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SCATTER WASH DRAINAGE AND STORM DRAIN STUDY

CONCEPTUAL PLAN

VOLUME I

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PREPARED FOR:

CITY OF PHOENIX ENGINEERING DEPARTMENT

FLOODPLAIN MANAGEMENT

ST-886366

PREPARED BY:

GREINER, INC.

SEPTEMBER 1989

Greiner

Scatter Wash Drainage and Storm Drain Study
Conceptual Plan

Volume I

Prepared for:

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EXECUTIVE SUMMARY

A Conceptual Drainage and Storm Drain Plan has been developed for Scatter Wash and its tributaries located east of Interstate 17 (I-17) and north of Deer Valley Drive, City of Phoenix, Arizona. The plan is comprised of mitigation measures including: channels, detention basins and storm drains. The plan also identifies "no-action" areas which require a more site-specific evaluation for local drainage relief or areas that should be left in their natural state to preserve the desert environment.

The plan provides regional outfalls for storm drains and channels that will serve future development in the upper Scatter Wash watershed. Downstream properties and roadways will also benefit by the reduction of stormwater and floodwater flows. These regional drainage facilities, however, are not a substitute for current City and County requirements for new development to provide on-site retention.

Study Objectives

The objectives of the study are to identify potential flooding and drainage problem areas in the Scatter Wash watershed above I-17 and to develop a conceptual flood control and stormwater drainage plan to mitigate these problems. The plan will include a drainage system to manage the 100-year stormwater runoff and a storm drain network to be located along major street alignments to convey the 2-year stormwater runoff. To achieve these objectives, five hydrologic computer models were developed using the HEC-1 Flood Hydrograph Package as follows:

Case 1: Existing watershed development condition model for the 100-year, 24-hour storm.

Case 2: Future watershed development condition model for the 100-year, 24-hour storm.

Case 3: Existing watershed development condition model with the selected Conceptual Drainage Plan for the 100-year, 24-hour storm.

Case 4: Existing watershed development condition model with the Storm Drain Plan for the 2-year, 24-hour storm.

Case 5: Existing watershed development condition model incorporating both the Drainage Plan and the Storm Drain Plan for the 100-year, 24-hour storm.

The City of Phoenix Department of Engineering Floodplain Management Section established a Steering Committee to review the results and recommendations of the study and to provide direction for the development of the recommended Conceptual Plan. Represented on the Steering Committee were: the Arizona State Land Department, Flood Control District of Maricopa County, City Planning Department, City Engineering Department - Storm Drain Section and the City Water and Wastewater Department.

Hydrologic Modeling - Case 1 and Case 2

The Case 1 model for existing conditions was developed to identify potential drainage and flooding problem areas. The problem areas identified were: Happy

Valley Road at I-17, Pinnacle Peak Road at I-17, South Branch of Scatter Wash at I-17, the commercial/industrial area bounded by I-17, Williams Drive, 19th Avenue and Deer Valley Drive, and the Deer Valley Drive interchange at I-17. Major contributory factors creating these drainage problems are the absence of well-defined watercourses and the inadequate capacity of the culverts located under I-17, and Pinnacle Peak Road.

The Case 2 model for future conditions was developed to determine whether full implementation of on-site retention requirements by future development will be adequate to mitigate the identified drainage problems. The results of the model indicated that additional measures would be required.

For the results of the Case 1 and Case 2 models, see Section 5 of this report.

Conceptual Drainage Plan - Case 3

A Conceptual Drainage Plan was developed to provide a solution to the identified drainage problems. The proposed plan is comprised of open channels, detention basins and guidelines for "no-action" areas. Three channel concepts were evaluated: earthen, landscaped recreation and drainage corridors, and concrete lined. Factors considered in developing the plan were: location and magnitude of runoff, location and adequacy of outfalls, availability of vacant land, City guidelines for desert land preservation and City parks and recreation requirements. The plan was developed from alternative schemes reviewed by the City Floodplain Management Section and the Steering Committee.

A hydrologic model of the plan was developed (Case 3) by modifying the Case 1 model for existing conditions. Existing watershed conditions were used on the assumption that future development will be required to limit the runoff rate to current levels. The model identified the need for regional detention basins to reduce runoff rates to the culverts located under I-17.

Refer to Section 6 of this report for a description of the Concept Drainage Plan features and the results of the hydrologic model.

Storm Drain Plan - Case 4

A Storm Drain Plan was developed to provide drainage for existing and proposed major streets in the study area. The storm drains were sized for 2-year stormwater flows. The Case 4 hydrologic model was developed to calculate these flows. The storm drains would either discharge into the drainage system proposed in the Conceptual Drainage Plan or into other regional facilities such as those associated with the Outer Loop Highway. See Section 7 of the report for a description of the Storm Drain Plan and the results of the hydrologic model.

Selected Conceptual Drainage and Storm Drain Plan - Case 5

The components of the Drainage and Storm Drain Plans were incorporated into a single plan that was subsequently analyzed in the Case 5 hydrologic model. The results of this model were used to size the detention basins and channels. Channel sizes were calculated for the earthen, landscaped and concrete lining

options. The channel corridors were also extended to the Central Arizona Project (CAP) Canal to integrate the plan into the proposed linear park system associated with the Canal.

Conclusions

The Conceptual Drainage and Storm Drain Plan for Scatter Wash will provide the required drainage and flooding relief along I-17 during the 100-year storm event. The plan will also provide additional benefits to properties west of I-17 by reducing discharges from the I-17 culverts and at the Deer Valley Drive interchange.

The commercial/industrial area bounded by I-17, Williams Drive, 19th Avenue and Deer Valley Drive was identified as having a local drainage problem requiring further study. Areas with proposed densities of less than five residences per acre and the watershed above the CAP Canal were identified as "no-action" areas. In these areas, non-structural measures to mitigate potential flooding damages are preferred to preserve the desert and maintain the existing, natural drainage patterns. These measures can include a wide range of floodplain management techniques such as establishing safe finish floor elevations, creating erosion setbacks and flood proofing of existing structures.

Preliminary costs and right-of-way acquisition requirements were developed for each of the three channel options. Costs included construction, engineering and administration. The costs of the three plan options are as follows:

Plan With Earthen Channels	$20.9 Million
Plan With Landscaped Recreation Corridors	$25.1 Million
Plan With Concrete-Lined Channels	$25.0 Million

Right-of-way acquisition requirements for each plan option are as follows:

Plan With Earthen Channels	210 Acres
Plan With Landscaped Recreation Corridors	274 Acres
Plan With Concrete-Lined Channels	148 Acres

INTRODUCTION

The objective of the Scatter Wash Drainage and Storm Drain Study is to identify potential flooding and drainage problem areas in the Scatter Wash watershed above Interstate 17 (I-17) and to develop a Conceptual Flood Control and Stormwater Drainage Plan comprised of measures to mitigate these drainage problems. The plan will include a drainage system to manage the 100-year stormwater runoff and a storm drain network to be located along major street alignments to convey the 2-year stormwater runoff.

To achieve this objective, five hydrologic computer models are to be developed using the HEC-1 Flood Hydrograph Package as follows:

Case 1: Hydrologic model for the existing watershed condition for the 100-year, 24-hour storm. This model will reflect the present status of development.

Case 2: Hydrologic model for the future watershed condition for the 100-year, 24-hour storm. This model will reflect full watershed development.

Case 3: Hydrologic model for the existing watershed condition for the 100-year, 24-hour storm with the recommended drainage plan.

Case 4: Hydrologic model for the existing watershed condition for the 2-year, 24-hour storm with the recommended storm drain system.

Case 5: Hydrologic model for the existing watershed condition for the 100-year, 24-hour storm, incorporating the systems proposed in Case 3 and Case 4.

The purpose of this report is to present the selected Concept Plan for Scatter Wash and to document the methodology and results of the hydrologic analyses of Scatter Wash and its drainage subareas above I-17.

DRAINAGE AREA DESCRIPTION

The Scatter Wash study area is located in the rapidly urbanizing area of northwest Phoenix commonly referred to as Deer Valley. The study area is comprised of the watershed that contributes runoff to Scatter Wash at I-17. The limits of the area are I-17 to the west, the Union Hills ridge line to the north and east and Deer Valley Drive to the south. Figure 1 is the study area vicinity map.

Scatter Wash and its tributaries are generally comprised of poorly defined channels. Well defined natural channels, comprised of discernible bed and banks, are found in the upper watershed only. At the lower elevations below the Central Arizona Project (CAP) Canal, the small channels broaden into wide, shallow swales lacking definable channel banks and may be identified only from the heavier concentration of vegetation. A narrow earthen channel was excavated along I-17 to convey discharge from Pinnacle Peak Road to the double 8′ x 7′ box culvert located under I-17, approximately 0.25 miles north of Williams Drive (north branch of Scatter Wash). The main channel of Scatter Wash through the Phoenix-Metro and R.V. Park located on the north side of Williams Drive at I-17 has also been excavated (south branch of Scatter Wash). This channel discharges into a single 6′ x 7′ box culvert located under I-17. The location of these structures is shown on Figure 2.

Significant features which affect drainage patterns in the study area include the CAP Canal which bisects the study area along an alignment parallel to Union Hills, and I-17 which limits outflow from the study area to a few culverts. Runoff in the upper watershed flows generally from the northeast to the southwest. Runoff along I-17 is from north to south, and along the lower main channel of Scatter Wash, from east to west.

North of Williams Drive, the area is predominantly undeveloped desert valley and hills. Vegetation is comprised of desert brush, cacti and grasses. Cover density ranges from poor (less than 30 percent) to fair (30 percent to 70 percent). There is no agricultural development in the area. Single-family residences on large parcels of land are located on both sides of the CAP Canal in the central portions of the study area. These residences are served by dirt roads connecting to Happy Valley Road which is paved. The Phoenix-Metro and R.V. Park located at the downstream outlet of Scatter Wash is approximately 39 acres in size. East of 19th Avenue, along Williams Drive, the infrastructure for an industrial park, approximately 50 acres in size, has been constructed. North of the industrial park at 19th Avenue and Pinnacle Peak Road there is a test facility which includes an asphalt, paved loop track and a number of small support buildings.

Development in the portion of the study area south of Williams Drive is comprised of commercial and industrial uses and includes the western fringe of Phoenix Deer Valley Airport. Most of the improvements associated with these land uses are relatively old and constructed on grade, thus having little affect on the drainage pattern.

The portion of the study area bounded by Jomax Road on the north, 19th Avenue on the east, Happy Valley Road on the south and I-17 on the west is within the Deer Valley Village Core. This planning designation provides for future intense commercial, public service and high density residential development (Figure 3, Page 4.5).

STUDY AREA VICINITY

N

N.T.S.

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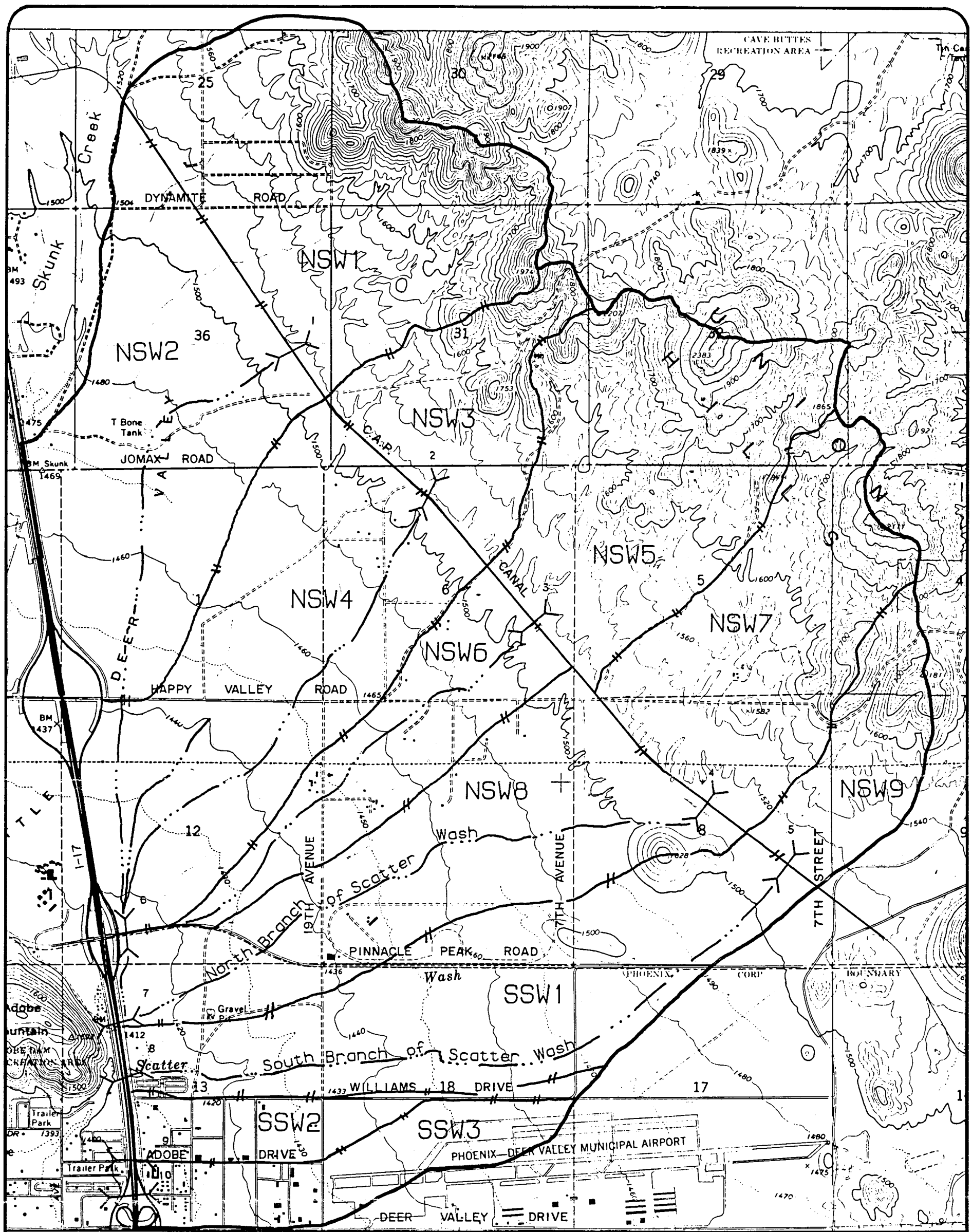
FIGURE 1



CULVERT SUMMARY

I.D.	TYPE AND SIZE
1	42" STEEL PIPE
2	30" STEEL PIPE
3	42" STEEL PIPE
4	36" STEEL PIPE
5	30" STEEL PIPE
6	2-8'x7' RCBC
7	2-8'x7' RCBC
8	1-6'x7' RCBC
9	1-65"x40" CMP
10	1-6'x3' RCBC

LEGEND

- STUDY WATERSHED AREA BOUNDARY
- DRAINAGE SUBAREA BOUNDARY
- NSW1 DRAINAGE SUBAREA I.D.
- MAJOR CULVERT AND I.D.
- PRIMARY FLOW PATH

N

2000 0 2000

scale feet

1"=2000'
20' C.I.

DRAINAGE SUBAREAS AND MAJOR DRAINAGE FEATURES

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FIGURE 2

PROCEDURES AND METHODOLOGY

A. Development of Existing and Post-Development (Future) Drainage Patterns, Drainage Areas and Subareas

Existing Drainage Areas and Patterns

Watershed subareas were delineated and hydrologic/hydraulic parameters established. Street flow patterns in urban areas were identified as well as the effects of the CAP Canal and highway embankments on drainage patterns. Sources of information to establish the drainage areas, drainage patterns and subareas include the following:

- U.S.G.S. Quadrangle Maps 7.5 Minute Series. These were used to establish the limits of the major drainage areas and existing topographic features and to establish general flow patterns; i.e. sheet flow, well established channels, etc.

- Landis Aerial Surveys, 1" = 1,200'. These aerial maps were photographed in December 1985 and were used to identify street flow patterns and areas of significant development. These aerial maps were used to locate existing drainage facilities and to develop curve numbers for existing conditions.

- City of Phoenix A.P. #40 Topographic Maps and Aerial Photos, 1" = 100'. The A.P. #40 aerials and topographic maps were used to establish flow patterns and subarea delineations in the immediate vicinity of I-17 and Williams Drive. The maps were also used to establish street geometry for capacity calculations.

- Phoenix-Cordes Junction Highway (I-17) Topographic Map. These were used to define topography within the I-17 right-of-way. The maps were prepared in 1983 at a scale of 1" = 50' and a contour interval of two feet.

- Field Reconnaissance. Field investigation was undertaken to verify information from the aerial photographs and topographic maps. Areas of new development or developments under construction were identified. All significant drainage structures crossing the CAP Canal were identified by location, type and size. The flow paths of all major mile and half-mile streets were identified and other street drainage patterns were documented. Major drainage structures along I-17 were identified.

- As-Built Plans. As-built plans for drainage structures associated with the CAP Canal were used for flow routing through the canal embankment. As-built plans of I-17 were used to identify drainage structures along the alignment.

Figure 2 presents drainage subarea boundaries and significant drainage features.

Post-Development (Future) Drainage Patterns and Areas

Future development conditions were based on adopted community land-use plans, current drainage criteria and approved master drainage plans and studies. No drainage or flood control improvements were assumed to be in place.

Flow patterns were developed by applying street patterns from similar existing developments or with the same zoning classification and assuming that future development will be developed in a similar pattern as the existing developments in the vicinity. Street widths were established by using the City of Phoenix typical sections for the appropriate type of development, i.e. residential, commercial, industrial, etc.

B. Criteria Used for HEC-1 Computer Modeling

The following criteria were used for HEC-1 computer modeling:

- o A 24-hour storm duration
- o Soil Conservation Service (SCS) Type IIA rainfall distribution (see Table 1)

Table 1

SCS Type IIA Distribution Pattern

Time Elapsed (Hours)	Cumulative Precipitation (Percent)	Time Elapsed (Minutes)	Cumulative Precipitation (Percent)
0.0	0.000	12.5	.900
0.5	.005	13.0	.905
1.0	.009	13.5	.912
1.5	.010	14.0	.919
2.0	.013	14.5	.923
2.5	.019	15.0	.930
3.0	.021	15.5	.934
3.5	.028	16.0	.939
4.0	.032	16.5	.944
4.5	.044	17.0	.950
5.0	.057	17.5	.958
5.5	.100	18.0	.961
6.0	.660	18.5	.963
6.5	.745	19.0	.969
7.0	.776	19.5	.971
7.5	.800	20.0	.974
8.0	.816	20.5	.979
8.5	.830	21.0	.981
9.0	.840	21.5	.985
9.5	.850	22.0	.989
10.0	.861	22.5	.991
10.5	.868	23.0	.993
11.0	.878	23.5	.996
11.5	.884	24.0	1.000
12.0	.891		

- Rainfall data taken from NOAA Atlas 2, Volume III, Arizona (see Table 2 and Appendix D)

Table 2

Scatter Wash Precipitation Values

Return Period (Years)	Precipitation Values 6-Hour Duration (In)	24-Hour Duration (In)
2	1.22	1.57
5	1.72	2.19
10	2.05	2.58
25	2.47	3.10
50	2.84	3.56
100	3.21	4.05

- Precipitation depths were not varied through the watershed subareas.

- Runoff curve numbers (CN) for desert areas were developed per SCS Technical Release Number 55 (TR55). The hydrologic characteristics of the study area soils were determined from the following SCS soil surveys: Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona (1986) and Soil Survey of Maricopa County, Arizona, Central Part (1987). The hydrologic soil groups in the study area as defined by the SCS are:

  Group B - Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

  Group C - Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

  Group D - (high runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with clay pan or clay layer at or near the surface and shallow soils. These layers have a very slow rate of water transmission.

  Valley soils in the study area are predominantly Group B soils with isolated areas of clay belonging to Group D. Soils north of the CAP Canal and within Union Hills are predominantly Group D soils composed of shallow and very

shallow gravelly and cobbly soils with exposure of bedrock. Just to the south of the above group is an association of soils belonging to the Group C classification. The distribution of study area soils is shown in Figure 3.

For future developed conditions, CN's were developed from TR55 procedures in conjunction with the development density - percent impervious relationships developed by the City of Phoenix (see Table 3).

Table 3

Development-Percent Impervious Relationships

Development/Density	Percent Impervious	Percent Contributing
0 - 2 Dwellings Per Acre	27	100
2 - 5 Dwellings Per Acre	47	50
5 - 15 Dwellings Per Acre	75	50
15+ Dwellings Per Acre	90	50
Mixed Use	85	50
Commercial	95	50
Hillside		
10% - 15% Slope	26	100
25% Slope	15	100
>35% Slope	6	100
Industrial	95	50

o The lag time equation used is as follows:

$$Lag = 24n(LL_{ca}/s^{0.5})^{0.38}$$

Where L = the length of the longest watercourse (in miles)

L_{ca} = upstream length along the longest watercourse to a point opposite the subbasin centroid (in miles)

s = overall slope of the longest watercourse, from headwater to concentration point (in feet/mile)

n = visually estimated mean of the n (Mannings Formula) values of all the channels within an area

Lag = lag time (in hours)

Values of "n" for the above equation are as follows: (Source: Pima County)

Undeveloped Watersheds

Mountain: the drainage area is quite rugged, with sharp edges and narrow, steep canyons through which watercourses meander around sharp bends, over large boul-

PREVIOUS INVESTIGATIONS

Previous hydrologic investigations of the study area were reviewed for the purpose of verifying the results of this study. Particular attention was given to the hydrologic modeling assumptions of these studies including: study area limits, storm frequency, precipitation distribution and duration, treatment of CAP embankment drainage, I-17 culvert analysis and land use. A comparison of the results of this study and the previous investigations can be found in Section 5C.

In 1977, the Northwest Storm Drainage Study was prepared for the City of Phoenix by Arthur Beard Engineers, Inc. The focus of the study was to develop a storm drainage plan for the area bounded by I-17 on the east, the Arizona Canal on the south and southwest, and Skunk Creek on the west and northwest. The hydrology of the contributing area east of I-17, including Scatter Wash, was also performed. The study utilized the Soil Conservation Service (SCS) TR-20 model to evaluate the 1-, 2-, 10- and 50-year, 24-hour storms. The SCS Type II precipitation distribution was used. The watersheds were analyzed for both existing and future full-development conditions. The study report does not clearly define how CAP Canal and I-17 embankment drainage was treated. It appears from the study results, however, that runoff from the area above the CAP Canal did not increase the peak discharges at I-17. It also appears that flows were routed through I-17 culverts without accounting for a detention or diversion affect.

In the late 1960's and into the last decade, the U.S. Army Corps of Engineers (COE) undertook a major flood control planning program for the Phoenix area. The hydrology for the recommended projects was reformulated in 1982 and published in the Gila River Basin; Phoenix, Arizona and Vicinity (Including New River); Hydrology Part 2. The Standard Project Flood (SPF) for Scatter Wash was calculated. The SPF represents the flood that would result from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the region. Using a discharge frequency analysis of urbanized basins, lesser discharge events are calculated as a percentage of the SPF as follows:

Discharge Frequency	Percent of SPF
2	3
5	7
10	12
25	21
50	32
100	45
SPF	100

The Scatter Wash watershed was evaluated for future fully-developed conditions. The area above the CAP was neglected due to the detention affect of the canal embankment. The detention and diversion affect of I-17 were neglected, and the discharges for Scatter Wash at I-17 were not provided in the published report.

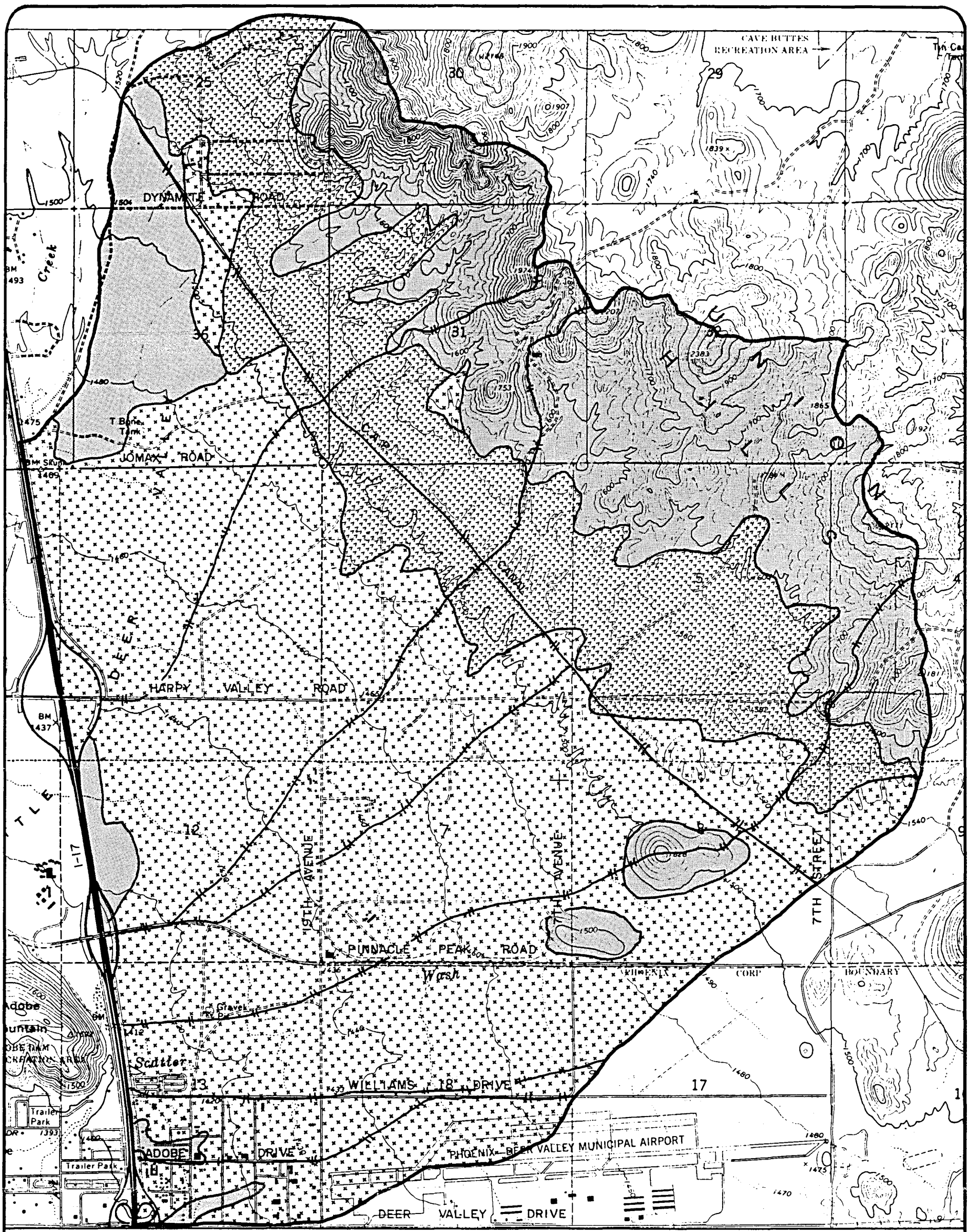
The COE addressed Scatter Wash hydrology again in 1985 in the Flood Insurance Study (FIS); New River and Scatter Wash, Maricopa County, Arizona. The purpose

for the study was to update the Flood Insurance Rate Maps to reflect the affect of a newly constructed levee that prevents high flows in Skunk Creek from overflowing into the Scatter Wash watershed just above I-17.

The 10-, 50- and 100-year peak discharges were used in the analysis. The hydrologic model developed for future conditions in the 1982 report was revised to reflect present watershed conditions. As before, tributary runoff from above the CAP Canal was ignored. Culvert and detention routing through I-17 were performed to determine breakout overflows both onto the I-17 roadways and south along the east side to Deer Valley Drive. A detailed hydraulic analysis of Scatter Wash was performed using the HEC-2 Backwater Computer Program. The downstream study limit was Skunk Creek and the study was ended upstream of I-17 in the vicinity of Williams Drive.

In 1986, Greiner Engineering Sciences, Inc. (now Greiner, Inc.) analyzed, for the Arizona Department of Transportation (ADOT), the off-site hydrology impacting the proposed Outer Loop Highway alignment along Beardsley Road. The HEC-1 computer program was utilized to evaluate the 10-, 50- and 100-year, 24-hour storm events for existing watershed conditions. Routing through the CAP Canal embankment was performed. Flows concentrating at I-17, however, were assumed to cross over unimpeded.

Recognizing that drainage problems were associated with I-17, ADOT requested PRC Engineering to undertake the I-17 Drainage Design Study (March, 1987). I-17 cross drainage was evaluated from Scatter Wash to Peoria Avenue. The SCS TR-20 program was utilized to calculate the 50- and 100-year, 24-hour storms for both existing and future watershed conditions. The study utilized the Scatter Wash discharges for existing conditions developed by Greiner for the Outer Loop Highway study and the COE values for future watershed conditions developed in 1982. Original hydrology was performed for the small watersheds contributing directly to the Deer Valley Drive interchange. The capacity of the I-17 culverts, detention along the east side of the roadway embankment, and flow diversions to the south were analyzed in detail.



LEGEND

- STUDY WATERSHED AREA BOUNDARY
- DRAINAGE SUBAREA BOUNDARY
- NSWI DRAINAGE SUBAREA I.D.
- GROUP B SOILS
- GROUP C SOILS
- GROUP D SOILS

N

2000 0 2000

scale feet

1"=2000'
20' C.I.

DISTRIBUTION OF HYDROLOGIC SOIL GROUPS

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FIGURE 3

ders and considerable debris obstruction. The ground cover, excluding small areas of rock outcrops, includes many trees and considerable underbrush. No drainage improvements exist in the area.

Mean Slope(S_c)	n (Min.)	n (Norm.)	n (Max.)
Generally greater than .03 ft./ft.	.040	.050	.060

Foothills: the drainage area is generally rolling, with rounded ridges and moderate side slopes. Watercourses meander in fairly straight unimproved channels with some boulders and lodged debris. Ground cover includes scattered brush and grasses. No drainage improvements exist in the area.

Mean Slope(S_c)	n (Min.)	n (Norm.)	n (Max.)
Generally from .01 to .04 ft./ft.	.030	.035	.040

Valley: the drainage area has comparatively uniform, gentle slopes and surface characteristics such that, in many cases, well-defined channelization does not occur. Ground cover consists of growths of grass and small shrubs, cacti, or similar vegetation. No drainage improvements exist in the area.

Mean Slope(S_c)	n (Min.)	n (Norm.)	n (Max.)
Generally less than .01 ft./ft.	.027	.030 - .040	.05

Rural Development

The drainage area has fairly uniform, gentle slopes with some watercourses either improved or along paved streets.

Watershed Type	Density	n (Min.)	n (Norm.)	n (Max.)
Suburban-Foothills	Less than 1 house per acre	.029	.034	.038
Suburban-Valley	Less than 1 house per acre	.027	.029 - .038	.047
Suburban-Foothills	1 to 2 houses/acre	.028	.032	.036
Suburban-Valley	1 to 2 houses/acre	.026	.028 - .036	.045

Urban Development

Light-Moderate Urbanization: the drainage area has fairly uniform, gentle slopes with most watercourses either improved or along paved streets.

Density	n (Min.)	n (Norm.)	n (Max.)
3 to 5 houses per acre (detached)	.020	.022	.025

Highly Urbanized: the drainage area is similar to a lightly to moderately urbanized basin, except that appreciable areas are developed to the extent that a large percentage of the watershed is impervious and essentially all watercourses are either improved or along paved streets and/or surfaces.

Density	n (Min.)	n (Norm.)	n (Max.)
Multiple dwellings Moderate industrial and light commercial	.018	.020	.022

Commercial/Industrial: the drainage area has fairly uniform, gentle slopes with essentially all watercourses either improved or along paved streets and/or surfaces. Areas are normally developed to the extent that only a minor percentage of the watershed remains pervious (less than 15 percent).

Watershed Type	Density	n (Min.)	n (Norm.)	n (Max.)
Highly Urbanized	Heavy commercial and industrial	.015	.018	.020

- For modeling post-development (future) conditions, the model was adjusted to reflect on site retention requirements by assuming a certain percentage of effective contributing area. These values are shown on Table 3. Proposed land uses for future fully-developed watershed conditions are shown on Figure 4.

C. Development of HEC-1 Input

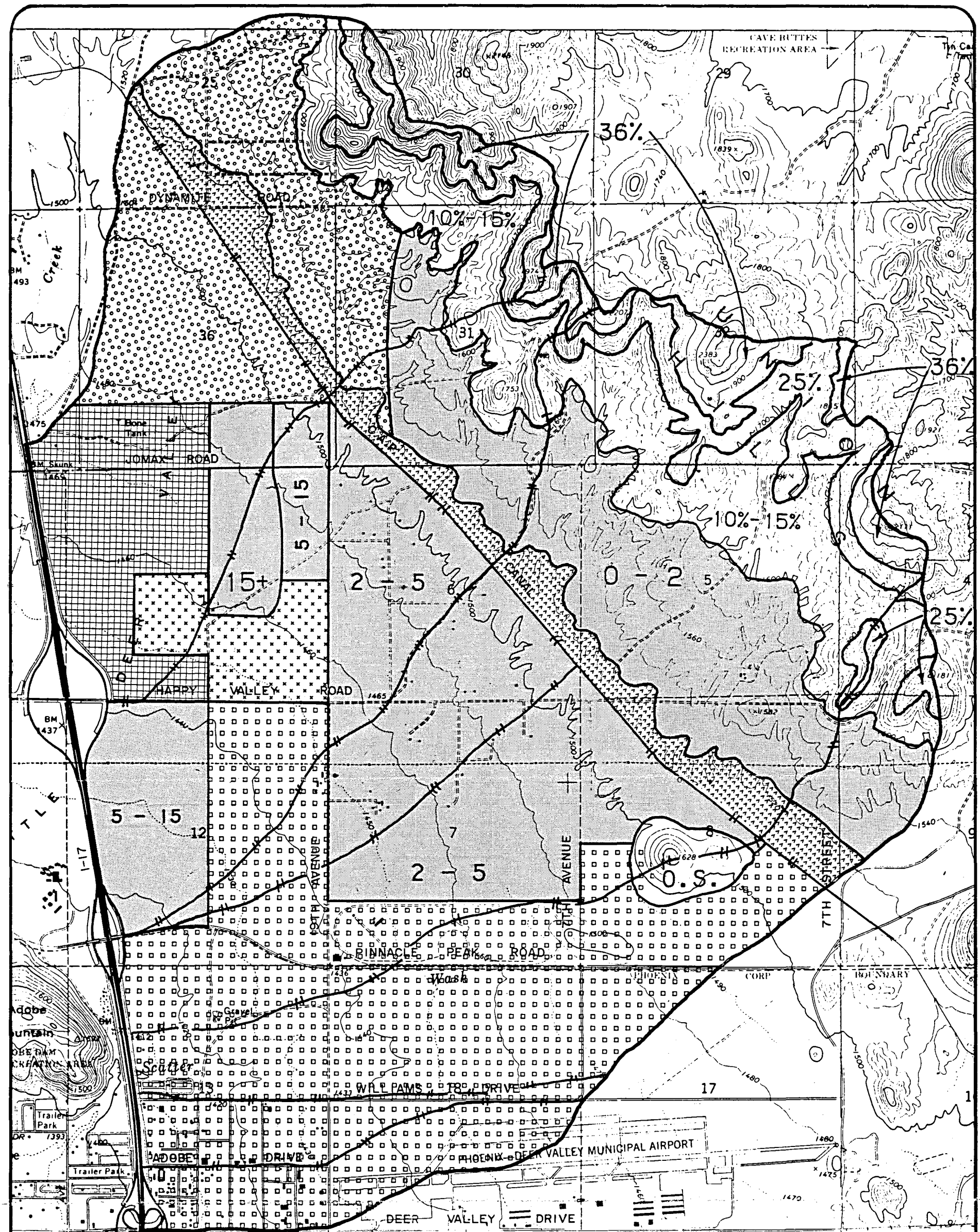
The HEC-1 Flood Hydrograph Package has many input component options. This section documents the input components used for hydrologic modeling for this study. Modeling techniques and methods are described in Section 3D.

Job Initialization. The "IT" card was used to define the time interval of six minutes and the number of hydrograph coordinates to be computed. The "IN" card was used to define the time interval of 0.5 hours for reading the "PC" card (cumulative precipitation time series). When the time series data is read from the "PC" card, values are computed internally using linear interpolation to match the tabulation interval of two minutes on the "IT" card.

Precipitation Data. A precipitation hyetograph is used as the input for all runoff calculations. The hypothetical storm used for input was the SCS Type IIA distribution. The "PC" card was used to input this precipitation mass curve. The "PB" card was used to define the total storm, basin-average precipitation values in inches. The values used for this study were derived from the NOAA Atlas II. The "PC" values for precipitation were used as a distribution pattern for the storm amount.

Loss Rate Data. Input data for the SCS dimensionless Unit Hydrograph method was used in areas where street flow patterns have not been developed. The "UD" card is used where this method is applied. The "UK" and "RK" cards are used to define the characteristics for kinematic wave routing of precipitation excess to the subbasin outlet. The "UK" card defines overland flow and the "RK" card defines the collector and/or main channel used for routing.

Hydrograph Combination. The "HC" card was used to calculate hydrograph combinations.



LEGEND

- STUDY WATERSHED AREA BOUNDARY
- DRAINAGE SUBAREA BOUNDARY
- 15+ RESIDENTIAL USE AND DENSITY
- PUBLIC
- COMMERCIAL
- INDUSTRIAL
- MIXED USE
- FLOODPLAIN
- 25% HILLSLOPE (RESIDENTIAL) AND PERCENT SLOPE

N

2000 0 2000

scale feet

1"=2000'
20' C.I.

PROPOSED LAND USES FULLY - DEVELOPED WATERSHED CONDITIONS

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FIGURE 4

Routing Data. The "RK" card was used to perform the kinematic routing method. This method was used for all routings. Input components are channel length, slope, roughness, shape and bottom width or diameter. The "RS" card was used to perform storage discharge routing for detention basins, retention basins, outlet structures along the CAP Canal and roadway embankments. A stage storage-discharge relationship was input using the reservoir volume versus discharge relationships as explained in the Storage Routing Data.

Storage Routing Data. All storage routing was performed using the modified Puls routing method. This method determines the outflow rate based on either a pipe or weir discharge coefficient, times the length of the spillway crest (feet) or the cross sectional area of the discharge pipe (square feet) times the head above the free outlet elevation or the spillway crest (feet) to the power of the theoretical exponent. The components used for storage routing are the "SE," "SQ" and "SV" cards which describe elevation (feet), discharge (cfs) and volume (ac/ft). The "SL" card was used to describe the flow through a low-level outlet along with an "SS" card to compute the flow for weir or ogee spillways. The "SL" card describes the elevation of the low level outlet, the cross-sectional area, the discharge coefficient and the exponent of head. The "SS" card describes the spillway crest elevation, the spillway length, the discharge coefficient and the exponent of head.

Diversion Data. The "DT," "DI" and "DQ" cards were used for flow diversions. The "DT" card is a diversion identifier card and names the diverted flow for future retrieval. The "DI" card specifies the inflow in cfs to the diversion location and the flow to be diverted. The "DQ" card specifies the rate of flow in cfs to be diverted. The "DR" card was used to retrieve previously diverted flows.

D. Modeling Techniques and Methods

This section describes the HEC-1 modeling techniques and hydrologic/ hydraulic computation methods used for this study.

Various routing procedures were required in modeling runoff hydrographs through the drainage areas. Specific procedures were required for routing through the CAP Canal embankment, through the I-17 roadway and Pinnacle Peak Roadway embankments, through retention basins and street flow routing with diversions. These procedures are described in detail below.

CAP Canal Embankment Routing. A number of concrete and steel pipe overchutes convey upstream runoff across the CAP Canal in the study area. The Bureau of Reclamation provided Greiner with locations and pipe geometry data as well as elevation-storage data for the ponding area behind the overchute inlets. The Bureau developed only one elevation-storage-discharge relationship for the entire ponding area behind the canal embankment through the study area. A simplified approach was developed in this study for calculating the discharge at each culvert by prorating total storage for each drainage subarea based on the length of fronting canal embankment. Elevation and storage data were input on "SE" and "SV" cards, respectively. Overchute data was input on the "SL" card.

A more complex analysis could be performed on these culverts by routing a combined hydrograph of the subareas using a combined stage-discharge table for the culverts and by using the Bureau's stage-storage data to develop a flow at each culvert outlet. The discharge hydrograph at each culvert would then be developed by prorating the combined outflow hydrograph based on the individual stage-discharge relationships for each culvert. Refer to Appendix D for the culvert rating calculations.

Pinnacle Peak Road Embankment Routing. The Pinnacle Peak Road embankment east of I-17 acts as a detention structure. A double 8′ x 7′ culvert conveys some flows through the embankment and into a roughly excavated earthen channel. Flows in excess of culvert capacity pond on the north side of the road and eventually overtop the road. These flows also drain southward together with the culvert discharge.

The standard HEC-1 procedure for this type of detention routing would be to use the "RS," "SV," "SE," "SL," "SS" sequence of control cards. Roadway embankment elevations, culvert data and ponding area elevations were obtained from I-17 as-built plans, City of Phoenix A.P. #40 topographic maps and the more recent I-17 strip topography developed by ADOT.

After preliminary runs, however, it was determined that the orifice flow equations utilized by HEC-1 were overestimating the discharge through the box culverts. A culvert rating curve was then developed using HEC No. 5 procedures. Both inlet and outlet controls were evaluated and the more conservative values were used. A separate rating curve was developed for flow weiring over the roadway. The culvert and weir discharge rating curves were combined and a single stage ("SE") discharge ("SQ") table was substituted into the HEC-1 model in lieu of the "SL" and "SS" cards.

I-17 Embankment Culvert Routing. Significant ponding occurs behind the double 8′ x 7′ box culvert located approximately 0.25 miles north of Williams Drive. Runoff to this culvert comes from the Pinnacle Peak Road culverts to the north and drainage areas located to the northeast.

Flows were routed through the culverts and ponding area in the same manner as described for Pinnacle Peak Road. Additionally, it was determined from preliminary runs that there are two overflow areas: one to the south and one to the west, across the I-17 frontage road. Separate rating curves were developed for the culverts and both overflow weirs. It was also found that the ponding tailwater extended northward to the outlet of the culvert at Pinnacle Peak Road. The stage-discharge relationship for this culvert was re-evaluated to assess the affect of this tailwater.

Weir overflows to the south were incorporated into the total inflow to the 6′ x 7′ box culvert at Scatter Wash. Weir overflows onto I-17 were assumed to be confined by the roadways and conveyed southward to the Deer Valley Drive interchange. The HEC-1 flow diversion cards ("DT," "DI" and "DQ") were used to divert the weir overflows southward and westward. The diversion sequence for the south weir was placed first, since it would overflow before the west weir.

Scatter Wash Culvert Routing. Total runoff to the 6′ x 7′ box culvert at Scatter Wash and I-17 is comprised of runoff from the east and overflows from the double 8′ x 7′ culverts located to the north. It was determined that detention ponding behind the culvert would be minimal. Flows in excess of the culvert's capacity would divert southward along I-17 to the Deer Valley Drive interchange. The culvert's capacity was calculated using HEC No. 5 procedures. The HEC-1 flow diversion cards ("DT," "DI and "DQ") were used to divert excess flows southward.

Deer Valley Drive Interchange. Retention routing was performed to determine the extent of breakout flows from the depressed roadway section to the west. Retention volume (SV) within the depressed roadway section was calculated from the City of Phoenix A.P. #40 topographic maps. A stage (SE) discharge (SQ) rating was developed for the breakout area on the west side of the interchange. The ADOT pumping station at the interchange was previously analyzed in the "I-17 Drainage Design Study" which determined that it would fail during the 100-year storm event. Pumping was, therefore, not included in the routing procedure.

Storm Drain Diversions

For project conditions, the divert commands were used to reflect the interception of flows into the proposed storm drains. Flows up to the conveyance capacity values specified were routed into the storm drain systems. Flows in excess of the storm drain capacity remained on the surface.

HYDROLOGIC MODELING

The hydrologic modeling for the study area is separated into existing conditions and post-development (future) conditions. Each condition was analyzed for the 100-year, 24-hour storm events.

A. Case 1: Existing Conditions

The study consists of twelve drainage subareas. Subareas were delineated and hydrologic/hydraulic parameters were established. Land use, channel geometry, drainage paths and points of diversion were analyzed to subdivide the drainage areas. Flows were first routed through a common flow path and then evaluated for split flows. With the exception of Williams Drive and Deer Valley Drive, existing paved roads within the study area have no curbs. The natural runoff pattern was, therefore, assumed to be unaffected by bisecting streets. Figure 2 shows the delineated subareas for existing conditions. Subarea characteristics and the 100-year storm runoff are summarized in Table 4 for existing conditions. The HEC-1 computer model is found in Appendix A.

Note: Comp. Interval of 2 minutes has been used. Not all of the hydrograph captured. Check results first before using.

Table 4

Summary of Drainage Subarea Characteristics
Existing Conditions

Subarea I.D.	Area (mi^2)	CN	Lag Time (hrs)	100-Year Runoff (cfs)
NSW1	1.37	83	0.26	2672
NSW2	1.33	79.3	0.48	1583
NSW3	0.54	82.7	0.24	1076
NSW4	1.52	75.8	0.47	1565
NSW5	1.17	84.3	0.39	1948
NSW6	0.60	76.0	0.48	615
NSW7	0.96	81.6	0.40	1415
NSW8	1.23	76.0	0.56	1134
NSW9	0.38	81.1	0.28	665
SSW1	1.24	76.0	0.66	1019
SSW2	0.28	76.3	0.29	516
SSW3	0.39	75.5	0.32	791

Major runoff concentration points are located at Happy Valley Road east of I-17, Pinnacle Peak Road at I-17, the north branch of Scatter Wash at the double 8′ x 7′ box culvert, the south branch of Scatter Wash at the 6′ x 7′ box culvert, Adobe Drive, Louise Drive and at the Deer Valley Drive interchange at I-17. Table 5 summarizes the discharges at these locations.

Table 5

Summary of Discharges
Existing Conditions

Location	Contributing Area (mi^2)	Peak Discharge
Happy Valley Road	2.70	1609 cfs
Pinnacle Peak Road	6.53	3521 cfs
North Branch Scatter Wash	8.72	3853 cfs
South Branch Scatter Wash*	1.24	2281 cfs
Adobe Drive*	0.28	1870 cfs
Louise Drive*	0.39	1925 cfs
Deer Valley Drive Interchange Inflow*	N/A	2383 cfs
Deer Valley Drive Interchange Outflow*	N/A	2279 cfs

*100-year peak discharges at these locations include overflows from adjacent concentration points located to the north.

During the 100-year storm event, there is significant ponding along I-17 and diversion of overflows from one drainage area to another. The following is a summary discussion of conditions at the major concentration points during the 100-year storm event. Figure 5 is a schematic presentation of this hydrology.

Happy Valley Road: Broad sheet flow of 1,609 cfs crosses the at-grade roadway from north to south.

Pinnacle Peak Road: The 100-year discharge of 3,521 cfs exceeds the capacity of the double 8′ x 7′ box culvert. A backwater condition will be created inundating more than 30 acres of land upstream of the culverts. Flows in excess of culvert capacity will weir over the roadway at a depth of approximately one foot. Maximum upstream depth of ponding would be approximately 8 feet. Culvert and roadway overflow discharges will combine downstream and flow along the east side of the I-17 corridor to the double 8′ x 7′ culvert located at the north branch of Scatter Wash. The detention effect of the roadway embankment reduces the peak outflow slightly from 3,521 cfs to 3,003 cfs.

North Branch of Scatter Wash: A total 100-year peak discharge of 3,853 cfs concentrates at the double 8′ x 7′ culvert. Flows in excess of culvert's capacity of 1,300 cfs overflow to the west onto I-17 (655 cfs), and southward along the east side of I-17 (1,468 cfs). Flow onto I-17 would either be contained by the median separating the northbound and southbound roadways and conveyed to the depressed Deer Valley Drive at I-17 or cross to the west side and eventually reenter Scatter Wash. The flows remaining on the east side of I-17 will flow southward into the south branch of Scatter Wash.

The depth of ponding behind the culvert will be approximately 10 feet. Backwater will cover more than 70 acres of land including portions of the mobile home park's R.V. storage area.

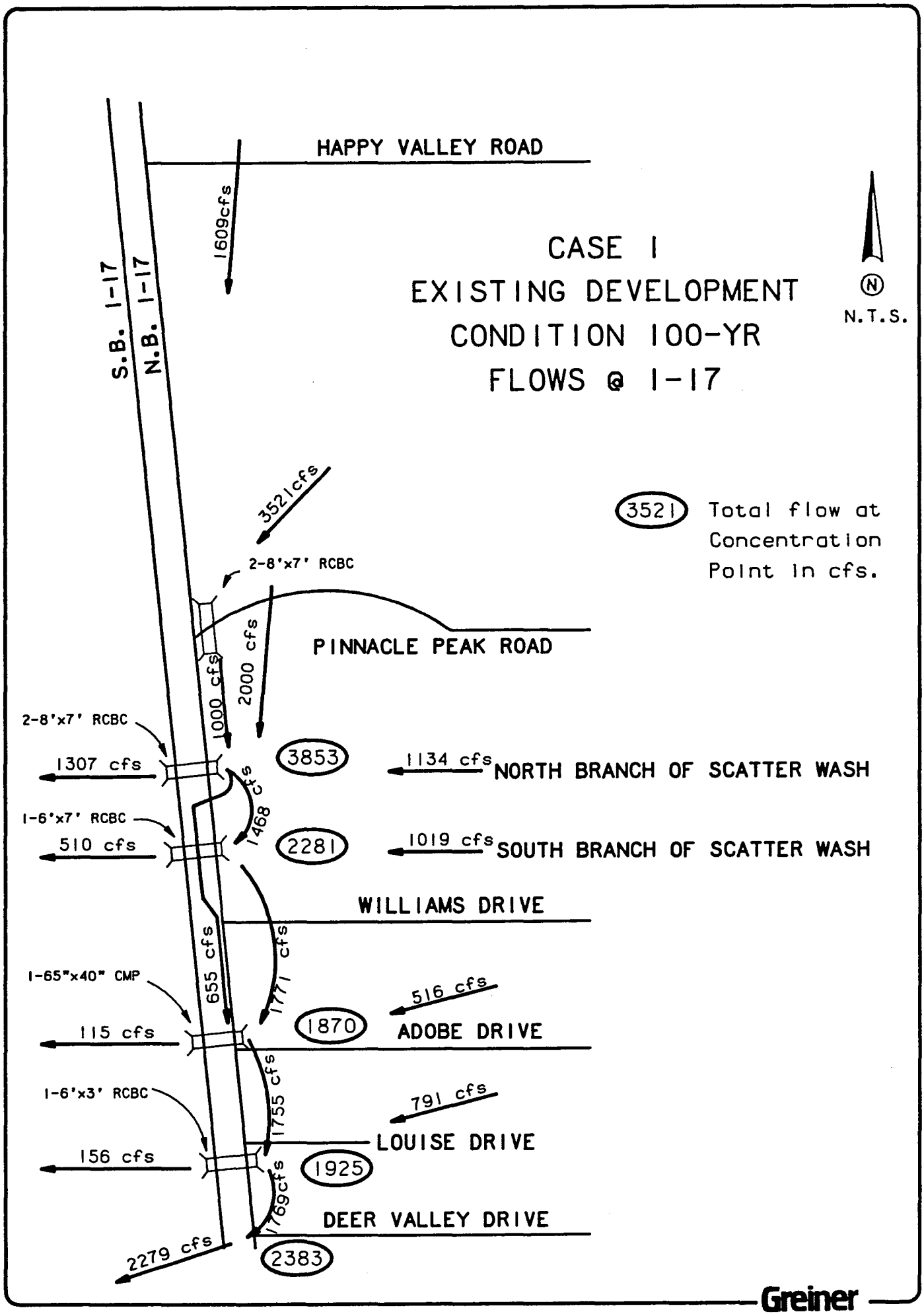

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FIGURE 5

South Branch of Scatter Wash: The 100-year discharge of approximately 2,281 cfs exceeds the capacity of the 6′ x 7′ culvert. Approximately 510 cfs will flow through the culvert and the remaining 1,771 cfs will flow southward along the I-17 corridor to the culvert at Adobe Drive. Portions of the mobile home park will be flooded.

Adobe Drive: Runoff in this area concentrates at the 65" x 40" CMP located under I-17 at Adobe Drive. The 100-year peak discharge of 1,870 cfs at this culvert consists of the overflows from the south branch of Scatter Wash and approximately 516 cfs from the east. The latter will constitute sheet flow through the industrial development in the area. Flows in excess of the culvert's capacity of 115 cfs will flow southward to the culvert at Louise Drive.

Louise Drive: A total of 1,925 cfs concentrate at the 6′ x 3′ culvert located under I-17 at this location. Approximately 156 cfs will flow through the culvert with the remaining flow of 1,769 cfs entering the depressed section of the Deer Valley Drive interchange. Total inflow to the depressed section, including median flow from the north branch of Scatter Wash, will be approximately 2,383 cfs.

B. Case 2: Post-Development (Future) Conditions

Drainage subarea delineations remained the same for future-condition hydrologic modeling. Watershed parameters were modified to reflect increased imperviousness and implementation of the on-site stormwater retention requirement. No street drainage or flood control improvements were incorporated into the model. Future condition subarea characteristics and 100-year peak discharges are summarized in Table 6. Table 7 provides a summary of discharges at the concentration points previously described. The HEC-1 computer model is found in Appendix B.

Table 6

Summary of Drainage Subarea Characteristics
Post-Development (Future) Conditions

Subarea I.D.	Effective* Area (mi^2)	CN	Percent Impervious	Lag Time (hrs)	100-Year Runoff (cfs)
NSW1	1.07	83	36.2	0.20	2555
NSW2	0.70	78.9	89.7	0.32	1780
NSW3	0.53	82.7	38.4	0.24	1204
NSW4	0.86	75.8	75.0	0.32	1982
NSW5	1.17	84.3	20.3	0.39	2026
NSW6	0.3	76.0	58.0	0.34	599
NSW7	0.96	81.6	21.0	0.40	1527
NSW8	0.62	76.0	54.8	0.42	1089
NSW9	0.38	81.1	21.9	0.28	715
SSW1	0.62	76.0	95.0	0.34	1581
SSW2	0.14	76.3	95.0	0.23	407
SSW3	0.20	75.5	95.0	0.26	560

*Area reduced to reflect on-site retention

Table 7

Summary of Discharges
Post-Development (Future) Conditions

Location	Peak Discharge
Happy Valley Road	1826 cfs
Pinnacle Peak Road	4208 cfs
North Branch Scatter Wash	4508 cfs
South Branch Scatter Wash	2346 cfs
Adobe Drive	1948 cfs
Louise Drive	2018 cfs
Deer Valley Drive Interchange	2684 cfs

As is the case with existing conditions, flows concentrating along I-17 exceed the capacity of the culverts and flow southward into the Deer Valley Drive interchange will occur. The schematic in Figure 6 represents this hydrology.

C. Model Verification

The HEC-1 model results for Case 1 and Case 2 were evaluated with respect to previous hydrologic investigations of Scatter Wash. These studies are: North-

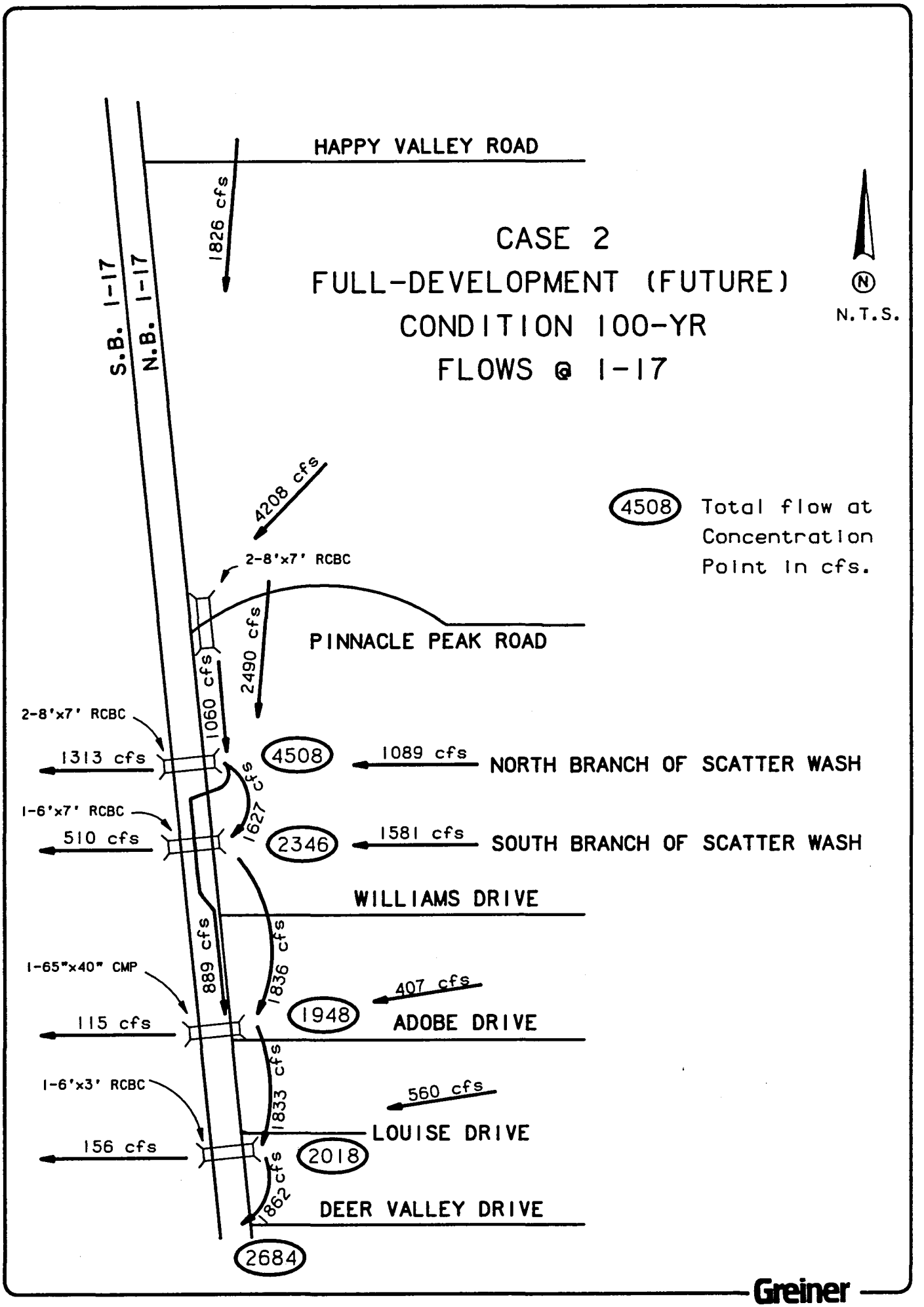

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FIGURE 6

west Storm Drainage Study (NSDS) prepared in 1977 for the City of Phoenix and the COE's FIS study prepared in 1985 and ADOT's I-17 Drainage Design Study. These studies were previously summarized in Section 3. Comparison with Case 1 model results are presented in Table 8. The Case 2 model results comparison is presented in Table 9. The discharge values presented are for total discharge upstream of the I-17 culverts.

Table 8

Comparison of Existing Condition Model Results

Study	50-Year Discharge	100-Year Discharge	Drainage Area Size
Case 1	3503 cfs	4815 cfs	10.34 sq. mi.
NSDS	1800 cfs*	Not Computed	9.92 sq. mi.
FIS	3200 cfs	5700 cfs	6.30 sq. mi.***
ADOT**	3400 cfs	4020 cfs	9.99 sq. mi.

*Approximation, model did not combine north and south branch flows east of I-17
**Adopted from Outer Loop Highway Drainage Study
***Neglects Area Above CAP Canal

Table 9

Comparison of Future-Condition Model Results

Study	50-Year Discharge	100-Year Discharge
Case 2	4566 cfs	5597 cfs
NSDS	Data not Available	
FIS	Not Performed	
ADOT*	3200 cfs	5700 cfs

*Adopted from 1982 COE Study

The results of the Case 1, FIS and ADOT studies compare favorably. The variations in results are attributable to fundamental differences in modeling techniques. The COE approach, as reflected in the FIS and ADOT studies, is based on a worst-case scenario storm that is developed for computing the Standard Project Flood (SPF). The 50- and 100-year discharges are then calculated as a percent-

age of the SPF. The lower peak discharge value for the Case 1, 100-year event may also be due in part to detention routing through the Pinnacle Peak Road culverts and hydrograph attenuation through channel routing.

The low NSDS discharge value is due to the relatively long times of concentration (Tc) used in the TR-20 analysis (1.29 - 5.45 hours).

In its General Design Memorandum Phase I: Plan Formulation for Indian Bend Wash (October 1973), the COE developed a flood frequency regression analysis for undeveloped and ungaged watersheds. For drainage area sizes 0 to 15 square miles, the following equations were developed:

Return Period (Years)	
50	$Q = 4539.83 (\log A) + 13523.12 (\log 5R24) - 2461.47$
100	$Q = 6580.04 (\log A) + 20226.14 (\log 5R24) - 3972.32$

Where: A = drainage area in square miles
5R24 = 5-year, 24-hour rainfall in inches

The percentage of variation of the computed flood frequency analysis, however, was found to be rather high (0.76). Table 10 compares the results of the Case 1 modeling to the results of the equations. As shown, there is little agreement between the results.

Table 10

Comparison of Model and Regression Analysis Results

Drainage Area I.D.	Area sq. mi.	50-Year Discharge (cfs) HEC-1	50-Year Discharge (cfs) Equation*	100-Year Discharge (cfs) HEC-1	100-Year Discharge (cfs) Equation*
NSW1	1.37	2189	2763	2672	3813
NSW2	1.33	1264	2705	1583	3728
NSW3	0.54	879	928	1076	1153
NSW4	1.52	1224	2968	1565	4110
NSW5	1.17	1596	2452	1948	3362
NSW6	0.60	481	1135	615	1454
NSW7	0.96	1145	2062	1415	2797
NSW8	1.23	888	2551	1134	3505
NSW9	0.38	539	235	665	149
SSW1**	1.24	796	2567	1019	3528
SSW2**	0.28	428	0	516	0
SSW3**	0.39	670	286	791	222

*5R24 = 2.19 Inches
**Urbanized Watersheds

A reasonable comparison of results is found with ADOT's I-17 Drainage Design Study. This study utilized the COE's 1982 hydrology and the Outer Loop hydrology for the north and south branches of Scatter Wash. However, the study also incorporated a detailed analysis of the culverts located under I-17 and the small drainage subareas concentrating between Williams Drive and Deer Valley Drive. Tables 11 and 12 compare discharges with the ADOT studies at the comparable concentration points.

Table 11

Comparison with ADOT I-17 Results
Existing Conditions

Location	Q50		Q100	
	Case 1	ADOT	Case 1	ADOT
North Branch Scatter Wash	2777	3400*	3853	4020*
South Branch Scatter Wash	726		962	
Scatter Wash (west of I-17)	1755	1820	1817	1840
SSW2	428	240	516	300
Total Flow at Adobe Drive	1016	1390	1870	1870
SSW3	670	450	791	570
Total Flow at Louise Drive	1005	1420	1925	1930
Deer Valley Drive Interchange	988	1220	2383	1730

*Separate Discharges Not Developed

Table 12

Comparison with ADOT I-17 Results
Post-Development Conditions

Location	Q50		Q100	
	Case 2	ADOT	Case 2	ADOT
North Branch Scatter Wash	3685	3200*	4508	5700*
South Branch Scatter Wash	1386		1581	
Scatter Wash (west of I-17)	1811	1820	1823	1860
SSW2	357	360	486	440
Total Flow at Adobe Drive	1375	1180	1948	3010
SSW3	491	770	560	930
Total Flow at Louise Drive	1584	1140	2018	2940
Deer Valley Drive Interchange	1598	940	2684	2740

*Separate Discharges Not Developed

D. Drainage Problem Areas

The Case 1 hydrology has identified the following drainage problems for mitigation by the "Conceptual Drainage Plan."

- Excessive runoff concentrating at Happy Valley Road east of I-17.
- Inadequate culvert capacity at Pinnacle Peak Road which causes extensive ponding to the north.
- I-17 culverts located between Pinnacle Peak Road and Deer Valley Drive do not have the capacity to convey 100-year stormwater runoff resulting in extensive ponding along the highway frontage including a mobile home and R.V. park. The I-17 roadway is also subject to flooding due to the lack of capacity of the Scatter Wash culverts.
- Major street flooding within the industrial area bounded by Williams Drive, 19th Avenue, Deer Valley Drive and I-17.
- The depressed interchange of I-17 with Deer Valley Drive is subject to flooding. When the storage capacity of the depressed section is exceeded, stormwater flows break out to the west and southwest.

CONCEPTUAL DRAINAGE PLAN

A conceptual drainage plan for Scatter Wash has been developed as a solution to the area's identified drainage problems. The proposed plan is comprised of both structural and non-structural measures including:

- o Landscaped recreation and drainage corridors
- o Constructed (hard) channels
- o Detention basins
- o Development guidelines and policies for "no-action" areas

The Concept Drainage Plan was developed from alternative concept plans previously submitted to the City of Phoenix Floodplain Management Section and through discussions with the Steering Committee. The committee is comprised of representatives of the Arizona State Land Department, Flood Control District of Maricopa County, City of Planning Department, City Engineering Department, Storm Drain Section and the City Water and Wastewater Department.

A. Plan Development

The drainage plan is comprised of an interconnected system of open channels and detention basins. A number of factors were considered in developing the drainage system. These factors are:

- o Location and magnitude of runoff
- o Location and adequacy of outfalls
- o Availability of vacant land suitable for open channels or detention basins
- o City design guidelines for preserving the area's desert environment
- o City parks and recreation requirements

The location and types of components of the Concept Plan are shown in Figure 10.

B. Hydrologic and Hydraulic Procedures

The Case 1 hydrologic model for the existing conditions, 100-year, 24-hour storm was modified and used to analyze the plan hydrology. The modified model is identified as Case 3. The existing conditions model was used rather than the Case 2, future conditions model, because the objective of the plan is to mitigate existing flooding problems. Also, current floodplain management and drainage regulations will require future development to maintain at existing levels, if not reduce, 100-year storm peak flows. The following criteria and procedures were followed in sizing and analyzing open channels.

- o Channels were sized for normal depth flow using the Manning Equation

- o Three channel concepts were evaluated: landscaped recreation/drainage corridors, earthen, and concrete lined

o Channel design properties were as follows ("Draft Maricopa County Design Manual"):

	Maximum Flow Depth (ft.)	Side Slopes H:V	Maximum Velocity (fps)	Minimum Freeboard (ft.)	Maximum Froude No.	Mannings "n"
Small Channels Q <1,000 cfs						
Concrete/Gunite	3	2:1	8.5*	1.0	0.95	0.02
Earthen	2.5	4:1	5.0	0.5	0.6	0.05
Landscaped	3	5:1	7.5	0.75	0.8	0.05
Large Channels 1,000 cfs <Q <4,000 cfs						
Concrete/Gunite	8	2:1	12.0*	2.0	0.95	0.02
Earthen	3	4:1	5.0	1.0	0.6	0.05
Landscaped	4	5:1	7.0	1.0	0.8	0.05

*Maximum Velocity = 20 fps for supercritical flow. Froude numbers for supercritical flow are between 1.15 and 2.0.

o A 20-foot wide maintenance road will be provided within the right-of-way requirements for the earthen and lined channels

o The landscaped corridors which consists of a minimum 200-foot wide right-of-way contain the following:

- 2-year low flow channel (unlined)
- 100-year floodplain
- Bike path
- Equestrian trail
- Desert landscaping
- Bridges at major streets

Figure 7 is a representation of this concept. The following criteria and procedures were followed in sizing detention basins:

o Maximum allowable depth of water is five feet
o 5:1 side slopes
o Basins will have ungated outflow pipes to assure drainage within 36 hours
o One foot of freeboard provided above spillway level

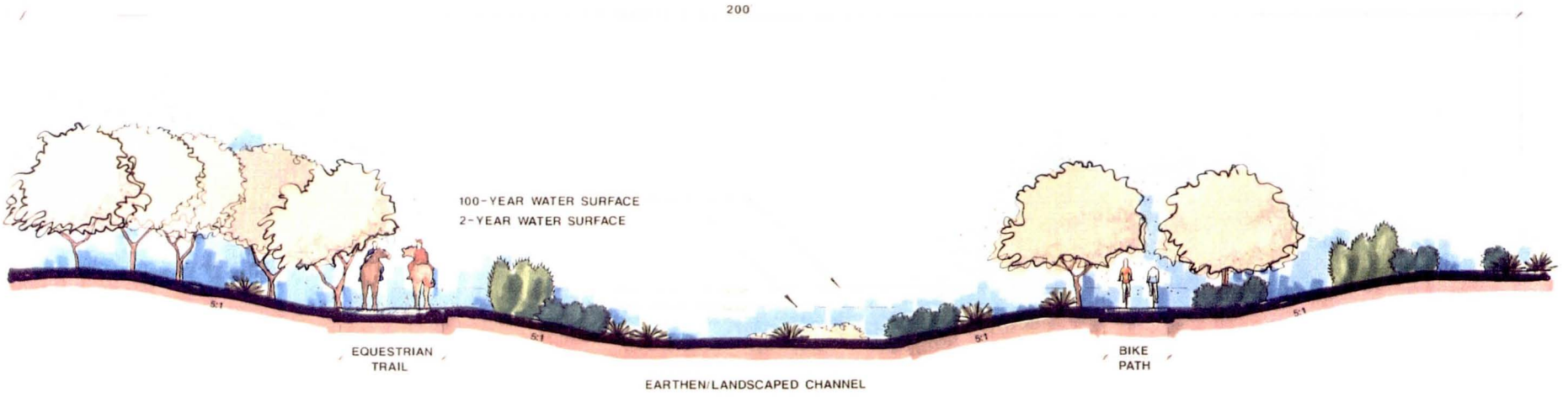
C. Case 3 Model Results

The model incorporates 17 drainage subareas. Table 13 summarizes drainage subarea characteristics. Subareas located above the CAP Canal are identical to those in the Case 1 model. Subareas located below the CAP were adjusted to incorporate the drainage plan components. Figure 8 shows the drainage subarea delineation used for Case 3 and Figure 9 is a schematic representation of the plan hydrology. Table 14 compares the results of plan hydrology to existing conditions (Case 1) at the key drainage problem area.

Table 13

Summary of Drainage Subarea Characteristics
Case 3

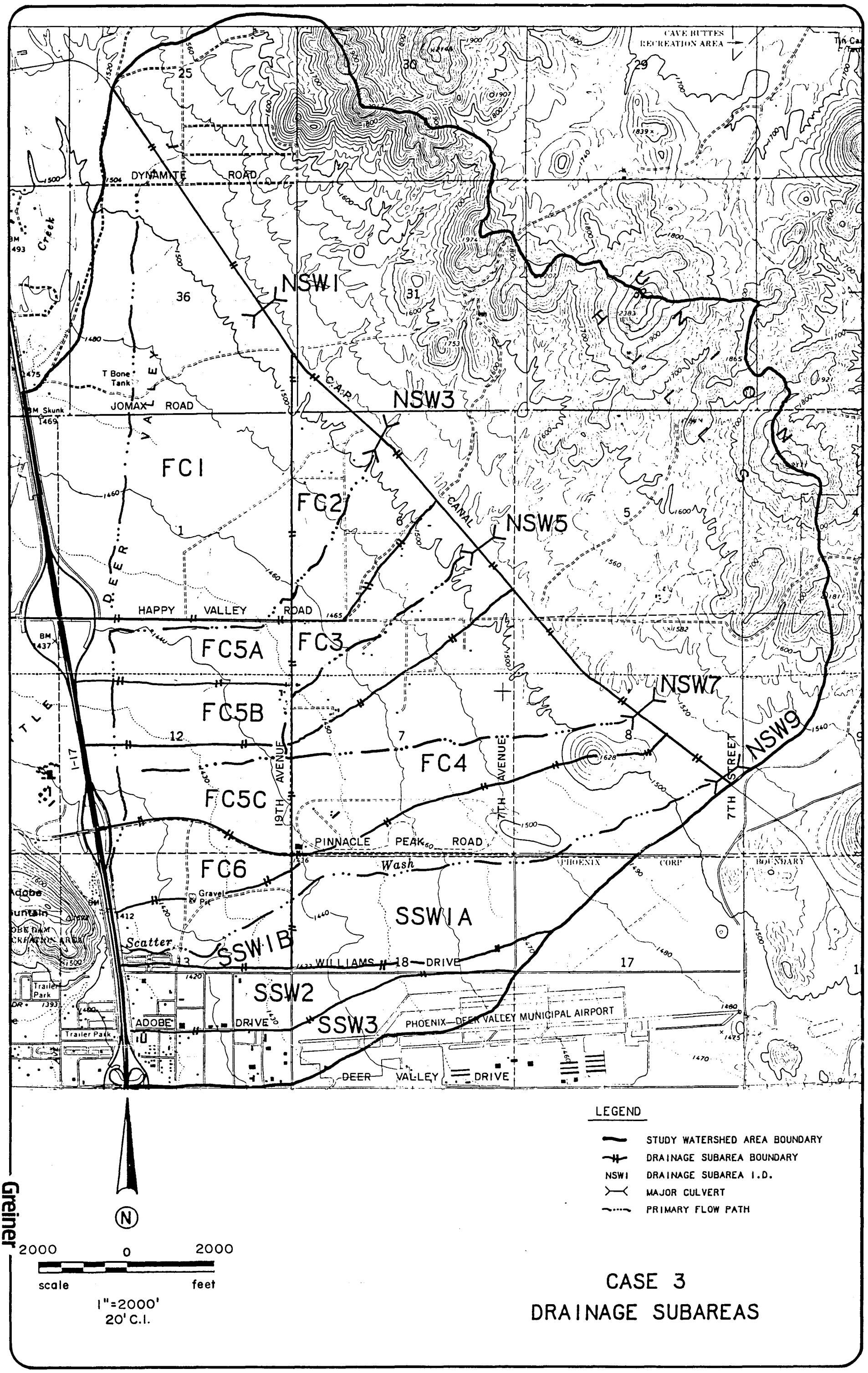
Subarea I.D.	Area (mi^2)	CN	Lag Time (hrs)	100-Year Runoff (cfs)
NSW1	1.37	83	0.26	2672
FC1	1.82	77.5	0.48	2001
NSW3	0.54	82.7	0.24	1076
FC2	0.40	77.1	0.22	667
FC5A	0.27	74.6	0.35	318
NSW5	1.17	84.3	0.39	1948
FC3	0.44	76.2	0.26	655
NSW7	0.96	81.6	0.40	1415
FC4	0.91	75.4	0.37	1074
FC5B	0.24	74.6	0.37	273
FC5C	0.37	74.8	0.34	446
FC6	0.23	75	0.25	331
NSW9	0.38	81.1	0.28	665
SSW1A	1.18	75.9	0.62	1010
SSW1B	0.06	86.0	0.10	163
SSW2	0.28	76.3	0.29	516
SSW3	0.39	75.5	0.32	791



RECREATION AND DRAINAGE CORRIDOR

Greiner, Inc.

FIGURE 7



CASE 3
DRAINAGE SUBAREAS

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FIGURE 8

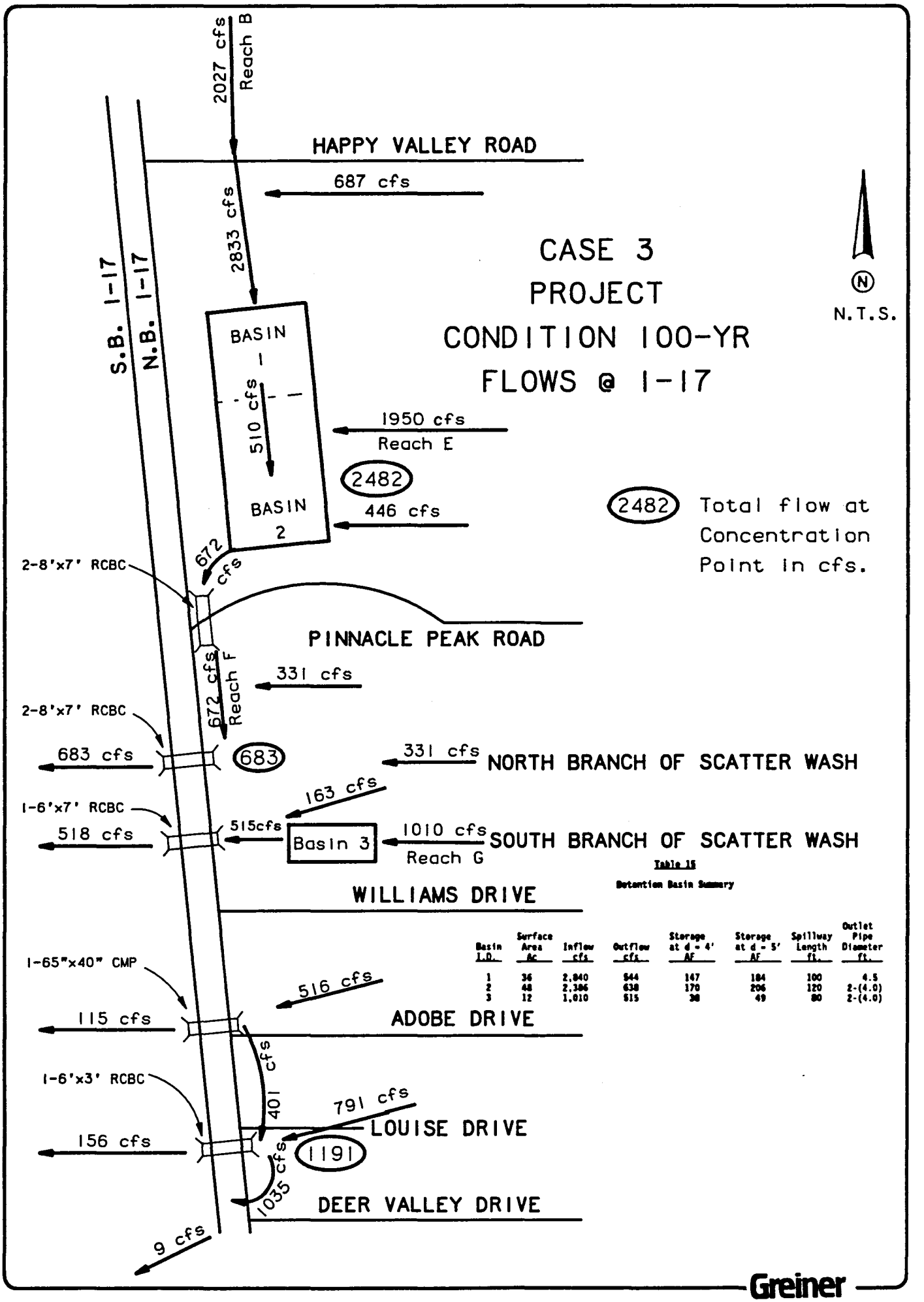

Table 15

Detention Basin Summary

Basin I.D.	Surface Area Ac	Inflow cfs	Outflow cfs	Storage at d = 4' AF	Storage at d = 5' AF	Spillway Length ft.	Outlet Pipe Diameter ft.
1	36	2,840	544	147	184	100	4.5
2	48	2,386	638	170	206	120	2-(4.0)
3	12	1,010	515	38	49	80	2-(4.0)

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FIGURE 9

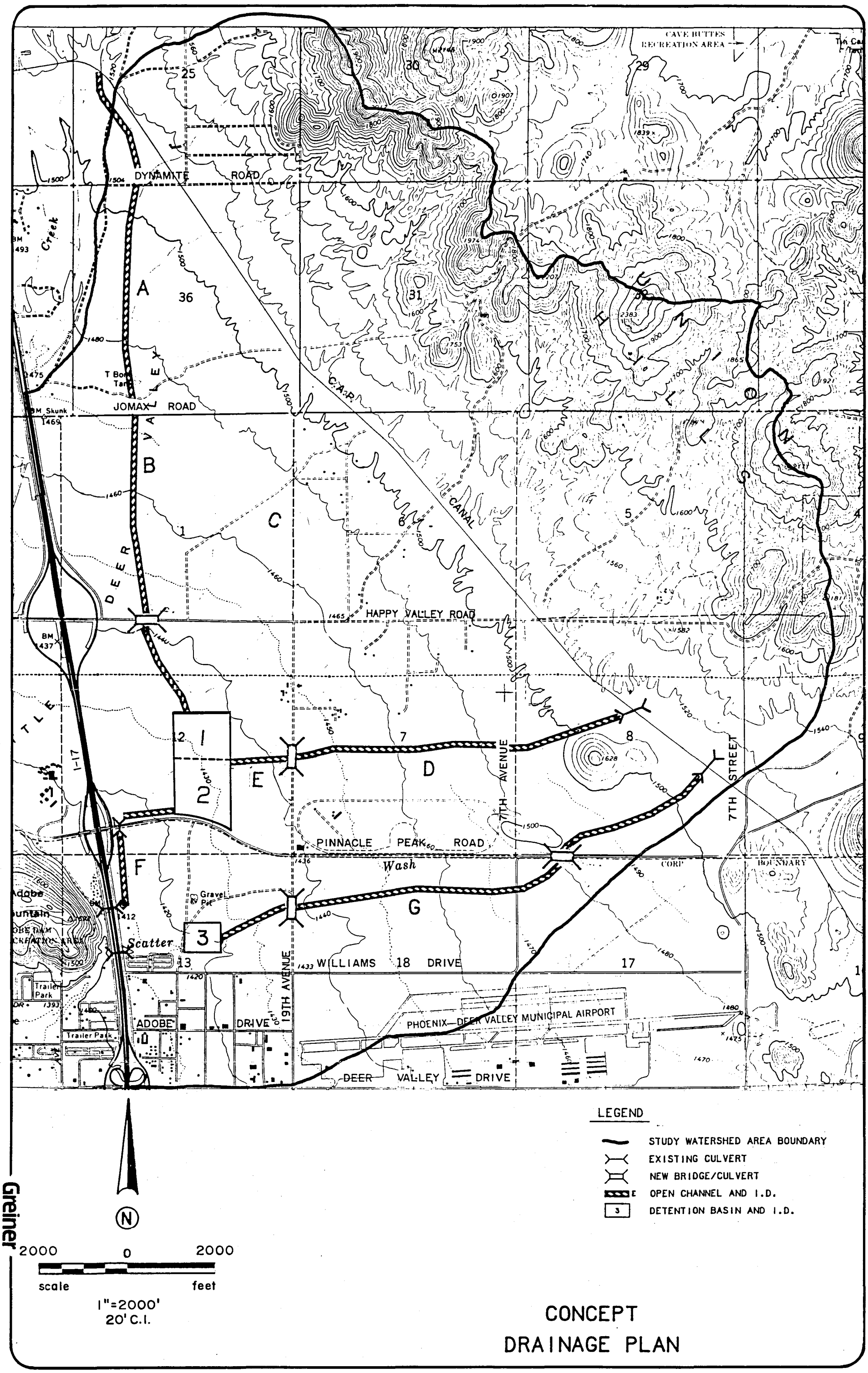

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FIGURE 10

CONCEPT
DRAINAGE PLAN

Table 14

Comparison of Case 1 and Case 3 Hydrology

Location	Case 1 Peak Discharge	Case 3 Peak Discharge
Happy Valley Road	1609	2027
Pinnacle Peak Road	3521	667
North Branch Scatter Wash	3853	683
South Branch Scatter Wash	2281	510
Adobe Drive	1870	516
Louise Drive*	1925	1191
Deer Valley Drive Interchange Inflow	2383	1035
Deer Valley Drive Interchange Outflow	2279	9

*Includes bypass flows from Adobe Drive

D. The Conceptual Drainage Plan

The major elements of the Conceptual Drainage Plan are described on the following pages. The referenced elements are shown on Figure 10.

Reach A and Reach B are the major collectors for intercepting runoff in drainage subarea FC1 for conveyance to Happy Valley Road. Recreational facilities and trails associated with Reach A will extend northward to the proposed linear park and trail system associated with the CAP Canal. The area is currently undeveloped and the channel alignment may be meandered for aesthetics. A bridge or culvert structure will be required where the open channel crosses Happy Valley Road.

Reach C extends from Happy Valley Road to Basin 1. Reach C will carry flows from channel Reach B and drainage subareas FC2 and FC5A. Reach D and Reach E will convey runoff from drainage subareas NSW7, FC3, FC4 and FC5B to Basin 2. A bridge or culvert will be required at the 19th Avenue channel crossing. Reach D will be extended to the CAP Canal to convey discharge from the existing pipe overchute and also to provide a connection to the parks and trail system proposed for the canal corridors.

Basins 1 and 2 are interconnected compartments of a larger detention basin. The larger basin will cover approximately 84 acres. The basin's spillway and low level outlet culverts will discharge flows to the existing culvert located under Pinnacle Peak Road. The combined spillway and culvert 100-year discharge from the basin of 672 cfs is within the capacity of the Pinnacle Peak Road culvert. The hydraulic performances of Basins 1 and 2 are semi-independent of each other. Basin 1 can, therefore, be detached and relocated northward to just south of Happy Valley Road without adversely affecting the performance of either basin. A channel would then be required to convey flows from Basin 1 to Basin 2. Due to right-of-way and hydraulic design constraints, a 7-foot deep lined channel

will be required to convey discharge from the culverts located under Pinnacle Peak Road to the I-17 culverts located on the north branch of Scatter Wash. Drainage subarea FC6 will also drain to this culvert.

Reach G extends from the CAP Canal and conveys runoff from drainage subareas NSW9 and SSW1A to detention basin 3 located on the south branch of Scatter Wash east of 24th Avenue. Reach G will also provide a connection to the proposed park and trail system associated with the CAP. Basin 3 will discharge directly into the existing Scatter Wash channel. The 100-year discharge from the basin of 510 cfs is within the capacity of the existing culvert under I-17. The channel should be lined through the existing mobile home and R.V. park to improve its hydraulic performance.

E. No Action Areas

No-action areas have been identified where no drainage improvements are proposed for the 100-year storm. These areas are as follows: Area 1 - areas with existing, constraining land uses that will be significantly impacted by major future drainage improvements; Area 2 - relatively undeveloped areas with a low potential for flooding; and Area 3 - foothill areas covered by the City's desert environmental preservation guidelines.

Area 1: Area 1 incorporates the commercial/industrial area bounded by Deer Valley Drive, I-17, Williams Drive and 19th Avenue. The area is extensively developed with relatively small light industries and commercial facilities. Under existing conditions, this area is subject to flooding from Scatter Wash overflows as well as runoff generated on-site. In addition to street flooding, the Deer Valley Drive, I-17 underpass is flooded and overflows adversely impact development to the west of I-17. Overflows into this area from Scatter Wash will be eliminated with the implementation of the Drainage Plan. While the Deer Valley Drive underpass will still be subject to flooding, no breakout to the west should occur during the 100-year storm event. The local street flooding problem, however, will not be eliminated. Presently, there is no adequate outfall available for either storm drains or open channels. The proposed 2-year storm drain to be located along 19th Avenue will provide some relief to the area, but future local drainage improvements will be required. It may be feasible to upgrade the 19th Avenue storm drain to a 100-year system. The downstream outfall channel, located along the Outer Loop Highway at Beardsley Road, has been designed to this level. A detailed site-specific study is required to evaluate the required measures to reduce the drainage problem.

Area 2: This area is approximately bounded by Happy Valley Road, 19th Avenue and the CAP Canal. Existing residential densities are very low and the proposed maximum density is five residences per acre. The area is protected from major runoff flows by the CAP Canal embankment. Nuisance drainage problems may still exist in association with discharges from the CAP pipe overchutes and locally generated runoff. These drainage problems can be resolved through minor channel improvements, improvements to roadway wash crossings and the establishment of appropriate drainageway setback and finish floor elevation requirements for new development. Flood proofing of structures currently subject to water damage may

also be appropriate. If the area is redeveloped as a planned community with clusters of high density development, on-site detention/retention should also be implemented per the City's current drainage ordinance.

Area 3: Area 3 incorporates the area located above the CAP Canal within the foothills of Union Hills. Development in this area is limited to a maximum of two residences per acre and mixed-uses at the lower elevations and residential densities of less than one unit per acre at the higher elevations. To preserve the desert environment, no improvements or modifications are proposed to the existing, natural drainage system. Future development can be protected from flooding through implementation of floodplain management techniques including minimum finish floor elevations and erosion setbacks. Existing improvements subject to flooding may be protected through flood proofing and minor improvements to road wash crossings.

CONCEPTUAL STORM DRAIN PLAN

A. Plan Development

A conceptual storm drain plan has been developed to provide preliminary sizing of a storm drain system for existing and proposed major streets in the study area.

The following criteria and procedures were used in sizing storm drains:

- o The 2-year, 24-hour storm and the HEC-1 program were used to calculate flow in storm drains.
- o The "Storm" hydraulic analysis program developed by the Los Angeles County Road Department was used to size the conduits.
- o Controlling downstream hydraulic head was set four feet above top of pipe.
- o A Manning's roughness coefficient of 0.013 was used for the storm drain conduit.

B. Hydrologic and Hydraulic Procedures

The Case 3 hydrologic model was modified to incorporate the proposed storm drain system. Drainage subarea characteristics are summarized in Table 15. This Case 4 model was then run for the 2-year, 24-hour storm. Preliminary conduit sizes were selected and then verified with the "Storm" program. A uniform average pipe slope of 0.4 percent was assumed. The hydraulic grade line was allowed to rise above the top of the pipe. The results of the hydrologic and hydraulic analyses are presented in Figure 11.

C. The Conceptual Storm Drain Plan

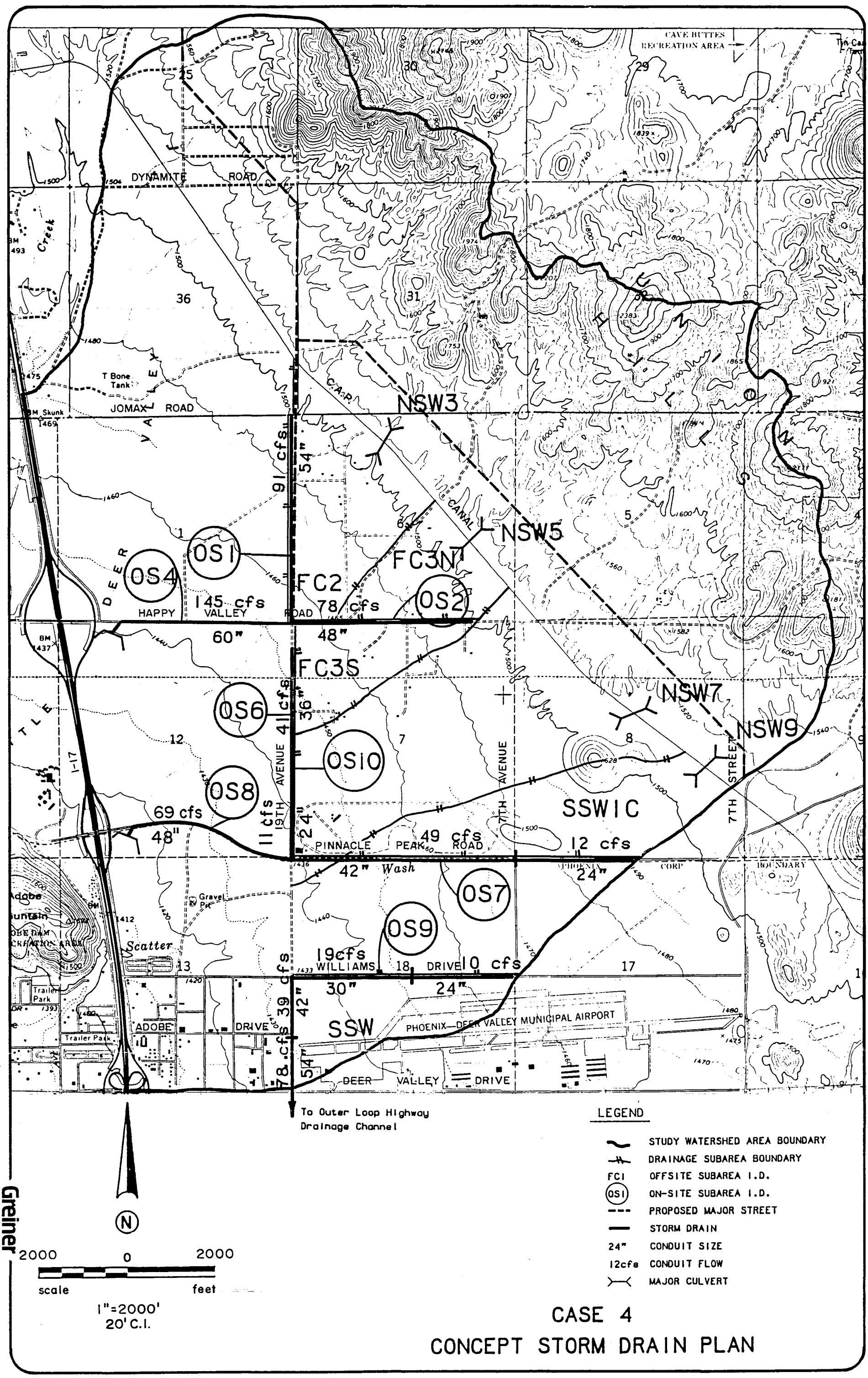
The conceptual storm drain plan is comprised of storm drains located along 19th Avenue, Happy Valley Road, Pinnacle Peak Road and Williams Drive. These storm drains convey both on-site (roadway pavement) and off-site runoff to regional drainage facilities. The storm drains located along Happy Valley Road and Pinnacle Peak Road discharge into the north-south drainageway proposed in the Master Drainage Plan.

The storm drain located along Williams Drive and 19th Avenue will discharge into the Outer Loop Highway drainage channel located along Beardsley Road. This channel was designed for the 100-year storm. It may, therefore, be possible to upgrade the proposed 19th Avenue storm drain south of Williams Drive to the 100-year level to provide additional drainage relief to areas currently subject to flooding of to the west along I-17.

Major storm drains are not required for the proposed major streets to be located north of the CAP Canal. These streets traverse the natural drainage pattern and minor roadside ditches and cross-culverts will be adequate to protect the roadways from off-site runoff. This approach will also assure minimal impact to the desert environment. On-site pavement runoff may be collected by small diameter storm drains for discharge into the existing washes.

Table 15

Subarea I.D.	Area (mi^2)	CN	Lag Time (hrs)	2-Year Runoff (cfs)
NSW3	0.54	82.7	0.24	182
FC2	0.38	77.1	0.22	73
OS1	0.02	95.0	0.24	19
NSW5	1.17	84.3	0.39	345
FC3N	0.19	76.2	0.19	35
OS2	0.02	95.0	0.24	19
OS4	0.02	95.0	0.02	23
FC35	0.23	76.2	0.24	37
OS6	0.01	95.0	0.12	11
OS10	0.01	95.0	0.12	11
SSW1C	0.47	75.9	0.45	49
OS7	0.03	95.0	0.36	23
OS8	0.02	95.0	0.24	19
OS9	0.02	95.0	0.24	19
SSW	0.28	80.0	0.32	60



CASE 4

CONCEPT STORM DRAIN PLAN

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FIGURE 11

CONCEPTUAL STORM DRAIN PLAN

If either the earthen channel or landscaped channel corridor concept is adopted for the Drainage Plan, the proposed storm drains may tie into the 30-inch diameter pipe set below the channel bed invert. This will assure adequate cover and slope for the proposed storm drains. Flows in excess of pipe capacity will bubble up to the surface and flow in the channel bed. The conduit will also provide for complete drainage of the channels during low flow events, eliminating nuisance water and minimizing weed growth.

CONCEPTUAL DRAINAGE AND STORM DRAIN PLAN

A final hydrologic model (Case 5) was developed incorporating both the open channels and detention basins of the Drainage Plan and the storm drains. The Case 3 hydrologic model for the Conceptual Drainage Plan was modified to incorporate the diversions into the storm drains modeled in Case 4. The results of the Case 5 model were used to calculate preliminary sizes for the open channels, detention basins and new bridges or culverts. The components of the Conceptual Drainage and Storm Drain Plan are shown in Figure 12. Figure 12 is preceded by structure summary tables. These tables identify the structure location, type, design discharge or volume, slope and channel characteristics (depth, top, width, etc.).

Table 16

Channel Design Summary

Earthen Channels

Reach I.D.	Q (cfs)	BW (ft.)	D* (ft.)	Yn (ft.)	V (fps)	Slope (ft./ft.)
A	1,000	80	3.5	2.6	4.0	0.006
B	2,000	120	4.0	3.0	4.5	0.006
C	2,830	210	4.0	3.1	3.9	0.004
D	1,070	60	4.0	3.0	5.0	0.008
E	1,950	150	4.0	3.0	4.2	0.005
F		Not Applicable				
G	1,010	60	3.5	3.0	4.7	0.007
H	80	8	3.0	1.8	3.0	0.008
I	50	8	2.5	1.5	2.5	0.007

Concrete Channels

Reach I.D.	Q (cfs)	BW (ft.)	D* (ft.)	Yn (ft.)	V (fps)	Slope (ft./ft.)
A	1,000	25	4.0	3.0	10.3	0.006
B	2,000	12	8.0	5.9	13.7	0.006
C	2,830	10	9.0	7.9	12.7	0.004
D	1,070	8	6.5	4.5	13.0	0.008
E	1,950	14	8.0	6.0	12.9	0.005
F	700	8	7.0	4.4	9.1	0.004
G	1,010	8	7.0	4.7	12.5	0.007
H	80	8	2.0	1.0	5.3	0.008
I	50	8	2.5	1.2	6.4	0.007

*Includes Freeboard

Table 16 (Continued)

Landscaped Recreation and Drainage Corridor

Reach I.D.	Slope (ft./ft.)	Q (cfs)	Yn* (ft.)	(fps)	BW (ft.)	Q (cfs)	Yn (ft.)	(fps)	BW (ft.)
A	0.006	100	2.0	2.7	8	900	3.0*	4.2	55
B	0.006	200	2.7	3.2	10	1,800	3.8**	5.0	75
C	0.004	300	3.1	3.1	16	2,530	4.1**	4.4	120
D	0.008	100	1.9	3.0	8	970	3.0*	4.8	50
E	0.005	150	2.8	3.0	10	1,800	4.0**	4.7	75
F			Not Applicable						
G	0.007	100	2.0	2.9	8	910	2.8	4.4	60
H	0.008	--	--	--	--	80	1.7	2.9	8
I	0.007	--	--	--	--	50	1.4	2.4	8

*Freeboard of 0.75′ Required
**Freeboard of 1.0′ Required

Table 17

Detention Basin Summary

Basin I.D.	Surface Area Ac	Inflow cfs	Outflow cfs	Storage at d = 4′ AF	Storage at d = 5′ AF	Spillway Length ft.	Outlet Pipe Diameter ft.
1	36	2,840	544	147	184	100	4.5
2	48	2,386	638	170	206	120	2-(4.0)
3	12	1,010	515	38	49	80	2-(4.0)

Table 18

Bridge and Culvert Summary

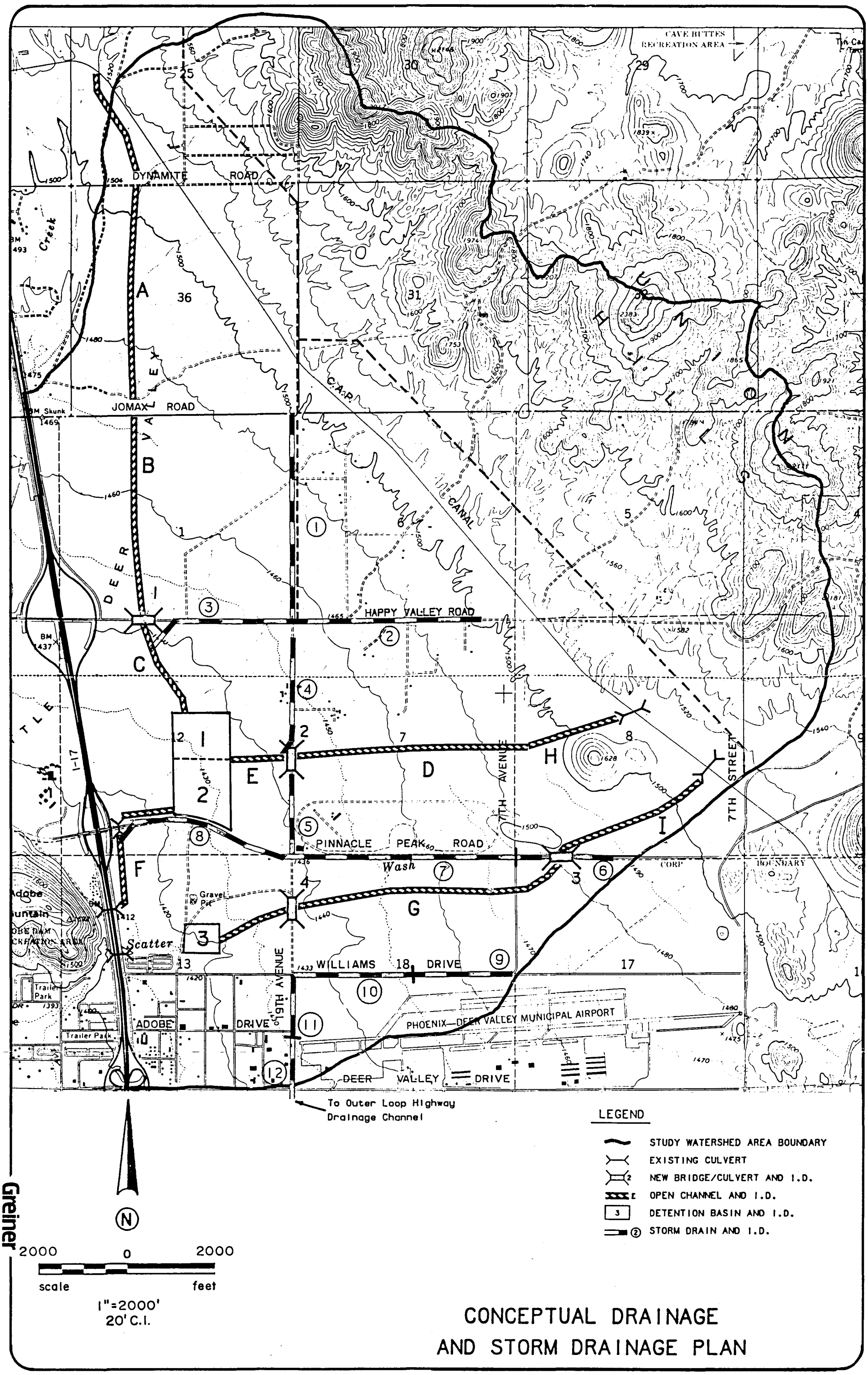
Structure I.D.	Design Discharge (cfs)	Channel Type	Structure Type	Size
1	2,000	Earthen	Bridge*	12,800 sf
		Landscaped	Bridge*	16,000 sf
		Concrete	Culvert	4-10′ x 8′
2	1,070	Earthen	Bridge*	8,000 sf
		Landscaped	Bridge*	16,000 sf
		Concrete	Culvert	3-8′ x 7′
3	50	All Types	Culvert	1-6′ x 3′
4	1,010	Earthen	Bridge*	8,000 sf
		Landscaped	Bridge*	16,000 sf
		Concrete	Culvert	3-8′ x 7′

*A bridge is required for earthen and landscaped channel crossings, and culverts for concrete channel crossings.

Table 19

Storm Drain Summary

Conduit I.D.	Design Discharge (cfs)	Conduit Size (ft.)	Length (ft.)
1	91	4.5	5,280
2	78	4.0	4,780
3	145	5.0	3,500
4	41	3.0	3,000
5	11	2.0	2,000
6	12	2.0	1,000
7	49	3.5	5,280
8	69	4.0	4,000
9	12	2.0	2,640
10	19	2.5	2,640
11	39	3.5	1,320
12	78	4.5	1,320



CONCEPTUAL DRAINAGE AND STORM DRAINAGE PLAN

Greiner

FIGURE 12

CAPITAL COSTS

Preliminary costs for the Concept Drainage and Storm Drain Plan components were developed for construction, engineering and administration. Construction costs for the drainage systems included the costs for storm drain trunkline conduit (concrete pipe), excavation (channels and detention basins), landscaping (landscaped corridor option and detention basins), channel lining, bridges or culverts. Unit costs were provided by the City of Phoenix.

Twenty percent was added to the estimated construction costs for the channels, storm drains and detention basins to include costs associated with appurtenances such as minor improvements to existing drainageways, outlet or inlet works, junction structures, manholes, laterals, catch basins, erosion protection, fencing, minor street reconstruction, minor utility relocation and conflict resolutions, etc. This fee was estimated on the basis of recently completed roadway drainage and flood control design projects.

Twenty percent was added to the construction costs for engineering and administration to cover the costs for survey, design, contract administration, field engineering and inspection services.

Land acquisition costs for additional right-of-way for open channels and detention basins were not developed. Right-of-way requirements for each item were, however, determined.

A factor of 20 percent was then added for contingency costs to reflect the effects of unknown potential difficulties or changes during final design and construction. This cost was added to the above mentioned costs. Estimated costs did not include major utility relocation and major street reconstruction.

The preliminary costs of the plan components are summarized in Tables 20 through 22. Table 23 is a summary of total estimated plan costs.

CAPITAL COSTS

Table 20

Channel Construction Cost Summary

Channel I.D.	Type	Item	Quantity	Unit Cost	Total Cost
A	Earthen	Excavation	70,400 CY	$ 4	$ 281,600
		Right-of-Way*	22 Ac	N/A	---
				Sub-Total:	$ 281,600
	Landscaped	Excavation	74,800 CY	4	$ 299,700
		Landscaping	37 Ac	7,500	277,500
		Right-of-Way**	37 Ac	N/A	---
				Sub-Total:	$ 576,700
	Concrete	Excavation	27,900 CY	4	$ 111,600
		Lining	34,300 SY	30	1,029,000
		Right-of-Way*	11 Ac	N/A	---
				Sub-Total:	$1,140,600
B	Earthen	Excavation	83,100 CY	4	$ 332,400
		Bridge	12,800 SF	55	704,000
		Right-of-Way	22 Ac	N/A	---
				Sub-Total:	$1,036,400
	Landscaped	Excavation	83,500 CY	4	$ 334,000
		Landscaping	25 Ac	7,500	187,500
		Bridge	16,000 SF	55	880,000
		Right-of-Way	25 Ac	N/A	---
				Sub-Total:	$1,401,500
	Concrete	Excavation	28,400 CY	4	$ 113,600
		Lining	29,300 SY	30	879,000
		Culvert	4-10′ x 8′	128,000	128,000
		Right-of-Way	8 Ac	N/A	---
				Sub-Total:	$1,119,600
C	Earthen	Excavation	56,600 CY	4	$ 226,400
		Right-of-Way	14 Ac	--	---
				Sub-Total:	$ 226,400
	Landscaped	Excavation	56,100 CY	4	$ 224,400
		Landscaping	10 Ac	7,500	75,000
		Right-of-Way	10 Ac	--	---
				Sub-Total:	$ 299,400
	Concrete	Excavation	17,100 CY	4	$ 68,400
		Lining	12,200 SY	30	366,000
		Right-of-Way	3.5 Ac	--	---
				Sub-Total:	$ 434,400

Table 20 (Continued)

Channel I.D.	Type	Item	Quantity	Unit Cost	Total Cost
D	Earthen	Excavation	42,000 CY	4	$ 168,000
		Bridge	8,000 SF	55	440,000
		Right-of-Way	14.5 Ac	--	---
				Sub-Total:	$ 608,000
	Landscaped	Excavation	45,200 CY	4	$ 180,800
		Landscaping	24 Ac	7,500	180,000
		Bridge	16,000 SF	55	880,000
		Right-of-Way	24 Ac	--	---
				Sub-Total:	$1,240,800
	Concrete	Excavation	15,600 CY	4	$ 62,400
		Lining	21,100 SF	30	633,000
		Culvert	3-8′ x 7′	67,200	67,200
		Right-of-Way	6.5 Ac	--	---
				Sub-Total:	$ 762,600
E	Earthen	Excavation	58,100 CY	4	$ 232,400
		Right-of-Way	15.5 Ac	--	---
				Sub-Total:	$ 232,400
	Landscaped	Excavation	55,800 CY	4	$ 223,200
		Landscaping	14.5 Ac	7,500	108,800
		Right-of-Way	14.5 Ac	--	---
				Sub-Total:	$ 332,000
	Concrete	Excavation	19,000 CY	4	$ 76,000
		Lining	17,800 SY	30	534,000
		Right-of-Way	5 Ac	--	---
				Sub-Total:	$ 610,000
F	Concrete	Excavation	9,100 CY	5	$ 45,500
		Lining	12,800 SY	30	384,000
		Right-of-Way	3 Ac	--	---
				Sub-Total:	$ 429,500
G	Earthen	Excavation	51,800 CY	4	$ 207,200
		Bridge	8,000 SF	55	440,000
		Right-of-Way	18 Ac	--	---
				Sub-Total:	$ 647,200
	Landscaped	Excavation	61,900 CY	4	$ 247,600
		Landscaping	30 Ac	7,500	225,000
		Bridge	16,000 SF	55	880,000
		Right-of-Way	30 Ac	--	---
				Sub-Total:	$1,352,600

CAPITAL COSTS

Table 20 (Continued)

Channel I.D.	Type	Item	Quantity	Unit Cost	Total Cost
	Concrete	Excavation	20,500 CY	4	$ 82,000
		Lining	27,400 SY	30	822,000
		Culvert	3-8′ x 7′	67,200	67,200
		Right-of-Way	8 Ac	--	---
				Sub-Total:	$ 971,200
H	Earthen	Excavation	3,600 CY	5	$ 18,000
		Right-of-Way	4 Ac	--	---
				Sub-Total:	$18,000
	Landscaped	Excavation	4,500 CY	5	$ 22,500
		Landscaping	15 Ac	7,500	112,500
		Right-of-Way	15 Ac	--	---
				Sub-Total:	$ 135,000
	Concrete	Excavation	1,800 CY	5	$ 9,000
		Lining	6,400 SY	30	192,000
		Right-of-Way	3 Ac	--	---
					$ 201,000
I	Earthen	Excavation	3,900 CY	5	$ 19,500
		Culvert	1-6′ x 3′	7,200	7,200
		Right-of-Way	4.5 Ac	--	---
				Sub-Total:	26,700
	Landscaped	Excavation	3,900 CY	5	$ 19,500
		Landscaping	19 Ac	7,500	142,500
		Culvert	1-6′ x 3′	7,200	7,200
		Right-of-Way	19 Ac	--	---
				Sub-Total:	$ 169,200
	Concrete	Excavation	1,900 CY	5	$ 9,500
		Lining	7,500 SY	30	225,000
		Culvert	1-6′x 3′	7,200	7,200
		Right-of-Way	3.5 Ac	--	---
				Sub-Total:	$ 241,700

*Right-of-way width calculated as top width plus 20 feet for a service road.
**Right-of-way width is 200 feet.

CAPITAL COSTS

Table 21

Detention Basin Cost Summary

Basin I.D.	Item	Quantity	Unit Cost	Total Cost
1	Excavation	296,900 CY	$ 3	$ 890,700
	Landscaping	36 Ac	7,500	270,000
	Right-of-Way	36 Ac		---
			Sub-Total:	$1,160,700
2	Excavation	332,300 CY	3	$ 996,900
	Landscaping	48 Ac	7,500	360,000
	Right-of-Way	48 Ac		---
			Sub-Total:	$1,356,900
3	Excavation	79,100 CY	4	$ 316,400
	Landscaping	12 AC	7,500	90,000
	Right-of-Way	12 Ac		---
			Sub-Total:	$2,924,000

Table 22

Storm Drain Construction Cost Summary

Conduit I.D.	Size (ft.)	Quantity (l.f.)	Unit Cost	Total Cost
1	4.5	5,280	$145	$ 765,600
2	4.0	4,780	125	597,500
3	5.0	3,500	165	577,500
4	3.0	3,000	82	246,000
5	2.0	2,000	62	124,000
6	2.0	1,000	62	62,000
7	3.5	5,280	106	559,700
8	4.0	4,000	125	500,000
9	2.0	2,640	62	163,700
10	2.5	2,640	70	184,800
11	3.5	1,320	106	139,900
12	4.5	1,320	145	191,400
N/A*	2.5	22,000	70	1,540,000
			Total:	$5,657,100

*Unspecified storm drain for on-site drainage of proposed major streets north of CAP Canal.

CAPITAL COSTS

Table 23

Total Concept Plan Costs

Option	Item	Cost
Earthen Channels	Channels	$ 3,506,000
	Detention Basins	2,924,000
	Storm Drains	5,652,000
Sub-Total:		**$12,082,000**
20% Appurtenances		$ 2,416,000
20% Engineering and Administration		2,900,000
Sub-Total:		**$17,398,000**
20% Contingency		$ 3,480,000
Total Estimated Cost		**$20,878,000**

Right-of-Way Requirements

Detention Basins -	96.0 Ac
Channels -	113.5 Ac
Total:	**209.5 Ac**

Option	Item	Cost
Landscaped Corridors	Channels	$ 5,937,000
	Detention Basins	2,924,000
	Storm Drains	5,652,000
Sub-Total:		**$14,513,000**
20% Appurtenances		2,903,000
20% Engineering and Administration		3,483,000
Sub-Total:		**$20,899,000**
20% Contingency		4,180,000
Total Estimated Cost:		**$25,079,000**

Right-of-Way Requirements

Detention Basins -	96.0 Ac
Channels -	177.5 Ac
Total:	**273.5 Ac**

CAPITAL COSTS

Table 23 (Continued)

Option	Item	Cost
Concrete Channels	Channels	$ 5,911,000
	Detention Basins	2,924,000
	Storm Drains	5,652,000
Sub-Total:		**$14,487,000**
20% Appurtenances		$ 2,897,000
20% Engineering and Administration		3,477,000
Sub-Total:		**$20,861,000**
20% Contingency		$ 4,172,000
Total Estimated Preliminary Cost:		**$25,033,000**

Right-of-Way Requirements

Detention Basins -	96.0 Ac
Channels -	51.5 Ac
Total:	**147.5 Ac**

PUBLIC INVOLVEMENT/MAILING LIST

A public meeting was held on August 16, 1989 to allow the public the opportunity to review the proposed plan and to offer comments. Approximately 25 persons attended, including representatives of state and local government agencies. Written comments subsequent to the meeting were also solicited.

The consensus of opinion expressed by the general public was a preference for adoption of the landscaped drainage and recreation corridor concept. Area residents expressed that there was a lack of convenient parks and areas for bicycle riding. The concept of a recreational loop tying into the CAP aqueduct was found appealing by the public.

An area of concern expressed by a number of individuals was the need to address, in more detail, the residual flooding that would still occur in the area located between I-17 and 19th Avenue and north of Deer Valley Drive. Additional study of residual drainage problems along Scatter Wash west of I-17 was also requested.

Mailing List for Notification of Public Meeting

Name	Business	Residence
Mr. Jones Osborn II Chairman	Meyers, Hendricks, Victor, Osborn & Maledon 2700 N. 3rd Street Phoenix, AZ 85004 263-8700	
Mr. Bernie Cain	John Hall Associates 11209 N. Tatum Boulevard, #260 Phoenix, AZ 85028 953-4000	3101 E. Yucca Street Phoenix, AZ 85028 971-6112
Mr. Michael Cantor	Law Office of Michael Cantor 111 W. Monroe, Suite 12000 Phoenix, AZ 85003 254-4187	10838 N. 35th Street Phoenix, AZ 85028 996-9522
Mr. Joe Cantadino	Coventry Homes 3875 N. 44th Street, Suite 201 Phoenix, AZ 85018 840-8300	
Mr. Kimball J. Corson	Lewis & Roca Lawyers First Interstate Bank Plaza 100 W. Washington Street Phoenix, AZ 85003 262-5311	Summit Ranch, Box 1358 Phoenix, AZ 85029

PUBLIC INVOLVEMENT/MAILING LIST

Name	Business	Residence
Ms. Peggy DeMarco	SunCor Development Partners 2828 N. Central, #1212 Phoenix, AZ 85004 244-0046	
Ms. Nicki Hansen	State Land Department 1624 W. Adams Phoenix, AZ 85007 255-3671	17417 N. 56th Avenue Glendale, AZ 85308 978-2932
Ms. Joni Hegel	Sierra National Corporation P.O. Box 15463 Phoenix, AZ 85060 948-0200	946-2299
Ms. Penny Howe		2902 E. Cholla Phoenix, AZ 85028 992-0713
Mr. Ronald Junck	2002 E. Osborn Phoenix, AZ 85016 955-2446	5305 N. 6th Street Phoenix, AZ 85012 265-6897
Mr. Lars Lagerman	Evans, Kitchel & Jenckes 2600 N. Central Avenue, 20th Fl. Phoenix, AZ 85004 234-8815	7507 N. 22nd Street Phoenix, AZ 85020 234-8815
Ms. Tara Laman	Realty Executives P.O. Box 969 Carefree, AZ 85377 488-9360	5054 E. Calle De Los Arboles Cave Creek, AZ 85331 488-9061
Mr. Guy Leohnis	Wahlers Construction, Inc. P.O. Box 19127 Phoenix, AZ 85005 257-9797	2402 E. Shangri-La Road Phoenix, AZ 85028 971-1778
Mr. G. Noel Lesniak	Motorola 3013 S. 52nd Street Tempe, AZ 85282 438-3249	31042 N. Rancho Moreno Cave Creek, AZ 85331 488-2972
Mr. David Lewis	Luke Land 7801 N. Black Canyon Highway Phoenix, AZ 85021 995-1936	863-1101

PUBLIC INVOLVEMENT/MAILING LIST

Name	Business	Residence
Mr. John F. Long	John F. Long Properties 5035 W. Camelback Road Phoenix, AZ 85032 272-0421	
Mr. Joseph McGarry	Lewis and Roca 100 W. Washington Phoenix, AZ 85003 262-5311	4517 N. Rubicon Avenue Phoenix, AZ 85018 840-6666
Mr. Bruce McKinney	Glenelyn Corporation 493-0081	815 E. Grovers Phoenix, AZ 85023 992-0183
Mr. Herman Middleton	Black Canyon Stage 1 P.O. Box 1139M Phoenix, AZ 85029 582-5109	25438 N. 17th Avenue Phoenix, AZ 85029 582-5109
Mr. Samuel Morse Vice-Chairman	Western Landscape Architects 3509 E. Shea Boulevard Suite 117 Phoenix, AZ 85028 953-2845	2207 W. Coolbrook Avenue Phoenix, AZ 85023 992-3400
Mr. Clark Nisbet	Sundstrand Aviation Operations 18008 N. Black Canyon Highway Phoenix, AZ 85023 439-6400	2906 E. Union Hills Phoenix, AZ 85024 992-5042
Ms. Mike Pehlman		19042 N. 22nd Street Phoenix, AZ 85024 992-9764
Ms. Linda Powers		7510 N. 1st Street Phoenix, AZ 85020 997-1887
Mr. Robert Smith	DFYS Architects 5110 N. 40th Street, Suite 107 Phoenix, AZ 85018 954-9060	4240 E. Acoma Drive Phoenix, AZ 85032 992-3559
Ms. Jan Triplitt	Nail Consultants 621 W. Lone Cactus Drive Phoenix, AZ 85027 1-582-0258	4726 E. Beverly Lane Phoenix, AZ 85032 867-1685

PUBLIC INVOLVEMENT/MAILING LIST

Name	Business	Residence
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Mr. Donald Viehmann	Viehmann, Martin & Associates 2402 E. Arizona Biltmore Circle Phoenix, AZ 85016 957-0660	

PUBLIC INVOLVEMENT/MAILING LIST

Agenda Only

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Mr. Howard Forman
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REFERENCES

1. Northwest Storm Drainage Study, prepared by Arthur Beard Engineers, Inc. for the City of Phoenix, 1977.

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17. National Engineering Handbook, Section 4, Hydrology, U.S. Soil Conservation Service, 1972.

REFERENCES

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19. General Plan for Phoenix - 1985/2000, City of Phoenix Planning Department, July 1988.

APPENDIX A

Two-Year and 10 Year Storm Hydrology

The Case 1 hydrologic model was run for the 2-year and 10-year, 24-hour storm events. This hydrology was performed to provide the full range of storm events required for the preparation of a revised Flood Insurance Study (FIS) for Scatter Wash. The table below is a summary of discharges at key locations for all Case 1 hydrology storm frequencies. The HEC-1 outputs for the 2-year and 10-year events are found in Appendix B.

Summary of Discharges
Existing Conditions

Location	Discharge 2-Year	10-Year	50-Year	100-Year
Happy Valley Road	203 cfs	689 cfs	1285 cfs	1609 cfs
Pinnacle Peak Road	367 cfs	1394 cfs	2782 cfs	3521 cfs
North Branch Scatter Wash at I-17	409 cfs	1160 cfs	2777 cfs	3853 cfs
South Branch Scatter Wash at I-17*	102 cfs	402 cfs	1470 cfs	2281 cfs
Adobe Drive at I-17*	119 cfs	262 cfs	1016 cfs	1870 cfs
Louise Drive at I-17*	234 cfs	588 cfs	1005 cfs	1925 cfs
Deer Valley Drive Interchange Inflow*	78 cfs	432 cfs	988 cfs	2383 cfs
Deer Valley Drive Interchange Outflow	0 cfs	0 cfs	840 cfs	2279 cfs

*Includes overflows from the north.