Clark County Regional Flood Control District

Las Vegas Valley Flood Insurance Study Hydrology Report

September 1991

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Serving the World's
Environmental Needs

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Consulting Engineers Inc.

October 4, 1991

Mr. Gale Fraser
Clark County Regional Flood Control District
301 E. Clark Avenue, Suite 301
Las Vegas, NV 89101

SUBJECT: Las Vegas Valley Flood Insurance Study Hydrology Report

Dear Gale:

Enclosed are three copies of the final Las Vegas Valley Flood Insurance Study Hydrology Report. This final report incorporates comments of the District, Clark County Department of Public Works, and the City of Henderson. To date, no comments have been received from the Cities of Las Vegas or North Las Vegas.

Our contract calls for delivery of 10 copies of the FIS Hydrology Report. These early copies have been provided now so you can forward two copies to FEMA in order to initiate their review process. In addition, we will be providing one hard copy of the Technical Appendix as well as computer files on disks. The remaining reports and the Technical Appendix will be submitted next week.

Please do not hesitate to contact me if you have any questions.

Very truly yours,

James M. Montgomery,
Consulting Engineers, Inc.

Chip Paulson

Chip Paulson
Project Engineer

Encls.

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CHAPTER 1

INTRODUCTION

STUDY PURPOSE

This report presents the results of a hydrologic analysis to determine peak discharges appropriate for use in Flood Insurance Studies (FIS) in Las Vegas Valley, Nevada. The hydrologic analysis was conducted by James M. Montgomery, Consulting Engineers, Inc. (JMM), under contract to Clark County Regional Flood Control District (CCRFCD), dated April 1990. Work was performed in conjunction with a Flood Control Master Plan Update for Las Vegas Valley. Peak discharges generated in this study will be used in future hydraulic analyses to update floodplain mapping for Las Vegas Valley.

Proposed FIS study reaches, as developed by CCRFCD and the local entities, are depicted in Figure 1-1. This figure also identifies concentration points at which FIS discharges will be required.

In conformance with guidelines for FIS hydrology, the analyses performed in this study are based on existing development conditions with existing flood control improvements. In specific cases, flood control improvements scheduled for construction in the near future (i.e., within the next two years) have been incorporated as "existing facilities".

Because of the large number of previous hydrologic studies throughout Las Vegas Valley, it was not the intent of this FIS hydrologic analysis to "reinvent the wheel". Rather, the philosophy was to determine the best available model of existing hydrologic conditions and to update it as necessary to conform to the criteria presented in the CCRFCD "Hydrologic Criteria and Drainage Design Manual" (1990). Further, it was the objective of the study to develop FIS discharges which agree as closely as possible with the "regulatory discharges" adopted by CCRFCD for planning and design purposes.

REPORT ORGANIZATION

This report has been assembled from preliminary draft reports prepared for each major watershed in Las Vegas Valley. Each chapter of the report represents a stand-alone summary of FIS hydrology for one of the following major watersheds:

Range Wash
Northern Las Vegas Wash
Gowan Area
Central Basin
Flamingo/Tropicana Wash
Duck Creek/Blue Diamond Wash
Pittman Wash
C-1 Channel
Lower Las Vegas Wash

The Introduction chapter presents background information pertaining to all of the study areas. Results and specific modeling assumptions for each study area are described in the associated chapter. A separately bound Technical Appendix contains HEC-1 routing diagrams and input/output printouts for 100-year flood simulations.

BASIC DATA AND ASSUMPTIONS

The key previous studies referenced in this work which affect the overall Las Vegas Valley study area are:

Hydrologic Documentation for Feasibility Study, Las Vegas Wash and Tributaries, U.S. Army Corps of Engineers, Los Angeles District, 1986
Clark County Flood Insurance Study (draft), JMM, 1985
Clark County Flood Control Master Plan, JMM, 1986
Special Flood Hazard Study, Las Vegas Wash and Tributaries, U.S. Army Corps of Engineers, Los Angeles District, 1988

The Master Plan utilized hydrologic modeling data from the FIS in drainage areas beyond the anticipated development boundary. The Corps of Engineers (COE) Special Flood Hazard Study, which was prepared as a supplement to the Feasibility Study for Las Vegas Wash and Tributaries, incorporated much of the Master Plan modeling information.

Existing land use information was based on digitized land use data provided by Clark County Comprehensive Planning (1986), supplemented by information obtained from an April 1990 aerial photograph. Thus land use conditions are considered accurate as of April 1990. Soils data were obtained from the SCS Soil Survey for Las Vegas Valley (1985). Subbasin boundaries were adopted from previous studies to the greatest extent possible; where necessary, additional subbasins were delineated based on 7.5 minute USGS maps, recent drainage studies, and aerial photos.

Modeling methods were selected to be consistent with the CCRFCD manual. Design storms were 6-hour events with depths as given in the manual. Storm distributions were SDN #3 (for areas under 10 square miles) and SDN #5 (for areas over 10 square miles), as developed by the COE. Point precipitation was reduced by depth-area reduction factors (DARF's) given in the CCRFCD Manual. Unique DARF's were computed for each concentration point of interest based on contributing drainage area or assumed upstream storm area. Hydrographs were computed from rainfall excess using the SCS unit hydrograph method, except in subbasins where kinematic runoff parameters were already available. The Muskingum routing method was used for channel routing except where improved channels were involved, in which case the kinematic method was used. Losses were computed using the SCS curve number (CN) method, based on standard CN tables provided in the CCRFCD manual.

HEC-1 models were executed using the 1988 version of the program. Although this program version is provisional and contains some "bugs" associated with use of the kinematic routing routine (although not in the kinematic algorithm itself), it was selected because it was the most recent version of the program being distributed and because it gives results which should agree better with the recently released 1990 HEC-1 version than would the 1985 version.

Because the new FIS modeling was based primarily on the COE existing conditions analysis, and because local entities generally accept the COE results, one of the objectives of the new analysis was to produce results consistent with the COE flows at common points of interest. The CCRFCD has adopted 100-year COE flows for Las Vegas Wash, Range Wash, Flamingo Wash, Tropicana Wash, Duck Creek, Blue Diamond Wash, Pittman Wash, and C-1 Channel as official "regulatory discharges" (see Appendix A). Certain COE flows for Range Wash, Flamingo Wash, Tropicana Wash, Blue Diamond Wash, Pittman Wash and C-1 Channel were identified as "interim discharges" due to concerns over their accuracy. It was hoped that conversion of the uniform loss rate method used by the COE to the curve number method recommended by CCRFCD, and other necessary model modifications, would produce results directly consistent with the COE discharges. At most model concentration points this was the case. At the remaining concentration points, model parameters (e.g., curve numbers and routing parameters) had to be adjusted within an acceptable range of values in order to better reproduce the COE flows. Thus, FIS flows were "calibrated" to the COE flows in order to assure reasonableness. Comparison within 10 percent was considered acceptable, although reasonable efforts were made to gain agreement to within 5 percent. It was felt that agreement of FIS flows at concentration points common to the COE study would allow discharges at non-COE concentration points to be computed which would be consistent with the COE flood frequency results. At the direction of CCRFCD, if modeled flows agree with regulatory discharges to within 10 percent, then the regulatory discharges will be adopted as FIS discharges.

The aggressive program of CCRFCD and each of the local agencies to design and construct major flood control facilities in Las Vegas Valley has lead to a "moving target" situation with regard to the definition of existing facilities. The proposed projects included in this FIS Hydrology study are based on information available in early 1991. When actual floodplain mapping is performed for FIS purposes, it will be important to assure that the assumed "existing conditions" in this hydrology study are correct; if not, the hydrology models will have to be revised accordingly.

In the remainder of this report, the terms "FIS Hydrology" and "FIS Model" refer to the flows and modeling developed for the present study, rather than to the 1985 draft Clark County Flood Insurance Study. Any differences in this terminology are clearly identified.

CHAPTER 2
RANGE WASH FIS HYDROLOGY

recommended flows involved hydrologic judgement and experience, and is not documented specifically in the Hydrologic Documentation Report; thus it is not possible to apply an identical strategy to the FIS discharge analysis.

The West Range Wash Diversion Dike was introduced to the existing conditions 10-, 50-, and 100-year HEC-1 models, and new simulations were performed. DARF's were adjusted for the control points downstream of the diversion, neglecting the tributary area upstream of the dike. Resulting discharges and recommended adopted FIS flows are presented in Table 2-3

At locations where a CCRFCD regulatory discharge was selected as the adopted flow based on the 100-year flow comparison, comparable flows for the 10-year and 50-year events were taken directly from the COE Special Flood Hazard Study or were modified only slightly. In other locations flows were generally taken from the HEC-1 models, with adjustments made to preserve consistency from upstream to downstream.

Discharges for the 500-year flood were determined by graphically extrapolating the discharges from the lower three storms. Flood frequency plots used to perform the extrapolations are shown in Figures 2-2 to 2-6. Extrapolations were performed using both the model discharges and the adopted discharges; extrapolations agreed well at all nodes with the exception of nodes CC and S, where differences were slightly larger. Adopted 500-year discharges were selected giving preference to the extrapolation based on the adopted 10-, 50-, and 100-year flows.

The HEC-1 input/output file and routing diagram are included in the Technical Appendix for reference.

TABLE 2-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR RANGE WASH FIS HYDROLOGY

FIS Hydrology				Boyle Facility Study				COE Computed Probability					
CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	Note	Description
CC	151	0.55	8282	CC	151	0.62	8039	1	156		8000	1	Main Chnl @ Vegas Valley
S	138	0.55	7876	S	138	0.62	7887	9	144		8000	1,9	Main Chnl @ Owens Ave
G1	74	0.64	7719	G-M	74	0.72	7538	14	82		7500	2	West Trib @ Carey
G	49	0.68	6305	G	49	0.72	5700	12	79		7500	3,11	W. Trib, W. Branch @ LVB
F1	46	0.68	6092					8	54		7000	4,11	W. Trib, W. Branch @ UPRR
F	41	0.71	6486	F	41	0.72	5591					10	W. Trib, W. Branch u/s UPRR
I2	25	0.77	3350	310	9.1	0.72	722					5	W. Trib, E. Branch @ LVB
I1	17	0.83	2678										W. Trib, E. Branch @ UPRR
I	16	0.83	2646	I	16	0.72	1547					6	W. Trib, E. Branch u/s UPRR
P	52	0.68	3766	P	52	0.72	3936	4	60		5600	7,11	East Trib @ Carey
P1	40	0.71	3824	P1	40	0.72	3004					8	East Trib @ u/s study limit

Area in square miles; flow in cfs.

Notes:

1. Agrees with CCRFCD regulatory flow within 5%; adequate calibration.
2. FIS Q higher than Boyle Q due to modified routing at UPRR, I-15 and LVB; Within 5% of interim discharge, so use interim discharge for FIS.
3. FIS Q and Boyle Q do not include contribution from East Branch West Trib at this node;
   FIS Q higher than Boyle Q due to higher CN's and routing impacts on peak timing.
4. COE flows are higher due to larger area;
5. FIS Hydrology includes all area upstream of subarea 310; Boyle includes subarea 310 only.
6. FIS discharge is higher due to site-specific (higher) DARF.
7. FIS discharge is lower due to site-specific (lower) DARF. Also, FIS added corrected routing step from node P1 to P.
   COE CP4 includes subbasins 318A/B; node P does not.
8. FIS Q higher than Boyle Q due to higher CN's; DARF's are equivalent.
9. COE report shows area of 114 sq mi; this is a typo error.
10. FIS flows are higher than Boyle flows due to higher CN's and altered routing timing.
11. Interim flow rejected; use FIS Hydrology flow.
12. FIS Hydrology does not include West Range Diversion Dike as an "existing facility" in these simulations.

TABLE 2-2

RANGE WASH EXISTING CONDITION DISCHARGES WITHOUT WEST RANGE WASH DIVERSION

Node	Area (sq mi)	10-Year Peak Discharge COE Reg Q	10-Year COE SFHS Q	10-Year Model Output	50-Year Peak Discharge COE Reg Q	50-Year COE SFHS Q	50-Year Model Output	100-Year Peak Discharge COE Reg Q	100-Year COE SFHS Q	100-Year Model Output	500-Year Peak Discharge COE SFHS Q	500-Year Model Extrap
CC	151	2074	1600	1960*	7201	5200	6060	11174	8000	8282	20000	18400
S	138	1998	1600	1960*	6937	5200	5780	10764	8000	7876	20000	17000
G1	74	1571	1400	1964	5651	4800	5770	8880	7500	7719	18000	16500
G	49			1784			4853			6305		12800
F1	46	1271	1300	1750	4655	4500	4696	7360	7000	6092	17000	12200
I2	25			795			2499			3350		7500
I1	17			784			2045			2678		5300
P	52	1347	950	901	4933	3500	2865	7800	5600	3766	14000	8500
P1	40			970			2923			3824		8400

Node	Location
CC	Main Channel @ Vegas Valley
S	Main Channel @ Owens
G1	West Trib @ Carey
G	West Trib, West Branch @ LVB
F1	West Trib, West Branch 2 UPRR
I2	West Trib, East Branch @ LVB
I1	West Trib, East Branch @ UPRR
P	East Trib @ Carey
P1	East Trib @ u/s Study Limit

Legend	
COE Reg Q =	Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q =	Corps of Engineers Special Flood Hazard Study
Model Output =	FIS Hydrology HEC-1 Model Output
Model Extrap =	Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Area =	Drainage Area from FIS Hydrology
Flow in cfs	

* Actual model output is less due to lower DARF; flow at G1 is used at downstream nodes to avoid decreasing flow values

TABLE 2-3

PROPOSED RANGE WASH FIS DISCHARGES

Node	Storm Area (sq mi)	10-Year Peak Discharge Model Output	10-Year Peak Discharge Adopted Flow	50-Year Peak Discharge Model Output	50-Year Peak Discharge Adopted Flow	100-Year Peak Discharge Model Output	100-Year Peak Discharge Adopted Flow	500-Year Peak Discharge Model Extrap	500-Year Peak Discharge Adopted Flow
CC	102	1540	1500	4480	4500	6010	6000	12800	12800
S	89	1270	1300	3820	3800	5190	5200	11200	11200
G1	24	950	950	2920	2900	3920	3900	8700	8700
G	11	690	690	1820	1800	2350	2900	4700	4700
F1	4	510	510	1360	1400	1790	1800	3500	3500
I2	13	560	560	1910	1900	2540	2500	5800	5800
I1	5	380	380	960	960	1260	1300	2500	2500
P	52	970	970	3030	3000	3960	4000	8500	8500
P1	40	900	900	2780	2800	3650	3700	8000	8000

Note: Includes proposed West Range Wash Diversion Dike as an existing facility.

Node	Location
CC	Main Channel @ Vegas Valley
S	Main Channel @ Owens
G1	West Trib @ Carey
G	West Trib, West Branch @ LVB
F1	West Trib, West Branch 2 UPRR
I2	West Trib, East Branch @ LVB
I1	West Trib, East Branch @ UPRR
P	East Trib @ Carey
P1	East Trib @ u/s Study Limit

Legend

Model Output =	FIS Hydrology HEC-1 Model Output
Adopted Flow =	Adopted Flow for FIS Purposes
Model Extrap =	Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Area =	Drainage Area from FIS Hydrology
Flow in cfs	

CHAPTER 2

RANGE WASH FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/existing facilities analysis of Range Wash conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for Range Wash. In addition, results could be used to assess the adequacy of existing facilities to handle existing flood discharges. The study area includes the entire watershed upstream of the confluence with Las Vegas Wash.

The basis of the hydrologic analysis was the HEC-1 model developed by Boyle Engineering Corporation for the "Hydrologic Analysis, Western and Eastern Tributaries of Range Wash", April 1990. Previous hydrologic studies of this watershed also include the CCRFCD Master Plan and the Corps of Engineers Special Flood Hazard Study. These are considered to be superseded by the Boyle study, although the Boyle study is based heavily on these previous studies. The Boyle report and HEC-1 runs were used as the source of basic subbasin area, curve number, lag time, and kinematic runoff parameters.

The Boyle HEC-1 data files were modified to reflect changes in CCRFCD modeling criteria, the HEC-1 program itself, and an improved understanding of flow conditions at the UPRR and I-15 crossings. In addition, at the direction of the City of North Las Vegas and the District, the West Range Wash Diversion Dike was assumed to be an "existing facility" for FIS hydrology purposes. Changes to the HEC-1 data are summarized in the following section.

Figure 2-1 is reproduced from the Boyle report, and shows subareas and concentration points used in the previous hydrologic analysis. Figure S-1 (Appendix B) shows Range Wash subareas used in this FIS hydrology study.

MODIFICATIONS TO EXISTING CONDITIONS MODEL FROM BOYLE

The following changes were made by JMM to the Range Wash existing conditions/existing facilities model prepared by Boyle Engineering Corporation as part of their Range Wash hydrology and facilities study.

1. Previous HEC-1 runs for the Boyle analysis were made using the 1985 version of the program. FIS Hydrology runs were made using the 1988 version.

2. Depth-area-reduction factors (DARF's) based on Hydro 40 were changed to the District Manual DARF's. The revised DARF's are lower than those used by Boyle, resulting in lower design rainfall depths.

3. Kinematic routing computations in upland, natural channel reaches were changed to the Muskingum routing method to assure compatibility with the 1988 version of the program. In addition, this method is consistent with the District's Hydrology Manual.

4. Curve numbers were converted from AMC 1.8 equivalents to AMC 2 equivalents. AMC 1.8 curve numbers were used by Boyle as a calibration parameter.

adopted under the "interim" status. Table 2-1 shows that for the two most downstream nodes, simulated 100-year flows agree to within 5 percent of the COE flows. In this case, based on instructions from the District, the adopted flows would be used directly for FIS discharges. Modeled flows also agree to within 5 percent with the CCRFCD interim discharge for West Tributary at Carey Avenue (node G1). Thus according to District instructions, the interim discharge would be adopted for use as an FIS discharge at this location. However, inclusion of the West Range Wash Diversion Dike will significantly reduce flows in lower Range Wash for FIS purposes.

At other points where FIS discharges are required, differences between the FIS Hydrology modeled 100-year flows and the COE computed probability flows exceed 10 percent. These differences are explainable by one of the following significant factors:

1. Drainage area differences based on the Boyle subbasin revisions.

2. Corrected modeling of routing conditions at the UPRR, I-15 and Las Vegas Blvd for West Tributary.

3. Use of the 1988 version of HEC-1, with associated changes in channel routing methodology.

4. Modified subbasin parameters (lower curve numbers, longer lag times) by Boyle for the East Tributary watershed.

Based on the "calibrated" results shown in Table 2-1 for the 100-year storm, HEC-1 "without diversion" models were developed for the 10-year and 50-year storms. These models utilize the same curve number and lag time parameters as the 100-year model; the only difference is in precipitation depth. Results are summarized in Table 2-2. It is seen that the 10-year and 50-year discharges do not compare as well with the COE computed probability flows as the 100-year discharges. In particular, at node CC the 10-year and 50-year discharges exceed the computed probability flows by slightly over 10 percent (11 and 16 percent, respectively). This is probably due in part to the fact that the COE analysis utilized higher uniform loss rates for the higher frequency events, whereas the District Manual allows for use of the same curve numbers for all of the storms analyzed in this study.

The model results for the 10-year flood show smaller flows at the two downstream nodes (S and CC) than are shown at the upstream nodes (G1, G and F1). This appears to be due to the fact that for the smaller 10-year rainfall, the lower subareas which have lower curve numbers contribute less flow than those subareas in the upper portion of the drainage area which have larger curve numbers. As the depth-area reduction factor decreases moving to downstream concentration points, the additional runoff from the larger drainage area is not sufficient to compensate for the lower rainfall amounts applied over the entire watershed. This condition does not affect the 50-year and 100-year simulations because the higher rainfall amounts for these storms make the results less sensitive to the curve numbers (loss rates) for individual subareas.

Table 2-2 presents discharges for each node based on the COE regional discharge-frequency relationship developed for the Feasibility Study. This is the relationship used to calibrate the COE HEC-1 models, and was used by the COE in conjunction with the model results to select discharges for the study. It can be seen that in many cases there are considerable differences between the regional values and the COE-adopted values, as well as between the regional values and the FIS Hydrology model results. The rationale used by the COE to determine

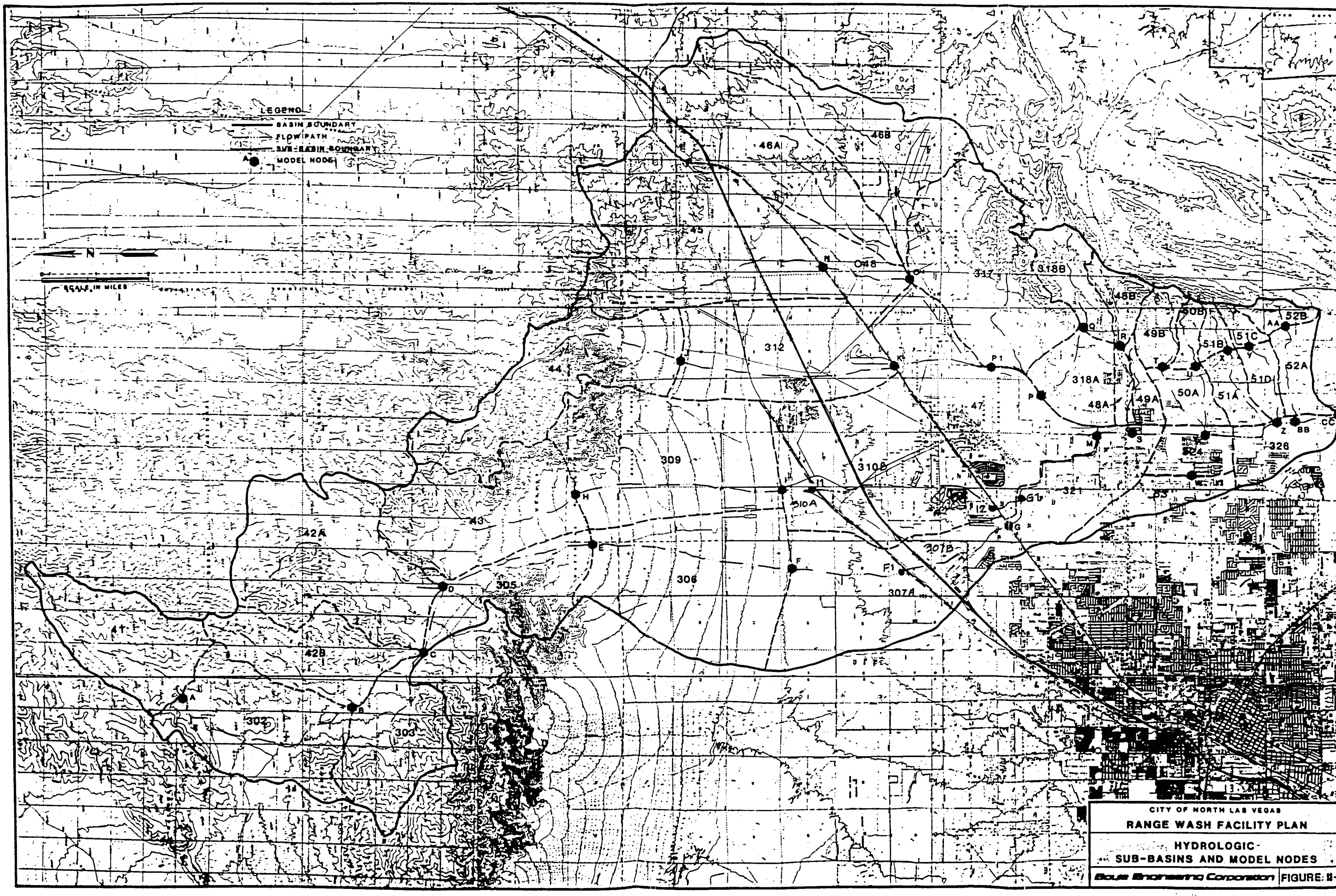

LEGEND
BASIN BOUNDARY
FLOWPATH
SUB-BASIN BOUNDARY
MODEL NODES
N
SCALE IN MILES
46A
46B
45
048
317
318B
48B
50B
52B
49B
51B
51C
312
44
318A
48A
49A
50A
51A
51D
52A
47
326
309
310B
321
43
42A
310A
307B
306
305
307A
42B
302
303
CITY OF NORTH LAS VEGAS
RANGE WASH FACILITY PLAN
HYDROLOGIC-
SUB-BASINS AND MODEL NODES
Boyle Engineering Corporation
FIGURE: II-1

FIGURE 2-1

FIGURE 2-2
RANGE WASH FIS DISCHARGES
(PLOT #1)

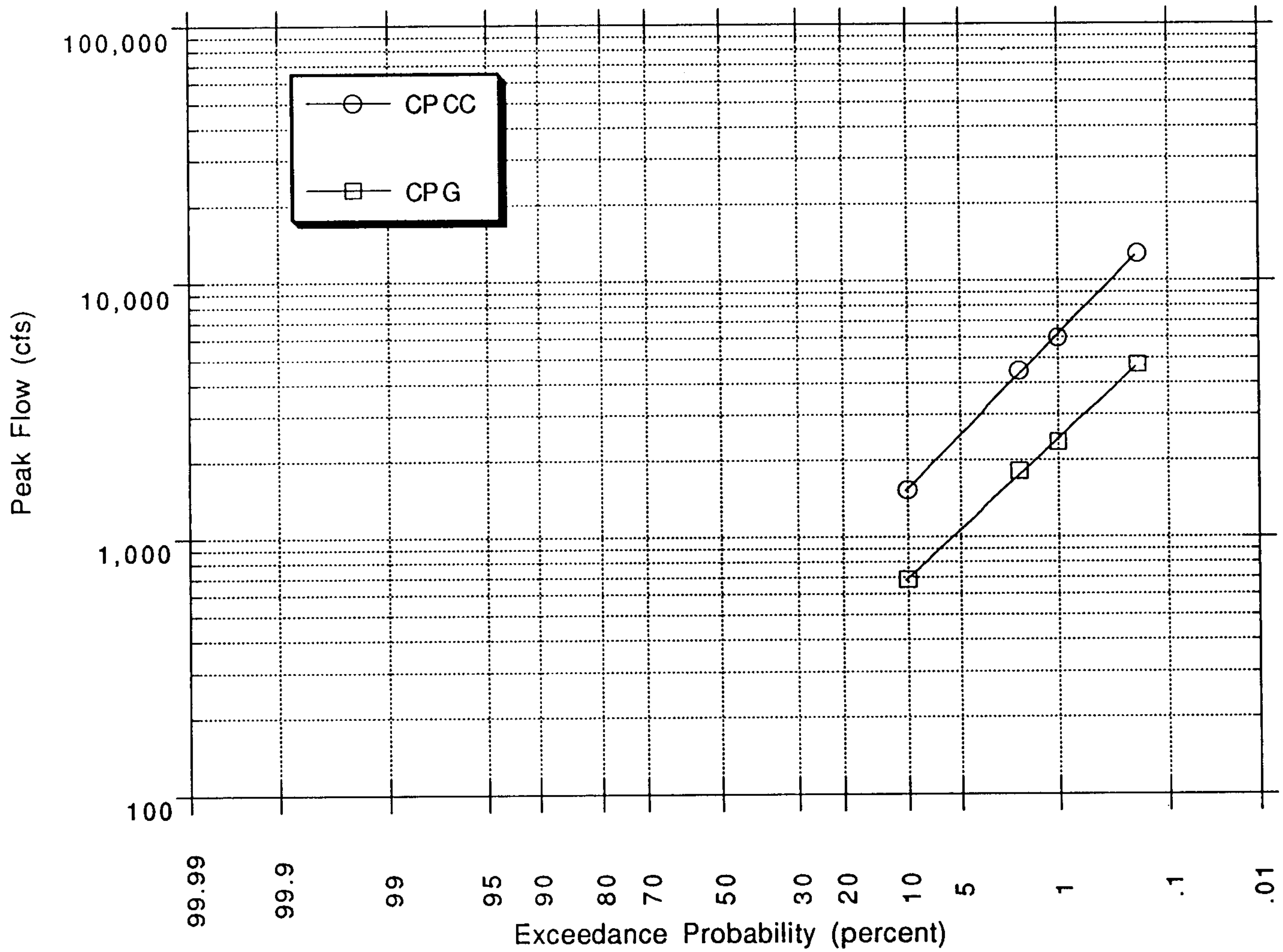


FIGURE 2-3
RANGE WASH FIS DISCHARGES
(PLOT #2)

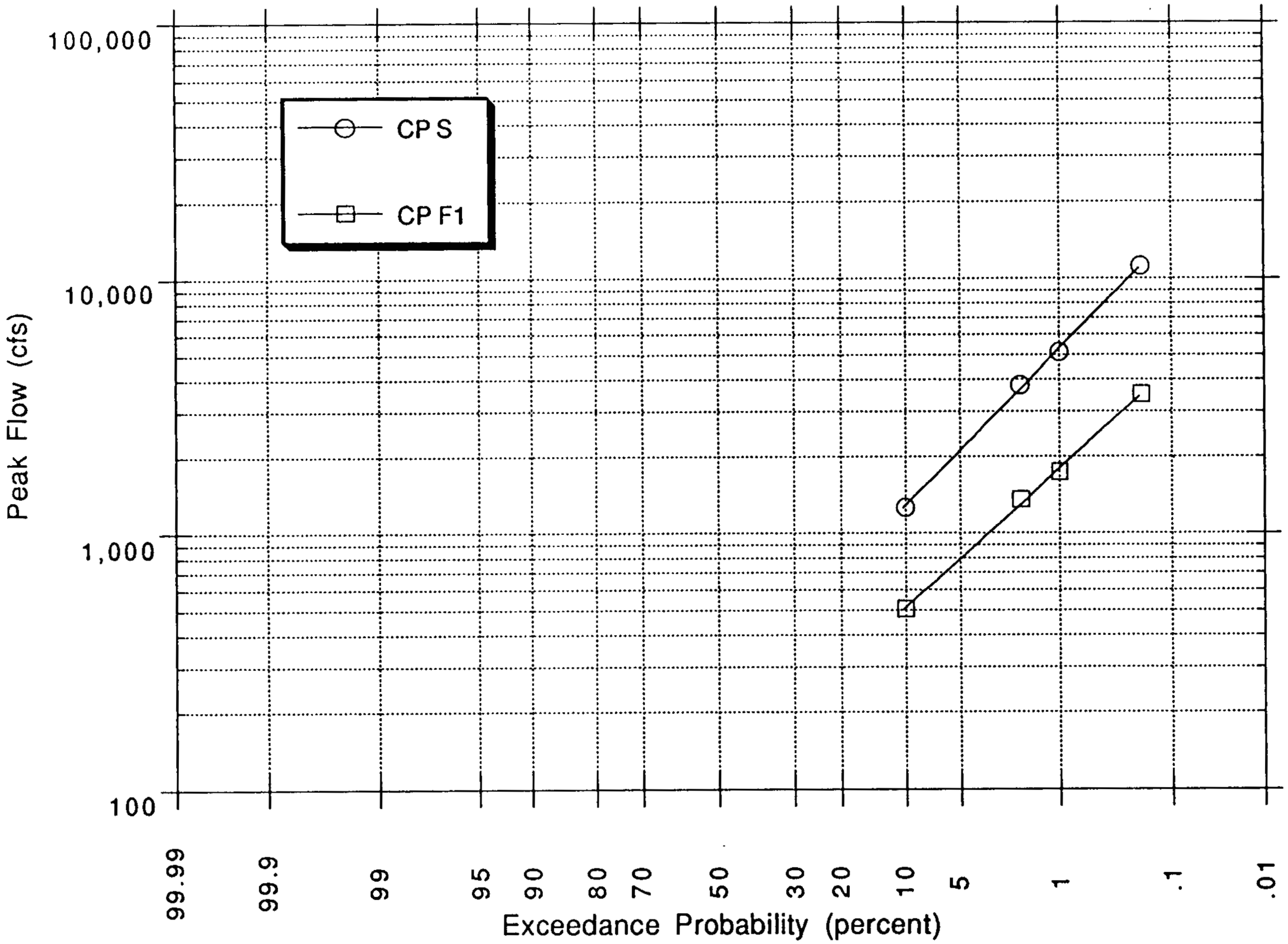


FIGURE 2-4
RANGE WASH FIS DISCHARGES
(PLOT #3)

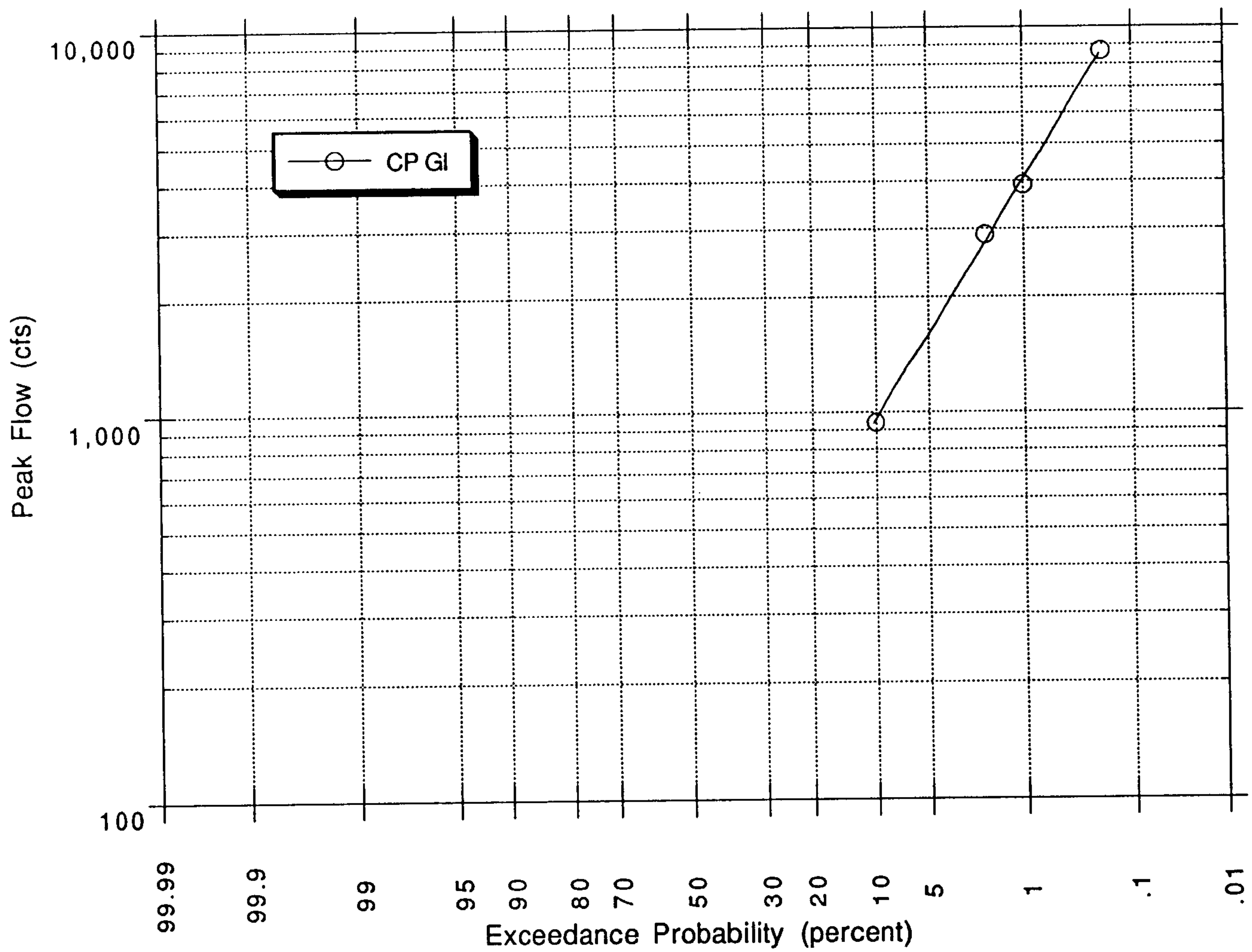


FIGURE 2-5
RANGE WASH FIS DISCHARGES
(PLOT #4)

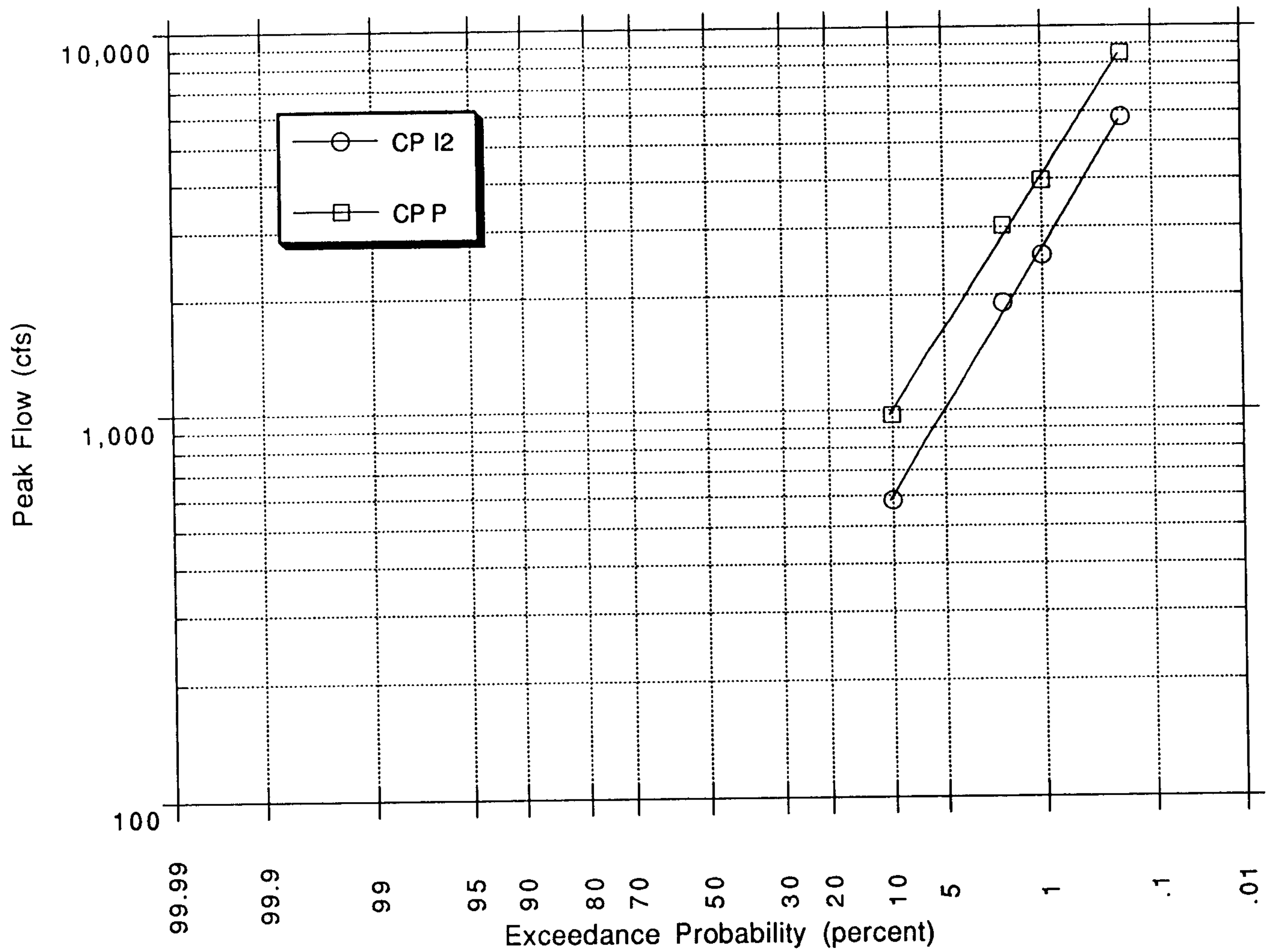
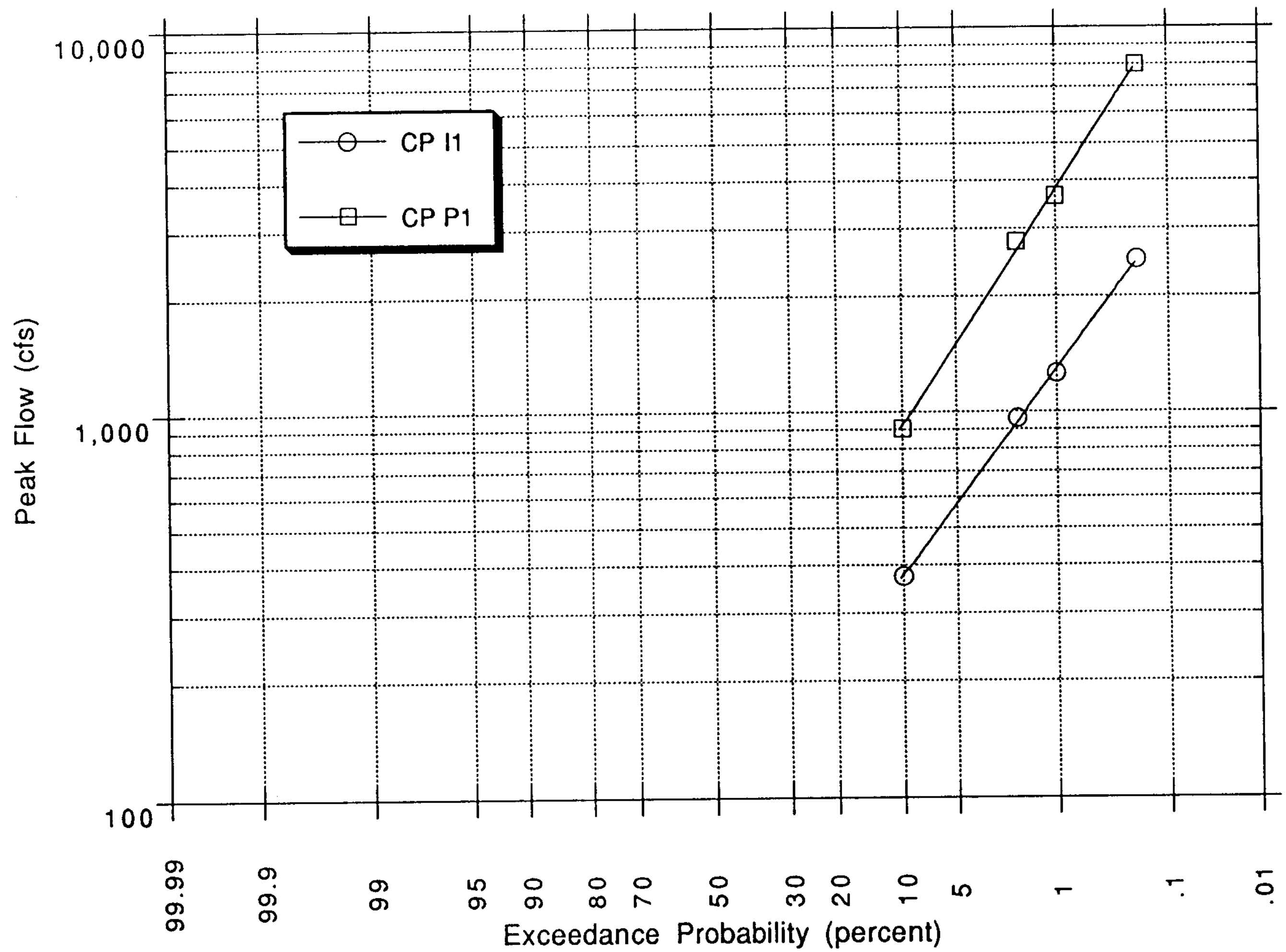


FIGURE 2-6
RANGE WASH FIS DISCHARGES
(PLOT #5)



CHAPTER 3
NORTHERN LAS VEGAS WASH
FIS HYDROLOGY

CHAPTER 3

NORTHERN LAS VEGAS WASH FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/facilities analysis of Northern Las Vegas Wash conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for Northern Las Vegas Wash. In addition, results could be used to assess the adequacy of existing facilities to handle existing flood discharges. "Northern Las Vegas Wash" is defined as the Las Vegas Wash watershed upstream of the Pecos/Lake Mead bridge. Major drainage features include the Main Branch of Las Vegas Wash (N Channel) and the Western Tributary to Las Vegas Wash (A Channel).

The bases of the hydrologic analysis were the HEC-1 models developed by Black and Veatch (B&V) for the "Flood Control Facilities Plan for the Northern Las Vegas Wash" for the City of North Las Vegas, August 1989. Previous hydrologic studies of the watershed also include the CCRFCD Master Plan; the Corps of Engineers' (COE) Special Flood Hazard Study; the "Hydrology Report - Methodologies and HEC-1 Model for Pre-Design of the Gowan Detention Basin" by G.C. Wallace, Inc., for the City of Las Vegas, August 1988; and the "Design Report for the Gowan Detention Basin Outfall Structure" by VTN for the City of North Las Vegas, May 1990. The HEC-1 data files from the B&V study were used as the primary source of basic subarea area, curve number, lag time, and kinematic runoff parameters for the Sheep Mountain and Spring Mountain Storm models. The VTN and Wallace models were used to supplement the B&V study with additional subareas and recommended drainage facilities. Chapter 4 describes the hydrologic analysis of the Gowan watershed.

JMM's modeling revisions have involved three separate areas. First, the B&V Spring Mountain Storm HEC-1 model was used as the basis for JMM's modeling of flows and calibration to the COE Special Flood Hazard Study flows at the A Channel Inlet. Second, the B&V Sheep Mountain Storm HEC-1 model was used as the basis of the analysis of the calibration flows at the upstream end of the Main Channel of Las Vegas Wash. Third, the B&V Lower Central Valley Storm was used to determine discharges associated with a storm occurring below existing and proposed detention basins.

In each case, the 10-, 50-, and 100-year existing conditions, existing facilities flows were modeled. 500-year discharges were determined through extrapolation. The major revisions to the B&V HEC-1 data files are described below. A subarea map is shown in Figure 3.1; this map was adapted from the B&V report. In addition, Northern Las Vegas Wash subareas are shown in Figure S-2 (Appendix B). Figure 3-2 shows the assumed areal coverage for the Sheep Mountain, Spring Mountain and Lower Central Valley storms.

For FIS purposes, three proposed flood control projects have been considered "existing facilities". These are the Upper Las Vegas Wash Detention Basin under design by Black & Veatch, modifications to the existing North Las Vegas Detention Basin proposed by B&V, and the West Range Wash Diversion Dike under design by Boyle. An initial set of model runs were made without these proposed facilities to allow for calibration to previous COE and B&V discharges. The proposed facilities were then introduced to the models to generate FIS flows.

MODIFICATIONS TO EXISTING CONDITIONS MODEL FROM BLACK & VEATCH

The following changes were made by JMM to the B&V existing conditions/existing facilities model.

1. Previous HEC-1 runs for the B&V analyses were made using the 1985 version of the program. FIS Hydrology runs were made using the 1988 version.

2. Kinematic routing computations in upland, natural channel reaches were changed to the Muskingum routing method (RM cards) to assure compatibility with the 1988 version of the HEC-1 program. In addition, this method is consistent with the District's Hydrology Manual. Routing computations for regularly-shaped, improved channels were left as kinematic wave method (RK cards). In cases where data files would not run using the 1988 version of the program due to conflicts with kinematic wave routing, routing steps were either subdivided, combined with adjacent routing steps, or replaced by Muskingum routing.

3. Where a diversion (DI and DQ cards) is immediately followed by a kinematic wave routing step, the 1988 version of the program often gives zero flow or translates the full flow without attenuation. There appears to be no predictable pattern as to when this will occur. To eliminate this problem, kinematic wave routing steps immediately downstream of a diversion were replaced by Muskingum routing.

4. Where the recall of a diversion (DR cards) was followed immediately with kinematic routing, the 1988 version of the program terminates with a "divide by zero" error. To eliminate this problem, dummy subbasins with near-zero (0.001 sq mi) areas were introduced at the diversion recall location so the program would continue to process through this step.

5. Depth-area reduction factors (DARF's) used by B&V were based on Hydro 40. These have been changed to the CCRFCD Manual DARF's and applied to B&V's precipitation depths. The revised DARF's for the three design storm models are lower than those used by B&V resulting in lower design precipitation depths.

Depth-Area Reduction Factors

	B&V	FIS
Spring Mountain Storm	0.62	0.51-0.56
Sheep Mountain Storm	0.62	0.54
Lower Central Valley Storm	0.62	0.53-0.66

6. For the Sheep Mountain and Spring Mountain Storm models, the DARF's appropriate for the total drainage/storm areas were modeled (169 and 200 sq mi, respectively). These storm centerings were selected because the B&V study determined that they produced critical flows for the respective branches of Las Vegas Wash. Additionally, for the Spring Mountain Storm models, a second run with a DARF for 136 sq mi was modeled for the West Tributary and Gowan area concentration points.

7. Curve numbers (CN) in the B&V modeling were accepted for the current modeling. The curve numbers used by B&V were consistently higher (by 1 unit) than those used by Wallace and VTN for the same subareas. Where subareas were taken from the Wallace

or VTN studies, the curve numbers were adjusted to be consistent with the B&V modeling.

8. For the Sheep Mountain Storm and Lower Central Valley Storm models, the King Charles Channel and related facilities were included as existing drainage facilities. These were not in the B&V model. The Upper Las Vegas Wash Detention Basin was not included in the model for calibration runs.

9. For the Sheep Mountain Storm models, 250 hydrograph ordinates were used for the 10- and 100-year runs; 180 hydrograph ordinates were used for the 50-year run. The original B&V runs used 300 ordinates (the maximum number). The changes to the number of hydrograph ordinates were made to eliminate kinematic wave (RK) routing problems with the new (1988) version of HEC-1. The output was reviewed to ensure all of the peak flows were occurring within the specified modeling period.

10. Upper Las Vegas Wash Detention Basin was modeled for FIS production runs using storage-outflow data provided by B&V based on final design criteria. It is noted that the final selected site is lower in the watershed than the site recommended in the original B&V report; the final site is modeled in the FIS simulations.

11. West Range Wash Diversion Dike was considered as an existing facility. This facility will direct a portion of the Range Wash watershed into the North Las Vegas Detention Basin. Hydrologic evaluations of various storm centerings by B&V determined that storms centered over Range Wash or a combination of Range and Las Vegas Washes would not produce higher discharges in lower Las Vegas Wash than storms centered in Las Vegas Wash alone. Thus, this diversion facility was not modeled for the Las Vegas Wash FIS study.

12. B&V has proposed that the North Las Vegas Wash Detention Basin be modified by closing one of the five outlet pipes. This modification was included in the FIS production runs (but not the calibration runs) using storage-outflow data provided by B&V.

SUMMARY OF RESULTS

Table 3-1 presents a summary of the simulated 100-year discharges for existing land use conditions at key points in the Upper Las Vegas Wash watershed. These flows do not include effects of the proposed detention basin improvements. Where available, a comparison between the preliminary flows modeled by the FIS Hydrology and those modeled by B&V and the COE are presented. Notes on the table provide partial explanations for the differences between the flows generated in the different studies.

The objective of the modeling was to develop discharges consistent with the CCRFCD adopted regulatory discharges from the COE Special Flood Hazard Study. For Northern Las Vegas Wash, flows were adopted at the UPRR and downstream of Las Vegas Blvd (CP 6 and CP 7). Table 3-1 shows that for both of these locations, simulated 100-year flows agree to within 5 percent of the COE flows.

Conversion from the 1985 to the 1988 version of HEC-1 and from kinematic to Muskingum channel routing has unusually complex effects on the simulated discharges. A detailed evaluation of model comparisons using the Range Wash HEC-1 data file yielded the following key conclusions:

1. The 1988 Kinematic routing gives much less attenuation than the 1985 kinematic routing. The 1988 program results are more consistent with the kinematic routing theory, which suggests that hydrographs should be translated but only minimally attenuated by this procedure.

2. Muskingum routing generally results in less peak attenuation than kinematic routing in the 1985 program, and more peak attenuation than kinematic routing in the 1988 program. This is due to the differences in the kinematic methods, not in the Muskingum methods.

As a result of the above effects, it is possible for conversion from 1985 kinematic routing to 1988 Muskingum routing to produce higher discharges in some locations. This helps explain why the FIS Hydrology 100-year discharge is lower than the B&V discharge at node 125, but is higher than the B&V discharge at node WTRIBUS.

Based on the "calibrated" results shown in Table 3-1 for the 100-year flood, HEC-1 models were developed for the 10- and 50-year floods. These models utilize the same curve number and lag time parameters as the 100-year model. Results are summarized in Table 3-2 for existing conditions at the same key points as Table 3-1 in the Upper Las Vegas Wash watershed. It is seen that at both CP 6 and CP 7, the 10- and 50-year discharges do not compare as well with the COE computed probability flows as the 100-year discharges. This is due in part to the fact that the COE analysis utilized higher uniform loss rates for the more frequent events, whereas the District Manual allows for use of the same curve numbers for all of the storms analyzed for this study.

Table 3-2 presents discharges based on the COE regional discharge-frequency relationship developed for the Feasibility Study. This is the relationship used to calibrate the COE HEC-1 models, and was used by the COE in conjunction with the model results to select discharges for the study. It can be seen that in some cases, there are considerable differences between the regional values and the COE-adopted values, as well as between the regional values and the FIS Hydrology model results. Nonetheless, in general, there is good agreement between the model output and the COE regional frequency values. Of the 15 comparisons between the two approaches, six are within ten percent and 10 are within 20 percent. It is seen that the slope of the frequency curve for the COE regional frequency discharges is steeper than that for the model output; this was the justification for the COE to use higher loss rates for the more frequent floods in its hydrologic analysis.

The rationale used by the COE to determine recommended flows involved hydrologic judgement and experience, and is not documented specifically in the Hydrologic Documentation Report for every concentration point; thus it is not possible to apply this identical strategy to the FIS discharge analysis.

After the "calibration" modeling summarized in Tables 3-1 and 3-2 had been completed, CCRFCD agreed with a recommendation of the City of North Las Vegas that Upper Las Vegas Wash Detention Basin and North Las Vegas Wash Detention Basin improvements should be added to the "existing conditions" analysis. These modeling changes were made based on the assumptions discussed in the previous section. Results of the B&V hydrologic analysis for the Upper Las Vegas Wash Detention Basin Predesign indicated that peak discharges in N Channel are generated by the Spring Mountain Storm (routed through the two Las Vegas Wash detention basins). The same analysis showed that peak flows in A Channel are generated by the Lower Central Valley Storm which is centered downstream of the detention basins. Thus FIS flows were generated using these two storm centerings. It is noted that the Lower Central

Valley Storm covers a portion of the Gowan watershed. Chapter 4 describes the existing conditions assumptions for this area, which include consideration of the proposed Gowan Detention Basin. This differs from the B&V existing conditions assumptions in this area. Use of the Lower Central Valley Storm produces different (more critical) discharges than the upper storms in lower N Channel, lower A Channel, and Las Vegas Wash below the confluence of these two channels.

Table 3-3 presents results of the 10-, 50-, and 100-year FIS modeling and recommended FIS discharges for Northern Las Vegas Wash study reaches. Due to the major facility differences between this FIS modeling and the modeling used to produce the CCRFCD regulatory discharges, the new model results are recommended as adopted FIS discharges.

Discharges for the 500-year flood were determined graphically by extrapolating the discharges for the lower three storms. Flood frequency plots used to perform the extrapolations are shown in Figures 3-3 and 3-4.

The HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix for reference.

TABLE 3-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR NORTHERN LAS VEGAS WASH FIS HYDROLOGY

FIS Hydrology CP/Node	Area*	DARF	Flow	B&V Facility Study CP/Node	Area*	DARF	Flow	COE Computed Probability CP/Node	Area	DARF	Flow	Note	Description
Sheep Mtn Storm: Main Las Vegas Wash													
125	163.7	0.535	11730	125	163.7	0.62	14719	-	-	-	-	1	Upper Las Vegas Det. Basin site
101	168.7	0.535	11412	101	168.7	0.62	14895	-	-	-	-	1,6	u/s of NLV Det. Basin Diversion
DIVDIKE	168.7	0.535	2065	DIVDIKE	168.7	0.62	4574	-	-	-	-	2	Divert flow fr/NLV Det. Basin
DIVDIKE(.)	168.7	0.535	9347	DIVDIKE(.)	168.7	0.62	10321	-	-	-	-	3	Remaining flow into NLV Det. Basin
NLVDET	168.7	0.535	5167	NLVDET	168.7	0.62	5248	-	-	-	-	4	Outflow fr/NLV Det. Bas.
303	168.7	0.535	5414	303	168.7	0.62	5262	-	-	-	-	4	N Channel at UPRR
NCHANNL	168.7	0.535	5400	NCHANNL	168.7	0.62	5247	-	-	-	-	4	N Channel u/s of Confluence
Spring Mtn Storm: Western Tributary to Las Vegas Wash													
WTRIBUS	136.3	0.56	14628	WTRIBUS	136.3	0.62	13132	-	-	-	-	3	u/s end of W. Tributary
GOWANDIV	0	0.56	3064	GOWANDIV	0	0.62	4321	-	-	-	-	7	all flows diverted fr/Gowan Area
GOWANDIV(.)	136.3	0.56	17626	GOWANDIV(.)	136.3	0.62	17363	-	-	-	-	4	combine W.Trib+Gowan Diversions
SNIC	198.2	0.51	14919	SNIC	198.2	0.62	14227	6**	733	-	14500	4,5,6	at SNIC
ACHANNL	198.2	0.51	15681	ACHANNL	198.2	0.62	14982	7**	735	-	15000	4,5	A Channel
LKMEAD	198.2	0.51	15643	LKMEAD	198.2	0.62	14948	7**	735	-	15000	4,5	Lake Mead Blvd.

* = Area of storm; may be smaller than total drainage area ** = location of CCRFCD regulatory discharge from COE study

Notes:

General - FIS hydrology based on new (1988) HEC-1, conversion to Muskingum routing in upland areas, and CCRFCD DARF's
B&V hydrology based on 1985 HEC-1, kinematic routing in all locations, and Hydro 40 DARF's
Simulations do not include Upper Las Vegas Wash Detention Basin and Interception Berm

1. FIS Q lower than B&V Q due to lower DARF and kinematic-to-Muskingum routing conversions
2. High flow difference due to diversion statement sensitive to inflow (only diverts Q over 8200 cfs)
3. FIS and B&V flows agree within 10%
4. FIS and B&V flows agree within 5%
5. FIS Q calibrates to COE flow within 5%; adopt CCRFCD regulatory flow
6. FIS Q lower than u/s node because storm centering has no rain over subareas low in watershed
7. Large flow difference due to rating curves for Rancho Rd culverts which are sensitive to inflow

TABLE 3-2

CALIBRATED NORTHERN LAS VEGAS WASH FIS DISCHARGES

Node	Area (sq mi)	10-Year Peak Discharge COE Reg Q	COE SFHS Q	Model Output	Calibrated Flow	50-Year Peak Discharge COE Reg Q	COE SFHS Q	Model Output	Calibrated Flow	100-Year Peak Discharge COE Reg Q	COE SFHS Q	Model Output	Calibrated Flow	500-Year Peak Discharge COE SFHS Q	Model Extrap	Calibrated Flow
Sheep Mtn Storm:																
125	163.7	2627	-	2858	2900	8803	-	9214	9200	13489	-	11730	11700	-	26000	26000
101	168.7	2832	-	2761	2800	9322	-	8964	9000	14195	-	11412	11400	-	25000	25000
DIVDIKE	168.7	-	-	0	0	-	-	444	400	-	-	2065	2100	-	11000	11000
DIVDIKE(.)	168.7	-	-	2761	2800	-	-	8521	8500	-	-	9347	9300	-	14000	14000
NLVDET	168.7	-	-	1651	1700	-	-	3915	3900	-	-	5167	5200	-	9400	9400
303	168.7	-	-	1637	1600	-	-	3901	3900	-	-	5414	5400	-	11000	11000
NCHANNL	168.7	-	-	1636	1600	-	-	3900	3900	-	-	5400	5400	-	11000	11000
Spring Mtn Storm:																
WTRIBUS	136.3	2341	-	3429	3400	7984	-	10229	10200	12312	-	14628	14600	-	30500	30500
GOWANDIV	0	-	-	694	700	-	-	2060	2100	-	-	3064	3100	-	7000	7000
GOWANDIV(.)	136.3	-	-	4043	4000	-	-	12256	12300	-	-	17626	17600	-	38000	38000
SNIC	198.2	2472	1900	3207	3200	8355	8500	10317	10300	12814	14500	14919	14500	39000	40000	39000
ACHANNL	198.2	3054	2000	3312	3300	9699	8600	10887	10900	14586	15000	15681	15000	40000	42000	40000
LKMEAD	198.2	3821*	2000	3305	3300	11712*	8600	10856	10900	17392*	15000	15643	15000	40000	42000	40000

Node	Location
125	Upper Las Vegas Detention Basin site
101	u/s of NLV Detention Basin Diversion
DIVDIKE	Divert flow fr/NLV Detention Basin
DIVDIKE(.)	Remaining flow into NLV Detention Basin
NLVDET	Outflow fr/NLV Detention Basin
303	N Channel at UPRR
NCHANNL	N Channel u/s of confluence with A Channel
LVWASH	d/s end of Gowan Area
WTRIBUS	u/s end of Western Tributary
GOWANDIV	all flows diverted fr/Gowan Area
GOWANDIV(.)	combine Western Tributary + Gowan Diversions
SNIC	at SNIC
ACHANNL	A Channel
LKMEAD	Lake Mead Blvd.

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Model Extrap = Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output

Area = Area of storm coverage only; not necessarily the total drainage area
* = Does not account for regulation by NLV Detention Basin
(shaded) = FIS concentration point

Note: Calibration simulations do not include Upper Las Vegas Wash Detention Basin

TABLE 3-3

PROPOSED NORTHERN LAS VEGAS WASH FIS DISCHARGES

Node	Storm	Area (sq mi)	DARF	10-Yr Peak Discharge (cfs)		50-Yr Peak Discharge (cfs)		100-Yr Peak Discharge (cfs)		500-Yr Peak Discharge (cfs)	
				Model Output	Adopted Flow	Model Output	Adopted Flow	Model Output	Adopted Flow	Model Extrap	Adopted Flow
RRBRIDGE	Spring Mountain	136.3	0.56	1444	1440	2598	2600	3052	3050	4626	4630
NC5	Spring Mountain	136.3	0.56	288	288	520	520	618	618	940	940
304	Lower Central Valley	64.5	0.66	1187	1190	2559	2560	3515	3520	6103	6100
ACHANNL	Lower Central Valley	111.6	0.59	2159	2160	5122	5120	6734	6730	12447	12400
NCHANNL	Lower Central Valley	172.2	0.53	1668	2160	4372	5120	5850	6730	11595	12400

Node	Location
RRBRIDGE	Total flow at RR bridge (before diversion along RR to A Channel - equivalent to node 303)
NC5	Outflow from NLV Det. Basin routed through N Channel (below King Charles Channel diversion)
304	Route subbasin 301, Gowan Outfall, and diverted Gowan Area flow through subbasin 304 to Craig Rd
ACHANNL	Upstream end of A Channel
NCHANNL	Intersection of N Channel and A Channel

Notes:

Area =	Area of storm coverage only; not necessarily the total drainage area
Model Output =	FIS HEC-1 Model Output
Adopted Flow =	Adopted Flow for FIS Purposes
Model Extrap =	Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Adopt Extrap =	Extrapolation of Adopted Flows for Q10, Q50, and Q100

FIS Hydrology includes Upper Las Vegas Wash Detention Basin and Interception Berm, Gowan Detention Basin and other Gowan Area facilities (see Chapter 4), and West Range Wash Diversion Dike

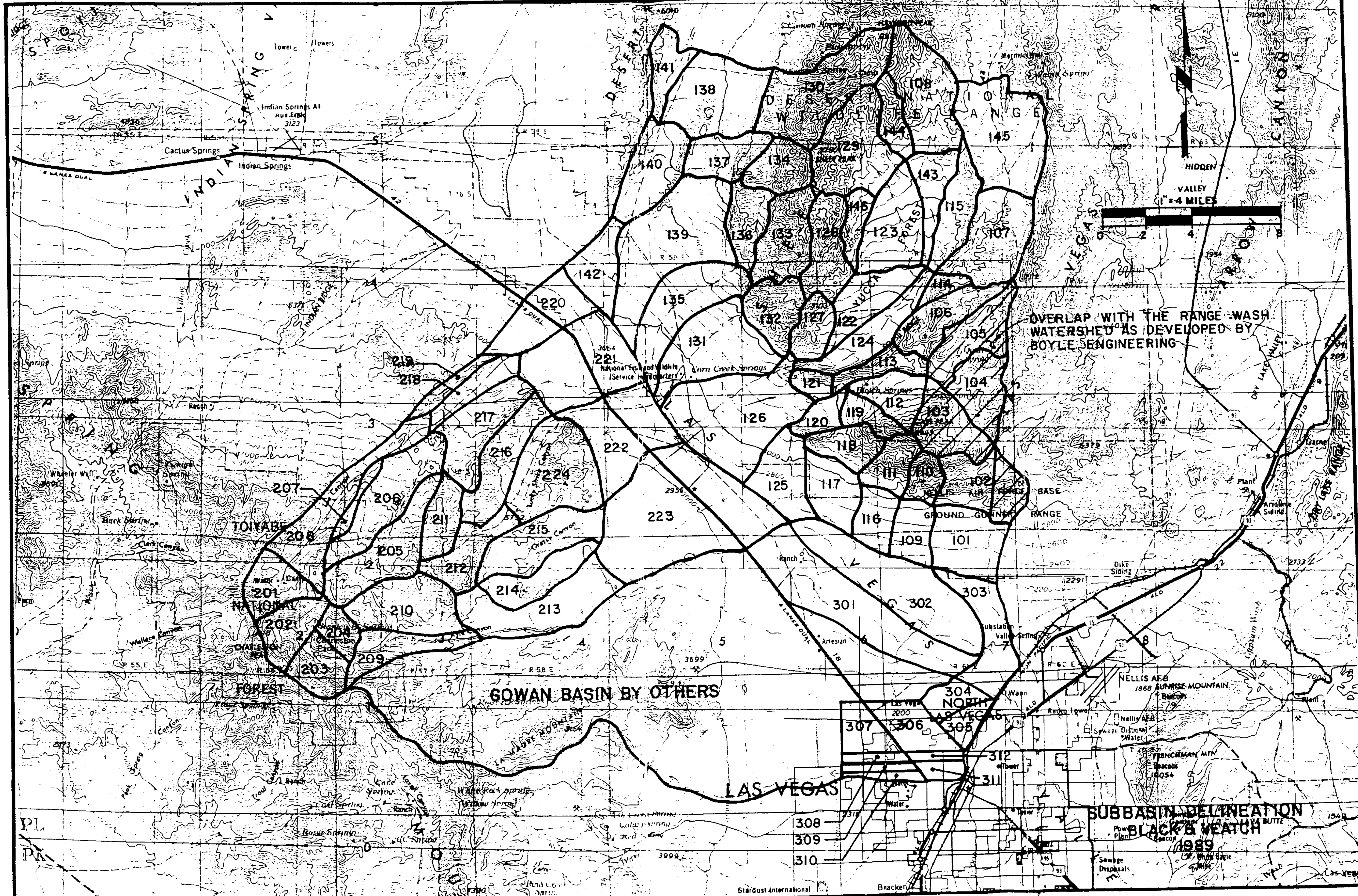

OVERLAP WITH THE RANGE WASH
WATERSHED AS DEVELOPED BY
BOYLE ENGINEERING
SUBBASIN DELINEATION
BLACK & VEATCH
1989
GOWAN BASIN BY OTHERS
LAS VEGAS
NORTH LAS VEGAS
1" = 4 MILES
0 2 4 8
HIDDEN VALLEY
NELLIS AIR FORCE BASE
GROUND GUNNERY RANGE
DESERT NATIONAL WILDLIFE RANGE
INDIAN SPRINGS VALLEY
TOIYABE
NATIONAL
FOREST
Cactus Springs
Indian Springs
Corn Creek Springs
Stardust International

FIGURE 3-1

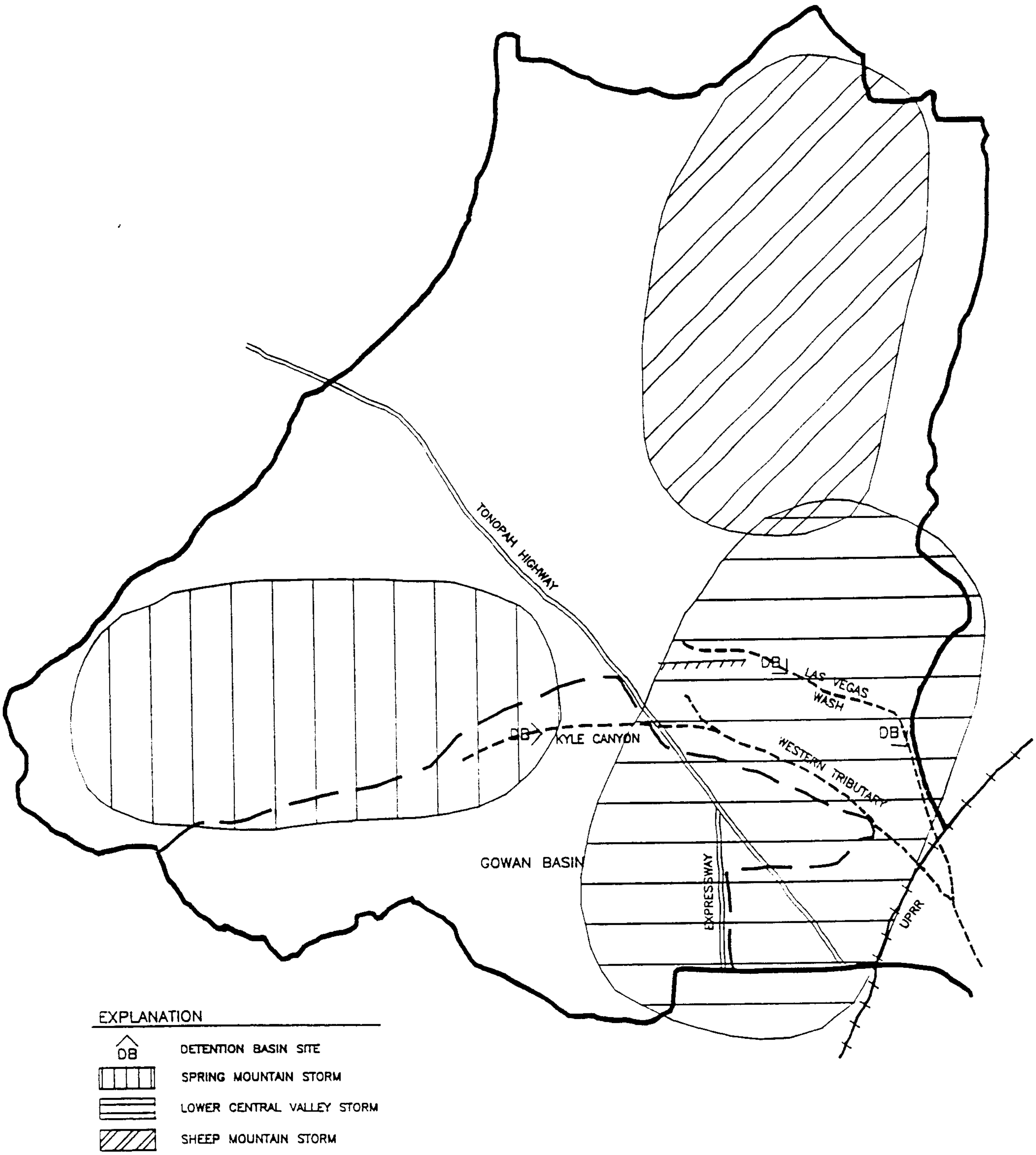


FIGURE 3-2

CCRFCD LAS VEGAS VALLEY MASTER PLAN UPDATE	NORTHERN LAS VEGAS WASH STORM CENTERINGS

FIGURE 3-3
NORTHERN LAS VEGAS WASH FIS DISCHARGES
(PLOT #1)

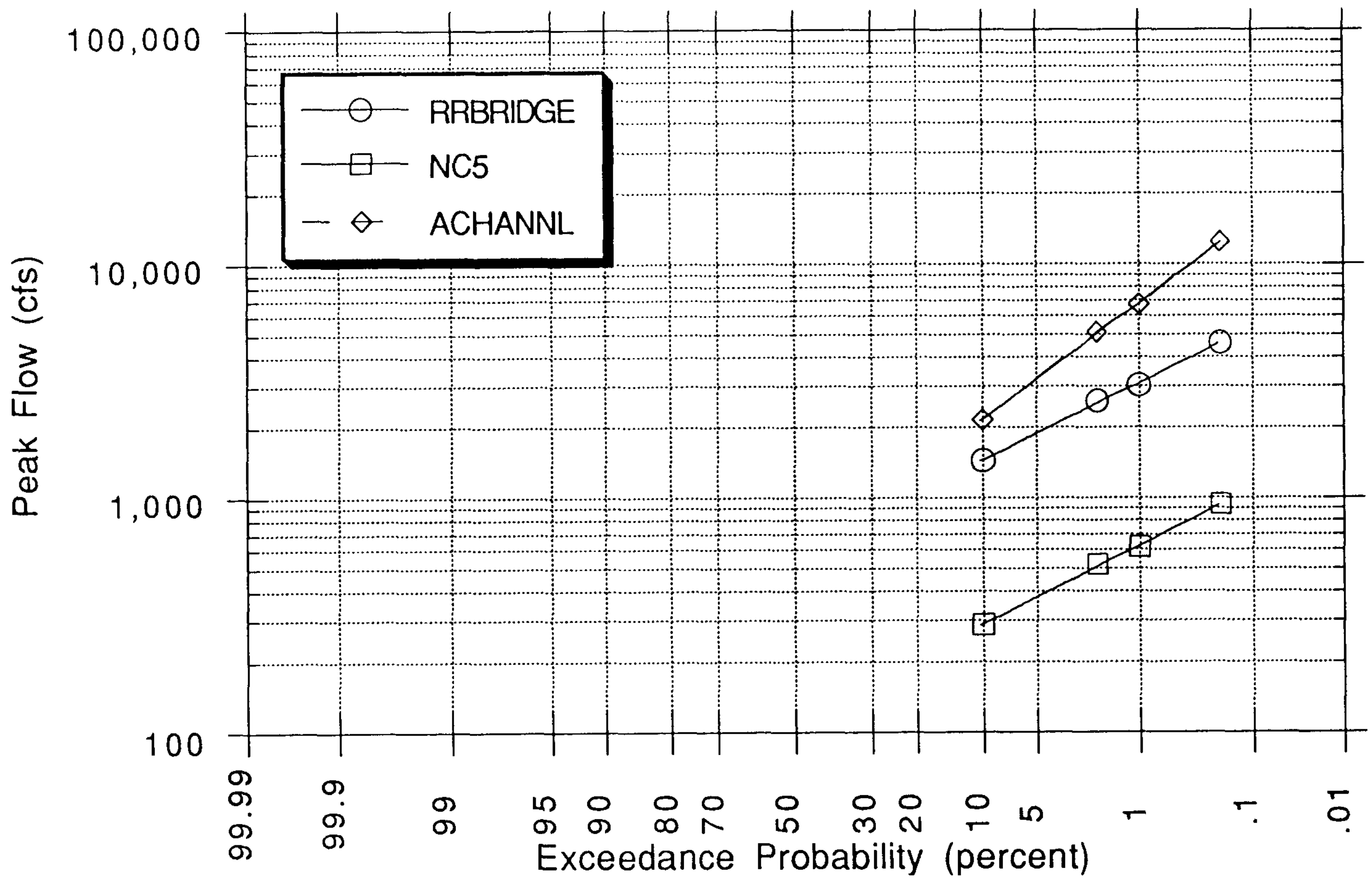
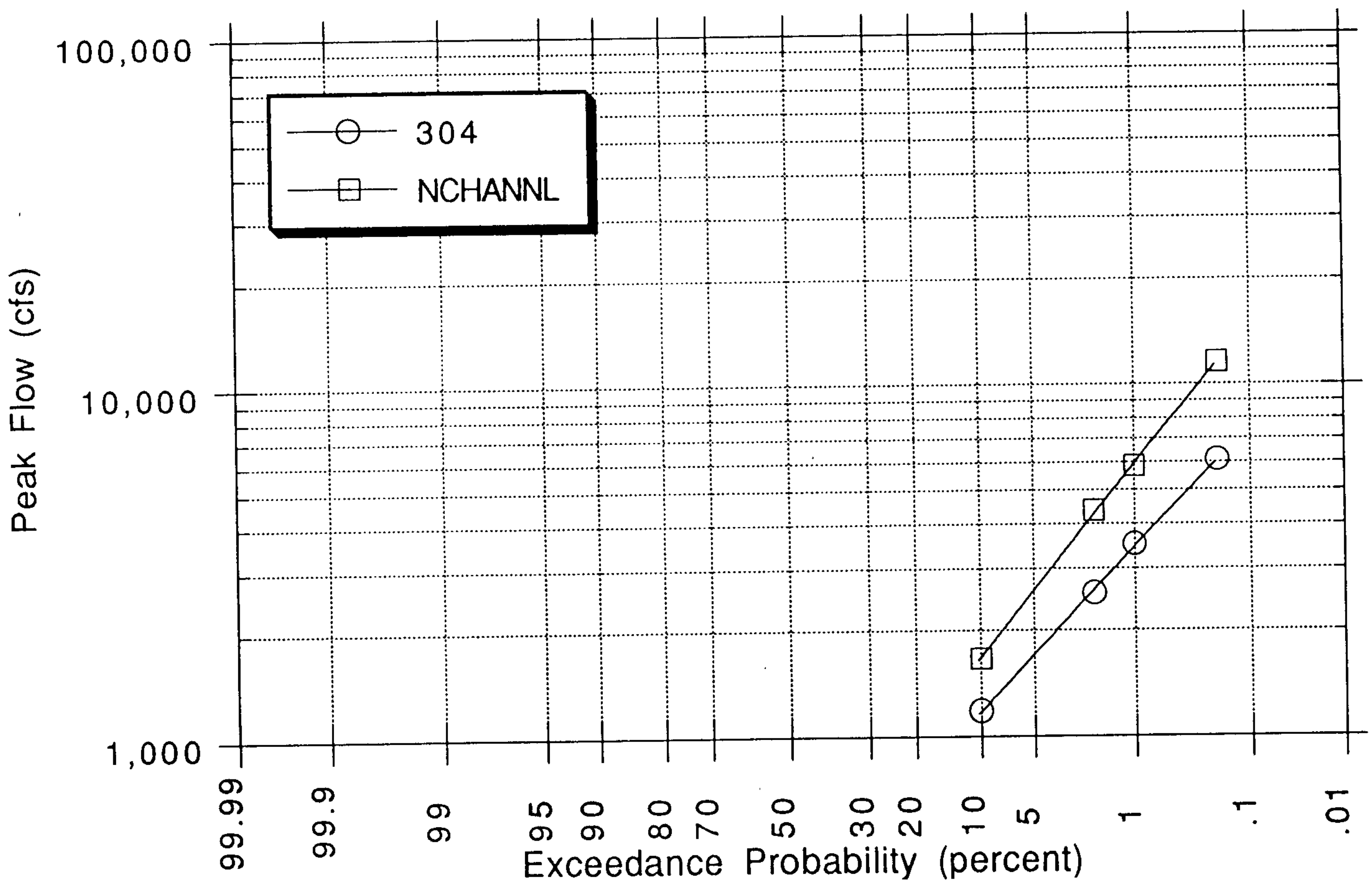


FIGURE 3-4
NORTHERN LAS VEGAS WASH FIS DISCHARGES
(PLOT #2)



CHAPTER 4
GOWAN AREA FIS HYDROLOGY

CHAPTER 4

GOWAN AREA FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/facilities analysis of the Gowan Area conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for the Gowan Area. In addition, results could be used to assess the adequacy of existing facilities to handle existing conditions flood discharges.

For the purposes of this report, the Gowan Area is defined as the watershed generally limited by the Angel Park Detention Basin tributary area on the south; the Kyle Canyon drainage area on the north; and Tonopah Highway and the Gowan Outfall tributary area on the east.

The bases of the hydrologic analysis were the HEC-1 models developed by Black and Veatch (B&V) for the "Flood Control Facilities Plan for the Northern Las Vegas Wash" for the City of North Las Vegas, August 1989. Previous hydrologic studies of the watershed also include the CCRFCD Master Plan; the Corps of Engineers' (COE) Special Flood Hazard Study; the "Hydrology Report - Methodologies and HEC-1 Model for Pre-Design of the Gowan Detention Basin" by G.C. Wallace, Inc., for the City of Las Vegas, August 1988; the "Gowan Detention Basin Pre-Design" by G.C. Wallace, Inc., for the City of Las Vegas, March 1989; the "Design Report for the Gowan Detention Basin Outfall Structure" by VTN for the City of North Las Vegas, May 1990; and the "Summerlin Stormwater Management Plan - Hydrology Report of Existing Conditions" by Boyle Engineering Corporation (Boyle), July 1990. The HEC-1 data files for the Lower Central Valley Storm from the B&V study were used as the primary source of basic subarea area, curve number, lag time, and kinematic routing parameters. The VTN, Wallace, and Boyle models were used to supplement the B&V study with additional subareas, curve numbers, and recommended drainage facilities.

The previous chapter describes the hydrologic analysis of Northern Las Vegas Wash, to which the Gowan Area is tributary.

For the Gowan Area, the 10-, 50-, and 100-year existing conditions, existing facilities flows were modeled. 500-year discharges were determined through extrapolation. The major revisions to the B&V data files are described below. The subarea delineations are the same as depicted in the Wallace report. These are shown in Figure S-2 (Appendix B).

REVIEW OF PAST STUDIES

The relationships among these past studies are complex, in that they borrowed extensively from each other and yet all were developed to analyze a different set of conditions. The basic assumptions and objectives of each of the recent predesign studies are briefly summarized below.

<u>Gowan Detention Basin Predesign/Wallace</u> - This was the first post-Master Plan detailed hydrology study in the Gowan Area. Subarea boundaries did not follow those used in the Master Plan. Two conditions were modeled - existing land use/existing facilities and ultimate land use/ultimate facilities. Problems with certain model parameters (e.g., subarea

precipitation) and recommended alternatives were corrected in the March 1989 update to the original report. Facility recommendations included an enlarged Angel Park Detention Basin, Gowan-North and Gowan-South Detention Basins, and Angel Park Outfall and Buffalo Channel connecting the Angel Park and Gowan Detention Basins, the Gowan Outfall Channel, and a series of detention basins and channels in the upper Gowan area watershed.

Upper Las Vegas Wash Facility Study/B&V - B&V included the Gowan Area in the hydrologic analysis of Upper Las Vegas Wash, but was only interested in results at Las Vegas Wash itself. B&V utilized the Wallace subareas, with small modifications, for the area west of Highway 95. B&V increased the Wallace curve numbers by 1.0 unit, and further adjusted curve numbers and lag times for certain key subareas in order to "calibrate" the model to the 1975 storm. Precipitation depths agreed with the 1989 Wallace study. Flow divisions at culverts in Highway 95 and Rancho Rd agreed with the Wallace study for Highway 95 north of Rancho Rd, but were revised for the culverts below the intersection of these two roadways. The B&V model shows more flow crossing Highway 95 rather than being routed south into the Gowan Detention Basin area under existing conditions. B&V modeled existing land use/existing facilities and ultimate land use/ultimate facilities. The proposed improvements in the Gowan Area were taken from the Wallace study recommendations. The B&V model yields similar results to the Wallace model, except in the area downstream of the Highway 95 and Rancho Rd culverts.

Gowan Outfall Structure Design/VTN - This study used the basic Wallace subareas in the area upstream of the Gowan Detention Basins, and developed a much more detailed subarea system in the drainage area tributary to the Gowan Outfall Channel itself. VTN made changes to the Wallace model in the lower Gowan Area (i.e., east of Highway 95) to include the effects of new developments. In addition, VTN further revised the flow splits at the Highway 95 and Rancho Rd culverts; in general the VTN model limits flow across these roadways to the culvert capacities (i.e., no flow over the roadway is assumed). The Gowan Outfall Structure study analyzed only ultimate land use with proposed improvements. In the upper Gowan Area this included the proposed diversions, channels and detention basins recommended in the Wallace study. Because the VTN project only considered ultimate conditions, it is not pertinent to the FIS hydrologic analysis.

Summerlin Stormwater Management Plan/Boyle - This study covered the Summerlin development area only, which includes the Angel Park Detention Basin drainage area and the southwestern portion of the Gowan-South Detention Basin drainage area. The hydrologic model terminated at the eastern edge of the proposed development, which is west of Highway 95. The Boyle study used a much more detailed subarea definition than past studies (e.g., it subdivides the Angel Park drainage area into 30 subbasins compared to the 12 subbasins used by Wallace), and subarea comparison with past studies is not straightforward. Boyle investigated soil types in the area, and as a result revised curve numbers compared to past modeling studies. Further, Boyle computed subarea lag times for large subbasins using the USBR lag formula rather than the upland method, and generally selected shorter lag times for the alluvial fan subareas and slightly longer lag times for the mountain subareas. Results of the Boyle existing conditions modeling are about 15% higher than results from previous studies. It is noted that the Summerlin report was received by JMM after initial model development had been completed in the Gowan Area.

Based on review of the above reports, it was concluded that the B&V modeling was the most appropriate starting point for development of an existing conditions model for FIS hydrology which would meet the guidelines of the CCRFCD Hydrology Manual.

MODIFICATIONS TO EXISTING CONDITIONS MODEL FROM BLACK & VEATCH

The following changes were made by JMM to the B&V existing conditions/existing facilities HEC-1 model.

1. Previous HEC-1 runs for the B&V analyses were made using the 1985 version of the program. FIS Hydrology runs were made using the 1988 version.

2. Kinematic routing computations in upland, natural channel reaches were changed to the Muskingum routing method (RM cards) to assure compatibility with the 1988 version of the HEC-1 program. In addition, this method is consistent with the District's Hydrology Manual. Routing computations for regularly-shaped, improved channels were left as kinematic wave method (RK cards). In cases where data files would not run using the 1988 version of the program due to conflicts with kinematic wave routing, routing steps were either subdivided, combined with adjacent routing steps, or replaced by Muskingum routing, or the total simulation period was shortened.

3. Where a diversion (DI and DQ cards) is immediately followed by a kinematic wave routing step, the 1988 version of the program often gives zero flow or translates the full flow without attenuation. There appears to be no predictable pattern as to when this will occur. To eliminate this problem, all kinematic wave routing steps immediately downstream of a diversion were replaced by Muskingum routing.

4. Depth-area reduction factors (DARF's) used by B&V were based on Hydro 40. These have been changed to the CCRFCD Manual DARF's and applied to B&V's point precipitation depths. The revised DARF's for concentration points of interest in the Lower Central Valley Storm model vary from 0.554 to 0.909 (depending on specific storm centering), compared to the single overall value of 0.62 used by B&V.

5. Separate storm centerings were simulated using appropriate DARF's for each control point where FIS flows are required. A total of seven different DARF's were modeled based largely on the storm centerings which VTN reported to have produced the largest peak discharges at the control points, and supplemented with storm centerings representing the total tributary area at the point of interest. The storm sizes ranged from 4.2 sq mi for the small upland alluvial fan areas to 158 sq mi for the control point at the Gowan Area outfall at Las Vegas Wash. Averaged DARF's were used for similar sized storms in order to keep the required simulations to a manageable number. For each storm centering, precipitation was modeled only for those subareas within the storm area.

6. In general, curve numbers (CN) in the B&V modeling were accepted for the current modeling. The curve numbers used by B&V were consistently higher (by 1 unit) than those used by Wallace and VTN for the same subareas. Where subareas were taken from the Wallace or VTN studies, the curve numbers were adjusted to be consistent with the B&V modeling.

   CN's in the area covered by Boyle's Summerlin analysis were revised based on the detailed hydrologic soils analysis from the Boyle study. New CN's were determined for the B&V/Wallace subareas based on the Boyle soils data and have been incorporated into the HEC-1 modeling. The revised CN's are generally slightly lower than those used by B&V.

7. For the Gowan Area model, there are several drainage improvements for which construction is either complete or will be complete by the time the FIS flows are used. These include the Gowan-North and Gowan-South Detention Basins and the Outfall Channel to Las Vegas Wash; Cheyenne Channel into the Gowan-South Detention Basin from the west; Angel Park Detention Basin expansion and Outfall Channel; the Hualapai Diversion into the Angel Park Detention Basin; and Buffalo Channel connecting the Angel Park Outfall Channel and Gowan-South Detention Basin. Each of these improvements was considered to be an "existing facility" for the purposes of the FIS Hydrology modeling. Existing condition subarea boundaries were not revised in these areas (although proposed facilities would have minor impacts on existing drainage patterns), but were brought into the improved facilities at the nearest existing node.

   The input data (storage rating curves) for the Gowan-North and Gowan-South Detention Basins were taken from the VTN model (3900EX4.DAT). This model is more recent (January 1990) than the Wallace modeling (August 1988) which combined the Gowan-North and Gowan-South basins into a single rating curve; the VTN model also included "refined Gowan S. and N. Stage Storage Curves." It is noted that final design of the Gowan Detention Basins, currently underway by Poggemeyer Design Group, could modify this data. The input data for the Angel Park Detention Basin was taken from the recommended improvements model in the Wallace report. This remains the proposed final configuration for Angel Park.

8. For those subareas located downstream of Highway 95 and north of the Angel Park Detention Basin, subarea designations from the Wallace existing conditions model were adopted (EPT.XX and GD.XX, respectively). Although the VTN analysis incorporated a more detailed subarea network, particularly downstream of Highway 95, this analysis only considered ultimate land use conditions and thus was not valid for FIS hydrology.

9. At each FIS control point, the critical storm for the 100-year recurrence interval was determined. Table 4-1 compares peak discharges generated by the different storm centerings at each control point of concern. The critical storm is that which produces the maximum peak discharge at the point of interest. The 100-year critical storm centering was also used for the 10- and 50-year model runs.

10. A slightly shortened modeling period (reduced number of hydrograph ordinates) was used for certain 10- and 50-year model runs. The original B&V runs used 300 ordinates (the maximum number). The changes to the number of hydrograph ordinates were required to eliminate RK routing problems with the new version of HEC-1. The output was reviewed to ensure that all of the peak flows were occurring within the specified modeling period.

11. As was stated previously, the Boyle modeling for Summerlin modified subarea lag times based on the recommendation of the CCRFCD Hydrology Manual. In order to test the sensitivity of this adjustment, lag times for the FIS Hydrology subbasins tributary to Angel Park Detention Basin were recomputed using the USBR lag formula, and a new Angel Park inflow was computed. (It is noted that the Boyle curve number revisions were already included in the FIS Hydrology model.) The results are compared below.

	Angel Park 100-year Inflow	Gowan-North 100-year Outflow
FIS Hydrology model	6,760 cfs	2,450 cfs
FIS Hydrology model with USBR lags	7,130 cfs	2,480 cfs
Boyle Summerlin model	7,830 cfs	Not Computed

These results indicate that the lag adjustments only increase the peak discharge by 5 percent. This magnitude of change was not considered significant enough to make lag adjustments to all of the Wallace/B&V subareas utilized in the FIS Hydrology analysis. (It is noted that similar changes would have to be made in the Gowan Area HEC-1 models prepared for Northern Las Vegas Wash.) It appears that the Boyle model is yielding higher results than the previous modeling efforts due to a combination of different curve numbers, shorter lag times, possible channel routing differences, and the use of a larger number of smaller subareas.

12. An in-depth investigation was performed of possible assumptions for flow routing and diversions at the Highway 95 and Rancho Rd culverts. As described in a previous section, the past studies arrive at different flow splits at these culverts. In addition to the past predesign studies listed previously, several other studies have modeled or made assumptions regarding these flow splits. These include: Preliminary Design Report for Upper Mendenhall and Southern Nevada Industrial Center Channels by JMM (October 1987); Paradiso Drainage Report Addendum by Summit Engineers (August 1989); Revised Hydrology Study for High Country Estates by ESI (December 1986); and drainage studies for Rainbow Vista Units 11 and 12. Based on this investigation, it was concluded that the flow split diversions in the Black & Veatch model were reasonable representations of the current physical conditions, and were more representative than the diversions in either the Wallace or VTN models.

SUMMARY OF RESULTS

Table 4-2 presents a summary of the simulated 100-year discharges for existing conditions at key points in the Gowan Area watershed. A comparison between the preliminary flows modeled by the FIS Hydrology and those modeled by Wallace and Boyle are presented for the few locations where subbasins and facility assumptions agree. Comparisons of flows cannot be made for nodes downstream of Angel Park because the existing conditions Wallace analysis did not include diversions and channel improvements which were incorporated as "existing" facilities in the FIS modeling; and the Boyle study only covers the Summerlin area. Notes on the table provide partial explanations for the differences between the flows generated in the different studies. Comparisons cannot be made between the FIS Hydrology results and the results of the VTN study because it only modeled future conditions/future facilities.

An objective of the hydrologic modeling for the FIS Hydrology study is to develop discharges consistent with the CCRFCD adopted regulatory discharges from the COE Special Flood Hazard Study. However, for the Gowan Area, no COE Special Flood Hazard Study flows are available. Therefore, the "adopted" flows are based on the FIS Hydrology modeled flows.

Conversion from the 1985 to the 1988 version of HEC-1 and from kinematic to Muskingum channel routing has unusually complex effects on the simulated discharges. A detailed evaluation of model comparisons using the Range Wash HEC-1 data file yielded the following key conclusions:

1. The 1988 kinematic routing gives much less attenuation than the 1985 kinematic routing. The 1988 program results are more consistent with the kinematic routing theory, which suggests that hydrographs should be translated but only minimally attenuated by this procedure.

2. Muskingum routing generally results in less peak attenuation than kinematic routing in the 1985 program, and more peak attenuation than kinematic routing in the 1988 program. This is due to the differences in the kinematic methods, not in the Muskingum methods.

As a result of the above effects, it is possible for conversion from 1985 kinematic routing to 1988 Muskingum routing to produce higher discharges in some locations. This helps explain why the FIS Hydrology 100-year discharge is higher than the Wallace discharge at nodes GD.14B(.), PDGC(.), and ANGEL.PK.

Based on the results shown in Table 4-2 for the 100-year flood, HEC-1 models were developed for the 10- and 50-year floods. These models utilize the same curve number and lag time parameters as the 100-year model. Results are summarized in Table 4-3 for existing conditions at the same key points as Table 4-2 in the Gowan Area.

Table 4-3 presents discharges based on the COE regional discharge-frequency relationship developed for the Feasibility Study. This is the relationship used to calibrate the COE HEC-1 models, and was used by the COE in conjunction with the model results to select discharges for the study. It can be seen that in some cases, there are considerable differences between the regional values and the FIS Hydrology model results. However, these differences are due in part to the fact that the COE regional discharge-frequency analysis does not account for regulation by the Angel Park, Gowan-North, and Gowan-South Detention Basins.

Due to the lack of COE Special Flood Hazard Study flows for the Gowan Area and the presence of the two major detention basins, the "adopted" flows for FIS purposes were selected based on the HEC-1 modeling results with little concern for differences between COE regional flows.

Modeling results indicate that both the Angel Park and Gowan Detention Basins are subject to overflow during the 100-year flood under existing conditions (note that "existing conditions" includes improvements to Angel Park and construction of the proposed Buffalo Channel connecting Angel Park with the proposed Gowan-South Detention Basin). The 100-year peak stage in Angel Park is 2618.7 compared to a spillway crest elevation of 2618.5. The Angel Park overflow (600 cfs) will be directed to the Gowan-South Detention Basin by the Angel Park Outfall and Buffalo Channel. The Gowan-North Detention Basin experiences a 100-year peak stage of 2325.7 compared to a spillway crest elevation of 2325.5. Future construction of proposed detention basins in the Gowan area watershed will eliminate this overflow under ultimate conditions.

Discharges for the 500-year flood were determined graphically by extrapolating the discharges for the lower three storms. In the case of nodes R.G-UPS and DET.GN, the effect of the Gowan-North Detention Basin regulation is such that the 10-year and 50-year flows are contained in the basin while the 100-year flood overtops the basin. This results in a very nonlinear frequency curve at these locations. Because the 100-year discharges for these two nodes below the basin incorporated overflows, it was considered reasonable to extrapolate to the 500-year peak flow using the 100-year model discharge and the slope of the frequency plot for node LVWASH (the downstream study limit). Flood frequency plots used to perform the extrapolations are shown in Figures 4-1 to 4-4.

The HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix.

TABLE 4-1

GOWAN AREA - SUMMARY OF CRITICAL STORMS

Location / Node No.	Storm*	Storm Area (sq mi)	CCRFCD DARF	Q100 (cfs)	Critical Storm
Downstream terminus at Las Vegas Wash					
Node LVWASH (all subareas)	VTN Storm 3	26	0.76	2710	
Node LVWASH (all subareas)	Entire drainage area	158	0.544	4592	X
Node EPT.5(.) (all subareas except EPT.2)	VTN Storm 3	26	0.76	2584	
Node EPT.5(.) (all subareas except EPT.2)	Entire drainage area	158	0.544	4573	X
Gowan Outfall Channel at Rancho Road					
Node R.G-UPS. (route basin outflow d/s)	VTN Storm 4	92	0.613	2312	
Node R.G-UPS. (route basin outflow d/s)	Tributary area	144	0.556	2405	X
Gowan-North and South Detention Basins					
DET.GN (Outflow from Gowan-North)	VTN Storm 4	92	0.613	2359	
DET.GN (Outflow from Gowan-North)	Tributary area	144	0.556	2454	X
GN_IN (total inflow to Gowan-North)	VTN Storm 4	92	0.613	4465	X
GN_IN (total inflow to Gowan-North)	Tributary area	144	0.556	4063	
Rancho Road at Hwy 95					
Node PDGC(.) (Painted Desert Golf Course)	Tributary area	67	0.652	1518	X
Inflow to Angel Park Detention Basin					
Node ANGEL.PK	Tributary area	24	0.770	6762	X
Alluvial Fan Apexes					
Node GD.1	Tributary area	4.2	0.909	2522	X
Node GD.21	Tributary area	4.2	0.909	4531	X
Node GD.18	Tributary area	4.2	0.909	4096	X

Either VTN Storm # or area covered by storm

TABLE 4-2

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR GOWAN AREA FIS HYDROLOGY

FIS Hydrology				Wallace Study				Boyle Summerlin Hydrology						Adopted
CP/Node	Area*	DARF	Flow	CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	Note	Description	Discharge
LVWASH	157.9	0.544	4592	-	-	-	-	-	-	-	-	1,2	d/s terminus at LV Wash	4600
EPT.5(.)	156.4	0.544	4573	-	-	-	-	-	-	-	-	1,2	all Gowan Subareas except EPT.2	4600
R.G-UPS.	143.9	0.556	2405	-	-	-	-	-	-	-	-	1,2	Gowan Outfall Chnl @ Rancho Rd	2400
DET.GN	143.9	0.556	2454	-	-	-	-	-	-	-	-	1,2	Outflow fr/Gowan-No. Det. Bas.	2450
GN_IN	143.9	0.613	4465	-	-	-	-	-	-	-	-	1,2	Inflow to Gowan-No. Det. Bas.	4500
GD.14B(.)	100.1	0.613	2991	GD.14(.)	100.1	0.62	2785	-	-	-	-	2,4	Inflow to Gowan-No. fr/north	3000
PDGC(.)	67.2	0.652	1518	PDGC(.)	67.2	0.62	1337	-	-	-	-	5	Rancho Road at Hwy 95 (PDGC)	1500
ANGEL.PK	24.1	0.77	6762	ANGEL.PK	24.1	0.765	6730	ANGELP	24.5	0.77	7830	3,4,6	Inflow to Angel Pk Det. Bas.	6800
GD.1	3.0	0.909	2522	-	-	-	-	3A	2.6	0.93	2420	7,8	Alluvial Fan Apex (GD.1)	2500
GD.21	6.0	0.909	4531	-	-	-	-	-	-	-	-	2,7	Alluvial Fan Apex (GD.21)	4500
GD.18	3.4	0.909	4096	-	-	-	-	-	-	-	-	2,7	Alluvial Fan Apex (GD.18)	4100

* = Total drainage area; may be different than storm area   ** = location of CCRFCD regulatory discharge from COE study

Notes:

General - FIS hydrology based on new (1988) HEC-1, conversion to Muskingum routing in upland areas, and CCRFCD DARF's
Wallace study based on 1985 HEC-1, kinematic routing in all locations, and Hydro 40 DARF's
Boyle study based on 1985 HEC-1, Muskingum routing in all locations, and CCRFCD DARF's

1. FIS Q cannot be compared to Wallace Q since Wallace "existing" analysis did not include Hualapai and Durango Diversions and "ultimate" analysis includes proposed detention basins
2. Not covered by Boyle analysis
3. Wallace Q reflects future conditions (existing conditions do not include Hualapai or Durango Diversions)
4. FIS and Wallace Q's agree within 10%
5. FIS and Wallace Q's agree within 15%
6. FIS and Boyle Q's agree within 15%
7. FIS Q cannot be compared to Wallace Q since DARF's based on different storm areas were used
8. Boyle analysis used larger DARF and different lag time computation
9. FIS Q's include Gowan-North and Gowan-South Detention Basins and Outfall to Las Vegas Wash; Cheyenne Channel into Gowan-South Detention Basin; Angel Park Detention Basin Expansion; Hualpai Diversion to Angel Park; and Buffalo Channel connecting Angel Park and Gowan-South Basin

TABLE 4-3

PROPOSED GOWAN AREA FIS DISCHARGES

		10-Year Peak Discharge				50-Year Peak Discharge				100-Year Peak Discharge				500-Year Peak Discharge		
Node	Area (sq mi)	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE SFHS Q	Adopt Extrap	Adopted Flow
LVWASH	157.9	2133*	-	1432	1400	7275*	-	2937	2940	11218*	-	4592	4600	-	8500	8200
EPT.5(.)	156.4	-	-	1415	1400	-	-	2864	2900	-	-	4573	4600	-	7800	7800
R.G-UPS.	143.9	-	-	343	340	-	-	533	530	-	-	2405	2400	-	4100	4100
DET.GN	143.9	-	-	343	340	-	-	533	530	-	-	2454	2450	-	4500	4500
GN_IN	143.9	-	-	1785	1800	-	-	4018	4000	-	-	4465	4500	-	8000	8000
GD.14B(.)	100.1	1758**	-	1069	1100	6212**	-	2735	2700	9700**	-	2991	3000	-	3500	3500
PDGC(.)	67.2	-	-	518	520	-	-	1201	1200	-	-	1518	1500	-	3000	3000
ANGEL.PK	24.1	885	-	3040	3000	3478	-	5798	5800	5640	-	6762	6800	-	10700	10700
GD.1	3.0	269	-	1183	1200	1241	-	2145	2100	2130	-	2522	2500	-	4000	4000
GD.21	6.0	434	-	2181	2200	1865	-	4035	4000	3120	-	4531	4500	-	7000	7000
GD.18	3.4	292	-	1911	1900	1348	-	3329	3300	2312	-	4096	4100	-	6100	6100

Node	Location
LVWASH	d/s terminus of Gowan Area at LV Wash
EPT.5(.)	all Gowan subareas except EPT.2
R.G-UPS.	Gowan Outfall Channel at Rancho Road
DET.GN	Outflow from Gowan-North Detention Basin
GN_IN	Inflow to Gowan-North Detention Basin
PDGC(.)	Rancho Road at Hwy 95 (PDGC)
ANGEL.PK	Inflow to Angel Park Detention Basin
GD.1	Alluvial Fan Apex (at GD.1)
GD.21	Alluvial Fan Apex (at GD.21)
GD.18	Alluvial Fan Apex (at GD.18)

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS Hydrology HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Model Extrap = Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Adopt Extrap = Extrapolation of Adopted Flows for Q10, Q50 and Q100

Area = Total drainage area
* = Does not account for regulation by Angel Park, Gowan-North, or Gowan-South Detention Basins
** = Does not account for regulation by Angel Park Detention Basin
(shaded) = FIS concentration point

Note: FIS Q's include Gowan-North and Gowan-South Detention Basins and Outfall to Las Vegas Wash; Cheyenne Channel into Gowan-South Basin Angel Park Detention Basin Expansion; Hualpai Diversion to Angel Park, and Buffalo Channel connecting Angel Park to Gowan-South Basin

FIGURE 4-1
GOWAN PLOT AREA FIS DISCHARGES
(PLOT #1)

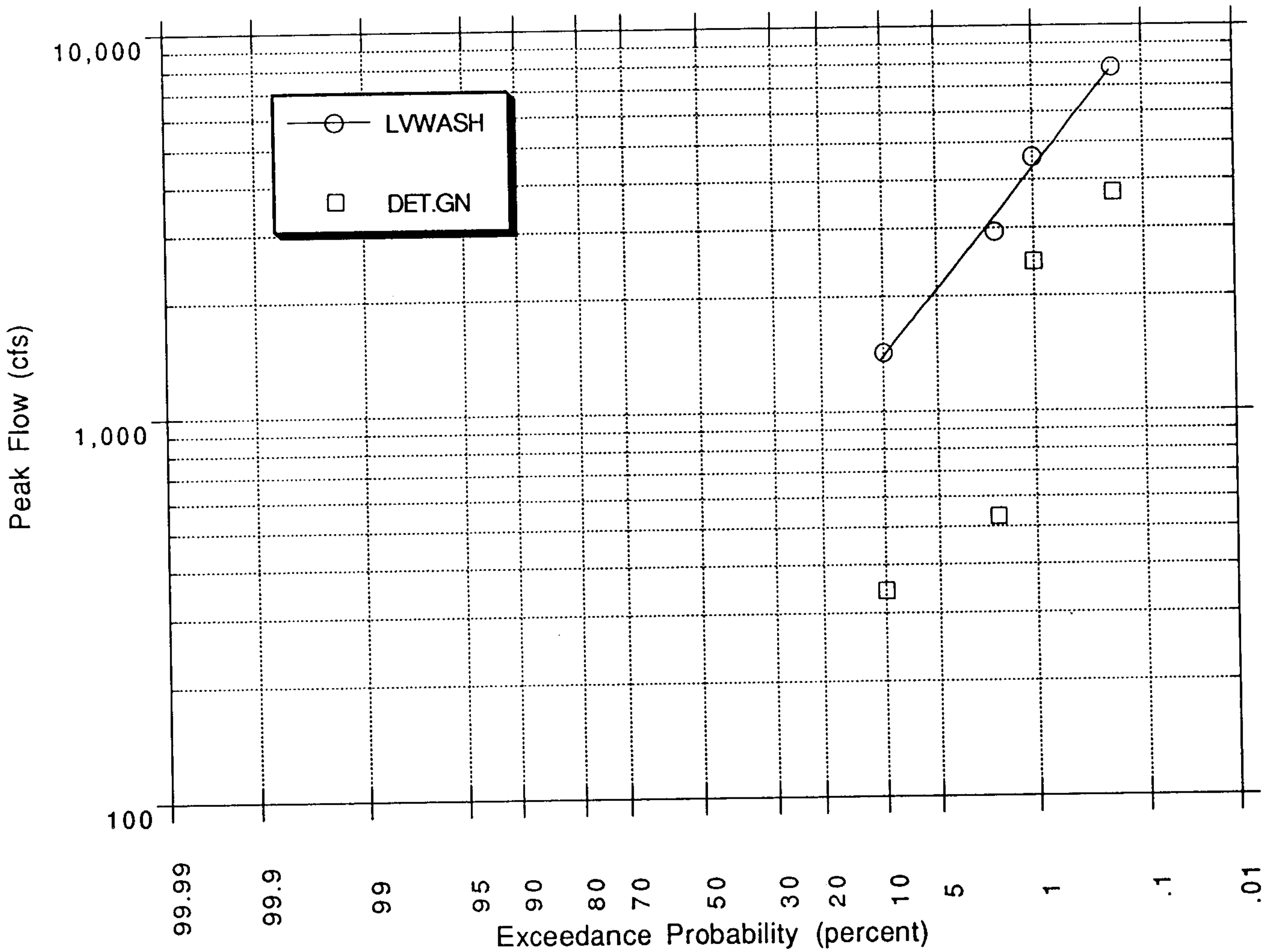


FIGURE 4-2
GOWAN AREA FIS DISCHARGES
(PLOT #2)

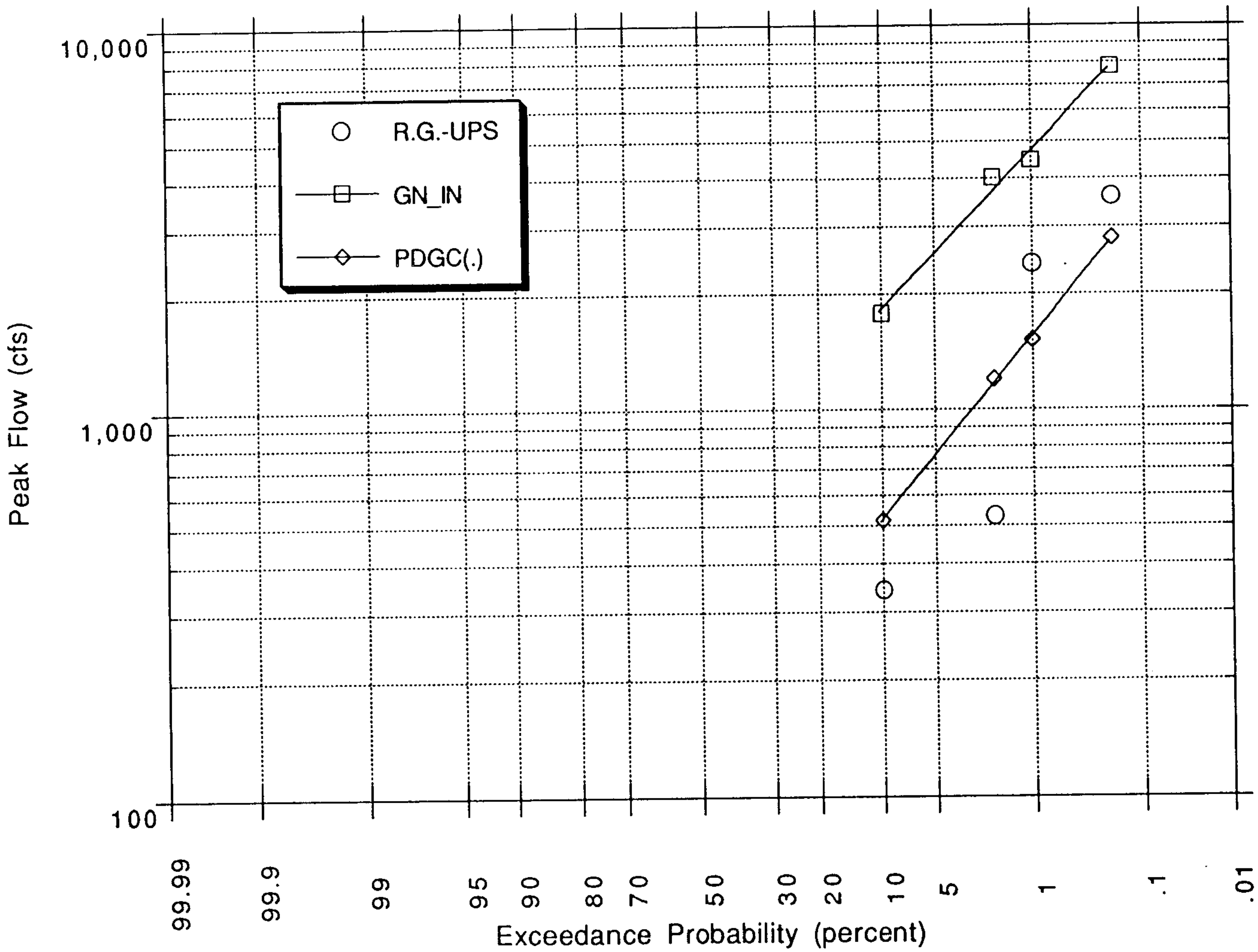


FIGURE 4-3
GOWAN AREA FIS DISCHARGES
(PLOT #3)

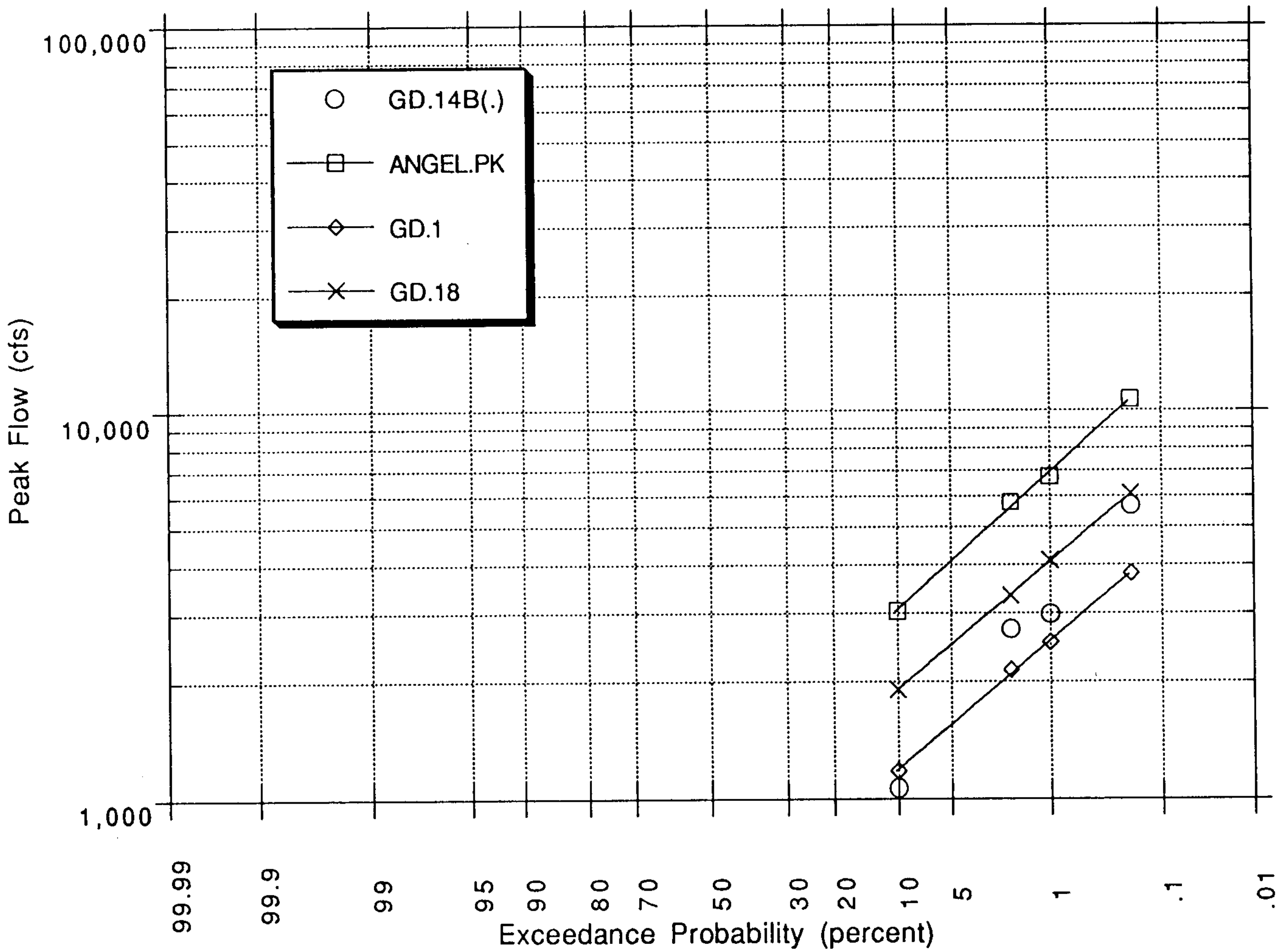
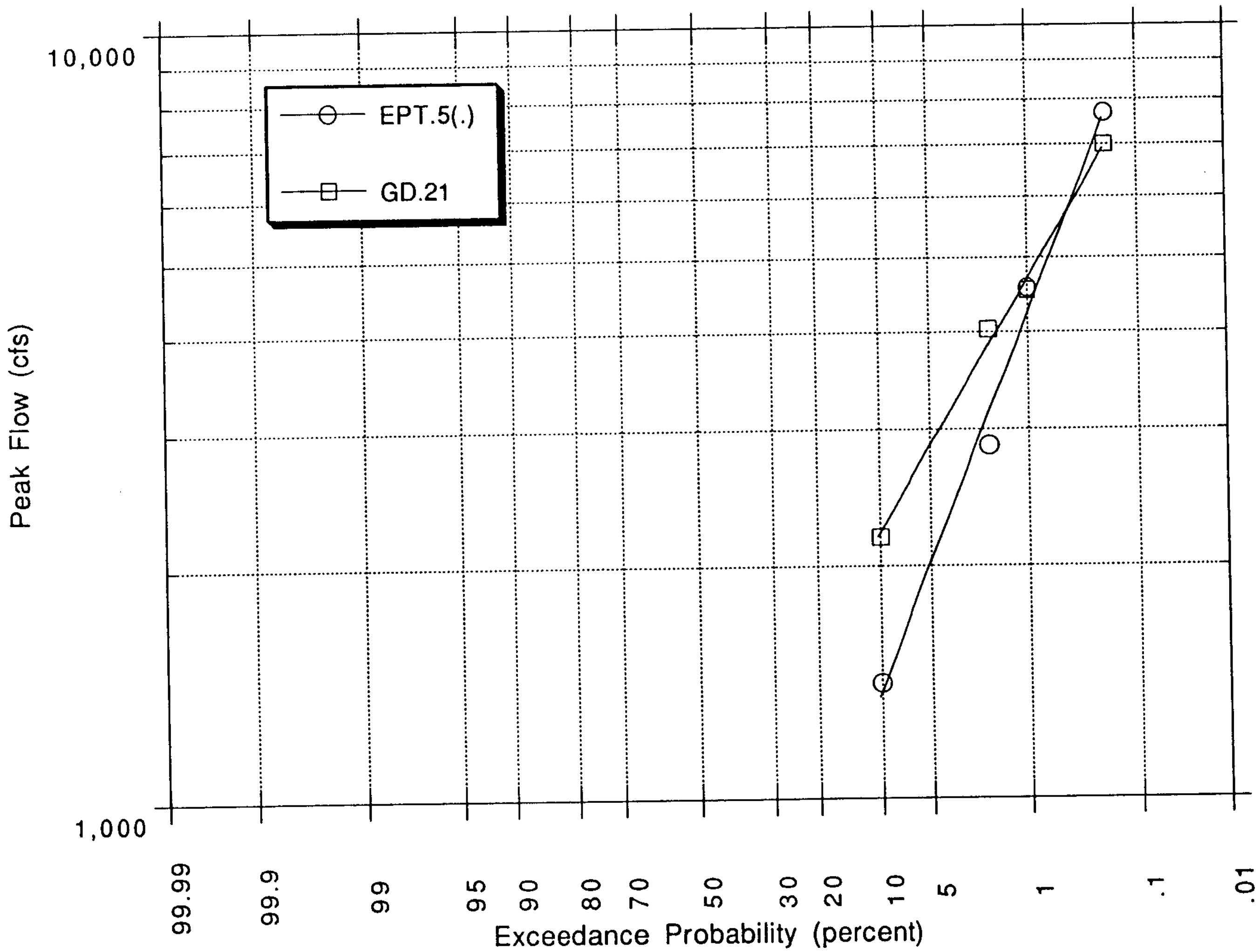


FIGURE 4-4
GOWAN AREA FIS DISCHARGES
(PLOT #4)



CHAPTER 5
CENTRAL BASIN FIS HYDROLOGY

CHAPTER 5

CENTRAL BASIN FIS HYDROLOGY

INTRODUCTION

This report summarizes the existing conditions/existing facilities analysis of the Central Basin drainage area conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future flood insurance studies for Las Vegas Creek. In addition, results could be used to assess the adequacy of existing facilities to handle existing condition flood discharges. The Central Basin study area includes all of the area tributary to Las Vegas Creek (Washington Avenue Channel) at Las Vegas Wash; the area tributary to the Freeway Channel; and most of the area between Washington Avenue Channel and Flamingo Wash. However, the only designated FIS flooding source in Central Basin is Las Vegas Creek from Meadows Detention Basin to Las Vegas Wash.

The basis of the hydrologic analysis was the group of HEC-1 models developed by MEA Engineers for the preliminary design analysis of Washington Avenue Channel. These are described in the report "Washington Avenue Channel Improvements, Predesign Report, Hydrology Study" (1990). The MEA hydrology study divided the Las Vegas Creek Watershed into several subwatersheds to compute design flows at critical locations. The study analyzed only assumed ultimate development conditions, but the majority of the existing drainage area is very close to buildout development. The MEA study also assumed construction of all proposed regional drainage facilities in the watershed; the FIS study had to modify this to reflect existing drainage improvements only. Previous studies in this watershed also include the CCRFCD Master Plan and the COE Special Flood Hazard Study which were used as references in modifying the MEA models to simulate existing condition land use and flow routing.

Peak discharges have been computed for proposed Las Vegas Creek FIS concentration points (Figure 1-1) for 10-, 50-, 100-, and 500-year return periods. The three lower floods were analyzed using HEC-1 models; the 500-year peak discharges were determined by graphical extrapolation.

Subareas used for the modeling are shown in Figures 5-1A, 5-1B, and 5-1C, which are reproduced from the MEA report.

ASSUMPTIONS FOR THE FIS HYDROLOGIC ANALYSIS

The FIS hydrologic analysis is based on existing land use conditions, and drainage improvements which are existing or scheduled for construction in the near future (e.g., the next two years). The following assumptions are made for the FIS hydrology analysis for the Central Basin.

- While Vegas Drive will be the northern drainage boundary west of Jones Boulevard when future proposed facilities are in place, the northern boundary for existing condition FIS flows is the boundary from the November 1990 MEA report on Washington Avenue Channel Improvements. This excludes the area roughly bounded by Jones Boulevard, Vegas Drive, Buffalo Road, and Washington Avenue from the Las Vegas Creek drainage area (see Figure 5-1A).

- The Lake Mead Storm Drain System and the Carey/Lake Mead Detention Basin are considered in place.
- The Oakey Detention Basin was proposed but not funded at the time of the analysis, and thus is not considered in place. It is noted that this project is now programmed for funding.
- The I-15 Conveyance System, which will convey flows northward along I-15 from Desert Inn Road to the Expressway, is not funded and thus is not considered in place.
- The Gowan Detention Basin and Outfall System are designed and funded, and thus are considered in place.
- The Durango Storm Drain System feeding into the Angel Park Detention Basin is considered in place on Durango Road from the detention basin to the first street south of Charleston.
- The Angel Park Outfall System including the Buffalo Channel north of Vegas Drive is considered in place. This connects the Angel Park and Gowan Detention Basins, and diverts a significant portion of the original Las Vegas Creek drainage area into the Gowan Basin.
- The capacity of the Freeway Channel south of Lake Mead Blvd is 584 cfs as described in the Final Hydrology Study for the Lake Mead Boulevard Storm Drain system (VTN, October 1989). This report indicates that 584 cfs capacity is available in the Freeway Channel for those areas south of the Lake Mead Storm Drain Drainage Basin which would otherwise drain to the Washington Avenue Channel and Las Vegas Creek drainage area. The Carey/Lake Mead Detention Basin and the Lake Mead Storm Drain System have been designed and sized to meet the capacity of the Freeway Channel north of Lake Mead Blvd.
- Flow originating north of the Expressway stays on the north side of the Expressway west of the UPRR and I-15.

MODIFICATIONS TO MEA HYDROLOGIC MODELS

The following paragraphs discuss the significant changes made to the MEA HEC-1 models in order to simulate assumed FIS conditions.

1. The MEA curve numbers, which reflect future proposed conditions, were replaced by existing condition curve numbers.

2. Subareas W3A, W3B, W4A and W4B were routed along the north side of the Expressway to the UPRR and I-15, where they encountered the flow split between the Freeway Channel and the Washington Avenue drainage areas.

3. Subareas W1A and W1B were added to the model, as was a flow split at the existing Buffalo Channel between Charleston Boulevard and Westcliff Drive.

4. Subareas below Charleston Boulevard and subarea CE-7C2 were not considered to contribute to Las Vegas Creek in existing conditions, and were removed from the model. Runoff from these subareas is intercepted and "detained" in the Charleston Underpass flooding area, from which it flows easterly away from Las Vegas Creek.

5. Separate simulation runs were made for storm distribution numbers (SDN) 3 and 5 to correctly simulate flows at concentration points in the upper and lower basin areas, respectively. The upper and lower basins were separated by the I-15 freeway. Results of the SDN 3 simulations were used for cumulative drainage areas less than 10 square miles; SDN 5 simulations were used for cumulative areas larger than10 square miles.

6. MEA developed separate models for the northern, southern and eastern drainage basins. These were linked together by JMM into one FIS model.

7. A flow split was taken from the COE model and added to the MEA model to simulate existing conditions at Rancho Road on Las Vegas Creek.

8. A flow split and diversion were added to the MEA model at the entrance to the Las Vegas Creek RCB structure at the UPRR to simulate the existing flow constriction at this location due to the limited RCB capacity Flow split data was taken from the COE model.

SUMMARY OF RESULTS

Table 5-1 presents a summary of the simulated 100-year discharges for existing conditions at key points in the Las Vegas Creek watershed. A comparison between the flows modeled by the FIS Hydrology and those modeled for the COE Special Flood Hazard Study is presented. Comparison of flows cannot be made between the FIS Hydrology and the MEA study because the MEA model simulates only future conditions. Notes in Table 5-1 provide partial explanations for the differences between the flows generated and the two studies compared.

In the lower portion of Washington Avenue Channel, breakouts from the main flow in the main flow path has been limited to the bankfull capacity of Washington Avenue Channel and the existing road crossings. It is possible that surcharging could occur in the channel, increasing the effective flow capacity. This situation should be investigated as part of the future hydraulic analysis and floodplain mapping for Las Vegas Creek.

An objective of the overall hydrologic modeling for the FIS Hydology study is to develop discharges consistent with the CCRFCD adopted regulatory discharges from the COE Special Flood Hazard Study. For Las Vegas Creek, the COE flows were not adopted as regulatory discharges due to concerns over the COE analysis, and thus were subject to future confirmation studies. In the Las Vegas Creek watershed construction of the Angel Park Detention Basin outfall channel to Gowan Detention Basin, considered as an existing facility, results in a substantial change from the COE model. This facility greatly reduces the effective drainage area tributary to the Las Vegas Creek FIS study reach. In addition, the COE analysis was performed prior to construction of the Meadows Detention Basin and also did not include the Carey/Lake Mead Detention Basin. The FIS Hydrology model discharges, therefore, must be considered more up to date information which will supersede the COE model flows. Thus, the adopted flows for FIS purposes are based on the new model results.

HEC-1 models were developed for the 10- and 50-year floods, utilizing the same curve number and lag time parameters as the 100-year model. Results are summarized and included in Table 5-2 for existing conditions at the same key locations as the 100-year flow values reported in Table 5-1.

500-year flow values were extrapolated by statistical and graphical methods from the 10-, 50- and 100-year values (Figures 5-2, 5-3 and 5-4), except in certain cases. These exceptions result from anomalies in the extrapolation results due to effects of Meadows Detention Basin on the lower return period peak flow values, and to channel breakouts and diversions. These factors influence the 10-year flows more significantly than the 100-year flows, creating artificially steep frequency curves at some concentration points. Extrapolated 500-year flows were adjusted for consistency at the following locations:

- The 500-year flow for station RETMED was set at the upstream station flow of 2,470/cfs. The Meadows Detention Basin is assumed to have no impact on the 500-year flow.

- The 500-year flow for stations DIV1 and W2C was based on straight-line interpolation between the flow values for stations RETMED and UPRR. The extrapolation for the UPRR station was considered to be accurate, while the 500-year extrapolated flows for the upstream stations were subject to reduction to be consistent with the UPRR 500-year flow.

- The 500-year flow values for stations UPRR and DIVWA were extrapolated from the lower recurrence flow values.

- Flow values increase for the 10-, 50- and 100-year recurrence intervals for stations BRUCE and PECOS (.). The capacity of the Washington Avenue Channel, however, has more of an effect on higher flow values as it has a limited capacity. The lower flow values, therefore, fluctuate to a much greater extent causing the slope of the extrapolation line to flatten out for those stations. For this reason, the extrapolated 500-year flows decrease rather than increase at those two stations. It was decided to retain the upstream 500-year flow of 2,800 cfs for those two stations.

HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix.

TABLE 5-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR CENTRAL BASIN FIS HYDROLOGY

FIS Hydrology				COE Special Flood Hazard Study						Adopted
CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	Note	Description	Discharge
LVWASH	17.6	0.81	1000	35	26.81		1200	1	d/s terminus at LV Wash	1000
DPECOS	17.4	0.81	1000	30	26.2		1000	5,6	Washington Ave Channel d.s. of Pecos	1000
PECOS (.)	17.4	0.81	1411	30	26.2		11000	2,3,4	Washington Ave Channel u.s. of Pecos	1410
BRUCE	11.4	0.85	1318	33	24.04		4000	3,4	Washington Ave Channel at Bruce	1320
DIVWA	7.5	0.89	1181	43	23.29		3800	3,4,6	Las Vegas Creek d.s. of UPRR box	1180
UPRR	7.5	0.89	1350	43	23.29		5500	3,4	Las Vegas Creek u.s. of UPRR box	1350
DIV1	6.8	0.89	1311	40	19.46		4800	3,4,6	Las Vegas Creek d.s. of I-15	1310
W2C	6.8	0.89	1311	40	19.46		6200	3,4	Las Vegas Creek u.s. of I-15	1310
RETMED	5.9	0.89	1096	39	18.57		6000	3,4	Outflow from Meadows Detention Basin	1100
MEDOWS	5.9	0.89	1581	-	-		-		Inflow to Meadows Detention Basin	1580
W2A	3.0	0.92	641	38	17.62		5800	3,4	Alta at Michael Way	640

Notes:

General - FIS hydrology based on new (1988) HEC-1, conversion to SCS loss rates, and CCRFCD DARF's
COE study based on 1985 HEC-1, and kinematic routing in all locations
All discharges are in cfs

1. FIS and COE Q's agree within 20%
2. Flows do not agree because FIS considers an upgrade to Lake Mead Blvd structure at Freeway Channel, which modifies breakout
3. Flows do not agree because FIS includes Meadows Det. Basin
4. Areas and flows do not agree because FIS considers Angel Park Outfall Channel to Gowan Basin an existing facility
5. Flow is limited by bankfull channel capacity; subject to verification by future detailed hydraulic analyses
6. Reduction in flow compared to upstream concentration point due to breakout

TABLE 5-2

PROPOSED CENTRAL BASIN FIS DISCHARGES

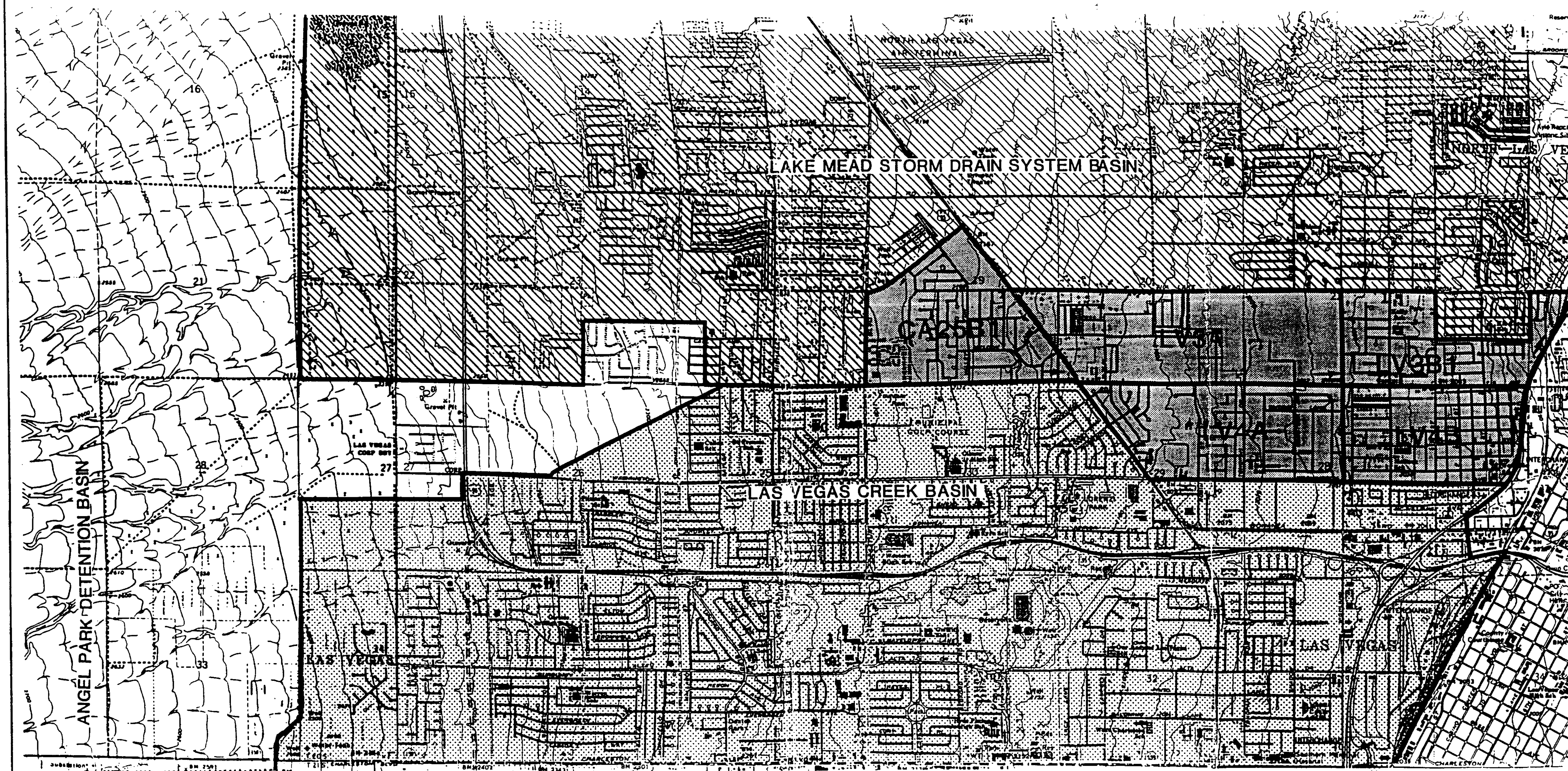
Node	Area (sq mi)	10-Year Peak Discharge COE Reg Q	COE SFHS Q*	Model Output	Adopted Flow	50-Year Peak Discharge COE Reg Q	COE SFHS Q*	Model Output	Adopted Flow	100-Year Peak Discharge COE Reg Q	COE SFHS Q*	Model Output	Adopted Flow	500-Year Peak Discharge COE SFHS Q*	Model Extrap	Adopted Flow
LVWASH	17.6		1000	441	460		1100	996	1000		1200	1000	1000	1800	1000	1000
DPECOS	17.4		1000	436	460		1000	1000	1000		1000	1000	1000	1000	1000	1000
PECOS (.)	17.4		1100	457	460		8500	1111	1110		11000	1411	1410	14500	2650	2800
BRUCE	11.4		1050	436	440		2600	1040	1040		4000	1318	1320	7300	2440	2800
DIVWA	7.5		880	241	240		2600	815	820		3800	1181	1180	7000	2800	2800
UPRR	7.5		1050	276	280		3500	932	930		5500	1350	1350	12000	3200	3200
DIV1	6.8		500	198	200		1800	918	920		4800	1311	1310	11000	3860	3090
W2C	6.8		500	198	200		1800	918	920		6200	1311	1310	18000	3860	3090
RETMED	5.9		450	116	120		1500	767	770		6000	1096	1100	18000	4120	2470
MEDOWS	5.9		-	713	710		-	1344	1340		-	1581	1580	-	2470	2470
W2A	3.0		350	280	280		1400	530	530		5800	641	640	17000	1000	1000

Node	Location
LVWASH	d/s terminus at LV Wash
DPECOS	Washington Ave. Channel d.s. of Pecos
PECOS (.)	Washington Ave. Channel u.s. of Pecos
BRUCE	Washington Ave. Channel at Bruce
DIVWA	L V Creek d.s. of UPRR box
UPRR	L V Creek u.s. of UPRR box
DIV1	L V Creek d.s. of I-15
W2C	L V Creek u.s. of I-15
RETMED	Outflow from Meadows Det. Basin u.s. of Rancho Rd
MEDOWS	Inflow to Meadows Detention Basin
W2A	Alta at Michael Way

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Model Extrap = Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
All discharges in cfs

Area = Total drainage area
* = Does not account for regulation by Angel Park Outfall

Note: Flows include effects of proposed Carey/Lake Mead Detention Basin and Gowan Area improvements (see Chapter 4).
Flows at DPECOS and LVWASH limited by bankfull channel capacity; subject to verification in future hydraulic analyses.

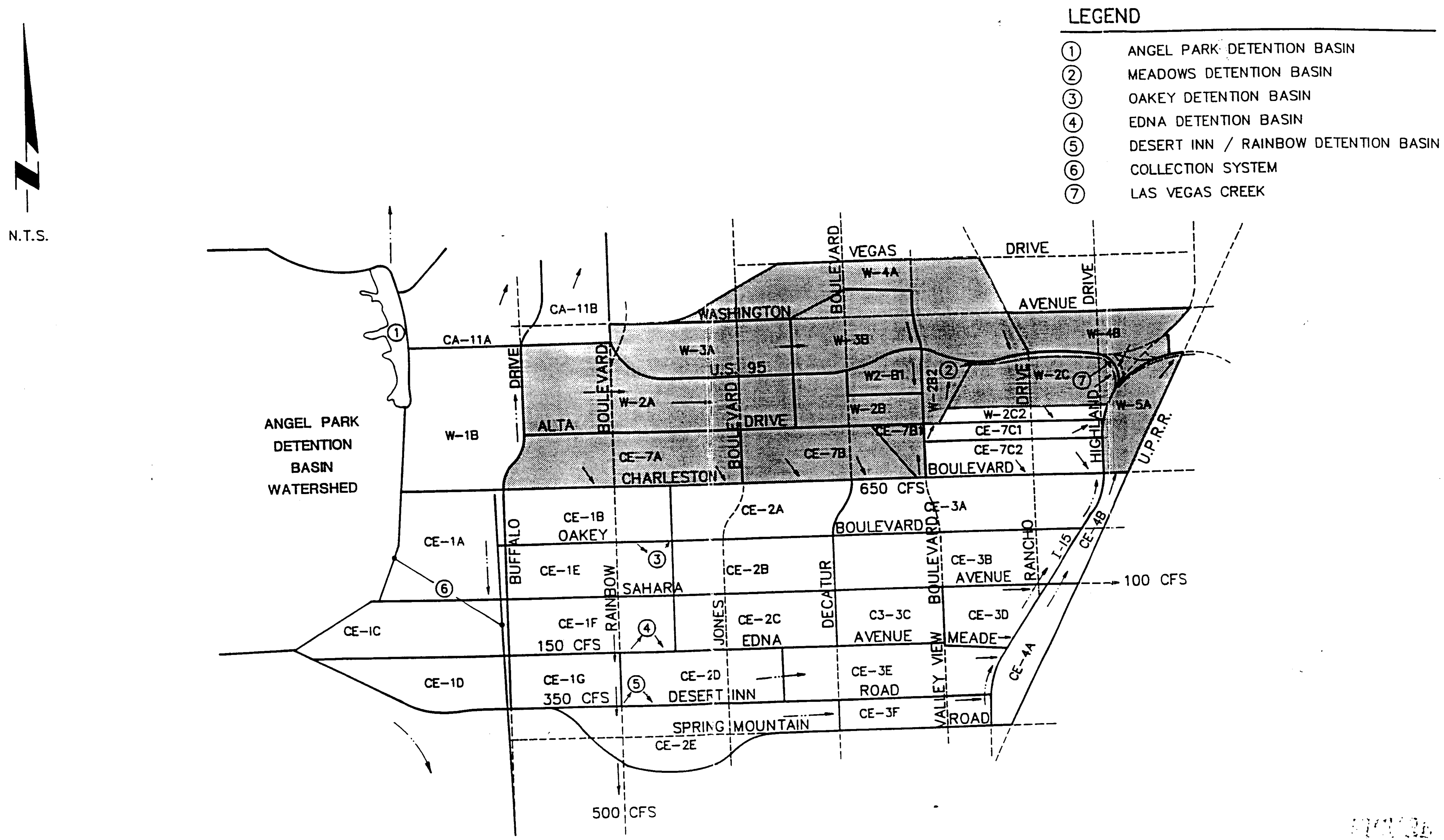


FIGURE

WASHINGTON AVENUE CHANNEL IMPROVEMENTS
PREDESIGN REPORT I–15 FREEWAY CHANNEL BASIN

MEA CONSULTING ENGINEERS

FIGURE 5-1A

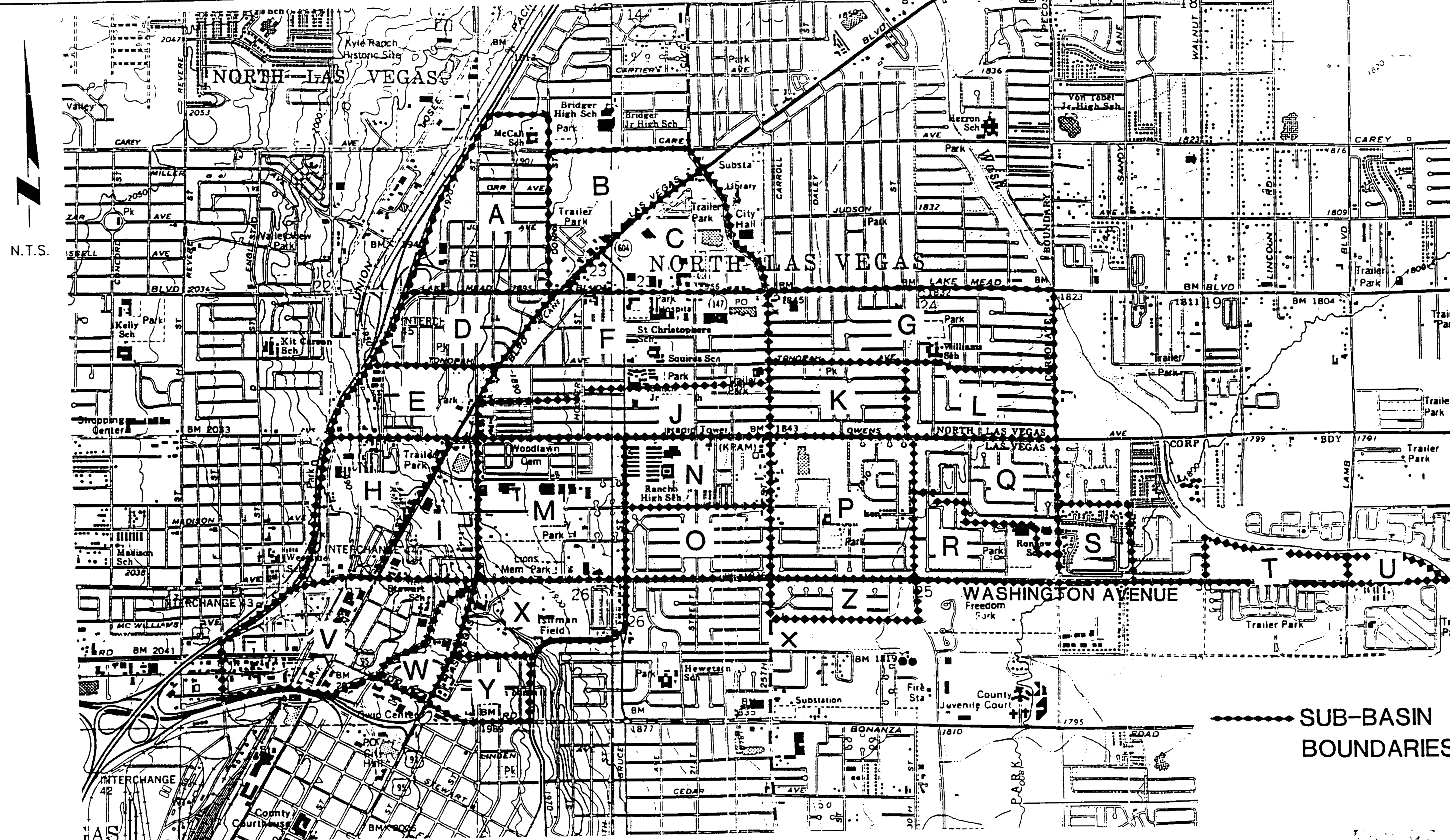


WASHINGTON AVENUE CHANNEL IMPROVEMENTS

PREDESIGN REPORT LAS VEGAS CREEK WATERSHED (NORTHERN BASIN)

MEA CONSULTING ENGINEERS

FIGURE 5-1B



WASHINGTON AVENUE CHANNEL IMPROVEMENTS

PREDESIGN REPORT ADJACENT DRAINAGE AREA

MEA CONSULTING ENGINEERS

FIGURE 5-1C

FIGURE 5-2
CENTRAL BASIN FIS DISCHARGES
(PLOT #1)

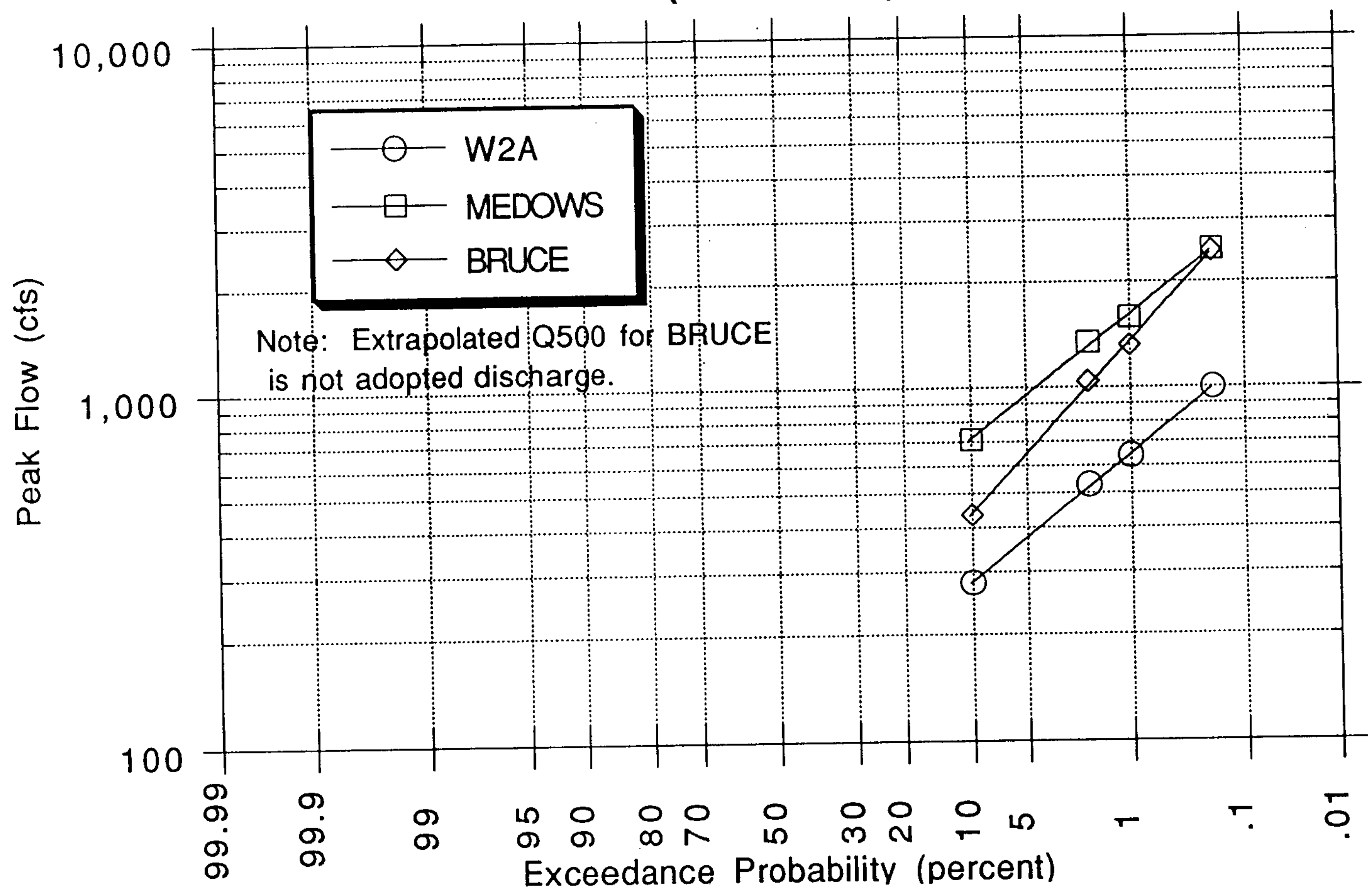


FIGURE 5-3
CENTRAL BASIN FIS DISCHARGES
(PLOT #2)

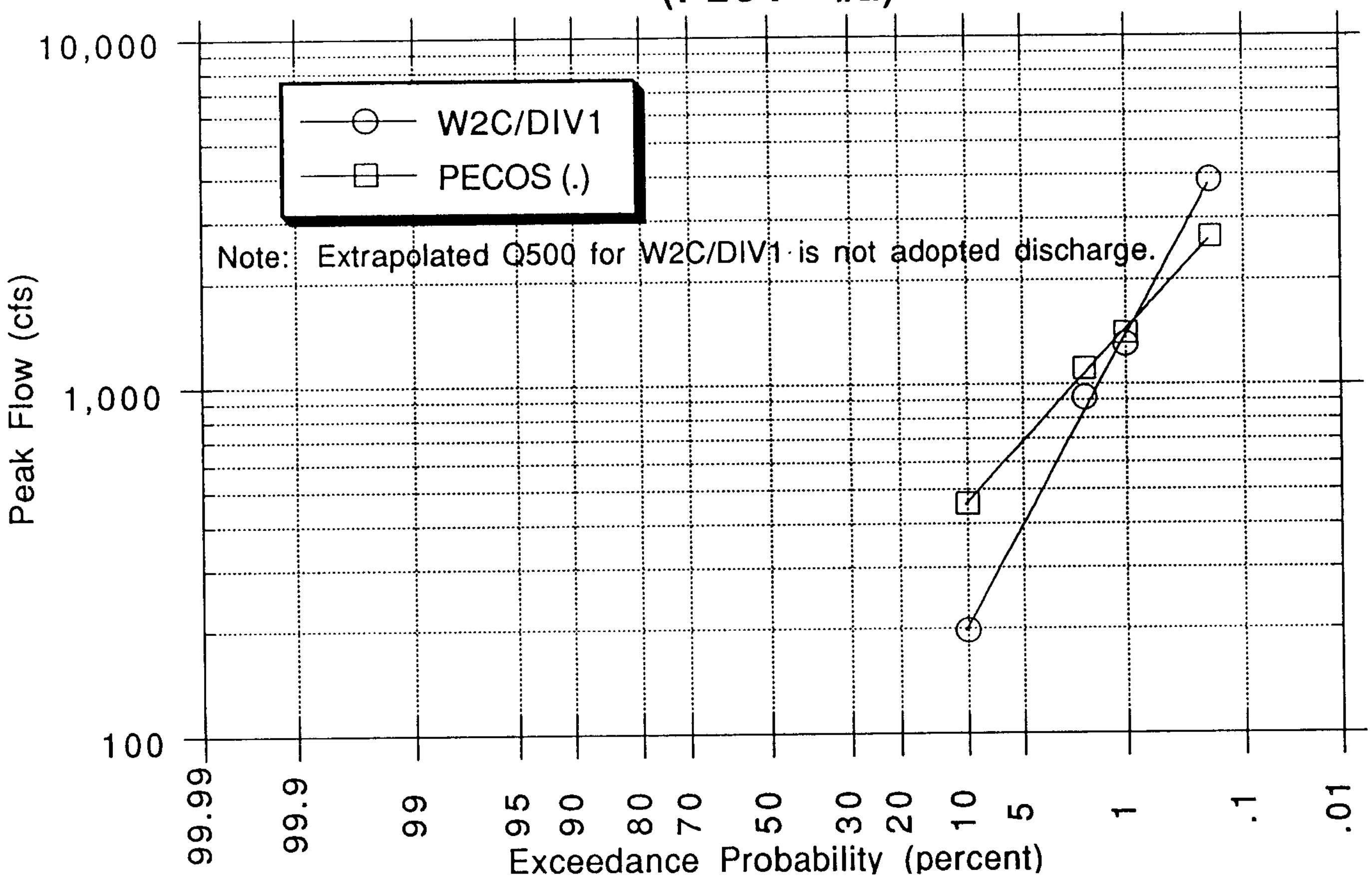
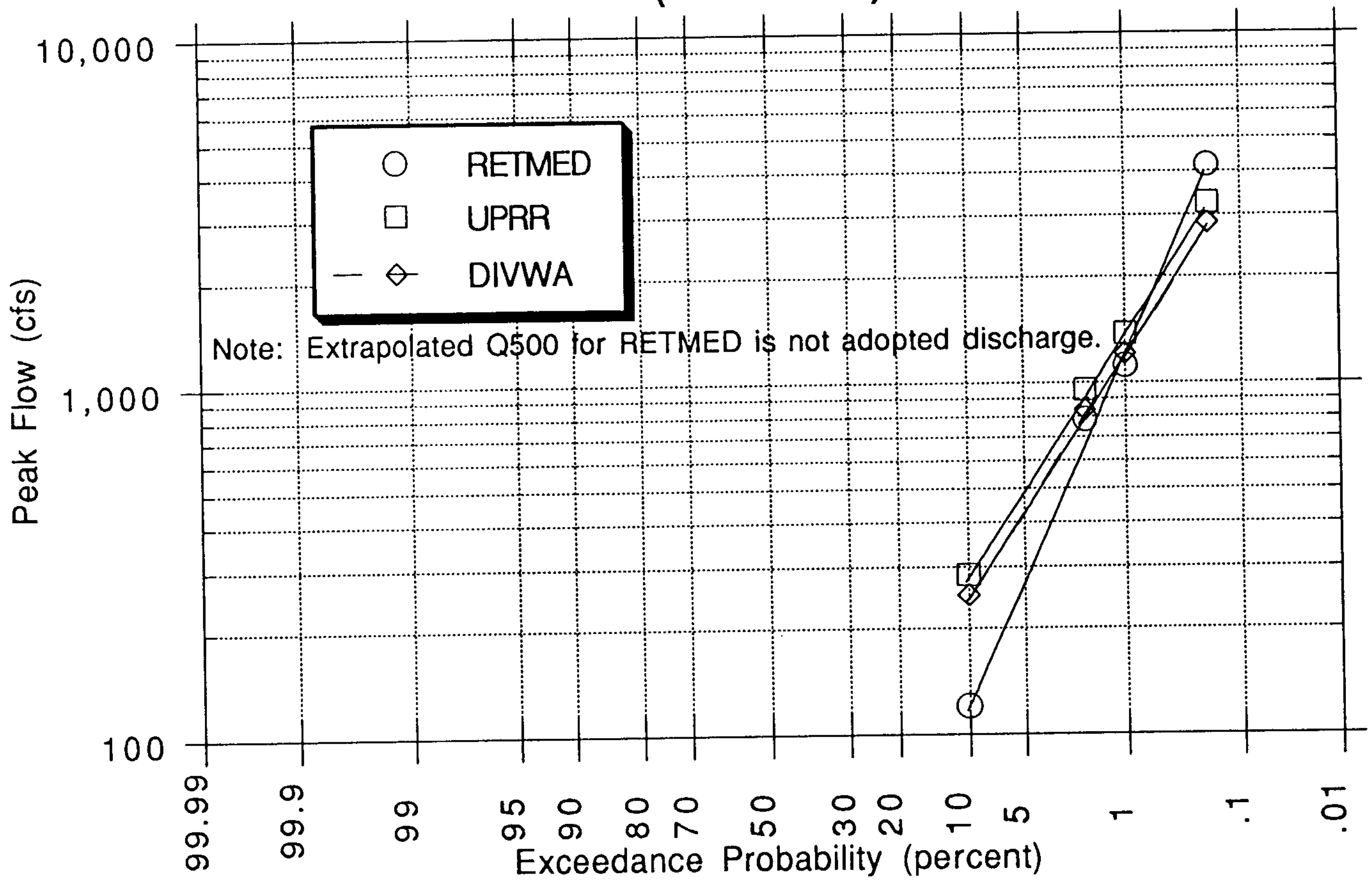


FIGURE 5-4
CENTRAL BASIN FIS DISCHARGES
(PLOT #3)



CHAPTER 6
FLAMINGO/TROPICANA WASH
FIS HYDROLOGY

CHAPTER 6

FLAMINGO/TROPICANA WASH FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/existing facilities analysis of the Flamingo/Tropicana Wash drainage basin conducted for the new FIS Hydrology study for Las Vegas Valley. The study area covered by this analysis includes the Flamingo Wash, Tropicana Wash, and Red Rock Wash drainage areas. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for Flamingo, Tropicana, and Red Rock Washes. In addition, results could be used to assess the adequacy of existing facilities to handle existing conditions flood discharges.

The basis of the hydrologic analysis was the HEC-1 models developed by the Corps of Engineers for the Feasibility Study of Las Vegas Wash and Tributaries, as described in the report "Hydrologic Documentation for Feasibility Studies for Flood Control and Allied Purposes, Tropicana and Flamingo Washes, Nevada" by COE (March 1990). Previous major studies in this watershed also include the CCRFCD Master Plan; the COE Special Flood Hazard Study; "Van Buskirk Channel Flood Control Facilities Preliminary Design Report" by JMM (December 1989); "Hydrology Report and Recommended Drainage Improvements for Northwest Quadrant McCarran International Airport" by Nimbus Engineers (January 1989); "Upper Flamingo Wash Detention Basin and Flamingo Wash Discharge Channel Predesign Memorandum" by Black & Veatch (September 1988); "Summerlin Stormwater Management Plan, Hydrology Report of Existing Conditions" by Boyle Engineering Corporation (July 1990); "Hydrology Report for the Southern Segment of the Las Vegas Beltway" by Kennedy/Jenks/Chilton (June 1990). In addition to these regional studies, a number of hydrology and stormwater management studies are available for new developments within the Flamingo/Tropicana watershed area.

Peak discharges have been computed for proposed FIS concentration points for 10-, 50-, 100-, and 500-year return periods. The three lower floods were analyzed using HEC-1 models; the 500-year peak discharges were determined by graphical extrapolation.

Subbasins are depicted in Figure S-4 (Appendix B).

MODIFICATIONS TO EXISTING CONDITIONS MODEL FROM COE

The following paragraphs discuss the significant changes made to the COE Flamingo/Tropicana Wash HEC-1 models as part of the FIS Hydrology project.

1. Previous HEC-1 analyses in the study area were performed using the 1985 version of the program. This FIS Hydrology study was performed using the 1988 version of HEC-1 on the PC.

2. In the previous basin-wide master planning by CCRFCD and COE, the drainage area upstream of Red Rock Detention Basin was not explicitly included in the hydrologic modeling; rather, a detention basin outflow hydrograph from the pertinent predesign study was input to the hydrologic models directly. In order to allow for more flexible flow computations from this portion of the watershed, upper Red Rock watershed

subareas were added to the COE model using subbasin data from the Upper Flamingo Wash Detention Basin Predesign Memorandum (Black & Veatch, 1988). To improve agreement with COE discharges, selected curve numbers were decreased and routing parameters were adjusted. The existing Red Rock Detention Basin hydrologic characteristics were taken from the COE Hydrologic Documentation Report. The Flamingo Wash tributary area south of the Red Rock watershed was also subdivided into more subbasins to provide greater detail to the hydrologic analysis.

3. Subarea soil losses were simulated using the SCS curve number method, rather than the uniform loss rates utilized in the COE model. This change was made to bring the model into conformance with the CCRFCD Hydrology Manual. Curve numbers were computed based on current land use and soil type information, using the curve number table in the CCRFCD Hydrology Manual. In the areas covered by the Boyle Summerlin hydrology study and the Nimbus Northwest McCarran Airport hydrology study, curve numbers were taken from the previous detailed HEC-1 models.

4. Lag times for subareas F1, F2, F3 and F4 were modified based on information from the Upper Flamingo Wash Detention Basin model.

5. Several minor changes were made to kinematic runoff parameters (UK and RK records) from the COE model, based on information in the Hydrologic Documentation Report for the Feasibility Study and on minor changes to subbasin boundaries.

6. A flow split at the limited capacity culvert in the UPRR grade in subarea T6 was added to the model.

7. The flow split at Flamingo Wash and the UPRR/I-15 culvert (at subarea F15) due to the limited structure capacity was modeled in accordance with the rating curve in the COE model. Per the COE model, flow into the Caesar's Palace/Las Vegas Blvd/Imperial Palace culvert was limited to the estimated hydraulic capacity of 6,000 cfs. Flows in excess of this amount were diverted to the north.

8. The area tributary to the northwest portion of McCarran Airport was modeled using subarea data from the Northwest McCarran Airport drainage study by Nimbus Engineers (subareas MNW-B through MNW-M). This study incorporates more detailed subareas than the COE model; these subareas account for flow diversions at the UPRR grade and correctly model flow patterns through the airport site.

9. Several subareas in the urbanized portion of the watershed were modified slightly to better reflect the impact of actual street patterns and other development-related factors on drainage conditions.

10. The Van Buskirk Channel watershed was modeled in detail for the preliminary design study for this area (JMM, December 1989). For purposes of the FIS Hydrology study, this watershed was reduced to an equivalent single subarea producing the same peak discharge, runoff volume, and time to peak as the detailed predesign model. Within the Van Buskirk drainage area, the results of the detailed modeling will be used. The single-subarea simplification will be used to model the contribution of the Van Buskirk watershed area to peak discharges in lower Flamingo Wash. For "existing conditions" it has been assumed that the Van Buskirk Outfall has been constructed along the recommended Pecos Rd alignment, but that no detention basins have been constructed within the Van Buskirk drainage area.

11. Subbasins in the vicinity of The Lakes development and lower Red Rock Wash were modified to reflect the recent development in this area.

12. Subarea F23 from the original Master Plan was added to the COE model to carry Flamingo Wash all the way to Las Vegas Wash.

13. Flows from Upper Blue Diamond Wash enter the Flamingo/Tropicana Wash drainage area via Tropicana Wash, subject to a flow split on the Blue Diamond alluvial fan. This is an uncontrolled division of runoff at present, and due to the alluvial nature of the channels the flow split probably varies over time. For existing condition modeling purposes, the flow split rating table in the COE Hydrologic Documentation report was adopted. This table shows about 30 to 40 percent of the Upper Blue Diamond Wash runoff entering lower Tropicana Wash, with the remainder flowing into lower Blue Diamond Wash and Duck Creek.

14. The proposed Upper Flamingo Wash Detention Basin and Outfall Channel, which has been designed and is currently under construction, is considered an existing facility for FIS hydrology purposes. The storage-elevation-outflow parameters for the basin were taken from design plans provided by Black & Veatch. The basin has a storage volume of 1,000 acre-feet at the spillway.

15. It was assumed that the proposed Las Vegas Beltway freeway, which will cross through the Flamingo/Tropicana watershed, will not change the overall drainage pattern. Drainage structures for the freeway will be designed with sufficient capacity to safely pass the 100-year discharge without significant flow diversions. It is noted that the Master Plan Update includes a proposed Beltway Channel which would divert flow from the Flamingo Wash watershed eastward into the Tropicana Wash watershed. This project is not designed or funded at this time, and thus is not considered an existing facility for the FIS Hydrology.

16. Channel routing computations in improved channel reaches were converted from the Muskingum method to the kinematic method. This conforms to the recommendations in the District Manual, and will allow for easier model modifications to simulate proposed channel improvements.

17. Peak discharges for FIS hydrology are required at numerous concentrations points in the Flamingo/Tropicana drainage area. Determination of appropriate storm centerings to generate critical peak discharges at each concentration point is complicated by two factors:

    (1) When the Upper Blue Diamond Wash drainage area is added to the Flamingo/Tropicana/Red Rock drainage area, the total area exceeds 200 square miles. This is the hypothetical limit of local thunderstorm coverage. In this case, different storm centerings with areas of coverage less than 200 square miles must be investigated.

    (2) The presence of two large regional detention basins suggests that critical storms could be centered either above or below the detention sites, depending on the contributing area downstream of the basins.

    Based on these factors, design storm centerings were developed as follows (see Figure 6-1):

a. For each concentration point upstream of the Flamingo/Tropicana confluence, a storm covering the full contributing upstream drainage area was investigated. In the case of Tropicana Wash and Flamingo Wash downstream of the Tropicana Wash confluence, this included the contribution from Upper Blue Diamond Wash. Depth-area reduction factors (DARF's) for this scenario were based on the total tributary area, using the CCRFCD Hydrology Manual DARF table. This is referred to as the "Basin-Wide Storm".

b. For each concentration point, a storm covering only the Flamingo, Red Rock and Tropicana watersheds was investigated. No runoff from the Upper Blue Diamond watershed was assumed. DARF's for each scenario were based on the total tributary area, excluding the Upper Blue Diamond area. This is referred to as the "Flamingo/Tropicana Storm". The Flamingo/Tropicana Storm produces discharges which differ from the Basin-Wide Storm only in the Tropicana Wash watershed and in the Flamingo Wash channel below the Tropicana Wash confluence.

c. Each FIS concentration point downstream of either of the two detention basins was also analyzed assuming a "Valley Storm", which was assumed to cover the area east of the Red Rock Detention Basin and east of the Upper Flamingo Detention Basin. DARF's for this scenario were based on the storm area upstream of each concentration point.

SUMMARY OF RESULTS

The existing conditions, 100-year HEC-1 model was executed for the three storm scenarios described above. Results are shown in Table 6-1. This table lists the peak discharge, appropriate DARF, and HEC-1 filename for each proposed FIS concentration point assuming occurrence of the Basin-Wide Storm, the Flamingo/Tropicana Storm, and the Valley Storm. The following conclusions may be drawn from Table 6-1.

1. For all Flamingo Wash locations between the Upper Flamingo Detention Basin and the Tropicana Wash confluence, the governing storm (i.e., the storm producing the largest peak discharge) is the Flamingo/Tropicana Storm. The Valley Storm produces similar flows in the lower portion of this reach.

2. Selection of the governing storm for the reach of Flamingo Wash downstream of the Tropicana Wash confluence is complicated by the 200 square mile storm coverage limit recommended in the CCRFCD Hydrology Manual. Drainage areas for the four FIS concentration points in this reach are given below:

Concentration Point		Excluding Upper Blue Diamond	Including Upper Blue Diamond
F17	-Flamingo W below Trop W	126.6 sq mi	196.1 sq mi
F20B	-Flamingo W at Pecos	138.5 sq mi	208.0 sq mi
F22	-Flamingo W at Bldr Hwy	143.2 sq mi	212.7 sq mi
F23	-Flamingo W at Las Vegas W	145.1 sq mi	214.6 sq mi

It is seen that for the Basin-Wide Storm, the total drainage area exceeds 200 square miles, so a smaller storm should be selected for design. In this case, the Flamingo/Tropicana Storm governs since it produces larger peak flows than the Valley Storm, although the two results are comparable.

3. For Tropicana Wash, any concentration points affected by the contribution of flows from the Upper Blue Diamond drainage area are governed by the Basin-Wide Storm. All other concentration points are governed by the more local Flamingo/Tropicana Storm.

Preliminary model results produced flows at Red Rock Detention Basin which were higher than expected. Several past studies were reviewed to compare FIS Hydrology flows with previous results. The following table summarizes 100-year, existing condition discharges from previous studies and from three different FIS Hydrology HEC-1 runs.

	Existing Q100 (cfs) at Red Rock Detention Basin	
Hydrologic Modeling Results	Inflow	Outflow
B&V Facility Planning Study for Flamingo Wash (1985)	9,370	1,400
COE Feasibility Study - Computed Probability (March 1990)	12,800	-
COE Feasibility Study - Expected Probability (March 1990)	15,500	4,100
FIS Hydrology - B&V CN's, Standard Muskingum Parameters	12,800	7,500
FIS Hydrology - Reduced CN's, Max Routing Muskingum Parameters	11,200	5,400
FIS Hydrology - Lowest CN's, Max Routing Muskingum Parameters	10,700	4,400

The B&V Facility Planning Study, which was used as the basis of the design of Red Rock Detention Basin, used a 3-hour storm similar to that used in the original CCRFCD Master Plan. The COE Feasibility Study used a 6-hour storm identical to that used in the FIS Hydrology, but used uniform loss rates rather than curve numbers to compute watershed losses. The FIS Hydrology model was based on subarea data reported in the B&V Preliminary Design Memorandum for Upper Flamingo Detention Basin (September 1988), consistent with the CCRFCD Design Manual.

The following conclusions are apparent from this comparison of flows.

1. The COE computed probability analysis demonstrates that the 6-hour Red Rock inflow peak and volume are significantly larger than the 3-hour storm peak and volume. Use of a 6-hour design storm causes the existing Red Rock Detention Basin to spill for a 100-year event, whereas it is capable of effectively detaining the 3-hour, 100-year design storm.

2. The COE Feasibility Study includes an upgrade in volume to Red Rock Detention Basin, indicating that the COE feels the basin is currently undersized with respect to the COE overall plan for Flamingo Wash. The COE proposal would add sufficient volume to the basin such that it would operate in close to a retention mode with a very minimal outflow.

3. The first FIS Hydrology alternative HEC-1 run uses the B&V subarea data directly, with Muskingum routing parameters consistent with the COE modeling method. This run indicates that while the CN loss rate approach can produce a similar basin inflow to the COE uniform loss rate approach, it generates a larger inflow hydrograph volume and hence a larger design outflow (i.e., larger flow over the spillway).

4. The second and third FIS Hydrology HEC-1 runs use different variations of modified curve numbers and Muskingum parameters in an attempt to develop a design hydrograph which can be detained by the existing basin without flow over the spillway. Results show that it is possible to manipulate input parameters within acceptable limits to reduce the simulated detention basin inflow and outflow, but the reductions are not large enough to prevent the basin spillway from overtopping. Thus the existing conditions/existing facilities FIS hydrology will have to show spill from the Red Rock Detention Basin.

Based on the above selection of governing storms, Tables 6-2 and 6-3 were prepared to compare FIS Hydrology model results for Flamingo Wash and Tropicana Wash with the results of recent previous studies in the watershed. The only study with sufficient documentation to compare results is the COE Special Flood Hazard Study, which produced the computed probability discharges adopted for regulatory purposes by the District. Unfortunately, the COE study does not include the effect of the proposed Upper Flamingo Detention Basin and Outfall Channel, which is located upstream of all the concentration points for which the COE reported flows. To provide a better basis of comparison, the FIS Hydrology model of the Flamingo/Tropicana Storm was executed with the proposed detention basin removed. The resulting flows are compared below to the COE computed probability discharges.

Concentration Point	Q100 With UF Det Bas	Q100 Without UF Det Bas	COE Comp. Prob. Q100
F7 -Flamingo Wash at Spanish Trails	4881 cfs	7800 cfs	7000 cfs
F17 -Flamingo Wash below Tropicana Wash	6047 cfs	6720 cfs	8800 cfs
F23 -Flamingo Wash at Las Vegas Wash	7223 cfs	8020 cfs	9000 cfs

Differences between the FIS Hydrology and COE flows at F7 are attributed to the use of subarea-specific curve numbers to model losses, rather than the uniform loss rates applied by the COE to all subareas. The tributary area to F7 consists primarily of mountainous drainages with high curve numbers, which would exceed the "average" loss conditions applied by the COE. The FIS Hydrology discharge at F17 is lower than the COE flow due to the use of revised flow split information for the UPRR and I-15 culverts upstream of this point. The revised flow split data was developed by the COE for the Flamingo/Tropicana Feasibility Study (which uses expected probability discharges), but has not yet been incorporated into the computed probability discharge HEC-1 models used for the Special Flood Hazard Study. The computed probability discharge HEC-1 models used for the Special Flood Hazard Study. The COE had intentions of modifying the computed probability models, but this effort is apparently on hold at this time. In addition, it is possible that COE discharges at F17 and F23 include contribution from the Upper Blue Diamond drainage area, whereas the FIS hydrology discharges are based on the Flamingo/Tropicana Storm which excludes this area. Even with the above qualifications, the FIS Hydrology without-basin discharge at F23 is nearly within 10 percent of the COE adopted flow. It is concluded that the FIS Hydrology HEC1 model for Flamingo Wash is reasonably consistent with the COE HEC-1 model, subject to the improvements discussed previously, for the concentration points where flows are required.

Node R6 is located on Red Rock Wash at the confluence with Flamingo Wash. This node is downstream of the alluvial fan apex (RR14) and the combination of the three other local canyons tributary to the fan (RR20-22); however, the modeled 100-year discharge at R6 (4,980 cfs) is less than the 100-year discharges at the fan apex (5,740 cfs) and the local canyon combination (5,020 cfs). This is attributed to three factors. First, significant hydrograph routing and peak flow attenuation occurs over the long Red Rock alluvial fan. Second, the time to peak for flow on the main branch of Red Rock Wash is about 8 hours, while the time to peak in the canyon drainages is about 4 hours; in addition, the main branch flow is routed through the Red Rock Detention Basin. Thus the peaks are significantly offset rather than being additive. Third, the DARF for R6 (0.65) is less than that for RR14 (0.68) or RR20-22 (0.86) because of the larger combined drainage area. The lower overall rainfall amount for a storm centered upstream of R6 produces less runoff per unit area, particularly considering the routing effects of Red Rock Detention Basin.

As discussed in the Duck Creek/Blue Diamond FIS Hydrology Report, a correction to a subbasin area in the Upper Blue Diamond watershed increased the total drainage area of this watershed by about 14 square miles. This situation, combined with the high curve numbers for the mountainous Upper Blue Diamond watershed, causes the FIS Hydrology HEC-1 model to generate discharges larger than the COE computed probability discharges for the main (south) branch of Tropicana Wash. The larger discharge at the Blue Diamond fan apex splits with a higher percentage of the flow entering Tropicana Wash, based on the COE flow split rating curve. The FIS Hydrology model more accurately reflects true upstream conditions. Differences between COE and FIS Hydrology flows on Tropicana Wash below the UPRR may also be due to the use of revised flow split data contained in the COE Feasibility Study report but not used in the computed probability modeling.

Because of the significant differences between the COE computed probability hydrologic analysis and the FIS hydrologic analysis (e.g., Upper Flamingo Detention Basin, correction to Upper Blue Diamond drainage area), the FIS Hydrology model results are recommended for use as FIS discharges. The lower Tropicana Wash model discharges are within 10 percent of the COE discharges, and thus the COE flows could be adopted as FIS flows. However, in order to preserve consistency with the upstream discharges, it is recommended that the model output be selected as adopted flows.

The FIS Hydrology HEC-1 model was used to compute 10-year and 50-year discharges, based on the same curve number and lag time parameters developed for the 100-year model. 500-year discharges were developed by graphical extrapolation of the 10-, 50-, and 100-year discharges. Probability plots are shown in Figures 6-2 through 6-11.

Results for FIS hydrology in the Flamingo/Tropicana watershed are summarized in Tables 6-4 and 6-5. In addition to model output, these tables show discharges for FIS concentration points computed using the COE regional discharge-frequency relationship developed for the

Feasibility Study. This is the relationship used to calibrate the COE HEC-1 models, and was used by the COE in conjunction with the model results to select discharges for the study. In the case of the Flamingo/Tropicana watershed, comparisons of model output to the COE regional discharges are not pertinent in most cases due to the effects of the two major detention basins.

HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix.

TABLE 6-1

COMPARISON OF ALTERNATIVE 100-YEAR STORM SIMULATIONS
FOR FLAMINGO/TROPICANA/RED ROCK WATERSHED

Node	Area (sq mi)	Description	Basin-Wide Storm			Flamingo/Tropicana Storm			Valley Storm		
			HEC1 File	Peak Q	DARF	HEC1 File	Peak Q	DARF	HEC1 File	Peak Q	DARF
RR14	53.0	Red Rock Basin inflow	F100	11300	0.68	F100	11300	0.68		-	
RR14	53.0	Red Rock Basin outflow	F100	5740	0.68	F100	5740	0.68		-	
RR20	1.4	RR20 Alluvial Fan	FFAN	1040	0.96	FFAN	1040	0.96	FFAN	1040	0.96
RR21	6.3	RR21 Alluvial Fan	FFAN	3330	0.91	FFAN	3330	0.91	FFAN	3330	0.91
RR22	2.2	RR22 Alluvial Fan	FFAN	1540	0.91	FFAN	1540	0.91	FFAN	1540	0.91
RR20-22	9.8	Combined Red Rock Fans	FFAN	5020	0.86	FFAN	5020	0.86	FFAN	5020	0.86
R6	73.3	Buffalo Channel	F100	4980	0.65	F100	4980	0.65	FVAL100	1560	0.89
F1	4.6	F1 Alluvial Fan	FFAN	3010	0.91	FFAN	3010	0.91		-	
F2	1.3	F2 Alluvial Fan	FFAN	1270	0.96	FFAN	1270	0.96		-	
F3	2.6	F3 Alluvial Fan	FFAN	2470	0.91	FFAN	2470	0.91		-	
F5	15.9	Upper Flamingo Basin inflow	F100	4570	0.81	F100	4570	0.81		-	
F5	15.9	Upper Flamingo Basin outflow	F100	1160	0.81	F100	1160	0.81			
F7	92.0	Flamingo W at Spanish Trails	F100	4820	0.6	F100	4820	0.6	FVAL100	2930	0.82
F14	103.3	Flamingo W at Decatur	F100	5310	0.6	F100	5310	0.6	FVAL100	3300	0.75
F15	104.6	Flamingo W u/s UPRR	F100	5410	0.6	F100	5410	0.6	FVAL100	3510	0.75
F15	104.6	Flamingo W d/s UPRR	F100	4640	0.6	F100	4640	0.6	FVAL100	3510	0.75
F16	105.2	Flamingo W at I-15	F100	4680	0.6	F100	4680	0.6	FVAL100	3600	0.75
F16OF	105.2	Flamingo Overflow at I-15	F100	0	0.6	F100	0	0.6	FVAL100	0	0.75
F17	126.6*	Flamingo W d/s Tropicana W	FLBD100	5910	0.5	F100	6000	0.565	FVAL100	5190	0.68
F20B	138.5*	Flamingo W at Pecos	FLBD100	5950	0.5	F100	6410	0.565	FVAL100	6150	0.65
F22	143.2*	Flamingo W at Bldr Hwy	FLBD100	5980	0.5	F100	7010	0.565	FVAL100	6700	0.65
F23	145.1*	Flamingo W at Las Vegas W	FLBD100	6010	0.5	F100	7110	0.565	FVAL100	6840	0.65
T8	1.2*	S.B. Tropicana W at Jones	BDTR100	5370	0.65	LTROP100	111	0.95	LTROP100	111	0.95
T9		S.B. Tropicana W at UPRR	BDTR100	5300	0.65	LTROP100	179	0.93	LTROP100	179	0.93
T5	4.2	M.B. Tropicana W at Jones	LTROP100	2640	0.9	LTROP100	2640	0.9	LTROP100	2640	0.9
T6	5.5	M.B. Tropicana W at UPRR	BDTR100	1190	0.65	LTROP100	3300	0.9	LTROP100	3300	0.9
T1	1.6	N.B. Tropicana W at Jones	LTROP100	1200	0.95	LTROP100	1200	0.95	LTROP100	1200	0.95
T3	2.6	N.B. Tropicana W at UPRR	BDTR100	856	0.65	LTROP100	4050	0.93	LTROP100	4050	0.93
T10	11*	Tropicana W at I-15	BDTR100	5110	0.63						
T11	12.1*	Tropicana W at Koval	BDTR100	5110	0.63						
MNW-J2	5.4	Airport Channel at I-15	LTROP100	266	0.9	LTROP100	266	0.9	LTROP100	266	0.9
MNW-M	8	Airport Channel at Tropicana	LTROP100	787	0.88	LTROP100	787	0.88	LTROP100	787	0.88
T12	20.8*	Tropicana W at Flamingo W	BDTR100	5250	0.63	F100	3150	0.81	F100	3150	0.81

* Excludes Upper Blue Diamond Area of 69.5 sq mi

TABLE 6-2

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR FLAMINGO WASH FIS HYDROLOGY

FIS Hydrology					COE Computed Probability						Adopted
CP/Node	Area	Storm	DARF	Flow	CP/Node	Area	DARF	Flow	Notes	Description	Discharge
RR14	53.0	1	0.68	5740						Red Rock Basin outflow	5000
RR20	1.4	1	0.96	1040						RR20 Alluvial Fan	1000
RR21	6.3	1	0.91	3330						RR21 Alluvial Fan	3300
RR22	2.2	1	0.91	1540						RR22 Alluvial Fan	1500
RR20-22	9.9	1	0.86	5020						Combined Red Rock Fans	5000
R6	70.1	1	0.65	4980						Buffalo Channel	5000
F1	4.6	1	0.91	3010						F1 Alluvial Fan	3000
F2	1.3	1	0.96	1270						F2 Alluvial Fan	1300
F3	2.6	1	0.91	2470						F3 Alluvial Fan	2500
F5	15.9	1	0.81	4570					5	Upper Flamingo Basin inflow	4600
F5	15.9	1	0.81	1160					5	Upper Flamingo Basin outflow	1200
F7	92.0	1	0.60	4820	CP26	91.9		7000	2	Flamingo W at Spanish Trails	4800
F14	103.3	1	0.60	5310	CP12	96.5		7800	1,2	Flamingo W at Decatur	5300
F15	104.6	1	0.60	5410	CP13	97.6		7800	1,2	Flamingo W u/s UPRR	5400
F15	104.6	1	0.60	4640	CP14	97.6		6000	1,2,4	Flamingo W d/s UPRR	4600
F16	105.2	1	0.60	4680	CP16	98.1		6000	1,2,4	Flamingo W at I-15	4700
F16OF	105.2	1	0.72	0						Flamingo Overflow at I-15	0
F17	126.6*	2	0.57	6000	CP35	127.8		8800	2,3,4	Flamingo W d/s Tropicana W	6000
F20B	138.5*	2	0.57	6410					3	Flamingo W at Pecos	6400
F22	143.2*	2	0.57	7010	CP 40	135.4		9000	1,2,3	Flamingo W at Boulder Hwy	7000
F23	145.1*	2	0.57	7110					3	Flamingo W at Las Vegas W	7100

* Drainage area does not include contribution from Upper Blue Diamond watershed
Storm #1 = Basin-wide storm   Storm #2 = Flamingo/Tropicana Storm   Storm #3 = Valley Storm
(Upstream of the Flamingo/Tropicana confluence, Storm #1 and Storm #2 are equivalent)

Notes:
1. Drainage areas differ due to improved understanding of flow patterns in upper and lower Flamingo/Tropicana watershed, and changes due to development.
2. FIS model includes Upper Flamingo Detention Basin; COE model does not.
3. Basin-wide Storm area exceeds 200 sq mi limit, so next highest storm flow was adopted. (Basin-wide Q's are about 1400 cfs higher)
4. FIS model incorporates flow splits revised by COE for Feasibility Study; these were not included in the "Computed Probability" modeling.
5. Upper Flamingo Detention Basin Design Report (B&V): Inflow = 5450; Outflow = 1325

TABLE 6-3

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR TROPICANA WASH FIS HYDROLOGY

FIS Hydrology					COE Computed Probability				Notes	Description	Adopted Discharge
CP/Node	Area	Storm	DARF	Flow	CP/Node	Area	DARF	Flow			
T8	1.2*	1	0.65	5370					1	S.B. Tropicana W at Jones	5400
T9	2.1*	1	0.65	5300					1	S.B. Tropicana W u/s UPRR	5300
T9	2.1*	1	0.65	5300	CP4	2.8		3000	1,2,3	S.B. Tropicana W d/s UPRR	5300
T5	4.2	2	0.9	2640						M.B. Tropicana W at Jones	2600
T6	5.5	2	0.9	3300						M.B. Tropicana W u/s UPRR	3300
T6	5.5	2	0.9	750					3	M.B. Tropicana W d/s UPRR	750
T6OF	8.2	2	0.9	2550	CP7	8.3		2400		Overflow along UPRR	2600
T1	1.6	2	0.95	1200						N.B. Tropicana W at Jones	1200
T3	2.6	2	0.93	4050						N.B. Tropicana W u/s UPRR	4100
T3	2.6	2	0.93	1660	CP9	10.9		3100	3	N.B. Tropicana W d/s UPRR	1700
T10	11*	1	0.63	5110	CP10	12.3		4800	1,2,3	Tropicana W at I-15	5100
T11	12.1*	1	0.63	5110	CP29	13.4		4800	1,2,3	Tropicana W at Koval	5100
MNW-J2	5.4	1	0.9	266						Airport Channel at I-15	270
MNW-M	8	1	0.88	787						Airport Channel at Tropicana	790
T12	20.8*	1	0.63	5250	CP30	20.3		4800	1,2	Tropicana W at Flamingo W	5300

* Drainage area does not include contribution from Upper Blue Diamond watershed (69.5 sq mi)
Storm #1 = Basin-wide storm Storm #2 = Flamingo/Tropicana Storm Storm #3 = Valley Storm

Notes:

1. FIS flow is higher than COE due to corrected (larger) Upper Blue Diamond drainage area; also, higher percentage of flow splits to Tropicana at the higher inflow.
2. FIS drainage area differs due to refined drainage boundaries from McCarran Airport drainage studies.
3. FIS model incorporates flow splits revised by COE for Feasiblity Study, but these were not included in "Computed Probability" modeling.

TABLE 6-4

PROPOSED FLAMINGO WASH FIS DISCHARGES

		10-Year Peak Discharge				50-Year Peak Discharge				100-Year Peak Discharge				500-Year Peak Discharge		
Node	Area (sq mi)	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE SFHS Q	Adopt Extrap	Adopted Flow
				3590	3600			8790	8800			11300	11300			
RR14	53.0	1370		1065	1100	5030		1370	1400	7950		5740	5700			
RR20	1.4	150		430	430	760		850	850	1340		1040	1000		1700	1700
RR21	6.3	440		1320	1300	1900		2710	2700	3180		3330	3300		5500	5500
RR22	2.2	220		610	610	1060		1250	1300	1850		1540	1500		2600	2600
RR20-22	9.9			1950	2000			4060	4100			5020	5000		8400	8400
R6	70.1			1460	1500			3210	3200			4980	5000		8800	8800
F1	4.6	430		1230	1200	1860		2460	2500	3130		3010	3000		4900	4900
F2	1.3	150		530	530	750		1030	1000	1330		1270	1300		2000	2000
F3	2.6	260		960	960	1210		2000	2000	2080		2470	2500		4200	4200
F5	15.9	740		1810	1800	3000		3640	3600	4930		4570	4600		7500	7500
F5	15.9			830	830			1080	1100			1160	1200		1400	1400
F7	92.0		1100	2350	2400		4100	3890	3900		7000	4820	4800	16000	7000	7000
F14	103.3		1100	2440	2400		4500	4170	4200		7800	5310	5300	16000	7800	7800
F15	104.6		1100	2460	2500		4500	4230	4200		7800	5410	5400	16000	8000	8000
F15	104.6		1100	2460	2500		4100	4150	4200		6000	4640	4600	11000	6700	6700
F16	105.2	1830	1100	2460	2500	6410	4100	4170	4200	9980	6000	4680	4700	10500	6800	6800
F16OF	105.2			0	0			0	0			0	0			
F17	126.6*	1960	1400	2270	2500	6790	5400	4860	4900	10500	8800	6000	6000	19500	10300	10300
F20B	138.5*			2000	2500			5290	5300			6410	6400		12700	12700
F22	143.2*	2040	1600	2020	2500	7100	5500	5430	5400	11000	9000	7010	7000	20000	14100	14100
F23	145.1*			2040	2500			5490	5500			7110	7100		14300	14300

TABLE 6-4

Node	Location
RR14	Red Rock Basin outflow
RR20	RR20 Alluvial Fan
RR21	RR21 Alluvial Fan
RR22	RR22 Alluvial Fan
	Combined Red Rock Fans
R6	Buffalo Channel
F1	F1 Alluvial Fan
F2	F2 Alluvial Fan
F3	F3 Alluvial Fan
F5	Upper Flamingo Basin inflow
F5	Upper Flamingo Basin outflow
F7	Flamingo W at Spanish Trails
F14	Flamingo W at Decatur
F15	Flamingo W u/s UPRR
F15	Flamingo W d/s UPRR
F16	Flamingo W at I-15
F16OF	Flamingo Overflow at I-15
F17	Flamingo W d/s Tropicana W
F20B	Flamingo W at Pecos
F22	Flamingo W at Boulder Hwy
F23	Flamingo W at Las Vegas W

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Model Extrap = Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Adopt Extrap = Extrapolation of Adopted Flows for Q10, Q50 and Q100

Area = Drainage Area from FIS Hydrology

Note: FIS flows include Upper Flamingo Wash Detention Basin and Van Buskirk Channel Outfall

* Drainage area does not include contribution from Upper Blue Diamond watershed (69.5 sq mi)

TABLE 6.5

PROPOSED TROPICANA WASH FIS DISCHARGES

		10-Year Peak Discharge				50-Year Peak Discharge				100-Year Peak Discharge				500-Year Peak Discharge		
Node	Area (sq mi)	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE SFHS Q	Adopt Extrap	Adopted Flow
T8	1.2*			1430	1400			3850	3900			5370	5400		10900	10900
T9U	2.1*			1420	1400			3800	3800	8590		5300	5300		10700	10700
T9D	2.1*		550	1420	1400		2400	3800	3800		3000	5300	5300	3000	10700	10700
T5	4.2			650	650			1920	1900			2640	2600		5700	5700
T6U	5.5			810	810			2420	2400	3795		3300	3300		7200	7200
T6D	5.5			750	750			750	750			750	750		750	750
T6OF	8.2		210	60	60		1400	1540	1500		2400	2550	2600	7000	5000	5000
T1	1.6			320	320			900	900			1200	1200		2500	2500
T3U	2.6			440	440			2730	2700	2080		4050	4100		8000	8000
T3D	2.6		310	440	440		1800	1530	1500		3100	1660	1700	8800	2000	2000
T10	11*		600	1460	1500		3000	3730	3700	9153	4800	5110	5100	11200	10000	10000
T11	12.1*		650	1460	1500		3000	3730	3700		4800	5110	5100	11200	10000	10000
MNW-J2	5.4			50	50			190	190			266	270		700	700
MNW-M	8			320	320			630	630			787	790		1300	1300
T12	20.8*		650	1490	1500		3000	3836	3800	9270	4800	5250	5300	11200	10300	10300

Node	Location
T8	S.B. Tropicana W at Jones
T9U	S.B. Tropicana W u/s UPRR
T9D	S.B. Tropicana W d/s UPRR
T5	M.B. Tropicana W at Jones
T6U	M.B. Tropicana W u/s UPRR
T6D	M.B. Tropicana W d/s UPRR
T6OF	Overflow along UPRR
T1	N.B. Tropicana W at Jones
T3U	N.B. Tropicana W u/s UPRR
T3D	N.B. Tropicana W d/s UPRR
T10	Tropicana W at I-15
T11	Tropicana W at Koval
MNW-J2	Airport Channel at I-15
MNW-M	Airport Channel at Tropicana
T12	Tropicana W at Flamingo W

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Model Extrap = Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Adopt Extrap = Extrapolation of Adopted Flows for Q10, Q50 and Q100

Area = Drainage Area from FIS Hydrology

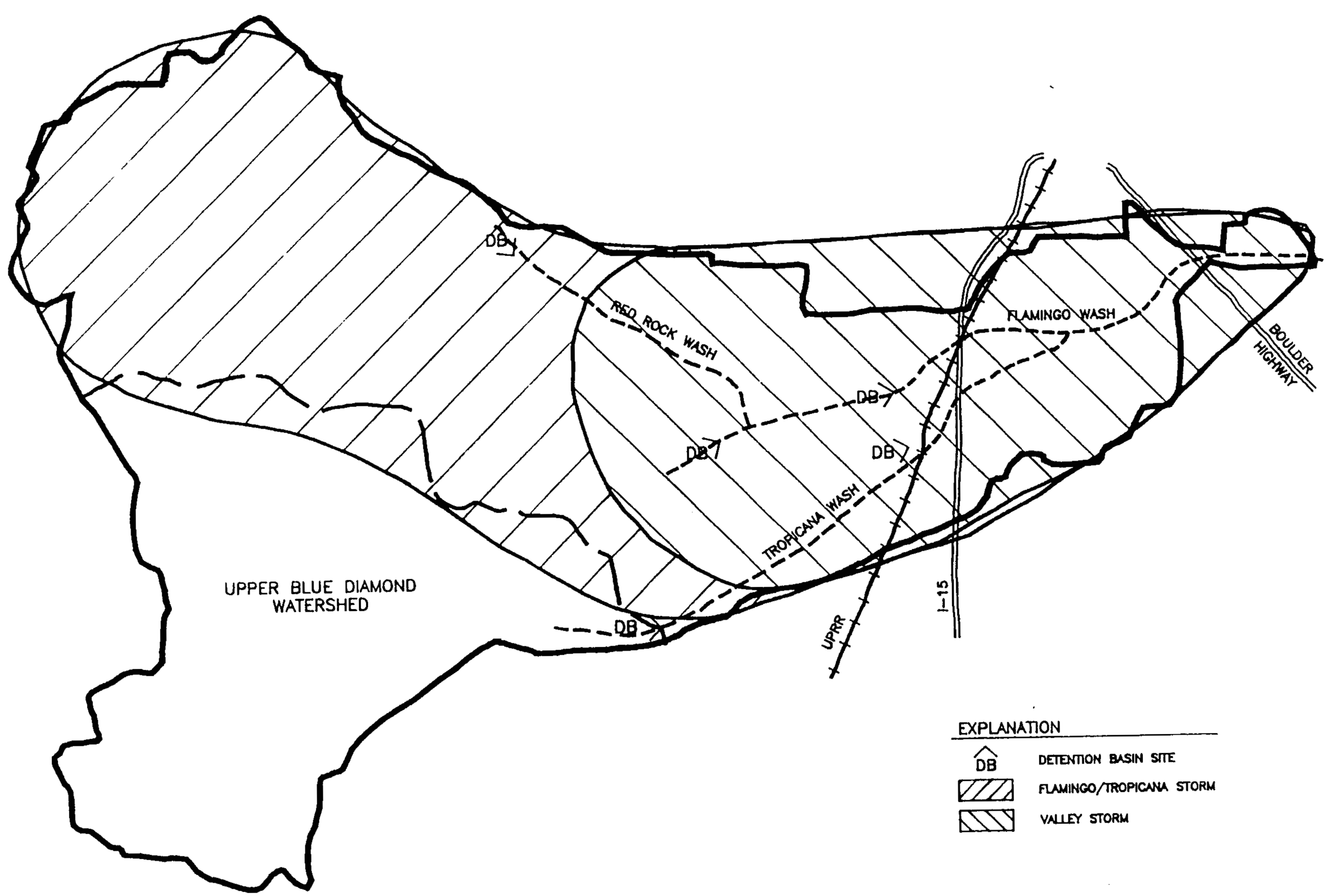


FIGURE 6-1

CCRFCD LAS VEGAS VALLEY
MASTER PLAN UPDATE

FLAMINGO/TROPICANA WATERSHED
STORM CENTERINGS

FIGURE 6-2
FLAMINGO WASH FIS DISCHARGES
(PLOT #1)

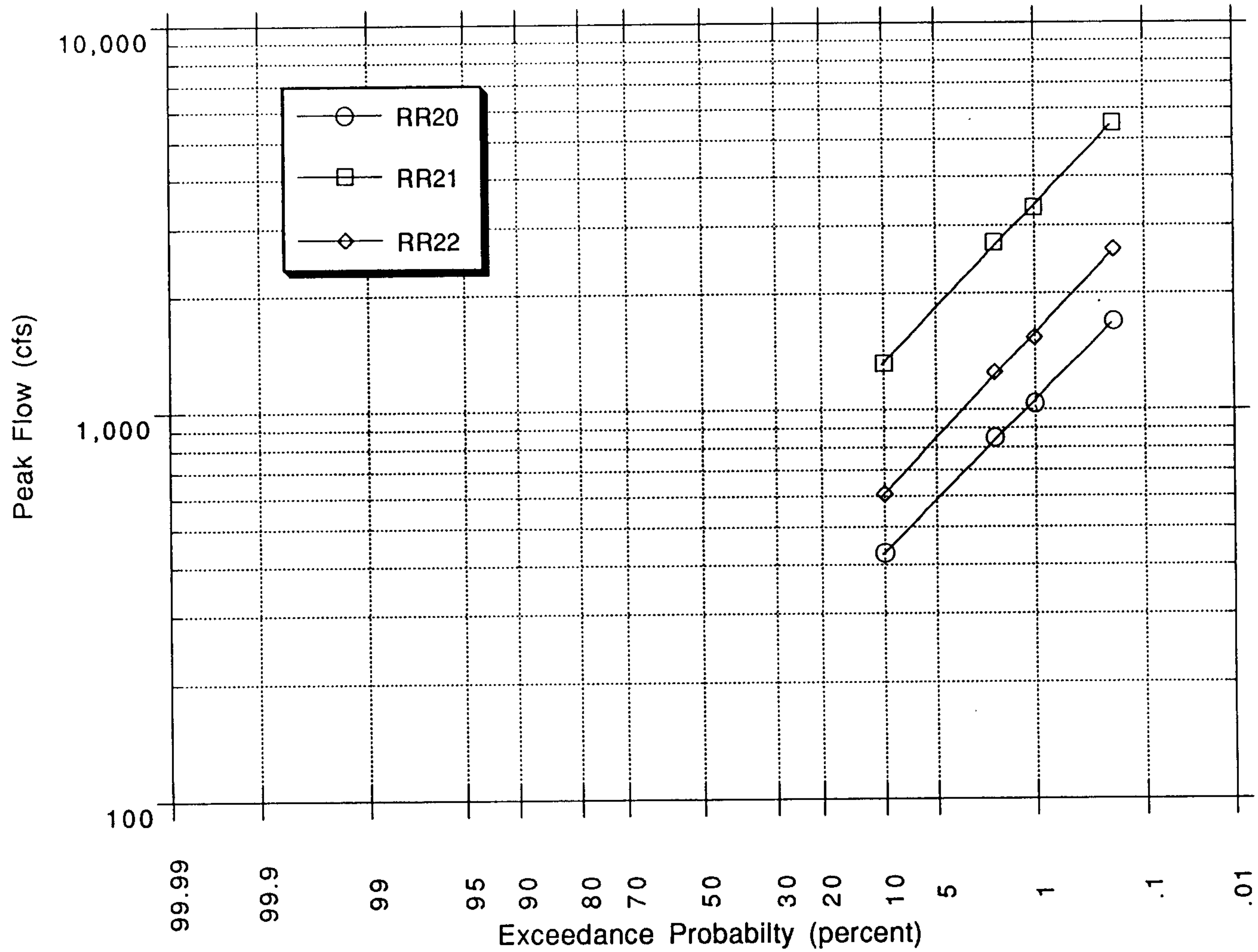


FIGURE 6-3
FLAMINGO WASH FIS DISCHARGES
(PLOT #2)

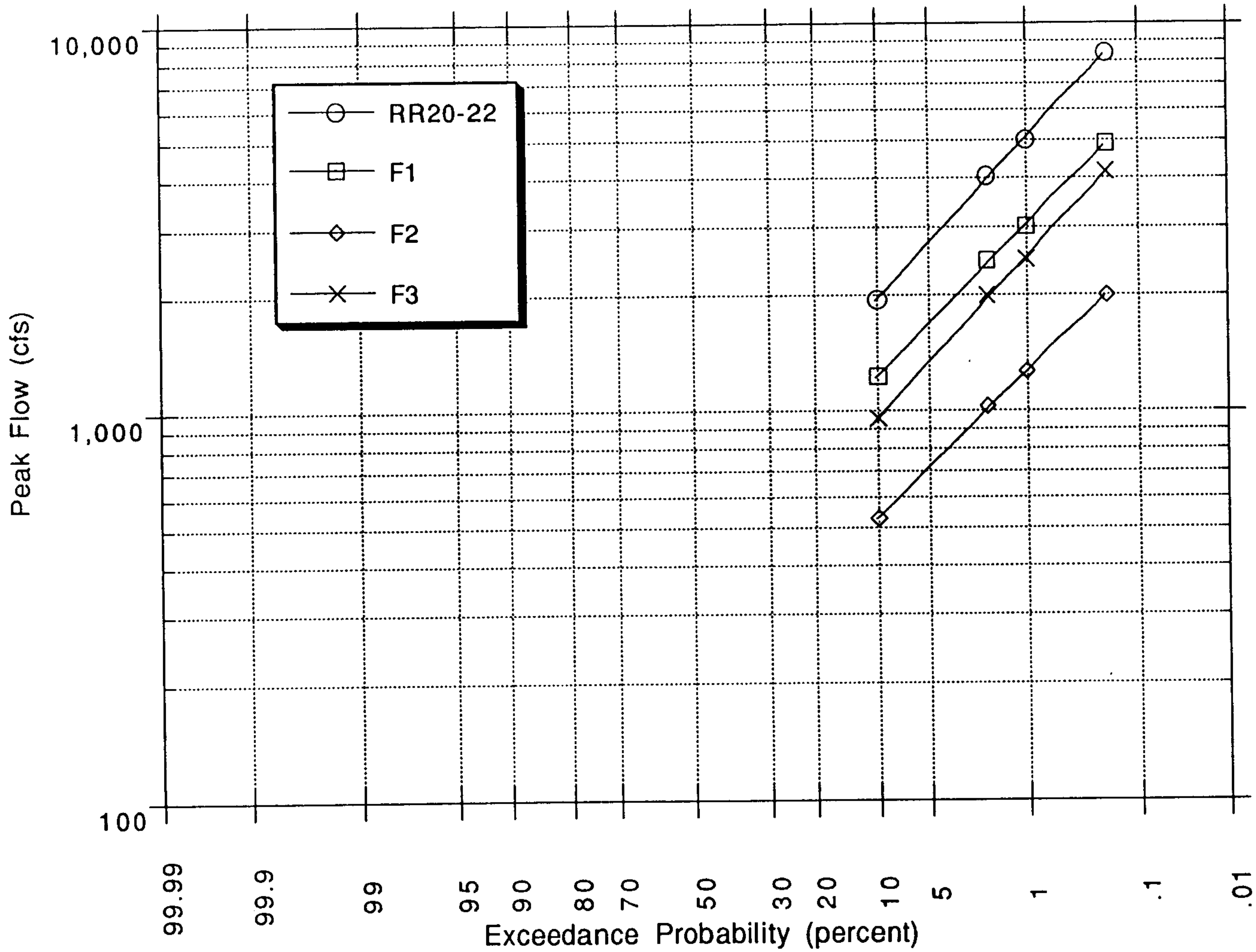


FIGURE 6-4
FLAMINGO WASH FIS DISCHARGES
(PLOT #3)

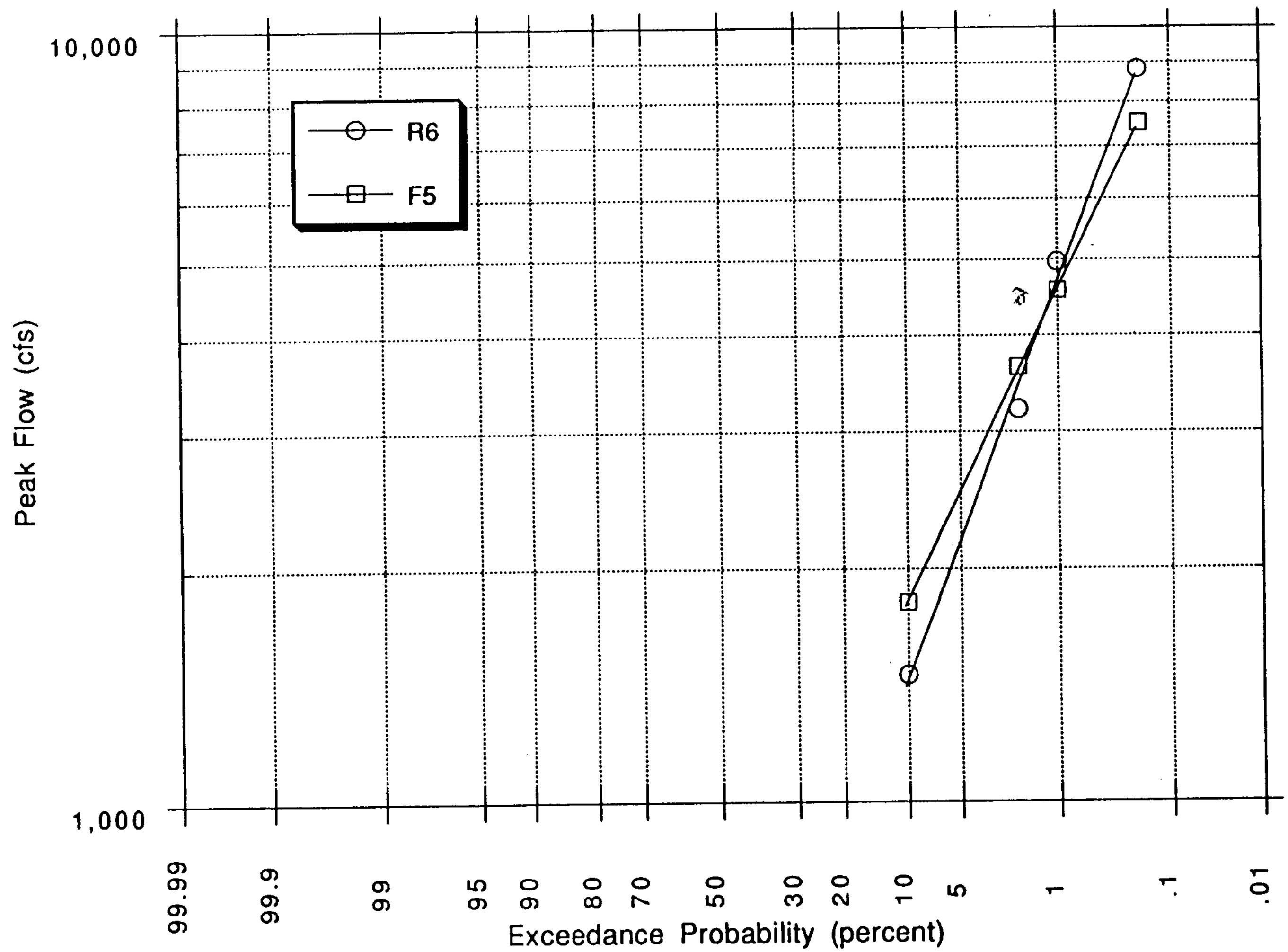


FIGURE 6-5
FLAMINGO WASH FIS DISCHARGES
(PLOT #4)

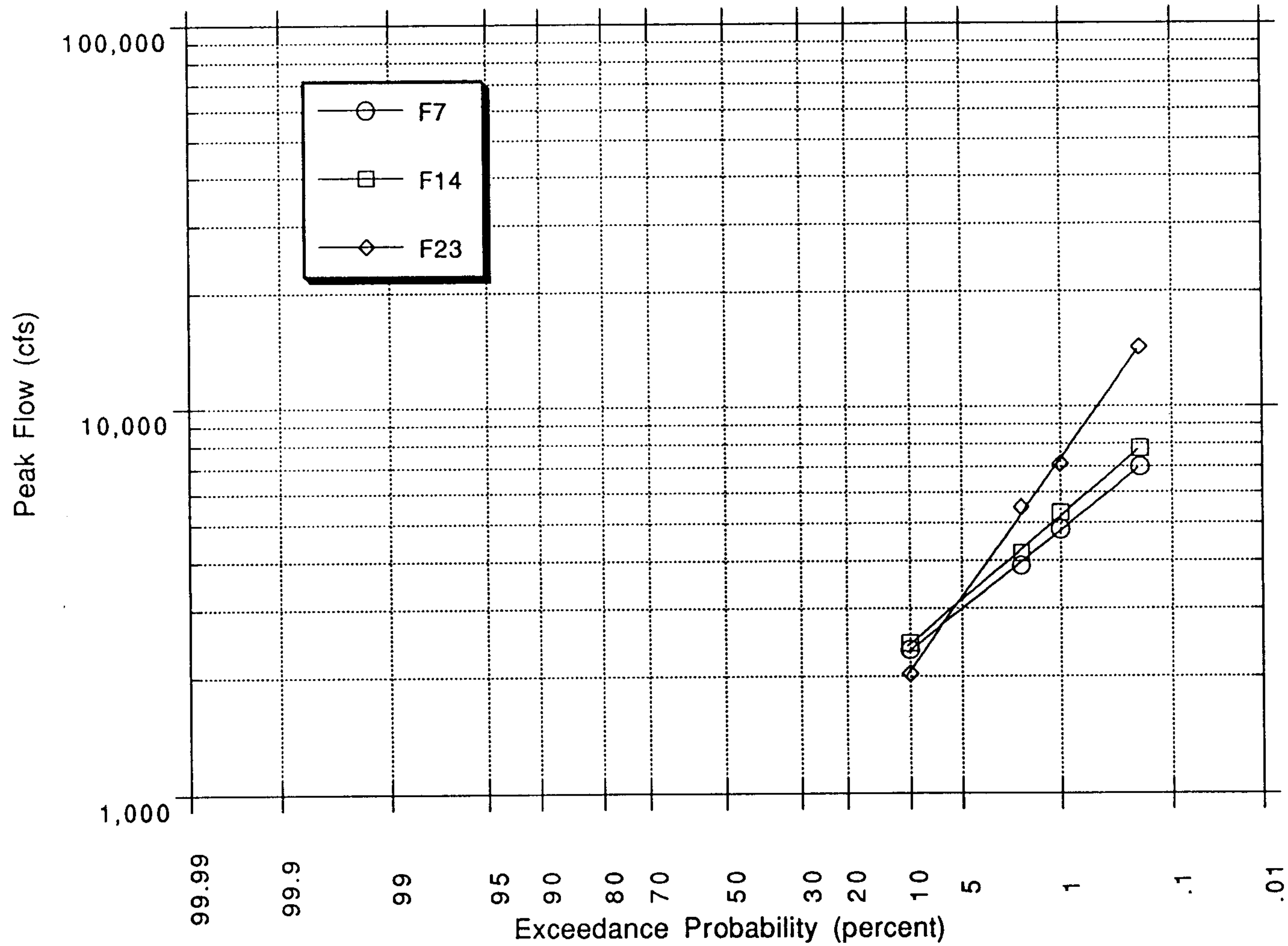


FIGURE 6-6
FLAMINGO WASH FIS DISCHARGES
(PLOT #5)

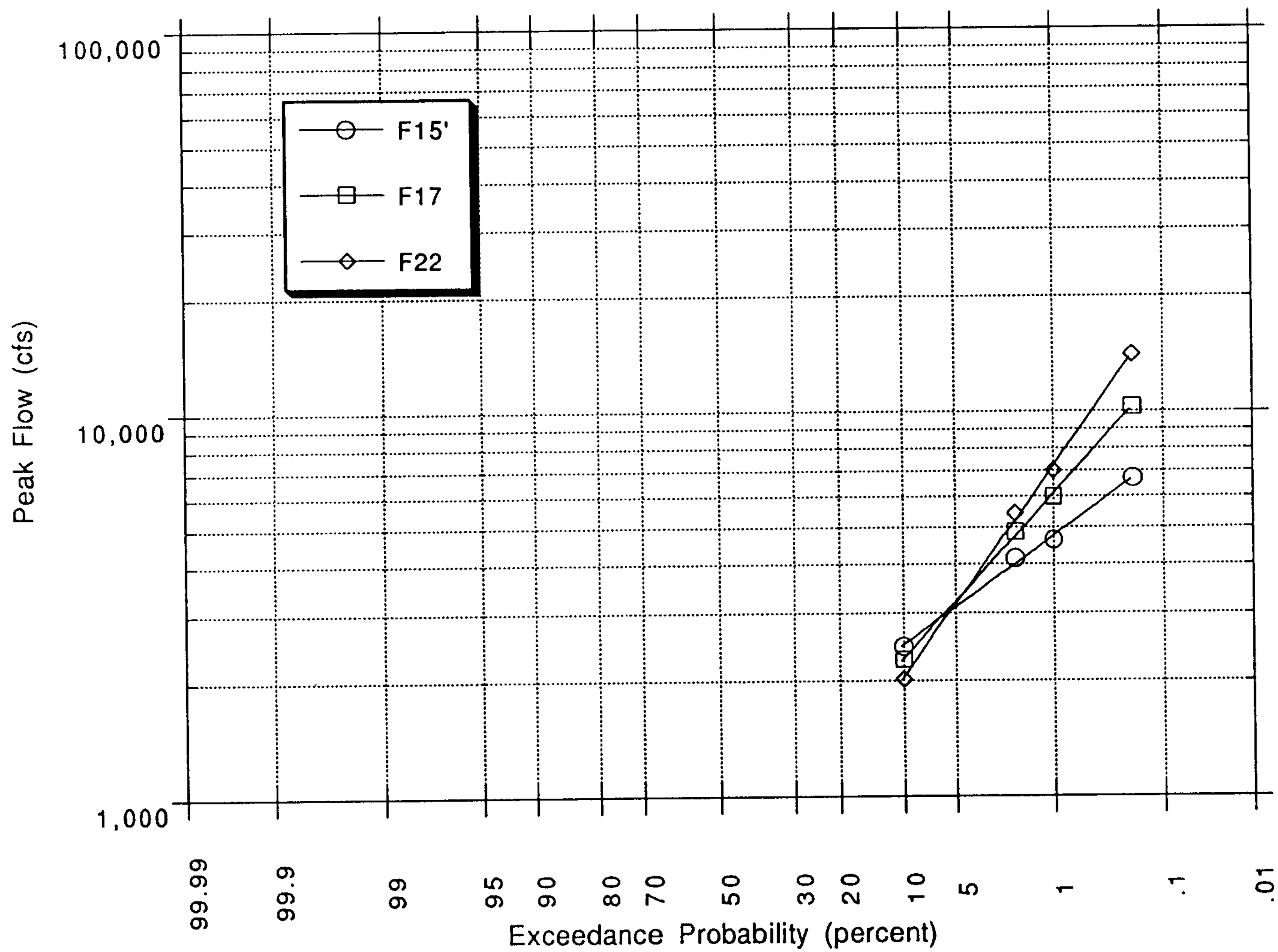


FIGURE 6-7
FLAMINGO WASH FIS DISCHARGES
(PLOT #6)

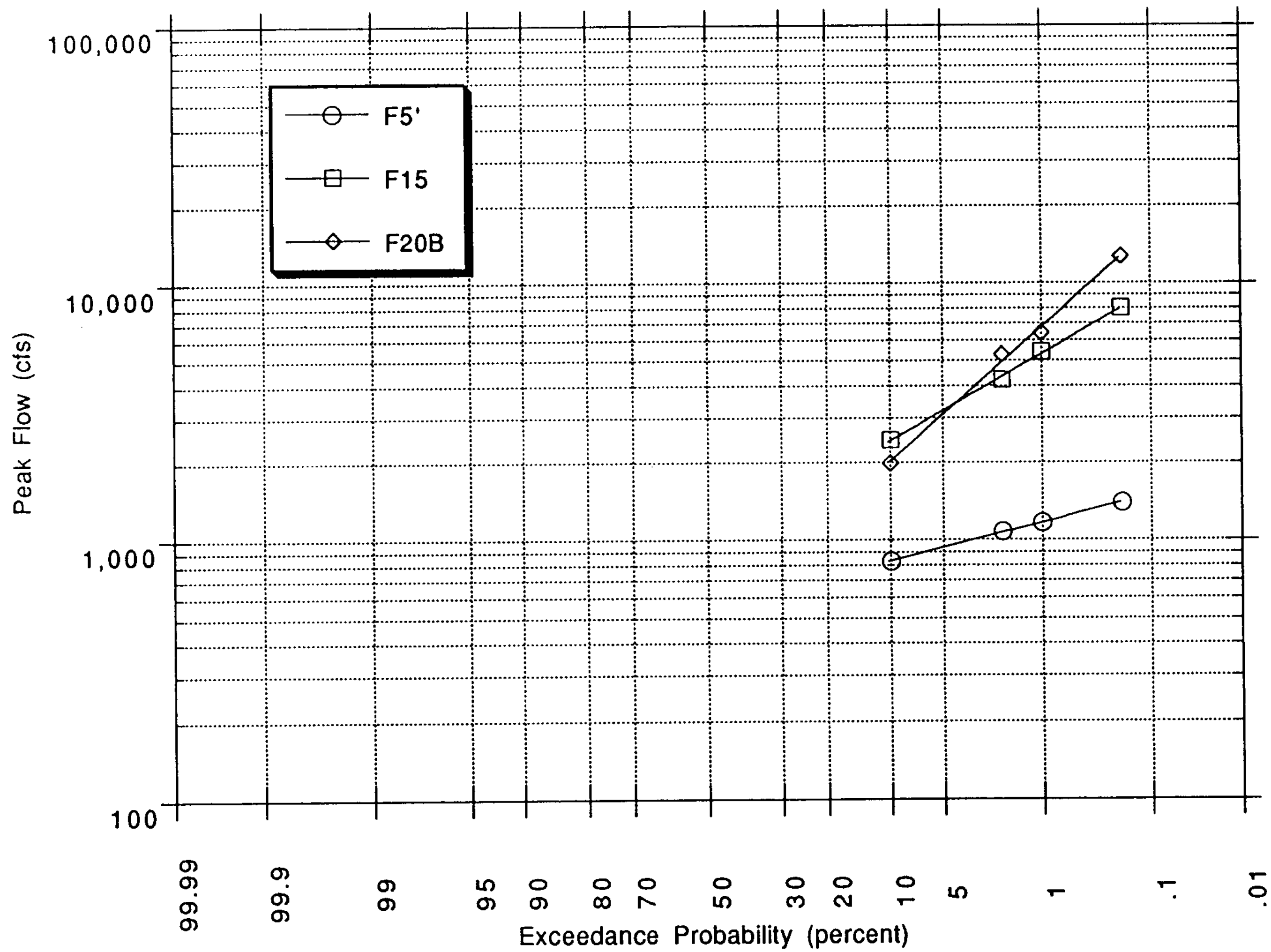


FIGURE 6-8
TROPICANA WASH FIS DISCHARGES
(PLOT #1)

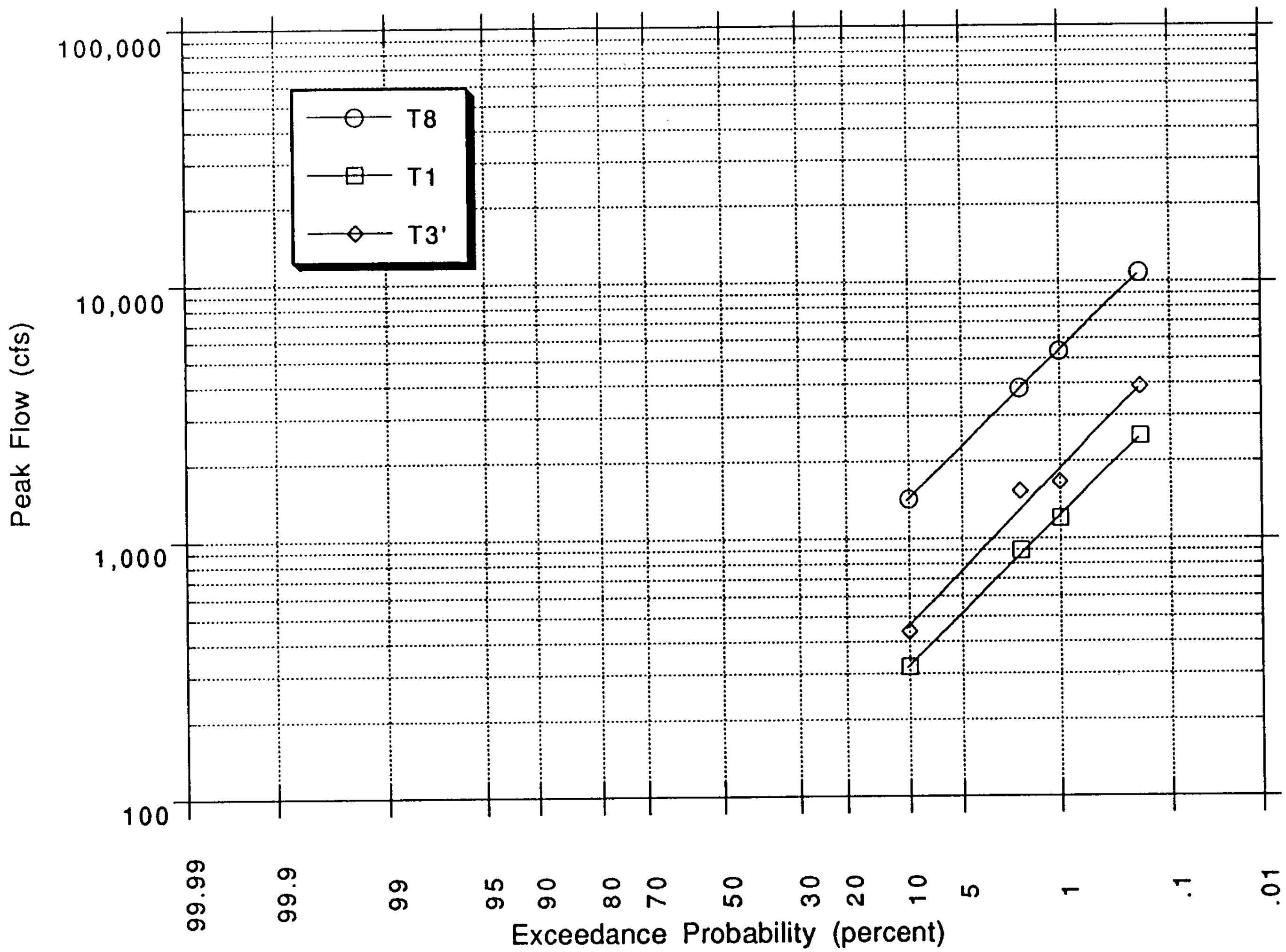


FIGURE 6-9
TROPICANA WASH FIS DISCHARGES
(PLOT #2)

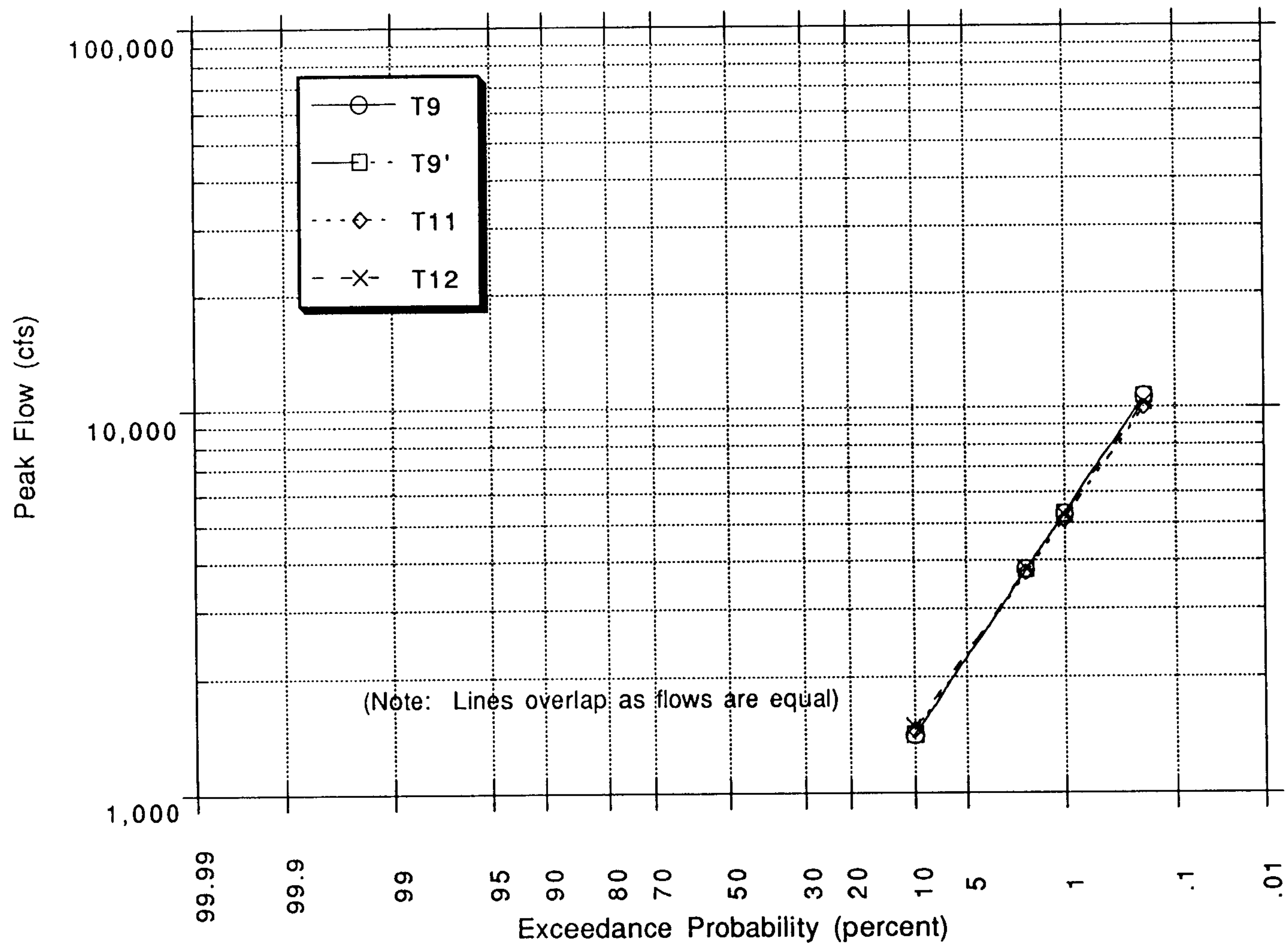


FIGURE 6-10
TROPICANA WASH FIS DISCHARGES
(PLOT #3)

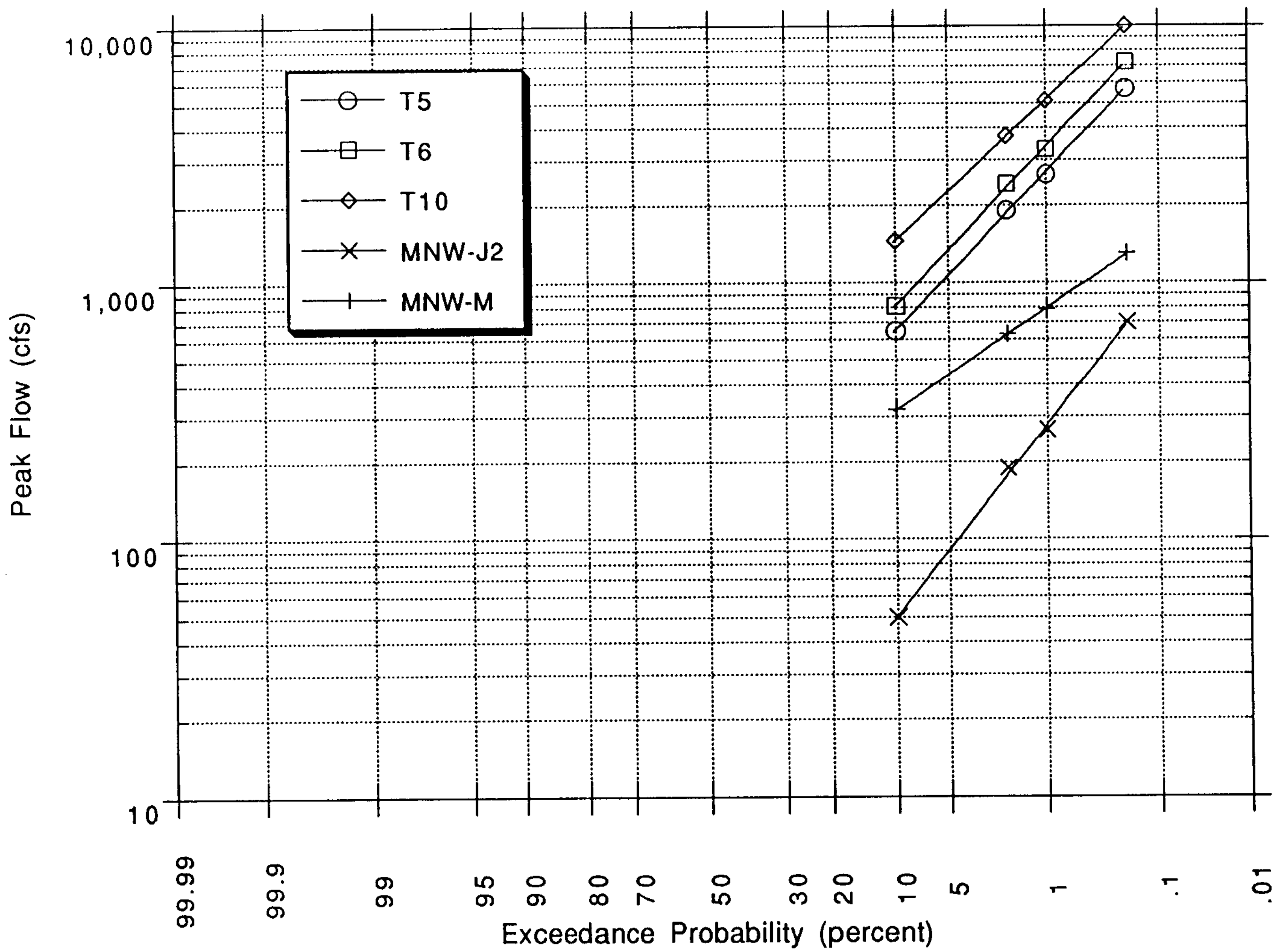
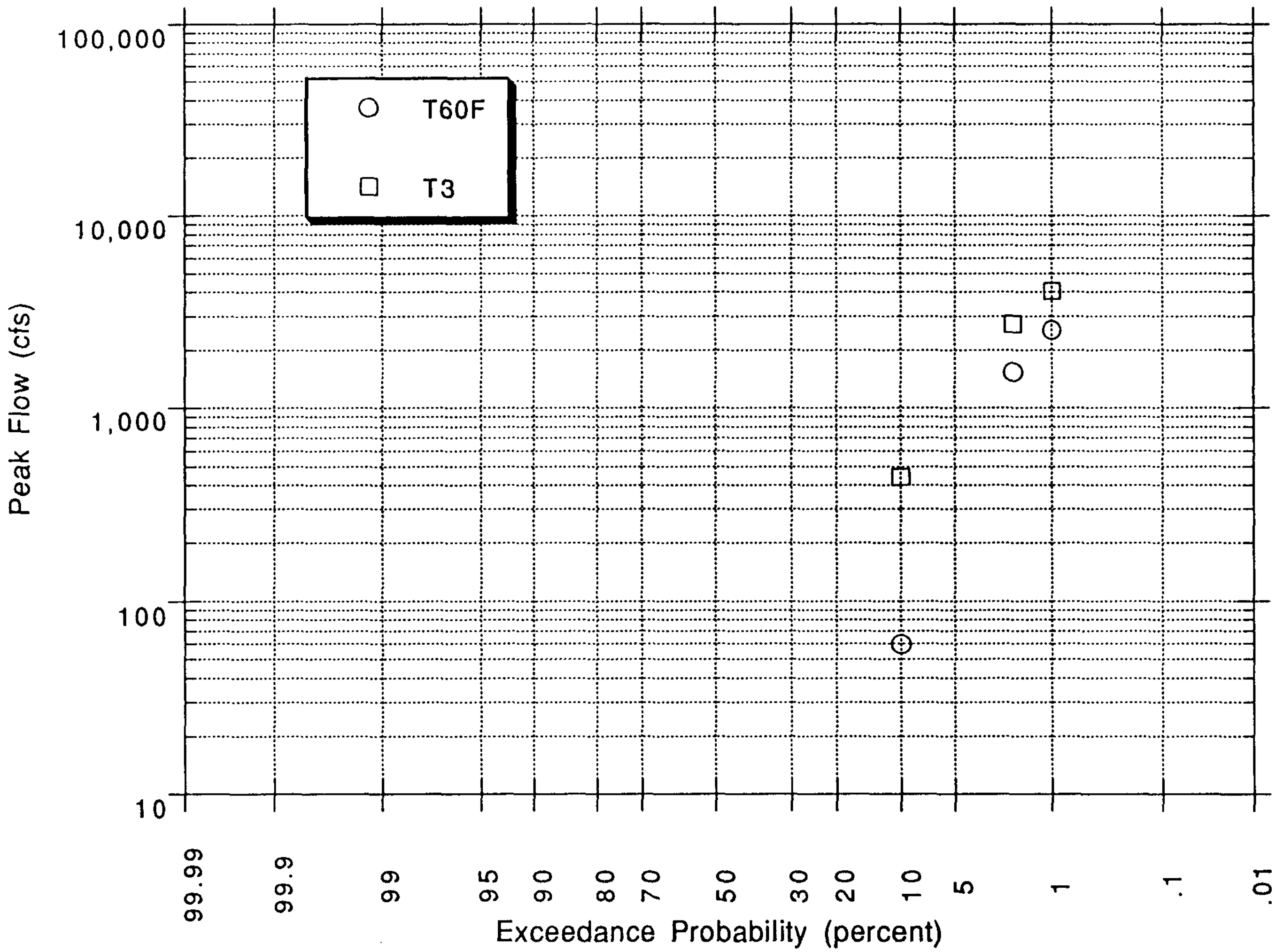


FIGURE 6-11
TROPICANA WASH FIS DISCHARGES
(PLOT #4)



CHAPTER 7
DUCK CREEK/BLUE DIAMOND WASH
FIS HYDROLOGY

CHAPTER 7

DUCK CREEK AND BLUE DIAMOND WASH FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/existing facilities analysis of Duck Creek and Blue Diamond Wash conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for Duck Creek and Blue Diamond Wash. In addition, results could be used to assess the adequacy of existing facilities to handle existing conditions flood discharges.

The basis of the hydrologic analysis was the HEC-1 models developed by the Corps of Engineers for the Feasibility Study of Las Vegas Wash and Tributaries. Previous studies in this watershed also include the CCRFCD Master Plan; the COE Special Flood Hazard Study; the Rawhide Channel Predesign Study by G.C. Wallace (December 1989); the McCarran Phase 2, Contract C-603, Drainage Study by Boyle Engineering Corporation (April 1989); and the preliminary Pharaoh's Kingdom Stormwater Management Plan by JMM (March 1989). The latter three studies were used to better define subareas and flowpaths in their respective areas of coverage. In many cases changes were significant, such as modeling diversions at the UPRR grade and modifying drainage boundaries in the vicinity of McCarran International Airport and Rawhide Channel. The ability to better define and subdivide subbasins used originally by the Master Plan and COE hydrology studies has resulted in new subareas for most of the area east of I-15. Significant subarea revisions were also made in the vicinity of the I-515 Expressway. Subareas are shown in Figure S-4 (Appendix B).

Peak discharges have been developed for proposed FIS concentration points for 10-, 50-, 100, and 500-year return periods. The three lower floods were analyzed using HEC-1 models; the 500-year peak discharges were determined by graphical extrapolation.

MODIFICATIONS TO EXISTING CONDITIONS MODEL FROM COE

The following paragraphs discuss the significant changes made to the COE Duck Creek/Blue Diamond HEC-1 models.

1. Previous HEC-1 analyses in the study area were performed using the 1985 version of the program. This FIS Hydrology study was performed using the 1988 version of HEC-1 on the PC.

2. Minor adjustments were made to the mountainous subareas in the Duck Creek and Blue Diamond watersheds, in order to gain better agreement with available topographic maps. This resulted in minor modifications to drainage areas. An error in subbasin area for subbasin B502 was corrected (old value = 14.7 sq mi; corrected value = 27.4 sq mi).

3. Lag times in the COE model were computed using a combination of methods, including the upland/velocity method and the SCS Curve Number method. These values were compared with lag times computed using the Bureau of Reclamation formula recommended in the CCRFCD Hydrology Manual. It was found that more consistent results were obtained using the USBR formula values, and thus these values were used in the HEC-1 model.

4. The Pharaoh's Kingdom Stormwater Management Plan took a detailed look at drainage to, and flow splits created by, the UPRR grade near the base of the alluvial apron. Flow divisions at the undersized UPRR culverts were not incorporated into the original Master Plan or COE HEC-1 models. Subarea boundaries and flow split data from the Pharaoh's Kingdom study were adopted for the FIS Hydrology.

5. It was assumed that the proposed Southern Section of the Las Vegas Beltway, which will cross through the Duck Creek/Blue Diamond watershed, will not change the overall drainage pattern. Drainage structures for the freeway will be designed with sufficient capacity to safely pass the 100-year discharge without significant flow diversions.

6. Subareas near the I-515 Expressway were modified to reflect current drainage patterns. The Expressway is elevated in several sections, causing runoff to be directed toward culverts and bridges.

7. Channel routing computations in improved channel reaches were converted from the Muskingum method to the kinematic method. This conforms to the recommendations in the District Manual, and will allow for easier model modifications to simulate proposed channel improvements.

8. Peak discharges for FIS hydrology are required at numerous concentrations points in the Duck Creek/Blue Diamond Wash drainage area. Determination of appropriate storm centerings to generate critical peak discharges at each concentration point is complicated by the fact that when the Upper Blue Diamond Wash drainage area is added to the Duck Creek drainage area, the total area exceeds 200 square miles. This is the hypothetical limit of local thunderstorm coverage. In this case, different storm centerings with areas of coverage less than 200 square miles must be investigated.

   Based on this consideration, design storm centerings were developed as follows:

   a. For each concentration point upstream of the Duck Creek/Blue Diamond Wash confluence, a storm covering the full contributing upstream drainage area was investigated. In the case of Blue Diamond Wash, this included the proportioned contribution from Upper Blue Diamond Wash.

   b. Below the Duck Creek/Blue Diamond Wash confluence, where the total drainage area exceeds 200 square miles, the controlling storm was assumed to be a storm covering the Duck Creek watershed but excluding the Upper Blue Diamond watershed. This is based on the conclusions of the original Master Plan, which found that the Duck Creek Storm was the controlling event in the lower Duck Creek drainage.

   Depth-area reduction factors (DARF's) at concentration points for each scenario were based on the total storm area coverage upstream of the concentration point, using the CCRFCD Hydrology Manual DARF table. Storm areas are shown in Figure 7-1.

9. Subarea losses were simulated using the SCS curve number method, rather than the uniform loss rates utilized in the COE model. Curve numbers were computed based on current land use and soil type information, using the curve number table in the CCRFCD Hydrology Manual.

10. The Rawhide Channel watershed was modeled in detail for the Preliminary Design Study for this area. For purposes of the FIS Hydrology, this watershed was reduced to an equivalent single subarea producing the same peak discharge, runoff volume, and time-to-peak as the detailed model. Within the Rawhide Channel drainage area, the results of the detailed modeling will be used. The single-subarea simplification will be used to model the contribution of the Rawhide Channel area to Duck Creek.

11. Flows from Upper Blue Diamond Wash can potentially leave the Duck Creek/Blue Diamond Wash drainage area via Tropicana Wash, subject to a flow split on the Blue Diamond alluvial fan. This is an uncontrolled division of runoff at present, and due to the alluvial nature of the channels the flow split probably varies over time. For existing condition modeling purposes, the flow split rating table in the COE Hydrologic Documentation report was adopted. This table shows about 30 percent of the Upper Blue Diamond Wash runoff entering lower Tropicana Wash, with the remainder flowing into lower Blue Diamond Wash and Duck Creek.

SUMMARY OF RESULTS

The existing conditions HEC-1 model was executed for the two storm scenarios discussed above. Table 7-1 was prepared to compare 100-year FIS Hydrology model results for Duck Creek and Blue Diamond Wash with the results at recent previous studies in the watershed. The only study appropriate for comparison is the COE Special Flood Hazard Study, which produced the computed probability discharges adopted for regulatory purposes by the District.

Table 7-1 shows that most modeled FIS Hydrology discharges agree within 10 percent of the COE flows. In these cases the adopted discharges for FIS purposes are set equal to the CCRFCD regulatory discharges. One exception is the flow on lower Blue Diamond Wash, which is affected by the improved diversion and flow split analysis at the UPRR grade. In this case the modeled discharge is the recommended flow for adoption. The other exception is at node D4, where the modeled flow is slightly more than 10 percent greater than the COE discharge. In this case a value between the COE flow and the modeled flow was selected, in order to preserve continuity with the adopted discharges at the upstream and downstream nodes.

The FIS Hydrology HEC-1 model was used to compute 10-year and 50-year discharges, based on the same curve number and lag time parameters developed for the 100-year model. 500-year discharges were extrapolated graphically from the three lower values. Flood frequency plots used to perform the extrapolations are shown in Figures 7-2 through 7-8. Table 7-2 summaries recommended FIS discharges for the Duck Creek and Blue Diamond watersheds.

The HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix.

TABLE 7-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR DUCK CREEK/BLUE DIAMOND FIS HYDROLOGY

FIS Hydrology				COE Computed Probability						Adopted
CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	Notes	Description	Discharge
Blue Diamond										
B504	69.5	0.65	14828						Blue Diamond Fan Apex	14800
B11	71.6#	0.64	8930					3	M.B. Blue Diamond u/s UPRR	8900
B11	71.6#	0.64	3474					3	M.B Blue Diamond d/s UPRR	3500
B11SPL	71.6#	0.64	3474					3	N. B. Blue Diamond d/s UPRR	3500
B12	72.7#	0.64	3433						N. B. Blue Diamond at I-15	3400
B14B	72.6#	0.64	3442						M.B. Blue Diamond at I-15	3400
B16A	82.5#	0.63	6748	CP4	66.2	-	8300	2,4	Combined Blue Diamond at Duck Cr	6700
Duck Creek										
D2B	53.6	0.67	9005						Main Branch at UPRR (upper)	9000
D3	71.5	0.65	9664						Main Branch at Interstate 15	9700
D4	119.5	0.58	11746	CP10	130.2	-	10500	5,8	Main+South Branches Below LVB	11000
D5B	146	0.55*	11193	CP12	137.5	-	11000	6,7	Paradise Rd (u/s Blue Diamond)	11000
D7	147*	0.55*	11165	CP14	205.8	-	11500	7	Main Channel at UPRR (lower)	11500
D10	158*	0.54*	10852	CP57	214.4	-	11500	7	Main Channel at Sunset Rd	11500
D11B	164*	0.54*	10845	CP8	226.3	-	11500	7	Main Channel at Boulder Highway	11500

= Area is maximum contributing area; affected by upstream diversions

* = Drainage area excludes Upper Blue Diamond (69.5 sq mi). DARF based on Duck Creek Storm, which assumes no rain over Upper Blue Diamond watershed (69.5 sq mi)

Notes:

1. FIS model uses revised flow splits at UPRR.
2. Drainage area difference due primarily to corrected subbasin area in Upper Blue Diamond watershed.
3. Some flow splits out and flows north along UPRR, out of Blue Diamond drainage area
4. FIS Q is more than 10% lower than COE Q due to lost flow at UPRR split in Note 3.
5. Higher FIS Q attributed to use of CN rather than uniform loss rate.
6. Q is lower than at u/s concentration point due to lower DARF without commensurate inflow from the additional area. Inflow is lower due to splits and diversions at UPRR (notes 1 and 3).
7. FIS Q is within 10% of COE Q/CCRFCD regulatory discharge; therefore adopt regulatory discharge for FIS.
8. Adopted Q selected to be consistent with downstream Q.

TABLE 7-2

PROPOSED DUCK CREEK/BLUE DIAMOND FIS DISCHARGES

		10-Year Peak Discharge				50-Year Peak Discharge				100-Year Peak Discharge				500-Year Peak Discharge			
Node	Area (sq mi)	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE SFHS Q	Model Extrap	Adopt Extrap	Adopted Flow
Blue Diamond Wash																	
B504	69.5	1500		5150	5100	5500		11830	11800	8700		14830	14800		26800		26800
B11	71.6#			3480	3500			7500	7500			8930	8900		11600		11600
B11DS	71.6#			1550	1550			2970	2950			3470	3500		4350		4400
B11SPL	71.6#			1550	1550			2970	2950			3470	3500		4350		4400
B12	72.7#			1530	1550			2930	2950			3430	3400		4310		4300
B14B	72.6#			1530	1550			2930	2950			3440	3400		4310		4300
B16A	82.5#		1450	2960	3000		5300	5730	5700		8300	6750	6700	20000	8490		8500
Duck Creek																	
D2B	53.6	1400		2830	2800	4900		7060	7100	7800		9010	9000		17200		17200
D3	71.5	1500		2940	2900	5600		7540	7500	8700		9660	9700		18800		19000
D4	119.5	1900	1550	3284	3000	6700	6500	9017	8500	10400	10500	11750	11000	28000	24000		24000
D5B	146*	2100	1700	2970	3000	7100	6600	8510	8500	11000	11000	11190	11000	29000	23600		24000
D7	147*		1750	2960	3000		7000	8490	8500		11500	11170	11500	30000	23500		24000
D10	158*		1700	2820	3000		7000	8220	8500		11500	10850	11500	31000	23100		24000
D11B	164*	2200	1700	2820	3000	7400	7000	8210	8500	11500	11500	10850	11500	33000	23100		24000

Node	Location
B504	Blue Diamond Fan Apex
B11	M.B. Blue Diamond u/s UPRR
B11	M.B Blue Diamond d/s UPRR
B11SPL	N. B. Blue Diamond d/s UPRR
B12	N. B. Blue Diamond at I-15
B14B	M.B. Blue Diamond at I-15
B16A	Combined Blue Diamond at Duck Cr
D2B	Main Branch at UPRR (upper)
D3	Main Branch at Interstate 15
D4	Main+South Branches Below LVB
D5B	Paradise Rd (u/s Blue Diamond)
D7	Main Channel at UPRR (lower)
D10	Main Channel at Sunset Rd
D11B	Main Channel at Boulder Highway

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS Hydrology HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Model Extrap = Extrapolation of Q10, Q50, and Q100 Flows from HEC-1 Model Output
Adopt Extrap = Extrapolation of Adopted Flows for Q10, Q50 and Q100

Area = Drainage Area from FIS Hydrology

= Area is maximum contributing area; affected by upstream diversions
* = Drainage area excludes Upper Blue Diamond (69.5 sq mi). DARF based on Duck Creek Storm, which assumes no rain over Upper Blue Diamond watershed (69.5 sq mi)

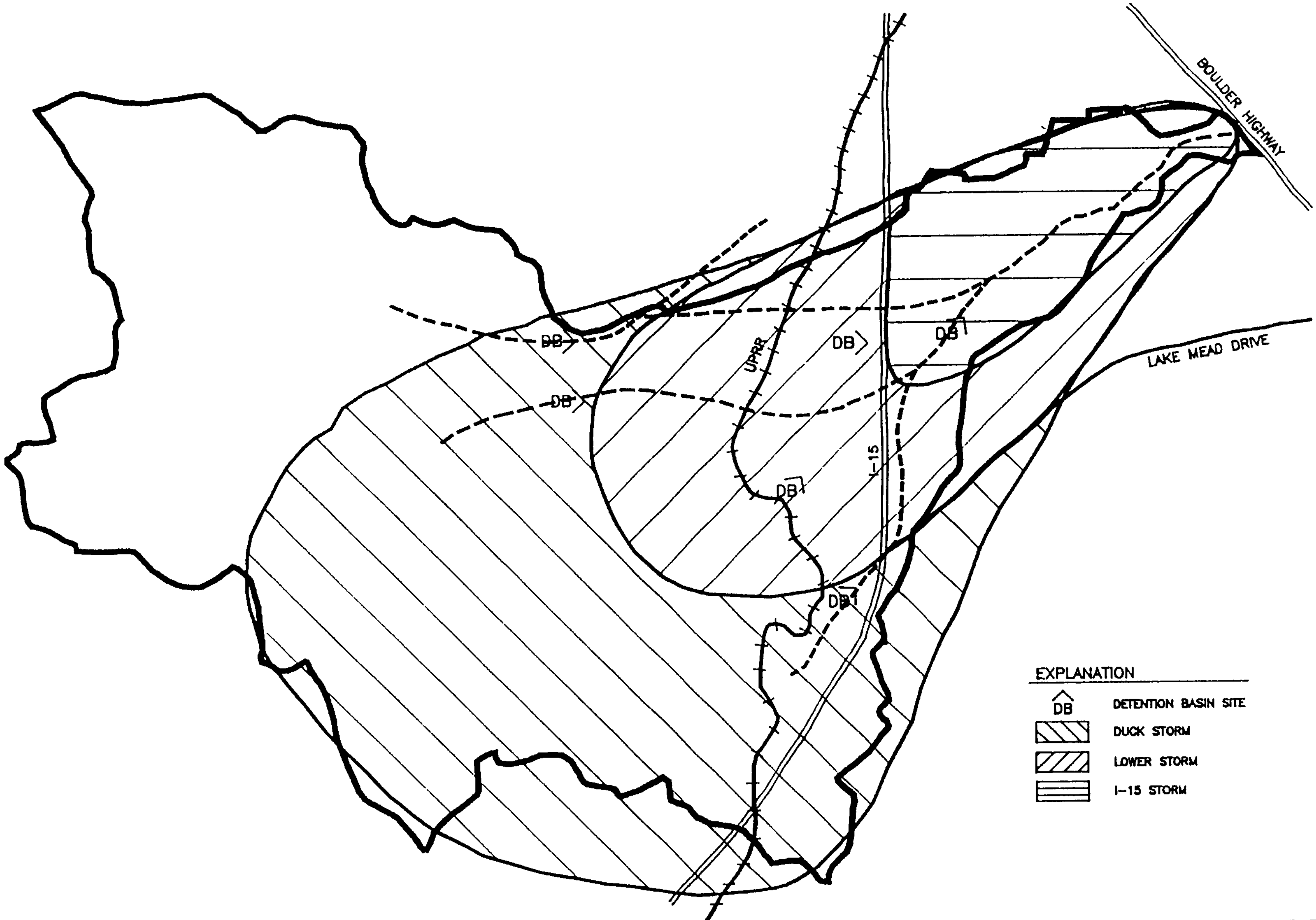


FIGURE 7-1

CCRFCD LAS VEGAS VALLEY
MASTER PLAN UPDATE

DUCK CREEK/BLUE DIAMOND WATERSHED
STORM CENTERINGS

FIGURE 7-2
BLUE DIAMOND FIS DISCHARGES
(PLOT #1)

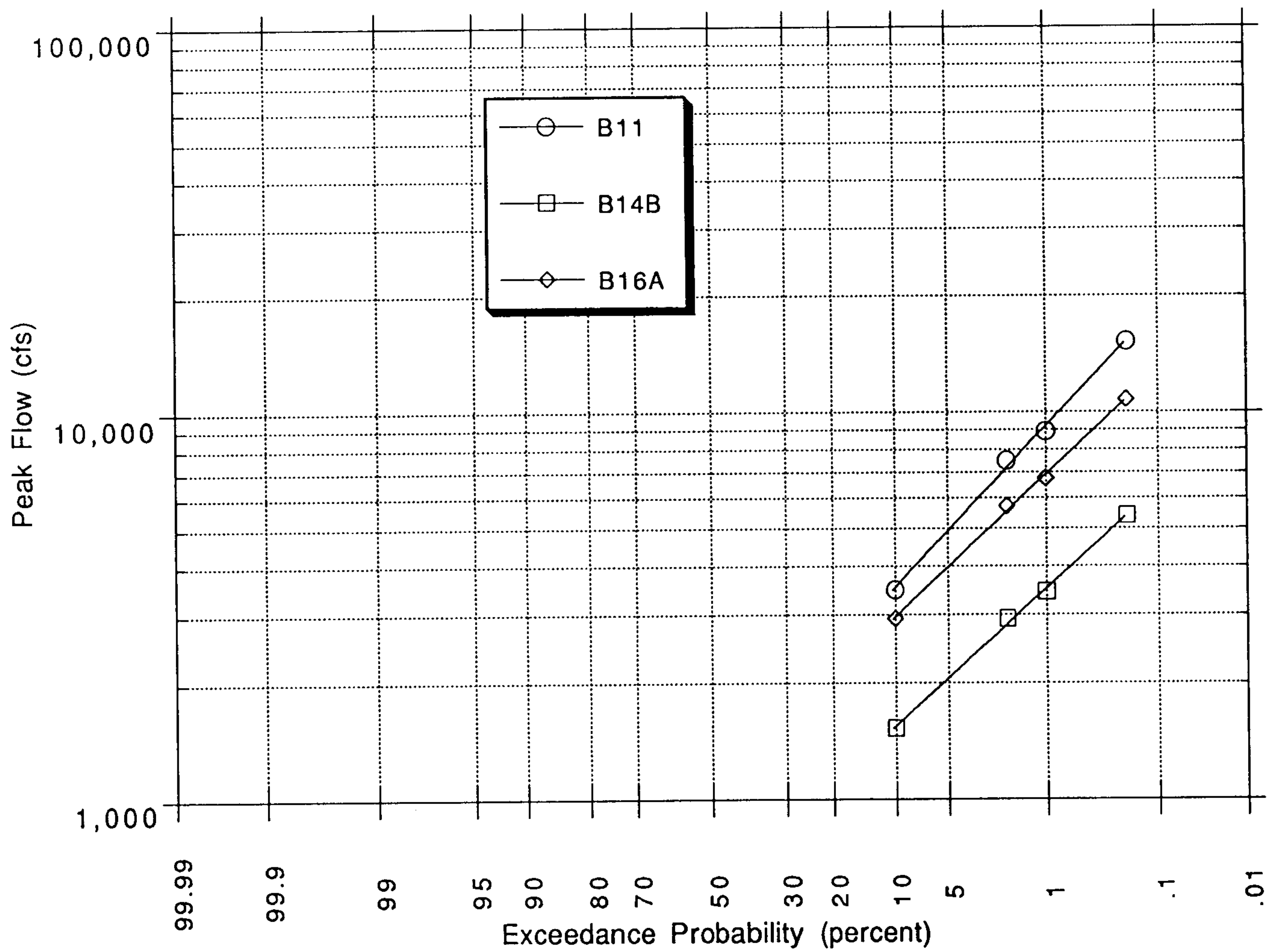


FIGURE 7-3
BLUE DIAMOND FIS DISCHARGES
(PLOT #2)

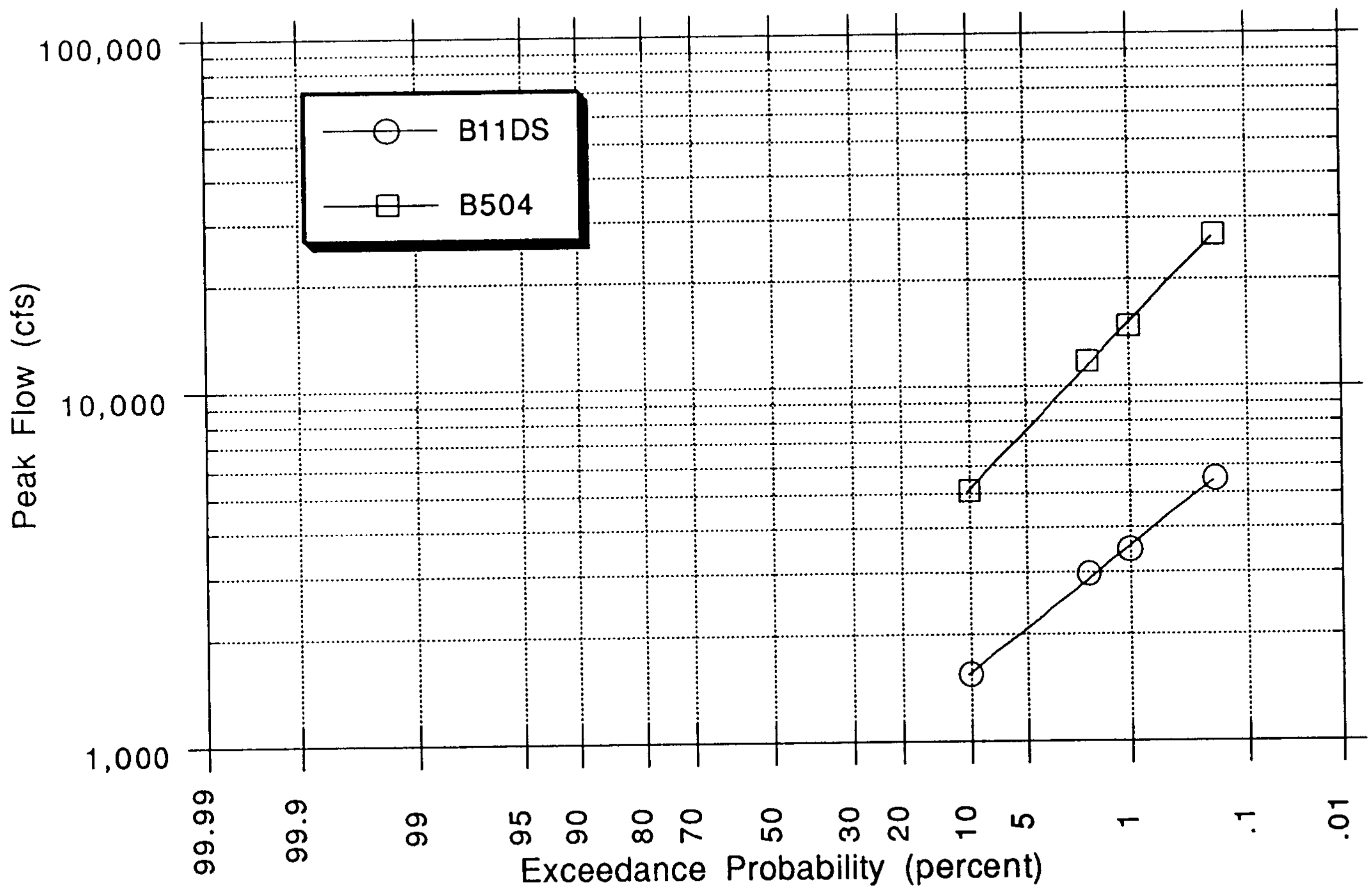


FIGURE 7-4
BLUE DIAMOND FIS DISCHARGES
(PLOT #3)

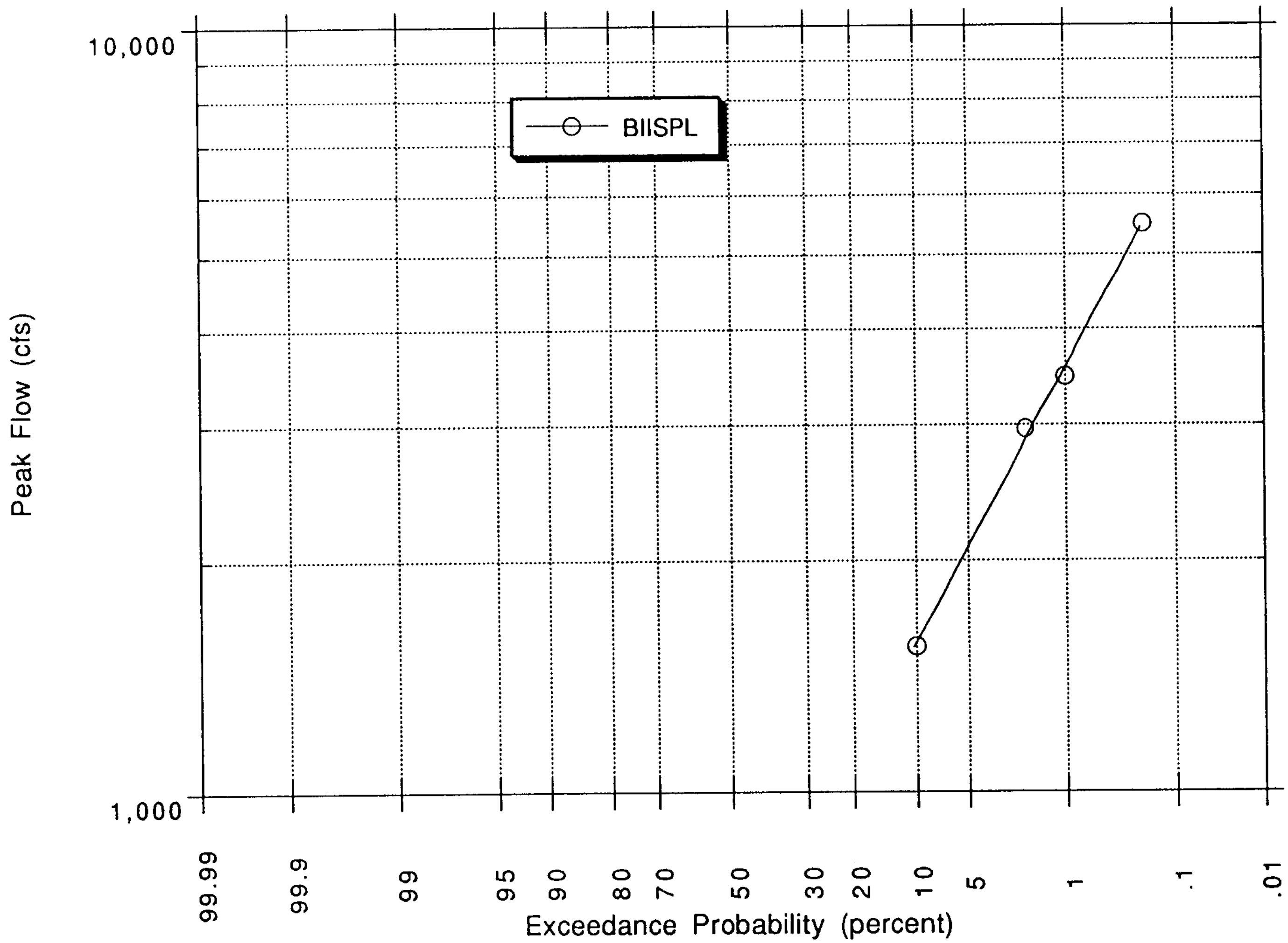


FIGURE 7-5
BLUE DIAMOND FIS DISCHARGES
(PLOT #4)

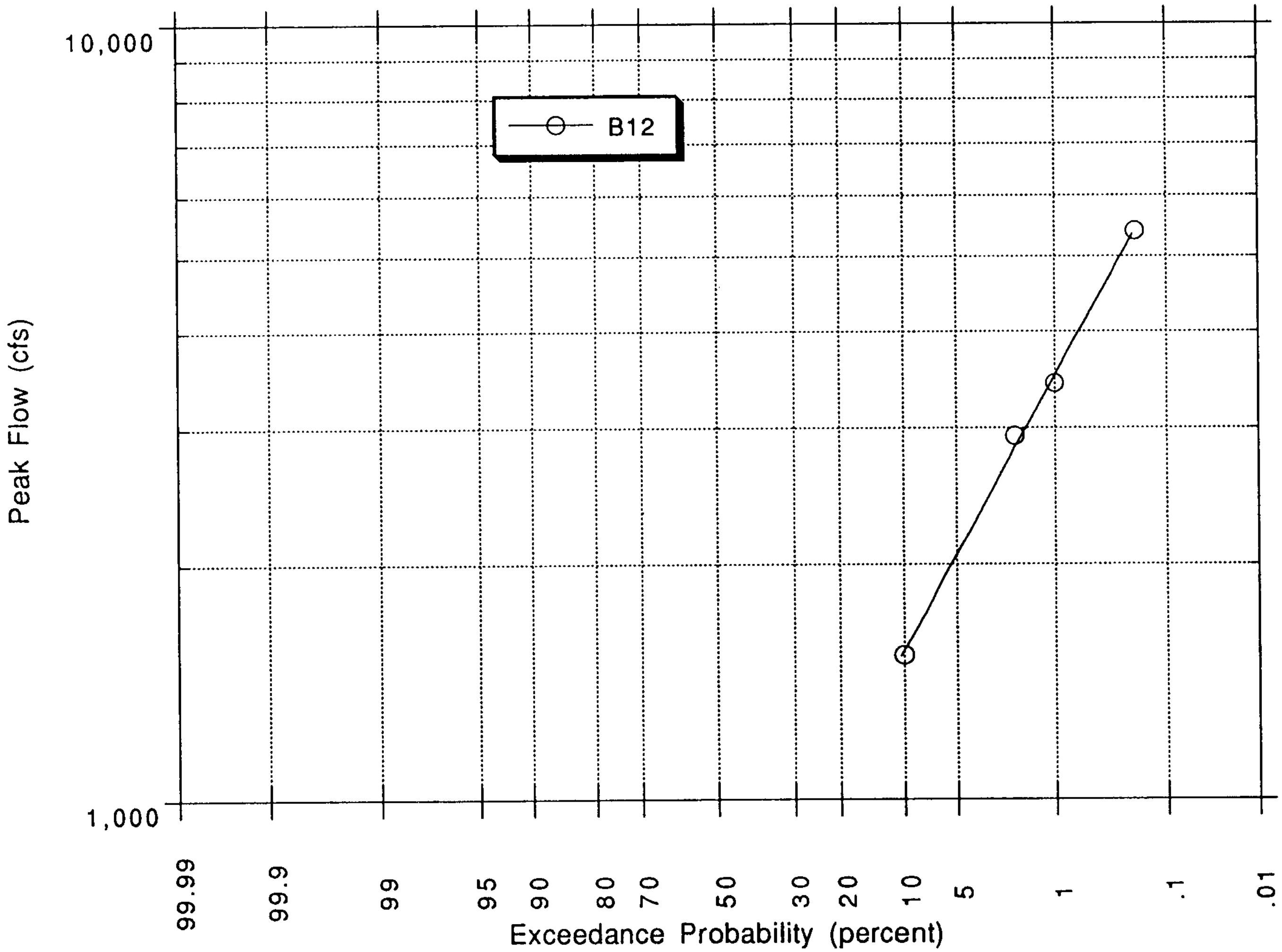


FIGURE 7-6
DUCK CREEK FIS DISCHARGES
(PLOT #1)

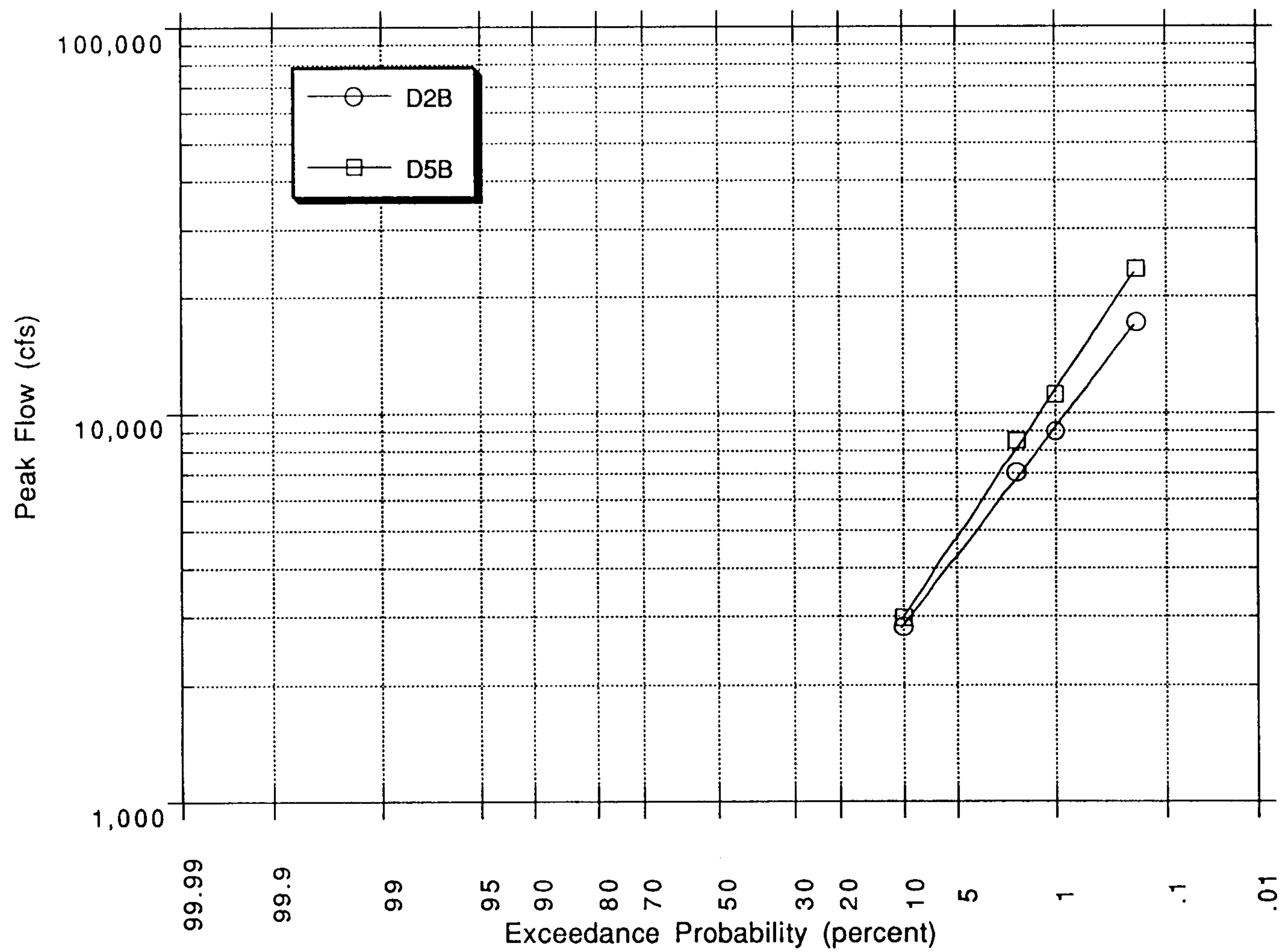


FIGURE 7-7
DUCK CREEK FIS DISCHARGES
(PLOT #2)

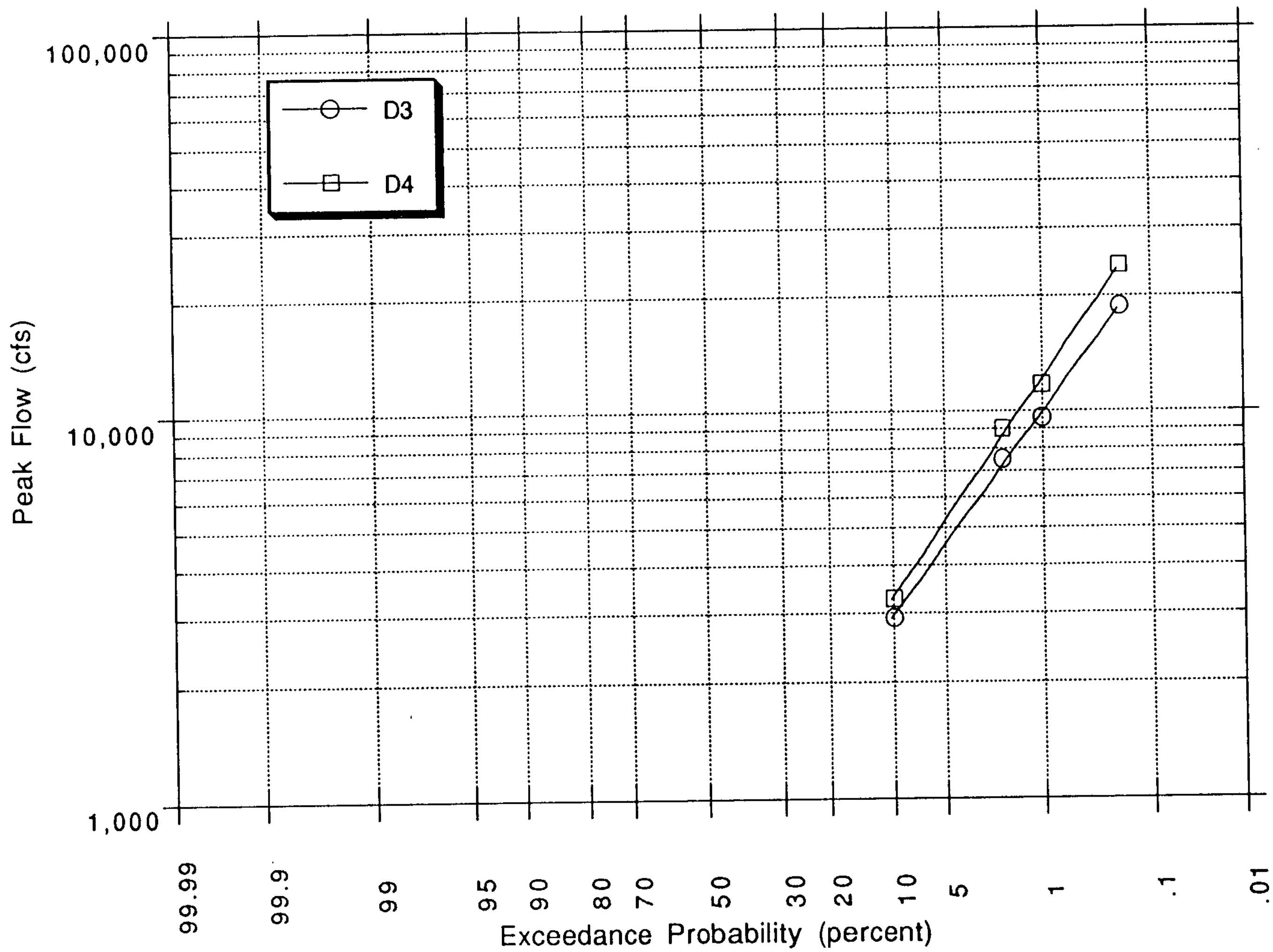
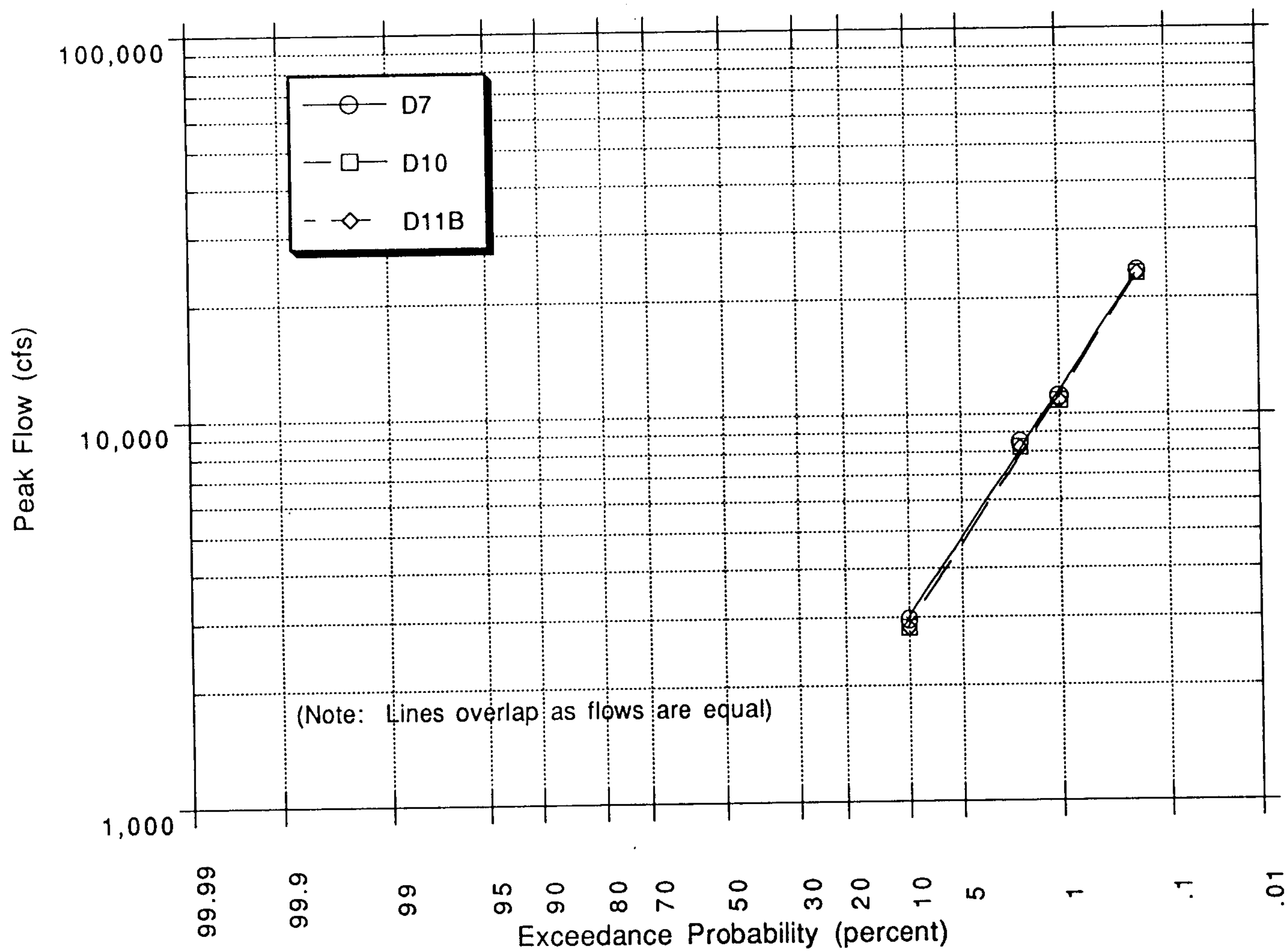


FIGURE 7-8
DUCK CREEK FIS DISCHARGES
(PLOT #3)



CHAPTER 8
PITTMAN WASH FIS HYDROLOGY

CHAPTER 8

PITTMAN WASH FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/existing facilities analysis of Pittman Wash in the City of Henderson (COH) conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future flood insurance studies for Pittman Wash. In addition, results could be used to assess the adequacy of existing facilities to handle existing conditions flood discharges.

The basis of the hydrologic analysis was the HEC-1 model developed by the Corps of Engineers (COE) for their Special Flood Hazard Study for Las Vegas Valley (July 1988), and the drainage study for Cosmo World by Boyle Engineering Corporation (1989). Previous hydrologic studies of this watershed include the CCRFCD Master Plan and the Henderson Stormwater Management Plan, which is considered to be superseded by the COE and Boyle studies. The HEC-1 runs were used as the source of basic subbasin lag time, routing, and basin area parameters. The subbasin boundaries reportedly were the same as those used in the original Master Plan and therefore, JMM's original subbasin boundary maps were utilized as the source map reference.

The HEC-1 data files were modified to reflect changes in CCRFCD modeling criteria, the HEC-1 program itself, and changes to the subbasin boundaries based on the proposed alignment of the new freeway and a better understanding of flood control in the City of Henderson.

MODIFICATIONS TO EXISTING CONDITIONS MODEL

1. Previous modeling utilized the 1985 version of HEC-1. FIS Hydrology modeling was performed using the 1988 version of HEC-1.

2. The appropriate hydrologic model to use as the basis for the Pittman Wash is that developed by Boyle Engineering Corporation for Cosmo World for the upper reaches of Pittman Wash. For the lower reach of Pittman Wash the appropriate model is the Corps of Engineers HEC-1 model developed for the Feasibility Study.

3. The subbasin boundaries in the upstream areas have been modified based on comments in the Boyle Hydrology study for Cosmo World and a detailed review of the USGS topographic maps . Subbasins are shown in Figure S-5 (Appendix B).

   The Boyle HEC-1 model extended below Lake Mead Boulevard. This portion of the model was not used, however, because the subbasin map provided did not extend below Lake Mead Boulevard.

4. Subbasin boundaries from the COE model in the watershed area between Lake Mead Drive and the Union Pacific Railroad have been modified to coincide with the two proposed Beltway road alignments. This modification does not represent a major change in the hydrologic modeling for Pittman Wash but will give information which will be useful in the event that either of these proposed alignments is selected.

5. Drainage boundaries from the COE model have been modified in the area upstream of Lake Mead Drive to account for the location of the proposed extension of I-515.

6. The existing condition model routes a maximum flow of 1,000 cfs in the Van Wagenen Channel. The future conditions model will have a new improved channel adjacent to the railroad which will route all developed flow reaching the railroad west to its confluence with the freeway extension channel.

7. Subarea A-1B as shown on the Henderson Stormwater Management Plan is divided by the freeway extension. The southwest portion of this drainage area is now routed to Duck Creek.

8. Drainage boundaries in the area of the Boulder Highway between Sunset and Pabco have been modified based on the hydrologic analysis prepared by JMM for the Boulder Highway Beautification project.

9. Previous models (e.g., the Master Plan) used kinematic routing for all channel routing computations. The FIS Hydrology modeling uses Muskingum routing for natural channel reaches and kinematic routing for improved channel reaches.

10. An important aspect of the Pittman Wash FIS modeling deals with an existing flow split in the gravel pit between Sunset Road and the UPRR. Flows from the Pittman Wash floodplain enter the gravel pit from the west, and the Pittman Channel exits the pit to the north. The Pittman Channel is tributary to Duck Creek west of Boulder Highway. However, the pit bottom is lower than the outlet channel invert, causing ponding in the pit. In addition, when sufficient ponding depths are reached an uncontrolled breakout from the pit occurs, with flows running eastward across Boulder Highway and eventually into Las Vegas Wash. Thus a flow split occurs in the gravel pit, and there are two separate downstream flow paths. The flow split data and the storage routing data needed to model the Pittman Wash gravel pit were taken from the COE HEC-1 model. This data was developed by the COE through field reconnaissance and hydraulic analysis in 1988. It is noted that the hydraulics of the flow split and hydrograph routing are complex, and could vary with changing conditions in the vicinity of the pit due to erosion and depostion. These complex hydraulic factors must be analyzed as part of the future floodplain mapping effort.

SUMMARY OF RESULTS

Table 8-1 presents a summary of the simulated 100-year discharges for existing conditions at key points in the Pittman Wash watershed. Where available, a comparison between the preliminary flows modeled by the FIS Hydrology study and those modeled by the COE and Boyle are presented. Notes on the table provide partial explanations for the differences between the flows generated in the different studies.

An objective of the hydrologic modeling for the FIS Hydrology is to confirm regulatory discharges for the Pittman Wash. Accepted discharges (with the "interim" classification) from the COE Special Flood Hazard Study were available for comparison at three of the six regulatory points on Pittman Wash.

The FIS Hydrology flow at the UPRR agrees with the COE flow to within 5 percent. Thus, the COE flow is selected as the adopted discharge. FIS Hydrology flows at other places in the lower Pittman Wash drainage area are greater than the COE computed probability discharges. Due to development changes in the drainage basin, the FIS Hydrology model includes more tributary area at these locations. Also, the curve number methodology used in the FIS Hydrology analysis produced more runoff volume at the gravel pit and a corresponding greater outflow to downstream areas of concentration. At these other locations the model results are selected as the adopted discharges.

Conversion from the 1985 to the 1988 version of HEC-1 and from kinematic to Muskingum channel routing has unusually complex effects on the simulated discharges. A detailed evaluation of model comparisons using the Range Wash HEC-1 data file yielded the following key conclusions:

1. The 1988 kinematic routing gives much less attenuation than the 1985 kinematic routing. The 1988 program results are more consistent with the kinematic routing theory, which suggests that hydrographs should be translated but only minimally attenuated by this procedure.

2. Muskingum routing generally results in less peak attenuation than kinematic routing in the 1985 program, and more peak attenuation than kinematic routing in the 1988 program. This is due to the differences in the kinematic methods, not in the Muskingum methods.

As a result of the above effects, it is possible for conversion from 1985 kinematic routing to 1988 Muskingum routing to produce higher discharges in some locations.

Based on the accepted results shown in Table 8-1 for the 100-year flood, HEC-1 models were developed for the 10- and 50-year floods. These models utilize the same curve number and lag time parameters as the 100-year model. Results are summarized in Table 8-2 for existing conditions at the same key points as Table 8-1 in the Pittman Wash watershed. It is seen that the 10- and 50-year discharges do not compare as well with the COE computed probability flows as the 100-year discharges. This is due in part to the fact that the COE analysis utilized higher uniform loss rates for the more frequent events, whereas the District Manual allows for use of the same curve numbers for all of the storms analyzed for this study.

Table 8-2 presents discharges based on the COE regional discharge-frequency relationship developed for the Feasibility Study. This is the relationship used to calibrate the COE HEC-1 models, and was used by the COE in conjunction with the model results to select discharges for the study. It can be seen that in some cases, there are considerable differences between the regional values and the COE-adopted values, as well as between the regional values and the FIS Hydrology model results. In part, this is due to the diversion and storage routing at the gravel pit in the lower watershed.

Discharges for the 500-year flood were determined graphically by extrapolating the discharges for the lower three storms. Frequency plots are shown in Figures 8-1 and 8-2.

The HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix.

TABLE 8-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR PITTMAN WASH FIS HYDROLOGY

FIS Hydrology				Boyle Report COSMO World				COE Computed Probability						Adopted
CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	Note	Description	Discharge
156	72.8	0.64	10631	WIG	73.84	0.675	15732	-	-	-	-	1,5	Southern Beltway alignment	10600
158	86.4	0.62	10454	-	-	-	-	CP 23	86.34	-	10500	2	UPRR	10500
WA	103.8*	0.60	4677	-	-	-	-	-	-	-	-	6	Confluence with Duck Creek	4700
B1E	100.3	0.60	2569	-	-	-	-	CP 9	88.87	-	1300	3	Breakout at Bldr Hwy	2600
B1A	111.9	0.59	2890	-	-	-	-	-	-	-	-		Breakout at confl. with downtown fl	2900
A1A	117.9	0.58	5637	-	-	-	-	CP 10	89.9	-	1500	4	Breakout u/s from Las Vegas Wash	5600

* = Area considers upstream diversions

Notes:

General - FIS hydrology based on new (1988) HEC-1, and CCRFCD DARF's
Boyle hydrology based on 1985 HEC-1, kinematic routing in all locations, and Hydro 40 DARF's
Boyle Cosmo World model incorporated into FIS model for upper Pittman Wash
All COE Computed Probability Q's were adopted as "interim discharges" by CCRFCD.

1. Large difference with Boyle flow is due in part to use of kinematic routing in upper Pittman
2. *Reduction in flows due to the effects of routing.*
3. FIS model includes subarea A1D, B3A-D, & B11A & B due to the new freeway and improvments in the drainage basin. Also, CN method produces greater volume of runoff to gravel pit.
4. *COE flow does not account for downtown flow contribution and return flow from freeway diversion*
5. Boyle Hydrology Study, Cosmo World, 1989.
6. Reduction in Q due to gravel pit storage routing and diversion (breakout).

TABLE 8-2

PROPOSED PITTMAN WASH FIS DISCHARGES

		10-Year Peak Discharge				50-Year Peak Discharge				100-Year Peak Discharge				500-Year Peak Discharge		
Node	Area (sq mi)	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	COE SFHS Q	Adopt Extrap	Adopted Flow
156	72.8	1545	-	3830	3800	5560	-	8105	8100	8736	-	10631	10600	-	18200	18200
158	86.4	1691	1850	3707	3700	5976	6600	8122	8100	9331	10500	10454	10500	22000	18300	18300
B1E	100.3	1781	350	297	300	6238	880	1236	1200	9710	1300	2569	2600	5000	7200	7200
B1A	111.9	1866	-	976	1000	6479	-	2197	2200	10053	-	2890	2900	-	5200	5200
WA	103.8*	1809	-	99		6335	-	2373	2400	9861	-	4677	4700	-		
A1A	117.9	1949	400	985	1000	6707	1050	2381	2400	10375	1500	5637	5600	5000	11000	11000

* = Area considers upstream diversions

Node	Location
156	Southern Beltway alignment
158	UPRR
WA	Confluence with Duck Creek
B1E	Breakout at Bldr Hwy d/s of gravel pit
B1A	Breakout at confl. w/downtown flow
A1A	Breakout just u/s from Las Vegas Wash

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship (does not account for gravel pit detention and diversion)
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Adopt Extrap = Extrapolation of Adopted Flows for Q10, Q50 and Q100

Discharges include effects of gravel pit west of Sunset Road (hydrograph routing and breakout diversion).

FIGURE 8-1
PITTMAN WASH FIS DISCHARGES
(PLOT #1)

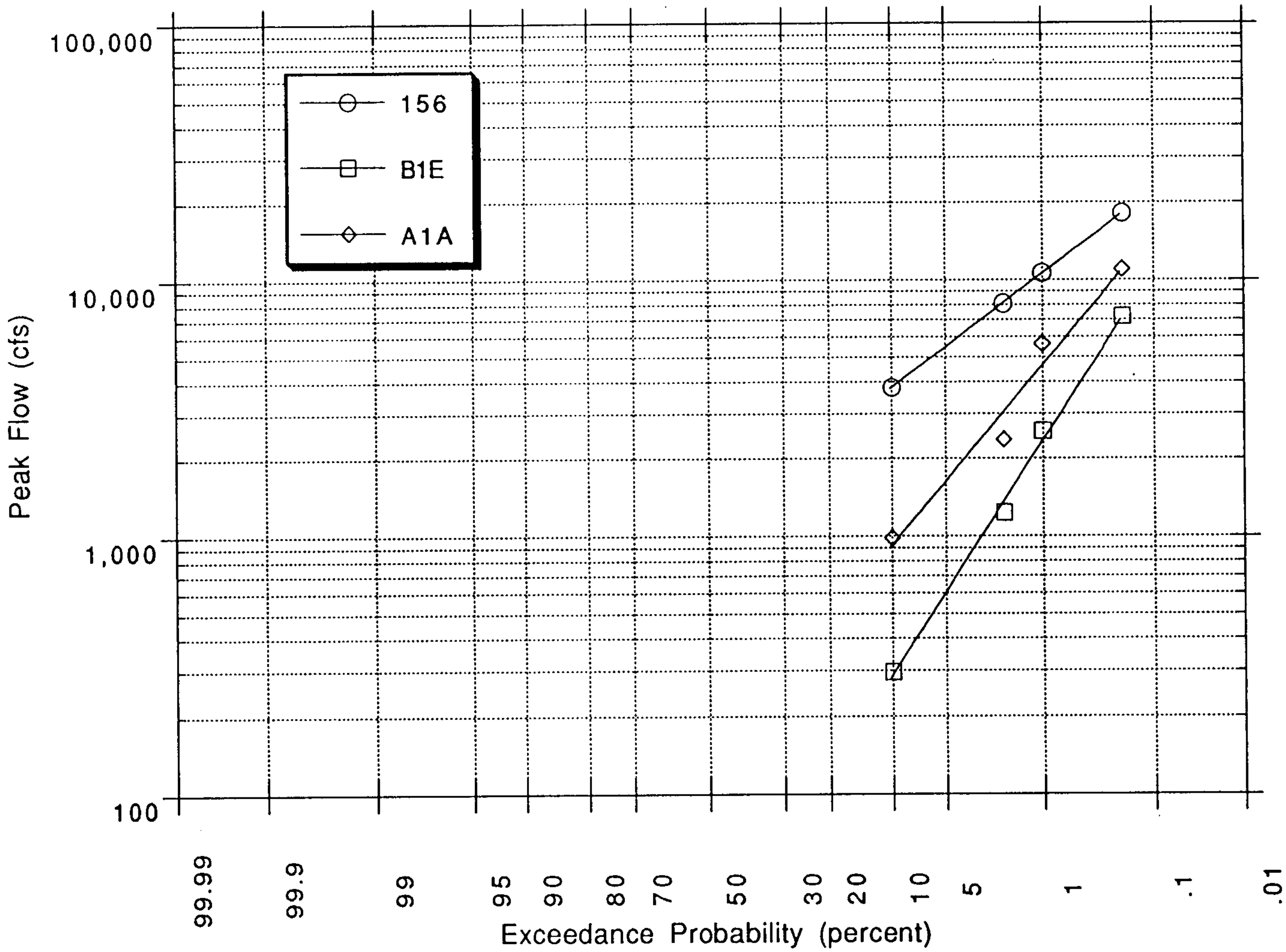
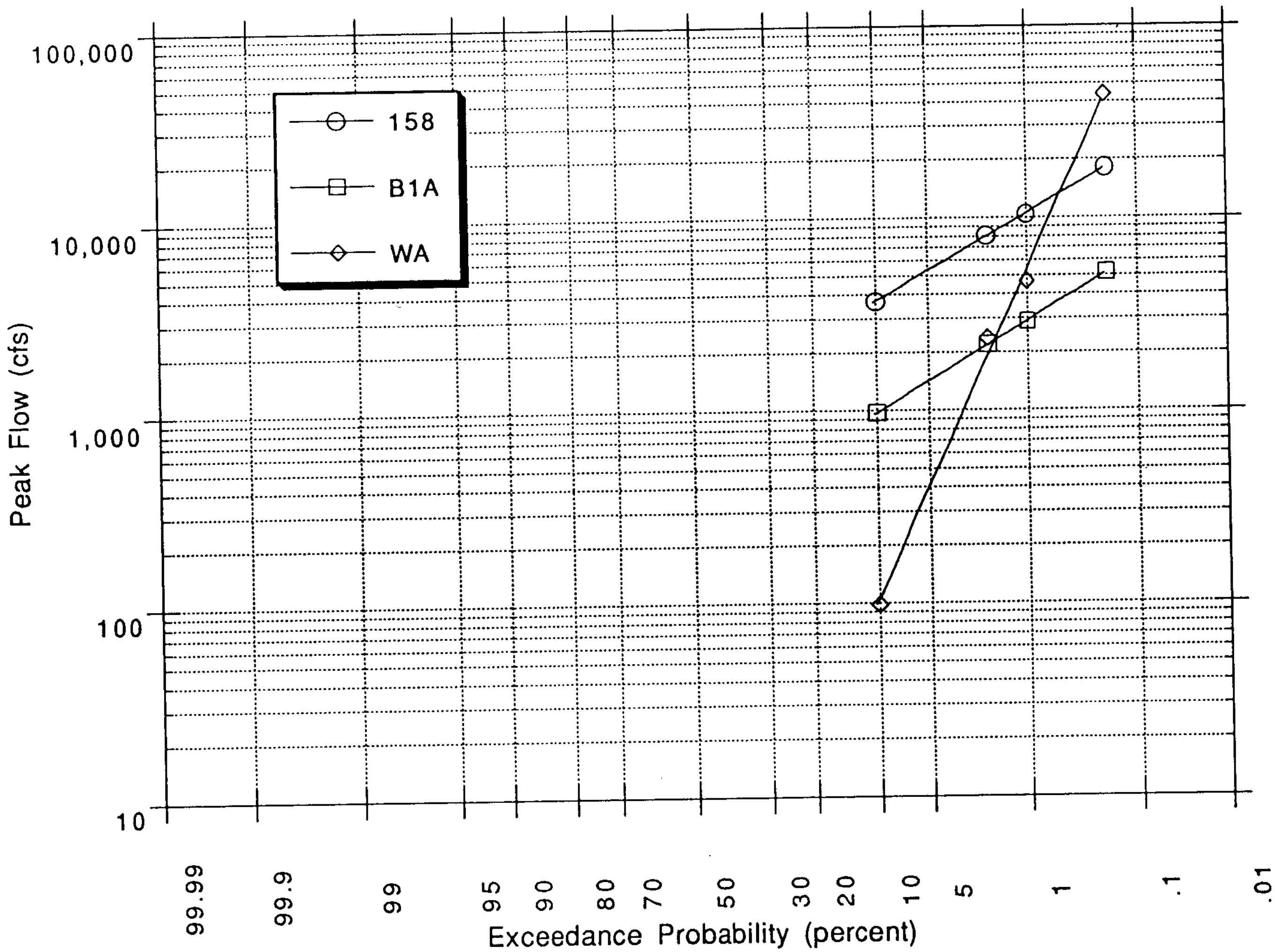


FIGURE 8-2
PITTMAN WASH FIS DISCHARGES
(PLOT #2)



CHAPTER 9
C-1 CHANNEL FIS HYDROLOGY

CHAPTER 9

C-1 CHANNEL FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/existing facilities analysis of the C-1 Channel Drainage Basin conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for the C-1 Channel. In addition, results could be used to assess the adequacy of existing facilities to handle existing conditions flood discharges.

The basis of the hydrologic analysis was the HEC-1 model developed by the Corps of Engineers (COE) for their Special Flood Hazard Study for Las Vegas Valley (July 1988). Previous hydrologic studies of this watershed include the CCRFCD Master Plan and the Henderson Stormwater Management Plan which are considered to be superseded by the COE study. The COE report and HEC-1 runs were used as the source of lag time, routing, and basin area parameters. The subbasin boundaries for the COE study were the same boundaries as for the original Master Plan.

The COE HEC-1 data files were modified to reflect changes in CCRFCD modeling criteria, the HEC-1 program itself, and changes to the subbasin boundaries based on current flood control planning for the City of Henderson. These changes are summarized in the following section.

An existing conditions subarea map for the C-1 Channel watershed is shown in Figure S-5 (Appendix B).

MODIFICATIONS TO EXISTING CONDITIONS MODEL

1. The appropriate hydrologic model to use as a basis for the C-1 Channel drainage area is the Corps of Engineers HEC-1 model developed for the Feasibility Study.

2. Previous studies used the 1985 version of HEC-1. The FIS Hydrology study is based on the 1988 version of HEC-1.

3. Subbasin boundaries have been modified to reflect changes in the hydrologic basin due to the extension of I-515, a detailed review of the topographic maps, and comments from the City of Henderson.

4. Channel reaches in natural areas were modeled using the Muskingum method, rather than the kinematic method used in previous analyses.

5. The Corps of Engineers model combines subbasins C-5F and C-5E prior to routing through subbasin C-5C. In the existing condition model, however, subbasin C-5F actually flows west along the southerly boundary of Section 27 and does not combine with area C-5E until it has routed through subbasin C-5C.

6. In the future condition model, the new proposed railroad alignment will allow subbasin C-5F to route north. The westerly boundary of subbasin C-5F will be relocated to the west section line of Section 35 to provide information for a future dike and channel

construction. Similarly, the westerly boundary of subbasin C-5E has been relocated to the west section line of Section 26 for the same reason.

7. Subbasins C-4A and C-5A have been combined due to topographic considerations. Similarly, the subbasin boundary between C-4B and C-5B has been relocated.

8. Subbasin C-5I has been divided in Section 33 immediately upstream of present development. This would provide hydrologic information for a proposed detention basin site for the future condition model to be located on City of Henderson property.

9. The aforementioned proposed railroad alignment will be proposed as a ditch and dike in the future condition model and in plan formulation. The ditch and dike will follow the railroad north through Section 26. At the northern section line of Section 26 it will turn west beneath the railroad and follow the section line to a proposed detention basin site in the southwest quarter of Section 22.

SUMMARY OF RESULTS

Table 9-1 presents a summary of the simulated 100-year discharges for existing conditions at key points in the C-1 Channel watershed. Where available, a comparison between the preliminary flows modeled by the FIS Hydrology study and those modeled by the COE are presented. Notes on the table provide partial explanations for the differences between the flows generated in the different studies.

An objective of the hydrologic modeling for the FIS Hydrology study is to confirm regulatory discharges for the C-1 Channel. Interim flows were calculated for all but one of the discharge points in the Corps of Engineer's Special Flood Hazard Study. A comparison to these flows and an explanation of the differences are shown in Table 9-1. The adopted flows are based on the FIS Hydrology model flows. All FIS discharges are within 10 percent of the COE flows, indicating that the COE flows should be selected as adopted discharges.

The comparison to the flow reported in the Highland Summit Hydrology Study by R.L. Nelson (1990) was also good. Even though the drainage area and the depth area reduction factors were not listed in that report, visual inspection of the drainage area map verified that the offsite drainage basin corresponded to the FIS Hydrology area.

The comparison to the VTN reported flow in the College Drive Predesign Report was not as good. While the drainage areas and the depth area reduction factor were similar, it was noted that the lag times reported in the VTN study were sometimes longer. For example, lag times for subbasins 8 and 9 in the VTN study were 1.01 hours, whereas the corresponding area (C1G2) in the FIS Hydrology study had a lag time of 0.74 hours. The lag times used in the FIS Hydrology study were checked and are compatible with the CCRFCD Design Manual methodology.

Conversion from the 1985 to the 1988 version of HEC-1 and from kinematic to Muskingum channel routing has unusually complex effects on the simulated discharges. A detailed evaluation of model comparisons using the Range Wash HEC-1 data file yielded the following key conclusions:

1. The 1988 kinematic routing gives much less attenuation than the 1985 kinematic routing. The 1988 program results are more consistent with the kinematic routing theory, which

suggests that hydrographs should be translated but only minimally attenuated by this procedure.

2. Muskingum routing generally results in less peak attenuation than kinematic routing in the 1985 program, and more peak attenuation than kinematic routing in the 1988 program. This is due to the differences in the kinematic methods, not in the Muskingum methods.

As a result of the above effects, it is possible for conversion from 1985 kinematic routing to 1988 Muskingum routing to produce higher discharges in some locations.

Based on acceptance of the results shown in Table 9-1 for the 100-year flood, HEC-1 models were developed for the 10- and 50-year floods. These models utilize the same curve number and lag time parameters as the 100-year model. Results are summarized in Table 9-2 for existing conditions at the same key points as Table 9-1 in the C-1 Channel watershed. It is seen that at most concentration points, the 10- and 50-year discharges do not agree as well with the COE computed probability flows as the 100-year discharges. This is due in part to the fact that the COE analysis utilized higher uniform loss rates for the more frequent events, whereas the District Manual allows for use of the same curve numbers for all of the storms analyzed for this study.

Table 9-2 presents discharges based on the COE regional discharge-frequency relationship developed for the Feasibility Study. This is the relationship used to calibrate the COE HEC-1 models, and was used by the COE in conjunction with the model results to select discharges for the study.

Discharges for the 500-year flood were determined graphically by extrapolating the discharges for the lower three storms. Frequency plots are shown in Figures 9-1 and 9-2.

The HEC-1 routing diagrams and 100-year input/output files are included in the Technical Appendix for reference.

TABLE 9-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR C-1 CHANNEL FIS HYDROLOGY

FIS Hydrology				Other Studies				COE Computed Probability						Adopted
CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	CP/Node	Area	DARF	Flow	Note	Description	Discharge
C1G1	8.9	0.87	3658	S	10.44	0.86	2960	CP 46	7.81	-	3800	1,4	UPRR	3800
							3894					5		
C5H	15.1	0.82	5888	-	-	-	-	CP 42	14	-	5800	2,3	Boulder Highway	5800
C4A	31.3	0.74	8283	-	-	-	-	CP 27	29.22	-	7600		Upstream of Major Ave.	7600
C3B1	36.5	0.72	9106	-	-	-	-	CP 23	34.37	-	8800		Apache Place	8800
C3A1	38.9	0.71	9487	-	-	-	-	-	-	-	-		Lake Mead Blvd.	9400

Notes:

General - FIS hydrology based on new (1988) HEC-1, and CCRFCD DARF's
All COE Computed Probability Q's were adopted as "interim discharges" by CCRFCD.

1. FIS model includes subarea C1N due to improvements in the drainage basin.
2. FIS model includes subareas C1M & C102 due to improvments in the drainage basin.
3. FIS and COE flows agree within 10% . Select CCRFCD "interim discharge" as adopted discharge.
4. VTN Hydrology Study, College Drive, August 1990
5. L R Nelson Hydrology Study, Highland Summit, August 1990. Drainage Area and Depth Area Reduction Factors not listed in report.

TABLE 9-2

PROPOSED C-1 CHANNEL FIS DISCHARGES

Node	Area (sq mi)	10-Year Peak Discharge COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	50-Year Peak Discharge COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	100-Year Peak Discharge COE Reg Q	COE SFHS Q	Model Output	Adopted Flow	500-Year Peak Discharge COE SFHS Q	Adopt Extrap	Adopted Flow
C1G1	8.9	539	610	1236	1200	2255	2450	2792	2800	3738	3800	3658	3800	8200	6500	6500
C5H	15.1	745	1000	1984	2000	3035	3700	5014	5000	4983	5800	5888	5800	12000	11300	11300
C4A	31.3	1056	1350	2629	2600	4079	5000	6217	6200	6573	7600	8283	7600	17000	15300	15300
C3B1	36.5	1141	1500	2894	2900	4331	5500	6752	6800	6935	8800	9108	8800	20000	16700	16700
C3A1	38.9	1166	-	2723	2900	4387	-	7002	7000	7002	-	9487	9400	-	18600	18600

Node	Location
C1G1	UPRR
C5H	Boulder Highway
C4A	U/S of Major Ave.
C3B1	Apache Place
C3A1	Lake Mead Blvd.

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS Hydrology HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Adopt Extrap = Extrapolation of Adopted Flows for Q10, Q50 and Q100

FIGURE 9-1
C-1 CHANNEL FIS DISCHARGES
(PLOT #1)

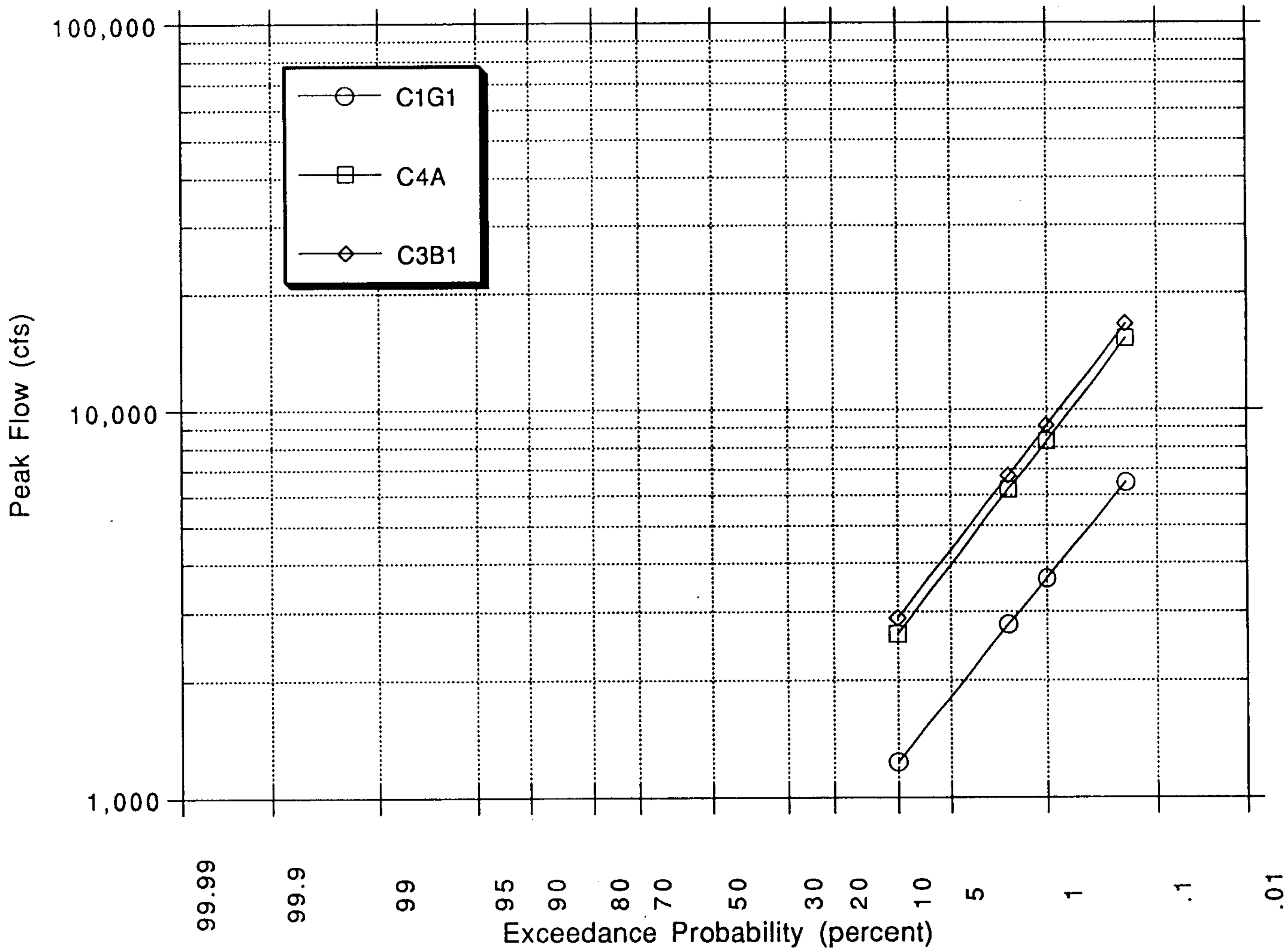
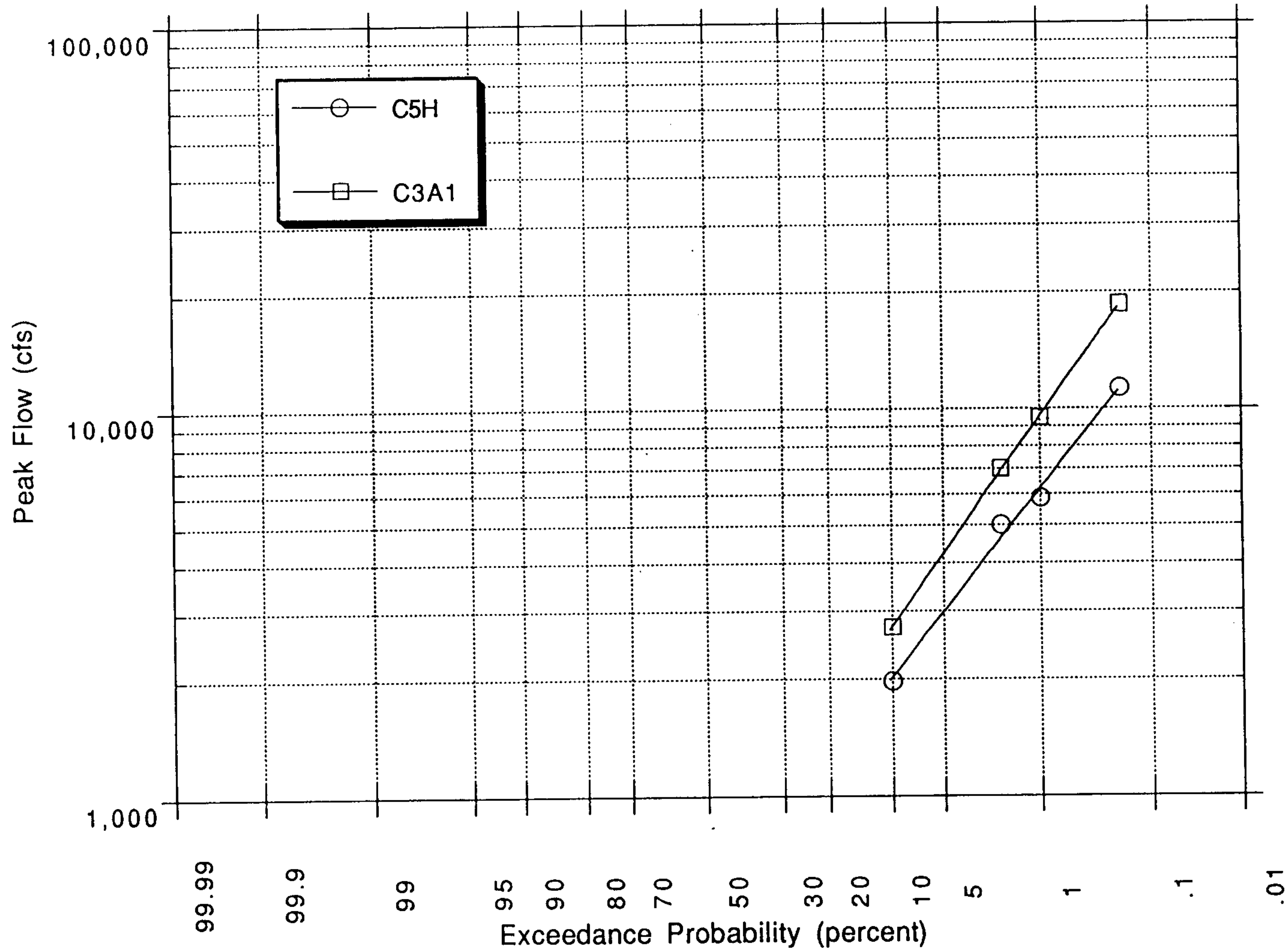


FIGURE 9-2
C-1 CHANNEL FIS DISCHARGES
(PLOT #2)



CHAPTER 10
LOWER LAS VEGAS WASH
FIS HYDROLOGY

CHAPTER 10

LOWER LAS VEGAS WASH FIS HYDROLOGY

INTRODUCTION

This chapter summarizes the existing conditions/existing facilities analysis of Lower Las Vegas Wash conducted for the new FIS Hydrology study for Las Vegas Valley. The purpose of the analysis was to develop acceptable discharges for use in future Flood Insurance Studies for Lower Las Vegas Wash. In addition, results could be used to assess the adequacy of existing facilities to handle existing conditions flood discharges. For purposes of this study, Lower Las Vegas Wash is defined as the main Las Vegas Wash Channel from the Pecos/Lake Mead bridge crossing in North Las Vegas downstream to the Lake Las Vegas intake structure.

The key previous hydrologic analysis of Lower Las Vegas Wash is the Corps of Engineers Special Flood Hazard Study. This study presents existing conditions, computed probability discharges for Lower Las Vegas Wash based on conditions at the time of the analysis (1988). Other previous studies include the CCRFCD Master Plan (1986) and the Clark County Flood Insurance Restudy (1985), both prepared by JMM. The COE study utilized information from each of these analyses. There are no recent feasibility or preliminary design level studies for Lower Las Vegas Wash.

METHOD OF ANALYSIS

The Lower Las Vegas Wash drainage area varies from 735 square miles at Pecos/Lake Mead to 1460 square miles at Telephone Line Road.

Inflows to the study reach consist of six major tributary confluences, and minor local tributary drainages. The major confluences are:

Las Vegas Creek (Washington Ave. Channel)	27	square miles
Range Wash	151	square miles
Flamingo Wash	145	square miles
Duck Creek	234*	square miles
Pittman Wash	118	square miles
C-1 Channel	39	square miles

*Including total Upper Blue Diamond watershed

Due to the large drainage area of Las Vegas Wash compared to the typical storm area of about 200 square miles, previous studies have estimated peak flows in Lower Las Vegas Wash based on the peak inflows from the various major tributaries. Past analyses by JMM and COE found that a general storm covering the entire drainage area would not generate critical peak discharges. The selected approach has been to begin at the upstream end of the study reach and move downstream, adopting the largest peak tributary inflows as Las Vegas Wash peak flows. This approach is conservative in that it does not account for channel routing effects in the Las Vegas Wash floodplain. In addition it does not consider the possibility of concurrent 100-year storms over more than one major tributary; an occurrence of an event of this type would have a return period exceeding 100 years.

Although there are no recent or pending improvements on Lower Las Vegas Wash which would affect peak discharges, the recommended approach accounts for facilities constructed or proposed for construction on each of the major tributaries. Facilities thus incorporated into the "existing conditions" analysis include:

West Range Wash Diversion Dike
North Las Vegas Detention Basin Modifications
Upper Las Vegas Wash Detention Basin and Collection Dike
Gowan Detention Basin and Outfall
Angel Park Detention Basin Modifications
Cheyenne Channel, Buffalo Channel, and Hualpai Diversion
Upper Flamingo Detention Basin

SUMMARY OF RESULTS

Table 10-1 and Figure 10-1 present a summary of existing conditions peak discharges for Lower Las Vegas Wash. Table 10-1 also shows currently adopted regulatory discharges based on the COE Special Flood Hazard Study. It is seen that the FIS Hydrology flows are all significantly lower than the COE flows. This is attributed to the major future detention facilities assumed in the FIS analysis which reduce the peak flows tributary to Las Vegas Wash at most key inflow points. These detention facilities also invalidate flows based on the COE regional regression equations, which do not account for regulation in the tributary watershed. As a result, the FIS Hydrology flows are recommended for use in future FIS studies.

Table 10-2 presents recommended FIS discharges for 10-, 50-, 100-, and 500-year return periods. FIS flows for all recurrence intervals were taken from model results or adopted flows for the major tributaries to Las Vegas Wash, as summarized in Figure 10-1. Although there is excellent agreement between the COE computed probability flows (regulatory discharges) and the FIS flows for the 10-year event, differences become progressively larger for the more severe events. In all cases the FIS flows have been selected as the adopted flows because they account for existing and pending flood control improvements.

TABLE 10-1

COMPARISON OF EXISTING CONDITION 100-YEAR DISCHARGES FOR LOWER LAS VEGAS WASH FIS HYDROLOGY

FIS Hydrology					COE Computed Probability						
CP/Node	Total Area	Storm Area	DARF	Flow	CP/Node	Total Area	DARF	Flow	Notes	Description	Adopted Discharge
L1	735	112	0.59	6730	CP7	735	-	15000	1,4	@ Pecos/Lake Mead	6730
L2	768	112	0.59	6730	CP9	768	-	15000	1,4	D/S of Las Vegas Creek	6730
					CP10	800	-	15000	4	@ Nellis Blvd	
L3	1011	145	0.57	7100					2	D/S of Flamingo Wash	7100
L4	1113	145	0.57	7100	CP3	1100	-	15000	2,4	@ Vegas Valley Dr	7100
L5	1473	164	0.54	11500	CP19	1460	-	16000	3	D/S of Duck Cr	11500

Notes:

General: FIS flows based on largest of upstream tributary inflows to Las Vegas Wash.
FIS flows include effects of pending flood control projects on all tributaries (Upper Las Vegas Wash Detention Basin, West Range Wash Diversion, Gowan Detention Basin, Angel Park Outfall, Upper Flamingo Detention Basin).

1. FIS flow from Northern Las Vegas Wash/Western Tributary drainage area.
2. FIS flow from Flamingo/Tropicana drainage area.
3. FIS flow from Duck/Blue Diamond drainage area.
4. COE flow from Northern Las Vegas Wash

TABLE 10-2

PROPOSED LOWER LAS VEGAS WASH FIS DISCHARGES

Node	Total Area (sq mi)	10-Year Peak Discharge COE Reg Q	10-Year COE SFHS Q	10-Year Model Output	10-Year Adopted Flow	50-Year Peak Discharge COE Reg Q	50-Year COE SFHS Q	50-Year Model Output	50-Year Adopted Flow	100-Year Peak Discharge COE Reg Q	100-Year COE SFHS Q	100-Year Model Output	100-Year Adopted Flow	500-Year Peak Discharge COE SFHS Q	500-Year Adopt Extrap	500-Year Adopted Flow
L1	735	3600	2000	2160	2200	10900	8600	5120	5100	16200	15000	6730	6700	40000	11600	11600
L2	768	3700	2100	2160	2200	11200	8600	5120	5100	16500	15000	6730	6700	40000	11600	11600
L3	1011	3900	2600	2500	2500	11700	9200	5500	5500	17200	15000	7100	7100	40000	14300	14300
L4	1113	3900	2600	2500	2500	11700	9200	5500	5500	17300	15000	7100	7100	40000	14300	14300
L5	1473	4100	3000	3000	3000	12100	10000	8500	8500	17700	16000	11500	11500	41000	24000	24000

Node	Location
L1	@ Pecos/Lake Mead
L2	D/S of Las Vegas Creek
L3	D/S of Flamingo Wash
L4	@ Vegas Valley Dr
L5	D/S of Duck Cr

COE Reg Q = Corps of Engineers Regional Discharge-Frequency Relationship
COE SFHS Q = Corps of Engineers Special Flood Hazard Study
Model Output = FIS Hydrology HEC-1 Model Output
Adopted Flow = Adopted Flow for FIS Purposes
Area = Drainage Area from FIS Hydrology

Note: FIS flows include effects of pending flood control projects on all tributaries (Upper Las Vegas Wash Detention Basin, West Range Wash Diversion, Gowan Detention Basin, Angel Park Outfall, Upper Flamingo Detention Basin).

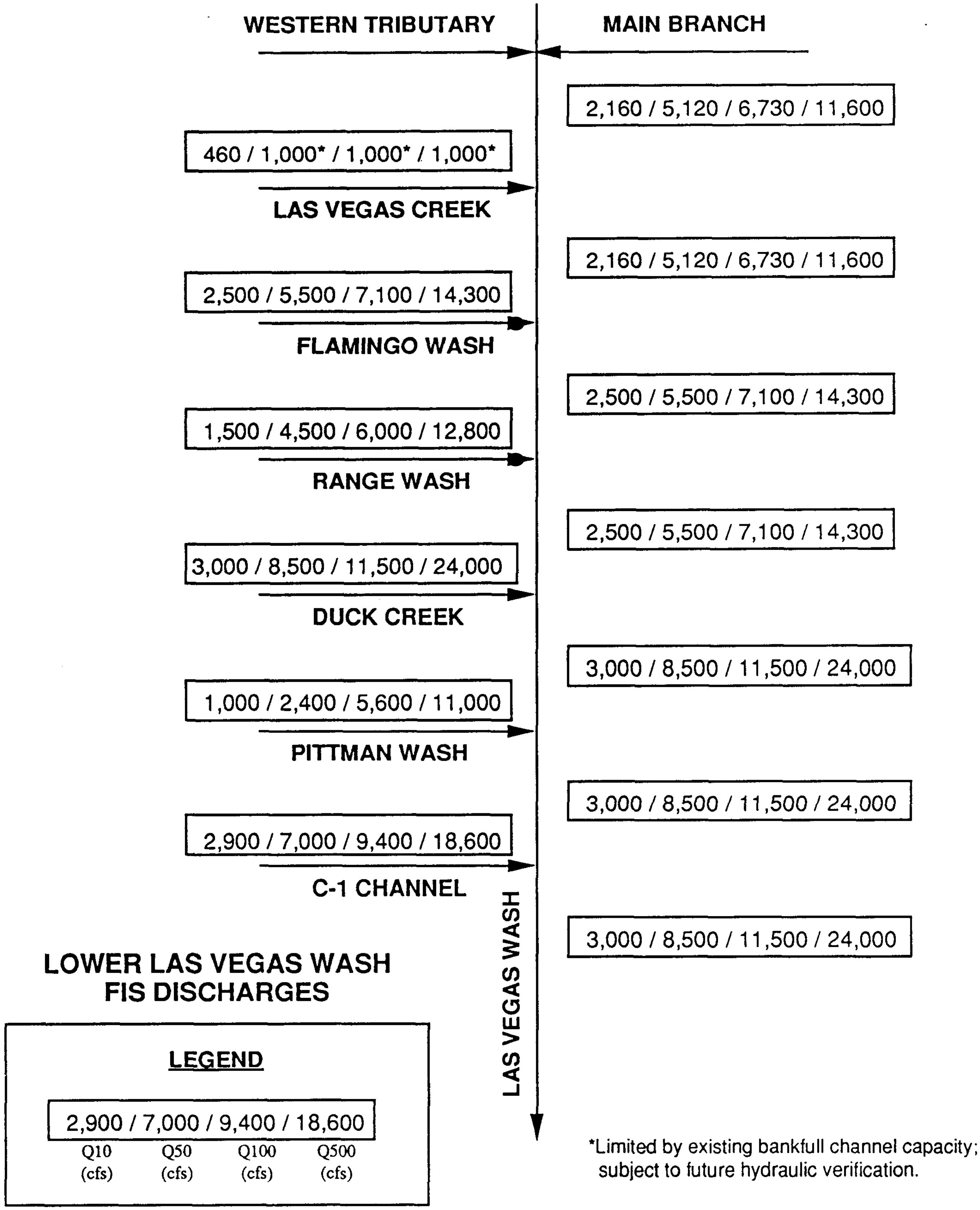


FIGURE 10-1

JMM

APPENDIX A

APPENDIX A

CCRFCD REGULATORY AND INTERIM DISCHARGES

REGIONAL FLOOD CONTROL DISTRICT
OF
CLARK COUNTY

AGENDA ITEM

Subject: REGULATORY DISCHARGES
Petitioner: VIRGINIA BAX-VALENTINE, P.E., GENERAL MANAGER/CHIEF ENGINEER
Recommendation: THAT THE BOARD ADOPT THE DISCHARGES FOR FLOOD INSURANCE PURPOSES ALONG WITH THE STRATEGY TO EVALUATE THE INTERIM DISCHARGE VALUES AND AMEND THE UNIFORM REGULATIONS TO INCLUDE THE INTERIM DISCHARGES

Fiscal Impact:
None

Background:

The U.S. Army Corps of Engineers (COE), Los Angeles District, prepared a report entitled "Special Flood Hazard Study, Las Vegas Wash and Tributaries, Clark County, Nevada," dated July, 1988. This Study was prepared by the COE to provide the District with computed probability discharges for regulatory purposes.

The District distributed copies of this Study to local public and private engineers with a solicitation for comments. Subsequent to the distribution of this study, meetings were held with representatives from Consulting Engineers Council (CEC), the Floodplain Management Committee and the Technical Advisory Committee. A strategy of adopting and examining discharge values in further detail evolved. Common to all the meetings held was the recognization of the need to adopt a single set of discharge values for flood insurance purposes.

Continued........................

T.C. AGENDA	FCD AGENDA
ITEM # 3	ITEM # 3
Date:	Date:
12-29-88	1-12-89

On December 8, 1988, representatives of CEC met with a subcommittee of the Floodplain Management Committee to discuss and review the COE's computed probability values. At its December 13, 1988 meeting, the Floodplain Management Committee recommended that the Technical Advisory Committee adopt the recommendations agreed upon at the December 8, 1988 meeting. The Floodplain Management Committee's recommendations are included in your backup.

STAFF RECOMMENDATION:

Staff recommends that the Board adopt items 1 through 5 and Enclosures A through C, as developed with the Floodplain Management Committee and recommended for approval by the Citizens Advisory Committee and Technical Advisory Committee.

Respectfully submitted,

VIRGINIA BAX-VALENTINE, P.E.
General Manager/Chief Engineer

T.C. AGENDA	FCD AGENDA
ITEM # 3	ITEM # 3
Date:	Date:
12-29-88	1-12-89

FLOODPLAIN MANAGEMENT COMMITTEE RECOMMENDATION

The Floodplain Management Committee, recognizing the need to adopt a single set of discharge values for Flood Insurance purposes, recommends that the Technical Advisory Committee:

1. Adopt the U.S. Army Corps of Engineers (COE), July 1988, Special Flood Hazard Study discharge values that were determined to be reasonable by representatives of the Consulting Engineers Council (CEC) and a subcommittee of the Floodplain Management Committee.

   Reasonableness was determined based upon a qualitative review of the following hydrologic parameters utilized by the COE.

   a. COE's regional approach appears appropriate for larger watersheds.
   b. COE's calibration of their hydrologic model was applied to USGS gaging stations with large watersheds.
   c. COE's loss rates utilized in their hydrologic model appear appropriate for their regional analysis of the larger watersheds.
   d. The rainfall depth-area factors do not differ greatly for storm areal extent of 100 square miles or greater (i.e. large watersheds).

   For flood insurance purposes the discharge values determined to be reasonable are the COE's 100-year return interval computed probability discharges values determined for existing conditions as identified on Enclosure A.

2. Request that staff direct the COE to restudy the Las Vegas Creek system. The restudy will incorporate the physical changes to the Angel Park Detention Basin and include the Meadows Detention Basin.

3. Request that staff proceed with the strategy to review the hydrologic parameters and adopt Flood Insurance discharge values for the drainage system not stated in item 1 above. Enclosure B presents the strategy.

4. Adopt, in the interim, the 100-year return interval COE's computed probability discharge values for existing conditions as identified in Enclosure C, for the District and it's entities.

5. Recognize that hydrologic analyses performed with site specific data and detailed hydrologic parameters may be proven to be more appropriate Flood Insurance discharge values than the COE's discharge values.

ENCLOSURE A:
DISCHARGE VALUES FOR FLOOD INSURANCE PURPOSES
RECOMMENDED FOR ADOPTION **13-Dec-88**

CONCENTRATION POINTS		DRAINAGE AREA (sq.mi.)	100-YEAR DISCHARGE (cfs)
CCRFCD MASTER PLAN (1)	CORPS OF ENGINEERS SPECIAL FLOOD HAZARD STUDY (COE)		
DUCK CREEK :			
#10 (FIG B11)	CP 10 BELOW LAS VEGAS BLVD	130.21	10,500
#12 (FIG B11)	CP 12 PARADISE RD	137.45	11,000
#14 (FIG B11)	CP 14 UNION PACIFIC RAILROAD	205.77	11,500
#57 (FIG B8)	CP 57 SUNSET ROAD	214.36	11,500
#8 (FIG B9)	CP 8 BOULDER HWY	226.31	11,500
RANGE WASH :			
#9 (FIG B-6)	CP 9 OWENS AVENUE	114.30	8,000
#1 (FIG B-9)	CP 1 u.s. of VEGAS VALLEY DRIVE	156.35	8,000
LAS VEGAS WASH :			
#6 (FIG B-5)	CP 6 UNION PACIFIC RAILROAD	733.00	14,500
#7 (FIG B-5)	CP 7 ds. of LAS VEGAS BOULEVARD	735.00	15,000
#9 (FIG B-5)	CP 9 HARRIS and MARION AVENUES	768.00	15,000
#10 (FIG B-5)	CP 10 NELLIS BLVD	800.00	15,000
#3 (FIG B-9)	CP 3 VEGAS VALLEY DRIVE	1100.00	15,000
#19 (FIG B-9)	CP 19 TELEPHONE LINE ROAD	1460.00	16,000
TROPICANA WASH :			
#10 (FIG B-8)	CP 10 I-15	12.34	4,800
#29 (FIG B-8)	CP 29 KOVAL LANE	13.43	4,800
#30 (FIG B-8)	CP 30 us. of FLAMINGO WASH	20.34	4,800
FLAMINGO WASH :			
#35 (FIG B-8)	CP 35 SPENCER STREET	127.76	8,800
#40 (FIG B-8)	CP 40 BOULDER HWY	135.43	9,000

Source: "Special Flood Hazard Study, Las Vegas Wash and Tributaries, Clark County, Nevada" U.S. Army Corps of Engineers, Los Angeles District, July, 1988. Values listed are for present conditions and computed probability.

(1) Clark County Regional Flood Control District - Flood Control Master Plan (October 1986), by James M. Montogomery, Inc.

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ENCLOSURE C:
DISCHARGE VALUES FOR FLOOD INSURANCE PURPOSES
RECOMMENDED TO BE UTILIZED AS INTERIM VALUES

13-Dec-88

CONCENTRATION POINTS		DRAINAGE AREA (sq.mi.)	100-YEAR DISCHARGE (cfs)
CCRFCD MASTER PLAN (1)	CORPS OF ENGINEERS SPECIAL FLOOD HAZARD STUDY (COE)		
HENDERSON C-1 CHANNEL :			
#46 FIG B-12	CP 46 @ UPRR	7.81	3,800
#42 FIG B-12	CP 42 d.s. of BOULDER HWY	14.00	5,800
#40 FIG B-12	CP 40 BASIC HIGH SCHOOL	21.77	6,400
#27 FIG B-12	CP 27 Major Ave.	29.22	7,600
#23 FIG B-12	CP 23 Apache Place	34.37	8,800
DUCK CREEK :			
#6 FIG B11	CP 4 BLUE DIAMOND @ PARADISE RD.	66.18	8,300
RANGE WASH :			
#8 FIG B-2	CP 8 I-15	53.94	7,000
#12 FIG B-5	CP 12 LAS VEGAS BOULEVARD	78.56	7,500
#14 FIG B-5	CP 14 CAREY AVENUE	82.18	7,500
#4 FIG B-6	CP 4 E. RANGE WASH u.s. of CAREY	59.84	5,600
TROPICANA WASH :			
#4 FIG B-8	CP 4 S. TROPICANA @ UPRR	2.79	3,000
#7 FIG B-8	CP 7 along UPRR	8.31	2,400
#9 FIG B-8	CP 9 N. TROPICANA @ UPRR	10.86	3,100
FLAMINGO WASH :			
#18 FIG B-8	CP 18 N. FLAMINGO @ I-15	7.75	1,500
#26 FIG B-7	CP 26 SPANISH TRAILS GOLF COURSE	91.86	7,000
#12 FIG B-8	CP 12 DECATUR BLVD	96.54	7,800
#13 FIG B-8	CP 13 @ UPRR	97.55	7,800
#14 FIG B-8	CP 14 @ UPRR	97.55	6,000
#16 FIG B-8	CP 16 @ I-15	98.07	6,000
PITTMAN WASH :			
#23 FIG B-11	CP 23 UPRR	86.34	10,500
#9 FIG B-9	CP 9 us. of BOULDER HIGHWAY	88.87	1,300
#10 FIG B-9	CP10 us. of LAS VEGAS WASH	89.90	1,500

Source: "Special Flood Hazard Study, Las Vegas Wash and Tributaries, Clark County, Nevada" U.S. Army Corps of Engineers, Los Angeles District, July, 1988. Values listed are for present conditions and computed probability.

(1) Clark County Regional Flood Control District - Flood Control Master Plan (October 1986), by James M. Montogomery, Inc.

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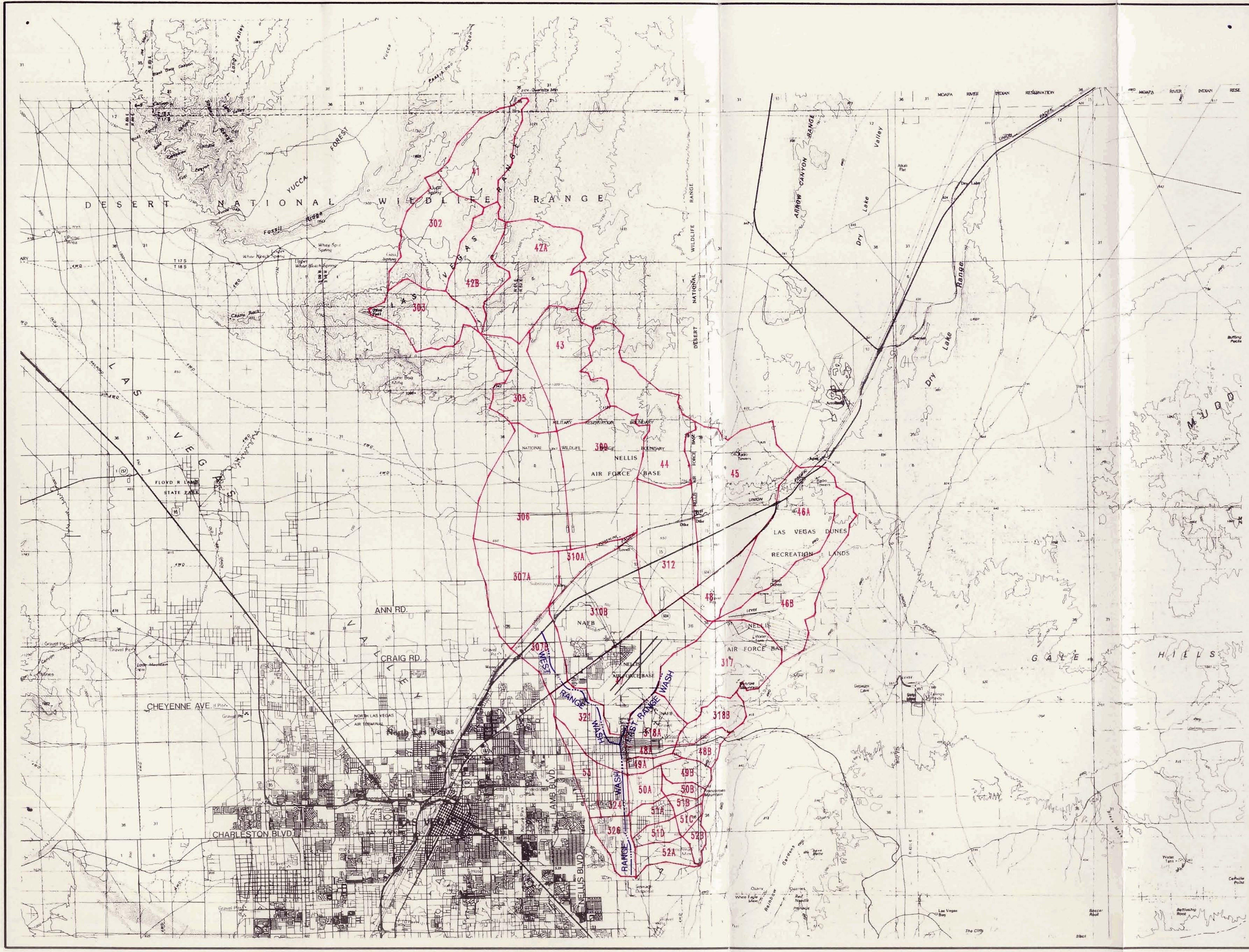
APPENDIX B

APPENDIX B

OVERALL WATERSHED SUBAREA MAPS



CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT

1991 FLOOD CONTROL MASTER PLAN UPDATE LAS VEGAS VALLEY

LEGEND

45 SUBAREA DESIGNATION

—— SUBAREA DELINEATION

0 7,500 15,000 22,500

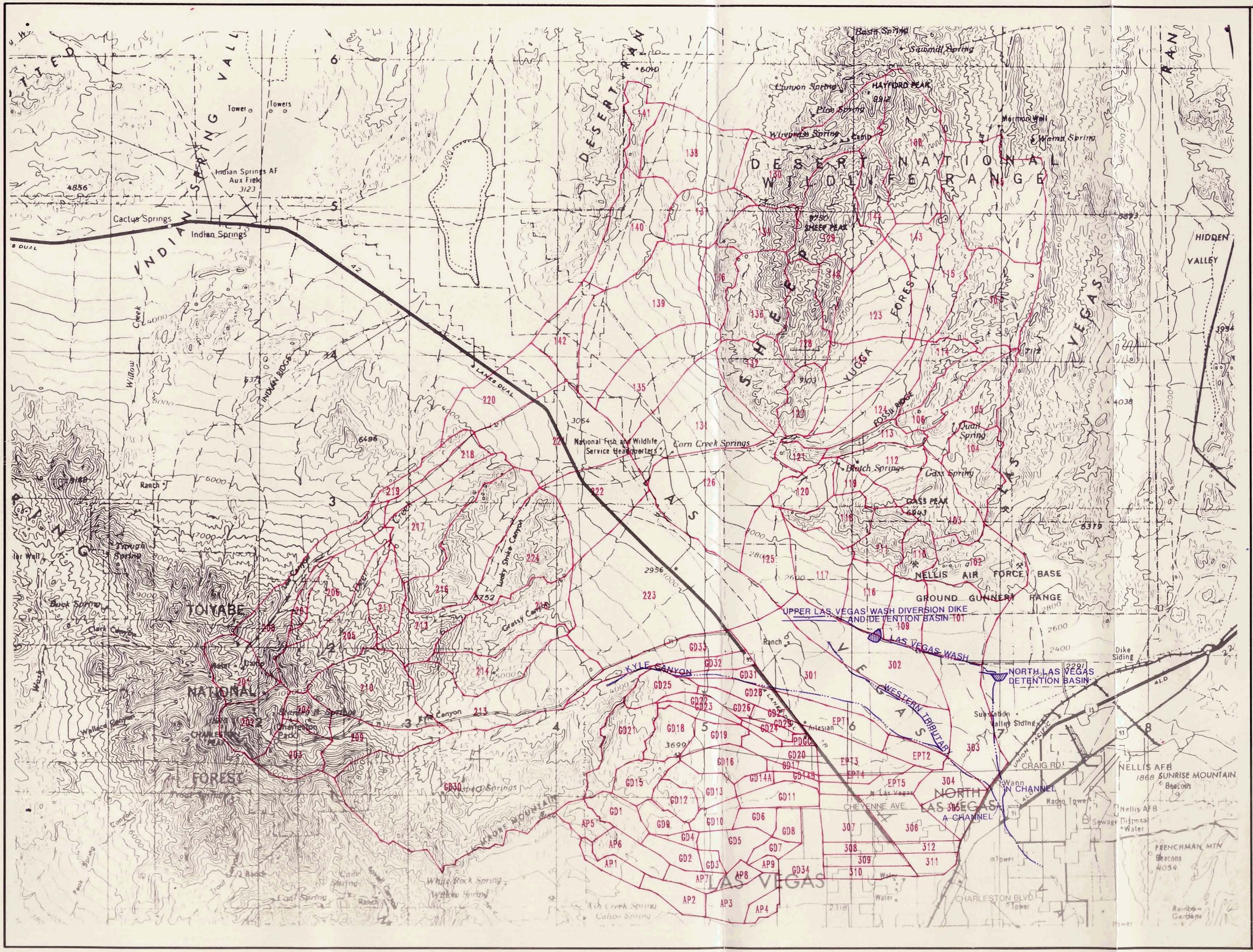
(APPROXIMATE)

RANGE WASH
HYDROLOGIC SUBAREAS

FIGURE S-1

JMM James M. Montgomery
Consulting Engineers, Inc.

Las Vegas, Nevada



CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

1991 FLOOD CONTROL MASTER PLAN UPDATE LAS VEGAS VALLEY

LEGEND

45 SUBAREA DESIGNATION

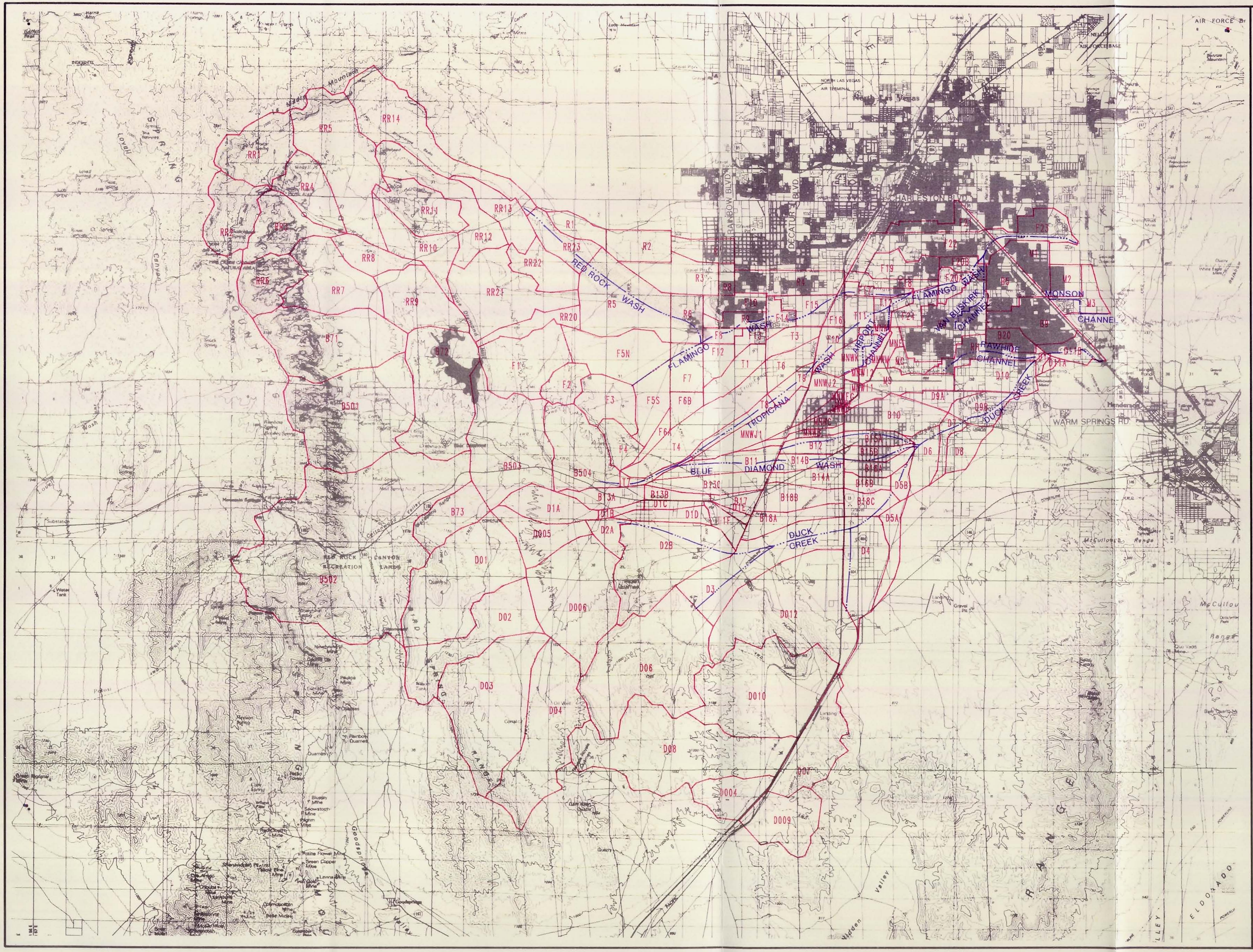
SUBAREA DELINEATION

NORTHERN LAS VEGAS WASH HYDROLOGIC SUBAREAS

FIGURE S-2

James M. Montgomery Consulting Engineers, Inc.

Las Vegas, Nevada



CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT

1991 FLOOD CONTROL MASTER PLAN UPDATE LAS VEGAS VALLEY

LEGEND

45 SUBAREA DESIGNATION

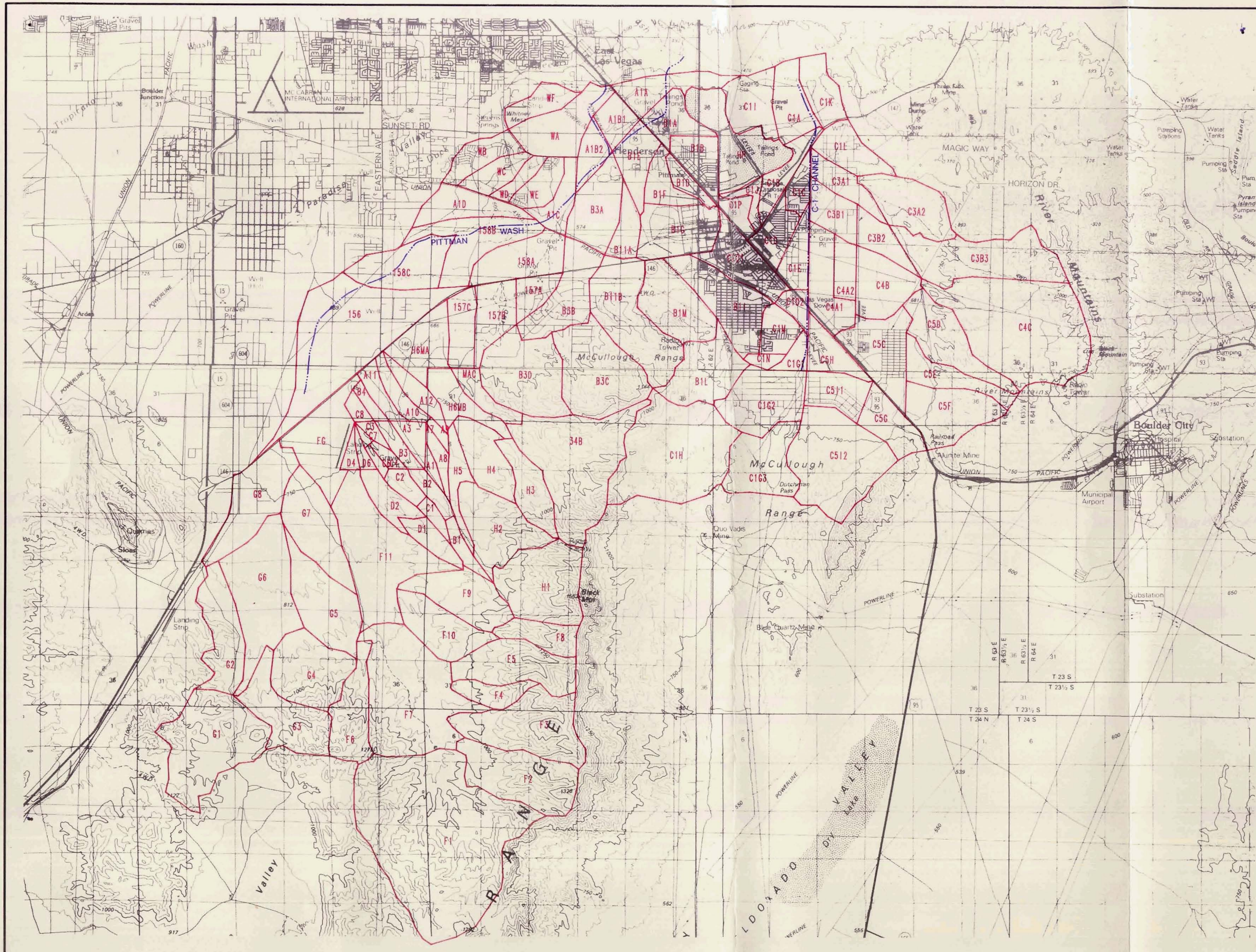
SUBAREA DELINEATION

0 7,500 15,000 22,500
(APPROXIMATE)

SOUTHWEST BASIN
HYDROLOGIC SUBAREAS

FIGURE S-4

JMM James M. Montgomery
Consulting Engineers, Inc.
Las Vegas, Nevada



CLARK COUNTY
REGIONAL FLOOD CONTROL DISTRICT

1991 FLOOD CONTROL MASTER PLAN UPDATE LAS VEGAS VALLEY

LEGEND

45 SUBAREA DESIGNATION

—— SUBAREA DELINEATION

N

0 5,000 10,000 15,000

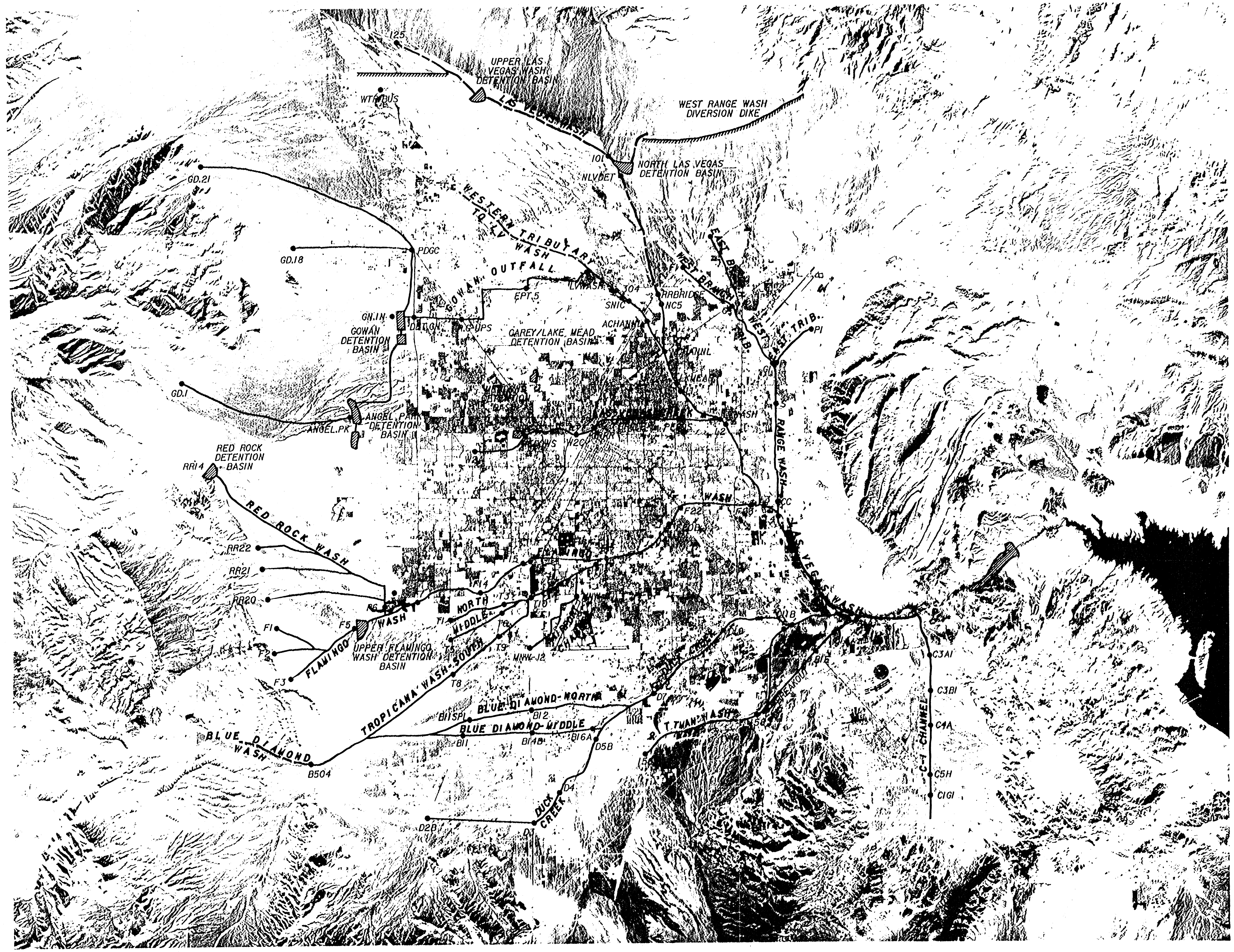
(APPROXIMATE)

HENDERSON BASIN HYDROLOGIC SUBAREAS

FIGURE S-5

JMM James M. Montgomery Consulting Engineers, Inc.

Las Vegas, Nevada



CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

FLOOD INSURANCE STUDY HYDROLOGIC ANALYSIS STREAMS AND CONCENTRATION POINTS

LEGEND

● F23 — FIS CONCENTRATION POINT OR MODEL NODE

FIGURE 1-1

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