# STORM DRAINAGE REPORT

## for

## MARICOPA ASSOCIATION OF GOVERNMENTS

## 1970



YOST AND GARDNER ENGINEERS

PHOENIX, ARIZONA

PHOTO BY - TED GREER

The wonderful, God-given rain!
O Children, love it while you can.
Heedless, it rushes to the drain
Considerately built, by Man.

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THE PREPARATION OF THIS REPORT WAS FINANCED IN PART THROUGH AN URBAN PLANNING GRANT FROM THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, UNDER THE PROVISIONS OF SECTION 701 OF THE HOUSING ACT OF 1954, AS AMENDED. FEBRUARY 1970.

YOST AND GARDNER ENGINEERS

PHOENIX, ARIZONA

YOST AND GARDNER ENGINEERS
2619 NORTH THIRD STREET
PHOENIX, ARIZONA 85004

HAROLD W. YOST
JOHN E. SCHAEFER
F. ROBERT STEVENS
GLENN C. BUSH
WENDELL H. FOLKERTS
T. B. GREER
LAURENCE K. PERRON

February 2, 1970

Dr. B. L. Tims, Chairman
Regional Council
Maricopa Association of Governments
Phoenix, Arizona

Dear Dr. Tims:

With this letter we respectfully submit our report on storm drainage for the area designated in our contract with the Maricopa Association of Governments, dated May 1, 1969. The area includes the cities of Glendale, Paradise Valley, Peoria, Phoenix, Scottsdale and Tolleson, and adjacent portions of Maricopa County.

Pursuant to the contract and the discussions precedent thereto, the report is written from a panoramic point of view and presents recommendations for major trunk drains generally on one mile intervals. It does not attempt to deal with the fine details of drainage interior to section lines or between the major washes in mountainous areas. On the other hand neither does it concern itself with major flood control problems but assumes that the works such as those presently proposed by the Flood Control District of Maricopa County and the Corps of Engineers will eventually be constructed.

We wish to acknowledge and express our appreciation for the information and assistance given by many officials and departments of the cities and towns in the study area and by numerous other public agencies. Particularly we wish to thank the MAG ad hoc Storm Drainage Committee for the benefit of its suggestions and a critical review of the final draft of this report. The conclusions, opinions, and recommendations are our own, however, and do not necessarily reflect those of any other person or agency.

Very truly yours,

YOST AND GARDNER ENGINEERS

By [signature]
John E. Schaefer

Registered Professional Engineer (Civil)
CERTIFICATE EXPIRES
JOHN E. SCHAEFER, JR.
DEC. 31, 1970
ARIZONA U.S.A.

JES:[illegible]

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# SECTION 1. - THE STUDY AREA

## 1.1 Location and Boundaries of the Study Area.

The area covered by this study includes about 480 square miles in Maricopa County, Arizona, lying immediately east of the Agua Fria-New River-Skunk Creek channel and north of the Gila and Salt Rivers. A portion of the City of Phoenix lying south of the Salt and north of the crest of the South Mountains is also included. Figure 1.1 shows the location and extent of the area.

The boundaries of the study area were chosen to include the municipalities in need of a current storm drainage report and the surrounding unincorporated areas which drain through these cities and towns. The area includes Phoenix, Scottsdale, Glendale, Paradise Valley, Peoria, Tolleson, and portions of Maricopa County, all of which are participating and co-operating. The City of Tempe, contiguous to both Phoenix and Scottsdale, has recently (1968) completed its own study. The proposed Union Hills Diversion Channel and Central Arizona Project canal were chosen as a logical northern boundary of the area because these are expected to intercept overland flow from the higher ground to the north. The east boundary is approximately the alignment of a poorly defined divide between lands draining through Scottsdale and those draining into the Arizona Canal and the Salt River to the east of the Scottsdale city limits. The crest of the South Phoenix Mountains and portions of 48th Street and the Gila Indian Reservation bound the part of the study area below the Salt River.

## 1.2 Natural Features.

About 92 percent of the area consists of Quaternary and Tertiary alluvial deposits of indeterminate thickness. Valley floor elevations range from 915 feet at the Gila-Agua Fria junction to 1530 feet along the northern boundary of the area. Ground slopes are gentle, varying from 10-15 feet per mile near the Salt River to 50 feet per mile in the foothill regions. Valley soils are typically silts and loams with more open gravelly formations near the major water courses. Clay soils predominate in some areas as shown in Plate A.

Rock outcrops of the Precambrian era occur in the South Mountains (also known as the Salt River Mountains), predominantly granite gneiss, and in the North Phoenix Mountains which are mainly micaceous schist with some recent volcanics in the extreme northwestern portion. The mountain slopes are steep, the tops 1000 to 1600 feet above the valley floor.

Native vegetation is that of the Sonoran Zone, with creosote bush and saguaro the predominant plants on the flats. Palo verde and iron-wood line the washes. Mesquite is also prevalent along water courses especially in the lower flood plain where it forms dense thickets. Relatively little of the study area is still in its native state. Only 24 percent has not been cultivated or urbanized at this time.

None of the water courses in the area have a permanent flow. Even the major rivers, which flowed year-round in their primeval state, have been dried up by dams and diversions. In the upper reaches, the washes are distinct, clearly defined water courses capable of carrying the sizeable flows resulting from intense summer storms. In the middle reaches, especially where the land is or has been farmed, the washes tend to disappear and the flows are spread out over the land and lose themselves by infiltration and evaporation. It is these intermediate areas which are subject to flooding when exceptionally heavy rainfall occurs. When these areas have been improved and built up the economic losses due to flooding can be severe. The lower washes and river channels have been fairly well preserved because the hazard of floods has forestalled permanent construction, however extensive mining of sand and gravel has altered the original topography considerably in certain areas.

Besides the aforementioned rivers that bound the study area on the south and west, there are two important natural drainageways entering the area from the north. The first is Cave Creek, draining a 252 square mile basin (above Peoria Avenue) in the New River Mountains. Cave Creek enters the area near Union Hills Drive and Central Avenue, angling southwesterly and generally following 19th Avenue. It loses its identity as a channel at the Arizona Canal but on numerous occasions it has flooded a large area along its old bed extending from the Arizona Canal to the Salt River (See Plate B). The other large natural channel entering the area is Indian Bend Wash. This drains most of Paradise Valley, a 142 square mile basin (above Indian Bend Road) lying immediately east of the Cave Creek drainage. The wash proper begins near 36th Street and Sweetwater Avenue and trends southeasterly as a broad swale to its crossing of the Arizona Canal near Indian Bend Road. Below the canal, the wash turns south, still as a swale but with a small waste ditch in its lowest portion, and empties into the Salt just north of Dorsey Lane in Tempe.

Both Indian Bend Wash and Cave Creek have been sources of serious flooding in the study area but both will be cut off from the larger part of their drainages by the Central Arizona Project Canal and the Union Hills Diversion Channel. (1)

The Phoenix Mountains, which lie entirely within the study area, and the South Mountains, which bound the area on the south, give rise to a large number of small, steep washes which must be considered in making provision for storm drainage. The individual areas contributing to these washes generally range from 200 to 1200 acres above the point of discharge onto the alluvial plain, the point where the identity of the wash tends to be lost. Because the mountain washes are steep and have a short collection time, the rates of runoff can be relatively high.

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(1) The most recent serious flood in Indian Bend Wash was on December 19, 1967, in Cave Creek on August 19, 1966. See the 1956 Phoenix Storm Drainage Report for an account of the storm of August 3, 1943 in which flooding ocurred in both basins.

## 1.3 Cultural Features.

The performance of the ground surface as a conductor of storm water has undergone profound changes in the study area as a result of human effort. Clearing and leveling the ground for flood irrigation of farm lands obliterated most the natural washes. The cultivated, more nearly level, bermed fields reduce the amount and rate of runoff appreciably. The major agricultural canals generally intersect natural washes at right angles and intercept storm runoff for use in irrigation, or discharge at wasteways or emergency spillways. The watercourses below these spillways have generally been obliterated. Where the fall of the ground is slight, as along the Arizona and Grand Canals, the canals were built high relative to the ground so they could deliver water to adjacent land. Consequently, in some places, the canals act as dams impounding runoff from higher ground causing flooding of the nearby houses and businesses that were built below the levels of the canal banks.

Urbanization provides a new set of artificial channels in the streets and drains. It affects infiltration into the subsoil by rendering large areas impervious with buildings and pavements. It makes the soil areas that do remain less pervious than they were in the natural state. The extent of present urbanization and the degree to which it is expected to go by 1995 within the study area is indicated by Table 1.1 which is based on information received from the planning and zoning agencies of the participating communities. Figure 1.1 shows the location and extent of the six municipalities lying wholly

TABLE 1.1 - Population, Areas, and Urbanization

| | Population 1965 Census (1) | Population Apr. 1969 Estimate (1) | Area in Corp. Limits Apr. 1969 Sq. Mi. (1) | Approx. Urbanized Area Jan. 1969 Sq. Mi. | Projected Population 1995 (3) | Projected 1995 Urbanized Area Sq. Mi. |
|---|---|---|---|---|---|---|
| Phoenix | 505,666 | 542,277 | 247.60(2) | 120(4) | 1,221,000 | 180 |
| Scottsdale | 54,504 | 66,000 | 67.30(2) | 12 | 172,000 | 28 |
| Glendale | 30,760 | 35,000 | 14.70 | 7.6 | 155,000 | 31 |
| Paradise Valley | 4,650 | 6,460 | 12.99 | 4 | 17,000 | 8 |
| Peoria | 3,802 | 4,500 | 2.42 | 0.5 | | |
| Tolleson | | 4,500 | 0.55 | 0.5 | | |

(1) From Population and Area of Incorporated Places and Unincorporated Area for Selected Years, compiled by Maricopa County Planning Dept., Sept. 28, 1962, revised April 1, 1969.

(2) Includes 16.7 sq. mi. for Phoenix and 25.5 sq. mi. for Scottsdale outside the study area.

(3) MAG-VATTS 1995 Population and Economic Forecast.

(4) From City of Phoenix Planning Dept. for June, 1965

or partially within the study area. Plate D shows population distribution now and as projected by planning agencies for the year 1995. Plate E shows land use in 1995, also as projected by the planning agencies, but generalized and simplified somewhat for the purposes of this study. Population and land use are of direct interest in planning for storm drains because they affect both the amount of runoff to be accommodated and the priority under which drainage works are built.

Particularly applicable to the subject of this report are the existing and the proposed flood control channels. Mention has already been made of those which form portions of the boundary of the study area. These channels have a dual role in the storm drainage picture: (a) they provide a point of discharge for local street and underground drainage lines, and (b) they serve as artificial drainage area divides and thus set limits on the area tributary to the local drains.

The flood control channels are shown on Plate C. All of these are future work being planned jointly by the Flood Control District of Maricopa County and the U. S. Army Corps of Engineers as part of a comprehensive storage and channelization project to protect Phoenix and its environs. The work is divided into five phases:

Phase A consists of a 40,000 cfs lined channel for Indian Bend Wash from immediately above the Arizona Canal to the Salt River.

Phase B includes the channelization of the Agua Fria, the New River, and Skunk Creek; construction of the Union Hills, Cave Creek, and Arizona Canal Diversion Channels; and construction of Cave Buttes, Adobe, and Dreamy Draw detention basins. Adobe and Cave Buttes detention basins and the Cave Creek channel are outside the limits of the study area and are not shown on Plate C. They have no direct effect on drainage within the study area.

Phase C includes a detention basin in the South Mountains near the foot of Central Avenue in Phoenix and the construction of a channel and levee along the Highline Canal from 35th Avenue to 44th Street with a spur channel to pick up the discharge from the Central Avenue dam. At 35th Avenue the channel turns north and discharges into the Salt River. Phase C also includes the Glendale-Peoria Drain and the Maryvale Drain which would carry flood waters of local origin westward from their namesake areas to New River and the Agua Fria respectively. The possibility of combining the main Maryvale channel with the proposed storm drainage channel presently under design by the Arizona Highway Department as part of Papago Freeway (Interstate I-10) is presently being studied by the Corps of Engineers.

Phase D comprises the channelization of the Salt River and the construction of Orme Dam at the Salt-Verde River junction. Orme Dam would be a multi-purpose structure, serving to store Central Arizona Project water as well as to provide flood control.

Phase E provides a channel in upper Indian Bend Wash above the Arizona Canal to 32nd Street.

The various phases would have priority in the order in which they are listed. Costs would be shared by the federal government and the Flood Control District of Maricopa County. As its contribution, the Flood Control District of Maricopa County would be required to provide rights-of-way, make all street and utility relocations, and be required to bear all post-construction costs of maintenance and operation to standards established by the Corps of Engineers. Table 1.2 summarizes presently available information on the Corps of Engineers projects affecting the area.

One of the important assumptions upon which this report is predicated is that the Corps of Engineers Flood Control Projects and the Central Arizona Project Canal (Granite Reef Aqueduct) will eventually be built. This does not mean that the storm drains recommended cannot be constructed until the major flood control works are in. They can be, provided interim natural or artificial low-flow channels are available at a suitable location and gradient to receive their discharge. The tolerability of increased amounts of water at the point of discharge must of course be evaluated in the design stage for each particular case. An important effect of the absence of the flood control channels on the storm drainage sytem will be that there is nothing to prevent the drains from being overtaxed by runoff from large areas above and outside the drainage areas they were designed to serve. Figure 1.2 shows locations in Paradise Valley where storm flows have breached the Old Paradise Verde Canal embankment and gives an estimate of the flows that occur.

TABLE 1.2 - Proposed Corps of Engineers Flood Control Projects

| Project | U. S. Portion | MCFCD Portion | Status |
|---|---|---|---|
| Phase A - Lower Indian Bend Channel | $7,250,000(1) | $1,770,000(1) | Under review by Corps and other agencies |
| Phase B - Northern and western basin and channel improvements | 59,680,000(2) | 11,120,000(2) | Cave Buttes and Dreamy Draw dams under design construction scheduled 1970-1971. |
| Phase C - Peoria-Glendale and Maryvale drains, South Phoenix works | No final estimates | | Under study |
| Phase D - Salt River Channelization - Orme Dam | 3,360,000(3) | 210,000(3) | Salt River channel from Country Club Drive (Mesa) to 59th Ave (Phoenix) under study |
| Phase E - Upper Indian Bend channel | No final estimates | | Under study |

(1) November, 1961 prices
(2) October, 1963 prices
(3) October, 1957 prices for Salt River channel clearing only. Current studies contemplate channel lining from Country Club Drive in Mesa to 59th Avenue in Phoenix and involve 15 bridges and a channel realignment at Sky Harbor airport.

Mention has been made of a storm drainage channel to parallel Papago Freeway West. Freeways and their interchanges are such massive structures that they inevitably affect storm drainage. Underpasses rapidly collect large volumes of storm water which must be pumped into drains in order to keep traffic moving and prevent hazard to life and property. The existing drain along the Black Canyon Freeway (I-17) was built for this purpose. The new Papago West and Superstition Freeways will have large channels designed for 50-year flows to be built as appurtenances to the highways. The proposed Papago East Freeway, if built as an elevated structure, would have little effect on existing or proposed storm drains except for the underpass drainage requirement at the Squaw Peak interchange just east of 20th Street in Phoenix. (1)

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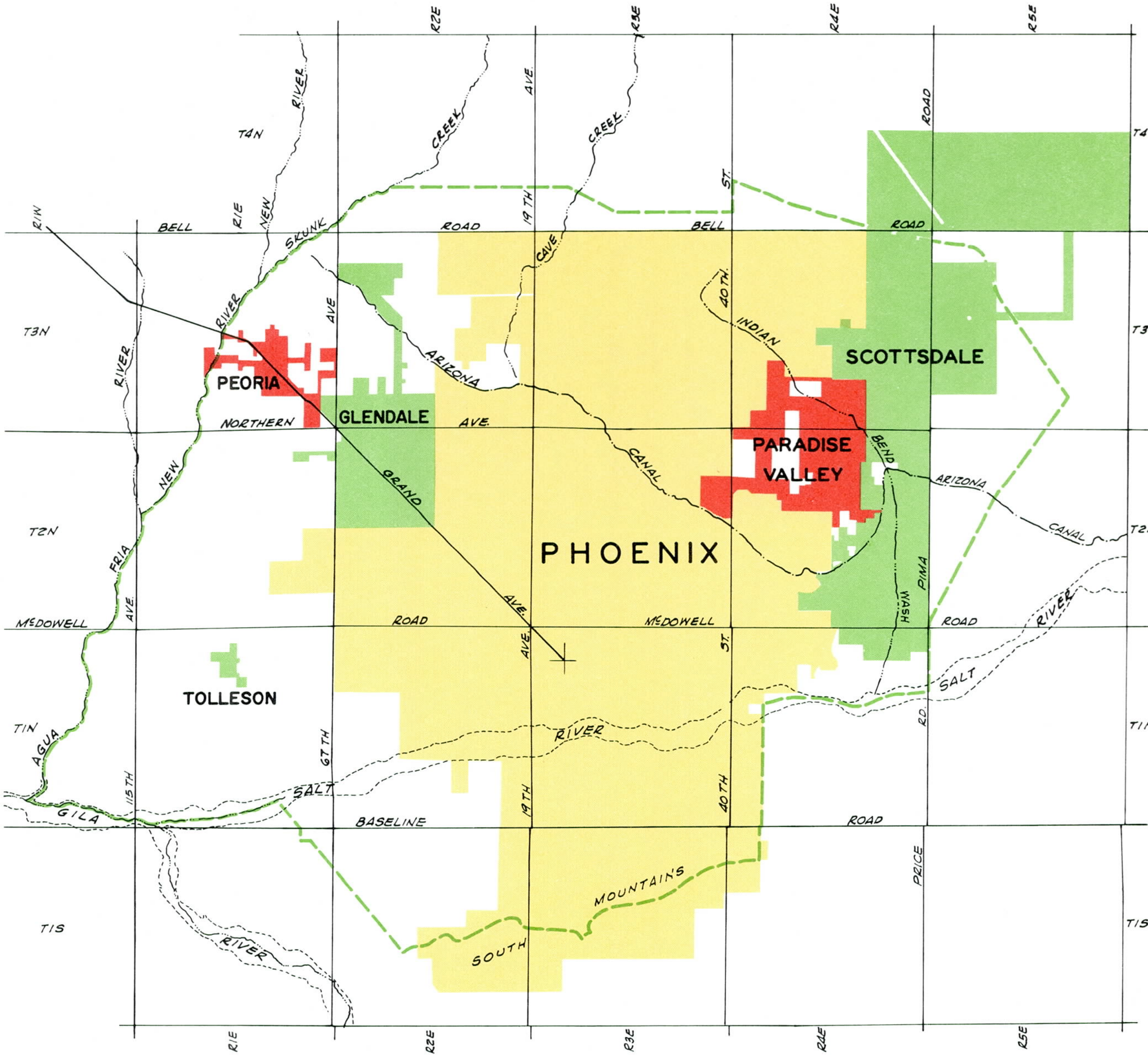
(1) The Papago Freeway, a report prepared for the Arizona Highway Department by Johannessen & Girand Engineers, Inc., June, 1968.





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GRAPHIC SCALE

10,000 0 10,000 20,000 30,000

SCALE IN FEET

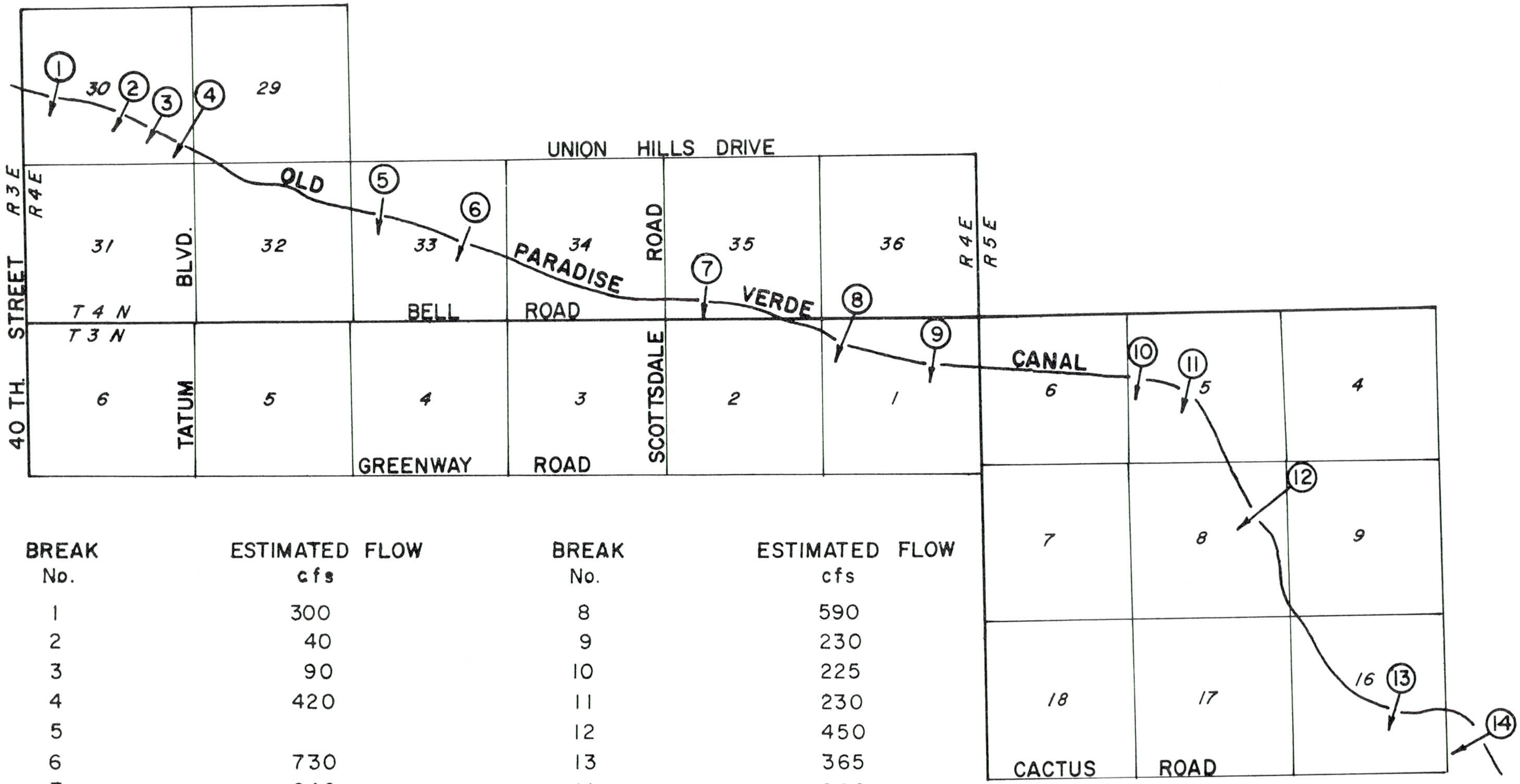
— — — — STUDY AREA BOUNDARY

CITY LIMITS SHOWN FROM INFORMATION FURNISHED BY PARTICIPATING MUNICIPALITIES

YOST AND GARDNER ENGINEERS
PHOENIX, ARIZONA

# STUDY AREA MAP

FIGURE 1.1




| BREAK No. | ESTIMATED FLOW cfs | BREAK No. | ESTIMATED FLOW cfs |
|---|---|---|---|
| 1 | 300 | 8 | 590 |
| 2 | 40 | 9 | 230 |
| 3 | 90 | 10 | 225 |
| 4 | 420 | 11 | 230 |
| 5 | | 12 | 450 |
| 6 | 730 | 13 | 365 |
| 7 | 240 | 14 | 280 |

NOTE: Estimates of flows are based on measured channel cross-sections and slopes.

FIGURE 1.2

BREAKS IN THE OLD PARADISE-VERDE CANAL EMBANKMENT WITH ESTIMATES OF FLOWS

## SECTION 2 - PREVIOUS STUDIES

There have been numerous flood control and storm drainage studies made in the past that relate in some way to the area covered in this report. Most of these have been made under sponsorship of various governmental agencies but some work has been done for private individuals. As many such reports as could be found were gathered together and reviewed as a preliminary to these studies. Where such studies are specific to certain identifiable areas, these have been shown in Figure 2.1.

Some of the studies, particularly those made by the Corps of Engineers, were made from the viewpoint of flood control. Others use the storm drainage approach which is basically different, as will be discussed hereinafter. Some were made nearly 15 years ago and developments since they were written affect the validity of some conclusions. Occasionally conclusions and recommendations of one of the reports are at variance with those of others. The aim of this study, however, has been to use the previous work to the fullest extent possible wherever it remains appropriate to do so in the light of present conditions. The studies that were found are listed below together with a brief description for each.

## 2.1 Studies by Municipalities

### City of Phoenix

1. Phoenix - Storm Drainage Report, Yost and Gardner Engineers, November 1956.

A general storm drainage study for Phoenix and its environs with detailed runoff computations for one and two-year recurrence intervals in urban and potentially urbanized bottom lands, and with 100-year flows for major drainages in mountainous areas. The area covered extends from 91st Avenue on the west to approximately 60th Street on the east and from the ridge of the Phoenix Mountains on the north to the South Mountain divide on the south.

The report recommends immediate construction of drains running from the Grand Canal to the Salt River on 24th Street, 7th Street, 7th Avenue, and 19th Avenue, improvements to the Old Cross-Cut Canal, and a beginning of right-of-way acquisition for the proposed Arizona Canal Floodway. Most of the storm drain construction in Phoenix since 1956 has been along the lines laid out by this report.

2. Tenth Street Wash, Yost and Gardner Engineers, June 1965.

Preliminary and interim reports on the 10th Street Wash drainage area in Sunnyslope, giving design flows for 10, 25, and 50-year recurrence intervals, and making recommendations for certain channel improvements and bridges. Bridges have been built crossing 10th Street Wash at Cave Creek Rd., Mountain View Rd., Butler Dr., and Peoria Ave., to accommodate the 25-year flows set forth in these studies.

3. Improvements to Old Cross-Cut Canal, City of Phoenix Project ST 67010.00 (BI), Yost and Gardner Engineers, June 1967.

A preliminary report on the possibilities of the Old Cross-Cut Canal as a storm drainageway. The study concludes that the canal could be developed to handle approximately 4000 cfs, adequate for 25-year flows from the area south of the North Phoenix Mountain divide between 36th and 64th Streets north of the Arizona Canal. Construction would need to permit use of the canal by the SRVWUA for routine irrigation releases. Drainage of the area north of the Arizona Canal west to 48th Street would require reconstruction of the Arizona Canal to permit reverse flow during storms. New bridges would be required for all street crossings of the Cross-Cut Canal. Control gates and a 0.4 mile connecting channel to the Salt River would be required below the Grand Canal.

City of Scottsdale.

1. Drainage Study - Indian School Road to Thomas Road West of Cross-Cut Canal, Coe & Van Loo Consulting Engineers, Inc., May 1969

An investigation into the causes of local flooding near the intersection of 63rd Place and Rose Circle Drive.

Recommends replacement of an existing 14-inch culvert at 63rd Place with a new 30-inch pipe discharging into an existing sump from which water is pumped into the Cross-Cut Canal. Also recommends a new electrically driven pump installation at Thomas Road to discharge all the water originating south of Thomas Road into the Cross-Cut Canal at a maximum rate of 13 cfs.

2. Thomas Road Drainage Study, Williams & Ellis, May, 1964

An analysis of catch basin and pipe capacity requirements for drainage of Thomas Road paving under Project US-351 (8).

3. Flood Control Feasibility Report - Indian Bend Wash, Water Resources Associates, December, 1967.

A study of the flooding potential of the Indian Bend Wash drainage area.

Recommends two reservoirs, interceptor floodways, and channelization of Indian Bend Wash from 64th Street to the Salt River to handle 1700 cfs above the Arizona Canal and 3000 cfs below.

City of Tempe

1. Master Plan for Storm Drainage - City of Tempe, Arizona, Williams and Ellis, March 1968.

A storm drainage study of the area encompassed by the present limits of Tempe plus its potential growth area between 40th Street and Price Road as far south as the Gila River Indian Reservation boundary (Pecos Road).

Recommends construction of a system of pipe drains up to 108 inches in diameter for storms of one-year design frequency.

## 2.2 Studies by Arizona Highway Department

1. Drainage Study Along Black Canyon Highway, Project I-17-1-201, Yost and Gardner Engineers, June 18, 1964.

A study of the effect of the Black Canyon Highway on storm runoff in the Deer Valley area.

Makes recommendations for disposition of underpass drainage and suggests cross-flow provisions based on 10-year storms. 50-year flows are also calculated.

2. Drainage Study of Ehrenberg-Phoenix Highway, Project I-10-2 (1), Yost and Gardner Engineers, July 1967.

An investigation of the effect of the proposed Papago Freeway (West) on storm drainage in the area between the Agua Fria River and the Black Canyon Freeway.

Recommends construction of a lined channel paralleling the freeway on the north. The capacity, for a 50-year recurrence interval design would vary from 125cfs at 27th Avenue to 4310 cfs at the point of discharge into the Agua Fria. The channel is presently under design and will be a part of the freeway construction.

3. Drainage Study of Superstition Freeway, Project F 208-1-201 PE. Yost and Gardner Engineers, August 1968.

Discusses flood water drainage along the proposed Superstition Freeway from Rural Road (Canal Drive) to the Roosevelt Canal and recommends construction of an unlined channel paralleling the Freeway from the Roosevelt Canal to Gilbert Road and a lined channel from Gilbert Road along the Freeway to Price Road and thence north to the Salt River. Drainage from the area south of the Freeway between Price and Rural Roads would be carried eastward to Price Road in a pipe and pumped into the Price Road channel. Flows to be accommodated vary from 150 cfs at the Roosevelt Canal to about 3800 cfs at the point of discharge for 50-year recurrence interval storms.

4. The Papago Freeway, A report prepared for the Arizona Highway Department by Johannessen and Girand Consulting Engineers, Inc., June 1968.

A "concept" study of various alternative constructions for the proposed freeway, to follow the approximate alignment of Culver and Moreland Streets from the present Black Canyon Freeway to Invergordon Road. Elevated, depressed, and variable grade designs are compared. The elevated concept would have relatively little impact on the storm drainage picture either as far as present or future drains are concerned. Both other concepts would require very extensive new drainage systems and the report discusses these and estimates their costs. At the time of this writing it appears that the elevated concept has been officially adopted.

## 2.3 Studies by Flood Control District of Maricopa County

1. Flood Control Survey Report, Northeastern Maricopa County - Area III, Yost and Gardner Engineers, September 1962.

A broad study of flood potentials in the portion of Maricopa County east of the Agua Fria and north of the Salt-Gila Divide.

Recommends numerous channel improvements and storage projects, generally designed for recurrence intervals of 100 years or more.

2. Comprehensive Flood Control Program Report, Citizens' Advisory Board, Flood Control District of Maricopa County, February 1963.

The basic flood control policy statement adopted by the Board of Directors of the Flood Control District of Maricopa County.

The report consists of a description of all drainage areas having flood potentials within or adjacent to Maricopa County. It includes a tabulation of major flood control problems, recommended solutions, and cost estimates, and evaluates benefit-cost ratios of the various projects.

2.4 Studies By U.S. Corps of Engineers

1. Interim Reports on Survey for Flood Control

1.1 Gila and Salt Rivers, Gillespie Dam to McDowell Damsite, Arizona, December 4, 1957

Recommends channel clearing and improvements in the Salt-Gila River system from Granite Reef to Gillespie Dam with short levees between 40th Street in Phoenix and Tempe Butte. Design capacity would be 270,000 cu. ft. per second. A 2000-foot wide low flow channel is part of the plan.

1.2 Indian Bend Wash, Arizona, April 15, 1962

Recommends a 7-mile concrete lined channelization of Indian Bend Wash from the Arizona Canal to the Salt River. Design capacity would be 40,000 cfs. A siphon would carry the Arizona Canal under the Indian Bend channel and provision would be made for dumping the entire Arizona Canal flow (2000 cfs) into the flood control channel when desired during storms. The project includes about 8,000 lin. ft. of training levees to collect flows at the channel inlet.

1.3 Phoenix, Arizona and Vicinity (Including New River) January 15, 1964.

The report recommends construction of four flood control detention dams:

1) On Cave Creek at the Cave Buttes site approximately two miles below the present dam. Maximum outflow would be 5400 cfs.

2) The Adobe detention basin, about 7 miles north of Bell Road and one mile west of the Black Canyon Freeway. Maximum outflow would be 2000 cfs.

3) The New River detention basin about 8 miles above the entry of Skunk Creek. Maximum outflow, 1000 cfs.

4) Dreamy Draw dam in the North Phoenix Mountains just south of Northern Avenue and one mile east of 16th Street. Maximum flow is 100 cfs.

Channel improvements under this project would include the following:

| Name | Length Miles | Construction | Design Flow, cfs. |
|---|---|---|---|
| Cave Creek | 3.6 | Trapezoidal, Conc. lined | 6000 |
| Union Hills | 9.75 | Trapezoidal, Conc. lined | 2000-13,400 |
| Dreamy Draw | 3.5 | Rectangular, Concrete | 100-1,500 |
| Arizona Canal (above Cave Creek) | 2 | Rectangular, Concrete | 1500-5,500 |
| Arizona Canal (lower) | 10 | Trapezoidal, Earth | 10,500-18,000 |
| Skunk Creek | 6.5 | Trapezoidal, Conc. lined | 24,400-41,400 |
| New River | 8.0 | Trapezoidal, Earth (revetted) | 53,400-55,000 |
| Agua Fria | 7.5 | Trapezoidal, Earth (revetted) | 70,000-74,000 |

The locations of these projects are shown on Plate C. None of the Corps of Engineers projects have been constructed. The present status is given in Table 1.2.

2. Flood Damage Reports (Descriptions and estimates of damage for notable floods in the Phoenix area)

2.1 Storm and Flood of 16-17 August 1963.

Glendale-Maryvale area near Phoenix, Arizona, June 1964.

2.2 Flood of December 1965 - January 1966

Salt and Gila Rivers, Granite Reef Dam to Gillespie Dam, Arizona, April 1966.

3. Flood-Plain Information Studies (Delineations of potential flood limits and guide lines for reduction of damages from future floods.)

Vol. I -Indian Bend Wash Report, June 1964.

Vol. II -Cave Creek Report November 1964 (Cave Creek above the present Cave Creek Dam.)

Vol. III -Skunk Creek Report, March 1965.

Vol. IV -Wickenburg Report, December 1965.

Vol. V -New River Report, April 1967.

Vol. VI -Agua Fria River, March 1968

## 2.5 Study by U.S. Department of Agriculture - Soil Conservation Service

1. Preliminary Data, Squaw Peak-Cave Creek Project, March 1954 (unpublished).

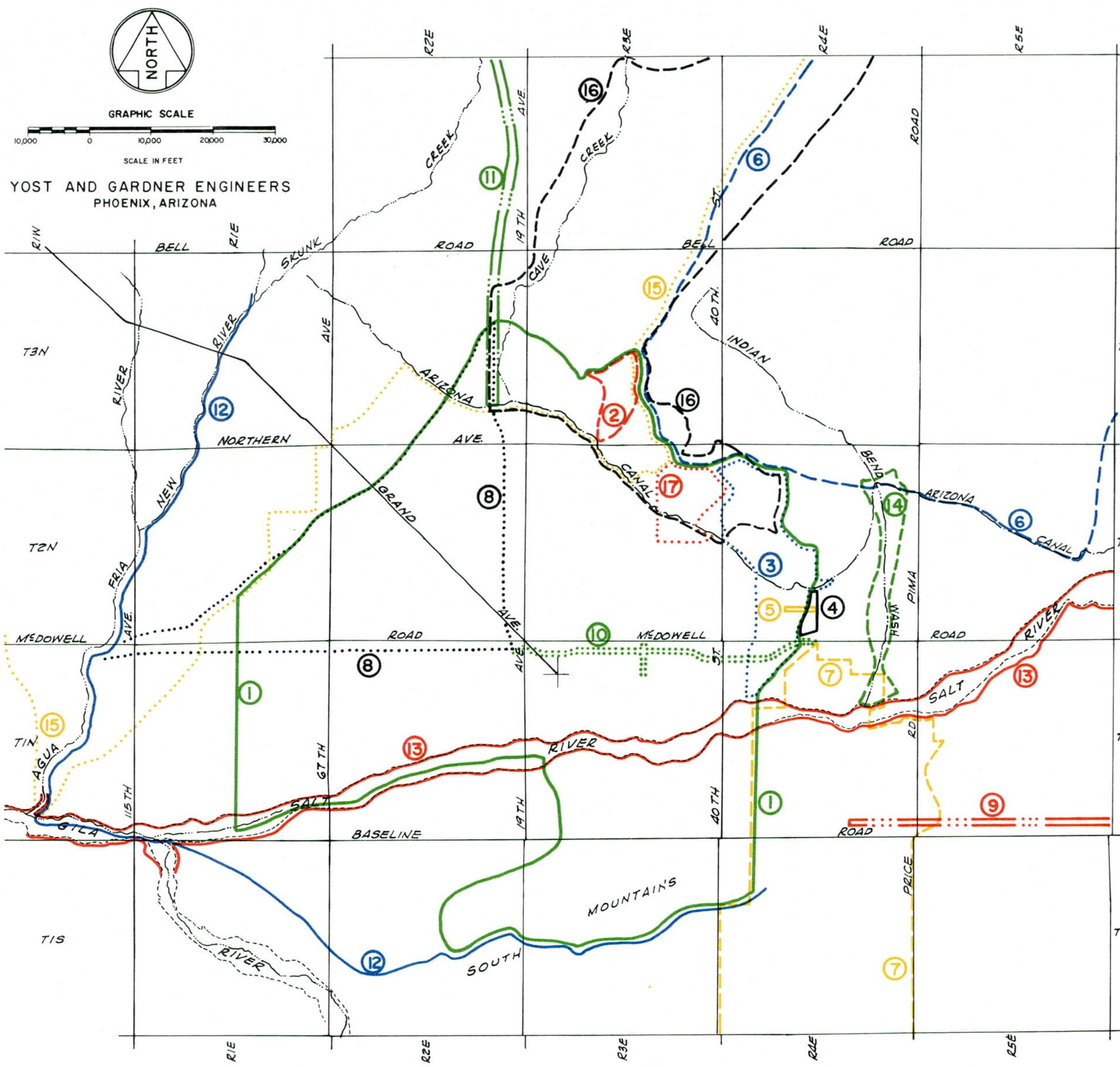
Studies and cost estimates for 16 potential damsites in the North Phoenix Mountains.

## 2.6 Studies by Others

1. Report on Storm Drainage of the Biltmore Lands, Yost and Gardner Engineers, December 1966.

A study of the flooding of Biltmore Fashion Park at 24th Street and Camelback Road in Phoenix resulting from the storm of September 12, and 13, 1966.

The report recommends certain ameliorative measures on Biltmore and adjoining property but points out that the permanent solution lies in the development of the Old Cross-Cut Arizona Canal Floodway.




OTHER STUDIES NOT SHOWN
MARICOPA CO. FLOOD CONTROL DISTRICT COMPREHENSIVE FLOOD CONTROL PROGRAM REPORT (1963)
USCE FLOOD DRAINAGE REPORT (SERIES), AND FLOOD PLAIN INFORMATION STUDIES (SERIES)

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## LEGEND

**CITY OF PHOENIX**
- (1) 1956 Phoenix Storm Drainage Report
- (2) 10th St. Wash Study
- (3) Cross-cut Canal Study

**CITY OF SCOTTSDALE**
- (4) Drainage Study–Indian School Rd. to Thomas Rd.
- (5) Thomas Rd. Drainage Study
- (6) Flood Control Feasibility Report–Indian Bend Wash

**CITY OF TEMPE**
- (7) Master Plan–Storm Drainage

**ARIZONA HIGHWAY DEPT.**
- (8) Drainage Study–Ehrenberg–Phoenix Highway
- (9) Superstition Freeway Study
- (10) Papago Freeway (East) Study
- (11) Drainage Study–Black Canyon Highway

**MARICOPA COUNTY FLOOD CONTROL DISTRICT**
- (12) Survey Report–Area III

**U.S. CORPS OF ENGINEERS–INTERIM REPORTS**
- (13) Gila & Salt Rivers
- (14) Indian Bend Wash
- (15) Phoenix And Vicinity

**U.S. SOIL CONSERVATION SERVICE**
- (16) Prelim. Study–Squaw Peak–Cave Creek Project

**BILTMORE HOTEL**
- (17) Storm Drainage Of The Biltmore Lands

# PREVIOUS FLOOD CONTROL AND STORM DRAINAGE STUDIES

FIG. 2.1

# SECTION 3. HYDROLOGY

## 3.1 General Considerations

The hydrologic aspects of storm drain design relate to the amount and especially the rate of storm water entering the drainage system. Since it is uneconomic to design for the worst possible condition, it is also important to know the statistical probability of occurrence of storms of various magnitudes. These quantities depend upon the rate and frequency of rainfall, its areal distribution, and the losses to atmosphere and subsoil that occur in the intervals of space and time between the impact of rainfall and the arrival of runoff at the inlet. In general, peak flow rates are reduced and runoff periods are prolonged by the inertial and frictional effects of the ground surface acting as the collecting system. The "losses" to the soil (infiltration) and to the air (evaporation and depression storage) can have an appreciable negative effect on both the peak rate and total volume of runoff.

The main concern of this study is storm drainage. Although this is related to flood control, there are important distinctions which are summarized in Table 3.1 While these distinctions may not be universally recognized, they do reflect current local usage and are essential to the point of view from which this report is written.

TABLE 3.1 - Flood Control and Storm Drainage - A Comparison

| | Flood Control | Storm Drainage |
|---|---|---|
| Area of Concern | Major natural channels, generally in lower reaches of drainage area | Upper reaches of drainage areas where natural channels tend to be obliterated or are minor |
| Purpose | To protect life and property values | To abate a nuisance |
| Degree of protection | Designed for 50-100 year recurrence intervals (channels) and for maximum probable storms (reservoirs) | Designed for 1-5 year recurrence intervals |
| Design basis | "Standard project storm" methods (USCE) & hydrograph analysis. Feasibility determined by favorable benefit; cost ratios | Usually designed by "Rational Formula" using local estimates of rainfall supply and loss rates |
| Methods | Generally include both storage and channel improvements. Natural channels utilized | Generally restricted to channel improvements. Drainage ways generally artificial street, pipes, ditches, etc. |
| Financing | Mostly federal with local participation for rights-of-way utility relocation, etc., and operation and maintenance. | Primarily local |

### 3.2 Methods of Computing Runoff Rates

Unless the system under design provides for temporary storage of storm water, and generally storm drainage systems do not do this for very good economic reasons, it is the rate of runoff and not its total volume that is of primary interest. It matters little to a householder whether water stood in his living room for one hour or twenty four. What does interest him and affects the size of his repair bills is how high the water got. Water levels are related directly to rate of flow, time of inundation to volume. Drainage systems must be sized and paid for in proportion to rate of flow; how long they carry water after a storm doesn't matter much.

There are several methods that have been used for computation of runoff rates, all of which are more or less empirical in nature. A good discussion of these is to be found in Ven Te Chow's, Handbook of Applied Hydrology, beginning on page 20-7. Of the methods described, the so called "Rational Method" appears to be the one in most common use [(1)] An adaption of the rational formula for local conditions was used for flow computations in the 1956 Phoenix Storm Drainage Report and in much of the subsequent work in the Phoenix area. The formula is developed and explained in the following paragraphs which are quoted with minor editing from the Arizona Highway Department's Drainage Study of the Superstition Freeway, by Yost and Gardner Engineers, Dated August 1968.

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(1) Design and Construction of Sanitary Storm Sewers, WPCF Manual of Practice No. 9, (ASCE Manual No. 37), Water Pollution Control Federation, 1969.

"If the rate of runoff were equal to the rate of supply, that is if there were no losses or storage, the relation between runoff and supply could be expressed by the formula:

$$Q = CIA$$

where Q is the rate of runoff in cubic feet per second
I is the rate of rainfall in inches per hour
A is the contributing area in acres
and C is the constant of proportionality, nearly equal to 1 (difference neglected) with the above stated units. In order to account for losses the sustained infiltration rate of soils, called $f_c$, is deducted from the supply in case of pervious areas and a loss rate of 0.2 inches per hour is deducted in impervious areas such as street paving. It is further observed that such things as channel storage, depression storage, evaporation, and surface detention work toward reducing the peak flow rate. These latter effects are accounted for by setting C equal to 0.8 for the portion of runoff originating in pervious areas and 0.9 for that coming from impervious areas. Therefore the runoff-rainfall relationship is expressed as:

$$Q = 0.8\, A_p\, (I_a - f_c) + 0.9\, A_i\, (I_a - 0.20) \text{ where}$$

$Q$ = design runoff rate in cubic feet per second
$A_p$ = pervious portion of the drainage area in acres
$A_i$ = impervious portion of the drainage area in acres
$I_a$ = average rainfall intensity over the area in inches per hour
$f_c$ = final or sustained infiltration capacity of the soil in the pervious area in inches per hour

In any location the pervious and impervious area (present or future conditions of development) contributing in a given time can be determined. The rainfall rate during that time period is determined for any design recurrence interval or frequency from the rainfall-intensity-duration curves (see Figure 3.1) and adjusted downward (minor) to correct for area coverage versus the point intensity obtained from the rainfall curves using the area-depth-design curve. (see Figure 3.3).

The storm duration or time period essential to reading the rainfall curves is that least period required for all increments of the area to contribute flow. In many cases portions of an area being studied will produce greater flows than the total because water can be collected from the partial area in a shorter 'time of concentration' and the partial area should therefore be considered with its appropriately greater rainfall intensity. An example illustrating this property is presented in Figure 3.25. The designer must seek out such areas and this is similar to hydrograph methods of centering the hypothetical design storm where it will produce the greatest rate of outflow.

This collecting period, critical storm duration, or time above referred to is usually called 'time of concentration' in this report and can be calculated for natural drainage basins from formulas given by the Corps of Engineers, Soil Conservation Service and others. (See Appendix 1). Various means are given in the literature but in the case of urban areas we estimate the time of concentration as follows:

At any point under consideration the means of flow to the point are considered. If travel is over streets or in man-made channels and conduits the velocity therein is estimated and the associated time of concentration arrived at. Future improvements in an area are apt to change flow travel time and thereby time of concentration. Obviously travel in streets and conduits is faster than overland flows. The tabular calculations reflect these considerations and show the final chosen times.

Infiltration rates are determined from soil maps, comparison with other soils, or by other means.

On storms of high intensity, such as 2 inches per hour, the choice of a pervious area infiltration rate varying between 0.6 and 0.7 inches per hour could make only 8 percent difference in the result while the same choice of loss rates could make an infinite difference (on the pervious area flows) if the storm being considered was one of 0.6 inches per hour intensity. Indicated loss rate of soils is approximately ½ inch per hour and of paving less than 0.2 inches per hour but our formula allows for the use of substantial loss rates in the determination of peak flows while we would be more conservative in calculating storage requirements (or the net total outflow).

Reference is made to our "Phoenix Storm Drainage Report" for a more detailed description and the studies and observations leading to use of the formula method."

Basic data required for the application of the rational method for the determination of runoff quantities and for making the preliminary selections of pipe sizes and estimates of cost given later in this report include the following items:

For determination of amount of rainfall:

1. Intensity-duration curves (Figure 3.1)
2. Area-depth curves (Figure 3.3)

For estimating losses:

3. Soil map (Plate A)
4. Infiltration rate table (Table 3.2)
5. Land use map (Plate E)
6. Pervious-impervious ratios (Table 3.3)

For determining drainage areas:

7. Contour maps (Plate G & H)

(large scale city street maps, USGS 7½ minute quadrangles, and field investigations were also utilized in this connection)

For computing concentration and flow times:

7. Contour maps
8. Flow time formulas for overland flow (Appendix 1)
9. Capacity charts for water carriers (Figures 3.15-3.23)

For choosing and sizing conveyance method

9. Capacity charts for water carriers

For estimating costs:

10. Unit cost table for pipes (Table 7.1)
11. Cost data for box culverts (Table 7.2)
12. Cost data for lined channels (Table 7.3)
13. Cost data for unlined channels (Table 7.4)

For setting project priorities:

5. Land use map - 1995 (Plate E)

14. Population distribution 1970 & 1995 (Plate D)

There is further discussion on the derivation of some of these items of basic design information later in Section 3.3 of this report.

It is important to consider the assumptions that are made in the design of a storm drainage system by the rational method just described, and others that, while not implicit in the method, do affect the final conclusions and recommendations of this report.
These are:

1. Local, limited-area summer thunderstorms are the worst condition in this area from the storm drainage viewpoint. It is not the total quantity of precipitation that determines the size of conduit necessary to carry it off (assuming negligible storage) but rather the rate at which it falls. Highest rainfall intensities in the report area typically occur in the late summer months as a result of thunderstorms that often cover a relatively small area. Figures 3.8 through 3.14 illustrate this type of storm. Numerous other summer storms have been plotted in this fashion and the maps published in other studies for the area. They are not reproduced here but are reflected in the area depth curves given in Figures 3.2 and 3.3 The runoff formula presented in Section 3.2 yields the peak rate for such summer storms. It is obviously incorrect for long, gentle winter rains even though these may produce more total runoff, but a system capable of handling summer peaks will readily accommodate the winter storms of the same recurrence interval. Experience indicates that the most likely cause of the troubles that do occur in prolonged winter storms is the clogging of inlets, not the inadequacy of the trunks.

2. Generalizations of the pervious/impervious relation and of infiltration capacity of soils are permissible and valid for drainage areas of 160 acres and over. This assumption reflects the natural "averaging process" that takes place in the accumulation and gathering movement of runoff water over all the sorts and conditions of the surfaces that occur in the area.

3. That paved streets may be utilized as water carriers for design purposes only to the point where not less than two lanes remain above water. For flows in excess of this requirement, pipes should be provided.

4. That, in general, the storm drainage system should be designed to handle storms with a 1-year recurrence interval with main drainage trunks spaced one mile apart. Certain critical high value areas which are presently subject to considerable nuisance and economic loss because of flooding should have protection for less frequent storms. This point is discussed in Section 4.

5. That the presently projected flood control channels or their equivalent will ultimately be built by the Corps of Engineers and the Flood Control District of Maricopa County and that they will be available to receive storm drainage system discharge. It is also assumed that existing natural and artificial channels along the alignments of the proposed flood control channels will serve or can be adapted to serve as interim outlets for drains.

6. That the Granite Reef Aqueduct to be constructed under the Central Arizona Project by the U.S. Bureau of Reclamation will act as a barrier to future floodwater flowages entering the study area from upper Paradise Valley, or that a future floodway analogous to the proposed Arizona Canal Diversion Channel will be constructed to route upper Paradise Valley

floodwaters into the Salt, perhaps in the vicinity of the present Evergreen Wasteway.

7. That joint facilities serving two or more municipalities are politically acceptable, that is, that storm drains may cross city limits and be designed to serve the drainage area regardless of civil boundaries.

3.3 Work of Agencies Concerned with Rainfall, Runoff, and Flood Control

A vast amount of data has been gathered and a great deal of work has been done by various federal agencies and other organizations relating directly and indirectly to flood control and storm drainage. Most of the formal studies have already been listed and discussed in Section 2 of this report. The materials mentioned below are more in the nature of basic data used either directly or as raw material for some of the design tools previously mentioned as essential to the use of the rational method for computing flows.

Publications of the U.S. Department of Commerce, Environmental Science Services Administration, Weather Bureau

Weather Bureau Technical Paper No. 24 - Rainfall Intensities for Local Drainage Design in the United States, for Durations of 5 to 240 minutes and 2,-5,- and 10 year Return Periods, Part II: Between 105° W and 115° W, August 1954.

Presents maps of 2 year, 1 hour rainfall amounts and methods of deriving design rainfall amounts for other durations and frequencies, based on partial duration series data.

Weather Bureau Technical Paper No. 25 - Rainfall Intensity-Duration-Frequency Curves, for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico, December 1955.

A collection of charts setting forth annual series rainfall intensity-duration curves for durations of 5 minutes to 24 hours, and return periods of 2, 5, 10, 25, 50 and 100 years for 203 Weather Bureau Stations.

Weather Bureau Technical Paper No. 28
Rainfall Intensities for Local Drainage Design in Western United States, for Durations of 20 minutes to 24 hours and 1- to 100 year Return Periods, November 1956.

An expansion of Technical Paper No. 24 giving data for longer durations and a wider range of return periods.

Weather Bureau Technical Paper No. 40
Rainfall Frequency Atlas of the United States for Durations from 30 minutes to 24 hours and Return Periods from 1 to 100 years, May 1961, Repaginated and Reprinted January 1963.

A collection of 49 isopluvial maps of the contiguous United States for 1 year - 30 minute to 100 year - 24 hour storms. There are also charts showing 6-hour probable maximum precipitation and diagrams giving seasonal probability of intense (excess over isopluvial map) rainfall for areas east of the 105th meridian. Values are derived from annual series data but charts give partial duration series quantities.

Arizona Isopluvial Series. Special Studies Branch, Office of Hydrology, Weather Bureau, March 1967.

Twelve isopluvial maps of the State of Arizona giving 6- and 24-hour rainfall amounts for 2-, 5-, 10-, 25-, 50-, and 100-year recurrence intervals, prepared for the Soil Conservation Service.

The 2-year and 100-year maps are reproduced on Figures 3.4 through 3.7 of this report.

The Weather Bureau papers give methods for computing intensities for durations and frequencies other than those mapped. A comparison of values derived from the various publications is given in Table 3.2. Generally, the differences are attributable to increasing amounts of basic data and to refinements in method over the years, and to differences in the degree of generalization. A discussion of the differences is contained in Technical Paper No. 40.

TABLE 3.2 - Comparison of Design Rainfall
Amounts Computed by Various Weather Bureau Publications
Values in Inches Per hour

| Return period | Storm Duration | | | | | |
|---|---|---|---|---|---|---|
| | 10-min. | 20-min. | 30-min. | 45-min. | 60-min. | 90-min. |
| <u>2-year</u> | | | | | | |
| T.P. #24 & 28 | 2.5 | 1.8 | 1.3 | 1.0 | 0.8 | 0.6 |
| T.P. #25* | 2.1 | 1.4 | 1.1 | 0.9 | 0.7 | 0.5 |
| T.P. #40 | 2.0 | 1.5 | 1.3 | 1.10 | 0.9 | 0.65 |
| <u>5-year</u> | | | | | | |
| T.P. #24 & 28 | 3.5 | 2.4 | 1.8 | 1.4 | 1.1 | 0.8 |
| T.P. #25* | 2.8 | 2.0 | 1.6 | 1.25 | 1.0 | 0.8 |
| T.P. #40 | 3.0 | 2.3 | 1.8 | 1.61 | 1.22 | 0.91 |
| <u>10-year</u> | | | | | | |
| T.P. #24 & 28 | 4.3 | 2.9 | 2.2 | 1.7 | 1.5 | 1.0 |
| T.P. #25* | 3.2 | 2.3 | 1.6 | 1.4 | 1.2 | 0.9 |
| T.P. #40 | 3.6 | 2.8 | 2.26 | 1.75 | 1.5 | 1.1 |

*Values shown are corrected to partial duration series equivalent for purposes of comparison.

Publications by U.S. Army, Corps of Engineers

Flood control is of greater concern than storm drainage in the civil works programs of the Corps of Engineers. Consequently the Corps' hydrologic approach is different from that used in this report. The Corps uses the "Standard project flood" concept under which the most severe storm "reasonably characteristic of the geographical region involved" (1) is considered as being transposed and centered over the drainage area under study in a way to produce maximum runoff. The analysis then proceeds using hydrograph methods. The Corps used the Queen Creek storm of August 19, 1954, as the design storm in its flood control studies for Phoenix and vicinity (2).

The differences in the design philosophies for flood control and storm drainage have been discussed previously. Because of these differences there is relatively little hydrologic data in the Corps reports that is directly applicable to the storm drainage design problem. Corps data on infiltration rates, on pervious-impervious area ratios, and on the rainfall area-depth relation have been noted. A concentration time formula for overland flow used by the Corps of Engineers is given in Appendix 1.

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(1) Ven Te Chow, Handbook of Hydrology, p.25-26

(2) U.S. Army Engineers District, Los Angeles, Interim Report on Survey for Flood Control, Phoenix, Arizona, and Vicinity, Jan. 15, 1964

Publications of the U.S. Department of the Interior, Geological Survey

The 7½ minute, 1:24000 scale quadrangle maps published by the U.S. Geological Survey were used extensively in the preparation of this report. The entire study area is covered by the maps of this series, all in fairly recent editions. The maps used included the following quadrangles:

| Name | Contour Interval, Feet | Latest Revision |
|---|---|---|
| Hedgpeth Hills | 10 and 20 | 1957 |
| Union Hills | 10 and 20 | 1964 |
| Curry's Corner | 10 | 1964 |
| McDowell Peak | 20 | 1965 |
| El Mirage | 5 | 1957 |
| Glendale | 5 | 1957 |
| Sunnyslope | 10 and 20 | 1965 |
| Paradise Valley | 10 and 20 | 1965 |
| South Mountain | 10 and 20 | 1964 |
| Tolleson | 5 | 1957 |
| Fowler | 10* | 1967 |
| Phoenix | 10 | 1952 |
| Tempe | 10 | 1967 |
| Laveen | 10 | 1967 |
| Lone Butte | 10 | 1967 |
| Guadalupe | 10 | 1967 |

* Contours fail to match adjoining map on west (Tolleson)

These maps are also obtainable without contours and some of these, notably the 1952 Phoenix quadrangle, are considerably more up-to-date. The series without contours was used for the base map that appears in all plates except Plate B of this report. The contours on Plates G & H are also from the U.S. Geological Survey.

The Water Resources Division of the U.S. Geological Survey maintains several stage recorders on streams in or near the study area:

| USGS NO. | Location | Year Estab. | Max. Disch. | Date |
|---|---|---|---|---|
| 9-5139.1 | New River near Glendale | 1961 | 19,800 cfs | 12/19/67 |
| 9-5122 | Phoenix South Mtn. Park | 1961 | 670 cfs | 9/4/65 |
| 9-5123 | Cave Creek near Cave Creek | 1958 | 12,400 cfs | 12/19/67 |
| 9-5121 | Indian Bend near Scottsdale | 1961 | 2,000 cfs | 12/19/67 |
| 9-5138.35 | New River at Bell Road | 1963 | 14,600 cfs | 12/19/67 |
| 9-5138.6 | Skunk Creek near Phoenix | 1960 | 11,500 cfs | 8/1/64 |

Data from these stations are published annually and are primarily of value in flood control studies. There are no storm drain discharge records available.

Flood Control District of Maricopa County

The district has completed several mapping projects, primarily along the streams considered as potential flood control channels. It also has a series of aerial photos made in 1966, to a scale of 100 feet to the inch with superimposed contours to a 2-foot interval. These cover areas along the Arizona and the Old Cross-Cut Canals and were very helpful for the studies of these areas.

City of Phoenix

There is a similar series of aerial photos to a 100 foot to the inch scale with 2-foot contours available from the City of Phoenix for portions of the area between Cactus Road and the Arizona Canal. These were made in 1967 and are useful for the study of drainage in the North Mountain area.

Landis Aerial Surveys, Inc.

This company annually publishes an atlas of aerial photographs to an approximate scale of 1200 feet to the inch. These are useful for the study of drainage patterns, current stage of development, and for general reference.

3.3 Hydrologic Design Procedure

This section will summarize what has been presented heretofore and will set forth the procedures used in this report to compute design flows for storm drains. The approach used is macroscopic and preliminary in nature but the same methods can be used with more refined topographic data for the final design of individual drainage projects. The procedure is as follows:

1. Decide on the desired spacing of drains and make a preliminary system layout guided by the contours and street pattern on the base map. In well-defined basins, the trunk drain should follow the thalweg as nearly as is practical. In drainage areas with continuous crossfall the trunk should follow the lower edge of the area. Wherever the topography permits, a one-mile spacing of drainage trunks has been chosen as the norm for this study.

2. The degree of protection to be afforded by the proposed drainage system, that is, the recurrence interval of the design storm, should be decided upon. A one-year recurrence interval has been selected for this study except that certain high value areas in critical locations are planned for longer recurrence intervals.

3. Beginning at the upper end of a basin on the contour map, delineate the boundary of the drainage area contributing to the uppermost point on the particular drainage trunk under consideration. Measure the area and the length and slope of the most direct flow path to the remotest point in the area.

4. Compute the concentration time to the inlet for the area under consideration. Use one of the formulas from Appendix 1 for the overland flow. Add flow time in gutters, channels, or pipes, using the appropriate chart, Figures 3.16 through 3.23, to estimate velocities.
5. Using the concentration time and the design recurrence interval, enter Figure 3.1 and pick the appropriate rainfall intensity.
6. Multiply the rainfall intensity from Figure 3.1 by the appropriate area reduction factor from the design area-depth curve, Figure 3.3. Use the reduced rainfall intensity value, $I_a$, in subsequent computations.
7. From the land use map, Plate E, and from Table 3.3, determine the pervious and the impervious acreage, $A_p$ and $A_i$ respectively, in the drainage area being considered. Note that this has been done for the study area, the values being posted on Plate F.
8. Use the soil map, Plate A, and Table 3.4 to arrive at an average infiltration rate, $f_c$, for the pervious area. This should be a weighted value for the area, tempered by the designer's judgment. It will be pointed out hereinafter that for much of the area and for short recurrence intervals (1 and 2 years) the contribution from the pervious areas can be ignored altogether when computing trunk (not lateral or inlet) flows. In the North Phoenix Mountains where flows were computed for 10 to 50 year recurrence intervals an infiltration rate of 0.6 to 0.8 inches per hour was used. The infiltration rates shown on Plate A are from the U.S. Department of Agriculture yearbook for 1955 and should be considered minimums for this area.

TABLE 3.3 - Pervious - Impervious Factors for Various Land Uses - Suggested Design Values

| Land Use in 1995 | Percent Pervious | | | Percent Impervious |
|---|---|---|---|---|
| | Flood Irrigated | Sprinklered | Desert | |
| Residential | | | | |
| Low Density, to 3 units per acre | 30 | 65 | 70 - 80 | 20 - 30 |
| Med. Density, 3 to 5 units per acre | 35 | 60 | 70 | 30 |
| High Density, over 5 units per acre | 40 | 50 | 60 | 40 |
| Parks and park-like areas | 10 | 80-90 | 90 - 95 | 5 - 10 |
| Farmlands and groves | 5 | - | - | 5 |
| Commercial | | 5-15 | | 85 - 90 |
| Industrial | | 10-30 | | 70 - 90 |

NOTE: The sum of pervious and impervious percentages is less than 100 percent for some categories because it is assumed that a portion of the area cannot contribute.

Table 3.4 - Infiltration Rates

| Source | Area | Predom. Soil Type | Infiltration Rate Range | Inches/Hr. Use |
|---|---|---|---|---|
| 1 | Between Ariz. & Grand Canals west of 27th Ave. | Cajon silt loam | | 0.90 |
| 1 | Between Ariz. & Grand Canals 7th Street to Old Cross-Cut | Mohave sandy loam | | 0.88 |
| 1 | Between Ariz. & Grand Canals 27th Ave. to 7th St. | McClellan loam | | 0.76 |
| 1 | Between High Line Canal & Salt River east of 7th St. | Cajon loam | | 0.61 |
| 1 | Between High Line Canal & Salt River west of 7th St. | Laveen loam | | 0.59 |
| 1 | Between Grand Canal & Salt River 27th Ave to 7th St | McClellan clay | | 0.52 |
| 1 | Between Grand Canal & Salt River west of 67th Ave | Cajon silty clay loam | | 0.48 |
| 1 | Between Grand Canal & Salt River east of 7th St. | Cajon clay | | 0.41 |
| 1 | Between Grand Canal & Salt River 27th Ave. to 67th Ave. | McClellan clay loam | | 0.35 |
| 2 | South Mountains above Highline Canal | Rough stony land (as outcrops) | | 0.80 |
| 2 | Upper Indian Bend or Paradise Valley | | 0.55 - 0.85 | |
| 2 | North Phoenix Mountains (above Arizona Canal) | | 0.6 - 0.9 | |
| 2 | Echo Canyon | | | 1.0 |
| 2 | Moon Valley | | 0.7 - 1.0 | |
| 2 | Cave Creek at Arizona Canal | | 0.7 - 1.0 | |

Table 3.4 (continued)

| Source | Area | Pred. Soil Type | Infiltration Rate Range | Inches/Hr. Use |
|---|---|---|---|---|
| 2 | Glendale Drain | | | 0.6+ |
| 2 | Maryvale Drain | | | 0.6- |
| 3 | Upper Indian Bend (Paradise Valley) | Rough, stony land steep slopes (Ia) | 0.1 - 0.2 | 0.15 |
| 3 | Upper Indian Bend (Paradise Valley | Rough, stony land thin soil (Ib) | 0.2 - 0.3 | 0.25 |
| 3 | Upper Indian Bend (Paradise Valley) | Stony phase soils, Anthony, Mohave & Pinal series (IIa) | 0.3 - 0.5 | 0.4 |
| 3 | Upper Indian Bend (Paradise Valley) | As above, moderately shallow (IIb) | 0.5 - 0.7 | 0.6 |
| 3 | Upper Indian Bend (Paradise Valley) | Mohave gravelly sandy loam (IIIa) | 0.7 - 2.0 | 0.9 |
| 3 | Upper Indian Bend (Paradise Valley) | As above, sandy (IIIb) | 2.0+ | 1.0 |
| 3 | Upper Indian Bend (Paradise Valley) | Sandy loams, Mohave, Anthony & Pinal Series (IV) | 1.5+ | 0.7 |
| 3 | Upper Indian Bend (Paradise Valley) | Clay & silt loams, Mohave & Anthony series (V) | 1.5+ | 0.7 |
| 4 & 5 | Major river channels | Group A-deep sands and and gravels - river wash | 2.0+ | |
| 4 & 5 | See Plate A | Group B - sandy loams | 0.15 - 0.30 min. | |
| 4 & 5 | See Plate A | Group C - Clays and clay loams | 0.05 - 0.15 min. | |
| 4 & 5 | See Plate A | Group D rock out-crops | 0.05 & under | |
| 6 | North of proposed Papago Fwy.- Agua Fria River to Black Canyon Fwy. | Clay loams | 0.4 - 0.6 | 0.6 |
| 7 | Mountainous areas | Rock outcrops | 0.2 - 0.65 | 0.35 |

Table 3.4 (continued)

| Source | Area | Predom. Soil Type | Infiltration Rate Range | Inches/Hr. Use |
|---|---|---|---|---|
| 7 | Valley areas | Alluvium | | 0.20 |
| 8 | | Open sandy soils | 0.5 - 1.0 | |
| 8 | | Loams | 0.1 - 0.50 | |
| 8 | | Dense clay soils | 0.01 - 0.10 | |

Sources


1 Phoenix Storm Drainage Report (1956) Yost and Gardner Engineers

2 Flood Control Survey Report - Northeastern Maricopa County (1962) Yost and Gardner Engineers

3 Flood Control Feasibility Report - Indian Bend Wash (1967) Water Resources Associates

4 General Soil Map of Maricopa County (1969) Soil Conservation Service - Milo James, Soil Scientist

5 Water, The yearbook of Agriculture (1955) U.S. Dept. of Agriculture, p. 157

6 Drainage Study of Ehrenberg - Phoenix Highway (1967) Yost and Gardner Engineers

7 Interim Report on Survey for Flood Control - Phoenix, Arizona and Vicinity (Including New River) - U.S. Army Engineer District, Los Angeles, Jan. 1964

8 Hydrology, Manual of Practice No. 28, American Society of Civil Engineers, New York, 1949.

9. Compute the discharge from the area under consideration from the formula

$$Q = 0.9\ A_i\ (I_a - 0.20) + 0.8\ A_p\ (I_a - f_c).$$

Q is the peak surface water runoff rate in cubic feet per second.

10. Proceed downstream along the drain trunk to the next inlet and compute the discharge for the next tributary drainage area as in steps 3 through 9. Use this rate for designing the inlet at this point. Also compute the trunk flow time from the previous inlet as in step 4 and add this to the concentration time for the first area. Repeat steps 3 through 9 using the total as the new concentration time and using the total drainage area contributing at the point under consideration as if this new combined area were the first one in the basin.

11. The pervious area runoff can usually be neglected for builtup residential areas on flat slopes for storms with one and two year recurrence intervals. The reason is that collection times on lawns are so long that the peak impervious runoff has passed before the pervious areas begin to contribute. To demonstrate, an accepted formula [1] for overland flow collection time on clipped sod is:

$$t_c = \frac{9.34\ l^{0.298}}{\sigma^{0.785}\ S^{0.302}}$$

Where $t_c$ is collection time in minutes

$l$ is length of overland flow in feet

$\sigma$ is rainfall excess, $(I_a - f_c)$, in inches per hour

S is surface slope in percent

(1) Chow, Ven Te, Handbook of Applied Hydrology, page 20-11

Assuming that 1 = 100 feet, $f_c$ = 0.6 and S = 0.4 for a typical sodded residential lot, the value of $t_c$ was computed for various values of $\sigma$ and plotted on Figure 3.24. Also plotted as dotted lines are the intensity-duration-frequency curves from Figure 3.1 adjusted for an 0.6 inch per hour infiltration rate. Figure 3.24 indicates that the collection time on the sodded area under the assumed conditions would be about 50 minutes for a 10-year storm and 25 minutes for a 25-year storm. For storms of less than a 10-year recurrence interval the collection time is so long that the runoff from the lot will not affect the peak flow in a drain designed for 1 or 2-year storms.

The following quotation from a recent paper [(1)] on storm drainage tends to confirm the minor nature of pervious area runoff in urban areas:

> "One of the startling features of the RRL (Road Research Laboratory) method is that it derives an understanding of urban runoff by utilizing only the impervious areas of a watershed directly connected to the storm drainage system. It excludes consideration of all other watershed areas that may have covers of grass, trees, or impervious areas not connected directly to the storm drainage system. Although this may seem unusual, students of the urban runoff process have long known of the dominant importance of the paved areas. Some other effective analytical methods, such as that developed in Chicago, also suggest the dominance of the paved areas."

This does not mean that pervious areas are completely disregarded in this study. The computations of Section 5 will show where they are taken into account. This will generally be in large lot desert or park-like areas and where ground slopes are relatively steep.

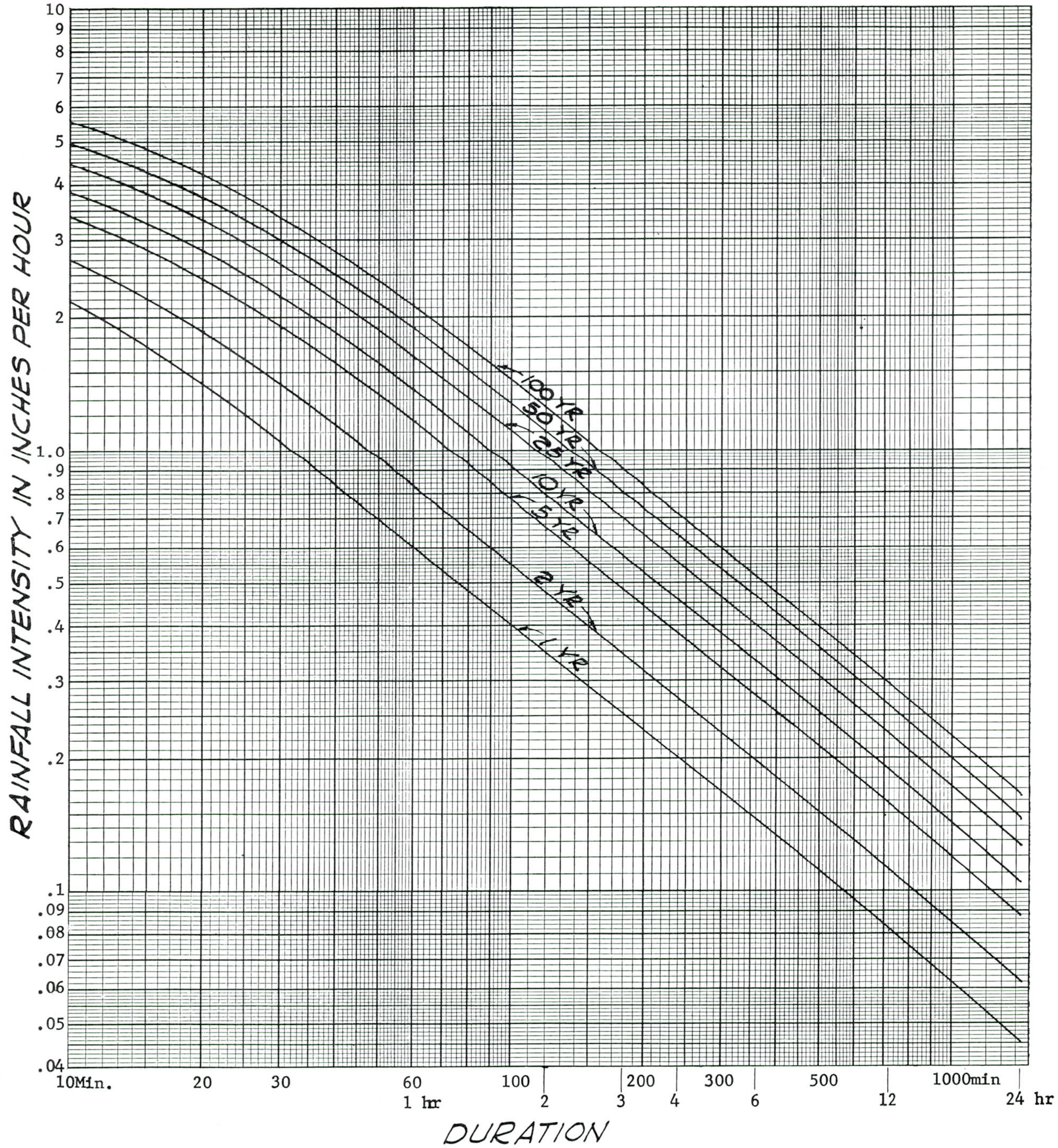
(1) Michael L. Terstriep and John B. Stall, Urban Runoff by Road Research Laboratory Method, Journal of the Hydraulics Division, ASCE, Vol. 95, No. HY6, Nov. 1969, p. 1811.

12. The above procedure is carried out down the length of the trunk to the point of final discharge. In the process of doing this, it frequently happens that the computed total flow will reach a maximum and then fall off as the computation proceeds down-stream. This is because the effect of the longer concentration time and concomitant lower rainfall intensity overshadows the effect of increasing tributary area. Once a maximum has been reached, the design flow should nevertheless be increased slightly, 5 to 10 cfs per mile, proceeding downstream even though the calculations show a decrease.

13. Occasionally a portion of drainage area may produce a larger runoff than that which occurs when the entire area begins to contribute. This is most likely to happen in areas that are largely impervious, and may also occur when the collection time from upstream areas is about equal to the concentration time of the latest increment of drainage area. The computations made for this study frequently show a check for this condition. If the shorter concentration time for a partial area yields a higher flow than the cumulative total area, the shorter time and the smaller area are carried forward in the computations.

Runoff calculations made according to this procedure are facilitated by a tabular format such as is used in Section 5 of this report.

After the flows for each trunk are computed they should be evaluated from the standpoint of the size of conduit necessary to accomodate them. A decision must be reached on the best method to handle the flows: by street drainage, pipes, ditches, or other conduits. Note that the choice affects collection time and consequently the rate of runoff. It may be necessary to make the computation more than once because of the changed assumptions. It may be desirable to revise the drainage pattern somewhat to divide the flows more equally between several trunks or it might be advisable to revise the spacing criterion mentioned in Step 1.

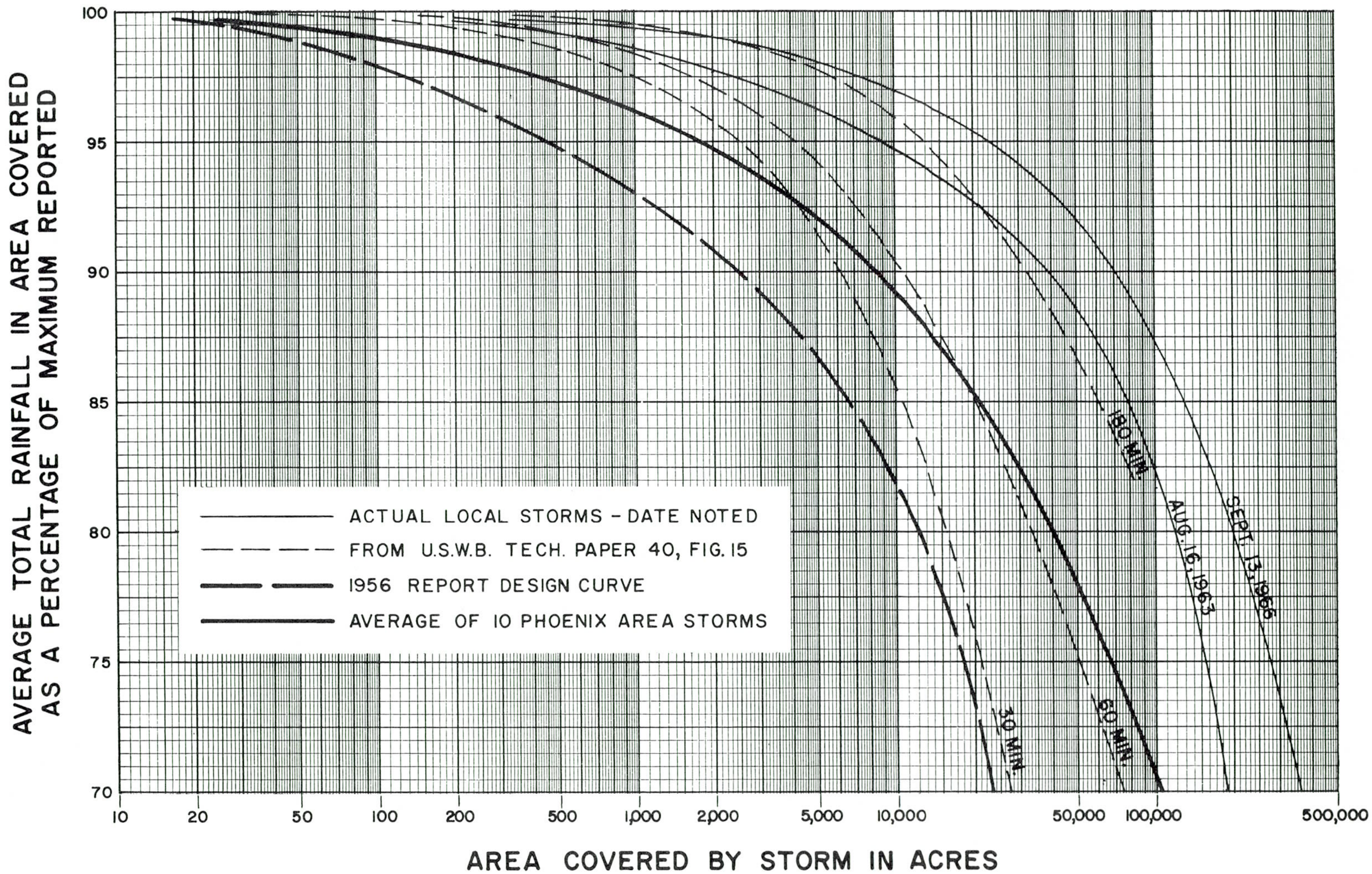



RAINFALL INTENSITY-DURATION-FREQUENCY RELATION
FOR PHOENIX, ARIZONA
(Partial Duration Series)

Curves are based on methods of U.S. Weather Bureau Technical Papers Nos. 28 and 40 and rainfall data prepared by U.S. Weather Bureau Office of Hydrology for the Soil Conservation Service, March 1967

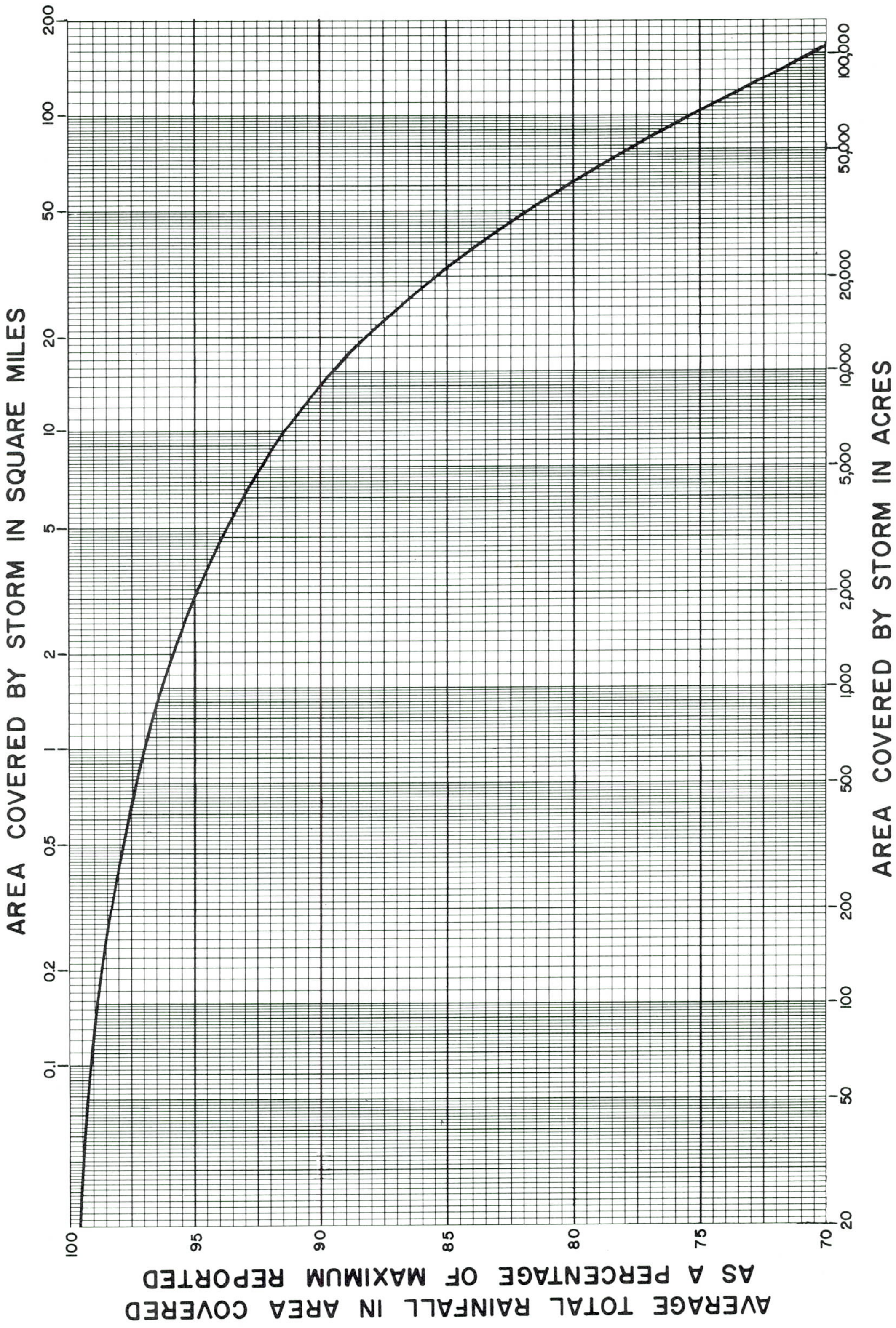
YOST AND GARDNER ENGINEERS
PHOENIX, ARIZONA

FIGURE 3.1




AREA-DEPTH CURVES

FIGURE 3.2




DESIGN AREA-DEPTH CURVE

FIGURE 3.3

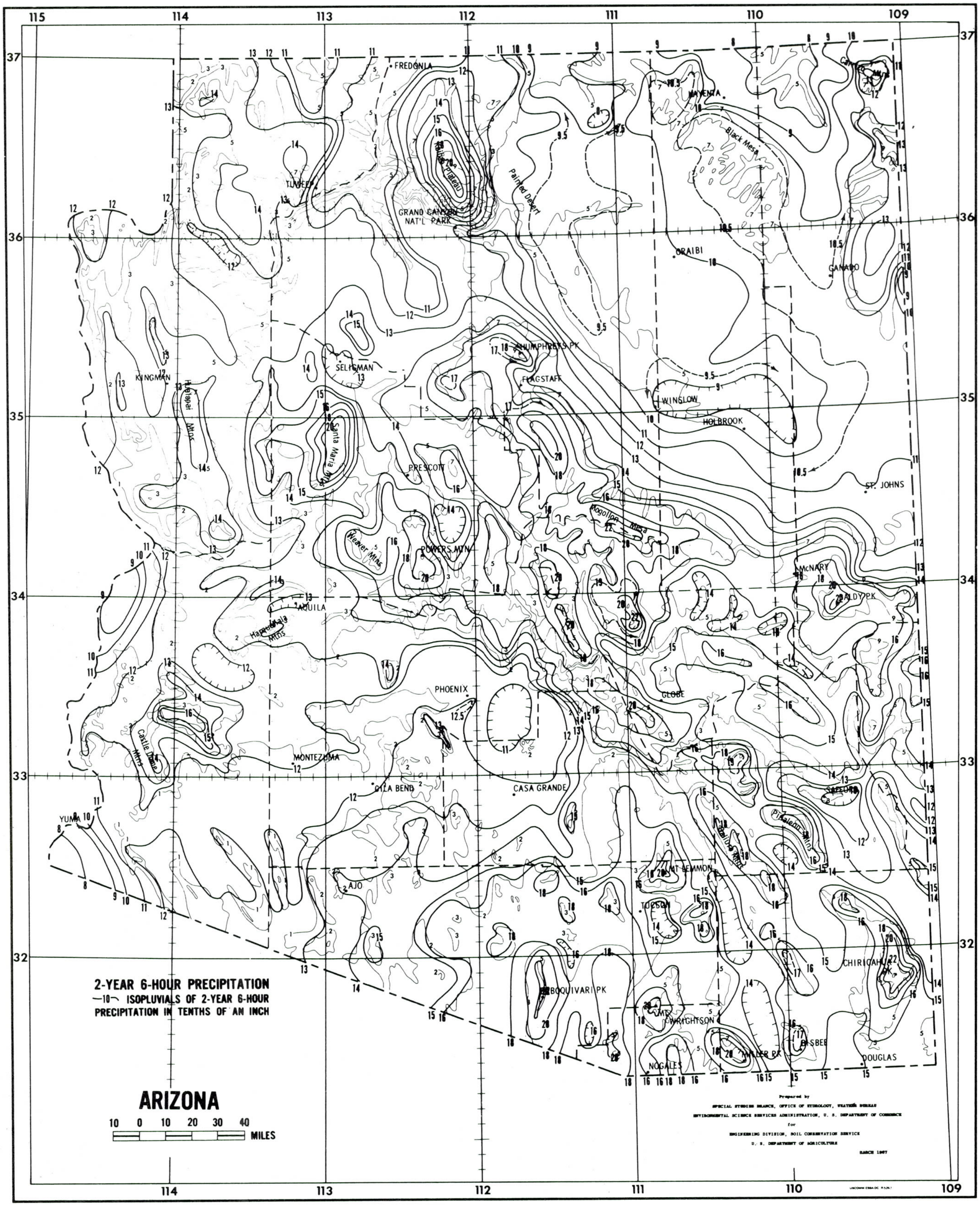

2-YEAR 6-HOUR PRECIPITATION
—10— ISOPLUVIALS OF 2-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH
ARIZONA
10 0 10 20 30 40 MILES
FREDONIA
GRAND CANYON NAT'L PARK
KINGMAN
SELIGMAN
FLAGSTAFF
HUMPHREYS PK
WINSLOW
HOLBROOK
PRESCOTT
ST. JOHNS
AGUILA
PHOENIX
GLOBE
MONTEZUMA
GILA BEND
CASA GRANDE
SAFFORD
YUMA
AJO
TUCSON
MT LEMMON
BABOQUIVARI PK
NOGALES
BISBEE
DOUGLAS
CHIRICAHUA PK
ORAIBI
GANADO
KAYENTA
McNARY
BALDY PK
POWERS MTN
TUWEEP
Prepared by
SPECIAL STUDIES BRANCH, OFFICE OF HYDROLOGY, WEATHER BUREAU
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, U. S. DEPARTMENT OF COMMERCE
for
ENGINEERING DIVISION, SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
MARCH 1967

FIGURE 3.4

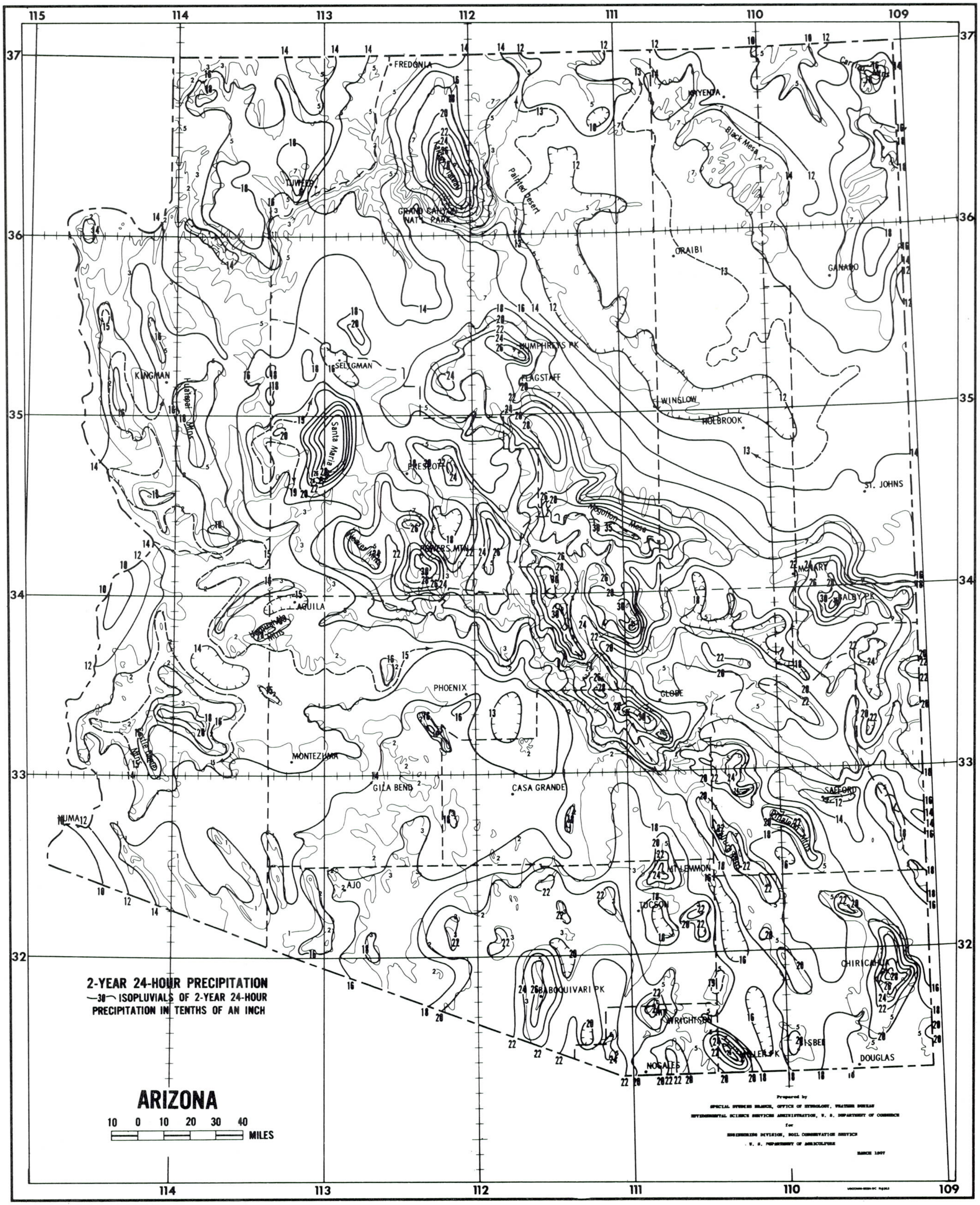

2-YEAR 24-HOUR PRECIPITATION
—30— ISOPLUVIALS OF 2-YEAR 24-HOUR PRECIPITATION IN TENTHS OF AN INCH
ARIZONA
10 0 10 20 30 40
MILES
115
114
113
112
111
110
109
37
36
35
34
33
32
FREDONIA
KAYENTA
Black Mesa
TUWEEP
GRAND CANYON NAT'L PARK
Painted Desert
ORAIBI
GANADO
HUMPHREYS PK
SELIGMAN
KINGMAN
FLAGSTAFF
WINSLOW
HOLBROOK
Santa Maria
PRESCOTT
ST. JOHNS
Mogollon Mesa
TOWERS MTN
MCNARY
BALDY PK
AQUILA
PHOENIX
GLOBE
MONTEZUMA
GILA BEND
CASA GRANDE
SAFFORD
YUMA
AJO
MT LEMMON
TUCSON
CHIRICAHUA
BABOQUIVARI PK
WRIGHTSON
NOGALES
BISBEE
DOUGLAS
Prepared by

FIGURE 3.5

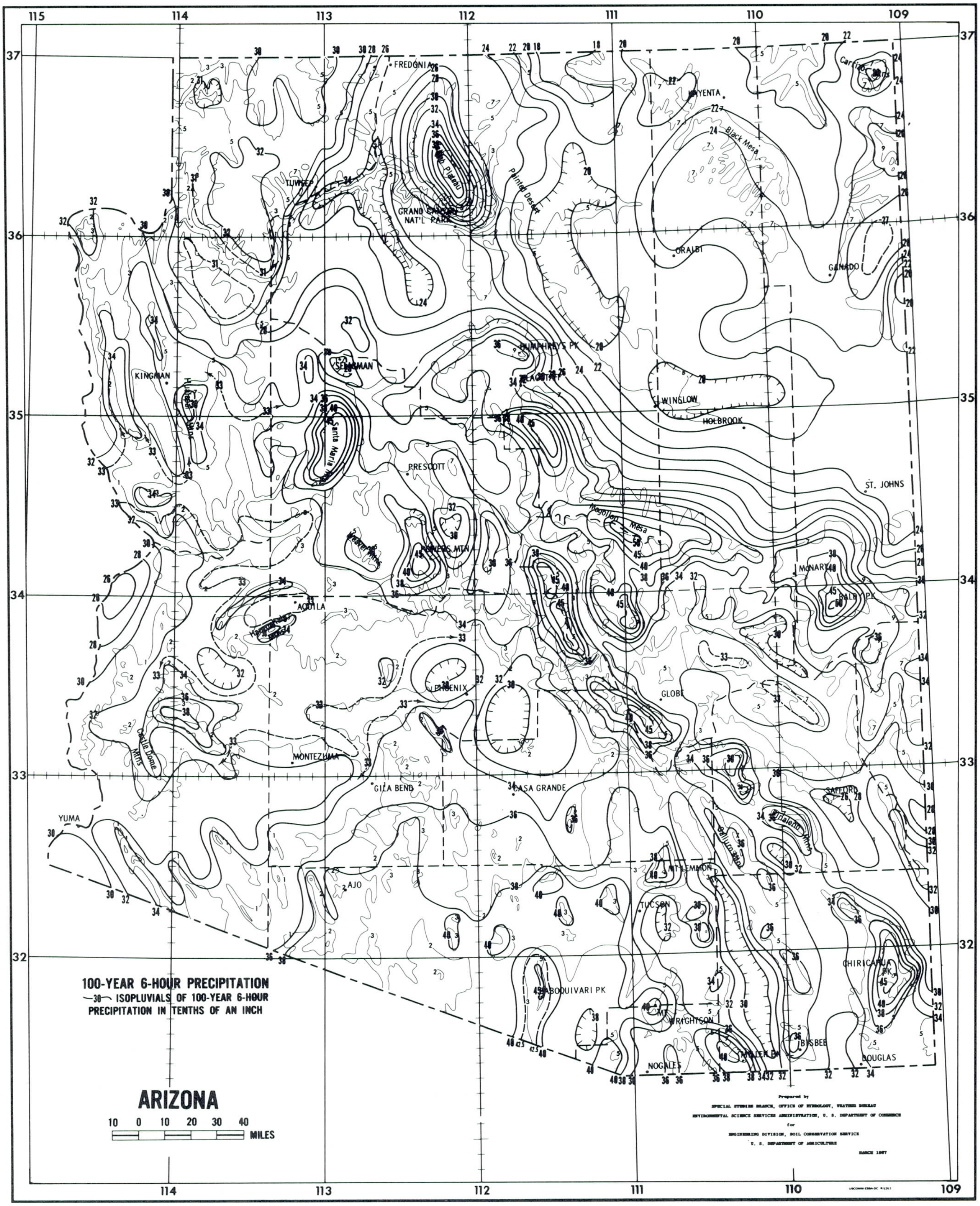
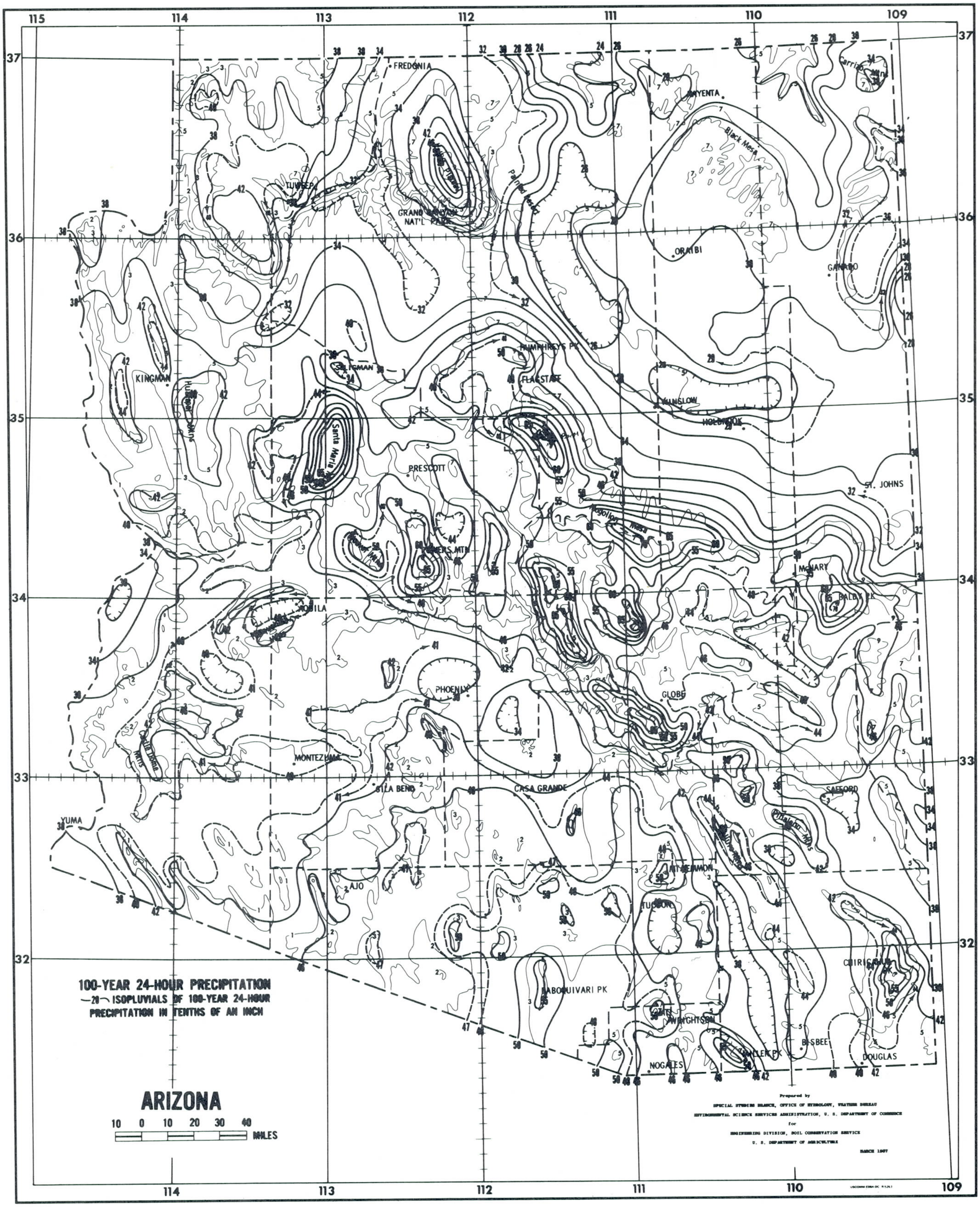

100-YEAR 6-HOUR PRECIPITATION
—30— ISOPLUVIALS OF 100-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH
ARIZONA
10 0 10 20 30 40 MILES
FREDONIA
KAYENTA
Black Mesa
TUWEEP
GRAND CANYON NAT'L PARK
Painted Desert
ORAIBI
GANADO
KINGMAN
SELIGMAN
HUMPHREYS PK
FLAGSTAFF
WINSLOW
HOLBROOK
Santa Maria Mts
PRESCOTT
ST. JOHNS
Mogollon Mesa
PINES MTN
McNARY
BALDY PK
AGUILA
PHOENIX
GLOBE
MONTEZUMA
GILA BEND
CASA GRANDE
SAFFORD
YUMA
AJO
MT LEMMON
TUCSON
BABOQUIVARI PK
MT WRIGHTSON
NOGALES
BISBEE
DOUGLAS
CHIRICAHUA PK
Pinaleno Mts
115
114
113
112
111
110
109
37
36
35
34
33
32

FIGURE 3.6


100-YEAR 24-HOUR PRECIPITATION
—20— ISOPLUVIALS OF 100-YEAR 24-HOUR PRECIPITATION IN TENTHS OF AN INCH
ARIZONA
10 0 10 20 30 40
MILES
FREDONIA
KAYENTA
Black Mesa
Carrizo Mtns
TUWEEP
GRAND CANYON NAT'L PARK
ORAIBI
GANADO
KINGMAN
Hualpai Mtns
SELIGMAN
HUMPHREYS PK
FLAGSTAFF
WINSLOW
HOLBROOK
Santa Maria
PRESCOTT
ST. JOHNS
Mogollon Mesa
TOWERS MTN
McNARY
BALDY PK
YOLLA
PHOENIX
GLOBE
MONTEZUMA
GILA BEND
CASA GRANDE
SAFFORD
YUMA
Castle Dome Mtns
AJO
Pinaleno Mtns
Santa Catalina Mtns
MT LEMMON
TUCSON
CHIRICAHUA PK
BABOQUIVARI PK
WRIGHTSON
MILLER PK
BISBEE
NOGALES
DOUGLAS
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ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, U. S. DEPARTMENT OF COMMERCE
for
ENGINEERING DIVISION, SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
MARCH 1967

FIGURE 3.7

# STORM OF AUGUST 3, 1943

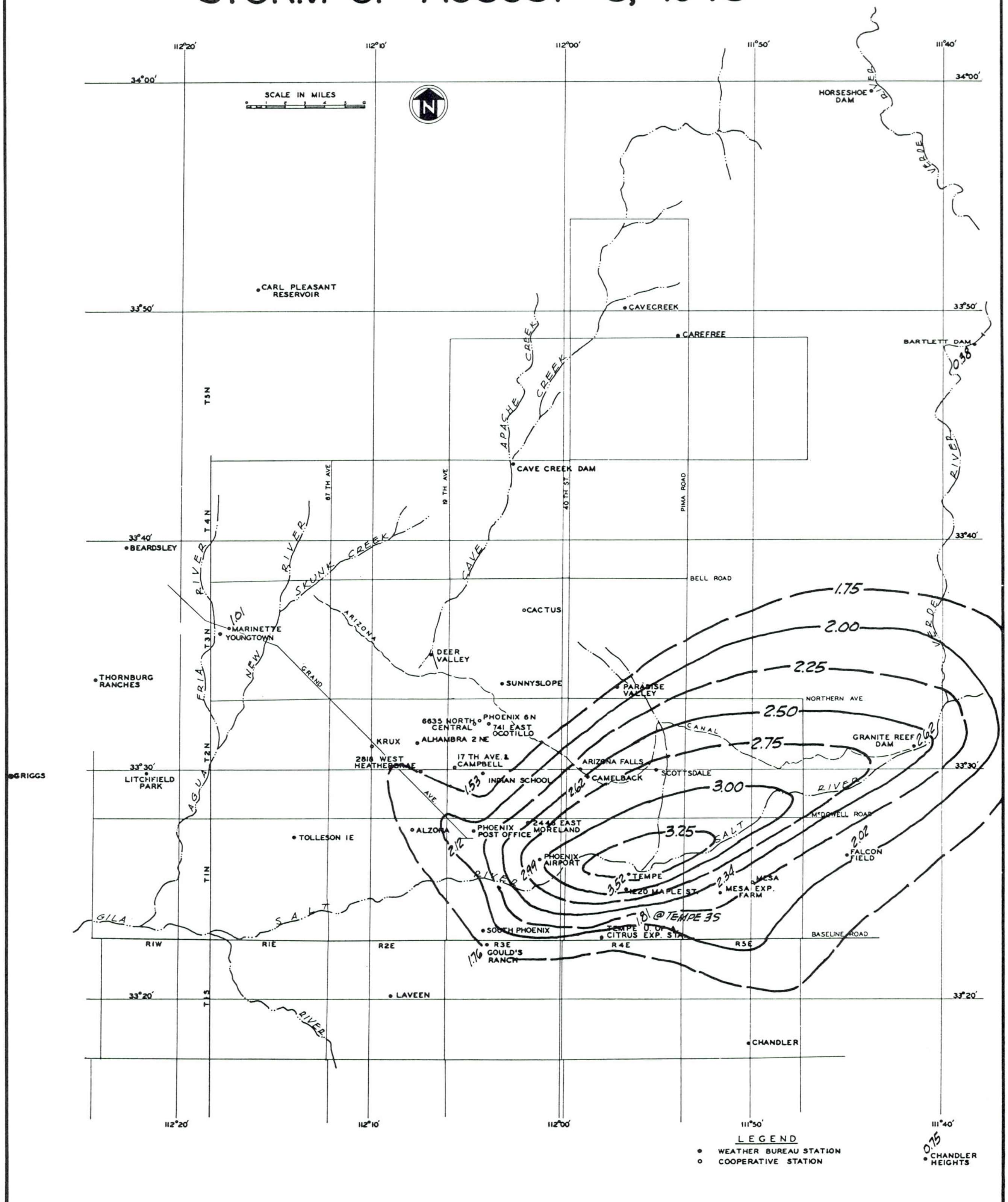



FIGURE 3.8

# STORM OF SEPTEMBER 12, 1958

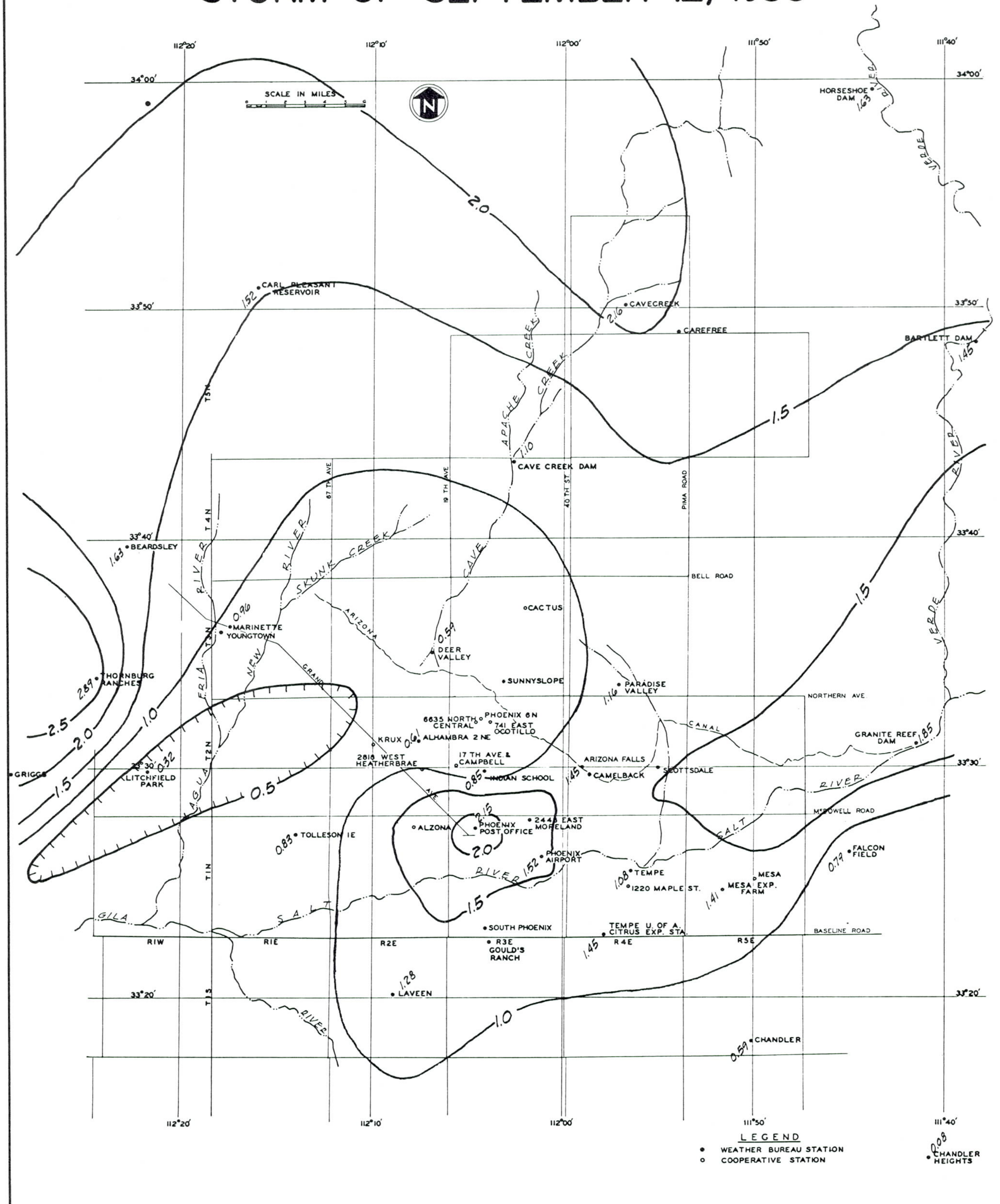



FIGURE 3.9

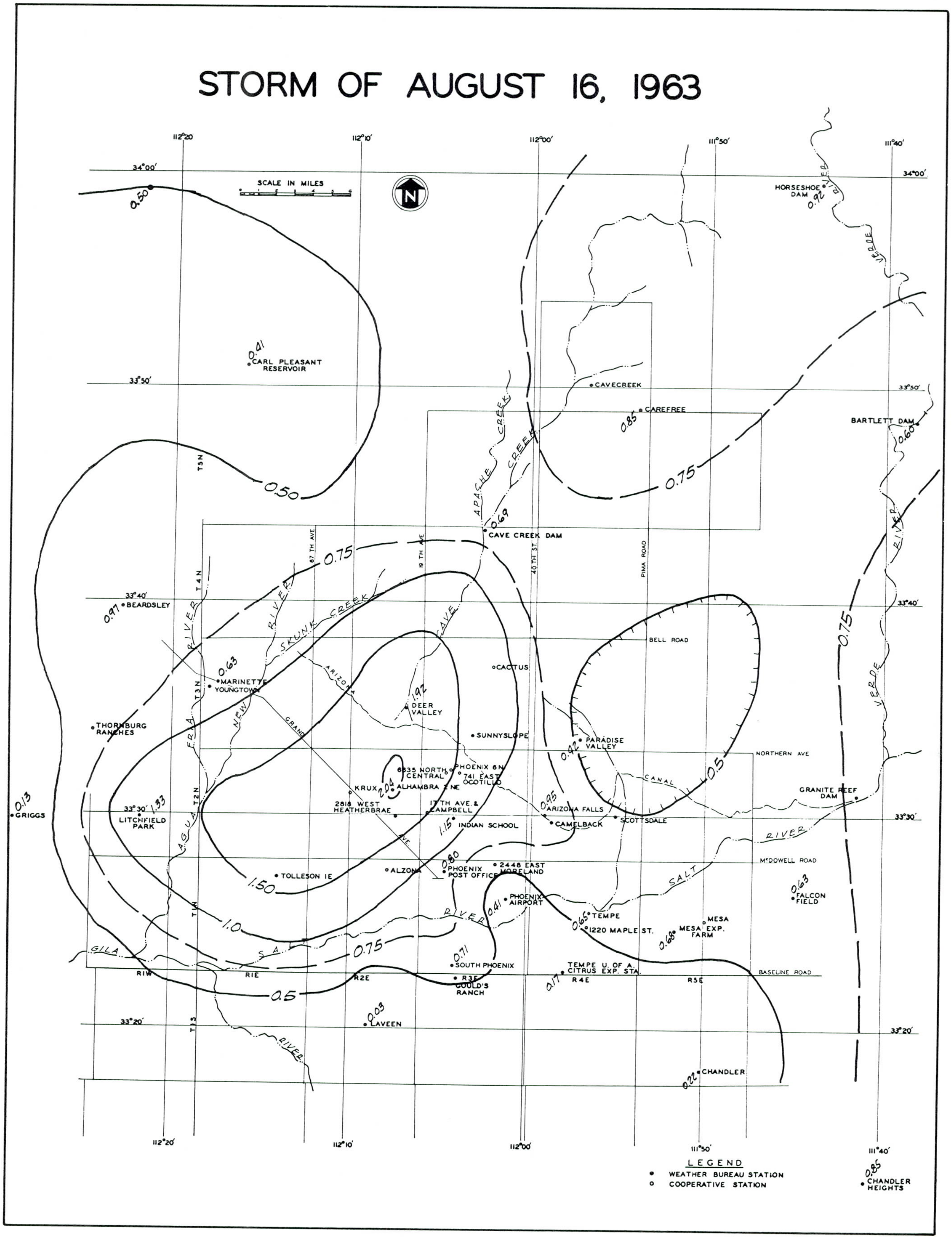

STORM OF AUGUST 16, 1963
SCALE IN MILES
CARL PLEASANT RESERVOIR
CAVECREEK
CAREFREE
BARTLETT DAM
HORSESHOE DAM
CAVE CREEK DAM
BEARDSLEY
MARINETTE
YOUNGTOWN
CACTUS
BELL ROAD
DEER VALLEY
THORNBURG RANCHES
SUNNYSLOPE
PARADISE VALLEY
NORTHERN AVE
6835 NORTH CENTRAL
PHOENIX 6N
741 EAST OCOTILLO
ALHAMBRA 2 NE
KRUX
2818 WEST HEATHERBRAE
17TH AVE & CAMPBELL
INDIAN SCHOOL
ARIZONA FALLS
CAMELBACK
SCOTTSDALE
GRANITE REEF DAM
GRIGGS
LITCHFIELD PARK
TOLLESON 1E
ALZONA
PHOENIX POST OFFICE
2448 EAST MORELAND
PHOENIX AIRPORT
TEMPE
1220 MAPLE ST.
MESA
MESA EXP. FARM
FALCON FIELD
McDOWELL ROAD
SOUTH PHOENIX
R3E GOULD'S RANCH
TEMPE U. OF A. CITRUS EXP. STA.
BASELINE ROAD
LAVEEN
CHANDLER
CHANDLER HEIGHTS
LEGEND
WEATHER BUREAU STATION
COOPERATIVE STATION


FIGURE 3.10

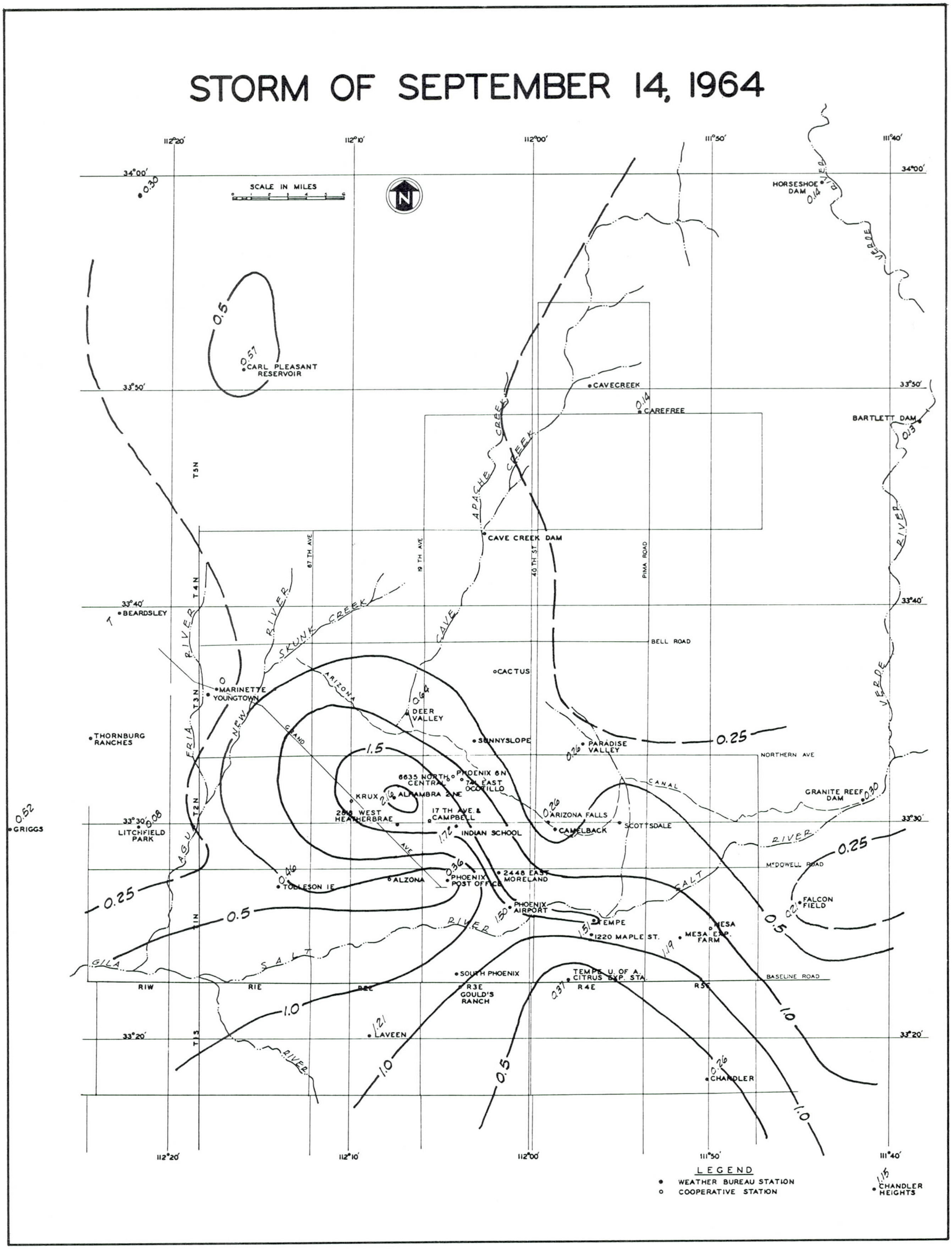

STORM OF SEPTEMBER 14, 1964
SCALE IN MILES
CARL PLEASANT RESERVOIR
CAVECREEK
CAREFREE
HORSESHOE DAM
BARTLETT DAM
CAVE CREEK DAM
BEARDSLEY
BELL ROAD
CACTUS
MARINETTE
YOUNGTOWN
DEER VALLEY
THORNBURG RANCHES
SUNNYSLOPE
PARADISE VALLEY
NORTHERN AVE
GRANITE REEF DAM
GRIGGS
LITCHFIELD PARK
ARIZONA FALLS
CAMELBACK
SCOTTSDALE
INDIAN SCHOOL
McDOWELL ROAD
TOLLESON 1E
ALZONA
PHOENIX POST OFFICE
2448 EAST MORELAND
FALCON FIELD
PHOENIX AIRPORT
TEMPE
1220 MAPLE ST.
MESA
MESA EXP. FARM
SOUTH PHOENIX
TEMPE U. OF A. CITRUS EXP. STA.
BASELINE ROAD
GOULD'S RANCH
LAVEEN
CHANDLER
CHANDLER HEIGHTS
LEGEND
WEATHER BUREAU STATION
COOPERATIVE STATION

FIGURE 3.11

# STORM OF SEPTEMBER 13, 1966

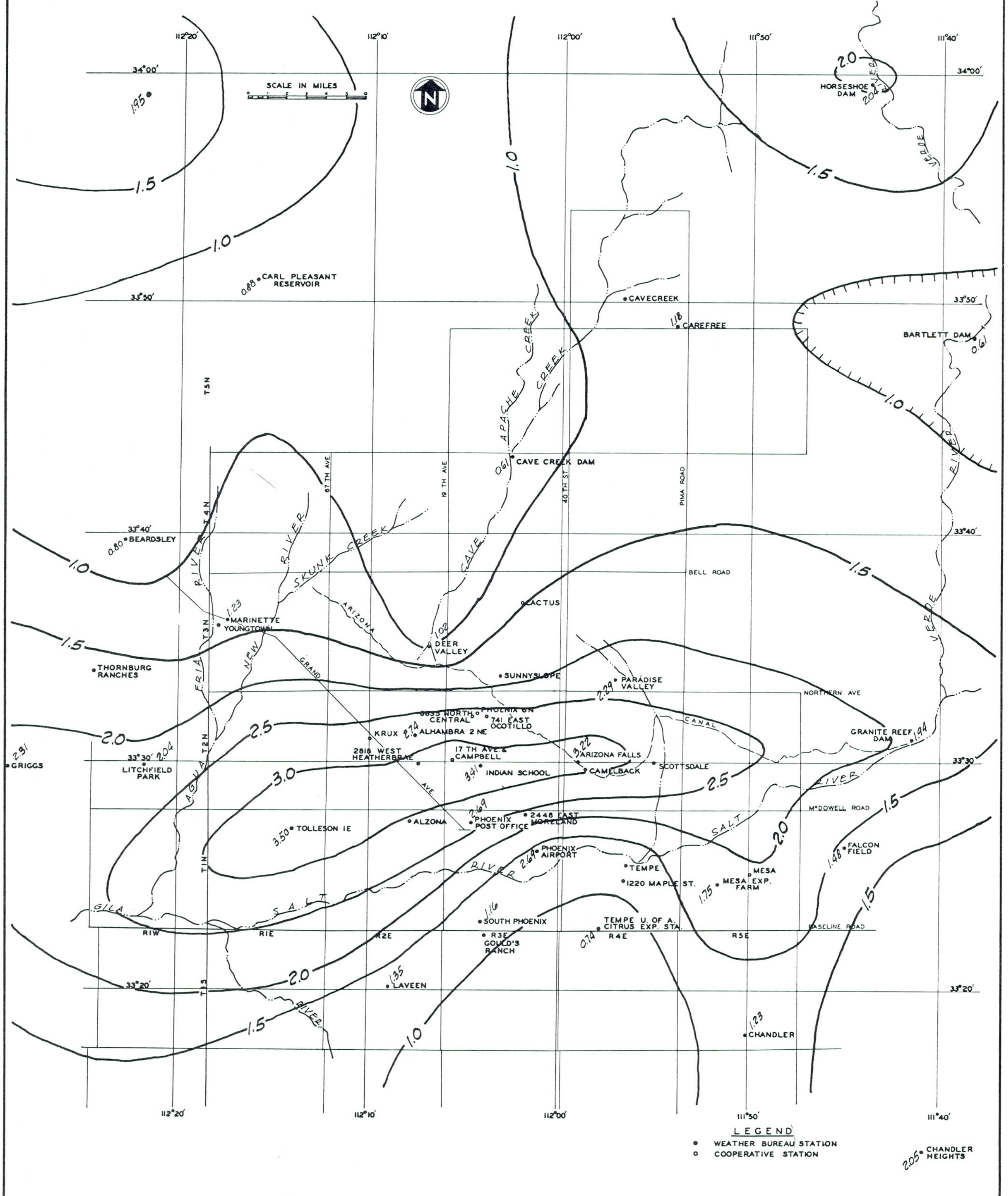



FIGURE 3.12

# STORM OF DECEMBER 19, 1967

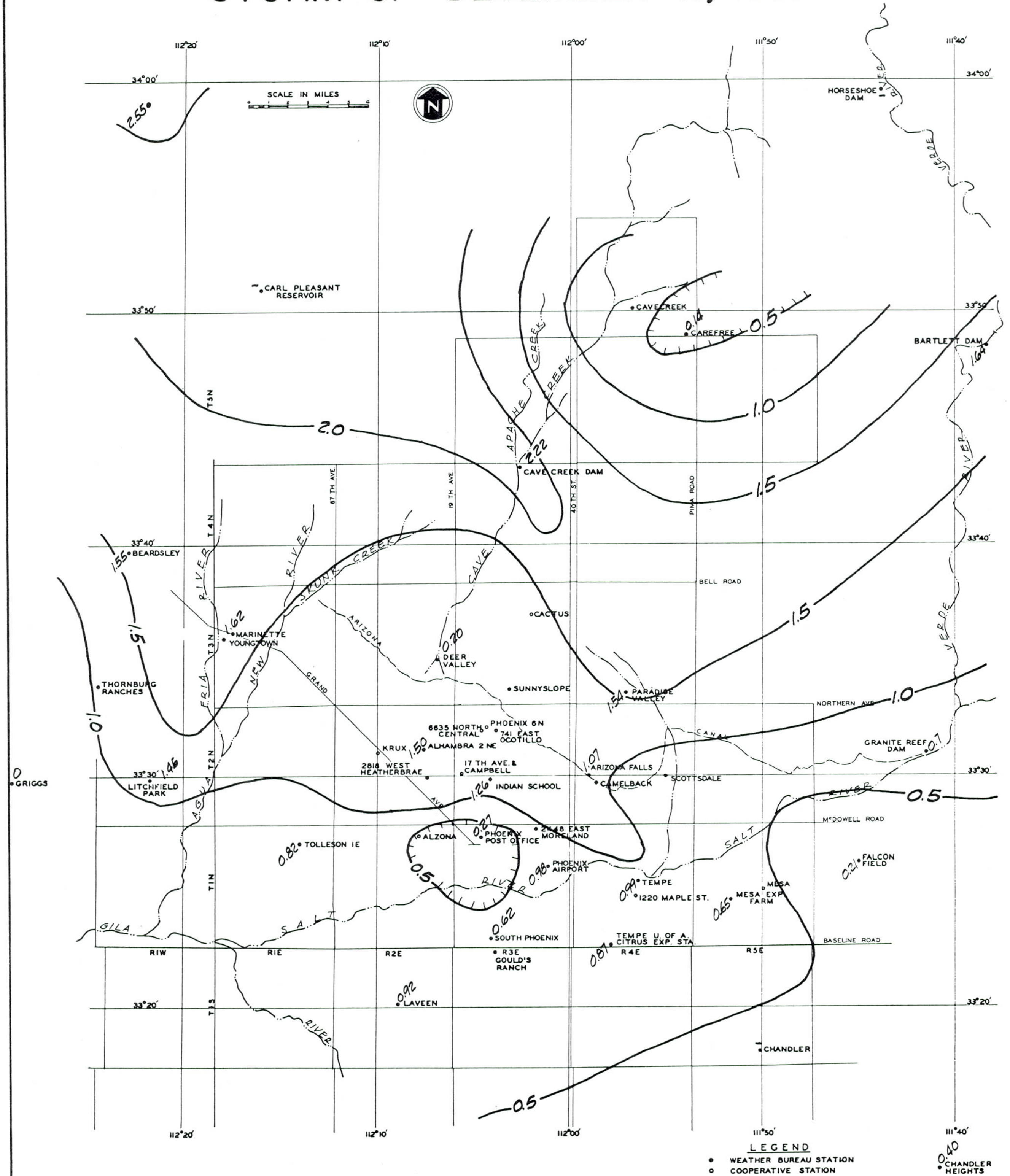



FIGURE 3.13

# STORM OF SEPTEMBER 14, 1969

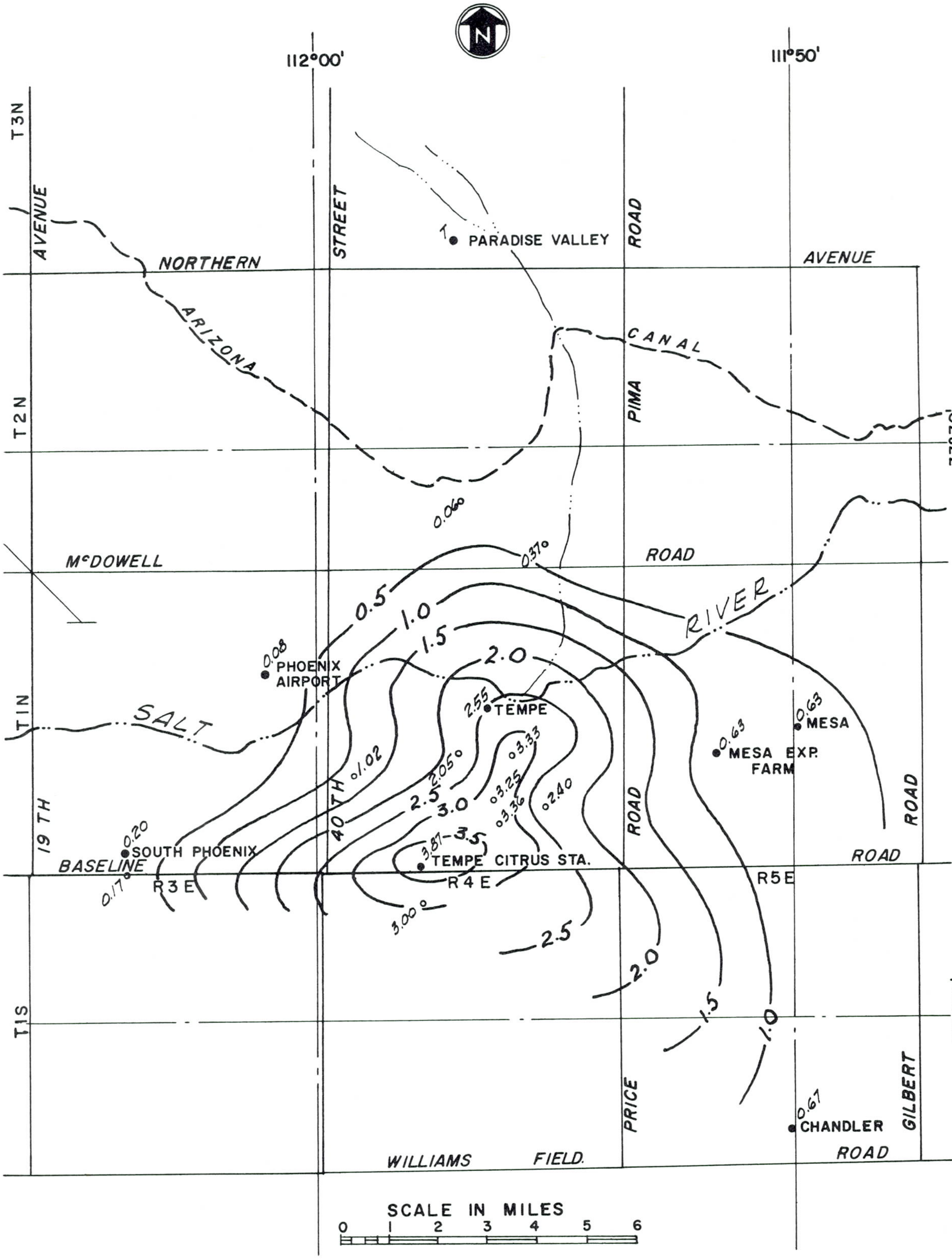
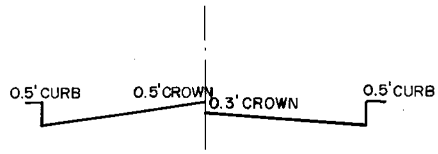
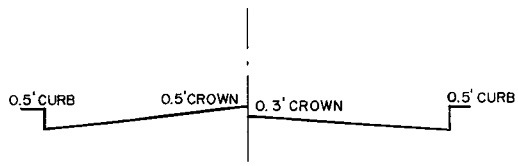



FIGURE 3.14



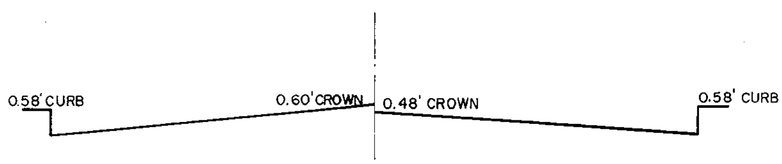

| | 0.5' CROWN | 0.3' CROWN |
|---|---|---|
| AREA TO TOP OF CURB | 8.0 SQ. FT. | 11.2 SQ. FT. |
| WETTED PERIMETER | 33.0 FT. | 33.0 FT. |
| HYDRAULIC RADIUS | 0.242 FT. | 0.342 FT. |

32 FT. STREET



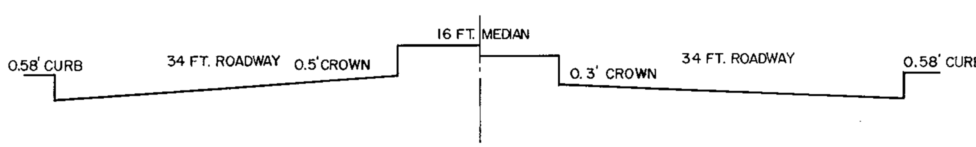

| | 0.5' CROWN | 0.3' CROWN |
|---|---|---|
| AREA TO TOP OF CURB | 10.0 SQ. FT. | 14.0 SQ. FT. |
| WETTED PERIMETER | 41.0 FT. | 41.0 FT. |
| HYDRAULIC RADIUS | 0.244 FT. | 0.342 FT. |

40 FT. STREET




| | 0.60' CROWN | 0.48' CROWN |
|---|---|---|
| AREA TO TOP OF CURB | 17.92 SQ. FT. | 21.76 SQ. FT. |
| WETTED PERIMETER | 62.97 FT. | 65.16 FT. |
| HYDRAULIC RADIUS | 0.285 FT. | 0.334 FT. |

64 FT. STREET

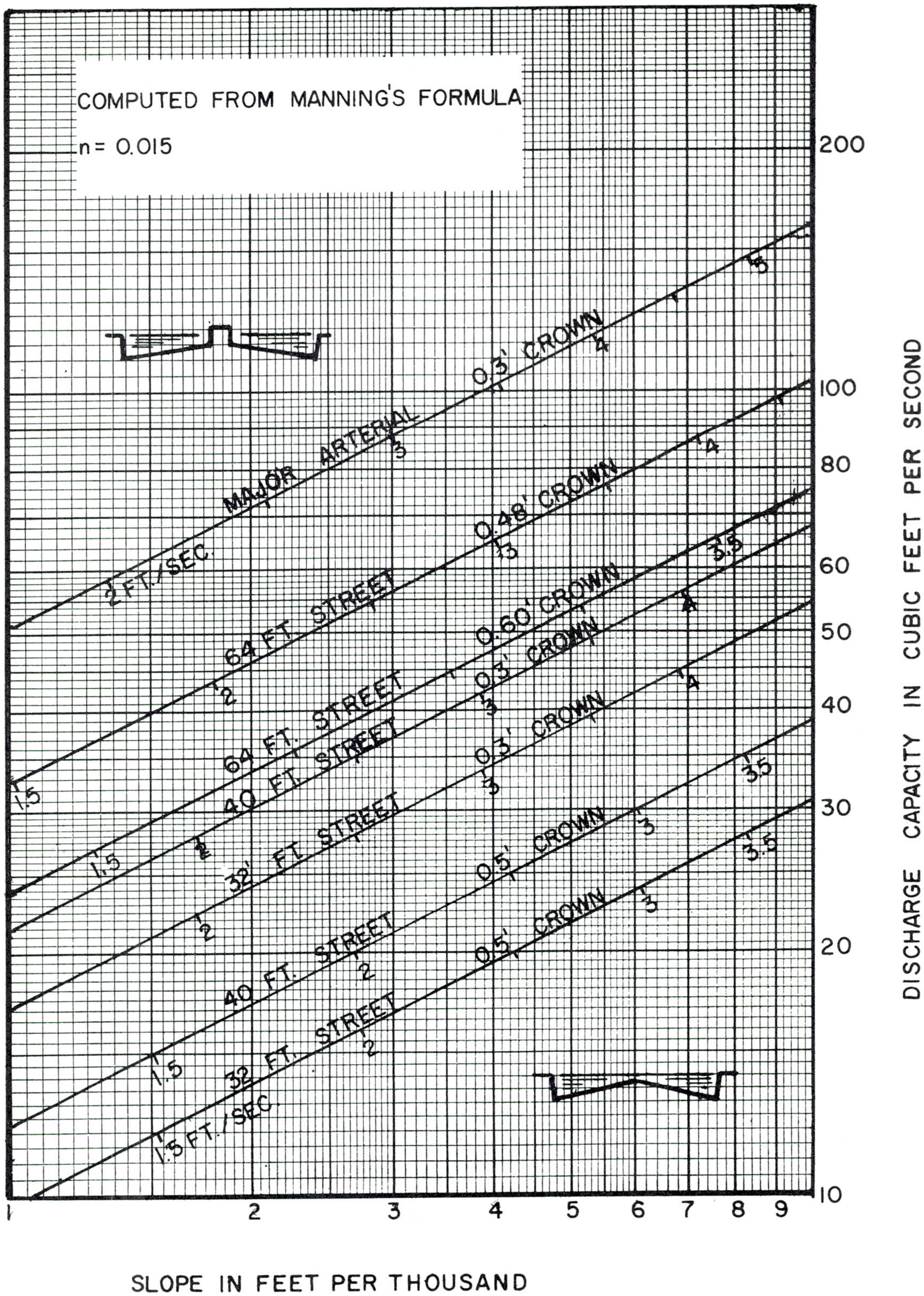



| | 0.5' CROWN | 0.3' CROWN |
|---|---|---|
| AREA TO TOP OF CURB | 22.44 SQ. FT. | 29.24 SQ. FT. |
| WETTED PERIMETER | 69.32 FT. | 69.72 FT. |
| HYDRAULIC RADIUS | 0.324 FT. | 0.419 FT. |

MAJOR ARTERIAL

## HYDRAULIC PROPERTIES OF TYPICAL STREET SECTIONS

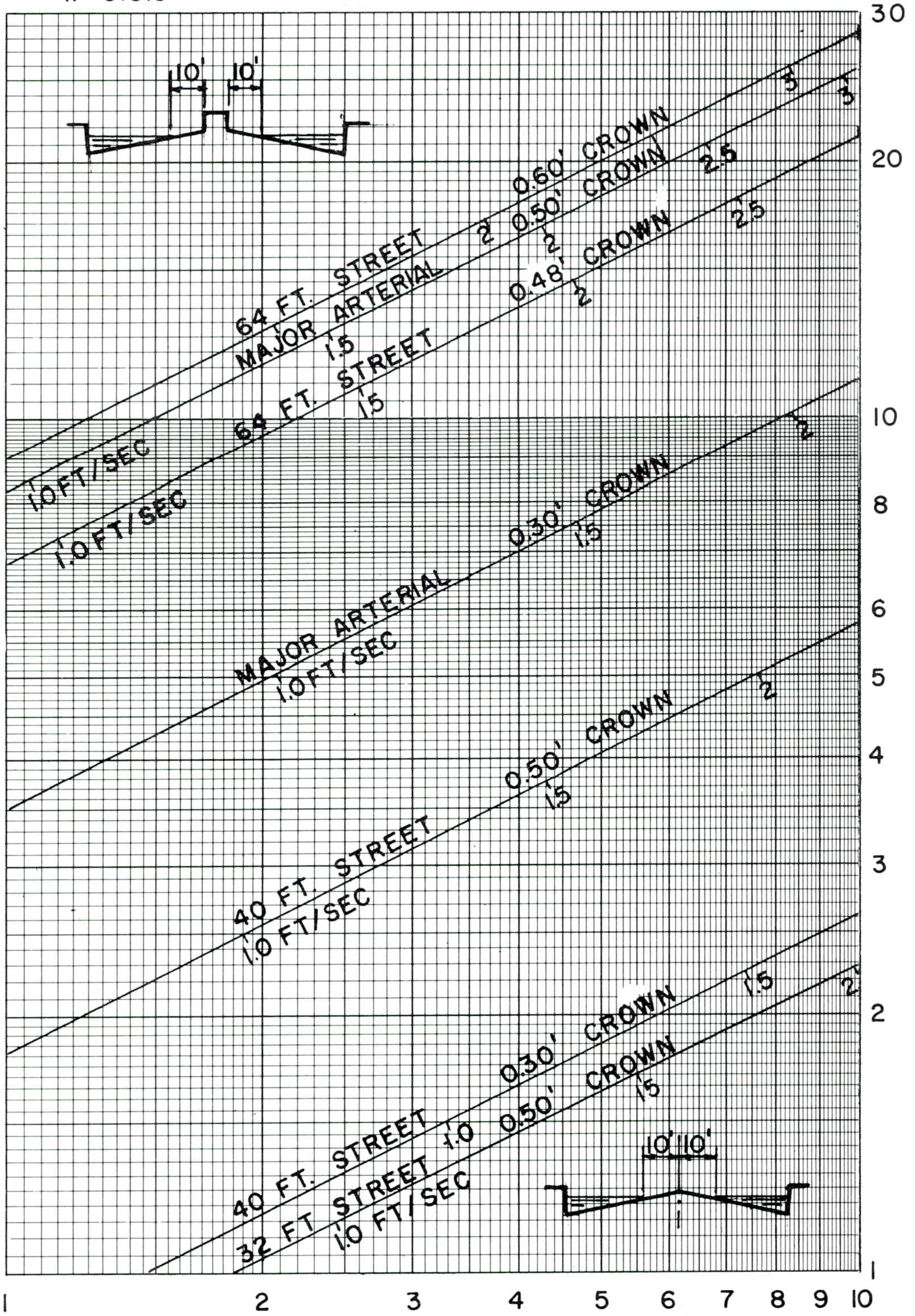
FIGURE 3.15




# TYPICAL STREET SECTION CAPACITIES FLOWING FULL TO TOP OF CURB

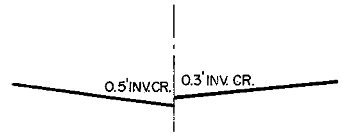
FIGURE 3.16

COMPUTED FROM MANNING'S FORMULA
n = 0.015



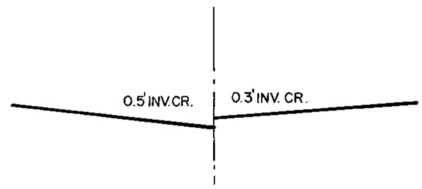

# TYPICAL STREET SECTION CAPACITIES FLOWING PARTIALLY FULL

FIGURE 3.17



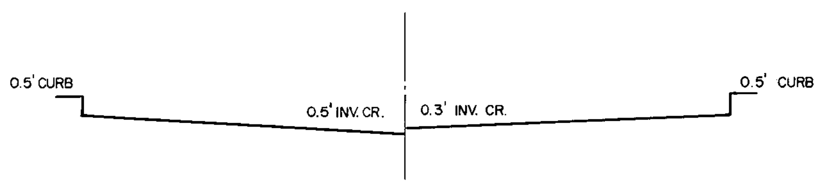

| | 0.5' INV. CROWN | 0.3' INV. CROWN |
|---|---|---|
| AREA TO TOP | 4.0 SQ. FT. | 2.4 SQ. FT. |
| WETTED PERIMETER | 16.0 FT. | 16.0 FT. |
| HYDRAULIC RADIUS | 0.250 FT. | 0.150 FT. |

16 FT. ALLEY



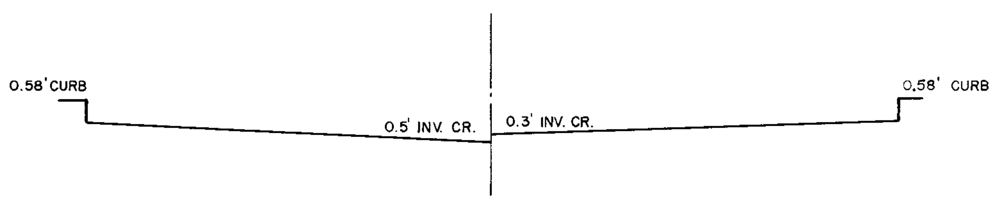

| | 0.5' INV. CROWN | 0.3' INV. CROWN |
|---|---|---|
| AREA TO TOP | 5.0 SQ. FT. | 3.0 SQ. FT. |
| WETTED PERIMETER | 20.0 FT. | 20.0 FT. |
| HYDRAULIC RADIUS | 0.250 FT. | 0.152 FT. |

20 FT. ALLEY




| | 0.5' INV. CROWN | 0.3' INV. CROWN |
|---|---|---|
| AREA TO TOP OF CURB | 24.0 SQ. FT. | 20.8 SQ. FT. |
| WETTED PERIMETER | 33.0 FT | 33.0 FT. |
| HYDRAULIC RADIUS | 0.727 FT. | 0.630 FT. |

32 FT. STREET



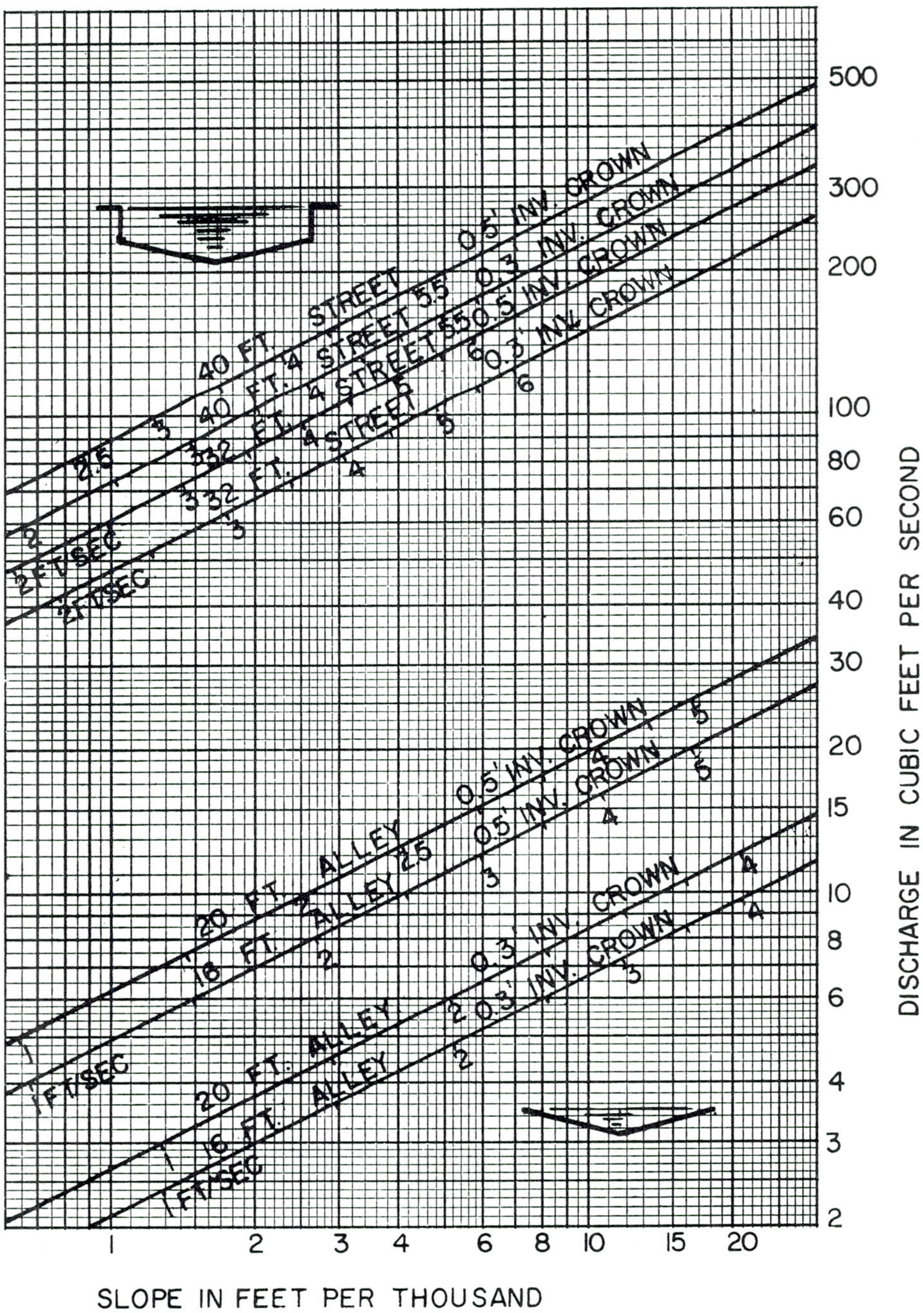

| | 0.5' INV. CROWN | 0.3' INV. CROWN |
|---|---|---|
| AREA TO TOP OF CURB | 33.2 SQ. FT. | 29.2 SQ. FT. |
| WETTED PERIMETER | 41.17 FT. | 41.16 FT. |
| HYDRAULIC RADIUS | 0.806 FT. | 0.709 FT. |

40 FT. STREET

HYDRAULIC PROPERTIES OF INVERTED CROWN SECTIONS

FIGURE 3.18

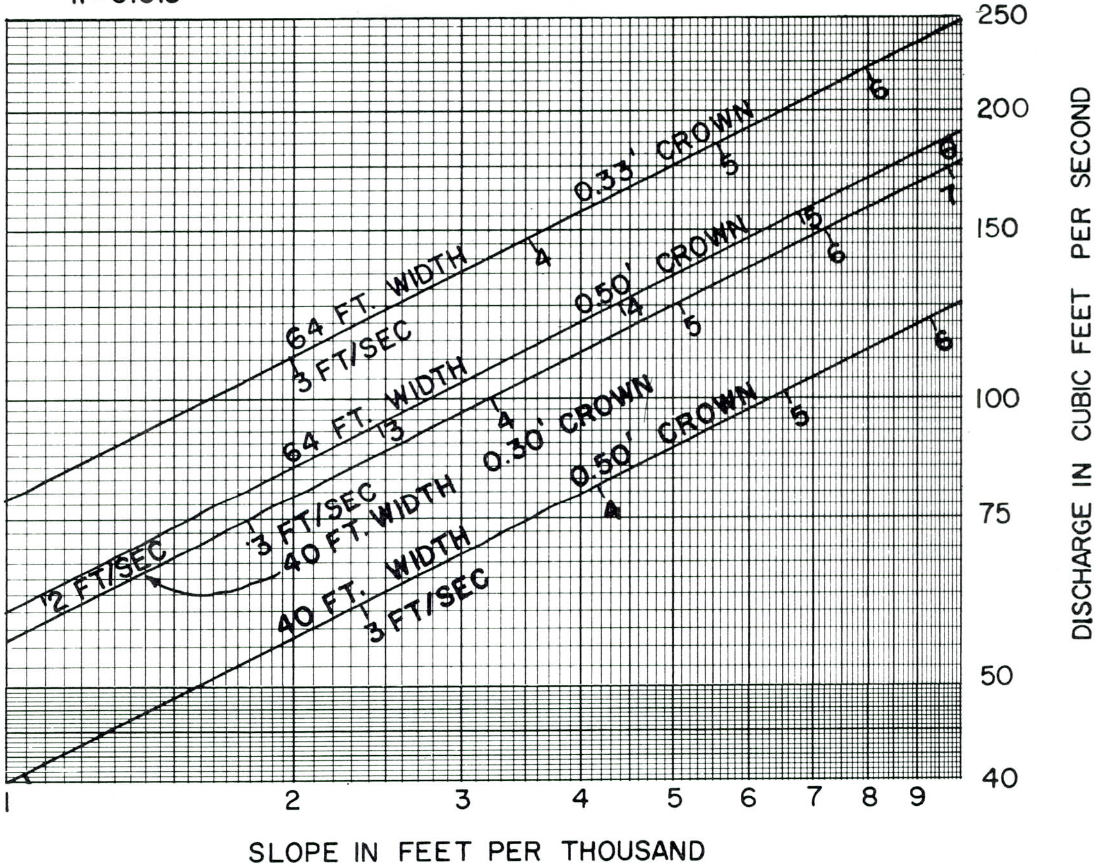
COMPUTED FROM MANNING'S FORMULA
n = 0.015

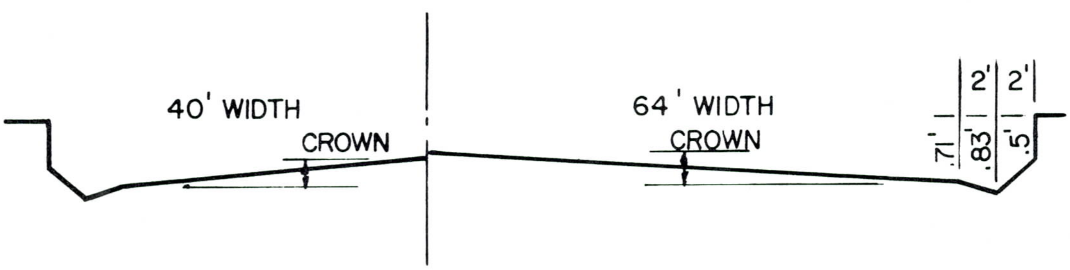



# INVERTED CROWN CAPACITIES FLOWING FULL

FIGURE 3.19

COMPUTED FROM MANNING'S FORMULA
n = 0.015

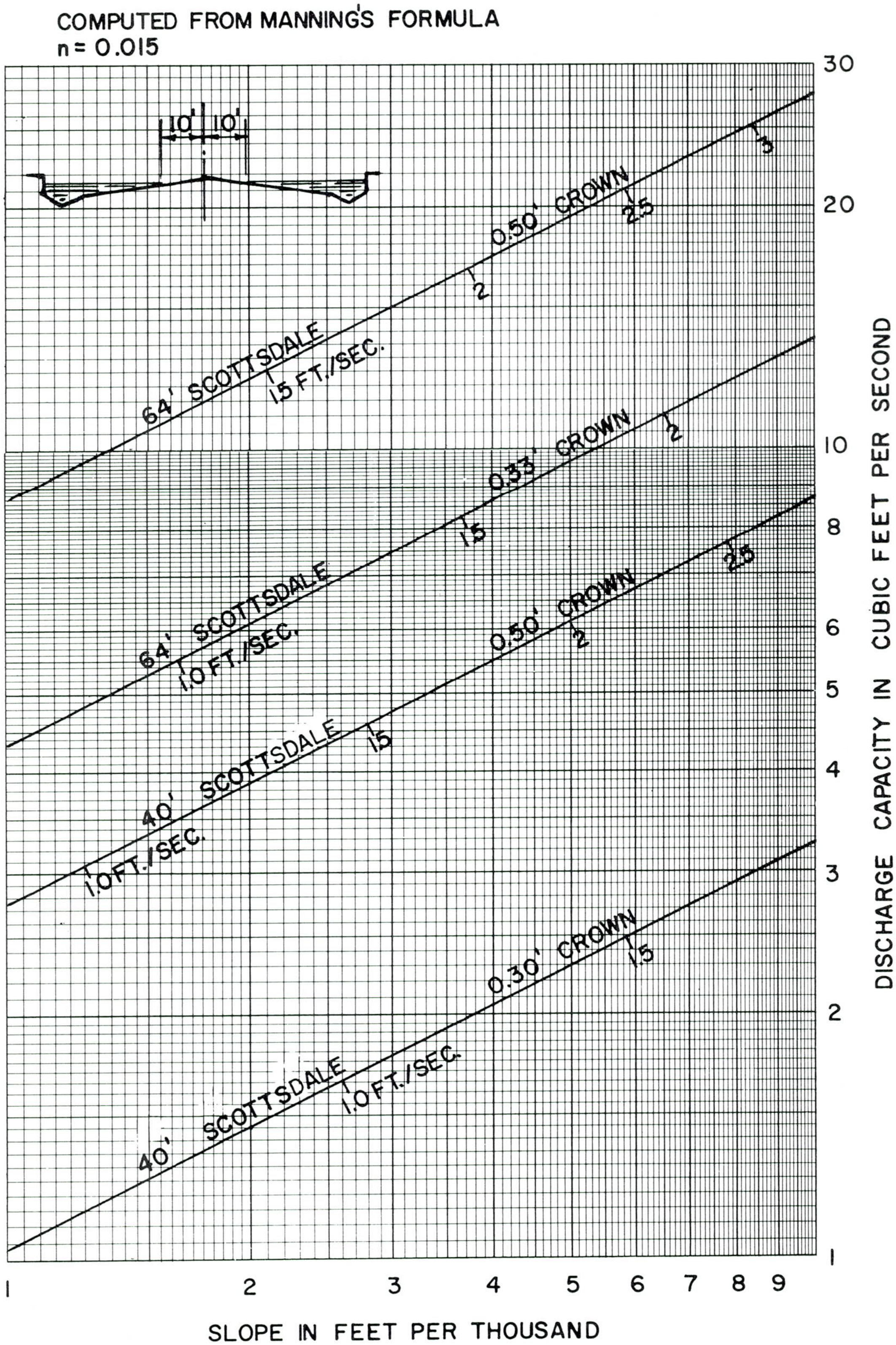



| | 40 FT. WIDTH | | 64 FT. WIDTH | |
|---|---|---|---|---|
| | 0.30' CROWN | 0.50' CROWN | 0.33' CROWN | 0.50' CROWN |
| AREA TO TOP OF CURB - SQ. FT. | 24.80 | 20.30 | 36.47 | 31.22 |
| WETTED PERIMETER - FT. | 40.90 | 40.90 | 64.90 | 64.90 |
| HYDRAULIC RADIUS - FT. | 0.606 | 0.496 | 0.562 | 0.481 |

# SPECIAL SCOTTSDALE SECTION CAPACITY FLOWING FULL TO TOP OF CURB

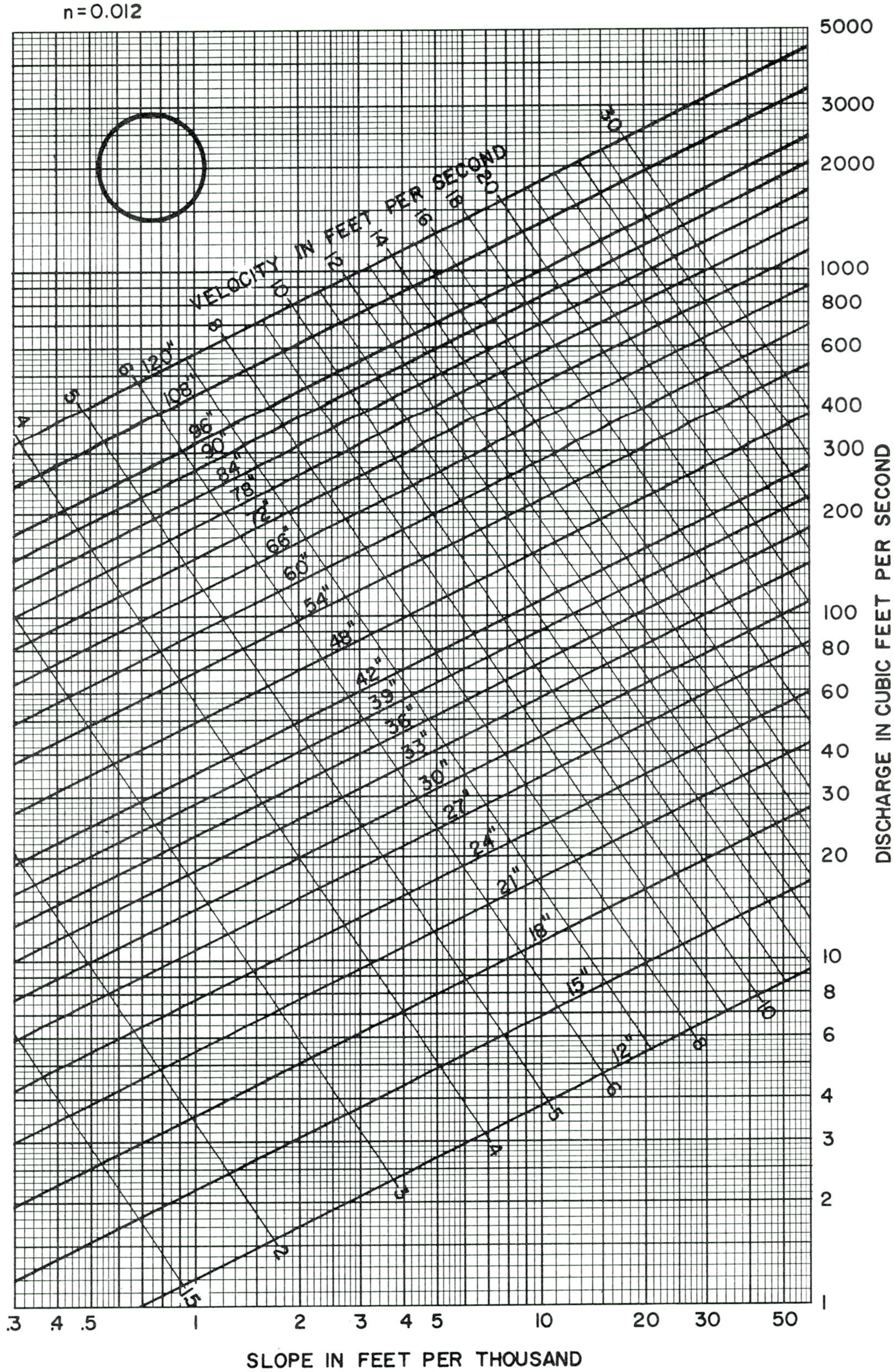
FIGURE 3.20




# SPECIAL SCOTTSDALE SECTION CAPACITY FLOWING PARTIALLY FULL

FIGURE 3.21

COMPUTED FROM MANNING'S FORMULA
n = 0.012

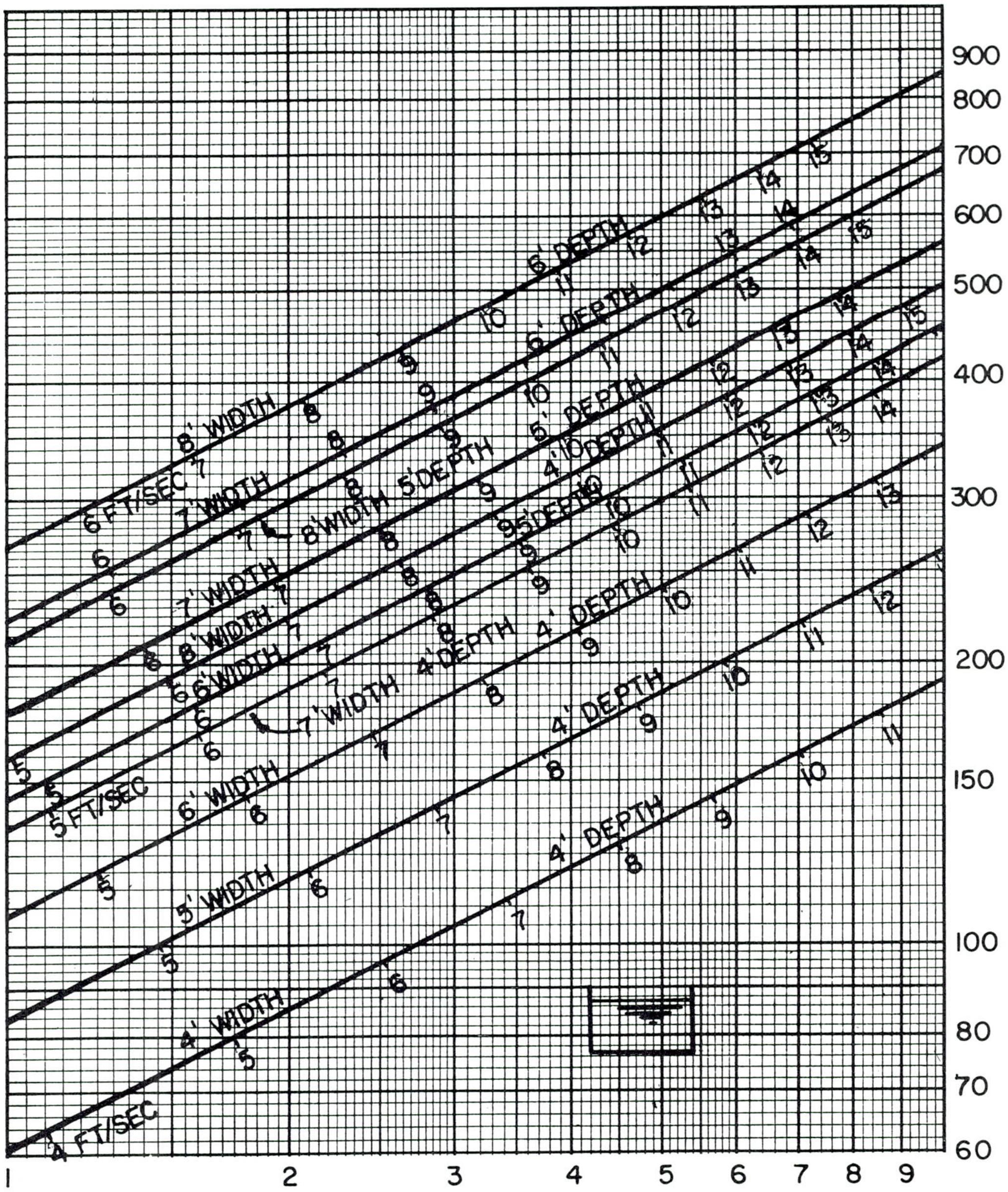



# PIPE CAPACITIES FLOWING FULL

FIGURE 3.22

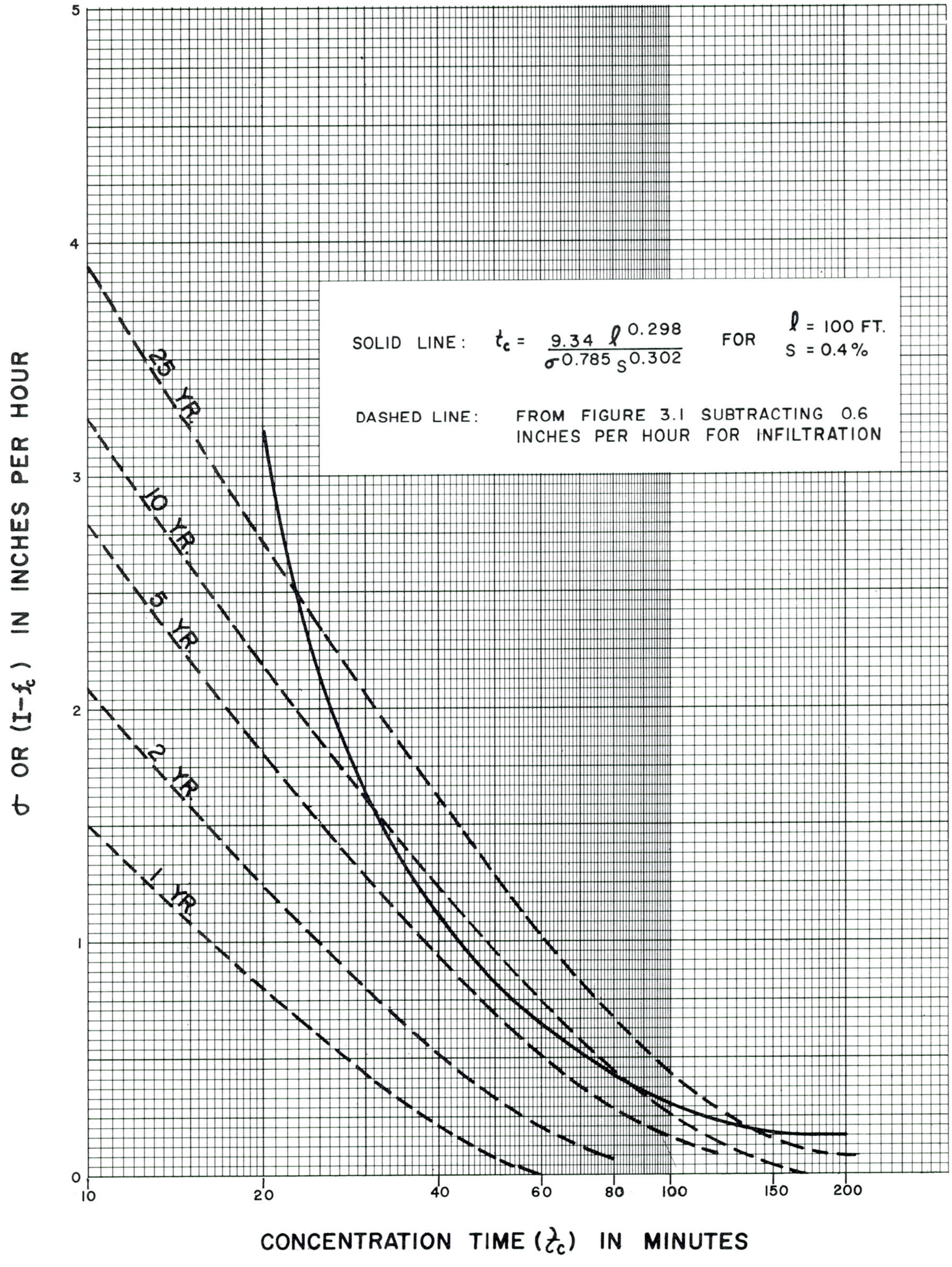
COMPUTED FROM MANNING'S FORMULA

n = 0.015



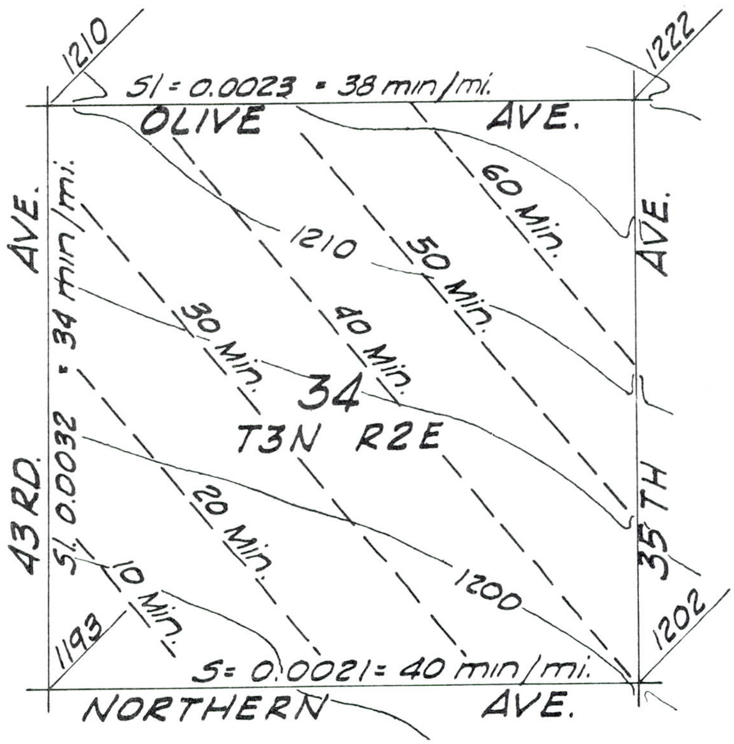

# RECTANGULAR CHANNEL CAPACITIES
# VARIOUS DEPTHS

FIGURE 3.23




# COLLECTION TIME ON SODDED RESIDENTIAL LOTS AS A FUNCTION OF RAINFALL EXCESS

FIGURE 3.24




Section 34, T3N, R2E

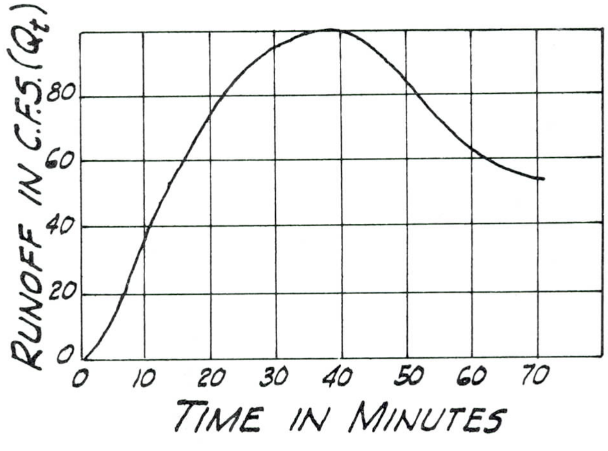
Assume 64' streets, 0.48' crown
(See Fig. 3.16)

Assume street flow to SW Cor of section

| | |
|---|---|
| Area of section | 640 Ac |
| Pervious | 366 Ac |
| Impervious | 198 Ac |
| Non-contributing | 76 Ac |

Infiltration rate 0.6 in/hr.

| Time Min. | Total Area Ac. | Perv. Area Ac. | Imp. Area Ac. | 1 Yr. Int. "/hr. | Area Red. Factor | Net Rain $I_a$ | $f_c$ in. | $(I_a - f_c)$ in. | $0.8\,(I_a - f_c)$ | $Q_p$ cfs | $0.9\,(I_a - 0.2)$ | $Q_i$ cfs | $Q_t$ cfs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 26 | 15 | 8 | 2.2 | 99.5 | 2.19 | 0.6 | 1.59 | 1.27 | 19 | 1.79 | 14 | 33 |
| 20 | 103 | 59 | 32 | 1.4 | 98.9 | 1.38 | ↓ | 0.78 | 0.62 | 37 | 1.06 | 34 | 71 |
| 30 | 213 | 122 | 66 | 1.05 | 98.2 | 1.03 | | 0.43 | 0.34 | 42 | 0.75 | 50 | 92 |
| 40 | 368 | 210 | 114 | 0.83 | 97.6 | 0.81 | | 0.21 | 0.17 | 36 | 0.55 | 63 | 99 |
| 50 | 502 | 287 | 156 | 0.70 | 97.3 | 0.68 | | 0.08 | 0.06 | 17 | 0.43 | 67 | 84 |
| 60 | 592 | 338 | 183 | 0.60 | 97.1 | 0.58 | | 0 | 0 | 0 | 0.34 | 62 | 62 |
| 70 | 634 | 362 | 196 | 0.53 | 97.0 | 0.51 | | 0 | 0 | 0 | 0.28 | 55 | 55 |




INVESTIGATION OF A TYPICAL SECTION FOR PEAK RUNOFF FROM PARTIAL AREA

FIGURE 3.25

## SECTION 4 - POLICY

Public recognition of the need for storm drains and the willingness of the people to spend large sums of money for this purpose is a relatively recent thing in the Salt River Valley. The general attitude has been that, since rainfall in amounts sufficient to cause trouble was very infrequent, it seemed more sensible to put up with an occasional inconvenience than to spend the considerable sums necessary for storm drains. Drainage was provided in the gutters of the street pavements and many of the downtown streets consequently were built with the high curbs (or deep gutters) necessary to contain and conduct the runoff which had accummulated over many blocks. At intersections shallow culverts, often of half-round corrugated metal pipe, were provided so that pedestrians could more conveniently cross the gutters. The intention was to provide a way for all storm water to run off without leaving puddles, how long it took to do this or how far it had to flow on the surface was not considered important.

The first major underground storm drainage projects in the area were built in the thirties under various federal programs initiated at that time as economic relief measures. Again, the design philosophy was to provide a means to carry the water off eventually without too much concern about how long this took. In fact the deliberate policy was to keep inlets small so that the collecting pipes and trunks would not be overloaded.

The usual point of disposal was the nearest Salt River Project lateral or waste ditch. While the Project is under no obligation to accept street runoff, it has been very co-operative in this respect, limiting the size and spacing of drains only as necessary to control the accumulation of water. In recent years because of operational problems, the Project has become increasingly restrictive in accepting street drainage.

With the continuing influx of people into the area, many from more humid regions where adequate underground storm drainage had long been provided as a matter of course, the public attitude changed. High curbs began to be looked upon as a nuisance, especially as automobiles got lower, and the old fashioned corrugated metal cross-walk culverts began to be regarded as unsightly and hazardous. Valley gutters, built to carry surface flow across intersecting streets, were no longer tolerated on arterials and even regarded with disfavor on residential streets.

For these reasons and possibly because there was a vague but growing public awareness of its responsibility to do something to take care of the increasing amounts and rates of storm runoff that it was generating by its modification of the drainage system nature provided, there was a willingness to approve bond issues specifically for storm drainage purposes. Since World War II about $25,000,000 have been spent locally for storm drains and related purposes by the cities and towns of the Salt River Valley and by the County and State Highway Departments.

Flood control is another matter. Storms requiring drains occur several times a year but major floods in the Valley only occur once or twice a generation. The only time the public had opportunity to vote on a bond issue for flood control, on March 8, 1966, the issue was defeated by an approximate 4 to 1 vote. This $23,500,000 issue would have provided local matching funds for a $90,000,000 program to be built by the Corps of Engineers. Even though the frequency of floods has been relatively low in this area, the damage potential is enormous, and growing rapidly. Hurricane-related storms of tropical Gulf of Mexico origin (the storm of August 26 - 30, 1951, is a classic example) penetrate to Central Arizona on the average of once every seven years. The public is fairly well acquainted with the torrential rains such storms may bring in other parts of the country.

The Southern California storms of last winter are also fresh in memory and well worth mentioning here. Flood damages were very severe in Santa Barbara, Ventura, San Bernadino, Riverside, and Orange Counties, around Los Angeles area. Damages in Cucamonga Creek near Ontario alone amounted to over $50,000,000. But the area protected by works of the Los Angeles County Flood Control District received practically no flood damage to private property. (There were relatively minor damages to flood control works). Corps of Engineers estimates of the amount of damage prevented in the District last winter alone aggregate $1,100,000,000, about 50% more than the combined total spent to date by the Corps and the District for flood control works.(1)

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(1) Fred Cline, USCE LA District Office, personal communication, January 6, 1970

There are many demands on the taxpayer's dollar and any proposals for new expenditures for flood control are apt to be cooly received unless the public is made aware of the danger and is educated to the fact that its very large investment in other public works is itself in some degree of peril. It is also essential that the privately held tax base is preserved and the community is protected from a disaster that could leave it economically moribund. Any public works program must be within the fiscal capabilities of a community but it should also be properly balanced to meet the community's overall needs. Flood control in the Valley area is very definitely one of these needs. The creation of the Flood Control District of Maricopa County and the highly worthwhile but modest program it has been able to carry out under its 5-cent tax levy is really a token response by the community in view of the magnitude of the problem. The question should again be put before the voters with the best educational effort it is possible to mount.

An effective flood control program can stand on its own merits and, under the continuing growth of Valley communities, will continue to show ever higher economic justifications, but it is also important from the storm drainage viewpoint that the flood control works are built eventually. The two systems are inter-related and to a certain extent each depends on the other. This has been discussed previously in this report.

This section will discuss in more detail some of the reasons for providing storm drainage and will consider some of its general economic aspects and the degree of protection that should be provided. It will also consider the question of drains serving more than one governmental entity and make recommendations on how these should be handled.

4.1 Hazards

The actual and potential damages associated with excessive amounts of rainfall are well known. They are set forth hereinafter not so much to be informative as to be systematic. They include two broad categories of hazards: those affecting public health and safety, and those affecting public and private property. In addition there is the element of nuisance which, while hardly a hazard, is nevertheless a proper factor to consider in the planning of storm drainage projects. The various factors are listed below, some with comments.

A. Hazards to public health and safety

1. Danger of loss of life. This is a more important consideration for flood control projects where large volumes of water and major channels are dealt with than it is for storm drains. In California there has been loss of life from mud slides which might sometimes have been prevented by adequate storm drains but conditions in the present study area are such that it is extremely unlikely that this should happen here.

2. Increased risk of traffic deaths and injuries. Statistics for Phoenix for the year 1968 indicate that accidents involving injuries or deaths are about 10 times as likely to occur when the streets are wet.[1] Prompt removal of water from street surfaces by effective storm drains should make a substantial reduction in the incidence of traffic accidents.

(1) See Appendix 2

3. Health hazard attendant on mosquito breeding in undrained pools. The U.S. Public Health Service comments appended to the Corps of Engineers Interim Report for Phoenix and Vicinity apply.

B. Hazards to public and private property.

1. Damages to homes and businesses by flooding. The reduction of such damage is also primarily a benefit resulting from major flood control projects. Street drains designed for the 1-year storm will not accomplish much of this. In those critical areas where the 10-year or greater storm is the basis for design there will be benefits coming under this category.

2. Damage to street paving. Asphalt pavements over 5 years old always seem to be in a markedly poorer state of repair immediately after a heavy rainstorm, particularly one of the winter storms that lasts several days. Cracks in the pavement are washed open by the pumping action of traffic and "chuck holes" suddenly appear everywhere. The sooner water, particularly standing water, is drawn off the pavement the less of this sort of damage there is likely to be.

3. Damage to vehicles. The increased risk of traffic accidents due to wet streets has already been mentioned. Such accidents always involve property damage even when no loss of life or limb occurs.

4. Damages to utilities. As more utilities are placed underground there is an increasing liklihood of loss due to water-filled manholes, vaults, and junction boxes. Even when these are not municipally owned, the general public is still the ultimate loser. Traffic signal circuits are frequently damaged by water in the streets, again at the cost and inconvenience of the public.

5. Erosion. While there is less of this as the cities become more highly built up, it is nevertheless a factor to be considered in some instances.

C. Nuisance. There are other aspects which are more related to inconvenience and cost rather than to risk.

1. Interruption and slowing down of traffic.
2. The need to clean up debris and pump out "bird baths" - both a public and a private requirement.
3. The loss of business in commercial establishments where trade is discouraged by standing water.

Natural washes should be preserved wherever this can be done consistently with the development of the land because, to a varying degree, they have this capability for groundwater recharge. They also offer a path for runoff in excess of the storm drain capacity. Where washes must be eliminated the street pattern should follow the same drainage routes the washes provided, as nearly as this may be accomplished.

Other reasons for following the natural drainage pattern in the construction of an artificial system include:

a) Natural routes usually have the steepest slopes, permitting the smallest conduit sizes.

b) The right-of-way for drains is apt to be less expensive and more readily available along routes subject to occasional flooding.

c) The improvement will be more effective in terms of upgrading adjoining property values.

d) There is less likelihood of incurring liability for flood damages if the natural drainage patterns are unchanged.

## 4.2 Economic Aspects

Storm water is collected and disposed of by a variety of natural and artificial means. Each has its place in any systematic drainage scheme but obvious factors influence the choice of the means best suited to any particular situation. Table 4.1 lists and compares the methods. Both the hydraulic capacity and the cost per unit of capacity can vary over a wide range depending primarily on the slope and size of the channel or conduit. The figures in Table 4.1 cover the usual range of slopes and sizes found in the study area. The reader should refer to the capacity charts and the unit cost data of Section 7 for a more precise basis of comparison in any particular case.

The best disposition of storm water is to allow it to soak into the ground wherever this can be done without creating a nuisance. The lawns of residential areas and the parks and park-like areas around schools and public buildings offer the best possibilities in urban areas. In the desert foothills, washes can be effective in disposing of a substantial amount of runoff. Keppel and Renard in a study made on Walnut Gulch near Tombstone, Arizona,[(1)] reported streambed infiltration rates of 2 to 3 inches per hour. A 2.5 inch per hour infiltration rate would remove 0.3 cfs per foot of bed width per mile of wash and this is probably one of the reasons local washes diminish in size and disappear in their lower reaches.

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(1) R. V. Keppel and K. G. Reynard, Transmission Losses in Ephemeral Stream Beds, Journal of the Hydraulics Div., ASCE, Vol. 88, No. HY3, May, 1962, p. 67.

In the design of artificial channels to replace washes it is important to keep in mind that it is not enough merely to provide equivalent hydraulic capacity. Collection time will be reduced and the water losses eliminated by an artificial channel. This, plus the fact that tributary areas are being rendered increasingly impervious, means that larger quantities and rates of storm runoff will occur than under natural conditions.

Artifically induced ground water recharge holds little or no promise as a storm drainage measure in this locality. The many dry wells or seepage pits constructed in the past have shown themselves to be unsatisfactory because they quickly become clogged and function only as tanks. Recharge by means of spreading basins is feasible and is extensively practiced in the Los Angeles area but the sites used are river bottom land which is suitably porous and which was available at little or no cost when it was procured. From the storm drainage standpoint, runoff is no longer a problem when it has reached the rivers and the other major channels in the study area. These locations are the only ones where spreading basins might be feasible locally. A case might be made for recharge measures on the basis of water conservation but recharge offers no benefit from the storm drainage standpoint.

Sheet flow occurs in the runoff from lawns and graded areas behind street curbs. It also takes place in the collection process on the street pavement before rainwater reaches the gutters. Sheet flow velocities are low, especially in sodded areas, therefor it has the effect of storage, increases collection time, and acts to reduce the peak quantities to be handled in the drainage system. Sheet flow is as inexpensive and innocuous a means of moving storm water as there is and the policy should be to use this mode of runoff wherever possible. The main limitations are the low capacity and the need to control erosion.

Streets and alleys are effective water carriers, especially where they have vertical curbs. Table 4.1 gives the usual range of hydraulic capacities. The primary function of street pavements, however, is to carry vehicular traffic and it is good judgment to limit the dependence upon the street as water carrier to a point where its capabilities to carry traffic are not unduly impaired. A street brimful of fast-moving water can be a serious hasard. Traffic must be able to cross streets as well as to drive on dry pavement in the center of the streets, so there must be a limitation on water depth at the gutter line. Another limit on the extent to which streets should be used as water carriers is set by the capacity of the storm water inlets to subsurface drains. It is not usually possible to carry water on the streets to its ultimate disposal point. At a flow of about 50 cfs (10 or 15 cfs if two dry traffic lanes are the criterion) it generally becomes advisable to use underground pipelines as conduits. Transition from street to pipe flow is made at the curb inlets and catch basins installed at the gutter line of the pavement. These inlets generally become the bottleneck of the system. It requires a relatively large structure to accelerate the water and introduce it into the pipe while providing for the safety of street traffic, so cost considerations favor an undersized inlet. Because of the small openings, inlets tend to become clogged with debris carried in the storm water. Table 4.2 gives the approximate hydraulic capacities and costs for some

TABLE 4.1 - Comparison of Storm Water Conveyance Methods

| Channel description | Capacity range for Usual range of bed slopes* | Rough first cost, dollars per 100 cfs of capacity** | |
|---|---|---|---|
| **Natural** | | | |
| Sheet flow | 0.0003 to 0.015 cfs/ft of width | 0 | |
| Washes | Unlimited | Land cost only | |
| **Pavements** | | | |
| Alleys with inverted crowns | 2 - 20 cfs | Additional cost chargeable to hydraulic capacity negligible. | |
| Curbed streets, normal section | 15 - 100 cfs (to top of curb) | | |
| Curbed streets with inverted crowns | 30 - 300 cfs (to top of curb) | | |
| **Open Channels** | | 0.003'/ft | 0.015'/ft |
| Earth ditches | unlimited except by velocity | 1 - 2 | Not Used |
| Concrete lined ditches (slipform) | 5 - 2000 cfs | - 20 | 0.50- 2 |
| Concrete ditches (gunite & other) | 50 cfs and up | 3 - 23 | 1-10 |
| Rectangular concrete channels | 50 cfs and up | 3 - 0 | 1- 3 |
| **Closed Conduits** | | | |
| Pipes | 1 - 1000 cfs | 15 - 38 | 7-17 |
| Box culverts | 50 - 7500 cfs | 14 - 56 | 6-25 |

* 3 to 15 feet per thousand - Refer to Figures 3.15 through 3.23 for more accurate information.

** Costs are inversely dependent on size of conduit. Ranges used are: pipe, 96 to 48 inches; box culverts, 10 by 10 ft to 4 by 4 ft; earth ditches (trapezoidal, 1.15:1 slopes, with freeboard and width twice depth) 12 ft to 6 ft of bottom width; concrete ditches (trapezoidal, 1:1 slopes, with freeboard and width twice depth) 16 ft to 4 ft on bottom width; rectangular concrete channels (2' min freeboard) 9 by 16 ft to 9 by 40 ft; slipform concrete channels (trapezoidal) sizes 1 ft bottom width by 3 ft deep, 1:1 side slopes 1-1/2 in thick to bottom width by 6 ft deep, 1:1.5 side slopes, 2-1/2 in thick. Costs contemplate construction in urban locations and do not include allowance for right-of-way.

TABLE 4.2 - Approximate Hydraulic Capacities of Clean Inlets in Cubic Feet per Second

| Water depth in feet at flowline of gutter | Catch Basins City of Phoenix Standard Details #210 | #212 | #216A | #216B | #217 | #218 |
|---|---|---|---|---|---|---|
| 0.1 | 2.0 | 2.1 | 0.3 | 0.5 | 0.7 | - |
| 0.2 | 2.8 | 3.2 | 0.9 | 1.4 | 2.1 | 10.3 |
| 0.3 | 3.4 | 4.2 | 1.5 | 2.3 | 3.4 | 14.9 |
| 0.4 | 4.0 | 5.1 | 2.3 | 3.6 | 5.3 | 21.4 |
| 0.42 | - | - | 2.5 | 4.0 | 5.8 | - |
| 0.5 | 4.4 | 6.0 | 3.4 | 5.3 | 7.7 | 24.9 |
| 0.6 | 4.8 | 6.9 | 4.0 | 6.3 | 9.2 | 28.0 |
| 0.67 | - | - | 4.6 | 7.2 | 10.5 | - |
| 0.7 | 5.2 | 7.7 | 4.8 | 7.5 | 11.0 | 30.3 |
| Approximate cost per inlet - complete | $300 | $350 | $500 | $575 | $650 | $800 |

of the inlet structures commonly used. These capacities include flow through horizontal gratings, a factor generally ignored or discounted in design because of the high probabilities of clogging during a storm. For these reasons design street flow should not be permitted to become so large that it becomes impractical to provide enough inlets to get it into pipes.

In the outlying portions of the study area there are places where population density will not reach the point where storm drains are required or feasible for 10 or 15 years, but street pavements may be needed almost immediately. In such situations the pavement should be designed for maximum hydraulic effectiveness even at the cost of some inconvenience during severe storms. Where storm drain construction is deferred, a location should be reserved for the future pipe and this should be kept clear of other utilities.

No cost data are given in Table 4.1 for streets used as water carriers because this capability of a street is incidental to its primary purpose of carrying traffic. The geometric properties that enhance its hydraulic capacity do not normally add appreciably to its cost. The special high capacity gutters shown in Figures 3.20 and 3.21 are an exception. These are estimated to cost $1.00 to $3.00 per lineal foot (each side) more than conventional curb and gutter. For the purposes of comparison, the additional hydraulic capacity is indicated in Table 4.3 for a street slope of 0.005 ft. per ft. These gutters are used to greatest advantages where they can discharge directly into open channels. Where it is necessary eventually to discharge into underground conduits the cost of the larger inlets required tends to offset the savings brought about by the higher gutter capacity.

TABLE 4.3 - Comparison of Hydraulic Capacities in CFS of Conventional and Special Scottsdale Street Cross-sections

For street slope of 0.005 ft per ft

| | 40' Street | | 64' Street | |
|---|---|---|---|---|
| | 0.3' Crown | 0.5' Crown | 0.3' Crown | 0.5' Crown |
| Flowing full | | | | |
| Scottsdale section | 125 | 90 | 175 | 135 |
| Conventional section | 48 | 27.5 | 115 | 73 |
| Difference | 77 | 62.5 | 60 | 62 |
| Equivalent pipe - in | 42 | 39 | 39 | 39 |
| Flowing partly full | | | | |
| Scottsdale section | 2.3 | 6.0 | 9.5 | 19 |
| Conventional section | 1.9 | 4.0 | 7.8 | 15 |
| Difference | 0.4 | 2.0 | 1.7 | 4 |
| Equivalent pipe - in | 12 | 12 | 12 | 15 |

Open channels probably have the lowest first cost per unit of capacity as shown in Table 4.1, however they have far higher maintenance costs. The 1968 operation and maintenance costs for all open channels and all closed conduits under the jurisdiction of the Los Angeles County Flood Control District averaged about $2,800 per mile and $200 per mile respectively. These costs are found to be nearly independent of size, varying less than 5 percent.[(1)] An additional disadvantage of open channels is that they require their own right-of-way. Closed conduits may occupy space under street pavements and do not present the obstacle to surface uses that open channels do. The cost of any necessary bridges should be considered. In certain locations, especially in populous areas and for larger channels the right-of-way must be fenced. For very large flows, however, there is no alternative for open channels.

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(1) C.J. Wilt, Personal communication, Dec. 10, 1969

4.3 Degree of Protection

The following is quoted from the Water and Pollution Control Federation Manual of Practice No. 9, Design and Construction of Sanitary and Storm Sewers, pp. 44 and 45:

"The average frequency of rainfall occurrence used for design determines the degree of protection afforded by a given storm sewer system. This protection should be consistent with the amount of damage prevented. But in practice, cost-benefit studies usually are not conducted for the ordinary urban storm drainage project. Judgment supported by records of performance in other similar areas is usually the basis of selecting the design frequency.

The range of frequencies used in engineering offices is as follows:

1. For storm sewers in residential areas, 2 to 15 yr. with 5 yr. commonly reported.

2. For storm sewers in commercial and high-value districts, 10 to 50 yr., depending on economic justification.

3. For flood protection works, 50 yr. or more.

Other factors which may affect choice of design frequency include:

1. Use of less frequent, more intense rainfall for design of those parts of the system not economically susceptible to future relief.

2. Use of less frequent, more intense rainfall for design of combined sewers than for separate storm sewers because of basement flooding and consequent greater damage which may occur with overloaded combined sewers.

3. Use of less frequent, more intense rainfall for design of special structures such as expressway drainage pumping systems where runoff exceeding capacity would seriously disrupt an important facility. Design frequencies of 50 yr. or more may be justified in such cases, particularly, in small drainage areas, even though the project may be located in a district justifying only 5 yr. frequency for normal drainage.

4. Adoption of less intense, greater frequency rainfall than normal but commensurate with available funds so that some degree of protection can be provided.

It should be apparent that the cost of storm sewers is not directly proportional to design frequency. Rousculp [(1)] cites studies of effects of various factors on sewer cost and shows that sewer systems designed for 10 year frequency storms may cost only about 6 to 11 percent more than systems designed for 5 year frequency storms depending on sewer slope, the lesser increase applying to steeper sewers."

[(1)] Rousculp, J.A., "Relation of Rainfall and Runoff to Cost of Sewers." Transactions ASCE, v. 104, P. 1473 (1939)

City of Phoenix practice for the past decade has been to design for the one-year storm with drains on one mile intervals. The performance of the Phoenix system has been generally satisfactory. Since mid-section streets are also usually through streets there remains the possibility of constructing intervening drains at a later time if it should become desirable to increase the degree of protection. It is strongly recommended that this policy of keeping mid-section line streets open be continued. They are often advantageous for sanitary sewer interceptors and utility feeders as well as for possible future supplementary drains. The drainage pattern proposed in this report is predicated upon 1995 land uses as presently projected by planning agencies, but a single 160-acre regional shopping center in an unexpected location can upset the drainage design. Because such development cannot be predicted, it is good policy to have additional routes available for the drains which may be made necessary.

An investigation was made into the effect on cost of designing for longer return periods. The reference cited above mentions a 6 to 11 percent increase to double the degree of protection but this is not attainable under present local conditions. The Phoenix 24th Street line was built from Camelback Road to the Salt River to provide approximate 1-year protection. The cost of this line as constructed in the period 1962-65 was $1,324,000. Had the line been built for 2-year flows it would have cost about 22 percent more. The line is fairly flat, with the large pipe at slopes under 2 feet per thousand, and this may account for the disagreement with Rousculp's experience.

In view of the generally satisfactory experience Phoenix has had with 1-year design and because of the high cost of building for longer recurrence intervals, it is recommended that the one-year, one mile design policy be continued. While the 1-year recurrence interval may seem low (and is low by eastern standards) and it seems that every year we read of storms that are obviously much more intense than the 1-year storm, it should be kept in mind that such storms almost invariably cover a very limited area and the probability that one will occur in any given place is still very low. Longer recurrence intervals will be used in this study for critical areas or for unusually large drainages. Such areas and lines are identified in the computations and on the maps showing proposed construction. (Plates G & H).

A considerable degree of protection can be achieved independently of the storm drain system by setting building floor elevations above expected high water levels. This aspect has been discussed in the series of <u>Flood Plain Information Studies for Maricopa County, Arizona</u>, prepared by the Corps of Engineers. Such measures should be covered in the subdivision or grading regulations and building codes of the local municipal authorities. Because requirements setting floor levels higher than they would normally be necessarily add to the cost of construction, they should not be needlessly stringent and should not be applied in areas that are not likely to be flooded.

Subdivisions and subdivision pavements should be designed to provide the maximum incidental drainage benefit obtainable by carefully fitting the layout to the ground and taking full advantage of the pavement as a water carrier even though underground pipes are provided. Storms beyond the capacity of the drains should be kept in mind. Streets should follow the natural drainage wherever possible so that the path of runoff is not blocked by private property. Cul-de-sac and L-shaped streets should not be so situated that drainage along the street is impossible or, if it is not practical to do otherwise, adequate drainage easements should be provided. These principles are presently generally applied by authorities reviewing subdivision plats but it is important that this be continued.

## 4.4 Joint Projects

Many of the storm drainage trunks that will eventually have to be built will serve two or more municipalities. The drains must follow the fall of the ground. This was not an important consideration when the common boundaries of the several contiguous municipalities in the Salt River Valley were established. In addition, there will be many lines that will serve county areas as well as areas located in some town or city. Of course much of what is now under Maricopa County jurisdiction will be annexed to some municipality before 1995. Table 4.4 lists the lines shown on Plates G and H which will serve two or more municipalities.

TABLE 4.4 - Regional drains serving two or more cities

| Line No. | General Location | Upper City | Lower City |
|---|---|---|---|
| II-5 | 71st Ave | Glendale | Phoenix |
| II-6 | 67th Ave | Glendale | Phoenix |
| II-7 | 59th Ave | Glendale | Phoenix |
| II-8 | 51st Ave | Glendale | Phoenix |
| II-9 | Grand & 43rd Ave | Glendale | Phoenix |
| III-2 | Olive Ave, 75th to 67th Avenues | Glendale | Peoria |
| IV-1 | Bell Road | Phoenix | Glendale |
| IV-2 | Greenway Rd - Arizona Canal to Black Canyon Hwy | Phoenix | Glendale |
| IV-3 | Thunderbird Rd - Arizona Canal to Black Canyon Hwy | Phoenix | Glendale |
| IV-4 | Cactus Rd - Arizona Canal to Black Canyon Hwy | Phoenix | Glendale |
| V-9 | Camelback Rd - 56th St to Indian Bend | Phoenix | Scottsdale |
| V-10 | Chapparal Rd - Scottsdale Rd to Indian Bend | Phoenix<br>Paradise Valley | Scottsdale |
| V-11 | McDonald Drive | Paradise Valley | Scottsdale |
| V-12 | Cactus Wren Dr - Invergordon to Indian Bend | Paradise Valley | Scottsdale |
| V-13 | Hummingbird Lane | Paradise Valley | Scottsdale |
| V-18 | Doubletree Rd - Tatum to Indian Bend | Phoenix | Paradise Valley |
| V-19 | Mountain View - 44th St to Indian Bend | Phoenix | Paradise Valley |
| V-26 | 68th St - North of Indian Bend | Phoenix<br>Scottsdale | Paradise Valley |
| V-30 | Northeast Scottsdale | Scottsdale<br>Salt River<br>Indian Reservation | Scottsdale |

It is interesting to note that all the cities except Peoria occur in both the "upper city" and the "lower city" column. Parts of Peoria will eventually drain through storm drain laterals in Glendale and existing Tempe drains already receive runoff originating in Scottsdale. How future changes in city limits will affect the situation is not known, but all communities should be interested in a method to handle the financing, construction, and maintenance of joint drainage projects. There is also the question of how and to what extent Maricopa County should participate in projects where lines are "in the County". Even the State Highway Department is involved in many of the projects, particularly those near freeways.

There are at least three ways in which such joint projects can be handled:

1. Each joint project is made the subject of negotiations between the public bodies involved, with all the details of financing, design, construction, operation and maintenance covered in an agreement, perhaps with one city undertaking the entire project acting partly as the agent of the other. There is local precedent for this approach in the sanitary sewer agreements among several valley cities.

2. All "regional" drains would be made the responsibility of the Flood Control District of Maricopa County which would assume the burden of all details of financing, design, construction, operation, and maintenance. The District could of course make its own agreements with public and private agencies in carrying out its responsibility.

3. Each drainage basin containing parts of one or more cities or of the county could form a drainage district under the provisions of the Improvement Act for the financing, design, and construction of its main trunk drain and as many laterals as are required. After these are constructed responsibility for operation and maintenance could devolve upon the various municipalities or the county for the portion of the system contained within its area of responsibility. Maintenance might also be made a district function, with the district continuing as an active entity for this purpose. There is no known local precedent for the construction of major storm drainage trunks under the Improvement Act. In California, however, Norwalk and Cerritos formed a drainage district that included both communities and built a joint facility in 1968 with the assistance of a $1,500,000 federal grant. The local contribution was assessed uniformly to the entire district on an area basis.[1]

There are many political and legal aspects of this question which are inappropriately discussed in an engineering study. These must be explored and evaluated and decisions reached on them before work on joint projects is undertaken. From an engineering viewpoint, however, the second alternative seems the best choice for it would bring all the advantages of a "specialist" agency to bear and should result in greater uniformity, facility, and efficiency. It does raise the problem of establishing the

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[1] William C. Stookey, personal communication Oct. 22, 1969.

priority of the regional projects to be undertaken. If this is to be a function of the Flood Control Advisory Board, the Board should be sensitive to the needs of each of the cities in the county.

Under the first alternative the costs of regional projects could be paid out of fund allocations by the bodies benefitting, [1] prorated on some equitable basis agreed upon such as each one's portion of the drainage area or its portion of the total assessed valuation in the drainage area. Since benefits are seldom evaluated in storm drainage projects, each participant's share of the benefit would not be a practical criterion.

If the work is undertaken by the Flood Control District of Maricopa County, costs would be paid out of a portion of its budgeted or capital funds allocated for regional drains and there would be no problem of determining each municipality's share.

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(1) The word "benefitting" as used herein is intended to include the discharge of an obligation an upstream property has toward a lower one for any increase in rate or quantity of runoff - a concept some authorities characterize separately as "contribution".

If the work is done under the Improvement Act, assessments would be computed in a "fair and equitable manner" as provided by law. (1) Since there is little precedent for this approach and since storm drainage trunks have previously been built locally with general obligation bond issue funds, it is likely that there will be considerable public opposition to a shift to the special assessment method. It has been pointed out that cities are being forced to use this means of raising public works capital to an increasing degree however, and if substantial federal grants become obtainable to mitigate the impact of the direct assessment of property owners, this method may come into wider use. (2) The City of Scottsdale regularly assesses developers on an area basis for storm drainage purposes at the time land is subdivided.

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(1) Arizona Revised Statutes 1956, Title 9, Chapter 6, Article 2.

(2) A Rationale for Use of the Special Assessment in Financing Storm Drain Improvements, Raymond Allen Bullock (A thesis submitted to the faculty of the Graduate School of Public and International Affairs, University of Pittsburgh, 1969).

## 5. RUNOFF COMPUTATIONS

This section of this report presents the flows for future drainage trunks, generally designed for one-year recurrence interval storms. In general, it is assumed that the trunks will be built on the section-line arterial or through streets running in the direction most nearly perpendicular to the ground surface contours. Locations are shown on Plates G and H.

For the purposes of these computations the study area was divided into six subordinate areas, designated hereinafter by the Roman numerals I to VI:

| Area No. | Disposition of Runoff |
|---|---|
| I | Lines draining into the Salt River from the north bank. |
| II | Lines draining into the proposed Papago Freeway channel. |
| III | Lines draining into the proposed Glendale-Peoria flood control channel. |
| IV | Lines draining into Skunk Creek or into the Arizona Canal Floodway. |
| V | Lines draining into Indian Bend Wash. |
| VI | Lines draining into the Salt River from the south bank. |

Trunk lines are numbered progressively within each area and are designated I-1, I-2, and so forth, in the left hand column of the tabular computations and on the maps, Plates G and H. Other numbers in the left hand column under each line designation are merely arbitrary numerical designations for the drainage areas contributing to the trunk at the points mentioned in the second (location) column.

Design flows and recommended conduit sizes are shown in the right hand column of the computations and are also posted on plates G and H.

For certain selected drainage areas the computations were repeated several times using rainfall intensities corresponding to successively greater recurrence intervals. The relation between runoff and recurrence interval for these areas is shown graphically in each case on the page following the tabular computation.

It should be noted that the sizes shown are predicated on slopes derived from USGS maps of various contour intervals and it is generally assumed that the pipe will be laid on a straight gradient from one quarter-section corner to another. Refinements in the gradient made possible by more accurate profiles than were used for this study could indicate the advisability of adjusting pipe sizes up or down. This is a matter that will come out in the final design of the trunk in question. The alignments shown may also need adjustment at the time of final design, especially if there is congestion of underground utilities or if it is possible to avoid closing streets in business districts during construction by moving to adjacent parallel residential streets.

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-1 | | | | | | | | | | | | | | | |
| | 95th @ Roosevelt | 59 | | 20 | | | 44 | 0.78 | 0.77 | | | 0.51 | 10 | | 10 27" pipe |
| | 99th @ Roosevelt | 90 | | 30 | | .0012 | | | | | | | | | |
| | Sum | 149 | | 50 | | | 59 | 0.61 | 0.60 | | | 0.36 | 18 | | 20 30" pipe |
| | 99th @ Van Buren | 307 | | 118 | | .00265 | | | | | | | | | |
| | Sum | 456 | | 168 | | | 70 | 0.53 | 0.52 | | | 0.29 | 49 | | 50 42" pipe |
| | 99th @ SP RR | 283 | | 145 | | .0025 | | | | | | | | | |
| | Sum | 739 | | 313 | | | 77 | 0.495 | 0.48 | | | 0.25 | 78 | | 80 48" pipe |
| | 99th @ Buckeye | 314 | | 142 | | .0025 | | | | | | | | | |
| | Sum | 1053 | | 455 | | | 84 | 0.46 | 0.446 | | | 0.22 | 100 | | 100 60" pipe |
| | 103rd Ave @ Buckeye | 150 | | 68 | | .0012 | | | | | | | | | |
| | Sum | 1203 | | 523 | | | 93 | 0.425 | 0.407 | | | 0.186 | 98 | | 110 63" pipe |
| | 107th Ave @ Van Buren | 120 | | 62 | | | 59 | 0 61 | 0 60 | | | 0.36 | 22 | | 25 33" pipe |
| | 107th Ave @ W½ Cor Sec. 8 | 293 | | 118 | | .0026 | | | | | | | | | |
| | Sum | 413 | | 180 | | | 68 | 0.545 | 0.53 | | | 0.296 | 53 | | 55 42" pipe |
| | 107th Ave @ Buckeye | 565 | | 282 | | .0034 | | | | | | | | | |
| | Sum | 1768 | | 805 | | | 102 | 0.39 | 0.371 | | | 0.154 | 126 | | 130 66" pipe |
| | 111th Ave @ Buckeye | 161 | | 72 | | .0012 | | | | | | | | | |
| | Sum | 1929 | | 877 | | | 110 | 0.37 | 0.35 | | | 0.135 | 118 | | 135 69" pipe |
| | 115th Ave @ Buckeye | 233 | | 95 | | .0012 | | | | | | | | | |
| | Sum | 2162 | | 972 | | | 118 | 0.355 | 0.336 | | | 0.123 | 119 | | 140 69" pipe |
| | 115th Ave @ W½ Cor Sec. 18 | 264 | | 92 | | .002 | | | | | | | | | |
| | Sum | 2426 | | 1064 | | | 126 | 0.335 | 0.316 | | | 0.105 | 111 | | 145 69" pipe |
| | 115th Ave @ Lower Buckeye | 288 | | 96 | | .002 | | | | | | | | | |
| | Sum | 2714 | | 1160 | | | 134 | 0.32 | 0.30 | | | 0.09 | 104 | | 150 69" pipe |
| | Add 10 cfs/ mile to River | | | | | | | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-2 | | | | | | | | | | | | | | | |
| | 87th Ave @ Roosevelt | 62 | | 43 | | .0019 | 44 | 0.77 | 0.76 | | | 0.50 | 21 | | 25 33" pipe |
| | 91st Ave @ Roosevelt | 70 | | 49 | | .0019 | | | | | | | | | |
| | Sum | 132 | | 92 | | | 53 | 0.68 | 0.67 | | | 0.42+ | 39 | | 40 39" pipe |
| | 91st Ave @ Van Buren | 320 | | 222 | | .0019 | | | | | | | | | |
| | Sum | 452 | | 314 | | | 63 | 0.58 | 0.565 | | | 0.33 | 103 | | 105 54" pipe |
| | 91st Ave @ SP RR | 320 | | 223 | | .00265 | | | | | | | | | |
| | Sum | 772 | | 537 | | | 70 | 0.53 | 0.513 | | | 0.28 | 151 | | 155 63" pipe |
| | 91st Ave @ Buckeye | 320 | | 224 | | .00265 | | | | | | | | | |
| | Sum | 1092 | | 761 | | | 76 | 0.50 | 0.48 | | | 0.252 | 192 | | 195 72" pipe |
| | 91st Ave @ W¼ Cor Sec. 15 | 320 | | 224 | | .0020 | | | | | | | | | |
| | Sum | 1412 | | 985 | | | 83 | 0.465 | 0.45 | | | 0.224 | 221 | | 225 75" pipe |
| | 91st Ave @ Lower Buckeye | 320 | | 224 | | .0020 | | | | | | | | | |
| | Sum | 1732 | | 1209 | | | 89 | 0.44 | 0.43 | | | 0.205 | 248 | | 250 78" pipe |
| | 91st Ave @ W¼ Cor Sec. 22 | 320 | | 224 | | .0020 | | | | | | | | | |
| | Sum | 2052 | | 1433 | | | 95 | 0.42 | 0.40 | | | 0.18 | 258 | | 260 78" pipe |
| | 91st Ave @ Broadway | 320 | | 224 | | .0020 | | | | | | | | | |
| | Sum | 2372 | | 1657 | | | 101 | 0.40 | 0.378 | | | 0.16 | 265 | | 265 78" pipe |
| | 91st Ave @ W¼ Cor Sec. 27 | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 2692 | | 1881 | | | 107 | 0.38 | 0.358 | | | 0.142 | 267 | | 270 81" pipe |
| | 91st Ave @ Southern | 320 | | 188 | | .0030 | | | | | | | | | |
| | Sum | 3012 | | 2069 | | | 112 | 0.365 | 0.342 | | | 0.128 | 264 | | 275 81" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-3 | | | | | | | | | | | | | | | |
| | 79th Ave @ Roosevelt | 67 | | 47 | | | 54 | 0.66 | 0.65 | | | 0.41 | 19 | | 20 27" pipe |
| | 83rd Ave @ Roosevelt | 80 | | 56 | | .0037 | | | | | | | | | |
| | Sum | 147 | | 103 | | | 63 | 0.58 | 0.57+ | | | 0.335 | 34 | | 40 39" pipe |
| | 83rd Ave @ Van Buren | 320 | | 224 | | .0027 | | | | | | | | | |
| | Sum | 467 | | 327 | | | 71 | 0.525 | 0.51+ | | | 0.28 | 92 | | 95 51" pipe |
| | 83rd Ave @ SP RR | 320 | | 224 | | .0027 | | | | | | | | | |
| | Sum | 787 | | 551 | | | 78 | 0.49 | 0.474 | | | 0.246 | 136 | | 140 60" pipe |
| | 83rd Ave @ Buckeye | 320 | | 224 | | .0027 | | | | | | | | | |
| | Sum | 1107 | | 775 | | | 84 | 0.46 | 0.442 | | | 0.218 | 168 | | 170 69" pipe |
| | 83rd Ave @ W½ Cor Sec. 14 | 320 | | 224 | | .0017 | | | | | | | | | |
| | Sum | 1427 | | 999 | | | 91 | 0.43 | 0.413 | | | 0.192 | 192 | | 195 72" pipe |
| | 83rd Ave @ Lower Buckeye | 320 | | 224 | | .0017 | | | | | | | | | |
| | Sum | 1747 | | 1223 | | | 98 | 0.405 | 0.385 | | | 0.167 | 204 | | 205 72" pipe |
| | 83rd Ave @ W½ Cor Sec. 23 | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 2067 | | 1447 | | | 104 | 0.39 | 0.37 | | | 0.152 | 220 | | 220 72" pipe |
| | 83rd Ave @ Broadway | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 2387 | | 1671 | | | 110 | 0.37 | 0.35 | | | 0.135 | 226 | | 230 72" pipe |
| | 83rd Ave @ W½ Cor Sec 26 | 320 | | 224 | | .0025 | | | | | | | | | |
| | Sum | 2707 | | 1895 | | | 116 | 0.355 | 0.335 | | | 0.121 | 229 | | 235 75" pipe |
| | 83rd Ave @ Southern | 280 | | 196 | | .0025 | | | | | | | | | |
| | Sum | 2987 | | 2091 | | | 122 | 0.34 | 0.32 | | | 0.108 | 225 | | 240 81" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-4 | | | | | | | | | | | | | | | |
| | 71st Ave @ Roosevelt | 68 | | 49 | | | 50 | 0.70 | 0.69 | | | 0.44 | 22 | | 25 36" pipe |
| | 75th Ave @ Roosevelt | 80 | | 56 | | .0026 | | | | | | | | | |
| | Sum | 148 | | 105 | | | 61 | 0.59 | 0.58 | | | 0.34 | 36 | | 40 39" pipe |
| | 75th Ave @ Van Buren | 320 | | 224 | | .0014 | | | | | | | | | |
| | Sum | 468 | | 329 | | | 68 | 0.545 | 0.53 | | | 0.30 | 99 | | 100 60" pipe |
| | 75th Ave @ SP RR | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 788 | | 553 | | | 77 | 0.495 | 0.48 | | | 0.25 | 138 | | 140 60" pipe |
| | 75th Ave @ Buckeye | 280 | | 196 | | .0023 | | | | | | | | | |
| | Sum | 1068 | | 749 | | | 83 | 0.465 | 0.45 | | | 0.22 | 164 | | 165 66" pipe |
| | 75th Ave @ W½ Sec 13 | 320 | | 224 | | .0023 | | | | | | | | | |
| | Sum | 1338 | | 973 | | | 90 | 0.435 | 0.415 | | | 0.19+ | 188 | | 190 69" pipe |
| | 75th Ave @ Lower Buckeye | 320 | | 224 | | .00285 | | | | | | | | | |
| | Sum | 1708 | | 1197 | | | 96 | 0.415 | 0.395 | | | 0.175 | 209 | | 210 69" pipe |
| | 75th Ave @ W¼ Sec 24 | 320 | | 224 | | .00285 | | | | | | | | | |
| | Sum | 2028 | | 1421 | | | 102 | 0.39 | 0.37 | | | 0.153 | 217 | | 220 72" pipe |
| | 75th Ave @ Broadway | 320 | | 224 | | .0015 | | | | | | | | | |
| | Sum | 2348 | | 1645 | | | 108 | 0.375 | 0.355 | | | 0.14 | 230 | | 230 81" pipe |
| | 75th Ave @ W½ Sec 25 | 320 | | 224 | | .0015 | | | | | | | | | |
| | Sum | 2668 | | 1869 | | | 115 | 0.36 | 0.34 | | | 0.125 | 233 | | 240 84" pipe |
| | 75th Ave @ River | 80 | | 56 | | .0015 | | | | | | | | | |
| | Sum | 2740 | | 1925 | | | 119 | 0.35 | 0.33 | | | 0.117 | 222 | | 245 84" pipe |

EXPECTED FLOWS - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-5 | | | | | | | | | | | | | | | |
| | 63rd Ave @ Roosevelt | 64 | | 45 | | | 47 | 0.73 | 0.72 | | | 0.47 | 21 | | 25 33" pipe |
| | 67th Ave @ Roosevelt | 80 | | 56 | | .0018 | | | | | | | | | |
| | Sum | 144 | | 101 | | | 58 | 0.62 | 0.61 | | | 0.37 | 37 | | 40 42" pipe |
| | 67th Ave @ Van Buren | 320 | | 224 | | .0018 | | | | | | | | | |
| | Sum | 464 | | 325 | | | 67 | 0.56 | 0.55 | | | .315 | 102 | | 105 54" pipe |
| | 67th Ave @ SP RR | 320 | | 224 | | .00245 | | | | | | | | | |
| | Sum | 784 | | 549 | | | 74 | 0.51 | 0.495 | | | 0.26+ | 151 | | 155 63" pipe |
| | 67th Ave @ Buckeye | 360 | | 252 | | .00245 | | | | | | | | | |
| | Sum | 1144 | | 801 | | | 80 | 0.48 | 0.46 | | | 0.234 | 187 | | 190 66" pipe |
| | 67th Ave @ W½ Sec 18 | 240 | | 168 | | .00285 | | | | | | | | | |
| | Sum | 1384 | | 969 | | | 85 | 0.455 | 0.44 | | | 0.212 | 206 | | 210 69" pipe |
| | 67th Ave @ Lower Buckeye | 320 | | 224 | | .00285 | | | | | | | | | |
| | Sum | 1704 | | 1193 | | | 90 | 0.435 | 0.417 | | | 0.195 | 232 | | 235 81" pipe |
| | 67th Ave @ W½ Sec 19 | 320 | | 224 | | .0015 | | | | | | | | | |
| | Sum | 2024 | | 1417 | | | 97 | 0.41 | 0.39 | | | 0.17 | 241 | | 245 81" pipe |
| | 67th Ave @ Broadway | 320 | | 224 | | .0015 | | | | | | | | | |
| | Sum | 2344 | | 1641 | | | 104 | 0.39 | 0.37 | | | 0.153 | 251 | | 255 81" pipe |
| | 67th Ave @ River | 240 | | 168 | | .0020 | | | | | | | | | |
| | Sum | 2584 | | 1809 | | | 110 | 0.37 | 0.35 | | | 0.135 | 244 | | 265 81" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-6 | | | | | | | | | | | | | | | |
| | 55th Ave @ Roosevelt | 65 | | 46 | | | 50 | 0.70 | 0.69 | | | 0.44 | 21 | | 25 33" pipe |
| | 59th Ave @ Roosevelt | 80 | | 56 | | .0023 | | | | | | | | | |
| | Sum | 145 | | 102 | | | 59 | 0.61 | 0.60 | | | 0.36 | 37 | | 40 39" pipe |
| | 59th Ave @ Van Buren | 320 | | 224 | | .0020 | | | | | | | | | |
| | Sum | 465 | | 326 | | | 68 | 0.54 | 0.53 | | | 0.30 | 98 | | 100 51" pipe |
| | 59th Ave @ SP RR | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 785 | | 550 | | | 74 | 0.51 | 0.49 | | | 0.26+ | 145 | | 145 60" pipe |
| | 39th Ave @ Buckeye | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 1105 | | 774 | | | 80 | 0.48 | 0.46 | | | 0.23 | 182 | | 185 69" pipe |
| | 59th Ave @ RID | 400 | | 280 | | .0021 | | | | | | | | | |
| | Sum | 1505 | | 1054 | | | 86 | 0.45 | 0.43 | | | 0.205 | 208 | | 210 72" pipe |
| | 59th Ave @ Lower Buckeye | 320 | | 224 | | .0021 | | | | | | | | | |
| | Sum | 1823 | | 1278 | | | 92 | 0.43 | 0.41 | | | 0.119 | 243 | | 245 75" pipe |
| | 59th Ave @ Broadway | 580 | | 406 | | .0027 | | | | | | | | | |
| | Sum | 2405 | | 1684 | | | 102 | 0.39 | 0.37 | | | 0.15+ | 258 | | 260 78" pipe |
| | 59th Ave @ River | 20 | | 14 | | .0021 | | | | | | | | | |
| | Sum | 2425 | | 1698 | | | 107 | 0.38 | 0.36 | | | .144 | 255 | | 265 78" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-7 | Mid Sec Line Sec 4 | 119 | | 83 | | .0023 | 56 | 0.62 | 0.61 | | | 0.37 | 31 | | 35 36" pipe |
| | 51st Ave @ Van Buren | | | | | | | | | | | | | | |
| | Sum | 413 | | 289 | | | 64 | 0.57 | 0.555 | | | 0.32 | 92 | | 95 48" pipe |
| | 51st @ RR | 320 | | 224 | | .0034 | | | | | | | | | |
| | Sum | 733 | | 513 | | | 70 | 0.53 | 0.51 | | | 0.28 | 144 | | 150 57" pipe |
| | 51st @ Buckeye | 320 | | 224 | | .0034 | | | | | | | | | |
| | Sum | 1053 | | 737 | | | 76 | 0.50 | 0.48 | | | 0.25 | 184 | | 190 63" pipe |
| | 51st @ RID | 300 | | 210 | | .0038 | | | | | | | | | |
| | Sum | 1353 | | 947 | | | 81 | .475 | 0.455 | | | 0.23 | 218 | | 220 72" pipe |
| | 51st @ Lower Buckeye | 340 | | 238 | | .0023 | | | | | | | | | |
| | Sum | 1693 | | 1185 | | | 88 | .445 | 0.425 | | | 0.20 | 237 | | 240 72" pipe |
| | 51st @ River | 360 | | 252 | | .0024 | | | | | | | | | |
| | Sum | 2053 | | 1437 | | | 96 | 0.41+ | 0.39 | | | 0.17 | 244 | | 250 75" pipe |
| I-8 | @ Roosevelt | 112 | | 45 | | | 59 | 0.61 | 0.60 | | | 0.36 | 16 | | 20 30" pipe |
| | 43rd Ave @ Van Buren | 320 | | 142 | | .0022 | | | | | | | | | |
| | Sum | 432 | | 187 | | | 70 | 0.53 | 0.52 | | | 0.29 | 54 | | 60 42" pipe |
| | 43rd Ave @ RR | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 752 | | 411 | | | 77 | 0.49 | 0.47+ | | | 0.24 | 99 | | 105 57" pipe |
| | 43rd Ave @ Buckeye | 296 | | 152 | | .0019 | | | | | | | | | |
| | Sum | 1048 | | 563 | | | 85 | 0.45+ | 0.44 | | | 0.21 | 118 | | 125 60" pipe |
| | 43rd Ave @ RID | 320 | | 224 | | .0019 | | | | | | | | | |
| | Sum | 1368 | | 787 | | | 92 | 0.43 | 0.41 | | | 0.19 | 150 | | 155 60" pipe |
| | 43rd @ Lower Buckeye | 320 | | 224 | | .0030 | | | | | | | | | |
| | Sum | 1688 | | 1011 | | | 97 | 0.41 | 0.39 | | | 0.17 | 172 | | 175 78" pipe |
| | Lower Buckeye to River | 180 | | 126 | | .0022 | | | | | | | | | |
| | Sum | 1868 | | 1137 | | | 103 | 0.39 | 0.37 | | | 0.15 | 173 | | |
| | Trial Max Buckeye to River | 790 | | 553 | | | | 0.59 | 0.57 | | | 0.33 | 183 | | 185 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-9 | 35th Ave | | | | | | | | | | | | | | |
| | NW¼ Sec. 11 | 160 | | 50 | | .0038 | 35 | 0.93 | 0.92 | | | 0.65 | 33 | | 35 33" pipe |
| | E½SW¼ Sec. 11 | 80 | | 24 | | .002 | | | | | | | | | |
| | Sum 33rd Ave & Maryland | 240 | | 74 | | | 43 | 0.79 | 0.78 | | | 0.52 | 39 | | 40 39" pipe |
| | S½SE¼ Sec. 10 & W½SW¼ Sec. 11 | 160 | | 48 | | .004 | | | | | | | | | |
| | Sum Bethany Home Rd | 400 | | 122 | | | 48 | 0.72 | 0.71 | | | 0.46 | 56 | | 55 39" pipe |
| | NE¼ Sec. 15 & NW¼ Sec. 14 | 320 | | 96 | | .004 | | | | | | | | | |
| | Sum Missouri Ave | 720 | | 218 | | | 55 | 0.65 | 0.64 | | | 0.40 | 87 | | 90 48" pipe |
| | SE¼ Sec. 15 & SW¼ Sec. 14 | 320 | | 112 | | .004 | | | | | | | | | |
| | Sum Camelback Rd | 1040 | | 330 | | | 61 | 0.60 | 0.59 | | | 0.35 | 115 | | 115 54" pipe |
| | NE¼Sec. 22 NE½NW¼Sec.22 NW¼Sec.23 | 400 | | 112 | | .0036 | | | | | | | | | |
| | Sum NE¼ & NE½ NW¼ Sec.22 | 240 | | 72 | | | 34 | 0.95 | 0.93 | | | 0.66 | 48 | | 50 39" pipe |
| | Sum Campbell Ave | 1440 | | 442 | | | 67 | 0.55 | 0.53 | | | 0.30 | 133 | | 135 54" pipe |
| | NE½ SE¼ Sec. 22 | 80 | | 32 | | .0038 | | | | | | | | | |
| | SW¼ Sec. 23 | 160 | | 48 | | .0038 | | | | | | | | | |
| | NW 30 Ac. Sec. 26 | 30 | | 27 | | .0038 | | | | | | | | | |
| | Sum Indian School Rd | 1710 | | 549 | | | 72 | 0.52 | 0.50 | | | 0.27 | 148 | | 150 |
| | SW½ NW¼ Sec. 26 | 80 | | 64 | | .0038 | | | | | | | | | |
| | Sum Osborn Rd | 1790 | | 613 | | | 77 | 0.49 | 0.47 | | | 0.24 | 147 | | 155 |
| | SW¼ Sec. 26 | 160 | | 128 | | .0038 | | | | | | | | | |
| | Sum Thomas Rd | 1950 | | 741 | | | 82 | 0.47 | 0.45 | | | 0.225 | 167 | | 170 |
| | NW¼ Sec. 35 | 149 | | 64 | | .0038 | | | | | | | | | |
| | Sum Encanto Blvd | 2099 | | 805 | | | 87 | 0.45 | 0.43 | | | 0.21 | 169 | | 175 |
| | SW¼ Sec. 35 | 149 | | 42 | | .0038 | | | | | | | | | |
| | Sum I-10 Channel | 2248 | | 847 | | | 94 | 0.42 | 0.40 | | | 0.18 | 153 | | 180 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-10 | 27th Ave | | | | | | | | | | | | | | |
| | Sec. 26 | 70 | | 31 | | .005 | | | | | | | | | |
| | Sec. 35 N½ | 240 | | 77 | | .0042 | | | | | | | | | |
| | Sum Butler Dr | 310 | | 108 | | | 42 | 0.80 | 0.79 | | | 0.53 | 57 | | 55 39" pipe |
| | S½ Sec. 35 (Pt. 36) | 320 | | 155 | | .0042 | | | | | | | | | |
| | Sum Northern Ave | 630 | | 263 | | | 49 | 0.71 | 0.70 | | | 0.45 | 123 | | 125 51" pipe |
| | N½ Sec. 2 (Pt. 1) | 200 | | 84 | | .0045 | | | | | | | | | |
| | Sum Orangewood Ave | 830 | | 347 | | | 55 | 0.65 | 0.64 | | | 0.40 | 139 | | 140 54" pipe |
| | S½ Sec. 2 (Pt.1) | 240 | | 72 | | .0045 | | | | | | | | | |
| | Sum Glendale Ave | 1070 | | 419 | | | 60 | 0.60 | 0.58 | | | 0.34 | 143 | | 145 54" pipe |
| | E¼ Sec. 2, W¼ Sec. 1 | 320 | | 104 | | .0045 | | | | | | | | | |
| | Sum | 1390 | | 523 | | | 63 | 0.58 | 0.56 | | | 0.32 | 167 | | 165 60" pipe |
| | N½ Sec. 11 | 240 | | 84 | | .004 | | | | | | | | | |
| | Sum Maryland Ave | 1630 | | 607 | | | 68 | 0.54 | 0.52 | | | 0.29 | 176 | | 175 60" pipe |
| | S½ Sec. 11 | 240 | | 104 | | .004 | | | | | | | | | |
| | Sum Bethany Home Rd | 1870 | | 711 | | | 73 | 0.52 | 0.50 | | | 0.27 | 192 | | 190 63" pipe |
| | N½ Sec. 14 | 240 | | 72 | | .0036 | | | | | | | | | |
| | Sum Missouri Ave | 2110 | | 783 | | | 78 | 0.49 | 0.47 | | | 0.24 | 188 | | 195 63" pipe |
| | S½ Sec. 14 | 240 | | 104 | | .0036 | | | | | | | | | |
| | Sum Camelback Rd | 2350 | | 887 | | | 84 | 0.46 | 0.44 | | | 0.22 | 195 | | 200 63" pipe |
| | N½ Sec. 23 | 240 | | 80 | | .0042 | | | | | | | | | |
| | Sum Campbell Ave | 2590 | | 967 | | | 89 | 0.44 | 0.42 | | | 0.20 | 193 | | 205 63" pipe |
| | S½ Sec. 23 | 240 | | 96 | | .0042 | | | | | | | | | |
| | Sum Indian School Rd | 2830 | | 1063 | | | 94 | 0.42 | 0.40 | | | 0.18 | 191 | | 210 63" pipe |
| | Sec. 26 | 150 | | 100 | | .0042 | | | | | | | | | |
| | Sum Grand Canal | 2980 | | 1163 | | | 97 | 41 | 0.39 | | | 0.17 | 198 | | 215 66" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-11 | 40th St | | | | | | | | | | | | | | |
| | Sec. 19 SW½NW¼ | 55 | | 17 | | .0085 | 17 | 1.57 | 1.56 | | | 1.224 | 21 | | 20 24" pipe |
| | Sec. 19 SW½SE¼ | 65 | | 20 | | .0068 | 19 | 1.46 | 1.45 | | | 1.125 | 23 | | 25 27" pipe |
| | Sec. 19 SW¼ | 110 | | 33 | | .0076 | | | | | | | | | |
| | Sum Indian School Rd | 230 | | 70 | | | 25 | 1.20 | 1.18 | | | 0.88 | 62 | | 65 39" pipe |
| | Sec. 30 N½ | 230 | | 99 | | .0045 | | | | | | | | | |
| | Sum Osborn Rd | 460 | | 169 | | | 31 | 1.02 | 1.00 | | | 0.72 | 122 | | 120 51" pipe |
| | Sec. 30 S½ | 229 | | 98 | | .0045 | | | | | | | | | |
| | Sum Thomas Rd | 689 | | 267 | | | 36 | 0.91 | 0.88 | | | 0.61 | 163 | | 165 60" pipe |
| | Sec. 31 NW¼ | 130 | | 39 | | .0038 | | | | | | | | | |
| | Sum Oak Ave | 819 | | 306 | | | 41 | 0.82 | 0.79 | | | 0.53 | 162 | | 170 60" pipe |
| | Sec. 31 SW¼ | 130 | | 39 | | .0038 | | | | | | | | | |
| | Sum McDowell Rd | 949 | | 345 | | | 46 | 0.75 | 0.72 | | | 0.47 | 162 | | 175 60" pipe |
| | Sec. 6 NW¼ | 100 | | 46 | | .0045 | | | | | | | | | |
| | Sum Roosevelt Ave | 1049 | | 391 | | | 51 | 0.69 | 0.67 | | | 0.42 | 164 | | 180 60" pipe |
| | Sec. 6 SW¼ | 100 | | 35 | | .0045 | | | | | | | | | |
| | Sum Van Buren St | 1149 | | 426 | | | 56 | 0.64 | 0.62 | | | 0.38 | 162 | | 185 78" pipe |
| | Sec. 7 NW¼ | 160 | | 136 | | .001 | | | | | | | | | |
| | Sum Harrison St | 1309 | | 562 | | | 64 | 0.58 | 0.56 | | | 0.324 | 182 | | 190 81" pipe |
| | Sec. 7 NE¼ NW¼ | 60 | | 12 | | .002 | | | | | | | | | |
| | Sum Salt River | 1369 | | 574 | | | 70 | 0.53 | 0.51 | | | 0.28 | 161 | | 195 81" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-12 | | | | | | | | | | | | | | | |
| 7 | Melvin at 48th St | 295 | 111 | 111 | 0.8 | | 31 | 1.02 | 1.00 | 0.16 | 18 | 0.72 | 80 | 98 | 100 |
| | 1000' of 42" pipe (10'/Sec) | | | | | 0.0080 | 2 | | | | | | | | |
| 8 | Van Buren at Old X-Cut | 67 | | 27 | | | 21 | 1.36 | 1.35 | | | 1.03 | 28 | 28 | 30 |
| | Sum 7 & 8 | 362 | 111 | 138 | 0.8 | | 33 | 0.98 | 0.955 | 0.12 | 13 | 0.68 | 94 | 107 | 110 |
| I-13 | | | | | | | | | | | | | | | |
| 3 | Roosevelt at 50th St | 91 | 82 | 9 | 0.8 | | 17 | 1.58 | 1.56 | 0.61 | 50 | 1.24 | 11 | 61 | 60 |
| 4 | Brill at 52nd St | 134 | 120 | 14 | 0.8 | | 15 | 1.70 | 1.68 | 0.70 | 84 | 1.33 | 19 | 103 | 100 |
| | 3600' of 42" pipe (11'/Sec) | | | | | 0.0100 | 5 | | | | | | | | |
| 5 | Roosevelt at 49th St | 74 | 14 | 60 | | | 32 | 1.00 | 0.99 | | | 0.71 | 43 | | |
| 5a | Portion draining in 20 min | 46 | | 38 | | | 20 | 1.40 | 1.39 | | | 1.07 | 41 | | |
| | Sum 4 & 5 | 208 | 134 | 74 | 0.8 | | 32 | 1.00 | 0.985 | 0.15 | 20 | 0.71 | 52 | 72 | |
| | Sum 4 & 5a | 180 | 120 | 52 | 0.8 | | 20 | 1.40 | 1.38 | 0.465 | 56 | 1.06 | 55 | 111 | 110 |
| | Sum 3 - 5a | 271 | 202 | 61 | 0.8 | | 20 | 1.42 | 1.39 | 0.47 | 95 | 1.07 | 65 | 160 | 160 |
| | 2100' of 60" pipe (8.2'/Sec) | | | | | 0.0033 | 4 | | | | | | | | |
| 6 | Roosevelt at Old X-Cut | 142 | | 60 | | | 24 | 1.23 | 1.21 | | | 0.91 | 55 | | |
| | Sum 3, 4, 5a, & 6 | 413 | 202 | 121 | 0.8 | | 24 | 1.23 | 1.20 | 0.32 | 65 | 0.93 | 112 | 177 | 180 |
| I-14 | | | | | | | | | | | | | | | |
| 1 | McDowell Rd at 52nd St | 68 | 61 | 7 | 0.8 | | 27 | 1.14 | 1.13 | 0.26 | 16 | 0.85 | 6 | 22 | 25 |
| | 3300' of 24" pipe | | | | | 0.0120 | 6 | | | | | | | | |
| 2 | McDowell Rd at Old X-Cut | 95 | | 33 | | | 15 | 1.70 | 1.68 | | | 1.33 | 44 | 44 | 45 |
| | Sum 1 & 2 | 163 | 61 | 40 | 0.8 | | 33 | 0.98 | 0.965 | 0.13 | 8 | 0.69 | 28 | 34 | 45 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I-15 | | | | | | | | | | | | | | | |
| 7 | 48th St at Oak | 288 | | 49 | | | 24 | 1.23 | 1.20 | | | 0.90 | 44 | | |
| 7a | 52nd St at Oak | 222 | | 38 | | | 19 | 1.46 | 1.43 | | | 1.11 | 42 | | 45 |
| | 2640' of 33" pipe (8.5'/Sec) | | | | | | 5 | | | | | | | | |
| I-16 | | | | | | | | | | | | | | | |
| 1 | 56th St at Camelback | 197 | 123 | 39 | 0.4 | | 31 | 1.02 | 1.00 | 0.48 | 59 | 0.72 | 28 | 87 | 90 |
| | 2500' of 36" pipe (13'/Sec) | | | | | 0.0176 | 3 | | | | | | | | |
| | 1900' of 39" pipe (11.5'/Sec) | | | | | 0.0126 | 3 | | | | | | | | |
| 2 | 56th St at Ariz Canal | 227 | 14 | 46 | 0.5 | | 27 | 1.13 | 1.11 | 0.49 | 7 | 0.82 | 38 | 45 | 45 |
| 1a | Portion draining in 21 min | 134 | 84 | 26 | 0.4 | | 21 | 1.36 | 1.34 | 0.75 | 63 | 1.03 | 27 | 90 | |
| | Sum 1a & 2 | 361 | 98 | 72 | 0.4 | | 27 | 1.13 | 1.10 | 0.56 | 55 | 0.81 | 58 | 113 | 115 |
| | 1600' of 48" pipe (9.5'/Sec) | | | | | 0.0062 | 3 | | | | | | | | |
| 3 | 56th St at Thomas Rd | 246 | 61 | 40 | 0.5 | | 28 | 1.10 | 1.08 | 0.465 | 21 | 0.79 | 32 | 60 | 60 |
| | 1900' of 36" pipe (8.2'/Sec) | | | | | 0.0063 | 4 | | | | | | | | |
| 4 | 56th St at Cheery Lynn | 366 | | 59 | | | 62 | 0.59 | 0.575 | | | 0.337 | 20 | | |
| 4a | Portion draining in 32 min | 189 | | 30 | | | 32 | 1.00 | 0.985 | | | 0.71 | 21 | | |
| | Sum 1a - 4a | 796 | 159 | 142 | 0.44 | | 32 | 1.00 | 0.965 | 0.42 | 67 | 0.69 | 98 | 165 | 165 |
| | 5750' of 57" (9.5'/Sec) | | | | | 0.0048 | 10 | | | | | | | | |
| 5 | 48th St at Earll Drive | 244 | | 66 | | | 70 | 0.53 | 0.52 | | | 0.29 | 19 | | |
| 5a | Portion draining in 42 min | 147 | | 40 | | | 42 | 0.80 | 0.79 | | | 0.53 | 21 | | 25 |
| | Sum 1a - 5a | 943 | 159 | 182 | 0.44 | | 42 | 0.80 | 0.77 | 0.26 | 41 | 0.515 | 93 | 134 | 165 |
| I-17 | | | | | | | | | | | | | | | |
| 6 | 48th St at Osborn Rd | 217 | | 58 | | 0.0045 | 59 | 0.62 | 0.61 | | | 0.37 | 22 | | 25 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-1 | 99th Ave | | | | | | | | | | | | | | |
| | Sec. 21 (N½) | 282 | | 94 | | .0021 | 53 | 0.67 | 0.66 | | | 0.41 | 39 | | 40 39" pipe |
| | Sec. 21 (S½) | 281 | | 94 | | .0021 | | | | | | | | | |
| | Sum Indian School Rd | 563 | | 188 | | | 62 | 0.59 | 0.58 | | | 0.34 | 64 | | 65 51" pipe |
| | Sec. 28 (N½) | 281 | | 95 | | .0015 | | | | | | | | | |
| | Sum Osborn Rd | 844 | | 283 | | | 71 | 0.53 | 0.51 | | | 0.28 | 79 | | 80 54" pipe |
| | Sec. 28 (S½) | 280 | | 95 | | .0015 | | | | | | | | | |
| | Sum Thomas Rd | 1124 | | 378 | | | 80 | 0.48 | 0.46 | | | 0.23 | 87 | | 90 57" pipe |
| | Sec. 33 (N½) | 280 | | 97 | | .0015 | | | | | | | | | |
| | Sum Encanto Blvd | 1404 | | 475 | | | 88 | 0.44 | 0.42 | | | 0.20 | 95 | | 95 57" pipe |
| | Sec. 33 (S½) | 279 | | 97 | | .0015 | | | | | | | | | |
| | Sum I-10 Channel | 1683 | | 572 | | | 96 | 0.41 | 0.39 | | | 0.17 | 97 | | 100 60" pipe |
| II-2 | 91st Ave | | | | | | | | | | | | | | |
| | Sec. 22 (N½) | 282 | | 98 | | .002 | 50 | 0.69 | 0.68 | | | 0.43 | 42 | | 40 39" pipe |
| | Sec. 22 (S½) | 281 | | 98 | | .002 | | | | | | | | | |
| | Sum Indian School Road | 563 | | 196 | | | 59 | 0.61 | 0.60 | | | 0.36 | 71 | | 70 51" pipe |
| | Sec. 27 (N½) | 281 | | 95 | | .0015 | | | | | | | | | |
| | Sum Osborn Road | 844 | | 291 | | | 68 | 0.54 | 0.52 | | | 0.29 | 85 | | 85 54" pipe |
| | Sec. 27 (S½) | 280 | | 95 | | .0015 | | | | | | | | | |
| | Sum Thomas Road | 1124 | | 386 | | | 76 | 0.50 | 0.48 | | | 0.25 | 97 | | 100 54" pipe |
| | Sec. 34 (N½) | 283 | | 96 | | .0023 | | | | | | | | | |
| | Sum Encanto Blvd. | 1407 | | 482 | | | 83 | 0.47 | 0.45 | | | 0.23 | 111 | | 110 57" pipe |
| | Sec. 34 (S½) | 282 | | 96 | | .0023 | | | | | | | | | |
| | Sum I-10 Channel | 1689 | | 578 | | | 90 | 0.45 | 0.43 | | | 0.21 | 121 | | 120 60" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-3 | 83rd Ave | | | | | | | | | | | | | | |
| | Sec. 23 (N½) | 258 | | 72 | | .002 | 48 | 0.72 | 0.71 | | | 0.46 | 33 | | 35 39" pipe |
| | Sec. 23 (S½) | 258 | | 73 | | .002 | | | | | | | | | |
| | Sum Indian School Rd | 516 | | 145 | | | 57 | 0.63 | 0.62 | | | 0.38 | 55 | | 55 45" pipe |
| | Sec. 26 (N½) | 283 | | 99 | | .002 | | | | | | | | | |
| | Sum Osborn Rd | 799 | | 244 | | | 65 | 0.57 | 0.55 | | | 0.32 | 78 | | 80 51" pipe |
| | Sec. 26 (S½) | 283 | | 99 | | .002 | | | | | | | | | |
| | Sum Thomas Rd | 1082 | | 343 | | | 73 | 0.52 | 0.50 | | | 0.27 | 93 | | 95 51" pipe |
| | Sec. 35 (N½) | 283 | | 103 | | .0034 | | | | | | | | | |
| | Sum Encanto | 1365 | | 446 | | | 79 | 0.49 | 0.47 | | | 0.24 | 107 | | 105 51" pipe |
| | Sec. 35 (S½) | 283 | | 103 | | .0034 | | | | | | | | | |
| | Sum McDowell Rd | 1648 | | 549 | | | 85 | 0.46 | 0.44 | | | 0.22 | 121 | | 120 54" pipe |
| II-4 | 75th Ave | | | | | | | | | | | | | | |
| | Sec. 24 (SW¼ & SW½ NW¼) | 212 | | 74 | | .003 | 64 | 0.58 | 0.57 | | | 0.33 | 25 | | 25 30" pipe |
| | Sec. 25 (NW¼) | 143 | | 43 | | .003 | | | | | | | | | |
| | Sum Osborn Road | 355 | | 117 | | | 73 | 0.52 | 0.51 | | | 0.28 | 33 | | 35 36" pipe |
| | Sec. 25 (SW¼) | 143 | | 43 | | .003 | | | | | | | | | |
| | Sum Thomas Road | 498 | | 160 | | | 81 | 0.47 | 0.46 | | | 0.23 | 37 | | 40 36" pipe |
| | Sec. 36 (NW¼) | 139 | | 46 | | .003 | | | | | | | | | |
| | Sum Encanto Blvd | 637 | | 206 | | | 89 | 0.44 | 0.43 | | | 0.21 | 43 | | 45 39" pipe |
| | Sec. 36 (SW¼) | 139 | | 46 | | .003 | | | | | | | | | |
| | Sum I-10 Channel | 776 | | 252 | | | 97 | 0.41 | 0.40 | | | 0.18 | 45 | | 50 42" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-5 | 71st Ave | | | | | | | | | | | | | | |
| | E½ S 3/4 Sec.1 (N½) | 120 | | 96 | | .003 | 40 | 0.83 | 0.82 | | | 0.56 | 54 | | 55 45" pipe |
| | E½ S 3/4 Sec. 1 (S½) | 120 | | 96 | | .003 | | | | | | | | | |
| | Sum Glendale Ave | 240 | | 192 | | | 48 | 0.72 | 0.71 | | | 0.46 | 88 | | 90 54" pipe |
| | E½ Sec. 12 (N½) | 160 | | 48 | | .002 | | | | | | | | | |
| | Sum Maryland Ave | 400 | | 240 | | | 55 | 0.65 | 0.64 | | | 0.40 | 96 | | 95 54" pipe |
| | E½ Sec. 12 (S½) | 160 | | 51 | | .002 | | | | | | | | | |
| | Sum Bethany Home Rd | 560 | | 291 | | | 62 | 0.59 | 0.58 | | | 0.34 | 99 | | 100 57" pipe |
| | E½ Sec. 13 (N½) | 160 | | 48 | | .0022 | | | | | | | | | |
| | Sum Missouri Ave | 720 | | 339 | | | 70 | 0.53 | 0.51 | | | 0.28 | 95 | | 105 57" pipe |
| | E½ Sec. 13 (S½) | 160 | | 48 | | .0022 | | | | | | | | | |
| | Sum Camelback Rd | 880 | | 387 | | | 77 | 0.49 | 0.47 | | | 0.24 | 93 | | 110 57" pipe |
| | NE¼ Sec. 24 | 160 | | 48 | | .003 | | | | | | | | | |
| | Sum Grand Canal | 1040 | | 435 | | | 85 | 0.46 | 0.44 | | | 0.22 | 96 | | 115 57" pipe |
| | SE¼ Sec. 24 | 160 | | 44 | | .003 | | | | | | | | | |
| | Sum Indian School Rd | 1200 | | 479 | | | 92 | 0.43 | 0.41 | | | 0.19 | 91 | | 120 57" pipe |
| | NE¼ Sec. 25 | 160 | | 48 | | .003 | | | | | | | | | |
| | Sum Osborn Rd | 1360 | | 527 | | | 98 | 0.41 | 0.39 | | | 0.17 | 90 | | 125 57" pipe |
| | SE¼ Sec. 25 | 160 | | 45 | | .003 | | | | | | | | | |
| | Sum Thomas Rd | 1520 | | 572 | | | 104 | 0.39 | 0.37 | | | 0.15+ | 86 | | 130 57" pipe |
| | NE¼ Sec. 36 | 160 | | 56 | | .003 | | | | | | | | | |
| | Sum Encanto Blvd | 1680 | | 628 | | | 110 | 0.37 | 0.35 | | | 0.135 | 85 | | 135 60" pipe |
| | SE¼ Sec. 36 | 160 | | 48 | | .003 | | | | | | | | | |
| | Sum I-10 Channel | 1840 | | 676 | | | 118 | 0.35 | 0.33 | | | 0.12 | 81 | | 140 66" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-6 | 67th Ave | | | | | | | | | | | | | | |
| | SW½SE¼ Sec. 6 | 72 | | 15 | | .0038 | 25 | 1.20 | 1.19 | | | 0.89 | 14 | | 15 24" pipe |
| | SW¼ & SW½ NW¼ Sec. 6 | 196 | | 57 | | .0038 | | | | | | | | | |
| | Sum Glendale Rd | 268 | | 72 | | | 34 | 0.95 | 0.94 | | | 0.67 | 48 | | 50 45" pipe |
| | N½ Sec. 7 | 281 | | 95 | | .0015 | | | | | | | | | |
| | Sum Maryland Ave | 549 | | 167 | | | 44 | 0.77 | 0.75 | | | 0.50 | 84 | | 85 54" pipe |
| | S½ Sec. 7 | 280 | | 95 | | .0015 | | | | | | | | | |
| | Sum Bethany Home Rd | 829 | | 262 | | | 52 | 0.69 | 0.67 | | | 0.42 | 110 | | 110 54" pipe |
| | N½ Sec. 18 | 283 | | 92 | | .0028 | | | | | | | | | |
| | Sum Missouri Ave | 1112 | | 354 | | | 59 | 0.61 | 0.59 | | | 0.35 | 124 | | 125 57" pipe |
| | S½ Sec. 18 | 282 | | 92 | | .0028 | | | | | | | | | |
| | Sum Camelback Rd | 1394 | | 446 | | | 65 | 0.57 | 0.55 | | | 0.32 | 143 | | 145 57" pipe |
| | N½ Sec. 19 | 295 | | 100 | | .0034 | | | | | | | | | |
| | Sum Campbell Ave | 1689 | | 546 | | | 71 | 0.53 | 0.51 | | | 0.28 | 153 | | 155 60" pipe |
| | S½ Sec. 19 | 295 | | 60 | | .0033 | | | | | | | | | |
| | Sum Indian School Rd | 1984 | | 606 | | | 77 | 0.49 | 0.47 | | | 0.243 | 147 | | 160 60" pipe |
| | N½ Sec. 30 | 283 | | 100 | | .0033 | | | | | | | | | |
| | Sum Osborn Rd | 2267 | | 706 | | | 82 | 0.47 | 0.45 | | | 0.225 | 159 | | 165 60" pipe |
| | S½ Sec. 30 | 283 | | 100 | | .0033 | | | | | | | | | |
| | Sum Thomas Rd | 2550 | | 806 | | | 88 | 0.44 | 0.42 | | | 0.20 | 161 | | 170 63" pipe |
| | N½ Sec. 31 | 283 | | 100 | | .0033 | | | | | | | | | |
| | Sum Encanto Blvd | 2833 | | 906 | | | 93 | 0.43 | 0.41 | | | 0.19 | 172 | | 175 72" pipe |
| | S½ Sec. 31 | 282 | | 100 | | .0025 | | | | | | | | | |
| | Sum I-10 Channel | 3115 | | 1006 | | | 103 | 0.39 | 0.37 | | | 0.153 | 153 | | 180 72" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-7 | 59th Ave | | | | | | | | | | | | | | |
| | SW½ NW¼ Sec. 8 | 80 | | 64 | | .002 | 32 | 1.00 | 0.99 | | | 0.71 | 46 | | 45 42" pipe |
| | SW¼ SW½ SE¼ Sec. 8 | 240 | | 192 | | .002 | | | | | | | | | |
| | Sum Bethany Home Rd | 320 | | 256 | | | 41 | 0.82 | 0.81 | | | 0.55 | 147 | | 145 60" pipe |
| | N½ Sec. 17 | 320 | | 257 | | .003 | | | | | | | | | |
| | Sum Missouri Ave | 640 | | 513 | | | 47 | 0.73 | 0.71 | | | 0.46 | 236 | | 235 72" pipe |
| | S½ Sec. 17 | 320 | | 256 | | .003 | | | | | | | | | |
| | Sum Camelback Rd | 960 | | 769 | | | 52 | 0.69 | 0.67 | | | 0.42 | 330 | | 330 78" pipe |
| | N½ Sec. 20 | 313 | | 170 | | .0034 | | | | | | | | | |
| | Sum Campbell Ave | 1273 | | 939 | | | 57 | 0.63 | 0.61 | | | 0.37 | 348 | | 350 81" pipe |
| | S½ Sec. 20 | 313 | | 171 | | .0034 | | | | | | | | | |
| | Sum Indian School Rd | 1586 | | 1110 | | | 61 | 0.60 | 0.57 | | | 0.33 | 367 | | 370 81" pipe |
| | N½ Sec. 29 | 292 | | 161 | | .0038 | | | | | | | | | |
| | Sum Osborn Rd | 1878 | | 1271 | | | 65 | 0.57 | 0.54 | | | 0.306 | 390 | | 390 81" pipe |
| | S½ Sec. 29 | 292 | | 65 | | .0042 | | | | | | | | | |
| | Sum Thomas Rd | 2170 | | 1336 | | | 69 | 0.54 | 0.51 | | | 0.28 | 374 | | 400 84" pipe |
| | N½ Sec. 32 | 286 | | 94 | | .0022 | | | | | | | | | |
| | Sum Encanto Blvd | 2456 | | 1430 | | | 74 | 0.51 | 0.48 | | | 0.25 | 358 | | 405 90" pipe |
| | S½ Sec. 32 | 286 | | 94 | | .0032 | | | | | | | | | |
| | Sum I-10 Channel | 2742 | | 1524 | | | 82 | 0.47 | 0.44 | | | 0.216 | 328 | | 410 96" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-8 | 51st Ave | | | | | | | | | | | | | | |
| | Sec. 33 (SE¼) | 285 | | 97 | | .0032 | 42 | 0.80 | 0.79 | | | 0.53 | 52 | | 55 42" pipe |
| | Sec. 4 (NE¼) | 160 | | 48 | | .003 | | | | | | | | | |
| | Sum 47th Ave & Orangewood | 445 | | 145 | | | 49 | 0.70 | 0.69 | | | 0.44 | 64 | | 65 45" pipe |
| | Sec. 4 (NW¼) | 160 | | 48 | | .003 | | | | | | | | | |
| | Sum 51st Ave & Orangewood | 605 | | 193 | | | 56 | 0.64 | 0.62 | | | 0.38 | 74 | | 75 48" pipe |
| | Sec. 4 (S½) | 270 | | 194 | | .0038 | | | | | | | | | |
| | Sum | 875 | | 387 | | | 62 | 0.59 | 0.57 | | | 0.33 | 128 | | 130 54" pipe |
| | Sec. 5 (SE¼SE¼) | 76 | | 42 | | .0032 | | | | | | | | | |
| | Sum Glendale Ave | 951 | | 429 | | | 62 | 0.59 | 0.57 | | | 0.33 | 142 | | 145 57" pipe |
| | Sec. 9 (N½) | 293 | | 161 | | .0038 | | | | | | | | | |
| | Sum Maryland Ave | 1244 | | 590 | | | 67 | 0.55 | 0.53 | | | 0.30 | 177 | | 175 60" pipe |
| | Sec. 9 (S½) | 293 | | 130 | | .0038 | | | | | | | | | |
| | Sum | 1593 | | 720 | | | 72 | 0.52 | 0.50 | | | 0.27 | 194 | | 195 63" pipe |
| | Sec. 8 (NE½) | 308 | | 238 | | .0023 | 66 | 0.56 | 0.55 | | | 0.315 | 75 | | 75 45" pipe |
| | Sum Bethany Home Rd | 1845 | | 958 | | | 72 | 0.52 | 0.50 | | | 0.27 | 258 | | 260 72" pipe |
| | Sec. 16 SW½ NW¼ | 80 | | 64 | | .0037 | | | | | | | | | |
| | Sum Missouri Ave | 1925 | | 1022 | | | 77 | 0.49 | 0.47 | | | 0.24 | 245 | | 265 72" pipe |
| | Sec. 16 SW¼ & SW½ SE¼ | 240 | | 192 | | .0037 | | | | | | | | | |
| | Sum Camelback Rd | 2165 | | 1214 | | | 82 | 0.47 | 0.45 | | | 0.225 | 274 | | 275 72" pipe |
| | Sec. 21 N½ | 307 | | 195 | | .0037 | | | | | | | | | |
| | Sum Campbell Ave | 2472 | | 1409 | | | 86 | 0.45 | 0.43 | | | 0.21 | 296 | | 300 75" pipe |
| | Sec. 21 S½ | 307 | | 195 | | .0037 | | | | | | | | | |
| | Sum Indian School Rd | 2779 | | 1604 | | | 91 | 0.43 | 0.41 | | | 0.19 | 305 | | 305 81" pipe |
| | Sec. 28 N½ | 282 | | 100 | | .0026 | | | | | | | | | |
| | Sum | 3061 | | 1704 | | | 95 | 0.42 | 0.40 | | | 0.18 | 307 | | 310 84" pipe |
| | Sec. 29 NE¼ | 146 | | 95 | | .002 | | | | | | | | | |
| | Sum Grand Canal | 3207 | | 1799 | | | 95 | 0.42 | 0.40 | | | 0.18 | 324 | | 325 84" pipe |
| | Sec. 28 S½ | 283 | | 100 | | .0023 | | | | | | | | | |
| | Sum Thomas Rd | 3490 | | 1899 | | | 100 | 0.40 | 0.38 | | | 0.16 | 304 | | 330 84" pipe |
| | Sec. 33 N½ | 284 | | 95 | | .003 | | | | | | | | | |
| | Sum Encanto Blvd. | 3774 | | 1994 | | | 105 | 0.38 | 0.36 | | | 0.145 | 290 | | 335 90" pipe |
| | Sec. 33 S½ | 283 | | 92 | | .003 | | | | | | | | | |
| | Sum I-10 Channel | 4057 | | 2086 | | | 110 | 0.37 | 0.35 | | | 0.135 | 282 | | 340 90" pipe |

EXPECTED FLOWS    1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| II-9 | 43rd Ave | | | | | | | | | | | | | | |
| | Sec. 27 | 222 | | 84 | | .0038 | 33 | 0.97 | 0.96 | | | 0.68 | 57 | | 55 39" pipe |
| | NE¼ Sec. 34 & W½NW¼ Sec. 35 | 221 | | 48 | | .003 | | | | | | | | | |
| | Sum Butler Dr & 47th Ave | 443 | | 132 | | | 40 | 0.83 | 0.82 | | | 0.56 | 74 | | 75 48" pipe |
| | NW¼ Sec. 34 | 141 | | 48 | | .0032 | | | | | | | | | |
| | Sum Butler Dr & 43rd Ave | 584 | | 180 | | | 47 | 0.73 | 0.72 | | | 0.47 | 85 | | 85 48" pipe |
| | S½ Sec. 34 & W½SW¼ Sec. 35 | 362 | | 168 | | .0038 | | | | | | | | | |
| | Sum Northern Ave | 946 | | 348 | | | 53 | 0.66 | 0.64 | | | 0.40 | 139 | | 140 57" pipe |
| | N½ Sec. 3 | 330 | | 116 | | .0038 | | | | | | | | | |
| | Sum Orangewood Ave | 1276 | | 464 | | | 59 | 0.61 | 0.59 | | | 0.35 | 162 | | 165 60" pipe |
| | S½ Sec. 3 | 290 | | 100 | | .0038 | | | | | | | | | |
| | Sum Glendale Ave | 1566 | | 564 | | | 64 | 0.57 | 0.55 | | | 0.32 | 180 | | 180 66" pipe |
| | NE½ Sec. 10 | 284 | | 120 | | .0027 | | | | | | | | | |
| | Sum Maryland Ave | 1850 | | 684 | | | 70 | 0.53 | 0.50 | | | 0.27 | 185 | | 185 66" pipe |
| | S½ Sec. 10 | 254 | | 98 | | .0027 | | | | | | | | | |
| | Sum Bethany Home Rd | 2104 | | 782 | | | 75 | 0.50 | 0.47 | | | 0.24 | 188 | | 190 66" pipe |
| | NW¼ Sec. 15 | 140 | | 50 | | .0036 | | | | | | | | | |
| | Sum | 2244 | | 832 | | | 80 | 0.48 | 0.46 | | | 0.23 | 192 | | 195 |
| | NE½NW¼ & NE¼ Sec. 16 | 240 | | 192 | | .0036 | 40 | 0.83 | 0.82 | | | 0.56 | 107 | | 110 51" pipe |
| | Sum Missouri Ave | 2484 | | 1024 | | | 80 | 0.48 | 0.46 | | | 0.23 | 236 | | 240 69" pipe |
| | Sec. 16 NE½SE¼ | 80 | | 64 | | .0036 | | | | | | | | | |
| | Sec. 15 SW¼ | 120 | | 43 | | | | | | | | | | | |
| | Sum Camelback Rd | 2684 | | 1131 | | | 85 | 0.46 | 0.44 | | | 0.22 | 250 | | 255 69" pipe |
| | Sec. 22 SW½NW¼ | 80 | | 64 | | .0048 | | | | | | | | | |
| | Sum Campbell Ave | 2764 | | 1195 | | | 90 | 0.44 | 0.42 | | | 0.20 | 240 | | 260 69" pipe |
| | Sec. 22 SW½SE¼ & SW¼ | 240 | | 192 | | .0048 | | | | | | | | | |
| | Sum Indian School Rd | 3004 | | 1387 | | | 94 | 0.42 | 0.40 | | | 0.18 | 250 | | 265 72" pipe |
| | Sec. 27 N½ | 280 | | 224 | | .0036 | | | | | | | | | |
| | Sum Grand Canal | 3284 | | 1611 | | | 99 | 0.40 | 0.38 | | | 0.16 | 158 | | 270 72" pipe |
| | Sec. 27 N½ | 322 | | 113 | | .0036 | | | | | | | | | |
| | Sum Thomas Rd | 3606 | | 1724 | | | 103 | 0.39 | 0.37 | | | 0.15 | 258 | | 275 72" pipe |
| | N½ Sec. 34 | 284 | | 110 | | .0036 | | | | | | | | | |
| | Sum Encanto Blvd | 3890 | | 1834 | | | 108 | 0.38 | 0.36 | | | 0.14 | 257 | | 280 72" pipe |
| | S½ Sec. 34 | 284 | | 110 | | .0036 | | | | | | | | | |
| | Sum I-10 Channel | 4174 | | 1944 | | | 115 | 0.36 | 0.34 | | | 0.125 | 243 | | 290 90" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| III-1 | 67th Ave | | | | | | | | | | | | | | |
| | Sec. 18 (N½N½) & (SW Part) | 119 | | 44 | | .0034 | 31 | 1.02 | 1.01 | | | 0.73 | 32 | | 35 36" pipe |
| | Sec. 18 (S½N½ & N½S½) | 198 | | 68 | | .0034 | | | | | | | | | |
| | Sum Cactus Rd | 317 | | 112 | | | 39 | 0.85 | 0.84 | | | 0.58 | 65 | | 65 42" pipe |
| | Sec. 19 (N½) | 280 | | 96 | | .0023 | | | | | | | | | |
| | Sum | 597 | | 208 | | | 46 | 0.75 | 0.73 | | | 0.48 | 100 | | 105 54" pipe |
| | Sec. 19 (S½) | 281 | | 96 | | .0023 | | | | | | | | | |
| | Sum Peoria Ave | 878 | | 304 | | | 53 | 0.67 | 0.65 | | | 0.405 | 123 | | 120 57" pipe |
| | Sec. 24 (E½) | 107 | | 38 | | .003 | | | | | | | | | |
| | Sum 71st Ave | 985 | | 342 | | | 60 | 0.60 | 0.58 | | | 0.34 | 116 | | 125 57" pipe |
| | Sec. 24 (W½) | 110 | | 39 | | .003 | | | | | | | | | |
| | Sum 75th Ave | 1095 | | 381 | | | 67 | 0.55 | 0.53 | | | 0.30 | 115 | | 135 57" pipe |
| III-2 | Olive Ave | | | | | | | | | | | | | | |
| | Sec. 30 & 19 (N½) | 290 | | 85 | | .003 | 50 | 0.70 | 0.69 | | | 0.44 | 37 | | 40 36" pipe |
| | Sec. 30 & 19 (S½) | 310 | | 90 | | .0034 | | | | | | | | | |
| | Sum 67th Ave | 600 | | 175 | | | 58 | 0.62 | 0.60 | | | 0.36 | 63 | | 65 42" pipe |
| | Sec . 25 (E½) | 260 | | 91 | | .004 | | | | | | | | | |
| | Sum 71st Ave | 860 | | 266 | | | 65 | 0.57 | 0.55 | | | 0.32 | 85 | | 85 48" pipe |
| | Sec. 25 (W½) | 300 | | 105 | | .004 | | | | | | | | | |
| | Sum 75th Ave | 1160 | | 371 | | | 71 | 0.53 | 0.51 | | | 0.28 | 104 | | 105 51" pipe |
| III-3 | 75th Ave | | | | | | | | | | | | | | |
| | Sec. 12 | 136 | | 36 | | .003 | 40 | 0.83 | 0.82 | | | 0.56 | 20 | | 20 27" pipe |
| | Sec. 13 | 208 | | 72 | | .0038 | | | | | | | | | |
| | Sum Cactus Rd | 344 | | 108 | | | 58 | 0.62 | 0.61 | | | 0.37 | 40 | | 40 39" pipe |
| | Area III-1 | 1095 | | 381 | | | | | | | | | | | |
| | Sum Peoria Ave | 1439 | | 489 | | | 67 | 0.55 | 0.53 | | | 0.30 | 147 | | 145 57" pipe |
| | Sec. 26 (NE¼NW¼ & NE¼) | 240 | | 100 | | .002 | 32 | 1.00 | 0.99 | | | 0.71 | 71 | | 70 45" pipe |
| | Sum Mountain View Rd | 1679 | | 589 | | | 67 | 0.55 | 0.53 | | | 0.30 | 177 | | 180 63" pipe |
| | Area III-2 | 1160 | | 371 | | | | | | | | | | | |
| | Sec. 26 (NE¼SE¼) | 80 | | 60 | | | | | | | | | | | |
| | N. Part Sec. 36 | 160 | | 88 | | .0014 | 45 | 0.76 | 0.75 | | | 0.50 | 44 | | 45 39" pipe |
| | Sum | 3079 | | 1109 | | | 78 | 0.49 | 0.47 | | | 0.24 | 266 | | 265 78" pipe |
| | Sec. 36 (NW Part) | 80 | | 24 | | .002 | | | | | | | | | |
| | Sum Butler Dr | 3159 | | 1133 | | | 84 | 0.46 | 0.44 | | | 0.216 | 245 | | 270 78" pipe |
| | Sec. 36 (SW¼) | 160 | | 98 | | .002 | | | | | | | | | |
| | Sum Glendale Channel | 3319 | | 1231 | | | 93 | 0.43 | 0.41 | | | 0.19 | 234 | | 275 87" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious: $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious: $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| III-4 | Cactus Road | | | | | | | | | | | | | | |
| | Sec. 11 | 64 | | 32 | | .0034 | 70 | 0.53 | 0.52 | | | 0.29 | 10 | | 10 Street flow |
| | Sec. 14 | 134 | | 74 | | .003 | | | | | | | | | |
| | Sum Cactus Rd &83rd | 198 | | 106 | | | 138 | 0.31 | 0.30 | | | 0.09 | 10 | | 15 27" pipe |
| | Sec. 10 (SE Part) | 24 | | 12 | | .003 | | | | | | | | | |
| | Sec. 15 | 237 | | 113 | | .003 | 118 | 0.35 | 0.34 | | | 0.13 | 15 | | 20 30" pipe |
| | Sum Cactus Rd & 91st | 459 | | 231 | | | 158 | 0.28 | 0.27 | | | 0.07 | 16 | | 20 30" pipe |
| | Sec. 23 (E½) | 260 | | 93 | | .003 | 50 | 0.69 | 0.68 | | | 0.43 | 40 | | 40 39" pipe |
| | Sec. 23 (W½) | 305 | | 109 | | .003 | 60 | 0.60 | 0.59 | | | 0.35 | 71 | | 75 54" pipe |
| | Sum Peoria Ave & 83rd | 565 | | 202 | | | | | | | | | | | |
| | Sec. 22 (NE¼) | 181 | | 103 | | .0012 | | | | | | | | | |
| | Sum Grand Ave & 91st | 1205 | | 536 | | | 160 | 0.28 | 0.26 | | | 0.06 | 32 | | 95 60" pipe |
| | Sec. 16 (SE Part) | 80 | | 64 | | .001 | | | | | | | | | |
| | Sec. 21 (NE Part) | 20 | | 9 | | .001 | | | | | | | | | |
| | Sum New River | 1305 | | 609 | | | 168 | 0.27 | 0.25 | | | 0.045 | 28 | | 100 63" pipe |
| III-5 | Peoria Ave. | | | | | | | | | | | | | | |
| | Sec. 22 (SW½ SE¼) | 80 | | 29 | | .0034 | 34 | 0.95 | 0.94 | | | 0.67 | 20 | | 20 27" pipe |
| | Sec. 22 (W Part) | 204 | | 74 | | .0034 | 43 | 0.79 | 0.78 | | | 0.52 | 39 | | 40 36" pipe |
| | Sum 91st Ave. | 284 | | 103 | | | 43 | 0.79 | 0.78 | | | 0.52 | 54 | | 55 45" pipe |
| | Sec. 21 | 342 | | 143 | | .003 | | | | | | | | | |
| | Sum New River | 626 | | 246 | | | 53 | 0.67 | 0.66 | | | 0.42 | 103 | | 105 60" pipe |
| III-6 | Olive Ave. | | | | | | | | | | | | | | |
| | Sec. 27 (E½) | 282 | | 152 | | .003 | 45 | 0.76 | 0.75 | | | 0.50 | 76 | | 80 48" pipe |
| | Sec. 27 (W½) | 283 | | 50 | | .002 | | | | | | | | | |
| | Sum 91st Ave. | 565 | | 202 | | | 52 | 0.68 | 0.66 | | | 0.42 | 85 | | 90 57" pipe |
| | Sec. 28 | 177 | | 85 | | .0028 | | | | | | | | | |
| | Sum New River | 742 | | 287 | | | 66 | 0.56 | 0.54 | | | 0.31 | 89 | | 100 60" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| III-7 | 83rd Ave | | | | | | | | | | | | | | |
| | Sec. 26 (SE¼NW¼) | 80 | | 64 | | .003 | 32 | 1.00 | 0.99 | | | 0.71 | 46 | | 45 39" pipe |
| | Sec. 26 (SW¼SE¼) | 80 | | 64 | | .003 | | | | | | | | | |
| | Sec. 26 (SW¼) | 160 | | 128 | | .003 | | | | | | | | | |
| | Sum 83rd Ave & Olive Ave | 320 | | 256 | | | 41 | 0.82 | 0.81 | | | 0.55 | 141 | | 140 60" pipe |
| | Sec. 35 | 64 | | 32 | | .003 | | | | | | | | | |
| | Sum Glendale Channel | 386 | | 288 | | | 55 | 0.65 | 0.64 | | | 0.40 | 115 | | 145 63" pipe |
| III-8 | SE Part Sec. 36 (N.Pt.) | 20 | | 18 | | .0015 | 18 | 1.50 | 1.49 | | | 1.16 | 21 | | 25 39" pipe |
| | SE Part Sec. 36 (S.Pt.) | 60 | | 54 | | .0015 | | | | | | | | | |
| | Sum Glendale Channel | 80 | | 72 | | | 30 | 1.05 | 1.04 | | | 0.76 | 55 | | 55 51" pipe |
| III-9 | 59th Ave | | | | | | | | | | | | | | |
| | Sec. 17 (SW Part) | 185 | | 37 | | .0032 | 50 | 0.70 | 0.69 | | | 0.44 | 17 | | 20 27" pipe |
| | Sec. 20 (E½) | 255 | | 87 | | .0042 | 50 | 0.70 | 0.69 | | | 0.44 | 39 | | 40 36" pipe |
| | Sec. 20 (W½) | 295 | | 101 | | .0036 | | | | | | | | | |
| | Sum Peoria Ave | 735 | | 225 | | | 68 | 0.54 | 0.53 | | | 0.30 | 68 | | 70 48" pipe |
| | Sec. 29 (E½) | 255 | | 87 | | .0036 | 50 | 0.70 | 0.69 | | | 0.44 | 39 | | 40 36" pipe |
| | Sec. 29 (W½) | 295 | | 101 | | .0023 | | | | | | | | | |
| | Sum Glendale Channel | 1285 | | 413 | | | 83 | 0.47 | 0.45 | | | 0.23 | 95 | | 95 57" pipe |
| III-10 | 51st Ave | | | | | | | | | | | | | | |
| | Sec. 21 (SE Part) | 40 | | 12 | | .003 | 30 | 1.05 | 1.04 | | | 0.76 | 10 | | 10 Street flow |
| | Sec. 21 (W Part) | 200 | | 60 | | .003 | | | | | | | | | |
| | Sum Peoria Ave & 51st | 240 | | 72 | | | 39 | 0.85 | 0.84 | | | 0.58 | 42 | | 45 39" pipe |
| | Sec. 27 (W½) | 286 | | 98 | | .003 | 39 | 0.85 | 0.84 | | | 0.58 | 57 | | 55 42" pipe |
| | Sec. 28 (E½) | 260 | | 89 | | .003 | | | | | | | | | |
| | Sum 47th Ave & Olive | 546 | | 187 | | | 48 | 0.72 | 0.71 | | | 0.46 | 86 | | 85 48" pipe |
| | Sec. 28 (W½) | 300 | | 103 | | .003 | | | | | | | | | |
| | Sum 51st Ave & Olive | 846 | | 290 | | | 55 | 0.65 | 0.64 | | | 0.40 | 116 | | 115 63" pipe |
| | Sum Glendale Channel | 1086 | | 362 | | | 58 | 0.61 | 0.59 | | | 0.35 | 127 | | 130 63" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| III-11 | Northern Avenue | | | | | | | | | | | | | | |
| | Sec. 33 NW¼ NE¼ | 71 | | 24 | | .003 | 55 | 0.65 | 0.64 | | | 0.40 | 10 | | 10 Street flow |
| | Sec. 33 (NW¼) | 142 | | 48 | | .0021 | | | | | | | | | |
| | Sum | 213 | | 72 | | | 63 | 0.58 | 0.57 | | | 0.33 | 24 | | 25 33" pipe |
| | Sec. 33 (NE¼ SW¼) | 71 | | 24 | | .003 | | | | | | | | | |
| | Sum 51st Avenue | 284 | | 96 | | | 71 | 0.53 | 0.52 | | | 0.29 | 28 | | 30 33" pipe |
| | S 3/4 Sec. 32 (E½) | 213 | | 75 | | .004 | | | | | | | | | |
| | Sum 55th Avenue | 497 | | 171 | | | 78 | 0.49 | 0.48 | | | 0.25 | 43 | | 45 36" pipe |
| | S 3/4 Sec. 32 (W½) | 213 | | 75 | | .004 | | | | | | | | | |
| | Sum 59th Avenue | 710 | | 246 | | | 85 | 0.46 | 0.45 | | | 0.23 | 57 | | 55 39" pipe |
| | S 3/4 Sec. 33 (E½) | 213 | | 77 | | .0036 | | | | | | | | | |
| | Sum Glendale Channel | 923 | | 323 | | | 93 | 0.43 | 0.42 | | | 0.20 | 65 | | 65 48" pipe |
| III-12 | | | | | | | | | | | | | | | |
| | Sec. 5 (NE¼) | 142 | | 50 | | .0034 | 52 | 0.69 | 0.68 | | | 0.43 | 22 | | 25 30" pipe |
| | Sec. 5 (NW¼) | 151 | | 101 | | .0034 | | | | | | | | | |
| | Sum 59th Avenue | 293 | | 151 | | | 61 | 0.59 | 0.58 | | | 0.34 | 52 | | 50 39" pipe |
| | Sec. 6 (NE¼) | 143 | | 47 | | .0030 | | | | | | | | | |
| | Sum 63rd Avenue | 436 | | 198 | | | 68 | 0.54 | 0.53 | | | 0.30 | 60 | | 60 42" pipe |
| | Sec. 6 NE¼ NW¼ | 62 | | 21 | | .0015 | | | | | | | | | |
| | Sum | 498 | | 219 | | | 77 | 0.49 | 0.48 | | | 0.25 | 54 | | 55 48" pipe |
| | Sec. 6 NE¼ SE¼ | 72 | | 24 | | .0015 | 16 | 1.65 | 1.63 | | | 1.29 | 31 | | 30 39" pipe |
| | Sum | 570 | | 243 | | | 77 | 0.49 | 0.48 | | | 0.25 | 61 | | 60 48" pipe |
| | Sec. 5 SE Part | 114 | | 68 | | .0032 | 38 | 0.86 | 0.85 | | | 0.59 | 40 | | 40 36" pipe |
| | Sec. 5 SW Part | 76 | | 68 | | .0025 | | | | | | | | | |
| | Sum Glendale & 59th Avenue | 190 | | 136 | | | 42 | 0.80 | 0.79 | | | 0.53 | 72 | | 70 48" pipe |
| | Sum Glendale Channel | 760 | | 379 | | | 77 | 0.49 | 0.48 | | | 0.25 | 95 | | 100 63" pipe |
| III-13 | | | | | | | | | | | | | | | |
| | Sec. 36 E Part | 160 | | 48 | | .0015 | 55 | 0.65 | 0.64 | | | 0.40 | 19 | | 20 33" pipe |
| | Sec. 31 (W½) | 142 | | 51 | | .0015 | | | | | | | | | |
| | Sum Glendale Channel | 302 | | 99 | | | 61 | 0.60 | 0.59 | | | 0.35 | 35 | | 35 39" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-1 | Bell Road | | | | | | | | | | | | | | |
| | Sec. 36 (E.Pt) | 428 | | 165 | | .004 | 54 | 0.66 | 0.65 | | | 0.41 | 68 | | 70 42" pipe |
| | Sec. 36 (W.Pt) | 80 | | 48 | | .004 | | | | | | | | | |
| | Sum Sec. 36 @ 27th Ave | 508 | | 213 | | | 59 | 0.61 | 0.60 | | | 0.36 | 77 | | 75 42" pipe |
| | Sec. 35 (E½) | 385 | | 140 | | .0034 | | | | | | | | | |
| | Sum E½ 35 - 36 | 893 | | 353 | | | 66 | 0.56 | 0.54 | | | 0.31 | 110 | | 110 51" pipe |
| | Sec. 35 (W½) | 390 | | 117 | | .0034 | | | | | | | | | |
| | Sum 35 - 36 @ 35th Ave | 1283 | | 470 | | | 72 | 0.52 | 0.50 | | | 0.27 | 127 | | 125 54" pipe |
| | Sec. 34 (E½) | 400 | | 112 | | .0049 | | | | | | | | | |
| | Sum E½ 34 - 36 | 1683 | | 582 | | | 78 | 0.49 | 0.47 | | | 0.25 | 146 | | 145 54" pipe |
| | Sec. 34 (W½) | 400 | | 112 | | .0049 | | | | | | | | | |
| | Sum 34 - 36 @ 43rd Ave | 2083 | | 694 | | | 83 | 0.46 | 0.44 | | | 0.22 | 153 | | 155 54" pipe |
| | Sec. 33 (E½) | 398 | | 106 | | .0034 | | | | | | | | | |
| | Sum E½ 33 - 36 | 2481 | | 800 | | | 88 | 0.44 | 0.42 | | | 0.20 | 160 | | 160 60" pipe |
| | Sec. 33 (W½) | 398 | | 106 | | .0034 | | | | | | | | | |
| | Sum 33 - 36 @ 51st Ave | 2879 | | 906 | | | 94 | 0.42 | 0.40 | | | 0.18 | 163 | | 165 63" pipe |
| | Sec. 32 (E½) | 400 | | 106 | | .0032 | | | | | | | | | |
| | Sum E½ 32 - 36 | 3279 | | 1012 | | | 100 | 0.40 | 0.38 | | | 0.16 | 162 | | 170 63" pipe |
| | Sec. 32 (W½) | 330 | | 92 | | .0032 | | | | | | | | | |
| | Sum 32 - 36 @ 59th Ave | 3609 | | 1104 | | | 106 | 0.38 | 0.36 | | | 0.15 | 166 | | 175 63" pipe |
| | Sec. 31 & part of 36 | 56 | | 28 | | .0038 | | | | | | | | | |
| | Sum 36, 31, 32, 33, 34, 35, 36 | 3665 | | 1132 | | | 113 | 0.36 | 0.34 | | | 0.13 | 147 | | 180 63" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-2 | Greenway Road | | | | | | | | | | | | | | |
| | Sec. 1 (E.Pt) | 480 | | 154 | | .004 | 56 | 0.64 | 0.63 | | | 0.39 | 60 | | 60 42" pipe |
| | Sec. 1 (W.Pt) | 30 | | 9 | | | | | | | | | | | |
| | Sum Sec. 1 @ 27th Ave | 510 | | 163 | | .004 | 60 | 0.60 | 0.59 | | | 0.35 | 57 | | 60 42" pipe |
| | Sec. 2 (E½) | 305 | | 93 | | | | | | | | | | | |
| | Sum E½ 2 & Sec. 1 | 815 | | 256 | | .0034 | 67 | 0.55 | 0.53 | | | 0.30 | 77 | | 75 45" pipe |
| | Sec. 2 (W½) | 309 | | 94 | | .0034 | | | | | | | | | |
| | Sum 1 - 2 @ 35th Ave | 1124 | | 350 | | | 73 | 0.52 | 0.50 | | | 0.27 | 95 | | 95 48" pipe |
| | Sec. 3 (E½) | 320 | | 98 | | .0034 | | | | | | | | | |
| | Sum E½ 3, 2, 1, | 1444 | | 448 | | | 79 | 0.49 | 0.47 | | | 0.25 | 112 | | 110 51" pipe |
| | Sec. 3 (W½) | 320 | | 98 | | .0034 | | | | | | | | | |
| | Sum 3-2-1 @ 43rd Ave | 1764 | | 546 | | | 85 | 0.46 | 0.44 | | | 0.22 | 120 | | 120 54" pipe |
| | Sec. 4 (E½) | 320 | | 93 | | .0044 | | | | | | | | | |
| | Sum E½ 4, 3, 2, 1 | 2084 | | 639 | | | 91 | 0.43 | 0.41 | | | 0.19 | 121 | | 125 54" pipe |
| | Sec. 4 (W½) | 320 | | 93 | | .0044 | | | | | | | | | |
| | Sum 4 - 1 @ 51st Ave | 2404 | | 732 | | | 96 | 0.42 | 0.39 | | | 0.17 | 124 | | 130 54" pipe |
| | Sec. 5 (E½) | 320 | | 96 | | .0032 | | | | | | | | | |
| | Sum E½ 5 - 1 | 2724 | | 828 | | | 101 | 0.40 | 0.38 | | | 0.16 | 132 | | 135 57" pipe |
| | Sec. 5 (W½) | 320 | | 96 | | .0032 | | | | | | | | | |
| | Sum 5 - 1 @ 59th Ave | 3044 | | 924 | | | 107 | 0.38 | 0.36 | | | 0.15 | 133 | | 140 57" pipe |
| | Sec. 6 (E½) | 320 | | 92 | | .003 | | | | | | | | | |
| | Sum E½ 6 - 1 | 3364 | | 1016 | | | 113 | 0.36 | 0.34 | | | 0.13 | 138 | | 145 60" pipe |
| | Sec. 6 (W½) | 199 | | 60 | | .003 | | | | | | | | | |
| | Sum 6-1 @ 67th Ave | 3563 | | 1076 | | | 119 | 0.35 | 0.33 | | | 0.12 | 129 | | 150 60" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a-f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-3 | Thunderbird Rd | | | | | | | | | | | | | | |
| | Sec. 12 | 145 | | 44 | | .003 | 49 | 0.70 | 0.69 | | | 0.44 | 20 | | 20 30" pipe |
| | Sec. 11 (E½) | 303 | | 91 | | .004 | | | | | | | | | |
| | Sum 12 - E½11 | 448 | | 135 | | | 62 | 0.59 | 0.58 | | | 0.34 | 46 | | 50 39" pipe |
| | Sec. 11 (W½) | 320 | | 96 | | .004 | | | | | | | | | |
| | Sum 11 - 12 @35th Ave | 768 | | 231 | | | 69 | 0.54 | 0.53 | | | 0.30 | 70 | | 70 42" pipe |
| | Sec. 10 (E½) | 320 | | 96 | | .003 | | | | | | | | | |
| | Sum 11 - 12 E½10 | 1088 | | 327 | | | 75 | 0.50 | 0.48 | | | 0.25 | 82 | | 85 48" pipe |
| | Sec. 10 (W½) | 320 | | 96 | | .003 | | | | | | | | | |
| | Sum 10, 11, 12 @43rd Ave | 1408 | | 423 | | | 82 | 0.47 | 0.45 | | | 0.23 | 98 | | 100 51" pipe |
| | Sec. 9 (E½) | 320 | | 96 | | .004 | | | | | | | | | |
| | Sum E½9, 10, 11, 12 | 1728 | | 519 | | | 88 | 0.44 | 0.42 | | | 0.20 | 104 | | 105 51" pipe |
| | Sec. 9 (W½) | 320 | | 96 | | .004 | | | | | | | | | |
| | Sum 9, 10, 11, 12 @51st Ave | 2048 | | 615 | | | 94 | 0.42 | 0.40 | | | 0.18 | 110 | | 110 51" pipe |
| | Sec. 8 (E½) | 320 | | 96 | | .0032 | | | | | | | | | |
| | Sum E½ 8 - 12 | 2368 | | 711 | | | 100 | 0.40 | 0.38 | | | 0.16 | 114 | | 115 54" pipe |
| | Sec. 8 (W½) | 320 | | 64 | | .0032 | | | | | | | | | |
| | Sum 8 - 12 @59th Ave | 2688 | | 775 | | | 106 | 0.38 | 0.36 | | | 0.15 | 116 | | 120 54" pipe |
| | Sec. 7 (E¼) | 160 | | 48 | | .0032 | | | | | | | | | |
| | Sum E¼ 7 - 12 | 2848 | | 823 | | | 109 | 0.37 | 0.35 | | | 0.14 | 115 | | 125 54" pipe |
| IV-4 | Cactus Road | | | | | | | | | | | | | | |
| | Sec. 14 (E½) | 255 | | 115 | | .0034 | 49 | 0.71 | 0.70 | | | 0.45 | 53 | | 55 39" pipe |
| | Sec. 14 (W½) | 295 | | 135 | | .0034 | | | | | | | | | |
| | Sum Sec. 14 @ 35th Avenue | 550 | | 250 | | | 56 | 0.64 | 0.63 | | | 0.39 | 98 | | 100 51" pipe |
| | Sec. 15 (E½) | 320 | | 100 | | .0027 | | | | | | | | | |
| | Sum E½ 15, 14 | 870 | | 350 | | | 63 | 0.58 | 0.57 | | | 0.34 | 120 | | 120 57" pipe |
| | Sec. 15 (W½) | 320 | | 100 | | .0027 | | | | | | | | | |
| | Sum 15 - 14 @ 43rd Avenue | 1190 | | 450 | | | 69 | 0.54 | 0.52 | | | 0.29 | 130 | | 130 57" pipe |
| | Sec. 16 (E½) | 320 | | 99 | | .004 | | | | | | | | | |
| | Sum E½ 16 - 14 | 1510 | | 549 | | | 75 | 0.50 | 0.48 | | | 0.25 | 137 | | 140 57" pipe |
| | Sec. 16 (W½) | 320 | | 99 | | .004 | | | | | | | | | |
| | Sum 16 - 14 @ 51st Avenue | 1830 | | 648 | | | 80 | 0.48 | 0.46 | | | 0.24 | 155 | | 155 57" pipe |
| | Sec. 17 (E¼) | 160 | | 50 | | .004 | | | | | | | | | |
| | Sum E¼ 17 - 14 | 1990 | | 698 | | | 83 | 0.46 | 0.44 | | | 0.22 | 154 | | 160 57" pipe |
| | Sec. 14 (E 1/8) | 64 | | 29 | | | 41 | 0.82 | 0.81 | | | 0.55 | 16 | | 15 27" pipe |
| | Sec 14 (E¼) | 128 | | 58 | | | 44 | 0.77 | 0.76 | | | 0.50 | 29 | | 30 33" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-5 | Peoria Ave | | | | | | | | | | | | | | |
| | Sec. 23 (E½) | 255 | | 77 | | .0021 | 40 | 0.83 | 0.82 | | | 0.56 | 43 | | 45 42" pipe |
| | Sec. 23 (W½) | 295 | | 89 | | .0026 | | | | | | | | | |
| | Sum 35th Ave | 550 | | 166 | | | 49 | 0.70 | 0.68 | | | 0.43 | 72 | | 75 48" pipe |
| | Sec. 22 (E½) | 320 | | 93 | | .0028 | | | | | | | | | |
| | Sum 39th Ave | 870 | | 259 | | | 56 | 0.64 | 0.62 | | | 0.38 | 99 | | 100 51" pipe |
| | Sec. 22 (W½) | 320 | | 92 | | .0028 | | | | | | | | | |
| | Sum 43rd Ave | 1190 | | 351 | | | 63 | 0.58 | 0.56 | | | 0.33 | 116 | | 120 57" pipe |
| | Sec. 21 (E 1/8) | 80 | | 24 | | .0028 | | | | | | | | | |
| | Sum Arizona Canal | 1270 | | 375 | | | 65 | 0.57 | 0.55 | | | 0.32 | 120 | | 125 57" pipe |
| | Sec. 23 (E 1/8) | 64 | | 20 | | | 32 | 1.00 | 0.99 | | | 0.71 | 14 | | 15 27" pipe |
| | Sec. 23 (E¼) | 128 | | 39 | | | 35 | 0.93 | 0.92 | | | 0.65 | 25 | | 25 33" pipe |
| IV-6 | Bell Road | | | | | | | | | | | | | | |
| | Sec. 36 (NW½ SW¼) | 80 | | 21 | | .005 | | | | | | | | | |
| | Sec. 35 (SE¼) | 160 | | 33 | | .005 | | | | | | | | | |
| | Sec. 2 (E. Part) | 220 | | 44 | | .005 | | | | | | | | | |
| | Sum 32nd Street | 460 | | 98 | | | 56 | 0.64 | 0.63 | | | 0.39 | 38 | | 40 36" pipe |
| | Sec. 35 (SW¼) | 160 | | 33 | | .005 | | | | | | | | | |
| | Sec. 2 (W. Part) | 220 | | 55 | | .004 | | | | | | | | | |
| | Sum Cavecreek Road | 840 | | 186 | | | 64 | 0.57 | 0.55 | | | 0.315 | 59 | | 60 45" pipe |
| | Sec. 34 (S½) | 320 | | 65 | | .006 | | | | | | | | | |
| | Sec. 3 (NE½ N½) | 160 | | 45 | | .004 | | | | | | | | | |
| | Sum 16th Street | 1320 | | 296 | | | 75 | 0.51 | 0.49 | | | 0.26 | 77 | | 80 45" pipe |
| | Sec. 33 (S½) | 360 | | 77 | | .005 | | | | | | | | | |
| | Sum 7th Street | 1680 | | 373 | | | 85 | 0.46 | 0.44 | | | 0.216 | 81 | | 90 57" pipe |
| | Sec. 32 | 610 | | 123 | | .0045 | | | | | | | | | |
| | Sum Cave Creek | 2290 | | 496 | | | 101 | 0.40 | 0.38 | | | 0.16 | 80 | | 100 57" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-7 | | | | | | | | | | | | | | | |
| | Sec. 11 (W½) | 240 | | 60 | | | 24 | 1.23 | 1.21 | | | 0.91 | 55 | | 55 |
| | Sec. 10 & 15 | 680 | | 191 | | | | | | | | | | | |
| | Sum Greenway & Cave Creek Rd | 920 | | 251 | | | 33 | 0.97 | 0.94 | | | 0.67 | 168 | | 170 66" pipe |
| | Sec. 2 (SW½SW¼) | 180 | | 72 | | | | | | | | | | | |
| | Sum ½Mi. N. of Greenway Rd & CaveCreek Rd | 1100 | | 323 | | | 36 | 0.91 | 0.88 | | | 0.61 | 197 | | 200 69" pipe |
| | Sec. 3 (E Part) | 180 | | 50 | | | | | | | | | | | |
| | Sec. 3 (NW ¼) | 80 | | 24 | | | | | | | | | | | |
| | Sec. 10 & Sec. 3 (SW¼) | 320 | | 70 | | | | | | | | | | | |
| | Sum 20th St | 1680 | | 467 | | | 41 | 0.82 | 0.79 | | | 0.53 | 248 | | 250 69" pipe |
| | Sec. 9 & Sec. 4 (E. Part) | 300 | | 60 | | | | | | | | | | | |
| | Sum 12th St | 1980 | | 527 | | | 54 | 0.66 | 0.63 | | | 0.39 | 206 | | 260 69" pipe |
| | Sec. 4 (W Part) | 200 | | 40 | | | | | | | | | | | |
| | Sum 7th St | 2180 | | 567 | | | 59 | 0.62 | 0.59 | | | 0.35 | 198 | | 270 69" pipe |
| | Sec. 5 (SE Part) | 320 | | 64 | | | | | | | | | | | |
| | Sum Greenway Rd | 2500 | | 631 | | | 70 | 0.53 | 0.50 | | | 0.27 | 171 | | 280 69" pipe |
| | Sec. 5 (NW Part) | 240 | | 48 | | | | | | | | | | | |
| | Sec. 6 (SE Part) | 80 | | 16 | | | | | | | | | | | |
| | Sum Cave Creek | 2820 | | 695 | | | 74 | 0.52 | 0.49 | | | 0.26 | 181 | | 300 81" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

Note: 50% Pervious Area Contributing

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-8 | (Thunderbird Road) | | | | | | | | | | | | | | |
| | Sec. 9 (NW Part) | 100 | 40 | 20 | 0.70 | | 13 | 1.90 | 1.88 | 0.94 | 38 | 1.51 | 30 | 70 | 48" Pipe |
| | Sec. 9 (Central Part) & Sec. 10 (W. Part) | 400 | 160 | 80 | 0.75 | | 18 | 1.50 | 1.47 | 0.58 | 93 | 1.14 | 91 | 184 | |
| | Sum - 7th St. & Hearn Road | 500 | 200 | 100 | 0.75 | | 20 | 1.41 | 1.37 | 0.46 | 94 | 1.05 | 105 | 200 | 69" Pipe |
| | Sec. 16 (SE Part) & Sec. 21 (N. Part) | 420 | 168 | 84 | 0.70 | | 31 | 1.02 | 1.00 | 0.24 | 40 | 0.72 | 60 | 100 | 45" Pipe |
| | Sec. 16 (Central Part) | 430 | 172 | 86 | 0.75 | | 30 | 1.05 | 1.03 | 0.22 | 38 | 0.75 | 65 | 105 | |
| | Sec. 16 (NE Part) & Sec. 9 (S¼) | 290 | 116 | 58 | 0.80 | | 28 | 1.10 | 1.08 | 0.22 | 26 | 0.79 | 46 | 92 | |
| | Sum - 7th St. & Thunderbird Road | 1640 | 656 | 328 | 0.75 | | 34 | 0.96 | 0.92 | 0.14 | 92 | 0.65 | 214 | 305 | 66" Pipe |
| | Sum - Roberts Rd. & Canterbury Drive | | | | | | | | | | | | | 310 | 81" Pipe |
| | Sec. 17 (Central Part) & Sec. 20 (N. Part) | 520 | 208 | 104 | 0.70 | | 27 | 1.13 | 1.10 | 0.32 | 67 | 0.81 | 85 | 150 | |
| | Sum - Thunderbird Rd. & Canterbury Drive | 2160 | 864 | 432 | 0.75 | | 42 | 0.80 | 0.76 | 0.01 | 9 | 0.51 | 221 | 315 | 60" Pipe |
| | Sec. 17 (N½ NW¼) | 80 | | 16 | | | | | | | | | | | |
| | Sum - Thunderbird Road & Wash in Sec. 3 | 2240 | 964 | 448 | 0.75 | | 48 | 0.72 | 0.68 | 0 | 0 | 0.47 | 210 | 320 | 75" Pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

Note: 50% Pervious Area Contributing

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IV-9 | (19th Ave.) | | | | | | | | | | | | | | |
| | Sec. 18 (SW Part) | 50 | 20 | 10 | 0.75 | | 5 | 3.00 | 2.98 | 1.81 | 36 | 2.50 | 25 | 60 | 39" Pipe |
| | Sec. 19 (NW¼) | 180 | 68 | 45 | 0.75 | | 13 | 1.88 | 1.85 | 0.88 | 60 | 1.49 | 67 | 130 | |
| | Sum - Cholla Street | 230 | 88 | 55 | 0.75 | | 11 | 2.08 | 2.04 | 1.03 | 91 | 1.66 | 92 | 185 | 57" Pipe |
| | Sec. 19 (SW¼) | 280 | 98 | 84 | 0.75 | | 21 | 1.36 | 1.33 | 0.46 | 45 | 1.02 | 86 | 130 | |
| | Sum - Peoria Ave. | 510 | 186 | 139 | 0.75 | | 15 | 1.70 | 1.65 | 0.72 | 134 | 1.31 | 182 | 315 | 69" Pipe |
| | Sec. 30 (NW¼) | 190 | 0 | 67 | | | | | | | | | | | |
| | Sum - Mtn. View Rd. | 700 | 186 | 206 | 0.75 | | 19 | 1.46 | 1.41 | 0.53 | 99 | 1.09 | 225 | 325 | 90" Pipe |
| | Sec. 30 (N½ SW¼) | 80 | 0 | 32 | | | | | | | | | | | |
| | Sum - Arizona Canal | 780 | 186 | 238 | 0.75 | | 22 | 1.31 | 1.27 | 0.42 | 78 | 0.96 | 228 | 330 | 90" Pipe |
| IV-10 | (7th Street) | | | | | | | | | | | | | | |
| | Sec. 20 (W½) & Sec. 19 (E½) | 360 | 144 | 72 | 0.75 | | 19 | 1.46 | 1.42 | 0.54 | 78 | 1.10 | 80 | 160 | 45" Pipe |
| | Sec. 30 (NE¼) | 80 | 0 | 32 | | | | | | | | | | | |
| | Sec. 20 (SW¼) & Sec. 29 (NW¼) | 250 | 106 | 38 | 0.75 | | 16 | 1.63 | 1.60 | 0.68 | 72 | 1.26 | 48 | 120 | |
| | Sum - Mountain View Road | 690 | 250 | 142 | 0.75 | | 22 | 1.30 | 1.26 | 0.41 | 103 | 0.95 | 135 | 240 | 54" Pipe |
| | Sec. 30 (SE¼) & Sec. 29 (SW¼) | 120 | 42 | 36 | 0.75 | | 19 | 1.46 | 1.44 | 0.49 | 21 | 1.12 | 41 | 62 | |
| | Sum - Arizona Avenue | 810 | 292 | 178 | 0.75 | | 24 | 1.23 | 1.19 | 0.35 | 102 | 0.89 | 159 | 260 | 66" Pipe |

EXPECTED FLOWS 2 - year rainfall intensity and duration unless noted

Echo Wash at Arizona Canal

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Echo Canyon Wash | | | | | | | | | | | | | | |
| | 23 | 675 | 472 | 135 | 1.0 | | 61 | 0.82 | 0.79 | 0 | 0 | 0.53 | 72 | 72 | |
| | 24 | 209 | 146 | 42 | 0.8 | | 23 | 1.70 | 1.67 | 0.70 | 102 | 1.32 | 55 | 157 | |
| | Sum 23, 24 | 884 | 618 | 177 | 0.95 | | 61 | 0.82 | 0.79 | 0 | 0 | 0.53 | 94 | 94 | 160 |
| | 29a | 238 | 167 | 48 | 0.6 | | 23 | 1.70 | 1.63 | 0.82 | 137 | 1.29 | 62 | 199 | |
| | 29b | 207 | 145 | 41 | 1.0 | | 22 | 1.75 | 1.68 | 0.54 | 78 | 1.33 | 55 | 133 | |
| | 22 | 82 | 57 | 16 | 1.0 | | 12 | 2.48 | 2.46 | 1.17 | 67 | 2.03 | 33 | 100 | |
| | Sum 22, 23, 24, 29 | 1411 | 987 | 282 | 0.9 | | 64 | 0.80 | 0.76 | 0 | 0 | 0.50 | 141 | 141 | 160 |
| | 28a | 271 | 190 | 54 | 0.3 | | 22 | 1.75 | 1.72 | 1.13 | 215 | 1.37 | 74 | 289 | |
| | 28b | 146 | 102 | 29 | 1.0 | | 22 | 1.75 | 1.73 | 0.58 | 59 | 1.38 | 40 | 99 | |
| | Sum 28a, 28b | 417 | 292 | 83 | 0.55 | | 44 | 1.06 | 1.03 | 0.38 | 111 | 0.75 | 62 | 173 | |
| | 21 | 132 | 92 | 26 | 0.5 | | 18 | 1.98 | 1.96 | 1.17 | 108 | 1.58 | 41 | 149 | |
| | Sum 21, 22, 23, 24, 28, 29 | 1960 | 1370 | 391 | 0.8 | | 66 | 0.77 | 0.73 | 0 | 0 | 0.48 | 188 | 188 | 300 |
| | 27 | 194 | 136 | 39 | 0.9 | | 27 | 1.51 | 1.48 | 0.46 | 62 | 1.15 | 45 | 107 | |
| | Sum | 2154 | 1506 | 430 | 0.81 | | 68 | 0.75 | 0.71 | 0 | 0 | 0.46 | 198 | 198 | 305 |
| | 20 | 142 | 99 | 28 | 1.0 | | 24 | 1.64 | 1.61 | 0.49 | 48 | 1.27 | 35 | 83 | |
| | Sum | 2296 | 1605 | 458 | 0.82 | | 71 | 0.72 | 0.68 | 0 | 0 | 0.43 | 197 | 197 | 310 |
| | 26 | 250 | 175 | 50 | 0.9 | | 16 | 2.12 | 2.08 | 0.94 | 164 | 1.69 | 84 | 248 | |
| | Sum | 2546 | 1780 | 508 | 0.83 | | 87 | 0.62 | 0.58 | 0 | 0 | 0.34 | 173 | 173 | |
| | 19 | 107 | 75 | 21 | 1.0 | | 20 | 1.85 | 1.83 | 0.66 | 50 | 1.47 | 31 | 81 | |
| | Sum | 2653 | 1855 | 529 | 0.83 | | 97 | 0.56 | 0.53 | 0 | 0 | 0.30 | 159 | 159 | 320 |
| | 25a | 216 | 151 | 43 | 0.3 | | 29 | 1.44 | 1.41 | 0.89 | 134 | 1.09 | 47 | 181 | |
| | 25b | 140 | 98 | 28 | 1.0 | | 31 | 1.39 | 1.37 | 0.30 | 29 | 1.05 | 29 | 58 | |
| | Sum 25 | 356 | 249 | 71 | 0.58 | | 47 | 1.00 | 0.98 | 0.32 | 80 | 0.70 | 50 | 130 | |
| | Sum Echo Wash | 3009 | 2104 | 600 | 0.80 | | 97 | 0.56 | 0.52 | 0 | 0 | 0.29 | 174 | 174 | 330 |

EXPECTED FLOWS 10 - year rainfall intensity and duration unless noted

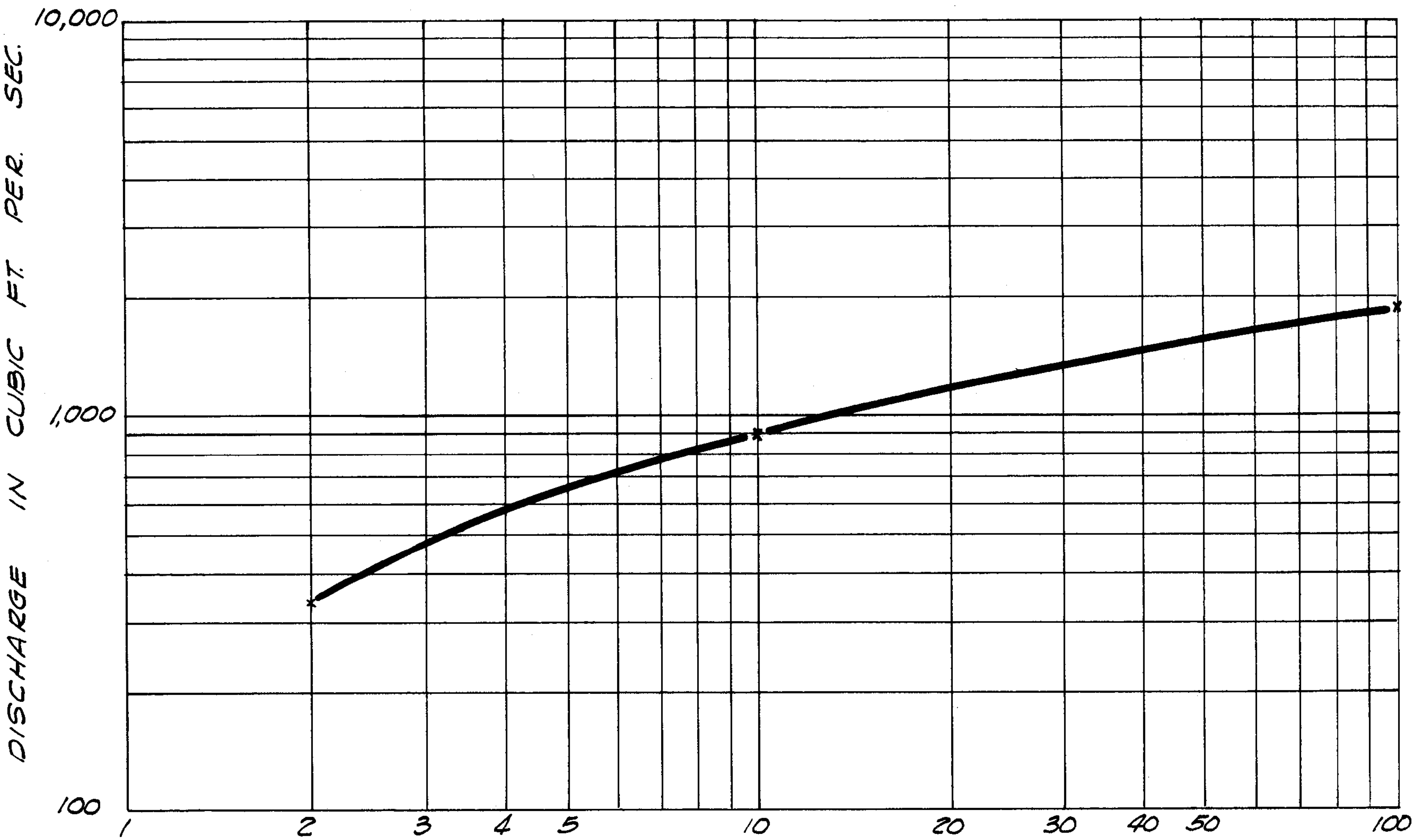
Echo Wash at Arizona Canal

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Echo Canyon Wash | | | | | | | | | | | | | | |
| | 23 | 675 | 472 | 135 | 1.0 | | 61 | 1.33 | 1.29 | 0.23 | 108 | 0.98 | 132 | 240 | 240 |
| | 24 | 209 | 146 | 42 | 0.8 | | 23 | 2.62 | 2.57 | 1.42 | 208 | 2.13 | 90 | 298 | 298 |
| | Sum 23, 24 | 884 | 618 | 177 | 0.95 | | 61 | 1.33 | 1.29 | 0.27 | 167 | 0.98 | 173 | 340 | 340 |
| | 29a | 238 | 167 | 48 | 0.6 | | 23 | 2.62 | 2.52 | 1.53 | 256 | 2.09 | 100 | 356 | 356 |
| | 29b | 207 | 145 | 41 | 1.0 | | 22 | 2.70 | 2.60 | 1.28 | 186 | 2.16 | 89 | 275 | |
| | 22 | 82 | 57 | 16 | 1.0 | | 12 | 4.15 | 4.11 | 2.48 | 141 | 3.52 | 56 | 197 | |
| | Sum 22, 23, 24, 29 | 1411 | 987 | 282 | 0.9 | | 64 | 1.31 | 1.25 | 0.28 | 276 | 1.00 | 282 | 558 | 560 |
| | 28a | 271 | 190 | 54 | 0.3 | | 22 | 2.70 | 2.65 | 1.88 | 358 | 2.25 | 122 | 480 | |
| | 28b | 146 | 102 | 29 | 1.0 | | 22 | 2.70 | 2.66 | 1.33 | 136 | 2.25 | 65 | 201 | |
| | Sum 28a, 28b | 417 | 292 | 83 | 0.55 | | 44 | 1.72 | 1.68 | 0.90 | 263 | 1.37 | 114 | 377 | |
| | 21 | 132 | 92 | 26 | 0.5 | | 18 | 3.00 | 2.97 | 1.97 | 181 | 2.52 | 66 | 247 | |
| | Sum 21, 22, 23, 24, 28, 29 | 1960 | 1370 | 391 | 0.8 | | 66 | 1.27 | 1.21 | 0.33 | 452 | 0.96 | 375 | 827 | 830 |
| | 27 | 194 | 136 | 39 | 0.9 | | 27 | 2.38 | 2.34 | 1.15 | 156 | 1.96 | 76 | 232 | |
| | Sum | 2154 | 1506 | 430 | 0.81 | | 68 | 1.25 | 1.18 | 0.30 | 452 | 0.95 | 408 | 860 | 860 |
| | 20 | 142 | 99 | 28 | 1.0 | | 24 | 2.55 | 2.52 | 1.22 | 121 | 2.12 | 59 | 180 | |
| | Sum | 2296 | 1605 | 458 | 0.82 | | 71 | 1.19 | 1.12 | 0.24 | 286 | 0.89 | 408 | 694 | 870 |
| | 26 | 250 | 175 | 50 | 0.9 | | 16 | 3.16 | 3.10 | 1.76 | 308 | 2.66 | 133 | 441 | |
| | Sum | 2546 | 1780 | 508 | 0.83 | | 87 | 1.03 | 0.97 | 0.11 | 196 | 0.75 | 381 | 577 | 880 |
| | 19 | 107 | 75 | 21 | 1.0 | | 20 | 2.82 | 2.79 | 1.43 | 107 | 2.36 | 48 | 155 | |
| | Sum | 2653 | 1855 | 529 | 0.83 | | 97 | 0.94 | 0.88 | 0.04 | 74 | 0.67 | 354 | 428 | 890 |
| | 25a | 216 | 151 | 43 | 0.3 | | 29 | 2.28 | 2.24 | 1.55 | 234 | 1.22 | 52 | 286 | |
| | 25b | 140 | 98 | 28 | 1.0 | | 31 | 2.18 | 2.15 | 0.92 | 90 | 0.65 | 18 | 108 | |
| | Sum 25 | 356 | 249 | 71 | 0.58 | | 47 | 1.66 | 1.62 | 0.83 | 207 | 0.57 | 40 | 247 | |
| | Sum Echo Wash | 3009 | 2104 | 600 | 0.80 | | 97 | 0.94 | 0.88 | 0.06 | 126 | 0.0 | 0 | 126 | 900 |

EXPECTED FLOWS 100 - year rainfall intensity and duration unless noted

Echo Wash at Arizona Canal

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Echo Canyon Wash | | | | | | | | | | | | | | |
| | 23 | 675 | 472 | 135 | 1.0 | | 61 | 2.1 | 2.03 | 0.82 | 387 | 1.65 | 223 | 610 | 610 |
| | 24 | 209 | 146 | 42 | 0.8 | | 23 | 3.9 | 3.83 | 2.42 | 354 | 3.27 | 137 | 491 | |
| | Sum 23, 24 | 884 | 618 | 177 | 0.95 | | 61 | 2.1 | 2.04 | 0.87 | 536 | 1.66 | 294 | 830 | 830 |
| | 29a | 238 | 167 | 48 | 0.6 | | 23 | 3.9 | 3.75 | 2.52 | 421 | 3.20 | 154 | 575 | |
| | 29b | 207 | 145 | 41 | 1.0 | | 22 | 4.0 | 3.85 | 2.28 | 330 | 3.29 | 135 | 465 | |
| | 22 | 82 | 57 | 16 | 1.0 | | 12 | 5.2 | 5.15 | 3.32 | 189 | 4.46 | 71 | 260 | |
| | Sum 22, 23, 24, 29 | 1411 | 987 | 282 | 0.9 | | 64 | 2.0 | 1.91 | 0.81 | 800 | 1.54 | 434 | 1234 | 1240 |
| | 28a | 271 | 190 | 54 | 0.3 | | 22 | 4.0 | 3.92 | 2.90 | 551 | 3.35 | 181 | 732 | |
| | 28b | 146 | 102 | 29 | 1.0 | | 22 | 4.0 | 3.94 | 2.35 | 240 | 3.37 | 98 | 338 | |
| | Sum 28a, 28b | 417 | 292 | 83 | 0.55 | | 44 | 2.65 | 2.58 | 1.62 | 474 | 2.14 | 178 | 652 | |
| | 21 | 132 | 92 | 26 | 0.5 | | 18 | 4.45 | 4.41 | 3.13 | 298 | 3.79 | 99 | 397 | |
| | Sum 21, 22, 23, 24,28,29 | 1960 | 1370 | 391 | 0.8 | | 66 | 2.0 | 1.90 | 0.88 | 1205 | 1.53 | 598 | 1803 | 1800 |
| | 27 | 194 | 136 | 39 | 0.9 | | 27 | 3.6 | 3.54 | 2.11 | 287 | 3.01 | 117 | 404 | |
| | Sum | 2154 | 1506 | 430 | 0.81 | | 68 | 1.95 | 1.84 | 0.82 | 1238 | 1.48 | 636 | 1874 | 1880 |
| | 20 | 142 | 99 | 28 | 1.0 | | 24 | 3.85 | 3.79 | 2.23 | 221 | 3.23 | 90 | 311 | |
| | Sum | 2296 | 1605 | 458 | 0.82 | | 71 | 1.86 | 1.76 | 0.75 | 1202 | 1.40 | 641 | 1843 | 1885 |
| | 26 | 250 | 175 | 50 | 0.9 | | 16 | 4.7 | 4.60 | 2.96 | 519 | 3.96 | 198 | 717 | |
| | Sum | 2546 | 1780 | 508 | 0.83 | | 87 | 1.6 | 1.51 | 0.54 | 961 | 1.18 | 599 | 1560 | |
| | 19 | 107 | 75 | 21 | 1.0 | | 20 | 4.25 | 4.20 | 2.56 | 192 | 3.60 | 76 | 268 | |
| | Sum | 2653 | 1855 | 529 | 0.83 | | 97 | 1.46 | 1.37 | 0.43 | 799 | 1.05 | 555 | 1354 | 1890 |
| | 25a | 216 | 151 | 43 | 0.3 | | 29 | 3.45 | 3.38 | 2.46 | 372 | 2.86 | 123 | 495 | |
| | 25b | 140 | 98 | 28 | 1.0 | | 31 | 3.30 | 3.25 | 1.80 | 176 | 2.75 | 77 | 253 | |
| | Sum 25 | 356 | 249 | 71 | 0.58 | | 47 | 2.52 | 2.46 | 1.50 | 374 | 2.03 | 144 | 518 | |
| | Sum Echo Wash | 3009 | 2104 | 600 | 0.80 | | 97 | 1.46 | 1.37 | 0.46 | 970 | 1.05 | 630 | 1600 | 1900 |




FREQUENCY - DISCHARGE RELATION

ECHO CANYON WASH AT ARIZONA CANAL

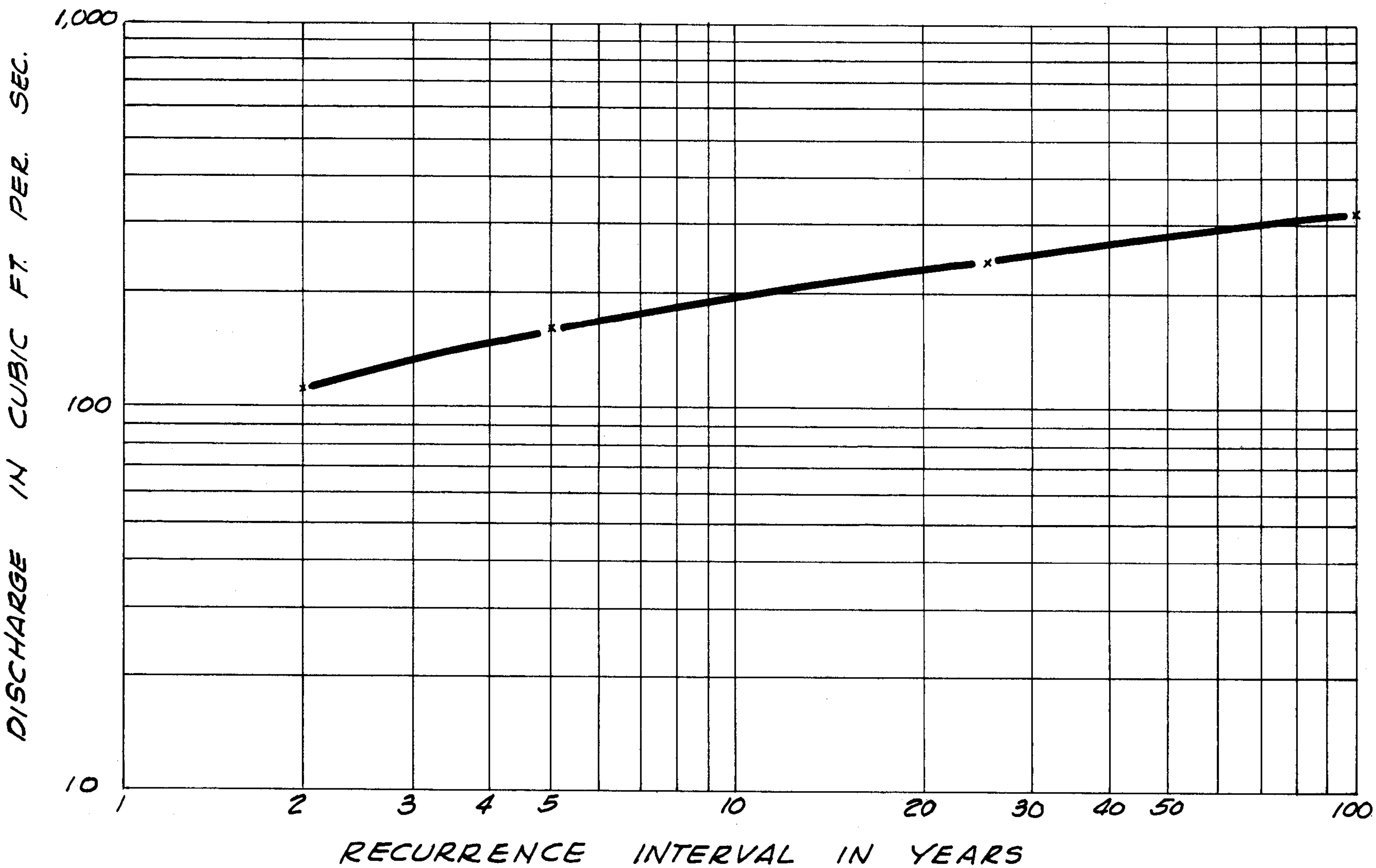
EXPECTED FLOWS 25 - year rainfall intensity and duration unless noted

Note: 50% Pervious Area Contributing

| Area No. | LOCATION | AREA - ACRES: Total Area A | AREA - ACRES: Perv. Area $A_p$ | AREA - ACRES: Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Concentration Time: Min. $t_c$ | RAIN: Point Intensity I in/hr | RAIN: Average Intensity $I_a$ in/hr | RUNOFF: Pervious: $(I_a - f_c)0.8 = I_n$ in | RUNOFF: Pervious: $I_n A_p$ cfs | RUNOFF: Impervious: $(I_a - 0.2)0.9 = I_m$ in | RUNOFF: Impervious: $I_m A_i$ cfs | RUNOFF: Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unnamed Wash #4 (Northern Ave. & 10th Street) | | | | | | | | | | | | | | |
| | Sec. 34 (NW¼) | 170 | 68 | 34 | 0.75 | | 12 | 4.20 | 4.14 | 2.71 | 185 | 3.55 | 121 | 306 | 305 |
| | Sec. 34 (SW¼) & Sec. 33 (East Part) | 120 | 48 | 24 | 0.75 | | 10 | 4.50 | 4.45 | 2.96 | 142 | 3.83 | 92 | 234 | 235 |
| | Sum - Northern Ave. & 16th St. | 290 | 116 | 58 | 0.75 | | 18 | 3.50 | 3.42 | 2.14 | 248 | 2.90 | 168 | 416 | 415 |
| | Sec. 33 (SE¼) | 83 | | 29 | | | | | | | | | | | |
| | Sum - Northern Ave. & 12th St. | 373 | 116 | 87 | 0.75 | | 35 | 2.40 | 2.35 | 1.28 | 149 | 1.94 | 169 | 318 | 420 |
| | Sec. 33 (SW¼) | 50 | | 15 | | | | | | | | | | | |
| | Sum - Arizona Canal | 423 | 116 | 102 | 0.75 | | 48 | 1.93 | 1.88 | 0.90 | 104 | 1.51 | 154 | 258 | 425 |
| | Unnamed Wash #5 (Myrtle Ave. & 16th St.) Sec. 34 (S. Part) | 30 | 12 | 6 | 0.75 | | 9 | 4.70 | 4.69 | 3.15 | 38 | 4.04 | 25 | 63 | 65 |
| | Sec. 3 (N. Part) | 165 | 66 | 33 | 0.75 | | | | | | | | | | |
| | Sum - Orangewood Ave. & 18th Street | 195 | 78 | 39 | 0.75 | | 25 | 2.95 | 2.90 | 1.72 | 134 | 2.43 | 95 | 229 | 230 |
| | Sec. 3 (W. Part) & Sec. 4 (East Part) | 125 | | 25 | | | | | | | | | | | |
| | Sum - Arizona Canal | 320 | 78 | 64 | 0.75 | | 37 | 2.30 | 2.25 | 1.20 | 94 | 1.85 | 118 | 212 | 240 |

EXPECTED FLOWS - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area $A$ | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unnamed Wash #5 - 5-Year Recurrence Interval | | | | | | | | | | | | | | |
| | (Myrtle Avenue & 16th Street) | | | | | | | | | | | | | | |
| | Section 34 (S. Part) | 30 | 12 | 6 | 0.75 | | 9 | 3.6 | 3.58 | 2.26 | 27 | 3.04 | 18 | 45 | 45 |
| | Section 3 (North Part) | 165 | 66 | 33 | 0.75 | | | | | | | | | | |
| | Sum - Orangewood Avenue & 18th Street | 195 | 78 | 39 | 0.75 | | 25 | 2.15 | 2.12 | 1.10 | 86 | 1.725 | 67 | 153 | 155 |
| | Sec. 3 (W.Part) & Sec. 4 (E.Part) | 125 | | 25 | | | | | | | | | | | |
| | Sum - Arizona Canal | 320 | 78 | 64 | 0.75 | | 37 | 1.67 | 1.635 | 0.71 | 55 | 1.29 | 83 | 138 | 160 |
| | Unnamed Wash #5 - 100-Year Recurrence Interval | | | | | | | | | | | | | | |
| | (Myrtle Avenue & 16th Street) Section 34 (South Part) | 30 | 12 | 6 | 0.75 | | 9 | 5.9 | 5.86 | 4.09 | 49 | 5.10 | 31 | 80 | 80 |
| | Section 3 (North Part) | 165 | 66 | 33 | 0.75 | | | | | | | | | | |
| | Sum - Orangewood Avenue & 18st Street | 195 | 78 | 39 | 0.75 | | 25 | 3.8 | 3.74 | 2.39 | 186 | 3.18 | 124 | 310 | 310 |
| | Sec. 3 (W.Part) & Sec. 4 (E.Part) | 125 | | 25 | | | | | | | | | | | |
| | Sum - Arizona Canal | 320 | 78 | 64 | 0.75 | | 37 | 3.0 | 2.94 | 1.75 | 136 | 2.47 | 158 | 294 | 320 |



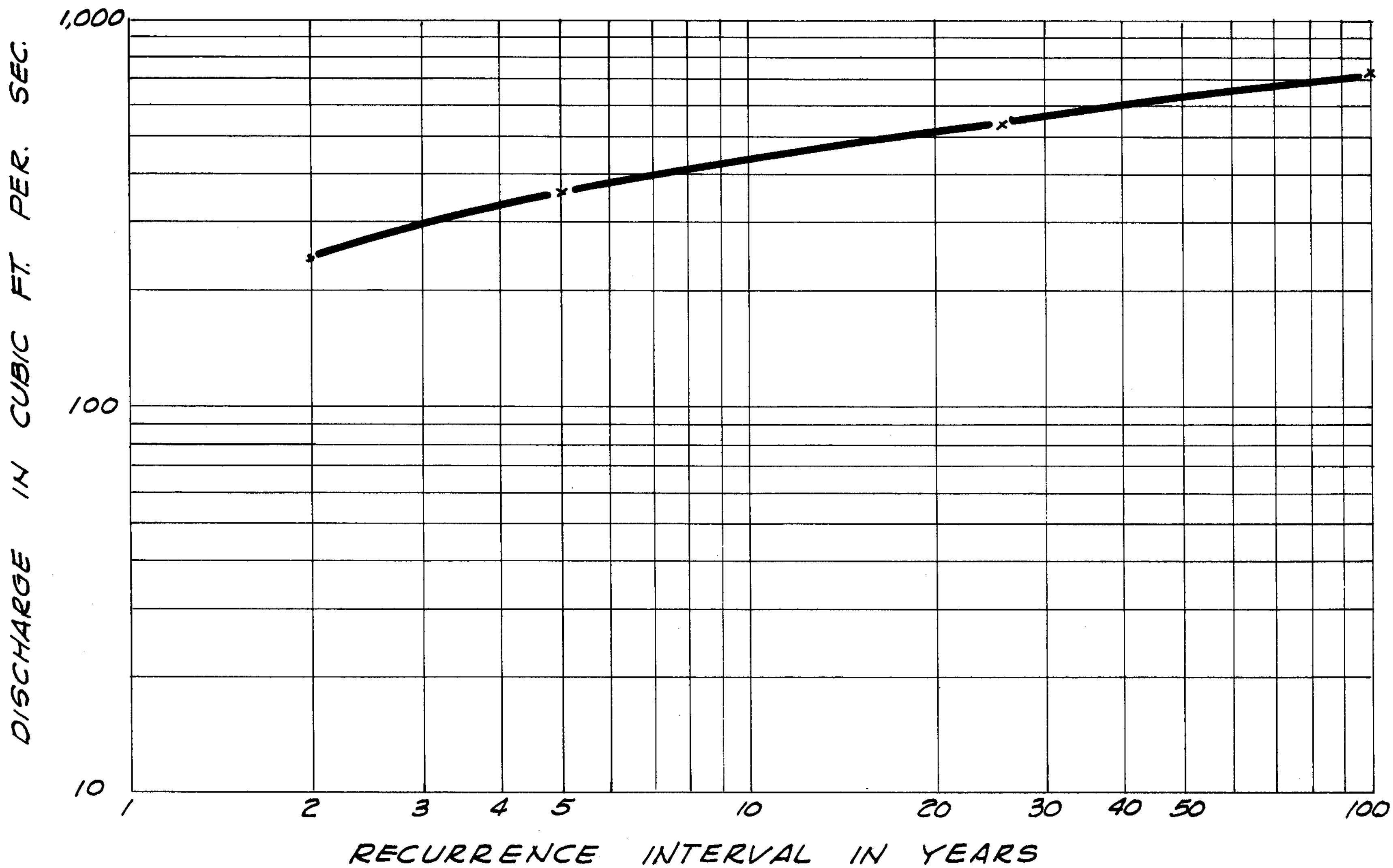

## FREQUENCY - DISCHARGE RELATION

UNNAMED WASH NO. 5 - MYRTLE AVE. AT 16TH ST.

EXPECTED FLOWS 25 - year rainfall intensity and duration unless noted

Note: 50% Pervious Area Contributing

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unnamed Wash #6 | | | | | | | | | | | | | | |
| | (16th Street & Aurelius Ave.) | | | | | | | | | | | | | | |
| | Sec. 2 (NE¼) | 260 | 104 | 52 | 0.75 | | 16 | 3.70 | 3.63 | 2.30 | 240 | 3.09 | 160 | 400 | 400 |
| | Sec. 3 (NE¼) & Sec. 2 (W. Part) | 190 | 76 | 38 | 0.75 | | 16 | 3.70 | 3.63 | 2.30 | 175 | 3.09 | 118 | 293 | |
| | Sum - 20th Street & Myrtle Avenue | 450 | 180 | 90 | 0.75 | | 28 | 2.75 | 2.68 | 1.55 | 280 | 2.23 | 203 | 483 | 485 |
| | Sec. 3 (SW¼) | 100 | | 20 | | | | | | | | | | | |
| | Sum Arizona Canal | 550 | 180 | 110 | 0.75 | | 40 | 2.20 | 2.14 | 1.11 | 200 | 1.75 | 193 | 393 | 490 |
| | Unnamed Wash #7 | | | | | | | | | | | | | | |
| | Sec. 2 (SE¼) | 290 | 116 | 58 | 0.75 | | 15 | 3.80 | 3.72 | 2.38 | 276 | 3.17 | 184 | 460 | 460 |
| | Sec. 11 (NW Part) & Sec. 2 (SW¼) | 195 | 78 | 39 | 0.75 | | 15 | 3.80 | 3.74 | 2.39 | 186 | 3.19 | 125 | 311 | |
| | Sum - 22nd Street & Northern Avenue | 485 | 194 | 97 | 0.75 | | 27 | 2.80 | 2.73 | 1.58 | 307 | 2.28 | 221 | 528 | 530 |
| | Sec. 3 (SE Part) & Sec. 10 (NE P.) | 230 | | 69 | | | | | | | | | | | |
| | Sum - Arizona Canal | 715 | 194 | 166 | 0.75 | | 43 | 2.10 | 2.04 | 1.03 | 200 | 1.66 | 276 | 476 | 540 |
| | Unnamed Wash #7 - <u>5-Year</u> | | | | | | | | | | | | | | |
| | Sec. 2 (SE¼) | 290 | 116 | 58 | 0.75 | | 15 | 2.85 | 2.79 | 1.63 | 189 | 2.33 | 135 | 324 | 330 |
| | Sec. 11 (NW Part) & Sec. 2 (SW¼) | 195 | 78 | 39 | 0.75 | | 15 | 2.85 | 2.80 | 1.64 | 128 | 2.34 | 55 | 183 | |
| | Sum 22nd Street & Northern Avenue | 485 | 194 | 97 | 0.75 | | 27 | 2.03 | 1.975 | 1.00 | 194 | 1.60 | 155 | 349 | 350 |
| | Sec. 3 (SE Part) & Sec. 10 (NE P.) | 230 | | 69 | | | | | | | | | | | |
| | Sum at Arizona Canal | 715 | 194 | 166 | 0.75 | | 43 | 1.50 | 1.45 | 0.56 | 109 | 1.125 | 187 | 296 | 360 |
| | Unnamed Wash #7 - <u>100-Year</u> | | | | | | | | | | | | | | |
| | Sec. 2 (SE¼) | 290 | 116 | 58 | 0.75 | | 15 | 4.80 | 4.69 | 3.15 | 366 | 4.04 | 234 | 600 | 600 |
| | Sec. 11 (NW Part) & Sec. 2 (SW¼) | 195 | 78 | 39 | 0.75 | | 15 | 4.80 | 4.72 | 3.18 | 248 | 4.06 | 158 | 406 | |
| | Sum 22nd Street & Northern Avenue | 485 | 194 | 97 | 0.75 | | 27 | 3.60 | 3.50 | 2.20 | 427 | 2.97 | 288 | 715 | 720 |
| | Sec. 3 (SE Part) & Sec. 10 (NE P.) | 230 | | 69 | | | | | | | | | | | |
| | Sum at Arizona Canal | 715 | 194 | 166 | 0.75 | | 43 | 2.70 | 2.61 | 1.49 | 289 | 2.17 | 360 | 649 | 730 |




FREQUENCY - DISCHARGE RELATION

UNNAMED WASH NO. 7

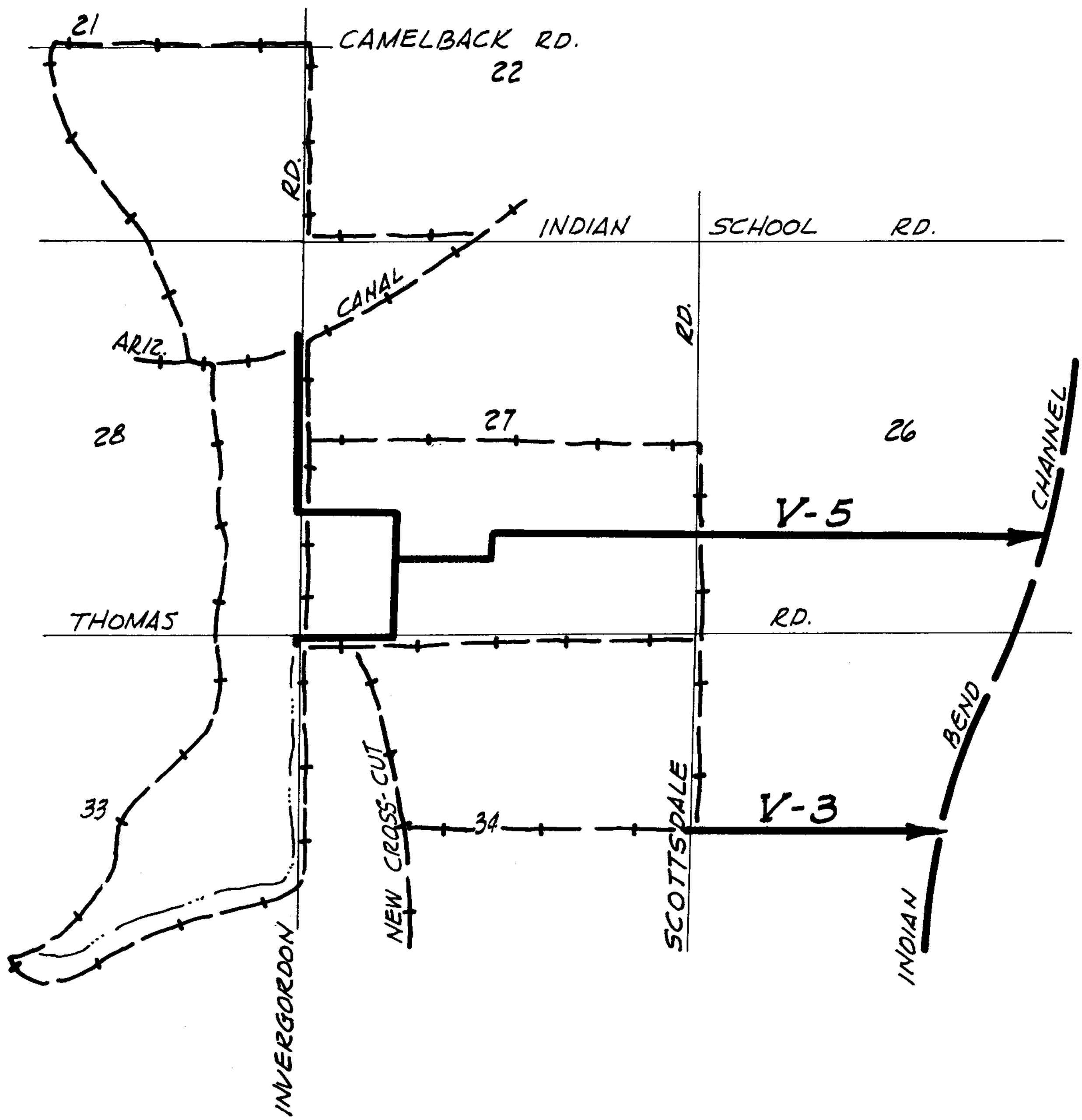
EXPECTED FLOWS 25 - year rainfall intensity and duration unless noted

Note: 50% Pervious Area Contributing

| Area No. | LOCATION | AREA - ACRES: Total Area $A$ | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unnamed Wash #8 (33rd Street & Arizona Canal) | | | | | | | | | | | | | | |
| | Sec. 1 (SW¼) & Sec. 12 (NW¼) | 256 | 102 | 52 | 0.75 | | 14 | 3.90 | 3.82 | 2.46 | 251 | 3.26 | 170 | 421 | 420 |
| | Sec. 12 (SW¼) | 96 | | 19 | | | | | | | | | | | |
| | Sum - Bethany Home Road | 352 | 102 | 71 | | | 27 | 2.80 | 2.74 | 1.59 | 162 | 2.29 | 163 | 325 | 425 |
| | Sec. 13 (NW¼) | 60 | | 12 | | | | | | | | | | | |
| | Sum - West Channel | 412 | 102 | 83 | 0.75 | | 38 | 2.27 | 2.22 | 1.18 | 121 | 1.82 | 151 | 272 | 430 Not a Maximum |
| | Sec. 12 (North Central Part) | 90 | 36 | 18 | 0.75 | | 16 | 3.70 | 3.66 | 2.33 | 84 | 3.11 | 56 | 140 | 140 |
| | Sec. 12 (South Central Part) | 74 | | 15 | | | | | | | | | | | |
| | Sum - Bethany Home Road | 164 | 36 | 33 | | | 28 | 2.75 | 2.71 | 1.57 | 57 | 2.26 | 75 | 132 | 145 |
| | Sec. 13 (North West Part) | 24 | | 5 | | | | | | | | | | | |
| | Sum - Central Channel | 188 | 36 | 38 | 0.75 | | 38 | 2.27 | 2.23 | 1.18 | 43 | 1.83 | 70 | 113 | 150 |
| | Sec. 12 (NE¼) | 86 | 35 | 17 | 0.75 | | 9 | 4.70 | 4.65 | 2.47 | 87 | 4.01 | 69 | 156 | 155 |
| | Sec. 12 (SE Part) | 83 | | 17 | | | | | | | | | | | |
| | Sum - Bethany Home Road | 169 | 35 | 34 | | | 23 | 3.10 | 3.06 | 1.85 | 65 | 2.57 | 88 | 153 | 160 |
| | Sec. 13 (NW Part) | 37 | | 8 | | | | | | | | | | | |
| | Sum - East Channel | 206 | 35 | 42 | 0.75 | | 41 | 2.15 | 2.12 | 1.10 | 39 | 1.73 | 73 | 112 | 165 |
| | Sum - Arizona Canal | 806 | 173 | 163 | 0.75 | | 41 | 2.15 | 2.08 | 1.06 | 184 | 1.69 | 276 | 460 | 460 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | AREA - ACRES: Perv. Area $A_p$ | AREA - ACRES: Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Concentration Time: Min. $t_c$ | RAIN: Point Intensity I in/hr | RAIN: Average Intensity $I_a$ in/hr | RUNOFF Pervious: $(I_a-f_c)0.8 = I_n$ in | RUNOFF Pervious: $I_nA_p$ cfs | RUNOFF Impervious: $(I_a-0.2)0.9 = I_m$ in | RUNOFF Impervious: $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-2 | | | | | | | | | | | | | | | |
| 1 | McDowell Rd at New X-Cut | 181 | 44 | 45 | 0.5 | 0.001 | 35 | 0.93 | 0.915 | 0.33 | 15 | 0.64 | 29 | 44 | 45 |
| 1a | Park area alone | 110 | 44 | 9 | 0.5 | | 20 | 1.42 | 1.40 | 0.72 | 32 | 1.08 | 10 | 42 | |
| | 4100' of 33" pipe (8.6'/Sec) | | | | | 0.0088 | 8 | | | | | | | | |
| 2 | McDowell at Scottsdale Rd | 236 | | 90 | | | 72 | 0.53 | 0.52 | | | 0.288 | 27 | | |
| 2a | Portion draining in 28 min | 89 | | 62 | | | 28 | 1.10 | 1.09 | | | 0.80 | 50 | | |
| 2b | Portion draining in 43 min | 158 | | 90 | | | 43 | 0.79 | 0.78 | | | 0.522 | 47 | | |
| | Sum 1a, 2a | 268 | 44 | 71 | 0.5 | | 28 | 1.10 | 1.08 | 0.465 | 20 | 0.79 | 56 | 76 | 80 |
| | 1600' of 60" pipe (11'/Sec) | | | | | 0.006 | 3 | | | | | | | | |
| 3 | McDowell Rd at Belleview St | 246 | | 107 | | | 44 | 0.78 | 0.765 | | | 0.51 | 55 | | |
| 3a | Portion draining in 31 min | 173 | | 100 | | | 31 | 1.02 | 1.00 | | | 0.72 | 72 | | |
| | Sum 1a - 3a | 441 | | 171 | | | 31 | 1.02 | 0.995 | | 20 | 0.715 | 122 | 142 | 150 |
| | 2700' of 72" pipe (11'/Sec) | | | | | 0.006 | | | | | | | | | Exist 72" OK for 350 cfs |
| | 3300' of 78" | | | | | | | | | | | | | | |
| V-2 | Same as above - 5-year storm | | | | | | | | | | | | | | |
| 1 | McDowell Rd at New X-Cut | 181 | 44 | 45 | 0.5 | | 35 | 1.72 | 1.69 | 0.952 | 42 | 1.34 | 60 | 102 | 105 |
| 1a | Park area alone | 110 | 44 | 9 | 0.5 | | 20 | 2.43 | 2.41 | 1.53 | 67 | 1.99 | 18 | 85 | |
| | 4100' of 42" pipe (10.8'/Sec) | | | | | 0.0088 | 6 | | | | | | | | |
| 2 | McDowell at Scottsdale Rd | 236 | | 90 | | | 72 | 1.00 | 0.98 | | | 0.70 | 63 | | |
| 2a | Portion draining in 26 min | 83 | | 58 | | | 26 | 2.10 | 2.08 | | | 1.69 | 98 | | |
| 2b | Portion draining in 41 min | 151 | | 86 | | | 41 | 1.54 | 1.52 | | | 1.19 | 102 | | |
| | Sum 1 & 2b | 332 | 44 | 131 | 0.5 | | 41 | 1.54 | 1.50 | 0.80 | 35 | 1.17 | 153 | 188 | 190 |
| | 1600' of 60" pipe (11'/Sec) | | | | | 0.006 | 3 | | | | | | | | Exist 60" OK for 220 cfs |
| 3 | McDowell Rd at Belleview St | 246 | | 107 | | | 44 | 1.47 | 1.44 | | | 1.12 | 120 | | |
| | Sum 1, 2b & 3 | 578 | 44 | 238 | 0.5 | | 44 | 1.47 | 1.425 | 0.74 | 33 | 1.10 | 262 | 295 | Exist 72" OK for 350 cfs |
| | 2700' of 72" pipe | | | | | 0.006 | | | | | | | | | |
| | 3300' of 78" pipe | | | | | | | | | | | | | | |

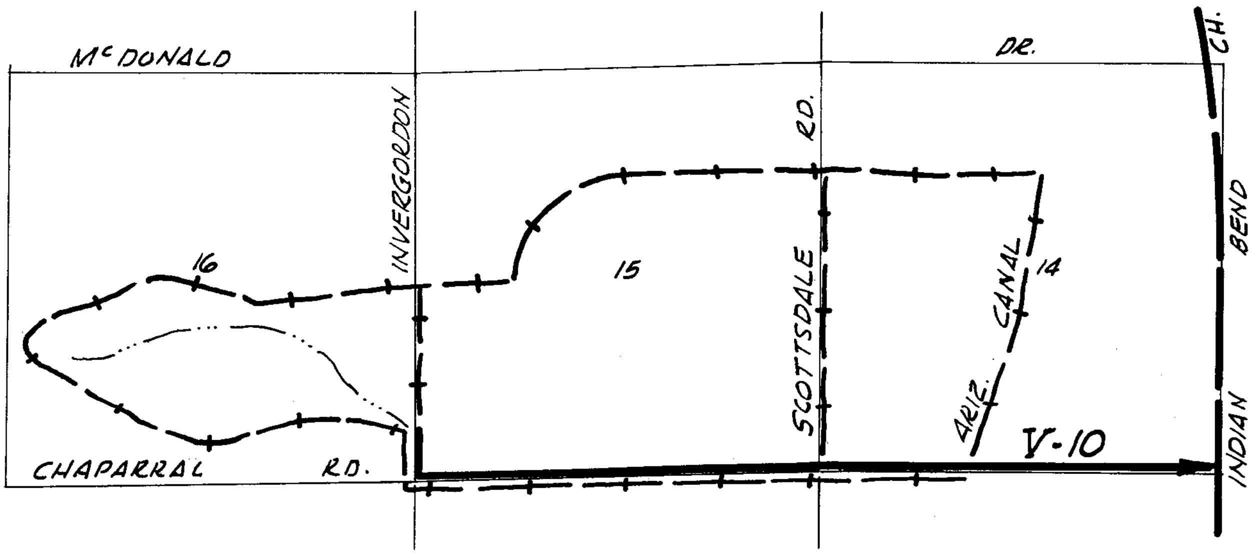

CAMELBACK RD.
21
22
RD.
INDIAN
SCHOOL
RD.
CANAL
RD.
ARIZ.
27
28
26
V-5
CHANNEL
THOMAS
RD.
BEND
33
34
V-3
NEW CROSS-CUT
SCOTTSDALE
INDIAN
INVERGORDON

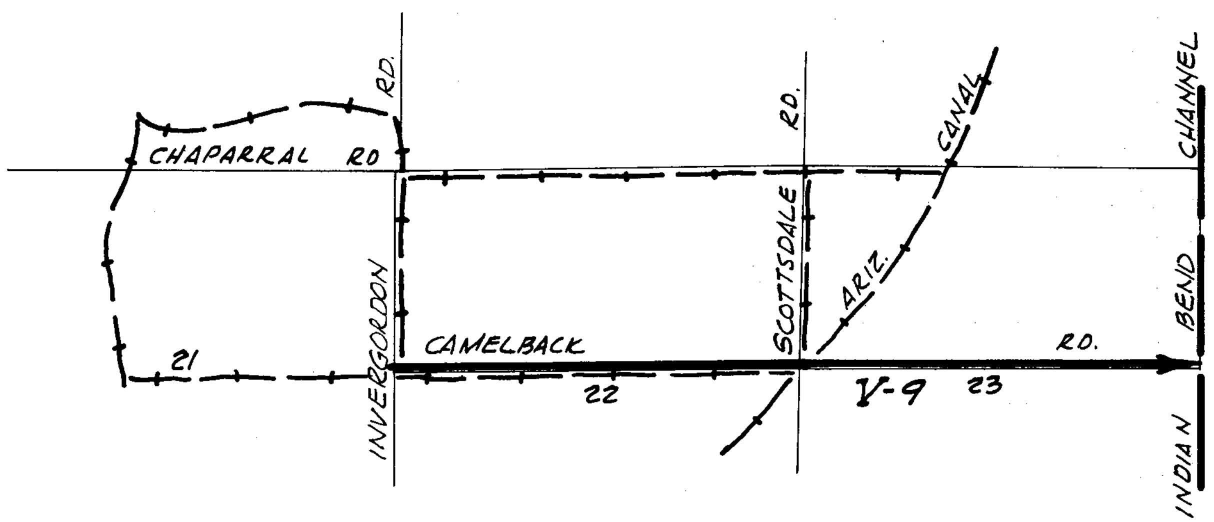
EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-3 8 | Scottsdale Rd at Oak St | 270 | | 100 | | | 62 | 0.59 | 0.58 | | | 0.342 | 34 | | 35 30" pipe |
| V-3 | Same but 5 year storm | | | | | | | 1.12 | 1.10 | | | 0.81 | 81 | | 80 39" pipe |
| V-5 4 | Invergordon at Ariz. Canal | 278 | 208 | 70 | | | 40 | 0.84 | 0.82 | | | 0.56 | 39 | | 40 36" pipe |
| | 2400' of 36" pipe (6.5'/Sec) | | | | | 0.0046 | 6 | | | | | | | | |
| 5 | Invergordon at Earll Dr | 87 | 61 | 26 | | | 32 | 1.0 | 0.99 | | | 0.71 | 18 | | |
| 5a | Same, longer coll. time | 87 | 61 | 26 | | | 46 | 0.75 | 0.74 | | | 0.485 | 13 | | |
| | Sum 4 & 5a | 365 | | 96 | | | 46 | 0.75 | 0.74 | | | 0.485 | 47 | | 50 45" pipe |
| | 2000' of 45" pipe (5'/Sec) | | | | | 0.00195 | 7 | | | | | | | | |
| 6 | Thomas Rd at Invergordon | 183 | 70 | 30 | 0.6 | | 45 | 0.76 | 0.75 | 0.12 | 8 | 0.495 | 9 | 17 | 18 27" pipe |
| | 2300' of 27" pipe (4.5'/Sec) | | | | | 0.00305 | 9 | | | | | | | | |
| | Sum 4, 5a, & 6 at jct | 548 | 70 | 126 | 0.6 | | 53 | 0.67 | 0.65 | 0.04 | 3 | 0.405 | 51 | 84 | 55 45" pipe |
| | 1600' of 45" pipe (5'/Sec) | | | | | 0.00195 | 5 | | | | | | | | |
| | 2640' of 45" pipe (7'/Sec) | | | | | 0.0038 | 6 | | | | | | | | |
| 7 | Earll Dr. at Scottsdale Rd | 320 | | 144 | | | 70 | 0.53 | 0.52 | | | 0.288 | 42 | | |
| 7a | Portion contributing in 64 min | 292 | | 132 | | | 64 | 0.58 | 0.57 | | | 0.333 | 44 | | |
| | Sum 4 - 7a | 840 | 70 | 258 | 0.6 | | 64 | 0.58 | 0.56 | | | 0.324 | 84 | | 85 48" pipe |
| | 4700' of 48" pipe (7'/Sec) | | | | | 0.0034 | 11 | | | | | | | | |
| V-5 | Same but 5 year storm | | | | | | | | | | | | | | |
| 4 | Invergordon at Ariz. Canal | 278 | 208 | 70 | | | 40 | 1.58 | 1.55 | | | 1.21 | 85 | | 85 45" pipe |
| | 2400' of 45" pipe (8'/Sec) | | | | | 0.0046 | 5 | | | | | | | | |
| 5 | Invergordon at Earll Dr | 87 | 61 | 26 | | | 32 | 1.81 | 1.79 | | | 1.43 | 37 | | |
| 5a | Same with longer coll. time | 87 | 61 | 26 | | | 45 | 1.44 | 1.425 | | | 1.10 | 29 | | |
| | Sum 4 & 5 | 365 | | 96 | | | 45 | 1.44 | 1.405 | | | 1.08 | 103 | | 105 57" pipe |
| | 2000' of 57" pipe (6.2'/Sec) | | | | | 0.00195 | 5 | | | | | | | | |
| 6 | Thomas Rd. at Invergordon | 183 | 70 | 30 | 0.6 | | 45 | 1.44 | 1.42 | 0.655 | 46 | 1.10 | 33 | 79 | 80 48" pipe |
| | 2300' of 48" pipe (6.8'/Sec) | | | | | 0.00305 | 6 | | | | | | | | |
| | Sum 4-6 at jct | 548 | 70 | 126 | 0.6 | | 51 | 1.31 | 1.27 | 0.535 | 38 | 0.963 | 122 | 160 | 160 |
| | 1600' of 66" pipe (6.8'/Sec) | | | | | 0.00195 | 4 | | | | | | | | |
| | 2640' of 60" pipe (8.7'/Sec) | | | | | 0.0038 | 5 | | | | | | | | |
| 7 | Earll Dr. at Scottsdale Rd | 320 | | 144 | | | 70 | 1.02 | 0.99 | | | 0.71 | 102 | | |
| 7a | Portion contributing in 60 min | 274 | | 123 | | | 60 | 1.26 | 1.23 | | | 0.927 | 114 | | |
| | Sum 4 - 7a | 822 | 70 | 249 | 0.6 | | 60 | 1.26 | 1.215 | 0.49 | 34 | 0.915 | 228 | 262 | 270 72" pipe |
| | 4700' of 72" pipe (9.3'/Sec) | | | | | 0.0034 | 9 | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-7 | | | | | | | | | | | | | | | |
| 1 | Indian School Rd at 68th St | 235 | 127 | 82 | | | 70 | 0.53 | 0.52 | | | 0.29 | 24 | | |
| 1a | Portion draining in 37 min | 200 | 108 | 70 | | | 37 | 0.90 | 0.88 | | | 0.61 | 43 | | 45 |
| | 1800' of 33" pipe (8'/Sec) | | | | | 0.0068 | 4 | | | | | | | | (use 36" pipe |
| | 2640' of 36" pipe (6'/Sec) | | | | | 0.0034 | 7 | | | | | | | | (for entire reach |
| 2 | Scottsdale Rd. at East 2nd St | 80 | 43 | 28 | | | 43 | 0.79 | 0.78 | | | 0.52 | 15 | | |
| 3 | Scottsdale Rd. at Indian School | 85 | | 30 | | | 32 | 1.00 | 0.99 | | | 0.71 | 21 | | 20 |
| | 1320' of 24" pipe (6.9'/Sec) | | | | | 0.0076 | 3 | | | | | | | | |
| | Sum 1a - 3 | 365 | | 128 | | | 48 | 0.72 | 0.70 | | | 0.45 | 58 | | 60 39" pipe |
| | 1900' 39" pipe (7.1'/Sec) | | | | | 0.0045 | | | | | | | | | can connect |
| | | | | | | | | | | | | | | | exist 48" pipe at |
| V-7 | Same, but 5 year storm | | | | | | | | | | | | | | 2nd & Hinton Ave. |
| 1 | Indian School Rd. at 68th St | 235 | | 82 | | | 70 | 1.02 | 1.00 | | | 0.72 | 59 | | |
| 1a | Portion draining in 37 min | 200 | | 70 | | | 37 | 1.66 | 1.63 | | | 1.28 | 90 | | 90 48" pipe |
| | 4400' of 48" pipe (7.8'/Sec) | | | | | 0.0041 | 10 | | | | | | | | |
| 2 | Scottsdale Rd. E 2nd St | 80 | | 28 | | | 43 | 1.50 | 1.485 | | | 1.155 | 32 | | |
| 3 | Scottsdale Rd at Indian School Rd | 85 | | 30 | | | 32 | 1.82 | 1.80 | | | 1.44 | 43 | | 45 |
| | 1320' of 33" pipe (8.2'/Sec) | | | | | 0.0076 | 3 | | | | | | | | |
| | Sum 1a - 3 | 365 | | 128 | | | 45 | 1.44 | 1.40 | | | 1.08 | 138 | | 140 54" pipe on |
| | 5000' of 54" pipe (8.4'/Sec) | | | | | 0.0040 | | | | | | | | | 2nd St. from Scottsdale |
| | | | | | | | | | | | | | | | Rd to Indian Bend |


Mc DONALD
DR.
CH.
INVERGORDON
RD.
SCOTTSDALE
ARIZ. CANAL
BEND
16
15
14
CHAPARRAL
RD.
V-10
INDIAN

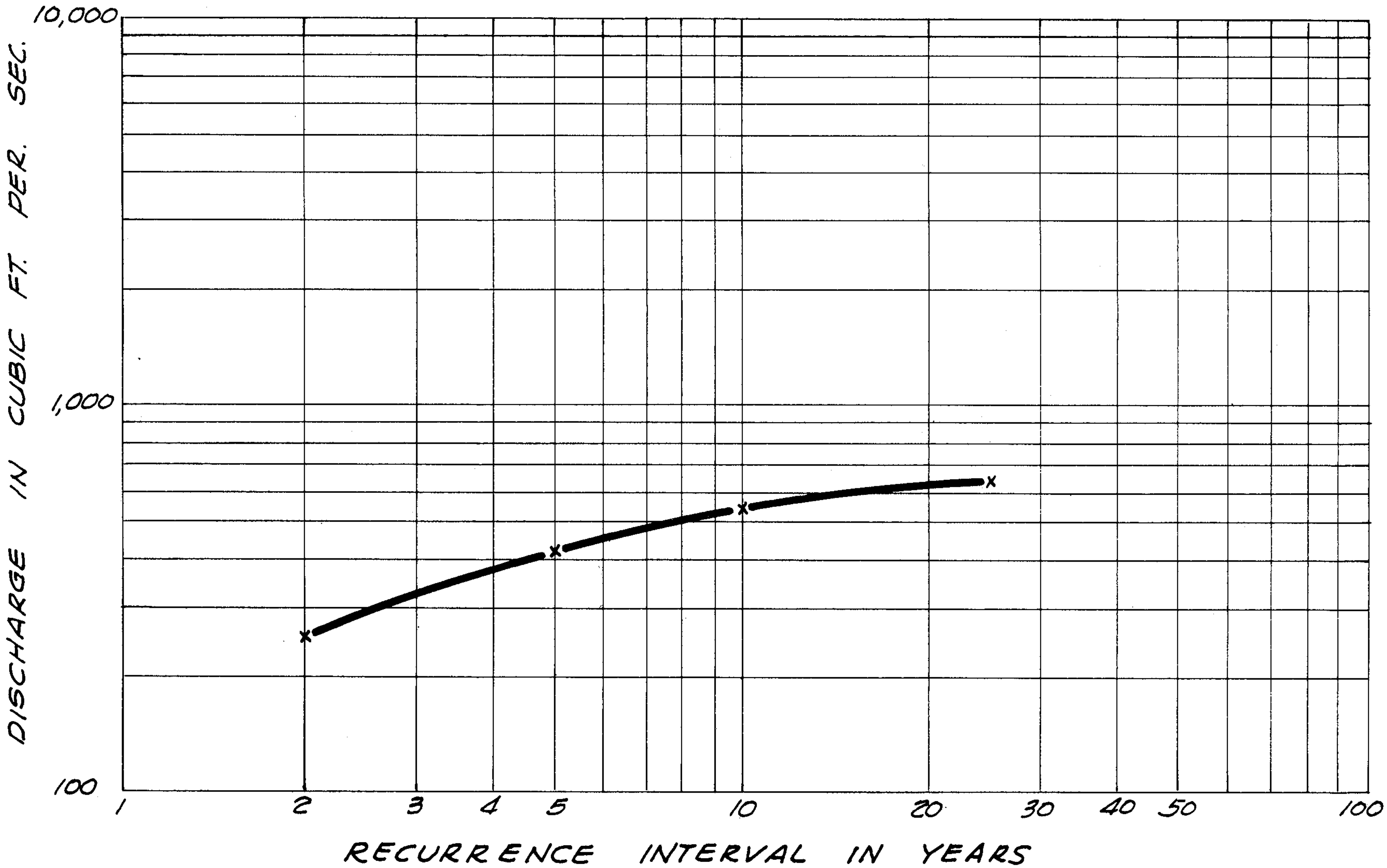

RD.
RD.
CANAL
CHANNEL
CHAPARRAL RD
SCOTTSDALE
ARIZ.
BEND
INVERGORDON
CAMELBACK
RD.
21
22
V-9
23
INDIAN

EXPECTED FLOWS - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-9 | 2 Year | | | | | | | | | | | | | | |
| 4 | Camelback at Invergordon | 285 | 164 | 61 | 0.70 | | 30 | 1.41 | 1.38 | 0.54 | 89 | 1.06 | 65 | 154 | |
| | 5280' of 66" pipe (13'/Sec) | | | | | 0.0072 | 8 | | | | | | | | |
| 5 | Camelback at Scottsdale Rd | 303 | 165 | 116 | 0.80 | | 53 | 0.92 | 0.90 | 0.08 | 13 | 0.63 | 73 | 86 | |
| 5a | Portion Contrib. in 38 min | 239 | 130 | 84 | 0.80 | | 38 | 1.20 | 1.178 | 0.30 | 39 | 0.88 | 74 | 113 | |
| | Sum 4 & 5a | 524 | 294 | 145 | 0.75 | | 38 | 1.20 | 1.164 | 0.33 | 97 | 0.87 | 126 | 223 | |
| 6 | Area Bd by Scotts. Chap & Ariz Canal | 60 | 30 | 24 | 0.80 | | 53 | 0.92 | 0.91 | 0.09 | 3 | 0.64 | 15 | 18 | |
| 6a | Area Contrib in 38 min | 44 | 22 | 18 | 0.80 | | 38 | 1.20 | 1.194 | 0.32 | 7 | 0.895 | 16 | 23 | |
| | Sum 4, 5a & 6a | 568 | 316 | 163 | 0.75 | | 38 | 1.20 | 1.163 | 0.33 | 105 | 0.87 | 142 | 247 | |
| | 5280' of 84" pipe (13'/Sec) | | | | | 0.0053 | 8 | | | | | | | | |
| V-9 | 5 Year | | | | | | | | | | | | | | |
| 4 | Camelback at Invergordon | 285 | 164 | 61 | 0.70 | | 30 | 1.90 | 1.86 | 0.93 | 153 | 1.49 | 91 | 244 | |
| | 5280' of 66" pipe (13'/Sec) | | | | | 0.0072 | 8 | | | | | | | | |
| 5 | Camelback at Scottsdale Rd | 303 | 165 | 116 | 0.80 | | 53 | 1.30 | 1.275 | 0.38 | 62 | 0.97 | 112 | 174 | |
| 5a | Portion contrib in 38 min | 239 | 130 | 84 | 0.80 | | 38 | 1.63 | 1.595 | 0.64 | 83 | 1.26 | 106 | 189 | |
| | Sum 4 & 5a | 524 | 294 | 145 | 0.75 | | 38 | 1.63 | 1.58 | 0.66 | 194 | 1.24 | 180 | 374 | |
| 6 | Area Bd by Scotts. Chap & Ariz Canal | 60 | 30 | 24 | 0.80 | | 53 | 1.30 | 1.286 | 0.39 | 11 | 0.98 | 23 | 34 | |
| | Area contrib in 38 min | 44 | 22 | 18 | 0.80 | | 38 | 1.63 | 1.62 | 0.65 | 14 | 1.28 | 23 | 37 | |
| | Sum 4, 5a & 6a | 568 | 316 | 163 | 0.75 | | 38 | 1.63 | 1.58 | 0.66 | 208 | 1.24 | 202 | 410 | |
| | 5280' of 84" pipe | | | | | 0.0053 | 8 | | | | | | | | |
| V-9 | 25 Year | | | | | | | | | | | | | | |
| 4 | Camelback at Invergordon | 285 | 164 | 61 | 0.70 | | 30 | 2.63 | 2.58 | 1.50 | 236 | 2.14 | 130 | 366 | |
| | 5280' of 66" pipe (13'/Sec) | | | | | 0.0072 | 8 | | | | | | | | |
| 5 | Camelback at Scottsdale Rd | 303 | 165 | 116 | 0.80 | | 53 | 1.80 | 1.765 | 0.77 | 127 | 1.41 | 164 | 291 | |
| 5a | Portion Contrib in 38 min | 239 | 130 | 84 | 0.80 | | 38 | 2.26 | 2.218 | 1.13 | 147 | 1.82 | 153 | 300 | |
| | Sum 4 & 5a | 524 | 294 | 145 | 0.75 | | 38 | 2.26 | 2.195 | 1.16 | 341 | 1.80 | 261 | 602 | |
| 6 | Area Bd by Scotts, Chap, & Ariz Canal | 60 | 30 | 24 | 0.80 | | 53 | 1.80 | 1.782 | 0.79 | 24 | 1.42 | 34 | 58 | |
| 6a | Area Contrib in 38 min | 44 | 22 | 18 | 0.80 | | 38 | 2.26 | 2.24 | 1.15 | 25 | 1.84 | 33 | 58 | |
| | Sum 4, 5a & 6a | 568 | 316 | 163 | 0.75 | | 38 | 2.26 | 2.19 | 1.15 | 353 | 1.79 | 292 | 645 | |
| | 5280' of 84" pipe (13'/Sec) | | | | | 0.0053 | 8 | | | | | | | | |

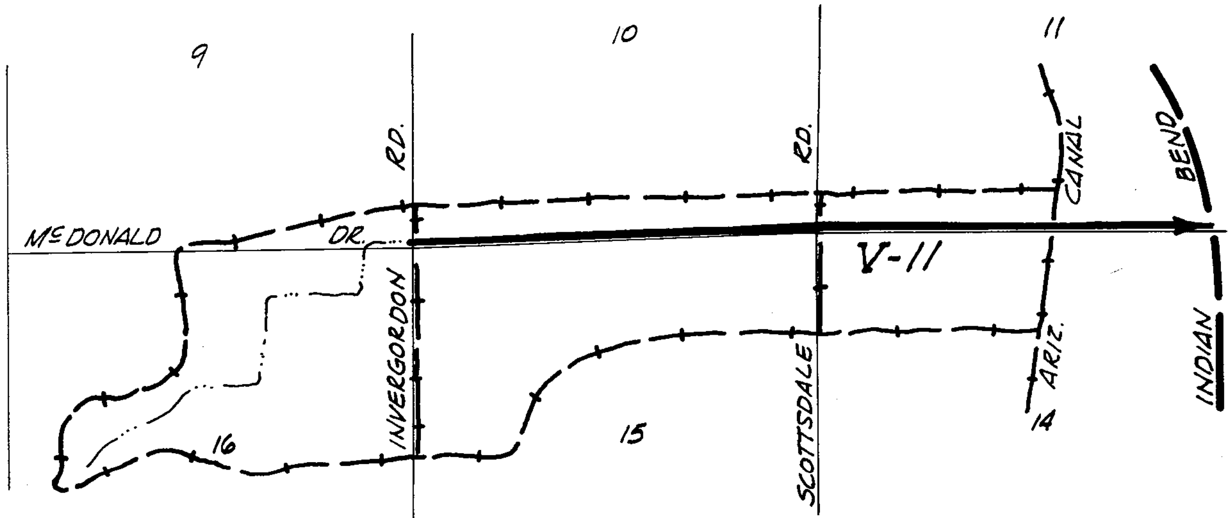
EXPECTED FLOWS 10 - year rainfall intensity and duration unless noted

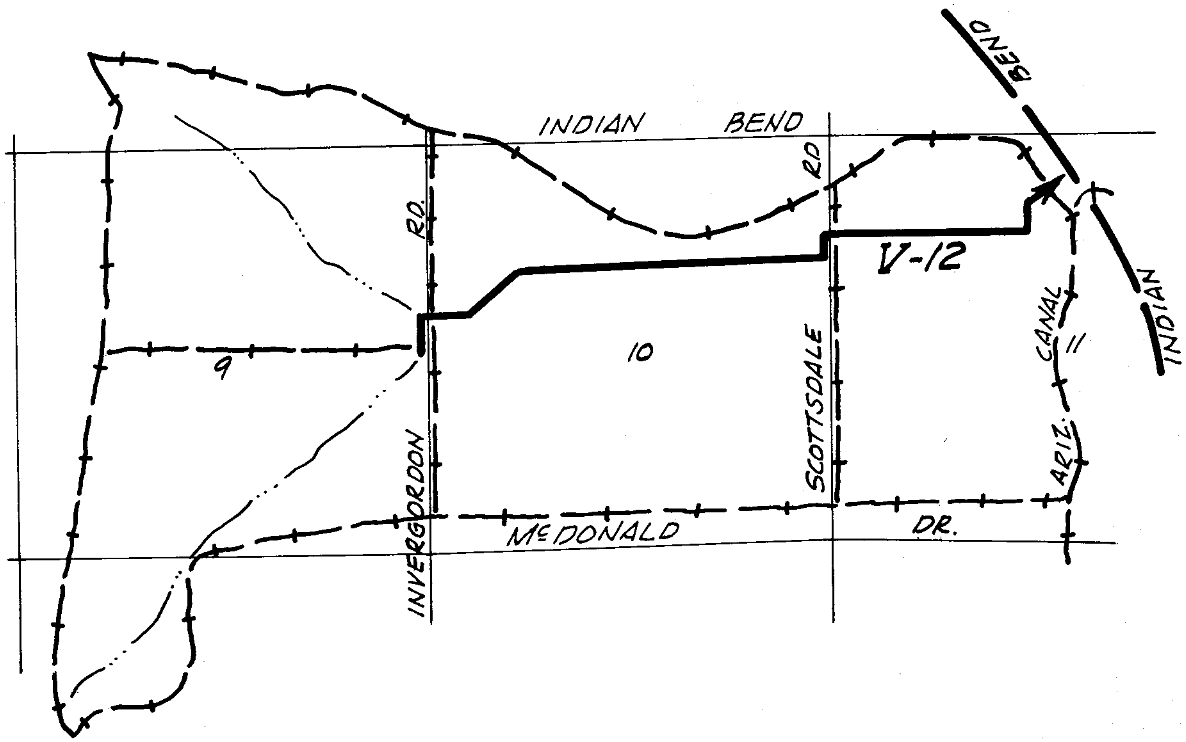
| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-9 | | | | | | | | | | | | | | | |
| 4 | Camelback at Invergordon | 285 | 164 | 61 | 0.70 | | 30 | 2.25 | 2.21 | 1.21 | 199 | 1.82 | 111 | 310 | 310 (66" pipe) |
| | 5280' of 66" pipe (13'/Sec) | | | | | 0.0072 | 8 | | | | | | | | |
| 5 | Camelback at Scottsdale Rd | 303 | 165 | 116 | 0.80 | | 53 | 1.50 | 1.47 | 0.535 | 88 | 1.14 | 132 | 220 | |
| 5a | Portion contributing in 38 min | 239 | 130 | 84 | 0.80 | | 38 | 1.90 | 1.86 | 0.85 | 110 | 1.495 | 126 | 236 | |
| | Sum 4 & 5a | 524 | 294 | 145 | 0.75 | | 38 | 1.90 | 1.84 | 0.87 | 256 | 1.475 | 214 | 470 | 470 (84" pipe) |
| 6 | Area Bd. by Scottsdale, Chap. & Ariz. Canal | 60 | 30 | 24 | 0.80 | | 53 | 1.50 | 1.49 | 0.55 | 16 | 1.16 | 27 | 43 | |
| 6a | Area contributing in 38 min | 44 | 22 | 18 | 0.80 | | 38 | 1.90 | 1.89 | 0.87 | 19 | 1.52 | 27 | 46 | |
| | Sum 4, 5a, & 6a | 568 | 316 | 163 | 0.75 | | 38 | 1.90 | 1.85 | 0.87 | 275 | 1.48 | 242 | 519 | |
| | 5280' of 84" pipe (13'/Sec) | | | | | 0.0053 | 8 | | | | | | | | |
| V-10 | | | | | | | | | | | | | | | |
| 1 | Invergordon 750' N of Chaparral Rd | 180 | 151 | 29 | 0.4 | | 15 | 3.25 | 3.20 | 2.24 | 338 | 2.70 | 78 | 416 | 420 72" pipe |
| | 6000' of 72" pipe | | | | | 0.0091 | 6 | | | | | | | | |
| 2 | Scottsdale Rd & Chaparral Rd | 428 | 340 | 88 | 0.8 | | 33 | 2.10 | 2.05 | 1.00 | 340 | 1.67 | 146 | 486 | |
| 2a | Portion draining in 21 min | 428 | 85 | 22 | 0.8 | | 21 | 2.80 | 2.73 | 1.54 | 131 | 2.27 | 50 | 181 | |
| | Sum 1 & 2 | 608 | 491 | 117 | 0.68 | | 33 | 2.10 | 2.05 | 1.00 | 491 | 1.67 | 195 | 686 | 690 90" pipe |
| | Sum 1 & 2a | 608 | 236 | 51 | 0.68 | | 21 | 2.80 | 2.73 | 2.05 | 485 | .2.27 | 115 | 600 | |
| | 2000' 90" pipe (16'/Sec) | | | | | 0.0072 | 2 | | | | | | | | |
| 3 | Chaparral & Ariz. Canal | 227 | 160 | 67 | 0.60 | | 67 | 1.25 | 1.23 | 0.50 | 80 | 0.93 | 62 | 142 | |
| 3a | Portion draining in 23 min | 227 | 71 | 30 | 0.60 | | 23 | 2.64 | 2.59 | 1.59 | 113 | 2.15 | 64 | 177 | |
| 3b | Portion draining in 35 min | 227 | 116 | 49 | 0.60 | | 35 | 2.0 | 1.96 | 1.09 | 127 | 1.58 | 77 | 204 | |
| | Sum 1, 2a, & 3a | 835 | 307 | 81 | 0.66 | | 23 | 2.64 | 2.59 | 1.59 | 489 | 2.15 | 174 | 663 | 690 |
| | 3280' 90" pipe (16'/Sec) | | | | | | | | | | | | | | |
| V-10 | Same as above - 5 year storm | | | | | | | | | | | | | | |
| 1 | Invergordon 750' N of Chaparral Rd | 180 | 151 | 29 | 0.4 | | 15 | 2.85 | 2.81 | 1.93 | 292 | 2.35 | 68 | 360 | 360 (69" pipe) |
| | 6000' of 66" pipe (15'/sec) | | | | | 0.0091 | 7 | | | | | | | | |
| 2a | Scottsdale Road & Chaparral Road | 428 | 85 | 22 | 0.8 | | 21 | 2.30 | 2.24 | 1.15 | 98 | 1.83 | 40 | 138 | |
| 2 | Scottsdale Road & Chaparral Road | 428 | 340 | 88 | 0.8 | | 33 | 1.80 | 1.75 | 0.76 | 258 | 1.40 | 123 | 381 | |
| | Sum 1 & 2 | 608 | 491 | 117 | 0.68 | | 33 | 1.80 | 1.74 | 0.85 | 417 | 1.38 | 162 | 579 | 580 (84" pipe) |




FREQUENCY - DISCHARGE RELATION

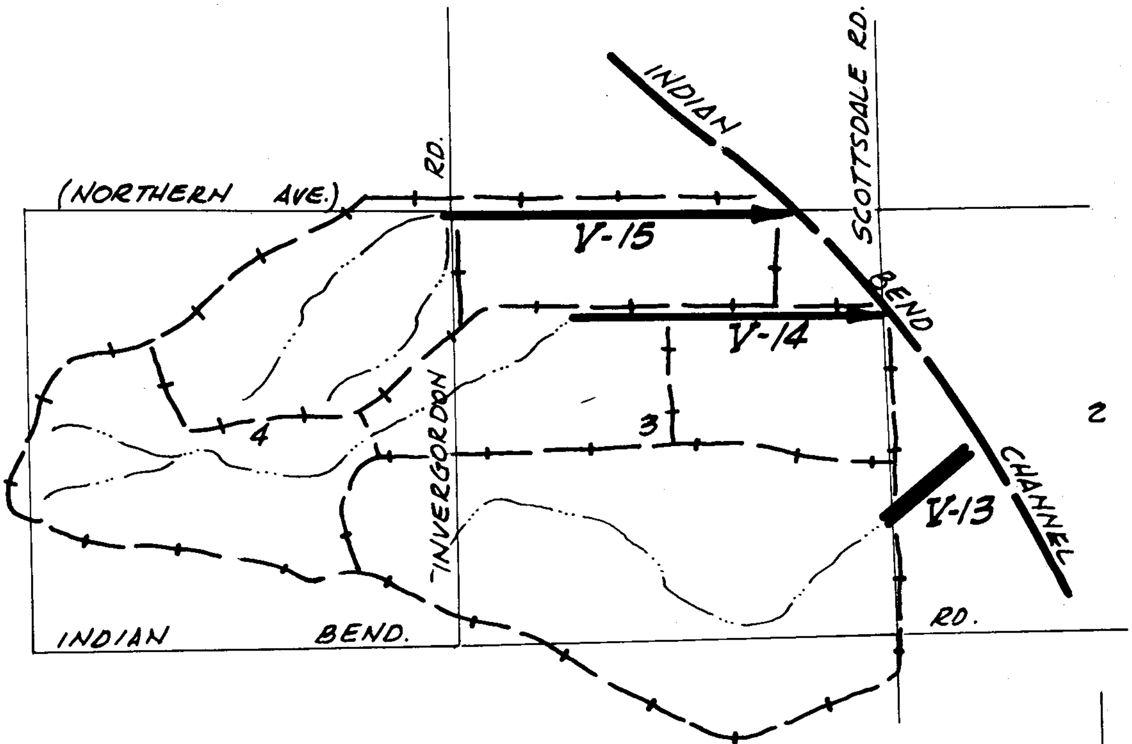
LINE V-9 - CAMELBACK RD. AT INDIAN BEND CHANNEL

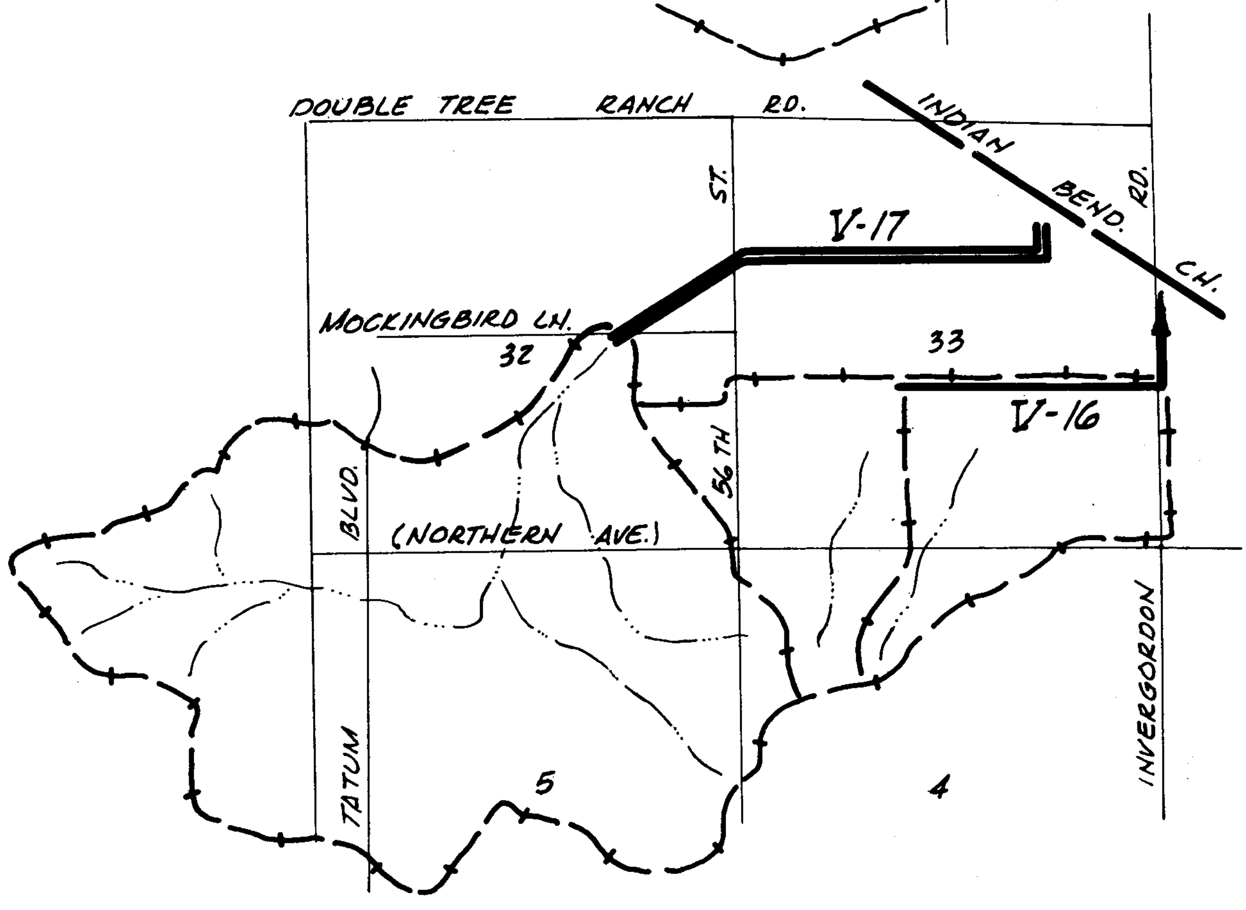

9
10
11
RD.
RD.
CANAL
BEND
McDONALD
DR.
V-11
INVERGORDON
SCOTTSDALE
ARIZ.
INDIAN
16
15
14


BEND
INDIAN
BEND
RD
RD.
V-12
CANAL
11
INDIAN
9
10
SCOTTSDALE
ARIZ.
INVERGORDON
McDONALD
DR.

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

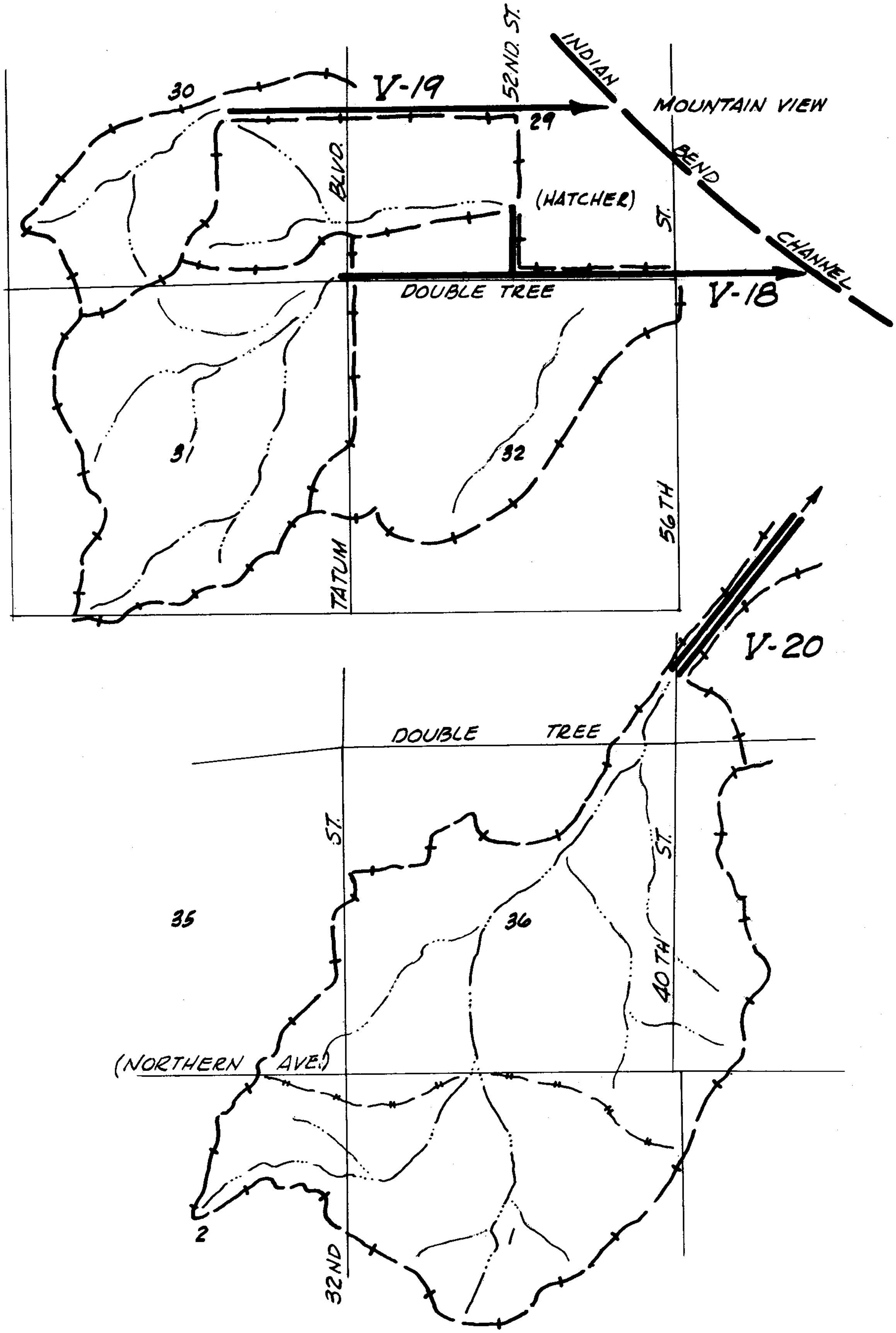
| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-11 | | | | | | | | | | | | | | | |
| 1 | McDonald Dr. & Invergordon | 275 | 230 | 87 | 0.7 | | 27 | 1.15 | 1.13 | 0.36 | 83 | 0.84 | 73 | 156 | 115 (Use 50% of Perv Area) |
| | 5280' of 42" pipe (13'/Sec) | | | | | 0.01175 | 7 | | | | | | | | |
| 2 | McDonald Dr. & Scottsdale Rd | 266 | 210 | 56 | 0.6 | | 34 | 0.95 | 0.93 | 0.26 | 55 | 0.66 | 37 | 94 | Neglect previous contrib. |
| | Sum 1 & 2 | 541 | 115 | 143 | 0.7 | | 34 | 0.95 | 0.92 | 0.18 | 21 | 0.65 | 93 | 114 | 115 48" (1 Yr) |
| | 3000' of 48" pipe (9'/Sec) | | | | | 0.00667 | 6 | | | | | | | | |
| 3 | McDonald & Ariz Canal | 120 | | 35 | | | 40 | 0.83 | 0.82 | | | 0.56 | 20 | | |
| | Sum 1, 2, 3 | 661 | 115 | 178 | 0.7 | | 40 | 0.83 | 0.805 | 0.08 | 9 | 0.545 | 97 | 106 | 115 48" (1 Yr) |
| V-12 | | | | | | | | | | | | | | | |
| 4 | Lincoln & Invergordon (N) | 324 | 130 | 64 | 0.7 | | 23 | 1.29 | 1.26 | 0.45 | 58 | 0.954 | 61 | 119 | Use 50% of Perv Area |
| 5 | Lincoln & Invergordon (S) | 332 | 133 | 65 | 0.7 | | 50 | 0.65 | 0.64 | | | 0.396 | 26 | 26 | |
| 5a | Portion draining in 25 min | 76 | 30 | 15 | 0.7 | | 25 | 1.20 | 1.19 | 0.39 | 12 | 0.89 | 13 | 25 | |
| | Sum 4 & 5a | 400 | 163 | 79 | 0.7 | | 25 | 1.20 | 1.17 | 0.38 | 62 | 0.87 | 69 | 131 | 135 48" |
| | 5500" of 48" pipe (10.5'/Sec) | | | | | 0.0071 | 9 | | | | | | | | |
| 6 | Scottsdale Rd & Cactus Wren Dr | 501 | | 110 | | | 34 | 0.95 | 0.925 | | | 0.65 | 72 | | |
| | Sum 4, 5a & 6 | 901 | 163 | 189 | 0.7 | | 34 | 0.95 | 0.915 | 0.17 | 28 | 0.64 | 121 | 149 | 150 54" |
| | 3400' of 54" pipe (11.6'/Sec) | | | | | 0.00647 | 5 | | | | | | | | |
| 7 | At Indian Bend (Portion) | 150 | | 52 | | | 35 | 0.93 | 0.92 | | | 0.65 | 34 | | Doesn't enter trunk |


INDIAN
SCOTTSDALE RD.
RD.
(NORTHERN AVE.)
V-15
BEND
V-14
INVERGORDON
4
3
2
CHANNEL
V-13
RD.
INDIAN
BEND.


DOUBLE TREE RANCH RD.
INDIAN
BEND.
RD.
ST.
V-17
CH.
MOCKINGBIRD LN.
32
33
V-16
56 TH
BLVD.
(NORTHERN AVE.)
INVERGORDON
TATUM
5
4

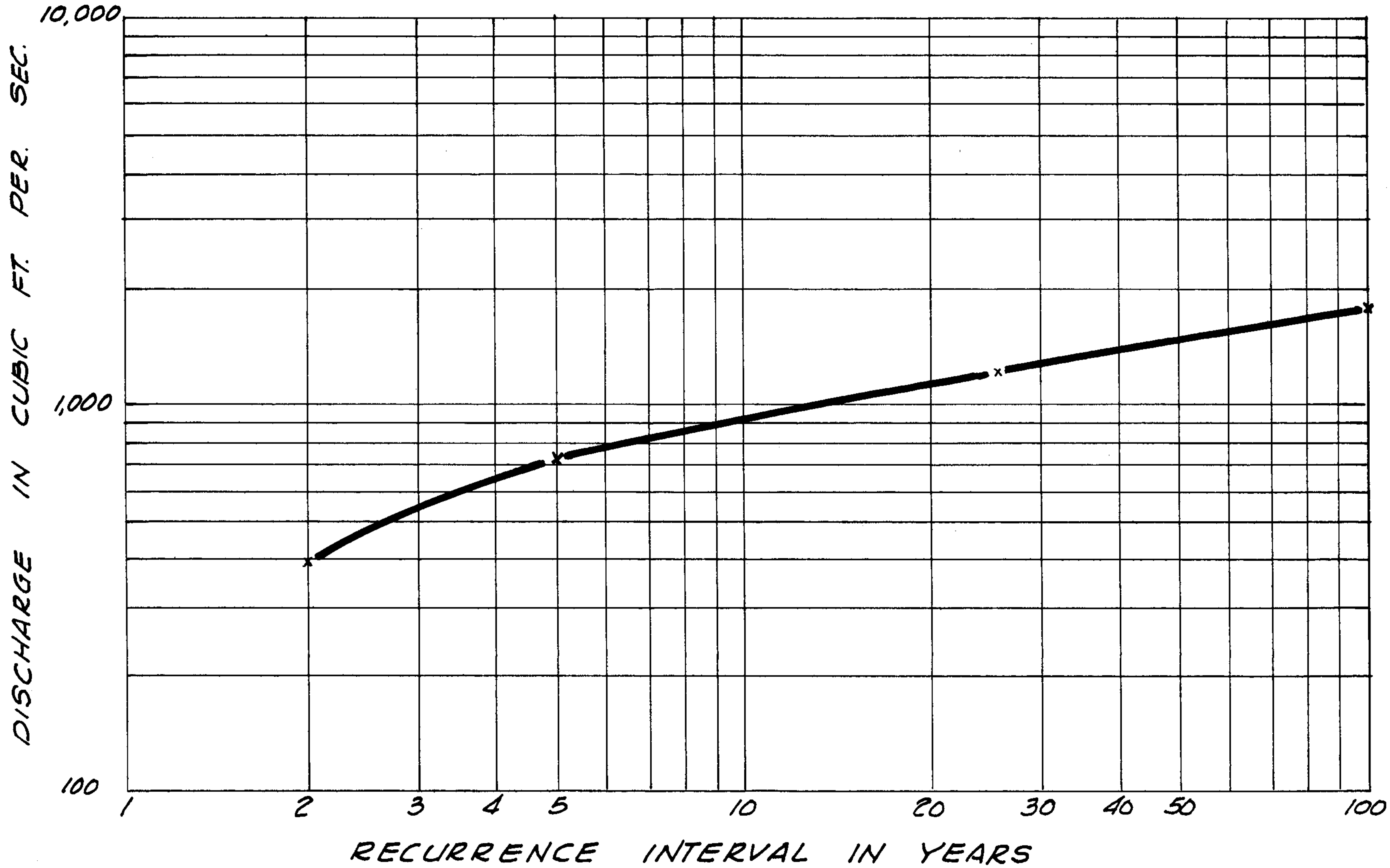
EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area $A$ | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-13 | Hummingbird Ln. & Scottsdale Rd | 416 | | 81 | | | 50 | 0.70 | 0.68 | | | 0.43 | 35 | | |
| | Same but 5 year storm | | | | | | | 1.32 | 1.29 | | | 0.98 | 80 | | |
| | 10 year storm | | | | | | | 1.56 | 1.52 | | | 1.19 | 96 | | |
| | 25 year storm | | 330 | 81 | 0.6 | | | 1.85 | 1.80 | 0.96 | 316 | 1.44 | 117 | 433 | 450 cfs channel |
| V-14 | | | | | | | | | | | | | | | |
| 1 | Cheney Dr. at Ironwood | 200 | 83 | 33 | 0.6 | | 16 | 1.65 | 1.63 | 0.825 | 69 | 1.29 | 42 | 111 | 110 ) |
| 2 | Mockingbird Ln at Stallion Dr | 111 | | 22 | | 0.0190 | 14 | 1.80 | 1.78 | | | 1.42 | 31 | | ) |
| | Sum 1 & 2 | 311 | 83 | 55 | 0.6 | | 30 | 1.05 | 1.03 | 0.34 | 28 | 0.75 | 41 | 69 | 110 ) |
| | 4000' of 45" pipe (10'/Sec) | | | | | 0.0075 | 7 | | | | | | | | ) 45" pipe |
| 3 | Stallion Dr. at Scottsdale Rd | 102 | | 20 | | | 15 | 1.70 | 1.68 | | | 1.33 | 27 | | ) |
| | Sum 1 - 3 | 413 | 83 | 75 | | | 45 | 0.76 | 0.74 | 0.11 | 9 | 0.49 | 37 | 46 | 110 ) |
| V-15 | | | | | | | | | | | | | | | |
| 4 | Northern at Invergordon | 169 | 45 | 34 | 0.6 | | 14 | 1.80 | 1.75 | 0.92 | 41 | 1.395 | 34 | 75 | 75 |
| | 4000' of 39" pipe (8.5'/Sec) | | | | | 0.00625 | 8 | | | | | | | | |
| 5 | Northern at Indian Bend Wash | 120 | | 24 | | 0.00715 | 26 | 1.17 | 1.16 | | | 0.865 | 21 | | |
| | Sum 4 & 5 | 289 | 45 | 58 | 0.6 | | 26 | 1.17 | 1.145 | 0.445 | 20 | 0.85 | 49 | 69 | 75 |
| V-16 | | | | | | | | | | | | | | | |
| 1 | Mockingbird at 59th St | 186 | 75 | 37 | 0.6 | | 12 | 1.95 | 1.92 | 1.06 | 80 | 1.55 | 57 | 137 | 140 57" pipe |
| | 3300' of 57" pipe (8.2'/Sec) | | | | | 0.00365 | 7 | | | | | | | | |
| 2 | Mockingbird at 64th St | 181 | | 36 | | 0.00716 | 25 | 1.20 | 1.18 | | | 0.88 | 32 | 32 | |
| 2a | Portion draining in 19 min | 143 | | 29 | | | 19 | 1.46 | 1.44 | | | 1.11 | 32 | 32 | |
| | Sum 1 & 2a | 329 | 75 | 66 | 0.6 | | 19 | 1.46 | 1.42 | 0.66 | 49 | 1.10 | 72 | 121 | 140 |
| V-17 | 25 year storm<br>Mockingbird Lane at 54th St | 885 | 708 | 177 | 0.8 | | 60 | 1.60 | 1.54 | 0.59 | 418 | 1.205 | 213 | 631 | 650 cfs Channel |


V-19
V-18
V-20
INDIAN BEND CHANNEL
MOUNTAIN VIEW
52ND. ST.
29
30
31
32
(HATCHER)
BLVD.
ST.
DOUBLE TREE
TATUM
56TH
DOUBLE TREE
ST.
35
36
40TH
ST.
(NORTHERN AVE.)
2
1
32ND

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-18 | | | | | | | | | | | | | | | |
| 1 | Doubletree & Tatum | 464 | 190 | 83 | 0.6 | | 30 | 1.05 | 1.02 | 0.34 | 65 | 0.74 | 61 | 126 | 130 45" pipe (1 Yr) |
| | 2640' of 45" pipe (11.8'/Sec) | | | | | 0.0100 | 4 | | | | | | | | |
| 2 | 52nd St at (Hatcher Rd) | 210 | | 42 | | | 51 | 0.68 | 0.67 | | | 0.42 | 18 | 20 | use 36" pipe |
| 2a | Portion draining in 35 min | 110 | | 22 | | | 35 | 0.93 | 0.92 | | | 0.65 | 14 | 14 | |
| | Sum 1 & 2a | 574 | 190 | 105 | 0.6 | | 35 | 0.93 | 0.90 | 0.24 | 46 | 0.63 | 66 | 112 | 130 51" pipe |
| 3 | Doubletree at 56th St | 403 | | 81 | | | 77 | | | | | | | | |
| 3a | Portion draining in 40 min | 200 | | 40 | | | 40 | 0.83 | | | | | | | |
| | Sum 1, 2a & 3a | 974 | 190 | 145 | 0.6 | | 40 | 0.83 | 0.80 | 0.16 | 30 | 0.54 | 78 | 108 | 130 |
| V-19 | | | | | | | | | | | | | | | |
| 4 | Mountain View & 44th St | 142 | 57 | 28 | 0.6 | | 15 | 1.70 | 1.67 | 0.86 | 49 | 1.32 | 37 | 86 | 90 |
| | 2640' of 36" pipe (12.5'/Sec) | | | | | 0.0152 | | | | | | | | | |
| | 3960' of 39" pipe (10.9'/Sec) | | | | | 0.0100 | | | | | | | | | |
| V-20 | | | | | | | | | | | | | | | |
| 5 | 40th St & (Berneil Dr) | 1155 | 982 | 173 | 0.6 | | 48 | 1.90 | 1.82 | 0.975 | 955 | 1.46 | 252 | 1207 | 25 Year |
| 5a | (upper portion) | 415 | 176 | 62 | 0.6 | | 18 | 3.50 | 3.41 | 2.25 | 396 | 2.89 | 179 | 575 | 25 Year |
| 6 | 28th St 900' N. of Shea | 237 | | 60 | | | 38 | 0.85 | 0.83 | | | 0.57 | 34 | 35 | 35 30" pipe |
| | 3500' of 30" pipe (7'/Sec) | | | | | 0.0066 | 8 | | | | | | | | |
| 7 | 32nd St at Shea Blvd | 491 | | 132 | | | 57 | 0.62 | 0.605 | | | 0.364 | 48 | | |
| 7a | Portion draining in 38 + 8 =46 min | 350 | | 97 | | | 46 | 0.74 | 0.72 | | | 0.47 | 45 | | |
| | Sum 6 & 7a | 587 | | 157 | | | 46 | 0.74 | 0.72 | | | 0.47 | 74 | 75 | 75 45" pipe |
| | 5280' of 45" pipe (7'/Sec) | | | | | 0.00312 | 13 | | | | | | | | |
| 8 | 40th St & Shea Blvd | 604 | | 121 | | | 86 | | | | | | | | |
| 8a | Portion draining in 46 + 13 = 59 min | 300 | | 60 | | | 59 | 0.61 | 0.60 | | | | | | |
| | Sum 6, 7a & 8a | 887 | | 217 | | | 59 | 0.61 | 0.59 | | | 0.35 | 76 | 8 | 80 48" pipe |
| | 3700' of 48" pipe (7'/Sec) | | | | | 0.0070 | 9 | | | | | | | | |
| 9 | Shea Blvd at 46th St | 362 | | 72 | | | 76 | | | | | | | | |
| 9a | Portion draining in 68 min | 300 | | 60 | | | 68 | | | | | | | | |
| | Sum 6, 7a , 8a, & 9a | 1187 | | 277 | | | 68 | 0.54 | 0.52 | | | 0.29 | 81 | | 85 |
| V-20 | | | | | | | | | | | | | | | |
| 5 | 40th Street & Berneil Drive | 1155 | 982 | 173 | 0.6 | | 48 | 1.38 | 1.325 | 0.58 | 570 | 1.01 | 175 | 745 | 5 year |
| 5 | 40th Street & Berneil Drive | 1155 | 982 | 173 | 0.6 | | 48 | 2.50 | 2.40 | 1.44 | 1415 | 1.98 | 342 | 1757 | 100 year |




FREQUENCY-DISCHARGE RELATION

UNNAMED WASH AT 40TH ST. AND BERNEIL DR.
(LINE V-20)

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-21 | | | | | | | | | | | | | | | |
| 1 | Cactus at 24th St | 515 | | 152 | | | 65 | 0.57 | 0.55 | | | 0.315 | 48 | | 50 36" pipe |
| 1a | Portion draining in 46 min | 242 | | 72 | | | 46 | 0.75 | 0.735 | | | 0.48 | 35 | | |
| | 2640' of 36" pipe (7'/Sec) | | | | | 0.00493 | 6 | | | | | | | | |
| 2 | Cactus at 28th St | 362 | | 110 | | | 66 | 0.56 | 0.545 | | | 0.31 | 34 | | |
| | Sum 1 & 2 | 877 | | 262 | | | 71 | 0.525 | 0.505 | | | 0.275 | 72 | | 75 42" pipe |
| | 2640' of 42 " pipe (8'/Sec) | | | | | 0.00530 | 5 | | | | | | | | |
| 3 | Cactus at 32nd St | 321 | | 98 | | | 83 | 0.47 | 0.46 | | | 0.23 | 22 | | |
| 3a | Portion draining in 76 min | 310 | | 95 | | | 76 | 0.50 | 0.49 | | | 0.26 | 25 | | |
| | Sum 1, 2 & 3a | 1187 | | 357 | | | 76 | 0.50 | 0.48 | | | 0.25 | 90 | | 90 |
| | 2640' of 48" pipe (8'/Sec) | | | | | 0.00455 | 6 | | | | | | | | |
| 4a | Cholla at 36th St | 160 | | 44 | | | 68 | 0.55 | 0.545 | | | 0.31 | 14 | | 27" pipe 3.5'/Sec |
| 4b | Cactus at 36th St | 161 | | 44 | | | 71 | 0.525 | 0.52 | | | 0.29 | 13 | | |
| | Sum 1, 2, 3a & 4 | 1508 | | 445 | | | 82 | 0.47 | 0.45 | | | 0.225 | 101 | | 110 54" pipe |
| | 2640' of 54" pipe (9'/Sec) | | | | | 0.00455 | 5 | | | | | | | | |
| 5a | Cholla at 40th St | 160 | | 44 | | | 64 | 0.57 | 0.565 | | | 0.33 | 14 | | |
| 5b | Cactus at 40th St | 160 | | 44 | | | 69 | 0.535 | 0.53 | | | 0.30 | 13 | | |
| | Sum 1, 2, 3a, 4 & 5 | 1828 | | 533 | | | 87 | 0.45 | 0.43 | | | 0.21 | 112 | | 115 |

EXPECTED FLOWS    1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-22 | | | | | | | | | | | | | | | |
| 1 | SE ¼ Sec 36 | 160 | | 21 | | | 49 | 0.70 | 0.69 | | | 0.44 | 9 | | |
| 2 | SW ¼ Sec 36 | 160 | | 21 | | | 52 | 0.68 | 0.67 | | | 0.425 | 9 | | 10 |
| | Sum 1 & 2 | 320 | | 42 | | | 62 | 0.59 | 0.58 | | | 0.342 | 14 | | 15 24" pipe |
| | 2640' of 24" pipe (5.0'/Sec) | | | | | 0.00455 | 9 | | | | | | | | |
| 3 | NE ¼ Sec 1 | 160 | | 32 | | | 64 | 0.58 | 0.57 | | | 0.333 | 11 | | 10 |
| 4 | NW ¼ Sec 1 | 160 | | 32 | | | 75 | 0.50 | 0.495 | | | 0.265 | 9 | | |
| | Sum 1, 2, 3, 4 | 640 | | 106 | | | 71 | 0.53 | 0.515 | | | 0.283 | 30 | | 30 30" pipe |
| | 2640' of 30" pipe (6.0'/Sec) | | | | | 0.00455 | 7 | | | | | | | | |
| 5 | SE ¼ Sec 1 | 160 | | 32 | | | 48 | 0.71 | 0.70 | | | 0.45 | 14 | | 15 |
| 6 | SW ¼ Sec 1 | 160 | | 32 | | | 64 | 0.58 | 0.57 | | | 0.333 | 11 | | |
| | Sum 1 - 6 | 960 | | 170 | | | 78 | 0.49 | 0.472 | | | 0.244 | 42 | | 45 36" pipe |
| | 2640' of 36" pipe (7'/Sec) | | | | | 0.00492 | 6 | | | | | | | | |
| 7 | 32nd St & Acoma Dr. | 450 | | 116 | | | 80 | 0.48 | 0.469 | | | 0.242 | 28 | | |
| | Sum 1 - 7 | 1410 | | 286 | | | 84 | 0.46 | 0.44 | | | 0.216 | 62 | | 65 45" pipe |
| | 2640' of 45" pipe (6.0'/Sec) | | | | | 0.00266 | 7 | | | | | | | | |
| 8 | Thunderbird Rd & 32nd St ** | 193 | | 45 | | | 34 | 0.95 | 0.935 | | | 0.66 | 30 | | Trial - not a maximum |
| | Sum 1 - 8 | 1603 | | 331 | | | 91 | 0.43 | 0.41 | | | 0.19 | 63 | | 65 48" pipe |
| | 1000' of 48" pipe (5.5'/Sec) | | | | | 0.00200 | 3 | | | | | | | | |
| 9 | Thunderbird Rd & 34th St | 105 | | 29 | | | 41 | 0.82 | 0.81 | | | 0.55 | 16 | | |
| | Sum 1 - 9 | 1708 | | 360 | | | 94 | 0.42 | 0.40 | | | 0.18 | 65 | | 65 48" pipe |
| | 1400' of 48" pipe (7'/Sec) | | | | | 0.00357 | 3 | | | | | | | | |
| 10 | Emil Zola & 34th St | 162 | | 44 | | | 38 | 0.87 | 0.86 | | | 0.60 | 26 | | |
| | Sum 1 - 10 | 1870 | | 404 | | | 97 | 0.41 | 0.39 | | | 0.17 | 69 | | 70 48" pipe * |
| | 1320' of 48" pipe* (7.5'/Sec) | | | | | | 3 | | | | | | | | |
| 11 | Sweetwater & 34th St | 254 | | 66 | | | 53 | 0.66 | 0.65 | | | 0.405 | 27 | | |
| | Sum 1 - 11 | 2124 | | 470 | | | 100 | 0.40 | 0.38 | | | 0.162 | 76 | | |
| 12 | Cactus at 32nd St | 292 | | 75 | | | 86 | 0.45 | 0.44 | | | 0.216 | 16 | | |
| | Sum 1 - 12 | 2416 | | 545 | | | 100 | 0.40 | 0.378 | | | 0.16 | 88 | | 90 54" pipe |
| | 1500' of 54" pipe (6.0'/Sec) | | | | | 0.0020 | | | | | | | | | |

* Might use 48" pipe if gradient maintained

**NOTE: Portion of Line V-22 below Thunderbird Road to be disregarded if Indian Bend Flood Control channel begins at that point.

EXPECTED FLOWS    1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a-f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-23 | | | | | | | | | | | | | | | |
| 1 | 44th St at Grover's Ave | 132 | | 35 | | | 40 | 0.83 | 0.82 | | | 0.56 | 20 | | 20 |
| 2 | 40th St at Grover's Ave | 200 | | 52 | | | 54 | 0.66 | | | | | | | |
| 2a | Portion draining in 51 min | 190 | | 50 | | | 50 | 0.70 | 0.69 | | | 0.44 | 22 | | |
| | Sum 1 & 2a | 322 | | 85 | | | 50 | 0.70 | 0.683 | | | 0.434 | 37 | | 40 30" pipe |
| | 2640' of 30" pipe (7.2'/Sec) | | | | | 0.00695 | 6 | | | | | | | | |
| 3 | 44th St at Bell Rd | 160 | | 42 | | | 48 | 0.73 | 0.72 | | | 0.47 | 20 | | |
| 4 | 40th St at Bell Rd | 185 | | 48 | | | 56 | 0.64 | 0.63 | | | 0.387 | 19 | | |
| | Sum 1 - 4 | 667 | | 175 | | | 56 | 0.64 | 0.62 | | | 0.378 | 66 | | 70 42" pipe |
| | 2640' of 42" pipe (8'/Sec) | | | | | 0.00530 | 6 | | | | | | | | |
| 5 | 44th St at Northern | 160 | | 32 | | | 54 | 0.66 | 0.65 | | | 0.405 | 13 | | 15 |
| 5a | Portion draining in 56+6-13=49min | 145 | | 29 | | | 49 | 0.71 | 0.703 | | | 0.452 | 13 | | |
| 6 | 40th St at Northern | 181 | | 37 | | | 77 | | | | | | | | |
| 6a | Portion draining in 56+6=62 min | 145 | | 30 | | | 62 | 0.59 | 0.58 | | | 0.342 | 10 | | |
| | Sum 1 - 5, 5a, 6a | 957 | | 234 | | | 62 | 0.59 | 0.57 | | | 0.33 | 78 | | 80 42" pipe |
| | 2640' of 42" pipe (8'/Sec) | | | | | 0.00510 | 6 | | | | | | | | |
| 7 | 44th St at Greenway Rd | 118 | | 24 | | | 63 | 0.585 | 0.58 | | | 0.342 | 8 | | |
| 7a | Portion draining in 62+6-15=53min | 99 | | 20 | | | 53 | 0.67 | 0.66 | | | 0.414 | 8 | | |
| 8 | 40th St at Greenway Rd | 175 | | 35 | | | 81 | 0.475 | 0.46 | | | 0.234 | 8 | | |
| 8a | Portion draining in 68 min | 147 | | 29 | | | 68 | 0.545 | 0.54 | | | 0.308 | 9 | | |
| | Sum 1 - 8a | 1203 | | 283 | | | 68 | 0.545 | 0.52 | | | 0.288 | 83 | | 85 45" pipe |
| | 2640' of 45" pipe (8'/Sec) | | | | | 0.00510 | 6 | | | | | | | | |
| 9 | 40th St at Acoma | 248 | | 68 | | | 104 | | | | | | | | |
| 9a | Portion draining in 68+6=74 min | 176 | | 48 | | | 74 | 0.510 | 0.50 | | | 0.27 | 13 | | |
| | Sum 1 - 9a | 1379 | | 331 | | | 74 | 0.51 | 0.486 | | | 0.258 | 86 | | 90 45" pipe |
| | 2640' of 45" pipe (9.5'/Sec) | | | | | 0.00645 | 5 | | | | | | | | |
| 10 | 40th St & Thunderbird Rd | 248 | | 68 | | | 104 | | | | | | | | |
| 10a | Portion draining in 74+6=80 min | 191 | | 53 | | | 80 | 0.48 | 0.47 | | | 0.243 | 13 | | |
| | Sum 1 - 10a | 1570 | | 384 | | | 80 | 0.48 | 0.46 | | | 0.234 | 90 | | 90 48" pipe |
| | 2640' of 48" pipe (8.2'/Sec) | | | | | 0.00455 | 5 | | | | | | | | |
| 11 | 40th St at Cholla Rd | 248 | | 50 | | | 104 | | | | | | | | |
| 11a | Portion draining in 80+6=86 min | 205 | | 42 | | | 86 | 0.46 | 0.455 | | | 0.23 | 10 | | |
| | Sum 1 - 11a | 1775 | | 426 | | | 86 | 0.46 | 0.437 | | | 0.213 | 93 | | 95 48" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-24 | | | | | | | | | | | | | | | |
| 1 | Tatum Blvd at Bell Rd | 362 | | 72 | | | 53 | 0.66 | 0.645 | | | 0.40 | 29 | 30 | |
| | 2640 of 27" pipe | | | | | 0.0068 | 6 | | | | | | | | |
| 2 | Tatum at Northern | 320 | | 64 | | | 76 | | | | | | | | |
| 2a | Portion draining in 59 min | 250 | | 50 | | | 59 | 0.61 | 0.60 | | | 0.36 | 18 | | |
| | Sum 1 & 2a | 612 | | 122 | | | 59 | 0.61 | 0.59 | | | 0.35 | 43 | 45 | |
| | 2640' of 33" pipe | | | | | 0.0068 | 6 | | | | | | | | |
| 3 | Tatum at Greenway | 320 | | 64 | | | 76 | | | | | | | | |
| 3a | Portion draining in 65 min | 274 | | 55 | | | 65 | 0.57 | 0.56 | | | 0.324 | 18 | | |
| | Sum 1 - 3a | 886 | | 177 | | | 65 | 0.57 | 0.55 | | | 0.315 | 56 | 56 | 60 |
| | 2640' of 36" pipe | | | | | 0.0060 | 6 | | | | | | | | |
| 4 | Tatum at Acoma | 320 | | 64 | | | 91 | | | | | | | | |
| 4a | Portion draining in 71 min | 250 | | 50 | | | 71 | 0.53 | 0.52 | | | 0.29 | 15 | | |
| | Sum 1 - 4a | 1136 | | 227 | | | 71 | 0.53 | 0.51 | | | 0.28 | 64 | 65 | |
| | 2640' of 39" pipe | | | | | 0.0060 | 6 | | | | | | | | |
| 5 | Tatum at Thunderbird | 320 | | 64 | | | 91 | | | | | | | | |
| 5a | Portion draining in 77 min | 270 | | 54 | | | 77 | 0.50 | 0.49 | | | 0.26 | 14 | | |
| | Sum 1 - 5a | 1406 | | 281 | | | 77 | 0.50 | 0.48 | | | 0.25 | 71 | 72 | |
| | 2640' of 42" pipe | | | | | 0.0055 | 6 | | | | | | | | |
| 6 | Tatum at Cholla | 320 | | 64 | | | 92 | | | | | | | | |
| 6a | Portion draining in 83 min | 288 | | 58 | | | 83 | 0.465 | 0.455 | | | 0.23 | 13 | | |
| | Sum 1 - 6a | 1694 | | 339 | | | 83 | 0.465 | 0.44 | | | 0.216 | 73 | 75 | |
| | 2640' of 42" pipe | | | | | 0.0055 | 5 | | | | | | | | |
| 7 | Tatum at Cactus | 320 | | 64 | | | 92 | | | | | | | | |
| 7a | Portion draining in 89 min | 309 | | 62 | | | 89 | 0.44 | 0.43 | | | 0.207 | 13 | | |
| | Sum 1 - 7a | 2003 | | 401 | | | 89 | 0.44 | 0.42 | | | 0.20 | 80 | 80 | |
| | 2640' of 45" pipe | | | | | 0.0042 | 6 | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area $A$ | AREA - ACRES: Perv. Area $A_p$ | AREA - ACRES: Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Concentration Time: Min. $t_c$ | RAIN: Point Intensity I in/hr | RAIN: Average Intensity $I_a$ in/hr | RUNOFF: Pervious: $(I_a - f_c)0.8 = I_n$ in | RUNOFF: Pervious: $I_n A_p$ cfs | RUNOFF: Impervious: $(I_a - 0.2)0.9 = I_m$ in | RUNOFF: Impervious: $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-25 | | | | | | | | | | | | | | | |
| 1 | 56th St at Northern | 562 | | 112 | | | 61 | 0.59 | 0.57 | | | 0.333 | 37 | | 40 |
| | 2640' of 30" pipe | | | | | 0.0075 | 5 | | | | | | | | |
| 2 | 56th St at Greenway Rd | 320 | | 64 | | | 70 | | | | | | | | |
| 2a | Portion draining in 66 min | 302 | | 60 | | | 66 | 0.56 | 0.55 | | | 0.315 | 19 | | |
| | Sum 1 & 2a | 864 | | 172 | | | 66 | 0.56 | 0.54 | | | 0.306 | 53 | | 55 |
| | 2640' of 36" pipe | | | | | 0.0068 | 6 | | | | | | | | |
| 3 | 56th St at Acoma | 285 | | 57 | | | 58 | 0.62 | 0.61 | | | 0.37 | 21 | | |
| | Sum 1 - 3 | 1149 | | 229 | | | 72 | 0.53 | 0.51 | | | 0.28 | 64 | | 65 |
| | 2640' of 39" pipe | | | | | 0.0068 | 5 | | | | | | | | |
| 4 | 56th St at Thunderbird | 285 | | 57 | | | 65 | 0.56 | 0.55 | | | 0.315 | 18 | | |
| | Sum 1 - 4 | 1434 | | 286 | | | 77 | 0.49 | 0.47 | | | 0.243 | 69 | | 70 |
| | 2640' of 42" pipe | | | | | 0.0055 | 6 | | | | | | | | |
| 5 | 56th St at Sweetwater | 290 | | 58 | | | 58 | 0.62 | 0.61 | | | 0.37 | 21 | | |
| | Sum 1 - 5 | 1724 | | 344 | | | 83 | 0.47 | 0.45 | | | 0.225 | 77 | | 80 |
| | 2640' of 45" pipe (8.5) | | | | | 0.0055 | 5 | | | | | | | | |
| 6 | 56th St at Cactus | 290 | | 58 | | | 58 | 0.62 | 0.61 | | | 0.37 | 21 | | |
| | Sum 1 - 6 | 2014 | | 402 | | | 88 | 0.44 | 0.42 | | | 0.20 | 80 | | 85 |
| | 2640' of 45" pipe (8.0) | | | | | 0.00495 | 6 | | | | | | | | |
| 7 | 56th St at Cholla | 290 | | 52 | | | 58 | 0.62 | 0.61 | | | 0.37 | 19 | | |
| | Sum 1 - 7 | 2304 | | 454 | | | 94 | 0.42 | 0.397 | | | 0.177 | 80 | | 85 |
| | 2640' of 45" pipe | | | | | 0.00495 | 6 | | | | | | | | |
| 8 | 56th St at Shea Blvd | 266 | | 47 | | | 58 | 0.62 | 0.61 | | | 0.37 | 17 | | |
| | Sum 1 - 8 | 2570 | | 501 | | | 100 | 0.40 | 0.38 | | | 0.162 | 81 | | 85 |
| | 2640' of 45" pipe | | | | | 0.00495 | | | | | | | | | 45" pipe to Wash |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-26 | | | | | | | | | | | | | | | |
| 1 | Greenway Rd at 68th St | 230 | | 60 | | | 66 | 0.56 | 0.55 | | | 0.315 | 19 | | |
| 2 | Greenway Rd at 68th St | 285 | | 74 | | | 44 | 0.77 | 0.75 | | | 0.495 | 37 | | |
| 1a | Portion draining in 44 min | 115 | | 30 | | | 44 | 0.77 | 0.76 | | | 0.505 | 15 | | Not a maximum |
| | Sum 1 & 2 | 515 | | 134 | | | 66 | 0.56 | 0.545 | | | 0.31 | 42 | | 45 |
| | 5280' of 33" pipe (8'/Sec) | | | | | 0.0072 | 11 | | | | | | | | |
| 3 | Thunderbird Rd at 64th St | 587 | | 142 | | | 81 | 0.48 | 0.465 | | | 0.238 | 34 | | |
| 3a | Portion draining in 77 min | 559 | | 135 | | | 77 | 0.50 | 0.485 | | | 0.256 | 35 | | |
| | Sum 1 - 3a | 1074 | | 269 | | | 77 | o.50 | 0.48 | | | 0.252 | 68 | | 70 |
| | 5280' of 39" pipe (9'/Sec) | | | | | 0.0072 | 10 | | | | | | | | |
| 4 | Cactus Rd at 64th St | 514 | | 104 | | | 87 | 0.45 | 0.437 | | | 0.213 | 22 | | |
| | Sum 1 - 4 | 1588 | | 373 | | | 87 | 0.45 | 0.43 | | | 0.207 | 77 | | 80 |
| | 5280' of 48" pipe (7'/Sec) | | | | | 0.0034 | 13 | | | | | | | | |
| 5 | Shea Blvd at 64th St | 517 | | 104 | | | 100 | 0.40 | 0.39 | | | 0.17 | 18 | | |
| | Sum 1 - 5 | 2105 | | 477 | | | 100 | 0.40 | 0.38 | | | 0.162 | 77 | | 80 |
| | 5280' of 48" pipe (7.5'/Sec) | | | | | 0.0038 | 12 | | | | | | | | |
| 6 | Mtn. View at 68th St (West) | 205 | | 44 | | | 32 | 1.0 | 0.985 | | | 0.705 | 31 | | |
| | Sum 1 - 6 | 2310 | | 521 | | | 112 | 0.37 | 0.35 | | | 0.135 | 71 | | 80 |
| 7 | Greenway Rd at 76th St | 163 | | 74 | | | 58 | 0.62 | 0.61 | | | 0.37 | 27 | | |
| 8 | Greenway Rd at Scottsdale | 350 | | 159 | | | 69 | 0.54 | 0.526 | | | 0.294 | 47 | | 50 |
| | 6600' of 33" pipe (8.5'/Sec) | | | | | 0.00795 | 12 | | | | | | | | |
| 9 | Scottsdale Rd at Sutton Dr | 886 | | 503 | | | 103 | 0.39 | 0.375 | | | 0.157 | 79 | | |
| 9a | Portion draining in 81 min | 692 | | 393 | | | 81 | 0.475 | 0.46 | | | 0.234 | 92 | | |
| | Sum 7 - 9a | 1042 | | 552 | | | 81 | 0.475 | 0.455 | | | 0.230 | 127 | | 130 |
| | 3960' of 48" pipe (10.7'/Sec) | | | | | 0.0074 | 6 | | | | | | | | |
| 10 | Scottsdale Rd at Cactus | 700 | | 172 | | | 69 | 0.54 | 0.525 | | | 0.294 | 50 | | |
| | Sum 7 - 10 | 1742 | | 724 | | | 87 | 0.45 | 0.427 | | | 0.204 | 148 | | 150 |
| | 5280' of 51" pipe (10.5'/Sec) | | | | | 0.00663 | 8 | | | | | | | | |
| 11 | Scottsdale Rd at Shea Blvd | 955 | | 192 | | | 90 | 0.44 | 0.425 | | | 0.202 | 39 | | |
| | Sum 7 - 11 | 2697 | | 916 | | | 95 | 0.42 | 0.395 | | | 0.175 | 160 | | 160 |
| | 5280' of 57" pipe (7.5'/Sec) | | | | | 0.00303 | 12 | | | | | | | | |
| 12 | Mtn View at 68th St (East) | 360 | | 79 | | | 48 | 0.72 | 0.705 | | | 0.455 | 36 | | |
| | Sum 7 - 12 | 3057 | | 995 | | | 107 | 0.38 | 0.357 | | | 0.141 | 140 | | 160 |
| | Sum 1 - 12 | 5367 | | 1516 | | | 112 | 0.37 | 0.34 | | | 0.126 | 192 | | 200 |
| | 5280' of 60" pipe (10.2'/Sec) | | | | | 0.0053 | 8 | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-26 | (continued) | | | | | | | | | | | | | | |
| 13 | Mockingbird Lane at 68th St | 480 | | 96 | | | 103 | 0.39 | 0.38 | | | 0.162 | 16 | | |
| | Sum 1 - 13 | 5847 | | 1612 | | | 120 | | | | | | | | |
| 14 | Doubletree at 76th St | 280 | | 62 | | | 103 | 0.39 | 0.386 | | | 0.167 | 10 | | |
| 14a | Portion draining in 44 min | 110 | | 24 | | | 44 | 0.77 | 0.762 | | | 0.506 | 12 | | 12 27" pipe |
| | 2640' of 27" pipe (2.9'/Sec) | | | | | 0.00114 | 15 | | | | | | | | |
| 15 | Doubletree at Scottsdale Rd | 160 | | 35 | | | 76 | 0.50 | 0.492 | | | 0.262 | 9 | | |
| 15a | Portion draining in 59 min | 140 | | 31 | | | 59 | 0.61 | 0.60 | | | 0.36 | 11 | | |
| | Sum 14a - 15a | 250 | | 55 | | | 59 | 0.61 | 0.598 | | | 0.358 | 20 | | 20 |
| | 2640' of 27" pipe (5.6'/Sec) | | | | | 0.0047 | 8 | | | | | | | | |
| 16 | Mockingbird at Scottsdale Rd | 320 | | 63 | | | 111 | 0.37 | 0.36 | | | 0.144 | 9 | | |
| 16a | Portion draining in 67 min | 193 | | 38 | | | 67 | 0.55 | 0.54 | | | 0.306 | 12 | | |
| | Sum 14a - 16a | 443 | | 93 | | | 67 | 0.55 | 0.536 | | | 0.302 | 28 | | 30 42" pipe |
| | 2640' of 42" pipe (3.1'/Sec) | | | | | 0.0007 | 14 | | | | | | | | |
| | Sum 1 - 16a | 6290 | | 1705 | | | 120 | 0.35 | 0.32 | | | 0.108 | 185 | | 200 60" pipe |
| | 1000' of 60" pipe (10.2'/Sec) | | | | | 0.0053 | | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

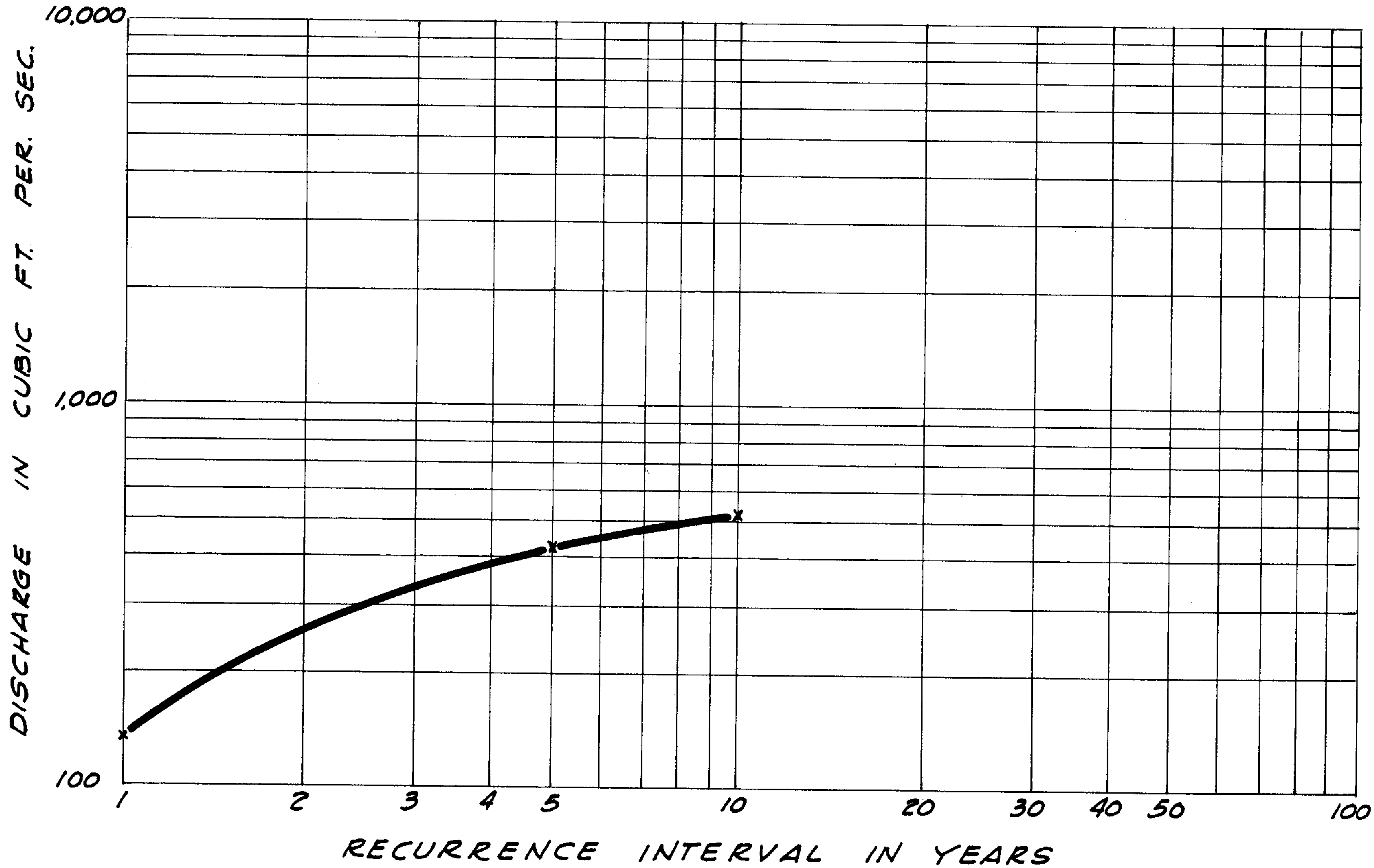
| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-28 | | | | | | | | | | | | | | | |
| 1 | Greenway at Hayden Rd | 266 | | 32 | | | 68 | 0.55 | 0.54 | | | 0.306 | 10 | | 20 |
| | 2640' of 24" pipe (7.2'/Sec) | | | | | 0.0089 | 6 | | | | | | | | |
| 2 | Hayden at Acoma | 303 | | 141 | | | 54 | 0.66 | 0.643 | | | 0.40 | 57 | | |
| | Sum 1 & 2 | 569 | | 173 | | | 74 | 0.52 | 0.505 | | | 0.275 | 48 | | Not a maximum |
| 1a | Portion draining in 54-6=48 min | 186 | | 22 | | | 48 | 0.71 | 0.70 | | | 0.45 | 10 | | |
| | Sum 1a & 2 | 489 | | 163 | | | 54 | 0.66 | 0.645 | | | 0.40 | 65 | | 65 |
| | 2640' of 36" pipe (9.5'/Sec) | | | | | 0.0089 | 4.6 | | | | | | | | |
| 3 | Hayden at Thunderbird | 275 | | 120 | | | 54 | 0.66 | 0.647 | | | 0.402 | 48 | | |
| | Sum 1a - 3 | 764 | | 283 | | | 59 | 0.61 | 0.59 | | | 0.35 | 99 | | 100 |
| | 5280' of 42" pipe (10.5'/Sec) | | | | | 0.0085 | 8.5 | | | | | | | | |
| 4 | Hayden at Cactus | 691 | | 138 | | | 65 | 0.57 | 0.554 | | | 0.318 | 44 | | |
| | Sum 1a - 4 | 1455 | | 421 | | | 67 | 0.55 | 0.525 | | | 0.292 | 122 | | 125 |
| | 5280' of 48" pipe (10'/Sec) | | | | | 0.00625 | 9 | | | | | | | | |
| 5 | Hayden at Shea Blvd | 485 | | 107 | | | 75 | 0.50 | 0.488 | | | 0.259 | 28 | | |
| | Sum 1a - 5 | 1940 | | 528 | | | 76 | 0.50 | 0.475 | | | 0.247 | 130 | | 130 |
| | 5280' of 51" pipe (9'/Sec) | | | | | 0.00492 | 10 | | | | | | | | |
| 6 | Hayden at Doubletree | 555 | | 104 | | | 92 | 0.43 | 0.417 | | | 0.195 | 20 | | |
| 6a | Portion draining in 86 min | 518 | | 97 | | | 86 | 0.45 | 0.44 | | | 0.216 | 21 | | |
| | Sum 1a - 6a | 2458 | | 625 | | | 86 | 0.45 | 0.425 | | | 0.202 | 126 | | 130 |
| | 5280' of 54" pipe (8.5'/Sec) | | | | | 0.00416 | 10 | | | | | | | | |
| 7 | Hayden at Northern | 640 | | 158 | | | 81 | 0.475 | 0.46 | | | 0.234 | 37 | | |
| | Sum 1a - 7 | 3098 | | 783 | | | 96 | 0.42 | 0.394 | | | 0.175 | 137 | | 140 |
| | 7280' of 63" pipe (6.5'/Sec) | | | | | 0.0019 | 14 | | | | | | | | |
| 8 | Northern Avenue at Scottsdale Rd | 320 | | 63 | | | 44 | 0.78 | 0.765 | | | 0.51 | 32 | | |

EXPECTED FLOWS 5 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | AREA - ACRES: Perv. Area $A_p$ | AREA - ACRES: Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Concentration Time: Min. $t_c$ | RAIN: Point Intensity I in/hr | RAIN: Average Intensity $I_a$ in/hr | RUNOFF Pervious: $(I_a - f_c)0.8 = I_n$ in | RUNOFF Pervious: $I_n A_p$ cfs | RUNOFF Impervious: $(I_a - 0.2)0.9 = I_m$ in | RUNOFF Impervious: $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-28 | | | | | | | | | | | | | | | |
| 1 | Greenway at Hayden Rd | 266 | | 32 | | | 68 | 1.03 | 1.01 | | | 0.73 | 23 | | 25 27" pipe |
| | 2640' of 27" pipe (7.2'/Sec) | | | | | 0.0089 | 6 | | | | | | | | |
| 2 | Hayden at Acoma | 303 | | 141 | | | 54 | 1.26 | 1.23 | | | 0.93 | 132 | | |
| | Sum 1 & 2 | 569 | | 173 | | | 74 | 0.98 | 0.95 | | | 0.68 | 118 | | |
| 1a | Portion draining in 54-6=48 min | 186 | | 22 | | | 48 | 1.38 | 1.36 | | | 1.04 | 23 | | |
| | Sum 1a & 2 | 489 | | 163 | | | 54 | 1.26 | 1.23 | | | 0.93 | 152 | | 155 51" pipe |
| | 2640' of 51" pipe (12'/Sec) | | | | | 0.0089 | 4 | | | | | | | | |
| 3 | Hayden at Thunderbird | 275 | | 120 | | | 54 | 1.26 | 1.23 | | | 0.93 | 112 | | |
| | Sum 1a -3 | 764 | | 283 | | | 58 | 1.20 | 1.16 | | | 0.864 | 244 | | 250 60" pipe |
| | 5280' of 60" pipe (13'/Sec) | | | | | 0.0085 | 7 | | | | | | | | |
| 4 | Hayden at Cactus | 691 | | 138 | | | 65 | 1.10 | 1.065 | | | 0.78 | 108 | | |
| | Sum 1a - 4 | 1455 | | 421 | | | 65 | 1.10 | 1.05 | | | 0.765 | 322 | | 325 69" pipe |
| | 5280 of 69" pipe (12.5'/Sec) | | | | | 0.00625 | 7 | | | | | | | | |
| 5 | Hayden at Shea Blvd | 485 | | 107 | | | 75 | 0.96 | 0.935 | | | 0.66 | 76 | | |
| 5a | Portion draining in 72 min | 465 | | 103 | | | 72 | 1.01 | 0.985 | | | 0.705 | 73 | | |
| | Sum 1a - 5a | 1920 | | 524 | | | 72 | 1.01 | 0.96 | | | 0.684 | 358 | | 360 75" pipe |
| | 5280' of 75" pipe (11.6'/Sec) | | | | | 0.00492 | 8 | | | | | | | | |
| 6 | Hayden at Doubletree | 555 | | 104 | | | 92 | 0.82 | 0.795 | | | 0.54 | 56 | | |
| 6a | Portion draining in 80 min | 482 | | 90 | | | 80 | 0.93 | 0.91 | | | 0.64 | 58 | | |
| | Sum 1a - 6a | 2402 | | 614 | | | 80 | 0.93 | 0.87 | | | 0.604 | 371 | | 375 78" pipe |
| | 5280' of 78" pipe (11'/Sec) | | | | | 0.00416 | 8 | | | | | | | | |
| 7 | Hayden at | 640 | | 158 | | | 81 | 0.91 | 0.88 | | | 0.61 | 96 | | |
| | Sum 1a - 7 | 3042 | | 772 | | | 88 | 0.86 | 0.81 | | | 0.55 | 425 | | 430 96" pipe |
| | 7280' of 96" pipe (8.8'/Sec) | | | | | 0.0019 | 10 | | | | | | | | |
| 8 | Northern Avenue at Scottsdale Rd | 320 | | 63 | | | 44 | 1.45 | 1.42 | | | 1.10 | 69 | | |

EXPECTED FLOWS 10 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-28 | | | | | | | | | | | | | | | |
| 1 | Greenway at Hayden Rd | 266 | | 32 | | | 68 | 1.25 | 1.22 | | | 0.92 | 29 | | 30 |
| | 2640' of 27" pipe (7.8'/Sec) | | | | | 0.0089 | 6 | | | | | | | | |
| 2 | Hayden at Acoma | 303 | | 141 | | | 54 | 1.48 | 1.45 | | | 1.13 | 159 | | 160 |
| | Sum 1 & 2 | 569 | | 173 | | | 74 | 1.16 | 1.12 | | | 0.83 | 143 | | 160 |
| 1a | Portion draining in 54-6=48 min | 186 | | 22 | | | 48 | 1.62 | 1.595 | | | 1.26 | 28 | | |
| | Sum 1a & 2 | 489 | | 163 | | | 54 | 1.48 | 1.44 | | | 1.12 | 183 | | 185 |
| | 2640' of 54" pipe (12'/Sec) | | | | | 0.0089 | 4 | | | | | | | | |
| 3 | Hayden at Thunderbird | 275 | | 120 | | | 54 | 1.48 | 1.45 | | | 1.13 | 136 | | |
| | Sum 1a - 3 | 764 | | 283 | | | 58 | 1.40 | 1.35 | | | 1.035 | 294 | | 300 |
| | 5280' of 63" pipe (13.5'/Sec) | | | | | 0.0085 | 8 | | | | | | | | |
| 4 | Hayden at Cactus | 691 | | 138 | | | 65 | 1.30 | 1.26 | | | 0.95 | 131 | | |
| | Sum 1a - 4 | 1455 | | 421 | | | 66 | 1.28 | 1.22 | | | 0.92 | 387 | | 400 |
| | 5280' of 75" pipe (13'/Sec) | | | | | 0.00625 | 7 | | | | | | | | |
| 5 | Hayden at Shea Blvd | 485 | | 107 | | | 75 | 1.14 | 1.11 | | | 0.82 | 88 | | |
| | Sum 1a - 5 | 1940 | | 528 | | | 73 | 1.18 | 1.12 | | | 0.83 | 436 | | 440 |
| | 5280' of 81" pipe (12.2'/Sec) | | | | | 0.00492 | 7 | | | | | | | | |
| 6 | Hayden at Double Tree | 555 | | 104 | | | 92 | 0.98 | 0.95 | | | 0.68 | 71 | | |
| 6a | Portion draining in 80 min | 482 | | 90 | | | 80 | 1.10 | 1.07 | | | 0.785 | 70 | | |
| | Sum 1a - 6a | 2422 | | 616 | | | 80 | 1.10 | 1.04 | | | 0.755 | 465 | | 465 |
| | 5280' of 84" pipe (11.5'/Sec) | | | | | 0.00416 | 8 | | | | | | | | |
| 7 | Hayden at Northern | 640 | | 158 | | | 81 | 1.08 | 1.045 | | | 0.76 | 120 | | |
| | Sum 1a - 7 | 3062 | | 774 | | | 88 | 1.00 | 0.935 | | | 0.66 | 512 | | 515 |
| | 7280' of 102" pipe (9'/Sec) | | | | | 0.0019 | 10 | | | | | | | | |
| 8 | Northern Avenue at Scottsdale Rd | 320 | | 63 | | | 44 | 1.70 | 1.665 | | | 1.32 | 83 | | |




FREQUENCY-DISCHARGE RELATION

LINE V-28 - HAYDEN RD. AT NORTHERN AVE.

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious: $(I_a-f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious: $(I_a-0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-29 | | | | | | | | | | | | | | | |
| 1 | Pima at Greenway | 73 | | 15 | | | 59 | 0.61 | 0.605 | | | 0.364 | 6 | | |
| 1a | West half of 1 | 51 | | 10 | | | 15 | 1.7 | 1.68 | | | 1.33 | 13.3 | | 14 (Pipe in Greenway) |
| | 2640' of 21" pipe (7'/Sec) | | | | | | 6 | | | | | | | | |
| 2 | Pima at Acoma | 410 | | 110 | | | 49 | | | | | | | | |
| 2a | Portion draining in 21 min | 246 | | 59 | | | 21 | 1.37 | 1.34 | | | 1.025 | 60 | | |
| | Sum 1a & 2a | 297 | | 69 | | | 21 | 1.37 | 1.34 | | | 1.025 | 71 | | 75 |
| | 2640' of 39" pipe (10'/Sec) | | | | | 0.0091 | 4 | | | | | | | | |
| 3 | Pima at Thunderbird | 410 | | 110 | | | 49 | | | | | | | | |
| 3a | Portion draining in 25 min | 266 | | 76 | | | 25 | 1.20 | 1.18 | | | 0.88 | 67 | | 80 |
| | Sum 1a - 3a | 563 | | 145 | | | 25 | 1.20 | 1.16 | | | 0.865 | 125 | | 125 |
| | 2640' of 48" pipe (11'/Sec) | | | | | 0.0080 | 4 | | | | | | | | |
| 4 | Pima at Sweetwater | 410 | | 75 | | | 51 | | | | | | | | |
| 4a | Portion draining in 29 min | 331 | | 62 | | | 29 | 1.07 | 1.05 | | | 0.765 | 47 | | |
| | Sum 1a - 4a | 894 | | 207 | | | 29 | 1.07 | 1.03 | | | 0.747 | 155 | | 155 |
| | 2640' of 54" pipe (10.5'/Sec) | | | | | 0.00645 | 5 | | | | | | | | |
| 5 | Pima at Cactus | 365 | | 67 | | | 54 | | | | | | | | |
| 5a | Portion draining in 34 min | 287 | | 53 | | | 34 | 0.95 | 0.93 | | | 0.656 | 35 | | |
| | Sum 1a - 5a | 1181 | | 260 | | | 34 | 0.95 | 0.91 | | | 0.64 | 166 | | 165 |
| | 5280' of 54" pipe (10.5'/Sec) | | | | | 0.0072 | 9 | | | | | | | | |
| 6 | Pima at Shea | 820 | | 163 | | | 74 | 0.51 | 0.492 | | | 0.263 | 43 | | |
| 6a | Portion draining in 43 min | 609 | | 125 | | | 43 | 0.79 | 0.765 | | | 0.508 | 64 | | |
| | Sum 1a - 6a | 1790 | | 385 | | | 43 | 0.79 | 0.75 | | | 0.495 | 190 | | 190 |
| | 5280' of 57" pipe (10.5'/Sec) | | | | | 0.0053 | 9 | | | | | | | | |
| 7 | Pima at Double Tree Rd | 761 | | 151 | | | 81 | 0.47 | 0.455 | | | 0.23 | 35 | | |
| 7a | Portion draining in 52 min | 585 | | 116 | | | 52 | 0.68 | 0.66 | | | 0.415 | 48 | | |
| | Sum 1a - 7a | 2375 | | 501 | | | 52 | 0.68 | 0.642 | | | 0.398 | 200 | | 200 |
| | 5280' of 60" pipe (10'/Sec) | | | | | 0.0049 | 9 | | | | | | | | |
| 8 | Pima at Northern | 725 | | 149 | | | 81 | 0.47 | 0.46 | | | 0.234 | 35 | | |
| 8a | Portion draining in 61 min | 545 | | 112 | | | 61 | 0.59 | 0.57 | | | 0.33 | 37 | | |
| | Sum 1a - 8a | 2920 | | 613 | | | 61 | 0.59 | 0.555 | | | 0.32 | 196 | | 200 |
| | 2640' of 66" pipe (8.5'/Sec) | | | | | 0.0030 | 5 | | | | | | | | |
| 9 | Pima at Cheney | 362 | | 80 | | | 66 | 0.56 | 0.546 | | | 0.311 | 25 | | |
| | Sum 1a - 9 | 3282 | | 693 | | | 66 | 0.56 | 0.524 | | | 0.292 | 202 | | 210 |
| | 9880' of 69" pipe (8.5'/Sec) | | | | | 0.0030 | 5 | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | AREA - ACRES: Perv. Area $A_p$ | AREA - ACRES: Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Concentration Time: Min. $t_c$ | RAIN: Point Intensity I in/hr | RAIN: Average Intensity $I_a$ in/hr | RUNOFF: Pervious $(I_a-f_c)0.8 = I_n$ in | RUNOFF: Pervious $I_nA_p$ cfs | RUNOFF: Impervious $(I_a-0.2)0.9 = I_m$ in | RUNOFF: Impervious $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-30 | | | | | | | | | | | | | | | |
| 1 | Dobson Rd at Thunderbird | 338 | | 68 | | | 40 | 0.84 | 0.82 | | | 0.56 | 38 | | |
| | 5280' of 30" pipe (8'/Sec) | | | | | 0.0078 | 11 | | | | | | | | |
| 2 | Dobson at Cactus | 628 | | 126 | | | 70 | | | | | | | | |
| 2a | Portion contrib. in 51 min | 458 | | 91 | | | 51 | 0.69 | 0.67 | | | 0.42 | 38 | | |
| | Sum 1 & 2a | 796 | | 159 | | | 51 | 0.69 | 0.665 | | | 0.42 | 67 | | |
| | 5280' of 39" pipe (8.3'/Sec) | | | | | 0.0060 | 11 | | | | | | | | |
| 3 | Dobson at Shea | 640 | | 128 | | | 89 | | | | | | | | |
| 3a | Portion draining in 62 min | 446 | | 89 | | | 62 | 0.59 | 0.575 | | | 0.338 | 30 | | |
| | Sum 1 - 3a | 1242 | | 248 | | | 62 | 0.59 | 0.565 | | | 0.328 | 81 | | 85 |
| | 5280' of 45" pipe (8.5'/Sec) | | | | | 0.0053 | 10 | | | | | | | | |
| 4 | Dobson at Double Tree | 640 | | 128 | | | 102 | | | | | | | | |
| 4a | Portion contrib. in 72 min | 450 | | 91 | | | 72 | 0.52 | 0.506 | | | 0.275 | 25 | | |
| | Sum 1 - 4a | 1692 | | 339 | | | 72 | 0.52 | 0.495 | | | 0.265 | 90 | | 90 |
| | 5280' of 45" pipe (8.1'/Sec) | | | | | 0.0049 | 11 | | | | | | | | |
| 5 | Dobson at Northern | 640 | | 128 | | | 102 | | | | | | | | |
| 5a | Portion contrib. in 83 min | 520 | | 104 | | | 83 | 0.46 | 0.445 | | | 0.22 | 23 | | |
| | Sum 1 - 5a | 2212 | | 443 | | | 83 | 0.46 | 0.435 | | | 0.21 | 94 | | 95 |
| | 5280' of 48" pipe (8.0'/Sec) | | | | | 0.0045 | 11 | | | | | | | | |
| 6 | Dobson at Indian Bend | 640 | | 128 | | | 105 | | | | | | | | |
| 6a | Portion contrib. in 94 min | 573 | | 115 | | | 94 | 0.43 | 0.418 | | | 0.196 | 23 | | |
| | Sum 1 - 6a | 2785 | | 558 | | | 94 | 0.43 | | | | | | | |
| 7 | Alma School at Cactus | 186 | | 37 | | | 46 | 0.75 | 0.735 | | | 0.48 | 18 | | |
| 7a | Portion contrib in 33 min | 165 | | 33 | | | | 0.97 | 0.95 | | | 0.675 | 22 | | 25 |
| | 5280' of 27" pipe (7'/Sec) | | | | | 0.0075 | 13 | | | | | | | | |
| 8 | Alma School at Shea | 640 | | 156 | | | 90 | | | | | | | | |
| 8a | Portion contrib. in 46 min | 345 | | 69 | | | 46 | 0.75 | 0.735 | | | 0.48 | | | |
| 9 | Country Club at Shea | 337 | | 67 | | | 55 | 0.65 | 0.61 | | | 0.39 | 26 | | |
| 9a | Portion contrib in 32 min | 225 | | 45 | | | 32 | | | | | | | | 31 |
| | 5280' of 30" pipe (6.5'/Sec) | | | | | 0.0068 | 14 | | | | | | | | |
| | Sum 7a, 8a, 9a | 735 | | 147 | | | 46 | 0.75 | 0.730 | | | 0.475 | 70 | | Not a maximum |
| | 5280' of 48" pipe (8'/Sec) | | | | | 0.00417 | 11 | | | | | | | | 90 |
| 10 | Double Tree at Mesa Blvd | 270 | | 54 | | | 39 | 0.85 | 0.83 | | | 0.57 | 31 | | 32 |
| | 5280' of 27" pipe (8'/Sec) | | | | | 0.0095 | 11 | | | | | | | | |
| 11 | Country Club at Double Tree | 640 | | 128 | | | 74 | 0.51 | 0.495 | | | 0.266 | 34 | | |
| 11a | Portion draining in 50 min | 432 | | 87 | | | 50 | 0.70 | 0.682 | | | 0.434 | 38 | | |
| | Sum 10 & 11a | 702 | | 141 | | | 50 | 0.70 | 0.68 | | | 0.431 | 61 | | 65 |

EXPECTED FLOWS 1- year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | AREA - ACRES: Perv. Area $A_p$ | AREA - ACRES: Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Concentration Time: Min. $t_c$ | RAIN: Point Intensity I in/hr | RAIN: Average Intensity $I_a$ in/hr | RUNOFF Pervious: $(I_a - f_c)0.8 = I_n$ in | RUNOFF Pervious: $I_n A_p$ cfs | RUNOFF Impervious: $(I_a - 0.2)0.9 = I_m$ in | RUNOFF Impervious: $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-30 | (CONTINUED) | | | | | | | | | | | | | | |
| | 5280' of 39" pipe (8.5'/Sec) | | | | | 0.0062 | 10 | | | | | | | | |
| 12 | Alma School at Double Tree | 640 | | 128 | | | 98 | 0.41 | 0.40 | | | 0.18 | 23 | | |
| 12a | Portion draining in 60 minutes | 392 | | 79 | | | 60 | 0.60 | 0.585 | | | 0.347 | 28 | | |
| | Sum 10 - 12a | 1094 | | 220 | | | 60 | 0.60 | 0.575 | | | 0.337 | 74 | | |
| | Sum 7a - 12a | 1829 | | 367 | | | 60 | 0.60 | 0.57 | | | 0.333 | 122 | | 125 |
| | 5280' of 51" pipe (9'/Sec) | | | | | 0.0049 | 10 | | | | | | | | |
| 13 | Mesa Drive at Northern | 404 | | 81 | | | 80 | 0.48 | 0.47 | | | 0.243 | 20 | | |
| 13a | Portion draining in 50 minutes | 279 | | 56 | | | 50 | 0.70 | 0.685 | | | 0.45 | 25 | | 25 a maximum |
| | 5280' of 27" pipe (6.5'/Sec) | | | | | 0.00645 | 14 | | | | | | | | |
| 14 | Country Club at Northern | 640 | | 128 | | | 89 | | | | | | | | |
| 14a | Portion draining in 64 minutes | 460 | | 92 | | | 64 | 0.58 | 0.565 | | | 0.328 | 30 | | |
| | Sum 13a - 14a | 739 | | 148 | | | 64 | 0.58 | 0.56 | | | 0.324 | 48 | | 50 |
| | 5280' of 36" pipe (7.5'/Sec) | | | | | 0.0056 | 12 | | | | | | | | |
| 15 | Alma School at Northern | 640 | | 128 | | | 90 | | | | | | | | |
| 15a | Portion draining in 76 minutes | 540 | | 108 | | | 76 | 0.50 | 0.485 | | | 0.266 | 29 | | |
| | Sum 7a - 15a | 3108 | | 623 | | | 76 | 0.50 | 0.469 | | | 0.242 | 151 | | |
| | 5280' of 54" pipe (10.5'/Sec) | | | | | 0.0065 | 8 | | | | | | | | |
| 16 | Country Club at Indian Bend | 320 | | 64 | | | 100 | 0.40 | 0.39 | | | 0.17 | 11 | | |
| 16a | Portion draining in 60 minutes | 212 | | 42 | | | 60 | 0.60 | 0.59 | | | 0.36 | 15 | | 15 a maximum |
| | 5280' of 24" pipe (5.5'/Sec) | | | | | 0.0051 | 16 | | | | | | | | |
| 17 | Alma School at Indian Bend | 640 | | 128 | | | 101 | | | | | | | | |
| 17a | Portion draining in 76 minutes | 483 | | 96 | | | 76 | 0.50 | 0.485 | | | 0.266 | 26 | | |
| | Sum 7a - 17a | 3803 | | 761 | | | 84 | 0.47 | 0.437 | | | 0.213 | 163 | | |
| | 5280' of 66" pipe (7.0'/Sec) | | | | | 0.00208 | 13 | | | | | | | | 170 |
| | Sum 1 - 17a | 6588 | | 1319 | | | 94 | 0.42 | 0.384 | | | 0.166 | 218 | | 220 |
| | 7920' of 72" pipe (7.5'/Sec) | | | | | 0.00227 | 18 | | | | | | | | |
| 18 | Alma School at McDonald Drive | 320 | | 64 | | | 112 | 0.37 | 0.36 | | | 0.144 | 9 | | |
| 18a | Portion contrib. in 70 minutes | 219 | | 44 | | | 70 | 0.53 | 0.52 | | | 0.29 | 13 | | 13 a maximum |
| | 5500' of ditch (3.5'/Sec) | | | | | 0.00076 | 27 | | | | | | | | |
| 19 | Dobson at Arizona Canal | 546 | | 109 | | | 150 | | | | | | | | |
| 19a | Portion contrib. in 97 minutes | 350 | | 70 | | | 97 | 0.41 | 0.40 | | | 0.18 | 13 | | |
| | Sum 18a & 19a | 569 | | 114 | | | 97 | 0.41 | 0.40 | | | 0.18 | 20 | | 22 |
| | 5500' of ditch (3.5'/Sec) | | | | | | 27 | | | | | | | | |
| 20 | Pima Road at Arizona Canal | 418 | | 84 | | | 110 | | | | | | | | |
| | Sum 18a - 20 | 987 | | 198 | | | 124 | 0.34 | 0.33 | | | 0.12 | 24 | | 24 |
| | Sum 1 - 20 | 7575 | | 1517 | | | 112 | 0.37 | 0.34 | | | 0.126 | 192 | | 220 |
| | 7500' of ditch (3.5'/Sec) | | | | | 0.00067 | | | | | | | | | |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-31 | | | | | | | | | | | | | | | |
| 1 | Pima Rd at McDonald Dr | 127 | | 28 | | | 63 | 0.58 | 0.57 | | | | 0.333 | 9 | |
| 1a | Portion draining in 44 min | 76 | | 17 | | | 44 | 0.78 | 0.772 | | | | 0.515 | 9 | 10 |
| | 1600' of 24" pipe (3.5'/Sec) | | | | | 0.0020 | 8 | | | | | | | | |
| 2 | McDonald at 86th St | 179 | | 45 | | | 61 | 0.59 | 0.58 | | | | 0.342 | 15 | |
| 2a | Portion draining in 52 min | 153 | | 38 | | | 52 | 0.68 | 0.67 | | | | 0.424 | 16 | |
| | Sum 1a & 2a | 229 | | 55 | | | 52 | 0.68 | 0.66 | | | | 0.415 | 23 | 25 |
| | 3800' of 36" pipe (4.0'/Sec) | | | | | 0.00157 | 16 | | | | | | | | |
| 3 | McDonald Dr at Hayden Rd | 330 | | 82 | | | 82 | 0.47 | 0.46 | | | | 0.234 | 19 | |
| 3a | Portion draining in 68 min | 274 | | 68 | | | 68 | 0.55 | 0.54 | | | | 0.306 | 21 | |
| | Sum 1a - 3a | 503 | | 123 | | | 68 | 0.55 | 0.535 | | | | 0.292 | 36 | 40 |
| V-32 | | | | | | | | | | | | | | | |
| 1 | Chaparral at Pima Rd | 1280 | | 64 | | | 190 | | | | | | | | 10 |
| 2 | Chaparral at 86th St | 310 | | 93 | | | 80 | 0.48 | 0.46 | | | | 0.234 | 22 | |
| | Sum 1 & 2 | 1590 | | 157 | | | 80 | 0.48 | 0.456 | | | | 0.23 | 36 | 40 |
| | 4000' of 39" pipe (4.0'/Sec) | | | | | 0.0015 | 17 | | | | | | | | |
| 3 | Chaparral at Hayden | 330 | | 98 | | | 85 | 0.46 | 0.45 | | | | 0.225 | 22 | |
| | Sum 1 - 3 | 1920 | | 255 | | | 87 | 0.44 | 0.417 | | | | 0.195 | 50 | 50 |
| V-33 | | | | | | | | | | | | | | | |
| 1 | Indian School at Pima Rd | 700 | | 40 | | | 170 | | | | | | | | 10 |
| 2 | Indian School at 86th St | 320 | | 84 | | | 80 | 0.48 | 0.46 | | | | 0.234 | 20 | |
| | Sum 1 & 2 | 1020 | | 124 | | | 80 | 0.48 | 0.46 | | | | 0.234 | 29 | 30 |
| | 4000' of 39" pipe (3.8'/Sec) | | | | | 0.0013 | 18 | | | | | | | | |
| 3 | Indian School at Hayden | 325 | | 84 | | | 80 | 0.48 | 0.46 | | | | 0.234 | 20 | |
| | Sum 1 - 3 | 1345 | | 208 | | | 98 | 0.41 | 0.394 | | | | 0.175 | 36 | 40 |

EXPECTED FLOWS    1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF: Pervious: $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious: $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-34 | | | | | | | | | | | | | | | |
| 1 | 86th at Thomas Rd | 320 | | 107 | | | 105 | | | | | | | | |
| 1a | Portion draining in 60 min | 199 | | 67 | | | 60 | 0.60 | 0.59 | | | 0.35 | 23 | | 25 |
| | 1000' of 33" pipe (4.3'/Sec) | | | | | 0.0020 | 4 | | | | | | | | |
| 2 | Pima at Thomas | 414 | | 77 | | | 151 | | | | | | | | |
| 2a | Portion contrib in 64 min | 300+ | | 60 | | | 64 | 0.58 | 0.57 | | | 0.33 | 20 | | |
| | Sum 1a & 2a | 500 | | 137 | | | 64 | 0.58 | 0.565 | | | 0.238 | 33 | | 35 |
| | 6000' of 36" pipe (6'/Sec) | | | | | 0.00333 | 17 | | | | | | | | |
| 3 | McDowell at 85th St | 705 | | 200 | | | 117 | | | | | | | | |
| 3a | Portion draining in 81 min | 485 | | 138 | | | 81 | 0.48 | 0.47 | | | 0.243 | 34 | | |
| | Sum 1a - 3a | 985 | | 275 | | | 81 | 0.48 | 0.464 | | | 0.238 | 65 | | 65 |
| | 4000' of 48" pipe (5.6'/Sec) | | | | | 0.00225 | 12 | | | | | | | | |
| 4 | Roosevelt at 84th St | 234 | | 120 | | | 60 | 0.60 | 0.59 | | | 0.35 | 42 | | |
| | Sum 1a - 4 | 1219 | | 395 | | | 93 | 0.43 | 0.414 | | | 0.192 | 76 | | 80 |
| | 4000' of 54" pipe (4.8'/Sec) | | | | | 0.00125 | | | | | | | | | |

EXPECTED FLOWS 1- year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-26 | (Alternate with Interceptor Channel) | | | | | | | | | | | | | | |
| 1 | Shea Blvd. at 76th Street | 285 | | 54 | | | 93 | 0.43 | 0.42 | | | 0.198 | 11 | | |
| 1a | Portion contrib. in 44 min. | 131 | | 25 | | | 44 | 0.77 | 0.76 | | | 0.505 | 13 | | |
| 1b | Portion contrib. in 54 min. | 191 | | 36 | | | 54 | 0.66 | 0.65 | | | 0.405 | 15 | | 20 Use 36" |
| | 2640' of 36" pipe (3'/sec) | | | | | 0.0007 | 15 | | | | | | | | |
| 2 | Shea Blvd. at Scottsdale Road | 160 | | 30 | | | 69 | 0.54 | 0.53 | | | 0.30 | 9 | | |
| 2a | Assume flow to W. in pipe | 160 | | 30 | | | 32 | 1.0 | 0.985 | | | 0.705 | 21 | | |
| | Sum 1b & 2a | 351 | | 96 | | | 69 | 0.54 | 0.525 | | | 0.29 | 28 | | 30 |
| | 2640' of 36" pipe (8'/ sec) | | | | | 0.0064 | 5 | | | | | | | | |
| 3 | Scottsdale Road at Mountain View | 200 | | 44 | | | 40 | 0.83 | 0.82 | | | 0.56 | 25 | | |
| 4 | Scottsdale Road at Mountain View | 335 | | 73 | | | 50 | 0.70 | 0.68 | | | 0.43 | 31 | | |
| | Sum 1b, 2a, 3, & 4 | 886 | | 213 | | | 74 | 0.52 | 0.50 | | | 0.27 | 58 | | 60 |
| | 2640' of 48" pipe (4.8'/sec) | | | | | 0.0015 | 9 | | | | | | | | Adverse grade |
| 5 | Mountain View at 68th Street | 305 | | 67 | | | 50 | 0.70 | 0.68 | | | 0.43 | 29 | | |
| | Sum 1b - 5 | 1191 | | 280 | | | 83 | 0.46 | 0.44 | | | 0.22 | 62 | | 70 |
| | 5280' of 48" pipe (8.5'/sec) | | | | | 0.0055 | 16 | | | | | | | | |
| 13 | Mockingbird Lane at 68th Street | 480 | | 96 | | | 103 | 0.39 | 0.38 | | | 0.162 | 16 | | |
| 14 | Doubletree at 76th Street | 280 | | 62 | | | 103 | 0.39 | 0.386 | | | 0.167 | 10 | | |
| 14a | Portion draining in 44 min. | 110 | | 24 | | | 44 | 0.77 | 0.762 | | | 0.506 | 12 | | 20 |
| | 2640' of 27" pipe (5.6'/sec) | | | | | 0.00114 | 15 | | | | | | | | |
| 15 | Doubletree at Scottsdale Road | 160 | | 35 | | | 76 | 0.50 | 0.492 | | | 0.262 | 9 | | |
| 15a | Portion draining in 59 min. | 140 | | 31 | | | 59 | 0.61 | 0.60 | | | 0.36 | 11 | | |
| | Sum 14a & 15a | 250 | | 55 | | | 59 | 0.61 | 0.598 | | | 0.358 | 20 | | |
| | 2640' 27" pipe (5.6'/sec) | | | | | 0.0047 | 8 | | | | | | | | |
| 16 | Mockingbird at Scottsdale Road | 320 | | 63 | | | 111 | 0.37 | 0.36 | | | 0.144 | 9 | | |
| 16a | Portion draining in 67 min. | 193 | | 38 | | | 67 | 0.55 | 0.54 | | | 0.306 | 12 | | |
| | Sum 14a - 16a | 443 | | 93 | | | 67 | 0.55 | 0.536 | | | 0.302 | 28 | | 30 42" pipe |
| | 2640' of 42" pipe (3.1'/sec) | | | | | 0.0007 | 14 | | | | | | | | |
| | Sum 1b - 16a | 2114 | | 469 | | | 81 | 0.48 | 0.455 | | | 0.23 | 108 | | 110 60" pipe |
| | 1000' of 60" pipe | | | | | 0.001 | | | | | | | | | |
| V-28 | (Alternate with Interceptor Channel) | | | | | | | | | | | | | | |
| 1 | Hayden at Cholla | 242 | | 54 | | | 54 | 0.66 | 0.646 | | | 0.40 | 22 | | 25 |
| | 2640' of 27" pipe (6.5'/sec) | | | | | 0.006 | 7 | | | | | | | | |
| 2 | Hayden at Shea | 243 | | 53 | | | 56 | 0.64 | 0.626 | | | 0.384 | 20 | | |
| | Sum 1 & 2 | 485 | | 107 | | | 61 | 0.60 | 0.585 | | | 0.345 | 37 | | 40 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-28 | (Alternate with Interceptor Channel CONTINUED) | | | | | | | | | | | | | | |
| | 2640' of 33" pipe (6.6'/sec) | | | | | 0.004 | 7 | | | | | | | | |
| 3 | Hayden at Mountain View | 278 | | 52 | | | 66 | 0.56 | 0.55 | | | 0.315 | 17 | | |
| | Sum 1 - 3 | 763 | | 159 | | | 68 | 0.55 | 0.53 | | | 0.297 | 47 | | 50 |
| | 2640' of 39" pipe (6.5'/sec) | | | | | 0.004 | 7 | | | | | | | | |
| 4 | Hayden at Double Tree | 277 | | 52 | | | 68 | 0.55 | 0.54 | | | 0.306 | 16 | | |
| | Sum 1 - 4 | 1040 | | 211 | | | 75 | 0.51 | 0.49 | | | 0.261 | 55 | | 60 |
| | 2640' of 42" pipe (7'/sec) | | | | | 0.004 | 5 | | | | | | | | |
| 5 | Hayden at Mockingbird | 320 | | 79 | | | 73 | 0.52 | 0.508 | | | 0.277 | 22 | | |
| | Sum 1 - 5 | 1360 | | 290 | | | 80 | 0.48 | 0.458 | | | 0.232 | 67 | | 70 |
| | 2640' of 42" pipe (7'/sec) | | | | | 0.004 | 5 | | | | | | | | |
| 6 | Hayden at Northern | 320 | | 79 | | | 75 | 0.51 | 0.50 | | | 0.27 | 22 | | |
| | Sum 1-6 | 1680 | | 369 | | | 85 | 0.46 | 0.44 | | | 0.216 | 80 | | 85 |
| | 5280' of 54" pipe (6'/sec) | | | | | 0.002 | | | | | | | | | |
| V-29 | (Alternate with Interceptor Channel) | | | | | | | | | | | | | | |
| 7 | Pima at Cholla | 410 | | 82 | | | 83 | 0.47 | 0.458 | | | 0.232 | 19 | | |
| 7a | Portion draining in 40 min. | 205 | | 41 | | | 40 | 0.84 | 0.825 | | | 0.562 | 23 | | 25 |
| | 2640' 27" pipe (7'/sec) | | | | | 0.007 | 5 | | | | | | | | |
| 8 | Pima at Shea | 410 | | 82 | | | 85 | 0.46 | 0.45 | | | 0.225 | 19 | | |
| 8a | Portion draining in 45 min. | 217 | | 44 | | | 45 | 0.75 | 0.735 | | | 0.48 | 21 | | |
| | Sum 7a & 8a | 422 | | 85 | | | 45 | 0.75 | 0.73 | | | 0.476 | 41 | | 45 |
| | 2640' of 36" pipe (7.5'/sec) | | | | | 0.00575 | 6 | | | | | | | | |
| 9 | Pima at Mountain View | 380 | | 76 | | | 85 | 0.46 | 0.45 | | | 0.225 | 17 | | |
| 9a | Portion draining in 51 min. | 228 | | 46 | | | 51 | 0.69 | 0.676 | | | 0.428 | 20 | | |
| | Sum 7a - 9a | 650 | | 131 | | | 51 | 0.69 | 0.67 | | | 0.424 | 56 | | 60 |
| | 2640' of 39" pipe (8'/sec) | | | | | 0.00575 | 6 | | | | | | | | |
| 10 | Pima at Double Tree | 380 | | 76 | | | 85 | 0.46 | 0.45 | | | 0.225 | 17 | | |
| 10a | Portion draining in 57 min. | 255 | | 51 | | | 57 | 0.63 | 0.617 | | | 0.376 | 19 | | |
| | Sum 7a-10a | 905 | | 182 | | | 57 | 0.63 | 0.61 | | | 0.37 | 67 | | 70 |
| | 2640' of 42" pipe (8'/sec) | | | | | 0.005 | 6 | | | | | | | | |
| 11 | Pima at Mockingbird | 362 | | 72 | | | 85 | 0.46 | 0.45 | | | .0225 | 16 | | |
| 11a | Portion draining in 63 minutes | 268 | | 54 | | | 63 | 0.59 | 0.577 | | | 0.34 | 18 | | |
| | Sum 7a-11a | 1173 | | 236 | | | 63 | 0.59 | 0.567 | | | 0.33 | 78 | | 80 |
| | 2640' of 45" pipe (8.3'/sec) | | | | | 0.005 | 6 | | | | | | | | |
| 12 | Pima at Northern Avenue | 362 | | 72 | | | 85 | 0.46 | 0.45 | | | 0.225 | 16 | | |
| 12a | Portion draining in 69 minutes | 294 | | 59 | | | 69 | 0.54 | 0.53 | | | 0.298 | 18 | | |
| | Sum 7a - 12a | 1467 | | 295 | | | 69 | 0.54 | 0.515 | | | 0.284 | 84 | | 90 |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-29 | (Alternate with Interceptor Channel - CONTINUED) | | | | | | | | | | | | | | |
| | 2640' of 48" pipe (8'/sec) | | | | | 0.0045 | 6 | | | | | | | | |
| 13 | Pima at Cheney | 362 | | 72 | | | 85 | 0.46 | 0.45 | | | 0.225 | 16 | | |
| 13a | Portion draining in 75 minutes | 320 | | 64 | | | 75 | 0.50 | 0.49 | | | 0.261 | 17 | | |
| | Sum 7a - 13a | 1787 | | 359 | | | 75 | 0.50 | 0.475 | | | 0.247 | 89 | | 100 |
| | 5280' ± 60" pipe | | | | | 0.0015 | | | | | | | | | |
| V-30 | (Alternate with Interceptor Channel - | | | | | | | | | | | | | | |
| 1 | 96th Street at Cholla | 320 | | 64 | | | 69 | 0.54 | 0.527 | | | 0.294 | 19 | | 20 |
| | 2640' 27" pipe (6'/sec) | | | | | 0.006 | 8 | | | | | | | | |
| 2 | 96th Street at Shea | 320 | | 64 | | | 69 | 0.54 | 0.527 | | | 0.294 | 19 | | |
| | Sum 1 & 2 | 640 | | 128 | | | 77 | 0.50 | 0.485 | | | 0.256 | 33 | | 35 |
| | 2640' of 33" pipe (6.6'/sec) | | | | | 0.0053 | 7 | | | | | | | | |
| 3 | 96th Street at Mountain View | 320 | | 64 | | | 74 | 0.52 | 0.51 | | | 0.304 | 20 | | |
| | Sum 1 - 3 | 960 | | 192 | | | 84 | 0.47 | 0.455 | | | 0.23 | 44 | | 45 |
| | 2640' of 36" pipe (7'/sec) | | | | | 0.0053 | 6 | | | | | | | | |
| 4 | 96th Street at Double Tree | 320 | | 64 | | | 72 | 0.525 | 0.512 | | | 0.28 | 18 | | |
| | Sum 1 - 4 | 1280 | | 256 | | | 90 | 0.44 | 0.422 | | | 0.20 | 51 | | 55 |
| | 2640' of 39" pipe (7.5'/sec) | | | | | 0.005 | 6 | | | | | | | | |
| 5 | 96th Street at Mockingbird | 320 | | 64 | | | 72 | 0.525 | 0.512 | | | 0.28 | 18 | | |
| | Sum 1-5 | 1600 | | 320 | | | 96 | 0.42 | 0.40 | | | 0.18 | 58 | | 60 |
| | 2640' of 39" pipe (7.5'/sec) | | | | | 0.005 | 6 | | | | | | | | |
| 6 | 96th Street at Northern | 320 | | 64 | | | 72 | 0.525 | 0.512 | | | 0.28 | 18 | | |
| | Sum 1 - 6 | 1920 | | 384 | | | 102 | 0.39 | 0.37 | | | 0.153 | 59 | | 65 |
| | 2640' of 42" pipe (7.5'/sec) | | | | | 0.0045 | 6 | | | | | | | | |
| 7 | 96th Street at Cheney | 320 | | 64 | | | 80 | 0.48 | 0.47 | | | 0.24 | 15 | | |
| | Sum 1 - 7 | 2240 | | 448 | | | 108 | 0.38 | 0.36 | | | 0.144 | 65 | | 70 |
| | 2640' of 42" pipe (7.5'/sec) | | | | | 0.0045 | 6 | | | | | | | | |
| 8 | 96th Street at Indian Bend | 320 | | 64 | | | 85 | 0.46 | 0.45 | | | 0.225 | 15 | | |
| | Sum 1 - 8 | 2560 | | 512 | | | 114 | 0.36 | 0.34 | | | 0.126 | 65 | | 75 |
| | 5280' of 48" pipe (5.7'/sec) | | | | | 0.0022 | | | | | | | | | |

EXPECTED FLOWS    1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI-1 | Western Canal | | | | | | | | | | | | | | |
| | Sec. 15 (NE Part) | 50 | 40 | 10 | 0.60 | .007 | 17 | 1.58 | 1.56 | 0.77 | 10 | 1.23 | 13 | 25 | 27" pipe |
| | Sec. 15 (SW Part) | 60 | 48 | 12 | | | | | | | | | | | |
| | Sum 43rd Ave, ½Mi. So. Elliot | 110 | 88 | 22 | 0.60 | .010 | 23 | 1.28 | 1.26 | 0.53 | 14 | 0.954 | 21 | 35 | 27" pipe |
| | Sum South Mtn Channel | 110 | 88 | 22 | 0.60 | .010 | 28 | 1.10 | 1.09 | 0.39 | 10 | 0.80 | 18 | 40 | 30" pipe |
| | Sec. 21 (NE¼) | 70 | 59 | 11 | | .008 | | | | | | | | | |
| | Sec. 16 (SE¼) | 160 | 128 | 32 | | .008 | | | | | | | | | |
| | Sum 47th Ave & Warner Rd | 230 | 187 | 43 | 0.60 | | 35 | 0.93 | 0.91 | 0.25 | 14 | 0.64 | 28 | 45 | 33" pipe |
| | Sec. 21 NW¼ | 53 | 37 | 16 | | | | | | | | | | | |
| | Sec. 16 (SW¼) | 51 | 28 | 23 | | | | | | | | | | | |
| | Sum 51st Ave & Warner Rd | 334 | 252 | 82 | 0.60 | | 40 | 0.83 | 0.81 | 0.17 | 13 | 0.55 | 45 | 58 | 48" pipe |
| | Sum South Mtn Channel | 334 | 252 | 82 | | | 45 | 0.76 | 0.74 | 0.11 | 9 | 0.49 | 40 | 60 | 51" pipe |
| VI-2 | Dobbins Rd | | | | | | | | | | | | | | |
| | Sec. 9 (E. Part) | 223 | | 71 | | .015 | 20 | 1.40 | 1.38 | | | 1.06 | 76 | | 75 45" pipe |
| | Sec. 9 (W½) | 280 | | 90 | | .0038 | | | | | | | | | |
| | Sec. 16 | 40 | | 12 | | | | | | | | | | | |
| | Sum 51st Ave | 543 | | 173 | | | 26 | 1.17 | 1.15 | | | 0.855 | 148 | | 150 63" pipe |
| | Sec. 8 (E½) | 195 | | 117 | | .0019 | | | | | | | | | |
| | Sum 55th Ave | 738 | | 290 | | | 33 | 0.97 | 0.94 | | | 0.666 | 193 | | 195 72" pipe |
| | Sec. 8 (W½) | 194 | | 117 | | .0019 | | | | | | | | | |
| | Sec. 17 & 18 | 34 | | 17 | | | | | | | | | | | |
| | Sum 59th Ave | 966 | | 424 | | | 40 | 0.83 | 0.80 | | | 0.54 | 229 | | 230 84" pipe |
| | Sec. 7 | 15 | | 15 | | .0015 | | | | | | | | | |
| | Sum South Mtn Channel | 981 | | 439 | | | 56 | 0.64 | 0.62 | | | 0.38 | 167 | | 235 84" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI-3 | Southern Ave | | | | | | | | | | | | | | |
| | Sec. 35 (N½) | 255 | | 86 | | .0045 | 38 | 0.86 | 0.85 | | | 0.59 | 51 | | 50 36" pipe |
| | Sec. 35 (S½) | 230 | | 77 | | .0045 | | | | | | | | | |
| | Sum 35th & Southern | 485 | | 163 | | | 45 | 0.76 | 0.74 | | | 0.486 | 80 | | 80 45" pipe |
| | Sec 34 (N½) | 268 | | 93 | | .0034 | | | | | | | | | |
| | Sum 39th & Southern | 753 | | 256 | | | 51 | 0.69 | 0.67 | | | 0.42 | 108 | | 110 54" pipe |
| | Sec. 34 (S½) | 267 | | 90 | | .0034 | | | | | | | | | |
| | Sum 43rd Below Southern | 1020 | | 346 | | | 57 | 0.63 | 0.61 | | | 0.37 | 128 | | 130 63" pipe |
| | Sec. 33 (SE½) | 289 | | 98 | | .003 | | | | | | | | | |
| | Sum 51st & Baseline | 1309 | | 444 | | | 77 | 0.49 | 0.47 | | | 0.24 | 107 | | 135 |
| VI-4 | 43rd Ave. | | | | | | | | | | | | | | |
| | Sec. 10 (N½NE¼) | 100 | | 30 | | .005 | 21 | 1.37 | 1.35 | | | 1.035 | 31 | | 30 30" pipe |
| | Sum 43rd and Dobbins | 320 | | 126 | | | 28 | 1.10 | 1.07 | | | 0.78 | 99 | | 100 51" pipe |
| | Sec. 3 (S½) | 205 | | 89 | | | | | | | | | | | |
| | Sum | 525 | | 215 | | | 35 | 0.92 | 0.90 | | | 0.63 | 135 | | 135 57" pipe |
| VI-5 | 35th Ave | | | | | | | | | | | | | | |
| | Sec. 11 (N¼) | 150 | | 45 | | .006 | 38 | 0.86 | 0.85 | | | 0.59 | 27 | | 25 30" pipe |
| | Sec. 2 (S½) | 290 | | 98 | | | | | | | | | | | |
| | Sum | 440 | | 143 | | | 46 | 0.75 | 0.73 | | | 0.48 | 69 | | 70 42" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI-6 | Baseline Rd | | | | | | | | | | | | | | |
| | Sec. 2 (NE¼) | 160 | | 48 | | .005 | 42 | 0.80 | 0.79 | | | 0.53 | 26 | | 25 30" pipe |
| | Sec. 2 (NW¼) | 160 | | 52 | | | | | | | | | | | |
| | Add Line VI-5 | 440 | | 143 | | | | | | | | | | | |
| | Sum 35th Ave | 760 | | 243 | | | 50 | 0.70 | 0.68 | | | 0.43 | 105 | | 105 48" pipe |
| | Sec. 3 NE¼ | 147 | | 37 | | | | | | | | | | | |
| | Sum 39th Ave | 907 | | 280 | | | 55 | 0.65 | 0.63 | | | 0.39 | 109 | | 110 48" pipe |
| | Sec. 3 NW¼ | 147 | | 37 | | | | | | | | | | | |
| | Add Line VI-4 | 525 | | 215 | | | | | | | | | | | |
| | Sum 43rd Ave | 1579 | | 532 | | | 60 | 0.60 | 0.58 | | | 0.34 | 180 | | 180 60" pipe |
| | Sec. 4 E½ | 290 | | 101 | | | | | | | | | | | |
| | Sum 47th Ave | 1869 | | 633 | | | 65 | 0.57 | 0.54 | | | 0.31 | 196 | | 195 60" pipe |
| | Add Line VI-3 | 1309 | | 444 | | | | | | | | | | | |
| | Sec. 4 W½ | 289 | | 101 | | | | | | | | | | | |
| | Sum 51st Ave | 3467 | | 1178 | | | 70 | 0.53 | 0.50 | | | 0.27 | 318 | | 320 87" pipe |
| | Sec. 5 E½ | 289 | | 98 | | | | | | | | | | | |
| | Sum 55th Ave | 3756 | | 1276 | | | 76 | 0.50 | 0.47 | | | 0.24 | 306 | | 325 87" pipe |
| | Sec. 5 W½ | 289 | | 98 | | | | | | | | | | | |
| | Sum 59th Ave | 4045 | | 1374 | | | 82 | 0.47 | 0.44 | | | 0.216 | 297 | | 330 90" pipe |
| | Sec. 6 | 68 | | 36 | | | | | | | | | | | |
| | Sec. 1 NE½ | 18 | | 9 | | | | | | | | | | | |
| | Sum South Mountain Channel | 4131 | | 1419 | | | 106 | 0.38 | 0.36 | | | 0.144 | 204 | | 340 96" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES: Total Area $A$ | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time: Street Slope | Min. $t_c$ | RAIN: Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious: $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious: $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI-7 | 27th Ave | | | | | | | | | | | | | | |
| | Sec. 12 (n.Part) | 40 | | 8 | | .005 | 44 | 0.78 | 0.77 | | | 0.51 | 4 | | 5 Street Flow |
| | Sec. 1 (S½) | 232 | | 82 | | .005 | | | | | | | | | |
| | Sum South Mountain Ave | 272 | | 90 | | | 53 | 0.67 | 0.66 | | | 0.41 | 37 | | 40 33" pipe |
| | Sec. 1 (N½) | 268 | | 95 | | .005 | | | | | | | | | |
| | Sum Baseline Rd | 540 | | 185 | | | 60 | 0.60 | 0.59 | | | 0.35 | 65 | | 65 42" pipe |
| | Sec. 36 (S½) | 292 | | 92 | | .005 | | | | | | | | | |
| | Sum Vineyard Rd | 832 | | 277 | | | 66 | 0.56 | 0.54 | | | 0.31 | 86 | | 85 45" pipe |
| | Sec. 36 (N½) | 291 | | 91 | | .0045 | | | | | | | | | |
| | Sum Southern Ave | 1123 | | 368 | | | 71 | 0.53 | 0.51 | | | 0.28 | 103 | | 105 51" pipe |
| | Sec. 25 (S½) | 291 | | 103 | | .004 | | | | | | | | | |
| | Sum Roeser Rd | 1414 | | 471 | | | 77 | 0.49 | 0.47 | | | 0.24 | 113 | | 115 57" pipe |
| | Sec. 25 (N½) | 290 | | 103 | | .0035 | | | | | | | | | |
| | Sum Broadway Rd | 1704 | | 574 | | | 84 | 0.46 | 0.44 | | | 0.216 | 124 | | 125 57" pipe |
| | Sec. 24 (S. Part) | 40 | | 32 | | .003 | | | | | | | | | |
| | Sum Salt River | 1744 | | 606 | | | 86 | 0.45 | 0.43 | | | 0.21 | 127 | | 130 60" pipe |
| VI-8 | 19th Ave | | | | | | | | | | | | | | |
| | Sec. 6 (NW¼SW¼) | 72 | | 22 | | .006 | 19 | 1.47 | 1.46 | | | 1.13 | 25 | | 25 27" pipe |
| | Sec. 6 (NW¼&NW½&NE¼) | 216 | | 72 | | | | | | | | | | | |
| | Sum Baseline Rd | 288 | | 94 | | | 26 | 1.17 | 1.15 | | | 0.855 | 80 | | 80 42" pipe |
| | Sec. 31 (S½) | 297 | | 92 | | .007 | | | | | | | | | |
| | Sum Vineyard Rd | 585 | | 186 | | | 31 | 1.02 | 0.99 | | | 0.71 | 132 | | 135 51" pipe |
| | Sec. 31 (N½) | 296 | | 91 | | .005 | | | | | | | | | |
| | Sum Southern Ave | 881 | | 277 | | | 35 | 0.93 | 0.90 | | | 0.63 | 175 | | 175 57" pipe |
| | Sec. 30 (S½) | 290 | | 96 | | .004 | | | | | | | | | |
| | Sum Roeser Rd | 1171 | | 373 | | | 40 | 0.83 | 0.80 | | | 0.54 | 202 | | 200 |
| VI-9 | 7th Ave | | | | | | | | | | | | | | |
| | Sec. 32 (S½) | 257 | | 91 | | .011 | 37 | 0.89 | 0.87 | | | 0.60 | 58 | | 60 33" pipe |
| | Sec. 32 (N½) | 275 | | 97 | | | | | | | | | | | |
| | Sum Southern Ave | 532 | | 188 | | | 42 | 0.80 | 0.78 | | | 0.52 | 98 | | 100 45" pipe |
| | Sec. 29 (S½) | 292 | | 107 | | | | | | | | | | | |
| | Sum Roeser Rd | 824 | | 295 | | | 46 | 0.75 | 0.73 | | | 0.48 | 142 | | 145 51" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a - f_c)0.8 = I_n$ in | $I_n A_p$ cfs | Impervious $(I_a - 0.2)0.9 = I_m$ in | $I_m A_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI-10 | Riverside St | | | | | | | | | | | | | | |
| | Sec. 20 (E½ SE¼) | 80 | | 24 | | .0023 | 32 | 1.00 | 0.99 | | | 0.71 | 17 | | 15 27" pipe |
| | Sec. 20 (W½ SE¼) | 70 | | 21 | | .0023 | | | | | | | | | |
| | Sum Central Ave | 150 | | 45 | | | 37 | 0.88 | 0.87 | | | 0.60 | 27 | | 30 33" pipe |
| | Sec. 20 (E Part SW¼) | 60 | | 18 | | .0025 | | | | | | | | | |
| | Sum 3rd Ave | 210 | | 63 | | | 42 | 0.80 | 0.79 | | | 0.51 | 32 | | 35 36" pipe |
| | Sec. 20 (W Part SW¼) | 60 | | 18 | | .0021 | | | | | | | | | |
| | Sum 7th Ave | 270 | | 81 | | | 47 | 0.74 | 0.73 | | | 0.48 | 39 | | 40 39" pipe |
| VI-11 | | | | | | | | | | | | | | | |
| | Sec. 34 (S Part) | 198 | | 55 | | .009 | 24 | 1.24 | 1.22 | | | 0.92 | 51 | | 50 33" pipe |
| | Sec. 34 (N ½) | 288 | | 87 | | .008 | | | | | | | | | |
| | Sum Southern Ave | 486 | | 142 | | | 29 | 1.07 | 1.04 | | | 0.76 | 108 | | 110 48" pipe |
| | Sec. 27 (E Part) | 222 | | 62 | | .005 | | | | | | | | | |
| | Sum Wier Ave | 708 | | 204 | | | 37 | 0.89 | 0.86 | | | 0.59 | 120 | | 120 57" pipe |
| | Sec. 27 (W Part) | 222 | | 67 | | .006 | | | | | | | | | |
| | Sum 16th St | 930 | | 271 | | | 43 | 0.79 | 0.76 | | | 0.50 | 135 | | 135 60" pipe |
| | Sec. 28 (E ½) | 293 | | 94 | | .007 | | | | | | | | | |
| | Sum 12th St | 1223 | | 365 | | | 50 | 0.70 | 0.67 | | | 0.42 | 154 | | 155 63" pipe |
| VI-12 | | | | | | | | | | | | | | | |
| | Sec. 33 (S Part) | 219 | | 62 | | .008 | 32 | 1.00 | 0.98 | | | 0.70 | 43 | | 45 33" pipe |
| | Sec. 33 (N ½) | 291 | | 102 | | .006 | | | | | | | | | |
| | Sum Southern Ave | 510 | | 164 | | | 38 | 0.87 | 0.85 | | | 0.585 | 96 | | 95 42" pipe |
| | Sec. 28 (SW ¼) | 147 | | 42 | | .007 | | | | | | | | | |
| | Sum Roeser Rd | 657 | | 206 | | | 43 | 0.79 | 0.77 | | | 0.51 | 105 | | 105 45" pipe |
| | Sec. 28 (NW ¼) | 146 | | 44 | | .007 | | | | | | | | | |
| | VI-11 Area | 1223 | | 365 | | | | | | | | | | | |
| | Sum Broadway Rd | 1369 | | 409 | | | 50 | 0.70 | 0.67 | | | 0.42 | 172 | | 175 69" pipe |
| | Sec. 21 (SW ¼) | 151 | | 45 | | .002 | | | | | | | | | |
| | Sum Salt River | 1520 | | 454 | | | 57 | 0.63 | 0.60 | | | 0.36 | 164 | | 180 69" pipe |

EXPECTED FLOWS 1 - year rainfall intensity and duration unless noted

| Area No. | LOCATION | AREA - ACRES Total Area A | Perv. Area $A_p$ | Imperv. Area $A_i$ | Infiltr'n (final) in/hr $f_c$ | Concentration Time Street Slope | Min. $t_c$ | RAIN Point Intensity I in/hr | Average Intensity $I_a$ in/hr | RUNOFF Pervious $(I_a-f_c)0.8 = I_n$ in | $I_nA_p$ cfs | Impervious $(I_a-0.2)0.9 = I_m$ in | $I_mA_i$ cfs | Total Flow cfs | DESIGN FLOW AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VI-13 | Broadway Rd | | | | | | | | | | | | | | |
| | Sec. 25 (E 1/8) | 76 | | 28 | | .003 | 10 | 2.20 | 2.18 | | | 1.78 | 50 | | 50 42" pipe |
| | Sec. 25 (E ¼) | 152 | | 55 | | .003 | | | | | | | | | |
| | Sum 38th St | 152 | | 55 | | | 17 | 1.57 | 1.55 | | | 1.22 | 67 | | 70 48" pipe |
| | Sec. 25 (E½) | 152 | | 74 | | .003 | | | | | | | | | |
| | Sum 36th St. | 304 | | 129 | | | 21 | 1.37 | 1.34 | | | 1.03 | 133 | | 135 63" pipe |
| | Sec. 25 (W ½) | 304 | | 227 | | .003 | | | | | | | | | |
| | Sum 32nd St | 608 | | 356 | | | 28 | 1.10 | 1.07 | | | 0.78 | 278 | | 280 81" pipe |
| | Sec. 36 (E ½) | 292 | | 98 | | .003 | | | | | | | | | |
| | Sum 28th St | 900 | | 454 | | | 34 | 0.95 | 0.92 | | | 0.65 | 295 | | 295 81" pipe |
| | Sec. 26 (NW ¼) | 97 | | 33 | | .003 | | | | | | | | | |
| | Sum 25th St | 997 | | 487 | | | 39 | 0.85 | 0.82 | | | 0.56 | 273 | | 300 81" pipe |
| VI-14 | 24th St | | | | | | | | | | | | | | |
| | Sec. 36 (E ½) | 103 | | 56 | | .085 | 36 | 0.91 | 0.90 | | | 0.63 | 35 | | 35 36" pipe |
| | Sec. 36 (W ½) | 103 | | 56 | | .009 | | | | | | | | | |
| | Sum 32nd St | 206 | | 112 | | | 44 | 0.77 | 0.76 | | | 0.49 | 55 | | 55 42" pipe |
| | Sec. 35 | 289 | | 146 | | .010 | | | | | | | | | |
| | Sum 28th St | 495 | | 258 | | | 52 | 0.68 | 0.66 | | | 0.41 | 106 | | 105 51" pipe |
| | Sec. 26 (SW ¼) | 97 | | 33 | | .004 | | | | | | | | | |
| | Sum | 592 | | 291 | | | 57 | 0.63 | 0.61 | | | 0.37 | 108 | | 110 60" pipe |
| | Sec. 26 (NW ¼) | 32 | | 11 | | .002 | | | | | | | | | |
| | Sum | 624 | | 302 | | | 65 | 0.57 | 0.55 | | | 0.315 | 95 | | 115 60" pipe |
| | VI-13 Area | 997 | | 487 | | | | | | | | | | | |
| | Sum Broadway Rd | 1621 | | 789 | | | 65 | 0.57 | 0.55 | | | 0.315 | 248 | | 310 84" pipe |

## SECTION 6 - PROPOSED WORK

Storm drain trunks probably have the longest useful life of any item of public works. (The cloaca maxima, begun about 600 B.C. to drain the area of the Roman Forum is still in service.) They are such massive structures, generally so deep, and over the years have become so intricately enmeshed with all sorts of other underground systems that they are extremely difficult and expensive to replace if this should become necessary. For this reason only the most durable materials should be used and the lines should have adequate structural strength and hydraulic capacity for the demands to be made on them.

A proposal for new storm drain construction should first take into account what drainage assets a community already has and should consider how they can best be fitted into the ultimate development for the design period. This section begins with a discussion of existing natural and artificial drainage channels, considers the possibilities of a few potential storage sites, makes recommendations for future construction, and suggests an order of priority for the work to be done.

## 6.1 Existing Channels in the Study Area.

The major natural channels including the Salt, Agua Fria, and New Rivers, Cave Creek, Skunk Creek and Indian Bend Wash have all been investigated and adopted as suitable for flood control channelization projects by the Corps of Engineers. Dreamy Draw, while hardly a major channel, is so situated that it too is included as a suitable Corps project as a part of the proposed Arizona Canal diversion channel.

This discussion will concern itself with another group of natural and artificial water courses which, although too small for use as major flood control channels, nevertheless are useful parts of the storm drainage system. The hydraulic capacity of these channels should be preserved or enhanced. The 1956 Phoenix Storm Drainage Report speaks of the need for keeping natural waterways open and much has been done in this direction by review of subdivision plats and paving plans for storm drainage provisions. A continuing effort is necessary to inspect these channels, to keep them clean, and prevent encroachments. Any road or street crossings or other construction that might impair the hydraulic capacity should be planned for not less than the 25-year flow.

Table 6.1 is a listing of the existing natural channels which should be considered a part of the storm drainage system. As drainage easements or rights-of-way are dedicated, these should be taken under the regular operational purview of the various authorities having responsibility for flood control or storm drainage. Easement widths

TABLE 6.1 Existing Natural Channels Recommended for Inclusion in the Storm Drainage System

| Name of Channel | Reach From | Reach To | Ending in Section T & R | Authority | Length of Reach Miles | Approx. Nat. Cap. C.F.S. | Expected 25 Yr. Flow C.F.S. | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1. Cave Creek | Union Hills Channel | Arizona Canal | NW¼ SE¼ 25, 3N, 2E | Phoenix | 6.50 | 15,800 | 5,300 | Part of proposed park |
| 2. Unnamed (Sweetwater-Moon Valley) | Cave Creek | Thunderbird Rd. | SE¼ NW¼ 13, 3N, 3E | Phoenix | 3.25 | 1,800 | 2,600 | Presently maintained by City of Phoenix |
| 3. 10th Street Wash | A.C. Diversion Channel | Cholla Street | SW¼ SW¼ 33, 3N, 3E | Phoenix | 2.75 | 1,800 | 2,050 | See City of Phoenix Project |
| 4. Unnamed (Northern Avenue Wash) | A.C. Diversion Channel | 18th Street | NW¼ NW¼ 4, 2N, 3E | Phoenix | 1.20 | 770 | 425 | |
| 5. Unnamed (South Dreamy Draw) | A.C. Diversion Channel | Northern Avenue (extended) | NE¼ SE¼ 4, 2N, 3E | Phoenix | 0.95 | 195 | 240 | |
| 6. Unnamed (Myrtle Avenue Wash) | A.C. Diversion Channel | 24th Street (extended) | SW¼ SW¼ 3, 2N, 3E | Phoenix | 1.15 | 570 | 490 | |
| 7. Unnamed (Flynn Lane Wash) | A.C. Diversion Channel | Squaw Peak Park | NE¼ NW¼ 10, 2N, 3E | Phoenix | 1.15 | 700 | 540 | |
| 8. Kitache Wash (33rd Street) | Arizona Canal | Lincoln Drive | SW¼ NW¼ 13, 2N, 3E | Phoenix | 3.20 | 1,210 (W)<br>1,655 (E) | <br>460 | West branch flowing 4 ft. deep<br>East branch flowing 5 ft. deep<br>Length of 3 branches included |
| 9. Echo Wash | Arizona Canal | 56th Street | SE¼ SE¼ 13, 2N, 3E | Paradise Valley | 2.80 | 790 | 1,330 | East of 40th St. @ 4' depth |
| 10. Unnamed (39th Street Wash) | Stanford Drive | Lincoln Drive | SE¼ NE¼ 13, 2N, 3E | Paradise Valley | 1.05 | 440 | 570 | Tributary to Echo Wash |
| 11. Unnamed (Mockingbird) | Indian Bend Wash | Northern Avenue (extended) | W½, NE¼ 33, 3N, 4E | Paradise Valley | 1.80 | 230 | 575 | Drain Trunk No. V-20 |
| 12. Unnamed | Northern (extended) | Shea Blvd. | NW¼ NE¼ 30, 3N, 4E | Phoenix | 3.5 | 540 | 650 | Drain Trunk No. V-17 |
| 13. Old Cross-Cut Canal | Grand Canal | Arizona Canal | SW¼ NE¼ 7, 1N, 4E | Phoenix | 3.65 | 400-700 | - | Controlled by Salt River Project |

should be ample for access of mechanical maintenance equipment.

The Old Cross-Cut Canal was investigated as a drainageway under the Flood Control District of Maricopa County Survey Report in 1962 and under a City of Phoenix study made in 1967. The study concluded that the present canal (which belongs to the Salt River Valley Water Users Association and is used for transfer of water from the Arizona to the Grand Canal) could be enlarged and improved to serve both irrigation and storm drainage purposes. The head of the canal is so situated that it could serve as the discharge point for drainage of a 9.5 square mile area north of the Arizona Canal between 32nd and 60th Streets. This area has a 25-year runoff rate of about 4000 cfs. A capacity of 3200 to 4200 cfs in the old Cross-Cut could be provided by rebuilding the intake at the Arizona Canal, enlarging and lining the entire length of the canal, constructing new bridges at 6 street crossings, and enlarging the outlet structure at the Grand Canal. It would also be necessary to construct about 1320 feet of channel from the outlet structure to the Salt River. Estimated cost in 1967 exclusive of the outlet structure and river connection was $3,765,000.

The Old Cross Cut Canal offers the best possibilities for handling the large flows that develop from the area north of the Arizona Canal. The alternative of extending the proposed Arizona Canal Diversion Channel easterly to Echo Wash (near 40th Street) is probably no longer feasible because of excessive right-of-way cost through the Biltmore

Hotel grounds and the high-value residential district to the east. Another alternative, building the proposed 40th Street drain to accommodate 25-year flows from Echo Wash would require the equivalent of 132- to 168- inch pipe and present very serious structural difficulties. Logistic and equipment capabilities set 96 inches on pipe to be installed in city streets.

Use of the Old Cross-Cut entails the collection of runoff from streets and the washes along the north bank of a five mile reach of the Arizona Canal, roughly from 28th Street to 60th Street. This is beset with complexities for the same reason that the easterly extension of the Arizona Canal Diversion Channel is difficult. In addition there is the problem of very flat or adverse grades. In order to pick up the 28th and 33rd Street washes, the hydraulic gradient toward 48th Street could not exceed 0.001. To handle 25-year flows very large conduits are required (See Figure 6.1) and trench depths will approach 30 feet just west of 48th Street.

The logical place for a collection channel would be along the north bank of the Arizona Canal. From the Biltmore Hotel (about 30th Street) eastward as far as 41st Street there has been little or no occupancy of the land immediately adjacent to the Arizona Canal on the north side. This area is subject to flooding because of the damming effect of the canal on Echo Wash and on the washes entering at 28th, 33rd (Katiche) 35th, 37th, and 39th Streets. There are only three buildings within 80 feet of the water's edge in this portion and only one of these is a house so there would be no serious obstacle to a new channel.

From 31st to 44th Streets the north bank of the canal is from 40 to 60 feet wide and it would be possible although difficult to construct a pipeline or culvert in this reach.

From 44th Street to 48th Street subdivision lots abut directly on the canal right-of-way and the north berm is only 20 to 25 feet wide. Calle Redonda, with a 50-foot dedicated width, parallels the Arizona Canal immediately north of the tier of lots adjoining the Canal but this street is not continuous. It would be difficult and expensive to construct a conduit of the size required in this area.

For these reasons it was recommended in the Area III Survey Report for the Flood Control District of Maricopa County (1962) that the Arizona Canal itself be deepened and gated so that flow could be reversed from at least as far west as Echo Wash. This concept was also discussed in the 1967 City of Phoenix Study on the Old Cross-Cut Canal. It would of course present construction scheduling difficulties because of the brevity of canal dryups and would require the approval and very close cooperation of the Salt River Valley Water Users Association, but it nevertheless represents the most attractive alternative for the collection of runoff at the head of the Old Cross-Cut Canal. Such a project together with the reconstruction of the Old Cross-Cut Canal to a 4000 cfs capacity would probably have to be undertaken by local interests without Corps of Engineers participation. It would be of primary benefit to Phoenix but it would also be substantially beneficial to the western part of the Town of Paradise Valley. A portion of the City of Scottsdale west of 60th Street would also contribute runoff to this system. Aspects of the problem of drains serving more than one community are discussed in Section 4 of this report.

The Old Cross-Cut project and its associated collector channel are really flood control projects by the standard of Table 3.1 and as such are beyond the scope of this report. The reader is referred to the aforementioned studies for more detail.

There is an extensive system of existing underground drains serving the central portion of Phoenix, downtown Scottsdale, and a portion of Glendale. Parts of this system discharge into the irrigation and drainage lines of the Salt River Project. The drainage trunks 30 inches and larger are shown in red on Plate C. Practically all of these lines have been built since 1950. Extending from these trunk lines is an elaborate system of laterals and inlets. In the older parts of Phoenix, dating from the 1930's and earlier, there are several hundred drainage sumps or "dry wells" with associated inlets and short connecting pipes. Many of the latter are inverted siphons. The locations of these facilities are shown in the City's storm drain atlas. Because of siltation and clogging, the sumps are no longer effective and many of the inlets have been connected to subsequently installed laterals and trunks. Even this expedient has been only partially successful because the connecting pipes are small (generally 12 inches in diameter) and the original inlets are undersized horizontally-grated openings which are very quick to clog. As street reconstruction and other projects permit, they are gradually being replaced with more modern curb inlets and larger connecting lines.

6.2 Storage Projects.

In 1954 the Soil Conservation Service made preliminary studies of 16 potential sites for retention dams in the North Phoenix Mountains. Of these sites, 9 are no longer feasible because of intensive, usually high value, residential development in the reservoir area. Two of the sites are in the Dreamy Draw drainage which is now a part of the Corps of Engineers "Phase B" flood control project. Another site which is located on Cave Creek, will be made superfluous by the proposed Cave Buttes Dam and Union Hills diversion channel. A site on Echo Wash immediately north of McDonald Drive in the town of Paradise Valley remains undeveloped but this site is estimated to require 100 acres of some of the more valuable residential land in the Phoenix area. A site on the west branch of Katiche Wash near the southwest corner of Section 12, T2N, R3E, has relatively little storage capacity and would require about 10 acres of land. A site just north of the center of Section 34, T3N, R3E, has good storage capacity and a favorable damsite but a drainage area of only 230 acres. Another site, in the northeast quarter of the northwest quarter of Section 28, T3N, R3E, presently remains undeveloped but would require a dam 1900 feet long and this location is immediately adjacent to subdivided areas to the south.

The storage solution to the storm drainage problem is attractive when there are good reservoir sites available at low cost, when the drainage areas contributing are large, and when the cost of the outlet pipe or channel below the dam is relatively high. These conditions do not prevail in most cases in the North Phoenix Mountain area. The higher foothill lands where the dams and reservoirs would be located are mostly in private ownership and are rapidly rising in value. The natural washes are generally well defined and of adequate capacity for the 25- to 50-year flood, at least in the upper and middle reaches. In the subdividing and building up of the foothill areas these washes are generally being preserved and their hydraulic capacity improved. The drainage areas above the damsites are small, 300 acres is fairly typical, and where the canyons are narrow enough to afford short dams the bed slope is usually so steep that a site with any appreciable storage capacity is rare. For these reasons it is unlikely that providing storage for the purpose of reducing peak runoff rates will be practical in most cases.

There are a few instances where reservoirs could be placed in parks. Here the high cost of land would not be a consideration. Since park uses are not necessarily incompatible with temporary floodwater storage, such possibilities should receive serious consideration at the time drains for the area are under design. One such site is at the southwest entrance to Squaw Peak Park in Phoenix. There are already two small dams here with a combined storage capacity of about 10 acre-feet. Outlet pipes are 24 inches in diameter. The effect of these dams is to regulate the outflow to not more than 70 cfs so long as the dams are not overtopped. The drainage area contributing to these dams is about 290 acres and the unimpeded 25-year discharge would be about 720 cfs. A reservoir with a 22 acre-foot storage capacity would permit reduction of the runoff rate to a negligible amount. There is also the possibility for a dam with a contributing drainage area of about 200 acres in the northwest portion of Squaw Peak Park. Other park sites with storage potential occur in the North Mountains and in South Mountain Park. The South Mountain Park sites have received consideration for possible Flood Control District projects.

6.3 New Drainage Projects.

The results of the computations of Section 5 are shown in terms of pipe and channel systems on Plates G and H. These drawings show the entire trunk system essentially as it should look in 1995, except that presently existing lines are not shown (existing trunk lines are shown on Plate C). The most important data on Plates G and H are the flows posted in figures generally shown perpendicular to carrying lines. These are all one-year flows unless otherwise indicated in parentheses immediately under the line designation number.

The pipe sizes are chosen to be appropriate for the computed flow at the slope of the ground with the pipe assumed to be flowing full, an assumption that is slightly on the conservative side. It is of course the hydraulic gradient, not the ground slope, that governs pipe capacity and in the final design it may be possible to reduce the size of some of the trunks where there is a flat or adverse ground slope by varying the depth of the trench to provide a steeper slope. (The final trunk design should provide a hydraulic gradient that is everywhere at least two, preferably three, feet below the finished street grade so that the situation of water being discharged at inlets will not occur.) The invert elevation and the working water surface of the receiving channel at the trunk drain discharge should be considered in the final trunk design and if this information is not available, the designer must make the best assumption he can.

Drains in Areas II,III, and IV which will discharge into artificial channels cannot be put into service until the flood control channels are operative. Area V should have at least a low-flow channel above the Arizona Canal. Below the canal, Indian Bend Wash contains a small Salt River Project waste and pump collection ditch, but the wash proper is not under Project jurisdiction. The land is mostly in private ownership. The City of Scottsdale is gradually acquiring flowage right-of-way or fee title to this land. The construction of the Area V drains will probably have to await acquisition of Indian Bend right-of-way to carry storm flows to the Salt River. The lack of an adequate outlet not only makes the effective operation of a drain impossible but it also increases the amount of storm water the downstream area must contend with and there is always a possibility of liability for flooding property owners near the outlet of the drain.

Although through streets generally occur only on section and midsection lines, the final design should also include a study of possible alternative alignments. In some cases it may be advisable to make the line a little longer to secure a better gradient, to avoid underground congestion, or to minimize interference with businesses along the routes shown on Plates G or H.

The priority of construction for the various lines is not indicated on the drawings. This report contemplates three periods of major storm drain construction during the next 25 years. Individual lines have been assigned to one of these periods taking into account the population and land use projections of planning agencies and giving consideration to the opinions of municipal officials. The priority categories are:

| Priority | Approximate Construction Period |
|---|---|
| A | 1970 - 1975 |
| B | 1980 - 1985 |
| C | 1990 - 1995 |

Table 6.2 indicates the priority assignments. These assignments should also be reviewed prior to every proposed bond issue for storm drains. While qualitative projections by planning agencies seem to turn out to be fairly accurate (possibly because the very act of publishing a plan for urban development tends to give it direction), it is not often that the time and sequence can be foreseen with equal precision. There is not much question, however, about which projects are immediately needed.

In the Indian Bend drainage, the trunk layout (Plate H) does not take into account the proposed Interceptor Floodway[1] which would begin near 96th Street and Cactus Road, and flow westerly through the Shea Blvd. 64th Street intersection to the proposed Scottsdale Dam. At this time it is not clear what the ultimate flood control plan for Indian Bend will be. If the storage plan is adopted and if

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(1) Flood Control Feasibility Report - Indian Bend Wash, Water Resources Associates, December, 1967.

the Interceptor Floodway is built, the north-south drain pattern between 64th and 96th Streets would be interrupted. The portion of the system north of the Floodway would be as shown on Plate H, but the lines on the south could be considerably smaller. Figure 6.2 shows one-year design flows and line sizes for Lines V-26 through V-30 south of the Floodway if this channel is to be built.

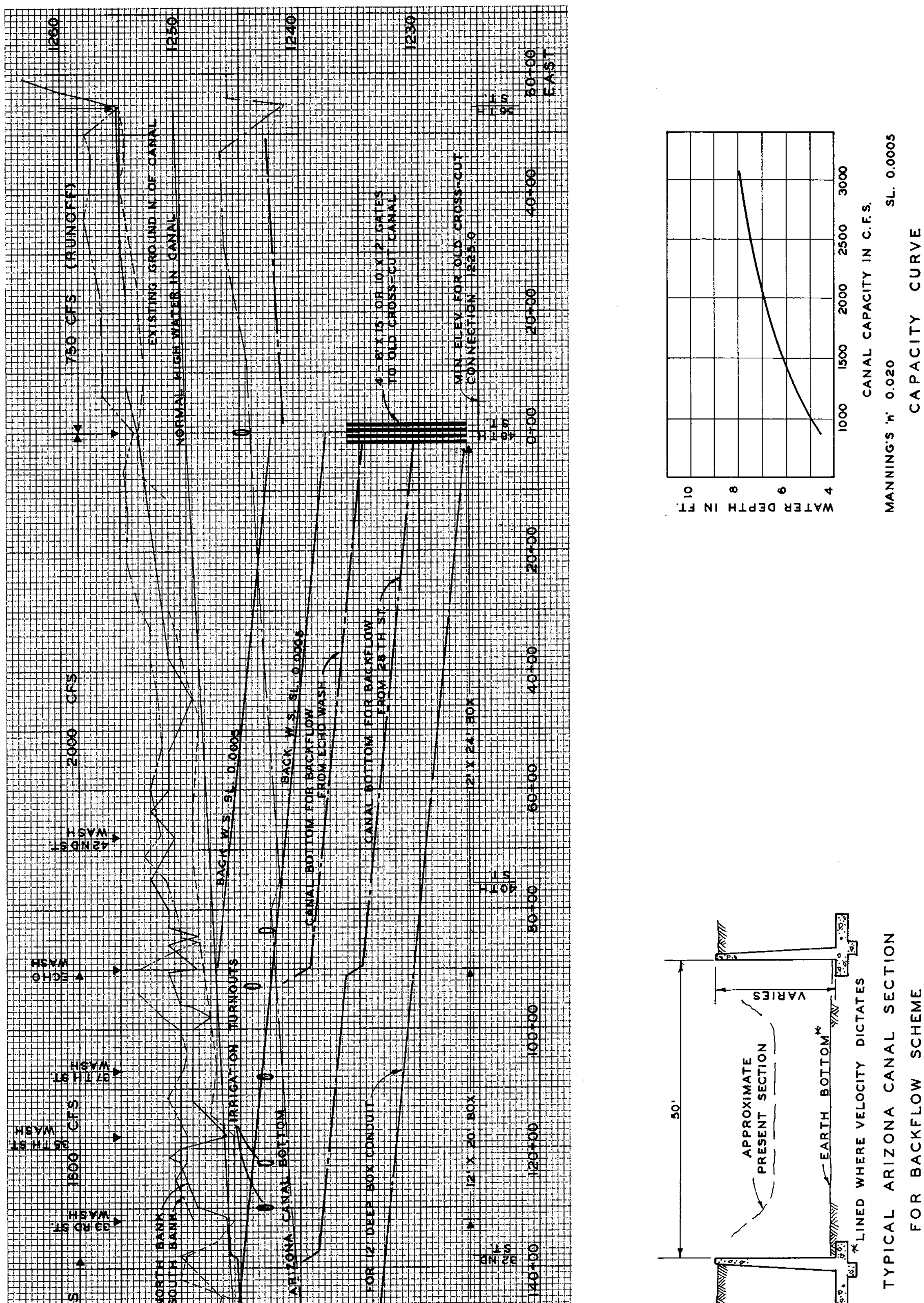
TABLE 6.2 Project Priorities

| | Priorities | | |
|---|---|---|---|
| | A | B | C |
| **Internal Lines** | | | |
| Scottsdale | V-2 | V-28 | |
| | V-3 | V-29 | |
| | V-5 | V-31 | |
| | V-7 | V-32 | |
| | V-34 | V-33 | |
| Glendale | | | III-8 |
| | | | III-9 |
| | | | III-10 |
| | | | III-11 |
| | | | III-12 |
| Peoria | | | III-1 |
| | | | III-3 |
| | | | III-4 |
| | | | III-5 |
| | | | III-6 |
| | | | III-7 |
| Paradise Valley | | V-14 | |
| | | V-15 | |
| | | V-16 | |
| | | V-17 | |
| Phoenix | I-8 | I-7 | I-5 |
| | I-9 | I-11 | I-6 |
| | I-10 | IV-5 | II-3 |
| | I-12 | IV-6 | II-4 |
| | I-13 | IV-10 | IV-7 |
| | I-14 | V-21 | IV-8 |
| | I-15 | V-22 | IV-9 |
| | I-16 | V-23 | V-25 |
| | I-17 | V-24 | VI-1 |
| | V-20 | | |
| | VI-7 | | |
| | VI-8 | | |
| | VI-9 | | |
| | VI-10 | | |
| | VI-11 | | |
| | VI-12 | | |
| | VI-13 | | |
| | VI-14 | | |

TABLE 6.2 Project Priorities (continued)

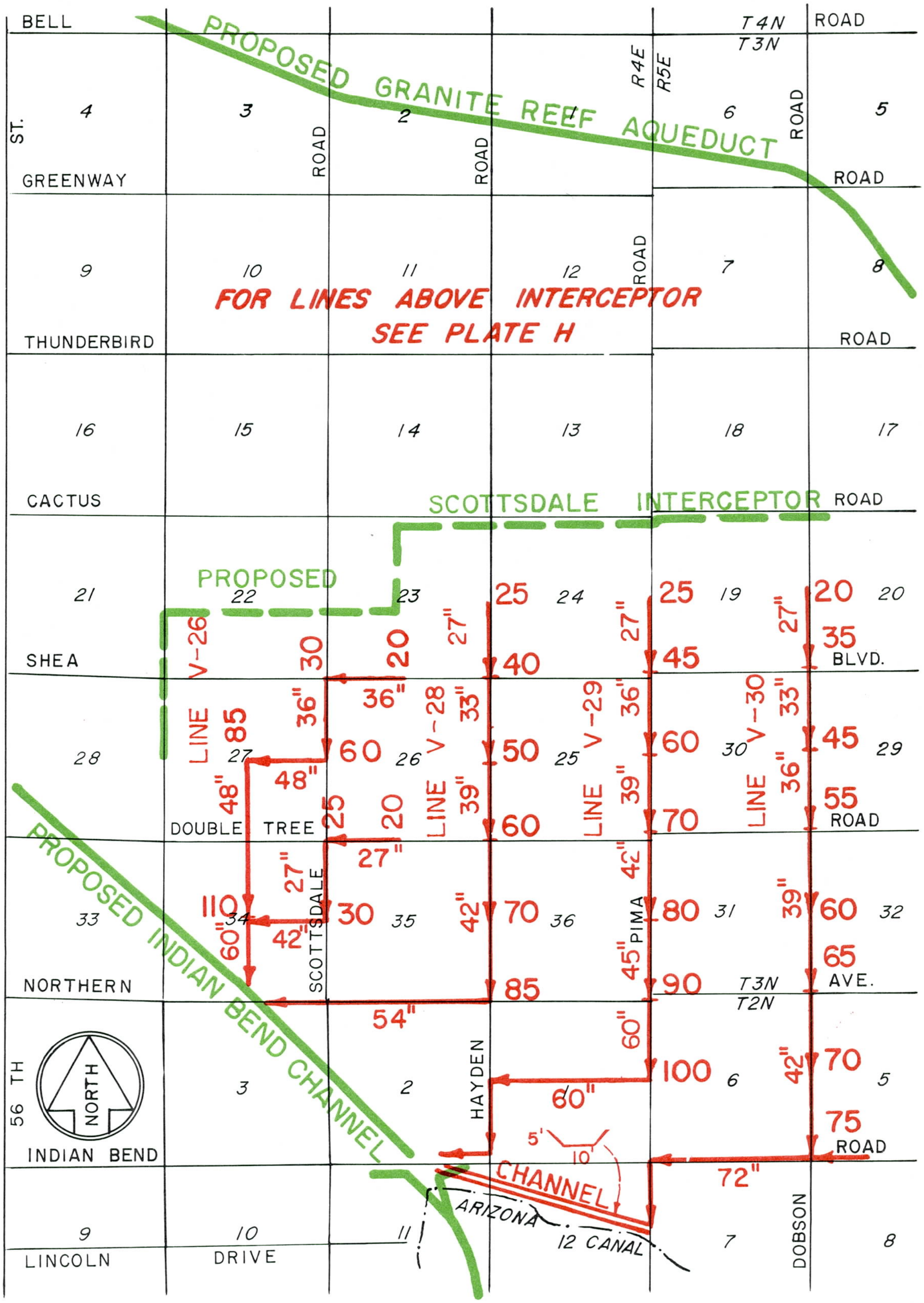
| | Priorities A | Priorities B | Priorities C |
|---|---|---|---|
| Regional Lines | II-6 | II-5 | III-2 |
| | II-7 | IV-2 | IV-1 |
| | II-8 | V-11 | IV-3 |
| | II-9 | V-12 | IV-4 |
| | V-9 | V-18 | V-26-W |
| | V-10 | V-19 | V-30 |
| | V-13 | | |
| | V-26-E | | |
| County Lines | | | |
| (Presently outside any incorporated area) | | | I-1 |
| | | | I-2 |
| | | | I-3 |
| | | | I-4 |
| | | | II-1 |
| | | | II-2 |
| | | | VI-2 |
| | | | VI-3 |
| | | | VI-4 |
| | | | VI-5 |
| | | | VI-6 |

Note: Suggested priorities are based on consideration of presently troublesome areas, population and land use projections, and, to a large extent, on estimates of when receiving channels will be available.




PROFILES FOR OLD CROSS-CUT COLLECTORS

FIGURE 6.1




ONE YEAR FLOWS AND PIPE SIZES FOR LINES V-26, V-28, V-29, AND V-30 BELOW PROPOSED SCOTTSDALE INTERCEPTOR FLOODWAY

FIGURE 6.2

## SECTION 7 - COST ESTIMATES

Estimates in this section are based on current prices for labor and materials. Labor contracts presently in effect expire on June 30, 1970, and it is uncertain what the new wage rates will be. Material prices are also presently in a volatile state. Nevertheless every effort has been taken to make these estimates representative for the date of this report, however no allowances are included for rights-of-way. Appropriate corrections should be applied to the costs shown herein when they are used at a later date.

The estimates include allowances for all appurtenances necessary to make a complete and working trunk drain installation within the limits of its own street even though these appurtenances are not specifically mentioned. It is assumed that the work will be done in units of about $1,000,000 contract value. Moderate contractor's overhead and profit are included.

Unit costs for pipe drains in Table 7.1 were developed for pipe sizes ranging from 21 to 96 inches. The column headed "Best Total Cost per Lin. Ft." represents the cost of lines in streets where no pavement replacement is required, where soil conditions are normal, and where there is no unusual conflict with other utilities. The usual condition in city streets will require pavement cut and replacement and perhaps the relocation of a parallel water, gas, or sewer main to permit the installation of the storm drain. There will also

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Estimates in this section are based on current prices for labor and materials. Labor contracts presently in effect expire on June 30, 1970, and it is uncertain what the new wage rates will be. Material prices are also presently in a volatile state. Nevertheless every effort has been taken to make these estimates representative for the date of this report, however no allowances are included for rights-of-way. Appropriate corrections should be applied to the costs shown herein when they are used at a later date.

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TABLE 7.1 Development of Unit Costs for Trunk Drains (Pipe Lines)

| | Excavation And Backfill | | | | | | | Intersection Costs | | Best Total Cost Per L. F. | | Paralleling Cost Per L. F. | | Total Cost In Built-Up Areas Per Lin. Ft. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pipe Size Inches I.D. | Trench Width Ft. | Trench Depth Ft. | Cu.Yds. Per L. F. | Cost Per Cu. Yd. | Cost Per L. F. | Pipe Cost Per L. F. | Installation Cost Per L.F | Inlet Cost Per L.F. | Utility X-ing Cost Per L. F. | Total | Use | Pavement Cut and Replacement | Utility Relocation | Total | Use | Pipe Size Inches I.D. |
| 21 | 3.5 | 7.2 | 0.93 | $0.60 | $0.56 | $5.49 | $2.68 | $2.50 | $0.21 | $11.44 | $11.50 | $2.25 | $3.00 | $16.75 | $17.00 | 21 |
| 24 | 3.8 | 7.5 | 1.06 | 0.60 | 0.64 | 5.84 | 2.76 | 2.50 | 0.21 | 11.95 | 12.00 | 2.40 | 3.30 | 17.70 | 18.00 | 24 |
| 27 | 4.3 | 7.8 | 1.24 | 0.60 | 0.74 | 6.98 | 2.95 | 2.50 | 0.26 | 13.43 | 13.50 | 2.75 | 3.60 | 19.85 | 20.00 | 27 |
| 30 | 4.6 | 8.1 | 1.38 | 0.60 | 0.83 | 7.54 | 3.05 | 2.50 | 0.26 | 14.18 | 14.50 | 2.90 | 3.90 | 21.30 | 21.50 | 30 |
| 33 | 4.9 | 8.4 | 1.52 | 0.60 | 0.91 | 8.77 | 3.84 | 2.50 | 0.32 | 16.34 | 16.50 | 3.10 | 4.20 | 23.80 | 24.00 | 33 |
| 36 | 5.2 | 8.7 | 1.68 | 0.60 | 1.01 | 9.56 | 4.02 | 2.50 | 0.32 | 17.41 | 17.50 | 3.30 | 4.50 | 25.30 | 25.50 | 36 |
| 39 | | | | | | | | | | | 21.00 | | | | 29.00 | 39 |
| 42 | 6.3 | 9.3 | 2.17 | 0.60 | 1.30 | 13.51 | 5.52 | 2.75 | 0.37 | 23.45 | 23.50 | 4.00 | 4.80 | 32.30 | 32.50 | 42 |
| 45 | | | | | | | | | | | 26.00 | | | | 35.00 | 45 |
| 48 | 6.8 | 9.8 | 2.47 | 0.60 | 1.48 | 16.49 | 6.08 | 2.75 | 0.37 | 27.17 | 27.50 | 4.30 | 5.10 | 36.90 | 37.00 | 48 |
| 51 | | | | | | | | | | | 30.00 | | | | 40.00 | 51 |
| 54 | 7.4 | 10.4 | 2.85 | 0.60 | 1.71 | 19.77 | 6.62 | 2.75 | 0.42 | 31.27 | 31.50 | 4.70 | 5.40 | 41.60 | 42.00 | 54 |
| 57 | | | | | | | | | | | 34.00 | | | | 45.00 | 57 |
| 60 | 8.0 | 11.0 | 3.26 | 0.65 | 2.12 | 24.02 | 7.26 | 2.75 | 0.42 | 36.57 | 36.50 | 5.10 | 5.70 | 47.30 | 47.50 | 60 |
| 63 | | | | | | | | | | | 39.50 | | | | 51.00 | 63 |
| 66 | 9.3 | 11.6 | 4.00 | 0.65 | 2.60 | 27.93 | 7.97 | 2.75 | 0.53 | 41.78 | 42.00 | 5.90 | 6.00 | 53.90 | 54.00 | 66 |
| 69 | | | | | | | | | | | 46.00 | | | | 57.50 | 69 |
| 72 | 9.8 | 12.2 | 4.43 | 0.65 | 2.88 | 32.60 | 8.83 | 2.75 | 0.63 | 47.69 | 48.00 | 6.20 | 6.30 | 60.50 | 60.50 | 72 |
| 75 | | | | | | | | | | | 52.00 | | | | 64.50 | 75 |
| 78 | 10.4 | 12.8 | 4.93 | 0.65 | 3.20 | 36.87 | 9.88 | 3.00 | 0.74 | 53.69 | 54.00 | 6.60 | 6.60 | 67.20 | 67.50 | 78 |
| 81 | | | | | | | | | | | 57.50 | | | | 71.50 | 81 |
| 84 | 11.0 | 13.3 | 5.42 | 0.70 | 3.79 | 41.77 | 10.93 | 3.00 | 0.84 | 60.33 | 60.50 | 7.00 | 6.90 | 74.40 | 74.50 | 84 |
| 87 | | | | | | | | | | | 64.50 | | | | 78.50 | 87 |
| 90 | 11.6 | 13.9 | 5.97 | 0.70 | 4.18 | 47.35 | 12.10 | 3.00 | 0.95 | 67.58 | 67.50 | 7.40 | 7.20 | 82.10 | 82.00 | 90 |
| 93 | | | | | | | | | | | 72.00 | | | | 86.50 | 93 |
| 96 | 12.2 | 14.5 | 6.55 | 0.70 | 4.59 | 52.66 | 13.37 | 3.00 | 1.05 | 74.67 | 75.00 | 7.70 | 7.50 | 90.20 | 90.50 | 96 |

be numerous perpendicular crossings of such lines. It is presumed that a part of the pavement replacement will require a concrete base. The very worst conditions which require cutting through concrete paving, moving of parallel utility lines, or extensive shoring of trenches will cost more per foot than the column headed "Total Cost in Built-Up Areas Per Lin. Ft.". In the tabular estimates which follow some adjustments for the effects of known local peculiarities have been made in arriving at the total cost of a line.

Tables 7.2 through 7.4 are included to give unit cost data for box culverts, lined trapezoidal and rectangular channels, and for earth ditches. The prices for these conveyance methods assume the open and relatively unimpeded construction conditions likely to exist where these constructions are used.

The tabular estimates include a lump sum allocation based on area for laterals and inlets on side streets not on the direct route of the drainage trunk. The costs of such work have conventionally been considered a partof street paving costs, to be financed by improvement districts or arterial street improvement programs.

TABLE 7.2 Unit Cost For Box Culverts
@ $100 per C.Y. for Concrete
$0.28 per Lb. for Reinf. Steel

| Size | Barrel C.Y. Conc./L.F. | Barrel Lbs. Steel/L.F. | Add for Wingwalls (80' Avg. Length) C.Y. Conc. | Add for Wingwalls (80' Avg. Length) Lbs. Stl. | Total Concrete C.Y./L.F. | Total Steel Lbs./L.F. | Approx. Cost/Ft. |
|---|---|---|---|---|---|---|---|
| 4' x 4' | 0.464 | 36.0 | 0.062 | 0.3 | 0.526 | 36.3 | $65.00 |
| 5' x 5' | 0.560 | 47.9 | 0.085 | 1.0 | 0.645 | 48.9 | 80.00 |
| 6' x 6' | 0.708 | 73.8 | 0.122 | 5.8 | 0.830 | 79.6 | 105.00 |
| 6' x 6'-2 Span | 1.215 | 143.3 | 0.140 | 9.2 | 1.355 | 152.5 | 180.00 |
| 8' x 6' | 0.889 | 90.3 | 0.163 | 2.9 | 1.052 | 93.2 | 135.00 |
| 8' x 6'-2 Span | 1.609 | 190.9 | 0.195 | 0.5 | 1.804 | 191.4 | 235.00 |
| 10' x 8' | 1.356 | 141.6 | 0.264 | 4.0 | 1.620 | 145.6 | 205.00 |
| 10' x 8'-2 Span | 2.381 | 294.5 | 0.333 | 1.0 | 2.714 | 295.5 | 355.0 |

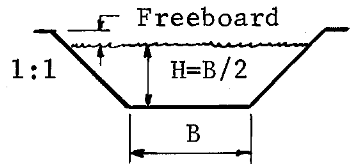



TABLE 7.3 Unit Cost for Trapezoidal Lined Channels
@ $1.00 Per C.Y. For Excavation
$1.00 Per S.F. For Lining
1 Foot Min. Freeboard

| Size | Area Sq. Ft. | Avg. Depth | Exc. C.Y./Ft. | Lining Sq. Ft./Ft. | Excavation @ $1.00/C.Y. | Lining @ $1.00/S.F. | Total Cost/Ft. |
|---|---|---|---|---|---|---|---|
| B=4' | 12 | 6' | 2.2 | 12.5 | $2.20 | $12.50 | $14.70 |
| B=6' | 27 | 8' | 4.2 | 17.3 | 4.20 | 17.30 | 21.50 |
| B=8' | 48 | 10' | 6.7 | 22.2 | 6.70 | 22.20 | 28.90 |
| B=10' | 75 | 12' | 9.8 | 27.0 | 9.80 | 27.00 | 36.80 |
| B=12' | 108 | 14' | 13.5 | 31.8 | 13.50 | 31.80 | 45.30 |
| B=16' | 192 | 16' | 19.0 | 41.4 | 19.00 | 41.40 | 60.40 |

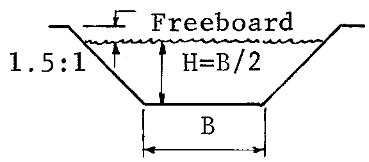



TABLE 7.4 Unit Cost for Earth Channels
@ $1.00 Per C. Y. for Excavation
1 Foot Min. Freeboard

| "B" Size | Area Sq. Ft. | Average Depth | Excavation C.Y./ Ft. | Total Cost/ Ft. |
|---|---|---|---|---|
| 4' | 28 | 4' | 1.5 | $1.50 |
| 6' | 31.5 | 6' | 3.3 | 3.30 |
| 8' | 56 | 8' | 5.9 | 5.90 |
| 10' | 87.5 | 10' | 9.3 | 9.30 |
| 12' | 126 | 12' | 13.3 | 13.30 |
| 16' | 224 | 14' | 18.2 | 18.20 |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-1 | | 1-Yr. | | | | | | |
| 115th Avenue | | | 170 | 2 | 72" Pipe | 3,000 | $48.00 | $144,000 |
| | | | 160 | 1.2-2 | 69" | 18,480 | 46.00 | 850,080 |
| | | | 130 | 1.2 | 66" | 2,640 | 42.00 | 110,880 |
| | | | 110 | 1.2 | 63" | 2,640 | 39.50 | 104,280 |
| | | | 100 | 1.2 | 60" | 2,640 | 36.50 | 96,360 |
| | | | 80 | 2.5 | 48" | 2,640 | 27.50 | 72,600 |
| | | | 50 | 2.5 | 42" | 2,640 | 23.50 | 62,040 |
| | | | 20 | 2.6 | 30" | 2,640 | 14.50 | 38,280 |
| | | | 55 | 2.5 | 42" | 2,640 | 23.50 | 62,040 |
| | | | 25 | 2.6 | 33" | 2,640 | 16.50 | 43,560 |
| | | | | | Subtotal | | | $1,584,120 |
| | | | | | Engineering & Contingencies | | | 316,780 |
| | | | | | Total | | | $1,900,900 |
| | | | | | Misc. Collectors & Laterals - 4½ Square Miles @ $160,000 | | | ($720,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-2 91st Avenue | | 1-Yr. | 275 | 3 | 81" Pipe | 4,700 | $57.50 | $270,250 |
| | | | 265 | 2-3 | 78" | 7,920 | 54.00 | 427,680 |
| | | | 225 | 2 | 75" | 2,640 | 52.00 | 137,280 |
| | | | 195 | 2 | 72" | 2,640 | 48.00 | 126,720 |
| | | | 155 | 2.65 | 63" | 2,640 | 39.50 | 104,280 |
| | | | 105 | 1.9 | 54" | 2,640 | 31.50 | 83,160 |
| | | | 40 | 1.9 | 39" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $1,204,810 |
| | | | | | Engineering & Contingencies | | | 240,990 |
| | | | | | Total | | | $1,445,800 |
| | | | | | Misc. Collectors & Laterals - 4½ Square Miles @ | | $200,000 | ($900,000) |
| I-3 83rd Avenue | | 1-Yr. | 240 | 2.5 | 81" Pipe | 600 | $57.50 | $34,500 |
| | | | 235 | 2.5 | 75" | 2,640 | 52.00 | 137,280 |
| | | | 230 | 1.7-3 | 72" | 10,560 | 48.00 | 506,880 |
| | | | 170 | 2.7 | 69" | 2,640 | 46.00 | 121,440 |
| | | | 140 | 2.7 | 60" | 2,640 | 36.50 | 96,360 |
| | | | 95 | 2.7 | 51" | 2,640 | 30.00 | 79,200 |
| | | | 40 | 3.7 | 39" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $1,031,100 |
| | | | | | Engineering & Contingencies | | | 206,200 |
| | | | | | Total | | | $1,237,300 |
| | | | | | Misc. Collectors & Laterals - 4½ Square Miles @ | | $200,000 | (900,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-4<br>75th Avenue | | 1-Yr. | 240 | 1.5 | 84" Pipe | 2,000 | $60.50 | $121,000 |
| | | | 230 | 1.5 | 81" | 2,640 | 57.50 | 151,800 |
| | | | 220 | 2.85 | 72" | 2,640 | 48.00 | 126,720 |
| | | | 210 | 2.3-2.85 | 69" | 5,280 | 46.00 | 242,880 |
| | | | 165 | 2.3 | 66" | 2,640 | 42.00 | 110,880 |
| | | | 140 | 2.3 | 60" | 5,280 | 36.50 | 192,720 |
| | | | 40 | 1.4 | 39" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $1,001,440 |
| | | | | | Engineering & Contingencies | | | 200,260 |
| | | | | | Total | | | $1,201,700 |
| | | | | | Misc. Collectors & Laterals -<br>4 Square Miles @ | | $200,000 | ($800,000) |
| I-5<br>67th Avenue | | 1-Yr. | 255 | 1.5-2 | 81" Pipe | 8,700 | $57.50 | $500,250 |
| | | | 210 | 2.85 | 69" | 2,640 | 46.00 | 121,440 |
| | | | 190 | 2.45 | 66" | 2,640 | 42.00 | 110,880 |
| | | | 155 | 2.45 | 63" | 2,640 | 39.50 | 104,280 |
| | | | 105 | 1.8 | 54" | 2,640 | 31.50 | 83,160 |
| | | | 40 | 1.8 | 42" | 2,640 | 23.50 | 62,040 |
| | | | | | Subtotal | | | $982,050 |
| | | | | | Engineering & Contingencies | | | 196,450 |
| | | | | | Total | | | $1,178,500 |
| | | | | | Misc. Collectors & Laterals -<br>4 Square Miles @ | | $200,000 | ($800,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-6 59th Avenue | | 1-Yr. | 260 | 2.1-2.7 | 78" Pipe | 2,000 | $54.00 | $108,000 |
| | | | 245 | 2.1 | 75" | 5,280 | 52.00 | 274,560 |
| | | | 210 | 2.1 | 72" | 2,640 | 48.00 | 126,720 |
| | | | 185 | 3 | 69" | 2,640 | 46.00 | 121,440 |
| | | | 145 | 3 | 60" | 2,640 | 36.50 | 96,360 |
| | | | 100 | 2 | 51" | 2,640 | 30.00 | 79,700 |
| | | | 40 | 2.3 | 39" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $862,220 |
| | | | | | Engineering & Contingencies | | | 172,480 |
| | | | | | Total | | | $1,034,700 |
| | | | | | Misc. Collectors & Laterals - 3 3/4 Square Miles @ $200,000 | | | ($750,000) |
| I-7 51st Avenue | | 1-Yr. | 250 | 2.4 | 75" Pipe | 800 | $58.00 | $46,400 |
| | | | 240 | 2.3-3.8 | 72" | 7,920 | 54.50 | 431,640 |
| | | | 190 | 3.4 | 63" | 2,640 | 45.00 | 118,800 |
| | | | 150 | 3.4 | 57" | 2,640 | 39.50 | 104,280 |
| | | | 95 | 2.3 | 48" | 2,640 | 32.00 | 84,480 |
| | | | 35 | 2.3 | 36" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $841,040 |
| | | | | | Engineering & Contingencies | | | 168,160 |
| | | | | | Total | | | $1,009,200 |
| | | | | | Misc. Collectors & Laterals - 3½ Square Miles @ $200,000 | | | ($700,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-8 43rd Avenue | | 1-Yr. | 175 | 3 | 78" Pipe | 3,500 | $61.00 | $213,500 |
| | | | 155 | 1.9 | 60" | 5,280 | 42.00 | 221,760 |
| | | | 105 | 1.9 | 57" | 2,640 | 39.50 | 104,280 |
| | | | 60 | 3 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 20 | 2.2 | 30" | 2,640 | 18.00 | 47,520 |
| | | | | | Subtotal | | | $660,980 |
| | | | | | Engineering & Contingencies | | | 132,220 |
| | | | | | Total | | | $793,200 |
| | | | | | Misc. Collectors & Laterals - 3¼ Square Miles @ $200,000 | | | ($650,000) |
| I-9 35th Avenue | | 1-Yr. | 135 | 3.8 | 54" Pipe | 5,280 | $42.00 | $221,760 |
| | | | 90 | 4 | 48" | 2,640 | 37.00 | 97,680 |
| | | | 55 | 2-4 | 39" | 3,960 | 29.00 | 114,840 |
| | | | 35 | 3.8 | 33" | 2,640 | 24.00 | 63,360 |
| | | | | | Subtotal | | | $497,640 |
| | | | | | Engineering & Contingencies | | | 99,560 |
| | | | | | Total | | | $597,200 |
| | | | | | Misc. Collectors & Laterals - 3½ Square Miles @ $140,000 | | | ($490,000) |

COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-10 | | 1-Yr. | | | | | | |
| 27th Avenue | | | 210 | 4.2 | 63" Pipe | 12,600 | $51.00 | $642,600 |
| | | | 175 | 3.6-4.2 | 60" | 5,280 | 47.50 | 250,800 |
| | | | 145 | 4.5 | 54" | 3,960 | 42.00 | 166,320 |
| | | | 90 | 4.2 | 48" | 2,640 | 37.00 | 97,680 |
| | | | 55 | 4.2 | 39" | 2,640 | 29.00 | 76,560 |
| | | | | | Subtotal | | | $1,233,960 |
| | | | | | Engineering & Contingencies | | | 246,840 |
| | | | | | Total | | | $1,480,800 |
| | | | | | Misc. Collectors & Laterals - 5 Square Miles @ $150,000 | | | ($750,000) |
| I-11 | | 1-Yr. | | | | | | |
| 40th Street | | | 190 | 1-2 | 81" Pipe | 2,800 | $71.50 | $200,000 |
| | | | 185 | 4.5 | 78" | 2,640 | 67.50 | 178,200 |
| | | | 180 | 3.8-4.5 | 60" | 10,560 | 47.50 | 501,600 |
| | | | 120 | 4.5 | 51" | 2,640 | 40.00 | 105,600 |
| | | | 65 | 7.6 | 39" | 2,640 | 29.00 | 76,560 |
| | | | 25 | 6.8 | 27" | 2,640 | 20.00 | 52,800 |
| | | | 20 | 8.5 | 24" | 2,640 | 18.00 | 47,520 |
| | | | | | Subtotal | | | $1,162,480 |
| | | | | | Engineering & Contingencies | | | 232,520 |
| | | | | | Total | | | $1,395,000 |
| | | | | | Misc. Collectors & Laterals - 3 Square Miles @ $160,000 | | | ($480,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-12 Melvin Street | | 1-Yr. | 100 | 8 | 42" Pipe | 1,320 | $32.50 | $42,900 |
| | | | | | Engineering & Contingencies | | | 8,600 |
| | | | | | Total | | | $51,500 |
| I-13 Roosevelt | | 1-Yr. | 160 | 3.3 | 60" Pipe | 2,100 | $47.50 | $99,750 |
| | | | 100 | 1 | 42" | 3,600 | 32.50 | 117,000 |
| | | | | | Subtotal | | | $216,750 |
| | | | | | Engineering & Contingencies | | | 43,350 |
| | | | | | Total | | | $260,100 |
| | | | | | Misc. Collectors & Laterals - | | | ($75,000) |
| I-14 McDowell | | 1-Yr. | 25 | 1.2 | 24" Pipe | 3,300 | $18.00 | $59,400 |
| | | | | | Engineering & Contingencies | | | 11,900 |
| | | | | | Total | | | $71,300 |
| I-15 Oak Street | | 1-Yr. | 45 | | 33" Pipe | 2,640 | $24.00 | $63,360 |
| | | | | | Engineering & Contingencies | | | 12,640 |
| | | | | | Total | | | $76,000 |

COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| I-16 Earll Drive | | 1-Yr. | 165 | 4.8 | 57" Pipe | 5,750 | $45.00 | $258,750 |
| | | | 115 | 6.2 | 48" | 1,600 | 37.00 | 59,200 |
| | | | 90 | 1.26 | 39" | 1,900 | 29.00 | 55,100 |
| | | | 90 | 1.76 | 36" | 2,500 | 25.50 | 63,750 |
| | | | 60 | 6.3 | 36" | 1,900 | 25.50 | 48,450 |
| | | | | | Subtotal | | | $485,250 |
| | | | | | Engineering & Contingencies | | | 97,050 |
| | | | | | Total | | | $582,300 |
| | | | | | Misc. Collectors & Laterals - 1½ Square Miles @ $140,000 | | | ($210,000) |
| I-17 Osborn Road | Street inlet to Old Cross-Cut | 1-Yr. | 25 | - | - | - | - | $3,000 |

<u>C O L L E C T O R   D E S I G N   A N D   C O S T S</u>

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| II-1 99th Avenue | | 1-Yr. | 100 | 1.5 | 60" Pipe | 1,000 | $36.50 | $36,500 |
| | | | 95 | 1.5 | 57" | 5,280 | 34.00 | 179,520 |
| | | | 80 | 1.5 | 54" | 2,640 | 31.50 | 83,160 |
| | | | 65 | 1.5 | 51" | 2,640 | 30.00 | 79,200 |
| | | | 40 | 2.1 | 39" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $433,820 |
| | | | | | Engineering & Contingencies | | | 86,780 |
| | | | | | Total | | | $520,600 |
| | | | | | Misc. Collectors & Laterals - 3¼ Square Miles @ $160,000 | | | ($520,000) |
| II-2 91st Avenue | | 1-Yr. | 120 | 2.3 | 60" Pipe | 1,000 | $36.50 | $36,500 |
| | | | 110 | 2.3 | 57" | 2,640 | 34.00 | 89,760 |
| | | | 100 | 1.5 | 54" | 5,280 | 31.50 | 166,320 |
| | | | 70 | 1.5 | 51" | 2,640 | 30.00 | 79,200 |
| | | | 40 | 2 | 39" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $427,220 |
| | | | | | Engineering & Contingencies | | | 85,480 |
| | | | | | Total | | | $512,700 |
| | | | | | Misc. Collectors & Laterals - 3¼ Square Miles @ $160,000 | | | ($520,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| II-3<br>83rd Avenue | | 1-Yr. | 120 | 3.4 | 54" Pipe | 1,000 | $37.00 | $37,000 |
| | | | 105 | 2-3.4 | 51" | 7,920 | 35.00 | 277,200 |
| | | | 55 | 2 | 45" | 2,640 | 30.00 | 79,200 |
| | | | 35 | 2 | 39" | 2,640 | 24.50 | 64,680 |
| | | | | | Subtotal | | | $458,080 |
| | | | | | Engineering & Contingencies | | | 91,620 |
| | | | | | Total | | | $549,700 |
| | | | | | Misc. Collectors & Laterals -<br>3¼ Square Miles @ $160,000 | | | ($520,000) |
| II-4<br>75th Avenue | | 1-Yr. | 50 | 3 | 42" Pipe | 1,000 | $28.00 | $28,000 |
| | | | 45 | 3 | 39" | 2,640 | 24.50 | 64,680 |
| | | | 40 | 3 | 36" | 5,280 | 21.00 | 110,880 |
| | | | 25 | 3 | 30" | 2,640 | 17.50 | 46,200 |
| | | | | | Subtotal | | | $249,760 |
| | | | | | Engineering & Contingencies | | | 49,940 |
| | | | | | Total | | | $299,700 |
| | | | | | Misc. Collectors & Laterals -<br>1½ Square Miles @ $140,000 | | | ($210,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| II-5 71st Avenue | | 1-Yr. | 140 | 3 | 66" Pipe | 1,000 | $54.00 | $54,000 |
| | | | 135 | 3 | 60" | 2,640 | 47.50 | 125,400 |
| | | | 130 | 2-3 | 57" | 15,840 | 45.00 | 712,800 |
| | | | 100 | 2 | 54" | 7,920 | 42.00 | 332,640 |
| | | | 55 | 3 | 45" | 2,640 | 35.00 | 92,400 |
| | | | | | Subtotal | | | $1,317,240 |
| | | | | | Engineering & Contingencies | | | 263,460 |
| | | | | | Total | | | $1,580,700 |
| | | | | | Misc. Collectors & Laterals - 3 Square Miles @ $140,000 | | | ($420,000) |
| II-6 67th Avenue | | 1-Yr. | 175 | 2.5-3.3 | 72" Pipe | 3,640 | $60.50 | $220,220 |
| | | | 170 | 3.3 | 63" | 2,640 | 51.00 | 134,640 |
| | | | 165 | 3.3 | 60" | 7,920 | 47.50 | 376,200 |
| | | | 145 | 2.8 | 57" | 5,280 | 45.00 | 237,600 |
| | | | 100 | 1.5 | 54" | 5,280 | 42.00 | 221,760 |
| | | | 50 | 1.5 | 45" | 2,640 | 35.00 | 92,400 |
| | | | 15 | 3.8 | 24" | 2,640 | 18.00 | 47,520 |
| | | | | | Subtotal | | | $1,330,340 |
| | | | | | Engineering & Contingencies | | | 266,060 |
| | | | | | Total | | | $1,596,400 |
| | | | | | Misc. Collectors & Laterals - 5½ Square Miles @ $170,000 | | | ($925,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| II-7<br>59th Avenue | | 1-Yr. | 410 | 3.2 | 96" Pipe | 1,000 | $90.50 | $90,500 |
| | | | 405 | 2.2 | 90" | 2,640 | 82.00 | 216,480 |
| | | | 400 | 4.2 | 84" | 2,640 | 74.50 | 196,680 |
| | | | 390 | 3.4-3.8 | 81" | 7,920 | 71.50 | 566,280 |
| | | | 330 | 3 | 78" | 2,640 | 67.50 | 178,200 |
| | | | 235 | 3 | 72" | 2,640 | 60.50 | 159,720 |
| | | | 145 | 2 | 60" | 2,640 | 47.50 | 125,400 |
| | | | 45 | 2 | 42" | 2,640 | 32.50 | 85,800 |
| Bethany Home Road Lateral | | | 45 | 2 | 42" | 2,640 | 32.50 | 85,800 |
| | | | | | Subtotal | | | $1,704,860 |
| | | | | | Engineering & Contingencies | | | 340,940 |
| | | | | | Total | | | $2,045,800 |
| | | | | | Misc. Collectors & Laterals - 4½ Square Miles @ $180,000 | | | ($810,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| II-8 51st Avenue | | 1-Yr. | 340 | 3 | 90" Pipe | 3,640 | $82.00 | $298,480 |
| | | | 330 | 2-2.6 | 84" | 5,280 | 74.50 | 393,360 |
| | | | 305 | 3.7 | 81" | 2,640 | 71.50 | 188,760 |
| | | | 300 | 3.7 | 75" | 2,640 | 64.50 | 170,280 |
| | | | 275 | 3.7 | 72" | 7,920 | 60.50 | 479,160 |
| | | | 175 | 3.8 | 60" | 2.640 | 47.50 | 125,400 |
| | | | 145 | 3.2 | 57" | 2,640 | 45.00 | 118,800 |
| | | | 75 | 3 | 48" | 2,640 | 37.00 | 97,680 |
| | | | 67 | 2.3-3 | 45" | 2,640 | 35.00 | 92,400 |
| | | | 55 | 3.2 | 42" | 2,640 | 32.50 | 85,800 |
| | | | | | Subtotal | | | $2,050,120 |
| | | | | | Engineering & Contingencies | | | 409,980 |
| | | | | | Total | | | $2,460,100 |
| | | | | | Misc. Collectors & Laterals - 7½ Square Miles @ $180,000 | | | ($1,350,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| II-9 | | 1-Yr. | | | | | | |
| 43rd Avenue | | | 290 | 3.6 | 84" Pipe | 3,640 | $74.50 | $271,180 |
| | | | 275 | 3.6-4.8 | 72" | 7,920 | 60.50 | 479,160 |
| | | | 260 | 3.6 | 69" | 7,920 | 57.50 | 455,400 |
| | | | 190 | 2.7-3.8 | 66" | 7,920 | 54.00 | 427,680 |
| | | | 165 | 3.8 | 60" | 2,640 | 47.50 | 125,400 |
| | | | 140 | 3.8 | 57" | 2,640 | 45.00 | 118,800 |
| | | | 85 | 3.0-3.2 | 48" | 5,280 | 37.00 | 195,360 |
| | | | 55 | 3.8 | 39" | 2,640 | 29.00 | 76,560 |
| | | | | | Subtotal | | | $2,149,540 |
| | | | | | Engineering & Contingencies | | | 429,860 |
| | | | | | Total | | | $2,579,400 |
| | | | | | Misc. Collectors & Laterals - 7 Square Miles @ | | $180,000 | ($1,260,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| III-1 | | 1-Yr. | | | | | | |
| Peoria - 67th Avenue | | | 115 | 3 | 57" Pipe | 5,280 | $39.50 | $208,560 |
| | | | 105 | 2.3 | 54" | 3,960 | 37.00 | 146,520 |
| | | | 65 | 2.3 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 35 | 3.4 | 36" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $484,440 |
| | | | | | Engineering & Contingencies | | | 96,860 |
| | | | | | Total | | | $581,300 |
| | | | | | Misc. Collectors & Laterals - 3 Square Miles @ $160,000 | | | ($480,000) |
| III-2 | | 1-Yr. | | | | | | |
| Olive - 67th Avenue | | | 85 | 4 | 48" Pipe | 2,640 | $32.00 | $84,480 |
| | | | 65 | 3.4 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 40 | 3 | 36" | 3,960 | 21.00 | 83,160 |
| | | | | | Subtotal | | | $241,560 |
| | | | | | Engineering & Contingencies | | | 48,340 |
| | | | | | Total | | | $289,900 |
| | | | | | Misc. Collectors & Laterals - 2 Square Miles @ $140,000 | | | ($280,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| III-3<br>75th Avenue | | 1-Yr. | 270 | 2 | 87" Pipe | 1,200 | $71.50 | $85,800 |
| | | | 265 | 2 | 78" | 5,280 | 61.00 | 322,080 |
| | | | 180 | 2 | 63" | 2,640 | 45.50 | 120,120 |
| | | | 145 | 2 | 57" | 2,640 | 40.00 | 105,600 |
| | | | 40 | 1.4-3.8 | 39" | 5,280 | 24.50 | 129,360 |
| | | | 20 | 3 | 27" | 5,280 | 16.50 | 87,120 |
| | | | | | Subtotal | | | $850,080 |
| | | | | | Engineering & Contingencies | | | 170.020 |
| | | | | | Total | | | $1,020,100 |
| | | | | | Misc. Collectors & Laterals - 3½ Square Miles @ $160,000 | | | ($560,000) |
| III-4<br>Cactus Road<br>Cactus Road | | 1-Yr. | 95 | 1-1.2 | 60" Pipe | 2,640 | $36.50 | $96,360 |
| | | | 20 | 3 | 30" | 3,960 | 14.50 | 57,420 |
| | | | 15 | 3 | 27" | 2,640 | 13.50 | 35,640 |
| | | | | | Subtotal | | | $189,420 |
| | | | | | Engineering & Contingencies | | | 37,880 |
| | | | | | Total | | | $227,300 |
| | | | | | Misc. Collectors & Laterals - 2 Square Miles @ $140,000 | | | ($280,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| III-5 Peoria Avenue | | 1-Yr. | 105 | 3 | 60" Pipe | 1,600 | $42.00 | $67,200 |
| | | | 55 | 3 | 45" | 1,600 | 30.00 | 48,000 |
| | | | 40 | 3.4 | 36" | 1,320 | 21.00 | 27,720 |
| | | | 20 | 3.4 | 27" | 1,320 | 16.50 | 21,780 |
| | | | | | Subtotal | | | $164,700 |
| | | | | | Engineering & Contingencies | | | 32,900 |
| | | | | | Total | | | $197,600 |
| | | | | | Misc. Collectors & Laterals - | | | ($120,000) |
| III-6 Olive Avenue | | 1-Yr. | 100 | 2.8 | 60" Pipe | 2,640 | $42.00 | $110,880 |
| | | | 90 | 2 | 57" | 2,640 | 40.00 | 105,600 |
| | | | 80 | 3 | 48" | 2,640 | 32.00 | 84,480 |
| | | | | | Subtotal | | | $300,960 |
| | | | | | Engineering & Contingencies | | | 60,240 |
| | | | | | Total | | | $361,200 |
| | | | | | Misc. Collectors & Laterals - 1½ Square Miles @ $160,000 | | | ($240,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| III-7 83rd Avenue | | 1-Yr. | 145 | 3 | 63" Pipe | 3,840 | $55.00 | $211,200 |
| | | | 140 | 3 | 60" | 2,640 | 43.00 | 113,520 |
| | | | 45 | 3 | 39" | 2,640 | 24.50 | 64,680 |
| Olive Avenue Lateral | | | 45 | 3 | 39" | 2,640 | 24.50 | 64,680 |
| | | | | | Subtotal | | | $454,080 |
| | | | | | Engineering & Contingencies | | | 90,820 |
| | | | | | Total | | | $544,900 |
| | | | | | Misc. Collectors & Laterals - 2 Square Miles @ $160,000 | | | ($320,000) |
| III-8 71st Avenue | | 1-Yr. | 55 | 1.5 | 51" Pipe | 1,200 | $30.00 | $36,000 |
| | | | 25 | 1.5 | 39" | 1,320 | 21.00 | 27,720 |
| | | | | | Subtotal | | | $63,720 |
| | | | | | Engineering & Contingencies | | | 12,780 |
| | | | | | Total | | | $76,500 |
| | | | | | Misc. Collectors & Laterals - | | | ($35,000) |
| III-9 59th Avenue | | 1-Yr. | 95 | 2.3 | 54" Pipe | 1,200 | $37.00 | $44,400 |
| | | | 70 | 3.6 | 48" | 5,280 | 32.50 | 171,600 |
| | | | 20 | 3.2 | 33" | 2,640 | 20.00 | 52,800 |
| | | | | | Subtotal | | | $268,800 |
| | | | | | Engineering & Contingencies | | | 53,800 |
| | | | | | Total | | | $322,600 |
| | | | | | Misc. Collectors & Laterals - 2 Square Miles @ $160,000 | | | ($320,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| III-10<br>51st Avenue | | 1-Yr. | 130 | 3 | 63" Pipe | 2,640 | $45.50 | $120,120 |
| | | | 55 | 3 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 45 | 3 | 39" | 2,640 | 24.50 | 64,680 |
| Olive Avenue Lateral | | | 85 | 3 | 48" | 2,640 | 32.00 | 84,480 |
| | | | 55 | 3 | 42" | 2,640 | 28.00 | 73,920 |
| | | | | | Subtotal | | | $417,120 |
| | | | | | Engineering & Contingencies | | | 83,380 |
| | | | | | Total | | | $500,500 |
| | | | | | Misc. Collector & Laterals - 1½ Square Miles @ $160,000 | | | ($240,000) |
| III-11<br>Northern Avenue | | 1-Yr. | 65 | 3.6 | 48" Pipe | 1,200 | $32.00 | $38,400 |
| | | | 55 | 4 | 39" | 2,640 | 24.50 | 64,680 |
| | | | 45 | 4 | 36" | 2,640 | 21.00 | 55,440 |
| | | | 30 | 3 | 33" | 2,640 | 20.00 | 52,800 |
| | | | 25 | 2.1 | 33" | 2,640 | 20.00 | 52,800 |
| | | | | | Subtotal | | | $264,120 |
| | | | | | Engineering & Contingencies | | | 52,780 |
| | | | | | Total | | | $316,900 |
| | | | | | Misc. Collectors & Laterals - 1½ Square Miles @ $140,000 | | | ($210,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| III-12 | | 1-Yr. | | | | | | |
| Grand Avenue | | | 100 | 2.5 | 63" Pipe | 2,500 | $51.00 | $127,500 |
| | | | 70 | 2.5 | 48" | 2,200 | 37.00 | 81,400 |
| | | | 40 | 3.2 | 36" | 2,000 | 25.50 | 51,000 |
| Orangewood Lateral | | | 50 | 3.0 | 42" | 1,500 | 32.50 | 48,750 |
| | | | 25 | 3.4 | 39" | 2,640 | 29.00 | 76,560 |
| | | | | | Subtotal | | | $385,210 |
| | | | | | Engineering & Contingencies | | | 77,090 |
| | | | | | Total | | | $462,300 |
| | | | | | Misc. Collectors & Laterals - 1½ Square Miles @ $140,000 | | | ($210,000) |
| III-13 Grand Avenue | | 1-Yr. | 35 | 1.5 | 39" Pipe | 3,000 | $29.00 | $87,000 |
| | | | | | Engineering & Contingencies | | | 17,400 |
| | | | | | Total | | | $104,400 |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| IV-1 Bell Road | | 1-Yr. | 175 | 3.2-3.8 | 63" Pipe | 13,600 | $39.50 | $537,200 |
| | | | 160 | 3.4 | 60" | 2,640 | 36.50 | 96,360 |
| | | | 155 | 3.4-4.9 | 54" | 7,920 | 31.50 | 249,480 |
| | | | 110 | 3.4 | 51" | 2,640 | 30.00 | 79,200 |
| | | | 75 | 4 | 42" | 4,500 | 23.50 | 105,750 |
| | | | | | Subtotal | | | $1,067,990 |
| | | | | | Engineering & Contingencies | | | 213,610 |
| | | | | | Total | | | $1,281,600 |
| | | | | | Misc. Collectors & Laterals - 7 Square Miles @ $160,000 | | | ($1,120,000) |
| IV-2 Greenway Road | | 1-Yr. | 145 | 3 | 60" Pipe | 4,600 | $36.50 | $167,900 |
| | | | 140 | 3.2 | 57" | 5,280 | 34.00 | 179,520 |
| | | | 130 | 4.4 | 54" | 7,920 | 31.50 | 250,425 |
| | | | 110 | 3.4 | 51" | 2,640 | 30.00 | 79,200 |
| | | | 95 | 3.4 | 48" | 2,640 | 27.50 | 72,600 |
| | | | 75 | 3.4 | 45" | 2,640 | 26.00 | 68,640 |
| | | | 60 | 4 | 42" | 4,000 | 23.50 | 94,000 |
| | | | | | Subtotal | | | $912,285 |
| | | | | | Engineering & Contingencies | | | 182,415 |
| | | | | | Total | | | $1,094,700 |
| | | | | | Misc. Collectors & Laterals - 6 Square Miles @ $160,000 | | | ($960,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| IV-3 Thunderbird Road | | 1-Yr. | | | | | | |
| | | | 115 | 3.2 | 54" | 3,500 | $31.50 | $110,250 |
| | | | 110 | 3-4 | 51" | 7,920 | 30.00 | 237,600 |
| | | | 85 | 3 | 48" | 2,640 | 27.50 | 72,600 |
| | | | 70 | 4 | 42" | 2,640 | 23.50 | 62,040 |
| | | | 50 | 4 | 39" | 2,640 | 21.00 | 55,440 |
| | | | 20 | 3 | 30" | 4,000 | 14.50 | 58,000 |
| | | | | | Subtotal | | | $595,930 |
| | | | | | Engineering & Contingencies | | | 119,170 |
| | | | | | Total | | | $715,100 |
| | | | | | Misc. Collectors & Laterals - 4¼ Square Miles @ $160,000 | | | ($680,000) |
| IV-4 Cactus Road | | 1-Yr. | | | | | | |
| | | | 140 | 2.7-4 | 57" Pipe | 7,920 | $34.00 | $269,280 |
| | | | 100 | 4 | 51" | 2,640 | 30.00 | 79,200 |
| | | | 55 | 3.4 | 39" | 2,640 | 21.00 | 55,440 |
| | | | 30 | | 33" | 1,320 | 16.50 | 21,780 |
| | | | 15 | | 27" | 1,320 | 13.50 | 17,820 |
| | | | | | Subtotal | | | $443,520 |
| | | | | | Engineering & Contingencies | | | 88,680 |
| | | | | | Total | | | $532,200 |
| | | | | | Misc. Collectors & Laterals - 3 Square Miles @ $160,000 | | | ($480,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| IV-5 Peoria Avenue | | 1-Yr. | 100 | 2.8 | 51" Pipe | 2,640 | $35.00 | $92,400 |
| | | | 75 | 2.6 | 48" | 2,640 | 32.00 | 84,480 |
| | | | 45 | 2.1 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 25 | | 33" | 1,320 | 20.00 | 26,400 |
| | | | 15 | | 27" | 1,320 | 16.50 | 21,780 |
| | | | | | Subtotal | | | $298,980 |
| | | | | | Engineering & Contingencies | | | 59,820 |
| | | | | | Total | | | $358,800 |
| | | | | | Misc. Collectors & Laterals - 2 Square Miles @ $160,000 | | | ($320,000) |
| IV-6 Bell Road | | 1-Yr. | 95 | 4.5 | 57" Pipe | 5,400 | $40.00 | $216,000 |
| | | | 90 | 4-6 | 45" | 11,200 | 28.00 | 313,600 |
| | | | 40 | 5 | 36" | 2,800 | 17.50 | 49,000 |
| | | | | | Subtotal | | | $578,600 |
| | | | | | Engineering & Contingencies | | | 115,700 |
| | | | | | Total | | | $694,300 |
| | | | | | Misc. Collectors & Laterals - 4 Square Miles @ $160,000 | | | ($480,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| IV-7 Greenway | | 1-Yr. | | | | | | |
| | | | 280 | 2.3 | 81" Pipe | 3,000 | $57.50 | $172,500 |
| | | | 270 | 2.3-5 | 69" Pipe | 18,400 | 46.00 | 846,400 |
| | | | 170 | 2.1 | 66" | 1,320 | 42.00 | 55,440 |
| | | | | | Subtotal | | | $1,074,340 |
| | | | | | Engineering & Contingencies | | | 214,860 |
| | | | | | Total | | | $1,289,200 |
| | | | | | Misc. Collectors & Laterals - 4½ Square Miles @ $160,000 | | | ($560,000) |
| IV-8 Thunderbird | | 1-Yr. | 320 | 3.8 | 75" Pipe | 1,320 | $58.00 | $76,560 |
| | | | 315 | 7 | 60" | 2,640 | 42.00 | 110,880 |
| | | | 310 | 2.3 | 81" | 1,320 | 57.50 | 75,900 |
| | | | 305 | 7 | 66" | 2,640 | 42.00 | 110,880 |
| | | | 200 | 2.4 | 69" | 1,320 | 46.00 | 60,720 |
| | | | 70 | 2.4 | 48" | 1,320 | 27.50 | 36,300 |
| | | | 100 | 7.5 | 45" | 1,320 | 26.00 | 34,320 |
| | | | | | Subtotal | | | $505,560 |
| | | | | | Engineering & Contingencies | | | 101,140 |
| | | | | | Total | | | $606,700 |
| | | | | | Misc. Collectors & Laterals | | | ($160,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| IV-9 19th Avenue | | 1-Yr. | 325 | 6.4 | 90" Pipe | 1,320 | $75.00 | $99,000 |
| | | | 315 | 6.4 | 69" | 2,640 | 51.50 | 135,960 |
| | | | 185 | 6.4 | 57" | 2,640 | 40.00 | 105,600 |
| | | | 60 | 5.3 | 39" | 2,640 | 24.50 | 64,680 |
| | | | | | Subtotal | | | $405,240 |
| | | | | | Engineering & Contingencies | | | 81,060 |
| | | | | | Total | | | $486,300 |
| | | | | | Misc. Collectors & Laterals - 4 Square Miles @ $160,000 | | | ($480,000) |
| IV-10 7th Avenue | | 1-Yr. | 260 | 12.5 | 66" Pipe | 1,320 | $54.00 | $71,280 |
| | | | 240 | 12.5 | 54" | 1,320 | 42.00 | 55,440 |
| | | | 160 | 15.2 | 45" | 2,640 | 35.00 | 92,400 |
| | | | | | Subtotal | | | $219,120 |
| | | | | | Engineering & Contingencies | | | 43,780 |
| | | | | | Total | | | $262,900 |
| | | | | | Misc. Collectors & Laterals - 1 1/2 Square Miles @ $140,000 | | | ($210,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-2 McDowell Road | | 5-Yr. | 105 | 8.8 | 42" Pipe | 4,100 | $32.50 | $133,250 |
| | | | | | Engineering & Contingencies | | | 26,650 |
| | | | | | Total | | | $159,900 |
| | | | | | Misc. Collectors & Laterals | | | ($35,000) |
| V-3 Oak Street | | 1-Yr. | 35 | 7.6 | 30" | 3,000 | $21.50 | $64,500 |
| | | | | | Engineering & Contingencies | | | 12,900 |
| | | | | | Total | | | $77,400 |
| V-5 Earll Drive | | 1-Yr. | 85 | 3.4 | 48" Pipe | 4,700 | $37.00 | $173,900 |
| | | | 55 | 1.9-3.8 | 45" Pipe | 4,240 | 35.00 | 148,400 |
| | | | | | Subtotal | | | $322,300 |
| | | | | | Engineering & Contingencies | | | 64,500 |
| | | | | | Total | | | $386,800 |
| | | | | | Misc. Collectors & Laterals | | | ($75,000) |
| V-7 2nd Street | | 1-Yr. | 60 | 4.5 | 39" Pipe | 2,640 | $24.50 | $64,680 |
| | | | 45 | 3.4 | 36" | 4,440 | 21.00 | 93,240 |
| Scottsdale Road Lateral | | | 20 | 7.6 | 24" | 1,320 | 15.00 | 19,800 |
| | | | | | Subtotal | | | $177,720 |
| | | | | | Engineering & Contingencies | | | 35,580 |
| | | | | | Total | | | $213,300 |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-9 Camelback Road | | 10-Yr. | 470 | 5.3 | 84" Pipe | 5,280 | $68.00 | $359,040 |
| | | | 310 | 7.2 | 66" | 5,280 | 48.00 | 253,440 |
| | | | | | Subtotal | | | $612,480 |
| | | | | | Engineering & Contingencies | | | 122,520 |
| | | | | | Total | | | $735,000 |
| | | | | | Misc. Collectors & Laterals | | | ($80,000) |
| V-10 Chaparral | | 10-Yr. | 690 | 7.2 | 90" Pipe | 5,280 | $75.00 | $396,000 |
| | | | 420 | 9.1 | 72" | 6,000 | 54.50 | 327,000 |
| | | | | | Subtotal | | | $723,000 |
| | | | | | Engineering & Contingencies | | | 144,600 |
| | | | | | Total | | | $867,600 |
| | | | | | Misc. Collectors & Laterals | | | ($110,000) |
| V-11 McDonald Drive | | 1-Yr. | 115 | 6.7 | 48" Pipe | 5,280 | $27.50 | $145,200 |
| | | | 115 | 11.8 | 42" | 5,280 | 23.50 | 124,080 |
| | | | | | Subtotal | | | $269,280 |
| | | | | | Engineering & Contingencies | | | 53,820 |
| | | | | | Total | | | $323,100 |
| | | | | | Misc. Collectors & Laterals | | | ($70,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-12 | | 1-Yr. | | | | | | |
| Cactus Wren Drive | | | 150 | 6.5 | 54" Pipe | 3,400 | $37.00 | $125,800 |
| | | | 130 | 7.1 | 48" | 5,500 | 32.00 | 176,000 |
| | | | | | Subtotal | | | $301,800 |
| | | | | | Engineering & Contingencies | | | 60,400 |
| | | | | | Total | | | $362,200 |
| | | | | | Misc. Collectors & Laterals | | | ($75,000) |
| V-13 | | 25-Yr. | | | | | | |
| Hummingbird Lane | 8' Bottom Width, Lined | | 450 | 2 | Channel | 900 | $28.90 | $26,010 |
| | | | | | Engineering & Contingencies | | | 5,290 |
| | | | | | Total | | | $31,300 |
| V-14 | | 1-Yr. | | | | | | |
| Stallion Drive | | | 110 | 7.5 | 45" Pipe | 4,000 | $26.00 | $104,000 |
| | | | | | Engineering & Contingencies | | | 20,800 |
| | | | | | Total | | | $124,800 |
| V-15 | | 1-Yr. | | | | | | |
| Northern Avenue | | | 75 | 6.25 | 39" Pipe | 4,000 | 21.00 | $84,000 |
| | | | | | Engineering & Contingencies | | | 16,800 |
| | | | | | Total | | | $100,800 |
| V-16 | | 1-Yr. | | | | | | |
| Mockingbird Lane | | | 140 | 3.6 | 57" Pipe | 3,300 | 40.00 | $132,000 |
| | | | | | Engineering & Contingencies | | | 26,400 |
| | | | | | Total | | | $158,400 |
| | | | | | Misc. Collectors & Laterals | | | ($35,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-17 Mockingbird Lane | 8' Bottom width, lined | 25-Yr. | 650 | 4.5 | Channel | 1,500 | $28.90 | $43,350 |
| | 8' Bottom width, lined | | 650 | 10.0 | | 600 | 28.90 | 17,340 |
| | | | | | Subtotal | | | $60,690 |
| | | | | | Engineering & Contingencies | | | 12,110 |
| | | | | | Total | | | $72,800 |
| V-18 Double Tree | | 1-Yr. | 130 | 5.7 | 51" Pipe | 5,280 | $30.00 | $158,400 |
| | | | 130 | 10 | 45" | 2,640 | 26.00 | 68,640 |
| 52nd Street Lateral | | | | 10 | 36" | 1,320 | 17.50 | 23,100 |
| | | | | | Subtotal | | | $250,140 |
| | | | | | Engineering & Contingencies | | | 50,060 |
| | | | | | Total | | | $300,200 |
| V-19 Mountain View Road | | 1-Yr. | 90 | 10.0 | 39" Pipe | 3,960 | $21.00 | $83,160 |
| | | | 90 | 15.2 | 36" | 2,640 | 17.50 | 46,200 |
| | | | | | Subtotal | | | $129,360 |
| | | | | | Engineering & Contingencies | | | 25,840 |
| | | | | | Total | | | $155,200 |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-20 | | 1-Yr. | | | | | | |
| Shea Blvd. | | | 80 | 7 | 48" Pipe | 3,700 | $27.50 | $101,750 |
| | | | 75 | 3.1 | 45" | 5,280 | 26.00 | 137,280 |
| | | | 35 | 6.6 | 30" | 3,500 | 14.50 | 50,750 |
| | 8' Bottom width, lined | 25-Yr. | 1207 | 14.3 | Channel - 4'x8' | 5,600 | 28.90 | 161,840 |
| | 10' Bottom width, lined | | 1207 | 7.1 | Channel - 5'x10' | 4,800 | 36.80 | 176,640 |
| | | | | | Subtotal | | | $628,260 |
| | | | | | Engineering & Contingencies | | | 125,640 |
| | | | | | Total | | | $753,900 |
| | | | | | Misc. Collectors & Laterals | | | ($240,000) |
| V-21 Cactus Road | | 1-Yr. | 140 | 4.6 | 54" Pipe | 2,640 | $31.50 | $83,160 |
| | | | 90 | 4.6 | 48" | 2,640 | 27.50 | 72,600 |
| | | | 75 | 5.3 | 42" | 2,640 | 23.50 | 62,040 |
| | | | 50 | 4.9 | 36" | 2,640 | 17.50 | 46,200 |
| | | | | | Subtotal | | | $264,000 |
| | | | | | Engineering & Contingencies | | | 52,800 |
| | | | | | Total | | | $316,800 |
| | | | | | Misc. Collectors & Laterals | | | ($105,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-22<br>32nd Street | | 1-Yr. | 65 | 2.7 | 45" Pipe | 2,640 | $26.00 | $68,640 |
| | | | 45 | 4.9 | 36" | 2,640 | 17.50 | 46,200 |
| | | | 30 | 4.6 | 30" | 2,640 | 14.50 | 38,280 |
| | | | 15 | 4.6 | 24" | 2,640 | 12.00 | 31,680 |
| | | | | | Subtotal | | | $184,800 |
| | | | | | Engineering & Contingencies | | | 37,000 |
| | | | | | Total | | | $221,800 |
| | | | | | Misc. Collectors & Laterals | | | ($240,000) |
| V-23<br>40th Street | | 1-Yr. | 95 | 4.6 | 48" Pipe | 5,280 | $27.50 | $145,200 |
| | | | 85 | 5.1-6.4 | 45" | 5,280 | 26.00 | 137,280 |
| | | | 80 | 5.1 | 42" | 5,280 | 23.50 | 124,080 |
| | | | 40 | 7 | 30" | 2,640 | 14.50 | 38,280 |
| | | | | | Subtotal | | | $444,840 |
| | | | | | Engineering & Contingencies | | | 88,960 |
| | | | | | Total | | | $533,800 |
| | | | | | Misc. Collectors & Laterals | | | ($560,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-24 Tatum Blvd. | | 1-Yr. | | | | | | |
| | | | 80 | 4.2 | 45" Pipe | 2,640 | $26.00 | $68,640 |
| | | | 75 | 5.5 | 42" | 5,280 | 23.50 | 124,080 |
| | | | 65 | 6 | 39" | 2,640 | 21.00 | 55,440 |
| | | | 55 | 6 | 36" | 2,640 | 17.50 | 46,200 |
| | | | 45 | 6.8 | 33" | 2,640 | 16.50 | 43,560 |
| | | | 30 | 6.8 | 27" | 2,640 | 13.50 | 35,640 |
| | | | | | Subtotal | | | $373,560 |
| | | | | | Engineering & Contingencies | | | 74,740 |
| | | | | | Total | | | $448,300 |
| | | | | | Misc. Collectors & Laterals | | | ($560,000) |
| V-25 56th Street | | 1-Yr. | | | | | | |
| | | | 85 | 5 | 45" Pipe | 10,560 | $26.00 | $274,560 |
| | | | 70 | 5.5 | 42" | 2,640 | 23.50 | 62,040 |
| | | | 65 | 6.8 | 39" | 2,640 | 21.00 | 55,440 |
| | | | 55 | 6.8 | 36" | 2,640 | 17.50 | 46,200 |
| | | | 40 | 7.5 | 30" | 2,640 | 14.50 | 38,280 |
| | | | | | Subtotal | | | $476,520 |
| | | | | | Engineering & Contingencies | | | 95,280 |
| | | | | | Total | | | $571,800 |
| | | | | | Misc. Collectors & Laterals | | | ($630,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-26<br>Invergordon Road - Scottsdale | | 1-Yr. | 200 | 5.3 | 60" Pipe | 5,280 | $42.00 | $221,760 |
| | | | 80 | 3.4-3.8 | 48" | 10,560 | 32.00 | 337,920 |
| | | | 70 | 7.2 | 39" | 5,280 | 21.00 | 110,880 |
| | | | 45 | 7.2 | 33" | 5,280 | 16.50 | 87,120 |
| | | | 160 | 3 | 57" | 5,280 | 40.00 | 211,200 |
| | | | 150 | 6.6 | 51" | 5,280 | 35.00 | 184,800 |
| | | | 130 | 7.4 | 48" | 5,280 | 32.00 | 168,960 |
| | | | 50 | 8 | 33" | 5,280 | 16.50 | 87,120 |
| | | | 30 | 0.7 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 20 | 1.1 | 27" | 5,280 | 13.50 | 71,280 |
| | | | | | Subtotal | | | $1,554,960 |
| | | | | | Engineering & Contingencies | | | 310,940 |
| | Both east & west branches | | | | Total | | | $1,865,900 |
| | East branch only | | | | Total | | | $1,027,000 |
| | | | | | Misc. Collectors & Laterals - 9 Square Miles @ | | $140,000 | ($1,260,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-28 Hayden Road | | 1-Yr. | | | | | | |
| | | | 140 | 1.9 | 63" Pipe | 7,280 | $39.50 | $287,560 |
| | | | 130 | 4.2 | 54" | 5,280 | 31.50 | 166,320 |
| | | | 125 | 4.9 | 51" | 5,280 | 30.00 | 158,400 |
| | | | 125 | 6.2 | 48" | 5,280 | 27.50 | 145,200 |
| | | | 100 | 8.5 | 42" | 5,280 | 23.50 | 124,080 |
| | | | 65 | 8.9 | 36" | 2,640 | 17.50 | 46,200 |
| | | | 20 | 8.9 | 24" | 2,640 | 12.00 | 31,680 |
| | | | | | Subtotal | | | $959,440 |
| | | | | | Engineering & Contingencies | | | 191,860 |
| | | | | | Total | | | $1,151,300 |
| | | | | | Misc. Collectors & Laterals - 6 Square Miles @ $140,000 | | | ($840,000) |
| V-29 Pima Road | | 1-Yr. | | | | | | |
| | | | 210 | 3 | 69" Pipe | 9,000 | $46.00 | $414,000 |
| | | | 200 | 3 | 66" | 2,640 | 42.00 | 110,880 |
| | | | 200 | 4.9 | 60" | 5,280 | 36.50 | 192,720 |
| | | | 190 | 5.3 | 57" | 5,280 | 34.00 | 179,520 |
| | | | 165 | 6.4-7.2 | 54" | 7,960 | 31.50 | 250,740 |
| | | | 125 | 8 | 48" | 2,640 | 27.50 | 72,600 |
| | | | 75 | 9.1 | 39" | 2,640 | 21.00 | 55,440 |
| | | | 15 | | 21" | 2,640 | 11.50 | 30,360 |
| | | | | | Subtotal | | | $1,306,260 |
| | | | | | Engineering & Contingencies | | | 261,240 |
| | | | | | Total | | | $1,567,500 |
| | | | | | Misc. Collectors & Laterals 6½ Square Miles @ $140,000 | | | ($910,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-30 Dobson Road - Alma School Road | | 1-Yr. | 220 | 2.3 | 72" Pipe | 7,920 | $48.00 | $380,160 |
| | | | 95 | 4.5 | 48" | 5,280 | 27.50 | 145,200 |
| | | | 90 | 4.9 | 45" | 10,560 | 26.00 | 274,560 |
| | | | 70 | 6.0 | 39" | 5,280 | 21.00 | 110,880 |
| | | | 40 | 7.8 | 30" | 5,280 | 14.50 | 76,560 |
| | | | 170 | 2 | 66" | 5,280 | 42.00 | 221,760 |
| | | | 150 | 6.5 | 54" | 5,280 | 31.50 | 166,320 |
| | | | 125 | 4.9 | 51" | 5,280 | 30.00 | 158,400 |
| | | | 90 | 4.2 | 48" | 5,280 | 27.50 | 145,200 |
| | | | 25 | 9,5 | 27" | 5,280 | 13.50 | 71,280 |
| | | | 15 | 5.1 | 24" | 5,280 | 12.00 | 63,360 |
| | | | 50 | 5.6 | 36" | 5,280 | 17.50 | 92,400 |
| | | | 25 | 7.5 | 27" | 5,280 | 13.50 | 71,280 |
| | | | 65 | 6.2 | 39" | 5,280 | 21.00 | 110,880 |
| | | | 35 | 4.9 | 27" | 5,280 | 13.50 | 71,280 |
| | | | 25 | | 30" | 5,280 | 14.50 | 76,560 |
| | | | | | Subtotal | | | $2,236,080 |
| | | | | | Engineering & Contingencies | | | 447,220 |
| | | | | | Total | | | $2,683,300 |
| | | | | | Misc. Collectors & Laterals - 8 Square Miles (Indian Reservation Area not included) | | | ($1,120,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-31 | | 1-Yr. | | | | | | |
| McDonald Drive | | | 25 | 1.6 | 36" Pipe | 3,800 | $17.50 | $66,500 |
| | | | 10 | 2 | 24" | 1,600 | 12.00 | 19,200 |
| | | | | | Subtotal | | | $85,700 |
| | | | | | Engineering & Contingencies | | | 17,100 |
| | | | | | Total | | | $102,800 |
| | | | | | Misc. Collectors & Laterals | | | ($35,000) |
| V-32 | | 1-Yr. | | | | | | |
| Chaparral Road | | | 40 | 1.5 | 39" Pipe | 4,000 | $21.00 | $84,000 |
| | | | 10 | | 24" | 1,600 | 12.00 | 19,200 |
| | | | | | Subtotal | | | $103,200 |
| | | | | | Engineering & Contingencies | | | 20,600 |
| | | | | | Total | | | $123,800 |
| | | | | | Misc. Collectors & Laterals | | | ($70,000) |
| V-33 | | 1-Yr. | | | | | | |
| Indian School Road | | | 30 | 1.3 | 39" Pipe | 4,000 | $24.50 | $98,000 |
| | | | 10 | | 24" | 1,600 | 15.00 | 24,000 |
| | | | | | Subtotal | | | $122,000 |
| | | | | | Engineering & Contingencies | | | 24,400 |
| | | | | | Total | | | $146,400 |
| | | | | | Misc. Collectors & Laterals | | | ($70,000) |

COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| V-34 | | 1-Yr. | 80 | 1.2 | 54" Pipe | 4,000 | $31.50 | $126,000 |
| | | | 65 | 2.2 | 48" | 4,000 | 27.50 | 110,000 |
| | | | 35 | 3.3 | 36" | 6,000 | 17.50 | 105,000 |
| | | | 25 | 2 | 33" | 1,000 | 16.50 | 16,500 |
| | | | | | Subtotal | | | $357,500 |
| | | | | | Engineering & Contingencies | | | 71,500 |
| | | | | | Total | | | $429,000 |
| | | | | | Misc. Collectors & Laterals | | | ($140,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-1 Western Canal | | 1-Yr. | 50 | | 48" Pipe | 2,640 | $27.50 | $72,600 |
| | | | 45 | 8 | 33" | 2,640 | 16.50 | 43,560 |
| | | | 40 | 10 | 30" | 2,640 | 14.50 | 38,280 |
| | | | 35 | 7 | 27" | 5,280 | 13.50 | 71,280 |
| | | | | | Subtotal | | | $225,720 |
| | | | | | Engineering & Contingencies | | | 45,180 |
| | | | | | Total | | | $270,900 |
| VI-2 Dobbins Road | | 1-Yr. | 230 | 1.5 | 84" Pipe | 6,700 | $68.00 | $455,600 |
| | | | 195 | 1.9 | 72" | 2,640 | 54.50 | 143,880 |
| | | | 150 | 3.8 | 63" | 2,640 | 50.50 | 133,320 |
| | | | 75 | 15. | 45" | 2,640 | 30.00 | 79,200 |
| | | | | | Subtotal | | | $812,000 |
| | | | | | Engineering & Contingencies | | | 162,400 |
| | | | | | Total | | | $974,400 |
| | | | | | Misc. Collectors & Laterals - 3 Square Miles @ $140,000 | | | ($420,000) |

## COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-3 Southern Avenue | | 1-Yr. | 130 | 3 | 63" Pipe | 8,000 | $50.00 | $404,000 |
| | | | 110 | 3.4 | 54" | 2,000 | 37.00 | 74,000 |
| | | | 80 | 4.5 | 45" | 2,640 | 30.00 | 79,200 |
| | | | 50 | 4.5 | 36" | 2,640 | 21.00 | 55,440 |
| | | | | | Subtotal | | | $612,640 |
| | | | | | Engineering & Contingencies | | | 122,560 |
| | | | | | Total | | | $735,200 |
| | | | | | Misc. Collectors & Laterals - 2½ Square Miles @ $140,000 | | | ($350,000) |
| VI-4 43rd Avenue | | 1-Yr. | 135 | | 57" Pipe | 2,640 | $40.00 | $105,600 |
| | | | 100 | | 51" | 2,640 | 35.00 | 92,400 |
| | | | 30 | 5 | 30" | 2,640 | 14.50 | 38,280 |
| | | | | | Subtotal | | | $236,280 |
| | | | | | Engineering & Contingencies | | | 47,220 |
| | | | | | Total | | | $283,500 |
| | | | | | Misc. Collectors & Laterals | | | ($105,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-5 35th Avenue | | 1-Yr. | 70 | | 42" Pipe | 2,640 | $28.00 | $73,920 |
| | | | 25 | 6 | 30" | 2,640 | 14.50 | 38,280 |
| | | | | | Subtotal | | | $112,200 |
| | | | | | Engineering & Contingencies | | | 22,400 |
| | | | | | Total | | | $134,600 |
| | | | | | Misc. Collectors & Laterals | | | ($105,000) |
| VI-6 Baseline | | 1-Yr. | 340 | 1.1 | 96" Pipe | 5,280 | 83.50 | $440,880 |
| | | | 330 | 1.5 | 90" | 5,280 | 75.00 | 396,000 |
| | | | 325 | 1.7 | 87" | 5,280 | 71.50 | 377,520 |
| | | | 195 | 4.7 | 60" | 5,280 | 42.00 | 221,760 |
| | | | 110 | 4.9 | 48" | 5,280 | 32.00 | 168,960 |
| | | | 25 | 5 | 30" | 2,640 | 17.50 | 92,400 |
| | | | | | Subtotal | | | $1,697,520 |
| | | | | | Engineering & Contingencies | | | 339,480 |
| | | | | | Total | | | $2,037,000 |
| | | | | | Misc. Collectors & Laterals 3½ Square Miles @ $160,000 | | | ($560,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-7<br>27th Avenue | | 1-Yr. | 130 | 3 | 60" Pipe | 800 | $42.00 | $33,600 |
| | | | 115 | 3.5 | 57" | 2,640 | 40.00 | 105,600 |
| | | | 105 | 4 | 51" | 2,640 | 35.00 | 92,400 |
| | | | 85 | 4.5 | 45" | 2,640 | 30.00 | 79,200 |
| | | | 65 | 5 | 42" | 2,640 | 28.00 | 73,900 |
| | | | 40 | 5 | 33" | 2,800 | 20.00 | 56,000 |
| | | | | | Subtotal | | | $440,700 |
| | | | | | Engineering & Contingencies | | | 88,100 |
| | | | | | Total | | | $528,800 |
| | | | | | Misc. Collectors & Laterals | | | ($350,000) |
| VI-8<br>19th Avenue | | 1-Yr. | 175 | 4 | 57" Pipe | 2,640 | $40.00 | $105,600 |
| | | | 135 | 5 | 51" | 2,640 | 35.00 | 92,400 |
| | | | 80 | 7 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 25 | 6 | 27" | 2,800 | 17.00 | 47,600 |
| | | | | | Subtotal | | | $319,520 |
| | | | | | Engineering & Contingencies | | | 63,880 |
| | | | | | Total | | | $383,400 |
| | | | | | Misc. Collectors & Laterals | | | ($210,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-9<br>7th Avenue | | 1-Yr. | 100 | | 45" Pipe | 2,640 | $30.00 | $79,200 |
| | | | 60 | 11 | 33" | 2,640 | 20.00 | 52,800 |
| | | | | | Subtotal | | | $132,000 |
| | | | | | Engineering & Contingencies | | | 26,400 |
| | | | | | Total | | | $158,400 |
| | | | | | Misc. Collectors & Laterals | | | ($140,000) |
| VI-10<br>Riverside Street | | 1-Yr. | 35 | 2.5 | 36" Pipe | 1,320 | $17.50 | $23,100 |
| | | | 30 | 2.3 | 33" | 1,320 | 16.50 | 21,780 |
| | | | 15 | 2.3 | 27" | 1,320 | 13.50 | 17,820 |
| | | | | | Subtotal | | | $62,700 |
| | | | | | Engineering & Contingencies | | | 12,500 |
| | | | | | Total | | | $75,200 |
| VI-11<br>Broadway - 20th Street | | 1-Yr. | 155 | 7 | 63" Pipe | 2,640 | $45.00 | $118,800 |
| | | | 135 | 6 | 60" | 3,960 | 42.00 | 166,320 |
| | | | 120 | 5 | 57" | 2,640 | 40.00 | 105,600 |
| | | | 110 | 8 | 48" | 3,960 | 32.00 | 126,720 |
| | | | 50 | 9 | 33" | 2,640 | 20.00 | 52,800 |
| | | | | | Subtotal | | | $570,240 |
| | | | | | Engineering & Contingencies | | | 114,060 |
| | | | | | Total | | | $684,300 |
| | | | | | Misc. Collectors & Laterals - 2½ Square Miles @ $140,000 | | | ($350,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-12<br>7th Street | | 1-Yr. | 175 | 2 | 69" Pipe | 3,500 | $57.50 | $201,250 |
| | | | 105 | 7 | 45" | 2,640 | 35.00 | 92,400 |
| | | | 95 | 6 | 42" | 2,640 | 28.00 | 73,920 |
| | | | 40 | 8 | 33" | 2,640 | 20.00 | 52,800 |
| | | | | | Subtotal | | | $420,370 |
| | | | | | Engineering & Contingencies | | | 84,030 |
| | | | | | Total | | | $504,400 |
| | | | | | Misc. Collectors & Laterals - 1½ Square Miles @ $140,000 | | | ($210,000) |
| VI-13<br>Broadway Road | | 1-Yr. | 280 | 3 | 81" Pipe | 4,400 | $65.00 | $286,000 |
| | | | 135 | 3 | 63" | 2,640 | 45.00 | 118,800 |
| | | | 70 | 3 | 48" | 1,320 | 32.00 | 42,240 |
| | | | 50 | 3 | 42" | 1,320 | 28.00 | 36,960 |
| | | | | | Subtotal | | | $484,000 |
| | | | | | Engineering & Contingencies | | | 96,800 |
| | | | | | Total | | | $580,800 |
| | | | | | Misc. Collectors & Laterals - 1½ Square Miles @ $140,000 | | | ($210,000) |

# COLLECTOR DESIGN AND COSTS

| LINE | REMARKS | DESIGN FREQUENCY | DESIGN FLOW-CFS | SLOPE FT/THOU | SIZE AND KIND | LENGTH FEET | UNIT COST | TOTAL COST |
|---|---|---|---|---|---|---|---|---|
| VI-14 | | 1-Yr. | | | | | | |
| Southern Avenue | | | 300 | | 84" Pipe | 3,700 | $68.00 | $251,600 |
| | | | 110 | 2 | 60" | 4,400 | 42.00 | 184,800 |
| | | | 105 | 4 | 51" | 2,640 | 35.00 | 92,400 |
| | | | 55 | 10 | 42" | 2,640 | 23.50 | 62,040 |
| | | | 35 | 8.5 | 36" | 2,640 | 17.50 | 46,200 |
| | | | | | Subtotal | | | $637,040 |
| | | | | | Engineering & Contingencies | | | 127,360 |
| | | | | | Total | | | $764,400 |
| | | | | | Misc. Collectors & Laterals - 2¼ Square Miles | | | ($320,000) |

## Estimate Summarized by Cities

### Scottsdale (Internal Lines Only)

"A" Priority (1970-1975)

| | | |
|---|---|---|
| V-2 | McDowell Road | $159,900 |
| V-3 | Oak Street | 77,400 |
| V-5 | Earll Drive | 386,800 |
| V-7 | 2nd Street | 213,300 |
| V-34 | | 429,000 |
| Miscellaneous Collectors and Laterals | | 250,000 |
| Total | | $1,516,400 |

"B" Priority (1980-1985)

| | | |
|---|---|---|
| V-28 | Hayden Road | $1,151,300 |
| V-29 | Pima Road | 1,567,500 |
| V-31 | McDonald Drive | 102,800 |
| V-52 | Chaparral Road | 123,800 |
| V-33 | Indian School Road | 146,400 |
| Miscellaneous Collectors and Laterals | | 1,925,000 |
| Total | | $5,016,800 |

| | |
|---|---|
| "C" Priority | None |
| Total Internal Lines | $4,358,200 |
| Total Miscellaneous Collectors and Laterals | 2,175,000 |
| TOTAL | $6,533,200 |

### Glendale (Internal Lines Only)

| | |
|---|---|
| "A" & "B" Priority | None |

"C" Priority (1990-1995)

| | | |
|---|---|---|
| III-8 | 71st Avenue | $76,500 |
| III-9 | 59th Avenue | 322,600 |
| III-10 | 51st Avenue | 500,500 |
| III-11 | Northern Avenue | 316,900 |
| III-12 | Grand Avenue | 462,300 |
| Total Internal Lines | | $1,678,800 |
| Total Miscellaneous Collectors and Laterals | | 1,015,000 |
| TOTAL | | $2,693,800 |

Phoenix (Internal Lines Only)

"A" Priority (1970-1975)

| | | |
|---|---|---|
| I-8 | 43rd Avenue | $793,200 |
| I-9 | 35th Avenue (above Grand Canal) | 597,200 |
| I-10 | 27th Avenue | 1,480,800 |
| I-12 | Melvin Street | 51,500 |
| I-13 | Roosevelt Street | 260,100 |
| I-14 | McDowell Road | 71,300 |
| I-15 | Oak Street | 76,000 |
| I-16 | Earll Drive | 582,300 |
| I-17 | Osborn Road | 3,000 |
| V-20 | Shea Boulevard | 753,900 |
| VI-7 | 27th Avenue | 528,800 |
| VI-8 | 19th Avenue | 383,400 |
| VI-9 | 7th Avenue | 158,400 |
| VI-10 | Riverside Street | 75,200 |
| VI-11 | Broadway - 20th Street | 684,300 |
| VI-12 | 7th Street | 504,400 |
| VI-13 | Broadway Road | 580,800 |
| VI-14 | Southern Avenue | 764,400 |
| Miscellaneous Collectors and Laterals | | 4,205,000 |
| Total | | $12,554,000 |

Additional "A" Priority Work (Separately covered - See page 233)

"B" Priority (1980-1985)

| | | |
|---|---|---|
| I-7 | 51st Avenue | $1,009,200 |
| I-11 | 40th Street | 1,395,000 |
| IV-5 | Peoria Avenue | 358,800 |
| IV-6 | Bell Road | 694,300 |
| IV-10 | 7th Avenue | 262,900 |
| V-21 | Cactus Road | 316,800 |
| V-22 | 32nd Street | 221,800 |
| V-23 | 40th Street | 533,800 |
| V-24 | Tatum Boulevard | 448,300 |
| Miscellaneous Collectors and Laterals | | 3,655,000 |
| Total | | $8,895,900 |

Phoenix (Internal Lines Only - continued)

"C" Priority (1990-1995)

| | | |
|---|---|---|
| I-5 | 67th Avenue | $1,178,500 |
| I-6 | 59th Avenue | 1,034,700 |
| II-3 | 83rd Avenue | 549,700 |
| II-4 | 75th Avenue | 299,700 |
| IV-7 | Greenway Road | 1,289,200 |
| IV-9 | 19th Avenue | 486,300 |
| IV-8 | Thunderbird Road | 606,700 |
| V-25 | 56th Street | 571,800 |
| VI-1 | Western Canal | 270,900 |
| Miscellaneous Collectors and Laterals | | 4,110,000 |
| Total | | $10,397,500 |
| Total Internal Lines | | 19,877,400 |
| Total Miscellaneous Collectors and Laterals | | 11,970,000 |
| TOTAL | | $31,847,400 |

Peoria (Internal Lines Only)

"A" & "B" Priority — None

"C" Priority (1990-1995)

| | | |
|---|---|---|
| III-1 | 67th Avenue | $581,300 |
| III-3 | 75th Avenue | 1,020,100 |
| III-4 | Cactus Road | 227,300 |
| III-5 | Peoria Avenue | 197,600 |
| III-6 | Olive Avenue | 361,200 |
| III-7 | 83rd Avenue | 544,900 |
| Total Internal Lines | | $2,932,400 |
| Total Miscellaneous Collectors and Laterals | | 2,000,000 |
| TOTAL | | $4,932,400 |

## Paradise Valley (Internal Lines Only)

"A" Priority — None

"B" Priority (1980-1985)

| | | |
|---|---|---|
| V-14 | Stallion Drive | $124,800 |
| V-15 | Northern Avenue | 100,800 |
| V-16 | Mockingbird Lane | 158,400 |
| V-17 | Mockingbird Lane | 72,800 |
| Miscellaneous Collectors and Laterals | | 35,000 |
| Total | | $491,800 |

"C" Priority

| | |
|---|---|
| Total Internal Lines | $456,800 |
| Total Miscellaneous Collectors and Laterals | 35,000 |
| TOTAL | $491,800 |

## Regional Lines

"A" Priority (1970-1975)

| | | |
|---|---|---|
| V-9 | Camelback Road | $735,000 |
| V-10 | Chaparral Road | 867,600 |
| V-26E | Invergordon & Scottsdale Roads | 1,027,000 |
| V-13 | Hummingbird Lane | 31,300 |
| II-6 | 67th Avenue | 1,596,400 |
| II-7 | 59th Avenue | 2,045,800 |
| II-8 | 51st Avenue | 2,460,100 |
| II-9 | 43rd Avenue | 2,579,400 |
| Total | | $11,342,600 |

"B" Priority (1980-1985)

| | | |
|---|---|---|
| II-5 | 71st Avenue | $1,580,700 |
| IV-2 | Greenway Road | 1,094,700 |
| V-11 | McDonald Drive | 323,100 |
| V-12 | Cactus Wren Drive | 362,200 |
| V-18 | Doubletree Ranch Road | 300,200 |
| V-19 | Mountain View Road | 155,200 |
| Total | | $3,816,100 |

Regional Lines (continued)

"C" Priority (1990-1995)

| | | |
|---|---|---|
| III-2 | Olive -67th Avenue | $289,900 |
| IV-1 | Bell Road | 1,281,600 |
| IV-3 | Thunderbird Road | 715,100 |
| IV-4 | Cactus Road | 532,200 |
| V-26W | Invergordon & Scottsdale Roads | 838,900 |
| V-30 | | 2,683,300 |
| I-1 | 115th Avenue | 1,900,900 |
| Total | | $8,241,900 |
| TOTAL REGIONAL LINES | | $23,400,600 |

County Lines (Presently completely outside any incorporated area)

"A" & "B" Priority — None

"C" Priority (1990-1995)

| | | |
|---|---|---|
| I-2 | 91st Avenue | $1,445,800 |
| I-3 | 83rd Avenue | 1,237,300 |
| I-4 | 75th Avenue | 1,201,700 |
| II-1 | 99th Avenue | 520,600 |
| II-2 | 91st Avenue | 512,700 |
| VI-2 | Dobbins Road | 974,400 |
| VI-3 | Southern Avenue | 735,200 |
| VI-4 | 43rd Avenue | 283,500 |
| VI-5 | 35th Avenue | 134,600 |
| VI-6 | Baseline Road | 2,037,000 |
| Total County Lines | | $9,082,800 |
| Total County Collectors and Laterals | | 5,740,000 |
| TOTAL | | $14,822,800 |

The foregoing estimate does not include work inside the City of Phoenix which was planned under studies previous to this one. The major items of this work, with current costs, are listed below.

## Proposed Improvement Program

### 1970 - 1980

| | | | |
|---|---|---|---|
| I | 16th Street: | | |
| | Van Buren to Grand Canal | | $1,100,000 |
| II | 10th Street Wash: | | 200,000 |
| III | Old Cross-Cut Canal: | | |
| | Washington & Van Buren bridges | $200,000 | |
| | Gates & undercrossing @ Arizona Canal | 110,000 | |
| | McDowell & Thomas Road bridges | 110,000 | |
| | Osborn & Indian School bridges | 65,000 | |
| | Enlarge channel | 250,000 | |
| | | | 735,000 |
| IV | 19th Avenue: | | |
| | Camelback to Bethany Home and connections to 23rd Avenue | $430,000 | |
| | Bethany Home to Northern | 440,000 | |
| | Northern to Arizona Canal | 220,000 | |
| | | | 1,090,000 |
| V | 15th Avenue: | | |
| | Salt River to Camelback, Phase I | $1,800,000 | |
| | Salt River to Camelback, Phase II | 1,280,000 | |
| | Bethany Home to Glendale Avenue | 140,000 | |
| | Glendale Avenue to Northern | 220,000 | |
| | | | 3,440,000 |
| VI | 23rd Avenue: | | |
| | Salt River to Camelback, Phase I | $1,800,000 | |
| | Salt River to Camelback, Phase II | 1,500,000 | |
| | Camelback to Glendale Avenue | 600,000 | |
| | | | 3,900,000 |
| VI | 7th Avenue: | | |
| | Glendale Avenue to Northern | | 255,000 |
| | TOTAL | | $10,720,000 |

## SECTION 8 - CONCLUSIONS

Set forth in this section are the principal conclusions and recommendations of this report. Most of these have been explicitly stated hereinbefore, together with the reasoning behind them, but there are some listed for the first time which have only been given passing mention or covered by implication.

### 8.1 Previously planned work.

There is a sizeable amount of storm drainage and flood control work for which studies have already been made and for which some engineering planning has been done. Projects falling into this category include:

10th St. Wash Channelization and bridges - (Phoenix)
Old Cross-Cut Canal improvement - (Phoenix - FCDMC)
19th - 23rd Avenue trunk - (Phoenix)
15th Avenue trunk - (Phoenix)
16th St. trunk completion - (Phoenix)
Other extensions of existing lines

This work is essential to an adequate storm drainage system for the area covered by this report. It is recommended that the above projects be included with the first phase construction set forth herein.

### 8.2 Flood control projects.

While flood control projects are beyond the scope of this study, there is nevertheless a close relation to storm drainage. Many of the lines proposed herein need storm drain channels for discharge points and depend upon others to limit inflow. Local communities should provide strong support to the Flood Control District of Maricopa County to revive the flood control program and again present it to the voters.

8.3 Proposed construction program.

Storm drains should continue to be designed by the methods outlined herein, at least until reliable local design data on the rainfall-runoff relation have been accumulated. Initial construction should provide trunk drains on approximately one-mile spacing designed for storms of one-year recurrence interval generally, but for 5 to 10-year recurrence intervals in extremely troublesome, high value, or highly vulnerable districts. Subdivision of land should maintain through streets on mid-section lines for future supplementary drains.

Drains should be laid out for maximum effectiveness and economy even though this means crossing political boundaries. Lines serving two or more cities could be made the responsibility of the Flood Control District of Maricopa County, although it is believed enabling legislation would be necessary. Alternatively such lines could be built under a special assessment district or under special agreements between the cities involved, similar to those already made for the collection and treatment of sanitary sewage. "Regional" drains (those crossing political boundaries) are among those most urgently required and the basic policy for their construction should be settled, perhaps through the good offices of the Maricopa Association of Governments.

Proposed construction is grouped by cities into three priority categories with estimated construction costs as presented in Table 8.1. Costs are based on February 1970 prices for labor and materials. Totals are given in the table with and without an allowance (based on drainage area) for side street laterals and collectors with their associated inlets. The costs of laterals, collectors, and inlets are often considered a part of paving cost and could properly be assessed against property if paving is done under the Improvement Act.

Additional comments on the program in Table 8.1 follow:

Glendale. Internal drains must await construction of the Glendale-Peoria flood control channel. The earliest benefits to Glendale will come through its joint drains with Phoenix which will discharge into the Papago West Freeway channel. Most of the first phase work shown for Glendale consists of laterals and collectors for these joint drains.

Paradise Valley. No "A" priority internal trunk drains are proposed but there will be "A" priority joint drains with Scottsdale. Paradise Valley's internal lines would be built after the Upper Indian Bend floodway becomes available.

Peoria. Based on population projections, Peoria's lines have been placed in the "C" priority category. The southeastern part of the city must await the proposed Glendale-Peoria flood control channel. Other Peoria drains discharge to the New River and could be built at any time if the need arises.

TABLE 8.1 - Recapitulation of Estimated Storm Drain Construction Costs

| | Total Program | "A" 1970 - 1975 | "B" 1980 - 1985 | "C" 1990 - 1995 |
|---|---|---|---|---|
| Glendale | | | | |
| Trunks | $1,678,800 | - | - | $ 1,678,800 |
| Laterals & collectors | 5,165,000 | $2,260,000 | $690,000 | 2,215,000 |
| Paradise Valley | | | | |
| Trunks | 456,800 | - | 456,800 | - |
| Laterals & collectors | 365,000 | 230,000 | 135,000 | - |
| Peoria | | | | |
| Trunks | 2,932,400 | - | - | 2,932,400 |
| Laterals & collectors | 2,000,000 | - | - | 2,000,000 |
| Phoenix | | | | |
| Trunks* | 19,877,400 | 8,349,000 | 5,240,900 | 6,287,500 |
| Laterals & collectors | 16,685,000 | 6,450,000 | 4,345,000 | 5,890,000 |
| Scottsdale | | | | |
| Trunks | 4,358,200 | 1,266,400 | 3,091,800 | - |
| Laterals & collectors | 3,980,000 | 750,000 | 1,970,000 | 1,260,000 |
| Tolleson | | | | |
| Trunks | - | - | - | - |
| Laterals & collectors | 160,000 | - | - | 160,000 |
| Regional agency | | | | |
| Trunks | 23,400,600 | 11,342,600 | 3,816,100 | 8,241,900 |
| County** | | | | |
| Trunks | 9,082,800 | - | - | 9,082,800 |
| Laterals & collectors | 5,740,000 | - | - | 5,740,000 |
| Total - trunks only | $61,787,000 | $20,958,000 | $12,605,600 | $28,223,400 |
| Grand total | $95,882,000 | $30,648,000 | $19,745,600 | $45,488,400 |

* Does not include $10,720,000 as previously planned work.

** Depending upon the progress of municipal annexations much of this work may be done by cities or a regional agency.

Phoenix. Much of the Phoenix program is needed and could well be built immediately if funds were available. The schedule proposed assumes that the Papago West Freeway channel will be ready within the next five years. Other important lines must await the Arizona Canal, Crosscut, and Indian Bend floodways. Much of the South Phoenix work should be done promptly. Lines on 27th Ave., 35th Ave., and 43rd Ave. have already been designed or built based on design flows given in the 1956 report. Plate G shows flows for these lines which are generally higher than the 1956 flows because of changes in land use projections. The effect of this is to provide slightly less than one-year protection and it means simply that supplemental drains might have to be built earlier than would otherwise have been the case.

Scottsdale. While much of it is urgently needed, the Scottsdale program hinges primarily on the availability of the Indian Bend floodway. The city makes some use of the New Cross-Cut Canal by means of pumping from a troublesome area lying to the west but this is at best a temporary expedient. The proposed "A" priority internal and regional lines will drain the present trouble spots above the canals by gravity. The pattern of Scottsdale's drains in the northern part of the city depends upon the future construction of the proposed interceptor channel. Plate H and the estimates show conditions without the channel. Figure 6.2 and Appendix 3 reflect conditions assuming the channel is built.

Tolleson. The Tolleson trunk drain (Line I-1) has been assigned a "C" priority on the basis of low population projections for the area. The city will derive a considerable degree of protection against overland flooding when the Papago West Freeway channel is complete.

## 8.4 Other conclusions and recommendations.

Certain existing natural channels should be considered a part of the drainage system of the city in which they occur (or the County). The city should acquire fee ownership of these channels, preferably by dedication as land is subdivided. Easements are not recommended because they are too readily blocked by fences or other temporary construction. Rights-of-way should be wide enough for access by modern maintenance equipment. These channels should be regularly inspected and kept ready to handle runoff, however, measures to improve the capacity over that of the channel in its natural state should be carefully evaluated for possible undesirable effects such as excessive erosion.

Even though subterranean drains are provided, the natural drainage pattern of an area should be preserved wherever possible in the development by providing properly graded, continuous streets, alleys, drainageways, or easements along or near the natural channels. Floor levels should be kept high enough relative to the street so there will be no flooding of buildings for at least the 25-year storm.

Reliance upon street pavements as water carriers should not be carried to the point where flowing water would close the street to traffic under design storm conditions.

Canal bank relief spillways (shown on Plate B) should be prominently marked on the ground and construction vulnerable to flood damage below such spillways should be discouraged, at least until flood control channel construction precludes the entry of overland flow into the Arizona Canal.

8.5 Envoi.

Not long ago, a program such as is outlined here would have been unthinkable. A hard summer rain then was a notable event, worth dropping your work to watch. Having your car stall in a puddle was something to joke about the next day. Water lay along uncurbed city streets for weeks and no one seemed to mind. It is no longer so. With the area well grown up to metropolitan status, those days are gone. Alas.

## APPENDIX 1

### CONCENTRATION TIME FORMULAS
(for overland flow)

| Formula | Source or Reference |
|---|---|
| 1. $t = 5.75\left(\frac{L^2}{S}\right)^{1/3}$<br>t = time in minutes<br>L = maximum length of flow path in miles<br>S = slope in ft./ft. | U. S. Navy |
| 2. $t = \left(\frac{11.9L^3}{H}\right)^{0.385}$<br>t = time in hours<br>L = maximum length of watercourse in miles<br>H = elev. diff. in ft. | U.S.B.R., Design of Small Dams, 1960 Ed., p. 47 |
| 3. $t = 1.1\left(\frac{L \cdot L_{ca}}{S^{\frac{1}{2}}}\right)^{0.38}$<br>t = time in hours<br>L = length of main channel in miles<br>$L_{ca}$ = distance from outlet to centroid of drainage area in miles<br>S = slope in ft./mile | U. S. Corps of Engineers |
| 4. $t = \frac{L^{1.15}}{7700\ H^{0.38}}$<br>t = time in hours<br>L = length of drainage area in ft.<br>H = elevation in difference in ft. | Soil Conservation Service for areas greater than 10 square miles (Quoted in Arizona Highway Dept. Hydraulic Design for Highway Drainage Dec., 1968) |

| Formula | Source or Reference |
|---|---|
| 5. $t_c = \frac{KL^{0.39}}{S^{0.20}}$ | Soil Conservation Service for small areas $L = 1000$ ft. or less |
| $t_c$ = time in minutes<br>L = length of drainage area in feet<br>S = slope of drainage area in percent<br>K = constant for ground cover<br>= 0.85 pavement<br>= 1.57 bare soil<br>= 2.05 poor grass<br>= 2.64 average grass<br>= 3.51 dense grass | Quoted in Arizona Highway Dept. Hydrologic Design for Highway Drainage, Dec. 1968 |
| 6. $t_c = \frac{C_2 \ell^x}{\sigma^y S^z}$ | Hicks, Los Angeles<br>Ref. Chow, Handbook of Applied Hydrology, p. 20-11 |
| $t_c$ = overland flow time in minutes after beginning of rainfall excess<br>$\sigma$ = supply rate of rainfall excess, inches per hour<br>$\ell$ = length of overland flow in feet<br>S = surface slope in % | |

| Surface | $C_2$ | x | y | z |
|---|---|---|---|---|
| Gutters (n=0.012) | 0.059 | 0.732 | 0.252 | 0.39 |
| Tar and sand | 1.3 | 0.323 | 0.64 | 0.448 |
| Tar and gravel | 2.23 | 0.373 | 0.684 | 0.366 |
| Clipped sod | 9.34 | 0.298 | 0.785 | 0.302 |

| Formula | Source or Reference |
|---|---|
| 7. $t_c = 0.0078\left(\frac{L}{S^{0.50}}\right)^{.770}$ | Rouse, Engineering Hydraulics p. 313 (for small agricultural areas) |
| $t_c$ = concentration time in minutes<br>L = maximum length of travel in feet<br>S = overall slope in ft./ft. | |

| Formula | Source or Reference |
| --- | --- |
| 8. $t_\ell = \dfrac{1.05 \; L^{0.24}}{S^{0.16} \; Imp.^{0.26}}$ | Schaakel et. al. ASCE Hyd. Div. Journal Hy6, p. 366, Nov. 1967 |

$t_\ell$ = average lag time, min.

L = length of main drainage channel in feet (150 - 6000 ft.)

S = slope of main channel in percent (0.5-6%)

Imp = ratio of imperviousness of the drainage area (>8%)

## CONCENTRATION TIME FORMULA COMPARISON

| | Reach (See Fig. A.1) 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| Formula 1 (Navy) | | | | | |
| L in feet | 2250 | 6500 | 5750 | 3000 | |
| L in miles | 0.426 | 1.230 | 1.089 | 0.568 | |
| S in ft. per ft. | 0.2610 | 0.0111 | 0.0073 | 0.0073 | |
| t in minutes | 5.1 | 29.6 | 31.4 | 20.3 | 86.4 |
| t in hr. | | | | | 1.44 |
| Formula 2 (USBR-Small Dams) | | | | | |
| L in mi. | 0.426 | 1.230 | 1.089 | 0.568 | |
| H in ft. | 588 | 72 | 42 | 22 | |
| t in hrs. | 0.083 | 0.635 | 0.679 | .411 | 1.81 |
| Formula 3 (USCE-Large D.A.'s) | | | | | |
| L in mi. | | | | | 3.312 |
| $L_{ca}$ in mi. | | | | | 1.656 |
| S in ft. per mile (overall) | | | | | 218 |
| t in hr. | | | | | 0.756 |
| S in ft. per mile (excl. mtn.) | | | | | 47.6 |
| t' in hr. | | | | | 1.01 |
| Formula 4 (SCS-Large D.A.'s) | | | | | |
| L in ft. | 2250 | 6500 | 5750 | 3000 | |
| H in ft. | 588 | 72 | 42 | 22 | |
| t in hr. | .083 | .620 | .661 | .408 | 1.76 |
| Formula 5 (SCS-Small D.A.'s) | | | | | |
| L in ft. | 2250 | 6500 | 5750 | 3000 | |
| S in percent | 26.10 | 1.11 | 0.73 | 0.73 | |
| K = 1.57 | | | | | |
| t in min. | 16.6 | 47.2 | 48.9 | 38 | 150.7 |
| t in hr. | | | | | 2.5 |
| Formula 6 (Hicks) | | | | | |
| Can't compare directly because of "$\sigma$" term, assume $\sigma = 1$ | | | | | |
| L in ft. | 2250 | 6500 | 5750 | 3000 | |
| S in percent | 26.10 | 1.11 | 0.73 | 0.73 | |
| $C_2 = 2.23$ x = 0.37 | | | | | |
| z = 0.37 | | | | | |
| t in min | 11.61 | 55.21 | 61.66 | 48.46 | 176.94 |
| t in hr. | | | | | 2.95 |

CONCENTRATION TIME FORMULA COMPARISON

| | Reach (See Fig. A.1) 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| Formula 7 (Rouse) | | | | | |
| L in ft. | 2250 | 6500 | 5750 | 3000 | |
| S in ft./ft. | .2610 | .0111 | .0073 | .0073 | |
| t in min. | 4.99 | 38.06 | 40.72 | 24.67 | 108.44 |
| t in hr. | | | | | 1.81 |
| Formula 8 (Schaakel) | | | | | |
| L in ft. | 2250 | 6500 | 5750 | 3000 | |
| S in percent | 26.10 | 1.11 | .73 | .73 | |
| Imp. is 0.20 | | | | | |
| t in min. | 6.05 | 12.85 | 13.42 | 11.47 | 43.79 |
| t in hr. | | | | | .73 |

## APPENDIX 2

## TRAFFIC ACCIDENTS ON WET STREETS

Traffic accidents in Phoenix in 1968:

| | Total | Occurring On Wet Streets | Percent |
|---|---|---|---|
| All types | 16,868 | 1,508 | 8.9 |
| With injuries | 6,701 | 586 | 8.7 |
| Involving Fatalities | 106 | 9 | 8.5 |

(Statistics from Phoenix Police Dept., Sgt. Turner, 30 Oct. 1969)

From Climatological Data for Arizona, ESSA:

There were 19 days with 0.1 inch of rainfall or more at Phoenix W. B. Airport in 1968.

Assume 4 hours of wet streets each storm = 76 hours
365 x 24 hours in a year = 8760 hours

Percent of time streets were wet, about = 0.86

Therefore in Phoenix in 1968 traffic accidents were approximately 10 times as likely to occur when the streets were wet as when they were dry.

## APPENDIX 3

### EFFECT OF SCOTTSDALE UNIT INTERCEPTOR ON DRAINAGE COSTS

The Flood Control Feasibility Report - Indian Bend Wash, made for the City of Scottsdale by John Erickson in December, 1967, recommends an interceptor channel leading from the vicinity of 96th Street (Dobson Rd) and Cactus Rd to a proposed detention basin near 56th St (Invergordon Rd) and Double Tree Road. The channel would be only one part of an extensive flood control project but it is the only portion to affect the pattern of the drainage systems proposed in this report. Lines affected are those portions of V-26, V-28, V-29, and V-30 below the interceptor channel alignment. Figure 6.2 shows the trunk system which would be required if the interceptor were built.

Using unit costs from Table 7.1 and pipe quantities and sizes from Plate H and from Figure 6.2, the following comparative total costs result:

| | |
|---|---|
| For portions of Lines V-26, 28, 29, and 30 as shown on Plate H below the alignment of the proposed Scottsdale Unit Interceptor | $5,150,840 |
| Alternative lines required if interceptor is built, as shown on Figure 6.1 | 3,688,280 |
| Savings in lines | $1,462,560 |

This savings is of course offset by the cost of the 5.5 mile interceptor channel. This cost is not itemized in the Erickson report but is a part of the "Scottsdale Dam and Reservoir Unit" estimated in 1967 to cost $3,602,000.

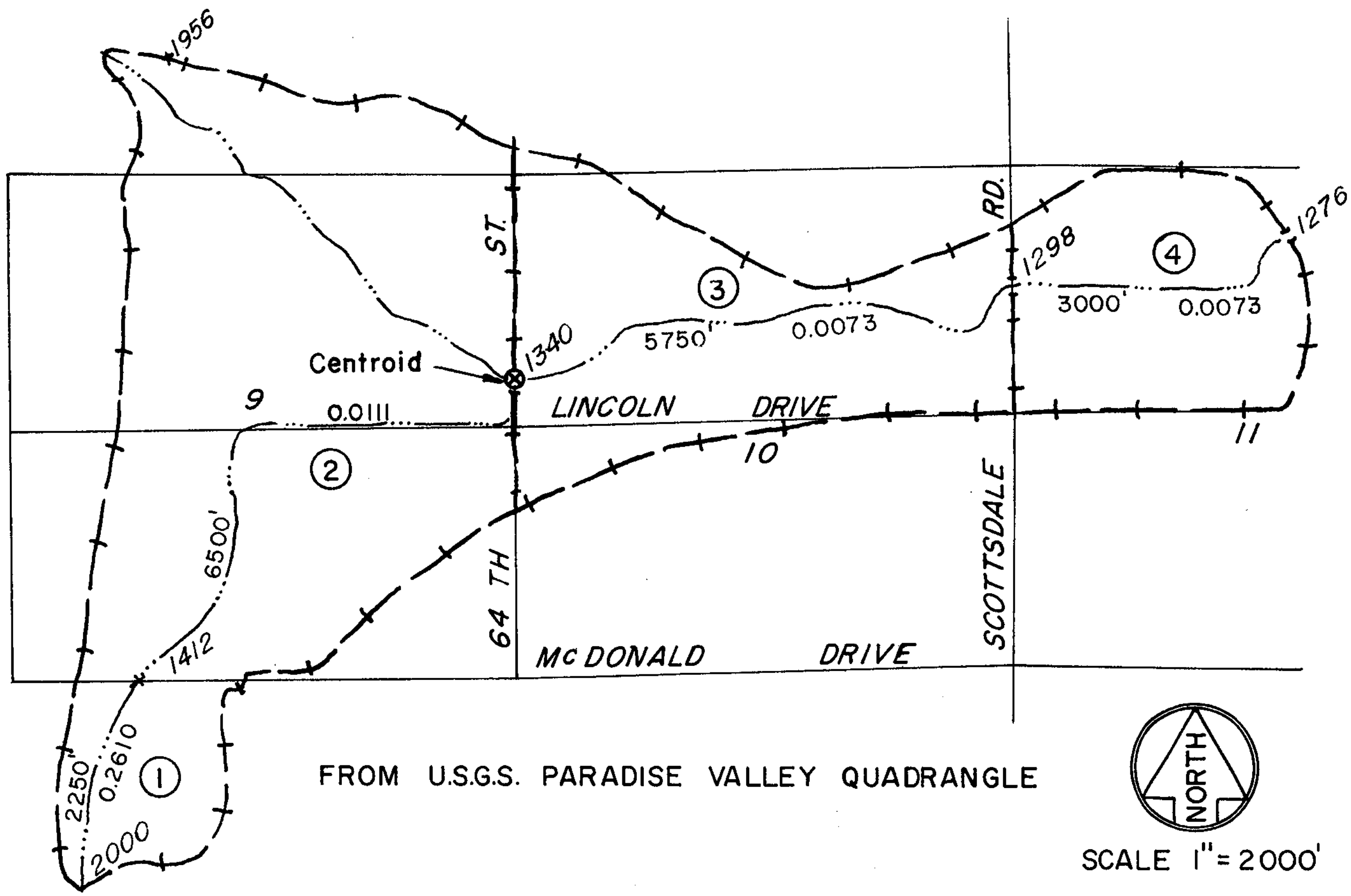
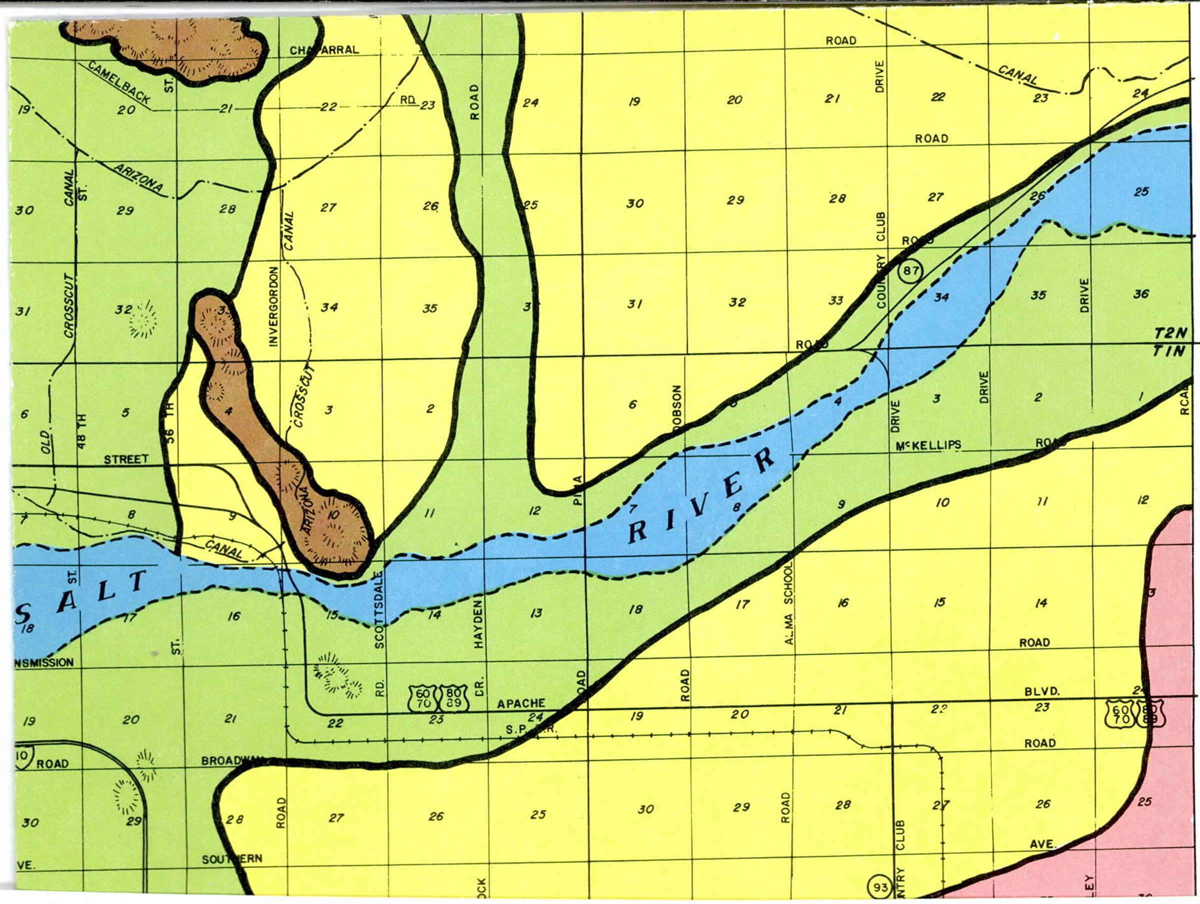


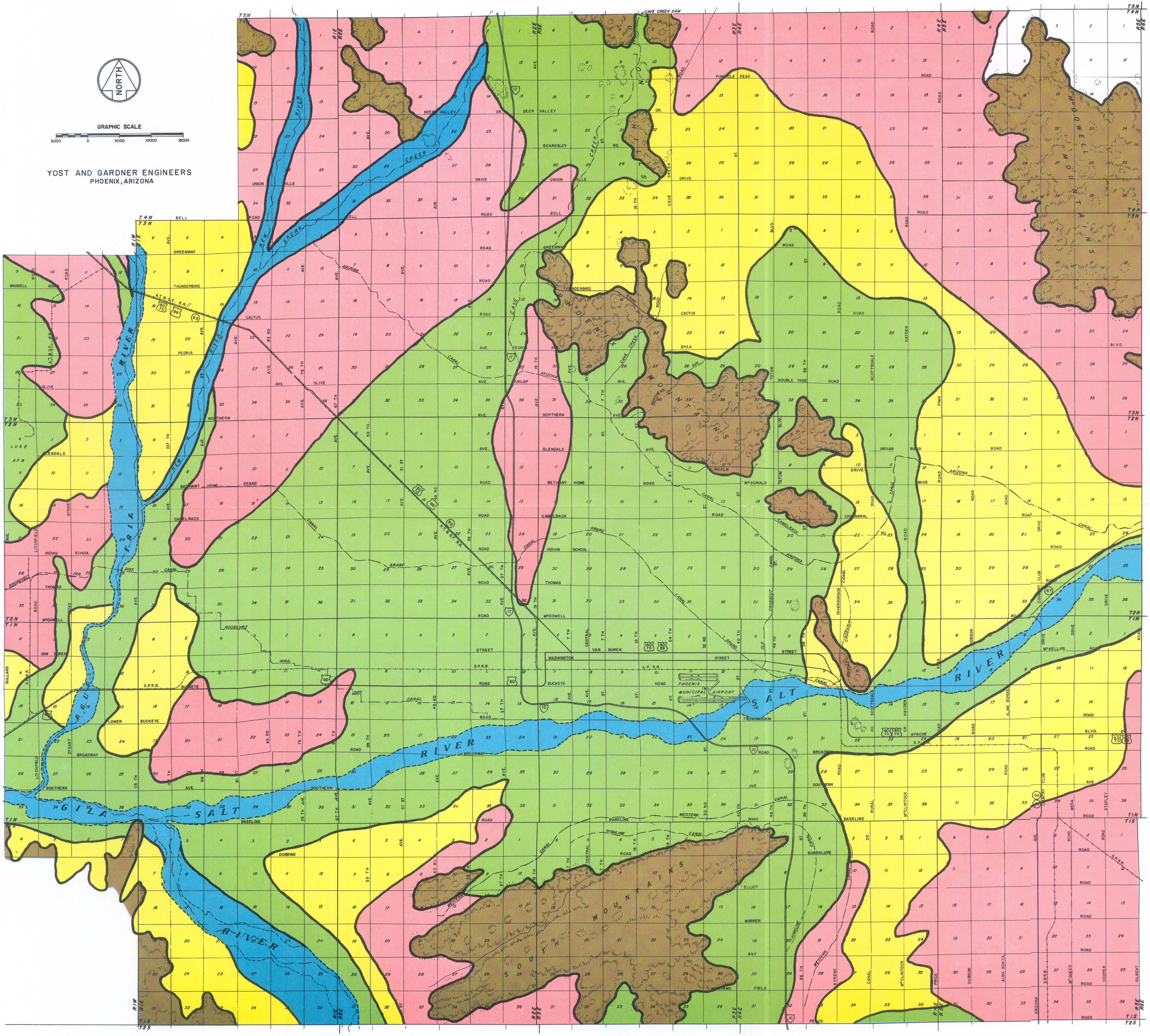

FIGURE A.1

AREA USED FOR COMPARISON OF CONCENTRATION TIME FORMULAS




# SOIL TYPES

PLATE A




| | |
|---|---|
| GROUP "A" - 2" per hour & over | Undifferentiated sandy alluvial soils subject to overflow. |
| Torrifluists - recent alluvial soil | GROUP "B" 0.15" to 0.30" per hour & over |
| Calciorthids - high calcium soils | GROUP "B" 0.15" to 0.30" per hour & over |
| GROUP "C" - 0.05" to 0.15" per hour & over | Haplargids - stratified clay soils |
| GROUP "D" - Less than 0.05" per hour | Rock outcropings - stony mountainous soils on steep slopes |

NOTE: Minimum infiltration rates shown are from "WATER" - The Yearbook of Agriculture (1955) U.S. Department of Agriculture - pg. 157

# SOIL TYPES

FROM "GENERAL SOIL MAP OF MARICOPA COUNTY"
U.S. Department of Agriculture, Soil Conservation Service
Phoenix, Arizona - 1969

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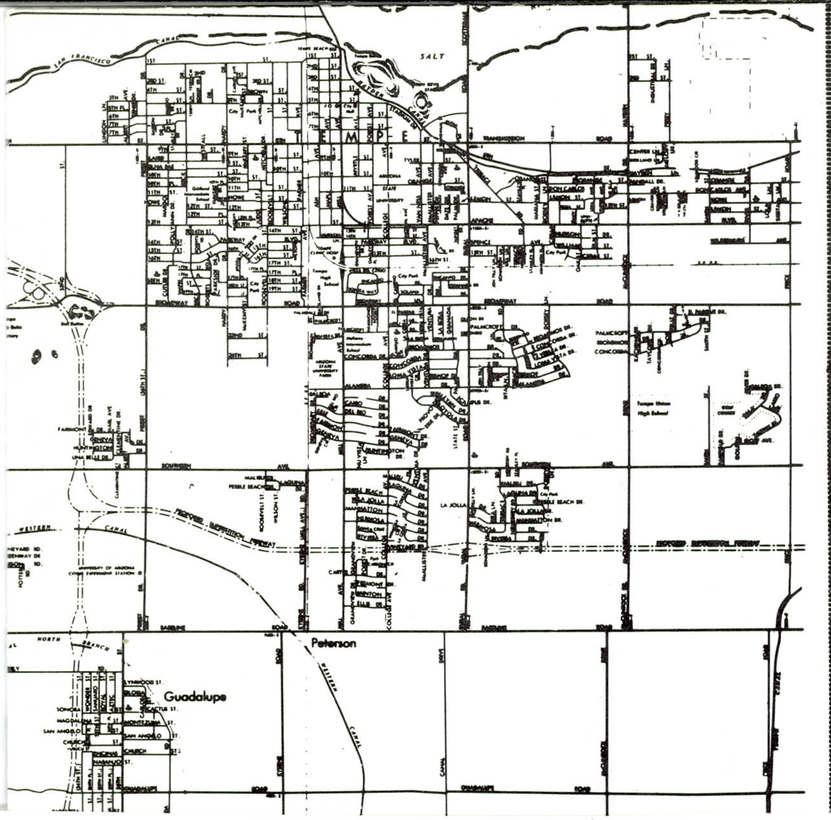
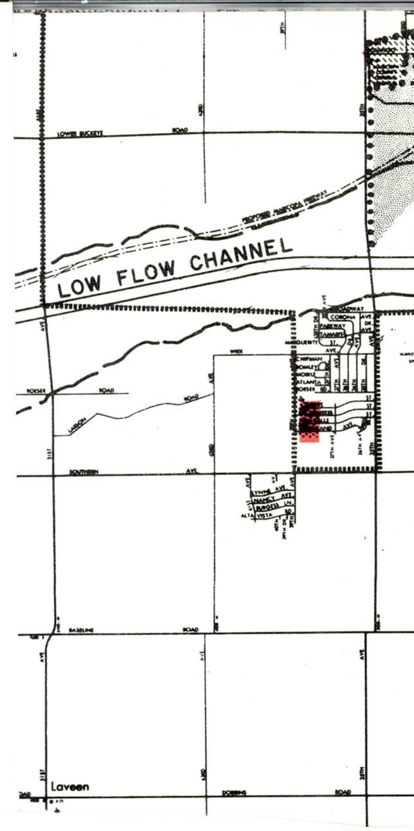
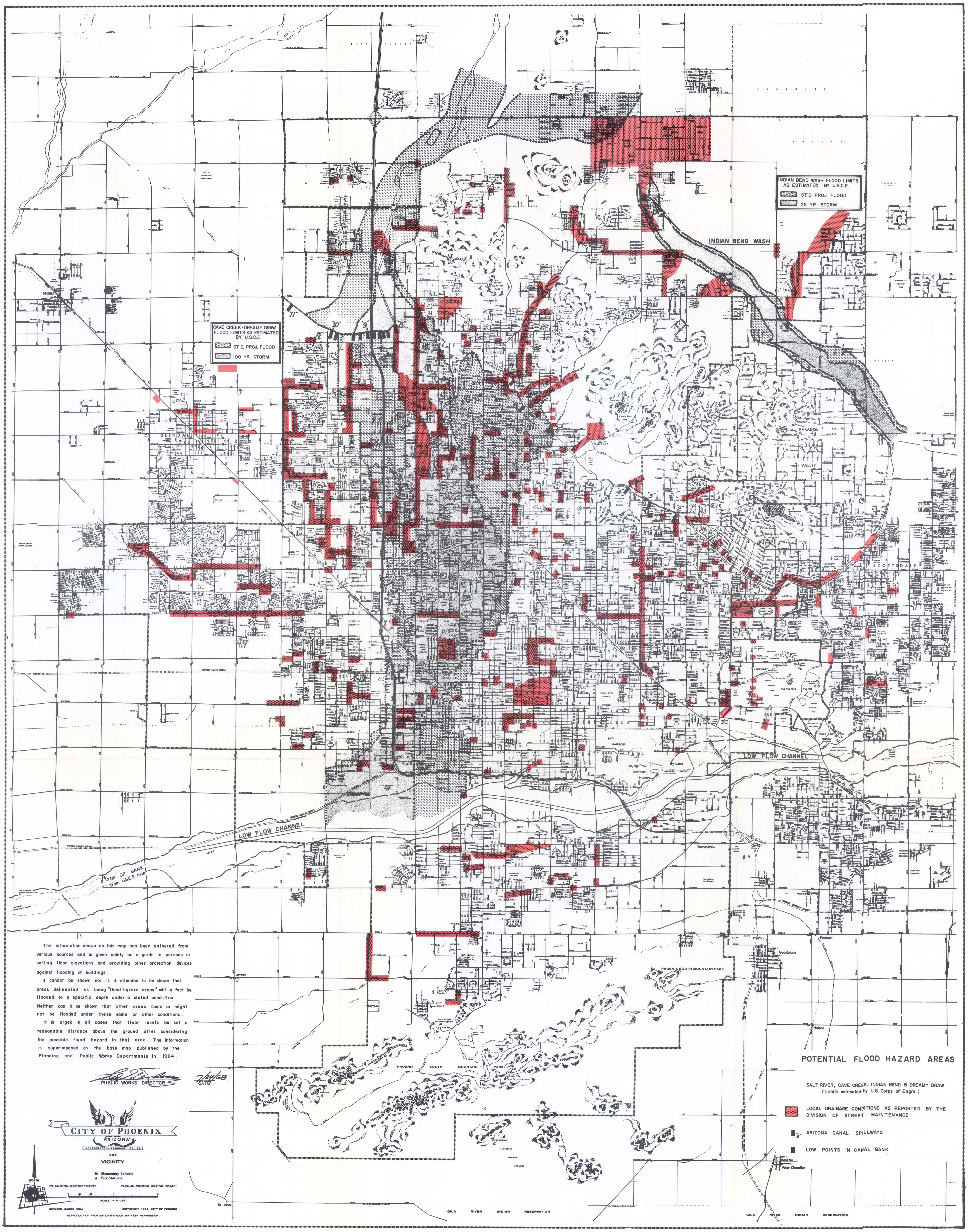
PLATE A




# POTENTIAL FLOOD HAZARD AREAS AND LOCALLY POOR DRAINAGE

PLATE B

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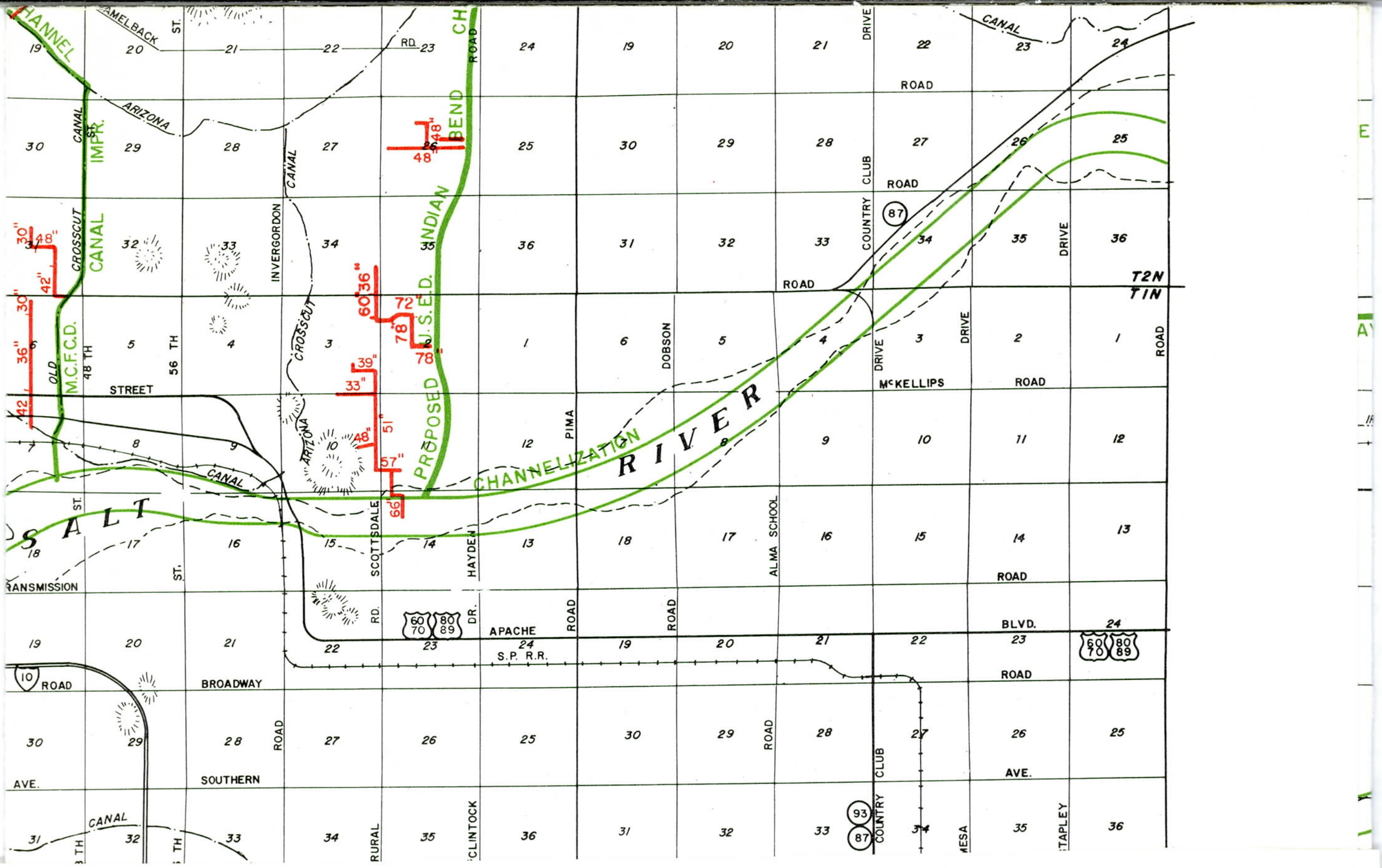
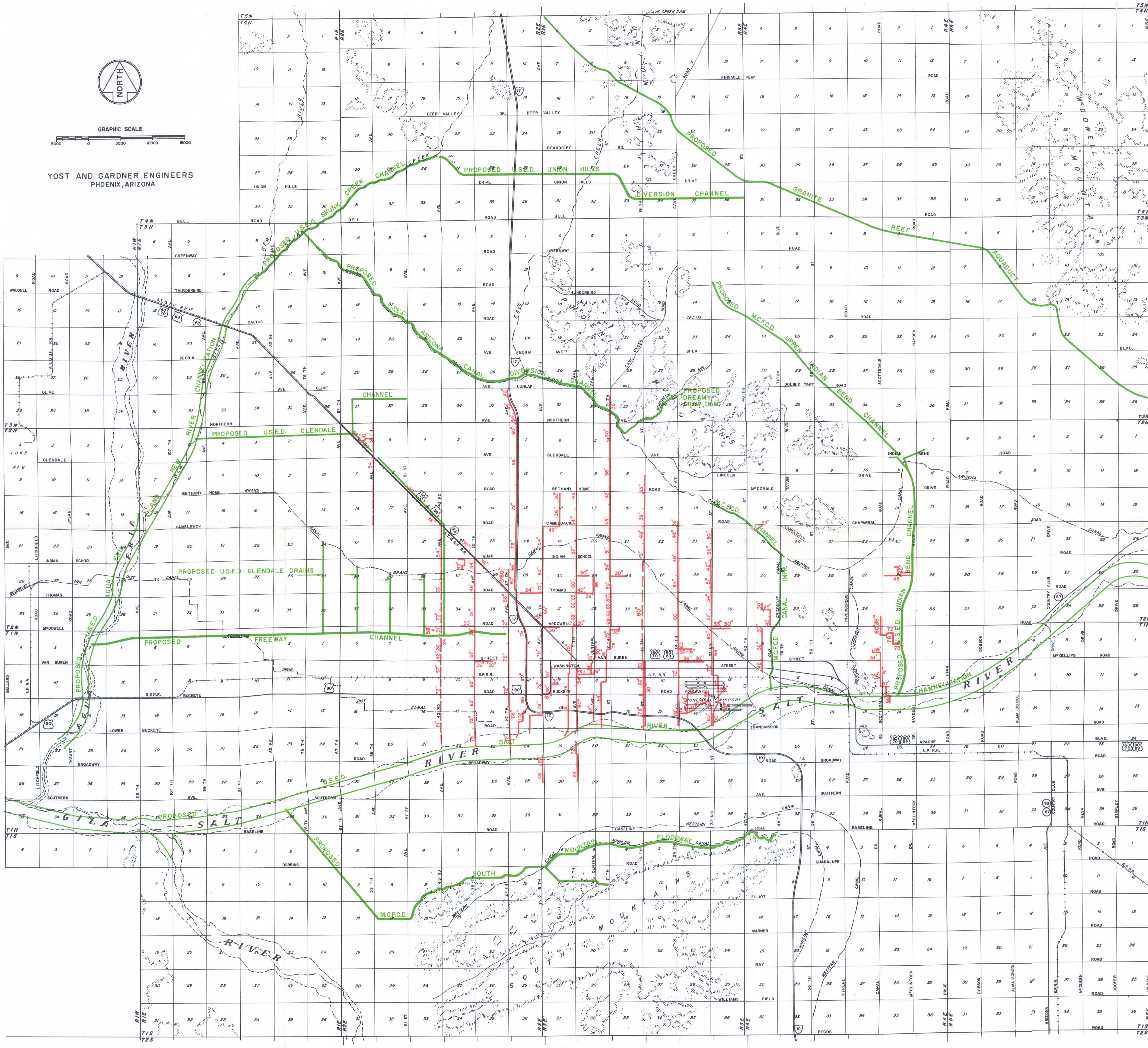
# POTENTIAL FLOOD HAZARD AREAS AND LOCALLY POOR DRAINAGE

PLATE B




# FLOOD CONTROL PROJECTS AND STORM DRAINAGE SYSTEMS

PLATE C




Existing Storm Drains - Generally 30" Diameter and Larger

Storm Drain Plans Completed by City of Phoenix

S.R.V.W.U.A. Tile Used as a Storm Drain

# FLOOD CONTROL PROJECTS AND STORM DRAINAGE SYSTEMS

From U.S. Army Corps of Engineers Interim Reports, Flood Control District of Maricopa County-Flood Control Survey Northeastern Maricopa County, and participating Municipalities

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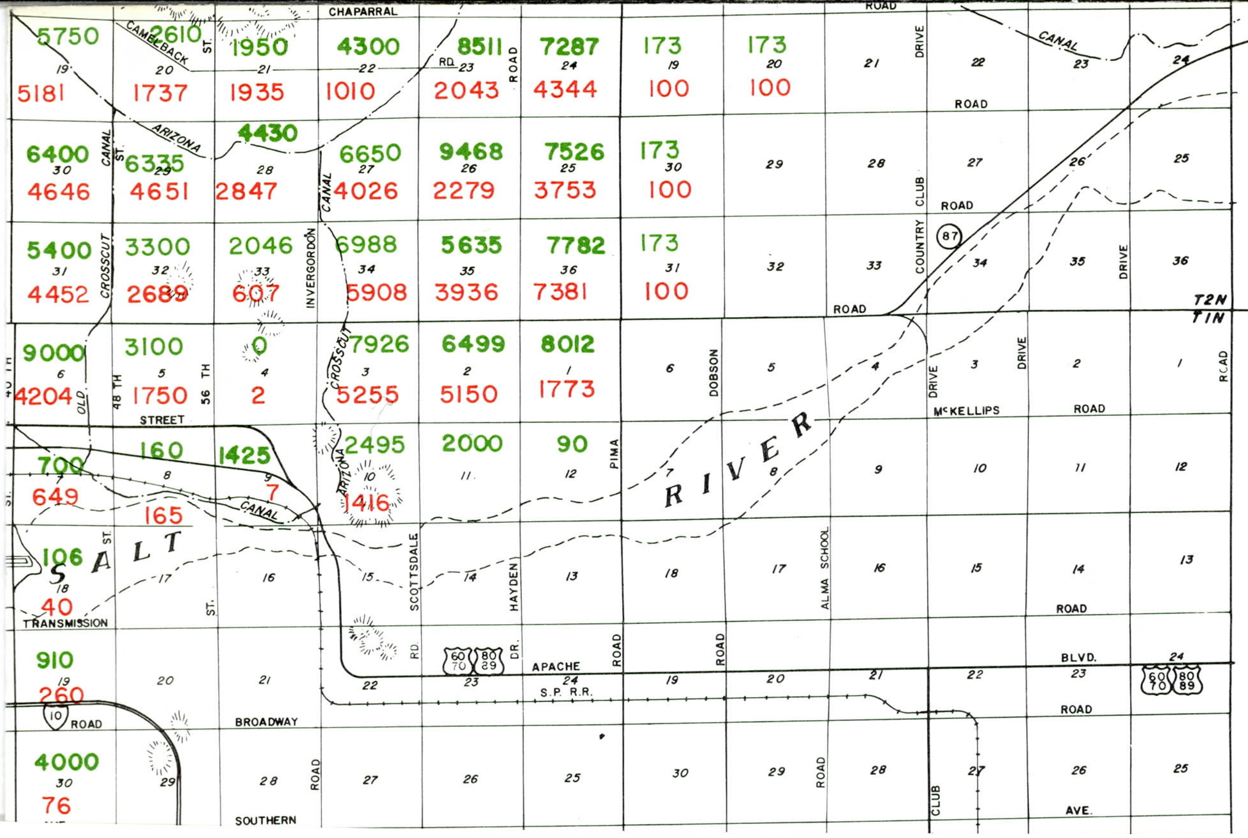
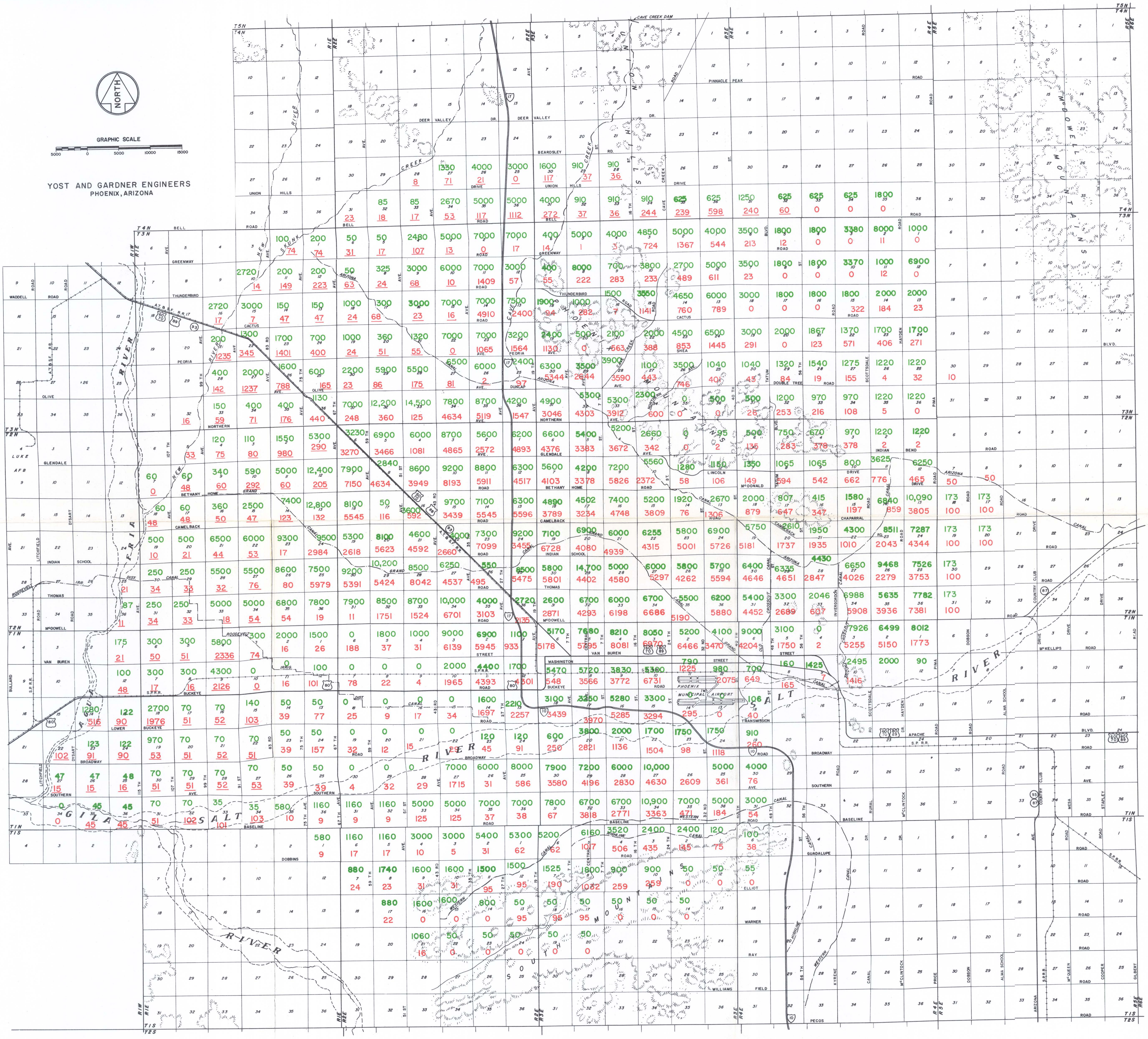
PLATE C




# PRESENT AND PROJECTED POPULATION DISTRIBUTION

PLATE D




LEGEND

| | |
|---|---|
| 123 | 1965 CENSUS POPULATION |
| 123 | 1964 VATTS POPULATION |
| 123 | 1995 VATTS PROJECTED POPULATION (RESIDENT) |

# PRESENT AND PROJECTED POPULATION DISTRIBUTION

PLATE D

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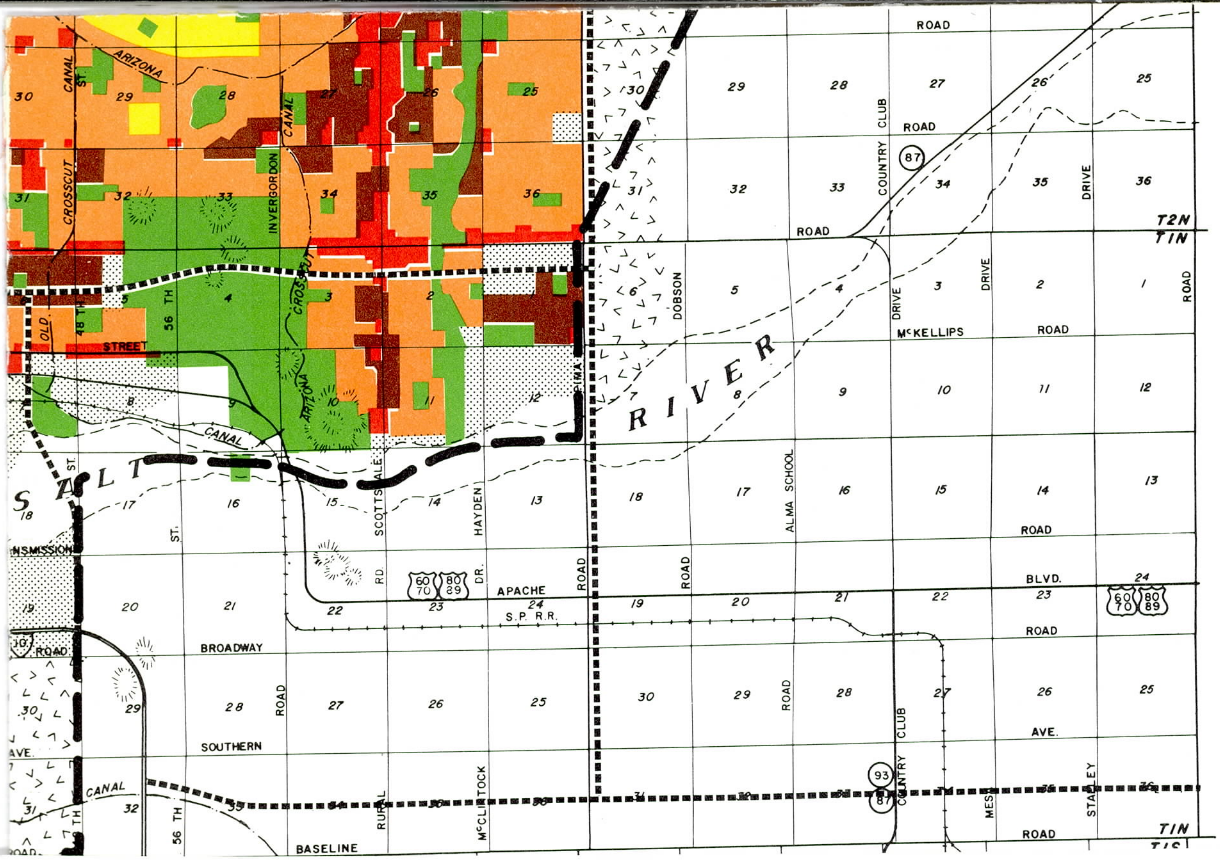
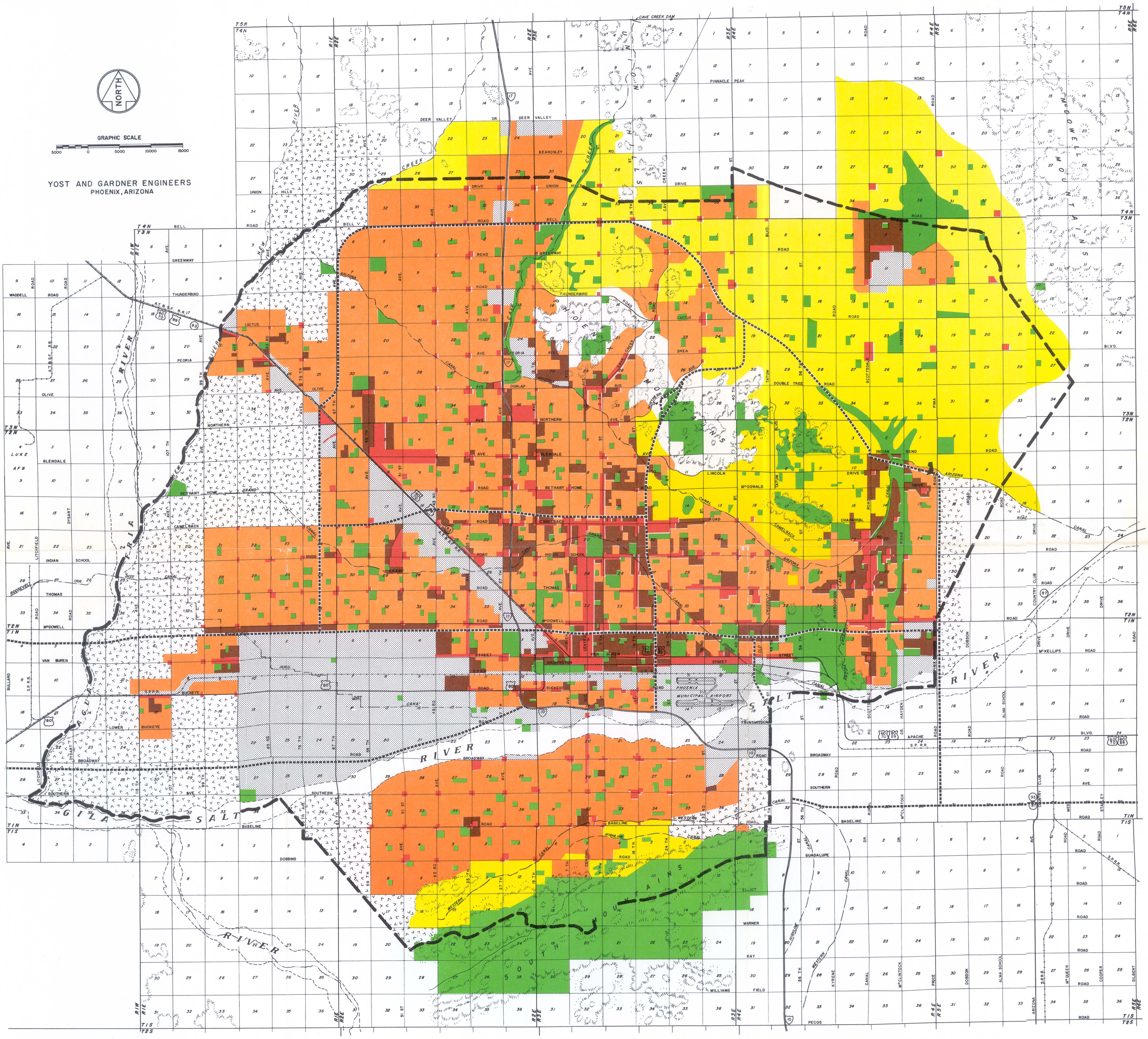



# PROJECTED LAND USE - 1995

PLATE E




- AGRICULTURAL
- LOW DENSITY RESIDENTIAL to 3.0 Housing Units per Acre
- MEDIUM DENSITY RESIDENTIAL 3.0 to 5.0 Units per Acre
- HIGH DENSITY RESIDENTIAL 5.0 & over Units per Acre
- PROPOSED FREEWAYS
- COMMERCIAL
- PARK AND PUBLIC
- INDUSTRIAL AND INDUSTRIAL RESERVE
- OPEN SPACE OR NOT ZONED
- REPORT BOUNDARY

# PROJECTED LAND USE - 1995

COMPILED FROM

City of Phoenix Preliminary Land Use - 1990, City of Scottsdale Comprehensive General Plan - 1980, City of Glendale 1985 Development Plan, Paradise Valley General Plan - 1982, Maricopa County Planning Department Future General Land Use - 1980, VATTS 1995 Projections - Resident Population

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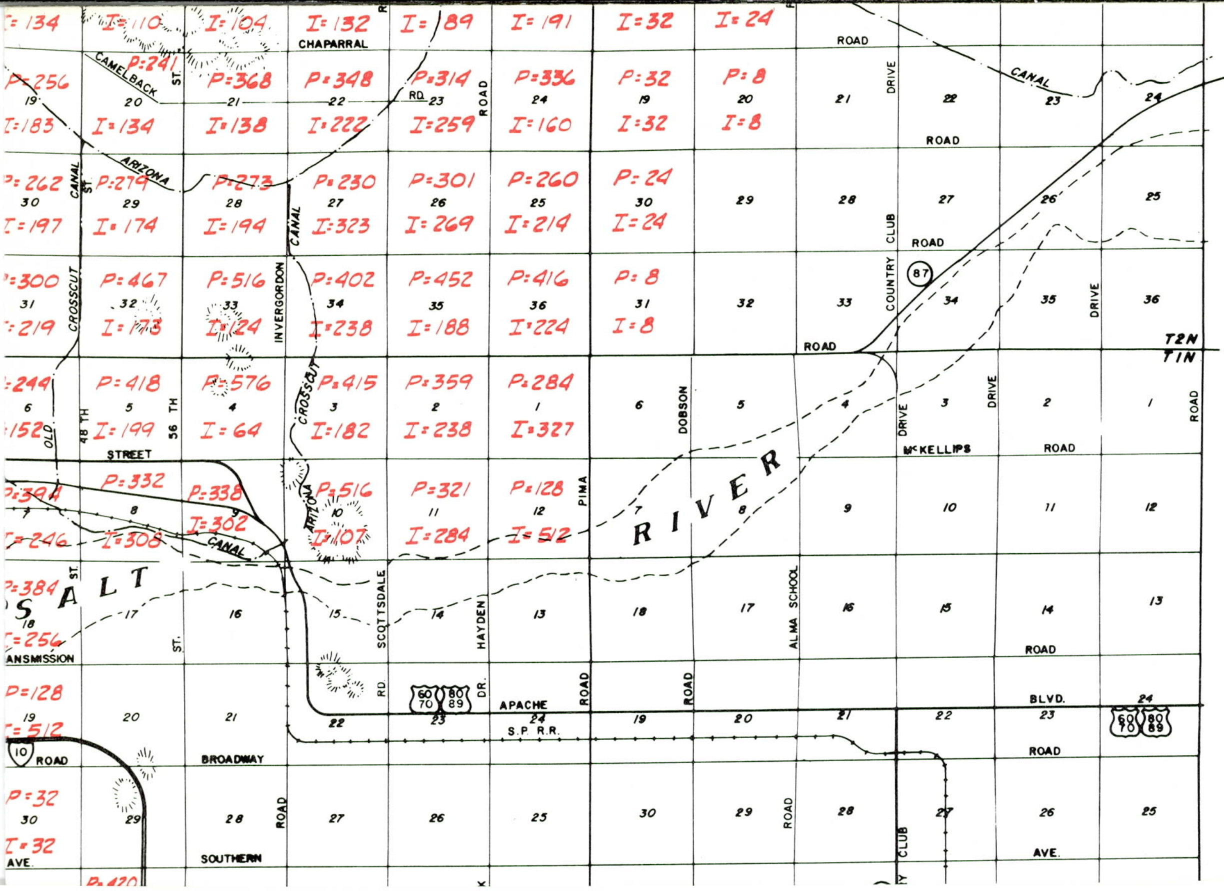
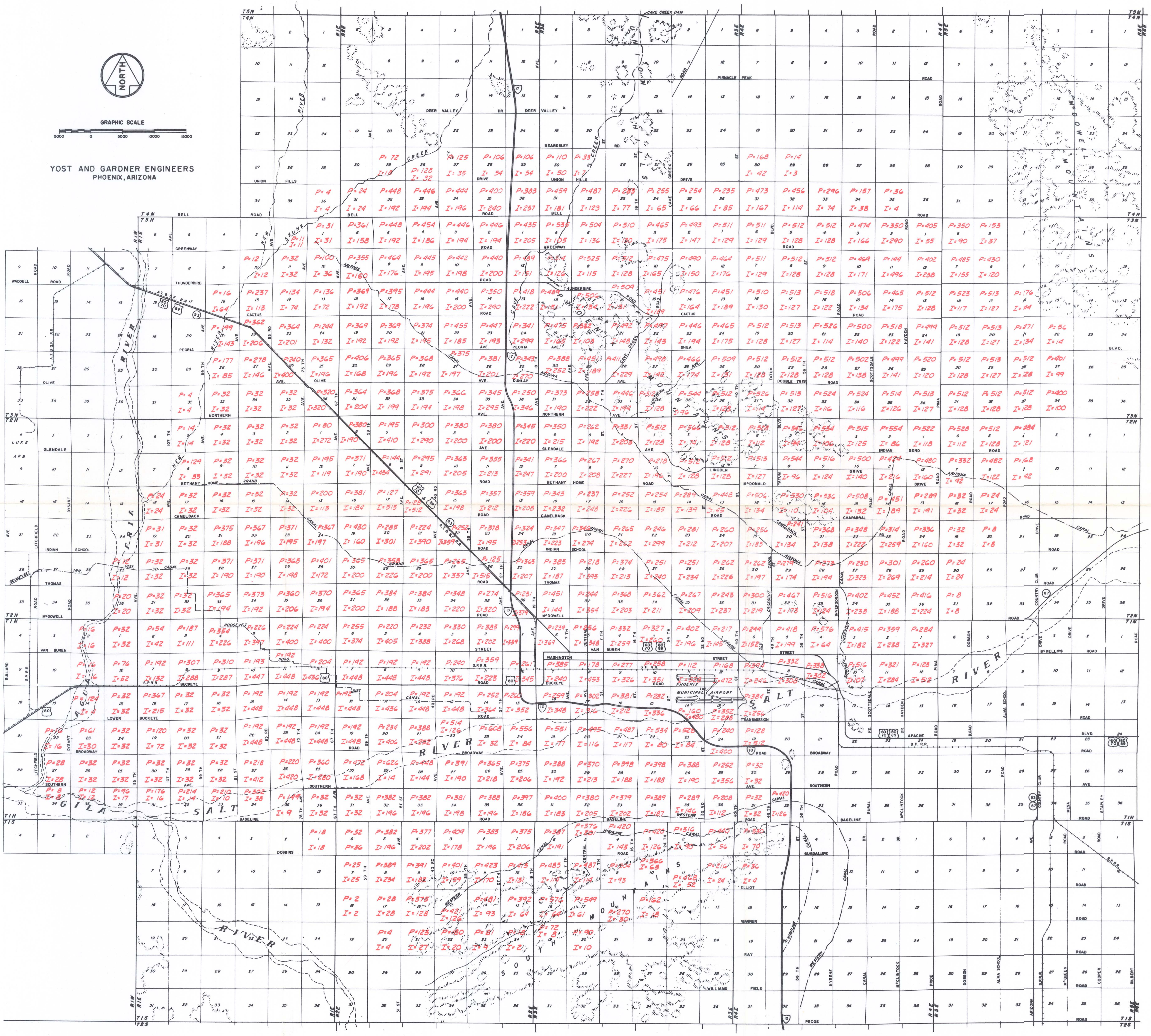
PLATE E




# PERVIOUS AND IMPERVIOUS AREAS BY SECTIONS

PLATE F




# PERVIOUS AND IMPERVIOUS AREAS BY SECTIONS

P=375 Indicates Pervious Area in Acres
I=128 Indicates Impervious Area in Acres

NOTE: The 1995 Land Use Map is the basis of these areas. Figures for peripheral sections are for the portion within the study area.

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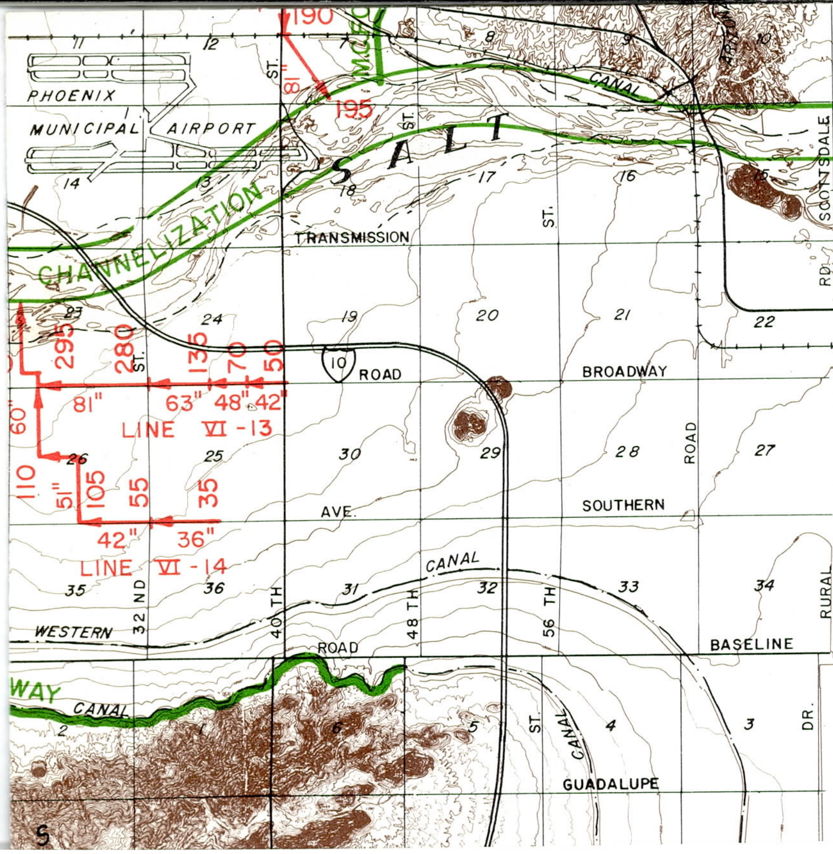
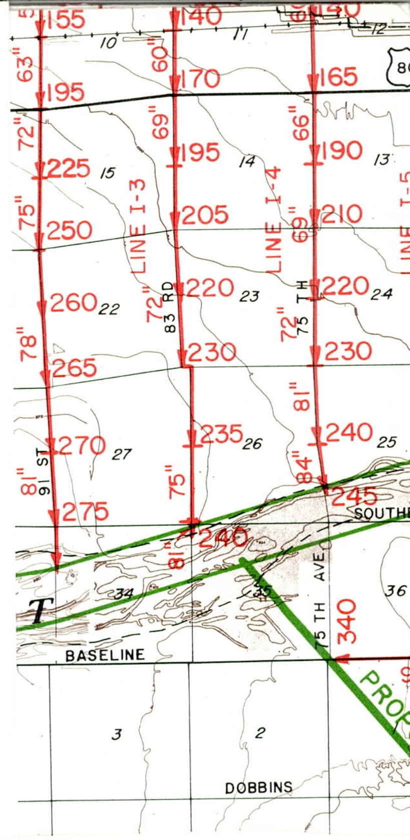
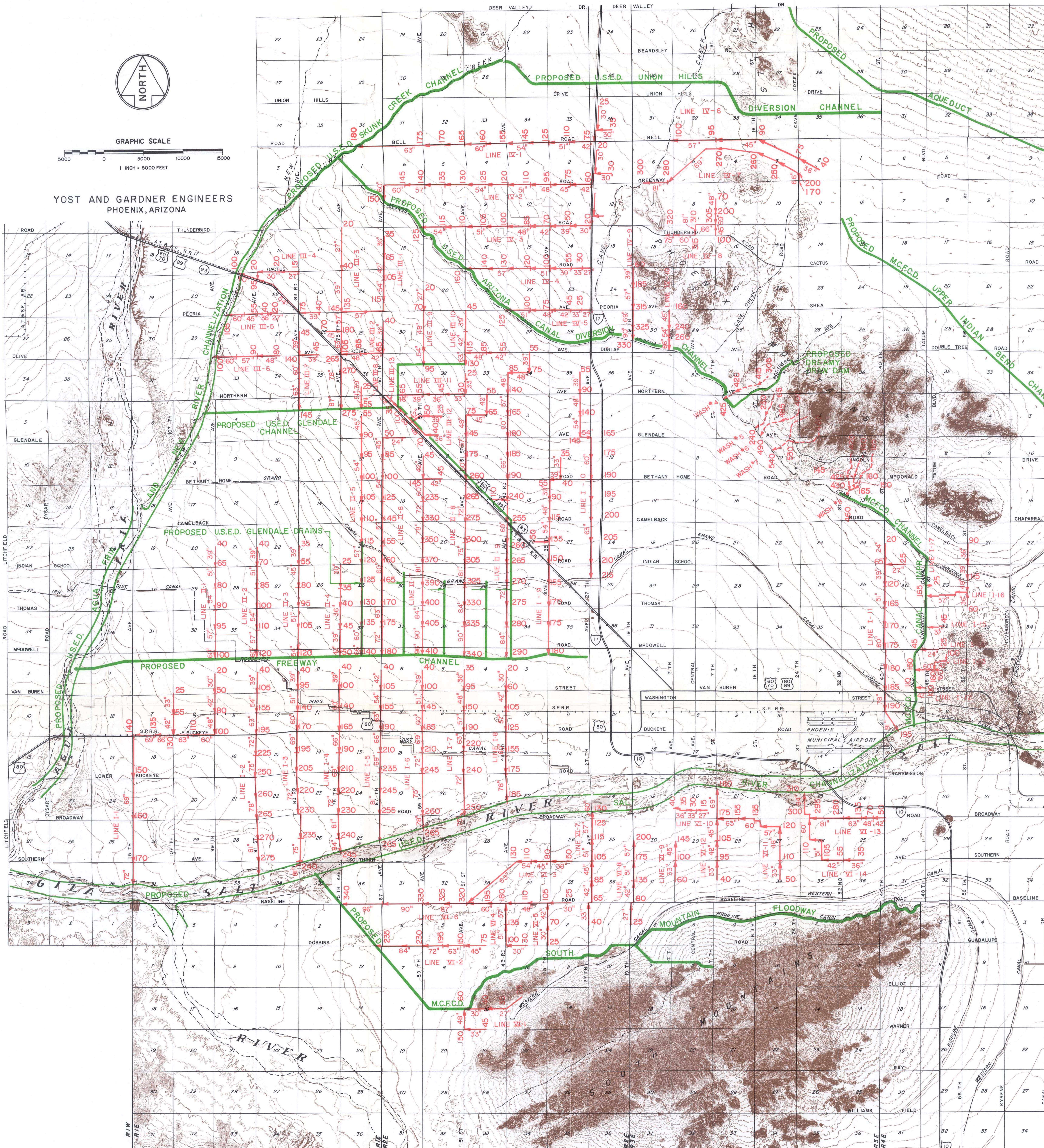
PLATE F




# PROPOSED STORM DRAINAGE SYSTEMS
# PHOENIX AND WESTERN AREAS

PLATE G




LINE I-12 — LINE DESIGNATION

45 — DESIGN FLOW IN C.F.S.

25 — NEW PIPE

24" — PIPE SIZE

NOTE: FLOWS SHOWN AT JUNCTIONS ARE FOR PEAK QUANTITY LEAVING

# PROPOSED STORM DRAINAGE SYSTEMS PHOENIX AND WESTERN AREAS

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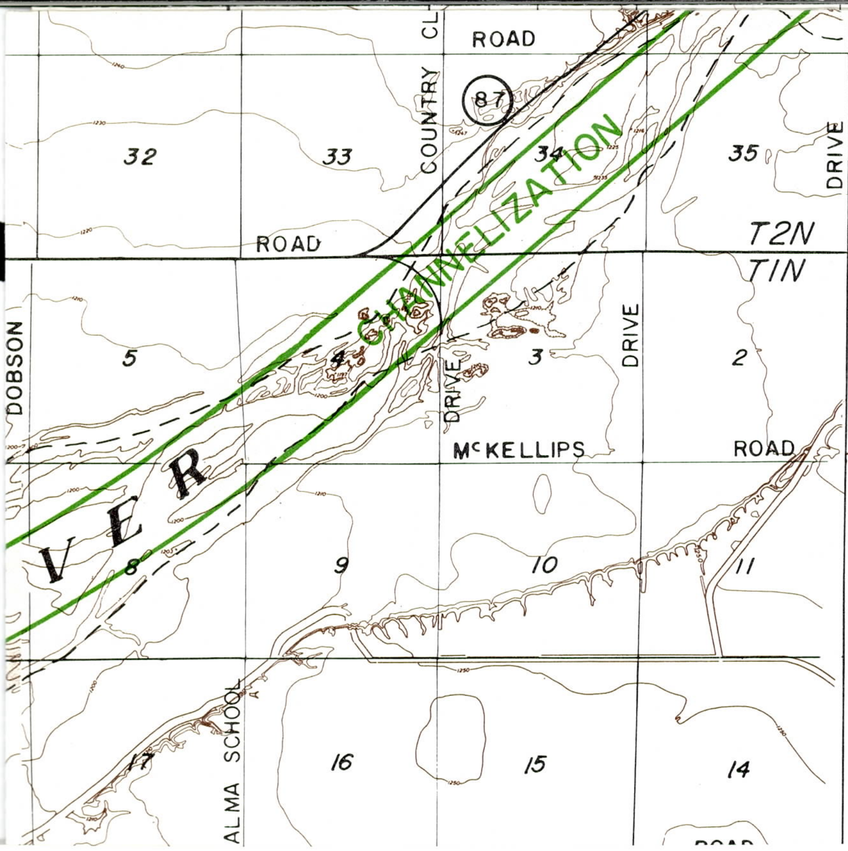
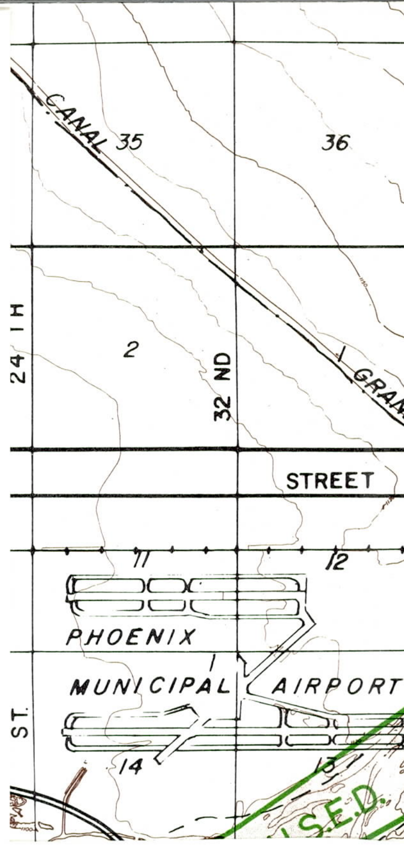
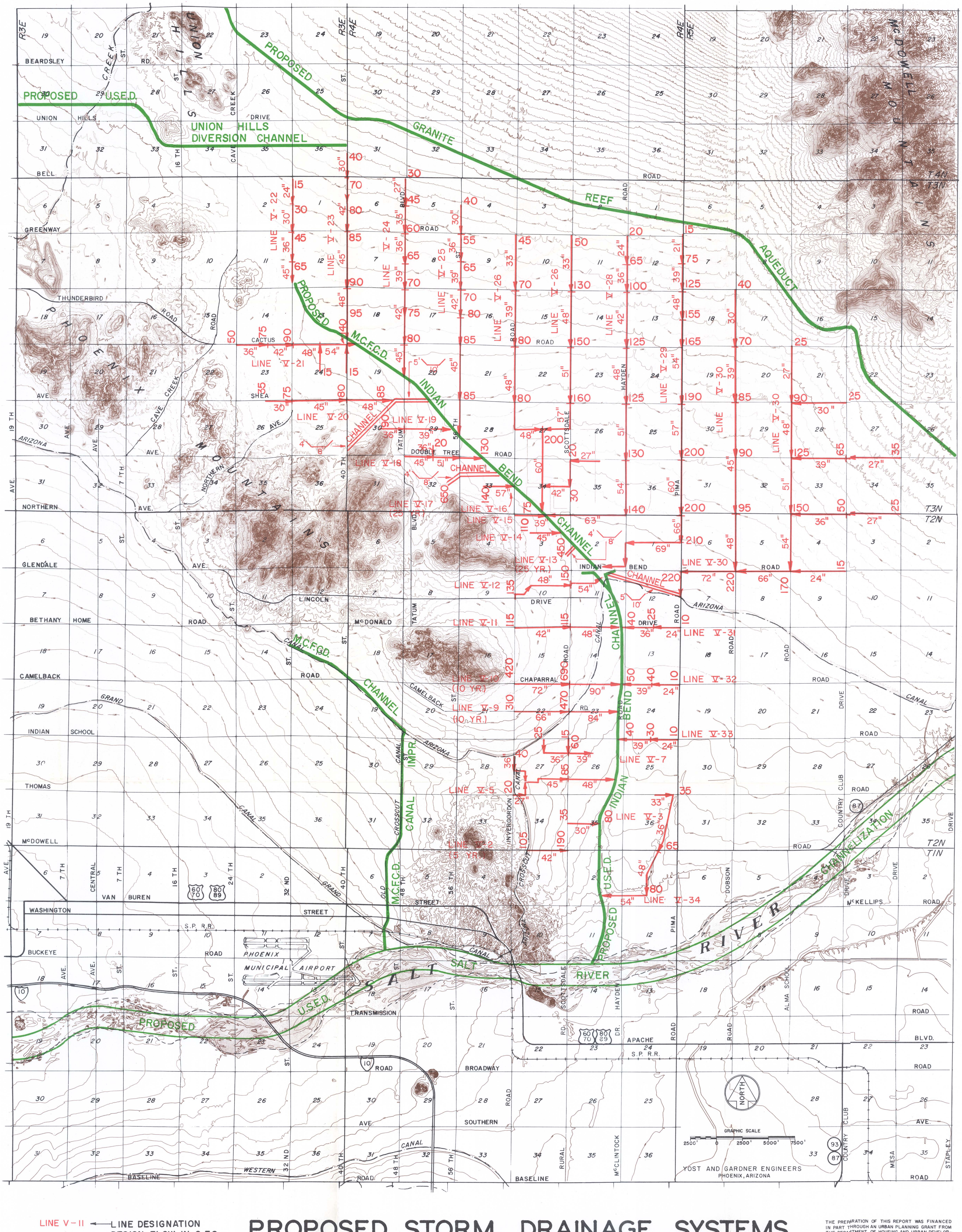
PLATE G




# PROPOSED STORM DRAINAGE SYSTEMS
# INDIAN BEND WASH

PLATE H




LINE V-11 ← LINE DESIGNATION
115 ← DESIGN FLOW IN C.F.S.
42" ← NEW PIPE
PIPE SIZE

NOTE: FLOWS SHOWN AT JUNCTIONS ARE FOR PEAK QUANTITY LEAVING.

# PROPOSED STORM DRAINAGE SYSTEMS
# INDIAN BEND WASH

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PLATE H