AMENDMENT TO THE

"MASTER DEVELOPMENT DRAINAGE PLAN

for

CORDERA AND BRIARGATE CROSSINGS EAST"

DETENTION FACILITY 1

located at

POWERS BLVD. & COTTONWOOD CREEK

Prepared for:
City of Colorado Springs, Colorado
Engineering Division

On Behalf of:
LP47, LLC dba La Plata Investments
1755 Telstar Drive, Suite 450
Colorado Springs, CO 80920

Prepared by:

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
(719) 575-0100
fax (719) 572-0208

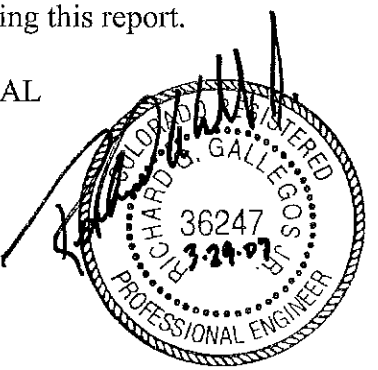
March 2007

06.104.072

Engineer's Statement:

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

SEAL



Richard G. Gallegos, Jr.
Registered Professional Engineer
State of Colorado
No. 36247

Developer's Statement:

I, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

LP47, LLC dba La Plata Investments
Business Name

By: _____
Thomas Taylor
Title: Director of Development Services
Address: 1755 Telstar Drive, Suite 450
Colorado Springs, CO 80920

City of Colorado Springs:

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.

_____ April 2, 2007
City Engineer Date

Conditions:

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APPENDIX

I. INTRODUCTION

A. Background

Matrix Design Group, Inc. has been retained by La Plata Investments to prepare this ***Amendment to the "Master Development Drainage Report for Cordera and Briargate Crossing East," Detention Facility 1,*** to evaluate the existing drainage conditions and design of detention pond DF1 within the Cottonwood Creek Drainage Basin. Under the approved ***Master Development Drainage Report for Cordera and Briargate Crossing East,*** prepared by Matrix Desgin Group, Inc., dated November 2004, DF1 was designed as a regional detention pond for the Cordera and Wolf Ranch developments; however, per the *Wolf Ranch Master Development Drainage Plan,* prepared by Kiowa Engineering, dated February 2005, Wolf Ranch will be constructing a detention pond within their property to serve the detention requirements for Wolf Ranch, negating the need for a joint detention pond. As the development plan for Wolf Ranch evolved, the location of an upstream detention basin was preferable to a joint basin. This drainage report will serve as an amendment to the approved MDDP to reflect the aforementioned changes.

Changes to the approved MDDP are minimal. The development plan for Cordera and Briargate Crossings East has not changed and, as a result, the drainage basins will remain the same. The only change to the approved MDDP is the watershed area tributary to the detention pond, DF-1, and consequently, the required size of the detention pond will be reduced. Located within the southern tip of Cordera Filing No. 1, DF-1 will have a total tributary area of 171.1 acres, as opposed to 529 acres per the approved MDDP.

B. Project Location

This site is located within the Corporate Limits of the City of Colorado Springs southeast of the intersection of Powers Boulevard and Briargate Parkway. See Vicinity Map. The site encompasses an area of land formally part of El Paso County, but has since been annexed into the City of Colorado Springs. Surrounding areas consist mainly of vacant undeveloped land and residential developments. More specifically, DF1 is located as follows:

1. General Location. Southwest ¼ of Section 25, southeast ¼ of Section 26, northeast ¼ of Section 35, and the northwest ¼ of Section 36, Township 12 South, Range 66 West of the 6th P.M. in the City of Colorado Springs, County of El Paso, State of Colorado.
2. Surrounding Streets. The site is bounded on the southwest by Powers Boulevard. Briargate Parkway is the northern boundary of the project.
3. Drainageway. The site is located within the ***Cottonwood Creek Drainage Basin***. The basin extends off-site to the east of Cordera Filing No. 1.
4. Surrounding Developments. DF1 is located within a sparsely developed area of Colorado Springs. In general, the following land uses are located around the study area:

   North: Cordera Filing No. 1, a single-family residential development.

   East: Wolf Ranch development, consisting of mainly single-family residential parcels.

   Southwest: Liberty High School, an Air Academy School District facility.

C. Property Description

Cordera Filing No. 1 as well as the entire Cordera Master Plan area is undeveloped with few adjacent improvements. Roadway and utility infrastructure is currently being extended to the site as part of other adjacent projects including the development of *Briargate Crossing West Filing No. 1*.

1. Drainage Area. DF1 will collect flows from a drainage area totaling 177.1 acres, which includes portions of Cordera Filing No. 1, Cordera Filing No. 2, and Briargate Crossing. Land-use from these areas includes right-of-way, single-family lots, and open space.

2. Ground Cover. This site is covered with sparse vegetation including natural grasses and some trees and shrubs.

3. General Topography. The portion within the Cottonwood Creek Drainage Basin flows to the southwest at a natural grade of about 4%.

4. General Soil Conditions. The *Soil Conservation Service of El Paso County Area, Colorado*, published by the United States Department of Agriculture, dated November 1991, has been utilized to investigate the existing general soil types within and tributary to the area impacting Cordera Filing No. 1. Four different soil types can be found in and around the study reach:

Soil ID No.	***Soil***	***Hydrologic Classification***	***Permeability***	***Erosion Hazard***
68	Peyton-Pring complex (3%-8% slope)	B	Rapid	Moderate to High
71	Pring coarse sandy loam	B	Rapid	Moderate
83	Stapleton sandy loam	B	Rapid	Moderate
85	Stapleton-Bernal sandy loams			
	Stapleton part	B	Rapid	Moderate
	Bernal part	D	Moderate	Moderate

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict stormwater runoff rates. Group "D" typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. For the purposes of this Final Drainage Report, it has been assumed that hydrologic group "B" characteristics exists across the study area due to the fact the soil type dominates the area. Only a minor area of the Stapleton-Bernal sandy loam exists in the area project area at the downstream portions of the site.

5. Major Drainageways. There are no existing major drainageways through the Cordera Filing No. 1. A stormwater collection system has been developed for Filing No. 1 and DF1 will be outfalling to Cottonwood Creek.

6. Irrigation Facilities. No known irrigation facilities exist on or around the site that could be influenced by local drainage. The site was formally used as pasture and grazing land for livestock, however there is no current agricultural use of the land.

7. Utilities and other Encumbrances. No known utilities currently encumber the proposed detention pond.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

DF1 is located within the Cottonwood Creek Drainage Basins per the current Drainage Basin Planning Studies. The Drainage Basin Planning Studies and Master Development Drainage Plans completed that include site are as follows.

Cottonwood Creek Drainage Basin Planning Study, URS Consultants, June 9, 1994

Cottonwood Creek Drainage Basin Planning Study, Ayres and Associates, June 2000.

Final Drainage Report for Cordera Filing No. 1 & Master Development Drainage Plan for Cordera and Briargate Crossing East, Matrix Design Group, November 2004.

Several subdivision preliminary and final drainage reports have also been completed for areas surrounding the site. A complete list of drainage reports used in the preparation of this report can be found in the References section of this report.

Cottonwood Creek Drainage Basin

The Cottonwood Creek Drainage Basin consists of approximately 11,900 acres (18.6 square miles) of land in the northern portion of the City of Colorado Springs. The basin drains a west-facing slope in the larger Monument Creek Basin, which is rapidly developing. The main channel and tributaries of Cottonwood Creek do not flow across the site.

Two Drainage Basin Planning Studies have been recently completed for Cottonwood Creek. URS Consultants completed one study in 1994 to evaluate hydrology of the basin and proposed improvements/new construction of trunk stormwater infrastructure, including placement of detention ponds. Ayres and Associates completed a subsequent study, June 2000, to re-evaluate the hydrology of the entire basin, reducing peak stormwater rates and eliminating the need for certain detention ponds and trunk infrastructure improvements. The study also incorporates a Prudent Line approach to development, where development is set back a certain distance from the existing channel thalweg to allow for natural reshaping of the channel that will protect the adjacent development.

The Cordera development is located on the upstream most portion of the Cottonwood Creek Drainage Basin. Due to the location of the development, the tributary area in the historic condition from the site does not generate sufficient concentrated flows to create a major drainage way through the property. A natural channel has formed downstream from the future Powers Boulevard alignment to Research Parkway. South of Research Parkway is the Fairfax Development, which consists primarily of single-family homes. The drainageway through the Fairfax development is an improved channel and linear park. The Fairfax Detention Pond has been constructed between Woodman Road and Research Parkway.

Adjacent to the site, Powers Boulevard contains a box culvert under the roadway to provide an outfall point for the site. Down stream facilities including detention ponds, bridges/culverts, and

channels have been evaluated for sufficient capacity to release undetained flows from the site. Recent changes to the rainfall depths used by the City of Colorado Springs and the implementation of Phase II of the water quality requirements for the City require, as well as larger tributary drainage areas found in this study than those used in the Drainage Basin Planning Study require larger detention/water quality volumes than originally planned. To meet the new City criteria, a new detention pond is proposed for the Cordera Development.

B. Floodplain Statement

Review of the ***Flood Insurance Rate Map Panels 528 (08041CO528 F)***, effective date March 17, 1997, reveal that no portion of ***Cordera Filing No. 1*** is within any designated 100-year floodplain boundary. See Floodplain Maps.

C. Sub-Basin Description

Historically, runoff has been directed to a natural channel that drains to the Fairfax Channel, located south of Research Drive. An 8'x12' concrete box culvert, located immediately south of Cordera Filing No. 1 within Powers Boulevard, accepts these historic flows. Offsite tributary areas impacting the development will be minor from the east, as a natural ridgeline exists along the eastern property line of Cordera Filing No. 1. Based upon master planning documents for the undeveloped area to the east, only minor areas will drain to Cordera when the offsite land is developed.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria

This report has been prepared in accordance to the criteria set forth in the ***City of Colorado Springs & El Paso County Drainage Criteria Manual, Volumes I and II***, dated November 1991 and including subsequent updates. In addition to the City Criteria Manual, the ***Urban Storm Drainage Criteria Manuals, Volumes 1-3***, published by the Urban Drainage and Flood Control District, latest update 2003, has also been used to supplement the City Criteria Manual.

Several subdivision drainage reports have been found within the files of the City Subdivision Engineering Review Unit that have been completed for specific developments adjacent to and within the study area. The reports have been listed as references within this report. Each has been reviewed to ensure compliance with the recommendations and drainage facilities proposed.

B. Hydrologic Criteria

Hydrologic analyses for the site have been completed utilizing a combination of methods. To evaluate larger drainage areas that range in size between 100-acres and 5-square miles, the *Hydraulic Engineering Center's Hydrologic Modeling System (HEC-HMS)*, version 2.2.2 software, produced by the Unites States Army Corps of Engineers, released May 2003, has been used to develop hydrograph data of each basin. The same program also routes basin flows to design points and provides information to determine preliminary trunk storm sewer sizes and the required detention pond volumes for the major and minor storm event. HEC-HMS updates the original HEC-1 program by modernizing algorithms and analysis techniques. The program is scheduled to replace HEC-1 by the Army Corps of Engineers in the near future. Per City Criteria, the SCS hydrograph procedure is required for large drainage basins greater than 100 acres, but less than 10 square miles. Two storm distributions are provided within the City Criteria – the two-hour storm and the 24-hour time distribution for SCS Type IIa. For the purposes of this analysis, the 24-hour distribution has been selected because of the detention pond requirements, which will calculate a greater volume of runoff to be detained. Lag times for the modeling have been calculated as:

$$T(l) = 0.6*T(c)$$

Where

T(l) = Lag Time
T(c) = Time of Concentration.

Weighted Curve Numbers and associated percent imperiousness have been calculated based upon Tables 5-4 through 5-7 within the Drainage Criteria Manual.

The City of Colorado Springs Subdivision Engineering Review Unit has issued revised rainfall data, effective January 1st, 2003 and summarized within a letter issued January 7th, 2003. The information provides 24-hour rainfall depths for the 5-year and 100-year storm events. Addendum #3 to the Pine Creek Drainage Basin Planning Study, completed by JR Engineering, uses depths of 2.6 inches for the 5-year and 4.4 inches for the 100-year storm events. The most

current Cottonwood Creek Drainage Basin Planning Study uses a 100-year storm event depth of 4.136 inches and only evaluates the major storm event.

The Subdivision Engineering Review Unit issued an update to the rainfall intensity frequency curves for the City of Colorado Springs on January 7, 2003. The updated information has been utilized in this study. The revised storm rainfall time intensity-frequency curves have been used for the Rational Method Analysis.

The design storm events are:

- Initial Storm = 5-Year Storm
- Major Storm = 100-Year Storm

Additional consideration has been given to the new criteria of the Phase II Water Quality Requirements for the City of Colorado Springs. To assist developers in meeting new requirements, the City has recently published ***Volume II*** of the ***Drainage Criteria Manual.*** The water quality capture volume, outfall structure, and sedimentation volumes have been designed for the ponds, and are described in detail in the proposed drainage facility section of this report.

C. Hydraulic Criteria

A detailed hydraulic analysis of the storm sewers, swales, and inlets has been completed as part of this study to place drainage facilities. Detention pond DF1 has been designed to City criteria, with supplemental information taken from the Urban Storm Drainage Criteria Manual, Volume II. The pond includes additional capacity for water quality treatment. A 40-hour release time has been used for the water quality outlet structure and an additional 20% of the water quality treatment volume has been provided for sediment accumulation. Calculations for the pond have been included in Appendix B of this report.

IV. DRAINAGE FACILITY DESIGN

A. Fully Developed Conditions

As stated earlier, the purpose of this report is to amend the approved ***Master Development Drainage Plan for Cordera and Briargate Crossing East***, prepared by Matrix Design Group, Inc., November 2004. The major change from the approved MDDP is the reduction in watershed area tributary to the detention pond, DF-1, which is due to changes to the development plan for Wolf Ranch. Since the development plan for Cordera has not changed, the only change to the approved MDDP will be the reduced size of the detention pond, DF-1, within the Cottonwood Creek Drainage Basin.

The tributary area for detention pond DF-1 will drain to an existing 8'x12' CBC under Powers Boulevard. Portions of Cordera Filing No. 1, Cordera Filing No. 2, and Briargate Crossing, totaling 171.1 acres of commercial, single family lots, multi-family lots, and open space/trail corridors, will drain to DF-1. Discharge rates for the detention pond will mimic the historic flows established under the approved MDDP to minimize impacts to downstream drainage systems.

Sub-basins CF1 through CF7 consist of the fully developed Cordera master plan area totaling 140.9 acres in size. Peak runoff rates for this area are Q(5)=135.7 cfs and Q(100)=374.2 cfs upstream of the proposed detention basin.

The runoff from sub-basins CF1 through CF8 (171.1 acres) will be combined at design point C8 and enter proposed detention pond DF-1. Peak runoff rates into the pond at this point are Q(5)=183.3 cfs and Q(100)=487.0 cfs. The peak release rates of the detention pond have been based upon the calculated historic runoff rates for the sub-basin so as not to overwhelm the existing down stream improvements. The peak release rates are Q(5)=36.8 cfs and Q(100)=128.2 cfs. Within the Cottonwood DBPS, a maximum of 901 cfs is allowed. The historic runoff rates have been maintained due to capacity issues at the next downstream detention pond in the Fairfax development and also because of the existing condition of the downstream channel. The channel from Powers Boulevard to Research Boulevard is currently in its historic state and suffering from erosion problems. By installing the proposed detention pond with the water quality capture volume, the downstream flow rates and flow frequency will be reduced helping to stabilize the downstream channel in its natural state.

B. Water Quality Capture Volume

With the watershed area tributary to the detention pond reduced from 529 acres to 171.1 acres, the required size of detention pond DF-1 has also reduced. The approved MDDP required a regional detention pond size of 50.5 ac-ft with 11.20 ac-ft for water quality capture volume. The new detention pond will have a total capacity of 15.3 ac-ft with 3.44 ac-ft for water quality capture volume (see Appendix for calculations).

The City of Colorado Springs has moved into the Phase II of providing water quality for new developments. The water quality capture volume required for this project will be combined with

the proposed detention ponds. It should be noted that the previously listed required detention volumes do not include water quality volumes. The water quality capture volumes have included a 20% increase in the volume to account for sediment that will be trapped in the detention pond. The water quality portion of a detention pond will be the first portion of the pond to fill up (the lowest volume in the pond).

Extended Detention Basin (EDB) criteria will be used. The detention ponds will be "dry", requiring a 40-hour drain time for the water quality capture volumes. As part of this report, the required additional volumes have been calculated. Upon full build out of the upstream tributary area, it is estimated that 3.44 acre-feet of water quality capture volume will be required (see Appendix).

C. Cost Estimate

Cost estimates for this detention facility have been calculated as part of the *Final Drainage Report for Cordera Filing No. 1 and Master Development Drainage Plan for Cordera and Briargate Crossing East.* Changes to the cost estimate will be based on actual construction costs after the pond is completed.

D. Drainage and Bridge Fees

All drainage and bridge fees have been paid as part of the *Final Drainage Report for Cordera Filing No. 1 and Master Development Drainage Plan for Cordera and Briargate Crossing East.* With the changes to the water quality pond per this amended MDDP, fees that have been paid are now in excess of what should be required. At this time, we have not gone to the Drainage Board to recover these fees. Once the facility is constructed, we may then go to the Board for reimbursement based upon actual construction costs.

Prepared By:

For and on behalf of **Matrix Design Group, Inc.**

Zach Hartjes, E.I.T.
Design Engineer

V. REFERENCES

1. ***City of Colorado Springs & El Paso County Drainage Criteria Manual,*** City of Colorado Springs, latest edition.

2. ***City of Colorado Springs Drainage Criteria Manual, Volume 2,*** City of Colorado Springs, November 1, 2002.

3. ***Colorado Department of Transportation, Powers Boulevard Design Plans***, URS Consultants, September 2002.

4. ***Cottonwood Creek Drainage Basin Planning Study, City of Colorado Springs and El Paso County***, URS Consultants, June 9, 1994.

5. ***Cottonwood Creek Drainage Basin Planning Study, Ayres and Associates***, June 2000.

6. ***Flood Insurance Rate Map for El Paso County, Colorado and Incorporated Areas, Panel 528 of 1300***, Federal Emergency Management Agency, Effective Date March 17, 1997.

7. ***Soil Survey of El Paso County Area, Colorado***. United States Department of Agriculture Soil Conservation Service, June 1981.

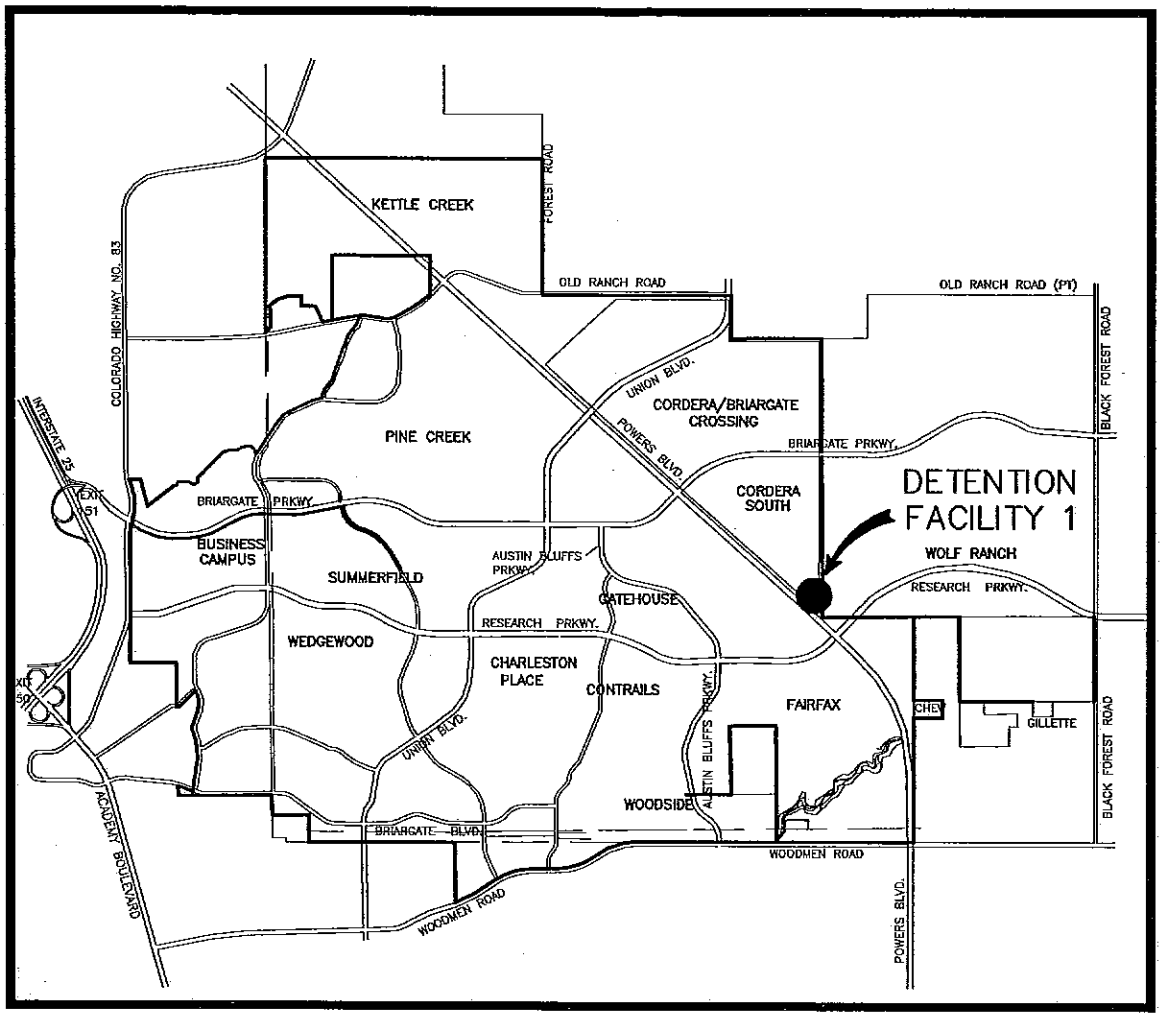
8. ***Letter - Summary of Preliminary Investigation Phase of Fairfax Pond Water Shed Analysis***, JR Engineering, September 16, 2003.

9. ***Final Drainage Report for Cordera Filing No. 1 & Master Development Drainage Plan for Cordera and Briargate Crossing East,*** Matrix Design Group, November 2004.

10. ***Wolf Ranch Master Development Drainage Plan***, Kiowa Engineering, February 2005.

APPENDIX A

MAPS



VICINITY MAP

NORTH
N.T.S.

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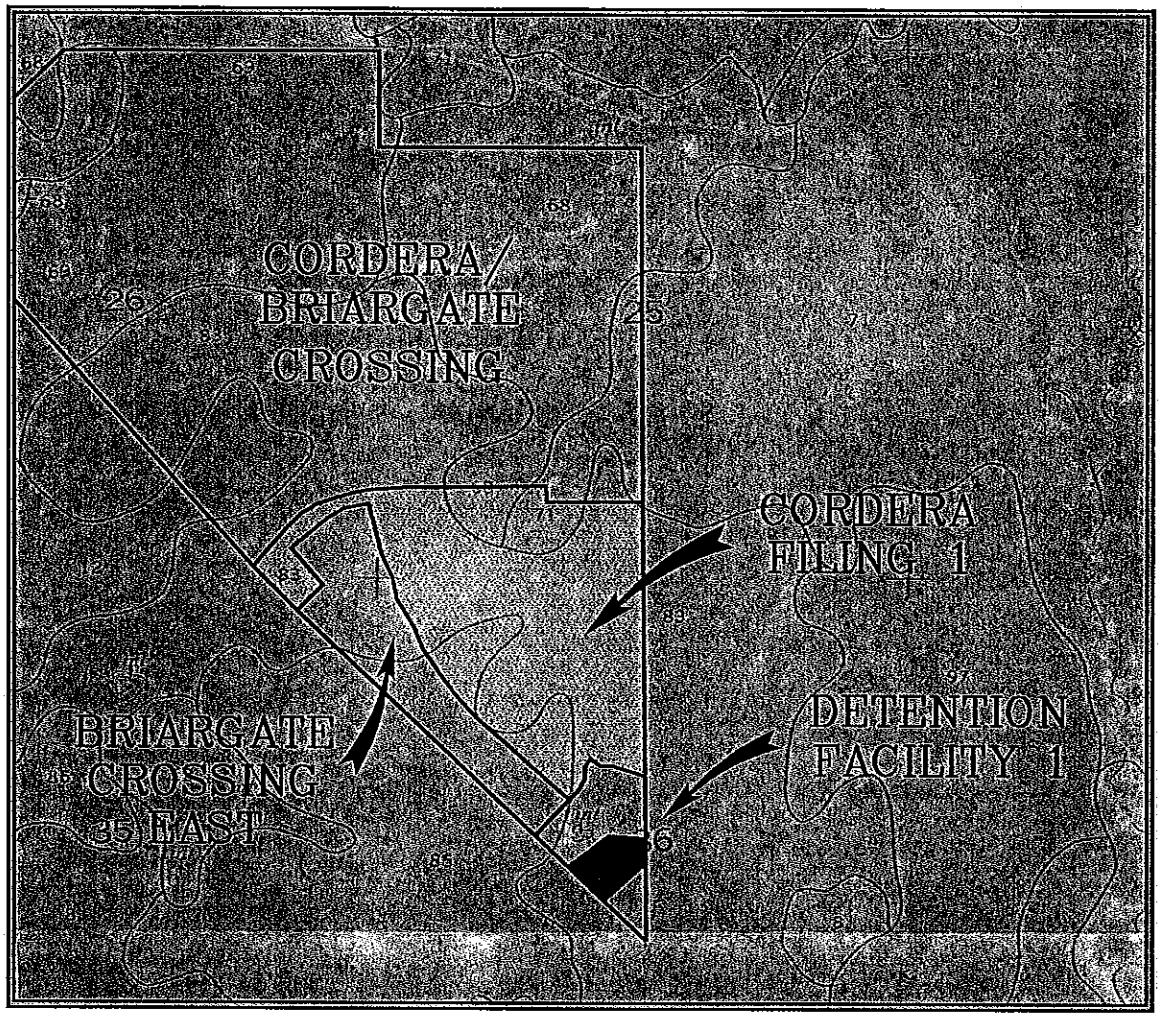

SOILS MAP

NORTH
N.T.S.

LEGEND

ID	SOIL NAME	HYD. GROUP
12	BRESSER SANDY LOAM	B
68	PEYTON–PRING COMPLEX (3%–8%)	B
69	PEYTON–PRING COMPLEX (8%–15%)	B
71	PRING	B
83	STAPLETON	B
85	STAPLETON–BERNAL COMPLEX	B/D

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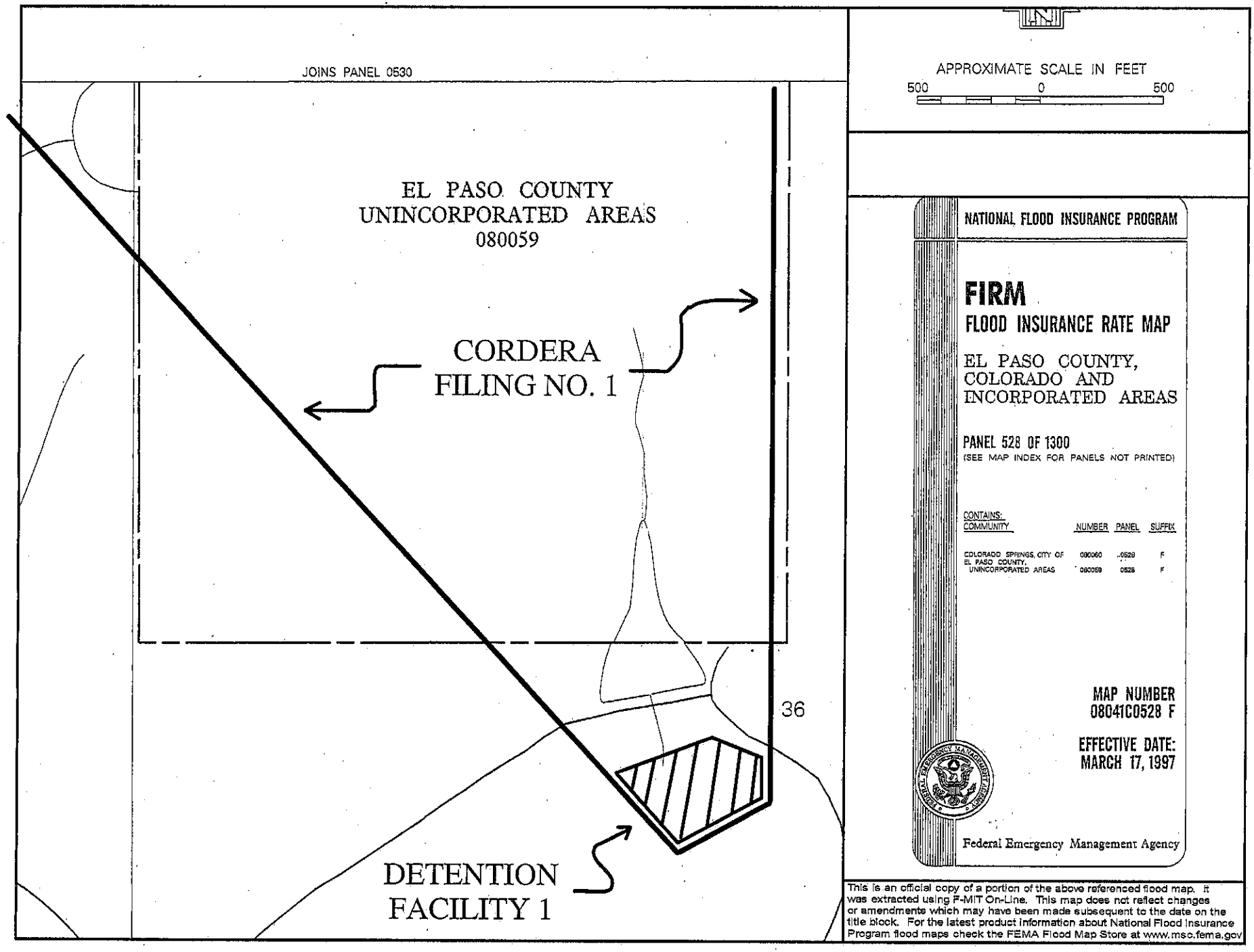


APPENDIX B

HYDROLOGIC AND HYDRAULIC CALCULATIONS

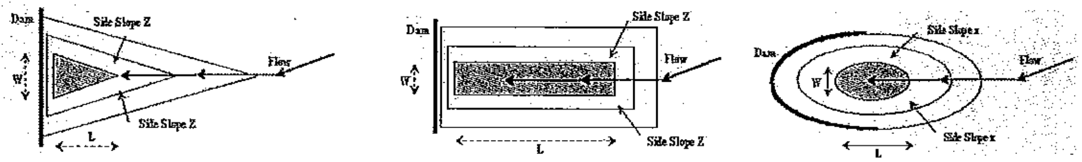
Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Designer: ZDH
Company: Matrix Design Group, Inc.
Date: November 22, 2006
Project: Detention Facility 1
Location: Cottonwood Creek

1. Basin Storage Volume	
A) Tributary Area's Imperviousness Ratio (i = I_a / 100)	I_a = 48.00 % i = 0.48
B) Contributing Watershed Area (Area)	Area = 171.120 acres
C) Water Quality Capture Volume (WQCV) (WQCV =1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i))	WQCV = 0.20 watershed inches
D) Design Volume: Vol = (WQCV / 12) * Area * 1.2	Vol = 3.4372 acre-feet
2. Outlet Works	
A) Outlet Type (Check One)	X Orifice Plate ____ Perforated Riser Pipe ____ Other: ____
B) Depth at Outlet Above Lowest Perforation (H)	H = 3.20 feet
C) Recommended Maximum Outlet Area per Row, (A_o)	A_o = 3.9 square inches
D) Perforation Dimensions: i) Circular Perforation Diameter or ii) Width of 2" High Rectangular Perforations	D = 1.625 inches W = ____ inches
E) Number of Columns (nc, See Table 6a-1 For Maximum)	nc = 2 number
F) Actual Design Outlet Area per Row (A_o)	A_o = 4.2 square inches
G) Number of Rows (nr)	nr = 10 number
H) Total Outlet Area (A_{ot})	A_{ot} = 39.8 square inches
3. Trash Rack	
A) Needed Open Area: A_t = 0.5 * (Figure 7 Value) * A_{ot}	A_t = 1.254 square inches
B) Type of Outlet Opening (Check One)	X ≤ 2" Diameter **Round** ____ 2" High **Rectangular** ____ Other: ____
C) For 2", or Smaller, **Round Opening** (Ref.: Figure 6a):	
i) Width of Trash Rack and Concrete Opening (W_{conc}) from Table 6a-1	W_{conc} = 36 inches
ii) Height of Trash Rack Screen (H_{TR})	H_{TR} = 68 inches

STAGE-STORAGE SIZING FOR POLYGONAL, ELLIPTICAL, OR IRREGULAR PONDS

Project:
Basin ID:



Design Information (Input):

Width of Pond Bottom, W = ft
Length of Pond Bottom, L = ft
Dam Side-slope (H:V), Z_d = ft/ft

Right Triangular Pond OR...
Equilateral Triangular Pond OR...
Rectangular Pond OR...
Elliptical Pond OR...
Irregular Pond (Use Overide values in cells G32:G52)

Stage-Storage Relationship:

	MINOR	MAJOR	
Storage Requirement from Sheet 'Modified FAA':	0.0000	0.0000	acre-ft.
Storage Requirement from Sheet 'Hydrograph':	0.0000	0.0000	acre-ft.
Water Quality Capture Design Volume from Sheet 'WQCV':	3.4372	acre-ft.	

Labels for WQCV, Minor, & Major Storage Stages (input)	Stage ft (input)	Side Slope (H:V) ft/ft Below El. (input)	Pond Width at Stage ft (output)	Pond Length at Stage ft (output)	Surface Area at Stage ft^2 (output)	Surface Area at Stage ft^2 User Overide	Volume Below Stage ft^3 (output)	Surface Area at Stage acres (output)	Volume Below Stage acre-ft (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (for goal seek)
	6953.00					0		0.0000	0.0000	
	6953.50		0.00	0.00		7,500	1,875	0.1722	0.0430	
	6954.00		0.00	0.00		19,622	8,656	0.4505	0.1987	
	6954.50		0.00	0.00		39,500	23,436	0.9068	0.5380	
	6955.00		0.00	0.00		61,500	48,686	1.4118	1.1177	
	6955.50		0.00	0.00		82,500	84,686	1.8939	1.9441	
	6956.00		0.00	0.00		99,825	130,267	2.2917	2.9905	
	6956.50		0.00	0.00		113,000	183,474	2.5941	4.2120	
	6957.00		0.00	0.00		123,500	242,599	2.8352	5.5693	
	6957.50		0.00	0.00		131,500	306,349	3.0188	7.0328	
	6958.00		0.00	0.00		138,392	373,822	3.1770	8.5818	
	6958.50		0.00	0.00		143,500	444,295	3.2943	10.1996	
	6959.00		0.00	0.00		147,000	516,920	3.3747	11.8668	
	6959.50		0.00	0.00		149,500	591,045	3.4320	13.5685	
	6960.00		0.00	0.00		152,433	666,528	3.4994	15.3014	
	6960.50		0.00	0.00		156,000	743,636	3.5813	17.0715	
	6961.00		0.00	0.00		159,500	822,511	3.6616	18.8823	
	6961.50		0.00	0.00		163,000	903,136	3.7420	20.7331	
	6962.00		0.00	0.00		166,823	985,592	3.8297	22.6261	
							#N/A		#N/A	
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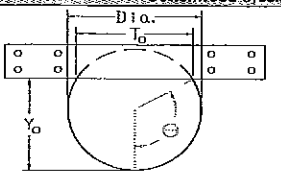
STAGE-DISCHARGE SIZING OF THE WEIRS AND ORIFICES (INLET CONTROL)

Project: Detention Facility 1
Basin ID: Cottonwood Creek



Sizing the Restrictor Plate for Circular Vertical Orifices or Pipes (Input)

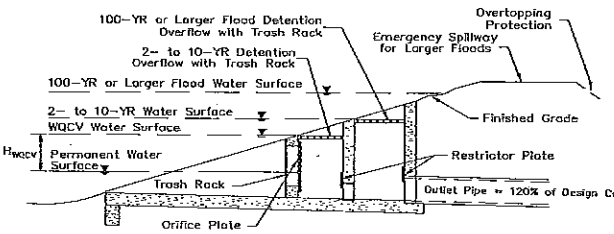
	#1 Vertical Orifice	#2 Vertical Orifice	
Water Surface Elevation at Design Depth	Elev: WS =	6,960.00	feet
Pipe/Vertical Orifice Entrance Invert Elevation	Elev: Invert =	6,946.00	feet
Required Peak Flow through Orifice at Design Depth	Q =	130.00	cfs
Pipe/Vertical Orifice Diameter (inches)	Dia =	36.00	inches
Orifice Coefficient	C_o =	0.67	

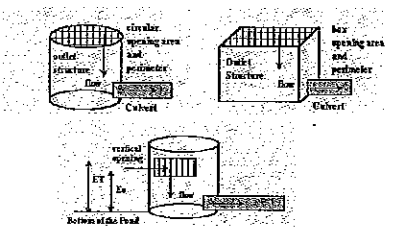
Full-flow Capacity (Calculated)

Full-flow area	Af =	7.07	sq ft
Half Central Angle in Radians	Theta =	3.14	rad
Full-flow capacity	Qf =	134.4	cfs
	Percent of Design Flow =	97%	

Calculation of Orifice Flow Condition

Half Central Angle (0<Theta<3.1416)	Theta =	2.67	rad
Flow area	A_o =	6.81	sq ft
Top width of Orifice (inches)	T_o =	19.44	inches
Height from Invert of Pipe to Bottom of Plate (inches)	Y_o =	33.15	inches
Elevation of Bottom of Plate	Elev Plate Bottom Edge =	6,948.76	feet
Resultant Peak Flow Through Orifice at Design Depth	Q_o =	130.0	cfs





Design Information (Input):

		#1 Horiz.	#2 Horiz.	#1 Vert.	#2 Vert.	
Circular Opening:	Diameter in Inches	Dia. =				inches
OR						
Rectangular Opening:	Width in Feet	W =	6.00	6.00	1.50	2.47 ft.
	Length (Height for Vertical)	L or H =	7.00	4.00	1.50	2.76 ft.
Percentage of Open Area After Trash Rack Reduction		% open =	60.00	60.00	100.00	100.00 %
Orifice Coefficient		C_o =	0.67	0.67	0.67	0.67
Weir Coefficient		C_w =	3.10	3.10		
Orifice Elevation (Bottom for Vertical)		E_o =	6956.20	6957.50	6,947.00	6,946.00 ft.

Calculation of Collection Capacity:

Net Opening Area (after Trash Rack Reduction)	A_o =	25.20	14.40	2.25	6.81	sq. ft.
User-Overide Net Opening Area	A_o =					sq. ft.
Perimeter as Weir Length	L_w =	21.20	15.20	ft.		
User-Overide Weir Length	L_w =			ft.		
Top Elevation of Vertical Orifice Opening, Top =				6948.50	6948.76	ft.
Center Elevation of Vertical Orifice Opening, Cen =				6947.75	6947.38	ft.

Routing 1: Water flows through WQCV plate and #1 horizontal opening into #1 vertical opening. This flow plus flow from #2 horizontal opening flows through #2 vertical opening.

			Horizontal Orifices				Vertical Orifices			
Labels for WQCV, Minor, & Major Storage W.S. Elevations (input)	Water Surface Elevation ft (linked)	WQCV Plate/Riser Flow cfs (User-linked)	#1 Horiz. Weir Flow cfs (output)	#1 Horiz. Orifice Flow cfs (output)	#2 Horiz. Weir Flow cfs (output)	#2 Horiz. Orifice Flow cfs (output)	#1 Vert. Collection Capacity cfs (output)	#2 Vert. Collection Capacity cfs (output)	Total Collection Capacity cfs (output)	Target Volumes for WQCV, Minor, & Major Storage Volumes (link for goal seek)
	6953.00	0.00	0.00	0.00	0.00	0.00	27.72	86.80	0.00	
	6953.50	1.04	0.00	0.00	0.00	0.00	29.01	90.58	1.04	
	6954.00	1.04	0.00	0.00	0.00	0.00	30.24	94.21	1.04	
	6954.50	1.04	0.00	0.00	0.00	0.00	31.43	97.70	1.04	
	6955.00	1.04	0.00	0.00	0.00	0.00	32.57	101.07	1.04	
	6955.50	1.04	0.00	0.00	0.00	0.00	33.68	104.34	1.04	
	6956.00	1.04	0.00	0.00	0.00	0.00	34.76	107.50	1.04	
	6956.50	1.04	10.80	74.21	0.00	0.00	35.79	110.58	11.84	
	6957.00	1.04	47.03	121.19	0.00	0.00	36.79	113.57	36.79	
	6957.50	1.04	97.41	154.49	0.00	0.00	37.77	116.48	37.77	
	6958.00	1.04	158.71	181.78	16.66	54.76	38.73	119.32	55.39	
	6958.50	1.04	229.24	205.49	47.12	77.42	39.66	122.10	86.78	
	6959.00	1.04	307.92	226.72	86.56	94.83	40.58	124.82	124.82	
	6959.50	1.04	393.97	246.14	133.28	109.50	41.47	127.47	127.47	
	6960.00	1.04	486.63	264.13	186.26	122.42	42.34	130.08	130.08	
	6960.50	1.04	586.00	280.97	244.64	134.10	43.20	132.63	132.63	
	6961.00	1.04	691.13	296.85	308.54	144.86	44.04	135.13	135.13	
	6961.50	1.04	801.86	311.93	376.96	154.85	44.86	137.59	137.59	
	6962.00	1.04	917.99	326.31	449.80	164.24	45.67	140.00	140.00	

Final Drainage Report for Detention Facility No. 1

HEC-HMS Input parameters - Cottonwood Creek
Fully Developed Conditions
Time of Concentration

Basin ID	Overland Time			Travel Time				Concentrated Flow					
	Length (ft)	Slope (ft/ft)	T(initial) (min)	Length (ft)	Weighted Slope (%)	Velocity (fps)	T(shallow flow) (min)	Length (ft)	Weighted Slope (%)	Velocity (fps)	T(travel) (min)	T(conc.) (min)	Lag Time (min)
CF1	50	2.0%	8.9	900	1.4%	2.2	6.8	1530	2.0%	12.0	2.1	17.9	10.7
CF2	100	2.0%	12.6	950	1.4%	2.2	7.2	275	4.7%	15.0	0.3	20.1	12.1
CF3	100	2.0%	12.6	400	1.3%	2.2	3.0	275	2.2%	13.0	0.4	16.0	9.6
CF4	200	2.0%	17.9	800	4.0%	3.2	4.2	0	0.0%	0.0	0	22.0	13.2
CF5	100	2.0%	12.6	500	1.4%	2.2	3.8	0	0.0%	0.0	0	16.4	9.9
CF6	50	3.0%	7.8	600	1.7%	2.5	4.0	300	3.0%	15.0	0.3	12.2	7.3
CF7	100	2.0%	12.6	500	3.6%	3.2	2.6	1000	2.0%	12.0	1.4	16.6	10.0
CF8	50	2.0%	8.9	500	3.3%	3.1	2.7	1000	3.0%	15.0	1.1	12.7	7.6

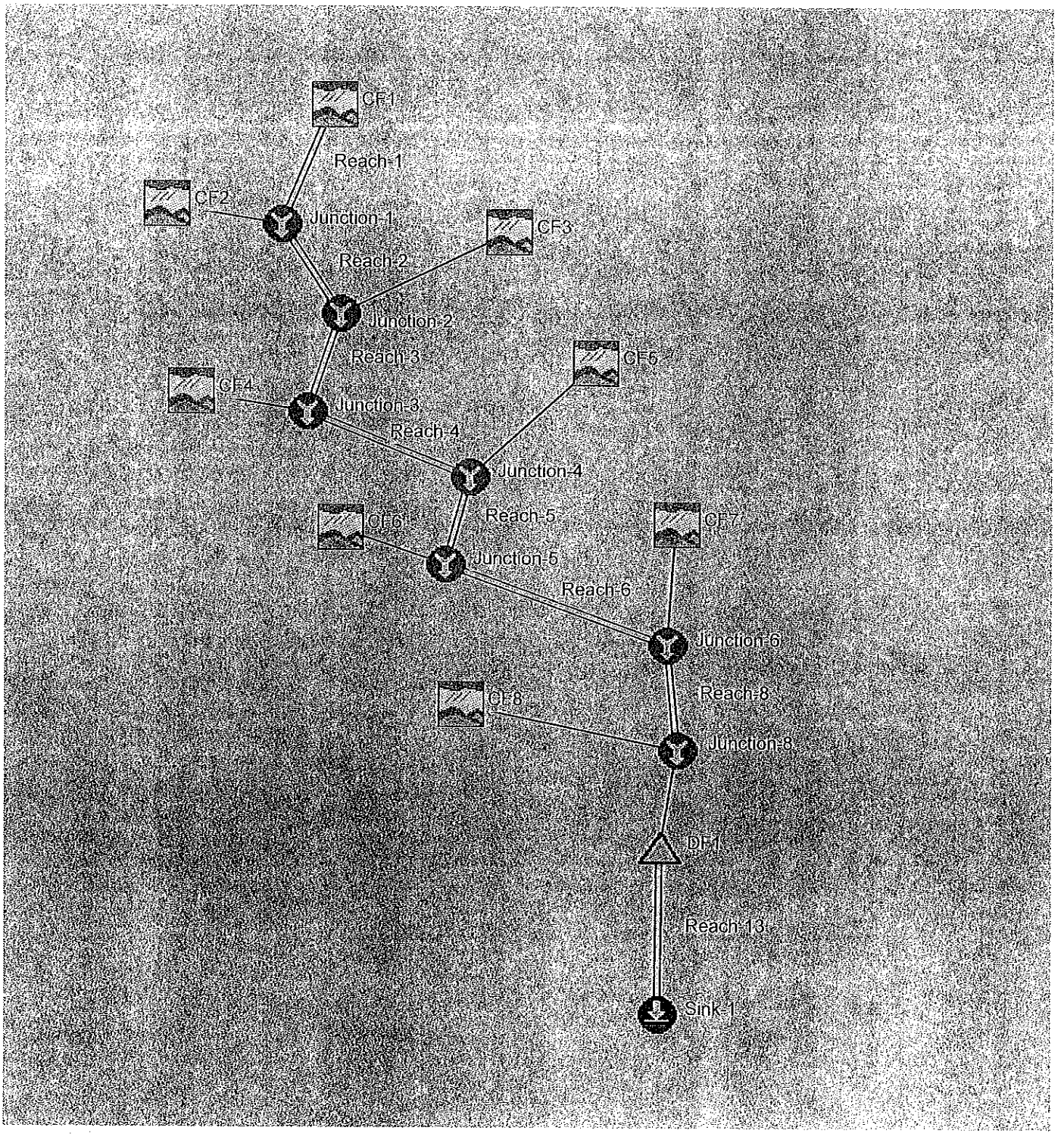
Final Drainage Report for Detention Facility No. 1

HEC-HMS Input parameters - Cottonwood Creek
Fully Developed Conditions
Curve Number Calculations

Basin ID	Total Area (ac)	Total Area (sq. mi.)	Residential			Parks (ac)	Open Space (ac)	Commercial (ac)	Schools (ac)	Weighted CN	Percent Impervious
			1 acre lots	1/4 acre lots	1/8 acre lots						
CF1	30.73	0.048	0.0	30.7	0.0	0.0	0.0	0.0	0.0	75.0	38%
CF2	32.28	0.050	0.0	32.3	0.0	0.0	0.0	0.0	0.0	75.0	38%
CF3	14.57	0.023	0.0	14.6	0.0	0.0	0.0	0.0	0.0	75.0	38%
CF4	12.17	0.019	0.0	5.9	0.0	6.3	0.0	0.0	0.0	67.7	18%
CF5	11.13	0.017	0.0	11.1	0.0	0.0	0.0	0.0	0.0	75.0	38%
CF6	16.02	0.025	0.0	0.0	16.0	0.0	0.0	0.0	0.0	85.0	65%
CF7	23.97	0.037	0.0	0.0	24.0	0.0	0.0	0.0	0.0	85.0	65%
CF8	30.25	0.047	0.0	0.0	30.3	0.0	0.0	0.0	0.0	85.0	65%

Land Use		*CN*	*% Imp.*
Residential	1 acre	68	20%
	1/4 Lots	75	38%
	1/8 Lots	85	65%
Parks		61	0%
Open Space		61	0%
Commercial		92	85%
Schools		80	52%

HEC-HMS **Project: Cottonwood 2-20-06** **Basin Model:**



HMS * Summary of Results

Project : Cottonwood 2-20-06 Run Name : Run 6

Start of Run : 01Jan00 0000 Basin Model : Cottonwood-Developed
End of Run : 02Jan00 0000 Met. Model : 5-yr Type IIa
Execution Time : 16Oct06 1458 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CF1	26.324	01 Jan 00 0606	1.8125	0.048
Reach-1	26.014	01 Jan 00 0608	1.8116	0.048
CF2	25.748	01 Jan 00 0606	1.8874	0.050
Junction-1	51.568	01 Jan 00 0606	3.6990	0.098
Reach-2	51.504	01 Jan 00 0608	3.6991	0.098
CF3	13.234	01 Jan 00 0604	0.86870	0.023
Junction-2	63.895	01 Jan 00 0606	4.5678	0.121
Reach-3	63.469	01 Jan 00 0606	4.5680	0.121
CF4	4.6481	01 Jan 00 0608	0.42615	0.019
Junction-3	68.075	01 Jan 00 0608	4.9942	0.140
Reach-4	68.013	01 Jan 00 0608	4.9942	0.140
CF5	9.6183	01 Jan 00 0604	0.64204	0.017
Junction-4	76.827	01 Jan 00 0608	5.6362	0.157
Reach-5	76.649	01 Jan 00 0608	5.6357	0.157
CF6	29.213	01 Jan 00 0602	1.6761	0.025
Junction-5	98.735	01 Jan 00 0606	7.3117	0.182
Reach-6	97.452	01 Jan 00 0608	7.3098	0.182
CF7	39.697	01 Jan 00 0604	2.4794	0.037
Junction-6	135.65	01 Jan 00 0606	9.7892	0.219
Reach-8	135.28	01 Jan 00 0606	9.7895	0.219
CF8	54.411	01 Jan 00 0602	3.1508	0.047
Junction-8	183.27	01 Jan 00 0604	12.940	0.266
DF1	36.837	01 Jan 00 0630	9.9220	0.266
Reach-13	36.836	01 Jan 00 0630	9.9209	0.266
Sink-1	36.836	01 Jan 00 0630	9.9209	0.266

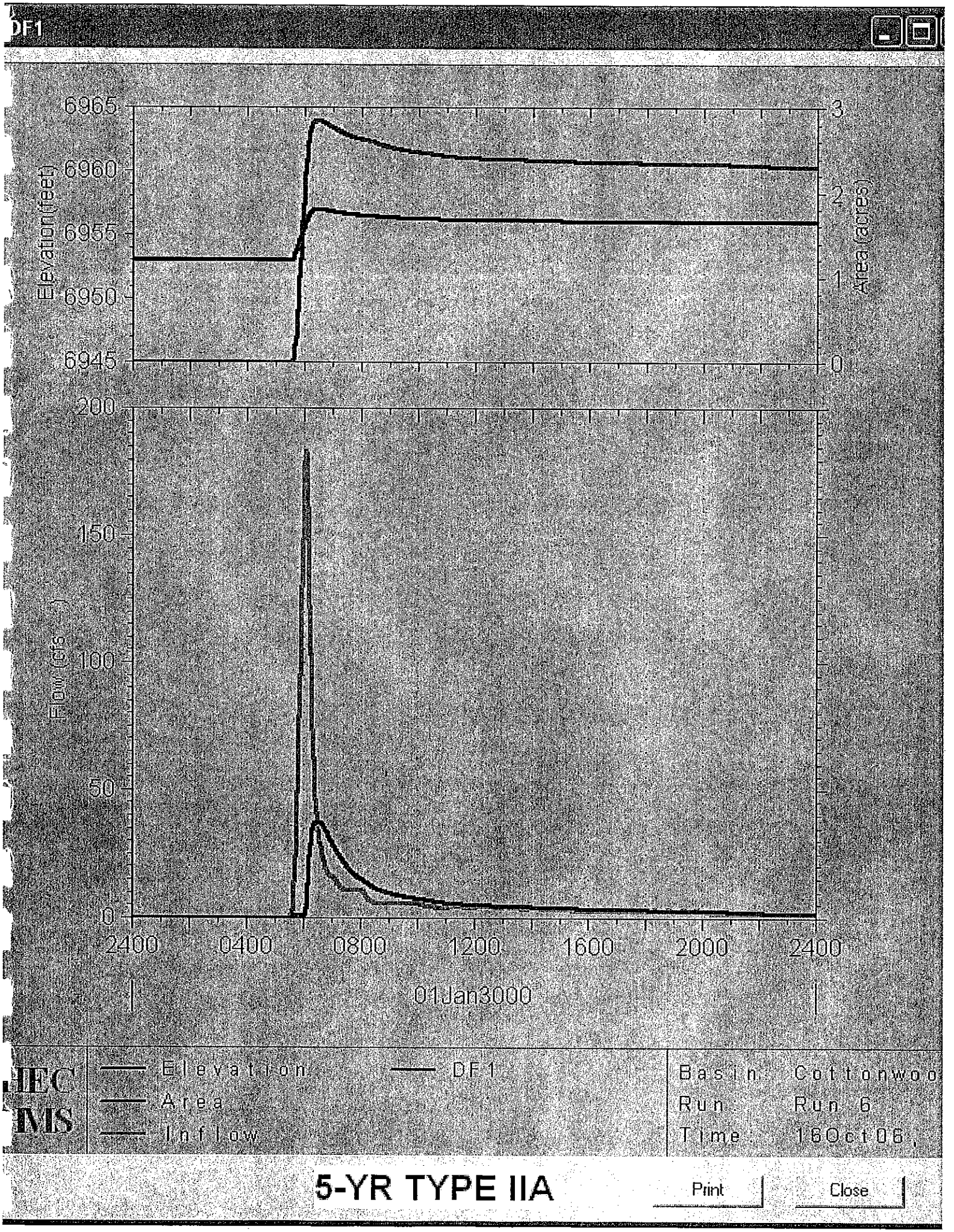
HMS * Summary of Results for DF1

Project : Cottonwood 2-20-06 Run Name : Run 6

Start of Run	: 01Jan00 0000	Basin Model	: Cottonwood-Developed
End of Run	: 02Jan00 0000	Met. Model	: 5-yr Type IIa
Execution Time	: 16Oct06 1458	Control Specs	: Control 1

Computed Results

Peak Inflow	: 183.27 (cfs)	Date/Time of Peak Inflow	: 01 Jan 00 0604
Peak Outflow	: 36.837 (cfs)	Date/Time of Peak Outflow	: 01 Jan 00 0630
Total Inflow	: 0.91 (in)	Peak Storage	: 5.6021(ac-ft)
Total Outflow	: 0.70 (in)	Peak Elevation	: 6957.0(ft)


DF1
6965
6960
6955
6950
6945
Elevation (feet)
3
2
1
0
Area (acres)
200
150
100
50
0
Flow (cfs)
2400
0400
0800
1200
1600
2000
2400
01Jan3000
Elevation
Area
Inflow
DF1
Basin Cottonwoo
Run Run 6
Time 18Oct06,
5-YR TYPE IIA
Print
Close

HMS * Summary of Results

Project : Cottonwood 2-20-06 Run Name : Run 5

Start of Run : 01Jan00 0000 Basin Model : Cottonwood-Developed
End of Run : 02Jan00 0000 Met. Model : 100-yr Type IIa
Execution Time : 16Oct06 1606 Control Specs : Control 1

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
CF1	78.309	01 Jan 00 0604	5.0395	0.048
Reach-1	77.980	01 Jan 00 0606	5.0385	0.048
CF2	77.792	01 Jan 00 0606	5.2481	0.050
Junction-1	155.77	01 Jan 00 0606	10.287	0.098
Reach-2	155.31	01 Jan 00 0606	10.287	0.098
CF3	39.029	01 Jan 00 0604	2.4152	0.023
Junction-2	192.63	01 Jan 00 0606	12.702	0.121
Reach-3	192.43	01 Jan 00 0606	12.703	0.121
CF4	19.769	01 Jan 00 0608	1.4602	0.019
Junction-3	212.11	01 Jan 00 0606	14.163	0.140
Reach-4	211.36	01 Jan 00 0606	14.164	0.140
CF5	28.569	01 Jan 00 0604	1.7851	0.017
Junction-4	238.93	01 Jan 00 0606	15.949	0.157
Reach-5	237.67	01 Jan 00 0606	15.949	0.157
CF6	63.981	01 Jan 00 0602	3.7536	0.025
Junction-5	290.93	01 Jan 00 0604	19.702	0.182
Reach-6	290.07	01 Jan 00 0606	19.699	0.182
CF7	88.687	01 Jan 00 0602	5.5531	0.037
Junction-6	374.20	01 Jan 00 0606	25.252	0.219
Reach-8	374.19	01 Jan 00 0606	25.253	0.219
CF8	119.66	01 Jan 00 0602	7.0565	0.047
Junction-8	487.03	01 Jan 00 0604	32.310	0.266
DF1	128.16	01 Jan 00 0624	29.098	0.266
Reach-13	128.16	01 Jan 00 0624	29.097	0.266
Sink-1	128.16	01 Jan 00 0624	29.097	0.266

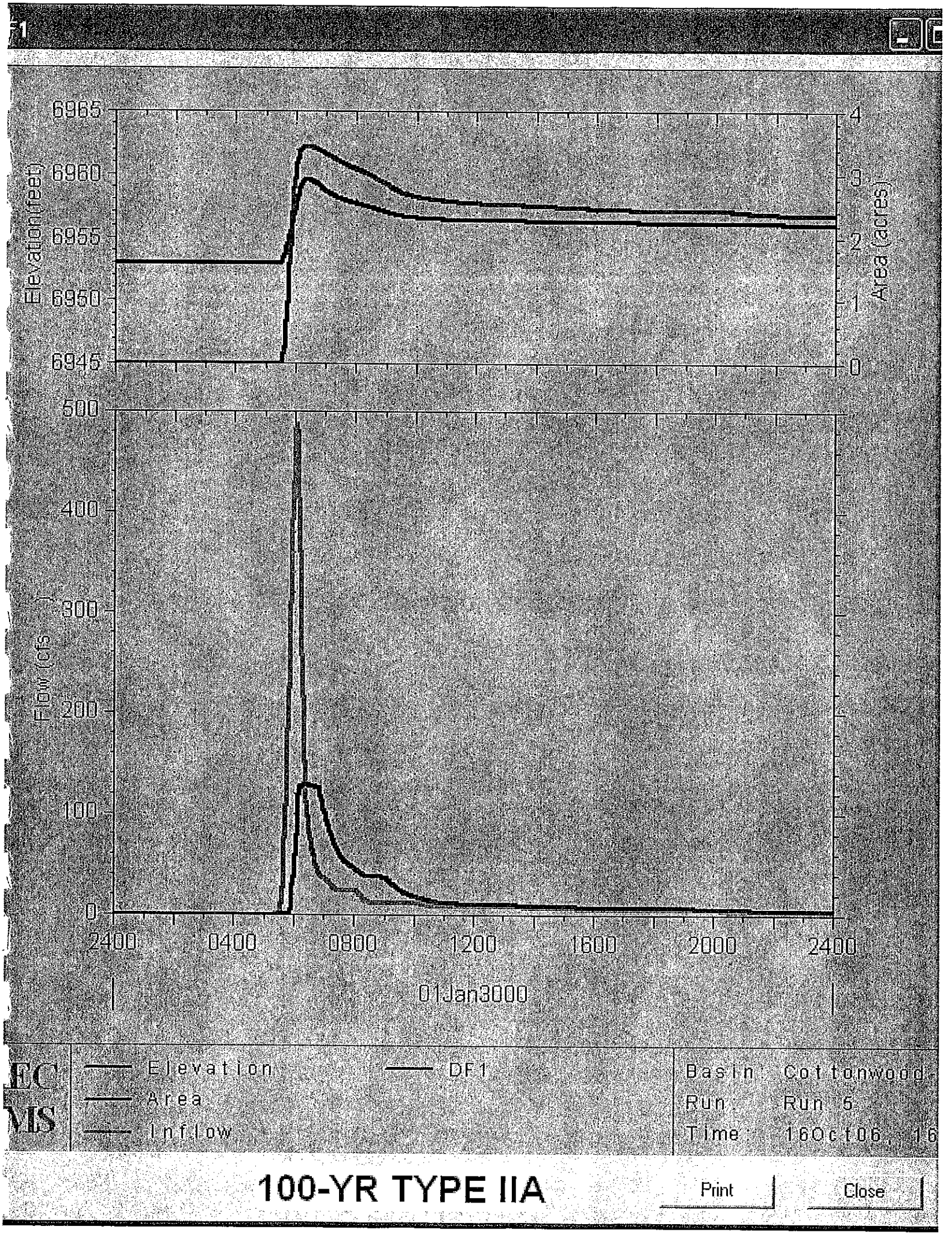
HMS * Summary of Results for DF1

Project : Cottonwood 2-20-06 Run Name : Run 5

Start of Run	: 01Jan00 0000	Basin Model	: Cottonwood-Developed
End of Run	: 02Jan00 0000	Met. Model	: 100-yr Type IIa
Execution Time	: 16Oct06 1456	Control Specs	: Control 1

Computed Results

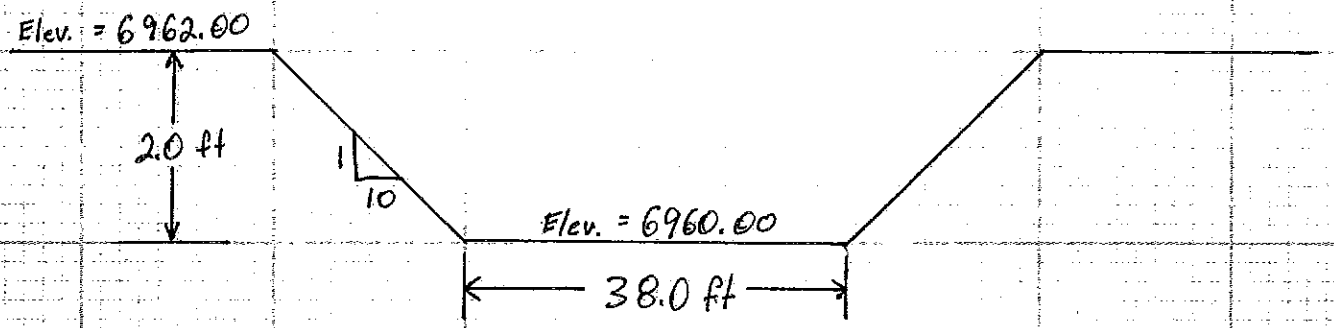
Peak Inflow	: 487.03 (cfs)	Date/Time of Peak Inflow	: 01 Jan 00 0604
Peak Outflow	: 128.16 (cfs)	Date/Time of Peak Outflow	: 01 Jan 00 0624
Total Inflow	: 2.28 (in)	Peak Storage	: 13.991(ac-ft)
Total Outflow	: 2.05 (in)	Peak Elevation	: 6959.6(ft)


6965
6960
6955
6950
6945
Elevation (feet)
4
3
2
1
0
Area (acres)
500
400
300
200
100
0
Flow (cfs)
2400
0400
0800
1200
1600
2000
2400
01Jan3000
Elevation
Area
Inflow
DF1
Basin Cottonwood
Run Run 5
Time 16Oct06 16
100-YR TYPE IIA
Print
Close

Matrix Design Group, Inc.
Integrated Design Solutions
Infrastructure Engineering
Community Development
Program Management

Job. No. 06.104.072
Date 2 / 5 / 07
Sheet 1 of 1
By ZACH HARTJES

Project CORDERA
Subject DF-1 : Spillway Calcs.



$Q_{Inflow} = 487.03$ cfs (100-YR).

Triangular Wier

$Q_T = C\left(\frac{\theta}{15}\right)\tan\left(\frac{\theta}{2}\right)\sqrt{2g}\,H^{5/2}$

$= .61\left(\frac{\theta}{15}\right)\tan\left(\frac{168.58}{2}\right)\sqrt{2(32.2)}\,(2)^{5/2}$

$Q_T = 147.70$ cfs

Rectangular Wier

$Q_R = \frac{2}{3}Cb\sqrt{2g}\,H^{3/2}$

$= \frac{2}{3}(.61)(38)\sqrt{2(32.2)}\,(2)^{3/2}$

$Q_R = 350.76$ cfs

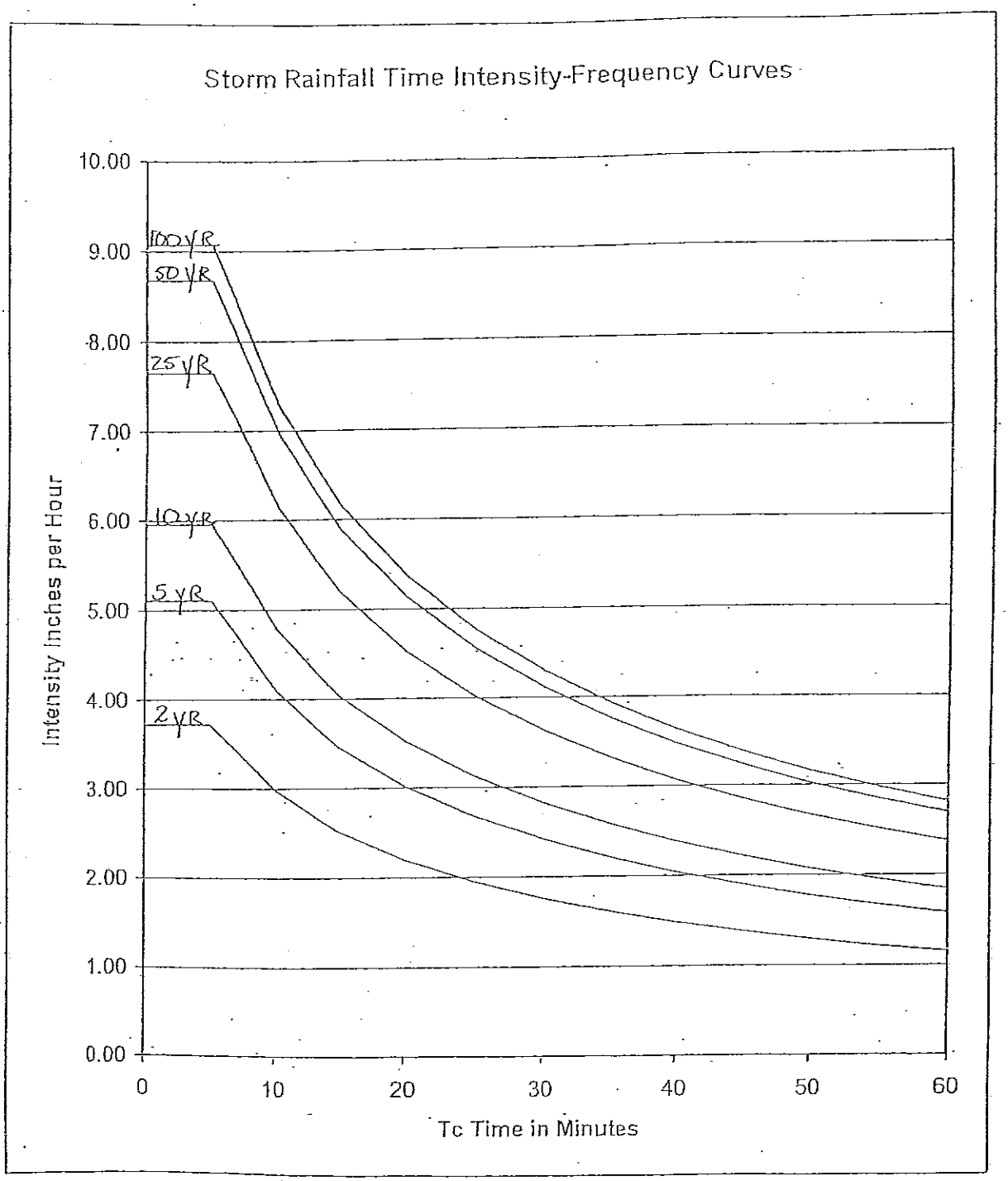
$Q_{Total} = Q_R + Q_T$

$= 350.76 + 147.70$

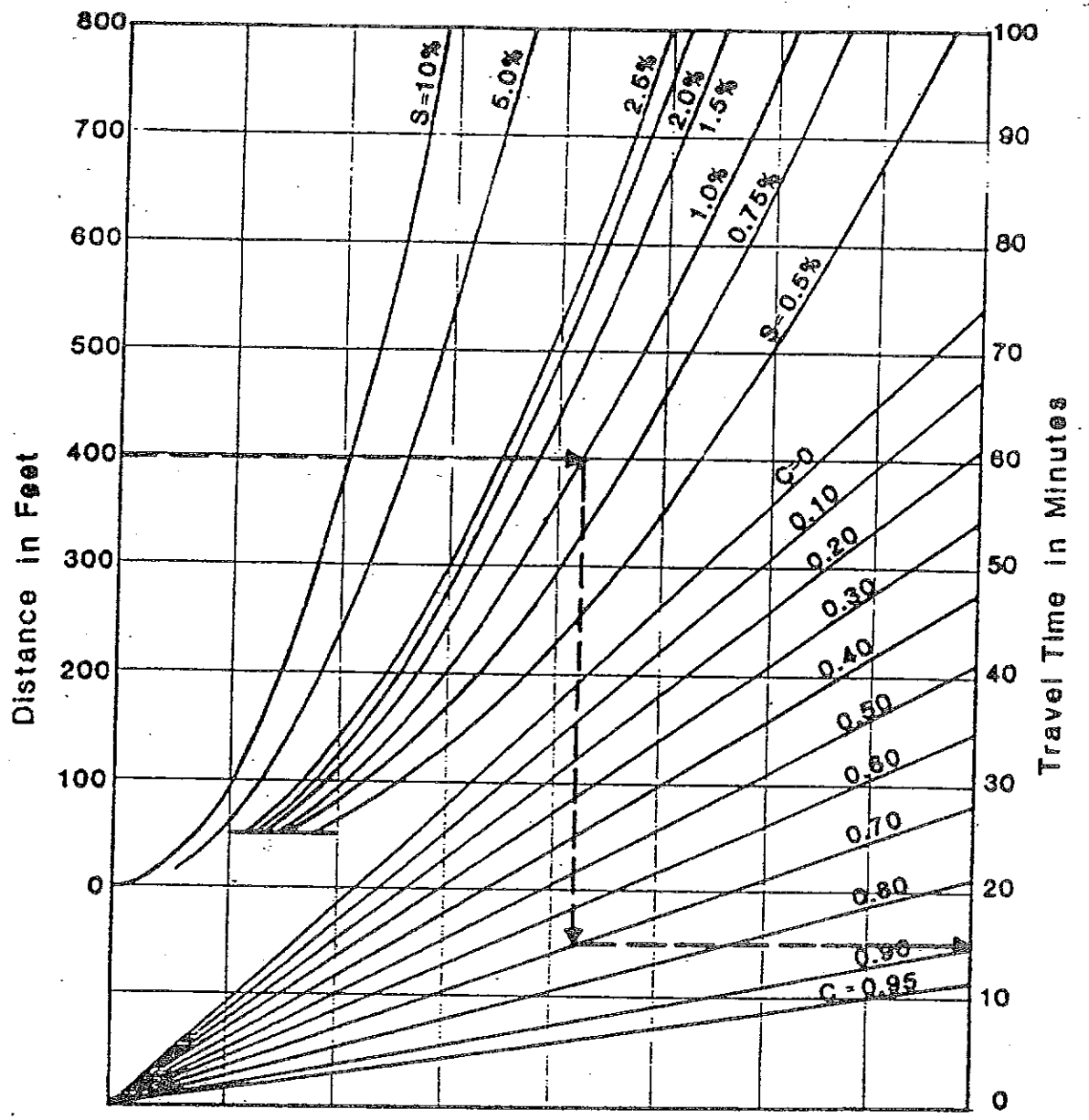
$Q_{Total} = 498.46$ cfs $>$ 487.03 cfs

APPENDIX C

STANDARD DESIGN CHARTS AND TABLES



Rainfall Depth - Duration - Frequency Table derived from Rainfall Atlas III for Colorado
Resource: Guo, James C.Y., (2001) "Urban Storm Water Modeling", Chapter 5: Runoff Prediction for Small Catchment, published by Auraria Campus Book Company, University of Colorado at Denver, Denver, Colorado.



REFERENCE : Wright – McLaughlin Engineers, Urban Storm Drainage Criteria Manual, Vol. 1, Denver Regional Council of Governments, Denver, Co. 1977

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Drainage Criteria Manual

Overland Flow Curves

Date
OCT. 1987

Figure
5-2

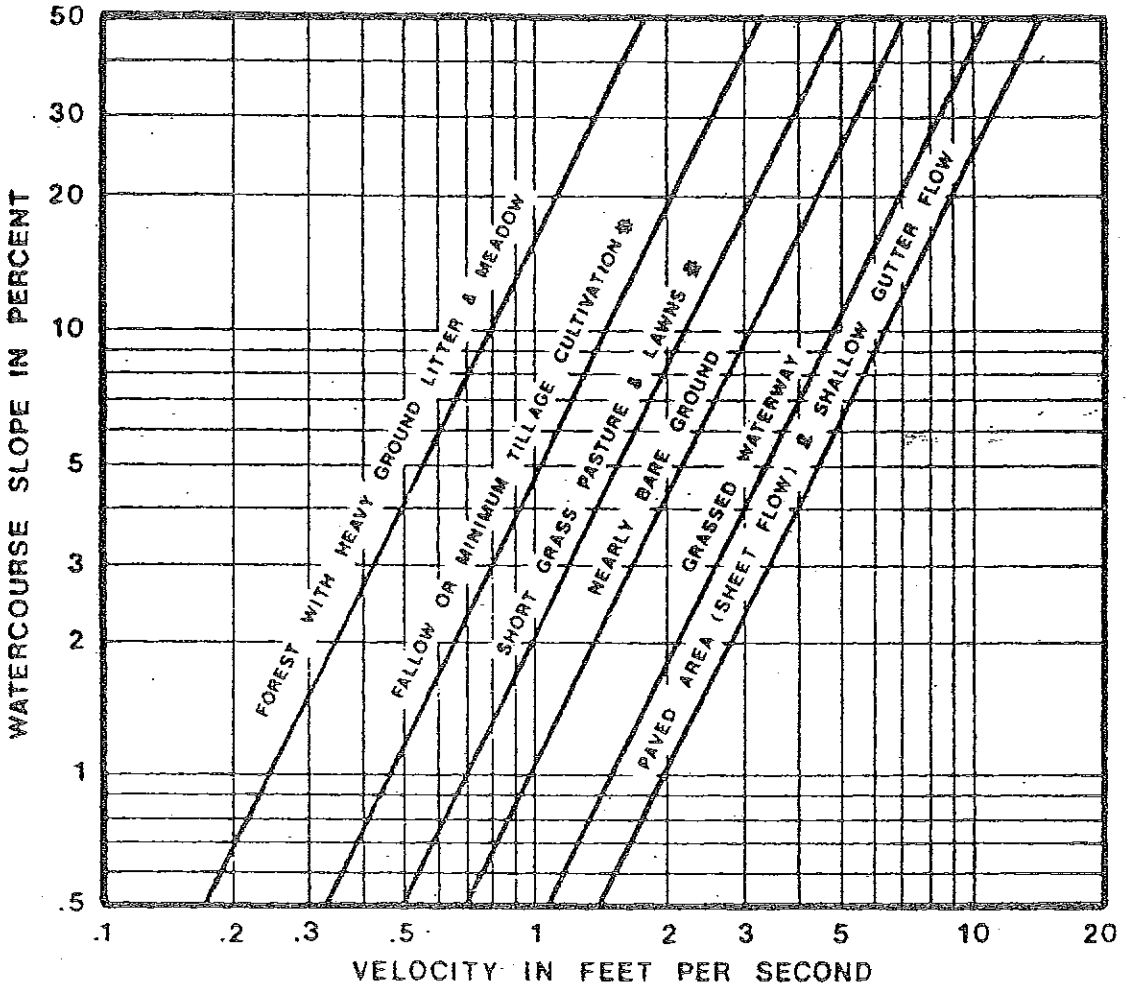
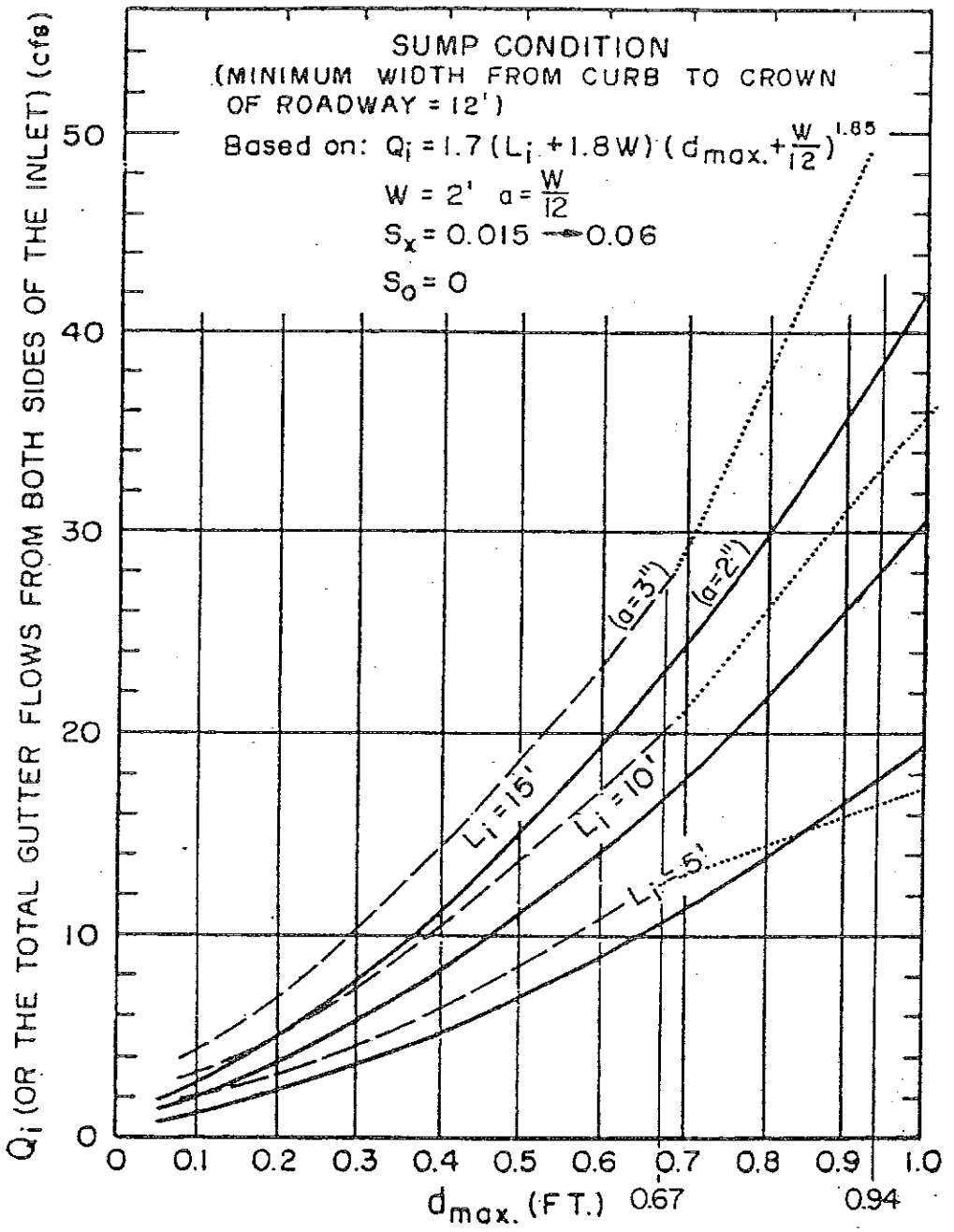


FIGURE RO-1

Estimate of Average Overland Flow Velocity for Use With the Rational Formula



REFERENCE : Izzard, Carl. f., Report presented at the Annual Meeting of the National Transportation Board, January 1977; Simplified Method For Design of Curb-opening Inlets

——— (As Modified by El Paso County, per Type R Inlet)

Note: Depth of ponding measured at curb above depressed area ; a = 3", For $d \leq .67$

$Q_i = (1.7 L_i + 6.12)(d_{max} + .25)^{1.85}$; $Q_i = 3.60 L_i (d - .08)^{.5}$ For $d \geq .94$; Note : No Clogging Factor

9/30/90

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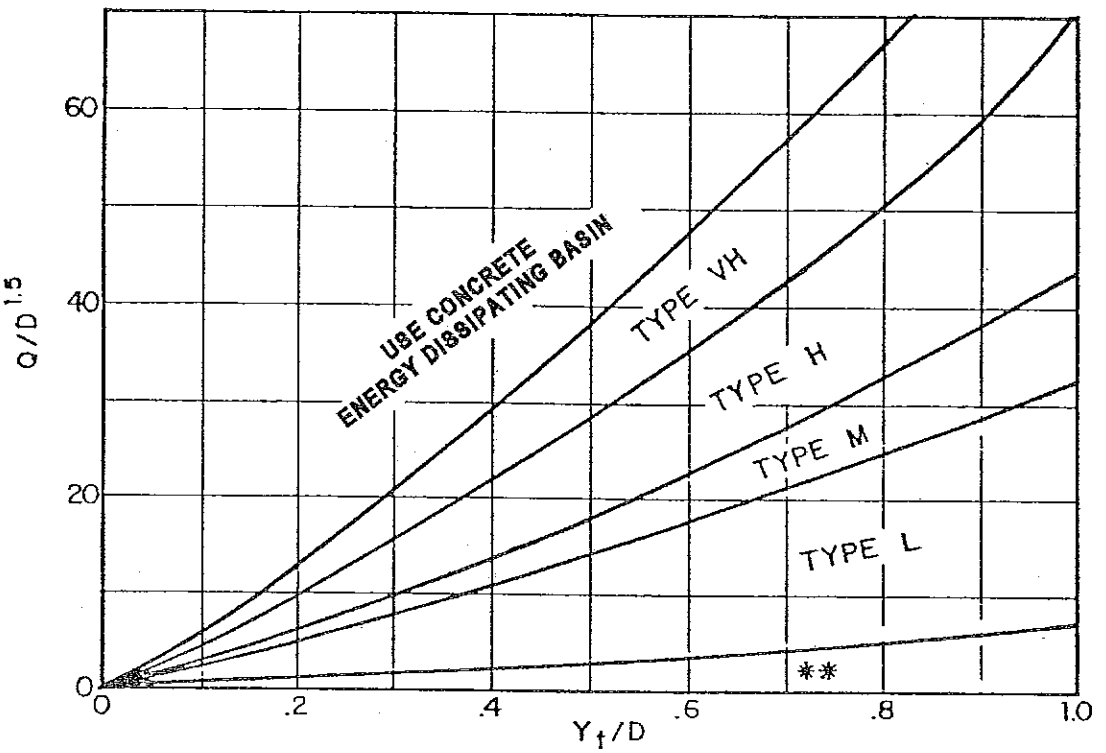
Figure
7-11

Sump Capacity for Curb-opening Inlets



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

FIGURE MD-21

Riprap Erosion Protection at Circular Conduit Outlet Valid for $Q/D^{2.5} \leq 6.0$

TABLE MD-7

Classification and Gradation of Ordinary Riprap

Riprap Designation	% Smaller Than Given Size by Weight	Intermediate Rock Dimensions (inches)	d_{50} (inches)*
Type VL	70-100	12	
	50-70	9	
	35-50	6	6**
	2-10	2	
Type L	70-100	15	
	50-70	12	
	35-50	9	9**
	2-10	3	
Type M	70-100	21	
	50-70	18	
	35-50	12	12**
	2-10	4	
Type H	70-100	30	
	50-70	24	
	35-50	18	18
	2-10	6	
Type VH	70-100	42	
	50-70	33	
	35-50	24	24
	2-10	9	

* d_{50} = mean particle size (intermediate dimension) by weight.

** Mix VL and L riprap with 30% (by volume) topsoil and bury it with 6+ inches of topsoil, all vibration compacted, and revegetate.

Rock used for riprap should be hard, durable, angular in shape, and free from cracks, overburden, shale, and organic matter. Neither breadth nor thickness of a single stone should be less than one-third its length, and rounded stone should be avoided. The rock should sustain a loss of not more than 40% after 500 revolutions in an abrasion test (Los Angeles machine—ASTM C-535-69) and should sustain a loss of not more than 10% after 12 cycles of freezing and thawing (AASHTO test 103 for ledge rock procedure A). Rock having a minimum specific gravity of 2.65 is preferred; however, in no case should rock have a specific gravity less than 2.50.

4.4.1.2 Grouted Boulders. Table MD-8 provides the classification and size requirements for boulders. When grouted boulders are used, they provide a relatively impervious channel lining which is less subject to vandalism than ordinary riprap. Grouted boulders require less routine maintenance by reducing silt and trash accumulation and are particularly useful for lining low-flow channels and steep banks. The appearance of grouted boulders is enhanced by exposing the tops of individual stones and by cleaning the projecting rocks with a wet broom right after the grouting operation. In addition, it is recommended that grouted boulders on channel banks and outside of frequent flow areas be buried with topsoil and revegetated with native grasses, with or without shrubs depending on the local setting. Boulders used for

Kiowa Engineering Corporation

January 30, 2007

Mr. Tim Mitros
Subdivision Engineering
City of Colorado Springs
30 South Nevada, Suite 700
Colorado Springs, Colorado 80903

RE: Wolf Ranch Detention Basin A Final Design, Colorado Springs, Colorado (Kiowa Project No. 05104)

Dear Tim:

At the request of Rockwell Consulting Kiowa was asked to confirm that the peak discharge rate at the existing Powers Boulevard box culvert was held to historic levels. To confirm this Kiowa obtained the outflow hydrograph for the Grand Cordera Detention basin from Matrix and combined it with the hydrologic model for the basins within Wolf Ranch that drain to Detention Basin A and eventually to the culvert under Powers Boulevard.

Attached is our HEC-1 input and output that accounts for the Grand Cordera detention basin. The 100-year peak discharge obtained at design point A was 287 cubic feet per second. This compares to 555 cubic feet per second for the 100-year existing basin condition peak discharge at design point A as summarized in the Cottonwood Creek DBPS update prepared by Ayres and Associates and as referenced in the Grand Cordera MDDP prepared by Matrix. The capacity of the existing box culvert under Powers Boulevard far exceeds the 287 cubic feet per second estimated by Kiowa.

If Kiowa can be of any further assistance, please do not hesitate to contact us.

Sincerely,
KIOWA ENGINEERING CORPORATION

Richard N. Wray, P.E.
Principal

Cc: Keith Cerjan, Rockwell Consulting
Rich Gallegos, Matrix Design Group
RNW/rnw
0130rnwl

[illegible] Colorado Springs, CO 80914
[illegible] (719) 550-[illegible]

```
**********************************
*                                *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1)  *
*            JUN 1998            *
*          VERSION 4.1           *
*                                *
*  RUN DATE  30JAN07  TIME  10:27:24  *
*                                *
**********************************
```


```
**********************************
*                                *
*  U.S. ARMY CORPS OF ENGINEERS  *
*  HYDROLOGIC ENGINEERING CENTER *
*       609 SECOND STREET        *
*     DAVIS, CALIFORNIA 95616    *
*         (916) 756-1104         *
*                                *
**********************************
```


```
X     X  XXXXXXX   XXXXX            X
X     X  X        X     X          XX
X     X  X        X                X
XXXXXXX  XXXX     X          XXXXX  X
X     X  X        X                X
X     X  X        X     X          X
X     X  XXXXXXX   XXXXX            XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1

HEC-1 INPUT PAGE 1

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  1       ID          Wolf Ranch, Master Developed Drainage Plan
  2       ID       A Basins, future development condition w/detention DETA-FD.DAT
  3       ID           OUTFLOW FROM CORDERA DETENTION BASIN MODELED   BN 05104
  4       ID            5-year and 100 Year, 24 hr Type IIA  Storm
  5       ID            HYDROGRAPH FROM CORDERA DETENTION BASIN INPUT TO RUN
          *DIAGRAM
  6       IT       5        0        0      300
  7       IO       5        0
  8       JR    PREC      .56        1

  9       KK    A-1
 10       KM       RUNOFF FROM SUB-BASIN A-1
 11       BA    .060
 12       IN      15
```

```
13          PB      4.4
14          PC   0.0000   0.0005   0.0015   0.0030   0.0045   0.0060   0.0080   0.0100   0.0120   0.0143
15          PC   0.0165   0.0188   0.0210   0.0233   0.0255   0.0278   0.0320   0.0390   0.0460   0.0530
16          PC   0.0600   0.0750   0.1000   0.4000   0.7000   0.7250   0.7500   0.7650   0.7800   0.7900
17          PC   0.8000   0.8100   0.8200   0.8250   0.8300   0.8350   0.8400   0.8450   0.8500   0.8550
18          PC   0.8600   0.8638   0.8675   0.8713   0.8750   0.8788   0.8825   0.8863   0.8900   0.8938
19          PC   0.8975   0.9013   0.9050   0.9083   0.9115   0.9148   0.9180   0.9210   0.9240   0.9270
20          PC   0.9300   0.9325   0.9350   0.9375   0.9400   0.9425   0.9450   0.9475   0.9500   0.9525
21          PC   0.9550   0.9575   0.9600   0.9625   0.9650   0.9675   0.9700   0.9725   0.9750   0.9775
22          PC   0.9800   0.9813   0.9825   0.9838   0.9850   0.9863   0.9875   0.9888   0.9900   0.9913
23          PC   0.9925   0.9938   0.9950   0.9963   0.9975   0.9988   1.0000
24          LS        0       61
25          UD     .292

26          KK       A3
27          KM    ROUTE FLOW FROM SUB-BASIN A-1 TO DP A3
28          RD     2700      .021      0.04              TRAP       10        4

29          KK      A-3
30          KM       RUNOFF FROM SUB-BASIN A-3
31          BA      .15
32          LS        0       73
33          UD     .221

34          KK     DPA3
35          KM        COMBINE SUB-BASIN A-3 AND A3
36          HC        2

37          KK      A3A
38          KM         ROUTE FLOW FROM DP A3 TO DP A4
39          RD     1100      .02      .013              CIRC        4

40          KK      A-4
41          KM    RUNOFF FROM SUB-BASIN A-4
42          BA    .0861
43          LS        0     76.3
44          UD     0.21
```

1


```
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

45          KK     DPA4
46          KM         COMBINE FLOW FROM A3A AND SUB-BASIN A-4
47          HC        2

48          KK       A4
49          KM    ROUTE RUNOFF FROM DPA4 TO A6
50          RD      450      .02      .013              CIRC      4.5

51          KK       A6
52          KM    ROUTE FLOW FROM A4 TO DP A6
```

```
53          RD    1550     .016     .013            TRAP      10        4

54          KK     A-11
55          KM    RUNOFF FROM SUB-BASIN A-11
56          BA     .981
57          LS        0     76.8
58          UD     .19

59          KK      A11
60          KM    ROUTE SUB-BASIN A-11 TO DP A8
61          RD    1400      .02     .013            CIRC      3.5

62          KK      A-8
63          KM    RUNOFF FROM BASIN A-8
64          BA     .979
65          LS        0     83.9
66          UD     .250

67          KK    DP A8
68          KM    COMBINE RUNOFF FROM SB A-8 AND A11
69          HC        2

70          KK      A8
71          KM    ROUTE FLOW FROM DES POINT A8 TO DP A7
72          RD    1100      .02     .013            CIRC      4.5

73          KK     A-7
74          KM    RUNOFF FROM SUB-BASIN A-7
75          BA    .0500
76          LS        0     76.6
77          UD     .172

78          KK    DP A7
79          KM    COMBINE RUNOFF FROM SUB-BASIN A-7 AND A8
80          HC        2

81          KK      A7
82          KM    ROUTE FLOW FROM DP A7 TO DP A6
83          RD     900     0.02    0.013            CIRC        5
1                                      HEC-1 INPUT                                                    PAGE  3
LINE        ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

84          KK     A-6
85          KM    RUNOFF FROM SUB-BASIN A-6
86          BA     .945
87          LS        0     80.8
88          UD     .21

89          KK    DPA6
90          KM    DESIGN POINT A6 COMBINE RUNOFF FROM SUB-BASIN A-6, A6 AND A7
```

```
 91          HC       3

 92          KK      A5
 93          KM    ROUTE FLOW FROM DESIGN POINT A6 TO DP A5
 94          RD     2200     .011      .04             TRAP       10        4

 95          KK     A-12
 96          KM    RUNOFF FROM SUB-BASIN A-12
 97          BA     .048
 98          LS        0       78
 99          UD     .181

100          KK     A12
101          KM    ROUTE RUNOFF FROM SUB-BASIN A-12 TO DP A9
102          RD     1950      .02      .013             CIRC        3

103          KK     A-9
104          KM    RUNOFF FROM SUB-BASIN A-9
105          BA     .059
106          LS        0     76.3
107          UD     .263

108          KK    DP A9
109          KM    COMBINE RUNOFF FROM SUB-BASIN A-9 AND A12
110          HC       2

111          KK      A9
112          KM    ROUTE FLOW FROM SUB-BASIN A-9 TO DESIGN POINT A5
113          RD      500      .02      .016             CIRC        4

114          KK    A-5
115          KM    RUNOFF FROM SUB-BASIN A-5
116          BA    .1114
117          LS        0     69.7
118          UD     .209

119          KK     DPA5
120          KM    DP A5 COMBINE RUNOFF FROM SUB-BASIN A-5, A5 AND A9 THIS IS INFLOW
121          KM    TO DETENTION BASIN A
122          HC       3
```



```
LINE         ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

123          KK      DBA
124          KM    ROUTE DP A5 THROUGH DETENTION BASIN A
125          RS        1     ELEV  6975.5
126          SV        0      .11       4.1      11.5      19.5        28      37.5      47.6
127          SE   6975.5     6976      6978      6980      6982      6984      6986      6988
128          SQ        0       10        20        40        80       120       160       900
129          SS     6987      250       2.6       1.5
```

```
130           ST    6998      15      2.6      1.5

131           KK     A10
132           KM   ROUTE FLOW FROM DET BASIN DBA TO DESIGN POINT A1
133           RD    1190    .032    .013            CIRC       4

134           KK      GC
135           KM           OUTFLOW HYDROGRAPH FROM CORDERA DETENTION BASIN
136           BA     .27
137           QI       0       0       0       0       0       0       0               0       0
138           QI       0       0       0       0       0       0       0       0       0       0
139           QI       0       0       0       1      37     127      _.     126     101      77
140           QI      60      51      45      40      38              37      30      24      21

141           KK   DP A1
142           KM        COMBINE OUTFLOW FROM GRAND CORDERA DETENTION BASIN AND A10
143           HC        2

144           KK    A-10
145           KM   RUNOFF FROM SUB-BASIN A-10
146           BA   .0096
147           LS       0    79.6
148           UD    .231

149           KK     DPA
150           KM   DESIGN POINT A COMBINE RUNOFF SUB-BASIN A-10 AND DP A1
151           HC        2
152           ZZ
```

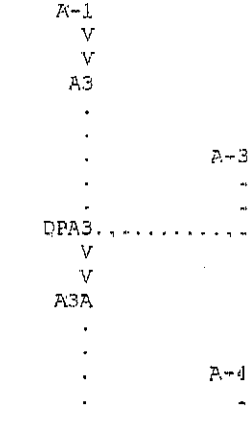
1

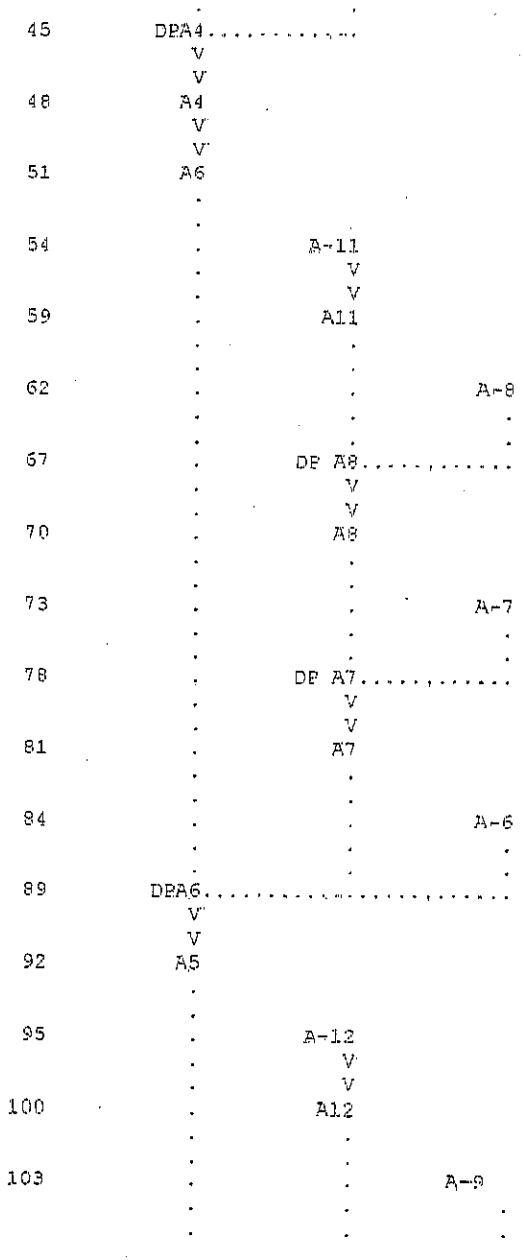
SCHEMATIC DIAGRAM OF STREAM NETWORK

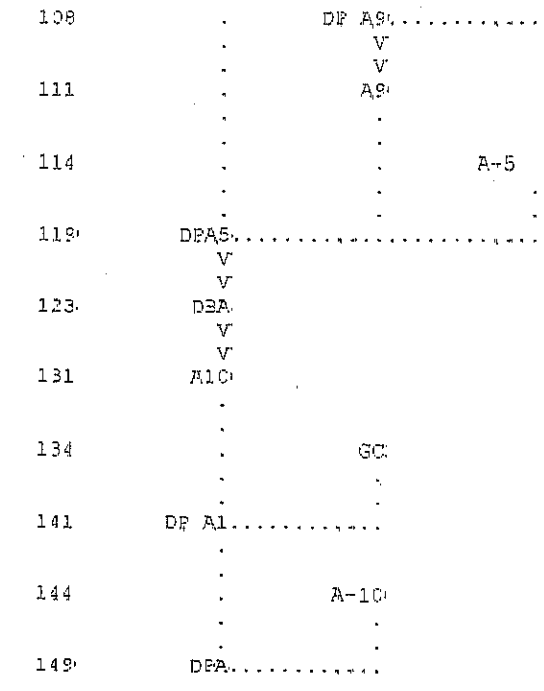
INPUT LINE NO.

(V) ROUTING (---->) DIVERSION OR PUMP FLOW

(.) CONNECTOR (<----) RETURN OF DIVERTED OR PUMPED FLOW




45
DPA4
48
A4
51
A6
54
A-11
59
A11
62
A-8
67
DP A8
70
A8
73
A-7
78
DP A7
81
A7
84
A-6
89
DPA6
92
A5
95
A-12
100
A12
103
A-9



(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
1**********************************************
*                                            *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)        *
*              JUN  1998                     *
*           VERSION 4.1                      *
*                                            *
*  RUN DATE   30JAN07  TIME  10:27:24        *
*                                            *
**********************************************
```

```
**********************************************
*                                            *
*    U.S. ARMY CORPS OF ENGINEERS            *
*    HYDROLOGIC ENGINEERING CENTER           *
*          609 SECOND STREET                 *
*        DAVIS, CALIFORNIA 95616             *
*          (916) 756-1104                    *
*                                            *
**********************************************
```

Wolf Ranch, Master Developed Drainage Plan
A Basins, future development condition w/detention DETA-FD.DAT
OUTFLOW FROM CORDERA DETENTION BASIN MODELED PN 05104
5-year and 100 Year, 24 hr Type IIA Storm
HYDROGRAPH FROM CORDERA DETENTION BASIN INPUT TO RUN

```
 7 IO        OUTPUT CONTROL VARIABLES
               IPRNT         5  PRINT CONTROL
```

```
                    IPLOT          0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

  IT          HYDROGRAPH TIME DATA
                   NMIN          5  MINUTES IN COMPUTATION INTERVAL
                  IDATE      1   0  STARTING DATE
                  ITIME         0000  STARTING TIME
                     NQ          300  NUMBER OF HYDROGRAPH ORDINATES
                 NDDATE      2   0  ENDING DATE
                 NDTIME         0005  ENDING TIME
                  ICENT          19  CENTURY MARK

              COMPUTATION INTERVAL      .08 HOURS
                  TOTAL TIME BASE    24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

  JP        MULTI-PLAN OPTION
                NPLAN          1  NUMBER OF PLANS

  JR        MULTI-RATIO OPTION
              RATIOS OF PRECIPITATION
              .56      1.00
1


          PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                              FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                        TIME TO PEAK IN HOURS

                                                                  RATIOS APPLIED TO PRECIPITATION
 OPERATION      STATION     AREA    PLAN                    RATIO 1  RATIO 2
                                                               .56      1.00

 HYDROGRAPH AT
+                A-1        .06      1    FLOW              3.       32.
                                          TIME            6.25     6.17

 ROUTED TO
+                A3         .06      1    FLOW              4.       32.
                                          TIME            6.50     6.33

 HYDROGRAPH AT
+                A-3        .15      1    FLOW             49.      194.
                                          TIME            6.17     6.08
```

2 COMBINED AT						
+	DPA3	.21	1	FLOW	49.	196.
				TIME	6.17	6.17
ROUTED TO						
+	A3A	.21	1	FLOW	49.	195.
				TIME	6.17	6.17
HYDROGRAPH AT						
+	A-4	.09	1	FLOW	39.	133.
				TIME	6.08	6.08
2 COMBINED AT						
+	DPA4	.30	1	FLOW	86.	322.
				TIME	6.17	6.08
ROUTED TO						
+	A4	.30	1	FLOW	86.	319.
				TIME	6.17	6.08
ROUTED TO						
+	A6	.30	1	FLOW	85.	315.
				TIME	6.17	6.17
HYDROGRAPH AT						
+	A-11	.08	1	FLOW	41.	134.
				TIME	6.08	6.08
ROUTED TO						
+	A11	.08	1	FLOW	39.	131.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-8	.08	1	FLOW	57.	152.
				TIME	6.17	6.08
2 COMBINED AT						
+	DP A8	.16	1	FLOW	95.	283.
				TIME	6.08	6.08
ROUTED TO						
+	A8	.16	1	FLOW	94.	278.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-7	.05	1	FLOW	26.	84.
				TIME	6.08	6.08
2 COMBINED AT						
+	DP A7	.21	1	FLOW	118.	362.
				TIME	6.08	6.08

ROUTED TO						
+	A7	.21	1	FLOW	116.	358.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-6	.05	1	FLOW	29.	84.
				TIME	6.08	6.08
3 COMBINED AT						
+	DPA6	.55	1	FLOW	228.	745.
				TIME	6.17	6.08
ROUTED TO						
+	A5	.55	1	FLOW	225.	732.
				TIME	6.25	6.17
HYDROGRAPH AT						
+	A-12	.05	1	FLOW	27.	84.
				TIME	6.08	6.08
ROUTED TO						
+	A12	.05	1	FLOW	26.	82.
				TIME	6.08	6.08
HYDROGRAPH AT						
+	A-9	.06	1	FLOW	24.	81.
				TIME	6.17	6.17
2 COMBINED AT						
+	DP A9	.11	1	FLOW	49.	161.
				TIME	6.17	6.08
ROUTED TO						
+	A9	.11	1	FLOW	49.	159.
				TIME	6.17	6.08
HYDROGRAPH AT						
+	A-5	.11	1	FLOW	27.	126.
				TIME	6.17	6.08
3 COMBINED AT						
+	DPA5	.77	1	FLOW	288.	1003.
				TIME	6.25	6.17
ROUTED TO						
+	DBA	.77	1	FLOW	38.	160.
				TIME	7.17	6.83

** PEAK STAGES IN FEET **

1	STAGE	6979.79	6985.98
	TIME	7.17	6.83

ROUTED TO						
+	A10	.77	1	FLOW	38.	160.
				TIME	7.25	6.92
HYDROGRAPH AT						
+	GC	.27	1	FLOW	128.	128.
				TIME	6.50	6.50
2 COMBINED AT						
+	DP A1	1.04	1	FLOW	162.	285.
				TIME	6.75	6.75
HYDROGRAPH AT						
+	A-10	.01	1	FLOW	5.	16.
				TIME	6.08	6.08
2 COMBINED AT						
+	DPA	1.05	1	FLOW	163.	287.
1				TIME	6.75	6.75

1

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION DBA
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	6975.53	6987.00	6988.00
STORAGE	0.	43.	48.
OUTFLOW	0.	530.	900.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.56	6979.79	.00	11.	38.	.00	7.17	.00
1.00	6985.98	.00	37.	160.	.00	6.83	.00

*** NORMAL END OF HEC-1 ***