CITY OF PHOENIX, ARIZONA

SOUTHEAST PHOENIX STORM DRAINAGE STUDY

Project No. ST-71181.00

YOST AND GARDNER ENGINEERS

Phoenix, Arizona

July 1, 1972

Nº 60

CITY OF PHOENIX
ARIZONA

ENGINEERING DEPARTMENT • 700 MUNICIPAL BUILDING • 251 WEST WASHINGTON • PHOENIX, ARIZONA 85003

December 7, 1972

Yost & Gardner Engineers
2619 North 3rd Street
Phoenix, Arizona 85004

Attention Mr. John Schaeffer, P.E.

Gentlemen:

Southeast Phoenix Storm Drain Study,
Project No. ST-71181.00

We have received the final copies of this report and find it acceptable, with the following reservations:

1. We do not agree with the priority given to the collector trunk on Broadway Road. A field inspection indicates that development in the area to be served by this line has not progressed as far as in areas to be served by the 24th Street, 16th Street and 7th Street lines. The existing development dictates that these three lines should be constructed first, while construction of the remainder must take a lower priority in our total drainage needs program.

2. It is our intention that trunk lines should extend under and beyond the Western Canal to pick up stormwater to the south, and that turnout structures should be constructed at all canal crossings to allow floodwaters to be diverted to the storm drain.

3. The concept of trunk lines spaced at one mile intervals and designed for a two year frequency has been adopted for the subject study area. It is reasonable for this area since there is little continuity to the collector street system in the study area. Where this concept is in conflict with previous studies or design manuals issued by the Engineering Department, this study shall prevail.

A copy of this letter is to be stapled to the inside front cover of each report.

Very truly yours,

J. E. Attebery

JFB:rmb

J. E. Attebery, P.E.
City Engineer

CITY OF PHOENIX, ARIZONA

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2619 NORTH THIRD STREET
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HAROLD W. YOST
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July 1, 1972

Mr. James E. Attebery, City Engineer
700 Municipal Building
251 West Washington Street
Phoenix, Arizona 85003

Re: City of Phoenix Project No. ST-71181.00
Contract No. 12890

Dear Sir:

With this letter, we respectfully submit our report and recommendations for a storm drainage construction program for the southeastern section of Phoenix. We propose a system designed for a two-year recurrence interval having north-south trunk drains on section line roads. Each trunk would have its own lateral system, and its own terminus at the Salt River, except that those east of 24th Street would be picked up by a large main on Broadway Road. The Broadway Road line would reach the river by an extension of 30th Street for which new right-of-way would be required.

Our estimate of the total cost of the proposed construction is $7,943,200 at current prices for labor and materials.

Very truly yours,

YOST AND GARDNER ENGINEERS

By
J. E. Schaefer

Registered Professional Engineer (Civil)
CERTIFICATE NO.
1517
JOHN E.
SCHAEFER
Date Signed 7/1/72
ARIZONA, U.S.A.

JES:fp

Contents

List of Figures

List of Tables

PLATES

1. Summary

1.1 Background and Purpose

The drainage of the area between the Salt River and the South Mountains has been given consideration in the following reports:

Ref. No.	Title	Agency	Date
1.	Phoenix Storm Drainage Report	City of Phoenix	1956
2.	Flood Control Survey Report, Northeastern Maricopa County	Flood Control District of Maricopa County	1962
3.	Comprehensive Flood Control Program Report	Flood Control District of Maricopa County	1963
4.	Storm Drainage Report	Maricopa Association of Governments	1970
5.	Watershed Work Plan - Guadalupe Watershed	Soil Conservation Service USDA	1971

References 2, 3, and 5 are flood control studies concerned with major channels and with runoff from mountainous areas. Ref. 1 was written 15 years ago when Phoenix had about 25 percent of its present population. This study dealt only in a cursory manner with drainage south of the river, and was predicated upon contour information from the U. S. Reclamation Service Map of 1902-3.

The Maricopa Association of Governments report, Ref. 4, presented results of a very general study covering an area of 480 square miles. It utilized 10-foot contour information from 1:24,000 scale U. S. Geological Survey maps made in the 1960's. It recommended two storm drainage trunks for the area south of the Salt River and east of 7th Street, each of which was divided approximately one mile above its outlet into two main branches. (Ref. 4, Plate G, Lines VI-11 to VI-13).

Recently the City of Phoenix has completed mapping the area between Broadway and Baseline Roads to a 2-foot contour interval to facilitate planning for the area. Other areas have been mapped to 2-foot and 5-foot contour intervals by the Flood Control District of Maricopa County.

Completion of the Maricopa and Superstition Freeways and Interstate Route I-10 in the vicinity has given impetus to the conversion of a portion of the area from agricultural and low density - low value residential uses to extensive new industrial and warehousing operations. New and higher density residential developments are also beginning to appear in areas which were projected as agricultural in the City of Phoenix Planning Department's 1990 Comprehensive Plan.

These developments, and the extensive street paving that accompanies them, suggest that it is proper to begin the detailed planning and construction of storm drains. The purpose of this study is to utilize the newer, more detailed topographical information that has just become available to select the best locations for trunk storm drains to serve the area, giving due consideration to right-of-way requirements and possible conflicts with other utility systems. The study also develops the hydraulic design factors, suggests pipe sizes, and makes preliminary cost estimates for the purpose of budgeting capital funds.

The report includes overall profiles for the trunk lines, used for the purpose of sizing pipe, establishing vertical clearance requirements, and estimating excavation quantities. It is not possible to provide here all the information required for construction, but the preparation of plans at the time the City is ready to build should be facilitated by the data provided.

1.2 Summary and Recommendations

The following is a brief recapitulation of the body of this report which sets forth some of its principal conclusions and recommendations.

1.2.1 Hydrology. The studies for this report were confined to an area bounded by the Salt River and Interstate Route 10 on the north, Route I-10 on the east, the South Mountain divide on the south, and 7th Street on the west. They attempt to see the area as it might be in the year 1990 when it is expected to be completely urban in character, with a typically urban variety of land uses.

Consideration is given to flood control projects being planned by the U.S. Army Corps of Engineers and the Soil Conservation Service in cooperation with the Flood Control District of Maricopa County. It is concluded that drainage projects as recommended may proceed independently of the flood control projects.

Rainfall intensity-duration-frequency relations are adopted from data published by the National Weather Service as adapted in the Phoenix area in the Maricopa Association of Governments Storm Drainage Report (Ref. 4). A two-year recurrence interval is chosen for the design storm because in many cases rights-of-way are not available for future paralleling of a system designed for a one-year storm (which has been the design basis for Phoenix drains north of the river). Street pavements will play an important part in the drainage system operation, being considered as collector channels up to the point where only one traffic lane in each direction is above the water surface.

Soils, infiltration rates, and land uses are considered but, for the relatively low intensity two-year storm, it is concluded that drainage design need be concerned only with runoff from the street system and adjacent impervious areas.

It is a recommendation of this report that the City provide instrumentation and data collection facilities for the detailed study of the performance of one of its completed drainage trunks such as the Seventh Street drain. A history of rainfall intensity variation in its drainage area and the hydrographs of the ensuing discharges would provide a statistical basis for a more modern and more reasonable design methodology that could result in substantial savings. Since such data need to be accumulated over several years because of the infrequent occurrence of measurable rainfall in Phoenix, it is important that this program be initiated as soon as possible.

1.2.2 Runoff Computations. The most recently available contour coverage of the study area was compiled into a base map from which drainage areas of about 160 acres each were delineated. The 2-year runoff from each of these areas was computed by the same modified rational method used in previous Phoenix storm drainage studies and designs. Flows from these areas were combined, with allowance for the attenuating effect of increasing length of drainage path, to arrive at the cumulative flows which the drains would be required to handle. In general required drain capacities vary from about 20 cfs at the head to 180 cfs at the point of last flow increment. The eastern half of the area, however, will all drain to 30th Street and the Salt River where the combined 2-year peak flow will be 455 cfs.

1.2.3 Drainage System. The proposed trunk drain system will require 24.5 miles of pipe ranging from 24 to 90 inches in diameter. Also required is an open trapezoidal channel 1700 feet long. Sizes are predicated on the use of concrete pipe with a Manning's "n" of 0.012. Trunks are located in arterial streets because of the critical need for good drainage in such streets and because adequate right-of-way is available in them. Additional right-of-way will be needed for the channel at the foot of 30th Street and ultimately for the construction of some of the lateral drains on east-west midsection lines.

The trunk drain on 48th Street and Broadway Road (Lines D and G, Plate III) will benefit the City of Tempe as well as Phoenix and it is recommended that an agreement be entered into for sharing the cost of this line.

The drainage system will not provide relief from major storms and the disposition of excessive runoff should always be kept in mind by those planning or having review responsibility for developments in the area. The means are well known and include such measures as keeping natural washes open, providing streets and drainage easements along natural swales, keeping floor levels high, etc.

Utility interferences with the proposed drainage system were considered in the study. Profiles were drawn for the trunk lines to point up the problems. The principal difficulty arises in the case of the Wood Street sanitary sewer and special venturi structures will be necessary to cross this line without affecting invert gradients. The report suggests drain locations for minimum interference based on information presently available. It is strongly recommended that specific horizontal and vertical space allocations be made for each drain trunk as soon as possible and designated as such on City quarter section maps. Such measures at this time could forestall substantial additional future costs arising out of underground interferences. Planning for the proposed southside water transmission main (City of Pheonix Project No. W-67063.00(B.I.))should be reviewed for this purpose and final construction drawings should keep the storm drain crossing zones clear.

1.2.4 Priorities and Costs. An evaluation of the factors that influence construction priorities from an engineering standpoint leads to the recommendation that the northern portion of each trunk be built first, both to permit immediate use of the new lines and because it is there that needs are greatest.

The Seventh Street trunk from Southern Avenue to the Salt River is given first priority, followed by lines in Broadway Road from 48th Street to the river, 24th Street from Southern Avenue to the river, and 16th Street from Southern Avenue to the river. The upper portions of the trunks and laterals would follow, approximately in the order given on page 70.

Estimated costs for each trunk drain system, evaluated at labor and material costs of July 1, 1972, are as follows:

Line A	7th St. trunk & laterals	$1,374,600
Line B	16th St. trunk & laterals	1,216,300
Line C	24th St. trunk & laterals	1,271,500
Line D	Broadway Rd. & 30th St.	1,694,900
Line E	32nd St. trunk & laterals	1,096,900
Line F	40th St. trunk & laterals	855,000
Line G	48th St. trunk only	434,000
TOTAL ESTIMATED PROGRAM COSTS		$7,943,200

These totals include allowances for engineering, contingencies, and incidental costs but no right-of-way costs have been included.

2. Hydrology and Basic Design Information

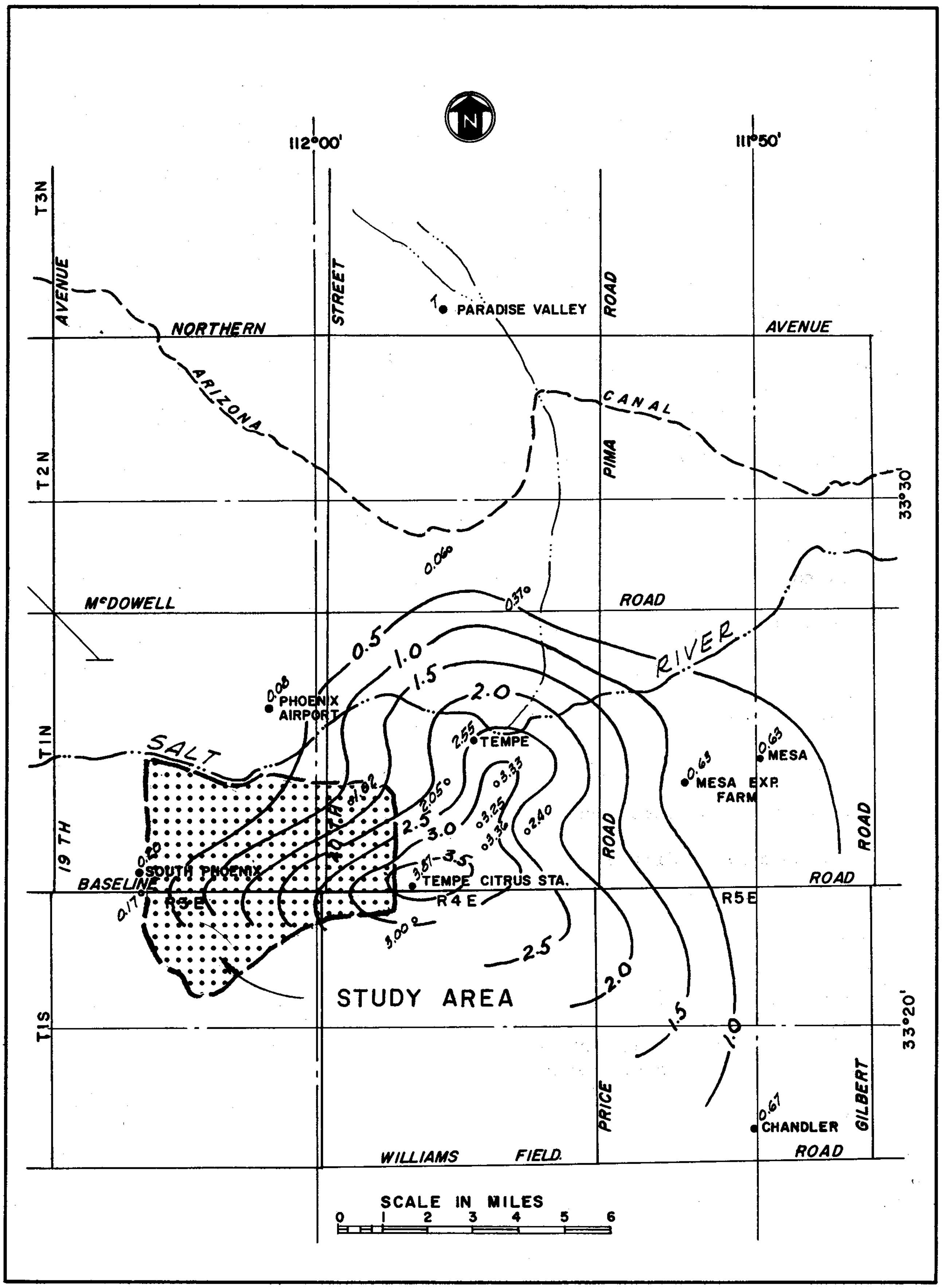
This section will set forth the basic information necessary for the planning of a storm drainage system on a consistent and, as nearly as possible, on a rational basis. Attention is given to the relationship that has been experienced locally between the frequency, duration, and severity of rainstorms. A study of ground contours and street pattern is made to ascertain the way in which runoff collects and the velocity with which it flows on its way to the river. Attention is given to the absorbent properties of the various types of soils found in the area. The extent to which soil is exposed to rainfall is accounted for by pervious/impervious area ratios which have been related to the uses to which land is or will be put. Finally, the man-made flood control or major drainage works presently in the planning stage are investigated to determine how they influence the upper and lower extremities of the systems to be provided to handle the storm drainage of the area.

It is obvious that there are many uncertainties and approximations in the so-called "rational" method of storm drainage system design. The method does attempt, however, to take into account as many of the measurable factors that influence rate of runoff as possible and it has in past practice produced a drainage system that serves Phoenix reasonably well at a moderate cost. The average cost per squre mile for storm drainage trunks, collectors, and laterals (omitting only catch basins and gutter inlets which are usually considered a part of paving costs) in the Phoenix area is about $450,000[1].

This is not to say that refinements in design methods are not possible or desirable. They should, however, be based on local experience with the rainfall-runoff relationship. Several Phoenix drains are provided with a substantially complete system of laterals and inlets. The drainage areas are well mapped and photographed so all parameters may be accurately evaluated. Instrumentation remains necessary to provide data on rainfall intensities and drain discharge hydrographs. A few years spent accumulating and studying such data would permit a critical evaluation of present criteria and could possibly result in substantial ultimate savings in storm drain construction costs.

Fig. 2.1 is included because it illustrates the nature of the severe, extremely local storms that can be expected in the Salt River Valley. While this was worse than the 100-year storm for the point of maximum rainfall (where the rain lasted less than one hour) there was surprisingly little damage. The Highline Canal was reported to have overtopped, but there was no sign the next morning that any flow had gone over the north bank of the Western Canal between 40th and 48th Streets. High water marks indicated a flow depth of 4.5 feet in the wash crossing Baseline Road east of 40th Street.

[1]Updated estimates from Ref. 4 for the one-year storm.



ISOHYETAL MAP FOR TEMPE STORM OF SEPTEMBER 14, 1969

FIGURE 2.1

2.1 The Study Area

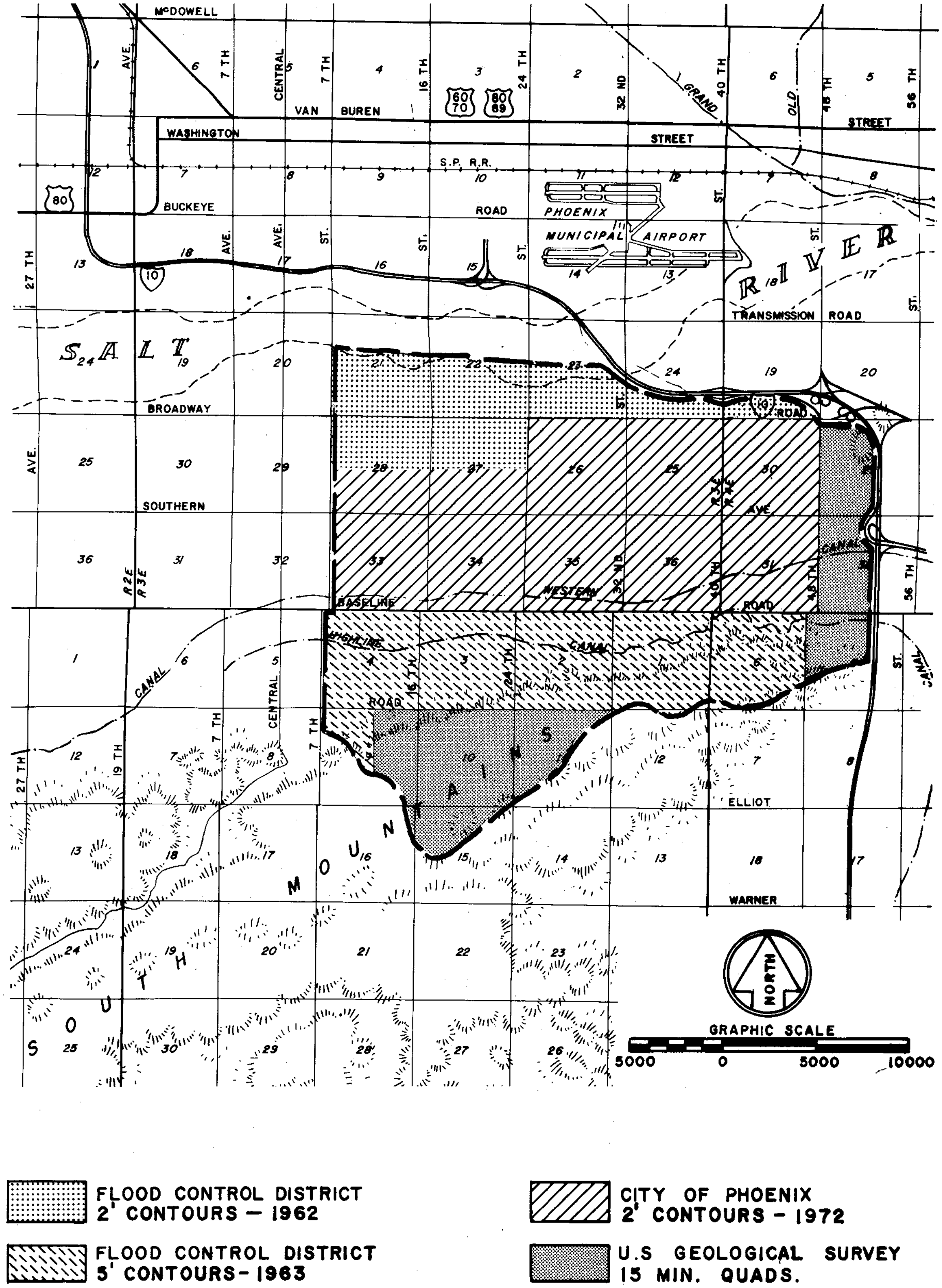
The area covered by this report consists of 21 square miles in the southeastern portion of Phoenix. It is bounded approximately by the Salt River on the north, by the Maricopa Freeway on the north and east, by the ridge of the Salt River Mountains on the south, and by Seventh Street on the west.[1] About 1.5 square miles of the area east of 48th Street lie inside the corporate boundaries of the City of Tempe. This portion is included in the study because it drains northwesterly into the City of Phoenix. Plate I, reproduced from aerial photography, gives a general view of the study area.

2.1.1 Topography. Elevations range from 2300 feet in the South Mountain Park to 1050 feet in the Salt River at 7th Street. The mountainous portion of the area forms a narrow band across the south edge, the toe of the rock outcrops forming a sharply defined line and break in the ground slope at an approximate elevation of 1250 feet. The Highline Canal and the upper (southern) edge of the irrigated area touch this line at 40th Street near the eastern edge of the study area but there is a gradual divergence proceeding westward until at 7th Street there is about one

1. The Pima Wash basin, which presently discharges at least a part of its runoff into the study area at the extreme southeast corner, is excluded from consideration in this report because it will be brought under control by the SCS Guadalupe Project. Low flows from this drainage are presently impounded by an earth dike about 6 feet high running between low outlying hills near the center of Section 5, T1S, R4E.

mile between the toe of the mountain and the irrigated land. This long narrow wedge of foothill land is traversed by innumerable small washes, all trending northerly and intersected by the Highline Canal. Because there are so many of these, none has a very large drainage area. The wedge between the South Mountains and the Highline Canal is being developed with low density housing, and the street pattern generally allows the surface runoff to collect and flow northward without impediment. The average ground slope in this region is around 100 feet per mile. Consequently ordinary street pavements have relatively large hydraulic capacity.

2.1.2 Mapping. Fairly good contour coverage is available for the study area. Ten square miles near the center were mapped to a 2-foot interval by the City of Phoenix early in 1972. There is also 2-foot coverage of the Salt River bed, made by the Flood Control District of Maricopa County in 1962 and now somewhat out of date because the river bed is constantly being worked for sand and gravel. The foothill area south of Baseline Road was also mapped by the District in 1963, a 5-foot interval being used. For the remainder of the area the best available contour information is from the U.S. Geological Survey 15-minute quadrangle maps which show 10-foot contours in this area. Fig. 2.2 shows the study area boundaries and the areal extent of the contour information from the sources mentioned. Contours shown in brown in Plate III are compiled from all four sources. Portions of the riverbed contour coverage have been eradicated where this is known to be unrespresentative of current conditions. In lieu of this, the map shows the results of a recent survey made to show



SOURCES OF CONTOUR INFORMATION FOR DRAINAGE STUDY

FIGURE 2.2

the limits of the present low-flow channel. (See Appendix 2.1)

2.1.3 Culture. At one time 70 percent of the study area was farmed, under irrigation from the Highline and Western Canals. Because of its proximity to Phoenix and Tempe this is rapidly being urbanized but at present about 56 percent of the irrigated area is still capable of cultivation. Much of this is being abandoned as farmland however and is currently used as pasture or lying fallow. The upper slopes of the agricultural areas have been found to be relatively frost-free and have long been considered excellent horticultural land with extensive citrus and commercial flower plantations. There is no remaining evidence of the original washes in the farmed area north of the Highline Canal.

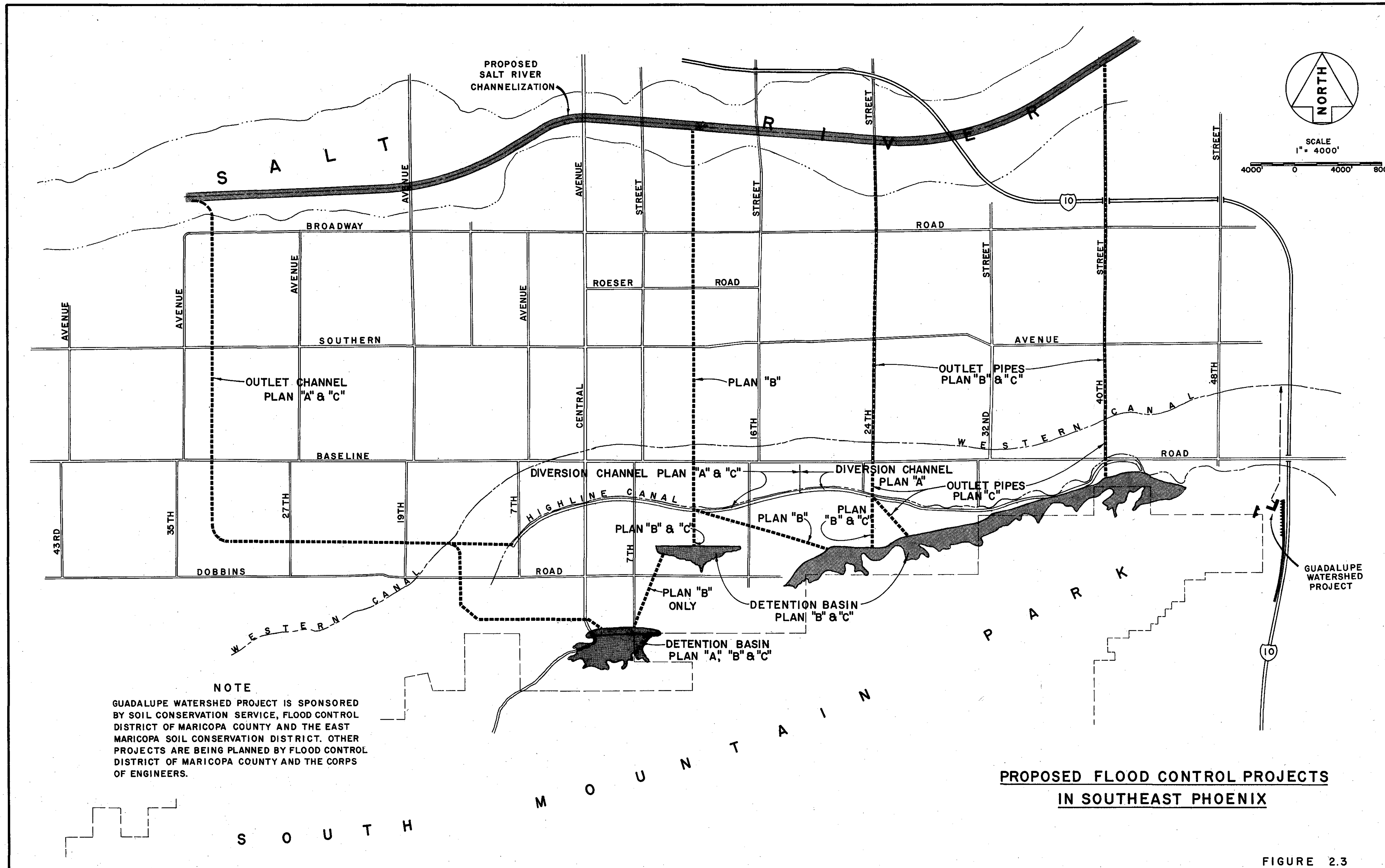
The urbanization that has taken place so far has been primarily medium density, single-family, residential development with strip-commercial usage along the east-west thoroughfares such as Southern Avenue and Broadway Road. Industrial and commercial (warehousing and wholesaling) development is beginning along the northerly edge of the area near the Maricopa Freeway and the Salt River. When the area is ultimately completely urbanized, and it appears that this will inevitably take place, it will have a good balance of most urban uses. It does not seem likely that any one use will be dominant to the extent that the character of the drainage will be affected.

Urbanization is expected to be complete in the area of this report by the year 1990. Present zoning and the land use projections made by the City of Phoenix Planning Department (Ref. 10) form the basis for the pervious/impervious ratios utilized in the runoff calculations made in Section 3 of this report.

2.1.4 Proposed Flood Control Projects. There are three separate flood control projects proposed for locations in or adjacent to the study area. These are located in Fig. 2.3 and a brief description follows:

1. The Guadalupe Watershed Project, being planned by the Soil Conservation Service in co-operation with the Flood Control District. The project includes a retarding structure on Pima Wash (which drains the eastern portion of South Mountain Park) and an outlet pipeline for controlled realease of water into the Western Canal. The outlet pipe is to be installed in 52nd Street, just inside the study area, but it will be too small (21-inch diameter) to be useful as a storm drain and there would be difficulties involved in making it serve both functions.

2. Salt River Channelization, a project under study by the Corps of Engineers and the Flood Control District. The first published report appeared in 1957 (Ref. 6). It recommended the clearing of a 2000-foot floodway between Gillespie and Granite Reef Dams. In addition, an unlined low flow channel was to be provided in certain reaches and short levees were to be constructed on the north bank of the Salt from the Tempe Bridge to 40th Street and on the south bank from Tempe Butte to the Southern Pacific Railroad bridge. Original design capacity for the channel at Phoenix was 270,000 cfs. Provision of storage capacity for flood control at Orme (McDowell or Maxwell) Dam under the Central



PROPOSED FLOOD CONTROL PROJECTS IN SOUTHEAST PHOENIX

FIGURE 2.3

Arizona Project would reduce Salt River Channel capacity requirements to 50,000 cfs.

The 1957 Corps of Engineers recommendation called for channel clearing without any substantial amount of grading except for the levees and low flow channels. (The only low-flow channel to be provided within the Phoenix city limits extended from 48th to 36th Streets). Reduction of capacity requirements and the pressure of the demand for land, especially for industrial and commercial purposes, led to consideration of channelization plans that would require less than 2000 feet of right-of-way width. The Corps is currently considering two structural alternatives: one a completely lined trapezoidal channel, the other a "soft-bottom" channel with lined banks. Other measures, not involving structures, are also under consideration. These studies have not yet been released to the public. Informal discussions with the Flood Control District and the Corps of Engineers and our own surveys of the present river bottom (Appendix 2.1) have led to our conclusion that storm drain invert elevations at the point of discharge to the Salt River should not be lower than those given in Table 2.1.

Table 2.1 - Suggested minimum invert elevations for Southeast Phoenix storms drains at point of discharge

Designation	Location of Proposed Outlet to River Channel	Approx. Present Grd. Elev.	Min. Invert Elevation
Line A	7th Street	1052	1051
Line B	16th Street	1055	1062
Line C	24th Street	1073	1076
Line D	30th Street	1085	1082

Within the past few years there has been an awakening of interest in some sort of "green belt" development along the Salt River bed. The principal proponents of this plan, called the "Rio Salado Project", have been the Arizona State University College of Architecture and the Valley Forward Association, a local community organization. A consulting firm has been engaged to draw up preliminary concepts with a view to securing federal grants for more detailed planning. At present there have been no specific proposals that would affect any of the recommendations of this report.

3. The South Phoenix Flood Control Project. In 1962, the Flood Control Survey Report for Area III (Ref. 2) made for the Flood Control District, recommended a channel paralleling the Highline Canal on the south extending westerly from 48th Street to discharge into the Salt River near 79th Avenue. Although this project did not have a favorable benefit/cost ratio at the time, the report suggested acquisition of right-of-way for

construction in about ten years. The Comprehensive Flood Control Program Report (Ref. 3) placed this project in a "deferred or not recommended" category. The Interim Report on Survey for Flood Control, Phoenix, Arizona and Vicinity published by the Corps of Engineers in Jan. 1964 (Ref. 7), shows the project as part of a comprehensive flood control plan. The proposed channel alignment is similar to that shown in the earlier references except that it turns north near 35th Avenue to enter the Salt River at that location. The project was assigned a "Phase C" priority in the Corps' report, ranking with the Glendale and Maryvale channels. At least three alternatives to this scheme are being investigated. All involve detention basins in the South Mountain foothills, with regulated discharge to the Salt River through pipelines on north-south arterials, or through a diversion channel along either the Highline or the Western Canal.

It is concluded from a review of the planning for the South Phoenix Flood Control Project that: (a) it is still much too early to discern the form the work will take, (b) when it is built, it will protect the storm drainage system from mountain runoff, and (c) the proposed outlet pipes for the eastern basins will probably be too small for use as storm drains. (The Guadalupe Project will use a 21-inch drain). On the other hand, the storm drains can double as flood retention basin outlets if the basin design permits deferring flood water releases until peak storm flows have passed through the drains.

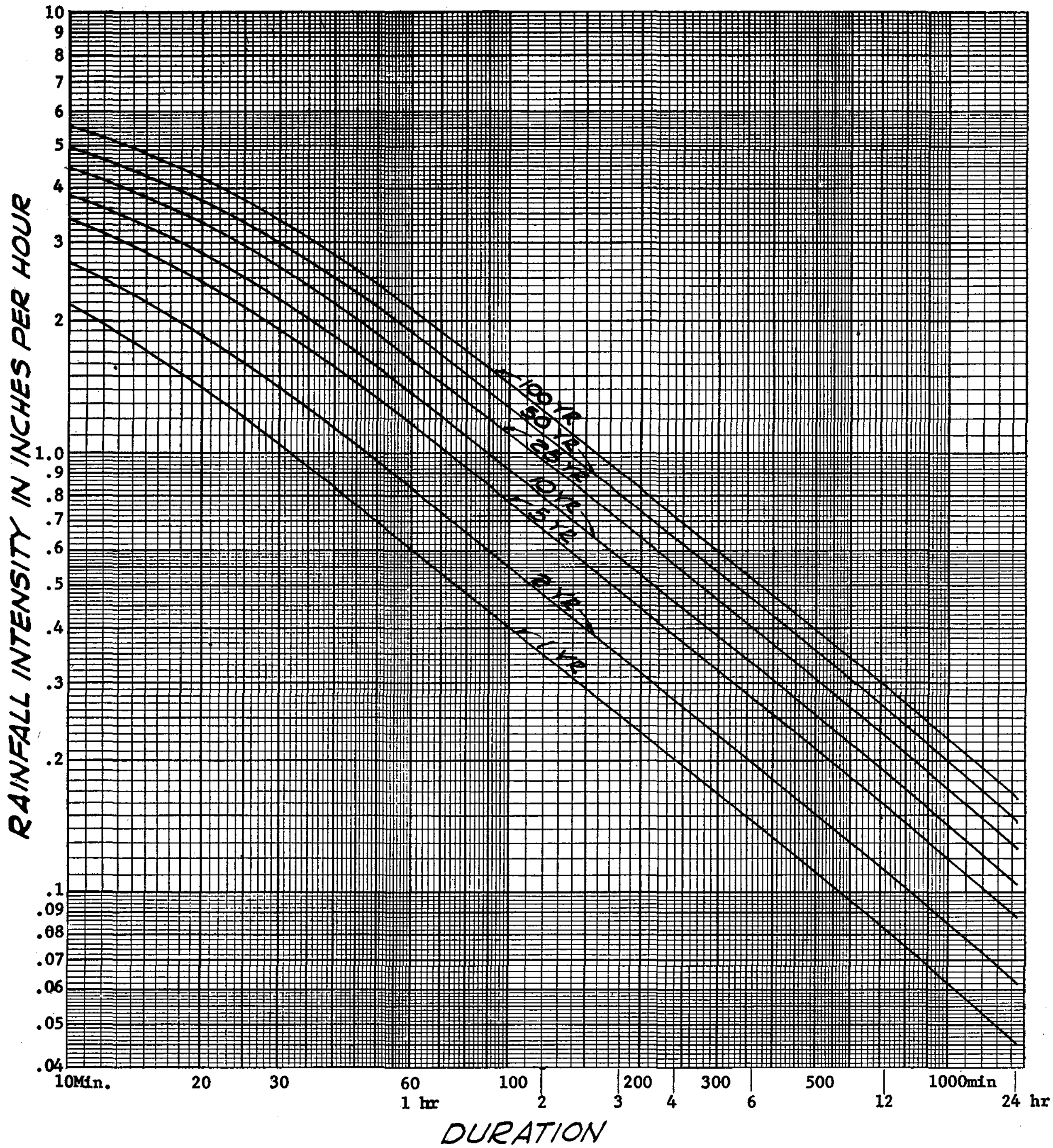
2.2 Rainfall

Basic information relating to rainfall has been presented in other studies. The relationship required for storm drain design are:

1. The intensity-duration-frequency relation for the locality under study (adopted here from Ref. 4). Fig. 2.4

2. The area-depth relationship (adopted from Ref. 4). Fig. 2.5

The 2-year recurrence interval has been adopted as the standard for which the storm drainage system in the southeast Phoenix area will be designed. While the 1-year standard has been used for many years in Phoenix, this was done with the expectation that the system could be upgraded later by building intervening trunk drains on mid-section lines. North of the Salt River through routes are generally available on mid-section lines but this is not always the case in southeast Phoenix.

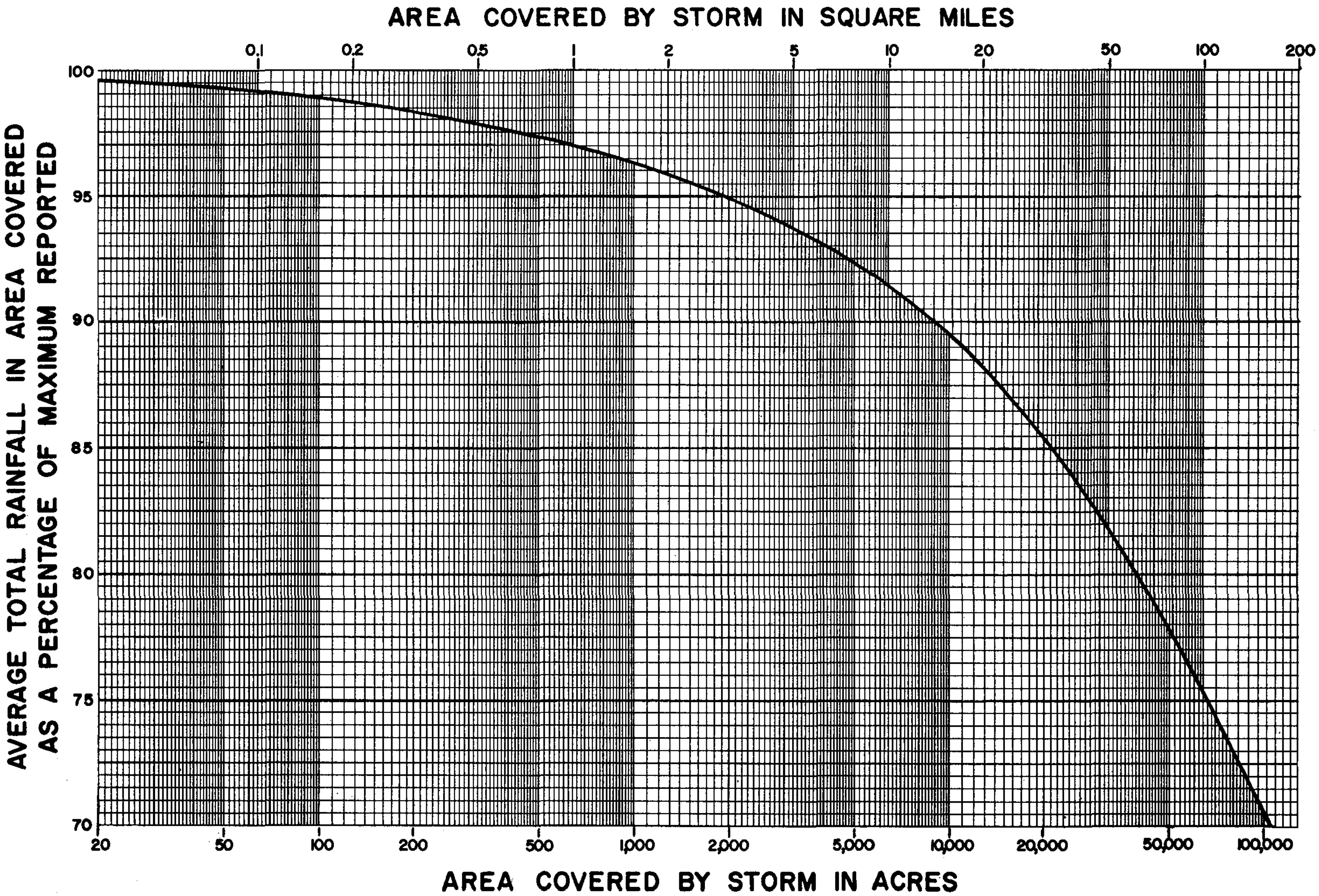


RAINFALL INTENSITY-DURATION-FREQUENCY RELATION
FOR PHOENIX, ARIZONA
(Partial Duration Series)

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

YOST AND GARDNER ENGINEERS
PHOENIX, ARIZONA

FIGURE 2.4



DESIGN AREA-DEPTH CURVE

FIGURE 2.5

2.3 Drainage Characteristics

Most of the land in the study area has been leveled for farming by flood irrigation and this has influenced the boundary pattern of the drainage areas. Generally, these now follow street alignments, giving the map a gridded appearance. Major flows will still sweep across streets in some instances but the two-year storm drainage (which is the concern of this study) will follow streets to the gutter inlets.

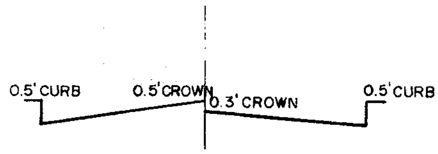
The pattern of runoff was analyzed by examination of the existing ground contours and street configurations. Where ambiguities or uncertainties became apparent, enough field investigation was done to clarify the problem. As a result of this work the entire study area was broken up into individual drainages of about 160 acres each. These are shown in blue in Plate III.

Flow from these drainages proceeds downhill along a single, definite route, picking up tributary contributions along the way. In a state of nature these routes will follow the swales ("thalwegs") defined by the ground contours. Under urban conditions this pattern is modified by the street layout. In general, the storm drainage system should follow this same configuration as nearly as possible in order to minimize trench depths and to avoid the possibility of introducing drainage problems where they did not exist before.

2.3.1 Street Conveyance and Inlets. Street pavements, when provided with curbs, generally form the uppermost portions of the storm drainage system. The hydraulic capacity of crowned streets flowing full to the top of curb is typically in the range from 10 to 100 cfs, depending on the slope of the street and the geometry of the crosss-section. Streets with inverted crowns have considerably greater capacity, typically 100 to 300 cfs, depending again on slope and dimensions. Fig. 2.6 and Fig. 2.7 give dimensions and hydraulic properties of typical normal and inverted crown street cross-sections. The carrying capacities of these streets for a range of longitudinal slopes may be estimated from Fig. 2.8 and Fig. 2.9, assuming that the streets are flowing full to the top of curb.

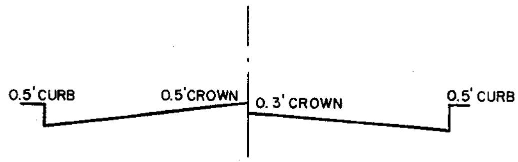
There are several reasons for not utilizing the full capacity of streets in the design of a storm drainage system. One reason is that a street flowing full of water is incapable of performing its main function which is to carry traffic. Another is that, unless street flow can empty directly into a flood control channel, it is necessary at some point to introduce the surface flow into an underground system. This is normally done by means of curb inlets and catch basins which have a hydraulic capacity in the range 2 to 20 cfs when clear of trash. When this is reduced by half to allow for clogging, the number of inlets required to introduce say 100 cfs into the underground system becomes unmanageably large.

Utilizing only the hydraulic capacity of streets below a level such that one traffic lane in each direction is above water, we have the



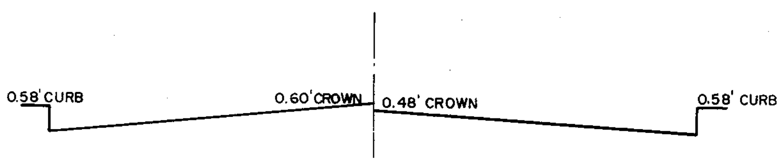
	0.5' CROWN	0.3' CROWN
AREA TO TOP OF CURB	8.0 SQ. FT.	11.2 SQ. FT.
WETTED PERIMETER	33.0 FT.	33.0 FT.
HYDRAULIC RADIUS	0.242 FT.	0.342 FT.

32 FT. STREET



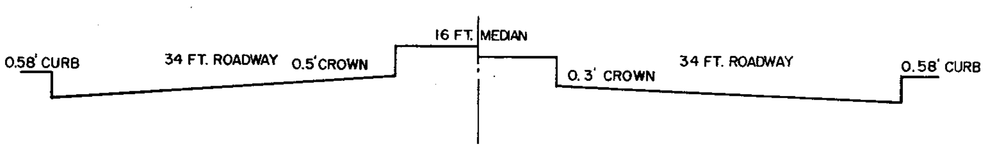
	0.5' CROWN	0.3' CROWN
AREA TO TOP OF CURB	10.0 SQ. FT.	14.0 SQ. FT.
WETTED PERIMETER	41.0 FT.	41.0 FT.
HYDRAULIC RADIUS	0.244 FT.	0.342 FT.

40 FT. STREET



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

64 FT. STREET

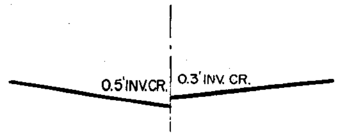


	0.5' CROWN	0.3' CROWN
AREA TO TOP OF CURB	22.44 SQ. FT.	29.24 SQ. FT.
WETTED PERIMETER	69.32 FT.	69.72 FT.
HYDRAULIC RADIUS	0.324 FT.	0.419 FT.

MAJOR ARTERIAL

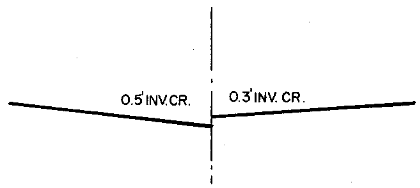
HYDRAULIC PROPERTIES OF TYPICAL STREET SECTIONS

FIGURE 2.6



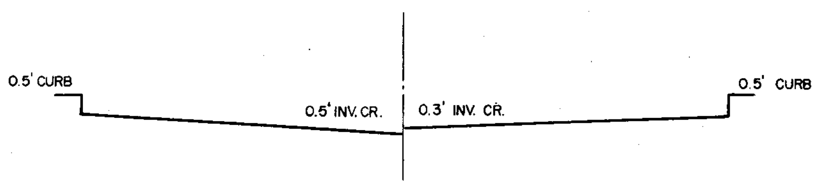
	0.5' INV. CROWN	0.3' INV. CROWN
AREA TO TOP	4.0 SQ. FT.	2.4 SQ. FT.
WETTED PERIMETER	16.0 FT.	16.0 FT.
HYDRAULIC RADIUS	0.250 FT.	0.150 FT.

16 FT. ALLEY



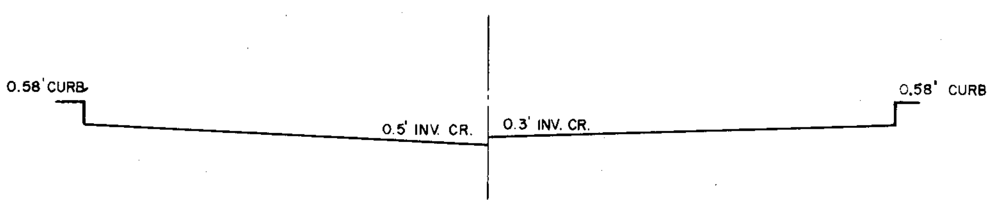
	0.5' INV. CROWN	0.3' INV. CROWN
AREA TO TOP	5.0 SQ. FT.	3.0 SQ. FT.
WETTED PERIMETER	20.0 FT.	20.0 FT.
HYDRAULIC RADIUS	0.250 FT.	0.152 FT.

20 FT. ALLEY



	0.5' INV. CROWN	0.3' INV. CROWN
AREA TO TOP OF CURB	240 SQ. FT.	20.8 SQ. FT.
WETTED PERIMETER	33.0 FT	33.0 FT.
HYDRAULIC RADIUS	0.727 FT.	0.630 FT.

32 FT. STREET



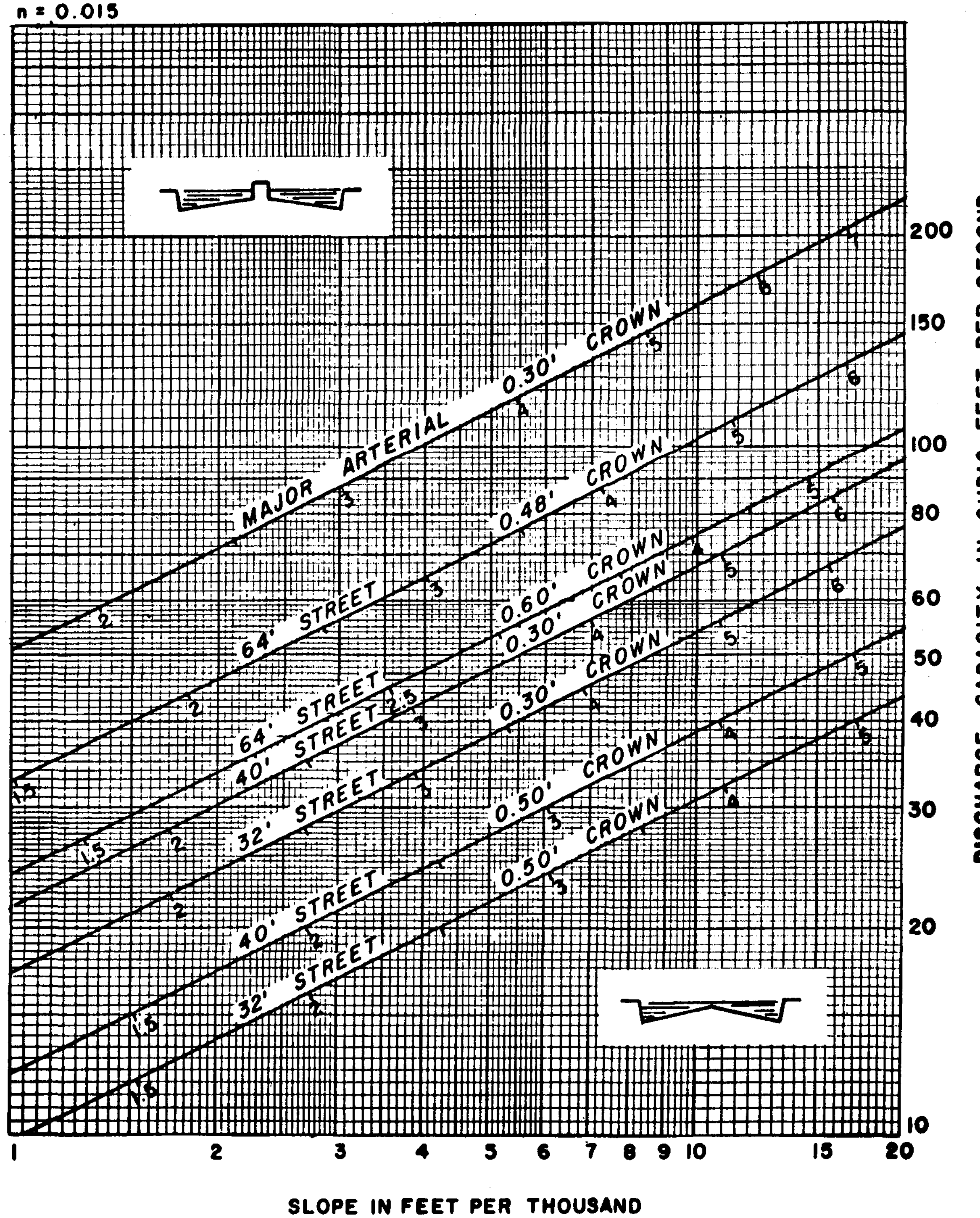
	0.5' INV. CROWN	0.3' INV. CROWN
AREA TO TOP OF CURB	33.2 SQ. FT.	29.2 SQ. FT.
WETTED PERIMETER	41.17 FT.	41.16 FT.
HYDRAULIC RADIUS	0.806 FT.	0.709 FT.

40 FT. STREET

HYDRAULIC PROPERTIES OF INVERTED CROWN SECTIONS

FIGURE 2.7

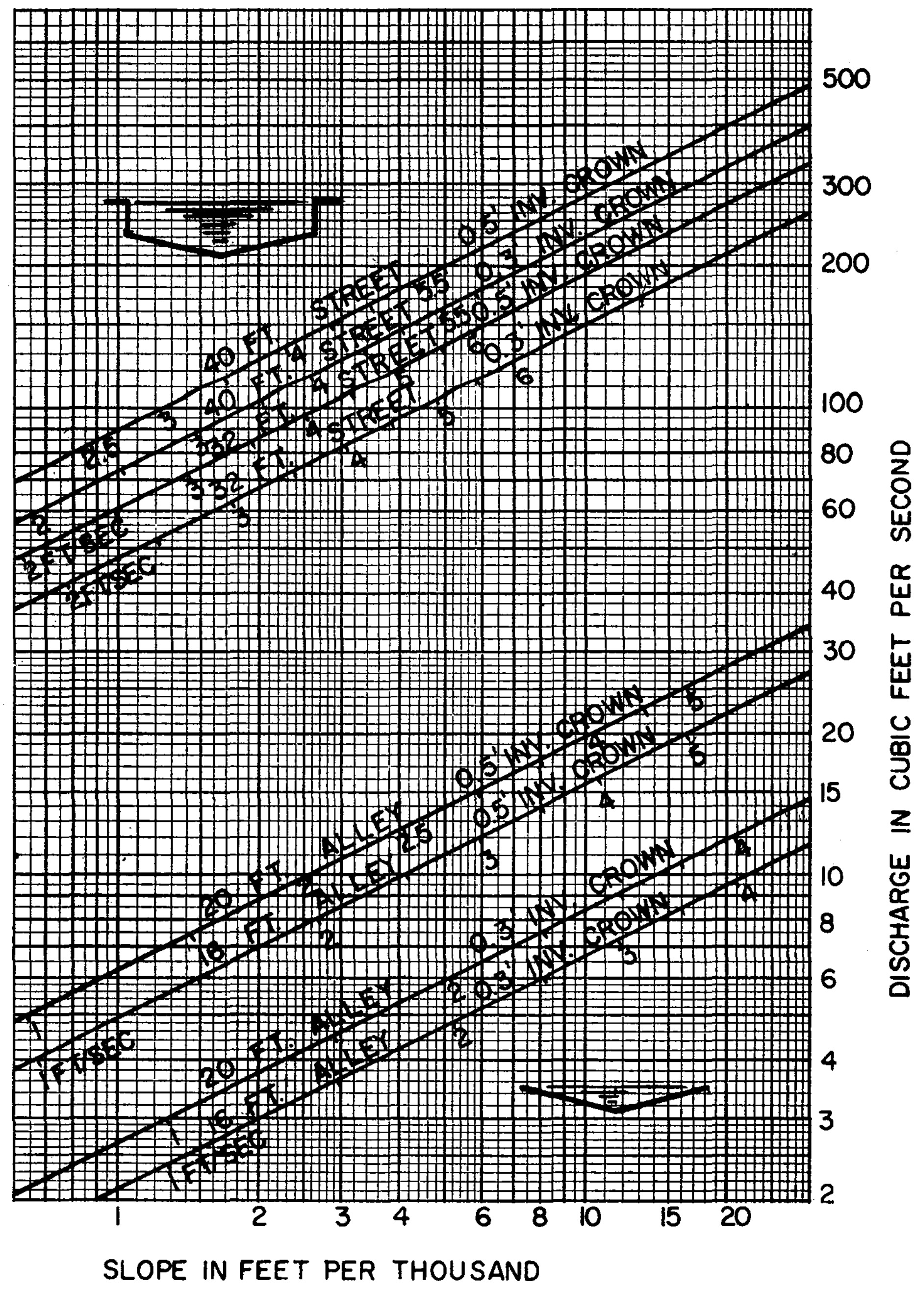
COMPUTED FROM MANNING'S FORMULA
n = 0.015



TYPICAL STREET SECTION CAPACITIES
FLOWING FULL TO TOP OF CURB

FIGURE 2.8

COMPUTED FROM MANNING'S FORMULA
n = 0.015



INVERTED CROWN CAPACITIES FLOWING FULL

FIGURE 2.9

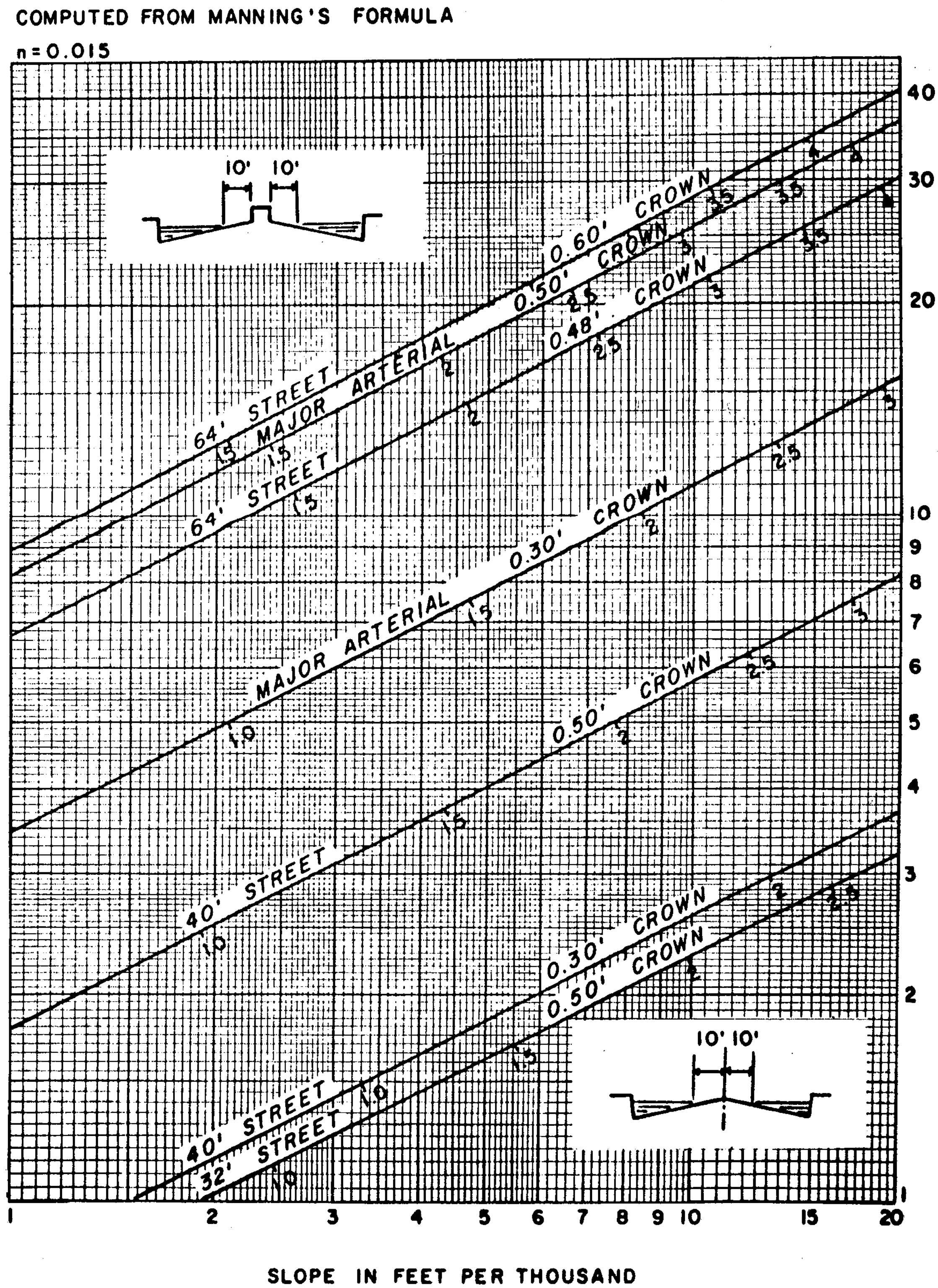
capacity range of 2 to 20 cfs for the slopes and cross-sections typical to the study area. Fig. 2.10 presents capacities in graphical form.

Street flow can be depended on for conveyance of runoff from the first 160 acres or so of a drainage area. Two-year peak flows for such areas are generally in the 60 cfs range. These would normally be carried in two or more parallel streets and be introduced into the pipe system from 8 to 10 inlets.

2.3.2 Pipe and Channel Flow. At or before the point where the 2-year runoff exceeds the street capacity shown in Fig. 2.10 for streets flowing partially full, curb inlets and piped drains should be provided to carry runoff water below the surface.

More will be said about the design of pipe collection systems in Section 4 of this report, however, it should be pointed out here that the presence or absence of drains and street pavements affects the hydrologic performance of a basin. The principal impact is on the time required to reach the peak flow and for this it is necessary to know how fast water will flow in the various trunks and branches of the system

As in the case of many engineering problems, there can be many solutions, each depending on its own given conditions which are also often under the control of the designer. The determination of the amount of flow to be handled by a pipe, and the sizing of the pipe, requires a preliminary assumption of pipe size. "Cut and try" approaches for such problems are facilitated by slope-capacity-velocity charts drawn for the cross-sectional and frictional characteristics of the conduit to be



TYPICAL STREET SECTION CAPACITIES FLOWING PARTIALLY FULL

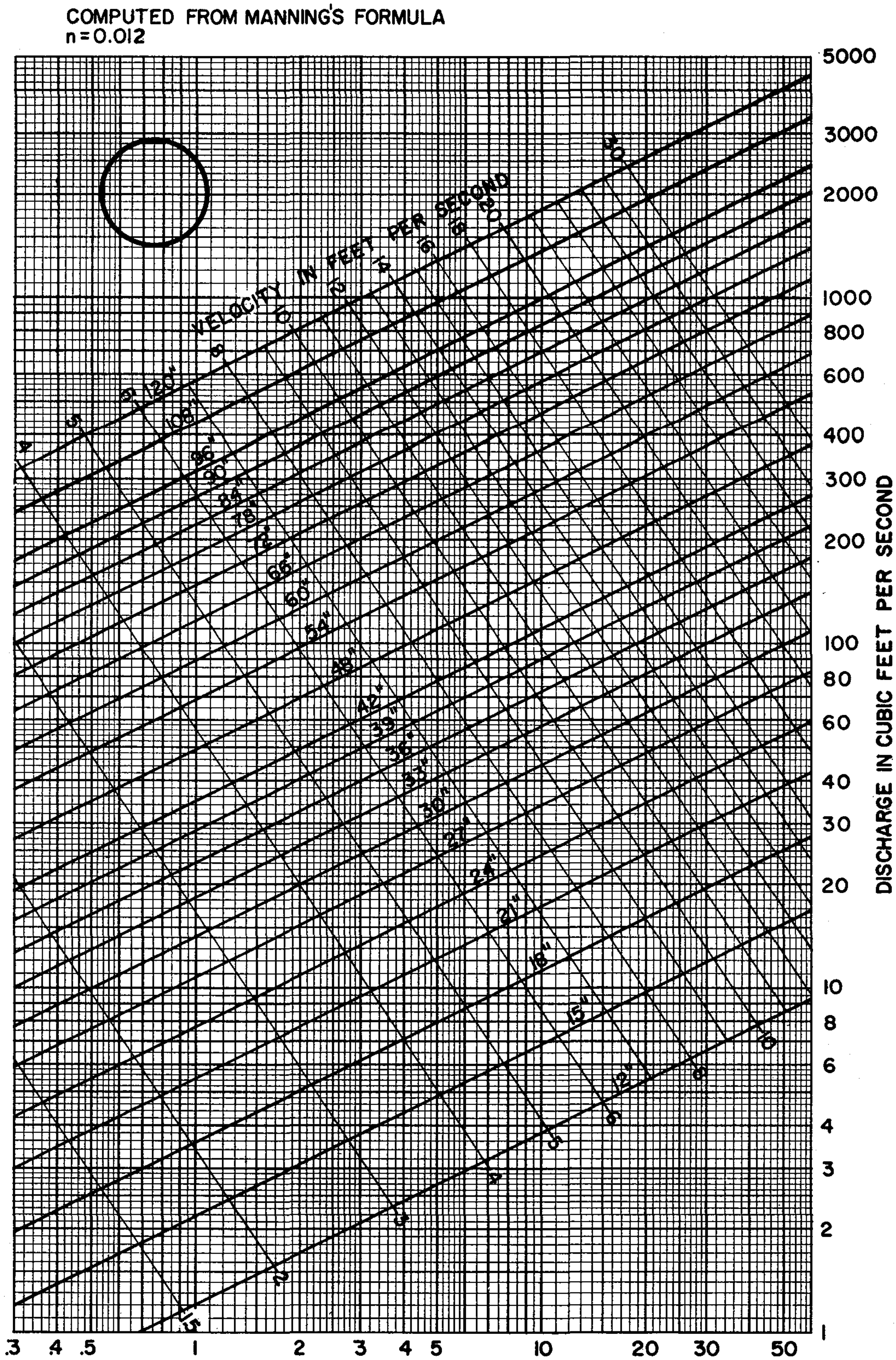
FIGURE 2.10

used and some of these are provided herein. Pipe capacities and flow velocities for various slopes are given in Fig. 2.11. Data for concrete lined rectangular channels may be estimated from Fig. 2.12.

2.3.3 Soil Types. Runoff from an area depends partly upon the qualities of the uppermost layers of the soil. Some are much better absorbers of water than others. Where infiltration losses are taken into account in the design (See Sec. 2.3.4) the types and characteristics of the soils found in the area are of interest.

Soils through the study area, except for the mountainous portion south of the Highline Canal, are geologically recent alluvial deposits. Clay soils predominate in a band along the south bank of the Salt River. Proceeding southward toward the mountains the soil becomes more coarsely granular with a corresponding increase in infiltration capacity. The mountainous portion of the area is characterized by exposed granite gneiss, much of it on slopes over 30 percent.

A comprehensive survey of Maricopa County soils was completed by the Soil Conservation Service in cooperation with local Soil Conservation Districts in June 1969. (Ref. 11). A perusal of this report, which consists of a map and 25 pages of explanatory text, will give a clearer conception of the nature of the soils in the study area.

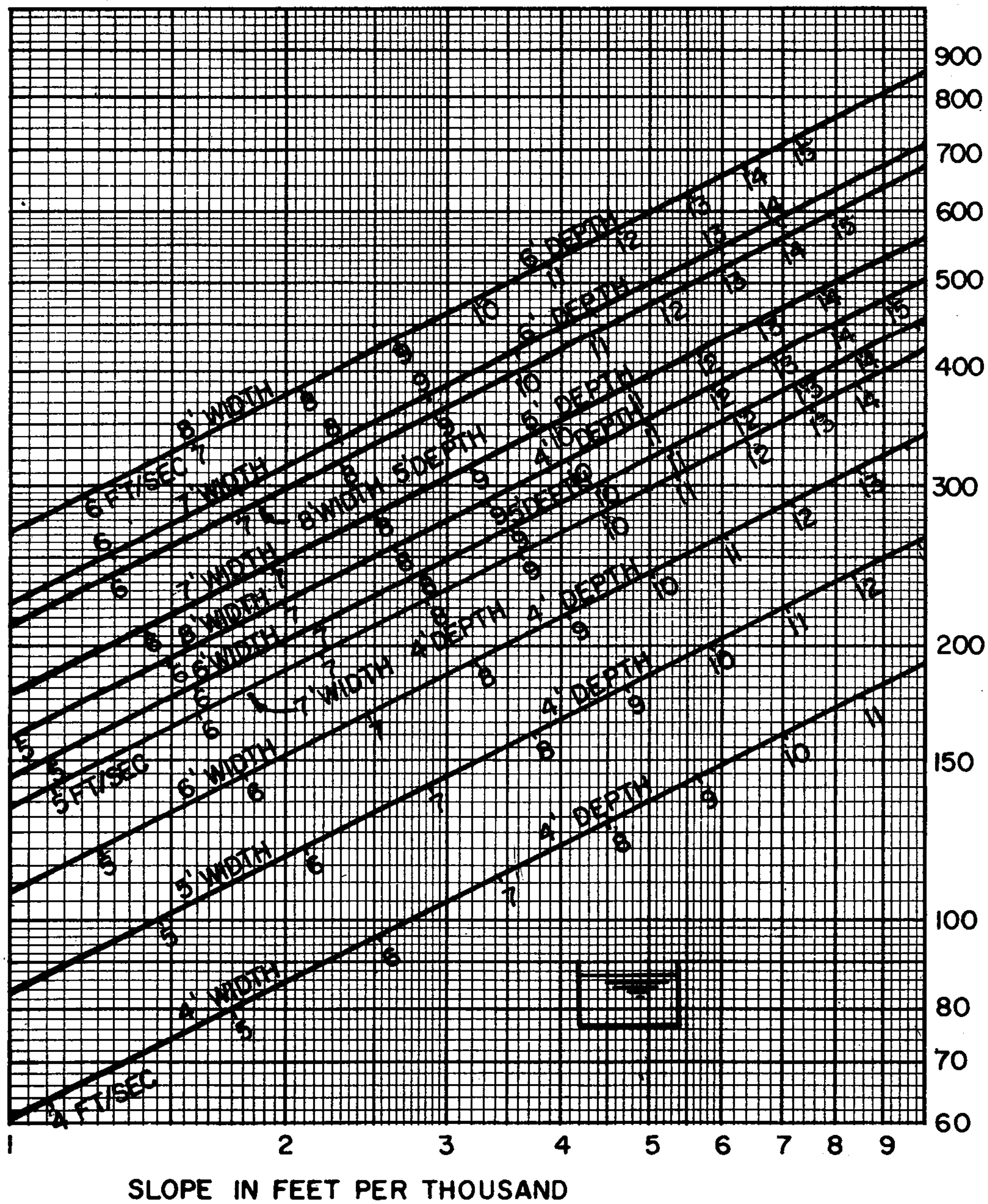


PIPE CAPACITIES FLOWING FULL

FIGURE 2.11

COMPUTED FROM MANNING'S FORMULA

n = 0.015



RECTANGULAR CHANNEL CAPACITIES VARIOUS DEPTHS

FIGURE 2.12

2.3.4 Land Use Pervious/Impervious Factors. As the urbanization of farm and desert land proceeds, more and more of the exposed soil is covered with impervious pavements and buildings. This increases both the peak rate and total volume of storm water runoff. The MAG Storm Drainage Report (Ref. 4) contains a table suggesting pervious/impervious factors for various categories of land use. Table 2.2 reproduces the data from Ref. 4, modified as indicated, and supplemented with a land use category for industrial park zoning.

Table 2.2 - Pervious/Impervious Factors for Various Land Uses - Design Values

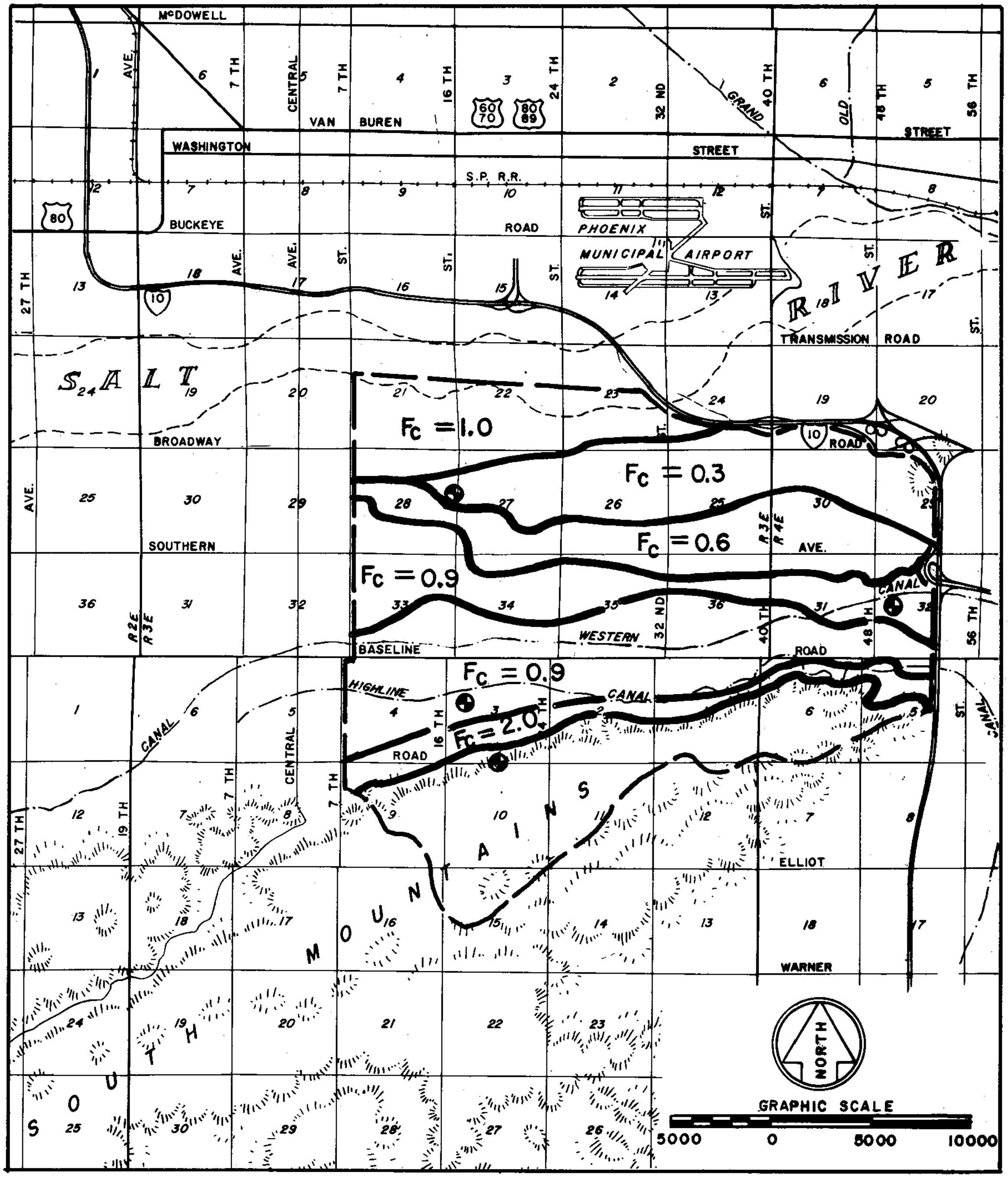
Land Use	Zoning Categories	Percent Pervious	Percent Impervious
Residential - low density	R1-18 to R1-43	65	20 - 30
Residential - medium density	R1-6 to R1-14	60	30
Residential - high density	R3 to R5	50	40
Parks and park-like	Various	80 - 95	5 - 10
Commercial	C1, C-2, & C-3	5 - 15	85 - 90
Industrial Park	IP	10 - 20	80 - 90
Industrial	A-1 & A-2	10 - 30	70 - 90

The factors in the table are intended to be applied to the gross area of any particular use category. They include allowances for street paving, driveways, sidewalks, roofs, etc. as these would exist under a completely built-up condition. They recognize some water falling on impervious areas must cross pervious areas on its way to the storm drain and that there are always some areas which do not contribute at all.

2.3.5 Infiltration Rates. A discussion of infiltration rates and their significance appears in Ref. 1 and it is unnecessary to repeat or elaborate here. Ref. 4 (pp 46-48) points out that flow from pervious portions of relatively flat urban areas may safely be neglected for 1- and 2-year recurrence interval design, consequently infiltration capacity is not of direct interest in this report. In order to arrive at values that are more specifically related to the study area, however, and to ascertain that infiltration capacities were not in some way unusual, infiltration tests were made at several locations.

The method used consisted of timed additions of measured amounts of water to a 20-inch diameter infiltrometer ring driven into the soil to a depth of 6 inches. The method is described in Ref. 8. Locations where tests were run are plotted in Fig. 2.13 and the infiltration rates obtained in each case are also shown. Field data and curves for each test are given in Appendix 2.2.

It is worth noting in this connection that there are measured data available on the infiltration capacity of the Salt River bed. These were obtained by the Geological Survey in 1965 from measurements of river flow and inundated area following the release of 20,000 acre-feet of water to the normally dry river bed at Granite Reef Dam during an 82-hour period. The indicated stabilized infiltration rate for the river



⊕ INDICATES TEST SITE

INFILTRATION RATES IN DRAINAGE STUDY AREA

FIGURE 2.13

reach between 16th Street and 7th Avenue was 1.1 foot per day or 0.44 in. per hour. This portion of the river has been extensively worked for sand and gravel, consequently water was ponded to an estimated average depth of 20 feet. A report on infiltration and its effects on groundwater levels during this period is presented in Ref. 9.

3. Runoff Computations

Working with the basic information discussed in the previous section, computations of the peak two year runoff were made for each of the drainage areas shown in Plate III. The method used has been described in Ref. 4, pp. 39 to 50. It begins with a determination of the pervious/impervious ratio for each drainage area, considering the land use projections of Ref. 10, current zoning information, and the factors from Table 2.2. These computations are shown in Appendix 3.1 and the values obtained are plotted on Plate II.

Peak flows for the 2-year storm are next computed for each area. These calculations appear in Appendix 3.2. The values obtained are posted as "Q" figures in Plate III. Because of the time lag in flow from one area to the next one below it, the peak flows are not simply added to arrive at the required capacity of the trunk drain to carry them off. The summation of successive drainage area contributions along the line of a trunk is made in Appendix 3.3 and the cumulative peak flows, proceeding downward toward the discharge end of each trunk are posted as "Q_c" values, also on Plate III.

The calcuation of cumulative flows requires an assumption that the individual area discharges will combine in a certain way, in other words, a tentative drainage system layout is assumed. Such a layout is made following the natural drainage pattern as nearly as possible. Refinements of the preliminary layout are sometimes necessary in the final design of the system but these are seldom drastic enough to require recomputation of flows unless they involve a change in the general drainage scheme. More consideration will be given to these changes in Section 4 of this report.

4. General Design Considerations

This section will attempt to present the factors influencing the design of pipe collection systems once the rates of flow to be accommodated have been determined. It is not intended that this should be a reference manual on hydraulic design. It is rather the intention that some of the more or less unquantifiable aspects of the drainage situation in the study area receive consideration. Some of these factors are very important. Factors such as right-of-way availability and the presence of interfering utilities have impact on both the configuration and the cost of the ultimate drainage system. A decision on how much water to allow the streets to carry before inlets are provided can change the amount of small piping required in each quarter section by 4 or 5 thousand feet.

Sometimes alternative ways of dealing with such problems are cleared up by cost analyses but often these are not possible, or depend upon so many assumptions that their validity is doubtful. The systems shown on Plate III are recommended as being the best solutions based on information presently available. They should not be regarded as immutable however, especially if considerable time elapses before they are built.

There are a few other considerations which will be mentioned here even though they are obvious and even though they have been said many times by many people. They are nevertheless often ignored in practice by those responsible for the urbanization of farm and desert lands. Whether this is inadvertent or deliberate is immaterial to the fact that people will be hurt repeatedly for many years by bad decisions. Probably every person who has been at all involved in drainage, street maintenance, or for that matter, in real estate sales in Phoenix for any length of time can point to properties that have been flooded, repaired, and resold repeatedly over the years.

1. The provision of storm drainage facilities cannot solve the flooding problem. Storm drains will carry one- or two-year flows but more severe storms occur somewhere in the Valley several times each summer. Development must always leave room for major storm runoff to take place across the surface when the drains are overtaxed, without doing extensive damage to homes and other buildings.

2. It is very difficult to find traces of natural washes north of the Highline Canal. South of the canal however they remain distinct. An inspection of developments in the area between the South Mountains and the Highline Canal leaves the impression that the washes have generally been kept open. It is inevitable that encroachments will be attempted as population pressure builds up and land values rise. The area has a certain inherent attractiveness as a residential setting and it will grow. As it does, continual attention will be required on the part of authorities reviewing subdivision plats and development plans to make sure that streets and easements are provided to take over the function of the natural washes.

3. While the Salt River Project irrigation system is designed to pick up tailwater from each quarter section in its area, it is entirely inadequate to become the basis for an urban drainage system. Urban runoff rates are much higher, acre for acre, than from agricultural land. The irrigation supply system capacity diminishes proceeding downhill from the canals whereas required storm drain capacity increases rapidly. Required drain pipe sizes, even for 2-year storms, are far larger than those provided for the underground irrigation laterals. It is best not to depend on the irrigation system for any but the most minor drainage requirements.

4.1 Street Conveyance and Inlets

This report has been concerned primarily with the sizing and locations of the major trunk drains to serve the areas down to about 160 acres. The drainage system within each quarter section, or its equivalent, will utilize pipe for collector lines and inlet connections, but much of the work of conveying runoff will be done by the street and alley system. The capabilities of such pavements and their limitations as water carriers have been discussed in Section 2.

The design of these "interior" or sub-quarter section systems is beyond the scope of this study, particularly because it cannot be done properly until the interior street pattern has been established. An examination of the streets shown in black on Plate III reveals that out of the 60 quarter sections included within the area of the map, in only 9 is subdivision substantially complete. In 24 quarter sections there has been some subdivision but it generally accounts for less than half of the area. In the remaining 27 quarter sections there is at this time no established and dedicated interior street pattern.

When interior drains are to be provided, probably in connection with street paving programs, the area should be divided into subsidiary drainages having a peak runoff no greater than street capacity as obtained from Fig. 2.10. For the purposes of preliminary design at least, the subsidiary area can be a pro-rated portion of the drainage area in which it is located as given in Plate III, that is:

$$A_t = \frac{QA}{Q_t}$$

where A_t = subsidiary area in acres

A = drainage area from Plate III, acres

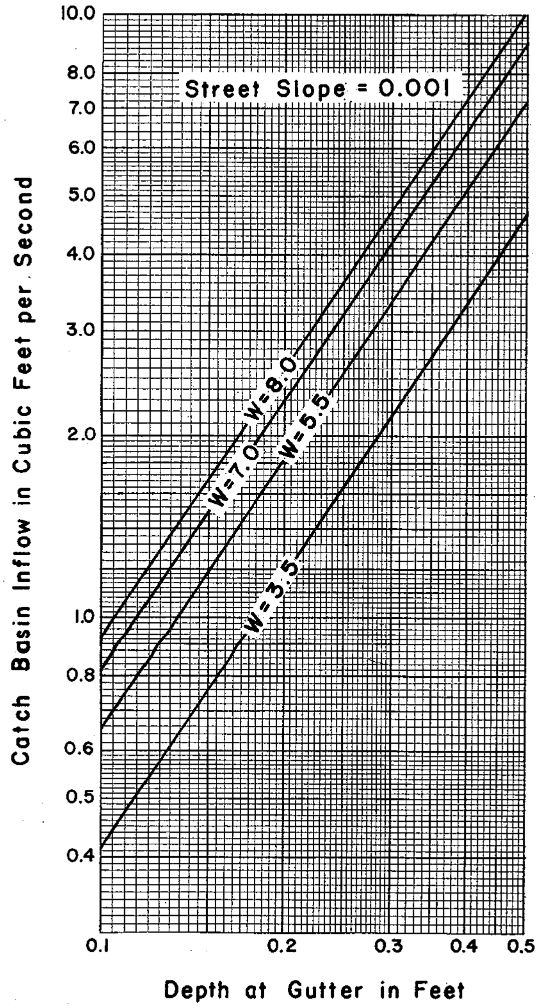
Q = peak discharge from Plate III, cfs

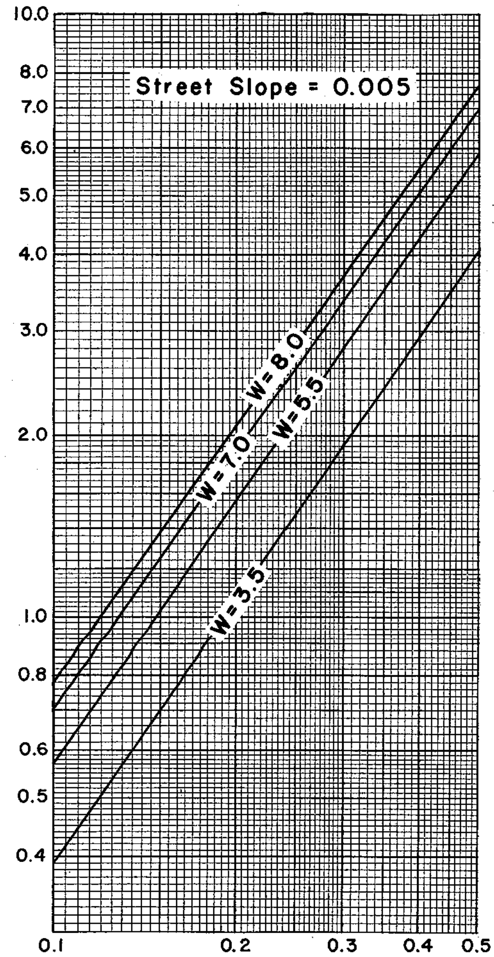
Q_t = peak subsidiary area runoff, cfs

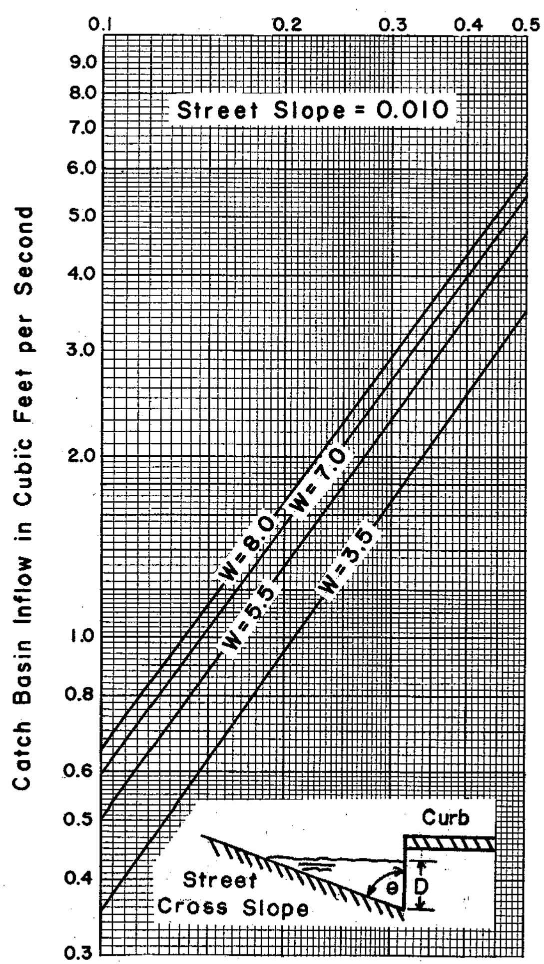
The subsidiary area runoff will be an arbitrarily chosen quantity and the selection of this value will determine the upper limits of the underground portion of the ultimately constructed system.

The City of Phoenix Standard Details for catch basins, particularly Nos. 216, 217, and 218 have good hydraulic capacity. An attempt to evaluate this was made in Ref. 4 (p. 64), however this assumed clean gratings which is not very realistic. Ref. 12 (p. D-7) recommends use of gratings on streets with a slope greater than 0.05 and it is probably good practice to discount a portion of the grated area for the flat slopes that are general in the area on this report. Ref. 15 (p.20) indicates that twice the ideally required area should be provided for grated openings.

Criteria for inlet design are set forth in Ref. 15 (which has only recently become available). Inlets, like the initial collector piping previously mentioned, are not within the scope of this report and consideration here is limited to that required to estimate the number of inlets and amount of small piping necessary to drain the street occupied by the trunk drain itself. For this purpose a plot of curb inlet capacities for various standard openings and on a range of longitudinal street slopes was prepared. This is presented in Fig. 4.1 which follows. The equation used is given in Ref. 14 (equa. 3, page 150). Fig. 4.1 shows the value of the constant "K" as being a function of street cross-slope at the gutter but since this is shown to be a relatively insensitive relationship and since the cross-slope varies in a narrow range, the value is assumed to be 0.23 in the curves.







CURB INLET CATCH BASIN CAPACITIES

$$Q = (K + C)\,WD\sqrt{gD}$$

K = 0.23 (a constant dependent upon θ)

$$C = \frac{0.45}{1.12^{\left(\frac{WV^2}{g\,a\,D\tan\theta}\right)}}$$

W = length of curb opening in feet

V = mean flow velocity at upstream end of inlet in feet per second

g = 32.2 feet per second per second

D = depth of flow in feet above normal gutter grade

a = depth of depression at curb in feet

Q = total inlet capacity in c.f.s.

θ = angle between gutter cross slope and vertical curb at inlet

FIGURE 4.1

4.2 Utility Interference

Maps of existing water and sewer systems were consulted in planning the layout of major drainage trunks. Principal interference was expected from sanitary sewer lines and large water feeders. Gas, irrigation, and other systems are generally shallow enough that they will be able to go over the drain lines without difficulty. Investigation showed that the 18-/21-inch sanitary trunk sewer on Wood Street will be the most difficult to cross. Specially designed low-head structures will be necessary at all four crossings of this line. This expedient has been used before in Phoenix in several locations on both sanitary and storm sewers. It need not affect head losses appreciably and is generally less expensive than deepening the storm drain.

Parallel utilities influence the plan location of storm drains in the street right-of-way. The scale of Plate III is too small to indicate where drains should be placed in order to minimize interferences with parallel existing lines. Table 4.1 suggests the most favorable locations based on a study of utility maps and a superficial inspection of the street. The final location is a matter to be settled in the ultimate design, however, it is strongly recommended that corridors be set aside for the storm drain lines and kept free of other new construction even though the drains may not be built for several years. If these corridors are kept clear of parallel utilities and if a suitable vertical zone is kept free of crossing lines, the ultimate savings in storm drain construction cost will be well worth the trouble.

Table 4.1 - Suggested plan locations for new storm drain trunks

Line	Location	Reach	Best Location
A	7th Street	Western Canal to Vineyard Rd.	East of centerline
		Vineyard Road to Southern Ave.	East side of R/W
		Southern Ave. to Sunland Ave.	West side of R/W
		Sunland Ave. to river	Near centerline
B	16th Street	Western Canal to Southern Ave.	West side of R/W
		Southern Ave. to river	Near centerline
C	24th Street	Western Canal to Vineyard Rd.	Between water and sewer
		Vineyard Rd. to Broadway Rd.	Near centerline
		Broadway Rd. to river	West side of R/W
D	Broadway	48th St. to 30th St.	North side of R/W
	30th Street	Broadway Rd. to river	West side of R/W
E	32nd Street	Western Canal to Vineyard Rd.	Near centerline
		Vineyard Rd. to Southern Ave.	West side(relay some 12" ACP)
		Southern Ave. to Roeser Road	West side of R/W
		Roeser Rd. to Broadway Rd.	East side of R/W
F	40th Street	Western Canal to Broadway Rd.	East side of R/W
G	48th Street	Western Canal to Southern Ave.	East side of R/W
		Southern Ave. to Broadway Rd.	East side of R/W

The City of Phoenix has preliminary plans for a large diameter water transmission main (Project No. W-67053.00(BI) which will present extensive co-ordination problems. Our profiles have ignored this main because its status remains indefinite and because the designer of the watermain has freedom to alter its vertical placement. Storm drains on the other hand must be kept within very narrow vertical constraints established by the minimum street elevation and the minimum flowline elevation at the point of discharge. Furthermore, deviations may be recovered very quickly with small head loss in a waterline whereas they must be made at small gradients over the relatively large distances in a gravity line. When final plans are drawn for the water transmission main, especially if this is to be constructed before the storm drains, consideration should be given to ultimate storm drain requirements, both for trunk lines and for connecting lateral lines.

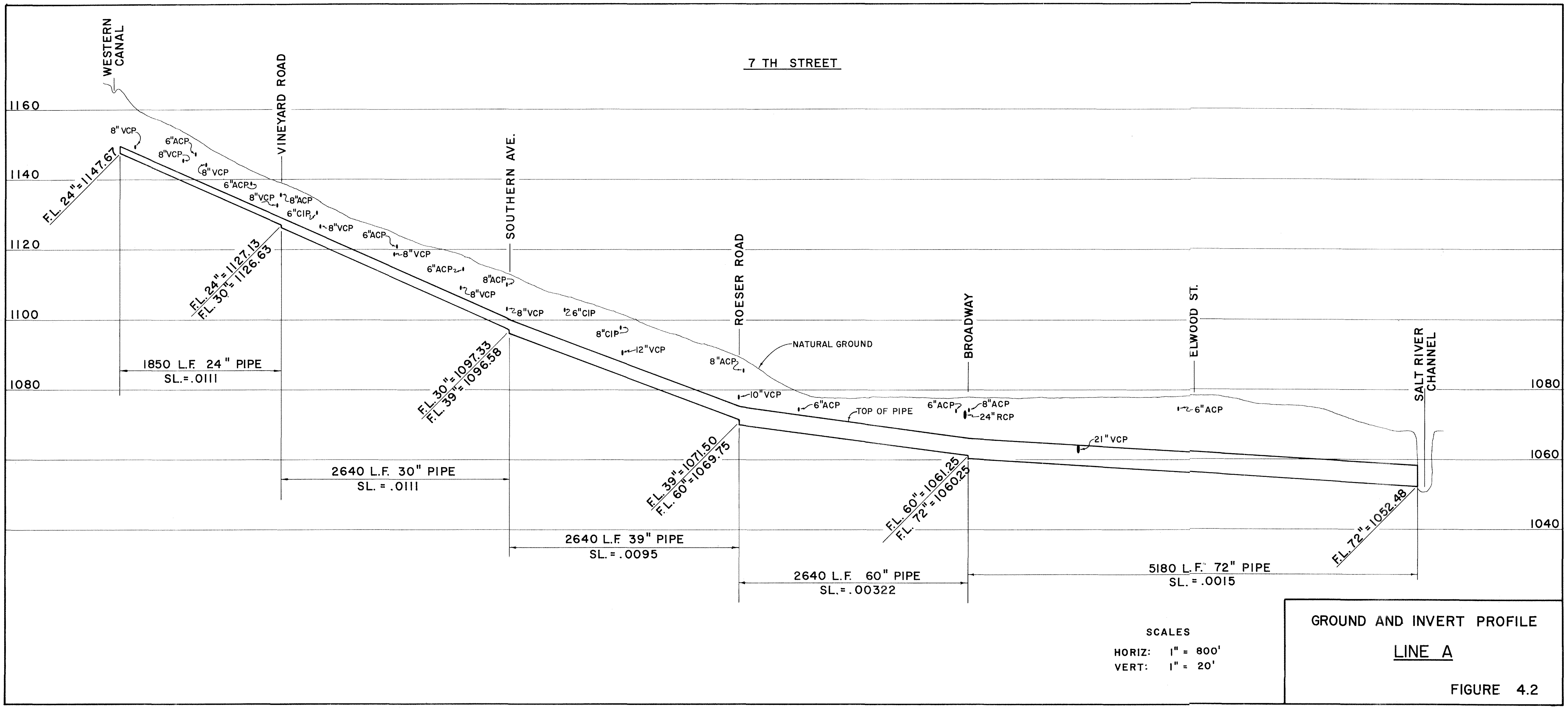
4.3 Proposed System

The recommended drainage layout is shown in red on Plate III. It consists of four major systems each extending from the Western Canal to the Salt River. The first three, proceeding from west to east, each serve a strip one mile wide. The fourth system discharges to the river near 30th Street but it has 3 main branches heading at the Western Canal at 32nd, 40th and 48th Streets respectively. The three branches carry water north to join the main trunk of the fourth system on Broadway Road. This carries flow westward from 48th Street to 30th Street and then turns north to the river. Each system has laterals at half-mile intervals that extend one-half mile east of the main north-south trunk to pick up flows from the eastern tier of quarter sections.

The systems shown in Plate III would require 24.5 miles of pipe ranging in size from 24-inch to 90-inch diameter. The sizes are adequate for the design flows developed in Section 3 provided pipe is laid at an adequate depth and gradient, and provided that pipe with a Manning's "n" not greater than 0.012 is used. This would be reinforced concrete pipe meeting requirements of American Society for Testing and Materials Standard C-76. If other pipe is used an appropriate revision of "n" value should be made and the sizes recomputed. In the final design due consideration should be given to head losses arising from junctions, transitions, and bends since these can have an appreciable effect on the elevation of the hydraulic gradient. Methods of computing such losses are conveniently described in Ref. 12. The design hydraulic gradient should be below the soffit of the trunk line pipe and at least three feet below the lowest gutter elevation in the finished street pavement to allow for head losses in the catch basin and connecting piping.

Trunk lines have been located on the major arterial thoroughfares wherever possible because it is here that right-of-way widths are generally adequate for large-diameter pipe and because it is along the arterials that the need for good drainage is normally most critical.

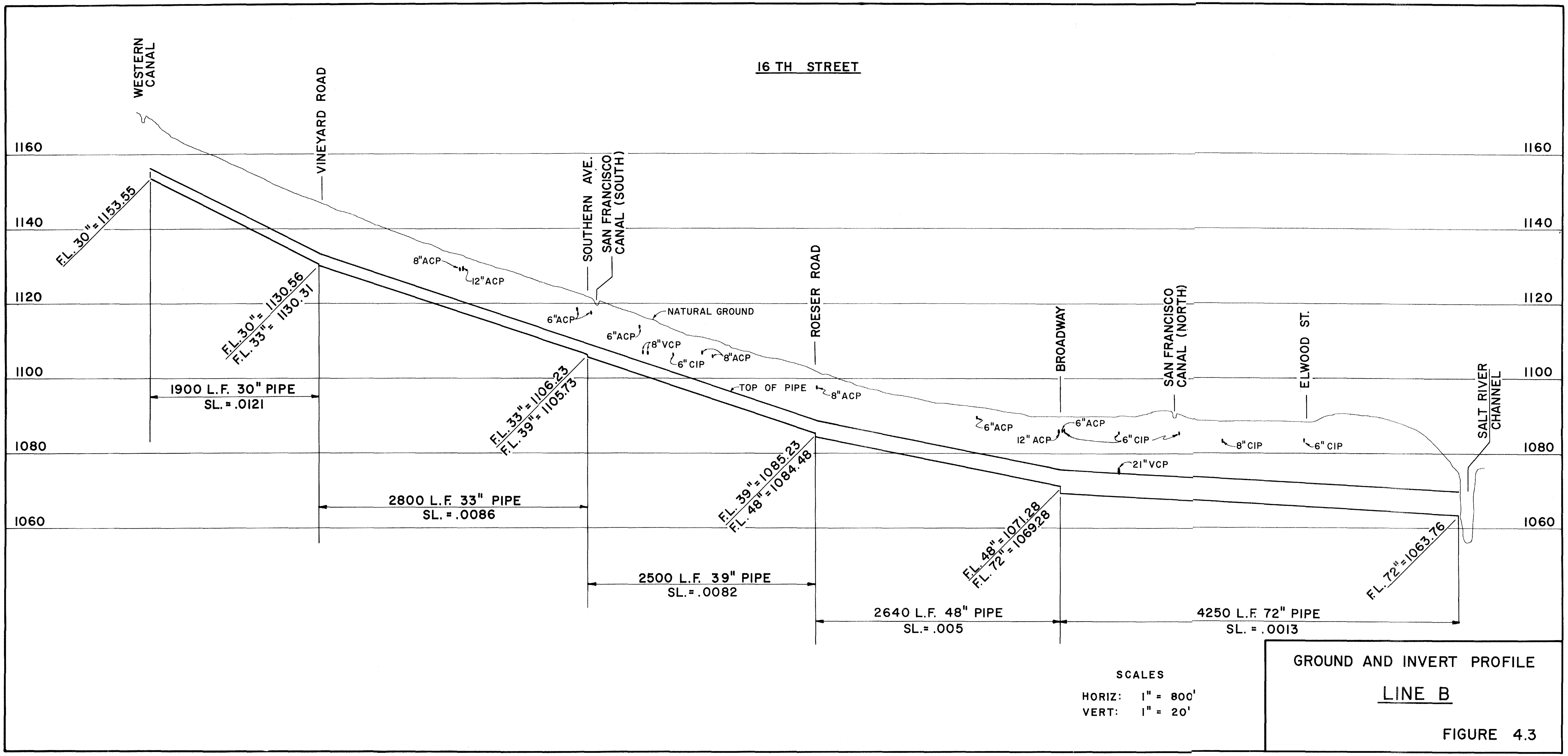
Profiles were drawn for each of the trunk lines "A" through "G" shown in Plate III in order to determine what hydraulic gradient should be used for design, what the outlet elevation should be, and to pinpoint the locations of critical utility interference. Figures 4.2 through 4.8 shows these profiles. The trench depths for the storm trunks will generally vary from 10 to 25 feet with most of the pipe in the 16- to 20-foot range. This will allow most utilities to cross over the drain with adequate cover and will provide sufficient depth of fall at catch basins. The hydraulic grade lines for design flow are not shown in the profiles because they fall near or under the soffit line of the pipe for the sizes selected. Hydraulic grade line is given in Appendix 4.1. The calculations are only carried to a degree of refinement necessary to fix the design water depth within a tolerance of 2 or 3 tenths of a foot. These should be redone for final design conditions. The water surface



GROUND AND INVERT PROFILE

LINE A

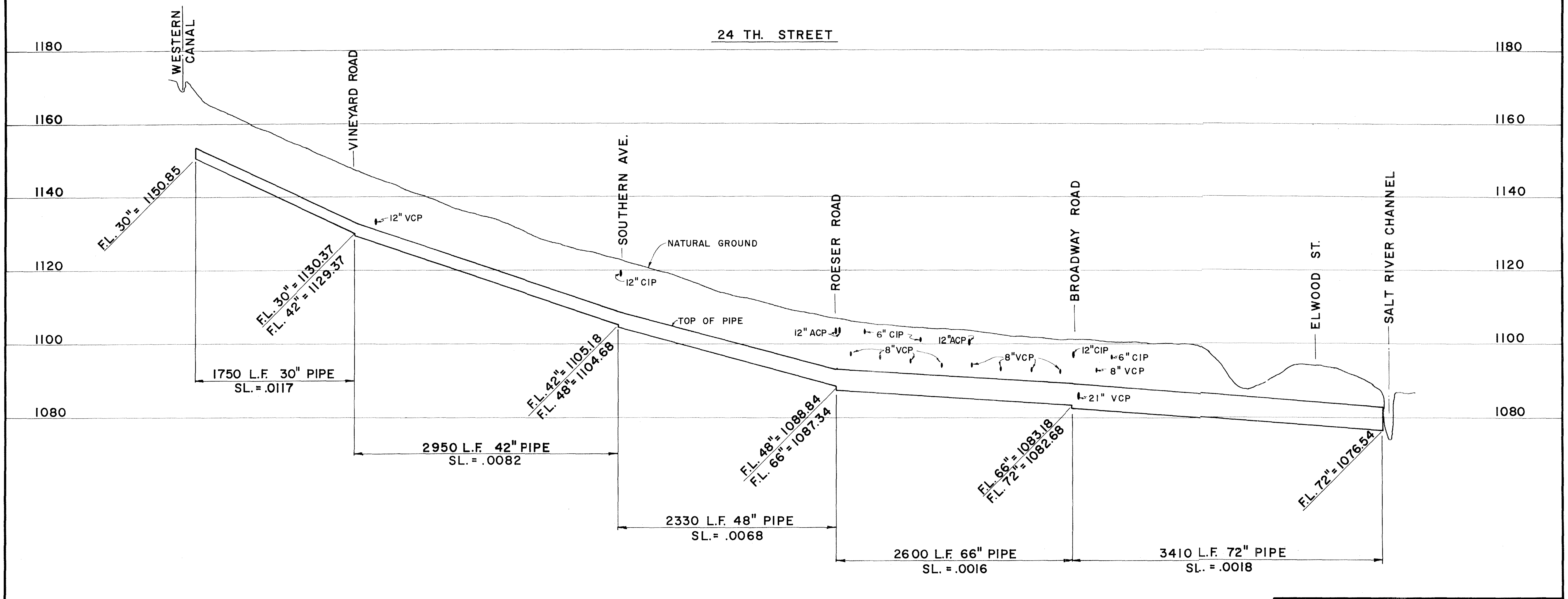
FIGURE 4.2



GROUND AND INVERT PROFILE

LINE B

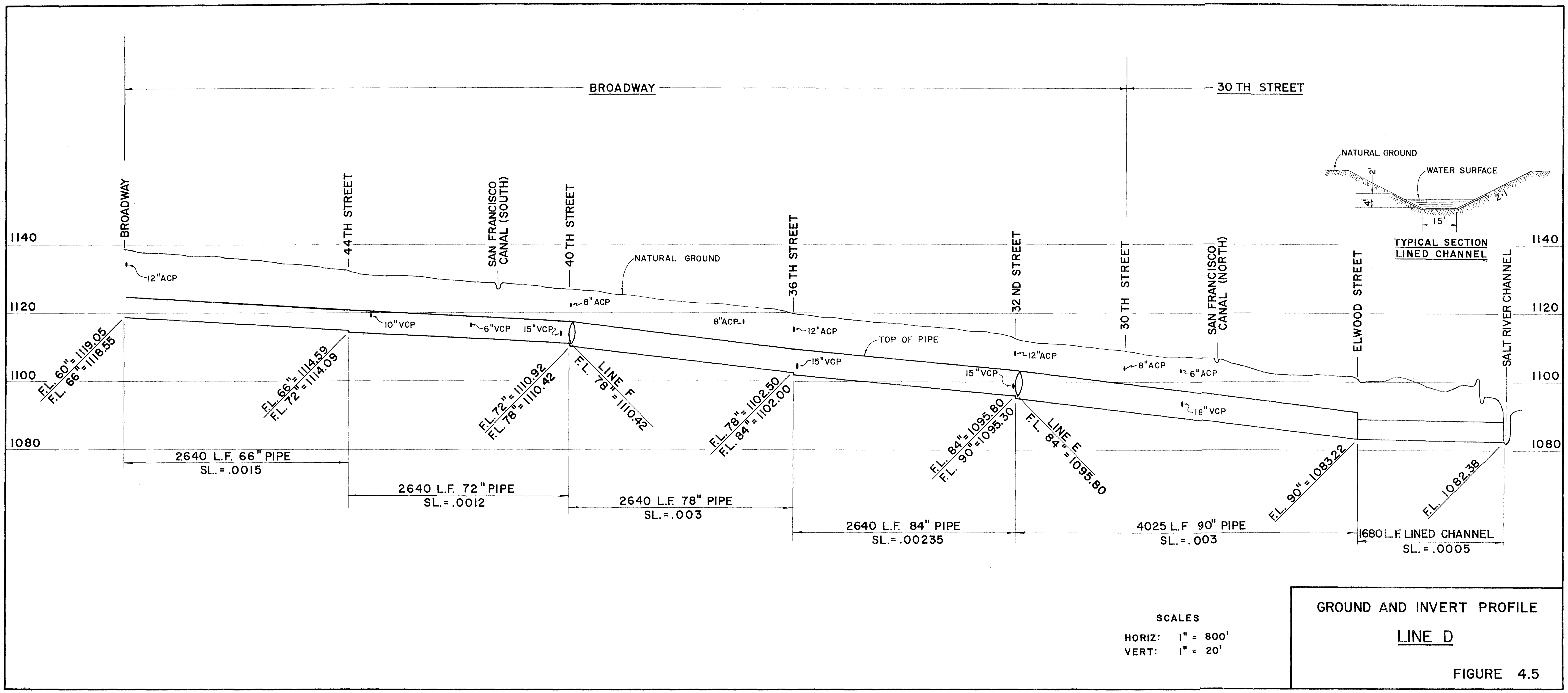
FIGURE 4.3



GROUND AND INVERT PROFILE

LINE C

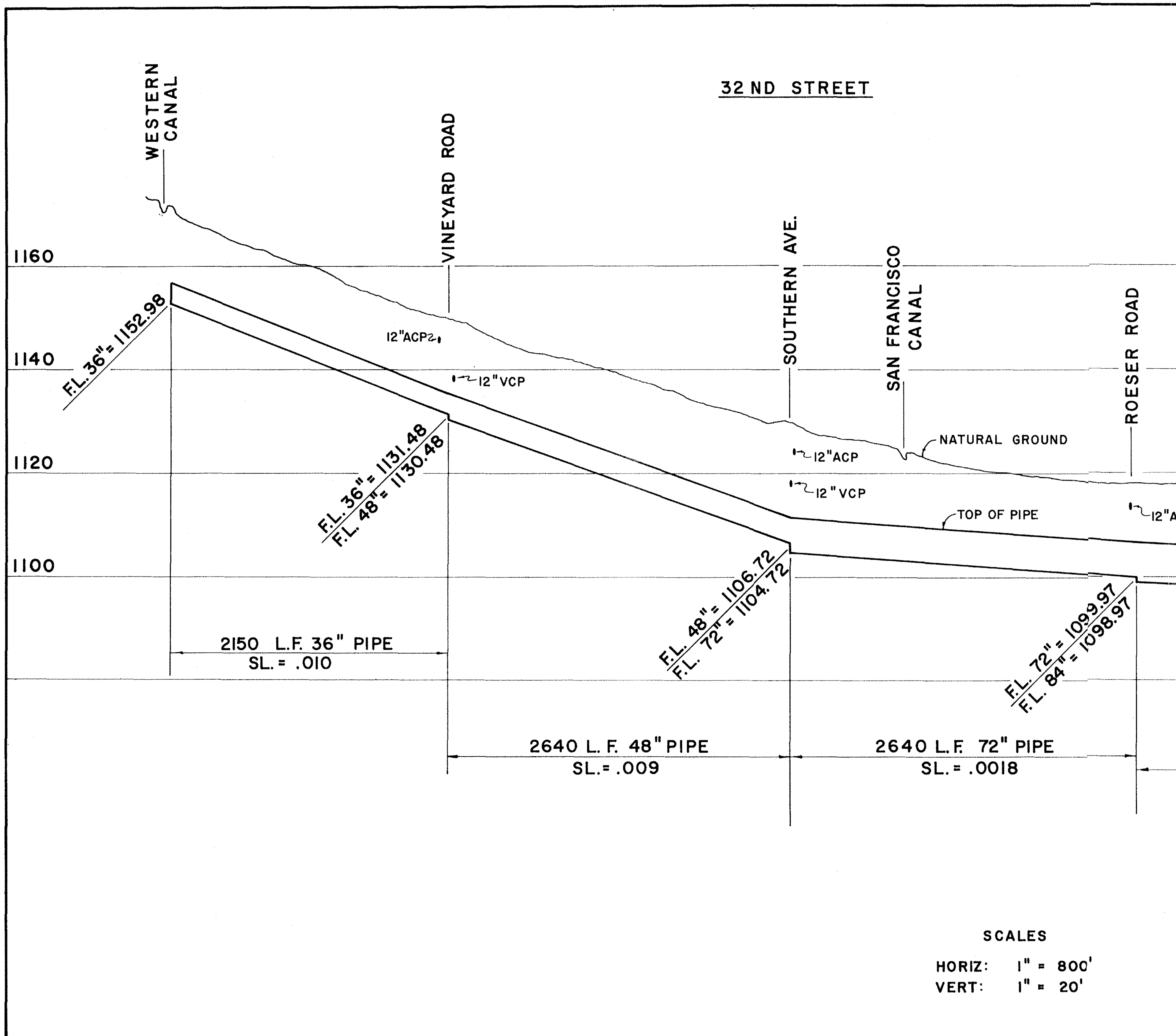
FIGURE 4.4



GROUND AND INVERT PROFILE

LINE D

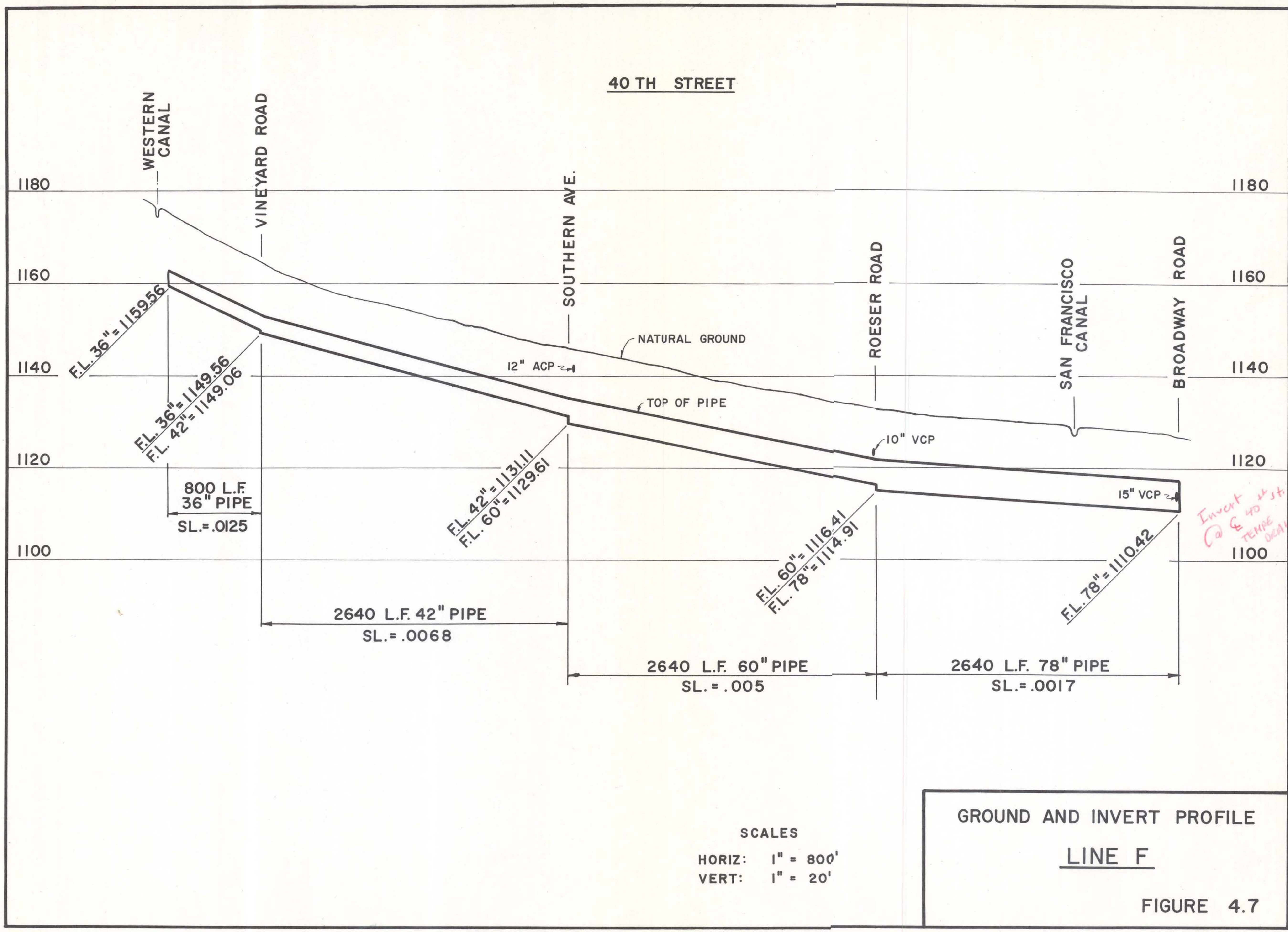
FIGURE 4.5



GROUND AND INVERT PROFILE

LINE E

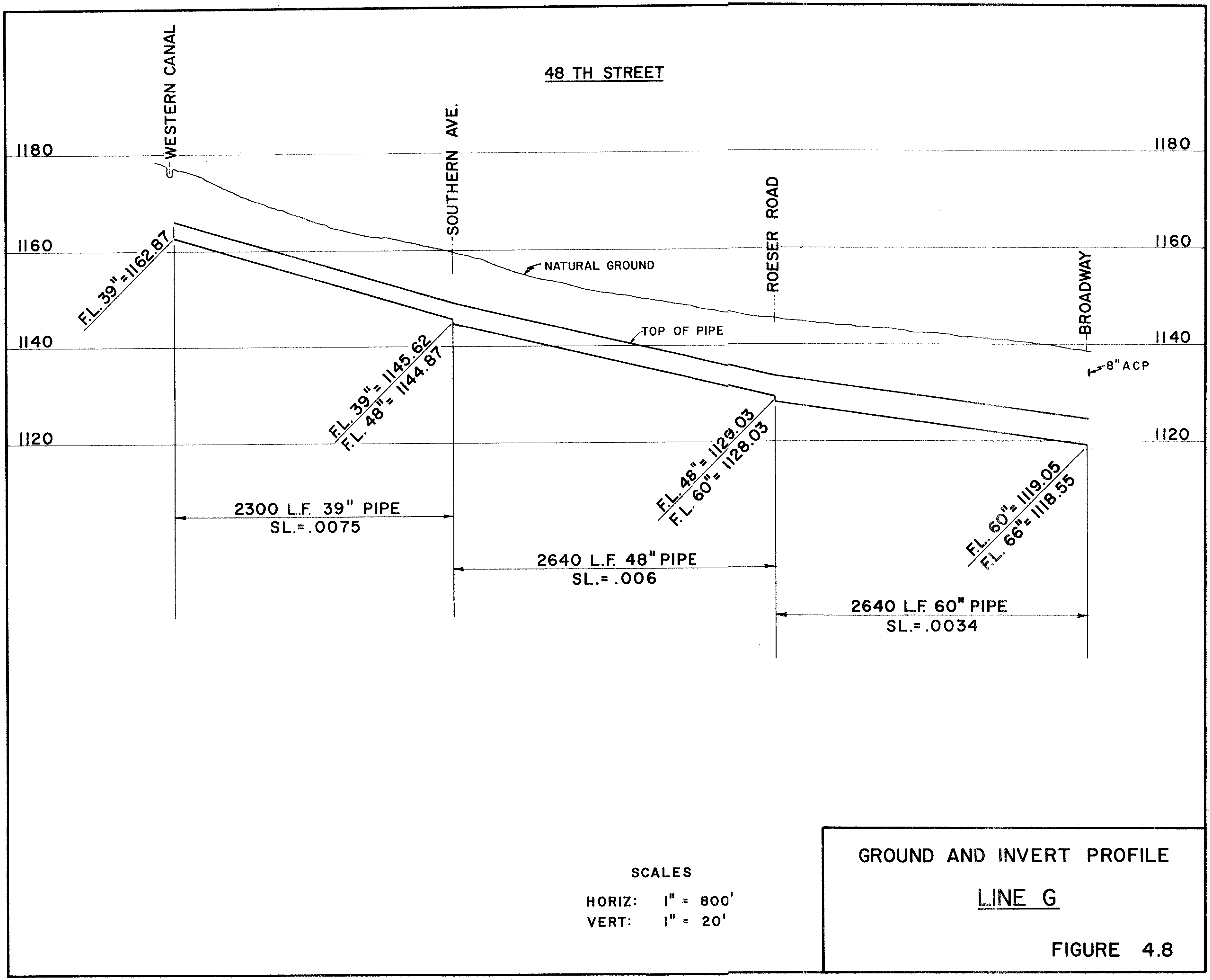
FIGURE 4.6



GROUND AND INVERT PROFILE

LINE F

FIGURE 4.7



GROUND AND INVERT PROFILE

LINE G

FIGURE 4.8

at the point of discharge of each line is unknown therefore it is assumed in the calculations that the pipe is just flowing full at its termination.

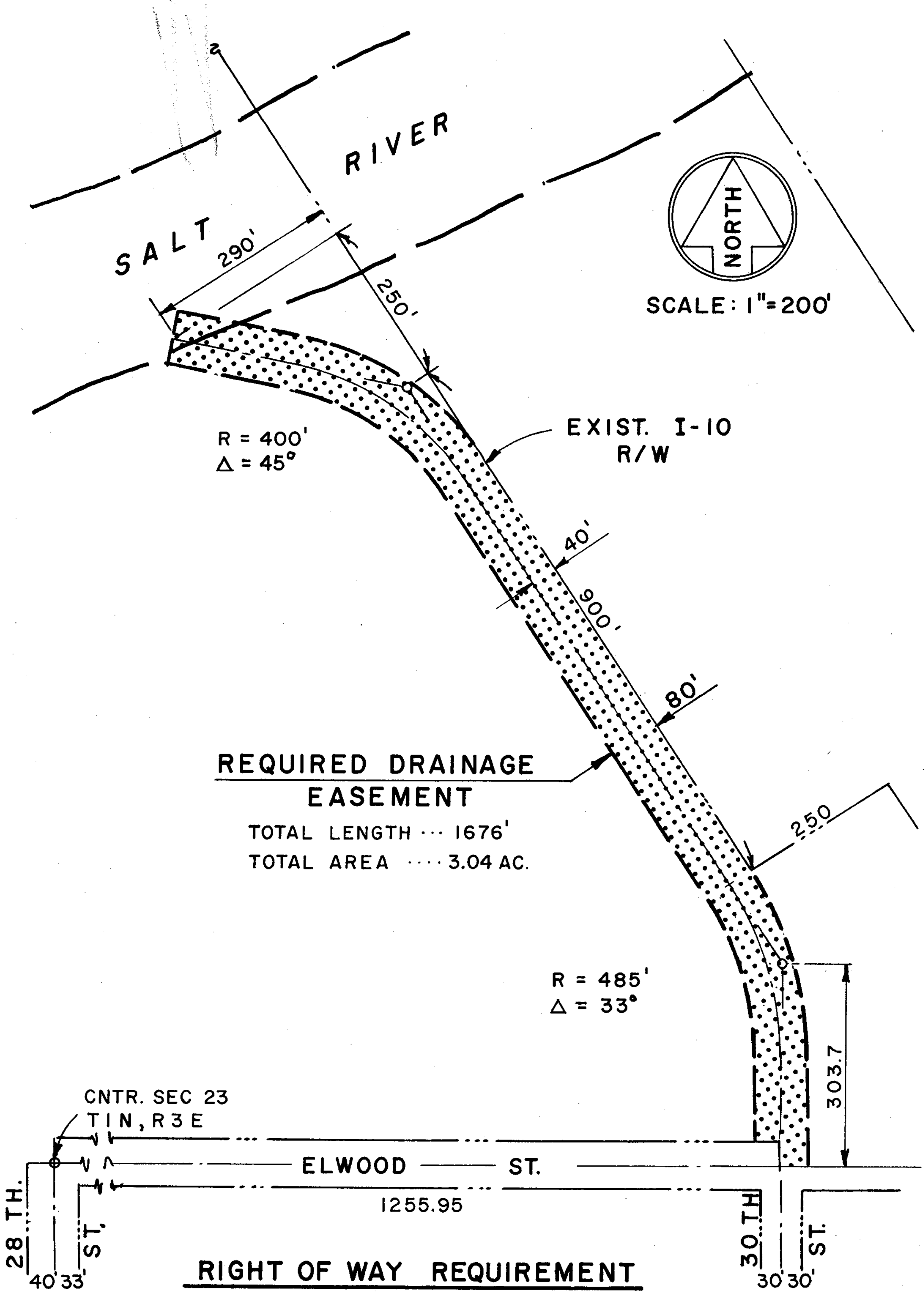
An open channel is shown for the lower portion of Line D because of the flat grade of the terrain and the shallowness of the river at the point of discharge. Appendix 4.2 presents the sizing computation. If the Salt River is channelized and lowered prior to construction of Line D, it may be possible to eliminate the open channel and extend the trunk as a pipe all the way to the river. Pipe sizes in the lower reaches of the other lines might also be reduced in this case by steepening the gradients.

4.4 Right-of-Way Requirements

The section and midsection line roads suggested as routes for the trunk drains shown in Plate III generally have adequate right-of-way for the proposed pipelines. One exception is Vineyard Road, one half mile south of Southern Avenue, which apparently is not dedicated at all between 7th and 12th Streets, between 16th and 20th Streets, between 32nd and 36th Streets, and between 40th and 44th Streets. Land in this area is still mostly in citrus groves and when subdivision occurs the right-of-way will undoubtedly be provided.

All the north-south midsection lines between 7th and 48th Streets have long reaches where no dedications have been made but the proposed system layout is such that 2-year protection can be provided without using these streets for trunk drains.

The only area where right-of-way is needed as soon as possible after actual planning for construction begins is at the foot of 30th Street and the Salt River. The 30th Street right-of-way goes no farther north than Elwood Street but the low flow channel of the river is about 1750 feet farther north. The Maricopa Freeway right-of-way has been widened at the river crossing beyond requirements for the roadway proper and it may be possible to use a portion of this to accommodate the outfall channel. If this is not feasible the new channel can parallel the freeway on the west. Fig. 4.9 shows the situation at this point.



RIGHT OF WAY REQUIREMENT FOR LINE D

FIGURE 4.9

4.5 Drainage of Tempe Lands

The proposed 48th Street trunk drain and a substantial portion of the capacity of the Broadway Road Line (Lines G and D, Plate III) are required for drainage of land within the corporate limits of Tempe. The problem of joint facilities serving two or more municipalities was dealt with in Ref. 4 (p. 74 ff). There is a good precedent for jointly sponsored public works projects among valley cities, particularly in the sanitary sewers and sewage treatment area, and it should be feasible for Phoenix and Tempe to reach a mutual satisfactory arrangement in this case also.

5. Priorities and Costs

The study area of this report is only a small fraction of the area encompassed by the City of Phoenix and any suggested schedule of priorities must be considered in the context of the city-wide storm drainage program. The City's 5-year capital improvement program (Ref. 13) envisions construction of trunk drains on 16th, 24th, and 40th Streets within the area, with priorities in the order mentioned. In this section further consideration is given to priorities within the area itself without attempting to relate them to requirements of the City as a whole. Consequently the suggestions are merely relative and no definite dates are assigned.

Cost estimates are based on current material prices and labor rates expected to become effective July 1, 1972. It is hoped that installation cost allowances are high enough to cover the expenses of the new and more stringent safety requirements of the Occupational Safety and Health Act of 1970. Experience with these regulations is too limited at this writing to be certain of their effect on pipeline construction costs. The estimates 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. Extension of the system into the subdivision street network are not included. It is assumed that work will be done in units of about $1,000,000 contract value. Moderate contractor's overhead and profit are included.

Unit costs for pipe drains in Table 5.1 were developed for pipe sizes ranging from 24 to 96 inches. The column headed "Best Total Cost Per Lin. ft." represents the cost of lines in streets where no pavement replacement is required, where soil conditions are normal, and where there is no unusual conflict with other utilities. The usual condition in the city streets will require pavement cut and replacement and perhaps the relocation of a parallel water, gas, or sewer main to permit the installation of the storm drain. There will also be numerous perpendicular crossings of such lines. It is presumed that about 6 percent of pavement replacement will be Type A, 94 percent Type B, and that replacement widths will be from 2 to 8 feet wider than nominal trench widths. The very worst conditions which require cutting through concrete paving, moving of parallel utility lines, or extensive shoring of trenches will cost more per foot than the column headed "Total Cost in Built-Up Areas Per Lin. Ft." In the estimates which follow some adjustments for the effects of known local peculiarities have been made in arriving at the total cost of a line.

TABLE 5.1 - Development of Unit Costs for Trunk Drains

Pipe Size Inches I.D.	Excavation and Backfill					Pipe* Cost Per L. F.	Installa- ion Cost Per L. F.	Intersection Costs		Best Total Cost Per L. F.		Paralleling Cost Per L. F.		Total Cost In Built-Up Areas Per Lin. Ft.		Pipe Size Inches I.D.
	Trench Width Ft.	Trench Depth Ft.	Cu. Yds. Per L. F.	Cost Per Cu. Yd.	Cost Per L. F.			Inlet Cost Per L.F.	Utility X-ing Cost Per L.F.	Total	Use	Pavement Cut and Replace- ment	Utility Reloca- tion	Total	Use	
24	3.8	14.2	2.00	$0.60	$1.20	$7.75	$3.30	$5.00	$0.36	$17.61	$17.50	$4.21	$4.10	$25.81	$26.00	24
27	4.3	15.0	2.39	0.60	1.43	8.75	3.50	5.00	0.38	19.06	19.00	4.58	4.50	28.08	28.00	27
30	4.6	15.6	2.66	0.60	1.59	9.45	4.69	5.00	0.39	21.12	21.00	4.79	4.90	30.69	30.50	30
33	4.9	16.1	2.92	0.60	1.75	10.53	5.90	5.00	0.41	23.59	23.00	5.00	5.25	33.25	33.50	33
36	5.2	16.6	3.20	0.60	1.92	11.45	6.19	6.00	0.42	25.98	26.00	5.22	5.60	36.82	37.00	36
39	5.8	17.0	3.65	0.60	2.19	12.93	7.35	6.00	0.44	28.91	29.00	5.66	5.80	40.46	40.50	39
42	6.3	17.2	4.02	0.60	2.41	14.40	8.50	6.00	0.47	31.78	32.00	6.02	6.00	44.02	44.00	42
48	6.8	17.8	4.49	0.60	2.69	17.10	9.35	6.00	0.49	35.63	35.50	6.39	6.40	48.29	48.50	48
54	7.4	18.2	5.00	0.60	3.00	20.10	10.90	6.00	0.52	40.52	40.50	8.26	6.75	55.51	55.50	54
60	8.0	18.5	5.48	0.65	3.56	24.00	11.20	6.00	0.55	45.31	45.50	8.70	7.10	61.30	61.50	60
66	9.3	18.7	6.45	0.65	4.19	28.00	12.25	7.00	0.58	52.02	52.00	9.65	7.50	69.15	69.00	66
72	9.8	18.9	6.86	0.65	4.46	32.60	13.60	7.00	0.61	58.27	58.50	12.92	7.90	79.32	79.50	72
78	10.4	18.8	7.25	0.65	4.71	38.25	15.20	7.00	0.65	65.81	66.00	13.35	8.25	87.60	87.50	78
84	11.0	18.3	7.46	0.70	5.22	42.20	16.90	7.00	0.68	72.00	72.00	13.80	8.60	94.40	94.50	84
90	11.6	17.6	7.57	0.70	5.30	47.40	18.60	7.00	0.71	79.01	79.00	14.22	9.00	102.22	102.00	90
96	12.2	17.0	7.69	0.70	5.37	58.60	20.60	7.00	0.74	92.31	92.50	14.65	9.40	116.55	116.50	96

*Tongue and Groove Joints C-76 Class III

5.1 Detailed Priority Considerations

The order in which work is done will be determined by decisions which take into account at least the following factors:

a. The functional requirements of the system. Under normal circumstances the lower, or downstream portion of any particular drainage trunk is built first.

b. Street paving program. In order to avoid unnecessary pavement cut and replacement, drains should be installed in advance of pavement whenever possible.

c. Relief of areas having inadequate drainage. Such areas are sources of continuing citizen complaint, require excessive street maintenance, and are a hazard to public health and safety.

d. Growth trends. Areas building up rapidly or developing a type of land use in which good drainage is essential tend to receive favorable treatment in planning and scheduling drainage projects.

5.1.1 Functional requirements. These dictate that the "outfall" portion of each drain, say from the line of Broadway Road to the Salt River be built before the remainder of the system. Fortunately a receiving channel is present and it is known that the ultimate channel will be deeper than the present one. It is also fortunate that the most densely settled areas and those with local drainage problems caused by flat or adverse grades are near the river. Thus factors a, c, and d all encourage early construction of the lower or northern portion of each trunk line.

5.1.2 Street paving programs. Present planning for street widening places arterial streets in the study area into three categories.

a. Those in the 6-year program, namely;

Broadway Rd. from 7th St. to 16th St.
Southern Ave. from 40th St. to 48th St.

b. After 1977 construction:

24th St. from Lower Buckeye Rd. to Broadway Rd.
Broadway Rd. from 24th St. to 48th St.
40th St. from Lower Buckeye Rd. to Broadway Rd.
16th St. from Broadway Rd. to Southern Ave.
Southern Ave. from 7th St. to 24th St.
Baseline Rd. from 7th St. to 48th St.

c. After 1977, if additional revenues become available:

7th St. from Southern Ave. to Baseline Rd.
Broadway Rd. from 16th St. to 24th St.
24th St. from Broadway Rd. to Southern Ave.

Interior streets, except for subdivision streets paved by dvelopers, would be paved under the improvement district program. There are no such projects under active consideration within the study area at the present time.

5.1.3 Areas with drainage problems. Local drainage problems are characteristic of the flat flood plain area between Broadway Road and Southern Avenue. Ref. 4 (Plate B) located seven of these in the study area:

1. South of Broadway Rd. from 7th St. to 16th St.
2. South of Old Southern Ave. from 7th St. to 12th St.
3. 16th St. from Chambers St. to Hidalgo Ave.
4. Chambers St. from 16th Pl. to 18th St.
5. The intersection of Southern Ave. and 20th St.
6. 24th St. from Southern Ave. to Sunland Ave. (extended)
7. 24th St. from Roeser Rd. to Broadway Rd.

Development of the area in the past two years has resulted in indications of potential difficulties in the following additional areas:

8. 22nd St. immediately south of Southern Ave.
9. 32nd St. immediately south of Broadway Rd.
10. 32nd St. immediately south of Interstate Route 10
11. 40th St. from Broadway Rd. to Roeser Rd.
12. Roeser Rd. from 40th St. to 44th St.
13. 24th St. south of the Highline Canal
14. 7th St. immediately south of Baseline Rd. and south of the Highline Canal
15. Chipman Rd. from 8th St. to 11th St.

The drainage difficulties in most of these areas would be alleviated by the construction of the trunk drains and laterals recommended in this report. Referring to the numbered areas, relief would be provided in the following manner:

Line A and its laterals would drain Areas 1 and 2. The Southern Avenue line between 7th and 12th Sts. could be on Old Southern Ave. instead. An extension of the 24-inch pipe in 7th St. beneath the Western and Highline Canals would serve Area 14.

Line B would drain Area 3, and a spur in Chambers St. would help Area 4. The Southern Ave. lateral would drain Area 5 and could be extended to Area 8.

Line C would drain Areas 6 and 7. An extension under the Western and Highline Canals would serve Area 13.

Lines D, E, F, and their laterals would drain Areas 9, 11, and 12. Area 10 cannot readily be drained by the proposed system. The natural drainage here has been cut off by the embankment for the 32nd St. - Maricopa Freeway overpass. A pipe jacked under the embankment discharging to a swale draining northwest along the freeway will solve this problem but this appears to be a Highway Department responsibility.

5.1.4 Growth trends. At the present time it appears that the most rapidly growing portion of the study area is in the northeast quadrant where single family, townhouse, and mobile home residential development is taking place. Several sizeable tracts may be seen in various stages of completion in the aerial photograph (Plate I). There is also a trend toward extensive industrial park construction in this area. Access to Interstate Route 10 is available from four different interchanges and this has undoubtedly influenced this growth.

5.1.5 Suggested priorities. Taking the above factors into account, the following order of construction is recommended at this time:

Seventh St.	Southern Ave. to Salt River
Broadway Rd.	48th St. to 30th St. & Salt River
24th St.	Southern Ave. to Salt River
16th St.	Southern Ave. to Salt River
Broadway Rd.	7th St. to 12th St., 16th St. to 20th St. and 24th to 28th St.
Southern Ave.	7th St. to 12th St., 16th St. to 20th St. and 24th to 28th St.
Roeser Rd.	7th St. to 12 th St., and 16th to 20th St.
48th St.	Western Canal to Broadway Rd.
40th St.	Western Canal to Broadway Rd.
32nd St.	Western Canal to Broadway Rd.
Roeser Rd.	24th St. to 28th St., 32nd St. to 36th St. 40th St. to 44th St.
Southern Ave.	32nd St. to 36th St., and 40th St. to 44th St.
7th St.	Western Canal to Southern Ave.
24th St.	Western Canal to Southern Ave.
16th St.	Western Canal to Southern Ave.
Vineyard Rd.	All lateral lines

Construction contracts may consist of portions or combinations of the items in this list. The list itself should be reviewed and rearranged as seems best considering conditions at the time the City is ready to proceed with further increments of its construction program.

5.2 Cost Estimates

Using pipe sizes from Plate III and unit prices from Table 5.1, costs for each trunk line and its laterals were developed as shown below. The unit prices used were adjusted in most cases between the "best cost" and "built-up area cost" to allow for intermediate construction conditions. Costs of right-of-way are not included but except for the extension of 30th Street to the Salt River rights-of-way should become available without cost as subdivision takes place.

Estimated Construction Costs

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line A - 7th St., trunk				
	24	1,850	$22.00	$40,700
	30	2,640	26.00	68,640
	39	2,640	35.00	92,400
	60	2,640	61.50	162,360
	72	5,180	79.50	411,810
Subtotal for trunk				775,910
Laterals				
	27	2,640	23.50	62,040
	36	5,280	34.00	179,520
	48	2,640	48.50	128,040
Subtotal for laterals				369,600
Total contract cost				1,145,510
Engineering and contingencies				229,090
Total Construction Cost - Line A				$1,374,600

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line B - 16th St., trunk				
	30	1,900	$26.00	$49,400
	33	2,800	28.00	78,400
	39	2,500	37.00	92,500
	48	2,640	48.50	128,040
	72	4,250	79.50	337,875
Subtotal for trunk				686,215
Laterals				
	27	2,640	23.50	62,040
	33	5,280	30.00	158,400
	39	2,640	40.50	106,920
Subtotal for laterals				327,360
Total contract cost				1,013,575
Engineering and contingencies				202,725
Total Construction Cost - Line B				$1,216,300
Line C - 24th St., trunk				
	30	1,750	$26.00	$45,500
	42	2,950	41.00	120,950
	48	2,330	48.50	113,005
	66	2,600	69.00	179,400
	72	3,410	79.50	271,095
Subtotal for trunk				729,950
Laterals				
	27	2,640	23.50	62,040
	33	2,640	28.00	73,920
	36	5,280	37.00	195,360
Subtotal for laterals				331,320
Total contract cost				1,061,270
Engineering and contingencies				210,230
Total Construction Cost - Line C				$1,271,500
Line D - Broadway, trunk				
	66	2,640	$69.00	$182,160
	72	2,640	79.50	209,880
	78	2,640	87.50	231,000
	84	2,640	94.50	249,480
	90	4,025	102.00	410,550
Subtotal for trunk				1,283,070
Lined channel to river	42	1,680	77.00	129,360
Total contract cost				$1,412,430
Engineering and contingencies				282,470
Total Construction Cost - Line D				$1,694,900

	Pipe Size In.	Length Feet	Unit Cost	Total Cost
Line E - 32nd St., trunk				
	36	2,150	$31.00	$66,650
	48	2,640	45.00	118,800
	72	2,640	79.50	209,880
	84	2,640	94.50	249,480
Subtotal for trunk				644,810
Laterals				
	33	2,640	28.00	73,920
	39	5,280	37.00	195,360
Subtotal for laterals				269,280
Total contract cost				914,090
Engineering and contingencies				182,810
Total Construction Cost - Line E				$1,096,900
Line F - 40th St., trunk				
	36	800	$31.00	$24,800
	42	2,640	41.00	108,240
	60	2,640	58.00	153,120
	78	2,640	87.50	231,000
Subtotal for trunk				517,160
Laterals				
	39	5,280	37.00	195,360
Total contract cost				712,520
Engineering and contingencies				142,480
Total Construction Cost - Line F				$855,000
Line G - 48th Street for trunk				
	39	2,300	$35.00	$80,500
	48	2,640	45.00	118,800
	60	2,640	61.50	162,360
Total contract cost				361,660
Engineering and contingencies				72,340
Total Construction Cost - Line G				$434,000

TOTAL ESTIMATED PROGRAM COSTS $7,943,200

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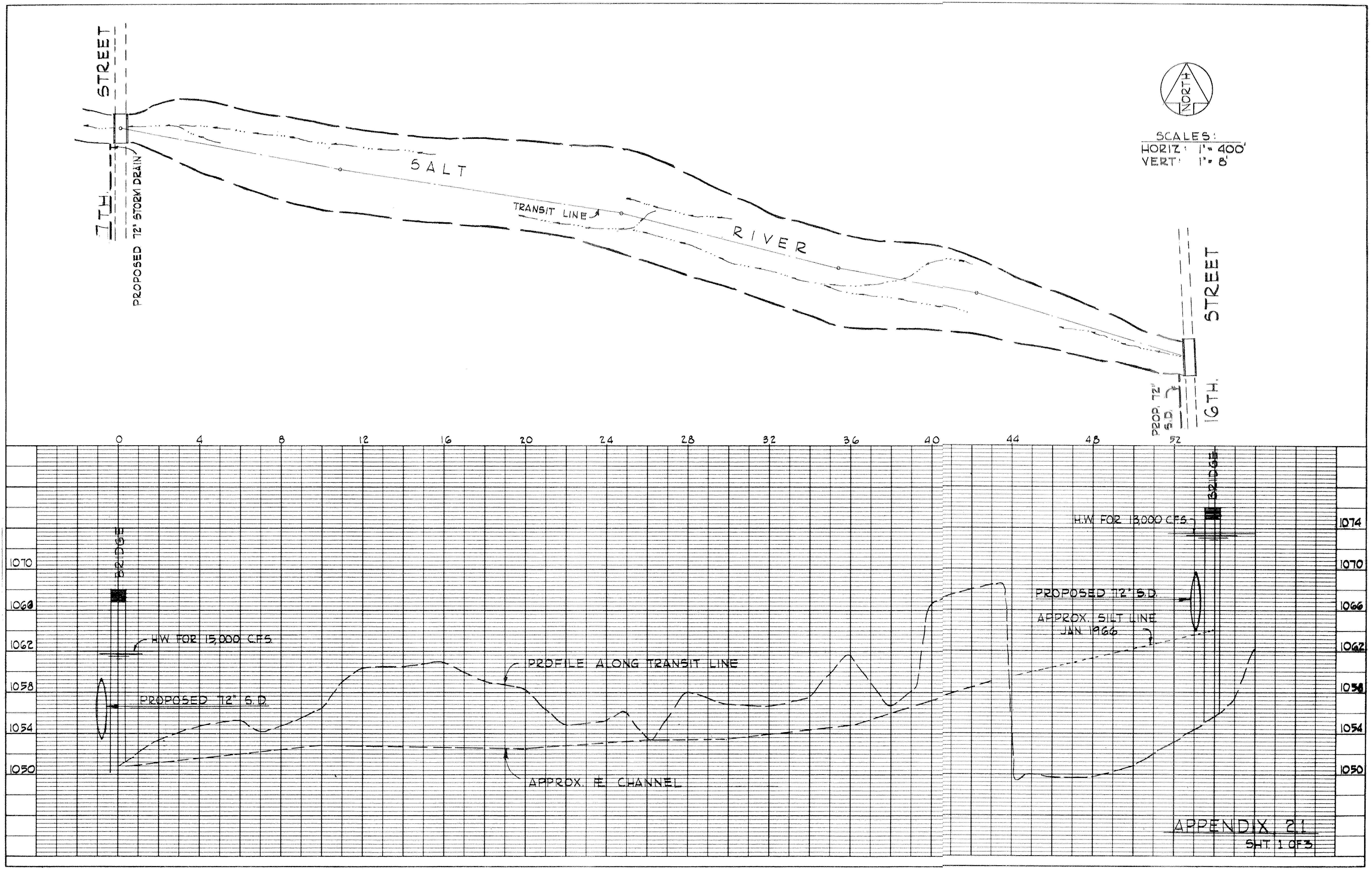
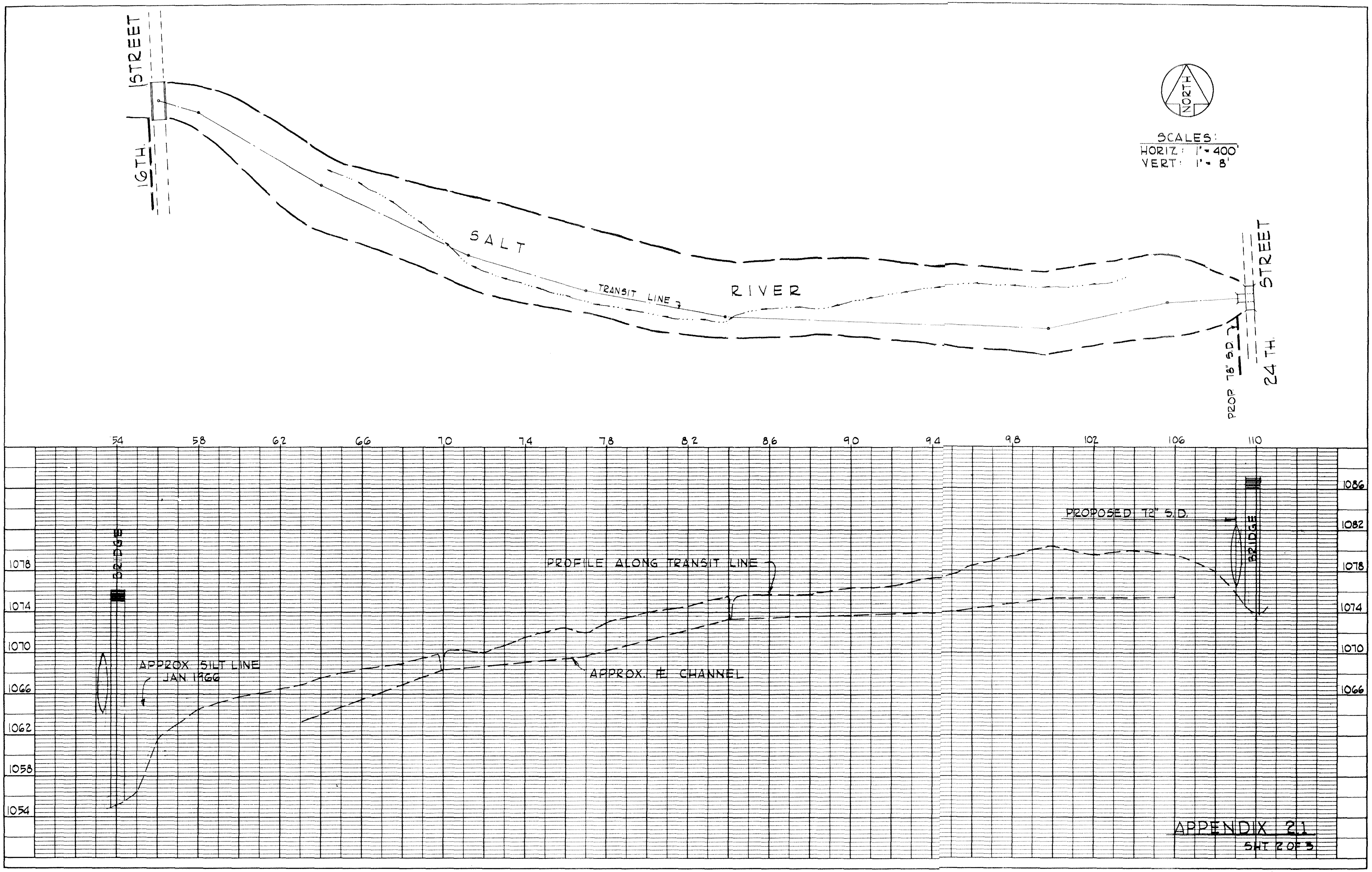
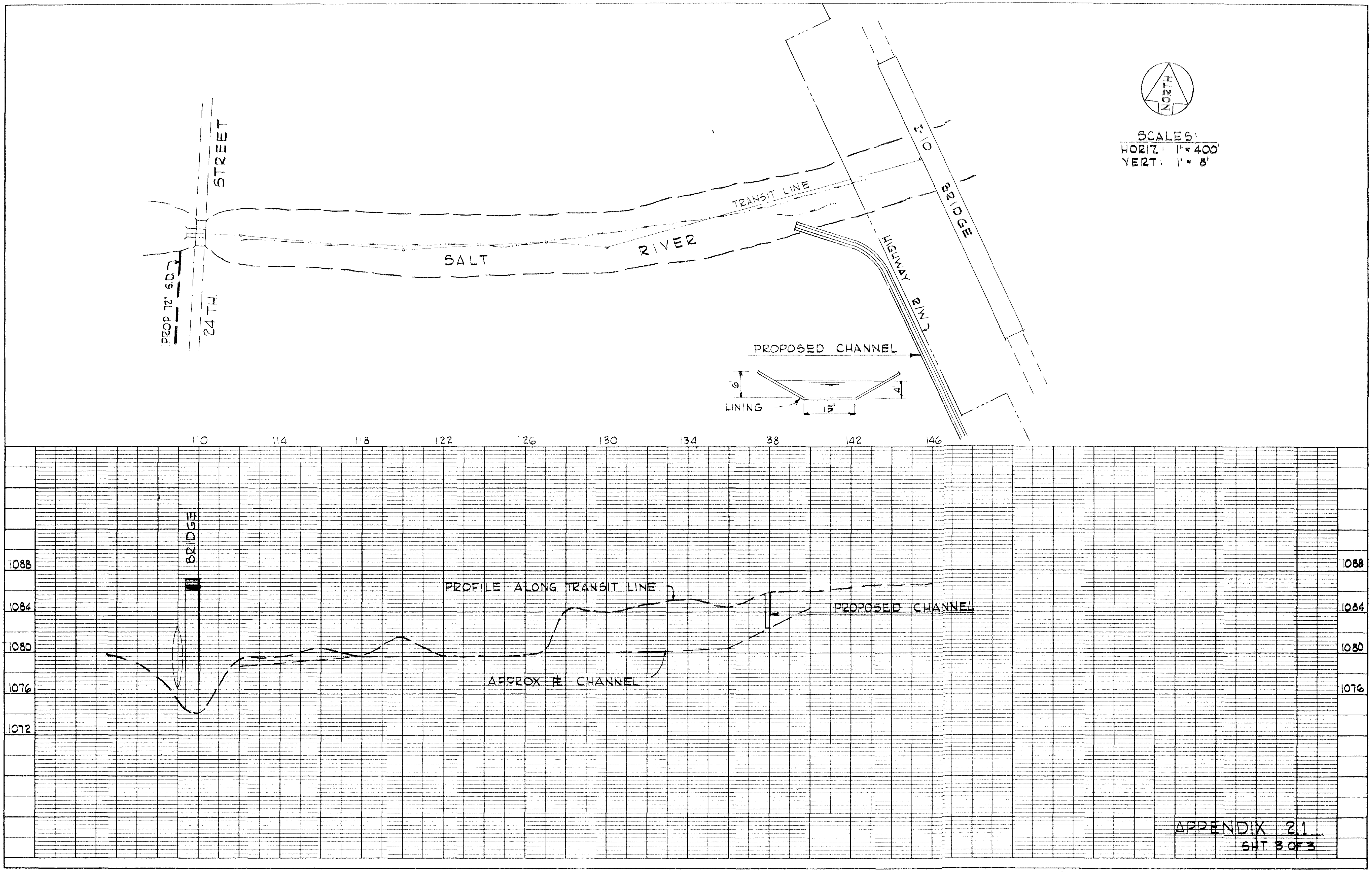

7TH STREET
PROPOSED 72" STORM DRAIN
SALT
RIVER
TRANSIT LINE
16TH STREET
PROP. 72" S.D.
NORTH
SCALES:
HORIZ: 1" = 400'
VERT: 1" = 8'
0
4
8
12
16
20
24
28
32
36
40
44
48
52
BRIDGE
H.W. FOR 15,000 C.F.S.
PROPOSED 72" S.D.
PROFILE ALONG TRANSIT LINE
APPROX. ℄ CHANNEL
H.W. FOR 13,000 C.F.S.
BRIDGE
PROPOSED 72" S.D.
APPROX. SILT LINE
JAN 1966
1074
1070
1066
1062
1058
1054
1050
APPENDIX 2.1
SHT. 1 OF 3



APPENDIX 21
SHT 2 OF 3



NORTH
SCALES:
HORIZ: 1" = 400'
VERT: 1" = 8'
24 TH. STREET
PROP 72" S.D.
SALT RIVER
TRANSIT LINE
I-10 BRIDGE
HIGHWAY R/W
PROPOSED CHANNEL
6'
4'
15'
LINING
110
114
118
122
126
130
134
138
142
146
1088
1084
1080
1076
1072
BRIDGE
PROFILE ALONG TRANSIT LINE
PROPOSED CHANNEL
APPROX ℄ CHANNEL
APPENDIX 21
SHT 3 OF 3

Yost and Gardner Engineers
Phoenix, Arizona

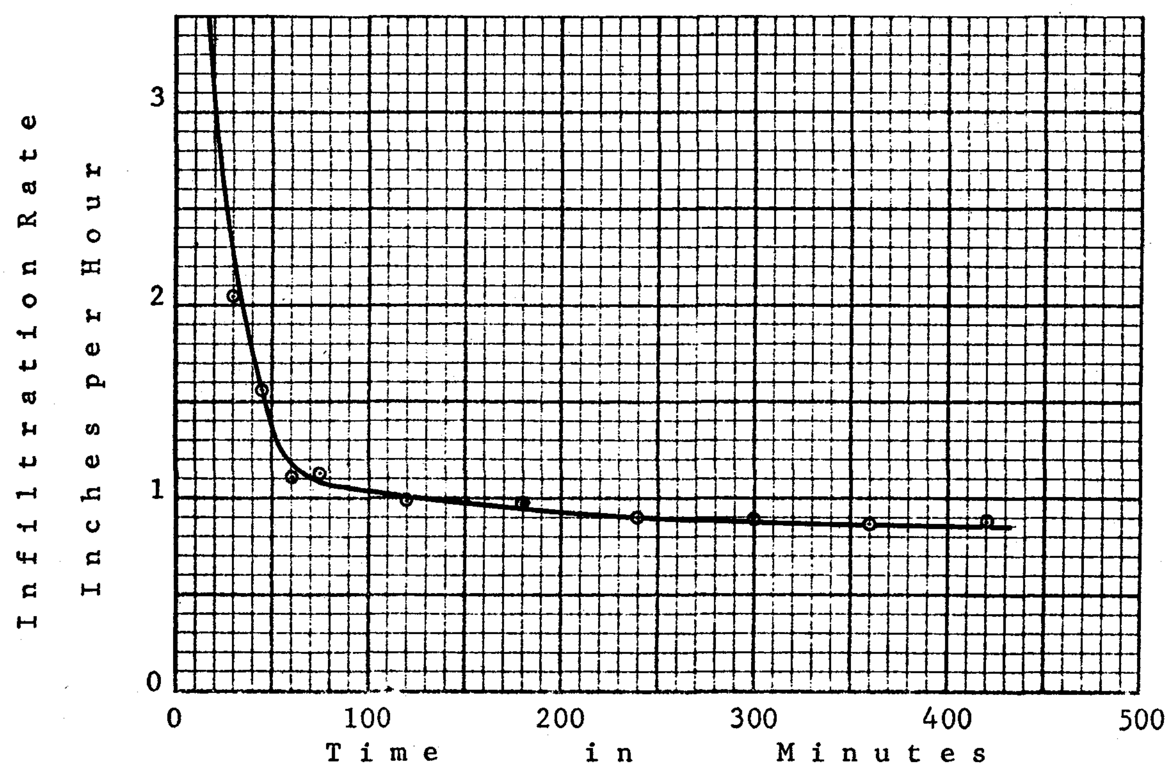
INFILTRATION TEST DATA
(Ref. USGS WSP #1544F)

Test No. 1 Location: 700' E. of 48th St.
100' S. of Western Canal
Date: 2/4/72 Site description: Cleared desert - dry weed cover -

By: T.B.G. Soil: sandy loam

Test cyl. diam.: 19.5 in., Length: 14.5 in., Gal. per vert. in.: 1.295

Time of reading	Elapsed time (mins.)	Quantity of water (ml.)	(gal.)	(in.)	Infiltration (in. per hr.)
9:35 a.m.	15	4810	1.27	0.98	3.92
9:50	30	2500	0.661	0.51	2.04
10:05	45	1925	0.51	0.392	1.57
10:20	60	1350	0.357	0.275	1.10
10:35	75	1380	0.365	0.281	1.12
10:50	90	1450	0.383	0.295	1.18
11:20	120	2440	0.645	0.496	0.99
12:20 p.m.	180	4750	1.255	0.97	0.97
1:20	240	4410	1.165	0.90	0.90
2:20	300	4340	1.15	0.885	0.89
3:20	360	4240	1.12	0.862	0.86
4:20	420	4380	1.16	0.892	0.89



Yost and Gardner Engineers
Phoenix, Arizona

INFILTRATION TEST DATA
(Ref. USGS WSP #1544F)

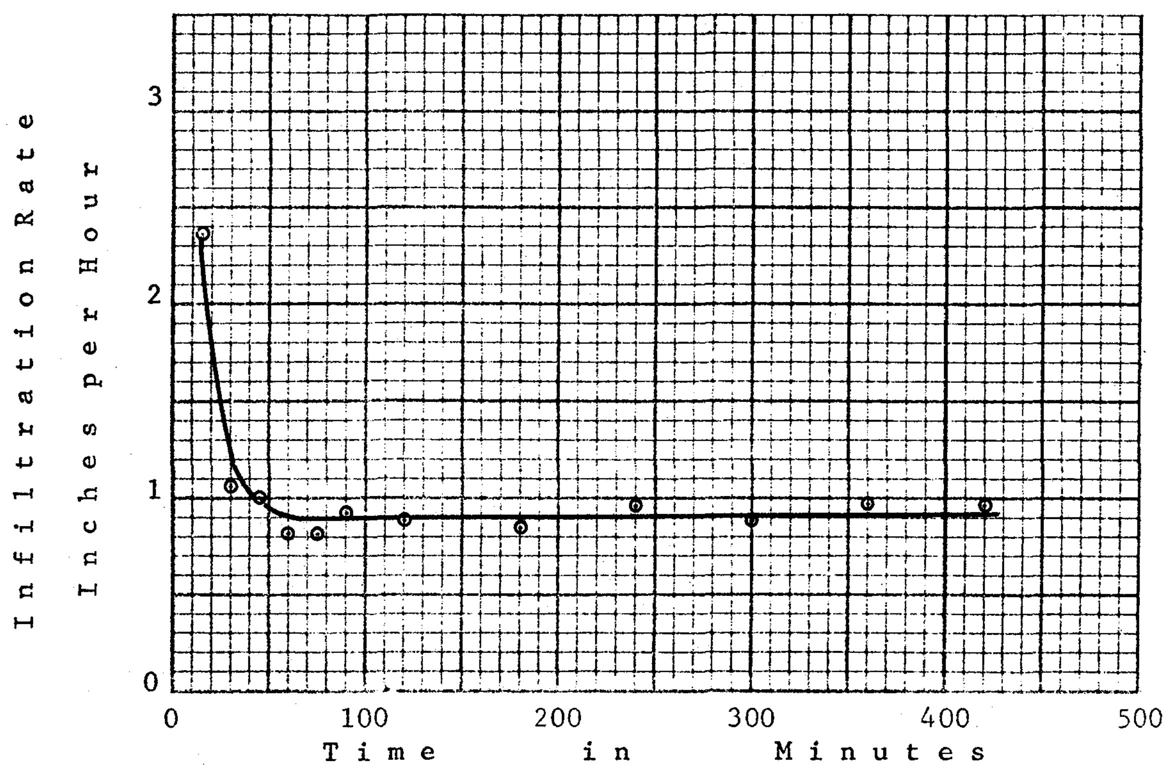
Test No. 2 — Location: 250' E. of 16th St. 100' S. of Highline Canal

Date: 2/7/72 — Site description: Cleared desert - sparse greasewood - mesquite trees - dry grass

By: T.B.G. — Soil: sandy loam

Test cyl. diam.: 19.5 in., Length: 14.5 in., Gal. per vert. in.: 1.295

Time of reading	Elapsed time (mins.)	Quantity of water (ml.)	(gal.)	(in.)	Infiltration (in. per hr.)
9:35 a.m.	15	2900	.766	0.59	2.36
9:50	30	1300	.344	0.265	1.06
10:05	45	1230	.325	0.25	1.00
10:20	60	1000	.264	0.603	0.81
10:35	75	1000	.264	0.203	0.81
10:50	90	1130	.299	0.23	0.92
11:20 a.m.	120	2200	.581	0.447	0.89
12:20 p.m.	180	4110	1.086	0.835	0.84
1:20	240	4720	1.25	0.962	0.96
2:20	300	4300	1.14	0.877	0.88
3:20	360	4780	1.263	0.972	0.97
4:20	420	4790	1.266	0.974	0.97



Yost and Gardner Engineers
Phoenix, Arizona

INFILTRATION TEST DATA
(Ref. USGS WSP #1544F)

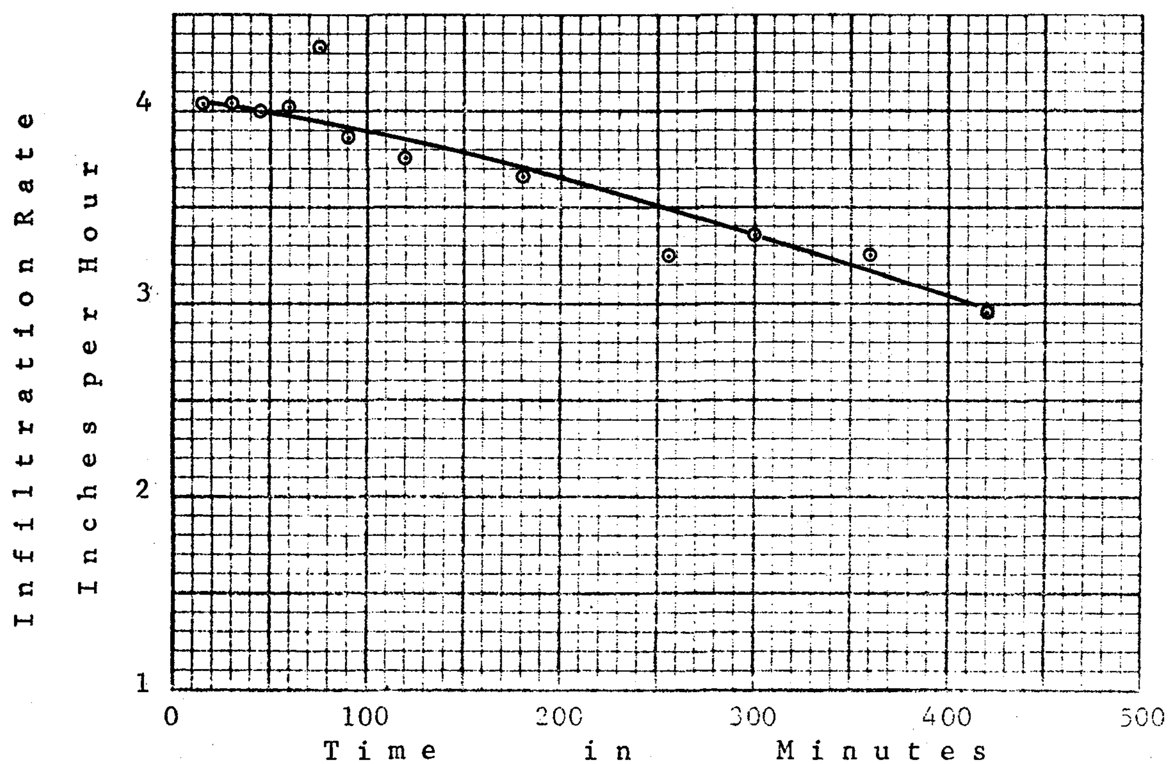
Test No. 3 — **Location:** 50' N. of E. Dobbins Rd.
50' E. of 19th St. (extended)

Date: 2/8/72 — **Site description:** Natural desert. Granite outcropping 30' north. Greasewood groundcover.

By: T.B.G. — **Soil:** decomposed granite.

Test cyl. diam.: 19.5 in., Length: 14.5 in., Gal. per vert. in.: 1.295

Time of reading	Elapsed time (mins.)	Quantity of water (ml.)	(gal.)	(in.)	Infiltration (in. per hr.)
9:45 a.m.	15	4950	1.31	1.01	4.04
10:00	30	4980	1.316	1.01	4.04
10:15	45	4900	1.29	1.00	4.00
10:30	60	5000	1.32	1.016	4.06
10:45	75	5340	1.41	1.085	4.34
11:00	90	4730	1.25	0.962	3.85
11:30	120	9200	2.43	1.87	3.74
12:30 p.m.	180	18000	4.76	3.66	3.66
1:45	255	20000	5.284	4.06	3.25
2:30	300	12400	3.28	2.52	3.35
3:30	360	16000	4.23	3.25	3.25
4:30	420	14550	3.84	2.95	2.95



Yost and Gardner Engineers
Phoenix, Arizona

INFILTRATION TEST DATA
(Ref. USGS WSP #1544F)

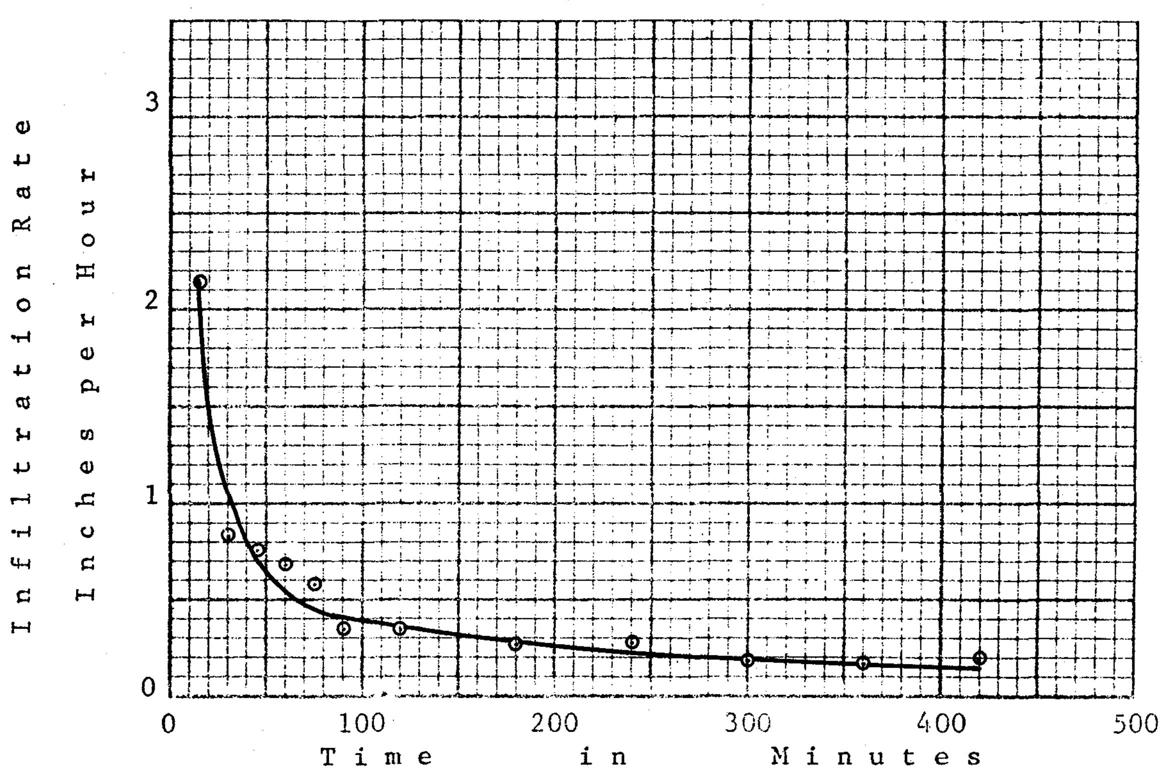
Test No. 4 — Location: 285' W. of 16th St.
40' S. of Roeser Rd.

Date: 2/9/72 — Site description: At edge of planted field - natural soil condition - not plowed.

By: T.B.G. — Soil: clayey loam

Test cyl. diam.: 19.5 in., Length: 14.5 in., Gal. per vert. in.: 1.295

Time of reading	Elapsed time (mins.)	Quantity of water (ml.)	(gal.)	(in.)	Infiltration (in. per hr.)
9:25 a.m.	15	2610	0.69	0.53	2.12
9:40	30	1000	0.264	0.203	0.81
9:55	45	930	0.246	0.19	0.76
10:10	60	830	0.22	0.17	0.68
10:25	75	710	0.188	0.145	0.58
10:40	90	420	0.111	0.0854	0.34
11:10	120	840	0.222	0.17	0.34
12:10 p.m.	180	1320	0.349	0.268	0.27
1:10	240	1350	0.357	0.275	0.28
2:10	300	930	0.246	0.189	0.19
3:10	360	810	0.214	0.165	0.17
4:10	420	960	0.254	0.195	0.20



Southeast Phoenix Storm Drains

Land Use - 1990

				Pervious			Impervious
SW¼ Sec. 32, T1N, R4E. & N. Pt. Sec. 5, T1S, R4E.							
240	Ac. M.D.R.	@	60% =	144	@	35% =	84
10	Ac. Parks	@	10% =	1	@	10% =	1
10	Ac. Comm.	@	0% =	0	@	90% =	9
260				145			94
NW¼ Sec. 32, T1N, R4E.							
136	Ac. M.D.R.	@	60% =	82	@	35% =	48
10	Ac. Parks	@	10% =	1	@	10% =	1
5	Ac. Comm.	@	0% =	0	@	90% =	5
151				83			54
SW¼ Sec. 29, T1N, R4E.							
171	Ac. M.D.R.	@	60% =	103	@	35% =	60
10	Ac. Parks	@	10% =	1	@	10% =	1
10	Ac. Comm.	@	0% =	0	@	90% =	9
191				104			70
NW¼ Sec. 29, T1N, R4E.							
100	Ac. M.D.R.	@	60% =	60	@	35% =	35
30	Ac. Parks	@	10% =	3	@	10% =	3
10	Ac. Comm.	@	0% =	0	@	90% =	9
140				63			47
NE¼ Sec. 30, & S. 660' SE¼ Sec. 19, T1N, R4E.							
40	Ac. H.D.R.	@	50% =	20	@	40% =	16
110	Ac. M.D.R.	@	60% =	66	@	35% =	39
5	Ac. Parks	@	10% =	1	@	10% =	1
5	Ac. Comm.	@	0% =	0	@	90% =	5
40	Ac. Ind. Park	@	30% =	12	@	70% =	28
200				99			89

NW¼ Sec. 30 & S. 660' SW¼ Sec. 19,
T1N, R4E.

Similar to NE¼ above.

			Pervious		Impervious

SE¼ Sec. 30, T1N, R4E.

			Pervious		Impervious
10	Ac. H.D.R.	@ 50% =	5	@ 40% =	4
120	Ac. M.D.R.	@ 60% =	72	@ 35% =	42
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
20	Ac. Ind. Park	@ 30% =	6	@ 70% =	14
160			84		66

SW¼ Sec. 30, T1N, R4E.

			Pervious		Impervious
60	Ac. H.D.R.	@ 50% =	30	@ 40% =	24
90	Ac. M.D.R.	@ 60% =	54	@ 35% =	21
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
160			85		51

SE¼ Sec. 31, T1N, R4E. &
N. Pt. NE¼ Sec. 6, T1S, R4E.

			Pervious		Impervious
180	Ac. M.D.R.	@ 60% =	103	@ 35% =	63
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
190			104		69

SW¼ Sec. 31, T1N, R4E. &
N.E. Pt. NW¼ Sec. 6, T1S, R4E.

			Pervious		Impervious
107	Ac. M.D.R.	@ 60% =	64	@ 35% =	37
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
117			65		43

NE¼ Sec. 31, T1N, R4E.

			Pervious		Impervious
152	Ac. M.D.R.	@ 60% =	91	@ 35% =	53
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
162			92		59

NW¼ Sec. 31, T1N, R4E.

			Pervious		Impervious
180	Ac. M.D.R.	@ 60% =	108	@ 35% =	63
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
190			109		69

S. Pt. SE¼ Sec. 36, T1N, R3E. &
N. Pt. NE¼ Sec. 1, T1S, R3E.

			Pervious		Impervious
127	Ac. M.D.R.	@ 60% =	76	@ 35% =	44
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	1	@ 90% =	5
137			77		50

S. Pt. SW¼ Sec. 36, T1N, R3E. &
N. Pt. NW¼ Sec. 1, T1S, R3E.

Acres	Use		Pervious		Impervious
129	Ac. M.D.R.	@ 60% =	78	@ 35% =	45
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
139			79		51

N. Pt. SE¼ Sec. 36, T1N, R3E.

Acres	Use		Pervious		Impervious
72	Ac. M.D.R.	@ 60% =	43	@ 35% =	25
4	Ac. Parks	@ 10% =	1	@ 10% =	1
4	Ac. Comm.	@ 0% =	0	@ 90% =	4
80			44		30

N. Pt. SW¼ Sec. 36, T1N, R3E.

Acres	Use		Pervious		Impervious
113	Ac. M.D.R.	@ 60% =	68	@ 35% =	40
2	Ac. Parks	@ 10% =	0	@ 10% =	1
3	Ac. Comm.	@ 0% =	0	@ 90% =	3
118			68		44

NE¼ Sec. 36, T1N, R3E. (NW¼ Sec. 36 similar)

Acres	Use		Pervious		Impervious
150	Ac. M.D.R.	@ 60% =	90	@ 35% =	52
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
160			91		58

SE¼ Sec. 25, T1N, R3E.

Acres	Use		Pervious		Impervious
7	Ac. H.D.R.	@ 50% =	4	@ 40% =	3
125	Ac. M.D.R.	@ 60% =	75	@ 35% =	44
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
18	Ac. Ind. Park	@ 30% =	5	@ 70% =	13
160			85		66

SW¼ Sec. 25, T1N, R3E.

Acres	Use		Pervious		Impervious
30	Ac. H.D.R.	@ 50% =	15	@ 40% =	12
120	Ac. M.D.R.	@ 60% =	72	@ 35% =	42
5	Ac. Parks	@ 10% =	1	@ 10% =	0
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
160			88		59

NE¼ Sec. 25 & S. 660' SE¼ Sec. 24,
T1N, R3E.

Acres	Use		Pervious		Impervious
45	Ac.H.D.R.	@ 50% =	23	@ 40% =	18
110	Ac. M.D.R.	@ 60% =	66	@ 35% =	39
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
35	Ac. Ind. Parks	@ 30% =	11	@ 70% =	24
200			101		87

				Pervious		Impervious
NW¼ Sec. 25 & S. 660' SW¼ Sec. 24, T1N, R3E.						
	40 Ac. H.D.R.	@ 50%	=	20	@ 40% =	16
	160 Ac. Ind. Park	@ 30%	=	48	@ 70% =	112
	200			68		128
W½NE¼ Sec. 26, T1N, R3E. (E½NE¼ Sec. 26 similar)						
	70 Ac. H.D.R.	@ 50%	=	35	@ 40% =	28
	5 Ac. Parks	@ 10%	=	1	@ 10% =	1
	5 Ac. Comm.	@ 0%	=	0	@ 90% =	5
	80			36		34
SE¼SE¼ Sec. 23, T1N, R3E.						
	24 Ac. H.D.R.	@ 50%	=	12	@ 40% =	10
	20 Ac. Ind. Park	@ 30%	=	6	@ 70% =	14
	44			18		24
S. Pt. SE¼ Sec. 35, T1N, R3E. & N. Pt. NE¼ Sec. 2, T1S, R3E.						
	150 Ac. M.D.R.	@ 60%	=	90	@ 35% =	53
	5 Ac. Parks	@ 10%	=	1	@ 10% =	1
	5 Ac. Comm.	@ 0%	=	0	@ 90% =	5
	160			91		59
S. Pt. SW¼ Sec. 35, T1N, R3E. & N. Pt. NW¼ Sec. 2, T1S, R3E.						
	130 Ac. M.D.R.	@ 60%	=	78	@ 35% =	45
	5 Ac. Parks	@ 10%	=	1	@ 10% =	1
	5 Ac. Comm.	@ 0%	=	0	@ 90% =	5
	140			79		51
SE¼ Sec. 35, T1N, R3E.						
	114 Ac. M.D.R.	@ 60%	=	68	@ 35% =	40
	5 Ac. Parks	@ 10%	=	1	@ 10% =	1
	5 Ac. Comm.	@ 0%	=	0	@ 90% =	5
	124			69		46
SW¼ Sec. 35, T1N, R3E.						
	100 Ac. M.D.R.	@ 60%	=	60	@ 35% =	35
	5 Ac. Parks	@ 10%	=	1	@ 10% =	1
	5 Ac. Comm.	@ 0%	=	0	@ 90% =	5
	110			61		41

			Pervious		Impervious

NE¼ Sec. 35, T1N, R3E.,
(NW¼ Sec. 35 similar)

171 Ac.	M.D.R.	@ 60% =	103	@ 35% =	60
5 Ac.	Parks	@ 10% =	1	@ 10% =	1
5 Ac.	Comm.	@ 0% =	0	@ 90% =	5
181			104		66

SE¼ Sec. 26, T1N, R3E.
(SW¼ Sec. 26 similar)

129 Ac.	M.D.R.	@ 60% =	77	@ 35% =	45
5 Ac.	Parks	@ 10% =	1	@ 10% =	1
5 Ac.	Comm.	@ 0% =	0	@ 90% =	5
139			78		51

NW¼ Sec. 26, T1N, R3E.

150 Ac.	M.D.R.	@ 60% =	75	@ 35% =	60
5 Ac.	Parks	@ 10% =	1	@ 10% =	1
5 Ac.	Comm.	@ 0% =	0	@ 90% =	5
160			76		66

S½SW¼SE¼ Sec. 23, T1N, R3E.

26 Ac.	H.D.R.	@ 50% =	13	@ 40% =	10

S½S½SW¼ Sec. 23, T1N, R3E.

30 Ac.	H.D.R.	@ 50% =	15	@ 40% =	12
10 Ac.	Comm.	@ 0% =	0	@ 90% =	9
40			15		21

S. Pt. SE¼ Sec. 34, T1N, R3E. &
N. Pt. NE¼ Sec. 3, T1S, R3E.

120 Ac.	M.D.R.	@ 60% =	72	@ 35% =	42
5 Ac.	Parks	@ 10% =	1	@ 10% =	1
5 Ac.	Comm.	@ 0% =	0	@ 90% =	5
130			73		48

S. Pt. SW¼ Sec. 34, T1N, R3E. &
N. Pt. NW¼ Sec. 3, T1S, R3E.

120 Ac.	M.D.R.	@ 60% =	72	@ 35% =	42
5 Ac.	Parks	@ 10% =	1	@ 10% =	1
5 Ac.	Comm.	@ 0% =	0	@ 90% =	5
130			73		48

					Pervious				Impervious
SE¼ Sec. 34, T1N, R3E.									
90	Ac. M.D.R.	@	60%	=	54	@	35%	=	32
5	Ac. Parks	@	10%	=	1	@	10%	=	1
5	Ac. Comm.	@	0%	=	0	@	90%	=	5
100					55				38
SW¼ Sec. 34, T1N, R3E.									
93	Ac. M.D.R.	@	60%	=	56	@	35%	=	33
5	Ac. Parks	@	10%	=	1	@	10%	=	1
5	Ac. Comm.	@	0%	=	0	@	90%	=	5
103					57				39
NE¼ Sec. 34, T1N, R3E.									
45	Ac. H.D.R.	@	50%	=	23	@	40%	=	18
121	Ac. M.D.R.	@	60%	=	73	@	35%	=	42
5	Ac. Parks	@	10%	=	1	@	10%	=	1
5	Ac. Comm.	@	0%	=	0	@	90%	=	5
176					97				66
NW¼ Sec. 34, T1N, R3E.									
162	Ac. M.D.R.	@	60%	=	97	@	35%	=	57
5	Ac. Parks	@	10%	=	1	@	10%	=	1
5	Ac. Comm.	@	0%	=	0	@	90%	=	5
172					98				63
SW¼ Sec. 27, T1N, R3E.									
138	Ac. M.D.R.	@	60%	=	82	@	35%	=	48
5	Ac. Parks	@	10%	=	1	@	10%	=	1
5	Ac. Comm.	@	0%	=	0	@	90%	=	5
148					83				54
NE¼ Sec. 27, & S½SE¼ Sec. 22, T1N, R3E.									
5	Ac. H.D.R.	@	50%	=	2	@	40%	=	2
170	Ac. M.D.R.	@	60%	=	102	@	35%	=	60
5	Ac. L.D.R.	@	65%	=	3	@	25%	=	1
10	Ac. Parks	@	10%	=	1	@	10%	=	1
10	Ac. Comm.	@	0%	=	0	@	90%	=	9
200					108				73
NW¼ Sec. 27, T1N, R3E.									
20	Ac. H.D.R.	@	50%	=	10	@	40%	=	8
105	Ac. M.D.R.	@	60%	=	63	@	35%	=	37
5	Ac. Parks	@	10%	=	1	@	10%	=	1
30	Ac. Comm.	@	0%	=	0	@	90%	=	5
160					74				51

SE¼ Sec. 27, T1N, R3E:

Acres	Use		Pervious		Impervious
10	Ac. H.D.R.	@ 50% =	5	@ 40% =	4
124	Ac. M.D.R.	@ 60% =	74	@ 35% =	43
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
144			80		53

S. Pt. SW¼ Sec. 22, T1N, R3E.

Acres	Use		Pervious		Impervious
40	Ac. M.D.R.	@ 60% =	24	@ 35% =	14
5	Ac. Parks	@ 10% =	1	@ 10% =	1
10	Ac. Comm.	@ 0% =	0	@ 90% =	9
55			25		24

S. Pt. S½ Sec. 33, T1N, R3E. &
N. Pt. N½ Sec. 4, T1S, R3E.

Acres	Use		Pervious		Impervious
5	Ac. H.D.R.	@ 50% =	3	@ 40% =	2
279	Ac. M.D.R.	@ 60% =	167	@ 35% =	98
10	Ac. Parks	@ 10% =	1	@ 10% =	1
15	Ac. Comm.	@ 0% =	0	@ 90% =	14
309			171		115

N. Pt. SE¼ Sec. 33, T1N, R3E.

Acres	Use		Pervious		Impervious
102	Ac. M.D.R.	@ 60% =	61	@ 35% =	36
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
112			62		42

N. Pt. SW¼ Sec. 33, T1N, R3E.

Acres	Use		Pervious		Impervious
97	Ac. M.D.R.	@ 60% =	58	@ 35% =	34
5	Ac. Parks	@ 10% =	1	@ 10% =	1
10	Ac. Comm.	@ 0% =	0	@ 90% =	5
112			59		40

NE¼ Sec. 33, T1N, R3E.

Acres	Use		Pervious		Impervious
5	Ac. H.D.R.	@ 50% =	3	@ 40%! =	2
145	Ac. M.D.R.	@ 60% =	87	@ 35% =	51
5	Ac. Parks	@ 10% =	1	@ 10% =	1
5	Ac. Comm.	@ 0% =	0	@ 90% =	5
160			91		59

NW¼ Sec. 33, T1N, R3E.

Acres	Use		Pervious		Impervious
135	Ac. H.D.R.	@ 50% =	6	@ 40% =	54
10	Ac. M.D.R.	@ 60% =	68	@ 35% =	4
5	Ac. Parks	@ 10% =	1	@ 10% =	1
10	Ac. Comm.	@ 0% =	0	@ 90% =	5
160			75		64

				Pervious			Impervious
SE¼ Sec. 28, T1N, R3E.							
15	Ac. H.D.R.	@ 50%	=	8	@ 40%	=	6
135	Ac. M.D.R.	@ 60%	=	81	@ 35%	=	47
5	Ac. Parks	@ 10%	=	1	@ 10%	=	1
5	Ac. Comm.	@ 0%	=	0	@ 90%	=	5
160				90			59

				Pervious			Impervious
SW¼ Sec. 28, T1N, R3E.							
105	Ac. H.D.R.	@ 50%	=	53	@ 40%	=	42
35	Ac. M.D.R.	@ 60%	=	21	@ 35%	=	12
5	Ac. Parks	@ 10%	=	1	@ 10%	=	1
15	Ac. Comm.	@ 0%	=	0	@ 90%	=	14
160				75			69

				Pervious			Impervious
NE¼ Sec. 28, T1N, R3E.							
130	Ac. H.D.R.	@ 50%	=	65	@ 40%	=	52
5	Ac. Parks	@ 10%	=	1	@ 10%	=	1
20	Ac. Comm.	@ 0%	=	0	@ 90%	=	18
5	Ac. Ind. Park	@ 30%	=	2	@ 70%	=	3
160				68			74

				Pervious			Impervious
NW¼ Sec. 28, T1N, R3E.							
135	Ac. H.D.R.	@ 50%	=	68	@ 40%	=	54
5	Ac. Parks	@ 10%	=	1	@ 10%	=	1
20	Ac. Comm.	@ 0%	=	0	@ 90%	=	18
160				69			73

				Pervious			Impervious
S½SE¼ Sec. 21, T1N, R3E.							
55	Ac. M.D.R.	@ 60%	=	33	@ 35%	=	19
5	Ac. Parks	@ 10%	=	1	@ 10%	=	1
20	Ac. Comm.	@ 0%	=	0	@ 90%	=	18
80				34			38

				Pervious			Impervious
S½SW¼ Sec. 21, T1N, R3E.							
55	Ac. M.D.R.	@ 60%	=	33	@ 35%	=	20
25	Ac. Comm.	@ 0%	=	0	@ 90%	=	23
80				33			43

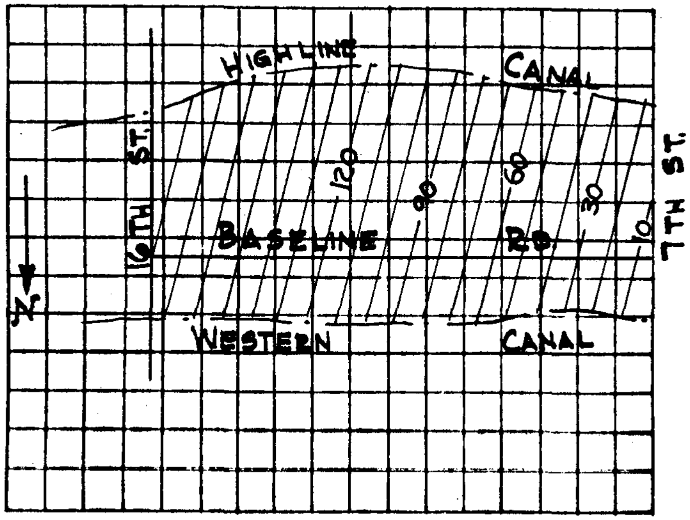
Done by T.B.G.

Date 2/28/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area S. Pt. Sec. 33, T1N, R3E., plus
N. Pt. Sec. 4, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	279	60	167	35	98		
H.D. Residential	5	50	3	40	2		
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	15	0	0	90	14		
Industrial							
Total Acres	309		171	37.2	115		

Mean land slope N-S .0125 E-W .001

Flow conveyance 40' Streets

Flow velocity N-S 2.3 ft./sec. 38 min./mile 138 ft/min.

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	5		2	2.70	.998	2.69					2.24	4	4	
20	19		7	1.85	.995	1.84					1.48	10	10	
30	35		13	1.41	.994	1.40					1.08	14	14	
40	51		19	1.14	.993	1.13					0.84	16	16	
50	68		25	0.96	.991	0.95					0.67	17	17	
60	85		32	0.83	.990	0.82					0.56	18	18	Max.
70	102		38	0.73	.989	0.72					0.47	18	18	
80	120		45	0.66	.987	0.65					0.40	18	18	
90	138		51	0.60	.986	0.59					0.35	18	18	
100	156		58	0.55	.985	0.54					0.31	18	18	
110	174		65	0.51	.984	0.50					0.27	17	17	
120	193		72	0.47	.983	0.46					0.23	17	17	

Yost and Gardner Engineers

LINE A

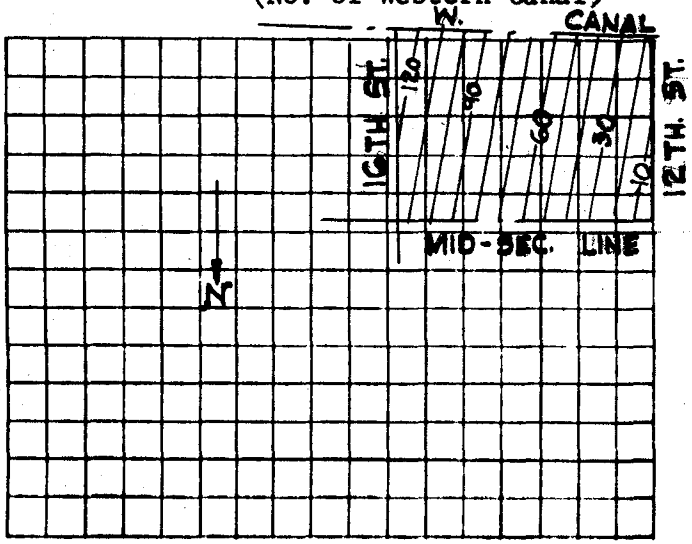
Done by T.B.G.

Date 2/28/72

Drainage Area SE¼ Sec. 33, T1N, R3E, (No. of Western Canal)

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	102	60	61	35	36		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	112		62	37.5	42		

Mean land slope N-S .011 E-W .00076

Flow conveyance 40' Streets

Flow velocity N-S 2.2 ft./sec. 40 min./mile 132 ft/min.

E-W 0.4 ft./sec. 220 min./mile 24 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	4		2	2.70	.998	2.69					2.24	4	4	
20	13		5	1.85	.997	1.84					1.48	7	7	
30	23		9	1.41	.995	1.40					1.08	10	10	
40	33		12	1.14	.995	1.13					0.84	10	10	
50	43		16	0.96	.993	0.95					0.67	11	11	
60	53		20	0.83	.992	0.82					0.56	11	11	
70	63		24	0.73	.992	0.72					0.47	11	11	Max.
80	73		27	0.66	.990	0.65					0.40	11	11	
90	83		31	0.60	.990	0.59					0.35	11	11	
100	93		35	0.55	.989	0.54					0.31	11	11	
110	103		38	0.51	.988	0.50					0.27	10	10	
120	110		41	0.47	.987	0.46					0.25	10	10	
130	112		42	0.45	.987	0.44					0.22	9	9	

Yost and Gardner Engineers

LINE A

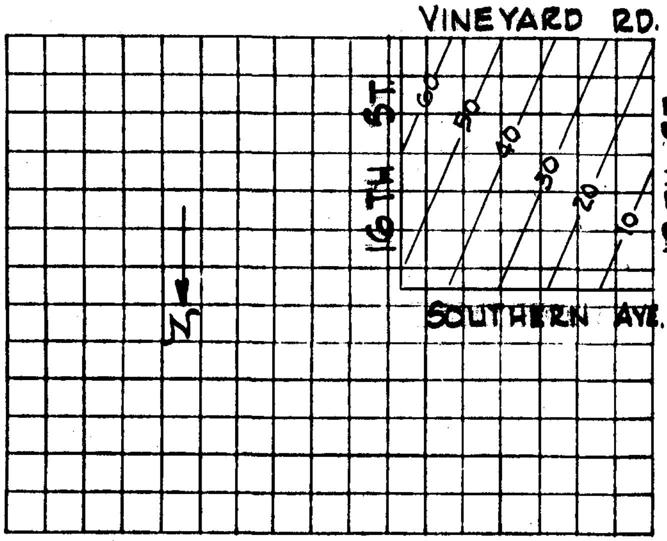
Done by T.B.G.

Date 2/28/72

Drainage Area NE¼ Sec. 33, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	145	60	87	35	51		
H.D. Residential	5	50	3	40	2		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	160		91	36.8	59		

Mean land slope N-S .0091 E-W .0015

Flow conveyance 40' Streets

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

E-W 0.9 ft./sec. 98 min./mile 54 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	8		3	2.70	.997	2.69					2.24	7	7	
20	31		11	1.85	.995	1.84					1.48	16	16	
30	63		23	1.41	.992	1.40					1.08	25	25	
40	95		35	1.14	.989	1.13					0.84	29	29	
50	127		47	0.96	.987	0.95					0.67	32	32	Max.
60	152		56	0.83	.985	0.82					0.56	31	31	
70	160		59	0.73	.985	0.72					0.47	28	28	
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE A

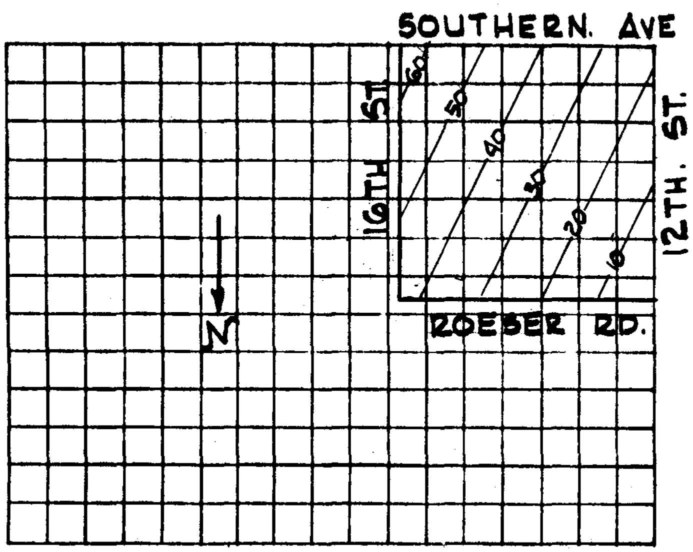
Done by T.B.G.

Date 2/28/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area SE¼ Sec. 28, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	135	60	81	35	47		
H.D. Residential	15	50	8	40	6		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	160		90	36.9	59		

Mean land slope N-S .0083 E-W .0019

Flow conveyance 40' Streets

Flow velocity N-S 2.05 ft./sec. 43 min./mile 123 ft/min.

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

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	9		3	2.70	.997	2.69					2.24	7	7	
20	34		13	1.85	.994	1.84					1.48	19	19	
30	70		26	1.41	.991	1.40					1.08	28	28	
40	107		40	1.14	.988	1.13					0.84	34	34	
50	138		51	0.96	.986	0.95					0.67	34	34	Max.
60	158		58	0.83	.985	0.82					0.56	32	32	
65 ~~70~~	160		59	0.78	.985	0.77					0.51	30	30	
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE A

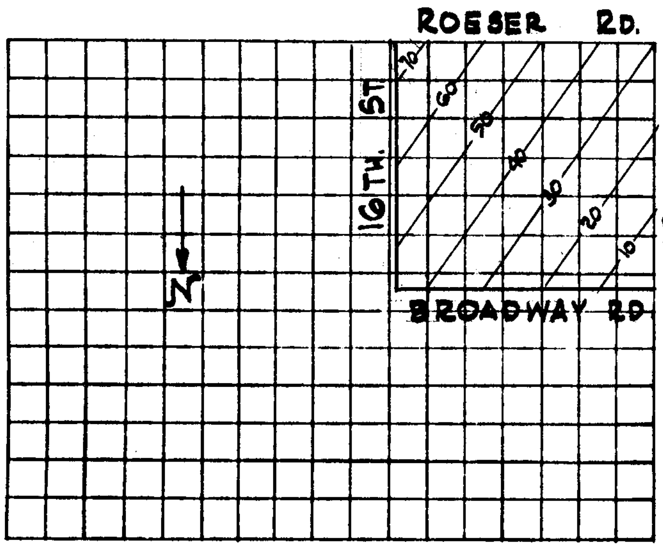
Done by T.B.G.

Date 2/28/72

Drainage Area NE¼ Sec. 28, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -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	130	50	65	40	52		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	20	0	0	90	18		
Industrial	5	30	2	70	3		
Total Acres	160		68	46.2	74		

Mean land slope N-S .0038 E-W 0.0019

Flow conveyance 40' Streets

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

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

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	6		3	2.70	.998	2.69					2.24	7	7	
20	23		11	1.85	.996	1.84					1.48	16	16	
30	52		24	1.41	.993	1.40					1.08	26	26	
40	93		43	1.14	.989	1.13					0.84	36	36	
50	125		58	0.96	.987	0.95					0.67	39	39	Max.
60	146		68	0.83	.986	0.82					0.56	38	38	
70	156		72	0.73	.985	0.72					0.47	34	34	
75 ~~80~~	160		74	0.70	.985	0.69					0.44	32	32	
90														
100														
110														
120														

Yost and Gardner Engineers

LINE A

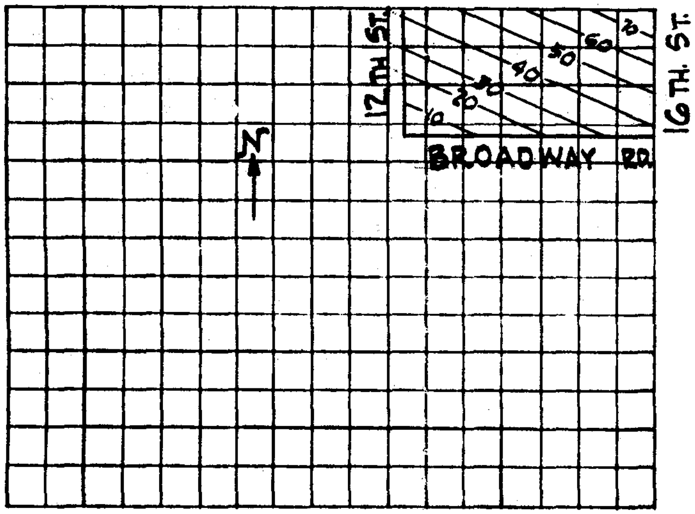
Done by T.B.G.

Date 3/7/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area S½SE¼ Sec. 21, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	55	60	33	35	19		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	20	0	0	90	18		
Industrial							
Total Acres	80		34	47.5	38		

Mean land slope N-S .001 E-W .0026

Flow conveyance 40' Streets

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

E-W 1.2 ft./sec. 73 min./mile 72 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	3		2	2.70	.998	2.69					2.24	4	4	
20	10		5	1.85	.997	1.84					1.48	7	7	
30	22		11	1.41	.996	1.40					1.08	12	12	
40	39		19	1.14	.994	1.13					0.84	16	16	
50	56		27	0.96	.992	0.95					0.67	18	18	
60	69		33	0.83	.991	0.82					0.56	19	19	Max.
70	76		36	0.73	.995	0.72					0.47	17	17	
80	80		38	0.66	.995	0.65					0.40	15	15	
90														
100														
110														
120														

Yost and Gardner Engineers

LINE A

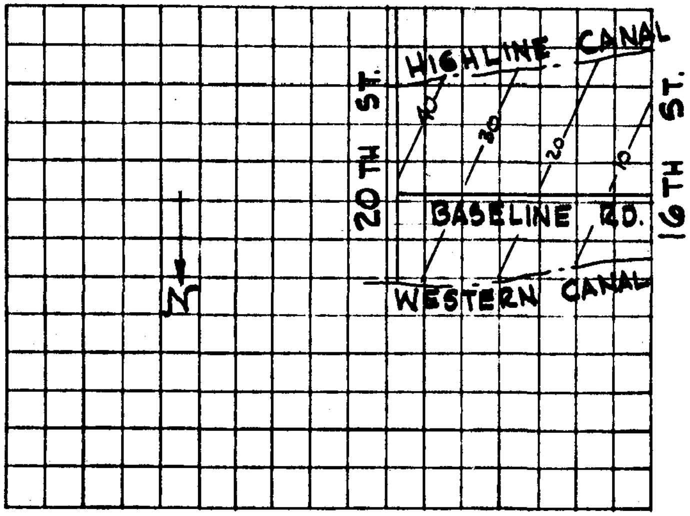
Done by T.B.G.

Date 2/25/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval

Drainage Area S. Pt. SW¼ Sec. 34, T1N, R3E, Plus N. Pt. NW¼ Sec. 3, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	120	60	72	35	42		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	130		73	36.9	48		

Mean land slope N-S .0137 E-W .003

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W 1.25 ft./sec. 70 min./mile 75 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	___-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	13		5	2.70	.997	2.69					2.24	11	11	
20	50		19	1.85	.993	1.84					1.48	28	28	
30	90		33	1.41	.990	1.40					1.08	36	36	
40	122		45	1.14	.987	1.13					0.84	38	38	Max.
45 (~~50~~)	130		48	1.05	.986	1.04					0.75	36	36	
60														
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE B

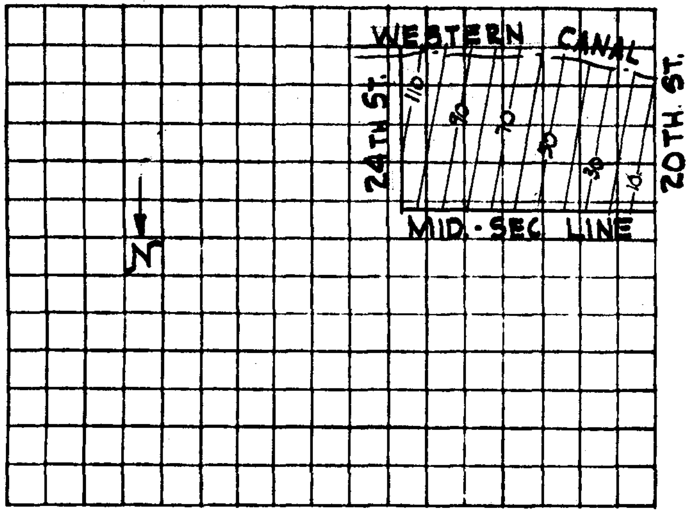
Done by T.B.G.

Date 2/25/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval

Drainage Area SE¼ Sec. 34, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	90	60	54	35	32		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	100		55	38	38		

Mean land slope N-S .013 E-W .00075

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W 0.4 ft./sec. 220 min./mile 24 ft/min.

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

	Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
	10	4		2	2.70	.998	2.69					2.24	4	4	
	20	12		5	1.85	.997	1.84					1.48	7	7	
	30	21		8	1.41	.995	1.40					1.08	9	9	
	40	30		11	1.14	.994	1.13					0.84	9	9	
	50	40		15	0.96	.993	0.95					0.67	10	10	
	60	50		19	0.83	.992	0.82					0.56	11	11	
	70	60		23	0.73	.991	0.72					0.47	11	11	Max.
	80	70		27	0.66	.991	0.65					0.40	11	11	
	90	80		30	0.60	.990	0.59					0.35	11	11	
	100	89		34	0.55	.989	0.54					0.31	11	11	
	110	96		36	0.51	.989	0.50					0.27	10	10	
115	120	100		38	0.49	.989	0.48					0.25	10	10	

Yost and Gardner Engineers

LINE B

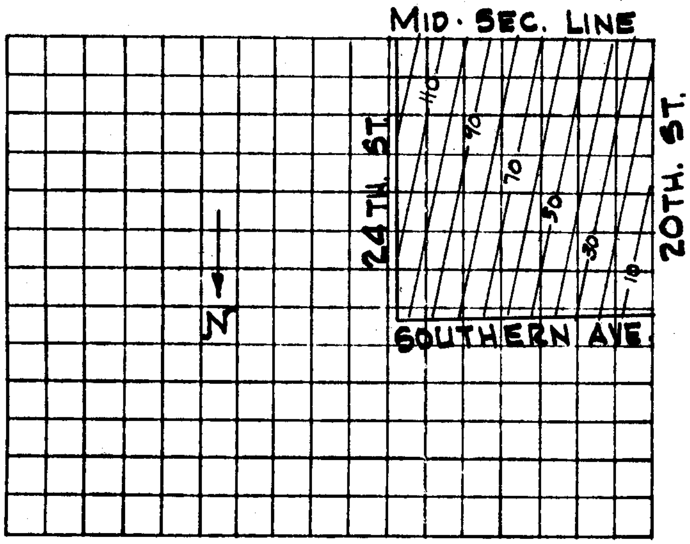
Done by T.B.G.

Date 2/25/72

Drainage Area NE¼ Sec. 34. T1N. R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	121	60	73	35	42		
H.D. Residential	45	50	23	40	18		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	176		97	37.5	66		

Mean land slope N-S .009 E-W .00076

Flow conveyance 40' Streets

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

E-W 0.4 ft./sec. 220 min./mile 24 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	6		2	2.70	.997	2.69					2.24	4	4	
20	14		5	1.85	.996	1.84					1.48	7	7	
30	31		12	1.41	.995	1.40					1.08	13	13	
40	48		18	1.14	.993	1.13					0.84	15	15	
50	65		24	0.96	.991	0.95					0.67	16	16	
60	82		31	0.83	.990	0.82					0.56	17	17	
70	99		37	0.73	.989	0.72					0.47	17	17	
80	116		44	0.66	.987	0.65					0.40	18	18	Max.
90	133		50	0.60	.986	0.59					0.35	18	18	
100	150		56	0.55	.986	0.54					0.31	17	17	
110	164		62	0.51	.985	0.50					0.27	17	17	
120	170		64	0.47	.985	0.46					0.23	15	15	
130	176		66	0.44	.985	0.43					0.21	14	14	

Yost and Gardner Engineers

LINE B

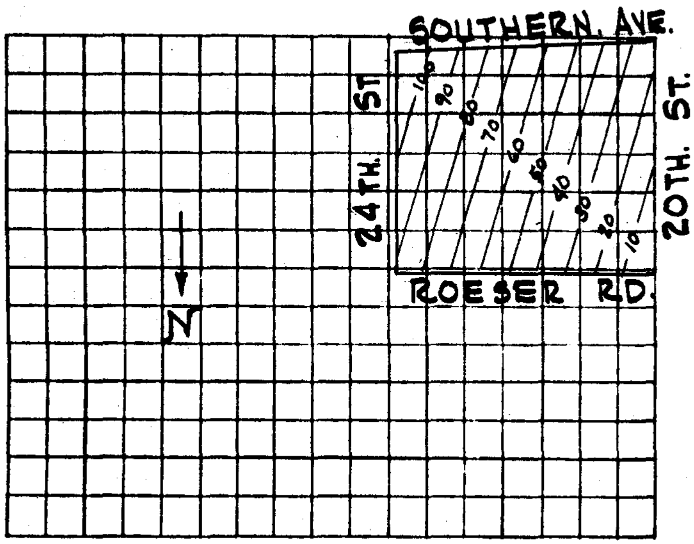
Done by T.B.G.

Date 2/25/72

Drainage Area SE¼ Sec. 27, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	124	60	74	35	43		
H.D. Residential	10	50	5	40	4		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	144		80	36.9	53		

Mean land slope N-S .0061 E-W .0011

Flow conveyance 40' Streets

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

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	4		2	2.70	.998	2.69					2.24	4	4	
20	14		5	1.85	.997	1.84					1.48	7	7	
30	30		11	1.41	.995	1.40					1.08	12	12	
40	46		17	1.14	.993	1.13					0.84	14	14	
50	62		23	0.96	.992	0.95					0.67	15	15	
60	78		29	0.83	.990	0.82					0.56	16	16	
70	94		35	0.73	.989	0.72					0.47	16	16	Max.
80	110		41	0.66	.988	0.65					0.40	16	16	
90	126		47	0.60	.987	0.59					0.35	16	16	
100	135		50	0.55	.986	0.54					0.31	16	16	
110	144		53	0.51	.986	0.50					0.27	14	14	
120														

Yost and Gardner Engineers

LINE B

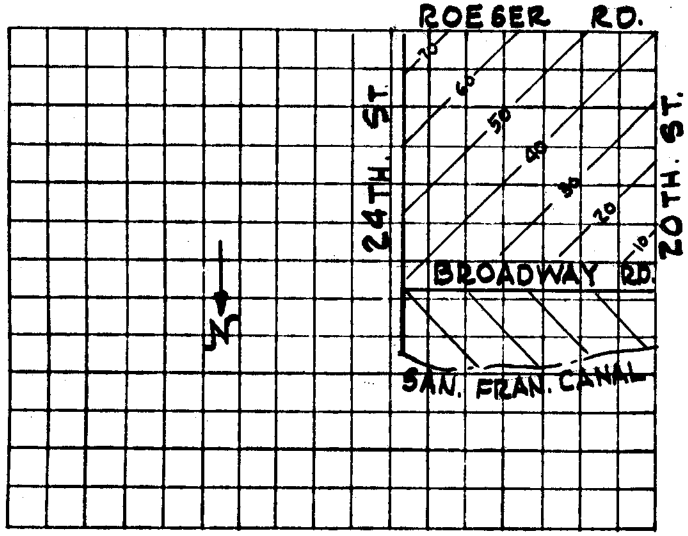
Done by T.B.G.

Date 2/28/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area NE¼ Sec. 27, T1N, R3E. Plus
S. Pt. SE¼ Sec. 22, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential	5	65	3	25	1		
M.D. Residential	170	60	102	35	60		
H.D. Residential	5	50	2	40	2		
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	10	0	0	90	9		
Industrial							
Total Acres	200		108	36.5	73		

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

Flow conveyance 40' Streets

Flow velocity N-S 1.1 ft./sec. 80 min./mile 66 ft/min.

E-W 1.1 ft./sec. 80 min./mile 66 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	10		4	2.70	.997	2.69					2.24	9	9	
20	33		12	1.85	.995	1.84					1.48	18	18	
30	68		25	1.41	.991	1.40					1.08	27	27	
40	114		42	1.14	.988	1.13					0.84	35	35	
50	158		58	0.96	.985	0.95					0.67	39	39	Max.
60	184		67	0.83	.984	0.82					0.56	38	38	
70	197		72	0.73	.983	0.72					0.47	34	34	
75 ~~80~~	200		73	0.70	.983	0.69					0.44	32	32	
90														
100														
110														
120														

Yost and Gardner Engineers

LINE B

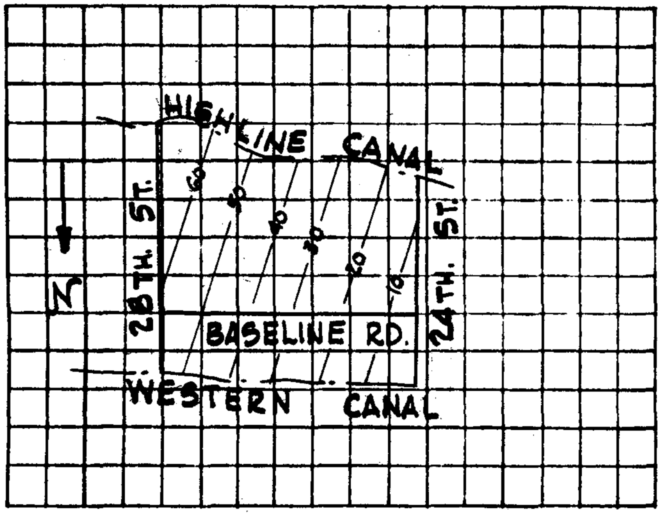
Done by T.B.G.

Date 2/24/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area S. Pt. SW¼ Sec. 35, T1N, R3E.
Plus N. Pt. NW¼ Sec. 2, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	130	60	78	35	45		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	140		79	36.4	51		

Mean land slope N-S .0016 E-W .0014

Flow conveyance 40' Streets

Flow velocity N-S 3.0 ft./sec. 29 min./mile 180 ft/min.

E-W 0.8 ft./sec. 110 min./mile 48 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	10		4	2.70	.996	2.69					2.24	9	9	
20	33		12	1.85	.995	1.84					1.48	18	18	
30	58		21	1.41	.993	1.40					1.08	23	23	
40	84		31	1.14	.990	1.13					0.84	26	26	
50	109		40	0.96	.988	0.95					0.67	27	27	Max.
60	133		48	0.83	.987	0.82					0.56	27	27	
70	140		51	0.73	.985	0.72					0.47	24	24	
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE C

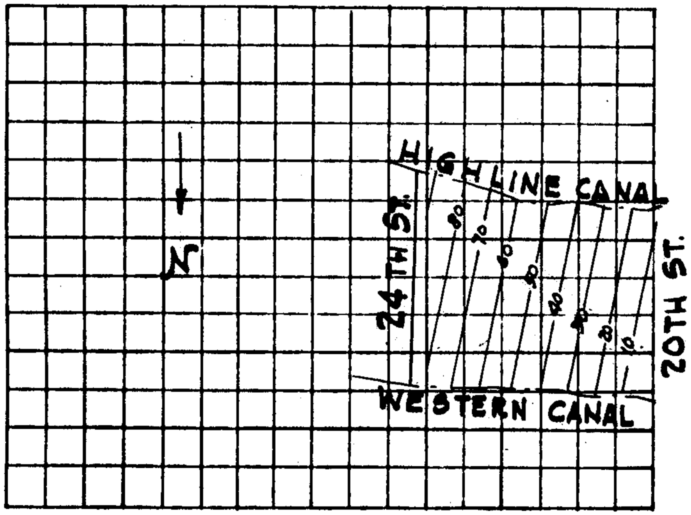
Done by T.B.G.

Date 2/24/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area S. Pt. SE¼ Sec. 34, T1N, R3E.
Plus N. Pt. NE¼ Sec. 3, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	120	60	72	35	42		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	130		73	36.9	48		

Mean land slope N-S .015 E-W .001

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W .5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	5		2	2.70	.997	2.69					2.24	4	4	
20	18		7	1.85	.995	1.84					1.48	10	10	
30	31		11	1.41	.992	1.40					1.08	12	12	
40	44		16	1.14	.990	1.13					0.84	13	13	
50	58		21	0.96	.988	0.95					0.67	14	14	
60	72		27	0.83	.987	0.82					0.56	15	15	Max.
70	86		32	0.73	.987	0.72					0.47	15	15	
80	101		37	0.66	.987	0.65					0.40	15	15	
90	116		43	0.60	.987	0.55					0.35	15	15	
100	130		48	0.55	.987	0.54					0.31	15	15	
110														
120														

Yost and Gardner Engineers

LINE C

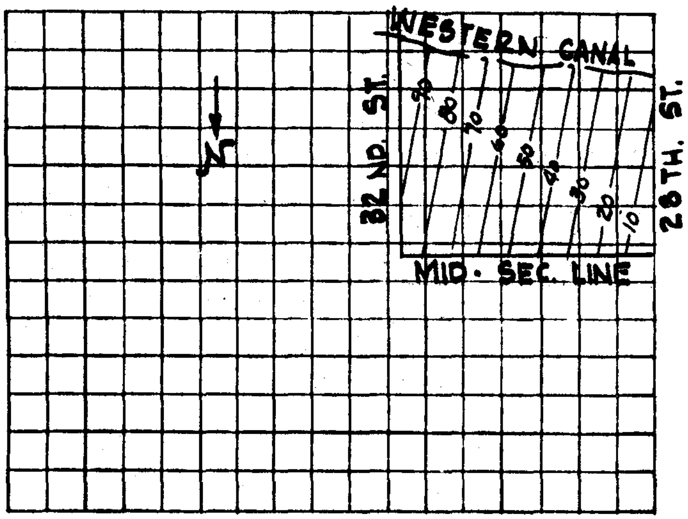
Done by T.B.G.

Date 2/25/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area SE¼ Sec. 35, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	114	60	68	35	40		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	124		69	37	46		

Mean land slope N-S .0115 E-W .001

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	5		2	2.70	.997	2.69					2.24	5	5	
20	17		6	1.85	.996	1.84					1.48	9	9	
30	31		12	1.41	.994	1.40					1.08	13	13	
40	45		17	1.14	.993	1.13					0.84	14	14	
50	59		22	0.96	.992	0.95					0.67	15	15-	
60	74		27	0.83	.990	0.82					0.56	15	15+	
70	90		33	0.73	.990	0.72					0.47	16	16-	
80	107		40	0.66	.988	0.65					0.40	16	16	Max.
90	120		45	0.60	.987	0.59					0.35	16	16	
100	124		46	0.55	.987	0.54					0.31	14	14	
110														
120														

Yost and Gardner Engineers

LINE C

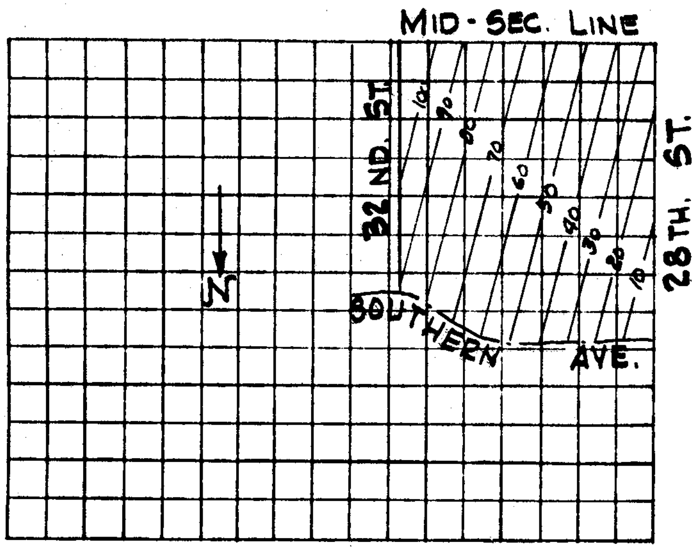
Done by T.B.G.

Date 2/25/72

Drainage Area NE¼ Sec. 35, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	171	60	103	35	60		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	181		104	36.4	66		

Mean land slope N-S .0076 E-W .001

Flow conveyance 40' Streets

Flow velocity N-S 2.0 ft./sec. 44 min./mile 120 ft/min.

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	4		2	2.70	.998	2.69					2.24	4	4	
20	17		6	1.85	.996	1.84					1.48	9	9	
30	37		13	1.41	.994	1.40					1.08	14	14	
40	60		22	1.14	.992	1.13					0.84	18	18	
50	81		30	0.96	.990	0.95					0.67	20	20	
60	104		38	0.83	.988	0.82					0.56	21	21	Max.
70	125		45	0.73	.987	0.72					0.47	21	21	
80	145		53	0.66	.986	0.65					0.40	21	21	
90	164		60	0.60	.984	0.59					0.35	21	21	
100	177		65	0.55	.982	0.54					0.31	20	20	
110	181		66	0.51	.982	0.50					0.27	18	18	
120														

Yost and Gardner Engineers

LINE C

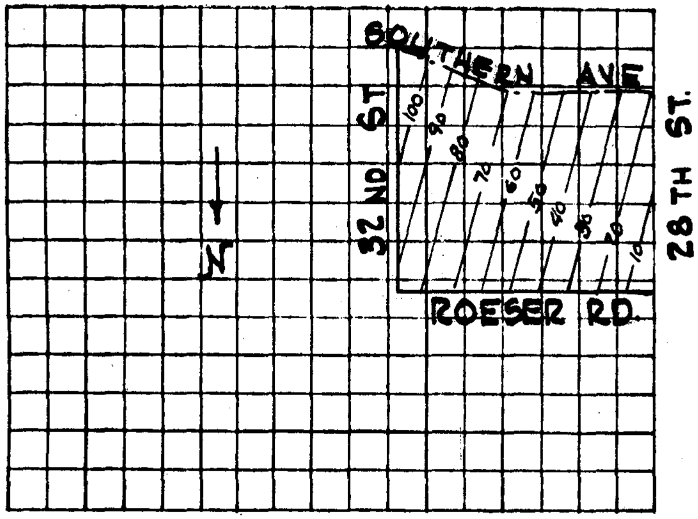
Done by T.B.G.

Date 2/25/72

Drainage Area SE¼ Sec. 26, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	129	60	77	35	45		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	139		78	36.7	51		

Mean land slope N-S .0067 E-W .001

Flow conveyance 40' Streets

Flow velocity N-S 1.85 ft./sec. 48 min./mile 111 ft/min.

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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
10	4		2	2.70	.998	2.69					2.24	4	4
20	15		6	1.85	.996	1.84					1.48	9	9
30	30		11	1.41	.995	1.40					1.08	12	12
40	45		17	1.14	.993	1.13					0.84	14	14
50	60		22	0.96	.992	0.95					0.67	15	15
60	75		28	0.83	.990	0.82					0.56	16	16 Max.
70	90		33	0.73	.990	0.72					0.47	16	16
80	105		39	0.66	.988	0.65					0.40	16	16
90	120		44	0.60	.987	0.59					0.35	15	15
100	134		49	0.55	.986	0.54					0.31	15	15
110	139		51	0.51	.986	0.50					0.27	14	14
120													

Yost and Gardner Engineers

LINE C

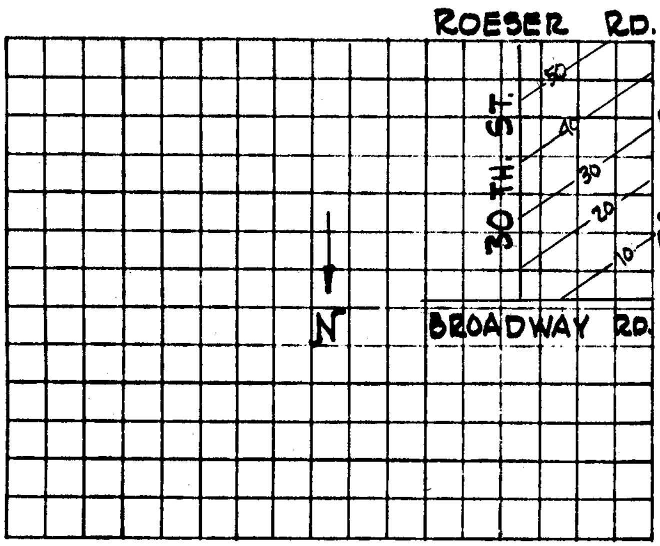
Done by T.B.G.

Date 2/25/72

Drainage Area W½NE¼ Sec. 26, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -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	70	50	35	40	28		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	80		36	42.5	34		

Mean land slope N-S .0019 E-W .0043

Flow conveyance 40' Streets

Flow velocity N-S 1.0 ft./sec. 88 min./mile 60 ft/min.

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

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	7		3	2.70		2.69					2.24	7	7	
20	24		10	1.85		1.84					1.48	15	15	
30	41		17	1.41		1.40					1.08	18	18	
40	58		25	1.14		1.13					0.84	21	21	Max.
50	73		31	0.96		0.95					0.67	21	21	
60	80		34	0.83		0.82					0.56	19	19	
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE C

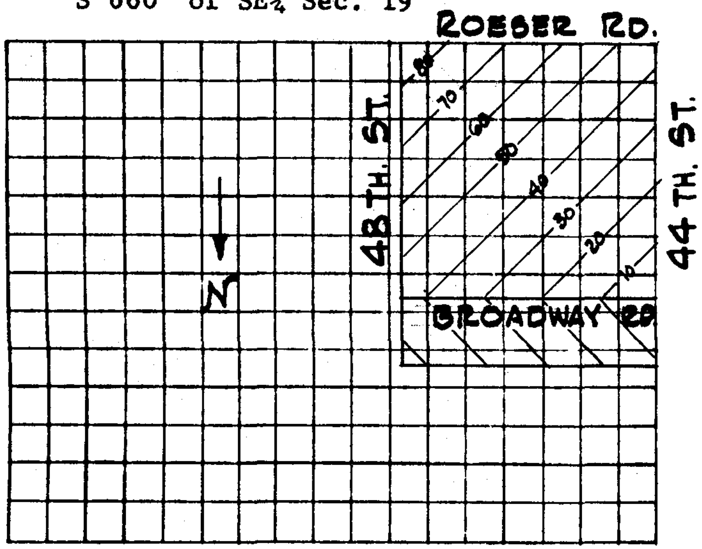
Done by T.B.G.

Date 3/6/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area NE¼ Sec. 30, T1N, R4E, plus
S 660' of SE¼ Sec. 19



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	110	60	66	35	39		
H.D. Residential	40	50	20	40	16		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial	40	30	12	70	28		
Total Acres	200		99	44.5	89		

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

Flow conveyance 40' Streets

Flow velocity N-S 1.0 ft./sec. 88 min./mile 60 ft/min.

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

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	8		4	2.70	.998	2.69					2.24	9	9	
20	29		13	1.85	.995	1.84					1.48	19	19	
30	58		26	1.41	.992	1.40					1.08	28	28	
40	96		43	1.14	.988	1.14					0.84	36	36	
50	137		61	0.96	.987	0.95					0.67	41	41	
60	167		74	0.83	.985	0.82					0.56	41	41	Max.
70	187		83	0.73	.984	0.72					0.47	39	39	
80	197		88	0.66	.983	0.65					0.40	35	35	
85 ~~90~~	200		89	0.63	.983	0.62					0.38	34	34	
100														
110														
120														

Yost and Gardner Engineers

LINE D

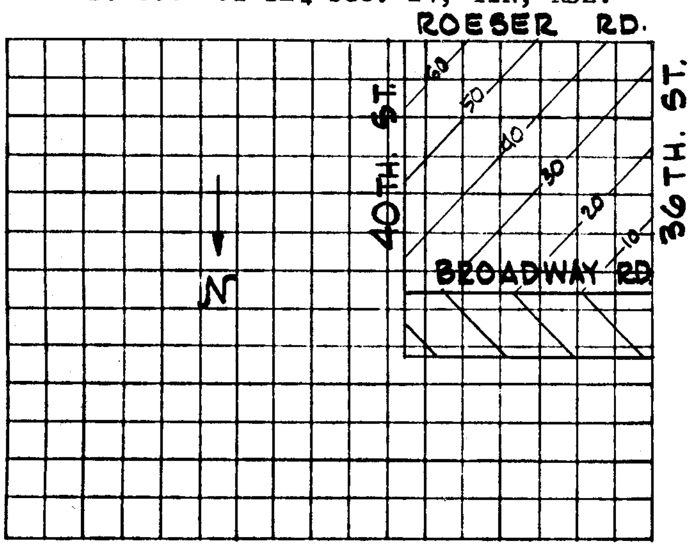
Done by T.B.G.

Date 2/18/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval

Drainage Area NE¼ Sec. 25, T1N, R3E. Plus S. 660' of SE¼ Sec. 24, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	110	60	66	35	39		
H.D. Residential	45	50	23	40	18		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial	35	30	11	70	24		
Total Acres	200		101	43.5	87		

Mean land slope N-S .003 E-W .0026

Flow conveyance 40' Streets

Flow velocity N-S 1.3 ft./sec. 68 min./mile 78 ft/min.

E-W 1.2 ft./sec. 73 min./mile 72 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	12		5	2.70	.995	2.69					2.24	11	11	
20	43		19	1.85	.991	1.84					1.48	28	28	
30	86		37	1.41	.987	1.39					1.05	39	39	
40	138		60	1.14	.985	1.12					0.83	50	50	
50	178		77	0.96	.983	0.94					0.67	52	52	Max.
60	194		84	0.83	.983	0.82					0.56	47	47	
70	200		87	0.73	"	0.72					0.47	41	41	
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE D

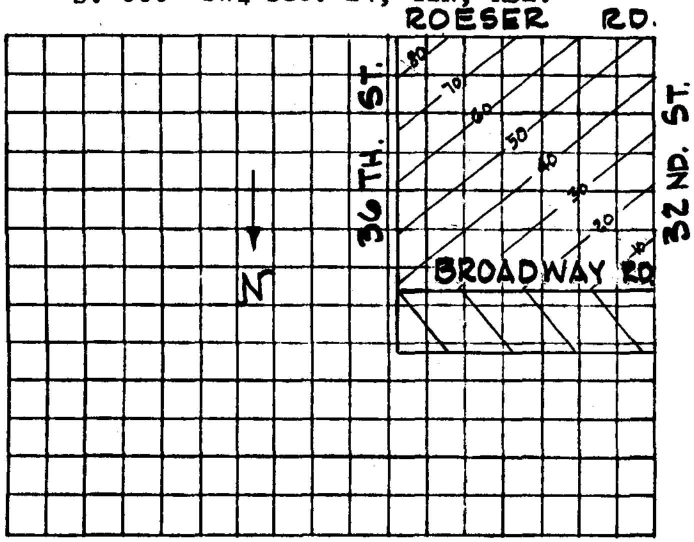
Done by T.B.G.

Date 2/24/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area NW¼ Sec. 25, T1N, R3E. plus
S. 660' SW¼ Sec. 24, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential							
H.D. Residential	40	50	20	40	16		
Parks & park-like							
Farmlands, groves							
Commercial							
Industrial	160	30	48	70	112		
Total Acres	200		68	64	128		

Mean land slope N-S .0015 E-W .0023

Flow conveyance 40' Street

Flow velocity N-S 0.9 ft./sec. 98 min./mile 54 ft/min.

E-W 1.1 ft./sec. 80 min./mile 66 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	8		5	2.70	.998	2.69					2.24	11	11	
20	31		20	1.85	.996	1.84					1.48	30	30	
30	63		40	1.41	.994	1.40					1.08	43	43	
40	102		65	1.14	.992	1.13					0.84	55	55	
50	139		89	0.96	.989	0.95					0.67	60	60	Max.
60	166		106	0.83	.987	0.82					0.56	59	59	
70	184		118	0.73	.986	0.72					0.47	55	55	
80	196		126	0.66	.985	0.65					0.40	50	50	
85 ~~90~~	200		128	0.63	.985	0.62					0.38	49	49	
100														
110														
120														

Yost and Gardner Engineers

LINE D

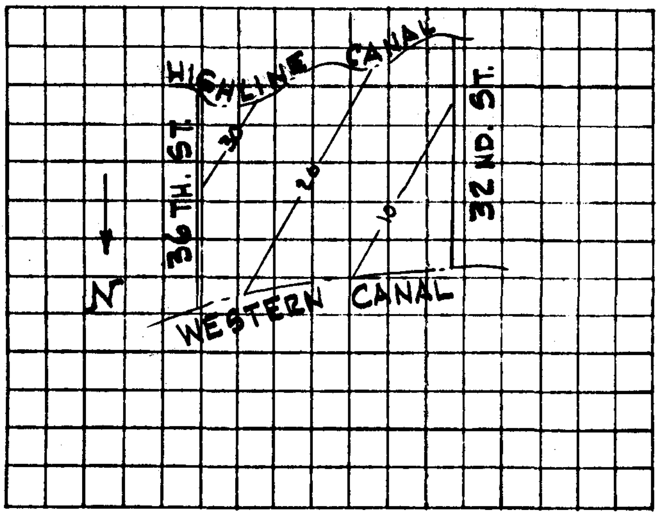
Done by T.B.G.

Date 2/21/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval

Drainage Area Pt. of SW¼ Sec. 36, T1N, R3E.
Plus Pt. of Sec. 1, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	129	60	78	35	45		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	139		79	36.7	51		

Mean land slope N-S .0185 E-W .0066

Flow conveyance 40' Streets

Flow velocity N-S 2.8 ft./sec. 31 min./mile 168 ft/min.

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

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	22		8	2.70	.995	2.69					2.24	18	18	
20	87		32	1.85	.990	1.83					1.47	47	47	
30	135		50	1.41	.987	1.39					1.07	54	54	Max.
35 ~~40~~	139		51	1.27	.987	1.25					0.95	48	48	
50														
60														
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE E

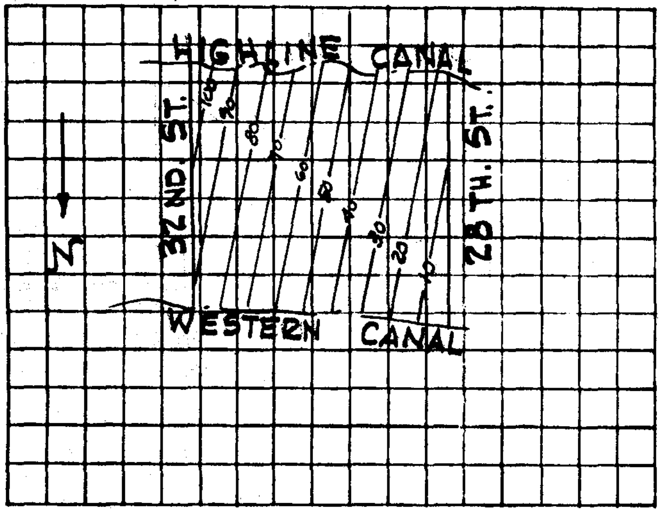
Done by T.B.G.

Date 2/21/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area S.Pt. SE¼ Sec. 35, T1N, R3E.
Plus N. Pt. Sec. 2, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	150	60	90	35	53		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	160		91	36.8	59		

Mean land slope N-S .0075 E-W .001

Flow conveyance 40' Streets

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

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	5		2	2.70	.997	2.69					2.24	4	4	
20	21		8	1.85	.996	1.84					1.48	12	12	
30	39		14	1.41	.994	1.40					1.08	15	15	
40	56		21	1.14	.993	1.13					0.84	18	18	
50	73		27	0.96	.992	0.95					0.67	18	18	
60	91		34	0.83	.990	0.82					0.56	19	19	Max
70	108		40	0.73	.990	0.72					0.47	19	19	
80	125		46	0.66	.989	0.65					0.40	18	18	
90	143		53	0.60	.988	0.59					0.35	18	18	
100	157		58	0.55	.987	0.54					0.31	18	18	
110	160		59	0.51	.987	0.50					0.27	16	16	
120														

Yost and Gardner Engineers

LINE E

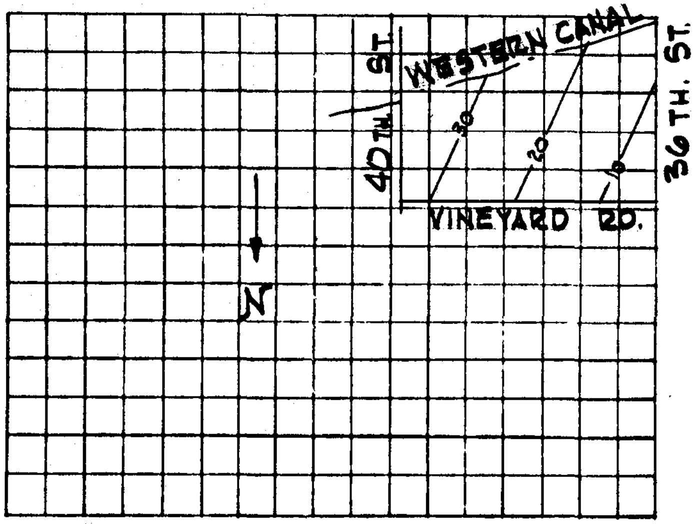
Done by T.B.G.

Date 2/17/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area N. Pt. SE¼ Sec. 36, T1N, R3E.
(N. of Western Canal)



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	72	60	43	35	25		
H.D. Residential							
Parks & park-like	4	10	1	10	1		
Farmlands, groves							
Commercial	4	0	0	90	4		
Industrial							
Total Acres	80		44	37.6	30		

Mean land slope N-S 0.010 E-W .003

Flow conveyance 40' Streets

Flow velocity N-S 2.3 ft./sec. 38 min./mile 138 ft/min.

E-W 1.25 ft./sec. 70 min./mile 75 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	12		5	2.70	.996	2.69					2.24	11	11	
20	40		15	1.85	.994	1.84					1.48	22	22	
30	64		24	1.41	.992	1.40					1.08	26	26	Max.
40	80		30	1.14	.991	1.13					0.84	25	25	
50														
60														
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE E

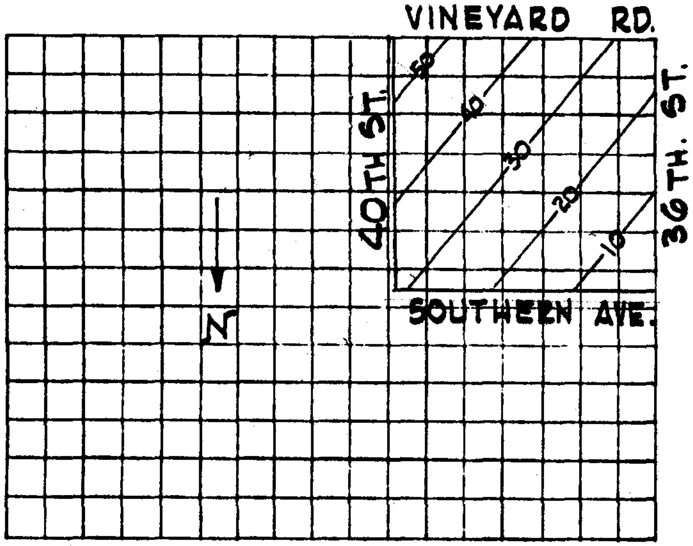
Done by T.B.G.

Date 2/18/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2-Year
Rec. Interval

Drainage Area NE¼ Sec. 36, T1N, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	150	60	90	35	52		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	160		91	36.2	58		

Mean land slope N-S .0068 E-W .0034

Flow conveyance 40' Streets

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

E-W 1.4 ft./sec. 63 min./mile 84 ft/min.

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

	Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
	10	10		4	2.70	.995	2.69					2.24	9	9	
	20	42		15	1.85	.991	1.83					1.47	22	22	
	30	93		34	1.41	.987	1.39					1.07	36	36	
	40	138		50	1.14	.985	1.12					0.83	42	42	Max.
	50	158		57	0.96	.985	0.95					0.68	39	39	
51	~~60~~	160		58	0.95	.985	0.94					0.67	39	39	
	70														
	80														
	90														
	100														
	110														
	120														

Yost and Gardner Engineers

LINE E

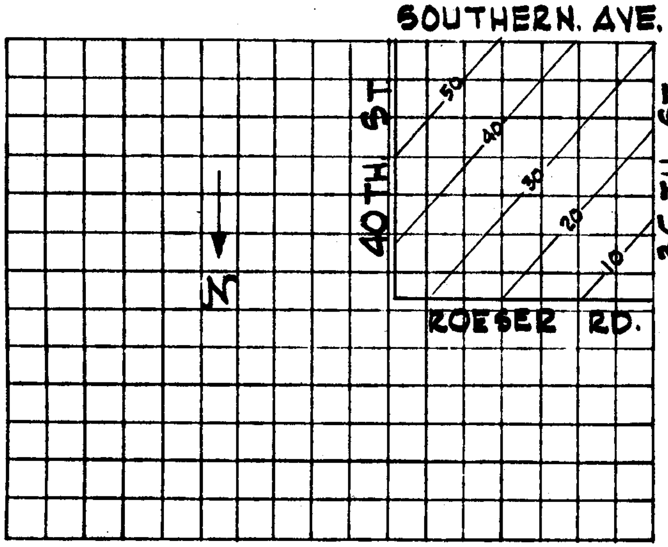
Done by T.B.G.

Date 2/18/72

Drainage Area SE¼ Sec. 25, T1N, R3E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	125	60	75	35	44		
H.D. Residential	7	50	4	40	3		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial	18	30	5	70	13		
Total Acres	160		85	41.2	66		

Mean land slope N-S .0038 E-W .0026

Flow conveyance 40' Streets

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

E-W 1.2 ft./sec. 73 min./mile 72 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	7		3	2.70	.996	2.69					2.24	7	7	
20	29		12	1.85	.993	1.84					1.48	18	18	
30	64		26	1.41	.988	1.39					1.05	27	27	
40	110		45	1.14	.986	1.12					0.83	37	37	
50	146		60	0.96	.985	0.95					0.67	40	40	Max.
60	160		66	0.83	.985	0.82					0.56	37	37	
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE E

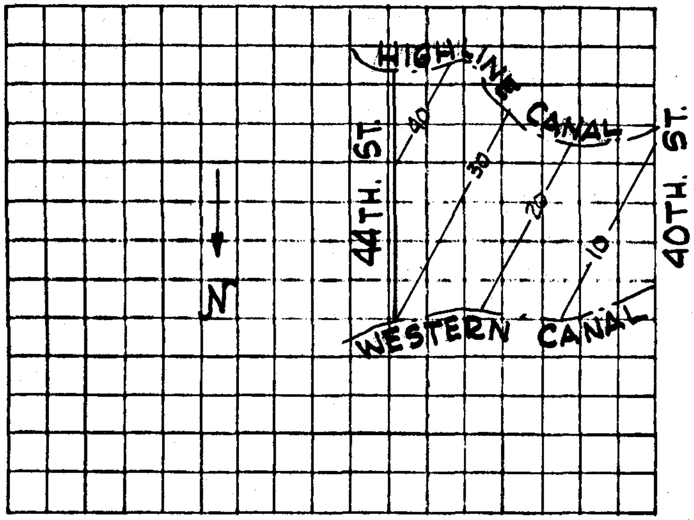
Done by T.B.G.

Date 2/21/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area SW ¼ Sec. 31, T1N, R4E, Plus
N. Pt. Sec. 6, T1S, R4E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	107	60	64	35	37		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	117		65	36.8	43		

Mean land slope N-S .012 E-W .0035

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W 1.4 ft./sec. 63 min./mile 84 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	18		7	2.70	.995	2.69					2.24	16	16	
20	42		16	1.85	.993	1.84					1.48	24	24	
30	77		28	1.41	.990	1.40					1.08	29	29	
40	109		40	1.14	.987	1.13					0.84	34	34	Max.
45 ~~50~~	117		43	1.02	.986	1.01					0.73	31	31	
60														
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE F

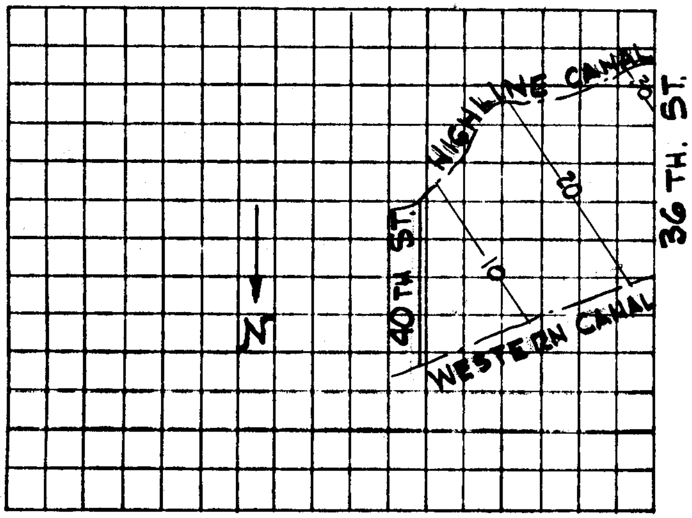
Done by T.B.G.

Date 2/21/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area S. Pt. of SE¼ Sect. 36, T1N, R3E.
plus N. Pt. Sec. 1, T1S, R3E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	127	60	76	35	44		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	9	5		
Industrial							
Total Acres	137		77	36.5	50		

Mean land slope N-S .0185 E-W .0066

Flow conveyance 40' Streets

Flow velocity N-S 2.8 ft./sec. 31 min./mile 168 ft/min.

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

Hydrologic soil group ___ Assumed infiltration cap. ___ in./hr.

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	30		11	2.70	.995	2.69					2.24	25	25	
20	90		32	1.85	.990	1.84					1.48	47	47	
30	134		49	1.41	.987	1.40					1.08	53	53	Max.
32 ~~40~~	137		50	1.35	.987	1.34					1.03	51	51	
50														
60														
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE F

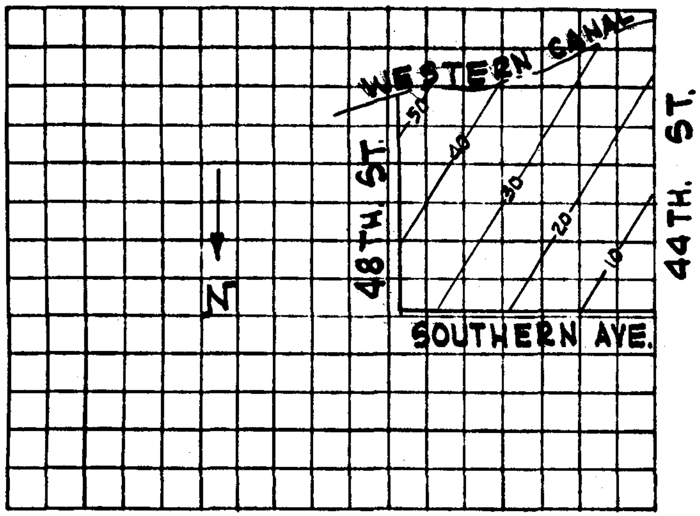
Done by T.B.G.

Date 2/14/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area NE¼ Sec. 31, T1N, R4E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	152	60	91	35	53		
H.D. Residential							
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	162		92	36.4	59		

Mean land slope N-S .0068 E-W .003

Flow conveyance 40' Streets

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

E-W 1.25 ft./sec. 70 min./mile 75 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	10		4	2.70	.997	2.69					2.24	9	9	
20	40		15	1.85	.994	1.84					1.48	22	22	
30	94		34	1.41	.990	1.40					1.08	37	37	
40	138		50	1.14	.988	1.13					0.84	42	42	Max.
50	158		57	0.96	.985	0.95					0.67	38	38	
52 ~~60~~	162		59	0.93	.985	0.92					0.65	38	38	
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE F

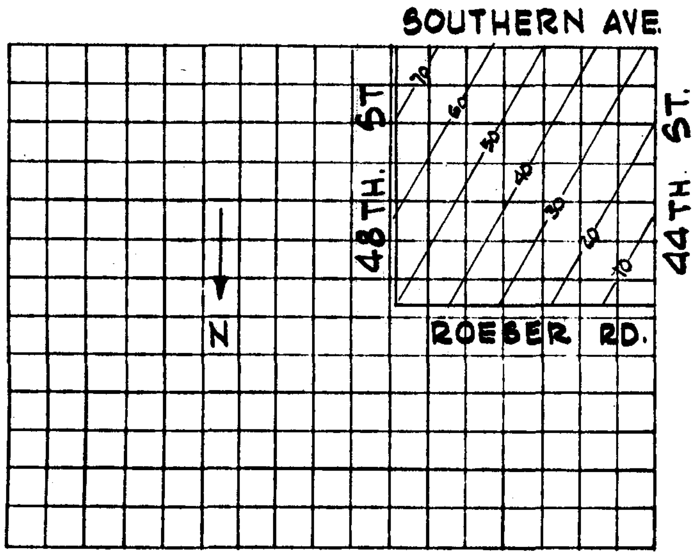
Done by T.B.G.

Date 2/4/72

Drainage Area SE¼ Sec. 30, T1N, R4E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	120	60	72	35	42		
H.D. Residential	10	50	5	40	4		
Parks & park-like	5	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial	20	30	6	70	14		
Total Acres	160		84	41.7	66		

Mean land slope N-S .005 E-W .0015

Flow conveyance 40' Streets

Flow velocity N-S 1.6 ft./sec. 55 min./mile 96 ft/min.

E-W 0.9 ft./sec. 98 min./mile 54 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	6		3	2.70	.997	2.69					2.24	7	7	
20	24		10	1.85	.995	1.84					1.48	15	15	
30	53		22	1.41	.993	1.40					1.08	24	24	
40	86		36	1.14	.991	1.13					0.84	30	30	
50	121		51	0.96	.988	0.94					0.67	34	34	Max.
60	146		61	0.83	.986	0.82					0.56	34	34	
70	157		65	0.73	.985	0.72					0.47	31	31	
75 ~~80~~	160		66	0.69	.985	0.68					0.43	29	29	
90														
100														
110														
120														

Yost and Gardner Engineers

LINE F

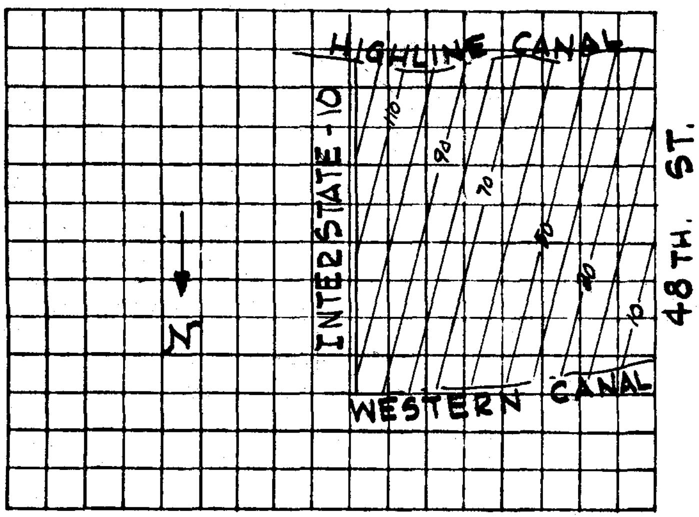
Done by T.B.G.

Date 2/15/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area SE¼ Sec. 32, T1N, R4E. Plus
N. Pt. of Sec. 5, T1S, R4E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	240	60	144	35	84		
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	10	10	0	90	9		
Industrial							
Total Acres	260		145	36	94		

Mean land slope N-S .011 E-W 0.0013

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W 0.5 ft./sec. 176 min./mile 30 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
10	5		2	2.70	.998	2.69					2.24	4	4	
20	21		8	1.85	.995	1.84					1.48	12	12	
30	46		17	1.41	.993	1.40					1.08	18	18	
40	75		28	1.14	.991	1.13					0.84	24	24	
50	102		37	0.96	.990	0.95					0.67	25	25	
60	128		46	0.83	.988	0.82					0.56	26	26	
70	155		56	0.73	.986	0.72					0.47	26	26	Max.
80	181		65	0.66	.985	0.65					0.40	26	26	
90	208		75	0.60	.984	0.59					0.35	26	26	
100	234		85	0.55	.983	0.54					0.31	26	26	
110	250		91	0.51	.982	0.50					0.27	25	25	
120	256		93	0.47	.981	0.46					0.23	21	21	
125	260		94	0.46	.981	0.45					0.22	21	21	

Yost and Gardner Engineers

LINE G

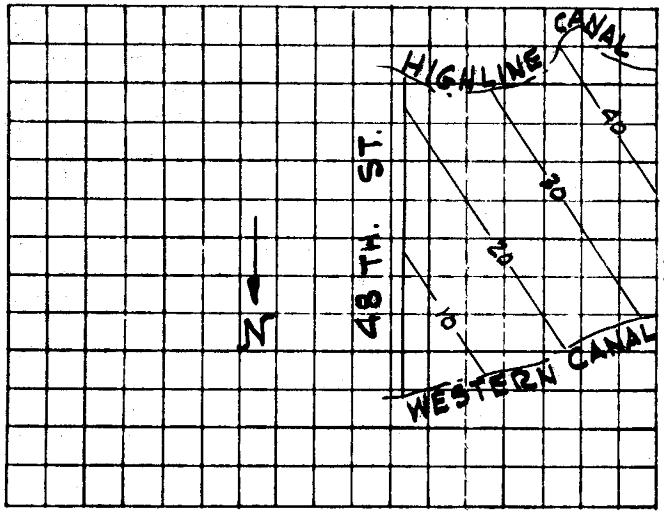
Done by T.B.G.

Date 2/21/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year Rec. Interval

Drainage Area SE¼ Sec. 31, T1N, R4E. plus N. Pt. Sec. 6, T1S, R4E.



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	180	60	103	35	63		
H.D. Residential							
Parks & park-like	5	5	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	190		104	36%	69		

Mean land slope N-S .012 E-W 0.0035

Flow conveyance 40' Streets

Flow velocity N-S 2.5 ft./sec. 35 min./mile 150 ft/min.

E-W 1.4 ft./sec. 63 min./mile 84 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-yr. intens. "/hr.	Area red. factor	I_a "/hr.	Infil. f_c "/hr.	$[I_a - f_c]$	$[I_a - f_c]^{0.8}$	Q_p cfs	$[I_a - 0.2]^{0.9}$	Q_i cfs	Q_t cfs	
10	14		5	2.70	.995	2.69					2.24	11	11	
20	57		21	1.85	.992	1.83					1.47	31	31	
30	112		41	1.41	.988	1.39					1.07	44	44	
40	157		57	1.14	.985	1.12					0.83	47	47	Max.
50	190		69	0.96	.984	0.95					0.67	46	46	
60														
70														
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE G

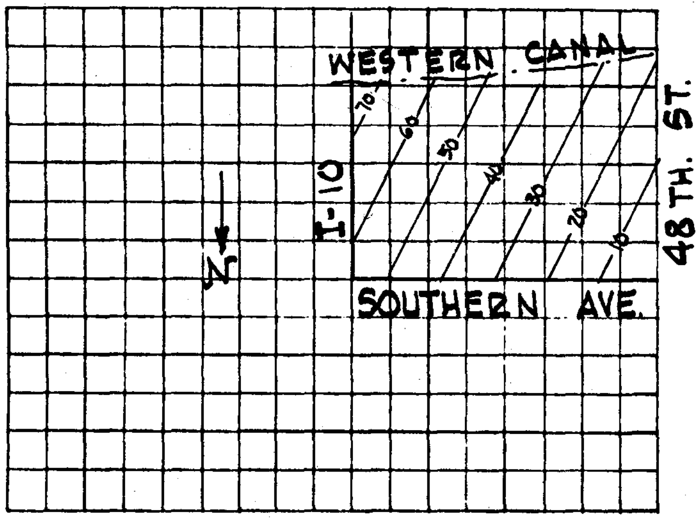
Done by T.B.G.

Date 2/10/72

Drainage Area NW¼ Sec. 32, T1N, R4E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	136	60	82	35	48		
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	5	0	0	90	5		
Industrial							
Total Acres	151		83	36	54		

Mean land slope N-S .007 E-W .0017

Flow conveyance 40' Streets

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

E-W 0.9 ft./sec. 98 min./mile 54 ft/min.

Hydrologic soil group ____ Assumed infiltration cap. 0.75 in./hr.

	Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2 -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	
	10	7		3	2.70	.997	2.69					2.24	7	7	
	20	28		10	1.85	.996	1.85					1.49	15	15	
	30	57		20	1.41	.993	1.40					1.08	22	22	
	40	82		29	1.14	.992	1.13					0.84	24	24	
	50	107		38	0.96	.990	0.95					0.67	25	25	
	60	130		47	0.83	.988	0.82					0.56	26	26	Max.
	70	146		52	0.73	.983	0.72					0.47	24	24	
75	80	151		54	0.70	.982	0.69					0.44	24	24	
	90														
	100														
	110														
	120														

Yost and Gardner Engineers

LINE G

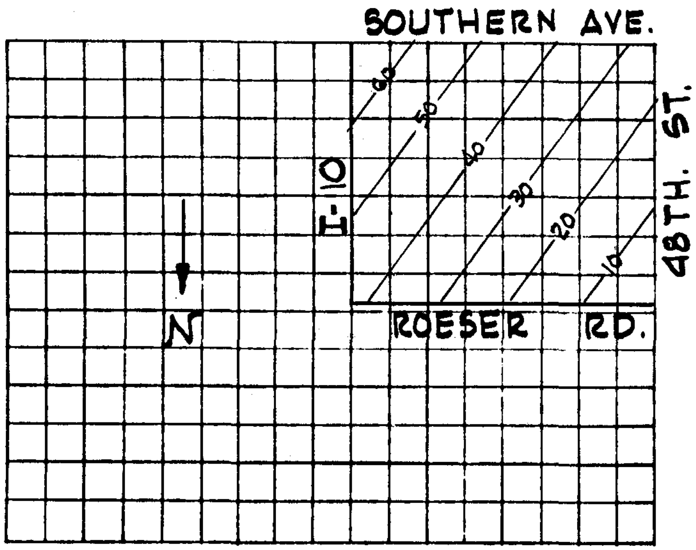
Done by T.B.G.

Date 2/10/72

Drainage Area SW¼ Sec. 29, T1N, R4E.

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval



Land Use	Gross Acres	Pervious %	Pervious Acres	Impervious %	Impervious Acres	Non-contrib. %	Non-contrib. Acres
L.D. Residential							
M.D. Residential	171	60	103	35	60		
H.D. Residential							
Parks & park-like	10	10	1	10	1		
Farmlands, groves							
Commercial	10	0	0	90	9		
Industrial							
Total Acres	191		104	36.7	70		

Mean land slope N-S .0057 E-W .0026

Flow conveyance 40' Streets

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

E-W 1.2 ft./sec. 73 min./mile 72 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	2-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	
10	9		3	2.70	.997	2.69					2.24	7	7	
20	35		13	1.85	.995	1.84					1.48	19	19	
30	80		29	1.41	.991	1.40					1.08	31	31	
40	127		47	1.14	.988	1.13					0.84	40	40	
50	166		61	0.96	.985	0.95					0.67	41	41	Max.
60	186		68	0.83	.984	0.82					0.56	38	38	
67 ~~70~~	191		70	0.79	.984	0.78					0.52	36	36	
80														
90														
100														
110														
120														

Yost and Gardner Engineers

LINE G

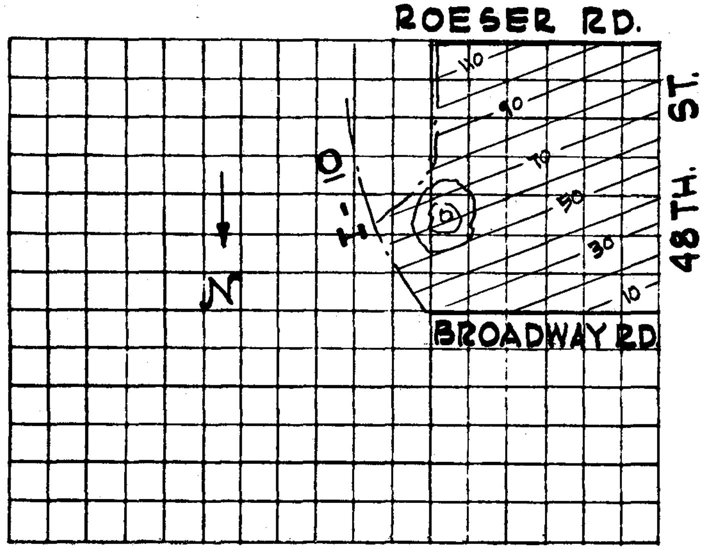
Done by T.B.G.

Date 2/10/72

URBAN RUNOFF COMPUTATION
(Modified Rational Method)

2 -Year
Rec. Interval

Drainage Area NW¼ Sec. 29, T1N, R4E.



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	110	10	11	10	11		
Farmlands, groves							
Commercial	10	0	0	90	9		
Industrial	20	30	6	70	14		
Total Acres	140		17	25	34		

Mean land slope N-S .00114 E-W .00375

Flow conveyance 40' Streets

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

E-W 1.4 ft./sec. 63 min./mile 84 ft/min.

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

Time Min.	Total area ac.	Perv. area ac.	Imp. area ac.	__-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	
10	3		1	2.70	.999	2.70					2.25	2	2	
20	12		3	1.85	.997	1.84					1.48	5	5	
30	27		7	1.41	.995	1.40					1.08	8	8	
40	44		11	1.14	.994	1.13					0.84	9	9	
50	62		15	0.96	.993	0.95					0.67	10	10	
60	77		19	0.83	.992	0.82					0.56	11	11	
70	91		22	0.73	.991	0.72					0.47	11	11	
80	107		26	0.66	.990	0.65					0.41	11	11	Max.
90	122		30	0.60	.989	0.59					0.35	11	11	
100	131		32	0.55	.988	0.54					0.31	10	10	
110	137		33	0.51	.988	0.50					0.27	9	9	
120	140		34	0.49	.988	0.48					0.25	9	9	

Yost and Gardner Engineers

LINE G

Line A:
7th Street - Western Canal to Salt River

*Area Contributing at Corresponding t_c

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
S. Pt. Sec. 33, T1N, R3E. N. Pt. N½ Sec. 4, T1S, R3E.	85		32			60	0.83	0.82			0.56	18	18	20 - 24" Pipe, S = .0111
SE¼ Sec. 33, T1N, R3E.	63		24			70	0.73	0.72			0.47	11	11	15 - 27" Pipe, S = .0019
SW¼ Sec. 33, T1N, R3E.	63		24			70	0.73	0.72			0.47	11	11	
Sum	211		80			64	0.79	0.78			0.52	42	42	40 - 30" Pipe, S = .0111
NE¼ Sec. 33, T1N, R3E.	127		47			50	0.96	0.95			0.67	32	32	35 - 36" Pipe, S = .0023
NW¼ Sec. 33, T1N, R3E.	137		51			51	0.96	0.95			0.67	34	34	
Sum	475		178			69	0.74	0.72			0.47	84	84	85 - 39" Pipe, S = .0095
SE¼ Sec. 28, T1N, R3E.	138		51			50	0.96	0.95			0.67	34	34	35 - 36" Pipe, S = .0026
SW¼ Sec. 28, T1N, R3E.	161		60			50	0.96	0.95			0.67	40	40	
Sum	774		289			73	0.71	0.69			0.44	127	127	130 - 60" Pipe, S = .00322
NE¼ Sec. 28, T1N, R3E.	125		58			50								
S½ SE¼ Sec. 21, T1N, R3E.	69		33			50								
Sum (Sub-Total)	194		91			50	0.96	0.94			0.67	61	61	60 - 48" Pipe, S = .0018
NW¼ Sec. 28, T1N, R3E.	125		58			50	0.96	0.95			0.67	32	32	
Sum	1093		438			80	0.66	0.64			0.40	175	175	175 - 72" Pipe, S = .0015
S½SW¼ Sec. 21, T1N, R3E.	69		33											
Sum	1162													

Line B:
16th Street - Western Canal to Salt River

*Area Contributing at Corresponding t_c

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
S. Pt. SW¼ Sec. 34, T1N, R3E. & N. Pt. NW¼ Sec. 3, T1S, R3E.	122		45			40	1.14	1.13			0.85	38	38	40 - 30" Pipe, S = .0121
SE¼ Sec. 34, T1N, R3E.	30		11			40	1.14	1.13			0.85	9	9	10 - 27" Pipe, S = .001
SW¼ Sec. 34, T1N, R3E.	30		11			40	1.14	1.13			0.85	9	9	
Sum	182		67			43	1.08	1.06			0.77	52	52	50 - 33" Pipe, S = .0086
NE¼ Sec. 34, T1N, R3E.	65		24			50	0.96	0.95			0.67	16	16	15 - 33" Pipe, S = .001
NW¼ Sec. 34, T1N, R3E.	64		23			50	0.96	0.95			0.67	15	15	
Sum	311		114			49	0.97	0.95			0.67	76	76	75 - 39" Pipe, S = .0082
SE¼ Sec. 27, T1N, R3E.	70		32			65	0.78	0.77			0.51	16+	16+	15 - 33" Pipe, S = .001
SW¼ Sec. 27, T1N, R3E.	72		33			65	0.78	0.77			0.51	17	17	
Sum	453		179			54	0.91	0.88			0.61	109	109	110 - 48" Pipe, S = .005
NE¼ Sec. 27, T1N, R3E. & S½ SE¼ Sec. 22, T1N, R3E.	158		58			50	0.96	0.95			0.67	39	39	40 = 39" Pipe, S = .0023
NW¼ Sec. 27, T1N, R3E.	115		41			50	0.96	0.95			0.67	27	27	
Sum	726		278			59	0.84	0.81			0.55	153	153	155 - 72" Pipe, S = .0013
S. Pt. SW¼ Sec. 22, T1N, R3E.	55		24			50	0.96	0.95			0.67	16	16	
Sum	781		302			63	0.80	0.72			0.51	154	154	160 - 72" Pipe, S = .0013

Line C:
24th Street - Western Canal to Salt River

*Area Contributing at Corresponding t_c

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
S. Pt. SE¼ Sec. 34, T1N. R3E. plus N. Pt. NW¼ Sec. 3, T1S, R3E.	58		21			50								Runoff @ 50 Min. - Not Max.
S. Pt. SW¼ Sec. 35, T1N, R3E. & N. Pt. NW¼ Sec. 2, T1S, R3E.	109		40			50								
Sum	167		61			50	0.96	0.95			0.67	41	41	40 - 30" Pipe, S = .0117
SE¼ Sec. 35, T1N, R3E.	107		40			80	0.66	0.65			0.40	16	16	15 - 33" Pipe, S = .001
SW¼ Sec. 35, T1N, R3E.	96		36											
Sum	370		137			53	0.92	0.90			0.63	86	86	85 - 42" Pipe, S = .0082
NE¼ Sec. 35, T1N, R3E.	104		38			60	0.83	0.82			0.56	21	21	20 - 36" Pipe, S = .001
NW¼ Sec. 35, T1N, R3E.	104		38			60	0.83	0.82			0.56	21		
Sum	578		213			59	0.84	0.81			0.55	117	117	115 - 48" Pipe, S = .0068
SE¼ Sec. 26, T1N, R3E.	75		28			60	0.83	0.82			0.56	16	16	15 - 27" Pipe, S = .0019
SW¼ Sec. 26, T1N, R3E.	75		28			60	0.83	0.82			0.56	16		
Sum	728		269			63	0.80	0.77			0.51	137	137	140 - 66" Pipe, S = .0016
W½NW¼ Sec. 26, T1N, R3E.	58		25			40	1.14	1.13			0.85	21		
S½SW¼SE¼ Sec. 23, T1N, R3E.	26		10			40	1.14	1.13			0.84	9	9	
Sum (Sub-Total	84		35			40	1.14	1.13			0.84	29	29	30 - 36" Pipe, S = .002
NW¼ Sec. 26, T1N, R3E.	116		50			50	0.96	0.95			0.68	34	34	
Sum	928		354			69	0.74	0.72			0.47	167	167	170 - 72" Pipe, S = .0018
S½S½SW¼ Sec. 23, T1N, R3E.	40		21			50	0.96	0.95			0.68	14	14	
Sum	968		375			72	0.72	0.70			0.45	169	169	175 - 72" Pipe, S = .0018

Line E:
32nd Street - Western Canal to Broadway

*Area Contributing at Corresponding t_c

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
S. Pt. SE¼ Sec. 35, T1N, R3E. & N. Pt. NE¼ Sec.2, T1S, R3E.	39		14			30								Runoff @ 30 Min. - Not Max.
S. Pt. SW¼ Sec. 36, T1N, R3E. & N. Pt. NW¼ Sec. 1, T1S, R3E.	135		50			30								
Sum	174		64			30	1.41	1.40			1.08	69	69	70 - 36" Pipe, S = .010
N. Pt. SE¼ Sec. 36, T1N, R3E.	64		24			30	1.41	1.40			1.08	26	26	25 - 33" Pipe, S = .0019
SW¼ Sec. 36, T1N, R3E.	94		35											
Sum	332		123			35	1.27	1.26			0.95	117	117	115 - 48" Pipe, S = .009
NE¼ Sec. 36, T1N, R3E.	138		50			40	1.14	1.12			0.83	42	42	40 - 39" Pipe, S = .0023
NW¼ Sec. 36, T1N, R3E.	138		50											
Sum	608		223			40	1.14	1.12			0.83	184	184	185 - 72" Pipe, S = .0018
SE¼ Sec. 25, T1N, R3E.	146		60			50	0.96	0.95			0.67	40	40	40 - 39" Pipe, S = .0025
SW¼ Sec. 25, T1N, R3E.	130		54											
Sum	884		337			45	1.03	1.01			0.73	246	246	245 - 84" Pipe, S = .0012
32nd Street at Broadway														See Sheet for t_c lag Correction

Lines D, E, F & G

Note: This sheet corrects for t_c lag to 32nd Street and Broadway

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
SW¼ Sec. 32, T1N, R4E.	7		3			12								
SE¼ Sec. 31, T1N, R4E.	23		8			12								
NW¼ Sec. 32, T1N, R4E.	20		7			16								
SW¼ Sec. 29, T1N, R4E.	40		15			21								
NW¼ Sec. 29, T1N, R4E.	24		8			28								
SW¼ Sec. 31, T1N, R4E. plus N. Pt. Sec. 6, T1S, R4E.	56		21			24								
S. Pt. SE¼ Sec. 36, T1N, R4E. plus N. Pt. Sec. 1, T1S, R4E.	108		39			24								
NE¼ Sec. 31, T1N, R4E.	40		15			20								
NW¼ Sec. 31, T1N, R4E.	110		40			30								
SE¼ Sec. 30, T1N, R4E.	39		16			25								
SW¼ Sec. 30, T1N, R4E.	69		22			35								
NE¼ Sec. 30, T1N, R4E.	73		33			34								
NW¼ Sec. 30, T1N, R4E.	100		45			41								
NE¼ Sec. 25, T1N, R4E.	160		70			46								
NW¼ Sec. 25, T1N, R4E.	139		89			50								
Sum	1008		431											
Sheet	726		277											
Sum - 32nd St. at Broadway	1734		708			51	0.95	0.90			0.63	446	446	445 - 90" Pipe, S = .003
E½NE¼ Sec. 26, T1N, R3E.	58		25			40								
Sum	1792		733			53	0.92	0.92			0.87	440	440	450 - 90" Pipe, S = .0035
SE¼SE¼ Sec. 23, T1N, R3E.	44		24			50	0.96	0.95			0.67	16	16	
Sum	1836		757			55	0.89	0.85			0.58	440	440	455 - Channel

Line F:
40th Street - Western Canal to Broadway

*Area Contributing at Corresponding t_c

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
SW¼ Sec. 31, T1N, R4E. & NE Pt. NW¼ Sec. 6, T1S, R3E.	77		28			30								Runoff @ 30 Min. - Not Max.
S. Pt. SE¼ Sec. 36, T1N, R3E. & N. Pt. NE¼ Sec. 1, T1S, R3E.	134		49			30								
Sum	211		77			30	1.41	1.39			1.07	82	82	80 - 36" Pipe, S = .0125
NE¼ Sec. 31, T1N, R4E.	138		50			40	1.13	1.12			0.83	42	42	40 - 39" Pipe, S = .002
NW¼ Sec. 31, T1N, R4E.	162		59			40								
Sum	511		186			36	1.23	1.20			0.90	167	167	165 - 60" Pipe, S = .005
SE¼ Sec. 30, T1N, R4E.	121		51			50	0.96	0.95			0.68	34	34	35 - 39" Pipe, S = .0015
SW¼ Sec. 30, T1N, R4E.	94		40											
Sum	726		277			41	1.13	1.11			0.82	227	227	230 - 78" Pipe, S = .0017
At 40th Street & Broadway						47								See Sheet for t_c lag correction

*Area Contributing at Corresponding t_c

Line G:
48th Street - Western Canal to Broadway

Line D:
Broadway - 48th Street to 40th Street

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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
SW¼ Sec. 32, T1N, R4E. & N. Pt. Sec. 5, T1S, R4E.	75		28			40								Runoff @ 40 Min. - Not Max.
SE¼ Sec. 31, T1N, R4E. & N. Pt. NE¼ Sec. 6, T1S, R4E.	157		57			40								Max. at 40 Mins.
Sum	232		85			40	1.14	1.12			0.83	70	70	70 - 39" Pipe, S = .0075
NW¼ Sec. 32, T1N, R4E.	130		47			60								
Sum	362		132			44	1.07	1.05			0.77	102	102	100 - 48" Pipe, S = .006
SW¼ Sec. 29, T1N, R4E.	166		61			50								
Sum	528		193			49	0.98	0.95			0.68	131	131	130 - 60" Pipe, S = .0034
NW¼ Sec. 29, T1N, R4E.	91		31			70								
Sum	619		224			56	0.88	0.85			0.59	132	132	135 - 66" Pipe, S = .0015
NE¼ Sec. 30, T1N, R4E.	167		74			60								
Sum	786		298			63	0.80	0.77			0.51	152	152	150 - 72" Pipe, S = .0015
40th Street & Broadway						69								See Sheet for t_c lag correction.

Lines D, F, & G

Note:
This sheet corrects for t_c lag to 40th Street at Broadway

EXPECTED FLOWS 2 year rainfall intensity and duration unless noted

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. 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
SW¼ Sec. 32 & N. Pt. Sec. 5	18		7			18								
SE¼ Sec. 31 & N. Pt. NE¼ Sec. 6	47		18			18								
NW¼ Sec. 32	34		12			22								
SW¼ Sec. 29	74		24			27								
NW¼ Sec. 29	34		11			34								
NE¼ Sec. 30 & SE Pt. Sec. 19	96		43			40								
NW¼ Sec. 30 & SW Pt. Sec. 19	125		56			47								
Line from South on 40th Street	726		277			47								
Sum - 40th Street at Broadway	1154		448			47	1.02	0.98			0.70	314	314	315 - 78" Pipe, S = .003
NE¼ Sec. 25, T1N, R3E.	178		77											
Sum - 36th St. at Broadway	1332		525			52	0.93	0.89			0.62	325	325	325 - 84" Pipe, S = .00235

Project: SE Phoenix Study
Line: "A"
Location: 7th Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Sheet 1 of 7
Calc. by: P.C.
Date: 6/72

Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Salt River	52.48	72	58.48	28.3	180	6.37	0.63	4588	0.00154							59.11
										0.00154	5180	7.98				
Broadway Rd.	60.25	72	66.46	28.3	175	6.37	0.63	4588	0.00154							67.09
														0.18		
Broadway Rd.	61.25	60	64.64	14.20	130	9.17	1.31	3516	0.00370							65.95
										0.00370	2640	9.76				
Roeser Rd.	69.75	60	73.14	14.20	130	9.17	1.31	3516	0.00370							74.45
														-0.31		
Roeser Rd.	71.50	39	74.06	7.04	85	12.06	2.27	865	0.00964							76.33
										0.00964	2640	25.40				
Southern Ave.	96.48	39	99.04	7.04	85	12.06	2.27	865	0.00964							01.31
														2.02		
Southern Ave.	97.33	30	02.40	4.90	40	8.17	1.04	444	0.00813							03.44
										0.00813	2640	21.45				
Vineyard Rd.	26.63	30	33.82	4.90	40	8.17	1.04	444	0.00813							35.22
														1.56		
Vineyard Rd.	27.13	24	36.05	3.14	18	5.73	0.51	245	0.00540							36.56
										0.00915	1850	16.91				
Western Canal	47.67	24	48.91	1.99	18	9.05	1.27	168	0.0149							50.18

Project: SE Phoenix Study
Line: "B"
Location: 16th Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Sheet 2 of 7
Calc. by: P.C.
Date: 6/72

Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Salt River	63.76	72	69.76	28.3	160	5.66	0.50	4588	0.00122							70.26
										0.00122	3160	3.86				
S.F. Canal (N)	67.87	72	72.79	24.7	160	6.47	0.65	4568	0.00123							73.44
										0.00127	1090	1.38				
Broadway Rd.	69.28	72	73.84	23.2	155	6.41	0.64	4298	0.00131							74.48
														-0.43		
Broadway Rd.	71.28	48	74.57	10.95	110	10.05	1.57	1546	0.00506							76.14
										0.00506	2640	13.33				
Roeser Rd.	84.48	48	87.77	10.95	110	10.05	1.57	1546	0.00506							89.34
														0.45		
Roeser Rd.	85.23	39	88.58	8.29	75	9.06	1.28	895	0.00703							89.86
										0.00777	2500	19.39				
Southern Ave.	05.73	39	08.17	6.70	75	11.19	1.95	813	0.00852							10.12
														1.34		
Southern Ave.	06.23	33	10.44	5.94	50	8.43	1.11	573	0.00762							11.55
										0.00808	2800	22.62				
Vineyard Rd.	30.31	33	32.46	4.86	50	10.29	1.65	542	0.00853							34.11
														0.59		
Vineyard Rd.	30.56	30	33.86	4.90	38	7.76	0.93	444	0.00734							34.79
										0.00943	1900	17.91				
Western Canal	53.55	30	55.22	3.43	38	11.08	1.23	354	0.01152							56.45

Project: SE Phoenix Study
Line: "C"
Location: 24th Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Sheet 3 of 7
Calc. by: P.C.
Date: 6/72

Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Salt River	76.54	72	82.54	28.25	175	6.20	0.60	4588	0.00145							83.14
										0.00162	2548	4.13				
San Fran. Canal	81.13	72	85.56	22.00	170	7.73	0.93	4031	0.00178							86.49
										0.00178	592	1.05				
Broadway Rd.	82.68	72	87.11	22.00	170	7.73	0.93	4031	0.00178							88.09
														0.10		
Broadway Rd.	83.18	66	87.44	19.64	140	7.13	0.79	3812	0.00135							88.23
										0.00135	2600	3.51				
Roeser Rd.	87.34	66	91.60	19.64	140	7.13	0.79	3812	0.00135							92.39
														-0.47		
Roeser Rd.	88.84	48	91.79	9.78	115	11.76	2.15	1378	0.00694							93.94
										0.00694	2330	16.17				
Southern Ave.	04.68	48	07.63	9.78	115	11.76	2.15	1378	0.00694							09.78
														0.73		
Southern Ave.	05.18	42	09.07	9.62	85	8.84	1.22	1090	0.00609							10.29
										0.00673	2950	19.85				
Vineyard Rd.	29.37	42	31.87	7.30	85	11.63	1.35	928	0.00837							33.22
														1.72		
Vineyard Rd.	30.37	30	35.00	4.90	40	8.17	1.04	444	0.00902							36.04
										0.01101	1750	19.27				
Western Canal	50.85	30	52.60	3.67	40	10.90	1.85	372	0.01310							54.45

Project: SE Phoenix Study
Line: "D"
Location: Broadway Rd. & 30th Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Calc. by: P.C.
Date: 6/72

Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Salt River	82.38	Chan.	86.38	92	500	5.43	0.46	22632	0.00049							86.84
										0.00191	1680	3.21				
Elwood St.	83.22	90	90.19	38.6	455	11.79	2.17	9001	0.00333							92.36
										0.00295	1654	4.88		0.10		
San Fran. Canal	87.74	90	94.16	38.2	450	11.77	2.16	8903	0.00256							96.32
										0.00256	1082	2.77				
30th St.	91.34	90	98.21	38.2	450	11.77	2.16	8903	0.00256							00.37
													0.32			
30th St.	91.34	90	97.97	37.8	445	11.77	2.16	8808	0.00255							00.13
										0.00255	1289	3.29				
32nd St.	95.30	90	01.93	37.8	445	10.05	1.57	8318	0.00255							03.50
														0.23		
32nd St.	95.80	84	01.26	32.0	325	10.16	1.60	6551	0.00246							02.86
										0.00246	2640	6.49				
36th St.	02.00	84	07.46	32.0	325	10.16	1.60	6551	0.00246							09.06
														0.10		
36th St.	02.50	78	07.83	28.97	315	10.87	1.84	5653	0.00311							09.67
										0.00311	2640	8.21				
40th St.	10.42	78	15.75	28.97	315	10.87	1.84	5663	0.00311							17.59
														0.54		
40th St.	10.92	72	17.69	28.25	150	5.31	0.44	4588	0.00107							18.13
										0.00107	2640	2.82				
44th St.	14.09	72	20.51	28.25	150	5.31	0.44	4588	0.00107							20.95
														0.14		
44th St.	14.59	66	20.59	23.79	135	5.67	0.50	3638	0.00138							21.09
										0.00138	2640	3.64				
48th St.	18.55	66	24.23	23.79	135	5.67	0.50	3638	0.00138							24.73

Project: SE Phoenix Study
Line: "E"
Location: 32nd Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Sheet 5 of 7
Calc. by: P.C.
Date: 6/72

Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Broadway Rd.	95.80	84	02.80	38.4	245	6.38	0.63	6921	0.00125							03.43
										0.00125	2640	3.31				
Roeser Rd.	98.97	84	06.11	38.4	245	6.38	0.63	6921	0.00125							06.74
														0.20		
Roeser Rd.	99.97	72	06.30	28.25	185	6.56	0.67	4588	0.00163							06.97
										0.00176	2640	4.30				
Southern Ave.	04.72	72	09.30	23.18	185	7.98	0.99	4268	0.00188							10.29
														-0.04		
Southern Ave.	06.72	48	09.40	8.96	115	12.83	2.60	1230	0.00874							12.00
										0.00874	2640	23.07				
Vineyard Rd.	30.48	48	33.16	8.96	115	12.83	2.60	1230	0.00874							35.76
														0.89		
Vineyard Rd.	31.48	36	35.43	7.06	70	9.93	1.33	723	0.00938							36.76
										0.00870	2150	18.71				
Western Canal	52.98	36	55.36	5.99	70	11.68	2.12	698	0.01002							52.48

Project: SE Phoenix Study
Line: "F"
Location: 40th Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Sheet 6 of 7
Calc. by: P.C.
Date: 6/72

Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Broadway Rd.	10.42	78	16.92	33.2	230	6.93	0.75	5680	0.00163							17.67
										0.00178	2640	4.70				
Roeser Rd.	14.91	78	20.03	28.2	230	8.16	1.04	5479	0.00192							21.07
														0.13		
Roeser Rd.	16.41	60	19.83	14.5	165	11.38	2.02	2318	0.00509							21.85
										0.00509	2640	13.43				
Southern Ave.	29.61	60	33.03	14.5	165	11.38	2.02	2318	0.00509							35.05
														1.22		
Southern Ave.	31.11	42	35.23	9.62	80	8.42	1.10	1090	0.00539							36.33
										0.00625	2640	16.50				
Vineyard Rd.	49.06	42	51.60	7.44	80	10.74	1.80	951	0.00710							53.40
															0.18	
Vineyard Rd.	49.56	36	51.78	4.04	80	19.79	6.09	470	0.02895							57.87
										0.02058	800	16.44				
Western Canal	59.56	36	69.91	4.90	80	16.32	4.14	723	0.01221							74.05

Project: SE Phoenix Study
Line: "G"
Location: 48th Street

HYDRAULIC GRADE LINE
CALCULATION SHEET

Sheet 7 of 7
Calc. by: P. C.
Date: 6/72

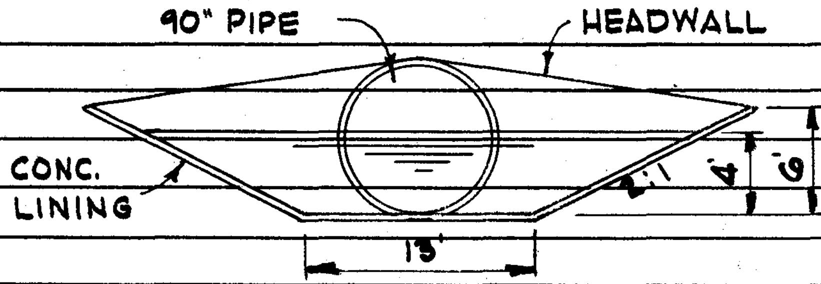
Station or Location	Elev. Inv.	Pipe Dia.	Elev. HGL	A S.F.	Q CFS	V FPS	$\frac{V^2}{2g}$	K	S_f	Ave. S_f	L Ft.	h_f	h_b	h_j	h_t	Elev. EGL
Broadway Rd.	19.05	60	24.05	19.61	135	6.88	0.74	2821	0.00229							24.79
										0.00279	2640	7.36				
Roeser Rd.	28.03	60	31.43	14.2	130	9.16	1.31	2270	0.00328							32.74
															0.06	
Roeser Rd.	29.03	48	32.01	10.03	100	9.96	1.54	1407	0.00507							33.55
										0.00507	2640	13.38				
Southern Ave.	44.87	48	47.85	10.03	100	9.96	1.54	1407	0.00507							49.39
															0.08	
Southern Ave.	45.62	39	48.03	6.52	70	10.73	1.79	794	0.00780							49.82
										0.00780	2300	17.94				
Western Canal	62.87	39	65.28	6.52	70	10.73	1.79	794	0.00780							67.07

AREA DESCRIPTION Southeast Phoenix Storm Drains

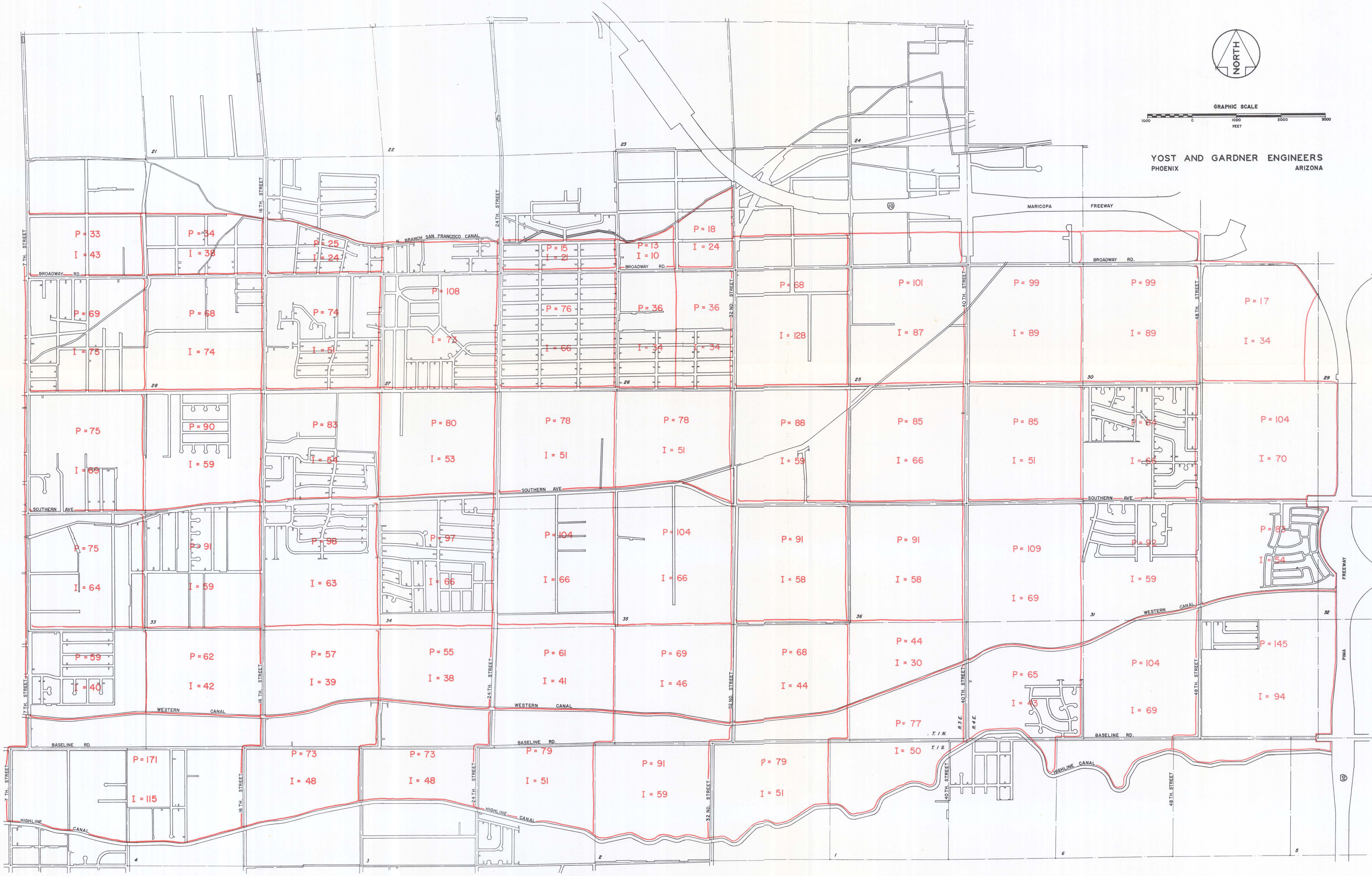
Channel from 1,320 feet North of Broadway on 30th Street

to Salt River

n=0.011 Big Concrete Culverts
n=0.012 Pipe Culverts 21" & Larger
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
	Required Q = 455 C.F.S.	.012	0.5	84	~~30.9~~ 2.72	5.44	457



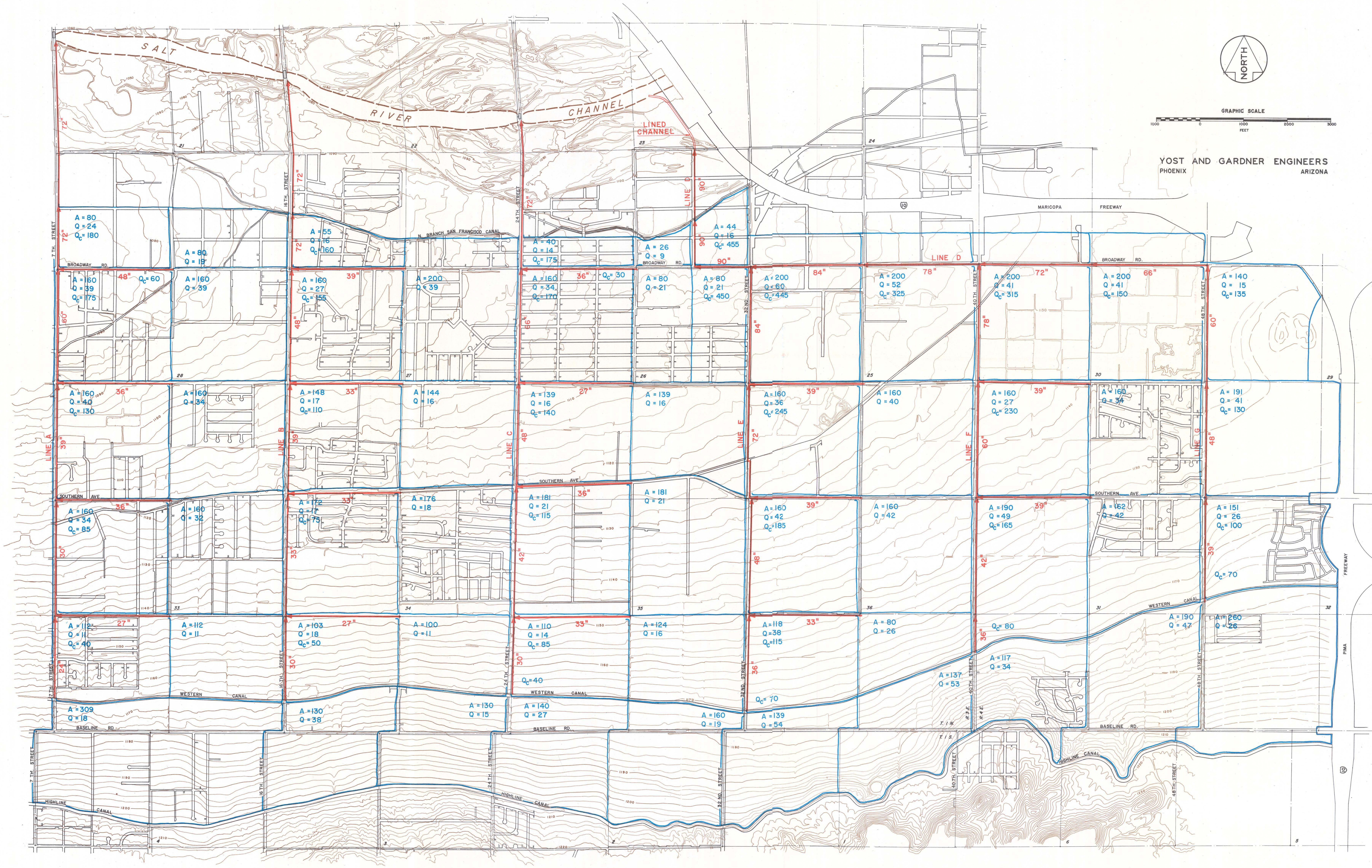
P = 91 INDICATES PERVIOUS AREA IN ACRES

I = 68 INDICATES IMPERVIOUS AREA IN ACRES

INDICATES DRAINAGE AREA BOUNDARY

PERVIOUS AND IMPERVIOUS AREAS BY QUARTER SECTIONS

PLATE II



LINE A	LINE DESIGNATION
39" (red line)	NEW PIPE
39"	PIPE SIZE
A = 160	DRAINAGE AREA IN ACRES
Q = 40	AREA FLOW IN C.F.S.
Q_c = 130	CUMULATIVE FLOW IN C.F.S. (DESIGN FLOW)
(blue line)	DRAINAGE AREA BOUNDARY

PROPOSED STORM DRAINAGE SYSTEMS
SOUTHEAST PHOENIX

PLATE III

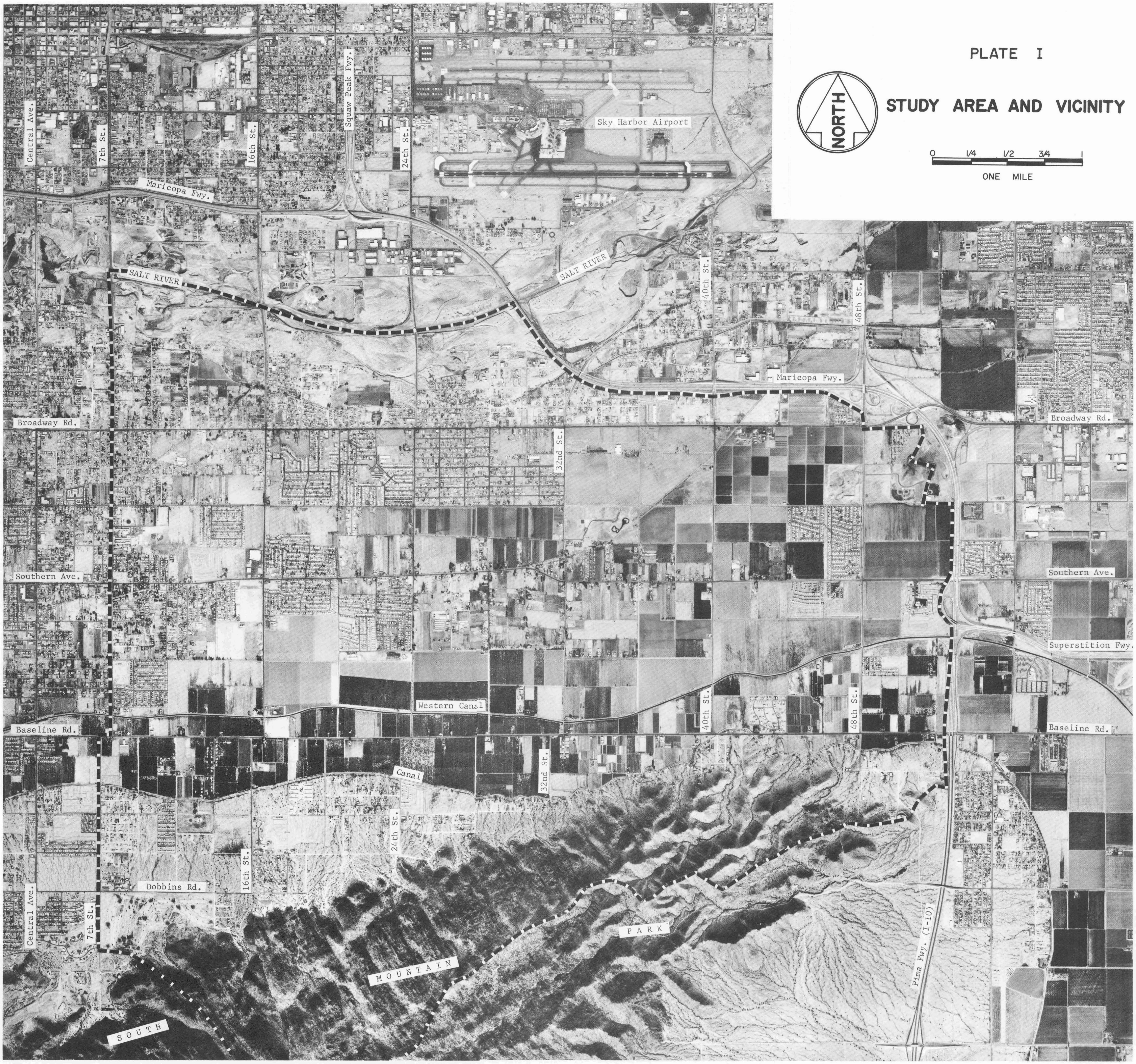


PLATE I
STUDY AREA AND VICINITY
NORTH
0 1/4 1/2 3/4 1
ONE MILE
Sky Harbor Airport
Central Ave.
7th St.
16th St.
Squaw Peak Fwy.
24th St.
Maricopa Fwy.
SALT RIVER
SALT RIVER
40th St.
48th St.
Maricopa Fwy.
Broadway Rd.
Broadway Rd.
32nd St.
Southern Ave.
Southern Ave.
Superstition Fwy.
Western Canal
40th St.
48th St.
Baseline Rd.
Baseline Rd.
Canal
32nd St.
24th St.
16th St.
Dobbins Rd.
Central Ave.
7th St.
PARK
MOUNTAIN
SOUTH
Pima Fwy. (I-10)