ARCADIA AREA DRAINAGE PROJECT

PROJECT NO. 94-21
FINAL ALTERNATES
HYDROLOGY & HYDRAULICS REPORT

VOLUME I

FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY, ARIZONA
2801 WEST DURANGO STREET
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I. INTRODUCTION

The purpose of this report is to document the hydrology and hydraulic models used to evaluate the Final Alternates in the Arcadia Area Drainage Project Study. The report is contained in two volumes: Volume I contains the narrative documentation while Volume II contains all of the modeling results. The study has been described in greater detail in the Final Recommendations Report (March 1997). Some of the general and background information has been repeated in this report for completeness. A separate report was also prepared for the Existing Condition Hydrology (September 8, 1995). This report will, therefore, primarily focus on the proposed conditions associated with the final alternatives.

The purpose of the Arcadia Area Drainage Project Study is to evaluate and recommend design alternates for storm drainage collection systems to alleviate lower frequency storm flooding problems in the Arcadia area north of the Arizona Canal, from 40th Street to 64th Street, and to reduce or eliminate the limits of the "A" Zone floodplain along the north side of the canal. The storm drainage collection systems (SYSTEMS) can outlet into the improved Old Cross Cut Canal (OCCC) system via an undercrossing of the Arizona Canal Diversion Channel (ACDC) via the Cudia City Wash Sedimentation Basin west of 40th Street. The project is a cooperative project between the Flood Control District of Maricopa County (DISTRICT) and the City of Phoenix (COP), with participation from the Salt River Project (SRP).

The project is located in the metropolitan Phoenix area, within the central area of Township 2 North and the westerly region of Range 4 East. The project limits are bounded by Camelback Mountain on the north, 64th Street on the east, 40th Street on the west and the Arizona Canal to the south and is shown on the Watershed Boundary Map (Figure 1).

Hydrology Criteria

The following is the scope for the hydrologic investigation. The 1991 U. S. Army Corps of Engineers computer program HEC-1, 4.01 Version was used to develop hydrologic models for the Arcadia area watershed. The methods and procedures in the Drainage Design Manual for Maricopa County, Arizona: Volume I - Hydrology (Dated June 1, 1992) is the basis for all hydrology calculations. All special procedures or parameters needed to model special watershed conditions, such as the flood irrigated lots near the canal, have been discussed with and approved by the DISTRICT.

The hydrologic base maps were prepared using the topographic mapping developed for this project. Subbasins and flow paths were identified to provide reasonable depiction of the actual watershed conditions and with sufficient detail to provide reasonable estimates of runoff for each subbasin.

Previous Investigations.

Because of the severe flooding problem in the developed area north of the Arizona Canal, there have been several studies previously performed in this area. They are:

Draft report: "ARCADIA AREA MASTER DRAINAGE STUDY" written by Arthur Beard Engineers, Inc., November 1985. (Ref. No. 1).

"OLD CROSS CUT PHOENIX ARIZONA" written by the U.S. Army Corp. of Engineers, June 1987. (Ref. No. 24).

"OLD CROSS CUT CANAL/LAFAYETTE DRAIN" written by the Flood Control District of Maricopa County, September 1993. (Ref. No. 8).

II. BACKGROUND

A. Historical Information

The Arizona Canal was constructed in the late 1800's to transmit irrigation water from the Granite Reef Diversion Dam to farm lands in the valley. At the time of its construction, there was very little development in what is now Phoenix and there was little concern with regional flooding. The construction of the canal itself has not increased runoff in the study area, however, the canal levees block runoff flow from Camelback Mountain and the surrounding drainage area creating areas of flooding along the north side of the canal.

Originally, this was not a concern relative to flooding problems due to the fact that the land north of the Arizona Canal was irrigated farm land. As the Phoenix city limits began to grow in the mid-1900's, the area north of the Arizona Canal began to transform into prime developed real estate including many affluential homes built adjacent to the north bank of the Arizona Canal. During this time period there was little concern for detaining or conveying the stormwater runoff produced by the newly developed area. Some of the rainfall that percolated into the ground or would runoff in small slow moving rivulets, is now collected in streets, storm channels, and ponding areas north of the Arizona Canal and drain through small drainage pipes into the Arizona Canal. Combined with the increase in development within the watershed, the encroachment of development adjacent to the north bank levee has resulted in a significant threat of flooding and property damage.

Current flooding problems in the Arcadia Area consist primarily of nuisance flooding in the streets north of the canal and along the north canal bank. This is due to the lack of any significant storm drain network or outlet for the storm runoff. Small culverts outletting into the canal are the only source of outflow for most of the Arcadia Area. There has been significant flooding reported in an isolated area of Arcadia -namely, the Camelback Castille Condominium Complex at the southeast corner of Camelback Road and the Arizona Canal. Again, this flooding was caused by insufficient storm drain facilities upstream of the complex and no place for the water to go as it backs up against the canal. The two most recent incidents of flooding occurred in July of 1992 and October of 1993. These storms were estimated to be between 2- and 5-year events.

In recognition of this continuing flooding potential, the Federal Emergency Management Agency (FEMA) has designated approximately 125 acres of land adjacent to the canal north bank levee between the study limits of 40th and 64th Streets as 100-year floodplain.

B. Basin Characteristics

The study area watershed is approximately four square miles in size. The hydrologic properties of the basin are based on physiographic characteristics and land use. Its physiographical characteristics change from a rugged mountainous outcrop, peak El. 2707 feet and steep side slopes up to 60 percent, to a relatively flat developed residential neighborhood (avg. elevation 1260 feet). Camelback Mountain is undeveloped and accounts for approximately 22 percent of the drainage area. The hillsides adjacent to Camelback Mountain slope to Camelback Road, at rates ranging from 2% to 15% and have, naturally desert landscape with medium density vegetative cover. The land use for this area can be classified as very light density residential development.

The area south of Camelback Road and north of the Arizona Canal varies from medium density residences to multi-family residential homes with a few business developments along Camelback Road. Most residences in this area utilize flood irrigation.

Runoff begins at the top of Camelback Mountain and flows southwardly in numerous gullies and poorly defined water courses. Runoff is then conveyed by small washes and streets in the hill slope areas and primarily flows as sheet flow along and across Camelback Road. This virtually occurs at every intersecting street along Camelback Road. South of Camelback Road the interconnecting streets channel the flow to the north bank of the Arizona Canal. The profile along the north bank is relatively flat (slopes less than .05%) with no defined water course with the exception of the Arcadia Drainage Channel east of 56th Street. The lower frequency storm runoff tends to pond and enter the canal at various drainage pipes. For the larger storms, stormwater runoff also overtops the north bank and discharges into the Arizona Canal, and flows very slowly in a northwesterly direction. The ponding water backs up into the low lying residences along the north canal bank.

C. Historic Storms

The following storm descriptions for the Phoenix area come from the Corps Old Cross Cut Report (Ref. No. 24).

General Winter Storms

Storms of this type normally move inland from the north Pacific Ocean, spreading generally light to moderate precipitation over large areas. Although they occur any time from late October through May, they are most common and generally heaviest from December through early March. These storms frequently last several days and may occur in series with only slight breaks between storms. They usually reflect orographic effects to a great degree, so the mountains of central Arizona often receive from four to ten times as much precipitation from winter storms as do the desert areas near Phoenix. Snow frequently falls in the mountains above 6,000 feet and occasionally falls at elevations below 3,000 feet (not a factor in this drainage area). Despite the normal low intensities of precipitation during general winter storms, the large areal extent and the relatively long duration of these storms can produce substantial volumes of runoff and high peak discharges on the larger rivers of the region.

General Summer Storms

Storms of this type normally result from a flow of warm and very moist tropical air into the region from the southeast or south, including the Gulf of California (Sea of Cortez), the tropical Pacific Ocean south of Baja California, and, to a slight extent, the Gulf of Mexico. Such storms over Arizona are often associated with tropical storms or hurricanes. General summer storms can occur any time from late June through mid-October, but are most frequent from August through early October. They usually last from 1 to 3 days and generally consist of numerous locally heavy storm cells embedded in more widespread, general light to moderate rain. Like their general winter counterparts they usually reflect orographic influence, with higher mountains often receiving from three to eight times as much precipitation as do most of the desert areas. Some of the late September and October general storms can show characteristics of both the summer and winter types. The areal extent and duration of general summer storms are usually somewhat less than those of general winter storms, but intensities may be higher. Because infiltration rates are normally higher during summer than during winter, runoff volumes are usually lower than from winter events, but the peak flows on intermediate-sized streams may be higher.

Local Storms

Local storms consist of heavy downpours of rain over relatively small areas (up to about 300 square miles) for short periods of time (up to about 7 hours). They are usually accompanied by lightning and thunder, and are often referred to as thunderstorms or cloudbursts. They can occur any time of the year, but are most prevalent and most intense during the summer months, July to September, when tropical moisture frequently invades Arizona from out of the south or southeast. During the latter part of the summer season they are often larger, of longer duration, and more apt to be associated with general summer storms. Runoff from local storms is usually of a high-peak, low-volume type, affecting mostly the smaller creeks and washes, and is characterized by a rapid rising and receding hydrogragh. They can result in serious flash flood, sometimes with loss of life and serious property damage.

The following flood reports describe the historical flooding characteristics of the Arcadia area.

Desert Flood of 1943

"In August 3, 1943 rainfall began at 3:30 am and continued until 11:00 am releasing an average precipitation of 2.12 inches for the Phoenix area. The Arcadia area at this time was primarily farmlands and there are no reports of inundation north of the Arizona Canal. There are however, reports of very heavy flow (no estimates of the flow are given) to the Arizona Canal at Camelback around 100 ft. east of 40th Street which today is occupied by the Camelback Castille Condominiums. A point of interest in this report that the author observed impounded water on the north bank of the Arizona Canal and recommended that culverts be put in the north bank to relieve the pressure on the north bank" (Ref. No. 13, pg. 17).

Flood of September 4-6, 1970

"On September 4th, 1970 a storm hit the phoenix area with the precipitation depths exceeding the 100-year 24-hour storm in Scottsdale while West Phoenix was experiencing the 5-year 24-hour recurrence interval. Flooding occurred in the Arcadia area along the north bank of the Arizona Canal between 56th and 72nd Streets. The runoff 'flowed westerly to the Falls Substation where part of the flow drained into the Canal with the rest crossing the Canal over the 56th Street bridge and causing damage to the south'. According to a Flood Damage Report by the City of Phoenix eyewitness accounts reported the Arizona Canal's north bank was overtopped northeast of 64th Street." (Ref. No. 2).

Report of Flood on June 22, 1972

"The flood that occurred on June 22,1972 lasted 18 hours with greatest intensity recorded in a two hour span. The unofficial depth recorded at 24th Street and Camelback was 5.25 inches. From 64th Street to Cave Creek approximately 500 acres of property area, north of the Arizona Canal, was inundated costing an estimated $608,000.00 in damages. The south bank of the Arizona Canal at 40th Street failed flooding homes south of the Arizona Canal. Together, with the break at 38th Street, an additional 2800 acres was flooded causing an estimated $3.7 million in damages." (Ref. No. 9).

III. METHOD OF ANALYSIS

A. Hydrology

The hydrology models used for the final alternates are consistent with the existing condition model previously approved by the District. Modifications to the existing condition model were made to reflect the improvements proposed in each alternate. The 2-, 10- or 100-year flows were "diverted" and conveyed to either a detention basin or storm drain facility (depending on the alternate) and routed to the SYSTEM outlet. The remaining flows were routed in the existing condition model flow paths to the canal. The following paragraphs describe the general features of the existing condition model as well as the specific variations for the final alternates.

1. Standards Used

The hydrologic modeling techniques used for this study are consistent with the policies, procedures and practices outlined in the 1992 version of "Drainage Design Manual for Maricopa County, Arizona" Volume 1 Hydrology. HEC-1, version 4.0.1E, was used for the hydrological computations. Table A-1, provides a detailed list of all of the hydrologic computer programs used for this study.

2. Rainfall

There is one rain gage located within the study area but it has not been in service long enough to generate accurate return-year precipitation depths. Therefore, the return-year rainfall depths were estimated using the NOAA ATLAS II 6-hour isopluvial maps from the Hydrology Manual.

The 6-hour rainfall precipitation frequency distribution pattern (No. 2.20) was calculated by the DRAINAGE DESIGN MENU SYSTEM (DDMS ver. 1.0 1994) program based on a drainage area of 4.2 square miles. PREFRE from the DDMS program calculated HEC-1 Parameter defaults and precipitation depths for various storm durations and frequencies (Table A-2).

3. HEC-1 Parameters

The rainfall losses were estimated using the Green and Ampt infiltration equation instead of the Initial Loss Plus Uniform Loss Rate because it is the more accurate of the two methods and the most preferred method of estimation by the FCDMC. The Clark Unit Hydrogaph method will be used since the subbasins are less than five square miles.

The hydrologic land use types as shown in Figure 3, (Land Use Map), were derived from the

Land Use Type table menu (HEC-1 parameter defaults provided by DDMS software). Table 4.3a, from the Drainage Design Manual for Maricopa County, Vol. 1, was used to correlate city zoning maps with hydrologic land use types for the Arcadia Area. Note that two different land use types were used for the areas north and south of Camelback Road even though the zoning is primarily the same. This was done to represent the differences in landscaping type (i.e. differences in percent vegetative cover and imperviousness) found north (desert landscaping) and south (flood irrigated lawns) of Camelback Road. Two additional Land Use Types were added to Table A-3, namely Mountainous and Hill Slopes. This was done to lower the percent impervious (RTIMP) values associated with the land development in these areas. A more in depth discussion of this process is presented in the Special Procedures section of this report.

The land use areas that utilize flood irrigation create a unique situation for the hydrograph generation. This is because for lower frequency storms a portion of the rainfall will be captured and retained thus not contributing to the peak flows. But, for larger frequency storms the irrigated lawns will eventually fill, overtop and begin to contribute to the runoff. A more detailed discussion of this situation and how it is handled is provided in the Special Procedure Section of this report (Section III.5.).

Soil types, as shown in Figure 4, were identified by using the Eastern Maricopa County soils map (Ref. No. 34). These types of soils and the corresponding loss rate parameters are identified within the DDMS software and determined from default lookup tables included with the software (see Table A-4 Eastern Maricopa County Soils Types). The percent impervious (RTIMP) values for the soil type RO (Rock Land) was reduced to 40% from 65%. This was done to reflect the actual inner-connecting portion that is impervious and contributing directly to runoff. The breakup of the subbasin soils type is found in Table A-6 and the related DDMS calculated loss rate parameters in Table A-7.

4. Watershed Delineation

The watershed limits, shown on Figure 1, (Watershed Boundary Map), are bound by the peaks of Camelback Mountain on the north, 64th Street on the east, 40th Street on the west (including the area immediately south of the ACDC entrance) and the Arizona Canal to the south. These limits closely reflect the watershed boundaries in the previous reports written by the U.S. Army Corps of Engineers (Ref. No. 19, 23 & 24) and the Flood Control District of Maricopa County (Ref. No. 8).

The watershed basin was subdivided into 42 separate subbasins (see Figure 5) with an average area of 64 acres; the largest being 161.3 acres and the smallest 23.7 acres. From the Eastern boundary of the watershed (64th Street) to 48th Street, runoff primarily flows from north to south and drains into the Arizona Canal at various locations. West of 48th Street the flow transitions from southerly to westerly. The subbasins are subdivided at the roadways where the proposed alternate storm drainage systems will be located, Camelback Road, Exeter Road, and Lafayette Boulevard. This will facilitate rerouting the subbasin flows for the alternative storm drainage system solutions.

The runoff flow paths for existing conditions, (see Figure 5) present a difficult situation because there are no well defined water courses. In all practicality, the numerous gullies and interconnecting streets found in this watershed will all contribute to conveying runoff. However, a single water course flow path has to be assumed so that time of concentrations can be determined. The flow paths shown on Figure 5 were determined by factoring in all of the variables, such as longest flow path that affect the time of concentrations, the flow paths that appear to carry the majority of runoff flow (determined from the contour maps), and historical records and reports of flooding in certain areas.

On the eastern end of the watershed boundary there is an overlap between the previous report written by the U.S. Army Corps of Engineers (Ref. No. 23) for the Indian Bend Wash and the proposed boundary for the Arcadia Area study. The main reason being that since the previous report was written (June 1981), the Phoenician Resort has been constructed which has changed the drainage flow patterns for the upper part of the subbasin. Some of the flow that has historically drained to 64th Street is redirected and flows down 62nd Street which will miss the interceptor drain at Lafayette Boulevard and 64th Street. The process describing the amount of flow to be intercepted will be explained in the next section of this report.

5. Special Procedures

This section describes and discusses the unique situations encountered within this watershed and the special procedures developed to address these situations. Table A-5 Special Procedures, provides a brief synopsis of all the special procedures used in this model.

Diversion

As shown in Table A-5 there are three different types of diversion procedures used in this model for the existing conditions. One type of diversion is for the on-site retention due to the flood irrigation lots. The second type of diversion is for existing storm drainage systems that exit the watershed. There are five cases where storm runoff exits the watershed which require use of the diversion procedure. And finally, there are diversions for split flow situations. A split flow situation occurs when the flow path changes due to higher runoff volumes. There are three split flow situations in this model.

As discussed earlier in Section III.3 of this report, there is a need to address the on-site retention for the flood irrigated lawns south of Camelback Road. A special procedure using diversion hydrographs is used in this model to account for the capture and retention of rainfall due to the depressed yards within the flood irrigation lawn watering area. This special procedure was developed by estimating that the maximum amount of rainfall to be diverted is the excess precipitation generated from the 10-year storm (i.e., the 10-year storm runoff is retained). Aerial photographs were then used to estimate the percentage of on-site retention for the subbasin area (i.e. the percentage of the area that is flood irrigated). The diversion card in HEC-1 was then used to subtract the irrigated lawn retention out of subbasin hydrographs. This process continues until the maximum volume is diverted (i.e. when the irrigated lawns are filled). These values are tabulated in Table A-6 (Subbasin Data Input Parameter Estimates).

Five of the six locations where stormwater exits the Arcadia Area watershed required different approaches unique to the individual conditions in calculating the amount of runoff to be diverted.

The following paragraphs discuss the procedures used in calculating the diversions at each of the five subject locations.

The interceptor drain at Lafayette Boulevard and 64th Street

The existing storm drain at Lafayette Boulevard and 64th Street conveys runoff to the east and into Indian Bend Wash in the City of Scottsdale (outside of the Arcadia Area watershed). The storm drain pipe in Lafayette Boulevard is a 54-inch RCP with a capacity of 125 cfs. This capacity was calculated assuming a worse case scenario with the outlet submerged. The inlet grate for the catch basin, 3-feet wide by 44-feet long, is capable of intercepting the maximum capacity of the pipe. Although runoff flow from subbasin 1 to subbasin 4 crosses the interceptor drain, there will be some runoff produced by these subbasins that will be conveyed in adjacent streets or areas which bypass the interceptor drain. Therefore, a conservative approach was used to anticipate that the Lafayette drain will intercept approximately half of the flow coming from subbasins 1 through 4. The HEC-1 DI and DQ cards respectively, represent the amount of flow generated and intercepted by the 2-year through the 100-year events. For the 100-year event the inlet capacity of the grate is greatly reduced due to the high velocities which will increase grate bypass flows.

56th Street Bridge

East of 56th Street, the north canal bank is much higher (four to nine feet) than the adjacent residential area, and storm water tributary to this area discharges into two 48-inch pipes, which enter the canal, westerly crossing 56th Street to the residential area, and southerly over the 56th Street Bridge. The flow diverted out of the watershed over the 56th Street Bridge was determined to be the excess capacity of the two 48-inch pipes. The conveyance capacity of the 56th Street bridge was also calculated to determine the amount of excess flows being conveyed by the bridge which would overtop the curbs and enter the Canal and remain within the watershed.

The Old Cross Cut Canal

At the Old Cross Cut Canal a maximum diversion of 1000 cfs is used and it is based solely on Salt River Project's option to outlet up to 1000 cfs from the Canal at any time.

Camelback Road 18-inch to 36-inch Storm Drain

At Camelback Road the 18-inch to 36-inch storm drain system was found to have a carrying capacity of 55 cfs. This system runs under the Arizona Canal and connects to the storm drain along 40th Street where it leaves the watershed. The maximum of 55 cfs will be diverted from subbasin 39 after it has been combined with the preceding contributing subbasins.

Low spot on South Canal Bank at 40th Street

There is a spillway section along the south bank of the Arizona Canal east of 40th Street that allows for certain overflows from the Arizona Canal. When the water surface in the canal exceeds the spillway elevation, the excess stormwater will leave the Arcadia Area watershed. The HEC-2 model created for the Arizona Canal indicated that runoff in excess of 10 cfs over maximum normal operating flows of 700 cfs will be diverted out of the canal at the spillway. The model is based on the maximum normal operating water surface elevations provided by SRP, which utilized a Mannings co-efficient of 0.030.

Split Flow

The last type of diversions encountered in the watershed are for the split flow situations previously described. The first diversion encountered of this type is located between subbasin 30 and subbasin 38. The main flow path from subbasin 38 to subbasin 30 is in the gully along Dromedary Road. However, there is a small channel along Rockridge Road where it intersects with Dromedary Road, which will intercept low flows and route them to subbasin 39.

The last two split flow diversions both occur on Camelback Road in subbasin 39. The first one is for the 24-inch pipes that connects to two 24-inch pipes and then to a 36-inch pipe which has a capacity of 60 cfs. The 36-inch pipe discharges into the Arizona Canal in subbasin 36. The other split flow diversion comes from the flow path from subbasin 37 to the concentration point of subbasin 39 on Camelback Road. The maximum flow that can travel this route is 160 cfs. Flow exceeding 160 cfs will over top the crown of Camelback Road and flow south eventually finding its way to subbasin 36. Flows exceeding 160 cfs will be diverted and combined with subbasin 36.

Time of Concentration

Another problem encountered was the time of concentration being too high for the mountainous rock outcropping areas. DDMS adjusted the slopes to a maximum of 315'/ft, based on Figure 5.4 (Slope Adjustment for Steep Water Courses) in the Hydrology Manual. However this figure was intended for grass lined channels built using the (Denver) Urban Drainage and Flood Control District Criteria (Ref. No. 48) and therefore the true slopes were used to calculate the times of concentrations for this project.

Percent Imperviousness

DDMS calculates the percent imperviousness (RTIMP) by adding the RTIMP values for the Soils Types to the RTIMP values for the hydrologic Land Use Types. In specific combinations of Ro (Rock Land) Soils type and certain Land Use types this process can lead to a RTIMP value greater than 100%. The Landiscor aerial maps show that Camelback Mountain is zoned RE-35. When this zoning is converted to the land use type of V.L.D.R. (RTIMP value of 5%) and added with the RTIMP of the soil type, 65%, the total value of 70% imperviousness appeared to be too high. Since there is a construction moratorium on Camelback Mountain for elevations greater than 1400 feet, two Land Use Types were created to reflect the actual percent of imperviousness. These are Mountainous and Hill Slopes. They were given zero and three percent of imperviousness respectively, which represents the actual conditions since there is very little to no development in these areas. Also, the RTIMP Value for Soil Type Ro was reduced to 40% from the DDMS default value of 65%.

6. Routing

There are two routing methods being used in this model for hydrograph routing. The Kinematic Wave method utilizing channel flow principles is used for all of the subbasins up to the Arizona Canal. This was done because the subbasins are fairly small and the Kinematic Wave method will minimize the hydrograph attenuation. Once the runoff reaches the north bank of the Arizona Canal, a Modified Puls Storage Routing was used. This method best represents the condition of stormwater routing within the Arizona Canal. A HEC-2 analysis of the Arizona Canal is used to generate a storage - discharge rating curve. This rating curve is used as input for the Modified Puls storage routing. The complete routing parameter estimates can be seen in Table A-8 (Subbasin Routing Parameter Estimates).

7. HEC-1 Data Input

The HEC-1 data input was created by the DDMS program and its sub-programs. Data input into the DDMS program is found in Table A-6 (Subbasin Data Input Parameter Estimate) which was created from topographical maps created specifically for this study, zoning maps from 1994 Landiscor aerial photographs and a CADD drawing referenced to the State Plane Coordinate System for the soils information. The soils drawing was then merged with the topographical map and the areas of the soils type for the subbasins are calculated by using the CADD software. The Land Use Types map was created by identifying the zoning boundaries as they correlate to the Land Use Types and overlaying them on the Subbasin map. These areas were calculated by using CADD software. Once Table A-6 was created, the data was entered into the required DDMS sub-programs. DDMS then calculates the loss rate parameters for each subbasin by using weighted area methods, the average area weighted logarithms (adj. XKSAT), or from the default look up menus that are provided with the software. Table A-3 and A-4 provide the DDMS defaults for the Land Use Types and the Soil Types, respectively. Table A-7 provides the breakdown of the DDMS calculated loss rates for the subbasin data input parameter estimates. Table A-8 gives the subbasin parameter estimates for Kinematic Wave and Modified Puls routing.

A Manning's coefficient of $n = 0.016$ was used for the Kinematic Wave Routing in the streets and it increases for the upper subbasins where the flow drains through natural washes and gullies. The flow through the streets is described as trapezoidal flow due to the fact that the rolled curbs act as a wide shallow trapezoidal channel.

8. Final Alternate Modifications

The existing condition HEC-1 model was modified to reflect the proposed facilities of each alternate. Runoff from subbasins that would be intercepted by the proposed facilities is diverted and conveyed to either a detention basin or a SYSTEM outlet. The remaining flows are routed

The modelling approach used for each of the final alternates is described below:

Alternate 1 - With the exception of the 2-year flow diversion from subbasins 37, 39, 40 and 41 (see Figure 5), all of the 10-year runoff from subbasins 37, 39, 40, 41 and 42 are intercepted by the proposed storm drain and conveyed to the Cudia City Wash. The 10-year runoff from subbasin 36 is collected and conveyed to the existing 36-inch storm drain in Camelback Road.

Alternate 2 - The "East" Camelback SYSTEM intercepts runoff from subbasins 1, 2, 6 and 7 (see Figure 5). At Invergordon Road, a maximum of 125 cfs is conveyed in the SYSTEM to the existing storm drain in Lafayette Blvd. The remainder of the flow, plus runoff from subbasins 3, 4, 5, 8, 9 and 10 are routed to the Arcadia Drainage Channel outletting into the Arizona Canal at 56th Street.

The "Central" Camelback SYSTEM intercepts the 10-year runoff from subbasins 11, 12, 16, 17, 21, 22 and 26 east of Arcadia Drive, and subbasins 30 and 38 west of Arcadia Drive. Subbasins 27, 28 and 29 are intercepted in the Arcadia Drive SYSTEM south of Camelback Road continuing to the OCCC outfall. The remainder of the subbasins east of Arcadia Drive and south of Camelback Road (subbasins 13, 14, 15, 18, 19, 20, 23, 24 and 25) continue to flow to the canal.

The SYSTEM in 44th Street from Colter Street to Camelback Road intercepts the 10-year runoff from subbasins 40 and 41. At Camelback Road, the 2-year runoff from subbasins 37 and 39 is added via the proposed City of Phoenix storm drain. The SYSTEM continues in Lafayette Blvd to Arcadia Drive intercepting the excess 10-year runoff from subbasins 37 and 39, as well as the full 10-year runoff from subbasins 31, 32 and 34. The Lafayette Blvd and Arcadia Drive SYSTEMS are combined and continue in Arcadia Drive to the OCCC outfall. The area south of Lafayette Blvd and west of Arcadia Drive (subbasins 33 and 35) continues to drain to the canal.

The tributary area to the "West" Camelback SYSTEM has been significantly reduced by the 44th Street/Lafayette Blvd SYSTEM. Only the 10-year runoff from subbasin 42 would be intercepted by the proposed "West" Camelback SYSTEM. The 10-year runoff from subbasin 36 is proposed to be collected and conveyed in a 36-inch lateral to the existing 36-inch storm drain in Camelback Road, outletting to the existing 40th Street storm drain.

Alternate 3 - The 2-year discharge from subbasins 1, 2, 3, 4, 6 and 7 is diverted to the City of Scottsdale Lafayette storm drain (see Figure 5). The 10-year excess flows, plus the full 10-year flow from subbasins 8, 9 and 10 are routed to the Arcadia Drainage Channel.

The 2-year flows from subbasins 11, 12, 16, 17, 21, 22, 26, 30 and 38 are intercepted and conveyed south in Arcadia Drive to Lafayette Blvd. The 10-year excess flows from subbasins 11 and 12 plus one-half of the 10-year flows from subbasins 13 and 14 are routed down 56th Street to Lafayette Blvd. The other half of the 10-year flows from subbasins 13 and 14 are added to the Arcadia Drainage Channel flows east of 56th Street. The 10-year excess flows from subbasins 16 and 17, plus the full 10-year flows from subbasins 18 and 19 are intercepted at Lafayette Blvd and routed to 56th Street. The combined flows at 56th Street are then routed to the Arizona Canal where the 10-year Arcadia Drainage Channel flows are added. The total combined flows are then routed to the OCCC via 56th Street and Osborn Road.

The 10-year excess flows from subbasins 21 and 22, plus the full 10-year flows from subbasins 23, 24 and 25 are routed to the canal. The total discharge is split between the three laterals under the canal and then routed to the OCCC via the Indian School Road storm drain SYSTEM.

The 44th Street SYSTEM intercepts the 10-year runoff from subbasins 40 and 41 and the 2-year Camelback Road runoff from subbasins 37 and 39 just as in Alternate 2. Continuing in Lafayette Blvd, the proposed SYSTEM intercepts the 10-year excess flow from subbasins 37 and 39 and the full 10-year runoff from subbasins 31, 32 and 34, again, just as in Alternate 2. Different from Alternate 2, however, Alternate 3 also intercepts the 10-year excess flow from subbasins 30 and 38. The total flow in the Lafayette Blvd SYSTEM is combined with the 2-year flow from subbasins 11, 12, 16, 17, 21, 22, 26, 27, 38, 30 and 38 at Arcadia Drive. The SYSTEM is then routed to the Arizona Canal, picking up the 10-year runoff from subbasin 29, routed under the canal and combined with the Indian School Road and Osborn Road SYSTEMS in the OCCC. Subbasins 33 and 35 continue to drain to the canal.

The "West" Camelback Road SYSTEM is identical to Alternate 2. The 10-year runoff from subbasin 42 is intercepted and conveyed to the Cudia City Wash Basin via the proposed storm drains in Camelback Road and 40th Street. Subbasin 36 is proposed to be collected and conveyed to the existing 36-inch storm drain in Camelback Road (via a 36-inch lateral), outletting to the existing 40th Street storm drain.

Alternate 4 - Both 10-year and 100-year inflow hydrographs were computed for each basin. Subbasins 1 through 10 (see Figure 5) would continue to be intercepted and conveyed by the Arcadia Drainage Channel to the Arizona Canal (without detention). Subbasins 11 through 15 were routed to the most easterly basin. Subbasins 16 through 20, 21 through 25 and 26 through 29 were routed to the three basins between 56th Street and Arcadia Drive. Subbasins 30 through 33 plus 38 and 34 and 35 are routed to two basins west of Arcadia Drive. The most westerly basin intercepts the 100-year runoff from subbasins 36 and 39 through 42. The 100-year inflow hydrographs from the HEC-1 model were input into a separate storage routing model (Pond 2). The maximum storage volumes necessary to reduce the basin outflow to the 10-year inflow values were then determined.

Alternate 5 - The 2-year peak discharge (plus the additional 10-year protection for the "West" Camelback SYSTEM) was diverted from the 100-year HEC-1 hydrograph for the entire Arcadia Area. This hydrograph was then imported into the Pond 2 storage routing model. The required storage volume for a basin outflow of 990 cfs (less the 2-year direct discharge) to the OCCC was computed.

9. Detention Basin Model (Pond 2)

The detention basins proposed in Alternates 4 and 5 were modelled using the Pond 2 (Version 5.17) computer program. Storage volumes are computed by summing the differences between the basin inflow and outflow for each interval of the hydrograph. The basin inflow hydrograph is imported directly from the HEC-1 output for each alternate. The outflow hydrograph is estimated as a linear function starting at 0 at the beginning of the rising limb of the inflow hydrograph and linearly increasing to the specified maximum outflow (input by the user) where it crosses the falling limb of the outflow hydrograph.

B. Hydraulics

The storm drains proposed for Alternates 1, 2 and 3 were sized using the Water Surface Pressure Gradient (WSPG) Hydraulic Analysis Computer Program F0515P developed in 1979 by the Los Angeles County Flood Control District.

The WSPG program computes and plots uniform and nonuniform steady flow water surface profiles and pressure gradients in open channels or closed conduits with irregular or regular sections. The flow in a system may alternate between super critical, subcritical or pressure flow in any sequence. The program will also analyze natural river channels although the principle use of the program is intended for determining profiles in improved flood control systems.

The computational procedure is based on solving Bernoulli's equation for the total energy at each section and Manning's formula for friction loss between the sections in a reach. The open channel flow procedure utilizes the standard step method. Confluences and bridge piers are analyzed using pressure and momentum theory. The program uses basic mathematical and hydraulic principles to calculate all such data as cross sectional area, wetted perimeter, normal depth, critical depth, pressure, and momentum.

The procedures used in the WSPG program are consistent with the Districts Drainage Design Manual, Volume II, Hydraulics criteria. Additional documentation on the WSPG program is available at the Huitt-Zollars, Inc. office.

IV. RESULTS

The results of the HEC-1, Pond 2 and WSPG computer models are contained in Volume II of this report. Due to the large quantity of material, (i.e, printouts) produced by these programs, only the input and summary output is provided. The complete input and output files have been provided to the District on diskette.

The discussion of the results and conclusions of the hydrologic and hydraulic analyses is provided in the Final Recommendations Report.

TABLE A-1

HYDROLGICAL COMPUTER PROGRAMS USED

PROGRAM NAME	VERSION	DATE	DEVELOPED BY:
DDMS	1.0	10-94	FCDMC
PREFRE		06-88	BUREC
LAND TYPES		10-94	FCDMC
SUBBASIN PREP		10-94	FCDMC
MCUHP1		10-94	FCDMC
HEC-1	4.0.1E	05-91	US ARMY CORP OF ENGINEERS
DODSON HEC-1 EDITOR	4.0	04-91	DODSON & ASSOCIATES

TABLE A-2

HEC-1 PARAMETER DEFUALTS

PRECIPITATION DEPTH (IN.) FROM ISOPLUVIAL MAPS						
STORM DURATION	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
6-HOUR	1.15	1.65	2.00	2.50	2.80	3.20
24-HOUR	1.40	1.90	2.40	3.00	3.40	3.80
PRECIPITATION DEPTHS (IN.) CALCULATED FROM PREFRE						
5-MIN.	0.31	0.42	0.49	0.59	0.67	0.75
10-MIN.	0.46	0.63	0.75	0.90	1.03	1.15
30-MIN.	0.56	0.79	0.94	1.15	1.32	1.47
5-MIN.	0.74	1.05	1.27	1.56	1.78	2.00
1-HOUR	0.90	1.30	1.57	1.94	2.22	2.50
2-HOUR	0.98	1.42	1.72	2.21	2.43	2.74
3-HOUR	1.04	1.51	1.82	2.24	2.57	2.89
6-HOUR	1.15	1.65	1.99	2.47	2.80	3.19
12-HOUR	1.25	1.82	2.20	2.71	3.11	3.51
24-HOUR	1.36	1.90	2.39	2.95	3.39	3.80

TABLE A-3

HEC-1 PARAMETER DEFUALTS

LAND USE TYPES					
LAND USE TYPE	DTHETA CONDITION	% VEG. COVER	RTIMP %	IA 2.50	KB ROUGHNESS TYPE
* DESERT	DRY	25.00	0.0	0.35	LOW
* OPEN	DRY	10.00	0.0	0.10	MIN
V.L.D.R.	NORMAL	30.00	5.0	0.30	LOW
L.D.R.	NORMAL	50.00	15.0	0.30	LOW
M.D.R.	NORMAL	50.00	30.0	0.25	LOW
M.F.R.	NORMAL	50.00	45.0	0.25	LOW
* INDUSTRIAL	NORMAL	60.00	55.0	0.15	MIN
COMMERCIAL	NORMAL	75.00	80.0	0.10	MIN
* PARK	NORMAL	90.00	0.0	0.20	HIGH
* ROW CROP	NORMAL	85.00	0.0	0.50	HIGH
GOLF COURSE	NORMAL	95	0.0	0.40	MIN
HILL SLOPES	DRY	10	3.0	0.15	HIGH
MOUNTAINHOUS	DRY	2	0.0	0.1	HIGH

* NOT PRESENT IN THE WATERSHED BOUNDARIES.

TABLE A-4

HEC-1 PARAMETER DEFAULTS

EASTERN MARICOPA COUNTY SOIL TYPES						
MAP SYMBOL	MAP UNIT	XKSAT	DTHETA DRY	DTHETA NORMAL	PSIF	RTIMP %
AoB	Antho Gravelly Sandy Loam	0.40	0.35	0.25	3.95	0
CeC	Calvelt Gravelly Loam	0.40	0.35	0.25	3.95	0
Es	Estrella Loam	0.25	0.35	0.25	4.80	0
LaA	Laveen Loam	0.25	0.35	0.25	4.80	0
Mv	Mohall Loam	0.25	0.35	0.25	4.80	0
PvC	Pinamt Very Gravelly Loam	0.40	0.35	0.25	3.95	0
TrB	Tremant/Gravelly Sandy Clay Loam	0.10	0.35	0.15	7.00	0
Ro	Rock Land/Gravelly/Sandy Loam	0.25	0.35	0.25	4.80	40
Ru	Rough Broken Land	0.40	0.35	0.25	3.95	10
Va	Valencia Sandy Loam	0.40	0.35	0.25	3.95	0

0222-01/TABLEA4.XLS

TABLE A-5

SPECIAL PROCEDURES

Operational Procedure	Modeling Problems	Modeling Solutions
Runoff Hydrograph Generation	HEC1 program does not allow for on-site retention. Specifically for the irrigated lawns in the Arcadia Area of the project.	Diversion cards will be programmed into the model for the irrigated areas. Max vol. to be diverted is the excess sub-basin precipitation from the 10 year - 6 hour storm.
Runoff Hydrograph Generation	There are several pipes and channels that intercept runoff and discharge outside the watershed.	Diversion cards will be used to divert a portion of the runoff that is intercepted by these pipes and channels.
Runoff Hydrograph Generation	There are several cases where the flow path changes due to higher runoff values i.e. split flow situations.	Diversion cards will be used to divert the portion of runoff that splits from the main flow path.
Runoff Hydrograph Generation	The time of concentration was too long for the mountainous rock outcrop areas because of the adjusted slopes.	The true slope for these sub-basins was used instead of the slope adjustment factors provided by DDMS Ver. 1.0. Research indicated that the adjusted slopes were intended for grass lined channels (ref. #47)
Runoff Hydrograph Generation	RTIMP value for mountainous sub-basins exceeded 100%, due to RTIMP from soils map being added to RTIMP from land use table.	Two new land use types: mountainous and hill were created and given low RTIMP values so that when added to the soils map RTIMP it more accuratety reflects the RTIMP for the sub-basin.

TABLE A-6 (1 of 5)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUB BASIN SOILS MAP UNIT AND LAND USE TYPE ESTIMATES																		DIVERSION DATA					
																		DT		DI		DQ	
SUB. #	CP #	TOTAL AREA SQ. MI.	SOILS MAP UNIT	MAP AREA AC.	MAP AREA SQ. MI.	LAND USE TYPE	LAND AREA AC.	LAND AREA SQ. MI.	FLOW LENGTH MILES	ELEV. HIGH FT.	ELEV. LOW FT.	STORM SIZE SQ. MI.	UA RECORD #	% ONSITE RETEN. 4	ADJ. % RETEN.	10YR-6HR EXCESS PREC. (IN)	ROUTING & DIVERSION NOTES	FIELD1 ISTAD D#	FIELD2 DSTRMX AC-FT	FIELD1 DINFLO T=0	FIELD2 DINFLO UNIT Qp	FIELD1 DIVFLO T=0	FIELD2 DIVFLO UNIT Qp
1	1	0.037	Ro	17.13	0.027	MOUNT.	17.13	0.027	0.280	1950.0	1356.3	0.7	2	0	0.0	1.20	KINEMATIC WAVE	D1	0.00	0	0.00	0	0.000
			Ru	6.73	0.011	MFR	6.73	0.011						0			ROUTE SUB1 TO SUB2						
																	NO DIVERSION						
2	2	0.119	Ru	3.82	0.006	GOLF	37.52	0.059	0.603	1356.3	1303.3	0.7	1	70	38.2	0.33	KINEMATIC WAVE	D2	0.80	0	1.00	0	0.382
			TrB	18.20	0.028	VLDR	27.37	0.043						10			ROUTE SUB2 TO SUB3						
			Va	43.8	0.068	MFR	11.04	0.017									DIVERT FLOW SUB2						
			LaA	10.11	0.016																		
3	3	0.067	Va	30.26	0.047	MFR	1.91	0.003	0.259	1303.3	1291.0	0.7	1	0	57.3	0.43	KINEMATIC WAVE	D3	0.88	0	1.00	0	0.573
			LaA	12.58	0.020	LDR	41.15	0.064						60			ROUTE SUB3 TO SUB4						
			Mv	0.22	0.0003												DIVERT FLOW SUB3						
4	4	0.065	Mv	27.13	0.042	LDR	41.32	0.065	0.250	1291.0	1280.4	0.7	1	55	55.0	0.53	KINEMATIC WAVE	D4	1.00	0	1.00	0	0.550
			LaA	14.19	0.022												ROUTE SUB4 TO SUB5						
																	DIVERT FLOW SUB4						
5	5	0.067	Mv	39.40	0.062	LDR	42.63	0.067	0.437	1280.4	1269.7	0.7	1	50	50.0	0.53	STORAGE ROUTE	D5	0.94	0	1.00	0	0.500
			LaA	3.23	0.005												DIVERT FLOW SUB5						
6	6	0.090	Ro	52.71	0.082	MOUNT.	52.71	0.082	0.263	1974.5	1359.0	0.7	2	0	0.0	1.19	KINEMATIC WAVE	D6	0.00	0	0.00	0	0.000
			Ru	5.07	0.008	MFR	5.07	0.008									ROUTE SUB6 TO SUB7						
																	NO DIVERSION						
7	7	0.153	Ro	1.66	0.003	MFR	27.07	0.042	0.563	1359.0	1319.2	0.7	1	70	43.6	0.66	KINEMATIC WAVE	D7	2.35	0	1.00	0	0.436
			Ru	35.49	0.055	VLDR	25.29	0.040						20			ROUTE SUB7 TO SUB8						
			TrB	53.08	0.083	MOUNT.	1.66	0.003						0			DIVERT FLOW SUB7						
			Va	7.71	0.012	HILL	12.80	0.020						0									
						GOLF	31.12	0.049						60									
8	8	0.068	TrB	6.16	0.010	LDR	43.80	0.068	0.436	1319.2	1296.4	0.7	1	60	60.0	0.45	KINEMATIC WAVE	D8	0.99	0	1.00	0	0.600
			Va	37.64	0.059												ROUTE SUB8 TO SUB9						
																	DIVERT FLOW SUB8						
9	9	0.065	Va	15.00	0.023	LDR	41.67	0.065	0.249	1296.4	1282.7	0.7	1	60	60.0	0.45	KINEMATIC WAVE	D9	0.94	0	1.00	0	0.600
			LaA	14.67	0.023												ROUTE SUB9 TO SUB10						
			Mv	12.00	0.019												DIVERT FLOW SUB9						

TABLE A-6 (2 of 5)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUB BASIN SOILS MAP UNIT AND LAND USE TYPE ESTIMATES																		DIVERSION DATA					
																		DT		DI		DQ	
SUB. #	CP #	TOTAL AREA SQ. MI.	SOILS MAP UNIT	MAP AREA AC.	MAP AREA SQ. MI.	LAND USE TYPE	LAND AREA AC.	LAND AREA SQ. MI.	FLOW LENGTH MILES	ELEV. HIGH FT.	ELEV. LOW FT.	STORM SIZE SQ. MI.	UA RECORD #	% ONSITE RETEN. 4	ADJ. % RETEN.	10YR-6HR EXCESS PREC. (IN)	ROUTING & DIVERSION NOTES	FIELD1 ISTAD D#	FIELD2 DSTRMX AC-FT	FIELD1 DINFLO T=0	FIELD2 DINFLO UNIT Qp	FIELD1 DIVFLO T=0	FIELD2 DIVFLO UNIT Qp
10	10	0.093	LaA	49.10	0.077	LDR	58.97	0.092	0.338	1282.7	1270.0	1.0	1	45	44.5	0.53	STORAGE ROUTE	D10	1.17	0	1.00	0	0.445
			Mv	10.55	0.016	MDR	0.68	0.001						0			DIVERT FLOW SUB10						
11	11	0.093	Ro	41.55	0.065	MOUNT.	41.55	0.065	0.557	2391.0	1416.6	1.0	2	0	0.0	1.01	KINEMATIC WAVE	D11	0.00	0	0.00	0	0.000
			Ru	17.68	0.028	HILL	17.68	0.028						0			ROUTE SUB11 TO SUB12						
																	NO DIVERSION						
12	12	0.120	Ru	30.04	0.047	VLDR	60.84	0.095	0.309	1416.6	1322.3	1.0	1	10	7.9	0.60	KINEMATIC WAVE	D12	0.30	0	1.00	0	0.079
			TrB	46.68	0.073	HILL	15.88	0.025									ROUTE SUB12 TO SUB13						
																	DIVERT FLOW SUB12						
13	13	0.129	TrB	63.26	0.099	LDR	82.48	0.129	0.258	1322.3	1294.5	1.0	1	20	20.0	0.71	KINEMATIC WAVE	D13	0.98	0	1.00	0	0.200
			Va	19.22	0.030												ROUTE SUB13 TO SUB14						
																	DIVERT FLOW SUB13						
14	14	0.126	TrB	1.09	0.002	LDR	80.49	0.126	0.249	1294.5	1275.9	1.0	1	60	60.0	0.39	KINEMATIC WAVE	D14	1.57	0	1.00	0	0.600
			Va	71.99	0.112												ROUTE SUB14 TO SUB15						
			LaA	7.41	0.012												DIVERT FLOW SUB14						
15	15	0.126	Va	10.52	0.016	LDR	75.49	0.118	0.376	1275.9	1254.8	1.0	1	60	58.8	0.52	STORAGE ROUTE	D15	2.05	0	1.00	0	0.588
			Mv	39.40	0.062	MDR	4.97	0.008						40			DIVERT FLOW SUB15						
			LaA	30.54	0.048																		
16	16	0.129	Ro	75.56	0.118	MOUNT.	75.56	0.118	0.653	2706.0	1371.6	1.0	2	0	0.0	1.16	KINEMATIC WAVE	D16	0.00	0	0.00	0	0.000
			Ru	7.23	0.011	HILL	7.23	0.011									ROUTE SUB16 TO SUB17						
																	NO DIVERSION						
17	17	0.073	Ru	24.62	0.038	VLDR	45.93	0.072	0.316	1371.6	1313.1	1.0	1	7.5	7.4	0.39	KINEMATIC WAVE	D17	0.11	0	1.00	0	0.074
			Va	15.15	0.024	HILL	0.70	0.001									ROUTE SUB17 TO SUB18						
			TrB	6.86	0.011												DIVERT FLOW SUB17						
18	18	0.067	Va	40.43	0.063	LDR	42.63	0.067	0.261	1313.1	1286.5	1.0	1	60	60.0	0.38	KINEMATIC WAVE	D18	0.81	0	1.00	0	0.600
			TrB	2.20	0.003												ROUTE SUB18 TO SUB19						
																	DIVERT FLOW SUB18						
19	19	0.075	Va	48.00	0.075	LDR	48.00	0.075	0.253	1286.5	1267.2	1.0	1	60	60.0	0.38	KINEMATIC WAVE	D19	0.91	0	1.00	0	0.600
																	ROUTE SUB19 TO SUB20						
																	DIVERT FLOW SUB19						

TABLE A-6 (3 of 5)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUB BASIN SOILS MAP UNIT AND LAND USE TYPE ESTIMATES																		DIVERSION DATA					
																		DT		DI		DQ	
SUB. #	CP #	TOTAL AREA SQ. MI.	SOILS MAP UNIT	MAP AREA AC.	MAP AREA SQ. MI.	LAND USE TYPE	LAND AREA AC.	LAND AREA SQ. MI.	FLOW LENGTH MILES	ELEV. HIGH FT.	ELEV. LOW FT.	STORM SIZE SQ. MI.	UA RECORD #	% ONSITE RETEN. 4	ADJ. % RETEN.	10YR-6HR EXCESS PREC. (IN)	ROUTING & DIVERSION NOTES	FIELD1 ISTAD D#	FIELD2 DSTRMX AC-FT	FIELD1 DINFLO T=0	FIELD2 DINFLO UNIT Qp	FIELD1 DIVFLO T=0	FIELD2 DIVFLO UNIT Qp
20	20	0.129	Va	35.37	0.055	LDR	82.47	0.129	0.279	1267.2	1252	0.8	1	60	60.0	0.45	STORAGE ROUTNG	D20	1.86	0	1.00	0	0.600
			Es	9.22	0.014												DIVERT FLOW SUB20						
			Mv	37.88	0.059																		
21	21	0.124	Ro	72.65	0.114	MOUNT.	72.65	0.114	0.565	2706.0	1388.7	0.8	2	0	0.0	1.14	KINEMATIC WAVE	D21	0.00	0	0.00	0	0.000
			Ru	7.03	0.011	HILL	7.03	0.011									ROUTE SUB21 TO SUB22						
																	NO DIVERSION						
22	22	0.112	Ro	4.28	0.007	MOUNT	4.28	0.007	0.517	1388.7	1318.8	0.8	1	0	6.3	0.33	KINEMATIC WAVE	D22	0.12	0	1.00	0	0.063
			Ru	25.84	0.040	HILL	7.06	0.011						0			ROUTE SUB22 TO SUB23						
			Va	41.27	0.064	VLDR	54.45	0.085						0			DIVERT FLOW SUB22						
						GOLF	5.60	0.009						80									
23	23	0.060	Va	38.55	0.060	LDR	38.07	0.059	0.235	1318.8	1288.4	0.8	1	60	59.3	0.38	KINEMATIC WAVE	D23	0.72	0	1.00	0	0.593
						VLDR	0.48	0.001									ROUTE SUB23 TO SUB24						
																	DIVERT FLOW SUB23						
24	24	0.077	Va	49.18	0.077	LDR	49.18	0.077	0.282	1288.4	1266.5	0.8	1	60	60.0	0.38	KINEMATIC WAVE	D24	0.93	0	1.00	0	0.600
																	ROUTE SUB24 TO SUB25						
																	DIVERT FLOW SUB24						
25	25	0.076	Va	48.81	0.076	LDR	48.81	0.076	0.255	1266.5	1255.0	0.8	1	60	60.0	0.38	STORAGE ROUTE	D25	0.93	0	1.00	0	0.600
																	DIVERT FLOW SUB25						
26	26	0.053	Ro	9.23	0.014	MOUNT.	9.23	0.014	0.517	1756.0	1319.0	0.8	1	0	31.2	0.35	KINEMATIC WAVE	D26	0.31	0	1.00	0	0.312
			Ru	8.00	0.013	HILL	6.02	0.009						0			ROUTE SUB26 TO SUB27						
			Va	16.92	0.026	VLDR	1.16	0.002						0			DIVERT SUB 26						
						GOLF	17.74	0.028						60									
27	27	0.061	Va	38.82	0.061	LDR	38.82	0.061	0.245	1319.0	1288.6	0.8	1	60	60.0	0.38	KINEMATIC WAVE	D27	0.74	0	1.00	0	0.600
																	ROUTE SUB27 TO SUB28						
																	DIVERT FLOW SUB27						
28	28	0.078	Va	49.74	0.078	LDR	49.74	0.078	0.272	1288.6	1264.5	0.8	1	60	60.0	0.38	KINEMATIC WAVE	D28	0.95	0	1.00	0	0.600
																	ROUTE SUB28 TO SUB29						
																	DIVERT FLOW SUB28						
29	29	0.058	Va	37.44	0.058	LDR	36.60	0.057	0.220	1264.5	1254.2	0.8	1	60	58.7	0.38	STORAGE ROUTE	D29	0.70	0	1.00	0	0.587
						MDR	0.84	0.001						0			DIVERT FLOW SUB29						

TABLE A-6 (4 of 5)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUB BASIN SOILS MAP UNIT AND LAND USE TYPE ESTIMATES																		DIVERSION DATA					
																		DT		DI		DQ	
SUB. #	CP #	TOTAL AREA SQ. MI.	SOILS MAP UNIT	MAP AREA AC.	MAP AREA SQ. MI.	LAND USE TYPE	LAND AREA AC.	LAND AREA SQ. MI.	FLOW LENGTH MILES	ELEV. HIGH FT.	ELEV. LOW FT.	STORM SIZE SQ. MI.	UA RECORD #	% ONSITE RETEN. 4	ADJ. % RETEN.	10YR-6HR EXCESS PREC. (IN)	ROUTING & DIVERSION NOTES	FIELD1 ISTAD D#	FIELD2 DSTRMX AC-FT	FIELD1 DINFLO T=0	FIELD2 DINFLO UNIT Qp	FIELD1 DIVFLO T=0	FIELD2 DIVFLO UNIT Qp
30	30	0.065	Ro	2.23	0.003	MOUNT.	2.23	0.003	0.481	1590.3	1316.4	0.9	1	0	0.0	0.33	KINEMATIC WAVE	D30	0.00	0	1.00	0	0.000
			Ru	11.23	0.018	HILL	4.67	0.007						0			ROUTE SUB30 TO SUB31						
			Va	27.82	0.043	VLDR	34.38	0.054						0			NO DIVERSION						
31	31	0.061	Va	39.34	0.061	LDR	39.34	0.061	0.247	1316.4	1287.0	0.9	1	40	40.0	0.34	KINEMATIC WAVE	D31	0.45	0	1.00	0	0.400
																	ROUTE SUB31 TO SUB32						
																	DIVERT FLOW SUB31						
32	32	0.065	Va	41.44	0.065	LDR	41.44	0.065	0.274	1287.0	1266.2	0.9	1	60	60.0	0.38	KINEMATIC WAVE	D32	0.79	0	1.00	0	0.600
																	ROUTE SUB32 TO SUB33						
																	DIVERT FLOW SUB31						
33	33	0.062	Va	39.56	0.062	LDR	21.42	0.033	0.216	1266.2	1252.0	0.9	1	60	37.0	0.51	STORAGE ROUTE	D33	0.62	0	1.00	0	0.370
						MDR	17.98	0.028						10			DIVERT FLOW SUB33						
						MFR	0.16	0.000															
34	34	0.167	Va	106.65	0.167	LDR	97.50	0.152	0.571	1314.7	1264.8	0.9	1	40	36.6	0.47	KINEMATIC WAVE	D34	1.53	0	1.00	0	0.366
						MDR	1.03	0.002						0			ROUTE SUB 34 TO SUB35						
						COMM.	8.12	0.013									DIVERT FLOW SUB34						
35	35	0.128	Va	81.63	0.128	LDR	2.85	0.0045	0.290	1264.8	1250.0	0.9	1	50	9.5	0.82	STORAGE ROUTE	D35	0.53	0	1.00	0	0.095
						MDR	63.07	0.0985						10			DIVERT FLOW SUB35						
						COMM.	15.47	0.0242															
						MFR	0.24	0.0004															
36	36	0.089	Va	40.45	0.063	MFR	20.11	0.0314	0.275	1255.0	1251.0	0.9	1	20	15.0	0.86	STORAGE ROUTE	D36	0.61	0	1.00	0	0.150
			AoB	16.51	0.026	MDR	30.18	0.047						15			DIVERT FLOW SUB36						
						COMM.	6.67																
37	37	0.049	PvC	10.00	0.016	VLDR	31.28	0.0489	0.299	1385.0	1310.9	0.9	1	0	0.0	0.27	KINEMATIC WAVE	D37	0.00	0	1.00	0	0.000
			Va	21.28	0.033												ROUTE SUB37 TO SUB39						
																	NO DIVERSION LAWNS						
38	38	0.252	Ro	107.74	0.168	MOUNT.	107.74	0.1683	1.284	2706.0	1325.5	0.9	2	0	0.0	0.95	KINEMATIC WAVE	D38	0.00	0	1.00	0	0.000
			Ru	45.32	0.071	HILL	37.62	0.0588									ROUTE SUB38 TO SUB39						
			Va	4.72	0.007	VLDR	15.68	0.0245									NO DIVERSION						
			PvC	3.26	0.005																		

TABLE A-6 (5 of 5)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUB BASIN SOILS MAP UNIT AND LAND USE TYPE ESTIMATES																		DIVERSION DATA					
																		DT		DI		DQ	
SUB. #	CP #	TOTAL AREA SQ. MI.	SOILS MAP UNIT	MAP AREA AC.	MAP AREA SQ. MI.	LAND USE TYPE	LAND AREA AC.	LAND AREA SQ. MI.	FLOW LENGTH MILES	ELEV. HIGH FT.	ELEV. LOW FT.	STORM SIZE SQ. MI.	UA RECORD #	% ONSITE RETEN. 4	ADJ. % RETEN.	10YR-6HR EXCESS PREC. (IN)	ROUTING & DIVERSION NOTES	FIELD1 ISTAD D#	FIELD2 DSTRMX AC-FT	FIELD1 DINFLO T=0	FIELD2 DINFLO UNIT Qp	FIELD1 DIVFLO T=0	FIELD2 DIVFLO UNIT Qp
39	39	0.224	Ro	5.86	0.009	MOUNT.	5.87	0.009	* .662	1325.5	1259.4	0.7	1	0	4.8	0.76	KINEMATIC WAVE	D39	0.44	0	0.00	0	0.000
			Ru	18.52	0.029	HILL	7.49	0.012	** .367								ROUTE SUB39 TO SUB36						
			PvC	29.95	0.047	VLDR	79.64	0.124									NO DIVERSION						
			Va	73.46	0.115	MFR	18.72	0.029															
			TrB	15.48	0.024	COMM.	31.55	0.049															
40	40	0.074	Ro	1.54	0.002	MOUNT.	1.54	0.002	0.306	1893.0	1328.2	0.7	2	0	0.0	0.67	KINEMATIC WAVE	D40	0.00	0	0.00	0	0.000
			Ru	25.78	0.040	VLDR	17.10	0.027									ROUTE SUB40 TO SUB41						
			CeC	19.91	0.031	HILL	28.59	0.045									NO DIVERSION						
41	41	0.156	CeC	13.56	0.021	MFR	26.75	0.042	0.541	1328.2	1269.0	0.7	1	0	0.0	0.58	KINEMATIC WAVE	D41	0.00	0	0.00	0	0.000
			Ru	4.03	0.006	VLDR	69.91	0.109									ROUTE SUB41 TO SUB39						
			Va	26.13	0.041	HILL	2.03	0.003									NO DIVERSION						
			PvC	41.81	0.065	COMM.	1.00	0.002															
			TrB	14.16	0.022																		
42	42	0.206	TrB	75.63	0.118	LDR	23.14	0.036	0.511	1273.7	1259.0	0.7	1	50	8.8	0.78	STORAGE ROUTE	D42	0.75	0	1.00	0	0.088
			AoB	28.60	0.045	VLDR	73.43	0.115									DIVERT FLOW SUB42						
			Va	27.36	0.043	COMM.	35.02	0.055															

* Flow length for Routing for sub37.

** Flow length for routing subbasin 41.

05-0222-01 / 5/31/96

TABLE A-7 (1 of 2)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUBBASIN #	AREA sq. mi.	IA (in.)	DTHETA WEIGHTED	PSIF (in.)	adj. XKSAT	RTIMP %	LENGTH MILES	EL. (ft.) HIGH	EL. (ft.) LOW	SLOPE ft/mi
1	0.037	0.142	0.322	4.55	0.310	52.0	0.280	1950.0	1356.3	2120.4
2	0.119	0.342	0.250	4.65	0.440	9.0	0.603	1356.3	1303.3	87.9
3	0.067	0.298	0.250	4.25	0.510	16.0	0.259	1303.3	1291.0	47.5
4	0.065	0.300	0.250	4.80	0.360	15.0	0.250	1291.0	1280.4	42.4
5	0.067	0.300	0.250	4.80	0.360	15.0	0.437	1280.4	1269.7	24.5
6	0.090	0.113	0.341	4.70	0.250	50.0	0.263	1974.5	1359.0	2340.3
7	0.153	0.295	0.269	5.40	0.280	18.0	0.563	1359.0	1319.2	70.7
8	0.068	0.300	0.250	4.35	0.480	15.0	0.436	1319.2	1296.4	52.3
9	0.065	0.300	0.250	4.50	0.430	15.0	0.249	1296.4	1282.7	55.0
10	0.093	0.299	0.250	4.80	0.360	15.0	0.338	1282.7	1270.0	37.6
11	0.093	0.115	0.350	4.55	0.270	39.0	0.557	2391.0	1416.6	1749.4
12	0.120	0.269	0.279	5.70	0.200	9.0	0.309	1416.6	1322.3	305.2
13	0.129	0.300	0.230	6.20	0.200	15.0	0.258	1322.3	1294.5	107.8
14	0.126	0.300	0.250	4.10	0.550	15.0	0.249	1294.5	1275.9	74.7
15	0.126	0.297	0.250	4.65	0.390	16.0	0.376	1275.9	1254.8	56.1
16	0.129	0.104	0.350	4.70	0.240	47.0	0.653	2706.0	1371.6	2043.5
17	0.073	0.298	0.252	4.35	0.400	10.0	0.316	1371.6	1313.1	185.1
18	0.067	0.300	0.250	4.15	0.530	15.0	0.261	1313.1	1286.5	101.9
19	0.075	0.300	0.250	3.95	0.580	15.0	0.253	1286.5	1267.2	76.3
20	0.129	0.300	0.250	4.45	0.450	15.0	0.279	1267.2	1252	54.5
21	0.124	0.104	0.350	4.70	0.240	46.0	0.565	2706.0	1388.7	2331.5

TABLE A-7 (2 of 2)

SUB BASIN DATA INPUT PARAMETER ESTIMATES

SUBBASIN #	AREA sq. mi.	IA (in.)	DTHETA WEIGHTED	PSIF (in.)	adj. XKSAT	RTIMP %	LENGTH MILES	EL. (ft.) HIGH	EL. (ft.) LOW	SLOPE ft/mi
22	0.112	0.281	0.266	4.00	0.480	11.0	0.517	1388.7	1318.8	135.2
23	0.060	0.300	0.250	3.95	0.580	15.0	0.235	1318.8	1288.4	129.4
24	0.077	0.300	0.250	3.95	0.580	15.0	0.282	1288.4	1266.5	77.7
25	0.076	0.300	0.250	3.95	0.580	15.0	0.255	1266.5	1255.0	45.1
26	0.053	0.272	0.295	4.25	0.520	17.0	0.517	1756.0	1319.0	845.3
27	0.061	0.300	0.250	3.95	0.580	15.0	0.245	1319.0	1288.6	124.1
28	0.078	0.300	0.250	3.95	0.580	15.0	0.272	1288.6	1264.5	88.6
29	0.058	0.299	0.250	3.95	0.580	15.0	0.220	1264.5	1254.2	46.8
30	0.065	0.272	0.267	4.00	0.460	10.0	0.481	1590.3	1316.4	569.4
31	0.061	0.300	0.260	3.67	0.690	15.0	0.247	1316.4	1287.0	119.0
32	0.065	0.300	0.250	3.95	0.580	15.0	0.274	1287.0	1266.2	75.9
33	0.062	0.277	0.250	3.95	0.580	22.0	0.216	1266.2	1252.0	65.7
34	0.167	0.284	0.250	3.95	0.590	20.0	0.571	1314.7	1264.8	87.4
35	0.128	0.223	0.250	3.95	0.600	39.0	0.290	1264.8	1250.0	51.0
36	0.089	0.232	0.250	3.95	0.590	41.0	0.275	1255.0	1251.0	14.5
37	0.049	0.300	0.250	3.95	0.490	5.0	0.299	1385.0	1310.9	247.8
38	0.252	0.131	0.340	4.55	0.280	37.0	1.284	2706.0	1325.5	1075.2
39	0.224	0.233	0.259	4.30	0.450	29.0	0.662	1325.5	1259.4	99.8
40	0.074	0.203	0.314	4.00	0.420	11.0	0.306	1893.0	1328.2	1845.8
41	0.156	0.281	0.252	4.35	0.420	16.0	0.541	1328.2	1269.0	109.4
42	0.206	0.247	0.250	5.60	0.250	27.0	0.511	1273.7	1259.0	28.8

TABLE A-8 (1 of 3)

SUBBASIN ROUTING PARAMETER ESTIMATES

		KINEMATIC WAVE ROUTING										COMBINE HYDROGRAPH	
		KK	RK									KM	HC
SUB. #	CP #	FIELD1	FIELD1 L	FIELD2 S	FIELD3 N	FIELD4 CA	FIELD5 SHAPE	FIELD6 WD	FIELD7 Z	FIELD8 UPSTQ	FIELD9 NDXMIN	COMENTS	FIELD1 #
1	1												
		R1-2	3183.8	0.0166	0.07		TRAP	0	3	YES			
2	2											Combine sub1 & sub2 at cp2	2
		R2-3	1367.5	0.009	0.016		TRAP	60	1	YES			
3	3											Combine sub2 & sub3 at cp3	2
		R3-4	1320.0	0.008	0.016		TRAP	44	1	YES			
4	4											Combine sub3 & sub4 at cp4	2
		R4-5	2307.4	0.005	0.016		TRAP	44	1	YES			
5	5	Storage Route using Modified Puls to Sub10										Combine sub4 & sub5 at cp5	2
6	6												
		R6-7	2972.0	0.013	0.07		TRAP	0	3	YES			
7	7											Combine sub6 & sub7 at cp7	2
		R7-8	2302.1	0.001	0.016		TRAP	40	1	YES			
8	8											Combine sub7 & sub8 at cp8	2
		R8-9	1314.7	0.010	0.016		TRAP	20	1	YES			
9	9											Combine sub8 & sub9 at cp9	2
		R9-10	1784.7	0.007	0.016		TRAP	40	1	YES			
10	10	Storage Route using Modified Puls to Sub15										Combine sub9,sub5 & sub10 at cp10	3
11	11												
		R11-12	1632.0	0.058	0.07		TRAP	0	3	YES			
12	12											Combine sub11 & sub12 at cp12	2
		R12-13	1362.2	0.020	0.016		TRAP	60	1	YES			
13	13											Combine sub12 & sub13 at cp13	2
		R13-14	1314.7	0.014	0.016		TRAP	60	1	YES			
14	14											Combine sub13 & sub14 at cp14	2
		R14-15	1985.3	0.011	0.016		TRAP	60	1	YES			
15	15	Storage Route using Modified Puls to Sub20										Combine sub14, sub10 & sub15 at cp1	3
16	16												
		R16-17	1668.0	0.035	0.07		TRAP	0	3	YES			
17	17											Combine sub16 & sub17 at cp17	2
		R17-18	1378.1	0.019	0.016		TRAP	40	1	YES			
18	18											Combine sub17 & sub18 at cp18	2
		R18-19	1335.8	0.014	0.016		TRAP	40	1	YES			
19	19											Combine sub18 & sub19 at cp19	2
		R19-20	1473.1	0.010	0.016		TRAP	30	1	YES			
20	20	Storage Route using Modified Puls to Sub25										Combine sub19, sub15 & sub20 at cp2	3
21	21												
		R21-22	2735.0	0.026	0.07		TRAP	0	3	YES			
22	22											Combine sub21 & sub22 at cp22	2

TABLE A-8 (2 of 3)

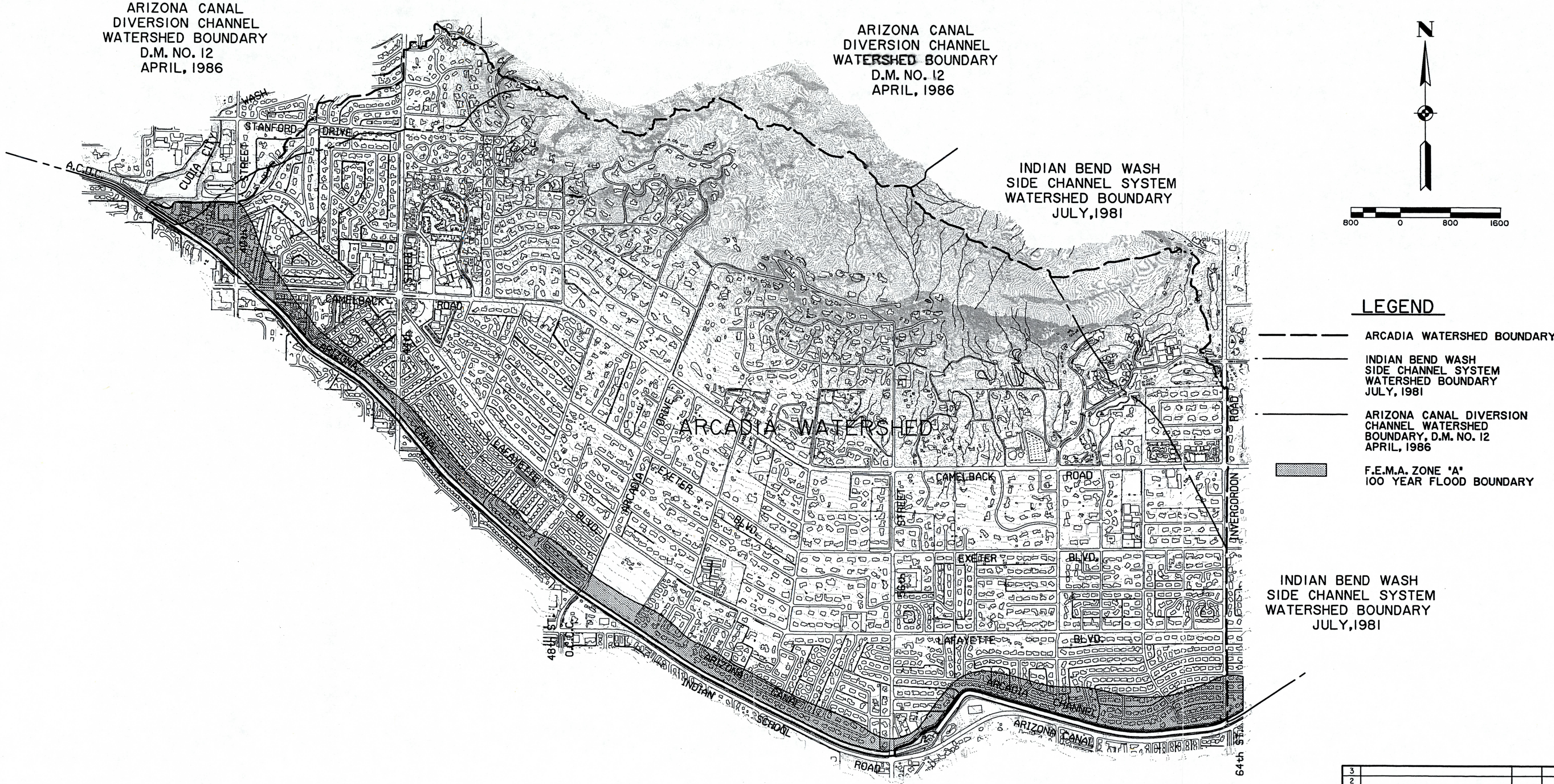
SUBBASIN ROUTING PARAMETER ESTIMATES

		KINEMATIC WAVE ROUTING										COMBINE HYDROGRAPH	
		KK	RK									KM	HC
SUB. #	CP #	FIELD1	FIELD1 L	FIELD2 S	FIELD3 N	FIELD4 CA	FIELD5 SHAPE	FIELD6 WD	FIELD7 Z	FIELD8 UPSTQ	FIELD9 NDXMIN	COMENTS	FIELD1 #
22	22												
		R22-23	1240.8	0.025	0.016		TRAP	20	1	YES			
23	23											Combine sub22 & sub23 at cp23	2
		R23-24	1488.9	0.015	0.016		TRAP	35	1	YES			
24	24											Combine sub23 & sub24 at cp24	2
		R24-25	1346.4	0.009	0.016		TRAP	40	1	YES			
25	25	Storage Route using Modified Puls to Sub29										Combine sub24, sub20 & sub25 at cp2	3
26	26												
		R26-27	1293.6	0.024	0.016		TRAP	35	1	YES			
27	27											Combine sub26 & sub27 at cp27	2
		R27-28	1436.2	0.017	0.016		TRAP	35	1	YES			
28	28											Combine sub27 & sub28 at cp28	2
		R28-29	1161.6	0.009	0.016		TRAP	35	1	YES			
29	29	Storage Route using Modified Puls to Sub33										Combine sub28, sub25 & sub29 at cp2	3
30	30											Combine sub38 & sub30 at cp30	2
		R30-31	1304.0	0.023	0.05		TRAP	20	1	YES			
31	31											Combine sub30 & sub31 at cp31	2
		R31-32	1260.0	0.019	0.016		TRAP	30	1	YES			
32	32											Combine sub31 & sub32 at cp32	2
		R32-33	1447.0	0.0144	0.07		TRAP	0	1	YES			
33	33	Storage Route using Modified Puls to Sub35										Combine sub32, sub29 & sub33 at cp3	3
34	34												
		R34-35	1531.2	0.018	0.016		TRAP	40	1	YES			
35	35	Storage Route using Modified Puls to Sub36										Combine sub34, sub33 & sub35 at cp3	3
36	36	Storage Route using Modified Puls to Sub42										Combine sub39, sub35, 2 recalled	5
												Diversions and sub36 at cp36	
37	37												
		R37-39	3500.0	0.018	0.016		TRAP	70	1	YES			
38	38												
		R38-39	1141.0	0.0149	0.032		TRAP	15	2	YES			
39	39											Combine sub37, recalled diversion,	
		R39-36	1250.0	0.006	0.016		TRAP	26	1	YES		sub41 and sub39 at cp39	4
40	40												
		R40-41	1452.0	0.0221	0.05		TRAP	6	2	YES			
41	41											Combine sub40 & sub41 at cp41	2
		R41-39	2865.0	0.0341	0.05		TRAP	4	3	YES			
42	42											Combine sub36 & sub42 at cp42	

TABLE A-8 (3 of 3)

SUBBASIN ROUTING PARAMETER ESTIMATES

MODIFIED PULS ROUTING																			
	KK	RS				SV							SQ						
SUB. #	FIELD1	FIELD1 NSTPS	FIELD2 ITYP	FIELD3 RSVRIC	FIELD4 X	FIELD1 AC-FT	FIELD2 AC-FT	FIELD3 AC-FT	FIELD4 AC-FT	FIELD5 AC-FT	FIELD6 AC-FT	FIELD7 AC-FT	FIELD1 CFS	FIELD2 CFS	FIELD3 CFS	FIELD4 CFS	FIELD5 CFS	FIELD6 CFS	FIELD7 CFS
5 10	R5-10	1	FLOW	-1	0	0	1	3	13	50	110	162	0	75	250	500	1200	2400	4000
10 15	R10-15	1	FLOW	-1	0	0	2	5	8	46	156	247	0	75	250	500	1200	2400	4000
15 20	R15-20	1	FLOW	-1	0	0	14	18	25	35	72	111	0	75	250	500	1200	2400	4000
20 29	R20-25	1	FLOW	-1	0	0	23	27	35	37	84	122	0	75	250	500	1200	2400	4000
25 29	R25-29	1	FLOW	-1.0	0.00	0	2	6	13	23	35	36	0	75	250	500	1200	2400	4000
29 33	R29-33	1	FLOW	-1.0	0.00	0	2	4	7	18	36	60	0	75	250	500	1200	2400	4000
33 35	R33-35	1	FLOW	-1.0	0.00	0	5	10	22	50	93	142	0	75	250	500	1200	2400	4000
35 36	R35-36	1	FLOW	-1.0	0.00	0	4	9	28	67	131	179	0	75	250	500	1200	2400	4000
36 42	R36-42	1	FLOW	-1.0	0.00	0	3	6	10	34	60	130	0	75	250	500	1200	2400	4000



NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

ARCADIA AREA
DRAINAGE STUDY
PROJECT NO. 94-21

	BY	DATE
DESIGNED	J. GIRAND	03-97
DRAWN	S. SMITH	03-97
CHECKED	R. WISE	03-97

Registered Professional Engineer Civil, Certificate No. 6106, JON GIRAND, ARIZONA, U.S.A.

HUITT - ZOLLARS
6245 N. 24th PARKWAY /SUITE 102 /PHOENIX, ARIZONA 85016-202
(602) 381-0125 FAX (602) 381-8053

WATERSHED BOUNDARY MAP

FIGURE 1

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

ARCADIA AREA DRAINAGE STUDY
PROJECT NO. 94-21

Registered Professional Engineer (Civil) — CERTIFICATE NO. 6106 — JON GIRAND — ARIZONA, U.S.A.

	BY	DATE
DESIGNED	J. GIRAND	03-97
DRAWN	S. SMITH	03-97
CHECKED	R. WISE	03-97

HUITT ~ ZOLLARS
6245 N. 24th PARKWAY /SUITE 102 /PHOENIX, ARIZONA 85016-2029 (602) 381-0125 FAX (602) 381-8053

EXISTING DRAINAGE SYSTEMS — FIGURE 2

FILE NAME: MAP-LAND.DGN 04-20-95

N

800 0 800 1600

LEGEND

— —	WATERSHED BOUNDARY
——	SUBBASIN BOUNDARY
2	SUBBASIN IDENTIFICATION NUMBER
——	LAND USE BOUNDARY
	COMMERCIAL
	GOLF COURSE
	HILL SIDE
	LOW DENSITY RESIDENTIAL
	MEDIUM DENSITY RESIDENTIAL
	MOUNTAIN
	MULTIPLE FAMILY RESIDENTIAL
	VERY LOW DENSITY RESIDENTIAL

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

ARCADIA AREA
DRAINAGE STUDY
PROJECT NO. 94-21

Registered Professional Engineer (Civil) — Certificate No. 6106 — JON GIRAND — ARIZONA, U.S.A.

	BY	DATE
DESIGNED	J. GIRAND	03-97
DRAWN	S. SMITH	03-97
CHECKED	R. WISE	03-97

HUITT - ZOLLARS
6245 N. 24th PARKWAY /SUITE 102 /PHOENIX, ARIZONA 85016-2029
(602) 381-0125 FAX (602) 381-8053

LAND USE MAP

FIGURE 3

FILE NAME: MAP-SOIL.DGN 04-20-95

LEGEND

— — — —	SUBBASIN BOUNDARY
———	SOILS BOUNDARY
2	SUBBASIN IDENTIFICATION NUMBER
AoB	ANTHO GRAVELLY SANDY LOAM
CeC	CALVELT GRAVELLY LOAM
Es	ESTRELLA LOAM
LaA	LAVEEN LOAM
Mv	MOHALL LOAM
PvC	PINAMT VERY GRAVELLY LOAM
TrB	TREMANT/GRAVELLY SANDY CLAY LOAM
Ro	ROCK LAND/GRAVELLY/SANDY LOAM
Ru	ROUGH BROKEN LAND
Va	VALENCIA SANDY LOAM

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

ARCADIA AREA
DRAINAGE STUDY
PROJECT NO. 94-21

	BY	DATE
DESIGNED	J. GIRAND	03-97
DRAWN	S. SMITH	03-97
CHECKED	R. WISE	03-97

Registered Professional Engineer Civil, Certificate No. 6106 JON GIRAND, Arizona, U.S.A.

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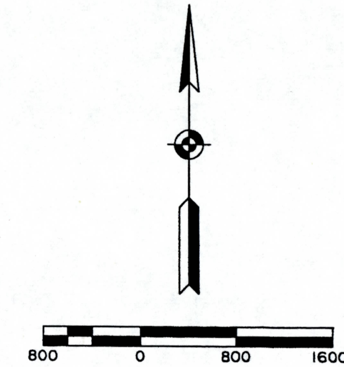
(602) 381-0125 FAX (602) 381-8053

GENERAL SOILS MAP — FIGURE 4

FILE NAME: MAP-DRA.DGN 04-20-95



LEGEND

— — —	WATERSHED BOUNDARY
———	SUBBASIN BOUNDARY
——→——	ROUTING REACH
2	SUBBASIN IDENTIFICATION NUMBER
●	CONCENTRATION POINT

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

ARCADIA AREA
DRAINAGE STUDY
PROJECT NO. 94-21

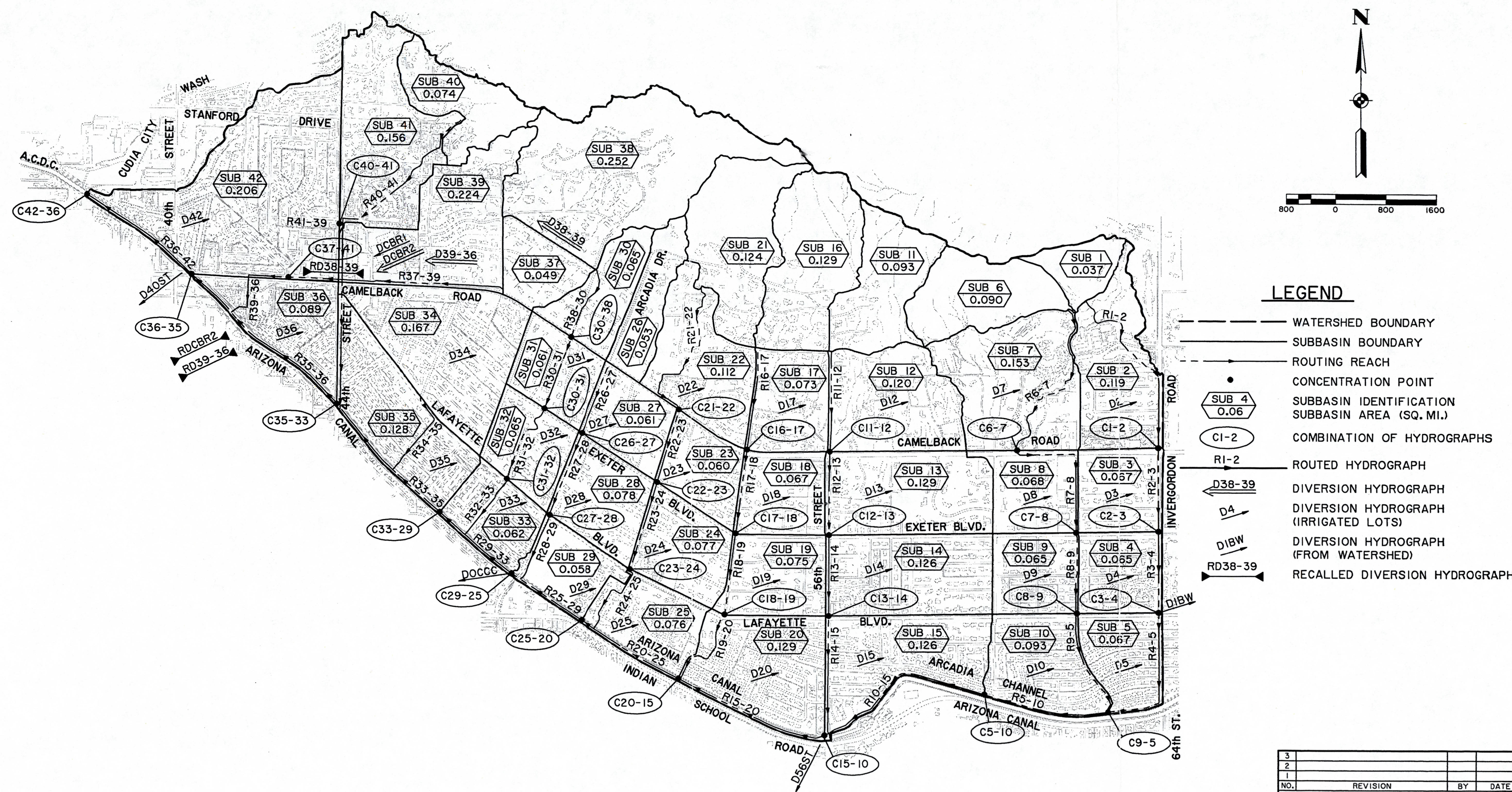
Registered Professional Engineer Civil — CERTIFICATE NO. 6106 JON GIRAND — ARIZONA, U.S.A.

	BY	DATE
DESIGNED	J. GIRAND	03-97
DRAWN	S. SMITH	03-97
CHECKED	R. WISE	03-97

HUITT - ZOLLARS
6245 N. 24th PARKWAY /SUITE 102 /PHOENIX, ARIZONA 85016-2029
(602) 381-0125 FAX (602) 381-8053

DRAINAGE AREA MAP — FIGURE 5

FILE NAME: MAP-HEC.DGN 04-20-95



NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT
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ENGINEERING DIVISION

ARCADIA AREA
DRAINAGE STUDY
PROJECT NO. 94-21

	BY	DATE
DESIGNED	J. GIRAND	03-97
DRAWN	S. SMITH	03-97
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Registered Professional Engineer, Civil — Certificate No. 6106 — JON GIRAND — ARIZONA, U.S.A.

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HEC-1 FLOW DIAGRAM (EXIST.) FIGURE 6

BIBLIOGRAPHY

STUDIES AND REPORTS

1. Arthur Beard Engineers, Inc. Arcadia Area Master Drainage Study, Draft Copy. November, 1985.

2. City of Phoenix, Arizona. Flood Damage Report Storm & Flood of September 4-6, 1970. February 1971.

3. Coe & Van Loo Consulting Engineers, Inc. Study of Arcadia - Arizona Canal Storm Drain Channel 64th Street to 56th Street. July, 1971.

4. Flood Control District of Maricopa County. Arcadia Area Drainage Project Study - OCCC Hydraulics. October, 1994.

5. Flood Control District of Maricopa County. Arizona Canal Diversion Channel Reach 4 Letter of Map Revision. October, 1992.

6. Flood Control District of Maricopa County. Contract FCD 94-21 Lafayette Interceptor Drain (LID) Project Study.

7. Flood Control District of Maricopa County. Evaluating Impact of Discharging 1,000 cfs from Arizona Canal into the ACDC. April, 1994.

8. Flood Control District of Maricopa County. Old Cross Cut Canal/Lafayette Interceptor Drain Hydrology Report. September, 1993.

9. Flood Control District of Maricopa County. Report on Flood of 22 June 1972. October, 1972.

10. Flood Control District of Maricopa County. Storm Report July 23-24, 1992. No Date.

11. Greiner, Inc. HEC-2 Water Surface Profiles of Old Cross Cut Canal. October, 1993.

12. Harris-Toups Associates. Cross sections of Arizona Canal. No Date.

13. Lee, L.L. Desert Flood of August 3, 1943. August, 1943.

14. Micheal Baker Jr. Inc. HEC-2 Data Input for 100-YR Storm Echo Canyon Wash. No Date.

15. Salt River Project. Arizona Canal Release Capacities. August, 1994.

16. Salt River Project. HEC-2 Program and Survey Data for Arizona Canal. 1990.

17. Salt River Project. Water Transmission System. 1993.

18. U.S. Army Corps of Engineers. Arizona Canal Diversion Channel Design Memorandum No. 3. March, 1985.

19. U.S. Army Corps of Engineers. Arizona Canal Diversion Channel Design Memorandum No. 12. April, 1986.

20. U.S. Army Corps of Engineers. Arizona Canal Diversion Channel Dreamy Draw to Cudia City Wash Economic Analysis. March, 1987.

21. U.S. Army Corps of Engineers. Arizona Canal Diversion Channel As-Builts Reach Four. June, 1992.

22. U.S. Army Corps of Engineers. Feasibility Report Phoenix Metropolitan Area Old Cross-Cut Canal Phoenix Arizona. April, 1989.

23. U.S. Army Corps of Engineers. Gila River Basin, Arizona Indian Bend Wash Design Memorandum No. 5 Feature Design For Side Channels System Project Design for Indian Bend Wash. July, 1981.

24. U.S. Army Corps of Engineers. Old Cross Cut Phoenix, Arizona. Hydrology For Feasibility Studies For Flood Control And Allied Purposes. June, 1987.

25. Wood/Patel Associates. Arcadia Estates Grading and Drainage Plan. December, 1994.

26. Meeting Notes regarding special proceedings on irrigated lots.

MAPPING

27. City of Phoenix. 1/4 Section Maps of Aerial Photographs. Various Dates.

28. City of Phoenix. 1/4 Section Right-of-Way Maps. Various Dates.

29. City of Phoenix. 1/4 Section Storm Drain Maps. No Date.

30. City of Phoenix. 1/4 Section Topographical Maps. July, 1991.

31. City of Phoenix. 1/4 Section Water/Wastewater Maps. No Date.

32. City of Scottsdale. 1/4 Section Water/Wastewater Maps. No Date.

33. Dimension Cable. 1/4 Section Map of Underground Cable TV Lines. Various Dates.

34. Flood Control District of Maricopa County. ARCSOILS.DWG. 1994.

35. Flood Control District of Maricopa County. Rain Gage Map. January, 1993.

36. Kaminski Hubbard. 1"=400' Topographical Map for ACDC Phase 1. No Date.

37. Landiscor. 1994 Phoenix Photo Atlas. 1994.

38. Michael Baker Jr. Inc. 1/4 Section Topographical Maps. Various Dates.

39. Salt River Project. 1/4 Section Maps of Underground Power. Various Dates.

40. Southwest Gas. 1/4 Section Underground Map of Gas Lines. Various Dates.

41. U.S. West. 1/4 Section Map of Telephone Lines. Various Dates.

CONSTRUCTION PLANS

42. City of Phoenix. Camelback Rd. 40th Street to 44th Street As-Builts. September, 1993.

43. City of Phoenix. Camelback Rd. 45th Street to 60th Street As-Builts. May, 1988.

44. City of Phoenix. Development Plans for 4255 Camelback East Apartments. February, 1973.

45. City of Scottsdale. Camelback Side Drain Extension. July, 1986

46. Ellis-Murphy. The Phoenician Resort Grading and Drainage Plans. March, 1987.

47. Holmquist & King. The Village at Camelback Mountain Storm Drainage Plans. December, 1973.

CRITERIA

48. Denver Regional Council of Governments, Urban Drainage and Flood Control District. Drainage Criteria Manual Volume 1. November, 1990.

49. Flood Control District of Maricopa County. Data Delivery Specifications: The Hydrologic Information System (HIS). No Date.

50. Flood Control District of Maricopa County. Drainage Design Menu System. March, 1994.

51. Flood Control District of Maricopa County. Drainage Design Manual for Maricopa County Volume 1 Hydrology. 1992.

52. "Additional Control Points in between Stanford Drive & Camelback and 32nd Street & 40th Street," October 6, 1994. (Arcadia Area). Memo from Martin Dent to Don Rerick. FCDMC.

CITY OF PHOENIX STORM DRAIN AS-BUILTS

	AS-BUILT #	PROJECT #	DESCRIPTION
53.	43390	ST72164.00	Arcadia Drainage Channel 56th St. to 64th St.
54.	6-92-11		Improvement Plans 64th St. & AZ Canal
55.	36928	W70141.00	Water Main AZ Canal & Jokake Dr.
56.	1006		Devel Plans Villa Arcadia Lafayette & 52nd St.
57.	16254		Improvement Plans Lafayette & Arcadia
58.	94375	M503-7(4)	Paving Plans Indian Sch. Rd. 32nd St. to 48th St.
59.	26975	P64186.00	Paving Plans 44th St. Indian Sch. to AZ Canal
60.	22587	S63208	Improvement Plans 46th Pl. & Turney
61.	101369	P87442.0	Lafayette Blvd. 50th St. to 54th St.
62.	19243		Drain Plans Lot 11 Del Ray Estates 12 Amended
63.	45670	14010	NE Corner 44th St. & Camelback Rd.
64.	88717	P76007.03	(FMS-P-769091) Camelback 40th St. to 44th St.
65.	16809	60-C-13A	Intersection Drainage Camelback Rd. & 44th St.
66.	36696		Development Plans for 4255 E. Camelback Rd.
67.	65994	P76007.00	Drainage Plans Camelback Rd. 32nd St. to 40th St.
68.	67145	ST76043.02	Drain Plans 40th St. Thomas to Camelback Rd.
69.	63937	NP7618302(ID)	Improvement District Arcadia Vista
70.	42685	P14128	Grade & Drain NW Cor Camelback Rd. & 44th St.
71.	64737	P76007.00	Camelback Rd. 32nd St. to 40th St.
72.	30038		Paving Plans NW Cor Camelback Rd. & 44th St.
73.	22757	P63111	Improvement Plans 43rd St. & Minnezona Ave.