Revised

Drainage Report
for
The Trails at Seven Bar
South Subdivision

May 3, 1993

DRAINAGE REPORT FOR THE TRAILS AT SEVEN BAR SOUTH SUBDIVISION

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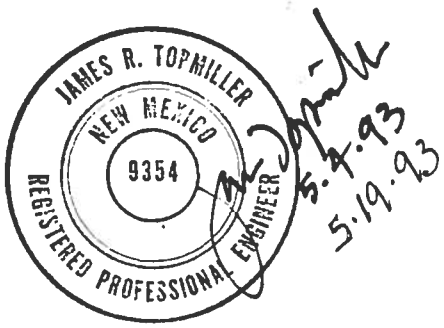


TABLE OF CONTENTS

Page

INTRODUCTION/PURPOSE OF REPORT 1

STUDY METHODOLOGIES 2

EXISTING SITE CONDITIONS 2
- Legal Description 2
- Topography and Existing Drainage Patterns 2
- Drainage Facilities 3

PROPOSED DEVELOPMENT 3

HYDROLOGIC ANALYSIS 4

DRAINAGE MANAGEMENT PLAN 6
- Drainage Master Plan 6

DRAINAGE MASTER PLAN SUMMARY 9

PHASE SUMMARY 10

CALABACILLAS ARROYO 11

CONCLUSION 12

APPENDICES

APPENDIX 1 VICINITY MAP, SOILS MAP, FLOODPLAIN MAP

APPENDIX 2 HYDROLOGIC COMPUTATIONS

APPENDIX 3 GENERAL HYDRAULIC CALCULATIONS - THE TRAILS AT SEVEN BAR SOUTH SUBDIVISION

APPENDIX 4 GENERAL HYDRAULIC CALCULATIONS - CALABACILLAS STORM DRAIN OUTFALL

APPENDIX 5 GENERAL HYDRAULIC CALCULATIONS - SEVEN BAR LOOP ROAD

APPENDIX 6 QUALITATIVE EROSIONAL STUDY - CALABACILLAS ARROYO

APPENDIX 7 CORRESPONDENCE AND REPORT SUBMITTED TO SOIL CONSERVATION SERVICE REGARDING DISCHARGE TO THE BLACK'S DIVERSION CHANNEL

PLATES

1 EXISTING DRAINAGE PLAN

2 DRAINAGE MASTER PLAN

3 SUBDIVISION DRAINAGE BASIN MAP (PROPOSED DEVELOPED CONDITIONS)

4 SUBDIVISION SITE GRADING AND DRAINAGE PLAN - SHEET 1 OF 2

5 SUBDIVISION SITE GRADING AND DRAINAGE PLAN - SHEET 2 OF 2

6 CALABACILLAS ARROYO STORM DRAIN OUTFALL - PLAN AND PROFILE

7 SEVEN BAR LOOP ROAD DRAINAGE PLAN - PLAN AND PROFILE - SHEET 1 0F 2

8 SEVEN BAR LOOP ROAD DRAINAGE PLAN - PLAN AND PROFILE - SHEET 2 OF 2

9 CALABACILLAS COURT DRAINAGE PLAN - PLAN AND PROFILE

10 PRELIMINARY PLAT (FOR TRACTS L-1 AND L-2)

INTRODUCTION/PURPOSE OF REPORT

This report presents (1) a Drainage Master Plan for proposed Tracts L-1 and L-2 of the Trails at Seven Bar South Subdivision (Tract N-2A-1) and Tract N-2A-2, Seven Bar Ranch, and (2) detailed drainage plan for the proposed subdivision of Tract L-2 into a 177 unit, single family residential subdivision. Tracts L-1 and L-2 of the Trails at Seven Bar South Subdivision are located in the southwest corner of Seven Bar Loop Road and Coors Bypass Road intersection. Tract L-1 is proposed to be a multi-family (apartment) site containing approximately 21 acres of currently undeveloped property. Tract L-2 is proposed to be a single family residential subdivision containing approximately 36 acres; this land is also currently undeveloped property. The multi-family tract is zoned SU for R-2 uses, and the single family residential tract is zoned R-T.

The purpose of this report is to obtain drainage report approval for the following:

- Approval of the Drainage Master Plan for Tract N-2A-2, L-1, and L-2.
- Preliminary Plat approval for the platting of Tract L-1 as a single tract of land, and Tract L-2 as a 177 unit, single family phased residential subdivision (see enclosed preliminary plat, DRB-93-022).
- Final plat approvals will be subject to City Hydrology's receipt and approval of final grading plans for each individual phase of development (as such phases are described in the preliminary plat enclosed).

Due to the location of this property, with respect to property owners and affected governmental agencies, the following entities are reviewing and being made a part of this report:

- City of Albuquerque Housing Services Division (Ms. Sylvia Fettes).
- Soil Conservation Services (Black Diversion Channel)
- AMAFCA (Calabacillas Arroyo)

The lead review agency for this drainage report is the Hydrology Division of the City of Albuquerque.

STUDY METHODOLOGIES

Site hydrological conditions will be analyzed for the 100-year, 6-hour storm event using the City of Albuquerque's Development Process Manual with revisions to Chapter 22, in accordance with those proposed to the DPM Steering Committee, dated January 1993.

EXISTING SITE CONDITIONS

The following provides information on the existing hydrological conditions of the property of this report.

Legal Description

The existing legal description of the property described within this report is Tract N-2A-1 (proposed Tracts L-1 and L-2) and Tract N-2A-2, Seven Bar Ranch (described as Tract K in the Seven Bar Ranch Sector Plan).

Topography and Existing Drainage Patterns

The natural topography of the Drainage Master Plan area varies significantly by site. Tract N-2A-1 has a mildly sloping ground with approximately 2% to 3% slopes. Drainage is sheet flow in a predominately easterly direction towards Coors Bypass Road and the east boundary of Tract L-1. Vegetation is light, low-lying grasses and shrubs. Soils are sandy and easily erodible. The remains of an abandoned asphalt airport runway exist on this property.

Tract N-2A-2 currently drains in a sheet-flow fashion in a predominately southeasterly direction at slopes of approximately 4% to 5%. Soil and vegetation conditions are identical to those found on Tract N-2A-1. Storm drainage runoff from this tract crosses the existing right-of-way of Seven Bar Loop Road and enters the runoff of Tract N-2A-1.

Sheet 1 of 2, enclosed in the pocket located at the back of this report, identifies the existing drainage conditions of this site. Three primary basins exist: The north basin, enclosing all of Tract N-2A-2 and the northerly portion of N-2A-1, yields a flow rate of approximately 52 cfs in the 100-year, 6-hour storm event; a small center basin, entirely enclosed by Tract N-2A-1, currently flows at approximately 10.5 cfs; and the south basin,

enclosed by Tract N-2A-1, yields an existing flow rate of approximately 44.9 cfs. As described above, all these basins drain to Coors Bypass Road.

Drainage Facilities

Several existing drainage facilities, that either serve or are in a position to serve this property, are located in the area. The AMAFCA Black Diversion Channel is located on the northwest line of Tracts N-2A-1 and N-2A-2. This perched channel is a concrete lined, rectangular box structure currently maintained and managed by AMAFCA but owned and originally constructed by the Soil Conservation Service. The Calabacillas Arroyo is an unlined and partially improved arroyo located on the southwestern boundary of Tract N-2A-1 (proposed Tract L-2) . This major arroyo is overlaid by an existing AMAFCA drainage easement. Finally, an existing 30" RCP storm drain has been extended to immediately south of the southeast corner of Tract N-2A-1 (proposed Tract L-1).

PROPOSED DEVELOPMENT

The drainage master plan area is proposed to be divided into three residential developments:

- The Trails at Seven Bar South Subdivision is a proposed subdivision of Tract N-2A-1 into two tracts. The western portion of Tract N-2A-1 (identified as Tract L-2) will consist of 177 single family detached homes on lots with minimum dimensions of 45 feet wide by 105 feet deep and is proposed to be developed in three phases. This project will consist of public streets, public underground utilities and public underground drainage facilities. Primary access will be obtained from two entrances off Seven Bar Loop Road, which is a proposed public street extended west from the Coors Boulevard Bypass. The southern half of Seven Bar Loop Road will be constructed during the development of this project.

- Tract L-1 is a proposed subdivision of the eastern portion of Tract N-2A-1. At this time this tract is intended for a future multi-family development. This project will probably consist of private drives and parking areas, privately

maintained surface drainage and common areas, and public underground utilities and public underground drainage facilities. Primary access will be obtained from an entrance on Coors Bypass and on Seven Bar Loop Road, a proposed public street extended west from the Coors Boulevard Bypass. The southern half of Seven Bar Loop Road will be constructed during the development of the Trails at Seven Bar South Subdivision.

- Tract N-2A-2 lies to the north of Seven Bar Loop Road and is owned by the City of Albuquerque. At this time the tract is intended for single family development. This project will probably consist of public streets and public maintained surface drainage and common areas, and public underground utilities and public underground drainage facilities. Primary access will be obtained from two entrances off Seven Bar Loop Road, a proposed public street extended west from the Coors Boulevard Bypass. The northern half of Seven Bar Loop Road will be constructed during the development of this project.

HYDROLOGIC ANALYSIS

The new rational method hydrologic procedures identified within the proposed revision to Chapter 22, Section 22.2 of the Development Process Manual (DPM Update), are utilized to determine peak flow rates for design of the storm drainage improvements within the projects. The 100-year, 6-hour storm is used as the design event.

For the purposes of this analysis, the developed master plan area falls within four general drainage basins: one in the Cabezon Channel watershed (flows in Coors Bypass) and three in the Calabacillas Arroyo watershed. The basins identified below refer to Plate 2 - the Drainage Master Plan.

1. The eastern portion of Tract N-2A-2 (Basin D), the eastern portion of the Seven Bar Loop right-of-way (Basin F) and the northern portion of the western half of the Coors Boulevard Bypass right-of-way (Basin I) together generate fully developed runoff of 18.3 cfs (3.3 cfs + 9.4 cfs + 5.6 cfs, respectively) that ultimately flow north in a storm drain in the Coors Bypass to the detention pond

adjacent to Cibola High School and eventually into the Cabezon Channel. This flow is less than the 18.5 cfs allowed from these basins in the SAD 223 Drainage Management Plan of August 1992. The storm drain and detention pond are proposed with the construction of SAD 223 improvements.

2. The southern portion of the western half of the Coors Boulevard Bypass right-of-way (Basin J) generates a fully developed runoff of 4.5 cfs and flows south into the Coors Boulevard Bypass storm drain system where it eventually discharges into the Calabacillas Arroyo. This runoff, and its collection, has been designed as a part of the SAD 223 - Part 3 plans. No improvements to the existing pavement section in Coors Boulevard Bypass will be made with this development.

3. The western portion of Tract N-2A-2 (Basin C) and the western portion of the Seven Bar Loop right-of-way (Basin E) together generate a fully developed runoff of 63.8 cfs (59.7 cfs + 4.1 cfs, respectively) that is proposed to be conveyed into the Black's Diversion Channel which empties into the Calabacillas Arroyo.

4. The remaining basins that comprise the whole of Tract N-2A-1 (Basins A, B, G and H) together generate a fully developed runoff of 191.8 cfs (115.1 cfs + 71.9 cfs + 2.3 cfs + 2.5 cfs, respectively) that is proposed to be routed and discharged directly into the Calabacillas Arroyo. Basin K generates 4.5 cfs that will be detained in the basin, then discharged to Coors Bypass in a controlled manner when SAD #223 improvements are complete.

Please refer to Tables 1 and 2 in Appendix 2, and Plate 2 for a detailed summary of hydrological parameters and basin characteristics.

DRAINAGE MANAGEMENT PLANS

For the purposes of the drainage management plan, the four general drainage basins above will again be used. Two sets of phasing will be used in the discussion below: "Master

Plan Phase" will refer to the phasing shown on Plate 2 - Drainage Master Plan, and "Subdivision Phase" will refer to the phasing of the Trails at Seven Bar South Subdivision as shown in Plates 3, 4 and 5.

Drainage Master Plan

The following describes the drainage master management plan for Tracts N-2A-1 and N-2A-2:

1. **Seven Bar Loop Road** - Under Master Plan Phase 1, the south half (eastern portion) of Seven Bar Loop Road will be built and will convey the street flow east to an inlet at the intersection with Coors Blvd. Bypass. A swale will be constructed in the north half of the Seven Bar Loop right-of-way to convey the undeveloped flow from Basins D and F east to an inlet at the intersection with Coors Blvd. Bypass. Both of these flows will then be conveyed to the temporary Public Retention Pond #2 on Basin K. This pond will be sized to accommodate twice the developed condition volume of a 100-year storm from Basins D, F and K. The flows from Basin I will be unchanged from the historical condition and will continue to flow north in an existing swale.

   As a part of Master Plan Phase 2, the north half (eastern portion) of Seven Bar Loop Road will be constructed and Tract N-2A-1 and will be developed for single family housing. Now the north half of Seven Bar Loop Road will convey the developed flows east to the existing inlet (although now modified) at the intersection with Coors Blvd. Bypass. As before, the flows will be collected and retained in the temporary Retention Pond #2.

   Under Master Plan Phase 1, the south half (western portion) of Seven Bar Loop Road will be built and will convey the street flow east to inlets located approximately 1400 feet west of the intersection with Coors Blvd. Bypass. The piped flows from these inlets will temporarily discharge into a swale to be constructed in the north half of the Seven Bar Loop right-of-way. This swale will also convey the undeveloped flow from Basins C and E east to a temporary

culvert that will cross south under Seven Bar Loop Road and into the temporary Retention Pond #1 on Tract L-1. This pond will be sized to accommodate twice the developed condition volume of a 100-year storm from Basin E and twice the undeveloped volume from Basin C.

As a part of Master Plan Phase 2, the north half (western portion) of Seven Bar Loop Road will be constructed and Tract N-2A-1 will be developed for single family housing. Now the north half of Seven Bar Loop Road will convey the developed flows east to new inlets located approximately 1400 feet west of the intersection with Coors Blvd. Bypass. As currently planned, a 42" storm drain will be constructed in Seven Bar Loop Road to convey all the developed flows from Basins C and E west and into the Black's Diversion Channel. The Black's Diversion Channel was designed by the Soil Conservation District but is currently operated and maintained by AMAFCA. In an analysis that was submitted to the SCS, it was shown that the addition of flows to the Black's Diversion Channel from a storm drain in the Seven Bar Loop Road would not adversely impact the peak flow in the channel due to the 48 minute difference in the respective times to peak. The SCS concurred with this conclusion and the correspondence can be found in Appendix 6. A preliminary design for the storm drain system in Seven Bar Loop Road can be found in Plate 7. The Retention Pond #1 will be removed and the culvert to it plugged.

As currently planned, the development of Tract L-1, under Master Plan Phase 3, will not have any impact on Basins C and E, on Seven Bar Loop Road. However, should the storm drain connection to the Black's Diversion Channel not be permitted, then provisions shall be made to accommodate all the developed flow from Basins C and E by routing it in a public drainage easement through Tract L-1 (adjacent to Coors Bypass) to the storm drain now proposed at the southern edge of Tracts L-1 and L-2 and discharge it into the Calabacillas Arroyo.

The improvements planned to Coors Bypass (SAD 223) under the Master Plan Phase 4 will have no effect on Basins C and E, or Seven Bar Loop Road.

The development of Tract L-1 for multi-family housing as a part of Master Plan Phase 3 will not impact this general basin other than possible landscaping improvements to the Retention Pond #2.

2. **Coors Boulevard Bypass Road** - Master Plan Phase 4 consists of the construction, by others, of improvements to the Coors Blvd. Bypass according to the SAD 223 - Part 3 plans. The flow from Basins D and F in Seven Bar Loop Road will be collected in the existing inlets in Seven Bar Loop Road but will now be conveyed to a manhole that is a part of a storm drain system in the Coors Blvd. Bypass. The developed flow from Basin I will now fall under the SAD 223 drainage improvements. Retention Pond #2 can be substantially reduced in size with the diversion of flows to the SAD 223 system.

   The flows from Basin J will continue to flow south in the new curb until intercepted by the existing storm drain system in the Coors Blvd. Bypass and eventually discharged into the Calabacillas Arroyo. As a part of the Master Plan Phase 4, the Coors Blvd. Bypass street project will be constructed by others to include drainage improvements for Basin J. The construction of Seven Bar Loop Road in Master Plan Phase I substantially reduced the amount of runoff reaching Coors Bypass.

3. **Tracts L-1 and L-2, Trails at Seven Bar South Subdivision** - As a part of the Master Plan Phase 1 development, a storm drain system will be built from the southwestern most corner of Tract L-1 to an outfall in the Calabacillas Arroyo. This system will be designed to accept all the developed flows from Basins A, B, C, E, H and G, although the flows from Basins C and E are planned to the Black's Diversion Channel. A swale will be provided to convey the flow from Tract L-3 (Basin H) south to the access easement and then northeasterly down to the storm drain inflow. The design of the outlet structure at the Calabacillas

Arroyo will be approved by AMAFCA and the storm drain/outfall configuration has been shown in Plate 6. AMAFCA has given preliminary approval to the outfall and suggests that they may be able to maintain the outfall structure. Retention Pond #1 will be constructed on Tract L-1 but it will not affect the drainage in Basin B. Basin B will be allowed free (undeveloped) discharge into the Coors Blvd. Bypass right-of-way until such time that Tract L-1 is developed (Master Plan Phase 3). This discharge however, reduced from pre-Seven Bar Loop street flows.

The improvements planned under the Master Plan Phase 2 as part of the development of Tract N-2A-2 will have no effect on Basins B, H or G, unless a connection to the Black's Diversion Channel by a storm drain in Seven Bar Loop Road is not permitted (see Section 2 above).

Under the Master Plan Phase 3, most of the developed flows of Tract L-1 (Basin B) will be graded to provide positive surface drainage to the storm drain system inlet at the southwest corner of Tract L-1. It will then be conveyed to the Calabacillas Arroyo. The surface drainage may be replaced by an underground storm drain system, the configuration of which will be determined at the time of the development of Tract L-1, with the provision that all the developed flow be conveyed to the storm drain system.

The improvements planned under the Master Plan Phase 4 (Coors Bypass improvements) will have no effect on Basins B, H or G.

DRAINAGE MASTER PLAN SUMMARY

The following outline describes required drainage infrastructure construction by phase:

Phase 1

Multi-phase residential development of Tract L-2.

Construction of south half of Seven Bar Loop pavement.

Construction of Retention Ponds #1 and #2.

Construction of storm drain system and outfall to Calabacillas Arroyo.

Phase 2

Residential Development of Tract N-2A-2.

Construction of north half of Seven Bar Loop Pavement.

Construction of storm drain system in Seven Bar Loop Road.

Removal of Retention Pond #1.

Phase 3

Multi-Family Development of Tract L-1.

Removal of Retention Pond #2 by developer of Tract L-1.

Extention of Storm Drain System north of Seven Bar Loop Road per SAD #223 to collect flows from Seven Bar Loop Road.

Construction of Graded Swale (or other On-Site Drainage System) across Tract L-1.

Phase 4

Construction of Coors Boulevard Bypass per SAD #223 Plans.

B. SUBDIVISION OF TRACT L-2

Under the Master Plan Phase 1, the Trails at Seven Bar South Subdivision will be developed in three subdivision phases as shown Plate 3. Subdivision Phase 1 consists of Basins A1 and A2. The flows from these basins will be conveyed in the street to two temporary retention ponds that are sized to contain twice the developed condition volume from these basins. The required pond volumes are 1.26 acre-feet and 0.58 acre-feet respectively for Basins A-1 and A-2.

Subdivision Phase 2 consists of Basins A6, A7, A8 and A9. The temporary retention ponds from Subdivision Phase 1 will be removed and the streets within the subdivision project will convey runoff to the intersection of Arroyo Crest Drive, Arroyo Bend Drive and Calabacillas Court, where it will be intercepted by a proposed storm sewer system within these three streets and conveyed to the proposed 48" and 54" storm drain system at the southern boundary of the tract as shown in Plates 6 and 8. This storm drain system and outfall to the Calabacillas Arroyo will be constructed as part of Subdivision Phase 2 development.

Subdivision Phase 3 will complete the Trails at Seven Bar South Subdivision with the additions of Basins A3, A4 and A5. No additional storm drain improvements will be required

for this phase, and all the flow will be conveyed in the street right-of-way to the intersection of Sand Sage Road and Arroyo Crest Drive.

Prior to final plat and construction plan approvals, final grades and construction details for the individual phases described above will be supplied to the City's Hydrology Division.

PHASE SUMMARY (SUBDIVISION)

Please refer to the Basins Map (Plate 3) for the following discussion.

Phase 1 consists of the development of 40 single family lots and their required streets in Basins A-1 and A-2. As described above, the flows from these basins will be routed to two retention ponds located approximately where Arroyo Bend Drive and Arroyo Crest Drive end at the phase boundary. These ponds are sized to contain twice the developed volume from each basin and will remain in place until the storm drain system in Phase 2 is complete.

Phase 2 consists of the development of 69 single family lots and their required streets that lie within Basins A-6, A-7, A-8 and A-9. At this time, a storm drain system will be constructed to intercept flows at the intersection of Arroyo Bend Drive, Arroyo Crest Drive and Calabacillas Court, and convey them to the storm drain in the drainage easement (also being constructed as a part of this phase) and then to the Calabacillas Arroyo. After completion of this storm drain system, the temporary retention ponds from Phase 1 will be removed.

Phase 3, the last phase, will consist of the development of 68 single family lots and the remaining streets that lie within Basins A-3, A-4 and A-5. Since all the drainage from these basin can be contained in the street flows and the storm drain system for this subdivision were constructed as a part of Phase 2 development, no other drainage improvements will be required for the development of Phase 3.

HYDRAULIC ANALYSIS

The storm sewer system internal to the Trails at Seven Bar South Subdivision is analyzed using current DPM methods for pressure flow conditions. Inlet capacity computations along with all hydraulic computations are included in Appendix 3. The inlet at the cul-de-sac of Calabacillas Court is in a sump condition and is also provided with emergency overflow spillway swale in the drainage easement which flows to the manhole grate/inlet on the 48" storm drain that flows into the Calabacillas Arroyo.

The storm sewer in Seven Bar Loop Road is analyzed using current DPM methods for pressure flow conditions. Inlet capacity computations along with all hydraulic computations are included in Appendix 4.

Street capacities have been analyzed and the results are provided in the Appendix. All flows in the 100-year storm event are confined in the curb.

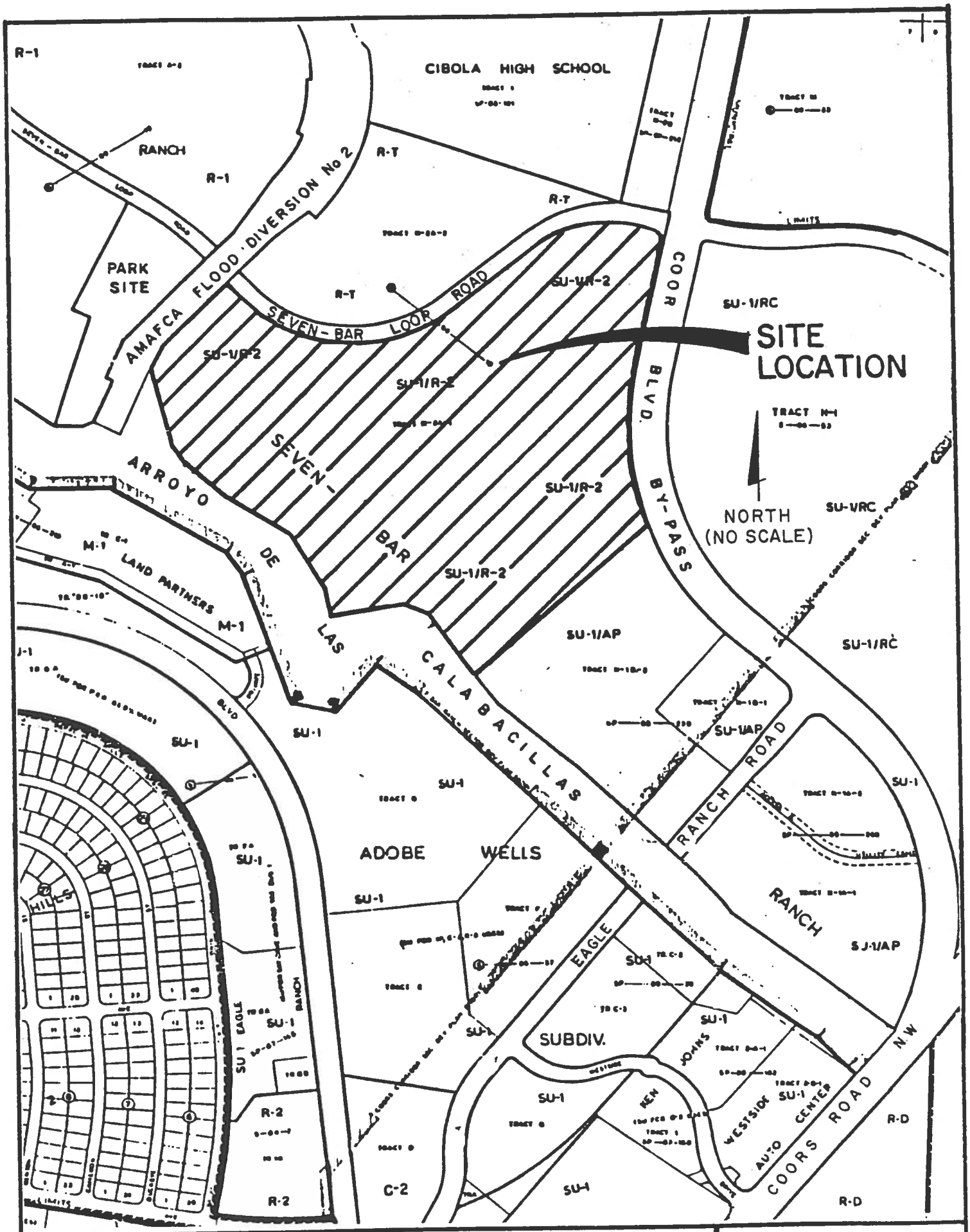
CALABACILLAS ARROYO

AMAFCA is currently reviewing a "Qualitative Study" of the existing prudent line along the north bank of the Calabacillas Arroyo. The study qualitatively concludes, via a review of the existing arroyo conditions as opposed to the arroyo conditions reviewed by the Simons-Li/AMAFCA Study (which established the current prudent line), that the existing prudent line continues to be satisfactory for defining development limits. AMAFCA's approval is anticipated in the near future.

CONCLUSION

The drainage management concepts presented in this report for both the Master Plan area, in general, and the imminent development of the single family residential development (Tract L-2) are both adequate and equitable to all concerned parties.

Approval of this report is recommended.



VICINITY MAP

MAP 1

DRAINAGE MASTER PLAN

HYDROLOGICAL FORMULAS

FROM SECTION 22.2 OF DPM - JANUARY 1993 UPDATE

EXISTING CONDITIONS = (CALCULATION OF Tp SPREADSHEET)

SITE HAS NATURAL CHANNEL WITH SLOPES > 4%

$$\text{GROUND SLOPE} = S = \frac{(L1)(S1)+(L2)(S2)+(L3)(S3)}{(L1+L2+L3)}$$

$$\text{ADJUSTED SLOPE} = S' = (0.052467)+(0.063627)(S)-(0.18197)\left(e^{(-62.375)(S)}\right) \qquad \text{b-10}$$

$$K''' = (0.207)\left(\frac{1}{\sqrt{S}}\right)(Q_p^{(0.15)}) \quad \text{WHERE } Q_p = \text{ESTIMATE PEAK FLOW} \qquad \text{b-11}$$

$$K'' = (0.302)\left(\frac{1}{\sqrt{S}}\right)(Q_p^{(0.15)})$$

$$K' = \frac{\left(\frac{L}{\sqrt{S}}\right)}{\left(\frac{L1}{K\sqrt{S_1}}\right)+\left(\frac{L2}{K\sqrt{S}}\right)+\left(\frac{L3}{K\sqrt{S_3}}\right)}$$

t_c = FORMULA b-1 FOR $L < 4000'$

= FORMULA b-6 FOR $4000' < L < 12{,}000'$

= FORMULA b-8 FOR $12{,}000' < L$

$$\text{INTENSITY } (I) = 0.726\left(\log_{10}(24.6 * t_c)\right)\left(\frac{1}{t_c}\right)(P_{60}) \qquad \text{a-12}$$

RATIONAL METHOD "C" = $(\%A)(0.27)+(\%B)(0.43)+(\%C)(0.61)+(\%D)(0.93)$ TABLE A-11

(ZONE 1)

-FOR THE 100-YEAR, 6-HOUR STORM

DEVELOPED CONDITIONS

-FOR SMALL WATERSHEDS, $t_p = 12$ MINUTES

$t_c = 8$ MINUTES

RATIONAL METHOD "C" = $(\%A)(0.27)+(\%B)(0.43)+(\%C)(0.61)+(\%D)(0.93)$

-FOR THE 100-YEAR 6-HOUR STORM

"C" = $(\%A)(0.08)+(\%B)(0.24)+(\%C)(0.47)+(\%D)(0.72)$

-FOR THE 10-YEAR 6-HOUR STORM (STREET FLOW ANALYSIS)

BOHANNAN-HUSTON INC.

PROJECT NAME SEVEN BAR RANCH SHEET 1 OF 2

PROJECT NO. 9229246 BY DF DATE

SUBJECT HYDROLOGY CH'D DATE

HYDROLOGICAL FORMULAS (CONT'D)

DEVELOPED CONDITIONS (CONT'D)

EXCESS PRECIPITATION: $E_c = (\%A)(0.44) + (\%B)(0.67) + (\%C)(0.95) + (\%A)(1.97)$ TAB A-8

VOLUME (100 YEAR) $= (\text{AREA}_{\text{TOTAL}})(E_c)$

BOHANNAN-HUSTON INC.

PROJECT NAME SEVEN BAR RANCH SHEET 2 OF 2

PROJECT NO. 922946 BY DF DATE

SUBJECT HYDROLOGY CH'D DATE

Seven Bar Ranch Conceptual Drainage Plan
Calculation of Time to Peak - Existing Conditions
Revised DPM procedure - 100-year, 6-hour Storm

Description	Var.	Unit	Basins North	Basins Center	Basins South
Basin					
Basin Area		Acres	35.15	6.92	38.3
Total Reach	L	Feet	1950.0	1450.0	2170.0
Overland Reach	L1	Feet	400.0	400.0	600.0
Overland K	K1		0.7	0.7	0.7
Overland Slope	S1	Percent	4.81	1.55	1.12
Adj. Overland Slope	S1'	Percent	4.647	1.550	1.120
Gully Reach	L2	Feet	800.0	500.0	420.0
Gully K	K2		2.000	2.000	2.000
Gully Slope	S2	Percent	1.630	1.610	2.020
Adj. Gully Slope	S2'	Percent	1.630	1.610	2.020
Arroyo Reach	L3	Feet	750.0	550.0	1150.0
Arroyo K	K3		3.000	3.000	3.000
Arroyo Slope	S3	Percent	2.030	1.120	1.420
Adj. Arroyo Slope	S3'	Percent	2.030	1.120	1.420
Lca	Lca	Feet	-	-	-
Base Discharge	Q	cfs	49.56	11.06	55.80
Ground Slope S	S	Percent	2.436	1.408	1.453
Adjusted Slope S'	S'	Percent	2.436	1.408	1.453
K	K		1.667	1.474	1.407
K'	K'		1.657	1.474	1.407
K''	K''		3.906	3.923	5.167
K'''	K'''		2.678	2.689	3.542
Kn	Kn		0.033	0.033	0.033
Orig. Tc	TC	Hrs.	0.208	0.230	0.355
Adjusted Tc	Tc'	Hrs.	0.208	0.230	0.355
Adjusted Tc	Tc'	Min.	12.49	13.82	21.32
Time Lag	Lg	Hrs.	-	-	-
Time to Peak	TP	Hrs.	0.139	0.154	0.237
Intensity	I	in/hr	4.63	4.44	3.60

Calculation of Intensity - Existing Conditions
Revised DPM procedure - 100-year, 6-hour Storm

Intensity (I)=0.726(log(0.41*Tc'))*(60/Tc')^P60

TRACT L-2 - THE TRAILS @ SEVEN BAR SUBDIVISION

BASIN TREATMENTS

BASIN	NUMBER OF 45' LOTS	NUMBER OF 50' LOTS	NUMBER OF 55' LOTS	PAVED AREA (FT^2)	TOTAL AREA (AC)	%D	%C	%B	%A
A-1	12	8	7	29,785	5.36	53.3	20.8	20.8	5.1
A-2	5	4	2	17,795	2.58	47.2	24.4	24.4	4.0
A-3	8	10	6	19,305	4.35	51.6	21.7	21.7	5.0
A-4	8	19	8	41,869	7.32	49.4	23.1	23.1	4.4
A-5	0	2	4	9,360	1.33	52.6	21.7	21.7	4.0
A-6	6	4	6	16,639	3.36	47.4	24.1	24.1	4.4
A-7	8	6	6	22,523	4.05	49.8	22.8	22.8	4.6
A-8	12	6	1	18,720	3.26	54.7	20.0	20.0	5.3
A-9	4	3	7	12,452	2.89	47.5	24.0	24.0	4.5

NOTES: 1) $\%D = \dfrac{(\#\text{ 45' LOTS})(2955\#) + (\#\text{ 50' LOTS})(3300\#) + (\#\text{ 55' LOTS})(3645\#) + \text{PAVED AREA}}{\text{TOTAL AREA}}$

%A - ASSUME 400# OF NATURAL VEGITATION PER LOT

%C, %B - SPLIT THE REMAINDER FOR LANDSCAPING

2) REFER TO PLATE 1 FOR BASIN LOCATION

BOHANNAN-HUSTON INC.

PROJECT NAME Seven Bar Ranch SHEET 2 OF 3

PROJECT NO. 92292416 BY DF DATE

SUBJECT Tract L-2 Hydrology CH'D DATE

A2-5

A7-1

HYDROLOGIC BASIN SUMMARY DATA - 100 YEAR STORM
SEVEN BAR RANCH

FILE: CDP:[C9229240.HYMO]SUBDIVBASIN.W20
JN: 9229240
DATE: MAY 17, 1993

100% DEVELOPED CONDITIONS

BASIN ID	AREA (ac)	COMPOSITE % LAND TREATMENTS A	B	C	D	RATIONAL METHOD COMPOSITE C	RATIONAL METHOD INTENSITY I(in/hr)	RATIONAL METHOD RUNOFF Q-100(cfs)	COMPOSITE EXCESS PRECIP. E	RATIONAL METHOD VOLUME V-100(ac-ft)
A-1	5.36	5	21	21	53	0.73	4.70	18.3	1.42	0.63
A-2	2.58	4	24	24	47	0.70	4.70	8.5	1.35	0.29
A-3	4.35	5	22	22	52	0.72	4.70	14.7	1.40	0.51
A-4	7.32	4	23	23	49	0.71	4.70	24.5	1.38	0.84
A-5	1.27	4	22	22	53	0.73	4.70	4.3	1.41	0.15
A-6	3.36	4	24	24	47	0.70	4.70	11.1	1.35	0.38
A-7	4.05	5	23	23	50	0.71	4.70	13.6	1.38	0.47
A-8	3.26	5	20	20	55	0.73	4.70	11.2	1.43	0.39
A-9	2.68	5	24	24	48	0.70	4.70	8.9	1.35	0.30
TOTAL:	34.22						TOTAL:	115.04		3.96

RETENTION PONDS - ALL TEMPORARY

POND #1 (MASTER DRAINAGE PLAN)

- TO BE SIZED TO RETAIN 200% OF THE 100-YEAR VOLUME FROM BASINS C (UNDEVELOPED) AND E (DEVELOPED)

$V_{100,C}$ = 0.57 AC-FT

$V_{100,E}$ = 0.15 AC-FT

0.72 AC-FT × 2 = 1.44 AC-FT MIN SIZE

1.59 AC-FT PROVIDED

POND #2 (MASTER DRAINAGE PLAN)

- TO BE SIZED TO RETAIN 200% OF THE 100-YEAR VOLUME FROM BASIN D (UNDEVELOPED) AND F (DEVELOPED)

$V_{100,D}$ = 0.04 AC-FT

$V_{100,F}$ = 0.34 AC-FT

0.38 AC-FT × 2 = 0.76 AC-FT MIN

0.92 AC-FT PROVIDED

POND # A-1 (SUBDIVISION DRAINAGE)

- 200% OF BASIN A-1

$V_{100,A-1}$ = 0.63 AC-FT × 2 = 1.26 AC-FT

POND # A-2 (SUBDIVISION DRAINAGE)

- 200% OF BASIN A-2

$V_{100,A-2}$ = 0.29 AC-FT × 2 = 0.58 AC-FT

BOHANNAN-HUSTON INC.

PROJECT NAME Seven Bar SHEET 1 OF 1

PROJECT NO. 92292.46 BY _____ DATE _____

SUBJECT Retention Ponds CH'D _____ DATE _____

AZ-10

HYDROLOGIC BASIN SUMMARY DATA - 10 YEAR STORM
SEVEN BAR RANCH

FILE: CDP:[C9229240.HYMO]SUBDIVBASIN_10.W20
JN: 9229240
DATE: MAY 17, 1993

100% DEVELOPED CONDITIONS

BASIN ID	AREA (ac)	% LAND TREATMENT A	B	C	D	RATIONAL METHOD COMPOSITE C	RATIONAL METHOD INTENSITY I(in/hr)	RATIONAL METHOD RUNOFF Q-10(cfs)	COMPOSITE EXCESS PRECIP. E	RATIONAL METHOD VOLUME V-10(ac-ft)
A-1	5.36	5	21	21	53	0.64	3.14	10.8	0.80	0.36
A-2	2.58	4	24	24	47	0.61	3.14	4.9	0.75	0.16
A-3	4.35	5	22	22	52	0.63	3.14	8.6	0.79	0.29
A-4	7.32	4	23	23	49	0.62	3.14	14.3	0.77	0.47
A-5	1.27	4	22	22	53	0.64	3.14	2.6	0.80	0.08
A-6	3.36	4	24	24	47	0.61	3.14	6.4	0.75	0.21
A-7	4.05	5	23	23	50	0.62	3.14	7.9	0.77	0.26
A-8	3.26	5	20	20	55	0.65	3.14	6.6	0.81	0.22
A-9	2.68	5	24	24	48	0.61	3.14	5.1	0.75	0.17
TOTAL:	34.22						TOTAL:	67.40		2.22

STREET CAPACITY ANALYSIS

ANALYSIS POINT	STREET	SLOPE (%)	CURB TYPE	Q_{100} (CFS)	NORMAL DEPTH-100-YEAR	Q_{10} (CFS)	NORMAL DEPTH-10-YEAR	BASIN
1	ARROYO BEND	0.500	STD	18.3	0.47'	10.8	0.40	A-1
2	ARROYO BEND	0.500	STD	29.5	0.56'	17.4	0.46'	A-1,B
3	ARROYO CREST	0.500	ROLLED	8.5	0.39'	4.9	0.32'	A-2
4	ARROYO CREST	0.851	ROLLED	8.5	0.35'	4.9	0.29'	A-2
5	ARROYO CREST	0.851	STD	52.0	0.63'	30.4	0.51'	A2,3,4,5
6	ARROYO CREST	0.851	STD	65.6	0.73'	38.3	0.65'	A2,3,4,5,7
7	CALABACILLAS CT	0.944	ROLLED	11.1	0.38'	6.4	0.31'	A-6
8	CALABACILLAS CT	0.944	STD	42.6	0.58'	25.1	0.50'	SEE CATCH BASIN SHEET
9	DAYFLOWER	0.569S	STD	17.7	0.46'	8.6	0.37'	A-3
10	SAND SAGE	0.67S	STD	24.5	0.50'	14.3	0.42'	A-4
11	SAND SAGE	0.67S	STD	39.2	0.59'	22.9	0.48'	A3,4
12	SAND SAGE	0.67S	STD	43.5	0.63'	25.5	0.51'	A3,4,5
	Calabacillas Ct		Std		0.83			See Catch Basin Sheet
	SEVEN BAR LOOP ROAD (HALF STREET SECTION)							
STA 44+50 TO 52+00		0.938	STD	4.1/2	0.28	2.9/2	0.26'	E
STA 30+00 TO 44+50		3.712	STD	9.4/2	0.30	6.1/2	0.26'	F

* SEE PLATE 3 FOR LOCATION OF ANALYSIS POINTS

BOHANNAN-HUSTON INC.

PROJECT NAME THE TRAILS @ SEVEN BAR SHEET ____ OF ____
PROJECT NO. 9223210 BY ____ DATE ____
SUBJECT STREET CAPACITY CH'D ____ DATE ____

HYDRAULIC GRADE LINE ANALYSIS - EQUATIONS USED

- FROM DPM CH. 22.3 EXCEPT WHERE NOTED.

CONVEYANCE $K = \frac{1.486\,AR^{2/3}}{n}$

$= \frac{1.486A\left(\frac{r}{2}\right)^{2/3}}{0.013}$

FRICTION SLOPE $= S_f = \left[\frac{Q}{K}\right]^2$

ENGERGY LOSSES

FRICTION LOSS $: H_f = S_f L$

BEND LOSS $: H_B = 0.2\left(\frac{\Delta}{90^\circ}\right)^{1/2}\frac{\bar{V}^2}{2g}$

JUNCTION LOSS $= \frac{Q_2V_2 - Q_1V_1 - Q_3V_3\cos\theta}{\left(\frac{A_1+A_2}{2}\right)g} + HV_1 - HV_2 = H_+$

* FROM LA METHOD - STANDARD S

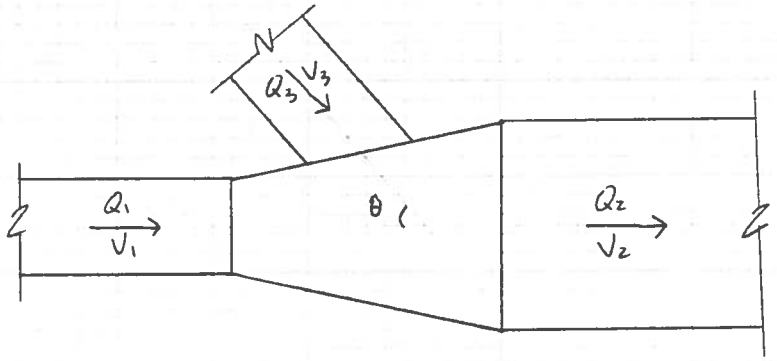
MANHOLE LOSS $= H_{MH} = 0.05\frac{\bar{V}^2}{2g}$

TRANSITION LOSS $= H_T = 0.1\frac{(V_1-V_2)^2}{2g}$ FOR CONTRACTION

$= 0.2\frac{(V_1-V_2)^2}{2g}$ FOR EXPANSION

VELOCITY HEAD $= HV = \frac{V^2}{2g}$

AVERAGE VELOCITY $= \bar{V} = \frac{V_1+V_2}{2}$



TYPICAL EQUATION NOTATION

BOHANNAN-HUSTON INC.

PROJECT NAME Cottonwood Mall SHEET 1 OF 1

PROJECT NO. 9013505 BY D.F. DATE 3/20/92

SUBJECT Drainage - Hydraulic CH'D DATE

CALABACILLAS CT. STORM DRAIN

CATCH BASIN CALCULATION SHEET

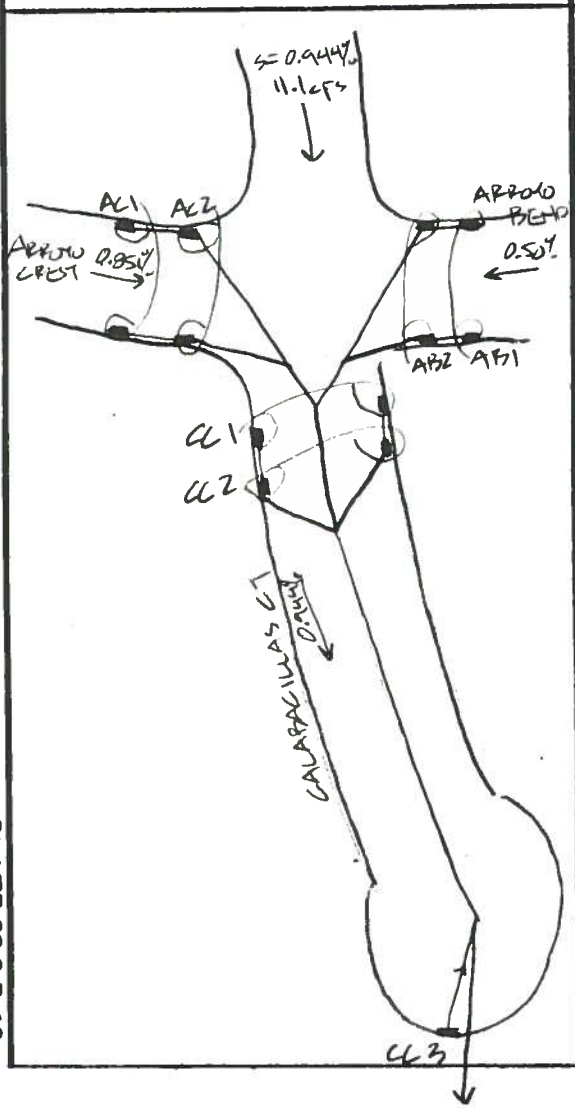
Sht. 1 of 1

PROJECT SEVEN OAK

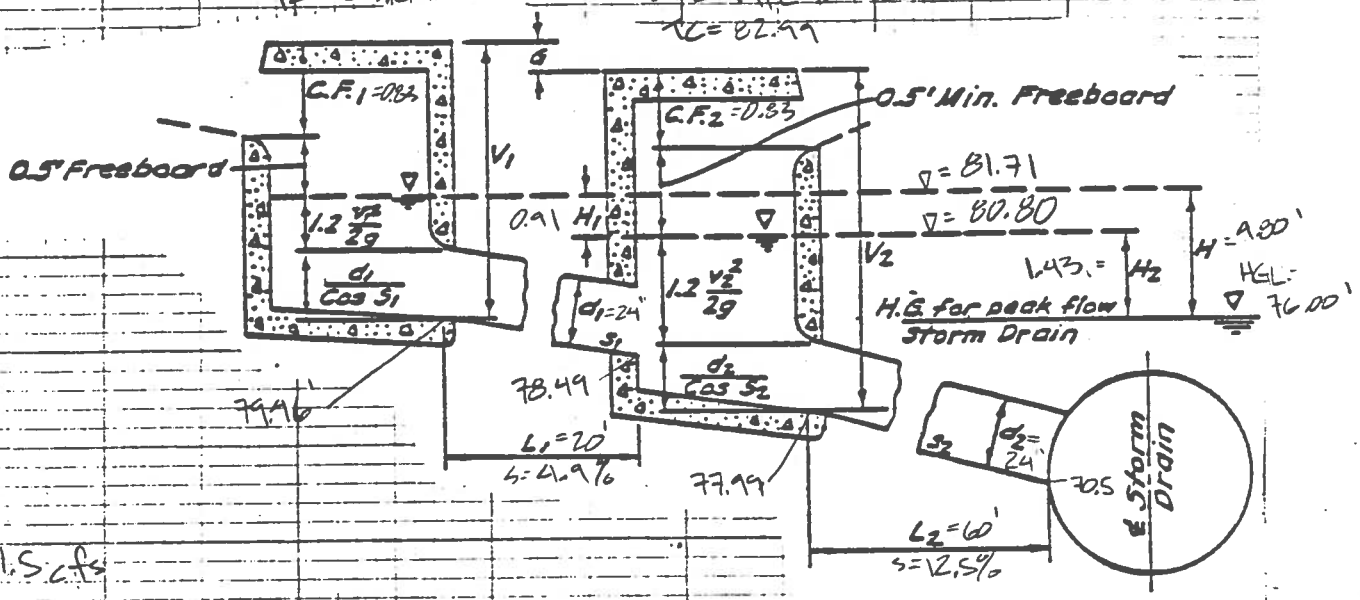
DESIGN FREQUENCY 100 YEAR

CALCULATED BY DF

DATE 5/1/93

FLOW DIAGRAM (Indicate street slopes)	Sym.	Drain. Area	Q Total	Q Inter.	Cap. of ½ Street	Gutter "d"	C.B. No.	C.B. Size	Connector Pipe Head	Connector Pipe L	Connector Pipe Dia.	V Depth
	AC1		65.8	2x11.5 = 23.0	84.5	0.74'	"A"	SGL				
	AC2		42.8	2x9.2 = 18.4	84.5	0.60'	"B"	DBL				
			24.4	41.4								
	AB1		29.5	2x6.2 = 12.4	43.7	0.56	"A"	SGL				
	AB2		17.1	2x5.0 = 10.0	43.7	0.46	"B"	DBL				
			7.1	22.4								
	CC1		42.6	2x7.8 = 15.6	93.9	0.58	"A"	SGL				
	CC2		27.0	2x7.0 = 14.0	93.9	0.50	"B"	DBL				
			13.0	29.6								
	CC3		22.5	ALL	93.9	0.83	"A"	SGL				

ARROYO CREST - TREAT EACH SIDE OF STREET EQUALLY



$Q_1 = 11.5$ cfs

$V_1 = 3.66$ fps

$H_{1\,REQ} = \frac{1.2V_1^2}{2g} = 0.25'$

$V_1 = 0.83' + 0.50' + 0.25 + 2.0' = 3.58'$

$INV = 83.04 - 3.58 = 79.46$

$H_{1\,AVAIL} = 0.91' > 0.25'$

$Q_2 = 11.5_{cfs} + 9.2_{cfs} = 20.7$ cfs

$V_2 = 6.6$ fps

$H_{2\,REQ} = \frac{1.2V_2^2}{2g} = 0.81'$

$V_2 = 0.83' + 0.50' + 0.81' + 2.0' = 4.14'$ USE 5'

$INV = 82.99 - 5.00' = 77.99'$

$H_{2\,AVAIL} = 4.80' > 0.81'$ ✓

BOHANNAN-HUSTON INC.

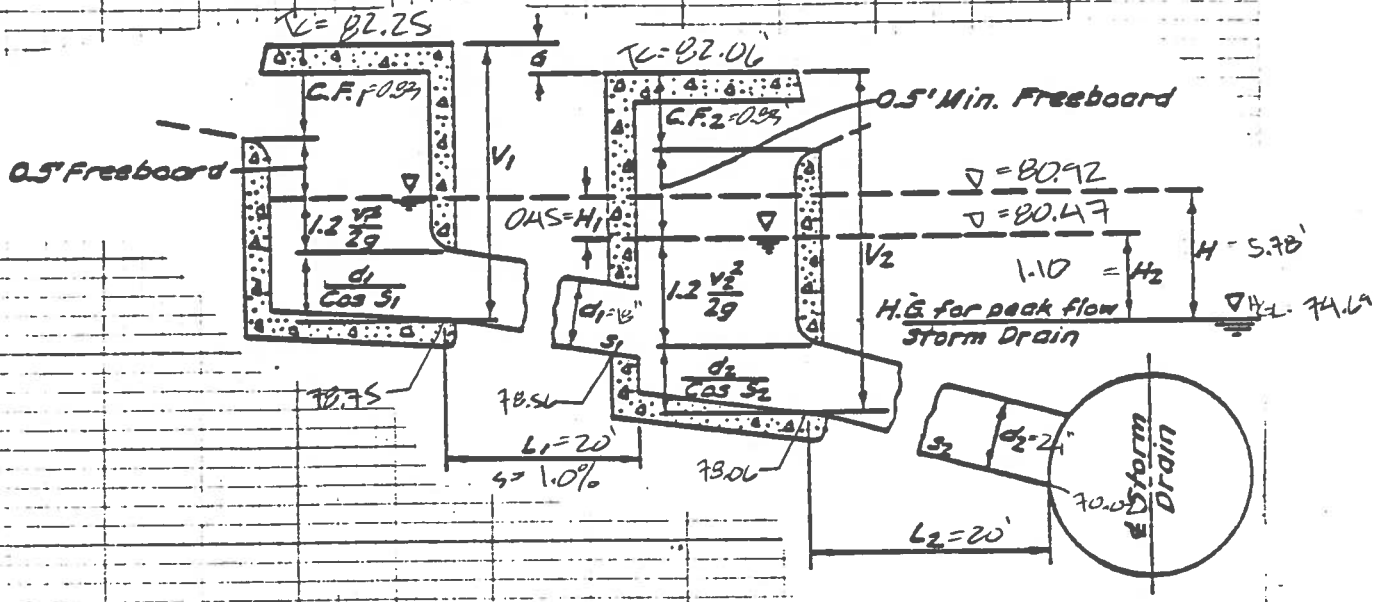
PROJECT NAME Seven Bar SHEET 1 OF 1

PROJECT NO. 9229216 BY DF DATE

SUBJECT Arroyo Crest Inlets CH'D DATE

CALABACILLAS COURT - TWO BATTERIES - EQUAL FLOWS ON EACH SIDE OF THE STREET

TYPE "A" INLET DBL TYPE "B" INLET



$Q_1 = 7.8$ cfs

$V_1 = 4.41$ fps

$H_{1,REQ} = \frac{1.2\,V_1^2}{2g} = 0.36'$

$V_1 = 0.83' + 0.5' + 0.36' + 1.5' = 3.19'$

USE $V_1 = 3.50'$

INV = 82.25 - 3.50 = 78.75

$H_{1,AVAIL} = 0.45' > 0.36'$

$Q_2 = 7.0$ cfs + 7.8 cfs = 14.8 cfs

$V_2 = 4.71$

$H_{2,REQ} = \frac{1.2\,V_2^2}{2g} = 0.414$

$V_2 = 0.83' + 0.50' + 0.41' + 2' = 3.74'$

USE $V_2 = 4.0'$

INV = 82.06 - 4' = 78.06'

$H_{2,AVAIL} = 5.78' > 0.41'$

BOHANNAN-HUSTON INC.

PROJECT NAME Seven Bar SHEET 1 OF 1

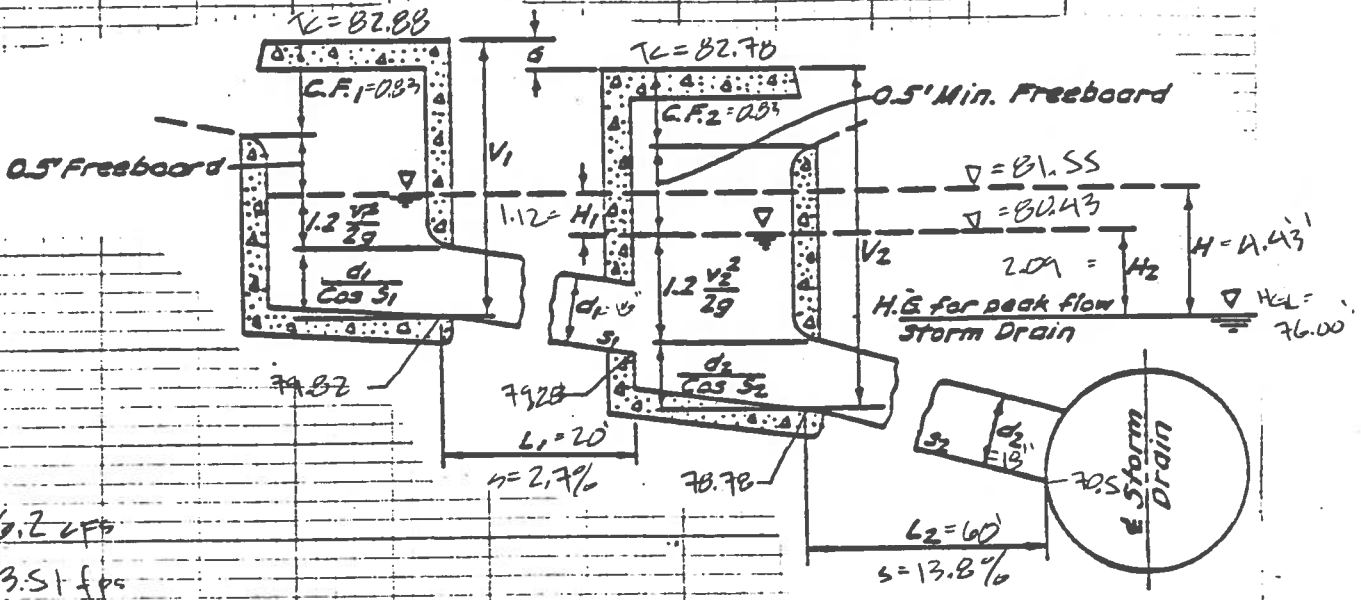
PROJECT NO. 9229246 BY DF DATE

SUBJECT Calabacillas Ct Inlets CH'D DATE

ARROYO BEND — EQUAL BATTERY OF INLETS ON EACH SIDE

TYPE "A" INLET

DBL TYPE "B" INLET



$Q_1 = 6.2$ cfs

$V_1 = 3.51$ fps

$H_{1\,REQ} = \frac{1.2\,V_1^2}{2g} = 0.23'$

$V_1 = 0.83' + 0.50' + 0.23' + 1.5' = 3.06'$

$I_{HY} = 82.88 - 3.06' = 79.82$

$H_{1\,AVAIL} = 1.12' > 0.23'$

$Q_2 = 5.0$ cfs

$V_2 = 2.83$ fps

$H_{2\,REQ} = \frac{1.2\,V_2^2}{2g} = 0.15'$

$V_2 = 0.83' + 0.50' + 0.15' + 1.5' = 2.98'$

USE $V_2 = 4.0'$

$I_{HY} = 82.78 - 4.0' = 78.78$

$H_{2\,AVAIL} = 4.43' > 0.15'$

BOHANNAN-HUSTON INC.

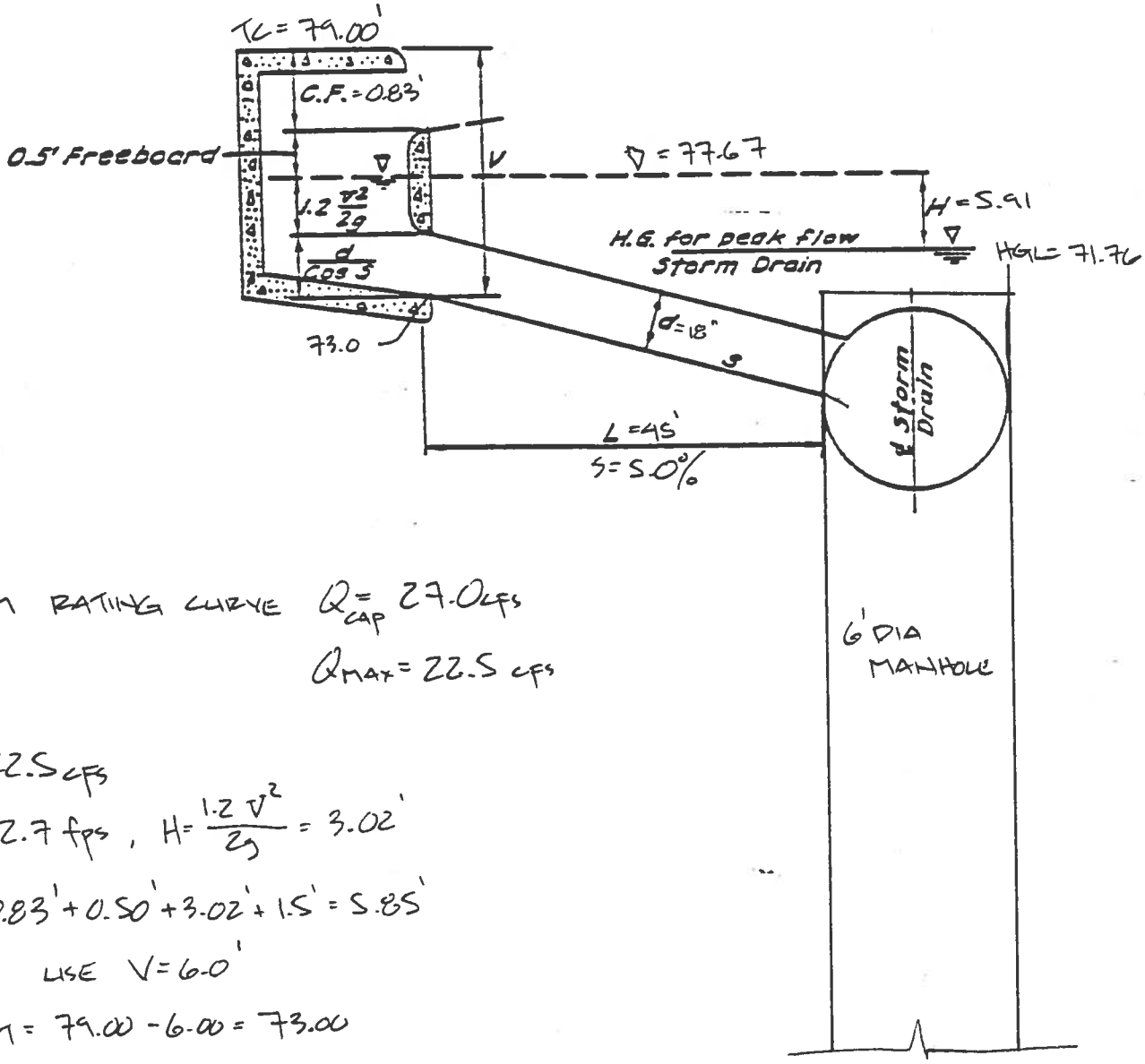
PROJECT NAME Seven Bar SHEET 1 OF 1

PROJECT NO. 9229246 BY DF DATE

SUBJECT Arroyo Bend Inlets CH'D DATE

CALABACILLAS CT. CUL-DE-SAC

TYPE "A" INLET IN SUMP CONDITION



FROM RATING CURVE $Q_{CAP} = 27.0$ cfs

$Q_{MAX} = 22.5$ cfs

$Q = 22.5$ cfs

$V = 12.7$ fps, $H = \frac{1.2\,V^2}{2g} = 3.02'$

$V = 0.83' + 0.50' + 3.02' + 1.5' = 5.85'$

USE $V = 6.0'$

INVERT = 79.00 − 6.00 = 73.00

$H_{AVAIL} = 5.91' > 3.02'$

BOHANNAN-HUSTON INC.

PROJECT NAME Seven Bar SHEET 1 OF 1

PROJECT NO. 9229246 BY DF DATE

SUBJECT CALABACILLAS CT. CUL DE SAC CHD DATE

A2-113

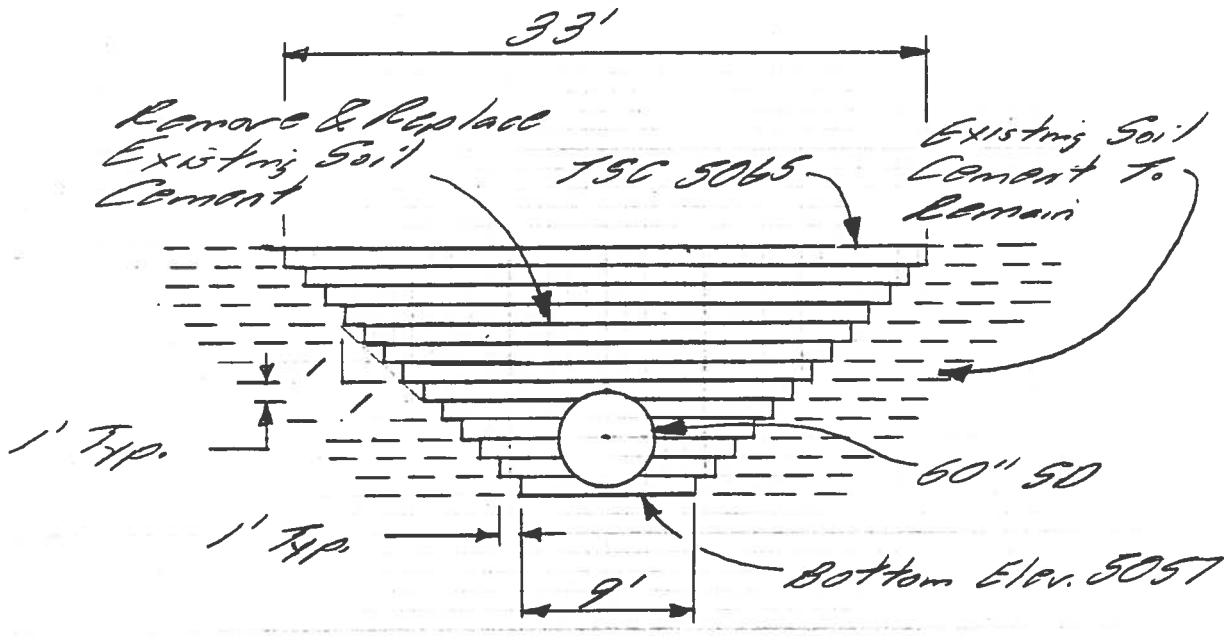
[illegible] Cubic Feet

SUMMARY OF HYDRAULIC CALCULATIONS

SUMMARY OF HYDRAULIC CALCULATIONS
THE TRAILS AT SEVEN BAR
5/17/93

Sta.	Struct	Diam.	Q	Area	Vel.	K	Sf	Length	MH Dia.	MH Angle	Hf	Hb	Hj	Hmh	Ht	Total Losses	HGL(dn)	HGL(up)	Low Point	HV
EASEMENT STORM DRAIN																				
1+71	OUTFALL											0.00	0.00	0.00	0.00	0.00		5062.50		2.63
		60	255.6	19.63	13.02	2604	0.0096	59.00			0.57					0.57				
2+30	MANHOLE								?	90		0.53	0.00	0.13	0.00	0.66	5063.07	5063.73		2.63
		60	255.6	19.63	13.02	2604	0.0096	52.00			0.50					0.50				
2+82	BEND									45		0.37	0.00	0.13	0.00	0.50	5064.23	5064.73		2.63
		60	255.6	19.63	13.02	2604	0.0096	15.00			0.14					0.14				
2+97	BEND									45		0.37	0.00	0.13	0.00	0.50	5064.88	5065.38		2.63
		60	255.6	19.63	13.02	2604	0.0096	211.00			2.03					2.03				
5+08	MANHOLE								120	15		0.18	1.83	0.11	0.01	2.13	5067.41	5070.30	5080.10	1.87
		48	138.0	12.57	10.98	1436	0.0092	190.00			1.75					1.75				
																		5072.06		
CALABACILLAS COURT																				
9+98.8	MH1								120	90		0.41	0.85	0.10	0.22	1.58	5068.17	5069.40	5080.10	2.22
		42	115.1	9.62	11.96	1006	0.0131	54.36			0.71					0.71				
9+49.4	MH2								48	30		0.21	0.00	0.09	0.00	0.30	5070.11	5071.17	5079.19	1.46
		42	93.4	9.62	9.71	1006	0.0086	233.01			2.01					2.01				
7+11.4	MH3								48	15		0.12	0.00	0.07	0.00	0.19	5073.18	5073.38	5081.25	1.46
		42	93.4	9.62	9.71	1006	0.0086	60.85			0.52					0.52				
6+50.6	MH4								48	15		0.11	0.42	0.07	0.00	0.60	5073.90	5074.69	5081.83	1.27
		36	63.8	7.07	9.03	667	0.0091	48.70			0.45					0.45				
6+01.9	MH5								48	45		0.17	0.47	0.06	0.00	0.70	5075.14	5076.00	5082.29	1.1
		30	41.4	4.91	8.43	410	0.0102	20.00			0.20					0.20				

Remarks. 1. 100YR EVENT, 100YR ELEV. IN STORM DRAIN Manning's 'n' 0.013
2. STATIONS REFER TO STATIONING SHOWN ON THE PNP SHEETS



SECTION A-A

SCALE 1"=10'

BOHANNAN-HUSTON INC.

PROJECT NAME _____ SHEET _____ OF _____

PROJECT NO. _____ BY _____ DATE _____

SUBJECT _____ CH'D _____ DATE _____

A4-2

CATCH BASIN CALCULATION SHEET

Sht 1 of 1

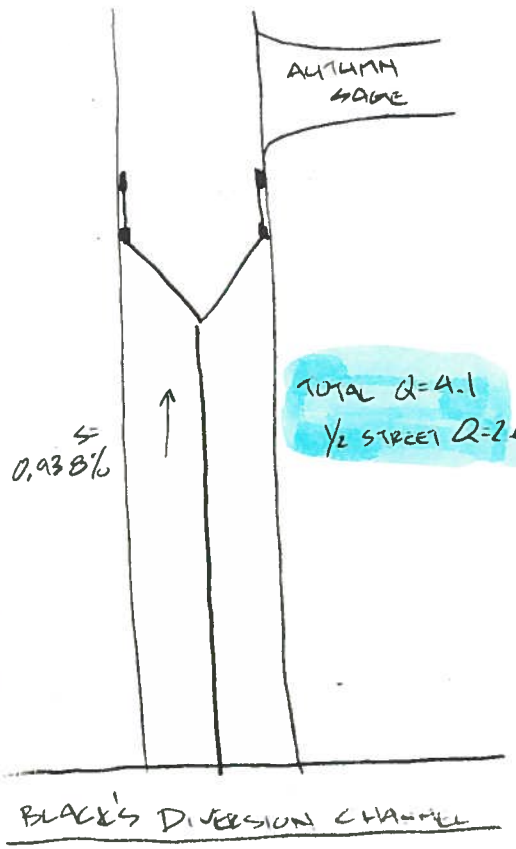
PROJECT Social Bar Loop Rd

DESIGN FREQUENCY 100-YEAR

CALCULATED BY DF

DATE

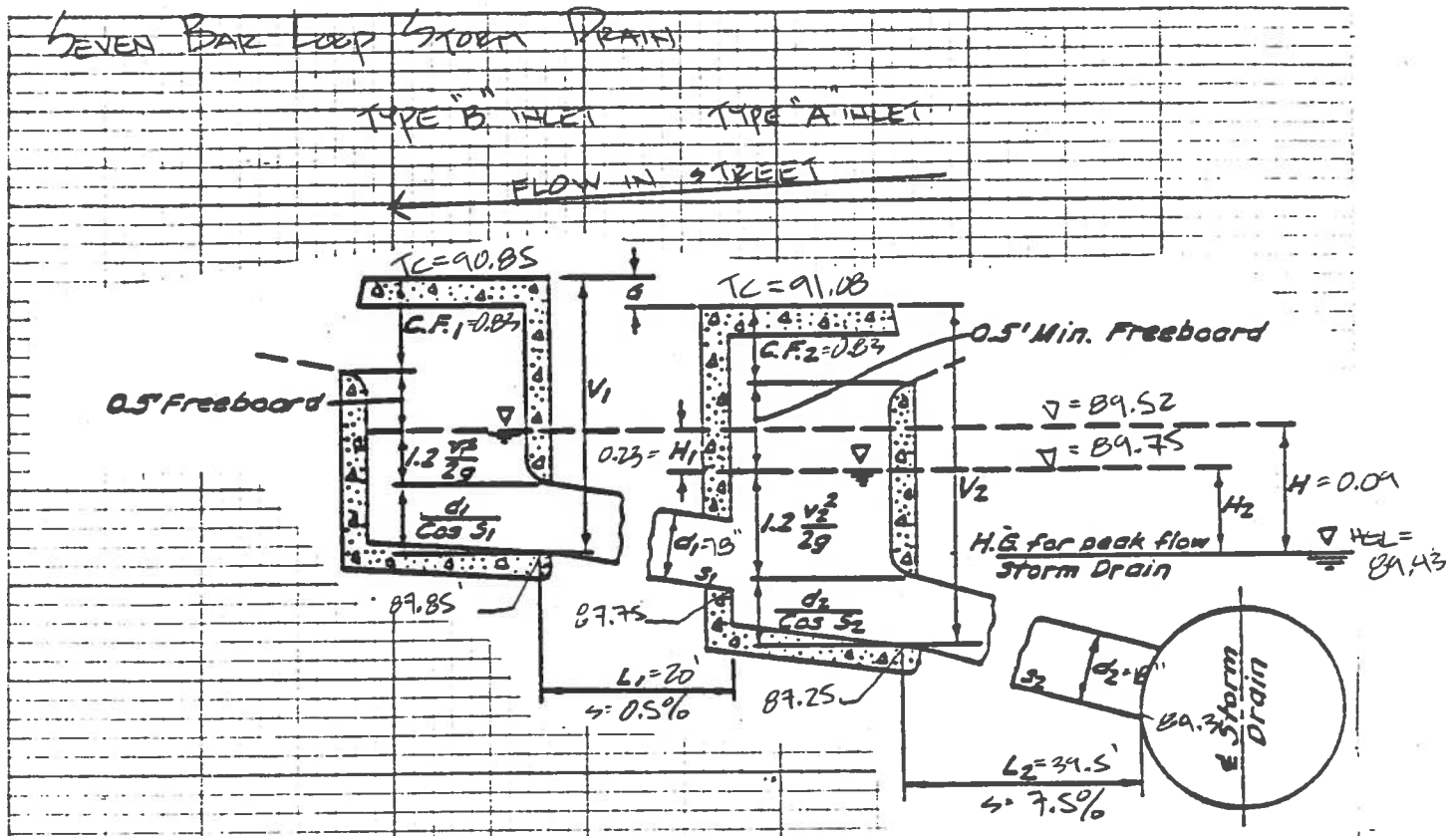
FLOW DIAGRAM (Indicate street slopes)	Sym.	Drain. Area	Q Total	Q Inter.	Cap. of ½ Street	Gutter "d"	C.B. No.	C.B. Size	Connector Pipe Head	Connector Pipe L	Connector Pipe Dia.	V Depth
		BASIN E	2.05	1.80	18.8	0.28	A	SGL				
			0.25	ALL	18.8	0.16	B	SGL				



4-82 80 PLATE 22.3 D-10

22.3

SEVEN BAR LOOP STORM DRAIN



$Q_1 = 0.25$ cfs

$V_1 = 0.14$ fps

$H_{1,REQ} = \frac{1.2\,V_1^2}{2g} = 0.0'$

$V_1 = 0.83 + 0.50 + 1.5' = 2.83'$

USE $V_1 = 3.0'$

$I_{HV} = 90.85 - 3.0' = 87.85'$

$H_{1,AVAIL} = 0.23'$

$Q_2 = 2.05$ cfs

$V_2 = 1.16$ fps

$H_{2,REQ} = \frac{1.2\,V_2^2}{2g} = 0.03'$

$V_2 = 0.83 + 0.50 + 0.03 + 1.5' = 2.86'$

USE $V_2 = 4.13'$

$I_{HV} = 91.08 - 4.13' = 86.95'$

$H_{2,AVAIL} = 0.09' \rightarrow 0.03'$

NOTE THAT INLET 2 (TYPE A) IS HIGHER THAN INLET 1 (TYPE B)

BOHANNAN-HUSTON INC.

PROJECT NAME SEVEN BAR SHEET 1 OF 1

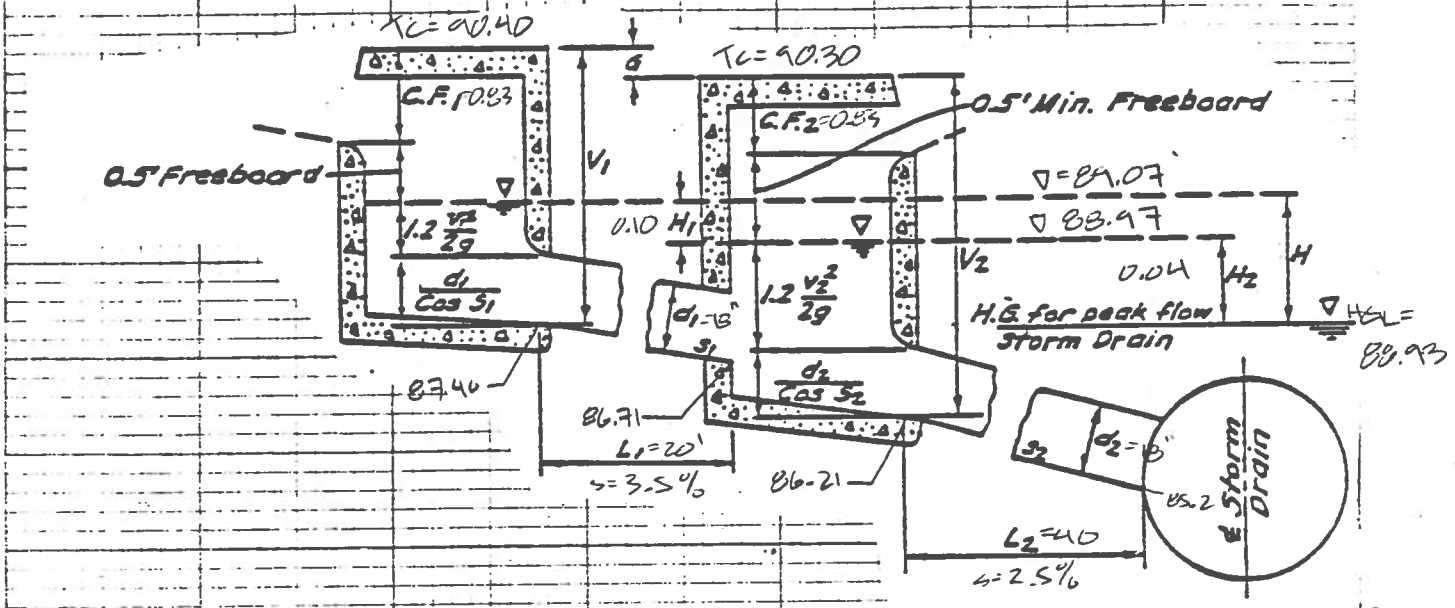
PROJECT NO. 922940 BY DF DATE 5/11/93

SUBJECT INLET CONTROL CH'D _____ DATE _____

Seven Bar Loop Road Storm Drain

Type "A" Inlet

Type "B" Inlet



$Q_1 = 2.03$ cfs

$V_1 = 1.16$ fps

$H_{1,REQ} = \frac{1.2\,V_1^2}{2g} = 0.03$

$V_1 = 0.83 + 0.50 + 0.02 + 1.5 = 2.86$

USE $V_1 = 3.0'$

$INV = 90.40 - 3.00 = 87.40$

$H_{1,AVAIL} = 0.10 > 0.03$

$Q_2 = 1.80$ cfs

$V_2 = 1.02$ fps

$H_{2,REQ} = \frac{1.2\,V_2^2}{2g} = 0.02'$

$V_2 = 0.83 + 0.50 + 0.03 + 1.5 = 2.85$

USE $V_1 = 4.0'$

$INV = 90.21 - 3.00 = 86.21$

$H_{2,AVAIL} = 0.04 > 0.02$

BOHANNAN-HUSTON INC.

PROJECT NAME Seven Bar SHEET 1 OF 1

PROJECT NO. 9229240 BY DATE

SUBJECT Inlet Control CH'D DATE

SUMMARY OF HYDRAULIC CALCULATIONS
SEVEN BAR LOOP ROAD TO THE BLACK'S DIVERSION CHANNEL

Station	Structure	Diam.	Q	Area	Vel.	K	Sf	Length	MH Dia.	MH Angle	Hf	Hb	Hj	Hmh	Ht	Total Losses	HGL(dn)	HGL(up)	Low Point	HV
52+10.00	BLACK'S											0.00	0.00	0.00	0.00	0.00		5086.24		0.68
		42	63.8	9.62	6.63	1006	0.0040	148.14			0.60					0.60				
50+61.86	MH#5								72	15		0.06	0.00	0.03	0.00	0.09	5086.84	5086.93	5100.97	0.68
		42	63.8	9.62	6.63	1006	0.0040	183.35			0.74					0.74				
48+78.51	MH#4								72	15		0.06	0.00	0.03	0.00	0.09	5087.66	5087.75	5095.24	0.68
		42	63.8	9.62	6.63	1006	0.0040	183.36			0.74					0.74				
46+95.15	MH#3								72	15		0.06	0.00	0.03	0.00	0.09	5088.49	5088.58	5092.59	0.68
		42	63.8	9.62	6.63	1006	0.0040	183.36			0.74					0.74				
45+11.79	MH#2								72	15		0.06	0.02	0.03	0.00	0.11	5089.32	5089.43	5090.87	0.68
		42	63.8	9.62	6.63	1006	0.0040	72.51			0.29					0.29				
44+39.25	MH#1								72	90		0.18	0.42	0.04	0.01	0.66	5089.72	5089.95	5090.19	1.11
		36	59.7	7.07	8.45	667	0.0080	100.00			0.80					0.80				

Remarks: 100YR EVENT, 100YR ELEV IN CBC Manning's 'n':0.013
STATIONS REFER TO PNP SHEETS
PRESSURE FLOW BEGINS AT STATION 50+41.86

$Q_{10} = .657(63.8) = 41.9$ cfs

$S_f \simeq .18\%$ $V \simeq 4.4$ fps

A-5.4

Seven Bar Swales

- Temporary - phase 1 swales

STA. 37+00 to STA 31+75

$Q = 4.6$ cfs

$s = 3.71\%$

Velocity = 3.2 fps

Depth = 0.22'

Vel > 3.0 fps - channel to be lined w/ asphalt

STA 37+00 to STA 40+50

$Q = 8.8$ cfs

$s = 0.50\%$

Velocity = 2.1 fps

Depth = 0.55'

Vel < 3.0 fps - earth channel

STA 47+00 to STA 40+50

$Q = 26.2$ cfs

$s = 1.38\%$

Velocity = 4.1 fps

Depth = 0.76'

Vel > 3.0 fps - channel to be lined w/ asphalt

BOHANNAN-HUSTON INC.

PROJECT NAME Seven Bar SHEET 1 OF 2

PROJECT NO. 122926 BY DATE

SUBJECT Seven Bar Swales CH'D DATE

SEVEN BAR SWALES

- INLET INTO TEMPORARY POND #1

INLET CONTROL FOR 24" RCP CULVERT

$Q = CA\sqrt{2gh}$

MAX SWALE DEPTH @ 40+50 = 6'

$Q_{max} = (0.6)(3.14)[(64.4)(6)]^{1/2} = 37.1 \text{ cfs} > Q_{SWALE} = 34.4 \text{ cfs}$ ✓

BOHANNAN-HUSTON INC.

PROJECT NAME SEVEN BAR SHEET 2 OF 2

PROJECT NO. 922946 BY DATE

SUBJECT SEVEN BAR SWALES CH'D DATE

REVISED QUALITATIVE EROSION STUDY FOR THE CALABACILLAS ARROYO MAY, 1993

Prepared for:

BROWN AND ASSOCIATES
3411 CANDELARIA RD NE
ALBUQUERQUE, NM 87107

and

NEW MEXICO AND ARIZONA LAND COMPANY
6100 INDIAN SCHOOL ROAD, NE, SUITE 100
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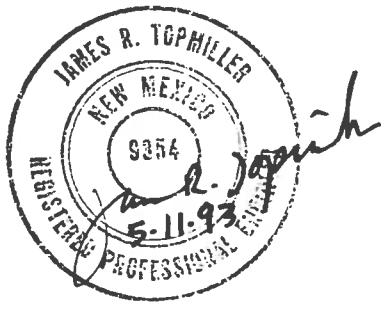

Prepared by:

BOHANNAN-HUSTON INC.
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REVISED
QUALITATIVE EROSION STUDY
for the
CALABACILLAS ARROYO

TABLE OF CONTENTS

COVER	1
TABLE OF CONTENTS	2
REPORT	3

APPENDICES

PLATE 1 - VICINITY MAP

PLATE 2 - FLOOD HAZARD BOUNDARY MAP

PLATE 3 - SOILS MAP

APPENDIX 1 SECTION 14.0 FROM VINYARD AND ASSOCIATES, INC. GEOTECHNICAL INVESTIGATION

REFERENCES

PLAN AND CROSS SECTIONS (IN ENVELOPE INSERT)

PURPOSE

The purpose of this report is to provide a qualitative erosion study of the Arroyo de las Calabacillas (hereafter Calabacillas Arroyo) as it impacts Tract N-2A-1 of Seven Bar Ranch, particularly with regard to an existing "prudent line". This "prudent line" as established in 1980 and described below, currently defines a portion of the southwestern boundary of the tract and the limit of the proposed residential development. This report evaluates the continued applicability of the "prudent line" in this reach.

INTRODUCTION

In April, 1983 Simons, Li and Associates, Inc. prepared a study entitled "Erosion Study to Determine Boundaries for Adjacent Development - Calabacillas Arroyo" for the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) that developed a map delineating boundaries along both sides of the Calabacillas Arroyo beyond which development would not be prudent without channel improvements. "Prudent" was then defined as an acceptable degree of risk no greater than that associated with the single-event erosion and flooding potential of a 100-year storm **or** a series of smaller events over a 25-year period. AMAFCA then used this study and, together with some alterations arising from field inspections, generated a prudent line and easement that was incorporated into a plat of Tract N-2A-1 on November 1, 1986. In 1989, the area within the AMAFCA easement was identified as a potential open space site in the Draft Calabacillas Arroyo Corridor Plan and was called the "S-Curve". The Simons, Li and Assoc. report refers to this area as the "Horseshoe Bend".

Since 1983, several storms have generated enough runoff in the Calabacillas Arroyo to cause moderate bank erosion along the upstream section and considerable bank erosion at the downstream section of the AMAFCA easement. The latter has created a condition where the bank has eroded back to the prudent line in one area. In response to this condition, AMAFCA built seven grade control structures with bank stabilization structures in the Calabacillas Arroyo from Unser Blvd to Coors Blvd. Two of these structures lie adjacent to Tract N-2A-1, one at the outfall of Black's Diversion Channel (structure number 6) and the other along the downstream half of the "S-Curve" (structure number 7). The structures were completed in May, 1992.

In the time since the Simons, Li and Assoc. report, Bernalillo County has redefined "prudent" as an acceptable degree of risk no greater than that associated with the single-event erosion and flooding potential of a 100-year storm **and** a series of smaller events over a 30-year period. It is both the subsequent bank erosion in the last 10 years and the new definition of "prudent" risk that has prompted this qualitative study to assess the development of Tract N-2A-1 along the banks of the Calabacillas Arroyo.

As a qualitative study, this will be a geomorphic analysis based on available data and observations. Lateral profiles in five locations along the Calabacillas Arroyo and adjacent to Tract N-2A-1 have been generated from three different sources: 1980 topography by Bohannan-Huston Inc. for use in a floodway study for FEMA and a HEC-2 analysis; a 1987 topographic survey by Hugg Surveying Inc. for ABQ Development Inc.; and a cross-section survey in March, 1993 by Bohannan-Huston Inc. The 1987 survey provided information for the north bank only, which is the bank along Tract N-2A-1. The analysis will be based mostly on the evaluation of the profile changes from 1980 to 1993.

PHYSICAL DESCRIPTION

The Calabacillas Arroyo flows in a general south-easterly direction along the south-west border of Tract N-2A-1 at a thalweg slope of between one and two percent. The SCS soil type for the site is Bluepoint loamy fine sand (BCC) and the hydrologic soil group is Type A (see Soil Map, Plate 3).

Black's Diversion is a concrete lined channel that flows from the north and discharges into the Calabacillas Arroyo. AMAFCA's grade control structure number six is located at the confluence of Black's Diversion Channel and the Calabacillas Arroyo.

Tract N-2A-1 slopes down from a high ridge along the north bank of the Calabacillas Arroyo to the southeast at a slope between two and five percent. The SCS soil type for the site is also Bluepoint loamy fine sand (BCC). Runoff from the site currently discharges into the Coors Boulevard Bypass right-of-way where it eventually discharges into the Calabacillas Arroyo just upstream of the Coors Boulevard crossing.

QUALITATIVE ANALYSIS

As described above, this qualitative geomorphic analysis relies on observations gathered at the area in and around the Calabacillas Arroyo, and a comparison of five lateral cross-sections taken from 1980, 1987 and 1993.

SITE OBSERVATIONS

For purposes of analysis, the Calabacillas Arroyo in the reach adjacent to Tract N-2A-1 can be divided into four general areas that exhibit the four different conditions of the north bank starting at the outlet of Black's Diversion Channel. The cross-sections refer to those shown on the plan and profile sheet, and also correspond to the cross-sections used in the 1980 Bohannan-Huston HEC-2 analysis and the 1983 Simons, Li and Associate study.

The first reach (Reach #1) is from cross-section M-M to approximately 130 feet upstream of cross-section L-L. Grade control structure number six is located in this reach as well as a soil cement bank protection that was constructed as a part of the Black's Diversion Channel. As the result of maintenance on the Black's Diversion Channel, a large amount of sediment has been dumped along the north bank for the length of this reach. This layer of sediment extends from the north bank to the center of the arroyo where it then drops 10 feet to 12 feet deep to the current arroyo channel thalweg. This sediment deposit is shown in section L-L. The prudent line in this reach is at the top of the arroyo slope on the north side.

The second reach (Reach #2) extends approximately 130 feet upstream, and 110 feet downstream, of section L-L. This reach is nearly trapezoidal in section and has a wide arroyo bottom. The north bank shows little sign of erosion and is partially vegetated,

the slope of the bank is at 2.5:1 (horizontal:vertical). The prudent line in this reach also lies at the top of the arroyo slope. Section L-L shows the geometry in this area.

The third reach (Reach #3) begins approximately 110 feet downstream of section L-L and continues around the "S-Curve" to the soil cement protection on the north bank. It is here that the bank exhibits the most severe unstabilized erosion since 1980. The arroyo wall on the north bank is nearly vertical and debris at the toe of the slope is evidence of recent erosion.

The fourth, and last, reach (Reach #4) begins with the soil cement structure and continues downstream to the grade control structure number 7 and the edge of Tract N-2A-1. The lower portion of this reach shows the greatest lateral change since 1980. As shown in the plan, the top of the arroyo slope now lies at or near the prudent line in one area. The north bank in this entire area is now protected by a soil cement structure completed in 1992.

ARROYO PROFILE ANALYSIS

Three sources of information were used to generate the cross-sections for the profile analysis. In 1980 Bohannan-Huston Inc. located 33 cross-sections (A-A through AG-AG) down the entire length of the Calabacillas Arroyo for the purpose of hydraulic (HEC-2) analysis. Five of these cross-sections (I-I through M-M) will be used as a basis for comparison with data from a 1987 topographic survey by Hugg Surveying and from a cross-section survey done by Bohannan-Huston in March, 1993 for the purpose of this study. The data from 1987 was obtained in the form of digitized topography and has information for the north bank only. These three sets of cross-sections were then superimposed to illustrate the changes in the arroyo profile over the last 10 years.

SECTION M-M

Because of the extensive soil cement bank protection built with Black's Diversion Channel, the north bank in this area shows little change. The south bank eroded appreciably from 1980 to 1987 but seems to have stabilized since then due to the construction of grade control structure number 6.

SECTION L-L

This section has shown little change since 1980. Both banks have a 2.5:1 slope and the arroyo bottom has maintained a constant width. Some degradation (a lowering of the arroyo bottom) has occurred, showing the arroyo becoming deeper over time and this may affect the bank stability in the long term.

SECTION K-K

At this section at the upstream end of the "S-Curve", the north bank of the arroyo is nearly vertical and appears to be experiencing some active erosion at the base and

degradation at the arroyo thalweg. However, at this location, the "prudent line" is over 100 feet from the arroyo bank.

SECTION J-J

While the top of the north bank has not changed, the toe has moved so that bank has become more vertical. Most of this change occurred between 1980 and 1987, with little change since then. Note that the arroyo bottom area in this area has shifted to the north as a result of erosion of the north bank and fill from a vehicular access (used in construction of the grade control structures) on the south bank. The "prudent line" at this point is practically at its most distant location from the arroyo bank, over 150 feet.

SECTION I-I

This section is just upstream of grade control structure number 7 and the soil cement structure shown in the section was completed in 1992. Starting at this section and downstream for approximately 300 feet, is where the most critical erosion occurred from 1980 to 1992. The soil cement structure appears to have stabilized the left bank.

DISCUSSION OF RESULTS BY REACH

Of the four reaches discussed under the site observations, the first and the fourth have received channel improvements to a degree where the Calabacillas Arroyo is considered an essentially improved channel in these areas. As such, the limit of development within Tract N-2A-1 adjacent to the Calabacillas Arroyo should be guided only by soils analysis and geotechnical recommendations for setbacks from a steep slope as specified in Section 14.0 of the report, "Geotechnical Investigation - Tracts L-1 and L-2 of the Seven Bar Ranch" (April 5, 1993), by Vinyard and Associates (attached in Appendix 1). This report assess a development setback based on the slope stability of the existing soils.

The second reach (Section L-L) has remained stable since the study done by Simons, Li and Associates and does not show any indications of lateral migration. As noted above and documented in the Simons, Li and Assoc. study, however, the Calabacillas Arroyo has shown a tendency for degradation (lowering of the arroyo thalweg) which might eventually affect the stability of the banks. This being said, the actual degradation since 1980 has been minimal and appears to be concentrated on the south side of the arroyo. Additionally, the recent construction of Grade Control Structure #6 will have a stabilizing influence on bank/lateral erosion in this reach. Accordingly, we believe that the "prudent line" is still valid as defined in 1980 (100-year event **or** a 25-year life), and as defined in 1993 (100-year event **and** a 30-year life) as well.

The area (Reach #3) showing the most erosion occurs along the portion of the AMAFCA drainage easement located within the adjacent Tract N-2A-1, also known as the "S-Curve" or "Horseshoe Bend". This easement land will be dedicated to the City of Albuquerque as open space in the subdivision's platting process. As pointed out in the Simons, Li and Assoc. study, this bend increased in amplitude from 1935 to 1983. Since then, work has been done by AMAFCA to mitigate this situation and to try to minimize further lateral migration of the arroyo.

In the unstabilized areas where the bank is nearly vertical and shows the most significant signs of erosion, the prudent line lies from 80 feet to 160 feet behind the top of the slope/bank. Judging from the historical changes in the arroyo profile, the prudent line adjacent to the AMAFCA easement is still considered to be valid. If used as open space or a park, the placement of any infrastructure within the easement should be carefully considered for potential future loss. Section J-J suggests bank stability over the last six years. At section K-K, the bank has experienced only minor lateral migration in the last six years. The subsequent construction of grade and bank stabilization upstream and downstream of this reach will control further lateral migration of the arroyo.

CONCLUSION

Base on the qualitative assessment of erosional conditions within the Calabacillas Arroyo, this report concludes that the proposed subdivision may "prudently" develop adjacent to the existing AMAFCA "prudent line" as established by the Simons, Li study of 1983, with protection adequate for the current Bernalillo County "prudent line" definition.

In summary, this conclusion is supported by the following:

1) Two major grade control/bank stabilization structures have been installed within the arroyo in the vicinity of the proposed subdivision. These structures will "guide" the arroyo and control meandering tendencies.

2) Comparisons of 1980, 1987 and 1993-dated topographic cross-sections of the arroyo reveal minimal cross-sectional change in the critical Reach 2 of this arroyo study. This reach has an unprotected bank. Additionally, the arroyo lies closest to the proposed subdivision in this reach. The Grade Control Structure #6 should also substantially protect this reach.

3) Open space lands between the arroyo and the proposed subdivision and significant bank depth provide protection, in the form of sacrificial soil, for the proposed subdivision.

4) The Simons, Li study of 1983 established the technical, quantitative groundwork for the initial "prudent line" along this reach of the Calabacillas Arroyo. This Revised Qualitative Erosion study has verified that existing erosional conditions within the arroyo are better (as in new structures) or identical to the conditions predicted by the Simons, Li study.

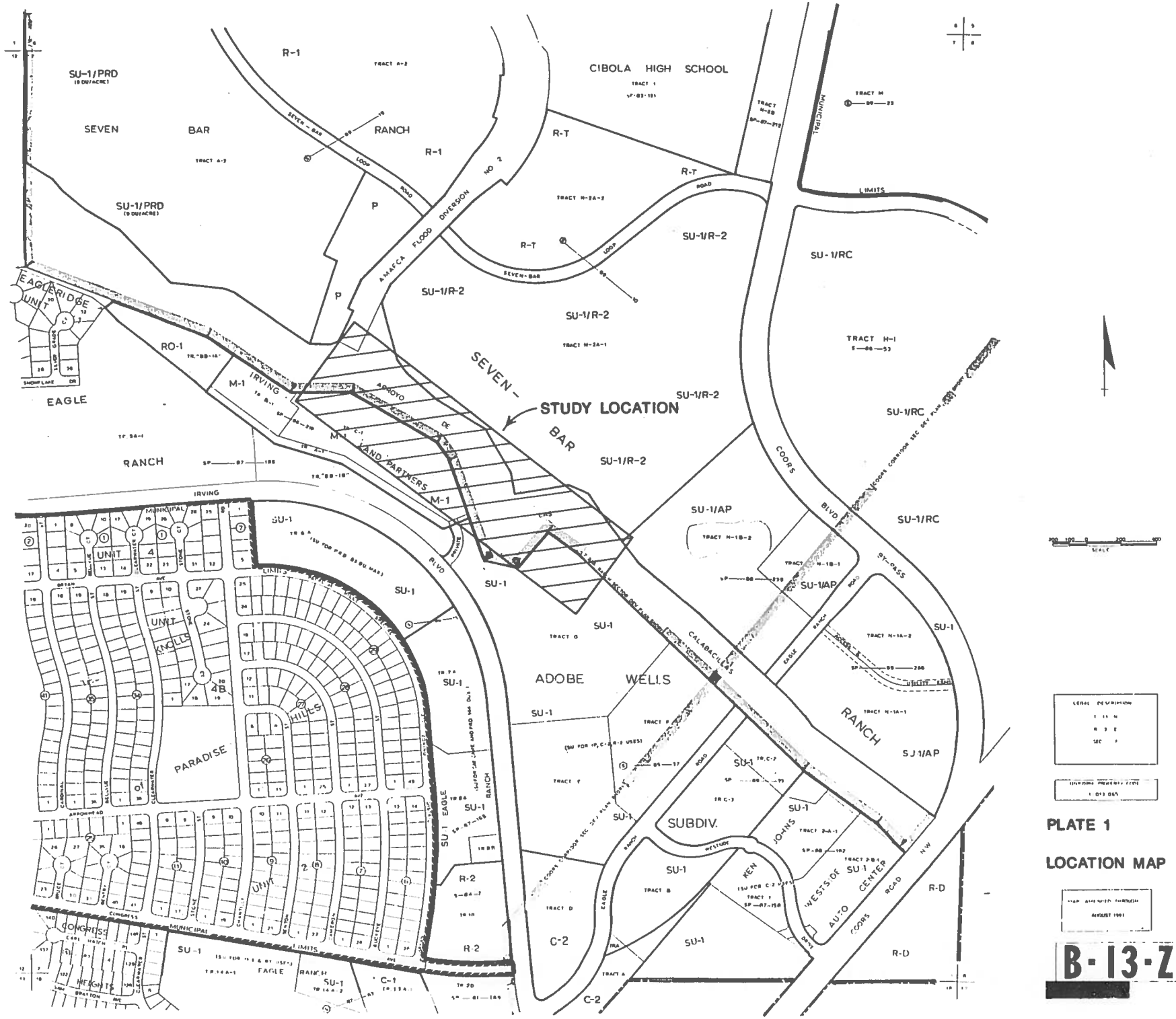

PLATE 1

LOCATION MAP

B-13-Z

FILE 9229240

March 29, 1993

Mr. Gordon Odell
U.S. Department of Agriculture
Soil Conservation Service
Room 2301
517 Gold Avenue, SW
Albuquerque, NM 87102-3157

Re: Storm Drain System Proposed for the Development of Tracts N-2A-1 and N-2A-2, Seven Bar Ranch, Adjacent to Black's Diversion Channel

Dear Mr. Odell:

The purpose of this letter is to request your office to review and approve, and advise AMAFCA accordingly of, our proposal to connect a public storm drain system to the Black's Diversion Channel. This public storm drain system will convey flow from a portion of the proposed Seven Bar Loop Road and a portion of Tract N-2A-2 in Seven Bar Ranch. The following discussion and technical enclosures support this request. Previously, we have spoken to both Greg Cunningham and Dan Murray of your office on this subject.

CHANNEL HISTORY

As we understand the situation, the Black's Diversion Channel was designed by the Soil Conservation Service, and constructed in 1974 under the sponsorship of the Central Rio Grande Soil and Water Conservation District, the Corrales Watershed District, and the Sandoval Soil and Water Conservation District. The Diversion was designed to pick up flows from the Black Arroyo at a location approximately half way between Golf Course Road and Ellison Road, and convey them southward to the Calabacillas Arroyo. In 1977, the operation and maintenance of the Black's Diversion was assumed by AMAFCA. In 1983, AMAFCA installed the 7-Bar Channel which intercepts some of the eastward flowing drainage from Rio Rancho and carries it to the mouth of Black's Diversion. In 1992, a dam at the confluence of the East and West Branches of Black Arroyo was completed that detains the developed flow in Black Arroyo and releases it so that, together with the flow from 7-Bar Channel, the combined flow in the Black's Diversion Channel is below its capacity. The current sediment ladened capacity of the Black's Diversion Channel using SCS criteria for freeboard and superelevation has been determined to be 3700 cfs.

PROPOSED DEVELOPMENT

Currently, Tract N-2A-1 is being subdivided into two tracts: Tract L-1 will be a single family subdivision adjacent to the Calabacillas Arroyo and the Black's Diversion Channel; and Tract L-2 will be a multi-family development fronting the Coors Bypass. Tract N-2A-2 lies to the north of Seven Bar Loop Road and has been acquired by the City of Albuquerque for the proposed development of single family, low-income housing. As a condition prior to the development of Tract N-2A-1, a Conceptual Drainage Plan (attached) was designed to set the

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overall drainage scheme for Tracts N-2A-1, N-2A-2 and the Seven Bar Loop Road right-of-way.

DRAINAGE MANAGEMENT PLAN

The previous area drainage plan, dated August 1992, was the Special Assessment District 223 Drainage Management Plan (attached - sheet 51 of COA Project #4193.93) developed by Easterling and Associates for the City of Albuquerque. In it approximately two-thirds of Tract N-2A-2 and half of the Seven Bar Loop Road right-of-way were designated to drain directly into the Black's Diversion Channel. The remainder of the drainage from Tract N-2A-2 and Seven Bar Loop were shown to flow into the Coors Bypass and north eventually into the Cabezon Channel.

The enclosed Conceptual Drainage Plan for Tracts L-1 and L-2 shows such a division of flows, continuing the general scheme of the previous SAD 223 plan. Developed flows from portions of Tract N-2A-2 (Basin C in the Conceptual Drainage Plan) and Seven Bar Loop Road street and right-of-way (Basin E in the Conceptual Drainage Plan) will be intercepted by a public storm drain system and conveyed to a connection through the wall of the Black's Diversion Channel approximately one foot above the channel invert.

TECHNICAL JUSTIFICATION

Attached you will find an excerpt from the AHYMO analysis for the Black's Diversion that reflects fully developed hydrological conditions with the completion of the Black Arroyo Dam. The total flow at the confluence of Black Arroyo and 7-Bar Channel was routed to the inflow from the proposed storm drain system in Seven Bar Loop Road. Two basins from the Conceptual Drainage Plan (E and C) and their associated routing were then modeled and added to the AHYMO analysis. The result is four detailed hydrographs that illustrate the impact of the addition of these two basins on flow in the Black's Diversion Channel.

Hydrograph number 1 shows the total flow at the confluence of Black Arroyo and 7-Bar Channel. As expected from flow from a dam, the hydrograph is attenuated with the peak of 3657.9 cfs occurring at 2.30 hours. Currently, this amount flows the entire distance of the Black's Diversion Channel and empties into the Calabacillas Arroyo. Hydrograph number 2 shows the result of the above flow being routed approximately 4500 feet to the proposed inflow at Seven Bar Loop Road. This hydrograph is similar to Hydrograph number 1 with a peak that still occurs approximately at 2.30 hours and a minor reduction in peak flow to 3654.1 cfs that resulted from the routing.

Hydrograph number 3 shows the routed flows from Basin E and Basin C at a point where they are proposed to enter the Black's Diversion Channel. Note that the peak flow of 52.3 cfs occurs at 1.50 hours, this is 0.8 hours (48 minutes) ahead of the peak flow in the Diversion Channel. This is a conservative value for the peak flows in Basins E and C

because, while the basins are small and the routing is over a short distance, the minimum basin time to peak for AHYMO was set at 8 minutes, the actual time to peak is probably less than 8 minutes. Accordingly, it is also likely that the time to peak in the storm drain at the Diversion Channel is before 1.50 hours. By referring to the rating curve after hydrograph number 1 and hydrograph number 2, the flow in the Diversion Channel at 1.50 hours is 511 cfs, which corresponds to a water surface elevation of approximately 1.76 feet above the channel invert. If the proposed storm drain connection is a 42" pipe entering 12" above the channel invert, then the pipe soffet will be 2.74 feet above the channel water surface elevation when the peak flow is in the pipe.

Hydrograph number 4 is the resultant hydrograph from the addition of hydrographs 2 and 3. Hydrograph number 3 has been added in the hand-written column to show its relation to the total hydrograph. As can be seen, the peak flow for the Diversion Channel is 3657.8 cfs, which is equal to the unrouted flow at the beginning of the Diversion Channel (hydrograph number 1), and it still occurs at 2.30 hours. At the time of the Diversion Channel peak, only residual flows (4 cfs) are remaining in the Seven Bar Loop storm drain system.

CONCLUSION

In conclusion, the flow from a proposed storm drain system in Seven Bar Loop Road does not appreciably impact the peak flow in the Black's Diversion Channel. This conclusion can be reached primarily because the flow in the proposed public storm drain system peaks and subsides significantly in advance of the peak flow in the Diversion Channel

We respectfully request your earliest possible review and approval of this proposed public storm drain connection to Black's Diversion Channel. Please notify Cliff Anderson at AMAFCA, as well as ourselves, of your decisions regarding this matter. Additionally, please let us know if your office or AMAFCA's will provide construction drawing review and approval, and if there are special criteria that must be followed during our design stages. If we can provide any additional information or can answer any questions, please feel free to contact James Topmiller or me.

Sincerely,

DANE FREDENBURG

Dane Fredenburg
Community Development and Planning

DF/rkl
Enclosures

cc: Mr. Cliff Anderson, AMAFCA
Mr. Bill Allen, Brown and Associates

i:\cdp\9229240\odell.ltr-3/29/93

United States Department of Agriculture
Soil Conservation Service
517 Gold Ave., SW, Room 3301
Albuquerque, New Mexico 87102

April 12, 1993

Mr. Dane Fredenburg
Bohannan-Huston, Inc.
7500 Jefferson St. NE
Albuquerque, NM 87109

Dear Mr. Fredenburg:

We have completed our review of your March 29, 1993, proposal to introduce 52.3 cfs to the Blacks Arroyo Diversion (Corrales FWD-2 Channel) from the storm drain system of Tracts N-2A-1 and N-2A-2 at the Seven Bar Ranch.

The basis supporting your proposal is that the timing of the peak discharge from this source is such that it will not be additive to that in Blacks Diversion. It is well prepared and presented.

Based on the above, we concur with your proposal. We do, however, suggest you consider the following:

1. In the last sentence of the "Channel History" section of your March 29, 1993, letter, it states: "The current sediment laden capacity of the Black's Diversion Channel using SCS criteria for freeboard and superelevation has been determined to be 3700 cfs".

While correct if carefully used and interpreted, this statement may be confusing or misleading to some, ie: 3700 cfs is the absolute maximum capacity, after the clear water discharge has been bulked. The diversion will not handle "3700 cfs of sediment laden flow" from hydrologic runoff alone. It may be clearer to say "the channel capacity for sediment laden flow varies from 3574.2 cfs to 3648.2 cfs because when bulked this volume approaches the absolute capacity of the diversion; 3700 cfs". Another way of expressing the above is that if the flow were truly clear water flow, the "capacity", in fact, would be 3700 cfs; it is much less (3574.2 to 3648.2 cfs) when sediment laden.

2. On June 5, 1990, we concurred in your May 1990 "Sediment Issues" report, including the 80 percent trap efficiency of the upstream dam. While we feel the dam is a positive step toward controlling the sediment load of the diversion, we also feel that the assumed 20 percent of sediment passing through the dam still constitutes a sediment laden condition and that the use of this assumption remains valid.

3. You are probably aware that the Corps of Engineers has publicly criticized the Harvey Jones Channel (Corrales FWD-1). They have reported that they believe the 100-year capacity should be much greater. The hydrologic differences appear to be in three areas: 1) their use of a "expected probability factor" (safety factor), 2) simultaneous peaking of both branches, and 3) a greater degree of upstream development. Their expected probability factor seems to create the greatest difference and is not used consistently throughout the area. We have not concurred in its use and particularly do not concur in the somewhat arbitrary manner in which it is applied.

They have also criticized the hydraulics, even though they reviewed and concurred in its design in 1990. It appears they have unpublished research that indicates roughness values in lined, sediment laden channels, that are higher than that now used by most designers. We have not, however, been able to obtain a full copy of the report. We will not likely be using this as criteria until we have had the opportunity to review it to determine its applicability.

You may wish to consider some of the above in current or future work; at present, we are not for the reasons stated.

If we can be of further assistance, please let us know.

Sincerely,

J. GORDON ODELL
State Conservation Engineer

cc: Mr. Cliff Anderson, Albuquerque Metropolitan Arroyo Flood Control Authority, 2600 Prospect N.E., Albuquerque, NM 87107