File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .1000 hrs

========================
Total Tc: .1000 hrs
========================

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

Tc Equations used...

==== User Defined ==

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .1500 hrs

Total Tc: .1500 hrs

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

Tc Equations used...

==== User Defined ==

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: User Defined

Segment #1 Time: .1500 hrs

========================
Total Tc: .1500 hrs
========================

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

Tc Equations used...

==== User Defined ==

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A14.1&14.2&B2.8	87	9.150			87.00
COMPOSITE AREA & WEIGHTED CN --->		9.150			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A15.1&15.4&15.6&16.1	71	4.220			71.00
COMPOSITE AREA & WEIGHTED CN --->		4.220			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A15.2	87	1.250			87.00
A16.2	71	2.320			71.00
COMPOSITE AREA & WEIGHTED CN --->		3.570			76.60 (77)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
A15.5&15.7&16.3	71	3.200			71.00
COMPOSITE AREA & WEIGHTED CN --->		3.200			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
A7	87	3.200			87.00
COMPOSITE AREA & WEIGHTED CN --->		3.200			87.00 (87)

::

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.2	87	2.180			87.00

COMPOSITE AREA & WEIGHTED CN ---> 2.180 87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A13.2	87	1.560			87.00
COMPOSITE AREA & WEIGHTED CN --->		1.560			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A7.1	71	1.830			71.00
A9.5	87	.740			87.00
COMPOSITE AREA & WEIGHTED CN --->		2.570			75.61 (76)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A7.2	71	2.240			71.00
A9.6	87	.480			87.00

COMPOSITE AREA & WEIGHTED CN ---> 2.720 73.82 (74)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A7.3	71	2.130			71.00
A9.4	87	2.210			87.00
COMPOSITE AREA & WEIGHTED CN --->		4.340			79.15 (79)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

::

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
A7.4	71	2.000			71.00
A9.7	87	.480			87.00
COMPOSITE AREA & WEIGHTED CN --->		2.480			74.10 (74)

::

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A7.5	71	2.960			71.00
A9.3	87	2.540			87.00
COMPOSITE AREA & WEIGHTED CN --->		5.500			78.39 (78)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A8.1	71	1.510			71.00
COMPOSITE AREA & WEIGHTED CN --->		1.510			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A8.2&13.4	71	2.640			71.00
COMPOSITE AREA & WEIGHTED CN --->		2.640			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A9.1	71	2.450			71.00
13.1	87	.840			87.00
COMPOSITE AREA & WEIGHTED CN --->		3.290			75.09 (75)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A15.2	87	1.250			87.00
COMPOSITE AREA & WEIGHTED CN --->		1.250			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A2	71	3.620			71.00
COMPOSITE AREA & WEIGHTED CN --->		3.620			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B1.1	71	1.520			71.00
COMPOSITE AREA & WEIGHTED CN --->		1.520			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.1	87	2.200			87.00
COMPOSITE AREA & WEIGHTED CN --->		2.200			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.3	87	2.600			87.00
COMPOSITE AREA & WEIGHTED CN --->		2.600			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.4	87	2.940			87.00
COMPOSITE AREA & WEIGHTED CN --->		2.940			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.5	87	3.450			87.00
COMPOSITE AREA & WEIGHTED CN --->		3.450			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B7.1	71	4.960			71.00
COMPOSITE AREA & WEIGHTED CN --->		4.960			71.00 (71)

Name.... SUBAREA B7.2

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B7.2	71	3.950			71.00
COMPOSITE AREA & WEIGHTED CN --->		3.950			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B7.3	71	2.130			71.00
COMPOSITE AREA & WEIGHTED CN --->		2.130			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.6&1.2	87	5.280			87.00
COMPOSITE AREA & WEIGHTED CN --->		5.280			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP W_PHASE2_DITCHES_2_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
B2.7	87	3.330			87.00
COMPOSITE AREA & WEIGHTED CN --->		3.330			87.00 (87)

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 10

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D30B	SUBAREA B1.1		SUBAREA B1.1	25yr
D24A	SUBAREA B2.5		SUBAREA B2.5	25yr

INFLOWS TO: JUNC 10

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBAREA B1.1	25yr	.317	11.9200	5.66
	SUBAREA B2.5	25yr	1.162	11.9200	20.55

TOTAL FLOW INTO: JUNC 10

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 10	25yr	1.478	11.9200	26.22

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 10
HYG Tag = 25yr

Peak Discharge = 26.22 cfs
Time to Peak = 11.9200 hrs
HYG Volume = 1.478 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.5200	.00	.00	.00	.00	.01
4.7200	.01	.01	.01	.01	.01
4.9200	.01	.01	.02	.02	.02
5.1200	.02	.02	.02	.02	.03
5.3200	.03	.03	.03	.03	.03
5.5200	.03	.04	.04	.04	.04
5.7200	.04	.04	.05	.05	.05
5.9200	.05	.05	.05	.06	.06
6.1200	.06	.06	.06	.06	.07
6.3200	.07	.07	.07	.07	.07
6.5200	.08	.08	.08	.08	.08
6.7200	.08	.09	.09	.09	.09
6.9200	.09	.10	.10	.10	.10
7.1200	.10	.10	.11	.11	.11
7.3200	.11	.11	.12	.12	.12
7.5200	.12	.12	.12	.13	.13
7.7200	.13	.13	.13	.14	.14
7.9200	.14	.14	.14	.15	.15
8.1200	.15	.16	.16	.16	.17
8.3200	.17	.18	.18	.19	.19
8.5200	.20	.20	.21	.21	.22
8.7200	.22	.23	.23	.24	.24
8.9200	.25	.25	.26	.27	.27
9.1200	.27	.28	.28	.28	.29
9.3200	.29	.29	.30	.30	.30
9.5200	.31	.31	.32	.32	.33
9.7200	.34	.35	.36	.37	.38
9.9200	.39	.40	.42	.43	.44
10.1200	.45	.47	.48	.50	.52
10.3200	.53	.55	.56	.58	.60
10.5200	.61	.64	.66	.68	.71
10.7200	.73	.76	.79	.82	.85
10.9200	.88	.91	.94	.97	1.03

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.1200	1.07	1.14	1.20	1.26	1.34
11.3200	1.40	1.48	1.56	1.62	1.71
11.5200	1.85	2.56	3.35	4.37	6.33
11.7200	7.82	10.27	12.78	16.10	22.35
11.9200	26.22	25.21	22.88	19.26	11.59
12.1200	7.00	5.14	4.32	3.93	3.59
12.3200	3.40	3.17	2.96	2.79	2.53
12.5200	2.37	2.21	2.07	1.99	1.92
12.7200	1.88	1.82	1.77	1.73	1.67
12.9200	1.64	1.58	1.53	1.50	1.45
13.1200	1.42	1.39	1.36	1.34	1.31
13.3200	1.29	1.26	1.23	1.21	1.18
13.5200	1.16	1.13	1.11	1.09	1.07
13.7200	1.05	1.03	1.02	1.00	.98
13.9200	.96	.94	.92	.91	.89
14.1200	.88	.87	.87	.86	.85
14.3200	.85	.84	.83	.83	.82
14.5200	.82	.81	.80	.80	.79
14.7200	.78	.78	.77	.76	.76
14.9200	.75	.74	.74	.73	.72
15.1200	.72	.71	.70	.70	.69
15.3200	.69	.68	.67	.66	.66
15.5200	.65	.64	.64	.63	.62
15.7200	.62	.61	.60	.60	.59
15.9200	.59	.58	.57	.57	.56
16.1200	.56	.55	.55	.55	.55
16.3200	.54	.54	.54	.54	.53
16.5200	.53	.53	.53	.53	.52
16.7200	.52	.52	.52	.51	.51
16.9200	.51	.51	.50	.50	.50
17.1200	.50	.49	.49	.49	.49
17.3200	.49	.48	.48	.48	.48
17.5200	.47	.47	.47	.47	.46
17.7200	.46	.46	.46	.45	.45
17.9200	.45	.45	.44	.44	.44
18.1200	.44	.44	.43	.43	.43
18.3200	.43	.42	.42	.42	.42
18.5200	.41	.41	.41	.41	.40
18.7200	.40	.40	.40	.39	.39
18.9200	.39	.39	.38	.38	.38
19.1200	.38	.38	.37	.37	.37
19.3200	.37	.36	.36	.36	.36
19.5200	.35	.35	.35	.35	.34
19.7200	.34	.34	.34	.33	.33
19.9200	.33	.33	.32	.32	.32
20.1200	.32	.32	.32	.32	.32
20.3200	.32	.32	.32	.32	.32

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.5200	.31	.31	.31	.31	.31
20.7200	.31	.31	.31	.31	.31
20.9200	.31	.31	.31	.31	.31
21.1200	.31	.31	.31	.31	.31
21.3200	.31	.30	.30	.30	.30
21.5200	.30	.30	.30	.30	.30
21.7200	.30	.30	.30	.30	.30
21.9200	.30	.30	.30	.30	.30
22.1200	.30	.30	.29	.29	.29
22.3200	.29	.29	.29	.29	.29
22.5200	.29	.29	.29	.29	.29
22.7200	.29	.29	.29	.29	.29
22.9200	.29	.29	.29	.28	.28
23.1200	.28	.28	.28	.28	.28
23.3200	.28	.28	.28	.28	.28
23.5200	.28	.28	.28	.28	.28
23.7200	.28	.28	.28	.28	.28
23.9200	.27	.27	.27	.23	.11
24.1200	.04	.02	.01	.00	.00

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 100

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D36	SUBA7.5&A9.3		SUBA7.5&A9.3	25yr
D53	SUBA7.4&A9.7		SUBA7.4&A9.7	25yr
D37	SUBA7.3&9.4		SUBA7.3&9.4	25yr
D54	SUBA7.2&A9.6		SUBA7.2&A9.6	25yr
D55	SUBA7.1&A9.5		SUBA7.1&A9.5	25yr

INFLOWS TO: JUNC 100

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBA7.5&A9.3	25yr	1.440	12.0000	22.49
	SUBA7.4&A9.7	25yr	.572	11.9200	10.31
	SUBA7.3&9.4	25yr	1.171	12.0000	18.27
	SUBA7.2&A9.6	25yr	.628	11.9600	11.00
	SUBA7.1&A9.5	25yr	.632	11.9600	10.59

TOTAL FLOW INTO: JUNC 100

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 100	25yr	4.443	12.0000	71.14

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 100
HYG Tag = 25yr

Peak Discharge =	71.14	cfs
Time to Peak =	12.0000	hrs
HYG Volume =	4.443	ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
7.0000	.00	.00	.00	.00	.00
7.2000	.01	.01	.01	.01	.02
7.4000	.02	.02	.03	.03	.03
7.6000	.04	.04	.04	.05	.05
7.8000	.06	.06	.06	.07	.07
8.0000	.08	.08	.09	.09	.10
8.2000	.11	.11	.12	.13	.13
8.4000	.14	.15	.16	.17	.18
8.6000	.20	.21	.22	.23	.25
8.8000	.26	.27	.29	.30	.32
9.0000	.33	.35	.36	.38	.39
9.2000	.41	.42	.43	.44	.45
9.4000	.47	.48	.49	.50	.51
9.6000	.53	.54	.56	.58	.60
9.8000	.63	.65	.68	.70	.73
10.0000	.76	.78	.81	.84	.88
10.2000	.91	.95	.99	1.03	1.07
10.4000	1.11	1.16	1.20	1.25	1.30
10.6000	1.35	1.41	1.47	1.54	1.61
10.8000	1.68	1.75	1.83	1.91	1.99
11.0000	2.08	2.17	2.28	2.40	2.53
11.2000	2.69	2.85	3.04	3.23	3.42
11.4000	3.63	3.84	4.06	4.36	5.28
11.6000	6.69	8.77	12.16	16.18	21.42
11.8000	27.94	36.11	49.08	62.26	69.44
12.0000	71.14	66.90	54.64	40.80	30.13
12.2000	23.00	18.54	15.73	13.77	12.36
12.4000	11.21	10.31	9.42	8.68	8.03
12.6000	7.47	7.04	6.71	6.46	6.25
12.8000	6.05	5.89	5.72	5.56	5.40
13.0000	5.24	5.10	4.96	4.83	4.72
13.2000	4.61	4.53	4.43	4.35	4.26
13.4000	4.17	4.09	4.00	3.92	3.84

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
13.6000	3.76	3.69	3.62	3.56	3.50
13.8000	3.43	3.37	3.31	3.25	3.19
14.0000	3.13	3.07	3.02	2.97	2.94
14.2000	2.90	2.88	2.85	2.83	2.81
14.4000	2.79	2.76	2.74	2.72	2.70
14.6000	2.68	2.66	2.64	2.62	2.60
14.8000	2.57	2.55	2.53	2.51	2.49
15.0000	2.47	2.45	2.43	2.41	2.38
15.2000	2.36	2.34	2.32	2.30	2.28
15.4000	2.25	2.23	2.21	2.19	2.17
15.6000	2.15	2.12	2.10	2.08	2.06
15.8000	2.04	2.02	1.99	1.97	1.95
16.0000	1.93	1.91	1.89	1.87	1.86
16.2000	1.85	1.84	1.83	1.82	1.81
16.4000	1.80	1.80	1.79	1.78	1.77
16.6000	1.77	1.76	1.75	1.74	1.74
16.8000	1.73	1.72	1.71	1.71	1.70
17.0000	1.69	1.68	1.67	1.67	1.66
17.2000	1.65	1.64	1.64	1.63	1.62
17.4000	1.61	1.60	1.60	1.59	1.58
17.6000	1.57	1.57	1.56	1.55	1.54
17.8000	1.53	1.53	1.52	1.51	1.50
18.0000	1.50	1.49	1.48	1.47	1.46
18.2000	1.46	1.45	1.44	1.43	1.43
18.4000	1.42	1.41	1.40	1.39	1.39
18.6000	1.38	1.37	1.36	1.35	1.35
18.8000	1.34	1.33	1.32	1.31	1.31
19.0000	1.30	1.29	1.28	1.27	1.27
19.2000	1.26	1.25	1.24	1.23	1.23
19.4000	1.22	1.21	1.20	1.19	1.19
19.6000	1.18	1.17	1.16	1.15	1.15
19.8000	1.14	1.13	1.12	1.11	1.11
20.0000	1.10	1.09	1.08	1.08	1.07
20.2000	1.07	1.07	1.07	1.06	1.06
20.4000	1.06	1.06	1.06	1.06	1.05
20.6000	1.05	1.05	1.05	1.05	1.05
20.8000	1.05	1.04	1.04	1.04	1.04
21.0000	1.04	1.04	1.03	1.03	1.03
21.2000	1.03	1.03	1.03	1.03	1.02
21.4000	1.02	1.02	1.02	1.02	1.02
21.6000	1.01	1.01	1.01	1.01	1.01
21.8000	1.01	1.01	1.00	1.00	1.00
22.0000	1.00	1.00	1.00	1.00	.99
22.2000	.99	.99	.99	.99	.99
22.4000	.98	.98	.98	.98	.98
22.6000	.98	.97	.97	.97	.97
22.8000	.97	.97	.97	.96	.96

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
23.0000	.96	.96	.96	.96	.96
23.2000	.95	.95	.95	.95	.95
23.4000	.95	.94	.94	.94	.94
23.6000	.94	.94	.93	.93	.93
23.8000	.93	.93	.93	.93	.92
24.0000	.92	.86	.66	.44	.26
24.2000	.16	.09	.05	.03	.02
24.4000	.01	.01	.00	.00	.00

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 20

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D32A	SUBAREA B7.3		SUBAREA B7.3	25yr
D26B	SUBAREA B2.3		SUBAREA B2.3	25yr
D26	SUBAREA B2.4		SUBAREA B2.4	25yr

INFLOWS TO: JUNC 20

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBAREA B7.3	25yr	.444	11.9200	7.93
	SUBAREA B2.3	25yr	.875	11.9600	14.32
	SUBAREA B2.4	25yr	.990	11.9600	16.20

TOTAL FLOW INTO: JUNC 20

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 20	25yr	2.309	11.9600	38.40

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 20
HYG Tag = 25yr

Peak Discharge =	38.40 cfs
Time to Peak =	11.9600 hrs
HYG Volume =	2.309 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.5200	.00	.00	.00	.00	.01
4.7200	.01	.01	.01	.01	.02
4.9200	.02	.02	.02	.03	.03
5.1200	.03	.03	.03	.04	.04
5.3200	.04	.04	.05	.05	.05
5.5200	.05	.06	.06	.06	.06
5.7200	.07	.07	.07	.07	.08
5.9200	.08	.08	.08	.09	.09
6.1200	.09	.09	.10	.10	.10
6.3200	.10	.11	.11	.11	.12
6.5200	.12	.12	.12	.13	.13
6.7200	.13	.14	.14	.14	.14
6.9200	.15	.15	.15	.16	.16
7.1200	.16	.16	.17	.17	.17
7.3200	.18	.18	.18	.19	.19
7.5200	.19	.19	.20	.20	.20
7.7200	.21	.21	.21	.22	.22
7.9200	.22	.23	.23	.23	.24
8.1200	.24	.25	.25	.26	.27
8.3200	.27	.28	.29	.29	.30
8.5200	.31	.32	.33	.33	.34
8.7200	.35	.36	.37	.37	.38
8.9200	.39	.40	.41	.42	.43
9.1200	.43	.44	.45	.45	.46
9.3200	.46	.47	.47	.48	.48
9.5200	.49	.49	.50	.51	.52
9.7200	.54	.55	.57	.58	.60
9.9200	.61	.63	.65	.66	.68
10.1200	.70	.73	.75	.77	.80
10.3200	.82	.85	.87	.90	.93
10.5200	.95	.98	1.02	1.05	1.09
10.7200	1.13	1.17	1.22	1.26	1.31
10.9200	1.35	1.40	1.45	1.50	1.56

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.1200	1.63	1.72	1.82	1.91	2.02
11.3200	2.13	2.24	2.36	2.47	2.60
11.5200	2.77	3.39	4.41	5.74	7.99
11.7200	10.40	13.49	17.14	21.63	28.98
11.9200	35.97	38.40	36.94	33.08	24.75
12.1200	16.73	11.59	8.91	7.41	6.45
12.3200	5.82	5.34	4.92	4.58	4.21
12.5200	3.91	3.64	3.40	3.23	3.09
12.7200	2.99	2.90	2.82	2.75	2.67
12.9200	2.60	2.52	2.44	2.38	2.31
13.1200	2.25	2.20	2.16	2.12	2.07
13.3200	2.03	1.99	1.95	1.91	1.87
13.5200	1.83	1.79	1.76	1.72	1.69
13.7200	1.66	1.63	1.60	1.57	1.54
13.9200	1.51	1.49	1.45	1.43	1.41
14.1200	1.39	1.37	1.36	1.34	1.33
14.3200	1.32	1.31	1.30	1.29	1.28
14.5200	1.27	1.26	1.25	1.24	1.23
14.7200	1.22	1.21	1.20	1.19	1.18
14.9200	1.17	1.16	1.15	1.14	1.13
15.1200	1.12	1.11	1.10	1.09	1.08
15.3200	1.07	1.06	1.05	1.04	1.03
15.5200	1.02	1.01	1.00	.99	.98
15.7200	.97	.96	.95	.94	.93
15.9200	.92	.91	.89	.88	.88
16.1200	.87	.86	.86	.85	.85
16.3200	.85	.84	.84	.84	.83
16.5200	.83	.83	.82	.82	.81
16.7200	.81	.81	.80	.80	.80
16.9200	.79	.79	.78	.78	.78
17.1200	.77	.77	.77	.76	.76
17.3200	.76	.75	.75	.74	.74
17.5200	.74	.73	.73	.73	.72
17.7200	.72	.72	.71	.71	.70
17.9200	.70	.70	.69	.69	.69
18.1200	.68	.68	.67	.67	.67
18.3200	.66	.66	.66	.65	.65
18.5200	.65	.64	.64	.63	.63
18.7200	.63	.62	.62	.61	.61
18.9200	.61	.60	.60	.60	.59
19.1200	.59	.59	.58	.58	.57
19.3200	.57	.57	.56	.56	.56
19.5200	.55	.55	.54	.54	.54
19.7200	.53	.53	.52	.52	.52
19.9200	.51	.51	.51	.50	.50
20.1200	.50	.50	.49	.49	.49
20.3200	.49	.49	.49	.49	.49

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.5200	.49	.49	.49	.49	.49
20.7200	.49	.48	.48	.48	.48
20.9200	.48	.48	.48	.48	.48
21.1200	.48	.48	.48	.48	.47
21.3200	.47	.47	.47	.47	.47
21.5200	.47	.47	.47	.47	.47
21.7200	.47	.47	.47	.46	.46
21.9200	.46	.46	.46	.46	.46
22.1200	.46	.46	.46	.46	.46
22.3200	.46	.46	.45	.45	.45
22.5200	.45	.45	.45	.45	.45
22.7200	.45	.45	.45	.45	.45
22.9200	.45	.44	.44	.44	.44
23.1200	.44	.44	.44	.44	.44
23.3200	.44	.44	.44	.43	.43
23.5200	.43	.43	.43	.43	.43
23.7200	.43	.43	.43	.43	.43
23.9200	.43	.43	.42	.39	.27
24.1200	.15	.07	.04	.02	.01
24.3200	.00	.00	.00		

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 30

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D50	SUBAREA B7.1		SUBAREA B7.1	25yr
D34	JUNC 90		JUNC 90	25yr
D61	SUBAREA A2		SUBAREA A2	25yr
D30	SUBB2.6&1.2		SUBB2.6&1.2	25yr
D32	JUNC 20		JUNC 20	25yr
D30A	JUNC 10		JUNC 10	25yr
D51	A15.2&A16.2		A15.2&A16.2	25yr
D20	JUNC 50		JUNC 50	25yr
D3	JUNC 40		JUNC 40	25yr

INFLOWS TO: JUNC 30

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBAREA B7.1	25yr	1.034	11.9200	18.47
	JUNC 90	25yr	2.298	11.9600	38.75
	SUBAREA A2	25yr	.754	12.0800	9.54
	SUBB2.6&1.2	25yr	1.778	11.9600	29.09
	JUNC 20	25yr	2.309	11.9600	38.40
	JUNC 10	25yr	1.478	11.9200	26.22
	A15.2&A16.2	25yr	.906	11.9600	15.18
	JUNC 50	25yr	4.200	12.0400	53.56
	JUNC 40	25yr	9.661	12.0000	148.56

TOTAL FLOW INTO: JUNC 30

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 30	25yr	24.420	11.9600	366.27

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 30
HYG Tag = 25yr

Peak Discharge = 366.27 cfs
Time to Peak = 11.9600 hrs
HYG Volume = 24.420 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.5200	.00	.01	.01	.02	.03
4.7200	.04	.06	.07	.08	.10
4.9200	.11	.12	.14	.15	.17
5.1200	.18	.20	.21	.23	.24
5.3200	.26	.27	.29	.31	.32
5.5200	.34	.35	.37	.39	.40
5.7200	.42	.44	.45	.47	.49
5.9200	.50	.52	.54	.56	.57
6.1200	.59	.61	.63	.64	.66
6.3200	.68	.70	.72	.73	.75
6.5200	.77	.79	.81	.83	.85
6.7200	.86	.88	.90	.92	.94
6.9200	.96	.98	1.00	1.02	1.04
7.1200	1.06	1.08	1.10	1.12	1.15
7.3200	1.17	1.19	1.21	1.24	1.26
7.5200	1.29	1.31	1.33	1.36	1.39
7.7200	1.41	1.44	1.46	1.49	1.51
7.9200	1.54	1.57	1.60	1.62	1.66
8.1200	1.69	1.73	1.78	1.83	1.88
8.3200	1.94	1.99	2.05	2.11	2.18
8.5200	2.24	2.31	2.37	2.44	2.51
8.7200	2.58	2.66	2.73	2.81	2.88
8.9200	2.96	3.04	3.12	3.20	3.27
9.1200	3.34	3.41	3.48	3.55	3.61
9.3200	3.67	3.73	3.79	3.85	3.91
9.5200	3.96	4.03	4.11	4.20	4.31
9.7200	4.43	4.56	4.70	4.84	4.99
9.9200	5.14	5.29	5.45	5.62	5.80
10.1200	5.98	6.18	6.40	6.61	6.85
10.3200	7.08	7.32	7.58	7.82	8.09
10.5200	8.35	8.65	8.96	9.28	9.66
10.7200	10.03	10.44	10.86	11.28	11.74
10.9200	12.18	12.65	13.13	13.64	14.29

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.1200	14.93	15.74	16.64	17.54	18.61
11.3200	19.62	20.73	21.88	23.00	24.27
11.5200	25.98	31.68	40.12	51.79	71.62
11.7200	92.78	121.85	156.20	200.17	271.56
11.9200	338.19	366.27	365.94	341.06	272.20
12.1200	206.47	160.56	130.68	109.80	93.99
12.3200	82.21	73.11	65.78	59.86	54.14
12.5200	49.57	45.55	42.07	39.41	37.25
12.7200	35.59	34.13	32.86	31.78	30.66
12.9200	29.72	28.76	27.84	27.05	26.24
13.1200	25.58	24.96	24.40	23.92	23.39
13.3200	22.94	22.46	21.99	21.56	21.07
13.5200	20.66	20.22	19.81	19.44	19.06
13.7200	18.73	18.38	18.04	17.73	17.38
13.9200	17.07	16.74	16.41	16.13	15.85
14.1200	15.62	15.42	15.24	15.10	14.96
14.3200	14.84	14.71	14.59	14.47	14.35
14.5200	14.25	14.14	14.01	13.91	13.79
14.7200	13.69	13.58	13.46	13.35	13.23
14.9200	13.14	13.02	12.90	12.79	12.67
15.1200	12.58	12.46	12.34	12.23	12.11
15.3200	12.01	11.89	11.77	11.66	11.55
15.5200	11.45	11.33	11.20	11.09	10.98
15.7200	10.88	10.76	10.63	10.52	10.40
15.9200	10.30	10.18	10.06	9.96	9.86
16.1200	9.78	9.71	9.64	9.59	9.54
16.3200	9.50	9.45	9.41	9.37	9.32
16.5200	9.29	9.25	9.20	9.16	9.12
16.7200	9.09	9.04	9.00	8.96	8.92
16.9200	8.88	8.84	8.80	8.76	8.72
17.1200	8.68	8.64	8.59	8.56	8.52
17.3200	8.48	8.44	8.39	8.35	8.31
17.5200	8.28	8.23	8.19	8.15	8.11
17.7200	8.07	8.03	7.98	7.94	7.90
17.9200	7.87	7.83	7.78	7.74	7.70
18.1200	7.66	7.62	7.57	7.53	7.49
18.3200	7.46	7.41	7.37	7.33	7.29
18.5200	7.25	7.21	7.16	7.12	7.08
18.7200	7.04	7.00	6.95	6.91	6.87
18.9200	6.84	6.79	6.75	6.71	6.66
19.1200	6.63	6.59	6.54	6.50	6.46
19.3200	6.42	6.38	6.33	6.29	6.25
19.5200	6.21	6.17	6.12	6.08	6.04
19.7200	6.00	5.96	5.91	5.87	5.83
19.9200	5.79	5.75	5.70	5.66	5.63
20.1200	5.61	5.58	5.56	5.55	5.54
20.3200	5.53	5.52	5.51	5.50	5.49

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.5200	5.49	5.48	5.46	5.45	5.45
20.7200	5.44	5.44	5.42	5.41	5.41
20.9200	5.40	5.40	5.38	5.37	5.37
21.1200	5.36	5.36	5.34	5.33	5.33
21.3200	5.32	5.32	5.30	5.29	5.29
21.5200	5.28	5.28	5.26	5.25	5.25
21.7200	5.24	5.24	5.22	5.21	5.21
21.9200	5.20	5.19	5.18	5.17	5.17
22.1200	5.16	5.15	5.14	5.13	5.13
22.3200	5.12	5.11	5.10	5.09	5.09
22.5200	5.08	5.07	5.06	5.05	5.05
22.7200	5.04	5.03	5.02	5.01	5.01
22.9200	5.00	4.99	4.98	4.97	4.97
23.1200	4.96	4.95	4.94	4.93	4.92
23.3200	4.92	4.91	4.90	4.89	4.88
23.5200	4.88	4.87	4.86	4.85	4.84
23.7200	4.84	4.83	4.82	4.81	4.80
23.9200	4.80	4.79	4.77	4.38	3.23
24.1200	2.15	1.42	.97	.67	.47
24.3200	.33	.23	.16	.12	.09
24.5200	.06	.04	.03	.02	.02
24.7200	.01	.01	.01	.00	.00
24.9200	.00	.00			

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 40

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D41	JUNC 70		JUNC 70	25yr
D4	JUNC 60		JUNC 60	25yr
D52	SUBA8.2&A13.4		SUBA8.2&A13.4	25yr
D2	JUNC 100		JUNC 100	25yr
D40	A15.1.4.6&16.1		A15.1.4.6&16.1	25yr

INFLOWS TO: JUNC 40

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 70	25yr	1.088	11.9600	17.96
	JUNC 60	25yr	2.701	12.0000	35.92
	SUBA8.2&A13.4	25yr	.550	11.9200	10.31
	JUNC 100	25yr	4.443	12.0000	71.14
	A15.1.4.6&16.1	25yr	.880	12.0000	14.70

TOTAL FLOW INTO: JUNC 40

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 40	25yr	9.661	12.0000	148.56

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 40
HYG Tag = 25yr

Peak Discharge	=	148.56 cfs
Time to Peak	=	12.0000 hrs
HYG Volume	=	9.661 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.6000	.00	.00	.00	.00	.01
4.8000	.01	.01	.01	.01	.02
5.0000	.02	.02	.02	.03	.03
5.2000	.03	.03	.04	.04	.04
5.4000	.04	.05	.05	.05	.05
5.6000	.06	.06	.06	.06	.07
5.8000	.07	.07	.07	.08	.08
6.0000	.08	.09	.09	.09	.09
6.2000	.10	.10	.10	.11	.11
6.4000	.11	.11	.12	.12	.12
6.6000	.13	.13	.13	.14	.14
6.8000	.14	.14	.15	.15	.15
7.0000	.16	.16	.17	.17	.17
7.2000	.18	.18	.19	.19	.20
7.4000	.21	.21	.22	.23	.23
7.6000	.24	.25	.26	.26	.27
7.8000	.28	.28	.29	.30	.31
8.0000	.32	.32	.33	.34	.35
8.2000	.37	.38	.39	.41	.43
8.4000	.44	.46	.48	.50	.52
8.6000	.54	.57	.59	.61	.64
8.8000	.66	.69	.71	.74	.77
9.0000	.79	.82	.85	.87	.90
9.2000	.93	.96	.98	1.01	1.04
9.4000	1.06	1.09	1.11	1.14	1.16
9.6000	1.19	1.23	1.27	1.31	1.35
9.8000	1.40	1.45	1.51	1.56	1.62
10.0000	1.67	1.73	1.80	1.87	1.94
10.2000	2.02	2.09	2.18	2.26	2.35
10.4000	2.45	2.54	2.64	2.73	2.84
10.6000	2.96	3.08	3.22	3.35	3.51
10.8000	3.66	3.82	3.99	4.16	4.34
11.0000	4.52	4.72	4.96	5.20	5.50

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.2000	5.84	6.18	6.58	6.97	7.39
11.4000	7.84	8.27	8.76	9.43	11.54
11.6000	14.59	19.00	26.44	34.62	46.07
11.8000	59.75	77.64	106.53	133.91	146.59
12.0000	148.56	139.17	111.77	84.92	65.43
12.2000	52.46	43.64	37.29	32.64	29.08
12.4000	26.23	23.93	21.69	19.90	18.31
12.6000	16.95	15.91	15.08	14.44	13.88
12.8000	13.40	12.98	12.54	12.18	11.79
13.0000	11.43	11.11	10.78	10.52	10.27
13.2000	10.04	9.84	9.63	9.45	9.25
13.4000	9.06	8.89	8.69	8.52	8.34
13.6000	8.17	8.02	7.86	7.73	7.58
13.8000	7.45	7.32	7.17	7.05	6.91
14.0000	6.78	6.66	6.55	6.45	6.37
14.2000	6.30	6.24	6.18	6.14	6.09
14.4000	6.03	5.99	5.94	5.90	5.85
14.6000	5.80	5.76	5.71	5.67	5.62
14.8000	5.57	5.53	5.48	5.44	5.39
15.0000	5.34	5.30	5.25	5.21	5.16
15.2000	5.11	5.07	5.02	4.98	4.93
15.4000	4.88	4.84	4.79	4.75	4.70
15.6000	4.65	4.60	4.55	4.51	4.46
15.8000	4.41	4.37	4.32	4.28	4.23
16.0000	4.17	4.13	4.09	4.06	4.03
16.2000	4.00	3.98	3.96	3.95	3.93
16.4000	3.91	3.89	3.87	3.86	3.84
16.6000	3.82	3.81	3.79	3.78	3.76
16.8000	3.74	3.72	3.71	3.69	3.68
17.0000	3.66	3.64	3.62	3.61	3.59
17.2000	3.57	3.56	3.54	3.53	3.51
17.4000	3.49	3.47	3.46	3.44	3.43
17.6000	3.41	3.39	3.37	3.36	3.34
17.8000	3.32	3.31	3.29	3.27	3.26
18.0000	3.24	3.22	3.20	3.19	3.17
18.2000	3.15	3.14	3.12	3.10	3.09
18.4000	3.07	3.05	3.03	3.02	3.00
18.6000	2.98	2.97	2.95	2.93	2.92
18.8000	2.90	2.88	2.86	2.85	2.83
19.0000	2.81	2.79	2.78	2.76	2.74
19.2000	2.72	2.71	2.69	2.67	2.66
19.4000	2.64	2.62	2.60	2.59	2.57
19.6000	2.55	2.53	2.52	2.50	2.48
19.8000	2.46	2.45	2.43	2.41	2.40
20.0000	2.38	2.36	2.35	2.34	2.33
20.2000	2.32	2.31	2.31	2.31	2.30
20.4000	2.30	2.29	2.29	2.29	2.28

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.6000	2.28	2.28	2.27	2.27	2.27
20.8000	2.26	2.26	2.26	2.25	2.25
21.0000	2.25	2.24	2.24	2.24	2.23
21.2000	2.23	2.23	2.22	2.22	2.22
21.4000	2.21	2.21	2.21	2.21	2.20
21.6000	2.20	2.19	2.19	2.19	2.19
21.8000	2.18	2.18	2.17	2.17	2.17
22.0000	2.16	2.16	2.16	2.16	2.15
22.2000	2.15	2.14	2.14	2.14	2.14
22.4000	2.13	2.13	2.12	2.12	2.12
22.6000	2.11	2.11	2.11	2.11	2.10
22.8000	2.10	2.09	2.09	2.09	2.09
23.0000	2.08	2.08	2.07	2.07	2.07
23.2000	2.06	2.06	2.06	2.06	2.05
23.4000	2.05	2.04	2.04	2.04	2.03
23.6000	2.03	2.03	2.02	2.02	2.02
23.8000	2.01	2.01	2.01	2.00	2.00
24.0000	1.99	1.83	1.35	.90	.58
24.2000	.38	.25	.17	.11	.08
24.4000	.05	.04	.03	.02	.01
24.6000	.01	.01	.00	.00	.00
24.8000	.00	.00			

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 50

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D22	SUBB2.7		SUBB2.7	25yr
D18	A14.1&14.2&B2.8		A14.1&14.2&B2.8	25yr

INFLOWS TO: JUNC 50

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBB2.7	25yr	1.121	11.9600	18.34
	A14.1&14.2&B2.8	25yr	3.079	12.0800	38.52

TOTAL FLOW INTO: JUNC 50

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 50	25yr	4.200	12.0400	53.56

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 50
HYG Tag = 25yr

Peak Discharge = 53.56 cfs
Time to Peak = 12.0400 hrs
HYG Volume = 4.200 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.5200	.00	.00	.00	.00	.01
4.7200	.01	.01	.02	.02	.03
4.9200	.03	.04	.04	.05	.05
5.1200	.05	.06	.06	.07	.07
5.3200	.08	.09	.09	.10	.10
5.5200	.11	.11	.12	.12	.13
5.7200	.13	.14	.14	.15	.16
5.9200	.16	.17	.17	.18	.18
6.1200	.19	.20	.20	.21	.21
6.3200	.22	.23	.23	.24	.24
6.5200	.25	.26	.26	.27	.28
6.7200	.28	.29	.29	.30	.31
6.9200	.31	.32	.33	.33	.34
7.1200	.35	.35	.36	.37	.37
7.3200	.38	.39	.39	.40	.41
7.5200	.41	.42	.43	.43	.44
7.7200	.45	.45	.46	.47	.47
7.9200	.48	.49	.50	.50	.51
8.1200	.52	.53	.54	.55	.56
8.3200	.58	.59	.61	.62	.64
8.5200	.65	.67	.69	.71	.72
8.7200	.74	.76	.78	.79	.81
8.9200	.83	.85	.87	.89	.91
9.1200	.93	.94	.96	.97	.98
9.3200	1.00	1.01	1.02	1.03	1.03
9.5200	1.04	1.05	1.06	1.08	1.09
9.7200	1.11	1.14	1.16	1.19	1.21
9.9200	1.24	1.27	1.30	1.33	1.37
10.1200	1.40	1.44	1.48	1.52	1.56
10.3200	1.60	1.65	1.70	1.74	1.79
10.5200	1.84	1.90	1.95	2.01	2.07
10.7200	2.14	2.21	2.28	2.36	2.44
10.9200	2.52	2.61	2.69	2.78	2.88

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.1200	2.99	3.11	3.25	3.41	3.57
11.3200	3.75	3.93	4.12	4.32	4.53
11.5200	4.79	5.34	6.28	7.64	9.76
11.7200	12.45	15.89	20.18	25.51	32.83
11.9200	41.21	48.02	52.14	53.56	51.08
12.1200	45.92	39.97	34.15	28.74	24.03
12.3200	20.15	17.25	15.00	13.20	11.70
12.5200	10.45	9.41	8.52	7.77	7.16
12.7200	6.65	6.23	5.88	5.59	5.33
12.9200	5.11	4.91	4.73	4.57	4.42
13.1200	4.29	4.17	4.06	3.96	3.87
13.3200	3.78	3.70	3.62	3.54	3.46
13.5200	3.39	3.32	3.25	3.18	3.12
13.7200	3.06	3.00	2.94	2.89	2.83
13.9200	2.78	2.73	2.67	2.62	2.58
14.1200	2.53	2.49	2.45	2.42	2.39
14.3200	2.37	2.34	2.32	2.30	2.28
14.5200	2.26	2.24	2.22	2.20	2.19
14.7200	2.17	2.15	2.13	2.11	2.10
14.9200	2.08	2.06	2.04	2.02	2.01
15.1200	1.99	1.97	1.95	1.94	1.92
15.3200	1.90	1.88	1.86	1.85	1.83
15.5200	1.81	1.79	1.77	1.76	1.74
15.7200	1.72	1.70	1.68	1.67	1.65
15.9200	1.63	1.61	1.59	1.58	1.56
16.1200	1.54	1.53	1.52	1.51	1.50
16.3200	1.49	1.48	1.47	1.46	1.46
16.5200	1.45	1.44	1.44	1.43	1.42
16.7200	1.42	1.41	1.40	1.40	1.39
16.9200	1.38	1.38	1.37	1.36	1.36
17.1200	1.35	1.35	1.34	1.33	1.33
17.3200	1.32	1.31	1.31	1.30	1.29
17.5200	1.29	1.28	1.27	1.27	1.26
17.7200	1.26	1.25	1.24	1.24	1.23
17.9200	1.22	1.22	1.21	1.20	1.20
18.1200	1.19	1.19	1.18	1.17	1.17
18.3200	1.16	1.15	1.15	1.14	1.13
18.5200	1.13	1.12	1.11	1.11	1.10
18.7200	1.09	1.09	1.08	1.08	1.07
18.9200	1.06	1.06	1.05	1.04	1.04
19.1200	1.03	1.02	1.02	1.01	1.00
19.3200	1.00	.99	.98	.98	.97
19.5200	.97	.96	.95	.95	.94
19.7200	.93	.93	.92	.91	.91
19.9200	.90	.89	.89	.88	.88
20.1200	.87	.87	.86	.86	.85
20.3200	.85	.85	.85	.85	.84

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.5200	.84	.84	.84	.84	.84
20.7200	.84	.83	.83	.83	.83
20.9200	.83	.83	.83	.83	.82
21.1200	.82	.82	.82	.82	.82
21.3200	.82	.82	.81	.81	.81
21.5200	.81	.81	.81	.81	.80
21.7200	.80	.80	.80	.80	.80
21.9200	.80	.80	.79	.79	.79
22.1200	.79	.79	.79	.79	.79
22.3200	.78	.78	.78	.78	.78
22.5200	.78	.78	.78	.77	.77
22.7200	.77	.77	.77	.77	.77
22.9200	.77	.76	.76	.76	.76
23.1200	.76	.76	.76	.75	.75
23.3200	.75	.75	.75	.75	.75
23.5200	.75	.74	.74	.74	.74
23.7200	.74	.74	.74	.74	.73
23.9200	.73	.73	.73	.71	.64
24.1200	.54	.44	.35	.27	.20
24.3200	.15	.11	.08	.06	.04
24.5200	.03	.02	.02	.01	.01
24.7200	.01	.00	.00	.00	.00
24.9200	.00	.00			

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 60

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D6	SUBA9.1&A13.1		SUBA9.1&A13.1	25yr
D7	A9.2		A9.2	25yr
D5	SUBA13.2		SUBA13.2	25yr
D7A	SUBA8.1		SUBA8.1	25yr

INFLOWS TO: JUNC 60

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBA9.1&A13.1	25yr	.784	11.9200	14.14
	A9.2	25yr	1.077	12.0800	13.47
	SUBA13.2	25yr	.525	12.0800	6.57
	SUBA8.1	25yr	.315	11.9200	5.62

TOTAL FLOW INTO: JUNC 60

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 60	25yr	2.701	12.0000	35.92

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 60
HYG Tag = 25yr

Peak Discharge =	35.92	cfs
Time to Peak =	12.0000	hrs
HYG Volume =	2.701	ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.6400	.00	.00	.00	.00	.01
4.8400	.01	.01	.01	.01	.01
5.0400	.02	.02	.02	.02	.02
5.2400	.02	.03	.03	.03	.03
5.4400	.03	.04	.04	.04	.04
5.6400	.04	.05	.05	.05	.05
5.8400	.06	.06	.06	.06	.06
6.0400	.07	.07	.07	.07	.08
6.2400	.08	.08	.08	.08	.09
6.4400	.09	.09	.09	.10	.10
6.6400	.10	.10	.11	.11	.11
6.8400	.11	.11	.12	.12	.12
7.0400	.12	.13	.13	.13	.13
7.2400	.14	.14	.14	.14	.15
7.4400	.15	.15	.16	.16	.16
7.6400	.16	.17	.17	.17	.17
7.8400	.18	.18	.18	.18	.19
8.0400	.19	.19	.20	.20	.20
8.2400	.21	.22	.22	.23	.24
8.4400	.24	.25	.26	.27	.27
8.6400	.28	.29	.30	.31	.32
8.8400	.33	.34	.35	.36	.37
9.0400	.38	.39	.40	.41	.41
9.2400	.42	.43	.44	.45	.45
9.4400	.46	.47	.47	.48	.49
9.6400	.50	.51	.52	.53	.54
9.8400	.56	.58	.59	.61	.63
10.0400	.64	.66	.68	.70	.73
10.2400	.75	.78	.80	.83	.86
10.4400	.88	.91	.94	.97	1.01
10.6400	1.04	1.08	1.12	1.16	1.21
10.8400	1.25	1.30	1.35	1.40	1.46
11.0400	1.51	1.58	1.64	1.73	1.82

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.2400	1.91	2.02	2.12	2.24	2.36
11.4400	2.49	2.62	2.81	3.38	4.10
11.6400	5.14	6.98	8.82	11.64	14.90
11.8400	19.26	26.39	32.44	34.92	35.92
12.0400	34.91	29.38	25.07	21.91	18.98
12.2400	16.29	13.83	11.84	10.28	9.04
12.4400	8.05	7.15	6.44	5.83	5.32
12.6400	4.92	4.57	4.30	4.06	3.86
12.8400	3.69	3.53	3.40	3.27	3.15
13.0400	3.06	2.96	2.88	2.81	2.74
13.2400	2.68	2.62	2.56	2.51	2.45
13.4400	2.40	2.35	2.30	2.25	2.21
13.6400	2.17	2.12	2.08	2.04	2.00
13.8400	1.97	1.93	1.90	1.86	1.82
14.0400	1.79	1.76	1.73	1.71	1.69
14.2400	1.67	1.65	1.64	1.62	1.60
14.4400	1.59	1.58	1.57	1.55	1.54
14.6400	1.53	1.51	1.50	1.49	1.48
14.8400	1.47	1.45	1.44	1.43	1.42
15.0400	1.40	1.39	1.38	1.37	1.35
15.2400	1.34	1.33	1.32	1.31	1.29
15.4400	1.28	1.27	1.26	1.24	1.23
15.6400	1.22	1.21	1.20	1.18	1.17
15.8400	1.16	1.14	1.13	1.12	1.11
16.0400	1.10	1.08	1.08	1.07	1.06
16.2400	1.05	1.05	1.04	1.03	1.03
16.4400	1.02	1.02	1.02	1.01	1.01
16.6400	1.00	1.00	.99	.99	.98
16.8400	.98	.97	.97	.97	.96
17.0400	.96	.95	.95	.94	.94
17.2400	.93	.93	.93	.92	.92
17.4400	.91	.91	.90	.90	.89
17.6400	.89	.89	.88	.88	.87
17.8400	.87	.86	.86	.85	.85
18.0400	.85	.84	.84	.83	.83
18.2400	.82	.82	.81	.81	.80
18.4400	.80	.80	.79	.79	.78
18.6400	.78	.77	.77	.76	.76
18.8400	.76	.75	.75	.74	.74
19.0400	.73	.73	.72	.72	.71
19.2400	.71	.71	.70	.70	.69
19.4400	.69	.68	.68	.67	.67
19.6400	.66	.66	.66	.65	.65
19.8400	.64	.64	.63	.63	.62
20.0400	.62	.62	.61	.61	.61
20.2400	.61	.60	.60	.60	.60
20.4400	.60	.60	.60	.60	.59

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.6400	.59	.59	.59	.59	.59
20.8400	.59	.59	.59	.59	.59
21.0400	.58	.58	.58	.58	.58
21.2400	.58	.58	.58	.58	.58
21.4400	.58	.58	.57	.57	.57
21.6400	.57	.57	.57	.57	.57
21.8400	.57	.57	.57	.56	.56
22.0400	.56	.56	.56	.56	.56
22.2400	.56	.56	.56	.56	.55
22.4400	.55	.55	.55	.55	.55
22.6400	.55	.55	.55	.55	.55
22.8400	.54	.54	.54	.54	.54
23.0400	.54	.54	.54	.54	.54
23.2400	.54	.54	.53	.53	.53
23.4400	.53	.53	.53	.53	.53
23.6400	.53	.53	.53	.52	.52
23.8400	.52	.52	.52	.52	.52
24.0400	.47	.36	.28	.22	.18
24.2400	.14	.10	.08	.06	.04
24.4400	.03	.02	.02	.01	.01
24.6400	.01	.00	.00	.00	.00
24.8400	.00				

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 70

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D41A	A15.5&.7&16.3		A15.5&.7&16.3	25yr
D16	SUBAREA A15.2		SUBAREA A15.2	25yr

INFLOWS TO: JUNC 70

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	A15.5&.7&16.3	25yr	.667	12.0000	11.15
	SUBAREA A15.2	25yr	.421	11.9600	6.89

TOTAL FLOW INTO: JUNC 70

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 70	25yr	1.088	11.9600	17.96

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 70
HYG Tag = 25yr

Peak Discharge = 17.96 cfs
Time to Peak = 11.9600 hrs
HYG Volume = 1.088 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.6000	.00	.00	.00	.00	.00
4.8000	.00	.00	.00	.00	.00
5.0000	.01	.01	.01	.01	.01
5.2000	.01	.01	.01	.01	.01
5.4000	.01	.01	.01	.01	.01
5.6000	.01	.01	.01	.01	.02
5.8000	.02	.02	.02	.02	.02
6.0000	.02	.02	.02	.02	.02
6.2000	.02	.02	.02	.02	.02
6.4000	.02	.03	.03	.03	.03
6.6000	.03	.03	.03	.03	.03
6.8000	.03	.03	.03	.03	.03
7.0000	.03	.04	.04	.04	.04
7.2000	.04	.04	.04	.04	.04
7.4000	.04	.04	.04	.04	.04
7.6000	.04	.05	.05	.05	.05
7.8000	.05	.05	.05	.05	.05
8.0000	.05	.05	.05	.05	.06
8.2000	.06	.06	.06	.06	.06
8.4000	.06	.07	.07	.07	.07
8.6000	.07	.08	.08	.08	.08
8.8000	.08	.08	.09	.09	.09
9.0000	.09	.09	.10	.10	.10
9.2000	.10	.10	.11	.11	.11
9.4000	.12	.12	.12	.12	.13
9.6000	.13	.13	.14	.14	.15
9.8000	.16	.16	.17	.17	.18
10.0000	.19	.19	.20	.21	.22
10.2000	.23	.23	.24	.25	.26
10.4000	.27	.28	.30	.31	.32
10.6000	.33	.35	.36	.38	.39
10.8000	.41	.43	.45	.47	.49
11.0000	.51	.53	.56	.59	.62

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
11.2000	.66	.70	.75	.79	.84
11.4000	.89	.94	1.00	1.07	1.29
11.6000	1.69	2.23	3.12	4.17	5.48
11.8000	7.14	9.18	12.47	16.06	17.96
12.0000	17.82	16.44	13.00	9.02	6.22
12.2000	4.74	3.89	3.36	3.02	2.76
12.4000	2.54	2.36	2.18	2.03	1.89
12.6000	1.76	1.67	1.60	1.54	1.50
12.8000	1.46	1.42	1.38	1.34	1.30
13.0000	1.27	1.23	1.20	1.17	1.14
13.2000	1.12	1.10	1.07	1.05	1.03
13.4000	1.01	.99	.97	.95	.93
13.6000	.91	.90	.88	.86	.85
13.8000	.83	.82	.80	.79	.77
14.0000	.76	.75	.73	.72	.71
14.2000	.71	.70	.69	.69	.68
14.4000	.68	.67	.67	.66	.66
14.6000	.65	.65	.64	.64	.63
14.8000	.63	.62	.62	.61	.61
15.0000	.60	.60	.59	.59	.58
15.2000	.58	.57	.57	.56	.56
15.4000	.55	.54	.54	.53	.53
15.6000	.52	.52	.51	.51	.50
15.8000	.50	.49	.49	.48	.48
16.0000	.47	.46	.46	.46	.45
16.2000	.45	.45	.45	.45	.44
16.4000	.44	.44	.44	.44	.43
16.6000	.43	.43	.43	.43	.42
16.8000	.42	.42	.42	.42	.42
17.0000	.41	.41	.41	.41	.41
17.2000	.40	.40	.40	.40	.40
17.4000	.39	.39	.39	.39	.39
17.6000	.39	.38	.38	.38	.38
17.8000	.38	.37	.37	.37	.37
18.0000	.37	.36	.36	.36	.36
18.2000	.36	.35	.35	.35	.35
18.4000	.35	.34	.34	.34	.34
18.6000	.34	.34	.33	.33	.33
18.8000	.33	.33	.32	.32	.32
19.0000	.32	.32	.31	.31	.31
19.2000	.31	.31	.30	.30	.30
19.4000	.30	.30	.29	.29	.29
19.6000	.29	.29	.28	.28	.28
19.8000	.28	.28	.27	.27	.27
20.0000	.27	.27	.27	.26	.26
20.2000	.26	.26	.26	.26	.26
20.4000	.26	.26	.26	.26	.26

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.6000	.26	.26	.26	.26	.26
20.8000	.26	.26	.26	.26	.26
21.0000	.25	.25	.25	.25	.25
21.2000	.25	.25	.25	.25	.25
21.4000	.25	.25	.25	.25	.25
21.6000	.25	.25	.25	.25	.25
21.8000	.25	.25	.25	.25	.25
22.0000	.25	.24	.24	.24	.24
22.2000	.24	.24	.24	.24	.24
22.4000	.24	.24	.24	.24	.24
22.6000	.24	.24	.24	.24	.24
22.8000	.24	.24	.24	.24	.24
23.0000	.24	.24	.24	.23	.23
23.2000	.23	.23	.23	.23	.23
23.4000	.23	.23	.23	.23	.23
23.6000	.23	.23	.23	.23	.23
23.8000	.23	.23	.23	.23	.23
24.0000	.23	.21	.16	.09	.05
24.2000	.02	.01	.01	.00	.00
24.4000	.00				

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 90

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D34A	SUBAREA B7.2		SUBAREA B7.2	25yr
D28	B2.2		B2.2	25yr
D28B	SUBAREA B2.1		SUBAREA B2.1	25yr

INFLOWS TO: JUNC 90

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBAREA B7.2	25yr	.823	11.9200	14.71
	B2.2	25yr	.734	11.9600	12.01
	SUBAREA B2.1	25yr	.741	11.9600	12.12

TOTAL FLOW INTO: JUNC 90

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 90	25yr	2.298	11.9600	38.75

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 90
HYG Tag = 25yr

Peak Discharge =	38.75 cfs
Time to Peak =	11.9600 hrs
HYG Volume =	2.298 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
4.5200	.00	.00	.00	.00	.01
4.7200	.01	.01	.01	.01	.01
4.9200	.01	.02	.02	.02	.02
5.1200	.02	.03	.03	.03	.03
5.3200	.03	.03	.04	.04	.04
5.5200	.04	.04	.05	.05	.05
5.7200	.05	.05	.06	.06	.06
5.9200	.06	.06	.07	.07	.07
6.1200	.07	.07	.08	.08	.08
6.3200	.08	.09	.09	.09	.09
6.5200	.09	.10	.10	.10	.10
6.7200	.10	.11	.11	.11	.11
6.9200	.12	.12	.12	.12	.13
7.1200	.13	.13	.13	.13	.14
7.3200	.14	.14	.14	.15	.15
7.5200	.15	.15	.16	.16	.16
7.7200	.16	.17	.17	.17	.17
7.9200	.18	.18	.18	.18	.19
8.1200	.19	.19	.20	.20	.21
8.3200	.22	.22	.23	.23	.24
8.5200	.24	.25	.26	.26	.27
8.7200	.28	.28	.29	.30	.30
8.9200	.31	.32	.32	.33	.34
9.1200	.34	.35	.35	.36	.37
9.3200	.37	.38	.38	.39	.39
9.5200	.40	.40	.41	.42	.43
9.7200	.45	.46	.47	.49	.50
9.9200	.52	.53	.55	.56	.58
10.1200	.60	.62	.64	.66	.69
10.3200	.71	.73	.76	.78	.81
10.5200	.83	.86	.89	.93	.96
10.7200	1.00	1.04	1.08	1.12	1.17
10.9200	1.21	1.26	1.31	1.35	1.42

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

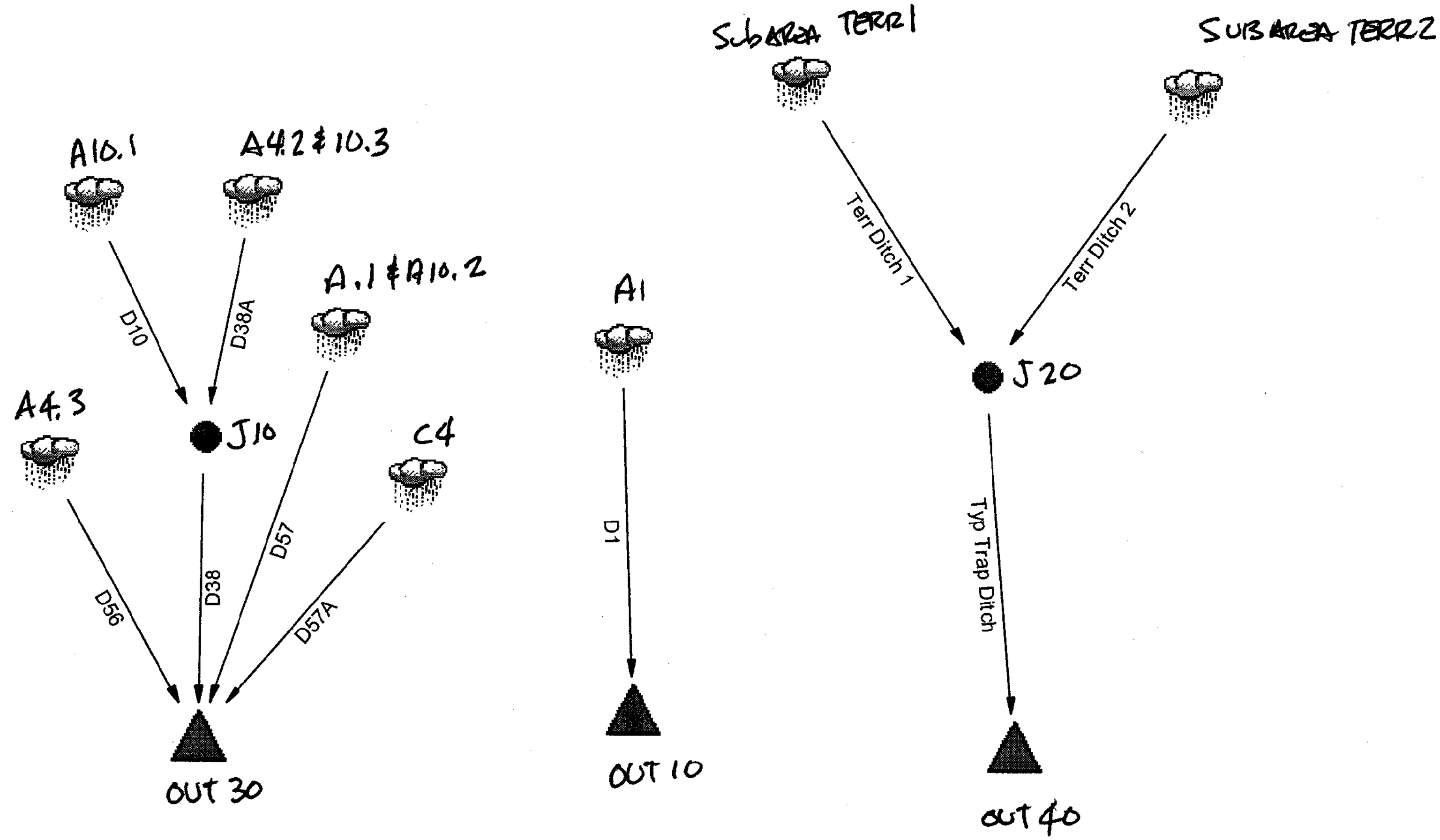
Time hrs					
11.1200	1.49	1.57	1.66	1.76	1.86
11.3200	1.96	2.07	2.19	2.30	2.42
11.5200	2.59	3.25	4.25	5.58	7.87
11.7200	10.22	13.42	17.13	21.83	29.81
11.9200	36.88	38.75	37.04	32.88	23.66
12.1200	15.72	11.01	8.61	7.29	6.41
12.3200	5.85	5.38	4.98	4.65	4.26
12.5200	3.97	3.70	3.45	3.29	3.15
12.7200	3.06	2.97	2.89	2.82	2.73
12.9200	2.66	2.59	2.51	2.44	2.37
13.1200	2.32	2.26	2.22	2.18	2.13
13.3200	2.09	2.05	2.01	1.97	1.92
13.5200	1.89	1.85	1.81	1.78	1.74
13.7200	1.71	1.68	1.65	1.62	1.59
13.9200	1.56	1.53	1.50	1.48	1.45
14.1200	1.43	1.42	1.40	1.39	1.38
14.3200	1.37	1.36	1.35	1.34	1.33
14.5200	1.32	1.31	1.30	1.29	1.28
14.7200	1.27	1.26	1.24	1.23	1.22
14.9200	1.22	1.20	1.19	1.18	1.17
15.1200	1.16	1.15	1.14	1.13	1.12
15.3200	1.11	1.10	1.09	1.08	1.07
15.5200	1.06	1.05	1.03	1.02	1.01
15.7200	1.00	.99	.98	.97	.96
15.9200	.95	.94	.93	.92	.91
16.1200	.90	.90	.89	.89	.88
16.3200	.88	.88	.87	.87	.87
16.5200	.86	.86	.85	.85	.85
16.7200	.84	.84	.84	.83	.83
16.9200	.82	.82	.82	.81	.81
17.1200	.81	.80	.80	.79	.79
17.3200	.79	.78	.78	.77	.77
17.5200	.77	.76	.76	.76	.75
17.7200	.75	.74	.74	.74	.73
17.9200	.73	.73	.72	.72	.71
18.1200	.71	.71	.70	.70	.69
18.3200	.69	.69	.68	.68	.68
18.5200	.67	.67	.66	.66	.66
18.7200	.65	.65	.64	.64	.64
18.9200	.63	.63	.62	.62	.62
19.1200	.61	.61	.61	.60	.60
19.3200	.59	.59	.59	.58	.58
19.5200	.58	.57	.57	.56	.56
19.7200	.56	.55	.55	.54	.54
19.9200	.54	.53	.53	.52	.52
20.1200	.52	.52	.52	.52	.51
20.3200	.51	.51	.51	.51	.51

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
20.5200	.51	.51	.51	.51	.51
20.7200	.51	.51	.50	.50	.50
20.9200	.50	.50	.50	.50	.50
21.1200	.50	.50	.50	.50	.50
21.3200	.50	.49	.49	.49	.49
21.5200	.49	.49	.49	.49	.49
21.7200	.49	.49	.49	.49	.48
21.9200	.48	.48	.48	.48	.48
22.1200	.48	.48	.48	.48	.48
22.3200	.48	.48	.47	.47	.47
22.5200	.47	.47	.47	.47	.47
22.7200	.47	.47	.47	.47	.47
22.9200	.47	.46	.46	.46	.46
23.1200	.46	.46	.46	.46	.46
23.3200	.46	.46	.46	.45	.45
23.5200	.45	.45	.45	.45	.45
23.7200	.45	.45	.45	.45	.45
23.9200	.45	.45	.44	.40	.26
24.1200	.13	.06	.03	.02	.01
24.3200	.00	.00			

Index of Starting Page Numbers for ID Names

ATTACHMENT 2.3 – OFFSITE DITCH FLOW MODEL



OFF SITE AREAS & TERRACE DITCHES

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NETWORK SUMMARY -- LINKS
(UN=Upstream Node; DL=DNstream End of Link; DN=DNstream Node)
(Trun.= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left & Rt)

DEFAULT Design Storm File,ID = KIF

Storm Tag Name = 25yr

Data Type, File, ID = Synthetic Storm TypeII 24hr
Storm Frequency = 25 yr
Total Rainfall Depth= 5.5000 in
Duration Multiplier = 1
Resulting Duration = 24.0000 hrs
Resulting Start Time= .0000 hrs Step= .1000 hrs End= 24.0000 hrs

ICPM CALCULATION TOLERANCES

Target Convergence= .000 cfs +/-
Max. Iterations = 35 loops
ICPM Time Step = .0400 hrs
Output Time Step = .0400 hrs
ICPM Ending Time = 35.0000 hrs

Link ID	Type		HYG Vol ac-ft	Trun.	Peak Time hrs	Peak Q cfs	End Points
D1	ADD	UN	1.667		12.0800	21.08	SUBAREA A1
		DL	1.667		12.0800	21.08	
		DN	1.667		12.0800	21.08	OUT 10
D10	ADD	UN	.535		11.9600	8.76	SUBAREA A10.1
		DL	.535		11.9600	8.76	
		DN	1.147		11.9200	19.55	JUNC 10
D38	ADD	UN	1.147		11.9200	19.55	JUNC 10
		DL	1.147		11.9200	19.55	
		DN	3.033		11.9600	51.67	OUT 30
D38A	ADD	UN	.612		11.9200	11.50	SUB A4.2&10.3
		DL	.612		11.9200	11.50	
		DN	1.147		11.9200	19.55	JUNC 10
D56	ADD	UN	.290		11.9200	5.43	SUBA4.3
		DL	.290		11.9200	5.43	
		DN	3.033		11.9600	51.67	OUT 30

NETWORK SUMMARY -- LINKS
(UN=Upstream Node; DL=DNstream End of Link; DN=DNstream Node)
(Trun.= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left & Rt)

Link ID	Type		HYG Vol ac-ft	Trun.	Peak Time hrs	Peak Q cfs	End Points
D57	ADD	UN	.792		11.9200	14.91	SUB A.1+A10.2
		DL	.792		11.9200	14.91	
		DN	3.033		11.9600	51.67	OUT 30
D57A	ADD	UN	.805		12.0000	13.45	SUBC4
		DL	.805		12.0000	13.45	
		DN	3.033		11.9600	51.67	OUT 30
TERR DITCH 1	ADD	UN	.146		11.9200	2.73	SUBAREA TERR 1
		DL	.146		11.9200	2.73	
		DN	.294		11.9200	5.51	JUNC 20
TERR DITCH 2	ADD	UN	.148		11.9200	2.77	SUBAREA TERR 2
		DL	.148		11.9200	2.77	
		DN	.294		11.9200	5.51	JUNC 20
TYP TRAP DITCH	ADD	UN	.294		11.9200	5.51	JUNC 20
		DL	.294		11.9200	5.51	
		DN	.294		11.9200	5.51	OUT 40

File.... C:\Haestad\PPKW\KIF\
Title... Project Date: 5/3/2004
Project Engineer: Daniel R. Smith
Project Title: KIF Lat Exp Interim Operation w/phase2&3 pond
Project Comments:
This model analyzes the cond of the expan during operation, while Phase 2/3 has a pond. The time of concentration is minimized due to the pond.

DESIGN STORMS SUMMARY

Design Storm File,ID = KIF

```
Storm Tag Name       = 2yr
----------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    TypeII  24hr
Storm Frequency     = 2 yr
Total Rainfall Depth= 3.2500 in
Duration Multiplier =  1
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= .1000 hrs  End= 24.0000 hrs

Storm Tag Name       = 10yr
----------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    TypeII  24hr
Storm Frequency     = 10 yr
Total Rainfall Depth= 3.6000 in
Duration Multiplier =  1
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= .1000 hrs  End= 24.0000 hrs

Storm Tag Name       = 25yr
----------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    TypeII  24hr
Storm Frequency     = 25 yr
Total Rainfall Depth= 5.5000 in
Duration Multiplier =  1
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= .1000 hrs  End= 24.0000 hrs

Storm Tag Name       = 100yr
----------------------------------------------------------------------
Data Type, File, ID = Synthetic Storm    TypeII  24hr
Storm Frequency     = 100 yr
Total Rainfall Depth= 6.5000 in
Duration Multiplier =  1
Resulting Duration  = 24.0000 hrs
Resulting Start Time= .0000 hrs  Step= .1000 hrs  End= 24.0000 hrs
```

CUMULATIVE RAINFALL DEPTHS (in)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
.0000	.0000	.0056	.0111	.0168	.0224
.5000	.0282	.0340	.0399	.0458	.0518
1.0000	.0578	.0639	.0700	.0762	.0824
1.5000	.0887	.0950	.1015	.1079	.1145
2.0000	.1210	.1277	.1343	.1411	.1478
2.5000	.1547	.1616	.1686	.1756	.1827
3.0000	.1898	.1970	.2042	.2115	.2188
3.5000	.2262	.2336	.2412	.2487	.2564
4.0000	.2640	.2718	.2796	.2876	.2957
4.5000	.3039	.3122	.3206	.3291	.3378
5.0000	.3465	.3554	.3643	.3734	.3826
5.5000	.3919	.4013	.4108	.4204	.4302
6.0000	.4400	.4500	.4600	.4702	.4805
6.5000	.4909	.5014	.5120	.5227	.5336
7.0000	.5445	.5556	.5667	.5780	.5894
7.5000	.6009	.6125	.6242	.6360	.6480
8.0000	.6600	.6724	.6853	.6988	.7128
8.5000	.7274	.7425	.7582	.7744	.7912
9.0000	.8085	.8261	.8437	.8613	.8789
9.5000	.8965	.9145	.9335	.9533	.9739
10.0000	.9955	1.0182	1.0421	1.0674	1.0941
10.5000	1.1220	1.1517	1.1836	1.2177	1.2540
11.0000	1.2925	1.3347	1.3823	1.4351	1.4931
11.5000	1.5565	1.6876	1.9490	2.3693	3.1232
12.0000	3.6465	3.7508	3.8425	3.9217	3.9884
12.5000	4.0425	4.0889	4.1325	4.1732	4.2110
13.0000	4.2460	4.2788	4.3100	4.3397	4.3679
13.5000	4.3945	4.4198	4.4440	4.4671	4.4891
14.0000	4.5100	4.5302	4.5499	4.5693	4.5883
14.5000	4.6070	4.6252	4.6430	4.6605	4.6776
15.0000	4.6943	4.7106	4.7265	4.7420	4.7572
15.5000	4.7720	4.7863	4.8003	4.8139	4.8272
16.0000	4.8400	4.8526	4.8650	4.8773	4.8895
16.5000	4.9015	4.9134	4.9252	4.9368	4.9483
17.0000	4.9596	4.9708	4.9819	4.9928	5.0036
17.5000	5.0143	5.0248	5.0352	5.0454	5.0555
18.0000	5.0655	5.0753	5.0850	5.0946	5.1040
18.5000	5.1133	5.1224	5.1314	5.1403	5.1490
19.0000	5.1576	5.1661	5.1744	5.1826	5.1906
19.5000	5.1985	5.2063	5.2139	5.2214	5.2288
20.0000	5.2360	5.2432	5.2502	5.2573	5.2644
20.5000	5.2714	5.2784	5.2854	5.2923	5.2993
21.0000	5.3061	5.3130	5.3198	5.3266	5.3334
21.5000	5.3402	5.3469	5.3536	5.3602	5.3669
22.0000	5.3735	5.3801	5.3866	5.3932	5.3997
22.5000	5.4062	5.4126	5.4190	5.4254	5.4318

CUMULATIVE RAINFALL DEPTHS (in)
Output Time increment = .1000 hrs
Time on left represents time for first value in each row.

Time hrs					
23.0000	5.4381	5.4445	5.4507	5.4570	5.4632
23.5000	5.4694	5.4756	5.4817	5.4878	5.4940
24.0000	5.5000				

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

```
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
TIME OF CONCENTRATION CALCULATOR
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

----------------------------------------------------------------------

Segment #1:  Tc: User Defined

                                    Segment #1 Time:     .0800 hrs
----------------------------------------------------------------------

                                         ========================
                                          Total Tc:      .0800 hrs

                                          Calculated Tc < Min.Tc:
                                          Use Minimum Tc...
                                          Use Tc =       .0833 hrs
                                         ========================
```

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== User Defined ====

Tc = Value entered by user

Where: Tc = Time of concentration

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .0800 hrs

=========================

Total Tc: .0800 hrs

Calculated Tc < Min.Tc:
Use Minimum Tc...
Use Tc = .0833 hrs

=========================

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== User Defined ==

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .0800 hrs

Total Tc: .0800 hrs

Calculated Tc < Min.Tc:
Use Minimum Tc...
Use Tc = .0833 hrs

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== User Defined ==

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .3300 hrs

Total Tc: .3300 hrs

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== User Defined ==

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: User Defined

Segment #1 Time: .1500 hrs

========================

Total Tc: .1500 hrs

========================

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== User Defined ====

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

::

TIME OF CONCENTRATION CALCULATOR

::

Segment #1: Tc: TR-55 Sheet

Mannings n	.0240	
Hydraulic Length	100.00	ft
2yr, 24hr P	3.2500	in
Slope	.330000	ft/ft
Avg.Velocity	2.28	ft/sec

Segment #1 Time: .0122 hrs

Segment #2: Tc: TR-55 Channel

Flow Area	3.5000	sq.ft
Wetted Perimeter	12.75	ft
Hydraulic Radius	.27	ft
Slope	.005000	ft/ft
Mannings n	.0350	
Hydraulic Length	300.00	ft
Avg.Velocity	1.27	ft/sec

Segment #2 Time: .0655 hrs

========================

Total Tc: .0777 hrs

Calculated Tc < Min.Tc:
Use Minimum Tc...
Use Tc = .0833 hrs

========================

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

```
-----------------------------------------------------------------------------
Tc Equations used...
-----------------------------------------------------------------------------


==== SCS TR-55 Sheet Flow ================================================

     Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

     Where:  Tc = Time of concentration, hrs
             n  = Mannings n
             Lf = Flow length, ft
             P  = 2yr, 24hr Rain depth, inches
             Sf = Slope, %


==== SCS Channel Flow ====================================================

     R  = Aq / Wp
     V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

     Tc = (Lf / V) / (3600sec/hr)

     Where:  R  = Hydraulic radius
             Aq = Flow area, sq.ft.
             Wp = Wetted perimeter, ft
             V  = Velocity, ft/sec
             Sf = Slope, ft/ft
             n  = Mannings n
             Tc = Time of concentration, hrs
             Lf = Flow length, ft
```

::
TIME OF CONCENTRATION CALCULATOR
::

Segment #1: Tc: TR-55 Sheet

Mannings n	.0240	
Hydraulic Length	100.00	ft
2yr, 24hr P	3.2500	in
Slope	.330000	ft/ft
Avg.Velocity	2.28	ft/sec

Segment #1 Time: .0122 hrs

Segment #2: Tc: TR-55 Channel

Flow Area	3.5000	sq.ft
Wetted Perimeter	12.75	ft
Hydraulic Radius	.27	ft
Slope	.005000	ft/ft
Mannings n	.0350	
Hydraulic Length	300.00	ft
Avg.Velocity	1.27	ft/sec

Segment #2 Time: .0655 hrs

Total Tc: .0777 hrs

Calculated Tc < Min.Tc:
Use Minimum Tc...
Use Tc = .0833 hrs

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== SCS TR-55 Sheet Flow ====

```
Tc = (.007 * ((n * Lf)**0.8)) / ((P**.5) * (Sf**.4))

Where:  Tc = Time of concentration, hrs
        n  = Mannings n
        Lf = Flow length, ft
        P  = 2yr, 24hr Rain depth, inches
        Sf = Slope, %
```

==== SCS Channel Flow ====

```
R  = Aq / Wp
V  = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

Tc = (Lf / V) / (3600sec/hr)

Where:  R  = Hydraulic radius
        Aq = Flow area, sq.ft.
        Wp = Wetted perimeter, ft
        V  = Velocity, ft/sec
        Sf = Slope, ft/ft
        n  = Mannings n
        Tc = Time of concentration, hrs
        Lf = Flow length, ft
```

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

TIME OF CONCENTRATION CALCULATOR

Segment #1: Tc: User Defined

Segment #1 Time: .1500 hrs

Total Tc: .1500 hrs

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

Tc Equations used...

==== User Defined ====

Tc = Value entered by user

Where: Tc = Time of concentration

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A4.1	71	1.940			71.00
A10.2	87	1.180			87.00
COMPOSITE AREA & WEIGHTED CN --->		3.120			77.05 (77)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A4.2	71	2.470			71.00
10.3	87	.270			87.00
COMPOSITE AREA & WEIGHTED CN --->		2.740			72.58 (73)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	%UC	Adjusted CN
A4.3	71	1.390			71.00
COMPOSITE AREA & WEIGHTED CN --->		1.390			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A1	71	8.000			71.00
COMPOSITE AREA & WEIGHTED CN --->		8.000			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
A10.1	87	1.590			87.00
COMPOSITE AREA & WEIGHTED CN --->		1.590			87.00 (87)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
3:1 Slope w/vegetation	71	.700			71.00
COMPOSITE AREA & WEIGHTED CN --->		.700			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
3:1 Slope vegetated	71	.710			71.00
COMPOSITE AREA & WEIGHTED CN --->		.710			71.00 (71)

File.... C:\Haestad\PPKW\KIF\KIF LAT EXP PHASE2_OFFSITE AREAS & TERRACE DITCHES_A.PPW

RUNOFF CURVE NUMBER DATA

Soil/Surface Description	CN	Area acres	Impervious Adjustment %C	Impervious Adjustment %UC	Adjusted CN
c4	71	3.860			71.00
COMPOSITE AREA & WEIGHTED CN --->		3.860			71.00 (71)

SUMMARY FOR HYDROGRAPH ADDITION
at Node: JUNC 20

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
TERR DITCH 1	SUBAREA TERR 1		SUBAREA TERR 1	25yr
TERR DITCH 2	SUBAREA TERR 2		SUBAREA TERR 2	25yr

INFLOWS TO: JUNC 20

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBAREA TERR 1	25yr	.146	11.9200	2.73
	SUBAREA TERR 2	25yr	.148	11.9200	2.77

TOTAL FLOW INTO: JUNC 20

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	JUNC 20	25yr	.294	11.9200	5.51

TOTAL NODE INFLOW...
HYG file =
HYG ID = JUNC 20
HYG Tag = 25yr

Peak Discharge =	5.51 cfs
Time to Peak =	11.9200 hrs
HYG Volume =	.294 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
9.1600	.00	.00	.00	.00	.00
9.3600	.01	.01	.01	.01	.01
9.5600	.01	.01	.01	.01	.01
9.7600	.01	.02	.02	.02	.02
9.9600	.02	.02	.02	.03	.03
10.1600	.03	.03	.03	.04	.04
10.3600	.04	.04	.05	.05	.05
10.5600	.05	.06	.06	.07	.07
10.7600	.07	.08	.08	.09	.09
10.9600	.10	.10	.11	.12	.12
11.1600	.14	.14	.16	.17	.18
11.3600	.19	.21	.22	.23	.26
11.5600	.40	.51	.72	1.07	1.33
11.7600	1.89	2.38	3.25	4.72	5.51
11.9600	5.17	4.80	3.85	2.05	1.29
12.1600	1.02	.91	.85	.79	.76
12.3600	.70	.66	.62	.56	.53
12.5600	.49	.47	.45	.44	.43
12.7600	.42	.41	.40	.38	.38
12.9600	.36	.35	.35	.34	.33
13.1600	.32	.32	.31	.30	.30
13.3600	.29	.29	.28	.27	.27
13.5600	.26	.26	.26	.25	.25
13.7600	.24	.24	.23	.23	.23
13.9600	.22	.22	.21	.21	.21
14.1600	.21	.20	.20	.20	.20
14.3600	.20	.20	.20	.19	.19
14.5600	.19	.19	.19	.19	.19
14.7600	.18	.18	.18	.18	.18
14.9600	.18	.18	.17	.17	.17
15.1600	.17	.17	.17	.16	.16
15.3600	.16	.16	.16	.16	.16
15.5600	.15	.15	.15	.15	.15

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
15.7600	.15	.14	.14	.14	.14
15.9600	.14	.14	.14	.13	.13
16.1600	.13	.13	.13	.13	.13
16.3600	.13	.13	.13	.13	.13
16.5600	.13	.13	.13	.13	.13
16.7600	.12	.12	.12	.12	.12
16.9600	.12	.12	.12	.12	.12
17.1600	.12	.12	.12	.12	.12
17.3600	.12	.12	.12	.12	.11
17.5600	.11	.11	.11	.11	.11
17.7600	.11	.11	.11	.11	.11
17.9600	.11	.11	.11	.11	.11
18.1600	.11	.10	.10	.10	.10
18.3600	.10	.10	.10	.10	.10
18.5600	.10	.10	.10	.10	.10
18.7600	.10	.10	.10	.10	.10
18.9600	.09	.09	.09	.09	.09
19.1600	.09	.09	.09	.09	.09
19.3600	.09	.09	.09	.09	.09
19.5600	.09	.08	.08	.08	.08
19.7600	.08	.08	.08	.08	.08
19.9600	.08	.08	.08	.08	.08
20.1600	.08	.08	.08	.08	.08
20.3600	.08	.08	.08	.08	.08
20.5600	.08	.08	.08	.08	.08
20.7600	.08	.08	.08	.08	.08
20.9600	.08	.08	.08	.08	.08
21.1600	.08	.08	.08	.08	.08
21.3600	.07	.07	.07	.07	.07
21.5600	.07	.07	.07	.07	.07
21.7600	.07	.07	.07	.07	.07
21.9600	.07	.07	.07	.07	.07
22.1600	.07	.07	.07	.07	.07
22.3600	.07	.07	.07	.07	.07
22.5600	.07	.07	.07	.07	.07
22.7600	.07	.07	.07	.07	.07
22.9600	.07	.07	.07	.07	.07
23.1600	.07	.07	.07	.07	.07
23.3600	.07	.07	.07	.07	.07
23.5600	.07	.07	.07	.07	.07
23.7600	.07	.07	.07	.07	.07
23.9600	.07	.07	.05	.02	.01
24.1600	.00				

SUMMARY FOR HYDROGRAPH ADDITION
at Node: OUT 10

HYG Directory: C:\Haestad\PPKW\KIF\

Upstream Link ID	Upstream Node ID	HYG file	HYG ID	HYG tag
D1	SUBAREA A1		SUBAREA A1	25yr

INFLOWS TO: OUT 10

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	SUBAREA A1	25yr	1.667	12.0800	21.08

TOTAL FLOW INTO: OUT 10

HYG file	HYG ID	HYG tag	Volume ac-ft	Peak Time hrs	Peak Flow cfs
	OUT 10	25yr	1.667	12.0800	21.08

TOTAL NODE INFLOW...
HYG file =
HYG ID = OUT 10
HYG Tag = 25yr

Peak Discharge = 21.08 cfs
Time to Peak = 12.0800 hrs
HYG Volume = 1.667 ac-ft

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
9.1600	.00	.00	.00	.00	.01
9.3600	.01	.01	.02	.02	.03
9.5600	.03	.04	.04	.05	.05
9.7600	.06	.06	.07	.07	.08
9.9600	.09	.09	.10	.11	.12
10.1600	.13	.13	.14	.15	.16
10.3600	.18	.19	.20	.21	.22
10.5600	.24	.25	.27	.28	.30
10.7600	.32	.34	.36	.38	.40
10.9600	.43	.45	.48	.51	.54
11.1600	.57	.61	.65	.69	.74
11.3600	.80	.85	.91	.98	1.06
11.5600	1.17	1.35	1.64	2.08	2.72
11.7600	3.62	4.83	6.47	8.66	11.51
11.9600	14.71	17.72	19.97	21.08	20.83
12.1600	19.35	17.11	14.63	12.31	10.32
12.3600	8.83	7.67	6.75	5.98	5.35
12.5600	4.82	4.36	3.98	3.65	3.37
12.7600	3.15	2.96	2.81	2.67	2.56
12.9600	2.45	2.36	2.28	2.21	2.15
13.1600	2.09	2.03	1.98	1.93	1.89
13.3600	1.85	1.81	1.77	1.74	1.70
13.5600	1.67	1.63	1.60	1.57	1.54
13.7600	1.51	1.48	1.45	1.43	1.40
13.9600	1.38	1.35	1.33	1.30	1.28
14.1600	1.26	1.24	1.22	1.21	1.19
14.3600	1.18	1.17	1.16	1.15	1.14
14.5600	1.13	1.12	1.11	1.10	1.10
14.7600	1.09	1.08	1.07	1.06	1.05
14.9600	1.04	1.04	1.03	1.02	1.01
15.1600	1.00	.99	.99	.98	.97
15.3600	.96	.95	.94	.93	.93
15.5600	.92	.91	.90	.89	.88

HYDROGRAPH ORDINATES (cfs)
Output Time increment = .0400 hrs
Time on left represents time for first value in each row.

Time hrs					
15.7600	.87	.86	.86	.85	.84
15.9600	.83	.82	.81	.80	.79
16.1600	.79	.78	.77	.77	.76
16.3600	.76	.75	.75	.75	.74
16.5600	.74	.74	.73	.73	.73
16.7600	.72	.72	.72	.71	.71
16.9600	.71	.71	.70	.70	.70
17.1600	.69	.69	.69	.68	.68
17.3600	.68	.67	.67	.67	.67
17.5600	.66	.66	.66	.65	.65
17.7600	.65	.64	.64	.64	.63
17.9600	.63	.63	.62	.62	.62
18.1600	.61	.61	.61	.61	.60
18.3600	.60	.60	.59	.59	.59
18.5600	.58	.58	.58	.57	.57
18.7600	.57	.56	.56	.56	.55
18.9600	.55	.55	.54	.54	.54
19.1600	.53	.53	.53	.52	.52
19.3600	.52	.51	.51	.51	.50
19.5600	.50	.50	.50	.49	.49
19.7600	.49	.48	.48	.48	.47
19.9600	.47	.47	.46	.46	.46
20.1600	.45	.45	.45	.45	.45
20.3600	.44	.44	.44	.44	.44
20.5600	.44	.44	.44	.44	.44
20.7600	.44	.44	.44	.43	.43
20.9600	.43	.43	.43	.43	.43
21.1600	.43	.43	.43	.43	.43
21.3600	.43	.43	.43	.43	.42
21.5600	.42	.42	.42	.42	.42
21.7600	.42	.42	.42	.42	.42
21.9600	.42	.42	.42	.42	.42
22.1600	.42	.41	.41	.41	.41
22.3600	.41	.41	.41	.41	.41
22.5600	.41	.41	.41	.41	.41
22.7600	.41	.41	.40	.40	.40
22.9600	.40	.40	.40	.40	.40
23.1600	.40	.40	.40	.40	.40
23.3600	.40	.40	.40	.39	.39
23.5600	.39	.39	.39	.39	.39
23.7600	.39	.39	.39	.39	.39
23.9600	.39	.38	.38	.36	.33
24.1600	.29	.24	.19	.14	.11
24.3600	.08	.06	.04	.03	.02
24.5600	.02	.01	.01	.01	.00
24.7600	.00	.00	.00	.00	.00

Index of Starting Page Numbers for ID Names

APPENDIX A – DITCH HYDRAULIC DESIGN

Attachment 3

PARSONS	CLIENT NAME: TVA PROJECT NAME: KINGSTON-DREDGE CELL				JOB NO.: 55090501
STANDARD CALCULATION SHEET	SUBJECT: DITCH DESIGN				CALC NO.:
	REVISION	0	1	2	3
	ORIGINATOR:	WPT			Page 1 of
	REVIEWER:	DAL			
	DATE:	6/9/04			

REFERENCES

1. DRAWINGS
   10W425-34E (DITCH NETWORK PLAN AND DRAINAGE AREAS)
   10W425-76 (DRAINAGE PLAN & SCHEDULE)
   10W425-71 (DITCH DETAILS)

2. ATTACHMENTS 2.2 AND 2.3 (DITCH FLOWS AND DITCH SIZING (DITCH CLASS 1 & TERRACE DITCHES)
3. "DESIGN CHARTS FOR OPEN CHANNEL FLOW" HYDRAULIC DESIGN SERIES NO. 3 - FEDERAL HIGHWAY ADMIN)
   SEE APPENDIX A FOR EXCERPTS
4. "DESIGN OF STABLE CHANNELS WITH FLEXIBLE LININGS" HYDRAULIC ENGR. CIRCULAR NO. 15 - FEDERAL HIGHWAY ADMIN)
   SEE APPENDIX B FOR EXCERPTS
5. "DESIGN OF ROCK CHUTES" - BY K.M. ROBINSON, C.E. RICE, K.C. KADAVY, AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS 1998
   SEE APPENDIX C FOR EXCERPTS.

THIS IS A DESIGN RECORD

EP3-2 12/96

PARSONS	CLIENT NAME: TVA				JOB NO.:
	PROJECT NAME: KINGSTON-DREDGE CELL				
STANDARD CALCULATION SHEET	SUBJECT: DITCH DESIGN				CALC NO.:
	REVISION	0	1	2	3
	ORIGINATOR:	WM			Page 2 of
	REVIEWER:	[illegible]			
	DATE:	6/9/04			

DESIGN CRITERIA

(1) SIZE DITCHES FOR 25-YR STORM FLOWS -

(2) CONFIRM NO OVERTOPPING FOR 100-YR STORM FLOWS

(3) PROVIDE EROSION PROTECTION FOR 25-YR STORM

PARSONS	CLIENT NAME: TVA FOSSIL ENGINEERING PROJECT NAME: KINGSTON PLANT-DREDGE CELL				JOB NO.: SS090501
STANDARD CALCULATION SHEET	SUBJECT: DITCH DESIGN-HYDRAULICS				CALC NO.:
	REVISION	0	1	2	3
	ORIGINATOR:	WPT			
	REVIEWER:	DMS			
	DATE:	6/9/04			Page 3 of

DITCH CLASS 1; n=.03
SEE ATTACHMENTS 2.2 and 2.3

TERRACE DITCHES; n=.03
SEE ATTACHMENTS 2.2 and 2.3

DITCH CLASSES 2 THRU 8 IN TABLE I

TABLE I

DESIGN CLASS	n	SLOPE	FLOW Q (CFS)	BASIS* DITCH	CHART PAGE	BOTT WIDTH	FLOW DEPTH	VELOCITY FPS	DITCH DEPTH
2	.03	.01	39	D7	A-3	5	1.2'	4.5	2.5
3	.03	.005	37	D60	A-4	10'	1.1	3.0	3.5
4	.03	.0055	171	D3	A-5	20	1.6'	4.2	3.5
5	.03	.0005	370	D62	A-5	40	3.3	2.0	4.0
6	.03	.33	39	D34	A-3	5	0.4	16.0	2.5
7	.042	.175	118	D19	A-4	10'	0.8'	14.0	4.0
8	.03	.0025	71	D2	A-3	5'	1.9'	4.0	3.5'

*

Attachment 3

PARSONS	CLIENT NAME: TVA				JOB NO.: 55090501
	PROJECT NAME: KINGSTON - DREDGE CELL				
STANDARD CALCULATION SHEET	SUBJECT: DITCH DESIGN - EROSION PROT.				CALC NO.:
	REVISION	0	1	2	3
	ORIGINATOR:	WPTaylor			Page 4 of 4
	REVIEWER:	DRS			
	DATE:	6/9/04			

See Chart A-1 - Ditch Bott = 10'

for Q = 117.7 cfs on Ditch D19
S = .15
V = 14 fps & d = 0.8' ≤ 0.8' Allow ~ OK

per Chart on sht. B-2 ∴
for D_{50} = 1.5' & S = 0.15
max depth = 0.8' for erosion control

for Q = 70 cfs - Ditch D20, S = 0.15
V = 12.5 fps & d = 0.55' < 0.8' with D_{50} = 1.5'
Use 10' Ditch

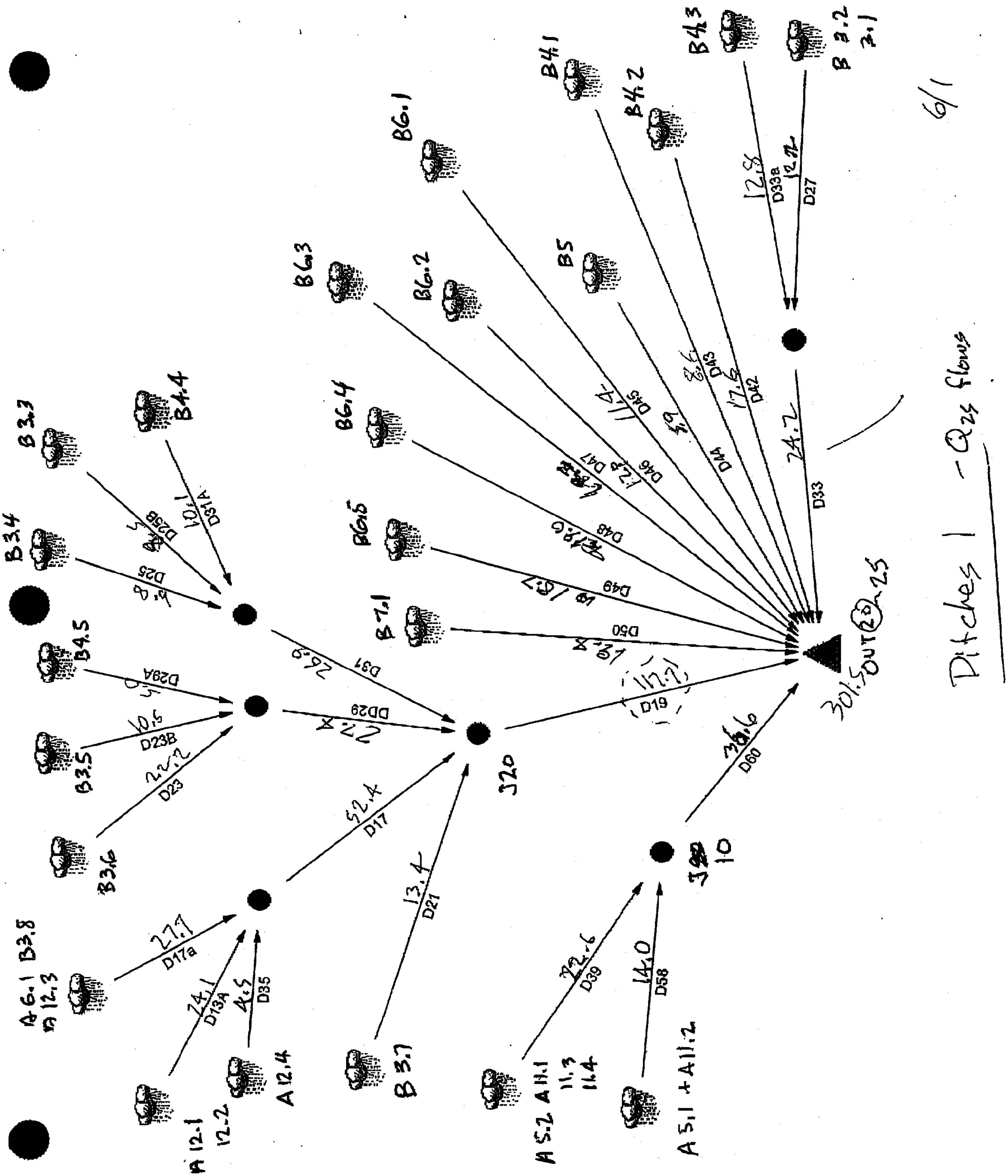
for Q = 59.5 cfs on Ditch D4
S = .175
W = 10' - See Chart on sht A-4
V = 12 fps & d = 0.48' < 0.7 with D_{50} = 1.0'
per Chart on sht B-2
for D_{50} = 1.5' & S = 0.175
max depth = 0.7 for erosion control.

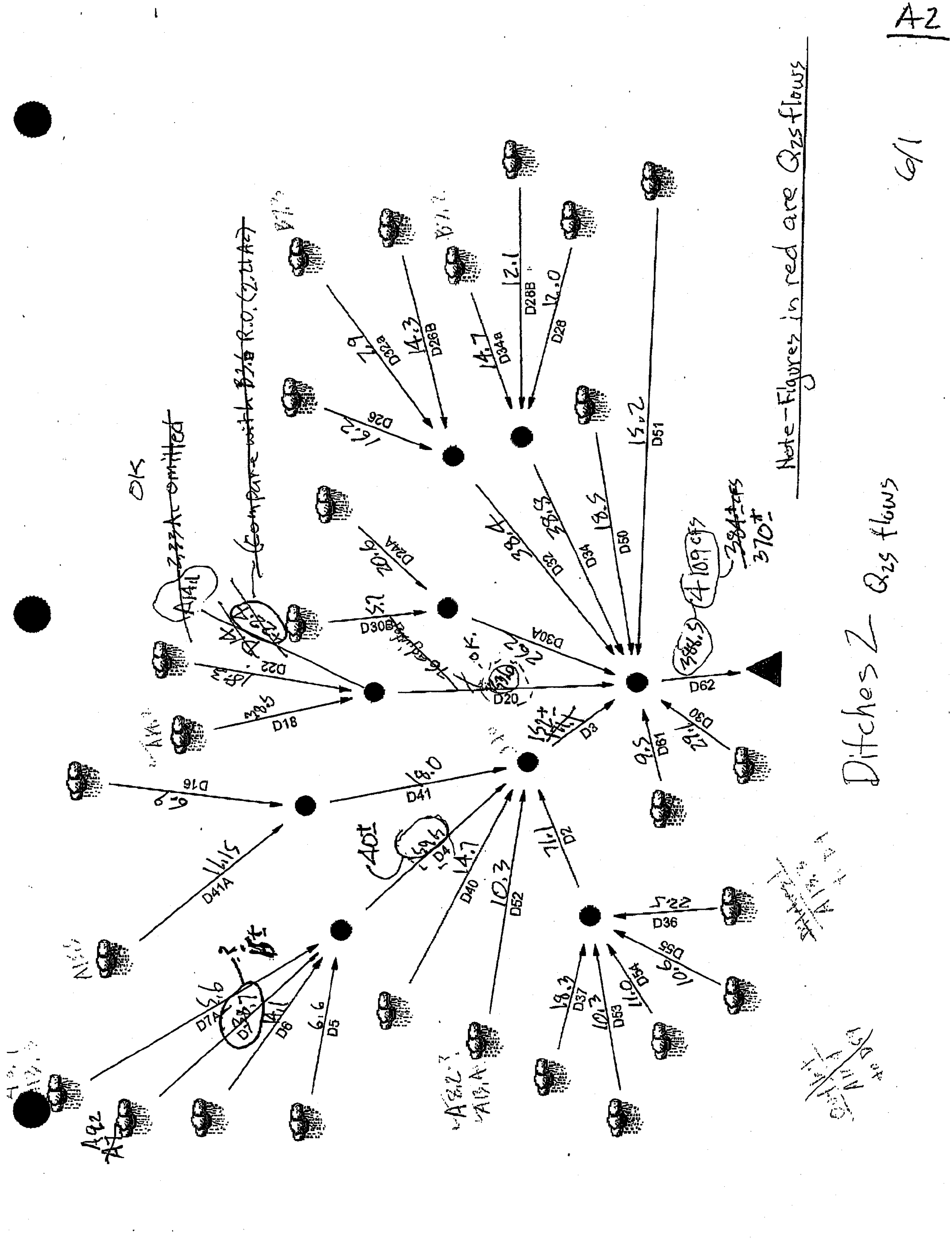
See Chart on sht B-2
for D_{50} = 1.00 & S = .15, $d_{max\ allow}$ = 0.54

for D_{50} = 1.00 & S = .175; $d_{max\ allow}$ = 0.46'

Conclusions - D_{50} = 1.00' Not sufficient -
Use D_{50} = 1.50' ~ could possibly use D_{50} = 1.25'

Appendix A A-1




A2
Note-Figures in red are Q25 flows
Ditches 2
Q25 flows
D62
D30A
D30B
D20
D22
D18
D16
D41
D41A
D3
D61
D30
D2
D4
D40
D52
D36
D55
D54
D53
D37
D7A
D7
D6
D5
D32a
D26B
D34a
D28B
D28
D26
D24A
D32
D34
D50
D51

A-3

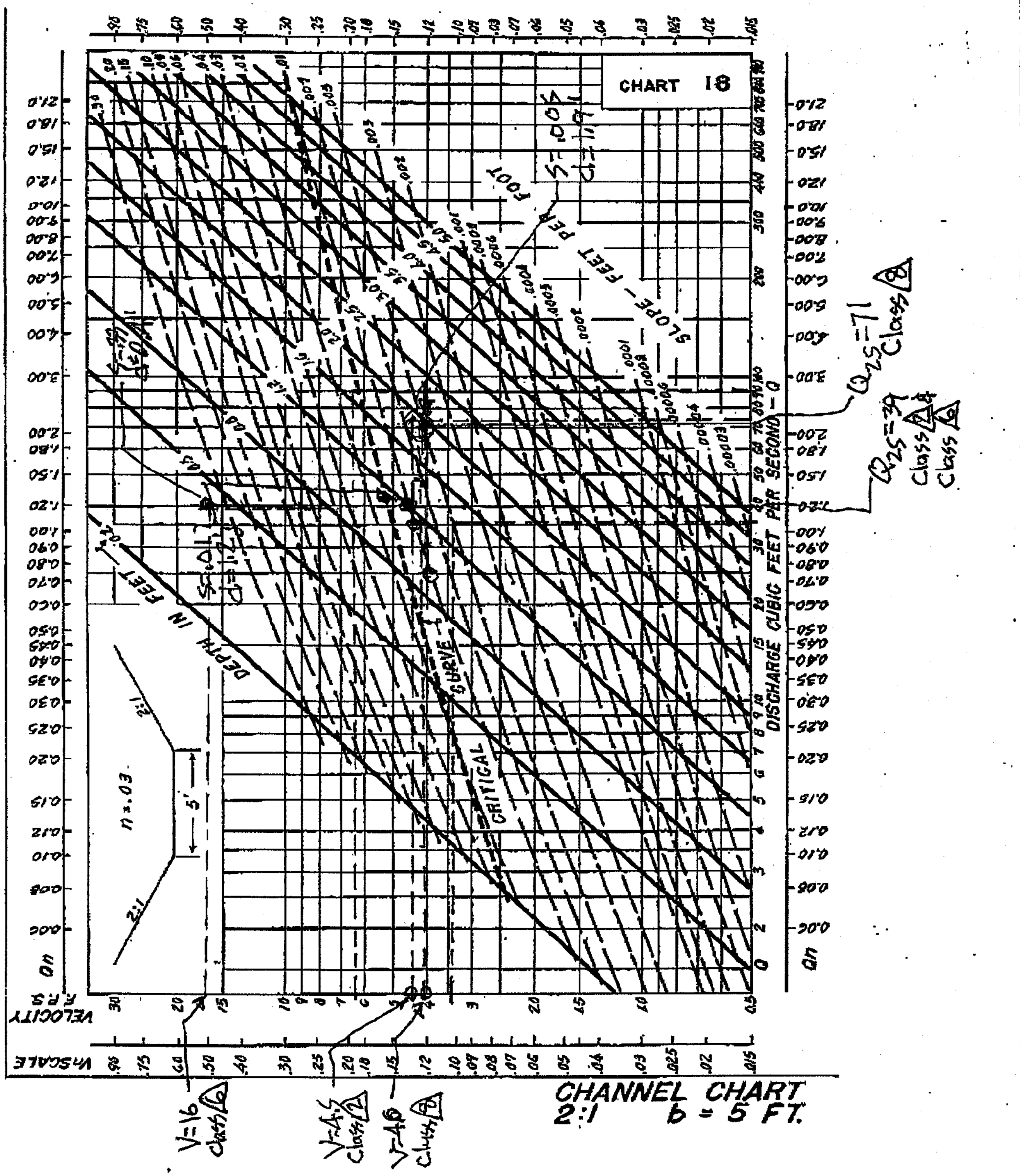
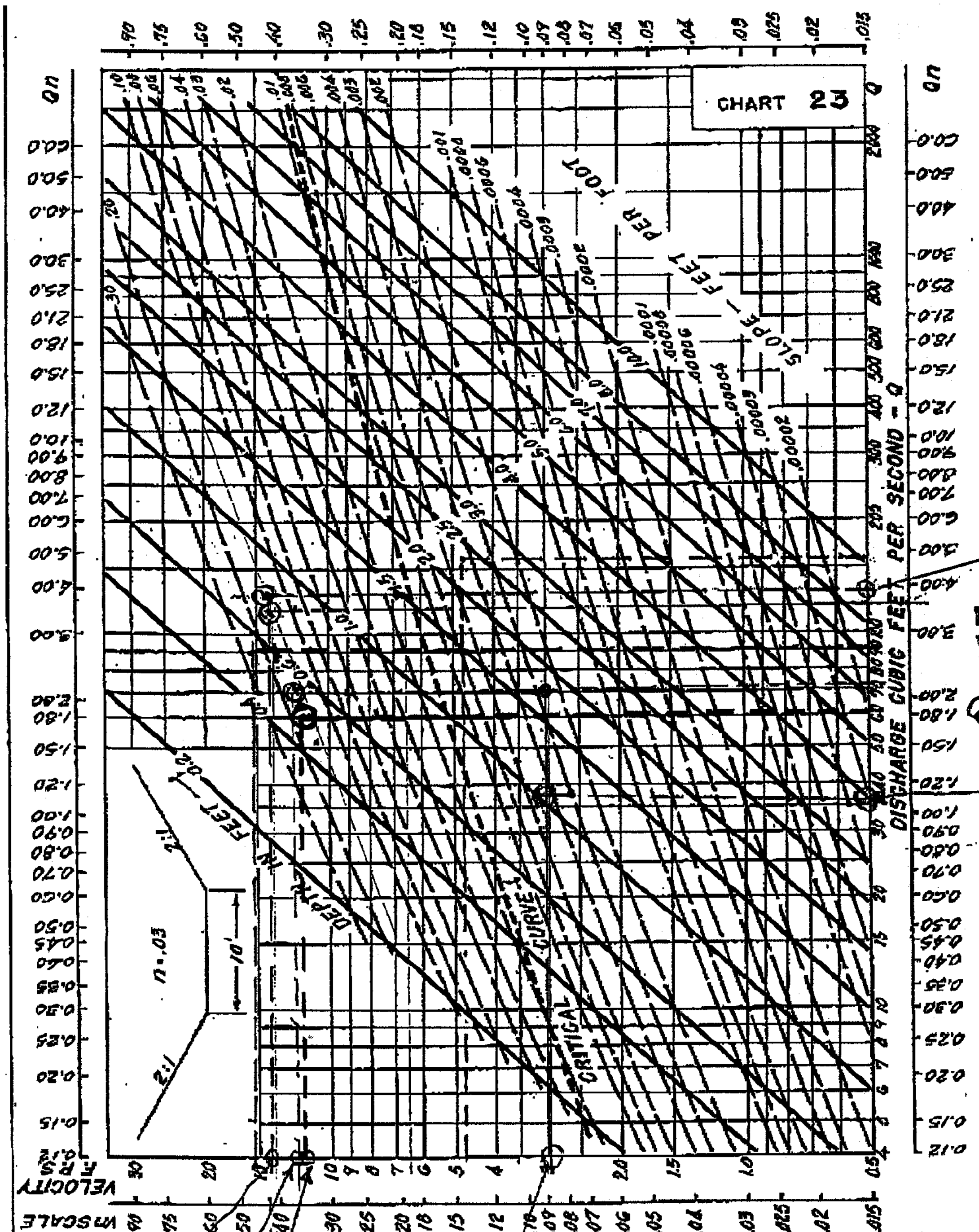


CHART 18
CHANNEL CHART
2:1 b = 5 FT.
DEPTH IN FEET
SLOPE — FEET PER FOOT
CRITICAL CURVE
DISCHARGE CUBIC FEET PER SECOND — Q
VELOCITY F.P.S.
Vn SCALE
Qn
n = .03
2:1
5'

A-4



CHANNEL CHART
2:1 b = 10 FT.

$Q_{25}=137$ 118 cFS
class 7

$Q_{25}=37$
class 3

$V_{D18}=14$
$V_{D20}=12.5$
$V_{D4}=12.0$
$V=\frac{.42}{0.042}=10$ fps

V=3.0
class 3

A-5

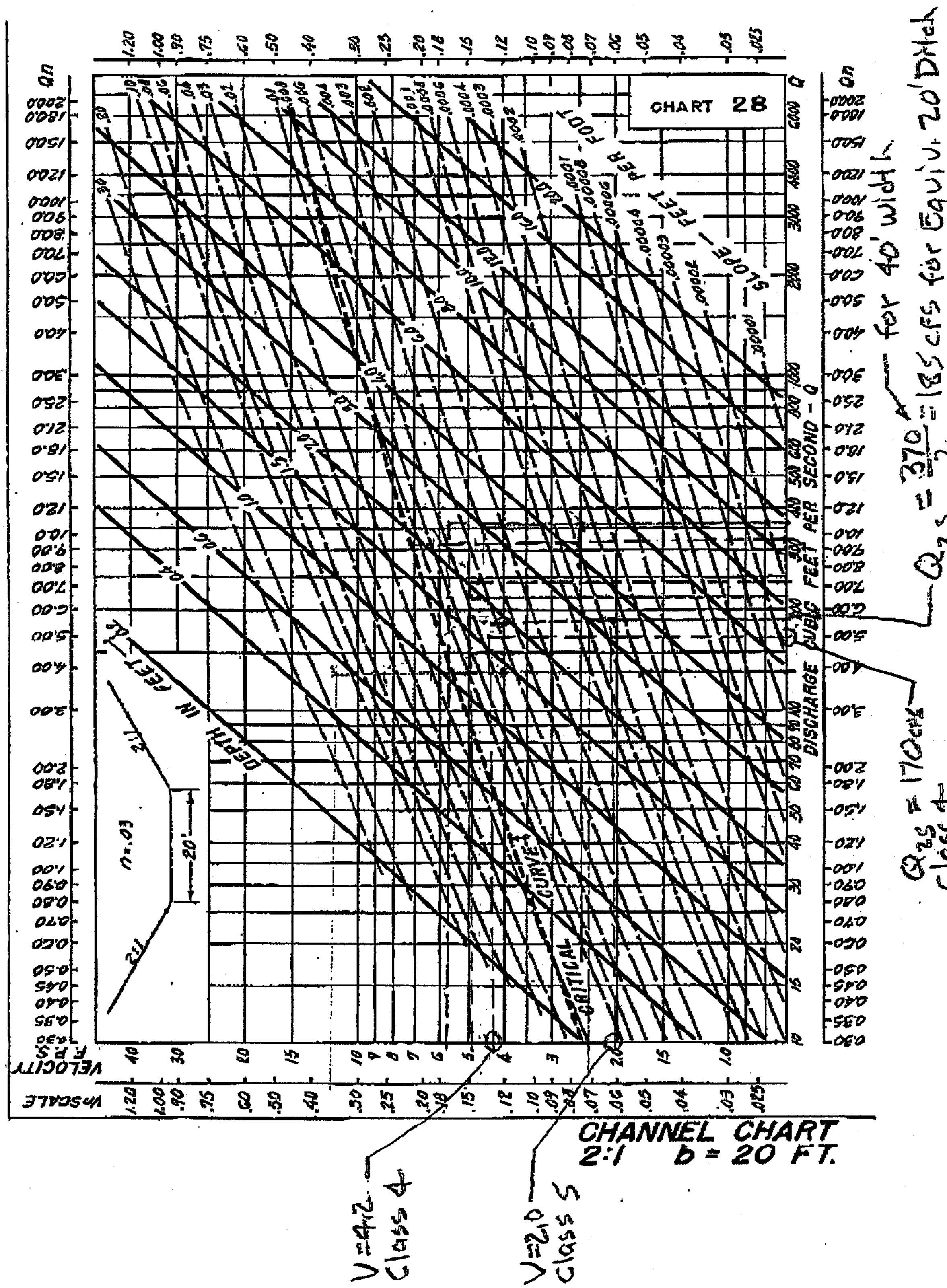


CHART 28
CHANNEL CHART
2:1 b = 20 FT.
DEPTH IN FEET
CRITICAL CURVE
SLOPE S FEET PER FOOT
DISCHARGE CUBIC FEET PER SECOND - Q
VELOCITY F.P.S.
n SCALE
Qn
n=.03
20'
2:1
Q25 = 370 for 40' width
= 185 cfs for Equiv. 20' Width
class 5
Q25 ≈ 170cfs
class 4
V=4.2
Class 4
V=2.0
Class 5

36

APPENDIX B – RIPRAP

Appendix B B-1

PB86-184835

DESIGN OF STABLE CHANNELS WITH FLEXIBLE LININGS, HYDRAULIC ENGINEERING CIRCULAR (HEC) 15

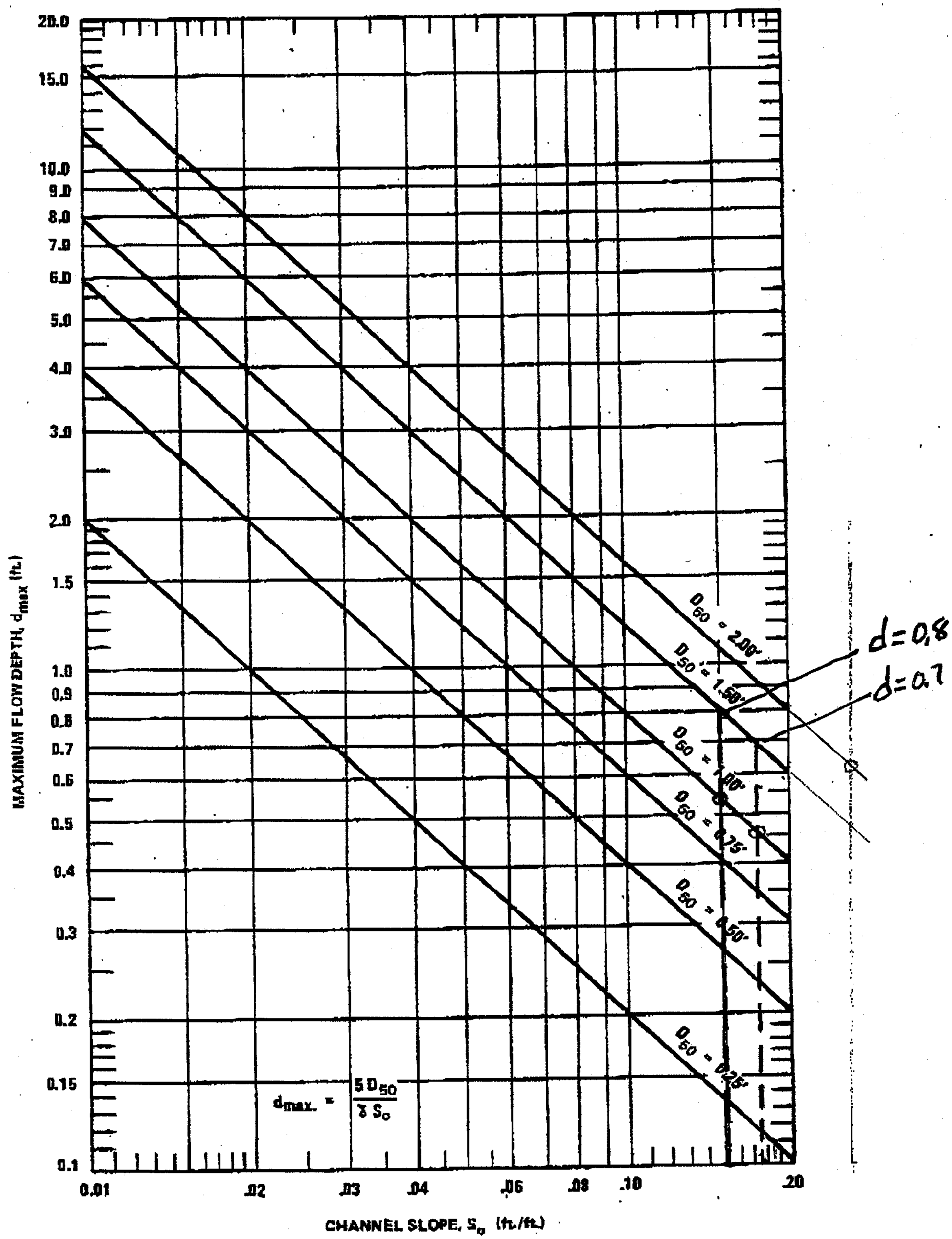
FEDERAL HIGHWAY ADMINISTRATION
WASHINGTON, D.C.

OCT 75

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
NTIS

B2

Chart 27



MAXIMUM PERMISSIBLE DEPTH OF FLOW (d_{max})
FOR CHANNELS LINED WITH ROCK RIPRAP

APPENDIX C – ROCK CHUTE DESIGN

Appendix C

C-1

DESIGN OF ROCK CHUTES

K. M. Robinson, C. E. Rice, K. C. Kadavy

ABSTRACT. *Rock chute design information is consolidated from several sources to provide a comprehensive design tool. The rock slope stability, boundary roughness, and outlet stability of rock chutes are each discussed. Tests were performed in three rectangular flumes and in two full size structures. Angular riprap with a median stone size ranging from 15 to 278 mm was examined on rock chutes with slopes ranging from 2 to 40%. The typical mode of channel failure is described. An empirical prediction equation is presented relating the highest stable discharge on a rock chute to the median stone size and the bed slope. A boundary roughness relationship is also presented that relates the Manning roughness coefficient to the median stone size and bed slope. These tests also suggest that the riprap size required for stability on the slope will remain stable in the outlet reach even with minimal tailwater. This article contains information needed to perform a rock chute design.*

Keywords. *Rock chutes, Riprap, Channel design, Hydraulics, Stability, Roughness, Grade control.*

Rock chutes or loose-riprap-lined channels are used to safely convey water to a lower elevation. These structures provide an alternative method of protecting the soil surface to maintain a stable slope and to dissipate a portion of the flow energy. Watershed management applications for this type of structure are numerous such as channel stabilization, grade control, and embankment overtopping. Depending on the availability and quality of accessible rock materials, rock chutes may offer economic advantages over more traditional structures. Flow cascading down a rock chute is visually pleasing, and these structures offer aesthetic advantages for sensitive locations. Construction of these chutes can be performed with unskilled labor and a comparatively small amount of equipment. A typical rock chute profile is shown in figure 1.

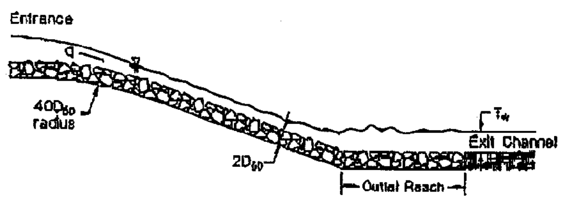


Figure 1—Typical rock chute profile.

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The authors are **Kerry M. Robinson,** P.E., ***ASAE Member Engineer,*** Research Hydraulic Engineer, **Charles E. Rice,** P.E., ***ASAE Member Engineer,*** Research Hydraulic Engineer, and **Kem C. Kadavy,** P.E., ***ASAE Member Engineer,*** Agricultural Engineer, USDA ARS, Stillwater, OK. **Corresponding author:** Kerry M. Robinson, 1301 N. Western St., Stillwater, OK 74075; tel: (405) 624-4135; fax; (405) 624-4136; e-mail: krob@ag.gov.

Rock chute structures have been the subject of several recent investigations. The objective of this article is to present pertinent information from several sources to provide the designer with a comprehensive design tool.

RELATED WORK

Rock chutes in various forms have been used for many years. Isbash (1936) examined the ability of flowing water to move rocks. The shape of a rock fill cross-section was described while stone of a known size and weight was deposited in flowing water. Isbash developed a relationship describing the minimum velocity necessary to move stones of a known size and specific gravity. Anderson et al. (1970) developed a design procedure for riprap-lined drainage channels by testing rounded stone on relatively flat slopes. Uniformly sized riprap materials remained stable at higher flow rates than non-uniform materials. The non-uniform materials enhanced the protection of the filter material below the rock layer. Wittler and Abt (1990) found that the stone gradation has a significant influence on chute performance. The uniformly sized riprap withstood higher flow rates than non-uniform material of the same D_{50}. The uniform material did fail more suddenly than the non-uniform materials once the slope became unstable.

Abt et al. (1987) and Abt and Johnson (1991) tested both angular and rounded stone and found that the rounded stone failed at a unit discharge of approximately 40% less than angular shaped stones of the same median stone size. These researchers developed design criteria for median stone sizes between 25 and 152 mm on slopes ranging between 1 and 20%.

Maynord (1988) developed a riprap sizing method for stable open channel flows on slopes of 2% or less. This design method, based on the average local velocity and flow depth, used the D_{30} as the characteristic rock size. The effects of riprap gradation, thickness, and shape were also examined. Maynord (1992) extended this design method to slopes between 2 and 20% for nonimpinging flows. Frizell

TVA-00002108

C-2

and Ruff (1995) examined riprap with a D_{50} of 380 mm on 2:1 slopes (horizontal:vertical). These researchers investigated riprap for embankment overtopping protection.

Anderson et al. (1970) developed a relationship for the boundary roughness of rock-lined channels. The Manning roughness was described as a function of the stone size only. Abt et al. (1987) also developed a relationship that predicts the Manning roughness as a function of the bed slope and stone size.

Rock chutes testing performed at the USDA-ARS Hydraulic Engineering Unit is the primary source of information for this report. These tests focused on three specific areas: rock slope stability, roughness, and outlet stability. Robinson et al. (1995) reported an empirical rock slope stability relationship for rock sizes ranging from 15 to 145 mm on slopes of 10 to 40%. This stability relationship predicts rock size as a function of the discharge and channel slope. Robinson et al. (1997) revised this design relationship in an attempt to better represent the data base. Rock chutes were tested to failure in three different flumes as well as full-size prototype structures for slopes of 8 to 40% and median rock sizes up to 278 mm. Rice et al. (1996) examined six design procedures and compared their results for a range of discharges and bed slopes. Rice et al. (1998a) developed empirical relationships to predict the Manning roughness coefficient as a function of stone size and bed slope. These roughness relationships allow calculation of the flow depth in a rock chute. Rice et al. (1998b) conducted tests to examine the rock size necessary to maintain stability of the rock chute outlet.

RIPRAP PROPERTIES

The rock chutes testing described in this article was performed using predominantly angular crushed limestone with a D_{50} of 15 to 278 mm. The rock layers in all tests were $2D_{50}$ thick. The D_{50} is the particle size for which 50% of the material sample is finer. The median stone diameter and the D_{50} are considered equal. Rock used in this study displayed a coefficient of uniformity ($C_u = D_{60}/D_{10}$) of 1.25 to 1.73. The specific gravity of the stones ranged from 2.54 to 2.82. The geometric standard deviation ($\sigma_g = D_{84.1}/D_{50} = D_{50}/D_{15.9}$) ranged from 1.15 to 1.47 with all but one rock sample ranging between 1.31 and 1.47. The length to width ratio (L/B) ranged from 1.98 to 2.36. The geometric stone properties were similar for all rock sizes, and the gradations exhibited by these materials were more uniform than well graded.

Sufficient quantities of each material were sampled to accurately represent each rock size. ASTM (1996) Standard D5519 suggests that a sample size should be large enough to ensure a representative gradation and to provide test results to the desired level of accuracy. The specimen size should be large enough that the addition or loss of the largest stone in the sample will not change the results by more than a specified amount. For this study the largest element in each test material represented 0.7% to 3.1% of the sample weight.

RESULTS AND DISCUSSION

ROCK SLOPE STABILITY

Rock chute stability tests were performed in three separate flumes with widths of 0.76, 1.07, and 1.83 m (2.5, 3.5, and 6.0 ft). Two full size prototype structures were also constructed and tested to failure. These large-scale chutes were constructed with a 2.74-m (9-ft) bottom width and 2:1 side slopes. A total of 38 rock chute stability tests were performed on slopes ranging from 2 to 40% for median rock sizes of 15 to 278 mm. Rock chutes testing was initially limited to slopes between 10 and 40%. However, interest was expressed in slopes below 10%. Eleven tests were conducted on slopes ranging from 2 to 8%. Four of these tests were conducted with bed slopes ranging from 2 to 6% with 2:1 side slopes. Table 1 lists the test results for this study. The tests were performed by introducing a base flow in the rock chute, then increasing the flow incrementally. Orifice plates and air-water differential manometers were used to measure flow in the two smaller models, while Parshall flumes were used to measure flow in the larger models. Rock slope stability was observed at each flow rate, with particular attention directed to stone movement on the slope. The flow rate was increased until the rock chute was judged to be unstable.

Table 1. Test results

Run No.	Flume Width (m)	D_{50} (mm)	Specific Gravity	Geometric Std. Dev.	Coef. of Uniformity	Slope (%)	Max. Stable q ($m^3/s/m$)
1	1.07	15	2.76	1.42	1.65	10	0.00578
2	1.07	15	2.76	1.42	1.65	12.5	0.00529
3	1.07	15	2.76	1.42	1.65	16.7	0.00378
4	1.07	15	2.76	1.42	1.65	22.2	0.00314
5	1.07	33	2.70	1.42	1.65	10	0.0248
6	1.07	33	2.70	1.42	1.65	12.5	0.0235
7	1.07	33	2.70	1.42	1.65	16.7	0.0186
8	1.07	33	2.70	1.42	1.65	22.2	0.0147
9	0.76	46	—	1.15	1.25	40	0.0381
10	1.07	52	2.82	1.46	1.72	10	0.0762
11	1.07	52	2.82	1.46	1.72	12.5	0.0624
12	1.07	52	2.82	1.46	1.72	16.7	0.0578
13	1.07	52	2.82	1.46	1.72	22.2	0.0483
14	0.76	52	2.82	1.46	1.72	40	0.0349
15	1.07	89	2.54	1.41	1.58	10	0.1738
16	1.07	89	2.54	1.41	1.58	12.5	0.1514
17	1.07	89	2.54	1.41	1.58	16.7	0.1596
18	1.07	89	2.54	1.41	1.58	22.2	0.1105
19	1.83	89	2.54	1.41	1.58	12.5	0.1663
20	1.83	89	2.54	1.41	1.58	22.2	0.1003
21	1.83	89	2.54	1.41	1.58	40	0.0865
22	1.83	145	2.55	1.35	1.54	12.5	0.3307
23	1.83	145	2.55	1.35	1.54	22.2	0.2239
24	1.83	145	2.55	1.35	1.54	40	0.1951
25*	2.74	188	2.58	1.47	1.73	16.7	0.4385
26*	2.74	278	2.59	1.31	1.47	33.3	0.6726
27	1.83	188	2.58	1.47	1.73	8	0.7525
28	1.83	188	2.58	1.47	1.73	22.2	0.5416
29	1.83	188	2.58	1.47	1.73	40	0.3279
30	1.07	52	2.82	1.46	1.72	6	0.1858
31	1.07	33	2.70	1.42	1.65	6	0.0892
32	1.07	33	2.70	1.42	1.65	4	0.1830
33	1.07	15	2.76	1.42	1.65	2	0.0427
34	1.83	192	2.61	1.35	1.58	6	1.6258
35*	1.07	52	2.82	1.46	1.72	6	0.2025
36*	1.07	52	2.82	1.46	1.72	4	0.2546
37*	1.07	33	2.70	1.42	1.65	4	0.1096
38*	1.07	33	2.70	1.42	1.65	2	0.2518

C-3

AN EXCEL PROGRAM TO DESIGN ROCK CHUTES FOR GRADE STABILIZATION

by
Eric A. Lorenz, P.E., Morris N. Lobrecht, P.E., and Kerry M. Robinson, Ph.D., P.E.

Introduction

Chutes, in general, are used to transport water from a higher elevation to a lower elevation in a non-erosive manner. Examples include flow from one waterway to another waterway, flow from a waterway to a drainage ditch, flow from a lake to a channel, etc. Chutes are composed of three parts: a level inlet apron, the chute slope, and a level outlet apron. The chute is assumed to have a uniform cross section throughout. Rock is commonly used to protect the underlying soil from erosion. Specifying the correct rock size and chute thickness are only a small portion of rock chute design. Proper design is very time consuming when several options are considered. This program will reduce design time by selecting the stable median **angular** rock size based on chute geometry and discharge. The output can be used for preparing final plans and field layout. The word angular is shown in bold in this paper and refers to rock that is 50% round and 50% cubical. The equations given in this paper are intended for use with English units. They can be used for cross sections having a trapezoidal, triangular, or rectangular shape. The equations are shown without proof and their verification is left up to the reader.

General Chute Hydraulics

Figure 1 shows a typical rock chute profile and defines various hydraulic properties of chutes in general.

d = depth of the outlet apron below the outlet channel (1-foot suggested minimum), feet
*D_{50} = median **angular** rock size (50% of the sample is finer by weight), inches*
g = acceleration due to gravity, 32.2 ft/sec^2
H_{drop} = height of drop from the weir crest elevation to the outlet channel elevation, feet
H_{ce} = minimum specific energy head corresponding to a given discharge (at critical depth), feet
H_p = static head required to force the discharge through the weir (H_{pe} is the energy head), feet
h_v = velocity head associated with the critical depth, feet
S_{ch} = chute bed slope (1/z), ft./ft.
Tw = tailwater depth in the outlet channel, feet
y_c = critical depth in the chute, feet
y_n = normal depth in the inlet channel, feet
z = horizontal component of the chute slope (z:1)
z_1 = normal depth in the chute slope, feet
z_2 = hydraulic jump height, feet

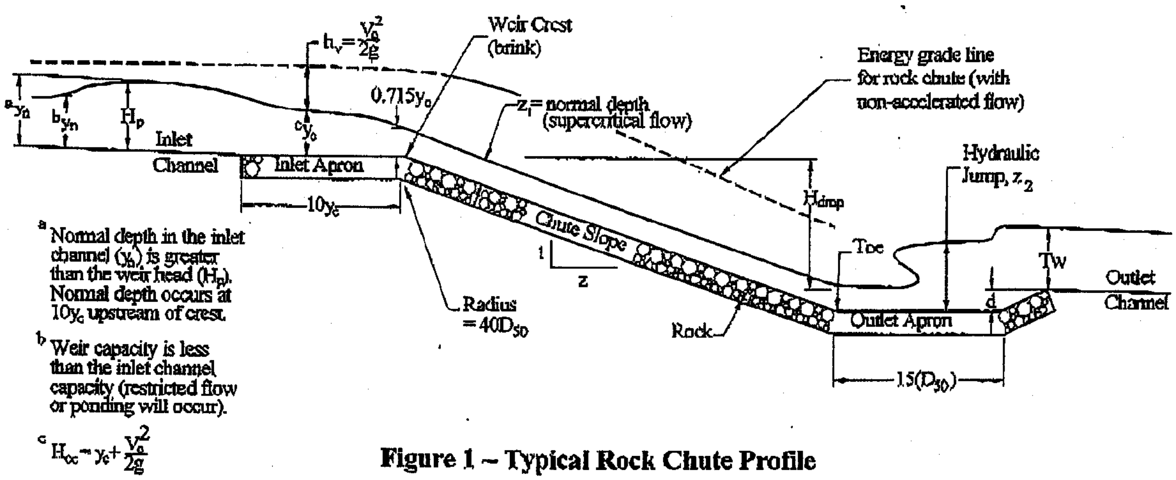


Figure 1 – Typical Rock Chute Profile

C-4

The most important property defining the chute is the weir head (H_p). The H_p determines the amount of flow that will go through the weir entrance (at the crest or brink) and down the chute. The shape of the weir entrance and the velocity of the approach channel affect the weir head. A method to control H_p will be discussed later in this paper. As the water approaches the inlet apron the flow accelerates. Several references define different locations upstream of the weir crest at which accelerated flow begins. The most conservative distance of $10y_c$ was used to set the inlet apron length. Critical depth occurs between $2y_c$ and $4y_c$ upstream of the weir crest. Depth at the weir crest is $0.715y_c$ (brink depth). Whenever the chute slope is steeper than critical slope, normal depth in the chute slope (z_1) is below critical depth resulting in supercritical flow. For rock chutes, the flow will reach normal depth, generally in the middle 1/3 of the slope, and continue down the slope without accelerating (roughness offsets the acceleration due to gravity). As flow reaches the outlet apron (near the toe) it will transition from supercritical flow to subcritical flow in the form of a hydraulic jump. The hydraulic jump height (z_2) varies with the chute slope (thus the velocity) and the chute cross section. The hydraulic jump height will normally be less than the weir head (H_p) for flat chute slopes. As the chute slope increases, z_2 will exceed H_p. Figure 2 illustrates a typical cross section of a rock chute.

m_{ch} = horizontal component of the chute side slope
Bw_{ch} = bottom width of the chute, feet

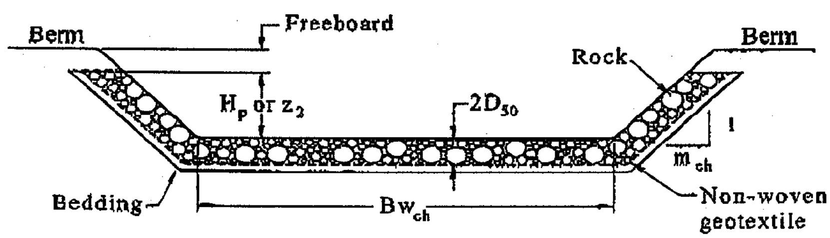


Figure 2 – Typical Rock Chute Cross Section

The height of protection along the side slope shall be the greater of H_p or z_2. The tailwater may be greater than the height of riprap along the side slope in the outlet apron. If good vegetation has been established above the riprap this is adequate to prevent erosion. Problems may occur during long duration discharges from flat watersheds or those below a watershed detention dam. Longer peak flows can be expected to have a greater potential for scouring on the side slopes. Consider placing riprap (or other types of protection) above H_p or z_2 and up to the tailwater depth (or higher) for this case. The hydraulic jump length is given as $15D_{50}$ from the research performed on rock chutes[1]. A rock thickness of $2D_{50}$[1] is recommended in addition to a non-woven geotextile over sand bedding. The geotextile acts as a filter and prevents material under the chute from being pulled up through the rocks. A non-woven geotextile is used because there is less chance of soil particle migration through this material as compared with a woven geotextile. The bedding should prevent migration of fine soil particles that may plug the non-woven geotextile. Also, the bedding provides better contact between the rock and the underlying soil and provides a cushion when the rock is placed. The cushion helps prevent damage to the non-woven geotextile.

Design Approach

The approach for designing rock chutes presented in this paper is given in sequential order (Equations 1 through 16). An example design is presented later to familiarize the reader with the design procedure and

C-5

Rock Chute Design Data

(Version 4.0 - 07/10/00, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: *Spillway protection* **County:** *Woodbury*
Designer: *Jim Villa* **Checked by:**
Date: *9/27/00* **Date:**

Input Channel Geometry

→ Inlet Channel	→ Chute	→ Outlet Channel
Bw = *20.0* ft.	Bw = *20.0* ft.	Bw = *40.0* ft.
Side slopes = *4.0* (m:1)	Factor of safety = *1.20* (F_s)	Side slopes = *4.0* (m:1)
n-value = *0.035*	Side slopes = *4.0* (m:1) → 2.0:1 max.	n-value = *0.045*
Bed slope = *0.0060* ft./ft.	Bed slope (5:1) = *0.200* ft./ft. → 2.5:1 max.	Bed slope = *0.0050* ft./ft.
Freeboard = *0.5* ft.	Outlet apron depth, d = *1.0* ft.	Base flow = *0.0* cfs

Design Storm Data (Table 2, NHCP, NRCS Grade Stabilization Structure No. 410)

Drainage area = *450.0* acres Rainfall = ○ 0-3 in. ◉ 3-5 in. ○ 5+ in.

Apron elev. — Inlet = *105.0* ft — Outlet = *99.0* ft. — (H_{drop} = 5 ft.)

Chute capacity = Q5-year ⎡ *Minimum capacity (based on a 5-year,*
Total capacity = Q10-year ⎣ *24-hour storm with a 3 - 5 inch rainfall)*

Q_{high} = *330.0* cfs High flow storm through chute → Tw (ft.) = *Program*

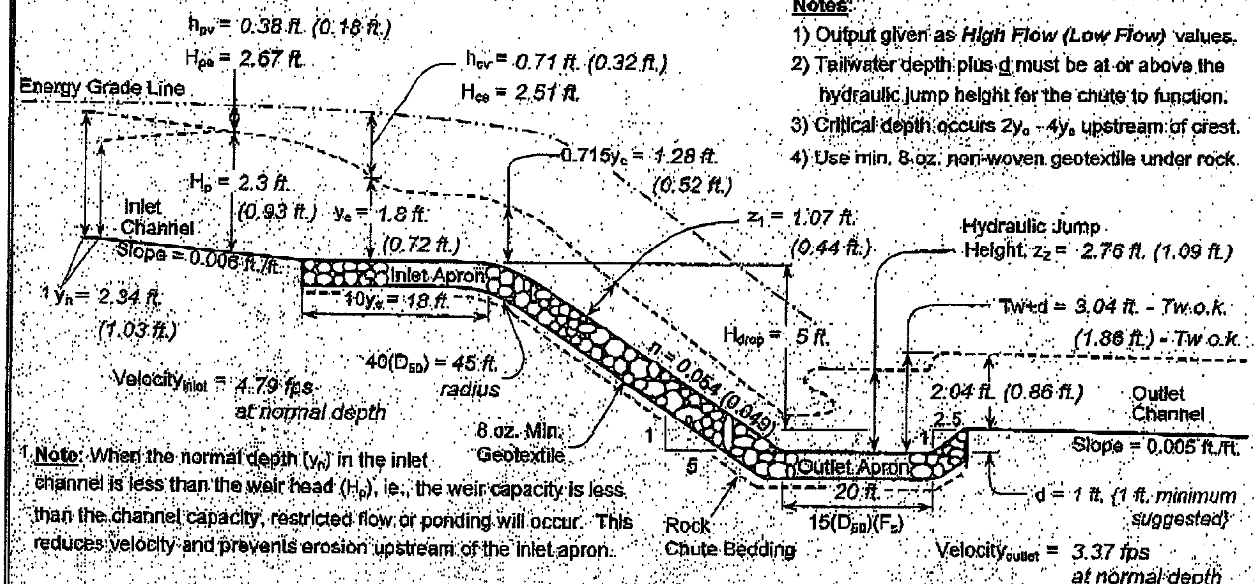
Q_{low} = *75.0* cfs Low flow storm through chute → Tw (ft.) = *Program*

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*

***Input tailwater (Tw)**:*

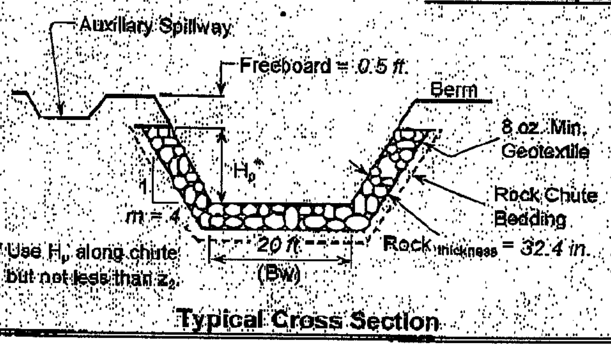
Profile and Cross Section (Output)

Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs $2y_c$ - $4y_c$ upstream of crest.
4) Use min. 8 oz. non-woven geotextile under rock.



[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute



*Use H_p along chute but not less than z_2.

Typical Cross Section

q_t =	*13.65 cfs/ft.*	Equivalent unit discharge
F_S =	*1.20*	Factor of safety (multiplier)
z_1 =	*1.07 ft.*	Normal depth in chute
n-value =	*0.054*	Manning's roughness coefficient
$D_{50}(F_s)$ =	*16.2 in.* (309 lbs. - 50% round / 50% angular)	
$2(D_{50})(F_s)$ =	*32.4 in.*	Rock chute thickness
Tw + d =	*3.04 ft.*	Tailwater above outlet apron
z_2 =	*2.76 ft.*	Hydraulic jump height
*** The outlet	*will*	*function adequately*

High Flow Storm Information

ATTACHMENT 3 – DRAINAGE AREA MAPS