COF Engineering Copy

DRAINAGE REPORT

FOR

THE QUEENS SUBDIVISION

Prepared For:

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PREPARED BY:

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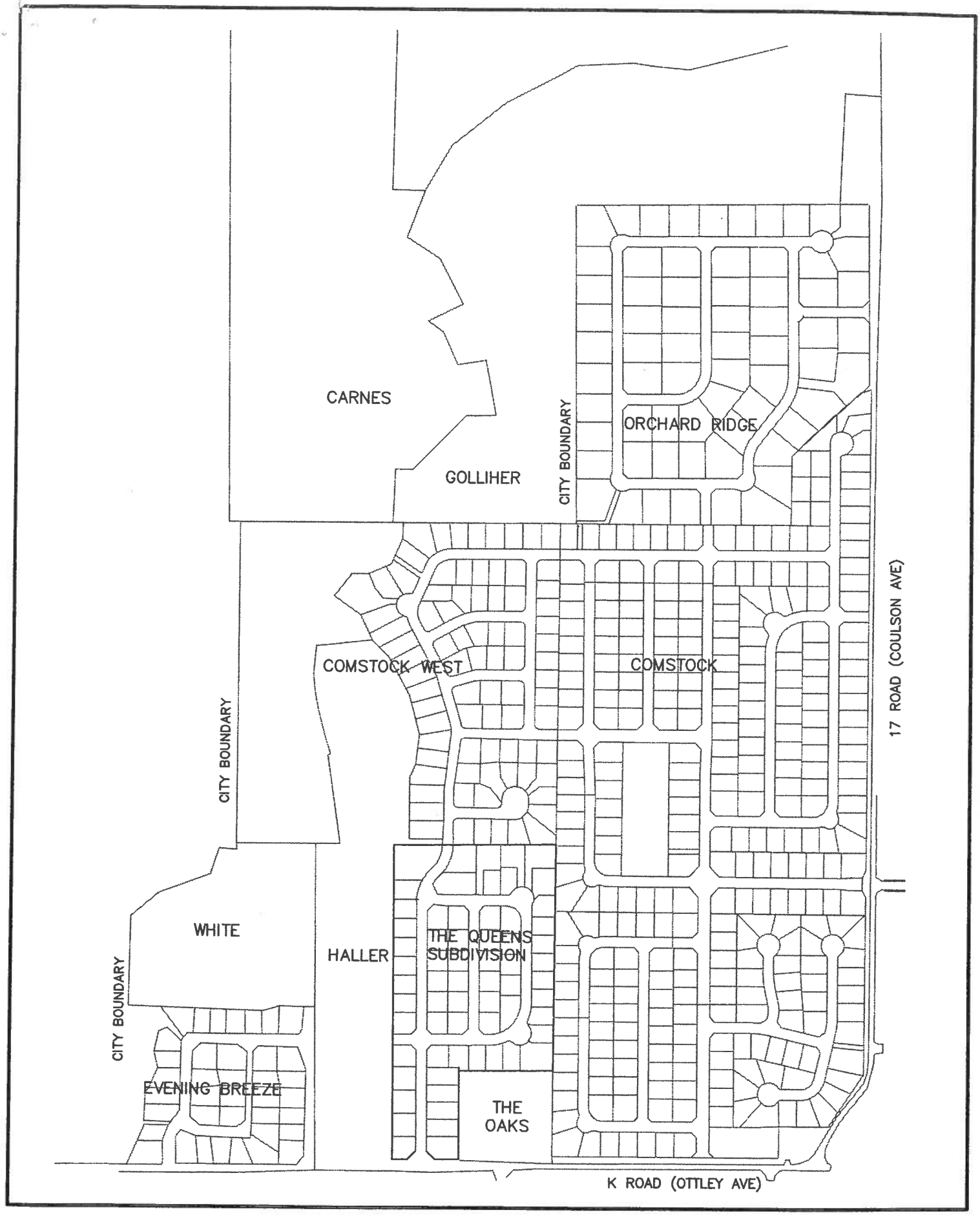
June 2003


CARNES
GOLLIHER
CITY BOUNDARY
ORCHARD RIDGE
COMSTOCK WEST
COMSTOCK
17 ROAD (COULSON AVE)
CITY BOUNDARY
WHITE
HALLER
THE QUEENS SUBDIVISION
CITY BOUNDARY
EVENING BREEZE
THE OAKS
K ROAD (OTTLEY AVE)

SITE MAP

NARRATIVE

INTRODUCTION

The purpose of this drainage report is to ensure the safe diversion of stormwater through The Queens Subdivision. This report will calculate historic and developed basin flows, street carrying capacities, inlet capacities, and storm sewer sizing to the Big Salt Wash located to the west of the property. This design will comply with all requirements of the City of Fruita.

LOCATION & DESCRIPTION

The Queens Subdivision is described as Lot 1 of the Oaks Minor Subdivision located in a portion of the SW ¼, SE ¼ of Section 7, Township 1 North, Range 2 West of the Ute Principal Meridian in Mesa County Colorado. More specifically it is situated along the north side of K Road (Ottley Avenue) west of Comstock Drive between Comstock and Evening Breeze subdivisions and contains approximately 16.18 acres. The development will contain 64 single-family residential units.

HISTORIC HYDROLOGIC CONDITIONS

The site has previously been in agricultural production and currently lies in a fallow state. Ground cover consists primarily of natural grasses and weeds. The soil is primarily a Billings silty clay loam, hydrologic soil group 'C'. The ground slopes slightly to the southwest at a slope of approximately 0.47%. There is no substantial off-site drainage flowing onto the site. There are swales along the south and west boundaries of the property that diverts surface water west to the Big Salt Wash.

HYDROLOGIC PROCEDURE

The Rational Method has been used to calculate both historic and developed basin flows for the 2 and 100-year events. Runoff coefficients, flow velocities, and rainfall intensities have been obtained from the Stormwater Management Manual for Mesa County. Standard HEC-12 procedures, also obtained from the Stormwater Management Manual, have been used to calculate street inundation and inlet capacities. No detention calculations have been performed. Stormwater from the site will be directly discharged to Big Salt Wash due to the close proximity of the development to the wash.

DEVELOPED HYDROLOGIC CONDITIONS

The site will continue to drain, as it has historically, to the south toward K Road. Twenty three percent of the total runoff will flow to Single Combination Inlet F-1, 34% to Single Combination Inlet F-2, and the remaining 43% of the total runoff will be diverted to an On Grade Single Combination Inlet E-4 (See Figure 1 for Inlet locations and two-year flow volumes). Inlets F-1 and F-2 will be constructed in a shallow 15" sump to positively collect runoff. All collected runoff will be directed to a proposed 24" storm sewer located along the north right-of-way of K Road under the existing wastewater drain ditch. The sewer will divert all stormwater approximately ¼ mile west to the Big Salt Wash. The site is not located within any 100-year floodplain. Any major storm event that inundates proposed inlets F-1 and F-2 will pond no deeper than 15" in Amethyst Drive and then overtop into K Road. The stormwater will then run in a proposed swale a minimum of 1' deep with 2:1 side slopes above the storm sewer to the wash.

Inlet D-9 will be placed on K Road east of Amethyst Drive to collect minimal half street runoff flows from the Oaks subdivision.

On-site detention is not a preferred alternative for this site because of its close proximity to the wash. This site is a good candidate for early and direct discharge to the watercourse in order to release stormwater early from sites lower in the basin prior to the peak discharge from upstream in the major basin.

An 18" RCP will connect all three inlets and will drain into a 24" HDPE pipe to the Big Salt Wash. The storm sewer is designed to handle up to the 100-year flow event within the subdivision. The outlet velocity of the sewer has been calculated to be 5.92 fps and therefore using the Urban Storm Drainage Manual Section 5.6.2 (see Calculations and Details) an apron with a entrance width of 4', an exit width of 10', and a length of 12', constructed of 12" dia. rocks has been designed for energy dissipation and erosion control. Although calculations determined a Type L Riprap with a mean diameter size of 9" could be used, the mean diameter was increased to 12" because of the steepness of the outlet slope.

CONCLUSIONS

Implementation of this drainage plan will safely divert the 100-year storm flows away from the proposed development and will not adversely affect adjacent property. This plan is in compliance with all applicable regulations of the City of Fruita.

CALCULATIONS
&
DETAILS

THE QUEENS
FLOW SUMMARY

Historic Basin Flow

Q(2)=1.18fs
Q(100)=6.66 cfs

Developed Basin Flow

Q(2)=2.91 cfs
Q(100)=15.07 cfs

Street Carrying Capacity (2 year event)

Maximum flow on Amethyst to Inlet F-1 = 0.67 cfs
Maximum flow on Amethyst to Inlet F-2 = 0.86 cfs

Maximum Half Street Flow for Urban Residential Collector = 1.00 cfs (See Figure G-5)

Maximum flow on Christina to Inlet E-4 = 1.08 cfs

Maximum Half Street Flow for Local Urban Residential = 8.90 cfs (See Figure G-5)

Inlet Capacity- Sump or Sag Condition

2-year flow to Inlet F-1 = 0.67 cfs
2-year flow to Inlet F-2 = 0.86 cfs

Maximum Single Combination Inlet Capacity = 3.20 cfs (See Table G-1)

Inlet Capacity- On-Grade Condition (See Figure 1)

2-year flow to Inlet E-4= 1.08 cfs

Maximum Single Combination Inlet Capacity = 1.50 cfs (See Table G-7b)

FLOW CALCULATION WORKSHEET

JOB NAME The Queens Subdivision
DATE June 2003

BASIN DESIGNATION Historic Basin
FLOWING TO Big Salt Wash

Basin Area $A := 16.18$ acres

Longest Runoff Distance $D_L := 1490$ feet

Overland Runoff Distance $D_O := 1140$ feet

Avg. Slope $S_1 := 0.47$ % slope

Concentrated Flow Distance $D_C := 350$ feet

Avg. Slope $S_2 := 0.47$ % slope

Velocity $V := 0.50$ fps

Runoff Coefficients $c_{h2} := 0.28$

$c_{h100} := 0.34$

Time of Concentration

$$t_{h2} := \frac{\left[1.8 \cdot \left(1.1 - c_{h2}\right) \cdot \sqrt{D_O}\right]}{\sqrt[3]{S_2}} + \frac{D_C}{(60 \cdot V)}$$

$t_{h2} = 75.764$ min

$$t_{h100} := \frac{\left[1.8 \cdot \left(1.1 - c_{h100}\right) \cdot \sqrt{D_O}\right]}{\sqrt[3]{S_2}} + \frac{D_C}{(60 \cdot V)}$$

$t_{h100} = 71.074$ min

Intensity $I_{h2} := 0.26$ in per hour

$I_{h100} := 1.21$ in per hour

$Q_{h2} := c_{h2} \cdot I_{h2} \cdot A$ $Q_{h2} = 1.178$ cfs

$Q_{h100} := c_{h100} \cdot I_{h100} \cdot A$ $Q_{h100} = 6.656$ cfs

FLOW CALCULATION WORKSHEET

JOB NAME The Queens Subdivision
DATE June 2003

BASIN DESIGNATION Developed Basin
FLOWING TO Big Salt Wash

Basin Area $A := 16.18$ acres

Longest Runoff Distance $D_L := 1500$ feet

Overland Runoff Distance $D_O := 100$ feet

Avg. Slope $S_1 := 0.45$ % slope

Concentrated Flow Distance $D_C := 1400$ feet

Avg. Slope $S_2 := 0.45$ % slope

Velocity $V := 1.40$ fps

Runoff Coefficients $c_{d2} := 0.36$

$c_{d100} := 0.45$

Time of Concentration

$$t_{d2} := \frac{\left[1.8 \cdot \left(1.1 - c_{d2}\right) \cdot \sqrt{D_O}\right]}{\sqrt[3]{S_2}} + \frac{D_C}{(60 \cdot V)}$$

$t_{d2} = 34.049$ min

$$t_{d100} := \frac{\left[1.8 \cdot \left(1.1 - c_{d100}\right) \cdot \sqrt{D_O}\right]}{\sqrt[3]{S_2}} + \frac{D_C}{(60 \cdot V)}$$

$t_{d100} = 31.935$ min

Intensity $I_{d2} := 0.50$ in per hour

$I_{d100} := 2.07$ in per hour

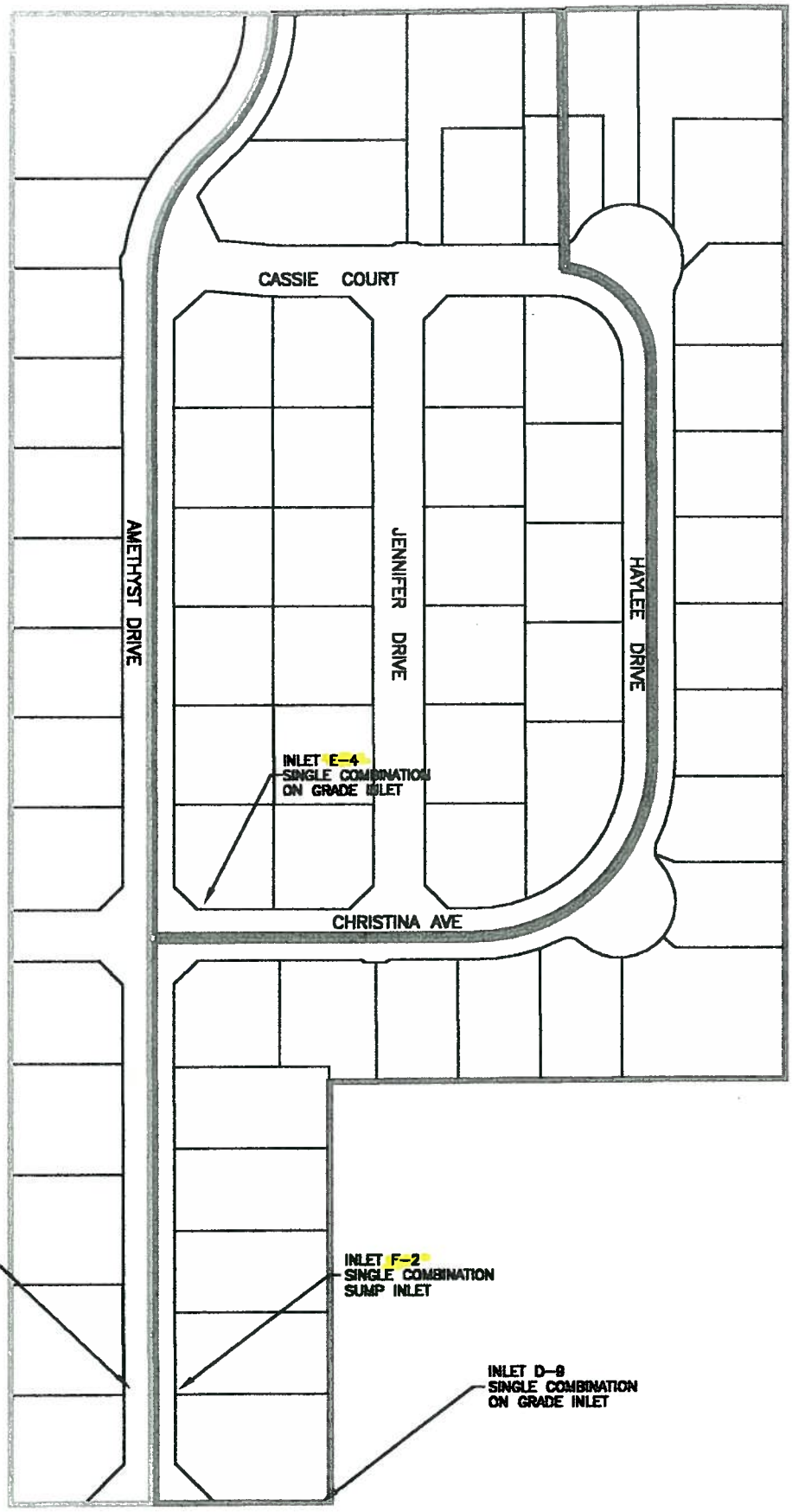
$Q_{d2} := c_{d2} \cdot I_{d2} \cdot A$ $Q_{d100} := c_{d100} \cdot I_{d100} \cdot A$

$Q_{d2} = 2.912$ cfs $Q_{d100} = 15.072$ cfs

BASIN #1
AREA–3.70 ACRES
FLOW TO INLET E–1=0.67 CFS

BASIN #2
AREA–5.51 ACRES
FLOW TO INLET F–2=0.99 CFS

BASIN #3
AREA–6.97 ACRES
FLOW TO INLET E–4=1.25 CFS



THE QUEENS
DRAINAGE BASINS AND INLETS
FIGURE 1

VARIABLE					COMPUTED	COMPUTED
Diameter ft	Channel Slope ft/ft	Mannings 'n'	Discharge cfs	Depth ft	Velocity fps	Capacity Full cfs
2.00	0.0040	0.010	18.60	2.00	5.92	18.60

24" HDPE STORM SEWER IN K ROAD

URBAN STORM DRAINAGE
SECTION 5.6.2

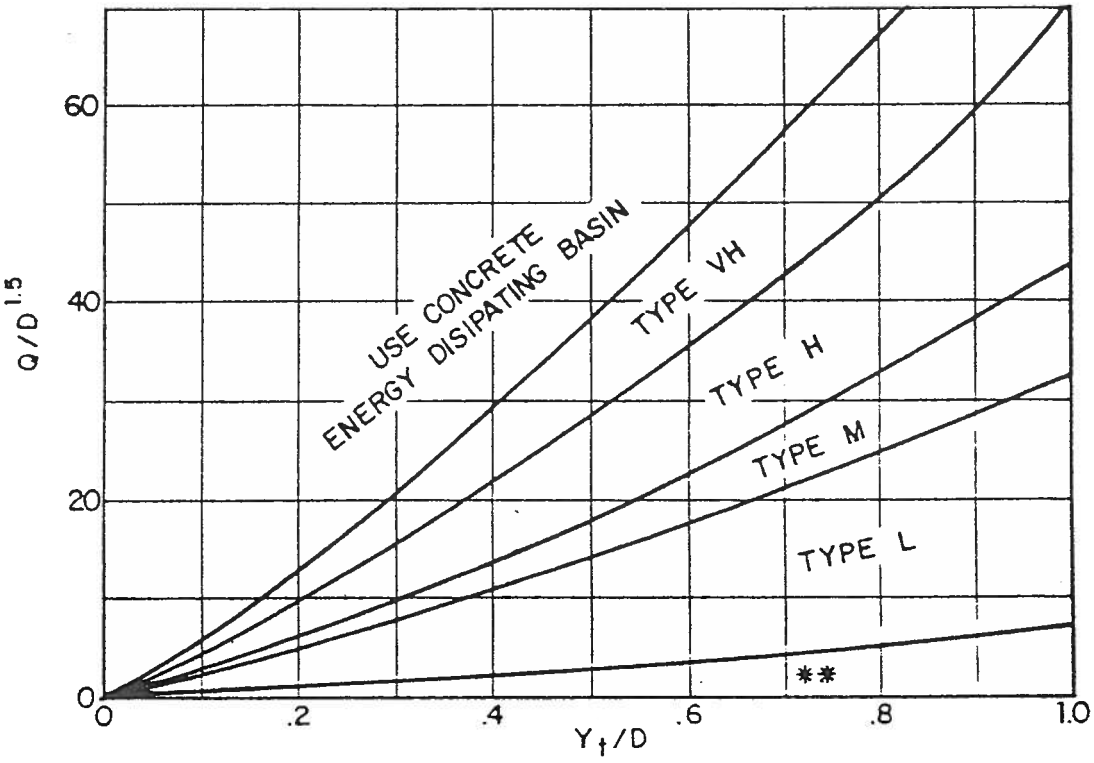
REQUIRED ROCK SIZE FOR RIPRAP PROTECTION

Q=18.60 cfs
Diameter of pipe (D) = 2 ft

$Q/D^{1.5} = 6.58$

Per 5.6.2 b if Tail Water Depth (Y_t) is unknown or a hydraulic jump is suspected downstream of the outlet $Y_t/H=0.40$.

Per Figure 5-7 below Type L Riprap will be required.



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.

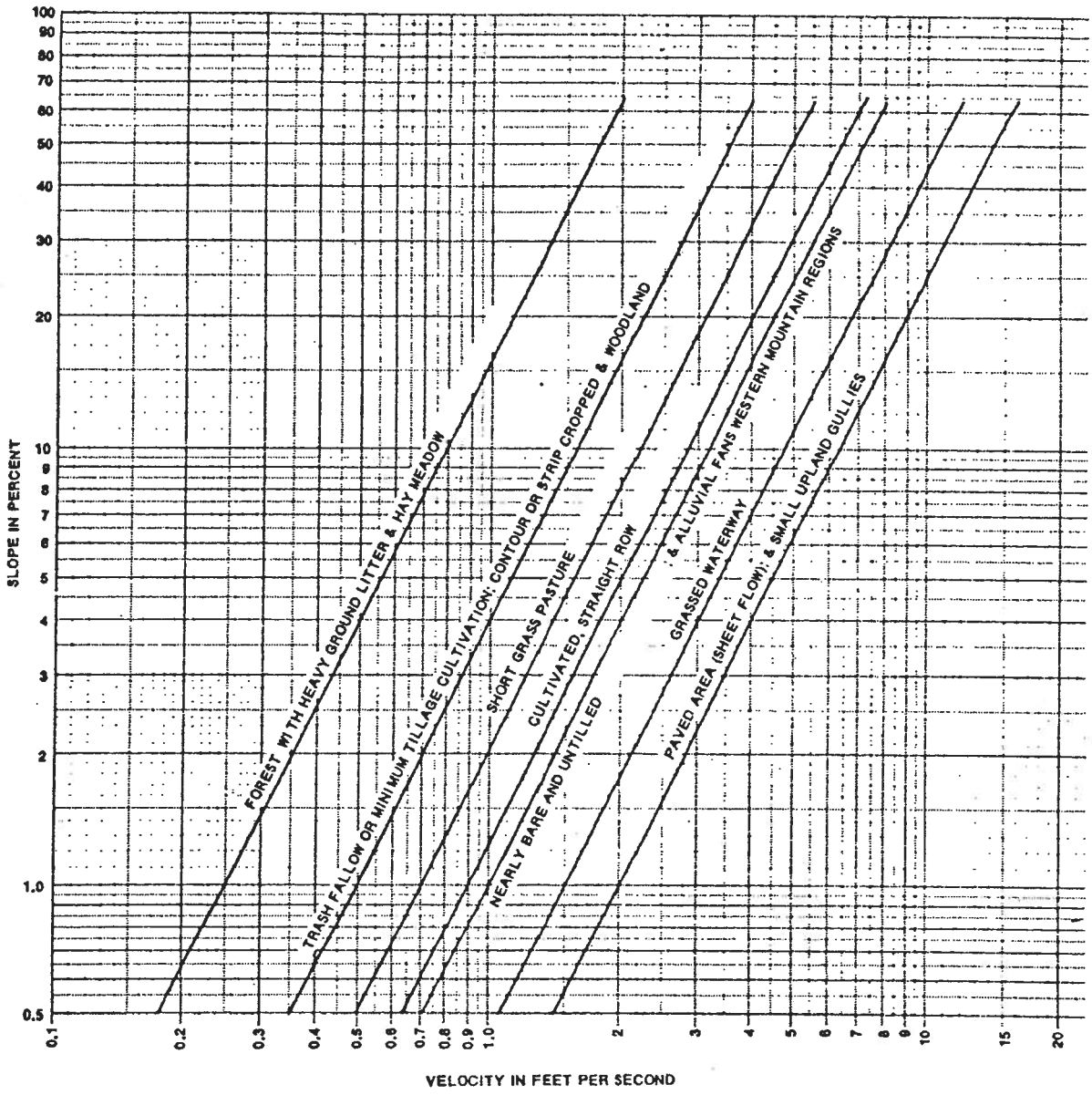
LAND USE OR SURFACE CHARACTERISTICS	SCS HYDROLOGIC SOIL GROUP (SEE APPENDIX "C" FOR DESCRIPTIONS)											
	A			B			C			D		
	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
UNDEVELOPED AREAS Bare ground	.10 - .20 .14 - .24	.16 - .26 .22 - .32	.25 - .35 .30 - .40	.14 - .22 .20 - .28	.22 - .30 .28 - .36	.30 - .38 .37 - .45	.20 - .28 .26 - .34	.28 - .36 .35 - .43	.36 - .44 .40 - .48	.24 - .32 .30 - .38	.30 - .38 .40 - .48	.40 - .48 .50 - .58
Cultivated/Agricultural	.08 - .18 .14 - .24	.13 - .23 .18 - .28	.16 - .26 .22 - .32	.11 - .19 .16 - .24	.15 - .23 .21 - .29	.21 - .29 .28 - .36	.14 - .22 .20 - .28	.19 - .27 .25 - .33	.26 - .34 .34 - .42	.18 - .26 .24 - .32	.23 - .31 .29 - .37	.31 - .39 .41 - .49
Pasture	.12 - .22 .15 - .25	.20 - .30 .25 - .35	.30 - .40 .37 - .47	.18 - .26 .23 - .31	.28 - .36 .34 - .42	.37 - .45 .45 - .53	.24 - .32 .30 - .38	.34 - .42 .42 - .50	.44 - .52 .52 - .60	.30 - .38 .37 - .45	.40 - .48 .50 - .58	.50 - .58 .62 - .70
Meadow	.10 - .20 .14 - .24	.16 - .26 .22 - .32	.25 - .35 .30 - .40	.14 - .22 .20 - .28	.22 - .30 .28 - .36	.30 - .38 .37 - .45	.20 - .28 .26 - .34	.28 - .36 .35 - .43	.36 - .44 .44 - .52	.24 - .32 .30 - .38	.30 - .38 .40 - .48	.40 - .48 .50 - .58
Forest	.05 - .15 .08 - .18	.08 - .18 .11 - .21	.11 - .21 .14 - .24	.08 - .16 .10 - .18	.11 - .19 .14 - .22	.14 - .22 .18 - .26	.10 - .18 .12 - .20	.13 - .21 .16 - .24	.16 - .24 .20 - .28	.12 - .20 .15 - .23	.16 - .24 .20 - .28	.20 - .28 .25 - .33
RESIDENTIAL AREAS 1/8 acre per unit	.40 - .50 .48 - .58	.43 - .53 .52 - .62	.46 - .56 .55 - .65	.42 - .50 .50 - .58	.45 - .53 .54 - .62	.50 - .58 .59 - .67	.45 - .53 .53 - .61	.48 - .56 .57 - .65	.53 - .61 .64 - .72	.48 - .56 .56 - .64	.51 - .59 .60 - .68	.57 - .65 .69 - .77
1/4 acre per unit	.27 - .37 .35 - .45	.31 - .41 .39 - .49	.34 - .44 .42 - .52	.29 - .37 .38 - .46	.34 - .42 .42 - .50	.38 - .46 .47 - .55	.32 - .40 .41 - .49	.36 - .44 .45 - .53	.41 - .49 .52 - .60	.35 - .43 .43 - .51	.39 - .47 .47 - .55	.45 - .53 .57 - .65
1/3 acre per unit	.22 - .32 .31 - .41	.26 - .36 .35 - .45	.29 - .39 .38 - .48	.25 - .33 .33 - .41	.29 - .37 .38 - .46	.33 - .41 .42 - .50	.28 - .36 .36 - .44	.32 - .40 .41 - .49	.37 - .45 .48 - .56	.31 - .39 .39 - .47	.35 - .43 .43 - .51	.42 - .50 .53 - .61
1/2 acre per unit	.16 - .26 .25 - .35	.20 - .30 .29 - .39	.24 - .34 .32 - .42	.19 - .27 .28 - .36	.23 - .31 .32 - .40	.28 - .36 .36 - .44	.22 - .30 .31 - .39	.27 - .35 .35 - .43	.32 - .40 .42 - .50	.26 - .34 .34 - .42	.30 - .38 .38 - .46	.37 - .45 .48 - .56
1 acre per unit	.14 - .24 .22 - .32	.19 - .29 .26 - .36	.22 - .32 .29 - .39	.17 - .25 .24 - .32	.21 - .29 .28 - .36	.26 - .34 .34 - .42	.20 - .28 .28 - .36	.25 - .33 .32 - .40	.31 - .39 .40 - .48	.24 - .32 .31 - .39	.29 - .37 .35 - .43	.35 - .43 .46 - .54
MISC. SURFACES Pavement and roofs	.93 .95	.94 .96	.95 .97	.93 .95	.94 .96	.95 .97	.93 .95	.94 .96	.95 .97	.93 .95	.94 .96	.95 .97
Traffic areas (soil and gravel)	.55 - .65 .65 - .70	.60 - .70 .70 - .75	.64 - .74 .74 - .79	.60 - .68 .68 - .76	.64 - .72 .72 - .80	.67 - .75 .75 - .83	.64 - .72 .72 - .80	.67 - .75 .75 - .83	.69 - .77 .77 - .85	.72 - .80 .79 - .87	.75 - .83 .82 - .90	.77 - .85 .84 - .92
Green landscaping (lawns, parks)	.10 - .20 .14 - .24	.16 - .26 .22 - .32	.25 - .35 .30 - .40	.14 - .22 .20 - .28	.22 - .30 .28 - .36	.30 - .38 .37 - .45	.20 - .28 .26 - .34	.28 - .36 .35 - .43	.36 - .44 .42 - .52	.24 - .32 .30 - .38	.30 - .38 .40 - .48	.40 - .48 .50 - .58
Non-green and gravel landscaping	.30 - .40 .34 - .44	.36 - .46 .42 - .52	.45 - .55 .50 - .60	.45 - .55 .50 - .60	.42 - .50 .48 - .56	.50 - .58 .57 - .65	.40 - .48 .46 - .54	.48 - .56 .55 - .63	.56 - .64 .64 - .72	.44 - .52 .50 - .58	.50 - .58 .60 - .68	.60 - .68 .70 - .78
Cemeteries, playgrounds	.20 - .30 .24 - .34	.26 - .36 .32 - .42	.35 - .45 .40 - .50	.35 - .45 .40 - .50	.32 - .40 .38 - .46	.40 - .48 .47 - .55	.30 - .38 .36 - .44	.38 - .44 .45 - .53	.46 - .54 .54 - .62	.34 - .42 .40 - .48	.40 - .48 .50 - .58	.50 - .58 .60 - .68

NOTES:
1. Values above and below pertain to the 2-year and 100-year storms, respectively.
2. The range of values provided allows for engineering judgement of site conditions such as basic shape, homogeneity of surface type, surface depression storage, and storm duration. In general, during shorter duration storms (Tc ≤ 10 minutes), infiltration capacity is higher, allowing use of a "C" value in the low range. Conversely, for longer duration storms (Tc) 30 minutes), use a ""C value in the higher range.
3. For residential development at less than 1/8 acre per unit or greater than 1 acre per unit, and also for commercial and industrial areas, use values under MISC SURFACES to estimate "C" value ranges for use.

RATIONAL METHOD RUNOFF COEFFICIENTS
(Modified from Table 4, UC-Davis, which appears to be a modification of work done by Rawls)

TABLE "B-1"

REPRODUCED FROM FIGURE 15.2, SCS 1972

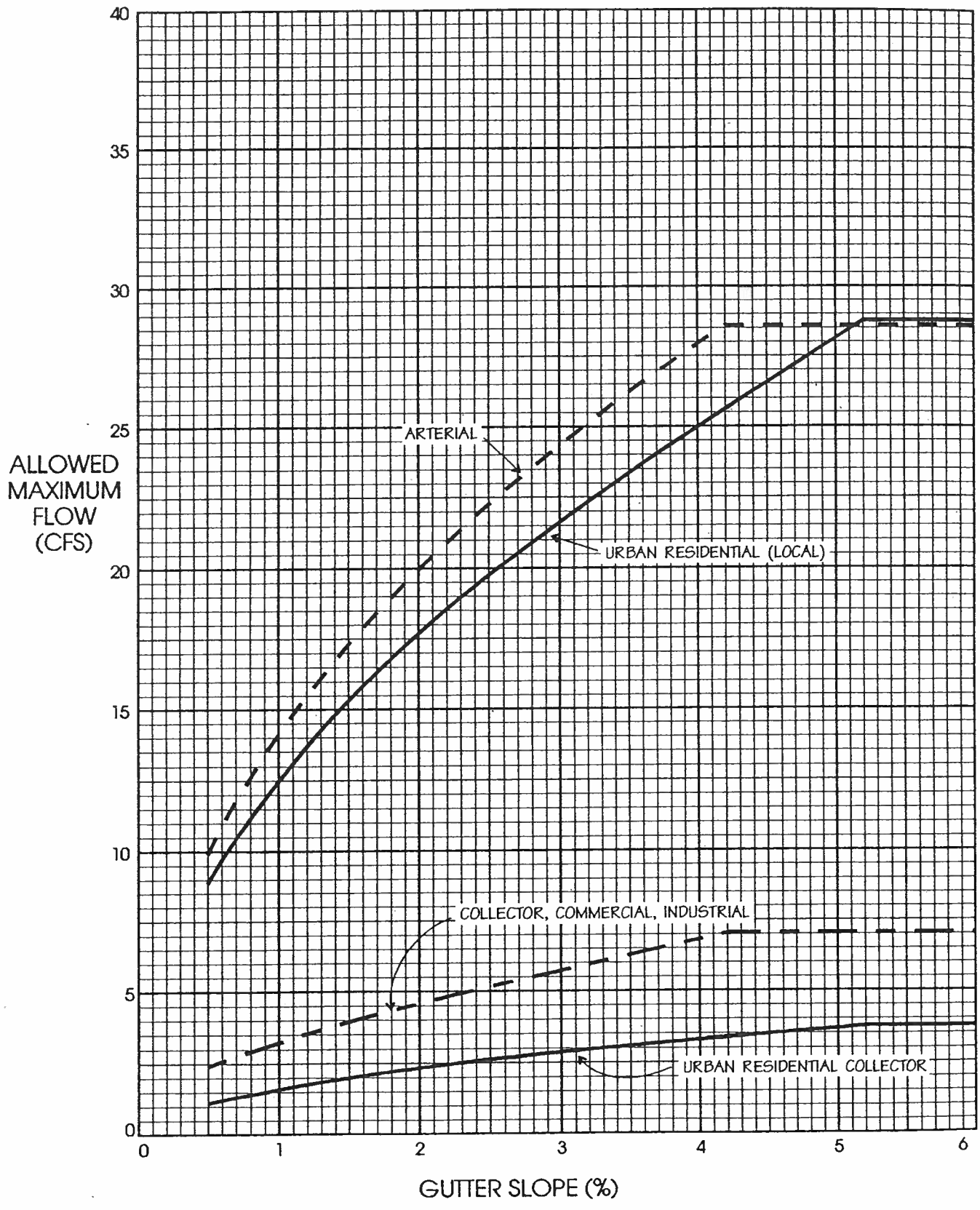


DETERMINATION OF "Ts"	FIGURE "E-3"

ROAD TYPE	COMBINATION INLET CAPACITY (CFS)					
	SINGLE		DOUBLE		TRIPLE	
	2-YR	100-YR	2-YR	100-YR	2-YR	100-YR
Urban Residential (local)	6.4	13	9.5	22	12.7	31
Residential Collector, Commercial and Industrial Streets	3.2	13	4.9	22	6.5	31
Collector Streets (3000 - 8000 ADT)	2.7	13	4.0	22	5.3	31
Principal and Minor Arterials	6.0	13	9.0	22	12.0	31

Inlet capacities shown above are based upon: 1) use of non-curved vane grates (similar to HEC-12 P-1⅞-4 grates; 2) HEC-12 procedures; 3) clogging factors per Section VI; and 4) City/County standard inlets with 2-inch radius on curb face and type C grates. Capacities shown for 2-year storms are based upon depths allowed by maximum street inundation per Figure "G-3". The 100-year capacities are based upon a ponded depth of 1.0 foot. Note that only combination inlets are allowed in sag or sump conditions.

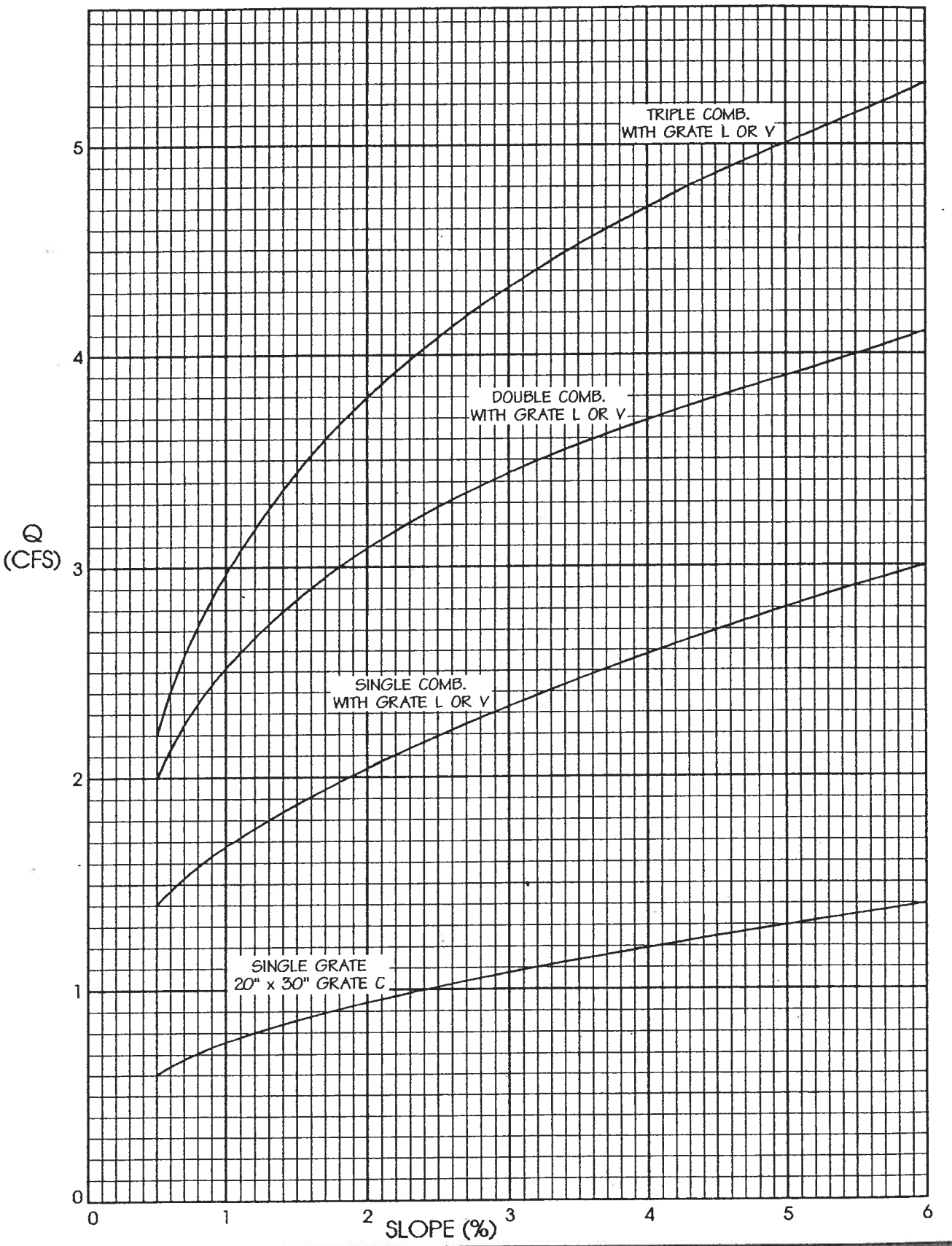
MAXIMUM INLET CAPACITIES: SUMP OR SAG CONDITION — **TABLE "G-1"**



MAXIMUM HALF STREET FLOWS (Sx=2%, n=0.016)
(Based upon Figures G-3 and G-4)

FIGURE "G-5"

INLET CAPACITIES PROVIDED ARE BASED UPON FIGURE "G-4", MAXIMUM ALLOWED FLOW CONDITIONS, SMF ENGINEERING CORP.'S HEC-12 SOFTWARE, CLOGGING FACTORS PRESENTED IN SECTION VI, AND CITY\COUNTY STANDARD INLETS.



MAXIMUM INLET CAPACITIES: ON-GRADE
RESIDENTIAL COLLECTOR, COMMERCIAL, INDUSTRIAL

FIGURE "G-7b"

TABLE "A-1a"
IDF DATA FOR USE IN THE GRAND VALLEY

Time (min)	2-Year Intensity (in/hr)	100-Year Intensity (in/hr)	Time (min)	2-Year Intensity (in/hr)	100-Year Intensity (in/hr)
5	1.11	4.41	33	0.51	2.03
6	1.07	4.23	34	0.50	1.99
7	1.03	4.07	35	0.49	1.95
8	0.99	3.92	36	0.49	1.91
9	0.95	3.78	37	0.48	1.88
10	0.92	3.64	38	0.47	1.85
11	0.89	3.52	39	0.46	1.82
12	0.86	3.41	40	0.45	1.79
13	0.83	3.30	41	0.45	1.76
14	0.81	3.20	42	0.44	1.73
15	0.79	3.11	43	0.43	1.70
16	0.76	3.02	44	0.42	1.67
17	0.74	2.93	45	0.42	1.64
18	0.72	2.85	46	0.41	1.61
19	0.70	2.77	47	0.40	1.59
20	0.68	2.70	48	0.40	1.57
21	0.67	2.63	49	0.39	1.55
22	0.65	2.57	50	0.39	1.53
23	0.64	2.51	51	0.38	1.50
24	0.62	2.45	52	0.38	1.48
25	0.61	2.39	53	0.37	1.46
26	0.59	2.34	54	0.37	1.44
27	0.58	2.29	55	0.36	1.42
28	0.57	2.24	56	0.36	1.40
29	0.56	2.19	57	0.35	1.38
30	0.54	2.15	58	0.35	1.37
31	0.53	2.11	59	0.34	1.35
32	0.52	2.07	60	0.34	1.33

Source: Mesa County 1992 (Modified)

$$I_2 = \frac{26.71}{Tc + 19.01} \qquad I_{100} = \frac{104.94}{Tc + 18.80}$$

CRANE ASSOCIATES

October 15, 2003

Eric Mende, City Engineer
City of Fruita
325 East Aspen St., Suite 155
Fruita, CO 81521

Re: Stormwater calculations for proposed storm sewer in K Road-Queens Subdivision

Dear Eric:

The enclosed calculations indicate the carrying capacity of the proposed storm sewer in K Road from the Queens Subdivision west to Big Salt Wash. The proposed sewer will consist of 36" RCP pipe laid at a slope of 0.4%. The 100-year runoff from the subdivision has been calculated to be 15.07 cfs (Queens Subdivision Drainage Report, June 2003) and the capacity of the existing 18" CMP culvert in front of the subdivision is approximately 3 cfs depending upon the depth of the ditch. In most cases it is just slightly above the top of the pipe. The two combined will produce approximately 18.1 cfs during the 100-year event.

The proposed storm sewer will carry significantly more water than required by the proposed development. The storm sewer will have a carrying capacity of 45.7 cfs with no head.

If I can be of any further assistance please contact me at your earliest convenience.

Sincerely,

Jeffory Crane

2917 L50 Lane, Hotchkiss, CO 81419 • (970) 872-2433 • jeffcrane@tds.net

Storm sewer in K Road

The Queens Subdivision

Sewer Pipes -- English Units

Civil Tools for Windows
(10-15-2003, 12:19:35)

Flowrate (cfs)	Diameter (in)	Friction ()	Slope (%)	Velocity (fps)
45.70	36.00	0.012	0.40	6.47

CRANE ASSOCIATES

September 19, 2003

Eric Mende, City Engineer
City of Fruita
325 East Aspen St., Suite 155
Fruita, CO 81521

Re: Stormwater calculations for proposed storm sewer in K Road-Queens Subdivision

Dear Eric:

The enclosed culvert calculations indicate the carrying capacity of the proposed storm sewer in K Road from the Queens Subdivision west to Big Salt Wash. The proposed sewer will consist of 24" HDPE smooth wall pipe laid at a constant slope of 1%. The 100-year runoff from the subdivision has been calculated to be 15.07 cfs (Queens Subdivision Drainage Report, June 2003) and the capacity of the existing 18" CMP culvert in front of the subdivision is approximately 3 cfs depending upon the depth of the ditch. In most cases it is just slightly above the top of the pipe. The two combined will produce approximately 18.1 cfs during the 100-year event.

The proposed storm sewer will carry significantly more water and the carrying capacity will increase downstream as the depth and the subsequent head on the sewer increases. At Storm Manhole D-7 at the intersection of Amethyst Drive and K Road, the carrying capacity will be 28.77 cfs. However, at Storm Manhole D-3 near Evening Breeze Subdivision, the carrying capacity is calculated to be approximately 50 cfs.

If I can be of any further assistance please contact me at your earliest convenience.

Sincerely,

Jeffory Crane

12/26/03

Note: Per review comments, credit of up to $10,843.13 is available based on added capacity.

Approx Cost of line per draft SIA = $76,228

Pipe Capacity = 28.77 cfs (worst case) Required capacity = 18.1 cfs

Additional capacity = $\frac{28.77-18.1}{28.77} \approx 37\%$

Possible Credit = 37%(76,228) = $28,270 exceeds fee

Alternate calc

$\frac{(48.63-18.1)}{48.63} = 63\%$ Added capacity

.63 x (76,228) = $48,023

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Queens ex. culvert in K Road

Culverts -- English Units
Civil Tools for Windows
(09-19-2003, 09:44:58)

```
           Diameter = 18 in
             Length = 73 ft
     Friction Coeff = .024
     Ent+Exit Coeff = 1
Inlet Control Coeff = .61
       Inv Elev Out = 4492.88 ft
        Inv Elev In = 4493.10 ft
     Tailwater Elev = 4494.38 ft
     Elev Increment = .25 ft
```

Headwater ft		Flowrate cfs
4494.60	OC	2.83
4494.85	OC	4.13
4495.10	OC	5.11
4495.35	OC	5.94
4495.60	OC	6.66
4495.85	OC	7.31
4496.10	OC	7.91
4496.35	OC	8.46
4496.60	OC	8.98
4496.85	OC	9.47
4497.10	OC	9.94
4497.35	OC	10.39
4497.60	OC	10.82
4497.85	OC	11.23
4498.10	OC	11.63
4498.35	OC	12.01

← TOP OF CULVERT

Queens Storm Sewer in K Road

Culverts -- English Units

Civil Tools for Windows

(09-19-2003, 09:30:13)

```
          Diameter = 24 in
            Length = 300 ft
     Friction Coeff = 0.01
     Ent+Exit Coeff = .8
Inlet Control Coeff = .61
       Inv Elev Out = 4485.44 ft
        Inv Elev In = 4488.44 ft
     Tailwater Elev = 4487.44 ft
     Elev Increment = .5 ft
```

Headwater ft		Flowrate cfs
4490.44	IC	15.38
4490.94	IC	18.84
4491.44	IC	21.75
4491.94	IC	24.32
4492.44	IC	26.64
4492.94	IC	28.77
4493.44	IC	30.76
4493.94	IC	32.62
4494.44	IC	34.39
4494.94	IC	36.07
4495.44	IC	37.67
4495.94	IC	39.21
4496.44	IC	40.69
4496.94	IC	42.12
4497.44	IC	43.50
4497.94	IC	44.84

← INLET ELEV @ SUBDIVISION (AMETHYST & K)

Queens Storm Sewer in K Road

Culverts -- English Units

Civil Tools for Windows
(09-19-2003, 09:24:28)

```
           Diameter = 24 in
             Length = 300 ft
     Friction Coeff = 0.01
     Ent+Exit Coeff = .8
Inlet Control Coeff = .61
       Inv Elev Out = 4475.84 ft
        Inv Elev In = 4478.84 ft
     Tailwater Elev = 4477.84 ft
     Elev Increment = 1 ft
```

Headwater ft		Flowrate cfs
4480.84	IC	15.38
4481.84	IC	21.75
4482.84	IC	26.64
4483.84	IC	30.76
4484.84	IC	34.39
4485.84	IC	37.67
4486.84	IC	40.69
4487.84	IC	43.50
4488.84	IC	46.14
4489.84	IC	48.63
4490.84	IC	51.01
4491.84	IC	53.27
4492.84	IC	55.45
4493.84	IC	57.54
4494.84	IC	59.56
4495.84	IC	61.52

← INLET ELEVATION @ D-3 NEAR EVENING BREEZE