CITY OF MESA, ARIZONA

STORMWATER DRAINAGE FOR THE CITY OF MESA

Project No. 71-6

YOST AND GARDNER ENGINEERS

Phoenix, Arizona

November 15, 1973

3/25/74

Herb –

I spent 2+ days reviewing this report.

The concept appears sound (referring to the retention basins) but I did not check the adequacy for flows. That would require an exhaustive review of the detailed data.

I think the plan for emptying the basins deserves study (by Mesa, not us). Discharge into irrigation canals seems to have greatest economic benefit. Would Tempe and Phoenix object to discharge into the Salt River, as was ~~they~~ threatened on our plan to discharge the RWCD floodway into the Salt River?

I did not attempt to review any factors, such as infiltration rates, "n" values for pipe, etc.

Lee

FLOOD CONTROL PROGRAM

FIVE YEAR BUILDING PROGRAM
($1,000)

LOCAL PROJECTS		FY-75	FY-76	FY-77	FY-78	FY-79	TOTAL
DETENTION BASIN - TEMPE CANAL AND WESTERN CANAL	FCD	168					168
	MESA	168					168
	TOTAL	336					336
TEMPE CANAL FLOODWAY - SOUTHERN AVENUE TO WESTERN CANAL	FCD	154					154
	MESA	154					154
	TOTAL	308					308
DETENTION BASIN - EXTENSION ROAD AND SUPERSTITION FREEWAY	FCD		190				190
	MESA		190				190
	TOTAL		380				380
DETENTION BASIN - CENTER STREET AND SUPERSTITION FREEWAY	FCD		150				150
	MESA		150				150
	TOTAL		300				300
DETENTION BASIN - STAPLEY DRIVE AND SUPERSTITION FREEWAY	FCD			256			256
	MESA			256			256
	TOTAL			512			512
DETENTION BASIN - GILBERT ROAD AND SUPERSTITION FREEWAY	FCD				227		227
	MESA				227		227
	TOTAL				454		454
DETENTION BASIN - LINDSAY ROAD AND SUPERSTITION FREEWAY	FCD					235	235
	MESA					235	235
	TOTAL					470	470
DETENTION BASIN - VAL VISTA DRIVE AND SUPERSTITION FREEWAY	FCD					180	180
	MESA					180	180
	TOTAL					360	360
DETENTION BASIN - GREENFIELD ROAD AND SUPERSTITION FREEWAY	FCD					120	120
	MESA					120	120
	TOTAL					240	240
TOTALS	FCD	322	340	256	227	535	1,680
	MESA	322	340	256	227	535	1,680
	TOTAL	644	680	512	454	1,070	3,360

FLOOD CONTROL PROJECTS

PROJECT BUDGET ESTIMATES - 1974 PRICES

Channel - Tempe Canal
Southern Avenue to Freeway:

Cross-sectional area = 158.5 sq. ft.	
Length = 2600 feet	
Excavation costs: 15,265 cu. yds. at $.75 =	$ 11,448.75
Underflow for low flows: 2600 feet of 24" C.P. at $15.00 =	39,000.00
Sub-Total	$ 50,448.75
Plus Engineering (10% of Const. Cost)	5,044.88
Total	$ 55,493.63

Tempe Canal Channel
Freeway to Guadalupe Road:

70 ft. of R/W width for a distance of 10,100 feet = 16.23 acres. 16.23 acres at $6,500 =	$105,498.16
Concrete lining for low floats: 10 feet wide x 10,100 feet = 101,000 sq. ft. at $.75 =	75,750.00
Plus Engineering at 10%	7,575.00
Total	$188,823.16

Tempe Canal Channel
Guadalupe Road to Retention Basin:

R/W 1550 x 100 = 155,000 sq. ft. = 3.56 acres. 3.56 acres at $6,500 =	$ 23,140.00
Excavation: 31,595 cu. yds. at $.75 =	23,696.25
Concrete lining for low-flow: 10 feet wide x 1550 = 15,500 at $.75 =	11,625.00
Sub-Total	$ 58,461.25
Plus Engineering (10% of Const. Cost)	3,532.13
Total	$ 61,993.38

Retention Basins:

Tempe Canal at Western Canal:

20 acres at $6,500 per acre =	$130,000.00
Excavation: 201,650 cu. yds. at $.75 =	151,237.50
Pumping Station =	25,000.00
Under drain pipe (low flows): 500 lin. ft. of 36" concrete pipe at $20.00 =	10,000.00
Sub-Total	$316,237.50
Plus Engineering (10% of Const. Cost)	18,623.75
Total	$334,861.25

Extension Road at Freeway:

12.11 acres at $15,000 per acre =	$181,650.00
Excavation: 210,380 cu. yds. at $.75 =	157,785.00
Pumping Station =	15,000.00
Under drain pipe (low flows): 350 lin. ft. of 24" concrete pipe at $15.00 =	5,250.00
Sub-Total	$359,685.00
Plus Engineering (10% of Const. Cost)	17,803.50
Total	$377,488.50

Center Street at Freeway:

17.5 acres at $8,000 =	$140,000.00
Excavation: 121,000 cu. yds. at $.75 =	90,750.00
Pumping Station =	15,000.00
Underdrain pipe (low flows): 2500 lin. ft. of 24" concrete pipe at $15.00 =	37,500.00
Sub-Total	$283,250.00
Plus Engineering (10% of Const. Cost)	14,325.00
Total	$297,575.00

Stapley Drive at Freeway:

14.7 acres at $15,000 =	$220,500.00
Excavation: 326,760 cu. yds. at $.75 =	245,070.00
Pumping Station =	15,000.00
Underdrain pipe (low flows): 350 lin. ft. of 24" concrete pipe at $15.00 =	5,250.00
Sub-Total	$485,820.00
Plus Engineering (10% of Const. Cost)	26,532.00
Total	$512,352.00

Gilbert Road at Freeway:

13.2 acres at $15,000 =	$198,000.00
Excavation: 284,325 cu. yds. at $.75 =	213,243.75
Pumping Station =	15,000.00
Underdrain pipe: 320 lin. ft. of 24" concrete pipe at $15.00 =	4,800.00
Sub-Total	$431,043.75
Plus Engineering (10% of Const. Cost)	23,304.38
Total	$454,348.13

Lindsay Road at Freeway:

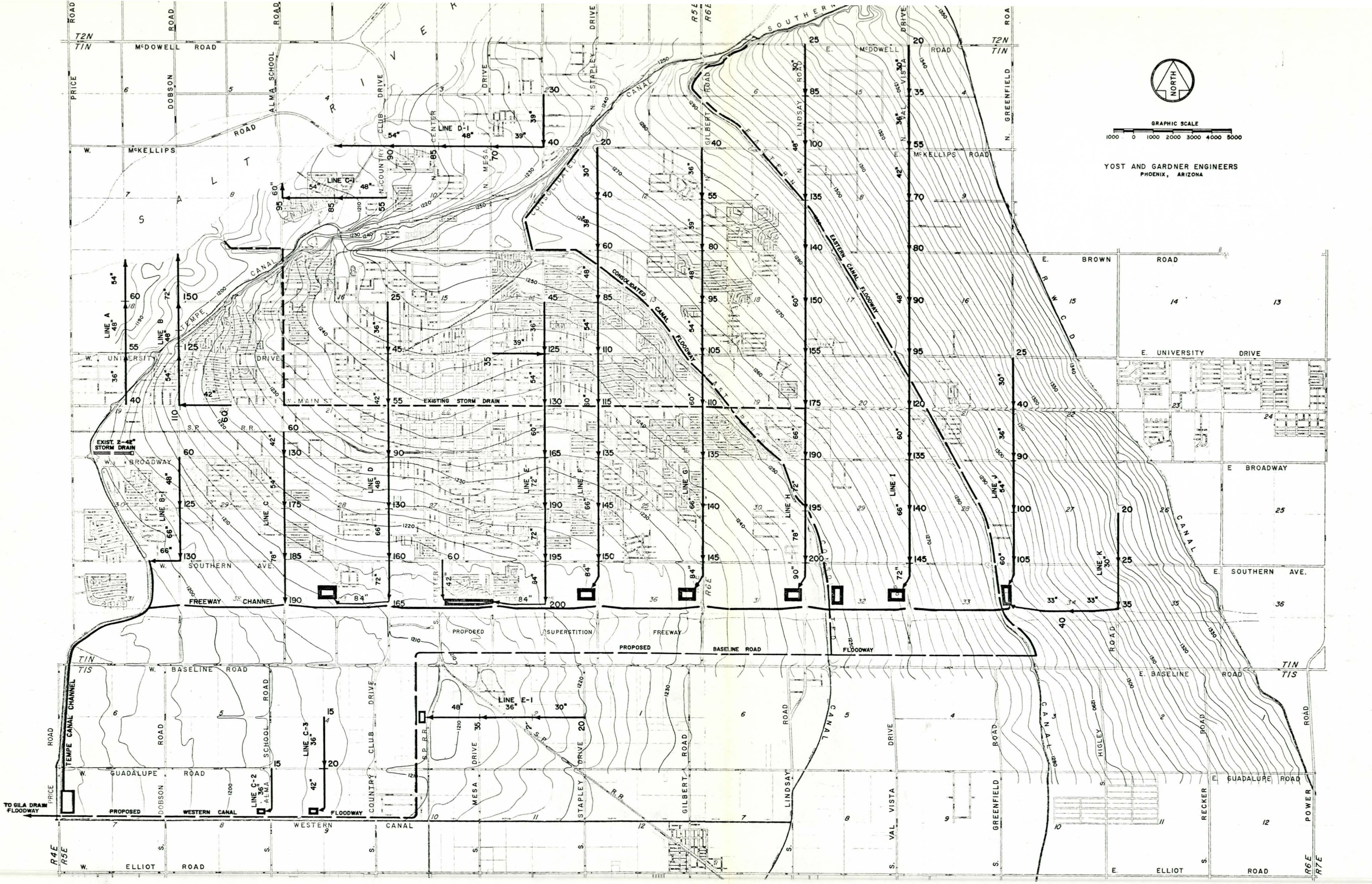
13.74 acres at $15,000 =	$206,100.00
Excavation: 292,130 cu. yds. at $.75 =	219,097.50
Pumping Station =	15,000.00
Underdrain pipe: 340 lin. ft. of 24" concrete pipe at $15.00 =	5,100.00
Sub-Total	$445,297.50
Plus Engineering (10% of Const. Cost)	23,919.75
Total	$469,217.25

Val Vista Drive at Freeway:

11.05 acres at $15,000 =	$165,750.00
Excavation: 202,870 cu. yds. at $.75 =	152,152.50
Pumping Station =	15,000.00
Underdrain pipe: 310 lin. ft. of 24" concrete pipe at $15.00 =	4,650.00
Sub-Total	$337,552.50
Plus Engineering (10% of Const. Cost)	17,180.25
Total	$354,732.75

Greenfield Road at Freeway:

7.82 acres at $15,000 =	$117,300.00
Excavation: 122,200 cu. yds. at $.75 =	91,650.00
Pumping Station =	15,000.00
Underdrain pipe: 250 lin. ft. of 24" concrete pipe at $15.00 =	3,750.00
Sub-Total	$227,700.00
Plus Engineering (10% of Const. Cost)	11,040.00
Total	$238,740.00



LINE A — LINE DESIGNATION

DESIGN FLOW IN C.F.S.

45 — 25

36"

NEW PIPE

PIPE SIZE

RETENTION BASIN

NOTE: FLOWS SHOWN AT JUNCTIONS ARE FOR PEAK QUANTITY LEAVING

PROPOSED STORM DRAINAGE SYSTEMS
CITY OF MESA

PLATE B—1

CITY OF MESA, ARIZONA

STORMWATER DRAINAGE FOR THE CITY OF MESA

Project No. 71-6

YOST AND GARDNER ENGINEERS

Phoenix, Arizona

November 15, 1973

SUPPLEMENT TO REPORT ON

STORMWATER DRAINAGE FOR THE CITY OF MESA

NOVEMBER 15, 1973

The storm drainage systems recommended in the original report and shown therein on Plate B required a series of seven retention basins along the north side of the indicated alignment of the proposed Baseline Road Floodway. The purpose of these basins and the reasons for their location are explained in Paragraph 4.3 on page 44 of the report.

The report also touches on the desirability of co-ordinating the drainage requirements of the City with those of the State Highway Department for the Superstition Freeway, discussing this in Paragraph 4.5 on page 49.

Discussions with City of Mesa and State Highway Department representatives at a meeting in the Mesa City Engineer's office on November 29, 1973, subsequent to the completion of the report, brought out some advantages of locating the retention basins on the north side of the freeway:

1. Right-of-way for a collecting channel is already available along the north edge of the freeway.

2. Requirements for passing storm water across the freeway would be reduced and could be eliminated altogether if the basins are large enough to handle discharge required by the freeway.

3. The corridor containing the freeway and drainage facilities could be more compact if the basins are located north of the freeway,minimizing land requirements for these purposes.

4. If the basins are developed as parks, they would be more immediately useful north of the freeway where the area is already more highly developed than if they were south of it.

For these reasons Plate B has been revised (and given the designation B-1) to show the retention basins along the north side of the freeway alignment. The revised plate accompanies this supplement.

Plate B-1 does not show the revisions that would be required for draining the area south of the freeway. Additional study should be given this area if the retention basins are built to the north.

No revisions have been made to the cost estimates. The changes in the work should reduce the cost somewhat because pipe runs will be shortened. Basin costs may be higher with the revised plan, especially if additional storage is provided to meet Highway Department requirements.

YOST AND GARDNER ENGINEERS

By J. E. Schaefer

Registered Professional Engineer (Civil)
CERTIFICATE NO. 1517
JOHN E. SCHAEFER
Date Signed 12-27
ARIZONA, U.S.A.

December 27, 1973

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

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

November 15, 1973

Mr. Charles K. Luster
Public Works Director
City of Mesa
55 North Center Street
Mesa, Arizona 85201

Re: Mesa Project 71-6

Dear Sir,

Transmitted with this letter is our report on storm drainage for the City of Mesa, submitted in accordance with our agreement dated April 4, 1973.

The purpose of this study is to evaluate requirements and make recommendations for a construction program adequate to serve Mesa and its present environs through the year 1990, and to estimate the costs.

Our recommendations are for a system of trunk drainage pipes and channels generally located on arterial streets at about one mile intervals. Less than 10 percent of the study area slopes toward the Salt River, the remainder falls toward the Gila. The proposed pattern of drains reflects this. A few short lines in the floodplain around Lehi would carry flow westward and discharge to the Salt River. Drainage for the remainder of Mesa is from north to south and east to west. Lines would discharge at the flood control channels proposed in the recent Maricopa County Study (Ref. 2), if that project is built. Failing this, a series of retention basins is suggested which in turn would be pumped out to irrigation canals under an agreement with the Salt River Project or to the Salt River through a facility installed by the City of Mesa.

The system is sized to handle impervious area runoff from storms such as may be expected to recur on an average of once every two years. In addition, ten-year flows from arterial streets are provided for. The calculations assume that present city policies requiring retention of 50-year, 24-hour runoff on the site of new developments will continue in effect.

The total cost of the trunk drain system at October 1, 1973, prices is estimated to be $21,836,100. This includes $2,913,120 for retention basins which are required if the floodways are not available. A pumpback system to carry water from the basins to the Salt River would add $1,005,600 to this amount. If the flood control channels as proposed in Ref. 2 are constructed, an alternative system utilizing these floodways for terminal points, could be built at a savings of $5,486,000 and the retention basins and the pumpback system would become unnecessary. The total trunk drain program in this case would cost $14,744,000 exclusive of floodway costs.

It is recommended that the City of Mesa support the floodway program currently under consideration by Maricopa County. Such support should be conditional on floodways that are deep enough and otherwise compatible with the storm drainage system outlined in this report, and that meet other municipal requirements relating to traffic, parkways, and general esthetic considerations.

Although the floodway system seems very attractive, it should be noted that it is necessarily remote in time. The three projects that would be of immediate benefit to Mesa are numbers 5, 6, and 7 in a priority list of 14 projects given in Ref. 2. Corps of Engineers studies, a prerequisite for Federal participation, are just now getting underway. All the uncertainities of future congressional authorization and appropriation measures remain. The most pressing Mesa drainage needs can hardly be deferred until the floodways become available.

The Arizona Highway Department has important drainage concerns in connection with the Superstition Freeway. Conferences were held with representatives of the State Highway Department during the preparation of this report, some jointly with representatives of the Mesa City Engineer's office. The projects recommended herein are believed to be compatible with the freeway as presently conceived. Hydraulic capacities are not sufficient to handle freeway drainage, however, since the magnitude of this is not known at this time, the City of Mesa should continue its liaison with the Highway Department to the end that the systems finally constructed are adequate to serve both purposes.

We wish to acknowledge and express our appreciation for the assistance given us by the City of Mesa personnel, particularly Mr. Peter L. Peterson, during the preparation of this report.

Respectfully submitted,

YOST AND GARDNER ENGINEERS

By

J. E. Schaefer

JES:fp

Contents

Figures and appendices have not been assigned page numbers. They appear in order following the text.

List of Figures

List of Figures

List of Tables

List of Appendices

List of Plates

1. The Study Area

An area of 65 square miles was delineated for the studies covered in this report. The corporate limits of the City of Mesa enclose 41 square miles of this, the remainder being agricultural land in a strip south of Mesa and in a separate tract northeast of the city. There are also several small parcels to the north and west of Mesa which were included in the study area but are outside the city.

Mesa is a city of 62,853 population[(1)] located in northeastern Maricopa County, Arizona. It is immediately adjacent to the City of Tempe on the west. Tempe has 63,550 inhabitants. The smaller City of Chandler (population 13,763) and Town of Gilbert (population 1,971) are nearby but not contiguous on the south. The populous though unincorporated town of Apache Junction and several burgeoning retirement colonies lie to the east in the unirrigated land above the Roosevelt Irrigation District Canal (hereinafter referred to simply as the Roosevelt Canal). The Salt River forms a part of the city's northern boundary. Beyond the river is the Salt River (Pima) Indian Reservation. The Salt River and Fort McDowell Reservations, which are contiguous, have a combined population of 996 persons. Fig. 1.1 shows the City of Mesa and its environs in relation to the boundaries of the area marked out for study.

[(1)] All population figures in this paragraph are 1970 census data. Indicators show continued rapid growth since the census.

1.1 Study Area Boundaries

The limits of the area studied were determined prior to the inception of the work and were based primarily upon topographical considerations. In general, the boundaries are or will be lines corresponding to watershed boundaries, some natural and others artificial. The eastern boundary follows the Roosevelt Canal because a flood control channel being planned by the Flood Control District of Maricopa County and the U.S. Soil Conservation Service and described in Ref. 1, will effectively block runoff from the Usery and Superstition mountains to the northeast.[(1)] Drainage from the north is limited by the Southern and Consolidated Canals and the Salt River so these were chosen to form the northern boundary. On the west, the Tempe Canal, where it forms the boundary between Tempe and Mesa, also bounds the study area. On the south, and west of Gilbert, the Western Canal serves this purpose because it is in itself a barrier but primarily it was selected because a branch of the proposed Gila Drain (Ref. 2) currently under consideration as a flood control project would follow this alignment.

The remainder of the south study area boundary is an arbitrarily chosen line back to the Roosevelt Canal on a route generally perpendicular to ground contours which would have little or no drainage crossing it.

The study area boundary is shown by the heavy dashed line in Fig. 1.1 with the present corporate limits of Mesa also indicated.

[(1)] References are listed on page 66.

1.2 Population

The population of Mesa has been increasing rapidly, in line with the general trend of Salt River valley communities, but as normally happens, the annual growth rate has been declining as the city grew:

Table 1.1 - Census Data for Mesa, Arizona

Year	Population	Average Annual Growth for Preceding Interval
1940	7,224	
1950	16,790	8.8 13.2 percent
1960	33,772	7.2 10.1 percent
1965	50,529	10.8 9.4 percent } 6.4%
1970	62,853	4.5 4.8 percent

Building permits, utility connections, and the other commonly used indicators point toward an apparent resurgence of the growth rate. The Mesa Planning and Zoning Department estimates that it is now about 11 percent per year, with current resident population at 90,000 within corporate limits.(1)

Mesa is also noted as a gathering place for winter visitors. Many live in mobile home communities north and east of the downtown area. This substantial transient population (60,000 persons who stayed a week or longer in the 1972-73 season) is not reflected in the above figures for resident population.

The transient population may or may not pay its way, but there is no question that it exerts a demand for municipal services, including pro-

(1) The figures on transient and current resident population were obtained from the Mesa Planning and Zoning Department.

vision of storm drainage facilities.

Population, its areal distribution, and trends to the year 1995 have been systematically studied in Maricopa County for several years, first by the Valley Area Traffic and Transportation team set up by co-operating local governmental units and since 1971, by the Maricopa Association of Governments Transportation and Planning Program. The information gathered and the projections have always been available for planning purposes. Storm drainage facilities are not needed where there are no people to benefit from them, consequently population studies and projections make an important contribution to the rationale behind the ultimate recommendations of this report. Plate A, prepared from data made available by Maricopa Association of Governments Transportation and Planning Program shows in detail where people live and will be living in the future throughout the study area.

1.3 Land Use

The amount of runoff produced per acre and the need for storm drainage facilities are also influenced by the uses to which the land is put. A long-range program should be based on current land use and on the best and most detailed available information on trends. Like population projections, future land use information is valuable for a variety of municipal planning purposes.

The most recent land use studies for the Mesa area were made by Victor Gruen and Associates in 1971 (Ref. 3). Continuous studies are also underway on land use by the Mesa Planning and Zoning Department and by the Maricopa County Planning Department. Information from these sources was compiled and is presented in Fig. 1.2. In the preparation of this figure there has been some generalization in order to adapt the information to drainage planning purposes and we have made some minor changes to reflect developments currently under way.

The role of land use data in computing runoff rates will be discussed in more detail later in this report. Briefly, there is a relationship between land use and the amount of paved surfaces in an area, affecting the portion of rainfall that filters into the soil and therefor does not have to be handled by drains. There is also some correlation between land use and the degree of protection that is economically justified. This aspect will be discussed in Section 3.1 of this report.

1.4 Natural Drainage and General Topographical Characteristics

Although it is situated on the Salt River, very little of the natural drainage of the city finds its way into that stream. In the vicinity of Mesa, the watershed boundary is formed by an escarpment, generally 50 to 100 feet high. The land south of this escarpment on which most of Mesa is situated (which presumably accounts for the name of the city) slopes southwesterly toward the Gila River, 16 miles distant from the southwest corner of the study area.

Conveying any drainage, either sanitary sewage or storm water, toward the Salt River from most parts of Mesa by gravity flow entails working against the natural slope of the land and involves very deep trenches where the pipeline crosses the line of the escarpment. This sharply limits the area that can economically be drained toward the Salt.

Mesa's gravity sanitary sewer system extends as far south as the Superstition Freeway alignment. South of that line pumping becomes necessary. Storm drains require much larger pipes, and pumps for the much greater flows are very expensive, consequently the dividing line for storm drainage is much farther north than it is for sanitary sewers. The existing Main Street storm drain discharges to the Salt River at Alma School Road but it is on such a flat gradient that its hydraulic capacity is limited to 190 c.f.s, which is insufficient to provide adequate storm drainage service for the entire area tributary to it.

In general, storm drainage conduits must take the slope of the land as nearly as this is permitted by the street system. If this rule is not followed, excessively large channels and pumping plants are required and there may also be the legal necessity to compensate someone for damages resulting from diversion of drainage from its natural path. An exception to the rule is the case where temporary storage is provided in a detention basin which is then emptied at a slow, controlled rate that will do no damage and might even provide an economic return. More discussion on this point follows in Section 3.3.

That part of the area which is now Mesa and which contributes to the Gila, lay at the very head of the desert washes that existed in the natural state. There never was any great quantity of water to be handled, there being little tributary area. Moreover the ground slopes were flat; the ephemeral streams occurring after storms flowed sluggishly. This means that there were probably no deep natural ravines in the area. At any rate, no traces remain of any well-defined and entrenched natural washes.

These are a common feature of the desert landscape elsewhere around Mesa.

The absence of gulleys and washes made for the fine agricultural land which accounts for Mesa's early settlement and prosperity but it is a drawback when it comes to providing drainage facilities for an urban community. Nearly level areas are hard to drain and require large pipes to carry relatively small amounts of water. The lack of washes and ravines means there are few places where the water that is once collected in a drain may be safely discharged. Both of these circumstances must have a profound influence on a drainage system designed for Mesa and will make it substantially different from one for a community more favorably situated from the drainage standpoint.

Canals have already been referred to as having been determinants in setting the study area boundaries because they affect the route taken by drainage water. This happens when a canal is deliberately built high relative to the land it traverses in order to provide a proper hydraulic gradient or to permit irrigation of adjoining land by gravity. This can be an advantage in designing a drainage system because it may limit the possibilities of inflow but it obviously can also cause problems where ponding results from the blockage of natural flow.

The Tempe, the Eastern, and the Consolidated canals flow through the study area and, in some spots cause local ponding that has proved to be a nuisance and a maintenance problem. During the agricultural era this was minimal but with increasing urbanization the need to remedy the condition becomes more pressing.

There are other areas where such trouble spots occur. Some are caused by high street crowns or median strips in roadways that prevent good cross-drainage.

A drainage system should alleviate as many of these situations as possible. While trunk drains must generally run along arterials, the secondary collector system can usually be designed to pick up water from local poorly drained areas.

1.4.1 Topographic Mapping

The best general contour coverage of the study area available for this report is the 1:24000 scale series of topographic maps published by the U. S. Geological Survey. The following sheets cover the area:

Name of Sheet	Contour Interval	Date of Publication
Tempe	10 feet	1952 - Photo Rev. 1967
Mesa	10 feet	1952 - Photo Rev. 1967
Buckhorn	10 feet	1956
Guadalupe	10 feet	1952 - Photo Rev. 1967
Chandler	10 feet	1952 - Photo Rev. 1967
Higley	10 feet	1956

In order to lay out proposed drainage sytems, compare alternatives, arrive at preliminary pipe and channel sizes, and estimate costs, it is necessary to have more detailed contour information than can be obtained from the U.S.G.S. maps. Furthermore the Mesa area sheets are old and do not reflect recent rapid changes in the surface culture. Consequently it was necessary to assemble all the more recent and more detailed contour information available and supplement it with extensive new field information obtained especially for this study. The results were compiled in the form of the contours shown on Plate B, with the Mesa Planning and Zoning Department's up-to-date street maps as a base. The sources of the contour information used in the compiled map are indicated in Fig. 1.3.

1.4.2 Soils Characteristics

The absorbent characteristics of a drainage area's soils becomes a factor in drainage system design when the intent is to provide protection for a more severe, lower frequency storm during which peak runoff is affected by contributions from all portions of the area. For storms of one and two-year frequency in urban areas with flat slopes such as exist in Mesa, it is appropriate and customary not to figure runoff from pervious areas. In the more severe storms, say of 5 to 10-year recurrence interval and worse, the rainfall rate may substantially exceed infiltration rate, particularly if there has been antecedent rainfall (which is always assumed to be the case for conservative design). Consequently attention was given in these studies to the types of soils found in the study area and to the infiltration rates characteristic of these soils. Because the ultimately recommended system is for the 2-year storm, however, (See Sec. 3.1) the infiltration capacity of basin soils did not become a factor in the design. The information is presented here for the sake of completeness and in the hope that it may be useful if portions of the system are ultimately designed to provide a higher degree of protection.

The U.S. Soil Conservation Service completed a comprehensive survey of Maricopa County soils in June, 1969. Fig. 1.4 of this report is adapted from the Soil Conservation Service map (Ref. 4) and shows the distribution of soils with characteristic sustained infiltration capacities ranging from 0.1 to 3 inches per hour. The infiltration capacity for the soils identified by name in Ref. 4 was obtained from another publication of the Soil Conservation Service (Ref. 5). The results, the sustained infiltration capacities in inches per hour, were plotted for each quarter section in the study area and are given in Fig. 1.5.

1.4.3 Drainage Areas

Within the general drainage pattern established by the ground contours in the study area there is a finer secondary pattern of smaller areas, the limits of which are often established by human intervention such as the leveling of fields for flood irrigation, the construction of dikes and roadways, etc. Such features may be obliterated in a flood or an unusually severe storm. They do have an important impact, however, on the design of a drainage system intended to handle low-stage, more frequent runoff levels. The boundaries of these subsidiary drainages, as derived from field and office study are shown in Fig. 1.6. Each area is given an identifying number subsequently to be used in the calculations for this report.

2. Hydrology

The purpose of the hydrologic studies made for this report is to arrive at reasonable peak runoff rates for given recurrence intervals for approximately 260 points distributed uniformly over the study area. The studies then consider the way in which these peak flows combine along the course of a collecting pipe or channel, making due allowance for the delay that occurs as the peak progresses down the drain from one area to the next, and arrive at a series of cummulative peak flow values that can be expected for the chosen recurrence interval along the length of the drain. This information is then utilized in combination with data on slope and conduit properties to arrive at a preliminary selection of conduit size. The latter steps in this process and the results are set forth later in this report.

The method used in making the flow computations is the well-known "rational formula" modified to handle pervious and impervious portions separately. It is applied repetitively to successively larger portions of each individual drainage area until a maximum rate of out-flow for the area is reached which is then adopted as the peak flow (Q_p) for the area. The maximum (for approximately square urban areas with paved streets) typically occurs before the entire area contributes. Concentration time for flow on city streets (Fig. 2.9 shows typical Mesa sections) may be taken from curves such as Fig. 2.10 relating capacity and velocity to slope and street cross-section.

The computations were made in a standardized format developed for previous studies of this type. The calculations are voluminous and are not included in this report, however, the calculations for Line F (See Plate B) are included in Appendix II and one copy of the entire set of calculations is being furnished to the City of Mesa Engineering Department.

Detailed description of the methodology is given in Ref. 6, pages 24 ff. Necessary basic information on rainfall has been derived from the Arizona State Highway Department Hydrologic Design Manual (Ref. 7) which is the source of the precipitation maps reproduced as Figs. 2.1 through 2.6. For ease of use, data from these maps are presented as curves in Fig. 2.7.

For large areas, the rainfall intensity from Fig. 2.7 should be reduced as shown in Fig. 2.8. None of the individual drainage areas encountered in this study were large enough to warrant reduction. The factor becomes significant for some of the longer trunk drains where the cummulative contributing area is 500 acres or more.

The extent of pervious and impervious areas in each drainage is computed on the form using land use information from Fig. 1.2 and pervious/impervious factors from Table 2.1. In many cases the values from the table were tempered to allow for the degree to which the land use indicated in Fig. 1.2 reflected present or future development. In commercial areas for example, developments prior to 1972 were allowed to discharge their entire storm runoff into the street or storm drainage system under an arrangement whereby the developer participated in the cost of the drainage facilities. Current policy is to require developers

Table 2.1 - Pervious/Impervious Factors for Various Land Uses - Design Values

Land Use	Zoning Categories	Percent Pervious	Percent Impervious
Residential - Low Density (to 5 units per acre)	SR to R1-6	65	25
Residential - Medium Density (5 to 10 units per acre)	R2	60	35
Residential - High Density (over 10 units per acre)	R3 and R4	50	40
Parks and park-like	Various	10 ?	10
Farmlands, groves		5 ?	5
Commercial	C-1, C-2, & C-3	0	90
Industrial	M-1 and M-2	30	70

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.

Can't understand why parks and farms are not larger percent pervious to retain storm water and discharge it to the collection system after the storm at acceptable rates. The analysis consequently makes a distinction between "present" and "future" commercial and industrial areas in computing runoff rates.

3. General Considerations

In addition to establishing peak value and frequency of runoff occurrences for each of the subsidiary drainages making up the study area and their cummulative magnitudes along the collecting drainage-ways, the task includes delineation of a suitable and economical system to accommodate these discharges. This section of the report deals with some of the general design considerations or criteria used in planning these systems.

It may be helpful here to reiterate: a) that we are concerned with storm drainage, not flood control (the relationship between the two is outlined in Table 3.1 which is reproduced from Ref. 6.) and b) it is assumed that the city's policy requiring retention of storm water on new developments remains in effect.

3.1 Degree of Protection to be Provided

In the early phases of this study consideration was given to the standards of capacity to be recommended for a storm drainage system. While other valley cities have systems designed for storms such as can be expected once every one or two years (Ref. 8) it was hoped a higher degree of protection could be provided for Mesa. An analysis was made for one trunk line to see what pipe capacity would be required to carry 5- and 10-year flows. Table 3.2 compares the peak flows for several points on Line F under the various recurrence intervals for which the calculations were made.

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

Table 3.2 - Line F (Stapley Drive), Peak discharges at selected points for various recurrence intervals

Location	Peak Discharge - cfs		
	1-Yr.	2-Yr.	10-Yr.
Brown Road	20	50	140
University Drive	30	100	430
Broadway	35	160	620
Southern Avenue	40	175	665

Notes: Pervious area contributions are excluded for one-year and two-year storms but are included for the 10-year storm. All discharge values given include runoff from commercial and industrial areas. Design flows (two-year values) for line F given later do not include runoff from future commercial and industrial areas.

When the flows at the lower end of Line F given in Table 3.2 are evaluated in terms of pipe sizes by means of Fig. 2.11, it is readily apparent that it is impractical to accommodate 10-year runoff through conventional subsurface piped drains. Other means such as open channels or continuous box culverts are even more expensive and have other obvious drawbacks, especially in congested urban areas.

For these reasons a two-year design frequency has been adopted as the general rule for determining the pipe sizes recommended in this report. Because of an established city policy to provide 10-year drainage on arterial streets, the area occupied by arterials around the perimeter of each quarter section (which amounts generally to 4 acres) has been deducted from the gross area and the runoff rates for the 10-year storm have been computed separately. These have then been added to the two-year flows from the remainder of the drainage area to determine flow rate. The propriety of adding 10-year to 2-year flows may be questioned, nevertheless it constitutes a consistent basis for design that provides 10-year protection for arterials (provided surface drainage onto arterials from side streets is limited) and slightly better than two-year protection generally.

Storms more severe than the design storm will of course overtax the drainage system but if it is designed to keep hydraulic gradients well below the ground surface, ponding conditions along the drain will nowhere be worse than they would have been had the drain not been built. In general they will be much better. It is not always recognized that a drain designed for the two-year storm still provides a great deal of benefit in alleviating conditions when worse storms occur.

This assumes that an entire trunk drain is built as a single project, or at least that the lower portions are built first. If it is necessary to build the upper portion of a drain some time before it can be provided with an outlet, say because of street paving schedules, it should be fitted with temporary bulkheads so that flooding conditions are not worsened by the drain for the area just below the new improvement.

Similarly, if retention basins are provided in the final design, the capacity provided in the basin should be substantially greater than the volume of runoff expected through the drain from the storm for which it was designed. This may be accomplished by designing for a longer return period as is customarily done in flood control projects, or a factor of safety may be provided in the form of liberal freeboard allowances. Some freeboard generally needs to be provided anyway because of the depth requirements for the inlet pipe. This aspect is discussed further in Section 3.3.

3.2 Existing Storm Drainage Facilities

The principal existing storm drain in Mesa is the Alma School Road - Main Street line, constructed to Mesa Drive in 1966 by the Arizona Highway Department as a part of a project for the widening of U.S. Routes 60, 70, 80 and 89. In 1973 this line was extended east to Lindsay Road, again by the Arizona Highway Department in connection with another widening project. Pipe sizes and slopes were obtained from plans for Highway Department Project F-022-3-513. The hydraulic capacity of the line was computed assuming a hydraulic gradient elevation approximately at the top of the pipe. Capacities obtained varied from 20 cfs in the 30-inch pipe at Lindsay Road to 190 cfs in the 84-inch line on Alma School Road. Pipe sizes and capacities are shown in Fig. 3.1. The line does not go all the way to the Salt River but terminates in the Tempe Wasteway operated by the Salt River Project.

The Main Street drain is a substantial asset to the city's system and should of course be maintained and kept in use. Its capacity is insufficient however to provide two-year or better service for the area that is tributary to it. It was not designed to do this: it was intended simply to serve the highway. Flows in excess of its capacity impounded by the high curb at the median strip, discharge from the inlets along the south curb of Main Street and flow to the south or southwest on the surface following the slope of the land.

There are a few other existing piped storm drain lines, generally installed in connection with subdivision or other development. These are shown on Plate B. There is also an existing open channel drain and sump adjacent to the Tempe Canal as shown on Plate B. A profile for this channel is given in Fig. 4.20 with a typical section shown in Fig. 4.22. Capacity calculations for the channel are presented in Appendix IV-2.

The existing facilities should be integrated into the ultimate drainage system. New drains to serve the area contributing to the Main Street drain will be necessary and the most effective placement for them will be from north to south across the Main Street pipe. Connecting the new and existing lines would be expensive and would not accomplish much. Inlet discharge from an overloaded Main Street line can find its way to the new north-south drains readily over the surface within a short distance of the crossing. A direct connection between the two lines would empty all low flows from the Main Street pipe into the intersecting north-south lines which are on a steeper gradient.

3.3 Use of Detention Basins

The Mesa area is characterized by large expanses of flat land on relatively mild slopes. Except for the Salt River, there are no entrenched natural water courses such as frequently occur in other areas. Consequently drains must be long and large in capacity and the capital investment per square mile for adequate drainage runs higher than it would for steeper ground more liberally laced with ravines and washes.

One way of counteracting the large investment requirements for drainage is to hold the water on the land and release it more slowly,perhaps not discharging it to the rivers at all but pumping it to the irrigation system or allowing it to percolate into the soil. This alternative permits a smaller and cheaper collection system at the expense of land used for storage and the cost of evacuating pumps or drains. The area devoted to detention basins can often serve a secondary purpose but the limitations are rather stringent and practically dictate that the secondary uses be public or quasi-public (such as parking).

Figure 3.3 is representative of the runoff to time relationship for a typical drainage area. It has been developed by the Soil Conservation Service from averaged values of many observed storms on rural drainages and is presented in "dimensionless" form, that is, flow rate and time values are shown as ratios to peak rate and total runoff time. It is used here to illustrate the efficacy of storage in reducing capacity requirements of the drain expected to accommodate runoff from the storm. For this purpose a third curve labeled "required drain capacity" is superimposed on the others and relates to the scales that have been added at the right and top of the curve.

The third curve is derived directly from the other two curves in the figure. It shows the limitations of storage as a means of reducing pipe capacity requirements, indicating that for the first 40 percent of the total runoff stored there is no reduction in the peak flow to be handled. It is necessary to store nearly 80 percent of the runoff in order to reduce pipe capacity requirements by 50 percent.

Of course, this applies to the design storm only. For lesser storms the benefit of storage is progressively higher but systems are nevertheless built to handle design storms. After the pipe is in the ground there is no advantage in not using it.

If storage can be arranged so that it only needs to accommodate flows in excess of drain capacity, not the entire flow, the situation becomes more favorable. This requires basins that are adjacent to, but not in, the main flow path of the drain, referred to hereinafter as "off-line" storage. It is also necessary to provide some means of diverting that part of the flow in excess of drain capacity out of the channel or conduit into the basin.

Referring again to Fig. 3.3, the horizontal line at the 0.5 mark on the left vertical (Q) scale divides the runoff hydrograph into two parts. Planimeter measurements of the area under the hydrograph indicate that only one fourth of it is above the 0.5 line. That is, required drain capacity could be reduced to one half of the peak flow rate by providing off-line storage for 25 percent of the mass runoff. This is considerably better than could be done with in-line storage where retention of three-fourths of the runoff is required to effect a 50 percent reduction in drain capacity requirements.

Devices for splitting the flow and diverting the portion in excess of drain capacity are essential to this scheme. These would not necessarily be complicated nor would they have to receive more maintenance than other portions of the drainage system. Fig. 3.2 indicates the type of installation that could be used in pipe systems and with open channels.

Provisions for returning the diverted water from the basin to the drain system after the storm has ended should utilize gravity flow wherever possible. The simplest way to accomplish this is by means of a valved basin drain running back to the main storm drainage pipe at a point low enough that the basin can be drained dry by gravity. The valve would then be manually opened and closed at appropriate times by city personnel. Normally the valve would be kept closed in anticipation of a storm. Automatic motorized operation of these valves is also a possibility.

Storage does not necessarily imply ground level basins. A certain amount of in-line storage is provided in the collection system itself and this may deliberately be maximized by constructing broad open landscaped swales in lieu of compact lined channels. In some part of the country roof storage is encouraged for expansive flat-roofed buildings such as shopping centers, warehouses, and manufacturing plants.

Limitations are occassionally set by ordinance on the rate of runoff into the public system permitted from parking areas and pedestrian malls. It then becomes the developer's responsibility to provide facilities for holding the water until it can be released.

All such measures have their own costs. Parking areas designed to hold water must either be built to appropriate and more expensive standards or they will break up more quickly. Roofs designed to hold ponded water are not usual in this area where snow is not a concern and where dead level roofs are avoided because of the difficulty of sealing them under the extreme expansion-contraction conditions that prevail.

A policy requiring developers of residential property to build in such a way that the 50-year, 24-hour storm would be retained on each lot has been in effect in Mesa for the last year or so. Such a policy does effect economies in the storm drainage system because it reduces the contributing areas and peak flows. It is also a conservation measure in that it makes use of a valuable resource at least some of which would otherwise go to waste. It is not really a nuisance because rains are infrequent and infiltration rates high enough that lawns are inundated only for a few hours, even after unusually heavy storms.

Detention basins in commercial and industrial areas are not so effective in reducing overall drainage system costs. In the first place land values are usually higher. Basins must be located in the lowest part of the area contributing runoff. This is often at or near an arterial street intersection and such locations generally bring premium prices. If, for the sake of economy, basins are made deep and lined, disposal by infiltration is ruled out and multiple use possibilities of the area utilized are more limited. Drainage should be provided to empty such basins within 24 hours. A full basin offers no protection and a glance at the rainfall data of Table 3.3 will show that heavy storms do occasionally occur on successive days. Emptying a basin within 24 hours of a storm imposes a significant load on the drainage system.

The most promising applications for storage then are in newly developing residential areas. "Garden type" industrial and commercial areas could readily work adequate detention basin capacity into the landscaping arrangement in ways that would also enhance percolation into the subsoil.

In any situation where water must be brought to the detention basin in pipes or channels, the basin should be large enough to hold substantially all of the runoff that the design storm would produce where in-line storage is used. Off-line storage should be at least 25 percent of this amount. Facility should be provided to drain the basin entirely within 24 hours. Mass runoff quantities would be of the order of 5-acre feet per quarter section for the 50-year storm depending very much on the development in the drainage area. If storage is provided in these amounts, design drain capacities can be reduced by almost 50 percent. This can best be done where basins can be used for secondary purposes such as recreation.

Storage in school grounds is already being used in Mesa at the Roosevelt Elementary School at 8th Avenue and the Tempe Canal. Projects are under construction on Gilbert Road near Hale Street and along parts of the Tempe Canal. Table 3.4 summarizes the available information on these and two other proposed projects.

Table 3.3 - Rainfall Data

Date	WEATHER			BUREAU			STATION		
	Apache Junction	Chandler	Falcon Field	Granite Reef Dam	Mesa Exp. Station	Scottsdale	Stewart Mountain	Tempe	Tempe Citrus Exp. Station
Dec. 28, 1972				1.28		1.26	1.17	1.17	1.04
Oct. 19	1.65	3.20	1.42	1.30		1.45	1.83	1.16	1.13
Oct. 7			1.02	1.26	1.02	1.15	1.75	1.17	1.22
Oct. 6		1.13							
Oct. 5						1.25	1.57		
Oct. 4	1.29								
Aug. 29, 1972	1.02								
Sept 20, 1971	1.48	1.00							
Sept 2							1.06		
Aug. 15, 1971	1.88								
Sept 6, 1970		1.35		2.38	1.35	3.57	3.10	1.96	
Sept 5,	2.82		1.11						
Mar. 3,				1.03			1.08	1.08	
Mar. 2, 1970	1.15			1.05					
Sept 16, 1969									1.40
Sept 15,								1.55	3.87
July 23							1.04		
Jan. 15, 1969						1.00	1.14		
Nov. 14, 1968					1.13				
Aug. 11			1.23						
July 31						1.16			
Mar. 10					1.05		1.15	1.01	1.17
Mar. 9, 1968	1.30			1.45					
Dec. 19, 1967							1.05		
Dec. 15			1.87		2.28	2.07		2.16	1.97
Dec. 14	1.20			1.68					
Dec. 13	1.87								
Nov. 29	1.00								
July 17							3.25		
July 11, 1967	1.00								

Date	WEATHER BUREAU STATION								
	Apache Junction	Chandler	Falcon Field	Granite Reef Dam	Mesa Exp. Station	Scottsdale	Stewart Mountain	Tempe	Tempe Citrus Exp. Station
Sept 13, 1966	1.28	1.23	1.48	1.94	1.75		1.35	1.77	
Aug. 19, 1966		1.60	1.09	1.46			1.34	2.15	
Aug. 18, 1966			1.16	1.09				1.31	
Dec. 23, 1965							1.86		
Dec. 22	1.70		1.47	2.08					
Dec. 11				1.33					
Dec. 10	1.87		1.55				1.39		1.12
Apr. 4				1.12					
Feb. 7, 1965		1.12			1.40		1.63		
Dec. 18, 1964					1.00				
Nov. 16				1.07			1.10		
Sept 15					1.19			1.51	
Aug. 27							1.62		
Aug. 14								1.69	
Aug. 3									2.01
Aug. 2							1.90		
Aug. 1				2.20					
July 15			1.15					1.01	
Mar. 3, 1964	1.40								
Nov. 21, 1963	1.54								
Oct. 19		1.15			1.14			1.19	1.42
Aug. 26					1.17				1.10
Aug. 17	1.32						1.24		
Feb. 10, 1963			1.02						
Jan. 22, 1962							1.26	1.01	
Dec. 16, 1961							1.18		
Sept 14, 1961									1.59
Oct. 15, 1960				1.05			1.27		
Aug. 22				1.21					
July 30				1.85					
July 23, 1960		1.	1.20						
Dec. 26, 1959				1.00			1.47		
Dec. 25			1.00	1.45	1.40		1.62		
Dec. 24		1.04	1.42						
Oct. 31			1.11						
Oct. 30		1.23		1.60	1.35			1.47	1.56
Oct. 29							1.50		
Feb. 9, 1959							1.20		

TABLE 3.4 - Existing and proposed storm drainage detention basins in the Mesa Area

	Name - Location	Approximate Contributing Area	Approximate Basin Dimensions: Bottom Length	Bottom Width	Water Depth	Bank Slope	Effective Storage Ac. Ft.	Type of Storage	Collection System	Inlet Arrangement	Outlet Arrangement	Control	Secondary Usage	Lining
1	Roosevelt Elementary School - South of West 8th Avenue and East of Tempe Canal	Emilita to Broadway Rd. Tempe Canal to Dobson Rd.	540 ft.	390 ft.	3 ft.	1:4	15.3	in-line	All surface (street) flow	concrete apron	18" pipe to pump discharge to Tempe Canal	manual	School playground	grass
2	Adjacent to Tempe Canal 1/8 miles south of Roosevelt School*	Emilita to Southern Ave. Tempe Canal to Dobson Rd.	840 ft.	50 ft.	5.3 ft.	1:2	6.3	in-line	All surface (street) flow	Open concrete flume and box	None apparent	none	Neighborhood play-ground	grass
3	Hy-Den Place on Gilbert Road 400' North of East Hale Street**	McKellips Road to Hale Gilbert to 24th Street	250 ft.	200 ft.	6.0 ft.	1:8	10.8	off-line	2 - 24" pipes	concrete boxes at NE, NW, and SE corners	Pumped to Gilbert Rd. drain from standpipe in southwest corner	manual	Park & recreation area	grass
4	Adjacent to Tempe Canal from Baseline Road to Superstition Freeway**	Freeway to Baseline Rd. Tempe Canal to Dobson Rd.	3000 ft.	8 ft.	12 ft.	1:4	47.4	?	?	?	?	-	None	earth
5	Kirk Estates NE side of Consolidated Canal and 1/4 mile east of Stapley Drive***													
6	SRPD Transmission line easement 1/4 mile north of University Drive between Gilbert Road and Consolidated Canal***													

*still under construction
**currently under construction
***proposed construction

3.4 Multiple Use of Basins and Channels

Channels and reservoirs for handling storm runoff in this locality normally perform their intended function during a small fraction of one percent of the time. Land for these purposes in urban areas is expensive. It is desirable to minimize the amount of land required, to locate the facilities away from the most expensive areas where this is possible. It is also good practice to utilize the land for other purposes where such uses are compatible with the short term presence of water.

Ownership and control should preferably rest with the city but this does not preclude use of privately held land for these purposes if suitable flowage and operating easements are obtained. City-owned land in basins could also be leased to private interests for use in ways that are not inconsistent with their primary purpose. The concentration and diversion of runoff inherent in the draining and storing process entails a certain risk of damage to holders of adjacent property, consequently it is vital that the drainage and storage functions are given first priority in any multiple use scheme.

Projects planned for multiple use should provide not only for rare massive inundation but also for the nearly continuous small flow that seems to be characteristic of any urban drain serving more than one or two square miles of contributing area.

Possible alternative uses which would not be ruled out by the risk of occasional flooding are listed below. While it is not easy to find such uses, the list is by no means complete and is intended merely to suggest types rather than to be exhaustive.

Recreational uses

- Parks and picnic areas
- Fields for athletic events
- Skeet, trap shooting, and rifle ranges
- Outdoor theaters
- Horse corrals

Agricultural uses

- Pastures for livestock
- Turf farms
- Possibly some types of arboriculture

Commercial uses

- Storage yard for concrete pipe and pre-cast concrete products, natural stone, brick, etc.
- Scrap metals salvage yard
- Golf driving range
- Midget auto track
- Heliport

Municipal uses

- Storage yard for vitrified clay and cast iron pipe and fittings

Strip parks and greenways have been developed around drainage channels, particularly in places where there was a pre-existent natural ravine. In Mesa's situation, except for the Salt River, this opportunity is not available. The one location where a landscaped drainageway would have been advantageous is from east to west approximately along Southern Avenue where a natural wash must have existed before the land was cleared for agriculture. To restore this now is probably out of the question. Natural channels need flat side slopes and small longitudinal slopes to keep velocities below eroding limits. This requires a much larger cross-section and a correspondingly greater width than for a lined artificial channel. Special structures will also be necessary at intervals to control erosion at drops. If the land is also to serve as a park, additional width will be needed for bridle paths, walkways, footpaths, maintenance roads, etc.

Greenways can be very attractive features in a city, particularly where they are used to link larger parks and park-like areas. To create them out of farm or urban land however would hardly be justifiable from the standpoint of drainage alone.

3.5 Other Utility Systems

Water, sanitary sewer, gas and other utility systems have generally been installed long before it becomes necessary to provide storm drainage in an urban area. Utility lines are comparatively small in diameter and, for economy and ease of construction, are often installed between the right-of-way line and the curb or edge of pavement. Consequently when the time comes to build storm drains, the only unoccupied area in the street is a band down the center under the pavement. It often happens that the original pavement is nearing the end of its useful life or has become too narrow for traffic by the time storm drains are built, therefor drains can usually be put in just before or as a part of street widening programs. In such cases the cost of removing and replacing pavement is less of a consideration.

In such a situation conflict with existing utility system is relatively minor. Interference usually occurs at street intersections and crossings are at right angles to the line of the drain. If the utilities and the drain are at normal depths, the problem is simply one of protecting crossing utilities from damage during construction and providing protection from settlement of trench backfill.

More serious interference sometimes occurs when a utility line is not installed parallel to the line of the street, resulting in a long diagonal crossing with the drain. Such situations are best avoided by locating the drain so they will not occur. If this is impossible, it is usually necessary to replace the diagonal utility with a new section laid parallel to the drain and connected to the existing system at each end. Salvaging and relaying existing utility pipe is seldom economical.

It is necessary to provide for continuity of utility system service during installation of storm drain piping. The costs of uncovering and supporting utility lines across storm drain trenches and installing the replacement pipe or permanent supporting structures that may be necessary are properly attributable to the cost of building the storm drain. In order to estimate how much this would cost, a detailed study was made by plotting the underground utilities in Stapley Drive from McKellips Road to Southern Avenue. For this purpose Stapley Drive was considered to be representative of the arterial streets in which major storm drains would be built. A suitable alignment for the Stapley drain was then selected and the number of utility crossings categorized by size and system was determined.

The presence of utility systems affects the cost of storm drains not only because of the number of crossings to be made but also because the alignment of the storm drain is affected. Alignment changes and lateral offsets in a large diameter pipe are always expensive because specially beveled joints or structures are necessary.

These costs were evaluated in the case of the Stapley drain and were applied in the estimates for other lines as a cost in dollars per linear foot of drain for utility crossings. Since it is sometimes better to relocate an interfering parallel utility for a block or two rather than to change storm drain alignment, an allowance for this cost has also been included in the estimates.

If it does not do so already, the city should reserve a portion of the rights-of-way of arterial streets for future storm drain construction, designating it as such on its utility maps, and planning future utility construction to keep the area clear.

3.6 Trunk Storm Drain Locations and Depths

The general pattern of the proposed storm drainage system shown on Plate B is discussed in Section 4 of this report. The specific location of each drain is a matter to be worked out in the final design when detailed right-of-way maps and up-to-date field topography and utility information are available. There are, however, some general considerations relating to the horizontal location and the depth of storm drains that should be mentioned.

The trunk drains shown on Plate B are nearly all located on arterial thoroughfares. There are several reasons for this: a) the need for storm drainage is most keenly felt where the traffic is heaviest, b) the most direct alignments for drains are found on arterials, interior streets generally being deliberately circuitous and indirect, and c) arterials are wider and provide more room for installation of large pipelines. Open channels are another matter. These impair access to adjoining property and should be located in such a way as to minimize this disadvantage.

Although it often is the last part of the roadway to be used for underground construction, the central portion has other advantages as a drain location. These mainly have to do with the fact that there is more room to work in the middle of the street than along the edges. Cranes and excavators used to build the larger drains are massive machines needing plenty of room to maneuver. There is less likelihood of damage to adjoining property, either from direct contact or by caving of trenches, if the trench is near the center of the street. Modern methods require that material removed from the trench be hauled away as it is excavated and the ability to get to the trench with equipment from both sides is a distinct advantage.

Once they are in place, storm drain pipe lines do not require as much human access for operation and maintenance as utility lines do, consequently it is appropriate that they should occupy the part of the street that is the most difficult and dangerous to get to.

Except for subways, storm drains are probably the largest underground structures in city streets. Because it is a continuous structure, like a wall, an underground pipe line can effectively block sewer service to one side of the street if it is at the wrong depth. Potable water and gas lines may be piped around the drain with little difficulty, but sewers cannot. Enough cover should be provided so that utility lines and house connection sewers can be carried over the top of the storm drain from either side of the street.

Drain trunks must also be deep enough to allow good inflow from gutter inlets and lateral piping. The problem of getting water off the street and into the underground system is one of the more difficult aspects of providing good drainage. There should be a free drop at the inlet and velocities in the collector piping should be high enough to scour out grit and silt that has accumulated between storms.

The hydraulic gradient for the trunk drain carrying its design flow must be far enough below grade so that water will not be discharged from the storm drain through gutter inlets at low points in the street profile.

All these considerations point up the need for adequate cover over storm drain trunks. The profiles shown in Figs. 4.2 through 4.19 were drawn using a criterion of 8 feet minimum cover except at the lower end of the lines where gradients are very flat and the desirability of adequate cover was tempered by the cost of excessively deep trenches and detention basins.

3.7 Materials, Design Standards and Construction Methods

Storm drains are usually considered to provide general rather than purely local benefit. They are expensive to build and more expensive to repair. They are not likely to become obsolete because of changes in land use or traffic patterns nor do they wear out in the usual sense. Consequently they should be designed to last as long as possible. Open channels should require as little maintenance as possible, not just to keep down the cost, but because hydraulic efficiency is impaired by growth of vegetation and the accumulation of debris. Normally this means substantial concrete linings, however, if channels also serve as park land, other considerations naturally come into play.

Pipe should be of dense, watertight concrete. Lines under traffic or heavy earth loads should utilize pipe conforming to American Society for Testing Materials Standard C 76, properly reinforced for the loads to be encountered. Lines with shallow cover and not subject to traffic may be built with unreinforced pipe conforming to ASTM Standard C 14. Cast-in-place concrete pipe is acceptable if constructed in accordance with recognized specifications such as those of the Arizona and California Highway Departments and the City of Phoenix.

Manholes, junction structures, and transitions should be of reinforced concrete, designed for the hydraulic, earth, and traffic loads to be encountered. Interior surfaces, especially in the waterways should be smooth, dense, and well finished. Manhole rings and covers should be made to facilitate ready access but strong enough for traffic loads and machined to fit so they will not be accidentally displaced. Fabricated steel gratings and inlet frames must also be substantial enough for heavy wheel loadings and must present plenty of open area for entry of water with a generous allowance for clogging.

The type of materials used and the details of construction for storm drains are well described in the standard specifications and details of agencies such as the Phoenix City Engineer's office, the Los Angeles County Flood Control District, and others.

4. Major System Design

By the major system we mean the larger components of the branching arrangement of drainage channels and pipe lines shown on Plate B, exclusive of the floodways into which they discharge. There is, of course, a larger, much more complex natural system of valleys and swales which carries runoff to the beginnings of the man-made system and accommodates all flows in excess of its capacity. This is sometimes called the major system (Ref. 9) but, preferring to call this the natural system, we are concerned here with the channels and pipelines, generally 30 inches in diameter and larger, which gather water from the lateral and collector piping reaching into the interior of each section.

4.1 Drainage Areas

Planning of the storm drainage system began with a study of the ground contours. Subsidiary areas of about 160 acres were laid out, paying attention to the natural and artificial drainage divides. Because the entire area is or has at one time been farmed under flood irrigation and was levelled for this purpose, the divides tend to fall on section and quarter section lines. Each individual area was studied and the following characteristics noted:

Gross area
Land use as projected for 1990
Amount of pervious and impervious area
Land slope
Infiltration capacity
Conveyance capability of streets in the area

In addition to division of areas into the various categories of land use, it was necessary to differentiate within categories on the basis of whether commercial or industrial uses began before or after the city's policy change which since Ocotber 1, 1972 requires retention of runoff water on the property. It was also necessary to determine the extent of residential buildup by quarter sections to compute impervious area contribution

Using this information and working on the forms in Appendix II entitled "Urban Runoff Computation" the peak outflow and concentration time for each area were computed. The boundaries of each of these subsidiary areas and their designating symbols are given in Fig. 1.6.

4.2 Storm Trunk and Channel Pattern

It was mentioned that most of the study area drains naturally toward the Gila River and not to the Salt. The contours of Plate B show the eastern half of the study area as sloping toward the southwest with the slope from north to south averaging 0.003 ft./ft. whereas the slope to the west is 0.002. The western half, except for the narrow fringe draining into the Salt River, consists of a northern half which drains southerly at a slope of about 0.002, and a southern half which drains toward the west at the flattest slopes to be found in the study area, 0.001.

The steeper slopes suggest pipe systems; flat slopes suggest open channels. Steep slopes are advantageous in a pipe because they permit use of smaller conduits to handle a given rate of flow. While this is also true for a channel, flat slopes can be an advantage because they permit velocities low enough for unlined earth channels in which the low velocity can be compensated for by providing additional cross-sectional area at a reasonable cost. If a channel must be lined for other reasons, it ought to be built to the maximum slope available in order to minimize cross-sectional area and the cost of lining it.

Pipe lines should also be kept short. Ninety-six inches is about the largest size of pipe that has been used for storm drains in this area. At typical Mesa slopes, say 0.003, a 96-inch line has a capacity of 175 cfs. There is no point in making pipelines so long that the accumulated flow exceeds the capacity of a 96-inch pipe. Parallel large diameter lines in the same street are impractical.

There is no such limitation on channel size. Economic factors apply of course, but except for the cost of land and except for esthetic reasons, channels may be as wide and as deep as necessary to handle all the flow put into them.

The study area is longer in the east to west direction than it is wide from north to south. In the eastern portion, the slopes are relatively steep from north to south and mild from east to west. These factors influenced the suggested pattern of piped trunk drains in the north to south arterials, discharging into an open channel flowing toward the west.

The open channel could be the Baseline Road Floodway and its extension along the Western Canal proposed in Ref. 2. Alternatively it could be a channel constructed in connection with the extension of the

Superstition Freeway. Plate B shows a freeway channel from the Tempe Canal to Extension Road and shows the Baseline Road and the Western Canal Floodways along the alignments suggested in Ref. 2 as receptor channels for the piped trunk drains.

The low land along the Salt River in northwest Mesa slopes to the west. In some places the fall is actually southward, away from the river. Drains to serve this area are shown running from east to west and empty directly into the river. Fig. 3.6 shows a plan for channelization of the Salt River. It may ultimately be necessary to extend drains to this channel but for the present they are shown in Plate B as terminating in the river bed at points where the grade and outflow conditions are suitable.

Probably the most difficult drainage conditions are found in the southwest corner of the study area. South of the Superstition Freeway and west of South Mesa Drive the natural fall is almost directly from east to west with an average slope of only five feet per mile. Short piped drains are shown in Plate B for the portion east of Alma School Road. West of Alma School Road in the Dobson Ranch the drainage has been planned to be retained in a lagoon which meanders through the subdivision.

The "Storm Drainage and Flood Control Study, Southeastern Maricopa County, State of Arizona" (Ref. 2) recommends open flood control channels along the uphill (eastern) side of the Consolidated and Eastern Canals from the Gila-Salt River drainage divide (which coincides with the southwesterly leg of the Consolidated Canal) to the proposed floodway along Baseline Road. These are shown in Fig. 3.7 but the pattern of trunk drains in Plate B does not show them and they were not considered in the determination of the trunk drain sizes for the lines that cross them.

If the Consolidated Canal Floodway and the Eastern Canal Floodway are built, they should be deep enough to intercept the storm drain. Such an arrangement would reduce the pipe sizes shown on Plate B for Lines F, G, H and I, each line beginning again with minimum size pipe below each floodway crossing. It would also be possible to run the trunk drains from east to west perhaps reducing pipe requirements even further. In the overall picture the savings in pipe would of course be offset by at least a portion of the cost of the channel.

It seems questionable, however, that either the Consolidated Canal Floodway or the Eastern Canal Floodway will be built as shown in Ref. 2. In both cases the ground slope is very flat, there being less than two feet of fall per mile. Ref. 2 suggests an unlined trapezoidal channel with side slopes of two horizontal to one vertical for these floodways. Right-of-way requirements for such a channel with allowance for a 12-foot maintenance road and normal freeboard would be in the range of 100 to 140 feet. (See channel computations in Appendix IV).

An unlined earth channel of this width would very likely be considered unattractive by residents. If it were to be landscaped and treated as a strip park it could be an esthetic asset. In that case it should be built with flatter side slopes for ease of mowing. The hydraulic design should also use a higher friction factor (0.035 instead of 0.025). This would increase right-of-way requirements by about 100 feet over those for the earth channel.

Lined rectangular channels to carry the 100-year flows given in Ref. 2 would be much more compact. With allowance for a maintenance road, the minimum right-of-way widths would range from 40 to 55 feet.

Because of this uncertainty, Plate B does not show these two floodways and the trunk drain pattern is carried down to Baseline Road. If it develops that the two floodways will be constructed, the city should make sure that they are deep enough to intercept storm drains and the pattern for Lines F, G, H, and I should be revised.

Two alternative arrangements were studied for the trunk drain pattern, assuming the floodways were available. One was to continue the north-to-south scheme, interrupting each drain as it intersected a floodway and beginning again with smaller pipe about one half mile below each floodway. The other alternative was to change the trunk drain orientation to the east-to-west direction for the area east of the Consolidated Canal floodway, assuming the north to south arterial drainage would be picked up by laterals. This second alternative is shown in Fig. 4.24. It seemed the most advantageous of the two because the piped runs are shorter allowing the use of smaller pipe and shallower trenches. The total footage of pipe required to serve the area is also somewhat less.

4.3 Disposal Points and Termination Requirements

The floodways proposed in Ref. 2 along the Western Canal and Baseline Road can be an important part of Mesa's drainage system. Unfortunately the proposed channel depths are insufficient to allow the drains to discharge by gravity. Proposed drain inverts at the floodway range from 10 to 22 feet below the ground surface. The floodway is to have depths ranging from 6.5 to 14 feet (Ref. 2, p. 40). It would be highly advantageous to be able to discharge the drains by gravity and every effort should be made to resolve the differences. A study of the trunk drain profiles beginning at Fig. 4.2 will show why the drains are at the depths shown. There is no apparent reason that the channel cannot be deeper. There is the possibility that costs are higher for a deep narrow channel than for a shallow wide one, and this is not claimed or demonstrated in the report - it isn't necessarily so, depending very much on land values. If cost is the determining factor then the additional cost to Mesa of the retention basins and pumps made necessary by a shallow flood control channel should also be taken into account. If the approval of the City of Mesa is required for the construction of the floodway, this ought to be made contingent on a design which would permit gravity discharge of its storm drains.

Figure 3.5 shows the arrangement that would be necessary at the lower end of each trunk drain if the floodway invert is too high to permit gravity flow. Retention basins are sized to store the complete impervious area runoff from a two-year recurrence interval storm of 24-hour duration with a basin water surface elevation no higher than the soffit of the inlet pipe. The extra depth from the pipe to the ground surface provides a safety factor that is essential in an installation of this type. A suitable spillway directed toward the floodway should also be provided. Dimensions for the retention basins are given in Table 4.1. As indicated by the note on Fig. 3.5 the shape of the basin can be varied as required by site restrictions or proposed secondary uses so long as elevation and volume requirements are met.

If the Baseline Road and Western Canal floodways are not built or are substantially delayed, the storm drainage system shown in Plate B can be built and put into use anyway providing other arrangements for final disposition of water are effected. The most obvious arrangement would be an agreement with the Salt River Project for discharge of the water into the canal system, perhaps through a drainage line along Baseline Road. Failing such an arrangement, Mesa could construct its own force main to collect water at low rates from the retention basins along Baseline Road and discharge it to the existing 84-inch drain at Country Club Drive and Main Street (See Fig. 4.23). The combined total design storage volume of all the retention basins listed in Table 4.1, except those along the Western Canal, is 302.80 acre feet. This could be completely emptied through a 24-inch pipeline at an 8 million gallon per day pumping rate in twelve days. About 100 horsepower would be required.

4.4 Trunk Drain Capacity Requirements

Given the pattern of the trunk drains selected on the basis of the considerations of topography, street alignment, and disposal points

Table 4.1 - Retention Basin Dimensions

Location	Bottom Width "W"*	Bottom Length "L"*	Total Depth "D"*	Water Depth "d"*	Surface Acres Required
Tempe Canal at Western Canal Floodway	520	1040	10.0	5.0	18.30
Alma School Rd. at Western Canal Floodway (Line C-2)	110	220	13.0	3.0	2.76
Extension Rd. at Western Canal Floodway (Line C-3)	120	240	15.0	3.5	3.41
Country Club Dr. at Baseline Rd. Floodway (Line D)	350	700	16.0	7.5	12.11
Mesa Dr. at Baseline Rd. Floodway (Line E)	370	740	21.0	7.0	15.30
1/2 Mile South of Baseline Rd. at Baseline Rd. Floodway (Line E-1)	220	440	11.0	4.0	5.28
Stapley Dr. at Baseline Rd. Floodway (Line F)	350	700	22.0	7.0	14.70
Gilbert Rd. at Baseline Rd. Floodway (Line G)	320	640	22.0	7.0	13.17
Lindsay Rd. at Baseline Rd. Floodway (Line H)	340	680	21.0	7.5	13.74
Val Vista Dr. at Baseline Rd. Floodway (Line I)	310	620	18.0	6.5	11.05
Greenfield Rd. at Baseline Rd. Floodway (Lines J, K and L)	250	500	16.0	6.0	7.82

*Dimension in feet

previously discussed, the problem becomes one of adding up the inflow quantities along the route of each drain in order to determine what flow capacity must be provided. This summation begins at the uppermost extremity of each drain and proceeds in the direction of flow. Although water enters the drain from a large number of gutter inlets and lateral pipes along its route, contributions are considered as being lumped together at the lower end of each of the individual drainage areas for which peak flows were calculated. Generally these points are about a quarter mile apart.

The summation is not a simple progressive addition of flows: if it were, the total would soon become larger than it needs to be. Rainfall intensity tends to diminish with the duration of the storm (Fig. 2.7), so credit can be taken for the increasing amount of time required for flow to travel down the drain to the successively lower points being considered. This is done in the summation sheets (App. III) by making a new runoff calculation for the total contributing area at each of the points where increments of flow are considered to occur.

In making this summation along the length of a drain it sometimes happens that the effect of the increasing flow time overshadows the effect of the increasing areas, and the total flows to be accommodated actually diminish. This does not mean that the total flow is less, simply that the new inflows do not contribute to the peak. When this occurs the design discharge is not decreased, however, since flows once in the pipe must pass through.

Appendix II is included in this report for illustrative purposes. It is the runoff calculation for Line F. Similar calculations were made for each of the trunk lines shown in Plate B but they are not included for reasons of economy. A complete set of these calculations is being furnished to the City Engineer.

4.5 Trunk Drain Sizes

Profiles were drawn for each of the trunk drains shown in Plate B for the purpose of determining what size pipe or other conduit was needed to carry the total computed peak flows. They were also helpful in pointing up areas of critical utility interference (notably the deeper sanitary sewer lines) and showed where constraints existed on terminal invert elevations.

For a given type of pipe, sizes are determined by the discharge to be carried and by the energy gradient of the flow. Discharge rates were discussed in the previous section. The energy gradient can deviate from the ground slope on which the pipe is laid for short distances, but by and large, it must be essentially parallel to the ground. Ground slopes were used in Manning's formula to arrive at the pipe sizes shown for the trunk drains on Plate B with the water surface assumed to be just below the soffit of the pipe. A Manning's "n" value of 0.012 was used. In the final design gradients should be recomputed in detail and allowance made for head losses occuring in junctions, transitions, and bends. If the pipe to be used is not reinforced concrete pipe conforming to ASTM Standard C-76, then an appropriate

Manning's "n" value should be selected for the pipe to be used and the sizes recalculated.

Figures 4.2 through 4.19 show ground and pipe profiles for each of the trunk drains. Trench depths generally vary from 11 to 22 feet. Depths were kept to the minimum which still permitted utility crossings with normal cover and which allowed a reasonable fall for catch basins and collector piping. Particular attention was paid to the lower end of the major north to south drains to study the possibility of flattening slopes to save trench depth but such large pipe sizes were required that it was not considered feasible to make the lines any shallower.

An open channel is shown on Plate B along the northern edge of the Superstition Freeway from Extension Road west to the Tempe Canal and along the Tempe Canal from Southern Avenue to the Western Canal floodway or to a retention basin at that location. The Tempe Canal channel is already under construction by agreements made between the city and the developers of the adjacent property. Right-of-way for the freeway channel has been reserved by the Arizona Highway Department.

Dimensions and hydraulic properties for the channels are given in App. IV. Channel profiles and cross-sections are given in Fig. 4.20, 4.21, and 4.22.

4.5 Freeway Crossings and Freeway Drainage

The most recent information from the Arizona Highway Department indicates that diamond interchanges will be constructed where arterial streets are crossed by the Superstition Freeway. Plans are still subject to change, but it is proposed to partially depress the arterial and partially elevate the through lanes of the freeway at these crossings. The on-and-off-ramps would also be depressed near their intersection with the arterial street. Since storm drains in the arterial right-of-way must be on continuous downgrade, it is necessary to offset the alignment in order to maintain cover over the pipe. Fig. 4.1 shows in more detail what is also shown at the freeway crossings in Plate B.

Freeway construction requires that special measures be taken for drainage. The depressed undercrossings will collect water and must be drained by pumps if gravity drainage cannot be worked out. The elevated portion of the freeway between interchanges impedes and collects runoff that must be provided for. There is also an accumulation of runoff on paved surfaces and in the medians. The system of drainage shown on Plate B does not provide for these flows, however it could be adapted to handle them by increasing retention basin sizes and by enlarging the channels and conduits south of the freeway. The amount of freeway drainage to be handled presumably will not be known until planning nears completion. City officials have had discussions with the Highway Department engineering staff on this matter. These should be pursued. It will be better to have one system that serves both needs than to have two independent systems.

5. Lateral Drainage Systems

This report has been concerned with the locations and sizes of the major trunk drains and retention basins. Little consideration has been given to the drainage system within each quarter section. These systems are essential to collect water and introduce it into the trunk drains and to extend the benefit of storm drainage into the areas between arterials. These systems will utilize pipe for laterals, collector lines, and inlet connections, but much of the work of gathering the water will be done by the street and alley system.

Allowance has of course been made for flows from these interior systems, assuming that runoff is carried first by streets and then by underground conduits. Further consideration is beyond the scope of this study. Local drainage of this kind is often constructed in connection with street paving projects and city personnel have long experience with it. Standard details have been adopted by most cities. Nomographs for design purposes are available in References 7, 8, and 10.

6. Cost Estimates

The estimates in this section are based on labor and material costs prevailing on October 1, 1973. They include allowances for all appurtenances necessary to construct a complete and working trunk drain installation within the limits of the street it occupies, including catch basins and local small diameter connecting piping. Where retention basins are shown in connection with a trunk drain, the full cost of these, including pumping facilities and land, is shown. The estimates assume construction of the floodways by others. If the floodways are not built and satisfactory arrangements are made for disposal of the water into Salt River Project canals there should be little additional cost. If this is not possible and it becomes necessary to install a drainage line, pumping station, and force main to empty the basins, the additional cost is estimated separately hereinafter. If the Baseline Road and Western Canal floodways are built with a low enough invert elevation to permit direct entry by the trunk drains, the costs assigned to retention basins may be deleted. Separate estimates are given for a system to drain the area served by the trunk drains, Lines F, G, H, and I which would be a possible alternative with attendant savings if the proposed floodways along the Consolidated and Eastern Canals north of Baseline Road are constructed.

6.1 Unit Costs

Unit costs for pipe drains in Table 6.1 were developed for pipe sizes ranging from 30 to 90 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. Normally extensive amounts of pavement cut and replacement and some utility relocation will be required. The very worst conditions which require cutting through concrete paving, moving of parallel utility lines, or other abnormal condition will cost more than the column headed "Total Cost in Built-up Areas per Lin. Ft.". In the estimates that follow the higher unit cost was cost used because it is assumed that the "built-up" condition will normally be the case by the time the storm drain is built.

6.2 Itemized Costs

Assuming that each trunk line will be constructed as a separate project, the costs for each are given below using pipe sizes and quantities from Plate B and unit prices from Table 6.1. No right-of-way costs are included except for retention basin sites.

TABLE 6.1 - Development of Unit Costs for Trunk Drains

Pipe Size Inches I.D.	Excavation and Backfill					Pipe* Cost Per L. F.	Installation Cost Per L. F.	Intersection Costs		Best Total Costs 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.			Inlet Cost Per L. F.	Utility X-ing Cost Per L. F.	Total	Use	Pavement Cut and Replacement	Utility Relocation	Total	Use	
30	4.6	11.7	1.99	$0.60	$1.19	$7.75	$4.92	$5.50	$0.68	$20.04	$20.00	$5.60	$5.15	$30.75	$31.00	30
33	4.9	12.0	2.18	0.60	1.31	9.50	6.20	5.50	0.71	23.22	23.00	5.80	5.50	34.30	34.50	33
36	5.2	12.5	2.41	0.60	1.45	11.50	6.50	6.50	0.74	26.69	26.50	6.70	5.90	39.10	39.00	36
39	6.0	12.8	2.84	0.60	1.71	13.50	7.72	6.50	0.77	30.20	30.00	6.90	6.10	43.00	43.00	39
42	6.3	13.5	3.15	0.60	1.89	15.50	8.93	6.50	0.80	33.62	33.50	7.20	6.30	47.00	47.00	42
48	6.8	15.2	3.83	0.60	2.30	18.00	9.83	6.50	0.86	37.49	37.50	7.80	6.70	52.00	52.00	48
54	7.4	16.3	4.47	0.60	2.68	21.00	11.45	6.50	0.92	42.55	42.50	9.30	7.10	58.90	59.00	54
60	8.0	17.2	5.10	0.60	3.06	24.00	11.76	6.50	0.98	46.30	46.50	9.80	7.45	63.75	64.00	60
66	8.6	18.3	5.83	0.65	3.79	28.00	12.86	7.50	1.04	53.19	53.00	11.10	7.90	72.00	72.00	66
72	9.2	16.3	5.55	0.60	3.33	32.00	14.28	7.50	1.10	58.21	58.00	11.70	8.30	78.00	78.00	72
78	9.8	18.1	6.57	0.65	4.27	38.00	15.96	7.50	1.16	66.89	67.00	13.20	8.65	88.85	89.00	78
84	10.3	21.5	8.20	0.70	5.74	42.00	17.75	7.50	1.28	74.27	74.00	13.70	9.05	96.75	97.00	84
90	10.9	19.2	7.75	0.70	5.43	46.00	19.53	7.50	1.40	79.86	80.00	15.00	9.45	104.45	104.50	90

*Tongue and Groove Joints C-76 Class III

Estimated Construction Costs

Trunk Lines

	Pipe Size in.	Length ft.	Unit Cost	Total Cost
Line A - Roosevelt Road				
	36	2,640	$39.00	$102,960
	48	2,640	52.00	137,280
	54	2,000	59.00	118,000
Subtotal for pipe				358,240
Outlet structure				6,000
Total contract cost				364,240
Engineering & contingencies				72,850
Total construction cost - Line A				$437,090
Line B - Dobson Road (North)				
	42	2,640	$47.00	$124,080
	48	800	52.00	41,600
	54	3,000	59.00	177,000
	72	4,140	78.00	322,920
Subtotal for pipe				665,600
Outlet structure				8,000
Total contract cost				673,600
Engineering & contingencies				134,720
Total construction cost - Line B				$808,320
Line B-1 - Dobson Road (South)				
	48	2,640	$52.00	$137,280
	66	4,240	72.00	305,280
Subtotal for pipe				442,560
Outlet structure				8,000
Total contract cost				450,560
Engineering & contingencies				90,110
Total construction cost - Line B-1				$540,670

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line C - Alma School Road				
	42	1,320	$47.00	$62,040
	54	2,640	59.00	155,760
	78	5,040	89.00	448,560
Subtotal for pipe				666,360
Outlet structure				10,000
Total contract cost				676,360
Engineering & contingencies				135,270
Total construction cost - Line C				$811,630
Line C-1 - McLellan Road				
	48	2,640	$52.00	$137,280
	54	2,640	59.00	155,760
	60	1,400	64.00	89,600
Subtotal for pipe				382,640
Outlet structure				7,000
Total contract cost				389,640
Engineering & contingencies				77,930
Total construction cost - Line C-1				$467,570
Line C-2 - Alma School Road (South)				
	36	2,600	$39.00	$101,400
Subtotal for pipe				101,400
Outlet structure				5,000
Retention basin				65,000
Total contract cost				171,400
Engineering & contingencies				34,280
Total construction cost - Line C-2				$205,680
Line C-3 - Extension Road (South)				
	36	2,640	$39.00	$102,960
	42	2,500	47.00	117,500
Subtotal for pipe				220,460
Outlet structure				5,000
Retention basin				79,000
Total contract cost				304,460
Engineering & contingencies				60,890
Total construction cost - Line C-3				$365,350

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line D - Country Club Drive				
	36	2,640	$39.00	$102,960
	42	5,280	47.00	248,160
	48	2,640	52.00	137,280
	66	2,640	72.00	190,080
	72	2,400	78.00	187,200
	90	2,400	104.50	250,800
Subtotal for pipe				1,116,480
Outlet structure				10,000
Retention basin				279,000
Miscellaneous				10,000
Total contract cost				1,415,480
Engineering & contingencies				283,100
Total construction cost - Line D				$1,698,580
Line D-1 - McKellips Road				
	39	5,280	$43.00	$227,040
	48	2,640	52.00	137,280
	54	5,990	59.00	353,410
Subtotal for pipe				717,730
Outlet structure				6,000
Total contract cost				723,730
Engineering & contingencies				144,750
Total construction cost - Line D-1				$868,480
Line E - Horne Road				
	30	2,400	$31.00	$ 74,400
	36	2,640	39.00	102,960
	39	2,640	43.00	113,520
	48	300	52.00	15,600
	54	2,640	59.00	155,760
	60	2,640	64.00	168,960
	72	5,280	78.00	411,840
	84	6,790	97.00	658,630
Subtotal for pipe				1,701,670
Outlet structure				10,000
Retention basin				388,700
Miscellaneous				10,000
Total contract cost				2,110,370
Engineering & contingencies				422,070
Total construction cost - Line E				$2,532,440

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line E-1				
(1/2 Mile South of Baseline)				
	30	2,640	$31.00	$ 81,840
	36	2,640	39.00	102,960
	48	2,800	52.00	145,600
Subtotal for pipe				330,400
Outlet structure				6,000
Retention basin				112,200
Miscellaneous				5,000
Total contract cost				453,600
Engineering & contingencies				90,720
Total construction cost - Line E-1				$544,320
Line F - Stapley Drive				
	30	2,640	$31.00	$ 81,840
	36	2,640	39.00	102,960
	48	2,640	52.00	137,280
	54	2,640	59.00	155,760
	60	5,280	64.00	337,920
	66	5,280	72.00	380,160
	84	4,600	97.00	446,200
Subtotal for pipe				1,642,120
Outlet structure				10,000
Retention basin				378,200
Miscellaneous				10,000
Total contract cost				2,040,320
Engineering & contingencies				408,060
Total construction cost - Line F				$2,448,380
Line G - Gilbert Road				
	36	2,640	$39.00	$102,960
	39	2,640	43.00	113,520
	48	2,640	52.00	137,280
	54	2,640	59.00	155,760
	60	5,280	64.00	337,920
	66	5,280	72.00	380,160
	84	4,800	97.00	465,600
Subtotal for pipe				1,693,200
Outlet structure				10,000
Retention basin				335,600
Miscellaneous				10,000
Total contract cost				2,048,800
Engineering & contingencies				409,760
Total construction cost - Line G				$2,458,560

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line H - Lindsay Road				
	30	2,640	$31.00	$ 81,840
	48	5,280	52.00	274,560
	60	10,560	64.00	675,840
	66	2,640	72.00	190,080
	72	2,640	78.00	205,920
	78	2,640	89.00	234,960
	90	4,800	104.50	501,600
Subtotal for pipe				2,164,800
Outlet structure				10,000
Retention basin				346,600
Miscellaneous				10,000
Total contract cost				2,531,400
Engineering & contingencies				506,280
Total construction cost - Line H				$3,037,680
Line I - Val Vista Drive				
	30	2,640	$31.00	$81,840
	36	2,640	39.00	102,960
	42	2,640	47.00	124,080
	48	10,560	52.00	549,120
	60	2,640	64.00	168,960
	66	5,280	72.00	380,160
	72	2,400	78.00	187,200
	78	2,300	89.00	204,700
Subtotal for pipe				1,799,020
Outlet structure				10,000
Retention basin				264,000
Miscellaneous				10,000
Total contract cost				2,083,020
Engineering & contingencies				416,600
Total construction cost - Line I				$2,499,620
Line J - Greenfield Road				
	30	2,640	$31.00	$81,840
	36	2,640	39.00	102,960
	54	2,640	59.00	155,760
	60	5,040	64.00	322,560
	72	2,500	78.00	195,000
Subtotal for pipe				858,120
Outlet structure				8,000
Retention basin				179,300
Miscellaneous				10,000
Total contract cost				1,055,420
Engineering & contingencies				211,080
Total construction cost - Line J				$1,266,500

	Pipe Size in.	Length feet	Unit Cost	Total Cost
Line K - Higley Road				
	30	5,040	$31.00	$156,240
	33	4,280	34.50	147,660
Subtotal for pipe				303,900
Total contract cost				303,900
Engineering & contingencies				60,780
Total construction cost - Line K				$364,680
Line L - Baseline Road				
	33	2,640	$31.00	$81,840
	36	2,100	34.50	72,450
Subtotal for pipe				154,290
Outlet structure				5,000
Total contract cost				159,290
Engineering & contingencies				31,860
Total construction cost - Line L				$191,150

Estimated Construction Cost

Channels

1.	North side of freeway - Extension Road to Alma School Road		
	Length = 2,400 feet		
	41,000 cubic yards @ $0.60	$24,600	
	2 - double 6'x5'x80' box culverts @ $17,000	34,000	
			$58,600
2.	North side of freeway - Alma School Road to Tempe Canal		
	Length = 7,000 feet		
	145,000 cubic yards @ $0.60	87,000	
			87,000
3.	Tempe Canal Channel - Southern Avenue to freeway		
	Length = 2,600 feet.		
	48,000 cubic yards @ $0.60	28,800	
	1 - double 6'x5'x80' box culvert @ $17,000	17,000	
			45,800
4.	Crossing for existing channel - Baseline Road		
	1 - double 6'x5'x80' box culvert @ $17,000	17,000	
			17,000
	Guadalupe Road		
	1 - double 6'x5'x80' box culvert @ $17,000	17,000	
			17,000
	Freeway -		
	1 - double 6'x5'x300' box culvert @ $64,000	64,000	
			64,000
	Grand total		$289,400

6.3 Cost of Pumpback Scheme for Draining Detention Basins

An alternative arrangement for draining detention basins along Baseline Road, shown on Fig. 4.23 will cost about one million dollars:

	Pipe Size in.	Length ft.	Unit Cost	Total Cost
Force main, modified pre-stressed concrete cylinder pipe	24	14,500	$20.00	$290,000
Drain, Class III reinforced concrete pipe	30	32,000	15.00	480,000
Drain, Class III reinforced concrete pipe	24	3,100	10.00	31,000
Pump station with appurtenances				25,000
Valves (manually operated)	8	each	1,500	12,000
Total contract cost				838,000
Engineering & contingencies				167,600
Total construction cost				$1,005,600

6.4 Cost of Alternative Construction Utilizing Eastern and Consolidated Floodways

If the Eastern and Consolidated floodways are constructed, Lines F, G, H, and I could be supplanted with the arrangement of drains shown in Fig. 4.24. The remainder of the system to the east and west of these lines would be unaffected. Estimated cost of this alternative scheme is given below. No costs connected with the floodway proper are included. Since it is assumed that these will be lined, costs of headwalls and erosion control aprons at pipe terminations are not included.

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Stapley Drive				
	78	4,600	$89.00	$409,400
	60	2,640	64.00	168,960
	54	2,640	59.00	155,760
	48	2,640	52.00	137,280
	39	2,640	43.00	113,520
Subtotal for pipe				984,920
Outlet structure				8,000
Retention basin				188,500
Miscellaneous cost				10,000
Total contract cost				1,191,420
Engineering & contingencies				238,280
Total construction cost				$1,429,700
Gilbert Road				
	72	4,600	$78.00	$358,800
	54	5,280	59.00	311,520
Subtotal for pipe				670,320
Outlet structure				8,000
Retention basin				174,800
Miscellaneous cost				10,000
Total contract cost				863,120
Engineering & contingencies				172,680
Total construction cost				$1,035,800
Consolidated Floodway Drains				
	72	1,400	$78.00	109,200
	60	2,640	64.00	168,960
	54	4,940	59.00	291,460
	48	5,280	52.00	274,560
	42	3,960	47.00	186,120
	36	2,640	39.00	102,960
	33	9,920	34.50	342,240
Total contract cost				1,475,500
Engineering & contingencies				295,100
Total construction cost				1,770,600

	Pipe Size in.	Length Feet	Unit Cost	Total Cost
Eastern Floodway Drains				
	48	2,300	$52.00	$119,600
	42	2,640	47.00	124,080
	39	1,100	43.00	47,300
	36	3,300	39.00	128,700
	33	5,280	34.50	182,160
Total contract cost				601,840
Engineering & contingencies				120,360
Total construction cost				$722,200
Total cost of alternative using Consolidated and Eastern Floodways				$4,958,300

6.5 Recapitulation of Estimated Construction Costs

The projects for which itemized estimates were given in the previous sections are recapitulated below. Costs are computed at prices prevailing on October 1, 1973.

Line Designation	Location	Total Constr. Cost
A	Roosevelt Road	$437,090
B	Dobson Road (North)	808,320
B-1	Dobson Road (South)	540,670
C	Alma School Road	811,630
C-1	McLellan Road	467,570
C-2	Alma School Road (South	205,680
C-3	Extension Road (South)	365,350
D	Country Club Drive	1,698,580
D-1	McKellips Road	868,480
E	Horne Road	2,532,440
E-1	1/2 Mile South of Baseline	544,320
F*	Stapley Drive	2,448,380
G*	Gilbert Road	2,458,560
H*	Lindsay Road	3,037,680
I*	Val Vista Drive	2,499,620
J	Greenfield Road	1,266,500
K	Higley Road	364,680
L	Baseline Road	191,150

Line Designation	Location	Total Constr. Cost
	Open channel at Freeway and Tempe Canal	$289,400
	Pumpback system for draining Baseline Road retention basins	1,005,600
	Total storm drain program	$22,841,700
*Alt.	Drains discharging to proposed floodways (Alternative to Lines F, G, H, and I)	$ 4,958,300

References

1. Watershed Work Plan, Apache Junection - Gilbert Watershed, Maricopa and Pinal Counties, Arizona, Jan. 1965, U.S. Soil Conservation Service and local agencies.(This original plan has been extended and modified since its inception).

2. Storm Drainage and Flood Control Study, Southeastern Maricopa County, State of Arizona, May 1973, Boyle Engineering Corporation and L. H. Bell Associates.

3. Mesa - 1990, The General Plan, Victor Gruen Associates, 1971.

4. General Soil Map, Maricopa County, Arizona U. S. Department of Agriculture, Soil Conservation Service, June, 1969.

5. SCS Soil Series Index to Irrigation Soil Groups Soil Conservation Service, June 1970.

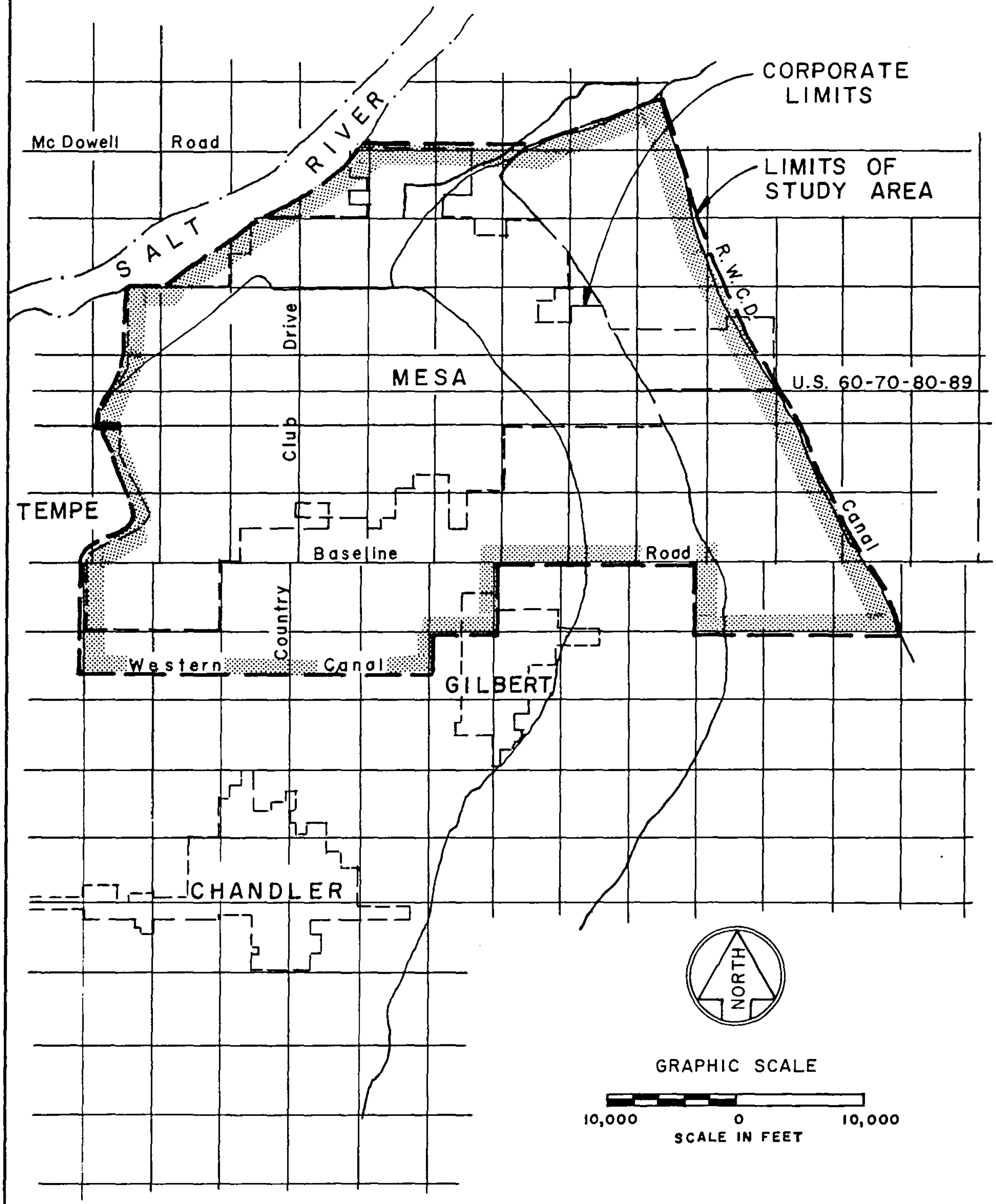
6. Storm Drainage Report for the Maricopa Association of Governments, Yost and Gardner Engineers, Feb. 2, 1970.

7. Hydrologic Design for Highway Drainage in Arizona, Arizona Highway Department, Dec. 1, 1968, Maps revised Aug. 1, 1970.

8. Memorandum on Flood Control and Drainage Design Standards and Criteria from Mr. Ross Blakley to Mr. Don Pierson, Chairman, Maricopa Associations of Governments Subcommittee, dated June 6, 1973.

9. Urban Storm Drainage Criteria Manual, Denver Regional Council of Governments. Prepared by Wright-McLaughlin Engineers, March 1969

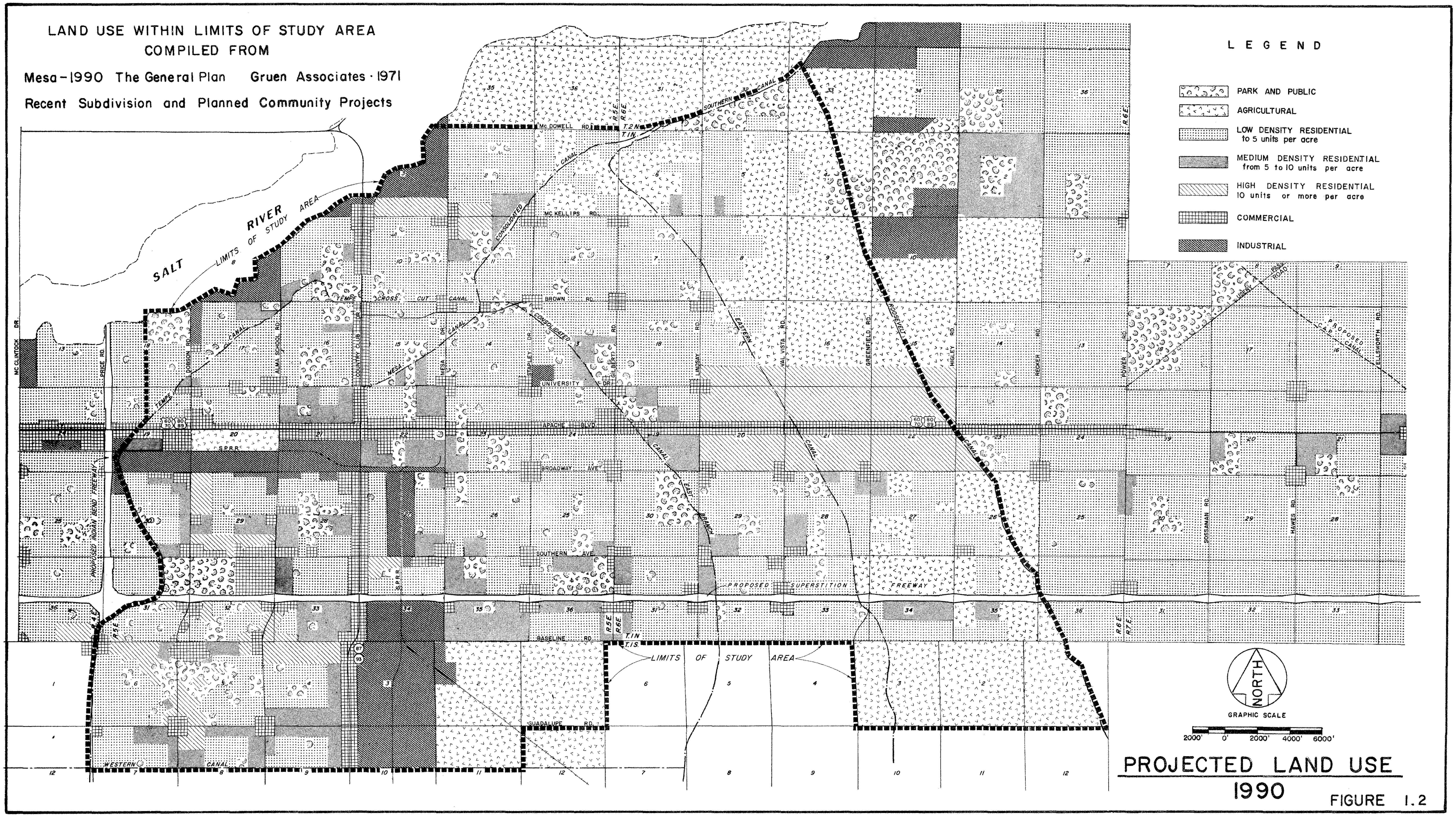
10. Storm Drain Design Manual, Lateral Storm Drains on Major Streets, City of Phoenix, May 1972.



YOST AND GARDNER ENGINEERS
PHOENIX, ARIZONA

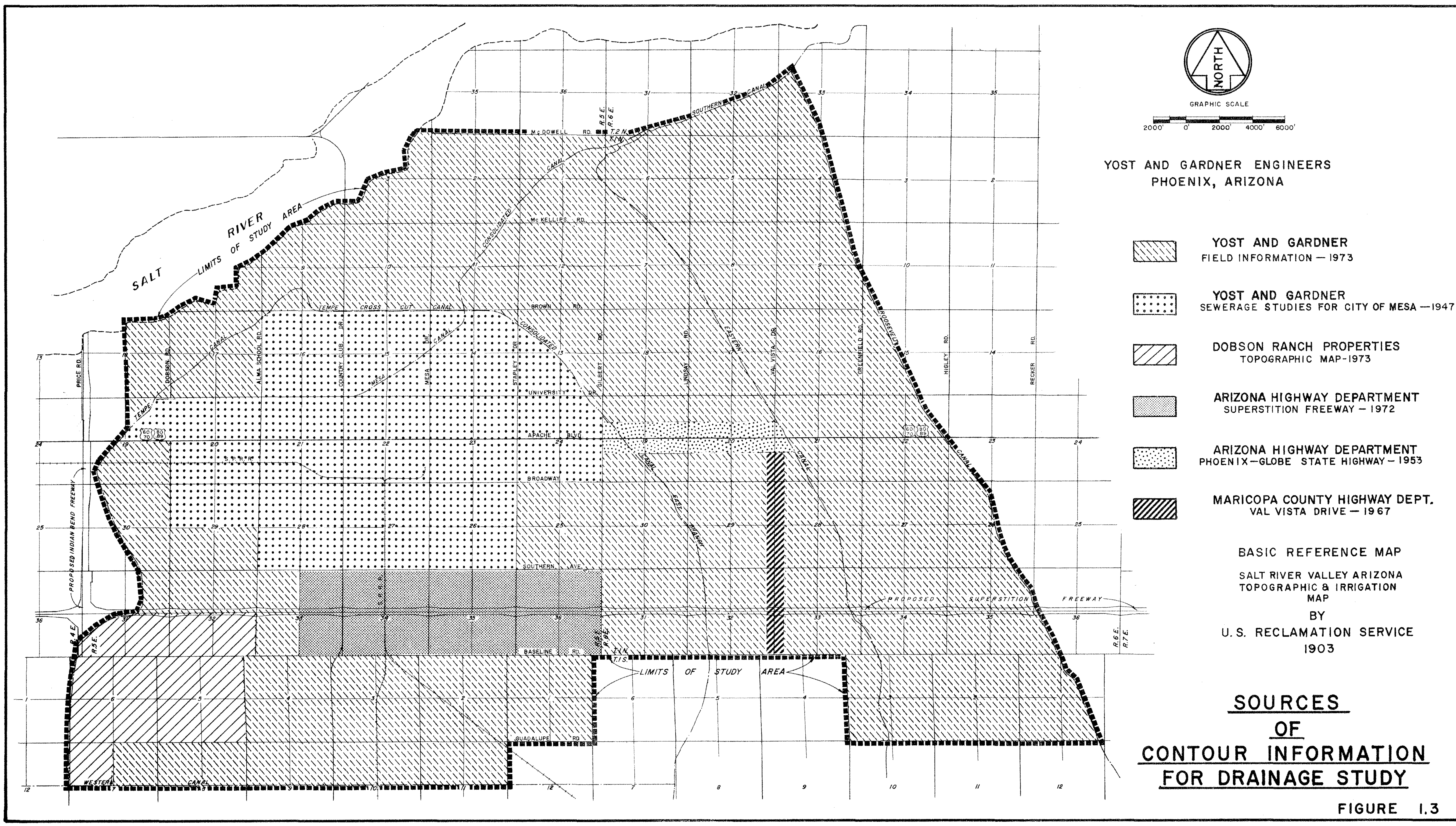
STUDY AREA MAP

FIGURE 1.1



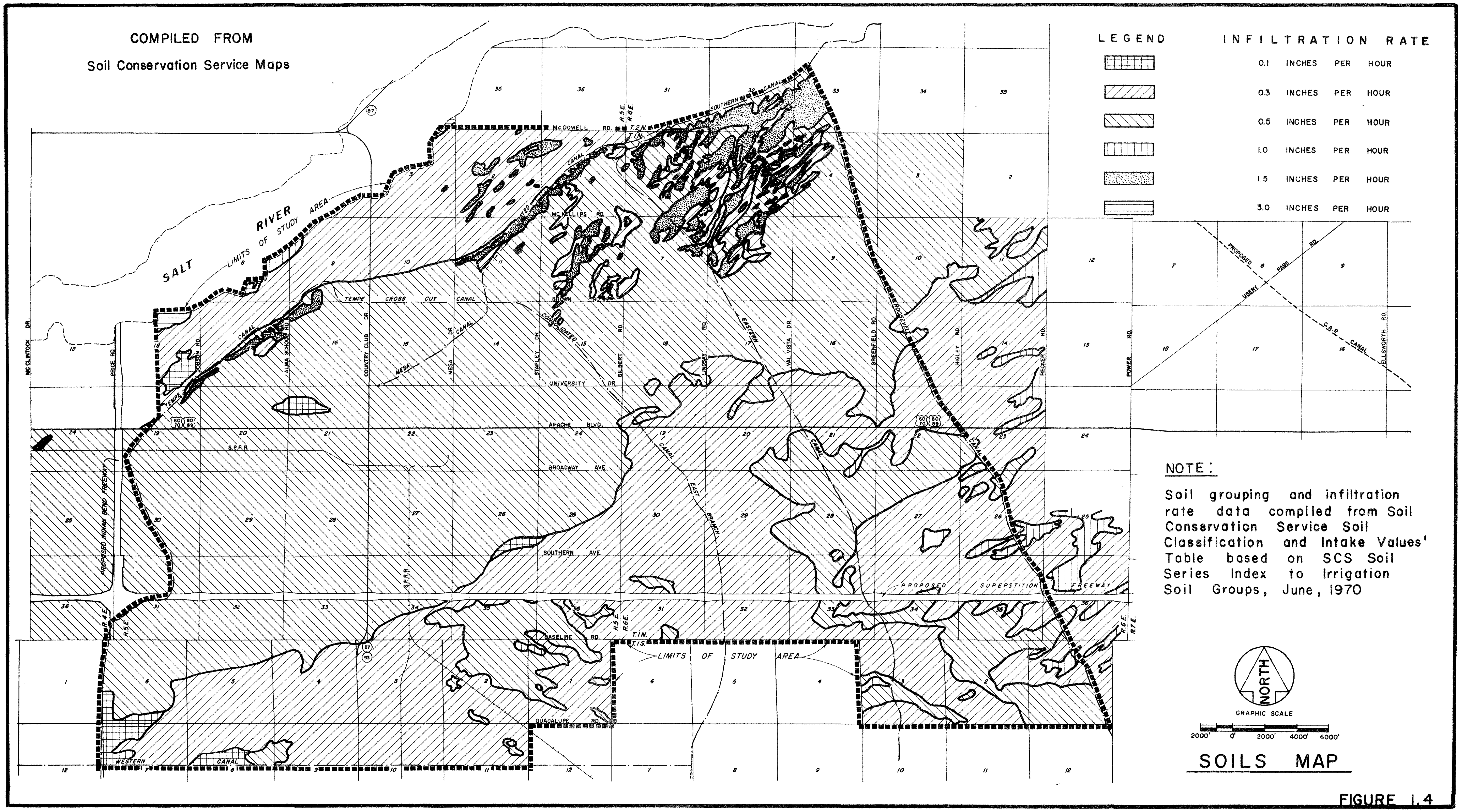
PROJECTED LAND USE
1990

FIGURE 1.2



SOURCES
OF
CONTOUR INFORMATION
FOR DRAINAGE STUDY

FIGURE 1.3

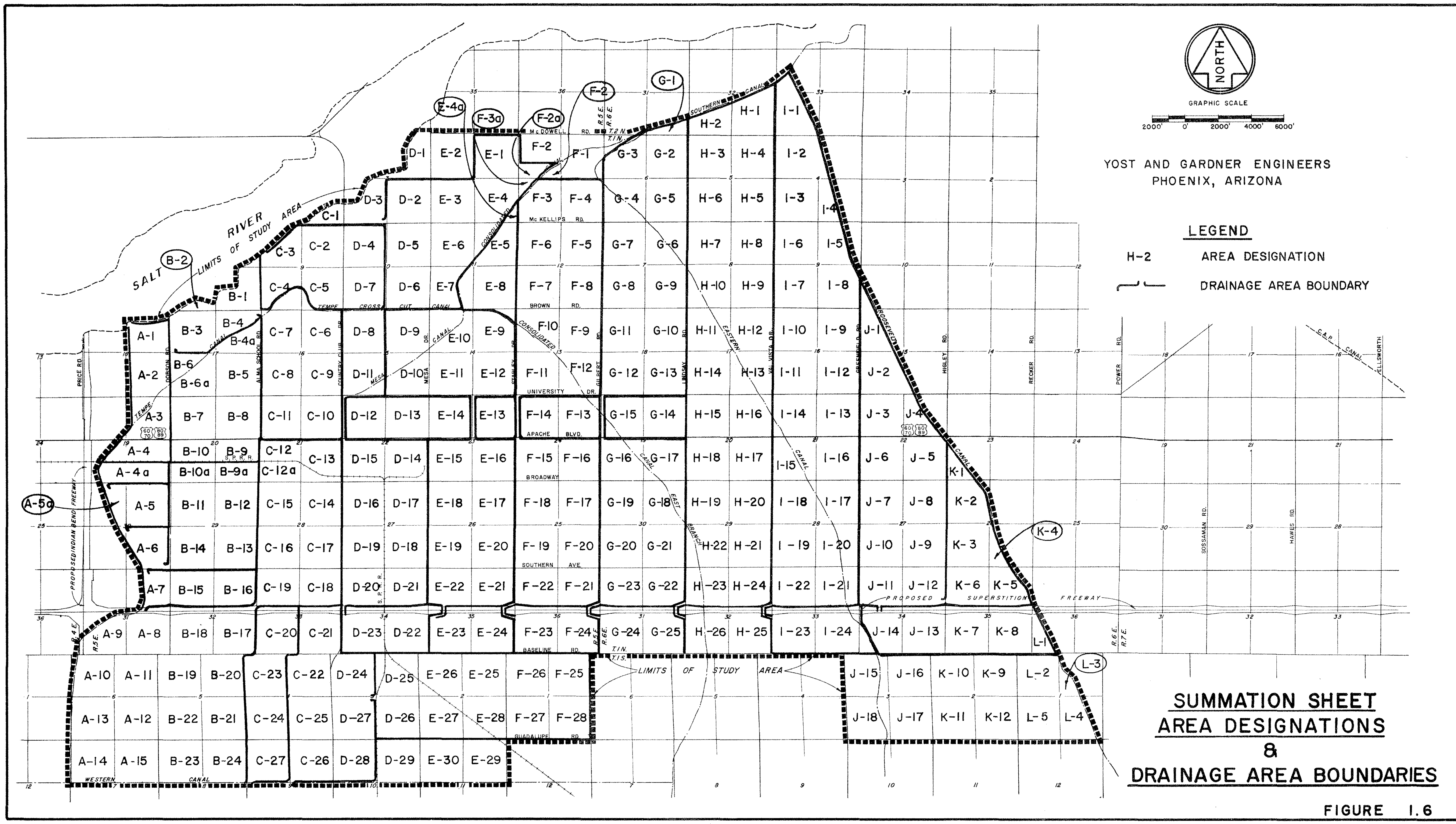


SOILS MAP

FIGURE 1.4

INFILTRATION RATES BY QUARTER SECTIONS ADOPTED VALUES

FIGURE 1.5



SUMMATION SHEET AREA DESIGNATIONS & DRAINAGE AREA BOUNDARIES

FIGURE 1.6

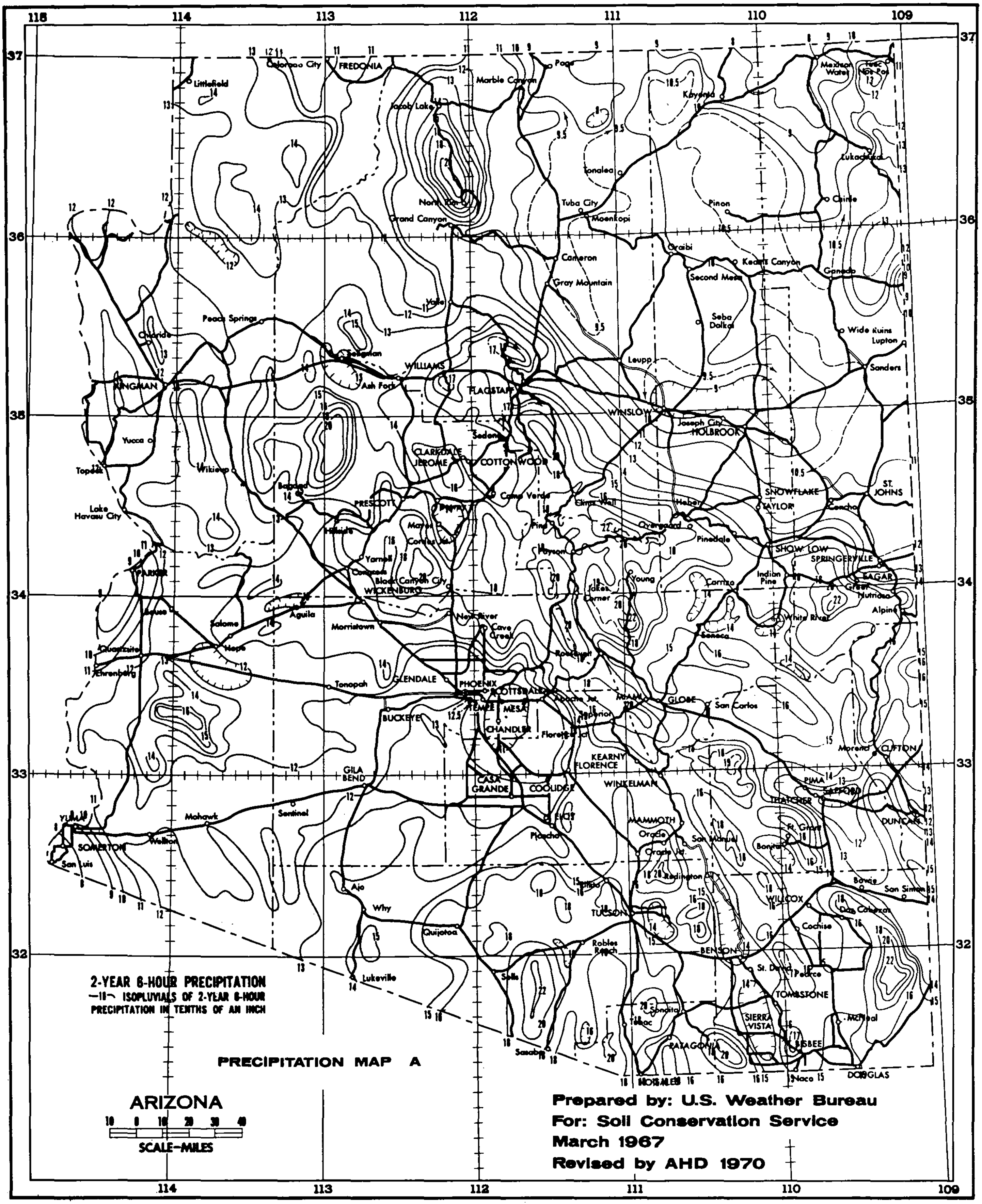

2-YEAR 6-HOUR PRECIPITATION
ISOPLUVIALS OF 2-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH
PRECIPITATION MAP A
ARIZONA
SCALE-MILES
Prepared by: U.S. Weather Bureau
For: Soil Conservation Service
March 1967
Revised by AHD 1970
FLAGSTAFF
WINSLOW
HOLBROOK
KINGMAN
PRESCOTT
PHOENIX
TUCSON
GLOBE
BENSON
TOMBSTONE
BISBEE
DOUGLAS
CASA GRANDE
COOLIDGE
FLORENCE
WICKENBURG
WILLIAMS
SHOW LOW
SNOWFLAKE
ST. JOHNS
SPRINGERVILLE
CLIFTON
DUNCAN
SAFFORD
WILLCOX
NOGALES
PARKER
YUMA
SOMERTON
GILA BEND
BUCKEYE
GLENDALE
SCOTTSDALE
MESA
TEMPE
CHANDLER
FREDONIA
Grand Canyon
Tuba City
Kayenta
Chinle
Ganado
Sedona
Cottonwood
Payson
Ajo
Lukeville
Sells
Bowie
San Simon

FIGURE 2.1

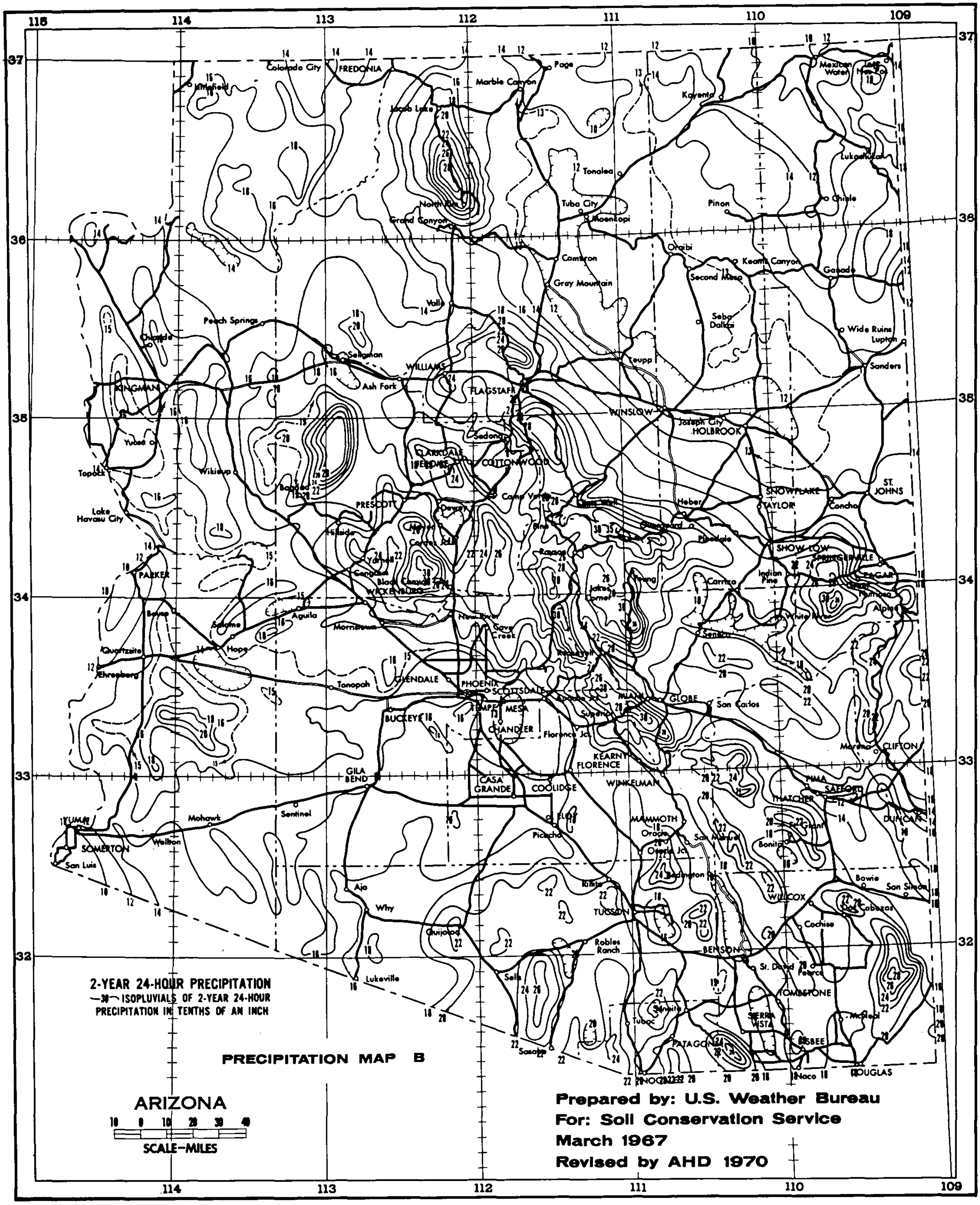

2-YEAR 24-HOUR PRECIPITATION
—30— ISOPLUVIALS OF 2-YEAR 24-HOUR PRECIPITATION IN TENTHS OF AN INCH
PRECIPITATION MAP B
ARIZONA
SCALE-MILES
Prepared by: U.S. Weather Bureau
For: Soil Conservation Service
March 1967
Revised by AHD 1970

FIGURE 2.2

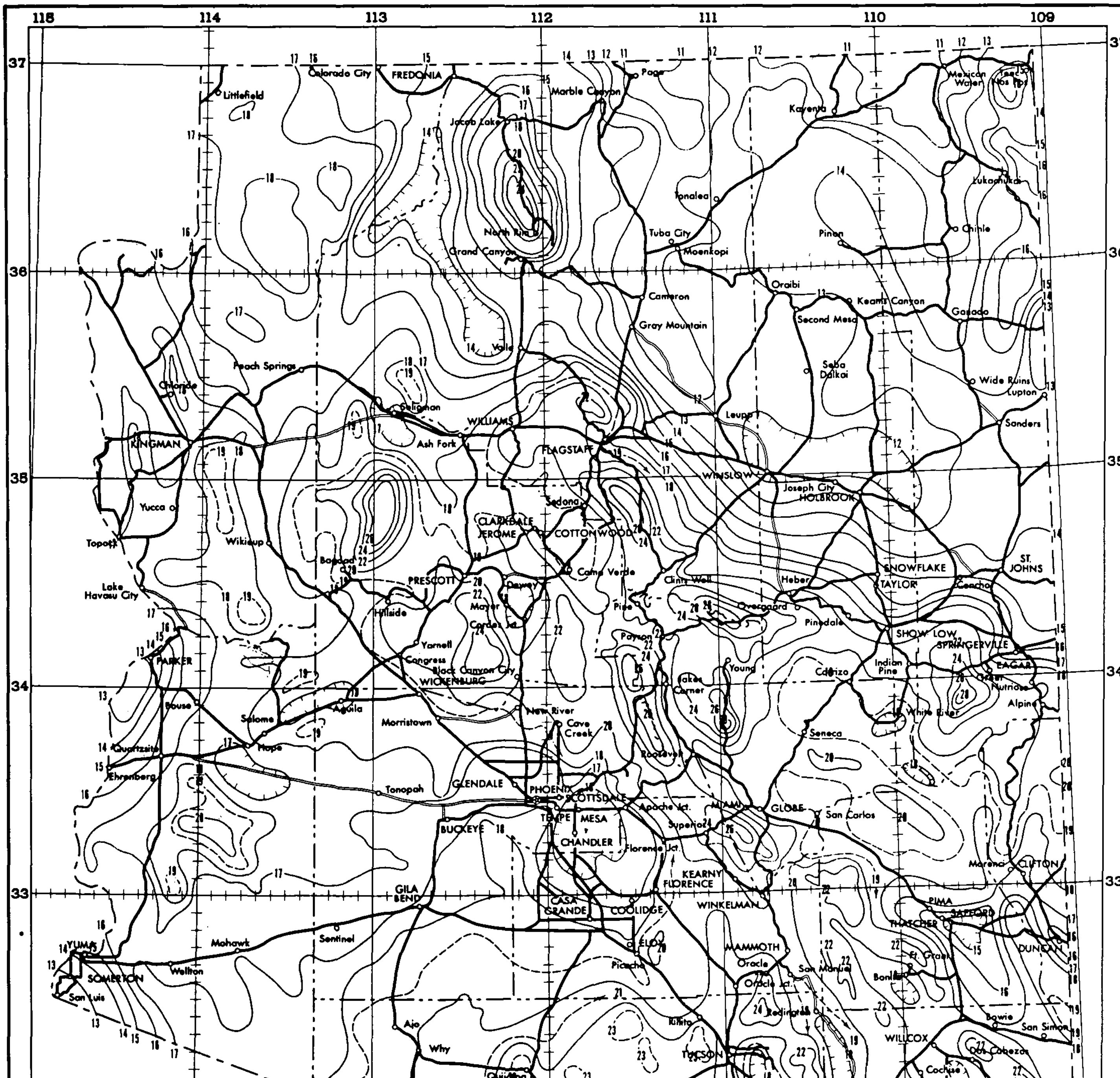

5-YEAR 6-HOUR PRECIPITATION
—38— ISOPLUVIALS OF 5-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH
PRECIPITATION MAP C
ARIZONA
SCALE-MILES
Prepared by: U.S. Weather Bureau
For: Soil Conservation Service
March 1967
Revised by AHD 1970
Colorado City
FREDONIA
Page
Marble Canyon
Littlefield
Jacob Lake
Tonalea
Tuba City
Moenkopi
Pinon
Chinle
North Rim
Grand Canyon
Cameron
Gray Mountain
Oraibi
Second Mesa
Keams Canyon
Ganado
Peach Springs
Chloride
Valle
Wide Ruins
Seligman
Leupp
Sanders
WILLIAMS
KINGMAN
Ash Fork
FLAGSTAFF
WINSLOW
Joseph City
HOLBROOK
Yucca
Sedona
CLARKDALE
JEROME
COTTONWOOD
Topock
Wikieup
Bagdad
PRESCOTT
Camp Verde
SNOWFLAKE
TAYLOR
Concho
ST. JOHNS
Lake Havasu City
Heber
Overgaard
Pinedale
Hillside
Mayer
Dewey
Cordes Jct.
Payson
SHOW LOW
SPRINGERVILLE
EAGAR
Yarnell
Congress
Black Canyon City
WICKENBURG
Indian Pine
Cibecue
PARKER
Bouse
Salome
Aguila
Morristown
New River
Cave Creek
Young
Alpine
Seneca
Quartzsite
Hope
Roosevelt
Ehrenberg
Tonopah
GLENDALE
PHOENIX
SCOTTSDALE
Apache Jct.
MIAMI
GLOBE
San Carlos
BUCKEYE
TEMPE
MESA
CHANDLER
Superior
Florence Jct.
Morenci
CLIFTON
KEARNY
FLORENCE
GILA BEND
CASA GRANDE
COOLIDGE
WINKELMAN
PIMA
THATCHER
SAFFORD
YUMA
Mohawk
Sentinel
Wellton
SOMERTON
ELOY
MAMMOTH
Oracle
Oracle Jct.
San Manuel
Ft. Grant
Bonita
DUNCAN
San Luis
Picacho
Redington
Bowie
San Simon
Ajo
Why
WILLCOX
TUCSON
Dos Cabezas
Cochise
Robles Ranch
BENSON
Lukeville
Sells
Pearce
TOMBSTONE
Sonoita
SIERRA VISTA
McNeal
Tubac
PATAGONIA
BISBEE
Sasabe
NOGALES
Naco
DOUGLAS

FIGURE 2.3

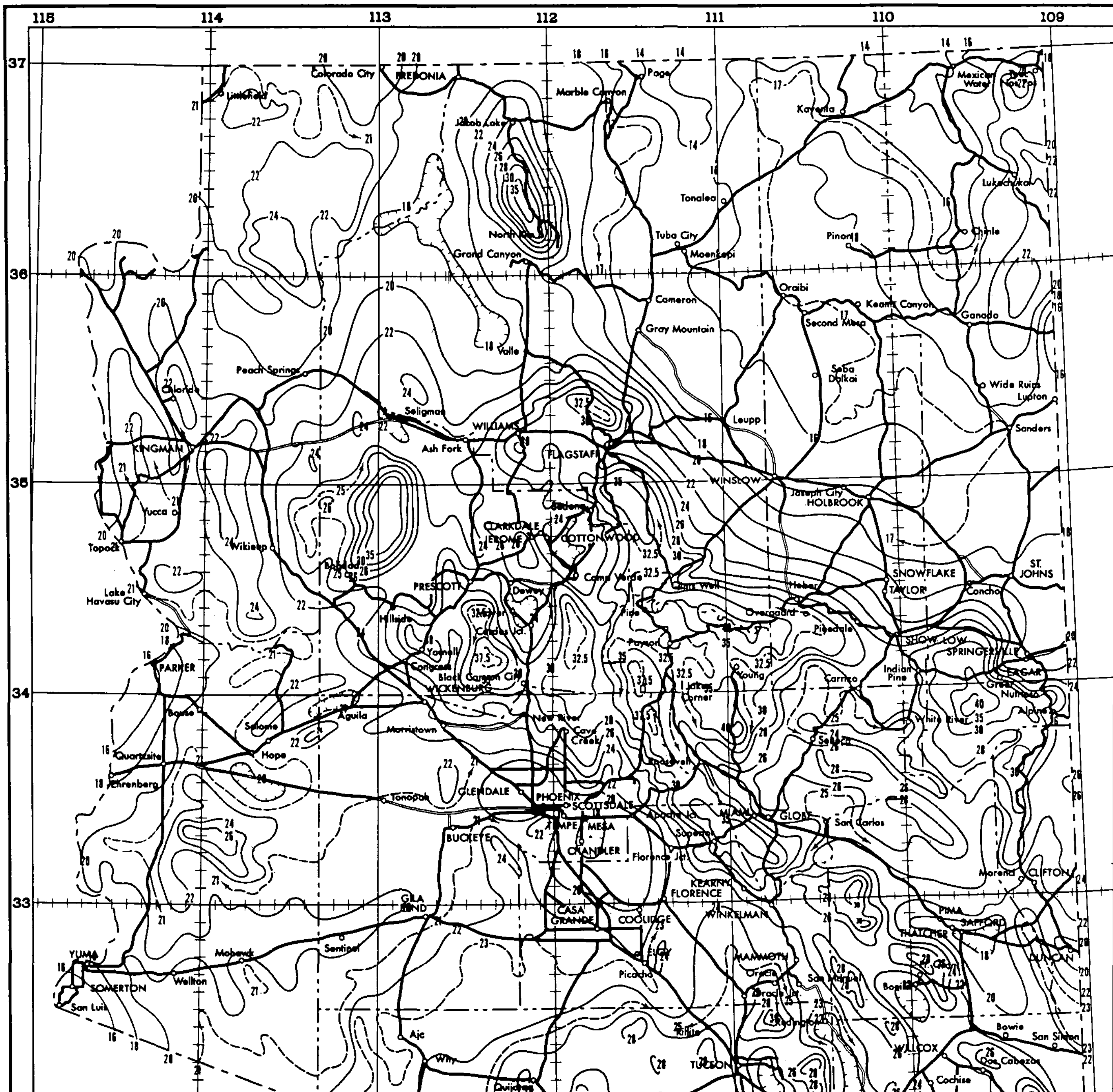

5-YEAR 24-HOUR PRECIPITATION
—20— ISOPLUVIALS OF 5-YEAR 24-HOUR PRECIPITATION IN TENTHS OF AN INCH
PRECIPITATION MAP D
ARIZONA
10 0 10 20 30 40
SCALE-MILES
Prepared by: U.S. Weather Bureau
For: Soil Conservation Service
March 1967
Revised by AHD 1970
115
114
113
112
111
110
109
37
36
35
34
33
32
PHOENIX
FLAGSTAFF
TUCSON
YUMA
KINGMAN
PRESCOTT
WINSLOW
HOLBROOK
GLOBE
DOUGLAS
BISBEE
TOMBSTONE
WICKENBURG
PARKER
FLORENCE
CASA GRANDE
COOLIDGE
SAFFORD
CLIFTON
SNOWFLAKE
ST. JOHNS
WILLIAMS
Grand Canyon
Page
Tuba City
Cameron
Kayenta
Chinle
Ganado
Sanders
Nogales
Ajo
Gila Bend
Benson
Willcox
Payson
Show Low
Springerville
Eagar
Lake Havasu City
Quartzsite
Ehrenberg
Sells
Lukeville
Sasabe

FIGURE 2.4

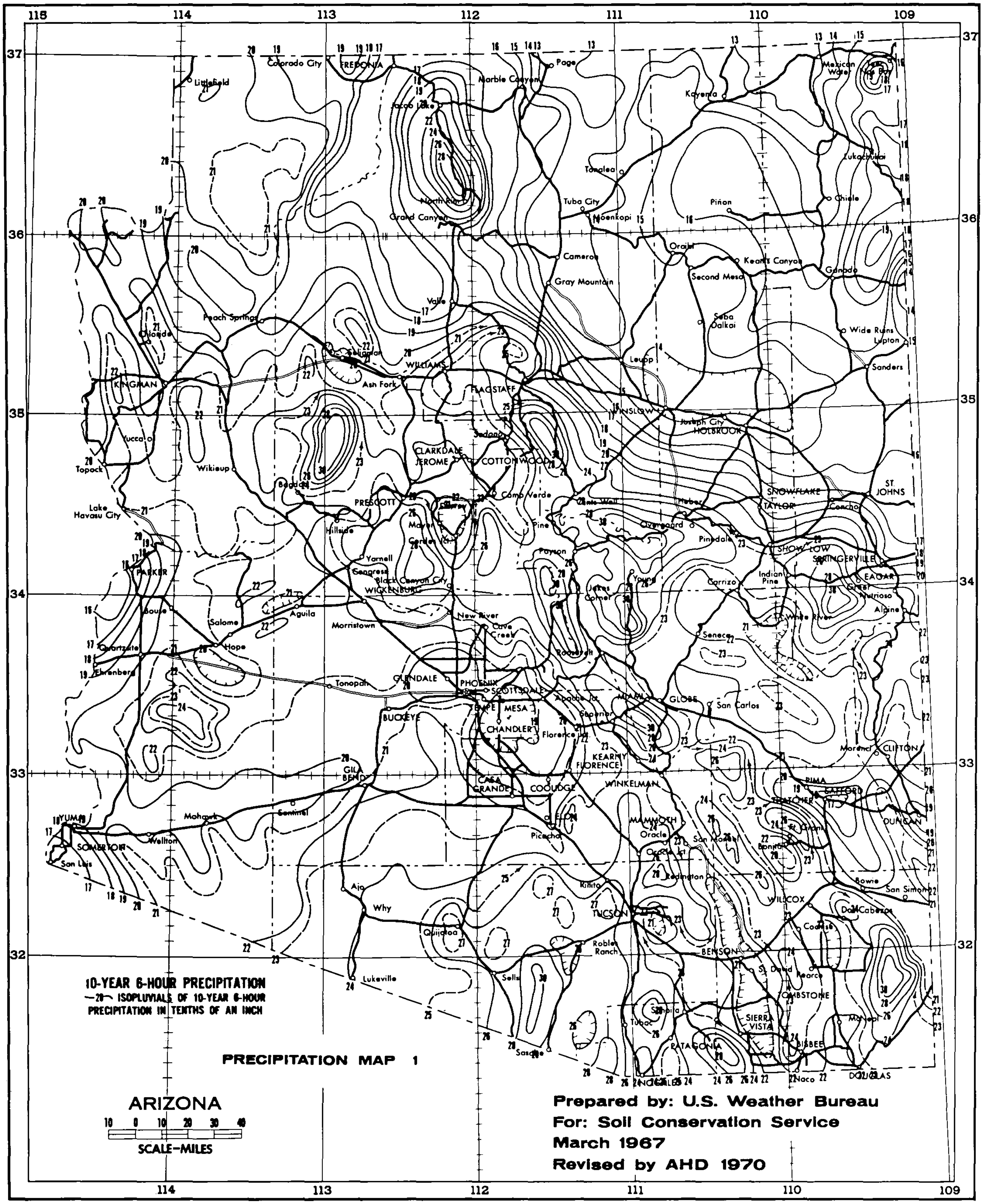

10-YEAR 6-HOUR PRECIPITATION
ISOPLUVIALS OF 10-YEAR 6-HOUR PRECIPITATION IN TENTHS OF AN INCH
PRECIPITATION MAP 1
ARIZONA
SCALE-MILES
Prepared by: U.S. Weather Bureau
For: Soil Conservation Service
March 1967
Revised by AHD 1970

FIGURE 2.5

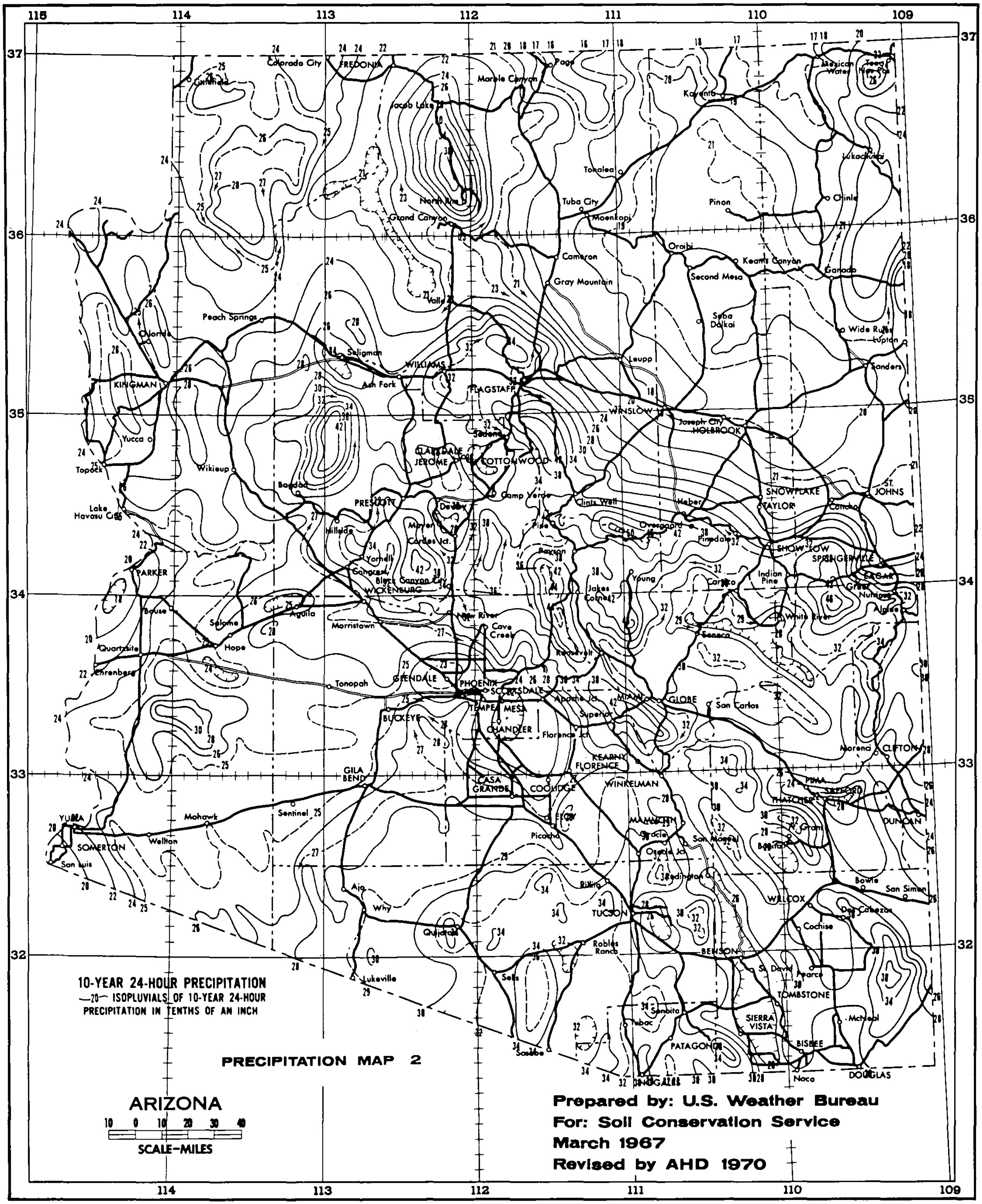
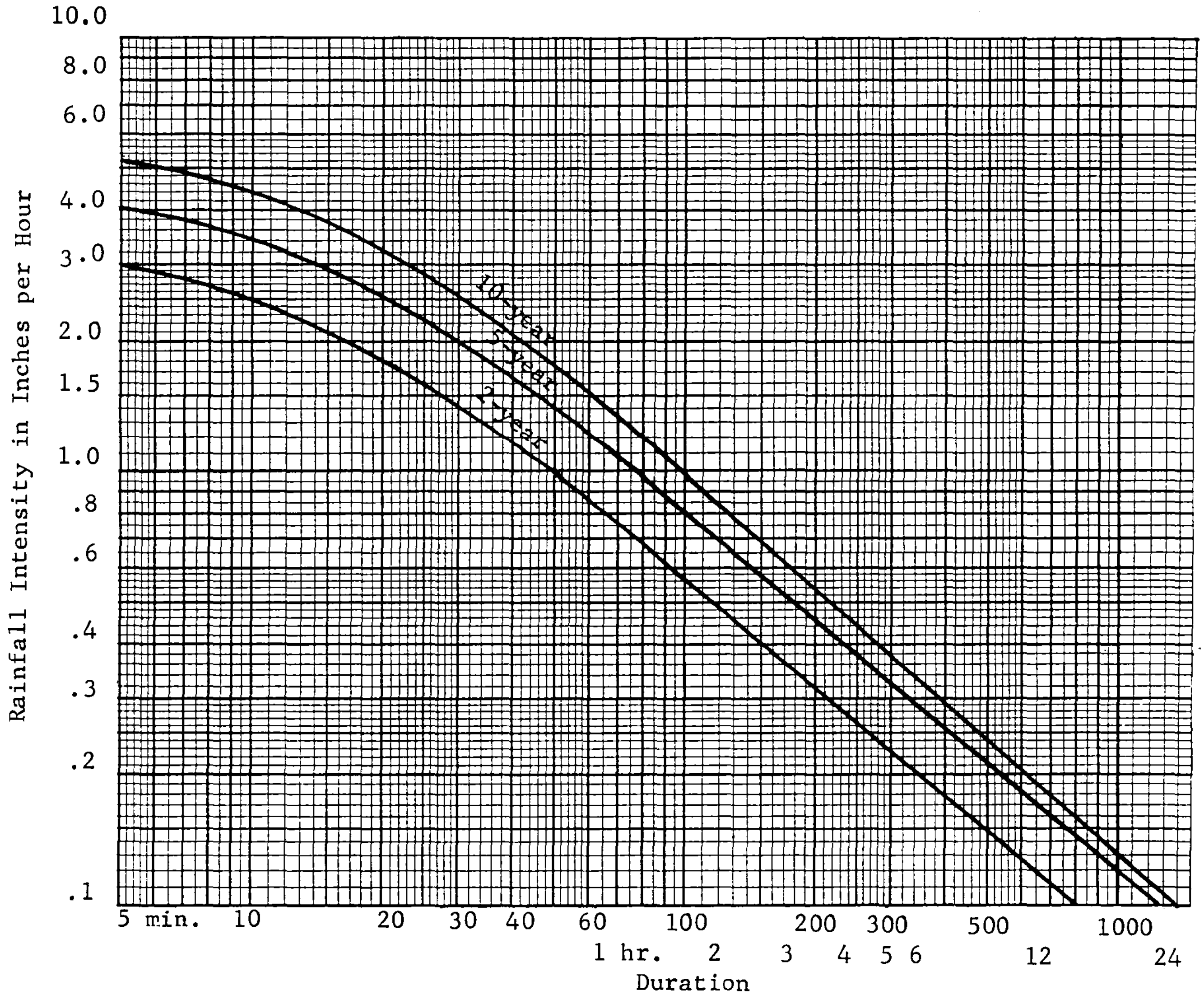

10-YEAR 24-HOUR PRECIPITATION
—20— ISOPLUVIALS OF 10-YEAR 24-HOUR PRECIPITATION IN TENTHS OF AN INCH
PRECIPITATION MAP 2
ARIZONA
10 0 10 20 30 40
SCALE-MILES
Prepared by: U.S. Weather Bureau
For: Soil Conservation Service
March 1967
Revised by AHD 1970

FIGURE 2.6

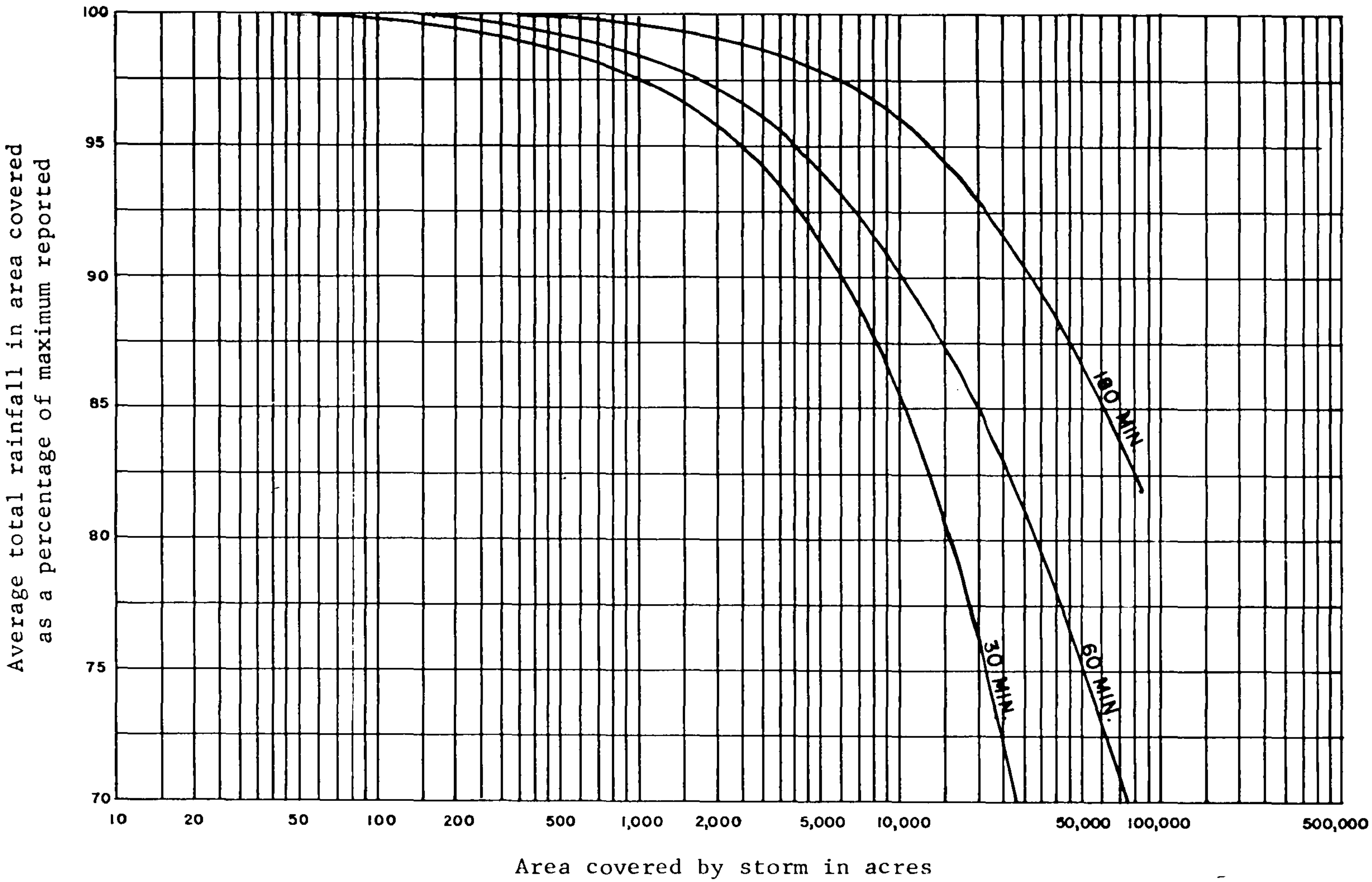


RAINFALL INTENSITY - DURATION - FREQUENCY RELATION
FOR MESA, ARIZONA

(Partial Duration Series)

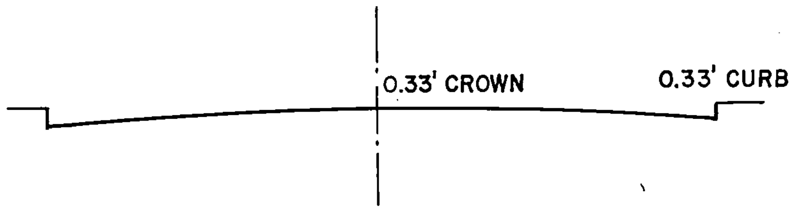
Curves are based on methods of U.S. Weather Bureau Technical Paper No. 40, Technical Memorandum WBTM WR-44, and rainfall data from pages 37c through 39 of the Arizona Highway Department Hydrologic Design Manual (1970 Revision).

FIGURE 2.7



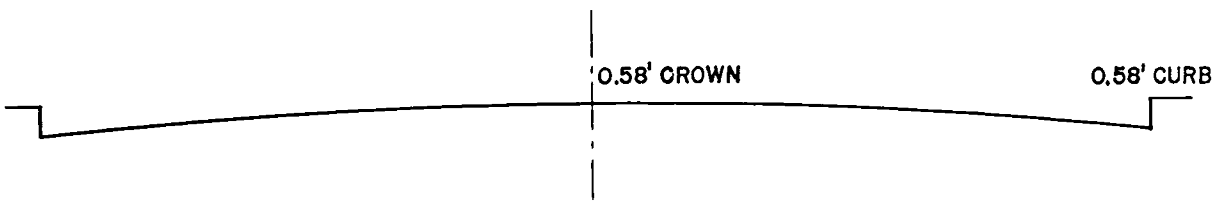
RAINFALL AREA-DEPTH CURVES
From U.S. Weather Bureau Technical Paper No. 40, Fig. 15

FIGURE 2.8



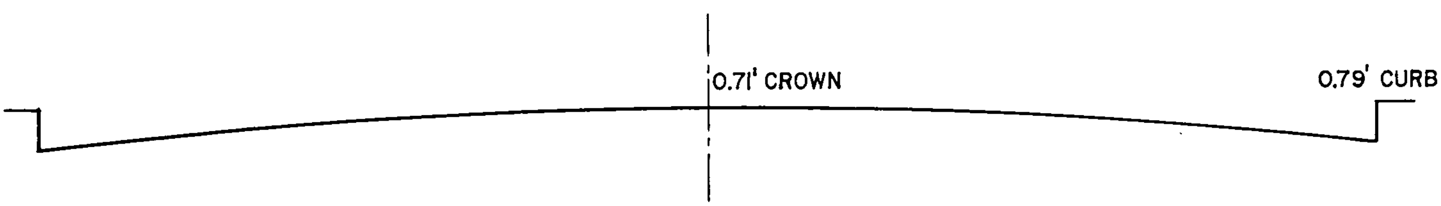
AREA TO TOP OF CURB	5.61 SQ. FT.
WETTED PERIMETER	34.01 FT.
HYDRAULIC RADIUS	0.165 FT.

35 FT. STREET



AREA TO TOP OF CURB	16.53 SQ. FT.
WETTED PERIMETER	57.01 FT.
HYDRAULIC RADIUS	0.290 FT.

58 FT. STREET

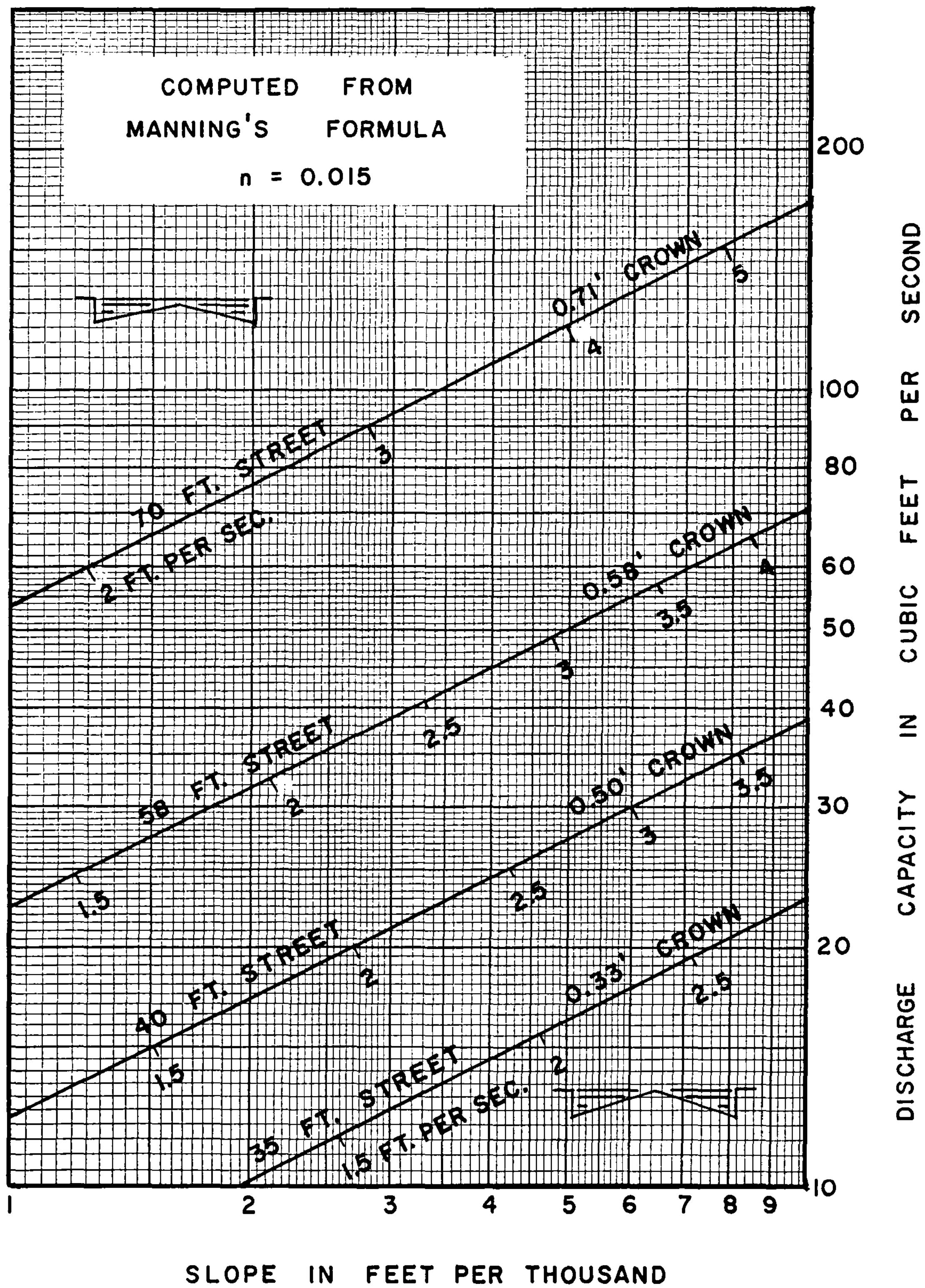


AREA TO TOP OF CURB	32.78 SQ. FT.
WETTED PERIMETER	70.60 FT.
HYDRAULIC RADIUS	0.464 FT.

70 FT. STREET

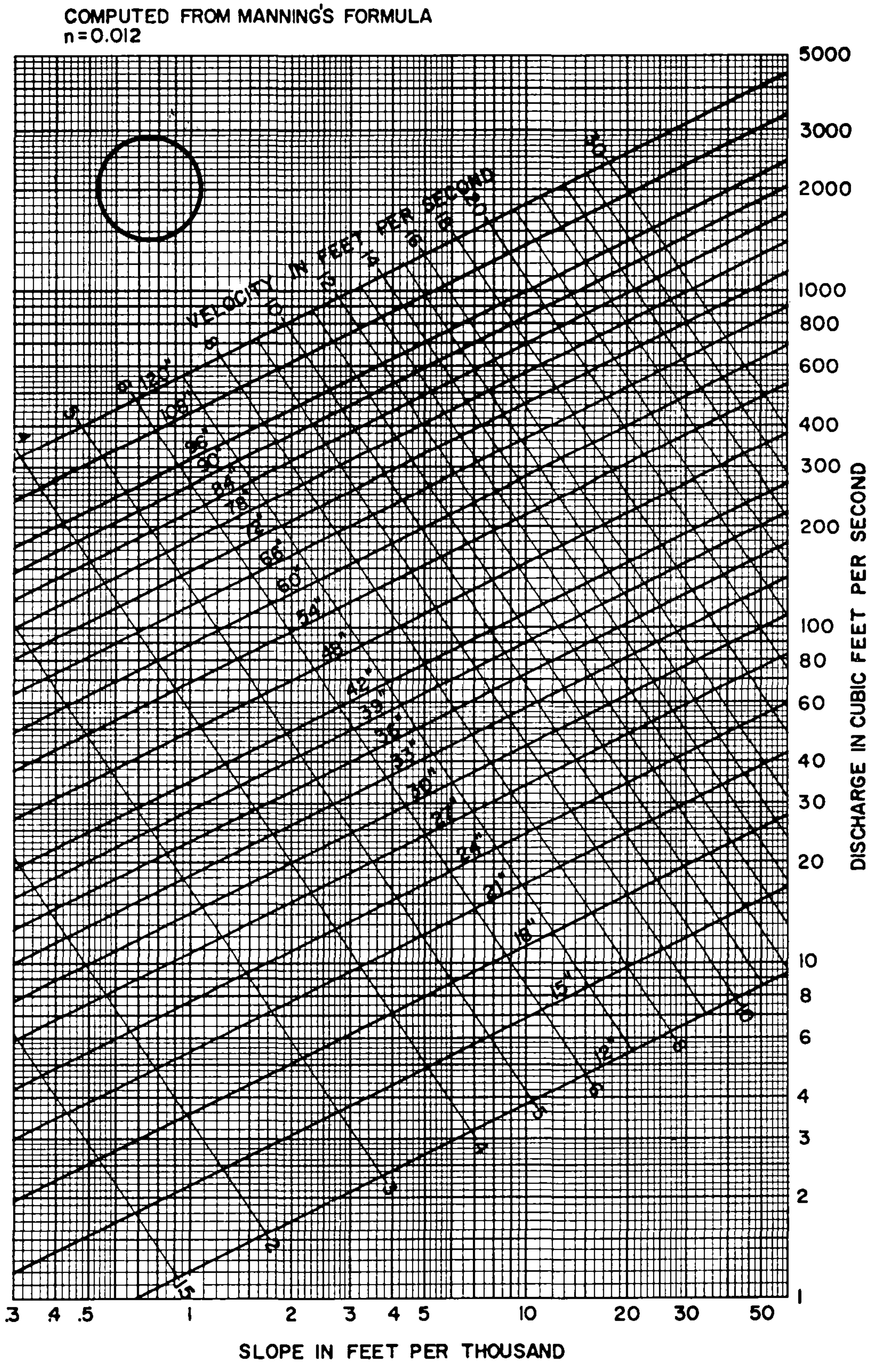
HYDRAULIC PROPERTIES OF TYPICAL STREET SECTIONS

FIGURE 2.9



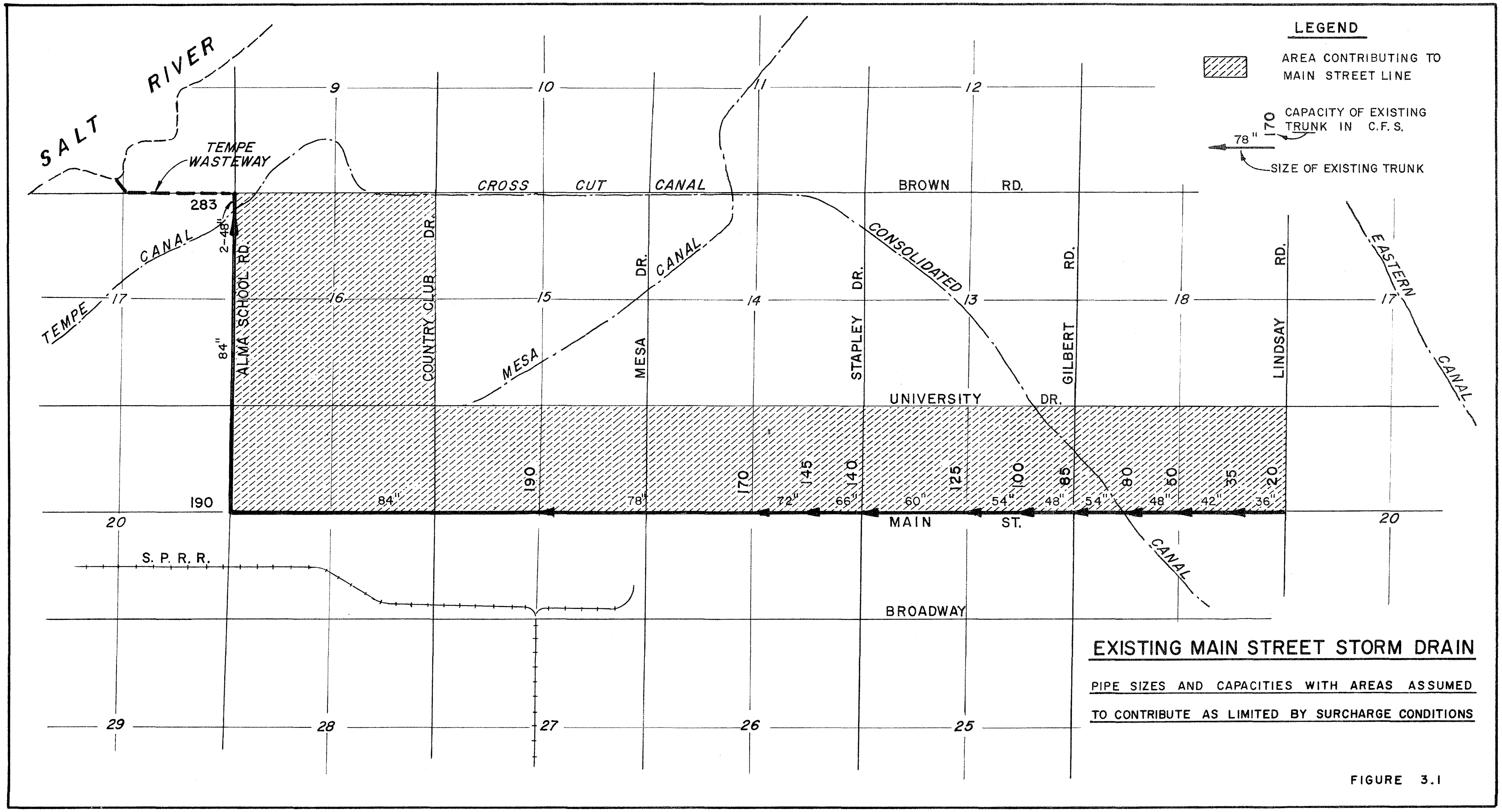
TYPICAL STREET SECTION CAPACITIES FLOWING FULL TO TOP OF CURB

FIGURE 2.10



PIPE CAPACITIES FLOWING FULL

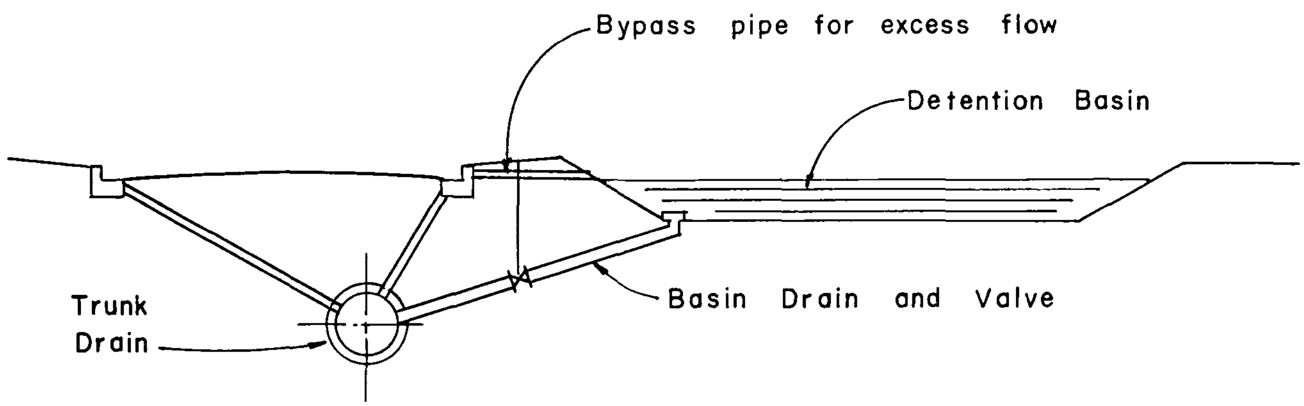
FIGURE 2.11



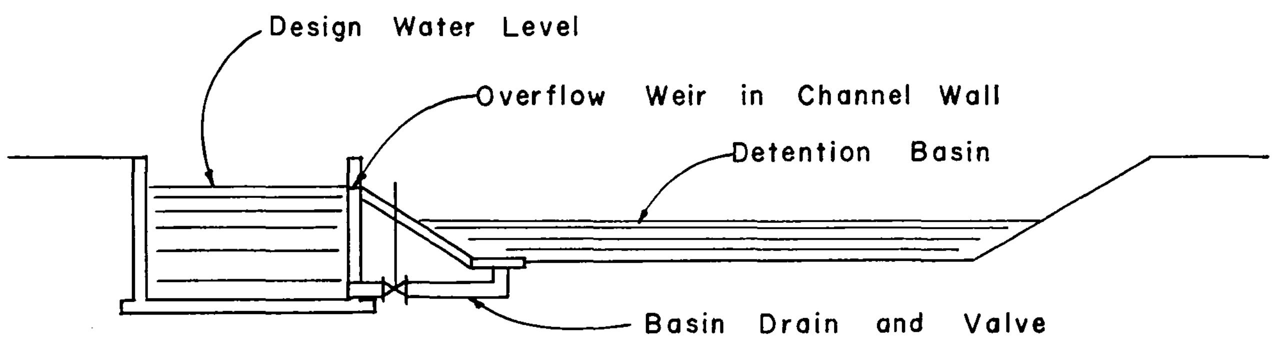
EXISTING MAIN STREET STORM DRAIN

PIPE SIZES AND CAPACITIES WITH AREAS ASSUMED TO CONTRIBUTE AS LIMITED BY SURCHARGE CONDITIONS

FIGURE 3.1

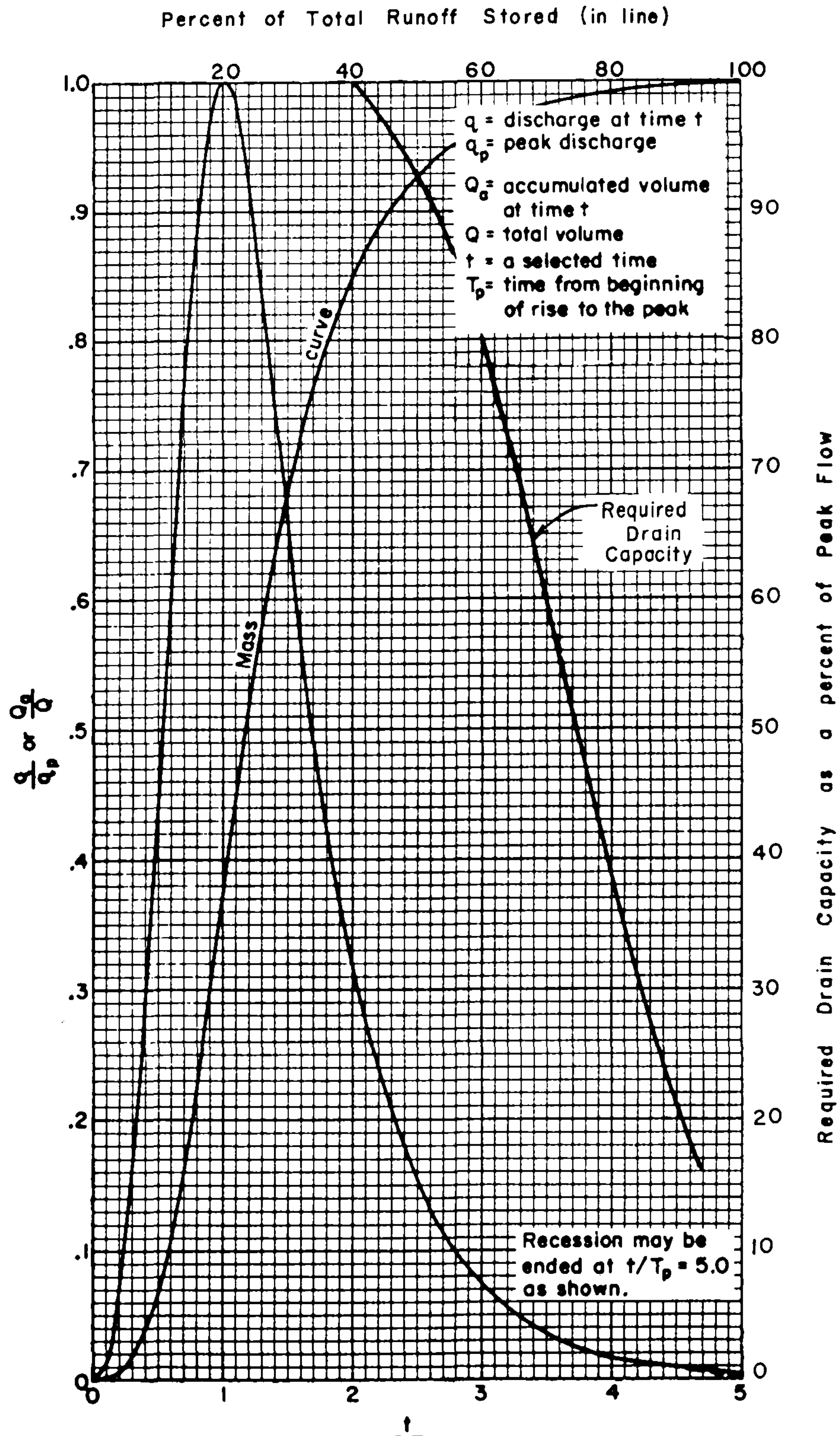


OFF-LINE STORAGE AND CONNECTION TO PIPED DRAINS



OFF-LINE STORAGE AND CONNECTION FOR OPEN CHANNEL DRAINS

FIGURE 3.2

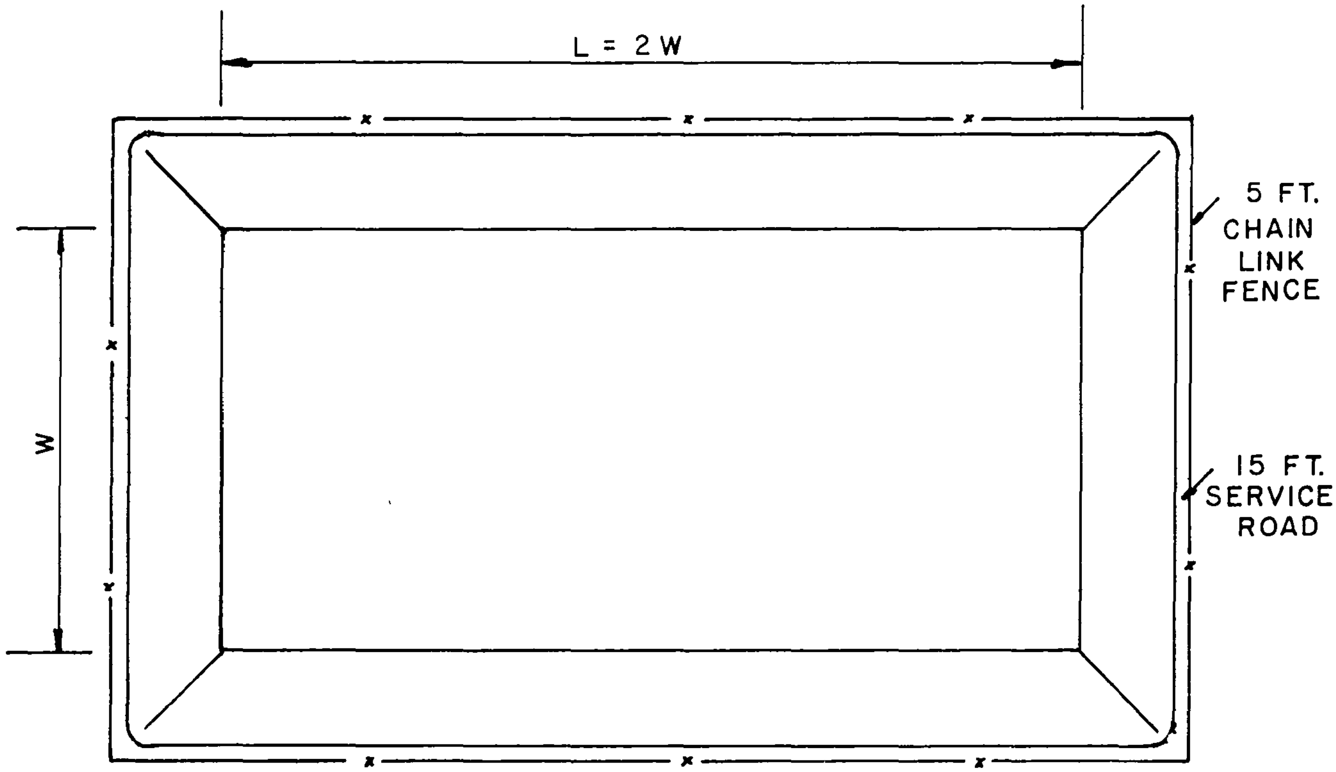


REFERENCE:

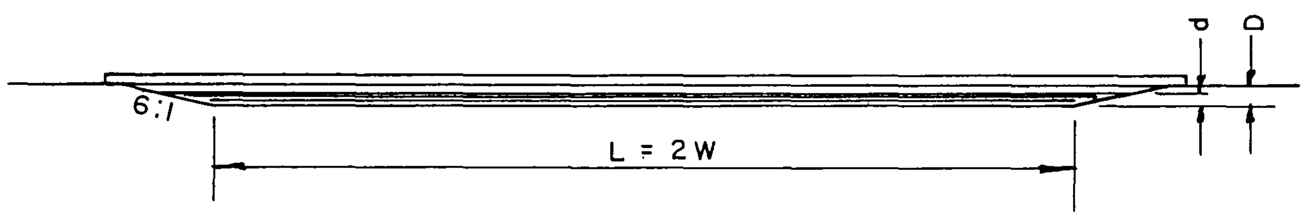
Soil Conservation Service, Engineering Division-Central Technical Unit, Std. Drawing No. ES-1004.

REPRESENTATIVE DIMENSIONLESS HYDROGRAPH AND MASS CURVE

FIGURE 3.3



PLAN

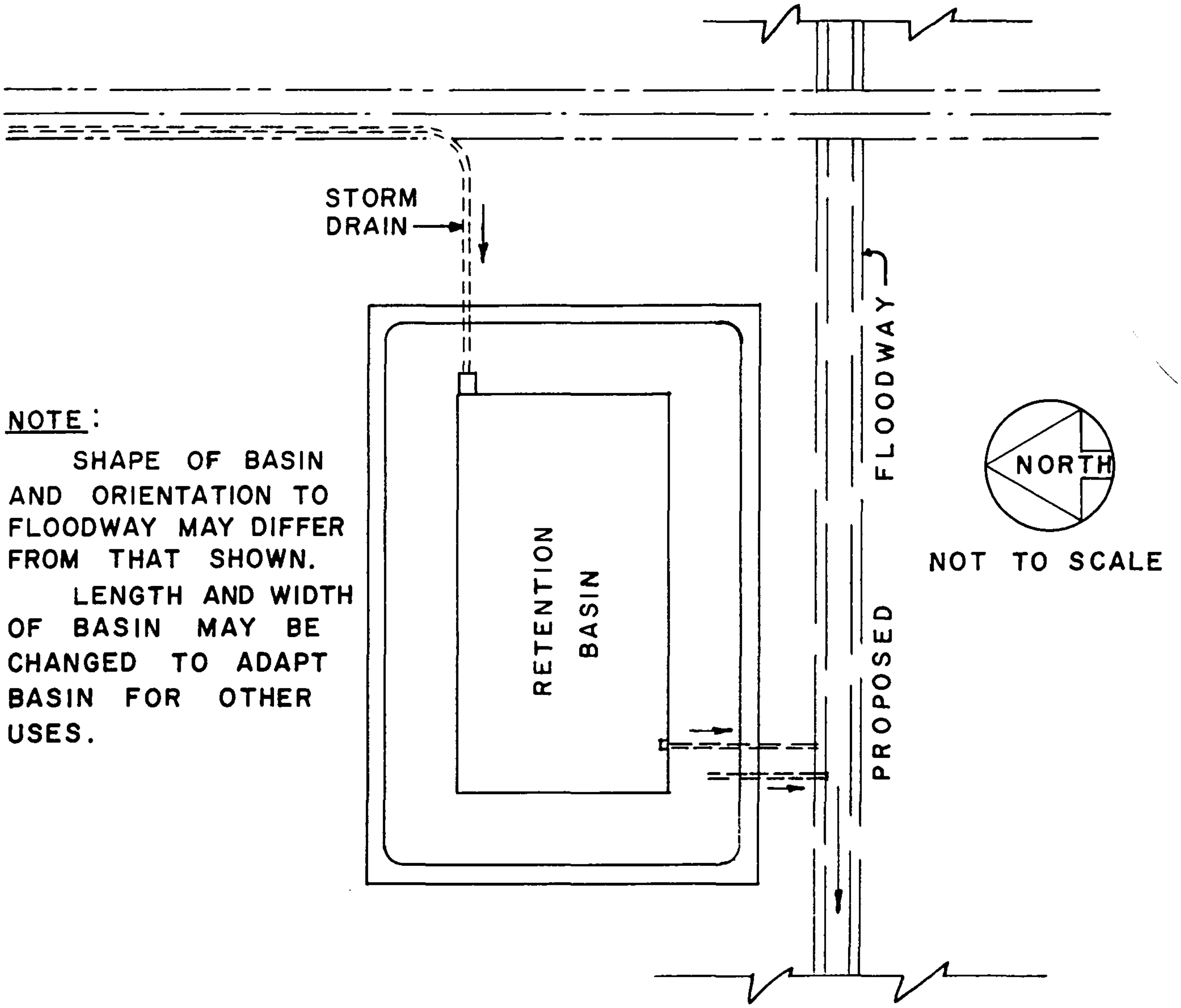


SECTION

BOTTOM	WIDTH	"W"	VARIES	110 FT.	TO	520 FT.
BOTTOM	LENGTH	"L"	VARIES	220 FT.	TO	1040 FT.
TOTAL	DEPTH	"D"	VARIES	10 FT.	TO	22 FT.
WATER	DEPTH	"d"	VARIES	3 FT.	TO	7.5 FT.

TYPICAL RETENTION BASIN

FIGURE 3.4

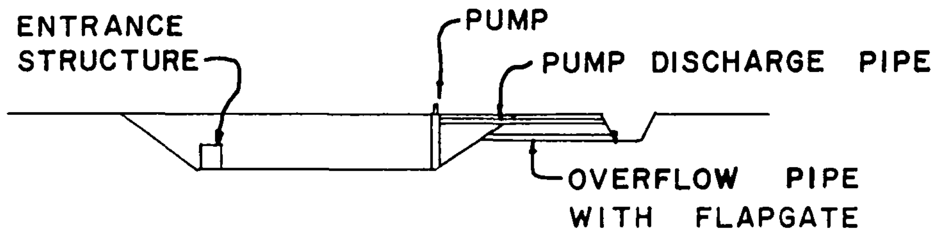


NOTE:

SHAPE OF BASIN AND ORIENTATION TO FLOODWAY MAY DIFFER FROM THAT SHOWN.

LENGTH AND WIDTH OF BASIN MAY BE CHANGED TO ADAPT BASIN FOR OTHER USES.

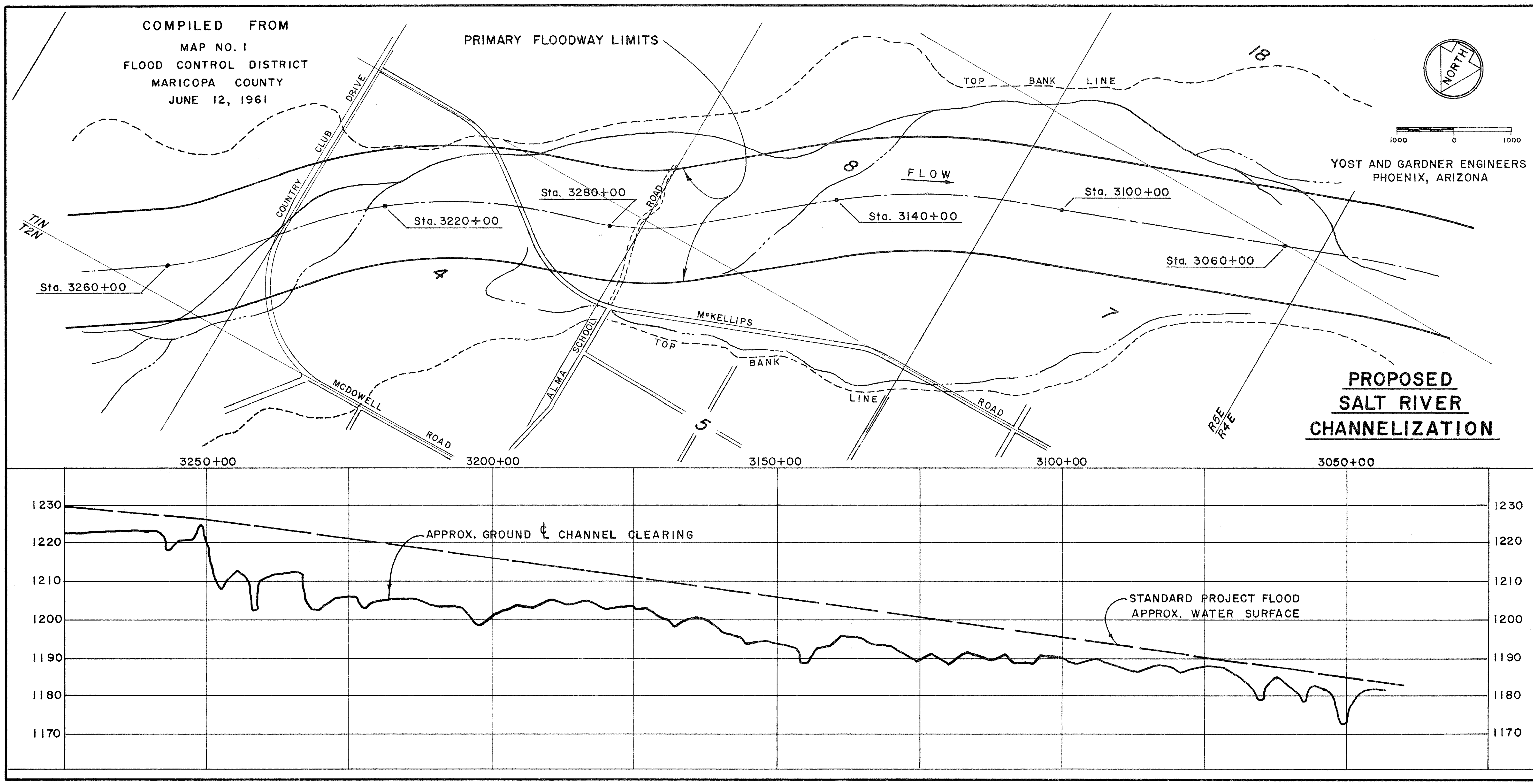
P L A N



S E C T I O N

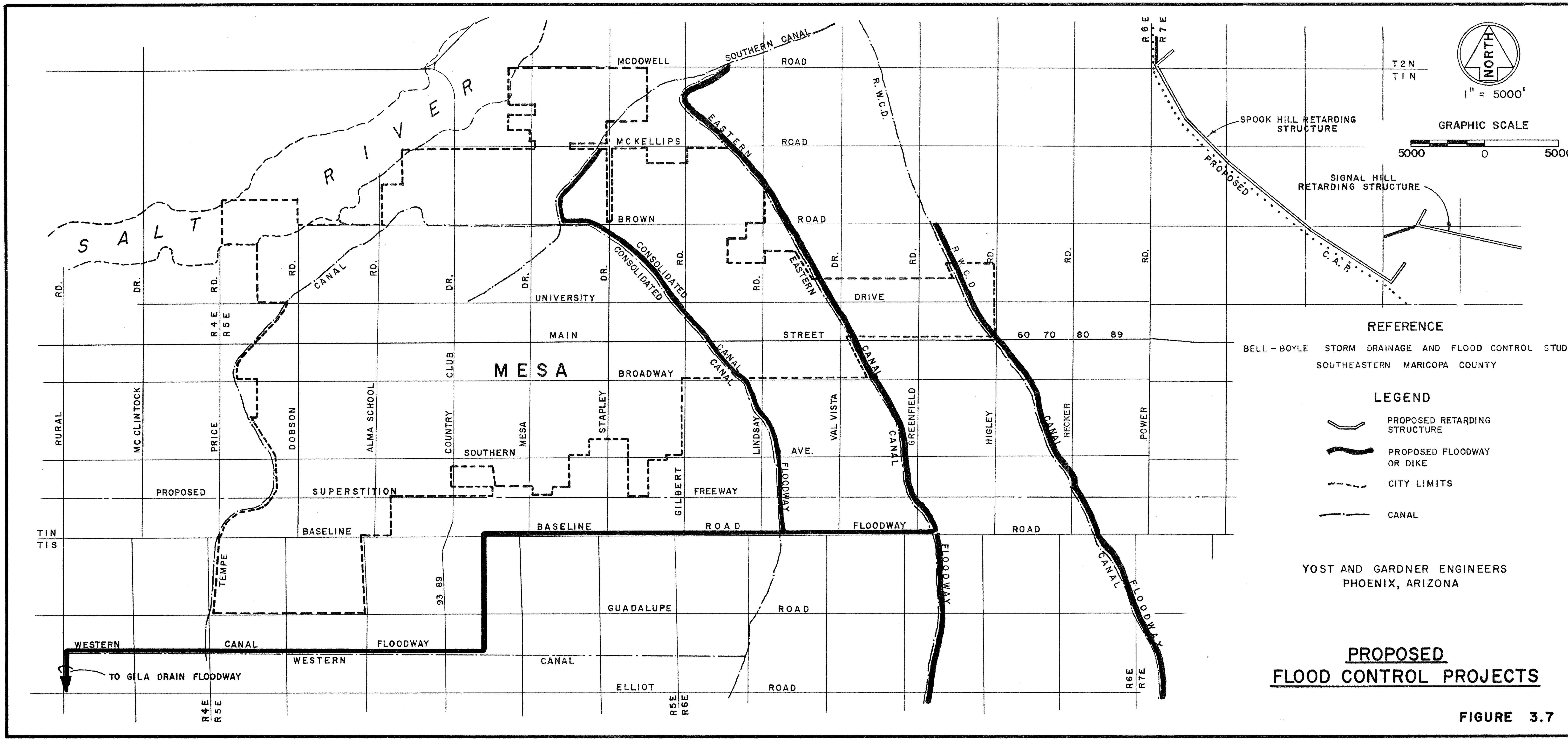
TYPICAL BASIN DISCHARGE SYSTEM

FIGURE 3.5



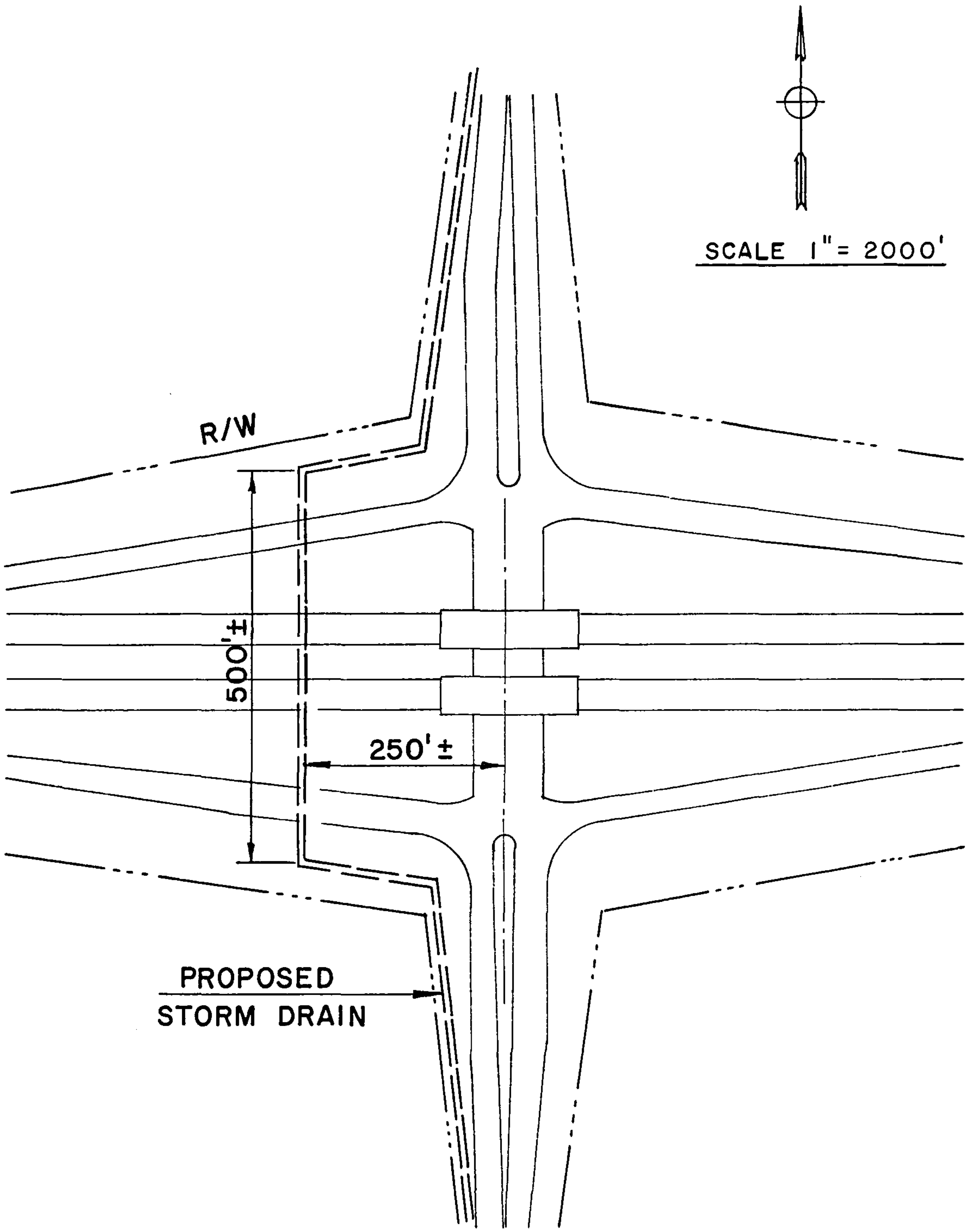
COMPILED FROM
MAP NO. 1
FLOOD CONTROL DISTRICT
MARICOPA COUNTY
JUNE 12, 1961
PRIMARY FLOODWAY LIMITS
TOP BANK LINE
18
NORTH
1000 0 1000
YOST AND GARDNER ENGINEERS
PHOENIX, ARIZONA
FLOW
8
Sta. 3280+00
Sta. 3220+00
Sta. 3140+00
Sta. 3100+00
Sta. 3060+00
Sta. 3260+00
T1N
T2N
COUNTRY CLUB DRIVE
ROAD
4
7
McKELLIPS
TOP
BANK
LINE
ROAD
MCDOWELL
ROAD
ALMA SCHOOL
5
R5E
R4E
PROPOSED
SALT RIVER
CHANNELIZATION
3250+00
3200+00
3150+00
3100+00
3050+00
1230
1220
1210
1200
1190
1180
1170
APPROX. GROUND ℄ CHANNEL CLEARING
STANDARD PROJECT FLOOD
APPROX. WATER SURFACE

FIGURE 3.6



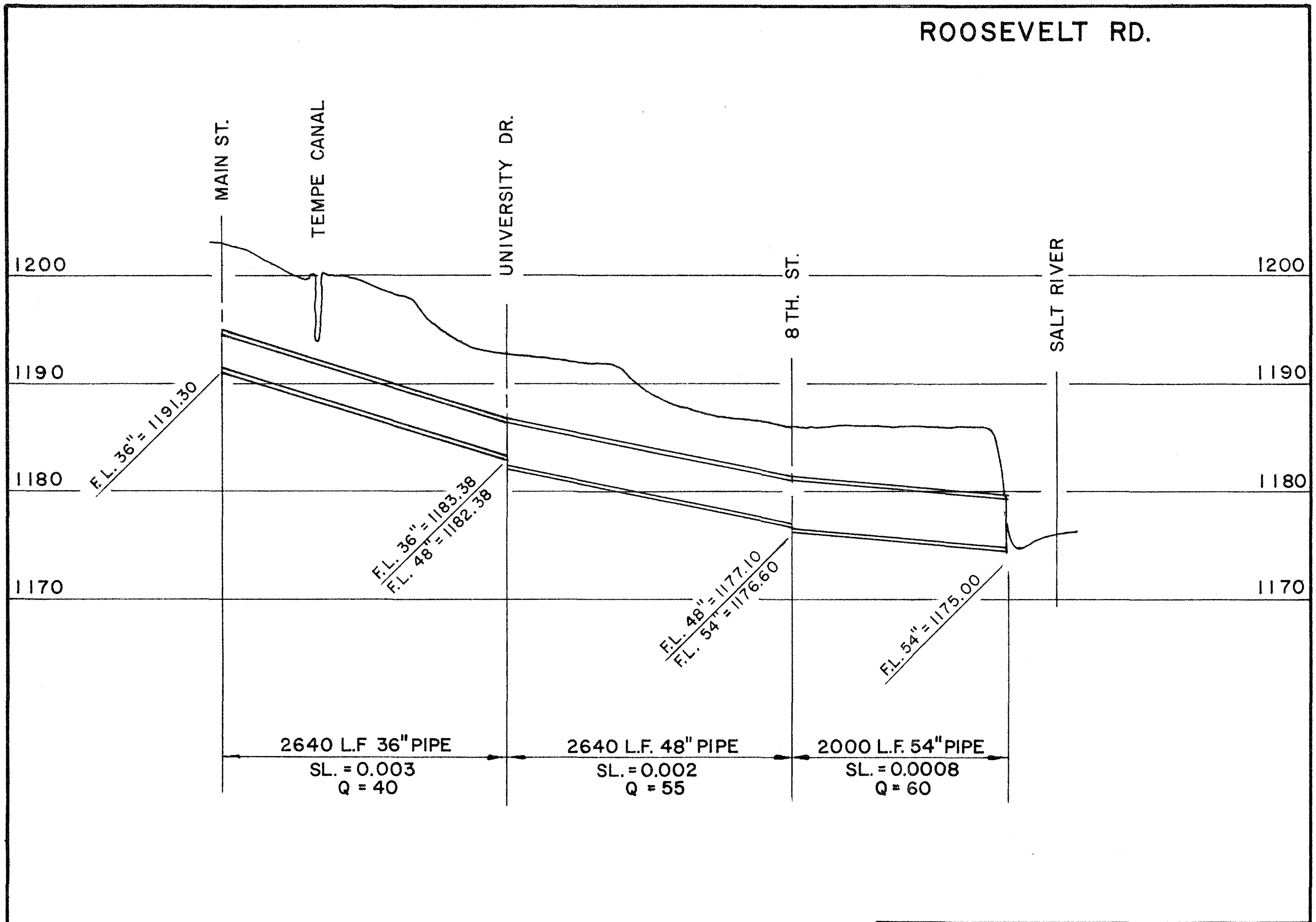
PROPOSED FLOOD CONTROL PROJECTS

FIGURE 3.7



TYPICAL FREEWAY CROSSING

FIGURE 4.1



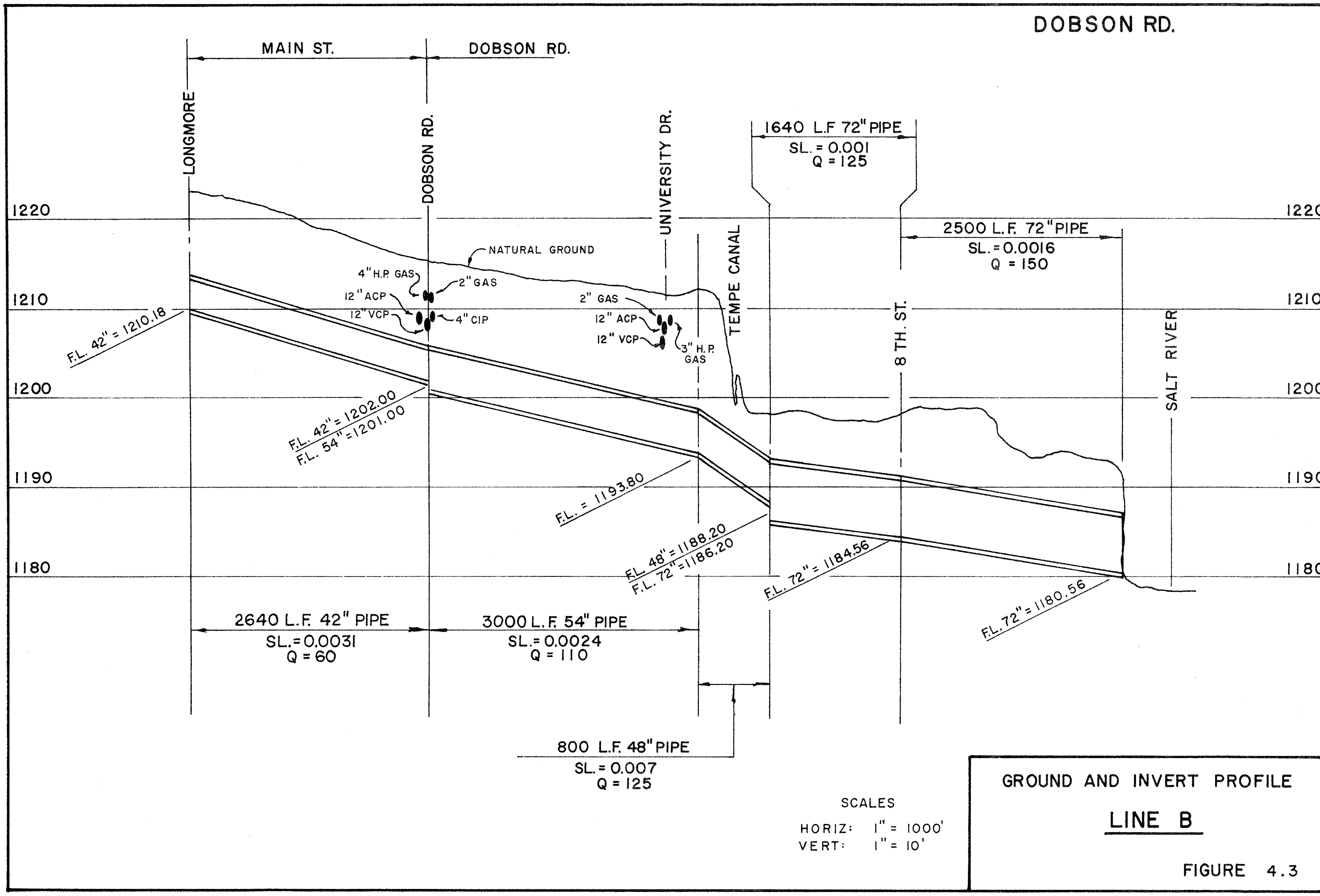
SCALES

HORIZ: 1" = 1000'
VERT: 1" = 10'

GROUND AND INVERT PROFILE

LINE A

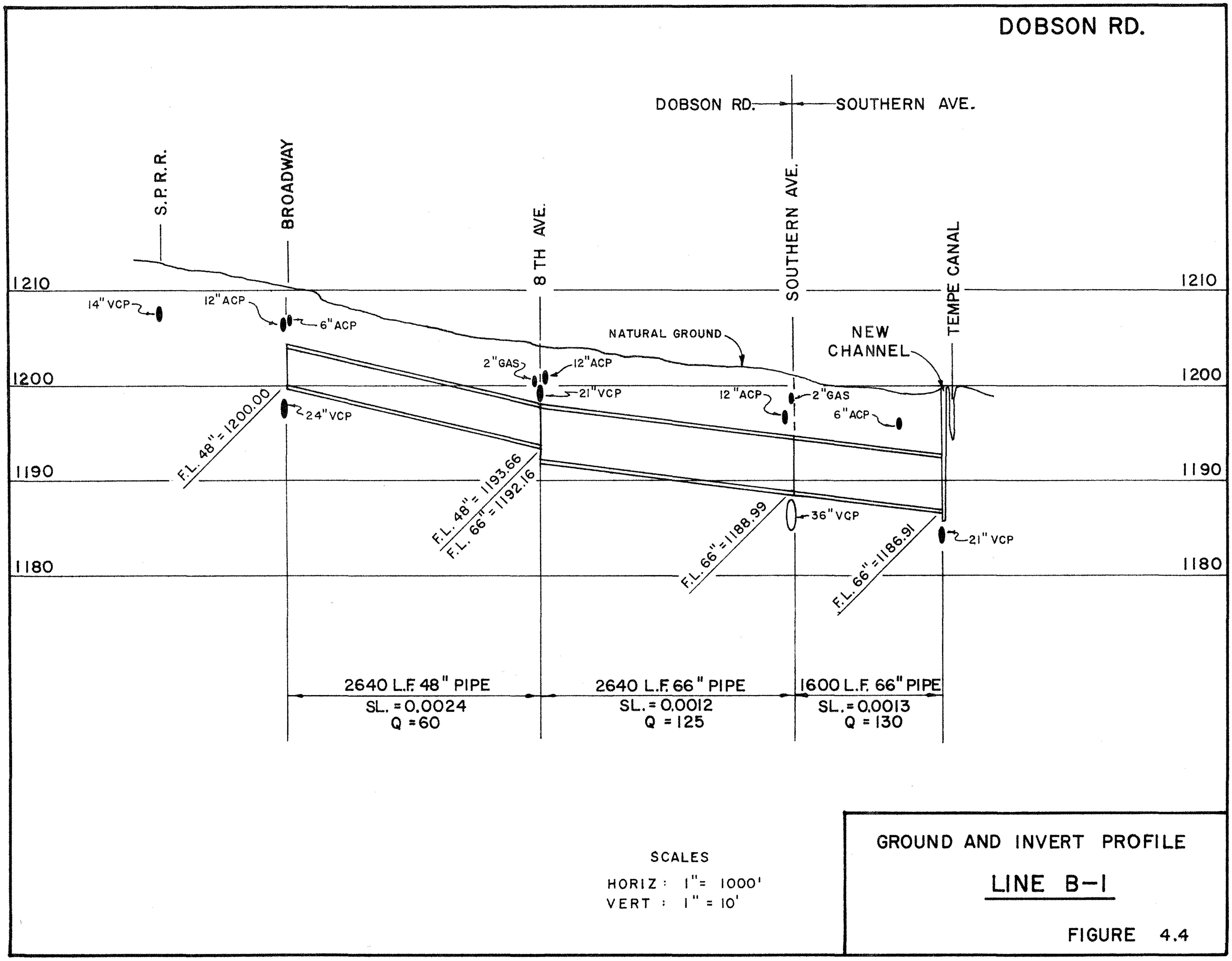
FIGURE 4.2



GROUND AND INVERT PROFILE

LINE B

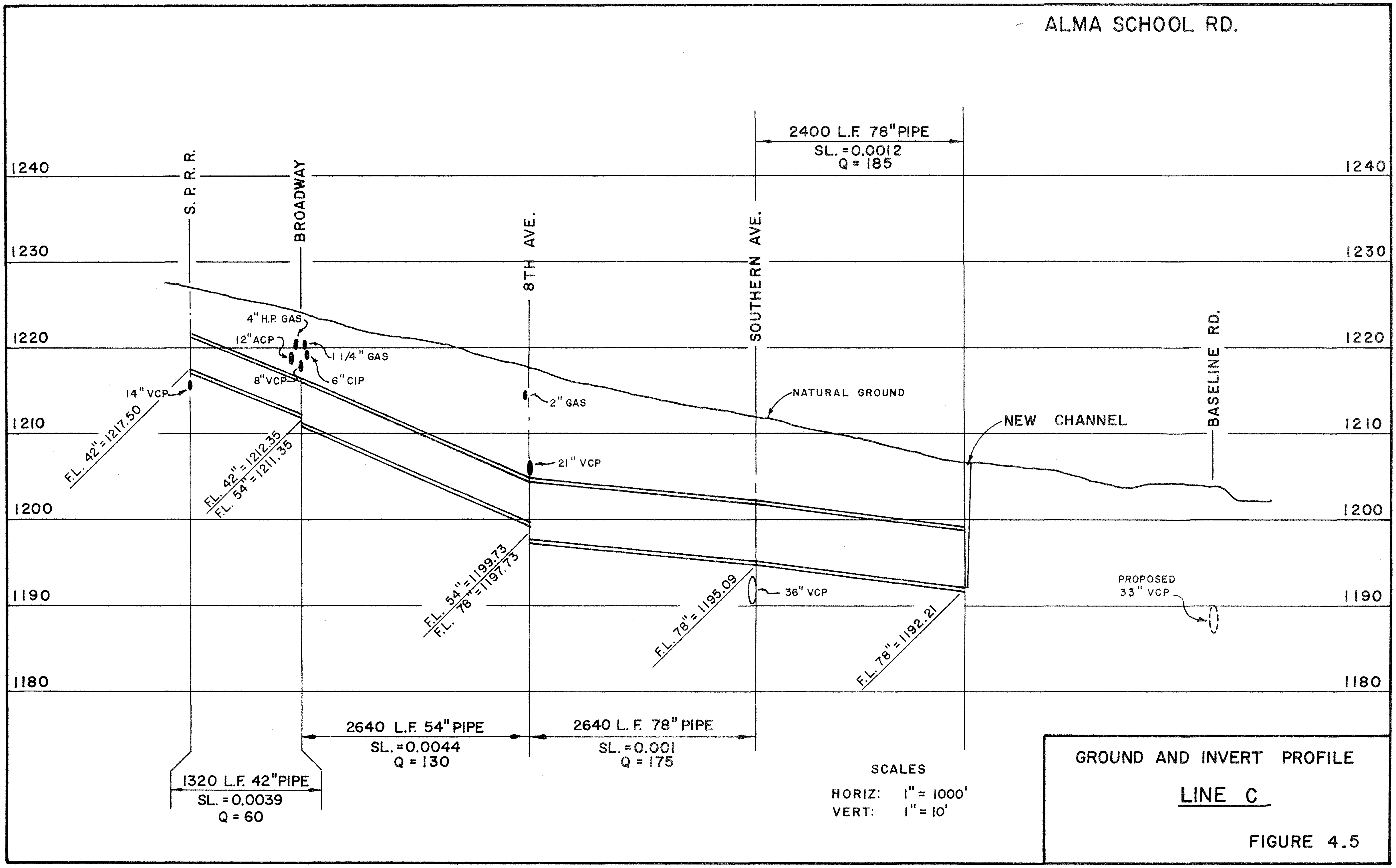
FIGURE 4.3



GROUND AND INVERT PROFILE

LINE B-1

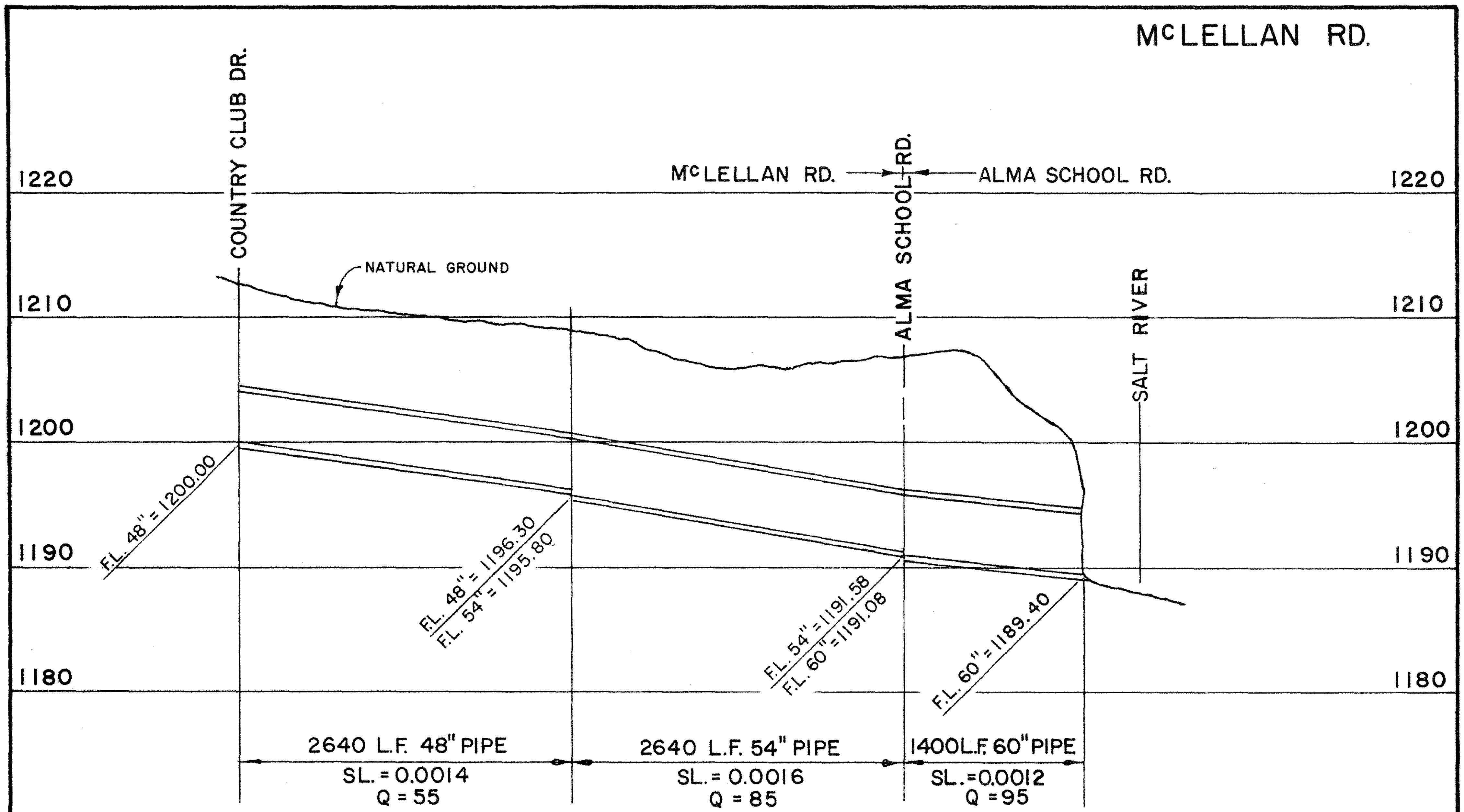
FIGURE 4.4



GROUND AND INVERT PROFILE

LINE C

FIGURE 4.5



SCALES

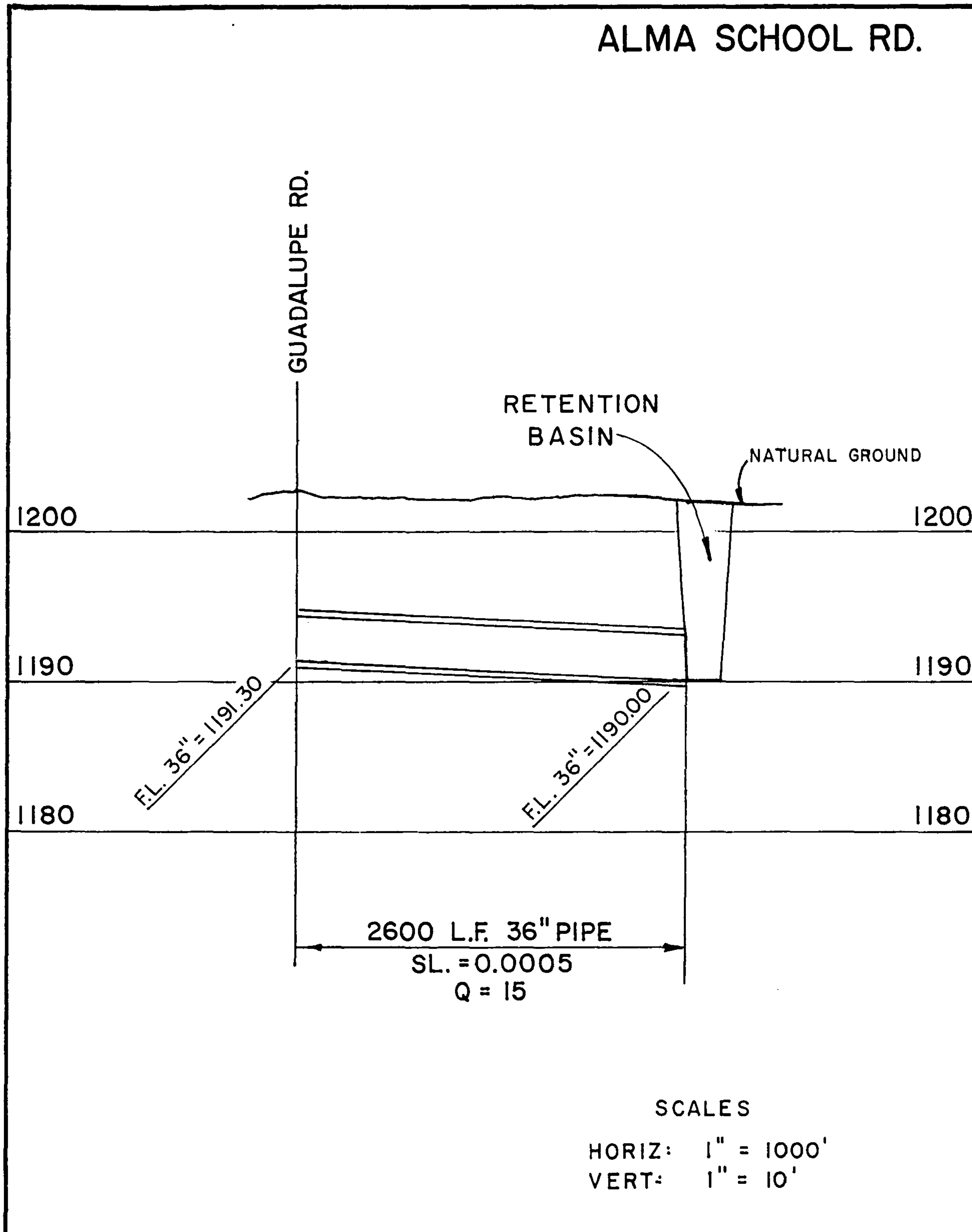
HORIZ: 1" = 1000'

VERT: 1" = 10'

GROUND AND INVERT PROFILE

LINE C-1

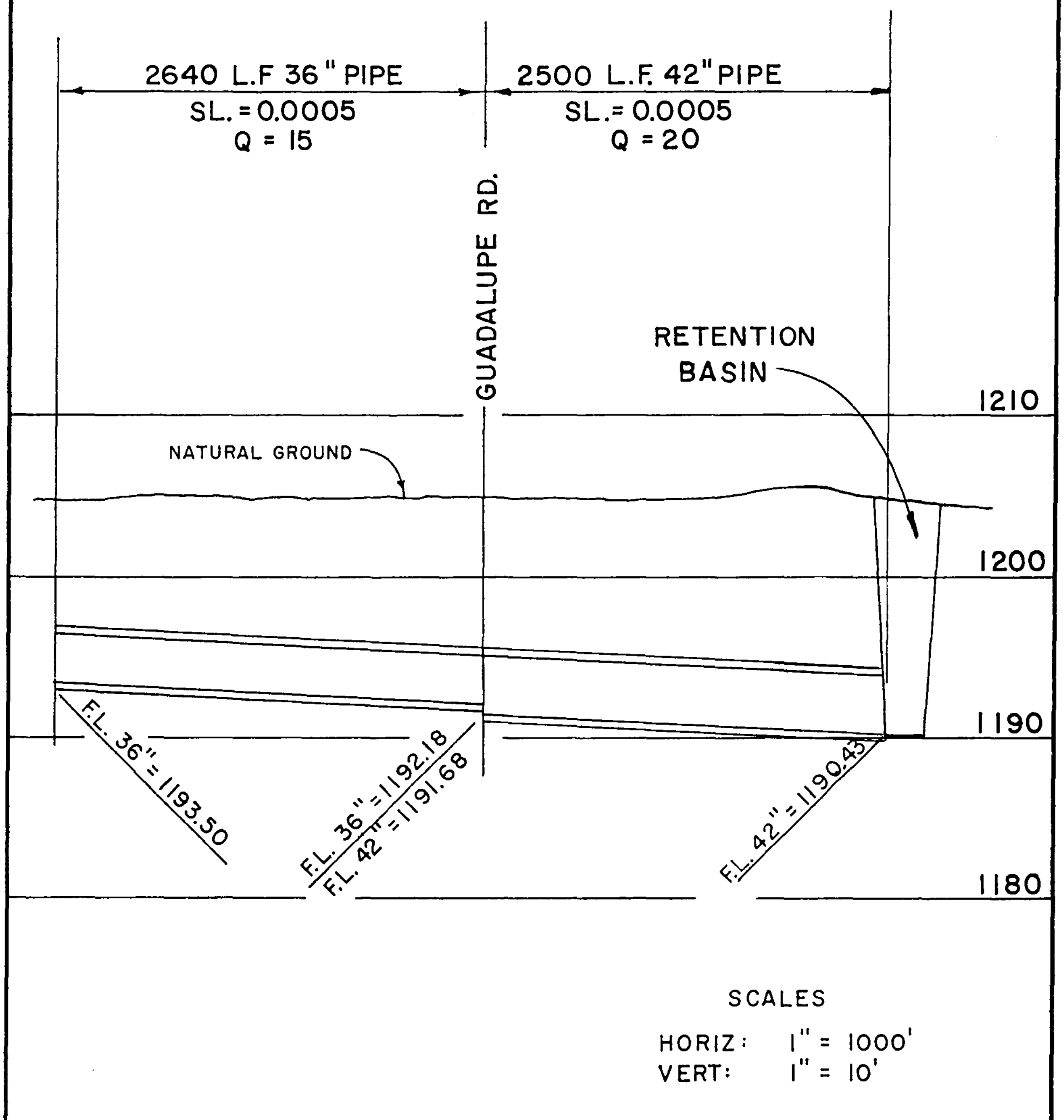
FIGURE 4.6



GROUND AND INVERT PROFILE

LINE C-2

FIGURE 4.7



GROUND AND INVERT PROFILE

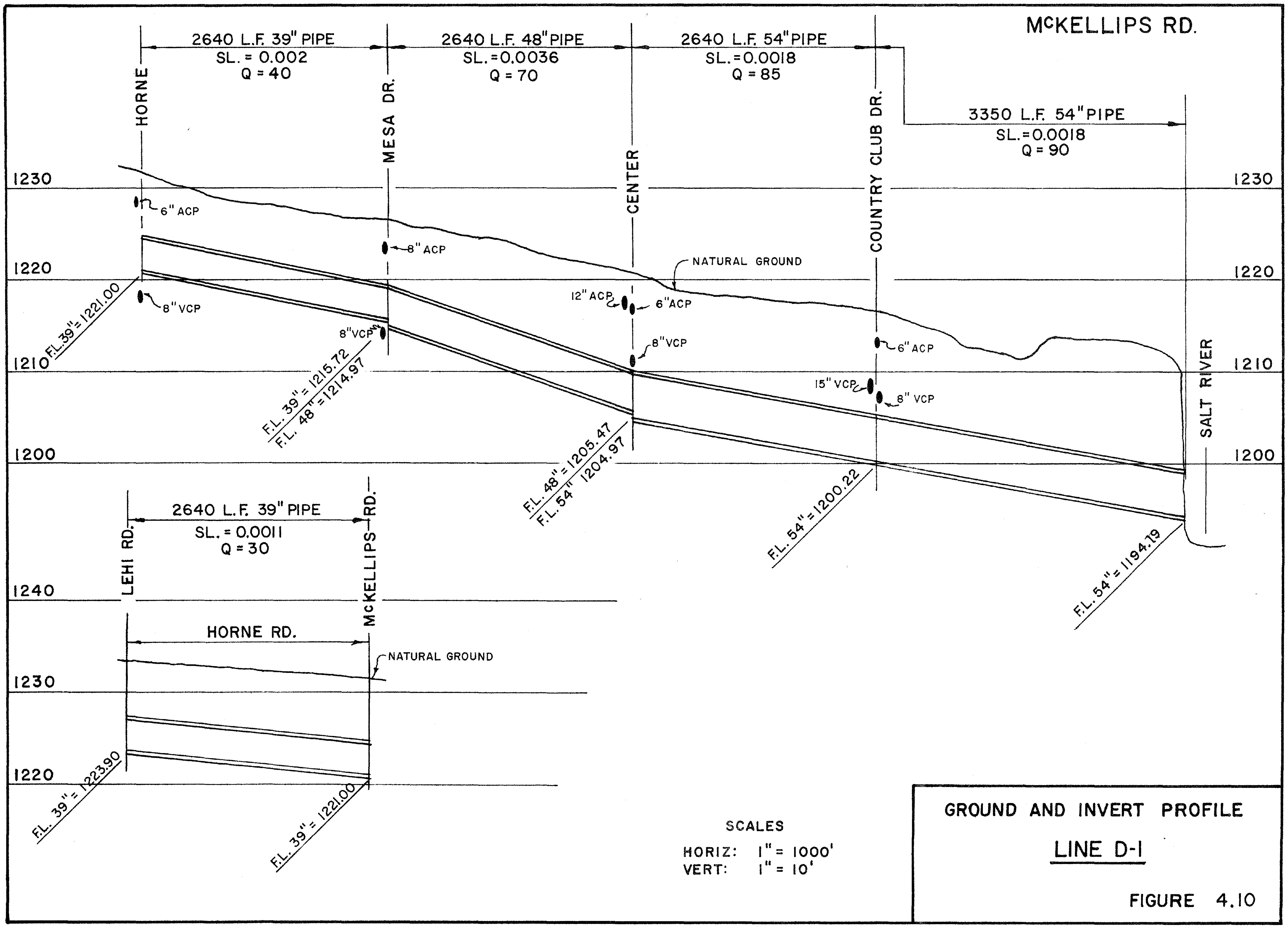
LINE C-3

FIGURE 4.8

GROUND AND INVERT PROFILE

LINE D

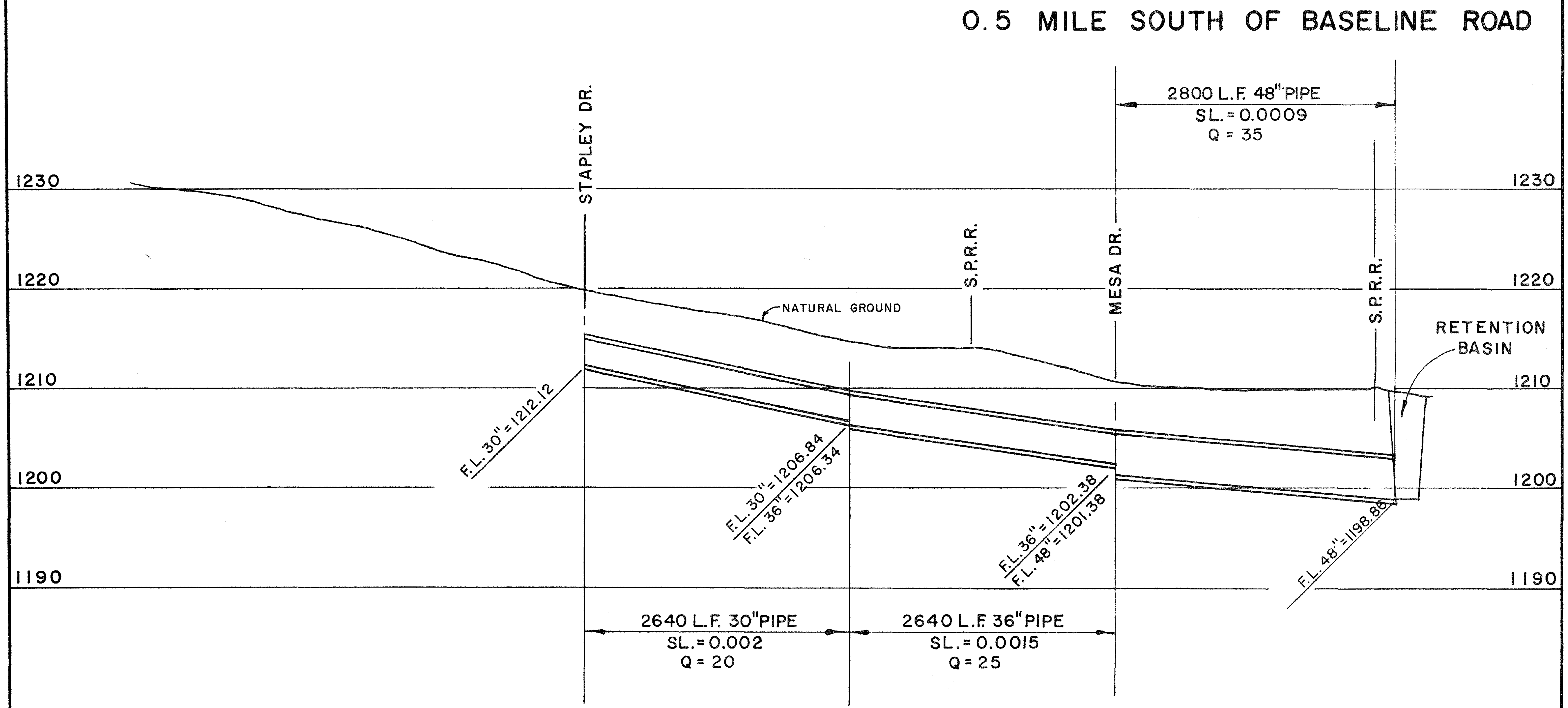
FIGURE 4.9


McKELLIPS RD.
2640 L.F. 39" PIPE
SL. = 0.002
Q = 40
2640 L.F. 48" PIPE
SL. = 0.0036
Q = 70
2640 L.F. 54" PIPE
SL. = 0.0018
Q = 85
3350 L.F. 54" PIPE
SL. = 0.0018
Q = 90
HORNE
MESA DR.
CENTER
COUNTRY CLUB DR.
SALT RIVER
1230
1220
1210
1200
6" ACP
8" ACP
8" VCP
12" ACP
6" ACP
8" VCP
6" ACP
15" VCP
8" VCP
NATURAL GROUND
F.L. 39" = 1221.00
F.L. 39" = 1215.72
F.L. 48" = 1214.97
F.L. 48" = 1205.47
F.L. 54" 1204.97
F.L. 54" = 1200.22
F.L. 54" = 1194.19
2640 L.F. 39" PIPE
SL. = 0.0011
Q = 30
LEHI RD.
McKELLIPS RD.
HORNE RD.
NATURAL GROUND
1240
1230
1220
F.L. 39" = 1223.90
F.L. 39" = 1221.00
SCALES
HORIZ: 1" = 1000'
VERT: 1" = 10'
GROUND AND INVERT PROFILE
LINE D-1
FIGURE 4.10

GROUND AND INVERT PROFILE

LINE E

FIGURE 4.11



SCALES

HORIZ: 1" = 1000'
VERT: 1" = 10'

GROUND AND INVERT PROFILE

LINE E-1

FIGURE 4.12

GROUND AND INVERT PROFILE

LINE F

FIGURE 4.13

GROUND AND INVERT PROFILE

LINE G

FIGURE 4.14

GROUND AND INVERT PROFILE

LINE H

FIGURE 4.15

GROUND AND INVERT PROFILE

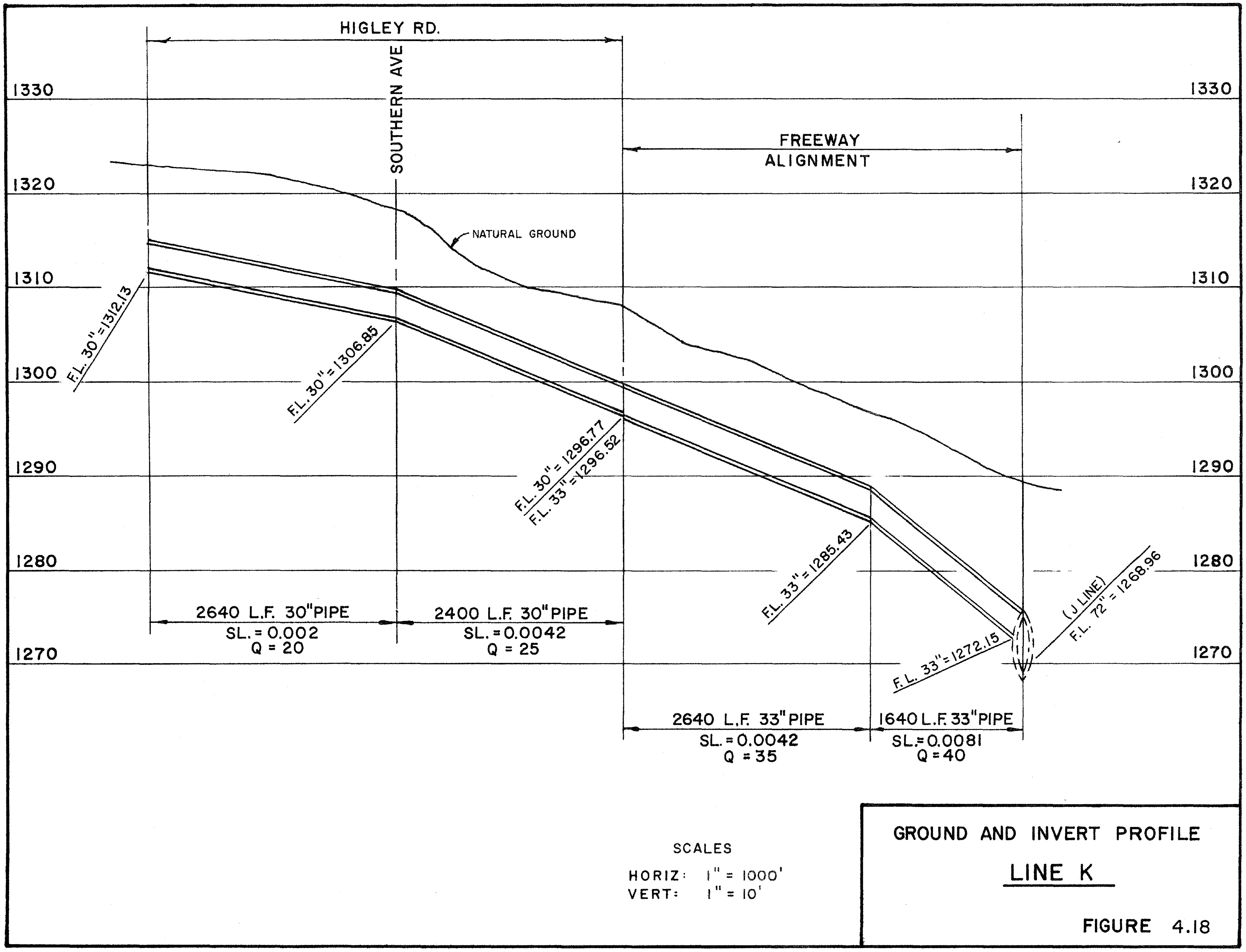
LINE I

FIGURE 4.16

GROUND AND INVERT PROFILE

LINE J

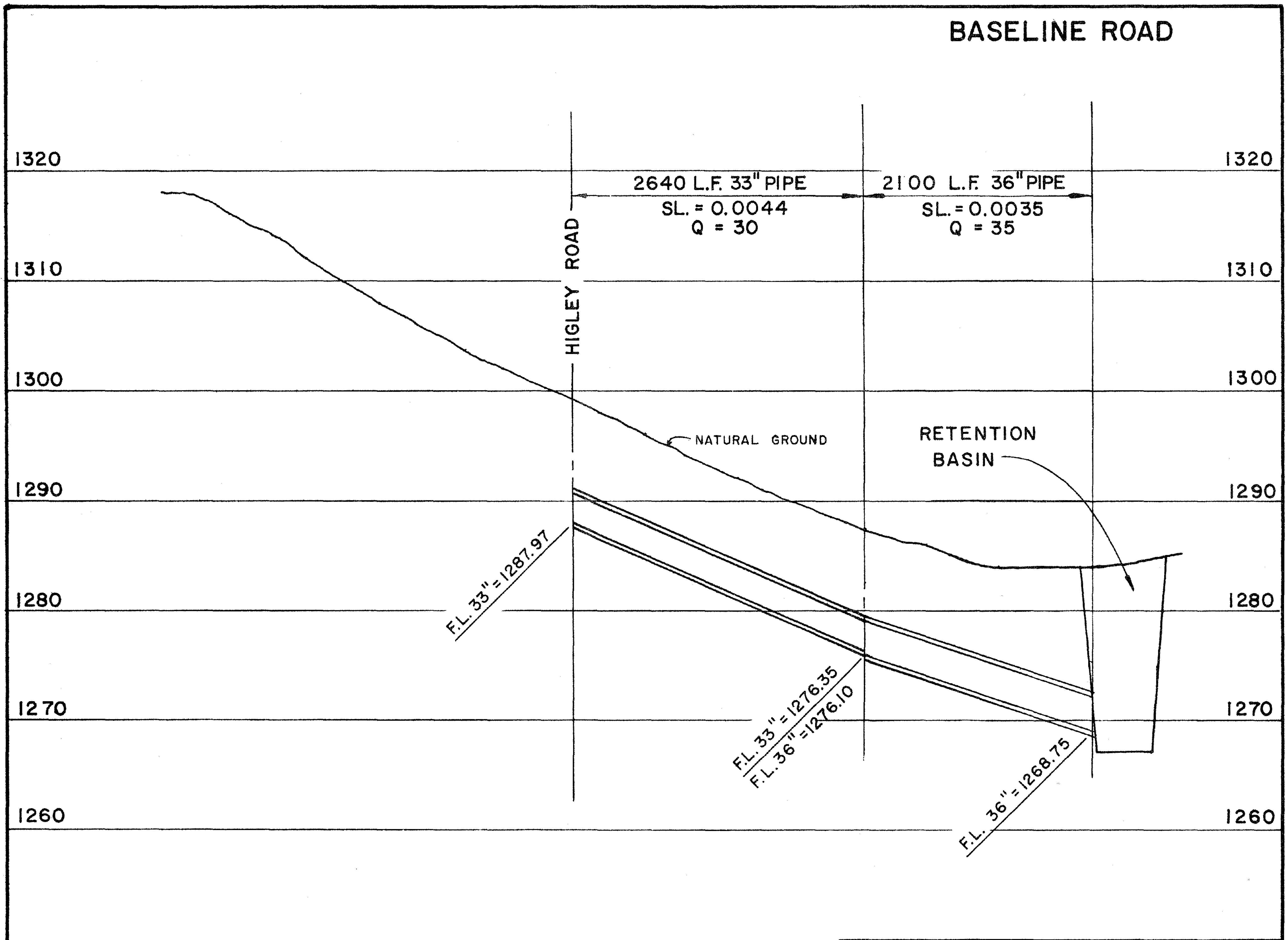
FIGURE 4.17



GROUND AND INVERT PROFILE

LINE K

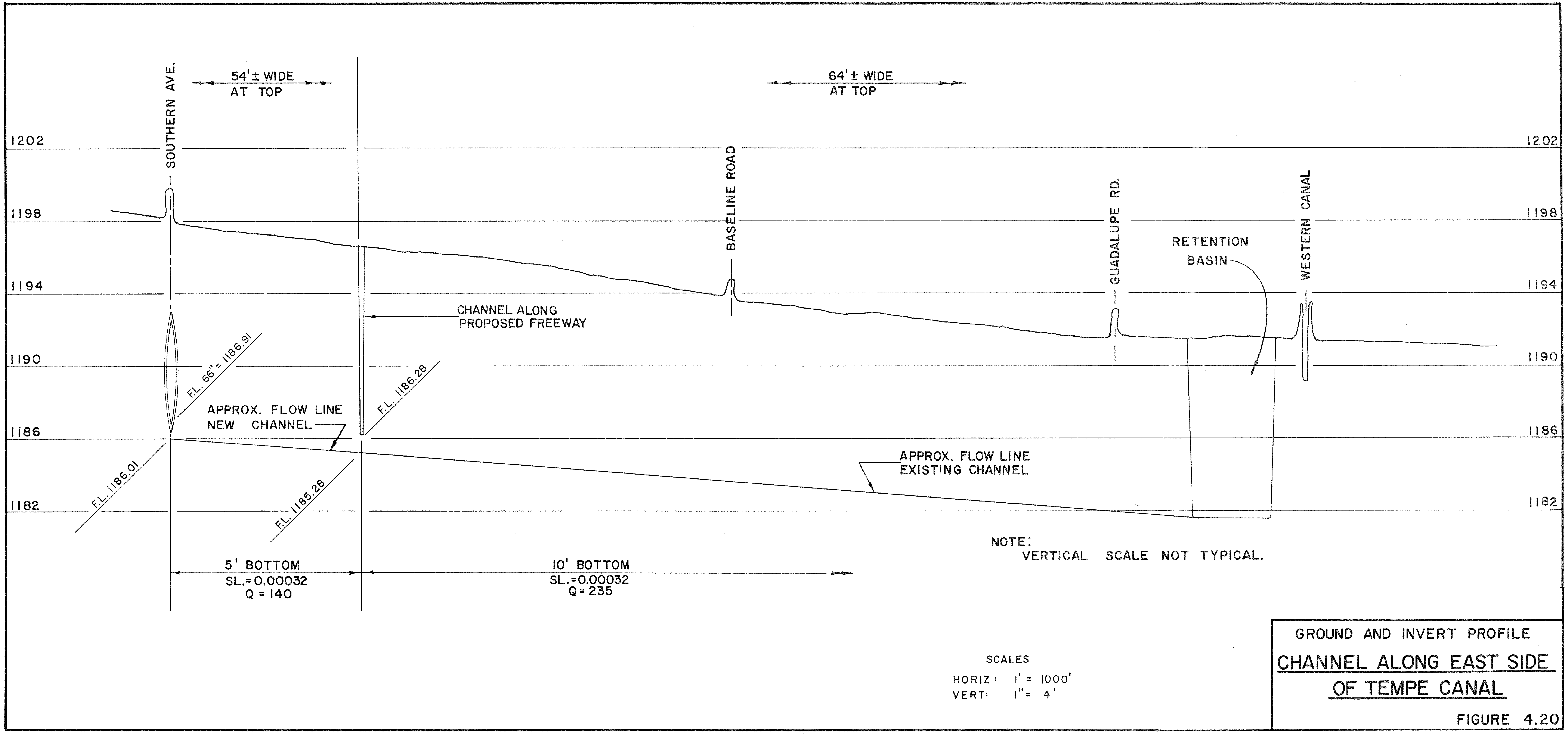
FIGURE 4.18



GROUND AND INVERT PROFILE

LINE L

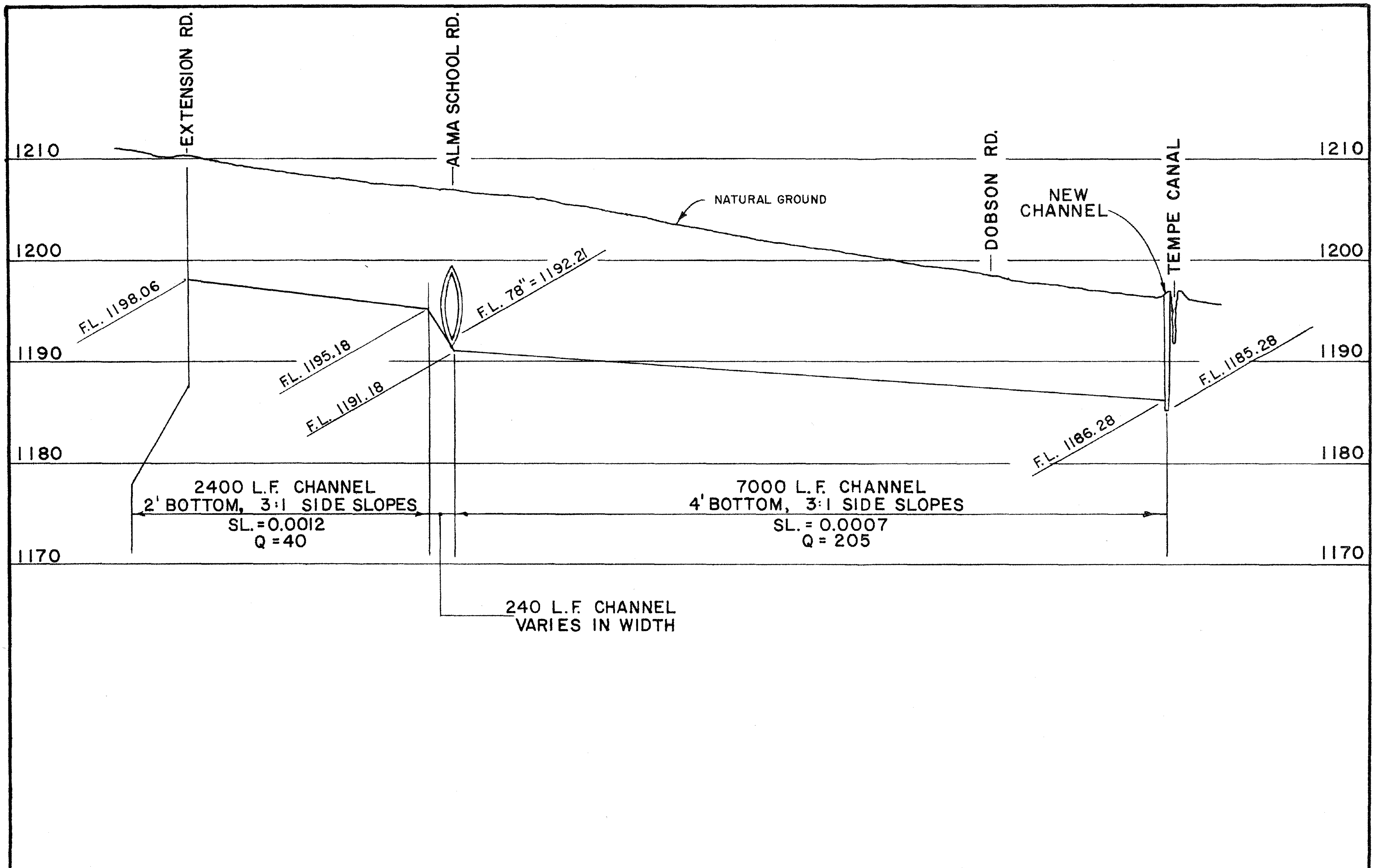
FIGURE 4.19



GROUND AND INVERT PROFILE

CHANNEL ALONG EAST SIDE OF TEMPE CANAL

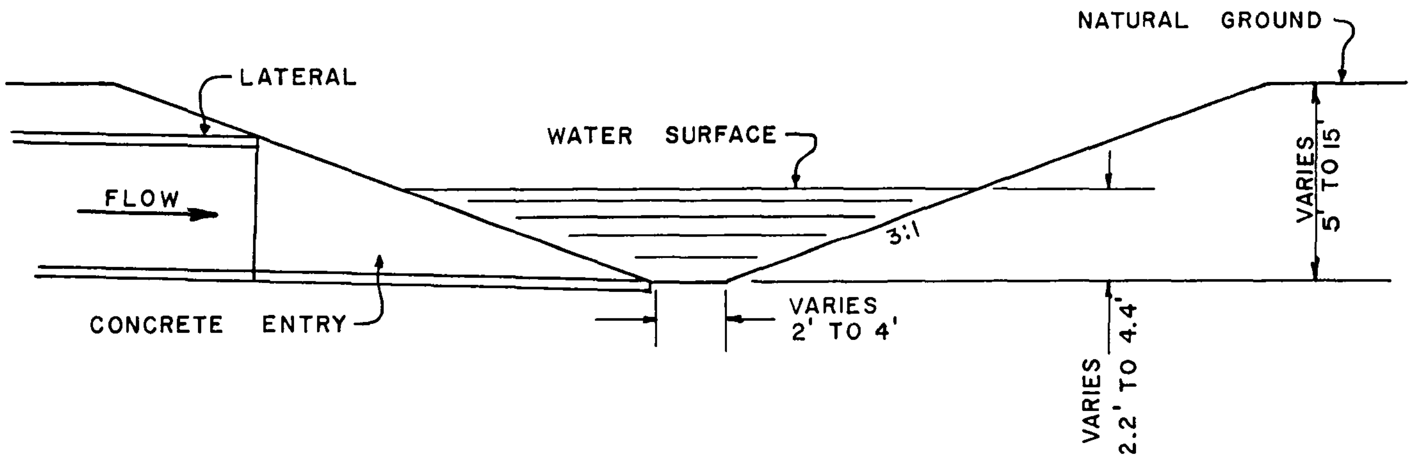
FIGURE 4.20



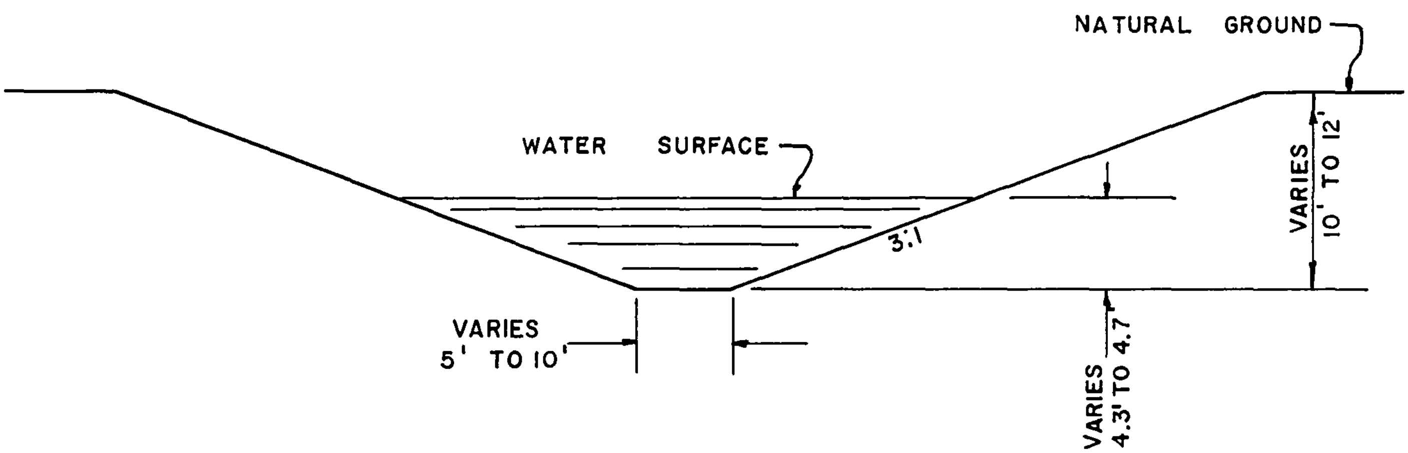
GROUND AND INVERT PROFILE

CHANNEL ALONG NORTH SIDE OF PROPOSED SUPERSTITION FREEWAY

FIGURE 4.21



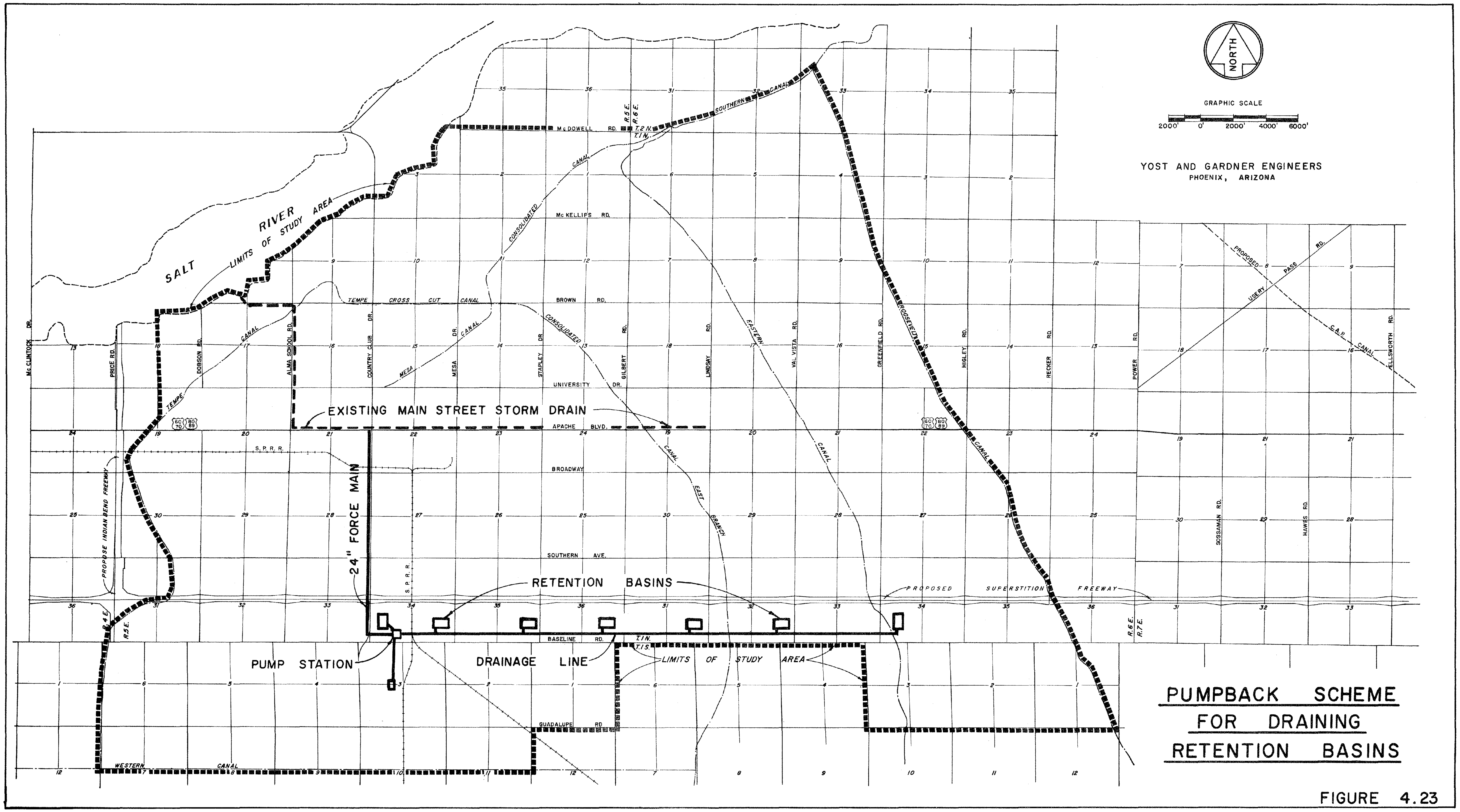
CHANNEL ALONG NORTH SIDE OF
PROPOSED SUPERSTITION FREEWAY
EXTENSION ROAD TO TEMPE CANAL



CHANNEL ALONG EAST SIDE OF TEMPE CANAL
SOUTHERN AVENUE TO WESTERN CANAL

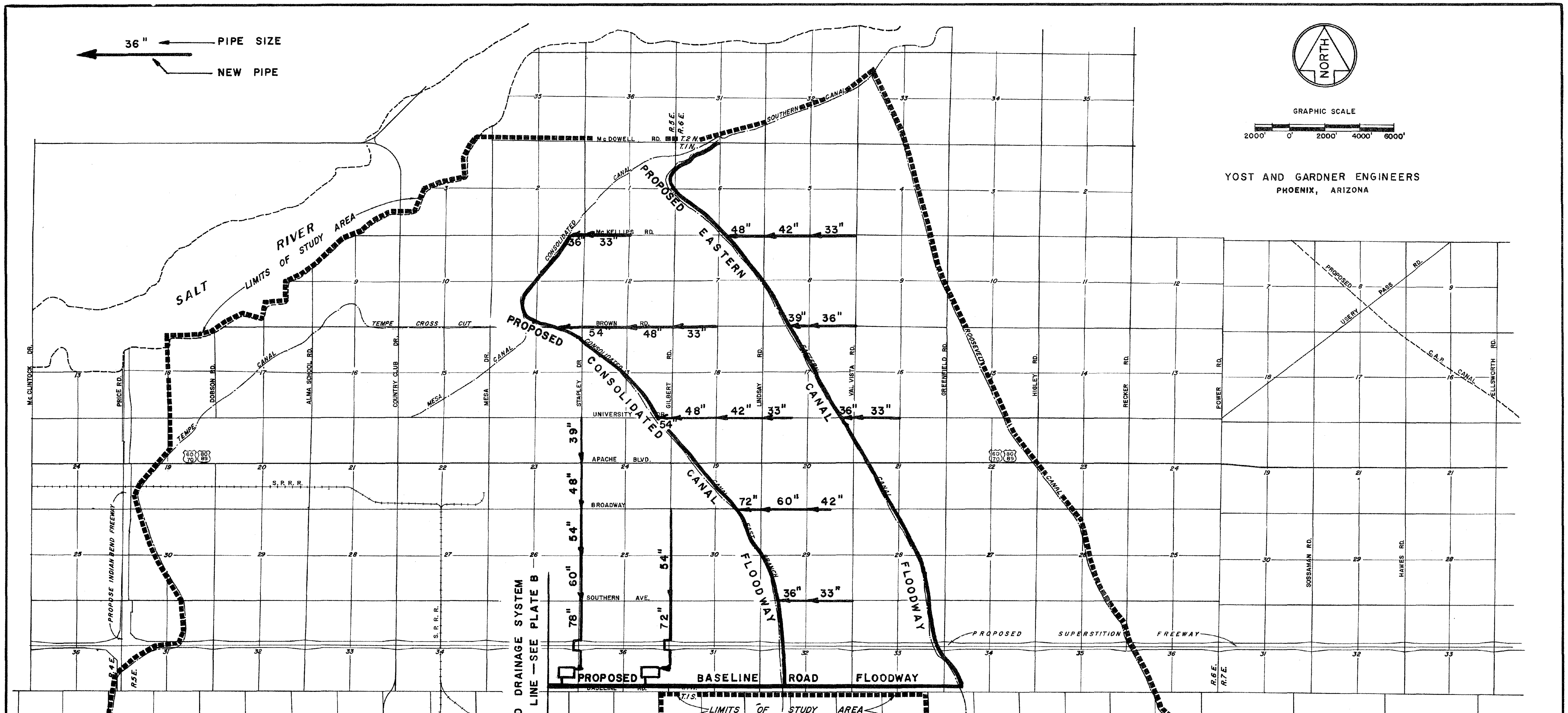
TYPICAL CHANNEL SECTIONS

FIGURE 4.22



PUMPBACK SCHEME FOR DRAINING RETENTION BASINS

FIGURE 4.23



ALTERNATE SCHEME FOR DRAINING INTO PROPOSED CANAL FLOODWAYS

FIGURE 4.24

RETENTION BASIN COMPUTATIONS

Location ___ Tempe Canal at Western Canal Floodway ___

Line Designation ___ Tempe Canal Channel

Design Recurrence Interval ___ 2-Year Interior Areas, 10-Year Arterials ___

Total Impervious Area ___ 656 ___ acres

Required Volume = CIA = (0.95) (1.3/12) (656) = 67.5 ___ acre-feet

Total Depth ___ 10 ___ feet

Water Depth ___ 5 ___ feet

Basin Length = Width (2):

$$2\,w^2 = \frac{(67.5)(43{,}560)}{5}$$

w = ___ 542 ___ ft.

542'-30' = 512'

Bottom of Basin	520	ft.	1040	ft.
Top of Basin	640	ft.	1160	ft.
Top (including roadways)	670	ft.	1190	ft.

Storage Volume Furnished:

$$5\ \frac{(550)(1070)}{43{,}560} = \quad 67.6 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(670)(1190)}{43{,}560} = \quad 18.30 \text{ acres}$$

Total Excavation ___ 236,300 cu. yds.

Chain Link Fence ___ 3,720 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Alma School Road at Western Canal Floodway

Line Designation C-2

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 21 acres

Required Volume = CIA = (0.95) (1.3/12) (21) = 2.2 acre-feet

Total Depth 13 feet

Water Depth 3 feet

Basin Length = Width (2):

$$2 w^2 = \frac{(2.2)(43,560)}{3}$$

w = 127 ft.

127' - 18' = 109'

Bottom of Basin	110	ft.	220	ft.
Top of Basin	266	ft.	376	ft.
Top (including roadways)	296	ft.	406	ft.

Storage Volume Furnished:

$$3 \frac{(128)(238)}{43,560} = $$ 2.1 ac.-ft.

Surface Area Required:

$$\frac{(296)(406)}{43,560} = $$ 2.76 acres

Total Excavation 27,000 cu. yds.

Chain Link Fence 1,404 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Extension Road at Western Canal Floodway

Line Designation C-3

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 29 acres

Required Volume = CIA = (0.95) (1.3/12) (29) = 3 acre-feet

Total Depth 15 feet

Water Depth 3.5 feet

Basin Length = Width (2):

$$2\ w^2 = \frac{(3)\ (43{,}560)}{3.5}$$

$$w = 137 \text{ ft.}$$

137'-21' = 116'

Bottom of Basin	120	ft.	240	ft.
Top of Basin	300	ft.	420	ft.
Top (including roadways)	330	ft.	450	ft.

Storage Volume Furnished:

$$3.5\ \frac{(141)\ (261)}{43{,}560} = 3.41 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(330)\ (450)}{43{,}560} = 3.41 \text{ acres}$$

Total Excavation 38,500 cu. yds.

Chain Link Fence 1,560 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Country Club Road at Baseline Road Floodway

Line Designation D

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 519 acres

Required Volume = CIA = (0.95) (1.3/12) (519) = 54 acre-feet

Total Depth 16 feet

Water Depth 7.5 feet

Basin Length = Width (2):

$$2\ w^2 = \frac{(54)\ (43{,}560)}{7.5}$$

$$w = 396 \text{ ft.}$$

396'-45' = 351'

Bottom of Basin	350	ft.	700	ft.
Top of Basin	542	ft.	892	ft.
Top (including roadways)	572	ft.	922	ft.

Storage Volume Furnished:

$$7.5\ \frac{(395)\ (745)}{43{,}560} = 50.7 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(572)\ (922)}{43{,}560} = 12.11 \text{ acres}$$

Total Excavation 210,400 cu. yds.

Chain Link Fence 2,988 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Mesa Drive at Baseline Road Floodway

Line Designation E

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 514 acres

Required Volume = CIA = (0.95) (1.3/12) (514) = 53 acre-feet

Total Depth 21 feet

Water Depth 7 feet

Basin Length = Width (2):

$$2\ w^2 = \frac{(53)\ (43{,}560)}{7}$$

w = 406 ft.

406' - 42' = 364'

Bottom of Basin	370	ft.	740	ft.
Top of Basin	622	ft.	992	ft.
Top (including roadways)	652	ft.	1022	ft.

Storage Volume Furnished:

$$7\ \frac{(412)\ (782)}{43{,}560} = \quad 51.8\ \text{ac.-ft.}$$

Surface Area Required:

$$\frac{(652)\ (1022)}{43{,}560} = \quad 15.30\ \text{acres}$$

Total Excavation 334,100 cu. yds.

Chain Link Fence 3,348 lin. ft.

RETENTION BASIN COMPUTATIONS

Location 1/2 Mile South Baseline Road at Baseline Road Floodway

Line Designation E-1

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 101 acres

Required Volume = CIA = (0.95) (1.3/12) (101) = 10.4 acre-feet

Total Depth 11 feet

Water Depth 4 feet

Basin Length = Width (2):

$$2\,w^2 = \frac{(10.4)\,(43{,}560)}{4}$$

w = 238 ft.

238'-24' = 214'

Bottom of Basin	220	ft.	440	ft.
Top of Basin	352	ft.	572	ft.
Top (including roadways)	382	ft.	602	ft.

Storage Volume Furnished:

$$4\ \frac{(244)(464)}{43{,}560} = \quad 10.4 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(382)(602)}{43{,}560} = \quad 5.28 \text{ acres}$$

Total Excavation 59,000 cu. yds.

Chain Link Fence 1,968 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Stapley Drive at Baseline Road Floodway

Line Designation F

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 457 acres

Required Volume = CIA = (0.95) (1.3/12) (457) = 47 acre-feet

Total Depth 22 feet

Water Depth 7 feet

Basin Length = Width (2):

$$2\,w^2 = \frac{(47)\,(43{,}560)}{7}$$

w = 382 ft.

382'-42' = 340'

Bottom of Basin	350	ft.	700	ft.
Top of Basin	614	ft.	964	ft.
Top (including roadways)	644	ft.	994	ft.

Storage Volume Furnished:

$$7\ \frac{(392)\,(742)}{43{,}560} =$$ 46.7 ac.-ft.

Surface Area Required:

$$\frac{(644)\,(994)}{43{,}560} =$$ 14.70 acres

Total Excavation 326,800 cu. yds.

Chain Link Fence 3,276 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Gilbert Road at Baseline Road Floodway

Line Designation G

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 403 acres

Required Volume = CIA = (0.95) (1.3/12) (403) = 42 acre-feet

Total Depth 22 feet

Water Depth 7 feet

Basin Length = Width (2):

$$2\,w^2 = \frac{(42)\,(43{,}560)}{7}$$

$$w = 362 \text{ ft.}$$

362'-42' = 320'

Bottom of Basin	320	ft.	640	ft.
Top of Basin	584	ft.	904	ft.
Top (including roadways)	614	ft.	934	ft.

Storage Volume Furnished:

$$7\;\frac{(362)\,(682)}{43{,}560} = 39.7 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(614)\,(934)}{43{,}560} = 13.17 \text{ acres}$$

Total Excavation 284,300 cu. yds.

Chain Link Fence 3,096 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Lindsay Road at Baseline Road Floodway

Line Designation H

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 465 acres

Required Volume = CIA = (0.95) (1.3/12) (465) = 48 acre-feet

Total Depth 21 feet

Water Depth 7.5 feet

Basin Length = Width (2):

$$2\ w^2 = \frac{(48)\ (43{,}560)}{7.5}$$

$$w = 373 \text{ ft.}$$

373'-45' = 328'

Bottom of Basin	340 ft.	680 ft.
Top of Basin	592 ft.	932 ft.
Top (including roadways)	622 ft.	962 ft.

Storage Volume Furnished:

$$7.5\ \frac{(385)(725)}{43{,}560} = \quad 48.1 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(622)\ (962)}{43{,}560} = \quad 13.74 \text{ acres}$$

Total Excavation 292,100 cu. yds.

Chain Link Fence 3,168 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Val Vista Drive at Baseline Road Floodway

Line Designation I

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 331 acres

Required Volume = CIA = (0.95) (1.3/12) (331) = 34 acre-feet

Total Depth 18 feet

Water Depth 6.5 feet

Basin Length = Width (2):

$$2\,w^2 = \frac{(34)\ (43,560)}{6.5}$$

$$w = 338 \text{ ft.}$$

338'-39' = 299'

Bottom of Basin	310	ft.	620	ft.
Top of Basin	526	ft.	836	ft.
Top (including roadways)	556	ft.	866	ft.

Storage Volume Furnished:

$$6.5\ \frac{(349)\ (659)}{43,560} = 34.3 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(556)\ (866)}{43,560} = 11.05 \text{ acres}$$

Total Excavation 202,900 cu. yds.

Chain Link Fence 2,844 lin. ft.

RETENTION BASIN COMPUTATIONS

Location Greenfield Road at Baseline Road Floodway

Line Designation J, K & L

Design Recurrence Interval 2-Year Interior Areas, 10-Year Arterials

Total Impervious Area 213 acres

Required Volume = CIA = (0.95) (1.3/12) (213) = 22 acre-feet

Total Depth 16 feet

Water Depth 6 feet

Basin Length = Width (2):

$$2\,w^2 = \frac{(22)\,(43{,}560)}{6}$$

w = 283 ft.

283'-36' = 247'

Bottom of Basin	250	ft.	500	ft.
Top of Basin	442	ft.	692	ft.
Top (including roadways)	477	ft.	722	ft.

Storage Volume Furnished:

$$6\ \frac{(286)\,(536)}{43{,}560} = \quad 21.1 \text{ ac.-ft.}$$

Surface Area Required:

$$\frac{(472)\,(722)}{43{,}560} = \quad 7.82 \text{ acres}$$

Total Excavation 122,200 cu. yds.

Chain Link Fence 2,388 lin. ft.

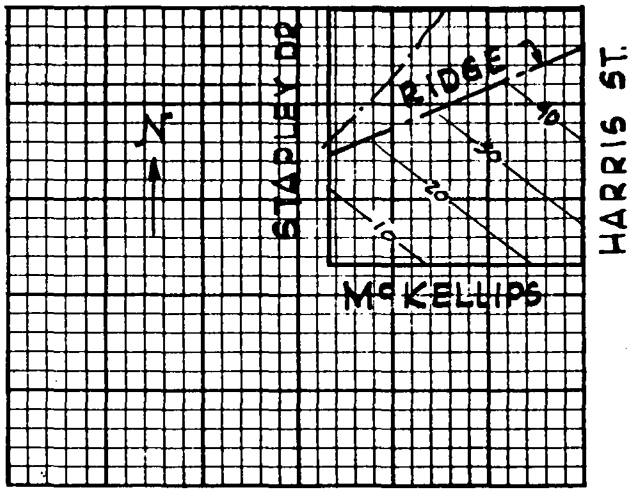
Done by T.B.G.

Date 6/21/73

Drainage Area SW¼ Sec. 1, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	20	0	0	0	0		
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves	78	0	0	5	4		
Commercial							
Industrial							
Total Acres	98	0	0	5	4		

Mean land slope N-S .0015 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S 1.5 ft./sec. 59 min./mile 90 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.4 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs
20	39		2	1.8	1.0	1.8					1.44	3	3
30	69		3	1.4	1.0	1.4					1.08	3	3
40	89		4	1.16	1.0	1.16					0.86	3+	3+
50	98		4	1.0	1.0	1.0					0.72	3	3
40	89		3	2.1	1.0	2.1					1.71	5	5
													8 Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-3

LINE F

1. Future Dev. = 100%
2. Pervious Areas Excluded

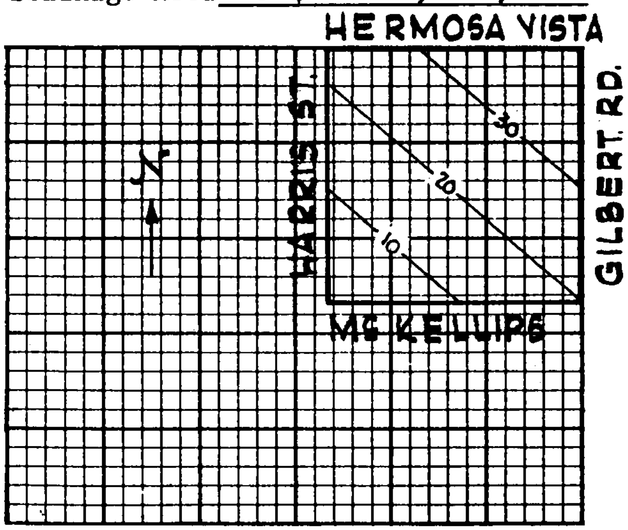
Done by T.B.G.

Date 6/21/73

Drainage Area SE¼ Sec. 1, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	80	0	0	0	0		
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves	80	5	4	5	4		
Commercial							
Industrial							
Total Acres	160		4		4		

Mean land slope N-S .0025 E-W .0034

Flow conveyance 40' Streets

Flow velocity N-S 1.95 ft./sec. 45 min./mile 117 ft./min.

E-W 2.25 ft./sec. 39 min./mile 135 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	$0.8(I_a - f_c)$	Q_p cfs	$0.9(I_a - 0.2)$	Q_i cfs	Q_t cfs
20	73		2	1.8	1.0	1.8					1.44	3-	3-
30	131		3	1.4	1.0	1.4					1.08	3	3
40	157		4	1.16	1.0	1.16					0.86	3+	3+
43	160		4	1.1	1.0	1.1					0.81	3	3
40			4	2.1	1.0	2.1					1.71	7	7
													10 Max.
						10-Year	Frequency - Arterials						
						2-Year	Frequency - Interior Areas						

Yost and Gardner Engineers

AREA F-4

LINE F

1. Future Dev. = 100%
2. Pervious Area Excluded

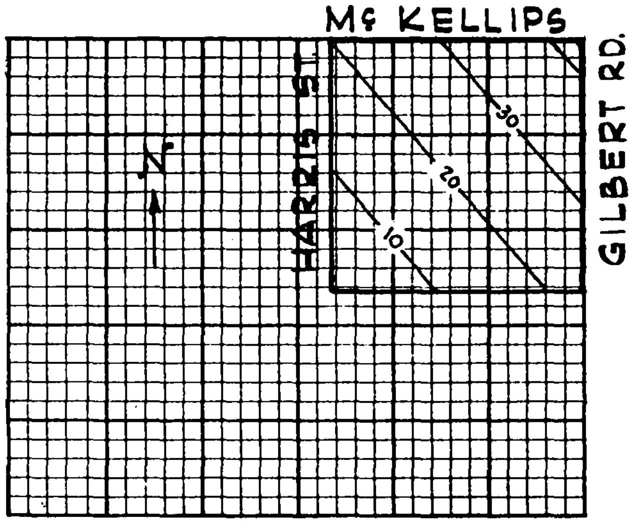
Done by T.B.G.

Date 6/21/73

Drainage Area NE¼ Sec. 12, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	132	45½	60	17½	23		
M.D. Residential							
H.D. Residential							
Parks & park-like	20	10	2	10	2		
Farmlands, groves							
Commercial	8	0	0	0	0		
Industrial							
Total Acres	160		62		25		

Mean land slope N-S .0031 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S 2.15 ft./sec. 41 min./mile 129 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.7 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs
20	68		11	1.8	1.0	1.8					1.44	16	16
30	131		21	1.4	1.0	1.4					1.08	23	23
40	158		25	1.16	1.0	1.16					0.86	22	22
30			4	2.5	1.0	2.5					2.07	8	8
													31 Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-5
LINE F

1. Future Dev. = 30%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

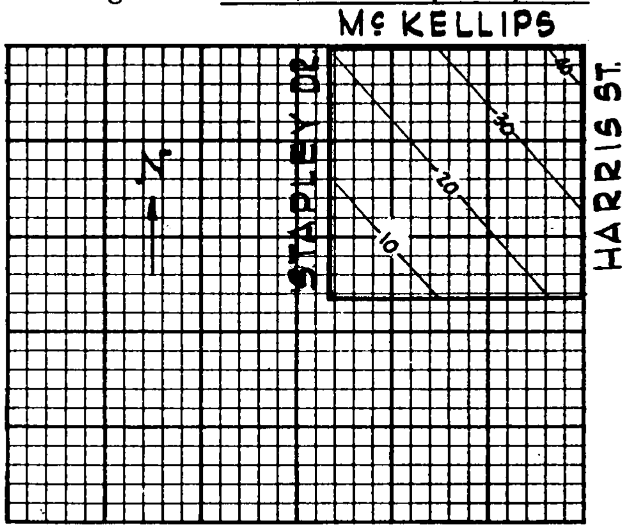
Done by T.B.G.

Date 6/21/73

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Drainage Area NW¼ Sec. 12, T1N, R5E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	138	0	0	0	0		
M.D. Residential							
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	12	0	0	0	0		
Industrial							
Total Acres	160		1		1		

Mean land slope N-S .0031 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S 2.15 ft./sec. 41 min./mile 129 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10- yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
20	68		0.4	1.8	1.0	1.8					1.44	1-	1-
30	131		1	1.4	1.0	1.4					1.08	1+	1+
40	158		1	1.16	1.0	1.16					0.86	1-	1-
30			4	2.5	1.0	2.5					2.07	8	8
													9 Max.

10-Year Frequency - Arterials
2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-6

LINE F

1. Future Dev. = 100%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

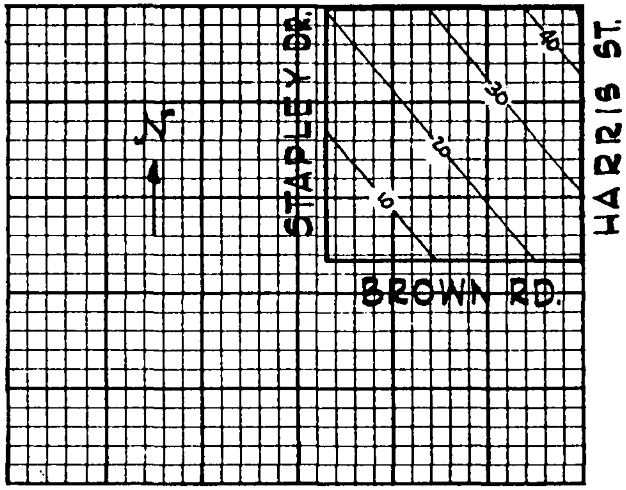
Done by T.B.G.

Date 6/21/73

Drainage Area SW¼ Sec. 12, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	139	0	0	0	0		
M.D. Residential							
H.D. Residential							
Parks & park-like	15	10	2	10	2		
Farmlands, groves							
Commercial	6	0	0	0	0		
Industrial							
Total Acres	160		2		2		

Mean land slope N-S .003 E-W .0019

Flow conveyance 40' Streets

Flow velocity N-S 2.1 ft./sec. 42 min./mile 126 ft./min.

E-W 1.7 ft./sec. 52 min./mile 102 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.7 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	I_a-f_c	0.8 I_a-f_c	Q_p cfs	0.9 I_a-0.2	Q_i cfs	Q_t cfs
20	60		1	1.8	1.0	1.8					1.44	1	1
30	128		2	1.4	1.0	1.4					1.08	2+	2+
40	154		2	1.16	1.0	1.16					0.86	2-	2-
30			4	2.5	1.0	2.5					2.07	8	8
													10 Max.
					10-Year Frequency - Arterials								
					2-Year Frequency - Interior Areas								

Yost and Gardner Engineers

AREA F-7
LINE F

1. Future Dev. = 100%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

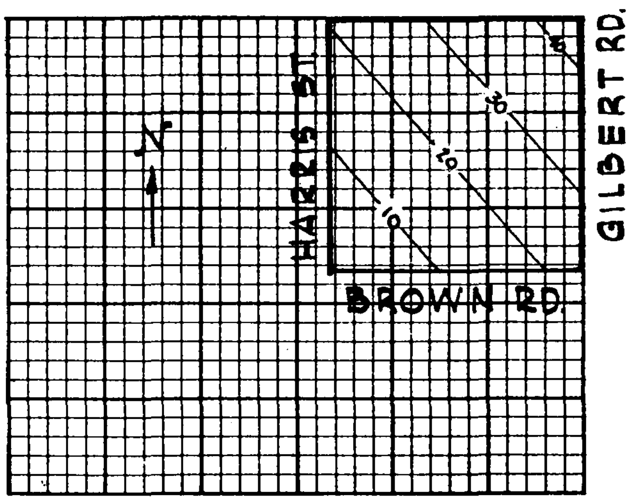
Done by T.B.G.

Date 6/21/73

Drainage Area SE¼ Sec. 12, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2-10 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	154	32½	50	12½	19		
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves							
Commercial	6	0	0	13½	1		
Industrial							
Total Acres	160		50		20		

Mean land slope N-S .003 E-W .0023

Flow conveyance 40" Streets

Flow velocity N-S 2.1 ft./sec. 42 min./mile 126 ft./min.

E-W 1.85 ft./sec. 48 min./mile 111 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.4 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
20	60		8	1.8	1.0	1.8					1.44	12	12
30	122		15	1.4	1.0	1.4					1.08	16	16
40	157		20	1.16	1.0	1.16					0.86	17	17
45	160		20	1.0	1.0	1.0					0.72	14	14
40			4	2.1	1.0	2.1					1.71	7	7
													24 Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-8

LINE F

1. Future Dev. = 50%
2. Comm. Dev. = 15%
3. Pervious Area Excluded

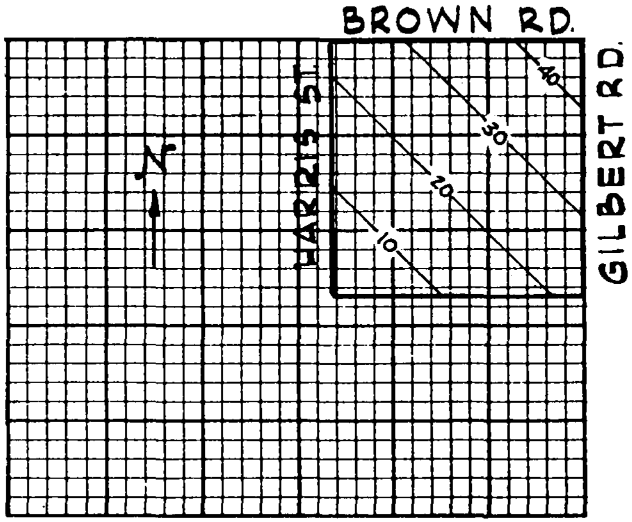
Done by T.B.G.

Date 6/21/73

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year Rec. Interval

Drainage Area NE¼ Sec. 13, T1N, R5E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	119	32½	39	12½	15		
M.D. Residential	30	30	9	17½	5		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	6	0	0	27	2		
Industrial							
Total Acres	160		49		23		

Mean land slope N-S .0024 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S 1.9 ft./sec. 46 min./mile 114 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	$0.8\ I_a - f_c$	Q_p cfs	$0.9\ I_a - 0.2$	Q_i cfs	Q_t cfs
20	60		9	1.8	1.0	1.8					1.44	13	13
30	119		17	1.4	1.0	1.4					1.08	18	18
40	154		22	1.16	1.0	1.16					0.86	19	19
45	160		23	1.07	1.0	1.07					0.78	18	18
40			4	2.1	1.0	2.1					1.71	7	7
													26 Max.
					10-Year Frequency - Arterials								
					2-Year Frequency - Interior Areas								

Yost and Gardner Engineers

AREA F-9
LINE F

1. Future Dev. = 50%
2. Comm. Dev. = 30%
3. Pervious Area Excluded

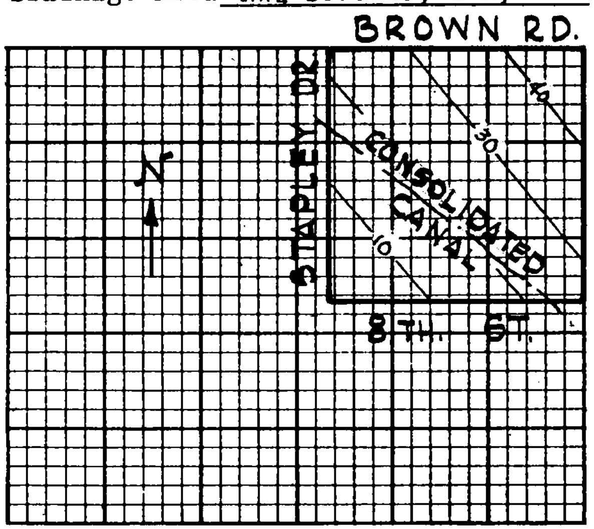
Done by T.B.G.

Date 6/21/73

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Drainage Area NW¼ Sec. 13, T1N, R5E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	142	52	74	20	28		
M.D. Residential							
H.D. Residential							
Parks & park-like	12	10	1	10	1		
Farmlands, groves							
Commercial	6	0	0	0	0		
Industrial							
Total Acres	160		75		29		

Mean land slope N-S .0024 E-W .0017

Flow conveyance 40' Streets

Flow velocity N-S 1.9 ft./sec. 46 min./mile 114 ft./min.

E-W 1.6 ft./sec. 55 min./mile 96 ft./min.

Hydrologic soil group ____ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
30	112		20	1.4	1.0	1.4					1.08	22	22
40	149		27	1.16	1.0	1.16					0.86	23	23
50	160		29	1.0	1.0	1.0					0.72	21	21
40			4	2.1	1.0	2.1					1.71	7	7
													30 Max.

10-Year Frequency - Arterials
2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-10

LINE F

1. Future Dev. = 20%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

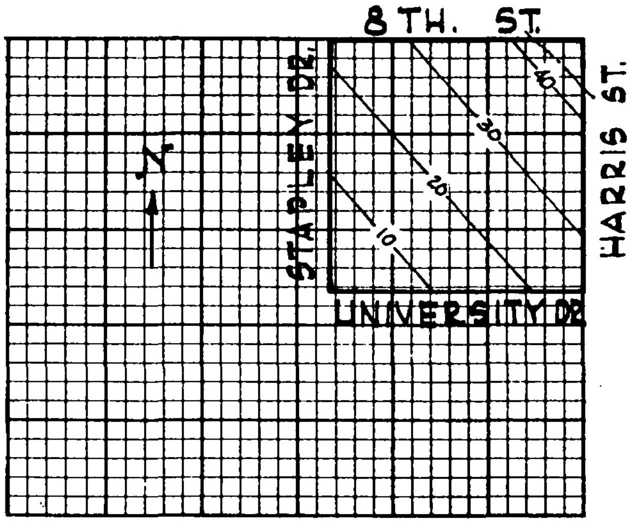
Done by T.B.G.

Date 6/21/73

Drainage Area SW¼ Sec. 13, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	106	65	69	25	27		
M.D. Residential							
H.D. Residential							
Parks & park-like	14	10	1	10	1		
Farmlands, groves							
Commercial							
Industrial	40	0	0	0	0		
Total Acres	160		70		28		

Mean land slope N-S .0025 E-W .0019

Flow conveyance 40' Streets

Flow velocity N-S 1.9 ft./sec. 46 min./mile 114 ft./min.

E-W 1.7 ft./sec. 52 min./mile 102 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
30	117		20	1.4	1.0	1.4					1.08	22	22
40	152		27	1.16	1.0	1.16					0.86	23	23
45	160		28	1.07	1.0	1.07					0.78	22	22
40			4	2.1	1.0	2.1					1.71	7	7
													30 Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-11

LINE F

1. Future Dev. = 0%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

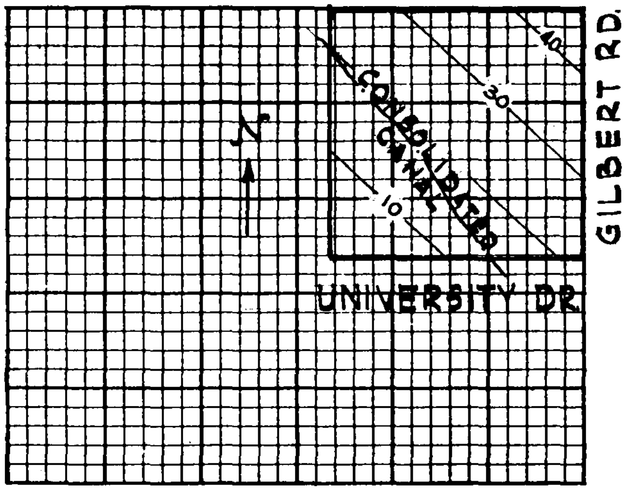
Done by T.B.G.

Date 6/21/73

Drainage Area SE¼ Sec. 13, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	98	30	29	17½	17		
H.D. Residential							
Parks & park-like	50	10	5	10	5		
Farmlands, groves							
Commercial	12	0	0	0	0		
Industrial							
Total Acres	160		34		22		

Mean land slope N-S .0021 E-W .0025

Flow conveyance 40' Streets

Flow velocity N-S 1.8 ft./sec. 49 min./mile 108 ft./min.

E-W 1.95 ft./sec. 45 min./mile 117 ft./min.

Hydrologic soil group ____ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs	
20	58		8	1.8	1.0	1.8					1.44	12	12	
30	121		17	1.4	1.0	1.4					1.08	18+	18+	
40	154		21	1.16	1.0	1.16					0.86	18	18	
45	160		22	1.07	1.0	1.07					0.78	17	17	
40			4	2.1	1.0	2.1					1.71	7	7	
													25	Max.
						10-Year	Frequency	- Arterials						
						2-Year	Frequency	- Interior Areas						

Yost and Gardner Engineers

AREA F-12

LINE F

1. Future Dev. = 50%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

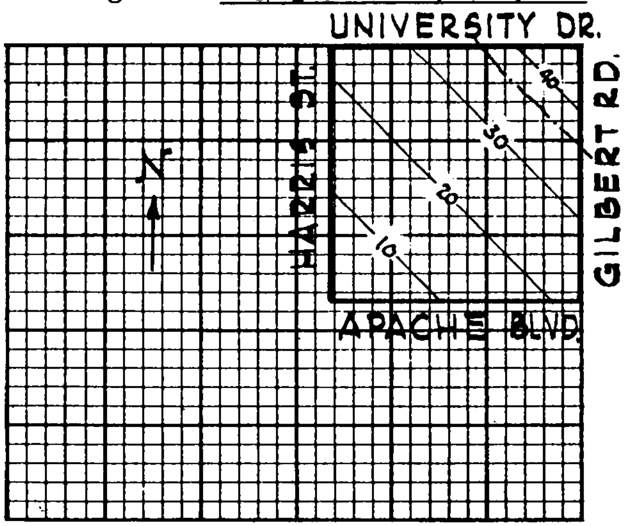
Done by T.B.G.

Date 6/21/73

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Drainage Area NE¼ Sec. 24, T1N, R5E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	84	39	33	15	13		
M.D. Residential							
H.D. Residential							
Parks & park-like	15	10	2	10	2		
Farmlands, groves							
Commercial	61	0	0	90	55		
Industrial							
Total Acres	160		35		70		

Mean land slope N-S .0025 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S 1.95 ft./sec. 45 min./mile 117 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ____ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
20	61		27	1.8	1.0	1.8					1.44	39	39
30	123		54	1.4	1.0	1.4					1.08	58+	58+
40	154		67	1.16	1.0	1.16					0.86	58-	58-
30			4	2.5	1.0	2.5					2.07	8	8
													66 Max.

10-Year Frequency - Arterials
2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-13

LINE F

1. Future Dev. = 40%
2. Comm. Dev. = 100%
3. Pervious Area Excluded

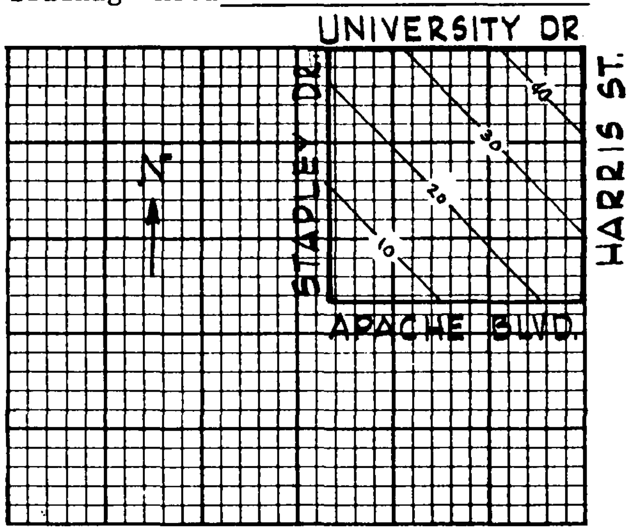
Done by T.B.G.

Date 6/21/73

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Drainage Area NW¼ Sec. 24, T1N, R5E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	126	65	82	25	32		
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves							
Commercial	34	0	0	9	3		
Industrial							
Total Acres	160		82		35		

Mean land slope N-S .0022 E-W .0021

Flow conveyance 40' Streets

Flow velocity N-S 1.83 ft./sec. 48 min./mile 110 ft./min.

E-W 1.8 ft./sec. 49 min./mile 108 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs	
30	114		25	1.4	1.0	1.4					1.08	27	27	
40	152		33	1.16	1.0	1.16					0.86	28	28	
48	160		35	1.0	1.0	1.0					0.72	25	25	
40			4	2.1	1.0	2.1					1.71	7	7	
													35	Max.
					10-Year Frequency - Arterials									
					2-Year Frequency - Interior Areas									

Yost and Gardner Engineers

AREA F-14

LINE F

1. Future Dev. = 0%
2. Comm. Dev. = 10%
3. Pervious Area Excluded

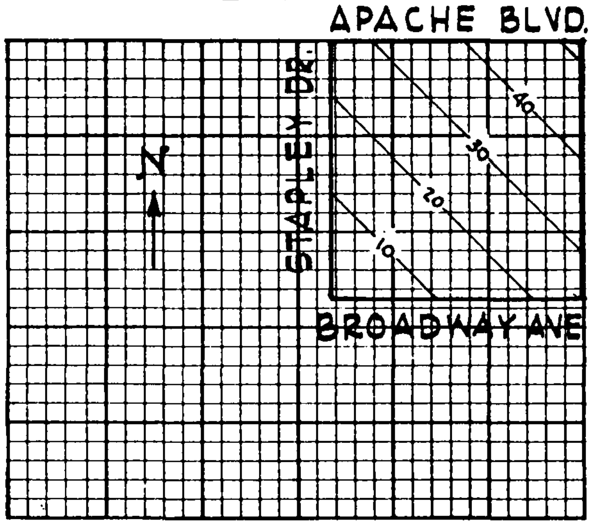
Done by T.B.G.

Date 6/21/73

Drainage Area SW¼ Sec. 24, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	116	65	75	25	29		
M.D. Residential							
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	34	0	0	54	18		
Industrial							
Total Acres	160		76		48		

Mean land slope N-S .0019 E-W .0019

Flow conveyance 40' Streets

Flow velocity N-S 1.7 ft./sec. 52 min./mile 102 ft./min.

E-W 1.7 ft./sec. 52 min./mile 102 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs
30	104		31	1.4	1.0	1.4					1.08	33	33
40	143		43	1.16	1.0	1.16					0.86	37	37
50	159		48	1.0	1.0	1.0					0.72	35	35
40			4	2.1	1.0	2.1					1.71	7	7
													44 Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-15

LINE F

1. Future Dev. = 0%
2. Comm. Dev. = 60%
3. Pervious Area Excluded

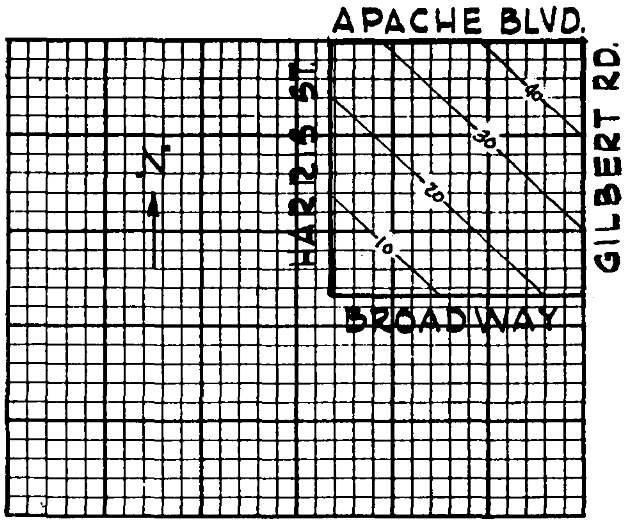
Done by T.B.G.

Date 6/21/73

Drainage Area SE¼ Sec. 24, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	116	65	75	25	29		
M.D. Residential							
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	34	0	0	54	18		
Industrial							
Total Acres	160		76		48		

Mean land slope N-S .0019 E-W .0022

Flow conveyance 40' Streets

Flow velocity N-S 1.7 ft./sec. 52 min./mile 102 ft./min.

E-W 1.83 ft./sec. 48 min./mile 110 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
30	109		33	1.4	1.0	1.4					1.08	36	36
40	147		44	1.16	1.0	1.16					0.86	38	38
50	160		48	1.0	1.0	1.0					0.72	35	35
40			4	2.1	1.0	2.1					1.71	7	7
													45 Max.

10-Year Frequency - Arterials
2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-16

LINE F

1. Future Dev. = 0%
2. Comm. Dev. = 60%
3. Pervious Area Excluded

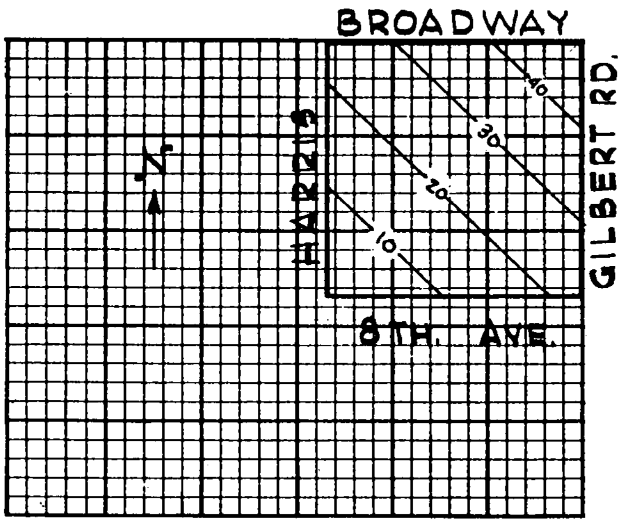
Done by T.B.G.

Date 6/21/73

Drainage Area NE¼ Sec. 25, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	135	52	70	20	27		
M.D. Residential							
H.D. Residential							
Parks & park-like	20	10	2	10	2		
Farmlands, groves							
Commercial	5	0	0	18	1		
Industrial							
Total Acres	160		72		30		

Mean land slope N-S .0022 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S 1.83 ft./sec. 48 min./mile 110 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	$0.8\ I_a - f_c$	Q_p cfs	$0.9\ I_a - 0.2$	Q_i cfs	Q_t cfs	
30	114		21	1.4	1.0	1.4					1.08	23	23	
40	150		28	1.16	1.0	1.16					0.86	24	24	
50	160		30	1.0	1.0	1.0					0.72	22	22	
40			4	2.1	1.0	2.1					1.71	7	7	
													31	Max.
					10-Year Frequency - Arterials									
					2-Year Frequency - Interior Areas									

Yost and Gardner Engineers

AREA F-17

LINE F

1. Future Dev. = 20%
2. Comm. Dev. = 20%
3. Pervious Area Excluded

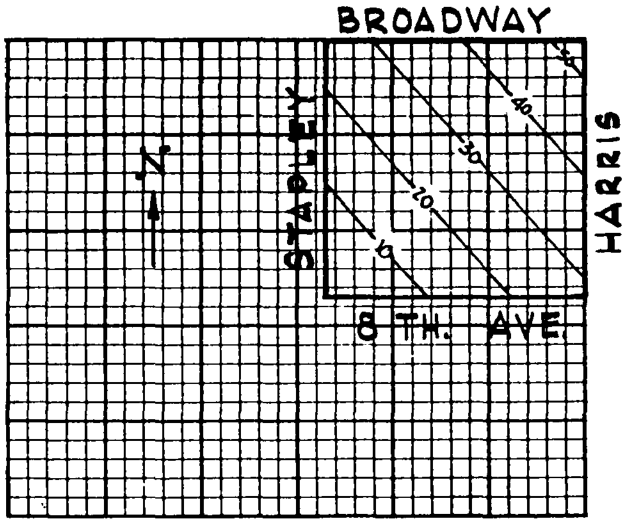
Done by T.B.G.

Date 6/21/73

Drainage Area NW¼ Sec. 25, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	150	52	78	20	30		
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves							
Commercial	10	0	0	18	2		
Industrial							
Total Acres	160		78		32		

Mean land slope N-S .0020 E-W .0016

Flow conveyance 40' Streets

Flow velocity N-S 1.75 ft./sec. 50 min./mile 105 ft./min.

E-W 1.55 ft./sec. 57 min./mile 93 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs	
30	97		19	1.4	1.0	1.4					1.08	19	21	
40	139		28	1.16	1.0	1.16					0.86	24	24	
50	158		32	1.0	1.0	1.0					0.72	23	23	
40			4	2.1	1.0	2.1					1.71	7	7	
													31	Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-18

LINE F

1. Future Dev. = 20%
2. Comm. Dev. = 20%
3. Pervious Area Excluded

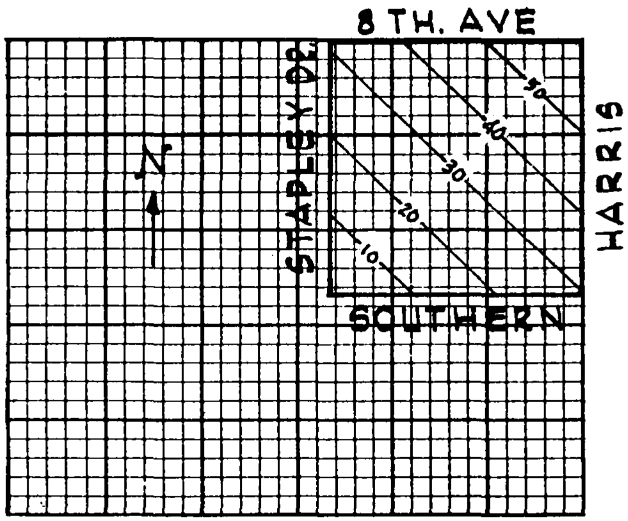
Done by T.B.G.

Date 6/21/73

Drainage Area SW¼ Sec. 25, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	140	32½	46	12½	18		
M.D. Residential							
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	10	0	0	0	0		
Industrial							
Total Acres	160		47		19		

Mean land slope N-S .0013 E-W .0015

Flow conveyance 40' Streets

Flow velocity N-S 1.4 ft./sec. 63 min./mile 84 ft./min.

E-W 1.5 ft./sec. 59 min./mile 90 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.4 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
40	121		14	1.16	1.0	1.16					0.86	12	12
50	149		18	1.0	1.0	1.0					0.72	13	13
60	160		19	0.86	1.0	0.86					0.59	11	11
50			4	1.75	1.0	1.75					1.40	6	6
					10-Year Frequency - Arterials								19 Max.
					2-Year Frequency - Interior Areas								

Yost and Gardner Engineers

AREA F-19

LINE F

1. Future Dev. = 50%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

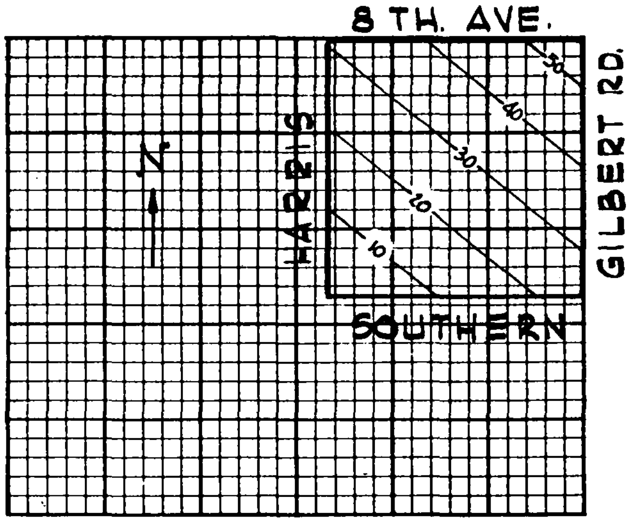
Done by T.B.G.

Date 6/21/73

Drainage Area SE¼ Sec. 25, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	50	49	25	19	10		
M.D. Residential	40	45	18	26	10		
H.D. Residential							
Parks & park-like	70	10	7	10	7		
Farmlands, groves							
Commercial							
Industrial							
Total Acres	160		50		27		

Mean land slope N-S .0014 E-W .0021

Flow conveyance 40' Streets

Flow velocity N-S 1.45 ft./sec. 61 min./mile 87 ft./min.

E-W 1.8 ft./sec. 49 min./mile 108 ft./min.

Hydrologic soil group ____ Assumed infiltration cap. 0.3 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
30	92		16	1.4	1.0	1.4					1.08	17	17
40	133		22	1.16	1.0	1.16					0.86	19	19
50	155		26	1.0	1.0	1.0					0.72	19-	19-
40			4	2.1	1.0	2.1					1.71	7	7
													26 Max

Yost and Gardner Engineers

AREA F-20

LINE F

1. Future Dev. = 25%
2. Pervious Area Excluded

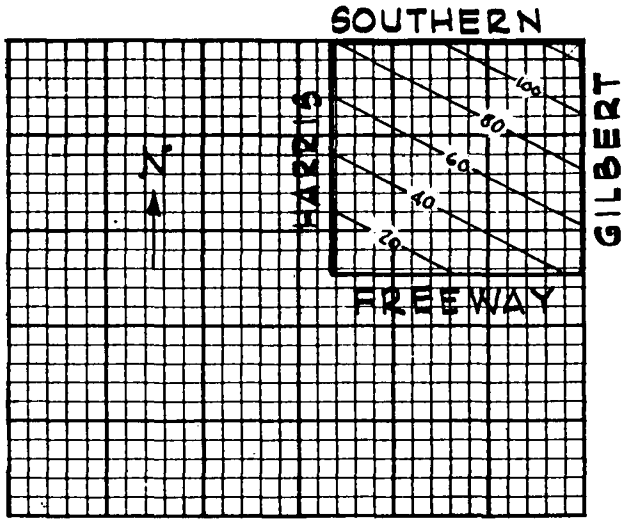
Done by T.B.G.

Date 6/21/73

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Drainage Area NE¼ Sec. 36, T1N, R5E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	40	0	0	0	0		
M.D. Residential							
H.D. Residential							
Parks & park-like	95	10	10	10	10		
Farmlands, groves							
Commercial	10	0	0	0	0		
Industrial							
Total Acres	145		10		10		

Mean land slope N-S .0001 E-W .0008

Flow conveyance 40' Streets

Flow velocity N-S Say 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.0 ft./sec. 88 min./mile 60 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.3 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	$0.8\ I_a - f_c$	Q_p cfs	$0.9\ I_a - 0.2$	Q_i cfs	Q_t cfs
80	104		7	0.68	1.0	0.68					0.43	3	3
90	119		8	0.63	1.0	0.63					0.39	3+	3+
100	130		9	0.58	1.0	0.58					0.34	3	3
90			4	1.08	1.0	1.08					0.79	3	3
													6 Max.

Yost and Gardner Engineers

AREA F-21

LINE F

1. Future Dev. = 100%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

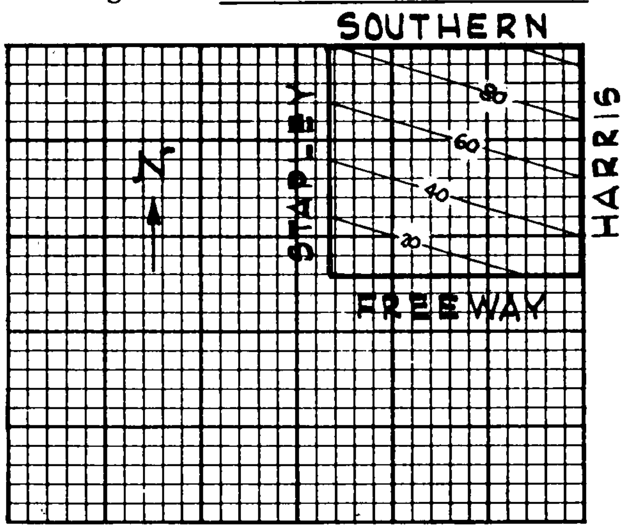
Done by T.B.G.

Date 6/21/73

Drainage Area NW¼ Sec. 36, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	27	0	0	0	0		
M.D. Residential	40	0	0	0	0		
H.D. Residential							
Parks & park-like	58	10	6	10	6		
Farmlands, groves							
Commercial	20	0	0	0	0		
Industrial							
Total Acres	145		6		6		

Mean land slope N-S .0003 E-W .0019

Flow conveyance 40' Streets

Flow velocity N-S Say 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.7 ft./sec. 52 min./mile 102 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.3 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs
80	122		5	0.68	1.0	0.68					0.43	2	2
90	137		6	0.63	1.0	0.63					0.39	2+	2+
100	144		6	0.58	1.0	0.58					0.34	2	2
90			4	1.08	1.0	1.08					0.79	3	3
													5 Max.
						10-Year Frequency -		Arterials					
						2-Year Frequency -		Interior Areas					

Yost and Gardner Engineers

AREA F-22

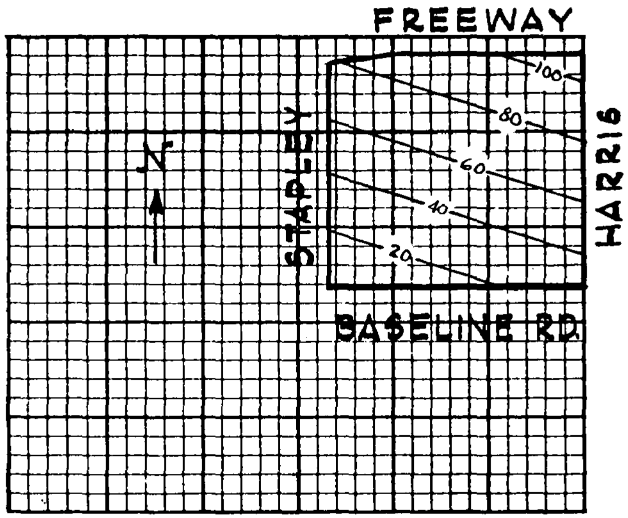
LINE F

1. Future Dev. = 100%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

Done by T.B.G.

Date 6/21/73

Drainage Area SW¼ Sec. 36, T1N, R5E.



URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	100	0	0	0	0		
M.D. Residential	30	0	0	0	0		
H.D. Residential							
Parks & park-like							
Farmlands, groves							
Commercial	10	0	0	0	0		
Industrial							
Total Acres	140		0		0		

Mean land slope N-S .0002 E-W .0018

Flow conveyance 40' Streets

Flow velocity N-S 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.65 ft./sec. 53 min./mile 99 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a-0.2	Q_i cfs	Q_t cfs
80	111		0	0.68	1.0	0.68					0.43	0	0
90	126		0	0.63	1.0	0.63					0.39	0	0
100	137		0	0.58	1.0	0.58					0.34	0	0
90			4	1.08							0.79	3	3
													3 Max.

10-Year Frequency - Arterials
2-Year Frequency - Interior Areas

Yost and Gardner Engineers

AREA F-23

LINE F

1. Future Dev. = 100%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

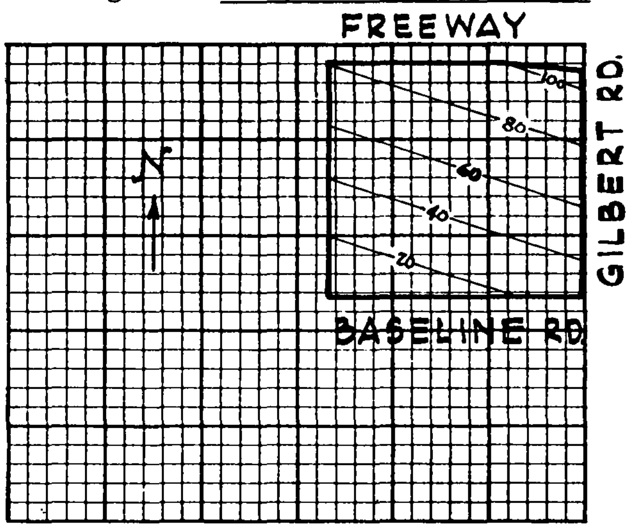
Done by T.B.G.

Date 6/22/73

Drainage Area SE¼ Sec. 36, T1N, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	67	0	0	0	0		
M.D. Residential	63	0	0	0	0		
H.D. Residential							
Parks & park-like							
Farmlands, groves							
Commercial	10	0	0	0	0		
Industrial							
Total Acres	140		0		0		

Mean land slope N-S .0002 E-W .0018

Flow conveyance 40' Streets

Flow velocity N-S 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.65 ft./sec. 53 min./mile 99 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	$0.8\ I_a - f_c$	Q_p cfs	$0.9\ I_a - 0.2$	Q_i cfs	Q_t cfs
80	111		0	0.68	1.0	0.68					0.43	0	0
90	126		0	0.63	1.0	0.63					0.39	0	0
100	137		0	0.58	1.0	0.58					0.34	0	0
90			4	1.08	1.0	1.08					0.79	3	3
													3 Max.

Yost and Gardner Engineers

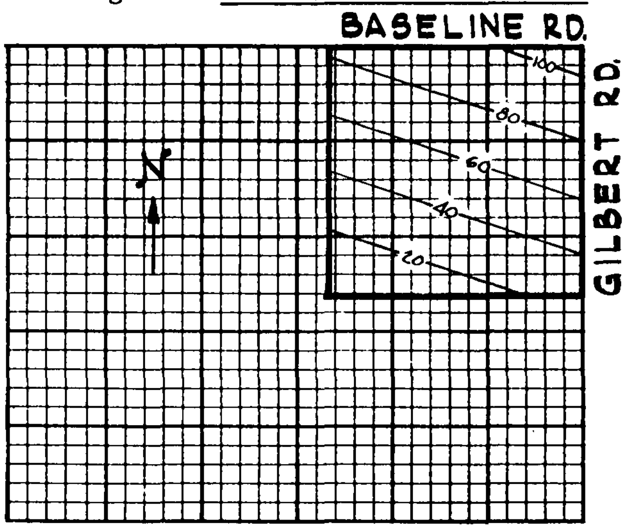
AREA F-24
LINE F

1. Future Dev. = 100%
2. Comm. Dev. = 0%
3. Pervious Area Excluded

Done by D.N.S.

Date 6/1/73

Drainage Area NE¼ Sec. 1, T1S, R5E.



URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves	160	5	8	5	8		
Commercial							
Industrial							
Total Acres	160		8		8		

Mean land slope N-S .0002 E-W .0021

Flow conveyance 40' Streets

Flow velocity N-S Say 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.8 ft./sec. 49 min./mile 108 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.4 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
80	122		6	0.68	1.0	0.68					0.43	3-	3-
90	137		7	0.63	1.0	0.63					0.39	3	3
100	148		7	0.58	1.0	0.58					0.34	2	2
90			4	1.08	1.0	1.08					0.79	4	4
													7 Max.

10-Year Frequency - Arterials

2-Year Frequency - Interior Areas

Yost and Gardner Engineers

1. Future Dev. = 0%
2. Pervious Area Excluded

AREA F-25

LINE F

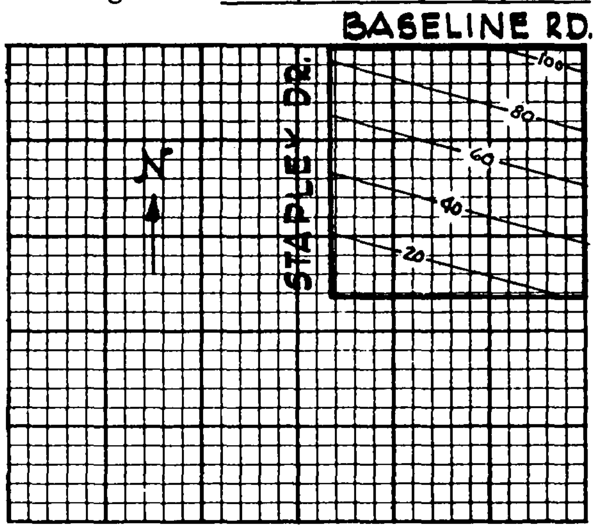
Done by D.N.S.

Date 5/31/73

Drainage Area NW¼ Sec. 1, T1S, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves	160	5	8	5	8		
Commercial							
Industrial							
Total Acres	160		8		8		

Mean land slope N-S .0002 E-W .0025

Flow conveyance 40' Streets

Flow velocity N-S Say 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.5 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs
80	123		6	0.68	1.0	0.68					0.43	3-	3-
90	141		7	0.63	1.0	0.63					0.39	3	3
100	152		8	0.58	1.0	0.58					0.34	3-	3-
90			4	1.08	1.0	1.08					0.79	4	4
													7 Max.
					10	-Year Fre	quency -	Arterials					
					2	-Year Fre	quency -	Interior	Areas				

Yost and Gardner Engineers

1. Future Dev. = 0%
2. Pervious Area Excluded

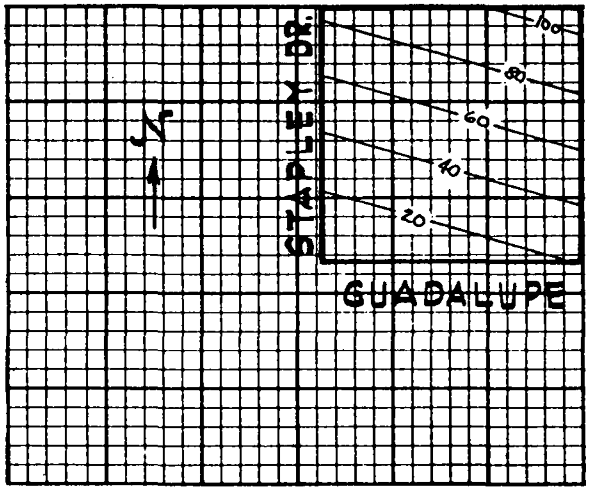
AREA F-26

LINE F

Done by D.N.S.

Date 6/1/73

Drainage Area SW¼ Sec. 1, T1S, R5E.



URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval

Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves	160	5	8	5	8		
Commercial							
Industrial							
Total Acres	160		8		8		

Mean land slope N-S .0005 E-W .0024

Flow conveyance 40' Streets

Flow velocity N-S Say 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.9 ft./sec. 46 min./mile 114 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.4 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10 yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 I_a -0.2	Q_i cfs	Q_t cfs
80	123		6	0.68	1.0	0.68					0.43	3-	3-
90	141		7	0.63	1.0	0.63					0.39	3	3
100	152		8	0.58	1.0	0.58					0.34	3-	3-
90			4	1.08	1.0	1.08					0.79	4	4
													7 Max.
						10-Year Frequency - Arterials							
						2-Year Frequency - Interior Areas							

Yost and Gardner Engineers

1. Future Dev. = 0%
2. Pervious Area Excluded

AREA F-27

LINE F

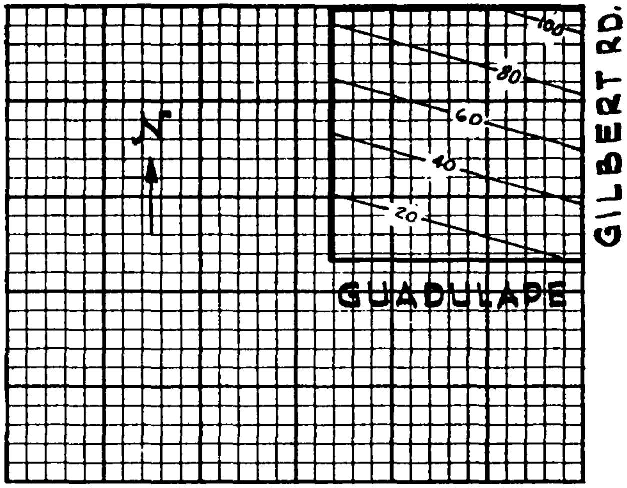
Done by D.N.S.

Date 6/1/73

Drainage Area SE¼ Sec. 1, T1S, R5E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 - 10 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential							
H.D. Residential							
Parks & park-like							
Farmlands, groves	160	5	8	5	8		
Commercial							
Industrial							
Total Acres	160		8		8		

Mean land slope N-S .0002 E-W .002

Flow conveyance 40' Streets

Flow velocity N-S Say 0.5 ft./sec. 176 min./mile 30 ft./min.

E-W 1.8 ft./sec. 49 min./mile 108 ft./min.

Hydrologic soil group ______ Assumed infiltration cap. 0.3 in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-10yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$I_a - f_c$	0.8 $I_a - f_c$	Q_p cfs	0.9 $I_a - 0.2$	Q_i cfs	Q_t cfs
80	122		6	0.68	1.0	0.68					0.43	3-	3-
90	137		7	0.63	1.0	0.63					0.39	3	3
100	148		7	0.58	1.0	0.58					0.34	3-	3-
90			4	1.08	1.0	1.08					0.79	4	4
													7 Max.

Yost and Gardner Engineers

1. Future Dev. = 0%
2. Pervious Area Excluded

AREA F-28

LINE F

Line A
Roosevelt Road - Main Street
to Salt River

EXPECTED FLOWS 2- **year rainfall intensity and duration unless noted**
Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A *	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
A-4 (Int.)	86		53			50	1.0	1.0			0.72	38		
A-4 (Arts.)	1		1			50	1.75	1.75			1.40	1	39	40, 36" Pipe, S = .003
A-3 (Int.)	141		23			30	1.4	1.4			1.08	25		
A-3 (Arts.)	4		4			30	2.5	2.5			2.07	8	33	
Sum (Int.)	227		76			58	0.90	0.90			0.63	48		
Sum (Arts.)	5		5			58	1.60	1.60			1.26	6	54	55, 48" Pipe, S = .002
A-2 (Int.)	140		1			30	1.4	1.4			1.08	1		
A-2 (Arts.)	4		4			30	2.5	2.5			2.07	8	9	
Sum (Int.)	367		77			65	0.80	0.80			0.54	42		
Sum (Arts.)	9		9			65	1.42	1.41			1.09	10	52	60, 54" Pipe, S = .0008
A-1 (Int.)	111		11			40	1.16	1.16			0.86	9		
A-1 (Arts.)	4		4			40	2.10	2.10			1.71	7	16	
Sum (Int.)	478		88			75	0.72	0.72			0.47	41		
Sum (Arts.)	13		13			75	1.27	1.26			0.96	12	53	65, To Salt River

Line B
Dobson Road - Main Street
to Salt River

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
B-8 (Int.)	162		55			40	1.16	1.16			0.86	47		
B-8 (Arts.)	4		4			40	2.1	2.1			1.71	7	54	
B-9 (Int.)	78		4			30	1.4	1.4			1.08	4		
B-9 (Arts.)	1		1			30	2.5	2.5			2.07	2	6	
Sum (Int.)	240		59			40	1.16	1.16			0.86	51		
Sum (Arts.)	5		5			40	2.1	2.1			1.71	9	60	60, 42" Pipe, S = .0031
B-7 (Int.)	153		65			40	1.16	1.16			0.86	56		
B-7 (Arts.)	4		4			40	2.1	2.1			1.71	7	63	
B-10 (Int.)	78		4			30	1.4	1.4			1.08	4		
B-10 (Arts.)	1		1			30	2.5	2.5			2.07	2	6	
Sum (Int.)	471		128			47	1.03	1.02			0.74	95		
Sum (Arts.)	10		10			47	1.83	1.81			1.45	15	110	110, 54" Pipe, S = .0024
B-6a (Int.)	88		32			30	1.4	1.4			1.08	35		
B-6a (Arts.)	4		4			30	2.5	2.5			2.07	8	43	
Sum (Int.)	559		160			54	0.93	0.92			0.65	104		
Sum (Arts.)	14		14			54	1.65	1.63			1.29	18	122	125, 48" Pipe, S = .007 125, 72" Pipe, S = .001
B-5 (Int.)	149		40			40	1.16	1.16			0.86	34		
B-5 (Arts.)	4		4			40	2.1	2.1			1.71	7	41	
B-4a (Int.)	79		6			20	1.8	1.8			1.44	9		
B-4a (Arts.)	4		4			20	3.2	3.2			2.7	11	20	
B-6 (Int.)	47		2			20	1.8	1.8			1.44	3		
B-6 (Arts.)	3		3			20	3.2	3.2			2.57	8	11	
Sum (Int.)	834		208			61	0.85	0.84			0.58	121		
Sum (Arts.)	25		25			61	1.50	1.48			1.15	29	150	150, 72" Pipe, S = .0016
B-3 (Int.)	138		1			30	1.4	1.4			1.08	1		
B-3 (Arts.)	4		4			30	2.5	2.5			2.07	8	9	
Sum (Int.)	972		209			68	0.77	0.76			0.50	105		
Sum (Arts.)	29		29			68	1.36	1.34			1.03	30	135	155, To Salt River

Line B-1
Dobson Road - Broadway Road to
Southern Avenue to Tempe Canal

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A *	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
B-9a (Int.)	79		25			30	1.4	1.4			1.08	27		
B-9a (Arts.)	3		3			30	2.5	2.5			2.07	6	33	
B-10a (Int.)	80		28			30	1.4	1.4			1.08	30		
B-10a(Arts.)	3		3			30	2.5	2.5			2.07	6	36	
Sum (Int.)	159		53			37	1.22	1.22			0.92	49		
Sum (Arts.)	6		6			37	2.20	2.20			1.80	11	60	60, 48" Pipe, S = .0024
B-12 (Int.)	147		30			40	1.16	1.16			0.86	26		
B-12 (Arts.)	4		4			40	2.10	2.10			1.71	7	33	
B-11 (Int.)	156		49			40	1.16	1.16			0.86	42		
B-11 (Arts.)	4		4			40	2.10	2.10			1.71	7	49	
Sum (Int.)	462		132			45	1.08	1.08			0.79	104		
Sum (Arts.)	14		14			45	1.9	1.9			1.53	21	125	125, 66" Pipe, S = .0012
B-13 (Int.)	145		6			40	1.16	1.16			0.86	5		
B-13 (Arts.)	4		4			40	2.10	2.10			1.71	7	12	
B-14 (Int.)	139		0									0		
B-14 (Arts.)	4		4			40	2.10	2.10			1.71	7	7	
Sum (Int.)	746		138			53	0.95	0.94			0.67	92		
Sum (Arts.)	22		22			53	1.69	1.67			1.32	29	121	130, 66" Pipe, S = .0013

Line C
Alma School Road - S.P.R.R.
to Proposed Superstition Freeway

EXPECTED FLOWS 2 **year rainfall intensity and duration unless noted**

Pervious Area Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
C-13 (Int.)	133		67			40	1.16	1.16			0.86	58		
C-13 (Arts.)	4		4			40	2.1	2.1			1.71	7	65	
C-12 (Int.)	70		50			30	1.4	1.4			1.08	54		
C-12 (Arts.)	1		1			30	2.5	2.5			2.07	2	56	60, 42" Pipe, S = .0039
C-12a (Int.)	70		42			30	1.4	1.4			1.08	45		
C-12a (Arts.)	3		3			30	2.5	2.5			2.07	6	51	
Sum (Int.)	273		159			49	1.0	1.0			0.72	114		
Sum (Arts.)	8		8			49	1.8	1.8			1.44	12	126	130, 54" Pipe, S = .0044
C-14 (Int.)	137		65			50	1.0	1.0			0.72	47		
C-14 (Arts.)	4		4			50	1.75	1.75			1.4	6	53	
C-15 (Int.)	146		12			40	1.16	1.16			0.86	10		
C-15 (Arts.)	4		4			40	2.1	2.1			1.71	7	17	
Sum (Int.)	536		236			54	0.93	0.92			0.65	153		
Sum (Arts.)	16		16			54	1.65	1.63			1.29	21	174	175, 78" Pipe, S = .001
C-17 (Int.)	138		15			50	1.0	1.0			0.72	11		
C-17 (Arts.)	4		4			50	1.75	1.75			1.4	6	17	
C-16 (Int.)	134		17			40	1.16	1.16			0.86	15		
C-16 (Arts.)	4		4			40	2.1	2.1			1.71	7	22	
Sum (Int.)	808		268			62	0.85	0.84			0.58	155		
Sum (Arts.)	24		24			62	1.50	1.48			1.15	28	183	185, 78" Pipe, S = .0012
C-18 (Int.)	119		27			50	1.0	1.0			0.72	19		
C-18 (Arts.)	4		4			50	1.75	1.75			1.4	6	25	25, Channel
C-19 (Int.)	97		1			60	0.86	0.86			0.59	1		
C-19 (Arts.)	4		4			60	1.52	1.52			1.19	5	6	
Sum (Int.)	1024		296			68	0.77	0.76			0.50	148		
Sum (Arts.)	32		32			68	1.36	1.34			1.03	33	181	190, Channel

Line C-1
McClellan Road - Country Club Drive
To Salt River

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
D-4 (Int.)	136		18			50	1.0	1.0			0.72	13		
D-4 (Arts.)	4		4			50	1.75	1.75			1.4	6	19	
D-7 (Int.)	154		18			30	1.4	1.4			1.08	19		
D-7 (Arts.)	4		4			30	2.5	2.5			2.07	8	27	
Sum (Int.)	290		36			30	1.4	1.4			1.08	39		
Sum (Arts.)	8		8			30	2.5	2.5			2.07	17	56	55, 48" Pipe, S = .0014
C-2 (Int.)	131		16			40	1.16	1.16			0.86	14		
C-2 (Arts.)	4		4			40	2.1	2.1			1.71	7	21	
C-5 (Int.)	138		10			30	1.4	1.4			1.08	11		
C-5 (Arts.)	4		4			30	2.5	2.5			2.07	8	19	
Sum (Int.)	559		62			38	1.2	1.19			0.89	55		
Sum (Arts.)	16		16			38	2.15	2.13			1.74	28	83	85, 54" Pipe, S = .0016
C-4 (Int.)	106		20			60	0.86	0.86			0.59	12		
C-4 (Arts.)	4		4			60	1.52	1.52			1.19	5	17	
C-3 (Int.)	66		9			60	0.86	0.86			0.59	5	5	
Sum (Int.)	731		91			47	1.03	1.02			0.74	67		
Sum (Arts.)	20		20			47	1.83	1.81			1.45	29	96	95, 60" Pipe, S = .0012 To Salt River

Line C-2
Alma School Road - Baseline to
Western Canal

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES: Total Area A*	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
C-23 (Int.)	123		1			50	1.0	1.0			0.72	1		
C-23 (Arts.)	4		4			50	1.75	1.75			1.40	6	7	
C-24 (Int.)	144		3			70	0.76	0.76			0.49	1		
C-24 (Arts.)	4		4			70	1.32	1.32			1.01	4	5	
Sum (Int.)	267		4			74	0.72	0.72			0.47	2		
Sum (Arts.)	8		8			74	1.28	1.28			0.97	8	10	15, 36" Pipe, S = .0005 To Retention Basin

Line C-3
Extension Road - Baseline Road
To Western Canal

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES: Total Area A *	AREA IN ACRES: Pervious Area A_p	AREA IN ACRES: Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Concentration Time: Min. t_c	RAIN: Point Intensity I	RAIN: Average Intensity Ia	RUNOFF Pervious: $(Ia-f_c)0.8$ = Inches	RUNOFF Pervious: $InxA_p$ = CFS	RUNOFF Impervious: $(Ia-0.2)0.9$ = Inches	RUNOFF Impervious: $InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
C-20 (Int.)	54		1			40	1.16	1.16			0.86	1		
C-20 (Arts.)	4		4			40	2.1	2.1			1.71	7	8	
C-21 (Int.)	119		0			60	0.86	0.86			0.59	0		
C-21 (Arts.)	4		4			60	1.52	1.52			1.19	5	5	
Sum (Int.)	173		1			64	0.82	0.82			0.56	1		
Sum (Arts.)	8		8			64	1.44	1.44			1.12	9	10	
D-24 (Int.)	126		0			90	0.63	0.63			0.39	0		
D-24 (Arts.)	4		4			90	1.08	1.08			0.79	3	3	
C-22 (Int.)	126		0			60	0.86	0.86			0.59	0		
C-22 (Arts.)	4		4			60	1.52	1.52			1.19	5	5	
Sum C-20 through C-22, & D-24 Int.	425		1			78	0.70	0.70			0.45	1		
Sum C-20 through C-22, & D-24	16		16			78	1.24	1.24			0.94	15	16	15, 36" Pipe, S = .0005
D-27 (Int.)	138		0			50	1.0	1.0			0.72	0		
D-27 (Arts.)	4		4			50	1.75	1.75			1.40	6	6	
C-25 (Int.)	127		0			50	1.0	1.0			0.72	0		
C-25 (Arts.)	4		4			50	1.75	1.75			1.40	6	6	
Sum (Int.)	690		1			90	0.63	0.62			0.38	1		
Sum (Arts.)	24		24			90	1.08	1.07			0.78	19	20	20, 42" Pipe, S = .0005 To Retention Basin

Line D
Country Club Drive - 8th Street
to Baseline Floodway

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES: Total Area A*	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
D-8 (Int.)	150		28			50	1.0	1.0			0.72	20		
D-8 (Arts.)	4		4			50	1.75	1.75			1.40	6	26	25, 36" Pipe, S = .0017
D-11(Int.)	131		32			50	1.0	1.0			0.72	23		
D-11 (Arts.)	4		4			50	1.75	1.75			1.40	6	29	
Sum (Int.)	281		60			60	0.86	0.86			0.59	35		
Sum (Arts.)	8		8			60	1.52	1.52			1.19	10	45	45, 42" Pipe, S = .0017
Sum (Int.)	281		60			69	0.76	0.76			0.50	30		
Sum (Arts.)	8		8			69	1.36	1.36			1.04	8	38	55, 42" Pipe, S = .0034
D-14 (Int.)	138		67			50	1.0	1.0			0.72	48		
D-14 (Arts.)	4		4			50	1.75	1.75			1.40	6	54	
D-15 (Int.)	138		44			50	1.0	1.0			0.72	32		
D-15 (Arts.)	4		4			50	1.75	1.75			1.40	6	38	
Sum (Int.)	557		171			76	0.7	0.69			0.44	75		
Sum (Arts.)	16		16			76	1.25	1.23			0.93	5	90	90, 48" Pipe, S = .0034
D-17 (Int.)	140		39			50	1.0	1.0			0.72	28		
D-17 (Arts.)	4		4			50	1.25	1.75			1.40	6	34	
D-16 (Int.)	141		57			50	1.0	1.0			0.72	41		
D-16 (Arts.)	4		4			50	1.75	1.75			1.40	6	47	
Sum (Int.)	838		267			82	0.67	0.66			0.41	110		
Sum (Arts.)	24		24			82	1.17	1.15			0.86	21	131	130, 66" Pipe, S = .0016
D-18 (Int.)	137		69			50	1.0	1.0			0.72	50		
D-18 (Arts.)	4		4			50	1.75	1.75			1.40	6	56	
D-19 (Int.)	137		18			50	1.0	1.0			0.72	13		
D-19 (Arts.)	4		4			50	1.75	1.75			1.40	6	19	
Sum (Int.)	1112		354			89	0.63	0.62			0.38	135		
Sum (Arts.)	32		32			89	1.10	1.08			0.79	25	160	160, 72" Pipe, S = .0015
D-20 (Int.)	124		15			50	1.0	1.0			0.72	11		
D-20 (Arts.)	4		4			50	1.75	1.75			1.40	6	17	
Sum (Int.)	1236		369			95	0.59	0.58			0.34	125		
Sum (Arts.)	36		36			95	1.02	1.00			0.72	26	151	165, 90" Pipe, S = .0005
D-21 (Int.)	124		12			50	1.0	1.0			0.72	8		
D-21 (Arts.)	4		4			50	1.75	1.75			1.40	6	14	
Sum (Int.)	1360		381			99	0.57	0.56			0.32	122		
Sum (Arts.)	40		40			99	1.00	0.98			0.70	28	150	170, 90" Pipe, S = .0005 175, 90" Pipe, S = .0005 To Retention Basin

Line D-1
McKellips Road - Horne
To Salt River

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
F-2a (Int.)	38		2			20	1.8	1.8			1.44	3		
F-2a (Arts.)	1		1			20	3.2	3.2			2.61	3	6	
F-3a (Int.)	14		1			10	2.5	2.5			2.07	2		
F-3a (Arts.)	1		1			10	4.4	4.4			3.78	4	6	
Sum (Int.)	52		3			20	1.8	1.8			1.44	4		
Sum (Arts.)	2		2			20	3.2	3.2			2.7	5	9	
E-1 (Int.)	135		19			50	1.0	1.0			0.72	14		
E-1 (Arts.)	4		4			50	1.52	1.52			1.19	5	19	
Sum (Int.)	187		22			37	1.22	1.22			0.92	20		
Sum (Arts.)	6		6			37	2.18	2.18			1.78	11	31	30, 39" Pipe, S = .0011
E-4 (Int.)	126		10			50	1.0	1.0			0.72	7		
E-4 (Arts.)	3		3			50	1.75	1.75			1.40	4	11	
E-5a (Int.)	35		2			17	1.98	1.98			1.6	3		
E-5a (Arts.)	1		1			17	3.5	3.5			2.97	3	6	
Sum (Int.)	348		34			49	1.00	1.00			0.72	24		
Sum (Arts.)	10		10			49	1.8	1.79			1.43	14	38	40, 39" Pipe, S = .002
E-3 (Int.)	135		13			50	1.08	1.08			0.72	9		
E-3 (Arts.)	4		4			50	1.75	1.75			1.4	6	15	
E-6 (Int.)	149		11			40	1.16	1.16			0.86	9		
E-6 (Arts.)	4		4			40	2.1	2.1			1.71	7	16	
E-7 (Int.)	134		2			40	1.16	1.16			0.86	2		
E-7 (Arts.)	4		4			40	2.1	2.1			1.71	7	9	
Sum (Int.)	766		60			58	0.98	0.97			0.69	41		
Sum (Arts.)	22		22			58	1.58	1.56			1.22	27	68	70, 48" Pipe, S = .0036
D-2 (Int.)	155		15			50	1.0	1.0			0.72	11		
D-2 (Arts.)	4		4			50	1.75	1.75			1.4	6	17	
D-5 (Int.)	132		8			30	1.4	1.4			1.08	9		
D-5 (Arts.)	4		4			30	2.5	2.5			2.07	8	17	
D-6 (Int.)	146		7			30	1.4	1.4			1.08	8		
D-6 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum (Int.)	1199		90			65	0.8	0.79			0.53	48		
Sum (Arts.)	34		34			65	1.42	1.40			1.08	37	85	85, 54" Pipe, S = .0018
Sum														90, 54" Pipe, S = .0018 To Salt River

Line E
Horne - 8th Street
to Baseline Floodway

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2-year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
E-4a (Int.)	15		7			20	1.8	1.8			1.44	10		
E-4a (Arts.)	1		1			20	3.2	3.2			2.7	3	13	To Consolidated Canal
E-5 (Int.)	119		8			40	1.16	1.16			0.86	7		
E-5 (Arts.)	3		3			40	2.1	2.1			1.71	5	12	
E-8(Int.)	136		1			50	1.0	1.0			0.72	1		
E-8 (Arts.)	4		4			50	1.75	1.75			1.4	6	7	
Sum (Int.)	255		9			53	0.85	0.85			0.58	5		
Sum (Arts.)	7		7			53	1.68	1.68			1.33	9	14	To Consolidated Canal
E-9 (Int.)	138		24			50	1.0	1.0			0.72	17		
E-9 (Arts.)	4		4			50	1.75	1.75			1.4	6	23	
E-10 (Int.)	108		22			70	0.76	0.76			0.49	11		
E-10 (Arts.)	4		4			70	1.32	1.32			1.01	4	15	
Sum (Int.)	246		46			50	1.0	1.0			0.72	33		
Sum (Arts.)	8		8			50	1.75	1.75			1.4	11	44	45, 36" Pipe, S = .004
E-11 (Int.)	139		40			50	1.0	1.0			0.72	29		
E-11 (Arts.)	4		4			50	1.75	1.75			1.4	6	35	
E-12 (Int.)	139		31			50	1.0	1.0			0.72	22		
E-12 (Arts.)	4		4			50	1.75	1.75			1.4	6	28	
Sum (Int.)	524		117			58	0.88	0.87			0.60	70		
Sum (Arts.)	16		16			58	1.58	1.56			1.22	20	90	
D-9 (Int.)	138		4			50	1.0	1.0			0.72	3		
D-9 (Arts.)	4		4			50	1.75	1.75			1.4	6	9	
D-10 (Int.)	135		35			50	1.0	1.0			0.72	25		
D-10 (Arts.)	4		4			50	1.75	1.75			1.4	6	31	
Sum (Int.)	273		39			61	0.85	0.85			0.59	23		
Sum (Arts.)	8		8			61	1.5	1.5			1.17	9	32	35, 39" Pipe, S = .0019
Sum from E-9-10-11-12 (Int.)	524		117			58	0.88	0.87			0.60	70		
Sum from E-9-10-11-12 (Arts.)	16		16			58	1.58	1.56			1.22	20	90	
Sum at University & Horne (Int.)	797		156			58	0.88	0.87			0.60	94		
Sum at University & Horne (Arts.)	24		24			58	1.58	1.56			1.22	29	123	125, 54" Pipe, S = .0034
Main to Broadway														130, 60" Pipe, S = .0021

Line E
Horne - 8th Street
to Baseline Floodway

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted
Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
E-15 (Int.)	129		44			50	1.0	1.0			0.72	32		
E-15 (Arts.)	4		4			50	1.75	1.75			1.4	6	38	
E-16 (Int.)	130		43			50	1.0	1.0			0.72	31		
E-16 (Arts.)	4		4			50	1.75	1.75			1.4	6	37	
Sum (Int.)	1056		243			65	0.8	0.79			0.53	129		
Sum (Arts.)	32		32			65	1.42	1.40			1.08	35	164	165, 72" Pipe, S = .0014
E-17 (Int.)	132		36			50	1.0	1.0			0.72	26		
E-17 (Arts.)	4		4			50	1.75	1.75			1.4	6	32	
E-18 (Int.)	139		30			90	0.62	0.62			0.38	11		
E-18 (Arts.)	4		4			90	1.08	1.08			0.79	3	14	
Sum (Int.)	1327		309			71	0.75	0.74			0.49	151		
Sum (Arts.)	40		40			71	1.32	1.30			0.99	40	191	190, 72" Pipe, S = .0018
E-19 (Int.)	136		26			50	1.0	1.0			0.72	19		
E-19 (Arts.)	4		4			50	1.75	1.75			1.4	6	25	25, 30" Pipe, S = .0032
E-22 (Int.)	114		18			40	1.16	1.16			0.86	15		
E-22 (Arts.)	4		4			40	2.1	2.1			1.71	7	22	
Sum (Int.)	250		44			59	0.87	0.87			0.6	26		
Sum (Arts.)	8		8			59	1.54	1.54			1.2	10	36	35, 48" Pipe, S = .00052
Sum at Horne & 8th Ave. (Int.)	1327		309			71	0.75	0.74			0.49	151		
Sum at Horne & 8th Ave. (Arts.)	40		40			71	1.32	1.30			0.99	40	191	
E-20 (Int.)	122		17			50	1.0	1.0			0.72	12		
E-20 (Arts.)	4		4			50	1.75	1.75			1.40	6	18	
Sum (Int.)	1449		326			78	0.68	0.67			0.42	137		
Sum (Arts.)	44		44			78	1.21	1.18			0.88	39	176	195, 84" Pipe, S = .0008
E-21 (Int.)	108		0			50	1.0	1.0			0.72	0		
E-21 (Arts.)	4		4			50	1.75	1.75			1.4	6	6	
Sum (Int.)	1557		326			87	0.64	0.63			0.39	127		
Sum (Arts.)	48		48			87	1.12	1.09			0.80	38	165	200, 84" Pipe, S = .00086
Sum at Freeway (Int.)	1807		370			91	0.62	0.60			0.36	133		
Sum at Freeway (Arts.)	56		56			91	1.07	1.04			0.75	42	175	205, 84" Pipe, S = .00088 To Retention Basin

Line E-1
1/2 Mile South of Baseline Road -
Stapley Drive to Center

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted
Pervious Areas Excluded

LOCATION	AREA IN ACRES: Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
F-25 (Int.)	137		7			90	0.63	0.63			0.39	3		
F-25 (Arts.)	4		4			90	1.08	1.08			0.79	3	6	
F-26 (Int.)	141		7			90	0.63	0.63			0.39	3		
F-26 (Arts.)	4		4			90	1.08	1.08			0.79	3	6	
F-27 (Int.)	141		7			90	0.63	0.63			0.39	3		
F-27 (Arts.)	4		4			90	1.08	1.08			0.79	3	6	
F-28 (Int.)	137		7			90	0.63	0.63			0.39	3		
F-28 (Arts.)	4		4			90	1.08	1.08			0.79	3	6	
Sum (Int.)	556		28			112	0.52	0.51			0.28	8		
Sum (Arts.)	16		16			112	0.90	0.89			0.62	10	18	20, 30" Pipe, S = .002
E-25 (Int.)	132		7			50	1.0	1.0			0.72	5		
E-25 (Arts.)	4		4			50	1.75	1.75			1.40	6	11	
E-28 (Int.)	141		7			50	1.0	1.0			0.72	5		
E-28 (Arts.)	4		4			50	1.75	1.75			1.40	6	11	
Sum (Int.)	829		42			123	0.47	0.46			0.23	10		
Sum (Arts.)	24		24			123	0.82	0.81			0.55	13	23	25, 36" Pipe, S = .0015
E-26 (Int.)	123		4			60	0.86	0.86			0.59	2		
E-26 (Arts.)	4		4			60	1.52	1.52			1.19	5	7	
E-27 (Int.)	133		7			50	1.0	1.0			0.72	5		
E-27 (Arts.)	4		4			50	1.75	1.75			1.40	6	11	
E-29 (Int.)	127		6			50	1.0	1.0			0.72	4		
E-29 (Arts.)	4		4			50	1.75	1.75			1.40	6	10	
E-30 (Int.)	123		6			50	1.0	1.0			0.72	4		
E-30 (Arts.)	4		4			50	1.75	1.75			1.40	6	10	
Sum - F-25, F-28, E-25, E-30, (Int.)	1335		65			134	0.44	0.43			0.21	14		
Sum - F-25, F-28, E-25, E-30 (Arts.)	40		40			134	0.76	0.74			0.49	20	34	35, 48" Pipe, S = .0009 To Retention Basin

Line F
Stapley Drive - McKellips Road
to Baseline Floodway

EXPECTED FLOWS 2 **year rainfall intensity and duration unless noted**

Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
F-4 (Int.)	157		4			40	1.16	1.16			0.86	3		
F-4 (Arts.)	4		4			40	2.1	2.1			1.71	7	10	
F-3 (Int.)	89		4			40	1.16	1.16			0.86	3		
F-3 (Arts.)	3		3			40	2.1	2.1			1.71	5	8	
Sum (Int.)	246		8			40	1.16	1.16			0.86	7		
Sum (Arts.)	7		7			40	2.1	2.1			1.71	12	19	20, 30" Pipe, S = .0026
F-5 (Int.)	131		21			30	1.4	1.4			1.08	23		
F-5 (Arts.)	4		4			30	2.5	2.5			2.07	8	31	
F-6 (Int.)	131		1			30	1.4	1.4			1.08	1		
F-6 (Arts.)	4		4			30	2.5	2.5			2.07	8	9	
Sum (Int.)	508		30			50	0.98	0.97			0.70	21		
Sum (Arts.)	15		15			50	1.75	1.73			1.38	21	42	40, 36" Pipe, S = .003
F-8 (Int.)	157		19			40	1.16	1.16			0.86	16		
F-8 (Arts.)	4		4			40	2.1	2.1			1.71	7	23	
F-7 (Int.)	128		2			30	1.4	1.4			1.08	2		
F-7 (Arts.)	4		4			30	2.5	2.5			2.07	8	10	
Sum (Int.)	793		51			58	0.88	0.87			0.60	31		
Sum (Arts.)	23		23			58	1.56	1.54			1.20	28	59	60, 48" Pipe, S = .0028
F-9 (Int.)	154		25			40	1.16	1.16			0.86	22		
F-9 (Arts.)	4		4			40	2.1	2.1			1.71	7	29	
F-10 (Int.)	149		27			40	1.16	1.16			0.86	23		
F-10 (Arts.)	4		4			40	2.1	2.1			1.71	7	30	
Sum (Int.)	1096		100			65	0.80	0.79			0.53	53		
Sum (Arts.)	31		31			65	1.42	1.40			1.08	33	86	85, 54" Pipe, S = .0028
F-12 (Int.)	154		21			30	1.16	1.16			0.86	18		
F-12 (Arts.)	4		4			30	2.1	2.1			1.71	7	25	
F-11 (Int.)	152		27			40	1.16	1.16			0.86	23		
F-11 (Arts.)	4		4			40	2.1	2.1			1.71	7	30	
Sum (Int.)	1369		148			72	0.74	0.73			0.48	71		
Sum (Arts.)	39		39			72	1.30	1.28			0.97	38	109	110, 60" Pipe, S = .0024

Line F
Stapley Drive - McKellips Road
to Baseline Floodway

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2-year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES: Total Area A *	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
F-13 (Int.)	(123)		(54)			(30)	(1.4)	(1.4)			(1.08)	(58)		
F-13 (Arts.)	(4)		(4)			(30)	(1.9)	(1.9)			(1.53)	(6)	(64)	Drains into Main St. Line
F-14 (Int.) (1/2)	(152)		(33)			(40)	(1.16)	(1.16)			(0.86)	(28)		
F-14 (Arts.) (1/2)	(4)		(4)			(40)	(2.1)	(2.1)			(1.71)	(7)	(35)	Drains into Main St. Line
Sum (Int.)	1369		148			79	0.68	0.67			0.42	62		
Sum (Arts.)	39		39			79	1.21	1.19			0.89	36	98	115, 60" Pipe, S = .002
F-16 (Int.)	147		44			40	1.16	1.16			0.86	38		
F-16 (Arts.)	4		4			40	2.1	2.1			1.71	7	45	
F-15 (Int.)	143		43			40	1.16	1.16			0.86	37		
F-15 (Arts.)	4		4			40	2.1	2.1			1.71	7	44	
Sum (Int.)	1659		235			84	0.65	0.64			0.40	94		
Sum (Arts.)	47		47			84	1.15	1.13			0.84	40	134	135, 66" Pipe, S = .0022
F-17(Int.)	150		28			40	1.16	1.16			0.86	24		
F-17 (Arts.)	4		4			40	2.1	2.1			1.71	7	31	
F-18 (Int.)	139		28			40	1.16	1.16			0.86	24		
F-18 (Arts.)	4		4			40	2.1	2.1			1.71	7	31	
Sum (Int.)	1948		291			91	0.61	0.59			0.35	102		
Sum (Arts.)	55		55			91	1.07	1.04			0.76	42	144	145, 66" Pipe, S = .0022
F-20 (Int.)	133		22			40	1.16	1.16			0.16	19		
F-20 (Arts.)	4		4			40	2.1	2.1			1.71	7	26	
F-19 (Int.)	149		18			50	0.98	0.98			0.70	13		
F-19 (Arts.)	4		4			50	1.75	1.75			1.4	6	19	
Sum (Int.)	2230		331			97	0.58	0.56			0.32	106		
Sum (Arts.)	63		63			97	1.01	0.98			0.70	44	150	150, 84" Pipe, S = .0005
F-21 (Int.)	119		8			90	0.62	0.62			0.38	3		
F-21 (Arts.)	4		4			90	1.08	1.08			0.79	3	6	
F-22 (Int.)	137		6			90	0.62	0.62			0.38	2		
F-22 (Arts.)	4		4			90	1.08	1.08			0.79	3	5	
Sum (Int.)	2486		345			109	0.52	0.50			0.27	93		
Sum (Arts.)	71		71			109	0.90	0.87			0.60	43	136	155, 84" Pipe, S = .00054 160, 84" Pipe, S = .00057

Line F
Stapely Drive - McKellips Road
to Baseline Floodway

EXPECTED FLOWS 2-year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
F-24 (Int.)	126		0			90	0.63	0.63			0.39	0		
F-24 (Arts.)	4		4			90	1.08	1.08			0.79	3	3	
F-23 (Int.)	126		0			90	0.63	0.63			0.39	0		
F-23 (Arts.)	4		4			90	1.08	1.08			0.79	3	3	
Sum (Int.)	2738		345			119	0.49	0.47			0.24	83		
Sum (Arts.)	79		79			119	0.85	0.82			0.56	44	127	160, To Retention Basin

Line G
Gilbert Road - McKellips Road
to Baseline Floodway

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
G-1 & G-2 (Int.)	143		4			30	1.4	1.4			1.08	4		
G-1 & G-2 (Arts.)	4		4			30	2.5	2.5			2.07	8	12	
G-3 (Int.)	77		4			30	1.4	1.4			1.08	4		
G-3 (Arts.)	4		4			30	2.5	2.5			2.07	8	12	
Sum (Int.)	220		8			39	1.2	1.2			0.90	7		
Sum (Arts.)	8		8			39	2.1	2.1			1.71	14	21	
G-5 (Int.)	147		9			30	1.4	1.4			1.08	10		
G-5 (Arts.)	4		4			30	2.5	2.5			2.07	8	18	
G-4 (Int.)	141		7			30	1.4	1.4			1.08	8		
G-4 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum - Int.)	508		24			49	1.0	1.0			0.72	17		
Sum - Arts.)	16		16			49	1.8	1.8			1.44	23	40	40, 36" Pipe, S = .0036
G-6 (Int.)	150		8			30	1.4	1.4			1.08	9		
G-6 (Arts.)	4		4			30	2.5	2.5			2.07	8	17	
G-7 (Int.)	133													
G-7 (Arts.)	4		4			30	2.5	2.5			2.07	8	8	
Sum (Int.)	791		39			56	0.90	0.89			0.62	24		
Sum (Arts.)	24		24			56	1.60	1.58			1.24	30	54	55, 39" Pipe, S = .0038
G-9 (Int.)	140		16			30	1.4	1.4			1.08	17		
G-9 (Arts.)	4		4			30	2.5	2.5			2.07	8	25	
G-8 (Int.)	153		31			40	1.16	1.16			0.86	27		
G-8 (Arts.)	4		4			40	2.1	2.1			1.71	7	34	
Sum (Int.)	1084		86			63	0.82	0.80			0.54	46		
Sum (Arts.)	32		32			63	1.45	1.42			1.10	35	81	80, 48" Pipe, S = .0032
G-10 (Int.)	130		8			30	1.4	1.4			1.08	9		
G-10 Arts.)	4		4			30	2.5	2.5			2.07	8	17	
G-11 (Int.)	149		18			40	1.16	1.16			0.86	15		
G-11 (Arts.)	4		4			40	2.1	2.1			1.71	7	22	
Sum (Int.)	1363		112			70	0.76	0.74			0.49	55		
Sum (Arts.)	40		40			70	1.32	1.29			0.98	39	94	95, 54" Pipe, S = .0024
G-13 (Int.)	131		7			30	1.4	1.4			1.08	8		
G-13 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
G-12 (Int.)	154		23			40	1.16	1.16			0.86	20		
G-12 (Arts.)	4		4			40	2.1	2.1			1.71	7	27	

Line G
Gilbert Road - McKellips Road
to Baseline Floodway

EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES: Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Sum (Int.)	1648		142			77	0.70	0.68			0.43	61		
Sum (Arts.)	48		48			77	1.25	1.22			0.92	44	105	105, 60" Pipe, S = .0021
G-14 (Int.)	(125)		(36)			(30)	(1.4)	(1.4)			(1.08)	(39)		
G-14 (Arts.)	(4)		(4)			(30)	(2.5)	(2.5)			(2.07)	(8)	(47)	Goes into existing Main Street Trunk
G-15 (Int.)	(132)		(7)			(30)	(1.4)	(1.4)			(1.08)	(8)		Goes into Main St. Trunk
G-15 (Arts.)	(4)		(4)			(30)	(2.5)	(2.5)			(2.07)	(8)	(16)	
Sum (Int.)	1648		142			84	0.65	0.63			0.39	55		
Sum (Arts.)	48		48			84	1.15	1.15			0.83	40	95	110, 60" Pipe, S = .002
G-17 (Int.)	130		58			30	1.4	1.4			1.08	63		
G-17 (Arts.)	4		4			30	2.5	2.5			2.07	8	71	
G-16 (Int.)	153		55			40	1.16	1.16			0.86	47		
G-16 (Arts.)	4		4			40	2.1	2.1			1.71	7	54	
Sum (Int.)	1931		255			90	0.62	0.60			0.36	92		
Sum (Arts.)	56		56			90	1.08	1.05			0.77	43	135	135, 66" Pipe, S = .0018
G-18 (Int.)	126		9			30	1.4	1.4			1.08	10		
G-18 (Arts.)	4		4			30	2.5	2.5			2.07	8	18	
G-19 (Int.)	151		0			40	1.16	1.16			0.86	0		
G-19 (Arts.)	4		4			40	2.1	2.1			1.71	7	7	
Sum (Int.)	2208		264			96	0.58	0.56			0.33	87		
Sum (Arts.)	64		64			96	1.02	0.99			0.71	45	132	140, 66" Pipe, S = .0018
G-21 (Int.)	160		19			40	1.16	1.16			0.86	16		
G-21 (Arts.)	4		4			40	2.1	2.1			1.71	7	23	
G-20 (Int.)	144		0			40	1.16	1.16			0.86	0		
G-20 (Arts.)	4		4			40	2.1	2.1			1.71	7	7	
Sum (Int.)	2512		283			102	0.56	0.54			0.31	88		
Sum (Arts.)	72		72			102	0.97	0.94			0.67	48	136	145, 84" Pipe, S = .0005
G-22 (Int.)	121		16			40	1.16	1.16			0.86	14		
G-22 (Arts.)	4		4			40	2.1	2.1			1.71	7	21	
G-23 (Int.)	127		14			30	1.4	1.4			1.08	15		
G-23 (Arts.)	4		4			30	2.5	2.5			2.07	8	23	
Sum (Int.)	2760		313			112	0.52	0.50			0.27	85		
Sum (Arts.)	80		80			112	0.90	0.87			0.60	48	133	150, 84" Pipe, S = .0005 To Retention Basin

Line H
Lindsay Road - McDowell Road
to Baseline Floodway

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES Total Area A *	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
H-12 (Int.)	150		19			30	1.4	1.4			1.08	21		
H-12 (Arts.)	4		4			30	2.5	2.5			2.07	8	29	
H-11 (Int.)	150		3			30	1.4	1.4			1.08	3		
H-11 (Arts.)	4		4			30	2.5	2.5			2.07	8	11	
Sum (Int.)	1615		164			62	0.85	0.83			0.57	93		
Sum (Arts.)	48		48			62	1.50	1.46			1.13	54	147	150, 60" Pipe, S = .0034
H-13 (Int.)	152		7			30	1.4	1.4			1.08	8		
H-13 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
H-14 (Int.)	138		14			30	1.4	1.4			1.08	15		
H-14 (Arts.)	4		4			30	2.5	2.5			2.07	8	23	
Sum (Int.)	1905		185			68	0.77	0.75			0.50	93		
Sum (Arts.)	56		56			68	1.38	1.35			1.04	58	151	155, 60" Pipe, S = .0034
H-16 (Int.)	157		36			30	1.4	1.4			1.08	39		
H-16 (Arts.)	4		4			30	2.5	2.5			2.07	8	47	
H-15 (Int.)	145		28			30	1.4	1.4			1.08	30		
H-15 (Arts.)	4		4			30	2.5	2.5			1.08	8	38	
Sum (Int.)	2207		249			74	0.73	0.71			0.46	115		
Sum (Arts.)	64		64			74	1.28	1.25			0.95	61	176	175, 66" Pipe, S = .0024
H-17 (Int.)	143		43			30	1.4	1.4			1.08	46		
H-17 (Arts.)	4		4			30	2.5	2.5			2.07	8	54	
H-18 (Int.)	127		20			30	1.4	1.4			1.08	22		
H-18 (Arts.)	4		4			30	2.5	2.5			2.07	8	30	
Sum (Int.)	2477		312			80	0.68	0.66			0.41	128		
Sum (Arts.)	72		72			80	1.20	1.16			0.86	62	190	190, 72" Pipe, S = .0018
H-20 (Int.)	138		1			30	1.4	1.4			1.08	1		
H-20 (Arts.)	4		4			30	2.5	2.5			2.07	8	9	
H-19 (Int.)	130		7			30	1.4	1.4			1.08	8		
H-19 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum (Int.)	2745		320			86	0.64	0.62			0.38	122		
Sum (Arts.)	80		80			86	1.12	1.09			0.80	64	186	195, 78" Pipe, S = .0012

Line H
Lindsay Road - McDowell Road
to Baseline Floodway

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES: Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity I_a	RUNOFF: Pervious $(I_a-f_c)0.8$ = Inches	$I_a x A_p$ = CFS	Impervious $(I_a-0.2)0.9$ = Inches	$I_a x A_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
H-1 (Interior)	75		4			30	1.4	1.4			1.08	4		
H-1 (Arterials)	4		4			30	2.5	2.5			2.07	8	12	
H-2 (Int.	70		7			30	1.4	1.4			1.08	8		
H-2 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum (Int.)	145		11			40	1.16	1.16			0.86	9		
Sum (Arts.)	8		8			40	2.1	2.1			1.71	14	23	25, 30" Pipe, S = .0034
H-4 (Int.)	143		14			30	1.4	1.4			1.08	15		
H-4 (Arts.)	4		4			30	2.5	2.5			2.07	8	23	
H-3 (Int.)	138		35			30	1.4	1.4			1.08	38		
H-3 (Arts.)	4		4			30	2.5	2.5			2.07	8	46	
Sum (Int.)	426		60			38	1.20	1.20			0.90	54		
Sum (Arts.)	16		16			38	2.15	2.15			1.76	28	82	85, 48" Pipe, S = .0034
H-5 (Int.)	146		7			30	1.4	1.4			1.08	8		
H-5 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
H-6 (Int.)	141		10			30	1.4	1.4			1.08	11		
H-6 (Arts.)	4		4			30	2.5	2.5			2.07	8	19	
Sum (Int.)	713		77			44	1.10	1.08			0.79	61		
Sum (Arts.)	24		24			44	1.92	1.89			1.52	36	97	100, 48" Pipe, S = .0042
H-8 (Int.)	153		15			30	1.4	1.4			1.08	16		
H-8 (Arts.)	4		4			30	2.5	2.5			2.07	8	24	
H-7 (Int.)	149		37			30	1.4	1.4			1.08	40		
H-7 (Arts.)	4		4			30	2.5	2.5			2.07	8	48	
Sum (Int.)	1015		129			50	1.0	0.99			0.71	92		
Sum (Arts.)	32		32			50	1.75	1.72			1.37	44	136	135, 60" Pipe, S = .0034
H-9 (Int.)	150		7			30	1.4	1.4			1.08	8		
H-9 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
H-10 (Int.)	150		5			30	1.4	1.4			1.08	5		
H-10 (Arts.)	4		4			30	2.5	2.5			2.07	8	13	
Sum (Int.)	1315		142			56	0.92	0.90			0.63	89		
Sum (Arts.)	40		40			56	1.60	1.57			1.23	49	138	140, 60" Pipe, S = .0034

Line H
Lindsay Road - McDowell Road
to Baseline Floodway

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES: Total Area A*	AREA IN ACRES: Pervious Area A_p	AREA IN ACRES: Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Concentration Time: Min. t_c	RAIN: Point Intensity I	RAIN: Average Intensity Ia	RUNOFF Pervious: $(Ia-f_c)0.8$ = Inches	RUNOFF Pervious: $InxA_p$ = CFS	RUNOFF Impervious: $(Ia-0.2)0.9$ = Inches	RUNOFF Impervious: $InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
H-21 (Int.)	145		4			40	1.16	1.16			0.86	3		
H-21 (Arts.)	4		4			40	2.1	2.1			1.71	7	10	
H-22 (Int.)	145		8			40	1.16	1.16			0.86	7		
H-22 (Arts.)	4		4			40	2.1	2.1			1.71	7	14	
Sum (Int.)	3035		332			93	0.60	0.58			0.34	113		
Sum (Arts.)	88		88			93	1.05	1.01			0.73	64	177	200, 90" Pipe, S = .0006
H-24 (Int.)	145		1			40	1.16	1.16			0.86	1		
H-24 (Arts.)	4		4			40	2.1	2.1			1.71	7	8	
H-23 (Int.)	127		0			40	1.16	1.16			0.86	0		
H-23 (Arts.)	4		4			40	2.1	2.1			1.71	7	7	
Sum (Int.)	3307		333			97	0.58	0.56			0.32	107		
Sum (Arts.)	96		96			97	1.0	0.96			0.68	65	172	205, 90" Pipe, S = .00062 To Retention Basin

Line I
Val Vista Road - McDowell Road
to Baseline Floodway

EXPECTED FLOWS 2 **year rainfall intensity and duration unless noted**

Pervious Areas excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr fc	Concentration Time Street Slope	Min. tc	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(I_a-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious (Ia-0.2)0.9 = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
I-1 (Interior)	112		12			25	1.60	1.60			1.26	15		
I-1 (Arterials)	2		2			25	2.85	2.85			2.39	5	20	20, 30" Pipe, S = .0022
I-2 (Int.)	149		12			30	1.4	1.4			1.08	13		
I-2 (Arts.)	4		4			30	2.5	2.5			2.07	8	21	
Sum (Int.)	261		24			36	1.26	1.26			0.95	23		
Sum (Arts.)	6		6			36	2.25	2.25			1.85	11	34	35, 36" Pipe, S = .0026
I-4 (Int.)	66		7			28	1.5	1.5			1.17	8		
I-4 (Arts.)	3		3			28	2.6	2.6			2.16	6	14	
I-3 (Int.)	145		13			30	1.4	1.4			1.08	14		
I-3 (Arts.)	4		4			30	2.5	2.5			2.07	8	22	
Sum ((Int.)	472		44			45	1.08	1.07			0.78	34		
Sum (Arts.)	13		13			45	1.90	1.88			1.51	20	54	55, 42" Pipe, S = .0032
I-5 (Int.)	112		6			28	1.5	1.5			1.17	7		
I-5 (Arts.)	4		4			28	2.6	2.6			2.16	9	16	
I-6 (Int.)	145		7			30	1.4	1.4			1.08	8		
I-6 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum (Int.)	729		57			52	0.96	0.95			0.68	39		
Sum (Arts.)	21		21			52	1.7	1.68			1.33	28	67	70, 48" Pipe, S = .0032
I-8 (Int.)	176		9			30	1.4	1.4			1.08	10		
I-8 (Arts.)	4		4			30	2.5	2.5			2.07	8	18	
I-7 (Int.)	154		8			30	1.4	1.4			1.08	9		
I-7 (Arts.)	4		4			30	2.5	2.5			2.07	8	17	
Sum (Int.)	1059		74			59	0.87	0.86			0.59	44		
Sum (Arts.)	29		29			59	1.55	1.53			1.20	35	79	80, 48" Pipe, S = .0032
I-9 (Int.)	160		8			30	1.4	1.4			1.08	9		
I-9 (Arts.)	4		4			30	2.5	2.5			2.07	8	17	
I-10 (Int.)	155		8			30	1.4	1.4			1.08	9		
I-10 (Arts.)	4		4			30	2.5	2.5			2.07	8	17	
Sum (Int.)	1374		90			65	0.81	0.79			0.53	48		
Sum (Arts.)	37		37			65	1.43	1.40			1.08	40	88	90, 48" Pipe, S = .0038
I-12 (Int.)	156		4			30	1.4	1.4			1.08	6		
I-12 (Arts.)	4		4			30	2.5	2.5			2.07	8	14	
I-11 (Int.)	151		9			30	1.4	1.4			1.08	10		
I-11 (Arts.)	4		4			30	2.5	2.5			2.07	8	18	
Sum (Int.)	1681		103			71	0.75	0.74			0.49	50		
Sum (Arts.)	45		45			71	1.32	1.29			0.98	44	94	95, 48" Pipe, S = .005

Line I
Val Vista Road - McDowell Road
to Baseline Floodway

EXPECTED FLOWS 2 **year rainfall intensity and duration unless noted**
Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES: Total Area A*	Pervious Area A_p	Imperv's Area A_i *	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Min. t_c	RAIN: Point Intensity I	Average Intensity Ia	RUNOFF: Pervious $(Ia-f_c)0.8$ = Inches	$IaxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$IaxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
I-13 (Int.)	156		27			30	1.4	1.4			1.08	29		
I-13 (Arts.)	4		4			30	2.5	2.5			2.07	8	37	
I-14 (int.)	153		35			30	1.4	1.4				38		
I-14 (Arts.)	4		4			30	2.5	2.5			1.08	8	46	
Sum (Int.)	1990		165			77	0.70	0.68			0.43	71		
Sum (Arts.)	53		53			77	1.25	1.22			0.92	49	120	120, 60" Pipe, S = .0026
I-16 (Int.)	154		0			30	1.4	1.4			1.08	0		
I-16 (Arts.)	4		4			30	2.5	2.5			2.07	8	8	
I-15 (Int.)	146		38			30	1.4	1.4			1.08	41		
I-15 (Arts.)	4		4			30	2.5	2.5			2.07	8	49	
Sum (Int.)	2290		203			83	0.67	0.65			0.41	83		
Sum (Arts.)	61		61			83	1.17	1.13			0.84	51	134	135, 66" Pipe, S = .0015
I-17 (Int.)	150		0			30	1.4	1.4			1.08	0		
I-17 (Arts.)	4		4			30	2.5	2.5			2.07	8	8	
I-18 (Int.)	149		4			30	1.4	1.4			1.08	4		
I-18 (Arts.)	4		4			30	2.5	2.5			2.07	8	12	
Sum (Int.)	2589		207			89	0.63	0.61			0.37	77		
Sum (Arts.)	69		69			89	1.10	1.07			0.78	54	131	140, 66" Pipe, S = .0015
I-20 (Int.)	154		12			40	1.16	1.16			0.86	10		
I-20 (Arts.)	4		4			40	2.1	2.1			1.71	7	17	
I-19 (Int.)	150		5			40	1.16	1.16			0.86	4		
I-19 (Arts.)	4		4			40	2.1	2.1			1.71	7	11	
Sum (Int.)	2893		224			96	0.58	0.56			0.32	72		
Sum (Arts.)	77		77			96	1.02	0.98			0.70	54	126	145, 72" Pipe, S = .001
I-21 (Int.)	140		3			40	1.16	1.16			0.86	3		
I-21 (Arts.)	4		4			40	2.1	2.1			1.71	7	10	
I-22 (Int.)	136		2			30	1.4	1.4			1.08	2		
I-22 (Arts.)	4		4			30	2.5	2.5			2.07	8	10	
Sum (Int.)	3169		229			103	0.55	0.53			0.30	69		
Sum (Arts.)	85		85			103	0.96	0.92			0.65	55	124	150, 78" Pipe, S = .0007 To Retention Basin

Line J
Greenfield Road - University Drive
to Baseline Floodway

EXPECTED FLOWS 2 Year rainfall intensity and duration unless noted
Pervious Areas Excluded

*Area Contributing at Corresponding t_c
Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
J-1 (Interior)	91		5			20	1.8	1.8			1.44	7		
J-1 (Arterials)	3		3			20	3.1	3.1			2.51	8	15	
J-2 (Int.)	164		4			30	1.4	1.4			1.08	4		
J-2 (Arts.)	4		4			30	2.5	2.5			2.07	8	12	
Sum (Int.)	255		9			29	1.45	1.45			1.13	10		
Sum (Arts.)	7		7			29	2.6	2.6			2.16	15	25	25, 30" Pipe, S = .0038
J-4 (Int.)	82		0			20	1.8	1.8			1.44	0		
J-4 (Arts.)	2		2			20	3.1	3.1			2.51	5	5	
J-3 (Int.)	152		5			30	1.4	1.4			1.08	5		
J-3 (Arts.)	4		4			30	2.5	2.5			2.07	8	13	
Sum (Int.)	489		14			37	1.23	1.22			0.92	13		
Sum (Arts.)	13		13			37	2.2	2.18			1.78	23	36	40, 36" Pipe, S = .0038
J-5 (Int.)	206		35			34	1.3	1.3			0.99	35		
J-5 (Arts.)	5		5			34	2.3	2.3			1.89	9	44	
J-6 (Int.)	160		19			30	1.4	1.4			1.08	21		
J-6 (Arts.)	4		4			30	2.5	2.5			2.07	8	29	
Sum (Int.)	855		68			43	1.10	1.09			0.80	54		
Sum (Arts.)	22		22			43	1.98	1.96			1.58	35	89	90, 54" Pipe, S = .002
J-8 (Int.)	150		5			30	1.4	1.4			1.08	5		
J-8 (Arts.)	4		4			30	2.5	2.5			2.07	8	13	
J-7 (Int.)	160		3			33	1.34	1.34			1.03	3		
J-7 (Arts.)	4		4			33	2.4	2.4			1.98	8	11	
Sum (Int.)	1165		76			49	1.01	0.99			0.71	54		
Sum (Arts.)	30		30			49	1.80	1.77			1.41	42	96	100, 60" Pipe, S = .0015
J-9 (Int.)	155		4			40	1.16	1.16			0.86	3		
J-9 (Arts.)	4		4			40	2.1	2.1			1.71	7	10	
J-10 (Int.)	154		8			40	1.16	1.16			0.86	7		
J-10 (Arts.)	4		4			40	2.1	2.1			1.71	7	14	
Sum (Int.)	1474		88			56	0.92	0.90			0.63	55		
Sum (Arts.)	38		38			56	1.60	1.57			1.23	47	102	105, 60" Pipe, S = .0015
J-12 (Int.)	140		7			30	1.4	1.4			1.08	8		
J-12 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
J-11 (Int.)	123		6			30	1.4	1.4			1.08	6		
J-11 (Arts.)	4		4			30	2.5	2.5			2.07	8	14	
Sum (Int.)	1737		101			63	0.83	0.81			0.55	55		
Sum (Arts.)	46		46			63	1.50	1.46			1.13	52	107	110, 72" Pipe, S = .0006

Line K

Higley Rd. - 1/2 Mile South of Broadway to Superstition Freeway, West to Line J

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency

Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$I_n x A_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$I_n x A_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
K-2 (Interior)	149		8			30	1.4	1.4			1.16	9		
K-2 (Arterials)	4		4			30	2.5	2.5			2.07	8	17	20, 30" Pipe, S = .002
K-3 & 4 (Int.)	191		6			40	1.16	1.16			0.86	5		
K-3 & 4 (Arts.)	4		4			40	2.1	2.1			1.71	7	12	
Sum (Int.)	340		14			41	1.14	1.14			0.85	12		
Sum (Arts.)	8		8			41	2.02	2.02			1.64	13	25	25, 30" Pipe, S = .0042
K-5 (Int.)	100		5			20	1.8	1.8			1.44	7		
K-5 (Arts.)	1		1			20	3.1	3.1			2.61	3	10	
K-6 (Int.)	92		3			20	1.8	1.8			1.44	4		
K-6 (Arts.)	4		4			20	3.1	3.1			2.61	10	14	
Sum (Int.)	532		22			48	1.02	1.01			0.73	16		
Sum (Arts.)	13		13			48	1.80	1.78			1.42	18	34	35, 33" Pipe, S = .0042
J-12 (Int.)	140		7			30	1.4	1.4			1.08	8		
J-12 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum (Int.) K-2 thru K-6 & J-12	672		29			55	0.92	0.91			0.64	19		
Sum (Arts.)	17		17			55	1.62	1.60			1.26	21	40	40, 33" Pipe, S = .0081
K-Line	532		22											
	13		13											
J-Line	1737		101											
	46		46											
Sum	2269		123			58	0.88	0.85			0.59	73		
	59		59			58	1.56	1.51			1.18	70	143	145, 72" Pipe, S = .001 To Retention Basin

Line L
Baseline Road - Between Eastern Canal
and R.W.C.D. Canal

EXPECTED FLOWS 2- **year rainfall intensity and duration unless noted**

Pervious Areas Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$I_a x A_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$I_a x A_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
K-8 & L-1 (Int.)	166		8			30	1.4	1.4			1.08	9		
K-8 & L-1 (Arts.)	5		5			30	2.5	2.5			2.07	10	19	
K-7 (Int.)	131		2			30	1.4	1.4			1.08	2		
K-7 (Arts.)	4		4			30	2.5	2.5			2.07	8	10	
Sum K-7 & K-8 & L-1 (Int.)	297		10			36	1.25	1.25			0.95	10		
Sum K-7 & K-8 & L-1 (Arts.)	9		9			36	2.25	2.25			1.85	17	27	30, 33" Pipe, S = .0044
J-13 - Arterials Only	4		4			30	2.5	2.5			2.07	8	8	
Sum J-13, K-7, & K-8 & L-1 (Int.)	297		10			42	1.12	1.12			0.83	8		
Sum J-13, K-7, & K-8 & L-1 (Arts.)	13		13			42	2.0	2.0			1.62	21	29	35, 36" Pipe, S = .0035 To Retention Basin

Freeway Channel
Alma School Road to Tempe Canal

EXPECTED FLOWS 2-year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
From Line C														
Sum (Int.)	1024		296			68	0.77	0.76			0.5	148		
Sum (Arts.)	32		32			68	1.36	1.34			1.03	33	181	190, Channel
B-16 (Int.)	135		0									0		
B-16 (Arts.)	4		4			40	2.10	2.10			1.71	7	7	
Sum (Int.)	1159		296			83	0.67	0.66			0.41	121		
Sum (Arts.)	36		36			83	1.18	1.16			0.86	31	152	195, Channel
B-15 (Int.)	121		12			40	1.16	1.16			0.86	10		
B-15 (Arts.)	4		4			40	2.1	2.1			1.71	7	17	
Sum (Int.)	1280		308			98	0.58	0.57			0.33	101		
Sum (Arts.)	40		40			98	1.00	0.98			0.70	28	129	200, Channel
A-7 (Int.)	55		6			50	1.0	1.0			0.72	4		
A-7 (Arts.)	2		2			50	1.75	1.75			1.40	3	7	
Sum Along Canal (Int.)	1335		314			108	0.52	0.51			0.28	88		
Sum Along Canal (Arts.)	42		42			108	0.90	0.88			0.61	26	114	205, Channel

Tempe Canal Channel

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

EXPECTED FLOWS 2-**year rainfall intensity and duration unless noted**

Pervious Areas Excluded

LOCATION	AREA IN ACRES Total Area A^*	Pervious Area A_p	Imperv's Area A_i^*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Line B-1 Sum (Int.)	746		138			53	0.95	0.94			0.67	92		
Sum (Arts.)	22		22			53	1.69	1.67			1.32	29	121	
A-6 (Int.)	113		23			90	0.63	0.63			0.39	9		
A-6 (Arts.)	3		3			90	1.08	1.08			0.79	2	11	
Sum (Int.)	859		161			53	0.95	0.94			0.67	108		
Sum (Arts.)	25		25			53	1.69	1.67			1.32	33	141	140, Channel
Freeway Channel at Canal														
Sum (Int.)	1335		314			108	0.52	0.51			0.28	88		
Sum (Arts.)	42		42			108	0.90	0.88			0.61	26	114	220
Sum at longer time (Int.)	2194		475			108	0.52	0.51			0.28	133		
(Arts.)	67		67			108	0.90	0.88			0.61	41	174	
Sum at average time (Int.)	2194		475			90	0.63	0.62			0.38	181		
(Arts.)	67		67			90	1.08	1.06			0.77	52	233	235, Channel

Existing Main Street Storm Drain

EXPECTED FLOWS 2-year rainfall intensity and duration unless noted

Pervious Areas Excluded

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

LOCATION	AREA IN ACRES Total Area A*	Pervious Area A_p	Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
G-14 (Int.)	125		36			30	1.4	1.4			1.08	39		
G-14 (Arts.)	4		4			30	2.5	2.5			2.07	8	47	Capacity = 50
G-15 (Int.)	132		7			30	1.4	1.4			1.08	8		
G-15 (Arts.)	4		4			30	2.5	2.5			2.07	8	16	
Sum (Int.)	257		43			40	1.16	1.16			0.86	37		
Sum (Arts.)	8		8			40	2.1	2.1			1.71	14	51	Capacity = 85
F-13 (Int.)	123		54			30	1.4	1.4			1.08	58		
F-13 (Arts.)	4		4			30	2.5	2.5			1.71	6	64	
Sum (Int.)	380		97			47	1.03	1.02			0.74	72		
Sum (Arts.)	12		12			47	1.85	1.84			1.48	18	90	Capacity = 125
F-14 (Int.)	152		33			40	1.16	1.16			0.86	28		
F-14 (Arts.)	4		4			40	2.1	2.1			1.71	7	35	
Sum (Int.)	532		130			54	0.93	0.93			0.66	86		
Sum (Arts.)	16		16			54	1.65	1.64			1.30	21	107	Capacity = 140
E-13 (Int.)	132		48			50	1.0	1.0			0.72	35		
E-13 (Arts)	4		4			50	1.75	1.75			1.40	6	41	
Sum (Int.)	664		178			62	0.83	0.82			0.56	100		
Sum (Arts.)	20		20			62	1.50	1.49			1.16	23	123	Capacity = 170
E-14 (Int.)	132		38			50	1.0	1.0			0.72	27		
E-14 (Arts.)	4		4			50	1.75	1.75			1.40	6	33	
Sum (Int.)	796		216			62	0.83	0.82			0.56	122		
Sum (Arts.)	24		24			62	1.50	1.49			1.16	28	150	Capacity = 170
D-13 (Int.)	131		58			50	1.0	1.0			0.72	42		
D-13 (Arts.)	4		4			50	1.75	1.75			1.40	6	48	
Sum (Int.)	927		274			71	0.75	0.74			0.49	135		
Sum (Arts.)	28		28			71	1.26	1.25			0.95	27	162	Capacity = 170
D-12 (Int.)	128		60			50	1.0	1.0			0.72	43		
D-12 (Arts.)	4		4			50	1.75	1.75			1.40	6	49	
Sum (Int.)	1055		334			89	0.62	0.61			0.37	124		
Sum (Arts.)	32		32			89	1.09	1.07			0.78	25	149	Capacity = 190
C-10 (Int.)	129		64			40	1.16	1.16			0.86	55		
C-10 (Arts.)	4		4			40	2.1	2.1			1.71	7	62	
Sum (Int.)	1184		398			98	0.57	0.56			0.32	128		
Sum (Arts.)	36		36			98	1.0	0.99			0.71	26	154	Capacity = 190

Existing Main Street Storm Drain

*Area Contributing at Corresponding t_c

Int. - Interior Areas, 2-Year Frequency
Arts. - Arterials, 10-Year Frequency

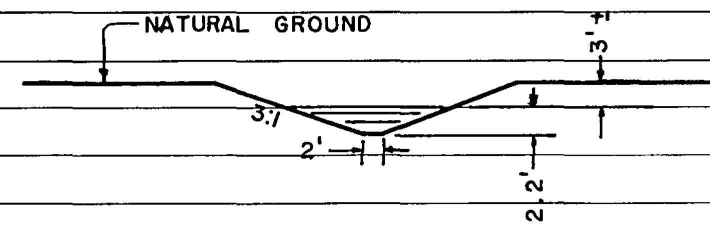
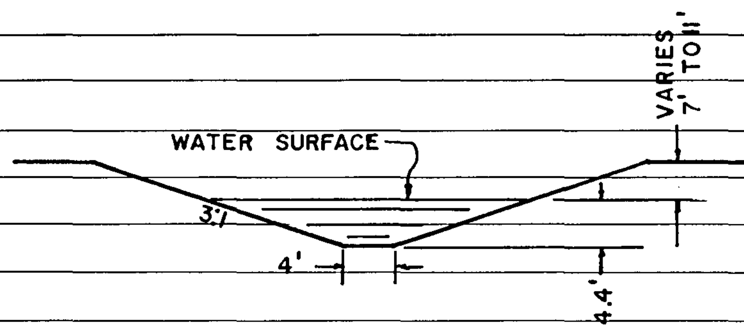
EXPECTED FLOWS 2- year rainfall intensity and duration unless noted

Pervious Areas Excluded

LOCATION	AREA IN ACRES: Total Area A *	AREA IN ACRES: Pervious Area A_p	AREA IN ACRES: Imperv's Area A_i*	Infiltr'n (final) in/hr f_c	Concentration Time: Street Slope	Concentration Time: Min. t_c	RAIN: Point Intensity I	RAIN: Average Intensity Ia	RUNOFF Pervious: $(Ia-f_c)0.8$ = Inches	RUNOFF Pervious: IxA_p = CFS	RUNOFF Impervious: (Ia-0.2)0.9 = Inches	RUNOFF Impervious: IxA_i =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
C-11 (Int.)	135		36			40	1.16	1.16			0.86	31		
C-11 (Arts.)	4		4			40	2.1	2.1			1.71	7	38	
Sum at Alma School Road & Main (Int.)	1319		434			107	0.53	0.52			0.29	126		
Sum at Alma School Road & Main (Arts.)	40		40			107	0.93	0.91			0.64	26	152	Capacity = 190
C-9 (Int.)	129		33			40	1.16	1.16			0.86	28		
C-9 (Arts.)	4		4			40	2.1	2.1			1.71	7	35	
C-8 (Int.)	149		25			60	0.86	0.86			0.59	15		
C-8 (Arts.)	4		4			60	1.52	1.52			1.19	5	20	
Sum at Alma School Road & University (Int.)	1597		492			116	0.50	0.49			0.26	128		
Sum at Alma School Road & University (Arts.)	48		48			116	0.86	0.84			0.58	28	156	Capacity = 190
C-6 (Int.)	143		35			40	1.16	1.16			0.86	30		
C-6 (Arts.)	4		4			40	2.1	2.1			1.71	7	37	
Sum at Alma School Road & 8th Street (Int.)	1740		527			125	0.47	0.46			0.23	121		
Sum at Alma School Road & 8th Street (Arts.)	52		52			125	0.80	0.79			0.53	28	149	Capacity = 190
C-7 (Int.)	200		46			20	1.8	1.8			1.44	66		
C-7 (Arts.)	4		4			20	3.1	3.1			2.61	10	76	
Sum at Alma School Road & Tempe Canal (Int.)	1940		573			132	0.45	0.44			0.22	126		
Sum at Alma School Road & Tempe Canal (Arts.)	56		56			132	0.77	0.76			0.50	28	154	Capacity = 190

AREA DESCRIPTION Trapezoidal Channel along North side of Proposed Superstition Freeway - Extension Road to Tempe Canal Channel

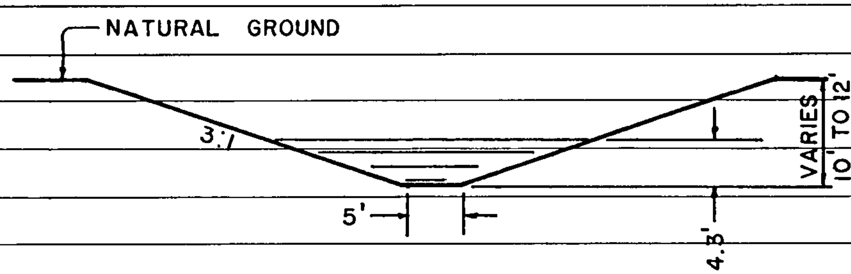
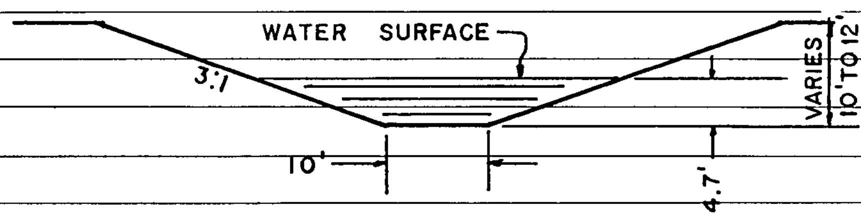
n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

STA. OR LOCATION	WATERWAY DESCRIPTION	Roughness n	Slope Ft. Per 1000	Area Sq.Ft. A	p = Wet Per r = A/p	Vel. Ft./Sec V	Quant. c.f.s. Q
Extension Rd. to Alma School Road		.025	1.2	18.9	15.9 1.19	2.3	44
Alma School Rd. to Tempe Canal		.025	0.70	75.7	31.8 2.38	2.8	212

Yost and Gardner Engineers

AREA DESCRIPTION Trapezoidal Channel along East side of Tempe Canal - Southern Avenue to Western Canal

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

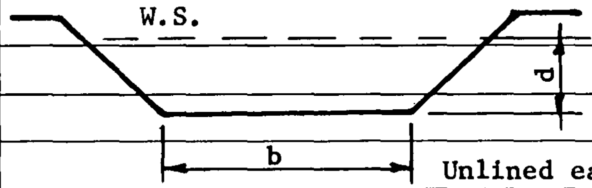
STA. OR LOCATION	WATERWAY DESCRIPTION	Roughness n	Slope Ft. Per 1000	Area Sq.Ft. A	p = Wet Per r = $\frac{A}{p}$	Vel. Ft./Sec V	Quant. c.f.s. Q
Southern Ave. to Proposed Superstition Freeway		.025	.32	77	32.2 2.39	1.9	146
Proposed Superstition Freeway to Western Canal		.025	.32	113	39.7 2.84	2.14	242

Yost and Gardner Engineers

AREA DESCRIPTION Eastern Canal Floodway

Trapezoidal Channel with 2:1 Bank Slope

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams



STA. OR LOCATION	WATERWAY DESCRIPTION	Rough-ness n	Slope Ft.Per 1000	Area Sq.Ft. A	p =Wet Per r = A/P	Vel. Ft./Sec V	Quant. c.f.s. Q
Brown Rd.	Try b = 50' d = 9.1	0.025	0.33			3.89	2380
Q = 2380	Total width (+12' road) = 108.4						
	Try b = 40 d = 10.0	0.025	0.33			3.98	2389
	Total width = 102.0						
	Try b = 30 d = 13.3	0.025	0.33			3.20	2412
	Total width = 95.2						
Baseline Rd.	Try b = 80' d = 9.6	0.025	0.33			4.23	4025
Q = 4030	Total width = 140.2						
	Try b = 70 d = 10.3	0.025	0.33			4.33	4044
	Total width = 133.2						
	Try b = 60 d = 11.1	0.025	0.33			4.43	4046
	Total width = 116.4						

Yost and Gardner Engineers

AREA DESCRIPTION Eastern Canal Floodway

Trapezoidal Channel With 6:1 Bank Slope

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

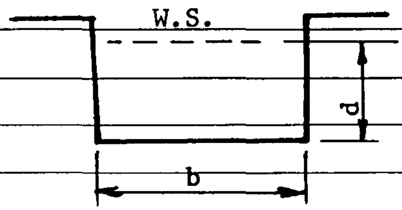
STA. OR LOCATION	WATERWAY DESCRIPTION		Rough-ness n	Slope Ft.Per 1000	Area Sq.Ft. A	p =Wet Per $r = \frac{A}{p}$	Vel. Ft./Sec V	Quant. c.f.s. Q
Brown Rd.	Try b = 50'	d = 9.1'	0.035	0.33			2.54	2414
	Total width =	201.2						
	Try b = 40	d = 9.7	0.035	0.33			2.55	2433
	Total width =	198.4						
	Try b = 30	d = 10.2	0.035	0.33			2.57	2389
	Total width =	194.4						
Baseline Rd.	Try b = 80	d = 10.2	0.035	0.33			2.83	4025
	Total width =	244.4						
	Try b = 70	d = 10.6	0.35	0.33			2.86	4059
	Total width =	239.2						
	Try b = 60	d = 11.1	0.35	0.33			2.87	4043
	Total width =	235.2						

Yost and Gardner Engineers

AREA DESCRIPTION Eastern Canal Floodway

Rectangular Channel

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

STA. OR LOCATION	WATERWAY DESCRIPTION	Rough-ness n	Slope Ft. Per 1000	Area Sq. Ft. A	p = Wet Per $r = \frac{A}{p}$	Vel. Ft./Sec V	Quant. c.f.s. Q
	 2' Freeboard Reinforced concrete walls and bottom						
N. End	Try b = 30' d = 7.9	0.012	0.33			6.73	1595
Q = 1570	25 d = 9.2	0.012	0.33			6.84	1572
	20 d = 11.5	0.012	0.33			6.88	1582
S. End	Try b = 40' d = 11.8	0.012	0.33			8.56	4039
Q = 4030	35 d = 13.3	0.012	0.33			8.66	4032
	30 d = 15.5	0.012	0.33			8.71	4051
Add 20'	for structure & maintenance road for minimum R/W width						

Yost and Gardner Engineers

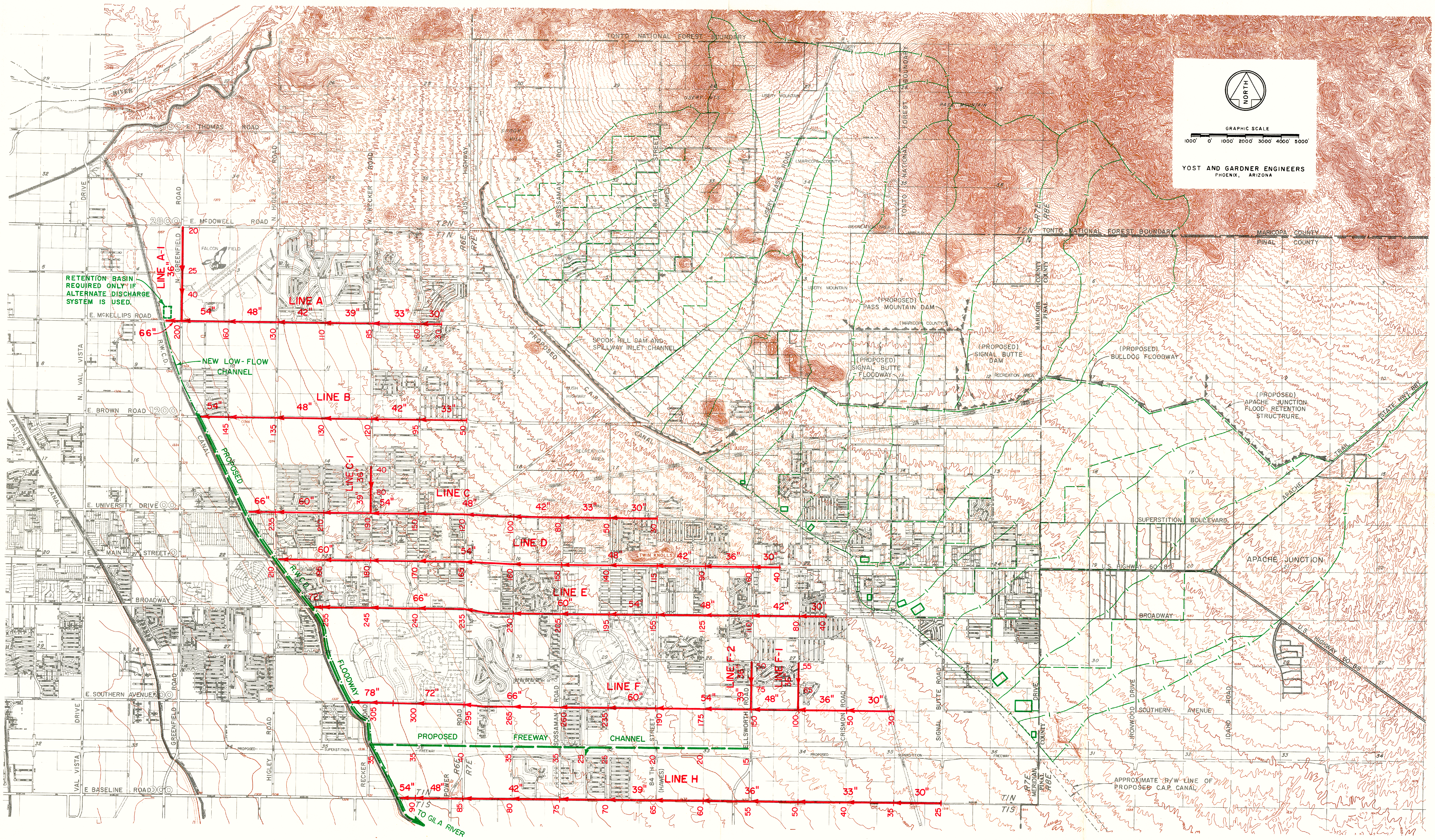
AREA DESCRIPTION Consolidated Canal Floodway

Rectangular Channel

n = 0.011 Big Concrete Culverts
n = 0.012 Pipe Culverts 21" & Larger
n = 0.014 Concrete Lined Channels
n = 0.015 Street Paving
n = 0.020 Earth - Best
n = 0.0225 Corr. Culverts
n = 0.030 Earth - Brushy - Poor
n = 0.050 Rocky Streams

STA. OR LOCATION	WATERWAY DESCRIPTION		Rough-ness n	Slope Ft.Per 1000	Area Sq.Ft. A	p =Wet Per r = A/P	Vel. Ft./Sec V	Quant. c.f.s. Q
N. End	Try b = 30'	d = 6.7'	0.012	0.33			6.25	1256
Q = 1256	b = 25	d = 7.9	0.012	0.33			6.43	1271
	b = 20	d = 9.7	0.012	0.33			6.51	1263
	b = 15	d = 13.2	0.012	0.33			6.38	1264
S. End	Try b = 40'	d = 9.7'	0.012	0.33			7.86	3050
Q = 3010	b = 35	d = 10.8	0.012	0.33			7.98	3015
	b. = 30	d = 12.5	0.012	0.33			8.09	3033

Yost and Gardner Engineers

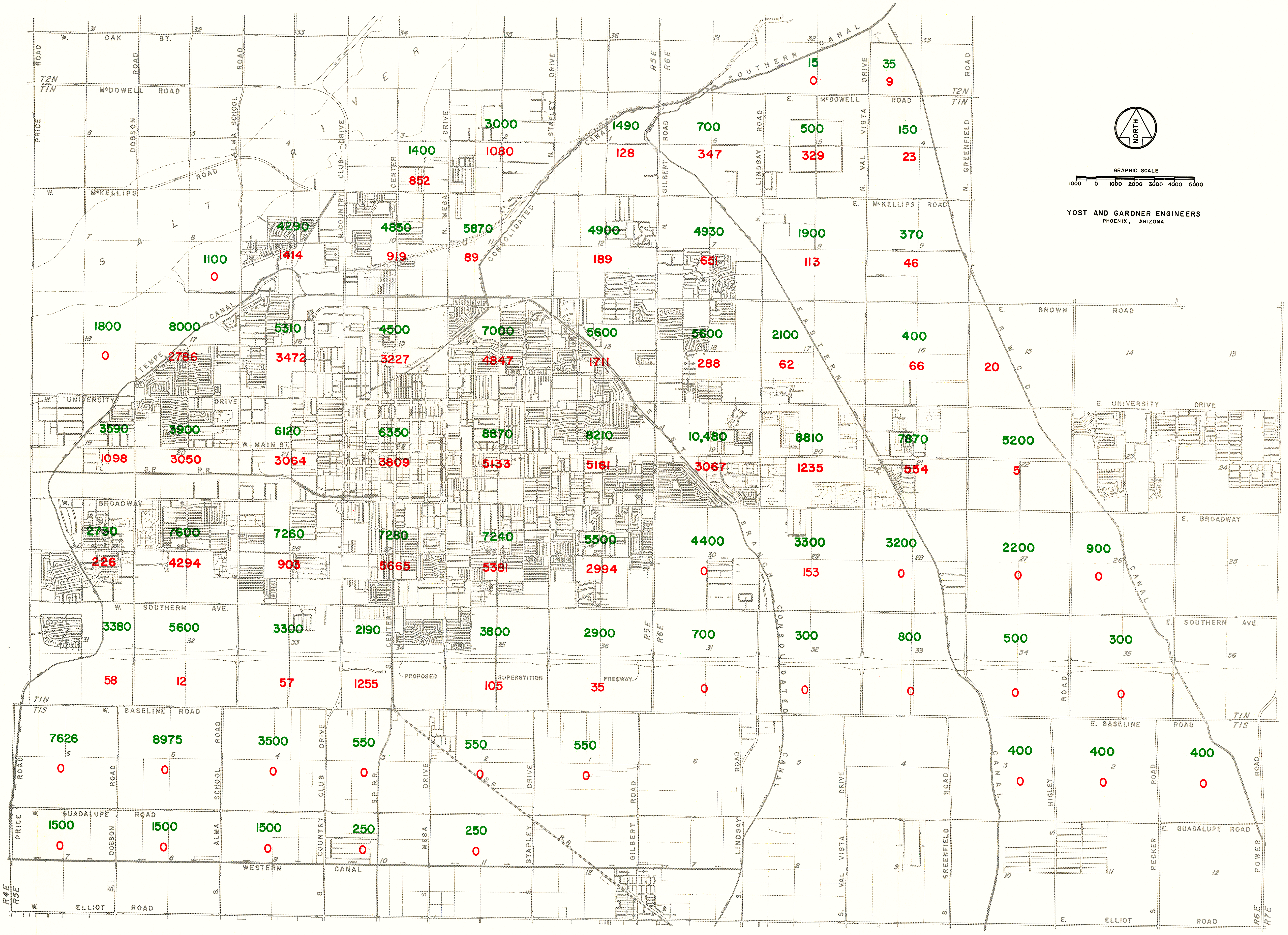


LEGEND

LINE B	LINE DESIGNATION
48"	PIPE SIZE
	NEW PIPE
130 / 120	DESIGN FLOW IN C.F.S. NOTE: FLOWS SHOWN AT JUNCTIONS ARE FOR PEAK QUANTITY LEAVING.
	FUTURE RETENTION BASIN
	PROPOSED DRAINAGE CHANNEL
	NEW LOW-FLOW CHANNEL
	DRAINAGE AREA BOUNDARY
	FUTURE TRUNK DRAIN

PROPOSED STORM DRAINAGE SYSTEMS EAST OF R.W.C.D. CANAL CITY OF MESA

PLATE II



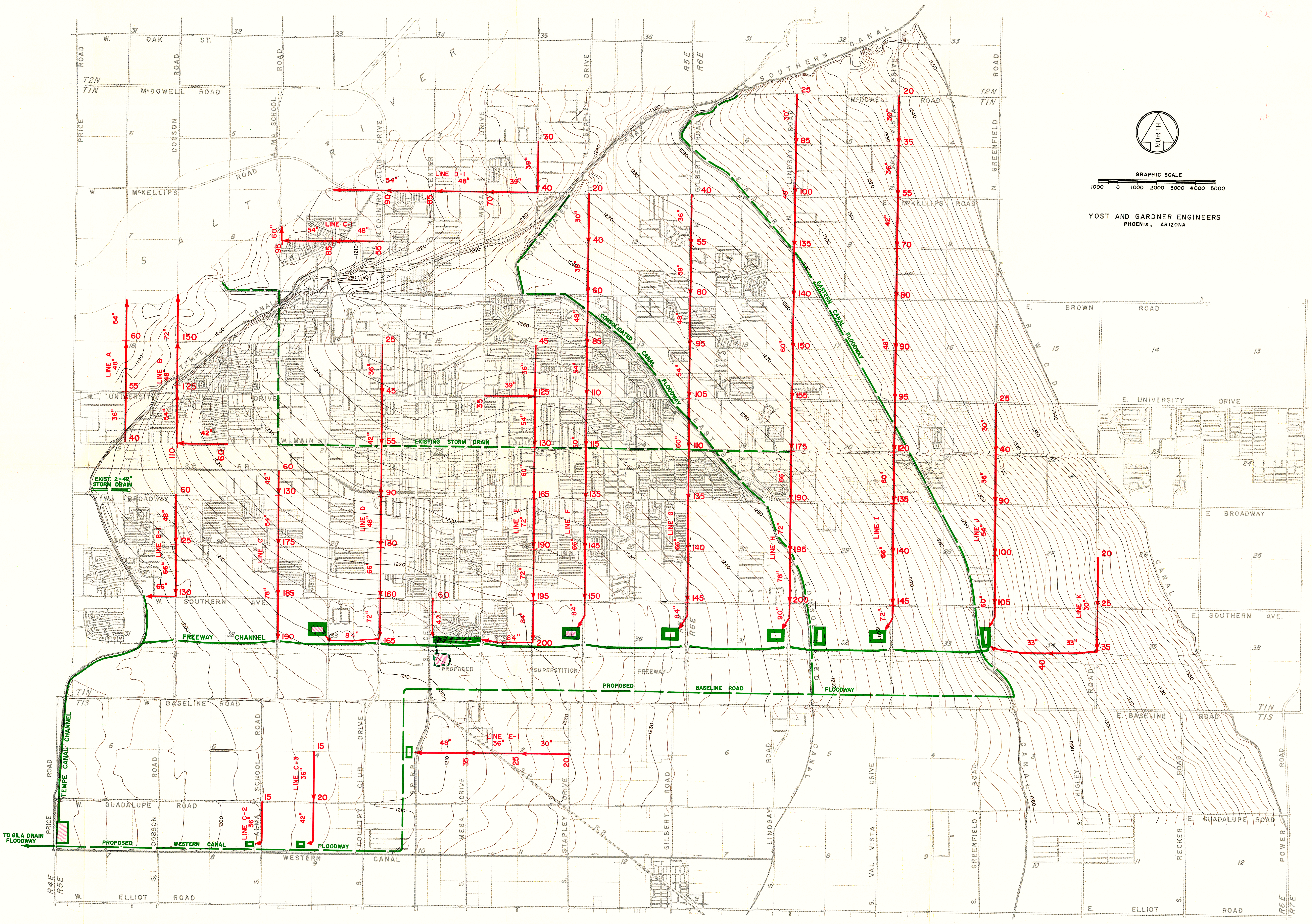
LEGEND

1255 1970 CENSUS POPULATION

2190 1995 MAG TRANSPORTATION AND PLANNING PROGRAM

PRESENT AND PROJECTED POPULATION DISTRIBUTION

PLATE A



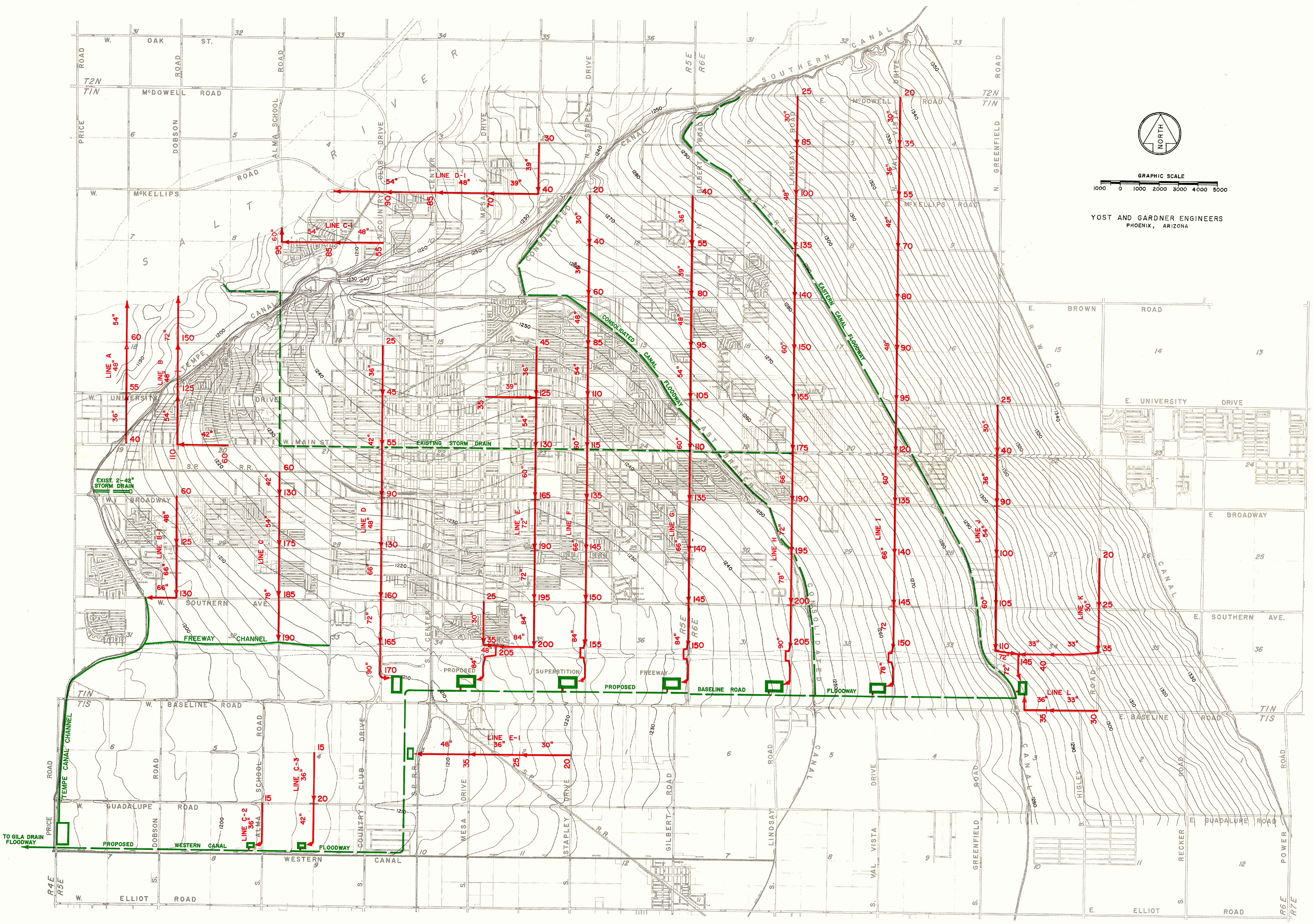
LINE A — LINE DESIGNATION
DESIGN FLOW IN C.F.S.
45 25
36"
NEW PIPE
PIPE SIZE

NOTE: FLOWS SHOWN AT JUNCTIONS ARE FOR PEAK QUANTITY LEAVING

RETENTION BASIN

PROPOSED STORM DRAINAGE SYSTEMS
CITY OF MESA

PLATE B-1



LINE A — LINE DESIGNATION

45 25 — DESIGN FLOW IN C.F.S.

36" — NEW PIPE

PIPE SIZE

NOTE: FLOWS SHOWN AT JUNCTIONS ARE FOR PEAK QUANTITY LEAVING

RETENTION BASIN

PROPOSED STORM DRAINAGE SYSTEMS CITY OF MESA

PLATE B