GRANITE REEF WASH DRAINAGE STUDY

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GRANITE REEF WASH DRAINAGE STUDY

Work Order No. 68736
Contract No. CY-1994-15

Submitted To:

Maricopa County
Department of Transportation
2901 West Durango Street
Phoenix, Arizona 85009

Submitted By:

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January, 1995
Revised June, 1995

68736

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GRANITE REEF WASH DRAINAGE STUDY
SUMMARY OF DISCHARGES

MODEL NAME	CONDITIONS	DISCHARGE (cfs) @ MCKELLIPS
Historic		
Regression Equations	Desert Conditions, No CAP or Arizona Canal Drainage Area = 40.6 sq. mi.	Q_{100} = 8,760 (V_{100} = 3,740 af)
	Desert Conditions, Arizona Canal in Place Drainage Area = 9.1 sq. mi.	Q_{100} = 4,325 (V_{100} = 497 af)
SG-GRW.DAT	Desert Conditions, Arizona Canal in Place FCD Phoenix S-Graph, 100-Year, 6-Hour Single Basin Model Uniform Loss Rate, DA = 9.1 sq. mi.	Q_{100} = 4,150
COE-100.DAT	Desert Conditions, Arizona Canal in Place COE IBW S-Graph, Standard Project Flood (SPF) Q_{100} = 0.45 SPF, DA = 9.1 sq. mi.	Q_{SPF} = 9,334 Q_{100} = 4,200
Specific Yield	Desert Conditions, Arizona Canal in Place Contribution From: City of Scottsdale SRPMIC	464 cfs/sq. mi. Q_{100} = 1,531 Q_{100} = 2,691
Existing		
EX100.DAT	Contributing Watershed From City and SRPMIC 100 Year 6 Hour Hypothetical DA = 10.8 sq mi	Q_{100} = 4,440
EX50.DAT	50-Year	Q_{50} = 3,500
EX25.DAT	25-Year	Q_{25} = 2,855
EX10.DAT	10-Year	Q_{10} = 2,013
EX5.DAT	5-Year	Q_5 = 1,442
EX2SD.DAT	2-Year	Q_2 = 800
Future		
FU100.DAT	Future w/ADOT Pima Channel 100-Year 6-Hour DA = 4.3 sq mi SCS CN Kinematic	Q_{100} = 4,440
FU50.DAT	50-Year	Q_{50} = 3,500
FU25.DAT	25-Year	Q_{25} = 2,855
FU10.DAT	10-Year	Q_{10} = 2,013
FU5.DAT	5-Year	Q_5 = 1,442
FU2.DAT	2-Year	Q_2 = 800
FU100BX.DAT	Future w/ADOT Pima Channel 100-Year 6-Hour New Box Culvert at McKellips DA = 4.3 sq mi	Q_{100} = 4,160*
FU100SD.DAT	Future w/ADOT Pima Channel 100-Year 6-Hour New Storm Drain at McDonald DA = 4.3 sq mi	Q_{100} = 4,300
FU2SD.DAT	Future w/ADOT Pima Channel 2-Year 6-Hour New Storm Drain at McDonald DA = 4.3 sq mi	Q_2 = 800
FIS		
FIS100.DAT	Flood Insurance Study DA = 7.5 sq mi SRPMIC DA = 6.2 sq mi COS DA = 1.3 sq mi	Q_{100} =1,417 Q_{SRPMIC} = 643 Q_{COS} = 1,398
FIS50.DAT	50-Year	Q_{50} = 1,158
FIS10.DAT	10-Year	Q_{10} = 720

* NOTE: Design Box Culvert Not Adequate

McDOT Work Order 68736

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INTRODUCTION

A. Authorization and Purpose

The Granite Reef Wash Drainage Study was authorized by the Maricopa County Department of Transportation (MCDOT) under Work Order Number 68736. MCDOT retained Simons, Li & Associates, Inc. (SLA) to conduct the drainage study.

The purpose of the drainage study was to conduct a hydrologic analysis of Granite Reef Wash under several watershed conditions. These conditions included historical, current, and future watershed conditions. The results of the analysis provide peak flow discharges and flow volumes for Granite Reef Wash at the crossing with McKellips Road.

B. Scope of Work

A summary of the project scope of work is as follows:

1. Calculate the historical 100-year peak discharge and volume of flow at the south right-of-way line at McKellips Road under the following conditions.

    a. Historical desert conditions without development, the Arizona Canal, or the Central Arizona Project. Define the historical drainage area and use approximate methods to predict the peak discharge and flow volume.

    b. Historical conditions following the construction of the Arizona Canal and the Central Arizona Canal. Define the drainage area and use approximate methods to predict discharge and flow volume.

2. Perform a hydrologic and hydraulic analysis of the peak flow, channel locations, flow volumes, and water surface elevations for current and future conditions of the Granite Reef Wash at McKellips Road and between McKellips Road and the future north bank of the Salt River.

    a. Current conditions assume that the Arizona Canal is not overtopped. The HEC-1 model developed for the April, 1989 hydrology study of the Outer Loop Highway (Pima Freeway) shall be utilized to the extent possible. The drainage area west of the proposed Outer Loop shall be added and the model modified to reflect current land use characteristics. Major storm drain systems located west of the proposed Outer Loop shall be included in the analysis.

    b. Future Condition following completion of Pima Freeway drainage channel.

    c. Future Condition following completion of the McKellips Road drainage structure.

    d. Future Condition following the completion of the 100-year north hardbank at the Salt River.

e. Estimate the 50-year peak flow for the current condition and the future condition following completion of the Pima Freeway drainage channel.

3. Determine the main channel location and overflow area at McKellips Road and at quarter mile intervals between McKellips Road and the north bank of the Salt River for the flows determined in Section 2. Cross sections and water surface elevations shall be estimated for these locations and flows.

A summary of supplemental scope of work items is as follows:

1. Construct a pre-development HEC-1 model of the Granite Reef Wash watershed assuming the Arizona Canal is in place. The model will simulate native desert conditions with the no agriculture or urbanized land use.

2. Construct an additional future HEC-1 model that incorporates a proposed storm drain in McDonald Drive. The proposed storm drain will service a drainage basin bounded approximately by the Arizona Canal on the north, Pima Road on the east, and McDonald Drive on the south.

   The City of Scottsdale's proposed storm drain has an approximate capacity for the 10-year storm. The sub-area contributing to the storm drain will be delineated and a portion of the flows will be diverted to Indian Bend Wash. The remaining storm flows will be routed to the next downstream subbasin.

II. WATERSHED CHARACTERISTICS

This section of the drainage study report provides a summary of the Granite Reef Wash watershed under three conditions: (1) Historical; (2) Current; and (3) Future. Historical conditions refers to conditions on the watershed prior to urbanization or conversion to agricultural land use. Existing conditions refers to present day conditions including the Arizona Canal. Future conditions refers to the impact of drainage improvements proposed by the construction of the future Outer Loop Highway (Pima Freeway). The discussion will attempt to describe the land use under each of the three conditions.

A. Historical Conditions

Historical conditions on the Granite Reef Wash watershed prior to urbanization or conversion to agriculture essentially reflects those of native Lower Sonoran desert. Examination of USGS topographic maps indicates that Granite Reef Wash originates from the McDowell Mountains in North Scottsdale. Remnants of the type and density of vegetation and basin characteristics (land form, channels, etc.) of historical Granite Reef Wash may be found at the present time to exist on the Salt River Pima Maricopa Indian Community (SRPMIC) north of the Arizona Canal and south of the City of Scottsdale boundary within the Community. Remnants of the upper watershed of Granite Reef Wash under historical conditions may be found at the present time to exist north of the Central Arizona Project canal.

Figure 1 illustrates the watershed boundary of Granite Reef Wash under historical conditions. The watershed area is approximately 40.6 square miles (26,000 acres).

B. Current Conditions

Current conditions on the Granite Reef Wash watershed depict conditions after the construction of the Arizona Canal and the Central Arizona Project Canal. Figure 2 illustrates the watershed boundary of Granite Reef Wash under current conditions. The predominant land use within the watershed is primarily agricultural. This land use is located within the SRPMIC. The urbanized portion of the Granite Reef Wash watershed is located within the City of Scottsdale.

The current watershed is bounded on the north by the Arizona Canal, assuming no overtopping of flood flow from the north, and on the south by the Salt River. The eastern boundary is Center Drive. The west drainage boundary, determined by the existing City street and drainage system, is bounded by Granite Reef Road and 82nd Street. The total drainage area contributing runoff to the McKellips Road is approximately 10.8 square miles under the current condition.

C. Future Conditions

Future conditions, as defined in this drainage study, includes the drainage improvements of the proposed Pima Freeway. Future conditions on the watershed are essentially as exist currently except for the addition of the freeway.

The future watershed area of Granite Reef Wash is depicted on Plate 2 (in back map pocket). The Pima Freeway, which will include an interceptor channel along the eastern edge of the highway, will become the eastern drainage boundary for determining runoff at McKellips Road under the future condition. After completion of the Pima Freeway, the total drainage area contributing runoff to McKellips Road will be reduced to approximately 4.3 square miles.

D. Soil Type and Vegetation

Soils information and data for this drainage study of Granite Reef Wash were obtained from the hydrologic study for the Pima Freeway (7) and from the City of Scottsdale's Storm Water Master Plan (1). Both studies utilize the standard SCS hydrologic soil group classification system. An estimate can be made of the runoff potential of the soils within any given subbasin of the project watershed by using the SCS system.

Plates 1 and 2 show the composition of hydrologic soil groups for current and future conditions, respectively. It was assumed that the distribution of soils type under pre-development or historical conditions is the same as the current and future conditions. The project watershed is composed of three hydrologic soil groups: B, C, and D as shown on Plates 1 and 2..

Due to the agricultural nature of the Indian Community, vegetation density is a function of the type of crops being grown and the maturity of the crops. This parameter is accounted for in the "hydrologic condition" assigned to the land in SCS curve number charts. For this watershed, an average condition between "good" and "poor" was chosen.

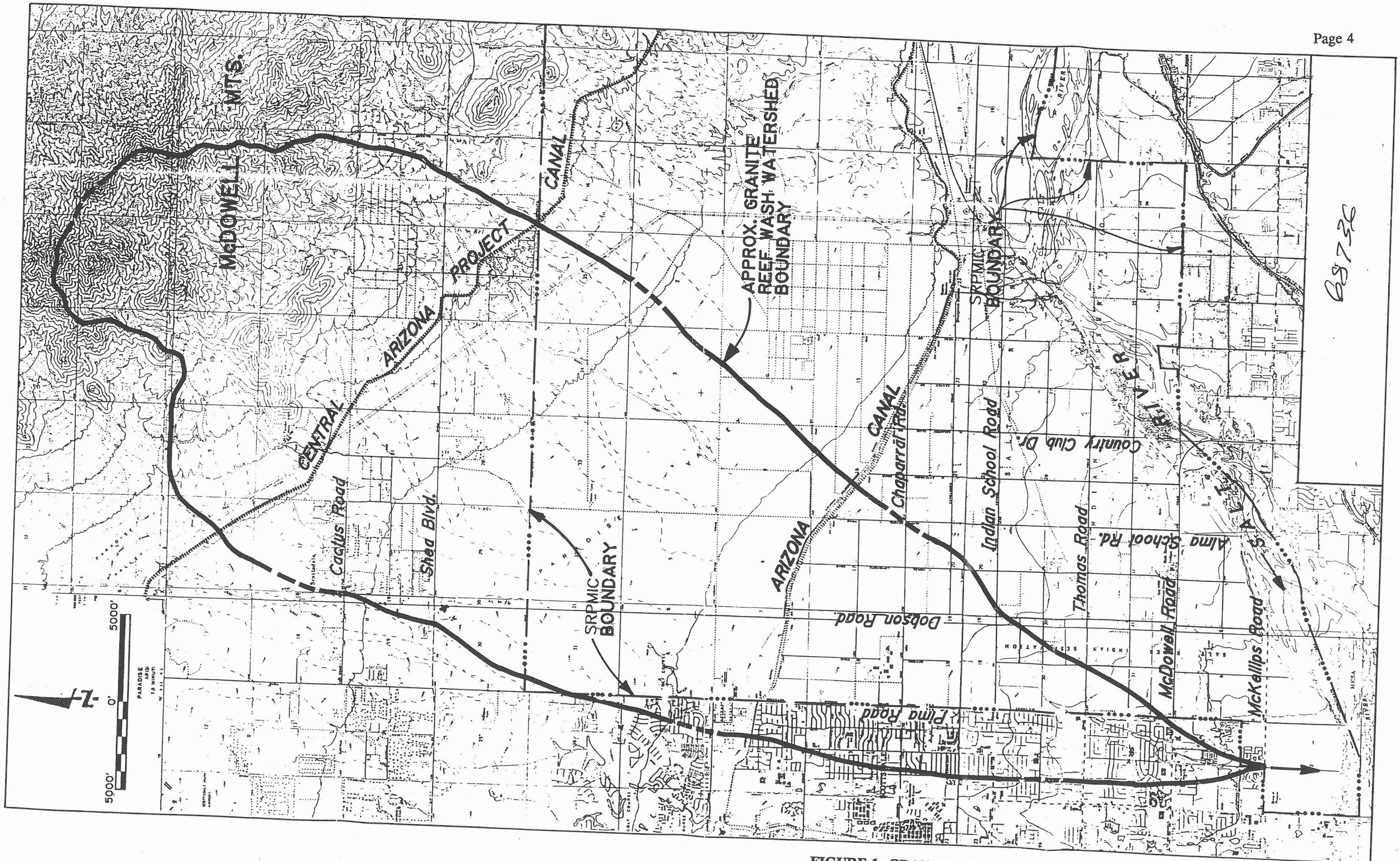

FIGURE 1. GRANITE REEF WATERSHED BOUNDARY (HISTORIC CONDITION)

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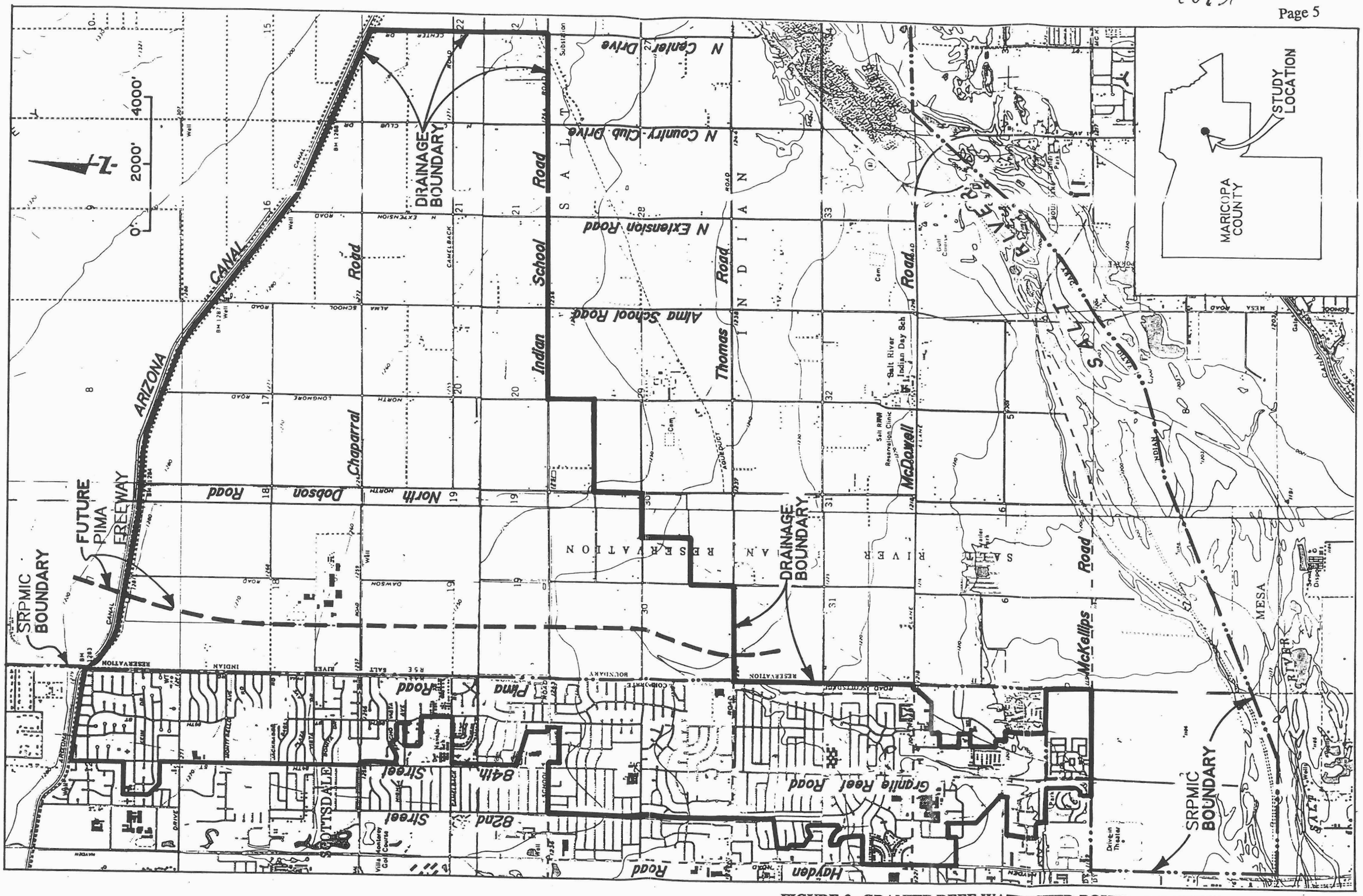

FIGURE 2. GRANITE REEF WATERSHED BOUNDARY (CURRENT CONDITION)

E. Existing Drainage Facilities

The contributing drainage area from the SRPMIC contains a network of irrigation/drainage/tailwater channels. The primary function of these channels is to deliver irrigation water to the agricultural fields. The channel network also functions as a drainage system for minor storms. Most channels are relatively small (2- to 4-feet deep and 2- to 4-feet wide), and are unable to transport large rates of runoff that might occur during a major storm. Plate 1 indicates that the irrigation channels are oriented north-south and east-west on a grid-like layout. Irrigation water generally flows west in east-west channels, and south in north-south channels.

The City of Scottsdale has constructed large diameter storm drains in Jackrabbit, Chaparral, Camelback, and Indian School Roads to capture City storm flows and direct the flows to Indian Bend Wash. The storm drains have the capacity to capture, from their respective subbasins, approximately the 10-year to 25-year storms. The City is proposing a new storm drain in McDonald Drive. This storm drain will have the capacity to capture approximately the 25-year storm.

Within the City's contributing drainage area to Granite Reef Wash, the major storm water conveyance facilities for the 100-year storm are the paved street sections. The existing major storm drain within Granite Reef Wash is a 48-inch pipeline under 87th Street which is insufficient for the 100-year storm.

McKellips Road crosses Granite Reef Wash at the present time as a dip low-flow crossing. The Maricopa County Department of Transportation (MCDOT) is proposing to construct a box culvert crossing of the wash to reduce the frequency of roadway closure due to flows in the wash. Upstream of McKellips Road, Granite Reef Wash is a small trapezoidal earth channel approximately 10-feet wide, 5-feet deep, with approximately 1:1 side slopes.

III. HYDROLOGY

A. Historical Conditions

The potential 100-year discharge and flow volume of Granite Reef Wash at McKellips Road was estimated for two historical conditions:

1) Assumes no watershed development; without the Central Arizona Project Canal and the Arizona Canal.

2) Assumes no watershed development, with the Arizona Canal in-place.

These estimations are mainly for providing qualitative comparisons between two historical conditions. Note that neither historical condition represents the current or future conditions.

The 100-year discharge was estimated by applying regression equations developed by the U.S. Geological Survey (12,13). The 1984 equations (12) were developed based on more than 2,000 station-years of systematic floods data at 101 streamflow-gaging stations in and near Pima County. The 1994 (13) study collected more than 1,300 gaging stations with a combined 40,000 station-years of annual peak discharges through water year 1986. The 1994 study divided the southwestern United States into 16 regions. The project area is classified in the Central Arizona Region 12. The 1994 equations are preferred initially based on their most up-to-date nature. However, the analysis shows significant over-prediction when applied to this project. The over-prediction may be the result of each region covering a larger area and its over-scattered database causes greater error in the prediction.

The database for the 1984 study was more localized in and near Pima County. Although average annual rainfall is higher in Pima County due to its somewhat higher altitude, the weather climate is very similar between Pima and Maricopa Counties. Some data used in the 1984 study was collected near the Tempe/Scottsdale area. SLA has applied these equations for approximate estimation with reasonable results. It is believed that the 1984 equations may be slightly over-predicting due to higher rainfall in Pima County area.

The 1984 equation (12) for the 100-year discharge can be expressed as:

$$\text{Log}Q_{100} = 3.08 + 0.643\ \text{Log}A - 0.066\ (\text{Log}A)^2$$

where:

Q_{100} = 100-year peak discharge (cfs)

A = Drainage area (square miles)

Flow volume was estimated based on the procedures outlined in the Flood Control District of Maricopa County manual (5):

$$V = C\ (P/12)\ A$$

where:

V = Flow Volume (acre-feet)

C = Runoff coefficient

P = Rainfall depth (inches)

A = Drainage area (acres)

Under the first condition, the watershed boundary of Granite Reef Wash was determined based on the ground contours shown on the USGS maps. The total drainage area contributing runoff to McKellips Road is approximately 40.6 square miles, as shown in Figure 1. The approximate 100-year discharge is 8,780 cfs, with a flow volume of 3,740 acre-feet.

The eastern and western boundaries of the second condition are identical to those of the first, while the northern boundary is limited by the Arizona Canal. The total drainage area is reduced to approximately 9.1 square miles. The approximate 100-year discharge is 4,325 cfs with a flow volume of 497 acre-feet.

Based on the above regression method, the construction of the Arizona Canal reduced the drainage area of Granite Reef Wash by 79% which reduced the potential 100-year peak discharge and flow volume at McKellips Road by 52% and 87%, respectively. Calculations for both conditions are presented in Appendix A.

Two HEC-1 models of historical conditions were developed for Granite Reef Wash. The HEC-1 models simulate the same historical conditions as the post-Arizona Canal condition.

Each of these models were developed based on a different hydrologic methodology. Table 1 lists the historical HEC-1 models and model approaches. The table also provides the 100-year discharges and volumes at McKellips Road.

Table 1. Historical Conditions HEC-1 Models and Results.

Model Name	Model Approach	Discharge/Volume (cfs)/(af)
SG-GRW.DAT	Flood Control District Method Phoenix Mountain S-Graph Initial/Uniform Loss Rate 100-Year 6-Hour Pattern 2.68	4150/904
COE100.DAT	Corps of Engineers Indian Bend Wash Method Indian Bend Wash S-Graph Exponential Loss Rate	4200/960

The total contributing watershed at McKellips Road was approximated using the USGS maps. The Granite Reef Wash watershed under historical conditions is approximately 9.1 square miles. The City of Scottsdale comprises 3.3 square miles of the watershed and the SRPMIC comprises 5.8 square miles.

The 100-year specific yield (historical conditions, post-Arizona Canal) in cubic feet per second per square mile (cfs/sq. mi.) was computed using the results of the regression technique and HEC-1 models SG-GRW.DAT and COE100.DAT. The specific yield is 464 cfs/sq. mi.

The 100-year discharge under historical post-Arizona Canal conditions contributing from the City of Scottsdale is approximately 1,531 cfs and from the SRPMIC is approximately 2,691 cfs. The computations and results are presented in Appendix A.

B. Current Conditions

A HEC-1 model was developed to simulate the current hydrologic characteristics of the Granite Reef Wash watershed. The watershed is comprised of the contributing portions of the agricultural lands of the SRPMIC and the contributing urbanized area of the City of Scottsdale.

The contributing watershed from the SRPMIC was taken from the Pima Freeway hydrology study (7). The SRPMIC watershed is shown on Plate 2 and is bordered by Pima Road on the west, the Arizona Canal on the north, Thomas Road on the south, and Center Drive on the east. The SRPMIC contributing watershed to Granite Reef Wash is 7.4 square miles and discharges into the City of Scottsdale approximately at the intersection of Thomas and Pima Roads.

The Pima Freeway hydrology study (7) goes into great detail of the development of the freeway hydrology model, assumptions, criteria, and results. This drainage study will only incorporate by reference the Pima Freeway report discussion of the drainage patterns and drainage facilities network of the SRPMIC agricultural lands. The freeway report goes into extensive detail describing and discussing the hydrologic characteristics of the SRPMIC agricultural lands.

The contributing watershed from the City of Scottsdale is highly urbanized. The contributing area from the City is approximately 3.4 square miles. This portion of the City of Scottsdale is a relatively older area of the City that was developed prior to current City drainage ordinances. There is very little on-site retention/detention and a high degree of impervious areas (rooftops, pavements, parking lots, etc.)

The City of Scottsdale has constructed large diameter storm drains in several major east-west arterial streets. These storm drains extend from Indian Bend Wash to Pima Road. The capacity of the storm drains can handle approximately the 10- to 25-year storm events. The storm drains discharge into Indian Bend Wash. Table 2 summarizes the storm drain data which was compiled from the City of Scottsdale's Storm Water Master Plan Individual Basin Reports (1).

Table 2. Summary of City of Scottsdale Major Storm Drains.

Street Location	Reach (Upstream/Downstream)	Pipe Diameter (in)	Pipe Slope (ft/ft)	Pipe Capacity (cfs)
Jackrabbit Road	IBW/86th Street	66	0.0019	146
Chaparral Road	IBW/82nd Street	96	0.0065	736
	82nd Street/83rd Street	90	0.0048	532
	83rd Street/Granite Reef	84	0.0041	409
	Granite Reef/86th Street	84	0.0031	356
	86th Street/87th Street	60	0.0010	82
	87th Street/Pima	36	0.0010	21
Camelback Road	IBW/82nd Street	60	0.0011	86
	82nd Street/Granite Reef	60	0.0021	119
	Granite Reef/85th Place	60	0.0033	150
	85th Place/86th Street	60	0.0019	114
Indian School Road	IBW/Hayden	72	0.0074	364
	Hayden/82nd Street	72	0.0025	212
	82nd Street/Pima	72	0.0011	140
87th Street	Thomas/Coronado	48	0.0015	56

The capacity of the storm drains are used in the current and future conditions models to divert a portion of storm water originating within the Granite Reef Wash watershed to Indian Bend Wash (except 87th Street storm drain). Diversion routines in the HEC-1 model at the major east-west arterials divert discharges up to the pipe capacities to Indian Bend Wash. The remaining flow is sent to the next downstream subbasin.

The City of Scottsdale is developing a Storm Water Master Plan (1) for the City south of the Central Arizona Project Canal. The city's contributing watershed to Granite Reef Wash was taken from the Master Plan for the City's subbasins south of the Arizona Canal and east of Indian Bend Wash. Subbasin delineation and hydrologic parameters were complied from the individual basin reports from City basins 9, 13, 14, and 15 from the Master Plan (1).

Average land slopes, percent pervious/impervious, SCS curve numbers, and routing parameters were extracted and complied from the above listed basin reports. Subbasins were delineated based on the City's one-half mile arterial streets and major east-west storm drains. The computation of subbasin hydrologic parameters are presented in Appendix B.

The rainfall distribution used to model current conditions (and future conditions) is the 100-year 6-hour rainfall using the HEC-1 hypothetical distribution. This distribution was selected because both the Pima Freeway study and the City's Master Plan utilize the HEC-1 hypothetical distribution. The Pima freeway study, however, uses the 100-year 24-hour versus the 100-year 6-hour duration. The 6-hour duration was selected based on hydrologic guidelines in the Flood Control District's Hydrology Manual (5).

Both studies (Pima and Master Plan) utilize the SCS curve number to simulate precipitation losses. The same curve numbers are used in this study for the contributing portions of the watershed as were used in the freeway and City studies. Curve numbers were area weighted in this study when City subbasins were composited to larger subbasins (see calculations Appendix B).

The basic construction of the current conditions HEC-1 model was to merge the HEC-1 models for the freeway study and the City model from the Master Plan. The merger of the models occurred at the intersection of Thomas and Pima Roads where the SRPMIC storm flows enter the City of Scottsdale.

The 100-year discharge and volume of flow for Granite Reef Wash under current conditions at McKellips Road is approximately 4,441 cfs and 770 af, respectively. A plot of the 100-year discharge hydrograph (see Figure 3) of Granite Reef Wash at McKellips Road indicates two distinct discharge peaks. The greatest peak of 4,441 cfs occurs at hour 3.3 and the second peak of 1,886 cfs occurs at hour 6.3, 3.0 hours after the first peak.

The first peak of the discharge hydrograph may be attributable to the urbanized watershed contributing from the City of Scottsdale. The higher degree of impervious area from the City contributes runoff to Granite Reef Wash faster (shorter times of concentration) than the contributing area of the SRPMIC. The second peak of the discharge hydrograph is lagged in time from the first peak and is attributable to the contributing areas from the SRPMIC.

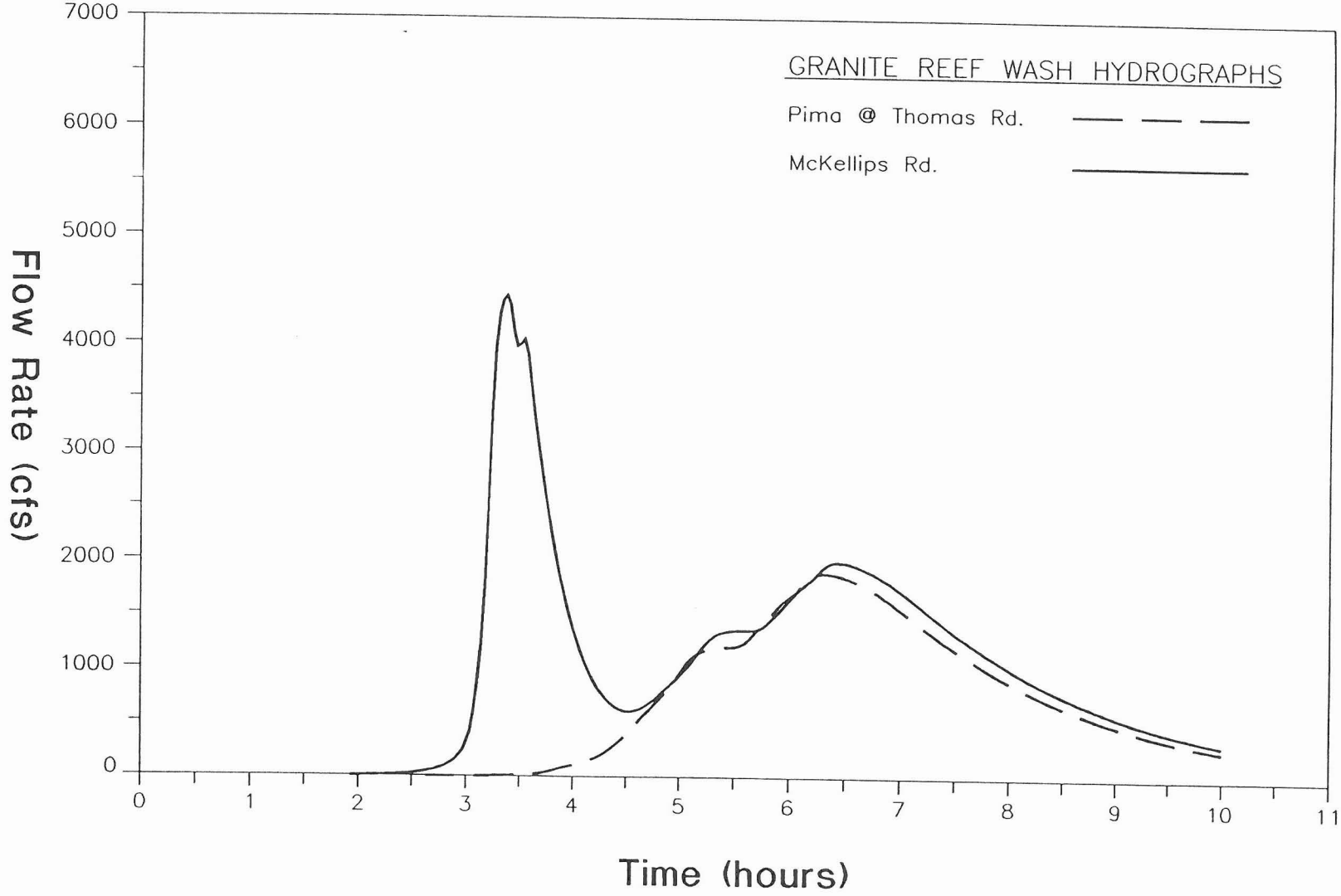

FIGURE 3. CURRENT 100-YEAR DISCHARGE HYDROGRAPH

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Water Resources & Civil Engineering Consultants

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The 100-year volume of flow contributing from the SRPMIC to Granite Reef Wash is estimated to be 476 acre feet. The volume of flow contributing to Granite Reef Wash (at McKellips Road) from the City of Scottsdale is estimated to be 294 acre feet.

The 50-year discharge and volume of flow for Granite Reef Wash under current conditions at McKellips Road is approximately 3,499 cfs and 607 af respectively. A plot of the 50-year discharge hydrograph of Granite Reef Wash at McKellips Road displays the same two peak hydrograph as the 100-year discharge hydrograph. An interpretation of the 50-year hydrograph provides the same interpretation and conclusions drawn for the 100-year event.

C. Future Conditions

Several HEC-1 models were constructed to simulate future conditions of the Granite Reef Wash watershed. These conditions include the construction of the Pima Freeway interceptor channel, a new City of Scottsdale storm drain in McDonald Drive, and the construction of a proposed box culvert at McKellips Road and Granite Reef Wash.

The Pima Freeway will be constructed east of Pima Road on the SRPMIC lands. An interceptor drainage channel will be constructed on the eastern side of the freeway to intercept off-site storm flows. The interceptor channel will have the capacity to capture the off-site 100-year storm runoff including on-site freeway pavement drainage. The Pima Freeway alignment through the SRPMIC is shown in Figure 2 and Plate 2.

The portion of the Community contributing runoff to Granite Reef Wash is a strip of land south of the Arizona Canal between Pima Road and the Freeway. This strip of Community land is assumed to drain to the intersection of Pima and Thomas Roads and enter the City at this location. The contributing area from the City of Scottsdale to Granite Reef Wash under future conditions remains the same as under current conditions.

Four HEC-1 models were constructed to simulate the future conditions. Table 3 lists the future model filenames and the conditions under which the models were constructed.

Table 3 also provides the 100- and 50-year future conditions discharges and volumes of Granite Reef Wash at McKellips Road as well as discharges and volumes for the other future conditions. Figure 4 provides a plot of the discharge hydrograph of Granite Reef Wash at McKellips Road under the 100-year conditions (FU100.DAT). The peak discharge is mainly attributable from the contributing area from the City of Scottsdale.

Table 3. Future Conditions HEC-1 Models and Results.

Future HEC-1 Model Names	Future Condition	Discharge/Volume (cfs/af)
FU100.DAT	Future with interceptor channel Drainage area = 4.3 sq. mi. 100-year 6-hour	4,441/364
FU50.DAT	Same as FU100.DAT, except 50 year storm	3,499/299
FU100SD.DAT	Same as FU100.DAT; includes new storm drain in McDonald Drive	4,298/348
FU100BOX.DAT	Same as FU100.DAT; includes new box culvert at McKellips Road	4,159/337

IV. GRANITE REEF WASH HYDRAULICS

Granite Reef Wash immediately downstream of McKellips Road is a relatively undefined undersized earth channel. The bottom width of the channel is approximately 10-feet wide with sideslopes of approximately 1(H):1(V). The channel has a depth of less than 7-feet and a slope of less than 0.1 percent. The lower channel has a steeper slope of approximately 0.3 percent. The channel is undefined from approximately 1,100-feet downstream of McKellips Road to the Salt River.

The Maricopa County Department of Transportation obtained a 1934 aerial photograph showing the Granite reef Wash Watershed south of the Arizona Canal. A copy of the 1934 photograph is provided in the map pocket as Plate 3 of this report. The photograph shows Granite Reef Wash as a fairly defined wash from Thomas Road to the Salt River following the present day alignment of Granite Reef Road. The photograph indicates the watershed south of the Arizona Canal to be predominately agricultural with a portion of native desert north of Indian School Road within the Indian Community.

A review of a 1953 aerial photograph of the Salt River in the vicinity of Indian Bend Wash and Granite Reef Wash reveals that Granite Reef Wash may have been partially diverted to join Indian Bend Wash. The diversion appears to have taken place approximately at the present day location of the well located approximately one-quarter mile north of McKellips on Granite Reef Road. The diversion appears to have been a constructed open channel that may divert flow from Granite Reef Wash due west from the well-site to Indian Bend Wash. If the well was constructed at this time (1953) the channel may just have been a conveyance channel delivering groundwater to users. The aerial photograph shows agricultural fields south of the present day well site all the way to the Salt River. There appears to be no defined Granite Reef Wash through this area south of McKellips.

Subsequent aerial photographs (1966, 1975, 1983) reveal increasing urbanization within the watershed contributing from the City of Scottsdale. The SRPMIC throughout the time record from 1934 until present day have utilized their lands from the Salt River to McKellips Road for agriculture. No defined wash appears in the photographs from 1953 onward that might indicate the presence of a historical Granite Reef Wash.

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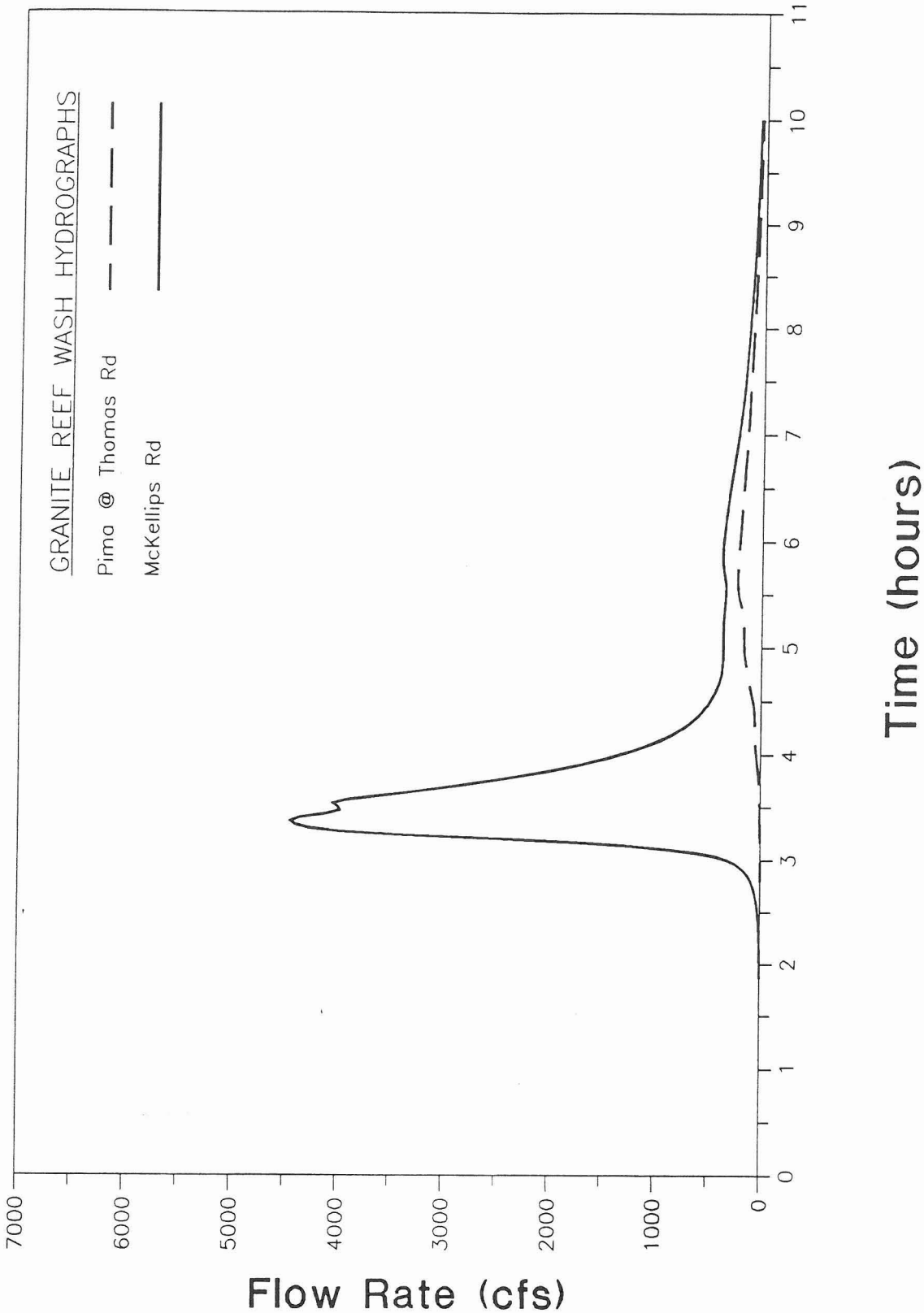

FIGURE 4. FUTURE 100-YEAR DISCHARGE HYDROGRAPH

The total length of proposed Granite Reef Wash channel improvements (3) is approximately 851 feet from the downstream end of the proposed box culvert at McKellips Road. Within the improvement reach, the upper 611 feet will be lined with gunite. The proposed channel has a 38-foot bottom width and 1.5 (H):1 (V) sideslopes. The improved channel is 7-feet deep on a slope of 0.053 percent.

A hydraulic analysis of Granite Reef Wash was performed using the surveyed cross-sections and improvement plans provided by MCDOT to SLA (3,6). The U.S. Army Corps of Engineers HEC-2 Water Surface Profile Model was used for the analyses. SLA prepared current and proposed conditions models for Granite Reef Wash starting at the north bank of the Salt River to the downstream face of the proposed box culvert at McKellips Road.

Based on the hydrologic analysis, the 100-year discharge for current and future conditions at McKellips Road is 4,440 cfs. The results of the hydraulic analysis indicates that the surveyed cross sections provided are not wide enough to contain the 100-year discharge. The current and proposed conditions model indicate the flow will not be contained within the current and proposed Granite Reef Wash.

V. SUMMARY AND CONCLUSIONS

This report presentes the results of the drainage study of Granite Reef Wash. The report summarizes the approach, assumptions, criteria, and results to develop peak discharges of Granite Reef Wash at McKellips Road for historical, current, and future conditions. The drainage study developed HEC-1 models to simulate the runoff response of the Granite Reef Wash watershed. The models simulated the response that would be associated with the 100-year and 50-year, 6-hour precipitation, and 6-hour hypothetical rainfall distribution.

The results of the drainage study have drawn the following conclusions.:

1. **Significant Change in Watershed Land Use**
   Under historical conditions, the Granite Reef Wash watershed was entirely native Sonoran desert. Typical vegetation of this land use is creosote, palo verde, mesquite, cactus, ocotillo, and various grasses and shrubs. Aerial photography from 1953, 1966, 1975, and 1983 shows significant increases in urbanization within the City of Scottsdale. The SRPMIC appears to have been using their lands for agricultural uses for an extended period of time. Review of the photographs indicates Granite Reef Wash downstream of McKellips Road ceased to exist from 1953 onward or is undefined.

2. **Shift in Runoff Response**
   Under historical conditions it can be assumed that the Granite Reef Wash watershed responded to rainfall in a fairly uniform, homogenous response across the watershed. Generally, all areas of the historic watershed responded similarly (i.e. uniform desert basin land conditions).

Under current conditions, the SRPMIC have altered the native desert conditions to an agricultural land use within their Community lands. The City of Scottsdale has completely urbanized the contributing area of the City's watershed. The result is a longer response to rainfall excess for the SRPMIC lands compared to native desert conditions, and a shorter response time for the City of Scottsdale areas compared to historical conditions.

The 100-year peak discharge under current conditions is slightly greater than historic conditions. The current (and future) 100-year discharge is attributable to the 3.4 square miles of the urbanized portion of the City of Scottsdale as opposed to the 9.1 total square miles under historic conditions.

Under future conditions with the Pima Freeway drainage improvements, the 100-year peak discharge remains the same as current conditions. In other words, the construction of the Pima Freeway drainage improvements (drainage channel) has no impact on the 100-year peak discharge at McKellips Road. The Pima Freeway drainage channel will, however, reduce the 100-year volume of flow. This supports the conclusion that the City of Scottsdale is now contributing and will continue to contribute the 100-year peak discharge of approximately 4,440 cfs for it's 3.4 square miles of contributing watershed as compared to the historic watershed (of 9.1 square miles) 100-year peak discharge of 4,230 cfs.

3. **McDonald Drive Storm Drain**
The proposed McDonald Drive storm drain will have a minor impact on reducing the peak flow of Granite Reef Wash at McKellips Road. The storm drain will reduce the peak discharge of Granite Reef Wash at McDonald Drive however, to result in a potential bypass of the 100-year storm flow of 450 cfs to the next downstream subbasin as opposed to by passing 703 cfs under current conditions.

4. **McKellips Road Box Culvert**
The proposed McKellips Road box culvert is insufficient to pass the estimated current and future 100-year peak discharges. This is also true for the current and future 50-year peak discharges.

5. **Granite Reef Wash**
Granite Reef Wash downstream of McKellips Road is undersized for the current and proposed channel conditions. Both the 100-year and 50-year discharges overtop the wash banks and flow spreads out (sheet flows) over the agricultural fields.

6. **Arizona Canal**
The construction of the Arizona Canal reduced the drainage area of Granite Reef Wash from 40.6 square miles to 9.1 square miles (under historic conditions). The potential historic 100-year peak discharge and flow volume was reduced at McKellips Road by 51 and 87 percent, respectively.

VI. RECOMMENDATIONS

The Granite Reef Wash Drainage Study has demonstrated the clear impact of changing land use on a watershed. The peak discharge and quantity of flow has increased within the contributing portion of the watershed attributable to the City of Scottsdale. The peak discharge has decreased within the contributing portion of the watershed attributable to the SRPMIC agricultural lands.

The drainage study delineated the City of Scottsdale contributing watershed to Granite Reef Wash from a preliminary or concept level using the City of Scottsdale Storm Water Master Plan basin reports. The actual contributing watershed from the City may in fact be smaller than indicated in this study.

Discussions with the City of Scottsdale staff, Boyle Engineering, MCDOT, and the Flood Control District have lead to questions of the watershed boundary for Granite Reef Wash within the City. The City has indicated that all storm water from north of Indian School Road are directed to Indian Bend Wash. Field trips to Indian School Road during rain storms have indicated that this may not be entirely true. There may be a potential under the 100-year event for some storm water to cross Indian School Road from the north and head southward.

Based on the study results and conclusions, the need for additional study of the Granite Reef Wash is warranted. The additional study should incorporate the following recommendations:

1. Delineate the contributing portion of the Granite Reef Wash watershed within the City of Scottsdale using the recent topographic mapping from the Storm Water Master Plan.

2. The 100-year peak discharge at McKellips Road should be based on the results of a detailed hydrologic model of the City of Scottsdale's contributing watershed. The SRPMIC contributing 100-year peak discharge has minor impact under current conditions. The volume of flow under current conditions from the SRPMIC needs to be accommodated.

3. Under current conditions the outlet for Granite Reef Wash to the Salt River is not well defined. The Arizona Department of Transportation will provide low flow outlets for Granite Reef Wash for the proposed design of the north bank levee of the Salt River as part of the East Papago Freeway project.

4. The SRPMIC portion between Pima Road and the proposed Pima Freeway will continue to contribute flows under future conditions to McKellips Road. It is recommended that the Indian community require on-site retention from new developments at such time as the new development replaces agricultural land use.

5. A channel needs to be designed from McKellips Road to the Salt River for Granite Reef Wash. In order for this design to proceed, adequate new topographic mapping needs to be developed for alternative alignments.

6. A flood insurance restudy is recommended to determine the new 100-year peak discharge and 100-year floodplain. It appears from the results of this study and the City's Storm Water Master Plan that the current 100-year regulatory discharge is too low (1,417 cfs).

7. Investigate the possibility of diverting City of Scottsdale storm flows in new storm drain pipes located in Thomas and McKellips Roads. The new storm drains could outlet to both Indian Bend Wash and/or the interceptor channel associated with the Pima Freeway.

ENDNOTE

The hydrologic technical data for the FIS regulatory discharges could not be located by FEMA, Michael Baker, Jr., the Flood Control District of Maricopa County, or the City of Scottsdale. Limited hydrologic data was obtained, however, from the Arizona Department of Water Resources microfiche files regarding Flood Insurance Studies for the City of Scottsdale (Granite Reef Wash and Indian Bend Wash). A review of the microfiche provided HEC-1 models that matched the regulatory discharges. It is assumed that these models are the models used to develop the regulatory discharges for Granite Reef Wash. The microfiche contains correspondence between the Corps of Engineers and Dewberry & Davis discussing the development of the hydrologic parameters used in the regulatory models.

SLA recreated the regulatory models using HEC-1 Version 4.0 (September, 1990). The discharges from the recreated models match the regulatory models. The re-created models and copies of microfiche correspondence have been provided to the City of Scottsdale and the Flood Control District of Maricopa County.

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VII. REFERENCES

1. Boyle Engineering Corporation, October 1993, "Storm Water Master Plan and Management Program, City of Scottsdale"(Draft).

2. City of Scottsdale, July 1985, "Drainage Report Preparation; Section 2".

3. INCA Engineers, Inc., February 1993, "McKellips Road Drainage Structure at Granite Reef Wash, Final Drainage Report", with Construction Plans (Total of 32 Sheets), dated February 9, 1993 and Cross-section Survey (Total of 6 Sheets), dated November, 1992.

4. FEMA, June 1984, "Flood Insurance Study, City of Scottsdale, Arizona".

5. Maricopa County, June 1992, "Drainage Design Manual for Maricopa County, Volume I - Hydrology".

6. Mathews Engineering & Architecture, Inc., October 18, 1991, "Granite Reef Wash Stabilization Project No. F1705" Construction Plan (Total of 6 Sheets).

7. Simons, Li & Associates, Inc., July 1989, "Final Hydrology Report, Outer Loop Highway, Arizona Canal to the Salt River".

8. Simons, Li & Associates, Inc., July 1989, "Concept Drainage Report, Outer Loop Highway, Arizona Canal to the Salt River".

9. U.S. Army Corps of Engineers, September 1990, "HEC-1, Flood Hydrograph Package, User's Manual".

10. U.S. Army Corps of Engineers, February 1991, "HEC-2 Water Surface Profiles , User's Manual".

11. U.S. Department of Agriculture, April 1986, "Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona".

12. U.S. Geological Survey, August 1984, "Estimation of Magnitude and Frequency of Floods in Pima County, Arizona, with Comparisons of Alternative Methods".

13. U.S. Geological Survey, 1994, "Methods for Estimating Magnitude and Frequency of Floods in Southwestern United States".

14. Arizona Department of Water Resources, Review of FIS Microfiche Files: City of Scottsdale.

sla Simons, Li & Associates, Inc.
Water Resources & Civil Engineering Consultants

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MEETING ATTENDANCE ROSTER

Project: GRANITE REEF WASH DRAINAGE STUDY

Project No.: MCDOT WORK ORDER 68736

Date: JAN. 19, 1995 Time: 2:00 PM

Location: FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

NAME	ORGANIZATION	ADDRESS	TELEPHONE	FAX NO.
Tom Phelan	MCDOT-Design		506-4662	
BARRY NAUSEDA	MCDOT ENGRING		506-4612	
ALEX MCLAREN	CITY OF SCOTTSDALE		994-7099	
BOB EICHINGER	SIMONS, LI + ASSOCIATES	4600 S. MILL TEMPE	491-1393	491-1396
Bill Erickson	City of Scottsdale		994-7652	
GARY M. SCOTT	MCDOT - R/W		506-8684	506-4161
Scott Schlund	Della Barr Ass	5067 N. 19th Ave PHX	242-2999	246-7247
DENNIS RICHARDS	SIMONS, LI & ASSOC.		491-1393	491-1396
PEDRO CALZA	FLOOD CONTROL		506-1501	
Afshin Ahouraiyan	Flood Control District		506-1501	
DICK PERREAULT	" " "	2801 W. DURANGO	506-1501	506-4601
Terry Boarland	ADOT	205 S. 17th Ave	255-7545	255-7630

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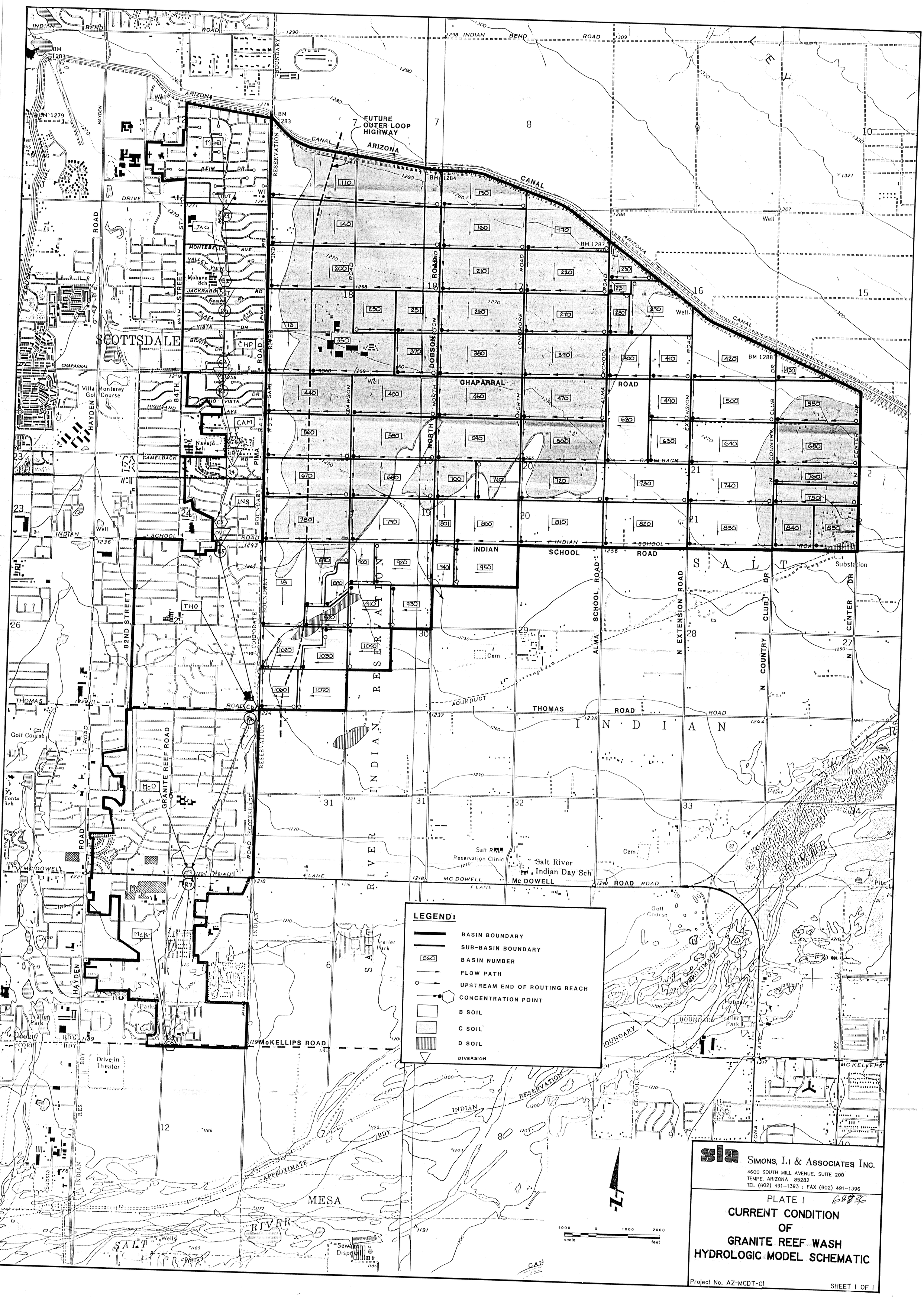
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THOMAS ROAD
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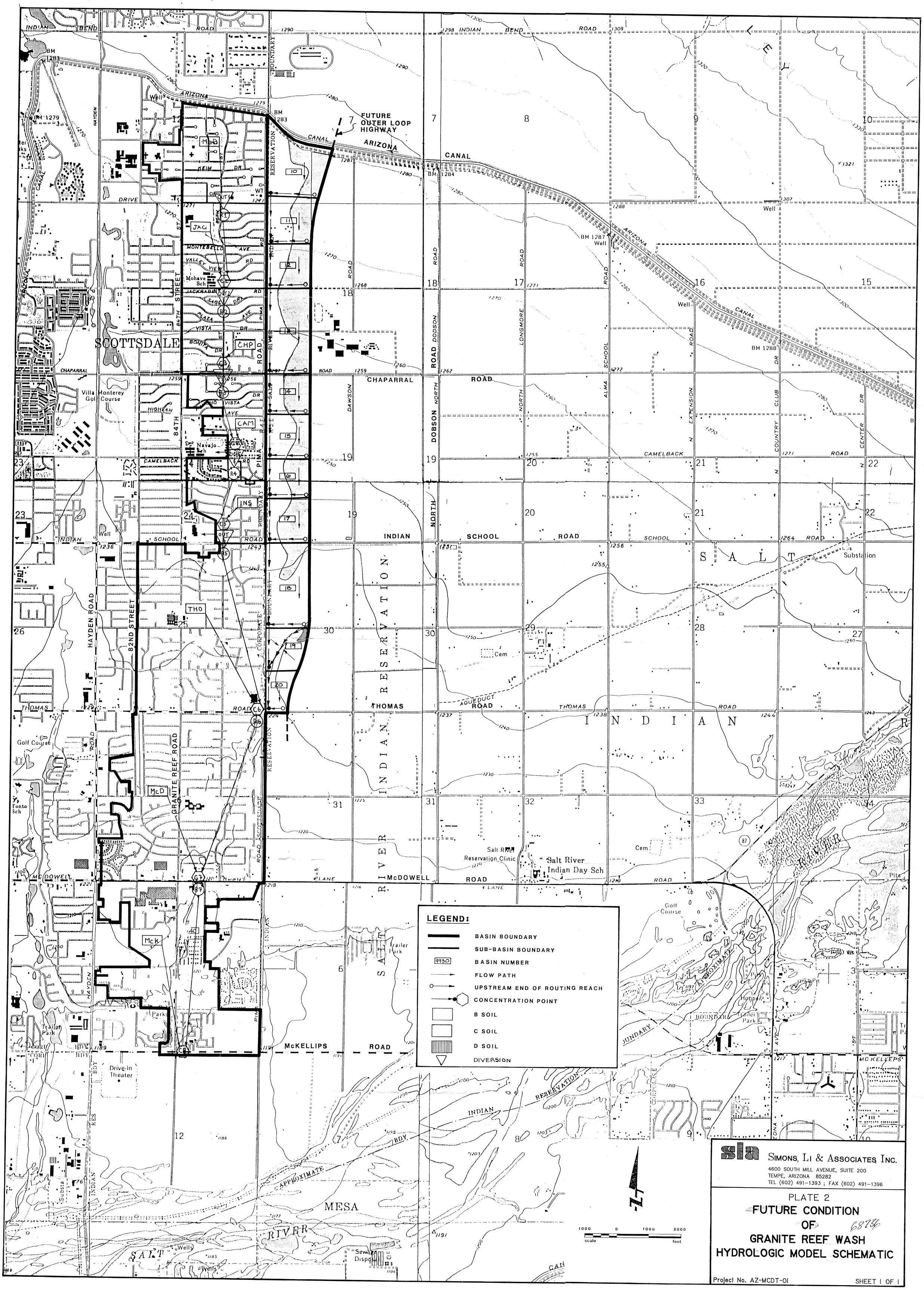
McKELLIPS ROAD
INDIAN RESERVATION
SALT RIVER
SALT RIVER MESA
GRANITE REEF ROAD
HAYDEN ROAD
ARIZONA CANAL
LEGEND:
BASIN BOUNDARY
SUB-BASIN BOUNDARY
BASIN NUMBER
FLOW PATH
UPSTREAM END OF ROUTING REACH
CONCENTRATION POINT
B SOIL
C SOIL
D SOIL
DIVERSION
scale
feet
SIMONS, LI & ASSOCIATES, INC.
4600 SOUTH MILL AVENUE, SUITE 200
TEMPE, ARIZONA 85282
TEL (602) 491-1393 ; FAX (602) 491-1396
PLATE I
CURRENT CONDITION
OF
GRANITE REEF WASH
HYDROLOGIC MODEL SCHEMATIC
Project No. AZ-MCDT-01
SHEET 1 OF 1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SCOTTSDALE
SALT RIVER INDIAN RESERVATION
INDIAN BEND ROAD
ARIZONA CANAL
CHAPARRAL ROAD
INDIAN SCHOOL ROAD
THOMAS ROAD
McDOWELL ROAD
McKELLIPS ROAD
GRANITE REEF ROAD
HAYDEN ROAD
84TH STREET
82ND STREET
DOBSON ROAD
PIMA ROAD
SALT RIVER MESA
APPROXIMATE BDY.
Salt River Indian Day Sch
Salt River Reservation Clinic
Sewage Disposal
Substation
Golf Course
Drive-In Theater
Trailer Park
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PLATE 2
FUTURE CONDITION
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Project No. AZ-MCDT-01
SHEET 1 OF 1

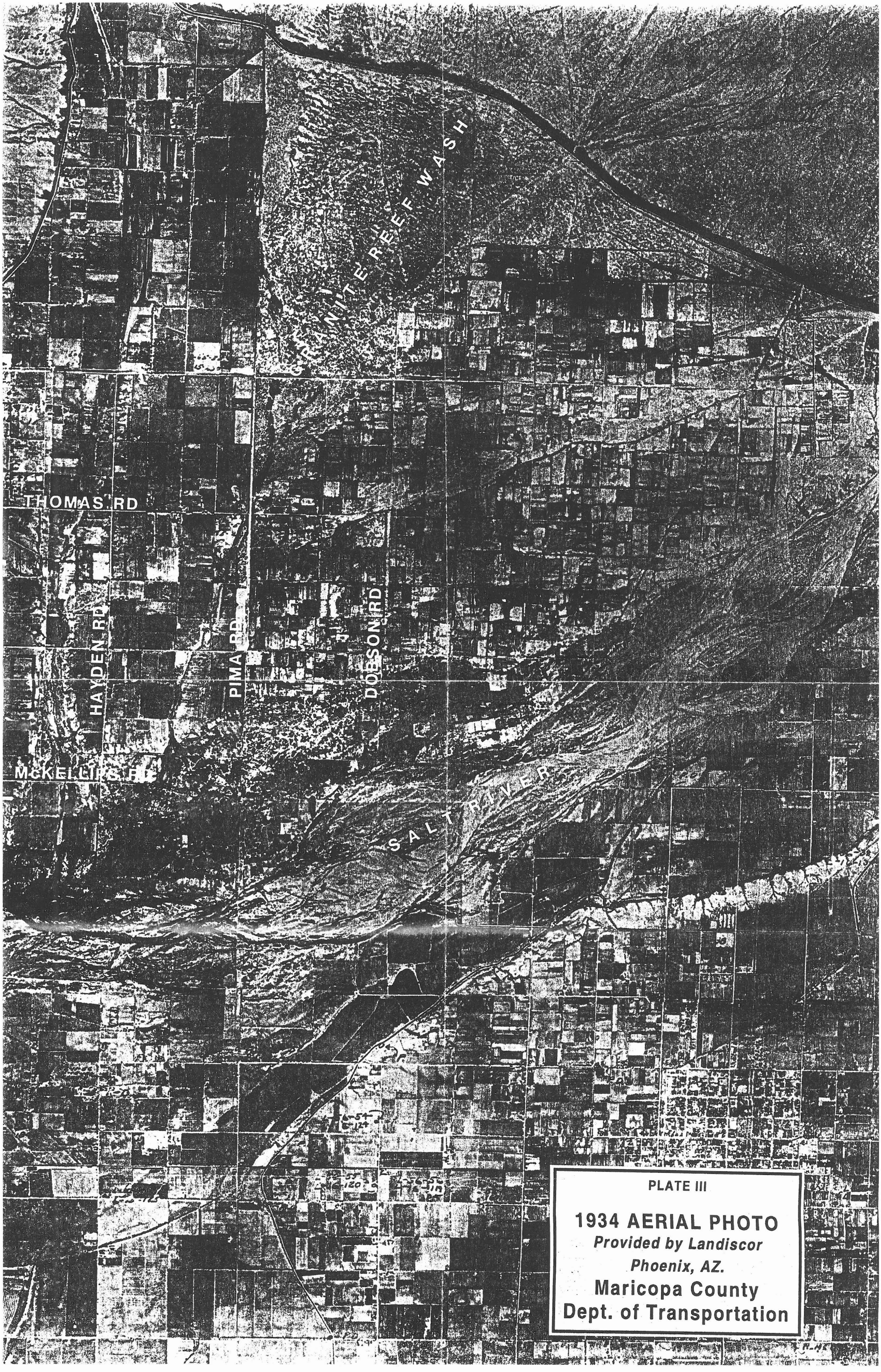

PLATE III

1934 AERIAL PHOTO

Provided by Landiscor

Phoenix, AZ.

Maricopa County

Dept. of Transportation