FINAL
HYDROLOGY REPORT
OUTER LOOP HIGHWAY
ARIZONA CANAL TO
THE SALT RIVER

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FINAL

HYDROLOGY REPORT

OUTER LOOP HIGHWAY

ARIZONA CANAL TO

THE SALT RIVER

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I. INTRODUCTION

The purpose of this report is to document the assumptions and methodologies used to develop the offsite hydrology for the Concept Drainage Plan for an approximate 6.3 mile reach of the Outer Loop Highway located between the Arizona Canal and the Salt River.

The following sections of this report present a discussion of drainage area characteristics, meteorological conditions, and the results of the hydrologic modeling process that was undertaken to develop the rainfall/runoff data required for the design of a cross-drainage system for this reach of the highway.

This report supersedes a "Preliminary Hydrology Report" published in December 1986 for this reach of the Outer Loop. The 1986 study was based on a highway alignment along Pima Road. This revised 1989 study is based on a new highway alignment that is located approximately one-quarter mile east of Pima Road.

II. DRAINAGE BASIN CHARACTERISTICS

2.1 Drainage Area

Figure 2.1 presents a vicinity map showing the preliminary highway alignment and the perimeter of the drainage area that contributes runoff to this segment of the highway.

The contributing watershed is located entirely on the Salt River Indian Reservation. The watershed is bounded on the north by the Arizona Canal and on the south by the Salt River. The proposed Outer Loop Highway alignment forms the western boundary. The eastern watershed boundary is a function of land contours which determine grade breaks that direct flowage patterns towards the west or south. The total drainage area contributing runoff to the freeway is approximately 7.6 square miles.

The following subsections discuss specific characteristics of the watershed.

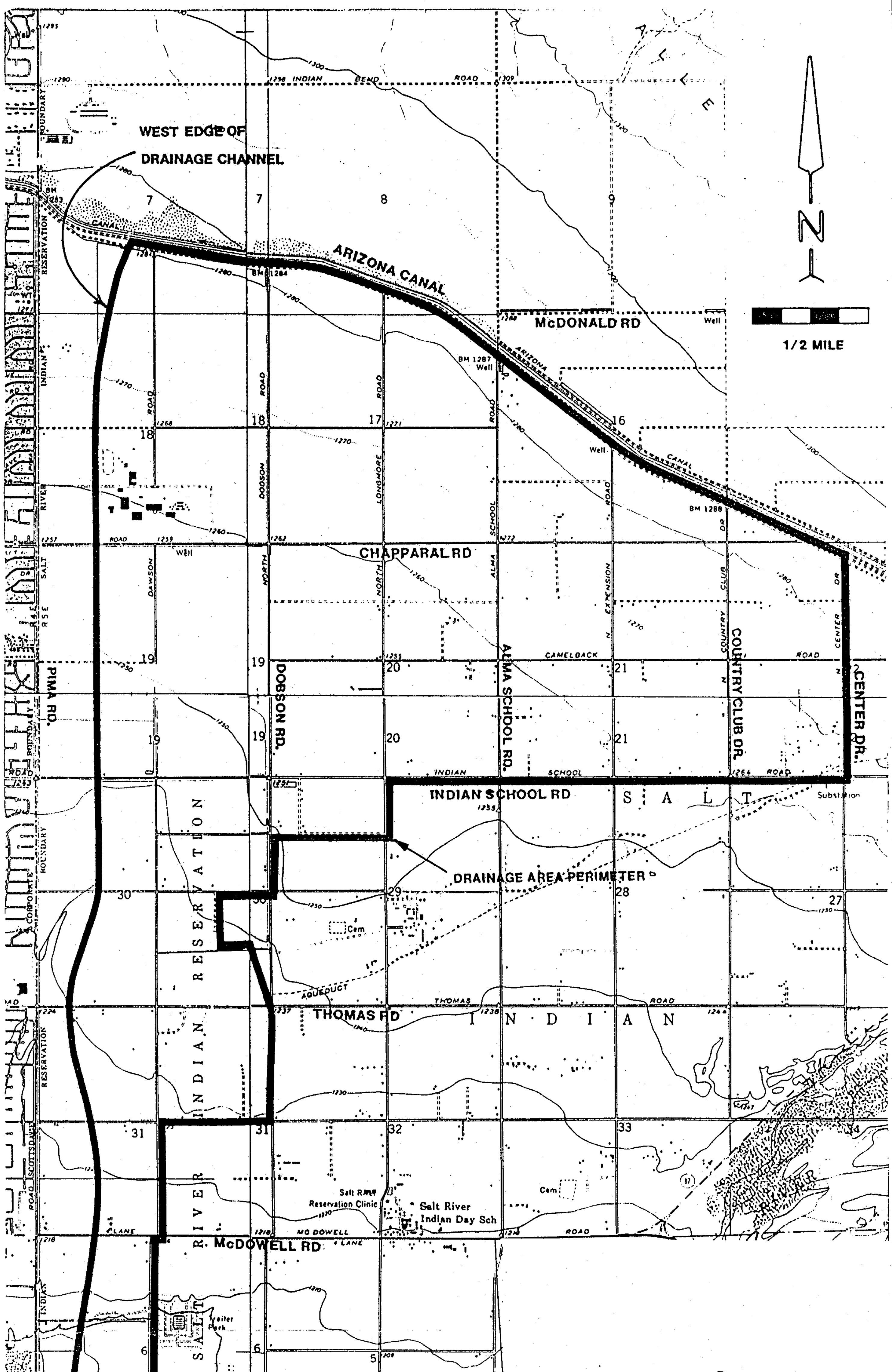
2.2 Land Use

Plate 1 is an aerial photograph of the project area showing the type of land use existing as of October 1986. As can be seen from this photograph, the primary land use on this portion of the Reservation is agriculture. Aside from a few scattered residential dwellings, the only other prominent land use is Scottsdale Community College which is located in the northwest quadrant of the watershed.

2.3 Soil Type and Vegetation

Soils information is needed in order to model the infiltration characteristics of the watershed. Such information is generally available from Soil Survey Reports published by the Soil Conservation Service (SCS). The watershed for this project was included in the Soil Survey of Aquila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona, U.S. Department of Agriculture, April 1986.

Using the standard SCS hydrologic soil group classification system, an estimate can be made of the runoff potential of the soils within any given sub-basin of the project watershed. The SCS system is based on four hydrologic soil groups, A through D. Soils in group A have very low runoff potential (i.e., high



SLA Simons, Li & Associates, Inc.

VICINITY MAP & DRAINAGE AREA

MARCH 1989 ALIGNMENT

FIGURE 2.1

infiltration rate), those in group B have moderately low runoff potential, those in group C have moderately high runoff potential, and those in group D have high runoff potential (i.e., very slow infiltration rate).

Plate 2 illustrates the composition of the project watershed in terms of hydrologic soil groups. The information in this figure is based on the previously referenced soil survey. As can be seen from Plate 2, the watershed is composed of three hydrologic soil groups (B, C, and D).

From the SCS soil survey, the following descriptions are provided for some of the major soil classifications comprising the drainage area.

1. <u>Soil Group B - Mohall Clay Loam</u>

   This deep and well-drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Slope is 0 to 3 percent.

   Typically, the surface layer is light brown clay loam about 2 inches thick. The upper 19 inches of the subsoil is light brown clay loam, and the lower 21 inches is light reddish brown and light brown, calcareous clay loam. The substratum to a depth of 60 inches or more is light reddish brown, calcareous extremely cobbly loamy sand.

   Permeability of this Mohall soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard to water erosion is slight.

2. <u>Soil Group B - Rillito Loam</u>

   This deep and well-drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Most of the areas used as cropland have slopes of less than 1 percent.

   Typically, the upper layer is light brown, calcareous loam about 11 inches thick. The next 13 inches is light brown, calcareous loam. The next 15 inches is light brown, calcareous, weakly lime- and silica-cemented gravelly loam. Below this to a depth of 60 inches or more is light brown, calcareous, weakly cemented extremely gravelly loam.

Permeability of this Rillito soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

3. Soil Group C - Contine Clay Loam

This deep and well-drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Slope is 0 to 3 percent.

Typically, the surface layer is brown, calcareous clay loam about 2 inches thick. The subsoil is reddish brown, calcareous clay loam and clay 28 inches thick. The substratum to a depth of 60 inches or more is light reddish brown, calcareous sandy loam.

Permeability of this Contine soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

4. Soil Group C - Contine Clay

This deep and well-drained soil is on fan terraces. It formed in alluvium derived dominantly from acid and basic igneous rock. Slope is 0 to 3 percent.

Typically, the surface layer is reddish brown, calcareous clay 12 inches thick. The subsoil is light reddish brown, calcareous clay 14 inches thick. The substratum to a depth of 60 inches or more is light reddish brown, calcareous gravelly clay.

Permeability of this Contine soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard to water erosion is slight.

Due to the agricultural nature of this watershed, 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.

The soils and vegetation data discussed in this section were used to select Soil Conservation Service (SCS) curve numbers. These curve numbers, which model the hydrologic abstractions and infiltration characteristics of the watershed, are discussed in more detail in Section 4.2 of this report.

2.4 Existing Drainage Facilities

Due to the extensive agricultural land use in the watershed, the contributing drainage area contains a dense network of irrigation/drainage channels. Although this system is primarily used for moving irrigation water through the area, it also serves as a drainage system for storm runoff. Most of the channels in this system 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.

III. RAINFALL CHARACTERISTICS

The hydrologic response of a watershed is dependent upon rainfall characteristics such as depth, duration, and the spatial and temporal distribution of the rainfall event. The rainfall depth is a function of the probability of occurrence and the duration of the event. This probability is expressed as a recurrence interval (50-year, 100-year, etc.), which is defined as the average interval of time within which the magnitude of an event will be equaled or exceeded once. Mathematically, recurrence interval is defined as the reciprocal of the probability of occurrence.

Evaluating storms with different recurrence intervals is required when considering the risk and economic factors associated with the design of a drainage system for a specific meteorological event. In order to incorporate a risk analysis into the freeway design process, ADOT has requested that both the 50- and 100-year storms be evaluated as part of the hydrologic analysis for the Outer Loop.

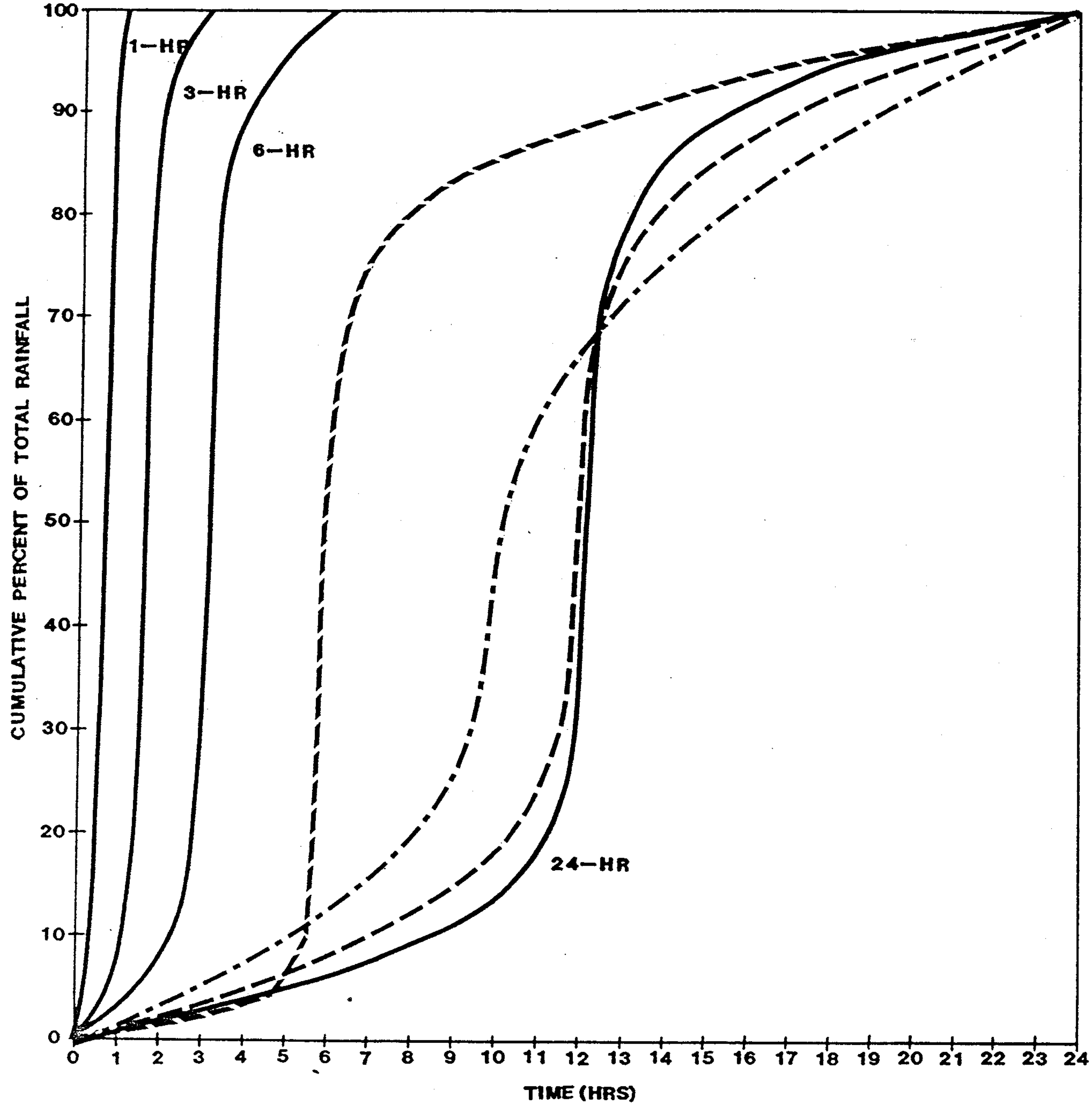
Rainfall depths for the project drainage area were developed using isopluvial maps and regression equations presented in the Precipitation-Frequency Atlas of the Western United States, Volume VIII - Arizona. Table 3.1 summarizes point precipitation values for the 50- and 100-year storms for durations of 5 minutes, 15 minutes and 1-, 2-, 3-, 6-, 12-, and 24-hours.

When using the hypothetical storm distribution in HEC-1, point rainfall values are automatically reduced (by the computer program) in accordance with procedures outlined in Weather Bureau Technical Paper No. 40, May 1961, to account for areal reduction of rainfall depths over large drainage areas. Due to the small size of the watershed under investigation, reduction in point precipitation values was used. inserting a drainage area size of 0.1 square mile on the

Incomplete references

Since De Leuw, Cather & Company and ADOT have previ hour, HEC-1 hypothetical storm distribution for use in drainage improvements for the reach of the Outer Loop fr the Salt River Indian Reservation, no attempt was made during this study to evaluate different storm distributions, i.e., the analysis was confined to the 100- and 50-year, 24-hour events. Figure 3.1 presents a graphical illustration of the selected rainfall distribution. The reader is referred to the Hydrology

no reference section



LEGEND

HEC—1 HYPOTHETICAL

SCS 24—HR TYPE I

SCS 24—HR TYPE II

SCS 24—HR TYPE IIA

SIMONS, LI & ASSOCIATES, INC.

RAINFALL DISTRIBUTIONS

FIGURE 3.1

Report, Outer Loop Freeway, CAP Aqueduct to Salt River Indian Reservation, August 19, 1986 by Simons, Li & Associates, Inc. for an overview of HEC-1 model sensitivity to several different rainfall distributions.

TABLE 3.1

Rainfall Depths as a Function of Recurrence Interval and Duration

Recurrence Interval (Years)	Point Precipitation Values (inches)							
	Duration							
	5-min	15-min	1-hr	2-hr	3-hr	6-hr	12-hr	24-hr
50	0.64	1.26	2.22 2.0	2.43 2.3	2.56 2.5	2.83 2.5	3.12 3.1	3.40
100	0.74	1.45	2.54 2.5	2.78 [illegible]	2.93 2.7	3.23 [illegible]	3.54 [illegible]	3.85 [illegible]

These values are about 0 to 0.3" higher than given in SLA report for Sect, 11

IV. HYDROLOGIC MODEL (HEC-1)

A computerized rainfall/runoff model was developed for the watershed using the U.S. Army Corps of Engineers Flood Hydrograph Package (HEC-1). HEC-1 uses numerical parameters to describe the amount and temporal distribution of rainfall, the runoff characteristics of the watershed, and the hydraulic properties of channels that collect and convey the direct runoff to concentration points. The computer output provides a runoff hydrograph at user selected locations. These hydrographs can be used to design drainage channels, detention/ retention basins, or to evaluate the capacity of existing drainage facilities.

This section of the report presents a detailed discussion of specific components of the computer model that were created to simulate the rainfall/ runoff response of the watershed. The results of the modeling process are also presented (Section 4.4) along with a brief discussion of model verification (Section 4.5).

4.1 Delineation of Drainage Sub-Basins

As discussed previously, there are several manmade features which effectively control the delineation of drainage area boundaries for this watershed. The proposed alignment of the Outer Loop sets the western boundary of the watershed while the Arizona Canal and the Salt River establish north and south boundaries, respectively. The eastern boundary of the watershed is a function of the land slope direction.

The drainage area has undergone extensive land leveling during its conversion from a natural desert environment to a network of irrigated agricultural fields. Consequently, the U.S.G.S. quadrangle maps were of no value in establishing drainage patterns or in delineating drainage sub-basins. In an effort to locate current topographic maps of the area, contact was established with the Bureau of Indian Affairs and the Salt River-Pima Maricopa Community Tribal Office. Although there were no topographic maps or engineering plans available for the agricultural fields and irrigation system, representatives from the Indian Community were most helpful in identifying the drainage patterns for the watershed. Using current (June 1986) aerial photographs (1" = 400'), Reservation personnel identified the drainage pattern for every field and irrigation lateral within the watershed boundaries. On the basis of this information, the drainage area was divided into 91 sub-basins, which were considered to have homogeneous hydrologic properties. This large number of sub-basins provides a very high resolution for the HEC-1 input parameters that are used to model the hydrologic response of the watershed.

Due to the absence of current topographic maps, SLA conducted field surveys of several parcels in order to determine land slopes that are required for input into the HEC-1 model. This survey data also served as confirmation of the drainage pattern information provided by Reservation personnel.

4.2 Interception/Infiltration

Precipitation losses due to interception and infiltration were modeled using the SCS curve number option in HEC-1. Selection of curve numbers was based on information gathered relative to type of soil cover, vegetation density, land use, and soil moisture conditions. An Antecedent Moisture Condition 2 (AMC 2) was assumed for all curve number selections. Based on this information, average curve numbers were developed for each of the 91 sub-basins to account for the combined effect of these drainage basin characteristics.

Numerous field inspections of the watershed revealed that the agricultural fields were graded to a configuration that would promote retention of water, i.e., there were often small berms constructed around the perimeter of the fields. Excess irrigation water that would pond along the downstream boundary of each field was drained through small culverts that connect to irrigation/drainage channels along the perimeter of adjacent fields. During major storms, these fields will probably function as very effective detention/retention basins with outflows being regulated, to some extent, by the culvert size draining each field and the extent of berming that surrounds each field. Such a condition could result in very minimal runoff relative to the design of a drainage interceptor channel for the proposed Outer Loop Highway.

Given the lack of current topographic data for this area, as well as the large number of sub-basins involved, there is no practical way that the detention/retention capacity of the fields could be modeled. Another variable that cannot be accounted for is the possibility of a future land use change that may or may not provide any onsite retention. Accordingly, as a conservative assumption for developing hydrology for the concept drainage design for the Outer

Loop, no onsite detention was considered in selecting curve numbers. Instead, curve numbers were based solely on existing land use, which is primarily agriculture. Assuming "straight row crops", with an average hydrologic condition between "good" and "poor", Table 2-2a. through c., Urban Hydrology For Small Watersheds, Technical Release No. 55, USDA, June 1986, was used as the basis for curve number selection. This same publication was also used to select curve numbers for the other land uses (desert shrub, Scottsdale Community College).

The curve numbers in TR-55 were developed from watersheds exposed to storms of 24-hour duration or less. Generally, these curve numbers are considered to be more applicable to long duration storms on the order of 24-hours. Research by Woodward (Runoff Curve Numbers for Semiarid Range and Forest Conditions, 1973) indicates the need to revise curve numbers upwards as storm duration decreases. However, since this hydrology study is based on a 24-hour event, the curve numbers from TR-55 require no adjustment for storm duration.

4.3 Configuration of the Hydrologic Model

The HEC-1 model developed by the Corps of Engineers Hydrologic Engineering Center, was used to simulate runoff conditions in the study area. The kinematic wave option was used to determine the hydrologic response of the sub-basin areas and for routing the resulting hydrographs through the tributary channels of the basin. This option was selected because runoff processes can be simulated using measurable geographic features such as overland flow elements and the shape, boundary roughness, length, and slope of channel elements. Unlike unit hydrograph techniques, the kinematic wave approach also provides for a non-linear response of runoff characteristics, i.e., peak discharge does not necessarily increase linearly with direct runoff when using the kinematic wave methodology.

A network of sub-basins and connecting channels was configured that simulates the natural drainage pattern in the basin. Plate 3 presents an illustration of the drainage patterns, sub-basin boundaries, and concentration points used in the model.

The following subsections describe the parameters that were used to model the physical characteristics of the watershed.

4.3.1 Kinematic Wave Parameters

The kinematic wave calculations used in HEC-1 are based on the hydraulic properties of simple geometric elements such as overland flow planes and prismatic channel cross-sections. These elements are selected and dimensioned so as to simulate the physical drainage characteristics of a specific watershed sub-basin.

Sub-basins can be described in terms of one or two planes discharging to a collector channel. For this project, overland flow planes were used to model runoff from the flat, agricultural fields. These planes are described in terms of an average overland flow length, slope, and roughness coefficient. The HEC-1 input data in APPENDIX A lists overland flow, kinematic wave parameters used for all the sub-basins in the study area.

The symmetrical shape and uniform slopes of the agricultural fields are ideally suited to overland flow plane modeling techniques. Lengths were measured from aerial photographs and average field slopes were based on survey levels completed by SLA. An average overland flow roughness value of 0.15 was used for all agricultural fields in the watershed. This value was based on an assumption of "row crops" and was thought to be a conservative average of roughness that might exist for a mixture of different crop conditions (grass and pasture, clover, small grain, row crops). This value (0.15) was taken from Table 4, Roughness Coefficients for Routing Surface Runoff, Engman, Journal of Irrigation and Drainage Engineering, February 1986.

Although runoff from the agricultural fields was easily simulated with overland flow planes, the selection of collector channel geometry to route the runoff from the fields was much more difficult. As discussed previously, irrigation water or rainfall runoff tends to pond at the downstream ends of the fields before draining into small ditches. As more and more water accumulates at the end of a field, some water may overtop the earth berms and either spill into earth drainage ditches along the edge of the roads, or begin flowing over the road or down the edge of a field as sheetflow. There is no simple solution to accurately modeling the complex combination of flow conditions that might occur at the end of each field. However, from field inspections, it was concluded that such flow would most likely be of the wide, shallow, sheet-flow variety. Accordingly, conveyance calculations were conducted for a channel represented by the cross-section at the downstream end of a typical field. A prismatic cross-section was then found which exhibited similar conveyance characteristics. As a result, a channel with a bottom-width of 10-feet, side-slopes of 100:1, and a Mannings "n" = 0.045 was used to collect the overland flow from each field and route the flow towards the proposed Outer Loop drainage channel.

In order to simulate flow through the interceptor channel that would be constructed along the east side of the Outer Loop, a concrete-lined trapezoidal channel was modeled along the east side of the proposed highway. This interceptor channel used 1:1 side-slopes and a bottom width that varied from 10 feet to 35 feet. An "n" value of 0.012 was used to simulate the concrete lining. Based on elevation data along Pima Road, the channel bed-slope was held constant at 0.0032 ft/ft. APPENDIX A presents a complete listing of all collector channel geometry used in the HEC-1 model.

4.3.2 Discussion of Key Modeling Assumptions

Although some features of this watershed are easily modeled with the options available in HEC-1, others present difficulties that must be resolved through the use of sound engineering judgement. Key modeling issues that fall within this latter category include: 1) detention/retention capacity of agricultural fields; 2) collector channel geometry used in routing operations; 3) routing through culverts that connect adjacent fields; and, 4) diversion of flow at road intersections. A brief discussion is presented on each of these issues to clarify the logic employed by SLA in developing the HEC-1 model.

1. Onsite detention/retention - This issue was previously discussed in Section 4.2. Although the agricultural fields in the watershed will undoubtedly retain some water due to the fact that they are constructed to allow maximum infiltration and containment of irrigation flows, there is no simple way to measure the amount of retention that might occur in each field. Modeling of the retention capability through reservoir routing would be extremely complex and time consuming for such a large number of sub-basins. Detailed topography of each field would also be required to develop stage-

discharge curves for a reservoir routing operation.

In consideration of these unknowns, a conservative approach (from a highway drainage system design standpoint) would be to ignore onsite retention and design the highway system on the assumption that there would be no reduction in flow due to onsite retention. This approach could also have some practical merit in that one might assume (as a worst-case condition) that the majority of the fields were being irrigated at the time the storm occurred. Under such conditions, the fields would obviously have their retention capacity reduced. Using this logic, SLA opted to ignore any onsite retention for use in the HEC-1 model.

2. Collector channel geometry - As noted previously, the routing of water through the drainage area is difficult to simulate because of the absence of any large, well-defined channels. The small irrigation/drainage channels along the edge of the fields will, for the most part, be capable of only carrying small flows on the order of 10 to 50 cfs. Any runoff in excess of this amount will either flow through the fields or down and across the roads. Since the majority of excess runoff from any fields would most likely flow in a wide shallow configuration (most probably confined to the downstream edge of each field), a wide, shallow trapezoidal cross-section was used to route water from field to field. Again, as a conservative assumption, no attempt was made to quantify hydrograph attenuation as a function of channel storage effects.

3. Routing through culverts - Present versions of HEC-1 have no capability to model pressure flow through closed conduits such as culverts. When flow being routed through a pipe exceeds approximately 90 percent of the pipe capacity, the program assumes that the capacity increases as required, with no upper limit to the size of pipe that would be required to pass the computed flow.

Most of the fields in the watershed are linked together by small culverts passing under the roads that separate the fields. These culverts join the small irrigation/drainage ditches that are located along the boundaries of each field. These culverts are normally located at the low point in one corner of the fields. In most instances, this is at a road intersection which is elevated 2- to 5-feet above the invert of the culvert. Under inlet control conditions, flow through the culvert will be a function of the headwater depth and culvert inlet geometry. This type of control will undoubtedly produce less culvert flow than would result using the HEC-1 procedure of increasing pipe size to pass all incoming flows. Accordingly, the methodology used by HEC-1 will not reflect the hydrograph attenuation that will most probably occur at each culvert/road intersection. As a result, pipes were not used for channel routing. Again, from a freeway drainage design standpoint, failure to acknowledge this probable ponding and detention storage will produce a conservative design, since larger discharges than will actually occur will probably be routed to the highway.

4. Diversion of flow - Each of the road intersections within the watershed creates a potential for a north/south or east/west diversion of flow at the intersection. Due to the symmetrical layout of the agricultural fields in the watershed, all drainage patterns are essentially north/south or east/west. Accordingly, as water begins to overtop an intersection, there is a potential for the flow to move either south or west. In most instances, the flow patterns provided by the Indian Reservation personnel were adhered to when routing flow from an intersection (these patterns only indicated the predominant flow direction of the irrigation laterals/drainage ditches, not the potential for a diversion). SLA field inspections of the area revealed six locations where there was some potential for a flow split. The splits at these locations were made on the basis of field inspections, engineering judgement, and a conservative approach that dictated taking the majority of the water westerly

towards the freeway.

4.4 Hydrologic Modeling Results

Table 4.1 presents the results of the HEC-1 modeling that was accomplished to predict peak discharge values for the design of an interceptor channel along the proposed Outer Loop alignment. This table lists all the concentration points along the highway where the flow is incremented.

TABLE 4.1

Peak Discharge Summary Along Outer Loop Alignment

Concentration Point (north to south)	1/ Q100 (cfs)	2/ Q50 (cfs)
110	90	67
142	185	139
202	283	212
352	489	369
442	522	393
562	555	418
672	586	441
782	1674	1191
873	1748	1247
892	1751	1250
1022	1794	1281
1060	1795	1282
1082	1807	1291
1085	1810	1294
1112	1821	1302
1171	1818	1299
1205	2013	1442
1222	2044	1465
1240	2051	1470
1252	2064	1479
1253	2063	1479

Note: All discharge values are based on 24-hour precipitation applied to a HEC-1 hypothetical rainfall distribution of 24-hour duration.

1/ Model No. 3FD1.24I
2/ Model No. 3FD5.24I

4.5 Verification of Model Results

In order to establish confidence in the results of the HEC-1 model, it is important to utilize an independent procedure to calculate peak discharge values that can be compared to the computerized modeling results. Due to the agricultural composition of this watershed, regional regression equations for specific areas of Arizona were considered inappropriate for this purpose. A preferred alternative procedure was found in the January 1975 edition of Technical Release 55 (TR55), Urban Hydrology for Small Watersheds. Chapter 4 and Appendices D and E of this publication contain procedures, tables, and figures for developing peak discharge estimates from agricultural watersheds ranging from 1 to 2000 acres in size. This procedure also contains an optional adjustment factor to simulate ponding that might occur in the agricultural fields under study for this reach of the Outer Loop. Calculations were performed both with and without this ponding adjustment and were based on a 100-year, 24-hour storm (Type II rainfall distribution) with 24-hour curve numbers.

Sub-Basins 270 and 730 were used for the verification analysis. Both of these sub-basins are approximately 80 acres in size and are homogeneous agricultural fields. Sub-Basin 270 is in Hydrologic Soil Group C, while Sub-Basin 730 is Hydrologic Soil Group B. The TR55 "with ponding" approach assumed two acres of each of these sub-basins would pond water.

The Cook Method (Chow, 1964, Chapter 21) was also used as a second method to verify results for the 50-year event. This empirical method, which is a much simpler procedure than TR55, computes peak discharge as a function of a "W" factor which provides a numerical rating for watershed: 1) relief; 2) infiltration; 3) vegetal cover; and, 4) surface storage.

The results of the verification calculations are summarized in Table 4.2. The TR55 procedure, with no ponding, produces excellent agreement with the HEC-1 results. As expected, the introduction of a ponding factor produced lower results than HEC-1. The Cook Method produced substantially higher peaks than either HEC-1 or TR55.

The data base used to develop the Cook Method is unknown. For the agricultural basin under investigation, the infiltration and surface storage components of the "W" factor are possible sources of error for this specific site. Since the TR55 procedure is a much more detailed and site-specific procedure, it is given more weight than the Cook Method in the model verification analysis.

As a matter of technical interest, it should be noted that the June 1986 edition of TR55 no longer includes the peak discharge procedure used in the preceding model verification analysis. SCS personnel (Gary Conaway) in Portland, Oregon, were contacted in an effort to determine why the procedure was excluded from the 1986 edition of TR55. Mr. Conaway indicated it was eliminated because of weaknesses in application to urbanized environments. However, since urbanization is not assumed to occur on the Reservation agricultural fields, the 1975 TR55 procedure should still provide a valid estimate of peak discharge. Mr. Conaway concurred in the validity of this conclusion. Accordingly, the 1975 TR55 procedure was adopted for use in this study. Based on this analysis, it appears that the model is providing a reasonable prediction of runoff from the agricultural fields that comprise the vast majority of the watershed.

TABLE 4.2

Comparison of Peak Discharge Calculations for Verification of HEC-1 Model

Sub-Basin	Area (ac)	CN	Q100 (cfs)			Q50 (cfs)			
			HEC-1	TR55 (no ponding)	TR55 (2.5% ponding)	HEC-1	TR55 (no ponding)	TR55 (2.5% ponding)	Cook Method
270	78.8	87	67	66	44	50	55	35	72
730	80.0	80	43	43	29	30	35	23	60

V. CONCLUSIONS AND RECOMMENDATIONS

This report presents a technical overview of the engineering parameters that were used to create a computerized rainfall/runoff model of the offsite drainage intercepted by that reach of the Outer Loop Highway extending from the Arizona Canal to the Salt River. The model simulates the runoff response that would be associated with both the 100- and 50-year, 24-hour precipitation applied to the 24-hour hypothetical rainfall distribution generated by HEC-1.

When compared to peak discharge estimates generated from independent calculation methods, the model results were judged to be realistic, although probably somewhat conservative. This conservatism is believed to result from the following factors:

1. No onsite detention has been assumed when modeling the agricultural fields, even though such detention undoubtedly exists. As a result, predicted HEC-1 peak discharges are probably high.

2. Any constriction of flow (and the resultant ponding of water at elevated road intersections), due to the small pipes that link each field, has been ignored. This allows water to flow freely from field to field without any hydrograph attenuation due to reservoir storage effects.

A very basic and key assumption used in this analysis is the depiction of flowage patterns through the drainage area. SLA was not provided with new topographic maps of the watershed. Since the U.S.G.S. quadrangle maps do not reflect the land-leveling and irrigation system construction that has occurred in the watershed, complete reliance was placed on representatives of the Salt River Indian Reservation to identify the drainage patterns for the agricultural fields. Should future development occur in this watershed that would alter this existing drainage pattern, the inflow points to the proposed highway interceptor channel could be significantly altered. Depending on how such alterations might occur, the proposed channel capacity might be subjected to either an under- or over-design.

It is also important to emphasize that any future land-use changes that might alter this watershed towards a more urbanized condition will undoubtedly generate a potential for increased runoff, as the farmland is covered with more impervious surfaces such as asphalt streets, parking lots, rooftops, etc. If such changes are ever allowed to occur, it is important that effective drainage ordinances be enforced to insure that peak discharges are not increased along the Outer Loop Highway alignment.

Although not specifically intended for such a purpose, the possible conservatism that might exist in the peak discharge values from the HEC-1 model may help to offset any minor inadvertent increases in runoff due future land-use changes.

In summary, SLA recommends that the HEC-1 model presented in this report be adopted for use in the concept design of offsite drainage structures for this reach of the Outer Loop Highway. Both 100- and 50-year storm frequencies should be considered for engineering and economic comparisons.

APPENDIX A

****

FLOOD HYDROGRAPH PACKAGE HEC-1 (IBM XT 512K VERSION) -FEB 1,1985

U.S. ARMY CORPS OF ENGINEERS, THE HYDROLOGIC ENGINEERING CENTER, 609 SECOND STREET, DAVIS, CA. 95616

****

THIS HEC-1 VERSION CONTAINS ALL OPTIONS EXCEPT ECONOMICS, AND THE NUMBER OF PLANS ARE REDUCED TO 3

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

ID        SIMONS, LI AND ASSOCIATES
ID        OUTER LOOP FREEWAY, PHASE 3  (FROM THE ARIZONA CANAL TO THE SALT RIVER)
ID        FINAL HYDROLOGY ANALYSIS FOR OFFSITE DRAINAGE,  MARCH 26, 1989
ID        MODEL 3FD1.24I - MARCH 1989 HIGHWAY ALIGNMENT
ID        100 YEAR EVENT, 24 HOUR HYPOTHETICAL STORM DISTRIBUTION
ID                         24 HOUR CN VALUES
ID                         WITH LINED CHANNEL ALONG OUTER LOOP ALIGNMENT (n=.012)
IT       5 26MAR89       0     289
*DIAGRAM
IO       5

KK     550     SUB
KM        RUNOFF FROM SUB 550
BA   .1250
PH             0.1    0.74    1.45    2.54    2.78    2.93    3.23    3.54    3.85
LS              83
UK    1320   .0029     .15     100
RK    2640   .0028    .045            TRAP      10     100

KK     651      CP
KM        ROUTE SUB 550 TO CP 651
RK    1320   .0029    .045            TRAP      10     100

KK     650     SUB
KM        RUNOFF FROM SUB 650
BA   .1250
LS              87
UK    1320   .0029     .15     100
RK    2640   .0028    .045            TRAP      10     100

KK     652      CP
KM        COMBINE SUB 650 WITH CP 651
HC       2

KK     640     SUB
KM        RUNOFF FROM SUB 640 AND ROUTE CP 652
BA   .1250
LS              80
UK    1320   .0029     .15     100
RK    2640   .0028    .045            TRAP      10     100     YES

KK     430     SUB
KM        RUNOFF FROM SUB 430
BA  0.0409
LS              80
UK     400   .0029     .15     100
RK    1650   .0028    .045            TRAP      10     100

KK     420     SUB
KM        RUNOFF FROM SUB 420 AND ROUTE SUB 430
BA  0.1510
LS              80
UK    1500   .0029     .15     100
RK    2600   .0028    .045            TRAP      10     100     YES
```

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

  47          KK     501      CP
  48          KM        ROUTE SUB 420 TO CP 501
  49          RK    1320   .0029    .045             TRAP      10      100

  50          KK     500     SUB
  51          KM        RUNOFF FROM SUB 500
  52          BA  0.1250
  53          LS              80
  54          UK    1320   .0029     .15     100
  55          RK    2640   .0028    .045             TRAP      10      100

  56          KK     502      CP
  57          KM        COMBINE CP 501 WITH SUB 500
  58          HC       2

  59          KK     641      CP
  60          KM        ROUTE CP 502 TO CP 641
  61          RK    1320   .0029    .045             TRAP      10      100

  62          KK     642      CP
  63          KM        COMBINE SUB 640 WITH CP 641
  64          HC       2

  65          KK     630     SUB
  66          KM        RUNOFF FROM SUB 630 AND ROUTE CP 642
  67          BA  0.0597
  68          LS              80
  69          UK    1280   .0029     .15     100
  70          RK    1300   .0028    .045             TRAP      10      100     YES

  71          KK     490     SUB
  72          KM        RUNOFF FROM SUB 490
  73          BA  0.0625
  74          LS              80
  75          UK    1320   .0029     .15     100
  76          RK    1320   .0028    .045             TRAP      10      100

  77          KK     631      CP
  78          KM        ROUTE SUB 490 TO CP 631
  79          RK    1280   .0029    .045             TRAP      10      100

  80          KK     632      CP
  81          KM        COMBINE SUB 630 WITH CP 631
  82          HC       2

  83          KK     621      CP
  84          KM        ROUTE CP 632 TO CP 621
  85          RK    1320   .0028    .045             TRAP      10      100
```

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

KK     230     SUB
KM         RUNOFF FROM SUB 230
BA  0.0447
LS              87
UK     800   .0029    .015     100
RK    1400   .0028    .045            TRAP      10     100

KK     231     SUB
KM         RUNOFF FROM SUB 231 AND ROUTE SUB 230
BA  0.0105
LS              87
UK     680   .0028     .15     100
RK     430   .0029    .045            TRAP      10     100     YES

KK     281      CP
KM         ROUTE SUB 231 TO CP 281
RK    1320   .0029    .045            TRAP      10     100

KK     290     SUB
KM         RUNOFF FROM SUB 290
BA  0.1131
LS              83
UK    1700   .0028     .15     100
RK    1720   .0029    .045            TRAP      10     100

KK     280     SUB
KM         RUNOFF FROM SUB 280 AND ROUTE SUB 290
BA  0.0317
LS              87
UK    1320   .0029     .15     100
RK     670   .0028    .045            TRAP      10     100     YES

KK     282      CP
KM         COMBINE SUB 280 WITH CP 281
HC       2

KK     401      CP
KM         ROUTE CP 282 TO CP 401
RK    1300   .0029    .045            TRAP      10     100

KK     410     SUB
KM         RUNOFF FROM SUB 410
BA  0.0625
LS              80
UK    1320   .0029     .15     100
RK    1320   .0028    .045            TRAP      10     100

KK     400     SUB
KM         RUNOFF FROM SUB 400 AND ROUTE SUB 410
BA  0.0606
LS              83
UK    1300   .0029     .15     100
RK    1300   .0028    .045            TRAP      10     100     YES
```

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

KK     402      CP
KM        COMBINE SUB 400 WITH CP 401
HC       2

KK     620     SUB
KM        RUNOFF FROM SUB 620 AND ROUTE CP 402
BA  0.1250
LS               80
UK    1320   .0028     .15     100
RK    2640   .0029    .045             TRAP       10      100      YES

KK     622      CP
KM        COMBINE SUB 620 WITH CP 621
HC       2

KK     600     SUB
KM        RUNOFF FROM SUB 600 AND ROUTE CP 622
BA  0.1250
LS               86
UK    1320   .0029     .15     100
RK    2640   .0028    .045             TRAP       10      100      YES

KK     170     SUB
KM        RUNOFF FROM SUB 170
BA  0.1297
LS               87
UK    1200   .0029     .15     100
RK    2650   .0028    .045             TRAP       10      100

KK     221      CP
KM        ROUTE SUB 170 TO CP 221
RK    1320   .0029    .045             TRAP       10      100

KK     220     SUB
KM        RUNOFF FROM SUB 220
BA  0.1250
LS               87
UK    1320   .0029     .15     100
RK    2640   .0028    .045             TRAP       10      100

KK     222      CP
KM        COMBINE SUB 220 WITH CP 221
HC       2

KK     271      CP
KM        ROUTE CP 222 TO CP 271
RK    1300   .0029    .045             TRAP       10      100

KK     270     SUB
KM        RUNOFF FROM SUB 270
BA  0.1231
LS               87
UK    1300   .0029     .15     100
RK    2640   .0028    .045             TRAP       10      100
```

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

 176          KK     272      CP
 177          KM        COMBINE CP 271 WITH SUB 270
 178          HC       2

 179          KK     391      CP
 180          KM        ROUTE CP 272 TO CP 391
 181          RK    1320   .0029    .045               TRAP      10      100

 182          KK     390     SUB
 183          KM        RUNOFF FROM SUB 390
 184          BA  0.1250
 185          LS               87
 186          UK    1320   .0029     .15      100
 187          RK    2640   .0028    .045               TRAP      10      100

 188          KK     392      CP
 189          KM        COMBINE CP 391 WITH SUB 390
 190          HC       2

 191          KK     394    DIV
 192          KM        DIVERT FLOW FROM CP 392 TO SUB 380
 193          DT     393
 194          DI       0      12      26       50    2000
 195          DQ       0       6      13       25    1975

 196          KK     471      CP
 197          KM        ROUTE NON-DIVERTED FLOW FROM CP 392 (DIV 394) TO CP 471
 198          RK    1320   .0029    .045               TRAP      10      100

 199          KK     470     SUB
 200          KM        RUNOFF FROM SUB 470
 201          BA  0.1250
 202          LS               87
 203          UK    1320   .0029     .15      100
 204          RK    2640   .0028    .045               TRAP      10      100

 205          KK     472      CP
 206          KM        COMBINE CP 471 WITH SUB 470
 207          HC       2

 208          KK     601      CP
 209          KM        ROUTE CP 472 TO CP 601
 210          RK    1320   .0029    .045               TRAP      10      100

 211          KK     602      CP
 212          KM        COMBINE SUB 600 WITH CP 601
 213          HC       2

 214          KK     604     DIV
 215          KM        DIVERT FLOW FROM CP 602 TO SUB 590
 216          DT     603
 217          DI       0      10     100     2000
 218          DQ       0       5      50     1000
```

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

 219        KK     721      CP
 220        KM        ROUTE NON-DIVERTED FLOW FROM CP 602 (DIV 604) TO CP 721
 221        RK    1320   .0029    .045            TRAP      10      100

 222        KK     720     SUB
 223        KM        RUNOFF FROM SUB 720
 224        BA  0.1250
 225        LS                84
 226        UK    1320   .0029     .15     100
 227        RK    2640   .0028    .045            TRAP      10      100

 228        KK     722      CP
 229        KM        COMBINE CP 721 WITH SUB 720
 230        HC       2

 231        KK     811      CP
 232        KM        ROUTE CP 722 TO CP 811
 233        RK    1320   .0029    .045            TRAP      10      100

 234        KK     760     SUB
 235        KM        RUNOFF FROM SUB 760
 236        BA  0.0625
 237        LS                87
 238        UK     660   .0029     .15     100
 239        RK    2640   .0028    .045            TRAP      10      100

 240        KK     751      CP
 241        KM        ROUTE SUB 760 TO CP 751
 242        RK     660   .0029    .045            TRAP      10      100

 243        KK     750     SUB
 244        KM        RUNOFF FROM SUB 750
 245        BA  0.0625
 246        LS                87
 247        UK     660   .0029     .15     100
 248        RK    2640   .0028    .045            TRAP      10      100

 249        KK     752      CP
 250        KM        COMBINE SUB 750 WITH CP 751
 251        HC       2

 252        KK     841      CP
 253        KM        ROUTE CP 752 TO CP 841
 254        RK    1320   .0029    .045            TRAP      10      100

 255        KK     850     SUB
 256        KM        RUNOFF FROM SUB 850
 257        BA  0.0701
 258        LS                81
 259        UK    1320   .0029     .10     100
 260        RK    1480   .0028    .045            TRAP      10      100
```

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

 261        KK     840     SUB
 262        KM        RUNOFF FROM SUB 840 AND ROUTE SUB 850
 263        BA  0.0549
 264        LS               87
 265        UK    1320   .0029     .15     100
 266        RK    1160   .0028    .045             TRAP      10     100     YES

 267        KK     842      CP
 268        KM        COMBINE SUB 840 WITH CP 841
 269        HC       2

 270        KK     830     SUB
 271        KM        RUNOFF FROM SUB 830 AND ROUTE CP 842
 272        BA  0.1250
 273        LS               81
 274        UK    1320   .0029     .15     100
 275        RK    2640   .0028    .045             TRAP      10     100     YES

 276        KK     740     SUB
 277        KM        RUNOFF FROM SUB 740
 278        BA  0.1250
 279        LS               81
 280        UK    1320   .0029     .15     100
 281        RK    2640   .0028    .045             TRAP      10     100

 282        KK     831      CP
 283        KM        ROUTE SUB 740 TO CP 831
 284        RK    1320   .0029    .045             TRAP      10     100

 285        KK     832      CP
 286        KM        COMBINE CP 831 WITH SUB 830
 287        HC       2

 288        KK     820     SUB
 289        KM        RUNOFF FROM SUB 820 AND ROUTE CP 832
 290        BA  0.1250
 291        LS               80
 292        UK    1320   .0029     .15     100
 293        RK    2640   .0028    .045             TRAP      10     100     YES

 294        KK     730     SUB
 295        KM        RUNOFF FROM SUB 730
 296        BA  0.1250
 297        LS               80
 298        UK    1320   .0029     .15     100
 299        RK    2640   .0028    .045             TRAP      10     100

 300        KK     821      CP
 301        KM        ROUTE SUB 730 TO CP 821
 302        RK    1320   .0029    .045             TRAP      10     100
```

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

 303         KK     822      CP
 304         KM        COMBINE SUB 820 WITH CP 821
 305         HC       2

 306         KK     824      DIV
 307         KM        DIVERT FLOW FROM CP 822 TO SUB 971
 308         KM        THIS DIVERT LEAVES THE SYSTEM & WILL NOT BE RETRIEVED.  SUB 971 HAS ALSO
 309         KM        BEEN EXCLUDED FROM THE SYSTEM
 310         DT     823
 311         DI       0      10      26      50     100    1000
 312         DQ       0       5      13      20      40     400

 313         KK     810     SUB
 314         KM        RUNOFF FROM SUB 810 AND ROUTE NON-DIVERTED FLOW FROM CP 822 (DIV 824)
 315         BA  0.1250
 316         LS              80
 317         UK    1320   .0029     .15     100
 318         RK    2640   .0028    .045             TRAP      10     100     YES

 319         KK     812      CP
 320         KM        COMBINE CP 811 WITH SUB 810
 321         HC       2

 322         KK     800     SUB
 323         KM        RUNOFF FROM SUB 800 AND ROUTE CP 812
 324         BA  0.0928
 325         LS              80
 326         UK    1320   .0029     .15     100
 327         RK    1960   .0028    .045             TRAP      10     100     YES

 328         KK     804     DIV
 329         KM        DIVERT SUB 800 TO IRRIGATION POND (SUB 945)
 330         DT     805
 331         DI       0      10      26      50     100    2000
 332         DQ       0       5      13      25      50      50

 333         KK     801     SUB
 334         KM        RUNOFF FROM SUB 801 AND ROUTE NON-DIVERTED FLOW FROM SUB 800 (DIV 804)
 335         BA  0.0331
 336         LS              80
 337         UK    1320   .0029     .15     100
 338         RK     700   .0028    .045             TRAP      10     100     YES

 339         KK     130     SUB
 340         KM        RUNOFF FROM SUB 130
 341         BA  0.1042
 342         LS              87
 343         UK    1000   .0029     .15     100
 344         RK    2620   .0028    .045             TRAP      10     100
```

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

 345          KK     161      CP
 346          KM        ROUTE SUB 130 TO CP 161
 347          RK    1260   .0029    .045            TRAP       10      100

 348          KK     160     SUB
 349          KM        RUNOFF FROM SUB 160
 350          BA  0.1193
 351          LS                87
 352          UK    1260   .0029     .15      100
 353          RK    2640   .0028    .045            TRAP       10      100

 354          KK     162      CP
 355          KM        COMBINE CP 161 WITH SUB 160
 356          HC       2

 357          KK     211      CP
 358          KM        ROUTE CP 162 TO CP 211
 359          RK    1320   .0029    .045            TRAP       10      100

 360          KK     210     SUB
 361          KM        RUNOFF FROM SUB 210
 362          BA  0.1217
 363          LS                87
 364          UK    1320   .0029     .15      100
 365          RK    2570   .0028    .045            TRAP       10      100

 366          KK     212      CP
 367          KM        COMBINE CP 211 WITH SUB 210
 368          HC       2

 369          KK     261      CP
 370          KM        ROUTE CP 212 TO CP 261
 371          RK    1300   .0029    .045            TRAP       10      100

 372          KK     260     SUB
 373          KM        RUNOFF FROM SUB 260
 374          BA  0.1203
 375          LS                87
 376          UK    1300   .0029     .15      100
 377          RK    2580   .0028    .045            TRAP       10      100

 378          KK     262      CP
 379          KM        COMBINE CP 261 WITH SUB 260
 380          HC       2

 381          KK     381      CP
 382          KM        ROUTE CP 262 TO CP 381
 383          RK    1320   .0029    .045            TRAP       10      100
```

```
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING          (---)) DIVERSION OR PUMP FLOW

   NO.     (.) CONNECTOR        ((---) RETURN OF DIVERTED OR PUMPED FLOW

    10       550
               V
               V
    17       651
               .
               .
    20         .          650
               .            .
               .            .
    26       652............
               V
               V
    29       640 ***
               .
               .
    35         .          430
               .            V
               .            V
    41         .          420 ***
               .            V
               .            V
    47         .          501
               .            .
               .            .
    50         .            .          500
               .            .            .
               .            .            .
    56         .          502............
               .            V
               .            V
    59         .          641
               .            .
               .            .
    62       642............
               V
               V
    65       630 ***
               .
               .
    71         .          490
               .            V
               .            V
    77         .          631
               .            .
               .            .
    80       632............
               V
               V
    83       621
               .
               .
    86         .          230
               .            V
               .            V
    92         .          231 ***
               .            V
```

```
              .           .
101           .           .         290
              .           .           V
              .           .           V
107           .           .         280 ***
              .           .           .
              .           .           .
113           .         282............
              .           V
              .           V
116           .         401
              .           .
              .           .
119           .           .         410
              .           .           V
              .           .           V
125           .           .         400 ***
              .           .           .
              .           .           .
131           .         402............
              .           V
              .           V
134           .         620 ***
              .           .
              .           .
140         622............
              V
              V
143         600 ***
              .
              .
149           .         170
              .           V
              .           V
155           .         221
              .           .
              .           .
158           .           .         220
              .           .           .
              .           .           .
164           .         222............
              .           V
              .           V
167           .         271
              .           .
              .           .
170           .           .         270
              .           .           .
              .           .           .
176           .         272............
              .           V
              .           V
179           .         391
              .           .
              .           .
182           .           .         390
              .           .           .
              .           .           .
188           .         392............
              .           .
              .           .
193           .           .-------)      393
191           .         394
                          V
```

```
              .           .
              .           .
199           .           .        470
              .           .          .
              .           .          .
205           .         472............
              .           V
              .           V
208           .         601
              .           .
              .           .
211         602............
              .
              .
216           .-------)    603
214         604
              V
              V
219         721
              .
              .
222           .         720
              .           .
              .           .
228         722............
              V
              V
231         811
              .
              .
234           .         760
              .           V
              .           V
240           .         751
              .           .
              .           .
243           .           .        750
              .           .          .
              .           .          .
249           .         752............
              .           V
              .           V
252           .         841
              .           .
              .           .
255           .           .        850
              .           .          V
              .           .          V
261           .           .        840 ***
              .           .          .
              .           .          .
267           .         842............
              .           V
              .           V
270           .         830 ***
              .           .
              .           .
276           .           .        740
              .           .          V
              .           .          V
282           .           .        831
              .           .          .
              .           .          .
```

```
              .           .
288           .         820 ***
              .           .
              .           .
294           .           .         730
              .           .           V
              .           .           V
300           .           .         821
              .           .           .
              .           .           .
303           .         822............
              .           .
              .           .
310           .           .-------)   .  823
306           .         824
              .           V
              .           V
313           .         810 ***
              .           .
              .           .
319         812............
              V
              V
322         800 ***
              .
              .
330           .-------)     805
328         804
              V
              V
333         801 ***
              .
              .
339           .         130
              .           V
              .           V
345           .         161
              .           .
              .           .
348           .           .         160
              .           .           .
              .           .           .
354           .         162............
              .           V
              .           V
357           .         211
              .           .
              .           .
360           .           .         210
              .           .           .
              .           .           .
366           .         212............
              .           V
              .           V
369           .         261
              .           .
              .           .
372           .           .         260
              .           .           .
              .           .           .
378           .         262............
              .           V
              .           V
381           .         381
```

```
384        .      .       393
           .      .        V
           .      .        V
387        .      .       380 ***
           .      .        .
           .      .        .
393        .     382........
           .      .
           .      .
398        .      .------->     383
396.       .     384
           .      V
           .      V
401        .     461
           .      .
           .      .
404        .      .       460
           .      .        .
           .      .        .
410        .     462........
           .      V
           .      V
413        .     591
           .      .
           .      .
418        .      .        .<-------      603
416        .      .       603
           .      .        V
           .      .        V
419        .      .       590 ***
           .      .        .
           .      .        .
425        .     592........
           .      V
           .      V
428        .     701
           .      .
           .      .
431        .      .       710
           .      .        V
           .      .        V
437        .      .       700 ***
           .      .        .
           .      .        .
443        .     702........
           .      V
           .      V
446        .     802
           .      .
           .      .
449        .      .       950
           .      .        .
           .      .        .
457        .      .        .         .<-------      805
455        .      .        .        805
           .      .        .         .
           .      .        .         .
458        .      .       946........
           .      .        V
           .      .        V
461        .      .       945 ***
           .      .        .
           .      .        .
```

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


 384        KK     393     RET
 385        KM        RETRIEVE DIVERT 393 FROM SUB 390  (CP 392)
 386        DR     393

 387        KK     380     SUB
 388        KM        RUNOFF FROM SUB 380 AND ROUTE RETRIEVAL 393
 389        BA  0.1250
 390        LS              87
 391        UK    1320   .0029     .15     100
 392        RK    2640   .0028    .045             TRAP      10     100     YES

 393        KK     382      CP
 394        KM        COMBINE CP 381 WITH SUB 380
 395        HC       2

 396        KK     384     DIV
 397        KM        DIVERT FLOW FROM CP 382 TO SUB 450
 398        DT     383
 399        DI       0      10     100    2000
 400        DQ       0       5      50    1000

 401        KK     461      CP
 402        KM        ROUTE NON-DIVERTED FLOW FROM CP 382 (DIV 384) TO CP 461
 403        RK    1320   .0029    .045             TRAP      10     100

 404        KK     460     SUB
 405        KM        RUNOFF FROM SUB 460
 406        BA  0.1250
 407        LS              87
 408        UK    1320   .0029     .15     100
 409        RK    2640   .0028    .045             TRAP      10     100

 410        KK     462      CP
 411        KM        COMBINE CP 461 WITH SUB 460
 412        HC       2

 413        KK     591      CP
 414        KM        ROUTE CP 462 TO CP 591
 415        RK    1320   .0029    .045             TRAP      10     100

 416        KK     603     RET
 417        KM        RETRIEVE DIVERT 603 FROM SUB 600  (CP 602)
 418        DR     603

 419        KK     590     SUB
 420        KM        RUNOFF FROM SUB 590 AND ROUTE RET 603
 421        BA  0.1250
 422        LS              87
 423        UK    1320   .0029     .15     100
 424        RK    2640   .0028    .045             TRAP      10     100     YES
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 425          KK     592      CP
 426          KM        COMBINE CP 591 WITH SUB 590
 427          HC       2

 428          KK     701      CP
 429          KM        ROUTE CP 592 TO CP 701
 430          RK    1320   .0029    .045            TRAP      10     100

 431          KK     710     SUB
 432          KM        RUNOFF FROM SUB 710
 433          BA  0.0644
 434          LS              83
 435          UK    1360   .0028     .15     100
 436          RK    1320   .0029    .045            TRAP      10     100

 437          KK     700     SUB
 438          KM        RUNOFF FROM SUB 700 AND ROUTE SUB 710
 439          BA  0.0601
 440          LS              85
 441          UK    1320   .0029     .15     100
 442          RK    1270   .0028    .045            TRAP      10     100     YES

 443          KK     702      CP
 444          KM        COMBINE CP 701 WITH SUB 700
 445          HC       2

 446          KK     802      CP
 447          KM        ROUTE CP 702 TO CP 802
 448          RK    1320   .0029    .045            TRAP      10     100

 449          KK     950     SUB
 450          KM        RUNOFF FROM SUB 950
 451          BA  0.0928
 452          LS              80
 453          UK    1960   .0028     .15     100
 454          RK    1300   .0015    .045            TRAP      10     100

 455          KK     805     RET
 456          KM        RETRIEVE DIVERT 805 FROM SUB 800
 457          DR     805

 458          KK     946      CP
 459          KM        COMBINE SUB 950 WITH RET 805
 460          HC       2

 461          KK     945     SUB
 462          KM        RUNOFF FROM SUB 945 AND ROUTE CP 946
 463          KM        THIS SUB-BASIN IS PRIMARILY AN IRRIGATION POND
 464          BA  0.0030
 465          LS              98
 466          UK      75    10.0    0.01     100
 467          RK     600   .0005    0.01            TRAP     150       1     YES
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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 468           KK     940     SUB
 469           KM        RUNOFF FROM SUB 940
 470           BA  0.0294
 471           LS              80
 472           UK    1170   .0020     .15     100
 473           RK     700   .0020    .045             TRAP      10     100

 474           KK     803      CP
 475           KM        COMBINE CP 802, SUB 945, SUB 940, AND SUB 801
 476           HC       4

 477           KK     806     DIV
 478           KM        DIVERT FLOW FROM CP 803 TO SUB 960
 479           KM        THIS DIVERT LEAVES THE SYSTEM AND WILL NOT BE RETRIEVED.  SUB 960 HAS
 480           KM        ALSO BEEN EXCLUDED FROM THE SYSTEM.
 481           DT     807
 482           DI       0      80     100     280     300    1000
 483           DQ       0       0      20     200     200     200

 484           KK     790     SUB
 485           KM        RUNOFF FROM SUB 790 AND ROUTE DIV 806
 486           BA  0.1250
 487           LS              82
 488           UK    1320   .0029     .15     100
 489           RK    2640   .0028    .045             TRAP      10     100     YES

 490           KK     383     RET
 491           KM        RETRIEVE DIVERT 383 FROM SUB 380  (CP 382)
 492           DR     383

 493           KK     451      CP
 494           KM        ROUTE RET 383 TO CP 451
 495           RK    1320   .0029    .045             TRAP      10     100

 496           KK     450     SUB
 497           KM        RUNOFF FROM SUB 450 AND ROUTE CP 451
 498           BA  0.1250
 499           LS              87
 500           UK    1320   .0029     .15     100
 501           RK    2640   .0028    .045             TRAP      10     100     YES

 502           KK     581      CP
 503           KM        ROUTE SUB 450 TO CP 581
 504           RK    1320   .0029    .045             TRAP      10     100

 505           KK     580     SUB
 506           KM        RUNOFF FROM SUB 580
 507           BA  0.1250
 508           LS              86
 509           UK    1320   .0029     .15     100
 510           RK    2640   .0028    .045             TRAP      10     100
```

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

KK     582       CP
KM         COMBINE CP 581 WITH SUB 580
HC       2

KK     681       CP
KM         ROUTE CP 582 TO CP 681
RK    1300   .0029     .045              TRAP      10      100

KK     680      SUB
KM         RUNOFF FROM SUB 680
BA  0.1231
LS               85
UK    1300   .0029      .15      100
RK    2640   .0028     .045              TRAP      10      100

KK     682       CP
KM         COMBINE CP 681 WITH SUB 680
HC       2

KK     791       CP
KM         ROUTE CP 682 TO CP 791
RK    1320   .0029     .045              TRAP      10      100

KK     792       CP
KM         COMBINE CP 791 WITH SUB 790
HC       2

KK     780      SUB
KM         RUNOFF FROM SUB 780 AND ROUTE CP 792
BA  0.0625
LS               87
UK    1320   .0029      .15      100
RK    1320   .0028     .045              TRAP      10      100      YES

KK     110      SUB
KM         RUNOFF FROM SUB 110
BA   .1895
LS               87
UK    1500   .0029      .15      100
RK    3950   .0028     .045              TRAP      10      100

KK     141       CP
KM         ROUTE SUB 110 TO CP 141
RK    1365   .0032     .012              TRAP      10        1

KK     140      SUB
KM         RUNOFF FROM SUB 140
BA   .1900
LS               87
UK    1365   .0029      .15      100
RK    3950   .0028     .045              TRAP      10      100
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 553          KK     142      CP
 554          KM        COMBINE SUB 140 WITH CP 141
 555          HC       2

 556          KK     201      CP
 557          KM        ROUTE CP 142 TO CP 201
 558          RK    1320   .0032    .012           TRAP       10       1

 559          KK     200     SUB
 560          KM        RUNOFF FROM SUB 200
 561          BA  0.1889
 562          LS               87
 563          UK    1320   .0029     .15     100
 564          RK    3990   .0028    .045           TRAP       10     100

 565          KK     202      CP
 566          KM   COMBINE SUB 200 WITH CP 201
 567          HC       2

 568          KK     351      CP
 569          KM        ROUTE CP 202 TO CP 351
 570          RK    2640   .0032    .012           TRAP       10       1

 571          KK     250     SUB
 572          KM        RUNOFF FROM SUB 250
 573          BA  0.0616
 574          LS               87
 575          UK    1320   .0029     .15     100
 576          RK    1300   .0028    .045           TRAP       10     100

 577          KK     251     SUB
 578          KM        RUNOFF FROM SUB 251
 579          BA  0.0621
 580          LS               87
 581          UK    1310   .0029     .15     100
 582          RK    1320   .0028    .045           TRAP       10     100

 583          KK     252      CP
 584          KM        COMBINE SUB 250 WITH SUB 251
 585          HC       2

 586          KK     371      CP
 587          KM        ROUTE CP 252 TO CP 371
 588          RK    1320   .0029    .045           TRAP       10     100

 589          KK     370     SUB
 590          KM        RUNOFF FROM SUB 370
 591          BA  0.0625
 592          LS               87
 593          UK    1320   .0029     .15     100
 594          RK    1320   .0028    .045           TRAP       10     100
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ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK     372       CP
KM        COMBINE CP 371 WITH SUB 370
HC       2

KK     350      SUB
KM        RUNOFF FROM SUB 350 & ROUTE CP 372
BA   .1920
LS                91
UK    1980   .0029     .08      100
RK    2690   .0028    .045               TRAP       10       100      YES

KK     352       CP
KM        COMBINE CP 351 & SUB 350
HC       2

KK     441       CP
KM        ROUTE CP 352 TO CP 441
RK    1320   .0032    .012               TRAP       15         1

KK     440      SUB
KM        RUNOFF FROM SUB 440
BA   .0644
LS                87
UK    1320   .0029     .15      100
RK    1350   .0028    .045               TRAP       10       100

KK     442       CP
KM        COMBINE SUB 440 & CP 441
HC       2

KK     561       CP
KM        ROUTE CP 442 TO CP 561
RK    1360   .0032    .012               TRAP       15         1

KK     560      SUB
KM        RUNOFF FROM SUB 560
BA   .0659
LS                87
UK    1330   .0029     .15      100
RK    1340   .0028    .045               TRAP       10       100

KK     562       CP
KM        COMBINE SUB 560 & CP 561
HC       2

KK     671       CP
KM        ROUTE CP 562 TO CP 671
RK    1280   .0032    .012               TRAP       15         1
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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 634           KK     670     SUB
 635           KM        RUNOFF FROM SUB 670
 636           BA   .0615
 637           LS               87
 638           UK    1300   .0029     .15     100
 639           RK    1340   .0028    .045             TRAP      10     100

 640           KK     672      CP
 641           KM        COMBINE SUB 670 & CP 671
 642           HC       2

 643           KK     781      CP
 644           KM        ROUTE CP 672 TO CP 781
 645           RK    1300   .0032    .012             TRAP      15       1

 646           KK     782      CP
 647           KM        COMBINE SUB 780 & CP 781
 648           HC       2

 649           KK     871      CP
 650           KM        ROUTE CP 782 TO CP 871
 651           RK    1970   .0032    .012             TRAP      30       1

 652           KK     870     SUB
 653           KM        RUNOFF FROM SUB 870
 654           BA   .0678
 655           LS               83
 656           UK    1300   .0029     .15     100
 657           RK    2500   .0028    .045             TRAP      10     100

 658           KK     930     SUB
 659           KM        RUNOFF FROM SUB 930
 660           BA  0.0606
 661           LS               80
 662           UK    1280   .0028     .15     100
 663           RK    1320   .0029    .045             TRAP      10     100

 664           KK     921      CP
 665           KM        ROUTE SUB 930 TO CP 921
 666           RK     500   .0028    .045             TRAP      10     100

 667           KK     920     SUB
 668           KM        RUNOFF FROM SUB 920
 669           BA  0.0680
 670           LS               80
 671           UK    1830   .0028     .15     100
 672           RK    1310   .0029    .045             TRAP      10     100

 673           KK     922      CP
 674           KM        COMBINE CP 921 WITH SUB 920
 675           HC       2
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 676          KK     900     SUB
 677          KM        RUNOFF FROM SUB 900 AND ROUTE CP 922
 678          BA  0.0373
 679          LS                80
 680          UK    1300   .0029     .15      100
 681          RK     800   .0028    .045              TRAP      10      100      YES

 682          KK     910     SUB
 683          KM        RUNOFF FROM SUB 910
 684          BA  0.0649
 685          LS                80
 686          UK    1360   .0028     .15      100
 687          RK    1330   .0029    .045              TRAP      10      100

 688          KK     901      CP
 689          KM        COMBINE SUB 910 WITH SUB 900
 690          HC       2

 691          KK     880     SUB
 692          KM        RUNOFF FROM SUB 880 AND ROUTE CP 901
 693          BA  0.0266
 694          LS                80
 695          UK     920   .0029     .15      100
 696          RK    1100   .0028    .045              TRAP      10      100      YES

 697          KK     872      CP
 698          KM        ROUTE SUB 880 TO CP 872
 699          RK     670   .0028    .045              TRAP      10      100

 700          KK     873      CP
 701          KM        COMBINE CP 872, CP 871, AND SUB 870
 702          HC       3

 703          KK     891      CP
 704          KM        ROUTE CP 873 TO CP 891
 705          RK     700   .0032    .012              TRAP      30        1

 706          KK     890     SUB
 707          KM        RUNOFF FROM SUB 890
 708          BA   .0406
 709          LS                82
 710          UK     800   .0029     .10      100
 711          RK    1390   .0028    .045              TRAP      10      100

 712          KK     892      CP
 713          KM        COMBINE SUB 890 WITH CP 891
 714          HC       2

 715          KK    1020     SUB
 716          KM        RUNOFF FROM SUB 1020 & ROUTE CP 892
 717          BA   .0182
 718          LS                79
 719          UK     600   .0028     .10      100
 720          RK    1370   .0032    .012              TRAP      30        1      YES
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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 721           KK    1040     SUB
 722           KM        RUNOFF FROM SUB 1040
 723           BA  0.0625
 724           LS               80
 725           UK    1300   .0028     .15     100
 726           RK    1340   .0029    .045             TRAP      10     100

 727           KK    1031      CP
 728           KM        ROUTE SUB 1040 TO CP 1031
 729           RK     800   .0028    .045             TRAP      10     100

 730           KK    1030     SUB
 731           KM        RUNOFF FROM SUB 1030 AND ROUTE CP 1031
 732           BA  0.0544
 733           LS               80
 734           UK    1100   .0028     .15     100
 735           RK    2000   .0029    .045             TRAP      10     100     YES

 736           KK    1070     SUB
 737           KM        RUNOFF FROM SUB 1070
 738           BA  0.0699
 739           LS               80
 740           UK    1500   .0029     .15     100
 741           RK    1300   .0028    .045             TRAP      10     100

 742           KK    1032      CP
 743           KM        COMBINE SUB 1070 WITH SUB 1030
 744           HC       2

 745           KK    1021      CP
 746           KM        ROUTE CP 1032 TO CP 1021
 747           RK     240   .0028    .045             TRAP      10     100

 748           KK    1022      CP
 749           KM        COMBINE SUB 1020 & CP 1021
 750           HC       2

 751           KK    1060     SUB
 752           KM        RUNOFF FROM SUB 1060 & ROUTE CP 1022
 753           BA   .0161
 754           LS               80
 755           UK    1270   .0028     .15     100
 756           RK    1370   .0032    .012             TRAP      30       1     YES

 757           KK    1083      CP
 758           KM        ROUTE SUB 1060 TO CP 1083
 759           RK    1260   .0032    .012             TRAP      30       1

 760           KK    1090     SUB
 761           KM        RUNOFF FROM SUB 1090
 762           BA  0.0413
 763           LS               80
 764           UK     800   .0029     .15     100
 765           RK    1740   .0028    .045             TRAP      10     100
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 766          KK    1080     SUB
 767          KM        RUNOFF FROM SUB 1080 AND ROUTE SUB 1090
 768          BA   .0294
 769          LS               77
 770          UK    1300   .0028     .10     100
 771          RK    1500   .0029    .045            TRAP      10     100     YES

 772          KK    1082      CP
 773          KM        COMBINE SUB 1080 WITH CP 1083
 774          HC       2

 775          KK    1084      CP
 776          KM        ROUTE CP 1082 TO CP 1084
 777          RK     705   .0032    .012            TRAP      30       1

 778          KK    1081     SUB
 779          KM        RUNOFF FROM SUB 1081
 780          BA   .0330
 781          LS               79
 782          UK     700   .0029     .10     100
 783          RK    1900   .0028    .045            TRAP      10     100

 784          KK    1085      CP
 785          KM        COMBINE CP 1084 & SUB 1081
 786          HC       2

 787          KK    1111      CP
 788          KM        ROUTE CP 1085 TO CP 1111
 789          RK     760   .0032    .012            TRAP      30       1

 790          KK    1110     SUB
 791          KM        RUNOFF FROM SUB 1110
 792          BA   .0709
 793          LS               80
 794          UK    1000   .0029     .15     100
 795          RK    1560   .0028    .045            TRAP      10     100

 796          KK    1112      CP
 797          KM        COMBINE CP 1111 & SUB 1110
 798          HC       2

 799          KK    1171      CP
 800          KM        ROUTE CP 1112 TO CP 1171
 801          RK    2800   .0032    .012            TRAP      30       1

 802          KK    1203      CP
 803          KM        ROUTE CP 1171 TO CP 1203
 804          RK    2010   .0032    .012            TRAP      30       1
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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

               KK    1071     SUB
               KM         RUNOFF FROM SUB 1071
               BA  0.0226
               LS               80
               UK     900   .0029     .15     100
               RK    1350   .0028    .045             TRAP      10      100

               KK    1072     SUB
               KM         RUNOFF FROM SUB 1072
               BA  0.0440
               LS               77
               UK     700   .0029     .10     100
               RK    1700   .0028    .045             TRAP      10      100

               KK    1074      CP
               KM         COMBINE SUB 1072 WITH SUB 1071
               HC       2

               KK    1073     SUB
               KM         RUNOFF FROM SUB 1073 AND ROUTE CP 1074
               BA  0.0430
               LS               80
               UK    1290   .0029     .15     100
               RK     930   .0028    .045             TRAP      10      100     YES

               KK    1092      CP
               KM         ROUTE SUB 1073 TO CP 1092
               RK    1320   .0029    .045             TRAP      10      100

               KK    1091     SUB
               KM         RUNOFF FROM SUB 1091
               BA  0.0353
               LS               82
               UK     600   .0029     .10     100
               RK    2000   .0028    .045             TRAP      10      100

               KK    1093      CP
               KM         COMBINE CP 1092 WITH SUB 1091
               HC       2

               KK    1122      CP
               KM         ROUTE CP 1093 TO CP 1122
               RK    1300   .0029    .045             TRAP      10      100

               KK    1121     SUB
               KM         RUNOFF FROM SUB 1121
               BA  0.0515
               LS               80
               UK     800   .0029     .15     100
               RK    1830   .0028    .045             TRAP      10      100
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


 847          KK    1131     SUB
 848          KM        RUNOFF FROM SUB 1131
 849          BA  0.0379
 850          LS              80
 851          UK    1320   .0029     .15     100
 852          RK     800   .0028    .045             TRAP      10     100

 853          KK    1132      CP
 854          KM        COMBINE SUB 1131 WITH SUB 1121
 855          HC       2

 856          KK    1133      CP
 857          KM        ROUTE CP 1132 TO CP 1133
 858          RK    1320   .0029    .045             TRAP      10     100

 859          KK    1130     SUB
 860          KM        RUNOFF FROM SUB 1130
 861          BA  0.0379
 862          LS              80
 863          UK    1320   .0029     .15     100
 864          RK     800   .0028    .045             TRAP      10     100

 865          KK    1134      CP
 866          KM        COMBINE CP 1133 WITH SUB 1130
 867          HC       2

 868          KK    1120     SUB
 869          KM        RUNOFF FROM SUB 1120 AND ROUTE CP 1134
 870          BA  0.0853
 871          LS              80
 872          UK    1300   .0029     .15     100
 873          RK    1830   .0028    .045             TRAP      10     100     YES

 874          KK    1123      CP
 875          KM        COMBINE CP 1122 WITH SUB 1120
 876          HC       2

 877          KK    1181      CP
 878          KM        ROUTE CP 1123 TO CP 1181
 879          RK    2750   .0029    .045             TRAP      10     100

 880          KK    1150     SUB
 881          KM        RUNOFF FROM SUB 1150
 882          BA   .0670
 883          LS              80
 884          UK    1400   .0029     .15     100
 885          RK    2260   .0028    .045             TRAP      10     100

 886          KK    1172      CP
 887          KM        ROUTE SUB 1150 TO CP 1172
 888          RK    1320   .0029    .045             TRAP      10     100
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ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK    1170     SUB
KM        RUNOFF FROM SUB 1170
BA   .0671
LS              80
UK    1320   .0029     .15     100
RK    2820   .0028    .045             TRAP      10      100

KK    1173      CP
KM        COMBINE CP 1181, CP 1172, AND SUB 1170
HC       3

KK    1201      CP
KM        ROUTE CP 1173 TO CP 1201
RK    1650   .0029    .045             TRAP      10      100

KK    1200     SUB
KM        RUNOFF FROM SUB 1200
BA   .1033
LS              80
UK    1650   .0029     .15     100
RK    2120   .0028    .045             TRAP      10      100

KK    1202      CP
KM        COMBINE CP 1201 WITH SUB 1200
HC       2

KK    1204      CP
KM        ROUTE CP 1202 TO CP 1204
RK    1600   .0010    .055             TRAP      50      100

KK    1205      CP
KM        COMBINE CP 1204 & CP 1203
HC       2

KK    1220     SUB
KM        RUNOFF FROM SUB 1220 AND ROUTE CP 1205
BA   .0710
LS              80
UK    1300   .0028     .15     100
RK    3330   .0032    .012             TRAP      35        1     YES

KK    1230     SUB
KM        RUNOFF FROM SUB 1230
BA  0.1399
LS              80
UK    1100   .0028     .15     100
RK    1170   .0029    .045             TRAP      10      100

KK    1221      CP
KM        ROUTE SUB 1230 TO CP 1221
RK     600   .0028    .045             TRAP      10      100
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ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

KK    1222      CP
KM        COMBINE CP 1221 WITH SUB 1220
HC       2

KK    1240     SUB
KM         RUNOFF FROM SUB 1240 AND ROUTE CP 1222
BA   .0446
LS               80
UK    1730   .0028     .15      100
RK    1160   .0032    .012              TRAP      35       1      YES

KK    1251      CP
KM        ROUTE SUB 1240 TO CP 1251
RK    1850   .0032    .012              TRAP      35       1

KK    1250     SUB
KM        RUNOFF FROM SUB 1250
BA   .0737
LS               80
UK    1800   .0029     .15      100
RK    1090   .0028    .045              TRAP      10     100

KK    1252      CP
KM        COMBINE CP 1251 WITH SUB 1250
HC       2

KK    1253      CP
KM        ROUTE CP 1252 TO CP 1253. THIS IS PROPOSED FREEWAY DRAINAGE CHANNEL
KM        OUTFALL AT THE SALT RIVER
RK    1000   .0032    .012              TRAP      35       1
ZZ
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474         803.....................................
              .
              .
481           .-------)    807
477         806
              V
              V
484         790 ***
              .
              .
492           .           .(-------    383
490           .         383
              .           V
              .           V
493           .         451
              .           V
              .           V
496           .         450 ***
              .           V
              .           V
502           .         581
              .           .
              .           .
505           .           .          580
              .           .            .
              .           .            .
511           .         582...........
              .           V
              .           V
514           .         681
              .           .
              .           .
517           .           .          680
              .           .            .
              .           .            .
523           .         682...........
              .           V
              .           V
526           .         791
              .           .
              .           .
529         792...........
              V
              V
532         780 ***
              .
              .
538           .         110
              .           V
              .           V
544           .         141
              .           .
              .           .
547           .           .          140
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553           .         142...........
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              .           V
556           .         201
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559           .           .          200
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568         .      351
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571         .       .      250
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577         .       .       .      251
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583         .       .      252............
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586         .       .      371
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589         .       .       .      370
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595         .       .      372............
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            .       .       V
598         .       .      350 ***
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604         .      352............
            .       V
            .       V
607         .      441
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610         .       .      440
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616         .      442............
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            .       V
619         .      561
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622         .       .      560
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628         .      562............
            .       V
            .       V
631         .      671
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634         .       .      670
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640         .      672............
            .       V
            .       V
643         .      781
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646        782............
            V
            V
649        871
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658         .         .        930
            .         .          V
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664         .         .        921
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667         .         .          .       920
            .         .          .         .
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673         .         .        922..........
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            .         .          V
676         .         .        900 ***
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682         .         .          .       910
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688         .         .        901..........
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691         .         .        880 ***
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            .         .          V
697         .         .        872
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700       873.....................
            V
            V
703       891
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706         .       890
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712       892..........
            V
            V
715      1020 ***
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721         .      1040
            .         V
            .         V
727         .      1031
            .         V
            .         V
730         .      1030 ***
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736         .         .      1070
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742         .      1032..........
            .         V
            .         V
745         .      1021
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748      1022..........
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               V
               V
 757        1083
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 760           .        1090
               .           V
               .           V
 766           .        1080 ***
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 772        1082............
               V
               V
 775        1084
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 778           .        1081
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 784        1085............
               V
               V
 787        1111
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 790           .        1110
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 796        1112............
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 799        1171
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 802        1203
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 805           .        1071
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 811           .           .        1072
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 817           .        1074............
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               .           V
 820           .        1073 ***
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 826           .        1092
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 829           .           .        1091
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 835           .        1093............
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 838           .        1122
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 841           .           .        1121
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853           .           .       1132............
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856           .           .       1133
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859           .           .           .       1130
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865           .           .       1134............
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868           .           .       1120 ***
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874           .       1123............
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              .          V
877           .       1181
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880           .           .       1150
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886           .           .       1172
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889           .           .           .       1170
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895           .       1173........................
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898           .       1201
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901           .           .       1200
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907           .       1202............
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              .          V
910           .       1204
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913       1205............
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             V
916       1220 ***
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922           .       1230
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928           .       1221
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931       1222............
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934       1240 ***
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  949           1252...........
                   V
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  952           1253
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(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	550	52.	13.42	23.	7.	7.	.13		
ROUTED TO	651	52.	13.67	23.	6.	6.	.13		
HYDROGRAPH AT	650	68.	13.33	27.	8.	8.	.13		
2 COMBINED AT	652	116.	13.50	49.	14.	14.	.25		
HYDROGRAPH AT	640	148.	13.83	68.	20.	20.	.38		
HYDROGRAPH AT	430	33.	12.75	7.	2.	2.	.04		
HYDROGRAPH AT	420	65.	13.50	30.	9.	9.	.19		
ROUTED TO	501	65.	13.67	30.	9.	9.	.19		
HYDROGRAPH AT	500	43.	13.58	20.	6.	6.	.13		
2 COMBINED AT	502	107.	13.67	50.	15.	15.	.32		
ROUTED TO	641	107.	13.83	50.	14.	14.	.32		
2 COMBINED AT	642	255.	13.83	117.	34.	34.	.69		
HYDROGRAPH AT	630	271.	13.92	125.	37.	37.	.75		
HYDROGRAPH AT	490	22.	13.42	10.	3.	3.	.06		
ROUTED TO	631	22.	13.75	10.	3.	3.	.06		
2 COMBINED AT	632	293.	13.92	135.	40.	40.	.81		
ROUTED TO	621	292.	14.00	135.	39.	39.	.81		
HYDROGRAPH AT	230	89.	12.33	10.	3.	3.	.04		
HYDROGRAPH AT	231	94.	12.42	13.	4.	4.	.06		
ROUTED TO	281	87.	12.75	14.	4.	4.	.06		
HYDROGRAPH AT	290	38.	13.67	20.	6.	6.	.11		
HYDROGRAPH AT	280	53.	13.33	27.	8.	8.	.14		
2 COMBINED AT	282	129.	12.75	40.	11.	11.	.20		
ROUTED TO	401	129.	12.92	41.	12.	12.	.20		
HYDROGRAPH AT	410	22.	13.42	10.	3.	3.	.06		
HYDROGRAPH AT	400	47.	13.42	21.	6.	6.	.12		
2 COMBINED AT	402	169.	13.00	62.	18.	18.	.32		
HYDROGRAPH AT	620	183.	13.50	80.	23.	23.	.45		

HYDROGRAPH AT	600	479.	14.17	233.	69.	69.	1.39
HYDROGRAPH AT	170	75.	13.25	28.	8.	8.	.13
ROUTED TO	221	75.	13.42	28.	8.	8.	.13
HYDROGRAPH AT	220	68.	13.33	27.	8.	8.	.13
2 COMBINED AT	222	143.	13.33	55.	16.	16.	.25
ROUTED TO	271	141.	13.50	54.	15.	15.	.25
HYDROGRAPH AT	270	67.	13.33	27.	8.	8.	.12
2 COMBINED AT	272	207.	13.50	81.	23.	23.	.38
ROUTED TO	391	206.	13.58	80.	23.	23.	.38
HYDROGRAPH AT	390	68.	13.33	27.	8.	8.	.13
2 COMBINED AT	392	269.	13.58	106.	30.	30.	.50
DIVERSION TO	393	244.	12.67	84.	23.	23.	.50
HYDROGRAPH AT	394	25.	12.67	23.	8.	8.	.50
ROUTED TO	471	25.	13.83	23.	7.	7.	.50
HYDROGRAPH AT	470	68.	13.33	27.	8.	8.	.13
2 COMBINED AT	472	93.	13.33	49.	15.	15.	.63
ROUTED TO	601	92.	13.50	48.	15.	15.	.63
2 COMBINED AT	602	554.	14.08	281.	84.	84.	2.01
DIVERSION TO	603	277.	14.08	141.	42.	42.	2.01
HYDROGRAPH AT	604	277.	14.08	141.	42.	42.	2.01
ROUTED TO	721	277.	14.25	140.	42.	42.	2.01
HYDROGRAPH AT	720	56.	13.42	24.	7.	7.	.13
2 COMBINED AT	722	316.	14.17	161.	48.	48.	2.14
ROUTED TO	811	316.	14.25	161.	48.	48.	2.14
HYDROGRAPH AT	760	52.	12.92	14.	4.	4.	.06
ROUTED TO	751	51.	13.08	14.	4.	4.	.06
HYDROGRAPH AT	750	52.	12.92	14.	4.	4.	.06
2 COMBINED AT	752	101.	13.08	28.	8.	8.	.13
ROUTED TO	841	101.	13.25	28.	8.	8.	.13
HYDROGRAPH AT	850	36.	13.00	12.	3.	3.	.07
HYDROGRAPH AT	840	67.	13.17	24.	7.	7.	.13
2 COMBINED AT	842	167.	13.17	52.	15.	15.	.25

HYDROGRAPH AT	740	46.	13.50	21.	6.	6.	.13
ROUTED TO	831	46.	13.75	21.	6.	6.	.13
2 COMBINED AT	832	237.	13.67	92.	26.	26.	.50
HYDROGRAPH AT	820	259.	14.00	110.	32.	32.	.63
HYDROGRAPH AT	730	43.	13.58	20.	6.	6.	.13
ROUTED TO	821	43.	13.83	20.	6.	6.	.13
2 COMBINED AT	822	300.	14.00	129.	38.	38.	.75
DIVERSION TO	823	120.	14.00	52.	16.	16.	.75
HYDROGRAPH AT	824	180.	14.00	77.	22.	22.	.75
HYDROGRAPH AT	810	200.	14.33	94.	28.	28.	.88
2 COMBINED AT	812	516.	14.25	255.	76.	76.	3.01
HYDROGRAPH AT	800	530.	14.42	266.	79.	79.	3.11
DIVERSION TO	805	50.	14.42	50.	19.	19.	3.11
HYDROGRAPH AT	804	480.	14.42	216.	60.	60.	3.11
HYDROGRAPH AT	801	485.	14.58	220.	62.	62.	3.14
HYDROGRAPH AT	130	69.	13.08	23.	6.	6.	.10
ROUTED TO	161	68.	13.33	23.	6.	6.	.10
HYDROGRAPH AT	160	66.	13.25	26.	7.	7.	.12
2 COMBINED AT	162	135.	13.25	48.	14.	14.	.22
ROUTED TO	211	135.	13.50	49.	14.	14.	.22
HYDROGRAPH AT	210	66.	13.33	26.	7.	7.	.12
2 COMBINED AT	212	199.	13.50	74.	21.	21.	.35
ROUTED TO	261	198.	13.58	74.	21.	21.	.35
HYDROGRAPH AT	260	66.	13.25	26.	7.	7.	.12
2 COMBINED AT	262	259.	13.58	99.	28.	28.	.47
ROUTED TO	381	258.	13.67	99.	28.	28.	.47
HYDROGRAPH AT	393	244.	13.58	84.	23.	23.	.00
HYDROGRAPH AT	380	278.	13.83	109.	30.	30.	.13
2 COMBINED AT	382	531.	13.75	208.	58.	58.	.59
DIVERSION TO	383	266.	13.75	104.	29.	29.	.59
HYDROGRAPH AT	384	266.	13.75	104.	29.	29.	.59
ROUTED TO	461	265.	13.92	103.	29.	29.	.59

2 COMBINED AT	462	319.	13.83	129.	37.	37.	.72
ROUTED TO	591	318.	13.92	129.	36.	36.	.72
HYDROGRAPH AT	603	277.	14.08	141.	42.	42.	.00
HYDROGRAPH AT	590	300.	14.42	161.	49.	49.	.13
2 COMBINED AT	592	594.	14.17	290.	85.	85.	.84
ROUTED TO	701	593.	14.33	290.	85.	85.	.84
HYDROGRAPH AT	710	26.	13.33	12.	3.	3.	.06
HYDROGRAPH AT	700	55.	13.33	24.	7.	7.	.12
2 COMBINED AT	702	629.	14.25	311.	92.	92.	.97
ROUTED TO	802	629.	14.42	312.	92.	92.	.97
HYDROGRAPH AT	950	23.	14.08	14.	4.	4.	.09
HYDROGRAPH AT	805	50.	13.25	50.	19.	19.	.00
2 COMBINED AT	946	73.	14.08	63.	23.	23.	.09
HYDROGRAPH AT	945	73.	14.17	63.	23.	23.	.10
HYDROGRAPH AT	940	10.	13.50	5.	1.	1.	.03
4 COMBINED AT	803	1191.	14.50	598.	178.	178.	4.23
DIVERSION TO	807	200.	14.50	193.	58.	58.	4.23
HYDROGRAPH AT	806	991.	14.50	406.	120.	120.	4.23
HYDROGRAPH AT	790	998.	14.67	423.	124.	124.	4.36
HYDROGRAPH AT	383	266.	13.75	104.	29.	29.	.00
ROUTED TO	451	265.	13.92	103.	29.	29.	.00
HYDROGRAPH AT	450	287.	14.17	126.	36.	36.	.13
ROUTED TO	581	287.	14.33	126.	36.	36.	.13
HYDROGRAPH AT	580	63.	13.33	26.	7.	7.	.13
2 COMBINED AT	582	326.	14.25	150.	43.	43.	.25
ROUTED TO	681	325.	14.42	149.	43.	43.	.25
HYDROGRAPH AT	680	59.	13.33	24.	7.	7.	.12
2 COMBINED AT	682	361.	14.33	173.	50.	50.	.37
ROUTED TO	791	360.	14.42	172.	50.	50.	.37
2 COMBINED AT	792	1345.	14.67	595.	174.	174.	4.73
HYDROGRAPH AT	780	1353.	14.75	606.	177.	177.	4.79
HYDROGRAPH AT	110	90.	13.58	40.	11.	11.	.19

HYDROGRAPH AT	140	96.	13.50	40.	12.	12.	.19
2 COMBINED AT	142	185.	13.58	80.	23.	23.	.38
ROUTED TO	201	185.	13.58	80.	23.	23.	.38
HYDROGRAPH AT	200	99.	13.42	40.	12.	12.	.19
2 COMBINED AT	202	283.	13.50	121.	35.	35.	.57
ROUTED TO	351	282.	13.58	121.	35.	35.	.57
HYDROGRAPH AT	250	34.	13.17	13.	4.	4.	.06
HYDROGRAPH AT	251	35.	13.17	14.	4.	4.	.06
2 COMBINED AT	252	69.	13.17	27.	8.	8.	.12
ROUTED TO	371	68.	13.33	27.	8.	8.	.12
HYDROGRAPH AT	370	35.	13.17	14.	4.	4.	.06
2 COMBINED AT	372	103.	13.25	40.	11.	11.	.19
HYDROGRAPH AT	350	218.	13.25	88.	25.	25.	.38
2 COMBINED AT	352	489.	13.50	209.	60.	60.	.95
ROUTED TO	441	489.	13.50	209.	60.	60.	.95
HYDROGRAPH AT	440	36.	13.17	14.	4.	4.	.06
2 COMBINED AT	442	522.	13.50	222.	63.	63.	1.01
ROUTED TO	561	522.	13.50	222.	63.	63.	1.01
HYDROGRAPH AT	560	36.	13.17	14.	4.	4.	.07
2 COMBINED AT	562	555.	13.50	236.	67.	67.	1.08
ROUTED TO	671	555.	13.50	236.	67.	67.	1.08
HYDROGRAPH AT	670	35.	13.17	13.	4.	4.	.06
2 COMBINED AT	672	586.	13.50	250.	71.	71.	1.14
ROUTED TO	781	586.	13.50	250.	71.	71.	1.14
2 COMBINED AT	782	1674.	14.67	848.	248.	248.	5.93
ROUTED TO	871	1671.	14.67	848.	248.	248.	5.93
HYDROGRAPH AT	870	28.	13.50	12.	4.	4.	.07
HYDROGRAPH AT	930	21.	13.42	10.	3.	3.	.06
ROUTED TO	921	21.	13.58	10.	3.	3.	.06
HYDROGRAPH AT	920	18.	13.92	10.	3.	3.	.07
2 COMBINED AT	922	39.	13.67	20.	6.	6.	.13
HYDROGRAPH AT	900	51.	13.58	26.	8.	8.	.17

2 COMBINED AT	901	73.	13.50	36.	11.	11.	.23
HYDROGRAPH AT	880	81.	13.50	40.	12.	12.	.26
ROUTED TO	872	81.	13.67	41.	12.	12.	.26
3 COMBINED AT	873	1748.	14.67	901.	263.	263.	6.26
ROUTED TO	891	1747.	14.67	901.	263.	263.	6.26
HYDROGRAPH AT	890	32.	12.75	8.	2.	2.	.04
2 COMBINED AT	892	1751.	14.67	907.	265.	265.	6.30
HYDROGRAPH AT	1020	1751.	14.75	909.	266.	266.	6.31
HYDROGRAPH AT	1040	22.	13.42	10.	3.	3.	.06
ROUTED TO	1031	22.	13.67	10.	3.	3.	.06
HYDROGRAPH AT	1030	38.	13.75	18.	5.	5.	.12
HYDROGRAPH AT	1070	22.	13.58	11.	3.	3.	.07
2 COMBINED AT	1032	60.	13.67	29.	9.	9.	.19
ROUTED TO	1021	60.	13.75	29.	9.	9.	.19
2 COMBINED AT	1022	1794.	14.67	938.	274.	274.	6.50
HYDROGRAPH AT	1060	1795.	14.75	940.	275.	275.	6.52
ROUTED TO	1083	1795.	14.75	940.	274.	274.	6.52
HYDROGRAPH AT	1090	21.	13.08	7.	2.	2.	.04
HYDROGRAPH AT	1080	30.	13.42	11.	3.	3.	.07
2 COMBINED AT	1082	1807.	14.75	951.	277.	277.	6.59
ROUTED TO	1084	1807.	14.75	951.	277.	277.	6.59
HYDROGRAPH AT	1081	21.	12.92	5.	2.	2.	.03
2 COMBINED AT	1085	1810.	14.75	956.	279.	279.	6.62
ROUTED TO	1111	1810.	14.75	955.	279.	279.	6.62
HYDROGRAPH AT	1110	31.	13.17	12.	3.	3.	.07
2 COMBINED AT	1112	1821.	14.75	966.	282.	282.	6.69
ROUTED TO	1171	1818.	14.75	966.	281.	281.	6.69
ROUTED TO	1203	1816.	14.83	966.	281.	281.	6.69
HYDROGRAPH AT	1071	11.	13.08	4.	1.	1.	.02
HYDROGRAPH AT	1072	26.	12.83	7.	2.	2.	.04
2 COMBINED AT	1074	36.	12.92	10.	3.	3.	.07
HYDROGRAPH AT	1073	50.	13.08	17.	5.	5.	.11

HYDROGRAPH AT	1091	29.	12.83	7.	2.	2.	.04
2 COMBINED AT	1093	67.	13.17	24.	7.	7.	.14
ROUTED TO	1122	67.	13.42	23.	7.	7.	.14
HYDROGRAPH AT	1121	26.	13.08	9.	2.	2.	.05
HYDROGRAPH AT	1131	13.	13.42	6.	2.	2.	.04
2 COMBINED AT	1132	39.	13.08	15.	4.	4.	.09
ROUTED TO	1133	39.	13.33	15.	4.	4.	.09
HYDROGRAPH AT	1130	13.	13.42	6.	2.	2.	.04
2 COMBINED AT	1134	52.	13.33	20.	6.	6.	.13
HYDROGRAPH AT	1120	78.	13.67	34.	10.	10.	.21
2 COMBINED AT	1123	142.	13.50	57.	16.	16.	.36
ROUTED TO	1181	138.	14.00	56.	16.	16.	.36
HYDROGRAPH AT	1150	22.	13.67	11.	3.	3.	.07
ROUTED TO	1172	22.	13.92	10.	3.	3.	.07
HYDROGRAPH AT	1170	23.	13.67	11.	3.	3.	.07
3 COMBINED AT	1173	181.	13.92	76.	22.	22.	.49
ROUTED TO	1201	181.	14.17	76.	22.	22.	.49
HYDROGRAPH AT	1200	30.	13.83	16.	5.	5.	.10
2 COMBINED AT	1202	209.	14.17	90.	27.	27.	.59
ROUTED TO	1204	208.	14.50	90.	26.	26.	.59
2 COMBINED AT	1205	2013.	14.75	1052.	307.	307.	7.29
HYDROGRAPH AT	1220	2021.	14.83	1061.	310.	310.	7.36
HYDROGRAPH AT	1230	56.	13.25	23.	7.	7.	.14
ROUTED TO	1221	56.	13.33	23.	7.	7.	.14
2 COMBINED AT	1222	2044.	14.83	1082.	316.	316.	7.50
HYDROGRAPH AT	1240	2051.	14.83	1087.	318.	318.	7.54
ROUTED TO	1251	2050.	14.83	1087.	317.	317.	7.54
HYDROGRAPH AT	1250	20.	13.83	11.	3.	3.	.07
2 COMBINED AT	1252	2064.	14.83	1097.	321.	321.	7.62
ROUTED TO	1253	2063.	14.83	1097.	321.	321.	7.62

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

APPENDIX B

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

   1          ID        SIMONS, LI AND ASSOCIATES
   2          ID        OUTER LOOP FREEWAY, PHASE 3  (FROM THE ARIZONA CANAL TO THE SALT RIVER)
   3          ID        FINAL HYDROLOGY ANALYSIS FOR OFFSITE DRAINAGE,  MARCH 26, 1989
   4          ID        MODEL 3FD5.24I - MARCH 1989 HIGHWAY ALIGNMENT
   5          ID        50 YEAR EVENT, 24 HOUR HYPOTHETICAL STORM DISTRIBUTION
   6          ID                        24 HOUR CN VALUES
   7          ID                        WITH LINED CHANNEL ALONG OUTER LOOP ALIGNMENT (n=.012)
   8          IT       5 26MAR89       0      289
   9          IO       5
*** NOLIST ***
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RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	550	38.	13.58	18.	5.	5.	.13		
ROUTED TO	651	38.	13.83	18.	5.	5.	.13		
HYDROGRAPH AT	650	50.	13.42	22.	6.	6.	.13		
2 COMBINED AT	652	85.	13.58	40.	12.	12.	.25		
HYDROGRAPH AT	640	108.	14.08	54.	16.	16.	.38		
HYDROGRAPH AT	430	23.	12.83	6.	2.	2.	.04		
HYDROGRAPH AT	420	46.	13.67	24.	7.	7.	.19		
ROUTED TO	501	46.	13.92	24.	7.	7.	.19		
HYDROGRAPH AT	500	30.	13.83	16.	5.	5.	.13		
2 COMBINED AT	502	76.	13.83	39.	12.	12.	.32		
ROUTED TO	641	76.	14.08	39.	12.	12.	.32		
2 COMBINED AT	642	184.	14.08	93.	28.	28.	.69		
HYDROGRAPH AT	630	196.	14.17	99.	30.	30.	.75		
HYDROGRAPH AT	490	15.	13.67	8.	2.	2.	.06		
ROUTED TO	631	15.	14.00	8.	2.	2.	.06		
2 COMBINED AT	632	211.	14.17	107.	32.	32.	.81		
ROUTED TO	621	210.	14.25	107.	32.	32.	.81		
HYDROGRAPH AT	230	69.	12.33	9.	2.	2.	.04		
HYDROGRAPH AT	231	72.	12.42	11.	3.	3.	.06		
ROUTED TO	281	73.	12.67	11.	3.	3.	.06		
HYDROGRAPH AT	290	28.	13.92	16.	5.	5.	.11		
HYDROGRAPH AT	280	38.	13.50	21.	6.	6.	.14		
2 COMBINED AT	282	98.	12.75	33.	9.	9.	.20		
ROUTED TO	401	98.	12.92	33.	9.	9.	.20		
HYDROGRAPH AT	410	15.	13.67	8.	2.	2.	.06		
HYDROGRAPH AT	400	33.	13.58	17.	5.	5.	.12		
2 COMBINED AT	402	124.	13.00	49.	14.	14.	.32		
HYDROGRAPH AT	620	129.	13.67	63.	19.	19.	.45		

HYDROGRAPH AT	600	344.	14.42	184.	56.	56.	1.39
HYDROGRAPH AT	170	56.	13.33	23.	7.	7.	.13
ROUTED TO	221	56.	13.58	23.	7.	7.	.13
HYDROGRAPH AT	220	50.	13.42	22.	6.	6.	.13
2 COMBINED AT	222	106.	13.50	45.	13.	13.	.25
ROUTED TO	271	106.	13.75	45.	13.	13.	.25
HYDROGRAPH AT	270	50.	13.42	22.	6.	6.	.12
2 COMBINED AT	272	153.	13.67	66.	19.	19.	.38
ROUTED TO	391	152.	13.83	66.	19.	19.	.38
HYDROGRAPH AT	390	50.	13.42	22.	6.	6.	.13
2 COMBINED AT	392	199.	13.75	87.	25.	25.	.50
DIVERSION TO	393	174.	12.83	65.	18.	18.	.50
HYDROGRAPH AT	394	25.	12.83	22.	7.	7.	.50
ROUTED TO	471	25.	13.83	22.	7.	7.	.50
HYDROGRAPH AT	470	50.	13.42	22.	6.	6.	.13
2 COMBINED AT	472	75.	13.42	43.	13.	13.	.63
ROUTED TO	601	75.	13.67	43.	13.	13.	.63
2 COMBINED AT	602	406.	14.42	227.	69.	69.	2.01
DIVERSION TO	603	203.	14.42	113.	34.	34.	2.01
HYDROGRAPH AT	604	203.	14.42	113.	34.	34.	2.01
ROUTED TO	721	203.	14.50	113.	34.	34.	2.01
HYDROGRAPH AT	720	41.	13.58	19.	6.	6.	.13
2 COMBINED AT	722	232.	14.42	130.	40.	40.	2.14
ROUTED TO	811	231.	14.58	130.	39.	39.	2.14
HYDROGRAPH AT	760	39.	13.00	12.	3.	3.	.06
ROUTED TO	751	39.	13.17	12.	3.	3.	.06
HYDROGRAPH AT	750	39.	13.00	12.	3.	3.	.06
2 COMBINED AT	752	77.	13.17	23.	7.	7.	.13
ROUTED TO	841	77.	13.33	23.	6.	6.	.13
HYDROGRAPH AT	850	26.	13.17	10.	3.	3.	.07
HYDROGRAPH AT	840	48.	13.33	19.	6.	6.	.13
2 COMBINED AT	842	125.	13.33	42.	12.	12.	.25

HYDROGRAPH AT	740	33.	13.75	16.	5.	5.	.13
ROUTED TO	831	32.	14.00	16.	5.	5.	.13
2 COMBINED AT	832	174.	13.83	74.	22.	22.	.50
HYDROGRAPH AT	820	189.	14.17	88.	26.	26.	.63
HYDROGRAPH AT	730	30.	13.83	16.	5.	5.	.13
ROUTED TO	821	30.	14.08	16.	5.	5.	.13
2 COMBINED AT	822	219.	14.17	103.	30.	30.	.75
DIVERSION TO	823	88.	14.17	41.	13.	13.	.75
HYDROGRAPH AT	824	132.	14.17	62.	18.	18.	.75
HYDROGRAPH AT	810	147.	14.58	75.	22.	22.	.88
2 COMBINED AT	812	378.	14.58	204.	61.	61.	3.01
HYDROGRAPH AT	800	389.	14.75	213.	64.	64.	3.11
DIVERSION TO	805	50.	14.75	49.	18.	18.	3.11
HYDROGRAPH AT	804	339.	14.75	163.	46.	46.	3.11
HYDROGRAPH AT	801	343.	14.83	166.	47.	47.	3.14
HYDROGRAPH AT	130	52.	13.25	19.	5.	5.	.10
ROUTED TO	161	52.	13.42	19.	5.	5.	.10
HYDROGRAPH AT	160	50.	13.42	21.	6.	6.	.12
2 COMBINED AT	162	102.	13.42	40.	11.	11.	.22
ROUTED TO	211	102.	13.58	40.	11.	11.	.22
HYDROGRAPH AT	210	49.	13.42	21.	6.	6.	.12
2 COMBINED AT	212	150.	13.58	61.	17.	17.	.35
ROUTED TO	261	149.	13.67	60.	17.	17.	.35
HYDROGRAPH AT	260	49.	13.42	21.	6.	6.	.12
2 COMBINED AT	262	196.	13.67	81.	23.	23.	.47
ROUTED TO	381	194.	13.83	81.	23.	23.	.47
HYDROGRAPH AT	393	174.	13.75	65.	18.	18.	.00
HYDROGRAPH AT	380	201.	14.08	85.	24.	24.	.13
2 COMBINED AT	382	389.	13.92	166.	47.	47.	.59
DIVERSION TO	383	195.	13.92	83.	24.	24.	.59
HYDROGRAPH AT	384	195.	13.92	83.	24.	24.	.59
ROUTED TO	461	194.	14.08	83.	24.	24.	.59

2 COMBINED AT	462	235.	14.00	103.	30.	30.	.72
ROUTED TO	591	234.	14.17	103.	30.	30.	.72
HYDROGRAPH AT	603	203.	14.42	113.	34.	34.	.00
HYDROGRAPH AT	590	222.	14.67	130.	40.	40.	.13
2 COMBINED AT	592	437.	14.42	233.	70.	70.	.84
ROUTED TO	701	437.	14.50	232.	69.	69.	.84
HYDROGRAPH AT	710	19.	13.58	9.	3.	3.	.06
HYDROGRAPH AT	700	40.	13.50	19.	6.	6.	.12
2 COMBINED AT	702	465.	14.42	249.	75.	75.	.97
ROUTED TO	802	465.	14.50	249.	74.	74.	.97
HYDROGRAPH AT	950	16.	14.42	11.	3.	3.	.09
HYDROGRAPH AT	805	50.	13.58	49.	18.	18.	.00
2 COMBINED AT	946	66.	14.42	59.	21.	21.	.09
HYDROGRAPH AT	945	66.	14.50	59.	21.	21.	.10
HYDROGRAPH AT	940	7.	13.67	4.	1.	1.	.03
4 COMBINED AT	803	869.	14.67	477.	144.	144.	4.23
DIVERSION TO	807	200.	14.67	186.	54.	54.	4.23
HYDROGRAPH AT	806	669.	14.67	291.	91.	91.	4.23
HYDROGRAPH AT	790	674.	14.92	304.	94.	94.	4.36
HYDROGRAPH AT	383	195.	13.92	83.	24.	24.	.00
ROUTED TO	451	194.	14.08	83.	24.	24.	.00
HYDROGRAPH AT	450	212.	14.42	100.	30.	30.	.13
ROUTED TO	581	211.	14.58	100.	29.	29.	.13
HYDROGRAPH AT	580	47.	13.50	21.	6.	6.	.13
2 COMBINED AT	582	241.	14.50	120.	35.	35.	.25
ROUTED TO	681	240.	14.67	119.	35.	35.	.25
HYDROGRAPH AT	680	44.	13.50	20.	6.	6.	.12
2 COMBINED AT	682	267.	14.58	138.	41.	41.	.37
ROUTED TO	791	266.	14.67	138.	41.	41.	.37
2 COMBINED AT	792	934.	14.92	442.	134.	134.	4.73
HYDROGRAPH AT	780	941.	15.00	451.	137.	137.	4.79
HYDROGRAPH AT	110	67.	13.75	33.	10.	10.	.19

HYDROGRAPH AT	140	72.	13.67	33.	10.	10.	.19
2 COMBINED AT	142	139.	13.67	66.	19.	19.	.38
ROUTED TO	201	139.	13.75	66.	19.	19.	.38
HYDROGRAPH AT	200	73.	13.58	33.	10.	10.	.19
2 COMBINED AT	202	212.	13.67	99.	29.	29.	.57
ROUTED TO	351	211.	13.75	99.	29.	29.	.57
HYDROGRAPH AT	250	25.	13.25	11.	3.	3.	.06
HYDROGRAPH AT	251	26.	13.25	11.	3.	3.	.06
2 COMBINED AT	252	51.	13.25	22.	6.	6.	.12
ROUTED TO	371	51.	13.50	22.	6.	6.	.12
HYDROGRAPH AT	370	26.	13.25	11.	3.	3.	.06
2 COMBINED AT	372	76.	13.42	33.	9.	9.	.19
HYDROGRAPH AT	350	165.	13.42	73.	21.	21.	.38
2 COMBINED AT	352	369.	13.58	171.	50.	50.	.95
ROUTED TO	441	368.	13.58	171.	50.	50.	.95
HYDROGRAPH AT	440	26.	13.33	11.	3.	3.	.06
2 COMBINED AT	442	393.	13.58	183.	53.	53.	1.01
ROUTED TO	561	392.	13.67	182.	53.	53.	1.01
HYDROGRAPH AT	560	27.	13.33	12.	3.	3.	.07
2 COMBINED AT	562	418.	13.58	194.	56.	56.	1.08
ROUTED TO	671	417.	13.67	194.	56.	56.	1.08
HYDROGRAPH AT	670	25.	13.25	11.	3.	3.	.06
2 COMBINED AT	672	441.	13.58	205.	59.	59.	1.14
ROUTED TO	781	441.	13.67	205.	59.	59.	1.14
2 COMBINED AT	782	1191.	14.92	647.	196.	196.	5.93
ROUTED TO	871	1189.	14.92	647.	196.	196.	5.93
HYDROGRAPH AT	870	21.	13.67	10.	3.	3.	.07
HYDROGRAPH AT	930	15.	13.58	8.	2.	2.	.06
ROUTED TO	921	15.	13.75	8.	2.	2.	.06
HYDROGRAPH AT	920	13.	14.25	8.	2.	2.	.07
2 COMBINED AT	922	27.	13.92	16.	5.	5.	.13
HYDROGRAPH AT	900	36.	13.83	20.	6.	6.	.17

2 COMBINED AT	901	51.	13.75	28.	8.	8.	.23
HYDROGRAPH AT	880	57.	13.75	32.	9.	9.	.26
ROUTED TO	872	57.	13.92	32.	9.	9.	.26
3 COMBINED AT	873	1247.	14.92	688.	208.	208.	6.26
ROUTED TO	891	1246.	14.92	688.	208.	208.	6.26
HYDROGRAPH AT	890	24.	12.83	6.	2.	2.	.04
2 COMBINED AT	892	1250.	14.92	693.	209.	209.	6.30
HYDROGRAPH AT	1020	1249.	15.00	695.	210.	210.	6.31
HYDROGRAPH AT	1040	15.	13.67	8.	2.	2.	.06
ROUTED TO	1031	15.	13.92	8.	2.	2.	.06
HYDROGRAPH AT	1030	27.	13.92	14.	4.	4.	.12
HYDROGRAPH AT	1070	15.	13.83	9.	3.	3.	.07
2 COMBINED AT	1032	43.	13.92	23.	7.	7.	.19
ROUTED TO	1021	43.	14.00	23.	7.	7.	.19
2 COMBINED AT	1022	1281.	14.92	717.	217.	217.	6.50
HYDROGRAPH AT	1060	1282.	15.00	719.	217.	217.	6.52
ROUTED TO	1083	1282.	15.00	719.	217.	217.	6.52
HYDROGRAPH AT	1090	15.	13.17	5.	2.	2.	.04
HYDROGRAPH AT	1080	21.	13.58	9.	3.	3.	.07
2 COMBINED AT	1082	1291.	15.00	728.	219.	219.	6.59
ROUTED TO	1084	1291.	15.00	727.	219.	219.	6.59
HYDROGRAPH AT	1081	15.	13.00	4.	1.	1.	.03
2 COMBINED AT	1085	1294.	15.00	731.	220.	220.	6.62
ROUTED TO	1111	1293.	15.00	731.	220.	220.	6.62
HYDROGRAPH AT	1110	22.	13.33	9.	3.	3.	.07
2 COMBINED AT	1112	1302.	15.00	740.	223.	223.	6.69
ROUTED TO	1171	1299.	15.08	739.	222.	222.	6.69
ROUTED TO	1203	1299.	15.08	739.	222.	222.	6.69
HYDROGRAPH AT	1071	7.	13.25	3.	1.	1.	.02
HYDROGRAPH AT	1072	18.	13.00	5.	1.	1.	.04
2 COMBINED AT	1074	25.	13.00	8.	2.	2.	.07
HYDROGRAPH AT	1073	35.	13.17	14.	4.	4.	.11

HYDROGRAPH AT	1091	21.	12.92	5.	2.	2.	.04
2 COMBINED AT	1093	48.	13.33	19.	5.	5.	.14
ROUTED TO	1122	48.	13.58	19.	5.	5.	.14
HYDROGRAPH AT	1121	19.	13.17	7.	2.	2.	.05
HYDROGRAPH AT	1131	9.	13.58	5.	1.	1.	.04
2 COMBINED AT	1132	27.	13.25	12.	3.	3.	.09
ROUTED TO	1133	27.	13.50	12.	3.	3.	.09
HYDROGRAPH AT	1130	9.	13.58	5.	1.	1.	.04
2 COMBINED AT	1134	37.	13.50	16.	5.	5.	.13
HYDROGRAPH AT	1120	55.	13.83	26.	8.	8.	.21
2 COMBINED AT	1123	101.	13.75	45.	13.	13.	.36
ROUTED TO	1181	100.	14.17	44.	13.	13.	.36
HYDROGRAPH AT	1150	15.	13.83	8.	2.	2.	.07
ROUTED TO	1172	15.	14.17	8.	2.	2.	.07
HYDROGRAPH AT	1170	16.	13.92	8.	2.	2.	.07
3 COMBINED AT	1173	130.	14.17	60.	18.	18.	.49
ROUTED TO	1201	130.	14.42	60.	18.	18.	.49
HYDROGRAPH AT	1200	21.	14.08	12.	4.	4.	.10
2 COMBINED AT	1202	150.	14.42	71.	21.	21.	.59
ROUTED TO	1204	149.	14.83	71.	21.	21.	.59
2 COMBINED AT	1205	1442.	15.08	806.	242.	242.	7.29
HYDROGRAPH AT	1220	1449.	15.08	814.	244.	244.	7.36
HYDROGRAPH AT	1230	39.	13.33	18.	5.	5.	.14
ROUTED TO	1221	39.	13.50	18.	5.	5.	.14
2 COMBINED AT	1222	1465.	15.08	829.	250.	250.	7.50
HYDROGRAPH AT	1240	1470.	15.08	834.	251.	251.	7.54
ROUTED TO	1251	1468.	15.17	834.	250.	250.	7.54
HYDROGRAPH AT	1250	14.	14.17	9.	3.	3.	.07
2 COMBINED AT	1252	1479.	15.17	842.	253.	253.	7.62
ROUTED TO	1253	1479.	15.17	841.	253.	253.	7.62

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

WEST EDGE OF
DRAINAGE CHANNEL
(BASIN BOUNDARY)
ARIZONA CANAL
McDonald Rd.
Chapparal Rd.
Indian School Rd.
Thomas Rd.
McDowell Rd.
McKellips Rd.
Pima Rd.
Dobson Rd.
Alma School Rd
Country Club Dr.
Center Dr.
SALT RIVER
LEGEND
BASIN BOUNDARY
SUB-BASIN BOUNDARY
580 BASIN NUMBER
CONCENTRATION POINT
FLOW PATH
UPSTREAM END OF
ROUTING REACH
N
SCALE: 1"=1000'-0"
FLOOD CONTROL DISTRICT
AUG 29 '89
OUTER LOOP HIGHWAY
MARCH 1989 ALIGNMENT
HYDROLOGIC MODEL SCHEMATIC
sla Simons, Li & Associates, Inc.
Cheyenne, WY. • Colorado Springs, CO. • Denver, CO. • Fort Collins, CO.
Newport Beach, CA. • Phoenix, AZ. • Tucson, AZ.

OUTER LOOP HIGHWAY
MARCH 1989 ALIGNMENT
HYDROLOGIC SOIL GROUP MAP

sla Simons, Li & Associates, Inc.
Cheyenne, WY. • Colorado Springs, CO. • Denver, CO. • Fort Collins, CO.
Newport Beach, CA. • Phoenix, AZ. • Tucson, AZ.

sla Simons, Li & Associates, Inc.

Cheyenne, WY. • Colorado Springs, CO. • Denver, CO. • Fort Collins, CO.
Newport Beach, CA. • Phoenix, AZ. • Tucson, AZ.

LEGEND

—— SUB-BASIN BOUNDARY

1240 SUB-BASIN NUMBER

AERIAL PHOTOGRAPH OF WATERSHED BOUNDARIES
MARCH 1989 ALIGNMENT

AUG 29 '89

PLATE 1