HYDROLOGY M15/D4 4 PLANS 1 of 2

M15/D4

---

4 Plans

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro, NE, Albuquerque, New Mexico 87108
(505) 265-6631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S.

RECEIVED
MAR 16 1979
CITY ENGINEERS

March 16, 1979

HAND-DELIVERED
City Hall

Mr. Bruno Conegliano
Assistant City Engineer-Hydrology
CITY OF ALBUQUERQUE
PO Box 1293
Albuquerque, New Mexico 87103

SUBJECT: NEWPORT INDUSTRIAL PARK-WEST, UNIT 1
PHASE I, RANDOLPH ROAD

Dear Mr. Conegliano:

On March 13, 1979, we hand-delivered a set of Contract Plans for the subject project for your advanced review and, as you have requested, we have prepared and are transmitting herewith the Design Analysis for the storm drainage portion of this project.

Please note that we have attached to the Analysis two (2) prints of the Contract Drawings (Sheet 9 & 10) on which we have shown the energy grade line in red.

Very truly yours,

JOHN A. ANDREWS, P.E.

JAAsm
Enclosure
cc: Mr. Tom Muchmore
Mr. M. B. "Pete" Ford

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro, NE, Albuquerque, New Mexico 87108
(505) 265-6631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S.

RECEIVED
MAR 13 1979 4:20 p.m.
CITY ENGINEERS

March 13, 1979

HAND-DELIVERED
City Hall

Mr. Bruno Conegliano
Assistant City Engineer-Hydrology
CITY OF ALBUQUERQUE
PO Box 1293
Albuquerque, New Mexico 87103

SUBJECT: NEWPORT INDUSTRIAL PARK-WEST, UNIT 1
PHASE I, RANDOLPH ROAD

Dear Mr. Conegliano:

I am transmitting herewith a set of prints of the final drawings for the construction of Randolph Road, for your review. I have sent the original tracings to the City this date for signatures and construction approval through Mr. Kielich. It is proposed that these tracings will be processed through the other City Departments prior to coming to you for your signature.

I am sending you this set of prints in order that you may review the plans in advance prior to the originals arriving on your desk for signature. If you have any comments on these enclosures, please notify me immediately so that they may be resolved on a timely basis.

You will note that the set of plans enclosed are for the construction of Randolph Road only and designated as Phase I. It was necessary to separate the Site Improvements for this subdivision into two (2) phases due to the extremely critical time period in which Randolph Road, with related utilities, is to be constructed. This office has discussed the phasing of this project with Mr. Heller, and he indicated his concurrence at that time.

As discussed with you this date, I am revising the final design calculations on the Storm Sewer on Randolph Road and propose to have them to you tomorrow morning for your review.

Very truly yours,

JOHN A. ANDREWS, P.E.

JAAsm
Enclosures
cc: Mr. Tom Muchmore
Mr. M. B. "Pete" Ford

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro, NE, Albuquerque, New Mexico 87108
(505) 265-8631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S.

February 12, 1979

RECEIVED
FEB 13 1979
CITY ENGINEERS

Mr. Bruno Conegliano
Assistant City Engineer - Hydrology
CITY OF ALBUQUERQUE
PO Box 1293
Albuquerque, New Mexico 87103

SUBJECT: NEWPORT INDUSTRIAL PARK - WEST, UNIT NO. 1

Dear Mr. Conegliano:

Enclosed is a copy of your letter dated February 7, 1979, on which we have obtained the signature of owner, Tom Muchmore. In signing this letter, the owners requested that the following clarifications to your letter be incorporated as a part of the agreement:

Paragraphs 2 and 3:

From the statements made in these paragraphs, it is our understanding that the City will bear the costs associated with any modifications and/or additions to the City's existing streets, storm sewer system and structures that may be required at Yale Boulevard, SE, and the 60-ft. Floodway Easement and at University Boulevard, SE, and the 60-ft. Floodway Easement;

Paragraph 4:

For clarity, this paragraph is re-written as follows: ... "Randolph Road will be designed to accept and convey the flows from offsite drainage areas designated as A-3, A-4 and C-2 in conjunction with flows from applicable onsite areas shown in the Drainage Report. All offsite flows will be collected and conveyed through appropriate drainage easements to Randolph Road. An appropriate storm sewer system will be constructed at the Western side of this subdivision on Randolph Road and University Boulevard to collect and convey storm water flows for ultimate disposal into the flood channel as included in the Drainage Report;" ...

Paragraph 5:

Although we are unaware that desilting facilities are required by existing City ordinances, we have agreed to construct these desilting facilities as requested;

Paragraph 6:

It is understood that the City will permit the use of swales in paved parking areas for conveying the drainage easement flows, provided existing ordinances regulating velocities and depths of flow are complied with in the design of the swales.

It is requested that this letter be attached to the Drainage Report along with your letter which Mr. Muchmore has signed.

Very truly yours,

John A. Andrews

JOHN A. ANDREWS, P.E.

JAAsm
Enclosure
cc: Mr. Tom Muchmore
Mr. James C. Jaramillo, C.A.O.
Mr. Richard S. Heller, City Engineer
Mr. Richard Leonard, A.M.A.F.C.A.

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

MAYOR
David Rusk

February 7, 1979

Mr. John Andrews
Andrews, Asbury & Robert
401 San Pedro N.E.
Albuquerque, New Mexico 87108

RE: NEWPORT PARK DEVELOPMENT

Dear Mr. Andrews:

I have received the revised drainage report for the captioned development together with your letter dated February 6, 1979. The drainage report is supposed to provide a conceptual outline of the scheme of solution to the drainage problem and not a detailed hydrologic and hydraulic analysis of the proposed facilities. In practice it is difficult to evaluate one without the other. I will therefore outline the drainage provisions that need to be provided and concurrence by your client will allow the approval of the plat for this development. Detailed design data will have to be supplied by your office to verify the adequacy and appropriateness of the facilities proposed.

1. A concrete lined channel will be constructed in the arroyo along the northern boundaries of this property.

2. The flood plain study by the U.S. Corp of Engineers, Albuquerque Arroyos, Part V, Albuquerque, New Mexico, April 1975, indicates that the existing facilities (the 2-54" pipes mentioned in the report) may not be adequate to convey the flood flows. Plate 6 in said report indicates that undesirable flows may be conveyed down Yale Blvd. This situation is not desirable from the point of view of the City, and an adequate way to convey these flood flows to the arroyo need to be provided. As far as this parcel is concerned the requirement is that an adequate intake structure be provided to receive the flows emanating from the east without damages to the lined channel. The solution will be provided in cooperation and participation with the City.

3. Discussions that I have had yesterday and today with engineers of the Soil Conservation Service and of the Corps of Engineers, have confirmed my opinion that it will be very difficult to convey the predicted flow of 614.7 cfs across the existing structure under University Blvd. A partial redesign of the structure may be required to convey the supercritical flow in the lined channel through the 2-72" pipe culverts. It is doubtful at this point whether a well designed inlet structure could prevent the formation of a hydraulic jump and the diversion of the flow to the northwest into the Kirtland Addition. A solution to this problem will be part of the facilities constructed with this development with the cooperation and the participation of the City.

4. Randolph Road will be design to accept the offsite flows from the offsite areas designated as A3, A4 and C2 in the drainage report. These flows will be collected within this subdivision and conveyed through the appropriate drainage easements to a storm sewer to be constructed at the western side of this property and to the flood channel through an appropriate structure.

5. Temporary desilting facilities will be provided to prevent the discharge of sediment onto Randolph Rd. until development of the tracts south of Randolph Rd. are developed.

6. At the time of development of the individual tracts, the location of the drainage easements may be modified but the flows will be collected in an appropriate facility as approved by the City Engineer.

7. The tracts to the north of Randolph Rd. will not be allowed to discharge into the flood channel in an uncontrolled fashion, but will be collected and conveyed through an inlet structure that will nto affect the structural integrity of the lining.

The developer can indicate his concurrence with the stipulations above with signature on the space provided. Copy of this letter will be attached to the drainage report as it constitutes a prerequisite to approval of the plat.

Very truly yours,

Bruno Conegliano
Assistant City Engineer-Hydrology

BC/fs

-c - James C. Jaramillo, C.A.O.
Richard S. Heller, City Engineer
Rick Leonard, A.M.A.F.C.A.
Drainage File

ACCEPTED:

Tom Muchmore

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro, NE, Albuquerque, New Mexico 87108
(505) 265-6631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S.

February 6, 1979

Mr. Bruno Conegliano
Assistant City Engineer - Hydrology
CITY OF ALBUQUERQUE
PO Box 1293
Albuquerque, New Mexico 87103

HAND-DELIVERED
City Hall

SUBJECT: NEWPORT INDUSTRIAL PARK-WEST, UNIT NO. 1
DRAINAGE REPORT

Dear Mr. Conegliano:

This letter is in reply to your letter dated January 19, 1979, on subject project.

As requested in your letter and in accordance with discussions we have had at meetings on this project, we have revised the Drainage Report for this project. Two (2) copies of this revised report dated February 6, 1979, are enclosed herewith. Revisions include provisions for carrying the runoff flows from Drainage Areas A-3, A-4 across the subject property from the South boundary to Randolph Road, SE; computations in the report and Map No. 3 have been revised to reflect these changes.

In the body of the report, we have re-written the section on developed conditions. We have not included the detailed hydraulic design calculations for the concrete-lined channel and the structure under University Boulevard, SE at the Floodway Easement. These design computations will be performed under the design phase of the project and submitted to you for your review in addition to the contract plans.

As requested, we will provide you with progress drawings of the various storm drainage plans prior to their completion for your review.

Your early approval of this report will be appreciated.

Very truly yours,

John A. Andrews

JOHN A. ANDREWS, P.E.

JAAsm
Attachment: Rev. Drainage Report (2)

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

January 19, 1979

Andrews, Asbury & Robert Inc.
401 San Pedro N.E.
Albuquerque, New Mexico 87108

Re: Newport Industrial Park

Gentlemen:

The drainage report submetted for Newport Industrial Park is not acceptable. The City will not consider the transfer of the boulevard flows emanating from the south (Drainage Area A) to University. These flows must be collected and conveyed to the lined channel through this property.

The computations performed to evaluate the capacity of the existing facilities are of a summary nature and inadequate: on Page 3 in the body of the report the statement is made that the 2-72" pipe culvert has "more than ample capacity to carry the generated flows". The mode of operation of the culvert, which obviously does not have a high velocity inlet, is not indicated. In any case, inlet control conditions would prevail and a head water depth of 10.0 + ft. would be required to convey the flow through the facility. With the roadway no higher than 2.0 ft. above the culvert structure, the flood flows would bypass the structure, converging toward the residential area to the N.W.

In similar fashion, the evaluation of the other facilities cannot be based simply on the normal depth of flow. The geometry of the system must be investigated as to its capability to receive the flows. The engineer must verify that flow instabilities (hydraulic jumps, flow velocities will not occur, or that adequate means for control of these instabilities has been provided.

These questions must be addressed in a comprehensive manner before approval to the drainage report will be granted.

Yours very truly,

Bruno Conegliano
Assistant City Engineer-Hydrology

BC/lg

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro, NE, Albuquerque, New Mexico 87108
(505) 265-6631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S.

December 5, 1978

RECEIVED
DEC 8 1978
CITY ENGINEERS

Mr. Bruno Conegliano
Assistant City Engineer, Hydrology
City of Albuquerque
P O Box 1293
Albuquerque, New Mexico 87103

Subject: Drainage Report, Newport Industrial Park-West, Unit 1

Dear Mr. Conegliano:

Transmitted herewith for your review and approval are two (2) copies of the Drainage Report for Newport Industrial Park-West, Unit 1, Site Improvements.

Your early review and approval of this report will be appreciated.

Please call if you have any questions.

Very truly yours,

John A. Andrews

John A. Andrews, P.E.

JAA:ys

cc: Mr. M.B."Pete" Ford
Jaynes Corp.
(W/Encl)

ZIA PUERTO - JOINT VENTURE
ALBUQUERQUE, NEW MEXICO

RECEIVED
MAR 16 1979
CITY ENGINEERS

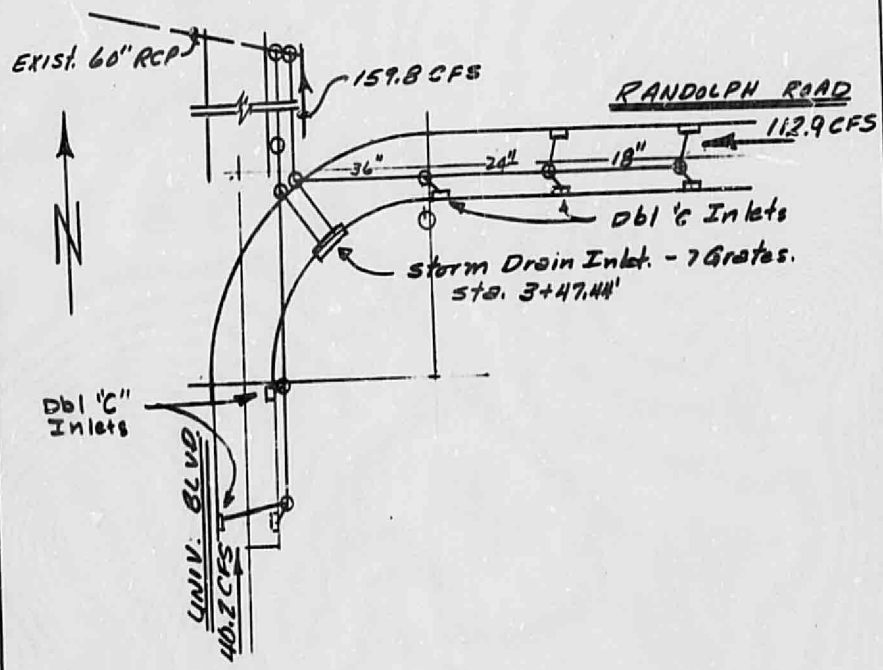
STORM DRAINAGE DESIGN ANALYSIS FOR NEWPORT INDUSTRIAL PARK-WEST, UNIT 1 PHASE I - RANDOLPH ROAD

MARCH 16, 1979

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro,NE
Albuquerque, New Mexico 87108

ANDREWS, ASBURY & ROBERT, INC. CONSULTING ENGINEERS 401 San Pedro, NE., Albuquerque, N.M. 87108 Telephone (505) 265-6631	Project Newport Industrial Park-West, Unit 1 Sheet 1 of 9 Job No. 129 By JA Chk'd ✓ Date 3-8-79

DRAINAGE- Randolph Road.-Univ. Blvd



CRITERIA

TOTAL FLOW TO BE COLLECTED IN STORM SEWER. - 160 CFS.

FLOWS SHOWN ARE FROM DRAINAGE REPORT- REVISED Feb. 6, 1979.

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
401 San Pedro, NE., Albuquerque, N.M. 87108
Telephone (505) 255-8831

Flow - Randolph Road.

$Q = 112.9$ CFS

Roadway = Slope = 3.2%

48' wide w/ 6" Crown.

Assume depth of flow = 0.55'

$n = 0.015$

$Area = (.05)(48) + (.50)(24) = 14.4'$

$WP = 48 + 1.10 = 49.1$

$R = \frac{14.4}{49.1} = 0.293$

$V = \frac{1.486}{0.015}(.293)^{2/3}(.032)^{1/2}$

$V = 7.82$ fps

$Q = AV = (14.40)(7.82) = 112.6$ CFS OK

$V \cdot D = (7.82)(0.55) = 4.3$

Assume - OK -

Collect. Flow in Storm Sewer.

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
401 San Pedro, NE., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Storm Runoff Collection

Randolph Road & Univ. Blvd.

Total Flow to be Collected = 160 CFS

Assume Dbl. "C" Inlet Capacity on Roadway-grade = 2 CFS Ea.

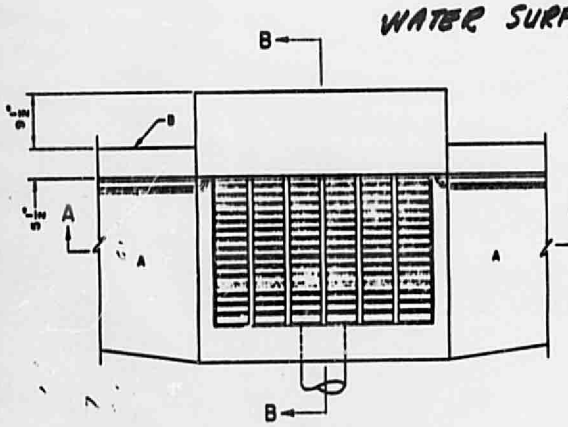
Use - 3 Inlets - So. of Curve on Univ. Blvd. = 6 CFS

Use - 5 Inlets - East of Curve on Randolph Rd. = 10 CFS.

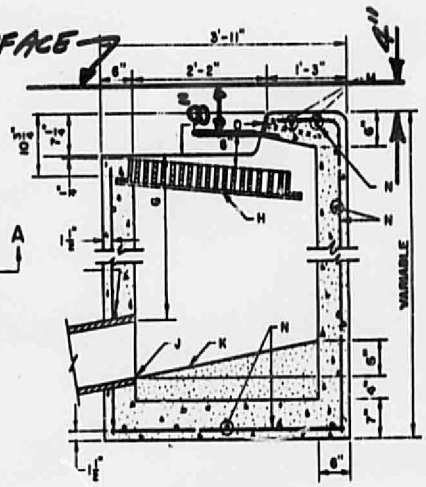
Required Flow to be collected by Inlet at Low Pt. = 160 - 16 CFS
= 144 CFS

Capacity of Type C Inlet with 1.0 feet maximum depth above Curb Flowline
= 22.87 CFS
(see Sheet-4- Following)

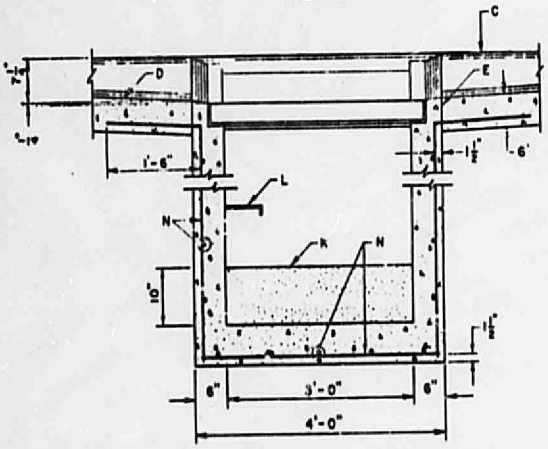
Number of Type C Inlet Grates req'd
$= \frac{144}{22.87} = 6.3$ - Use - 7 Grates



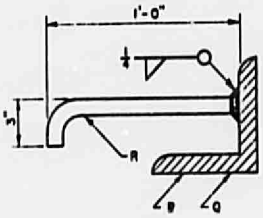
PLAN



SECTION B-B



SECTION A-A



ANCHOR DETAIL

GENERAL NOTES:

I. OUTLET PIPE SIZE PER DESIGN REQUIREMENT.

CONSTRUCTION NOTES:

A. FOR GUTTER TRANSITION SEE DWG. S-15 DROP INLET LOCATION.
B. BACK OF CURB.
C. TOP OF CURB.
D. GUTTER LINE.
E. CONSTRUCTION JOINT.
F. NORMAL GUTTER LINE.
G. 1'-10" MIN. UNESS OTHERWISE DIRECTED.
H. SEE DWG. S-16 FOR FRAME AND GRATING DETAILS.
J. INVERT.
K. GROUT.
L. USE STANDARD MH STEPS, SEE DWG. S-9. FIRST STEP SHALL BE 18" FROM TOP OF GRATE AND SHALL PROTRUDE 7", SPACING AT 12" O.C. LAST STEP 18" MAX. FROM BOTTOM.
M EXTEND NO. 4 REBARS 18" INTO CURB ON EACH SIDE OF INLET.
N. NO. 4 BARS AT 6" O.C EACH WAY.
O. SEE ANCHOR DETAIL, THIS DWG.
P. ∠ 3½" X 3½" X ⅜" X 4'-0" FOR SINGLE GRATE C INLET.
Q. ∠ 3½" X 3½" X ⅜" X 7'-6" FOR DOUBLE GRATE C INLET.
R. NO. 4 - 1'-3" ANCHOR AT 1'-9" O.C.

NEWPORT INDUSTRIAL PARK-WEST, UNIT 1
DRAINAGE ANALYSIS

Sheet 3A of 9

CITY OF ALBUQUERQUE

SEWER

DROP INLET SINGLE "C"

DWG. S-12

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
401 San Pedro, NE., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Capacity of Drop Inlet @ Low Point

CITY OF ALBUQUERQUE SINGLE "C"

THROAT

Equation - $Q_t = \frac{2}{3} L \sqrt{2g} \left(h_2^{3/2} - h_1^{3/2} \right)$

Ref Orifices under Low Heads - King & Brater, p. 4-5 Handbook of Hydraulics

Water Surface - 4" above top of curb.

$h_1 = 8" = 0.67$ feet
$h_2 = 14" = 1.167$ feet
$L = 3.50$ feet
- See City Std. Dwg.

$Q_t = \frac{2}{3}(3.50)\sqrt{2(32.2)}\left(\overline{1.167}^{3/2} - \overline{0.67}^{3/2}\right)$

$Q_t = 13.34$ CFS.

GRATE

Equation $Q = CA\sqrt{2gh}$ $C = 0.60$

Area = 14 Spaces @ 1" x 3.0' Lg = 3.50
Less straps = 3/4" x 5 x 1'-10" = - 0.55
2.95 ft²

Assume 50% Clogged - A = ~~1.98 ft²~~ 1.49 ft²

$Q = (0.60)(1.98)\sqrt{64.4(1)} = 9.53$ 7.17

14.20
13.34
27.54
50% : 13.77

TOTAL - THROAT PLUS GRATE

$Q_T = 13.34 + 9.53 = 22.87$ CFS. 7.17 20.51

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
401 San Pedro, NE., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project Newport Industrial Park West, Unit 1 Sheet 5 of 9 Job No. 129
By JA Chk'd _____ Date 3-12-79

Outlet Pipes from 7-Grate Inlet

Use - 1-36" Dia. RCP
1-24" Dia. RCP

Assume. 36" pipe Carries - 100CFS
24" pipe Carries - 44CFS

Slope of 36" pipe Req'd = 3.0% min.
$v = 14.5$ fps.

Slope of 24" pipe Req'd = 5.0% min.
$v = 14$ fps.

Depth of Inlet -
Allow for Velocity Head $= \frac{(14.5)^2}{64.4} = 3.26$.
Entrance $H_L = 0.2 \times 3.26 = 0.66$
3.91'

Depth of Inlet = 3.0' + 3.91' = 6.91'
Use - 7.0' depth.

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
401 San Pedro, NE., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Storm Sewer Analysis

The following 3 sheets - Storm Drainage Design Summary. Show the tabulation of computations & data for determining the Energy Grade Line of the Storm Sewers to be installed with this project.

In addition to the storm runoff, allowance has been made for conveyance of 30 MGD - of drain water from the Miles Waterworks Storage Reservoir. It is noted that this is not a definite requirement of water resources however, this flow has been included in computing the energy grade line.

Two separate Lines are to be constructed and are designated as Line A & Line B. Both of these lines are discharged into the existing 60" RCP in place under University Blvd.

Attached to this Analysis are two prints of the Contract drawings - Sheet 9 & 10 on which the Energy Grade line is shown.

A conservative approach was taken in performing the computation for development of the Energy Grade Line shown.

NEWPORT INDUSTRIAL PARK-WEST, UNIT 1

PHASE I, RANDOLPH ROAD

—Storm-Drainage Design Summary—

LINE "A" - Reinforced Concrete Pipe n=0.015

Line	Location	Type Structure	Pipe Diam (in.)	Length (ft)	Invert Slope, S_o	Invert Elev. (ft) (IN)	Invert Elev. (ft) (OUT)	Approx. Surface Elev. (ft)	Runoff, Design Flow, Q (cfs)	Full at Invert Slope: Cap., Q_f (cfs)	Full at Invert Slope: Vel., $V_f = \frac{Q_f}{A_f}$ (fps)	Design Conditions: Depth of Flow, d (ft)	Vel., $V = \frac{Q}{A}$ (fps)	Vel. Head $h_v = \frac{V^2}{2g}$ (ft)	Slope of Energy Gradient, S_e	Head Losses: Friction, h_f (ft)	Shock or Form: Coef. K	Shock or Form: Δh (ft)	Grade Line Elev.: Energy (ft)	Grade Line Elev.: Piezometric or Water Surface (ft)
	6+40	MH-A-1					41.10	47.47												
									4.0			0.45	6.81	0.72			0.2	0.14	42.41	
	RAND.	Pipe	18	100	.032					16	9.2					1.74				
																	0.4	0.29	40.67	
																			40.38	
	5+40	MH-A-2				37.90	37.40	44.27												
									8.0			0.60	10	1.55			0.2	0.31	39.86	
	RAND	Pipe	24	104	.050					42	13.5					2.66				
																	0.4	0.62	37.20	
																			36.57	
	4+36	MH-A-3				32.20	31.20	40.77												
									52			Full 1.32	7.36	0.84			0.2	0.17	35.21	A 36.15
	RAND	Pipe	36	96.32	.0498					125	18.0					0.78				
																	0.4	0.34	34.43	35.37
																			34.37	35.03
	3+41.68	MH-A-4				26.50	25.00	41.45												
									156			Full 2.1	16.21	4.08			0.6	2.45	35.03	
	UNIV.	Pipe	42	217.97	.0368					170	18.0					6.96			28.07	
																	0.4	1.63	26.44	

NEWPORT INDUSTRIAL PARK-WEST, UNIT 1
PHASE I, RANDOLPH ROAD

when this comes free

—Storm-Drainage Design Summary—

LINE "A"

Sheet 8 of 9

Line	Location	Type Structure	Pipe Diam (in.)	Length (ft)	Invert Slope, S_o	Invert Elev. (ft) (IN)	Invert Elev. (ft) (OUT)	Approx. Surface Elev. (ft)	Runoff, Design Flow, Q (cfs)	Full at Invert Slope: Cap., Q_f (cfs)	Full at Invert Slope: Vel., $V_f = \frac{Q_f}{A_f}$ (fps)	Design Conditions: Depth of Flow, d (ft)	Vel., $V = \frac{Q}{A}$ (fps)	Vel. Head $h_v = \frac{V^2}{2g}$ (ft)	Slope of Energy Gradient, S_e	Head Losses: Friction, h_f (ft)	Shock or Form: Coef. K	Shock or Form: Δh (ft)	Grade Line Elev.: Energy (ft)	Grade Line Elev.: Piezometric or Water Surface (ft)
4	NIV.																			
	2+76	MH A-5				17.00	15.50	26.10												
									206			Full 2-7-5	10.49	1.71			0.6	1.03	23.24	Pipe 0.50'
	UNIV.	Pipe	60	64	.0474					500	25.2				3.8	0.53				
	EX.																0.4	0.68	22.71	
							Pipe												22.03	
	UNIV.	MH A-6				12.20	04.32	24.40												
	EX.																			

NEWPORT INDUSTRIAL PARK-WEST, UNIT 1

PHASE I, RANDOLPH ROAD

—Storm-Drainage Design Summary—

LINE "E" Reinforced Concrete Pipe n=0.015

Line	Location	Type Structure	Pipe Diam (in.)	Length (ft)	Invert Slope, S_o	Invert Elev. (ft) (IN)	Invert Elev. (ft) (OUT)	Approx. Surface Elev. (ft)	Runoff, Design Flow, Q (cfs)	Full at Invert Slope: Cap., Q_f (cfs)	Full at Invert Slope: Vel., $V_f = \frac{Q_f}{A_f}$ (fps)	Design Conditions: Depth of Flow, d (ft)	Vel., $V = \frac{Q}{A}$ (fps)	Vel. Head $h_v = \frac{V^2}{2g}$ (ft)	Slope of Energy Gradient, S_e	Head Losses: Friction, h_f (ft)	Head Losses: Shock or Form: Coef. K	Head Losses: Shock or Form: Δh (ft)	Grade Line Elev.: Energy (ft)	Grade Line Elev.: Piezometric or Water Surface (ft)
	7+30.25	MH-B-1					42.00	48.27												
									4.0			0.42	8.7	1.17			0.2	0.23	43.82	
		Pipe	18	100	.060					24	12.5					2.84				
																	0.4	0.47	40.97	
																			40.51	
	6+30.25	MH-B-2					36.00	42.80												
									6.0			0.52	10.0	1.55			0.2	0.31	38.38	
		Pipe	18	122.72	.060					24	12.5					4.80				
																	0.4	0.62	33.58	
																			32.96	
	5+07.53	MH-B-3				28.31	26.00	41.49												
									50			2.13	7.18	1.31			0.2	0.26	29.70	
		Pipe	36	82.53	.010					53	8.2					1.04				
																	0.4	0.52	28.66	28.25
																			28.14	0'
	4+20	MH-B-4				25.16	24.70	33.00												
									50			~~Full +3.5~~	7.07	0.78			0.2	0.16	28.64	
	Exist.	Pipe	36	145'	.0442					120	17.5					1.08				
																	0.4	0.31	27.56	
																			27.25	
	Exist.	MH-B-5				18.29														

ZIA PUERTO - JOINT VENTURE
ALBUQUERQUE, NEW MEXICO

DRAINAGE REPORT
FOR
NEWPORT INDUSTRIAL PARK-WEST, UNIT 1
SITE IMPROVEMENTS

DECEMBER 1978
(Revised 2/6/79)

ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers
401 San Pedro, N. E.
Albuquerque, New Mexico 87108
505-265-6631

DRAINAGE REPORT
FOR
NEWPORT INDUSTRIAL PARK-WEST, UNIT 1
SITE IMPROVEMENTS

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MAPS	Existing Conditions	MAP NO. 2
	Developed Conditions	MAP NO. 3

(See special pocket at back of report for Map No. 2 and Map No. 3)

I

INTRODUCTION

Zia Puerto-Joint Venture proposes to improve a tract of land consisting of approximately 49 acres in the southeast quadrant of the City of Albuquerque, and within Section 33, T 10N, R 3E, NMPM, known as Newport Industrial Park-West, Unit 1. The Newport Industrial Park-West, Unit 1, formerly designated as Tract A of Zia Puerto Industrial Park, is bounded on the north by a 60' drainage and utility easement, to the west by University Boulevard, S.E. and to the south by the City of Albuquerque Miles Waterworks station and an abandoned AT&SF railroad spur right-of-way. (See enclosed Location Map, Map No. 1, page M-15 of the Zone Atlas.)

The following storm drainage analysis was made to determine the storm water runoff anticipated in the event of a 100-year frequency storm and to provide a plan to control storm water runoff that will conform to applicable drainage resolutions and ordinances.

II

EXISTING CONDITIONS

Existing drainage patterns for on site and off site drainage areas are shown on Map No. 2 of this report, together with the drainage area designations.

Areas external to the subject property that affect on site drainage patterns exist to the south, east and north.

The bed of the abandoned AT&SF railroad spur which bounds the property on the south diverts the off site storm runoff from Drainage Areas A and C to localized concentration points as shown on Map No. 2. Existing culverts under the railroad bed at the localized points are silted over (plugged) and are considered incapable of accepting any storm runoff.

The area to the east of Yale Blvd. that generates storm runoff to the subject site is designated as Drainage Area F. Storm runoff from Area F drains to the intersection of Yale Blvd. and Alamo Avenue by a combination of storm sewers and street flow. At this intersection the street flows are collected by cattle-guard type inlets and all flows are emptied by storm sewer pipes into the drainage and utility easement on the west side of Yale Blvd.

The area to the north of the subject property, Drainage Area E, drains directly to the 60' drainage and utility easement. The runoff from this area does not cross the subject property; however, it does contribute to the flow in 60' drainage easement.

The on site drainage patterns under the existing conditions are seen on Map No. 2.

Drainage areas A-1 through A-4 are intercepted by an existing 60" concrete pipe which conveys the storm runoff under Unviersity Boulevard and into a concrete-lined channel, away from the subject property.

Flows from Drainage Areas B, C, D, E & F enter the 60' drainage easement at various points as shown on Map No. 2. The combined runoff from these areas is collected in the existing earth channel located in the 60' drainage easement and is carried in a southwesterly direction and exits the property through two existing 72" concrete culvert pipes under University Boulevard.

There are two existing 72" diameter culvert pipes located at the crossing of the Mesa Drive extension with the 60' drainage easement channel. Site investigations revealed that these culvert pipes are more than half filled with silt which makes their capability of handling the generated flow questionable. Remedial measures to relieve this condition are covered under the developed conditions.

In order to arrive at peak runoff rates for the existing conditions, it was determined that areas that are presently developed would have a runoff coefficient (c) of 0.65 while areas that are presently undeveloped would have a runoff coefficient of 0.40. Where developed and undeveloped areas exist in the same drainage sub-basin, a combined runoff coefficient proportional to the areas involved was used.

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III

DEVELOPED CONDITIONS

A. General

Drainage patterns in the proposed developed condition for onsite and offsite drainage areas together with the drainage area designations and their contributory flows are shown on Map No. 3. This subdivision is to be developed as an Industrial Park; however, it is not known at the time of the writing of this report what the actual type, size or location of buildings will be or the actual type of ground cover proposed in the ultimate development of the subject site. The intent of this report is to establish the major drainage patterns and flows of the offsite and onsite drainage. In addition, this report will serve as a guide for the preparation of drainage plans on an individual basis when the actual construction of buildings and associated facilities is to occur.

B. Proposed Improvements

As an initial construction project, it is proposed to construct improvements to provide access to the subdivision, utility service and drainage facilities to control storm water runoff. This report addresses the drainage portion of the proposed improvements.

Drainage improvements to be constructed under the initial construction phase shall include the following:

1. Construct drainage facilities to convey storm waters generated by Drainage Areas A-3 and A-4 from the South boundary of the subdivision to Randolph Road, SE;
2. Construct drainage facilities to convey storm waters generated by Drainage Area C-2 from the South boundary of

the subdivision to Randolph Road, SE, and a facility to carry this flow from Randolph Road North, to the floodway easement. The latter facility shall be designed to collect and convey the flows from Drainage Area C-1 as well as convey the flows from Drainage Area C-2;

3. Construct a ditch and dike within the subdivision along ~~the~~ Southerly boundary ~~of the subdivision~~ to collect and direct local flows to the above-described facilities. (which one?) This ditch and dike shall extend to the West across the Northerly limits of Drainage Area A-2 to direct the local flows from this drainage area to University Boulevard; (I do not understand what is intended)

4. Construct pavement and curb and gutter on Randolph Road, SE. This pavement and curb and gutter should extend around the curve connecting University Boulevard to Randolph Road and to the South as necessary to collect the flows on University Boulevard.

5. Construct a storm sewer system in the vicinity of the intersection of Randolph Road and University Boulevard, SE, as required to collect and convey storm water flows converging at this intersection. The storm sewer shall extend Northerly along University Boulevard and connect to the existing 60" RCP storm sewer under University Boulevard that flows to the Northwest and into the existing concrete-lined drainage channel. (See Map No. 3 for location).

I do not understand this part. Revised 2/6/79

6. Construct storm sewer lines in the floodway easement from the West right-of-way line of Yale Boulevard, SE, to the East boundary of the subdivision. These storm sewer lines shall connect to the existing lines presently projecting from under Yale Boulevard on the West side;

7. Construct a continuous concrete-lined channel in the 60-foot wide Floodway and Utility Easement located along the Northerly boundary of the subdivision. Limits of the lining shall be from the drainage structure under University Boulevard, SE, to the East boundary of the subdivision and shall connect to the storm sewer lines described under Item No. 6, above;

8. Special transition structures and/or sections will be required to be included in the design of the above-described concrete-lined channel. These special transition structures shall be designed to provide for stability stable and continuity of flow in the channel. As a minimum, special transition structures will be required at the following locations:

   A. At the outlet of the storm sewer lines at the East boundary of the subdivision;

   B. At the connection of the two types of channel sections proposed near the midpoint of the subdivision; what is meant here

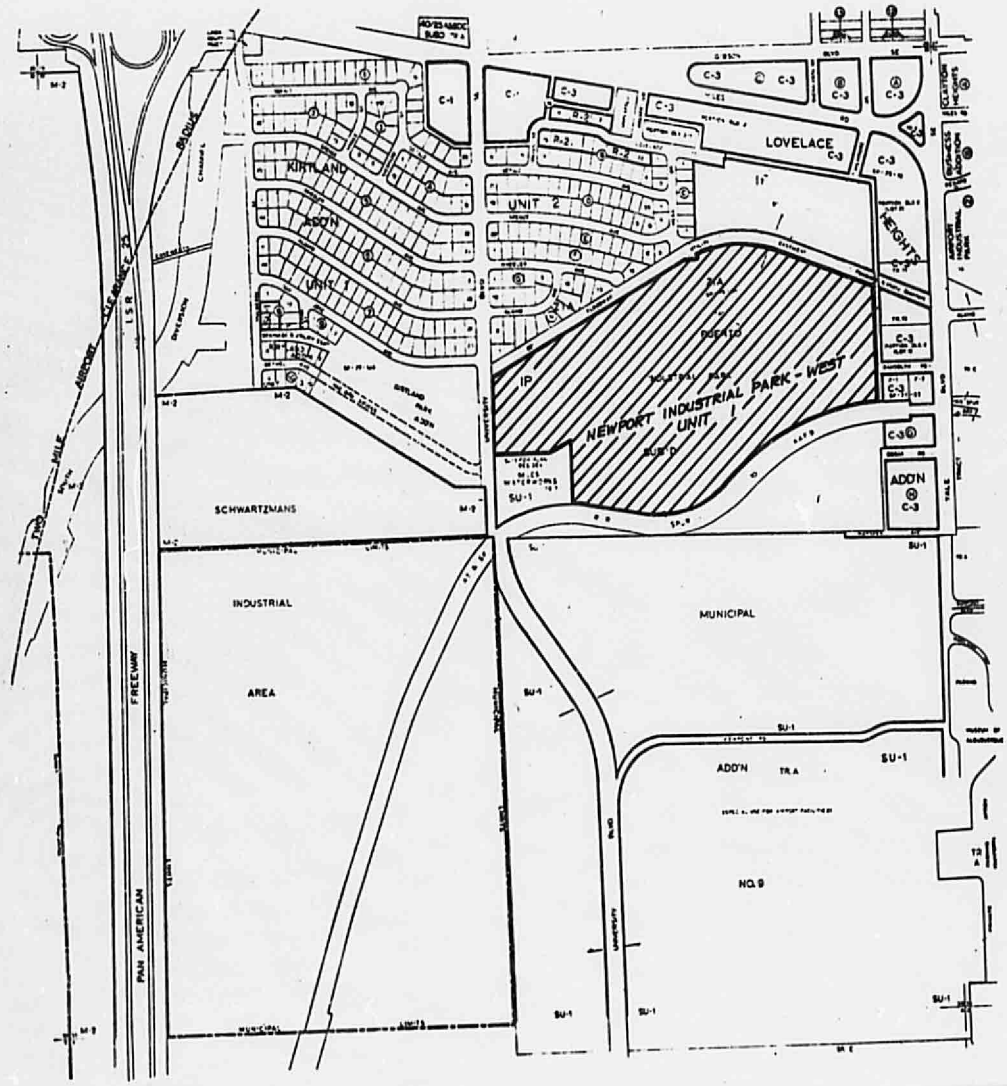
   C. At the channel connection to the drainage structure under University Boulevard. This transition structure shall be designed to provide for a high velocity inlet to the two (2) 72" diameter pipes presently under University Boulevard, SE;

9. Inlets to the concrete-lined channel shall be constructed as required to allow for the local and onsite flows to enter the channel. Channel inlets shall be designed to minimize disturbances in channel flow.

C. Onsite Drainage Control

Control of onsite drainage during the actual development of all portions of the Newport Industrial Park-West, Unit 1, all applicable City of Albuquerque and Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) ordinances and resolutions shall be complied with.

Particular attention is directed to Section 2, Paragraph B of the AMAFCA Resolution 1972-2 which states:
"...the storm water runoff from such lot, tract or parcel will discharge from such lot, tract or parcel into, and in such manner as does not exceed the capacity of storm drainage facilities downstream or, in the alternative, will discharge from such lot, tract, or parcel at no greater rate of flow, velocity and quantity or different location than existed before such alteration."



NEWPORT INDUSTRIAL
PARK - WEST
UNIT 1
DRAINAGE ANALYSIS

LOCATION MAP

M-15-Z

MAP No. 1

Revised 2/6/79

IV

DRAINAGE ANALYSIS

Following is the Drainage Analysis (computations) for the drainage areas affecting subject project, both in the existing and developed conditions.

DRAINAGE ANALYSIS

INDEX

	Sheet
Criteria, Reference Material and Design Parameters	1
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Combined Areas	7 - 9
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DRAINAGE ANALYSIS

CRITERIA

DESIGN STORM - 100 YEAR FREQUENCY

AMAFCA DRAINAGE RESOLUTION

CITY OF ALBUQUERQUE - DRAINAGE ORDINANCE

REFERENCE MATERIAL

1. ALBUQUERQUE HERN (1961) INTENSITY - DURATION - FREQUENCY CURVES
2. 100 YEAR - 6 HOUR PRECIPITATION, RAINFALL FREQUENCY MAP, U.S. WEATHER BUREAU.
3. TIME OF CONCENTRATION NOMOGRAPH, p. 2, Kirpich

DESIGN PARAMETERS

PEAK RUNOFF RATE - RATIONAL FORMULA, $Q = CIA$.

RUNOFF VOLUME = V = RUNOFF COEFFICIENT × RAINFALL × AREA

RUNOFF COEFFICIENTS
EXISTING GROUND SURFACE = 0.40
DEVELOPED SURFACES = 0.65

NOTE: WHERE UNDEVELOPED & DEVELOPED SURFACES COMPRISE ONE DRAINAGE AREA, A COMBINED RUNOFF COEFFICIENT WAS DETERMINED.

REFER TO MAPS 2 & 3 FOR DRAINAGE AREA DESIGNATIONS FOR EXISTING & DEVELOPED CONDITIONS RESPECTIVELY.

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Existing Conditions - Offsite
Peak Flows

Drainage Area A-2

A = Area = 18.6 ac.
H = Elev. difference = 118 ft.
L = Length of drainage area = 2110 ft.
C = Runoff coefficient = 0.4
TC = Time of concentration = 9 mins + 10 min.
I = Intensity = 5.4 in/hr.

$Q = CIA = .4 \times 5.4 \times 18.6 = 40.2$ cfs.

Drainage Area A-3

A = 19.8 ac.
H = 5309 - 5180 = 129 ft.
L = 2930 ft
C = 0.46
TC = 12 mins.
I = 5.11 in/hr.

$Q = CIA = .46 \times 5.11 \times 19.8 = 46.5$ cfs

Drainage Area A-4

A = 19.1 ac.
H = 5282 - 5196 = 86 ft.
L = 1380 ft.
C = 0.45
TC = 6 mins. ∴ use 10 minutes minimum
I = 5.4 in/hr.

$Q = CIA = 0.45 \times 5.4 \times 19.1 = 46.4$ cfs

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DRAINAGE AREA C-2

A = 9.9 AC.
H = 5292 - 5215 = 77 FT
L = 1840 FT.
C = 0.45
TC = 9 MINS, ∴ USE 10 MINS.
I = 5.4 in/hr

Q = CIA = 0.45 x 5.4 x 9.9 = 24.1 CFS.

DRAINAGE AREA E

A = 24.3 AC.
H = 5180 - 5140 = 40 FT.
L = 1380 FT.
C = 0.45
TC = 8 MINS. ∴ USE 10 MINS.
I = 5.4 in/hr.

Q = CIA = .45 x 5.4 x 24.3 = 59.1 CFS

DRAINAGE AREA F-1

A = 39.5 AC.
H = 5300 - 5206 = 94 FT.
L = 2640 FT.
C = 0.48
TC = 2.5 MINS, ∴ USE 10 MINS.
I = 5.4 in/hr.

Q = CIA = 0.48 x 5.4 x 39.5 = 102.4 CFS.

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DRAINAGE AREA F-2

A = 58.0 AC.
H = 5315 - 5265 = 50 FT
L = 2130 FT.
C = 0.60
TC = 5.4 MINS ∴ USE 10 MINS.
I = 5.4 IN/HR.

Q = CIA = 0.60 × 5.4 × 58.0 = 187.9 CFS

DRAINAGE AREA F-3

A = 46.5 ACRES
H = 5315 - 5206 = 109 FT.
L = 3320 FT.
C = 0.50
TC = 6.7 MINS ∴ USE 10 MINS.
I = 5.4 IN/HR.

Q = CIA = 0.50 × 5.4 × 46.5 = 125.0 CFS.

DRAINAGE AREA F-4

A = 26.1 AC.
H = 5315 - 5200 = 115 FT.
L = 3470 FT.
C = 0.50
TC = 5.6 MIN. ∴ USE 10 MINS.
I = 5.4 IN/HR

Q = CIA = 0.50 × 5.4 × 26.1 = 70.5 CFS.

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Existing Conditions - Onsite

Peak Flows & Volumes.

Drainage Area A-1

A = 19.8 ac.
H = 5196 - 5116 = 80 ft
L = 1480 ft
C = 0.40
TC = 6.5 mins, ∴ use 10 mins.
I = 5.4 in/hr.

$Q = CIA = 0.4 \times 5.4 \times 19.8 = 42.8$ cfs

$V = 0.4 \times 2.4'' \times 19.8 \times \frac{43560}{12} = 69000$ ft³

Drainage Area B-1

A = 3.8 ac
H = 5152 - 5118 = 34 ft
L = 570 ft
C = 0.40
TC = 5.1 mins ∴ use 10 min.
I = 5.4 in/hr.

$Q = CIA = 0.4 \times 5.4 \times 3.8 = 8.2$ cfs

$V = 0.4 \times 2.4'' \times 3.8 \times \frac{43560}{12} = 13240$ ft³

Drainage Area B-2

A = 9.7 ac
H = 5210 - 5130 = 80 ft
L = 1270
C = 0.40
TC = 5.7 min ∴ use 10 mins.
I = 5.4 in/hr.

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DRAINAGE AREA B-2 CONT.

$Q = CIA = .4 \times 5.4 \times 9.7 = 21.0$ CFS

$V = 0.4 \times 2.4'' \times 9.7 \times \frac{43560}{12} = 33800$ FT^3

DRAINAGE AREA C-1

A = 15.0 AC.
H = 5226 - 5125 = 101 FT
L = 1520. FT
C = 0.40
TC = 6.5 MINS ∴ USE 10 MINS
I = 5.4 IN/HR

$Q = CIA = .4 \times 5.4 \times 15 = 32.4$ CFS

$V = .4 \times 2.4'' \times 15.0 \times \frac{43560}{12} = 52270$ FT^3

DRAINAGE AREA D

A = 12.2 AC.
H = 5234 - 5150 = 84 FT
L = 1320
C = 0.44
TC = 6 MINS. ∴ USE 10 MINS
I = 5.4 IN/HR.

$Q = CIA = 0.44 \times 5.4 \times 12.2 = 29.0$ CFS

$V = 0.44 \times 2.4'' \times 12.2 \times \frac{43560}{12} = 46770$ FT^3

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EXISTING CONDITIONS -

FOLLOWING ARE COMPUTATIONS FOR PEAK FLOWS FOR COMBINED ONSITE AND OFFSITE DRAINAGE AREAS AT SELECTED CONCENTRATION POINTS.

DRAINAGE AREAS A-1, A-2, A-3 & A-4

DRAINAGE AREAS A-1 THROUGH A-4 PRESENTLY DRAIN TO AN EXISTING 60" CONCRETE PIPE LOCATED ON THE EAST SIDE OF UNIVERSITY BLVD. THE FLOW FROM THOSE AREAS EXITS THE SUBJECT PROPERTY THROUGH SAID PIPE.

TOTAL AREA = 19.8 + 18.6 + 19.8 + 19.1 = 77.3 AC.
H = 5308 - 5116 = 192 FT
L = 3890 FT.
C = 0.43
TC = 14 MINS
I = 4.85 IN/HR

Q = CIA = 0.43 × 4.85 × 77.3 = 161.2 CFS

DRAINAGE AREAS C-1 & C-2

TOTAL AREA = 15.0 + 9.9 = 24.9 AC.
H = 5290 - 5136 = 154 FT
L = 3180 FT
C = 0.42
TC = 12.5 MINS.
I = 5.04 IN/HR

Q = 0.42 × 5.04 × 24.9 = 52.7 CFS

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DRAINAGE AREAS F-1, F-2, F-3 & F-4

THE COMBINED FLOW FROM THOSE AREAS IS COLLECTED IN AN EXISTING STORM SEWER SYSTEM AT THE INTERSECTION OF YALE & ALAMO.

TOTAL AREA = 39.5 + 58.0 + 46.5 + 26.1 = 170.1 AC.
H = 5315 - 5200 = 115 FT
L = 3470 FT
C = 0.53
TC = 6.4 MINS ∴ USE 10 MINS
I = 5.4 IN/HR

Q = CIA = .53 × 5.4 × 170.1 = 485.8 CFS.

DRAINAGE AREAS ABOVE POINT C

THE TOTAL AREA DRAINING TO THIS POINT COMPRISES DRAINAGE AREAS D, E, & F.

TOTAL AREA = 206.6 AC.
H = 5315 - 5138 = 177 FT.
L = 4810 FT
C = 0.50
TC = 9.3 MINS ∴ USE 10 MINS
I = 5.4 IN/HR.

Q = CIA = 0.50 × 5.4 × 206.6 = 557.8 CFS

DRAINAGE AREAS ABOVE POINT D

THE TOTAL AREA DRAINING TO THIS POINT COMPRIZES DRAINAGE AREAS B-1, B-2, C-1, C-2, D, E, & F.

TOTAL AREA = 245.0 AC.
H = 5315 - 5118 =
L = 6190 FT
C = 0.49

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DRAINAGE AREAS ABOVE POINT D CONT.

TC = 11.8 MINS
I = 5.12 in/hr

Q = CIA = 0.49 x 5.12 x 245 = 614.7 CFS.

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Developed Conditions - Onsite

The following computations for onsite - developed conditions are presented for a comparison with the onsite - existing conditions. Refer to Map No 3 for drainage area designations.

Drainage Area A-1 (Combines Areas A-1-1, A-1-2 & A-1-3. See sk. 12 for A-1-1, & A-1-2, see sk. 12A for A-1-3)

A = 12.1 ac.
C = 0.45
TC < 10 mins ∴ use I = 5.4 in/hr

$Q = 0.45 \times 5.4 \times 12.1 = 29.7$ cfs

$V = 0.45 \times 2.4 \times 12.1 \times \frac{43560}{12} = 47846$ ft³

Drainage Area B-1

A = 18.2 ac.
H = 5175 - 5118 = 57 ft
L = 700 ft.
C = 0.40
TC = 4.1 mins ∴ use 10 mins.
I = 5.4 in/hr

$Q = CIA = 0.4 \times 5.4 \times 18.2 = 39.3$ cfs

$V = 0.4 \times 2.4'' \times 18.2 \times \frac{43560}{12} = 63420$ ft³

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Project Rayport Industrial Park - Drainage Sheet 11 of 19
Job No. 129
By RFF Chk'd Date 11/21/78

DRAINAGE AREA B-2

A = 12.6 AC
H = 5191 - 5141 = 50 FT
L = 760 FT
C = 0.40
TC = 4.8 MIN ∴ USE 10 MINS
I = 5.4 IN/HR

Q = 0.4 × 5.4 × 12.6 = 27.2 CFS

V = 0.4 × 2.4" × 12.6 × 43560/12 = 43910 FT³

DRAINAGE AREA C-1

A = 11.4 AC.
H = 5234 - 5166 = 68 FT
L = 1300 FT
C = 0.48
TC = 6 MINS., ∴ USE 10 MIN.
I = 5.4 IN/HR

Q = 0.48 × 5.4 × 11.4 = 27.5 CFS

V = 0.48 × 2.4" × 11.4 × 43560/12 = 47670 FT³

∴

TOTAL VOLUME ONSITE, EXISTING = 215,080 FT³

TOTAL VOLUME ONSITE, DEVELOPED = 202846 FT³

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Project Newport Industrial Park - Drainage Sheet 12 of 12
Job No. 129
By RE Chk'd Date 2-2-79

Developed Conditions

Following are computations for peak flows for combined onsite & offsite drainage areas, & at selected concentration points.

Point I

Drainage Area A-1-1 (onsite)
A = 4.7 ac.
C = 0.46
TC < 10 mins ∴ use I = 5.4 in/hr.

$Q = CIA = 0.46 \times 5.4 \times 4.7 = 11.7$ cfs

$V = .46 \times 2.4'' \times 4.7 \times \frac{43560}{12} = 18835$ ft³

Point II

Including Drainage Areas A-1-1 & A-4

A = 4.7 + 19.1 = 23.8 ac
C = 0.45
TC < 10 mins ∴ use I = 5.4 in/hr.

$Q = CIA = 0.45 \times 5.4 \times 23.8 = 57.8$ cfs

Drainage Area A-1-2

A = 4.8 ac
C = 0.45
TC < 10 mins ∴ use I = 5.4 in/hr

$Q = CIA = 0.45 \times 5.4 \times 4.8 = 11.7$ cfs

$V = .45 \times 2.4'' \times 4.8 \times \frac{43560}{12} = 18818$ ft³

REVISED 2-2-79

ANDREWS, ASBURY & ROBERT, INC. CONSULTING ENGINEERS 401 San Pedro, NE., Albuquerque, N.M. 87108 Telephone (505) 265-6631	Project Newport Industrial Park - Drainage Sheet 12A of 17 Job No. 129 By BF Chk'd Date 2-2-79

POINT III

INCLUDES AREAS A-1-1, A-4 & A-1-2

A = 23.8 + 4.8 = 28.6 AC.
C = 0.45
TC < 10 MINS ∴ USE I = 5.4 IN/HR

Q = CIA = 0.45 × 5.4 × 28.6 = 69.5 CFS

POINT IV

INCLUDES AREAS A-1-1, A-4, A-1-2 & A-3

A = 28.6 + 19.8 = 48.4 AC.
H = 5309 - 5160 = 149 FT
L = 3280 FT
C = 0.45
TC = 12.7 MINS
I = 5.01 IN/HR

Q = CIA = 0.45 × 5.01 × 48.4 = 109.1 CFS

DRAINAGE AREA A-1-3

A = 2.6 AC
C = 0.45
TC < 10 MINS ∴ USE I = 5.4 IN/HR.

Q = CIA = 0.45 × 5.4 × 2.6 = 6.3 CFS

$V = .45 \times 2.4'' \times 2.6 \times \frac{43560}{12} = 10193 \text{ FT}^3$

REVISED 2-2-79

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Project KIMPORT TOWNSTEAD Sheet 25 of 19
PAGE - DRAINAGE Job No. 127
By RF Chk'd Date 2-2-79

POINT V

INCLUDES AREAS A-1-1, A-4, A-1-2, A-3 & A-1-3

A = 48.4 + 2.6 = 51.0 AC.
C = 0.45
TC = 12.7 + 0.7 = 13.4 MINS
I = 4.92 in/hr

Q = CIA = 0.45 × 4.92 × 51 = 112.9 CFS

DRAINAGE AREA A-1-4

A = 4.4 AC
C = 0.45
TC < 10 MINS ∴ USE I = 5.4 in/hr.

Q = CIA = 0.45 × 5.4 × 4.4 = 10.7 CFS

POINT VI - TOTAL DRAINAGE AREA A

INCLUDES AREAS A-1-1, A-4, A-1-2, A-3, A-1-3, A-1-4, & A-2

A = 51.0 + 4.4 + 18.6 = 74 AC.
C = 0.45
TC = 13.4 + 1.0 = 14.4 MINS
I = 4.80 in/hr

Q = CIA = 0.45 × 4.8 × 74 = 159.8 CFS

Revised 2-2-79

ANDREWS, ASBURY & ROBERT, INC. CONSULTING ENGINEERS 401 San Pedro, NE., Albuquerque, N.M. 87108 Telephone (505) 265-6631	Project Newport Industrial Park - Drainage Sheet 13 of 19 Job No. 125 By RSF Chk'd Date 2-2-79

Drainage Areas above Point C

In the developed state, the total area draining to this point comprises areas C, E, F & B-2. Assume that under developed conditions, TC will be less than 10 mins.

Total Area = 228.3 ac.
C = 0.50
TC < 10 mins ∴ use I = 5.4 in/hr.

$Q = 0.5 \times 5.4 \times 228.3 = 616.4$ cfs

Drainage Areas above Point D

Total area draining to this point includes drainage areas B, C, E & F. Assume that TC in developed state is less than 10 mins.

Total Area = 246.5 ac.
C = 0.47
TC < 10 mins ∴ use I = 5.4 in/hr.

$Q = 0.47 \times 5.4 \times 246.5 = 652.2$ cfs.

∴ Peak flow entering 60" RCP under University Blvd.
Existing = 161.2 cfs
Developed = 159.8 cfs

Peak flow entering 2-72" RCP's under University Blvd. (Point D)
Existing = 614.7 cfs
Developed = 652.2 cfs

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FACILITY DESIGN

2-54" RCP's @ EAST END OF DEVELOPMENT.

2-54" RCP's will be installed from the outfall of the existing storm sewer system in Yale, to the east boundary of the subject property.

Required capacity (Q) = 485.8 cfs

for 1-54" RCP, flowing full.

$$Q = \frac{1.486}{n} R^{2/3} S^{1/2} A$$

$n = 0.015$

$S = 3.0\% \Rightarrow S^{1/2} = 0.173$

$A = \pi r^2 = \pi \times 2.25^2 = 15.90 \text{ ft}^2$

$P = \pi D = 14.14 \text{ ft}$

$R = A/P = \frac{15.90}{14.14} = 1.125 \text{ ft}$

$R^{2/3} = 1.082$

$$Q = \frac{1.486}{.015} \times 1.082 \times 0.173 \times 15.90$$

$= 294.8 \text{ cfs / pipe}$

For 2-54" RCP's $Q = 2 \times 294.8 = 589.6$ cfs
7-485.8 cfs
ok.

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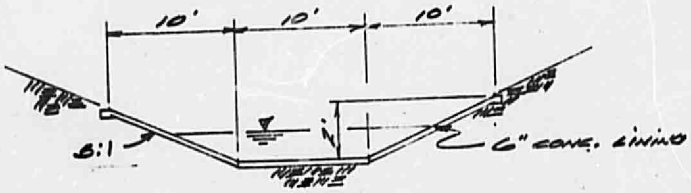
FACILITY DESIGN (CONT.)

CONCRETE LINED CHANNEL - TYPE B

REQUIRED CAPACITY = PEAK FLOW AT CONCENTRATION POINT C = 616.4 CFS



TYPICAL CHANNEL SECT.

CHANNEL SLOPE = 5.4% ⇒ $S^{1/2} = 0.184$

DEPTH OF FLOW = 1.68 ft ±, n = 0.15

$$\text{AREA} = \frac{26.8+10}{2} \times 1.68 = 30.91 \text{ ft}^2$$

WETTED PERIMETER = p = 27.13 FT

$$R = A/p = 30.91/27.13 = 1.139 \Rightarrow R^{2/3} = 1.091$$

$$V = \frac{1.486}{n} R^{2/3} S^{1/2} = \frac{1.486}{.015} \times 1.091 \times 0.184 = 19.89 \text{ fps}$$

$$Q = VA = 19.89 \times 30.91 = 614.8 \text{ CFS}$$

$Q_{ACTUAL} = 616.4$ OK

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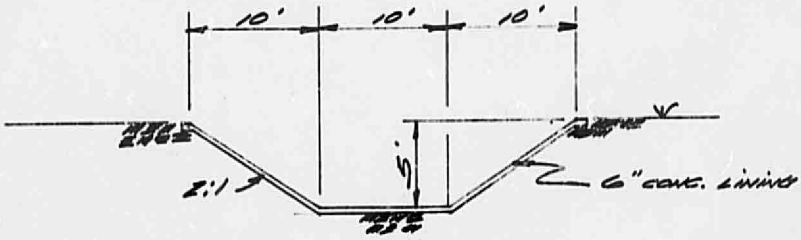
FACILITY DESIGN (CONT.)

CONCRETE LINED CHANNEL - TYPE A

REQUIRED CAPACITY = PEAK FLOW AT CONCENTRATION POINT D = 652.2 CFS



TYPICAL CHANNEL SECT.

CHANNEL SLOPE = 1.5% = $S^{1/2}$ = 0.122

DEPTH OF FLOW = 2.48 FT , n = 0.015

AREA = $\frac{17.92 + 10}{2} \times 2.48 = 37.10$ FT²

WETTED PERIMETER = 21.09 FT

$R = A/P = 37.10/21.09 = 1.759$ FT

$R^{2/3} = 1.460$

$V = \frac{1.486}{n} R^{2/3} S^{1/2} = \frac{1.486}{.015} \times 1.460 \times 0.122 = 17.65$ FPS

$Q = VA = 17.65 \times 37.10 = 654.8$ CFS OK

∴ CHANNEL WILL CARRY REQUIRED FLOW

Revised 2-6-77

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Facility Design (cont.)

2- Existing 72" RCP's @ University Blvd.

It is required that the 2 existing 72" RCP's under University Blvd., have the capacity to carry the peak flow at concentration point D. Q=652.2 cfs.

for 1-72" RCP, flowing full

$S = 1.45\% \Rightarrow S^{1/2} = 0.211$

$n = 0.015$

$A = \pi r^2 = 28.27 \text{ ft}^2$

$P = \pi D = 18.85 \text{ ft}$

$R = A/P = 1.50 \text{ ft}$; $R^{2/3} = 1.31$

$$Q = \frac{1.486}{n} R^{2/3} S^{1/2} A$$

$$= \frac{1.486}{.015} 1.31 \times 0.211 \times 28.27 = 774 \text{ cfs/pipe}$$

For 2-72" RCP's, $Q = 2 \times 774 = 1548$ cfs

> 652.2 cfs

ok

Note: Provide high velocity inlet structure.

Revised 2-6-77

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Project Newport Industries Sheet 18 of 17
Prel. Drainage Job No. 129
By RCF Chk'd Date 12/3/78

FACILITY DESIGN (CONT.)

STORM SEWER SYSTEM AT UNIVERSITY & RANDOLPH.

A STORM SEWER SYSTEM will be built AT UNIVERSITY & RANDOLPH, which will CONSIST OF INLETS AND STORM SEWER LINES, which will DISCHARGE INTO AN EXISTING 60" RCP LOCATED UNDER UNIVERSITY

PEAK FLOW @ UNIVERSITY & RANDOLPH = 159.8 cfs

∴ Required capacity of NEW STORM SEWER = 159.8 cfs

CAPACITY OF 42" RCP, FLOWING FULL

SLOPE = 4.2% ± ⇒ $S^{1/2} = 0.205$

$A = \pi r^2 = \pi \times 1.75^2 = 9.62 \text{ ft}^2$

$p = \pi D = \pi \times 3.5 = 11.0 \text{ ft}$

$R = A/p = \frac{9.62}{11} = 0.875 \Rightarrow R^{2/3} = 0.914$

$n = 0.015$

$Q = \frac{1.486}{.015} \times 0.914 \times 0.205 \times 9.62 = 178.6 \text{ cfs}$

$> 159.8 \text{ cfs}$
OK

NOTE:
INVESTIGATE THE POSSIBILITY OF utilizing EXISTING 36" RCP PRESENTLY being USED FOR WATER RESERVOIR OVERFLOW and DRAIN LINES, ALSO REQUIRED CAPACITY OF 60" RCP UNDER UNIVERSITY = 159.8 cfs

FACILITY DESIGN (CONT.)

THEN, CAPACITY OF EXISTING 60" RCP, FLOWING FULL

$S = 5.08\% \Rightarrow S^{1/2} = 0.225$

$n = 0.015$

$A = \pi R^2 = 19.63 \text{ ft}^2$

$P = \pi D = 15.71 \text{ ft}$

$R = A/P = 1.25 \Rightarrow R^{2/3} = 1.16$

$$Q = \frac{1.486}{n} R^{2/3} S^{1/2} A$$

$$= \frac{1.486}{.015} \times 1.16 \times 0.225 \times 19.63$$

$= 507.5 \text{ cfs} > 151.5 \text{ cfs req.}$ OK.

DRAINAGE STUDY

ZIA PUERTO

REGISTERED PROFESSIONAL ENGINEER
AND LAND SURVEYOR
NO. 3441
NEW MEXICO
JOHN W. BETTIS

ENCHANTMENT
ENGINEERING

DESCRIPTION OF PROPERTY

ZIA PUERTO IS A 69.031 ACRE TRACT LOCATED ROUGHLY BETWEEN GIBSON BOULVARD S.E. ON THE NORTH, UNIVERSITY BOULVARD S.E. ON THE WEST, YALE BOULVARD ON the EAST, AND THE RIGHT-OF-WAY OF THE A.T. & S.F. RAILROAD ON THE SOUTH.

WATER ENTERS THE PROPERTY FROM THE EAST AND SOUTH SIDES OF THE PROPERTY. ON THE EAST WATER IS CHANNELED DOWN YALE AND INTO A STORM SEWER WHICH EMPTIES ONTO THE PROPERTY. THE STORM SEWER CONSISTS OF ONE CONCRETE PIPE 5' IN diameter AND TWO CORRUGATED METAL PIPES 3.5' IN diameter. NO WATER ENTERS FROM THE EAST AT ANY OTHER

PLACE. ON THE SOUTH WATER COMES ONTO THE PROPERTY UNDER THE RAILROAD AT THREE POINTS. EXISTING STORM SEWERS CATCH WATER ON THE NORTH ON GIBSON AND ELEVATION DIFFERENCE KEEPS WATER OFF TO THE WEST.

THE MAIN PORTION OF THE WATER IS CARRIED ACROSS THE PROPERTY IN A DITCH AND EXISTS AT THE WEST INTO AN EXISTING CONCRETE CULVERT ON THE WEST SIDE OF UNIVERSITY BOULVARD.

DRAINAGE AREAS TO BE CONSIDERED CONSIST OF:

1. AREA WEST OF YALE AND EAST OF FIRST CULVERT UNDER RAILROAD.

2. AREA EAST OF YALE THAT DRAINS ACROSS PROPERTY.

3. REMAINING LAND SOUTH OF PROPERTY THAT

DRAINS ACROSS PROPERTY

4. The PROPERTY IN QUESTION.

SINCE NO EXTENSIVE TOPO OF THE WHOLE AREA EXISTED A NEW TOPO OF THE PROPERTY WAS PREPARED BY BOHANNAN-WESTMAN-HUSTON FROM AERIAL PHOTOS. DRAINAGE AREAS AFFECTING THE PROPERTY WERE ARRIVED AT USING DEPARTMENT OF INTERIOR GEOLOGICAL SURVEY MAPS, Albuquerque EAST QUADRANGLE AND Albuquerque WEST QUADRANGLE AND CORP OF ENGINEERS TOPO MAPS OF KIRTLAND AIR FORCE BASE. Also design FIGURES USED BY THE CITY OF Albuquerque WERE USED.

TERMS AND VALUES

THE FOLLOWING IS A LIST OF TERMS AND VALUES TO BE USED IN THIS REPORT.

$$Q = cIa = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

Q = QUANTITY OF WATER IN CUBIC FEET PER SEC.

a = AREA IN ACRES

A = AREA IN SQUARE FEET

* I = INTENSITY = 189/t+25

C = RUNOFF COEFFICIENT = .875 PAVING
.250 NATURAL GROUND
.450 MAX RUNOFF FOR 1 SQ. MILE

n = MANNING COEFFICIENT = .013 CONCRETE
.022 CMP
.015 ASPHALT
.025 SOIL

R = HYDRAULIC RADIUS IN FEET = A/P

P = WETTED PERIMETER

S = SLOPE

THE PROPERTY WILL REFER TO THE AREA TO BE SUBDIVIDED

* INTENSITY FOR 100 YEAR STORM 6 hour precipitation

L = LONGEST RUN FOR WATER IN THE DRAINAGE AREA

NATURAL RUNOFF FROM THE PROPERTY

AREA = 69.034 + 2.91 FLOODWAY EASEMENT
= 71.944 ACRES

L = 2600 FT.
I = 3.6 in/hr
C = .250

Q = CIA = 64.75 CFS

HYDROLOGY M15/D4 4 PLANS 2 of 2

AREA 1

DUE TO THE DIVERTING OF WATER BY YALE AND THE CHANNELING OF WATER IN NATURAL ARROYOS TO THE SOUTH ONLY THE 9.37 ACRES SHOWN ON THE MAP DRAINS THROUGH THE 2' DIAMETER CORRUGATED METAL PIPE ON TO THE PROPERTY.

AREA = 9.37 ACRES
L = 800 FT
I = 9.3 in/hr
C = 0.250

$Q = CIA = 10.07$ CFS

$Q_{PIPE} = 1.5 \times \frac{.022}{.015} = 22$ CFS @ 5% SLOPE

SINCE 22.0 CFS IS LARGER THAN THE 10.07 CFS EXPECTED RUNOFF, THE PIPE WILL PASS THE WATER ONTO THE PROPERTY AT THE POINT SHOWN ON THE DRAINAGE PLAT.

AREA 2

AREA 2 CONTAINS THE AREA TO THE EAST, WATER FROM WHICH COULD POSSIBLE RUN ACROSS THE PROPERTY. APPROXIMATELY HALF THE AREA IS PAVED. IT IS CONSIDERED THAT THE AREA OF 545 ACRES IS MORE THAN SUFFICIENT DUE TO PONDING AND CHANNELING OF WATER ON KIRTLAND AIR FORCE BASE. THE CALCULATIONS WILL ASSUME THAT WATER ON THIS AREA (545 ACRES) WILL RUNOFF ACROSS THE PROPERTY.

WATER FROM AREA 2 IS CAUGHT AND CHANNELED BY YALE BOULVARD INTO A RECIEVING AREA APPROXIMATELY 1300 FEET SOUTH OF GIBSON AND FROM THERE THROUGH CULVERTS ONTO THE PROPERTY. APPROXIMATELY

150 ACRES SOUTH OF THE RECIEVING AREA

MUST BE CARRIED BY YALE BOULVARD S.E..

AREA = 545 ACRES
I = 2.8 in/hr
C = 0.450 ≈ 1 SQUARE MILE INCLUDING THE PROPERTY

$Q_T = 686.7$ CFS

WATER CHANNELED BY YALE

$$Q_Y = Q_T \frac{150}{545} = 189 \text{ CFS}$$

CAPACITY OF YALE BOULVARD

66 FT OF PAVED SURFACE @ 5% SLOPE

$Q_{MAX} = 236$ CFS

SINCE 236 CFS IS LARGER THAN 189 CFS,

YALE WILL CARRY THE WATER IT MUST HANDLE.

CARRYING CAPACITY OF CULVERTS OFF YALE

THAT BRING WATER ONTO PROPERTY.

CONCRETE CULVERT 5' DIAMETER @ 3% SLOPE

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

WHERE $n = .013$

$S = .03$

$A = 19.63 \text{ ft}^2$

$R = 1.25$

$Q = 451.51$ CFS

TWO CORRUGATED METAL PIPES 3½ FT. DIA. @ 3%

$$\frac{Q}{2} = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

WHERE $n = .022$

$S = .03$

$A = 9.62 \text{ ft}^2$

$R = 0.875$

$Q/2 = 103.02$ CFS

$Q = 206.04$ CFS

TOTAL CAPACITY = 451.51 + 206.04 = 657.55 CFS

THE EXPECTED RUNOFF FROM AREA 2 IS

186.7 CFS OR APPROXIMATELY 30 CFS GREATER

THAN THE CAPACITY OF THE CULVERTS.

AREA 3

AREA 3 CONTAINS THE LAND ON THE SOUTH SIDE OF THE RAILROAD RIGHT-OF-WAY. DUE TO CHANNELING BY WATER FLOW BEFORE CONSTRUCTION OF YALE, DRAINAGE AREAS ARE WELL DEFINED. THE WATER FROM THIS AREA PASSES THROUGH TWO CULVERTS. ONE IS A 3' DIAMETER PIPE AND TAKES THE MAIN AMOUNT. THE OTHER IS A 1½' DIAMETER PIPE LOCATED APPROXIMATELY TWO HUNDRED FEET DOWN THE RAILROAD SPUR FROM THE SOUTHWEST CORNER OF THE PROPERTY. THE WATER FLOWS ACROSS THE PROPERTY FROM THESE TWO POINTS THROUGH A CULVERT UNDER UNIVERSITY.

THE DRAINAGE AREA CONSISTS OF 28.97 ACRES. EIGHT AND THREE HUNDREDTHS ACRES DRAIN

THROUGH THE 1½' DIAMETER CULVERT AND 20.44 ACRES DRAIN THROUGH THE 3' DIAMETER CULVERT.

@ 3' DIAMETER PIPE

$L = 1300$ FT.
$I = 3.9$ in/hr
$C = .25$
$A_{REA} = 20.44$ ACRES

$Q = 19.93$ CFS

$Q_{PIPE} = 40 \times \frac{.022}{.015} = 58.67$ CFS @ 5% SLOPE

SINCE 58.67 CFS IS GREATER THAN 19.93 CFS THE PIPE WILL HANDLE THE EXPECTED FLOW.

@ 1½' DIAMETER PIPE

$L = 600$ FT.
$I = 4.5$ in/hr
$C = 0.25$
$A_{REA} = 8.03$ ACRES

$Q = 9.03$ CFS

$Q_{pipe} = 6.3 \times \frac{.022}{.015} = 9.24$ CFS @ 5% SLOPE

SINCE 9.24 CFS IS GREATER THAN 9.03 CFS

THE PIPE WILL HANDLE THE EXPECTED FLOW.

The total water coming onto the property from all three areas equals 725.73 cfs. This water now travels across the property in several existing arroyos which show up on the Toro plat. These arroyos run into three culverts on the west side of the property. The water from the culverts is channeled into an existing concrete channel on the west side of University.

Two of the concrete culverts are 6' in diameter and one is 4.8' in diameter. The two 6' culverts carry the water from Areas 1, 2, part of 3, and the property. The 4.8' culvert carries the remainder of Area 3.

CAPACITY OF EXIT CULVERTS

2 @ 6' DIAMETER CONCRETE 3% SLOPE

$$Q_{pipe} = 600 \times \frac{.013}{.015} \times 2 = 1040 \text{ CFS}$$

1 @ 4.8' DIAMETER CONCRETE 3% SLOPE

$$Q_{pipe} = 300 \times \frac{.013}{.015} = 260 \text{ CFS}$$

SINCE THE TOTAL CARRYING CAPACITY OF THE CULVERTS IS 1300 CFS THEY WILL CARRY THE EXPECTED RUNOFF AFTER DEVELOPMENT. THAT RUNOFF IS 790.5 CFS AND DEPENDS ON THE FACT THAT RUNOFF OFF THE PROPERTY WILL NOT INCREASE AFTER DEVELOPMENT. THIS WILL BE ACCOMPLISHED BY PONDING WATER ON LOTS SO ONLY WATER FROM STREETS, DRIVES, AND SIDEWALKS WILL DRAIN OFF THE PROPERTY.

CAPACITY OF EXIT CULVERTS

2 @ 6' DIAMETER CONCRETE 3% SLOPE

$$Q_{PIPE} = 500 \times \frac{.013}{.015} \times 2 = 1040 \text{ CFS}$$

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$$Q_{PIPE} = 300 \times \frac{.013}{.015} = 260 \text{ CFS}$$

SINCE THE TOTAL CARRYING CAPACITY OF THE CULVERTS IS 1300 CFS THEY WILL CARRY THE EXPECTED RUNOFF AFTER DEVELOPMENT. THAT RUNOFF IS 790.5 CFS AND DEPENDS ON THE FACT THAT RUNOFF OFF THE PROPERTY WILL NOT INCREASE AFTER DEVELOPMENT. THIS WILL BE ACCOMPLISHED BY PONDING WATER ON LOTS SO ONLY WATER FROM STREETS, DRIVES, AND SIDEWALKS WILL DRAIN OFF THE PROPERTY.

DRAINAGE AFTER DEVELOPMENT

TOTAL AREA = 59.334* ACRES

ROAD AREA = 8460 x 33 / 43560 = 6.41 ACRES
WALK AREA = 8460 x 8 / 43560 = 1.55 ACRES
DRIVE AREA = 203 LOTS x 18 x 25 / 43560 = 2.09 ACRES

TOTAL PAVED AREA = 10.05 ACRES

AVERAGE AREAS PER LOT

203 LOTS STREETS = .031 ACRES
DRIVES = .010 ACRES
WALKS = .008 ACRES
UNPAVED = .243 ACRES

AREAS AND DISCHARGES FOR THE PAVED PORTIONS ARE SHOWN ON THE DRAINAGE PLAT.

* THIS ACREAGE DOES NOT INCLUDE THE AREA OF THE APARTMENT SITE, IT WILL BE HANDLED IN ANOTHER PART OF THE REPORT

PONDING ON LOTS

ASSUMED ROOF AREA = 1500 SQUARE FEET
= .034 ACRES

∴ AMOUNT OF WATER = $.034 \times 2.6^{*} \times \frac{1 ft}{12 in}$ = .007 AC-FT

GRASS AREA PER LOT = .243 - .034 = .209 ACRES

∴ W_{max} = .208 ACRES × .04 FT. POND = .0083 ACRE FT.

WITH AN AVERAGE DROP OF .04 FEET, AROUND HOUSES, WATER FROM EACH UNIT WILL POND AROUND ITSELF. THE ONLY RUNOFF WOULD BE FROM THE PAVED AREAS.

*RAINFALL FOR AREA 100 YEAR STORM 6 HOUR PRECIPITATION

APARTMENT SITE DRAINAGE

BUILDING PLANS OF THE APARTMENT SITE ARE NOT AVILABLE AT THIS TIME, HOWEVER THE DRAINAGE WILL BE CONSIDERED BY ASSUMING THE PERCENTAGES FOR A SIMILIAR APARTMENT SITE WHICH ARE GIVEN IN CHART XIA OF THE MASTER PLAN OF DRAINAGE FOR CITY OF ALBUQUERQUE AND ITS ENVIRONS BY HERKENHOFF AND ASSOCIATES. THE PERCENTAGES ARE AS FOLLOWS WITH THE CORROSPONDING AREAS:

TYPE OF SURFACE	% OF TOTAL AREA	AREA
ROOF	21	2.04 ACRES
PAVING	42	4.07 ACRES
UNDAMAGED LAWNS	11	1.07 ACRES
UNCLASSIFIED	26	2.52 ACRES
	100	9.70 ACRES

NATURAL APARTMENT SITE DRAINAGE

AREA = 9.70 ACRES
LENGTH OF LONGEST RUN = 1020 FT
SLOPE = 3.78%
I = 3.78 in/hr

$Q = CIA$

WHERE A = 9.7 ACRES
C = .25 NATURAL GROUND
I = 3.78 IN/HR

THEN

$Q = 9.17$ CFS

APARTMENT SITE DRAINAGE AFTER DEVELOPMENT

RUNOFF FROM ROOFS AND GRASSED AREAS WILL BE PONDED ON THE GRASSED AREAS.

ROOFED AREA = 2.04 ACRES

AMOUNT OF WATER = $2.04 \times 2.6^{*} \times \frac{1 in}{12 in}$ = 0.442 AC. FT.

W_{max} = 1.07 x .5 FT POND = .535 ACRE FT.

* RAINFALL FOR AREA 100 YR STORM 6 hr PRECIPITATION

WITH AN AVERAGE DROP OF .5 FT AROUND THE APARTMENTS, WATER WILL POND ON THE SURROUNDING LAND. THE ONLY RUNOFF WILL BE FROM THE PAVED AND UNCLASSIFIED AREAS WHICH IS:

PAVED AREA

$Q = CIA$ WHERE $A = 4.07$ ACRES
$C = 0.875$
$I = 3.78$ in/hr

THEN $Q = 13.46$ CFS

UNCLASSIFIED AREA

$Q = CIA$ WHERE $A = 2.52$ ACRES
$C = 0.25$
$I = 3.78$ in/hr

THEN $Q = 2.38$ CFS

THEREFORE TOTAL RUNOFF AFTER DEVELOPMENT IS

$13.46 + 2.38 = 15.84$ CFS OR AN INCREASED RUNOFF FROM THE APARTMENT SITE OF 6.67 CFS.

The design of the channel cross sections will be accomplished by use of the Manning and Chezy formulas. Two criteria must be met in the channel design: ① the channel must be able to carry the expected discharge and ② the velocity of flow must not exceed 5 ft/sec in the case of soil cross sections.

Ditch 3 will carry 19.93 cfs from area 3 to the intersection of Brandy and Mesa through the easement shown on the drainage plat.

Ditch 2 will carry 10.07 cfs from area 2 to Bethel through the easement shown on the

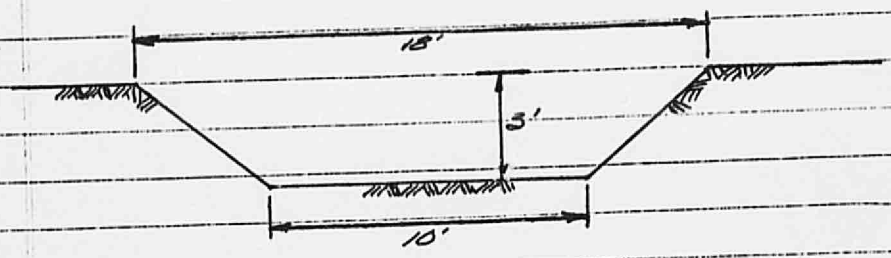
DRAINAGE PLAT. AS IN THE CASE OF DITCH 3, DITCH 2 WILL BE CONSTRUCTED OF SOIL.

DITCH 1 WILL BE DESIGNED TO CARRY THE DISCHARGE FROM AREAS 1, 2 AND 3 AND THE PROPERTY SOUTH OF THE 60' DRAINAGE EASEMENT. THIS DISCHARGE IS 686.7 CFS FOR THE EASTERLY HALF OF THE DITCH TO MESA DRIVE. THE WESTERLY HALF, FROM MESA TO UNIVERSITY, WILL BE DESIGNED TO CARRY 746.87 CFS.

DITCH 1

SECTION AA'

$Q_{100} = 686.7$ CFS $S = 3.5\%$



$Q = VA$

$V = c\sqrt{rs}$ WHERE r = HYDRAULIC RADIUS

s = SLOPE

c = CHEZY COEFFICIENT

$$c = \frac{1.811/n + 41.66 + .00281/s}{1 + n/\sqrt{r}\,(41.66 + .00281/s)}$$

WHERE $n = 0.022$

$s = 3.5\%$

$r = A/P = 2.1$

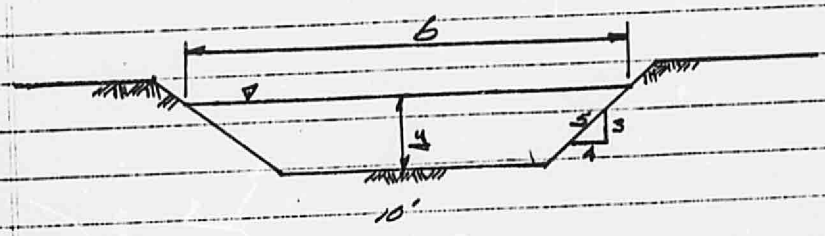
$c = 75.86$

THEN $V = 75.86\sqrt{2.1 \times .035} = 20.56$ FT/SEC

$Q = 20.56 \times 42 = 863.52$ CFS

THEREFORE CHANNEL WILL CARRY THE EXPECTED FLOW

WATER DEPTH IN CHANNEL FOR $Q_{100} = 686.7$ CFS



ASSUME $y = 2.62$ FT.

THEN $A = 55.34$ FT^2 $\quad b = 16.98$ FT

$p = 18.733$ FT

$R^{2/3} = \left(\frac{A}{P}\right)^{2/3} = 1.53$

$S = 5.5\%$ $\quad S^{1/2} = 0.187$

$n = 0.022$

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

$Q_{100} = 685$ CFS

THEN $y = 2.62$ FT

$V_{100} = Q/A = 12.43$ FT/SEC

SECTION ZB'

"EXPERIMENTS OF ZIPPEN AND KNAPP SHOWED THAT IN SUPERCRITICAL FLOW THE MAXIMUM AND MINIMUM SURFACE LEVELS WERE SYMMETRICALLY PLACED ABOUT THE UPSTREAM SURFACE LEVEL. THE WATER SURFACE THEREFORE RANGES BETWEEN LIMITS $v^2 b/rg$ ABOVE AND BELOW THE UPSTREAM SURFACE." *

$$\text{RISE} = v^2 b/rg$$

WHERE v = VELOCITY
b = WIDTH OF WATER SURFACE IN CHANNEL
r = RADIUS OF CURVE
$g = 32.2$ FT/SEC^2

$v = 19.43$ FT/SEC
$b = 16.98$ FT
$r = 745.76$ FT
$g = 32.2$ FT/SEC^2

$\therefore$ RISE $= 0.27$ FT

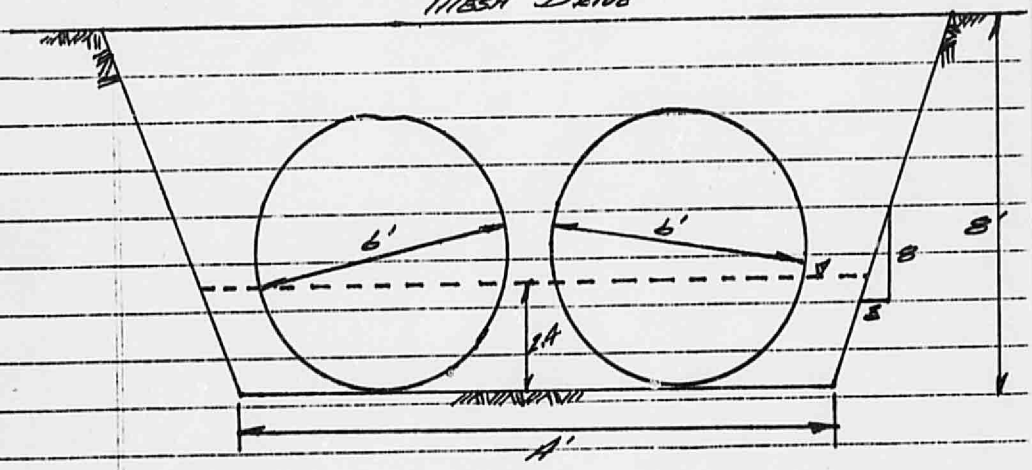
TOTAL DEPTH AT OUTSIDE OF CHANNEL $= 2.62 + .27 = 2.89$ FT.

* Open Channel Flow; Henderson. 1966 p. 254

ENTRANCE OF WATER AT CULVERTS UNDER MESA DRIVE:

Assume depth of water in channel at an infinitesimal distance from the culverts to be equal to 2.4 ft

MESA DRIVE



THEN

$$A_2 = \frac{14 + 15.8}{2} \times 2.4 = 35.76 \text{ ft}^2$$

$$V_2 = \frac{V_1 A_1}{A_2}$$

$V_1 = 19.43$ ft/sec, $A_1 = 36.54$ ft^2 } UPSTREAM CONDITIONS

$A_2 = 35.76$ ft^2

$V_2 = 19.20$ ft/sec

VELOCITY HEAD IN CHANNEL $= V_2^2/2g = 5.75$ ft.

TRANSITION FROM CHANNEL TO CULVERTS:

$V_3 = \frac{V_2 A_2}{A_3}$ $V_2 = 10.20$ FT/SEC

$A_2 = 35.76$ FT^2

A_3 = Two 6' dia culverts = 56.54 FT^2

$V_3 = 12.10$ FT/SEC

VELOCITY HEAD IN CULVERTS = $\frac{V_3^2}{2g}$ = 2.27 FT

VELOCITY HEAD LOSSES = 5.73 - 2.27 = 3.46 FT

ENTRANCE HEAD LOSSES = $k \frac{v^2}{2g}$ WHERE $k = 0.23$

ENTRANCE HEAD LOSSES = 0.52 FT

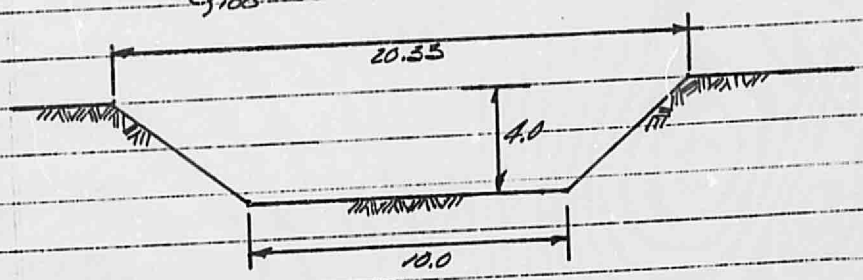
TOTAL HEAD LOSSES = 3.98 FT

TOTAL AVAILABLE HEAD = 5.60 FT

THEREFORE CULVERTS WILL CARRY EXPECTED RUNOFF.

SECTION EE'

$Q_{100} = 746.87$ cfs $S = 1\%$



$Q = VA$

$V = c\sqrt{rs}$ WHERE r = HYDRAULIC RADIUS

s = SLOPE

c = CHEZY COEFFICIENT

$$c = \frac{1.811/n + 41.66 + .00281/s}{1 + n/\sqrt{r}\,(41.66 + .00281/s)}$$

WHERE $n = .022$

$r = A/p = 2.60$

$s = 1\%$

$c = 80.43$

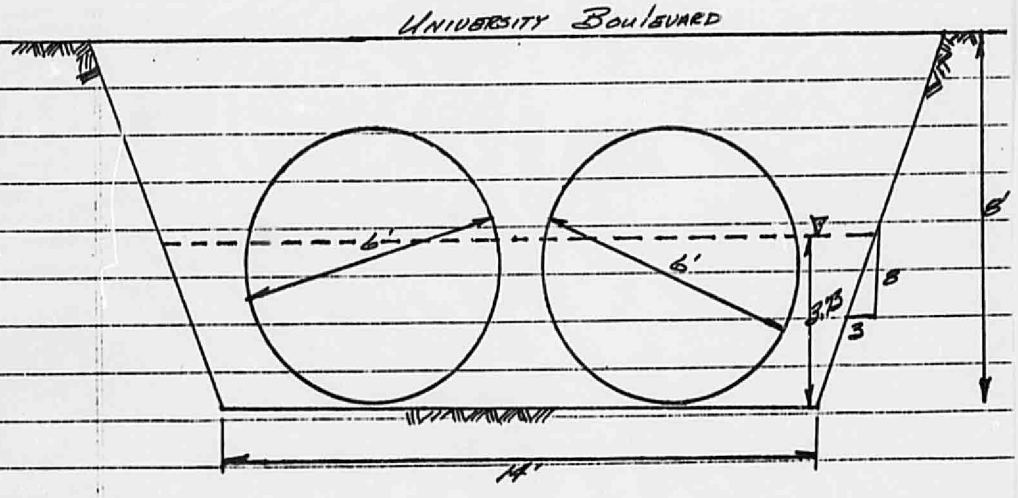
THEN $V = 80.43\sqrt{2.6 \times .01} = 12.97$ ft/sec

$Q = VA = 786.70$ cfs

THEN CHANNEL WILL CARRY EXPECTED FLOW

ENTRANCE OF WATER AT CULVERTS UNDER UNIVERSITY BOULEVARD.

$Q_{100} = 746.87$ THEREFORE, BY TRIAL AND ERROR CALCULATIONS THE DEPTH OF WATER AT AN INFINTESIMAL DISTANCE FROM CULVERTS IS EQUAL TO 3.73 FT.



THEN $A = \frac{14 + 16.80}{2} \times 3.73 = 57.44$ FT²

$V = Q/A =$ WHERE $Q_{100} = 746.87$ CFS
$A = 57.44$

$V = 13.00$ FT/SEC

VELOCITY HEAD IN CHANNEL $= V^2/2g = 2.62$ FT

TRANSITION FROM CHANNEL TO CULVERTS:

$V_2 = \frac{V_1 A_1}{A_2}$ WHERE $V_1 = 13.00$ FT/SEC, $A_1 = 57.44$ FT² } UPSTREAM CONDITIONS

$A_2 = 2\text{-}6'$ DIA PIPES $= 56.54$ FT²

$V_2 = 13.2$ FT/SEC

VELOCITY HEAD IN CULVERT $= \frac{V_2^2}{2g} = 2.71$ FT

VELOCITY HEAD LOSSES $= 2.71 - 2.62 = 0.09$ FT

ENTRANCE HEAD LOSSES $= k \frac{v^2}{2g}$

WHERE $k = 0.23$

ENTRANCE HEAD LOSSES $= 0.62$ FT

TOTAL HEAD LOSSES $= 0.71$ FT

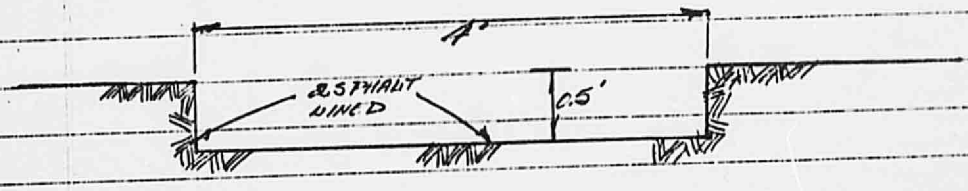
AVAILABLE HEAD $= 4.27$ FT

THEREFORE CULVERTS WILL CARRY FLOW.

DITCH 2

$Q = 10.07$ cfs

Slope = 4.8%



$A = bh = 4 \times .5 = 2\ ft^2$

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$

$A = 2\ ft^2$

$S = .048 \quad S^{1/2} = .219$

$n = .022$ asphalt

$R = A/P = 0.4$

$R^{2/3} = 0.542$

$Q = \frac{1.49}{.022} \times .542 \times .219 \times 2 = 16.08$ cfs

$10.07 < 16.08$ THEREFORE CHANNEL WILL CARRY THE WATER

Ditch 3.

$Q = 19.93$ cfs

Slope = 6.1%

$A = bh = 5 \times 1/2 = 2.5 \text{ ft}^2$

$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$

$A = 2.5 \text{ ft}^2$

$S = .064 \quad S^{1/2} = .252$

$n = .022$ ASPHALT

$R = A/P = 2.5/5 = .46$

$R^{2/3} = .557$

$Q = \frac{1.49}{.022} \times .557 \times .252 \times 2.5 = 23.77$ cfs

19.93 cfs < 23.77 cfs THEREFORE CHANNEL WILL CARRY THE EXPECTED RUNOFF

BIBLIOGRAPHY

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4. Open Channel Flow; Henderson, 1966.