## City of Albuquerque



July 5, 2000

Dan Grochowski, PE Bohannan Huston, Inc 7500 Jefferson NE Albuquerque, NM 87109

Petroglyph Golf Club Conceptual Drainage Plan Re:

Engineer's Stamp dated 5-17-00, (H09/D12)

Dear Mr. Grochowski,

Based upon the information provided in your submittal dated 5-17-00, the above referenced Conceptual Drainage Plan is approved for Site Development Plan for Subdivision.

Prior to Site Plan for Building Purposes, a comprehensive Grading Plan will be required that provides details about the planned construction. Also, an Infrastructure List will be necessary that identifies all drainage requirements needed for bonding.

If you have any questions, you can contact me at 924-3986.

Sincerely,

Bradley L. Bingham, PE

· Hydrology Review Engineer

Don Dixon, AMAFCA file

谦钫

# DRAINAGE REPORT FOR PETROGLYPH GOLF COURSE

**BOHANNAN HUSTON** 

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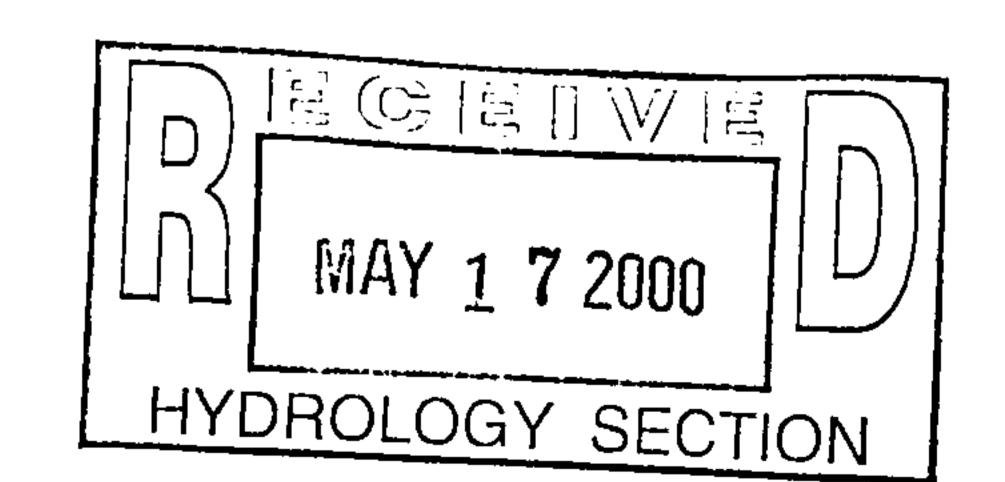
fax 505.821.0892

MAY 17, 1999

PREPARED FOR:

WESTLAND DEVELOPMENT CO. INC. 401 COORS BOULEVARD NW ALBUQUERQUE, NM 87121

"食","我是食食","老我是我们有人的,我们们有自己的最后就是自己的人,我们还有有什么的。""我们们的人也不知道我的一个意识的自己的意识。"



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#### I. INTRODUCTION

This report summarizes the results of the drainage analysis for the future development of the Westland North property as related to the Conceptual Drainage Plan for the Petroglyph Golf Club. The site is located on Albuquerque's West side between Unser Boulevard and Paseo del Volcan, south of the Petroglyph National Monument. A vicinity map is included as Figure 1. The proposed development is a golf course community. There will be 27 holes of golf with mixed density single-family homes throughout. No drainage improvements will be constructed within the limits of the Petroglyph National Monument at this time.

#### A. Purpose

The purpose of this report is to present the hydrologic and hydraulic analyses of the site that were used in determining the Conceptual Drainage Plan. The Conceptual Drainage Plan was created for Site Plan for Subdivision approval and Site Plan for Building Permit approval.

#### B. Scope of work

Tasks completed as part of this study include:

- Calculate off-site flows
- Calculate on-site flows
- Identify drainage easements
- Identify future flow directions and potential conveyance facilities
- Perform hydraulic analysis on the Mirehaven Arroyo
- Size culvert crossings under 98th Street
- Identify Federal Emergency Management Agency (FEMA) floodplains
- Create Conceptual Drainage Plan for the site

#### C. Previous Studies

This report has been prepared in close coordination with the Design Analysis Report that supports the Phase I roadway infrastructure for the Westland Development property, being prepared concurrently by Bohannan Huston, Inc. That drainage report supports the final roadway design of 98<sup>th</sup> Street and Petroglyph Parkway, and is being prepared as part of the preliminary and final plat approvals.

The West Interstate 40 Diversion Drainage Management Plan (West I-40 DMP), dated March 2000, prepared by Bohannan Huston, Inc. for Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), covers approximately 40 square miles of the west side, including the area of the proposed Petroglyph Golf Course. The document is in its last stages of review by AMAFCA and approval is anticipated in the near future. The DMP references the Westland Sector Development Plan.

The West I-40 DMP provides fully developed flow rates for basins within the study. Basins have been delineated to the proposed 98th Street extension. These flows were used in the preparation of the Conceptual Drainage Plan as described in subsequent sections.

#### D. Existing Project Area Description

The site consists of approximately 550 acres of undeveloped land that is currently used for the grazing of cattle. It is covered with native vegetation. The land drains, in general, from west to east at slopes ranging from 3.5% to 12%. The majority of the site slopes uniformly at an average of 5.5%. Elevations range from 5,670 feet at the western-most edge of the property to 5,255 feet at the eastern-most edge at the connection to the existing development.

A number of arroyos cross the site. The largest of these is the Mirehaven Arroyo, which is an AMAFCA facility. The braided floodplain width varies from 150 to

500 feet. A second arroyo, which is designated as the Dam 9 Arroyo and flows to the AMAFCA Dam #9 facility, is the only other major arroyo.

#### E. FEMA Floodplains

There are two FEMA floodplains that exist on site. Refer to Exhibits 1 and 2 in Appendix D. The first is for the Mirehaven Arroyo. The existing floodplain only encroaches into fairways of the golf course under proposed conditions. Although the floodplain will not interfere with any planned development, a Letter of Map Revision (LOMR) is required since the configuration of the floodplain will change under proposed conditions.

The second FEMA floodplain is for a smaller arroyo to the south, identified as Dam 9 Arroyo. The floodplain exists on a tributary to the Dam 9 Arroyo. The majority of this floodplain traverses areas designated for subdivision development. A Conditional Letter of Map Revision (CLOMR) will have to be submitted to FEMA upon completion of the final design.

#### II. HYDROLOGIC ANALYSES

The 100-year storm event was used for both existing and proposed conditions. Proposed conditions represent fully-developed flows.

#### A. 98th Street Analysis Points

Five analysis points are located along 98th Street at the future crossing structures. These points are identified as Str.1 through Str. 5 on Exhibit 1.

#### 1. Methodology

The AHYMO computer program was used to determine flows at these points. The models created for the West I-40 DMP were utilized. The AHYMO input and output files are available for reference if desired.

#### 2. Flows

The West I-40 DMP has analysis points at the future 98<sup>th</sup> Street as shown in Figure 2. Table 1 identifies the basins draining to 98<sup>th</sup> Street and the proposed crossings that they are associated with.

Table 1
West I-40 DMP Drainage Basins to 98th Street

West I-40 DMP	Crossing Structure
Drainage Basin	Under 98th Street
L14.5	Str. 5
L12.18	Str.4 (Mirehaven Arroyo)
L12.19	Str. 3
L9.1	Str. 2 and Str. 1
L7.1	Str. 1

For this study, Basin L9.1 was divided into Basins L9.1A and L9.1B in order to create separate basins to Str. 2 and Str. 1.

The alignment of 98th Street has changed since the I-40 DMP model was created. This has caused the drainage basins to Structures 1, 2, and 3 to increase. The basin areas to Structures 4 and 5 have not changed and their flows were obtained directly from the West I-40 DMP AHYMO output. For the remaining locations, the West I-40 DMP AHYMO model was modified slightly to represent the current conditions and re-run. Table 2 compares the existing and developed flows at these points. The existing model was not rerun to account for the new 98th Street alignment so the flows at Structures 1, 2, and 3 are approximate.

Table 2
Flows at 98th Street Analysis Points

Location	Developed Q100(cfs)	Existing Q100 (cfs)								
Str. 1	265	150								
Str. 2	105	50								
Str. 3	354	155								
Str. 4	1581	1311								
Str. 5	155	74								

#### B. On-Site and Off-Site Flows

On-site flows were determined for each parcel of land that is planned for golf course or subdivision. A letter identifies basins representing subdivisions, and basins representing golf course areas are identified by "GC", followed by a number. Flows were based on the most current development plan from Consensus Planning and may change with any modifications to the layout.

Off-site flows were identified for 16 basins that contribute runoff to the site. In order to minimize the number of easements, off-site drainage basins were combined where possible. Exhibit 1 delineates all off-site basins except Off-site Basins 7, 12, 13 and 16. These basins are shown on a work map in Appendix A.

#### 1. Methodology

With the exception of off-site basins 7, 12, and 16, on-site and off-site flows were determined with the procedure outlined in Chapter 22, Section A.6 of the Albuquerque Development Process Manual (DPM). This procedure provides values of cfs/ac for each treatment type in each precipitation zone. The Petroglyph Golf Course is located in Precipitation Zone 1. Section 4 provides a discussion on the procedure used to calculate flows for off-site basins 7, 12, and 16.

#### 2. Treatment Types

Treatment types are used to describe the land areas of the drainage basin. There are four treatment types, A, B, C and D. Type A is the most pervious and Type D is the least pervious. Type A is typically used for undisturbed land and Type D for impervious areas.

Land use for the subdivisions was based on the Consensus Planning layout that identified the density of the housing. The Type D percentage for subdivisions was estimated from the equation in the DPM based on dwelling units per acre. The remaining area was divided equally between Treatment Types B and C. Golf course areas were assumed to be 100% Type B as suggested in the DPM. All off-site basins are either located in the Petroglyph National Monument or in Atrisco Terrace, a planned open space corridor, and are considered to be either Treatment Type A or B, depending on the steepness of the topography. Appendix B contains a spreadsheet listing the treatment type percentages for each basin.

#### 3. Flows

Calculations of the on-site flows are provided in Appendix B and are shown on Exhibit 1.

#### 4. Flows for Off-Site Basins 7, 12 and 16

Off-site Basin 7 represents Dam 9 Arroyo, Off-site Basin 12 represents the Mirehaven Arroyo and Off-site Basin 16 represents the Ladera Arroyo. These basins were modeled as part of the West I-40 DMP analysis. Therefore, the AHYMO model in the DMP was used to estimate the off-site flows.

Off-site flows for these basins were determined by proportioning the flow to match the cfs/ac calculated by AHYMO for the entire basin. For example, the I-40 basin L12.18 was sub-divided to create an analysis point at the Petroglyph Golf Course western property boundary (Refer to the map in Appendix A.). The ratio of this area to the flow was set equal to the ratio of the area to flow at the analysis point in AHYMO at 98th Street. The off-site flow entering the property via the Mirehaven Arroyo was estimated to be 1,410 cfs. The off-site flow entering the property via the Dam 9 Arroyo was

estimated to be 60 cfs. The off-site flow from Ladera Arroyo passing through the northeast corner of the site was estimated to be 410 cfs.

#### III. HYDRAULIC ANALYSIS

There will be four culvert crossings and one trapbox "bridge" crossing under 98<sup>th</sup> Street. These crossings all occur in natural drainage ways. There are no proposed culvert crossings under Petroglyph Parkway from the golf course site. Some tracts will drain across Petroglyph Parkway via storm drain. Analysis of the storm drain crossings is included in the drainage report for 98<sup>th</sup> Street and Petroglyph Parkway, currently being prepared separately by Bohannan Huston, Inc.

#### A. Crossing Culverts

The sizes of crossing culverts were determined with Intergraph's Storm and Sanitary SelectCAD program. Analysis is based on the Federal Highway Administration's (FHWA) publication Hydraulic Design of Highway Culverts. The flows used for analysis are the developed flows mentioned in Section II.A.2, from the West I-40 DMP.

It was assumed that pipes would have at least 3 feet of cover. Therefore, headwater depths were allowed to reach a depth of the diameter plus three feet. Table 3 lists the culverts, flows, headwater depths, and discharge locations.

Table 3
Crossing Culvert Summary

Structure No.	Structure Size	Q100 (cfs)	Headwater (ft)	Discharge Locations
Str. 1	3-48" RCP	265	4.6	Dam No. 9
Str. 2	1-48" RCP	105	5.4	Dam No. 9
Str. 3	3-48" RCP	354	6.2	Dam No. 12
Str. 5	1-54" RCP	155	6.8	Mirehaven Arroyo

As an interim condition, Structure 5 will discharge into the existing detention pond behind the residential area prior to outletting into the Mirehaven Arroyo. In the

future this crossing will tie to a storm drain that will serve a future development in the area.

Outfall locations on the east side of 98th Street will be protected with dumped riprap, or similar measure, to protect against scour.

#### B. Mirehaven Arroyo

The HEC-RAS computer program was utilized to determine the water surface elevation in the arroyo and at the future Mirehaven Arroyo Bridge. HEC-RAS is a hydraulic program that uses the standard step method to generate a water surface profile for the channel section defined. The bridge across the Mirehaven Arroyo had to be designed to have a minimum of two feet of freeboard during the 100-year event. The 100-year design flow is 1581 cfs as provided by the West I-40 DMP.

The West I-40 DMP proposed that the Mirehaven Arroyo be contained in a 10-foot wide lined channel downstream of 98th Street. This channel will continue until it discharges into AMAFCA's Dam No. 12. In order to match the recommendation in the DMP, the bridge crossing was designed with the same configuration as the future channel. Upstream of the bridge, it was decided to reduce the floodplain to a constant width of about 150 feet. This increases the amount of developable land while still providing adequate conveyance.

Two scenarios were investigated for the protection of the arroyo. These options are described below:

#### 1. Option 1

Option 1 is a more naturalistic approach. It maintains a bottom width of 100 feet with 3:1 side slopes. The bottom would remain natural and the side slopes would be armored with dumped riprap. A cross section is provided on Exhibit 1.

Appendix C includes the output for this scenario, labeled as "OPT2BREV". The flow in the natural channel can be categorized as critical. The water surface in the natural channel fluctuates around critical depth. The average depth of flow is 2.4 feet. Velocities range from 6.5 to 12.5 fps. Based on these velocities, it is recommended that the d50 of the riprap be 12".

The design of the transition from 100 feet to the 10-foot wide bridge opening was achieved after a number of trials. The final design has two sections to the transition. The first section transitions the width of the arroyo from 100 feet to 35 feet over a length of 200 feet. The bottom would stay natural and berms would be constructed to funnel the runoff. Although the water surface elevation rises as the arroyo width contracts, critical depth is achieved at the grade change described below. The depth of flow is about 3.7 feet at this location and can be contained with berms.

The second section of the transition changes the width of the arroyo as well as the invert. It was desired to obtain supercritical flow under the bridge in order to eliminate hydraulic jumps and reduce the flow depth. This was accomplished by steepening the slope of the channel just upstream of the bridge to 8 percent and constructing the transition with soil cement. The cross section would be trapezoidal. The 8% section is 100 feet long and flattens out to 1.7% for the remaining 140 feet to the bridge. The 100-year flow depth at the upstream bridge face is about 5.5 feet.

#### 2. Option 2

Option 2 is a continuous, trapezoidal, soil cement channel. The soil cement can either be stepped or sloped. If it is stepped the side slopes are 2:1, if it is sloped, the side slopes are 4:1. These configurations are based on previous design approved by AMAFCA. Cross sections are shown on Exhibit

1. The soil cement channel would be constructed below existing ground so that the top of the soil cement would closely match the existing invert. By doing this, fill would be essentially eliminated. A transition will have to be provided at the upstream property boundary to divert the existing flows into the soil cement section and provide a smooth grade change along the invert.

Appendix C includes the HEC-RAS output for this option, labeled "OPT3REV". The flow is supercritical throughout the entire length. The average flow depth in the channel is 2.5 feet. The average velocity is 18.5 fps.

The transition from the 30-foot wide soil cement channel to the 10-foot wide bridge is accomplished with a steep approach similar to that described for Option 1. At about 240 feet upstream of the bridge, the slope of the soil cement channel increases to 8%. The 8% section covers 100 feet, at which point the slope flattens out to about 1.7%. The flow remains supercritical under the bridge. The flow depth at the upstream bridge face is about 5.5 feet.

If a supercritical transition at the bridge was not provided, the flow depth would be greater and hydraulic jumps would occur which both would require an increased vertical profile at 98th Street. The final configuration of the bridge crossing was determined to be a trapbox section; 10-foot bottom width, 2:1 side slopes to a depth of 5.5 feet deep and vertical walls from 5.5 feet to 7.5 feet. The span equals 32 feet.

#### IV. CONCEPTUAL DRAINAGE PATTERNS

This section attempts to identify assumptions and philosophies used in determining the drainage patterns through the Petroglyph Golf Course.

#### A. Flow Directions

In general, it was assumed that the proposed grading of the site would be similar to the existing ground elevations. Therefore, drainage patterns were based on existing contours. High points and low points were also based on existing contours.

Within subdivision areas, it was assumed that flow would be directed toward easements, if they were present, or towards roads via storm drain systems. Runoff from one subdivision was not permitted to enter another subdivision. Additionally, concentrated runoff from subdivisions were not allowed to enter the golf course areas.

The Mirehaven Arroyo will accept discharge from all adjacent tracts. The Dam 9 Arroyo is proposed to remain natural through the golf course area, but will be piped under the subdivision and daylight on the east side of 98th Street. A portion of the Tributary to the Dam 9 Arroyo will remain natural as well as it travels through Basin GC2, but will either be piped or confined in a channel from the end of Basin GC2 until 98th Street. Energy dissipation from outfalls into these arroyos will be included as part of the design.

There are three lake sites proposed with the golf course layout. These ponds are to serve as irrigation for the golf course. In order to minimize the sediment and debris in the ponds, they are not planned for use as stormwater management facilities.

#### B. Drainage Easements

Ten drainage easements have been identified on the Conceptual Drainage Plan. Widths of these easements have not been determined and they are shown for location purposes only. To minimize the number of easements, it was assumed that off-site flow from adjacent basins would be combined where possible and diverted to a common easement. It is possible to modify the configuration of the easements to maximize development area and to increase accessibility for maintenance.

#### V. SUMMARY

In general, the proposed flow patterns for the future golf course and residential developments closely match that of existing. Storm drain and/or open channels are proposed to collect runoff within the subdivisions and discharge it to an existing drainage way. The majority of runoff leaves the site to the east under 98th Street. A small portion will be collected and directed across Petroglyph Parkway.

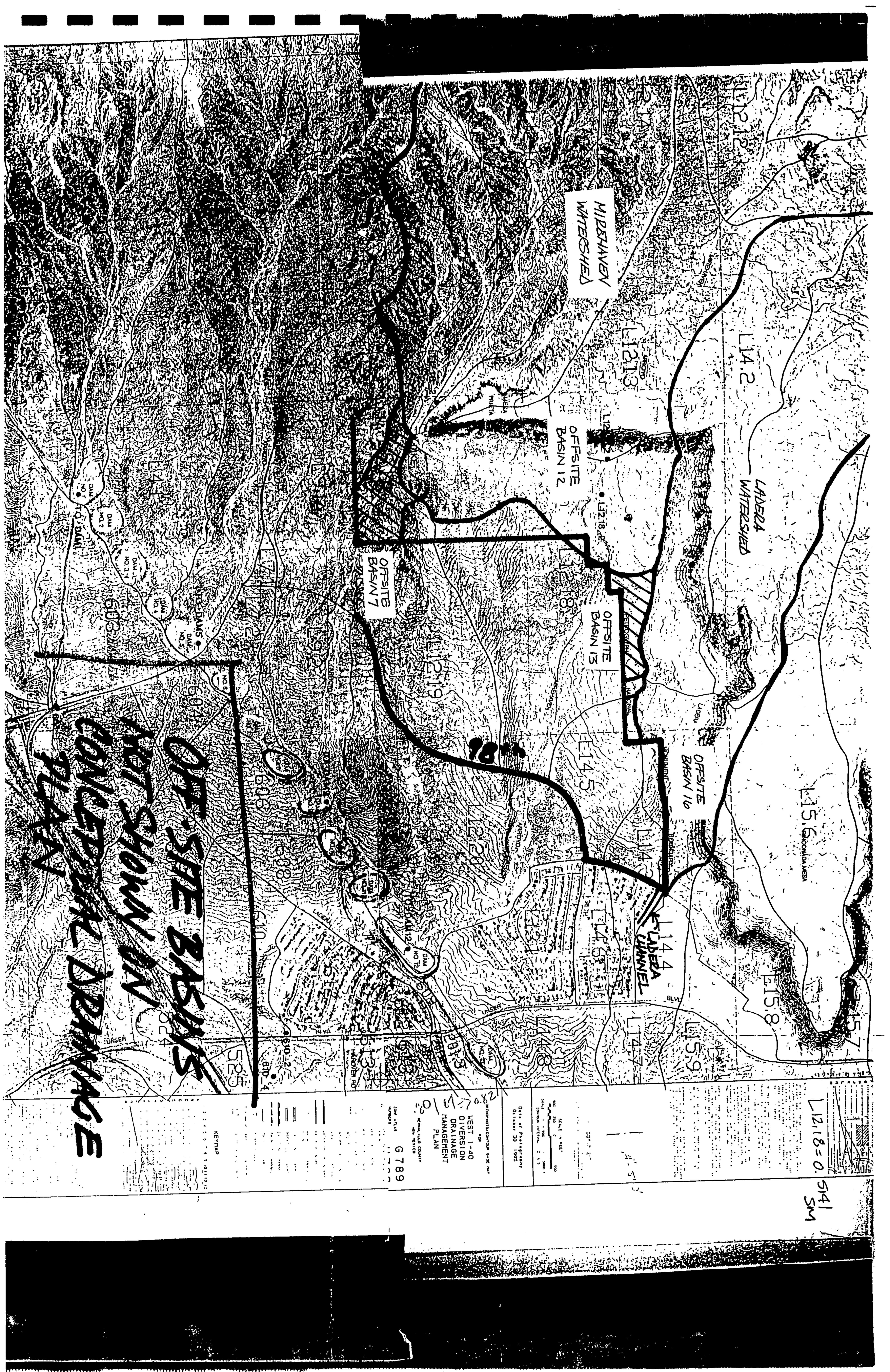
Two major arroyos pass through the golf course site. They are the Mirehaven Arroyo and Dam 9 Arroyo. A tributary to the Dam 9 Arroyo also traverses the site. FEMA floodplains exist for the Mirehaven and the Tributary to Dam 9 Arroyos. CLOMR/LOMRs will be required.

It is proposed that the Mirehaven Arroyo will either become a 30-foot wide soil cement channel or a 100-foot wide natural bottom channel with riprap-armored side slopes. The bridge crossing at 98th Street, identical under either option, will be a trapbox with a 10-foot bottom width, 2:1 side slopes for a height of 5.5 feet and vertical walls from 5.5 feet to 7.5 feet.

The Dam 9 Arroyo will remain in its natural condition as it enters the site. After about 700 feet it will be piped in 1-48" RCP under a subdivision and discharge on the east side of 98th Street. The Dam 9 Tributary will also be left partially in its natural state and partially piped or channelized.

## APPENDIX A OFF-SITE DRAINAGE BASINS

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### APPENDIX B

HYDROLOGIC CALCULATIONS

Westland Golf Course Development
Developed Area Flows
Assuming maximum dwelling units per acre shown on plan.

<u> </u>	Δ		- d Trooknoon	t Doroontog		Weighted Q100	Prop Q100	
	Area	Lai	nd Treatmen	Percentag	<u>es</u>	(cfs/ac)	(cfs)	
Basin	(Acres)	<u> </u>	В		U	(CIS/ac)	(013)	
A-1	13	0	21.5	21.5	57	3.54	46.1	
A-2	11.3	0	21.5	21.5	57	3.54	40.1	
A-3	9.1	0	21.5	21.5	57	3.54	32.3	
A-4	15.6	0	21.5	21.5	57	3.54	55.3	
B-1	3.4	0	15	15	70	3.79	12.9	
B-2	15.6	0	15	15	70	3.79	59.2	
C-1	22.6	0	33	33	34	3.10	70.1	
C-2	3.4	0	33	33	34	3.10	10.5	
D	8.5	0	15	15	70	3.79	32.2	
E-1	1	0	15	15	70	3.79	3.8	
E-2	9	0	15	15	70	3.79	34.1	
F	7	0	15	15	70	3.79	26.6	
G-1	6.5	0	15	15	70	3.79	24.7	
G-2	5.5	0	15	15	70	3.79	20.9	
H-1	4.5	0	21.5	21.5	57	3.54	15.9	
H-2	11.2	0	21.5	21.5	57	3.54	39.7	
H-3	3	0	21.5	21.5	57	3.54	10.6	
H-4	20.3	0	21.5	21.5	57	3.54	72.0	
1	15	0	33	33	34	3.10	46.5	
j	17	0	37	37	26	2.95	50.1	
K	14	0	33	33	34	3.10	43.4	
L-1	18	0	21.5	21.5	57	3.54	63.8	
L-2	22	0	21.5	21.5	57	3.54	78.0	
M	11	0	15	15	70	3.79	41.7	
<b>~</b>	216	Λ	100	Δ	0	2.03	43.8	
GC1	21.6 38.6	0	100	0	0	2.03	78.4	
GC2	11.4	0	100	0	0	2.03	23.1	
GC3-1	7.6	0	100	n	. 0	2.03	15.4	
GC3-2	71.2	0	100	0	0	2.03	144.5	
GC4	8.7	0	100	0	0	2.03	17.7	
GC5-1	12.7	0	100	0	0	2.03	25.8	
GC5-2	12.7 25.1	0	100	0	0	2.03	51.0	
GC6	23.1 23.2	0	100	0	0	2.03	47.1	
GC7	23.2 29.4	0	100	0	0	2.03	59.7	
GC8-1 GC8-2	29.4 9.6	0	100	0	0	2.03	19.5	
				4 ~ ~		Dia - b /-	sfo./o.o.\	
		<b>~</b> • •		100-year Peak Discharge (cfs/ac)				
From Tal	ble A-9, Alb. Df			4 20	2 U3 B	2.87	⊿ 37	

2.87

2.03

1.29

4.37

Precipitaion Zone 1: West of Rio Grande

#### Westland Golf Course Development Offsite Area Flows

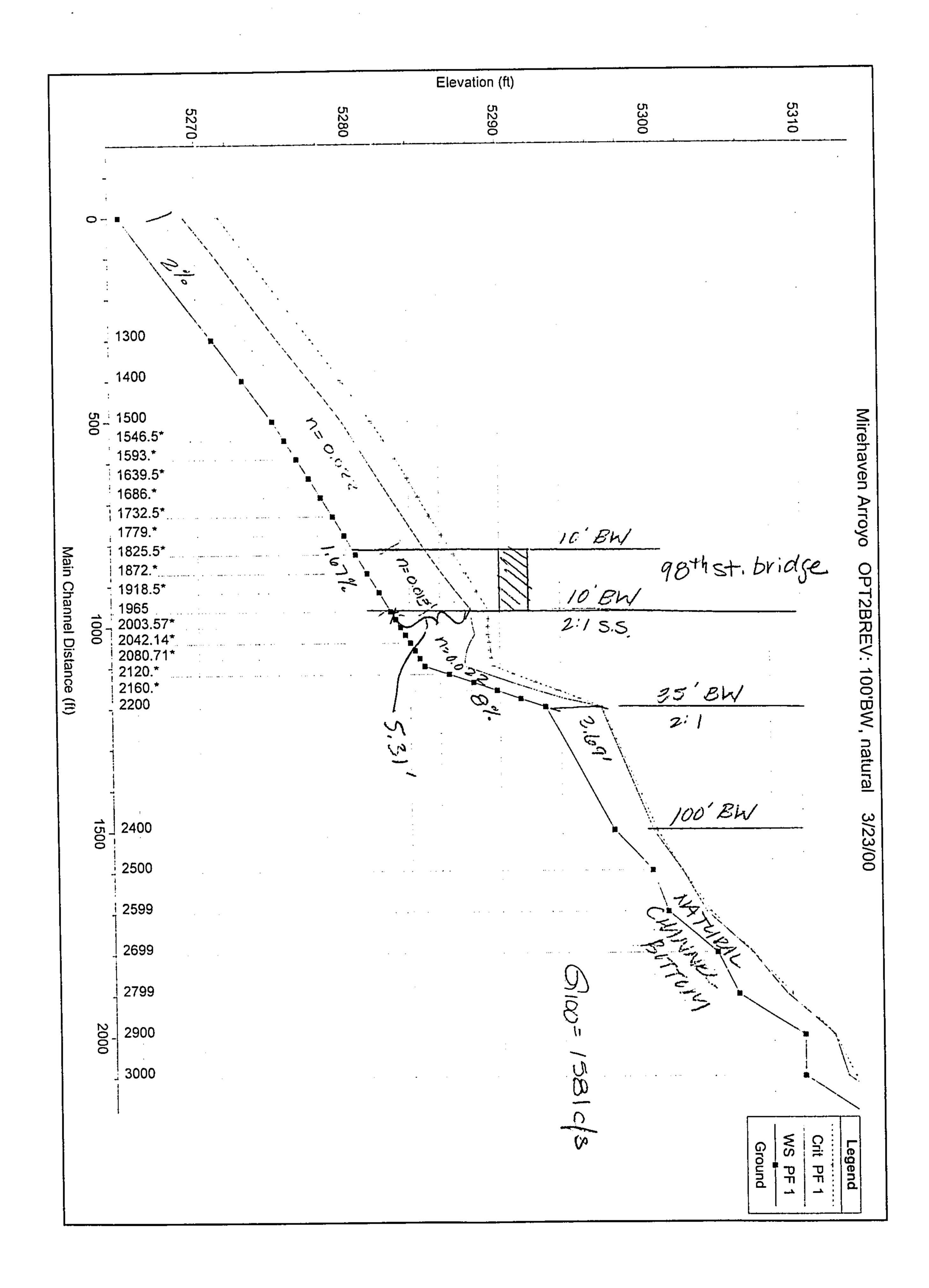
						Weighted	Prop	
Offsite	Area	Lar	Land Treatment Percentages				Q100	
Basin	(Acres)	Α	В	С	D	(cfs/ac)	(cfs)	
<del></del>								
1	7.9	0	100	0	0	2.03	16.0	slope > 10%
2	4.1	0	100	0	0	2.03	8.3	slope > 10%
3	17.7	100	0	0	0	1.29	22.8	
4	0.67	0	100	0	0	2.03	1.4	slope > 10%
5	12	100	0	0	0	1.29	15.5	
6	1.6	0	100	0	0	2.03	3.2	slope > 10%
7	28	Flow Base	d on West I-	40 DMP A	HYMO res	ults		
8	1.5	100	0	0	0	1.29	1.9	
9	6.9	0	100	0	0	2.03	14.0	slope > 10%
10	3.2	100	0	0	0	1.29	4.1	
11	11.5	100	0	0	0	1.29	14.8	
12	1530	Flow Base	d on West I-	40 DMP A	HYMO res	ults		
13	16.4	100	0	0	0	1.29	21.2	
14	1.4	100	0	0	0	1.29	1.8	
15	2.6	100	0	0	0	1.29	3.4	
16	617	Flow Base	d on West I-	40 DMP A	HYMO res	sults		
10	017	I IOW Dasc	d OH YVEST	TO DIVIL A		, a 1 C		

	100-year Peak Discharge (cfs/a						
From Table A-9, Alb. DPM	A	В	Ç	D			
Precipitaion Zone 1: West of Rio Grande	1.29	2.03	2.87	4.37			

Basins 1 - 4 are located within the Atrisco Terrace open space property. Basins 5 - 16 are located within the Petroglyph National Monument.

APPENDIX C

**HEC-RAS OUTPUT** 



### Bohannan & Huston

## FACSIMILE TRANSMITTAL COVER SHEET

<b>i</b> .	
Δ'n	
All I	

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Date:

July 5, 2000

To:

Brad Bingham

Company:

City of Albuquerque - Public Works

Fax No.:

924-3864

From:

Daniel Grochowski

Project No:

00 238A 01

Project Name: Petroglyph Golf Course

Number of Pages to follow (including cover) \_\_\_\_\_2\_\_\_

Re:

Report Cover Sheet Stamped and Dated 5/17/00

Comments:

Brad,

Here is the stamped cover sheet as we discussed.

Thanks for your help.

Dan G.

Original to Follow: 

Yes

If you do not receive all pages, please contact \_\_\_\_

## DRAINAGE REPORT FOR PETROGLYPH GOLF COURSE

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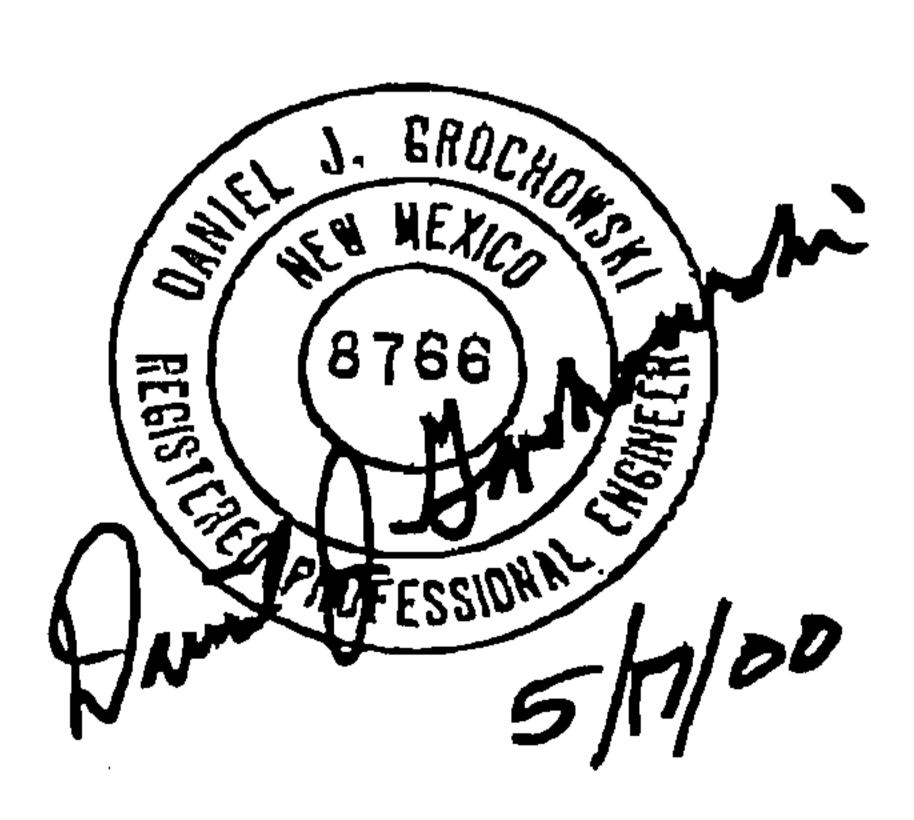
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MAY 17, 1999

PREPARED FOR:

WESTLAND DEVELOPMENT CO. INC. 401 COORS BOULEVARD NW ALBUQUERQUE, NM 87121



#### BOHANNAN HUSTON

#### DRAINAGE INFORMATION SHEET

DRB #:	N/A	EPC #:	N/A	WORK ORDER #: N/A
LEGAL D	ESCRIPTION:	PROPERTY OF V	VESTLAND	NORTH
CITY AD	DRESS: <u>N/A</u>	•		
ADDRES  ADDRES  ARCHITI  ADDRES  SURVEY  ADDRES  CONTRA	S: 7500 JEFFER WESTLAND S: 401 COORS ECT: CONSEN S: 924 PARI OR: N S:N	BOHANNAN-HUS RSON NE. ALB. N DEVELOPMENT BOULEVARD NY SUS PLANNING AVENUE SW. 8	CO. INC. X, 87121  7102	PHONE:
XXX	GRADING PLA EROSION CON	AN AN AN AN ATROL PLAN CERTIFICATION	PLAN	CHECK TYPE OF APPROVAL SOUGHT:  SKETCH PLAT APPROVAL  PRELIMINARY PLAT APPROVAL  S. DEV. PLAN FOR SUBD. APPROVAL  S. DEV. PLAN FOR BLDG. PERMIT APPROVAL  SECTOR PLAN APPROVAL  FINAL PLAT APPROVAL  FOUNDATION PERMIT APPROVAL  CERTIFICATE OF OCCUPANCY APPROVAL  GRADING PERMIT APPROVAL  GRADING PERMIT APPROVAL  S.A.D. DRAINAGE REPORT  DRAINAGE REQUIREMENTS  SUBDIVISION CERTIFICATION  OTHER (SPECIFY)
	JBMITTED:J	UNE 12, 2000 N HUSTON, INC.		

Revised 02/98



May 17, 2000

**BOHANNAN HUSTON** 

Courtyard One

7500 JEFFERSON NE

Albuquerque

NEW MEXICO 87109

voice 505.823.1000

fax 505.821.0892

Brad Bingham, P.E. Hydrology/Utility Development

City Of Albuquerque PO Box 1293

Albuquerque, NM 87103

Petroglyph Golf Club Conceptual Drainage Plan and Drainage Report

Dear Brad:

Re:

The Drainage Report and Conceptual Drainage Plan have been revised to reflect your comments dated April 14, 2000. They are being re-submitted for your review and approval for Site Development for Subdivision.

The major changes to the Conceptual Drainage Plan include:

- delineation of off-site basins with flows quantified
- increase in the number of drainage easements

The following list provides responses to each of your comments. The responses are shown in the same order as your comments.

The West I-40 DMP has been submitted to AMAFCA, but has not yet been approved. A draft AMAFCA Resolution was presented to the AMAFCA Board last month, and it is anticipated that approval will occur in May. The decision as to whether flow will be conveyed through or around the Petroglyph National Monument will not be included in AMAFCA's approval. The approval will only determine the conveyance improvements downstream of the Monument, which will accommodate either option. The flows used in our study from the I-40 DMP will not be affected by the decision upstream since the options result in essentially equal developed flows below the Monument.

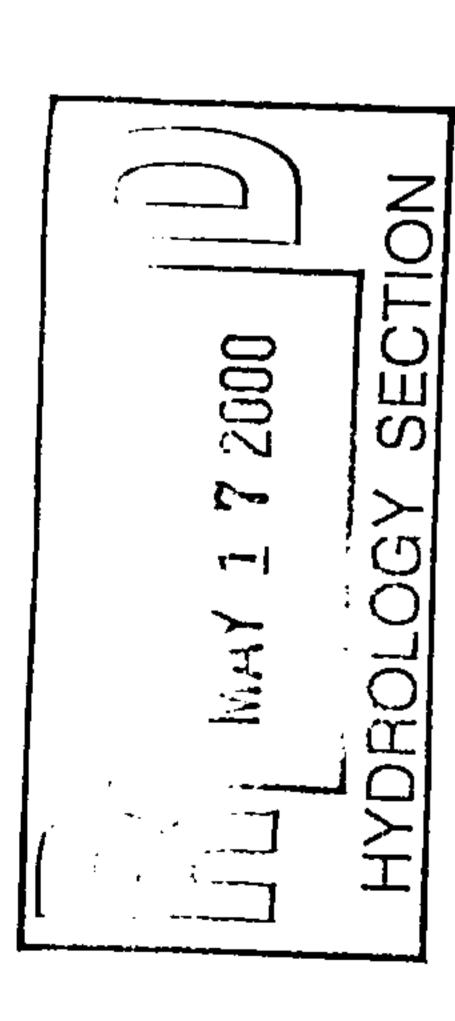
A figure has been added to the report that shows the project area superimposed on the West I-40 DMP Drainage Basin Map.

Sixteen off-site basins have been delineated and runoff amounts calculated. 10 off-site basins require drainage easements. Off-site drainage basins, easements and off- site flows are now all shown on the Conceptual Drainage Plan. In a few cases, the off-site basins are too large to be shown on the Conceptual Drainage Plan, in which case they are depicted on a larger scale map in Appendix A.

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Flows above the escarpment are considered developed in the West I-40 DMP.

An exhibit containing the FEMA floodplain map has been added in the report.



Brad Bingham, P.E. May 9, 2000 Page 2

- We are submitting the revised drainage report and Conceptual Drainage Plan for the Petroglyph Golf
  Course site to AMAFCA. We have had discussions with AMAFCA concerning the Mirehaven Arroyo
  and incorporated their comments into our proposed cross-sections.
- The basin north of GC3-2 is the clubhouse site. Basin I.D. and flow rate have been added to the report.
   Offsite runoff will enter this site, however we are assuming that since this basin is a part of the golf course it will drain naturally through the site. Runoff from the College Reservoir site has been analyzed and flow rates added to the plan.

All offsite flows are now shown on the plan. Details on how they will be conveyed through the site are not available at this stage. Drainage easements are provided where required and may consist of a pipe network or an open channel or a combination of both.

• In the interim condition, the runoff conveyed by Structure STR-5 will enter the detention pond located behind the existing development and ultimately be discharged in the Mirehaven Arroyo. It is anticipated that in the future condition, this structure will tie to a storm drain system built with new development and outlet to the Mirehaven Arroyo.

The Conceptual Drainage Plan has been revised to identify the downstream discharge point for all crossing structures.

- The drainage basin boundary between Basins F and G-2 has been added to the plan.
- Westland Development Company owns the property east of 98th Street so obtaining permission is not an obstacle. Bohannan Huston, Inc. will define the necessary easements as the tracts are developed.

As we discussed, an Infrastructure List is not being provided with this submittal. Please call if you have any questions or require additional information.

Sincerely,

Bohannan Huston, Inc.

Brenda Martin, P.E.
Water Resources Group

BM/gr Enclosure

cc: Mr. Leroy Chavez, Westland Development Co. Inc. (w/enclosure)

Mr. Chris Green, Consensus Planning Inc. (w/plan only)

Ms. Lisa Manwill, AMAFCA (w/enclosure)

Mr. Charles Leder, Leedshill Herkenhoff (w/enclosure)

Mr. Michael Mitzner, Mesa Golf, Inc. (w/plan only)

Mr. Art Schaupeter, Golf Course Architect (w/plan only)

Mr. Daniel J. Grochowski, Bohannan Huston, Inc. (w/enclosure)

**2**505 821 0892

#### DRAINAGE INFORMATION SHEET

DRB #:	WORK ORDER #: N/A
LEGAL DESCRIPTION: PROPERTY OF WESTLAND	NORTH
CITY ADDRESS: <u>N/A</u>	
ENGINEERING FIRM: <u>BOHANNAN-HUSTON INC.</u> ADDRESS: <u>7500 JEFFERSON NE. ALB. NM 87109</u>	DAN GROCHOWSKI CONTACT: <u>BRENDA MARTIN</u> PHONE: (505) 823-1000
OWNER: WESTLAND DEVELOPMENT CO. INC.	CONTACT: LEROY CHAVEZ
ADDRESS: 401 COORS BOULEVARD NW, 87121	PHONE: (505) 831-9600
ARCHITECT: CONSENSUS PLANNING	CONTACT: CHRIS GREEN
ADDRESS: 924 PARK AVENUE SW. 87102	PHONE: (505) 764-9801
SURVEYOR: N/A	CONTACT:
ADDRESS:	PHONE:
CONTRACTOR: N/A	
ADDRESS:	
TYPE OF SUBMITTAL:  XXX DRAINAGE REPORT  XXX DRAINAGE PLAN  FINAL GRADING & DRAINAGE PLAN  GRADING PLAN  EROSION CONTROL PLAN  ENGINEER'S CERTIFICATION  OTHER  PRE-DESIGN MEETING:  XXX YES  NO  COPY PROVIDED	CHECK TYPE OF APPROVAL SOUGHT:  SKETCH PLAT APPROVAL  PRELIMINARY PLAT APPROVAL  S. DEV. PLAN FOR SUBD. APPROVAL  S. DEV. PLAN FOR BLDG. PERMIT APPROVAL  SECTOR PLAN APPROVAL  FINAL PLAT APPROVAL  FOUNDATION PERMIT APPROVAL  BUILDING PERMIT APPROVAL  CERTIFICATE OF OCCUPANCY APPROVAL  GRADING PERMIT APPROVAL  PAVING PERMIT APPROVAL  S.A.D. DRAINAGE REPORT  DRAINAGE REQUIREMENTS  SUBDIVISION CERTIFICATION
	OTHER (SPECIFY)
DATE SUBMITTED: MAY 17, 2000	
BY: BOHANNAN HUSTON, INC.	

Revised 02/98

HEC-RAS Plan: OPT2BREV River: RIVER-1 Reach: Reach-1 Reach River Sta Q Total Min Ch El W.S. Elev Max Chi Dpth Crit W.S. Elev E.G. Elev E.G. Slope Vel Chil Flow Area Top Width Froude # Chi River Sta 上海连续的一种企业,是大学的大学的企业的企业(cfs)至于2012年(h)对在1012年(h)对1012年(h)对1012年(h)产品的 0.99 240.90 266.26 6.16 0.021367 5371.77 5371.21 1,21 Reach-1 5600 5371.21 5370.00 1581.00 1.02 149.34 220.31 9.40 0.017705 5370.89 5369.87 2.97 5369.87 1581.00 5366.90 1.49 116.20 158.69 10.44 0.044937 5368.13 5366.98 1.53 15400 Miles 5366.53 5365.00 1581.00 1,02 180.39 7.81 244.38 0.019657 5366.78 5366.11 1.99 5366.11 Reach-1 5300 5364.22 1581.00 1.46 101.02 153.36 12.26 0.038401 5364.08 5362.84 Reach-1 155 | 5200 2.19 5362.19 5360.00 1581.00 1.00 166.46 234.66 7.16 0.020062 5362.24 5361.51 Reach-1 5099 5361.51 5359.61 1581.00 1.46 129.49 167.75 9.42 0.045633 5359.17 5358.20 2.62 5357.79 Reach-1 5000 5355.17 1581.00 0.99 110.73 204.89 7.78 0.018824 5356.95 5357.88 1.95 5356.95 Reach-1 #12 4899 5355.00 1581.00 1.15 131.54 197.26 8.01 0.027351 5355.60 5354.75 5354.61 5352.40 1581.00 107.17 1.15 183.16 8.67 0.026445 5352.93 5351.95 5351.77 5350.00 1581.00 Reach-1 4699 168.95 1.05 227.12 2.45 5349.65 5350.37 0.022822 5349.60 Reach-1-4600 5347.15 1581.00 1.17 113.36 185.95 8.67 0.026928 5347.88 5346.93 1.74 Reach-1 4499 5346.74 5345.00 1581.00 0.99 113.29 207.89 7.72 0.019014 5347.77 5346.87 2.08 5346.87 Reach-1 4399 5344.79 1581.00 1.94 102.91 128.68 12.29 0.081824 5344.16 5342.53 1.82 Reach-1 4300 444 5341.82 5340.00 1581.00 0.99 105.86 202.09 7.91 0.018736 5342.49 5341.53 Reach-1 4199 2.55 5341.53 5338.98 1581.00 1.94 98.67 12.46 126.89 0.081436 5337.17 5338.87 Reach-1 4100 1.46 5336.46 5335.00 1581.00 0.97 126.24 217.48 7.58 0.018095 5337.75 5336.90 Reach-1 3999 5336.90 5335.00 1581.00 0.98 184.85  $\langle 6.56 \rangle$ 242.54 0.020182 5335.12 2.72 5334.46 5334.46 Reach-1 3900 网络 5331.74 1581.00 1.07 100.00 189.65 8.34 0.022545 5332.98 5331.98 1.90 Reach-1 3799 5331.90 5330.00 1581.00 1.00 100.00 198.45 7.97 0.019518 5332.84 (4.37)5331.85 Reach-1 3700 5331.85 5327.48 1581.00 1.80 100.00 133.86 11.81 0.070837 5329.40 5327.88 2.24 5327.24 5325.00 Reach-1 324 3600 43234 1581.00 0.99 100.00 198.99 7.95 0.019362 5327.08 5326.10 3.70 Reach-1 3500 4655 5326.10 5322.40 1581.00 1.01 100.00 196.94 8.03 0.020468 5325.60 5324.60 4.60 Reach-1 3399 5324.60 5320.00 1581.00 1.49 100.00 151.86 10.41 0.046679 5322.54 5321.33 2.17 5320.86 Reach-1 在 3300 本流 348 5318.69 1581.00 1.10 100.00 185.66 8.52 0.024295 5319.13 5318.12 2.41 5318.01 Reach-1 3200 - 44 5315.60 1581.00 0.99 100.00 199.51 7.92 0.018944 5317.65 5316.67 2.47 5316.67 Reach-1 3 3100 点数 2 5314.20 1581.00 1.56 100.00 147.17 10.74 0.051743 5314.67 2.88 5313.38 5312.88 Reach-1 3000 3000 5310.00 1581.00 1.01 100.00 196.92 8.03 0.019924 5312.97 5311.97 1.97 5311.97 Reach-1 2900 5310.00 1581.00 1.32 100.00 164.88 9.59 0.035940 5310.31 5309.21 3.23 5308.89 5305.66 Reach-1-12 2799 1581.00 100.00 195.63 8.08 0.020304 5307.64 5306.67 5306.63 Reach-1 2699 5304.24 1581.00 100.00 164.74 9.60 0.035867 5304.96 5303.83 2.51 5303.53 Reach-1 2599 2500 1581.00 5301.02 1.01 100.00 196.92 8.03 0.019924 5302.97 5301.97 Reach-1 2500 5301.97 5300.00 1581.00 1.22 100.00 173.39 9.12 0.030338 Reach-1 2400 5301.35 2.56 5300.33 5300.06 5297.50 1581.00 1.00 49.76 10.90 156.40 0.004564 5298.40 Reach-1 2200 5296.75 3.69 5296.69 5293.00 1581.00 1.62 44.19 108.96 15.45 0.013088 5297.71 5295.28 Reach-1 2180.\* 2.83 5294.23 5291.40 1581.00 1.93 41.26 94.69 17.77 0.019073 5297.04 5293.84 2.63 5292.43 Reach-1 2160.\* 1581.00 5289.80 2.14 38.89 86.66 19.47 0.023645 5296.29 5292.39 2.57 Reach-1 2140.\* 5290.77 5288.20 1581.00 2.31 36.71 80.83 0.027553 5295.53 5290.97 2.56 Reach-1 2120. 5289.16 5286.60 1581.00

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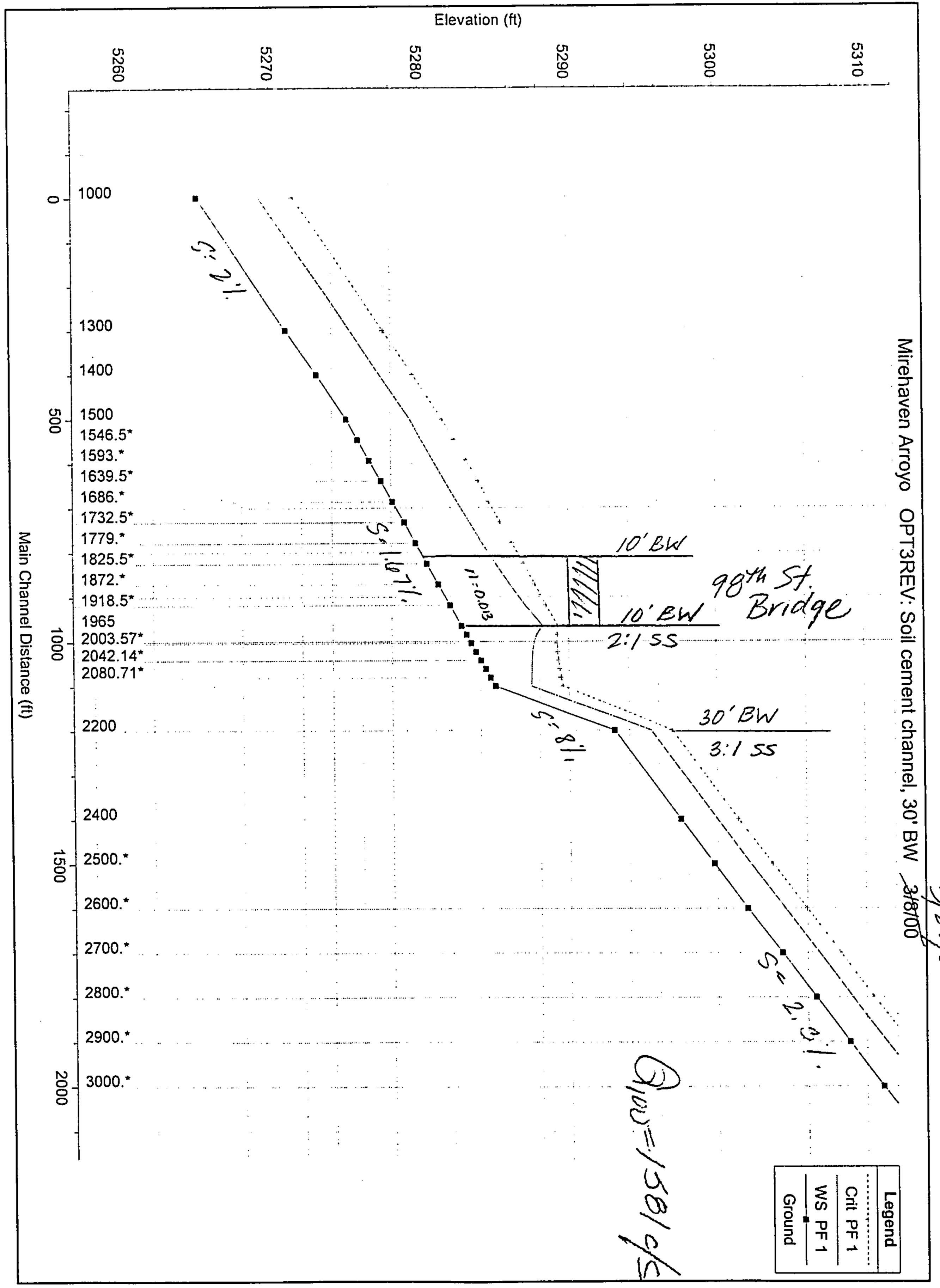
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HEC-RAS Plan: OPT2BREV River: RIVER-1 Reach: Reach: (Continued)

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2/23/00

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No By dayor

# APPENDIX D

### **EXHIBITS**

EXHIBIT 1 – CONCEPTUAL DRAINAGE PLAN EXHIBIT 2 – FEMA FLOODPLAIN MAP

# Bohannan & Huston

# FACSIMILE TRANSMITTAL COVER SHEET

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THE PARTY OF THE P

OHANNAN HUSTON

Lourtyard Ons

7500 JEFFERSON NE

//budue.doe

NEW MEXICO 87109

roice 505.823.1000

ax 505.821.0892

Date:

June 12, 2000

To:

Brad Bingham

Company:

City Hydrology

Fax No.:

924-3864

From:

Brenda Martin

**Project No:** 

00238

Project Name: Westland

Number of Pages to follow (including cover) \_\_\_\_3

Re:

Drainage Info. Sheet

Comments:

Brad - I was not sure which date you require on the drainage info sheet so I have attached one with today's date and one with the same date as drainage report. Thanks.

Original to Follow: 

Yes

If you do not receive all pages, please contact \_\_\_\_\_\_at 823-1000

Conceptual

# DRAINAGE REPORT FOR PETROGLYPH GOLF COURSE

**BOHANNAN HUSTON** 

Courtyard One

7500 JEFFERSON NE

Albuquerque

NEW MEXICO 87109

voice 505.823.1000

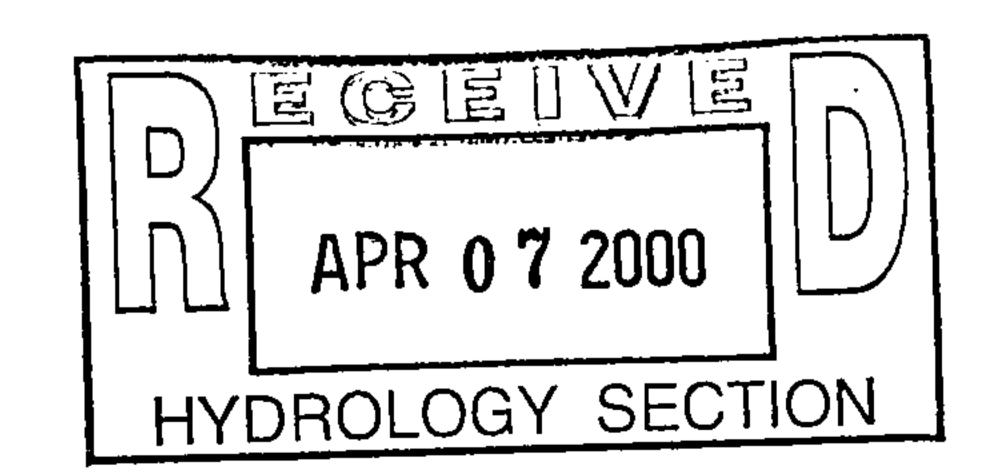
fax 505.821.0892

APRIL 7, 1999

PREPARED FOR:

WESTLAND DEVELOPMENT CO. INC. 401 COORS BOULEVARD NW ALBUQUERQUE, NM 87121

"我们的最后更多的,我也都是成为的人,我们也有的自己的基本,就是有来自为了我们的原因的对象的意思的。" "我们就是是来多。"我们都是成为的人,我们也有的自己的基本,就是有来自为了我们的原因的对象的意思,从是有有的人更是一个美国的自己的人



PONALD D. BROWN, CHAIR
DANIEL W. COOK, VICE-CHAIR
CLIFFORD E. ANDERSON, P.E., SECRETARY-TREASURER
LINDA STOVER, ASST. SECRETARY-TREASURER
DANIEL HERNANDEZ, DIRECTOR

JOHN P. KELLY, P.E. EXECUTIVE ENGINEER



Albuquerque Metropolitan Arroyo Flood Control Authority

2600 PROSPECT N.E. - ALBUQUERQUE, NM 87107

PHONE: FAX:

(505) 884-2215 (505) 884-0214

June 1, 2000

Brenda Martin, P.E.
Bohannan-Huston, Inc.
7500 Jefferson NE
Albuquerque, NM 87109

RE: PETROGLYPH GOLF CLUB CONCEPTUAL DRAINAGE PLAN AND DRAINAGE REPORT (ZAP H9).

### Dear Brenda:

Per your submittal, on the above referenced project, dated May 17, 2000 AMAFCA has the following comments/concerns:

- 1. Will 98<sup>th</sup> Street and Petroglyph Parkway be built with the Golf Club? It appears that portions of Petroglyph Parkway are in the FEMA floodplain. Will this be part of your LOMR submittal?
- 2. Can your interior streets handle the proposed flow?
- 3. Are the streets to be publicly or privately maintained?
- 4. Will 98<sup>th</sup> Street be built with the Golf Club? The culverts at 98<sup>th</sup> Street will silt up under the conditions shown in the report (page 9).
- 5. What happens down stream of each culvert on 98<sup>th</sup> Street? At some spots, there is quite a bit of developed flow that outfalls to unprotected areas. Will you grant drainage easements to the City for the area downstream of the culverts?
- 6. Please clarify that the proposed concrete channel from 98<sup>th</sup> Street to the Dam has a bottom width of ten feet. Page 10, of your report just stated that the channel would be ten feet wide.
- 7. What triggers the construction of the channel between 98th Street and the Dam?

Brenda Martin, P.E. Letter Continued June 1, 2000

- 8. AMAFCA feels somewhat certain that a LOMR is not required for this project because you are not increasing the water surface elevation. Permission from FEMA and the Floodplain Administer is definitely required.
- 9. Assuming a LOMR/CLOMR is required FEMA levee criteria may be enforced.
- 10. A sloped soil cement channel is not acceptable to AMAFCA. The sloped soil cement has not proven to be very durable under similar flow conditions.
- 11. A scour and erosion analysis must be performed if the natural bottom/armored slope channel option is chosen. You may need to construct grade control structure(s) with this option.
- 12. The dumped riprap d50 seems a little small for velocities of 12.5 fps.
- 13. FEMA will require 4-feet of freeboard at the bridge (98th Street).
- 14. Who will maintain the Drainage Easements referred to on page thirteen of your report?
- 15. Discuss how the southern (smaller) floodplain will be confined.
- 16. It is difficult to tell which portion of this project is residential. Are the gray blobs (technical term) sand traps? Please specify in the legend.
- 17. Provide Volume and 10-year Flows in your Hydrologic Calculations (Appendix B).

If you have any questions, please call Don Dixon at 884-2215.

Sincerely,

AMAFCA

Lisa Ann Manwill, P.E.

Development Review Engineer

c: Srad Bingham, P.E. - COA





# City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

April 14, 2000

Dan Grochowski, PE Bohannan Huston, Inc 7500 Jefferson NE Albuquerque, NM 87109

Re: Petroglyph Golf Club Conceptual Drainage Plan

Engineer's Stamp dated 4-7-00, (H09/D12)

Dear Mr. Grochowski,

Based upon the information provided in your submittal dated 4-7-00, the above referenced Conceptual Drainage Plan cannot be approved for Site Development Plan for Building Permit or Site Development Plan for Subdivision until the following comments are addressed:

- Has the I-40 DMP report been submitted? This report should be inclusive; i.e. please provide all pertinent information from the West I-40 DMP that will affect this project. On the I-40 basin map, please sketch in your project area.
- You have some easements shown (basins C-1, A-2 & A-3) but do not tell me what the runoff amounts are that these easements are needed for. Also needed is the offsite basin that contributes this runoff. Are you considering any <u>developed</u> flows from above the escarpment?
- Please provide an exhibit containing the FEMA map with your entire project superimposed on it. There is a huge flood plain just west of your site. Please provide enough contours outside your project area to determine all offsite runoff impacts to your site.
- AMAFCA will need to review this conceptual plan as well. Have you submitted to them yet? Please add a narrative on how you will dissipate the energy from your improvements to the Mirehaven and Dam 9 Arroyos. Preliminary discussions with AMAFCA indicate that channel improvements to the Mirehaven will be required up to the dam.

- There is a basin north of GC3-2 (clubhouse, perhaps) that is not labeled or analyzed. It also appears that some offsite runoff will enter this basin. The tank site basin also needs to be analyzed. Please quantify all offsite flows and discuss how you will be addressing them.
- At structure ST-5, there is a culvert but no mention of the downstream conveyance. What happens to this 155 cfs? I assume it is going to end up in the Mirehaven. Please discuss how and show conveyance on your exhibit.
- Where is the boundary between Basins F and G-2? I know it is arbitrary but you are establishing allowable discharges (and identifying infrastructure criteria) for each analysis point with this plan and I want to keep it easy to track.
- Does your client own the property east of 98<sup>th</sup> st? Permission (easements) would be necessary prior to any construction taking place.

If you have any questions, you can contact me at 924-3986.

Sincerely,
Bradley L. Bingham, PE

Hydrology Review Engineer

Lisa Manwill, AMAFCA file

# CLIENT/COURIER TRANSMITTAL

Brad Bingham, PE

To:

ENGINEERS

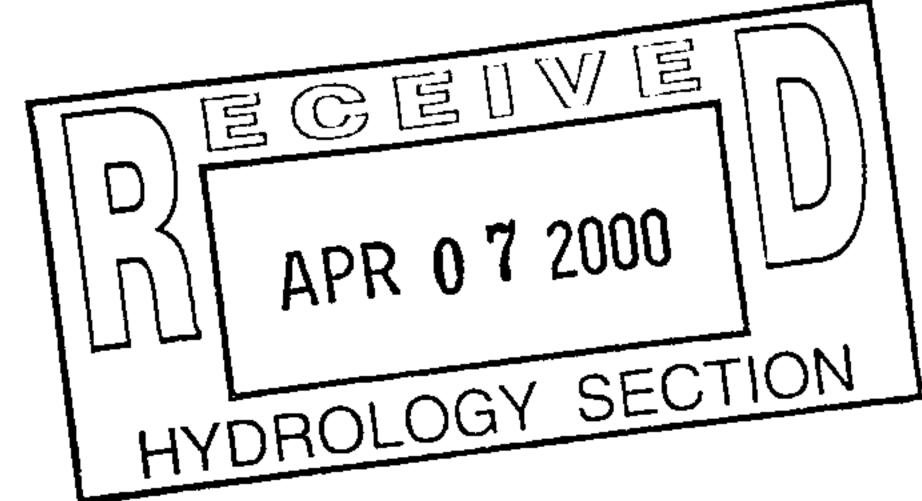
Requested By: Brenda Martin/gr

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PLANNERS PHOTOGRAMMETRISTS SURVEYORS SOFTWARE DEVELOPERS

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### I. INTRODUCTION

This report summarizes the results of the drainage analysis for the future development of the Westland North property as related to the Conceptual Drainage Plan for the Petroglyph Golf Club. The site is located on Albuquerque's West side between Unser Boulevard and Paseo del Volcan, south of the Petroglyph National Monument. A vicinity map is included as Figure 1. The proposed development is a golf course community. There will be 27 holes of golf with mixed density single-family homes throughout.

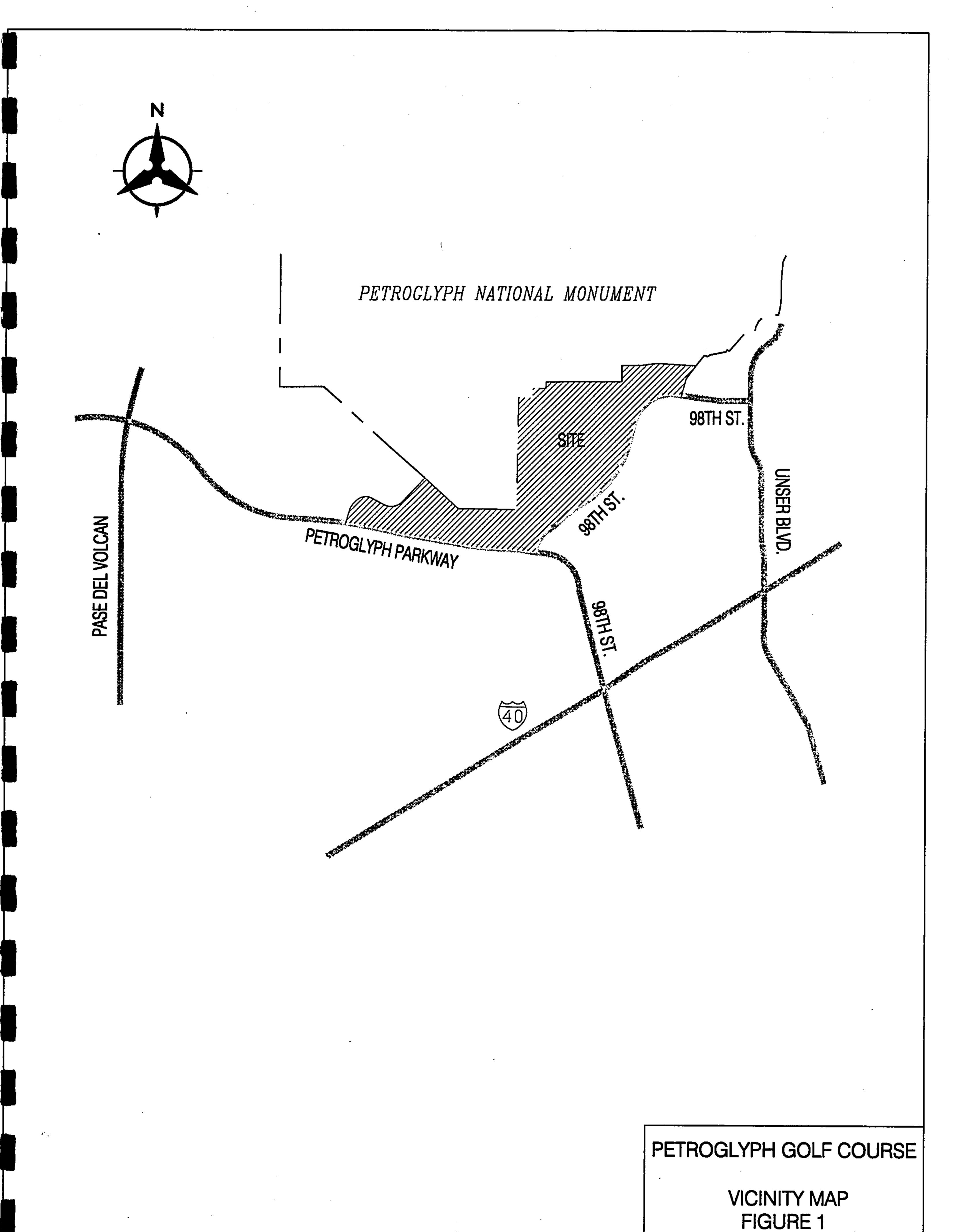
### A. Purpose

The purpose of this report is to present the hydrologic and hydraulic analyses of the site that were used in determining the Conceptual Drainage Plan. The Conceptual Drainage Plan was created for Site Plan for Subdivision approval and Site Plan for Building Permit approval.

### B. Scope of work

Tasks completed as part of this study include:

- Calculate off-site flows
- Calculate on-site flows for existing and proposed conditions
- Identify drainage easements
- Identify future flow directions and potential conveyance facilities
- Perform hydraulic analysis on the Mirehaven Arroyo AMAFCA approva
- Size culvert crossings under 98th Street
- Identify Federal Emergency Management Agency (FEMA) floodplains
- Create Conceptual Drainage Plan for the site



### C. Previous Studies

This report has been prepared in close coordination with the Design Analysis
Report that supports the Phase I roadway infrastructure for the Westland Development property, being prepared concurrently by Bohannan Huston, Inc. That drainage report supports the final roadway design of 98th Street and Petroglyph Parkway, and is being prepared as part of the preliminary and final plat approvals. — That report will need to be approved first.

The West Interstate 40 Diversion Drainage Management Plan (West I-40 DMP), dated March 2000, prepared by Bohannan Huston, Inc. for Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), covers approximately 40 square miles of the west side, including the area of the proposed Petroglyph Golf Course. This document references the Westland Sector Development Plan.

The West I-40 DMP provides fully developed flow rates for basins within the study. Basins have been delineated to the proposed 98th Street extension. These flows were used in the preparation of the Conceptual Drainage Plan as described in subsequent sections.

### D. Existing Project Area Description

The site consists of approximately 550 acres of undeveloped land that is currently used for the grazing of cattle. It is covered with native vegetation. The land drains, in general, from west to east at slopes ranging from 3.5% to 12%. The majority of the site slopes uniformly at an average of 5.5%. Elevations range from 5,670 feet at the western-most edge of the property to 5,255 feet at the eastern-most edge at the connection to the existing development.

A number of arroyos cross the site. The largest of these is the Mirehaven Arroyo, which is an AMAFCA facility. The braided floodplain width varies from 150 to 500 feet. A second arroyo, designated as the Dam 9 Arroyo, that flows to the AMAFCA Dam #9 facility, is the only other major arroyo.

### E. FEMA Floodplains

There are two FEMA floodplains that exist on site. Refer to Exhibit 1,

Conceptual Drainage Plan. The first is for the Mirehaven Arroyo. The existing floodplain only encroaches into fairways of the golf course in the proposed conditions.

It will not interfere with any planned development. Although the configuration of the floodplain will change under proposed conditions, a Letter of Map Revision (LOMR) is not required since there is no impact to occupied homes or buildings.

The second FEMA floodplain is for a smaller arroyo to the south, identified as Dam 9 Arroyo. The floodplain exists on a tributary to the Dam 9 Arroyo. The majority of this floodplain traverses areas designated for subdivision development. A Conditional Letter of Map Revision (CLOMR) will have to be submitted to FEMA upon completion of the final design.

### II. HYDROLOGIC ANALYSES

The 100-year storm event was used for both existing and proposed conditions.

### A. Off-Site Flows and Flows to West I-40 DMP Analysis Points

Off-site flows entering the site were calculated for the Mirehaven Arroyo and Dam 9 Arroyo. There are additional points of entry for off-site runoff, however they are minor in comparison. Drainage easements are shown on Exhibit 1 for these locations.

Five West I-40 Analysis Points were used in this study. These analysis points are all located along 98th Street at proposed crossing structures, referred to as Str. 1 through Str. 5, as shown on Exhibit 1.

### 1. Methodology

The off-site flows and flows to analysis points on 98th Street were all based on the results of the West I-40 DMP. The West I-40 DMP used the

AHYMO computer program to compute peak flow rates. The flows represent fully developed conditions.

Appendix A contains a portion of the I-40 DMP drainage basin map that was referenced in this study. AHYMO input and output files are available for reference if desired.

### 2. Flows

Off-site flows entering the site were determined by proportioning the flow to match the cfs/ac calculated by AHYMO for the next downstream analysis point. For example, the I-40 basin L12.18 was sub-divided to create an analysis point at the property boundary. (Refer to the map in Appendix A.) The ratio of this area to the flow was set equal to the ratio of the area to flow at the analysis point in AHYMO at 98th Street. The off-site flow entering the property via the Mirehaven Arroyo was estimated to be 1,440 cfs. The off-site flow entering the property via the Dam 9 Arroyo was estimated to be 60 cfs.

The alignment of 98th Street has changed since the I-40 DMP model was created. This has caused the drainage basins to Structures 1, 2, and 3 to increase. This is illustrated in the map in Appendix A. The basin areas to Structures 4 and 5 have not changed and their flows were obtained directly from the West I-40 DMP AHYMO output by referring to Basins L12.18 and L14.5, respectively. For the remaining locations, the West I-40 DMP AHYMO model was modified slightly to represent the current conditions and re-run. Table 1 compares the existing and developed flows at these points. The existing model was not re-run to account for the new 98th Street alignment so the flows at Structures 1, 2, and 3 are approximate.

Table 1
Flows at 98th Street Analysis Points

Location	Existing Q100 (cfs)	Developed Q100(cfs)						
Str. 1	265							
Str. 2	105							
Str. 3	399							
Str. 4	1581							
Str. 5	155							

**On-Site Flows** 

On-site flows were determined for each parcel of land that is planned for golf course or subdivision. A letter identifies basins representing subdivisions, and basins representing golf course areas are identified by "GC", followed by a number. Flows were based on the most current development plan from Consensus Planning and may change with any modifications to the layout.

### 1. Methodology

On-site flows were determined with the procedure outlined in Chapter 22, Section A.6 of the Albuquerque Development Process Manual (DPM). Values of cfs/ac are provided for each treatment type in each precipitation zone. The Petroglyph Golf Course is located in Precipitation Zone 2.

### 2. Treatment Types

Treatment types are used to describe the land areas of the drainage basin. There are four treatment types, A, B, C and D. Type A is the most pervious and Type D is the least pervious. Type A is typically used for undisturbed land and Type D for impervious areas.

Land use for the subdivisions was based on the Consensus Planning layout that identified the density of the housing. The Type D percentage for subdivisions was estimated from the equation in the DPM based on dwelling units per acre. The remaining area was divided equally between Treatment Types B and C. Golf course areas were assumed to be 100% Type B as suggested in the DPM. Appendix B contains a spreadsheet listing the treatment type percentages for each basin.

### 3. Flows

Calculations of the on-site flows are provided in Appendix B and are shown on Exhibit 1.

### III. HYDRAULIC ANALYSIS

There will be four culvert crossings and one trapbox "bridge" crossing under 98<sup>th</sup> Street. These crossings all occur in natural drainage ways. There are no proposed culvert crossings under Petroglyph Parkway from the golf course site. Some tracts will drain across Petroglyph Parkway as indicated by the flow arrows on Exhibit 1, probably via storm drain, however their analysis and design is not included in the Conceptual Drainage Plan.

### A. Crossing Culverts

The sizes of crossing culverts were determined with the Storm and Sanitary SelectCAD program by Intergraph. Analysis is based on the Federal Highway Administration's (FHWA) publication Hydraulic Design of Highway Culverts. The flows used for analysis are those mentioned in Section II.A.2, from the West I 50 DMP.

It was assumed that pipes would have at least 3 feet of cover. Therefore, headwater depths were allowed to reach a depth of the diameter plus three feet. Table 2 lists the culverts, flows and headwater depths.

Table 2
Crossing Culvert Summary

Structure No.	Structure Size	Q100 (cfs)	Headwater (ft)
Str. 1	3-48" RCP	265	4.6
Str. 2	1-48" RCP	105	5.4
Str. 3	3-48" RCP	354	6.2
Str. 5	1-54" RCP	155	6.8

### B. Mirehaven Arroyo Bridge Crossing

The HEC-RAS computer program was utilized to determine the water surface elevation at the future Mirehaven Arroyo Bridge. HEC-RAS is a hydraulic program that uses the standard step method to generate a water surface profile for the channel section defined. The bridge across the Mirehaven Arroyo had to be designed to have

Are you sure?

a minimum of two feet of freeboard during the 100-year event. The 100-year design flow is 1581 cfs as provided by the West I-40 DMP.

The West I-40 DMP proposed that the Mirehaven Arroyo be contained in a 10-foot wide lined channel downstream of 98th Street. In order to match the recommendation in the DMP, the bridge crossing was designed with the same configuration as the future channel. Upstream of the bridge, it was decided to reduce the floodplain to a constant width of about 150 feet. This increases the amount of developable land while still providing adequate conveyance.

Two scenarios were investigated for the protection of the arroyo. These options are described below:

### 1. Option 1

Option 1 is a more naturalistic approach. It maintains a bottom width of 100 feet with 3:1 side slopes. The bottom would remain natural and the side slopes would be armored with dumped riprap. A cross section is provided on Exhibit 1.

Appendix C includes the output for this scenario, labeled as "OPT2BREV". The flow in the natural channel can be categorized as critical. The water surface in the natural channel fluctuates around critical depth. The average depth of flow is 2.4 feet. Velocities range from 6.5 to 12.5 fps. Based on these velocities, it is recommended that the d50 of the riprap be 12".

The design of the transition from 100 feet to the 10-foot wide bridge opening was achieved after a number of trials. The final design has two sections to the transition. The first section transitions the width of the arroyo from 100 feet to 35 feet over a length of 200 feet. The bottom would stay natural and berms would be constructed to funnel the runoff. Although the

water surface elevation rises as the arroyo width contracts, critical depth is achieved at the grade change described below. The depth of flow is about 3.7 feet at this location and can be contained with berms.

The second section of the transition changes the width of the arroyo as well as the invert. It was desired to obtain supercritical flow under the bridge in order to eliminate hydraulic jumps and reduce the flow depth. This was accomplished by steepening the slope of the channel just upstream of the bridge to 8 percent and constructing the transition with soil cement. The cross section would be trapezoidal. The 8% section is 100 feet long and flattens out to 1.7% for the remaining 140 feet to the bridge. The 100-year flow depth at the upstream bridge face is about 5.5 feet.

### 2. Option 2

Option 2 is a continuous, trapezoidal, soil cement channel. The soil cement can either be stepped or sloped. If it is stepped the side slopes are 2:1, if it is sloped, the side slopes are 4:1. These configurations are based on previous design approved by AMAFCA. Cross sections are shown on Exhibit 1. The soil cement channel would be constructed below existing ground so that the top of the soil cement would closely match the existing invert. By doing this, fill would be essentially eliminated. A transition will have to be provided at the upstream property boundary to divert the existing flows into the soil cement section and provide a smooth grade change along the invert.

Appendix C includes the HEC-RAS output for this option, labeled "OPT3REV". The flow is supercritical throughout the entire length. The average flow depth in the channel is 2.5 feet. The average velocity is 18.5 fps.

The transition from the 30-foot wide soil cement channel to the 10-foot wide bridge is accomplished with a steep approach similar to that described for Option 1. At about 240 feet upstream of the bridge, the slope of the soil cement channel increases to 8%. The 8% section covers 100 feet, at which point the slope flattens out to about 1.7%. The flow remains supercritical under the bridge. The flow depth at the upstream bridge face is about 5.5 feet.

If a supercritical transition at the bridge was not provided, the flow depth would be greater and hydraulic jumps would occur which both would require an increased vertical profile at 98th Street. The final configuration of the bridge crossing was determined to be a trapbox section; 10-foot bottom width, 2:1 side slopes to a depth of 5.5 feet deep and vertical walls from 5.5 feet to 7.5 feet. The span equals 32 feet.

### IV. CONCEPTUAL DRAINAGE PATTERNS

This section attempts to identify assumptions and philosophies used in determining the drainage patterns through the Petroglyph Golf Course.

### A. Flow Directions

In general, it was assumed that the proposed grading of the site would be similar to the existing ground elevations. Therefore, drainage patterns were based on existing contours. High points and low points were also based on existing contours.

Within subdivision areas, it was assumed that flow would be directed toward easements, if they were present, or towards roads via storm drain systems. Runoff from one subdivision was not permitted to enter another subdivision. Additionally, concentrated runoff from subdivisions were not allowed to enter the golf course areas.

The Mirehaven Arroyo will accept discharge from all adjacent tracts. The Dam 9 Arroyo is proposed to remain natural through the golf course area, but will be piped under the subdivision and daylight on the east side of 98th Street. A portion of the Tributary to the Dam 9 Arroyo will remain natural as well as it travels through Basin GC2, but will either be piped or confined in a channel from the end of Basin GC2 until 98th Street.

There are three lake sites proposed with the golf course layout. These ponds are to serve as irrigation for the golf course. In order to minimize the sediment and debris in the ponds, they are not planned for use as stormwater management facilities.

### B. Drainage Easements

Five drainage easements have been identified on the Conceptual Drainage
Plan. Widths of these easements have not been determined and they are shown for
location purposes only. It was assumed that off-site flow would be collected where
possible and diverted to a common easement. It is possible to modify the configuration
of the easements to maximize development area and to increase accessibility for
maintenance.

### V. SUMMARY

In general, the proposed flow patterns for the future golf course and residential developments closely match that of existing. Storm drain and/or open channels are proposed to collect runoff within the subdivisions and discharge it to an existing drainage way. The majority of runoff leaves the site to the east under 98th Street. A small portion will be collected and directed across Petroglyph Parkway.

Two major arroyos pass through the golf course site. They are the Mirehaven Arroyo and Dam 9 Arroyo. A tributary to the Dam 9 Arroyo also traverses the site. FEMA floodplains exist for the Mirehaven and the Tributary to Dam 9 Arroyos. A CLOMR will be required for the Tributary to Dam 9 Arroyo only.

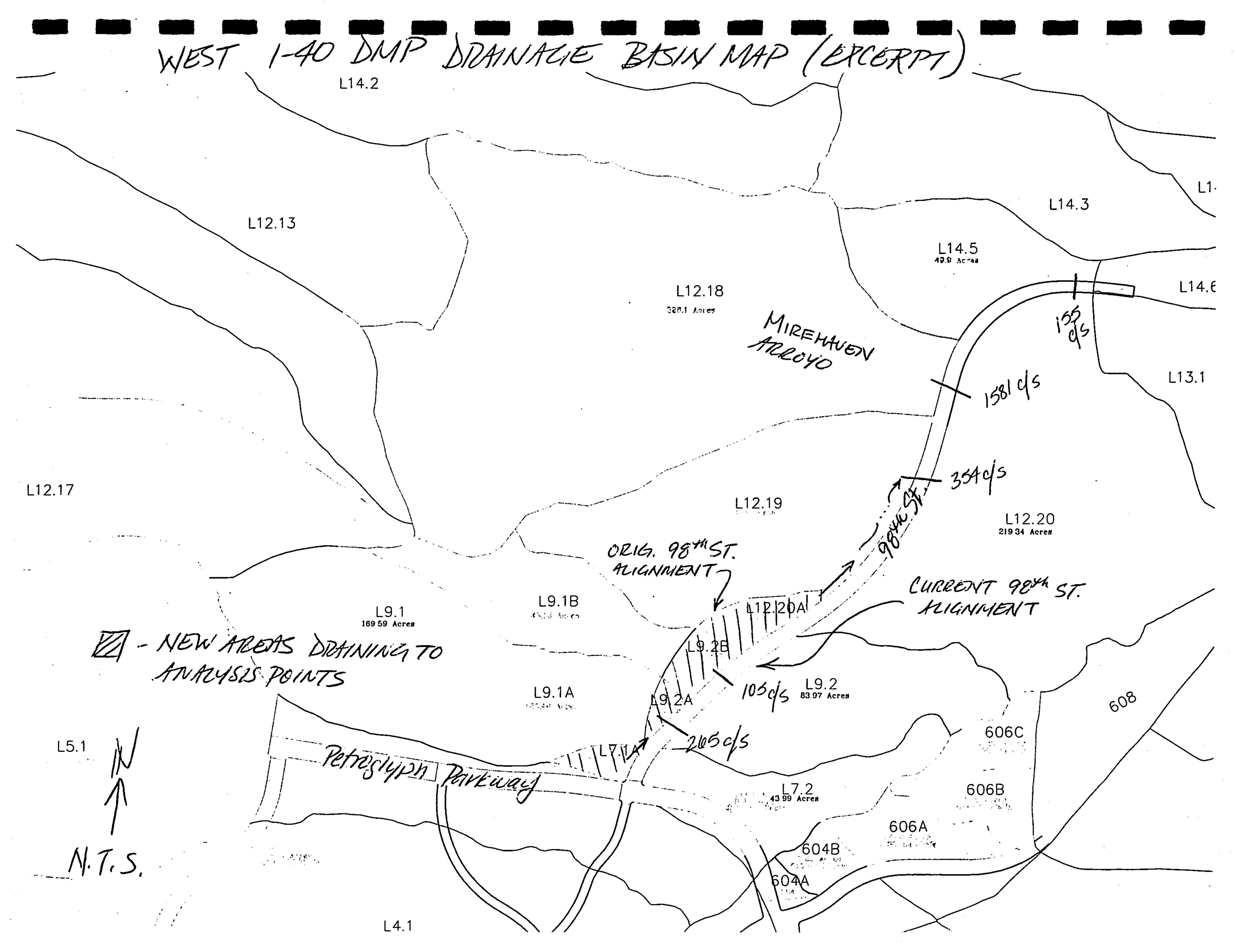
It is proposed that the Mirehaven Arroyo will either become a 30-foot wide soil cement channel or a 100-foot wide natural bottom channel with riprap-armored side slopes. The bridge crossing at 98th Street, identical under either option, will be a trapbox with a 10-foot bottom width, 2:1 side slopes for a height of 5.5 feet and vertical walls from 5.5 feet to 7.5 feet.

The Dam 9 Arroyo will remain in its natural condition as it enters the site. After about 700 feet it will be piped in 1-48" RCP under a subdivision and discharge on the east side of 98th Street. The Dam 9 Tributary will also be left partially in its natural state and partially piped or channelized

# **APPENDIX A**

•

WEST I-40 DMP DRAINAGE BASIN MAP



# APPENDIX B

TREATMENT TYPES AND ONSITE FLOWS

.

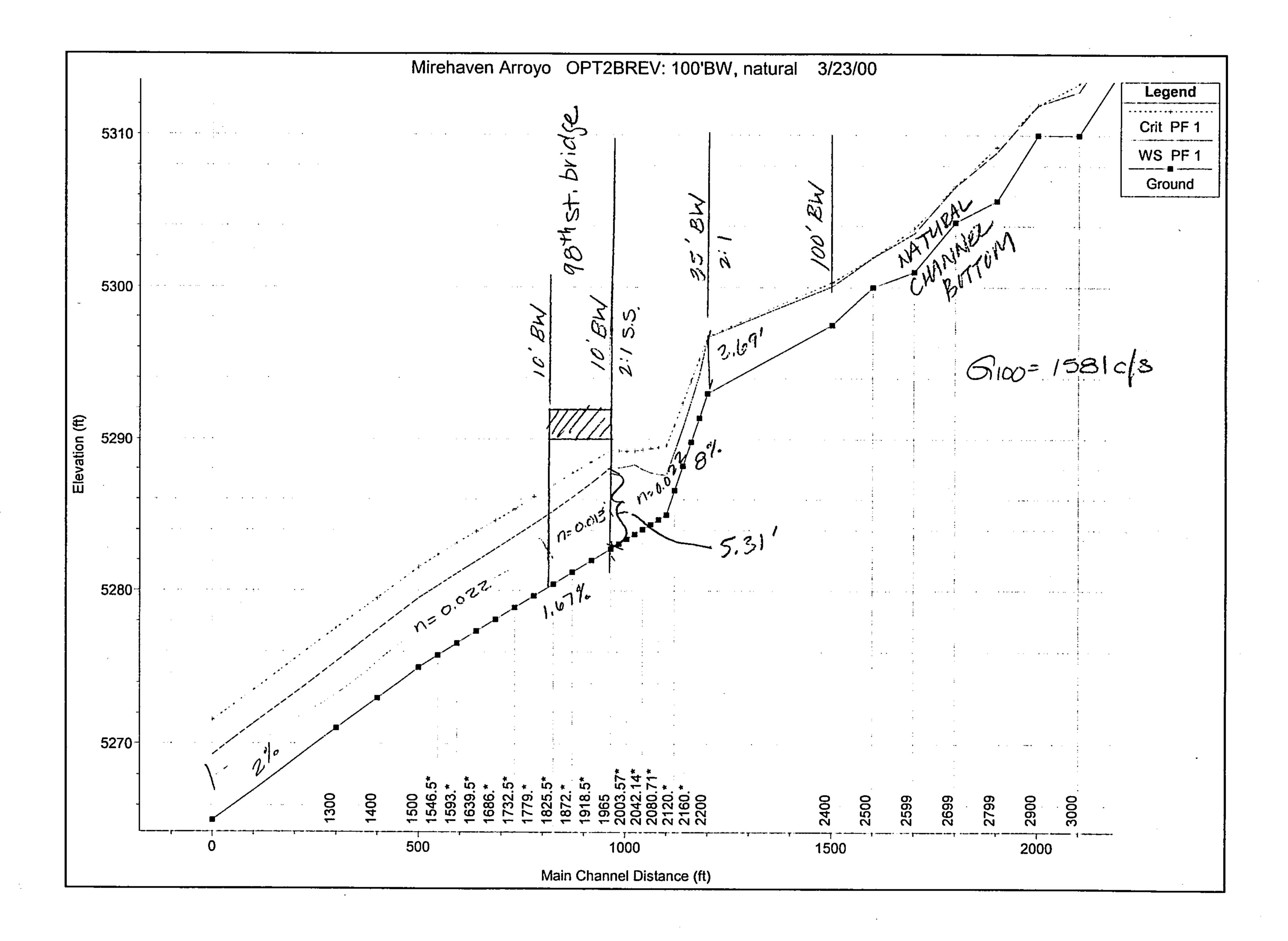
Westland Golf Course Development
Developed Area Flows
Assuming maximum dwelling units per acre shown on plan.

· 				<u>-</u>		Weighted	Prop
,	Area	La	and Treatmer	nt Percenta	ges	Q100	Q100
Basin	(Acres)	Α	В	С	D	(cfs/ac)	(cfs)
		_	· 				
A-1	13	0	21.5	21.5	57 	3.54	46.1
A-2	11.3	0	21.5	21.5	57	3.54	40.1
A-3	9.1	0	21.5	21.5	57	3.54	32.3
A-4	15.6	0	21.5	21.5	57	3.54	55.3
B-1	3.4	0	15	15	70	3.79	12.9
B-2	15.6	0	15	15	70	3.79	59.2
C-1	22.6	0	33	33	34	3.10	70.1
C-2	3.4	0	33	33	34	3.10	10.5
D	8.5	0	15	15	70	3.79	32.2
E-1	1	0	15	15	70	3.79	3.8
E-2	9	0	15	15	70	3.79	34.1
F	7	0	15	15	70	3.79	26.6
G-1	6.5	0	15	15	70	3.79	24.7
G-2	5.5	0	15	15	70	3.79	20.9
H-1	4.5	0	21.5	21.5	57	3.54	15.9
H-2	11.2	0	21.5	21.5	57	3.54	39.7
H-3	3	0	21.5	21.5	57	3.54	10.6
H-4	20.3	0	21.5	21.5	57	3.54	72.0
1	15	0	33	33	34)	3.10	46.5
J	17	0	37	37	(26)	2.95	50.1
K	14	0	33	33	(34)	3.10	43.4
L-1	18	0	21.5	21.5	57	3.54	63.8
L-2	22	0	21.5	21.5	57	3.54	78.0
M	11	0	15	15	70	3.79	41.7
004	. 216	^	400	^	^	2.02	42.0
GCI	21.0	0	100	0	0	2.03	43.8
GC2	38.6	0	100	0	0	2.03	78.4
GC3-1	11.4	0	100	0	0	2.03	23.1
GC3-2	7.6	0	100	0	0	2.03	15.4
GC4	71.2	0	100	Ü	0	2.03	144.5
GC5-1	8.7	0	100	0	0	2.03	17.7
GC5-2	12.7	0	100	0	0	2.03	25.8
GC6	25.1	0	100	0	0	2.03	51.0
GC7	23.2	0	100	0	0	2.03	47.1
GC8-1	29.4	0	100	0	0	2.03	59.7
GC8-2	9.6	0	100	0	0	2.03	19.5
				100-	vear Peak I	Discharge (cf:	s/ac)

	100-у	ear Peak D	ischarge (c	fs/ac)
From Table A-9, Alb. DPM	Α	В	С	D
Precipitaion Zone 1: West of Rio Grande	1.29	2.03	2.87	4.37

APPENDIX C

HEC-RAS OUTPUT



HEC-RAS Plan: OPT2BREV River: RIVER-1 Reach: Reach-1

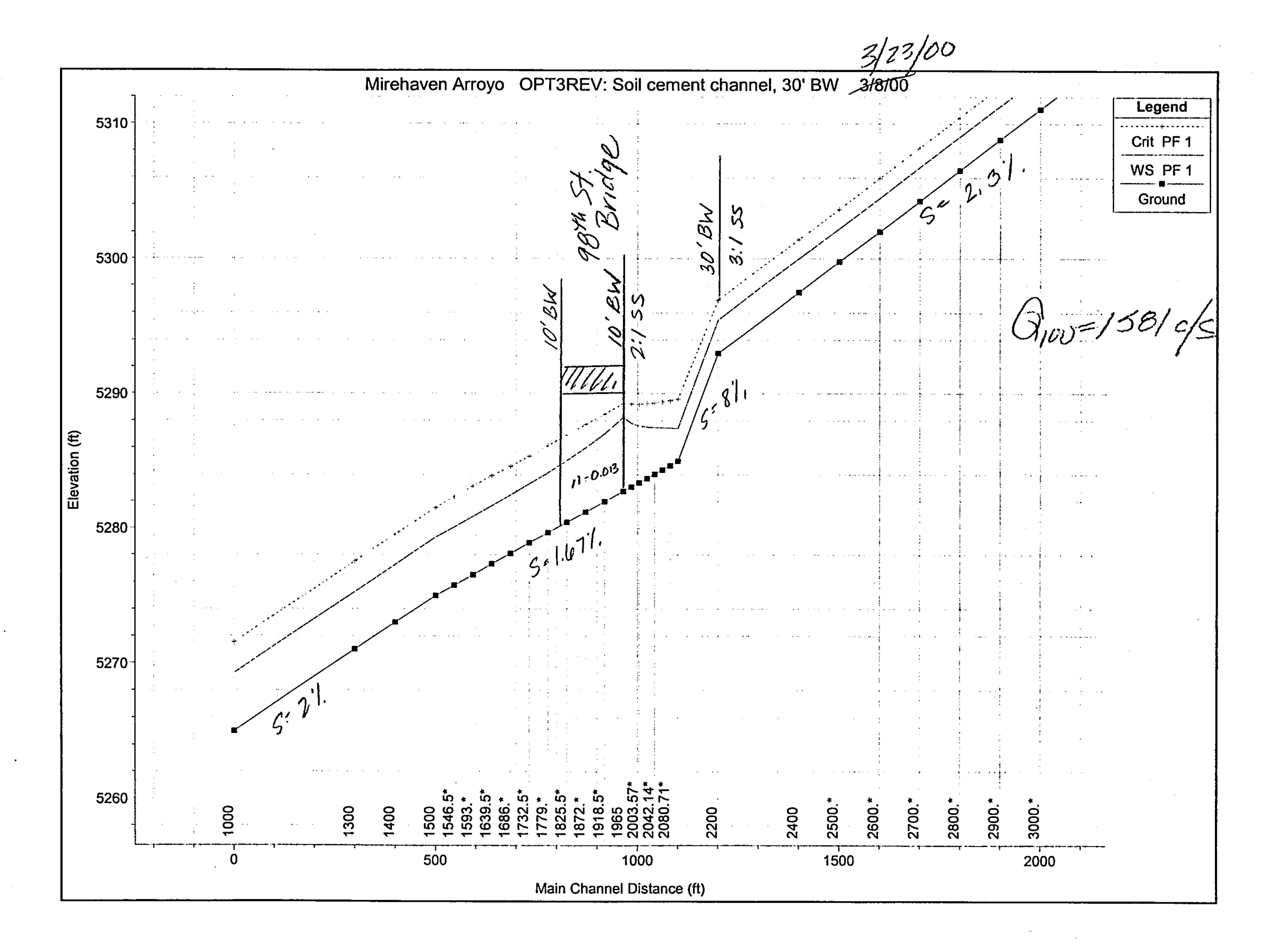
				-1 Reach: Reach									
				Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E,G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		PARTY AND THE	्रिके (cfs) 🚉	**X(** (ft) ***	73:40 (ft) 3:45 C	(ft) (5.5%)	(ft) 3/38	**** (ft) *****	(ft/ft)	(fl/s) :};	(sq ft)	2 (ft) 30.00	
	<u> </u>	5600	1581.00		1	1.21	5371.21	5371.77		1	• •	240.90	
	<del></del>	5499		5366.90	5369.87	2.97	5369.87	5370.89	0.017705	9.40	220.31	149.34	1.02
	<del></del>	5400	1581.00	5365.00	5366.53	1.53	5366.98	5368.13	0.044937	10.44	158.69	116.20	1.49
Y		5300	1581.00	5364.22	5366.11	1.99	5366.11	5366.78	0.019657	7.81	244.38	180.39	1.02
	**************************************	5200 : : : : : : : : : : : : : : : : : :	— <del>————————————————————————————————————</del>	5360.00	5362.19	2.19	5362.84	5364.08	0.038401	12.26	153.36	101.02	1.46
		5099	- <del> </del>		5361.51	1.98	5361.51	5362.24	0.020062	7.16	234.66	166.46	1.00
		5000		<del>- · · · · · · · · · · · · · · · · · · ·</del>	5357.79	2.62	5358.20	5359.17	0.045633	9.42	167.75	129.49	1.46
		4899	···			1.95	5356.95	5357.88	0.018824	7.78	204.89	110.73	0.99
		4800	1581.00		5354.61	2.21	5354.75	5355.60	0.027351	8.01	197.26	131.54	1.15
		4699		<del> </del>		1.77	5351.95	5352.93	0.026445	8.67	183.16	107.17	1.15
		4600	1581.00		· <del></del>	2.45	5349.65	5350.37	0.022822	7.15	227.12	168.95	1.05
i		4499	1581.00	<del> </del>		1.74	5346.93	5347.88	0.026928	8.67	185.95	113.36	1.17
	<del>*************************************</del>	4399	1581.00		<del></del>	2.08	5346.87	5347.77		7.72	207.89	113.29	0.99
		4300	1581.00		5341.82	1.82	5342.53	5344.16	·	12.29	128.68	102.91	1.94
	<del>៲៱៹៶៶៶៲៱៶៶៹ឨ៶៶ឨ៶ឨ៶ឨ៶ឨ៶ឨ៶ឨ៶ឨ៶ឨ៶៳៰</del>	4199	1581.00		<del></del>	2.55	5341.53	<del></del>	0.018736	·····	202.09	105.86	0.99
		4100	1581.00		5336.46	(1.46)	<u></u>	5338.87	0.081436	(12.46)	126.89	98.67	1.94
	Reach-1	<del> </del>	1581.00	<del></del>	5336.90	1.90	5336.90		<del></del>	7.58	217.48	126.24	0.97
		3900	1581.00		5334.46	2.72	5334.46	<del> </del>			242.54	184.85	0.98
	**************************************	3799	1581.00	<del></del>	5331.90	1.90	5331.98	<del></del>	<del></del>	· <del></del>	189.65	100.00	1.07
		3700	1581.00	<del> </del>	5331.85	- (4.37		<del></del>	0.019518	7.97	198.45	100.00	1.00
	<del></del>	3600	1581.00		5327.24	2.24		5329.40		11.81	133.86	100.00	1.80
		3500	1581.00	<del></del>	5326.10		·· <del>························</del> ··········	<del></del>			198.99	100.00	0.99
	******************	3399	1581.00	<del> </del>	5324.60	4.60	5324.60	5325.60			196.94	100.00	1.01
	<del></del>	3300	1581.00	<del></del>	5320.86	2.17		5322.54		- <del></del>	151.86	100.00	1.49
	<del></del>	3200	1581.00		5318.01	2.41	- <del></del>		·	<del></del>	185.66	100.00	
		3100	1581.00		5316.67	2.47	5316.67	5317.65	· · · · · · · · · · · · · · · · · · ·	7.92	199.51	100.00	
	**************************************	2900	1581.00		5312.88	2.88	· <del></del>	5314.67	· · · · · · · · · · · · · · · · · · ·	10.74	147.17	100.00	1.56
3	<del></del>	<u> </u>	·		5311.97	1.97	5311.97	5312.97			196.92	100.00	1.01
	<del> </del>	2799	1581.00		5308.89	3.23		5310.31	0.035940	- <del></del>	<del></del>	100.00	· <del></del>
- 1	<del></del>	2699	1581.00		5306.63	2.39	<del></del>	5307.64			195.63	100.00	
]		2599	1581.00		5303.53	2.51	5303.83	5304.96	· <del>· · · · · · · · · · · · · · · · · · </del>	9.60	164.74	100.00	
		2500	<del></del>		5301.97	1.97	5301.97	5302.97	0.019924	· <del></del>	196.92	100.00	· · · · · · · · · · · · · · · · · · ·
	**************************************	2200	1581.00	<del></del>	5300.06	2.56	5300.33	5301.35	· <del></del>	<del></del>	173.39	100.00	·
	<del></del>	<del></del>	1581.00	<del></del>	5296.69	3.69	5296.75	5298.40	<del></del>		156.40	49.76	1.00
	<del></del>	2180.*	<del></del>			2.83	5295.28	5297.71		15.45	108.96	44.19	
		2160.*		<del>   </del>	5292.43	2.63	5293.84	5297.04		17.77	94.69	41.26	1.93
	<del>~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~</del>	2140.* 2120.*			5290.77	2.57	5292.39	5296.29	<del> </del>	19.47	86.66	38.89	2.14
1	<del></del>	2120.	1581.00	<del></del>	<del></del>	2.56	·· <del>···································</del>	5295.53	·	20.97	80.83	36.71	2.31
			1581.00		5287.59	2.59	· · · · · · · · · · · · · · · · · · ·	5294.75		<del></del>	76.45	34.71	2.44
	reach-1	2080.71	1581.00	5284.68	5287.64	2.96	5289.45	5293.71	0.022049	20.70	83.69	34.17	2.12

- 100' BW

HEC-RAS Plan: OPT2BREV River: RIVER-1 Reach: Reach-1 (Continued)

1	Committee and the second second second second second second	the anti-contract is an armiditary area. As these	Carrier and Company of the Company o	Maria and the second se	The state of the s	**************************************							
					. W.S. Elev	<u> </u>			E.G. Slope :	Vel Chnl	Flow Area	Top Width	Froude # Chl ::
				(ft) 33 H	1982 (ft) 1982	(ft) (ft)	(ft) (ft)	(ft) 数型	(ft/ft) ** **	√h (ft/s) **	(sq ft)	(ft) 1.75 ·	Territory (Contraction)
	Reach-1	2061.42*	1581.00	5284.36	5287.74	3.38	5289.36	5292.90	0.016044	19.29	i		
	<del></del>	2042.14*	<del></del>	5284.04	5287.96	3.92	5289.27	5292.18	0.011136	17.71	102.01	33.88	1.58
		2022.85	*	5283.71	5288.28	4.57	5289.22	5291.65	0.007497	16.10	115.52	34.42	1.33
	Reach-1	2003.57*	1581.00	5283.39	5288.15	4.76	5289.20	5291.75	0.007803	16.88	112.46	33.14	1.36
_	Reach-1	1984.28*	1581.00	5283.07	5288.07	5.00	5289.22	5291.87	0.007966	17.64	110.42	32.07	1.39
	Reach-1	1965	1581.00	5282.75	5288.06	5.31	5289.26	5291.97	0.002782	18.36	109.57	31.25	1.40
	<del></del>	1918.5*		5281.98	5286.92	4.94	5288.47	5291.76	0.003729	20.25	98.37	29.80	1.61
	Reach-1	1872.*	1581.00	5281.20	5285.91	4.71	5287.71	5291.48	0.004540	21.64	91.48	28.84	1.76
		1825.5*		5280.42	5284.94	4.52	5286.94	5291.22	0.005356	22.88	86.07	28.07	1.90
	Reach-1	1779.	1581.00	5279.65	5284.07	4.42	5286.16	5290.78	0.016856	23.60	83.17	27.67	1.98
		1732.5*.	<del>}</del>	5278.88	5283.29	4.41	5285.37	5290.02	0.016885	23.62	83.12	27.66	1.98
	*****************	1686.*	· <del>· · · · · · · · · · · · · · · · · · </del>	5278.10	5282.51	4.41	5284.61	5289.25	0.016968	23.66	82.97	27.64	1.99
	Reach-1	1639.5*	1581.00	5277.33	5281.74	4.41	5283.91	5288.48	0.016978	23.66	82.98	27.66	1.99
	Reach-1	1593.*.	1581.00	5276.55	5280.96	4.41	5283.14	5287.71	0.016999	23.67	82.92	27.63	1.99
	Reach-1	1548.5* 3	1581.00	5275.77	5280.18	4.41	5282.35	5286.94	0.017012	23.68	82.87	27.60	1.99
	······································	1500	,	5275.00	5279.41	4.41	5281.52	5286.16	0.017013	23.68	82.89	27.63	1.99
- 1	<del></del>	1400	<del></del>	5273.00	5277.35	4.35	5279.52	5284.37	0.017944	24.10	81.29	27.39	2.04
	Reach-1	1300	1581.00	5271.00	5275.31	4.31	5277.52	5282.52	0.018630	24.41	80.19	27.23	2.07
l	Reach-1	1000	1581.00	5265.00	5269.25	4.25	5271.52	5276.73	0.019616	24.83	78.69	27.01	2.12
				·						· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·	<del></del>

PRITA



HEC-RAS Pla											•	
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chi
		²≱'≽ (cfs) % %:	7 (ft)	(ft)	/(ft) (ft)	(ft) (ft)	(ft)	(ft/ft)	्रेड्ड (ft/s) के	tada (sq ft)	(ft)	TARREST TO
Reach-1	5600	1581.00	5370.00			5373.94				164.51	53.61	0.96
Reach-1	5500.* N. K.	1581.00	5367.73	5370.40	2.67	5371.67	5374.50	0.017178	17.02	101.26	45.99	<del></del>
Reach-1		·	5365.47	5368.01	2.54	5369.41	5372.60	0.020414	17.97	95.58	45.24	1.99
Reach-1	<del></del>	· <del></del>	5363.20	5365.70	2.50	5367.14	5370.47	0.021630	18.30	93.75	45.00	2.04
Reach-1	******		5360.94	5363.42	2.48	5364.88	5368.27	0.022202	18.45	92.94	44.89	2.06
Reach-1		• <del>••••••••••••••••••••••••••••••••••••</del>	5358.67	5361.15	2.48	5362.60	5366.00	0.022171	18.44	92.98	44.90	2.06
Reach-1	**************************************	d ————————————————————————————————————	5356.41	5358.89	2.48	5360.35	5363.73	0.022155	18.44	93.00	44.90	2.06
Reach-1		1581.00	5354.14	5356.61	2.47	5358.08	5361.50	0.022503	18.53	92.52	44.84	2.08
Reach-1	******************	1581.00	5351.88	5354.36	2.48	5355.81	5359.21	0.022186	18.44	92.96	44.89	2.06
Reach-1	· · · · · · · · · · · · · · · · · · ·		5349.61	5352.09	2.48	5353.54	5356.93	0.022108	18.42	93.07	44.91	2.06
Réach-1		<del></del>		·· <del>···································</del>	2.48	5351.27	5354.69	0.022391	18.50	92.68	44.86	2.07
Reach-1	·····		······································	<del></del>		5349.02	5352.43	0.022360	18.49	92.72	44.86	2.07
Reach-1		<b>1</b>		5345.29	2.48	5346.75	5350.15	0.022312	18.48	92.78	44.87	2.07
Reach-1		{ <del></del>			·	5344.48	5347.89	0.022312	18.48	92.78	44.87	2.07
Reach-1	· · · · · · · · · · · · · · · · · · ·	1581.00		- <del></del>		·	5345.62	0.022328	18.48	92.76	44.87	2.07
Reach-1	***************************************	<del></del>					5343.36	0.022296	18.47	92.81	44.87	2.07
Reach-1		1581.00		·	- <del> </del>			0.022249	18.46	92.87	44.88	2.07
Reach-1		<del>                                     </del>		<del></del>	<del></del>		<del></del>	0.022171	18.44	92.98	44.90	2.06
Reach-1		1581.00		<del></del>	· <del>- · · · · · · · · · · · · · · · · · ·</del>		5336.54	0.022155	18.44		44.90	2.06
Reach-1	<del></del>	· <del></del>				5330.89	5334.31	0.022503	18.53		44.84	2.08
Reach-1	······	<del></del>		5327.17	· - · · · · · · · · · · · · · · · · · ·	5328.63	5332.02	0.022186	18.44		44.89	2.06
Reach-1				5324.90		5326.35	5329.74	0.022108	18.42	<del></del>	44.91	2.06
Reach-1	***************************************	<del></del>		5322.65	·	5324.10	· <del></del>	0.022108	18.42		44.91	2.06
Reach-1		···	5317.89 5315.62	5320.37		5321.83		0.022391	18.50		<del></del>	
Reach-1		·	5313.36	5318.10	<del></del>	5319.56		0.022360	<del></del>	<del></del>	<del></del>	
Reach-1		· <del></del>	····	5315.84	· <del></del>	5317.29		<del></del> -	18.48			2.07
Reach-1	<del></del>	·		5313.57			<del></del>	<del> </del>		<del></del>	······	
Reach-1		( <del></del>		5311.31 5309.04	·	5312.77	5316.17		18.47	92.81	44.87	2.07
Reach-1	**************************************	·		5306.78	2.48 2.48	5310.50	5313.90	<del></del>	18.46	92.87	44.88	
Reach-1	<del></del>	· <del></del>		5304.51	2.48	5308.23	5311.64	0.022265	18.46	92.85		<del></del>
Reach-1				5302.25		5305.96	5309.36		18.46	92.89		
Reach-1		·	· <del></del>		2.48	<del></del>	5307.10	<del></del>	18.45	92.92		
Reach-13200	·· <del>···································</del>				2.48	5301.44	<del></del>	<del></del>	18.43	93.05	44.91	2.06
Reach-1		1581.00		5287.43	2.48	5296.94	5300.33	· <del></del> -	18.44	92.98	44.90	
Reach-1 X	······································	· ————————————————————————————————————		5287.45	2.43	5289.59	5296.17	0.042346	25.11	69.89	- <del></del>	
Reach-1		·		5287.46	2.77 3.10	5289.49			23.29	76.33		-
Reach-1	**************************************	1581.00	<del></del>	5287.49		5289.38 5289.30	5294.00 5293.41	0.017571	22.06	81.69		2.21
Reach-1	<del></del>	· <del></del>	· <del></del>	5287.51	3.43	<del></del>	5293.41	0.012655	21.20	86.32	33.51	2.01
Reach-1	<del></del>	·		5287.61	4.22	<del></del>	<del></del>	<del></del>	20.61	90.30	32.55	
7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7		1001.00	<u> </u>	0201.01	4.22	5209.20	5292.03	0.006791	19.98	95.11	31.82	1.71

Noghan Magan

Reach	<b>4</b> (*),	T — — — — — — — — — — — — — — — — — — —			Max Chl Dpth	<del></del>	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		न, ने (cfs) ३०००	'	13 (ft) \$15 to	透視部 (ft) 治路計	(fi) ¥₹	(ft) 3.147	(ft/ft)	(ft/s)	(sq ft)	(ft) (ft)	
Reach-1	1984.28***	1581.00	5283.07	5287.81	4.74	5289.23	5292.23	0.004069	1		i	
Reach-1	1965:	1581.00	5282.75	5288.23	5.48	5289.26	5291.80	0.002458	17.60	114.70	31.90	1.33
	1918.5*	· · · · · · · · · · · · · · · · · · ·	5281.98	5287.03	5.05	5288.47	5291.56	0.003951	19.65	101.70	30.24	1.54
The state of the s	1872.*.		5281.20	5286.01	4.81	5287.71	5291.26	0.005564	21.05	94.30	29.23	1.69
· Property and the second seco	1825.5*		5280.42	5285.05	4.63	5286.94	5290.92	0.007394	22.18	89.06	28.49	1.82
Reach-1			5279.65	5284.15	4.50	5286.16	5290.50	0.009298	22.99	85.62	28.02	1.91
	1732.5*	· <del></del>	5278.88	5283.31	4.43	5285.37	5289.95	0.011105	23.48	83.66	27.74	1.96
Torbo discussiones income accusation and accusation and accusation and accusation and accusation and accusation and accusation accusation and accusation accusation and accusation accusati	1686.*	<del></del>	5278.10	5282.47	4.37	5284.61	5289.38	0.011729	23.91	82.01	27.50	2.01
Reach-1		· <del></del>	5277.33	5281.66	4.33	5283.91	5288.75	0.013593	24.22	80.86	27.35	2.05
- <del> </del>	1593.		5276.55	5280.86	4.31	5283.14	5288.07	0.015411	24.41	80.16	27.23	2.07
	1546.5*		5275.77	5280.06	4.29	5282.35	5287.36	0.017236	24.54	79.72	27.14	2.09
*******************************	1500	<del></del>	5275.00	5279.30	4.30	5281.52	5286.54	0.018714	24.44	80.05	27.21	2.08
the street of th	1400	- <del></del>	5273.00	5277.28	4.28	5279.52	5284.63	0.019128	24.62	79.42	27.12	·
	1300	l ————————————————————————————————————	5271.00	5275.26	4.26	5277.52	5282.68	0.019392	24.73	79.02	27.06	2.11
Reach-1	1000	1581.00	5265.00	5269.24	4.24	5271.52	5276.78	0.019824	24.92	78.39	26.96	2.13

# APPENDIX D

EXHIBIT 1
CONCEPTUAL DRAINAGE PLAN

### DRAINAGE INFORMATION SHEET

PROJECT TITLE: PETROGLYPH GOLF COURSE ZO	NE ATLAS/DRNG. FILE # H-9 (DO(2)
DRB #:	WORK ORDER #: N/A
LEGAL DESCRIPTION: PROPERTY OF WESTLAND NO	DRTH
CITY ADDRESS: N/A	
ENGINEERING FIRM: BOHANNAN-HUSTON INC. ADDRESS: 7500 JEFFERSON NE, ALB. NM 87109  OWNER: WESTLAND DEVELOPMENT CO. INC. ADDRESS: 401 COORS BOULEVARD NW, 87121  ARCHITECT: CONSENSUS PLANNING  ADDRESS: 924 PARK AVENUE SW, 87102  SURVEYOR: N/A  ADDRESS: CONTRACTOR: N/A  ADDRESS:	PHONE:  CONTACT:
TYPE OF SUBMITTAL:  DRAINAGE REPORT XXX_ DRAINAGE PLAN FINAL GRADING & DRAINAGE PLAN GRADING PLAN EROSION CONTROL PLAN ENGINEER'S CERTIFICATION OTHER  PRE-DESIGN MEETING: XXX_ YES NO COPY PROVIDED	CHECK TYPE OF APPROVAL SOUGHT:  SKETCH PLAT APPROVAL PRELIMINARY PLAT APPROVAL XXX S. DEV. PLAN FOR SUBÎD. APPROVAL XXX S. DEV. PLAN FOR BLDG. PERMIT APPROVAL SECTOR PLAN APPROVAL FINAL PLAT APPROVAL FOUNDATION PERMIT APPROVAL BUILDING PERMIT APPROVAL CERTIFICATE OF OCCUPANCY APPROVAL GRADING PERMIT APPROVAL PAVING PERMIT APPROVAL S.A.D. DRAINAGE REPORT DRAINAGE REQUIREMENTS SUBDIVISION CERTIFICATION OTHER (SPECIFY)
DATE SUBMITTED: MARCH 31, 2000  BY: BOHANNAN HUSTON, INC.	
Revised 02/98	MAR 31 2000  HYDROLOGY SECTION