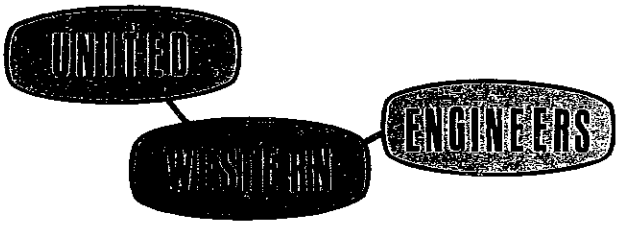

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LOWER CRAGMOR DRAINAGE, PHASE IV

DRAINAGE REPORT

UNITED WESTERN ENGINEERS

planners · consultants · engineers

Suite 104
3709 East Platte Avenue
Colorado Springs, Colo. 80909

(303)596-3222

March 23,1976

Mr. Dewitt Miller
Director of Public Works
City of Colorado Springs
P. O. Box 1575
Colorado Springs, Colorado 80901

Subject: Lower Cragmor Drainage, Phase IV

Dear Deke:

Based on my discussions with Don Jeffries and Dick Ernster I am submitting a revised drainage plan for subject project. This submittal is based on the following major problems encountered with the use of the Lower Cragmor Basin Study.

1. 42 CFS of the total 80 CFS in basin "C" was designated to flow easterly into Hancock, which is physically impossible.

2. The study is based on the simplified rational analysis, with one runoff coefficient (0.57). It appears to produce considerably more water than that required by City criteria.

3. A large (620 Acre) basin lying East of Templeton Gap Road was ignored. This basin is generally bounded on the East by Paseo Road and includes that area drained by Van Buren Phase 7.

This drainage study is based on City criteria, and satisfies that criteria in every respect. Numerous discrepancies with the Cragmor study may be observed, and this study reflects the extensive previous work in this basin by this firm. All streets were profiled in 1969 and the basin limits shown on the enclosed sheets are based on those surveys.

The soil type within the basin is the R4 Eastonville series, consisting of deep, dark colored, coarse textured silty sands, falling in Hydrologic group "A". Mapping is on file with the local SCS office.

A drainage plan is included showing the preliminary storm sewer locations and sizing, and the respective design flows. The basin covers 161 Acres and is reasonably slender. The length is 6600 feet and the average width is 1064 feet. For this reason the peak surface flows for which catch basins are designed cannot be summed for the storm sewer peak flows.

The grades shown on the enclosed plan are the minimum required for the storm sewer in question and will fall within the limits of the street gradients. The final design grades will be controlled by existing utilities. It may be seen that the storm sewer must contend with adverse street grades from Fillmore North to 3rd Street.

Two major transbasin diversions are created by the proposed storm sewer system. The area south of Fillmore Street naturally outfalls through an alley off Prospect Street to the Van Buren Phase IV channel. The area North of Fillmore Street naturally outfalls down El Paso Street to the same channel. For these reasons the Van Buren channel may be undersized from Templeton Gap Road to El Paso Street.

The computed 50 year runoff at the outfall point is 200.6 CFS, well below the 339 CFS specified in the Cragmor report, and will represent significant cost savings to the City.

The basin remaining in the Van Buren Area is shown on the enclosed plan. This basin includes everything east of Templeton Gap Road that is not drained by the Van Buren Phase I-III storm sewer network. As shown, 222.7 CFS drains from the lined channel installed in Van Buren Phase 7. This channel has always been proposed to continue behind the country club to the Templeton Gap Floodway. We have this alignment plotted on 40-scale profile sheets. As it now exists, the runoff terminates in an existing reservoir. The effect of the reservoir in staging the flow is unknown but is considered to be slight because of its small size and the fact that it normally contains significant storage. The area below the Phase 7 channel is all an "A" soil in very good range condition and therefore contributes very little to the flow.

226.1 CFS reaches Union Boulevard (ignoring the reservoir) where it might head south or west depending upon how it is graded at various times by the City or the Sod Farm. 233.1 CFS would terminate at the outfall, most of it coming down Meade Circle, under existing development conditions. The routing of Union Boulevard or any future development would have a dramatic effect on both quantity and location of this flow. Several years ago this firm projected 283 CFS for the basin-considering it fully developed and including the Van Buren 7 diversion. The Van Buren channel evidently has this in its design flows.

It is very apparent that another storm sewer system is needed down Meade Circle to be continued Northeasterly by future developers. To accomodate both flows in Templeton Gap Road would require extensive utility relocations, however, our proposed storm sewer is oversized to take up some of the hazard.

We recommend the following procedure.

1. Accept this revised drainage plan for the Lower Cragmor Phase IV area.

2. Develop a master plan for the remaining acreage in the Van Buren area-to include reassessment of the Van Buren Channel to El Paso Street.

We will procede with the design immediately upon receipt of your action concerning this proposal. We are now two to three weeks behind the schedule outlined in our proposal.

Respectfully submitted,

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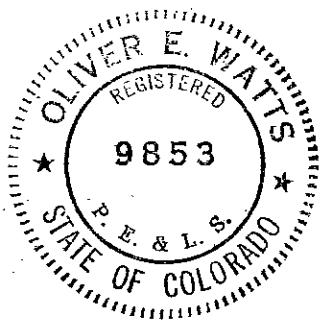

Oliver E. Watts
PE-LS 9853
Engineer Director

OEW/nb

Enclosures: Hydrology & Hydraulics-LC4-4pps
Hydrology-VB-3pps
Drainage Plan-LC4
Drainage Plan-Van Buren

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Project Lower Cragmor Phase III Page 1 of 3

Calc. by OEE WATTS date 3-12-76

Checked by _____ date _____

HYDROLOGY - INFLOW FROM UNGUREN AREA

CITY CRITERIA : SCS Method Simpl. Triang. Hydro.

AREA IN VB7 - see 9-24-73

Q_p = 222.7 CFS A = 0.5720 SM CN = 79 Tc = 0.244 HRS

FOR TOTAL CURVE NO.

AREA	COVER DESCRIPTION	CN	AR	A-SM	%A	%xCN	Use CN
VB 7	From 9-24-73	79	—	0.5720	0.6721	53.1	
Plate #1	HERB - 20% "D"	92	2.09	0.0187	0.0220	2.0	
	R/W Good "A" ✓ ✓	39	9.71	0.0871	0.1023	4.0	
VB Analysis To Union		39	—	0.1733	0.2036	7.9	
Total To Union				0.8511	1.0000	67.0	67
Union To Logan	R/W Good "A"	39	52.75	0.0757	0.0771	3.0	
Logan To Outfall	Rec - 90% "A"	92	38.07	0.0546	0.0638	5.8	
To Union	From Above	67		0.8511	0.8672	58.0	
Total To Outfall				0.9814	0.9999	66.2	66

FOR TIME OF CONCENTRATION Overland: $T_c = \left(\frac{11.9L^3}{H}\right)^{0.385}$ Overland

Or $T_c = \frac{L}{3600V}$ for Confined Ditches

Natural Vel in channel bearing VB 7 = 17.0 FPS - see letter of 9-7-74

Reach	Velocity V-FPS	Velocity L-FT	Overland H	Overland L-FT		Tc-hrs	ΣTc-hrs
To Golf Course							0.244
End VB7 To Reservoir	17.0	2760					
Reservoir To Union			30	460	0.204	0.045	0.289
						0.159	0.448
Union To Logan			15	1420		0.201	0.649
Logan To Outfall			15	1960		0.291	0.940
						Σ = 0.696	

NOTE: FIRST RESERVOIR IN GOLF COURSE MUCH TOO SMALL TO STAGE FLOWS AND IS IGNORED.

$q_p = \frac{484AQ}{T_{PO}}$ $T_{PO} = D/2 + 0.6T_c$ D = 1hr I = 2.0" $T_b = 2.67T_t$ $T_c = \left(\frac{11.9L^3}{H}\right)^{0.385}$

MAJOR BASIN	SUB BASIN	AREA Planim. Read	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH LENGTH	DITCH SLOPE	Curve #	TPO	FLOW Q	FLOW qp	Tb
VAN BUREN	FROM	PASED	TO TEMPLETON GAP - NO STRUCTURES PROPOSED										
	LIES BETWEEN	VAN BUREN PHASES	I - III	AND	GRAMOR STUDY								
VAN BUREN	TO UNION		0.8511			0.448			67	0.7688	0.17	91.7	USE ADDITIVE
	AT OUTFALL		0.9814			0.940			66	1.064	0.15	67.0	METHOD
VAN BUREN	PHASE 7		0.5720			0.244			79	0.646	0.52	222.7	1.72
	PHASE 7 TO UNION		0.2791	4650	200	0.291			43	0.675	0.02	4.0	1.80
	UNION TO OUTFALL		0.1303	3380	30	0.418			61	0.751	0.07	5.9	2.01
		Σ =	0.9814										
	BELOW VB7		0.4094			0.709			58	0.925	0.04	8.6	

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: LOWER CRAMOR PHASE IV By: DEW Date: 8-12-76

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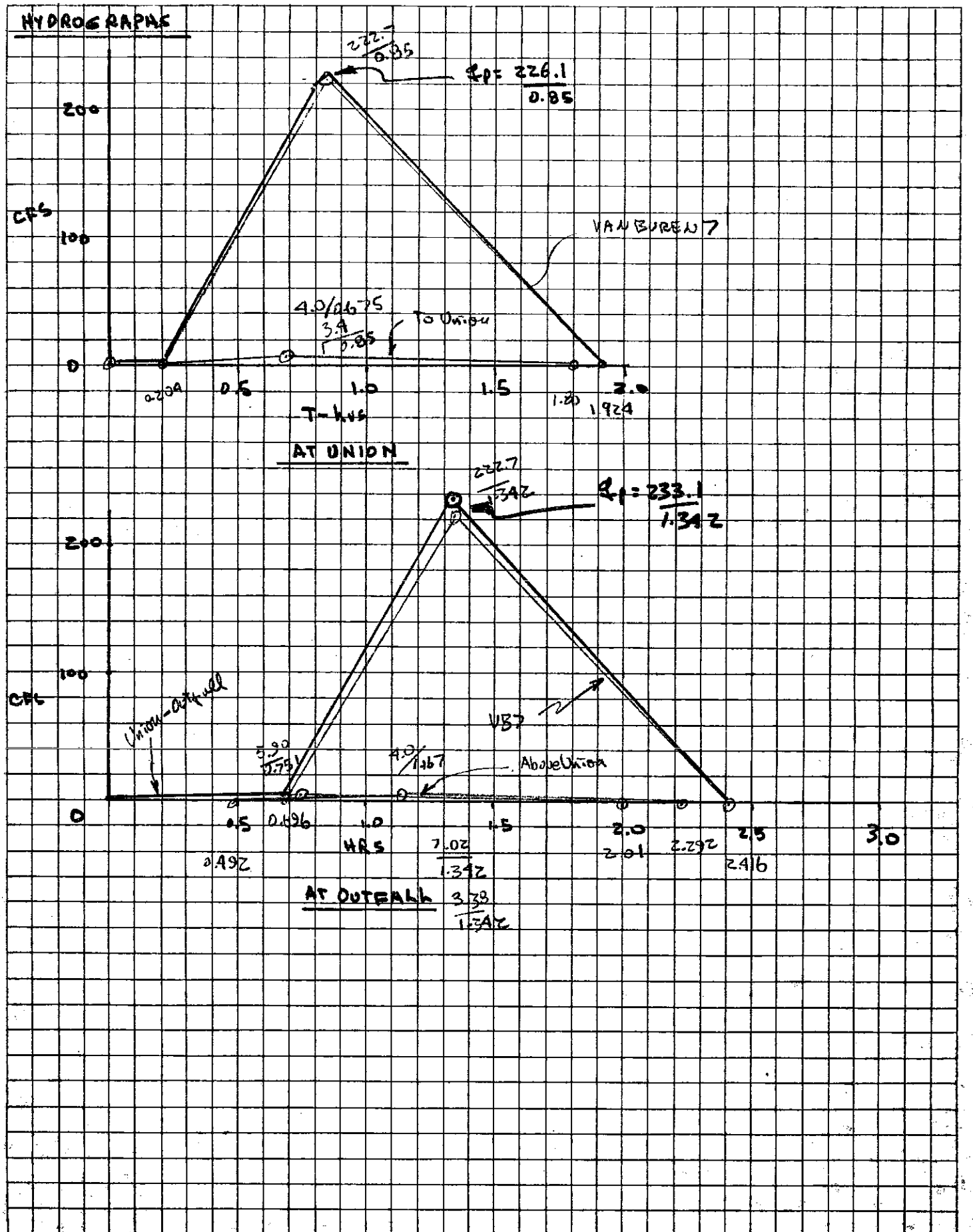
Project LC 56 ph IV

Calc. by DEW date 3-12

Checked by _____ date _____

HYDROGRAPHS



1"=200' $T_c = \left(\frac{11.9L^3}{H}\right)^{0.385}$ I = 2" D = 1hr $T_p = 0.5 + 0.6T_c$ $Q_p = \frac{484AQ}{T_p}$

MAJOR BASIN	SUB BASIN	AREA Planim. Read	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH SOIL GP LENGTH	DITCH DEVLP SLOPE	% CURVE #	TPO	FLOW Q	FLOW qp	Tb
IV	A	31.15	0.0447	1970	33	0.216	A	40% 4HP 60% SF	95 92 93	0.630	1.31	45.0	
	B	10.89	0.0156	810	21.2	0.092		Schobl	95	0.555	1.48	20.1	
	C+D	7.79	0.0112	1840	23.6	0.227		SF	92	0.636	1.24	10.6	
	D1	12.13	0.0174	1060	14	0.147		MF	95	0.588	1.48	21.2	
	E	10.95	0.0150	2025 ~~510~~	~~24.8~~ ~~9.0~~	~~0.349~~ ~~0.075~~		50% PBC 50% SF	97 92 94	~~0.650~~ ~~0.545~~	1.40	15.6	
	F	12.35	0.0177	1685	22.2	0.210		SF	92	0.626	1.24	17.0	
	G+H	19.46	0.0279	1940	20.9	0.253		SF	92	0.652	1.24	25.7	
	I	9.54	0.0137	1550	21.0	0.195		SF	92	0.617	1.24	13.3	
	J	3.55	0.00509	510	9.0	0.075		CS	97	0.595	1.67	~~55.0~~ 7.5	
	K	5.51	0.00791	840	8.0	0.139		SF	92	0.583	1.24	8.1	
	L	10.37	0.0149	1480	17.3	0.199		SF	92	0.620	1.24	14.4	
	M	4.69	0.00672	1200	17.7	0.155		SF	92	0.593	1.24	6.8	
	N	16.93	0.0236	1660	28	0.189		PBC - PUD	95	0.613	1.48	27.6	
	O	7.85	0.0113	1230	11.2	0.584		SF	92	0.850	1.24	8.0	
	P	3.69	0.00529	720	15.2	0.423		SF	92	0.759	1.24	4.2	
	Q	5.27	0.00756	1550	23.6	0.187	A	Street	97	0.612	1.67	10.0	

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: Lower Cragmor PHASE IV By: OZC Date: 3-19-76

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MAJOR BASIN	SUB BASIN	AREA Planim. Read	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH Soil Grp LENGTH	DITCH Deup SLOPE	V Curve#	TPO	FLOW Q	FLOW qp	Tb
III	R	4.78	0.00686	1460	16.9	0.198	A	Street	7	0.619	1.67	9.0	
Totals		175.90	0.252									264.1	
For Composite Hydrographs							Street or Storm S. Size & L	slope	V				
	A+B	CN 94	0.0603			0.216 + 0.020 = 0.236	36" 450'	0.49%	6.36	0.641	1.40	63.7	
	C+D+D1	94	0.0286			0.227 + 0.147 = 0.374				0.724	1.40	26.8	
	A-D1	94	0.0889			+0.020 = 0.394	24" 600'	1.4%	8.53	0.736	1.40	81.8	
	F+G+H	92	0.0456			0.253 + 0.016 = 0.269	24" 470'	1.48%	8.18	0.661	1.24	41.4	
	A-I	93	0.1482			0.394 + 0.027 0.421	48" 630'	0.32%	6.51	0.753	1.31	124.9	
	A-J	93	0.1533			+0.013 = 0.434	54" 370'	0.9%	7.86	0.760	1.31	127.8	
	A-K	93	0.1612			+0.011 0.445	48" 389'	0.66%	10.17	0.767	1.31	133.3	
	A-L	93	0.1761			+0.016 = 0.461	48" 600'	1.16%	10.60	0.776	1.31	143.9	
	A-M	93	0.1828			+0.005 = 0.466	48" 200'	1.3%	11.45	0.780	1.31	148.7	
	N+O	94	0.0349			0.189 + 0.047 = 0.236	30" 950'	0.97%	5.62	0.642	1.40	36.9	
	N+O+P	94	0.0402			+0.029 = 0.265	30" 775'	2.15%	7.52	0.659	1.40	41.3	
	A-Q	93	0.2456			0.466 + 0.006 = 0.472	48" 275'	1.24%	11.83	0.783	1.31	198.4	
	A-R	93	0.252			+0.022 0.494	60" 800'	1.53%	10.10	0.796	1.31	200.6	

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: LC IV

By: DEW

Date: 2-19

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Street and Storm Sewer Calculations

STREET	LOCATION	DIST	ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
PRIMROSE	B.O.T. & C. 6+00		8.0/8.0				26.8 CFS
		600	1.225%	26.8		26.8	24" RCP @ 1.4% min
	HANCOCK 0+00		0.65/99.60				
COLUMBINE	POINSETTA 6+50		10.08				25.7 CFS
		470	1.48%	25.7		25.7	24" RCP @ 1.3% min
	MARIGOLD 11+20		3.13				17.0 CFS
		238	2.50%	41.4		41.4	30" RCP @ 1.1% min
	HANCOCK 13+58		98.27/97.18				

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Project KC TV

Calc. by CEW date 3-19-76

Checked by _____ date _____

Street and Storm Sewer Calculations

CHART SOLUTION - MASTER PLAN USE ONLY

STREET	LOCATION	DIST	STREET/HGL ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
HANCOCK	4TH ST 17+00		2.40				45.0 CFS
		450	0.49%	45.0		45.0	36" RCP 0.36% min
	3rd ST 12+50		0.20				20.1 CFS
		250	Adverse	63.7		63.7	42" RCP 0.4% min
	Primrose 10+00		0.65/99.20				Use 4' D-10R
		630	Too Flat	81.8		81.8	48" RCP 0.32% min
	COLUMBINE 3+70		97.85/97.18				28.9 CFS Total (E+I)
		370	~~0.63~~ Too Flat	124.9		124.9	54" RCP 0.90% min
	FILMORE 0+70/134.89		96.85/95.70				7.5 CFS
		389	0.61%	127.8		127.8	48" RCP 0.66% min
	PIONEER 10+00		93.31/93.13				8.1 CFS
		600	1.16%	133.3		133.3	48" RCP 0.87% min
	UTE 4 ∿		86.14				14.4 CFS
		200	1.3%	143.9		143.9	48" RCP 1% min
	ALLEY 2 ∿		83.54				6.8 CFS
		275	1.24%	148.7		148.7	48" RCP 1.1% min
	T-GAP 0 → 75		80.12				Use 4' D-10R w/side
T GAP	Area N		29.58				27.6 CFS
		950	0.97%	27.6	3.0±/30	27.6	30" RCP 0.98% min
	Columbine		20.39				8.0 CFS
		775	2.15%	36.9	4.2/30	36.9	30" RCP 0.8% min
	FILMORE		3.69				4.2 CFS
		1710	1.38%	41.3	10.0/30	41.3	30" RCP 1.1% min
	HANCOCK		80.12				10.0 CFS
		800	1.53%	198.4		198.9	54" RCP 1.1% min Use 60"
	VAN BUREN		67.89				Cap = 322.9 @ 1.53%
		680	0.93%	200.6		200.6	54" RCP 1.0% min Use 60"
	OUTFALL		63.19/61.58 Max				Cap = 251.1 @ 0.93%

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Calc. by EWD date 3-19

Checked by _____ date _____

$\frac{tp}{Tpo}$ tp = 0.93 Tpo tc tc = $\left(\frac{\quad}{H}\right)$ overland as Pipe velocity D = 1 hr

MAJOR BASIN	SUB BASIN	AREA Planim. Read	AREA MILE	BASIN PER PROFILES LENGTH	BASIN PER PROFILES HEIGHT	Tc	DITCH Soil Type	DITCH Devel'p SLOPE	Curve #	TPO	FLOW Q	FLOW qp	Tb
A	4		0.019	1310	15.0	0.183	B	SF (Ave)	94	0.610	1.40	15.5	
	5		0.019	2990	14.6	0.479				0.788		16.3	
	6		0.010	1170	20.8	0.141				0.585		11.6	
	7		0.015	1470	19.7	0.188	B	SF	94	0.613	1.40	16.6	
B	16		0.095	3760	22.9	0.525	B	SF (Low)	85	0.815	0.80	45.1 ~~29.0~~	
	17		0.008	2010	27.0	0.239	B	SF	94	0.643	1.40	8.4	
	18		0.014	1580	15.9	0.222				0.633		15.0	
	19		0.019	1510	17.6	0.203				0.622	1.40	15.3	
	20		0.018	1685	22.2	0.210	B	SF	94	0.626	1.40	19.5	
	21 Revised to H.H.		0.013	1558	21.0	0.196	B	MF	95	0.617	1.48	15.1	
	22		0.004	510	9.0	0.075	B	MF	97	0.545	1.67	5.9	
	23		0.015	2025	24.8	0.521	B	MF	97	0.813	1.67	14.9	
	24		0.003	600	12.8	0.079	B	SF	94	0.547	1.40	3.7	
	25		0.015	810	21.2	0.092	B	SF (Ave)	94	0.555	1.40	18.3	
		Σ =	0.257										
A	8		0.002	860	12.1	0.122	B	Street	97	0.573	1.67	2.8	Σ = 224.0
		Σ =	0.259										

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: LOWER CRAGMOR PHASE III By: CBD/ATTS Date: 3-17-76

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Page 1 of 4 Pages

RE: SEE FILMORE AREA REPORT 12-29-70 THESE CALC'S REVISED FOR STORM SEWER SYSTEM
BASINS SAME AS IN 12-29-70, FIELD CONFIRMED PER PROFILES

MAJOR BASIN	SUB BASIN	Curve* Plamm. Reed	AREA MILE	BASIN LENGTH	BASIN HEIGHT	Tc	DITCH or ST'S LENGTH	DITCH or ST'S SLOPE	V	TPO	FLOW Q	FLOW qp	Tc
B	1/3 16 + 25	88	0.047			0.525 + 0.023 = 0.548	24" 400	0.44%	4.78	0.829	0.97	26.6	
	2/3 16 + 17	86	0.071			0.525 + 0.079 = 0.604				0.862	0.85	33.9	
	2/3 16 + 17 + 24	86	0.074			+0.079 = 0.683				0.910	0.85	33.4	
	16 + 17 + 24 + 25	87	0.121			+0.023 = 0.706	30" 600	1.3%	7.29	0.924	0.91	57.7	
	18 + 19	94	0.028			0.222 + 0.012 = 0.234	Curb 300	1.65%	7.20	0.640	1.40	29.6	
	18, 19, 20	94	0.046			+0.018 = 0.252	400' 30"	0.51%	6.03	0.651	1.40	47.8	
	16 Thru 25	90	0.199			0.706 + 0.029 = 0.735	42" 630'	0.32%	6.00	0.941	1.09	111.6	
B + A	+ A4	90	0.213			+0.024 = 0.759	42" 989'	1.00%	11.6	0.955	1.09	117.6	
	+ 1/2 A7	90	0.221			+0.012 = 0.771	48" 400'	1.4%	9.36	0.963	1.09	121.1	
	A5 + A6	94	0.029			0.479 + 0.141 = 0.620				0.872	1.40	22.5	
	A5 + A6 + 1/2 A7	94	0.036			+0.062 = 0.682	24" 1600	1.4%	7.16	0.909	1.40	26.8	
B	16 - 25	91	0.257			0.771 ← As Above	48"			0.963	1.16	149.8 ← Use	
A	16 - 25 4 - 7	94	0.257			0.771				0.963	1.40	180.8 ← Don't Use in Hydrograph	

HYDROLOGIC COMPUTATION – BASIC DATA

PROJ: LC ph IV

By: OEW

Date: 3-17

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Street and Storm Sewer Calculations

STREET	LOCATION	DIST	℄ Street / HGL ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW CAPACITY		PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
Hancock	Above 4th 18~		6203.65					
		200	0.90%	15.0	15.0/40.9		-0-	
	4th ST 16~		6201.85					
		400	0.40%	26.6	18.3/30.1		15.0	24" RCP 0.44% min
	3rd ST 12~		6200.25/0.09					
		200	Inverse				26.6	30" RCP 0.40% min
	Primrose 10~		6200.65/99.45					
		630	0.29%	57.7	14.9/35.2	0.7%	57.7	42" RCP @ 0.32% min
	Columbine 3+70		97.65/97.43					
		370	0.29%	111.6	5.9/35.7	0.7%	111.6	48" RCP @ 0.6% min
	Filmore 0+00/13+89		96.35/95.21					
		989	1.04%	117.6	15.5/47.6	1.3%	111.6	42" RCP @ 1.0% min
	Ute Drive 4~		86.04/85.32					
		400	1.4%	121.1	8.0/49.3		117.6	48" RCP @ 0.66% min
	Hancock/ T-Gap 0~/32~		80.44					
Templeton Gap		800	1.44%	~~149.8~~ 121.1	—		~~149.8~~ 117.6	48" RCP @ 1.6% - 1.1% fm 149.8
	Van Buren 40~		68.89	149.8			149.8	
		689	1.06%	~~149.8~~ 121.1	—		~~149.8~~ 117.6	~ @ 1.1% min
	& VB III Ditch 46+89		62.80/61.58					

WESTERN ENGINEERS

Project 85 215 phase IV

Calc. by [illegible] date 3-12

Checked by _____ date _____

Street and Storm Sewer Calculations

STREET	LOCATION	DIST	℄ Street/HGL ELEVATION & SLOPE	TOTAL RUNOFF	STREET FLOW CAPACITY	PIPE FLOW	TYPE PIPE, CATCH BASIN & SLOPE %
Primrose	824 6~		6208.45				
		600	1.3%	33.4	0/18.7	33.4	30" RCP @ 0.73% min
	Hancock 0~		6200.65				
Columbine	Poinsetta 6~		6208.81				
		400	1.475%	29.6		29.6	30" RCP @ 0.51% min
	Marigold 10~		6204.91				
		558³	1.19%	47.8		47.8	30" RCP @ 1.35% min
	Hancock 15+58³		98.27/97.37				
T-Gap	Filmore 16~		6203.49				
		1600	1.42%	26.8	[illegible]/30.0 1.5%	22.5	24" RCP @ 0.9% min
	Hancock 32~		6180.72				

UNITED WESTERN ENGINEERS

Project [illegible]
Calc. by [illegible] date 3-17
Checked by ______ date ______