HYDROLOGY J10/D9 1 of 2 2 PLANS

J10/D9

2 PLANS

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

December 10, 1980

Mr. Art Kelly
Civil Engineer
Gordon Herkenhoff & Associates
302 Eighth Street N.W.
Albuquerque, N.M. 87102

RE: BUTTRUM PLAZA

Dear Mr. Kelly:

I am sorry for the delay in submitting my comments for the revised Buttrum Plaza Drainage Report. As I indicated to you in our telephone conversation, this revised report is approved in concept and the following comments can be addressed on the construction plans:

1) Safety provisions required for the southwest pond since the pond is greater than 18" in depth.

2) Discuss or show on plan the required drainage scheme for the future restaurant and office building.

3) Obtain approval for the proposed designs in the City right-of-way from the City Engineer's Office.

4) Provide an adequate slope for the two discharge pipes. I believe a 1/4" drop per foot of run would be adequate.

Again, please be advised that this report was reviewed for concept only and was not reviewed for construction detail. The review for construction detail is performed when plans are submitted for a building permit.

Finally, I have noted your concerns regarding the November Interim Drainage Guidelines. I suggest you file your protest with the City Engineer.

If you have any questions concerning these comments, do not hesitate to call me.

Sincerely,

Fred J. Aguirre

Fred J. Aguirre, P.E.
Civil Engineer

FJA/tsl

cc: Bruno Conegliano, Asst. Hydrology Engineer

1960-1651.40-80

GORDON HERKENHOFF & ASSOCIATES, INC.
302 Eighth Street, N.W.
Albuquerque, New Mexico 87102
(505) 247-0294

October 1, 1980

Mr. Fred J. Aguirre, Civil Engineer
Municipal Development Department
Engineering Division
City of Albuquerque
P.O. Box 1293
Albuquerque, New Mexico 87103

RE: BUTTRUM PLAZA

In response to your letter dated August 5 concerning the subject project, we have the following comments:

1. Drainage areas have been delineated on the attached drainage plan together with flow directions.

2. A swale has been delineated for the south property line/alley area. Sheetflow obtains for the north/south alley and areas east to the N.E. pond.

3. The proposed outfall pipe connection to Coors Blvd. drop inlet has been shown in section on the plan.

4. The Northeast pond has been designed to be 110 x 90 x 1.5 feet deep and served by an eight (8) inch dia. outfall pipe to a sidewalk underdrain on Fortuna Road. The difficulty of obtaining sufficient slope has required the use of an eight inch diameter pipe in order to permit adequate detention discharge within the Q5 undeveloped flow parameters (see calculations).

5. All developed flows generated on the parking lot were routed through an asphalt lined channel to the pond designed to handle the velocity and capacity of the design year flows. Water blocks have been designated for parking lot entrances to contain and channel sheetflows.

6. Pond Volumes

A. Southwest pond

Top of pond	=	3,174 S.F.
Bottom of pond	=	1,647 S.F.
Average		2,410 S.F.
Depth		2.5 Ft.
Retention Value		6,026 C.F.

B. Northeast Pond

Top of Pond	= 9,900 S.F.
Bottom of Pond	= 8,181 S.F.
Average	9,040 S.F.
Depth	1.5 Ft.
Retention Volume	13,560 C.F.

7. Attached are pond routing calculations for each pond in question. Notice that in no case were the maximum allowable discharge rates exceeded. It was determined, however, that a six inch outfall pipe for the Northeast pond would result in a totally filled pond at the end of one hour of design storm. An eight inch pipe would result in at least two inches of freeboard while not exceeding the maximum allowable discharge rate (see calculations).

The preceeding satisfies the November 1979 Interim Drainage Guidelines. However, please be advised that we believe these guidelines to be in direct contradiction to the AMAFCA 1972-2 Drainage Resolution which is in fact the existing ordinance governing drainage for Albuquerque. We strongly disagree with your Department making legislative decisions on an administrative level and are conforming to your interim guidelines under protest.

Sincerely,

Art Kelly

ART KELLY
Civil Engineer

AK:pd
Enclosures

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

MAYOR
David Rusk

August 5, 1980

Mr. Charles W. Campbell
Gordon Herkenhoff & Associates, Inc.
302 Eighth Street, N. W.
Albuquerque, New Mexico 87102

Re: Buttrum Plaza

Dear Mr. Campbell:

The proposed drainage report is not in agreement with the November 1979 Interim Drainage Guidelines which requires that the entire storm runoff be routed to a pond or ponds and released, collectively, at no greater rate than the Q5 undeveloped. Also, the drainage plan is deficient in the following items:

1. No pond volume calculations are provided.

2. The drainage areas are not completely delineated on the grading plans. (The northwest building in particular).

3. Adequate swale definition is required along the south property line and also along the vacated alley to convey the roof runoff and offsite flows into their respective ponds.

4. Adequate detail is required to show the proposed connection from the pond into the back of the catch basin. This proposed connection must also be approved by the City Engineer's Office.

5. The ponds do not balance with their respective drainage area, however, in this case the ponds are over designed.

6. No calculations are provided for the required pond discharge rates.

If you have any questions concerning the above, please feel free to contact me.

Sincerely,

Fred J. Aguirre
Civil Engineer

FJA:pp

DRAINAGE AREA #2

TABLE I: INFLOW VOLUME & RATE
N.E. POND

Time (Min.)	Precipitation* (In.)	Total Inflow (cu.ft.)	Inflow Rate (cfs)
		--	--
5	0.30	2,602	8.67
10	0.54	4,683	15.61
15	0.23	1,995	6.65
20	0.14	1,214	4.05
25	0.14	1,214	4.05
30	0.14	1,214	4.05
35	0.08	694	2.31
40	0.08	694	2.31
45	0.08	694	2.31
50	0.08	694	2.31
55	0.08	694	2.31
60	0.08	694	2.31
65	0		

17,086 C.F. Total 1 hr. R.O. Volume

Area = 99,890 S.F. or 2.65 acres

Allowable discharge rate for N.E. Pond
2.6 in/hr x 2.65 x 0.4 = 2.76 cfs = Q5 yr.

*1 hr. - 100 yr. hyetograph (Intensity Vis. duration) for Albuquerque, New Mexico. Extrapolated for use at project location.

DRAINAGE AREA #2

TABLE II N.E. POND ROUTING
6" Outfall Pipe

Time (Min.)	Volume Int. Storage (CF)	H Depth (FT)	HW/Dia.	Qpd (cfs)	Volume Out(CF)	Volume Remainder (CF)
0	0	0	0	0	0	0
5	0	0	0	0	0	0
10	2,602	0.31	0.62	0.1	30	2,572
15	7,255	0.84	1.68	0.7	210	7,045
20	9,040	1.03	2.06	0.9	270	8,770
25	9,984	1.13	2.26	0.95	285	9,699
30	10,913	1.23	2.46	1.0	300	10,613
35	11,827	1.32	2.64	1.02	306	11,521
40	12,215	1.36	2.72	1.07	321	11,894
45	12,588	1.40	2.80	1.1	330	12,258
50	12,952	1.44	2.88	1.12	336	12,622
55	13,316	1.48	2.96	1.12	336	12,980
60	13,674	1.50	3.0	1.15	345	13,329
65	14,023	1.55	3.10	1.18	354	13,669

Pond Retention Volume = 13,560 C.F.

Conclusion - Fills to maximum pond volume in 1 Hr. of 100 Yr. Storm

DRAINAGE AREA #2

TABLE III N.E. POND ROUTING
8" Outfall Pipe

Time (Min.)	Volume Int. Storage (CF)	H Depth (FT)	HW/D	Qpd (cfs)	Volume Out (CF)	Volume Remainder (CF)
0	0	0	0	0	0	0
5	0	0	0	0	0	0
10	2,602	0.31	0.46	0.1	30	2,572
15	7,255	0.84	1.25	1.30	390	6,865
20	8,860	1.02	1.52	1.50	450	8,410
25	9,624	1.10	1.64	1.65	495	9,129
30	10,343	1.18	1.76	1.75	525	9,818
35	11,032	1.24	1.85	1.85	555	10,477
40	11,171	1.26	1.88	1.87	561	10,610
45	11,304	1.28	1.91	1.90	570	10,734
50	11,428	1.30	1.94	1.93	579	10,849
55	11,543	1.30	1.94	1.93	579	10,964
60	11,658	1.31	1.96	1.96	588	11,070
65	11,764	1.32	1.97	1.96	588	11,176

Conclusion: Two inch freeboard remains after 1 Hr. - 100 Yr. Storm

DRAINAGE AREA #1

TABLE IV INFLOW VOLUME & RATE
S.W. Pond

Time (Min)	Precipitation*	Total Inflow (CF)	Inflow Rate (CFS)
5	0.30	--	--
10	0.54	784	2.61
15	0.23	1,411	4.70
20	0.14	601	2.00
25	0.14	366	1.22
30	0.14	366	1.22
35	0.08	366	1.22
40	0.08	209	0.70
45	0.08	209	0.70
50	0.08	209	0.70
55	0.08	209	0.70
60	0.08	209	0.70
65	0	209	0.70

5,148 C.F. Total 1 Hr. R.O. Vol.

34,732 S. F. or 0.80 acres

*1 hr - 100 yr. hyetograph (Intensity Vis. Duration)
for Albuquerque, New Mexico. Extrapolated for use at project location.

DRAINAGE AREA #1

TABLE V S.W. POND ROUTING
6" Outfall Pipe

Time (Min)	Vol. In - + Storage	H Depth(FT)	HW/D	Q Pond (CSS)	Vol Out (CF)	Volume Remainder(CF)
0	0	0	0	0	0	0
5	0	0	0	0	0	0
10	784	0.45	0.90	0.20	60	724
15	2,135	1.10	2.20	0.90	270	1,865
20	2,466	1.25	2.50	1.0	300	2,166
25	2,532	1.27	2.54	1.02	306	2,226
30	2,592	1.29	2.58	1.02	306	2,286
35	2,652	1.31	2.62	1.04	312	2,340
40	2,549	1.28	2.56	1.02	306	2,243
45	2,452	1.25	2.50	1.0	300	2,152
50	2,361	1.20	2.40	0.98	294	2,067
55	2,276	1.16	2.32	0.95	285	1,991
60	2,200	1.13	2.26	0.92	276	1,924
65	2,133	1.10	2.20	0.90	270	1,863

Pond Retention Volume = 6,026 C.F.

ENGINEER'S REPORT ON
STORM DRAINAGE
FOR BUTTRUM PLAZA

Prepared For: Buttrum Construction Comapny

By: Gordon Herkenhoff and Associates, Inc.

Date: February, 1980

Revised: October, 1980

I hereby certify that this drainage report for Buttrum Plaza was prepared under my direction, conforms to Drainage Resolution 1972-2 and the City of Albuquerque Resolution No. 59-1976, and is true and correct to the best of knowledge.

Gordon Herkenhoff

Gordon Herkenhoff
N.M. P.E., L.S. #243

March 30, 1980

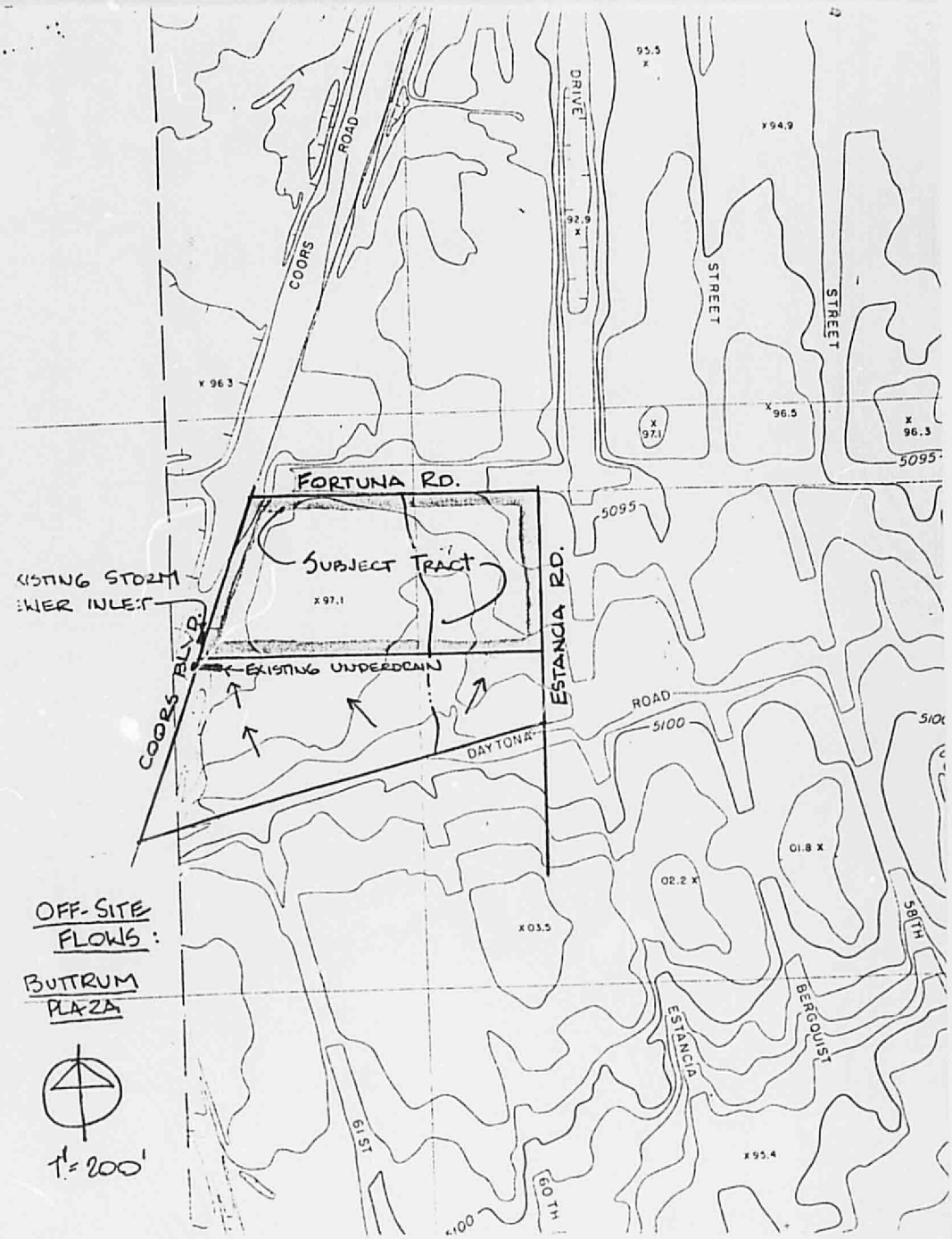
Date

Revised Oct. 10, 1980

Approved for the City of Albuquerque

G. E. HERKENHOFF
NEW MEXICO
243
REGISTERED PROFESSIONAL ENGINEER AND LAND SURVEYOR

Subject Tract
TOWN
ATRISCO
YELLOW
FREIGHT
AIRPORT
ADDN
UNIT
RIO
GRANDE
CANAL
ELENDALE
ADDN
J-11-Z


FORTUNA RD.
SUBJECT TRACT
EXISTING STORM SEWER INLET
EXISTING UNDERDRAIN
COORS BLVD.
COORS ROAD
ESTANCIA RD.
DAYTONA ROAD
DRIVE
STREET
STREET
ESTANCIA
BERGQUIST
58TH
61ST
60TH
5095
5100
OFF-SITE FLOWS:
BUTTRUM PLAZA
1" = 200'

ENGINEER'S REPORT ON
STORM DRAINAGE
FOR BUTTRUM PLAZA

INTRODUCTION: Buttrum Plaza is a 3.45 acre site which lies at the southeast corner of Coors Boulevard and Fortuna Road, N.W. The site in Phase I is being developed as a convenience center with related parking. Phase II will consist of an office complex and restaurant.

PURPOSE: The purpose of this report is to provide information regarding storm water runoff for Buttrum Plaza and make recommendations regarding its treatment.

HYDROLOGY: The ponding requirements are arrived at with the formula: ponding requirement = (area) (rainfall) (runoff coefficient). The runoff coefficient used is 0.95 for buildings and paved surfaces and 0.30 for undeveloped areas. Rainfall for the 100-year design storm is 2.2".

SITE DEVELOPMENT: Buttrum Plaza shall be developed as follows:

I. Future Restaurant Site: To be left undeveloped and allowed to drain as it has historically to Fortuna Road. (12,486 S.F.)

II. Office Site: To be left undeveloped. The pond for drainage area 2 is located within this site. (27,333 S.F.) ? WHERE

III. Drainage Area 1:

Area:	34,732 S.F. (Retail/Parking)
Runoff Coefficient:	0.95
Rainfall:	2.2"

Ponding Requirement: (34,732) (2.2"/12") (0.95) = 5,939 C.F.

Ponding Provided:

Top of Pond:	3,174 S.F.
Bottom on Pond:	1,647 S.F.
Average:	2,410 S.F.
Depth:	2.5 Feet
Capacity:	6,026 C.F.

NOTE: Outfall is provided by a 6" pipe to the existing double 'C' inlet in Coors with the $Q=Q_5$.

IV. Drainage Area 2:

Area:	27,333 S.F. (undeveloped)*
	C=0.30
Area:	72,557 S.F. (Retail/Parking)
	C=0.95

*includes pond.

Weighted Runoff Coefficient:

$$\frac{(27{,}333\ \text{S.F.})\ (0.30)+(72{,}557\ \text{S.F.})(0.95)}{99{,}890\ \text{S.F.}}=0.70$$

Ponding Requirement:

(99,890) (0.70) (2.2"/12") = 12,586 C.F.

Ponding Provided:

Top of Pond:	9,900 S.F.
Bottom of Pond:	8,181 S.F.
Average:	9,040 S.F.
Depth:	1.5 Feet
Capacity:	13,560 C.F.

NOTE: Outfall is provided with an 8" pipe to Fortuna Road with $Q=Q_5$.

RECOMMENDATIONS: It is recommended that the developer construct the drainage facilities as shown on the enclosed grading/drainage plan; and that the City of Albuquerque approve this report as it adequately deals with storm runoff for the subject property and meets all existing City ordinances related to drainage.

1651.40

ENGINEER'S REPORT
ON
STORM DRAINAGE

BUTTRUM PLAZA

ALBUQUERQUE, NEW MEXICO

MAY, 1981

GORDON HERKENHOFF & ASSOCIATES, INC.
302 Eighth Street, N.W.
Albuquerque, New Mexico 87102
ENGINEERS ARCHITECTS PLANNERS

1651.40

ENGINEER'S REPORT
ON
STORM DRAINAGE

BUTTRUM PLAZA

ALBUQUERQUE, NEW MEXICO

MAY, 1981

GORDON HERKENHOFF & ASSOCIATES, INC.
302 Eighth Street, N.W.
Albuquerque, New Mexico 87102
ENGINEERS ARCHITECTS PLANNERS

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Figure 1 - Hyetograph for 100 Yr. Storm at the Buttrum Plaza Site

Figure 2 - Rational Method Curve

Figure 3 - Qp_{100} Developed vs. Qp_{100} undeveloped

Grading Plan - Buttrum Plaza

Appendix A - Calculations

ENGINEER'S REPORT
ON STORM DRAINAGE
BUTTRUM PLAZA

A. PURPOSE:

The purpose of this report is to present the analyses of and recommendations for handling storm water runoff for the Buttrum Plaza site.

B. GENERAL:

Buttrum Plaza is a proposed 3.45 acre commercial development in Albuquerque, New Mexico. The Plaza site is bounded westerly by Coors Boulevard, northerly by Fortuna Road, easterly by Estancia Drive and on the south by undeveloped lands of others. The three adjacent roadways are paved and provided with standard curbs and gutters. Coors Boulevard flow drains to a double C drop inlet in a dip at the southwesterly part of the Plaza site. Outflow from the southwesterly of two onsite ponds is to be released into that drop inlet. Fortuna Road has a water block at Coors Boulevard and otherwise drains to the east at about 0.003 gradient. Estancia Drive drains north to Fortuna Road at about 0.006 gradient. Outflow from the northeasterly of the two ponds is to be released near the intersection of Fortuna Road and Estancia Drive, from which location it will pass easterly.

In the undeveloped state, the majority of onsite storm flow would be delivered to Fortuna Road and to the southwest corner of the site. (See the existing contours of the accompanying Drainage Plan.)

It is proposed in this report that detention ponds be provided at both the southwest and northeast corners of the site. When fully developed, storm flows from 75% of the site will be directed to those ponds and flows from the remaining 25% are to be released to the three roadways.

C. SITE DEVELOPMENT:

Buttrum Plaza is to be developed in two or more phases. Approval of the Drainage Plan for the entire site is requested at this time.

Phase I construction will consist of developing 2.70 acres of the site for parking areas, buildings, alleys and two detention ponds. The Phase I lands are designated as Drainage Areas, 1, 2 and 3 on the Drainage Plan. Flow from the 2.59 acres of Areas 1 (1.53 acres) and 2 (1.06 acres) will be conveyed to ponding. The 0.11 acres of Area 3 flow will be released easterly to Estancia Drive. As part of the Phase I work, the 0.45 acres of Area 4 lands will be rough graded to deliver flow to the northeast pond and that pond will be sized on that basis. As a result of development, Drainage Area 4 flows will be redirected easterly to Estancia Drive and both the pond volume and release rate as calculated in this report will then be in effect oversized relative to the drainage area served. The lands of Drainage Area No. 5 will be left in the natural state until such time as they are developed.

Phase II work will be to develop the 0.45 acres of Drainage Area 4 lands and redirect flows to Estancia Drive and to develop the 0.31 acres of Drainage Area 5 lands to deliver flow to Coors Boulevard and to Fortuna Road. Construction in the two areas will not necessarily be concurrent.

D. HYDROLOGY:

Two rational method hydrologies were used in the analyses of this report.

In both hydrologies, the rational "C" used for undeveloped lands was 0.40 and for developed lands was 0.95. (Inadvertently, however, a "C" of 0.30 was used for 0.45 acres of Drainage Area 4 (undeveloped) flows to the Northeast Pond, for which a waiver is requested).

1. The Hydrology Used to Size Storm Carriers

The first hydrology was that of the conventional rational formula using Yarnell's $I_{100}=189/_{t+25}$ curve. This approach was used to size alley swales and the Drainage Area No. 2 channel along the southerly line of Fortuna Road. Outflow rates (only) for the broad parking lot swales were also estimated by this method as a matter of information. (The parking lot swales are capable of handling flows by reason of size). Times of concentration were estimated as follows:

In all cases, the velocity of the upper 100 foot length of a waterway was assumed to be the average of zero fps and the gradient-related overland flow velocity for "paved area (sheet flow) and shallow gutter flow" of Fig. 3-1 of S.C.S. Technical Release No. 55. For subsequent reaches, alley swale and channel times of concentration were estimated by routing flow with Manning's formula. The less definable times of concentration for the broad variable section parking lot swales were read directly from Fig. 3-1.

2. Hydrology Used for Pond Routing and Related Analyses

The second hydrology was derived from the 100 year storm hyetograph presented in the City's "Design Procedure, Routing of Runoff through a Ponding Area" paper. The ordinates of that hyetograph, and of all other examples of Design Procedure precipitation have been multiplied by a 0.917 factor in the remainder of this report. This factor represents the ratio of the 2.2" six hour duration, 100 year return frequency rainfall at this location to that of the corresponding 2.4" amount in the example of the Design Procedure.

The resulting hyetograph for the Buttrum Plaza site is shown on Figure 1. This graph was used to estimate inflow volumes and rates to the detention ponds. Figure 2 shows both the accumulation over time of the Figure 1 hyetograph precipitation and the Rational Formula type curve derived from that hyetograph. The Rational curve was required in order to estimate direct flow releases to streets on the same time scale as the delayed releases from the ponds.

The 2.6 (cfs per acre, 100% runoff) value on the second page of the Design Procedure was multiplied by 0.917 to develop a value of 2.38 CFS. This 10 minute, 5 year return frequency intensity, multiplied by 0.40 and by the contributing acreage was used to estimate permissible peak outflow rates from ponds.

E. HYDRAULICS:

The detailed hydraulic investigations were for two alley swales, the Drainage Area 2 Channel, for pipe outflow characteristics at ponds and reservoir routing through these ponds. Conclusions are:

Alley Swales:

The inverted crowns of the two alley swales are depressed to the extent that the swales will convey over two times the computed 100 year flow rates at less than 18' width flow. (See result of calculations on Drainage Plan).

Drainage Area 2 Channel:

This channel will accept and convey the Drainage Area No. 2 flows to the Northeast Pond. (See calculations, Drainage Area 2.)

Pipe Outflow Characteristics:

The estimated entrance and outlet control capacities of the pipes for the Southwest and Northeast Ponds have been developed. Entrance control generally governs. (See Reservoir Routing calculations, Drainage Areas 1 and 2).

Flow Routing through Ponds:

The conventional reservoir routing technique was used with the consequence that city criteria as to Q_5 releases are substantially satisfied. (See Reservoir Routing calculations, Drainage Areas 1 and 2). The paved entrances north of the Southwest Pond and the Northeast Pone are to serve as overflow sections.

F. CONFORMANCE WITH OFFSITE RELEASE RESTRICTIONS

1. First Criteria

The positive discharge from the ponds is to be limited to the Q_5 for undeveloped lands.

Following the example on the second page of the Design Procedure and with reference to the pond routing of the attached calculations, the comparisons of permissible and computed release rates are:

<u>Southwest Pond</u>		
Allowable:	2.38 CFS x 1.53 Ac. x 0.40	1.46 CFS
Computed by routing flow thru Pond:		1.36 CFS
<u>Northeast Pond</u>		
Allowable:	2.38 CFS x 1.51 Ac. x .040	1.44 CFS
Computed by routing flows		1.55 CFS

On this basis, the Drainage Plan is in substantial compliance with this first criteria. Overall, Q_5 undeveloped = 2.90 CFS & Q_5 from ponds = 2.91 CFS.

2. <u>Second Criteria</u>:
   Qp_{100} developed is not to exceed Qp_{100} undeveloped.

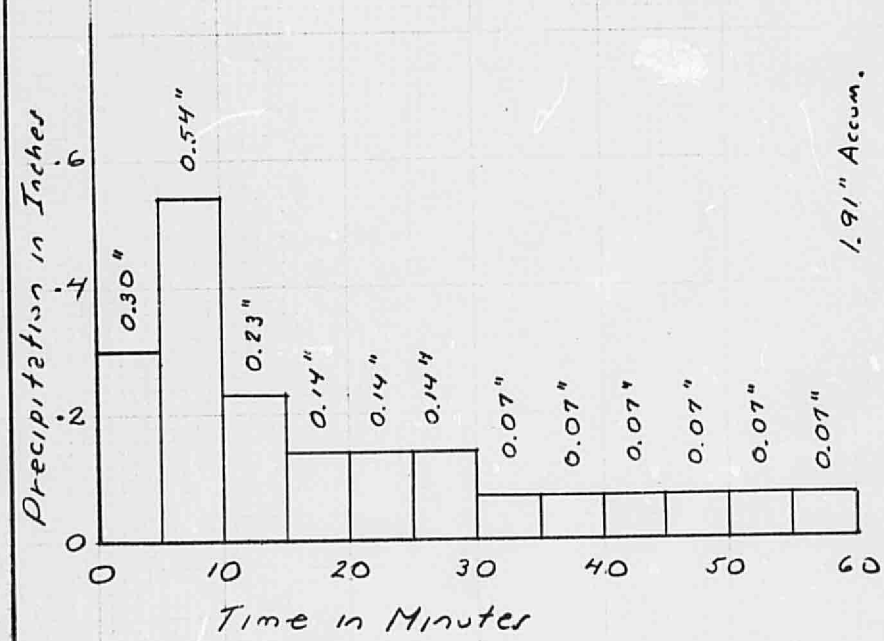
See Figure 3 on which the hydrograph of historic flow rates is compared to a composite hydrograph of developed flows which are to be released offsite. The historic flows are based on C = 0.40 for 3.45 acres applied to the derived rational method curve of Figure 2. The composite hydrograph was developed by adding the ordinates of the outflow hydrographs for the Southwest and Northeast Ponds to the ordinates of one hydrograph representing the total direct offsite flow for Drainage Areas 3, 4 and 5. The direct offsite flow hydrograph was based on C = 0.95 for 0.86 acres applied to the Rational Method curve of Figure 2.

The peak rate of flow offsite after development is 5.35 cfs which is less than the 6.95 cfs peak rate before development and this second criteria is therefore met.

G. RECOMMENDATIONS:

It is recommended that the developer construct the drainage facilities as shown on the enclosed grading/drainage plan; and that the City of Albuquerque approve this report as it adequately deals with storm runoff for the subject property and meets all existing City ordinances related to drainage.

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE

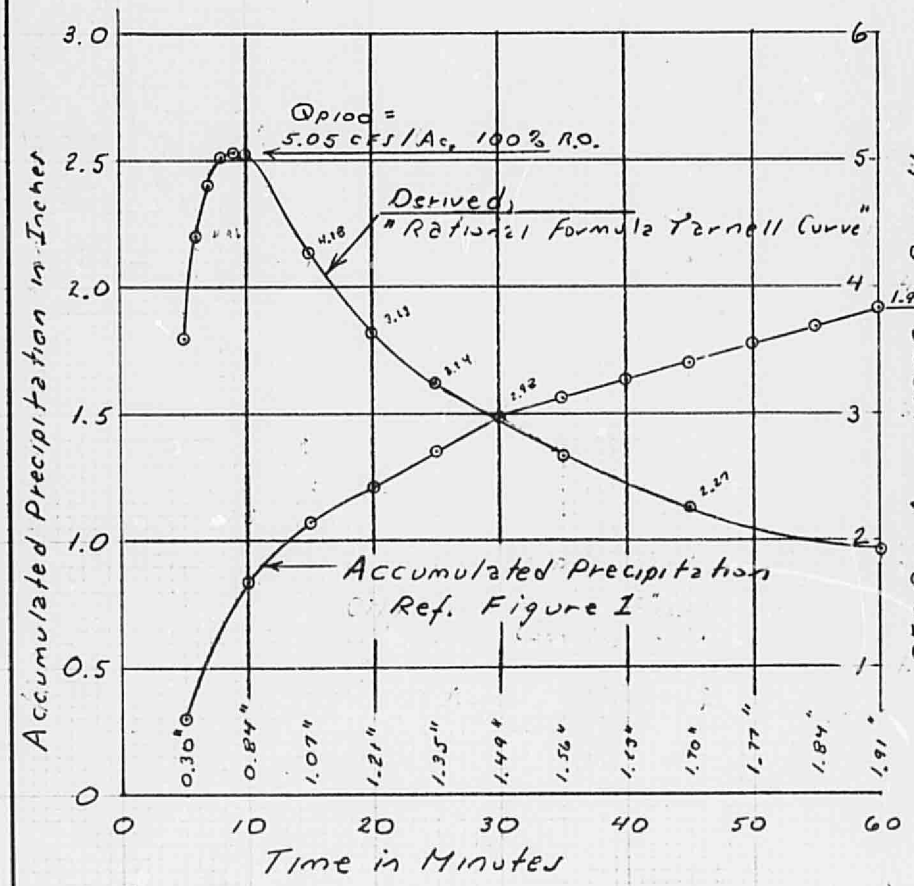


HYETOGRAPH FOR 100 YEAR STORM

BUTTRUM PLAZA SITE

Figure 1

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-8294 ENGINEERING COMPUTATIONS	NAME OF PROJECT Buffum Plaza Drain Plan			SHEET NUMBER OF
	COMPUTED BY RR	CHECKED BY	JOB NUMBER	DATE

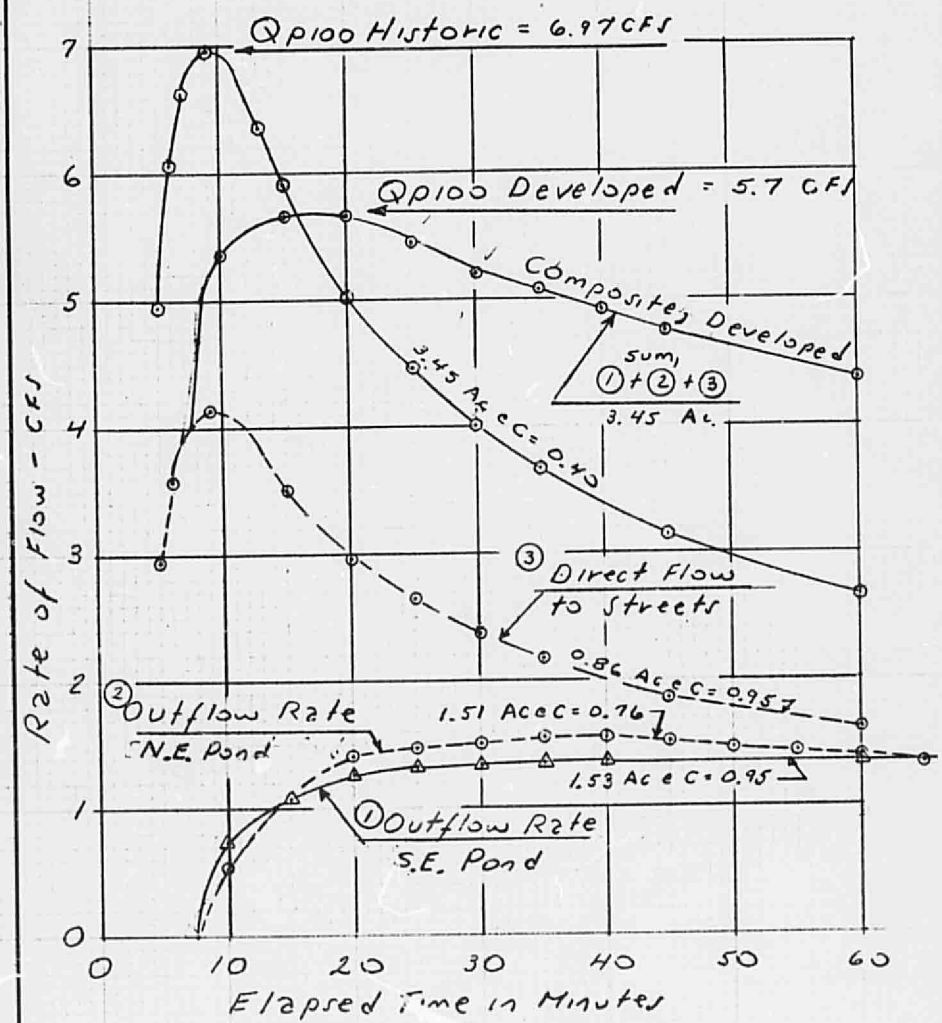


DERIVATION - RATIONAL METHOD CURVE

Figure 2

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE

Note: Curve ③ & "Historic" are based on Yarnell type curve of Figure 2. Curves 1 & 2 are Pond Outflows.



Qp100 Developed V.S. Qp100 Undeveloped

Figure 3

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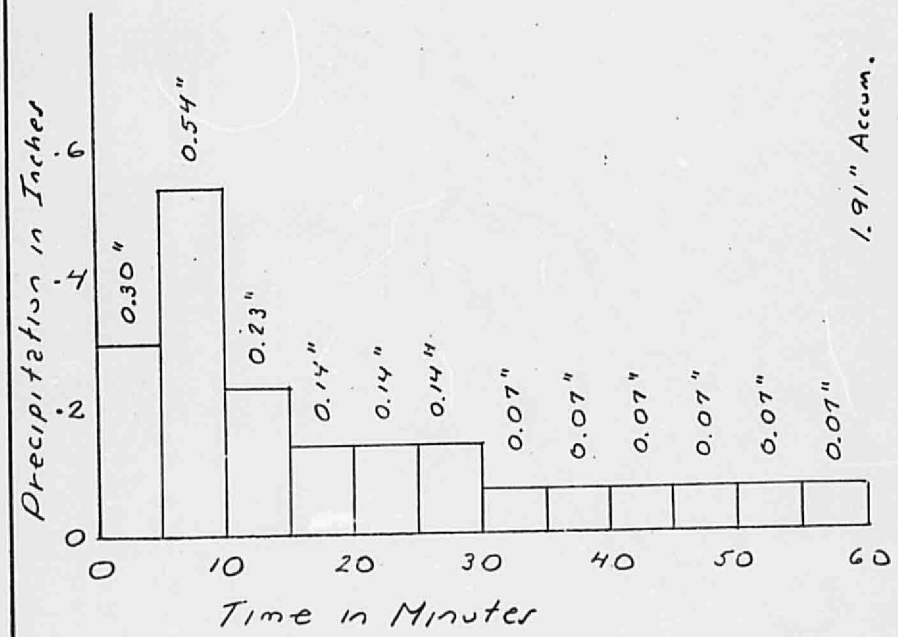
	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE

APPENDIX A

CALCULATIONS

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE



HYETOGRAPH FOR 100 YEAR STORM

BUTTRUM PLAZA SITE

Figure 1

1A

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE

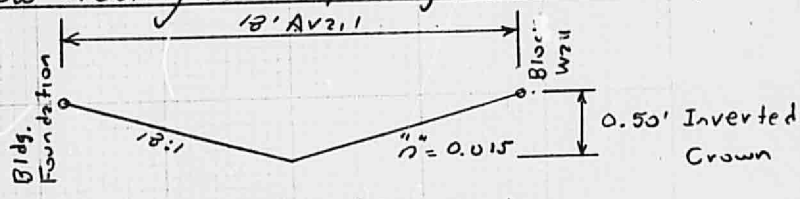
Drainage Area No 1:

Flow Routing in Alley along South Boundary

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER 1 OF
	COMPUTED BY A	CHECKED BY	JOB NUMBER 1651.40	DATE 5/12/81

Drainage Area No 1

Flow Routing in Alley Along South Boundary



Typical Alley Section

(Computer Derived):

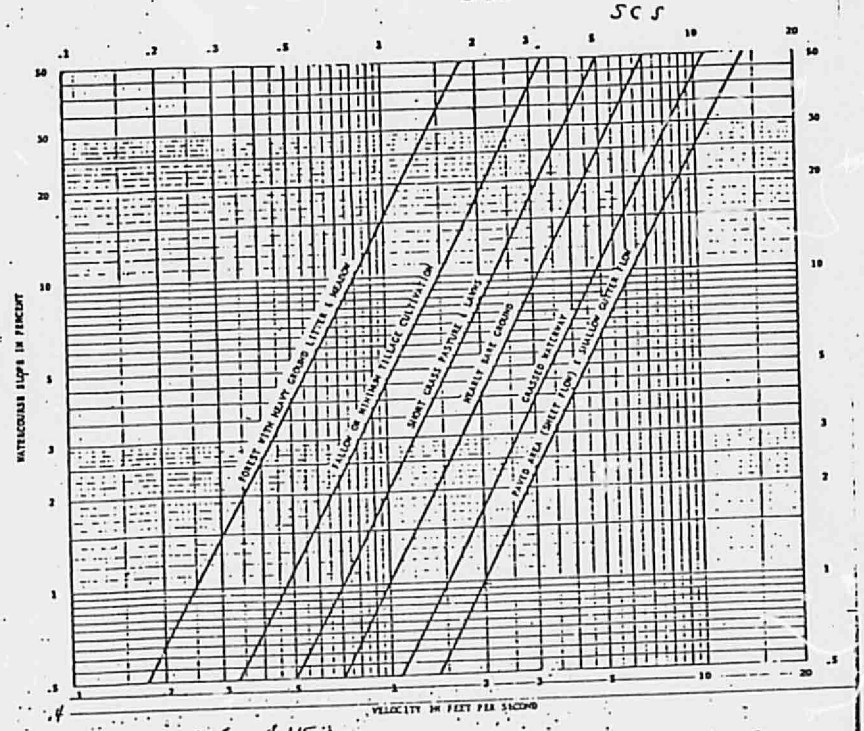
Location		@ 100' West	@ 200' West	@ 300' West	@ 360' West	@ 400' W. (into Pond)
		← S = 0.004 →				← S = 0.01 →
Accum Area	Ac.	0.17	0.33	0.50	0.61	0.67
Rational C	---	0.95	0.95	0.95	0.95	0.95
Velocity:						
Into Reach	fps	0	1.38	1.56	1.76	2.54
Out Reach	fps	OLF 1.4	1.56	1.76	1.84	3.16
Avg.	fps	0.7	1.47	1.66	1.80	2.85
Length Reach	Ft.	100	100	100	60	40
Increm TC	Min.	2.4	1.1	1.0	0.6	0.2
TC	Min.	2.4	3.5	4.5	5.1	5.3
I 189/t+25	---	6.90	6.63	6.41	6.28	6.24
Q_{100}	CFS	1.1	2.1	3.0	3.6	4.0
Depth Flow Out	Ft.	0.20	0.26	0.29	0.31	0.36
Width Flow Out	Ft.	7.20	9.36	10.44	11.16	7.2

Freeboard:
Depress ℄ of Alley 0.50'; @ 18' width flow,
C2p = 10 CFS ±, (2.5 x 4.0 CFS for Q_{100})

4

then computed by dividing the total overland flow length by the average velocity.

Source: TR 55 SCS



Also in Sec 4 NE?

Figure 3-1.--Average velocities for estimating travel time for overland flow.

Storm sewer or road gutter flow

Travel time through the storm sewer or road gutter system to the main open channel is the sum of travel times in each individual component of the system between the uppermost inlet and the outlet. In most cases average velocities can be used without a significant loss of accuracy. During major storm events, the sewer system may be fully taxed and additional overland flow may occur, generally at a significantly lower velocity than the flow in the storm sewers. By using average conduit sizes and an average slope (excluding any vertical drops in the system), the average velocity can be estimated using Manning's formula.

Since the hydraulic radius of a pipe flowing half full is the same as when flowing full, the respective velocities are equal. Travel time may

NOTE Average Values @ 0 for 1st 100 L.F.$^{\pm}$ All swales — Then use tabulated values for P.Lot TC's — (Alley swales were routed using computed velocities) 4

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY Ph	CHECKED BY	JOB NUMBER 1651.40	DATE 5/12/81

Drainage Area No 1

Flow Routing in Parking Lot Swale

Calculations:

TC: 1st 55' @ $\frac{0 \text{ fps} + 1.5 \text{ fps}^{*}}{2}$ = Incr TC = 1.2 min

Next 210' @ 1.5 fps TC = 1.2 + 2.4 = 3.6 min

Last 45' @ 1.9 fps** TC = 3.6 + 0.4 = 4.0 min.

Drainage Area to pond = 0.75 Ac

Q_{100} to Pond = $0.95 \times \frac{189}{25+4} \times 0.75$

= 4.6 CFS into Pond

@ S = 0.009 = 1.9 fps **

@ S = 0.006 = 1.5 fps *

Parking Area (Sheet Flow) or Shallow Gutter Flow

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	COMPUTED BY	CHECKED BY	JOB NUMBER 1651.40	DATE 5/11/81

DRAINAGE AREA NO. 1:

Reservoir Routing
Southwest Pond

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT Buffrum Plaza Drainage			SHEET NUMBER 1 OF
	COMPUTED BY RR	CHECKED BY	JOB NUMBER 1651.40	DATE 5/11/81

Southwest Pond

Reservoir Routing

A. CONTRIBUTING AREA:

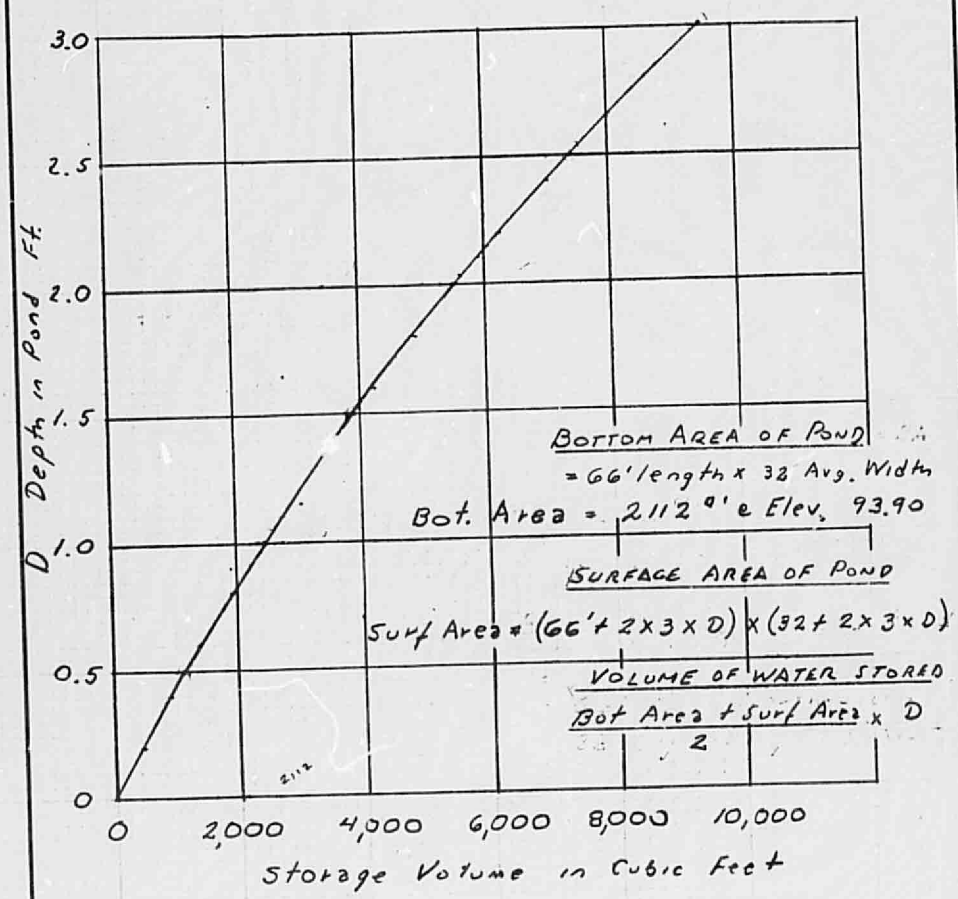
Drainage Areas: 1-A 0.67 Ac Alley Swale
1-B 0.75 Ac P. Lot
1-C 0.11 Ac Pond Locale
1.53 Ac, Use C = 0.95

B. PRECIP HYETOGRAPH, INFLOW HYDROGRAPH VOLUMES AND RATES:

End of Period Time MIN.	Precip Amt.*	Multiplier	Vol. Into Pond CF	Division	Inflow Rate CFS
5	0.30"	× 1/12 × 0.95 × 1.53 × 43,560 = 5276	1586	÷ 300 seconds	5.29
10	0.54		2855		9.52
15	0.23		1216		4.05
20	0.14		740		2.47
25	0.14		740		2.47
30	0.14		740		2.47
35	0.07		370		1.30
40	0.07		370		1.30
45	0.07		370		1.30
50	0.07		370		1.30
55	0.07		370		1.30
60	0.07		370		1.30
65			370		1.30
	1.91" ok				

2.2"/2.4" = 0.917 multiplier for Design Procedure Hyetograph Precip

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER 2 OF
	COMPUTED BY RR	CHECKED BY	JOB NUMBER 1651.40	DATE 5/11/81



BOTTOM AREA OF POND
= 66' length x 32 Avg. Width
Bot. Area = 2112 @ Elev. 93.90

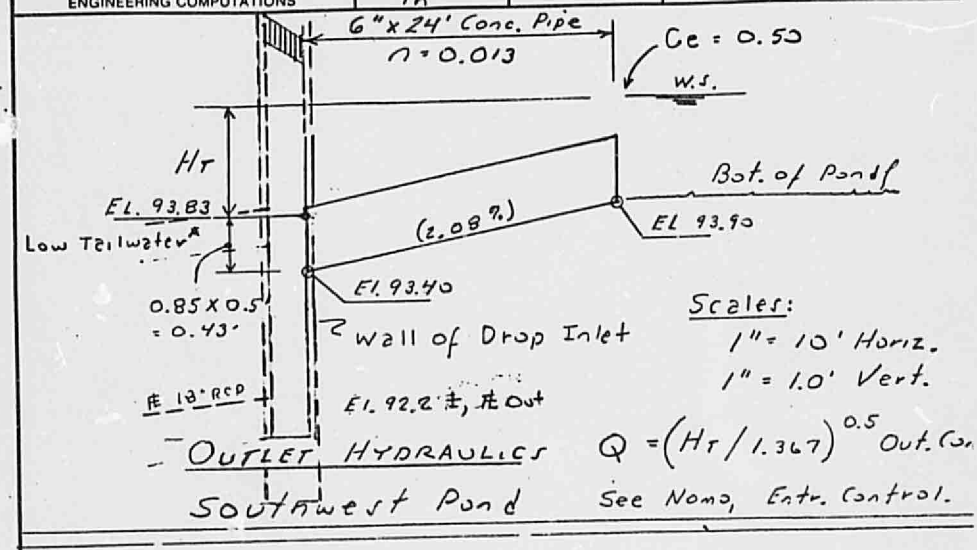
SURFACE AREA OF POND
Surf Area = (66' + 2 x 3 x D) x (32 + 2 x 3 x D)

VOLUME OF WATER STORED
$\frac{\text{Bot Area + Surf Area}}{2} \times D$

Storage-Depth Curve
Southwest Pond

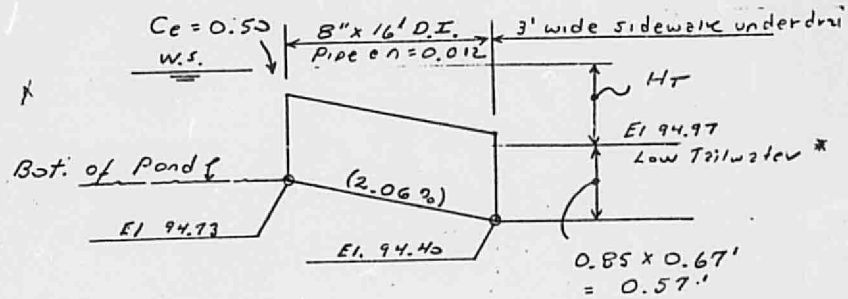
GORDON HERKENHOFF & ASSOCIATES, INC.
302 Eighth Street, N.W.
Albuquerque, New Mexico 87102
(505) 247-0294
ENGINEERING COMPUTATIONS

NAME OF PROJECT			SHEET NUMBER
Buffrum Plaza Drain. Plan			3 OF
COMPUTED BY	CHECKED BY	JOB NUMBER	DATE
JR			



OUTLET HYDRAULICS $Q = (H_T / 1.367)^{0.5}$ Out. Con.

Southwest Pond See Nomo, Entr. Control.

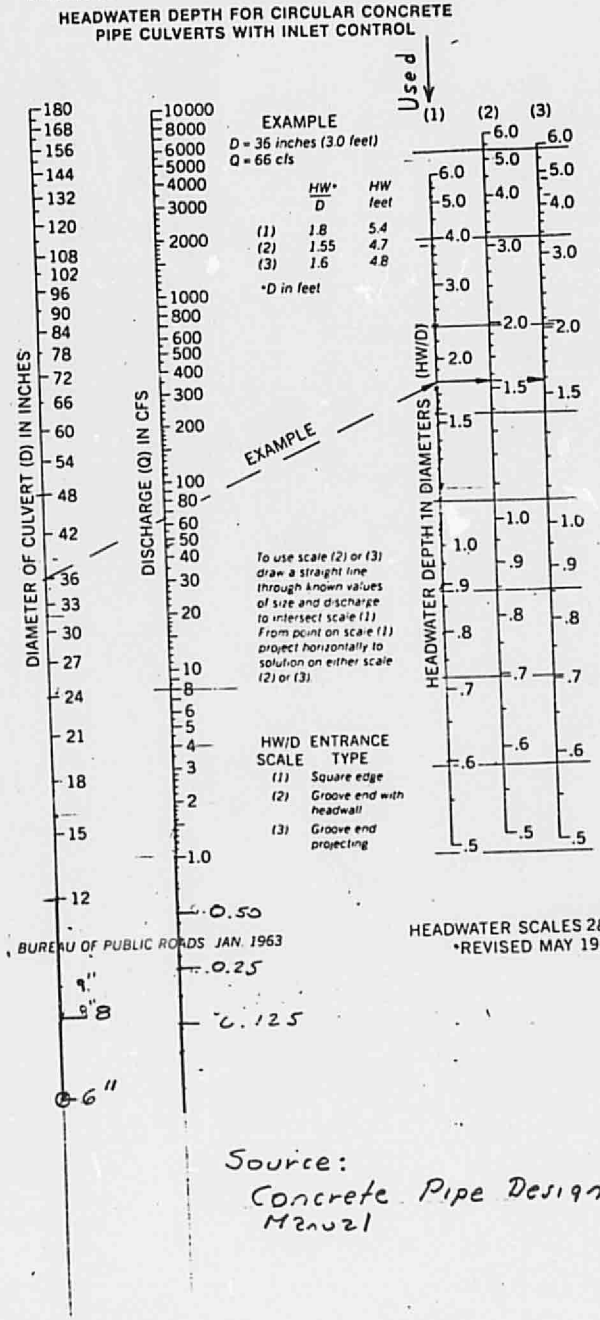


OUTLET HYDRAULICS $Q = (H_T / 0.284)^{0.5}$ Out. Con.

Northeast Pond See Nomo, Entr Control

FIGURE 29

HEADWATER DEPTH FOR CIRCULAR CONCRETE PIPE CULVERTS WITH INLET CONTROL



Source:
Concrete Pipe Design Manual

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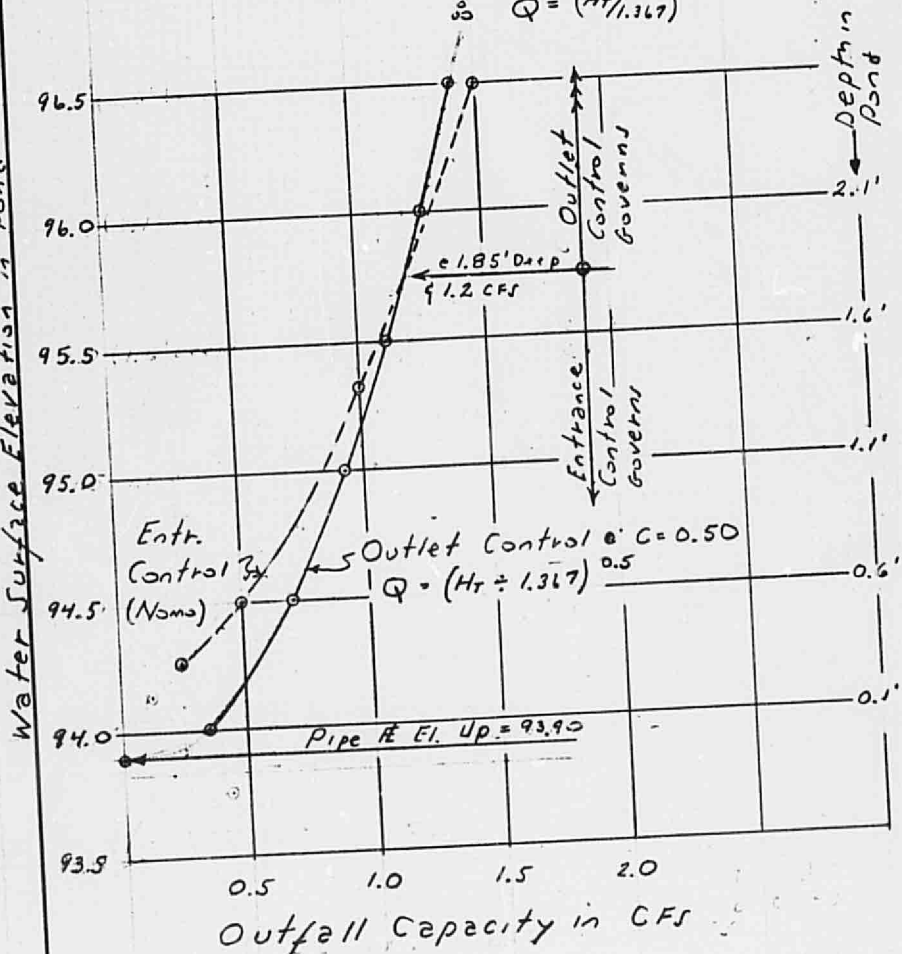
Outlet Control:

$$H_T = \left[\frac{2.5204\,(1+0.5)}{0.5^4} + \frac{466.18 \times 0.013^2 \times 24'}{0.5^{1.333}}\right]\frac{Q^2}{100}$$

$$\therefore\ Q = (H_T/1.367)^{0.5}$$



Outlet Hydraulics
Southwest Pond
6" x 24' RCP @ S = 0.0208

n = 0.013

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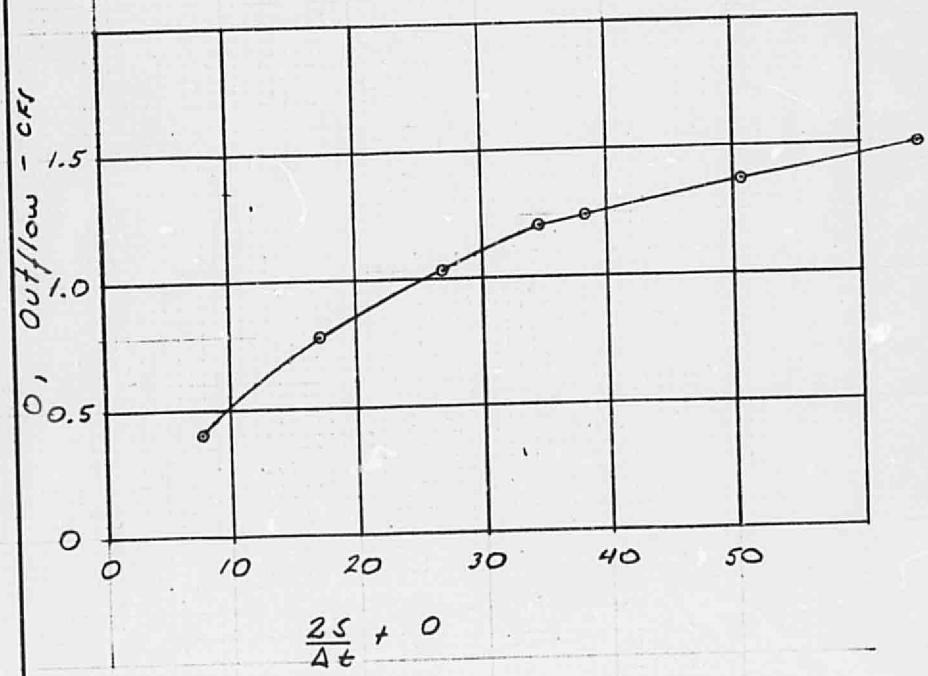
Derivation, this graph:

"O" for a given depth was read from Page 8, plot

"S" for the same depth was read from Page 2

$\frac{2 \times S}{300 \text{ seconds}}$ + "O" above = $\frac{2S}{\Delta t} + O$, plot



Routing Curve
Southwest Pond

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Southwest Pond

Reservoir Routing

Δt = 300 seconds

CON

CONCLUSION: The computed Q_{p100} is 1.36 cfs & occurs at 40 to 65 minutes at which time the water surface elev. = 96.35

Time	I_1	I_1+I_2	$2S/\Delta t + O$	O	$2S/\Delta t - O$	Pond Depth	W.S. Elev.
0	---	---	---	---			
5	---	---	10.57*	0	10.57	0.60	94.50
10	5.29	5.29	15.86	0.72	14.42	0.90	94.80
15	9.52	14.81	29.23	1.09	27.05	1.61	95.51
20	4.05	13.57	40.62	1.27	38.08	2.13	96.03
25	2.47	6.52	44.60	1.31	41.98	2.25	96.15
30	2.47	4.94	46.92	1.33	44.26	2.33	96.23
35	2.47	4.94	49.20	1.35	46.50	2.42	96.32
40	1.30	3.77	50.27	1.36	47.55	2.45	96.35
45	1.30	2.60	50.15	1.36	47.43	"	"
50	1.30	2.60	50.03	1.36	47.31	"	"
55	1.30	2.60	49.91	1.36	47.19	"	"
60	1.30	2.60	49.79	1.36	47.07	"	"
65	1.30	2.60	49.67	1.36	46.95	"	"
70	0	1.30	48.25	1.35	45.55	2.40	96.30
75	"	0	45.55	1.32	42.91	2.30	96.20
80	"	0	42.91	1.29	40.33	2.20	96.10
85	"	"	40.33	1.26	37.81	2.10	96.00
90	"	"	37.81	1.23	35.35	1.97	95.87

MAX. Q OUT

MAX. DEPTH

end of calculations

* $\frac{0.30}{12}$" x 1.53 Ac x 43,560 x 0.95 = 1586 cf,

x $2/\Delta t$, = 1586 x 2/300 = 10.57 entry for initial cond.

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Southwest Pond

A Simplified Test of Page 7 Routing

Time	① Incr. Volume In CF	② Accum Volume CF	③ Depth Pond Ft	④ Q out Pond CFS	⑤ Vol Out Pond CF	⑥ Net Rem Vol in Pond CF	
0							
5	0	1586	0.66	0.55	(165)	1421	
10	2855	4276	1.63	1.10	(330)	3946	
15	1216	5162	1.88	1.20	(360)	4802	
20	740	5542	2.00	1.24	(372)	5170	
25	740	5910	2.11	1.27	(381)	5529	
30	740	6269	2.21	1.30	(390)	5879	Qp = 1.30 CFS *
35	370	6249	2.20	1.29	(387)	5862	
40	370	6232	2.20	1.29	(387)	5845	

① Is from Page 1
② Is ① + Previous ⑥
③ Based on Vol in ②, Read from
④ Based on Depth ③,
⑤ 300 × ④
⑥ ② - ⑤

* V.S. 1.36 CFS, Reservoir Routing

End

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER OF
	COMPUTED BY Ph	CHECKED BY	JOB NUMBER 1651.40	DATE 5/13/81

Drainage Area No 2

Qp100 in the Drainage Area 2 Channel
(Via Parking Lot Swale & Channel)

Calculations:

TC 1st 70'@ $\frac{0 fps + 2.8 fps}{2}$ = Initial TC = 0.8 min
Next 140'@ 2.0 fps (Swale) Incr TC = 1.1 min
Next 85'@ 3.0 fps (Ch) Incr TC = 0.5 min
TC into Pond = 2.4 min

Drainage Area = 0.64 Ac.

C = 0.95

$$Qp100 = 0.95 \times \frac{139}{25+2.4} \times 0.64 = 4.2 \text{ CFS}$$

CONCLUSION: Size Channel for 4.2 CFS

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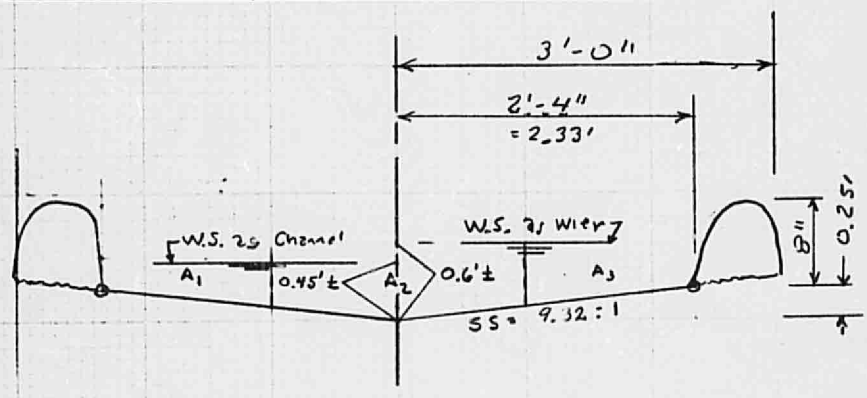
	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE

Drainage Area No. 2

The Drainage Area No 2 Channel

GORDON HERKENHOFF & ASSOCIATES, INC. 302 Eighth Street, N.W. Albuquerque, New Mexico 87102 (505) 247-0294 ENGINEERING COMPUTATIONS	NAME OF PROJECT			SHEET NUMBER 1 OF
	COMPUTED BY R	CHECKED BY	JOB NUMBER 1651.40	DATE 5/13/81

The Drainage Area No 2 Channel



1. Entrance Conditions:

Broad Crested Wier e C = 2.70, no end contractions, ignore approach velocity.

Analyse as a three section wier.

A_1 & A_3 e 1.33' width & A_2 e 2.0' width.

By trial & error:

A_2: Assume 0.60' deep e ℄ Channel

Then $A_2 = 2 \times \frac{0.60 + 0.49}{2} = 1.09^{\square'}$

$ED_2 = 1.09^{\square'}/2 = 0.54'$ Avg Depth

$Q_{2p_2} = 2.7 \times 2 \times 0.54^{1.5} = 2.14$ CFS

And A_1 or $A_3 = \frac{0.49 + 0.35}{2} \times 1.33 = 0.56^{\square'}$

$ED_{1 \text{ or } 3} = 0.56'/1.33 = 0.42'$ Avg Depth

$Q_{2p_{1+3}} = 2 \times 1.33 \times 2.7 \times 0.42^{1.5}$ 1.95 CFS

Sum = 4.09 CFS

Close enough OK ≈ 4.2 CFS flow

17

The Drainage Area 2 Channel

A. (Cont'd)

Q100 will enter the channel e about 0.35' depth against a 0.67' (8") high curb. (OK)

($V = \frac{4.09}{2.21^{ft^2}} = 1.85$ fps, Froude No. = 0.47, Subcritical)

B. Channel Flow Characteristics:

① Asphalt Section A-A

"n" = 0.015

S = 0.004

Bott Width = 4.66'

Side Slopes = 9.32:1

By trial & error:

Try D = 0.45' e ℄

Then $A = 2 \times 2.33 \times (0.45 + 0.20) = 1.51^{ft^2}$

$WP = 4.66 + 0.20 + 0.20 = 5.06'$

$R = 0.298$, $R^{2/3} = 0.447$

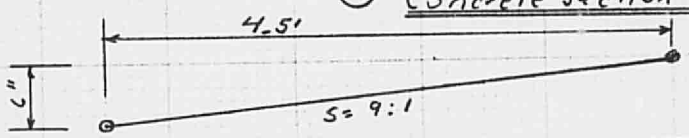
$V = \frac{1.486}{0.015} \times 0.004^{0.5} \times 0.447 = 2.80$ fps

$Cap = 2.80 \text{ fps} \times 1.51^{ft^2} = 4.23$ cfs, vs 4.2 cfs (OK)

Froude No. $= V/\sqrt{gD}$

$= 2.80 / \left(32.2 \times \frac{1.51}{4.66}\right)^{0.5} = 0.87$ Subcritical

② Concrete Section B-B



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	COMPUTED BY	CHECKED BY	JOB NUMBER	DATE
	RH		1651.40	5/13/81

The Drainage Area No 2 Channel

B. Channel Flow Characteristics

(2) Lower Reach - Conc Part. (Cont'd)

$n = 0.014$

$S = 0.01$

Bo H = 0' width

S.S. = 9:1

$Q_{p100} = 4.2$ CFS

By trial & error, Depth of Flow = 0.37'

@ D = 0.37', Area = (0.37 X 9 + 0) 0.37 = 1.23 □'

WP = 2 X 0.37 X 9 = 6.66'

$R^{2/3} = 0.324$

$V = \frac{1.486}{0.014} \times 0.01^{0.5} \times 0.324 = 3.43$ fps

Cap = 3.43 fps X 1.23 □' = 4.22 CFS, > 4.2 CFS OK

Total head = $0.37' + \frac{3.43^2}{64.4} = 0.56'$ Supercritical ±7

Froude No. = $V/\sqrt{gD} = 3.43/(32.2 \times 0.37')^{0.5} = 0.99$

SUMMARY:	Wier	A-A Asphalt	B-B Concrete
@ Depth	0.60'+	0.45'	0.37'
Velocity	1.85 fps+	2.80 fps	3.43 fps
Total Head	0.65'+	0.57'	0.55'
Froude No.	0.47	0.87	0.99

CONCLUSION:
Decreasing depth, increasing velocity (OK)

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302 Eighth Street, N.W.
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(505) 247-0294
ENGINEERING COMPUTATIONS

NAME OF PROJECT			SHEET NUMBER OF
COMPUTED BY	CHECKED BY	JOB NUMBER	DATE

DRAINAGE AREA No. 2

Reservoir Routing
Northeast Pond

GORDON HERKENHOFF & ASSOCIATES, INC.
302 Eighth Street, N.W.
Albuquerque, New Mexico 87102
(505) 247-0294
ENGINEERING COMPUTATIONS

NAME OF PROJECT			SHEET NUMBER 1 OF
COMPUTED BY AK	CHECKED BY RA	JOB NUMBER 163140	DATE

N.E. POND — SIZE 150' x 90'

SERVING AREA:

@ C = 0.95 : 1.16 − 50x90/43,560 = 1.06 AC ULT COND
@ C = 0.30 : 0.34 + 50x90/43,560 = 0.44 AC
@ C = 0.40 : = 0.01 AC
1.51 AC INITIAL COND

comp "C"

1.06/1.51 X 0.95 = 0.67
0.44/1.51 X 0.30 = 0.09
0.01/1.51 X 0.40 = 0
0.76 comp C

TOTAL AREA: 65,776 S.F.
Dev. Area: 46,174 S.F. ?
UDev Area: 19,602 S.F.

TOTAL DRAINAGE & PONDING Req.:
65,776 X 2.2/12 X 0.76 = 9165

PROVIDED PONDING — NORTHEAST CORNER

TOP OF POND AREA: 4,500 S.F.
BOTTOM OF POND Area: 3,444 S.F. (42' x 82' @ EL. 94.73)
AVERAGE AREA: 3,972 S.F.
DEPTH: 1.17 FT.
STORAGE CAPACITY: 4,647 CF

TIME (MIN.)	PREC	TOTAL INFLOW (CF)	INFLOW RATE
5	0.30	—	—
10	0.54	1,250	4.17
15	0.23	2,250	7.50
20	0.14	958	3.19
25	0.14	583	1.94
30	0.14	583	1.94
35	0.08	583	1.94
40	0.08	333	1.11
45	0.08	333	1.11
50	0.08	333	1.11
55	0.08	333	1.11
60	0.08	333	1.11
65	~~0.08~~ 0	333	1.11

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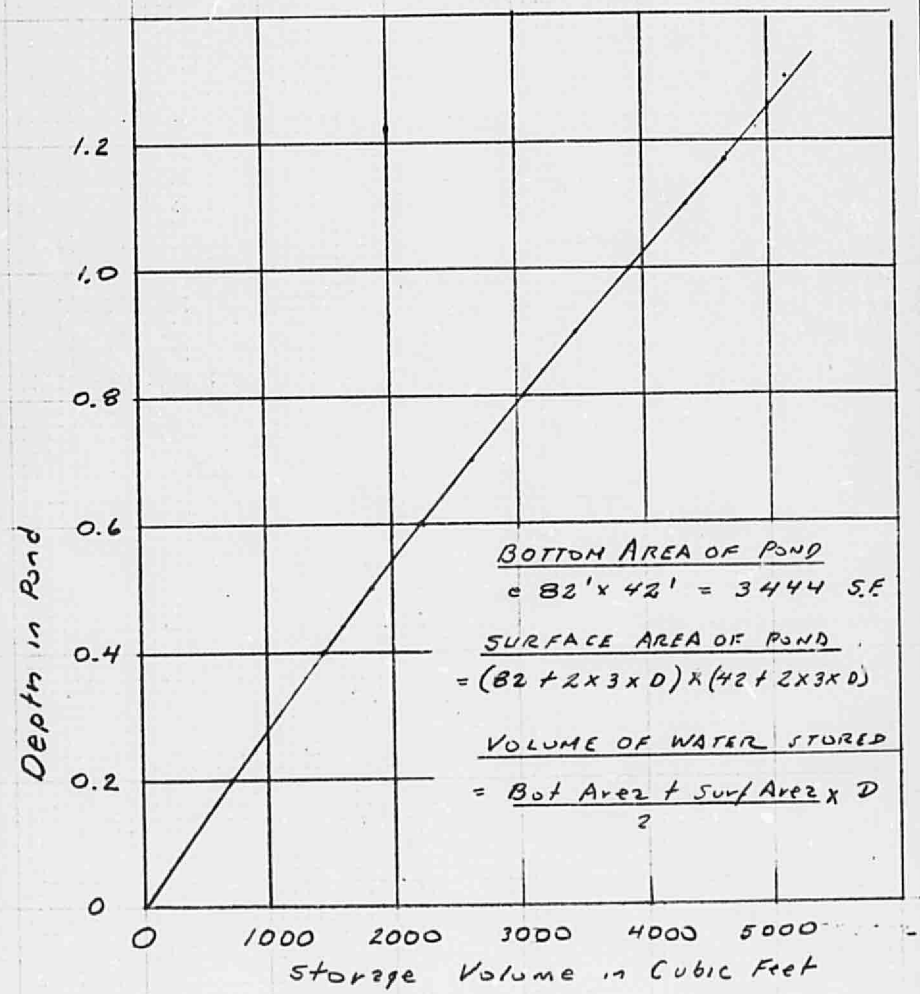
Northeast Pond



Storage Depth Curve
Northeast Pond

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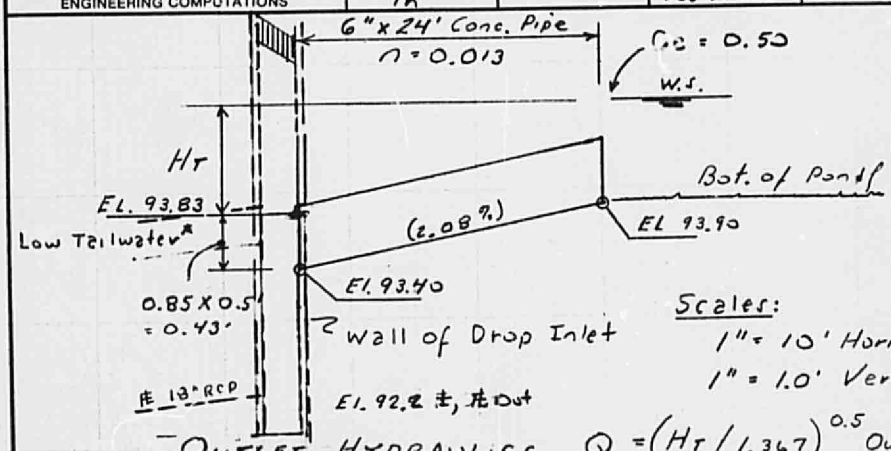
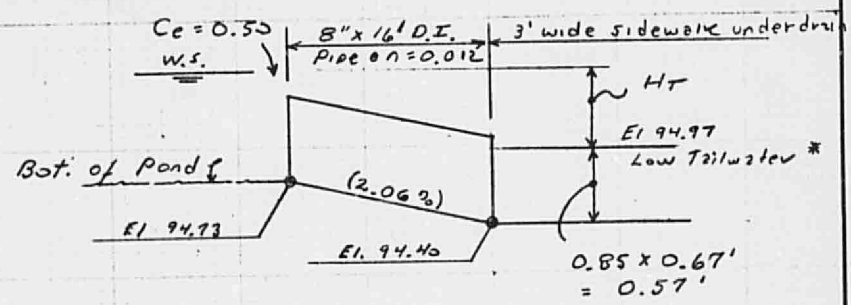
	COMPUTED BY TR	CHECKED BY	JOB NUMBER 1651.40	DATE 5/8/81



Scales:
1" = 10' Horiz.
1" = 1.0' Vert.

OUTLET HYDRAULICS $Q = (H_T / 1.367)^{0.5}$ Out. Con.

Southwest Pond See Nomo, Entr. Control.



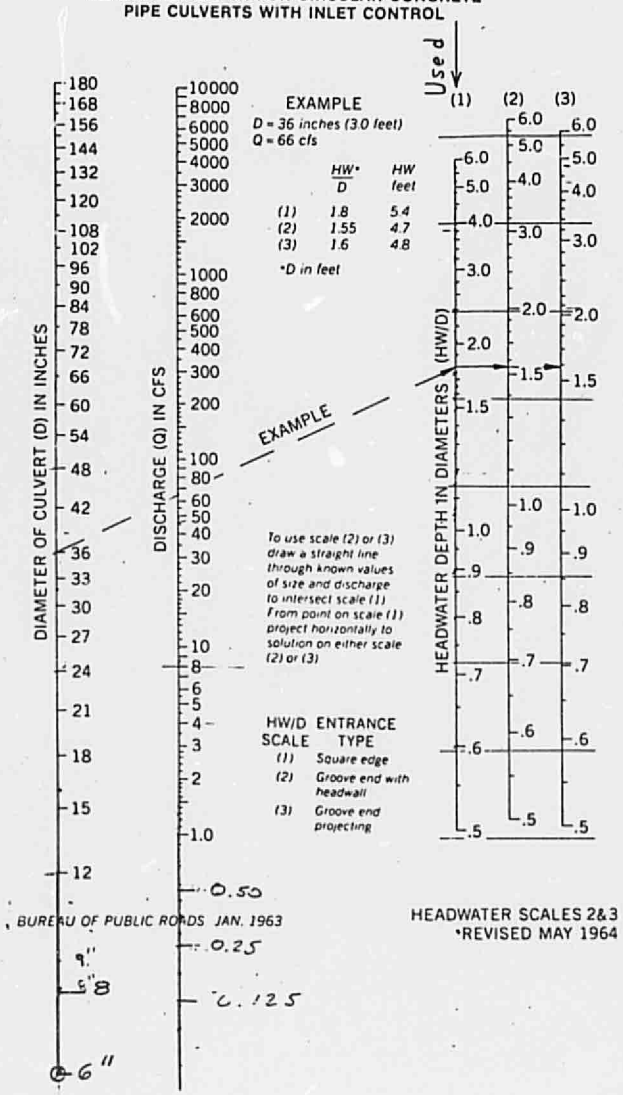
OUTLET HYDRAULICS $Q = (H_T / 0.284)^{0.5}$ Out. Con.

Northeast Pond See Nomo, Entr Control

FIGURE 29

HEADWATER DEPTH FOR CIRCULAR CONCRETE PIPE CULVERTS WITH INLET CONTROL

4



BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER SCALES 2&3
*REVISED MAY 1964

Source:
Concrete Pipe Design Manual

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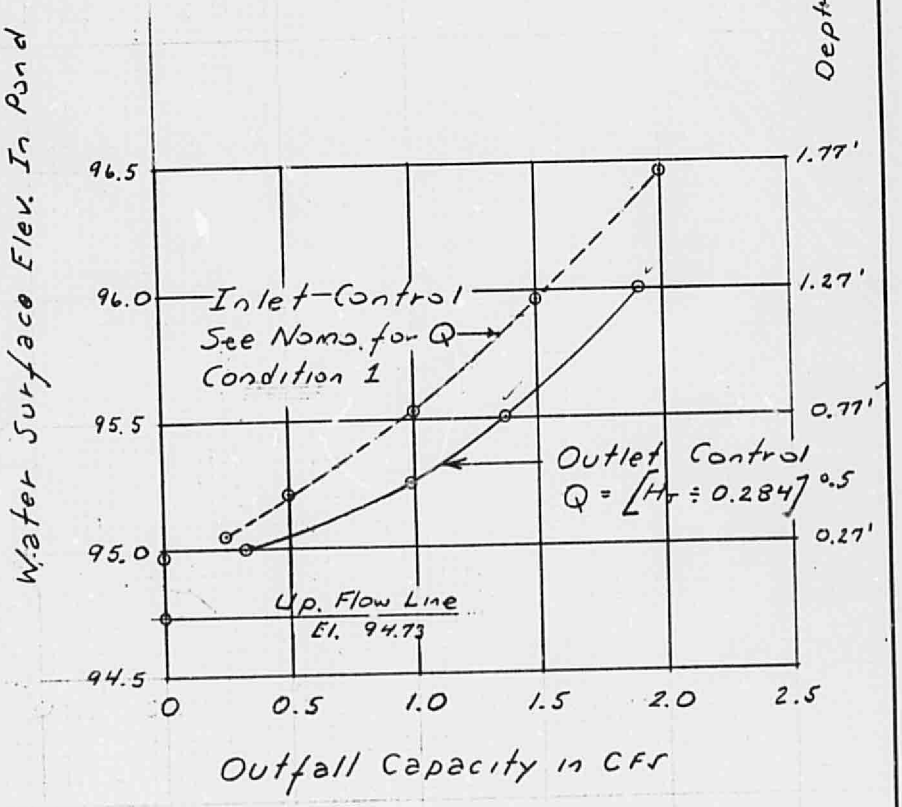
Outlet Con. Form.

$$H_T = \left[\frac{2.5204\,(1+0.5)}{0.667^4} + \frac{466.18 \times 0.012^2 \times 16}{0.667^{5.331}} \right] \frac{Q^2}{100}$$

(19.10 and 9.31)

N.E. POND



N.E. POND
8" X 16' DI Pipe @ "n" = 0.012
INLET CONTROL GOVERNS

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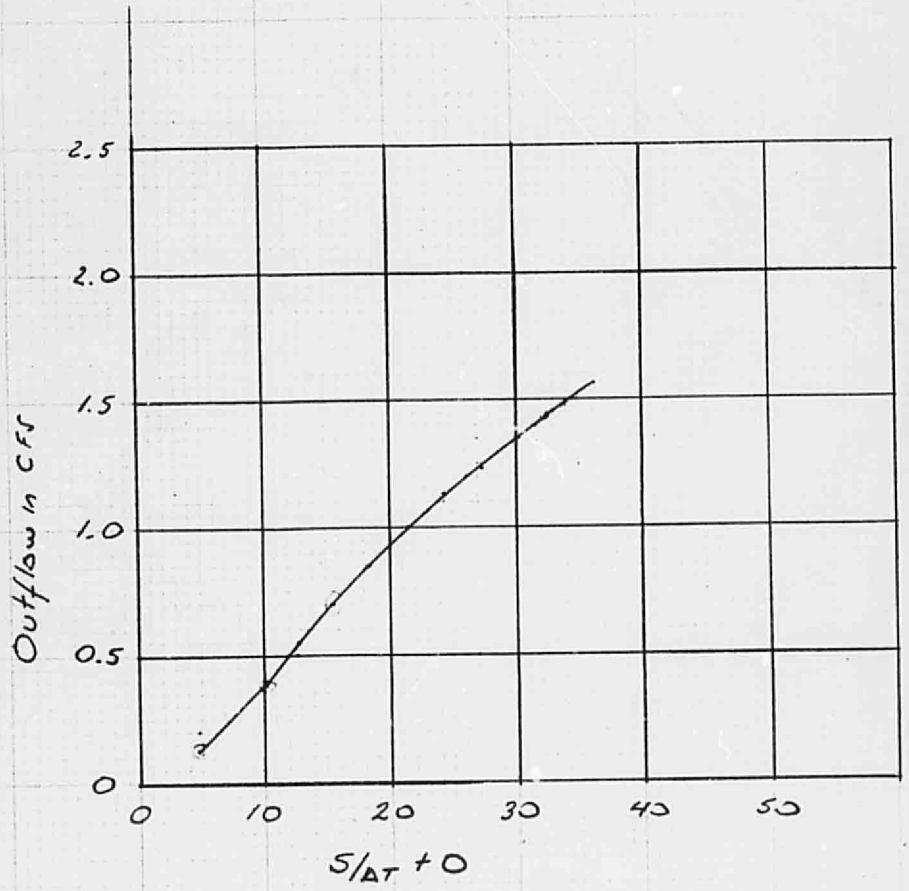

Routing Curve
Northeast Pond

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Reservoir Routing
Northeast Pond

Time	I_1 CFS	I_1+I_2 CFS	$2S/\Delta t + O$	O	$2S/\Delta t - O$	Pond Depth Ft	W.S. Elev.
0	---	---	---	---			BOH El. 94.73
5	---	---	8.33*	0	8.33	0	
10	4.17	4.17	12.50	0.52	11.46	0.49'	95.22
15	7.50	11.67	23.13	1.07	20.99	0.85'	95.58
20	3.19	10.69	31.68	1.40	28.88	1.14'	95.87
25	1.94	5.13	34.01	1.48	31.05	1.20'	95.93
30	1.94	3.88	34.93	1.50	31.93	1.23'	95.96
35	1.94	3.88	35.81	1.55	32.71	1.28'	96.01
40	0.97	2.91	35.62	1.54	32.54	1.27'	96.00
45	0.97	1.94	34.48	1.51	31.46	1.24	95.97
50	0.97	1.94	33.40	1.47	30.46	1.20'	95.93
55	0.97	1.94	32.40	1.43	29.54	1.17'	95.90
60	0.97	1.94	31.48	1.40	28.68	1.14'	95.87
65	0.97	0.97	29.65	1.34	26.97	1.10'	95.83

CONCLUSIONS

The computed Q100 out is 1.55 CFS, & occurs at 35 minutes & at a time when the water surface elevation is 96.01.

* (1250 CFS, Page 1) x 2/300 seconds = 8.33

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Drainage Areas 3, 4 & 5

Composite Hydrograph
Direct Flow to Streets

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Drainage Areas 3, 4 & 5

Direct Flow to Streets:

Drainage Area 3 = 0.11 Ac
Drainage Area 4 = 0.45 Ac.
Drainage Area 5 = 0.30 Ac.
0.86 Ac, all C = 0.95

Multiply 0.86(Ac) X 0.95 X Ordinates of the Yarnell type Curve of Figure 2 to develop a hydrograph of outflow for these lands. Plot on Figure 3 and add the ordinates of 2 pond outflow curves to get the Q100 developed release to offsite.

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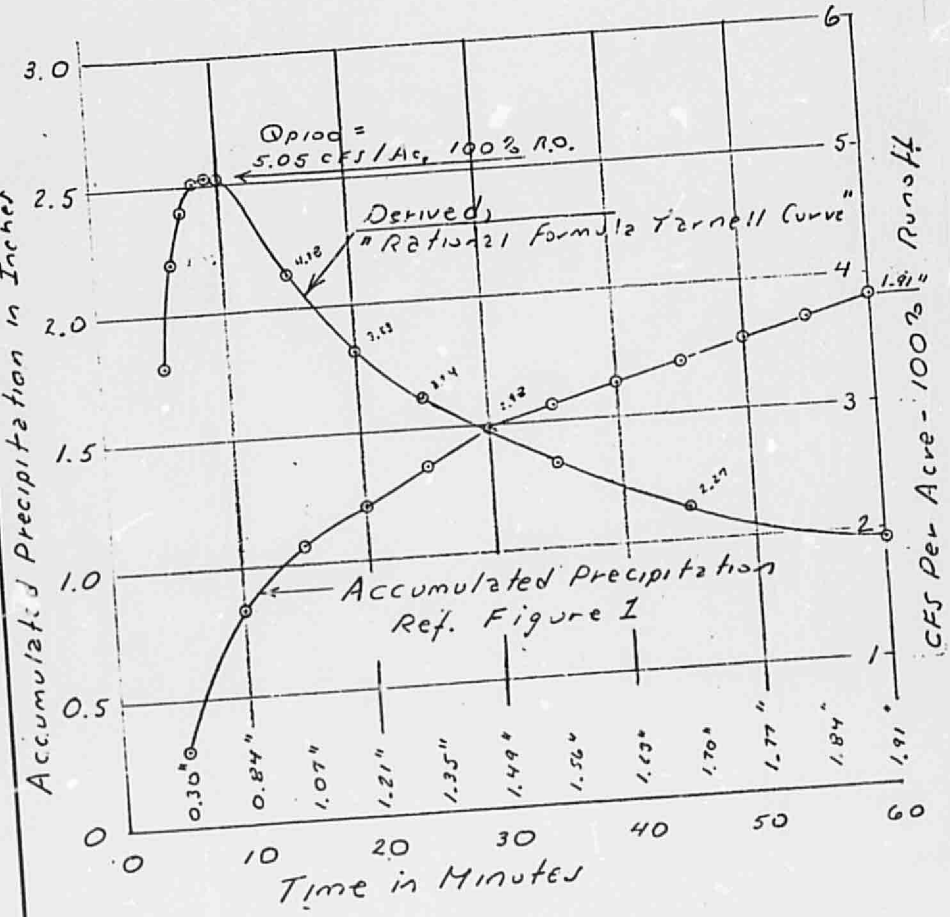

DERIVATION - RATIONAL METHOD CURVE

Figure 2

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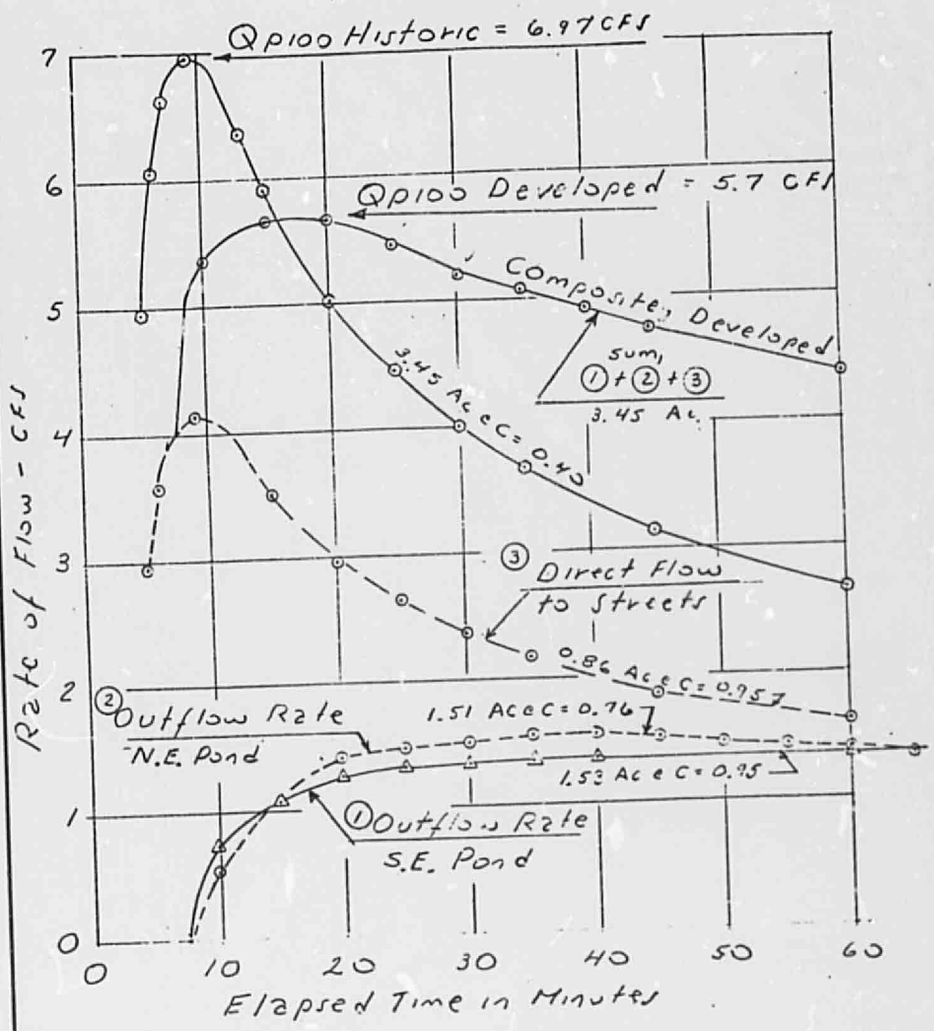
Note: Curve ③ & "Historic" are based on Yarnell type curve of Figure 2. Curves 1 & 2 are Pond Outflows.



Qp100 Developed V.S. Qp100 Undeveloped

Figure 3

HYDROLOGY J10/D9 2 of 2 2 PLANS

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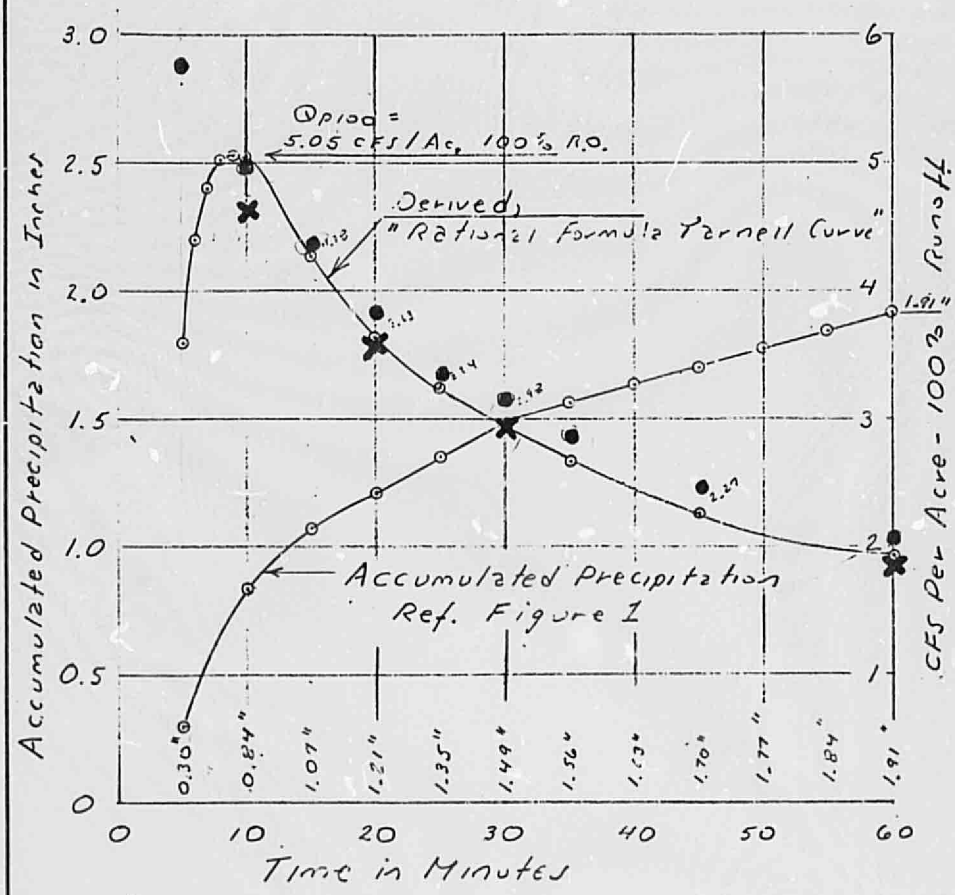
● $\frac{2.2''}{2.4''} \times \frac{189}{t+25}$, plot. 6 hr criteria

✖ $\frac{1.91''}{2.22''} \times \frac{189}{t+25}$, plot

$\frac{189}{25+60} = 2.22''$



DERIVATION - RATIONAL METHOD CURVE 32

Figure 2

ENGINEER'S REPORT
ON STORM DRAINAGE
BUTTRUM PLAZA

A. PURPOSE:

The purpose of this report is to present the analyses of and recommendations for handling storm water runoff for the Buttrum Plaza site.

B. GENERAL:

Buttrum Plaza is a proposed 3.45 acre commercial development in Albuquerque, New Mexico. The Plaza site is bounded westerly by Coors Boulevard, northerly by Fortuna Road, easterly by Estancia Drive and on the south by undeveloped lands of others. The three adjacent roadways are paved and provided with standard curbs and gutters. Coors Boulevard flow drains to a double C drop inlet in a dip at the southwesterly part of the Plaza site. Outflow from the southwesterly of two onsite ponds is to be released into that drop inlet. Fortuna Road has a water block at Coors Boulevard and otherwise drains to the east at about 0.003 gradient. Estancia Drive drains north to Fortuna Road at about 0.006 gradient. Outflow from the northeasterly of the two ponds is to be released near the intersection of Fortuna Road and Estancia Drive, from which location it will pass easterly.

In the undeveloped state, the majority of onsite storm flow would be delivered to Fortuna Road and to the southwest corner of the site. (See the existing contours of the accompanying Drainage Plan.)

It is proposed in this report that detention ponds be provided at both the southwest and northwest corners of the site. When fully developed, storm flows from 75% of the site will be directed to those ponds and flows from the remaining 25% are to be released to the three roadways.

C. SITE DEVELOPMENT:

Buttrum Plaza is to be developed in two or more phases. Approval of the Drainage Plan for the entire site is requested at this time.

Phase I construction will consist of developing 2.70 acres of the site for parking areas, buildings, alleys and two detention ponds. The Phase I lands are designated as Drainage Areas, 1, 2 and 3 on the Drainage Plan. Flow from the 2.59 acres of Areas 1 (1.53 acres) and 2 (1.06 acres) will be conveyed to ponding. The 0.11 acres of Area 3 flow will be released easterly to Estancia Drive. As part of the Phase I work, the 0.45 acres of Area 4 lands will be rough graded to deliver flow to the northeast pond and that pond will be sized on that basis. After development, Drainage Area 4 flows will be redirected easterly to Estancia Drive and both the pond volume and release rate will then be in effect oversized relative to the drainage area served. The lands of Drainage Area No. 5 will be left in the natural state until such time as the e developed.

Phase II work will be to develop the 0.45 acres of Drainage Area 4 lands and redirect flows to Estancia Drive and to develop the 0.31 acres of Drainage Area 5 lands to deliver flow to Coors Boulevard and to Fortuna Road. Construction in the two areas will not necessarily be concurrent.

D. HYDROLOGY:

Two rational method hydrologies were used in the analyses of this report.

In both hydrologies, the rational "C" used for undeveloped lands was 0.40 and for developed lands was 0.95. (Inadvertently, however, a "C" of 0.30 was used for 0.45 acres of Drainage Area 4 (undeveloped) flows to the Northeast Pond, for which a waiver is requested).

1. The Hydrology Used to Size Storm Carriers

The first hydrology was that of the conventional rational formula using Yarnell's $I_{100}=189/_{t+25}$ curve. This approach was used to size alley swales and the Drainage Area No. 2 channel along the southerly line of Fortuna Road. Outflow rates (only) for the broad parking lot swales were also estimated by this method as a matter of information. (The parking lot swales are capable of handling flows by reason of size). Times of concentration were estimated as follows:

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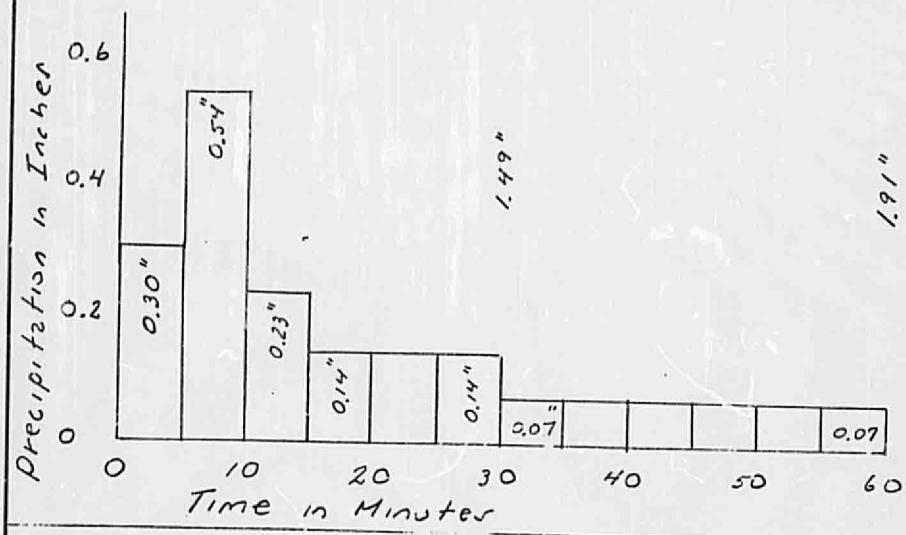

HYETOGRAPH FOR 100 YEAR STORM
AT THE BUTTRUM PLAZA SITE

Figure 1

* This hyetograph was derived from Fig. 1 of the City's "Design procedures, Routing of the Runoff through a Ponding Area". The six hour duration reduction factor for this site is 2.2"/2.4"(Fig 1) = 0.917. Mult. Fig. 1 ordinates by 0.917

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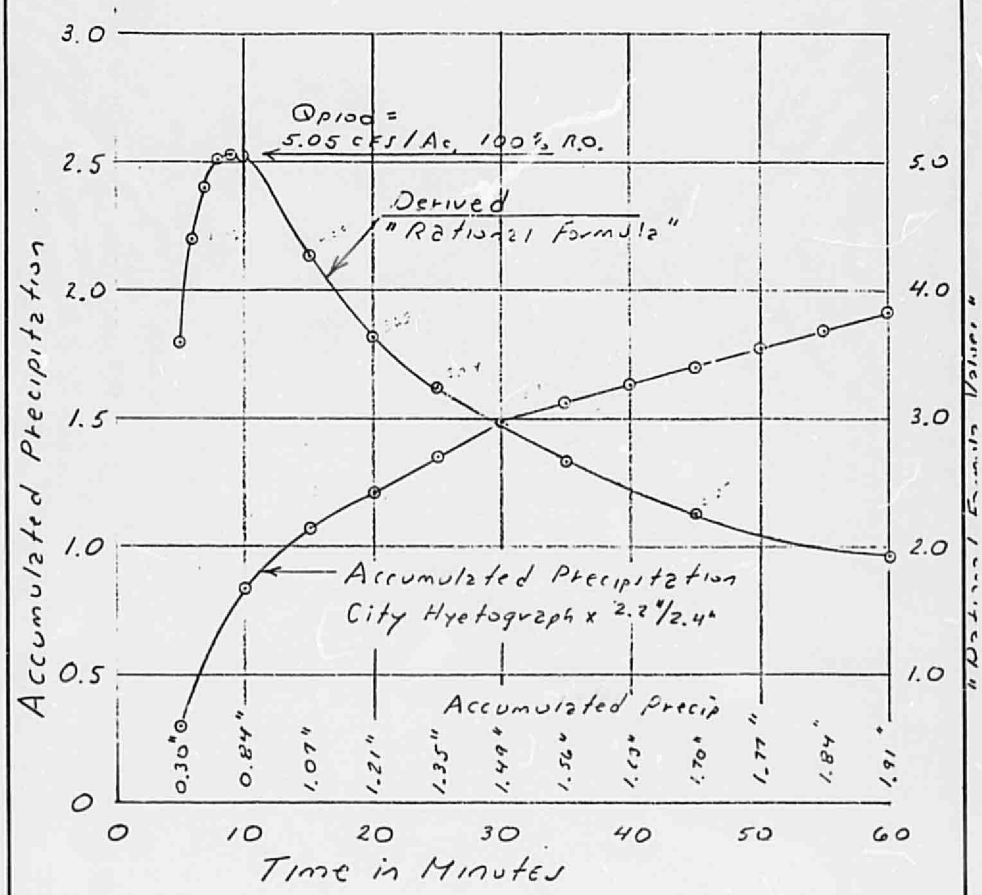

DERIVATION - RATIONAL METHOD CURVE

Figure 2

In all cases, the velocity of the upper 100 foot length of a waterway was assumed to be the average of zero fps and the gradient-related overland flow velocity for "paved area (sheet flow) and shallow gutter flow" of Fig. 3-1 of S.C.S. Technical Release No. 55. For subsequent reaches, alley swale and channel times of concentration were estimated by routing flow with Manning's formula. The less definable times of concentration for the broad variable section parking lot swales were read directly from Fig. 3-1.

2. Hydrology Used for Pond Routing and Related Analyses

The second hydrology was derived from the 100 year storm hyetograph presented in the City's "Design Procedure, Routing of Runoff through a Ponding Area" paper. The ordinates of that hyetograph, and of all other examples of Design Procedure precipitation have been multiplied by a 0.917 factor in the remainder of this report. This factor represents the ratio of the 2.2" six hour duration, 100 year return frequency rainfall at this location to that of the corresponding 2.4" amount in the example of the Design Procedure.

The resulting hyetograph for the Buttrum Plaza site is shown on Figure 1. This graph was used to estimate inflow volumes and rates to the detention ponds. Figure 2 shows both the accumulation over time of the Figure 1 hyetograph precipitation and the Rational Formula type curve derived from that hyetograph. The Rational curve was required in order to estimate direct flow releases to streets on the same time scale as the delayed releases from the ponds.

The 2.6 (cfs per acre, 100% runoff) value on the second page of the Design Procedure was multiplied by 0.917 to develop a value of 2.38 CFS. This 10 minute, 5 year return frequency intensity, multiplied by 0.40 and by the contributing acreage was used to estimate permissible peak outflow rates from ponds.

E. HYDRAULICS:

The detailed hydraulic investigations were for two alley swales, the Drainage Area 2 Channel, for pipe outflow characteristics at ponds and reservoir routing through these ponds. Conclusions are:

Alley Swales:

The inverted crowns of the two alley swales are depressed to the extent that the swales will convey over two times the computed 100 year flow rates at less than 18' width flow. (See calculations on Drainage Plan).

Drainage Area 2 Channel:

This channel will accept and convey the Drainage Area No. 2 flows to the Northeast Pond. (See calculations, Drainage Area 2.)

Pipe Outflow Characteristics:

The estimated entrance and outlet control capacities of the pipes for the Southwest and Northeast Ponds have been developed. Entrance control generally governs. (See Reservoir Routing calculations, Drainage Areas 1 and 2).

Flow Routing through Ponds:

The conventional reservoir routing technique was used with the consequence that city criteria as to Q_5 releases are substantially satisfied. (See Reservoir Routing calculations, Drainage Areas 1 and 2).

F. CONFORMANCE WITH OFFSITE RELEASE RESTRICTIONS

1. First Criteria

The positive discharge from the ponds is to be limited to the Q_5 for undeveloped lands.

Following the example on the second page of the Design Procedure and with reference to the pond routing of the attached calculations, the comparisons of permissible and computed release rates are:

Southwest Pond

Allowable:	2.38 CFS x 1.53 Ac. x 0.40	1.46 CFS
Computed by routing flow thru Pond:		1.36 CFS

Northeast Pond

Allowable:	2.38 CFS x 1.51 Ac. x .040	1.44 CFS
Computed by routing flows		1.55 CFS

On a per pond basis, the Drainage Plan is in substantial conformity with this first criteria. Overall, Q_5 undeveloped = 2.90 CFS & Q_5 from ponds = 2.91 CFS.

2. Second Criteria:

Qp_{100} developed is not to exceed Qp_{100} undeveloped.

See Figure 3 on which the hydrograph of historic flow rates is compared to a composite hydrograph of developed flows which are to be released offsite. The historic flows are based on C = 0.40 for 3.45 acres applied to the derived rational method curve of Figure 2. The composite hydrograph was developed by adding the ordinates of the outflow hydrographs for the Southwest and Northeast Ponds to the ordinates of one hydrograph representing the total direct offsite flow for Drainage Areas 3, 4 and 5. The direct offsite flow hydrograph was based on C = 0.95 for 0.86 acres applied to the Rational Method curve of Figure 2.

The peak rate of flow offsite after development is shown to be less than the peak rate before development and this second criteria is therefore met.

G. RECOMMENDATIONS:

It is recommended that the developer construct the drainage facilities as shown on the enclosed grading/drainage plan; and that the City of Albuquerque approve this report as it adequately deals with storm runoff for the subject property and meets all existing City ordinances related to drainage.

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303 Eighth Street, N.W.
Albuquerque, New Mexico 87102
(505) 247 0294
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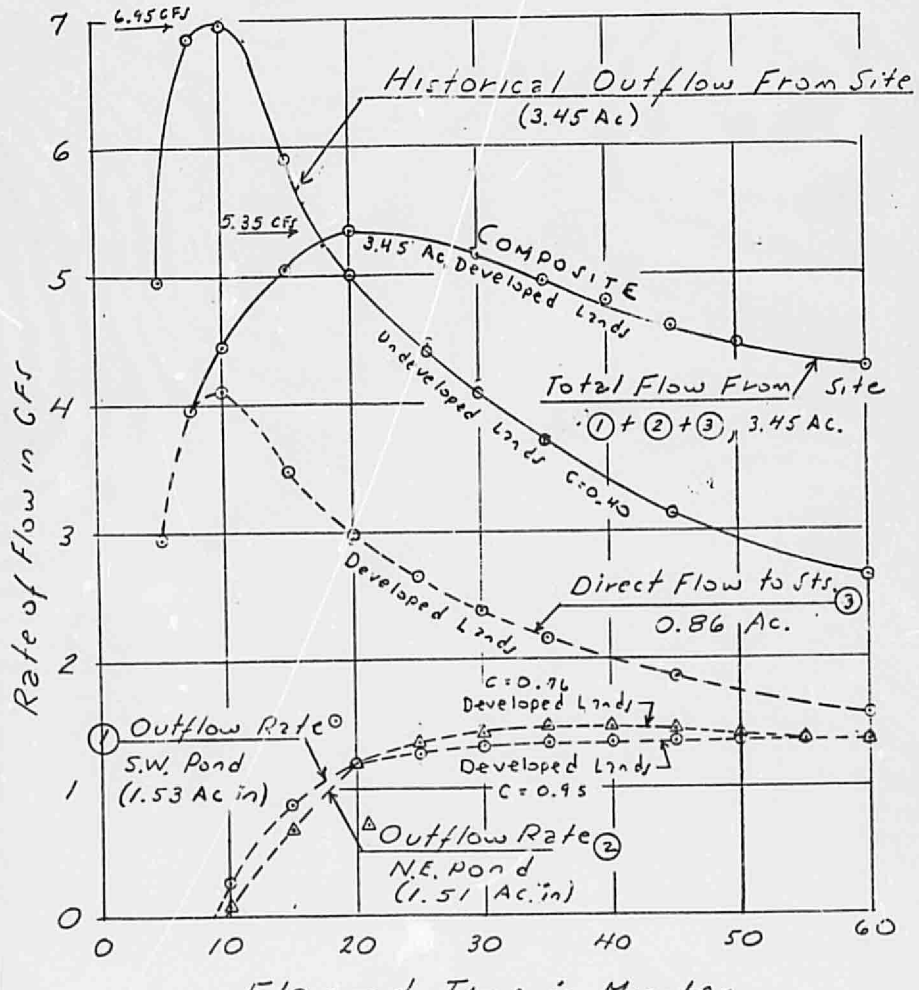

Qp100 Developed V.S. Qp100 Undeveloped

Figure 3

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