Collar, Williams & White Engineering, Inc.

Consulting Engineers

MALCOLM S. WHITE
PRESIDENT

DONALD H. COLLAR, P.E.
VICE-PRESIDENT

2922 NORTH 70TH STREET
SCOTTSDALE, ARIZONA 85251

Feb. 3, 1975

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2801 W. Durango
Phoenix, AZ 85009

Daniel C. Raby, City Engineer
Department of Public Works
City of Scottsdale
3939 Civic Center Plaza
Scottsdale, Arizona 85251

Re: Project M-703-6 (1)
McDowell Rd. - 64th St. to
Scottsdale Road

Dear Mr. Raby:

Submitted herein are the results of a drainage investigation used to establish the criteria for design for the proposed roadway drainage and storm sewer for the improvement & rehabilitation of McDowell Rd. from 64th Street East to Scottsdale Road. (Roadway section improvements from 64th Street East to 70th Street).

This Report and the Improvement Plans prepared by Collar, Williams & White Engineering, Inc. for M-703-6 (1) incorporate Scottsdale Projects FC-7434-C and P-7452-C.

Respectfully Submitted,
Collar, Williams & White Eng. Inc.

Donald H. Collar

Donald H. Collar, P.E.

Registered Professional Engineer
CERTIFICATE NO.
1873
DONALD H.
COLLAR
Date Signed 2/3/75
ARIZONA, U.S.A.

DHC:ms
encl.

PHONE: 947-5433

SALT RIVER PROJECT
P.O. BOX 1980
PHOENIX, ARIZONA 85001

June 24, 1975

TELEPHONE 273-5900

Collar, Williams & White Engineering, Inc.
2922 N. 70 Street
Scottsdale, AZ 85251

Attention: Edward B. Rolper

Gentlemen:

McDOWELL ROAD: 64 - 70 STREET (PAVING)
JOB NO. 730529
A.D.O.T. M-703-6(1) SRPD CSO 11683 (SC)

Attached is a marked set of plans indicating as you requested:

1. Street light locations, southside of McDowell. (Also approximate future locations northside of McDowell. Based on staggered arterial system specifications.)

2. Power source - Sump pump and underpass lights (SH7: Sta 13+90).

Please note additional markings relating to electrical facilities within the job area. For more specific details please forward two sets of final plans.

If you have any questions please call Dick Hudson, Electric System Design, 273-2246, or me, 273-5258.

Sincerely,

Tom M. Allison

Tom M. Allison
Power Consultant
Power Use Planning Department

TMA:hla

Attachment: Plans

ARIZONA HIGHWAY DEPARTMENT

PHOENIX, ARIZONA

August 4, 1969

To: Consulting Engineers

From: Pre-Engineering (Consultants) Division

Re: Hydraulic Reports

The following requirements supplement and are in addition to the existing Hydrologic Manual.

Hydraulic Reports must be submitted in duplicate (one each for Plans Division and ~~Bridge Design~~ DRAINAGE DESIGN DIVISION) bound in an 8½" x 11" folder, and must contain, but need not be limited to, the following:

1. Cover and title Sheet showing Project Name and Number, Title of Report, Authorship (Firm Name), and Date of Submittal.

2. Letter of Transmittal.

3. Index or Table of Contents.

4. A narrative describing the topographic features and hydrologic history of the project area, noting general drainage patterns, the history and effect of known flooding in the area, and recurring problem areas. The history of man-made developments and their effect upon natural drainage patterns, including an estimate of the effect the proposed highway construction might be expected to have upon major drainage flows. And finally, a projected estimate of future development in the project area which might affect the characteristics of future drainage flows and ultimately the performance of the hydraulic structures on the project.

5. An outline of the Scope of the Study, including the criteria, assumptions, and methods used in the design procedure, listing all references.

6. A general area map of the entire project at a small (reduced) scale showing topographic features and drainage areas.

7. A structure summary sheet listing all pipe and box culverts by station, and including the following:

   a. Station.
   b. Drainage Area.
   c. Discharge (Design Q).
   d. Type and Size of Structure, including length.
   e. Inlet and Outlet treatment (headwall, end section, etc.)
   f. Invert Elevation at centerline.
   g. Invert slope in %.
   h. Subgrade elevation.
   i. Allowable Headwater Elevation.
   j. Design Headwater Elevation.
   k. Natural Channel Velocity.
   l. Culvert Outlet Velocity.
   m. Outlet protection (Type).

8. For each culvert, channel, or diversion, the following:

   a. A copy of Hydraulic Survey Report Form (A.H.D. 66-451).

   b. A copy of the drainage area map, aerial photo, or other source used, delineating and identifying contributing drainage area(s). One copy may be submitted for entire report, if feasible, with individual drainage areas identified. (See No. 6).

   c. All hydrologic computations on applicable Arizona Highway Department Hydrologic Design Data Sheets. The Rational Method shall be used for <u>ALL</u> drainage areas under 0.1 sq. mile (64 acres).

   d. Stream or channel cross sections and profile necessary to develop natural stage-discharge relationships and velocity computations. The proposed culvert or bridge structure should be shown on the profile in its proper location along with the outline of the roadway prism. This data should be plotted to a reduced scale commensurate with the size of the report folder.

   e. Natural stage-discharge and velocity computations when applicable.

   f. Hydraulic computations for all culverts, channels, diversions, etc., including culvert extensions of sufficient length to affect the hydraulic characteristics of the structure.

Culvert computations should be submitted on A.H.D. Culvert Computation Sheets in accordance with the suggested Hydraulic Design Procedures (Green Cover) available from the Plans Division.

g. When a culvert is located in an area of high damage potential (i.e., urban, suburban or industrial area), it will be necessary to include a site sketch locating the various man-made improvements which may be affected by ponding or discharge. Where ponding exceeds the proposed right of way, the inundated area must be delineated by the limiting contour on the site sketch, and a recommendation for acquisition of additional right of way included in the report.

h. A concise summary of results and recommendations for each structure. Where a choice between a pipe culvert and a concrete box culvert is possible within the limits of the hydraulic analysis, a cost comparison should be submitted, including an annual cost based upon the estimated structure life, considering local acidity and abrasive characteristics and their effect upon the structure.

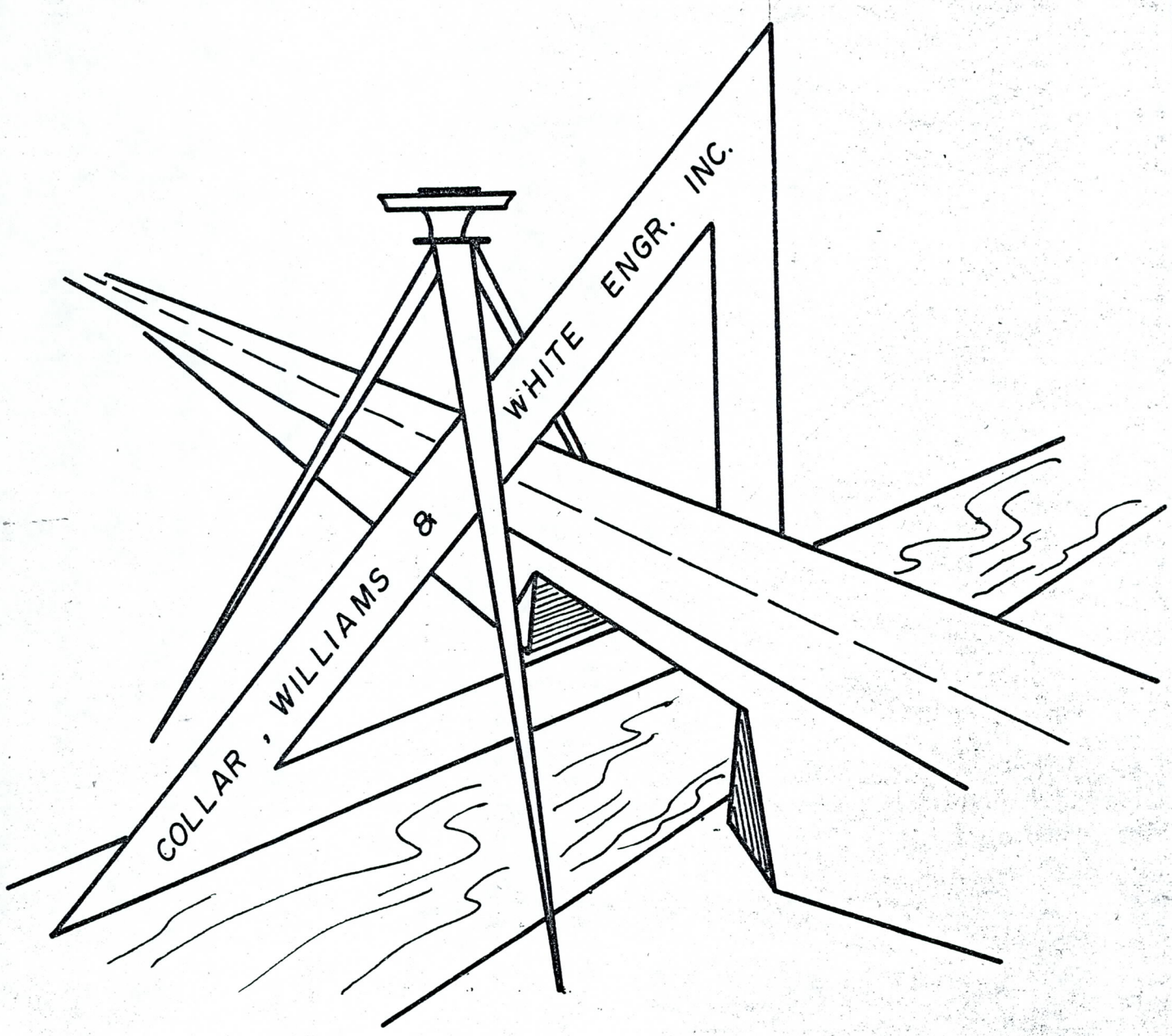
Soil characteristics should be considered when designing channels, ditches, and dykes. Unlined or unprotected slopes should be flat enough to withstand hydrostatic forces without excessive sloughing or erosion. Actual stability analysis may be required for dykes, levees, ditches, and channels. Analysis may include a slip circle analysis of slopes for rapid draw down condition, and allowable velocities procedure (Soil Conservation Service) for stability against erosion. The data compiled, if any, should be included in the report.

Roadway cross sections of each culvert should be plotted to a 10:10 scale and submitted in roll or sheet form with the Plans Division Report only. These sections should include the roadway prism, the culvert profile, and natural ground line extended to the right of way line downstream and the right of way line or limit of ponding upstream, whichever is greater. The design high water line should be indicated as well as the culvert length, slope, and inlet, outlet and center line elevations.

DON PHELPS, Ass't. Coordinator
Engineering Consultants

DP:ba

DRAINAGE REPORT



FOR

CITY OF SCOTTSDALE

ON

MCDOWELL RD. - 64th ST. TO
SCOTTSDALE RD.
M-703-6 (1)

Collar, Williams & White Engineering, Inc.
2922 N. 70TH ST.
SCOTTSDALE, ARIZONA
JOB No. 730529

Collar, Williams & White Engineering, Inc.

Consulting Engineers

MALCOLM S. WHITE
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VICE-PRESIDENT

2922 NORTH 70TH STREET
SCOTTSDALE, ARIZONA 85251

Feb. 3, 1975

Iannella
George ~~Fatta~~ Capital Improvements Engineer
Daniel C. Raby, ~~City Engineer~~
~~Department of Public Works~~
City of Scottsdale
3939 Civic Center Plaza
Scottsdale, Arizona 85251

Re: Project M-703-6 (1)
McDowell Rd. - 64th St. to
Scottsdale Road

Iannella
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This Report and the Improvement Plans prepared by Collar, Williams & White Engineering, Inc. for M-703-6 (1) incorporate Scottsdale Projects FC-7434-C and P-7452-C.

Respectfully Submitted,
Collar, Williams & White Eng. Inc.

Donald H. Collar, P.E.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
1873
DONALD H.
COLLAR
Date Signed 2/3/75
ARIZONA, U.S.A.

DHC:ms
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PHONE: 947-5433

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SCOPE

The purpose of this investigation is to determine and evaluate the existing, and proposed roadway drainage and storm sewer design for the McDowell Road improvement project between 64th Street and Scottsdale Road.

DRAINAGE AREA

The 7½ minute, 1:24000 scale quadrangle maps published by the U. S. Geological Survey and aerial maps furnished by the City of Scottsdale and City of Phoenix were used to locate stream channels, watershed boundaries, and watershed slopes.

Actual field investigation and topography were used in critical areas for watershed flow determination.

The map on page 4 indicates the extent of the drainage area.

NATURAL FEATURES

The proposed improvements for McDowell Road, discussed in this report extends from 64th Street to Scottsdale Road, constituting approximately one mile of roadway.

The watershed areas effecting McDowell Road lies north and west of the described limits, and are divided by the "Cross Cut Canal" into two watershed areas. The westerly area extends north to Thomas Road, and west to the McDowell Buttes. The area west of 64th Street is generally undeveloped land, which is gently rolling slopes with sparse desert brush. The soil complex can be classifies as a "C" hydrologic soil group as per Soil Conservation Service classification system. The area east of 64th Street is either improved residential or has a potential of residential improvement. Drainage from these areas flow southeasterly to McDowell Road and passes under the road by way of concrete box or pipe culvert.

NATURAL FEATURES continued

The area east of the "Cross Cut Canal" is mostly improved residential and commercial areas, which lie to the north of McDowell Road and drain onto the road. There are scattered commercial areas south of McDowell Road which also drain onto the roadway. The drainage area north of McDowell Road consists of a 660 foot strip of commercian area parallel to the road, with residential areas north of the commercial area, extending to Thomas Road. At McDowell Road and Scottsdale Road, in the northeast corner lies approximately one square quarter mile of improved commercial land. The contributing watershed area is confined to the first quarter mile, north of and parallel to McDowell Road. The general slope of the ground in this area is approximately 1% west to east, and 0.5% north to south.

DESIGN CRITERIA

~~RESULTS OF COMPUTATION~~

The results of this study and computations are indicated on sheet "Summary of Storm Drainage Calculations", as flow rates and proposed storm sewer pipe sizes.

This study is predicated on the following assumptions, proposed conditions and methods:

A. Hydrologic data and methods of computations - from Hydrologic Design for Highway Drainage in Arizona by Arizona Highwat Department Bridge Division. The "SCS" and "Rational Method" are employed.

B. Streets shall have one lane in each direction clear of storm water inundation in a 10 year frequency storm, (36 ft. wide roadway, one lane equal to 12 ft.)

Design Criteria, cont.

~~RESULTS OF COMPUTATION continued~~

C. All undeveloped commercial areas, north of and draining onto McDowell Road shall be required to hold onsite retention for a ~~10~~ 50 year ~~frequency~~ 24 hr. duration storm.

D. Storm drain pipes are sized to carry runoff from a minimum 10 year frequency storm. The Manning formula was used to size pipes, assuming that the pipes are flowing full, and the hydraulic grade line is within the pipe.

E. Time of concentration for runoff flow was based on overland flow for roofs, lawns and commercial areas and street flow in gutters (assuming streets flowing at a 24 foot spread). Time of concentration in storm sewer was neglected; size of storm sewers are predicated on sums of flows at catch basins and manholes.

overly conservative? or are they insignificant?

~~RESULTS OF COMPUTATION~~

ANALYTICAL RESULTS

Using procedures ~~outlined by~~ established by the above criteria, calculations were carried out, for sizing stormwater drainage piping and appurtances. The data is summarized in TABLE I.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The storm water flows generated by McDowell Road and tributary drainage areas draining to McDowell Road can be controlled, collected and dispersed safely, without hazardous flood water inundation.

The storm water concentrating west of the "Cross Cut Canal" collect at two locations, Sta. 6+03 - 6' x 4' concrete box culvert, and Sta. 14+60 - a 48" C. M. Pipe. The 6' x 4' concrete box culvert has the capacity to carry approximately 140 cfs; this structure shall be required to carry 43.2 cfs. (calculated runoff), allowing capacity of 96.8 cfs for higher frequency storms. The existing 48" C. M. Pipe, adjacent and parallel to the "Cross Cut Canal", carries a capacity for approximately 34.8 cfs, runoff is expected to reach an estimated 120.9 cfs for a 10 year frequency storm. The excess water in this area ponds, north of the roadway. The City of Scottsdale is anticipating constructing a concrete box culvert at this location in the near future to carry pedestrian and bicycle traffic across McDowell Road; when this structure is placed drainage conditions will be improved. ~~An additional 48" C.M. Pipe is recommended to improve drainage conditions at present: the flow capacity would double, thus becoming 69.6 cfs, and ponding the remaining 51.3 cfs would occur.~~

The roadway drainage from McDowell Road, west of the "Cross Cut Canal" will be collected in catch basins which will drain directly into the existing 6'x 4' concrete box culvert and also discharge north of the roadway at Sta. 12+62; an underground storm sewer system need not be employed. why not south?

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS, continued

The drainage of storm water east of McDowell Road has several existing drainage problems as a result of roadways presently constructed above existing developments, creating drainage land locks, and previously developed residential and commercial areas being constructed without storm drainage facilities. The residential areas north of McDowell Road tend to drain east with a greater gradient than south. The following drainage condition exists: (1) flows from the residential areas west of 68th Street will approach 68th Street until street capacity is reached, overflow into easterly residential areas will ~~accur~~ occur; half street capacity of 68th street flows to McDowell Road. (2) The residential area located between 68th Street and 70th Street is relatively flat, the excess flow from 68th Street and the generated runoff from this residential area reaches McDowell Road at 69th Street and 70th Street, with a higher concentration of runoff at 70th Street. The proposed underground storm sewer is a necessity to eliminate flooding at intersections of 68th Street, 69th Street and 70th Street. Catch basins are located at intersections and along McDowell Road to eliminate storm water inundation.

Drainage land lock situations occurred along McDowell Road at the "Pitre Buick" property, east of the "Cross Cut Canal" and north of McDowell Road, and in front of the commercial area south of McDowell Road between Sta. 33+70 to Sta. 38+40. Large capacity City of Phoenix type "F" catch basins are recommended to handle runoff from these areas. The driveways are depressed on the south side of McDowell Road from Sta. 33+70 to Sta. 38+40, creating a possibility of roadway drainage onto private property; the catch basin at Sta. 35+36 (south side) has increased capacity to handle flows greater than a 10 year storm and thus intercept runoff into this area.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS, continued

The catch basins and trunk lines are sized to handle only a 10 year frequency storm, with appropriate clogging factors. except in areas where higher frequency storms could cause inundation to existing businesses. The proposed system connects to an existing 60 inch storm sewer, capable of handling approximately 196.3 cfs, of which Scottsdale Road north of McDowell Road utilizes 51.7 cfs thru a 36 inch pipe. McDowell Road west of Scottsdale Road will utilize capacity of 129.3 cfs, leaving approximately 15.3 cfs available additional flow capacity.

Culverts under McDowell contributing from S/O Roadway? /No

Drainage Computations

Area # 1 not expected to urbanize, flow onto 64 th. St., 200 ft. south of Thomas Road.

Drainage Area = 0.14 Sq. Miles

Drainage Length = 6000 ft.

Elevation
Top of Drainage Area = 1500 ft.
At structure = 1275 ft.

Drainage Slope - 3.75 %

Drainage Width - 800 ft.

Width factor (W_f) = 1.10

Vegetative Cover - Desert Brush

Vegetative Density - 20 %

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Runoff - Q	0.23	0.48	0.57	0.90	inches

Time of Concentration

$$T_c = \frac{2.05\ (6000)^{0.37}}{(3.75)^{0.20}\ (60)} = 0.66 \text{ hr.}$$

$\frac{6000 \text{ ft}}{.66 \text{ hr}(3600 \text{ sec/hr})}$ $V_{ave} = 2.52$ fps ave

Time of Peak $T_p = T_c(W_f) = 0.72$ hr.

Peak Discharge

$Q_p = \frac{484\ A\ Q}{T_p}$	21.6	45.2	53.6	84.7	cfs.

This flow continues north, and is received by existing storm drainage facilities around the intersection of 64 th.Street and Thomas Road.

Area # 2 not expected to urbanize, flow at 64 th., Street, 300 ft. north of McDowell Road.

Drainage Area = 0.05 Sq. Miles

Drainage Length = 3100 ft.

Elevation
Top of Drainage Area = 1420 ft.
At Structure = 1290 ft.

Drainage Area Slope = 4.19 %

Drainage Width = 400 ft.

Width factor (W_f) = 1.24

Vegetative Cover - Desert Brush

Vegetative Density = 20%

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Runoff- Q	0.23	0.48	0.57	0.90	inches

Drainage Computations continued

Time of Concentration

$$T_c = \frac{2.05\ (3100)^{0.37}}{(4.19)^{0.20}\ (60)} = 0.50 \text{ hr.}$$

Time of Peak $T_p = T_c(W_f) = 0.62$ hr.

Peak Discharge

$$Q_p = \frac{484\ A\ Q}{T_p} = \quad 9.0 \quad 18.3 \quad 22.2 \quad 35.1 \quad \text{cfs.}$$

Area # 3 not expected to urbanize, flow at existing 30" C.M.P. culvert across 64 th. Street, north of McDowell Road.

Drainage Area = 0.03 Sq. Miles

Drainage Length = 2900 ft.

Elevation
Top of Drainage Area = 1350 ft.
At Structure = 2900 ft.

Drainage Area Slope = 2.76 %

Drainage Width = 260 ft.

Width factor (W_f) = 1.24

Vegetative Cover - Desert Brush

Vegetative Density - 10 %

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.
Runoff -Q	0.23	0.48	0.57	0.90

Time of Concentration

$$T_p = \frac{2.04\ (2900)^{0.37}}{(2.76)^{0.20}\ (60)} = 0.53 \text{ hr.}$$

Time of Peak $T_p = T_c(W_f) = 0.66$ hr.

Peak Discharge

$$Q_p = \frac{484\ A\ Q}{T_p} \quad 5.1 \quad 10.6 \quad 12.5 \quad 19.8 \quad \text{cfs.}$$

Capacity of 30" C.M.P. culvert
Length = 80 ft., Slope = 0.2 %

Q = 15.8 cfs which is greater than 12.5 cfs.(10 yr. storm)

Area # 4 not expected to urbanize with residential housing, flow onto 64 th. Street, 1500 ft. north of McDowell Road.

Drainage Computation continued

Drainage Area = 0.07 Sq. Miles

Drainage Length = 2000 ft.

Elevation
Top of Drainage Area = 1325 ft.
At Structure = 1290 ft.

Drainage Area Slope = 1.75 %

Drainage Width = 600 ft.

Width factor (W_f) = 1.24

Vegetative Cover - Desert Brush

Vegetative Density - 10 %

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Runoff - Q	0.23	0.48	0.57	0.90	inches

Time of Concentration

T_c = 0.65 hr. (overland flow, average grass cover)

use bare soil, no. average grass surface in Arizona.

Time of Peak $T_p = T_c(W_f)$ = 0.81 hr.

Peak Discharge

$Q_p = \frac{484\ A\ Q}{T_p}$ =	9.6	20.1	23.8	37.6	cfs

Area # 5 expected to urbanize (R1-7) with residential housing, flow at 6 ft. X 4 ft. conc. box culvert at McDowell Road, 600 ft. east of 64 th. Street.

Drainage Area
impervious 2.3 Ac. C = 0.95

pervious 6.9 Ac. C = 0.30

Total Area = 9.2 Ac. Weighted "C" = 0.46

Elevation
Top of Drainage Area = 1290 ft.
At Structure = 1280 ft.

Time of Concentration T_c = 25 min. (overland flow)

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity "i"	1.6	2.3	2.5	3.2	inches
Peak Discharge Q_p = CiA	6.8	9.7	10.6	13.5	cfs.

change in time of concentration for contributing areas #2 and #3 equal to

$$\frac{600}{2(60)} = 5.0 \text{ min.}$$

Drainage Computations continued

$Q_{\#2}$	T_p = 0.72 hr.	7.7	16.1	19.1	30.3	cfs.
$Q_{\#3}$	T_p = 0.76 hr.	4.4	9.2	10.9	17.2	cfs.
Total "Q"		18.9	35.0	40.6	61.0	cfs.

Capacity of the existing 6 ft. X 4 ft. conc. box culvert approximately 120 cfs., which is greater than 40.6 cfs. expected flow from a 10 yr storm.

Catch Basin # 1 opposite Sta. 5+80, 45 ft. north of the monument line, located over the existing conc. box culvert.

Contributing roadway area = $\frac{580(52)}{43560}$ = .69 Ac. Weighted "C" = 0.75

McDowell Rd. only .95

T_c = 10 min. , i = 3.8 inches, Discharge Q = 2.0 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.16 ft.

W = 66.7(0.16) = 10.7 ft. which is less than 24 ft.

use Type "B" catch basin, Interception Capacity = 1.1 cfs.
By pass = 0.9 cfs.

Catch Basin # 2 opposite Sta. 6+25, 7 ft. south of monument line, located over the existing conc. box culvert.

Contributing roadway area = $\frac{625(36)}{43560}$ = 0.52 Ac. Weighted "C" = 0.75

T_c= 10 min. , i = 3.8 inches, Discharge Q = 1.9 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.16 ft.

W = 66.7(0.16) = 10.7 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 1.5 cfs.
by pass = 0.4 cfs.

Catch Basin # 3 opposite Sta. 12+62, 7 ft. south of monument line.

Contributing roadway area = $\frac{(1262-625)(36)}{43560}$ = o.53 Ac. Weighted "C" = 0.75

T_c = 10 min., i = 3.8 inches, Discharge Q = 1.9 + 0.4 = 2.3 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.18 ft.

Drainage Computations continued

W = 66.7(0.18) = 12.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 1.8 cfs.
By pass = 0.5 cfs.
Connection Pipe - 12" R.G.R.C.P. @ S = 0.0120 ft./ft. (n=0.013)

Catch Basin # 4 opposite Sta. 12+62, 45 ft. north of monument line.

Contributing roadway area = $\frac{(1262 - 580)(52)}{43560}$ = 0.81 Ac. Weighted "C" = 0.75

T_c = 10 min., i = 3.8 inches, Discharge Q = 2.3 + 0.9 = 3.1 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.20 ft.

W = 66.7(0.20) = 13.3 ft. whichis less than 24 ft.

use Type "C" catch basin, Interception Capacity = 2.1 cfs.
By pass = 1.0 cfs.
Connection Pipe - 18" R.G.R.C.P. @ S = 0.0500 ft./ft. (n=0.013)
Required discharge capacity of connection pipe epual to 3.9 cfs, additional flow coming from catch basin # 3.

Total dicharge from catch basins #3 and #4 will flow in to drainage ditch north of and parallel to the proposed McDowell Road improvements.

Area # 6 urbanized or expected to urbanize into residential housing (R1-7), flow at existing 48" C.M.P. at Sta. 14+50.

Drainage Area		
impervious	34.0 Ac.	C = 0.95
pervious	101.8 Ac.	C = 0.30
Total Area =	135.8 Ac.	Weighted "C" = 0.46

Elevation
Top of Drainage Area = 1270 ft.
At Structure = 1263 ft.

Drainage Area Length = 5400 ft.
Drainage Area Slope = 0.13 %

Time of Concentration
Channel flow $\frac{5300}{2(60)}$ = 44 min.
Overland flow 25 min. ← 1 fps across a lawn?
T_c = 69 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	0.9	1.2	1.7	2.1	inches
Peak Discharge Q = CiA	56.2	75.0	106.2	131.2	cfs.

Drainage Computation continued

change in time of concentration for contributinh area # 4 equal to

$$\frac{2900}{2(60)} = 24.2 \text{ min.}$$

$Q_{\#4}$ T_p= 1.31 hr.	5.9	12.4	14.7	23.3	cfs.
Total "Q"	62.1	87.4	120.9	154.5	cfs

with what HW @ roadway elev.?

Existing 48" C.M.P. culvert @ S = 0.0020 ft./ft. Capacity = 34.8 cfs.

Proposed - an additional 48" C.M.P. at same alignment as the existing culvert.
Total possible capacity = 69.6 cfs. which is less the the expected flow from a 10 yr. storm.
Any flow over the capacity of the proposed and existing pipes will pond, and over flow into the existing canal, prior to inundating the roadway, which is the present condition. A conc. box culvert, to carry storm water and bicycle traffic under McDowell Road, is proposed by the City of Scottsdale for future construction. When the box culvert is constructed, there should be more ~~the~~ ample capacity for the storm water.

Catch Basin # 5 opposite Sta. 22+94, 57 ft. north of the monument line.

Area #7 presently improved commercial,(C-3).

Drainage Area

impervious	4.3 Ac.	C = 0.95
pervious	0.8 Ac.	C = 0.30
Total Area =	5.1 Ac.	Weighted "C" = 0.85

Time of Concentration

Overland flow 10 min.

overland flow from the paved area is minimal.

Channel flow $\frac{800}{1.5(60)}$ = 9 min.

T_c = 19 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	1.8	2.6	2.8	3.7	inches
Peak Discharge Q = CiA	7.8	11.3	12.1	16.0	cfs.

This area will be land locked with respect to drainage.

use Type "F" catch basin, Interception 100% OF WHAT? 10yr.? IF will flood on 100yr. should design for this. when roadway is const.

Connection pipe to proposed storm drainage system 18" R.G.R.C.P.
@ S = 0.0150 ft./ft., discharge capacity = 12.9 cfs.
(n=0.013)

Drainage Computation continued

Catch Basin # 6 opposite Sta. 22+94, 44.5 ft. south of monument line.

Area # 8 - presently improved commercial,(C-3).

Drainage Area

impervious	0.43 Ac.	C = 0.95
pervious	0.07 Ac.	C = 0.30
Total Area =	0.50 Ac.	Weighted "C" = 0.85

Time of Conentration

Overland flow 10 min. ← 1 fps. min. for AHD approval?

Channal flow $\frac{270}{3(60)}$ = 1.5 min.

T_c = 11.5 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.3	3.4	3.8	4.7	inches
Peak Discharge Q = CiA	1.0	1.4	1.6	2.0	cfs.

Contributing roadway area = $\frac{(2294 + 1262)(44.5)}{43560}$ = 1.05 Ac.

"C" = 0.75 , T_c = 10 min., i = 3.8 inches,

Discharge Q = 3.8 + 0.5 + 1.6 = 5.9 cfs

$Z = \frac{1}{0.020} = 50$, $\frac{Z}{n} = 3333$, y = 0.25 ft.

W = 50(0.25) = 12.5 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 2.8 cfs
By pass = 3.1 cfs

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0060 ft./ft., (n=0.013). Discharge Capacity = 2.6 cfs.

Catch Basin # 7 opposite Sta. 25 + 86, 44.5 ft. south of monument line.

Area #9 presently improved commercial (C-3).

Drainage Area

impervious	0.57 Ac.	C = 0.95
pervious	0.10 Ac.	C = 0.30
Total Area =	0.67 Ac.	Weighted "C" = 0.85

Drainage Computation continued

Time of Concentration
Overland flow 15 min.

Channel flow $\frac{250}{3(60)}$ = 1.4 min.

T_c = 16.4 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.
Rainfall intensity	2.0	3.3	3.5	3.9 inches
Peak Discharge Q = CiA	1.1	1.9	2.0	2.2 cfs

Contributing roadway area = $\frac{(2586 - 2294)(44.5)}{43560}$ = 0.30 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 1.1 + 2.0 + 3.1 = 6.2 cfs

$Z = \frac{1}{0.018} = 55.6$, $\frac{Z}{n} = 3704$, y = 0.27 ft.

* W = 55.6(0.27) = 15.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 3.0 cfs
By pass = 3.2 cfs

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0075 ft./ft., (n=0.013). Discharge Capacity = 3.1 cfs.

The by pass of 3.1 cfs will flow around the southwest curb return at 68 th. Street and south onto 68th. Street.

Catch Basin #8 opposite Sta. 25+86, 44.5 ft. north of the monument line

Area #10 presently improved commercial (C-3).

Drainage Area

impervious	2.0 Ac.	C = 0.95
pervious	0.3 Ac.	C = 0.30
Total Area =	2.3 Ac.	Weighted "C" = 0.85

Time of Concentration
Overland flow 10 min.

Channel flow $\frac{450}{2(60)}$ = 3.8 min.

T_c = 13.8 min.

Drainage Computations continued

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.2	3.1	3.3	4.2	inches
Peak Discharge Q = CiA	4.3	6.1	6.5	8.2	cfs

Forty percent of this flow, flows to McDowell Road, the other sixty percent flows to 68th Street.

Contributing roadway area = $\frac{(2586 - 1262)\ (44.5)}{43560}$ = 1.35 ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 4.9 + 1.0 + 0.4(6.5) = 8.5 cfs

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, Y = 0.27 ft.

* W = 66.7(0.27) = 18.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 3.0 cfs
By pass = 5.5 cfs.

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0100 ft./ft., (n=0.013). Discharge Capacity = 3.6 cfs.

Catch Basin #9 opposite Sta. 26+96, located on the north end of the northwest curb return at the intersection of 68th Street and McDowell Road.

Area #11 urbanized residential housing, (R1-7).

Drainage area

impervious	5.3 ac.	C = 0.95
Pervious	16.0 ac.	C = 0.30
Total Area =	21.3 ac.	Weighted "C" = 0.46

Average slope = 0.96%

Time of Concentration
Overland flow 25 min.

From where?

Channel flow $\frac{2000}{1.5(60)}$ = 22.2 min. V cf 1.5 fps?

T_c = 47.2 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.
Rainfall Intensity	1.0	1.5	1.6	2.1 inches

Drainage Computations continued

Peak Discharge Q = CiA	9.8	14.7	15.7	20.6	cfs.

68 th. Street half street capacity = 7.8 cfs,

overflow onto easterly residential areas = 7.9 cfs.

Discharge at Catch Basin #9 Q = 7.8 + 0.6(6.5) = 11.7 cfs

y = 0.33 ft., 68 th. Street half width = 32 ft.

use Type "D" catch basin, Interception Capacity = 2.7(4.6) + 1.7 = 14.1 cfs
no by pass.

Connection pipe to proposed storm drain system - 18" R.G.R.C.P.,
@ S = 0.0130 ft./ft., (n=0.013). Discharge Capacity = 12.0 cfs.

Catch Basin #10 opposite Sta. 35+37, 44.5 ft. north of monument line.

Area #12 presently improved commercial,(C-3).

Drainage Area		
impervious	0.42 Ac.	C = 0.95
pervious	0.02 Ac.	C = 0.30
Total Area	0.44 Ac.	Weighted "C" = 0.92

Time of Concentration T_c = 10 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.5	3.6	3.8	4.9	inches
Peak Discharge Q = CiA	1.0	1.5	1.5	2.0	cfs

Contributing roadway area $= \frac{300(32)}{43560} + \frac{(3537-2586)(44.5)}{43560} = 1.19$ Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches,

Discharge Q = 4.3 + 1.5 + 5.5 = 11.3 cfs.

$Z = \frac{1}{0.20} = 50$, $\frac{Z}{n} = 3333$, y = 0.36 ft.

* W = 50(0.36) = 18 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 4.4 cfs
By pass = 6.9 cfs.

Connection pipe to proposed storm drain system - 12" R.G.R.C.P.,
@ S = 0.0406 ft./ft., (n=0.013). Discharge Capacity = 7.2 cfs.

Drainage Computation continued

Catch Basin #11 opposite Sta. 35 + 37, 44.5 ft. south of monument line.

Area #13 presently improved commercial,(C-3)

Drainage Area

impervious	0.25 Ac.	C = 0.95
pervious	0.01 Ac.	C = 0.30
Total Area =	0.26 Ac.	Weighted "C" = 0.92

Time of Concentration T_c = 10 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	3.0	3.6	3.8	4.9	inches
Peak Discharge Q = CiA	0.7	0.9	0.9	1.2	cfs

Contributing roadway area = $\frac{(3537 - 2751)(44.5)}{43560}$ = 0.80 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 2.9 + 0.9 = 3.8 cfs +3.2 from CB#7

$Z = \frac{1}{0.02} = 50$, $\frac{Z}{n} = 3333$, y = 0.24 ft.

W = 50(0.24) = 12 ft. which is less than 24 ft.

use Type "D" catch basin, Interception Capacity = 9.4 cfs
no by pass.

Connection pipe to proposed storm drain system - 18" R.G.R.C.P ,
@ S = 0.0290 ft./ft., (n=0.013). Discharge Capacity = 17.9 cfs.

Catch Basin #12 opposite Sta. 36+37, 44.5 ft. north of monument line.

Area #14 urganized residential housing,(R1-7).

Drainage Area

impervious	3.6 Ac.	C = 0.95
pervious	10.9 Ac.	C = 0.30
Total Area	14.5 Ac.	Weighted "C" = 0.46

Time of Concentration

Overland flow 30 min.

Channel flow $\frac{1600}{1(60)}$ = 26.7 min.

T_c = 56.7 min.

Drainage Computation continued

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	0.9	1.3	1.4	1.9	inches
Peak Discharge Q = CiA	6.0	8.7	9.3	12.7	cfs.

Street capacity of 69 th. Street = 8.0 cfs
Total flow to the easterly residential area = 7.9 + 1.3 = 9.2 cfs

Area #15 presently improved commercial area, (C-3).

Drainage Area
impervious 0.65 Ac. C = 0.95

pervious 0.16 Ac. C = 0.30

Total Area = 0.81 Ac. Weighted "C" = 0.82

Time of Concentration
Overland flow 10 min.

Channel flow $\frac{180}{1(60)}$ = 2 min.

T_c = 12 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.3	3.3	3.5	4.6	inches
Peak Discharge Q = CiA	1.5	2.2	2.3	3.1	cfs

Total flow from 69 th. Street = 8.0 + 2.3 = 10.3 cfs.

Contributing roadway area = $\frac{(3637 - 3537)(44.5)}{43560}$ = 0.10 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches,

Discharge Q = 0.4 + 10.3 + 6.9 = 17.6 cfs

where did this come from 2.3+9.3 = 11.6?

Z = $\frac{1}{0.017}$ = 58.8, $\frac{Z}{n}$ = 3920, y = 0.40 ft.

W = 58.8(0.40) = 23.5 ft. which is less than 24 ft.

use Type "D" catch basin, Interception Capacity = 3.2(4.6) + 2.3 = 10.2 cfs
By pass = 7.6 cfs.

Connection pipe to proposed storm drain system - 15" R.G.R.C.P.,
@ S = 0.0384 ft./ft., (n=0.013). Discharge capacity = 12.7 cfs.

Drainage Computation continued

Catch Basin #13 opposite Sta. 38+18, 58 ft. south of monument line.

Area #16 presently improved commercial area,(C-3).

Drainage Area		
impervious	0.90 Ac.	C = 0.90
pervious	0.16 Ac.	C = 0.30
Total Area =	1.06 Ac.	Weighted "C" = 0.85

Time of Concentration T_c = 15 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.5	3.0	3.2	4.1	inches
Peak Discharge Q = CiA	2.3	2.7	2.9	3.7	cfs

This area will be land locked with respect to drainage.

use Type "F" catch basin, Interception 100%

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0457 ft./ft., (n=0.013). Discharge capacity = 7.6 cfs.

Area #17 presently improved commercial area, (C-3).

Drainage Area - impervious 0.28 Ac. C = 0.95

Time of concentration T_c = 10 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	3.0	3.6	3.8	4.9	inches
Peak Discharge Q = CiA	0.8	1.0	1.0	1.3	cfs.

Contributing roadway area $= \frac{(4009 - 3537)(44.5)}{43560} = 0.48$ Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Total dischagre Q = 1.0 + 1.7 = 2.7 cfs,

This runoff flows to 70 th. Street, and south on 70 th. Street.

Catch Basin #14 opposite Sta 39+91, existing Type "F" catch basin, 44.5 ft. north of monument line.

Area #18 presently urbanized residential housing,(R1-7).

Drainage Computations continued

Drainage Area

impervious	3.1 Ac.	C = 0.95
pervious	9.2 Ac.	C = 0.30
Total Area	= 12.3 Ac.	Weighted "C" = 0.46

Average Slope of drainage area 0.64%

Time of concentration

Overland flow 30 min.

Channel flow $\frac{1600}{1(60)}$ = 26.7 min.

T_c = 56.7 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	0.9	1.3	1.4	1.9	inches
Peak Discharge Q = CiA	5.1	7.4	7.9	10.8	cfs.

Total flow from residential areas = 7.9 + 9.2 = 17.1 cfs.

Area #19 presently improved commercial area,(C-3).

Drainage Area

impervious	1.1 Ac.	C = 0.95
pervious	0.2 Ac.	C = 0.30
Total Area	= 1.3 Ac.	Weighted "C" = 0.85

Time of concentration

Overland flow 10 min.

Channel flow $\frac{150}{1(60)}$ = 2.5 min.

T_c = 12.5 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.3	3.2	3.4	4.5	inches
Peak Discharge Q = CiA	2.5	3.5	3.8	5.0	cfs.

Contributing roadway area = $\frac{(4009 - 3637)(44.5)}{43560}$ = 0.38 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches, Q = 1.4 cfs

Drainage Computations continued

Flow from commercial area #19 separated, 1.9 cfs to 70 th. Street, 1.9 cfs to McDowell Road.

Total flow at 70 th. Street and McDowell Road.

70 th Street discharge Q = 17.1 + 1.9 = 19.0 cfs.

McDowell Road discharge Q = 1.9 + 1.4 + 7.6 = 10.9 cfs.

Total discharge to Catch Basin #14 Q = 29.9 cfs.

McDowell Road drainage - Q = 10.9 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.31 ft.

W = 66.7(0.31) = 20.7 ft. which is less than 24 ft.

Existing Catch Basin #14 with a hydraulic head of 0.31 ft,
Interception capacity = 2.7(5.43) = 14.6 cfs

Existing Type "A" catch basin located on the north end of the northeast curb return of 70th. Street and McDowell Road,
Interception capacity = 3.2 cfs.

Total runoff removal = 14.6 + 3.2 = 17.8 cfs. By pass = 12.1 cfs.

It is proposed that the existing Type "F" catch basin be reconstructed to flow to the proposed storm drain system, this would allow this catch basin to flow at full capacity.
Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.2000 ft./ft., (n=0.013). Discharge capacity = 15.9 cfs.

Catch Basin #15 opposite Sta. 40+89, 44.5 ft. north of monument line.

Contributing roadway area = $\frac{(4089 - 4009)(44.5)}{43560}$ = 0.08 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 12.1 + 0.3 = 12.4 cfs

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.33 ft.

W = 66.7(0.33) = 22.0 ft. which is less than 24.0 ft.

use Type "D" catch basin, Interception capacity = 2.7(4.6) + 1.7 = 14.1 cfs
no by pass.

Connection pipe to proposed storm drain system - 15" R.G.R.C.P., @ S = 0.1000 ft./ft., (n=0.013). Discharge capacity = 20.7 cfs.

Drainage Computation continued

Catch Basin #16 opposite Sta. 46+51, 44.5 ft. south of monument line.

Area #20 presently improved commercial area, (C-3).

Drainage area		
impervious	0.34 ac.	C = 0.95
Pervious	0.06 ac.	C = 0.30
Total Area =	0.40 ac.	Weighted "C" = 0.85

Time of Concentration

Overland flow 10 min.

Channel Flow $\frac{200}{2.5(60)}$ = 1.3 min.

T_c = 11.3 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.
Rainflal intensity	2.3	3.4	3.6	4.7 inches
Peak Discharge Q = CiA	0.8	1.2	1.2	1.6 cfs.

Contributing roadway area = $\frac{(4651 - 4009)\ (44.5)}{43560}$ = 0.66 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches.

Discharge Q = 2.4 + 1.2 = 3.6 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.18 ft.

W = 66.7(0.18) = 12.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception capacity = 1.8 cfs,
By pass 0.6 cfs into southerly shopping center area.

Connection pipe to proposed storm drain system - 12" R.G.R.C.P.,
@ S = 0.0429 ft./ft., (n-0.013). Discharge capacity = 17.0 cfs.

Roadway drainage from Sta. 47+36 to the intersection of Scottsdale Road and McDowell Road. (south side of McDowell Road)

Roadway area = $\frac{(5271 - 4736)\ (44.5)}{43560}$ = 0.55 ac.

"C" = 0.95, T_c = 10 min. i = 3.8 inches

Discharge south onto Scottsdale Road Q = 2.0 cfs.

Runoff flow is intercepted by a Type "A" catch basin located on the south end of the southwest curb return of the intersection of Scottsdale Road and McDowell Road.

Drainage Computation continued

Catch Basin #17 opposite Sta. 46+51, 44.5 ft. north of monument line.

Area #21 presently improved commercial area (C-3).

Drainage Area

impervious	3.5 Ac.	C = 0.95
pervious	0.6 Ac.	C = 0.30
Total Area =	4.1 Ac.	Weighted "C" = 0.85

Time of Concentration

Overland flow 12 min.

Channel flow $\frac{460}{1.5(60)}$ = 5.1 min.

T_c = 17.1 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	1.9	2.8	3.0	3.9	inches
Peak Discharge Q = CiA	6.6	9.7	10.2	13.6	cfs

Contributing roadway area = $\frac{(4651 - 4089)(44.5)}{43560}$ = 0.57 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 10.4 + 2.1 = 12.5 cfs

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.32 ft.

* W = 66.7(0.32) = 21.3 ft. which is less than 24 ft.

use Type "D" catch basin, Interception capacity = 2.7(5.43) + 1.6 = 16.3 cfs
no by pass.

Connection pipe to proposed storm drain system - 15" R.G.R.C.P.,
@ S = 0.0650 ft./ft.,(n=0.013). Discharge capacity = 16.7 cfs.

Catch Basin #18 opposite Sta. 52+21, 44.5 ft. north of monument line.

Area #22 presently improved commercial area,(C-3).

Drainage Area

impervious	4.6 Ac.	C =0.95
pervious	0.8 Ac.	C = 0.30
Total Area =	5.4 Ac.	Weighted "C" = 0.85

Drainage Computation continued

Time of Concentration

Overland flow 10 min.

Channel flow $\frac{850}{1.5(60)}$ = 9.4 min.

T_c = 19.4 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	1.8	2.7	2.8	3.6	inches
Peak Discharge Q = CiA	8.3	12.4	12.9	16.5	cfs

Contributing roadway area = $\frac{(5221 - 4651)(44.5)}{43560}$ = 0.58 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches,

Discharge Q = 12.9 + 2.1 = 15.0 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.35 ft.

* W = 66.7(0.35) = 23.3 ft. which is less than 24 ft.

Existing catch basin Sta. 50+61, 44.5 ft. north of monument line, Type "B" catch basin, interception capacity = 3.0 cfs.

Required capacity of catch basin #18 Q = 12.0 cfs.

use combination Type "C" and "F", the Type "C" catch basin presently exists. It is proposed to place a Type "F" catch basin along the front of the existing catch basin.
Total interception capacity Q = 2.9(5.43) + 1.7 = 17.5 cfs
no by pass.

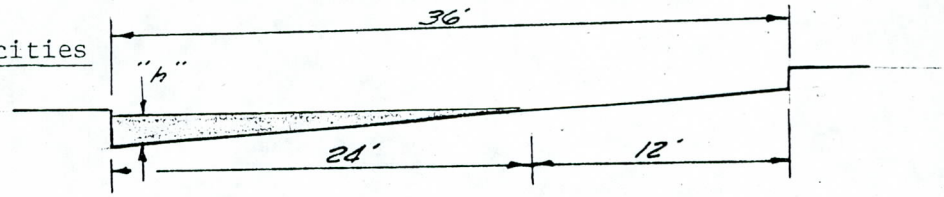
Connection pipe to proposed storm drain system - 15" R.G.R.C.P., @ S = 0.0350 ft./ft.,(n=0.013). Discharge capacity = 12.2 cfs.

Drainage Computation continued

Drainage Precipitation

	Storm Frequency 2 yr.	5 yr.	10 yr.	25 yr.	
P = 6 hour	1.1	1.7	1.9	2.4	inches
P = 24 hour	1.3	2.0	2.4	3.0	inches
P = 1 hour	0.9	1.3	1.4	1.8	inches

Roadway Drainage Capacities



flow in gutter should use triangular flow formula

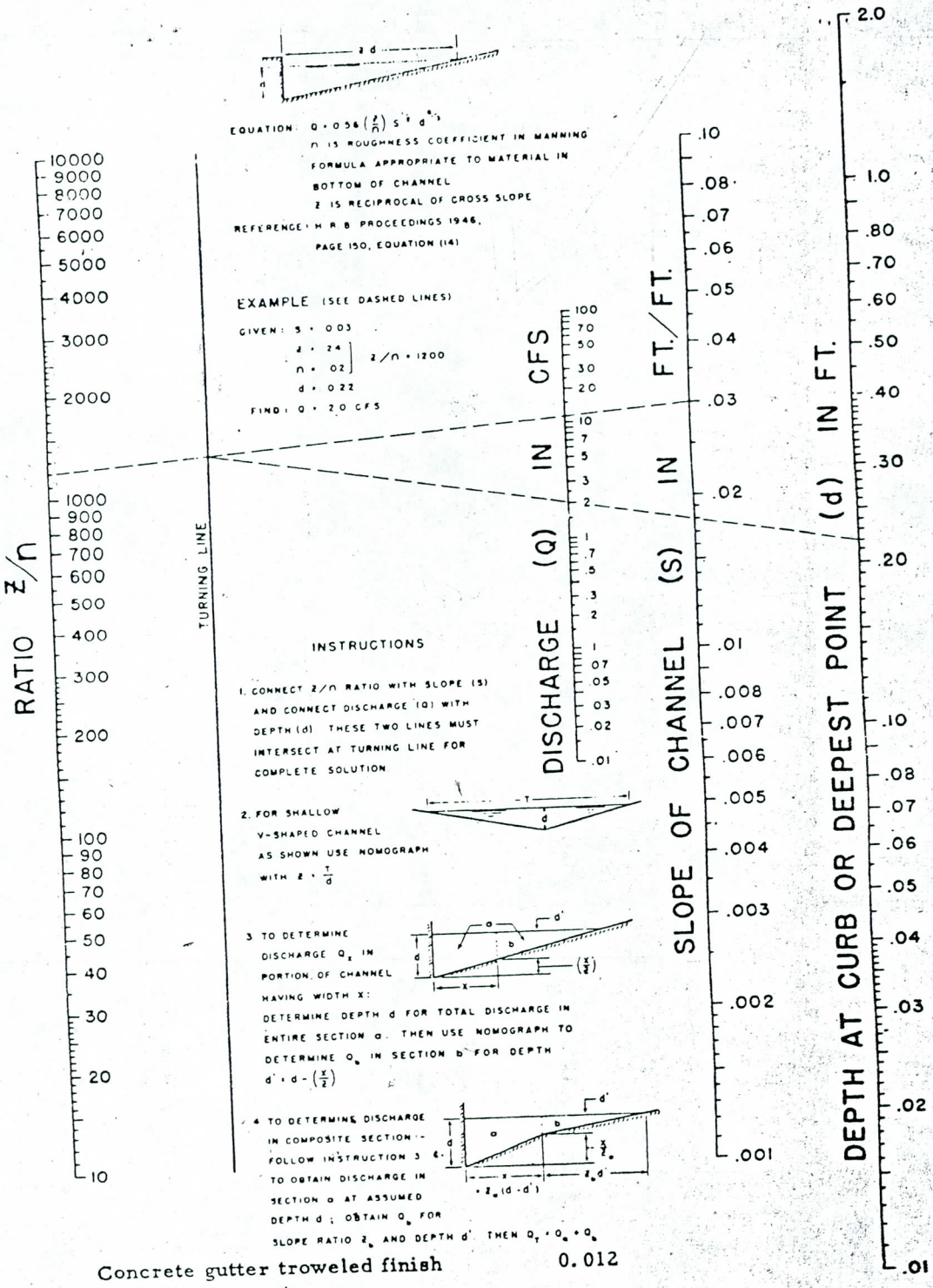
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} \qquad n = 0.015 \text{ (asphalt)}$$

Cross slope (ft./ft.)	h (ft.)	A (Sq.ft.)	R (ft.)	Q (cfs)
0.025	0.60	7.20	0.293	$314.66\ S^{1/2}$
0.020	0.48	5.76	0.235	$217.30\ S^{1/2}$
0.017	0.41	4.92	0.205	$169.46\ S^{1/2}$
0.015	0.36	4.32	0.177	$134.91\ S^{1/2}$

Street Cross Slopes (ft./ft.)

Street Slopes (ft./ft.)	0.025 Q	0.025 V	0.020 Q	0.020 V	0.017 Q	0.017 V	0.015 Q	0.015 V
0.0200	44.5	6.2	30.7	5.3	24.0	4.9	19.1	4.4
0.0150	38.5	5.3	26.6	4.6	20.8	4.2	16.5	3.8
0.0100	31.5	4.4	21.7	3.8	16.9	3.4	13.5	3.1
0.0050	22.3	3.1	15.4	2.7	12.0	2.4	9.5	2.2

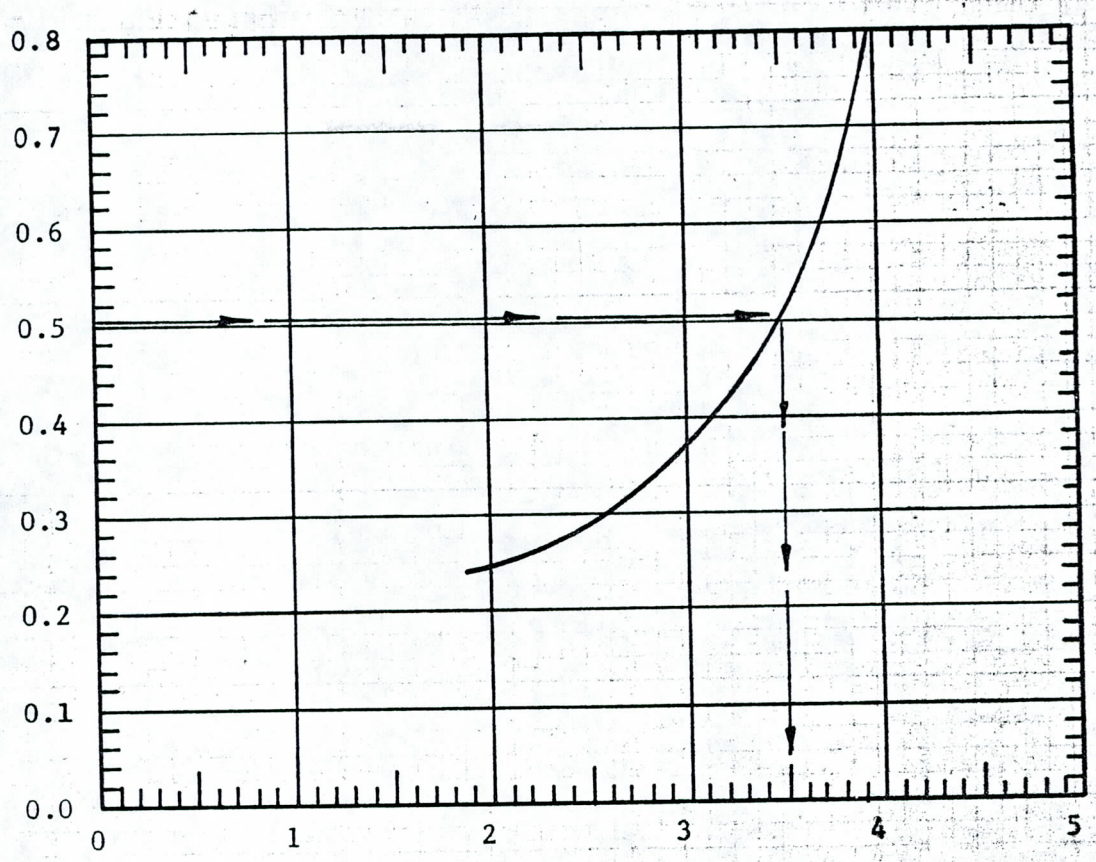
(Q - street capacity flowing full, cfs., V - street velocity, fps.)



Concrete gutter troweled finish	0.012
Asphalt pavement	
(1) Smooth texture	0.013
(2) Rough texture	0.016
Concrete gutter with asphalt pavement	
(1) Smooth	0.013
(2) Rough	0.015
Concrete pavement	
(1) Float finish	0.014
(2) Broom finish	0.016
	0.016

For gutters with small slope where sediment may accumulate, increase all above values of "n" by 0.002.

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS



FLOW INTO INLET PER SQ. FT. OF OPEN AREA (CFS/FT^2)
CAPACITY OF GRATED INLET IN SUMP

FOR TYPE E AREA = 1.25x3.34x0.75 = 3.1 ft^2
FOR TYPE"F" AREA = 2.125x3.41x0.75 = 5.43

FOR TYPE "D" AREA = 2.125x3.34x0.65 = 4.6 ft^2
Capacity from this chart + 4' curb opening

HAVE ANY CLOGGING FACTORS BEEN APPLIED to designs?

Approximate Hydraulic Capacityes of Clean Inlets in Cubic Feet per Second

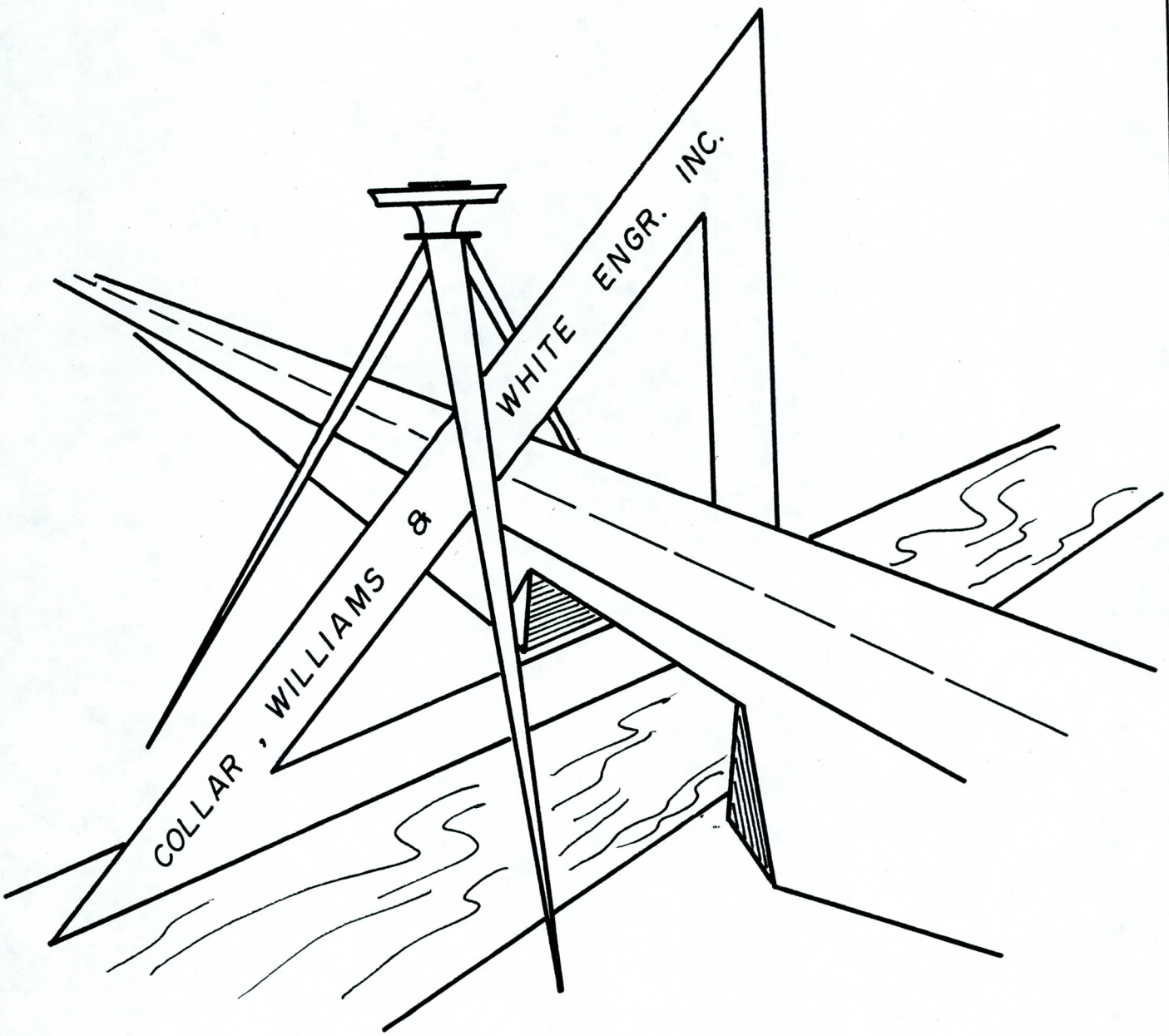
Catch Basins

City of Phoenix Standard Details

Water depth in feet at flow line of gutter	#210	#212	#216A	#216B	#217C	#218D
0.1	2.0	2.1	0.3	0.5	0.7	0.[illegible]
0.2	2.8	3.2	0.9	1.4	2.1	10.3
0.3	3.4	4.2	1.5	2.3	3.4	14.9
0.4	4.0	5.1	2.3	3.6	5.3	21.4
0.42	–	–	2.5	4.0	5.8	–
0.5	4.4	6.0	3.4	5.3	7.7	24.9
0.6	4.8	6.9	4.0	6.3	9.2	28.0
0.67	–	–	4.6	7.2	10.5	–
0.7	5.2	7.7	4.8	7.5	11.0	30.3

As per "Yost and Gardner Engineers", 1970

DRAINAGE REPORT



FOR

CITY OF SCOTTSDALE

ON

MCDOWELL RD. - 64th ST. TO
SCOTTSDALE RD.
M-703-6 (1)

Collar, Williams & White Engineering, Inc.
2922 N. 70TH ST.
SCOTTSDALE, ARIZONA
JOB No. 730529

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SCOPE

The purpose of this investigation is to determine and evaluate the existing, and proposed roadway drainage and storm sewer design for the McDowell Road improvement project between 64th Street and Scottsdale Road.

DRAINAGE AREA

The 7½ minute, 1:24000 scale quadrangle maps published by the U. S. Geological Survey and aerial maps furnished by the City of Scottsdale and City of Phoenix were used to locate stream channels, watershed boundaries, and watershed slopes.

Actual field investigation and topography were used in critical areas for watershed flow determination.

The map on page 4 indicates the extent of the drainage area.

NATURAL FEATURES

The proposed improvements for McDowell Road, discussed in this report extends from 64th Street to Scottsdale Road, constituting approximately one mile of roadway.

The watershed areas effecting McDowell Road lies north and west of the described limits, and are divided by the "Cross Cut Canal" into two watershed areas. The westerly area extends north to Thomas Road, and west to the McDowell Buttes. The area west of 64th Street is generally undeveloped land, which is gently rolling slopes with sparse desert brush. The soil complex can be classifies as a "C" hydrologic soil group as per Soil Conservation Service classification system. The area east of 64th Street is either improved residential or has a potential of residential improvement. Drainage from these areas flow southeasterly to McDowell Road and passes under the road by way of concrete box or pipe culvert.

NATURAL FEATURES continued

The area east of the "Cross Cut Canal" is mostly improved residential and commercial areas, which lie to the north of McDowell Road and drain onto the road. There are scattered commercial areas south of McDowell Road which also drain onto the roadway. The drainage area north of McDowell Road consists of a 660 foot strip of commercian area parallel to the road, with residential areas north of the commercial area, extending to Thomas Road. At McDowell Road and Scottsdale Road, in the northeast corner lies approximately one square quarter mile of improved commercial land. The contributing watershed area is confined to the first quarter mile, north of and parallel to McDowell Road. The general slope of the ground in this area is approximately 1% west to east, and 0.5% north to south.

RESULTS OF COMPUTATION

The results of this study and computations are indicated on sheet "Summary of Storm Drainage Calculations", as flow rates and proposed storm sewer pipe sizes.

This study is predicated on the following assumptions, proposed conditions and methods:

A. Hydrologic data and methods of computations - from Hydrologic Design for Highway Drainage in Arizona by Arizona Highwat Department Bridge Division. The "SCS" and "Rational Method" are employed.

B. Streets shall have one lane in each direction clear of storm water inundation in a 10 year frequency storm, (36 ft. wide roadway, one lane equal to 12 ft.)

RESULTS OF COMPUTATION continued

C. All undeveloped commercial areas, north of and draining onto McDowell Road shall be required to hold onsite retention for a 10 year frequency storm.

D. Storm drain pipes are sized to carry runoff from a minimum 10 year frequency storm. The Manning formula was used to size pipes, assuming that the pipes are flowing full, and the hydraulic grade line is within the pipe.

E. Time of concentration for runoff flow was based on overland flow for roofs, lawns and commercial areas and street flow in gutters (assuming streets flowing at a 24 foot spread). Time of concentration in storm sewer was neglected; size of storm sewers are predicated on sums of flows at catch basins and manholes.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The storm water flows generated by McDowell Road and tributary drainage areas draining to McDowell Road can be controlled, collected and dispersed safely, without hazardous flood water inundation.

The storm water concentrating west of the "Cross Cut Canal" collect at two locations, Sta. 6+03 - 6' x 4' concrete box culvert, and Sta. 14+60 - a 48" C. M. Pipe. The 6' x 4' concrete box culvert has the capacity to carry approximately 140 cfs; this structure shall be required to carry 43.2 cfs. (calculated runoff), allowing capacity of 96.8 cfs for higher frequency storms. The existing 48" C. M. Pipe, adjacent and parallel to the "Cross Cut Canal", carries a capacity for approximately 34.8 cfs, runoff is expected to reach an estimated 120.9 cfs for a 10 year frequency storm. The excess water in this area ponds, north of the roadway. The City of Scottsdale is anticipating constructing a concrete box culvert at this location in the near future to carry pedestrian and bicycle traffic across McDowell Road; when this structure is placed drainage conditions will be improved. An additional 48" C.M. Pipe is recommended to improve drainage conditions at present; the flow capacity would double, thus becoming 69.6 cfs, and ponding the remaining 51.3 cfs would occur.

The roadway drainage from McDowell Road, west of the "Cross Cut Canal" will be collected in catch basins which will drain directly into the existing 6'x 4' concrete box culvert and also discharge north of the roadway at Sta. 12+62; an underground storm sewer system need not be employed.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS continued

The drainage of storm water east of McDowell Road has several existing drainage problems as a result of roadways presently constructed above existing developments, creating drainage land locks, and previously developed residential and commercial areas being constructed without storm drainage facilities. The residential areas north of McDowell Road tend to drain east with a greater gradient than south. The following drainage condition exists: (1) flows from the residential areas west of 68th Street will approach 68th Street until street capacity is reached, overflow into easterly residential areas will accur; half street capacity of 68th street flows to McDowell Road. (2) The residential area located between 68th Street and 70th Street is relatively flat, the excess flow from 68th Street and the generated runoff from this residential area reaches McDowell Road at 69th Street and 70th Street, with a higher concentration of runoff at 70th Street. The proposed underground storm sewer is a necessity to eliminate flooding at intersections of 68th Street, 69th Street and 70th Street. Catch basins are located at intersections and along McDowell Road to eliminate storm water inundation.

Drainage land lock situations occurred along McDowell Road at the "Pitre Buick" property, east of the "Cross Cut Canal" and north of McDowell Road, and in front of the commercial area south of McDowell Road between Sta. 33+70 to Sta. 38+40. Large capacity type "F" catch basins are recommended to handle runoff from these areas. The driveways are depressed on the south side of McDowell Road from Sta. 33+70 to Sta. 38+40, creating a possibility of roadway drainage onto private property; the catch basin at Sta. 35+36 (south side) has increased capacity to handle flows greater than a 10 year storm and thus intercept runoff into this area.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS continued

The catch basins and trunk lines are sized to handle only a 10 year frequency storm, except in areas where higher frequency storms could cause inundation to existing businesses. The proposed system connects to an existing 60 inch storm sewer, capable of handling approximately 196.3 cfs, of which Scottsdale Road north of McDowell Road utilizes 51.7 cfs thru a 36 inch pipe. McDowell Road west of Scottsdale Road will utilize capacity of 129.3 cfs, leaving approximately 15.3 cfs available additional flow capacity.

Drainage Computations

Area # 1 not expected to urbanize, flow onto 64 th. St., 200 ft. south of Thomas Road.

Drainage Area = 0.14 Sq. Miles

Drainage Length = 6000 ft.

Elevation
Top of Drainage Area = 1500 ft.
At structure = 1275 ft.

Drainage Slope - 3.75 %

Drainage Width - 800 ft.

Width factor (W_f) = 1.10

Vegetative Cover - Desert Brush

Vegetative Density - 20 %

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Runoff - Q	0.23	0.48	0.57	0.90	inches

Time of Concentration

$$T_c = \frac{2.05\ (6000)^{0.37}}{(3.75)^{0.20}\ (60)} = 0.66 \text{ hr.}$$

Time of Peak $T_p = T_c(W_f) = 0.72$ hr.

Peak Discharge

$Q_p = \frac{484\ A\ Q}{T_p}$	21.6	45.2	53.6	84.7	cfs.

This flow continues north, and is received by existing storm drainage facilities around the intersection of 64 th.Street and Thomas Road.

Area # 2 not expected to urbanize, flow at 64 th. Street, 300 ft. north of McDowell Road.

Drainage Area = 0.05 Sq. Miles

Drainage Length = 3100 ft.

Elevation
Top of Drainage Area = 1420 ft.
At Structure = 1290 ft.

Drainage Area Slope = 4.19 %

Drainage Width = 400 ft.

Width factor (W_f) = 1.24

Vegetative Cover - Desert Brush

Vegetative Density = 20%

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Runoff- Q	0.23	0.48	0.57	0.90	inches

Drainage Computations continued

Time of Concentration

$$T_c = \frac{2.05\ (3100)^{0.37}}{(4.19)^{0.20}\ (60)} = 0.50 \text{ hr.}$$

Time of Peak $T_p = T_c(W_f) = 0.62$ hr.

Peak Discharge

$$Q_p = \frac{484\ A\ Q}{T_p} = \quad 9.0 \quad 18.3 \quad 22.2 \quad 35.1 \quad \text{cfs.}$$

Area # 3 not expected to urbanize, flow at existing 30" C.M.P. culvert across 64 th. Street, north of McDowell Road.

Drainage Area = 0.03 Sq. Miles

Drainage Length = 2900 ft.

Elevation
Top of Drainage Area = 1350 ft.
At Structure = 2900 ft.

Drainage Area Slope = 2.76 %

Drainage Width = 260 ft.

Width factor (W_f) = 1.24

Vegetative Cover - Desert Brush

Vegetative Density - 10 %

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.
Runoff -Q	0.23	0.48	0.57	0.90

Time of Concentration

$$T_p = \frac{2.04\ (2900)^{0.37}}{(2.76)^{0.20}\ (60)} = 0.53 \text{ hr.}$$

Time of Peak $T_p = T_c(W_f) = 0.66$ hr.

Peak Discharge

$$Q_p = \frac{484\ A\ Q}{T_p} \quad 5.1 \quad 10.6 \quad 12.5 \quad 19.8 \quad \text{cfs.}$$

Capacity of 30" C.M.P. culvert
Length = 80 ft., Slope = 0.2 %

Q = 15.8 cfs which is greater than 12.5 cfs.(10 yr. storm)

Area # 4 not expected to urbanize with residential housing, flow onto 64 th. Street, 1500 ft. north of McDowell Road.

Drainage Computation continued

Drainage Area = 0.07 Sq. Miles

Drainage Length = 2000 ft.

Elevation
Top of Drainage Area = 1325 ft.
At Structure = 1290 ft.

Drainage Area Slope = 1.75 %

Drainage Width = 600 ft.

Width factor (W_f) = 1.24

Vegetative Cover - Desert Brush

Vegetative Density - 10 %

Soil Group - "C"

Curve Number - 88

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Runoff - Q	0.23	0.48	0.57	0.90	inches

Time of Concentration

T_c = 0.65 hr. (overland flow, average grass cover)

Time of Peak $T_p = T_c(W_f)$ = 0.81 hr.

Peak Discharge

$Q_p = \frac{484\ A\ Q}{T_p}$ = 9.6 20.1 23.8 37.6 cfs

Area # 5 expected to urbanize (R1-7) with residential housing, flow at 6 ft. X 4 ft. conc. box culvert at McDowell Road, 600 ft. east of 64 th. Street.

Drainage Area
impervious 2.3 Ac. C = 0.95

pervious 6.9 Ac. C = 0.30

Total Area = 9.2 Ac. Weighted "C" = 0.46

Elevation
Top of Drainage Area = 1290 ft.
At Structure = 1280 ft.

Time of Concentration T_c = 25 min. (overland flow)

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity "i"	1.6	2.3	2.5	3.2	inches
Peak Discharge Q_p = CiA	6.8	9.7	10.6	13.5	cfs.

change in time of concentration for contributing areas #2 and #3 equal to

$$\frac{600}{2(60)} = 5.0 \text{ min.}$$

Drainage Computations continued

$Q_{\#2}$	T_p = 0.72 hr.	7.7	16.1	19.1	30.3	cfs.
$Q_{\#3}$	T_p = 0.76 hr.	4.4	9.2	10.9	17.2	cfs.
Total "Q"		18.9	35.0	40.6	61.0	cfs.

Capacity of the existing 6 ft. X 4 ft. conc. box culvert approximately 120 cfs., which is greater than 40.6 cfs. expected flow from a 10 yr storm.

Catch Basin # 1 opposite Sta. 5+80, 45 ft. north of the monument line, located over the existing conc. box culvert.

Contributing roadway area = $\frac{580(52)}{43560}$ = .69 Ac. Weighted "C" = 0.75

T_c = 10 min. , i = 3.8 inches, Discharge Q = 2.0 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.16 ft.

W = 66.7(0.16) = 10.7 ft. which is less than 24 ft.

use Type "B" catch basin, Interception Capacity = 1.1 cfs.
By pass = 0.9 cfs.

Catch Basin # 2 opposite Sta. 6+25, 7 ft. south of monument line, located over the existing conc. box culvert.

Contributing roadway area = $\frac{625(36)}{43560}$ = 0.52 Ac. Weighted "C" = 0.75

T_c= 10 min. , i = 3.8 inches, Discharge Q = 1.9 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.16 ft.

W = 66.7(0.16) = 10.7 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 1.5 cfs.
by pass = 0.4 cfs.

Catch Basin # 3 opposite Sta. 12+62, 7 ft. south of monument line.

Contributing roadway area = $\frac{(1262-625)(36)}{43560}$ = o.53 Ac. Weighted "C" = 0.75

T_c = 10 min., i = 3.8 inches, Discharge Q = 1.9 + 0.4 = 2.3 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.18 ft.

Drainage Computations continued

W = 66.7(0.18) = 12.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 1.8 cfs.
By pass = 0.5 cfs.
Connection Pipe - 12" R.G.R.C.P. @ S = 0.0120 ft./ft. (n=0.013)

Catch Basin # 4 opposite Sta. 12+62, 45 ft. north of monument line.

Contributing roadway area = $\frac{(1262 - 580)(52)}{43560}$ = 0.81 Ac. Weighted "C" = 0.75

T_c = 10 min., i = 3.8 inches, Discharge Q = 2.3 + 0.9 = 3.1 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.20 ft.

W = 66.7(0.20) = 13.3 ft. whichis less than 24 ft.

use Type "C" catch basin, Interception Capacity = 2.1 cfs.
By pass = 1.0 cfs.
Connection Pipe - 18" R.G.R.C.P. @ S = 0.0500 ft./ft. (n=0.013)
Required discharge capacity of connection pipe epual to 3.9 cfs, additional flow coming from catch basin # 3.

Total dicharge from catch basins #3 and #4 will flow in to drainage ditch north of and parallel to the proposed McDowell Road improvements.

Area # 6 urbanized or expected to urbanize into residential housing (R1-7), flow at existing 48" C.M.P. at Sta. 14+50.

Drainage Area

impervious	34.0 Ac.	C = 0.95
pervious	101.8 Ac.	C = 0.30
Total Area =	135.8 Ac.	Weighted "C" = 0.46

Elevation
Top of Drainage Area = 1270 ft.
At Structure = 1263 ft.

Drainage Area Length = 5400 ft.
Drainage Area Slope = 0.13 %

Time of Concentration
Channel flow $\frac{5300}{2(60)}$ = 44 min.
Overland flow 25 min.
T_c = 69 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	0.9	1.2	1.7	2.1	inches
Peak Discharge Q = CiA	56.2	75.0	106.2	131.2	cfs.

Drainage Computation continued

change in time of concentration for contributinh area # 4 equal to

$$\frac{2900}{2(60)} = 24.2 \text{ min.}$$

$Q_{\#4}$ T_p= 1.31 hr.	5.9	12.4	14.7	23.3	cfs.
Total "Q"	62.1	87.4	120.9	154.5	cfs

Existing 48" C.M.P. culvert @ S = 0.0020 ft./ft. Capacity = 34.8 cfs.

Proposed - an additional 48" C.M.P. at same alignment as the existing culvert.
Total possible capacity = 69.6 cfs. which is less the the expected flow from a 10 yr. storm.
Any flow over the capacity of the proposed and existing pipes will pond, and over flow into the existing canal, prior to inundating the roadway, which is the present condition. A conc. box culvert, to carry storm water and bicycle traffic under McDowell Road, is proposed by the City of Scottsdale for future construction. When the box culvert is constructed, there should be more the ample capacity for the storm water.

Catch Basin # 5 opposite Sta. 22+94, 57 ft. north of the monument line.

Area #7 presently improved commercial,(C-3).

Drainage Area

impervious	4.3 Ac.	C = 0.95
pervious	0.8 Ac.	C = 0.30
Total Area =	5.1 Ac.	Weighted "C" = 0.85

Time of Concentration

Overland flow		10 min.
Channel flow	$\frac{800}{1.5(60)}$ =	9 min.
	T_c =	19 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	1.8	2.6	2.8	3.7	inches
Peak Discharge Q = CiA	7.8	11.3	12.1	16.0	cfs.

This area will be land locked with respect to drainage.

use Type "F" catch basin, Interception 100%

Connection pipe to proposed storm drainage system 18" R.G.R.C.P. @ S = 0.0150 ft./ft., discharge capacity = 12.9 cfs. (n=0.013)

Drainage Computation continued

Catch Basin # 6 opposite Sta. 22+94, 44.5 ft. south of monument line.

Area # 8 - presently improved commercial,(C-3).

Drainage Area

impervious	0.43 Ac.	C = 0.95
pervious	0.07 Ac.	C = 0.30
Total Area =	0.50 Ac.	Weighted "C" = 0.85

Time of Conentration

Overland flow 10 min.

Channal flow $\frac{270}{3(60)}$ = 1.5 min.

T_c = 11.5 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.3	3.4	3.8	4.7	inches
Peak Discharge Q = CiA	1.0	1.4	1.6	2.0	cfs.

Contributing roadway area = $\frac{(2294 + 1262)(44.5)}{43560}$ = 1.05 Ac.

"C" = 0.75 , T_c = 10 min., i = 3.8 inches,

Discharge Q = 3.8 + 0.5 + 1.6 = 5.9 cfs

$Z = \frac{1}{0.020} = 50$, $\frac{Z}{n} = 3333$, y = 0.25 ft.

W = 50(0.25) = 12.5 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 2.8 cfs
By pass = 3.1 cfs

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0060 ft./ft., (n=0.013). Discharge Capacity = 2.6 cfs.

Catch Basin # 7 opposite Sta. 25 + 86, 44.5 ft. south of monument line.

Area #9 presently improved commercial (C-3).

Drainage Area

impervious	0.57 Ac.	C = 0.95
pervious	0.10 Ac.	C = 0.30
Total Area =	0.67 Ac.	Weighted "C" = 0.85

Drainage Computation continued

Time of Concentration
Overland flow 15 min.

Channel flow $\frac{250}{3(60)}$ = 1.4 min.

T_c = 16.4 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.0	3.3	3.5	3.9	inches
Peak Discharge Q = CiA	1.1	1.9	2.0	2.2	cfs

Contributing roadway area = $\frac{(2586 - 2294)(44.5)}{43560}$ = 0.30 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 1.1 + 2.0 + 3.1 = 6.2 cfs

$Z = \frac{1}{0.018} = 55.6$, $\frac{Z}{n} = 3704$, y = 0.27 ft.

W = 55.6(0.27) = 15.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 3.0 cfs
By pass = 3.2 cfs

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0075 ft./ft., (n=0.013). Discharge Capacity = 3.1 cfs.

The by pass of 3.1 cfs will flow around the southwest curb return at 68 th. Street and south onto 68th. Street.

Catch Basin #8 opposite Sta. 25+86, 44.5 ft. north of the monument line

Area #10 presently improved commercial (C-3).

Drainage Area

impervious	2.0 Ac.	C = 0.95
pervious	0.3 Ac.	C = 0.30
Total Area =	2.3 Ac.	Weighted "C" = 0.85

Time of Concentration
Overland flow 10 min.

Channel flow $\frac{450}{2(60)}$ = 3.8 min.

T_c = 13.8 min.

Drainage Computations continued

Design frequency	2 yr.	5 yr.	10 yrs	25 yr.	
Rainfall intensity	2.2	3.1	3.3	4.2	inches
Peak Discharge $Q = CiA$	4.3	6.1	6.5	8.2	cfs

Forty percent of this flow, flows to McDowell Road, the other sixty percent flows to 68th Street.

Contributing roadway area = $\frac{(2586 - 1262)\ (44.5)}{43560}$ = 1.35 ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 4.9 + 1.0 + 0.4(6.5) = 8.5 cfs

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, Y = 0.27 ft.

W = 66.7(0.27) = 18.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 3.0 cfs
By pass = 5.5 cfs.

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0100 ft./ft., (n=0.013). Discharge Capacity = 3.6 cfs.

Catch Basin #9 opposite Sta. 26+96, located on the north end of the northwest curb return at the intersection of 68th Street and McDowell Road.

Area #11 urbanized residential housing, (R1-7).

Drainage area

impervious	5.3 ac.	C = 0.95
Pervious	16.0 ac.	C = 0.30
Total Area =	21.3 ac.	Weighted "C" = 0.46

Average slope = 0.96%

Time of Concentration
Overland flow 25 min.

Channel flow $\frac{2000}{1.5(60)}$ = 22.2 min.

T_c = 47.2 min.

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.
Rainfall Intensity	1.0	1.5	1.6	2.1 inches

Drainage Computations continued

Peak Discharge Q = CiA	9.8	14.7	15.7	20.6	cfs.

68 th. Street half street capacity = 7.8 cfs,

overflow onto easterly residential areas = 7.9 cfs.

Discharge at Catch Basin #9 Q = 7.8 + 0.6(6.5) = 11.7 cfs

y = 0.33 ft., 68 th. Street half width = 32 ft.

use Type "D" catch basin, Interception Capacity = 2.7(4.6) + 1.7 = 14.1 cfs
no by pass.

Connection pipe to proposed storm drain system - 18" R.G.R.C.P.,
@ S = 0.0130 ft./ft., (n=0.013). Discharge Capacity = 12.0 cfs.

Catch Basin #10 opposite Sta. 35+37, 44.5 ft. north of monument line.

Area #12 presently improved commercial,(C-3).

Drainage Area		
impervious	0.42 Ac.	C = 0.95
pervious	0.02 Ac.	C = 0.30
Total Area	0.44 Ac.	Weighted "C" = 0.92

Time of Concentration T_c = 10 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.5	3.6	3.8	4.9	inches
Peak Discharge Q = CiA	1.0	1.5	1.5	2.0	cfs

Contributing roadway area = $\frac{300(32)}{43560} + \frac{(3537-2586)(44.5)}{43560}$ = 1.19 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches,

Discharge Q = 4.3 + 1.5 + 5.5 = 11.3 cfs.

$Z = \frac{1}{0.20} = 50$, $\frac{Z}{n} = 3333$, y = 0.36 ft.

W = 50(0.36) = 18 ft. which is less than 24 ft.

use Type "C" catch basin, Interception Capacity = 4.4 cfs
By pass = 6.9 cfs.

Connection pipe to proposed storm drain system - 12" R.G.R.C.P.,
@ S = 0.0406 ft./ft., (n=0.013). Discharge Capacity = 7.2 cfs.

Drainage Computation continued

Catch Basin #11 opposite Sta. 35 + 37, 44.5 ft. south of monument line.

Area #13 presently improved commercial,(C-3)

Drainage Area

impervious	0.25 Ac.	C = 0.95
pervious	0.01 Ac.	C = 0.30
Total Area =	0.26 Ac.	Weighted "C" = 0.92

Time of Concentration T_c = 10 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	3.0	3.6	3.8	4.9	inches
Peak Discharge Q = CiA	0.7	0.9	0.9	1.2	cfs

Contributing roadway area = $\frac{(3537 - 2751)(44.5)}{43560}$ = 0.80 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 2.9 + 0.9 = 3.8 cfs

$Z = \frac{1}{0.02} = 50$, $\frac{Z}{n} = 3333$, y = 0.24 ft.

W = 50(0.24) = 12 ft. which is less than 24 ft.

use Type "D" catch basin, Interception Capacity = 9.4 cfs
no by pass.

Connection pipe to proposed storm drain system - 18" R.G.R.C.P ,
@ S = 0.0290 ft./ft., (n=0.013). Discharge Capacity = 17.9 cfs.

Catch Basin #12 opposite Sta. 36+37, 44.5 ft. north of monument line.

Area #14 urganized residential housing,(R1-7).

Drainage Area

impervious	3.6 Ac.	C = 0.95
pervious	10.9 Ac.	C = 0.30
Total Area	14.5 Ac.	Weighted "C" = 0.46

Time of Concentration

Overland flow 30 min.

Channel flow $\frac{1600}{1(60)}$ = 26.7 min.

T_c = 56.7 min.

Drainage Computation continued

Design Frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	0.9	1.3	1.4	1.9	inches
Peak Discharge Q = CiA	6.0	8.7	9.3	12.7	cfs.

Street capacity of 69 th. Street = 8.0 cfs
Total flow to the easterly residential area = 7.9 + 1.3 = 9.2 cfs

Area #15 -presently improved commercial area, (C-3).

Drainage Area
impervious 0.65 Ac. C = 0.95

pervious 0.16 Ac. C = 0.30

Total Area = 0.81 Ac. Weighted "C" = 0.82

Time of Concentration
Overland flow 10 min.

Channel flow $\frac{180}{1(60)}$ = 2 min.

T_c = 12 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.3	3.3	3.5	4.6	inches
Peak Discharge Q = CiA	1.5	2.2	2.3	3.1	cfs

Total flow from 69 th. Street = 8.0 + 2.3 = 10.3 cfs.

Contributing roadway area = $\frac{(3637 - 3537)(44.5)}{43560}$ = 0.10 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches,

Discharge Q = 0.4 + 10.3 + 6.9 = 17.6 cfs

$Z = \frac{1}{0.017} = 58.8$, $\frac{Z}{n} = 3920$, y = 0.40 ft.

W = 58.8(0.40) = 23.5 ft. which is less than 24 ft.

use Type "D" catch basin, Interception Capacity = 3.2(4.6) + 2.3 = 10.2 cfs
By pass = 7.6 cfs.

Connection pipe to proposed storm drain system - 15" R.G.R.C.P.,
@ S = 0.0384 ft./ft., (n=0.013). Discharge capacity = 12.7 cfs.

Drainage Computation continued

Catch Basin #13 opposite Sta. 38+18, 58 ft. south of monument line.

Area #16 presently improved commercial area,(C-3).

Drainage Area impervious	0.90 Ac.	C = 0.90
pervious	0.16 Ac.	C = 0.30
Total Area =	1.06 Ac.	Weighted "C" = 0.85

Time of Concentration T_c = 15 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.5	3.0	3.2	4.1	inches
Peak Discharge Q = CiA	2.3	2.7	2.9	3.7	cfs

This area will be land locked with respect to drainage.

use Type "F" catch basin, Interception 100%

Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.0457 ft./ft., (n=0.013). Discharge capacity = 7.6 cfs.

Area #17 presently improved commercial area, (C-3).

Drainage Area - impervious 0.28 Ac. C = 0.95

Time of concentration T_c = 10 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	3.0	3.6	3.8	4.9	inches
Peak Discharge Q = CiA	0.8	1.0	1.0	1.3	cfs.

Contributing roadway area $= \frac{(4009 - 3537)(44.5)}{43560} = 0.48$ Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Total dischagre Q = 1.0 + 1.7 = 2.7 cfs,

This runoff flows to 70 th. Street, and south on 70 th. Street.

Catch Basin #14 opposite Sta 39+91, existing Type "F" catch basin, 44.5 ft. north of monument line.

Area #18 presently urbanized residential housing,(R1-7).

Drainage Computations continued

Drainage Area

impervious	3.1 Ac.	C = 0.95
pervious	9.2 Ac.	C = 0.30
Total Area	= 12.3 Ac.	Weighted "C" = 0.46

Average Slope of drainage area 0.64%

Time of concentration

Overland flow 30 min.

Channel flow $\frac{1600}{1(60)}$ = 26.7 min.

T_c = 56.7 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	0.9	1.3	1.4	1.9	inches
Peak Discharge Q = CiA	5.1	7.4	7.9	10.8	cfs.

Total flow from residential areas = 7.9 + 9.2 = 17.1 cfs.

Area #19 presently improved commercial area,(C-3).

Drainage Area

impervious	1.1 Ac.	C = 0.95
pervious	0.2 Ac.	C = 0.30
Total Area	= 1.3 Ac.	Weighted "C" = 0,85

Time of concentration

Overland flow 10 min.

Channel flow $\frac{150}{1(60)}$ = 2.5 min.

T_c = 12.5 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	2.3	3.2	3.4	4.5	inches
Peak Discharge Q = CiA	2.5	3.5	3.8	5.0	cfs.

Contributing roadway area = $\frac{(4009 - 3637)(44.5)}{43560}$ = 0.38 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches, Q = 1.4 cfs

Drainage Computations continued

Flow from commercial area #19 separated, 1.9 cfs to 70 th. Street, 1.9 cfs to McDowell Road.

Total flow at 70 th. Street and McDowell Road.

70 th Street discharge Q = 17.1 + 1.9 = 19.0 cfs.

McDowell Road discharge Q = 1.9 + 1.4 + 7.6 = 10.9 cfs.

Total discharge to Catch Basin #14 Q = 29.9 cfs.

McDowell Road drainage - Q = 10.9 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.31 ft.

W = 66.7(0.31) = 20.7 ft. which is less than 24 ft.

Existing Catch Basin #14 with a hydraulic head of 0.31 ft,
Interception capacity = 2.7(5.43) = 14.6 cfs

Existing Type "A" catch basin located on the north end of the northeast curb return of 70th. Street and McDowell Road,
Interception capacity = 3.2 cfs.

Total runoff removal = 14.6 + 3.2 = 17.8 cfs. By pass = 12.1 cfs.

It is proposed that the existing Type "F" catch basin be reconstructed to flow to the proposed storm drain system, this would allow this catch basin to flow at full capacity.
Connection pipe to proposed storm drain system - 12" R.G.R.C.P., @ S = 0.2000 ft./ft., (n=0.013). Discharge capacity = 15.9 cfs.

Catch Basin #15 opposite Sta. 40+89, 44.5 ft. north of monument line.

Contributing roadway area = $\frac{(4089 - 4009)(44.5)}{43560}$ = 0.08 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 12.1 + 0.3 = 12.4 cfs

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.33 ft.

W = 66.7(0.33) = 22.0 ft. which is less than 24.0 ft.

use Type "D" catch basin, Interception capacity = 2.7(4.6) + 1.7 = 14.1 cfs
no by pass.

Connection pipe to proposed storm drain system - 15" R.G.R.C.P., @ S = 0.1000 ft./ft., (n=0.013). Discharge capacity = 20.7 cfs.

Drainage Computation continued

Catch Basin #16 opposite Sta. 46+51, 44.5 ft. south of monument line.

Area #20 presently improved commercial area, (C-3).

Drainage area impervious	0.34 ac.	C = 0.95
Pervious	0.06 ac.	C = 0.30
Total Area =	0.40 ac.	Weighted "C" = 0.85

Time of Concentration
Overland flow 10 min.

Channel Flow $\frac{200}{2.5(60)}$ = 1.3 min.

T_c = 11.3 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.
Rainflal intensity	2.3	3.4	3.6	4.7 inches
Peak Discharge Q = CiA	0.8	1.2	1.2	1.6 cfs.

Contributing roadway area = $\frac{(4651 - 4009)\ (44.5)}{43560}$ = 0.66 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches.

Discharge Q = 2.4 + 1.2 = 3.6 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.18 ft.

W = 66.7(0.18) = 12.0 ft. which is less than 24 ft.

use Type "C" catch basin, Interception capacity = 1.8 cfs,
By pass 0.6 cfs into southerly shopping center area.

Connection pipe to proposed storm drain system - 12" R.G.R.C.P.,
@ S = 0.0429 ft./ft., (n-0.013). Discharge capacity = 17.0 cfs.

Roadway drainage from Sta. 47+36 to the intersection of Scottsdale Road and McDowell Road. (south side of McDowell Road)

Roadway area = $\frac{(5271 - 4736)\ (44.5)}{43560}$ = 0.55 ac.

"C" = 0.95, T_c = 10 min. i = 3.8 inches

Discharge south onto Scottsdale Road Q = 2.0 cfs.

Runoff flow is intercepted by a Type "A" catch basin located on the south end of the southwest curb return of the intersection of Scottsdale Road and McDowell Road.

Drainage Computation continued

Catch Basin #17 opposite Sta. 46+51, 44.5 ft. north of monument line.

Area #21 presently improved commercial area (C-3).

Drainage Area

impervious	3.5 Ac.	C = 0.95
pervious	0.6 Ac.	C = 0.30
Total Area =	4.1 Ac.	Weighted "C" = 0.85

Time of Concentration

Overland flow 12 min.

Channel flow $\frac{460}{1.5(60)}$ = 5.1 min.

T_c = 17.1 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	1.9	2.8	3.0	3.9	inches
Peak Discharge Q = CiA	6.6	9.7	10.2	13.6	cfs

Contributing roadway area = $\frac{(4651 - 4089)(44.5)}{43560}$ = 0.57 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches

Discharge Q = 10.4 + 2.1 = 12.5 cfs

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.32 ft.

W = 66.7(0.32) = 21.3 ft. which is less than 24 ft.

use Type "D" catch basin, Interception capacity = 2.7(5.43) + 1.6 = 16.3 cfs
no by pass.

Connection pipe to proposed storm drain system - 15" R.G.R.C.P.,
@ S = 0.0650 ft./ft.,(n=0.013). Discharge capacity = 16.7 cfs.

Catch Basin #18 opposite Sta. 52+21, 44.5 ft. north of monument line.

Area #22 presently improved commercial area,(C-3).

Drainage Area

impervious	4.6 Ac.	C =0.95
pervious	0.8 Ac.	C = 0.30
Total Area =	5.4 Ac.	Weighted "C" = 0.85

Drainage Computation continued

Time of Concentration

Overland flow 10 min.

Channel flow $\frac{850}{1.5(60)}$ = 9.4 min.

T_c = 19.4 min.

Design frequency	2 yr.	5 yr.	10 yr.	25 yr.	
Rainfall intensity	1.8	2.7	2.8	3.6	inches
Peak Discharge Q = CiA	8.3	12.4	12.9	16.5	cfs

Contributing roadway area = $\frac{(5221 - 4651)(44.5)}{43560}$ = 0.58 Ac.

"C" = 0.95, T_c = 10 min., i = 3.8 inches,

Discharge Q = 12.9 + 2.1 = 15.0 cfs.

$Z = \frac{1}{0.015} = 66.7$, $\frac{Z}{n} = 4444$, y = 0.35 ft.

W = 66.7(0.35) = 23.3 ft. which is less than 24 ft.

Existing catch basin Sta. 50+61, 44.5 ft. north of monument line, Type "B" catch basin, interception capacity = 3.0 cfs.

Required capacity of catch basin #18 Q = 12.0 cfs.

use combination Type "C" and "F", the Type "C" catch basin presently exists. It is proposed to place a Type "F" catch basin along the front of the existing catch basin.
Total interception capacity Q = 2.9(5.43) + 1.7 = 17.5 cfs
no by pass.

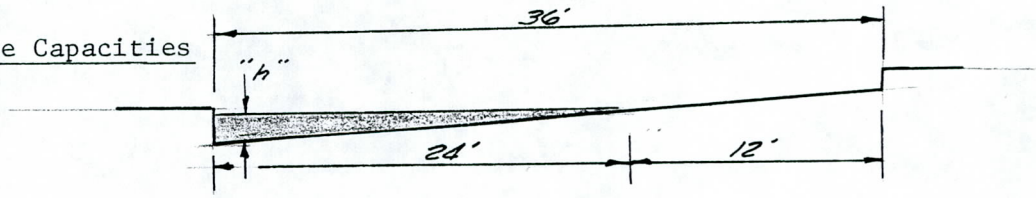
Connection pipe to proposed storm drain system - 15" R.G.R.C.P., @ S = 0.0350 ft./ft.,(n=0.013). Discharge capacity = 12.2 cfs.

Drainage Computation continued

Drainage Precipitation

	Storm Frequency 2 yr.	5 yr.	10 yr.	25 yr.	
P = 6 hour	1.1	1.7	1.9	2.4	inches
P = 24 hour /	1.3	2.0	2.4	3.0	inches
P = 1 hour	0.9	1.3	1.4	1.8	inches

Roadway Drainage Capacities



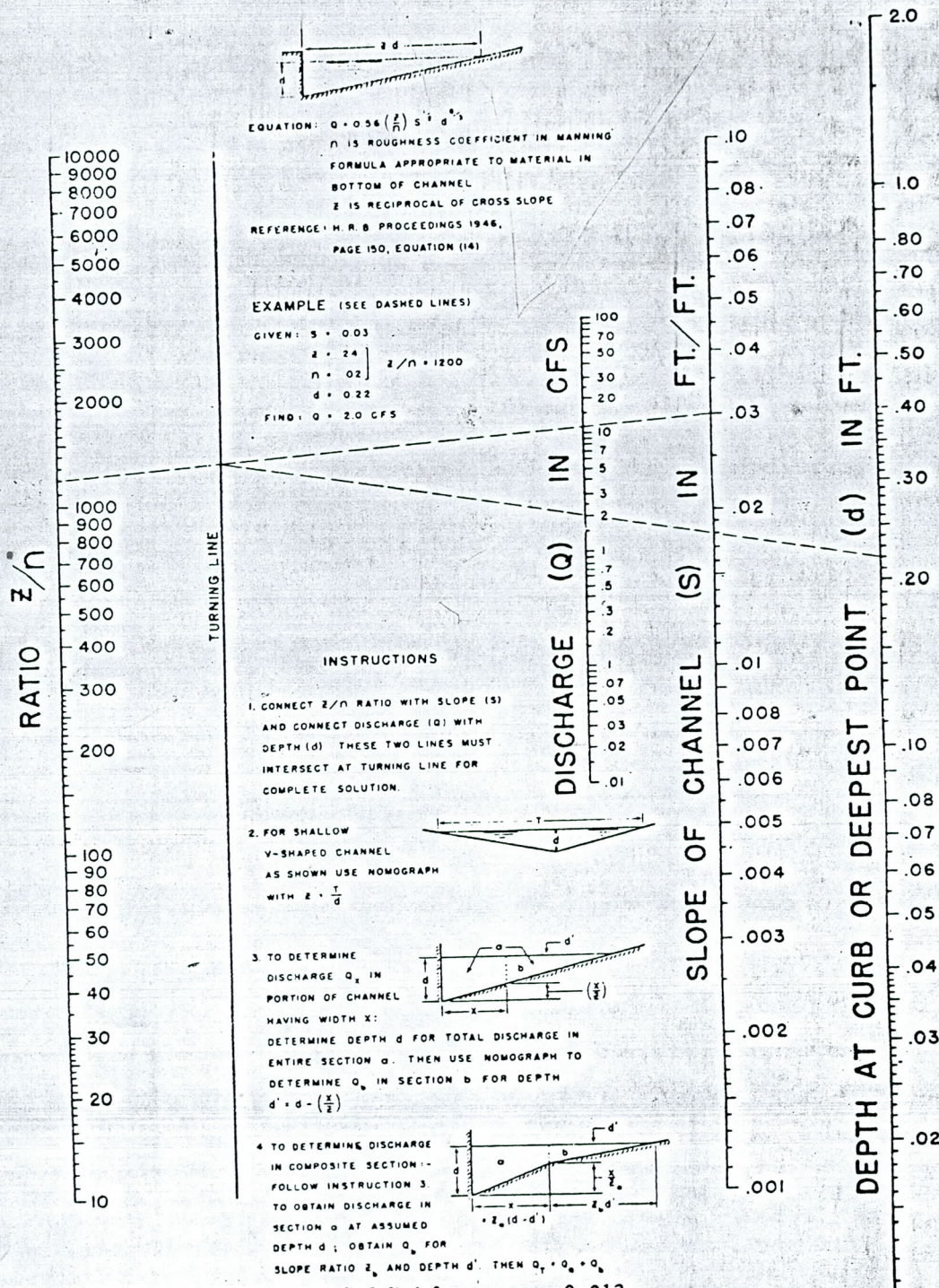
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} \qquad n = 0.015 \text{ (asphalt)}$$

Cross slope (ft./ft.)	h (ft.)	A (Sq.ft.)	R (ft.)	Q (cfs)
0.025	0.60	7.20	0.293	$314.66 S^{1/2}$
0.020	0.48	5.76	0.235	$217.30 S^{1/2}$
0.017	0.41	4.92	0.205	$169.46 S^{1/2}$
0.015	0.36	4.32	0.177	$134.91 S^{1/2}$

Street Cross Slopes (ft./ft.)

Street Slopes (ft./ft.)	0.025 Q	0.025 V	0.020 Q	0.020 V	0.017 Q	0.017 V	0.015 Q	0.015 V
0.0200	44.5	6.2	30.7	5.3	24.0	4.9	19.1	4.4
0.0150	38.5	5.3	26.6	4.6	20.8	4.2	16.5	3.8
0.0100	31.5	4.4	21.7	3.8	16.9	3.4	13.5	3.1
0.0050	22.3	3.1	15.4	2.7	12.0	2.4	9.5	2.2

(Q - street capacity flowing full, cfs., V - street velocity, fps.)



Concrete gutter troweled finish	0.012
Asphalt pavement	
(1) Smooth texture	0.013
(2) Rough texture	0.016
Concrete gutter with asphalt pavement	
(1) Smooth	0.013
(2) Rough	0.015
Concrete pavement	
(1) Float finish	0.014
(2) Broom finish	0.016
	0.016

For gutters with small slope where sediment may accumulate, increase all above values of "n" by 0.002.

NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS

1-30-75

Removeals

SH. 4 OF 4 McDowell Rd. Improvements

Item	Description		
1.	A.C. Pavement	13,025	Sy
2	C. & G.	1,690	LF
3	~~D/W Entr.~~		SF.
4.	S/W	6,635	SF
5	Conc. Return Aprons	220	SF
6	Asphaltic Conc. C.	45	LF.
7	Conc. Headwall	2	EA.
8	Delineators	11	EA
9	Signal Span	—	LS.
10	Misc.	—	LS.

SH. 2 OF 4 68th ST INT. 1-30-75

CONSTRUCTION

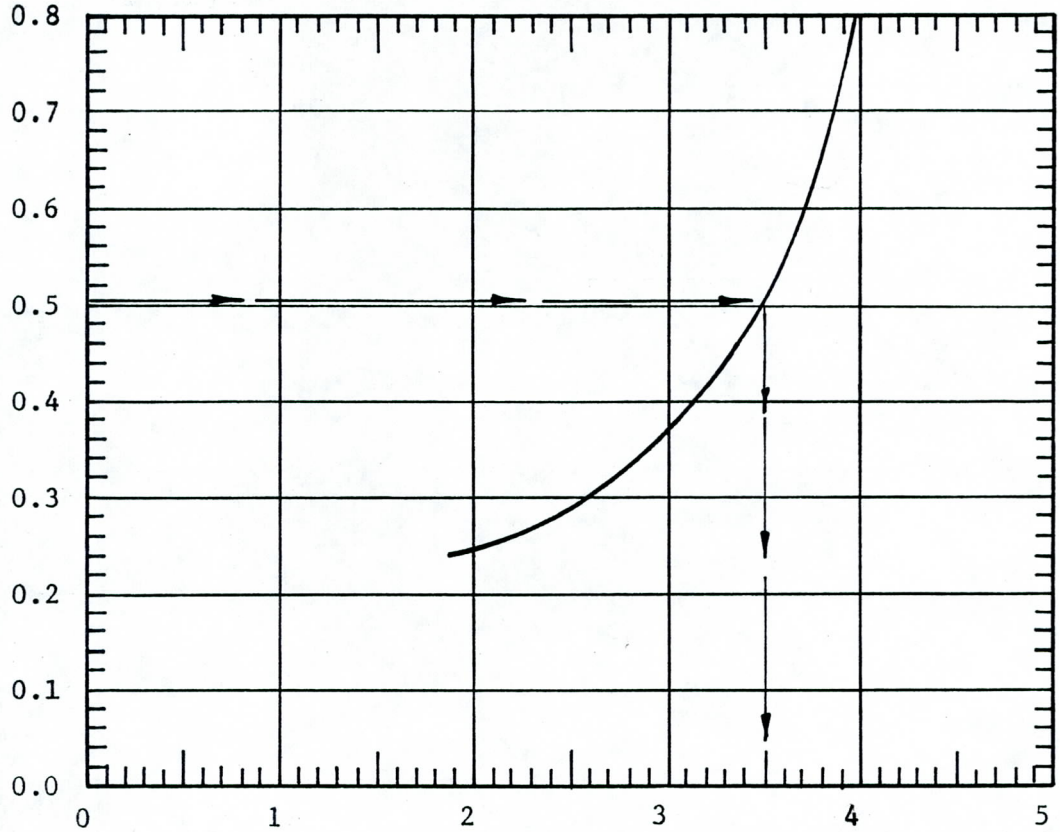
28	1½" P.V.C. Sch. 40		LF
29	¾" P.V.C. Sch. 40		LF.
30	No. 3½ Conc. Pull Box		EA
31	Elect. Service		EA.
32	Type "I" Pedestal Foundation		EA
33	Type "A" Pole "		EA
34	" F " "		EA
35	" Q " "		EA
36	No. 5 Conc. Pull Box (TS-1-2)		EA
37	Elect. Wiring Per Condu. Sch.	—	LS
38	Traffic Signal Equip.	—	LS.
39	2" TOP SOIL	3,560	Sy
40	Fill Material Imported		Sy
~~41~~	~~Grade Ditch~~		LF
~~42~~	SEE SH. 3		

1-30-75

TOTAL CONSTRUCTION

SH. 1 OF 4 McDowell Rd Improvements

Item	Description	Quantity	Unit Price	Total
1	Grading under pavement	16,345 Sy		
2	8" Select Material	16,095 Sy		
3	4" A.B.C.	17,490 Sy		
4	1 3/4" A.C. Base Course	16,095 Sy		
5	3/4" A.C. Seal Course	30,865 Sy		
6	Preservative Seal	3,050 Gal		
7	A.C. Overlay	1,461 Tons		
8	1" A.C. Seal Course	250 Sy		
9	2" A.C. 3/4" FDGM Single "	1,625 Sy		
10	8" A.B.C.	35 Sy		
11	9" A.B.C.	250 Sy		
12	V.C.&G #146	7,810 LF		
13	R.C.&G #147	15 LF		
14	Single C. #141	5,930 LF		
15	4" Conc. S/W #180	4,295 SF		
16	D/W Entrance #158	4,270 SF		
17	Conc. Valley Gutter #165	108 SF		
18	Conc. Curb Ret. Aprons #165	530 SF		
19	Survey Monu. #193	2 EA		
20	Type "A" V.B.&C (Replace)	8 EA		
21	W.V.B.&C. Adjust	4 EA		
22	G.V.B.&C. Adjust	1 EA		
23	M.H. Adjust	10 EA		
24	S.S.C.O. Adjust	1 EA		
25	Survey Monu. Adjust	2 EA		
26	2 1/2" P.V.C. Sch. 40	LF		
27	2" P.V.C. Sch 40	LF		



FLOW INTO INLET PER SQ. FT. OF OPEN AREA (CFS/FT^2)
CAPACITY OF GRATED INLET IN SUMP

FOR TYPE E AREA = 1.25x3.34x0.75 = 3.1 ft^2
FOR TYPE"F" AREA = 2.125x3.41x0.75 = 5.43

FOR TYPE "D" AREA = 2.125x3.34x0.65 = 4.6 ft^2
Capacity from this chart + 4' curb opening

Approximate Hydraulic Capacityes of Clean Inlets in Cubic Feet per Second

Water depth in feet at flow line of gutter	Catch Basins City of Phoenix Standard Details #210	#212	#216A	#216B	#217C	#218D
0.1	2.0	2.1	0.3	0.5	0.7	[illegible]
0.2	2.8	3.2	0.9	1.4	2.1	10.3
0.3	3.4	4.2	1.5	2.3	3.4	14.9
0.4	4.0	5.1	2.3	3.6	5.3	21.4
0.42	-	-	2.5	4.0	5.8	-
0.5	4.4	6.0	3.4	5.3	7.7	24.9
0.6	4.8	6.9	4.0	6.3	9.2	28.0
0.67	-	-	4.6	7.2	10.5	-
0.7	5.2	7.7	4.8	7.5	11.0	30.3

As per "Yost and Gardner Engineers", 1970