INSPECTIONS

STORM DRAINAGE MASTER PLAN HEWLETT-PACKARD AT BRIARGATE COLORADO SPRINGS, COLORADO

December 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

DEC Job 101

DEC Denver Engineering Corporation
1626 Cole Boulevard • Suite 300 • Building 7 • Golden, Colorado 80401 • (303) 232-6262

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HEWLETT-PACKARD AT BRIARGATE

COLORADO SPRINGS, COLORADO

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Golden, Colorado 80401
(303) 233-0533

DEC Job No. 101

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.

Prepared by:

Bruce Prommersberger, P.E.
Project Manager

Reviewed by:

David E. Moothart, P.E.
Vice-President
Colorado Professional Engineer No. 18183

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 Corporation

By: _____

Title: _____

Address: _____

_____

_____

ORIGINAL SET SIGNED BY DEVELOPER

CITY OF COLORADO SPRINGS

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

Gary Haynes
City Engineer

Date: 1/19/84

TABLE OF CONTENTS

STORM DRAINAGE MASTER PLAN
HEWLETT-PACKARD AT BRIARGATE
COLORADO SPRINGS, COLORADO

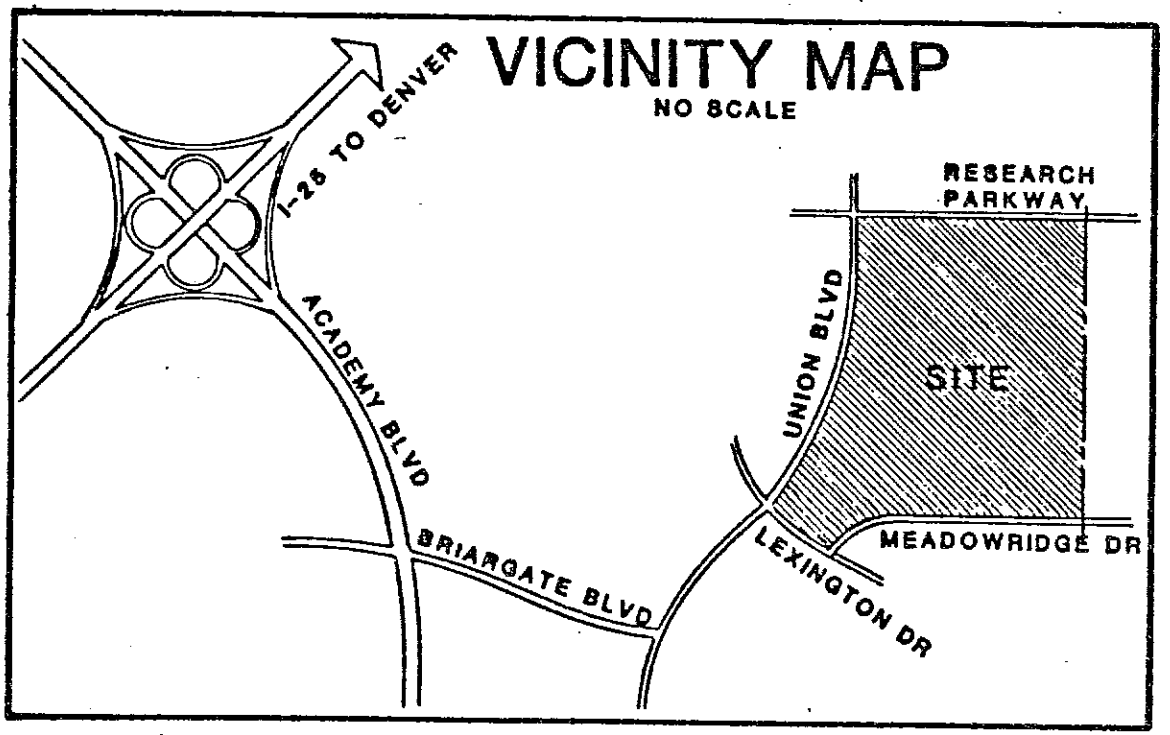
Objective

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.



Drainage Considerations

The site generally drains from the 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.

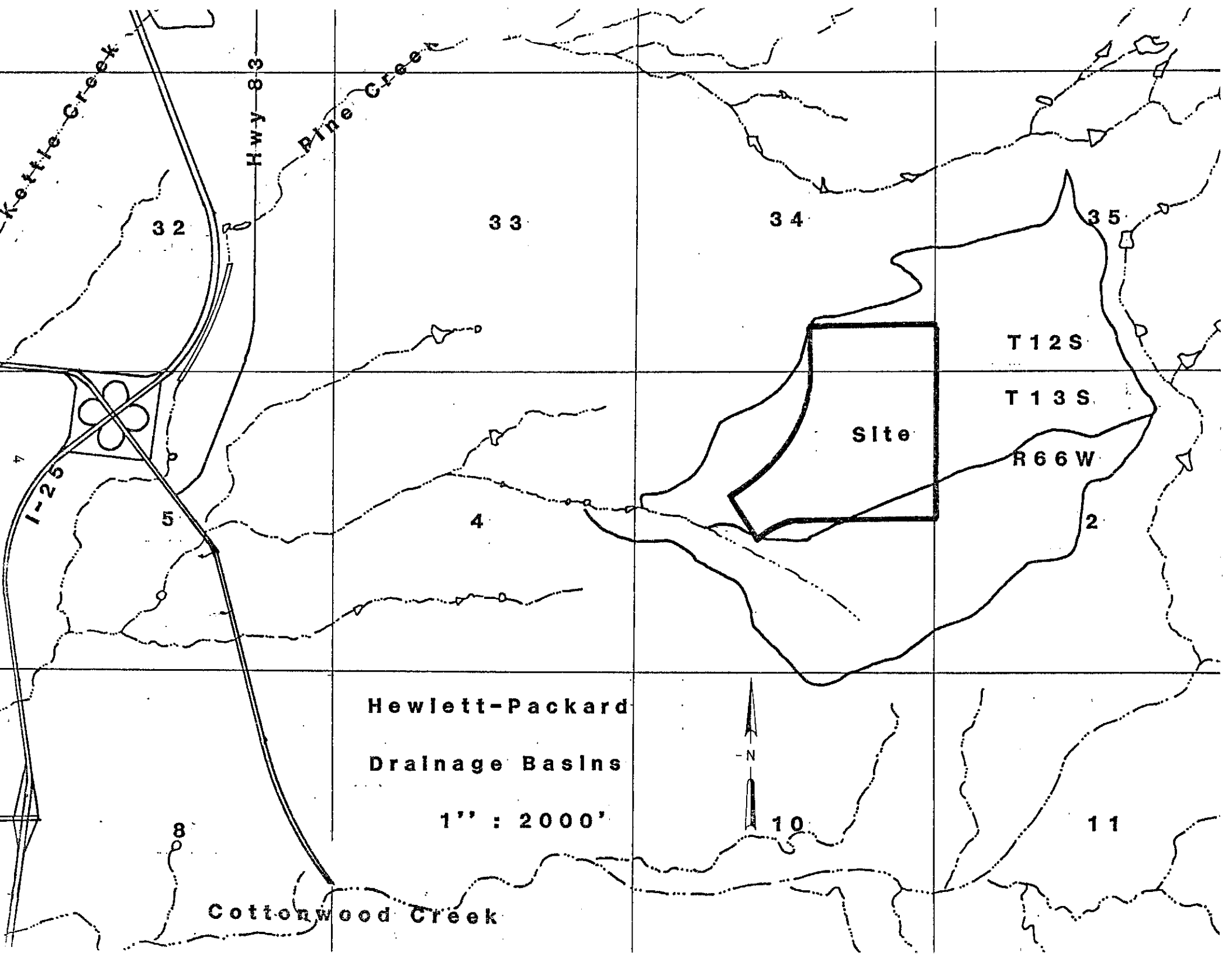
3. The finished grades cause runoff in the central part of the site to drain to the middle of the site, often to low points on the north side of the proposed buildings. The runoff in this portion of the site is collected and conveyed by a series of pipes south to the major collection facilities along Meadow Ridge Drive. This system is sized for the 100-year sotrm.

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 form 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 a September 29, 1983 letter from Donell Jeffries to Gary Haynes, City Engineer. A copy of this letter is included in the Appendix. Soil information is taken from Soil Survey of El Paso


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

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.

A minor 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 732 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 732 cfs.

2. Install a third 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-Packard storm drainage facilities is $2,285,680. The portion of this cost to be reimbursed by the City of Colorado Springs is $1,104,265. The reimbursable cost is computed assuming a concrete channel from the first point of interception of offsite flows near the northeast corner of the site at design point 23, along the east and south property line, terminating at the existing culvert crossing at Lexington and Meadow Ridge at design point 35.

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 a preliminary estimate only. Final design has not yet been performed. 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 downstream. 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 I
HYDROLOGY

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)
		•							•	•		•	
A	3.85	0.006	A	ROAD & LAWN	70	84	1820	0.118	1230	0.28	2.1	1.01	7.4
B	1.22	0.002	A	ROAD & LAWN	67	49	880	0.052	1410	0.21	0.6	0.85	2.4
C	7.26	0.011	A	ROAD & LAWN	48	96	1550	0.197	1080	—	—	0.15	1.7
D	5.96	0.009	A	ROAD & LAWN	52	101	1110	0.109	1250	0.01	0.1	0.25	2.8
E	2.40	0.004	A	ROAD & LAWN	**52**	55	700	0.097	1290	0.01	0.1	0.25	1.3
F	1.65	0.003	A	ROAD & LAWN	63	57	2040	0.167	1130	0.13	0.4	0.66	2.2
G	4.43	0.007	A	LAWN	39	56	1860	0.282	950	—	—	0.01	0.1
H	OFFSITE												320
I	2.15	0.003	A	ROAD & LAWN	71	36	850	0.058	1400	0.31	1.3	1.06	4.5
J	1.69	0.003	A	ROAD & LAWN	55	31	870	0.064	1380	0.02	0.1	0.35	1.4
K	3.31	0.005	A	BLDG, ROAD & LAWN	71	14	720	0.071	1370	0.31	2.1	1.06	7.3
L	6.44	0.010	A	BLDG, PARKING & LAWN	83	14	620	0.057	1400	0.76	10.7	1.86	26.0
M	8.70	0.014	A	BLDG, PARKING & LAWN	82	8	875	0.122	1220	0.72	12.2	1.78	30.4
N	3.84	0.006	A	ROAD & LAWN	95	19	550	0.058	1400	1.58	13.3	2.94	24.7
O	3.85	0.006	A	PARKING & LAWN	84	21	850	0.102	1275	0.82	6.2	1.94	14.8
P	1.15	0.002	A	PARKING & LAWN	87	9	240	0.017	1493	0.98	2.9	2.18	6.5
Q	12.16	0.019	A	BLDG, PARKING & LAWN	77	16	1250	0.223	1020	0.50	9.7	1.43	27.7
													161.2

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DESIGN CALCULATIONS

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Feature DRAINAGE HYDROLOGY
Designed BDP Date 12-5-83 Sht. 1 of 15
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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	0.009	A	BLDG, PARKING & LAWN	86	12	850	0.098	1290	0.93	10.7	2.10	24.4
S	5.10	0.008	A	BLDG, PARKING & LAWN	86	4	330	0.042	1430	0.93	10.6	2.10	24.0
T	3.82	0.006	A	BLDG, PARKING & LAWN	81	4	380	0.050	1415	0.67	5.7	1.71	14.5
U	2.30	0.004	A	ROAD & LAWN	74	16	860	0.085	1320	0.40	2.1	1.24	6.5
V	0.58	0.001	A	ROAD & LAWN	66	8	360	0.033	1460	0.18	0.3	0.80	1.2
W	2.95	0.005	A	BLDG, ROAD & LAWN	71	8	720	0.095	1300	0.31	2.0	1.06	6.9
X	12.93	0.020	A	BLDG, ROAD & LAWN	81	23	1130	0.174	1120	0.67	15.0	1.71	38.3
Y	7.24	0.011	A	BLDG, PARKING & LAWN	76	14	780	0.080	1330	0.47	6.8	1.37	20.0
Z	3.76	0.006	A	BLDG, PARKING & LAWN	85	10	560	0.058	1400	0.87	7.3	2.02	16.9
AA	1.63	0.003	A	ROAD	69	42	2230	0.221	1040	0.25	0.8	0.95	3.0
BB	5.96	0.009	A	LAWN & CHANNEL	60		2230	0.031	1465	0.08	1.0	0.53	7.0
CC	OFFSITE												CUMULATIVE 509
DD	3.00	0.005	A	PARKING & LAWN	82	10	750	0.091	1305	0.72	4.7	1.78	11.6
EE	0.94	0.001	A	PARKING & LAWN	45	13	520	0.045	1425	—	—	0.08	0.1
FF	2.90	0.005	A	PARKING & LAWN	84	10	540	0.054	1405	0.82	5.7	1.94	13.6
GG	7.30	0.011	A	BLDG, PARKING & LAWN	83	9	800	0.106	1260	0.76	10.6	1.86	25.8
HH	4.19	0.007	A	BLDG, PARKING & LAWN	89	7	470	0.054	1405	1.11	10.9	2.36	23.2
													237.0
													398.2

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Designed BDP Date 12-5-83 Sht. 3 of 15
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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)
		.							.	.		.	
II	5.04	0.008	A	BLDG, PARKING & LAWN	86	5	470	0.062	1390	0.93	10.3	2.10	23.3
JJ	2.92	0.005	A	BLDG, PARKING & LAWN	86	5	500	0.069	1365	0.93	6.3	2.10	14.3
KK	3.43	0.005	A	ROAD & LAWN	66	38	1300	0.106	1260	0.18	1.2	0.80	5.0
LL	2.05	0.003	A	BLDG, ROAD & LAWN	66	10	750	0.129	1205	0.18	0.7	0.80	2.9
MM	8.14	0.013	A	ROAD & BALLFIELD	41	54	1640	0.271	965	—	—	0.03	0.1
NN	1.08	0.002	A	ROAD & LAWN	77	16	910	0.094	1300	0.50	2.6	1.43	7.4
OO	9.90	0.015	A	BLDG, PARKING & LAWN	83	19	550	0.061	1390	0.76	15.9	1.86	38.8
PP	7.70	0.012	A	BLDG, PARKING & LAWN	71	10	470	0.095	1425	0.31	5.2	1.06	18.2
QQ	3.10	0.005	A	BLDG, ROAD & LAWN	89	8	480	0.051	1410	1.11	7.8	2.36	16.6
RR	8.00	0.013	A	BLDG, PARKING & LAWN	82	9	830	0.137	1195	0.72	11.1	1.78	27.7
SS	7.20	0.011	A	BLDG, PARKING & LAWN	87	17	700	0.063	1385	0.98	15.0	2.18	33.2
TT	7.32	0.011	A	BLDG, ROAD & BALLFIELD	45	44	680	0.105	1265	—	—	0.08	1.2
UU	2.43	0.004	A	ROAD & LAWN	47	15	1500	0.208	1060	—	—	0.12	0.5
VV	2.30	0.004	A	ROAD & LAWN	54	41	1650	0.186	1095	0.02	0.1	0.31	1.4
													190.6
													588.8

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Detail DRAINAGE HYDROLOGY
Designer BDP Date 12-5-83
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COMPUTATION OF RUNOFF CURVE NUMBERS

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

ENTIRE SITE IS BLAKELAND LOAMY SAND ∴ SOIL TYPE A

PARKING LOTS, STREETS, DRIVEWAYS, ROOFS — CN = 98

LAWNS, GOOD CONDITION — CN = 39

COMPUTE COMPOSITE CN FOR SITE

COMPARE WITH PLANNING DATA

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BASIN	AREA (ACRES)	AREA (SQ. MI)	% CN = 39	% CN = 98	CN
A	3.85	0.006	47	53	70
B	1.22	0.002	53	47	67
C	7.26	0.011	85	15	48
D	5.96	0.009	78	22	52
E	2.40	0.004	78	22	52
F	1.65	0.003	60	40	63
G	4.43	0.007	100	0	39
H	OFFSITE	OFFSITE	OFFSITE	OFFSITE	OFFSITE
I	2.15	0.003	45	55	71
J	1.69	0.003	73	27	55
K	3.31	0.005	46	54	71
L	6.44	0.010	25	75	83
M	8.70	0.014	27	73	82
N	3.84	0.006	5	95	95
O	3.85	0.006	24	76	84
P	1.15	0.002	19	81	87
Q	12.16	0.019	35	65	77
R	6.00	0.009	20	80	86
S	5.10	0.008	20	80	86
T	3.82	0.006	29	71	81
U	2.30	0.004	40	60	74
V	0.58	0.001	53	47	66
W	2.95	0.005	45	55	71
X	12.95	0.020	29	71	81
Y	7.24	0.011	37	63	76
Z	3.76	0.006	22	78	85
AA	1.63	0.003	50	50	69
BB	5.96	0.009	65	35	60
CC	OFFSITE	OFFSITE	OFFSITE	OFFSITE	OFFSITE
DD	3.00	0.005	27	73	82
EE	0.94	0.001	90	10	45
FF	2.96	0.005	23	77	84
GG	7.30	0.011	25	75	83
HH	4.19	0.007	15	85	89
II	5.04	0.008	20	80	86
JJ	2.92	0.005	20	80	86

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Designer BDP Date 12-5-83
Checker _____ Date _____

BASIN	AREA (ACRES)	AREA (Sq. Mi.)	% CN: 39	% CN: 98	CN
EE	3.43	0.005	55	45	66
LL	2.05	0.003	54	46	66
MM	8.14	0.013	97	3	41
NN	1.08	0.002	36	64	77
OO	9.90	0.015	25	75	83
PP	7.70	0.012	46	54	71
QQ	3.10	0.005	15	85	89
RR	8.00	0.013	27	73	82
SS	7.20	0.011	18	82	87
TT	7.32	0.011	89	11	45
UU	2.43	0.004	86	14	47
VV	2.30	0.004	75	25	54
	211.27	0.331			

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DETERMINE CUMULATIVE CN FOR SITE

$$\Sigma CN = \frac{\Sigma (A \times CN)}{\Sigma A} = \frac{15,401.81}{211.27} = 72.90 \approx \underline{73}$$

CHECK VS. PLANNING DATA

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

$$CN = (0.181)(98) + (0.402)(98) + (0.417)(39) = 73.40 \approx \underline{73}$$

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COMPUTATION OF TIME OF CONCENTRATION

DETERMINE CHANGE IN ELEVATION FOR EACH SUBBASIN

DETERMINE BASIN LENGTH

DETERMINE BASIN SLOPE, $\Delta EL/LENGTH$

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

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

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

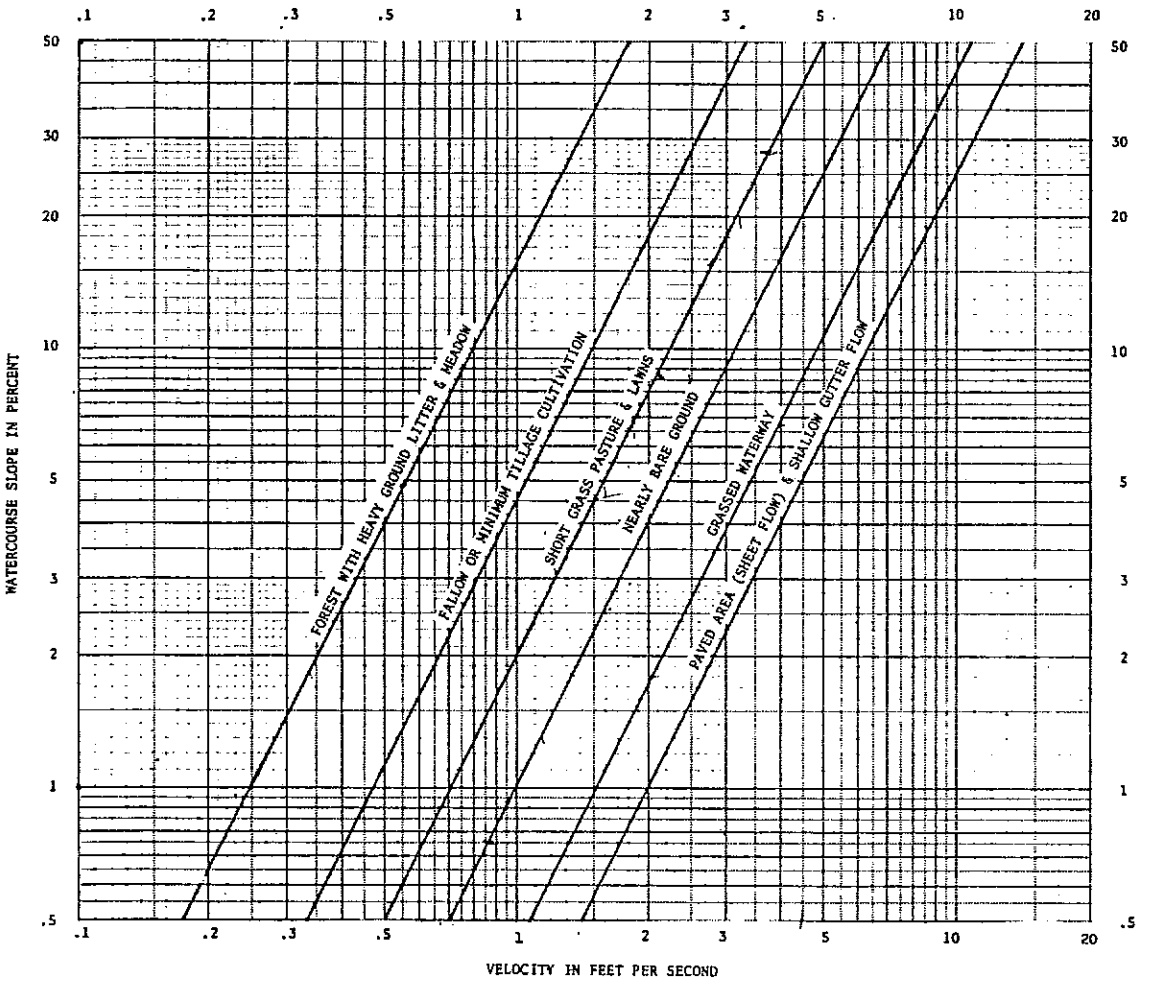

Figure 3-1.--Average velocities for estimating travel time for overland flow.

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

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BASIN	ΔL (FT)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	t_c (HR)	Σ t_c (IF READ)
A	80	1820	4.6	4.3	.118	
B	49	880	5.6	4.7	.052	
C	83	300	27.7	3.7	.023	
	13	1250	1.0	2.0	.174	.197
D	87	300	29.0	3.8	.022	
	14	810	1.7	2.6	.087	.109
E	55	700	7.9	2.0	.097	
F	57	2040	2.8	3.4	.167	
G	46	1280	3.6	1.3	.274	
	10	580	1.7	20 (EST)	.008	.282
H						OFFSITE
I	30	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	
	15	430	3.5	3.7	.032	.058
O	4	170	2.4	1.1	.043	
	17	680	2.5	3.2	.059	.102
P	9	240	3.8	4.0	.017	
Q	7 (EST)	400	1.8	1.0	.111	
	9	850	1.1	2.1	.112	.223
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	
W	8	720	1.1	2.1	.095	
X	7 (EST)	350	2.0	1.0	.097	
	16	780	2.1	2.8	.077	.174
Y	14	780	1.8	2.7	.080	
Z	10	900	1.8	2.7	.058	

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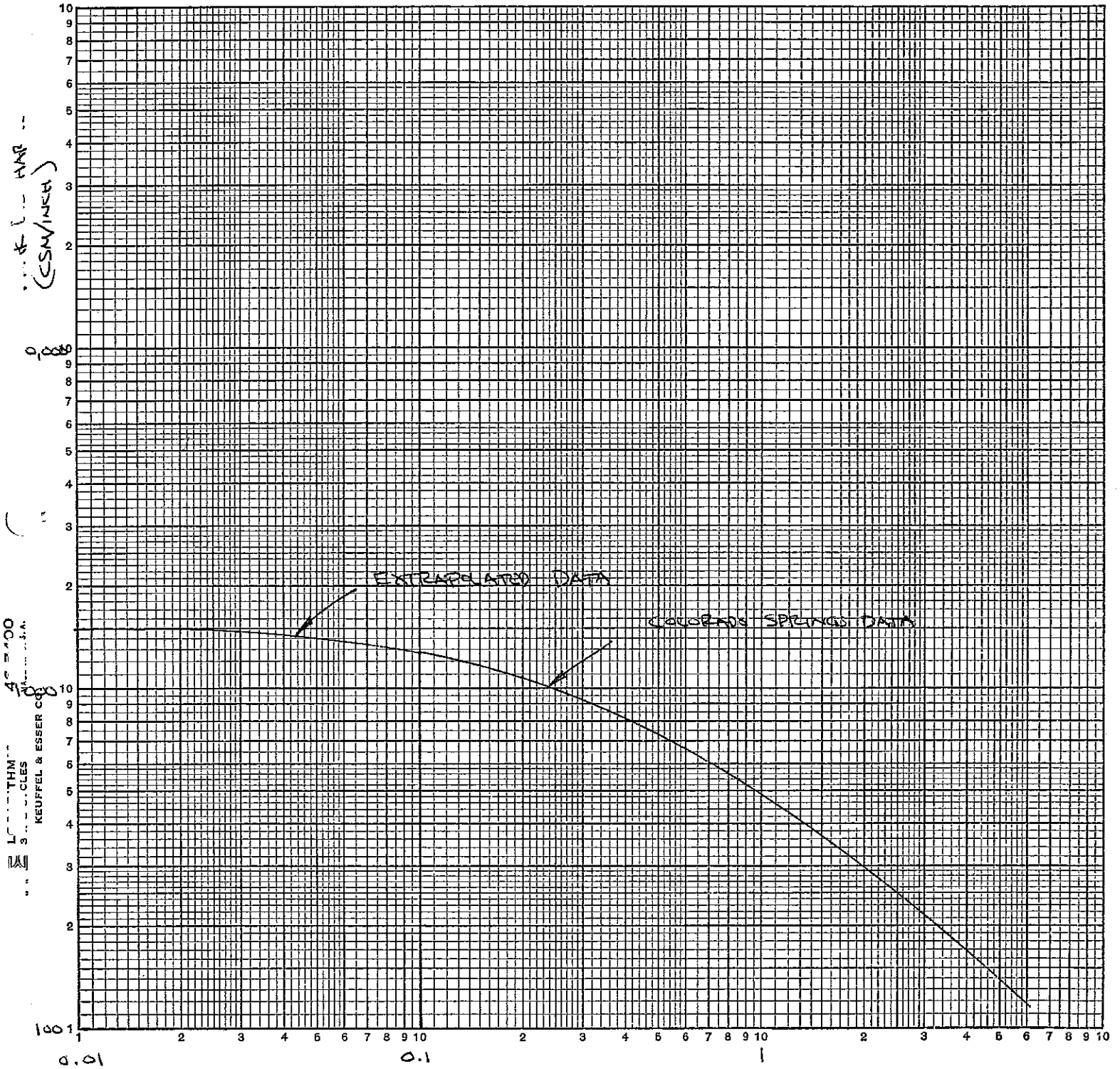
DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE HYDROLOGY
Designer BDP Date 12-5-83
Checker _____ Date _____

BASIN	Δℓ (FT)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	T_t (HR)	ΣT_t (IF REQD)
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	200	2.0	1.0	.056	
	6	550	1.1	2.1	.073	.129
MM	44	1070	4.1	1.4	.212	
	10	570	1.8	2.7	.059	.271
NN	16	910	1.8	2.7	.094	
OO	2	100	2.0	1.0	.028	
	17	450	3.8	3.8	.033	.061
PP	10	470	2.1	2.9	.045	
QQ	8	480	1.7	2.6	.051	
RR	2	130	1.5	0.9	.040	
	7	700	1.0	2.0	.097	.137
SS	17	700	2.4	3.1	.063	
TT	44	680	6.5	1.8	.105	
UU	15	1500	1.0	2.0	.208	
VV	15 (EST)	300	5.0	1.6	.052	
	26	1350	1.9	2.8	.134	.186

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

HEWLETT-PACKARD @ BRIARGATE
DRAINAGE HYDROLOGY
BDP 12-5-83



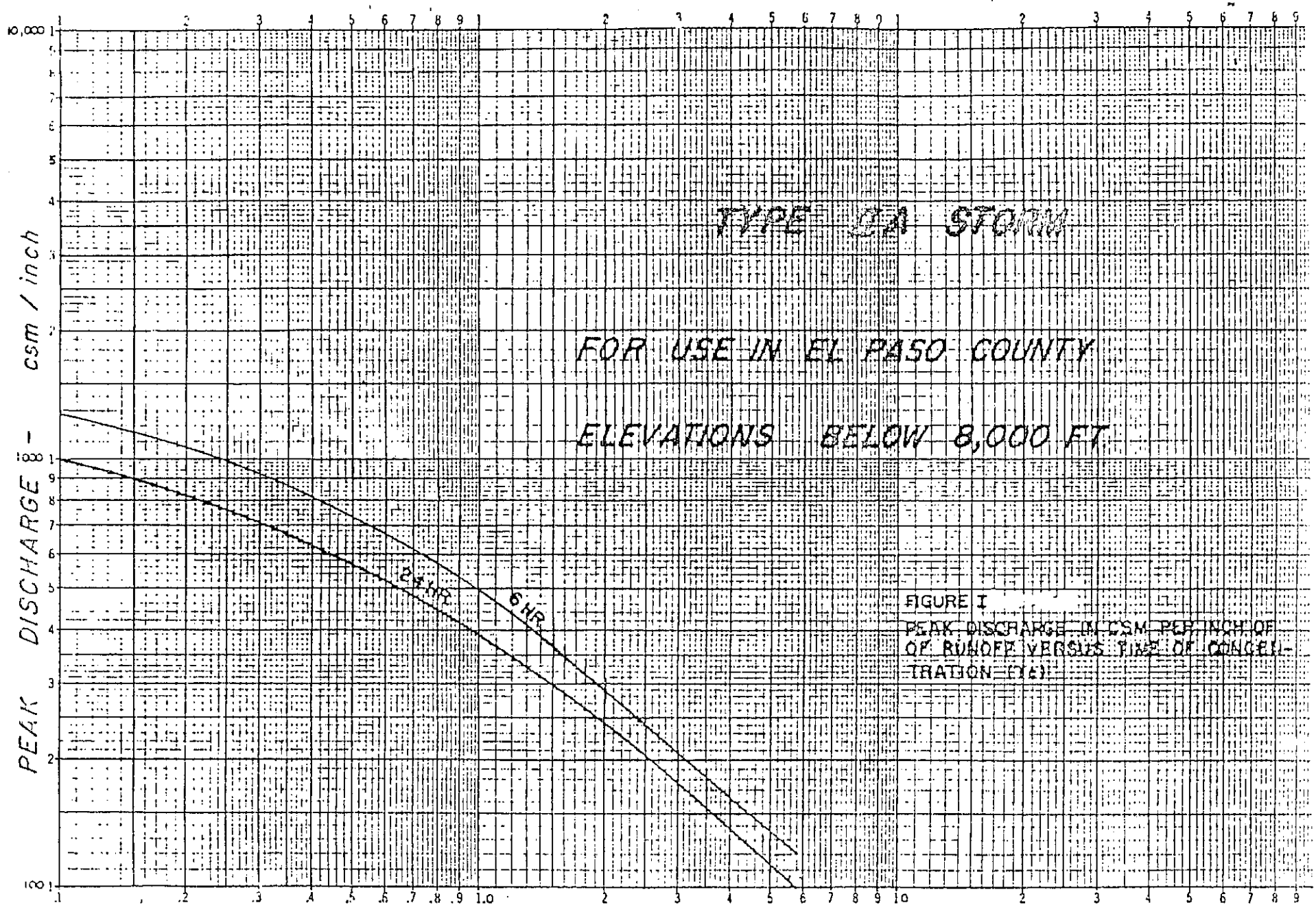


FIGURE I

PEAK DISCHARGE IN CSM PER INCH OF RUNOFF VERSUS TIME OF CONCENTRATION (TC)

SHEET 13/15
JOB NO. 101
HYDROLOGY
DRAINAGE
BMP 12-5-83

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Designer BDP Date 12-5-83
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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

$$0 = P - 0.2S$$

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

$$CN = 48.78$$

FIND POINT of ZERO RUNOFF FOR 100 YEAR STORM

$$0 = P - 0.2S$$

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

$$CN = 36.36$$

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Designer BDP Date 12-5-83
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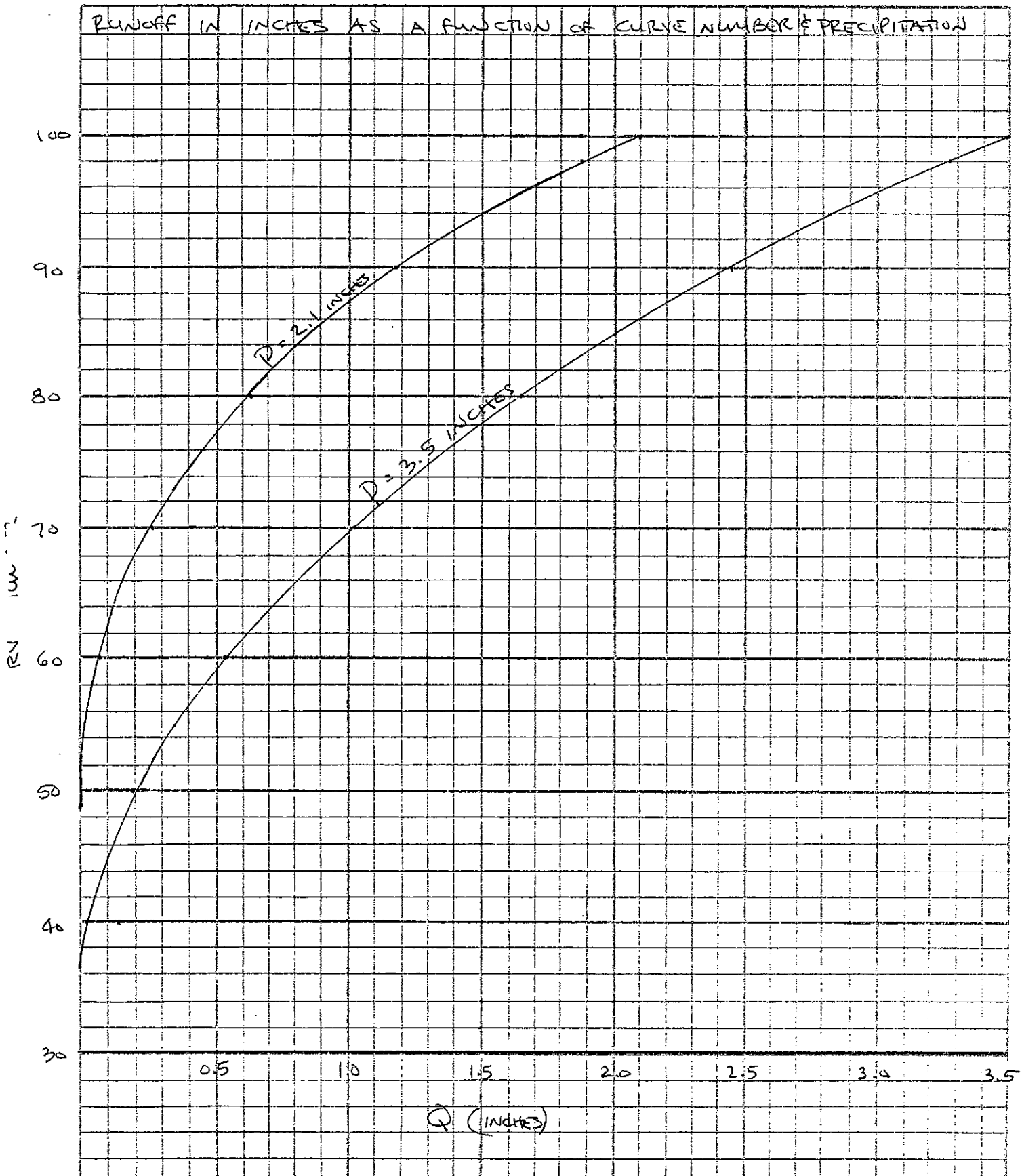

DONELL JEFFRIES
PROFESSIONAL ENGINEER
REGISTERED LAND SURVEYOR
SUBDIVISION LAYOUT AND DESIGN

3315 Springridge Circle
Colorado Springs, Colorado 80906
(303) 576-5576

September 29, 1983

Mr. Gary Haynes
City Engineer
Colorado Springs, Colorado

Re: Peak Drainage Flows Affecting the Hewlett Packard Briargate Site

Dear Gary:

Mr. Bruce Prommersberger, Project Manager for Gingery Associates Inc., recently contacted me regarding a discrepancy in the peak flow computations at the southwest corner of their site. His calculations show 1,080 c.f.s. at that point, while my 1980 computations show 675 c.f.s., and the existing twin 66" RCP culverts were designed for the smaller amount. The reason for the predicted difference in peak flows is two-fold.

1. At the time of my calculations in 1980, I assumed that a larger portion (about 50 acres) of the finished Hewlett Packard tract would flow into the Union Boulevard sub-basin, rather than to the south line of the property. The current design features a central system running north to south, which has increased the area draining to the southwest corner.

2. In computing the 1,080 c.f.s. flow, Mr. Prommersberger used my peak runoff quantities of 463 c.f.s. and 309 c.f.s. entering the Hewlett Packard site from the two basins east of their property. These quantities were shown in the drainage reports for Kambridge Point and Contrails No. 2 Subdivisions. However, my computations for the peak flows from those two basins were somewhat conservative as to the times of concentration.

As a safety factor, I generally use an average velocity of 10 feet per second for upstream flows. A more detailed analysis of the velocities indicates that the runoff will take considerably longer than shown to reach the Hewlett Packard tract, thus resulting in a reduction of the predicted storm water peak flows.

The following pages show the results of my re-computations. The times of concentration were taken from Figure 3-1, SCS Technical Release 55.

NORTHERLY BASIN INFLOW INTO HEWLETT PACKARD TRACT

Time Of Concentration

1,000 lf of concrete channel @ 2 %	Use 18 feet per second	= 55 seconds
1,200 lf of street flow @ 1 %	Use 2 " " "	= 600 "
2,500 lf of street & overland flow @ 3%	Use 3.5 " " "	= 714 "
		1369 seconds = 0.38 hours.

Acres	Square Miles	Curve Number	Basin Length	Time of Concen.	CSM/ Inch	100 Year Runoff	100 Year Peak c.f.s.
190	.2969	75	4,700'	0.38	830	1.30"	320

SOUTHERLY BASIN INFLOW INTO HEWLETT PACKARD TRACT

Time Of Concentration

1,500 lf of grassed swale @ 1 %	Use 2 feet per second	= 750 seconds
1,800 lf of streets @ 2%	Use 3 " " "	= 600 "
1,500 lf of streets @ 5 %	Use 5 " " "	= 300 "
		1650 seconds = 0.46 hours

Acres	Square Miles	Curve Number	Basin Length	Time of Concen.	CSM/ Inch	100 Year Runoff	100 Year Peak c.f.s.
151	.2359	72	4,800'	0.46	770	1.12"	203

COMBINED BASINS INFLOW INTO HEWLETT PACKARD TRACT

Acres	Square Miles	Curve Number	Basin Length	Time of Concen.	CSM/ Inch	100 Year Runoff	100 Year Peak c.f.s.
341*	.5328	74	6,100	0.46	770	1.24"	509

* Does not include any Hewlett Packard area.

Following are comparisons of these revised quantities with those shown on drainage studies of Kambridge Point, Contrails No. 2, and Phase III Master Plan.

	Previous	This Computation	Difference
Northerly Basin	463 c.f.s.	320 c.f.s.	143 c.f.s.
Southerly Basin	309 c.f.s.	203 c.f.s.	106 c.f.s.
Combined Basins	541 c.f.s.	509 c.f.s.	32 c.f.s.

The effect of the predicted reduction in 100 Year peak flows will not be significant on the already constructed drainage facilities in Contrails No. 1 and Kambridge Point Subdivisions. Those structures were sized for the 5 Year Storm, and the 100 Year Storm will flow overland along the linear park.

In Contrails No. 2 Subdivision the storm sewer designed in Research Parkway was sized to carry the 5 Year Storm flows, and again the 100 Year Storm will flow westerly in the street. The proposed 54" RCP culvert which crosses Research Parkway will carry the entire 100 Year Storm flow, although the total predicted is less than 500 c.f.s..

The concrete channel which has been designed between Research Parkway and the Hewlett Packard site will be constructed as presently approved. The channel as designed will carry 512 c.f.s. when full, or 320 c.f.s. with a freeboard of seven inches.

Please contact me if additional information is desired regarding the afore-mentioned discrepancy in peak flows.

Sincerely,

Donell Jeffries

cc: Bruce Pommersberger
Jerry Novak

APPENDIX 2
DRAINAGE FACILITIES

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

DESIGN SYSTEM ASSUMING n = 0.015 FOR RCP ℄
NO LOSSES. WORK FROM U/S TO D/S.
AT FINAL DESIGN, WORK FROM D/S TO U/S
USING n = 0.013 ℄ APPROPRIATE LOSSES.
PERIMETER ROAD IS 6" VERTICAL CURB ℄
30' ℄-℄.
USE COLORADO SPRINGS DIOR INLETS ALONG
CURB.
USE CDOH TYPE 13 WHERE DESIGNATED
IN PARKING LOTS. CDOH TYPE 13 TO BE
PLACED IN 1' SUMP.

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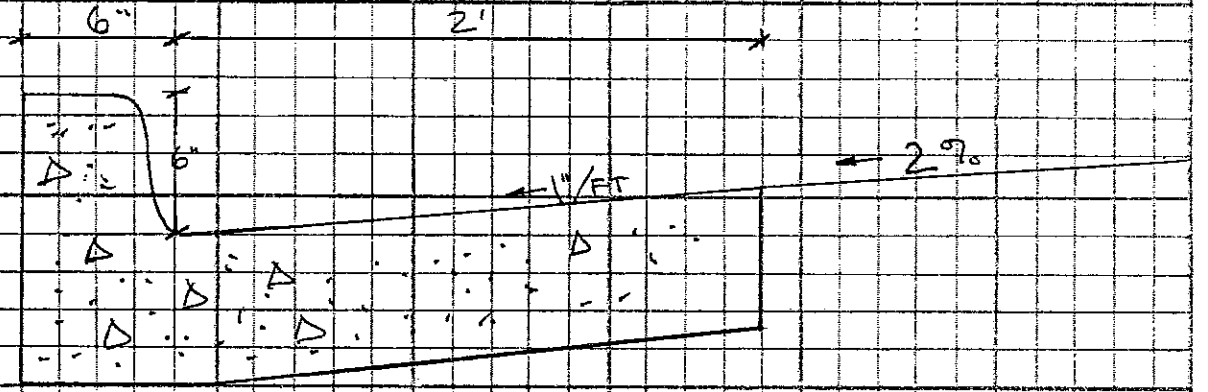
DESIGN CALCULATIONS

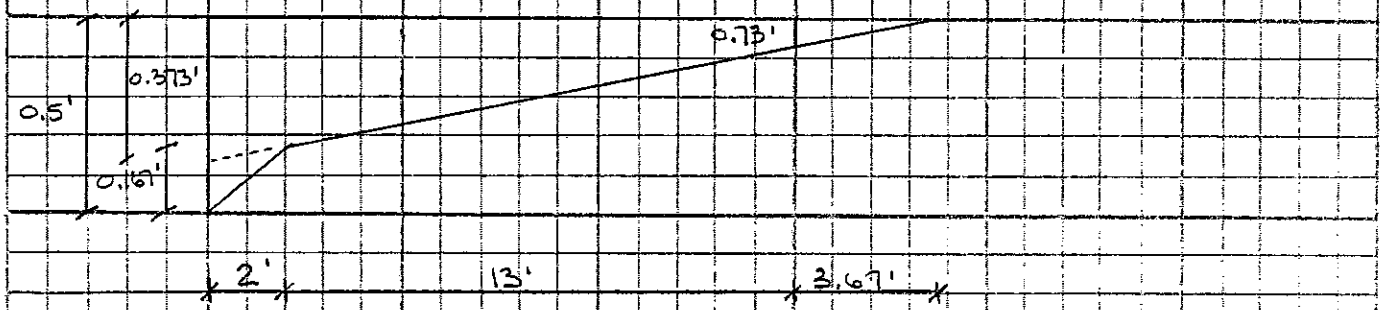
Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

DETERMINE GUTTER CAPACITY



STREET IS 30' F-F

ΔEL F-CROWN = $2'\left(1''/FT\right) + 13\left(0.02 FT/FT\right)\left(12''/FT\right) = 5.12''$



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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

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

Z = RECIPROCAL of CROSS SLOPE

n = 0.016

y = DEPTH of FLOW

S = SLOPE of STREET

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

$$Q = 127.77 \sqrt{S}$$

FOR 6" VERTICAL CURB FLOWING FULL ON 30' ℄-℄ STREET

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
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TYPE 13 INLET C.D.O.T. STANDARD M-604-AB

24 OPENINGS × (7 5/16" × 1 3/4") = 2.13 SF/GRATING

REDUCE BY 50% TO ALLOW FOR CLOGGING = 1.065F

SAY 1 SF/INLET

$Q = CA\sqrt{2gh}$

USE 1 FT. SUMP

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

$Q = 4$ CFS

DIOR INLET CAPACITIES FROM COLORADO SPRINGS "DETERMINATION of STORM RUNOFF CRITERIA" (SEE TABLE 6)

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DESIGN CALCULATIONS

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Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

(1) PART OF BASIN C Q<1 CFS 5YR 1.7 CFS 100YR
STREET SLOPE ±1% Q ALLOW = 12.78 CFS
DESIGN FOR 5 YR STORM
USE PAN ACROSS DRIVEWAY

(2) BASIN A 2.1 CFS 5YR 9.2 CFS 100 YR
STREET SLOPE = 5% Q ALLOW = 28.6 CFS
4' DIOR Q ALLOW = 8.6 CFS
DESIGN FOR 5 YR STORM
EQ = 0.1 + 2.1 = 2.2 CFS

(3) BASIN K 2.1 CFS 5YR 7.3 CFS 100 YR
STREET SLOPE = 2% Q ALLOW = 18.1 CFS
4' DIOR Q ALLOW = 6.5 CFS
DESIGN FOR 100 YR DUE TO LOW POINT
EQ = 2.2 + 7.3 = 9.5 CFS

(4) ½ BASIN Q 4.9 CFS 5YR 13.9 CFS 100 YR
SLOPE ACROSS LOT = 3.6% USE 2%
USE 2@4 DIOR INLETS - DESIGN FOR 5 YR STORM
4 DIOR Q ALLOW = 6.5 CFS
EQ = 9.5 + 4.9 = 14.4 CFS

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DESIGN CALCULATIONS

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Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
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△5 BASIN P 2.9 CFS 5YR 6.5 CFS 100 YR

SLOPE ACROSS LOT: 3%. USE 1.5%.

DESIGN FOR 5YR STORM

4' D10R QALLOW = 7.7 CFS

EQ = 14.4 + 2.9 = 17.3 CFS

△6

BASIN H	1.3 CFS	5YR	4.5 CFS	100YR
BASIN T	0.1 CFS	5YR	1.4 CFS	100 YR
	1.4 CFS		5.9 CFS	

STREET SLOPE = 4% QALLOW = 25.55 CFS

DESIGN FOR 5 YR STORM

4' D10R QALLOW = 4.4 CFS

EQ = 17.3 + 1.4 = 18.7 CFS

△7 BASIN W 2.0 CFS 5YR 6.9 CFS 100YR

STREET SLOPE = 1.7% QALLOW = 12.77 CFS

DESIGN FOR 5YR

4' D10R QALLOW = 8.6 CFS

EQ = 18.7 + 2.0 = 20.7 CFS

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Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
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(8) 70% BASIN X 10.5 CFS 5YR 26.8 CFS 100 YR
BASIN V 0.3 CFS 5YR 1.2 CFS 100 YR
10.8 CFS 28.0 CFS

SLOPE ACROSS LOT = 4% USE 2%

SLOPE ALONG CURB = 1.3% QALLOW = 14.57 CFS

DESIGN FOR 5YR STORM

10' DIOR Q ALLOW = 10.9 CFS

EQ = 10.8 CFS

(9) ½ BASIN FF 0.2 CFS 5YR 2.2 CFS 100 YR

SLOPE ACROSS LOT = 1.5% USE 0.75%

4' DIOR QALLOW = 7.5 CFS

DESIGN FOR 5YR STORM

EQ = 10.8 + 0.2 = 11.0 CFS

(10) ½ BASIN FF 0.2 CFS 5YR 2.2 CFS 100 YR

SLOPE ACROSS LOT = 1.5% USE 0.75%

4' DIOR QALLOW = 7.5 CFS

DESIGN FOR 5YR STORM

EQ = 11.0 + 0.2 = 11.2 CFS

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Designer BDP Date 12-6-83
Checker _____ Date _____

(11)	BASIN 4	2.1 CFS 5YR	6.5 CFS 100YR
	BASIN EE	0.1 CFS 5YR	0.1 CFS 100YR
		2.2 CFS	6.6 CFS

STREET SLOPE = 2.5 % Q ALLOW = 20.2 CFS

DESIGN FOR 5YR STORM

OUTLOT Q ALLOW = 5.7 CFS

EQ = 11.2 + 2.2 = 13.4 CFS

(12) COLLECT (7) & (11) AT EXISTING MANHOLE

EQ = 20.7 + 13.4 = 34.1 CFS

SEE (36) FOR ADDITIONAL RUNOFF TO UNION

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Designer BDP Date 12-6-83
Checker _____ Date _____

(13) PART OF BASIN C << 1 CFS 5 YR 1.7 CFS 100 YR
BASIN D 0.1 CFS 5 YR 2.8 CFS 100 YR
0.2 CFS 4.5

RUNOFF COLLECTS @ LOW POINT

STREET SLOPE = 2%. Q_{ALLOW} = 18.1 CFS

DESIGN FOR 100 YR STORM

4' DIOR Q_{ALLOW} = 6.5 CFS

EQ: 4.5 CFS

(14) BASIN L 10.7 CFS 5 YR 26.0 CFS 100 YR

PARKING LOT SLOPE 3% N-S ≠ 2% E-W

CURB CAPACITY = 22.1 CFS ≠ 18.1 CFS

DESIGN FOR 100 YR

4' DIOR @ 2% Q_{ALLOW} = 6.5 CFS
4' DIOR @ 3% Q_{ALLOW} = 5.2 CFS
8' DIOR @ 3% Q_{ALLOW} = 14.8 CFS
8' DIOR @ 2% Q_{ALLOW} = 12.5

ΣQ = 4.5 + 26.0 = 30.5 CFS

(15) BASIN S 10.5 CFS 5 YR 24.0 CFS 100 YR

SLOPE ACROSS LOT = 4% USE 2%

DESIGN FOR 100 YR

6' DIOR Q_{ALLOW} = 12.2 CFS USE 3 EA.

EQ = 30.5 + 24.0 = 54.5 CFS

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(16) ½ BASIN Q (SEE (4)) 4.9 CFS 5YR 13.9 CFS 100YR

SLOPE ACROSS LOT = 3.6% USE 1.8%

DESIGN FOR 100YR

4' DIOR Q ALLOW = 7.0 CFS USE 2EA.

EQ = 59.5 + 13.9 = 68.4 CFS

(17) BASIN R 10.7 CFS 5YR 24.4 CFS 100YR

SLOPE ALONG CURB = 2% Q ALLOW = 18.07 CFS

NEED DIOR TO PICK UP 7.5 CFS

6' DIOR Q ALLOW = 12.2 CFS

24.4 - 7.5 = 16.9 CFS

USE CDOT TYPE 13 @ LOW POINT

EQ = 68.4 + 24.4 = 92.8 CFS

(18) BASIN Y 6.8 CFS 5YR 20.0 CFS 100YR

DESIGN FOR 100YR

LOW POINT COLLECTS ± 30% OF BASIN → 6 CFS

SLOPE ALONG CURB = 2% SLOPE @ LOW POINT = 0.5% USE 0.5%

4' DIOR Q ALLOW = 6.3 CFS

REMAINDER OF BASIN ±70% → 14 CFS

STREET SLOPE = 2%, 6' DIOR Q ALLOW = 12.2 CFS, USE 2EA

EQ = 92.8 + 20.0 = 112.8 CFS

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19 • ½ BASIN DD 2.4 CFS 5YR 5.8 CFS 100YR

DESIGN FOR 100 YR

SLOPE ACROSS LOT TO LOW POINT = 2.5% USE 1.25%

4' DIOR Q ALLOW = 8.2 CFS

SUB EQ = 5.8 CFS

• BASIN JJ 6.3 CFS 5YR 14.3 CFS 100YR

DESIGN FOR 100YR @ LOW POINT @ LOADING DOCK

TYPE 13 Q ALLOW = 4 CFS USE 4 EA

SUB EQ = 5.8 + 14.3 = 20.1 CFS

• BASIN II 10.3 CFS 5YR 23.3 CFS 100YR

DESIGN FOR 100YR SIZE DIOR @ 2%

6' DIOR Q ALLOW = 12.2 CFS USE 3 EA.

SUB EQ = 20.1 + 23.3 = 43.4

• EQ = 112.8 + 43.4 = 156.2 CFS

20 30% BASIN X (SEE 8) 4.5 CFS 5YR 11.5 CFS 100YR

DESIGN FOR 100YR

SLOPE ACROSS LOT = 2.6% CURB SLOPE = 0.9% USE 1%

6' DIOR Q ALLOW: 8.8 CFS USE 2 EA

EQ = 156.2 + 11.5 = 167.7 CFS

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Designer BDP Date 12-6-83
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(21) BASIN HH 10.9 CFS 5YR 23.2 CFS 100YR
SLOPE ACROSS LOT ±2.5% USE 1%
DESIGN FOR 100 YR
4' DIOR Q ALLOW = 8.6 CFS - USE 2@
TYPE 13 Q ALLOW = 8.0 CFS - USE 2@
EQ = 167.7 + 23.2 = 190.9 CFS

(22) • BASN RR 11.1 CFS 5YR 27.7 CFS 100YR
DESIGN FOR 5YR
STREET SLOPE = 1.6% Q ALLOW = 16.2 CFS
DESIGN @ 1.5% 4' DIOR Q ALLOW = 7.7 CFS USE 2@
SUB EQ = 11.1 CFS
• BASIN QQ 7.8 CFS 5YR 16.6 CFS 100YR
DESIGN FOR 5YR
STREET SLOPE = 1.8% Q ALLOW = 17.2 CFS
MOST OF BASIN ON W. SIDE
6' DIOR Q ALLOW = 11.6 CFS USE 1@ W. SIDE
4' DIOR Q ALLOW = 7.0 CFS USE 1@ E. SIDE IN CONJUNCTION W/BASIN RR
SUB EQ = 11.1 + 7.8 = 18.9 CFS
• EQ = 190.9 + 18.9 = 209.8 CFS

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DESIGN CALCULATIONS

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Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
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△23 BASIN H 320 CFS 100 YR

PER SEPTEMBER 29, 1983 LETTER FROM DONELL JEFFRIES TO GARY HAYNES, CITY OF COLORADO SPRINGS

EQ = 320 CFS

△24 • BASIN M 12.2 CFS 5YR 30.4 CFS 100 YR

DESIGN FOR 100 YR

45% DRAINS TO N. SIDE BLDG = 13.7 CFS

SLOPE ACROSS LOT = 4%. USE 2%

6' DIOR QALLOW = 12.2 CFS USE 2EA

E. SIDE BLDG & PARKING LOT @ 3/4%

20% BASIN = 6.1 CFS

USE 2EA 4' DIOR

35% BASIN = 10.6 CFS REMAINING

@ 4%. 6' DIOR QALLOW = 10.6 CFS USE 2EA

SUB EQ = 30.4 CFS

• BASIN N 13.3 CFS 5YR 24.7 CFS 100 YR

DESIGN FOR 100 YR

SLOPE ACROSS LOT = ± 4% USE 2%

6' DIOR Q ALLOW = 12.2 CFS USE 2EA

SUB EQ = 30.4 + 24.7 = 55.1 CFS

• EQ = 320 + 55.1 = 375.1 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

25 • BASIN T 5.7 CFS 5YR 14.5 CFS 100 YR

DESIGN FOR 100 YR @ LOW POINT

TYPE 13 Q ALLOW = 4 CFS USE 4 EA.

SUB EQ = 14.5 CFS

• BASIN Q 6.2 CFS 5YR 14.8 CFS 100 YR

DESIGN FOR 100 YR

CURB SLOPE = ±1% Q ALLOW = 12.8 CFS

4' DIOR Q ALLOW = 8.6 CFS USE 2 EA

SUB EQ = 14.5 + 14.8 = 29.3 CFS

• EQ = 375.1 + 29.3 = 404.4 CFS

FLOWS FROM THIS POINT GENERALLY DRAIN AWAY FROM BUILDING. COLORADO SPRINGS REQUIRES DESIGN FOR 100 YR STORM IF EQ > 500 CFS. THIS WILL OCCUR ONCE BASIN CC IS REACHED. DESIGN FOR 100 YR STORM FROM THIS POINT.

26 • BASIN G 0.1 CFS 5YR 0.1 CFS 100 YR

DISCHARGES DIRECTLY TO CHANNEL

SUB EQ = 0.1 CFS

• 60% BASIN Z 4.4 CFS 5YR 10.1 CFS 100 YR

PARKING LOT SLOPE 2% 6" DIOR Q ALLOW = 12.2 CFS

• BASIN E	0.1 CFS 5YR	1.3 CFS 100 YR
BASIN F	0.4 CFS 5YR	2.2 CFS 100 YR
	0.5 CFS	3.5 CFS

STREET SLOPE 2% 14' DIOR Q ALLOW = 6.5 CFS

• EQ = 404.4 + 10.1 + 3.5 = 418.0 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

△27 BASIN CC 509 CFS 100YR (CUMULATIVE)

PER SEPTEMBER 29, 1983 LETTER FROM DONALD JEFFRIES TO GARY HAYNES, CITY OF COLORADO SPRINGS

EQ = 509 - 320 + 418.0 = 607.0 CFS

△28 40% BASIN Z 2.9 CFS 5YR 6.8 CFS 100YR

STREET SLOPE 2% 4' DIOR QALLOW = 6.5 CFS OK

EQ = 607.0 + 6.8 = 615.8 CFS

△29 ½ BASIN DD (SEE △19) 2.4 CFS 5YR 5.8 CFS 100YR

STREET SLOPE = 2% 4' DIOR QALLOW = 6.5 CFS

EQ = 615.8 + 5.8 = 621.6 CFS

△30 • BASIN SS 15.0 CFS 5YR 33.2 CFS 100YR

STREET SLOPE = 2% 6' DIOR QALLOW = 12.2 CFS : 3 EA

SUB EQ = 33.2 CFS

• 75% BASIN AA 0.6 CFS 5YR 2.3 CFS 100YR

STREET SLOPE = 2% 4' DIOR QALLOW = 6.5 CFS

SUB EQ = 33.24 2.3 = 35.5 CFS

• EQ = 621.6 + 35.5 = 657.1 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
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Designer BDP Date 12-6-83
Checker Date

△31
- BASIN BB 1.0 CFS 5YR 7.0 CFS 100YR
  DRAINS DIRECTLY TO CHANNEL
  SUB EQ = 7.0 CFS
- 25% BASIN AA 0.2 CFS 5YR 0.8 CFS 100YR
  RUN TO COMMON POINT W/ BASIN VV
- BASIN VV 0.1 CFS 5YR 1.4 CFS 100YR
  STREET SLOPE = 2% 4' DIOR Q ALLOW = 6.5 CFS
  SUB SUB EQ = 1.4 + 0.8 = 2.2 CFS
  SUB EQ = 2.2 + 7.0 = 9.2 CFS
- EQ = 657.1 + 9.2 = 666.3 CFS

△32
COLLECTION POINT
DESIGN FOR EQ FROM △22 & △31
EQ = 209.8 + 666.3 = 876.1 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker _____ Date _____

33

- BASIN GG 10.6 CFS 5YR 25.8 CFS 100YR

30% (7.7 CFS) COLLECTS @ W. SIDE PLANTER

CURB SLOPE = 0.8% PARKING LOT SLOPE = 2.5%

4' DIOR @ 1% Q ALLOW = 8.6 CFS

70% (18.1 CFS) COLLECTS @ LOW POINT

TYPE 13 Q ALLOW = 4 CFS USE 5 EA.

- BASIN PP 5.2 CFS 5YR 18.2 CFS 100YR

STREET SLOPE = 0.4% USE 0.5%

STREET CAPACITY = 9 CFS

12' DIOR Q ALLOW = 8.8 CFS

USE 2 EA = 17.6 CFS ∴ 0.6 CFS CONTINUES TO L.P.

SUB EQ = 25.8 + 18.2 = 44.0 CFS

- EQ = 876.1 + 44.0 = 920.1 CFS

34

BASIN	LL	0.7 CFS	5YR	2.9 CFS 100YR
BASIN	NN	2.6 CFS	5YR	7.4 CFS 100YR
BASIN	UU	0.0 CFS	5YR	0.5 CFS 100YR
BASIN	OO	15.9 CFS	5YR	38.8 CFS 100YR
		19.2 CFS		49.6 CFS

STREET SLOPE = ± 1.75%

4' DIOR Q ALLOW = 7.1 CFS - USE ON S. SIDE
6' DIOR Q ALLOW = 11.4 CFS - USE 4 EA

EQ = 920.1 + 49.6 = 969.7 CFS

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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail DRAINAGE FACILITIES
Designer BDP Date 12-6-83
Checker Date

35	BASIN MM	0.0 CFS	5YR	0.1 CFS	100YR
	BASIN TT	0.0 CFS	5YR	1.2 CFS	100YR
		0.0 CFS		1.3 CFS	

COLLECT @ EXISTING 8' DIOR @ LEXINGTON/HERMAN RIDGE

EQ = 969.7 + 1.3 = 971.0 CFS

36	BASIN FF	1.2 CFS	5YR	5.0 CFS	100YR

COLLECT @ EXISTING FACILITIES ON UNION

APPENDIX 3
HYDRAULICS

DEC
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DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail HYDRAULICS
Designer BDP Date 12-15-83
Checker _____ Date _____

PIPE DESIGN

PRELIMINARY SIZE OF PIPE BASED ON MANNING EQUATION. n = 0.015 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 320 CFS TO 732 CFS. AT MAXIMUM Q, S = 0.017 FT/FT, B = 6 FT, Z = 1.5:1, y = 2.86 FT.
FREEBOARD = 1.0' OR 0.25y, WHICHEVER IS GREATER.
USE 1.0' FREEBOARD. 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'x4' RCBC (8' WIDTH & 4' HEIGHT).

D/S FROM CULVERT

USE MANNING FOR CAPACITY OF 8'x4' RCBC.
n = 0.013 & S = 0.025 FT/FT

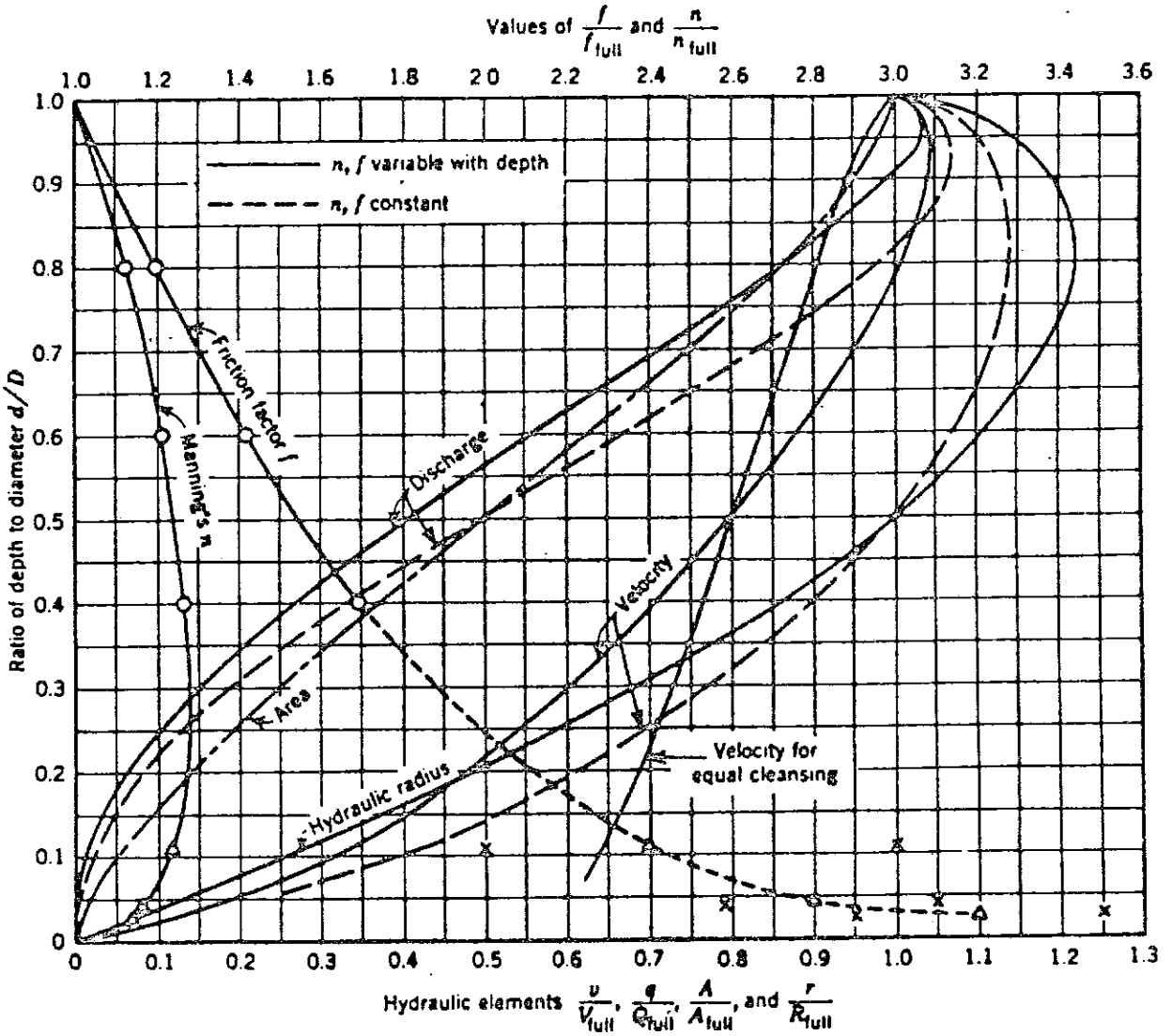
EXISTING 66" ϕ CULVERTS @ LEXINGTON

1215 LF @ 1%, 2 ea.
Q_{MANN} = 677 cfs
PIPES WILL FLOW UNDER PRESSURE

@ CULVERT ENTRANCE REQUIRED HEADWATER DEPTH = 13.5 FT
SEE BUREAU OF PUBLIC ROADS CHART 21

CHECK EXISTING CHANNEL

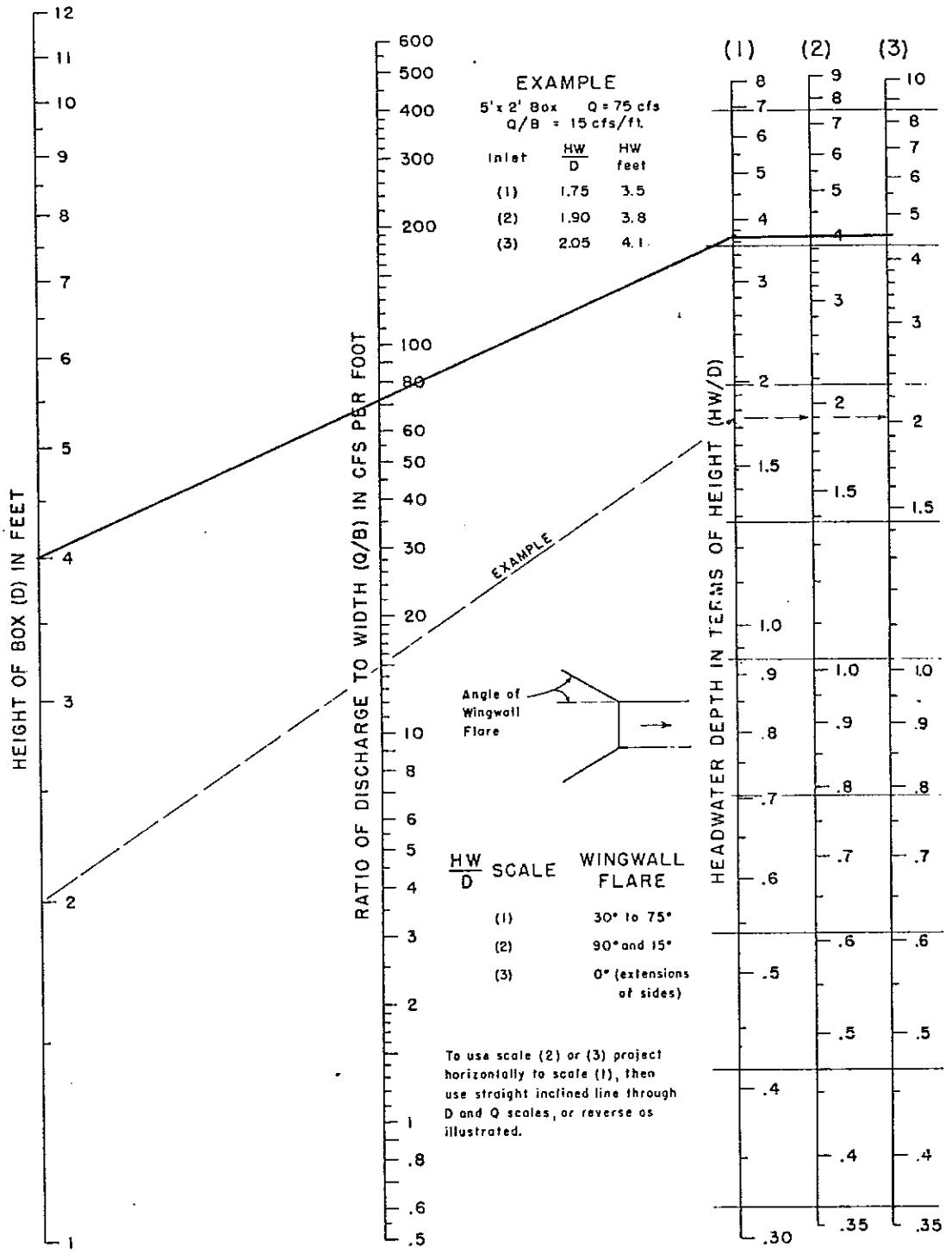
S = 0.005 FT/FT B = 6 FT Z = 1.5:1 n = 0.015 y = 5.5 FT Q = 1,150 cfs
USING THIS FLOW, Q = 1150 - 675 + 732 = 1207
y = 5.63 ∴ 0.87 FT FREEBD AVAILABLE



v	= Actual velocity of flow (fps)	A	= Area occupied by flow (ft^2)
V_{full}	= Velocity flowing full (fps)	A_{full}	= Area of pipe (ft^2)
q	= Actual quantity of flow (cfs)	r	= Actual hydraulic radius (ft.)
Q_{full}	= Capacity flowing full (cfs)	R_{full}	= Hydraulic radius of full pipe (ft.)

FIGURE 8-I. HYDRAULIC ELEMENTS OF CIRCULAR CONDUITS (2)

CHART I

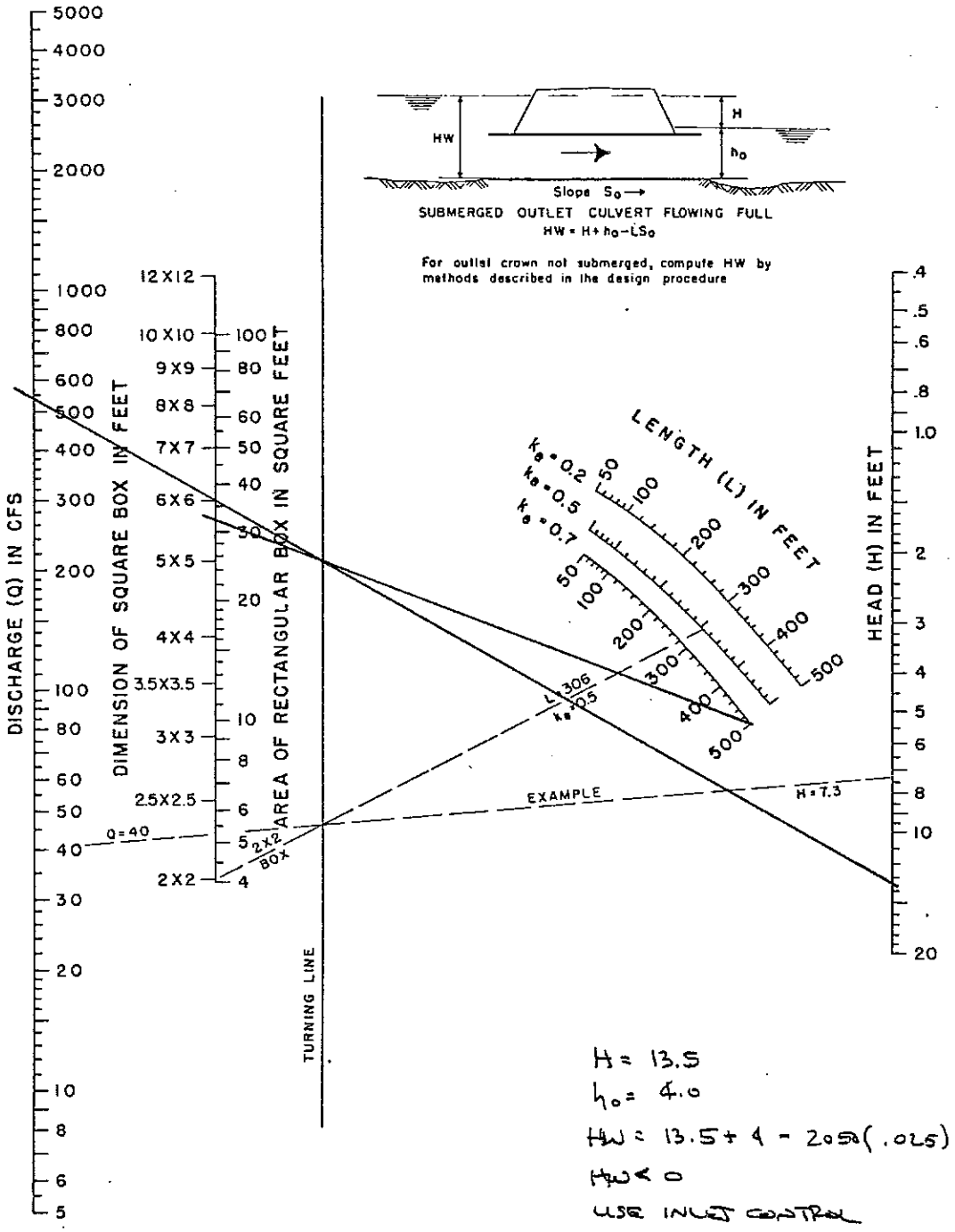


4 x 4' = 16'

HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 8



$H = 13.5$

$h_o = 4.0$

$HW = 13.5 + 4 - 20(.025)$

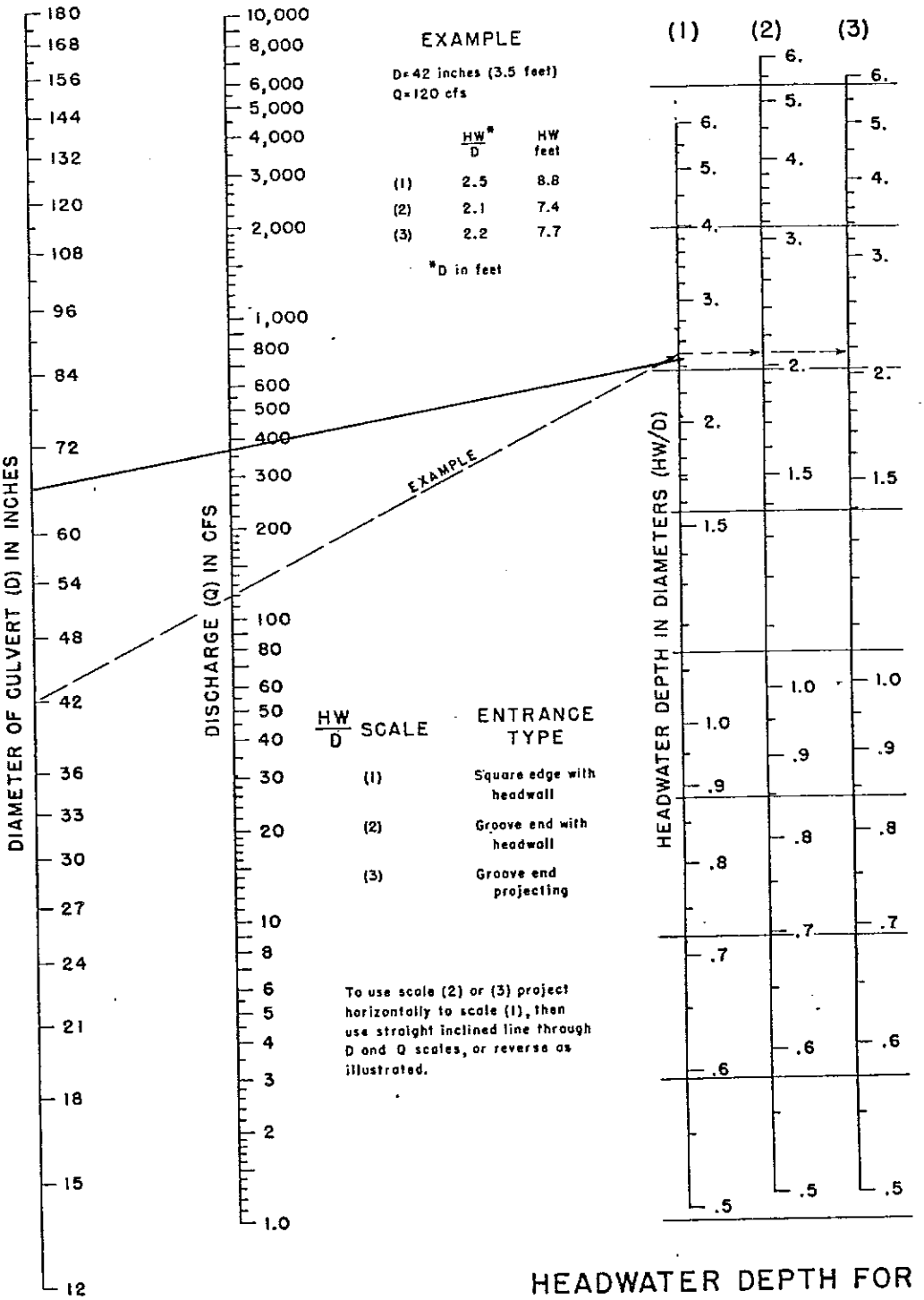
$HW < 0$

USE INLET CONTROL

HEAD FOR CONCRETE BOX CULVERTS FLOWING FULL n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

APPENDIX 4
PRELIMINARY DESIGN DATA

STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ 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)
	PART C											<<1						
1												<<1				PAN		
	A											2.1						
2												2.2				18	.038	
	K											2.1		7.3				
3												9.5				18	.040	
	50% Q											4.9						
4												14.4				18	.033	
	P											2.9						
5												17.3				18	.038	
	I											1.3						
	J											0.1						
6												18.7				21	.024	

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101 2/7

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	CA	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)
	W											2.0						
7												20.7				24	.015	
	70% X											10.5						
	Y											0.3						
8												10.8				18	.025	
	50% FF											0.2						
9												11.0				18	.020	
	50% FF											0.2						
10												11.2				18	.018	
	44											2.1						
	EE											0.1						
11												13.4				21	.019	
	7											20.7						
	11											13.4						
12												34.1				EXISTING 36		

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101

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)
	PART C	.007		48		80	280	.021										
	D	.009		52		101	1,110	.109										
13			.016		50					.109	1250			0.20	3.9	18	0.010	4.27
	L	.010		83		14	620	.057										
14			.026		63				.026	.135	1200			0.66	20.6	24	0.013	7.27
	S	.008		86		4	330	.042	.005						24.0	24	0.025	9.67
15			.034		68				.025	.160	1150			0.90	35.2	24	0.040	12.73
	50% Q	.010		89		5	670	.169	.011							18	0.019	6.15
16			.044		73				.002	.169	1130			1.18	58.7	33	0.026	12.19
	R	.009		86		12	850	.098								21	0.030	
17			.053		75				.006	.175	1120			1.30	77.2	36	0.025	12.93
	Y	.011		76		14	780	.080	.027							24	0.020	8.38
18			.064		75				.005	.180	1105			1.30	92.1	42	0.018	11.92

EDEGD
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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101 4/7

DESIGN POINT	BASIN	AREA (SQ. MI.)	W AREA (SQ. MI.)	W	W 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)
	50% DD	.002		82		8	420	.042	.009							18	0.017	5.86
	JJ	.005		86		5	500	.069	.014							24	0.014	7.46
	II	.008		86		5	470	.062	.009							30	0.025	11.11
19			.079		77				.009	.189	1095			1.43	123.7	42	0.030	15.38
	30% X	.006		81		9	970	.224	.019						11.5	18	0.020	7.45
20			.085		78					.243	1005			1.50	127.9	54	0.010	10.39
	HH	.007		89		7	470	.054	.003						23.2	24	0.020	8.82
21			.092		78				.008	.251	995			1.50	137.3	60	0.006	8.72
	RR	.013		82		9	830	.137										
	QQ	.005		89		8	480	.051										
22			.110		79				.019	.270	970			1.57	167.5	60	.009	10.69

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101 SA

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	JN W	JN 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)
	H*	.297		75			4,700	0.38										
23			.297		75					0.38	830			1.30	320	66	0.018	16.42
	M	.014		82		8	875	.122	.004							36	0.005	5.61
	N	.006		95		19	550	.058	.026							42	0.005	6.41
24			.317		76				.013	.393	825			1.37	358	72	0.013	14.93
																B=6 Z=1.5 y=2.42	0.013	15.36
	T	.006		81		12	850	.098	.010							21	0.013	6.72
	O	.006		84		21	850	.102	.014							30	0.007	6.29
25			.329		76				.005	.398	820			1.37	370	B=6 Z=1.5 y=2.42	0.014	15.88
	G	.007		39		56	1860	.282										
	60% Z	.009		85		10	560	.058										
	E	.003		52		55	700	.097										
	F	.004		63		57	2040	.167										
26			.347		75				.006	.404	815			1.30	368	B=6 Z=1.5 y=2.42	0.014	15.88
	CC*	.533		74			6,100	0.46										
27			.583		74					0.46	770			1.24	557	B=6 Z=1.5 y=2.84	0.017	19.12

* PER 9-29-83 DONELL JEFFRIES LETTER

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101 6/7

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ AREA (SQ. MI.)	U	U/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)
	40% B	.002		85		10	560	.058										
28			.585		74				1.000	.460	770			1.24	559	B=6 z=1.5 y=2.85	0.017	19.09
	50% DD	.002		82		10	750	.091										
29			.587		74				.007	.467	765			1.24	557	B=6 z=1.5 y=2.84	0.017	19.12
	SS	.011		87		17	700	.063										
	75% AA	.002		69		31	1530	.152										
30			.600		74				.010	.477	760			1.24	565	B=6 z=1.5 y=2.86	0.017	19.20
	BB	.009		60			2230	.031										
	25% AA	.001		69		11	700	.069										
	VV	.001		54		41	1650	.186										
31			.614		74				.010	.487	750			1.24	571	8×4	0.025	22.80
	22	.110		79				.270										
	31	.614		74				.487										
32			.724		75				.003	.490	745			1.30	701	8×4	0.025	24.07

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STORM DRAINAGE SYSTEM PRELIMINARY DESIGN DATA

HEWLETT-PACKARD @ BRIARGATE BDP 12-12-83 101 7/7

DESIGN POINT	BASIN	AREA (SQ. MI.)	Σ 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)
	GG	.011		83		9	800	.106	.028						25.8	27	0.010	7.02
	PP	.012		71		10	470	.045	.003						44.0	33	0.015	9.26
33			.747		75				.006	.496	740			1.30	719	8x4	0.025	24.23
	LL	.003		66		10	750	.129										
	NN	.008		77		16	910	.094										
	MM	.004		47		15	1500	.208										
	OO	.015		83		19	550	.061							49.6	30	0.020	
34			.771		75				.008	.504	730			1.30	732	8x4	0.025	24.34
35															732	8x4	0.025	24.34

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APPENDIX 5
COST ESTIMATE

FORM NO. 17

Denver Engineering Corporation 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	QUANTITY TAKE-OFF SHEET	SHEET 1 OF 19
	PROJECT NAME: HEWLETT-PACKARD @BRIARGATE	JOB NO.: 101
	LOCATION: COLORADO SPRINGS, COLORADO	DATE: 12-13-83
PROJECT DESCRIPTION: STORM DRAINAGE		PREPARED BY: BDP
		CHECKED BY:

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

* REMOVABLE

FORM NO. 17

DENVER ENGINEERING CORPORATION
Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 2 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
JOB NO. 101
LOCATION: COLORADO SPRINGS, COLORADO
DATE: 12-13-83
PREPARED BY: BDP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
10	18"ϕ RCP 0'-10'	280	LF		
	5'ϕ MH	1	EA		
	18"ϕ RCP	55	LF		
	4' DIOR	1	EA		
11	18"ϕ RCP	70	LF		
	4' DIOR *	1	EA		
12	21"ϕ RCP *	50	LF		
	24"ϕ RCP *	345	LF		
	5'ϕ MH *	1	EA		
	24"ϕ RCP *	395	LF		
	5'ϕ MH *	1	EA		
	24"ϕ RCP * ↓	135	LF		
	SUBTOTAL ①				
	4' DIOR 0'-10'	10	EA		
	10' DIOR	1	EA		
	4'ϕ MH	2	EA		
	5'ϕ MH	8	EA		
	18"ϕ RCP	2,365	LF		
	21"ϕ RCP	210	LF		
	24"ϕ RCP ↓	875	LF		

FORM NO. 17

DENG

Denver Engineering Corporation

1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 3 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE

LOCATION: COLORADO SPRINGS, COLORADO

JOB NO. 101

DATE 12-13-83

PREPARED BY BDP

CHECKED BY

PROJECT DESCRIPTION

STORM DRAINAGE

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

FORM NO. 17

DEC
Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 4 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE

JOB NO. 101

LOCATION: COLORADO SPRINGS, COLORADO

DATE: 12-13-83

PROJECT DESCRIPTION: STORM DRAINAGE

PREPARED BY: BDP

CHECKED BY:

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
18	36"ϕ RCP	20'-25'	250	LF		
	6'ϕ MH	20'-25'	1	EA		
	24"ϕ RCP	20'-25'	145	LF		
	5'ϕ MH	15'-20'	1	EA		
	24"ϕ RCP	15'-20'	225	LF		
	5'ϕ MH	15'-20'	1	EA		
	24"ϕ RCP	10'-15'	50	LF		
	5'ϕ MH	10'-15'	1	EA		
	24"ϕ RCP	10'-15'	150	LF		
	5'ϕ MH	10'-15'	1	EA		
	24"ϕ RCP	0'-10'	210	LF		
	4'DIOR	0'-10'	1	EA		
	24"ϕ RCP	0'-10'	10	LF		
	6'DIOR	0'-10'	1	EA		
	18"ϕ RCP	0'-10'	25	LF		
	6'DIOR	0'-10'	1	EA		
19	42"ϕ RCP	25'-30'	200	LF		
	42"ϕ RCP	30'-35'	190	LF		
	6'ϕ MH	30'-35'	1	EA		
	30"ϕ RCP	10'-15'	270	LF		
	6'DIOR	10'-15'	1	EA		
	18"ϕ RCP	10'-15'	20	LF		
	6'DIOR	10'-15'	1	EA		
	30"ϕ RCP	10'-15'	55	LF		
	6'DIOR	10'-15'	1	EA		
	24"ϕ RCP	10'-15'	120	LF		
	5'ϕ MH	0'-10'	1	EA		
	24"ϕ RCP	0'-10'	120	LF		
	5'ϕ MH	0'-10'	1	EA		
	24"ϕ RCP	0'-10'	50	LF		
	5'ϕ MH	0'-10'	1	EA		
	24"ϕ RCP	0'-10'	75	LF		
	TYPE 13	0'-10'	4	EA		

FORM NO. 17

Denver Engineering Corporation 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	QUANTITY TAKE-OFF SHEET	SHEET 5 OF 19
	PROJECT NAME HEWLETT-PACKARD @BRIARGATE	JOB NO. 101
	LOCATION COLORADO SPRINGS, COLORADO	DATE 12-13-83
PROJECT DESCRIPTION STORM DRAINAGE		PREPARED BY BDP CHECKED BY

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	18"ϕ RCP	0'-10'	180	LF		
	4' DIOR	0'-10'	1	EA		
20	42"ϕ RCP	30'-35'	100	LF		
	6' ϕ MH	30'-35'	1	EA		
	18"ϕ RCP	10'-15'	260	LF		
	6' DIOR	10'-15'	1	EA		
	18" ϕ RCP	0'-10'	250	LF		
	6' DIOR	0'-10'	1	EA		
21	54"ϕ RCP	30'-35'	60	LF		
	54"ϕ RCP	15'-20'	240	LF		
	SPECIAL MH	15'-20'	1	EA		
	24"ϕ RCP	10'-15'	100	LF		
	4' DIOR	10'-15'	1	EA		
	18"ϕ RCP	0'-10'	45	LF		
	4' DIOR	0'-10'	1	EA		
	18"ϕ RCP	0'-10'	30	LF		
	TYPE 13	0'-10'	2	EA		
22	60"ϕ RCP	15'-20'	340	LF		
	60"ϕ RCP	10'-15'	20	LF		
	SPECIAL MH	10'-15'	1	EA		
	60"ϕ RCP	10'-15'	255	LF		
	SPECIAL MH	10'-15'	1	EA		
	18"ϕ RCP	10'-15'	15	LF		
	6' DIOR	10'-15'	1	EA		
	24"ϕ RCP	0'-10'	90	LF		
	4' DIOR	0'-10'	1	EA		
	24"ϕ RCP	0'-10'	175	LF		
	4' DIOR	0'-10'	1	EA		

FORM NO. 17

BDEC Denver Engineering Corporation 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	QUANTITY TAKE-OFF SHEET	SHEET 6 OF 19
	PROJECT NAME HEWLETT-PACKARD @BRIARGATE	JOB NO. 101
	LOCATION COLORADO SPRINGS, COLORADO	DATE 12-13-83
PROJECT DESCRIPTION STORM DRAINAGE		PREPARED BY BDP CHECKED BY

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

FORM NO. 17

DEC
Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 7 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
LOCATION: COLORADO SPRINGS, COLORADO
JOB NO. 101
DATE 12-13-83
PREPARED BY BDP
CHECKED BY

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	SUBTOTAL ② (CONT)					
	18" ∅ RCP	0'-10'	610	LF		
		10'-15'	1,010	LF		
		15'-20'	210	LF		
	21" ∅ RCP	10'-15'	100	LF		
	24" ∅ RCP	0'-10'	900	LF		
		10'-15'	580	LF		
		15'-20'	1,020	LF		
		20'-25'	145	LF		
	30" ∅ RCP	10'-15'	325	LF		
	33" ∅ RCP	10'-15'	40	LF		
		15'-20'	190	LF		
		30'-35'	30	LF		
	36" ∅ RCP	20'-25'	250	LF		
	42" ∅ RCP	25'-30'	200	LF		
		30'-35'	290	LF		
	54" ∅ RCP	15'-20'	240	LF		
		30'-35'	60	LF		
	60" ∅ RCP	10'-15'	275	LF		
		15'-20'	340	LF		

FORM NO. 17

DENCO
Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 8 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
JOB NO.: 101
LOCATION: COLORADO SPRINGS, COLORADO
DATE: 12-13-83
PREPARED BY: BDP
CHECKED BY:

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
23	66"ϕ RCP ** 10'-15'	90	LF		
	SPECIAL MH ** 10'-15'	1	EA		
24	66"ϕ RCP ** 10'-15'	400	LF		
	SPECIAL MH ** 10'-15'	1	EA		
	66"ϕ RCP ** 10'-15'	365	LF		
	SPERIAL MH ** 10'-15'	1	EA		
	42"ϕ RCP 10'-15'	220	LF		
	5'ϕ MH 10'-15'	1	EA		
	42"ϕ RCP 10'-15'	200	LF		
	42"ϕ RCP 0'-10'	200	LF		
	18"ϕ RCP 0'-10'	20	LF		
	6' DIOR 0'-10'	1	EA		
	18"ϕ RCP 0'-10'	20	LF		
	6' DIOR 0'-10'	1	EA		
	5'ϕ MH 0'-10'	1	EA		
	36"ϕ RCP 0'-10'	100	LF		
	5'ϕ MH 0'-10'	1	EA		
	18"ϕ RCP 0'-10'	15	LF		
	6' DIOR 0'-10'	1	EA		
	18"ϕ RCP 0'-10'	15	LF		
	6' DIOR 0'-10'	1	EA		
	30"ϕ RCP 0'-10'	130	LF		
	5'ϕ MH 0'-10'	1	EA		
	30"ϕ RCP 0'-10'	55	LF		
	5'ϕ MH 0'-10'	1	EA		
	18"ϕ RCP 0'-10'	10	LF		
	4' DIOR 0'-10'	1	EA		
	18"ϕ RCP 0'-10'	10	LF		
	4' DIOR 0'-10'	1	EA		
	24"ϕ RCP 0'-10'	120	LF		
	5'ϕ MH 0'-10'	1	EA		
	24"ϕ RCP 0'-10'	60	LF		
	6' DIOR 0'-10'	1	EA		

** TO BE REIMBURSED AS CONCRETE CHANNEL

FORM NO. 17

DEC
Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 9 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
LOCATION: COLORADO SPRINGS, COLORADO
JOB NO. 101
DATE 12-13-83
PREPARED BY BDP
CHECKED BY

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	21" ⌀ RCP	0'-10'	180	LF		
	6' DIOR	0'-10'	1	EA		
25	72" ⌀ RCP *	10'-15'	70	LF		
	CONC. CHNL *		200	LF		
	30" ⌀ RCP	0'-10'	320	LF		
	4' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	70	LF		
	4' DIOR	0'-10'	1	EA		
	21" ⌀ RCP	0'-10'	220	LF		
	TYPE 13	0'-10'	4	EA		
26	CONC. CHNL. *		320	LF		
	18" ⌀ RCP	0'-10'	50	LF		
	4' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	20	LF		
	6' DIOR	0'-10'	1	EA		
27	CONC. CHNL. *		125	LF		
28	CONC. CHNL. *		30	LF		
	18" ⌀ RCP	0'-10'	70	LF		
	4' DIOR	0'-10'	1	EA		
29	CONC. CHNL. *		495	LF		
	18" ⌀ RCP	0'-10'	70	LF		
	4' DIOR	0'-10'	1	EA		
30	CONC. CHNL. *		950	LF		
	18" ⌀ RCP	0'-10'	50	LF		
	6' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	50	LF		
	6' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	20	LF		
	4' DIOR	0'-10'	1	EA		
	18" ⌀ RCP	0'-10'	30	LF		
	6' DIOR	0'-10'	1	EA		

FORM NO. 17

DENVER ENGINEERING CORPORATION Denver Engineering Corporation 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	QUANTITY TAKE-OFF SHEET	SHEET 10 OF 19
	PROJECT NAME HEWLETT-PACKARD @BRIARGATE	JOB NO. 101
	LOCATION COLORADO SPRINGS, COLORADO	DATE 12-13-83
PROJECT DESCRIPTION STORM DRAINAGE		PREPARED BY BDP CHECKED BY

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
31	CONCHNL *		700	LF		
	18" ϕ RCP	0'-10'	50	LF		
	4' DIOR	0'-10'	1	EA		
32	8'x4' RCBC *	15'-20'	230	LF		
	RCBC MH RISER *		13	LF		
	60" ϕ RCP	10'-15'	110	LF		
33	8'x4' RCBC *	15'-20'	435	LF		
	8'x4' RCBC *	20'-25'	120	LF		
	RCBC MH RISER *		18	LF		
	33" ϕ RCP	0'-10'	85	LF		
	12' DIOR	0'-10'	1	EA		
	21" ϕ RCP	0'-10'	270	LF		
	12' DIOR	0'-10'	1	EA		
	27" ϕ RCP	10'-15'	200	LF		
	5' ϕ MH	10'-15'	1	EA		
	27" ϕ RCP	10'-15'	235	LF		
	5' ϕ MH	10'-15'	1	EA		
	27" ϕ RCP	10'-15'	275	LF		
	TYPE 13	0'-10'	5	EA		
	18" ϕ RCP	0'-10'	180	LF		
	4' DIOR	0'-10'	1	EA		
34	8'x4' RCBC *	20'-25'	335	LF		
	RCBC MH RISER *		22	LF		
	8'x4' RCBC *	20'-25'	400	LF		
	RCBC MH RISER *		18	LF		
	30" ϕ RCP	0'-10'	70	LF		
	5' ϕ MH	10'-15'	1	EA		
	30" ϕ RCP	0'-10'	80	LF		
	5' ϕ MH	10'-15'	1	EA		
	30" ϕ RCP	0'-10'	50	LF		
	4' DIOR	0'-10'	1	EA		
	30" ϕ RCP	0'-10'	25	LF		
	6' DIOR	0'-10'	1	EA		

FORM NO. 17

Denver Engineering Corporation 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	QUANTITY TAKE-OFF SHEET	SHEET 11 OF 19
	PROJECT NAME HEWLETT-PACKARD @BRIARGATE	JOB NO. 101
	LOCATION COLORADO SPRINGS, COLORADO	DATE 12-13-83
PROJECT DESCRIPTION STORM DRAINAGE		PREPARED BY BDP CHECKED BY

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	18" ∅ RCP 0'-10'	150	LF		
	6' DIOR 0'-10'	1	EA		
	18" ∅ RCP 0'-10'	120	LF		
	6' DIOR 0'-10'	1	EA		
	18" ∅ RCP 0'-10'	120	LF		
	6' DIOR 0'-10'	1	EA		
35	8'x4' RCBC * 20'-25'	130	LF		
	RCBC MH. RISER *	16	LF		
	8'x4' RCBC * 15'-20'	400	LF		
	TRANSITION STRUCTURE *	1	EA		
	ENERGY DISSIPATION STRUCTURE *	1	EA		
	18" ∅ RCP * 0'-10'	75	LF		

FORM NO. 17

DEC

Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 12 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
LOCATION: COLORADO SPRINGS, COLORADO
JOB NO. 101
DATE 12-13-83
PREPARED BY BDP
CHECKED BY

PROJECT DESCRIPTION

STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	SUBTOTAL ③					
	4'DIOR	0'-10'	11	EA		
	6'DIOR	0'-10'	14	EA		
	12'DIOR	0'-10'	2	EA		
	TYPE 13	0'-10'	9	EA		
	5'Ø MH	0'-10'	5	EA		
		10'-15'	5	EA		
	SPECIAL MH	10'-15'	3	EA		
	18"Ø RCP	0'-10'	1,215	LF		
	21"Ø RCP	0'-10'	670	LF		
	24"Ø RCP	0'-10'	180	LF		
	27"Ø RCP	10'-15'	710	LF		
	30"Ø RCP	0'-10'	730	LF		
	33"Ø RCP	0'-10'	85.	LF		
	36"Ø RCP	0'-10'	100.	LF		
	42"Ø RCP	0'-10'	20	LF		
		10'-15'	420	LF		
	60"Ø RCP	10'-15'	110	LF		
	66"Ø RCP	10'-15'	855	LF		
	72"Ø RCP	10'-15'	70	LF		
	8'x4' RCBC	15'-20'	1,065	LF		
		20'-25'	985	LF		
	RCBC MH RISER		87	LF		
	CONCRETE CHANNEL		2,820	LF		
	TRANSITION STRUCTURE		1	EA		
	ENERGY DISSIPATION STRUCTURE		1	EA		

FORM NO. 17

Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 13 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
LOCATION: COLORADO SPRINGS, COLORADO
JOB NO. 101
DATE 12-13-83
PREPARED BY BDP
CHECKED BY

PROJECT DESCRIPTION: STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	TOTAL					
	4' DIOR	0'-10'	26	EA	1,000	26,000
		10'-15'	3	EA	1,250	3,750
		15'-20'	2	EA	1,750	3,500
	6' DIOR	0'-10'	20	EA	1,200	24,000
		10'-15'	6	EA	1,450	8,700
	8' DIOR	10'-15'	2	EA	1,650	3,300
	10' DIOR	0'-10'	1	EA	1,500	1,500
	12' DIOR	0'-10'	2	EA	1,600	3,200
	TYPE 13	0'-10'	15	EA	1,000	15,000
		10'-15'	4	EA	1,250	5,000
	4' Ø MH	0'-10'	2	EA	1,000	2,000
	5' Ø MH	0'-10'	16	EA	1,200	19,200
		10'-15'	7	EA	1,450	10,150
		15'-20'	4	EA	1,950	7,800
		30'-35'	1	EA	4,000	4,000
	6' Ø MH	15'-20'	1	EA	2,250	2,250
		20'-25'	1	EA	2,750	2,750
		30'-35'	2	EA	4,500	9,000
	SPECIAL MH	10'-15'	5	EA	2,500	12,500
		15'-20'	1	EA	3,500	3,500
	TRANSITION STRUCTURE		1	EA	15,000	15,000
	ENERGY DISSIPATION STRUCTURE		1	EA	15,000	15,000
	CONCRETE CHANNER		2,820	LF	150	423,000

FORM NO. 17

DENEC
Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 14 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE
JOB NO. 101
LOCATION: COLORADO SPRINGS, COLORADO
DATE: 12-13-83
PREPARED BY: BDP
CHECKED BY:

PROJECT DESCRIPTION

STORM DRAINAGE

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	TOTAL (CONT)					
	18" ϕ RCP	0'-10'	4,190	LF	21	87,990
		10'-15'	1,010	LF	30	30,300
		15'-20'	210	LF	43	9,030
	21" ϕ RCP	0'-10'	880	LF	26	22,880
		10'-15'	100	LF	34	3,400
	24" ϕ RCP	0'-10'	1,955	LF	31	60,605
		10'-15'	580	LF	40	23,200
		15'-20'	1,020	LF	52	53,040
		20'-25'	145	LF	65	9,425
	27" ϕ RCP	10'-15'	710	LF	37	26,270
	30" ϕ RCP	0'-10'	730	LF	46	33,580
		10'-15'	325	LF	57	18,525
	33" ϕ RCP	0'-10'	85	LF	52	4,420
		10'-15'	40	LF	62	2,480
		15'-20'	190	LF	76	14,440
		30'-35'	30	LF	146	4,380
	36" ϕ RCP	0'-10'	100	LF	60	6,000
		20'-25'	250	LF	104	26,000
	42" ϕ RCP	0'-10'	200	LF	72	14,400
		10'-15'	420	LF	82	34,440
		25'-30'	200	LF	141	28,200
		30'-35'	290	LF	171	49,590
	54" ϕ RCP	15'-20'	240	LF	129	30,960
		30'-35'	60	LF	210	12,600
	60" ϕ RCP	10'-15'	385	LF	135	51,975
		15'-20'	340	LF	151	51,340
	66" ϕ RCP	10'-15'	855	LF	175	149,625
	72" ϕ RCP	10'-15'	70	LF	187	13,090
	8'x4' RCBC	15'-20'	1,065	LF	270	287,550
		20'-25'	985	LF	295	290,575
	RCBC MH RISER		87	LF	86	7,480

FORM NO. 17

DENVER ENGINEERING CORPORATION 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	QUANTITY TAKE-OFF SHEET	SHEET 15 OF 19
	PROJECT NAME HEWLETT-PACKARD @BRIARGATE	JOB NO. 101
	LOCATION COLORADO SPRINGS, COLORADO	DATE 12-13-83
PROJECT DESCRIPTION STORM DRAINAGE		PREPARED BY BDP CHECKED BY

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
	TOTAL (CONT)				
	SHEET 13				620,000
	SHEET 14				1,457,790
	SUBTOTAL				2,077,890
	CONTINGENCY @ 10%				207,790
	TOTAL			#	2,285,680

Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401
(303)-232-6262

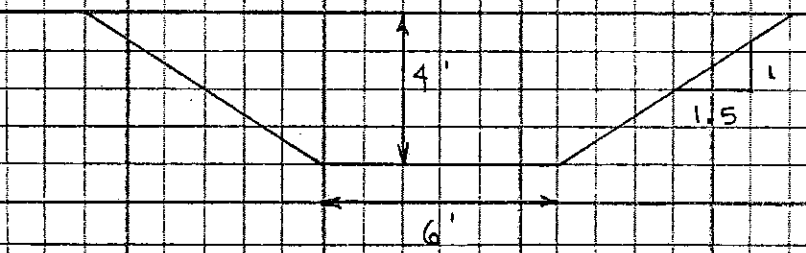
DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail COST ESTIMATE
Designer BDP Date 12-13-83
Checker _____ Date _____

CHANNEL QUANTITIES

MAX. CHANNEL DEPTH of FLOW = 2.86 FT

FRBD = 1.0' OR 0.25 Dw WHICHEVER GREATER
USE 1.0' FRBD



6" CONCRETE CC ON SLOPE PAVING @ $170/CY
TO ALLOW FOR SPECIAL DESIGN ON SUPERELEVATION CHANNEL,
USE $215/CY

$P = 6 + 2\sqrt{4^2 + [1.5(4)]^2} = 20.42$ SF/LF

@ 9", $V = 20.42 \frac{SF}{LF} \times \frac{9 IN}{12 IN/FT} = 15.32 \frac{CF}{LF}$

CONCRETE COST = $\frac{15.32 CF/LF}{27 CF/CY} \times \$215/CY = \$122/LF$

USE 6" Ø PVC UNDERDRAIN @ $6/LF

FILTER MATERIAL = $\frac{1' \times 6' \times 1'}{27 CF/CY} \times \frac{\$18}{CY} = \$4/LF$

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

SUBTOTAL = $122 + 6 + 4 + 4 = \$136/LF$
+ CONTINGENCY @ 10% = $14/LF

(COST OF EXCAVATION INCLUDED IN GRADING)

FORM NO. 17

DENCO Denver Engineering Corporation 1626 Cole Boulevard Suite 300 Building 7 Golden, Colorado 80401	**QUANTITY TAKE-OFF SHEET**	SHEET 17 OF 19
	PROJECT NAME HEWLETT-PACKARD @BRIARGATE	JOB NO. 101
	LOCATION COLORADO SPRINGS, COLORADO	DATE 12-13-83
PROJECT DESCRIPTION *REIMBURSABLE STORM DRAINAGE		PREPARED BY BDP CHECKED BY

ITEM NO.	DESCRIPTION		ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
2	4' DIOR	0'-10'	1	EA	1,000	1,000
3	18" ϕ RCP	0'-10'	250	LF	21	5,250
	5' ϕ MH	0'-10'	1	EA	1,200	1,200
4	18" ϕ RCP	0'-10'	210	LF	21	4,410
	4' ϕ MH	0'-10'	1	EA	1,000	1,000
5	18" ϕ RCP	0'-10'	280	LF	21	5,880
	4' ϕ MH	0'-10'	1	EA	1,000	1,000
6	18" ϕ RCP	0'-10'	180	LF	21	3,780
	5' ϕ MH	0'-10'	1	EA	1,200	1,200
	18" ϕ RCP	0'-10'	55	LF	21	1,155
	4' DIOR	0'-10'	1	EA	1,000	1,000
7	21" ϕ RCP	0'-10'	160	LF	26	4,160
	5' ϕ MH	0'-10'	1	EA	1,200	1,200
11	4' DIOR	0'-10'	1	EA	1,000	1,000
12	21" ϕ RCP	0'-10'	50	LF	26	1,300
	24" ϕ RCP	0'-10'	345	LF	31	10,695
	5' ϕ MH	0'-10'	1	EA	1,200	1,200
	24" ϕ RCP	0'-10'	395	LF	31	12,245
	5' ϕ MH	0'-10'	1	EA	1,200	1,200
	24" ϕ RCP	0'-10'	135	LF	31	4,185
23	CONC. CHNL.		90	LF	157	14,130
24	CONC. CHNL.		765	LF	157	120,105
25	CONC. CHNL.		270	LF	157	42,390
26	CONC. CHNL.		320	LF	157	50,240
27	CONC. CHNL.		125	LF	157	19,625
28	CONC. CHNL.		30	LF	157	4,710
29	CONC. CHNL.		495	LF	157	77,715
30	CONC. CHNL.		950	LF	157	149,150
31	CONC. CHNL.		700	LF	157	109,900
32	CONC. CHNL.		230	LF	157	36,110
33	CONC. CHNL.		555	LF	157	87,135
34	CONC. CHNL.		735	LF	157	115,395

FORM NO. 17

DEC

Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401

QUANTITY TAKE-OFF SHEET

SHEET 18 OF 19

PROJECT NAME: HEWLETT-PACKARD @BRIARGATE

JOB NO. 101

LOCATION: COLORADO SPRINGS, COLORADO

DATE: 12-13-83

PROJECT DESCRIPTION

* REIMBURSABLE
STORM DRAINAGE

PREPARED BY BDP

CHECKED BY

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT COST	TOTAL COST
35	CONC. CHNL	530	LF	157	83,210
	TRANS. STR.	1	EA	15,000	15,000
	E.D. STR.	1	EA	15,000	15,000
	SUBTOTAL				1,003,875
	CONTINGENCY @ 10%				100,390
	TOTAL REIMBURSABLE			$	1,104,265

Denver Engineering Corporation
1626 Cole Boulevard
Suite 300 Building 7
Golden, Colorado 80401
(303)·232·6262

DESIGN CALCULATIONS

Project HEWLETT-PACKARD @ BRIARGATE
Detail REIMBURSABLE COST ESTIMATE
Designer BDP Date 12-13-83
Checker Date

CHANNEL VOLUME FOR EARTHWORK

$V = \left(\frac{18+6}{2}\right) 4 + 15.32 + 6 = 69.32 \text{ CF} = 2.57 \text{ CF/LF}$

DOUBLE THIS FIGURE TO ACCOUNT FOR NECESSARY EXCAVATION OTHER THAN CHANNEL CROSS SECTION.: 5.13 CF/LF

USE $1.25/CY ∴ $6.42/LF SAY $7/LF

∴ CHANNEL COST = $150 + $7 = $157/LF

APPENDIX 6
DRAINAGE PLAN