R_f =	1.00	
Interception Rate of Side Flow Rx (from *Street Hy*)	R_x =	0.94	
Interception Capacity	Q_i =	4.8	cfs
Under Clogging Condition			
Clogging Coefficient for Multiple-unit Grate Inlet	Coef =	1.00	
Clogging Factor for Multiple-unit Grate Inlet	Clog =	0.50	
Effective (unclogged) Length of Multiple-unit Grate Inlet	L_e =	3.34	ft
Interception Rate of Side Flow Rx (from *Street Hy*)	R_x =	0.75	
Actual Interception Capacity	Q_a =	**4.4**	**cfs**
Carry-Over Flow = Q_o-Q_a (to be applied to curb opening)	Q_{curb} =	**0.5**	**cfs**
Curb Opening Analysis (Calculated)			
Equivalent Slope S_e (based on grate carry-over)	S_e =	0.1868	ft/ft
Required Length L_T to Have 100% Interception	L_T =	3.49	ft
Clogging Coefficient	Coef =	1.00	
Clogging Factor for Multiple-unit Curb Opening Inlet	Clog =	0.10	
Effective (Unclogged) Length	L_e =	3.49	ft
Under No-Clogging Condition			
Effective Length of Curb Opening Inlet (must be $\leq L_T$)	L =	3.49	ft
Interception Capacity	Q_i =	0.2	cfs
Under Clogging Condition			
Actual Interception Capacity	Q_a =	**0.2**	**cfs**
Carry-Over Flow = Q_{curb}-Q_a =	Q_b =	**0.3**	**cfs**
Capture Percentage = Q_a/Q_o =	C% =	**93.9**	**%**

WILSON
&COMPANY

DESIGN MEMORANDUM

TO: **Reviewer**

FROM: **Mario Juarez-Infante, PE, WCEA**

RE: **Lyon Boulevard Storm Drain Project – Cattle Guard Inlet Capacity**

Given:

L = 45' (width of roadway measure face to face of curb)
Normal depth = 0.67 ft (assumes street is running full)

Find:

Inlet Capacity, Q

Soln:

Capacity of the inlet operates as a *weir* to a depth up to 0.39 ft (American Iron And Steel Institute, *Modern Sewer Design*, 3rd Edition, 1995). The quantity intercepted is expressed by the following:

$Q = 3.0\ L\ D^{1.5}$

Where Q = rate of discharge into the grate opening (ft^3/s)
L = perimeter length of the grate, disregarding bars and neglecting the side against the curb (ft)
D = depth of the water in the grate (ft)

$Q_{inlet} = 3.0 \times 45\ ft \times (0.39\ ft)^{1.5} = 32.88\ ft^3/s$

When the depth exceeds 0.4 ft, the inlet begins to operate as an *orifice* and its discharge is expressed by the following:

$Q = 3.0\ A\ D^{0.5}$

Where Q = rate of discharge into the grate opening (ft^3/s)
A = opening of the grate (ft^2)
D = depth of the water in the grate (ft)

$Q_{inlet} = 3.0 \times (45\ ft \times 3\ ft) \times (0.67 ft)^{0.5} = 331.5\ ft^3/s$ ← Controls, ∴ $Q_{Capacity}$ = 331.5 ft3/s

A portion of Paradise Boulevard will require regarding and paving to accommodate inlet installation and allow for a sump condition sensitive to vehicular traffic.

2600 American Road SE, Suite 100, Rio Rancho, NM 88012 PHONE 505/898-8021 FAX 505/898-8501

FL-DOT Report

Date: 08-18-2004
Frequency: 100 yrs
Proj: Alignment 081804.st

Line No	To Line	Type of struc	n - value	Len (ft)	Drainage Area (C1 = 0.2, C2 = 0.5, C3 = 0.9) Increment (ac)	Sub-total (ac)	Sum CA	Time of conc (min)	Time of flow in sect (min)	Inten (I) (in/hr)	Total CA	Add Q / Total flow Q (cfs)	Inlet elev (ft)	Elev of HGL / Elev of Crown / Elev of Invert Up (ft)	Down (ft)	Fall (ft)	Rise / Span Size (in)	HGL Pipe Slope (%)	Actual Full Flow Vel (ft/s)	Cap (cfs)	Line description
1	End	MH	0.013	88.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	3.02	0.05	0.0	0.00	0.00 758.0	5311.50	5300.47 5300.20 5294.20	5297.65 5297.65 5291.65	2.82 2.55	72 72 Cir	3.21 2.90	26.81 25.50	758.0 721.1	Inserted Line
2	1	MH	0.013	228.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	2.87	0.14	0.0	0.00	0.00 758.0	5316.05	5309.12 5307.01 5301.01	5301.81 5300.40 5294.40	7.31 6.61	72 72 Cir	3.21 2.90	26.81 25.51	758.0 721.2	
3	2	MH	0.013	71.5	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	2.80	0.07	0.0	0.00	111.0 758.0	5317.31	5312.06 5310.42 5302.92	5311.36 5308.51 5301.01	0.70 1.91	90 90 Cir	0.98 2.67	17.16 28.42	758.0 1255.4	
4	3	MH	0.013	429.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	2.32	0.49	0.0	0.00	12.00 647.0	5322.80	5318.84 5319.85 5312.35	5312.51 5310.42 5302.92	6.33 9.43	90 90 Cir	1.47 2.20	15.29 25.78	647.0 1138.7	
5	4	MH	0.013	500.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	1.74	0.58	0.0	0.00	0.00 635.0	5341.14	5322.17 5323.34 5315.84	5319.63 5319.85 5312.35	2.54 3.49	90 90 Cir	0.51 0.70	15.23 14.52	635.0 641.7	
6	5	MH	0.013	615.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	1.02	0.71	0.0	0.00	19.00 635.0	5343.86	5327.55 5325.19 5317.69	5323.34 5323.34 5315.84	4.21 1.85	90 90 Cir	0.68 0.30	14.37 9.54	635.0 421.3	
7	6	MH	0.013	770.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.10	0.92	0.0	0.00	212.0 616.0	5342.29	5333.14 5327.50 5320.00	5328.19 5325.19 5317.69	4.96 2.31	90 90 Cir	0.64 0.30	13.94 9.52	616.0 420.7	
8	7	MH	0.013	88.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00	0.10	0.0	0.00	404.0 404.0	5342.74	5334.70 5329.72 5323.72	5333.90 5327.60 5321.60	0.80 2.12	72 72 Cir	0.91 2.41	14.29 23.25	404.0 657.5	

NOTES: Intensity = 127.16 / (Inlet time + 17.80) ^ 0.82 (in/hr) ; Time of flow in section is based on full flow.

FL-DOT Report

Line No	To Line	Type of struc	n - value	Len	Drainage Area C1 = 0.2 C2 = 0.5 C3 = 0.9			Time of conc	Time of flow in sect	Inten (I)	Total CA	Add Q / Total flow	Inlet elev	Elev of HGL / Elev of Crown / Elev of Invert			Rise / Span	HGL / Pipe	Actual / Full Flow		Date: 08-18-2004 / Frequency: 100 yrs / Proj: Irving Boulevard.stm
				(ft)	Incre-ment (ac)	Sub-total (ac)	Sum CA	(min)	(min)	(in/hr)		Q (cfs)	(ft)	Up (ft)	Down (ft)	Fall (ft)	Size (in)	Slope (%)	Vel (ft/s)	Cap (cfs)	Line description
1	End	MH	0.013	100.0	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00	0.00	0.13	0.0	0.00	161.0 161.0	5317.31	5313.26 5311.00 5307.00	5312.00 5309.00 5305.00	1.26 2.00	48 48 Cir	1.26 2.00	12.81 16.17	161.0 203.1	

NOTES: Intensity = 127.16 / (Inlet time + 17.80) ^ 0.82 (in/hr) ; Time of flow in section is based on full flow.

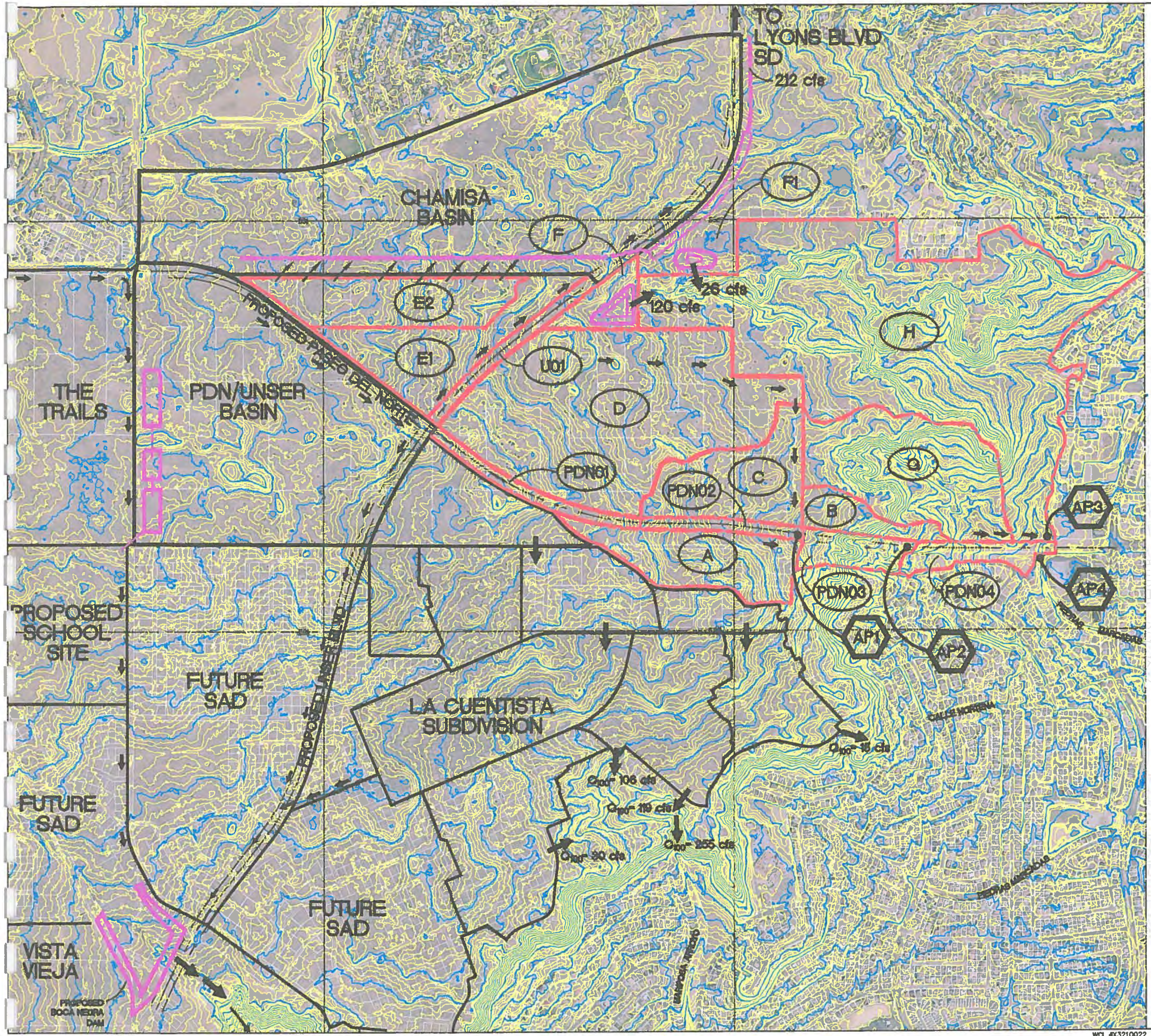


TABLE A

BASIN SUMMARY

BASIN	AREA (sq mi)	AREA (ac)	%A	%B	%C	%D	Q100 (cfs)	VOL100 (ac-ft)
A	0.060	37.63	0	15	35	50	99.7	4.168
B	0.022	13.53	100	0	0	0	14.8	0.419
C	0.064	40.14	0	10	10	80	139.5	5.550
D	0.235	146.62	0	10	10	80	383.6	20.378
E1	0.068	42.38	0	15	35	50	101.5	4.724
E2	0.064	39.78	0	15	35	50	103.1	4.446
F	0.019	12.18	0	10	40	50	37.3	1.336
F1	0.020	12.50	0	60	40	0	26.0	
G	0.106	66.08	100	0	0	0	72.7	2.019
H	0.391	244.67	100	0	0	0	255.4	7.446
U01	0.015	9.27	0	10	0	90	34.3	1.385
PDN01	0.016	10.08	0	10	0	90	36.6	1.477
PDN02	0.011	7.00	0	10	0	90	25.2	1.015
PDN03	0.020	12.66	0	10	0	90	45.7	1.846
PDN04	0.019	11.82	0	10	0	90	43.4	1.754
TOTAL	1.130	706.34						

TABLE B

ANALYSIS POINT SUMMARY

AP#	Q100 (cfs)
AP1	625.7
AP2	666.3
AP3	326.0
AP4	965.3

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PUBLIC WORKS DEPARTMENT
ENGINEERING GROUP

PASEO DEL NORTE
DEVELOPED OVERALL DRAINAGE BASIN MAP

FIGURE 3

WCI #X3210022
AUGUST 2004