FINAL DRAINAGE REPORT
VOLUME II

I-10 CORRIDOR STUDY

40TH STREET TO BASELINE ROAD

MARCH, 1988

SUBMITTED BY:

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ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION

SECTION ADOT BRIDGE DRAINAGE SECTION

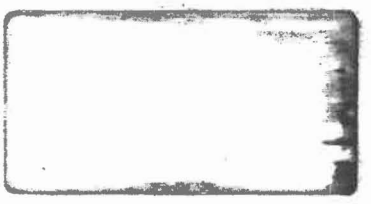
☐ **PROJECT NO.** IR-10-3(222)

☐ **PERMIT NO:**
- ☐ ENCROACHMENT-USE
- ☐ OUTDOOR ADVERTISING

☐ **PARCEL NO:**

☐ **OTHER** 40th St. To Baseline Road

• 82-4304 R3/86



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INTRODUCTION

The drainage analysis for the I-10 Corridor Study from 40th Street to Baseline Road includes: I-10 from the 40th Street interchange eastward and then southward to approximately 2200 feet south of Baseline Road; Hohokam Freeway (48th Street) from Broadway Road intersection northward to Tempe Drain; Broadway Road from 48th Street northeast to Priest Drive; and the I-10/Superstition Freeway interchange, as shown in Figures 1A, 2A, 3A, and 4A (Appendix A).

The existing drainage systems within the study area include an established drainage system west of Bell Butte for the area including Broadway Road, 48th Street, and I-10 between 48th Street and Bell Butte with its outfall into Tempe Drain. South of Bell Butte, flow from this section of I-10 discharge into either the municipal storm drainage systems, Salt River Project Western and Highland Canals, or onto private undeveloped land. The section of I-10 located between 40th and 48th Streets drains onto ADOT'S right-of-way where it either ponds on-site, discharges into the municipal storm drainage systems or is retained in private retention basins.

The ultimate drainage systems proposed within the study area are designed according to Functional Plan Alternative C-1 and the availability of outfalls.

The drainage study includes the evaluation of the existing drainage systems within the study area as they exist at the present and the recommended ultimate drainage systems according to the Functional Plan Alternative C-1 (Figure 1). For clarification, usage of the term: "existing drainage systems" will refer to the drainage systems as they exist at the present, while usage of the term: "ultimate drainage systems" will refer to the required drainage systems based on the completion of all future roadway improvements within the study area, as shown on Functional Plan Alternative C-1 (Figure 1).

The existing drainage systems within the study area are divided into 12 drainage areas, each representing a separate existing drainage system which discharges into a separate outfall and are designated as follows: Drainage Areas 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100 and 1200. The twelve drainage areas are shown delineated in green on Figures 1A through 4A in Appendix A. Several of the twelve drainage areas are further delineated into subareas, as necessary to describe their hydrologic and hydraulic characteristics. The subareas are assigned by an alpha-numeric-alpha designation such as SA800J. The prefix 'SA' represents Subarea, the number '800' represents the drainage area the subarea is located within, and the suffix 'J' represents that specific subarea within drainage area 800. Those drainage areas requiring subarea delineation are shown in blue on Figures 1A through 4A. (Appendix A). In addition, there are eight drainage areas located throughout the study area whose runoff is permanently retained on-site. Those drainage areas are designated Retention Sites 1 through 8, as shown on Figures 2A and 3A (Appendix A).

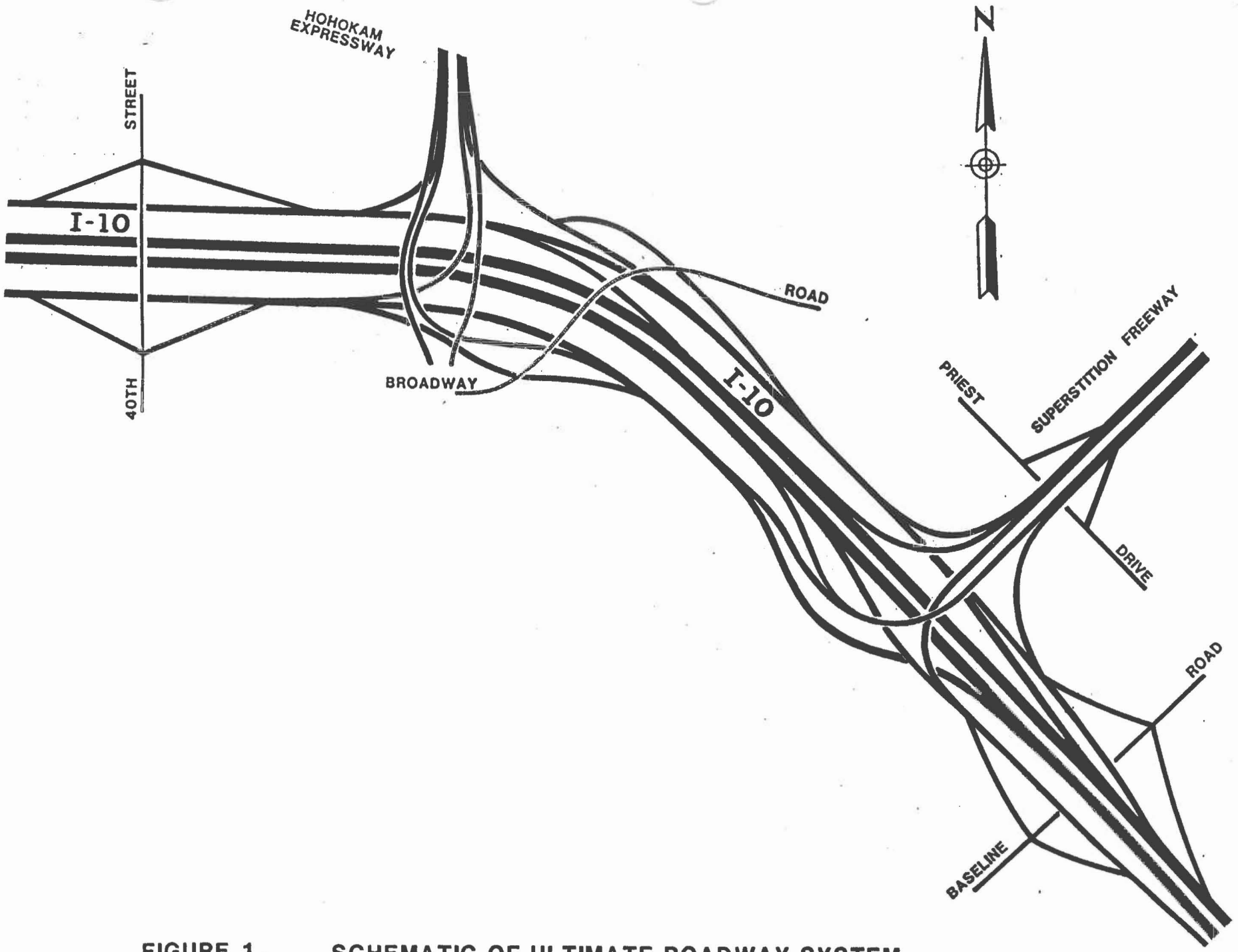

FIGURE 1. SCHEMATIC OF ULTIMATE ROADWAY SYSTEM ACCORDING TO FUNCTIONAL PLAN ALTERNATIVE C-1.

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The ultimate drainage systems for the study area according to Functional Plan Alternative C-1, are delineated into twelve drainage areas. The drainage area boundaries are shown in green and are designated as follows: Drainage Areas 100, 200, 300, 400, 600, 700, 800, 900, 1000, 1100, 1200, and 1300, as shown in Figures 5A, 6A, 7A, 8A and 9A (Appendix A). Drainage Areas 100 through 1000 represent the portion of the study area located south of Bell Butte where an existing drainage system does not exist. Consequently, for analysis, this portion of the study area is divided into drainage areas contributing flows to the proposed detention basins in the ultimate drainage system scheme, as shown in Figures 5A through 9A (Appendix A). The detention basins for each of the drainage areas are assigned the same numeric designation as the drainage area they are located in and have the prefix 'DB' representing detention basin proceeding the numeric designation. Drainage areas 1100, 1200, and 1300 represent drainage areas with established drainage systems and are further delineated into subareas representing either areas contributing flow to detention basins or to an inlet or series of inlets, as shown on Figures 8A and 9A (Appendix A). The subareas delineations are shown in blue in Figures 8A and 9A (Appendix A). The subareas are assigned an alpha-numeric-alpha designation such as SA1000J. The prefix 'SA' represents subarea, the number '1000' represents the drainage the subarea is located in, and the suffix 'J' represents that particular subarea within Drainage Area 1000. The Detention Basins are also assigned an alpha-numeric-alpha designation such as 'DB1000C'. The prefix 'DB' represents Detention Basin and '1000C' represents the Subarea that the detention basin is located in.

The stationing shown on Figures 1A through 9A in Appendix A, are based on the following ADOT plans:

1. Phoenix Interstate Freeway, Maricopa County, I-10-3(33), AS BUILT, updated March 20, 1974.

2. Phoenix Interstate Freeway, Maricopa County, I-10-3(51), AS BUILT, updated November 20, 1973; and

3. Superstition Freeway, Maricopa County, F-028-1(1), updated June 17, 1974. (Note equation of Sta. 174+76.92 Bk = 74+78.06 AH at Kyrene Road.)

EXISTING DRAINAGE SYSTEMS ANALYSES

The I-10 Corridor Study for the existing drainage systems is divided into twelve drainage areas, as shown in Figures 1A through 4A (Appendix A). Each drainage area represents a separate existing drainage system which discharges into a separate outfall. Table 1 lists the twelve drainage areas, their approximate size in acres, and the location of their outfalls. The I-10 Corridor Study also includes eight existing retention sites within ADOT's right-of-way, located throughout the study area, labeled Retention Sites 1 through 8, as shown on Figures 1A through 4A (Appendix A). Table 2 lists the eight retention sites and their size in acres.

The total area of the I-10 Corridor Study, including the twelve drainage areas and the seven retention sites, is approximately 322.5 acres, excluding all off-site properties draining onto ADOT right-of-way.

The twelve drainage areas are designated in Figures 1A through 4A (Appendix A) as: Drainage Areas 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, and 1200. The twelve drainage areas are delineated in green in Figures 1A and 2A. Several of the drainage areas are further delineated into subareas as necessary to describe their hydrologic/hydraulic characteristics. Those drainage areas requiring subarea delineation are shown in blue in Figures 1A through 4A. The subareas are assigned an alpha-numeric-alpha designation such as SA600J. The prefix 'SA' represents subarea, the numeric value 600 represents the drainage area the subarea is located in, and the suffix 'J' represents that particular subarea within Drainage Area 600.

The following sections explain the procedure used in analyzing the existing drainage systems and retention sites, and presents the results of the analysis of each drainage area.

TABLE 1. EXISTING DRAINAGE AREAS AND LOCATION OF OUTFALLS.

Drainage Area Designation	Area 1 (acres)	Location of Outfall
100	14.0	Discharges into Highland Canal.
200	37.9	Discharges onto undeveloped private property.
300	4.5	Discharges onto undeveloped private property.
400	21.1	Discharges into retention basin east of I-10 and north of Southern Avenue (designated Retention Site 1)
500	21.0	Retained on-site until it can be pumped into Western Canal.
600	30.7	Ponds on-site or discharges into Tempe's storm drain system along Alameda Drive and Fairmont Drive.
700	1.3	Discharges into Chevrolet's private retention basin.
800	100.7	Discharges into the Tempe Drain at 48th Street.
900	6.4	Discharges into Tempe's 18" storm drain along Broadway Road.
1000	17.3	Discharges into Pepsi Cola's private retention basin.
1100	15.4	Discharges into ADOT's storm sewer at 40th Street.
1200	12.8	Discharges into City of Phoenix storm drain located south of I-10 and east of 40th Street.
Total Area	283.1	

TABLE 2. EXISTING RETENTION SITES AND CONTRIBUTING AREA.

Retention Site Designation		Area (Acres)
Retention Site	1	2.4
Retention Site	2	9.9
Retention Site	3	4.9
Retention Site	4	1.5
Retention Site	5	1.2
Retention Site	6	11.4
Retention Site	7	3.9
Retention Site	8	4.2
	Total Area	39.4

METHOD OF ANALYSIS

The I-10 corridor study area is divided into twelve existing drainage systems and eight retention sites. The defined drainage areas to the individual drainage systems and retention sites are shown in Figures 1A through 4A (Appendix A). Each drainage area represents an existing drainage system discharging from the study area at different locations and is assigned a numeric designation of 100 through 1200. Drainage Areas 800, 900, 1000, 1100, and 1200 are further delineated into subareas, as necessary to adequately define and describe their hydrologic and hydraulic characteristics. The subareas are assigned an alpha-numeric-alpha designation, with the prefix 'SA' representing subarea, the number representing the drainage area the subarea is located in and the suffix letter representing the individual subarea. The seven drainage areas with permanent retention located throughout the study area are designated as: Retention Sites 1 through 7.

The U.S. Soil Conservation Service TR-20 program was used to compute the runoff hydrographs for the 10-year and the 50-year frequency storm events, for each of the drainage areas, subareas, and retention sites located within the study area.

For all TR-20 computer runs, the rainfall distribution was developed from a procedure provided by ADOT, dated April 17, 1987, which along with providing the 24-hour rainfall distribution, generates the point precipitation values for the different design frequencies. The TR-20 program limits the rainfall distribution entries to 100. However, since the recommended time increment is 0.1 hours, the total number of entries for the 24-hour distribution exceeds 100. In order to use the 0.1 hour time increment, the 24-hour rainfall distribution was truncated 8 hours at the beginning and at the end, resulting in an 8-hour rainfall distribution from hour 8 to hour 16. The precipitation lost during the truncation procedure is re-distributed at the beginning and at the end of the truncated rainfall distribution, as shown in Figure 1C (Appendix C).

To evaluate the adequacy of the existing drainage systems, the 10-year frequency storm event is used according to the design criteria presented in "Hydrologic Design for Highway Drainage in Arizona: for Interstate projects." The 50-year frequency storm event is used to check surcharging conditions in the existing drainage systems and the volume of storage and depth of ponding occurring within the existing drainage systems.

The precipitation depths of 2.29 inches for the 10-year and 3.20 inches for the 50-year storm events are used for all analyses.

The hydrologic requirements of each drainage area, subarea, and retention site for TR-20 analysis were defined by the drainage area in square miles, a composite curve number, and the time of concentration in hours. With the use of a planimeter, the areas of the drainage area, subareas, and retention sites were directly measured for existing condition from Maricopa County topographic maps. The composite curve numbers are averaged by weighting the runoff curve numbers for each land use condition encountered within each drainage area, subarea, and retention site. The runoff curve numbers for the different land uses and hydrologic soil groups are included in the Design Criteria (Appendix B).

The time of concentration is the distance the runoff has to travel from the hydraulically most distant point of a drainage area, subarea, or retention site to either the point of interception into the existing drainage systems or the location of ponding. Maricopa County topographic maps were used for measuring the overland travel path distance and determining the average slope of the travel path for each of the drainage areas, subareas, and retention sites. The time of concentration was determined using the Kinematic Wave Nomograph and the HTN rainfall-frequency curve.

The TR-20 program was used to develop the inflow hydrographs for drainage areas 800, 900, 1000, 1100, and 1200 whose existing drainage systems consist of closed conduits. The Stormwater Management Model subroutine EXTRAN was used to analyze the hydraulics.

DRAINAGE AREA 100

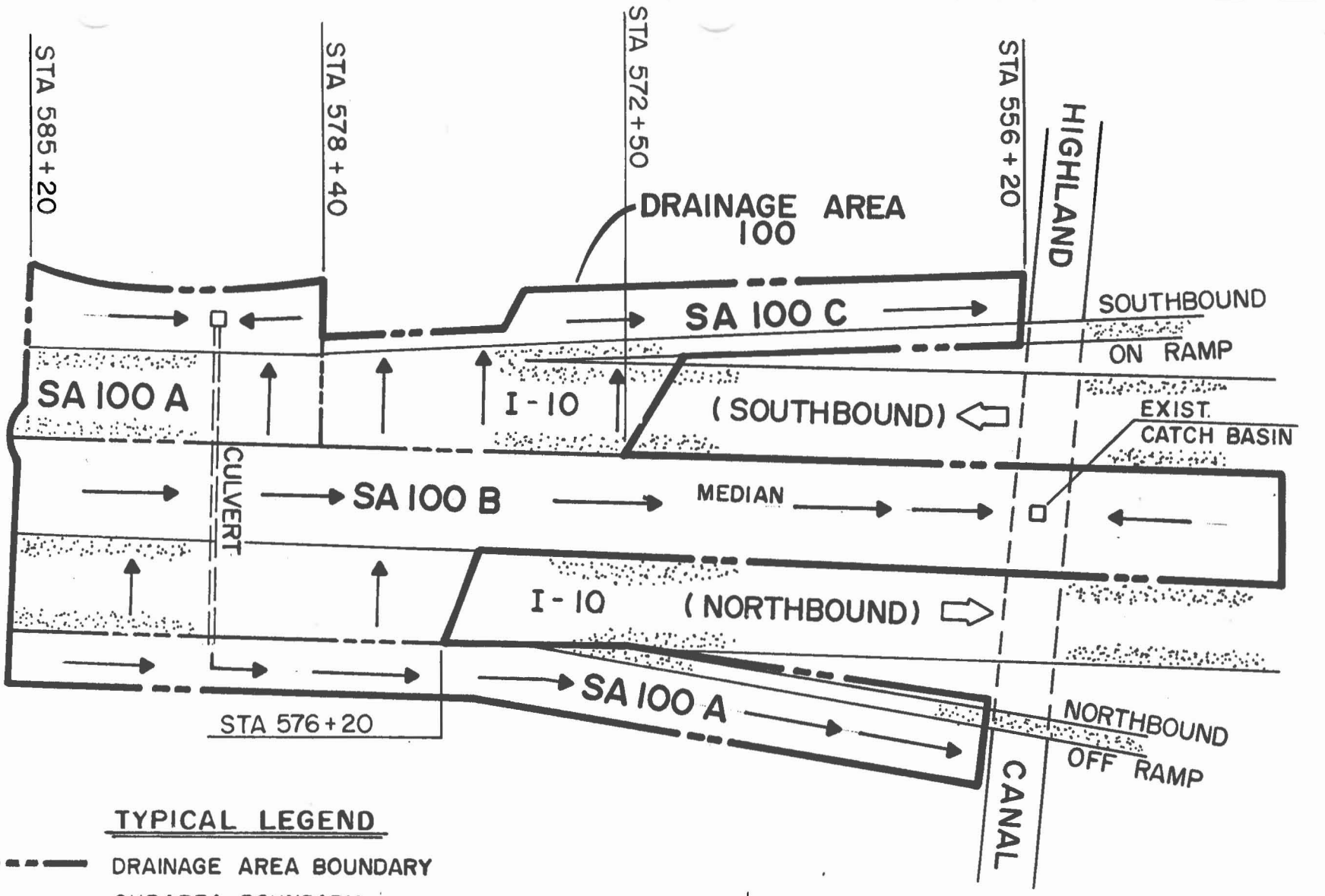
Drainage Area 100 consists of approximately 14.0 acres of I-10 located south of Baseline Road from Sta. 585+20 northward to Sta. 556+20, as shown in Figure 1A (Appendix A)and Figure 2.

Drainage Area 100 is divided into three subareas designated subareas SA100A, SA100B, and SA100C. Subarea SA100A contains the I-10 southbound lanes and the west right-of-way from Sta. 585+20 northward to Sta. 578+40 and the east right-of-way from Sta. 585+20 northward to Sta. 556+20 including that section of the I-10 northbound off-ramp. Runoff from the I-10 southbound lanes flow in the westerly direction onto the west right-of-way and then overland in a northerly direction to a culvert which discharges the flow to the east side of I-10, which in turn flows overland in the northerly direction along with flow from the east right-of-way with discharge into the Highland Canal. The 10-year and 50-year storm events projected peak flows at the outfall are 6.0 cfs and 9.4 cfs, respectively.

Subarea SA100B includes the median between the I-10 northbound and southbound lanes from Sta. 585+20 northbound to Sta. 576+20 and the I-10 northbound lanes from Sta. 585+20 northward to Sta. 576+20, as shown in Figures 1A and 2. Runoff from the I-10 northbound lanes flow in the westerly direction onto the median, then overland in the northerly direction along with flow from the median to an existing catch basin which discharges into the Highland Canal. The 10-year and the 50-year storm events projected peak flows are 7.7 cfs and 12.1 cfs, respectively.

Subarea SA100C includes the I-10 southbound lanes from Sta. 578+40 northward to Sta. 572+50 and the west right-of-way and I-10 southbound on-ramp from Sta. 578+00 northward to Sta. 556+20, as shown in Figures 1A (Appendix A) and 2. Runoff from the I-10 southbound lanes is in a westerly direction onto the west right-of-way, then flows overland along with flows from the west right-of-way in the northerly direction and discharges into the Highland Canal. The projected peak flow for the 10-year and 50-year storm events into Highland Canal are 7.5 cfs and 11.8 cfs, respectively.

Table 3 summarizes the 10-year and 50-year storm events projected peak flows for subareas SA100A, SA100B, and SA100C at their outfall into Highland Canal.



TYPICAL LEGEND

———	DRAINAGE AREA BOUNDARY
— — —	SUBAREA BOUNDARY
SA100A	SUBAREA DESIGNATION
D.B.	EXISTING DETENTION BASIN
→	DIRECTION OF FLOW
□	EXISTING CATCH BASIN
═══	EXISTING CONDUIT OR STORM DRAIN

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FIGURE 2. FLOW SCHEMATIC OF DRAINAGE AREA 100.

TABLE 3. DRAINAGE AREA 100
PROJECTED PEAK FLOWS FOR THE 10-YEAR
AND 50-YEAR STORM EVENTS AT THE OUTFALL

Subarea Designation	Storm Frequency (year)	Projected Peak Flow (cfs)	Outfall Location
SA100A	10	7.7	Highland Canal
	50	12.1	
SA100B	10	6.0	Highland Canal
	50	9.4	
SA100C	10	7.5	Highland Canal
	50	11.8	

DRAINAGE AREA 200

Drainage Area 200 consists of approximately 37.9 acres of I-10 located south of Baseline Road from Sta. 576+20 northward to Sta. 525+75 (Western Canal), as shown in Figures 1A (Appendix A) and 3.

Drainage Area 200 is divided into five sub-areas, designated subareas SA200 A through E, as shown in Figures 1A and 3. Runoff within the drainage area flows overland in a northerly direction overtopping Baseline Road, through the existing 24" culverts under the I-10 on and off ramps north of Baseline Road, continuing northward along both the east and west right-of-ways, with the west flows from subareas SA200A and SA200B discharging in the easterly direction through a 24" culvert under I-10 at Sta. 532+50 and combining with flow from subareas SA200C and SA200D, and discharging onto undeveloped land.

Originally, the outfall for Drainage Area 200 was a 30" RCP beginning at the cul-de-sac of Edward Drive and flowing in an easterly direction until it connected to Tempe's 66" storm drain along Priest Drive. The developer of the property has since removed the 30" RCP and, as a result, runoff from Drainage Area 200 now ponds onto the undeveloped land, as shown on Figure 3.

Flows from subareas SA200A and SA200B must flow through a 24" RCP at Sta. 532+50 to reach the outfall. When the ponding depth exceeds the top of the earth berm at the entrance to the 24" RCP, the excess runoff overtops the earth berm and flows northwest onto undeveloped land to pond, as shown in Figure 3.

The projected peak flows for Drainage Area 200 are 41.5 cfs and 56.0 cfs for the 10-year and 50-year storm events, respectively. The projected peak flows over the earth berm are 4.0 cfs and 13.6 cfs for the 10-year and 50-year storm events, respectively. The results are summarized in Table 4.

TABLE 4. DRAINAGE AREA 200
PROJECTED PEAK FLOWS AT OUTFALL
FOR THE 10-YEAR AND THE 50 YEAR STORM
EVENTS AT THE OUTFALL.

Storm Frequency (year)	Projected Peak Flow (cfs)	Outfall Location	Projected Excess Flow (cfs)	Outfall Location
10	41.5	Undeveloped	4.0	Undeveloped
50	56.0	Land	13.6	Land

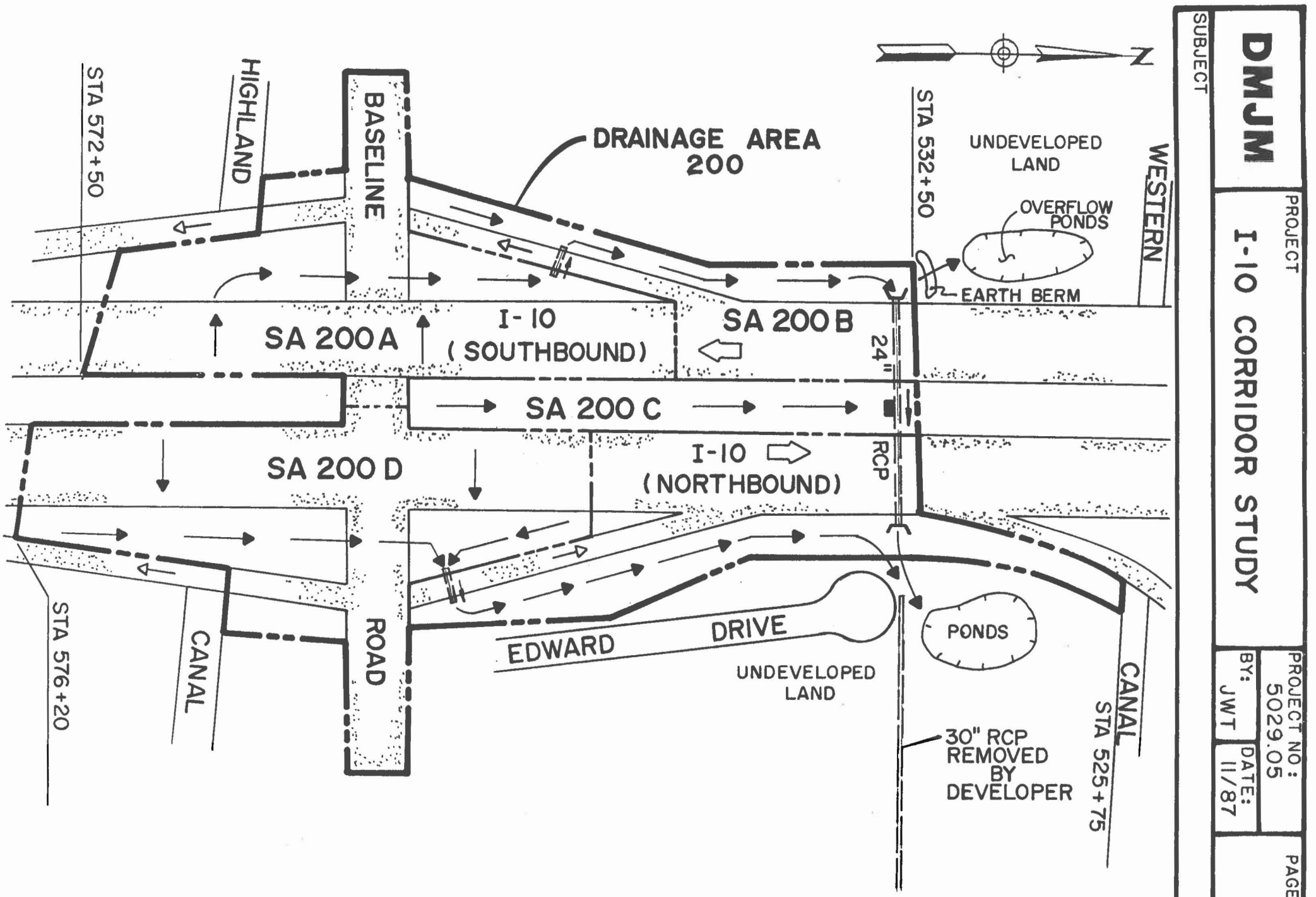

FIGURE 3. FLOW SCHEMATIC OF DRAINAGE AREA 200.

DRAINAGE AREA 300

Drainage Area 300 consists of approximately 4.5 acres of I-10 located south of the I-10/Superstition Freeway interchange from Sta. 532+50, northward to Sta. 525+75 (south bank of Western Canal), as shown in Figures 1A (Appendix A) and 4.

Drainage Area 300 is divided into three subareas designated as subareas SA300 A through C. Flows from subareas SA300A and SA300B are overland in a northerly direction to a 24" RCP at Sta. 525 + 75, as shown in Figure 4. The 24" RCP carries the flows under I-10 in a westerly direction and combines with flow from subarea SA300C prior to discharge into the Western Canal.

The projected peak flows from Drainage Area 300 at the outfall into the Western Canal for the 10-year and 50-year storm events are 8.8 cfs and 13.7 cfs, respectively. The projected ponding depths at SA300A and SA300B for the 50-year storm event are 1.0 feet and 0.5 feet, respectively.

The projected peak flows for Drainage Area 300 at the outfall are summarized in Table 5.

TABLE 5. DRAINAGE AREA 300
PROJECTED PEAK FLOWS AT OUTFALL FOR THE 10-YEAR AND THE 50-YEAR STORM EVENTS

Projected Drainage Area	Storm Peak Frequency (year)	Flow (cfs)	Outfall
Entire Watershed (SA300A-C)	10	8.8	Western Canal
	50	13.7	

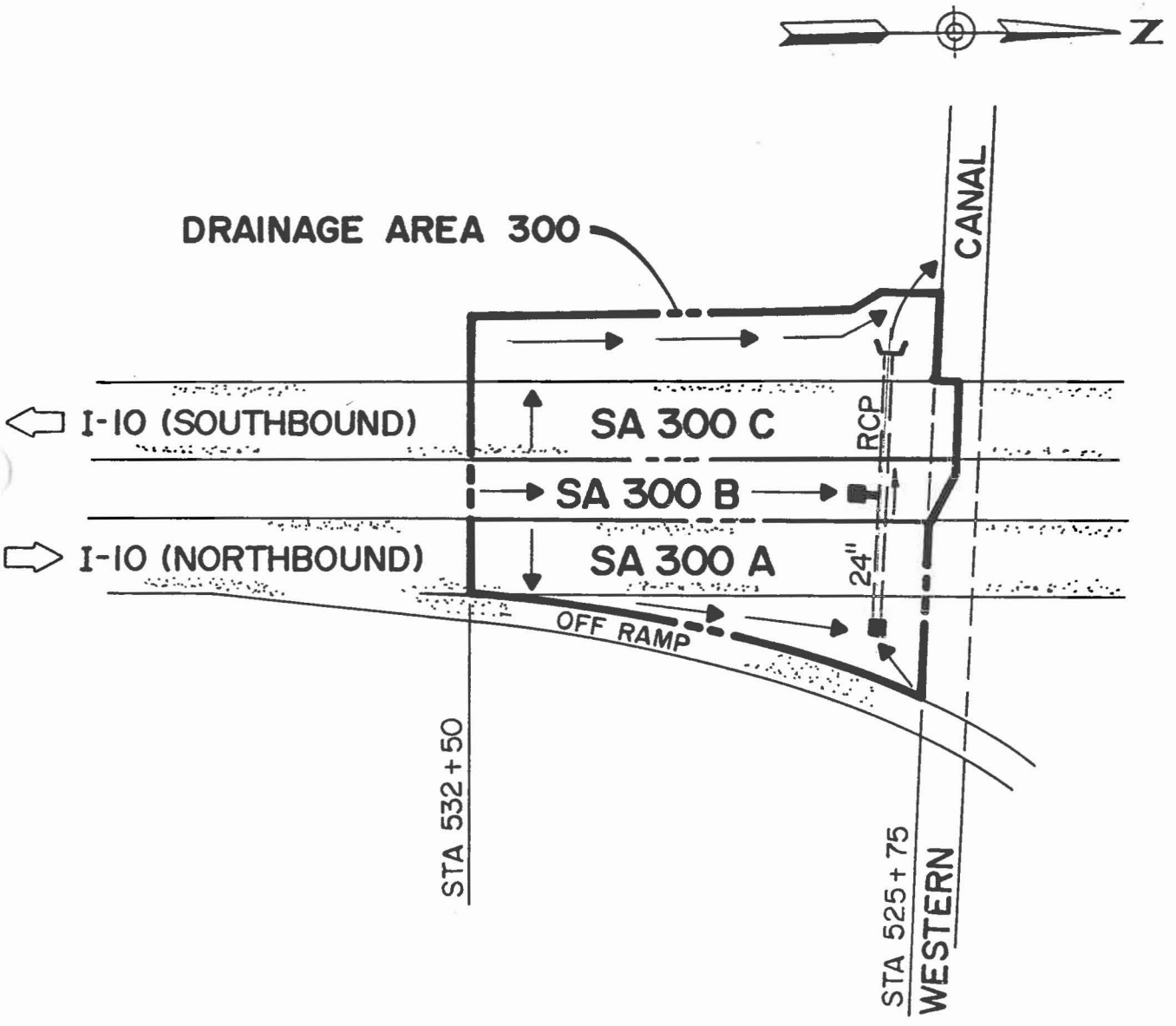

FIGURE 4. FLOW SCHEMATIC OF DRAINAGE AREA 300.

DRAINAGE AREA 400

Drainage Area 400 consists of approximately 21.1 acres of the east one-half of the I-10/Superstition Freeway interchange from Sta. 525+75 (Western Canal) northward to Sta. 504+50 (Southern Avenue) and discharges into Retention Site 1, as shown on Figures 1A and 2A (Appendix A)
and 5.

Drainage Area 400 is divided into four sub-areas designated subareas SA400 A through D, as shown on Figures 5. Runoff from subarea SA400A flows under the on-ramp from I-10 to Superstition Freeway through a 24" culvert. Discharge from the SA400A combines with flow from subarea SA400B and is retained on-site until it can be discharged under Superstition Freeway through a 24" culvert. The discharged flow from the culvert under the Superstition Freeway combines with flow from subarea SA400C and is retained on-site until it can be discharged through a 24" culvert under the I-10 on-ramp from Superstition Freeway. The discharge then flows overland in the northerly direction to Southern Avenue, turns easterly along Southern Avenue for approximately 800 feet and discharges through a culvert under Southern Avenue into Retention Site 1, as shown in Figures 2A (Appendix A) and 5.

Drainage Area 400 projected peak flows into Retention Site 1 for the 10-year and 50-year storm events are 14.9 cfs and 20.2 cfs, respectively. Topographic information on Retention Site 1 indicates a storage capacity of approximately 1.9 acre-feet, and a storage requirement of 2.47 and 3.93 acre feet for the 10-year and 50-year storm events, respectively.

The projected peak flows and storage requirements are presented in Table 6.

TABLE 6. DRAINAGE AREA 400
PROJECTED PEAK FLOWS AND STORAGE REQUIREMENTS
FOR THE 10-YEAR AND 50-YEAR STORM EVENTS AT RETENTION SITE 1

Drainage Area	Storm Frequency (year)	Projected Peak Flows Entering Ret. Site 1 (cfs)	Projected Storage Requirements at Ret. Site 1 (Acre-Feet)
400	10	14.9	2.5
	50	20.2	3.9

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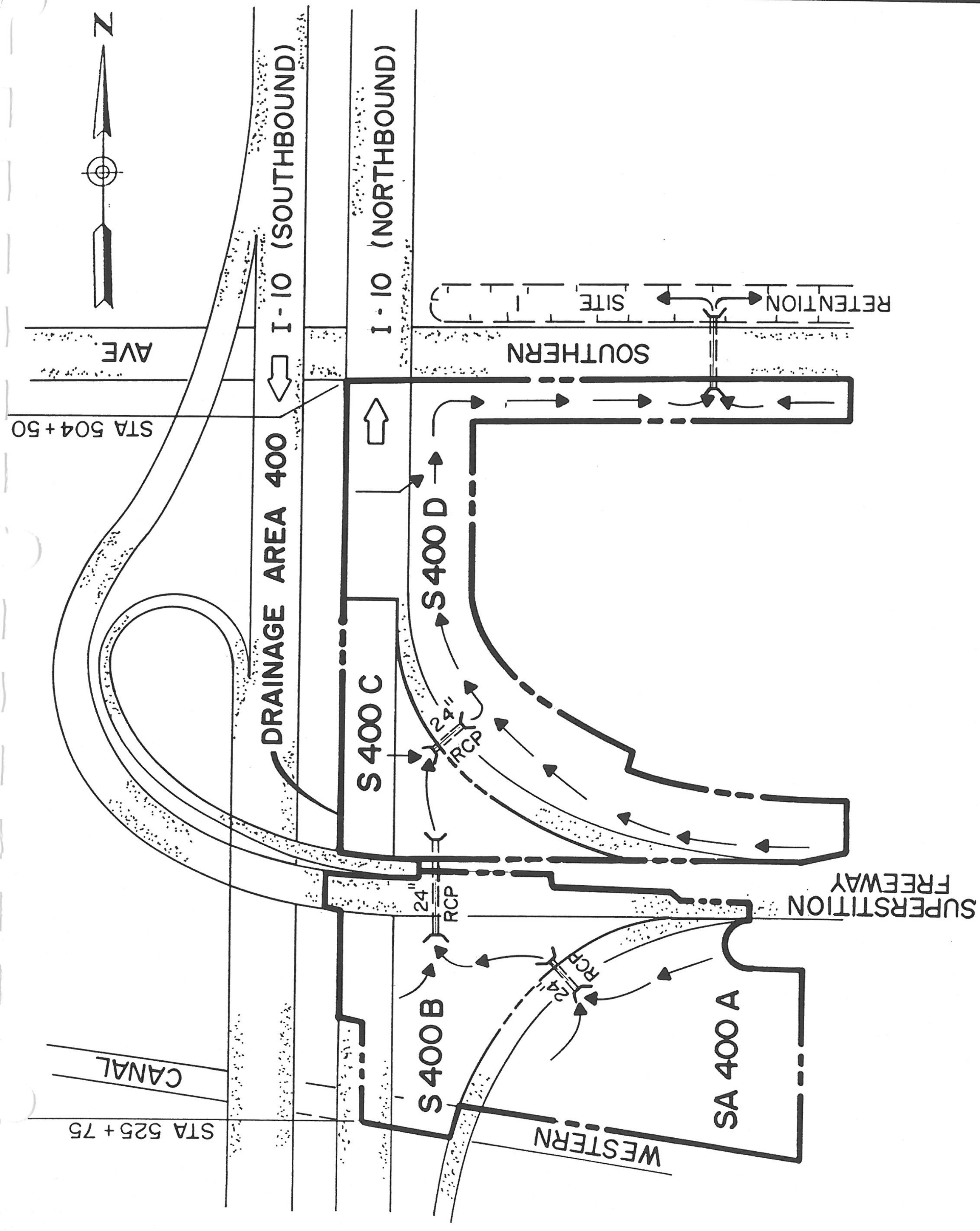

FIGURE 5. FLOW SCHEMATIC OF DRAINAGE AREA 400.

DRAINAGE AREA 500

Drainage Area 500 consists of 21 acres of the western one-half of the I-10/Superstition Freeway interchange from Sta. 525+75 (Western Canal) northward to Sta. 506+20 (Southern Avenue), as shown in Figures 2A (Appendix A) and 6.

Drainage Area 500 is divided into five subareas designated SA500 A through E, as shown in Figures 1A (Appendix A) and 6. The existing drainage systems consist of a closed conduit system (18" & 30" RCP's) along Southern Avenue for subareas SA500D & E and an open channel and culvert system for subareas SA500A, SA500B, and SA500C. Both the closed conduit and the open channel systems convey the flow to the Southern Avenue Pump Station, which in turn pumps the flow through a 18" discharge line southward into Western Canal.

It is estimated that the 18" RCP from the catch basin located in subarea SA500C is discharging approximately 7.0 cfs to the pump station. During the 50-year storm event, the cumulative peak flow from subareas SA500A, B, & C at the catch basin in subarea SA500C is projected at 24.5 cfs with a ponding volume of approximately 1.1 acre-feet. Subareas SA500 D & E contribute an additional projected peak flow of 20 cfs. The total pumping capacity required for the 50-year storm event is estimated at 27 cfs (20 cfs from Southern Avenue and 7 cfs from the catch basin in subarea SA500C). According to an Intergovernmental Agreement between ADOT and the Salt River Project (SRP license to use project right-of-way, CSR No. 95195-6, License No. 15191, dated March 10, 1966) permits installation of a 24" drain line to the Western Canal with a maximum discharge into the Canal to be 7,000 gpm (15.6 cfs). The cummulative project peak inflow exceeds the allowable maximum pumping rate resulting in inundation of the Southern Avenue underpass.

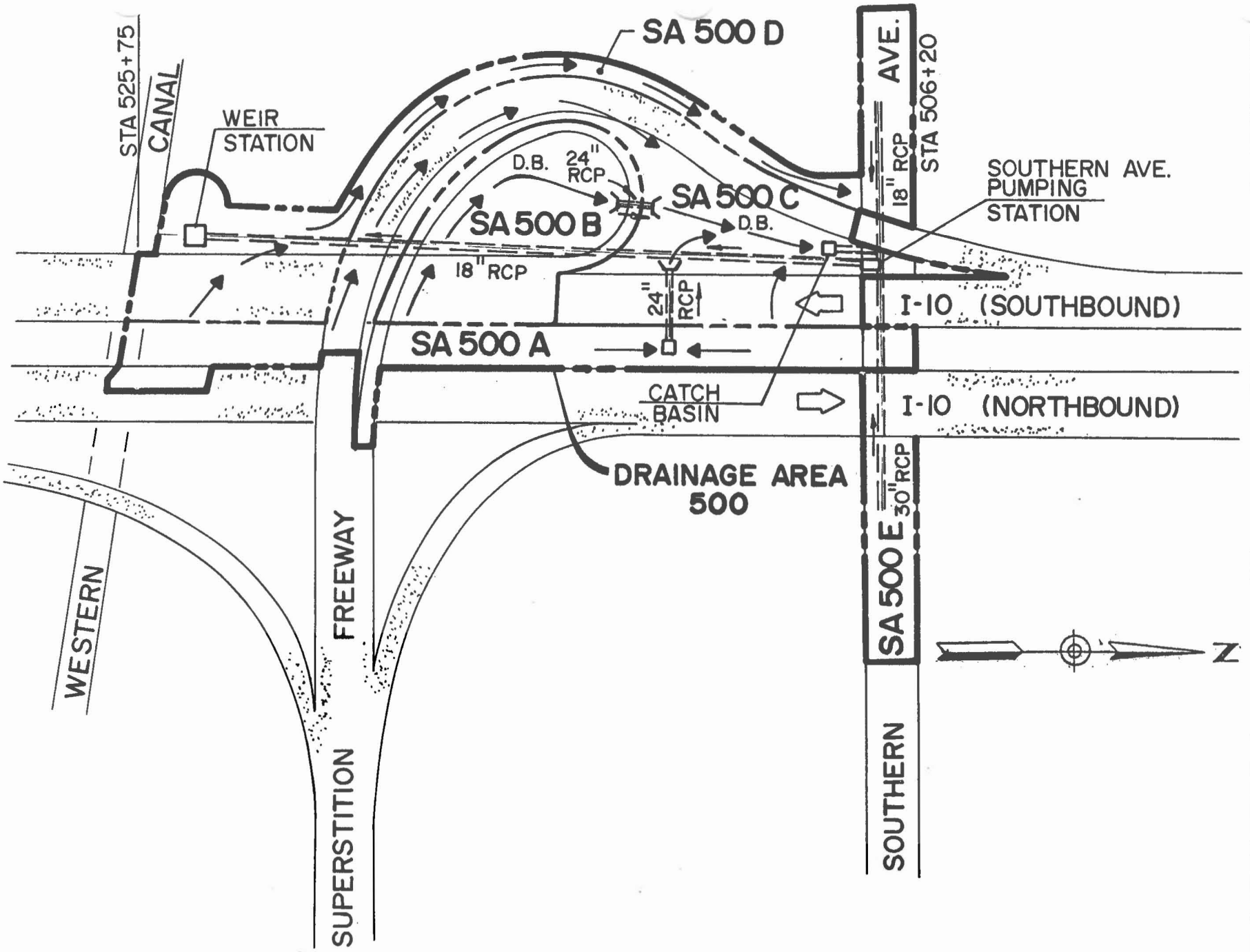

FIGURE 6. FLOW SCHEMATIC OF DRAINAGE AREA 500.

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DRAINAGE AREA 600

Drainage Area 600 consists of approximately 30.7 acres along I-10 from Sta. 506 + 20 northward to Sta. 459+00, as shown on Figures 2A and 3A (Appendix A) and 7. Drainage Area 600 is divided into six subareas designated subareas SA700 A through F.

The existing drainage system, as shown in Figures 2A and 3A (Appendix A) and 7, consists of Tempe's twin 30" culverts crossing from the east side of I-10 to the west side at Fairmont Drive (Sta. 492+00). On the west side of I-10 the existing drainage system changes to a 27" RCP and runs northward parallel to Diablo Way, upsizing to a 30" RCP as it approaches Alameda Drive, and connecting to Tempe's 32" storm drain along Alameda Drive. The 32" RCP storm drain along Alameda Drive also extends in the easterly direction across I-10 to where Alameda Drive terminates in a cul-de-sac.

Flow from subarea SA600A is easterly from I-10 northbound lanes onto the right-of-way, then northward along the right-of-way to be intercepted by the twin 30" culvert crossing I-10 at Fairmont Drive, along with flow from the adjacent residential development. Subarea SA600A projected peak flows for the 10-year and 50-year storm events are 7.5 cfs and 11.3 cfs, respectively.

Flow from the subarea SA600B south of Alameda Drive is westerly from the I-10 southbound lanes onto Diablo Way and Fairmont Drive shoulders where it ponds. Flow north of alameda Drive is westerly from I-10 southbound lanes onto the right-of-way, then overland in the southerly direction with ponding occurring along the north shoulder of Alameda Drive. The projected peak flow from SA600B for the 10-year and 50-year storm events is 16.9 cfs and 25.8 cfs, respectively. The projected ponding is estimated at 1.8 acre-feet and 2.7 acre-feet for the 10-year and 50-year storm events, respectively.

Flows from subareas SA600D and SA600F are directed along the median in the northerly and southerly direction, respectively, to a low point at Sta 479 + 00 (Alameda Drive) where it ponds. The projected peak flows for the 10-year and 50-year storm events are 10.0 cfs and 15.7 cfs, respectively. The on-site ponding is estimated at 1.1 acre-feet and 1.7 acre-feet for the 10-year and 50-year storm events, repectively.

Flow from subarea SA600C is in the easterly direction from the I-10 northbound lanes onto the right-of-way, then northward to Alameda Drive, where the flow is discharged into a 24" culvert crossing I-10 at Sta. 479 + 00. Flow from SA600E is in the southeasterly direction along the right-of-way to Alameda Drive, where it is discharged into the same 24" culvert as flow from Subarea SA600C. The cummulative peak flow from Subareas SA600C and SA600E at the 24" culvert into the Alameda Drive cul-de-sac for the 10-year and 50-year storm events are projected at 6.7 cfs and 12.1 cfs, respectively. The projected peak flows for Drainage Area 600 are summarized in Table 7.

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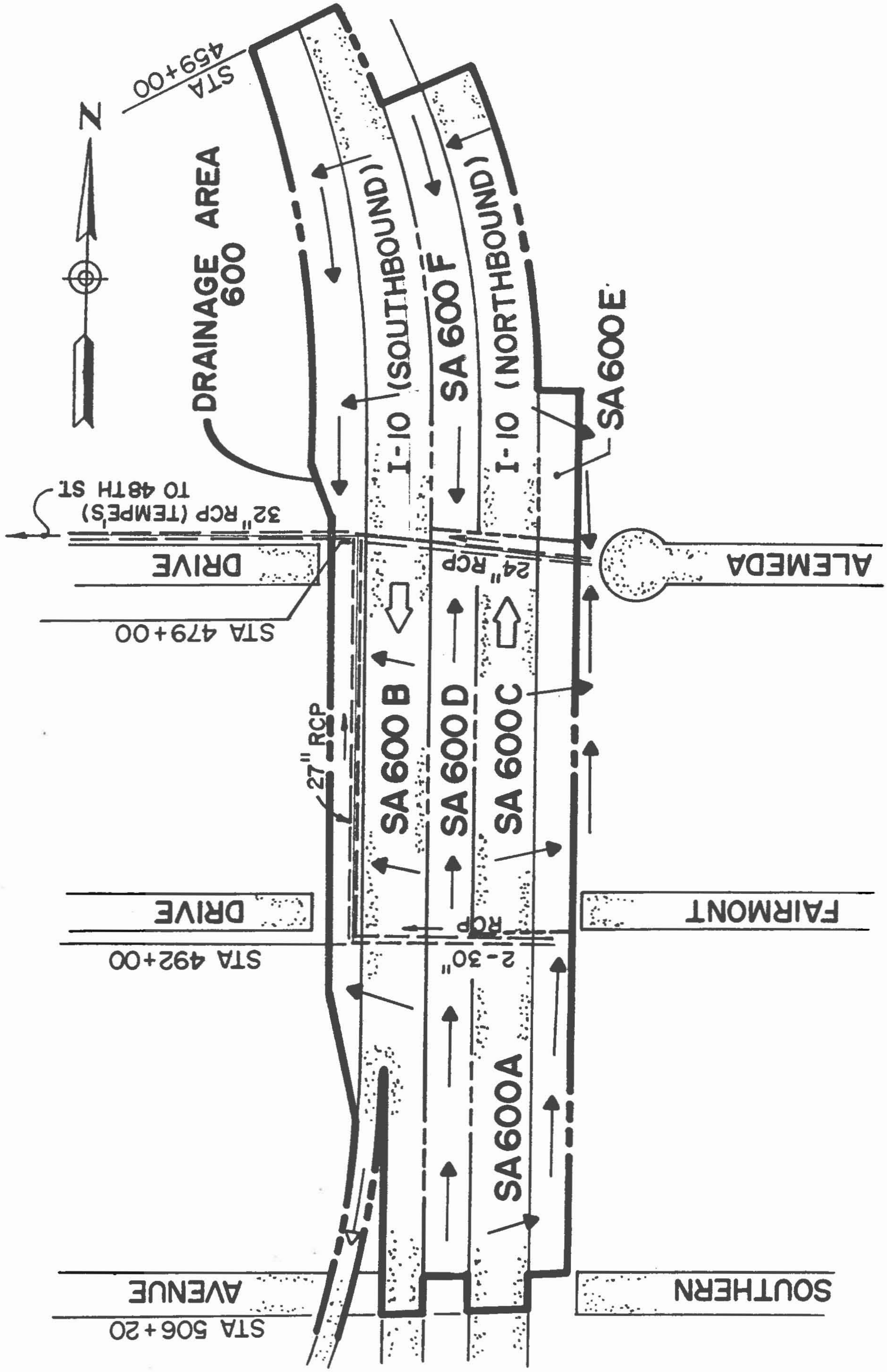

FIGURE 7. FLOW SCHEMATIC OF DRAINAGE AREA 600.

TABLE 7. DRAINAGE AREA 600
PROJECTED PEAK FLOWS, ON-SITE RETENTION
AND OUTFALL LOCATIONS

Subarea	Storm Frequency (years)	Projected Peak Flow (cfs)	On-Site Retention (acre-feet)	Outfall Locations
SA600A	10	7.5	--	Tempe's twin 30" RCP's crossing I-10 at Fairmont Drive.
	50	11.3	--	
SA600C & SA600E	10	6.7	--	Tempe's 24" Storm Drain at Alameda Drive cul-de-sac.
	50	10.3	--	
SA600D & SA600F	10	10.0	1.1	Retention in the median at Sta. 479+00 (Alameda Drive).
	50	15.7	1.7	
SA600B	10	16.9	1.8	Retained along Diablo Way, Alameda Dr., and Fairmont Drive.
	50	25.8	2.7	

Drainage Area 700

Drainage Area 700 consists of approximately 6.4 acres of I-10 northbound lanes right-of-way from Sta. 461 + 50 southward to Sta. 472 + 00 and a portion of the Chevrolet Facility, as shown on Figure 2A (Appendix B) and 8.

Drainage Area 700 is divided into two subareas designated subareas SA700A & SA700b. Subareas SA700A consists of approximately 1.3 acres of I-10 east right-of-way with overland flow in the southerly direction with discharge into the Chevrolet retention basin. Subarea SA700B is approximately 5.1 acres belonging to the Chevrolet Facility which drains into their retention basin.

The projected peak flows entering the Chevrolet retention basin from ADOT's subarea SA700A for the 10-year and 50-year storm events are 3.0 cfs and 14.7 cfs, respectively. Flow from subarea SA700B into the retention basin is estimated at 4.5 cfs and 21.7 cfs for the 10-year and 50-year storm events, respectively. The estimated volume of runoff from subarea SA700A into the Chevrolet retention basin is 0.2 acre-feet for the 10-year and 0.3 acre-feet for the 50-year storm events. Subarea SA700B contributes approximately 0.9 acre-feet of the 10-year and 1.4 acre-feet for the 50-year storm events.

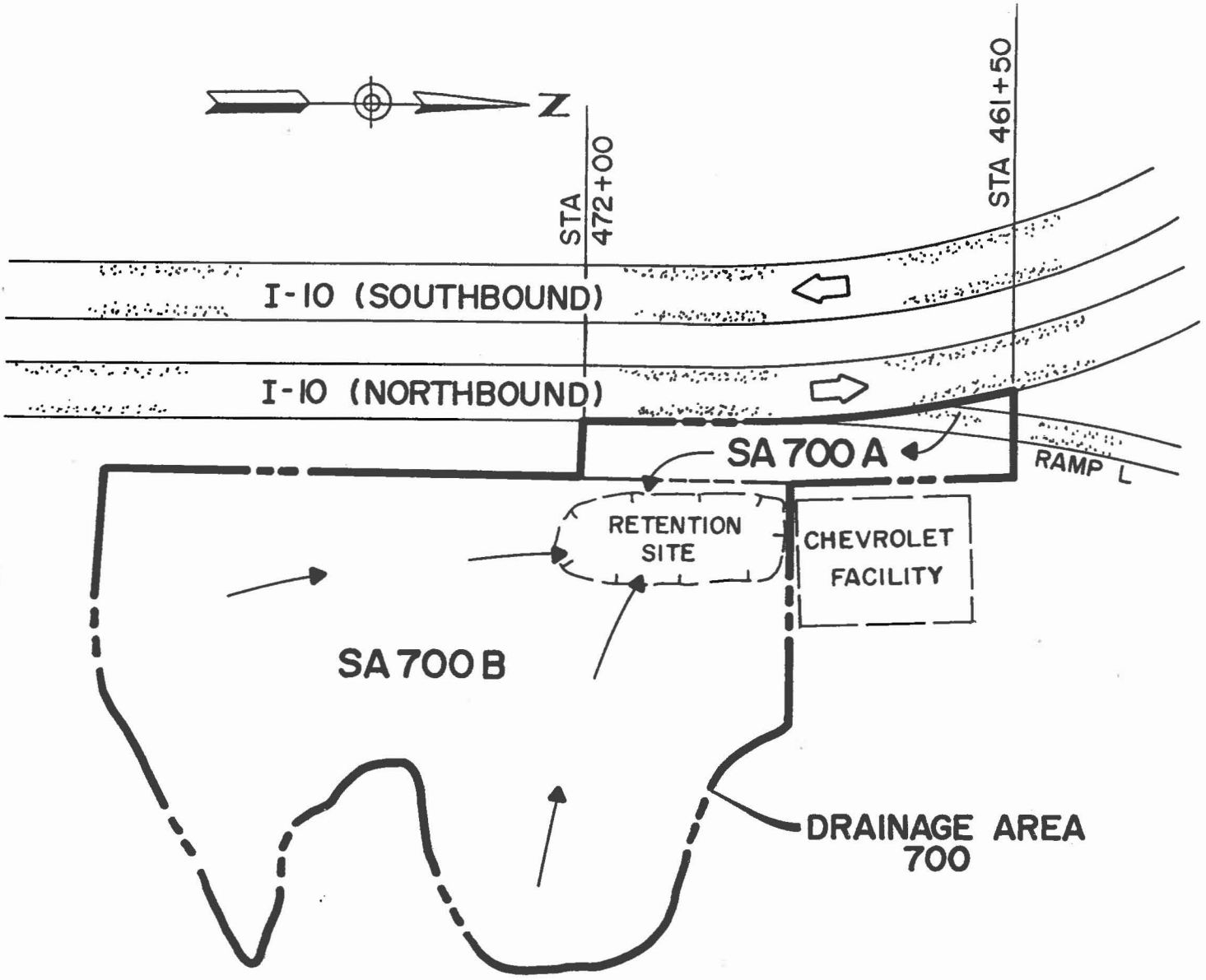

FIGURE 8. FLOW SCHEMATIC OF DRAINAGE AREA 700.

Drainage Area 800

Drainage Area 800 consists of approximately 100.7 acres of the I-10 Broadway/48th Street Interchange, as shown on Figures 3A (Appendix A), and 9. Drainage Area 800 is divided into nineteen subareas, designated subareas SA800 A through R.

The existing drainage system is a closed conduit system beginning at the outfall into Tempe Drain at 48th Street, as shown on Figure 9. The closed conduit is a 54" RCP which runs southward parallel to 48th Street, crosses to the southside of I-10, then turns eastward. The storm drain then runs parallel to I-10 in the easterly direction to approximately 250 feet west of Broadway Road overpass, at this point it reduces to a 48" and continues eastward. At approximately 100 feet east of Broadway Road overpass, the 48" RCP turns to the northeast and crosses I-10. The 48" RCP continues in the northeast direction for approximately 600 feet at which point it reduces to a 42" RCP and continues in the northeast direction until it crosses Broadway Road. At that point, the storm drain turns eastward, reduces to a 30" RCP, and continues parallel to Broadway Road. At approximately 200 feet west of Ramp "M", the storm drain reduces to a 24" diameter and continues parallel to Broadway to its termination point at Priest Drive.

The existing drainage system has a capacity of approximately 111 cfs under open channel flow conditions at the outfall. Flows from the existing drainage system located in Drainage Area 800 is limited to 93 cfs at Tempe Drain, according to an Intergovernmental Agreement C-3891, dated December 19, 1977, and the "Supplemental Agreement" between the City of Tempe, Maricopa County Flood Control District, and Arizona Department of Transportation. The Tempe Drain, which serves as the outfall for Drainage Area 800, lies north of I-10 and outfalls into the Salt River. The Tempe Drain is a concrete lined channel from 42nd Street eastward with a capacity of approximately 2000 cfs.

The existing drainage system for Drainage Area 800 consists of several subareas some of whose catch basins are located in sump conditions which provide inadvertent detention and influence the peak flow at the outfall. Table 8 lists the projected volume of storage and the estimated depth of ponding that occurs at these catch basins for the 10-year and the 50-year storm events.

The projected outfall peak flow from Drainage Area 800 into the Tempe Drain for the 10-year and the 50-year storm evens are 45 cfs and 71 cfs, respectively. The peak flows include 2.0 cfs from Tempe's pumping station located approximately 750 feet south of I-10 and along the east shoulder of 48th Street, as shown on Figure 9. The existing drainage system operates under open channel conditions for the 10-year storm, while the 50-year storm event does cause some surcharging to occur at various locations within the system.

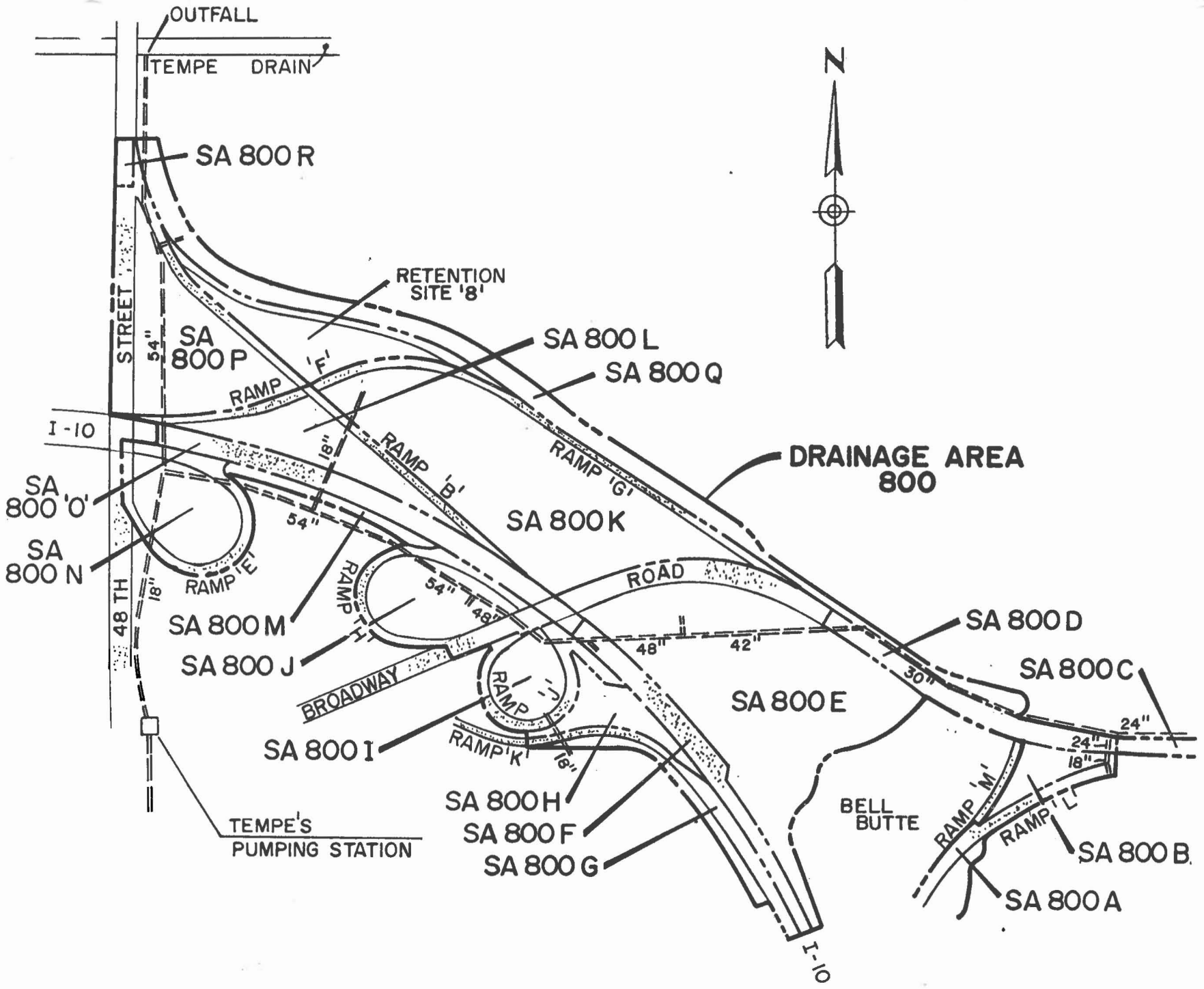

FIGURE 9. FLOW SCHEMATIC OF DRAINAGE AREA 800.

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TABLE 8. DRAINAGE AREA 800 PROJECTED STORAGE AT SUMP CONDITIONS.

Subarea Designation	Storm Frequency (Year)	Projected Storage (A-F)	Depth (FT)
SA800E	10	1.2	1.4
	50	2.0	2.2
SA800I	10	0.64	0.8
	50	1.00	1.3
SA800J	10	0.45	0.6
	50	0.69	1.0
SA800K	10	1.59	0.7
	50	2.32	1.0
SA800L	10	0.33	0.7
	50	0.51	1.0
SA800N	10	0.21	0.7
	50	0.31	1.1
SA800P	10	0.44	1.5
	50	0.68	2.3
Total		12.37	

Drainage Area 900

Drainage Area 900 consists of approximately 6.4 acres located south of I-10 and east of 48th Street, as shown on Figures 3A (Appendix A) and 10. Drainage Area 900 is divided into three subareas, designated subareas SA900A, SA900B, and SA900C.

The existing storm sewer system consists of an 18" storm drain along Broadway Road that conveys flows from subareas SA900B and SA900A in the westerly direction, as shown on Figures 2A (Appendix A) and 10. A series of catch basins along 48th street south of the I-10/48th Street overpass intercept flow from subarea SA900C and discharge into Tempe's storm drain system.

The project peak flows for the 10-year & 50-year storm events are presented in Table 9.

TABLE 9. DRAINAGE AREA 900 PROJECTED PEAK FLOWS FOR THE 10-YEAR AND THE 50-YEAR STORM EVENTS AT THE OUTFALL

Subarea Area Designation	Storm Frequency (Year)	Projected Peak Flow (CFS)	Outfall Location
SA900A	10	7.4	24" Storm Drain along
	50	10.8	Broadway Road
SA900C	10	7.7	78" Storm Drain along
	50	11.0	48th Street (Tempe's)

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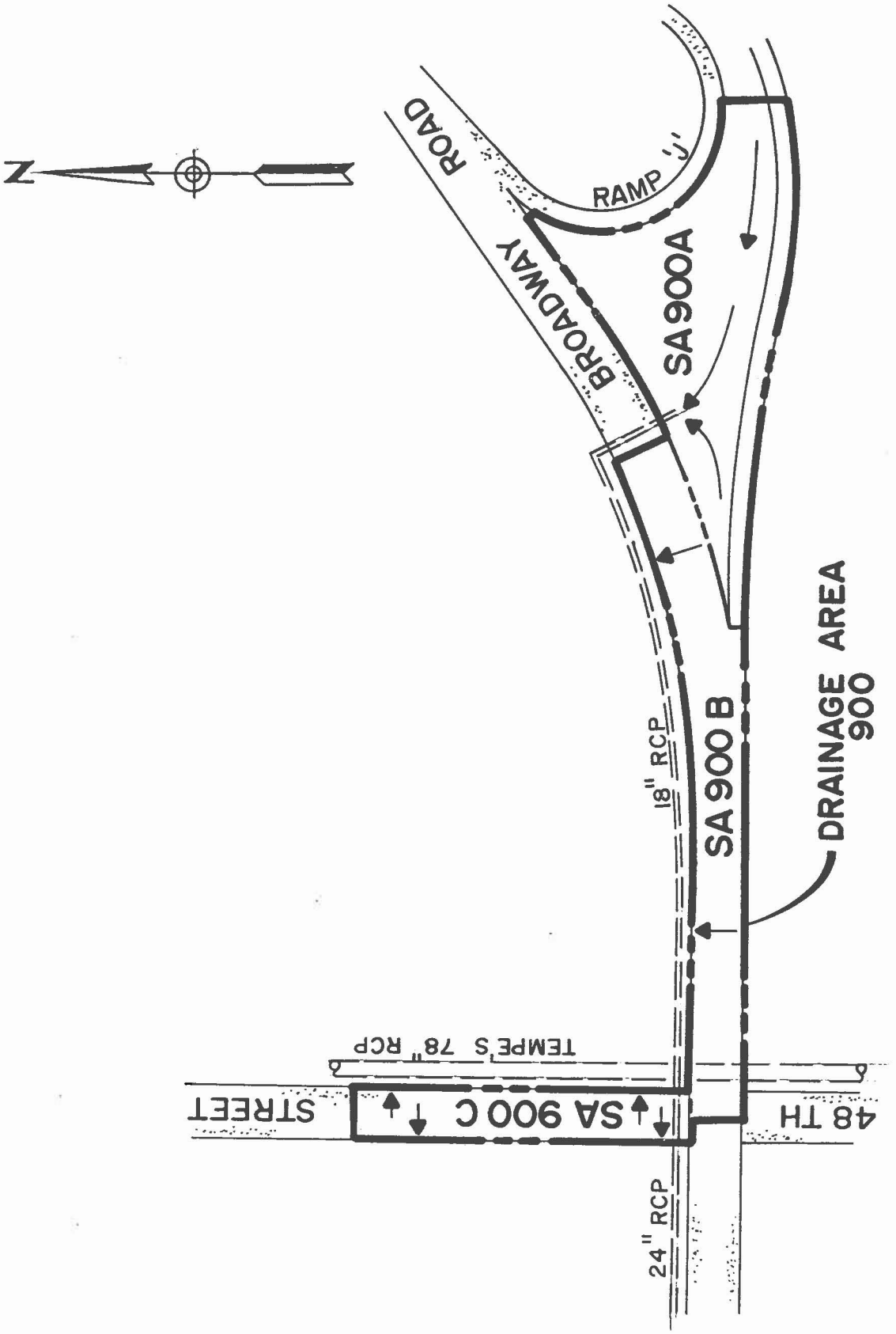

FIGURE 10. FLOW SCHEMATIC OF DRAINAGE AREA 900.

Drainage Area 1000

Drainage Area 1000 consists of approximately 17.3 acres located along I-10 between 40th Street and 48th Street, as shown on Figures 3A and 4A (Appendix A) and 11. Drainage Area 1000 is divided into two subareas, designated subareas SA1000 A & B. Subarea SA1000A includes the I-10 westbound lanes from Sta. 415 + 00 westward to Sta. 393 + 50 and Ramp 'A' at I-10 Hohokam Expressway Interchange. Subarea SA1000B includes I-10 westbound lanes from Sta. 393 + 50 westward to 390 + 00 and Ramp 'A' at the I-10/40th Street Interchange.

Existing drainage is overland along the I-10 right-of-way in the westerly direction with discharge into Pepsi Cola's retention basin, as shown in Figures 2A (Appendix A) and 11. The projected peak flows and runoff volume entering Pepsi Cola's retention basin are presented in Table 10.

TABLE 10 DRAINAGE AREA 1000 PROJECTED PEAK FLOWS FOR THE 10-YEAR AND THE 50-YEAR STORM EVENTS AND STORAGE REQUIREMENTS

Subarea Area Designation	Storm Frequency (Year)	Projected Peak Flow (CFS)	Projected Storage Volume (A-F)	Outfall
SA1000A & SA1000B	10	7.6	2.0	Pepsi-Cola's Retention Basin.
	50	12.2	3.3	

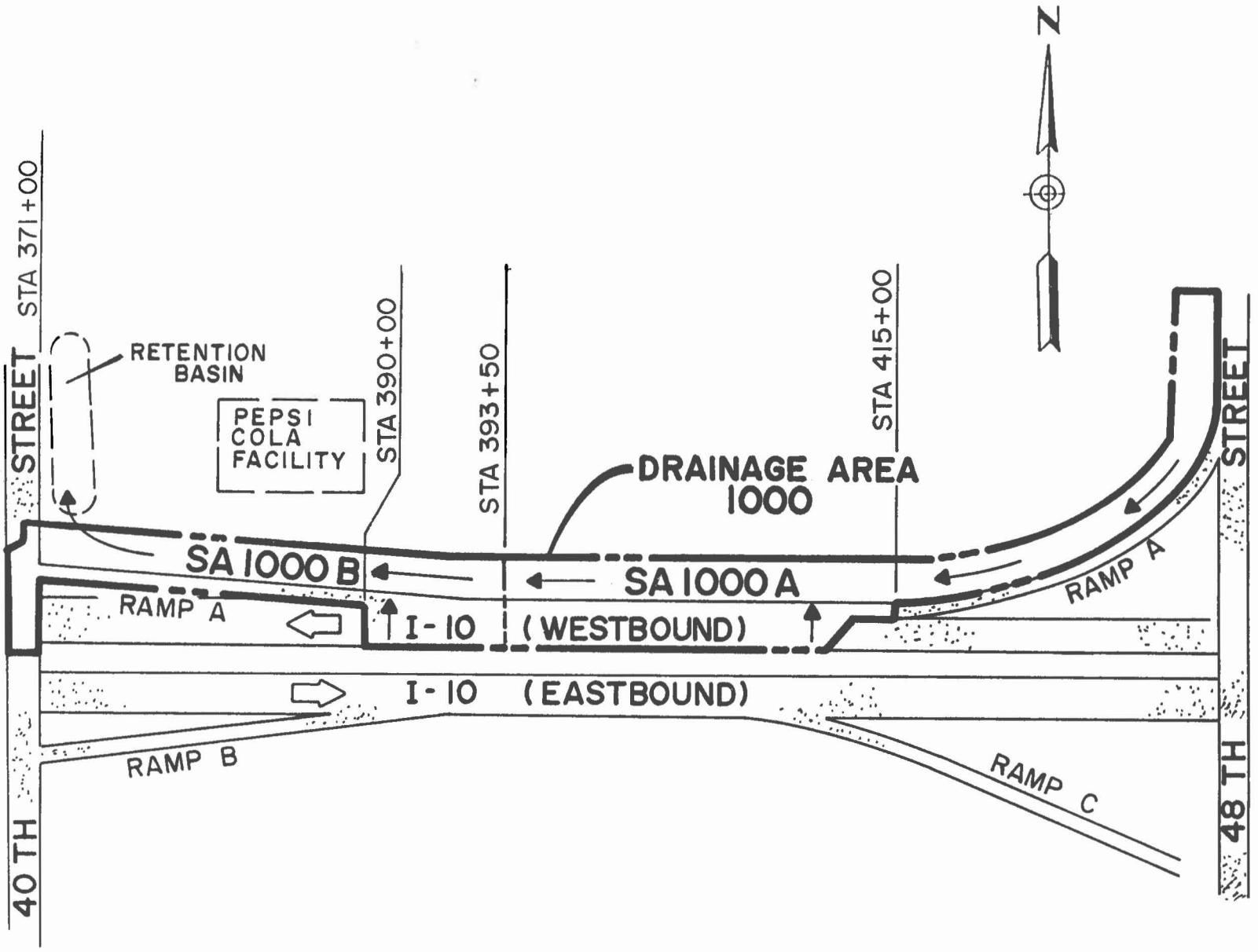

FIGURE 11. FLOW SCHEMATIC OF DRAINAGE AREA 1000.

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Drainage Area 1100

Drainage Area 1100 consists of approximately 15.4 acres along I-10 from Sta. 415 + 00 westward to Sta. 371 + 00, as shown in Figures 3A and 4A (Appendix A) and 12. Drainage area 1100 is divided into three subareas, designated subareas SA1100A, SA1100B, and SA1100C.

Subarea SA1100B includes the median between the I-10 eastbound and westbound lanes from Sta. 415 + 00 westward to Sta. 371 + 00. Subarea SA1100A includes the southeast infield area at the I-10/40th Street Interchange. Subarea SA1100C includes the northeast infield area at the I-10/40th Street Interchange.

The existing drainage system consists of a closed conduit system from its 32nd Street outfall into the Tempe Drain, eastward along I-10 north right-of-way to where it temporarily terminates east of the 40th Street overpass. From the temporary termination point, laterals are extended to the infield areas (subareas SA1100 A & C) and the HOV Lanes and the median (subarea SA1100 B) to collect and convey runoff to the existing drainage system, as shown on Figures 3A and 4A (Appendix A) and 12.

The projected peak flows for the 10-year and the 50-year storm events are presented in Table 11.

TABLE 11. DRAINAGE AREA 1100 PROJECTED PEAK FLOWS FOR THE 10-YEAR THE 50-YEAR STORM EVENTS AT THE OUTFALL

Subarea Designation	Storm Frequency (Year)	Peak Flow (cfs)	Outfall Location
SA1100A	10	5.7	40th Street Ramp B
	50	8.9	infield catch basin.
SA1100B	10	2.6	Catch basins & slotted
	50	4.2	drains located in the HOV Lanes.
SA1100C	10	5.2	40th Street Ramp A
	50	8.1	field catch basin.

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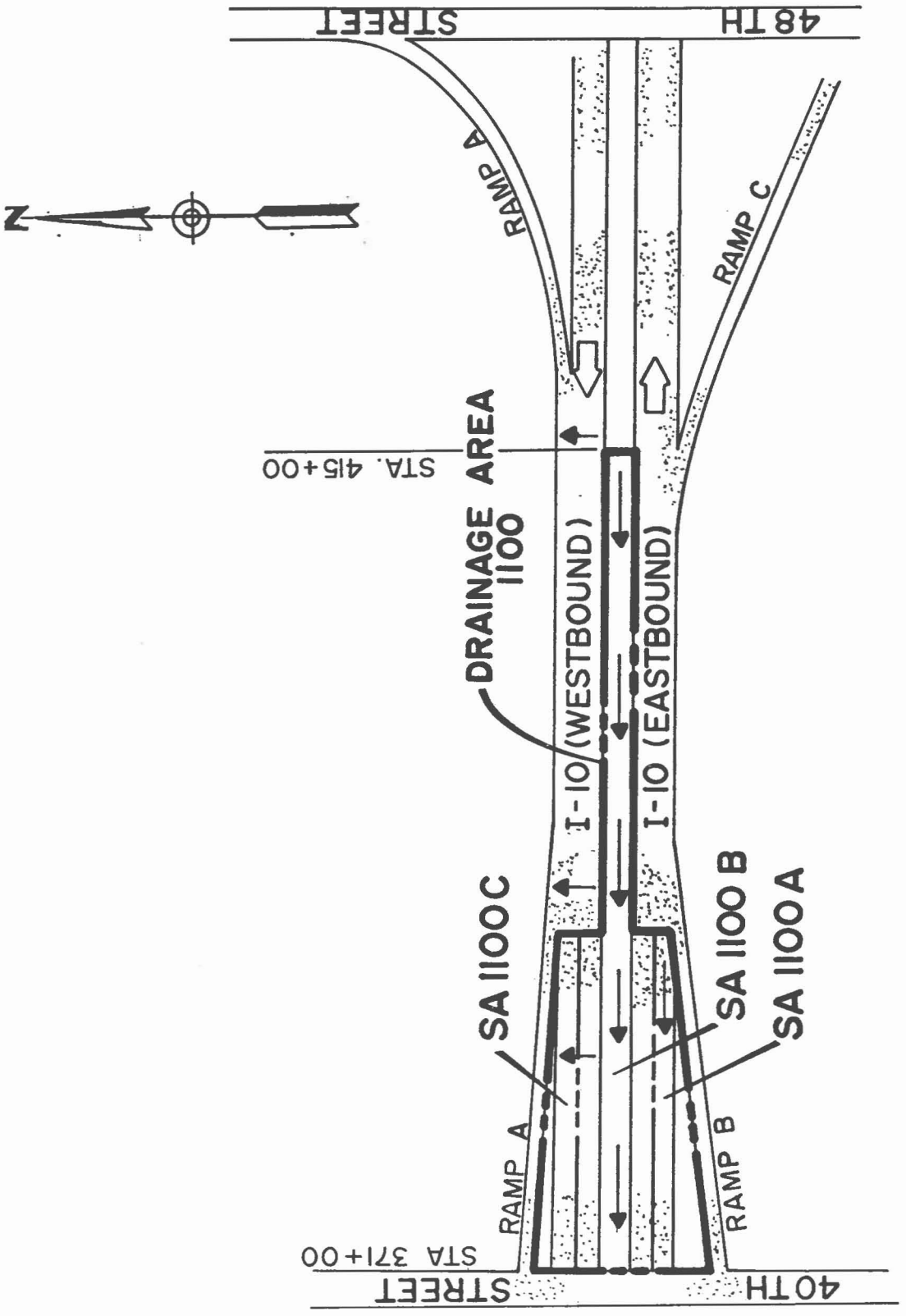

FIGURE 12. FLOW SCHEMATIC OF DRAINAGE AREA 1100.

Drainage Area 1200

Drainage Area 1200 consists of approximately 12.8 acres of ADOT right-of-way, the I-10 westbound lanes located between 40th and 48th street, and an additional 51.7 acres of residential development that drains onto ADOT's right-of-way, as shown on Figure 3A and 4A (Appendix A) and 13.

Drainage Area 1200 is divided into two subareas, designated SA1200A for the residential development and SA1200B for the ADOT area.

The existing drainage system consists of an inlet located in the southeast corner of the I-10/40th Street overpass, as shown in Figures 4A (Appendix A) and 13, with flows overland from subareas SA1200 A & B in the westerly direction from 48th Street to 40th Street to the existing inlet. The inlet is connected to the City of Phoenix storm sewer system along the east of 40th Street and flows to the south.

The terrain of the residential development designated subarea SA1200A, as shown in Figure 3A and 4A (Appendix A) and 13, slopes from the south to the north with flows from the residential developments collecting along the noise wall. Openings have been provided along the existing noise wall to allow flow to pass onto ADOT right-of-way and continue westward to the inlet.

The projected peak flows and runoff volume for the 10-year and the 50-year storm events as shown on Table 12.

TABLE 12. DRAINAGE AREA 1200 PROJECTED FOR THE 10-YEAR AND 50-YEAR STORM EVENTS AT THE PEAK FLOWS OUTFALL

Subarea Designation	Storm Frequency (Years)	Peak Flow (CFS)	Projected Runoff Volume (A-F)	Outfall Location
SA1200A (Commerc. & Res.)	10	48.6	___	___
	50	79.5	___	___
SA1200B	10	6.6	___	___
	50	10.6	___	___
SA1200 A & B Combined Subareas	10	38.4	6.9	Grate Inlet at 40th Street connects to the City of Phoenix storm drainage system.
	50	67.9	11.2	

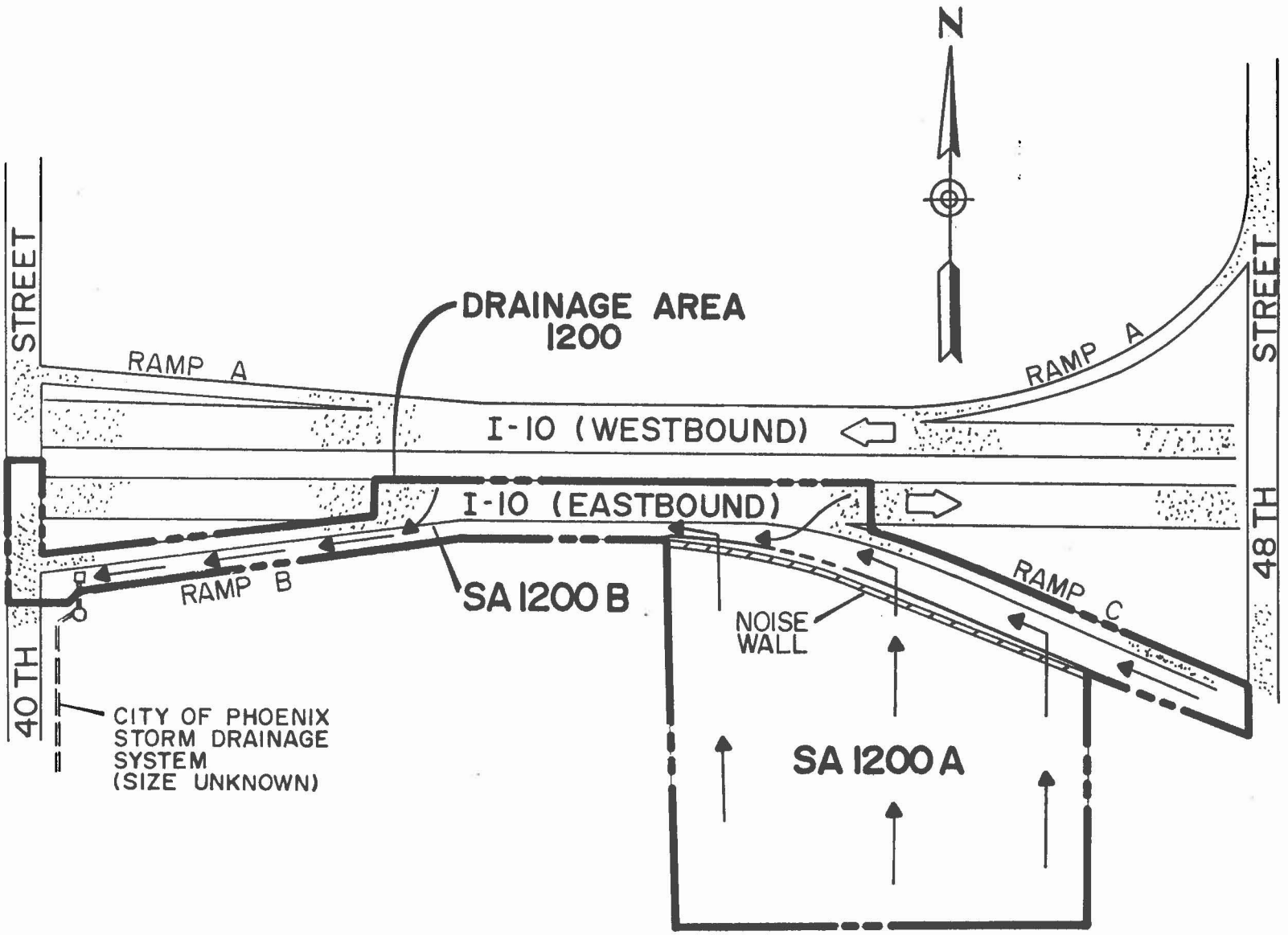

FIGURE 13. FLOW SCHEMATIC OF DRAINAGE AREA 1200.

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RETENTION SITES

There are eight retention sites located throughout the I-10 Corridor study area, as shown on Figures 2A and 3A (Appendix A). The eight retention sites are designated: Retention Sites 1 through 8. These eight retention sites are collection points where the runoff is permanently retained on-site.

Table 13 lists the eight retention sites and the projected volume of storage that occurs at each retention site, for the 10-year and the 50-year storm events.

TABLE 13. RETENTION SITES PROJECTED STORAGE REQUIREMENT FOR THE 10-YEAR AND 50-YEAR STORM EVENTS.

Retention Site Designation	**Storm Frequency** (Year)	**Projected Volume of Storage** (Acre-feet)
Retention Site 1	10	2.47
	50	3.93
Retention Site 2	10	2.72
	50	4.26
Retention Site 3	10	0.52
	50	0.85
Retention Site 4	10	0.21
	50	0.35
Retention Site 5	10	0.15
	50	0.23
Retention Site 6	10	1.3
	50	2.1
Retention Site 7	10	0.4
	50	0.7
Retention Site 8	10	0.52
	50	0.82

OFFSITE DISCHARGE FROM ADOT RIGHT-OF-WAY

Table 14 summarizes those existing drainage areas and subareas within the I-10 Corridor study area currently discharging highway runoff outside ADOT's right-of-way for both the 10-year and the 50-year storm events and the location of the outfall.

TABLE 14. DRAINAGE AREAS/SUBAREAS CURRENTLY DISCHARGING OUTSIDE ADOT'S RIGHT-O-WAY

Drainage Area/ Subarea Designation	Storm Frequency (Year)	Projected Peak Flows (CFS)	Outfall Location
100/SA100B	10	7.7	Highland
	50	12.1	Canal
100/SA100A	10	6.0	Highland
	50	9.4	Canal
100/SA100C	10	7.5	Highland
	50	11.8	Canal
200/SA200 A-C	10	41.5	Undeveloped
	50	56.0	land overland flow to Western Canal
300/SA300 A-C	10	8.8	Western
	50	13.7	Canal
500/SA500 A-C	10	7.0	Western
	50	7.0	Canal
500/SA500 D & E	10	13.5	Western
	50	20.3	Canal
600/SA600A	10	7.5	Tempe's twin 30"
	50	11.3	RCP's storm drains @ Fairmont Drive crossing I-10
600/SA600 C & E	10	6.7	Tempe's 32"
	50	10.3	storm drain at Alameda Drive

TABLE 14. CONTINUED.

Drainage Area/ Subarea Designation	Storm Frequency (Year)	Projected Peak Flows (CFS)	Outfall Location
600/SA600B	10 50	16.9 25.8	Off-site retention along Diablo Way, Fairmont Drive and Alameda Drive
700/SA700A	10 50	3.0 4.5	Chevrolet's Retention Basin
900/SA900 B & C	10 50	7.4 10.8	Tempe's 24" storm drain at 48th Street and Broadway Road
900/SA900C	10 50	7.7 11.0	Tempe's 78" storm drain along 48th Street
1000/SA1000 A & B	10 50	7.6 12.2	Pepsi Cola's Retention Basin
1200/SA1200B	10 50	6.6 10.6	City of Phoenix Storm Drainage System

ULTIMATE DRAINAGE SYSTEMS

BACKGROUND

As discussed earlier in the introduction, the ultimate drainage systems "refers to the design of the ultimate drainage systems" based on completion of all future roadway improvements within the I-10 corridor study area according to Functional Plan Alternative C-1 (refer to Figure 1).

In the future, several drainage outfalls currently being utilized will no longer permit ADOT runoff. As a result the following constraints are placed on the ultimate drainage systems:

1. All off-site drainage onto ADOT right-of-way remains separate. This condition focuses on subarea SA1200 (Figures 3A and 4A, Appendix A), whose runoff flows onto ADOT property. Under ultimate condition, a separate drainage system will need to be provided along the south side of I-10 in a westerly direction to the existing outfall (inlet) located in the southeast corner of the I-10/40th Street overpass, as shown on Figure 9A (Appendix A).

2. Discharge of ADOT's runoff into the Western Canal and the Highland Canal will not be permitted in the future by Salt River Project (SRP) due to concern for the adverse affect on water quality.

3. All discharge from ADOT right-of-way presently entering the City of Tempe or another municipality drainage system will not be permitted in the future.

4. The current intergovernmental agreement, dated December 19, 1977, and the "Supplemental Agreement" between the City of Tempe, Maricopa County Flood Control District, and the Department of Transportation that limits the discharge into the Tempe Drain by ADOT to a maximum peak flow of 93 cfs, continues to be enforced in the future.

5. The present design of the I-10 storm drainage system from the 32nd Street outfall into the Tempe Drain eastward to 40th Street, which took into consideration in its original design an additional peak flow of 96 cfs to account for the Section of I-10 to be constructed in the future between 40th Street and 48th Street, continues to be the allowable maximum peak flow.

6. The current practice of providing permanent retention without a means of emptying the facility will not be permitted in the future.

ULTIMATE DRAINAGE SYSTEMS CONT.

Because of these conditions, many of the outfalls presently being utilized will not be permitted or accessible under ultimate development. Table 15 lists the existing outfalls and their future conditions when the Functional Plan Alternative C-1 is completed.

From the information presented in Table 15, the only outfalls available to ADOT upon ultimate development are: The Tempe Drain outfall at 48th Street and the additional capacity designed in the existing ADOT storm drainage system along I-10 at 40th Street overpass.

The two ultimate drainage systems will be referred to as follows:

1. The ultimate drainage system for Baseline Road to the Tempe Drain;

2. And the ultimate drainage system for 48th Street to 40th Street.

TABLE 15. STATUS OF EXISTING DRAINAGE OUTFALLS FOR THE ULTIMATE DRAINAGE SYSTEMS

Drainage Area/ Subarea Designation	Existing Outfall	Ultimate Development Outfall Condition
100/SA100B	Highland Canal	Not permitted by SRP
100/SA100A	Highland Canal	Not permitted by SRP
100/SA100C	Highland Canal	Not permitted by SRP
200/SA200 A-C	Undeveloped land overland flow to Western Canal.	Development will eliminate this area as outfall
300/SA300 A-C	Western Canal	Not permitted by SRP
400/SA400 A-D	Retention Site 1	Available but permanent retention not allowed
500/SA500 A-C	Western Canal	Not permitted by SRP
500/SA500 D & E	Western Canal	Not permitted by SRP
600/SA600A	Tempe's twin 30" RCP's storm drains @ Fairmont Drive crossing I-10.	Not permitted by the City of Tempe
600/SA600 C & E	Tempe's 32" storm drain at Alameda Drive.	Not permitted by the City of Tempe
600/SA600B	Off-site retention along Diablo Way, Fairmont Drive	Use of Municipal permanent retention off-site not permitted
700/SA700A	Chevrolet's retention Basin	Use of private retention basin not permitted

TABLE 15. CONTINUED...

Drainage Area/ Subarea Designation	Existing Outfall	Ultimate Development Future Outfall Condition
800/SA 800 A-R	Tempe Drain	Permitted at allowable maximum peak flow of 93 cfs
900/SA 900 A-C	ADOT's storm drain along Broadway Road and 78" along 48th St.	Permitted
1000/SA1000 A & B	Pepsi Cola's retention basin.	Use of private retention basin not permitted
1100/SA1100 A & B	ADOT storm drainage system at 40th Street.	Permitted
1200/SA1200 A	City of Phoenix storm drainage system.	Not permitted by the City of Phoenix
Retention Sites 1-7		Permanent retention not permitted

METHOD OF ANALYSIS

The approach used to analyze the two ultimate drainage systems begins with delineation of the study area into specific drainage areas. Those drainage areas located south of Bell Butte are designated Drainage Areas 100 through 1000, as shown in Figures 5A through 8A (Appendix A) and 14, and were delineated according to the area contributing flow to each of the proposed detention basins in the ultimate drainage system. Each detention basin is assigned an alpha-numeric designation with the alpha designation 'DB' representing detention basin and the numeric value representing the drainage area the detention basin is located in.

Drainage Area 1100, which is located north of Bell Butte, is further delineated into subareas as necessary to describe the hydrologic and hydraulic characteristics of the existing closed conduit system, as shown on Figure 8A (Appendix A). Each subarea is assigned an alpha-numeric-alpha designation such as SA1100A with the prefix 'SA' representing subarea, the numeric value '800' representing the drainage area the subarea is located in, and the suffix 'A' representing a specific subarea.

The 48th Street to 40th Street ultimate drainage system consists of drainage areas 1200 and 1300, as shown in Figures 8A and 9A (Appendix A). Both Drainage Areas 1200 and 1300 are further delineated into subareas in order to describe the existing closed conduit drainage system. Each subarea is assigned an alpha-numeric-alpha designation similar to Drainage Area 1100.

The drainage areas for the ultimate drainage systems are shown delineated in green while Subareas are delineated in blue on Figures 5A, 6A, 7A, 8A and 9A (Appendix A).

The U.S. Soil Conservation Service TR-20 program was used to compute the runoff hydrographs from each of the drainage areas and subareas located within the study area for the ultimate drainage systems.

For all runoff hydrographs developed using TR-20, the rainfall distribution was developed from a procedure provided by ADOT, dated April 17, 1987, which, along with providing the 24-hour rainfall distribution, generates the point precipitation values for the different design frequencies. The TR-20 program limits the number of rainfall distribution entries to 100. Using the recommended time increment of 0.1 hours, the total number of entries for the 24-hour distribution exceeds the limit of 100. In order to use the 0.1 hour time increment, the 24-hour rainfall distribution was truncated 8 hours at the beginning and 8 hours at the end of the 24 hour rainfall destribution, resulting in an 8-hour rainfall distribution from hour 8 to hour 16. The precipitation lost during the truncation was redistributed at the beginning and end of the truncated rainfall distribution, as shown in Figure 1C (Appendix C).

To design the ultimate drainage systems, the 10-year frequency storm event was used according to the design criteria presented in "Hydrologic Design for Highway Drainage in Arizona: for Interstate projects," and the 50-year frequency storm event was used to check surcharging criteria and to size the detention basins.

The precipitation depths of 2.29 inches for the 10-year and the 3.20 inches for the 50-year storm events were used.

The hydrologic requirements of each drainage area and subarea, for determining the runoff hydrographs using TR-20 are: the drainage area in square miles, a composite curve number, and the time of concentration in hours. By use of a planimeter, the drainage areas, subareas, and retention sites were directly measured from Figures 3A, 4A and 5A (Appendix A). The composite curve numbers were averaged by weighting the runoff curve numbers for each land use condition encountered within each drainage area and subarea. The runoff curve numbers for the different land uses and hydrologic soil groups are listed in Design Criteria (Appendix B).

The time of concentration is the distance the runoff has to travel from the hydraulically most distant point of a drainage area or subarea, to either the point of interception into the existing drainage systems or location of ponding. Measuring the overland travel path and the average slope of the travel path from Maricopa County topographic maps, the time of concentration was determined using the HTN rainfall frequency curve and the Kimematic Routing Nomograph.

Once the runoff hydrographs were developed, they were inserted into the Stormwater Management Model subroutine EXTRAN to analyze the hydraulics of the ultimate drainage systems for both the 10-year and the 50-year storm events.

ULTIMATE DRAINAGE SYSTEM FROM BASELINE ROAD TO TEMPE DRAIN

ALTERNATIVE A

Alternate A analyzes the feasibility of utilizing a series of detention basins, closed conduits, and open channels to provide an ultimate drainage system along I-10 from south of Baseline Road northward to Bell Butte, as shown on Figures 5A, 6A, 7A, 8A (Appendix A) and 14. From south of Bell Butte at Detention Basin DB1000, Alternative A proposes to convey the flow in the northeast direction to Detention Basin DB1000, where the flow is then conveyed by conduit to the existing storm drainage system to the outfall at Tempe Drain, as shown in Figures 9A (Appendix A) and 14. The drainage system within Drainage Area 1100 consist of several detention basins attenuating the peak flows in order to remain below the 93 cfs permitted at the outfall into Tempe Drain.

The flows south of Baseline Road for Drainage Area 100 is collected in Detention Basin DB100, as shown in Figure 14. A pumping facility is provided at Detention Basin DB100 to convey the flow over Highland Canal into Detention Basin DB200. Discharge from Detention Basin DB200 is then discharged through culverts under Baseline Road and the northbound on ramp into an open channel, which is then transported northward to a culvert under I-10 into Detention Basin DB400. Flows from Drainage Areas 300 and 400 are also conveyed through culverts and open channels to Detention Basin DB400, as shown in Figures 5A (Appendix A) and 14.

A pumping station at Detention Basin DB400 discharges the flows over Western Canal into Detention Basin DB900. Detention Basin DB900 regulates the discharge of flows for the area south of Western Canal, including Drainage Area 900. Because the discharge from Detention Basin DB900 flows to Detention Basin DB800, which is located at a site that does not allow for expansion to provide additional storage, it is important that Detention Basin DB900 have sufficient storage capacity to restrict descharge in order not to cause flooding problems at Detention Basin DB800. Detention Basin DB800 also collects flows from Drainage Areas 600, 700, and 800 by means of culverts and open channel drainage system, as shown on Figures 5A, 6A, 7A (Appendix A) and 14.

Discharge from Detention Basin DB800 is pumped into a closed conduit system in the northerly direction parallel to I-10 with discharge into Detention Basin DB1000 along with flows from Drainage Area 1000. At Detention Basin DB1000, the flows are conveyed in a northeasterly direction into Detention Basin DB1100A which regulates the discharge into the existing drainage systems through a closed conduit along Broadway Road, as shown on Figure 14.

The remaining ultimate drainage system consists of detention basins along Broadway Road, I-10 and 48th Street which regulates the flow into the existing drainage system in order to maintain a peak flow at the outfall into Tempe drain below the 93 cfs allowable.

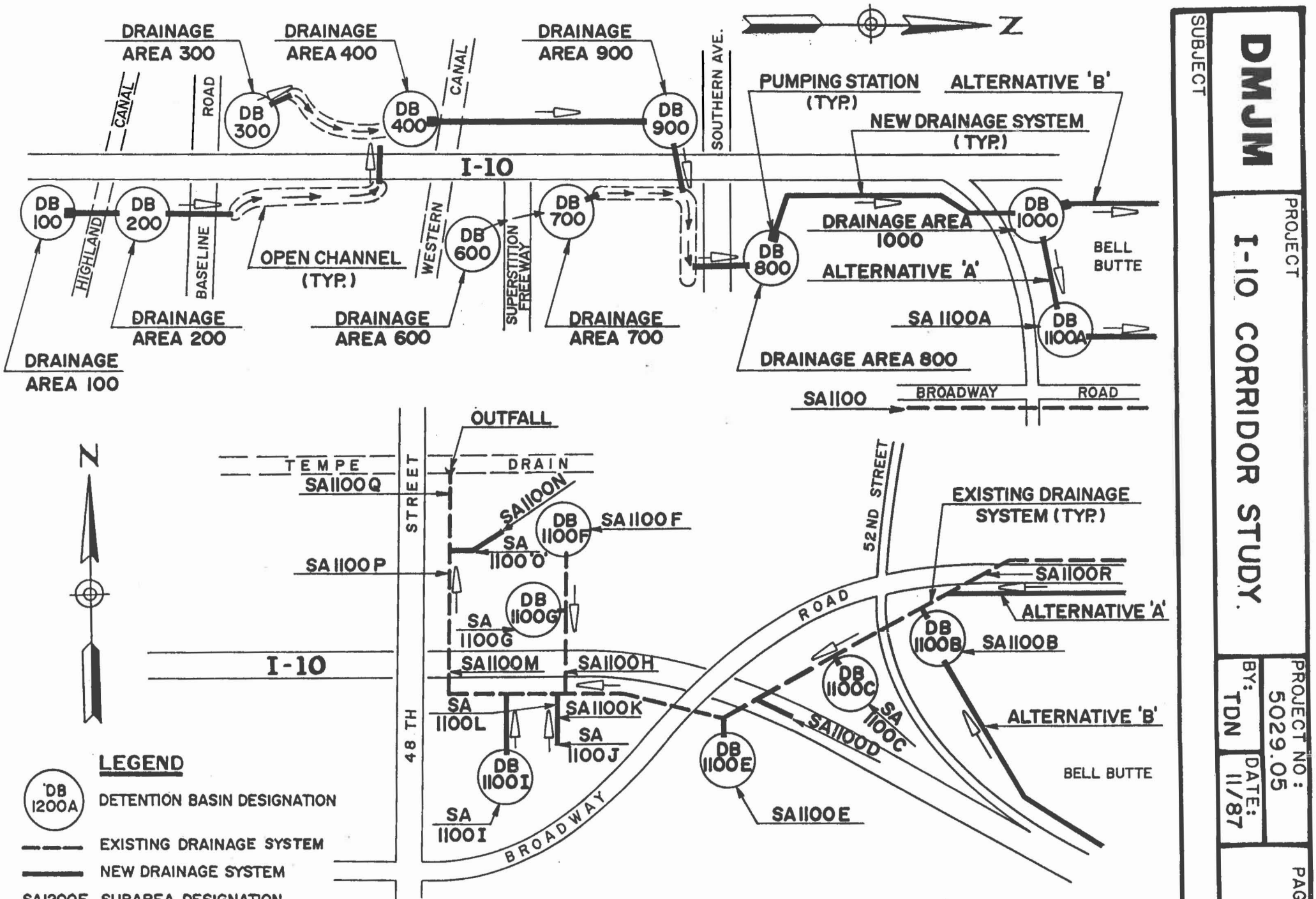

FIGURE 14. FLOW SCHEMATIC OF ULTIMATE DRAINAGE SYSTEM FROM BASELINE ROAD TO TEMPE DRAIN.

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The concept presented in Alternative A is to allow the peak flow from Drainage Area 1100 to reach the outfall before the flow from Baseline Road to Bell Butte arrives, and thereby maintain a peak flow below the 93 cfs limit, for both the 10-year and the 50-year storm events.

The pump facility for Alternative A at Detention Basin DB100 is assumed to have a pumping rate of 1.0 cfs while the pumping facilities at Detention Basins DB400 and DB800 are assumed to have pumping rates of 5.0 cfs and 10.0 cfs, respectively.

The 10-year storm event generates an outfall peak flow of approximately 88 cfs at the Tempe Drain, which is less than the allowable peak flow of 93 cfs. The projected storage requirements at the detention basins for the 10-year storm event are presented in Table 16. The EXTRAN Hydraulic analysis of Alternative A indicates that the peak flow for the area south of Bell Butte from Detention Basin DB1100A occurs at approximately 8 hours 43-minutes while the peak flow at the outfall into Tempe drain occurs at approximately 4 hours 17 minutes, indicating that the majority of peak flow at the Tempe Drain outfall can be attributed to Drainage Area 1100 and not the additional flow from south of Bell Butte.

Pumping rates at Detention Basins DB400 and DB800 are increased to 10 cfs and 15 cfs. The remaining criteria used in the 10-year storm event analysis continues for the 50-year storm event analysis.

The 50-year storm event generates an outfall peak flow at the Tempe Drain of approximately 138 cfs. Surcharging will occur at various locations of the closed conduit system. The storage requirements at the proposed detention basins for the 50-year storm event are presented in Table 17. The EXTRAN hydraulic analysis generates similar results for arrival of peak flows as the 10-year storm events showing the peak flow at Tempe Drain occurs at approximately 4-hours and 19-minutes, while the peak flow at Detention Basin DB1100A occurs at approximately 6-hours and 53-minutes.

The 50-year storm event projected peak flow at the Tempe Drain outfall of 138 cfs does exceed the maximum allowable peak flow of 93 cfs. In order to reduce the peak flow to an acceptable flow rate, will require diverting some of the flows from Subareas SA1100D, SA1100H, SA1100M into Detention Basins in order to attentuate their peak flows prior to discharging into the storm sewer system.

The 10-year and 50-year projected peak flows for Alternative A of the ultimate drainage system from Baseline Road to Tempe Drain are shown on Figures 15 and 16 respectively.

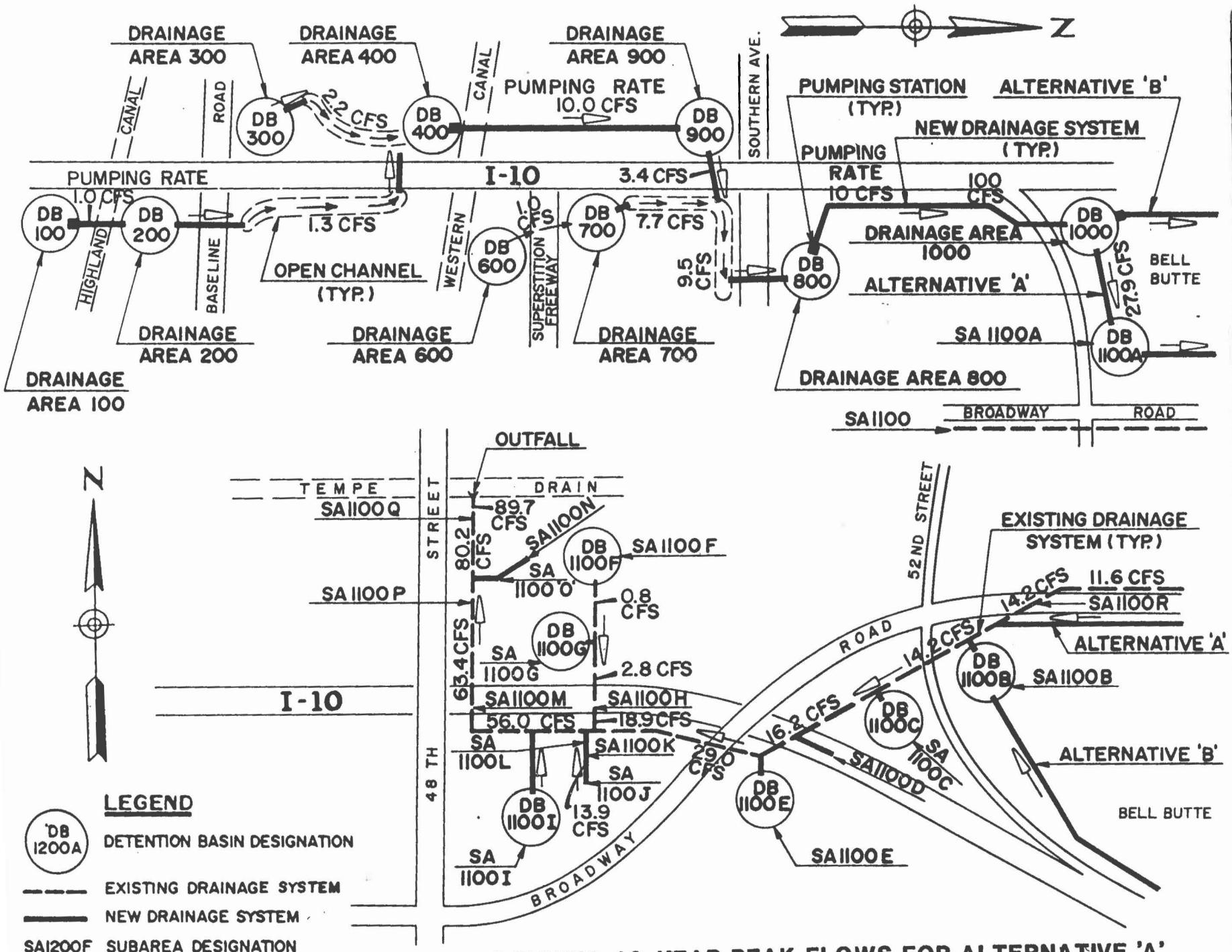

FIGURE 15. PROJECTED 10-YEAR PEAK FLOWS FOR ALTERNATIVE 'A' FROM BASELINE ROAD TO TEMPE DRAIN

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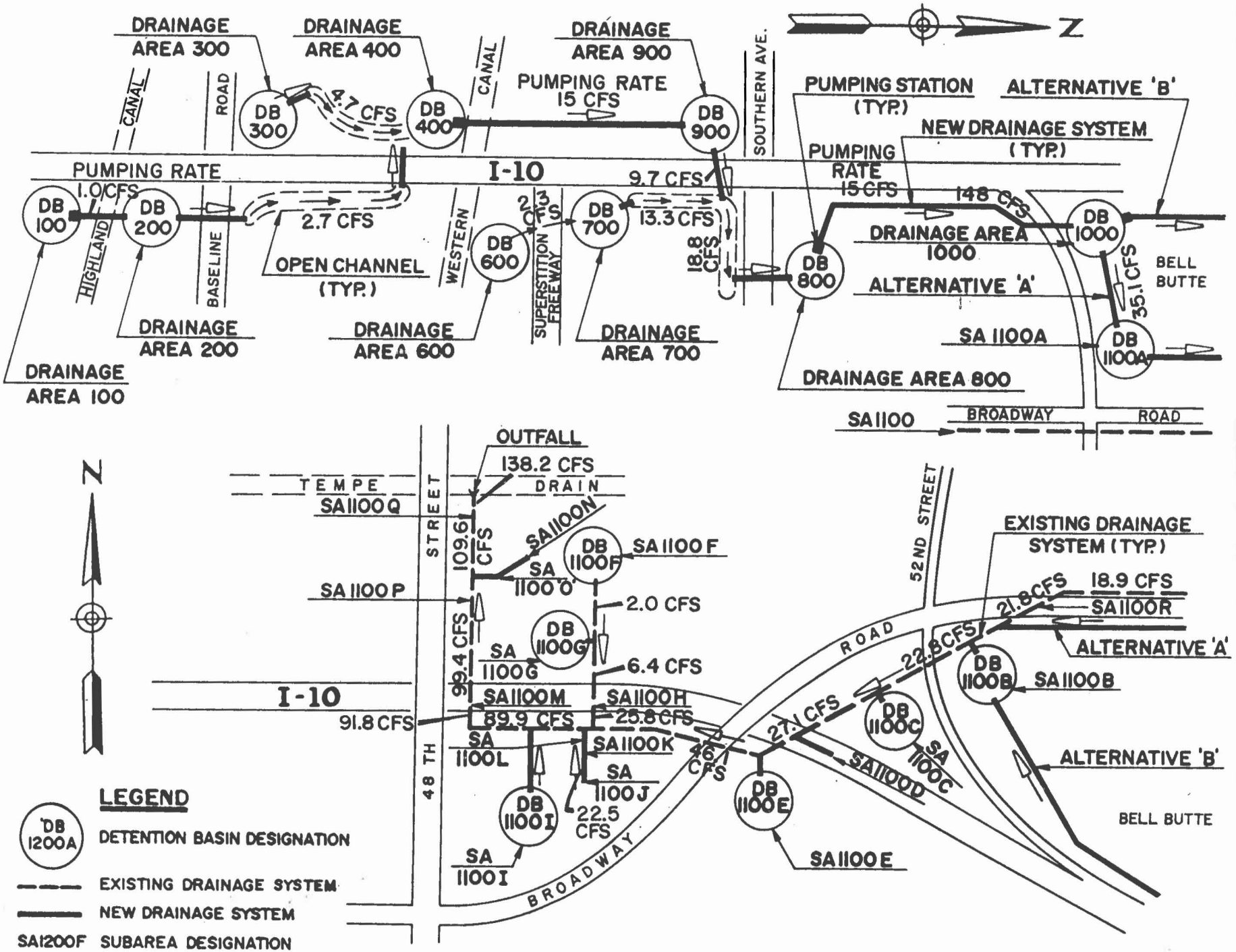

FIGURE 16. PROJECTED 50-YEAR PEAK FLOWS FOR ALTERNATIVE 'A' FROM BASELINE ROAD TO TEMPE DRAIN

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TABLE 16. ALTERNATIVE A: PROJECTED STORAGE REQUIREMENTS FOR THE BASELINE ROAD TO 48TH STREET ULTIMATED DRAINAGE SYSTEM DETENTION BASINS FOR THE 10-YEAR STORM EVENT

Detention Basin Designation	Project Storage Requirements (Acre-Feet)
DB100	0.2
DB200	0.9
DB300	1.1
DB400	2.3
DB600	0.3
DB700	1.3
DB800	1.6
DB900	6.3
DB1000	3.5
DB1100A	4.8
DB1100B	0.7
DB1100C	0.7
DB1100E	1.0
DB1100F	0.3
DB1100G	0.4
DB1100I	1.3
DB1100N	1.4

TABLE 17. ALTERNATIVE A: PROJECTED STORAGE REQUIREMENTS FOR THE BASELINE ROAD TO 48TH STREET ULTIMATE DRAINAGE SYSTEM DETENTION BASINS FOR THE 50-YEAR STORM EVENT

Detention Basin Designation	Project Storage Requirements (Acre-Feet)
DB100	0.2
DB200	1.2
DB300	1.7
DB400	4.0
DB600	0.5
DB700	2.0
DB800	2.9
DB900	9.1
DB1000	5.6
DB1100A	8.3
DB1100B	1.1
DB1100C	1.0
DB1100E	1.6
DB1100F	0.5
DB1100G	0.6
DB1100I	2.0
DB1100N	2.1

Alternative B:

Alternative B for the ultimate drainage system from Baseline Road to Tempe Drain is identical to Alternative A with the exception of the discharge from Detention Basin DB1000. A pumping facility is located at Detention Basin DB1000 to discharge the flow in the southwesterly direction around Bell Butte into Detention Basin DB1100B, as shown on Figure 8A (Appendix A) and 14. The pumping station has a projected pumping rate of 10 and 15 cfs.

The 10-year storm event generates a peak flow at Tempe Drain of approximately 88 cfs. Note, that this peak flow for Alternative B is identical to the peak flow generated in Alternative A, reinforcing the conclusion drawn earlier that the peak flow at the Tempe Drain outfall is a result of runoff generated from Drainage Area 1100.

Table 18 lists the projected storage requirements at the detention basins for the 10-year storm event. The storage requirements are identical to Alternative A for the 10-year storm event, except for Detention Basin DB1000 and DB1100B. The 50-year storm event was not analyzed for Alternative B because of the similarity.

The projected peak flows from Alternative B of the Ultimate Drainage System from Baseline Road to Tempe Drain are shown on Figure 17.

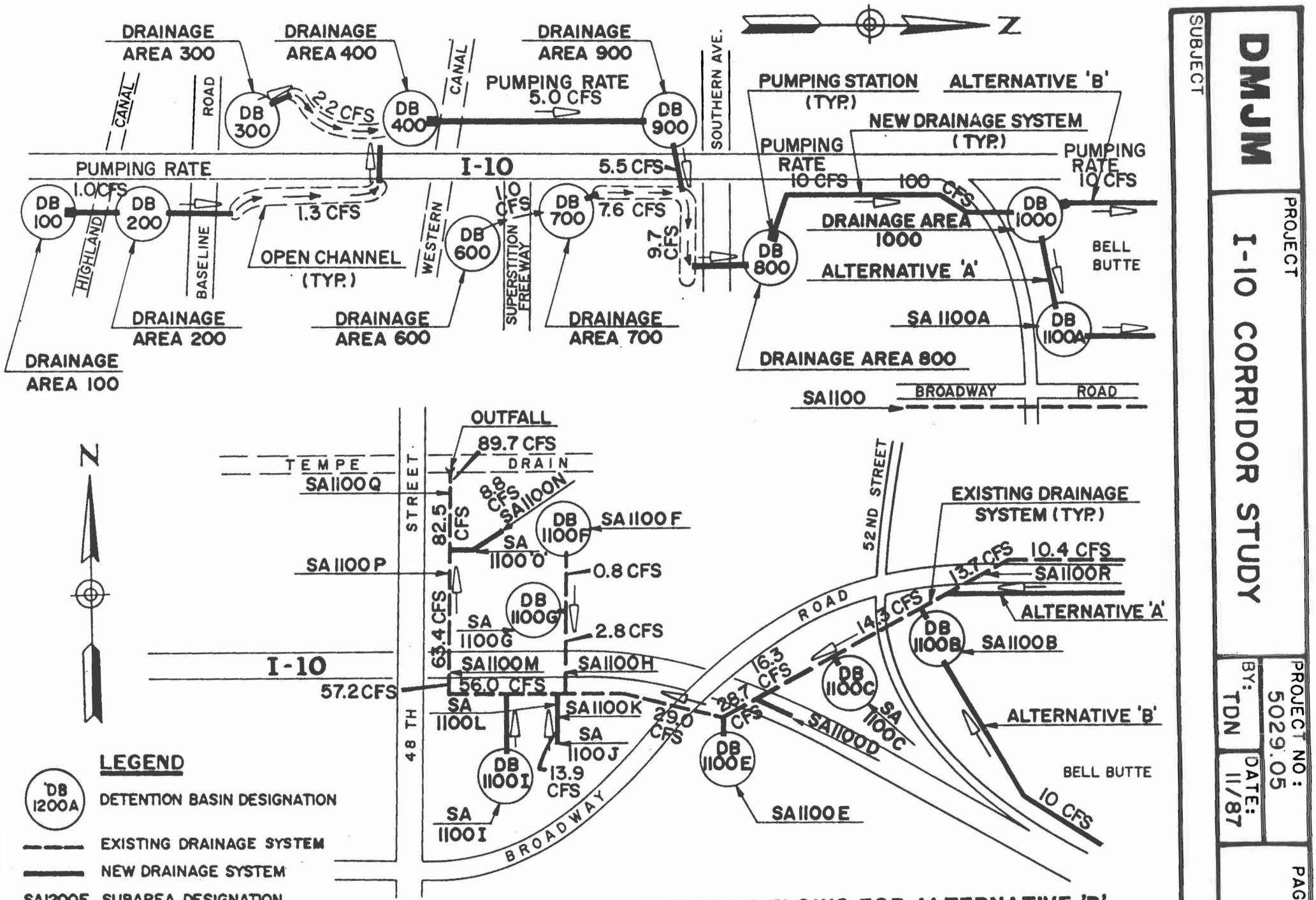

FIGURE 17. PROJECTED 10-YEAR PEAK FLOWS FOR ALTERNATIVE 'B' FROM BASELINE ROAD TO TEMPE DRAIN

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TABLE 18. ALTERNATIVE B: PROJECTED STORAGE REQUIREMENTS FOR THE BASELINE ROAD TO 48TH STREET ULTIMATE DRAINAGE SYSTEM PROPOSED DETENTION BASINS FOR THE 10-YEAR STORM EVENT

Detention Basin Designation	Projected Storage Requirement (Acre-Feet)
DB100	0.2
DB200	0.9
DB300	1.1
DB400	2.3
DB600	0.3
DB700	1.3
DB800	1.7
DB900	6.3
DB1000	3.1
DB1100A	3.2
DB1100B	4.8
DB1100C	0.7
DB1100E	1.0
DB1100F	0.5
DB1100G	0.4
DB1100I	1.3
DB1100N	1.4

Summary

The Baseline Road to 48th Street Ultimate Drainage System Alternatives A and B both provide acceptable outfall peak flows into Tempe drain for the 10-year storm events. The concept of delaying the timing of the peak flow from south of Bell Butte until the peak flow from Drainage Area 1100 has been discharged into Tempe drain appears workable.

Alternative A generates an outfall projected peak flow into the Tempe drain of 138 cfs, for the 50-year storm event, which exceed the allowable peak flow of 93 cfs. Review of EXTRAN output indicates that the magnitude of reduction required in the 50-year outfall peak flow in order to reduce the discharge at the Tempe Drain outfall to below 93 cfs, requires diverting a portion of the flows from Drainage Area 800, which includes Subareas SA800M, SA800H, and SA800D, into detention facilities. It originally was assumed in this scheme that the flows from these subareas were to discharge directly into the storm sewer system. However, in order to provide the peak flow reductions necessary to comply with the outfall flow restriction, the flows from these subareas must first drain into detention basins to provide the necessary peak flow attenuation, then back into the drainage system for conveyance to Tempe drain. A balancing of the rate of discharge and the storage requirements from Drainage Area 800 will be required in order to pass the peak flow into the Tempe Drain outfall before the peak flow for the area south of Bell Butte arrives.

ULTIMATE DRAINAGE SYSTEM ALONG I-10 BETWEEN 40TH STREET AND 48TH STREET
(REANALYSIS IN VOLUME I SUPERCEEDS THIS ANALYSIS)

The 48th Street to 40th Street Ultimate Drainage System for the section of I-10 from 48th Street (Hohokam Expressway) westward to approximately 1000 feet west of 40th street, is divided into two drainage areas designated, Drainage Areas 1200 and 1300, as shown in Figures 8A, 9A (Appendix A) and 18. Drainage Areas 1200 and 1300 are further delineated into subareas as necessary to describe their hydrologic and hydraulic characteristics. The subareas for both drainage areas are assigned an alpha-numeric-alpha designation with the prefix alpha "SA" representing subarea, the numeric value representing the drainage area the subarea is located in, and the suffix representing a specific subarea, as shown in Figure 8A, 9A (Appendix A). The detention basins are also assigned a similar alpha-numeric-alpha designation with the prefix 'DB' representing detention basin, numeric value represents the drainage area the detention basin is part of, and the suffix matching the subarea the detention basin is located in.

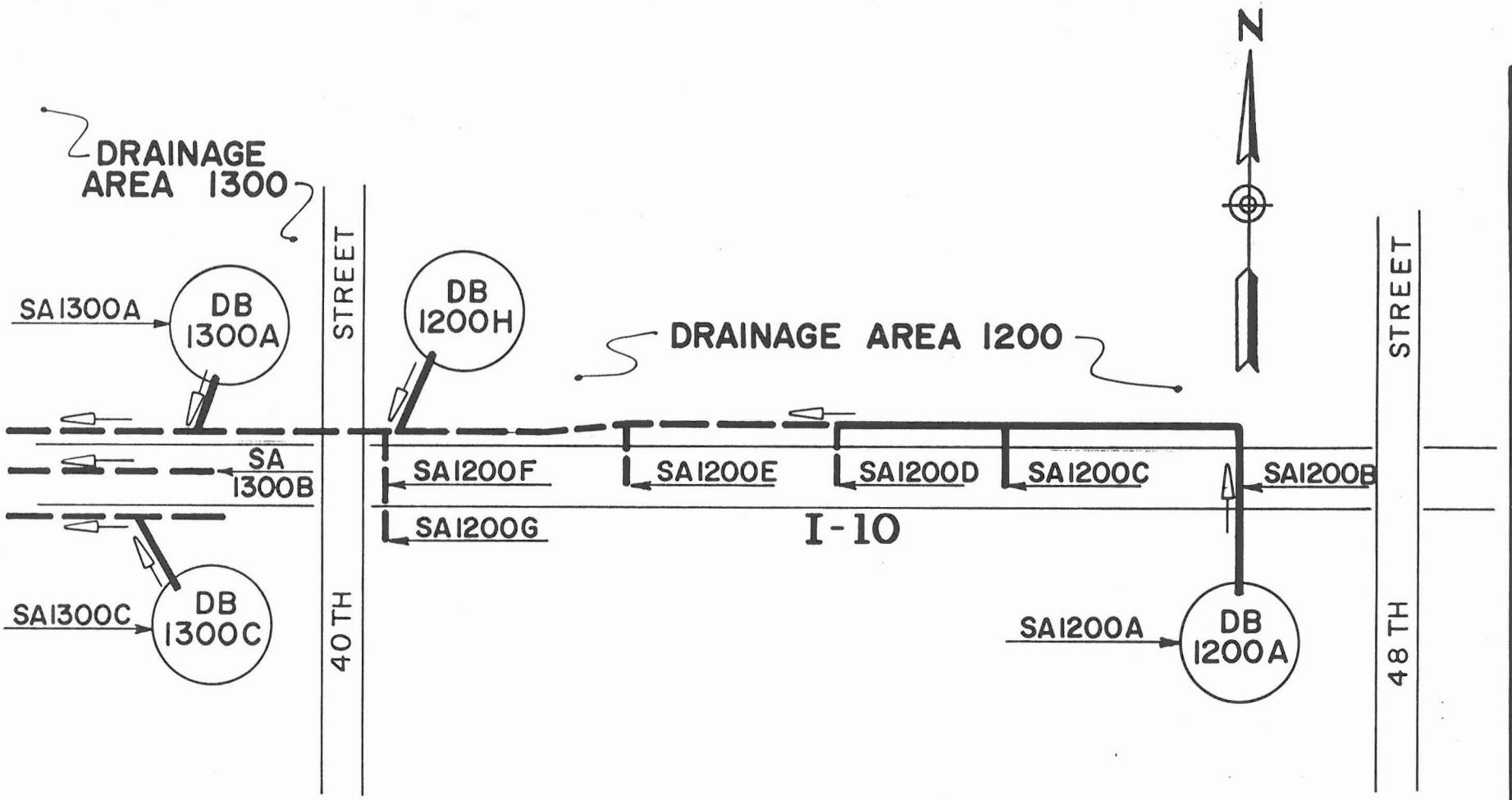
The maximum allowable peak flow for the Ultimate Drainage System from 48th Street to 40th Street is based on the "Final Drainage Report for the Phoenix-Casa Grande Highway, Salt River Bridge to 40th Street", Maricopa County, date February 1985, which included in its hydraulic calculations an additional peak flow of 97 cfs for the 50-year storm event to account for future drainage from 48th to 40th street. A peak flow of 131 cfs can be used when including the east side ramps and the infields at the 40th Street/I-10 Overpass.

The existing drainage system which outfalls west of 32nd Street into Tempe Drain runs eastward along the north side of I-10 to its temporary termination point, approximately 120' east of 40th Street. Extension of the drainage system was in the design phase to be extended eastward, in the 48th Street project, to provide drainage for the proposed HOV Lanes. Later, ADOT decided not to provide the HOV Lanes between 40th and 48th streets. Although, the drainage system extension for HOV Lanes has been temporarily delayed in the 48th Street Project, the proposed drainage system is shown as existing in Figure 8A and 9A (Appendix A).

Additional hydraulic analysis of I-10 drainage system between 40th Street and 48th Street where the 48th Street Project generates a projected peak flow of 84 cfs for the 10-year storm event, assuming a tailwater elevation at the outfall into Tempe Drain at the crown of the existing 54" storm drain.

Determination of the hydraulic grade line for the 50-year storm event using EXTRAN and a tailwater elevation from the 1985 sewer Drainage Report of 1124.3 feet, causes significant surcharging and runoff loss when the HGL exceeds the proposed ground elevation. Because of the runoff losses caused when using the tailwater elevation of 1124.3, a reliable peak flow cannot be determined at this time. In the next section of the I-10 corridor study from the 40th Street to 16th Street, the entire drainage system will be analyzed from the Tempe Drain outfall west of 32nd Street using an established tailwater elevation to determine the 50-year projected peak flows and hydraulic grade of the 32nd to 48th Street ultimate drainage system.

Drainage Area 1300 has already been included in the existing I-10 drainage system. Any modification to the existing drainage area will require additional detention to reduce the peak flows to the rates they were prior to the change, in order not to increase flow in the existing drainage system.



LEGEND

DB 1200A — DETENTION BASIN DESIGNATION

EXISTING DRAINAGE SYSTEM

NEW DRAINAGE SYSTEM

SA1200F SUBAREA DESIGNATION

FIGURE 18. FLOW SCHEMATIC OF ULTIMATE DRAINAGE SYSTEM FROM 48TH STREET TO 40TH STREET.

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APPENDIX A

- Figures 1A through 4A. Existing Drainage Systems
- Figure 5A through 9A. Ultimate Drainage Systems

APPENDIX B

- Drainage Criteria

DRAINAGE CRITERIA

This section summarizes the criteria used in the evaluation of the existing drainage systems located within the I-10 Corridor Study area and used to design the ultimate drainage systems.

REFERENCES

The following publications and computer programs were used in conjunction with the drainage criteria in this section in evaluating the existing drainage systems and designing the ultimate drainage systems:

1. ADOT Drainage Design Services - Hydrologic Design for Highway Drainage in Arizona, subsequent revisions thereto.

2. ADOT Drainage Design Services - Hydraulic Design Notes distributed in 1969 and 1972.

3. Design of Urban Highway Drainage, "The State of the Art", U.S. Department of Transportation, August 1979.

4. TR-20, Project Formulation - Hydrology (1982 Version), Technical Release. Soil Conservation Service.

5. Stormwater Management Model Users Manual Version III, Addendum I, EXTRAN. EPA Cooperative Agreement No. CR805664.

6. A nomograph based on Kinematic Wave Theory For Determining Time of Concentration for Overland Flow. Report No. 44, Federal Highway Administration, Robert M. Ragan, December 1971.

SURFACE DRAINAGE

1. Method used to develop hydrographs - TR 20 Program.

2. Design Frequency - 10 year and 50-year.

3. Times of Concentration - Kinematic Wave Methodology (Nomograph).

4. Point Precipitation Volumes - Tempe Point Precipitation Values for various storm frequencies as provided by ADOT.

5. SCS Curve Numbers:

   a. Paved Surfaces 98

   b. Vegetation (Hydrologic Soil Group = C) 89

   c. Urban Residential Districts 83

STORM SEWERS

1. Methods used in the evaluation of the existing drainage systems and design of the ultimate drainage systems:

   a. TR-20 Program.

   b. EXTRAN Program.

2. Design Frequency:

   a. 10 year storm event - design of closed-conduit system when flowing full for Interstate Pavement Drainage.

   b. 50 year storm event - verify that the hydraulic gradient does not exceed an elevation of 6 inches below the low steel of a catch basin grate.

3. Method for Hydraulic Analysis - EXTRAN Program.

4. Manning's 'n':

a.	Concrete Pipe	0.012
b.	Box Culverts	0.015
c.	Corrugated Metal Pipe	0.024
d.	Cast Iron Pipe	0.013
e.	Steel Pipe	0.011

5. Minimum Velocity - Three feet per second desirable for design flow.

6. Minimum Pipe Size - 18" laterals, 24" main line.

7. Maximum length of pipe between manholes or access points:

a.	Under 36 inches	400 ft.
b.	35-60 inches	500 ft.
c.	Over 60 inches	1,000 ft.

DETENTION/RETENTION BASINS

1. 50 year storm event - verify that ponding depth at the detention/retention basins are a minimum 6 inches below subgrade for Interstate Roads.

2. Discharge from detention basins - calculated using the orifice equation.

6. Manning's Roughness Coefficient 'n':

   a. Concrete pavement and shoulder 0.016

   b. Asphaltic concrete pavement and shoulders 0.016

   c. Overland 0.035

   d. Channel 0.025

PAVEMENT DESIGN

This section is limited to the drainage of pavements where an underground sewer system is not required and where pavement runoff must be concentrated at the roadway shoulder to prevent erosion of the embankment face.

1. Storm frequency shall be in accordance with criteria in Section 1.2, Design Frequency, ADOT Manual I, pages 1 and 2.

2. Allowable ponding widths shall be as follows:

Roadway Type	Maximum Spread	Frequency
Rural 4-lane divided	Lt. shoulder width Rt. shoulder width plus 1/2 adjacent traffic lane width	10 years
Urban 4 or 6 lane divided by raised median	Lt. gutter width plus any shoulder width Rt. shoulder, parking or distress lane width plus 1/2 adjacent traffic lane width	10 years

Roadway Type	Maximum Spread	Frequency
4 or 6 lane undivided	Shoulder, parking or distress lane width plus 1/2 adjacent traffic lane width	10 years
2-lane undivided	Gutter and/or shoulder parking or distress lane width	10 years
22' or 24' ramps (Including accel. & decel. lane)	Left - 2' Right - 8'	10 years

APPENDIX C

- 8-Hour Rainfall Distribution

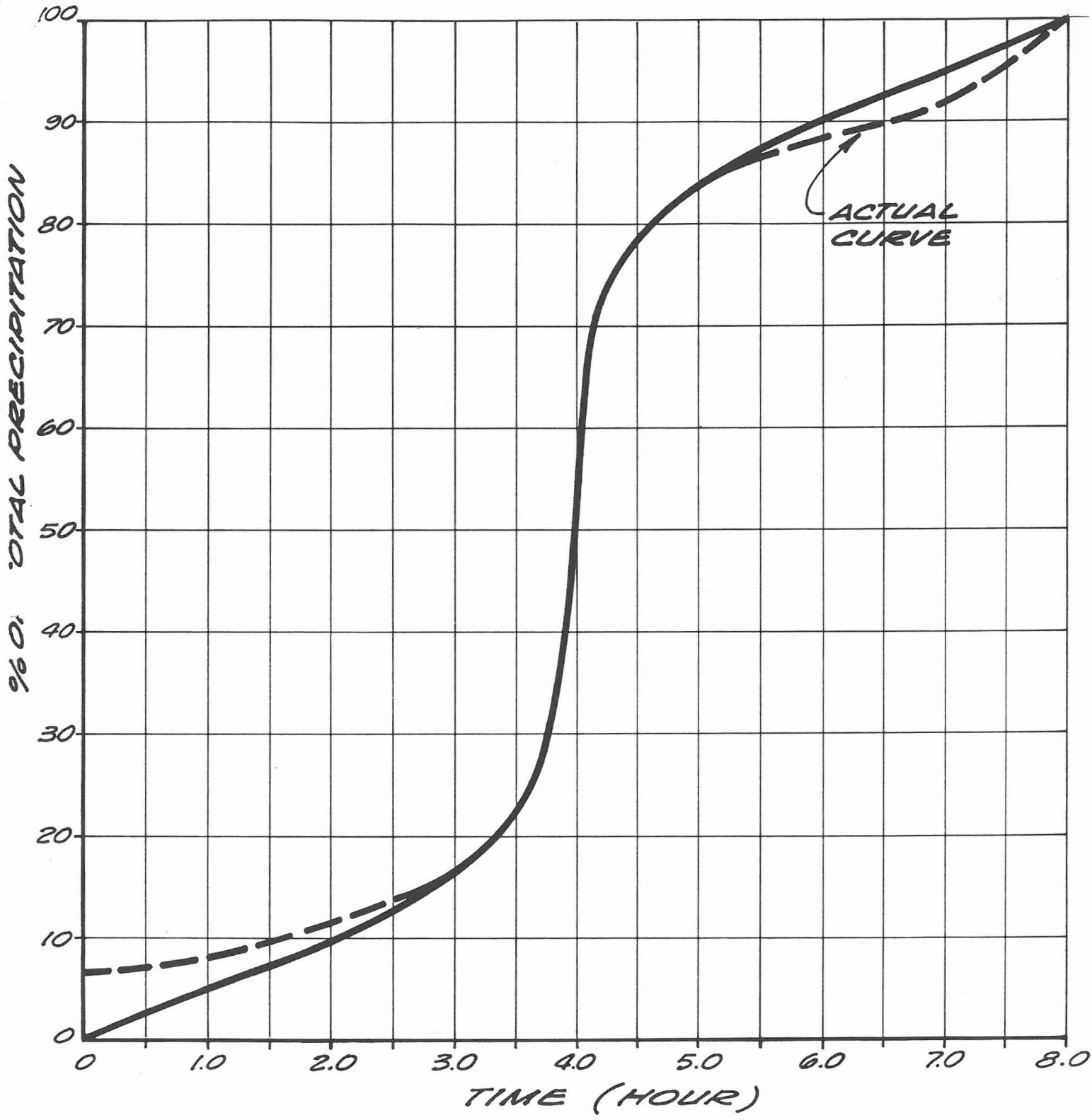

FIGURE 1C - 8-HOUR RAINFALL DISTRIBUTION