CITY OF ALBUQUERQUE

ALBUQUERQUE, NEW MEXICO

INTER-OFFICE CORRESPONDENCE January 6, 1984 REF. NO._____

TO: Fred Aguirre, Civil Engineer/Hydrology

FROM: Jim Fink, Planning & Programming Hydrologist Jim Fink

SUBJECT: EMBUDO HILLS CHANNEL

My biggest concern with the proposed diversion channel configurations that Bohannan,Huston proposed is that it is undesirable to have sheet flows entering the concrete lined channels. These flows have the potential to start paralleling the edge of the concrete section and eventually undermining the channel.

JF/tsl

FILE w/ REPORT

J23-D9

BOHANNAN-HUSTON INC.
4125 CARLISLE BLVD., N.E. ALBUQUERQUE, NEW MEXICO 87107 (505) 881-2000
6713 VISCOUNT BLVD., EL PASO, TEXAS 79925 (915) 778-4491
330 GARFIELD SANTA FE, NEW MEXICO 87501 (505) 988-7671

December 19, 1983

Mr. Fred Haas
Design Engineer
MSM-SP Group
2601 Wyoming Blvd., NE
Albuquerque, NM 87112

Dear Fred:

The purpose of this letter is to express our understanding of some of the comments contained in the Embudo Hills Drainage exhibit submitted to Fred Aquirre on December 13, 1983. As was agreed upon at the meeting of October 31, 1983, the entire internal storm drain system will be designed by Bohannan-Huston, Inc. As a part of this design, the necessary diversion berms and inlet structure to the storm drain on the northern boundary of the development will also be done by Bohannan-Huston, Inc. We will also design the upland diversion channel on the southeast boundary of the property.

However, it is not our understanding, nor our intention to design any diversion facilities which may be required to divert any upland flows from that portion of land immediately east of the American Service Corporation Development. The only off-site flows we are intercepting are those which are collected at the upstream terminus of the storm drain and the flows which enter the upland diversion channel.

It is also our understanding that the design of any facilities required to convey runoff across drainage easements between streets will be the responsibility of the American Service Corporation's consultant.

If you have any questions, please contact Marlin Larson or me.

Sincerely yours,

Michial M. Emery

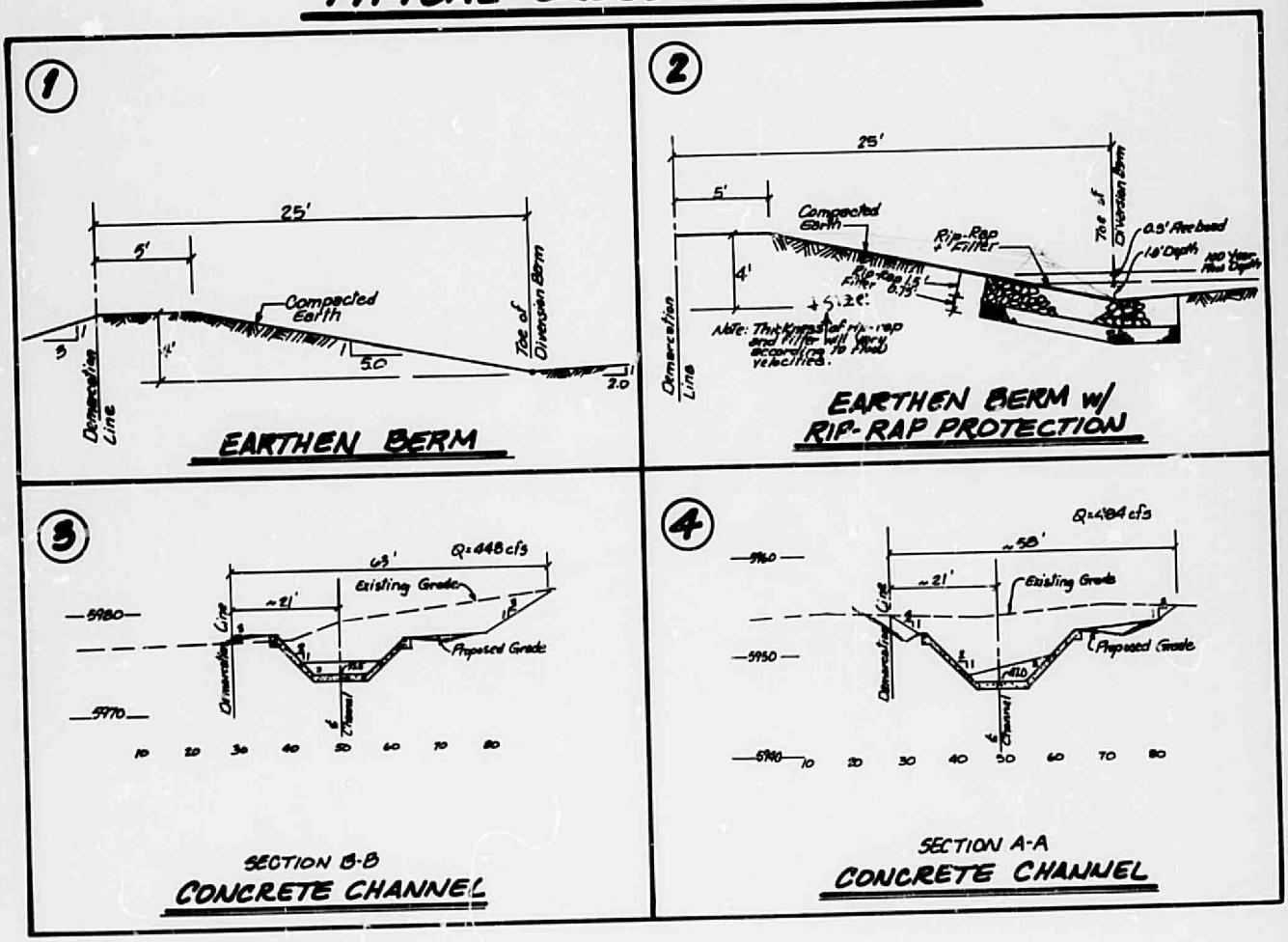
Michial Emery, P.E.
Vice President

cc: Mr. Ron Brown
Mr. Steve Tomita
Mr. Fred Aguirre

J23-D9 A-1

KD:vg
Job No. 3 182 0

TYPICAL CROSS-SECTIONS



To: File 31820

From: Brian Burnett

Re: Embudo Hills Channel - Field Visit with Rex Funk - 12/20/83

Dave Millikan & I meet in the field with Rex Funk, City Parks and Recreation to discuss the Embudo Hills Diversion Channel. Important items discussed were:

1. Side-slopes of berms should be held at 5:1 maximum.

2. Any rip-rap material used to protection the diversion berm should be of native material (NO BROKEN CURB & GUTTER)

3. Rigorous erosion control plan should be specified for disturbed areas. Rex should be contacted to establish proper vegetative mix

4. Excavation limits should be shown on the plan to minimize disturbance of native top-soil.

5. Construction plans should be routed to Rex for review and comment

I, BRIAN G. BURNETT, a New Mexico Registered Professional Engineer in Civil Engineering, certify that the accompanying report was prepared by me, or under my direction, and is true and correct to the best of my knowledge and belief.

Brian G. Burnett 7-24-84

Brian G. Burnett, P.E. Date

N.M.P.E. No. 8541

DESIGN REPORT
FOR
EMBUDO HILLS UPLAND DIVERSION CHANNEL

PREPARED FOR:

SPROUL ENTERPRISES
P.O. BOX 25485
ALBUQUERQUE, NEW MEXICO 87125

PREPARED BY:

BOHANNAN–HUSTON, INC.
4125 CARLISLE BOULEVARD N.E.
ALBUQUERQUE, NEW MEXICO 87107

JANUARY, 1984

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FIGURES

APPENDIX

POCKET

PURPOSE AND SCOPE

The purpose of this report is to present supporting analysis and assumptions for the design of the Embudo Hills Upland Diversion Channel. Topics discussed are broken down in the following outline:

- **I. PROJECT LOCATION AND DESCRIPTION**
- **II. HYDROLOGY**
  - A. Review of Embudo Hills Drainage Master Plan
  - B. Location of Small Diversion Berm
  - C. Topographic Information
- **III. SOILS INVESTIGATION**
  - A. Seismic Refraction Survey Report
  - B. Field Observations and Testing
  - C. Plot of Rock Profile
- **IV. DIVERSION CHANNEL CHARACTERISTICS**
  - A. Earthen Diversion Berm
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    2. Flow depths and velocities
    3. Riprap sizing
    4. Centerline location
  - B. Concrete Diversion Channel
    1. Flow depths and velocities
    2. Superelevation and freeboard
    3. Typical cross sections
    4. Centerline location
- **V. HYDRAULIC DESIGN**
  - A. Upper Transition (earthen diversion to concrete diversion)
    1. Sediment considerations
    2. Hydraulic jump potential
    3. Bank protection
  - B. Concrete Confluence (at existing Upper Lomas Channel)
    1. Confluence angle
    2. Transition length and bottom width of diversion channel
    3. Flow rate combinations and design guidelines
    4. Momentum balance check
    5. Superelevation
    6. Wave propagation
  - C. Water Surface Profile

VI. MISCELLANEOUS ITEMS

A. Utility Conflicts
B. Maintenance and Access
C. Erosion Control
D. Limits of Construction
E. Introduction of Off-Site Flows
F. Joint Details/Expansion Joint
G. Impacts of Diversion Channel on American Services Subdivision

I. PROJECT LOCATION AND DESCRIPTION

The Embudo Hills Upland Diversion Channel is located in northeast Albuquerque adjacent to the Sandia Mountain foothills. Figure 1 identifies the project area. The diversion channel is one element of a comprehensive drainage management plan for the Embudo Hills Subdivision.

The diversion facility will consist of a concrete channel and earthen berm. Its primary purpose is to divert upland runoff around the proposed subdivision and into the Upper Lomas Channel. Runoff is then conveyed westward to the Lomas Desalting Basin. From the basin, storm waters eventually discharge into the Tijeras Arroyo via the Lomas and Tramway Channels.

II. HYDROLOGY

A. Review of Drainage Master Plan

Peak flow rate information for the basins impacting the diversion facility is contained in the "Drainage Master Plan for Embudo Hills," by Bohannan–Huston, Inc. This report was published in March, 1981.

Contained in the rear pocket is a plate indicating the developed condition flow rates. The peak flow rate at the concrete confluence is 1698 cfs.

As outlined on the drainage plate, Basins U3 and U4 generate a combined flow rate of 448 cfs. By proportioning the total flow rate based on watershed size, Basin U3 generates approximately 115 cfs and Basin U4 generates approximately 333 cfs.

For design purposes, the following flow rates will be utilized:

Upper Lomas Channel:	1214 cfs
Embudo Hills Diversion Channel –	
Sta 4+00 to 9+00:	484 cfs
Sta 9+00 to 14+00:	48 cfs
Sta 14+00 to 27+50:	130 cfs
Concrete Confluence:	1698 cfs

B. Small Diversion Berm

One of the important elements of the management plan is the construction of a small diversion berm which will be constructed on City Open Space at approximately Station 21+00, just east of the larger, earthen diversion berm. The purpose of this berm is to insure that one of the flow paths in Basin U4 does not run along the demarcation line between Stations 14+00 and 21+00. The topographic information on the Master Drainage Plate (in rear pocket) clearly indicates that there is a potential for this flow path to run along the demarcation line beginning at Station 21+00. The berm will be 3 feet high with 5:1 side slopes.

C. Topographic Information

Topographic information at a 1"=50' scale was obtained from aerial reconnaissance and plane table surveys.

III. SOILS INVESTIGATION

A. Seismic Refraction Survey

In October, 1982, the firm of Sergent, Hauskins, and Beckwith (SH&B) conducted a seismic refraction survey for the centerline of the diversion channel. Basically, the report attempted to identify the depth at which rock outcrops would be encountered during excavation. Appendix 1 contains a copy of the report. The principal findings of the study are as follows:

1. The alignment of the proposed drainage channel is underlain by granite bedrock with a veneer of alluvial soils.
2. The bedrock appears weathered, with the upper portion approaching soil in consistency.
3. The calculated depth to competent rock was quite variable, indicating a highly erratic bedrock surface.
4. The alluvial soils and the upper, highly weatered, portion of the bedrock exhibited seismic velocities ranging to 2,500 feet per second and are expected to be readily excavated with conventional earth moving equipment.

B. Field Observations and Testing

A back hoe was used to excavate material at various stations in an effort to verify the soil investigation prepared by SH&B. In general, it was observed that materials with associated wave velocities of 2,500 fps, or less, could be excavated by the equipment. However, materials with wave velocities greater than the 2,500 fps threshold proved much more difficult to excavate. Appendix 2 contains a summary of the field observations.

C. Plot of Rock Profile

Based on the SH&B report and field measurements, a profile was drawn on the diversion channel profile to identify the depth of material that can be excavated using conventional earth moving equipment. Removal of material below this profile would probably require blasting.

IV. DIVERSION CHANNEL CHARACTERISTICS

A. Earthen Diversion Berm

1. Typical cross sections

Figure 2 indicates the typical cross sections for the earthen diversion berm. The basic elements of these cross sections have been reviewed and approved by both the City Hydrology Section and the Parks and Recreation Department.

2. Flow depths and velocities

The diversion berm is located between Stations 14+00 and 27+50. Based on the proposed channel slopes, Mannings Equation was utilized to compute flow depths and velocities for the various reaches. A Manning's 'n' value of 0.30 was used. Following is a summary of the computations:

Start Station	End Station	Slope	100-Year Flow Depth (ft)	100-Year Flow Velocity (fps)	
14+00	14+25	0.060	1.35	9.5	
14+25	18+00	0.0813	1.30	10.3	(Figure 2b)
18+00	21+00	0.0767	1.30	10.3	
21+00	23+00	0.045	1.40	8.8	(Figure 2a)
23+00	27+30	0.010	1.90	4.8	

3. Riprap sizing

Due to the relatively low flow velocities in the upper reach of the diversion berm, no riprap protection has been proposed between Stations 23+00 and 27+30. Figure 2a depicts the typical cross section for this reach.

Channel slopes between Stations 14+00 and 23+00 range from 0.045 to 0.092. Due to the increase in flow velocities along this reach, riprap protection was selected to minimize erosion along the side slope and toe of berm. Figure 2b indicates a typical cross section utilizing the riprap.

Riprap was sized using information contained in the ***"Design of Stable Channels with Flexible Linings,"*** published by the U.S. Department of Transportation. Figure 3 contains a chart which can be used to select the D_{50} material size based on flow depth and

channel slope. The filter blanket consists of pit-run gravel with average size of 5/8". The thickness of the riprap was computed as 1.5 times the D_{50} size, while the thickness of the filter material was computed as 0.75 times the D_{50} size. Embedment configuration was based on information contained in the AMAFCA publication entitled, "Design Guide for Riprap Lined Flood Control Channels."

4. Centerline location

In January, 1983, Bohannan–Huston, Inc. approached the City and EPC to relocate the demarcation line which separates the Embudo Hills Subdivision from City Open Space. Appendix 3 contains a letter which outlines the key reasons for the request.

Once the new demarcation line was established, the centerline of the diversion channel was placed ~~25~~ 31 feet from the line. This allowed for the design of a 4-foot high diversion with 5:1 side slopes. The advantage of the shallow side slopes is that they minimize the visual impact of the facility on City Open Space.

B. Concrete Diversion Channel

1. Flow depths and velocities

The concrete diversion channel extends from the upper Lomas Channel confluence at Station 3+50 to Station 14+00. Based on Manning's Equation, the channel flow depths and velocities are as follows:

Station Start	Station End	Slope	Flow Depth	Flow Velocity	Super-elevation	Freeboard	TOTAL DEPTH
3+95	6+00	.0826	2.14'	31.47	1.01'	3.01'	6.16'
6+00	6+50	.0852	1.89'	37.72	1.35'	3.17'	6.41'
6+50	7+00	.0852	1.57'	35.85	1.57'	3.04'	6.03'
7+00	7+50	.0852	1.35'	34.09	1.48'	2.94'	5.77'
7+50	8+00	.0852	1.20'	32.43	1.53'	2.86'	5.59'
8+00		.0425	1.46'	25.65	1.02'	2.73'	5.21'
	12+00	.0425	1.46'	25.65	—	2.73'	4.19'
12+00	14+00	.060	1.27'	28.12	—	2.76	4.03'

2. Superelevation and freeboard

Superelevation was computed utilizing the equation:

$$S = 1.3 \frac{V^2(b+2zD)}{gr}$$

Freeboard was computed utilizing the equation:

$$2 + 0.025 V \sqrt[3]{D}$$

3. Typical cross sections

Typical cross sections for the concrete diversion channel are shown in Figure 4. Per DPM 22.8 D., the channel thickness will be 8" in reaches with velocities exceeding 30 f.p.s.

4. Centerline location

The centerline location was matched to the ~~25~~ 31-foot offset from the demarcation line established for the earthen diversion berm. The distance permits the construction of a 12-foot maintenance road on the west side of the channel (Section VI B).

V. HYDRAULIC DESIGN

A. Upper Transition (Earthen Diversion to Concrete Diversion)

1. Sediment considerations

One method of designing the transition from the earthen cross section to the concrete cross section was to create a "sediment pool" immediately upstream of the concrete section. This would allow sediment to drop out and the water surface to reach the required energy grade line for conveyance down the concrete channel. To be effective, this method requires frequent maintenance of the "sediment pool". In an effort to minimize maintenance of this area, an alternate design was selected. This approach attempts to accelerate the runoff through the transition and into the concrete channel. And any sediment conveyed in the concrete channels will be dropped out of the system at the Lomas Basin.

A 5-foot concrete cutoff wall will be provided along with riprap bank protection upstream of the concrete section.

2. Hydraulic jump potential

A computer program entitled "DITCH" was used to analyze the potential of a hydraulic jump at the transition from earthen channel to concrete channel. This program was developed by Bohannan–Huston, Inc. to compute flow characteristics for trapezoidal sections. Appendix 4 contains the cross sections and data used in the program. The computer output is also included. The high Froude numbers (>2.0) indicate that the potential of a hydraulic jump occurring at the transition is very small. Due to the depth of runoff at this location, the berm and concrete channel freeboard was increased to 5 feet.

3. Bank protection

Using Figure 3, a riprap D_{50} size of 2.0 feet was selected. As outlined in Section IV A.3., the riprap layer is 3.0 feet thick along with a filter material thickness of 1.5 feet. The construction plan detail for the transition indicates the limits of bank protection.

B. Concrete Confluence (at existing Upper Lomas Channel)

1. Confluence angle

The Corps of Engineers manual entitled ***Hydraulic Design of Flood Control Channels*** states that confluence angle (or angle of junction intersection) "should be preferably zero, but not greater than 12 degrees". The confluence angle for this project is approximately 3° which is well below the 12° standard established by the Corps.

2. Transition length and bottom width of diversion channel.

The transition length from a 10-foot bottom, 2:1 side slope channel to a 4-foot bottom, 1.5:1 channel is 150 feet. The hydraulic analysis of this transition is outlined in the next sections. A 4-foot bottom width was selected to permit small earth moving equipment some mobility if removal of sediment is required. (It should be noted that bottom widths less than 4 feet will meet the necessary hydraulic conditions; however, the 4-foot width was selected to address maintenance concerns).

3. Flow rate combinations and design guidelines

Section 22.4 of the DPM lists the following criteria for combining flows when the side inlet flow is in excess of 25% of the main channel flow:

a. Velocity head for flows from both chan s within one foot of each other for the 10-year and 100-year design discharges and the four combinations of side inlet and main channel flows which result.

b. The depth of flow for the side inlet and the main channel must be matched within 20% for both the 10-year and the 100-year design discharges and the four combinations of side inlet and main channel flows which result.

c. The centerline radius of the side channel may not be less than the quantity (QV/100) in feet.

d. Energy and momentum balance type equations must be provided to support all designs involving side channels.

The program DITCH was used to compute flow depths and velocities for the side and main channels. For reference, Station 13+50 was used to obtain values in the Upper Lomas Channel, and Station 5+100 was used to obtain values in the diversion channel. The following table summarizes useful data:

Channel	Flow Rate (cfs)		Velocity (fps)		Depth (ft)		Velocity Head (ft)	
	10*	100	10	100	10	100	10	100
Upper Lomas	798	1214	35.4	39.9	1.78	2.27	19.5	24.7
Embudo Diversion	318	484	30.0	32.5	1.64	2.09	14.0	16.40

*10-year flows = .657 x (100-year flows)

Appendix 5 contains output from the program.

As indicated in the table, criteria A cannot be met in any case. This is primarily due to extremely high velocities encountered in the Upper Lomas Channel. This particular criteria is extremely difficult to meet since the slope and configuration of the Upper Lomas Channel cannot be changed. Based on the fact that other criteria is more closely matched and that the momentum balance is satisfactory, we feel that the hydraulic performance of the confluence is acceptable even though criteria A is not met.

The flow depths for the 10-year and 100-year design discharges do match within 20%. The other flow combinations (100-yr.-10-yr., 10-yr.-100-yr., 0-100-yr.,100-yr.-0) were investigated; however, the flow depths do not meet the 20% criteria. The impacts on the channel from flow combinations listed above are discussed in a later section.

The centerline radius of the side channel is greater than (QV/100 in feet), therefore criteria C is met. Criteria D is discussed in the next section.

4. Momentum balance check

An energy and momentum balance equation was used to analyze the confluence. The equation which seemed most applicable is as follows:

$$\frac{Q_3^2}{gA_3}\cos\alpha_3 + \left(\frac{b_3}{2} + \frac{zd_3}{3}\right)(d_3)^2\cos^2\alpha_3 = \frac{Q_1^2}{gA_1}\cos\alpha_1 + \frac{Q_2^2}{gA_2}\cos\alpha_2\cos\theta + \left(\frac{b_1}{2} + \frac{zd_1}{3}\right)d_1^2\cos^2\alpha_1 + A_2 h - \frac{P_2 l n^2 V_2^2}{2.21\, R_2^{1/3}}$$

The equation is presented in detail on Page 5-13 of ***Technical Release No. 25—Design of Open Channels*** by the Soil Conservation Service, and has been included as Figure 5.

Obviously, the above equation is quite cumbersome due to the many terms. Therefore, a computer program entitled MOMENTUM was used to simplify computations. The program produces a rating curve for different flow depths given a specific flow rate. The right-hand column of the output (Appendix 6) represents the momentum term of the equation. For a trapezoidal channel, the following equations apply:

$$M_3 = \frac{Q_3^2}{gA_3}\cos\alpha_3 + \left(\frac{b_3}{2} + \frac{zd_3}{3}\right)d_3^2\cos^2\alpha_3$$

$$M_1 = \frac{Q_1^2}{gA_1}\cos\alpha_1 + \left(\frac{b_1}{2} + \frac{zd_1}{3}\right)d_1^2\cos^2\alpha_1$$

Appendix 7 contains computations using the momentum balance equation. By utilizing values from the DITCH program, a "first guess" was substituted into the equation for the 100-year case. A 12% difference was achieved on this first attempt. Computations are included which zero-in on the terms which balance the equation. The most important term of this final check is that the Froude numbers are greater than 1.3. For the final case, the conditions produce a Froude number of greater than 1.3 indicating that there is sufficient momentum from the two converging channels to push the water into the main, downstream channel and that a hydraulic pump is not likely to occur. This same method was used for three other cases combining the 10- and 100-year flow rates.

5. Superelevation

Superelevation was computed for the curved portion of the concrete diversion channel. In an effort to minimize the efforts of oscillating waves in the channel, superelevation was provided on the inside of the channel, as well. Instead of extending the slope paving up this additional height, concrete blocks were used. See Section IV B.1. for superelevation values. Calculations are included in Appendix 8.

6. Wave propagation

The occurrence of standing waves in the channel is most likely to occur during conditions when high flows occur in the converging channel with little, or no, flow in the main channel. Several equations from Henderson's, ***Open Channel Flow,*** were used to investigate the potential and magnitude of the waves. These equations take the form:

$$\frac{y_2}{y_1} = \frac{\tan\beta_1}{\tan(\beta_1 - \theta_1)}$$

$$\sin\beta_1 = \frac{1}{F_1}\sqrt{\frac{1}{2}\left(\frac{\tan\beta_1}{\tan\beta_1 - \theta}\right)\left(\frac{\tan\beta_1}{\tan\beta_1 - \theta_1} + 1\right)}$$

also: $\sin\beta = \frac{1}{F_1}\sqrt{\frac{1}{2}\frac{y_2}{y_1}\left(\frac{y_2}{y_1} + 1\right)}$

Calculations indicated that for the case of the 100-year flow in the Embudo Channel and 0 flow in the Upper Lomas Channel, wave could occur with total height of the water surface ranging from 6 to 6.5 feet, indicating that the waves will not be contained within the channel downstream of the confluence. Therefore, a splitter wall was included to minimize the occurrence of the standing waves.

C. Water Surface Profile

The DITCH program was used to establish the water surface profile for the channel. One set of the construction plans has been marked showing the water surface profile. Computer output is included in Appendix 9.

VI. MISCELLANEOUS ITEMS

A. Utility Conflicts

A 16" concrete transmission line crosses beneath the diversion channel at approximately Station 10+75. As indicated on the profile sheets, the line is about 10 feet below the channel invert at that point.

B. Maintenance and access

A maintenance road is proposed for the west side of the concrete channel. The width of the road is 15 feet, as stated in the DPM. Access to the maintenance road will be from the 20-foot waterline easement which runs westward from Monte Largo Drive. It is proposed that the 5:1 side slope along the earthen diversion berm be utilized as the maintenance road for this reach of the channel.

C. Erosion Control

Rex A. Funk, of City Parks and Recreation, was contacted for assistance in establishing an erosion control plan for areas disturbed during construction. The vegetative mix outlined in Appendix 10 has been used on areas in the Elena Gallegos Grant and in several City Parks located in the Sandia Mountain Foothills.

D. Limits of Construction

In an effort to minimize grading on City Open Space, limits of construction have been outlined on the plans. The boundaries represent the area in which the contractor is authorized to grade. All other areas are off-limits.

E. Introduction of Off-Site Flows

Several well-defined arroyos impact the concrete diversion channel. At these locations, side inlets are placed in the channel.

F. Joint Details/Expansion Joint

Joint details, established by the City Hydrology Section, will be used. The joints are similar to those used on the Pino–Beta Channel Project. Expansion joint calculations are included in Appendix 11. Two joints have been included to meet the 3" requirement.

G. Impacts of Diversion Channel on American Services Subdivision

The berm and channel will impact grading in the proposed American Services Subdivision. Throughout the design phase, close coordination has been carried out with the developer's engineer.

EMBUDO HILLS

MAJOR RESIDENTIAL STREET LAYOUT

MAJOR RESIDENTIAL STREET

OTHER RESIDENTIAL STREET

ROUNDS ESTATE

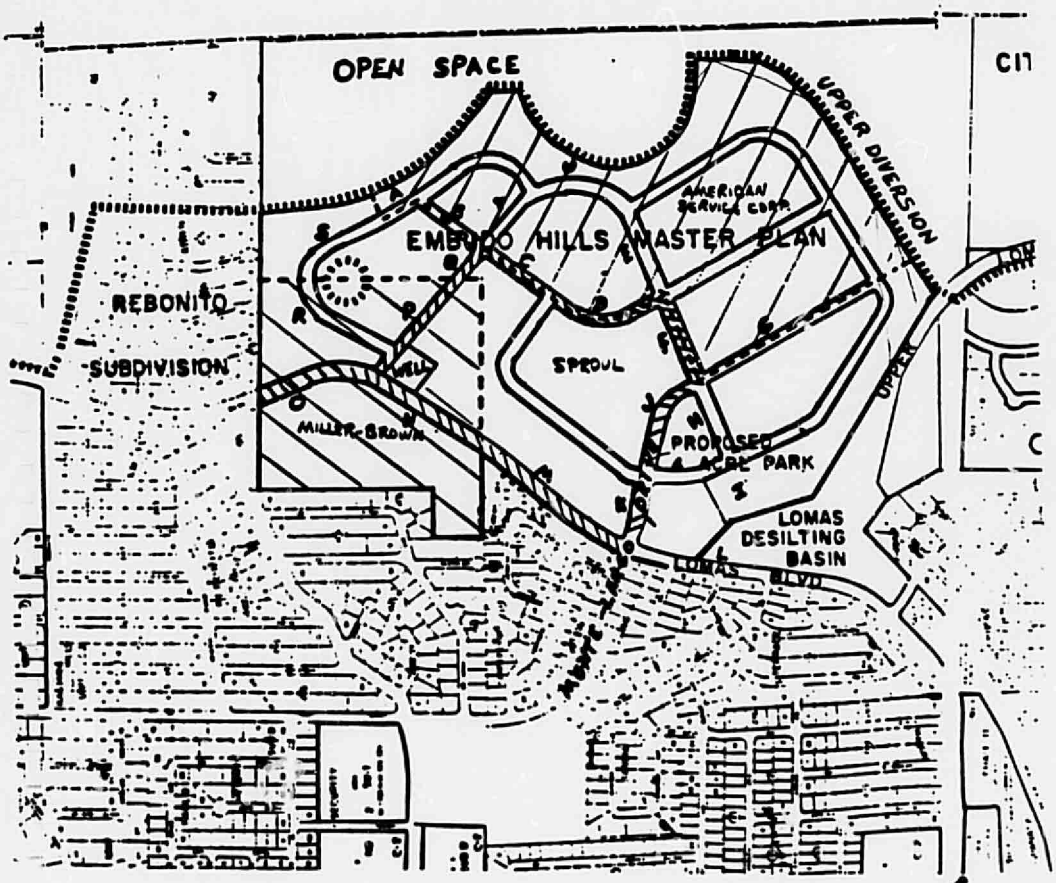
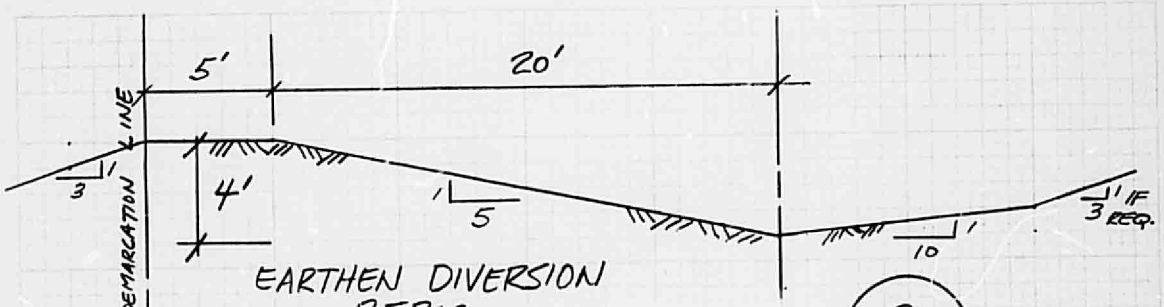


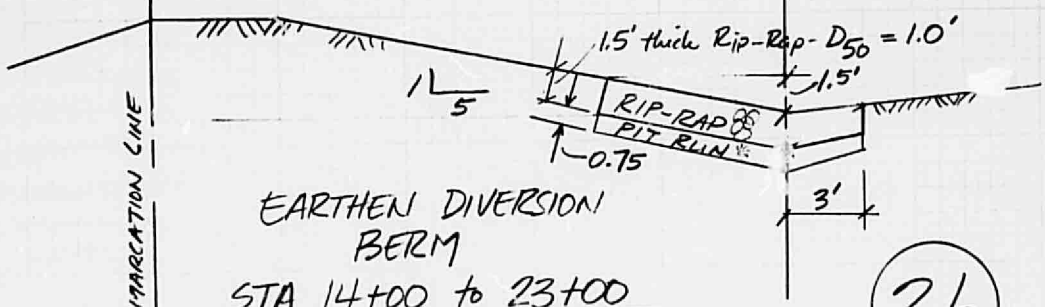
FIGURE 1

1



EARTHEN DIVERSION
BERM
STA 23+00 to 27+30

29

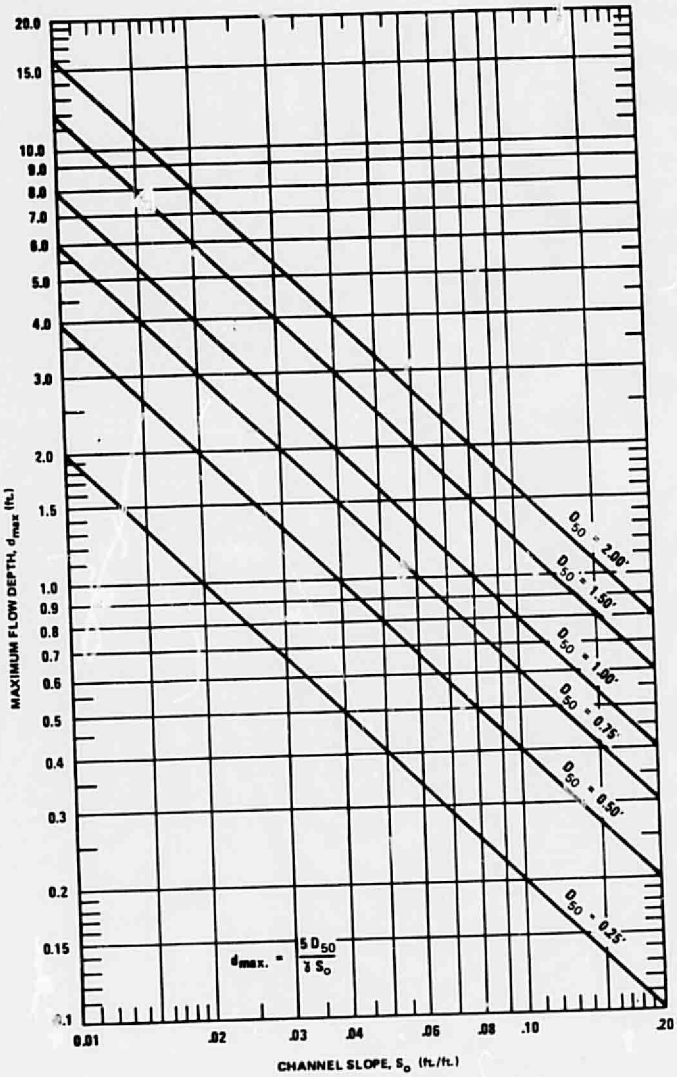


EARTHEN DIVERSION
BERM
STA 14+00 to 23+00

26

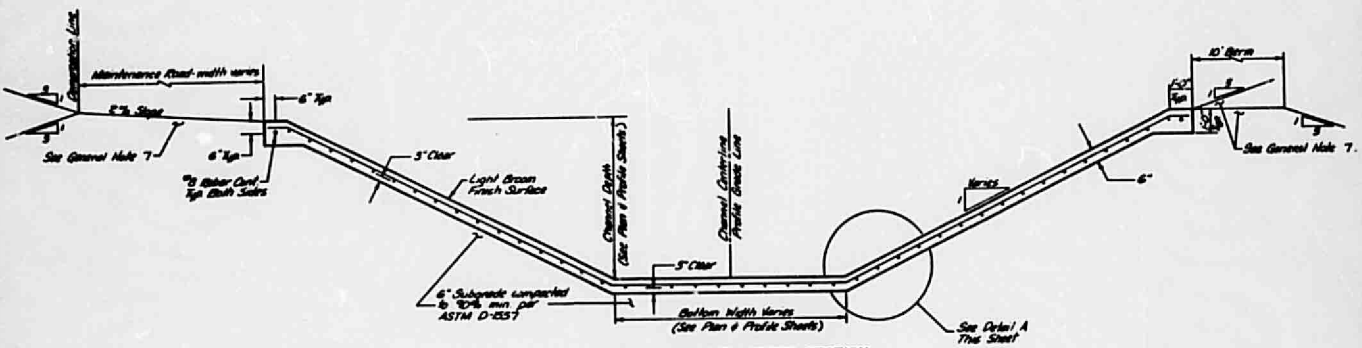
PROJECT NAME
PROJECT NO.
SUBJECT
SHEET
OF
BY
DATE
CH'D
DATE

Chart 27



MAXIMUM PERMISSIBLE DEPTH OF FLOW (d_{max})
FOR CHANNELS LINED WITH ROCK RIPRAP

3



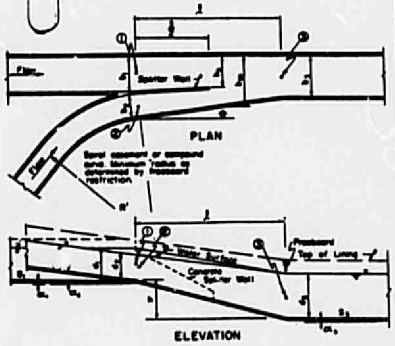
TYPICAL CHANNEL CROSS SECTION

4

NOMENCLATURE

A	= cross-sectional area of water prism	ft.^{2}
b	= base width of channel section	ft.
c	= constant - see Chart A	--
d	= vertical depth of water	ft.
g	= acceleration due to gravity (32.2)	fps.^{2}
h	= difference in invert elevation between any two sections	ft.
L	= length of channel reach	ft.
n	= coefficient of roughness in Manning's formula	--
P_a	= average wetted perimeter between two sections	ft.
P_m	= wetted perimeter at middle section	ft.
Q	= rate of discharge	cfs.
R_a	= average hydraulic radius between two sections	ft.
R_m	= hydraulic radius at middle section	ft.
R'	= radius of curve on centerline	ft.
S_c	= critical slope of channel invert	--
S	= channel invert slope	--
V_a	= average velocity between two sections	fps.
V_m	= velocity at middle section	fps.
Z	= side slope of trapezoidal section (horizontal to vertical)	--
θ	= angle of merging channels	deg.
α'	= invert slope angle	deg.
F	= Froude number	--

Numerical subscripts refer to appropriate channel numbers.



1. TRAPEZOIDAL CHANNELS

Constant Width Main Channel

$$\frac{Q^2}{gA_1}\cos\alpha_1 + \left(\frac{b_1}{2} + \frac{Zd_1}{2}\right)\left(d_1^2\right)\cos^2\alpha_1 + \frac{Q^2}{gA_1}\cos\alpha_1 + \frac{Q^2}{gA_2}\cos\alpha_2\cos\theta + \left(\frac{b_2}{2} + \frac{Zd_2}{2}\right)\left(d_2^2\right)\cos^2\alpha_2 + L_a S_c - \frac{P_a L^2 V_a^2}{2.21\, R_a^{1/3}}$$

Unequal Width Main Chann. 1

$$\frac{Q^2}{gA_1}\cos\alpha_1 + \left(\frac{b_1}{2} + \frac{Zd_1}{2}\right)\left(d_1^2\right)\cos^2\alpha_1 + \frac{Q^2}{gA_1}\cos\alpha_1 + \frac{Q^2}{gA_2}\cos\alpha_2\cos\theta + \left(\frac{b_2^2}{2} + \frac{Zd_2}{2}\right)\left(d_2^2\right)\cos^2\alpha_2 + (h_1\cos\alpha_1)\, L_a S_c - \frac{P_a L^2 V_a^2}{2.21\, R_a^{1/3}}$$

Note: For flows at supercritical velocities these equations may be used only for preliminary design. Final design must be based on results of supplemental hydraulic model studies.

$$d_m = \frac{d_3 + d_1}{2}$$

2. RECTANGULAR CHANNELS

Constant Width Main Channel

$$\frac{Q^2}{gA_1}\cos\alpha_1 + \frac{b_1 d_1^2}{2}\cos^2\alpha_1 - \frac{b_1 d_1 b}{2} + \frac{Q^2}{gA_1}\cos\alpha_1 + \frac{Q^2}{gA_2}\cos\alpha_2\cos\theta + \frac{b_2 d_2 b}{2} + \frac{b_2 d_2^2}{2}\cos^2\alpha_2 - \frac{P_a L^2 V_a^2}{2.21\, R_a^{1/3}}$$

Unequal Width Main Channel

$$\frac{Q^2}{gA_1}\cos\alpha_1 + \frac{b_1 d_1^2}{2}\cos^2\alpha_1 - \frac{b_1 d_1 b}{2} + \frac{Q^2}{gA_1}\cos\alpha_1 + \frac{Q^2}{gA_2}\cos\alpha_2\cos\theta + \frac{b_2 d_2 b}{2} + \frac{b_2 d_2^2}{2}\cos^2\alpha_2 + \frac{(b_2 - b_1)}{2}\left(d_2^2\right)\cos^2\alpha_2 - \frac{P_a L^2 V_a^2}{2.21\, R_a^{1/3}}$$

SPECIAL CASE

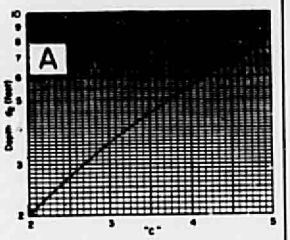
Limiting Criteria - Rectangular Channels
Supercritical Velocity Flow in All Branches.

Constant Width Main Channel

$$\frac{Q^2}{gA_1} + \frac{b_1 d_1^2}{2} - \frac{b_1 d_1 b}{2} = \frac{Q^2}{gA} + \frac{Q^2}{gA_2} + \frac{b_2 d_2 b}{2} + \frac{b_2 d_2^2}{2} - \frac{P_a L^2 V_a^2}{2.21\, R_a^{1/3}}$$

Unequal Width Main Channel

$$\frac{Q^2}{gA_1} + \frac{b_1 d_1^2}{2} - \frac{b_1 d_1 b}{2} = \frac{Q^2}{gA_1} + \frac{Q^2}{gA_2} + \frac{b_2 d_2 b}{2} + \frac{b_2 d_2^2}{2} + \frac{(b_2 - b_1)}{2}\left(d_2^2\right) - \frac{P_a L^2 V_a^2}{2.21\, R_a^{1/3}}$$



Criteria

$\tan\alpha < 0.1$

Convergence angle θ less than 10°

$F = \frac{V}{\sqrt{gd}} \geq 1.2$

$\theta \quad \geq 10^\circ$

$1.2 \geq \frac{d_1}{d_2} \geq 0.8$

Height of sidewall at ③ $= 1.2\, d_3 + 0.25\, d_3 \left[1 - 11.1\left(\frac{d_3}{d_2} - 1\right)^2\right] + 1.2\, \frac{V_3^2 b_3}{gA_3}$

Height of splitter wall
upstream $= d_{1,2}$ max.
downstream $= 6''$ min.

$$\ell = d_3\left[b_1 + b_2 - b_3\right]^{1/3}$$

$b_3 \geq 0.8\,(b_1 + b_2)$

$$b_0 = \frac{b_1(b_1 + b_2 + b_3)}{(b_1 + b_2)} \quad \text{when } b_1 > b_2$$

$$b_0 = \frac{b_2(b_1 + b_2 + b_3)}{(b_1 + b_2)} \quad \text{when } b_1 < b_2$$

FIGURE 5-1
HYDRAULICS JUNCTION STRUCTURES

REFERENCE: FLOW ANALYSIS AT OPEN CHANNEL JUNCTIONS; U.S.C.E.-L.A. 1947

5

SERGENT, HAUSKINS & BECKWITH

SEISMIC REFRACTION SURVEY REPORT

Upland Drainage Channel at Embudo Mills

Albuquerque, New Mexico

SHB Job No. 882-1203

Consulting Geotechnical Engineers

SHB

SERGENT, HAUSKINS & BECKWITH CONSULTING GEOTECHNICAL ENGINEERS

APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING

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NORMAN H. WETZ, P.E.
WAYNE A. ERICSON, P.E.
JOHN B. HAUSKINS, P.E.
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DONALD G. METZGER, P.G.
ALLON C. OWEN, JR., P.E.
ROBERT D. BOOTH, P.E.
ROBERT W. CROSSLEY, P.E.
RALPH E. WEEKS, P.G.

October 26, 1982

SHB Job No. E82-1103

Bohannan-Huston, Inc.
4125 Carlisle Boulevard, N.E.
Albuquerque, New Mexico 87107

Attention: David M. Y. Millikan, P.E.

Re: Upland Drainage Channel
at Embudo Hills
Albuquerque, New Mexico

Gentlemen:

Our Seismic Refraction Survey Report on the referenced project is herewith submitted. The report presents the acquired seismic refraction data as well as our interpretation and evaluation of the relative ease of excavation of the subsurface materials.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By _____
Darrel L. Buffington, Staff Engineer

Reviewed by _____
Robert D. Booth, P.E.

ROBERT D. BOOTH
REGISTERED PROFESSIONAL ENGINEER

Copies: Addressee (4)

REPLY TO: 4700 LINCOLN ROAD, N.E., ALBUQUERQUE, NEW MEXICO 87109

PHOENIX (602) 272-6848
ALBUQUERQUE (505) 884-0950
SANTA FE (505) 471-7836
SALT LAKE CITY (801) 566-5411

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SHB Job No. E82-1103

Upland Drainage Channel
at Embudo Hills
Albuquerque, New Mexico
SHB Job No. E82-1103

1. INTRODUCTION

This report presents the results of surface seismic refraction surveys performed along the alignment of the proposed Upland Drainage Channel. These surveys were performed to determine the compressional wave velocities and depths to velocity interfaces of the near-surface geologic materials which would be excavated during construction of the drainage channel. The compressional wave velocity is an indirect measurement of the density of a material. Accordingly, the compressional wave velocity can be used to differentiate between soil and rock in the subsurface. Further, the hardness, degree of fracturing and amount of weathering or decomposition of rock, which generally control the excavatability of the rock, also are reflected by the compressional wave velocity.

The proposed drainage channel is to divert surface runoff around the proposed Embudo Hills residential development located east of Lomas Boulevard and Tramway Boulevard. The drainage channel is to have a total length on the order of 2,200 feet and will discharge into the existing Upper Lomas Channel. The alignment of the drainage channel was staked in the field by Bohannan-Huston, Inc. It is understood that maximum cuts on the order of 10 feet will be required for construction of the channel.

2. FIELD INVESTIGATION

A total of 20 seismic refraction surveys were performed along the proposed drainage channel alignment. The surveys were generally performed at 100 foot intervals.

The surveys were performed utilizing a Nimbus Model ES-1200 Signal Enhancement Seismograph. An eight pound sledge hammer striking a metal plate was used for generation of compressional waves. Maximum total geophone spread lengths of 50 feet were used, with geophones spaced at 5 and 10 foot intervals along the spread. Plots of the distance from the impact point to the recording geophone versus travel time of the compression wave for each survey are presented in Appendix A.

3. INTERPRETATION & EVALUATION OF RESULTS

3.1 Seismic Refraction Surveys

The results of the seismic surveys indicate there are from one to three layers of materials with significantly differing velocities within the depth of concern for the proposed construction. Established equations for analysis of refraction survey data enable calculation of approximate depths of these layers based on the change of slope of the distance versus travel time plots for the surveys. These equations make the following assumptions: (1) each layer is isotropic, (2) propogation of

waves in the subsurface materials can be described by straight line rays, (3) velocities increase with depth, and (4) the contact of the layers is horizontal. These assumptions are considered to be generally valid for the geologic conditions along the proposed drainage channel. Table 1, included in Appendix A, presents a summary of the velocities measured and the depth calculated for the layers encountered in the seismic surveys.

Based on the refraction survey data, as well as observed field conditions, the alignment of the proposed drainage channel is underlain by granitic bedrock with a veneer of alluvial soils. The bedrock appears weathered, with the upper portion approaching soil in consistency. The calculated depth to competent rock was quite variable, indicating a highly erratic bedrock surface.

The alluvial soils and the upper, highly weathered, portion of the bedrock exhibited seismic velocities ranging to 2,500 feet per second and are expected to be readily excavated with conventional earthmoving equipment. The thickness of the first layer ranged to 15 feet, but generally was on the order of 2 to 4 feet thick. The underlying materials became more competent with depth. Between stations 1+00 and 7+00, 13+00 and 16+00, and 19+00 and 21+00, the underlying materials to depths of 20 feet or more had seismic velocities in the range of 3,000 to 4,600 feet per second. Based on charts

published by Caterpillar Tractor Company*, excavation of these materials can be accomplished by ripping with a D-8 tractor or equivalent utilizing a single shank ripper. Materials exhibiting seismic velocities in excess of 5,000 feet per second were encountered between stations 8+00 and 12+00, and stations 17+00 and 19+00 and at station 22+00. Calculated depth to the top of the high velocity materials ranged from 8 to 16 feet. These materials will generally require either blasting or the use of a "Ho-Ram" type hydraulic breaker to facilitate excavation.

*Caterpillar Performance Handbook, 12th edition, Caterpillar Tractor Company, Peoria, Illinois.

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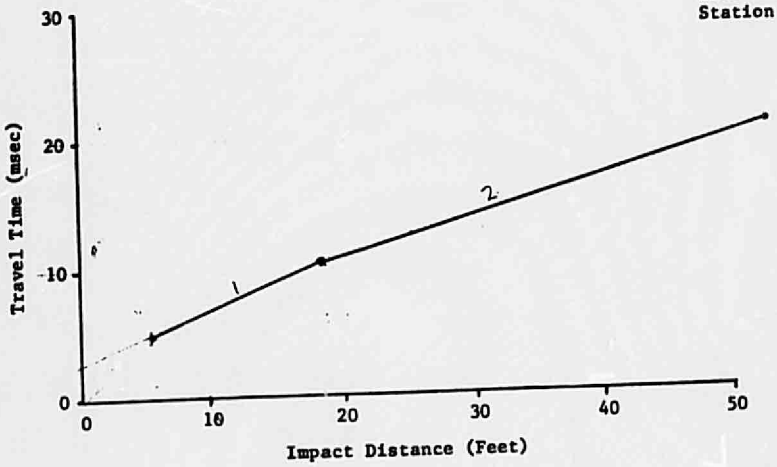
Station 2+00



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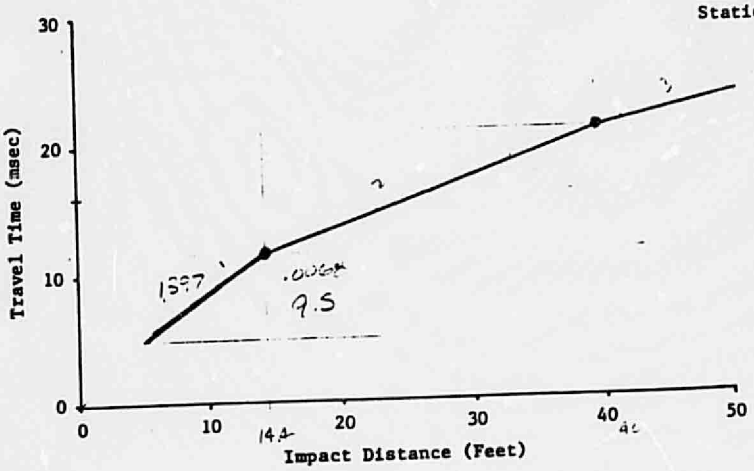
Station 3+00



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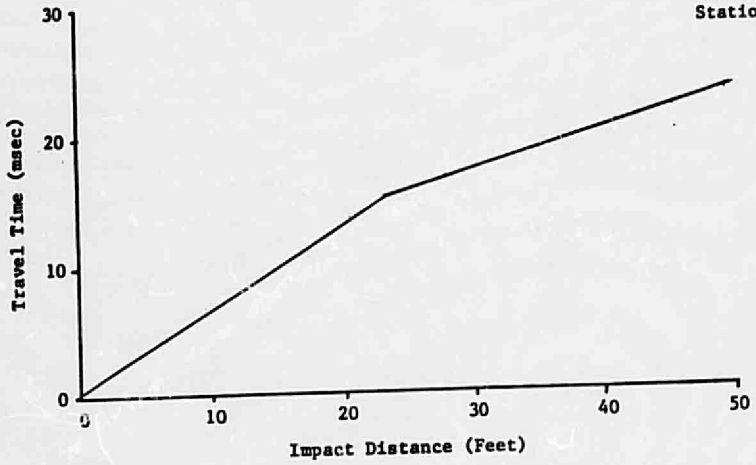
Line No. 5
Station 6+00
2U



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Station 7+00
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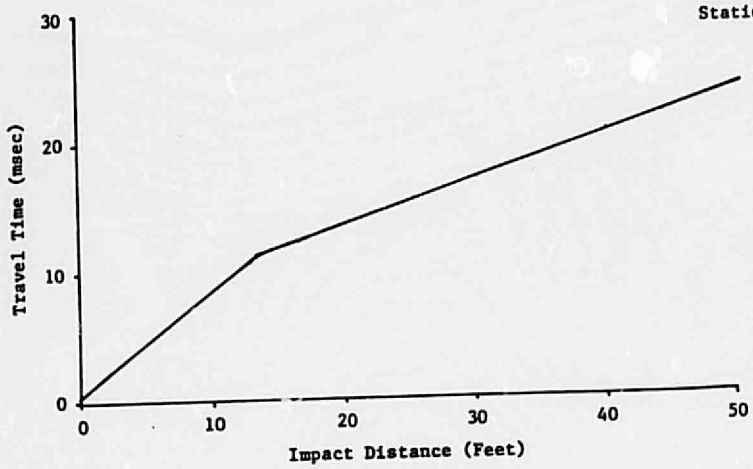

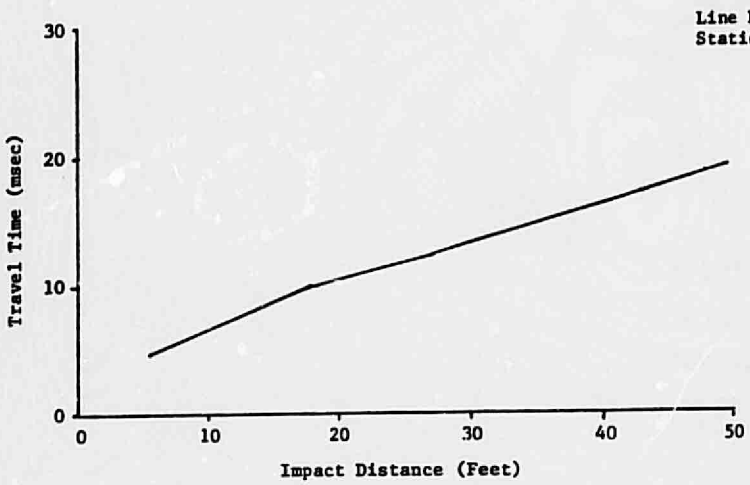

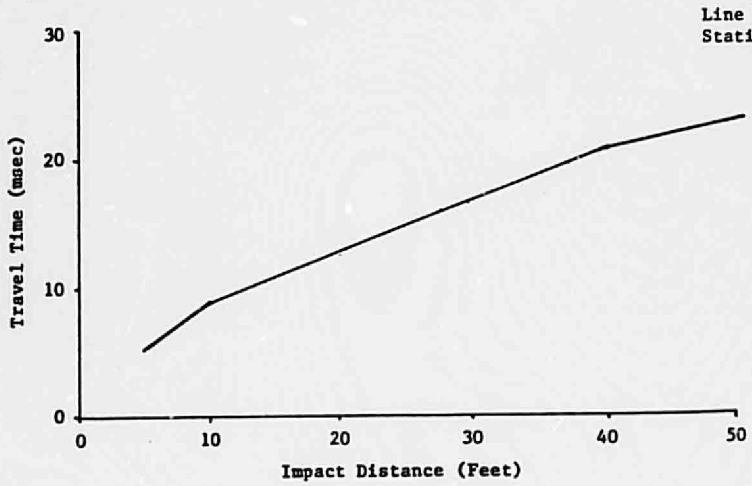

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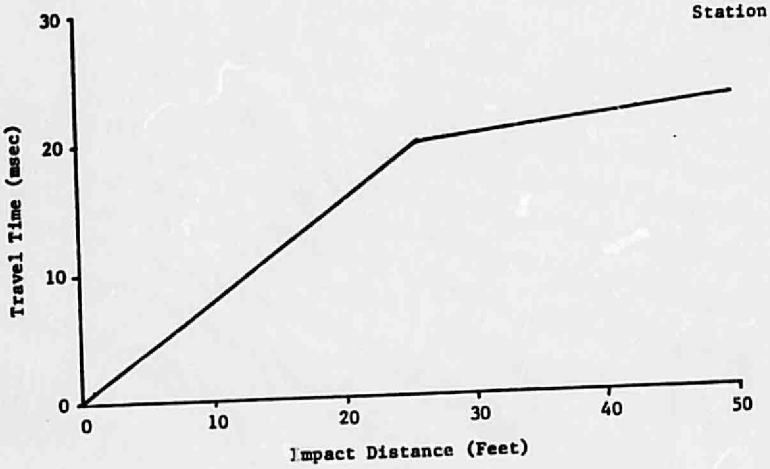
Line No. 7
Station 8+00
27'



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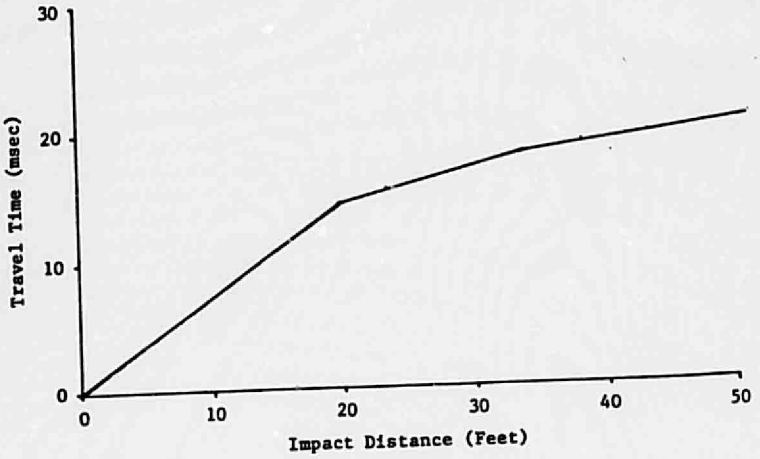
Station 9+00
20'



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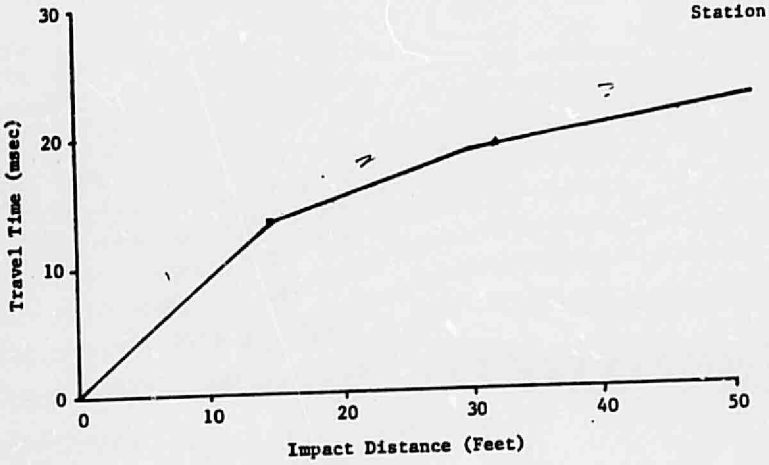
Line No. 9
Station 10+00



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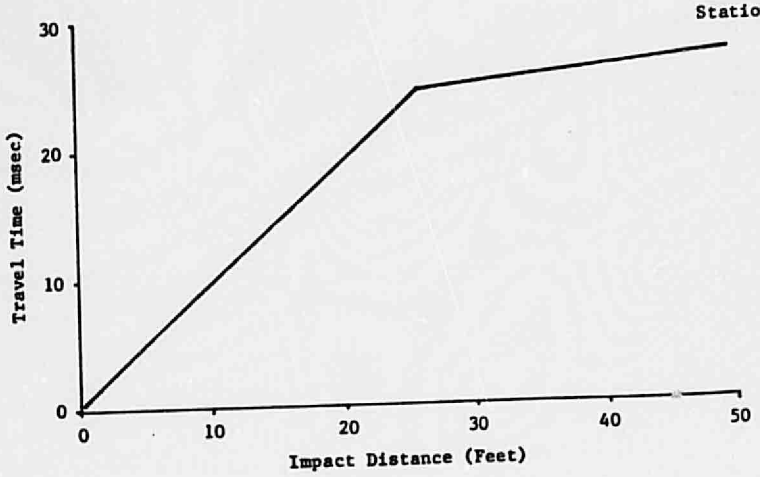
Station 11+00



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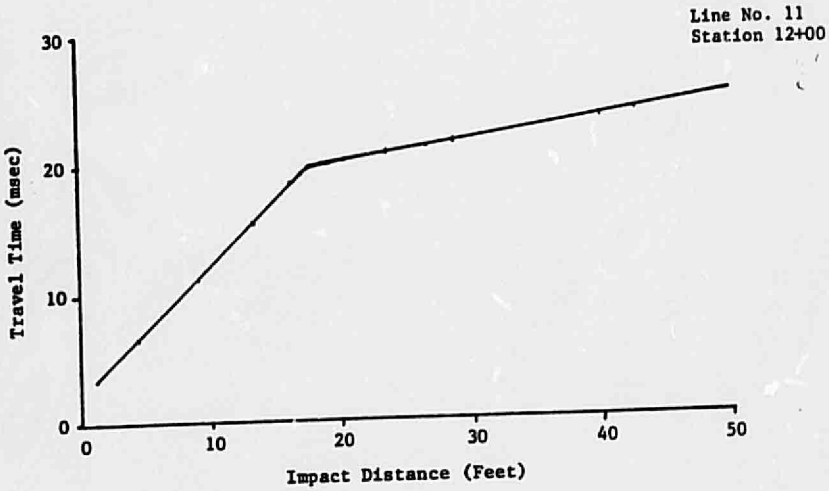

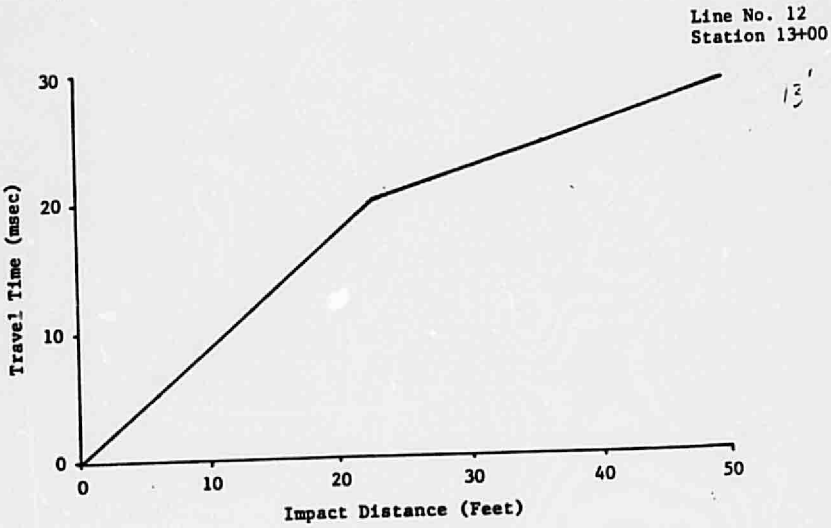

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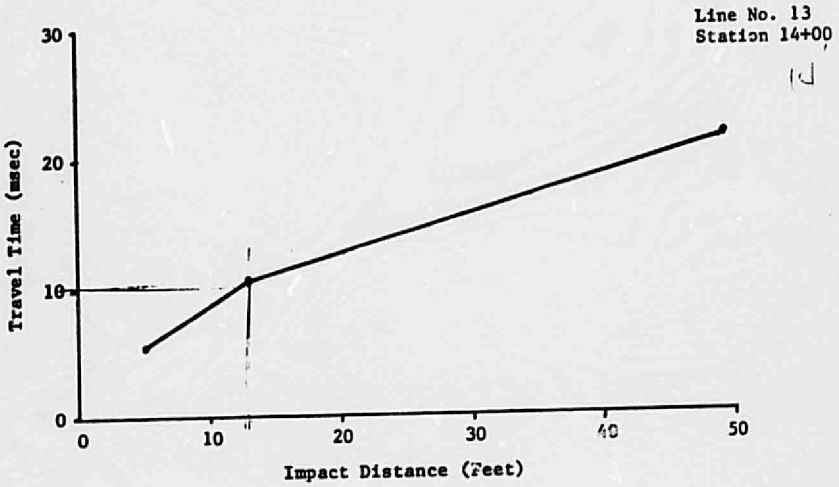

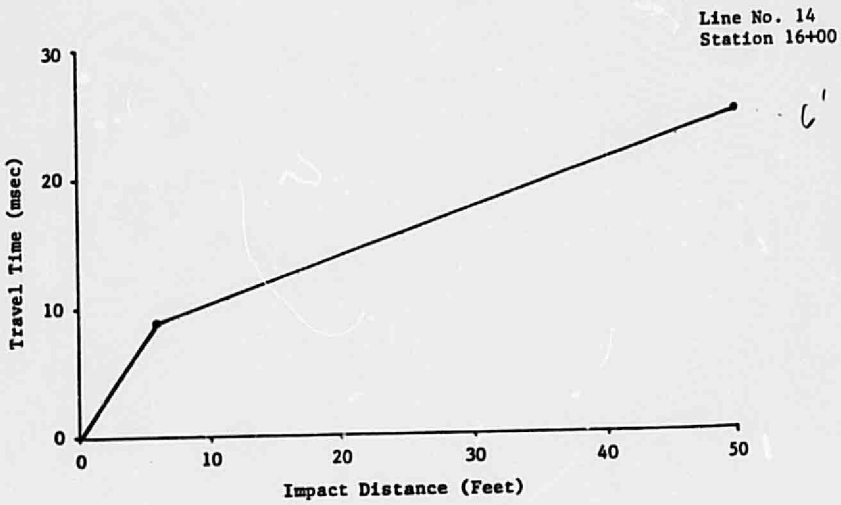

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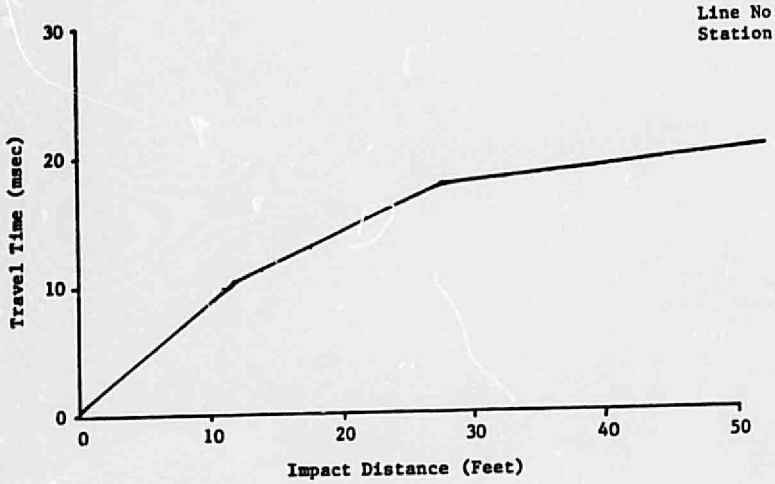
Line No. 15
Station 17+00



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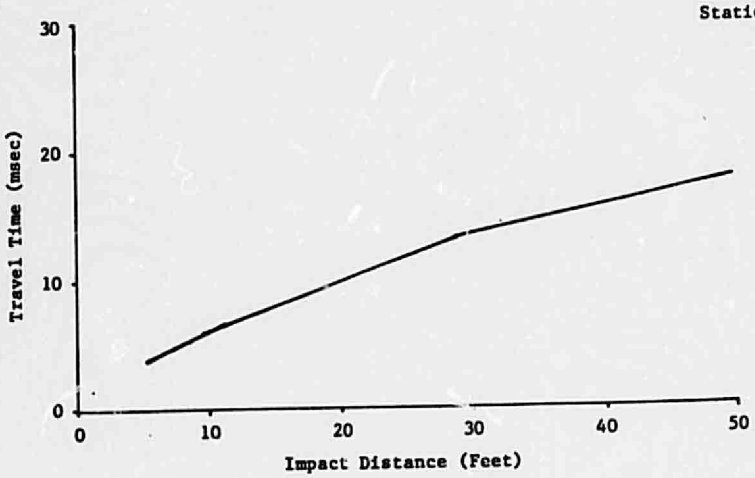

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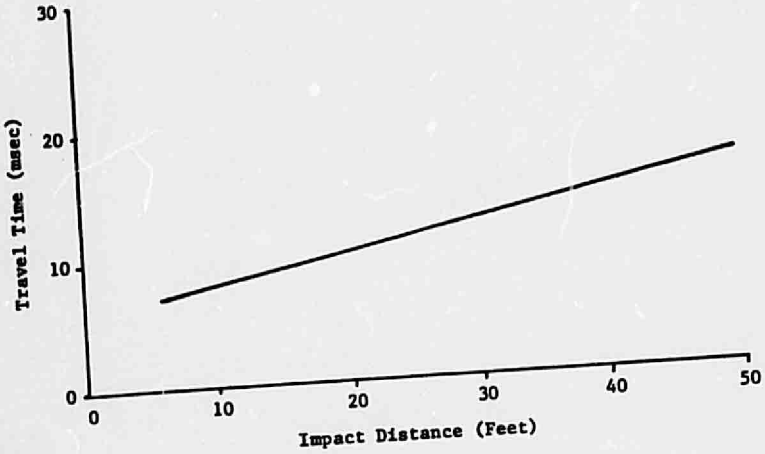
Line No. 17
Station 19+00



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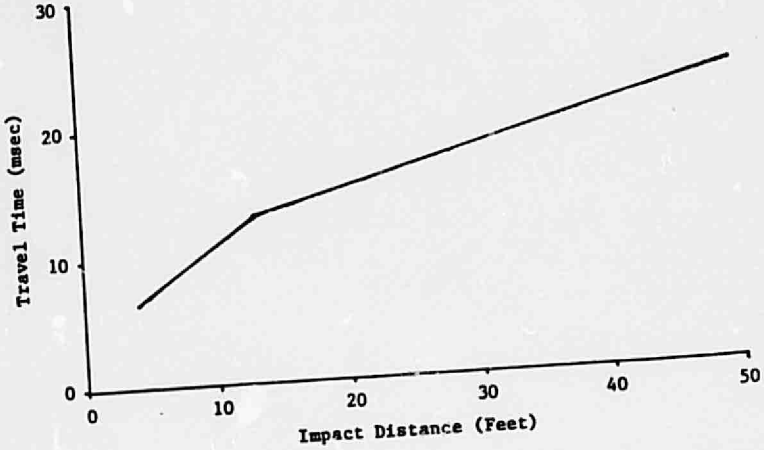

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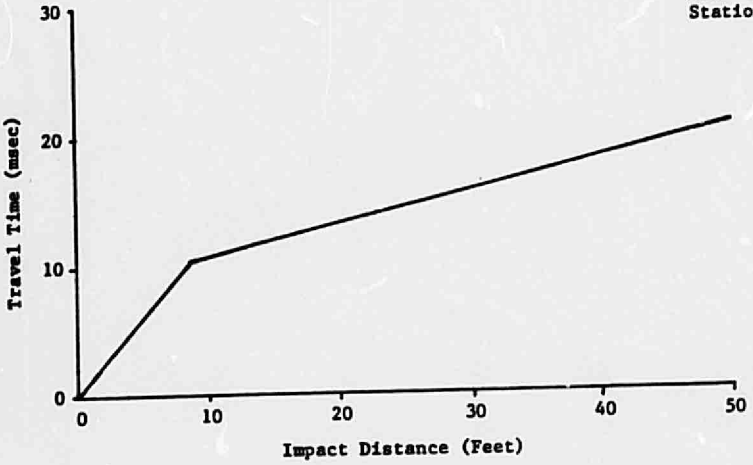
Line No. 19
Station 21+00



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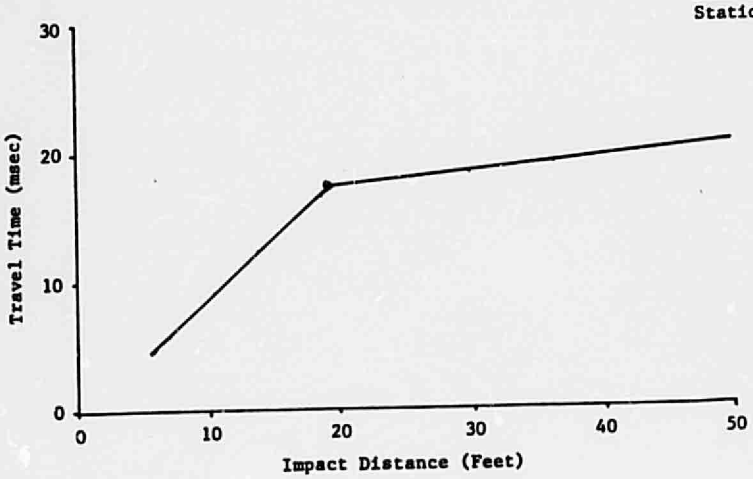
Station 22+00



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Upland Drainage Channel
At Embudo Hills
Albuquerque, New Mexico
SHB Job No. E82-1103

TABLE NO. 1

		Layer No. 1		Layer No. 2		Layer No. 3
Line	Station	Velocity (fps)	Depth (ft.)	Velocity (fps)	Depth (ft.)	Velocity (fps)
1	2+00	2,500	4.0	3,625	—	—
2	3+00	1,410	3.0	2,440	15.0	4,600
3	4+00	2,444	4.0	3,330	—	—
4	5+00	1,440	3.0	2,500	17.0	4,500
5	6+00	1,600	7.0	4,210	—	—
6	7+00	1,235	4.0	2,960	—	—
7	8+00	1,430	9.0	7,000	—	—
8	9+00	1,400	7.0	3,670	16.0	7,333
9	10+00	1,110	4.0	2,660	13.0	5,556
10	11+00	1,200	10.0	8,000	—	—
11	12+00	1,000	8.0	6,330	—	—
12	13+00	1,160	8.0	3,050	—	—
13	14+00	1,500	4.0	3,330	—	—
14	16+00	680	2.0	2,700	—	—
15	17+00	1,230	2.0	2,125	14.0	9,000
16	18+00	2,000	2.0	3,000	14.0	5,300
17	19+00	4,550	(0) —	—	—	—
18	20+00	1,370	5.0	3,650	—	—
19	21+00	1,250	3.0	4,000	—	—
20	22+00	1,081	8.0	9,145	—	—

[illegible]

[illegible]

[illegible] gradation

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BOHANNAN-HUSTON INC.
4125 Carlisle Blvd. N.E. Albuquerque, N.M. 87107
(505) 881-2000

TELEPHONE CONFERENCE NOTES

JOB No. 31280

PROJECT TITLE Embudo Hills Channel

DATE January 5, 1984 TIME 4:45pm

CONVERSATION
RP Bohannan OF Bohannan-Huston
AND Steve Tomita OF American Services Co.

SUBJECT Rock Excavation Embudo Hills Channel

CONTENT Steve Tomita returned my call @ 4:45 pm.

I asked Steve whether he had any additional information regarding the depth of rock along the Embudo Hills Channel alignment. Steve explained that he had actually excavated to non-trenchable rock in several places to better interpret the Seismic Refraction Survey performed by SH&B. Various points along the channel alignment were excavated with the following results:

Location	Description
Sta 12+00 5' South	Non-trenchable rock @ 6.5' deep
Sta 15+56.50 10' West	" " " @ 3.0' deep
Sta 17+00.00 7' SW	" " " @ 3.0' deep
Sta 19+00.00 5' N	" " " @ 1.0' deep
Sta 18+00	Similar to Sta 19+00

In general, Steve explained that the non-trenchable rock corresponded to a seismic velocity range of about 2500 to 3,000 feet per second. The discrepancy between these results and those predicted by SH&B

BOHANNAN-HUSTON INC.
4125 Carlisle Blvd. N.E. Albuquerque, N.M. 87107
(505) 881-2000

TELEPHONE CONFERENCE NOTES

JOB No. 31250

PROJECT TITLE: Embudo Hills Channel

DATE: 1/5/84 TIME: 4:45 pm

CONVERSATION
RP Bohannan OF
AND Steve Tomita OF

SUBJECT: (Cont.)

CONTENT: are apparently due in part to interpretation of Caterpillar Performance Handbook Charts. The Cat Handbook assumes rock overburden is removed so the rock material is more easily spalled and fractured during excavation. Sufficient overburden is apparently not removed in trenching, therefore a greater effort is required in excavating rock materials.

Steve stated he intended to have additional seismic refraction survey work done by F.M. Fox. He would correlate these results by additional trench excavation.

Ronald P. Bohannan

Note to file: need to correlate SH&B data and plot rock profile along channel alignment.

June 1980

BOHANNAN-HUSTON INC.
4125 Carlisle Blvd. N.E. Albuquerque, N.M. 87107
(505) 881-2000

TELEPHONE CONFERENCE NOTES

JOB No.

PROJECT TITLE: Embudo Hills Channel

DATE: January 6, 1984 TIME: 9:40 am

CONVERSATION: E P Bohannan OF E-H

AND: Darrel Buffington OF SH&B

SUBJECT: Interpretation of Seismic Refraction Survey Report for Embudo Hills Channel.

CONTENT: I contacted Darrel Buffington to confirm interpretation of the Seismic Refraction Survey Results. The following was resolved:

1. The impact distances on the Distance Versus Travel Time Plots are horizontal distance between the impact point and the geophone monitors. The seconds units on the Plots are milliseconds or .001 seconds.

2. Table No. 1 is given to summarize depths to different materials. Example: Line 1 sta 2+00 material has velocity of 2500 fps from 0 to 4 ft deep, 3625 fps below 4'.

3. A general rule of thumb: Slope break points in Travel Time / Distance plots indicate change in material Vertical distance to material change is roughly 1/4 to 1/3 horizontal distance to geophone monitor.

4. Due to the high fragmentation of rock, boulders

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DATE 1/6/84 TIME 9:40 am

CONVERSATION RP Bohannan OF B-H

AND Darrel Buffington OF SH&B

SUBJECT (Cont.)

CONTENT and soils in the area, tests performed immediately adjacent each other (5') may give substantially different results.

Ronald P. Bohannan

Note to design file:

Correlate Steve Tomita information for general idea of rock makeup in the area, keep channel profile as shallow as possible.

June 1980

ENGINEERS PLANNERS PHOTOGRAMMETRISTS

BOHANNAN-HUSTON INC.

4125 CARLISLE BLVD., N. E. ALBUQUERQUE, NEW MEXICO 87107 505 881-2000
6773 VISCOUNT BLVD., EL PASO, TEXAS 79925 915 778-4481
330 GARFIELD, SANTA FE, NEW MEXICO 87501 505 988-7871

January 26, 1983

Mr. Vern Hagen
City Planning
City of Albuquerque
P. O. Box 1293
Albuquerque, NM 87103

Re: Proposed Realignment of Demarcation Line

Dear Vern:

As you are aware, the approved Master Plan for Embudo Hills indicates that its easterly boundary along the majority of the development is Scenic Drive. At the time the Master Plan was approved, it was envisioned that a drainage channel would be constructed east of Scenic Drive to collect the runoff from the upland basins and convey them to the Upper Lomas Channel. This channel and Scenic Drive were to be constructed in the City Open Space.

Since the Embudo Hills Master Plan was approved, the City Council has eliminated Scenic Drive. Upon elimination of Scenic Drive, it has been assumed that the upland drainage channel would be located within what was the proposed right-of-way for Scenic Drive.

The proposed alignment of Scenic Drive was curvilinear along Embudo Hills. If the proposed alignment of Scenic Drive is followed by the upland drainage channel, additional channel depth would be required (due to the curvilinear alignment) to provide the necessary freeboard.

In order to lessen the visual impact and the width of encroachment of the channel within the Open Space, we request that the alignment of the drainage channel be revised. In order to realign the channel, a modification of the existing Demarcation Line will be required. The proposed realignment of the Demarcation Line results in a land trade between the City and Embudo Hills. The amount of Embudo Hills land being given to the City is 1.97 acres. The amount of City land being given to Embudo Hills is 1.01 acres. This results in a net gain in City Open Space of approximately 0.96 acres.

As you are aware, this proposed change has been discussed on two different occassions in meetings with city staff from MDD—Planning, MDD—Engineering, Parks and Recreation and Property Management. At the most recent meeting, on Friday, January 7, 1983, there was a general consensus among City staff that the conceptual presentation of this proposal was acceptable both in terms of control of surface water drainage and also of minimization of adverse impacts upon the open space. This application to the Environmental Planning Commission for their recommendation to City Council is our next step in this approval process.

We are enclosing a copy of the Embudo Hills Master Plan showing the proposed realignment and an application for zone map amendment. Please have these items distributed and placed on the agenda for the March meeting of the Environmental Planning Commission.

If you have any questions, feel free to contact Dave Millikan or me.

Sincerely yours,

Michael M. Emery, P.E.
Vice President

cc: Mr. Ron Brown

Enclosures

DMYM/dlh
Job No. 2 101 0

Inv. 6000 WSE 6000.60 NORMAL DEPTH = 0.50'
Velocity 10.73
F = 2.73 Assume 0.30

0+00 BW = 79'
SS = 3.2:1
S = .1250

0+17 BW = 61'
SS = 3.5:1
S = .01176

1+62 BW = [illegible]'
SS = 2:1
S = .0645

0+40 BW = 43'
SS = 3.4:1
S = 0.0870

0+61. BW = 31'
SS = 3.7:1
S = .0952

0+83 BW = 22'
SS = 3.5:1
S = .0909

1+07 BW = 15'
SS = 3.33:1
S = .0833

1+31 BW = 11
SS = 3:1
S = .0833

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VAX/VMS  C31820        RESULT 13-JAN-1984 11:01    LPA0: 13-JAN-1984 11:01    USI
VAX/VMS  C31820        RESULT 13-JAN-1984 11:01    LPA0: 13-JAN-1984 11:01    USI
VAX/VMS  C31820        RESULT 13-JAN-1984 11:01    LPA0: 13-JAN-1984 11:01    USI

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VAX/VMS  C31820        RESULT 13-JAN-1984 11:01    LPA0: 13-JAN-1984 11:01    USI
VAX/VMS  C31820        RESULT 13-JAN-1984 11:01    LPA0: 13-JAN-1984 11:01    USI
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DITCH PROGRAM RUN
EMBUDO HILLS CHANNEL
(Upstream of Concrete Channel Lining)
(100yr Q = 448 cfs)

***** SUPERCRITICAL RUN -- COMPUTATIONS PROCEED IN DOWNSTREAM DIRECTION ***

STATION 0.0

W S ELEV 6000.60	DISCH CFS 448.0	FLOW AREA 48.6	FLOW DPTH 0.60	VEL FT/SEC 9.23	REACH DIST 0.0	BTM ELE 6000.00
MANNINGS N 0.030	BTM WIDTH 79.0	SIDE SLOPE 3.2	CRIT DPTH 0.99	NORM DPTH 0.51	FR NO. 2.12	SEQ DPTH 1.53
CHANNEL SLOPE 0.12500	ELEV EGL 6001.92	FRICT SLOPE 0.07054	RNLDS NO/1000 50.0	CURVE RADIUS 0.0	SUPER ELEV 0.0	

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STATION 17.0

W S ELEV 5998.50	DISCH CFS 448.0	FLOW AREA 39.6	FLOW DPTH 0.63	VEL FT/SEC 11.32	REACH DIST 17.0	BTM ELE 5997.88
MANNINGS N 0.030	BTM WIDTH 61.0	SIDE SLOPE 3.5	CRIT DPTH 1.16	NORM DPTH 0.60	FR NO. 2.57	SEQ DPTH 1.98
CHANNEL SLOPE 0.11760	ELEV EGL 6000.49	FRICT SLOPE 0.10191	RNLDS NO/1000 63.3	CURVE RADIUS 0.0	SUPER ELEV 0.0	

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STATION 40.0

W S ELEV 5995.97	DISCH CFS 448.0	FLOW AREA 36.6	FLOW DPTH 0.80	VEL FT/SEC 12.25	REACH DIST 23.0	BTM ELE 5995.17
MANNINGS N 0.030	BTM WIDTH 43.0	SIDE SLOPE 3.4	CRIT DPTH 1.44	NORM DPTH 0.81	FR NO. 2.49	SEQ DPTH 2.44
CHANNEL SLOPE 0.08700	ELEV EGL 5998.30	FRICT SLOPE 0.08910	RNLDS NO/1000 85.2	CURVE RADIUS 0.0	SUPER ELEV 0.0	

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STATION 61.0

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5994.40	448.0	36.7	1.05	12.21	21.0	5993.34

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.030	31.0	3.7	1.73	0.94	2.21	2.81

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.09520	5996.71	0.06564	106.2	0.0	0.0

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STATION 83.0

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5992.52	448.0	33.7	1.27	13.30	22.0	5991.25

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.030	22.0	3.5	2.09	1.16	2.25	3.46

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.09090	5995.27	0.06194	132.7	0.0	0.0

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STATION 107.0

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5990.63	448.0	31.6	1.57	14.16	24.0	5989.07

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.030	15.0	3.3	2.50	1.44	2.24	4.23

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV

0.08330	5993.75	0.06221	160.3	0.0	0.0

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STATION 131.0

W S ELEV 5988.91	DISCH CFS 448.0	FLOW AREA 30.4	FLOW DPTH 1.84	VEL FT/SEC 14.75	REACH DIST 24.0	BTM ELE 5987.07
MANNINGS N 0.030	BTM WIDTH 11.0	SIDE SLOPE 3.0	CRIT DPTH 2.86	NORM DPTH 1.68	FR NO. 2.21	SEQ DPTH 4.91
CHANNEL SLOPE 0.08330	ELEV EGL 5992.28	FRICT SLOPE 0.05956	RNLDS NO/1000 183.3	CURVE RADIUS 0.0	SUPER ELEV 0.0	

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STATION 162.0 (Channel ℄ Sta 14+00)

W S ELEV 5986.50	DISCH CFS 448.0	FLOW AREA 28.2	FLOW DPTH 2.01	VEL FT/SEC 15.90	REACH DIST 31.0	BTM ELE 5984.49
MANNINGS N 0.030	BTM WIDTH 10.0	SIDE SLOPE 2.0	CRIT DPTH 3.19	NORM DPTH 1.98	FR NO. 2.24	SEQ DPTH 5.45
CHANNEL SLOPE 0.06450	ELEV EGL 5990.42	FRICT SLOPE 0.06057	RNLDS NO/1000 [illegible].5	CURVE RADIUS 0.0	SUPER ELEV 0.0	

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146-B
1431
1407
0403
0461
0440
0400
1176
Q=445
Q=333
Q=11

STATION 400.0 (Channel @ Sta 14+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5941.93	798.0	22.2	1.76	35.96	50.0	5940.17

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.26	12.21

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5962.01	0.06543	452.4	581.0	0.7

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STATION 450.0 (Channel @ Sta 13+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5939.32	798.0	22.5	1.78	35.43	50.0	5937.54

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.15	12.10

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5958.81	0.06264	450.2	0.0	0.0

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STATION 500.0 (Channel @ Sta 13+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5936.71	798.0	22.8	1.80	35.00	50.0	5934.91

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.07	12.01

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5955.73	0.06046	448.5	0.0	0.0

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W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5938.60	318.0	10.6	1.64	29.96	50.0	5936.96

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.72	4.84	10.45

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5952.54	0.06245	296.8	411.6	0.3

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STATION 900.0 (Channel & Sta 5+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5935.99	318.0	10.8	1.66	29.48	50.0	5934.33

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.72	4.74	10.34

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5949.49	0.05973	294.7	411.6	0.3

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STATION 950.0 (Channel & Sta 4+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5933.38	318.0	10.9	1.68	29.13	50.0	5931.70

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.72	4.67	10.26

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5946.55	0.05778	293.2	0.0	0.0

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STATION 800.0 (Channel & Sta 6+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5943.37	484.0	15.5	2.15	31.16	50.0	5941.22

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	1.88	4.50	12.66

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5958.45	0.05096	381.4	411.6	0.3

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STATION 850.0 (Channel & Sta 8+50 ~~6+50~~)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5939.04	484.0	14.8	2.08	32.78	50.0	5936.96

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	2.13	4.81	13.12

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5955.73	0.05852	390.3	411.6	0.3

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STATION 900.0 (Channel & Sta 9+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5936.42	484.0	14.9	2.09	32.51	50.0	5934.33

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	2.13	4.76	13.04

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5952.83	0.05720	388.8	411.6	0.3

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W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5942.42	1214.0	30.1	2.25	40.33	50.0	5940.17

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.30	15.79

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5967.68	0.06292	620.6	581.0	0.9

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STATION 450.0 (Channel & Sta 13+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5939.81	1214.0	30.4	2.27	39.94	50.0	5937.54

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.23	15.69

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5964.58	0.06119	618.4	0.0	0.0

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STATION 500.0 (Channel & Sta 13+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5937.19	1214.0	30.6	2.28	39.61	50.0	5934.91

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.18	15.61

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5961.56	0.05975	616.5	0.0	0.0

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UPPER LOMAS DOWNSTREAM OF CONF. Case 1

DISCHARGE= 1698.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	17.50			
2	0.00	7.50	4	5.00	25.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	1.02	1672.91	939.14	43456.86	88217.28
0.20	0.20	2.06	824.27	329.50	10550.26	43466.46
0.30	0.30	3.14	541.63	177.98	4555.57	28562.02
0.40	0.40	4.24	400.47	114.70	2490.74	21118.87
0.50	0.50	5.38	315.91	81.43	1550.15	16660.01
0.60	0.60	6.54	259.63	61.46	1047.33	13693.12
0.70	0.70	7.74	219.52	48.39	748.99	11578.64
0.80	0.80	8.96	189.51	39.29	558.46	9996.81
0.90	0.90	10.22	166.23	32.66	429.95	8770.00
1.00	1.00	11.50	147.65	27.67	339.53	7791.63
1.10	1.10	12.82	132.50	23.79	273.72	6993.88
1.20	1.20	14.16	119.92	20.71	224.49	6331.54
1.30	1.30	15.54	109.30	18.22	186.81	5773.34
1.40	1.40	16.94	100.24	16.17	157.41	5296.91
1.50	1.50	18.38	92.41	14.47	134.10	4885.89
1.60	1.60	19.84	85.58	13.03	115.34	4527.98
1.70	1.70	21.34	79.59	11.80	100.06	4213.79
1.80	1.80	22.86	74.28	10.74	87.47	3936.02
1.90	1.90	24.42	69.55	9.83	77.01	3688.92
2.00	2.00	26.00	65.31	9.03	68.23	3467.86
2.10	2.10	27.62	61.49	8.33	60.81	3269.14
2.20	2.20	29.26	58.03	7.70	54.49	3089.69
2.30	2.30	30.94	54.89	7.15	49.08	2927.01
2.40	2.40	32.64	52.02	6.66	44.42	2778.99
2.50	2.50	34.37	49.40	6.21	40.39	2643.88
2.60	2.60	36.14	46.98	5.81	36.88	2520.19
2.70	2.70	37.93	44.76	5.45	33.81	2406.66
2.80	2.80	39.76	42.71	5.12	31.12	2302.20
2.90	2.90	41.61	40.80	4.82	28.75	2205.86
3.00	3.00	43.50	39.03	4.55	26.66	2116.90
3.10	3.10	45.41	37.39	4.30	24.81	2034.55
3.20	3.20	47.36	35.85	4.06	23.16	1958.22
3.30	3.30	49.33	34.42	3.85	21.69	1887.37
3.40	3.40	51.34	33.07	3.66	20.39	1821.52
3.50	3.50	53.37	31.81	3.47	19.21	1760.26
3.60	3.60	55.44	30.63	3.31	18.17	1703.22
3.70	3.70	57.53	29.51	3.15	17.22	1650.06
3.80	3.80	59.66	28.46	3.00	16.38	1600.48
3.90	3.90	61.81	27.47	2.87	15.62	1554.23
4.00	4.00	64.00	26.53	2.74	14.93	1511.07
4.10	4.10	66.21	25.64	2.62	14.31	1470.78
4.20	4.20	68.46	24.80	2.51	13.75	1433.17
4.30	4.30	70.73	24.01	2.41	13.25	1398.06
4.40	4.40	73.04	23.25	2.31	12.79	1365.30
4.50	4.50	75.37	22.53	2.22	12.38	1334.75
4.60	4.60	77.74	21.84	2.13	12.01	1306.26
4.70	4.70	80.13	21.19	2.05	11.67	1279.73
4.80	4.80	82.56	20.57	1.97	11.37	1255.05
4.90	4.90	85.01	19.97	1.90	11.09	1232.11
5.00	5.00	87.50	19.41	1.83	10.85	1210.82

Normal Depth = 2.85,
Velocity = 41.6
Froude = 4.96

MOMENTUM PROGRAM RUN
Upper Lomas Downstream of Confluence

Q combined - Case 3

DISCHARGE= 1284.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	17.50			
2	0.00	7.50	4	5.00	25.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	1.02	1265.02	710.16	24849.28	50443.89
0.20	0.20	2.06	623.30	249.17	6032.87	24854.81
0.30	0.30	3.14	409.57	134.58	2605.07	16332.36
0.40	0.40	4.24	302.83	86.74	1424.41	12076.42
0.50	0.50	5.38	238.88	61.58	886.61	9526.99
0.60	0.60	6.54	196.33	46.47	599.13	7830.73
0.70	0.70	7.74	166.00	36.59	428.58	6621.95
0.80	0.80	8.96	143.30	29.71	319.68	5717.80
0.90	0.90	10.22	125.70	24.70	246.24	5016.70
1.00	1.00	11.50	111.65	20.92	194.57	4457.72
1.10	1.10	12.82	100.20	17.99	156.99	4002.07
1.20	1.20	14.16	90.68	15.66	128.88	3623.92
1.30	1.30	15.54	82.65	13.78	107.38	3305.36
1.40	1.40	16.94	75.80	12.23	90.61	3033.63
1.50	1.50	18.38	69.88	10.94	77.32	2799.36
1.60	1.60	19.84	64.72	9.85	66.64	2595.52
1.70	1.70	21.34	60.18	8.92	57.94	2416.74
1.80	1.80	22.86	56.17	8.12	50.79	2258.86
1.90	1.90	24.42	52.59	7.43	44.85	2118.57
2.00	2.00	26.00	49.38	6.83	39.87	1993.25
2.10	2.10	27.62	46.50	6.30	35.67	1880.76
2.20	2.20	29.26	43.88	5.82	32.10	1779.37
2.30	2.30	30.94	41.51	5.41	29.05	1687.63
2.40	2.40	32.64	39.34	5.03	26.43	1604.35
2.50	2.50	34.37	37.35	4.70	24.17	1528.53
2.60	2.60	36.14	35.53	4.39	22.20	1459.31
2.70	2.70	37.93	33.85	4.12	20.49	1395.98
2.80	2.80	39.76	32.29	3.87	18.99	1337.92
2.90	2.90	41.61	30.85	3.64	17.68	1284.58
3.00	3.00	43.50	29.52	3.44	16.53	1235.52
3.10	3.10	45.41	28.27	3.25	15.51	1190.34
3.20	3.20	47.36	27.11	3.07	14.61	1148.68
3.30	3.30	49.33	26.03	2.91	13.82	1110.23
3.40	3.40	51.34	25.01	2.76	13.11	1074.74
3.50	3.50	53.37	24.06	2.63	12.49	1041.95
3.60	3.60	55.44	23.16	2.50	11.93	1011.66
3.70	3.70	57.53	22.32	2.38	11.43	983.68
3.80	3.80	59.66	21.52	2.27	10.99	957.84
3.90	3.90	61.81	20.77	2.17	10.60	934.00
4.00	4.00	64.00	20.06	2.07	10.25	912.01
4.10	4.10	66.21	19.39	1.98	9.94	891.76
4.20	4.20	68.46	18.76	1.90	9.66	873.13
4.30	4.30	70.73	18.15	1.82	9.42	856.04
4.40	4.40	73.04	17.58	1.75	9.20	840.38
4.50	4.50	75.37	17.03	1.68	9.01	826.09
4.60	4.60	77.74	16.52	1.61	8.84	813.08
4.70	4.70	80.13	16.02	1.55	8.69	801.29
4.80	4.80	82.56	15.55	1.49	8.56	790.66
4.90	4.90	85.01	15.10	1.43	8.44	781.13
5.00	5.00	87.50	14.67	1.38	8.34	772.65

Q combined – Case 2

DISCHARGE= 1116.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	17.50			
2	0.00	7.50	4	5.00	25.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	1.02	1099.51	617.24	18772.09	38107.20
0.20	0.20	2.06	541.75	216.57	4557.50	18776.30
0.30	0.30	3.14	355.98	116.98	1968.04	12338.18
0.40	0.40	4.24	263.21	75.39	1076.15	9123.18
0.50	0.50	5.38	207.63	53.52	669.90	7197.36
0.60	0.60	6.54	170.64	40.39	452.75	5916.09
0.70	0.70	7.74	144.28	31.80	323.94	5003.11
0.80	0.80	8.96	124.55	25.82	241.69	4320.28
0.90	0.90	10.22	109.25	21.47	186.24	3790.88
1.00	1.00	11.50	97.04	18.18	147.23	3368.87
1.10	1.10	12.82	87.09	15.63	118.86	3024.96
1.20	1.20	14.16	78.81	13.61	97.65	2739.61
1.30	1.30	15.54	71.84	11.98	81.43	2499.33
1.40	1.40	16.94	65.88	10.63	68.79	2294.45
1.50	1.50	18.38	60.73	9.51	58.78	2117.90
1.60	1.60	19.84	56.25	8.56	50.73	1964.38
1.70	1.70	21.34	52.31	7.76	44.19	1829.83
1.80	1.80	22.86	48.82	7.06	38.81	1711.10
1.90	1.90	24.42	45.71	6.46	34.34	1605.70
2.00	2.00	26.00	42.92	5.93	30.61	1511.64
2.10	2.10	27.62	40.41	5.47	27.46	1427.32
2.20	2.20	29.26	38.14	5.06	24.79	1351.42
2.30	2.30	30.94	36.08	4.70	22.51	1282.86
2.40	2.40	32.64	34.19	4.37	20.55	1220.72
2.50	2.50	34.37	32.47	4.08	18.87	1164.26
2.60	2.60	36.14	30.88	3.82	17.41	1112.84
2.70	2.70	37.93	29.42	3.58	16.14	1065.90
2.80	2.80	39.76	28.07	3.36	15.03	1022.98
2.90	2.90	41.61	26.82	3.17	14.07	983.69
3.00	3.00	43.50	25.66	2.99	13.22	947.67
3.10	3.10	45.41	24.57	2.82	12.48	914.62
3.20	3.20	47.36	23.56	2.67	11.82	884.28
3.30	3.30	49.33	22.62	2.53	11.25	856.42
3.40	3.40	51.34	21.74	2.40	10.74	830.64
3.50	3.50	53.37	20.91	2.28	10.29	807.35
3.60	3.60	55.44	20.13	2.17	9.89	785.80
3.70	3.70	57.53	19.40	2.07	9.54	766.04
3.80	3.80	59.66	18.71	1.97	9.23	747.96
3.90	3.90	61.81	18.05	1.89	8.96	731.43
4.00	4.00	64.00	17.44	1.80	8.72	716.36
4.10	4.10	66.21	16.85	1.72	8.51	702.65
4.20	4.20	68.46	16.30	1.65	8.33	690.23
4.30	4.30	70.73	15.78	1.58	8.17	679.02
4.40	4.40	73.04	15.28	1.52	8.03	668.95
4.50	4.50	75.37	14.81	1.46	7.90	659.96
4.60	4.60	77.74	14.36	1.40	7.80	652.01
4.70	4.70	80.13	13.93	1.35	7.71	645.03
4.80	4.80	82.56	13.52	1.30	7.64	638.99
4.90	4.90	85.01	13.13	1.25	7.58	633.84
5.00	5.00	87.50	12.75	1.20	7.53	629.54

Q combined - Case 4

DISCHARGE= 1532.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	17.50			
2	0.00	7.50	4	5.00	25.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	1.02	1509.36	847.33	35375.35	71811.81
0.20	0.20	2.06	743.69	297.29	8588.30	35383.18
0.30	0.30	3.14	488.68	160.58	3708.44	23250.52
0.40	0.40	4.24	361.32	103.49	2027.62	17191.62
0.50	0.50	5.38	285.02	73.47	1261.96	13562.05
0.60	0.60	6.54	234.25	55.45	852.67	11147.01
0.70	0.70	7.74	198.06	43.65	609.83	9425.88
0.80	0.80	8.96	170.98	35.45	454.76	8138.38
0.90	0.90	10.22	149.98	29.47	350.16	7139.90
1.00	1.00	11.50	133.22	24.96	276.57	6343.67
1.10	1.10	12.82	119.55	21.46	223.02	5694.50
1.20	1.20	14.16	108.19	18.69	182.96	5155.59
1.30	1.30	15.54	98.62	16.44	152.31	4701.46
1.40	1.40	16.94	90.44	14.59	128.40	4313.94
1.50	1.50	18.38	83.37	13.05	109.44	3979.68
1.60	1.60	19.84	77.22	11.75	94.19	3688.69
1.70	1.70	21.34	71.81	10.65	81.77	3433.31
1.80	1.80	22.86	67.02	9.69	71.54	3207.61
1.90	1.90	24.42	62.75	8.87	63.04	3006.90
2.00	2.00	26.00	58.92	8.15	55.91	2827.42
2.10	2.10	27.62	55.48	7.51	49.89	2666.15
2.20	2.20	29.26	52.36	6.95	44.77	2520.60
2.30	2.30	30.94	49.52	6.45	40.38	2388.73
2.40	2.40	32.64	46.94	6.00	36.61	2268.83
2.50	2.50	34.37	44.57	5.60	33.34	2159.47
2.60	2.60	36.14	42.39	5.24	30.50	2059.44
2.70	2.70	37.93	40.38	4.92	28.03	1967.71
2.80	2.80	39.76	38.53	4.62	25.85	1883.40
2.90	2.90	41.61	36.81	4.35	23.94	1805.75
3.00	3.00	43.50	35.22	4.10	22.26	1734.11
3.10	3.10	45.41	33.73	3.88	20.77	1667.90
3.20	3.20	47.36	32.35	3.67	19.45	1606.62
3.30	3.30	49.33	31.05	3.48	18.27	1549.85
3.40	3.40	51.34	29.84	3.30	17.23	1497.18
3.50	3.50	53.37	28.70	3.13	16.29	1448.29
3.60	3.60	55.44	27.63	2.98	15.46	1402.86
3.70	3.70	57.53	26.63	2.84	14.71	1360.64
3.80	3.80	59.66	25.68	2.71	14.04	1321.38
3.90	3.90	61.81	24.78	2.59	13.44	1284.86
4.00	4.00	64.00	23.94	2.47	12.90	1250.89
4.10	4.10	66.21	23.14	2.37	12.41	1219.30
4.20	4.20	68.46	22.38	2.27	11.98	1189.94
4.30	4.30	70.73	21.66	2.17	11.58	1162.65
4.40	4.40	73.04	20.97	2.08	11.23	1137.32
4.50	4.50	75.37	20.33	2.00	10.91	1113.83
4.60	4.60	77.74	19.71	1.92	10.63	1092.07
4.70	4.70	80.13	19.12	1.85	10.38	1071.94
4.80	4.80	82.56	18.56	1.78	10.15	1053.36
4.90	4.90	85.01	18.02	1.71	9.94	1036.24
5.00	5.00	87.50	17.51	1.65	9.76	1020.52

100yr Embudo Hills

DISCHARGE= 484.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	11.50			
2	0.00	7.50	4	5.00	19.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	0.41	1166.27	661.58	21120.82	17530.21
0.20	0.20	0.86	562.79	229.38	4918.42	8459.42
0.30	0.30	1.34	362.55	122.40	2041.30	5449.65
0.40	0.40	1.84	263.04	77.93	1074.81	3954.17
0.50	0.50	2.38	203.79	54.65	645.38	3063.73
0.60	0.60	2.94	164.63	40.75	421.43	2475.33
0.70	0.70	3.54	136.92	31.70	291.79	2059.15
0.80	0.80	4.16	116.35	25.43	210.99	1750.34
0.90	0.90	4.82	100.52	20.90	157.80	1512.89
1.00	1.00	5.50	88.00	17.50	121.25	1325.23
1.10	1.10	6.22	77.88	14.87	95.27	1173.65
1.20	1.20	6.96	69.54	12.81	76.29	1049.01
1.30	1.30	7.74	62.57	11.14	62.10	945.01
1.40	1.40	8.54	56.67	9.79	51.28	857.17
1.50	1.50	9.38	51.63	8.66	42.89	782.19
1.60	1.60	10.24	47.27	7.72	36.29	717.62
1.70	1.70	11.14	43.47	6.92	31.04	661.58
1.80	1.80	12.06	40.13	6.24	26.81	612.63
1.90	1.90	13.02	37.19	5.66	23.37	569.62
2.00	2.00	14.00	34.57	5.15	20.56	531.64
2.10	2.10	15.02	32.23	4.70	18.23	497.97
2.20	2.20	16.06	30.14	4.31	16.30	467.94
2.30	2.30	17.14	28.25	3.97	14.69	441.23
2.40	2.40	18.24	26.54	3.66	13.33	417.28
2.50	2.50	19.37	24.98	3.39	12.19	395.80
2.60	2.60	20.54	23.56	3.15	11.22	376.50
2.70	2.70	21.73	22.27	2.93	10.40	359.14
2.80	2.80	22.96	21.08	2.73	9.70	343.51
2.90	2.90	24.21	19.99	2.55	9.10	329.45
3.00	3.00	25.50	18.98	2.39	8.59	316.80
3.10	3.10	26.81	18.05	2.24	8.16	305.42
3.20	3.20	28.16	17.19	2.10	7.79	295.21
3.30	3.30	29.53	16.39	1.98	7.47	286.07
3.40	3.40	30.94	15.64	1.87	7.20	277.91
3.50	3.50	32.37	14.95	1.76	6.97	270.65
3.60	3.60	33.84	14.30	1.67	6.78	264.23
3.70	3.70	35.33	13.70	1.58	6.61	258.59
3.80	3.80	36.86	13.13	1.50	6.48	253.69
3.90	3.90	38.41	12.60	1.42	6.36	249.46
4.00	4.00	40.00	12.10	1.35	6.27	245.88
4.10	4.10	41.61	11.63	1.28	6.20	242.90
4.20	4.20	43.26	11.19	1.22	6.14	240.49
4.30	4.30	44.93	10.77	1.16	6.10	238.63
4.40	4.40	46.64	10.38	1.11	6.07	237.29
4.50	4.50	48.37	10.01	1.06	6.05	236.45
4.60	4.60	50.14	9.65	1.01	6.05	236.08
4.70	4.70	51.93	9.32	0.97	6.05	236.17
4.80	4.80	53.76	9.00	0.93	6.06	236.70
4.90	4.90	55.61	8.70	0.89	6.08	237.66
5.00	5.00	57.50	8.42	0.85	6.10	239.02

Depth = 2.05'
Velocity = 32.78 fps
Froude = 4.81

MOMENTUM PROGRAM RUN
Embudo Hills Upstream of Confluence

10 year Embudo

DISCHARGE= 318.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	11.50			
2	0.00	7.50	4	5.00	19.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	0.41	766.27	434.67	9117.52	7567.48
0.20	0.20	0.86	369.77	150.71	2123.30	3651.82
0.30	0.30	1.34	238.20	80.42	881.36	2352.63
0.40	0.40	1.84	172.83	51.20	464.20	1707.14
0.50	0.50	2.38	133.89	35.91	278.88	1322.88
0.60	0.60	2.94	108.16	26.77	182.27	1069.02
0.70	0.70	3.54	89.96	20.82	126.36	889.55
0.80	0.80	4.16	76.44	16.71	91.54	756.46
0.90	0.90	4.82	66.04	13.73	68.63	654.22
1.00	1.00	5.50	57.82	11.49	52.91	573.50
1.10	1.10	6.22	51.17	9.77	41.75	508.39
1.20	1.20	6.96	45.69	8.41	33.62	454.96
1.30	1.30	7.74	41.11	7.32	27.55	410.49
1.40	1.40	8.54	37.24	6.43	22.93	373.03
1.50	1.50	9.38	33.92	5.69	19.37	341.17
1.60	1.60	10.24	31.05	5.07	16.58	313.86
1.70	1.70	11.14	28.56	4.55	14.36	290.27
1.80	1.80	12.06	26.37	4.10	12.60	269.80
1.90	1.90	13.02	24.43	3.72	11.17	251.95
2.00	2.00	14.00	22.71	3.38	10.01	236.32
2.10	2.10	15.02	21.18	3.09	9.06	222.61
2.20	2.20	16.06	19.80	2.83	8.29	210.55
2.30	2.30	17.14	18.56	2.61	7.65	199.94
2.40	2.40	18.24	17.43	2.41	7.12	190.61
2.50	2.50	19.37	16.41	2.23	6.68	182.40
2.60	2.60	20.54	15.48	2.07	6.32	175.20
2.70	2.70	21.73	14.63	1.92	6.02	168.91
2.80	2.80	22.96	13.85	1.79	5.78	163.44
2.90	2.90	24.21	13.13	1.68	5.58	158.71
3.00	3.00	25.50	12.47	1.57	5.41	154.66
3.10	3.10	26.81	11.86	1.47	5.28	151.23
3.20	3.20	28.16	11.29	1.38	5.18	148.39
3.30	3.30	29.53	10.77	1.30	5.10	146.08
3.40	3.40	30.94	10.28	1.23	5.04	144.27
3.50	3.50	32.37	9.82	1.16	5.00	142.94
3.60	3.60	33.84	9.40	1.10	4.97	142.05
3.70	3.70	35.33	9.00	1.04	4.96	141.58
3.80	3.80	36.86	8.63	0.98	4.96	141.52
3.90	3.90	38.41	8.28	0.93	4.96	141.83
4.00	4.00	40.00	7.95	0.89	4.98	142.51
4.10	4.10	41.61	7.64	0.84	5.01	143.55
4.20	4.20	43.26	7.35	0.80	5.04	144.92
4.30	4.30	44.93	7.08	0.76	5.08	146.62
4.40	4.40	46.64	6.82	0.73	5.12	148.65
4.50	4.50	48.37	6.57	0.70	5.17	150.98
4.60	4.60	50.14	6.34	0.67	5.22	153.62
4.70	4.70	51.93	6.12	0.64	5.28	156.56
4.80	4.80	53.76	5.92	0.61	5.34	159.79
4.90	4.90	55.61	5.72	0.58	5.41	163.31
5.00	5.00	57.50	5.53	0.56	5.47	167.12

100yr. Upper Lomas

DISCHARGE= 1214.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	17.50			
2	0.00	7.50	4	5.00	25.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	1.02	1196.06	671.44	22213.72	45093.70
0.20	0.20	2.06	589.32	235.58	5393.03	22218.68
0.30	0.30	3.14	387.24	127.25	2328.80	14600.16
0.40	0.40	4.24	286.32	82.01	1273.37	10795.66
0.50	0.50	5.38	225.86	58.22	792.63	8516.67
0.60	0.60	6.54	185.63	43.94	535.65	7000.39
0.70	0.70	7.74	156.95	34.59	383.20	5919.89
0.80	0.80	8.96	135.49	28.09	285.86	5111.72
0.90	0.90	10.22	118.84	23.35	220.22	4485.09
1.00	1.00	11.50	105.57	19.78	174.04	3985.50
1.10	1.10	12.82	94.73	17.01	140.45	3578.32
1.20	1.20	14.16	85.73	14.81	115.34	3240.41
1.30	1.30	15.54	78.15	13.03	96.13	2955.80
1.40	1.40	16.94	71.66	11.56	81.15	2713.06
1.50	1.50	18.38	66.07	10.34	69.28	2503.82
1.60	1.60	19.84	61.19	9.31	59.74	2321.81
1.70	1.70	21.34	56.90	8.44	51.98	2162.21
1.80	1.80	22.86	53.11	7.68	45.59	2021.31
1.90	1.90	24.42	49.72	7.03	40.29	1896.15
2.00	2.00	26.00	46.69	6.45	35.85	1784.39
2.10	2.10	27.62	43.96	5.95	32.11	1684.12
2.20	2.20	29.26	41.49	5.51	28.93	1593.78
2.30	2.30	30.94	39.24	5.11	26.21	1512.09
2.40	2.40	32.64	37.19	4.76	23.88	1437.98
2.50	2.50	34.37	35.32	4.44	21.87	1370.56
2.60	2.60	36.14	33.59	4.15	20.12	1309.05
2.70	2.70	37.93	32.00	3.90	18.60	1252.83
2.80	2.80	39.76	30.53	3.66	17.28	1201.33
2.90	2.90	41.61	29.17	3.45	16.11	1154.09
3.00	3.00	43.50	27.91	3.25	15.09	1110.69
3.10	3.10	45.41	26.73	3.07	14.20	1070.76
3.20	3.20	47.36	25.63	2.91	13.40	1034.01
3.30	3.30	49.33	24.61	2.75	12.70	1000.16
3.40	3.40	51.34	23.65	2.61	12.08	968.96
3.50	3.50	53.37	22.74	2.48	11.53	940.21
3.60	3.60	55.44	21.90	2.36	11.05	913.71
3.70	3.70	57.53	21.10	2.25	10.61	889.29
3.80	3.80	59.66	20.35	2.15	10.23	866.82
3.90	3.90	61.81	19.64	2.05	9.89	846.15
4.00	4.00	64.00	18.97	1.96	9.59	827.16
4.10	4.10	66.21	18.33	1.88	9.32	809.74
4.20	4.20	68.46	17.73	1.80	9.08	793.81
4.30	4.30	70.73	17.16	1.72	8.87	779.27
4.40	4.40	73.04	16.62	1.65	8.69	766.04
4.50	4.50	75.37	16.11	1.58	8.53	754.04
4.60	4.60	77.74	15.62	1.52	8.39	743.23
4.70	4.70	80.13	15.15	1.46	8.26	733.52
4.80	4.80	82.56	14.70	1.41	8.16	724.88
4.90	4.90	85.01	14.28	1.36	8.07	717.25
5.00	5.00	87.50	13.87	1.31	7.99	710.59

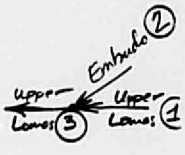
10yr. Upper Lomas

DISCHARGE= 798.0

POINT	ELEV	DIST	POINT	ELEV	DIST	POINT	ELEV	DIST
1	5.00	0.00	3	0.00	17.50			
2	0.00	7.50	4	5.00	25.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA SQ.FT.	FLOW VEL. FPS	FROUDE NO.	E (FT)	M CU.FT.
0.10	0.10	1.02	786.21	441.36	9598.25	19484.31
0.20	0.20	2.06	387.38	154.86	2330.36	9600.46
0.30	0.30	3.14	254.55	83.64	1006.41	6308.76
0.40	0.40	4.24	188.21	53.91	550.43	4665.11
0.50	0.50	5.38	148.47	38.27	342.77	3680.67
0.60	0.60	6.54	122.02	28.88	231.79	3025.84
0.70	0.70	7.74	103.17	22.74	165.97	2559.38
0.80	0.80	8.96	89.06	18.46	123.97	2210.66
0.90	0.90	10.22	78.12	15.35	95.66	1940.44
1.00	1.00	11.50	69.39	13.00	75.77	1725.20
1.10	1.10	12.82	62.27	11.18	61.31	1549.95
1.20	1.20	14.16	56.36	9.73	50.52	1404.71
1.30	1.30	15.54	51.37	8.56	42.27	1282.58
1.40	1.40	16.94	47.11	7.60	35.86	1178.62
1.50	1.50	18.38	43.43	6.80	30.79	1089.21
1.60	1.60	19.84	40.22	6.12	26.72	1011.65
1.70	1.70	21.34	37.40	5.55	23.42	943.86
1.80	1.80	22.86	34.91	5.05	20.72	884.23
1.90	1.90	24.42	32.68	4.62	18.49	831.49
2.00	2.00	26.00	30.69	4.24	16.63	784.64
2.10	2.10	27.62	28.90	3.91	15.07	742.83
2.20	2.20	29.26	27.27	3.62	13.75	705.41
2.30	2.30	30.94	25.80	3.36	12.63	671.83
2.40	2.40	32.64	24.45	3.13	11.68	641.61
2.50	2.50	34.37	23.21	2.92	10.87	614.38
2.60	2.60	36.14	22.08	2.73	10.17	589.81
2.70	2.70	37.93	21.04	2.56	9.57	567.62
2.80	2.80	39.76	20.07	2.41	9.06	547.57
2.90	2.90	41.61	19.18	2.27	8.61	529.47
3.00	3.00	43.50	18.34	2.14	8.23	513.13
3.10	3.10	45.41	17.57	2.02	7.89	498.41
3.20	3.20	47.36	16.85	1.91	7.61	485.16
3.30	3.30	49.33	16.18	1.81	7.36	473.28
3.40	3.40	51.34	15.54	1.72	7.15	462.66
3.50	3.50	53.37	14.95	1.63	6.97	453.21
3.60	3.60	55.44	14.39	1.55	6.82	444.85
3.70	3.70	57.53	13.87	1.48	6.69	437.51
3.80	3.80	59.66	13.38	1.41	6.58	431.12
3.90	3.90	61.81	12.91	1.35	6.49	425.64
4.00	4.00	64.00	12.47	1.29	6.41	421.01
4.10	4.10	66.21	12.05	1.23	6.36	417.18
4.20	4.20	68.46	11.66	1.18	6.31	414.12
4.30	4.30	70.73	11.28	1.13	6.28	411.79
4.40	4.40	73.04	10.93	1.09	6.25	410.15
4.50	4.50	75.37	10.59	1.04	6.24	409.19
4.60	4.60	77.74	10.26	1.00	6.24	408.86
4.70	4.70	80.13	9.96	0.96	6.24	409.15
4.80	4.80	82.56	9.67	0.93	6.25	410.04
4.90	4.90	85.01	9.39	0.89	6.27	411.50
5.00	5.00	87.50	9.12	0.86	6.29	413.52

	CASE 1	CASE 2	CASE 3	CASE 4
Q-Embudo	100-484	10-318	100-484	10-318
Q-Upper Lomas	100-1214	10-798	10-798	100-1214
Q-Combined	1698	1116	1284	1532
① η	0.013	0.013	0.013	0.013
① L	180	180	180	180
① h	9.5	9.5	9.5	9.5
① θ	3.3°	3.3°	3.3°	3.3°
① α	3.01	3.01°	3.01°	3.01°
① Q	1214	798	798	1214
① d *	2.27	1.78	1.78	2.27
① A *	30.4	22.5	22.5	30.4
① b	10	10	10	10
① Z	1.5	1.5	1.5	1.5
① Froude No. M **	5.23	5.15	5.15	5.23
	1536	896	896	1536
② Q	484	318	484	318
② d *	2.08	1.64	2.08	1.64
② A *	14.8	10.6	14.8	10.6
② b	4	4	4	4
② Z	1.5	1.5	1.5	1.5
② Froude No. M **	4.81	4.84	4.81	4.84
	504	299	504	299
③ Q	1698	1116	1284	1532
③ d	3.0	2.5	2.6	2.9
③ A				
③ b	10	10	10	10
③ Z	1.5	1.5	1.5	1.5
③ Froude No. M	4.55	4.08	4.39	4.35
④ A				
④ P				
④ V				
④ R				
% difference between right and left sides of equation				



Trial **FINAL**

* FROM DITCH RUNS APPENDIX 9

** FROM APPENDIX 6

PROJECT NAME _____ SHEET ____ OF ____

PROJECT NO. _____ BY _____ DATE _____

SUBJECT _____ CH'D _____ DATE _____

	CASE 1	CASE 2	CASE 3	CASE 4
Q-Embudo	100-484	10-318	100-484	10-318
Q-Upper Lomas	100-1214	10-798	10-798	100-1214
Q-Combined	1698	1116	1284	1532
① η	0.013	0.013	0.013	0.013
① h	180	180	180	180
① θ	9.5	9.5	9.5	9.5
① α	3.3°	3.3°	3.3°	3.3°
① Q	3.01	3.01	3.01	3.01
① d *	1214	798	798	1214
① A *	2.27	1.78	1.78	2.27
① b	30.4	22.5	22.5	30.4
① z	10	10	10	10
① Froude No. M**	1.5	1.5	1.5	1.5
	5.23	5.15	5.15	5.23
	1536	896	896	1536
② Q	484	318	484	318
② d *	2.08	1.64	2.08	1.64
② A *	14.8	10.6	14.8	10.6
② b	4	4	4	4
② z	1.5	1.5	1.5	1.5
② Froude No. M**	4.81	4.84	4.81	4.84
	504	299	504	299
③ Q	1698	1116	1284	1532
③ d	3.0	2.2		2.9
③ A	43.5	29.3		41.6
③ b	10	10	10	10
③ z	1.5	1.5	1.5	1.5
③ Froude No. M	4.55	5.06		4.35
	2116	1351		1805
④ A	36.95	25.9		36.0
④ P	16.5	17.2		19.3
④ V	39.5	36.8		38.4
④ R	2.3	1.50		1.85
% difference between right and left sides of equation	<1% good	1351 = 1158 14% NG		1805 = 1855 03% GOOD

Trial 1

$P_1 = 17.93$ $P_1 = 16.4$ $P_1 = 16.4$ $P_1 = 16.6$ $P_2 = 20.4$

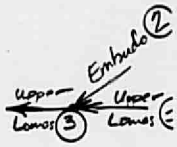
* From DITCH RUNS APPENDIX 9

** FROM APPENDIX 6

Embudo ② Upper Lomas ③ Upper Lomas ④

PROJECT NAME Embudo Hills SHEET ___ OF ___
PROJECT NO. 31820 BY BB DATE 1-84
SUBJECT CONFLUENCE ANALYSIS CH'D ___ DATE ___

	CASE 1	CASE 2	CASE 3	CASE 4
Q-Embudo	100-484	10-318	100-484	10-318
Q-Upper Lomas	100-1214	10-798	10-798	100-1214
Q-Combined	1698	1116	1284	1532
η	0.013	0.013	0.013	0.013
L	180	180	180	180
h	9.5	9.5	9.5	9.5
θ	33°	3.3°	3.3°	3.3°
α	3.01	3.01°	3.01°	3.01°
① Q	1214	798	798	1214
① d *	2.27	1.78	1.78	2.27
① A *	30.4	22.5	22.5	30.4
① b	10	10	10	10
① z	1.5	1.5	1.5	1.5
① Froude No.	5.23	5.15	5.15	5.23
① M **	1536	896	896	1536
② Q	484	318	484	318
② d *	2.08	1.64	2.08	1.64
② A *	14.8	10.6	14.8	10.6
② b	4	4	4	4
② z	1.5	1.5	1.5	1.5
② Froude No.	4.81	4.84	4.81	4.84
② M **	504	299	504	299
③ Q	1698	1116	1284	1532
③ d			2.6	
③ A			36.1	
③ b	10	10	10	10
③ z	1.5	1.5	1.5	1.5
③ Froude No.			4.39	
③ M			1459	
ⓐ A			293	
ⓐ P			18.65	
ⓐ V			35.5	
ⓐ R			1.56	
% difference between right and left sides of equation			1459 = 1386 5% OK	



$P_1 = 17.93$
$P_3 = 19.37$

* FROM DITCH RUNS APPENDIX 9

** FROM APPENDIX 6

Trial 3

PROJECT NAME Embudo Hills SHEET ___ OF ___
PROJECT NO. 31870 BY BB DATE 1-84
SUBJECT CONFLUENCE ANALYSIS CH'D ___ DATE ___

	CASE 1	CASE 2	CASE 3	CASE 4
Q-Embudo	100-484	10-318	100-484	10-318
Q-Upper Lomas	100-1214	10-798	10-798	100-1214
Q-Combined	1698	1116	1284	1532
① η	0.013	0.013	0.013	0.013
① S	180	180	180	180
① n	9.5	9.5	9.5	9.5
① θ	3.3°	3.3°	3.3°	3.3°
① α	3.01	3.01	3.01	3.01
① Q	1214	798	798	1214
① d *	2.27	1.78	1.78	2.27
① A *	30.4	22.5	22.5	30.4
① b	10	10	10	10
① z	1.5	1.5	1.5	1.5
① Froude No.	5.23	5.15	5.15	5.23
① M**	1536	896	896	1536
② Q	484	318	484	318
② d *	2.08	1.64	2.08	1.64
② A *	14.8	10.6	14.8	10.6
② b	4	4	4	4
② z	1.5	1.5	1.5	1.5
② Froude No.	4.81	4.84	4.81	4.84
② M**	504	299	504	299
③ Q	1698	1116	1284	1532
③ d		2.5	3.9	
③ A		34.4	41.62	
③ b	10	10	10	10
③ z	1.5	1.5	1.5	1.5
③ Froude No.		4.08	3.17	
③ M		1164	1284	
④ A	dC	28.5	32.1	
④ P		18.5	19.2	
④ V		34.0	33.2	
④ R		1.53	1.64	
% difference between right and left sides of equation		1164 - 1207 4% OK	1284 = 1445	
		$P_1 = 17.93$ $P_3 = 19.01$	$P_1 = 17.93$ $P_3 = 20.46$	

Embudo ②

Upper Lomas ③ ← Upper Lomas: ④

Trial 2

* From DITCH RUNS APPENDIX 9

** FROM APPENDIX 6

PROJECT NAME Embudo Hills SHEET OF

PROJECT NO. 31820 BY BB DATE 1-84

SUBJECT CONFLUENCE ANALYSIS CH'D DATE

$$F_1 = \frac{Q_1^2}{gA_1}\cos\alpha_1 + \left(\frac{b_1}{2} + \frac{z d_1}{3}\right) d_1^2 \cos^2\alpha_1$$

F_3 = left hand side of equation.

$$F_3 = F_1 + \frac{Q_2^2}{gA_2}\cos\alpha_2 \cos\theta + A_a h - \frac{P_a l n^2 V_a^2}{2.21\, R_a^{1/3}}$$

~~Need to~~ Knows	Need to compute
Q_2 =	A_2
α_2 =	A_a
θ =	P_a
l	V_a
h	R_a
n	

F_1

PROJECT NAME _____ SHEET ____ OF ____
PROJECT NO. _____ BY ____ DATE ____
SUBJECT _____ CH'D ____ DATE ____

Rating curve

$$F_3 = \frac{Q_3^2}{s A_3^2} \cos\alpha_3 + \left(\frac{h_3}{2} + \frac{2}{3}\frac{h_3}{2}\right)\frac{1}{3} \cos\ldots$$

$$F_3 = \_\_\_\_\_$$

Rating Curve

$$F_1 = \frac{Q_1^2}{s A_1^2} \cos\alpha_1 + \left(\frac{h_1}{2} + \frac{2}{3}\frac{h_1}{2}\right) \ldots$$

$$F_3 = F_1 + \frac{Q_3^2}{s A^2} \cos\alpha_0 \cos\theta + \_\_\_\_\_$$

Definition of Terms

$\alpha_2 = S_2 - S_1$ (in degrees)

l = length of confluence

h = difference in elevation between 1 & 3

n = manning's n (.013)

A_a = Average cross-sectional area of water prism @ 1 & 3

P_a = Average wetted perimeter between 1 and 3

V_a = Average velocity between 1 and 3

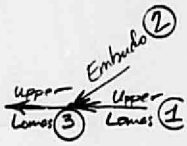
R_a = Average hydraulic radius between 1 & 3.

PROJECT NAME _____ SHEET ___ OF ___

PROJECT NO. _____ BY BB DATE 1-84

SUBJECT CONFLUENCE ANALYSIS CH'D _____ DATE _____

	CASE 1	CASE 2	CASE 3	CASE 4
Q-Embudo	100-484	10-318	100-484	10-318
Q-Upper Lomas	100-1214	10-798	10-798	100-1214
Q-Combined	1698	1116	1284	1532
n	0.013	0.013	0.013	0.013
l	180	180	180	180
h	9.5	9.5	9.5	9.5
θ	3.3°	3.3°	3.3°	3.3°
α	3.01	3.01°	3.01°	3.01°
① Q	1214	798	798	1214
① d *	2.27	1.78	1.78	2.27
① A *	30.4	22.5	22.5	30.4
① b	10	10	10	10
① z	1.5	1.5	1.5	1.5
① Froude No. M**	5.23	5.15	5.15	5.23
	1536	896	896	1536
② Q	484	318	484	318
② d *	2.08	1.64	2.08	1.64
② A *	14.8	10.6	14.8	10.6
② b	4	4	4	4
② z	1.5	1.5	1.5	1.5
② Froude No. M**	4.81	4.84	4.81	4.84
	504	299	504	299
③ Q	1698	1116	1284	1532
③ d				
③ A				
③ b	10	10	10	10
③ z	1.5	1.5	1.5	1.5
③ Froude No. M				
④ A				
④ P				
④ V				
④ R				
% difference between right and left sides of equation				



Trial _____

* From DITCH RUNS APPENDIX 9

** FROM APPENDIX 6

PROJECT NAME _____ SHEET ___ OF ___

PROJECT NO. _____ BY _____ DATE _____

SUBJECT _____ CH'D _____ DATE _____

Embudo Hills Channel
Hydraulics Review for Final Channel Design

- Superelevation (DPM Chapter 22.3 Pg 59)

$$s = 1.3 \frac{V^2 (b + 2zD)}{gr}$$

s = superelevation ft.
V = velocity of flow fps
b = bottom width of channel
z = cotangent of bank slope
D = depth of flow in straight reach
g = acceleration due to gravity 32.2
r = centerline radius ft

- Freeboard (DPM Chapter 22.3 Pg 61)

Q > 100 V > 35 fps Freeboard = $2.0 + 0.025\, V \sqrt[3]{D}$

Q < 100 V < 35 fps Freeboard = $1.0 + .025\, V \sqrt[3]{D}$

- Concrete lining thickness

min thickness = 6"

8+00 to 14+00 Bottom & lower 18" Slope = 7" V < 30 fps

8+95.38 to 8+00 Bottom & lower 18" Slope → 8" V > 30 fps

- All flow depths, velocities & froude numbers calculated by normal depth with Manning equation

3+95.38 to 6+00.00

Q = 454
BW = 4
SS1 = 1.5
SS2 = 1.5
S = .0526
n = .013

D = 2.14'
V = 31.47
f = 4.56

$$\text{Superelevation} = 1.3\,\frac{(31.47)^2(4 + 2\times 1.5\times 2.14)}{32.2\times 411.57}$$
$$= 1.01'$$

$$\text{Freeboard} = 2.0 + 0.02 \times 31.47\sqrt[3]{2.14} = 3.01'$$

Depth = 2.14
Required Depth = [illegible]

6+00

Q = 454
BW = 4
SS1 = 1.5
SS2 = 1.5
S = .0852
n = .013

D = 1.89'
V = 37.72
f = 5.77

$$\text{Superelevation} = 1.3\,\frac{(37.72)^2(4 + 2\times 1.5\times 1.89)}{32.2\times 411.57}$$
$$= 1.35'$$

$$\text{Freeboard} = 2.0 + .025\times 37.72\sqrt[3]{1.89} = 3.17'$$

$$1.35 + 3.17 + 1.89 = 6.41'$$

6+50

Q = 484
BW = 6
SS1 = 1.67:1
SS2 = 1.67:1
S = .0852
n = .013

D = 1.57
V = 35.95
f = 5.76

$$\text{Superelevation} = 1.3\,\frac{(35.95)^2(6 + 2\times 1.67\times 1.57)}{32.2\times 411.57}$$
$$= 1.42'$$

$$\text{Freeboard} = 2.0 + .025\times 35.95\sqrt[3]{1.57} = 3.04$$

$$1.42 + 3.04 + 1.57 = 6.03$$

7+00

Q = 484
BW = 8
SS1 = 1.83:1
SS2 = 1.83:1
S = .0852
n = .013

D = 1.35
V = 34.07
f = 5.74

$$\text{Superelevation} = 1.3\,\frac{(34.07)^2(8 + 2\times 1.83\times 1.35)}{32.2\times 411.57}$$
$$= 1.48'$$

$$\text{Freeboard} = 2.0 + .025\times 34.07\sqrt[3]{1.35}$$
$$= 2.94'$$

$$2.94 + 1.48 + 1.35 = 5.77$$

7+50 to 8+00

Q = 484
BW = 10
SS1 = 2.0:1
SS2 = 2.0:1
S = .0552
n = .013

D = 1.20
V = 32.43
f = 5.69

superelevation = $1.3 \frac{(32.43)^2 (10 + 2 \times 2 \times 1.20)}{32.2 \times 411.57}$
= 1.53'

freebord = $2.0 + .025\ 32.43 \sqrt[3]{1.20}$
= 2.86

1.20 + 1.53 + 2.86 = 5.59

8+00 to 12+00

Q = 484
BW = 10
SS1 = 2:1
SS2 = 2:1
S = .0425
n = .013

D = 1.46'
V = 25.65
f = 4.15

superelevation = $1.3 \frac{(25.65)^2 (10 + 2 \times 2 \times 1.46)}{32.2 \times 411.57}$
= 1.02'

freebord = $2.0 + .025 \times 25.65 \sqrt[3]{1.46}$
= 2.73

1.46 + 2.73 + 1.02 = 5.21 to 5+83.66

1.46 + 2.73 = 4.19 8+00 to 12+00

12+00 to 14+00

Q = 445
BW = 10
SS1 = 2:1
SS2 = 2:1
S = .0600
n = .013

D = 1.27
V = 28.12
f = 4.92

freebord = $2.0 + .025 \times 28.12 \sqrt[3]{1.27}$
= 2.76

1.27 + 2.76 = 4.03

16+50 to 18+00

Q = 130
BW = 10
SS1 = 5:1
SS2 = 5:1
S = .0813
n = .03

D = 0.86
V = 10.61
f = 2.30

freebord = $2.0 + .025 \times 10.61 \sqrt[3]{0.86}$
= 2.25

0.86 + 2.25 = 3.11'

7+50 to 8+00

Q = 484
BW = 10
SS1 = 2.0:1
SS2 = 2.0:1
S = .0552
n = .013

D = 1.20
V = 32.43
f = 5.69

superelevation $= 1.3 \frac{(32.43)^2 (10 + 2 \times 2 \times 1.20)}{32.2 \times 411.57}$
$= 1.53'$

freeband $= 2.0 + .025\ 32.43 \sqrt[3]{1.20}$
$= 2.86$

$1.20 + 1.53 + 2.86 =$ 5.59

8+00 to 12+00

Q = 484
BW = 10
SS1 = 2:1
SS2 = 2:1
S = .0425
n = .013

D = 1.46'
V = 25.65
f = 4.15

superelevation $= 1.3 \frac{(25.65)^2 (10 + 2 \times 2 \times 1.46)}{32.2 \times 411.57}$
$= 1.02'$

freeband $= 2.0 + .025 \times 25.65 \sqrt[3]{1.46}$
$= 2.73$

$1.46 + 2.73 + 1.02 =$ 5.21 to 5+53.66

$1.46 + 2.73 =$ 4.19 8+00 to 12+00

12+00 to 14+00

Q = 445
BW = 10
SS1 = 2:1
SS2 = 2:1
S = .0600
n = .013

D = 1.27
V = 28.12
f = 4.92

freeband $= 2.0 + .025 \times 28.12 \sqrt[3]{1.27}$
$= 2.76$

$1.27 + 2.76 =$ 4.03

16+00 to 18+00

Q = 130
BW = 10
SS1 = 5:1
SS2 = 5:1
S = .0813
n = .03

D = 0.86
V = 10.61
f = 2.30

freeband $= 2.0 + .025 \times 10.61 \sqrt[3]{0.86}$
$= 2.25$

$0.86 + 2.25 =$ 3.11'

18+00 to 21+00

Q = 130
BW = 10
SS1 = 5:1
SS2 = 5:1
S = .0767
n = .03

D = 0.87
V = 10.40
f = 2.24

$F = 2.0 + .025 \times 10.40 \sqrt[3]{0.87} = 2.24'$

$0.87 + 2.25 = 3.12'$

21+00 to 23+00

Q = 130
BW = 10
SS1 = 5:1
SS2 = 3:1
S = .045
n = .03

D = 1.03
V = 8.92
f = 1.76

$F = 2.0 + .025 \times 8.92 \sqrt[3]{1.03}$

$2.23 + 1.03 = 3.26$

23+00 to 27+30

Q = 130
BW = 10
SS1 = 5:1
SS2 = 3:1
S = .0100
n = .03

D = 1.53
V = 5.25
f = 0.88

$F = 2.0 + .025 \times 5.25 \sqrt[3]{1.53}$

$2.15 + 1.53 = 3.68$

Riprap Channel near 14+00

Q = 448
BW = 10
SS1 = 2:1
SS2 = 2:1
S = .0813
n = .03

D = 1.16
V = 31.13
f = 5.54

$F = 2.0 + .025 \times 31.13 \sqrt[3]{1.16} = 2.82'$

$1.16 + 2.82 = 3.98$

S = .0600
D = 2.02
V = 15.76
f = 2.21

$F = 2.0 + .025 \times 15.76 \sqrt[3]{2.02} = 2.50'$

$2.50 + 2.02 = 4.52$

```
VAX/VMS  C31820        RESULT 12-JAN-1984 14:14    LPAO: 12-JAN-1984 14:14    USF
VAX/VMS  C31820        RESULT 12-JAN-1984 14:14    LPAO: 12-JAN-1984 14:14    USF
VAX/VMS  C31820        RESULT 12-JAN-1984 14:14    LPAO: 12-JAN-1984 14:14    USF

                    CCCC   333     1     888    222     000
                   C      3   3   11    8   8  2   2   0   0
                   C          3    1    8   8      2   0  00
                   C        3      1     888     2    0 0 0
                   C          3    1    8   8   2     00  0
                   C      3   3    1    8   8  2      0   0
                    CCCC   333    111    888   22222   000

RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RR  RR      EE                  SS  UU      UU  LL              TT
RR  RR      EE                  SS  UU      UU  LL              TT
RR    RR    EE                  SS  UU      UU  LL              TT
RR    RR    EE                  SS  UU      UU  LL              TT
RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT
RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT

BBBBBBBB      IIIIII    TTTTTTTTTT      ;;;;        11
BBBBBBBB      IIIIII    TTTTTTTTTT      ;;;;        11
BB      BB      II          TT        ;;;;      1111
BB      BB      II          TT        ;;;;      1111
BB      BB      II          TT                    11
BB      BB      II          TT                    11
BBBBBBBB        II          TT        ;;;;        11
BBBBBBBB        II          TT        ;;;;        11
BB      BB      II          TT        ;;;;        11
BB      BB      II          TT        ;;;;        11
BB      BB      II          TT          ;;        11
BB      BB      II          TT          ;;        11
BBBBBBBB      IIIIII        TT        ;;        111111
BBBBBBBB      IIIIII        TT        ;;        111111

                    CCCC   333     1     888    222     000
                   C      3   3   11    8   8  2   2   0   0
                   C          3    1    8   8      2   0  00
                   C        3      1     888     2    0 0 0
                   C          3    1    8   8   2     00  0
                   C      3   3    1    8   8  2      0   0
                    CCCC   333    111    888   22222   000

VAX/VMS  C31820        RESULT 12-JAN-1984 14:14    LPAO: 12-JAN-1984 14:14    US
VAX/VMS  C31820        RESULT 12-JAN-1984 14:14    LPAO: 12-JAN-1984 14:14    US
VAX/VMS  C31820        RESULT 12-JAN-1984 14:14    LPAO: 12-JAN-1984 14:14    US
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DITCH PROGRAM RUN
EMBUDO HILLS CHANNEL ABOVE CONFLUENCE
(100yr. Storm Q = 448 & 484 cfs)

* *

STATION 950.0 (Channel @ Sta 4+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5933.80	484.0	15.0	2.10	32.30	50.0	5931.70

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	2.13	4.72	12.98

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5950.00	0.05620	387.6	0.0	0.0

* *

STATION 1000.0 (Channel @ Sta 4+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5931.18	484.0	15.1	2.10	32.[illegible]	50.0	5929.07

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	2.13	4.69	12.93

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5947.21	0.05541	386.7	0.[illegible]	0.0

* *

STATION 800.0 (Channel @ Sta 6+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5943.37	484.0	15.5	2.15	31.16	50.0	5941.22

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	1.88	4.50	12.66

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5958.45	0.05096	381.4	411.6	0.3

* *

STATION 850.0 (Channel @ Sta ~~6+50~~ 5+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5939.04	484.0	14.8	2.08	32.78	50.0	5936.96

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	2.13	4.81	13.12

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5955.73	0.05852	390.3	411.6	0.3

* *

STATION 900.0 (Channel @ Sta 5+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5936.42	484.0	14.9	2.09	32.51	50.0	5934.33

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	4.63	2.13	4.76	13.04

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5952.83	0.05720	388.8	411.6	0.3

STATION 650.0 (Channel @ Sta 7+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5955.47	484.0	19.0	1.47	25.53	50.0	5954.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.32	1.20	4.12	7.83

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5965.59	0.04143	270.7	411.6	0.5

* *

STATION 700.0 (Channel @ Sta 7+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5951.33	484.0	17.4	1.59	27.86	50.0	5949.74

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	8.0	1.8	3.66	1.35	4.38	9.10

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5963.38	0.04703	306.1	411.6	0.5

* *

STATION 750.0 (Channel @ Sta 6+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5947.29	484.0	16.3	1.81	29.68	50.0	5945.48

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	6.0	1.7	4.08	1.56	4.49	10.62

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5960.96	0.04975	343.7	411.6	0.4

* *

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5961.86	484.0	19.2	1.48	25.17	50.0	5960.38

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.32	1.46	4.04	7.76

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5971.70	0.03976	269.5	0.0	0.0

* *

STATION 550.0 (Channel & Sta 8+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5959.73	484.0	19.1	1.48	25.33	50.0	5958.25

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.32	1.46	4.07	7.79

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5969.69	0.04050	270.0	411.6	0.5

* *

STATION 600.0 (Channel & Sta 8+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5957.59	484.0	19.0	1.47	25.45	50.0	5956.13

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.32	1.46	4.10	7.81

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5967.65	0.04102	270.4	411.6	0.5

* *

5968.11	448.0	17.4	1.36	25.78	50.0	5966.75

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.39	4.29	7.62

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5978.44	0.04573	257.6	0.0	0.0

* *

STATION 400.0 (Channel @ Sta 10+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5966.00	448.0	17.5	1.37	25.60	50.0	5964.63

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.39	4.24	7.59

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5976.17	0.04478	257.0	0.0	0.0

* *

STATION 450.0 (Channel @ Sta 9+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5963.88	448.0	17.6	1.38	25.47	50.0	5962.50

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.39	4.21	7.56

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5973.95	0.04411	256.6	0.0	0.0

* *

STATION 500.0 (Channel @ Sta 9+00)

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.26	4.22	7.57

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5985.48	0.04429	256.7	0.0	0.0

* *

STATION 250.0 (Channel & Sta 11+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5972.34	448.0	17.0	1.34	26.38	50.0	5971.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.39	4.42	7.73

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5983.15	0.04891	259.4	0.0	0.0

* *

STATION 300.0 (Channel & Sta 11+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5970.23	448.0	17.2	1.35	26.04	50.0	5968.88

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.39	4.34	7.67

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5980.75	0.04705	256.4	0.0	0.0

* *

STATION 350.0 (Channel & Sta 10+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE

SLOPE	EGL	SLOPE	NO/1000	RADIUS	ELEV
0.06000	5990.36	0.01893	232.9	0.0	0.0

* *

BE CAREFUL!
YOUR CROSS SECTIONS LOOK LIKE THEY MAY BE TOO FAR APART.

STATION 100.0 (Channel @ Sta 13+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5981.54	448.0	20.2	1.54	22.19	50.0	5980.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.26	3.50	6.90

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5989.19	0.02956	245.4	0.0	0.0

* *

STATION 150.0 (Channel @ Sta 12+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5978.44	448.0	18.5	1.44	24.18	50.0	5977.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	3.19	1.26	3.93	7.31

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5987.52	0.03793	252.4	0.0	0.0

* *

STATION 200.0 (Channel @ Sta 12+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5975.38	448.0	17.6	1.38	25.50	50.0	5974.00

***** SUPERCRITICAL RUN -- COMPUTATIONS PROCEED IN DOWNSTREAM DIRECTION **

STATION 0.0 (Channel @ Sta 14+00)

W S ELEV 5988.00	DISCH CFS 448.0	FLOW AREA 28.0	FLOW DPTH 2.00	VEL FT/SEC 16.00	REACH DIST 0.0	BTM ELE 5986.00
MANNINGS N 0.013	BTM WIDTH 10.0	SIDE SLOPE 2.0	CRIT DPTH 3.19	NORM DPTH 1.26	FR NO. 2.26	SEQ DPTH 5.47
CHANNEL SLOPE 0.06000	ELEV EGL 5991.98	FRICT SLOPE 0.01157	RNLDS NO/1000 219.0	CURVE RADIUS 0.0	SUPER ELEV 0.0	

* *

BE CAREFUL!
YOUR CROSS SECTIONS LOOK LIKE THEY MAY BE TOO FAR APART.

STATION 25.0 (Channel @ Sta ~~13+50~~ 13+75)

W S ELEV 5986.44	DISCH CFS 448.0	FLOW AREA 26.9	FLOW DPTH 1.94	VEL FT/SEC 16.66	REACH DIST 25.0	BTM ELE 5984.50
MANNINGS N 0.013	BTM WIDTH 10.0	SIDE SLOPE 2.0	CRIT DPTH 3.19	NORM DPTH 1.26	FR NO. 2.39	SEQ DPT 5.64
CHANNEL SLOPE 0.06000	ELEV EGL 5990.75	FRICT SLOPE 0.01298	RNLDS NO/1000 222.2	CURVE RADIUS 0.0	SUPER ELEV 0.0	

* *

STATION 50.0 (Channel @ Sta 13+50)

W S ELEV 5984.75	DISCH CFS 448.0	FLOW AREA 23.6	FLOW DPTH 1.75	VEL FT/SEC 19.01	REACH DIST 25.0	BTM ELE 5983.00
MANNINGS N 0.013	BTM WIDTH 10.0	SIDE SLOPE 2.0	CRIT DPTH 3.19	NORM DPTH 1.26	FR NO. 2.84	SEQ DPTH 6.20
CHANNEL	ELEV	FRICT	RNLDS	CURVE	SUPER	

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VAX/VMS  C31820        RESULT 12-JAN-1984 16:10    LPA0: 12-JAN-1984 16:10    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 16:10    LPA0: 12-JAN-1984 16:10    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 16:10    LPA0: 12-JAN-1984 16:10    USE

                    CCCC   333     1     888    222    000
                   C     3    3   11    8   8  2   2  0   0
                   C          3    1    8   8      2  0  00
                   C        3      1     888     2   0 0 0
                   C       3       1    8   8   2    00  0
                   C     3    3    1    8   8  2     0   0
                    CCCC   333    111    888   22222   000

RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RRRRRRRR    EEEEEEEEEE   SSSSSSSS   UU      UU  LL          TTTTTTTTTT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE           SS         UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RR  RR      EE                  SS UU      UU  LL              TT
RR  RR      EE                  SS UU      UU  LL              TT
RR    RR    EE                  SS UU      UU  LL              TT
RR    RR    EE                  SS UU      UU  LL              TT
RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT
RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT

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                    CCCC   333     1     888    222    000
                   C     3    3   11    8   8  2   2  0   0
                   C          3    1    8   8      2  0  00
                   C        3      1     888     2   0 0 0
                   C       3       1    8   8   2    00  0
                   C     3    3    1    8   8  2     0   0
                    CCCC   333    111    888   22222   000

VAX/VMS  C31820        RESULT 12-JAN-1984 16:10    LPA0: 12-JAN-1984 16:10    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 16:10    LPA0: 12-JAN-1984 16:10    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 16:10    LPA0: 12-JAN-1984 16:10    USE
```

DITCH PROGRAM RUN
EMBUDO HILLS CHANNEL ABOVE CONFLUENCE
(10yr Storm Q= 294 & 316 cfs)

(Channel ℄ Sta 4+00)

```
                          STATION  1000.0

   W S        DISCH      FLOW       FLOW       VEL       REACH      BTM
   ELEV        CFS       AREA       DPTH     FT/SEC      DIST       ELE
 5930.76      318.0      11.0       1.69      28.87       50.0    5929.07

 MANNINGS      BTM       SIDE       CRIT       NORM        FR       SEQ
    N         WIDTH      SLOPE      DPTH       DPTH        NO.      DPTH
  0.013         4.0      1.5        3.77       1.72       4.61     10.20

 CHANNEL       ELEV      FRICT      RNLDS      CURVE      SUPER
  SLOPE        EGL       SLOPE     NO/1000     RADIUS      ELEV
 0.05260     5943.70    0.05638     292.1        0.0        0.0

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STATION 850.0 (Channel @ Sta 5+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5938.60	318.0	10.6	1.64	29.96	50.0	5936.96

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.72	4.84	10.45

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5952.54	0.06245	296.8	411.6	0.3

* *

STATION 900.0 (Channel @ Sta 5+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5935.99	318.0	10.8	1.66	29.48	50.0	5934.33

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.72	4.74	10.34

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5949.49	0.05973	294.7	411.6	0.3

* *

STATION 950.0 (Channel @ Sta 4+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5933.38	318.0	10.9	1.68	29.13	50.0	5931.70

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.72	4.67	10.26

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5946.55	0.05778	293.2	0.0	0.0

* *

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5950.98	318.0	12.7	1.24	24.98	50.0	5949.74

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	8.0	1.8	2.91	1.06	4.37	7.06

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5960.67	0.04971	223.6	411.6	0.4

* *

STATION 750.0 (Channel ℄ Sta 6+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5946.90	318.0	11.8	1.42	26.87	50.0	5945.48

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	6.0	1.7	3.28	1.24	4.51	8.34

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5958.11	0.05296	255.8	411.6	0.3

* *

STATION 800.0 (Channel ℄ Sta 6+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5942.93	318.0	11.2	1.71	28.38	50.0	5941.22

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	4.0	1.5	3.77	1.51	4.51	10.08

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5955.44	0.05381	289.9	411.6	0.2

* *

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.63	1.15	3.95	5.94

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5967.06	0.04053	193.7	411.6	0.4

* *

STATION 600.0 (Channel @ Sta 8+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5957.28	318.0	14.3	1.16	22.31	50.0	5956.13

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.63	1.15	3.98	5.97

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5965.01	0.04120	194.0	411.6	0.4

* *

STATION 650.0 (Channel @ Sta 7+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5955.15	318.0	14.2	1.15	22.40	50.0	5954.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.63	0.94	4.01	5.98

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08520	5962.94	0.04169	194.2	411.6	0.4

* *

STATION 700.0 (Channel @ Sta 7+00)

N	WIDTH	SLOPE	DPTH	DPTH	NO.	DPTH
0.013	10.0	2.0	2.51	1.10	4.15	5.79

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5973.56	0.04552	183.8	0.0	0.0

* *

STATION 450.0 (Channel & Sta 9+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5963.58	294.0	13.2	1.08	22.31	50.0	5962.50

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	1.10	4.10	5.76

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5971.31	0.04440	183.4	0.0	0.0

* *

STATION 500.0 (Channel & Sta 9+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5961.55	318.0	14.5	1.17	21.99	50.0	5960.38

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.63	1.15	3.91	5.91

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5969.06	0.03949	193.2	0.0	0.0

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STATION 550.0 (Channel & Sta 8+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5959.41	318.0	14.3	1.16	22.19	50.0	5958.25

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5980.94	0.05493	187.0	0.0	0.0

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STATION 300.0 (Channel & Sta 11+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5969.92	294.0	12.6	1.05	23.24	50.0	5968.88

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	1.10	[illegible]	5.91

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5978.31	0.05015	185.5	0.0	0.0

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STATION 350.0 (Channel & Sta 10+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5967.81	294.0	12.9	1.06	22.79	50.0	5966.75

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	1.10	4.22	5.84

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04250	5975.88	0.04728	184.5	0.0	0.0

* *

STATION 400.0 (Channel & Sta 10+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5965.70	294.0	13.1	1.08	22.50	50.0	5964.63

MANNINGS	BTM	SIDE	CRIT	NORM	FR	SEQ

SLOPE	EGL	SLOPE	NO/1000	RADIUS	ELEV
0.06000	5988.17	0.03872	181.0	0.0	0.0

* *

STATION 150.0 (Channel & Sta 12+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5978.07	294.0	13.0	1.07	22.68	50.0	5977.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	0.99	4.19	5.82

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5986.06	0.04662	184.2	0.0	0.0

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STATION 200.0 (Channel & Sta 12+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5975.04	294.0	12.5	1.04	23.49	50.0	5974.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	0.99	4.40	5.95

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5983.60	0.05172	186.0	0.0	0.0

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STATION 250.0 (Channel & Sta 11+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5972.02	294.0	12.3	1.02	23.97	50.0	5971.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	1.10	4.52	6.03

***** SUPERCRITICAL RUN -- COMPUTATIONS PROCEED IN DOWNSTREAM DIRECTION ***

STATION 0.0 (Channel ℄ Sta 14+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5987.60	294.0	21.1	1.60	13.92	0.0	5986.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	0.99	2.16	4.16

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5990.61	0.01118	158.7	0.0	0.0

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BE CAREFUL!
YOUR CROSS SECTIONS LOOK LIKE THEY MAY BE TOO FAR APART.

STATION 50.0 (Channel ℄ Sta 13+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5984.25	294.0	15.6	1.25	18.88	50.0	5983.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	0.99	3.26	5.16

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.06000	5989.78	0.02712	174.6	0.0	0.0

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STATION 100.0 (Channel ℄ Sta 13+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5981.13	294.0	13.8	1.13	21.30	50.0	5980.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	2.0	2.51	0.99	3.85	5.59

CHANNEL	ELEV	FRICT	RNLDS	CURVE	SUPER

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VAX/VMS  C31820        RESULT 12-JAN-1984 11:01    LPA0: 12-JAN-1984 11:01    USI
VAX/VMS  C31820        RESULT 12-JAN-1984 11:01    LPA0: 12-JAN-1984 11:01    USI
VAX/VMS  C31820        RESULT 12-JAN-1984 11:01    LPA0: 12-JAN-1984 11:01    USI

                        CCCC   333     1     888    222    000
                       C      3   3   11    8   8  2   2  0   0
                       C          3    1    8   8      2  0  00
                       C        3      1     888     2   0 0 0
                       C          3    1    8   8    2    00  0
                       C      3   3    1    8   8   2     0   0
                        CCCC   333    111    888   22222   000

RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RR  RR      EE                  SS  UU      UU  LL              TT
RR  RR      EE                  SS  UU      UU  LL              TT
RR    RR    EE                  SS  UU      UU  LL              TT
RR    RR    EE                  SS  UU      UU  LL              TT
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RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT

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                        CCCC   333     1     888    222    000
                       C      3   3   11    8   8  2   2  0   0
                       C          3    1    8   8      2  0  00
                       C        3      1     888     2   0 0 0
                       C          3    1    8   8    2    00  0
                       C      3   3    1    8   8   2     0   0
                        CCCC   333    111    888   22222   000

VAX/VMS  C31820        RESULT 12-JAN-1984 11:01    LPA0: 12-JAN-1984 11:01    US
VAX/VMS  C31820        RESULT 12-JAN-1984 11:01    LPA0: 12-JAN-1984 11:01    US
VAX/VMS  C31820        RESULT 12-JAN-1984 11:01    LPA0: 12-JAN-1984 11:01    US
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DITCH PROGRAM RUN
UPPER LOMAS CHANNEL ABOVE CONFLUENCE
(100 yr. Storm, 1214 cfs)

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5967.68	0.06292	620.6	581.0	0.9

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STATION 450.0 (Channel & Sta 13+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5939.81	1214.0	30.4	2.27	39.94	50.0	5937.54

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.23	15.69

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5964.58	0.06119	618.4	0.0	0.0

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STATION 500.0 (Channel & Sta 13+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5937.19	1214.0	30.6	2.28	39.61	50.0	5934.91

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.18	15.61

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5961.56	0.05975	616.5	0.0	0.0

* *

0.08000	5977.06	0.05835	614.7	581.0	0.8

* *

STATION 300.0 (Channel @ Sta 15+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5949.06	1214.0	30.3	2.26	40.12	50.0	5946.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.10	5.27	15.73

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5974.06	0.06198	619.4	581.0	0.9

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STATION 350.0 (Channel @ Sta 14+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5945.03	1214.0	29.8	2.23	40.80	50.0	5942.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.38	15.90

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5970.88	0.06503	623.1	581.0	0.9

* *

STATION 400.0 (Channel @ Sta 14+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5942.42	1214.0	30.1	2.25	40.33	50.0	5940.17

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.37	5.30	15.79

* *

STATION 150.0 (Channel @ Sta 16+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5961.21	1214.0	32.8	2.41	36.97	50.0	5958.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.10	4.72	14.94

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5982.44	0.04910	601.3	0.0	0.0

* *

STATION 200.0 (Channel @ Sta 16+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5957.15	1214.0	31.7	2.35	38.25	50.0	5954.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.10	4.94	15.26

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5979.86	0.05407	608.8	581.0	0.8

* *

STATION 250.0 (Channel @ Sta 15+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5953.10	1214.0	30.9	2.30	39.28	50.0	5950.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.10	5.12	15.53

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV

***** SUPERCRITICAL RUN -- COMPUTATIONS PROCEED IN DOWNSTREAM DIRECTION *'

STATION 0.0 (Channel @ Sta 18+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5969.70	1214.0	34.4	2.50	35.32	0.0	5967.20

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.49	4.44	14.50

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04400	5989.07	0.04311	591.2	0.0	0.0

* *

STATION 50.0 (Channel @ Sta 17+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5967.50	1214.0	34.3	2.50	35.36	50.0	5965.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.49	4.45	14.51

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04400	5986.91	0.04325	591.4	0.0	0.0

* *

STATION 100.0 (Channel @ Sta 17+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5965.30	1214.0	34.3	2.50	35.39	50.0	5962.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	5.77	2.10	4.45	14.52

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5984.74	0.04337	591.6	0.0	0.0

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VAX/VMS  C31820        RESULT 12-JAN-1984 15:47    LPA0: 12-JAN-1984 15:47    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 15:47    LPA0: 12-JAN-1984 15:47    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 15:47    LPA0: 12-JAN-1984 15:47    USE

                 CCCC   333     1     888    222    000
                C    3    3   11    8   8  2   2  0   0
                C         3    1    8   8      2  0  00
                C        3     1     888      2   0 0 0
                C       3      1    8   8    2    00  0
                C    3    3    1    8   8   2     0   0
                 CCCC   333   111     888   22222   000

RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RRRRRRRR    EEEEEEEEEE    SSSSSSSS  UU      UU  LL          TTTTTTTTTT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RR      RR  EE          SS          UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RRRRRRRR    EEEEEEEE      SSSSSS    UU      UU  LL              TT
RR   RR     EE                  SS  UU      UU  LL              TT
RR    RR    EE                  SS  UU      UU  LL              TT
RR     RR   EE                  SS  UU      UU  LL              TT
RR      RR  EE                  SS  UU      UU  LL              TT
RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT
RR      RR  EEEEEEEEEE  SSSSSSSS    UUUUUUUUUU  LLLLLLLLLL      TT

BBBBBBBB      IIIIII    TTTTTTTTTT      ;;;;        11
BBBBBBBB      IIIIII    TTTTTTTTTT      ;;;;        11
BB      BB      II          TT        ;;;;      1111
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BB      BB      II          TT          ;;        11
BB      BB      II          TT          ;;      111111
BBBBBBBB      IIIIII        TT        ;;        111111
BBBBBBBB      IIIIII        TT        ;;

                 CCCC   333     1     888    222    000
                C    3    3   11    8   8  2   2  0   0
                C         3    1    8   8      2  0  00
                C        3     1     888      2   0 0 0
                C       3      1    8   8    2    00  0
                C    3    3    1    8   8   2     0   0
                 CCCC   333   111     888   22222   000

VAX/VMS  C31820        RESULT 12-JAN-1984 15:47    LPA0: 12-JAN-1984 15:47    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 15:47    LPA0: 12-JAN-1984 15:47    USE
VAX/VMS  C31820        RESULT 12-JAN-1984 15:47    LPA0: 12-JAN-1984 15:47    USE
```

DITCH PROGRAM RUN
UPPER LOMAS CHANNEL ABOVE CONFLUENCE
(10yr Storm, 798 cfs)

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5962.01	0.06543	452.4	581.0	0.7

* *

STATION 450.0 (Channel @ Sta 13+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5939.32	798.0	22.5	1.78	35.43	50.0	5937.54

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.15	12.10

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5958.81	0.06264	450.2	0.0	0.0

* *

STATION 500.0 (Channel @ Sta 13+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5936.71	798.0	22.8	1.80	35.00	50.0	5934.91

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.07	12.01

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5955.73	0.06046	448.5	0.0	0.0

* *

0.08000	5971.95	0.06205	449.8	581.0	0.7

* *

STATION 300.0 (Channel & Sta 15+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5948.55	798.0	22.1	1.75	36.06	50.0	5946.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.66	5.28	12.23

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5968.74	0.06595	452.8	581.0	0.7

* *

STATION 350.0 (Channel & Sta 14+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5944.53	798.0	21.8	1.73	36.63	50.0	5942.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.39	12.35

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.05260	5965.37	0.06904	455.1	581.0	0.7

* *

STATION 400.0 (Channel & Sta 14+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5941.93	798.0	22.2	1.76	35.96	50.0	5940.17

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.87	5.26	12.21

* *

STATION 150.0 (Channel @ Sta 16+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5960.68	798.0	24.2	1.88	33.03	50.0	5958.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.66	4.68	11.57

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5977.62	0.05112	440.0	0.0	0.0

* *

STATION 200.0 (Channel @ Sta 16+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5956.63	798.0	23.2	1.83	34.33	50.0	5954.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.66	4.94	11.86

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5974.92	0.05716	445.6	581.0	0.6

* *

STATION 250.0 (Channel @ Sta 15+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5952.58	798.0	22.6	1.78	35.31	50.0	5950.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.66	5.13	12.07

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV

***** SUPERCRITICAL RUN -- COMPUTATIONS PROCEED IN DOWNSTREAM DIRECTION **

STATION 0.0 (Channel @ Sta 18+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5969.17	798.0	25.5	1.97	31.27	0.0	5967.20

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.97	4.35	11.18

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04400	5984.36	0.04367	432.0	0.0	0.0

* *

STATION 50.0 (Channel @ Sta 17+50)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5966.97	798.0	25.5	1.97	31.29	50.0	5965.00

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.97	4.35	11.18

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.04400	5982.17	0.04373	432.1	0.0	0.0

* *

STATION 100.0 (Channel @ Sta 17+00)

W S ELEV	DISCH CFS	FLOW AREA	FLOW DPTH	VEL FT/SEC	REACH DIST	BTM ELE
5964.77	798.0	25.5	1.97	31.31	50.0	5962.80

MANNINGS N	BTM WIDTH	SIDE SLOPE	CRIT DPTH	NORM DPTH	FR NO.	SEQ DPTH
0.013	10.0	1.5	4.60	1.66	4.36	11.19

CHANNEL SLOPE	ELEV EGL	FRICT SLOPE	RNLDS NO/1000	CURVE RADIUS	SUPER ELEV
0.08000	5979.99	0.04380	432.2	0.0	0.0

Elena Gallegos Park Conservation Plan

The Elena Gallegos Park consists of 640 acres of rangeland and juniper woodland along the base of the Sandia Mountains, east of Tramway Road. Acess to the park is by Tramway Road approximately 2.3 miles north of Montgomery Boulevard. The objective of this plan is to control soil erosion by means of simple structures and exclusion and reseeding of the rangeland. The erosion problems are occurring due to off-road vehicle use, and past overuse by livestock. Many roads and trails have deteriorated through water erosion into gullies. Methods of controlling the erosion include rock and brush dams, earthen beams, gravel mulch, rock and wire blankets, reseeding and fencing to control off-road vehicle traffic and/or livestock.

This plan also contains resource information about the soils vegetation, and wildlife of the area. Vegetative transects and photo points will be established to monitor the vegetative improvement or decline in the park. The Soil Conservation Service (SCS) will provide onsite technical assistance, designs and specifications as needed.

Rock and brush dams

These dams will be constructed where possible in gullies that are actively eroding. They will help to slow down the flow of water and trap silt. They will consist of alternating layers of rock and bruch with a rock apron on the downstream side. (See the attached design sheet). They will be constructed in a stairstep fashion going up the gully. SCS will assist with the placement and locating of the rock and brush dams.

Earthen berms

These beams will help to slow down water and catch silt on the roads throughout the park. A series of earthen berms will be constructed along the roads in a stairstep fashion. Soil will be dug out upslope and the berm filled downslope across the road. (See drawing #1). The dug out part will be dug at a gentle slope and the berm should be gently sloped and compacted. The height of the berm should be low enough and the slope gentle enough to allow vehicles to pass over it. In areas where there is no vehicle traffic, the berm may be higher and the slope steeper. Native grasses will be seeded in the dug out area to assist with the erosion control and to help reseed the road itself. The extra moisture collected here should give the seeding a better chance of success.

Reseeding

Native grass seed will be used to seed bare areas and roads that are not in use. Native species that are adapted to most of the park area are listed in the "Native Plant Communities" section of the plan. SCS will assist in selecting site-specific species for areas needing reseeding. If the seed is planted as a mix, the seeding rate should be enough to seed approximately 20 seeds per square foot. If species are seeded singly SCS will provide seeding rates for the species selected. Where it is possible, a grass drill should be

used to seed the areas that are fairly level, such as roads. Where it is not possible a "cyclone" or "whirlybird" type seeder should be used, or the seed may be seeded by hand. Seeding with a drill is the preferred method. A good seedbed should be prepared where it is possible before seeding. Once seeded, a hay or straw mulch should be spread over the seeding to keep the soil cooler and conserve moisture. Recommended time for seeding would be from July 15 to September 1. This is the period of time when the greatest chance for precipitation occurs. If supplemental water is available, it should be used to aid in establishment, and it should be applied lightly in order to prevent washing away of the seed and for better penetration into the soil. SCS will assist with more seeding information where it is needed.

Rock and Wire Blankets

This will be constructed on the steep hillsides and drainages where there is little or no vegetation. They will attempt to slow the water down and catch silt coming down the slope. They will consist of a net-wire blanket with rock and brush and tied down to the hillside with re-enforcing bars. (See drawing #2). The area can also be seeded to try to establish vegetation to assist in stabilizing the slope. The SCS will assist in locating these blankets.

Gravel Mulch

A gravel mulch will be used in drainage areas where slopes are not too steep to control water erosion. Gravel ranging in size from 4-6 inches should be used. A ground cover of 100% should be achieved. Some grading and shaping may also need to be done depending on the area to be treated. SCS will provide onsite assistance in locating areas needing to be mulched as it is needed.

Firebreak

A firebreak will be established around picnic areas and other areas where there is a chance of man-made fires. The firebreak will consist of approximately 6 feet of area cleared of vegetation or consisting of inflammable material. The firebreak should be maintained throughout the year, especially during the summer months when the fire danger is especially high. Firebreaks may also be constructed along the boundary fences if it is feasible.

Fencing and Trails

The fences and trails will be constructed by the city. Care should be taken to locate the trails where they will not cause erosion. Also care should be taken in the construction of the trails in making cuts and fills so that erosion will not be started. The SCS will provide any additional assistance if it is needed.

Seeding Rates and Mixtures

Black grama	1.0 lb. PLS/ac.
sideoats grama	4.0 lb. PLS/ac.
blue grama	1.5 lb. PLS/ac.
sand dropseed	1.0 lb. PLS/ac.
Indian ricegrass	6.0 lb. PLS/ac.

Mixture #1

60% Black grama	0.6 lb. PLS/ac.
30% Indian ricegrass	1.8 lb. PLS/ac.
10% blue grama	0.15 lb. PLS/ac.

Mixture #2

50% Indian ricegrass	3.0 lb. PLS/ac.
40% blue grama	0.6 lb. PLS/ac.
10% sand d ropseed	0.1 lb. PLS/ac.

Mixture #3

50% Indian ricegrass	3.0 lb. PLS/ac.
30% sideoats grama	~~1.2 lb. PLS/ac.~~
20% blue grama	0.3 lb. PLS/ac.

Mixture #4 very gravelly soil, steeper slopes

50% sideoats grama	2.0 lb. PLS/ac.
40% blue grama	0.6 lb. PLS/ac.
10% Indian ricegrass	0.6 lb. PLS/ac.

Continuously Reinforced Concrete
Terminal Expansion Joints

Thermal Coefficient of Expansion*:

Concrete - $5.5 \times 10^{-6} - 7.5 \times 10^{-6}$

Steel - 6.5×10^{-6}

Use - 6.5×10^{-6}

Length of pavement which expands**:

250 ft at each end

Variation in temperature for slab:

$90°F - 25°F = 65°F$

Required expansion joint:

$250 \times (6.5 \times 10^{-6}) \times 65° \times 12 in/ft = 1.27''$

Since joint is 50% effective: use 3" of total expansion joint.

~~Assume box culverts have same amount of expansion 1.27" x 2 = 2.54"~~

~~Use 3" of expansion joint~~

* Reinforced Concrete Design, 2nd Ed., Wang + Salmon, 1965 p. 2

** A.C.I. Manual of Concrete Practice, 1981 p. 325.4 R-6,7

PROJECT Pino + Bota Arroyos
PROJECT No. 20596
SUBJECT Expansion Joints

Dmyn 6-16-83