RETURN WITHIN 2 WEEKS TO:
CITY OF COLORADO SPRINGS
STORM WATER & SUBDIVISION
101 W. COSTILLA , SUITE 113
COLORADO SPRINGS, CO 80903
(719) 578-6212

STORM DRAINAGE MASTER PLAN

HEWLETT-PACKARD AT BRIARGATE

COLORADO SPRINGS, COLORADO

GINGERY ASSOCIATES, INC.

CONSULTING ENGINEERS

2840 SO. VALLEJO ST.
ENGLEWOOD, COLO.
80110 (303) 761-4860

City Set

PD DP80-46-A3(83)

STORM DRAINAGE MASTER PLAN

HEWLETT-PACKARD AT BRIARGATE

COLORADO SPRINGS, COLORADO

April 1983

Prepared For:

Hewlett-Packard Corporation
1501 Page Mill Road, 29u
Palo Alto, California 94304
thru:
Fisher, Reece & Johnson, Architects, P.C.
1500 South Pearl Street
Denver, Colorado 80210

Prepared By:

Gingery Associates, Inc.
2840 South Vallejo Street
Englewood, Colorado 80110
(303)761-4860

G.A.I. Job No. 3164.003

Engineer's Statement

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by the negligent acts, errors or omissions on my part in preparing this report.

Bruce Prommersberger
Colorado Professional Engineer, No. 15689
Project Manager

Developer's Statement

The Developer and/or his representative has read and will comply with all the requirements specified in this drainage report and plan.

Hewlett-Packard

Conditions:
1. Resolving the descrepancy in the flow quantities between this report and previously filed report for Contrails Subdivision prepared by Donell Jeffries, P.E.
2. Letter of amendment showing the results of Item No. 1.
3. Reimbursement based upon the cost of a concrete channel for the major flow.
4. Developer's signature.
5. Easements for all public facilities including maintenance road along major chn'l.

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.

Gary R. Haynes 7-5-83
City Engineer Date

← Subject to Conditions

Storm Drainage Master Plan
Hewlett-Packard at Briargate
Colorado Springs, Colorado

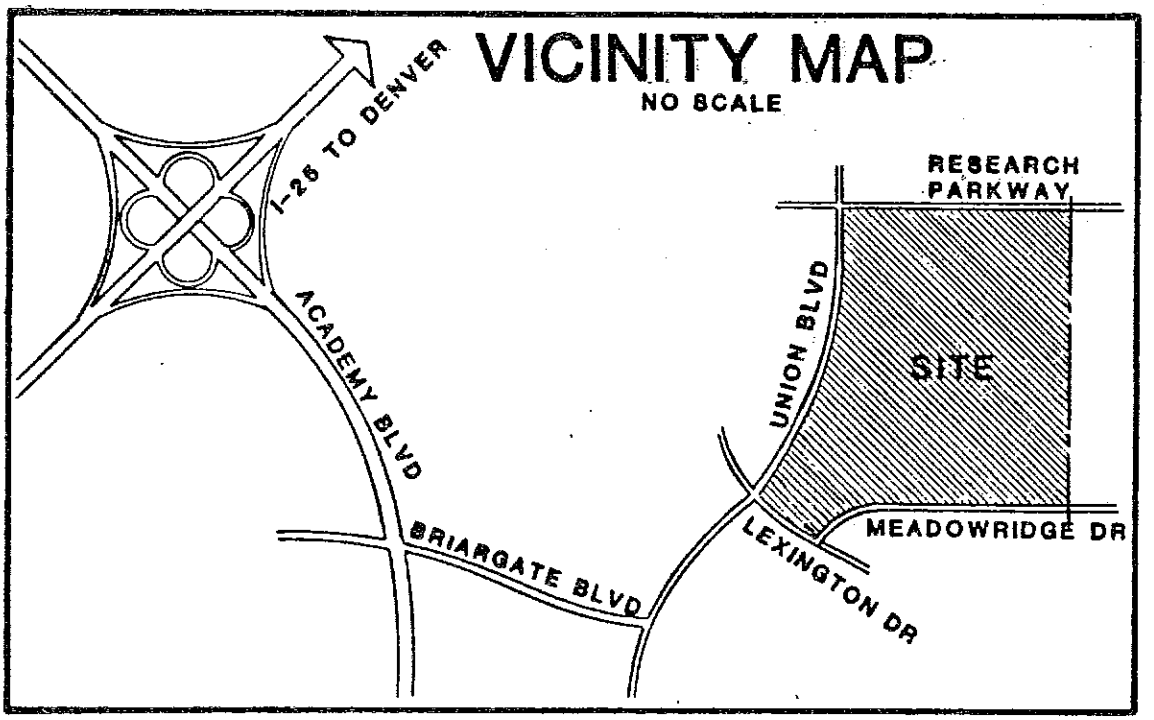
Objective

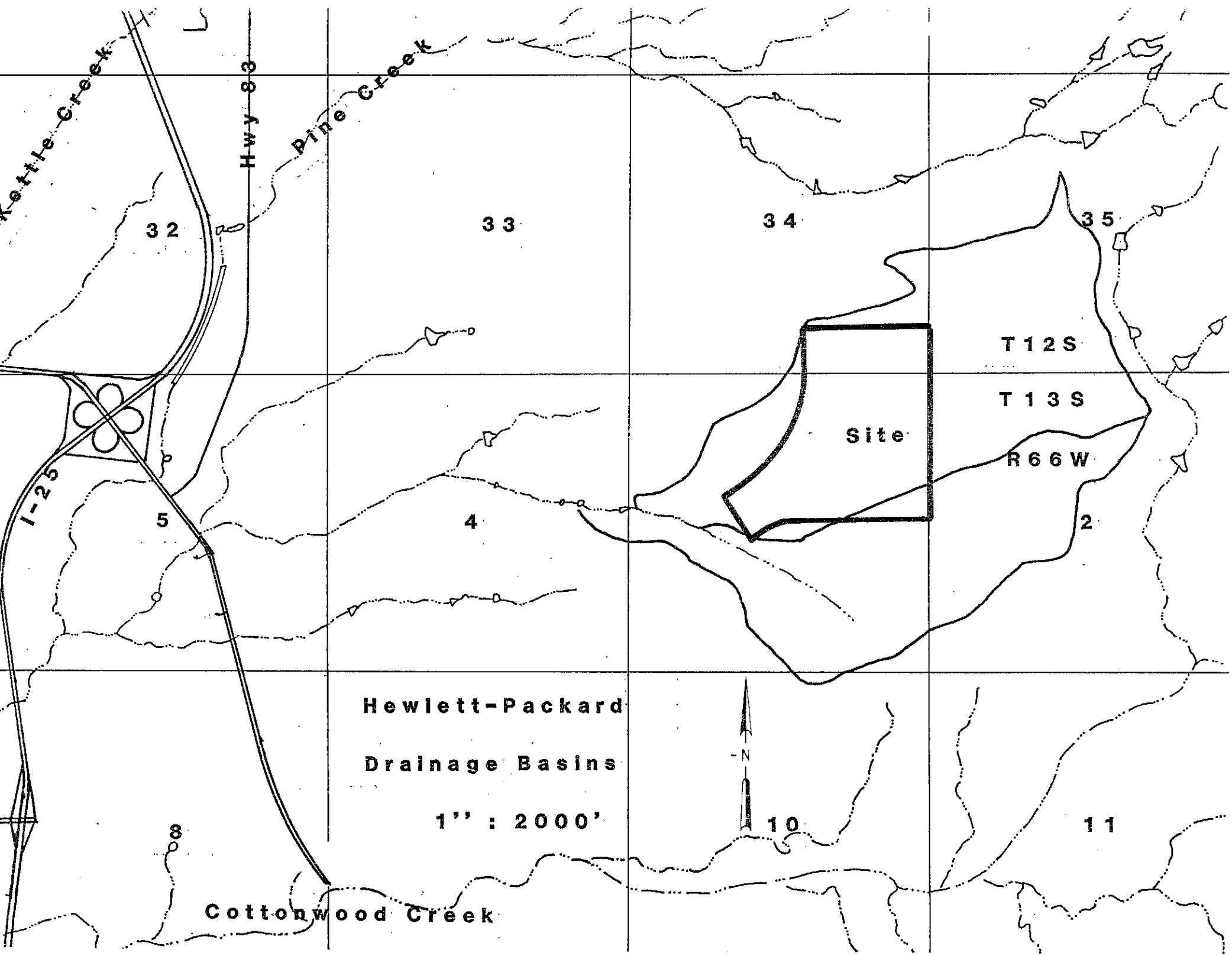
This report presents results of a storm drainage study for Hewlett-Packard at Briargate in Colorado Springs, Colorado. This report is intended to be a master plan to define the drainage facilities required for this site. The plan will assure continuity of drainage design as the site progresses through its planned phased development. The master plan describes drainage facilities to safely handle stormwater runoff when the site is fully developed as presently planned. A detailed design will be required as each phase is developed.

Location

The vicinity map and drainage basin map included in this report show the location of the Hewlett-Packard site. The site is located in the southeast quarter of Section 34, Township 12 South, Range 66 West, and the northeast, northwest and southwest quarters of Section 3, Township 13 South, Range 66 West, of the Sixth Principal Meridian, El Paso County, Colorado.

The 206-acre site is tributary to Cottonwood Creek. Approximately 307 acres upstream contribute additional runoff onto the site. The site is currently undeveloped and has a cover of native grasses. The soil for the entire site is Blakeland loamy sand. This is a deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. Blakeland loamy sand belongs to hydrologic soil group A.


VICINITY MAP
NO SCALE
I-25 TO DENVER
ACADEMY BLVD
BRIARGATE BLVD
RESEARCH PARKWAY
UNION BLVD
SITE
MEADOWRIDGE DR
LEXINGTON DR


Kettle Creek
Hwy 83
Pine Creek
32
33
34
35
T12S
T13S
R66W
Site
I-25
5
4
2
Hewlett-Packard
Drainage Basins
1'' : 2000'
N
8
10
11
Cottonwood Creek

Drainage Considerations

The site generally drains from northeast to southwest. Stormwater runoff from the north will be intercepted by Research Parkway and carried to the east where it will be conveyed through drainage facilities provided for the subdivision to the east. Offsite flows enter the site from the east at two points shown on the drainage plan as design points 23 and 27. No runoff enters the site from either the west or the south.

The site is generally divided into five drainage zones.

1. Runoff from the northwest portion of the site is conveyed south along the perimeter road and Union Boulevard to the existing manhole at the driveway across from Brigantine Drive and then to the existing storm sewer which continues down Union.
2. Runoff from a small strip from Brigantine to Lexington Drive along Union is collected in existing inlets to the storm sewer in Union Boulevard.
3. The finished grades cause runoff in the central part of the site to INTERIOR SYSTEM drain to the middle of the site, often to low points on the north side of the proposed buildings. The runoff in this portion of the site is collected and conveyed by a series of pipes south to the major collection facilities along Meadow Ridge Drive. This system is sized for the 100-year storm.
4. Runoff from the east side of the site and from offsite sources to the east are collected and conveyed by pipe and concrete channel south along the east property line and west along the south property line. Flows in the channel will be supercritical. This channel terminates at the driveway off Meadow Ridge Drive. From here, flow continues in a

reinforced concrete box culvert. Approximately 230 feet downstream from the entrance to the box culvert, runoff from the central portion of the site joins with the runoff from the east side of the site and the offsite flows.

5. Runoff from the southwest portion of the site is collected and conveyed to the box culvert.

Hydrology

Hydrology is computed by SCS TR55, Urban Hydrology for Small Watersheds, as required by City of Colorado Springs Determination of Storm Runoff Criteria, March 1977. Information regarding offsite flows is taken from Drainage Study Kembridge Point at Briargate Filing No. 1, January 9, 1983, by Donell Jeffries. Soil information is taken from Soil Survey of El Paso County Area, Colorado, Soil Conservation Service, June 1981. Hydrologic computations are included in the Appendix.

Drainage Facilities

Drainage facilities are sized for the 5-year or 100-year storms as appropriate. The majority of the inlets and storm sewers are sized for the 100-year storm due to site grading constraints. These constraints exist due to natural topography and the need to maintain certain building elevations to conform with the overall architectural plan. Where drainage facilities are sized to collect the 5-year storm, runoff in excess of the 5-year storm will travel in the streets and will eventually flow to the existing concrete channel at Lexington and Meadow Ridge. Computations for sizing the drainage facilities are included in the Appendix.

Storm Sewers

The storm sewer system, as planned, is a system of inlets, reinforced concrete pipe, reinforced concrete box culverts and concrete channel. Hydraulic computations and preliminary design data are included in the Appendix.

The major constraint to the system is the two existing 66-inch culverts at Lexington and Meadow Ridge. These culverts are sized to handle 675 cfs. Calculations in this study indicate that 1,080 cfs will reach this point. Three alternatives are available to solve this problem.

1. Leave the crossing as it is now. Pressurize the box culvert to develop sufficient head to pass 1,080 cfs.
2. Install a third 66-inch culvert and reconstruct one branch of the concrete channel from the discharge end of the three culverts to the main channel.
3. Remove the two existing culverts, lower the water main, and continue the box culverts across Lexington to the channel.

For all three alternatives, an energy dissipator will be required at the discharge end of the culverts. The current plan and cost estimate shows Alternative 1, which is the least expensive. Alternative 3, however, would function the best.

Cost Estimate

The construction cost estimate for the Hewlett-Package storm drainage facilities is $2,236,400.. These estimated costs of construction are intended to provide Hewlett-Packard and the City of Colorado Springs an indication of the costs involved and are considered to be an estimate only. We, as engineers, have

no control over the cost of labor and materials, or competitive bidding, and cannot guarantee the accuracy of the construction costs. The unit prices used in the estimate reflect estimated current costs and do not provide for inflation. Although this is a planned phased development, no exact buildout schedule is available, so inflationary costs cannot be estimated.

Erosion and Sedimentation Control

Blakeland loamy sand requires good erosion control to minimize soil losses and sedimentation downstreem. When protective cover is removed, soil blowing is a hazard. An erosion control plan must be developed with the storm sewer design as each phase of the site is constructed.

APPENDIX

GINGERY ASSOCIATES, INC.
CONSULTING ENGINEERS
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DESIGN CALCULATIONS

Project_____
Feature_____
Designed____ Date____ Sht.____ of____
Checked____ Date____ Job No.____

HYDROLOGY

GINGERY ASSOCIATES, INC.
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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 1 of 18
Checked [illegible] Date 4/13/83 Job No. 3164.003

BASIN	AREA (ACRES)	AREA (SQ. MI.)	SOIL TYPE	LAND USE	CURVE NO.	BASIN HT. (FT.)	BASIN LENGTH (FT.)	TIME CONC. (HR.)	GSM IN	5 YEAR RUNOFF (IN.)	5 YEAR PEAK Q (CFS)	100 YEAR RUNOFF (IN.)	100 YEAR PEAK Q (CFS)
A	3.85	.006	A	ROAD & LAWN	74	84	1820	.118	1230	0.40	3.0	1.24	9.2
B	1.22	.002	A	ROAD & LAWN	74	49	880	.052	1410	0.40	1.1	1.24	3.5
C	7.26	.011	A	LAWN & ROAD	48	96	1550	.197	1080	—	—	0.15	1.8
D	5.96	.009	A	LAWN & ROAD	48	101	1110	.109	1250	—	—	0.15	1.7
E	2.40	.004	A	LAWN & ROAD	45	55	700	.097	1290	—	—	0.08	0.4
F	1.65	.003	A	LAWN & ROAD	63	57	2040	.167	1130	0.13	0.4	0.66	2.2
G	4.43	.007	A	LAWN	39	56	1860	.282	950	—	—	0.01	0.1
H	OFFSITE												443
I	2.15	.003	A	ROAD & LAWN	74	36	850	.059	1400	0.40	1.7	1.24	5.2
J	1.69	.003	A	LAWN & ROAD	51	31	870	.064	1380	0.003	0.1	0.22	0.9
K	3.31	.005	A	ROAD, BLDG & LAWN	69	14	720	.071	1370	0.25	1.7	0.95	6.5
L	6.44	.010	A	BLDG, PARKING & LAWN	92	14	620	.057	1400	1.33	18.6	2.64	37.0
M	8.70	.014	A	BLDG, PARKING & LAWN	89	8	875	.122	1220	1.11	19.0	2.36	40.3
N	3.84	.006	A	ROAD & LAWN	89	19	550	.058	1400	1.11	9.3	2.36	19.8
O	3.85	.006	A	PARKING & LAWN	92	21	850	.102	1275	1.33	10.2	2.64	20.2
P	1.15	.002	A	PARKING & LAWN	92	9	240	.017	1493	1.33	4.0	2.64	7.9
Q	12.16	.019	A	BLDG, PARKING & LAWN	89	16	1250	.223	1020	1.11	21.5	2.36	45.7
													202.4

GINGERY ASSOCIATES, INC.
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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 2 of 18
Checked LWG Date 4/13/83 Job No. 3164.003

BASIN	AREA (ACRES)	AREA (SQ. MI.)	SOIL TYPE	LAND USE	CURVE NO.	BASIN (HT. FT.)	BASIN LENGTH (FT.)	TIME CONC. (HR.)	CSM/IN	5 YEAR RUNOFF (IN.)	5 YEAR PEAK Q (CFS)	100 YEAR RUNOFF (IN.)	100 YEAR PEAK Q (CFS)
R	6.00	.009	A	BLDG, PARKING & LAWN	92	12	850	.098	1290	1.33	15.4	2.64	30.7
S	5.10	.008	A	BLDG, PARKING & LAWN	92	4	330	.042	1430	1.33	15.2	2.64	30.2
T	3.82	.006	A	BLDG, PARKING & LAWN	92	4	380	.050	1415	1.33	11.3	2.64	22.4
U	2.30	.004	A	ROAD & LAWN	71	16	800	.085	1320	0.31	1.6	1.06	5.6
V	0.58	.001	A	LAWN & ROAD	48	8	360	.033	1460	—	—	0.15	0.2
W	2.95	.005	A	ROAD, BLDG & LAWN	69	8	720	.095	1300	0.25	1.6	0.95	6.2
X	12.93	.020	A	ROAD, BLDG & LAWN	77	23	1130	.174	1120	0.50	11.2	1.43	32.0
Y	7.24	.011	A	BLDG, PARKING & LAWN	89	14	780	.080	1330	1.11	16.2	2.36	34.5
Z	3.76	.006	A	BLDG, PARKING & LAWN	92	10	560	.058	1400	1.33	11.2	2.64	22.2
AA	1.63	.003	A	ROAD	98	42	2230	.221	1040	1.87	5.8	3.27	10.2
BB	5.96	.009	A	LAWN & CONCRETE CHANNEL	86		2230	.031	1465	0.93	12.3	2.10	27.7
CC	OFFSITE												CUMULATIVE 702
DD	3.00	.005	A	PARKING & LAWN	89	10	750	.091	1305	1.11	7.2	2.36	15.4
EE	0.94	.001	A	PARKING & LAWN	54	13	520	.045	1425	0.02	0.1	0.31	0.4
FF	2.90	.005	A	PARKING & LAWN	89	10	540	.054	1405	1.11	7.8	2.36	16.6
GG	7.30	.011	A	PARKING, BLDG & LAWN	92	9	800	.106	1260	1.33	18.4	2.64	36.6
HH	4.19	.007	A	PARKING, BLDG & LAWN	95	7	470	.054	1405	1.58	15.5	2.94	28.9
													319.8

577.7

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 2-23-83 Sht. 3 of 18
Checked CM2 Date 4/12/83 Job No. 3164.003

BASIN	AREA (ACRES)	AREA (SQ. MI.)	SOIL TYPE	LAND USE	CURVE NO.	BASIN (MT. (FT.)	BASIN LENGTH (FT.)	TIME (conc.) (HR.)	CSM IN	5 YEAR RUNOFF (IN.)	5 YEAR PEAK Q (CFS)	100 YEAR RUNOFF (IN.)	100 YEAR PEAK Q (CFS)
II	5.04	.008	A	PARKING, BLDG & LAWN	92	5	470	.002	1390	1.33	14.8	2.64	29.4
JJ	2.92	.005	A	PARKING, BLDG & LAWN	95	5	500	.009	1365	1.58	10.8	2.94	20.1
KK	3.43	.005	A	ROAD & LAWN	69	38	1300	.100	1260	0.25	1.6	0.95	6.0
LL	2.05	.003	A	BLDG, ROAD & LAWN	74	10	750	.129	1215	0.40	1.4	1.24	4.5
MM	8.14	.013	A	BALLFIELD & ROAD	42	54	1640	.271	965	—	—	0.04	0.5
NN	1.08	.002	A	LAWN, ROAD & WALK	66	16	910	.094	1300	0.18	0.5	0.80	2.1
OO	9.90	.015	A	PARKING, BLDG & LAWN	89	19	550	.001	1390	1.11	23.1	2.36	49.2
PP	7.70	.012	A	PARKING, BLDG & LAWN	74	10	470	.045	1425	0.40	6.8	1.24	21.2
QQ	3.10	.005	A	BLDG, ROAD & LAWN	95	8	480	.051	1410	1.58	11.1	2.94	20.7
RR	8.00	.013	A	BLDG, PARKING & LAWN	89	9	830	.137	1195	1.11	17.2	2.36	36.7
SS	7.20	.011	A	PARKING, BLDG & LAWN	95	17	700	.063	1385	1.58	24.1	2.94	44.8
TT	7.32	.011	A	BALLFIELD, ROAD & BLDG	45	44	680	.105	1265	—	—	0.08	1.1
UU	2.43	.004	A	LAWN, ROAD & WALK	51	15	1500	.208	1060	0.003	0.1	0.22	0.9
VV	2.30	.004	A	LAWN, ROAD & WALK	54	41	1650	.186	1095	0.02	0.1	0.31	1.4
													238.6
													760.8

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed JMB Date 3-23-83 Sht. 4 of 18
Checked BDR Date 3-23-83 Job No. 3164.003

COMPUTATION OF BASIN AREAS BY PLANIMETER/DIGITIZER

BASIN	AREA (ACRES)	AREA (SQ. MI.)	BASIN	AREA (ACRES)	AREA (SQ. MI.)
A	3.85	0.006	AA	1.63	0.003
B	1.22	0.002	BB	5.96	0.009
C	7.26	0.011	CC	OFFSITE	
D	5.96	0.009	DD	3.00	0.005
E	2.40	0.004	EE	0.94	0.001
F	1.65	0.003	FF	2.90	0.005
G	4.43	0.007	GG	7.30	0.011
H	OFFSITE		HH	4.19	0.007
I	2.15	0.003	II	5.04	0.008
J	1.69	0.003	JJ	2.92	0.005
K	3.31	0.005	KK	3.43	0.005
L	6.44	0.010	LL	2.05	0.003
M	8.70	0.014	MM	8.14	0.013
N	3.84	0.006	NN	1.08	0.002
O	3.85	0.006	OO	9.90	0.015
P	1.15	0.002	PP	7.70	0.012
Q	12.16	0.019	QQ	3.10	0.005
R	6.00	0.009	RR	8.00	0 013
S	5.10	0.008	SS	7.20	0.011
T	3.82	0.006	TT	7.32	0.011
U	2.30	0.004	UU	2.43	0.004
V	0.58	0.001	VV	2.30	0.004
W	2.95	0.005			
X	12.93	0.020			
Y	7.24	0.011			
Z	3.76	0.006			
	114.74	0.180		96.53	0.151
				211.27	0.331

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 5 of 18
Checked GWS Date 4/13/83 Job No. 3164.003

COMPUTATION OF RUNOFF CURVE NUMBERS

USE TABLE 2-2, PAGE 2-5, SCS TR-55

ENTIRE SITE IS BLAKELAND LOAMY SAND → SOIL TYPE A

BASIN	DESCRIPTION	CN
A	ROAD 60% LAWN 40% 0.60(98) + 0.40(39) = 74	74
B	ROAD 60% LAWN 40%	74
C	LAWN 85% ROAD 15% 0.85(39) + 0.15(98) =	48
D	LAWN 85% ROAD 15%	48
E	LAWN 90% ROAD 10% 0.90(39) + 0.10(98)	45
F	LAWN 60% ROAD 40% 0.60(39) + 0.40(98)	63
G	LAWN 100%	39
H	OFFSITE	
I	ROAD 60% LAWN 40%	74
J	LAWN 80% ROAD 20% 0.80(39) + 0.20(98)	51
K	ROAD & BLDG 50% LAWN 50%	69
L	BLDG & PARKING 90% LAWN 10% 0.90(98) + 0.10(39)	92
M	BLDG & PARKING 85% LAWN 15% 0.85(98) + 0.15(39)	89

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 6 of 18
Checked CGS Date 4/11/83 Job No. 3164.003

BASIN	DESCRIPTION	CN
N	ROAD 85% 0.85(98) + 0.15(39) LAWN 15%	89
O	PARKING 90% 0.90(98) + 0.10(39) LAWN 10%	92
P	PARKING 90% LAWN 10%	92
Q	BLDG & PARKING 85% LAWN 15%	89
R	BLDG & PARKING 90% LAWN 10%	92
S	BLDG & PARKING 90% LAWN 10%	92
T	BLDG & PARKING 90% LAWN 10%	92
U	ROAD 55% 0.55(98) + 0.45(39) LAWN 45%	71
V	LAWN 85% 0.85(39) + 0.15(98) ROAD 15%	48
W	ROAD & BLDG 50% 0.50(98) + 0.50(39) LAWN 50%	69
X	ROAD & BLDG 65% 0.65(98) + 0.35(39) LAWN 35%	77
Y	BLDG & PARKING 85% LAWN 15%	89
Z	BLDG & PARKING 90% LAWN 10%	92

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 7 of 18
Checked CLS Date 4/13/83 Job No. 3164.003

BASIN	DESCRIPTION		CN
AA	ROAD 100%		98
BB	LAWN 80% CONCRETE CHANNEL 20%	0.80(98) + 0.20(39)	86
CC	OFFSITE		
DD	PARKING 85% LAWN 15%	0.85(98) + 0.15(39)	89
EE	LAWN 75% ROAD 25%	0.75(39) + 0.25(98)	54
FF	PARKING 85% LAWN 15%		89
GG	PARKING & BLDG 90% LAWN 10%	0.90(98) + 0.10(39)	92
HH	PARKING & BLDG 95% LAWN 5%	0.95(98) + 0.05(39)	95
II	PARKING & BLDG 90% LAWN 10%		92
JJ	PARKING & BLDG 95% LAWN 5%		95
KK	ROAD 50% LAWN 50%	0.50(98) + 0.50(39)	69
LL	BLDG & ROAD 60% LAWN 40%	0.60(98) + 0.40(39)	74
MM	BALLFIELD 95% ROAD 5%	0.95(39) + 0.05(98)	42
NN	LAWN 55% ROAD & WALK 45%	0.55(39) + 0.45(98)	66
OO	PARKING & BLDG 85% LAWN 15%		89

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 8 of 18
Checked CHS Date 4/13/83 Job No. 3164.03

BASIN	DESCRIPTION		CN
PP	PARKING & BLDG 60% LAWN 40%	0.60(98) + 0.40 (39)	74
QQ	BLDG & ROAD 95% LAWN 5%	0.95 (98) + 0.05(39)	95
RR	BLDG & PARKING 85% LAWN 15%	0.85(98) + 0.15 (39)	89
SS	PARKING & BLDG 95% LAWN 5%		95
TT	BALLFIELD 90% ROAD & BLDG 10%	0.90(39) + 0.10(98)	45
UU	LAWN 80% ROAD & WALK 20%	0.80 (39) + 0.20(98)	51
VV	LAWN 75% ROAD & WALK 25%	0.75 (39) + 0.25 (98)	54

GINGERY ASSOCIATES, INC.
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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-88 Sht. 9 of 18
Checked GBS Date 4/13/88 Job No. 3169.003

DETERMINE CUMULATIVE CN FOR SITE

$$\Sigma CN = \frac{\Sigma (A \times CN)}{A} = \frac{16,451.49}{211.27} = 77.87$$

CHECK VS. PLANNING DATA

BUILDINGS & SUPPORT	18.1%	58.3%
PARKING & DRIVES	40.2%	
OPEN SPACE	41.7%	
	100.0%	

$CN = 0.583(98) + 0.417(39) = 73.40$

ANALYSIS

Δ = 5.8% MORE IMPERVIOUS THAN PLANNING DATA → CONSERVATIVE → OK

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DESIGN CALCULATIONS

Project HEWLETT PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 10 of 18
Checked CLS Date 9/13/83 Job No. 3164.003

COMPUTATION of TIME of CONCENTRATION

DETERMINE CHANGE IN ELEVATION FOR EACH SUB BASIN.

DETERMINE BASIN LENGTH.

DETERMINE BASIN SLOPE, $\Delta ER/LENGTH$.

USE FIGURE 3-1, PAGE 3-2, SCS TR-55, MARCH 1980 TO FIND VELOCITY.

$$t_c\ (HR) = \frac{1}{VELOCITY\ (FPS)} \times \frac{LENGTH\ (FT)}{3600\ (SEC/HR)}$$

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

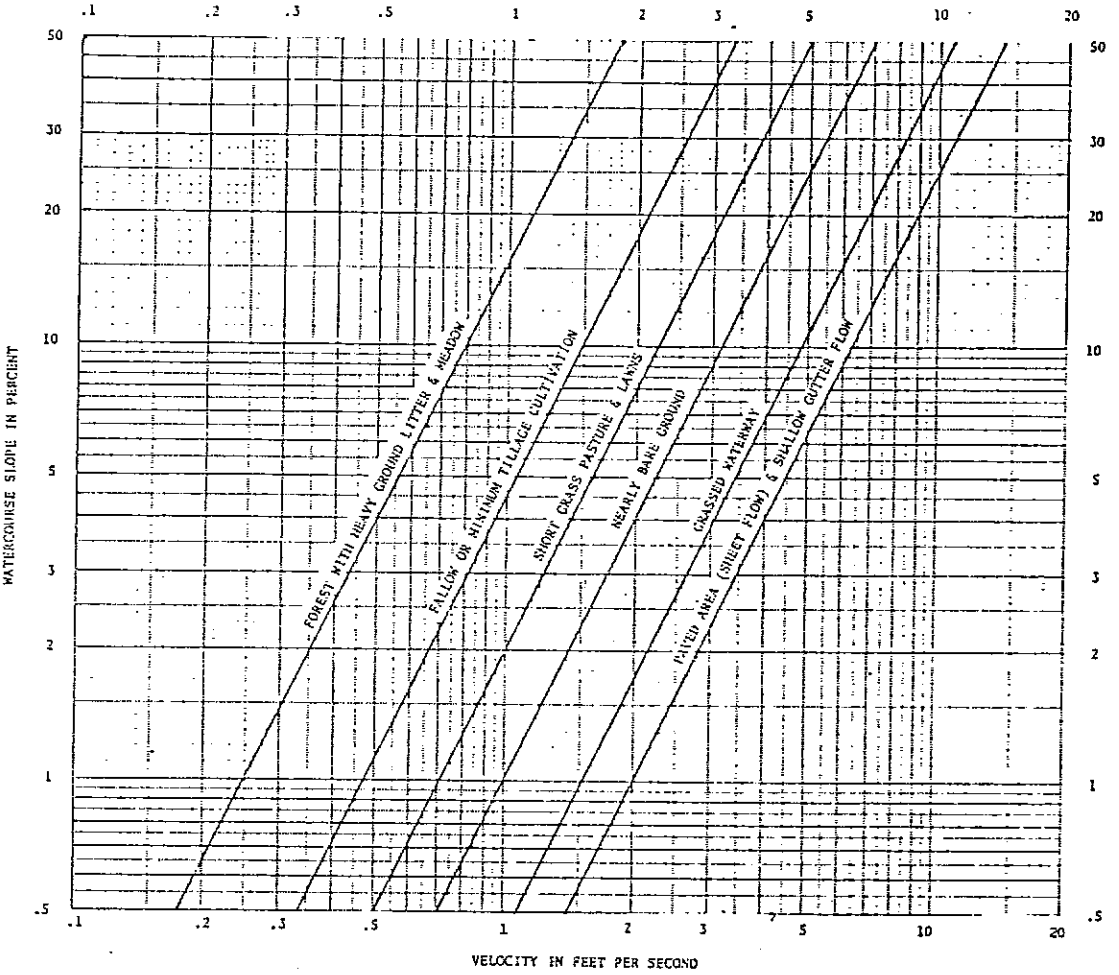

Figure 3-1.--Average velocities for estimating travel time for overland flow.

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

FIGURE 3-1
PAGE 3-2
SCS TR-55
MARCH 1980

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDF Date 3-21-83 Sht. 12 of 18
Checked LHS Date 4/17/83 Job No. 3164.03

BASIN	ΔEL (FT)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	t_c (HR)	Σt_c (IF REQD)
A	84	1820	4.6	4.3	.118	
B	49	880	5.6	4.7	.052	
C	83	300	27.7	3.7	.023	.197
	13	1250	1.0	2.0	.174	
D	87	300	29.0	3.8	.022	.109
	14	810	1.7	2.6	.087	
E	55	700	7.9	2.0	.097	
F	57	2040	2.8	3.4	.167	
G	46	1280	3.6	1.3	.274	.282
	10	580	1.7	20(EST)	.008	
H						OFFSITE
I	36	850	4.2	4.1	.058	
J	31	870	3.6	3.7	.064	
K	14	720	1.9	2.8	.071	
L	14	620	2.3	3.0	.057	
M	8	875	1.0	2.0	.122	
N	4	120	3.3	1.3	.026	.058
	15	430	3.5	3.7	.032	
O	4	170	2.4	1.1	.043	.102
	17	680	2.5	3.2	.059	
P	9	240	3.8	4.0	.017	
Q	7(EST)	400	1.8	1.0	.111	.223
	9	850	1.1	2.1	.112	
R	12	850	1.4	2.4	.098	
S	4	330	1.2	2.2	.042	
T	4	380	1.1	2.1	.050	
U	16	860	1.9	2.8	.085	
V	8	360	2.2	3.0	.033	

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 13 of 18
Checked CBS Date 4/13/83 Job No. 3169.003

BASIN	AREA (ET)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	t_c (HR)	t_c (IF REQD)
W	8	720	1.1	2.1	.095	
X	7(EST) 16	350 780	2.0 2.1	1.0 2.8	.097 .077	.174
Y	14	780	1.8	2.7	.080	
Z	10	560	1.8	2.7	.058	
AA	42	2230	1.9	2.8	.221	
BB		2230		20 (EST)	.031	
CC						OFFSITE
DD	10	750	1.3	2.3	.091	
EE	13	520	2.5	3.2	.045	
FF	10	540	1.9	2.8	.054	
GG	9	800	1.1	2.1	.106	
HH	7	470	1.5	2.4	.054	
II	5	470	1.1	2.1	.062	
JJ	5	500	1.0	2.0	.069	
KK	38	1300	2.9	3.4	.106	
LL	4 6	200 550	2.0 1.1	1.0 2.1	.056 .073	.129
MM	44 10	1070 570	4.1 1.8	1.4 2.7	.212 .059	.271
NN	16	910	1.8	2.7	.094	
OO	2 17	100 450	2.0 3.8	1.0 3.8	.028 .033	.061
PP	10	470	2.1	2.9	.045	
QQ	8	480	1.7	2.6	.051	
RR	2 7	130 700	1.5 1.0	0.9 2.0	.040 .097	.137
SS	17	700	2.9	3.1	.063	
TT	44	680	6.5	1.8	.105	

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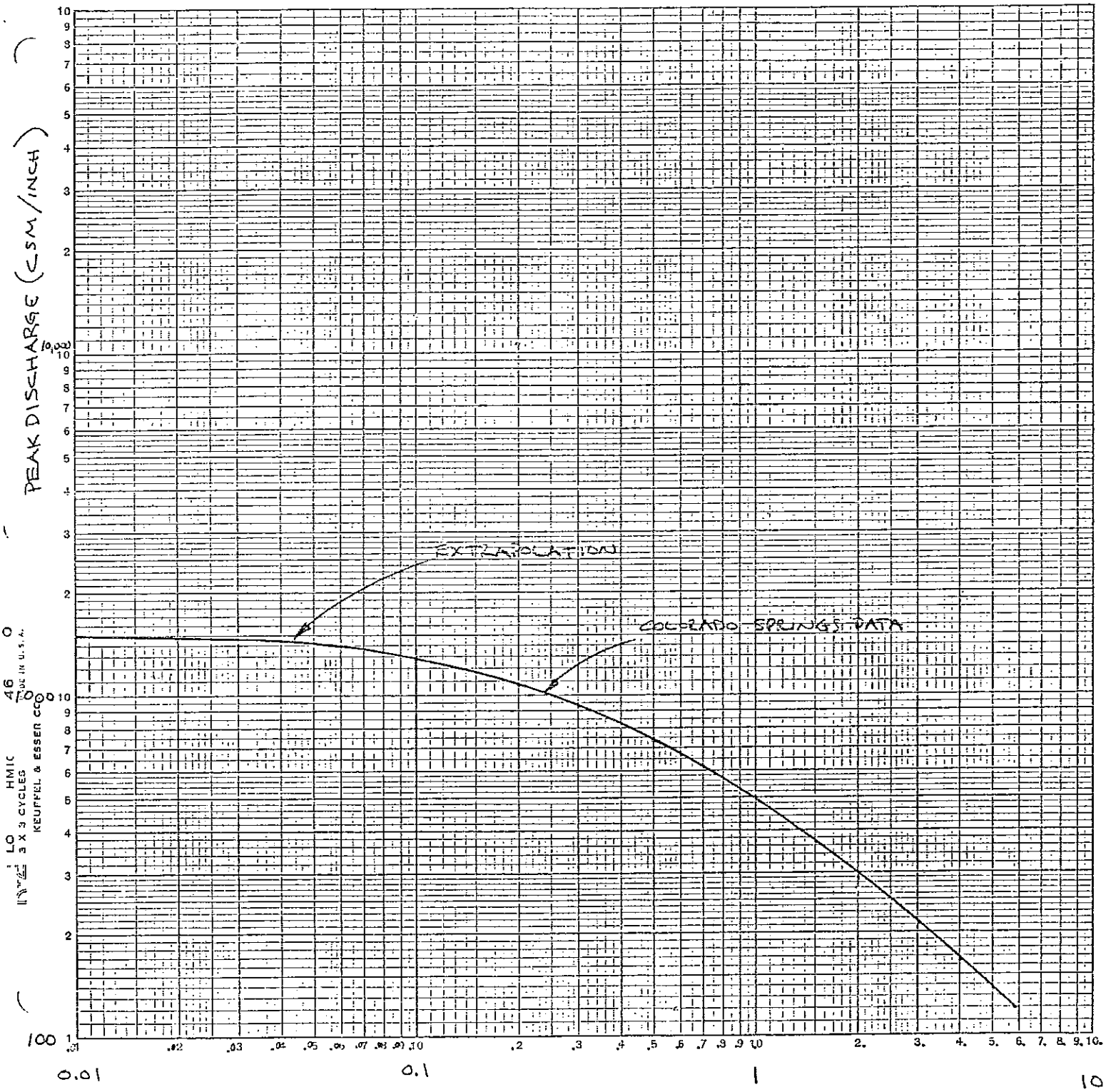
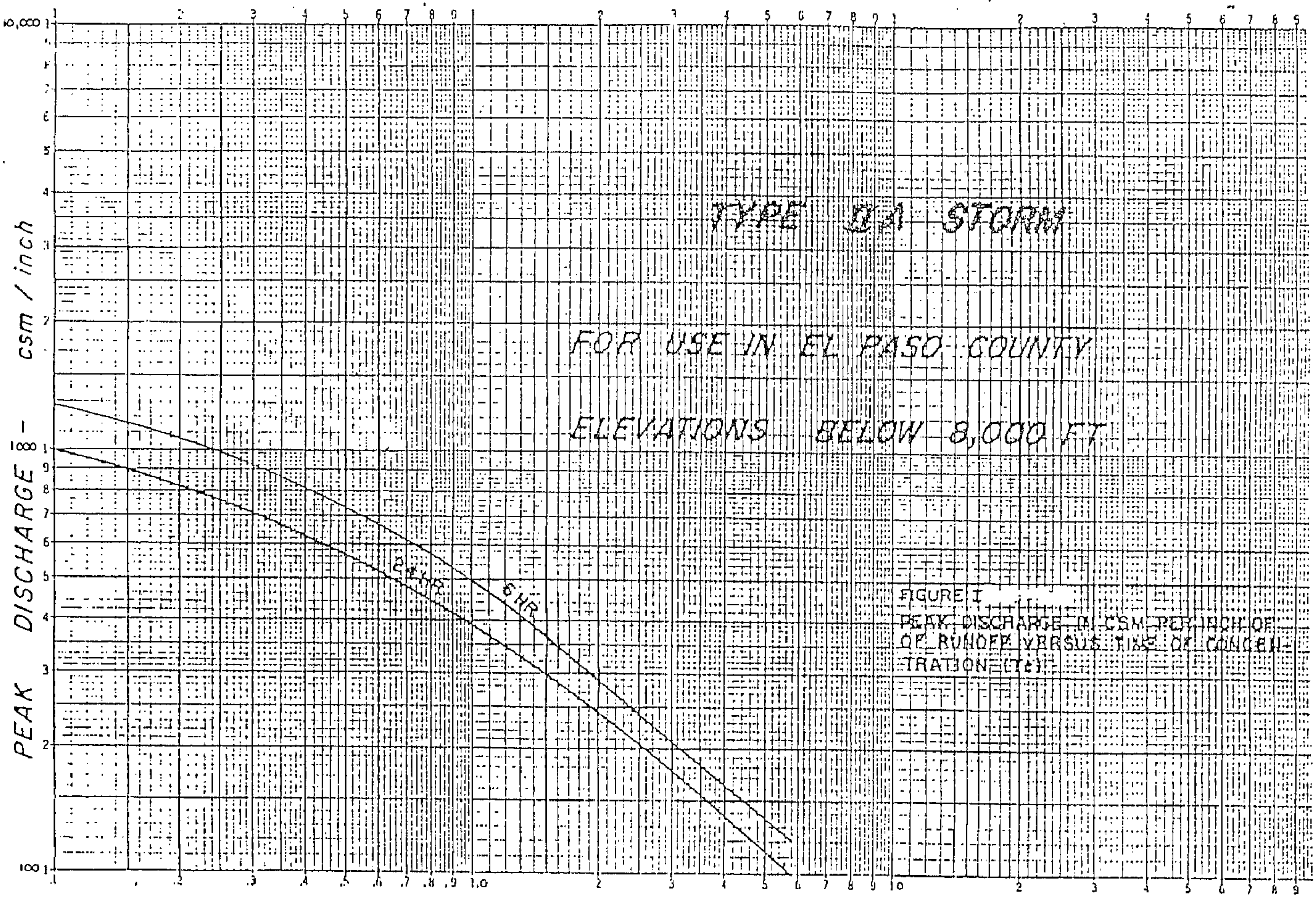
DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 14 of 18
Checked CBS Date 4/12/83 Job No. 3164.003

BASIN	ΔEL (FT)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	t_c (HR)	Σt_c (IF REQD)
UU	15	1500	1.0	2.0	.208	
VV	15 (EST)	300	5.0	1.6	.052	.186
	26	1350	1.9	2.8	.134	

t_c 0.01 - 0.1 EXTRAPOLATED FROM t_c 0.1 - 5.8 DATA PRESENTED FOR 6 HR TYPE II A STORM, COLORADO SPRINGS DRAINAGE CRITERIA, FIGURE I





TIME OF CONCENTRATION - HOURS
Revised 7-13-77 CA

FIGURE I

HEWLETT-PACKARD DRAINAGE HYDROL
BDP 3-23-83
16/18
3164.003

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE HYDROLOGY
Designed BDP Date 3-23-83 Sht. 17 of 18
Checked GDS Date 4/13/83 Job No. 3164-003

DETERMINE RUNOFF IN INCHES BY

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S}$$

$$S = \frac{1000}{CN} - 10$$

FIND POINT of ZERO RUNOFF FOR 5 YEAR STORM (2.1 INCHES)

$$0 = P - 0.2S$$

$$0 = 2.1 - 0.2\left(\frac{1000}{CN} - 10\right)$$

$$CN = 48.78$$

FIND POINT of ZERO RUNOFF FOR 100 YEAR STORM (3.5 INCHES)

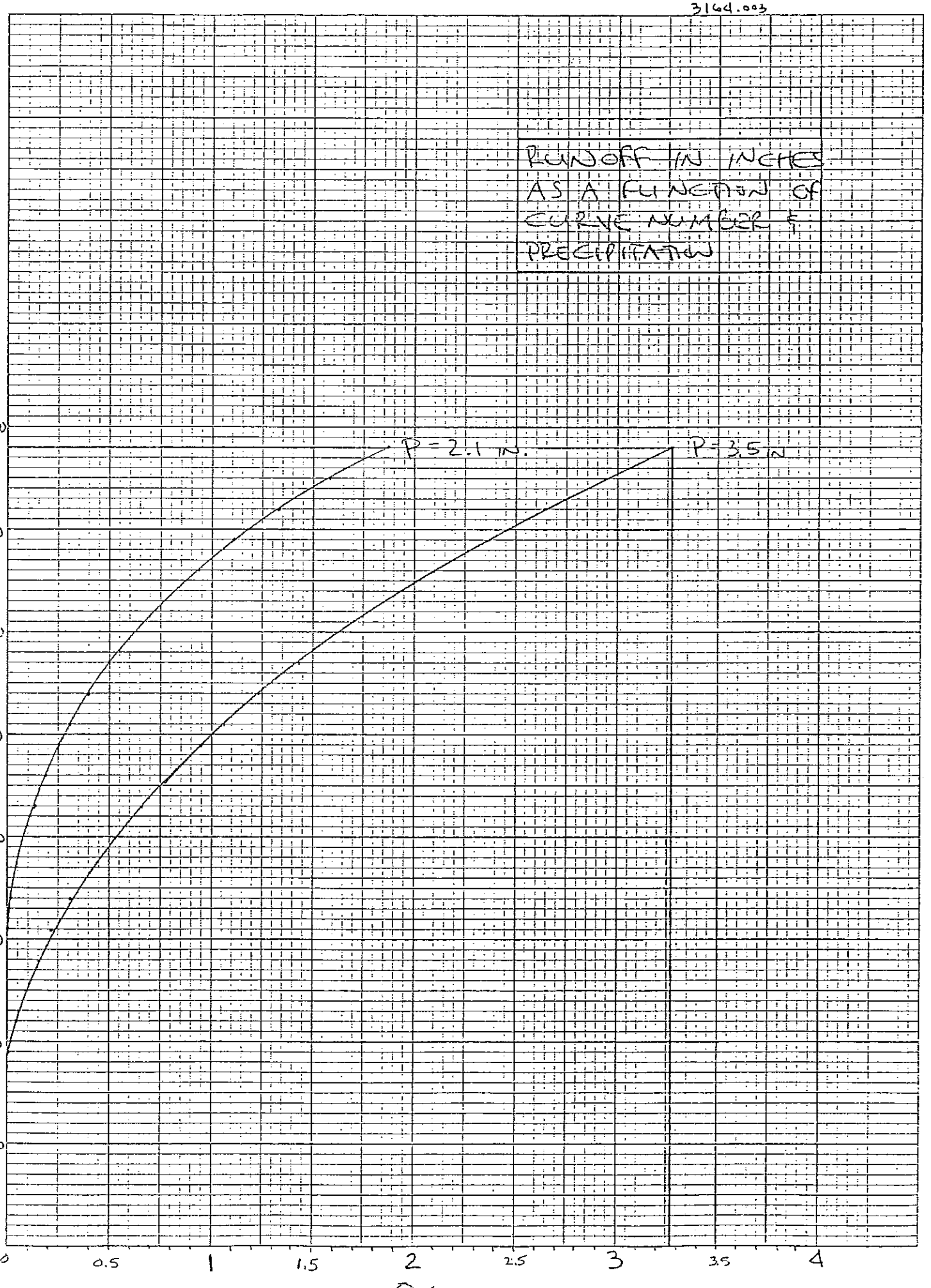
$$0 = P - 0.2S$$

$$0 = 3.5 - 0.2\left(\frac{1000}{CN} - 10\right)$$

$$CN = 36.36$$

HEWLETT-PACKARD DRAINAGE HYDROLOGY
BDP 3-23-83 18/18

3164.003



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DESIGN CALCULATIONS

Project_____
Feature_____
Designed____ Date____ Sht.____ of____
Checked____ Date____ Job No.____

DRAINAGE FACILITIES

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BJP Date 4-18-83 Sht. 1 of 18
Checked CGG Date 4/20/83 Job No. 3169.003

DESIGN SYSTEM ASSUMING $n = 0.015$ FOR RCP & NO LOSSES. WORK FROM U/S TO D/S.
WHEN PRELIMINARY IS COMPLETE, WORK FROM D/S TO U/S & CHECK USING $n = 0.013$ & LOSSES.

PERIMETER ROAD IS 6" VERTICAL CURB & 30' FF.

USE COLORADO SPRINGS D10R INLETS ALONG CURB.
USE CDOH TYPE 13 WHERE DESIGNATED IN PARKING LOTS. CDOH TYPE 13 TO BE PLACED IN 1 FT. SUMP.

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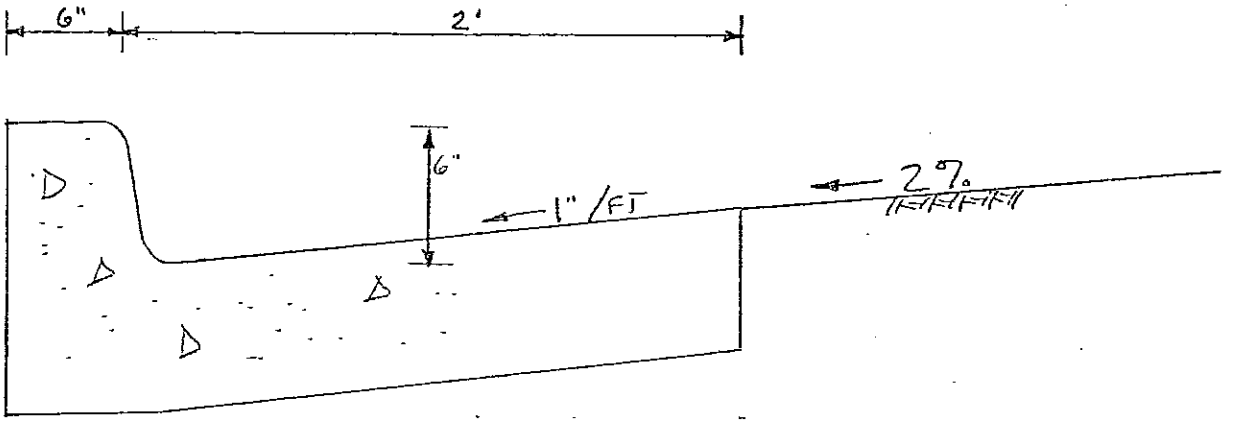
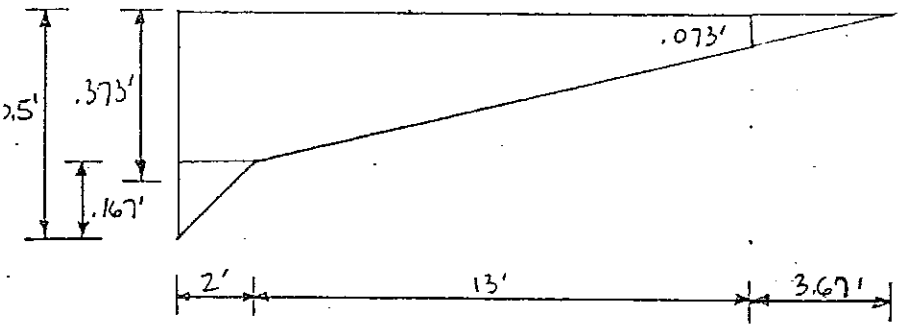
DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BLP Date 9-18-85 Sht. 2 of 18
Checked CDG Date 4/24/87 Job No. 3164.003



STREET IS 30' ℄ - ℄

ΔEL ℄ - CROWN = 2' (1"/FT) + 13' (0.02 FT/FT)(12"/FT) = 5.12"



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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BLK Date 4-18-88 Sht. 3 of 18
Checked CLS Date 4/28/88 Job No. 316.4.003

$$Q = 0.56 \frac{Z}{n} y^{8/3} S^{1/2}$$

Z = RECIPROCAL of CROSS SLOPE

n = 0.016

y = DEPTH of FLOW

S = SLOPE of STREET

$$Q = 0.56 \left[\frac{1/0.02}{0.016} (0.373)^{8/3} - \frac{1/0.02}{0.016} (0.073)^{8/3} + \frac{1/0.083}{0.016} (0.167)^{8/3} - \frac{1/0.02}{0.016} (0.040)^{8/3} \right] \sqrt{S}$$

$$Q = 0.56 \left[3125 (0.373)^{8/3} - 3125 (0.073)^{8/3} - 3125 (0.040)^{8/3} + 753 (0.167)^{8/3} \right] \sqrt{S}$$

$$Q = 0.56 [225.29 - 2.91 - 0.58 + 6.37] \sqrt{S}$$

$$\underline{Q = 127.77 \sqrt{S}} \quad \text{FOR 6" CURB FLOWING FULL}$$

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BGH Date 4-18-83 Sht. 4 of 18
Checked CLS Date 11/28/83 Job No. 3164.03

TYPE 13 INLET CDOH STANDARD M-604-AB

24 OPENINGS $\times \left(7\frac{5}{16}" \times 1\frac{3}{4}"\right) = 2.13$ SF/GRATING

REDUCED BY 50% TO ALLOW FOR CLOGGING = 1.06 SF

SAY 1 SF

$Q = CA\sqrt{2gh}$

USE 1 FT SUMP

$Q = (0.5)(1.0)\sqrt{2g(1)}$

$Q = 4$ CFS

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DESIGN CALCULATIONS

Project HEWLETT - PACKARD
Feature DRAINAGE FACILITIES
Designed BDR Date 1-18-85 Sht. 5 of 18
Checked [illegible] Date 4/28/83 Job No. 3164.003

(1) PART OF BASIN C <<1 CFS 5YR ±1 CFS 100YR
STREET SLOPE ±1% Q_{ALLOW} = 12.78 CFS
DESIGN FOR 5YR STORM
USE PAN ACROSS DRIVEWAY

(2) BASIN A 3.0 CFS 5YR 9.2 CFS 100YR
STREET SLOPE = 5% Q_{ALLOW} = 28.6 CFS
4' DIOR Q_{ALLOW} = 8.6 CFS
DESIGN FOR 5YR STORM
EQ = ±1 + 3.0 = 4.0 CFS

(3) BASIN K 1.7 CFS 5YR 6.5 CFS 100YR
STREET SLOPE ±2% Q_{ALLOW} = 18.1 CFS
4' DIOR Q_{ALLOW} = 6.5 CFS
DESIGN BASIN K FOR 100YR STORM DUE TO LOW POINT
EQ = 4.0 CFS + 6.5 CFS = 10.5 CFS

(4) ½ BASIN Q (21.5/2) CFS 5YR (45.7/2) CFS 100YR
SLOPE ACROSS PARKING LOT = 3.6%
USE ½ of SLOPE FOR DIOR CAPACITY → 1.8% SAY 2%
USE 2 ON DIOR INLETS - DESIGN FOR 5YR STORM
21.5/2 = 10.75 CFS 10.75/2 = 5.38 CFS PER INLET
4' DIOR INLET Q_{ALLOW} = 6.5 CFS
EQ = 10.5 + 10.8 = 21.3 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BKP Date 1-18-83 Sht. 6 of 8
Checked CDS Date 1-28-83 Job No. 3160d.005

(5) BASIN P 4.0 CFS 5YR 7.9 CFS 100YR
SLOPE ACROSS PARKING LOT = 3%
USE ½ SLOPE TO SIZE DIOR → 1.5%
DESIGN FOR 5 YEAR STORM
4' DIOR Q_{ALLOW} = 7.7 CFS
ΣQ = 21.3 + 4.0 = 25.3 CFS

(6)

BASIN I	1.7 CFS 5YR	5.2 CFS 100 YR
BASIN J	0.1 CFS 5YR	0.9 CFS 100 YR
	1.8 CFS	6.1 CFS

STREET SLOPE = 4% Q_{ALLOW} = 25.55 CFS
DESIGN FOR 5YR STORM
4' DIOR Q_{ALLOW} = 4.4 CFS
ΣQ = 25.3 + 1.8 = 27.1 CFS

(7) BASIN W 1.6 CFS 5YR 6.2 CFS 100 YR
STREET SLOPE 1% Q_{ALLOW} = 12.77 CFS
DESIGN FOR 5YR
4' DIOR Q_{ALLOW} 8.6 CFS
ΣQ = 27.1 + 1.6 = 28.7 CFS

(8) 70% of BASIN X 0.70(11.2 CFS) 5YR 0.70(32.0 CFS) 100YR
BASIN V 0.0 CFS 5YR 0.2 CFS 100YR
SLOPE ACROSS PARKING LOT = 4%
CHECK of SLOPE FOR DIOR CAPACITY → 2%
CHECK SLOPE ALONG PARKING LOT CURB → 1.3%
USE 1.3% FOR DIOR CAPACITY
CURB CAPACITY = 19.57 CFS
DESIGN FOR 70% of 5 YR STORM Q = 0.70(11.2) = 7.8 CFS
BY INTERPOLATION UDFCD SPCS, TABLE 6 4' DIOR Q_{ALLOW} @ 1.3% = 8.1 CFS
ΣQ = 0.0 + 7.8 = 7.8 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BJP Date 1-18-83 Sht. 7 of 8
Checked ____ Date ____ Job No. 3164.003

CHECK STREET CAPACITY TO HANDLE 100 YEAR

BASIN	100YR - DESIGN FLOW
C(PART)	0.0
A	6.2
K	0.0
Q	12.1
P	3.9
I	3.5
J	0.8
W	4.6
X (PART)	19.6
V	0.2
	45.9 CFS

STREET CAPACITY = $2(127.77)\sqrt{0.022}$ = 37.9 CFS
EXCESS FLOW = 45.9 - 37.9 = 8.0 CFS
BY INSPECTION OF PREVIOUS CALCULATIONS, INLETS CAN HANDLE EXCESS FLOW.
27"ø FROM (7) - (8) CAPACITY = 39.8 CFS
31.3 CFS @ (7) + 8.0 CFS EXCESS = 39.3 CFS OK

VOID 4-26-83 DUE TO REDESIGN

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BCP Date 1-19-83 Sht. 8 of 18
Checked CWG Date 1/20/83 Job No. 3160A.003

(9) 1/2 BASIN FF 0.50 (7.8 CFS) 5YR 0.50 (10.6 CFS) 100YR

SLOPE ACROSS PARKING LOT = ±1.5%
USE 1/2 SLOPE TO SIZE DIOR → ± 3/4 %
DESIGN FOR 5YR STORM Q = 3.9 CFS
BY INTERPOLATION COLO. SPGS. TABLE 6 4' DIOR Q ALLOW = 7.5 CFS
EQ = 7.8 + 3.9 = 11.7 CFS

(10) 1/2 BASIN FF

SEE ABOVE CALCULATIONS
EQ = 11.7 + 3.9 = 15.6 CFS

(11)

BASIN U	1.6 CFS	5YR		5.6 CFS	100YR
BASIN EE	0.1 CFS	5YR		0.4 CFS	100YR
	1.7 CFS			6.0 CFS	

STREET SLOPE = 2.5% Q ALLOW = 20.2 CFS
DESIGN FOR 5YR STORM
4' DIOR Q ALLOW = 5.7 CFS
EQ = 15.6 + 1.7 = 17.3 CFS

(12) COLLECT FLOWS @ EXIST. MH EQ = 46.0 CFS
28.7 + 17.3 = 46.0 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BDP Date 4-18-88 Sht. 9 of 18
Checked CGS Date 4/18/88 Job No. 3169.002

(13) PART OF BASIN C << 1 CFS 5YR ± 1 CFS 100YR
BASIN D << 1 CFS 5YR 1.7 CFS 100YR
± 0.5 CFS ± 2.7 CFS

RUNOFF COLLECTS @ LOW POINT
STREET SLOPE ± 2% Q ALLOW = 18.1 CFS
DESIGN FOR 100 YR FLOW
4' DIOR Q ALLOW = 6.5 CFS
EQ = 2.7 CFS

(14) BASIN L 18.6 CFS 5YR 37.0 CFS 100YR
PARKING LOT SLOPE 3% N-S & 2% E-W
CURB CAPACITY = 22.1 CFS & 18.1 CFS
4' DIOR @ 2% Q ALLOW = 6.5 CFS DESIGN FOR 100 YR
8' DIOR @ 3% Q ALLOW = 14.8 CFS
IF 100% PICKUP FOR 8' DIOR @ 3% Q ALLOW = 24.7 CFS
EQ = 2.7 + 37.0 = 39.7 CFS

(15) BASIN S 15.2 CFS 5YR 30.2 CFS 100YR
SLOPE ACROSS PARKING LOT = 4%
USE ½ SLOPE FOR DIOR CAPACITIES → 2%
DESIGN FOR 100 YR STORM
30.2/3 = 10.1 CFS
6' DIOR Q ALLOW = 12.2 CFS 3EA
EQ = 39.7 + 30.2 = 69.9 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BDF Date 4-18-83 Sht. 10 of 18
Checked LLG Date 4/21/83 Job No. 3141.003

(16) ½ BASIN Q (SEE (4)) (21.5/2) CFS 5YR (45.7/2) CFS 100YR
SLOPE ACROSS PARKING LOT = 3.6%
USE ½ SLOPE FOR DIOR CAPACITIES → 1.8%
DESIGN FOR 100YR (22.9 CFS)
6' DIOR Q_{ALLOW} = 11.6 CFS BY INTERPOLATION TABLE 6 — USE 2 EA
EQ = 22.9 + 69.9 = 92.8 CFS

(17) BASIN R 15.4 CFS 5YR 30.7 CFS 100 YR
SLOPE ALONG CURB = 2%. DESIGN FOR 100 YR
NEED DIOR TO PICK UP 7.5 CFS
6' DIOR Q_{ALLOW} = 12.2 CFS
30.7 - 7.5 = 23.2 CFS
USE 6 EA TYPE 13 @ LOW POINT
EQ = 92.8 + 30.7 = 123.5 CFS

(18) BASIN Y 16.2 CFS 5YR 34.5 CFS 100 YR
DESIGN FOR 100 YR
LOW POINT IN PARKING AREA ± 30% OF BASIN SAY 10 CFS
SLOPE ALONG CURB = 2%/AVG. SLOPE ACROSS LOW POINT ≈ ½%
DESIGN FOR ½%. 16' DIOR Q_{ALLOW} = 10.6 CFS — USE 1 EA.
REMAINDER OF BASIN Q = 34.5 - 10 = 24.5 CFS
STREET SLOPE = 2% 8' DIOR Q_{ALLOW} = 12.5 CFS — USE 2 EA
EQ = 123.5 + 34.5 = 158.0 CFS

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DESIGN CALCULATIONS

Project HEWLETT - PACKARD
Feature DRAINAGE FACILITIES
Designed RDK Date 4-18-83 Sht. 11 of 18
Checked CLS Date 4/25/83 Job No. 3169.03

(19) 1/2 BASIN DD 0.50(7.2 cfs) 5YR 0.50(15.4 cfs) 100YR
DESIGN FOR 100YR - DRAINS TO LOW POINT (7.7 cfs)
SLOPE ACROSS LOT = 2.5% DESIGN DIOR @ 1.25%
6' DIOR Q ALLOW = 9.7 cfs - 1 EA. Q = 7.7 cfs TO BASIN JJ
BASIN JJ 10.8 cfs 5YR 20.1 cfs 100YR
LOW POINT @ LOADING DOCK - DESIGN FOR 100YR STORM
TYPE 13 Q ALLOW = 4 cfs - USE 5 EA
Q = 7.7 + 20.1 = 27.8 cfs TO BASIN II
BASIN II 14.8 cfs 5YR 29.4 cfs 100YR
SIZE DIOR FOR 27. DESIGN FOR 100YR
6' DIOR Q ALLOW = 12.2 cfs USE 3 EA
EQ = 158.0 + 29.4 + 27.8 = 215.2 cfs

(20) 30% BASIN X (SEE (8)) 0.30 (11.2 cfs) 5YR 0.30 (32.0 cfs) 100YR
DESIGN FOR 100YR → 9.6 cfs
1/2 PARKING LOT SLOPE = 1.3% CURB SLOPE = 0.9%
DESIGN DIOR @ 1%
8' DIOR Q ALLOW = 9.4 cfs USE 1 EA
EQ = 215.2 + 9.6 = 224.8 cfs

(21) BASIN HH 15.5 cfs 5YR 28.9 cfs 100YR
SLOPE ACROSS LOT = ± 2.5%
DESIGN @ 1% FOR 100YR
12' DIOR Q ALLOW = 10.9 cfs - USE 2 EA
TYPE 13 Q ALLOW = 4 cfs - USE 2 EA
EQ = 224.8 + 28.9 = 253.7 cfs

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BDP Date 1-18-83 Sht. 12 of 18
Checked [illegible] Date 1/21/83 Job No. 3164.003

22 BASIN RR 17.2 cfs 5YR 36.7 cfs 100YR
DESIGN FOR 5YR
STREET SLOPES @ 1.6% → Q_{ALLOW} = 16.2 cfs
DESIGN @ 1.5% 6' DIOR Q_{ALLOW} = 10.6 cfs
4' DIOR Q_{ALLOW} = 7.7 cfs } 18.3 cfs
USE 1 EA 6' & 1 EA 4'

BASIN QQ 11.1 cfs 5YR 20.7 cfs 100YR
DESIGN FOR 5YR
STREET SLOPES @ 1.8% → Q_{ALLOW} = 17.22 cfs
MOST OF BASIN ON W. SIDE, DESIGN W. SIDE FULL Q, MIN. Q ON EAST
BY INTERPOLATION, 8' DIOR Q_{ALLOW} @ 1.8% = 11.9 cfs USE 1 EA
FOR E. SIDE, USE DIOR FROM RR
ΣQ = 253.7 + 17.2 + 11.1 = 282.0 cfs

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DESIGN CALCULATIONS

Project HEWLETT - PACKARD
Feature DRAINAGE FACILITIES
Designed BVP Date 4-18-83 Sht. 13 of 18
Checked CHS Date 4/25/83 Job No. 3164.003

2B BASIN H 443 CFS PER RANGEWOOD MASTER PLAN
BY DONALD JEFFRIES
INCLUDES FLOW FROM BASIN B
COLLECTED ON RESEARCH PKWY

EQ = 443 CFS

2A BASIN M 19.0 CFS 5 YR 40.3 CFS 100 YR
DESIGN FOR 100 YR
45% DRAINS TO N. SIDE BLDG 8 (18 CFS)
SLOPE ACROSS LOT = 4%
USE ½ SLOPE TO DESIGN DIOR → 2%
6' DIOR Q ALLOW = 12.2 CFS → USE 2
E SIDE BLDG. & PARKING LOT DRAINS ¾ % ± 20% BASIN → 8 CFS
MW. FACILITIES REQ'D → 2EA 4' DIOR
14.3 CFS REMAINING → @ 4%. 2EA 6' DIOR REQD
Q = 40.3 CFS TO BASIN N
BASIN N 9.3 CFS 5 YR 19.8 CFS 100 YR
DESIGN FOR 100 YR
SLOPE ACROSS LOT ± 4%
USE ½ SLOPE TO DESIGN DIOR → 2%
6' DIOR = 12.2 CFS → 2EA
Q = 40.3 + 19.8 = 60.1 CFS TO INTERCEPTOR
EQ = 60.1 + 443 = 503.1 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BDP Date 1-18-83 Sht. 14 of 18
Checked GG Date 1/21/83 Job No. 7604.003

(25) BASIN I 11.3 CFS 5YR 22.4 CFS 100YR
DESIGN FOR 100 YR STORM
TYPE 13 Q ALLOW = 4 CFS USE 6 EA
Q = 22.4 TO BASIN O

BASIN O 10.2 CFS 5YR 20.2 CFS 100YR
DESIGN FOR 100 YR STORM
CURB SLOPE = ± 1% Q ALLOW = 12.8 CFS
12' DIOR Q ALLOW = 10.4 CFS USE 2 EA
Q = 20.2 + 22.4 = 42.6 CFS TO CHANNEL
EQ = 503.1 + 42.6 = 545.7 CFS

ALL FLOWS TO CHANNEL DESIGNED FOR 100YR TO THIS POINT. GENERALLY DESIGN FOR 5 YR FROM HERE. FLOWS IN EXCESS OF 5YR WILL GO TO STREET.

(26) BASIN G 0.0 CFS 5YR (0.1 CFS) 100YR
DISCHARGES DIRECTLY TO CHANNEL
BASIN E 0.0 CFS 5YR 0.4 CFS 100 YR
BASIN F 0.9 CFS 5YR 2.2 CFS 100 YR
DESIGN FOR 5 YR STORM (2.6 CFS)
STREET SLOPE 2% Q ALLOW = 18.1 CFS
4' DIOR Q ALLOW = 6.5 CFS — WILL PICK UP 100 YR STORM
60% BASIN Z 0.60(11.2 CFS) 5YR 0.60(22.2 CFS) 100 YR
DESIGN FOR 5 YR Q = (16.7 CFS)
4' DIOR Q ALLOW = 6.5 CFS. USE 1 EA
EQ = 545.7 + 0.1 + 0.4 + 16.7 = 552.9 CFS

(27) BASIN CC 702 CFS CUMULATIVE 100YR FOR RANGEWOOD
EQ = 552.9 + 702 - 443 = 811.9 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BDP Date 4-18-83 Sht. 15 of 18
Checked CMS Date 4/20/83 Job No. 3164.003

(28) 40% BASIN Z 0.40(11.2 CFS) 5YR 0.40(22.2 CFS) 100YR
DESIGN FOR 5 YR
Q = 0.40(11.2) = 4.5 CFS
STREET SLOPE 2% Q ALLOW = 18.1 CFS
4' DIOR Q ALLOW = 16.5 CFS USE 1 EA.
EQ = 811.9 + 4.5 = 816.4 CFS

(29) ½ BASIN DD (SEE (A)) 0.50(7.2 CFS) 5YR 0.50(15.4 CFS) 100YR
DESIGN FOR 5 YR 3.6 CFS
PICK UP ON ROAD - SLOPE @ 2%
4' DIOR Q ALLOW = 6.5 CFS - USE 1 EA.
EQ = 816.4 + 3.6 = 820.0 CFS

(30) BASIN SS 24.1 CFS 5YR 44.8 CFS 100YR
STREET SLOPE = ± 2% Q ALLOW = 18.1 CFS
DESIGN FOR 5YR
6' DIOR Q ALLOW = 12.2 CFS → USE 2 EA.
75% BASIN AA 0.75(5.8 CFS) 5YR 0.75(10.2 CFS) 100 YR
STREET SLOPES @ 2% DESIGN FOR 5YR
4' DIOR Q ALLOW = 6.5 CFS USE 1 EA
EQ = 820.0 + 24.1 + 4.4 = 848.5 CFS

(31) BASIN BB 12.3 CFS 5YR 27.7 CFS 100YR
DRAINS DIRECTLY TO CHANNEL
25% BASIN AA 0.25(5.8 CFS) 5YR 0.25(10.2 CFS) 100YR
RUN 1.5 CFS TO COLLECTION POINT W/ BASIN VV
BASIN VV 0.1 CFS 5YR 1.4 CFS 100YR
STREET SLOPE 2% 4' DIOR Q ALLOW = 6.5 CFS - USE 1 EA
EQ = 848.5 + 12.3 + 1.5 + 0.1 = 862.4 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed BDP Date 1-18-83 Sht. 16 of 18
Checked CLS Date 1/28/83 Job No. 3164.003

△32 COLLECTION POINT
DESIGN FOR EQ FROM △22 & △31
EQ = 282.0 + 862.4 CFS = 1,144.4 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed RLP Date 4-18-83 Sht. 17 of 18
Checked [illegible] Date 4/22/83 Job No. 316-4.003

(33) BASIN GG 18.4 CFS 5YR 36.6 CFS 100YR
30% OF BASIN COLLECTS ON N. SIDE OF PLANTER
SLOPE ALONG CURB = 0.8%
SLOPE ACROSS LOT = 2.5%
DESIGN DIOR @ 1% FOR 100 YR STORM 0.30 (36.6) = 11.0 CFS
19' DIOR Q ALLOW = 11.3 CFS — USE 1 EA
70% OF BASIN COLLECTS @ LOW POINT → 25.6 CFS
TYPE 13 Q ALLOW = 9 CFS 6.4 REQD USE 7 EA.
BASIN PP 6.8 CFS 5YR 21.2 CFS 100YR
DESIGN FOR 5YR STREET SLOPE = 0.9%
@ 0.5% 12' DIOR Q ALLOW = 8.8 CFS (BY INTERPOLATION ± 7 CFS @ 0.9%)
USE 1 EA 12' DIOR
Q TO INTERCEPTOR = 36.6 + 6.8 = 43.4 CFS
ΣQ = 1,144.4 + 43.4 = 1,187.8 CFS

(34) BASIN LL 1.4 CFS 5YR 4.5 CFS 100YR
DESIGN FOR 5YR — DISCHARGE TO PERIMETER ROAD
BASIN NN 0.5 CFS 5YR 2.1 CFS 100YR
DESIGN FOR 5YR - DRAIN TO LOW POINT IN PERIMETER ROAD
BASIN MM 0.1 CFS 5YR 0.9 CFS 100YR
DESIGN FOR 5YR - DRAIN TO LOW POINT IN PERIMETER ROAD
BASIN OO 23.1 CFS 5YR 49.2 CFS 100YR
DESIGN FOR 5YR — SLOPE ACROSS PARKING LOT = 4%
DESIGN DIOR @ 2% 23.1/2 = 11.6 11.6 + 1.4 = 13.0
6' DIOR Q ALLOW = 12.2 CFS
8' DIOR Q ALLOW = 12.9 CFS
4' DIOR Q ALLOW = 6.5 CFS

ΣQ = 1,187.8 + 1.4 + 0.5 + 0.1 + 23.1 = 1,212.9 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature DRAINAGE FACILITIES
Designed RDF Date 4-12-96 Sht. 18 of 8
Checked CGS Date 4/26/96 Job No. 2166.003

(35) BASIN MM 0.0 CFS 5YR 0.5 CFS 100YR
DESIGN FOR 5YR
BASIN TT 0.0 CFS 5YR 1.1 CFS 100YR
DESIGN FOR 5YR
BASIN MM & TT CALCULATE TO 0.0 CFS IN 5YR BY SCS TR-55
IN REALITY, THERE IS SOME RUNOFF FROM ASPHALT.
DRAIN TO EXISTING 8'DIOR @ LEXINGTON/MEADOW RIDGE
EQ= 1,212.9 + 0.0 = 1212.9 CFS

(36) BASIN KK 1.6 CFS 5YR 6.0 CFS 100YR
DRAINS TO EXISTING FACILITIES ON UNION

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DESIGN CALCULATIONS

Project _____
Feature _____
Designed _____ Date _____ Sht. ____ of ____
Checked _____ Date _____ Job No. _____

HYDRAULICS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature HYDRAULICS
Designed ELP Date 4-26-83 Sht. 1 of 4
Checked GGS Date 5/23/83 Job No. 3164.003

PIPE DESIGN

PRELIMINARY SIZE OF PIPE BASED ON MANNING EQUATION. $n = 0.015$ WAS USED TO ACCOUNT FOR HEAD LOSSES. FINAL DESIGN TO BE BASED ON $n = 0.013$ & WILL CONSIDER HEAD LOSSES.

CHANNEL DESIGN

CHANNEL WILL BE DESIGNED FOR SUPERCRITICAL FLOW. CHANNEL CAPACITY VARIES FROM 443 CFS TO 820 CFS. AT MAXIMUM Q & SLOPE = 0.017 FT/FT, B = 6 FT, Z = 1.5:1, $y = \pm 3.5$ FT FREEBOARD OF 1 FT WILL BE PROVIDED. SPECIAL DESIGN CONSIDERATIONS PER COLORADO SPRINGS CRITERIA WILL BE MADE FOR SUPERCRITICAL CHANNEL.

CULVERT SIZING @ (31)

SEE BUREAU OF PUBLIC ROADS CHARTS 1 & 8
USE 8' x 6' RCBC (8' WIDTH x 6' HEIGHT)

D/S FROM CULVERT

USE MANNING FOR CAPACITY OF 8' x 6' RCBC ($n = 0.015$).
@ S: 0.025 FT/FT & Q = 1,080 CFS, $y = \pm 5$ FT

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD
Feature HYDRAULICS
Designed RDP Date 4-26-83 Sht. 2 of 4
Checked ____ Date 4/27/83 Job No. 3164.003

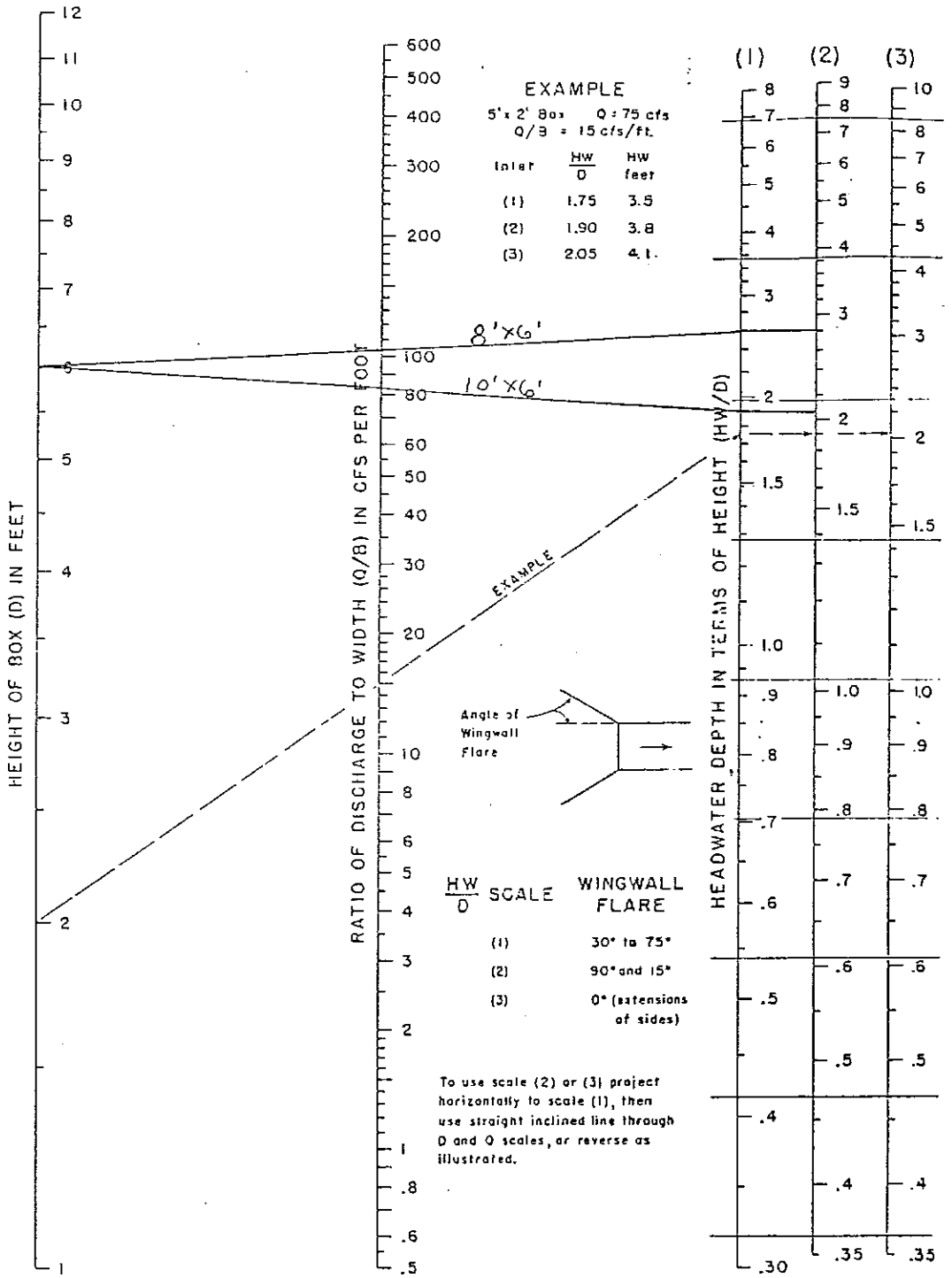
EXISTING 66"ø PIPES @ LEXINGTON
121.5 LF @ 1%, 2 EA.
Q_{ALLOW} = 672 CFS
PIPES WILL FLOW UNDER PRESSURE

CHECK EXISTING CHANNEL
S = 0.005 FT/FT
P = 6 FT
Z = 1.5 : 1
n = 0.015
y = 5.5 FT
} Q = 1,150 CFS

THIS DESIGN ASSUMED 675 CFS @ LEXINGTON.
ACTUALLY, THERE IS 1,080 CFS @ LEXINGTON
1,080 - 675 = 405 CFS
1,150 + 405 = 1,555 CFS
CHANNEL FLOWS @ y = ± 6.35 FT
1 FT of FREEBOARD HAS BEEN PROVIDED, SO
AVAILABLE CHANNEL DEPTH = 6.5 FT.

HEWLETT-PACKARD
HYDRAULICS
BDP 4-26-83 3/4
3164.cd3

CHART 1



2.8 x 6' = 16.8

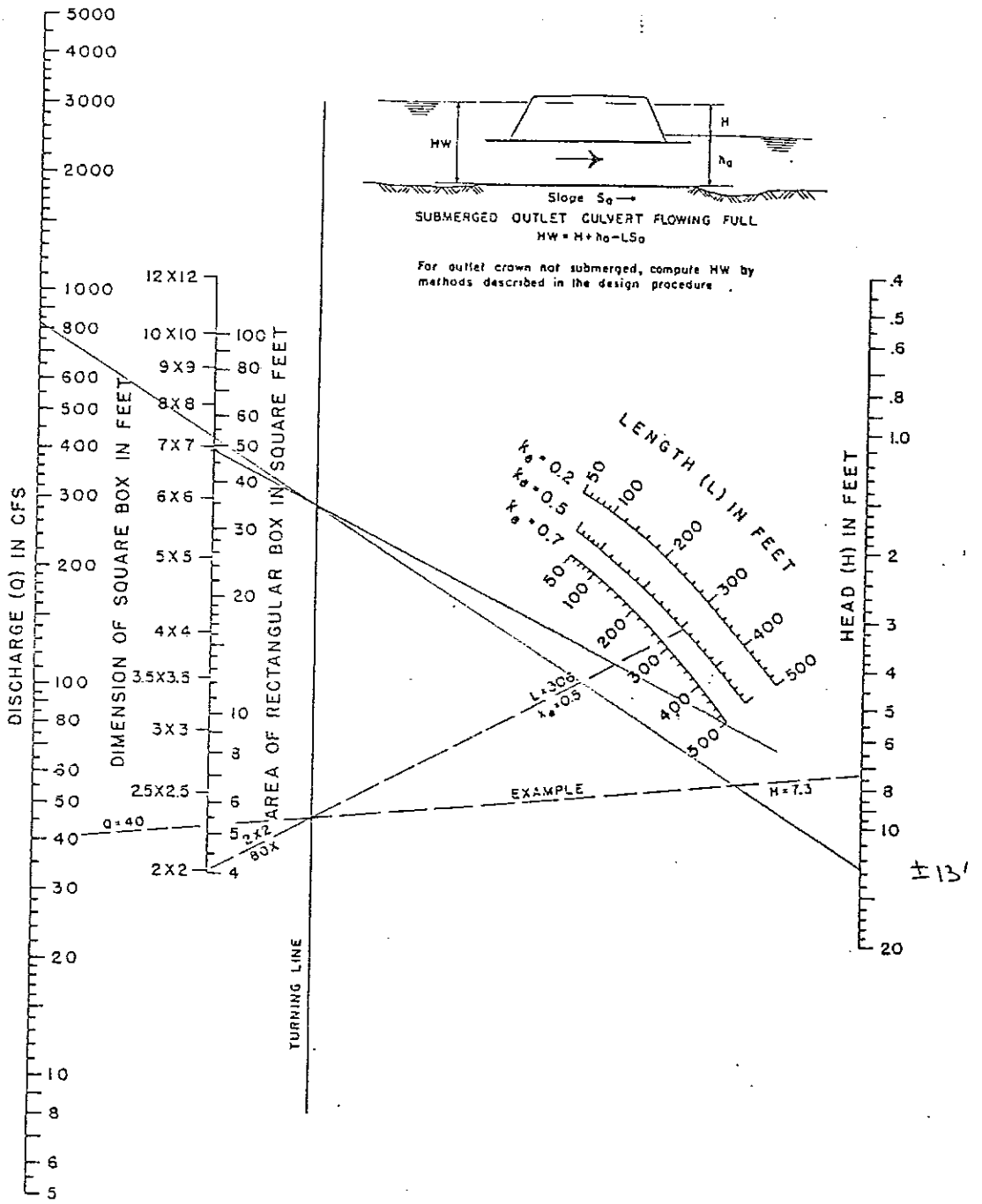
2.05 x 6' = 12.1

HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HEWLETT-PACKARD
HYDRAULICS
BCP 4-26-83 4/4
3164.003

CHART 8



HEAD FOR
CONCRETE BOX CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

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DESIGN CALCULATIONS

Project _____
Feature _____
Designed _____ Date _____ Sht. ____ of ____
Checked _____ Date _____ Job No. _____

PRELIMINARY DESIGN DATA

STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD BDP 4-26-83 7.1(?)1. GG3 CK. GGS 4/28/83 1/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	W AREA (SQ. MI.)	Σ	Σ W	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM INCH	5 YR RUNOFF (IN)	5 YR PEAK (CFS)	100 YR RUNOFF (IN)	100 YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	PART C												(<<1)					
1													<<1			USE PAN		
	A												(3.0)					
2													4.0			18	.038	
	K												1.7		(6.5)			
3													10.5			18	.040	
	½Q												(10.8)					
4													21.3			21	.032	
	P												(4.0)					
5													25.3			21	.039	

GINGERY ASSOCIATES INC.

STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD RDP 9-26-83 7.1cfs/ac² CK CDS 4/28/83 2/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)			BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM/INCH	5YR RUNOFF (IN)	5YR PEAK (CFS)	100YR RUNOFF (IN)	100YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	H											(1.7)						
	J											(0.1)						
6												27.1				24	.029	
	W											(1.6)						
7												28.7				27	.015	

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD BDP 4-26-83 3 [illegible] 4/28/83 2/10

Design Point	Basin	Area (Sq. Mi.)	Σ Area (Sq. Mi.)	CN	Σ CN W	Basin Height (FT)	Basin Length (FT)	Basin t_c (HR)	Basin t_c (HR)	Σ Time (HR)	CSM/Inch	5 YR Runoff (IN)	5 YR Peak (CFS)	100 YR Runoff (IN)	100 YR Peak (CFS)	Pipe Diameter (IN)	Pipe Slope (FT/FT)	Pipe Velocity (FPS)
	7½ X											7.8						
	V											(0.0)						
8												7.8				18	.025	
	½FF											(3.9)						
9												11.7				18	.020	
	½FF											(3.9)						
10												15.6				21	.018	
	U											(1.6)						
	EE											(0.1)						
11												17.3				21	.019	
12												46.0				EXISTING 36		

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD BJP 4-26-83 3114.003 CK: LGS 4/28/83 4/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	Ʒ	Ʒ W	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM/INCH	5 YR RUNOFF (IN)	5 YR PEAK (CFS)	100 YR RUNOFF (IN)	100 YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	C	.007		48		80	280	.021										
	D	.009		48		101	1,110	.109										
13			.016		48					.109	1250	—	—	0.15	3.0	18	0.01[illegible]	3.91
	L	.010		92		14	620	.057										
14			.026		65				(.028)	.137	1195	0.16	5.0	0.75	23.3	24	0.013	7.13
	J	.008		92		4	330	.042								24	0.025	9.87
									.005									
15			.034		71				(.025)	.162	1140	0.31	12.0	1.06	41.1	27	0.040	13.23
	½ Q	.010		89		5	670	.169										
16			.044		75				(.002)	.164	1135	0.43	21.5	1.30	64.9	33	0.026	12.69
	R	.009		92		12	858	.098								21	0.030	10.05
									.003									
17			.053		78				(.006)	.170	1125	0.54	32.2	1.50	894	36	0.025	12.65

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD RDP 4-26-83 31604.003 GK. CGS 4/28/83 5/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	3	CN W	BASIN INITIAL (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	I/SM INCH	5YR RUNOFF (IN)	5YR FLOW (CFS)	100YR RUNOFF (IN)	100YR FLOW (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	Y	.011		89		10	780	.080								27	0.020	9.72
									.023									
20			.004		80				.006	.176	1115	0.62	44.2	1.64	117.0	42	0.013	12.16
	±200	.002		89		8	420	.042								18	0.017	6.24
	JJ	.005		95		5	500	.069	.008							27	0.018	8.07
	II	.008		92		5	470	.062	.013							30	0.025	11.05
									.006									
19			.079		82				(.009)	.185	1100	0.72	62.6	1.78	154.7	48	0.030	16.25
	307.X	.006		77		9	970	(.224)								18	0.020	7.06
									(.020)									
23			.085		82				.002	.244	1005	0.72	61.5	1.78	152.1	54	0.010	10.32
	HH	.007		95		7	470	.054										
									.003									
21			.092		83				(.008)	.252	995	0.76	69.6	1.86	170.3	60	0.005	9.17

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD PDP 9-26-85 3161.003 CK: 1.6 4/28/88 6/16

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	CN	CN W	BASIN INITIAL (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	I5M/INCH	5YR RUNOFF (IN)	5YR PEAK (CFS)	100YR RUNOFF (IN)	100YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	P-1	.013		89		7	830	.137										
	P-2	.015		95		8	480	.051										
A1			.109		95				.018	.270	970	0.87	92.0	2.02	213.6	60	.009	10.90

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD   P.A.P.   9-26-82   3110[illegible].003   CK: [illegible] 4/7/93   7/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	CN	Σ CN	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM INCH	5 YR RUNOFF (IN)	5 YR PEAK (CFS)	100 YR RUNOFF (IN)	100 YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	H	.305		74		120	5,000	.140										
(2)			.302		74					.140	1180	0.40	143	1.24	[illegible]	72	.013	17.75
	M	.014		89		8	875	.122								36	.005	[illegible]
									.004									
	N	.006		89		19	550	.058								42	[illegible]	6.37
									.026									
(4)			.323		75				(.012)	.152	1164	0.43	161.5	1.30	487.8	78	.013	16.10
																B=6 Z=1.5 [illegible]	.013	[illegible]
	T	.006		92		9	380	.050								24	.017	7.15
									.009									
	J	.006		92		21	850	.102								36	.007	6.95
									.013									
(5)			.325		76				.013 .003	.168	1170	0.47	177.9	1.37	518.6	B=6 Z=1.5 V=12.39	.014	17.45
	G	.007		39		56	1800	.282										
	E	.004		45		55	700	.097										
	F	.003		63		57	2040	.167										
	EX. Z	.004		92		10	560	.058										
(3)			.253		75			(.005)		.173	1120	0.43	171.0	1.30	516.9	B=6 Z=1.5 V=7.84	.014	17.37

* [illegible] DRAINAGE STUDY [illegible] POINT AT BRIARGATE FILING NO. 1 BY [illegible]

GINGERY ASSOCIATES INC.

STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD   RDP   9-26-83   2169.002   [illegible] 1/26/83   8/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	W AREA (SQ. MI.)	CN	CN W	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM/INCH	5 YR RUNOFF (IN)	5 YR PEAK (CFS)	100 YR RUNOFF (IN)	100 YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	CC	.531*		73		140	6000	0.17			1120	0.37	220	1.18	702			
[illegible]			.531		73				(.002)	.175	1115	0.37	239.7	1.18	764.4	[illegible]	.017	[illegible]
	40% Z	.002		92				<<.175										
[illegible]			.533		73				(.000)	.175	1115	0.37	240.5	1.18	767.1	[illegible]	.017	20.78
	½ DD	.002		89				<<.175										
[illegible]			.585		74				(.007)	.182	1100	0.40	257.4	1.29	797.9	[illegible] y=3.42	.017	20.9[illegible]
	SS	.011		95		17	700	.063										
	75% AA	.002		98		31	1530	.152										
[illegible]			.598		74				(.009)	.191	1070	0.40	260.7	1.24	808.3	[illegible] y=3.44	.017	21.10
	BB	.007		86				.031										
	25% AA	.001		98		11	700	.069										
	VV	.004		54		41	1650	.186										
[illegible]			.612		74				.009	.200	1080	0.40	264.4	1.24	819.6	8x6 BOX	.025	19.75

* [illegible]
AA = .263 − .263 + .531 = .581

GINGERY ASSOCIATES INC.

STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT - PACKARD BDP 9-26-83 3161.CB3 CK [illegible] 4/28/83 9/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	CN	Σ CN / W	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM / INCH	5 YR RUNOFF (IN)	5 YR PEAK (CFS)	100 YR RUNOFF (IN)	100 YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
△[illegible]		.109		85					.270*						213.6			
△21		.612		74					.200						819.6			
									.003									
△22			.721		76					.211*	1050	0.47	355.8	1.37	1027.2	8'×6'	.025	26.45

* 20% BASIN × t_c EXCEEDED Σ TIME TO DESIGN POINT. t_c + t_c USED TO DESIGN PIPE TO △22 BUT MAY BE ARTIFICIALLY HIGH FOR ENTIRE BASIN TO △22. THEREFORE, USE Σ TIME TO △23, NEGLECTING 20% K → .185 + .002 = .189 .270 − .244 + .185 = .211

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	CN	Σ CN / W	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM / INCH	5 YR RUNOFF (IN)	5 YR PEAK (CFS)	100 YR RUNOFF (IN)	100 YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	5G	.011		92		9	800	.106								30	.015	7.33
									.027									
	PP	.012		74		10	470	.045								30	.015	9.77
									.002									
△23			.744		76				(.010)	.221	1060	0.47	363.7	1.37	1060.1	8'×6'	.025	26.66

GINGERY ASSOCIATES INC.

STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD RDP 9-26-83 3169.0003 CK. CGS 4/28/83 10/10

DESIGN POINT	BASIN	AREA (SQ. MI.)	W. AREA (SQ. MI.)	CN	CN W	BASIN HEIGHT (FT)	BASIN LENGTH (FT)	BASIN t_c (HR)	BASIN t_c (HR)	Σ TIME (HR)	CSM INCH	5YR RUNOFF (IN)	5YR PEAK (CFS)	100YR RUNOFF (IN)	100YR PEAK (CFS)	PIPE DIAMETER (IN)	PIPE SLOPE (FT/FT)	PIPE VELOCITY (FPS)
	LL	.005		74		10	750	.129										
									.094									
	DD	.015		89		19	550	.087								24	.020	9.00
									.001									
	NN	.012		66		16	910	.094										
	UU	.009		51		15	1500	.208								24	.020	9.00
									.000									
31			.768		C.S. SUM 76				.008	.230	1025	0.97	370.0	1.37	1,078.5	8'x6'	.025	26.70
32															1,078.5	8'x6'	.025	26.70

GINGERY ASSOCIATES INC.

GINGERY ASSOCIATES, INC.
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DESIGN CALCULATIONS

Project _____
Feature _____
Designed _____ Date _____ Sht. ____ of ____
Checked _____ Date _____ Job No. _____

COST ESTIMATE

FORM NO. 17

GINGERY ASSOCIATES, INC.
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QUANTITY TAKE-OFF SHEET

SHEET 1 OF 15

PROJECT NAME: HEWLETT PACKARD
LOCATION: BRIARGATE
JOB NO.: 3164.003
DATE: 4-27-83
PREPARED BY: BDP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
1					
2	4' DIOR 0'-10'	1	EA		
3	4' DIOR	1	EA		
	5' ø MH	1	EA		
	18" ø RCP	250	LF		
	18" ø RCP	260	LF		
4	4' DIOR	2	EA		
	4' ø MH	1	EA		
	18" ø RCP	210	LF		
	18" ø RCP	170	LF		
	18" ø RCP	50	LF		
5	4' DIOR	1	EA		
	4' ø MH	1	EA		
	21" ø RCP	280	LF		
	18" ø RCP	55	LF		
6	4' DIOR	1	EA		
	5' ø MH	1	EA		
	21" ø RCP	180	LF		
	18" ø RCP	55	LF		
7	4' DIOR	1	EA		
	5' ø MH	1	EA		
	24" ø RCP	160	LF		
	18" ø RCP	70	LF		
8	4' DIOR	1	EA		
	5' ø MH	1	EA		
	18" ø RCP	70	LF		
9	4' DIOR	1	EA		
	5' ø MH	1	EA		
	18" ø RCP	240	LF		
	18" ø RCP	70	LF		

FORM NO. 17

GINGERY ASSOCIATES, INC.
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QUANTITY TAKE-OFF SHEET

SHEET 2 OF 15

PROJECT NAME: HEWLETT PACKARD
LOCATION: BRIARGATE
JOB NO. 3164.003
DATE: 4-27-83
PREPARED BY: BDP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
10	4' DIOR 0'-10'	1	EA		
	5' ∅ MH	1	EA		
	18" ∅ RCP	280	LF		
	18" ∅ RCP	55	LF		
11	4' DIOR	1	EA		
	21" ∅ RCP	70	LF		
12	21" ∅ RCP	50	LF		
	27" ∅ RCP	880	LF		
	5' ∅ MH	2	EA		
	SUBTOTAL (1)				
	4' DIOR 0'-10'	11	EA		
	4' ∅ MH	2	EA		
	5' ∅ MH	8	EA		
	18" ∅ RCP	1,835	LF		
	21" ∅ RCP	580	LF		
	24" ∅ RCP	160	LF		
	27" ∅ RCP	880	LF		

FORM NO. 17

GINGERY ASSOCIATES, INC.
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QUANTITY TAKE-OFF SHEET

SHEET 3 OF 15

PROJECT NAME: HEWLETT PACKARD
JOB NO.: 3164.003
LOCATION: BRIARGATE
DATE: 4-27-83
PREPARED BY: BOP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
13	4' DIOR	10'-15'	1	EA		
14	4' DIOR	10'-15'	1	EA		
	8' DIOR	10'-15'	2	EA		
	18" ⌀ RCP	10'-15'	400	LF		
	18" ⌀ RCP	10'-15'	45	LF		
	24" ⌀ RCP	10'-15'	160	LF		
15	5' ⌀ MH	15'-20'	2	EA		
	24" ⌀ RCP	15'-20'	380	LF		
	24" ⌀ RCP	15'-20'	270	LF		
	24" ⌀ RCP	0'-10'	170	LF		
	18" ⌀ RCP	0'-10'	70	LF		
	18" ⌀ RCP	0'-10'	10	LF		
	6' DIOR	0'-10'	3	EA		
16	5' ⌀ MH	30'-35'	1	EA		
	27" ⌀ RCP	15'-20'	95	LF		
	6' DIOR	15'-20'	2	EA		
	18" ⌀ RCP	15'-20'	50	LF		
	18" ⌀ RCP	15'-20'	210	LF		
17	6' ⌀ MH	15'-20'	1	EA		
	TYPE 13	10'-15'	6	EA		
	6' DIOR	10'-15'	1	EA		
	18" ⌀ RCP	10'-15'	270	LF		
	21" ⌀ RCP	10-15'	100	LF		
	33" ⌀ RCP	30'-35'	30	LF		
	33" ⌀ RCP	15'-20'	190	LF		
	33" ⌀ RCP	10'-15'	40	LF		
18	6' ⌀ MH	20'-25'	1	EA		
	36" ⌀ RCP	20'-25'	250	LF		
	5' ⌀ MH	15'-20'	2	EA		
	5' ⌀ MH	10'-15'	2	EA		
	8' DIOR	0'-10'	2	EA		
	16' DIOR	0'-10'	1	EA		
	27" ⌀	20'-25'	145	LF		

FORM NO. 17

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QUANTITY TAKE-OFF SHEET

SHEET 4 OF 15

PROJECT NAME: HEWLETT PACKARD
LOCATION: BRIARGATE
JOB NO.: 3168.003
DATE: 4-27-83
PREPARED BY: RLF
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
19	(CONT)					
	27" ⌀ RCP	15'-20'	225	LF		
	27" ⌀ RCP	10'-15'	50	LF		
	27" ⌀ RCP	10'-15'	150	LF		
	27" ⌀ RCP	0'-10'	720	LF		
	18" ⌀ RCP	0'-10'	25	LF		
19	6' ⌀ MH	30'-35'	1	EA		
	42" ⌀ RCP	30'-35'	190	LF		
	42" ⌀ RCP	25'-30'	200	LF		
	30" ⌀ RCP	10'-15'	270	LF		
	6' DIOR	10'-15'	3	EA		
	18" ⌀ RCP	10'-15'	20	LF		
	30" ⌀ RCP	10'-15'	55	LF		
	27" ⌀ RCP	10'-15'	120	LF		
	5' ⌀ MH	0'-10'	3	EA		
	27" ⌀ RCP	0'-10'	245	LF		
	TYPE 13	0'-10'	5	EA		
	6' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	180	LF		
20	6' ⌀ MH	30'-35'	1	EA		
	48" ⌀ RCP	30'-35'	100	LF		
	4' ⌀ MH	10'-15'	1	EA		
	8' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	25	LF		
	18" ⌀ RCP	10'-15'	260	LF		
21	SPECIAL MH	15'-20'	1	EA		
	TYPE 13	0'-10'	2	EA		
	12' DIOR	0'-10'	1	EA		
	12' DIOR	10'-15'	1	EA		
	18" ⌀ RCP	0'-10'	75	LF		
	24" ⌀ RCP	10'-15'	100	LF		
	54" ⌀ RCP	30'-35'	60	LF		
	54" ⌀ RCP	15'-20'	70	LF		

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QUANTITY TAKE-OFF SHEET

SHEET 5 OF 15

PROJECT NAME: HEWLETT - PACKARD

JOB NO.: 3164.003

LOCATION: BRIARGATE

DATE: 9-27-82

PROJECT DESCRIPTION: STORM DRAINAGE

PREPARED BY: RDP

CHECKED BY:

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
2-2	4' DIOR 0'-16'	1	EA		
	6' DIOR 0'-10'	1	EA		
	8' DIOR 0'-10'	1	EA		
	SPECIAL MH 10'-15'	2	EA		
	60" Ø RCP 10'-15'	20	LF		
	60" Ø RCP 15'-20'	340	LF		
	60" Ø RCP 10'-15'	255	LF		

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QUANTITY TAKE-OFF SHEET

SHEET 6 OF 15

PROJECT NAME: HEWLETT-PACKARD

JOB NO.: 3164.003

LOCATION: BRIARGATE

DATE: 4-27-83

PROJECT DESCRIPTION: STORM DRAINAGE

PREPARED BY: RDP

CHECKED BY:

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	SUBTOTAL (2)				
	4' DIAR 0'-10'	1	EA		
	10'-15'	2			
	6' DIAR 0'-10'	3			
	10'-15'	4			
	15'-20'	2			
	8' DIAR 0'-10'	4			
	10'-15'	1			
	12' DIAR 0'-10'	1			
	10'-15'	1			
	16' DIAR 0'-10'	1			
	TYPE 13 0'-10'	7			
	10'-15'	6			
	4' Ø MH 10'-15'	1			
	5' Ø MH 0'-10'	3			
	10'-15'	2			
	15'-20'	4			
	30'-35'	1			
	6' Ø MH 15'-20'	1			
	20'-25'	1			
	30'-35'	2			
	SPECIAL MH 10'-15'	2			
	15'-20'	1	↓		

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QUANTITY TAKE-OFF SHEET

SHEET 7 OF 15

PROJECT NAME: HEWLETT-PACKARD
JOB NO.: 3164.003
LOCATION: BRIARGATE
DATE: 4-27-83
PREPARED BY: BDP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	SUBTOTAL (2) (CONT)				
	18"Ø RCP 0'-10'	610	LF		
	10'-15'	995			
	15'-20'	260			
	21" Ø RCP 10'-15'	100			
	24" Ø RCP 0'-10'	170			
	10'-15'	260			
	15'-20'	650			
	27" Ø RCP 0'-10'	465			
	10'-15'	320			
	15'-20'	320			
	20'-25'	145			
	30" Ø RCP 10'-15'	325			
	33" Ø RCP 10'-15'	40			
	15'-20'	190			
	30'-35'	30			
	36" Ø RCP 20'-25'	250			
	42" Ø RCP 25'-30'	200			
	30'-35'	190			
	48" Ø RCP 30'-35'	100			
	54" Ø RCP 15'-20'	240			
	30'-35'	60			
	60" Ø RCP 10'-15'	275			
	15'-20'	340			

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QUANTITY TAKE-OFF SHEET

SHEET 8 OF 15
PROJECT NAME: HEWLETT-PACKARD
JOB NO.: 316d.003
LOCATION: BRIARGATE
DATE: 4-27-82
PREPARED BY: MP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
A3	SPECIAL MH	10'-15'	1	EA		
	72" ∅ RCP	10'-15'	90	LF		
A4	SPECIAL MH	10'-15'	2	EA		
	72" ∅ RCP	10'-15'	40	LF		
	72" ∅ RCP	10'-15'	365	LF		
	6' DICR	0'-10'	1	EA		
	21" ∅ RCP	0'-10'	180	LF		
	6' DICR	0'-10'	1	EA		
	27" ∅ RCP	0'-10'	60	LF		
	5' ∅ MH	0'-10'	1	EA		
	27" ∅ RCP	0'-10'	120	LF		
	4' DICR	0'-10'	2	EA		
	18" ∅ RCP	0'-10'	20	LF		
	5' ∅ MH	0'-10'	1	EA		
	36" ∅ RCP	0'-10'	55	LF		
	5' ∅ MH	0'-10'	1	EA		
	30" ∅ RCP	0'-10'	130	LF		
	5' ∅ MH	0'-10'	1	EA		
	6' DICR	0'-10'	2	EA		
	18" ∅ RCP	0'-10'	20	LF		
	36" ∅ RCP	0'-10'	100	LF		
	5' ∅ MH	0'-10'	1	EA		
	6' DICR	0'-10'	2	EA		
	18" ∅ RCP	0'-10'	40	LF		
	42" ∅ RCP	0'-10'	200	LF		
	42" ∅ RCP	10'-15'	200	LF		
	5' ∅ MH	10'-15'	1	EA		
	42" ∅ RCP	0'-15'	270	LF		

FORM NO. 17

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QUANTITY TAKE-OFF SHEET

SHEET 9 OF 15
PROJECT NAME HEWLETT - PACKARD
JOB NO. 3164.003
LOCATION BRIARGATE
DATE 4-27-83
PREPARED BY TSP
CHECKED BY

PROJECT DESCRIPTION
STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
25	78" Ø RCP	10'-15'	70	LF		
	CONC. CHNL.		200	LF		
	TYPE 13	0'-10'	6	EA		
	24" Ø RCP	0'-10'	220	LF		
	12' DIOR	0'-10'	1	EA		
	18" Ø RCP	0'-10'	70	LF		
	12' DIOR	0'-10'	1	EA		
	24" Ø RCP	0'-10'	320	LF		
27	4' DIOR	0'-10'	2	EA		
	18" Ø RCP	0'-10'	70	LF		
	CONC. CHNL.		320	LF		
28	CONC. CHNL.		125	LF		
29	CONC. CHNL.		30	LF		
	4' DIOR	0'-10'	1	EA		
	18" Ø RCP	0'-10'	70	LF		
29	18" Ø RCP	0'-10'	70	LF		
	4' DIOR	0'-10'	1	EA		
	CONC. CHNL.		495	LF		
30	6' DIOR	0'-10'	2	EA		
	4' DIOR	0'-10'	1	EA		
	18" Ø RCP	0'-10'	100	LF		
	CONC. CHNL.		950	LF		
31	CONC. CHNL.		700	LF		
32	60" Ø	10'-15'	110	LF		
	8' x 6' RCBC	15'-20'	230	LF		
	RCBC MH RISER		11	LF		
33	8' x 6' RCBC	15'-20'	435	LF		
	8' x 6' RCBC	20'-25'	120	LF		
	RCBC MH RISER		16	LF		
	24" RCP	0'-10'	85	LF		
	12' DIOR	0'-10'	1	EA		
	24" RCP	10'-15'	200	LF		
	24" Ø [illegible]	10'-15'	1	EA		

FORM NO. 17

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QUANTITY TAKE-OFF SHEET

SHEET 14 OF 15

PROJECT NAME: HEWLETT-PACKARD
JOB NO.: 3164.003
LOCATION: BRIARGATE
DATE: 4-27-82
PREPARED BY: RGF
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	30" ⌀ RCP	10'-15'	235	LF		
	5' ⌀ MH	10'-15'	1	EA		
	36" ⌀ RCP	10'-15'	275	LF		
	TYPE 13	0'-10'	7	EA		
	18" ⌀ RCP	0'-10'	180	LF		
	18" DIOR	0'-10'	1	EA		
54	6'x6' RCBC	20'-25'	235	LF		
	RCBC MH RISER		20	LF		
	6'x6' RCBC	20'-25'	400	LF		
	RCBC MH RISER		16	LF		
	24" ⌀ RCP	0'-10'	200	LF		
	5' ⌀ MH	10'-15'	2	EA		
	4' DIOR	0'-10'	1	EA		
	6' DIOR	0'-10'	1	EA		
	8' DIOR	0'-10'		EA		
	24" ⌀ RCP	0'-10'	25	LF		
	18" ⌀ RCP	0'-10'	30	LF		
63	8'x6' RCBC	20'-25'	130	LF		
	RCBC MH RISER		14	LF		
	8'x6' RCBC	15'-20'	400	LF		
	TRANSITION STRUCTURE		1	EA		
	ENERGY DISSIPATION STRUCTURE		1	EA		

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QUANTITY TAKE-OFF SHEET

SHEET 11 OF 15
PROJECT NAME: HEWLETT - PACKARD
JOB NO.: 3164.002
LOCATION: RIFLECATT
DATE: 4-27-83
PREPARED BY: RLF
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	SUBTOTAL (3)				
	4' DIOR 0'-10'	7	EA		
	6' DIOR 0'-10'	7			
	8' DIOR 0'-10'	1			
	12' DIOR 0'-10'	3			
	14' DIOR 0'-10'	1			
	TYPE 13 0'-10'	13			
	5' ϕ MH 0'-10'	5			
	10'-15'	5			
	SPECIAL MH 10'-15'	3	↓		
	18" ϕ RCP 0'-10'	670	LF		
	24" ϕ RCP 0'-10'	180			
	24" ϕ RCP 0'-10'	615			
	27" ϕ RCP 0'-10'	180			
	30" ϕ RCP 0'-10'	185			
	10'-15'	710			
	33" ϕ RCP 0'-10'	85			
	36" ϕ RCP 0'-10'	420			
	42" ϕ RCP 0'-10'	200			
	10'-15'	420			
	66" ϕ RCP 10'-15'	110			
	72" ϕ RCP 10'-15'	855			
	78" ϕ RCP 10'-15'	70			
	81"x58" RCPE 10'-20'	1,065			
	20'-25'	965			
	[illegible] MH RISER	77			
	[illegible]	2820	↓		
	[illegible]	1	EA		
	ENERGY DISSIPATION STRUCTURE	1	EA		

FORM NO. 17

GINGERY ASSOCIATES, INC.
CONSULTING ENGINEERS
2840 SO. VALLEJO ST.
ENGLEWOOD, COLO.
80110 (303) 761-4660

QUANTITY TAKE-OFF SHEET

SHEET 12 OF 15

PROJECT NAME: HEWLETT-PACKARD

JOB NO.: 3168 003

LOCATION: BERTHOUD

DATE: 4-27-83

PROJECT DESCRIPTION: STORM DRAINAGE

PREPARED BY: RTS

CHECKED BY:

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	TOTALS					
	4'DIOR	0'-10'	19	EA	1,000	19,000
		10'-15'	2		1,250	2,500
	6'DIOR	0'-10'	10		1,200	12,000
		10'-15'	4		1,450	5,800
		15'-20'	2		1,950	3,900
	8'DIOR	0'-10'	5		1,400	7,000
		10'-15'	1		1,650	1,650
	10'DIOR	0'-10'	4		1,600	6,400
		10'-15'	1		1,850	1,850
	12'DIOR	0'-10'	1		1,500	1,500
	16'DIOR	0'-10'	1		2,000	2,000
	TYPE 13	0'-10'	20	EA	1,000	20,000
		10'-15'	6		1,250	7,500
	4'ØMH	0'-10'	2	EA	1,000	2,000
		10'-15'	1		1,250	1,250
	5'ØMH	0'-10'	16		1,200	19,200
		10'-15'	7		1,450	10,150
		15'-20'	4		1,950	7,800
		30'-35'	1		4,000	4,000
	6'ØMH	15'-20'	1		2,250	2,250
		20'-25'	1		2,750	2,750
		30'-35'	2		4,500	9,000
	STORM MH	10'-15'	5		2,500	12,500
		15'-20'	1		3,500	3,500
	TRANSITION STRUCTURE		1	EA	15,000	15,000
	ENERGY DISSIPATION STRUCTURE		1	EA	15,000	15,000

FORM NO. 17

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QUANTITY TAKE-OFF SHEET

SHEET 12 OF 15
PROJECT NAME HEWLETT-PACKARD
JOB NO. 3160A.003
LOCATION PALO ALTO
DATE 4-27-83
PREPARED BY RF
CHECKED BY

PROJECT DESCRIPTION
STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	TOTALS (CONT)				
	18" ⌀ RCP 0'-10'	3,115	LF	20	62,300
	10'-15'	995		28	27,860
	15'-20'	260		40	10,400
	21" ⌀ RCP 0'-10'	760		24	18,240
	10'-15'	100		32	3,200
	24" ⌀ RCP 0'-10'	775		29	22,475
	10'-15'	260		37	9,620
	15'-20'	650		49	31,850
	[illegible]	1,525		35	53,375
	[illegible]	320		43	13,760
	[illegible]	320		56	17,920
	[illegible]	145		73	10,585
	[illegible] 0'-10'	185		43	7,955
	10'-15'	1,035		53	54,855
	33" ⌀ RCP 0'-10'	85		49	4,165
	10'-15'	40		58	2,320
	15'-20'	190		71	13,490
	30'-35'	30		136	4,080
	36" ⌀ RCP 0'-10'	420		56	23,520
	20'-25'	250		97	24,250
	42" ⌀ RCP 0'-10'	200		67	13,400
	10'-15'	420		77	32,340
	25'-30'	200		132	26,400
	[illegible]	190		160	30,400
	[illegible] RCP 30'-35'	100		176	17,600
	54" ⌀ RCP 15'-20'	240		121	29,040
	[illegible]	60		196	11,760
	[illegible]	385		120	46,200
	[illegible]	300		141	42,300
	[illegible]	855		175	149,625
	[illegible] 10'-15'	70		202	14,140

FORM NO. 17

GINGERY ASSOCIATES, INC.
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QUANTITY TAKE-OFF SHEET

SHEET 14 OF 15
PROJECT NAME HEWLETT-PACKARD
JOB NO. 3164.005
LOCATION PRIARGATE
DATE 4-27-83
PROJECT DESCRIPTION STORM DRAINAGE
PREPARED BY ZCF
CHECKED BY

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	TOTALS (CONT)				
	8' x 6' RCBC 15'-20'	1,065	LF	260	276 900
	20'-25'	985	↓	281	279 785
	REF. MH RISER	77	LF	80	6 160
	CONCRETE CHANNEL	2,820	LF	155	937 100
	SHEET 12				195 850
	SHEET 13				837 375
	SHEET 14				999 900
	SUBTOTAL				2,033 075
	+ CONTINGENCY 10%				203 310
	TOTAL				2,236,385

GINGERY ASSOCIATES, INC.
CONSULTING ENGINEERS
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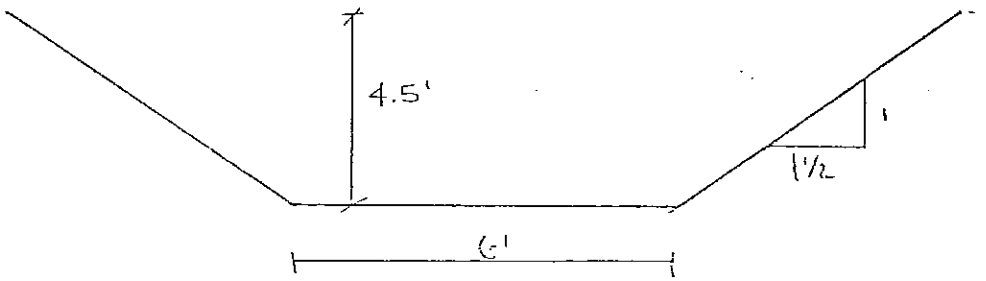
DESIGN CALCULATIONS

Project HEWLETT PACKARD
Feature COST ESTIMATE
Designed VLV Date 1-27-83 Sht. 15 of 15
Checked _____ Date _____ Job No. 3160.03

CHANNEL QUANTITIES



6" OK ON SLOPE PAVING @ $160/CY
TO ALLOW FOR SPECIAL DESIGN @ SUPERCRITICAL, USE 9" @ $200/CY.

$$P = 6 + 2\sqrt{4.5^2 + [1.5(4.5)]^2} = 22.22 \text{ SF/LF}$$

$$@9" \quad V = 22.22 \frac{SF}{LF} \times \frac{9 IN}{12 IN/FT} = 16.67 \frac{CF}{LF}$$

$$\text{CONCRETE COST} = \frac{16.67 \text{ CF/LF}}{27 \text{ CF/CY}} \times \frac{\$200}{CY} \cong \$125/LF$$

USE 6" PVC UNDERDRAIN @ $6/LF

$$\text{FILTER MATERIAL} \quad \frac{1' \times 6' \times 1'}{27} \times \frac{\$18}{CY} \cong \$4/LF$$

$$\text{ACCESS ROAD} \quad \frac{12' \times 0.5' \times 1'}{27} \times \frac{\$10}{T} \times \frac{1.8 T}{CY} \cong \$4/LF$$

SUBTOTAL = 125 + 6 + 4 + 4 ≅ $139/LF
+ CONTINGENCY @ 10% → $14/LF

$153/LF

[COST OF EXCAVATION TO BE INCLUDED IN GRADING]