

## **TECHNICAL MEMORANDUM**

DATE:	July 28, 2010	
TO:	Trace Robinson, P.E., Tom Beesley, P.E. Riverton City 12830 S. Redwood Road Riverton, Utah 84065	PROF
FROM:	Craig Bagley, P.E., Matthew Stayner, P.E. Bowen, Collins & Associates 154 East 14000 South Draper, Utah 84020	
SUBJECT:	2010 Riverton City Storm Drain Master Plan Amend	ment

#### INTRODUCTION

Riverton City (City) retained Bowen Collins & Associates (BC&A) to complete an amendment to the 2004 Riverton City Storm Drain Master Plan. This amendment includes new hydrologic and hydraulic evaluations of the portion of Riverton City located west of Bangerter Highway. This area was restudied primarily because the future land use assumptions and drainage patterns in a portion of the study area have significantly changed since the 2004 master plan was completed. The study area and the areas where projected land use have changed since 2004 are shown in Figure 1.

50/0218

The primary objective of this amendment is to identify storm drain improvements that will address future drainage needs in the study area while complying with the general discharge limits published in Salt Lake County's Southwest Canal and Creek Study associated with Rose Creek and Midas Creek. Another objective of this project was to perform a hydrologic evaluation of Rose and Midas Creeks. The results of that analysis are presented in a separate Technical Memorandum.

#### HYDROLOGIC ANALYSIS

A hydrologic computer model of the study area was developed in HEC-HMS (version 3.4) for the purpose of estimating storm water runoff volumes and peak discharges generated by a design cloudburst event. The model development process is outlined Appendix A.



## DRAINAGE FACILITIES ANALYSIS

The evaluation of drainage system facilities was performed only for projected full build-out development conditions. The capacity of the storm drain pipes was evaluated using the 10-year design storm event. The detention basins were evaluated using the 100-year design storm event.

The following major tasks were completed to identify needed drainage system facilities:

- Peak discharge rates and runoff volumes from design storm simulations were computed for the study area.
- Hydraulic capacities for existing storm drain pipelines in the study area were estimated based on storm drain inventory information collected as part of this study.
- Results from the hydrologic and hydraulic analyses were used to identify deficiencies in existing storm drain pipes and to estimate needed capacities of future storm drain pipes and storm water detention facilities in the study area.
- Recommended improvements that are needed to safely manage storm water runoff in the study area under projected future development conditions were identified. Work was also performed to confirm that recommended improvements complied with channel capacities and recommended discharge restrictions identified in the Southwest Canal and Creek Study.

## SOUTHWEST CANAL AND CREEK STUDY CONSIDERATIONS

The Southwest Canal and Creek Study (SWCC) was prepared as a master drainage document to help Salt Lake County personnel identify design discharges and regional facilities that are required to manage storm water runoff in the canals and creeks in the southwest portion of Salt Lake County. Post-development design discharges for the segments of Rose Creek and Midas Creek that are located in Riverton were estimated based on the assumption that all future development would construct storm water detention facilities to attenuate the peak runoff rate to a maximum discharge of 0.2 cfs per acre.

Estimated allowable peak discharge into Midas Creek and Rose Creek were calculated by multiplying the total contributing area by 0.2 cfs per acre, in compliance with the assumption used in the SWCC study. It should be noted that the portion of the Rose Creek drainage area associated with this Master Plan Ammendment includes about 350 acres of land that the SWCC study assumed would drain to Midas Creek (see Figure 2). Table 1 shows the SWCC estimated allowable peak discharge. It also shows that the average unit discharge needs to be decreased to 0.16 to account for the additional 350 acres.





			1	1	-	1		1	1	
Road	District	Area	Release	Flow	Q	n	Slope	D	Pipe	Notes:
		(ac)	Rate				(ft/ft)			RW runoff coefficient 95%, 10year intensity 2.46in/hr typical
			@ 0.16							
			cfs/ac							
			(-f-)							
			(CTS)							
				2						(2cfs ) Release Western Springs mini pond 12960S 4370W
4570	4570-1	8.9	1.42		3.4	0.013	0.005	1.12	15	
4570	4570rw-1	0.3			3.4	0.013	0.005	1.12	18	
4570	4570-2	12.5	2.00		5.4	0.013	0.005	1.33	18	
4570	4570rw-2	0.5			5.4	0.013	0.005	1 33	18	
4570	4570-3	11.8	1 89		73	0.013	0.005	1 49	24	
4570	4570rw-2	0.6	1.05		73	0.013	0.005	1.49	24	
4370	4570111 2	0.0		10.7	7.5	0.015	0.005	1.45	24	(10 7cfc) 4570 Point Source(4570nu 2 + Tributanu)
12200	122000	2.0		10.7	17.0	0.012	0.005	2.00	24	(10.7CIS) 4570 POINT SOURCE(45701W-2 + TIBURALY)
13200	13200fw-0	3.0			17.8	0.013	0.005	2.08	24	
				5						(5 cfs) CenterCal Estimate point source(13200rw-1)
13202	13200-1	14.69	2.35		25.2	0.013	0.005	2.37	30	
13200	13200rw-1	1.5			25.2	0.013	0.005	2.37	30	
13202	13200-2	14.1	2.26		27.4	0.013	0.005	2.45	36	
13200	13200rw-2	1.1			27.4	0.013	0.005	2.45	36	
				6						(6 cfs)CenterCal Estimate point source(13200rw-3)
13200	13200-3	12.4	1.98		35.4	0.013	0.005	2.69	36	
13200	13200rw-3	0.4			35.4	0.013	0.005	2.69	36	
13200				-19						19cfs Diversion from 13200S System(13200rw-4)
13200	13200-4	13.7	2 1 9	10	18.6	0.013	0.005	2 11	36	36" to account for spillway(20cfs)(13200rw-4)
12200	12200 4	1 0	2.15		19.6	0.013	0.005	2.11	26	
13200	122001-4	12.0	1.09		20.6	0.013	0.005	2.11	40	
15200	13200-5	12.4	1.96		20.0	0.015	0.005	2.20	42	
13200	13200rw-5	1.0			20.6	0.013	0.005	2.20	42	
13200	13200-6	13.8	2.21		22.8	0.013	0.005	2.28	42	
13200	13200rw-6	1.1			22.8	0.013	0.005	2.28	42	
4150	4150rw-6a	1.7			22.8	0.013	0.005	2.28	42	
4150	4150-6	4	0.64		23.4	0.013	0.005	2.31	42	
4150	4150rw-6	1.4			23.4	0.013	0.005	2.31	42	
				17.8						Confluence (4150rw-5 + tributary)
	WSD	76	12.16		12.2	0.013	0.01	1.58	18	Confluence Western Springs Drainage (@13200rw6 for WSD)
4150	4150-10N	46.7	7.47		60.9	0.013	0.003	3.63	42	
4150	4150-11S	33.8	5.41		66.3	0.013	0.003	3.75	42	42" RCP@0.5%
									42	Existing outfall
									76	
4150	4150.2	10.2	1.05		1.0	0.010	0.005	0.05	15	
4150	4150-3	10.3	1.05		1.0	0.013	0.005	0.85	15	
4150	4150rw-3	1.3			1.6	0.013	0.005	0.85	15	
4150	4150-4	17.4	2.78		4.4	0.013	0.005	1.23	18	
4150	4150rw-4	1.0			4.4	0.013	0.005	1.23	24	
4150	4150-5	29.1	4.66		9.1	0.013	0.005	1.62	24	
4150	4150rw-5	1.4			9.1	0.013	0.005	1.62	24	
	4150rw-6a									accounted in 13200rw-6
				30						11cfs From Center Cal and additional diversion(13200rw-4)
4150	4150-7	12	1.92	50	31.9	0.013	0.005	2.59	36	36" to account for spillway(19"cfs)
4150	415004-7	1 /	2.52		31.0	0.013	0.005	2.55	26	
4150	1150 0	12.4	2 05		3/ 0	0.013	0.005	2.55	20	
4150	4150-0	1 /	2.05		24.0	0.013	0.005	2.05	26	
4150	4150/W-8	1.4	1.20		34.0	0.013	0.005	2.05	30	
4150	4150-9	8.6	1.38		35.3	0.013	0.005	2.69	36	
4150	4150rw-9	0.7			35.3	0.013	0.005	2.69	36	
										Existing (2) 19"x30"

Discharge Point	Contributing Area (acres)	Average Unit Discharge (cfs/ac)	Discharge (cfs)
SWCC Rose Creek Drainage Area in Riverton West of Bangerter	1417	0.20	284
Riverton SDMP Update Drainage Area West of Bangerter	1767	0.16	283

 Table 1

 Summary of Allowable Discharges into Rose Creek

Table 2 shows the future discharge points for Rose and Midas Creeks. Discharge values for Q1 - Q11 were obtained from the updated hydrologic model that was completed as part of this study. Discharge values for Q12 - Q16 were provided by Riverton City and are based on the best available data from the 2004 SDMP, Salt Lake County discharge permits and development submittal calculations. Discharge point Q6, from the UDOT detention basin, was decreased from 66 cfs (UDOT design) to 52.5 cfs in order to bring the total discharge for Rose Creek down to the allowable discharge.

The recommended discharge restriction applies to all development, including City streets. If future streets are dedicated to the City that are not shown on Figure 2, runoff from those streets will need to be detained to the discharge restriction shown in Table 2. Alternatively, the streets can be allowed to discharge undetained to the storm drain system, in which case the private development area will be required to restrict their discharge beyond what is shown in Table 2.

Table 2
<b>Summary of Future Discharges</b>
into Midas and Rose Creeks

Discharge Point ID <sup>1</sup>	Future Discharge into Creek <sup>2</sup>	Contributing Area	Unit Discharge	
	(cfs)	(acres)	(cfs/ac)	
	Discharges in	to Midas Creek		
Q1	18.8	51.8	0.36	
Q2	61.7	437.0	0.14	
Total:	80.5	488.8	0.16	
Allowable <sup>1</sup> :	97.8			
	Discharges in	nto Rose Creek		
Q3	2.5	12.7	0.20	
Q4	15.9	63.1	0.25	
Q5	20.2	101.2	0.20	
Q6	52.5	408	0.13	
Q7	1.5	7.5	0.20	
Q8	2.9	14.7	0.20	
Q9	86.7	410.8	0.21	

Discharge Point ID <sup>1</sup>	Future Discharge into Creek <sup>2</sup> (cfs)	Contributing Area (acres)	Unit Discharge (cfs/ac)
Q10	5.3	26.7	0.20
Q11	5	25	0.20
Q12	33.5	164.5	0.20
Q13	12.1	261.2	0.05
Q14	31.26	196.2	0.16
Q15	3.32	27.8	0.12
Q16	10.7	47.8	0.22
Total: Allowable <sup>1</sup> :	283.4 283.4	1767	0.16

into Midas and Rose Creeks (Continued)

Table 2Summary of Future Discharges

1 -See Figure 2 for locations of discharge points

2 – Based on the 10-year storm event.

#### **RECOMMENDED DRAINAGE SYSTEM IMPROVEMENT PROJECTS**

Information obtained by coordinating with City officials, field reconnaissance, and performing hydrologic and hydraulic analyses of projected full build-out conditions was used to identify drainage system improvements that are needed to safely collect and convey runoff in the study area. The recommended storm drain pipe improvements for the study area are shown on Figure 2 and are summarized in Table 3. The recommended regional detention basin improvements for the study area are shown on Figure 2 and are summarized in Table 3.

# Table 3Recommended Storm Drain PipeDesign Criteria

	Recommended Deisgn	Estimated	Manning's	Existing Diameter	Proposed Diameter	Discharge Capacity	
ID	Discharge* (cfs)	Slope	'n'	(in)	(in)	(cts)	
Subbasin 1	1800 South Street						
118S-1	1.6	0.010	0.013	-	18	10.5	
Subbasin 1	Subbasin 12600 South Street						
126S1-1	24.8	0.019	0.013	24	-	31.3	
126S2-1	31.8	0.020	0.013	30	-	58.6	
126S2-2	14.2	0.020	0.036	36	-	34.4	
126S2-3	15.9	0.020	0.013	24	-	32.1	
126S2-1	31.8	0.020	0.013	30	-	58.6	

Table	3
-------	---

## Recommended Storm Drain Pipe Design Criteria (Continued)

	Recommended			Existing	Proposed	Discharge
	Deisgn	Estimated	Manning's	Diameter	Diameter	Capacity
ID	Discharge* (cfs)	Slope	'n'	(in)	(in)	(cfs)
Subbasin <sup>•</sup>	13200 South Street					
132S1-1	2.2	0.022	0.013	-	18	15.6
132S1-2	12.6	0.022	0.013	-	18	15.6
Subbasin <sup>•</sup>	13400 South Street					
134S2-1	5.1	0.015	0.013	-	18	12.9
134S3-1	2.9	0.015	0.013	-	18	12.9
134S3-2	33.5	0.002	0.013	-	42	45.1
Subbasin 4	4000 West Street					
40W1-1	1.4	0.015	0.013	-	18	12.9
40W2-1	8.1	0.005	0.013	-	18	7.4
40W2-2	16.0	0.003	0.013	-	30	20.6
40W2-3	15.9	0.003	0.013	30	-	20.6
40W3-1	28.3	0.004	0.014	42	-	59.2
40W3-2	54.8	0.004	0.013	42	-	63.8
40W4-1	6.9	0.005	0.013	-	18	7.4
Subbasin 4	4150 West Street					
4150W1-1	2.7	0.010	0.013	-	18	10.5
4150W1-2	16.8	0.005	0.013	-	24	16.0
4150W2-1	5.2	0.005	0.013	-	18	7.4
Subbasin 4	4570 West Street					
4570W1-1	7.9	0.007	0.015	-	18	7.6
4570W1-2	15.8	0.007	0.013	-	24	19.0
4570W2-1	23.7	0.006	0.013	-	30	31.9
Subbasin	Butterfield Property	y				
BF1-1	31.1	0.011	0.014	-	30	40.1
BF2-1	6.0	0.018	0.015	-	18	12.2
BF3-1	4.4	0.011	0.013	-	18	11.0
BF3-2	2.0	0.005	0.013	-	18	7.4
Subbasin	Diversion					
Div-1	22.4	0.005	0.013	-	30	29.1
Subbasin	Havest Creek Estat	es				
HC-1	1.5	0.010	0.013	-	18	10.5
Subbasin	Midas Creek Outfal	1				
MC-1	61.7	0.004	0.013	42	-	62.2

Table 3
Summary of Storm Drain Hydrologic and Hydraulic
Analyses Modeling Results
(Continued)

	Recommended			Existing	Proposed	Discharge
	Deisgn	Estimated	Manning's	Diameter	Diameter	Capacity
ID	Discharge* (cfs)	Slope	'n'	(in)	(in)	(cfs)
Subbasin	Property Reserve I	nc.				
PRI4-2	51.8	0.007	0.013	-	36	56.0
PRI7-1	32.5	0.002	0.014	-	42	41.9
PRI7-2	32.5	0.002	0.014	-	42	41.9
PRI14-1	5.8	0.022	0.015	-	18	13.5
PRI15-1	7.4	0.007	0.013	-	18	8.8
PRI17-1	5.6	0.005	0.013	-	18	7.4
PRI19-1	82.0	0.009	0.013	-	42	93.0
PRI20-1	86.7	0.008	0.015	-	42	78.2
Subbasin	Riverton Boulevard	k				
RB3-1	63.3	0.009	0.013	-	36	61.7
Subbasin	Scenic Cove					
SC-1	18.8	0.005	0.015	-	30	25.2
Subbasin	Sunday Drive					
SD1-1	3.2	0.019	0.013	-	18	14.5
SD1-2	9.0	0.019	0.013	-	18	14.5
SD2-1	2.9	0.003	0.015	-	18	5.0
SD2-2	31.9	0.019	0.013	-	30	56.7
SD2-3	36.2	0.022	0.015	-	30	52.9
Subbasin	Western Springs					
WS10-1	2	0.005	0.013	-	18	7.4
WS10-2	29.1	0.018	0.013	-	30	55.2

\* Recommend design discharge for storm drain pipes is based on the 10-year storm event

Future Pipe	
Existing Pipe	

	Volume*	Outflow
ID	(ac-ft)	(cfs)
DB1	10.4	6
DB2	0.4	2
DB3	-	3.1
DB4	0.4	2.5
DB5	0.7	2.9
DB6	0.3	2.2
DB7	-	2
DB8	1.7	11.7
DB9	5.1	20.2
DB10	7.4	525

# Table 4Recommended Detention Basin<br/>Design Parameters

\* Based on the 100 yr storm

## CONCEPTUAL COST ESTIMATE

Conceptual cost estimates for the recommended improvements are presented in Table 5 for detention basins and Table 6 for storm drain pipes. Unit costs used in developing the conceptual construction costs are presented in Appendix C. The unit costs for construction were developed in 2010 dollars using information from a variety of sources including recent bids for similar projects, local contractors, and construction estimating guides.

Table 5
<b>Estimated Cost of Capital Improvements</b>
<b>Detention Basins</b>

Project Identifier	Type	Land Area (acres)	Excavation and Hauling (yd <sup>3</sup> )	Landscaping (ft <sup>3</sup> )		Estimated Project Cost
DB1	Regional	3.5	25,168	151,008	\$	1,814,000
DB2	Local	0.25	968	10,890	\$	274,000
DB3	Existing	-	-	-		-
DB4	Local	0.25	968	10,890	\$	274,000
DB5	Local	0.25	1,694	10,890	\$	287,000
DB6	Local	0.25	726	10,890	\$	270,000
DB7	Existing	-	-	-	-	
DB8	Regional	0.6	4,114	24,684	\$	582,000
DB9	Regional	1.7	12,342	74,052	\$	938,000
DB10	Regional	2.5	17,908	107,448	\$	588,000
				Total:	\$	5,027,000

Project Identifier	Surface Condition	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Sstimated Project Cost	
Subbasin 11	1800 South Street							
118S-1	Existing Asphalt	1,287	18	8	4	0	\$	253,352
Subbasin 13	3200 South Street	_						
132S1-1	Undeveloped	1,110	18	6	3	0	\$	158,748
132S1-2	Undeveloped	1,206	18	8	4	0	\$	182,071
						Subbasin Total	\$	340,820
Subbasin 13	3400 South Street	1.001	1.0					
134S2-1	Existing Asphalt	1,301	18	8	4	0	\$	255,610
134S3-1	Existing Asphalt	733	18	4	2	0	\$	140,676
13483-2	Undeveloped	303	42	2	1	0	\$	82,513
Calle and a	000 <b>TI</b> 7					Subbasin Total	\$	478,799
Subbasin 40 $40$ $1$ $1$	DOU West Street	405	10	4		0	¢	101.924
40W1-1	Existing Asphalt	485	18	4	2	0	\$	101,834
40W2-1	Existing Asphalt	1,190	18	6	3	0	\$	225,278
40W2-2	Existing Asphalt	280	30	2	1	0	\$	70,061
40W4-1	Existing Asphalt	1,217	18	8	4	U Saabba ata Tatab	\$ ¢	242,423
Subbasin 41	50 West Street					Subbasin Total	\$	039,595
4150W1	Undeveloped	837	10	6	3	0	¢	120 231
4150W1-1	Undeveloped	037 429	10	4	2	0	ф Ф	85,000
4150W2 1	Undeveloped	430	24 19	4	2	0	ф Ф	83,090 151,706
4150 W 2-1	Olideveloped	1,040	10	0	5	U Subbasin Total	ф Ф	366 117
Subbasin 45	570 West Street					Subbasili Totai	φ	500,117
4570W1-1	Undeveloped	1.024	18	6	3	0	\$	149.472
4570W1-2	Undeveloped	1.027	24	6	3	1	\$	245.066
4570W2-1	Undeveloped	1.265	30	8	4	0	\$	239.726
	F	-,		÷		Subbasin Total	\$	634,264
Subbasin B	utterfield Property							
BF1-1	Undeveloped	1,611	30	10	5	0	\$	304,027
BF2-1	Undeveloped	157	18	2	1	0	\$	29,929
BF3-1	Undeveloped	494	18	4	2	0	\$	79,269
BF3-2	Undeveloped	78	18	2	1	0	\$	21,414
	-					Subbasin Total	\$	434,639
Subbasin D	iversion							
Div-1	Undeveloped	802.502	30	6	3	0	\$	158.052
Subhasin H	avest Creek Estates							,=
	Undeveloped	1 102	10	6	2	0	¢	157.022
пс-1	Undeveloped	1,102	10	0	3	U	Ф	157,922

Table 6Estimated Cost of Capital ImprovementsStorm Drain Pipes By Subbasin

Project Identifier	Surface Condition	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Estimated Project Cost	
Subbasin P	roperty Reserve Inc.		_	_				
PRI4-2	Undeveloped	1,233	36	8	4	1	\$	360,711
PRI7-1	Undeveloped	2,473	42	14	7	0	\$	658,345
PRI7-2	Undeveloped	652	42	4	2	0	\$	175,501
PRI14-1	Undeveloped	1,558	18	8	4	0	\$	220,123
PRI15-1	Undeveloped	906	18	6	3	0	\$	136,781
PRI17-1	Undeveloped	1,060	18	3	3	1	\$	209,520
PRI19-1	Undeveloped	1,596	42	8	4	0	\$	418,161
PRI20-1	Undeveloped	301	42	2	1	1	\$	149,454
						Subbasin Total	\$	2,328,596
Subbasin R	iverton Boulevard		-				1	
RB3-1	Undeveloped	1,314	36	8	4	0	\$	309,000
Subbasin So	cenic Cove							
SC-1	Undeveloped	885	30	6	3	0	\$	170,304
Subbasin Su	unday Drive			_				
SD1-1	Undeveloped	1,036	18	0	3	0	\$	128,138
SD1-2	Undeveloped	1,055	18	0	3	0	\$	130,101
SD2-1	Existing Asphalt	718	18	4	2	0	\$	138,300
SD2-2	Undeveloped	598	30	4	2	0	\$	114,711
SD2-3	Undeveloped	452	30	4	2	0	\$	93,105
						Subbasin Total	\$	604,355
Subbasin W	estern Springs							
WS10-1	Undeveloped	137	18	2	1	0	\$	27,736
WS10-2	Undeveloped	994	30	6	3	0	\$	186,499
						Subbasin Total	\$	214,235
					Storm	Drain Pipe Total	\$	7,090,000

Table 6Estimated Cost of Capital ImprovementsStorm Drain Pipes By Subbasin(Continued)

## LIMITATIONS OF MASTER PLAN DATA

This technical memorandum presents information that is intended to be used to plan for the funding and design of needed storm drain facilities in Riverton City. The design discharges associated with the recommended structural improvements are associated with projected full build-out conditions. More detailed analyses and studies should be completed during the design phase of the recommended storm drain projects. Some of the needed projects could be phased to match available funding streams. For example, a detention or retention facility could initially be constructed with a volume smaller than what is recommended if a significant portion of the storm drain collection system in developed parts of the City will not be constructed for some time. In addition, the actual locations of some of the drainage corridors, pipelines, and detention facilities may be changed to better fit conditions not known when this plan was developed.

## REFERENCES

Bowen, Collins and Associates, April 2003, 2002 Southwest Canal and Creek Study.

- Farmer, E.E., and J.E. Fletcher, February 1972, <u>Rainfall Intensity-Duration-Frequency</u> <u>Relations for the Wasatch Mountains of Northern Utah</u>, Water Resources Research, Vol.8, No. 1.
- Hansen, Allen and Luce, Inc., June 2004, <u>Riverton Storm Drainage Master Plan Amendment</u>, <u>West of Bangerter Highway</u>.
- U.S. Department of Agriculture, Soil Conservation Service, June 1986, <u>Urban Hydrology for</u> <u>Small Watersheds, Technical Release 55</u>.

# APPENDIX A HYDROLOGIC ANALYSIS

#### HYDROLOGIC ANALYSIS

A hydrologic computer model of the study area was developed in HEC-HMS (version 3.4), for the purpose of estimating storm water runoff volumes and peak discharges generated by a design cloudburst event. The model development process is outlined in the following general steps, with detailed information on each step provided later in this technical memorandum:

- 1. Delineate drainage basin and subbasin boundaries in the study area based on topography, parcel maps, aerial photography, existing storm drainage facility information and information from the City.
- 2. Estimate hydrologic modeling parameters for each subbasin in the study area based on soil type, land use, slope, and other storm water conveyance characteristics.
- 3. Develop a design precipitation event using local rainfall data.
- 4. Combine subbasin, channel routing, and storage elements in an integrated hydrologic model for the study area.

#### **Drainage Basin Delineation**

Aerial photography, topographic mapping, field observations, an existing storm drainage facility inventory and system knowledge from City employees were used to delineate drainage subbasins in the study area. The revised subbasins for this updated analysis are based on the best available data at this time. Subbasin boundaries for the hydrologic model are shown in Figure A-1.

### **Hydrologic Modeling Parameters**

*Loss Method.* The SCS Curve Number method was used in the hydrologic model to calculate infiltration losses (see NRCS TR-55 publication for additional information). This method requires the input of a composite Curve Number and the percent impervious for each subbasin. A composite Curve Number was estimated for each subbasin based on soil type and vegetative ground cover. The hydrologic soil type was obtain from the NRCS SSURGO dataset. Table A1 shows the Curve Numbers used in this study based on soil type and as assumed grass cover in developed areas.

# Table A1SCS Curve Number

Soil Type	Curve Number*
А	49
В	69
С	79
D	84



P:\Riverton\2009 Storm Drain Master Plan Update\Report\Figure 2 - Hydrologic Model.xls

\* From Table 2-2 in TR-55 "Open Space – Grass Cover 50% to 75%"

The amount of directly-connected impervious area for assumed post-development conditions was estimated using projected full build-out land use conditions. Table A2 shows the percent directly connected impervious used in this study based on land use. See Appendix B for input parameters used in this study.

Land Use Type	Directly Connected Imperviousness (Percent)
1/5 acre Residential Lot	40%
1/4 acre Residential Lot	35%
1/3 acre Residential Lot	25%
1/2 acre Residential Lot	20%
1 acre Residential Lot	15%
Roadway	90%
Commercial and Business	85%
School	50%

Table A2Average Imperviousness Based on Lot Size

*Transform Method.* The SCS Unit Hydrograph was used in the hydrologic model to convert rainfall to runoff. This method requires "lag time" as an input parameter. Worksheet 3 in TR-55 was used to estimate the time of concentration. Previous studies have shown that the lag time in urban areas can be approximated as the time of concentration. See Appendix D for Time of Concentration input parameters used in this study.

*Routing Method.* The Muskingum-Cunge routing method was used in the hydrologic model to compute the effects of routing runoff hydrographs in the computer model. The input parameters for this routing method require the geometry and Manning's "n" of the conveyance facility. A schematic of the modeled drainage subbasin routing is presented in Figure A-1. See Appendix B for input parameters used in this study.

### **Design Storm**

The design storm developed for the 2004 Storm Drain Master Plan was used in this study to analyze the storm drain pipes. Critical characteristics of the design storm are listed below:

Storm Duration:3 HoursStorm Distribution:Farmer and Fletcher, Second QuartileStorm Depth:1.13 inches

The storm depth is based on a 10-year recurrence interval as shown in the Rainfall Intensity Duration Analysis, Salt Lake County, Utah, (TRC North American Weather Consultants and Metrological Solutions Inc.).

The 100-year design storms developed for the Southwest Canal and Creek Study were used to analyze parameters of existing and proposed detention facilities. Critical characteristics of the detention facility design storms are listed below:

Storm Duration:	3 Hours
Storm Distribution:	Modified Farmer and Fletcher
Storm Depth:	1.77 inches (south valley subbasins) and
	1.97 inches (high elevation subbasins)

### Hydrologic Modeling Methods

The HEC-1 hydrologic computer model used to develop the 2004 Storm Drain Master Plan. That model was converted into a file so that the newer HEC-HMS computer program could be utilized. Drainage basin and subbasin boundaries in the study area were updated, added or removed to reflect recent proposed land use changes. Subbasins not affected by the proposed land use changes were left in the hydrologic model unchanged.

The hydrologic analysis of the study area was performed using the HEC-HMS software package, version 3.4, developed by the U.S. Army Corps of Engineers (USACE). The model input parameters were assembled as described.

The following standard assumptions were made in completing the hydrologic analysis of the study area:

- 1. Design Storm return frequency is equal to associated runoff return frequency.
- 2. Design storm rainfall has a uniform spatial distribution over the watershed.
- 3. Normal (SCS Type II) antecedent soil moisture conditions exist at the beginning of the design storm.
- 4. The hydrologic computer model accurately simulates watershed response to precipitation.
- 5. All storm water runoff generated by the model is conveyed through downstream model elements (the hydrologic model does not account for storm drain inlet or conveyance deficiencies).

## APPENDIX B HYDROLOGIC INPUT PARAMETERS

## HEC-HMS MODEL INPUT PARAMETERS

	Curve	Percent	Lag Time		Curve	Percent	Lag Time
Subbasin	Number	Impervious	(Min.)	Subbasin	Number	Impervious	(Min.)
118S	77.6	90	6	PRI1	81.2	21	20
126S1	84	90	7	PRI10	80.3	85	10
126S2	60	90	7	PRI14	79.9	85	19
132S1	60	90	9	PRI15	81.1	85	25
132S2	60	90	8	PRI16	60	85	10
134S2	84	90	7	PRI17	60	85	11
134S3	84	90	5	PRI18	84	85	13
40W1	84	90	8	PRI19	60	85	16
40W2	84	90	8	PRI2	84	25	19
40W3	84	90	8	PRI20	60	85	8
40W4	84	90	5	PRI3	81.9	52.1	16
4150W1	84	90	10	PRI4	81.2	46.5	23
4150W2	84	90	6	PRI5	84	25	17
4150W3	60	90	8	PRI6	83.5	85	31
4150W4	60	90	6	PRI7	71.5	85	25
4570W1	69	90	12	PRI8	73.1	85	13
4570W2	84	90	8	PRI9	84	85	10
4570W3	84	90	8	RB1	84	90	15
BF1	84	20	21	RB2	84	90	11
BF2	84	40.8	14	RB3	84	90	7
BF3	84	20	9	RBT	77.3	20	25
BF4	60	85	10	RC	60	90	9
CC	83.9	15	20	SC	79.6	28.3	20
CF	84	35	14	SCE1	84	25	15
DEL	84	65.2	17	SCE2	84	20	8
FS1	60	85	8	SF1	84	20	14
FS2	84	85	7	SF2	84	20	23
IHC	74.9	85	18	SH	84	50	17
MAS1	76.3	85	18	SNK24	84	20	16
MAS2	81.6	85	19	SNK25	84	20	15

## Table B-1 Subbasin Parameters

Name	Length (ft)	Slope	Manning's n	Shape	Diameter (ft)	Width	Side Slope
126S1-1	702	0.019	0.015	Circle	2	-	-
126S1-2	262	0.0275	0.013	Circle	2	-	-
126S2-1	110	0.0203	0.013	Circle	2.5	-	-
126S2-10	328	0.0203	0.013	Circle	2.5	-	-
126S2-2	42	0.005	0.036	Circle	3	-	-
126S2-3	288	0.0199	0.013	Circle	2	-	-
126S2-4	1006	0.01565	0.014	Circle	2	-	-
132S1-2	1180	0.022	0.013	Circle	2	-	-
40W2-1	1230	0.003	0.013	Circle	2.5	-	-
40W2-2	334	0.0025	0.013	Circle	2.5	-	-
40W2-3	220	0.0025	0.015	Circle	2.5	-	-
40W3-1	950	0.004	0.014	Circle	3.5	-	-
40W3-2	396	0.004	0.014	Circle	3.5	-	-
40W4-1	1100	0.005	0.013	Circle	2	-	-
4150W1-1	860	0.01	0.013	Circle	1.5	-	-
4150W1-2	430	0.005	0.013	Circle	2	-	-
4150W2-1	300	0.005	0.013	Circle	1.5	-	-
4570W1-1	1144	0.006	0.015	Circle	1.75	-	-
4570W2-1	1260	0.005	0.013	Circle	3	-	-
AH1-1	183	0.0046	0.015	Circle	3	-	-
AH2-1	203	0.005	0.015	Circle	2	-	-
AH4-1	765	0.0208	0.015	Circle	2	-	-
BF1-1	590	0.018	0.015	Circle	2.25	-	-
BF2-1	196	0.011	0.014	Circle	2	-	-
CF-1	184	0.0147	0.015	Circle	2.5	-	-
CV2-1	505	0.004	0.015	Circle	1.25	-	-
CV3-1	1472	0.005	0.015	Circle	2.5	-	-
DM2-1	828	0.015	0.015	Circle	2.5	-	-
DM2-2	729	0.006	0.015	Circle	3	-	-
FH1-1	213	0.01	0.015	Circle	3	-	-
FH2-1	1168	0.01	0.015	Circle	2.25	-	-
FH3-1	558	0.01	0.015	Circle	4	-	-
FH4-1	923	0.01	0.015	Circle	4	-	-
FH4-2	275	0.01	0.015	Circle	4.5	-	-
FH5-1	96	0.01	0.015	Circle	4.5	-	-
FH5-2	1979	0.03	0.015	Circle	2.5	-	-
FH5-3	1390	0.0224	0.015	Circle	3	-	-
Fh6-1	640	0.04	0.015	Circle	3	-	-
FH7-1	1375	0.01	0.015	Circle	3	-	-
FS1-1	315	0.01	0.014	Circle	2	-	-

Table B-2Reach Parameters

## Table B-2 Reach Parameters (Continued)

Name	Length (ft)	Slope	Manning's n	Shape	Diameter (ft)	Width	Side Slope
FS1-2	260	0.018	0.013	Circle	2	-	-
FS1-3	340	0.01565	0.013	Circle	2	-	-
FS2-1	335	0.0166	0.013	Circle	2.5	-	-
HP-1	1309	0.02	0.015	Circle	2.5	-	-
HP-2	648	0.008	0.015	Circle	3	-	-
MC-1	1147	0.01	0.04	Trapezoid	-	4	2
MC-2	351	0.01	0.04	Trapezoid	-	4	2
MC-3	1657	0.01	0.04	Trapezoid	-	4	2
MC-4	1033	0.01	0.04	Trapezoid	-	4	2
MC-5	307	0.0038	0.014	Circle	3.5	-	-
MM1-1	1672	0.01	0.014	Circle	2	-	-
MM2-1	1300	0.02	0.015	Circle	2.5	-	-
MM3-1	1134	0.02	0.015	Circle	3	-	-
MVC2	180	0.005	0.013	Circle	4	-	-
PH1-1	850	0.004	0.015	Circle	1.5	-	-
PH2-1	371	0.005	0.015	Circle	2	-	-
PRI14-1	1550	0.022	0.015	Circle	3	-	-
PRI15-1	800	0.007	0.013	Circle	2	-	-
PRI19-1	1600	0.0085	0.013	Circle	3	-	-
PRI20-1	624	0.008	0.015	Circle	2	-	-
PRI7-1	2800	0.002	0.014	Circle	3.5	-	-
PRI7-2	680	0.002	0.014	Circle	3.5	-	-
RB3-1	1320	0.0085	0.013	Circle	3	-	-
RBT-1	1282	0.02	0.015	Circle	3	-	-
RC-1	808	0.02	0.04	Trapezoid	-	4	2
RC-2	1608	0.02	0.04	Trapezoid	-	4	2
RC-3	1460	0.02	0.04	Trapezoid	-	4	2
RC-4	1813	0.02	0.04	Trapezoid	-	4	2
RC-5	2094	0.02	0.04	Trapezoid	-	4	2
RC-6	524	0.02	0.04	Trapezoid	-	4	2
RC-7	1503	0.02	0.04	Trapezoid	-	4	2
RC-8	1198	0.02	0.04	Trapezoid	-	4	2
RC-9	498	0.02	0.04	Trapezoid	-	4	2
RS-1	434	0.042	0.015	Circle	2.5	-	-
SC-1	1207	0.005	0.015	Circle	1.5	-	-
SD1-1	1030	0.019	0.013	Circle	2	-	-
SD1-2	1050	0.019	0.013	Circle	2.5	-	-
SD2-1	963	0.003	0.015	Circle	1.5	-	_

Name	Length (ft)	Slope	Manning's n	Shape	Diameter (ft)	Width	Side Slope
SD2-2	680	0.019	0.013	Circle	3	-	-
SD2-3	1050	0.022	0.015	Circle	3.5	1	-
SF3-1	531	0.005	0.015	Circle	3	-	-
SF3-2	419	0.02	0.015	Circle	2	-	-
SF4-1	122	0.005	0.015	Circle	2	1	-
WS10-1	1024	0.018	0.013	Circle	3	1	-
WS2-1	185	0.005	0.015	Circle	2.5	-	-
WS3-1	345	0.0288	0.015	Circle	2.5	-	-
WS4-1	630	0.0288	0.015	Circle	2.5	-	-
WS6-1	482	0.0383	0.015	Circle	1.5	-	-
WS7-1	1005	0.0075	0.014	Circle	2	-	-
WS8-1	1239	0.0066	0.014	Circle	2	-	-
WS9-1	733	0.0276	0.015	Circle	1.5	-	-

### Table B-2 Reach Parameters (Continued)

## HEC-HMS MODEL DESIGN STORMS

# Table B-33-Hour, 10-Year Farmer FletcherSecond Quartile Design Storm

Time	Precipitation (inches)
0:00	0
0:03	0
0:06	0
0:09	0.00226
0:12	0.00226
0:15	0.00226
0:18	0.00226
0:21	0.00226
0:24	0.00226
0:27	0.00339
0:30	0.00339
0:33	0.00452
0:36	0.00565
0:39	0.00904
0:42	0.01017
0:45	0.01017
0:48	0.01469
0:51	0.01921
0:54	0.0226
0:57	0.02712
1:00	0.03277
1:03	0.03729
1:06	0.03842
1:09	0.03955
1:12	0.04294
1:15	0.04407
1:18	0.05085
1:21	0.05876
1:24	0.06102
1:27	0.06102
1:30	0.06102

<b>T:</b>	Precipitation
1 1 2 2	(incres)
1:33	0.05876
1:36	0.05085
1:39	0.0452
1:42	0.03955
1:45	0.0339
1:48	0.02486
1:51	0.0226
1:54	0.02034
1:57	0.01808
2:00	0.01582
2:03	0.01356
2:06	0.01243
2:09	0.0113
2:12	0.01017
2:15	0.01017
2:18	0.00904
2:21	0.00678
2:24	0.00678
2:27	0.00565
2:30	0.00565
2:33	0.00565
2:36	0.00565
2:39	0.00452
2:42	0.00452
2:45	0.00452
2:48	0.00339
2:51	0.00339
2:54	0.00226
2:57	0.00226
3:00	0.00113
Total:	1.13

### Table B-4 3-Hour, 100-Year Modified Farmer Fletcher Valley South

Time	Precipitation (inches)
0:00	0
0:15	0.04
0:30	0.04
0:45	0.96
1:00	0.3
1:15	0.12
1:30	0.07
1:45	0.04
2:00	0.04
2:15	0.04
2:30	0.04
2:45	0.04
3:00	0.04
Total:	1.77

### Table B-5 3-Hour, 100-Year Modified Farmer Fletcher High Elevation

Time	Precipitation (inches)
0:00	0
0:15	0.06
0:30	0.06
0:45	0.99
1:00	0.31
1:15	0.12
1:30	0.07
1:45	0.06
2:00	0.06
2:15	0.06
2:30	0.06
2:45	0.06
3:00	0.06
Total:	1.97

B-6

## APPENDIX C CONCEPTUAL COST ESTIMATE DATA

Description	Unit	Unit Cost		
Detention Basins				
Excavation and Hauling	Cubic Yard	\$13		
<b>Regional Detention Basins</b> <sup>(1)</sup>				
Property Acquisition	Acre	\$260,000		
Landscaping (Non-irrigated Native)	Square Foot	\$0.30		
Inlet Apron	Lump Sum	\$15,000		
Outlet Structure	Lump Sum	\$50,000		
Emergency Spillway	Lump Sum	\$5,000		
Local Detention Basins <sup>(2)</sup>				
Property Acquisition	Quarter Acre Lot	\$150,000		
Landscaping (Irrigated Turfgrass)	Square Foot	\$2.60		
Inlet/Outlet Structure	Lump Sum	\$12,000		
Storm Drain Pipelines				
18-inch RCP <sup>(3)</sup>	Linear Foot	\$100		
18-inch RCP <sup>(4)</sup>	Linear Foot	\$80		
24-inch RCP <sup>(3)</sup>	Linear Foot	\$125		
24-inch RCP <sup>(4)</sup>	Linear Foot	\$100		
30-inch RCP <sup>(3)</sup>	Linear Foot	\$135		
30-inch RCP <sup>(4)</sup>	Linear Foot	\$110		
36-inch RCP <sup>(3)</sup>	Linear Foot	\$170		
36-inch RCP <sup>(4)</sup>	Linear Foot	\$145		
42-inch RCP <sup>(3)</sup>	Linear Foot	\$195		
42-inch RCP <sup>(4)</sup>	Linear Foot	\$170		
48-inch RCP <sup>(3)</sup>	Linear Foot	\$240		
48-inch RCP <sup>(4)</sup>	Linear Foot	\$215		
Manhole	Each	\$4,000		
Catch Basin	Each	\$2,800		
Traffic Control	Linear Foot	\$16		
Other				
Contingency	25 Percent of Construction	Cost		
Engineering, Legal, and Administration	15 Percent of Construction	Cost w/ Contingency		

 Table C-1

 Conceptual Cost Estimate Unit Cost Summary

(1) - All regional detention basins include an inlet apron, an outlet structure, an emergency spillway, nonirrigated native landscaping, and the property values assuming the land is undeveloped.

(2) - All local detention basins include a combination inlet/outlet structure, irrigated turfgrass landscaping, and property values assuming the land is developed.

(3) - Includes trenching, installation, backfill, and asphalt surface restoration.

(4) - Includes trenching, installation, and backfill w/out asphalt surface restoration

Project Identifier	Surface Condition	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Estimated Project Cost	
Subbasin 11800	South Street	-		1	-			
118S-1	Existing Asphalt	1287	18	8	4		\$	253,352
Subbasin 13200	South Street	-		I				
132\$1-1	Undeveloped	1110	18	6	3		\$	158,748
132\$1-2	Undeveloped	1206	18	8	4		\$	182,071
						Subbasin Total	\$	340,820
Subbasin 13400	South Street			-	-			
134S2-1	Existing Asphalt	1301	18	8	4		\$	255,610
134S3-1	Existing Asphalt	733	18	4	2		\$	140,676
134S3-2	Undeveloped	303	42	2	1		\$	82,513
						Subbasin Total	\$	478,799
Subbasin 4000	West Street							
40W1-1	Existing Asphalt	485	18	4	2		\$	101,834
40W2-1	Existing Asphalt	1190	18	6	3		\$	225,278
40W2-2	Existing Asphalt	280	30	2	1		\$	70,061
40W4-1	Existing Asphalt	1217	18	8	4		\$	242,423
						Subbasin Total	\$	639,595
Subbasin 4150	West Street							
4150W1-1	Undeveloped	837	18	6	3		\$	129,231
4150W1-2	Undeveloped	438	24	4	2		\$	85,090
4150W2-1	Undeveloped	1046	18	6	3		\$	151,796
				-	-	Subbasin Total	\$	366,117
Subbasin 4570	West Street							
4570W1-1	Undeveloped	1024	18	6	3		\$	149,472
4570W1-2	Undeveloped	1027	24	6	3	1	\$	245,066
4570W2-1	Undeveloped	1265	30	8	4		\$	239,726
				-	-	Subbasin Total	\$	634,264

Table C-2Estimated Cost of Capital Improvements

Project Identifier	Surface Condition	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)	Estimated Project Cost	
Subbasin Butte	rfield Property							
BF1-1	Undeveloped	1611	30	10	5		\$	304,027
BF2-1	Undeveloped	157	18	2	1		\$	29,929
BF3-1	Undeveloped	494	18	4	2		\$	79,269
BF3-2	Undeveloped	78	18	2	1		\$	21,414
DB1: 10.4 ac-ft	Detention Basin							
Excavation and Hauling 25,168 Cubic Yards						\$	327,184	
Landscaping (Non-irrigated Native) ###### Square Feet					\$	45,302		
Inlet Apron 1 -						15,000		
Outlet Structur	re				1	-		50,000
Emergency Sp	illway				1	-		5,000
Land acquisition	on				3.5	acre	\$	901,333
Eng, Legal, Ac	dmin, Conting (35%)						\$	470,337
							\$	1,814,157
DB2: .4 ac-ft De	etention Basin							
Excavation and	d Hauling				968	Cubic Yards	\$	12,584
Landscaping (	Irrigated Turfgrass)				10,890	Square Feet	\$	28,314
Inlet/Outlet Sta	ructure				1	-	\$	12,000
Land acquisition	on				0.2	acre	\$	150,000
Eng, Legal, Ac	lmin, Conting (35%)						\$	71,014
							\$	273,912
						Subbasin Total	\$	2,522,708
Subbasin Diver	sion							
Div-1	Undeveloped	803	30	6	3		\$	158,052
Subbasin Haves	st Creek Estates							
HC-1	Undeveloped	1102	18	6	3		\$	157.922

# Table C-2Estimated Cost of Capital Improvements<br/>(Continued)

Project Identifier	Surface Condition	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)		Estimated Project Cost	
Subbasin Prope	erty Reserve Inc.	1000	2.5		<b>I</b> .		¢	2 (0 511	
PRI4-2	Undeveloped	1233	36	8	4	1	\$	360,711	
PRI7-1	Undeveloped	2473	42	14	7		\$	658,345	
PRI/-2	Undeveloped	652	42	4	2		\$	175,501	
PRI14-1	Undeveloped	1558	18	8	4		\$	220,123	
PRII5-I	Undeveloped	906	18	6	3	1	\$	136,781	
PRI1/-1	Undeveloped	1060	18	3	3	1	\$	209,520	
PRII9-1	Undeveloped	1596	42	8	4	1	\$	418,161	
PRI20-1	Undeveloped	301	42	2	1	1	\$	149,454	
DB8: 1.7 ac-ft D	Detention Basin				4 114	Cubic Vorde	¢	53 482	
Landscaping (	Non irrigated Native)				24 684	Square Feet	φ ¢	7 405	
Inlet Aprop	Non-Inigated Native)				24,004	Square rect	Ψ	15,000	
Outlet Structur	re				1	_		50,000	
Emergency Sp	nillway				1	_		5 000	
Land acquisiti	on				0.6	acre	\$	300.000	
Eng, Legal, Ad	dmin, Conting (35%)						\$	150,811	
							\$	581,698	
								·	
DB9: 5.1 ac-ft D	Detention Basin								
Excavation and	d Hauling				12,342	Cubic Yards	\$	160,446	
Landscaping (	Non-irrigated Native)				74,052	Square Feet	\$	22,216	
Inlet Apron					1	-		15,000	
Outlet Structur	re				1			50,000	
Emergency Sp	villway				1	-		5,000	
Land acquisiti	on				1.7	acre	\$	442,000	
Eng, Legal, Ad	dmin, Conting (35%)						\$	243,132	
							\$	937,793	

# Table C-2Estimated Cost of Capital Improvements<br/>(Continued)

# Table C-2Estimated Cost of Capital Improvements<br/>(Continued)

Project Identifier	Surface Condition	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)		Estimated Project Cost	
DB10: 7.4 ac-ft									
Excavation and	l Hauling				17,908	Cubic Yards	\$	232,804	
Landscaping (I	Non-irrigated Native)				######	Square Feet	\$	32,234	
Inlet Apron					1	-		15,000	
Outlet Structure 1 -								50,000	
Emergency Spillway 1 -								5,000	
Land acquisition2.5acre								641,333	
Eng, Legal, Admin, Conting (35%)								341,730	
Total DB10 cost								1,318,102	
Riverton Portion of DB10 Cost (based on volume)44.6%								587,802	
Subbasin Total									
<i></i>					_	Subbasin Total	\$	4,435,889	
Subbasin River	ton Boulevard			-	I .	Subbasin Total	\$	4,435,889	
Subbasin River RB3-1	ton Boulevard Undeveloped	1314	36	8	4	Subbasin Total	\$ \$	<b>4,435,889</b> 309,000	
Subbasin River RB3-1 Subbasin Scenic	ton Boulevard Undeveloped	1314	36	8	4	Subbasin Total	\$ \$	<b>4,435,889</b> 309,000	
Subbasin River RB3-1 Subbasin Scenic SC-1	ton Boulevard Undeveloped c Cove Undeveloped	1314 885	36 30	8 6	4	Subbasin Total	\$ \$ \$	<b>4,435,889</b> 309,000 170,304	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda	ton Boulevard Undeveloped c Cove Undeveloped ny Drive	1314 885	36 30	8	4	Subbasin Total	\$ \$ \$	<b>4,435,889</b> 309,000 170,304	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1	ton Boulevard Undeveloped Cove Undeveloped ay Drive Undeveloped	1314 885 1036	36 30 18	8 6 0	4	Subbasin Total	\$ \$ \$ \$	4,435,889 309,000 170,304 128,138	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2	ton Boulevard Undeveloped c Cove Undeveloped my Drive Undeveloped Undeveloped	1314 885 1036 1055	36 30 18 18	8 6 0 0	4 3 3 3	Subbasin Total	\$ \$ \$ \$ \$	4,435,889 309,000 170,304 128,138 130,101	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1	ton Boulevard Undeveloped Cove Undeveloped ay Drive Undeveloped Undeveloped Existing Asphalt	1314 885 1036 1055 718	36 30 18 18 18	8 6 0 0 4	4 3 3 3 2	Subbasin Total	\$ \$ \$ \$ \$ \$ \$	4,435,889 309,000 170,304 128,138 130,101 138,300	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2	ton Boulevard Undeveloped c Cove Undeveloped by Drive Undeveloped Undeveloped Existing Asphalt Undeveloped	1314 885 1036 1055 718 598	36 30 18 18 18 30	8 6 0 0 4 4	4 3 3 2 2 2	Subbasin Total	\$ \$ \$ \$ \$ \$ \$ \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3	ton Boulevard Undeveloped Cove Undeveloped My Drive Undeveloped Undeveloped Existing Asphalt Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 0 4 4 4 4	4 3 3 2 2 2 2 2	Subbasin Total	\$ \$ \$ \$ \$ \$ \$ \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3 DB4: .4 ac-ft De	ton Boulevard Undeveloped Cove Undeveloped Undeveloped Undeveloped Existing Asphalt Undeveloped Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 0 4 4 4 4	4 3 3 2 2 2 2	Subbasin Total	\$           \$           \$           \$           \$           \$           \$           \$           \$           \$           \$           \$           \$           \$           \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3 DB4: .4 ac-ft De Excavation and	ton Boulevard Undeveloped c Cove Undeveloped My Drive Undeveloped Existing Asphalt Undeveloped Undeveloped Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 0 4 4 4 4	4 3 3 2 2 2 2 968	Subbasin Total	\$           \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105 12,584	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3 DB4: .4 ac-ft De Excavation and Landscaping (I	ton Boulevard Undeveloped Cove Undeveloped Undeveloped Undeveloped Existing Asphalt Undeveloped Undeveloped Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 0 4 4 4 4	4 3 3 2 2 2 2 2 2 968 10,890	Subbasin Total	\$           \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105 12,584 28,314	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3 DB4: .4 ac-ft De Excavation and Landscaping (I Inlet/Outlet Str	ton Boulevard Undeveloped Cove Undeveloped Undeveloped Undeveloped Existing Asphalt Undeveloped Undeveloped Undeveloped Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 0 4 4 4 4	4 3 3 2 2 2 2 968 10,890 1	Subbasin Total	\$           \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105 12,584 28,314 12,000	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3 DB4: .4 ac-ft De Excavation and Landscaping (I Inlet/Outlet Str Land acquisitio	ton Boulevard Undeveloped Cove Undeveloped Undeveloped Undeveloped Existing Asphalt Undeveloped Undeveloped Undeveloped Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 4 4 4 4	4 3 3 2 2 2 2 2 2 2 968 10,890 1 0.20	Subbasin Total	\$           \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105 12,584 28,314 12,000 150,000	
Subbasin River RB3-1 Subbasin Scenic SC-1 Subbasin Sunda SD1-1 SD1-2 SD2-1 SD2-2 SD2-3 DB4: .4 ac-ft De Excavation and Landscaping (I Inlet/Outlet Str Land acquisitio Eng, Legal, Ad	ton Boulevard Undeveloped Cove Undeveloped Undeveloped Undeveloped Existing Asphalt Undeveloped Undeveloped Undeveloped Undeveloped Undeveloped Undeveloped Undeveloped Undeveloped	1314 885 1036 1055 718 598 452	36 30 18 18 18 30 30	8 6 0 0 4 4 4 4	4 3 3 2 2 2 2 2 968 10,890 1 0.20	Subbasin Total	\$           \$	4,435,889 309,000 170,304 128,138 130,101 138,300 114,711 93,105 12,584 28,314 12,000 150,000 71,014	

Table C-2
<b>Estimated Cost of Capital Improvements</b>
(Continued)

Project Identifier	Surface Condition Basin	Pipe Length (ft)	Diameter (in)	Catch Basin / Inlet Box (EA)	Junction Box / Manhole (EA)	Outlet Works (EA)		Estimated Project Cost
Excavation and	1 Hauling				1,694	Cubic Yards	\$	22,022
Landscaping (I	(rrigated Turfgrass)				10,890	Square Feet	\$	28,314
Inlet/Outlet Structure 1 -						\$	12,000	
Land acquisition 0.23 acre						\$	150,000	
Eng, Legal, Admin, Conting (35%)							\$	74,318
								286,654
DB6: .3 ac-ft De	tention Basin							
Excavation and	1 Hauling				726	Cubic Yards	\$	9,438
Landscaping (I	(rrigated Turfgrass)				10,890	Square Feet	\$	28,314
Inlet/Outlet Str	ructure				1	-	\$	12,000
Land acquisition	on				0.15	acre	\$	150,000
Eng, Legal, Ad	lmin, Conting (35%)						\$	69,913
							\$	269,665
						Subbasin Total	\$	1,434,587
Subbasin Weste	ern Springs							
WS10-1	Undeveloped	137	18	2	1		\$	27,736
WS10-2	Undeveloped	994	30	6	3		\$	186,499
						Subbasin Total	\$	214,235
						Total	\$	12,116,000

## APPENDIX D TIME OF CONCENTRATION WORKSHEETS

## TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>)

Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentin</u>	9	Date:	3/9/10	)
Location: Riverton, Utah	_ Checked	By: <u>M. Stayner</u>	Date:	3/9/10	)	
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{40^{\circ}}{2}$	W1					
NOTES: Space for as many as two segments per flow to or description of flow segments.	ype can be u	ised for each worl	ksheet. Ind	clude a ma	p, sche	ematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Sec	gment ID					
1. Surface description (Table 3-1)		Dense Grass				
2. Manning's roughness coeff., n (Table 3-1)		0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	1				
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01	+		= (	0.01
$P_2^{0.5} s^{0.4}$		I	L			
Shallow Concetrated Flow Seg	ment ID					
7. Surface description (paved or unpaved)		Paved				
8. Flow length, L	ft	400				
9. Watercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0				
11. $T_t = L$ Compute $T_t$	hr	0.06	+			06
3600 V		0.00	L	]		.00
Channel Flow Segm	nent ID					
12 Cross sectional flow area a	ft <sup>2</sup>	2.4	r			
13 Wetted perimeter P		3.1				
14. Hydraulic radius $r = a$ . Compute r		0.3				
$P_{w}$		0.5	l			
15. Channel Slope, s	ft/ft	0.003	[			
16. Manning's Roughness Coeff n		0.000				
$17 V = 1.49 r^{2/3} s^{1/2}$ Compute V	ft/e	0.02				
n		3.4				
18 Flow length	ft [	770	<b></b>			
10 T = 1 Compute T		//U	L		<b></b>	ı
3600 V		0.06 +	· L	=		.06
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr		0.13

## TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>)

Project: Riverton Storm Drain Master Plan				Designed By: K. Ballentine	Date: _	3/9/10
Location: Riverton, Utah				Checked By: <u>M. Stayner</u>	Date: _	3/9/10
Check one:	Preser	nt 🗸	Developed			
Check one: 🗸	T <sub>c</sub>	Tt	through subarea 40W	/2		

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to $T_c$ only)	Segment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	1	
4. Two-year 24-hour rainfall, P2	in	1.3	
5. Land slope, s	ft/ft	0.010	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute $T_1$	hr	0.01 + = 0.	01
Shallow Concetrated Flow	Segment ID		
7. Surface description (paved or unpaved)		Paved	
8. Flow length, L	ft	400	
9. Watercourse slope, s	ft/ft	0.010	
10. Average velocity, V (Figure 3-1)	ft/s	2.0	
11. $T_t = \underline{L}$ Compute $T_t \dots$ 3600 V	hr	0.06 + = 0.0	06
Channel Flow	Segment ID		
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1	
13. Wetted perimeter, Pw	ft	6.3	
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5	
Pw			
15. Channel Slope, s	ft/ft	0.003	
16. Manning's Roughness Coeff., n		0.02	
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	3.4	
n			
18. Flow length, L	ft	770	
19. $T_t = \underline{L}$ Compute $T_t$	hr	0.06 + = 0.0	06
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in step:	s 6, 11, and 19	hr 0.	13
#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>)

Project: Riverton Storm Drain Master Plan	Designed I	By: K. Ballenti	ne	Date:	3/9	9/10
Location: Riverton, Utah	Checked E	By: <u>M. Stayner</u>		Date:	3/9	9/10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{400}{100}$	V3					
NOTES: Space for as many as two segments per flow ty or description of flow segments.	pe can be us	ed for each wo	orksheet.	Include a m	nap, s	chematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segu	ment ID					
1. Surface description (Table 3-1)	Γ	Dense Grass				
2. Manning's roughness coeff., n (Table 3-1)		0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	1				
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01	+		=	0.01
$P_2^{0.5} s^{0.4}$	L				L	
Shallow Concetrated Flow Segr	ment ID					
7. Surface description (paved or unpaved)	Γ	Paved		]		
8. Flow length, L	ft	400		·····		
9 Watercourse slope, s	ft/ft	0.010				
10 Average velocity V (Figure 3-1)	ft/s	2.0				
$11 T_{r} = 1 $ Compute T <sub>r</sub>	hr	0.06			= [	0.06
3600 V	Ľ	0.00			L	0.00
Channel Flow Segm	ent ID					
12. Cross sectional flow area, a	ft²	3.1		······]		
13. Wetted perimeter, P <sub>w</sub>	ft	6.3	_			
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5				
P <sub>w</sub>	L	i				
15. Channel Slope, s	ft/ft	0.005				
16. Manning's Roughness Coeff., n		0.02				
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	4.4	-	1. M. 1. M		
n						
18. Flow length, L	ft Г	1 000		]		
19 T, = I Compute T.	hr	0.06	+		=	0.06
3600 V		0.00	· L	]	10.00	0.00
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19				nr	0.13

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan \_\_\_\_\_ Designed By: K. Ballentine 3/9/10 Date: Location: Riverton, Utah Checked By: M. Stayner 3/9/10 Date: Check one: Present ✓ Developed Check one: T<sub>c</sub> through subarea 40W4 Tt NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... **Dense Grass** 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L < 100 ft) ..... ft 1 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007$ (nL) <sup>0.8</sup> Compute T<sub>1</sub>.....hr + 0.01 = 0.01 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 300 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. $T_t = L_{-}$ Compute Tt ..... hr 0.04 + = 0.04 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ...... ft<sup>2</sup> 3.1 13. Wetted perimeter, Pw ..... ft 6.3 14. Hydraulic radius, r = a Compute r ..... ft 0.5 Pw 15. Channel Slope, s ..... ft/ft 0.020 16. Manning's Roughness Coeff., n ..... 0.02 17. V = 1.49 $r^{2/3} s^{1/2}$ Compute V ..... ft/s 8.8 n 18. Flow length, L ..... ft 900 19. $T_t = L$ Compute T<sub>1</sub>.....hr 0.03 + = 0.03 3600 V

		10-1 ADV-0		•		
Project: Riverton Storm Drain Master Plan	Designed B	y: <u>K. Ballenti</u>	ne	_ Date: _	3/9/	/10
Location: <u>Riverton</u> , Utah	Checked By	/: <u>M. Stayner</u>		_ Date: _	3/9/	/10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>118</u>	S					
NOTES: Space for as many as two segments per flow typor description of flow segments.	pe can be use	ed for each wo	orksheet. In	iclude a ma	ap, sc	hematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	ment ID					
1. Surface description (Table 3-1)		Dense Grass	-1			
2 Manning's roughness coeff in (Table 3-1)						
3. Flow length $L$ (total $L < 100$ ft)	ft	0.24				
4. Two-year 24 hour rainfall P	in	1				
5 Land slope s		1.3				
6. $T = 0.007$ (nl.) <sup>0.8</sup>	br	0.010			- F	0.01
$P_2^{0.5} s^{0.4}$		0.01	」、「			0.01
Shallow Concertated Flow						
Stallow Concetrated Flow Segn						
7. Surface description (paved or unpaved)		Paved				
8. Flow length, L	ft	300				
9. Watercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0				
11. $T_{i} = 1$ Compute $T_{i}$	hr	0.04			= Г	0.04
3600 V		0.04				0.04
Channel Flow Segme	ent ID					
				]		
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1				
13. Wetted perimeter, P <sub>w</sub>	ft 🗧	6.3				
14. Hydraulic radius, r = <u>a</u> Compute r	ft 📂	0.5				
P <sub>w</sub>	L			]		
15. Channel Slope, s	ft/ft	0.020		7		
16. Manning's Roughness Coeff., n		0.02				
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	8.8				
n		0.0				
18. Flow length, L	ft	1.350		]		
19. T <sub>t</sub> = L Compute T <sub>t</sub>	hr	0.04	+	10 <sup>1</sup>	= [	0.04
3600 V		0.04			L	0.04
20. Watershed or subarea $T_{c} \mbox{ or } T_{t}$ (add $T_{t} \mbox{ in steps 6, 11, a}$	and 19			h	٢ſ	0.10

Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentine</u>		Date:	3/9/10
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>		Date:	3/9/10
Check one: Present ✓ Developed					
Check one: $\sqrt{T_2}$ T, through subgrea 1	26S1				
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be u	sed for each works	sheet. Inc	lude a ma	ap, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only)	egment ID				
1. Surface description (Table 3-1)		Dense Grass			
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	1			
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3			
5. Land slope, s	ft/ft	0.010			
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01 +			= 0.01
$P_2^{0.5} s^{0.4}$	L			]	0.01
Shallow Concetrated Flow Se	ament ID				
	ິ [	· · · · · ·			
7. Surface description (paved or unpaved)	[	Paved	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
8. Flow length, L	ft	300			
9. Watercourse slope, s	ft/ft	0.010			
10. Average velocity, V (Figure 3-1)	ft/s	2.0			
11. T <sub>1</sub> = L Compute T <sub>1</sub>	hr	0.04 +			= 0.04
3600 V	L	0.04	1		0.04
Channel Flow Sea	ment ID				
<u>Sey</u>					
12. Cross sectional flow area, a	ft²	3.1			
13. Wetted perimeter, P <sub>w</sub>	ft	6.3			
14. Hydraulic radius, r = a Compute r	ft	0.5			
Pw	L	0.0			
15. Channel Slope, s	ft/ft 🛛 🕅	0.020			
16. Manning's Roughness Coeff., n	F	0.02			
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	8.8			
n	L	0.0			
18. Flow length, L	ft Г	2 100		]	
19. $T_t = L$ Compute T.	hr F	0.07 ±	T		- 0.07
3600 V		0.07	l		0.07
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 1	1, and 19			hr	0.12

Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentine</u>	9	_ Date: _	3/9/	/10
Location: Riverton, Utah	_ Checked I	By: <u>M. Stayner</u>		_ Date:	3/9/	10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>12</u>	6S2					
NOTES: Space for as many as two segments per flow to or description of flow segments.	ype can be us	sed for each worl	sheet. In	clude a ma	p, sc	hematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	gment ID					
1. Surface description (Table 3-1)         2. Manning's roughness coeff., n (Table 3-1)         3. Flow length, L (total L ≤ 100 ft)         4. Two-year 24-hour rainfall, P2         5. Land slope, s         6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$ Shallow Concetrated Flow         Seg         7. Surface description (paved or unpaved)         8. Flow length, L         9. Watercourse slope, s	ft [ ft/ft ] ft/ft [ hr [ hr [ hr [	Dense Grass 0.24 1 1.3 0.010 0.01 0.01 Paved 400 0.010	+		=	0.01
10. Average velocity, V (Figure 3-1)	ft/s	2.0			- <b>-</b>	
3600 V		0.06	• L		- L	0.06
Channel Flow Segm	nent ID					
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup>	1.8 4.7 0.4				
15. Channel Slope, s	ft/ft 🛛 🗌	0.020				
16. Manning's Roughness Coeff., n		0.02				
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	7.3				
n						
18. Flow length, L	ft	1,400				
$19. I_t = \underline{L} \qquad Compute T_t \dots$ $3600 V$	hr	0.05 +		=		0.05
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr	Γ	0.12

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan \_\_\_\_\_ Designed By: K. Ballentine Date: 3/9/10 Location: Riverton, Utah Checked By: M. Stayner 3/9/10 Date: Check one: Present ✓ Developed Check one: ✓ T<sub>c</sub> T<sub>t</sub> through subarea 132S1 NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... Dense Grass 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L < 100 ft) ..... ft 1 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>t</sub>.....hr 0.01 + = 0.01 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 400 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. T<sub>t</sub> = <u>L</u> Compute T<sub>1</sub> ..... hr 0.06 = 0.06 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 1.8 13. Wetted perimeter, Pw ..... ft 4.8 14. Hydraulic radius, r = a Compute r ..... ft 0.4 Pw 15. Channel Slope, s ..... ft/ft 0.005 16. Manning's Roughness Coeff., n ..... 0.02 17. V = 1.49 $r^{2/3} s^{1/2}$ Compute V ..... ft/s 3.6 n 18. Flow length, L ..... ft 1,100 19. $T_1 = L$ Compute T<sub>1</sub>.....hr 0.08 + = 0.08 3600 V

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan Designed By: K. Ballentine 3/9/10 Date: Location: Riverton, Utah Checked By: M. Stayner 3/9/10 Date: Check one: Present ✓ Developed Check one: V T<sub>c</sub> through subarea 132S2 Tr NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... **Dense Grass** 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L < 100 ft) ..... ft 1 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>1</sub>.....hr +0.01 $\equiv$ 0.01 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Seament ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 400 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. $T_1 = L$ Compute Tt ..... hr 0.06 + = 0.06 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 1.8 13. Wetted perimeter, Pw ..... ft 4.8 14. Hydraulic radius, r = a Compute r ..... ft 0.4 Pw 15. Channel Slope, s ..... ft/ft 0.005 16. Manning's Roughness Coeff., n ..... 0.02 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V ..... ft/s 3.6 n 18. Flow length, L ..... ft 800 19. T<sub>t</sub> = <u>L</u> Compute T<sub>t</sub> ...... hr 0.06 + = 0.06 3600 V

Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentine</u>	Date	:3	3/9/10
Location: <u>Riverton</u> , Utah	_ Checked E	3y: <u>M. Stayner</u>	Date	:3	/9/10
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{134}{1}$	152		_		
NOTES: Space for as many as two segments per flow ty or description of flow segments.	/pe can be us	ed for each works	heet. Include a	map,	schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID				
1. Surface description (Table 3-1)		Dense Grass		٦	
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	1		-	
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3		-	
5. Land slope, s	ft/ft	0.010		-	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01 +		1 =	0.01
$P_2^{0.5} s^{0.4}$	L		L		0.01
	-	······		_	
Shallow Concetrated Flow Segr	ment ID				
7 Surface description (powed or uppeyed)	Г			-	
7. Surface description (paved of unpaved)	·····	Paved		_	
	ft	300			
9. vvatercourse slope, s	ft/ft	0.010		4	
10. Average velocity, V (Figure 3-1)	ft/s	2.0			, <b></b>
11. $I_t = \underline{L}$ Compute $T_t$	hr _	0.04 +		=	0.04
3600 V					
Channel Flow Segm	ent ID			1	
	L				
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1	16 - 111 AL	]	
13. Wetted perimeter, Pw	ft	6.3		1	
14. Hydraulic radius, r = <u>a</u> Compute r	ft 🕇	0.5	3	1	
Pw	<u> </u>			1	
15. Channel Slope, s	ft/ft	0.010		1	
16. Manning's Roughness Coeff., n		0.02		1	
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	6.2		1	
n	L			1	
18. Flow length, L	ft	1.400	······	1	
19. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr 📙	0.06 +	6.1.000 A	=	0.06
3600 V	924-18-49931599 (1998)55	0.00	L	]	
20. Watershed or subarea $T_{c} \mbox{ or } T_{t}$ (add $T_{t} \mbox{ in steps 6, 11, }$	and 19			. hr	0.12

TR 55 Worksheet 3: Tin	ne of Concentra	ation (T <sub>c</sub> ) or Travel	Time (T <sub>t</sub> )
Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: <u>Riverton</u> , Utah	Checked	By: M. Stayner	Date: <u>3/9/10</u>
Check one: Present ✓ Developed			
Check one: ✓ T <sub>c</sub> T <sub>t</sub> through subar	ea <u>134S3</u>		
NOTES: Space for as many as two segments pe or description of flow segments.	r flow type can be ι	used for each worksheet	. Include a map, schematic,
Sheet Flow (Applicable to $T_c$ only)	Segment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L ≤ 100 ft)	ft	1	
4. Two-year 24-hour rainfall, P2	in	1.3	
5. Land slope, s	ft/ft	0.010	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01 +	= 0.01
Shallow Concetrated Flow	Segment ID		
7 Surface description (payed or uppayed)			
8 Elow length 1		Paved	
9. Watercourse slope is	IL #/#	300	
10 Average velocity V (Figure 2.1)	II/IL	0.010	
	II/S	2.0	
3600 V	nr	0.04 +	= 0.04
Channel Flow	Segment ID		
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1	
13. Wetted perimeter, P <sub>w</sub>	ft	6.3	
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5	
15 Channel Slope s	ft/ft	0.010	]
16 Manning's Roughness Coeff n		0.010	
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	ft/s	0.02	
n		0.2	
18. Flow length, L	ft	700	
19. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.03 +	= 0.03
3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps	6, 11, and 19		

		a 2005)				
Project: Riverton Storm Drain Master Plan	Designed	By: <u>K.</u> Ballenti	ne	_ Date: _	3/9	/10
Location: <u>Riverton</u> , Utah	Checked By: <u>M. Stayner</u>			_ Date: _	3/9/	/10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{415}{100}$	50W1					
NOTES: Space for as many as two segments per flow ty	vpe can be us	ed for each wo	orksheet. Ir	nclude a ma	ap, sc	chematic,
or description of now segments.						
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID					
1. Surface description (Table 3-1)		Dense Grass				
2. Manning's roughness coeff., n (Table 3-1)		0.24	-			
3. Flow length, L (total L $\leq$ 100 ft)	ft	1				
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3	-			
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01	+		= [	0.01
P <sub>2</sub> <sup>05</sup> s <sup>0.4</sup>	L				L	0.01
	_					
Shallow Concetrated Flow Segr	ment ID					
7 Surface description (neurod or unnourod)	г					
7. Surface description (paved of unpaved)		Paved				
	π	400				
9. vvatercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0				
11. $I_t = \underline{L}$ Compute $T_t$	hr [	0.06	+		=	0.06
3600 V						
Channel Flow Segme	ent ID					
	L					
12. Cross sectional flow area, a	ft² [	3.1				
13. Wetted perimeter, P <sub>w</sub>	ft	6.3				
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5				
Pw	L					
15. Channel Slope, s	ft/ft	0.010	1	]		
16. Manning's Roughness Coeff., n		0.02				
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	6.3				
n	L	0.0		]		
18. Flow length, L	ft 🔽	2 000				
19. T <sub>L</sub> = L Compute T <sub>L</sub>	hr F	0.00	+		- r	0.00
3600 V		0.09	· L	]	- L	0.09
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, $\alpha$	and 19			hr	· Г	0.16

#### FL-ENG-21B 06/04 TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan \_\_\_\_\_ Designed By: K. Ballentine Date: 3/9/10 Location: Riverton, Utah Checked By: M. Stayner 3/9/10 Date: Check one: Present ✓ Developed through subarea 4150W2 Check one: T<sub>c</sub> T NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... **Dense Grass** 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L ≤ 100 ft) ..... ft 1 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>1</sub>.....hr 0.01 + -0.01 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 300 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 Compute T<sub>1</sub> ..... hr 11. $T_t = L$ 0.04 + = 0.04 3600 V

Channel Flow		Segment ID
12. Cross sectional flow	area, a	ft <sup>2</sup>
15. Wetted perimeter, 1	w	
14. Hydraulic radius, r =	a Compute r	ft
	Pw	
15. Channel Slope, s		ft/ft
16. Manning's Roughne	ss Coeff., n	
17. V = $1.49 r^{2/3} s^{1/2}$	Compute V	ft/s
n		
18. Flow length, L		ft
19. Τ <sub>ι</sub> = <u>L</u>	Compute T <sub>1</sub>	hr
3600 V		

3.1	
6.3	
0.5	

18. F	low length, L		ft	1,050			
19. 7	ī = <u> </u>	Compute T <sub>1</sub>	hr	0.05	+	= [	0.05
	3600 V						192
20.	Watershed or subare	$a T_c$ or $T_l$ (add $T_l$ in steps 6, 11, a	nd 19			hr	0.10

0.13

TR 55 Worksheet 3: Time of	Concentra	ation (T <sub>c</sub> ) or Travel	Time (T <sub>t</sub> )
Project: Riverton Storm Drain Master Plan	_ Designed	d By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: <u>Riverton, Utah</u>	_ Checked	By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🗸 Developed			
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{41}{2}$	50W3		
NOTES: Space for as many as two segments per flow t or description of flow segments.	ype can be i	used for each workshee	et. Include a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Sec	gment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	1	
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3	
5. Land slope, s	ft/ft	0.010	
6. $T_1 = \frac{0.007 \text{ (nL)}^{0.8}}{P_2^{0.5} \text{ s}^{0.4}}$ Compute $T_1$	hr	0.01 +	= 0.01
Shallow Concetrated Flow Seg	gment ID		
7. Surface description (paved or unpaved)		Paved	
8. Flow length, L	ft	400	
9. Watercourse slope, s	ft/ft	0.010	
10. Average velocity, V (Figure 3-1)	ft/s	2.0	
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub> 3600 V	hr	0.06 +	= 0.06
Channel Flow Segn	nent ID		
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8	
13. Wetted perimeter, P <sub>w</sub>	ft	4.8	
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.4	
15 Channel Slope s	ft/ft	0.005	
16 Manning's Roughness Coeff in		0.02	
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	ft/e	3.6	
n oompute v		3.0	
18 Flow length 1	ft	800	
$19 T_{\rm r} = 1$	hr		
3600 V		0.00	

3600 V 20. Watershed or subarea  $T_c$  or  $T_t$  (add  $T_t$  in steps 6, 11, and 19 ...... hr

TR 55 Worksheet 3: Time of 0	Concentra	ition (T <sub>c</sub> ) or Trave	l Time (T <sub>t</sub> )	
Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentine</u>	Date:	3/9/10
Location: Riverton, Utah	_ Checked	By: <u>M. Stayner</u>	Date:	3/9/10
Check one: Present ✓ Developed				
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>45</u>	70W1			
NOTES: Space for as many as two segments per flow ty or description of flow segments.	ype can be u	ised for each workshe	et. Include a m	ap, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Sec	gment ID			
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L $\leq$ 100 ft)	ft	1		
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3		
5. Land slope, s	ft/ft	0.010		
6. $T_1 = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_1$	hr	0.01 +		= 0.01
Shallow Concetrated Flow Seg	jment ID			
7. Surface description (paved or unpaved)		Paved		
8. Flow length, L	ft	400		
9. Watercourse slope, s	ft/ft	0.010		
10. Average velocity, V (Figure 3-1)	ft/s	2.0		
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.06 +		= 0.06
Channel Flow Segn	nent ID			
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1		
13. Wetted perimeter, P <sub>w</sub>	ft	6.3		
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5		
Pw		Note an en		
15. Channel Slope, s	ft/ft	0.005		
16. Manning's Roughness Coeff., n		0.02		
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	4.4	***	
n		L.		
18. Flow length, L	ft	2,100		
19. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.13 +		= 0.13
3600 V				

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan Designed By: K. Ballentine Date: 3/9/10 Location: Riverton, Utah Checked By: M. Stayner Date: 3/9/10 Check one: Present Developed Check one: ✓ T<sub>c</sub> through subarea 4570W2 Tr NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... **Dense Grass** 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L ≤ 100 ft) ..... ft 1 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute Tt ..... hr 0.01 + = 0.01 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 400 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. $T_t = \_L$ Compute T<sub>t</sub> ..... hr 0.06 + = 0.06 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 1.8 13. Wetted perimeter, Pw ..... ft 4.7 14. Hydraulic radius, r = a Compute r ..... ft 0.4 Pw 15. Channel Slope, s ..... ft/ft 0.005 16. Manning's Roughness Coeff., n ..... 0.02 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V ..... ft/s 3.7 n 18. Flow length, L ..... ft 800 19. $T_1 = L$ Compute T<sub>1</sub>.....hr 0.06 = 0.06 3600 V

Project:Riverton Storm Drain Master Plan	Designed By: K. Ballentine	Date: 3/9/10
Location: Riverton, Utah	Checked By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🗸 Developed		
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{457}{2}$	70W3	
NOTES: Space for as many as two segments per flow ty or description of flow segments.	pe can be used for each worksheet. Inc	clude a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID	
1. Surface description (Table 3-1)	Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)	0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft 1	
4. Two-year 24-hour rainfall, P <sub>2</sub>	in 1.3	
5. Land slope, s	ft/ft 0.010	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr 0.01 +	= 0.01
. 2		
Shallow Concetrated Flow Seg	ment ID	
7. Surface description (payed or unpayed)	Payed	
8. Flow length 1	ft 400	
9 Watercourse slope s	ft/ft 0.010	
10 Average velocity V (Figure 3-1)	ft/c 0.010	
11 T = L Compute T		
3600 V	hr 0.06 +	=0.06
Channel Flow Segm	ent ID	
12. Cross sectional flow area, a	ft <sup>2</sup> 1.8	
13. Wetted perimeter, P <sub>w</sub>	ft 4.7	
14. Hydraulic radius, r = <u>a</u> Compute r	ft 0.4	
15 Channel Slope s	ft/ft 0.005	
16. Manning's Roughness Coeff n	0.005	
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	t/c 0.02	
n Compute v	105 3.7	
18 Flow longth	ft	
	1 <u>900</u>	
3600 V	nr 0.07 +	= 0.07
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19	hr 0.14

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan \_\_\_\_\_ Designed By: K. Ballentine 3/9/10 Date: Location: Riverton, Utah \_\_\_\_\_ Checked By: M. Stayner Date: 3/9/10 Check one: Present ✓ Developed Check one: ✓ T<sub>c</sub> Tr through subarea 4150W4 NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... Dense Grass 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 Flow length, L (total L ≤ 100 ft) ..... ft 1 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>t</sub>.....hr 0.01 + = 0.01 $P_{2}^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 300 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. T<sub>t</sub> =\_\_L Compute T<sub>1</sub> ..... hr 0.04 + = 0.04 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 3.1 13. Wetted perimeter, Pw ..... ft 6.3 14. Hydraulic radius, r = a Compute r ..... ft 0.5 Pw 15. Channel Slope, s ..... ft/ft 0.010 16. Manning's Roughness Coeff., n ..... 0.02 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V ..... ft/s 6.2 n 18. Flow length, L ..... ft 1,100 19. $T_1 = L$ Compute Tt ..... hr 0.05 + = 0.05 3600 V

Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentine</u>	Date:	3/9/10
Location: Riverton, Utah	Checked I	By: <u>M. Stayner</u>	Date:	3/9/10
Check one: Present 🗸 Developed				
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea BF1	-		_	
NOTES: Space for as many as two segments per flow types or description of flow segments.	pe can be u	sed for each worksl	heet. Include a i	map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	ment ID			]
1. Surface description (Table 3-1)		Dense Grass		]
2. Manning's roughness coeff., n (Table 3-1)		0.24		1
3. Flow length, L (total L $\leq$ 100 ft)	ft	30		
4. Two-year 24-hour rainfall, P2	in	1.3		
5. Land slope, s	ft/ft	0.010		9
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr [	0.19 +		= 0.19
Shallow Concetrated Flow Segn	nent ID [			
7. Surface description (paved or unpaved)		Paved		
8. Flow length, L	ft	400		
9. Watercourse slope, s	ft/ft	0.010		
10. Average velocity, V (Figure 3-1)	ft/s	20		
11. $T_t = \underline{L}$ Compute $T_t$	hr	0.06 +		= 0.06
Channel Flow Segme	ent ID			
	L			
12. Cross sectional flow area, a	ft² [	31		
13. Wetted perimeter, Pw	ft	63		
14. Hvdraulic radius, r = a Compute r	ft	0.5		
P	Ľ	0.0		
15. Channel Slope, s	ft/ft	0.005	]	
16. Manning's Roughness Coeff n		0.000		
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	ft/e	0.02		
n		4.4		
18 Flow length L	ft [	1.000		
10 T. = 1 Compute T	IL   ha	1,600		······
	nr 🛛 🗋	0.10 +		= 0.10
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19			hr 0.35

Project: Riverton Storm Drain Master Plan	Designed	d By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🖌 Developed			
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea <u>B</u>	F2		
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be ι	used for each worksheet. I	nclude a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Se	egment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	30	
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3	
5. Land slope, s	ft/ft	0.020	
6. $T_t = \underline{0.007 (nL)}^{0.8}$ Compute $T_t$	hr	0.14 +	= 0.14
Shallow Concetrated Flow Se	gment ID		
7. Surface description (paved or unpaved)		Paved	
8. Flow length, L	ft	300	
9. Watercourse slope, s	ft/ft	0.010	
10. Average velocity, V (Figure 3-1)	ft/s	20	
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.04 +	= 0.04
Channel Flow Seg	ment ID		
	2		
12. Cross sectional flow area, a	ft²	3.1	
13. Wetted perimeter, P <sub>w</sub>	ft	6.3	
14. Hydraulic radius, r = <u>a</u> Compute r P <sub>w</sub>	ft	0.5	
15. Channel Slope, s	ft/ft	0.010	
16. Manning's Roughness Coeff. n		0.010	
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	ft/s	6.2	
n		0.2	
18 Flow length I	ft	000	
19. $T_1 = L$ Compute $T_1$			= [ 0.04 ]
3600 V			0.04
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 17)	1, and 19		hr 0.23

Project: Riverton Storm Drain Master Plan	Designe	d By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: <u>Riverton, Utah</u>	Checked	By: <u>M. Stayner</u>	Date: 3/9/10
Check one: Present 🗸 Developed			
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>BF3</u>			
NOTES: Space for as many as two segments per flow type or description of flow segments.	pe can be	used for each worksheet.	Include a map, schematic,
<u>Sheet Flow</u> (Applicable to $T_c$ only) Segn	ment ID		
1. Surface description (Table 3-1)	•••••	Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	10	
4. Two-year 24-hour rainfall, P2	in	13	
5. Land slope, s	ft/ft	0.010	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08 +	= 0.08
$P_2$ S			
Shallow Concetrated Flow Segm	nent ID		
7 Surface description (pound or upround)			
7. Surface description (paved or unpaved)		Paved	
	ft	300	
9. Watercourse slope, s	ft/ft	0.010	
10. Average velocity, V (Figure 3-1)	ft/s	2.0	
11. $T_t = \underline{L}$ Compute $T_t$	hr	0.04 +	= 0.04
Channel Flow Segme	ent ID		
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8	
13. Wetted perimeter, P <sub>w</sub>	ft	4.7	
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.4	
Pw			
15. Channel Slope, s	ft/ft	0.005	
16. Manning's Roughness Coeff., n	•••••	0.02	
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	37	
n			
18. Flow length, L	ft	400	
19. $T_t = \underline{L}$ Compute $T_t$	hr	0.03 +	= 0.03
3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19		hr 0.15

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan \_\_\_\_\_ Designed By: K. Ballentine 3/9/10 Date: Location: \_Riverton, Utah Checked By: M. Stayner 3/9/10 Date: Check one: ✓ Developed Present Check one: 🗸 T<sub>c</sub> through subarea BF4 Tt NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Seament ID 1. Surface description (Table 3-1) ..... **Dense Grass** 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 Flow length, L (total L ≤ 100 ft) ..... ft 10 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>t</sub>.....hr 0.08 + = 0.08 $P_{2}^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 400 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. $T_1 = L$ Compute Tt ..... hr 0.06 = 0.06 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 1.8 13. Wetted perimeter, Pw ..... ft 4.7 14. Hydraulic radius, r = a Compute r ..... ft 0.4 Pw 15. Channel Slope, s ..... ft/ft 0.005 16. Manning's Roughness Coeff., n ..... 0.02 17. V = 1.49 $r^{2/3} s^{1/2}$ Compute V ..... ft/s 3.7 n 18. Flow length, L ..... ft 500 19. $T_t = \_L$ Compute T<sub>1</sub>.....hr 0.04 + = 0.04 3600 V

Project: Riverton Storm Drain Master Plan	Designed E	By: K. Ballentine	Date:	3/9/10
Location: <u>Riverton</u> , Utah	Checked B	y: <u>M. Stayner</u>	Date:	3/9/10
Check one: Present 🗸 Developed				
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through sub	area <u>CC</u>			
NOTES: Space for as many as two segments or description of flow segments.	per flow type can be use	ed for each worksheet.	Include a map	, schematic,
Sheet Flow (Applicable to $T_c$ only)	Segment ID			
1. Surface description (Table 3-1)	·····	Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L < 100 ft)	ft	30		
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	13		
5. Land slope, s	ft/ft	0.010		
$6 T_{\rm t} = 0.007  (\text{nL})^{0.8}$	br	0.010		
$P_2^{0.5} s^{0.4}$		0.19	=	0.19
Shallow Concetrated Flow	Segment ID		]	
7. Surface description (paved or unpaved)	·····	Paved		
8. Flow length, L	ft	525		
9. Watercourse slope, s	ft/ft	0.010		
10. Average velocity, V (Figure 3-1)	ft/s	20		
11. $T_t = L$ Compute $T_t$	hr h	0.07 +		0.07
3600 V		0.07		0.07
Channel Flow	Segment ID			
		[,		
12. Cross sectional flow area, a	ft²	3.1		
13. Wetted perimeter, P <sub>w</sub>	ft 📙	6.3		
14. Hydraulic radius, r = a Compute r	ft	0.5		
Pw		0.0		
15. Channel Slope, s	ft/ft	0.005		
16. Manning's Roughness Coeff., n		0.02		
17. V = 1.49 $r^{2/3} s^{1/2}$ Compute V	ft/s	1.4		
n		7.7		
18. Flow length	ft [	1 100		
	br			
3600 V		0.07	=	0.07
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in ste	eps 6, 11, and 19		hr	0.33

Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentine</u>	Э	_ Date:	3/9/	10
Location: Riverton, Utah	Checked	By: <u>M. Stayner</u>		_ Date:	3/9/	10
Check one: Present 🖌 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>CF</u>						
NOTES: Space for as many as two segments per flow ty or description of flow segments.	vpe can be u	sed for each work	ksheet. In	clude a ma	p, sc	hematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID					
1. Surface description (Table 3-1)2. Manning's roughness coeff., n (Table 3-1)3. Flow length, L (total L $\leq$ 100 ft)4. Two-year 24-hour rainfall, P25. Land slope, s6. $T_t = 0.007 (nL)^{0.8} P_2^{0.5} s^{0.4}$	ft in ft/ft hr	Dense Grass 0.24 30 1.3 0.010 0.19	+		=	0.19
Shallow Concetrated Flow Segr	ment ID					
7. Surface description (paved or unpaved)8. Flow length, L9. Watercourse slope, s10. Average velocity, V (Figure 3-1)11. $T_t = L$ 3600 V	ft ft/ft ft/s hr	Paved 100 0.010 2.0 0.01	+		=	0.01
Channel Flow Segm	ent ID					
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup> ft ft	1.8 4.7 0.4				
15. Channel Slope, s 16. Manning's Roughness Coeff., n 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/ft  ft/s	0.010 0.02 5.2				
18. Flow length, L 19. $T_t = \underline{L}$ Compute $T_t$	ft hr	500 0.03	+		= [	0.03
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr		0.23

Project: Riverton Storm Drain Master Plan	Designed By: K. Ballentine	Date: <u>3/9/09</u>
Location: <u>Riverton</u> , Utah	Checked By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🗸 Developed		
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>DEL</u>		
NOTES: Space for as many as two segments per flow ty or description of flow segments.	be can be used for each worksheet.	Include a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	ment ID	
1. Surface description (Table 3-1)	Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		10.1 21.10 10.0
3. Flow length, L (total L $\leq$ 100 ft)	ft 30	
4. Two-year 24-hour rainfall, P2	in 1.3	
5. Land slope, s	ft/ft 0.010	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr 0.19 +	= 0.19
$P_2^{0.5} s^{0.4}$		
Shallow Concetrated Flow Segn	nent ID	
7. Surface description (paved or unpaved)	·····Paved	
8. Flow length, L	ft 700	
9. Watercourse slope, s	ft/ft 0.010	
10. Average velocity, V (Figure 3-1)	ft/s 2.0	
11. $T_t = L$ Compute $T_t$	hr 0.10 +	= 0.10
3600 V	0.10	0.10
Channel Flow Segme	ent ID	
12 Cross sectional flow area a	ff <sup>2</sup>	
13 Wetted perimeter P	ft 1.0	
14. Hydraulic radius $r = a$ . Compute r	ft 0.4	
P	0.4	
15. Channel Slope, s	ft/ft 0.005	]
16. Manning's Roughness Coeff n	0.003	
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	ft/s 2.6	
n	3.0	
18. Flow length, L.	ft 0	
19. $T_{i} = 1$ Compute T.	hr	
3600 V		
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19	hr 0.29

Project: Riverton Storm Drain Master Plan	Designed By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: Riverton, Utah	Checked By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🖌 Developed		
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>FS1</u>		
NOTES: Space for as many as two segments per flow typ or description of flow segments.	be can be used for each workshe	eet. Include a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	nent ID	
1. Surface description (Table 3-1)	Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)	0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft 10	
4. Two-year 24-hour rainfall, P2	in 1.3	
5. Land slope, s	ft/ft 0.010	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr 0.08 +	= 0.08
$P_2^{0.5} s^{0.4}$		0.00
Shallow Concetrated Flow Segn	ent ID	
7. Surface description (paved or unpaved)	Paved	
8. Flow length, L	ft 300	
9. Watercourse slope, s	ft/ft 0.010	
10. Average velocity, V (Figure 3-1)	ft/s 2.0	
11. $T_t = L$ Compute $T_1$	hr 0.04 +	= 0.04
3600 V		0.04
Channel Flow Segme	nt ID	
12 Cross sectional flow area a	ft <sup>2</sup>	
13 Wetted perimeter P	ft C.2	
14. Hydraulia radius $r = a$ . Compute r	ft 0.5	
T4. Hydraulic fadius, f – <u>a</u> Compute f	11 0.5	
Fw 15. Channel Sland a	£/£	
10. Magning's Development Cooff		
To. Manning S Roughness Coeff., n	0.02	
$17. V = 1.49 r s^{-1}$ Compute V	tt/s 4.4	
	<i></i>	
18. Flow length, L	tt 300	
19. $T_t = \_L$ Compute $T_t$	hr 0.02 +	= 0.02
3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19	hr 0.14

Project: Riverton Storm Drain Master Plan	Designed	d By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: Riverton, Utah	Checked	By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🖌 Developed			
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>FS2</u>	2		
NOTES: Space for as many as two segments per flow ty or description of flow segments.	rpe can be ι	used for each worksheet.	Include a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segu	ment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	10	
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3	
5. Land slope, s	ft/ft	0.010	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08 +	= 0.08
$P_2^{0.0} s^{0.7}$			
Shallow Concetrated Flow Segr	ment ID		
7. Surface description (paved or unpaved)		Paved	
8. Flow length, L	ft	100	
9. Watercourse slope, s	ft/ft	0.010	
10. Average velocity, V (Figure 3-1)	ft/s	2.0	
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.01 +	= 0.01
3600 V			
Channel Flow Segm	ent ID		
12. Cross sectional flow area, a	ft²	1.8	
13. Wetted perimeter, P <sub>w</sub>	ft	4.7	
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.4	
Pw		PROFESSION	
15. Channel Slope, s	ft/ft	0.005	
16. Manning's Roughness Coeff., n		0.02	
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	3.7	
n		·····	
18. Flow length, L	ft	200	
19. $T_t = \underline{L}$ Compute $T_t$	hr	0.02 +	= 0.02
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19		hr 0.11

Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentine</u>		Date:	3/9/10
Location: Riverton, Utah	Checked I	By: <u>M. Stayner</u>		Date:	3/9/10
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>IHC</u>	;		_		
NOTES: Space for as many as two segments per flow ty or description of flow segments.	vpe can be us	sed for each works	sheet. Inc	lude a map	, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID [				
<ol> <li>Surface description (Table 3-1)</li> <li>Manning's roughness coeff., n (Table 3-1)</li> </ol>		Dense Grass 0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	30			
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3			
5. Land slope, s	ft/ft	0.010			·
6. $T_t = 0.007 (nL)^{0.0}$ Compute $T_t$	hr	0.19 +	•	=	0.19
$P_2^{0.3} s^{0.4}$					
Shallow Concetrated Flow Segr	ment ID [				
7. Surface description (paved or unpaved)		Paved			
8. Flow length, L	ft	400			
9. Watercourse slope, s	ft/ft	0.010			
10. Average velocity, V (Figure 3-1)	ft/s	2.0	x		
11. T <sub>t</sub> = L Compute T <sub>t</sub>	hr	0.06 +		=	0.06
3600 V	L	0.00			0.00
Channel Flow Segm	ent ID				
12. Create another of flow error of	ru2 [				
12. Cross sectional now area, a	It	1.8			
13. Wetted perimeter, $P_w$	ft	4.8			
14. Hydraulic radius, r = <u>a</u> Compute r	ft [	0.4			
15 Channel Slope s	ft/ft	0.005			
16. Manning's Roughness Coeff in		0.000			
$17 V = 1.40 r^{2/3} s^{1/2}$	ft/c	0.02			
n Compute v		3.0			
18 Flow length	ft [	700		]	
	IL   br	/00			[]
$19. I_t - \underline{L}$ Compute $I_t$	nr [	0.05 +		=	0.05
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr	0.30

Project: Riverton Storm Drain Master Plan	Designed B	y: <u>K. Ballentir</u>	ıe	_ Date: _	3/9/	10
Location: <u>Riverton</u> , Utah	Checked By	: M. Stayner		_ Date: _	3/9/	10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>MAS</u>	S1					
NOTES: Space for as many as two segments per flow type or description of flow segments.	pe can be use	d for each wo	rksheet. Ir	nclude a ma	ip, sci	hematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	ment ID					
<ol> <li>Surface description (Table 3-1)</li> <li>Manning's roughness coeff. p (Table 3-1)</li> </ol>		Dense Grass				
2. Manning stoughness coent, if (Table 3-1)		0.24	-			
3. Flow length, L (total L $\leq$ 100 ft)		30				
4. Two-year 24-hour raintail, P <sub>2</sub>	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $I_t = 0.007 (nL)^{30}$ Compute $I_t$	hr	0.19	+ [		= [_	0.19
$P_2$ S						
Shallow Concetrated Flow Segn	nent ID					
7 Surface description (payed or uppayed)						
8 Elow longth 1	£4	Paved				
0. Plow length, L		400	_			
9. Water course slope, s		0.010				
10. Average velocity, V (Figure 3-1)	tt/s	2.0				
$11. I_t = \underline{L}$ Compute $I_t$	hr	0.06	+		=	0.06
Channel Flow Segme	ent ID		1			
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1				
13. Wetted perimeter, P <sub>w</sub>	ft	6.3				
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5				
P <sub>w</sub>			- r			
15. Channel Slope, s	ft/ft	0.005				
16. Manning's Roughness Coeff., n		0.02				
17. $V = 1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	4.4				
n						
18. Flow length, L	ft	800				
19. $T_t = \_L$ Compute $T_t$	hr	0.05	+		=	0.05
$$3600\ V$$ 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19			hr	Γ	0.30

Project: <u>Riverton Storm Drain Master Plan</u>	Designed By: K. Ballentine	Date: _	3/9/10
Location: Riverton, Utah	Checked By: <u>M. Stayner</u>	Date: _	3/9/10

Check one: Present ✓ Developed

Check one:	√	$T_{c}$	Τ <sub>t</sub>	through subarea	MAS
Check one:	V	l c	l t	through subarea	

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to T <sub>c</sub> only) Segment ID	
1. Surface description (Table 3-1)	Dense Grass
2. Manning's roughness coeff., n (Table 3-1)	0.24
3. Flow length, L (total L $\leq$ 100 ft) ft	30
4. Two-year 24-hour rainfall, P <sub>2</sub> in	13
5. Land slope, s ft/ft	0.010
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	0.19 + = 0.19
$P_2^{0.5} s^{0.4}$	0.19
Shallow Concetrated Flow Segment ID	
7. Surface description (paved or unpaved)	Paved
8. Flow length, L ft	400
9. Watercourse slope, s ft/ft	0.010
10. Average velocity, V (Figure 3-1) ft/s	2.0
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub> hr	0.06 + = 0.06
3600 V	
Channel Flow Segment ID	
12. Cross sectional flow area, a ft <sup>2</sup>	3.1
13. Wetted perimeter, $P_w$ ft	6.3
14. Hydraulic radius, r = <u>a</u> Compute r ft	0.5
Pw	
15. Channel Slope, s ft/ft	0.005
16. Manning's Roughness Coeff., n	0.02
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V ft/s	4.4
n	
18. Flow length, L ft	1,000
19. $T_t = \_L$ Compute $T_t$	0.06 + = 0.06
3600 V	
20. watershed or subarea $I_c$ or $I_t$ (add $I_t$ in steps 6, 11, and 19	hr   0.31

Project: Riverton Storm Drain Master Plan	Designed By: K. Ballentine	Date:	3/9/09
Location: Riverton, Utah	Checked By: <u>M. Stayner</u>	Date:	3/9/09

Check one: Present ✓ Developed

Check one:	$\checkmark$	Tc	T,	through subarea	PRI1
	•		A 10	anougnoubarou	

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to T <sub>c</sub> only) Segme	ent ID					
1. Surface description (Table 3-1)	Г	Dense Grass	1			
2. Manning's roughness coeff., n (Table 3-1)		0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	30	+			
4. Two-year 24-hour rainfall, P2	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.19	+		=	0.19
$P_2^{0.5} s^{0.4}$	L				2	0.10
Shallow Concetrated Flow Segme	ent ID	· · · · · · · · · · · · · · · · · · ·				
	L	Nacional Parameters and a second				
7. Surface description (paved or unpaved)	[	Paved	Τ			
8. Flow length, L	ft	400				
9. Watercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0				
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.06	+		=	0.06
3600 V						
Channel Flow Segmer	nt ID					
12 Cross sectional flow area a	ft <sup>2</sup>					
13. Wetted perimeter P	n	1.8				
14. Hydraulic radius r = a. Compute r	n	4.7				
$P_w$	L	0.4				
15. Channel Slope, s	. ft/ft	0.010	Τ			
16. Manning's Roughness Coeff., n		0.02				
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	5.2		5.00 - 10 <u>- 10 - 10 - 10 - 10</u>		
n	L					
18. Flow length, L	ft 🛛 🗌	1,900				
19. $T_t = \_L$ Compute $T_t$	hr	0.10	+		=	0.10
3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, ar	nd 19				hr	0.35

Project: Riverton Storm Drain Master Plan	Designed By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>
Location: Riverton, Utah	Checked By: <u>M. Stayner</u>	Date: <u>3/9/10</u>
Check one: Present 🗸 Developed		
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>PRI</u>	2	
NOTES: Space for as many as two segments per flow typor description of flow segments.	pe can be used for each worksheet. In	clude a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	nent ID	
1. Surface description (Table 3-1)         2. Manning's roughness coeff., n (Table 3-1)         3. Flow length, L (total L $\leq$ 100 ft)         4. Two-year 24-hour rainfall, P2         5. Land slope, s         6. T <sub>t</sub> = $0.007 (nL)^{0.8}$ P2 <sup>0.5</sup> s <sup>0.4</sup> Shallow Concetrated Flow         7. Surface description (paved or unpaved)         8. Flow length, L         9. Watercourse slope, s         10. Average velocity, V (Figure 3-1)         11. T <sub>t</sub> = L         Compute T <sub>t</sub>	Dense Grass           0.24	= 0.19
3600 V Channel Flow Segme	ent ID	
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup> 1.8 ft 4.7 ft 0.4	
15. Channel Slope, s 16. Manning's Roughness Coeff., n 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V n	ft/ft 0.005 0.02 ft/s 3.6	
18. Flow length, L 19. $T_t = \underline{L}$ Compute $T_t$ 3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	ft 0 + hr + + and 19	= 

Project: Riverton Storm Drain Master Plan	Designe	d By: <u>K. Ballentine</u>	_ Date: _	3/9/09
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>	_ Date: _	3/9/09
Check one: Present 🗸 Developed				
Check one: ✔ T <sub>c</sub> Tt through subarea <u>F</u>	PRI3			
NOTES: Space for as many as two segments per flow or description of flow segments.	v type can be	used for each worksheet.	nclude a m	ap, schematic,
Sheet Flow (Applicable to $T_c$ only)	Segment ID			
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L $\leq$ 100 ft)	ft	30		
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3		
5. Land slope, s	ft/ft	0.010		
6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$	hr	0.19 +		= 0.19
Shallow Concetrated Flow S	egment ID		]	
		L		
7. Surface description (paved or unpaved)		Paved		
8. Flow length, L	ft	570		
9. Watercourse slope, s	ft/ft	0.010		
10. Average velocity, V (Figure 3-1)	ft/s	2.0		
11. $T_t = L$ Compute $T_t$	hr	0.08 +		= 0.08
Channel Flow Se	gment ID			
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8		
13. Wetted perimeter. P.	ft	47		
14. Hydraulic radius, r = a Compute r	ft	0.4		
Pw				
15. Channel Slope, s	ft/ft	0.005		
16. Manning's Roughness Coeff., n		0.02		
$17 V = 1.49 r^{2/3} s^{1/2}$ Compute V		3.6		
n <u></u>				
18. Flow length, L	ft	0		
$19 T_{i} = 1 \qquad Compute T_{i}$	hr			= []
3600 V				
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6,	11, and 19		ł	nr 0.27

Broject: Riverton Storm Drain Master Plan	Designed	K. Ballentir			3/0	/00
Project	Designed	л Бу. <u></u>	Date: _	3/9	109	
Location: Riverton, Otan	Checked	By: M. Stayner		Date: _	3/9	/10
Check one: Present 🗸 Developed						
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea <u>F</u>	PRI4					
NOTES: Space for as many as two segments per flow or description of flow segments.	v type can be i	used for each wo	rksheet. I	Include a m	ap, so	chematic
Sheet Flow (Applicable to T <sub>c</sub> only)	egment ID					
1. Surface description (Table 3-1)		Dense Grass				
2. Manning's roughness coeff., n (Table 3-1)		0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	30				
4. Two-year 24-hour rainfall, P2	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$	hr	0.19	+		= [	0.19
Shallow Concetrated Flow S	egment ID					
7. Surface description (paved or unpaved)		Paved				
8. Flow length, L	ft	400	-			
9. Watercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0	-			
11. $T_t = L$ Compute $T_t$	hr	0.06	+		= [	0.06
3600 V					L	0.00
Channel Flow Se	gment ID					
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8				
13. Wetted perimeter, Pw	ft	4.7				
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.4				
Fw 45. Observal Olana	CL / CL					
15. Channel Slope, s	n/n	0.005				
16. Wanning's Roughness Coeff., n		0.02				
$r_{17.} v = 1.49 r^{-1} s^{-1}$ Compute V	tt/s	3.6		]		
18. Flow length, L.	ft	1 800	-1			
19. $T_{i} = L$ Compute $T_{i}$	hr	0.14	+ 1		= Г	0.14
3600 V		0.14			- L	0.14
20. watershed or subarea $I_c$ or $I_t$ (add $I_t$ in steps 6, 7	11, and 19		••••••	h	r	0.38

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan Designed By: K. Ballentine 3/9/09 Date: Location: Riverton, Utah \_\_\_\_\_ Checked By: M. Stayner 3/9/10 Date: Check one: Present ✓ Developed Check one: ✓ T<sub>c</sub> Ti through subarea PRI5 NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... **Dense Grass** 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L $\leq$ 100 ft) ..... ft 30 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>1</sub>.....hr 0.19 + = 0.19 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 700 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. T<sub>t</sub> = <u>L</u> Compute T<sub>t</sub> ..... hr + 0.10 = 0.10 3600 V **Channel Flow** Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 1.8 13. Wetted perimeter, Pw ..... ft 4.7 14. Hydraulic radius, r = a Compute r ..... ft 0.4 Pw 15. Channel Slope, s ..... ft/ft 0.005 16. Manning's Roughness Coeff., n ..... 0.02 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V ..... ft/s 3.6 n 18. Flow length, L ..... ft 0 19. T<sub>t</sub> = <u>L</u> Compute Tt ..... hr + = 3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, and 19 ...... hr

Project: Riverton Storm Drain Master Plan	Designed By: K. Ballentine	Date: _	3/9/10
Location: Riverton, Utah	Checked By: M. Stayner	Date:	3/9/10

Check one: Present ✓ Developed

Check one:	$\checkmark$	Tc	$T_{t}$	through subarea PRI6
	1000	Ŷ		J

NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to $T_c$ only)	Segment ID			 ]	
1. Surface description (Table 3-1)		Dense Grass		]	
2. Manning's roughness coeff., n (Table 3-1)		0.24		1	
3. Flow length, L (total L $\leq$ 100 ft)	ft	30		1	
4. Two-year 24-hour rainfall, P2	in	1.3		1	
5. Land slope, s	ft/ft	0.010		1	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.19	+	] =	0.19
Shallow Concetrated Flow	Segment ID			 ]	
7. Surface description (paved or unpaved)		Paved		]	
8. Flow length, L	ft	400			
9. Watercourse slope, s	ft/ft	0.010			
10. Average velocity, V (Figure 3-1)	ft/s	2.0			
11. $T_t = \underline{L}$ Compute $T_t \dots$ 3600 V	hr	0.06	+	=	0.06
Channel Flow	Segment ID			 ]	
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1			
13. Wetted perimeter, Pw	ft	6.3			
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5			
Pw	L				
15. Channel Slope, s	ft/ft	0.004			
16. Manning's Roughness Coeff., n		0.02			
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	3.9			
n	L				
18. Flow length, L	ft [	3,800			
19. $T_t = \underline{L}$ Compute $T_t$	hr	0.27	+	 =	0.27
20. Watershed or subarea $T_c$ or $T_1$ (add $T_1$ in step	os 6, 11, and 19		••••••	 hr	0.51

#### 1 0

IR 35 WORKSheet 3: Time of	of Concentra	ation (1 <sub>c</sub> ) or Trav	vel lime (T <sub>t</sub> )	
Project: Riverton Storm Drain Master Plan	Designed By: <u>K. Ballentine</u> Checked By: <u>M. Stayner</u>		Date:	3/9/10
Location: Riverton, Utah			Date:	Date:
Check one: Present 🗸 Developed				
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea	PRI8		_	
NOTES: Space for as many as two segments per flow or description of flow segments.	w type can be ι	ised for each worksl	heet. Include a r	nap, schematic
Sheet Flow (Applicable to T <sub>c</sub> only)	Segment ID			]
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L $\leq$ 100 ft)	ft	30		
4. Two-year 24-hour rainfall, P2	in	1.3		
5. Land slope, s	ft/ft	0.020		
6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$	hr	0.14 +		= 0.14
Shallow Concetrated Flow S	egment ID			
7 Surface description (payed or unpayed)		Payed		
8 Flow length 1	ft	200		
9 Watercourse slope s	ft/ft	0.010		
10 Average velocity V (Figure 3-1)	ft/c	0.010		
11 $T_{r} = 1$	105	2.0	T	-
3600 V		0.04		- 0.04
Channel Flow Se	gment ID			
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1		
13. Wetted perimeter, P <sub>w</sub>	ft	6.3		
14. Hydraulic radius, r = <u>a</u> Compute r P <sub>w</sub>	ft	0.5		
15. Channel Slope, s	ft/ft	0.005		
16. Manning's Roughness Coeff., n		0.02		
17. V = 1.49 $r^{2/3} s^{1/2}$ Compute V	ft/s	4.4		
n		<u> </u>		
18. Flow length, L	ft	400		
19. $T_t = \underline{L}$ Compute $T_t$	hr	0.03 +		= 0.03
3600 V				

Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentine</u>	Date: <u>3/9/10</u>		
Location: Riverton, Utah	_ Checked	By: <u>M. Stayner</u>	Date: <u>3/9/10</u>		
Check one: Present 🗸 Developed					
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea PF	RI9				
NOTES: Space for as many as two segments per flow t or description of flow segments.	type can be ι	used for each worksheet.	Include a map, schematic		
Sheet Flow (Applicable to T <sub>c</sub> only) See	gment ID				
1. Surface description (Table 3-1)         2. Manning's roughness coeff., n (Table 3-1)         3. Flow length, L (total L ≤ 100 ft)         4. Two-year 24-hour rainfall, P2         5. Land slope, s         6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$ Shallow Concetrated Flow         Seg         7. Surface description (paved or unpaved)         8. Flow length, L         9. Watercourse slope, s         10. Average velocity, V (Figure 3-1)	ft ft ft/ft hr gment ID ft ft	Dense Grass         0.24         10         1.3         0.010         0.08         +         Paved         300         0.010         2.0	= 0.08		
$11. I_t = \underline{L}$ Compute $I_t$	hr	0.04 +	= 0.04		
Channel Flow Segn	nent ID				
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup> ft ft	3.1 6.3 0.5			
15. Channel Slope, s 16. Manning's Roughness Coeff., n 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/ft ft/s	0.010 0.02 6.2			
18. Flow length, L 19. $T_t = \_L$ Compute $T_t$	ft hr	1,100 0.05 +	= 0.05		
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	, and 19		hr 0.17		
Project: Riverton Storm Drain Master Plan	Designed	d By: <u>K. Ballentine</u>	Date: _	3/9	/10
---	-----------------------------	--	-----------------	--------	-----------
Location: Riverton, Utah	Checked	By: <u>M. Stayner</u>	Date: _	3/9,	/10
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>P</u>	RI10				
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be i	used for each workshe	et. Include a m	ap, so	chematic,
Sheet Flow (Applicable to T <sub>c</sub> only)	egment ID				
1. Surface description (Table 3-1)2. Manning's roughness coeff., n (Table 3-1)3. Flow length, L (total L $\leq$ 100 ft)4. Two-year 24-hour rainfall, P25. Land slope, s6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	ft in ft/ft hr	Dense Grass           0.24           10           1.3           0.010           0.08		=	0.08
Shallow Concetrated Flow Se	egment ID				
<ol> <li>Surface description (paved or unpaved)</li> <li>Flow length, L</li> <li>Watercourse slope, s</li> <li>Average velocity, V (Figure 3-1)</li> <li>T<sub>t</sub> = L Compute T<sub>t</sub></li> <li>3600 V</li> </ol>	ft ft/ft ft/s hr	Paved           300           0.010           2.0           0.04		= [	0.04
Channel Flow Seg	ment ID				
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup> ft ft	3.1 6.3 0.5			
15. Channel Slope, s 16. Manning's Roughness Coeff., n 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/ft ft/s	0.010 0.02 6.2			
18. Flow length, L 19. $T_t = \underline{L}$ Compute $T_t$	ft hr	1,200 0.05 +		= [	0.05
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 1	1, and 19		h	r [	0.17

Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentine</u>	Date: _	3/9/10	
Location: Riverton, Utah	_ Checked E	By: <u>M. Stayner</u>	Date: _	3/9/10	
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>PR</u>	114				
NOTES: Space for as many as two segments per flow ty or description of flow segments.	ype can be us	sed for each workshee	et. Include a m	ap, schematic	,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	gment ID [				
<ol> <li>Surface description (Table 3-1)</li> <li>Manning's roughness coeff., n (Table 3-1)</li> <li>Flow length, L (total L ≤ 100 ft)</li> <li>Two-year 24-hour rainfall, P<sub>2</sub></li> </ol>	ft ft in	Dense Grass 0.24 10 1.3			
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.010 +		= 0.08	
Shallow Concetrated FlowSeg7. Surface description (paved or unpaved)8. Flow length, L8. Flow length, L9. Watercourse slope, s10. Average velocity, V (Figure 3-1)11. $T_t = \_L$ Compute $T_t$	ment ID [ ftftft/ftft/sft/shr	Paved 400 0.010 2.0 0.06 +		= 0.06	
3600 V					
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup>	1.8       4.7       0.4			
15. Channel Slope, s 16. Manning's Roughness Coeff., n 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/ft ft/s	0.005 0.02 3.6			
18. Flow length, L 19. $T_t = \underline{L}$ Compute $T_t$ 3600 V	ft hr	2,300 0.18 +		= 0.18	]
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19		h	r 0.31	1

TR 55 Worksheet 3: Time of	Concentra	ation (T <sub>c</sub> ) or Travel <sup>·</sup>	Time (T <sub>t</sub> )		
Project: Riverton Storm Drain Master Plan	Designed	Designed By: <u>K. Ballentine</u>		3/9/10	
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>	Date:	3/9/10	
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>P</u>	RI15				
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be i	used for each worksheet.	Include a map	o, schematic,	
Sheet Flow (Applicable to T <sub>c</sub> only)	egment ID				
1. Surface description (Table 3-1)		Dense Grass	]		
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	30			
4. Two-year 24-hour rainfall, P2	in	1.3			
5. Land slope, s	ft/ft	0.010			
6. $T_t = \underline{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute $T_t$	hr	0.19 +	=	0.19	
Shallow Concetrated Flow Se	egment ID				
7. Surface description (paved or unpaved)		Paved			
8. Flow length, L	ft	400			
9. Watercourse slope, s	ft/ft	0.010			
10. Average velocity, V (Figure 3-1)	ft/s	2.0			
11. $T_t = \underline{L}$ Compute $T_t$	hr	0.06 +	=	0.06	
Channel Flow Seg	ment ID				
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8			
13. Wetted perimeter, P <sub>w</sub>	ft	4.7			
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.4			
P <sub>w</sub>		r			
15. Channel Slope, s	ft/ft	0.005			
16. Manning's Roughness Coeff., n		0.02			
17. V = $1.49 r^{23} s^{22}$ Compute V	ft/s	3.6			
18. Flow length, L	ft	2,100	1		
19. $T_t = \underline{L}$ Compute $T_t$	hr	0.16 +	=	0.16	
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 1	1, and 19		hr	0.41	

Project: Riverton Storm Drain Master Plan	Designed By:	K. Ballentine	)	Date:	3/9/10	
Location: Riverton, Utah	Checked By:	M. Stayner		Date:	3/9/10	
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{PRI}{T}$	16					
NOTES: Space for as many as two segments per flow ty or description of flow segments.	rpe can be used	for each work	sheet. Incl	lude a ma	p, schen	natic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID					
<ol> <li>Surface description (Table 3-1)</li> <li>Manning's roughness coeff., n (Table 3-1)</li> </ol>	D	ense Grass 0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	10				
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08	+		= 0.	08
$P_2^{0.5} s^{0.4}$						
Shallow Concetrated Flow Segr	ment ID					
7. Surface description (paved or unpaved)		Paved				
8. Flow length, L	ft	300				
9. Watercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0				
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr	0.04	+	=	= 00	04
3600 V	L		L			
Channel Flow Segme	ent ID					
12 Cross sectional flow gross a	<i>t</i> <sub>1</sub> 2					
12. Wetted perimeter D	II	3.1				
13. Wetted perimeter, $P_w$	π	6.3				
14. Hydraulic radius, $r = \underline{a}$ Compute r	ft	0.5		]		
15. Channel Slope s	ft/ft	0.010				
16 Manning's Roughness Coeff in		0.010				
$17 V = 1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	6.2				
n		0.3	l	]		
18. Flow length, L	ft [	1 200		]		
19. $T_{i} = 1$ Compute T.	hr	0.05			-	75-7
3600 V		0.05			0.(	5
20. Watershed or subarea $T_{c}$ or $T_{t}$ (add $T_{t}$ in steps 6, 11, a	and 19			hr	0.	17

			• •	
Project: Riverton Storm Drain Master Plan	_ Designed	d By: <u>K. Ballentine</u>	Date: _	3/9/10
Location: Riverton, Utah	_ Checked	By: M. Stayner	Date: _	3/9/10
Check one: Present 🗸 Developed				
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea Pf	RI17			
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be ι	used for each worksheet.	Include a ma	ap, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Se	gment ID			
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L < 100 ft)	ft	10		
4. Two-year 24-hour rainfall, P2	in	13		
5. Land slope, s	ft/ft	0.010		
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08 +		= 0.00
$P_2^{0.5} s^{0.4}$		0.00		0.08
Shallow Concetrated Flow Seg	gment ID			
7. Surface description (paved or unpaved)		Paved		
8. Flow length, L	ft	400		
9 Watercourse slope is	ft/ft	400		
10 Average velocity V (Figure 3-1)	ft/c	0.010		
11 T = 1	103	2.0		
3600 V		0.06		= 0.06
Channel Flow Segr	nent ID			
12. Cross sectional flow area. a	$\mathrm{ft}^2$	31		
13. Wetted perimeter P	ft	63		
14 Hydraulic radius r = a Compute r	ft	0.5		
$P_w$		0.5		
15. Channel Slope, s	ft/ft	0.010		
16. Manning's Roughness Coeff., n		0.02		
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	6.2		
n				
18. Flow length, L	ft	1 300	]	
19. $T_1 = L$ Compute $T_1$	hr	0.06 +		= 0.06
3600 V	ercenterceto, 1022-			0.00
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11	, and 19		hı	0.19

Project: <u>Riverton Storm Drain Master Plan</u>	_ Designe	d By: K. Ballentine	Date: <u>3/9/10</u>
Location: Riverton, Utah	_ Checked	By: <u>M</u> . Stayner	Date: <u>3/9/10</u>
Check one: Present 🗸 Developed			
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{Pf}{P}$	RI18		
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be	used for each worksheet.	Include a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Se	gment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	30	
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3	
5. Land slope, s	ft/ft	0.020	
6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$	hr	0.14 +	= 0.14
Shallow Concetrated Flow Sec	gment ID		
7. Surface description (paved or unpaved)	•••••	Paved	
8. Flow length, L	ft	300	
9. Watercourse slope, s	ft/ft	0.010	
10. Average velocity, V (Figure 3-1)	ft/s	20	
11. $T_t = \underline{L}$ Compute $T_t$	hr	0.04 +	= 0.04
Channel Flow Segr	ment ID		
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1	
13. Wetted perimeter, P <sub>w</sub>	ft	6.3	
14. Hydraulic radius, r = <u>a</u> Compute r P <sub>w</sub>	ft	0.5	
15. Channel Slope, s	ft/ft	0.010	
16. Manning's Roughness Coeff., n		0.02	
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	62	
n			
18. Flow length, L	ft	600	
19. $T_1 = \underline{L}$ Compute $T_1$	hr	0.03 +	= 0.03
3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11	, and 19		

Project: Riverton Storm Drain Master Plan	Designed	d By: <u>K. Ballen</u>	tine	Date: _	3/9	9/10
Location: <u>Riverton</u> , Utah	Checked	By: <u>M.</u> Stayne	r	Date: _	3/9	0/10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{1}{2}$	PRI19					
NOTES: Space for as many as two segments per flow or description of flow segments.	v type can be ι	used for each w	orksheet.	Include a m	ap, si	chematic
Sheet Flow (Applicable to $T_c$ only)	Segment ID					
1. Surface description (Table 3-1)		Dense Gras	s			
2. Manning's roughness coeff., n (Table 3-1)		0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	10				
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3				
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08	+		= [	0.08
Shallow Concetrated Flow	agmont ID	[				
	egment iD	L				
7. Surface description (payed or unpayed)		David		<u> </u>		
8. Flow length 1	ft	Paved				
9 Watercourse slope s	It	300				
10 Average velocity V (Figure 3-1)	It/It	0.010				
11 T = $\int$ Compute T	11/5	2.0				
3600 V		0.04	_] + [		= [	0.04
Channel Flow Seg	gment ID	[				
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1				
13. Wetted perimeter, P <sub>w</sub>	ft	6.3				
14. Hydraulic radius, r = <u>a</u> Compute r P	ft	0.5				
15. Channel Slope, s	ft/ft	0.010		1		
16. Manning's Roughness Coeff n		0.010				
$17 \text{ V} = 1.49 \text{ r}^{2/3} \text{ s}^{1/2}$	ft/s	0.02				
n		0.3				
18. Flow length, L	ft	000		]		
19. $T_{t} = L$ Compute T.	hr	900				0.0.
3600 V		0.04	] * [		= L	0.04
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 1	1, and 19			hr	ſ	0.16

Project: Riverton Storm Drain Master Plan	Designed E	By: K. Ballentine	Dat	e:	3/9/10
Location: Riverton, Utah	Checked B	y: <u>M. Stayner</u>	Dat	e:3	3/9/10
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>PRI</u>	120				
NOTES: Space for as many as two segments per flow ty or description of flow segments.	vpe can be use	ed for each works	heet. Include	a map,	schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID				
1. Surface description (Table 3-1)		Dense Grass			
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	10			
4. Two-year 24-hour rainfall, P2	in	1.3			
5. Land slope, s	ft/ft	0.010		-	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08 +	1	- =	0.08
$P_2^{0.5} s^{0.4}$			L		0.00
Shallow Concetrated Flow Segr	ment ID				
	<b></b>				
7. Surface description (paved or unpaved)	······	Paved			
8. Flow length, L	ft	400			
9. Watercourse slope, s	ft/ft	0.010			
10. Average velocity, V (Figure 3-1)	ft/s	2.0			
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub> 3600 V	hr	0.06 +		=	0.06
Channel Flow Segm	ent ID				
	Ľ				
12. Cross sectional flow area, a	ft <sup>2</sup>	31	<u></u>		
13. Wetted perimeter, Pw	ft	6.3		-	
14. Hydraulic radius, r = a Compute r	ft	0.5		_	
P <sub>w</sub>	L	0.0			
15. Channel Slope, s	ft/ft	0.010		7	
16 Manning's Roughness Coeff n		0.010		-	
$17 V = 1.49 r^{2/3} s^{1/2}$	ft/e	6.2		-	
n		0.3			
18 Flow length	ft -				
	It	0			[]
2600 V	Dr			=	
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr	0.13

Project: Riverton Storm Drain Master Plan	Designe	d By: <u>K. Ballentine</u>	Date: <u>3/9/</u>	10
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>	Date: <u>3/9/</u>	10
Check one: Present 🗸 Developed				
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>R</u>	B1			
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be	used for each workshee	t. Include a map, sci	hematic,
Sheet Flow (Applicable to T <sub>c</sub> only)	egment ID			
1. Surface description (Table 3-1)2. Manning's roughness coeff., n (Table 3-1)3. Flow length, L (total L $\leq$ 100 ft)4. Two-year 24-hour rainfall, P25. Land slope, s6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$ Shallow Concetrated Flow	ft in ft/ft hr	Dense Grass           0.24           1           1.3           0.010           0.01	=	0.01
7. Surface description (paved or unpaved)8. Flow length, L9. Watercourse slope, s10. Average velocity, V (Figure 3-1)11. $T_t = \underline{L}$ 3600 V	ft ft/ft ft/s hr	Paved           400           0.005           1.5           0.07         +		0.07
Channel Flow Seg	ment ID			
<ul> <li>12. Cross sectional flow area, a</li> <li>13. Wetted perimeter, P<sub>w</sub></li> <li>14. Hydraulic radius, r = <u>a</u> Compute r</li> </ul>	ft <sup>2</sup> ft ft	1.8       4.8       0.4		
15. Channel Slope, s 16. Manning's Roughness Coeff., n 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/ft ft/s	0.003 0.02 2.8		
18. Flow length, L 19. $T_t = \underline{L}$ Compute $T_t$ 3600 V 20. Watershed or subarea T or T (add T in store 6.1)	ft hr	1,600 0.16 +	=	0.16
20. Material of Subarou 10 of 11 (add 11 in steps 0, 1	, anu 19	•••••••••••••••••••••••••••••••••••••••		0.25

Project Riverton Storm Drain Master Plan	Designer	K. Ballentine	Deter	3/0/10
	Designed	и Бу	Date: _	3/3/10
Location: Kivenon, otan	Checked	By: M. Stayner	Date:	3/9/10
Check one: Present 🗸 Developed				
Check one: $\sqrt{T_c}$ T <sub>t</sub> through subarea <sup>1</sup>	RB2			
NOTES: Space for as many as two segments per flow or description of flow segments.	ν type can be ι	used for each worksheet.	Include a ma	ap, schematic
Sheet Flow (Applicable to $T_c$ only)	Segment ID			
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L $\leq$ 100 ft)	ft	1		
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	13		
5. Land slope, s	ft/ft	0.010		
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.01 +		= 0.01
$P_2^{05} s^{04}$				0.01
Shallow Conservated Flow		<u> </u>		
Shallow Concernated Flow S	egment ID			
7. Surface description (paved or unpaved)		Paved		
8. Flow length, L	ft	400		
9. Watercourse slope, s	ft/ft	0.010		
10. Average velocity, V (Figure 3-1)	ft/s	2.0		
11. $T_{1} = L$ Compute T	hr			-
3600 V		0.06		- 0.06
Channel Flow				
<u>Chamerriow</u> Se	gmentio			
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8		
13. Wetted perimeter, P <sub>w</sub>	ft	47		
14. Hydraulic radius, r = a Compute r	ft	0.4		
Pw				
15. Channel Slope, s	ft/ft	0.005		
16. Manning's Roughness Coeff., n		0.02		
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	37		
n		0.1		
18. Flow length, L	ft	1 600		
19. T <sub>t</sub> = L Compute T <sub>t</sub>	hr	0.12 +		- 0.40
3600 V		0.12	]	- 0.12
20. Watershed or subarea $T_{c}$ or $T_{t}$ (add $T_{t}$ in steps 6, 1	1, and 19		hr	0.19

Project: Riverton Storm Drain Master Plan	_ Designed	By: <u>K. Ballentine</u>	Date: _	3/9/10
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>	Date: _	3/9/10
Check one: Present 🗸 Developed				
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{RE}{2}$	33			
NOTES: Space for as many as two segments per flow a or description of flow segments.	type can be u	sed for each worksheet.	Include a m	ap, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Se	gment ID			
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L $\leq$ 100 ft)	ft	1		
4. Two-year 24-hour rainfall, P2	in	1.3		
5. Land slope, s	ft/ft	0.010		
6. $T_t = 0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute $T_t$	hr	0.01 +		= 0.01
Shallow Concetrated Flow Sec	gment ID			
7. Surface description (paved or unpaved)	[	Paved		
8. Flow length, L	ft	400		
9. Watercourse slope, s	ft/ft	0.010		
10. Average velocity, V (Figure 3-1)	ft/s	2.0		
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub> 3600 V	hr	0.06 +		= 0.06
Channel Flow Segr	ment ID [			
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1	·]	
13. Wetted perimeter, P <sub>w</sub>	ft	6.3		
14. Hydraulic radius, r = <u>a</u> Compute r P <sub>w</sub>	ft	0.5		
15. Channel Slope, s	ft/ft 🛛 🗌	0.010		
16. Manning's Roughness Coeff., n	F	0.02		
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	6.3		
n	enanditation and Alaskatiki			
18. Flow length, L	ft 🛛	1 000		
19. $T_t = \_L$ Compute $T_t$	hr	0.04 +		= 0.04
3600 V 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11	, and 19		h	r 0.11

Project: Riverton Storm Drain Master Plan	Designed By: <u>K. Ballentine</u>			_ Date:	3/9/10
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>		_ Date:	3/9/10
Check one: Present 🗸 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>RB</u>	Т				
NOTES: Space for as many as two segments per flow ty or description of flow segments.	rpe can be u	ised for each wo	orksheet. In	clude a map	, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID				
1. Surface description (Table 3-1)		Dense Grass			
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	30			
4. Two-year 24-hour rainfall, P2	in	1.3			
5. Land slope, s	ft/ft	0.010	-		
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.19	]+	=	0.19
$P_2 \sim s^{-1}$					
Shallow Concetrated Flow Segr	ment ID				
		terre average a			
7. Surface description (paved or unpaved)		Paved			
8. Flow length, L	ft	1,000			
9. Watercourse slope, s	ft/ft	0.010			
10. Average velocity, V (Figure 3-1)	ft/s	2.0			
11. $T_t = \_L$ Compute $T_t$	hr	0.14	T+ [	=	0.14
3600 V			J [		0.14
Channel Flow Segme	ent ID		1		
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1			
13. Wetted perimeter, Pw	ft	6.3			
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5			
Pw	1		_1		
15. Channel Slope, s	ft/ft [	0.005			
16. Manning's Roughness Coeff., n		0.02	-		
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	4.4			
n					
18. Flow length, L	ft [	1 200	1	]	
19. $T_1 = L$ Compute $T_1$	hr	0.08	+		
3600 V		0.00	L		0.08
20. Watershed or subarea $T_{\rm c}$ or $T_{\rm t}$ (add $T_{\rm t}$ in steps 6, 11,	and 19			hr	0.41

Project: Riverton Storm Drain Master Plan	_ Designed	d By: <u>K. Ballenti</u>	ne	Date:	3/9	/10
Location: Riverton, Utah	_ Checked	By: <u>M. Stayner</u>		Date:	3/9,	/10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\frac{RC}{2}$	;					
NOTES: Space for as many as two segments per flow to or description of flow segments.	ype can be i	used for each wo	rksheet. li	nclude a ma	ip, sc	chematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	gment ID					
1. Surface description (Table 3-1)		Dense Grass				
2. Manning's roughness coeff., n (Table 3-1)		0.24				
3. Flow length, L (total L $\leq$ 100 ft)	ft	10				
4. Two-year 24-hour rainfall, P <sub>2</sub>	in	1.3				
5. Land slope, s	ft/ft	0.010	1			
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.08	+		= [	0.08
Shallow Concetrated Flow Seg	ment ID					
7. Surface description (paved or unpaved)		Paved				
8. Flow length, L	ft	300				
9. Watercourse slope, s	ft/ft	0.010	-			
10. Average velocity, V (Figure 3-1)	ft/s	20				
11. $T_t = \underline{L}$ Compute $T_t$	hr	0.04	+		= [	0.04
3600 V						0.04
Channel Flow Segm	ent ID		<u> </u>			
		l				
12. Cross sectional flow area, a	ft <sup>2</sup>	31				
13. Wetted perimeter, Pw	ft	63				
14. Hydraulic radius, r = a Compute r	ft	0.5				
P <sub>w</sub>		0.5		l		
15. Channel Slope, s	ft/ft	0.005	Т.,			
16. Manning's Roughness Coeff n	ועונ	0.005	+			
$17 V = 1.49 r^{2/3} s^{1/2}$	ft/c	0.02	-			
n	11/5	4.4				
18 Flow length	fŧ					
19 T = $1$ Compute T	il	500	<u> </u>		_	
3600 V	nr	0.03	+		=	0.03
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr	Г	0.15

0.15 

Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentin</u>	е	_ Date: _	3/9	/10
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>		_ Date: _	3/9	/10
Check one: Present 🗸 Developed						
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>SC</u>			· · · · · · · · · · · · · · · · · · ·			
NOTES: Space for as many as two segments per flow ty or description of flow segments.	rpe can be u	ised for each wor	ksheet. li	nclude a ma	ip, so	chematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	ment ID					
<ol> <li>Surface description (Table 3-1)</li> <li>Manning's roughness coeff., n (Table 3-1)</li> </ol>		Dense Grass				
3. Flow length, L (total L < 100 ft)	ft	30				
4. Two-year 24-hour rainfall, P2	in	1.3	-			
5. Land slope, s	ft/ft	0.010				
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.19	+		= [	0.19
$P_2^{0.5} s^{0.4}$					_	
Shallow Concetrated Flow Segr	nent ID					
		r				
7. Surface description (paved or unpaved)		Paved				
8. Flow length, L	ft	600				
9. Watercourse slope, s	ft/ft	0.010				
10. Average velocity, V (Figure 3-1)	ft/s	2.0				
11. $T_t = \_L$ Compute $T_t$	hr	0.08	+		=	0.08
Channel Flow Segme	ent ID			]		
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1	1			
13. Wetted perimeter, P <sub>w</sub>	ft	6.3				
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5				
Pw	I		1			
15. Channel Slope, s	ft/ft	0.005	1			
16. Manning's Roughness Coeff., n		0.02				
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	4.4				
n .	I					
18. Flow length, L	ft [	1 000	1			
19. T <sub>t</sub> = <u>L</u> Compute T <sub>1</sub>	hr	0.06	+		= [	0.06
3600 V		0.00	L		L	0.00
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19			hr	Γ	0.34

0.34

Project: Riverton Storm Drain Master Plan	Designed By: K. Baller	ntine	Date:3/9/10
Location: <u>Riverton</u> , Utah	Checked By: M. Stayne	er	Date: <u>3/9/10</u>
Check one: Present 🖌 Developed			
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea <u>SCE</u>	1		
NOTES: Space for as many as two segments per flow typ or description of flow segments.	be can be used for each v	vorksheet. Inclu	ide a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segn	nent ID		
1. Surface description (Table 3-1)         2. Manning's roughness coeff., n (Table 3-1)         3. Flow length, L (total L $\leq$ 100 ft)         4. Two-year 24-hour rainfall, P2         5. Land slope, s         6. T <sub>1</sub> = $0.007 (nL)^{0.8}$ $P_2^{0.5} s^{0.4}$ Compute T <sub>1</sub> Segm         7. Surface description (paved or unpaved)         8. Flow length, L         9. Watercourse slope, s         10. Average velocity, V (Figure 3-1)         11. T <sub>t</sub> = L         Compute T <sub>1</sub>	Dense Gras           0.24		= 0.14
Channel FlowSegme12. Cross sectional flow area, a13.13. Wetted perimeter, $P_w$ 14.14. Hydraulic radius, $r = \underline{a}$ Compute r14. $P_w$ 15.15. Channel Slope, s16.16. Manning's Roughness Coeff., n17.17. $V = \underline{1.49 r^{2/3} s^{1/2}}$ Compute V	nt ID $3.1$ ft $6.3$ ft $0.5$ ft/ft $0.005$ ft/s $4.4$		
n 18. Flow length, L 19. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub> 3600 V 20. Watershed or subarea T <sub>c</sub> or T <sub>t</sub> (add T <sub>t</sub> in steps 6, 11, a	ft 800 hr 0.05 nd 19	 ] + [	= 0.05

Project:	_ Designed	By: <u>K. Ballentine</u>	Date: _	3/9/10
Location: Riverton, Utah	_ Checked	By: <u>M. Stayner</u>	Date: _	3/9/10
Check one: Present 🖌 Developed				
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea $\underline{SC}$	CE2			
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be ι	ised for each worksheet.	Include a m	ap, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Se	gment ID			
1. Surface description (Table 3-1)		Dense Grass		
2. Manning's roughness coeff., n (Table 3-1)		0.24		
3. Flow length, L (total L $\leq$ 100 ft)	ft	10		
4. Two-year 24-hour rainfall, P2	in	1.3		
5. Land slope, s	ft/ft	0.020		
6. $T_t = 0.007 (nL)^{0.8}$ $P_0^{0.5} s^{0.4}$ Compute $T_t$	hr	0.06 +		= 0.06
Shallow Concetrated Flow Sec	ament ID			
	ginentid			
7. Surface description (paved or unpaved)		Payed		
8. Flow length L	ft	500		
9 Watercourse slope s	ft/ft	0.010		
10 Average velocity $V$ (Figure 3-1)	it/it	0.010		
11 $T = 1$	IVS	2.0		<b></b>
3600 V		0.07 +		= 0.07
Channel Flow Segr	ment ID			
12. Cross sectional flow area, a	ft <sup>2</sup>	31		
13. Wetted perimeter, P <sub>w</sub>	ft	6.3		
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.5		
Pw 15. Observal Slaves a	<i>c. 1c.</i>	[		
15. Channel Slope, s	ft/ft	0.005		
16. Manning's Roughness Coeff., n		0.02		
17. V = $1.49 r^{20} s''^2$ Compute V	ft/s	4.4		
n	1.0%			
18. Flow length, L	ft	0		
19. $T_t = \_L$ Compute $T_t$	hr	+		=
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11	, and 19		h	0.13

		9 <b>•</b> 1 22 <b>•</b>
Project: Riverton Storm Drain Master Plan	_ Designed By: <u>K. Ballentine</u>	Date: 3/9/10
Location: Riverton, Utah	_ Checked By: <u>M. Stayner</u>	Date: 3/9/10
Check one: Present 🗸 Developed		
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>SF</u>	1	
NOTES: Space for as many as two segments per flow t or description of flow segments.	ype can be used for each workshe	et. Include a map, schematic
Sheet Flow (Applicable to T <sub>c</sub> only) See	jment ID	
1. Surface description (Table 3-1)	Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)	0.24	
3. Flow length, L (total L < 100 ft)		
4. Two-year 24-hour rainfall, P2	in 1.3	
5. Land slope, s	ft/ft 0.010	
6. $T_1 = 0.007 (nL)^{0.8}$ Compute $T_1$	hr 0.19 +	= 0.10
$P_2^{0.5} s^{0.4}$	0.13	0.19
Shallow Concetrated Flow Seg	ment ID	
7. Surface description (paved or unpaved)	Paved	
8. Flow length, L	ft 200	
9. Watercourse slope, s	ft/ft 0.010	
10. Average velocity, V (Figure 3-1)	ft/s 2.0	
11. T <sub>t</sub> = <u>L</u> Compute T <sub>t</sub>	hr 0.03 +	= 0.03
Channel Flow Segn	ient ID	
12. Cross sectional flow area a	$ft^2$ 2.4	
13 Wetted perimeter P	ft 6.2	
14 Hydraulic radius $r = a$ Compute r	ft 0.5	
$P_w$	0.5	
15. Channel Slope, s	ft/ft 0.005	
16. Manning's Roughness Coeff., n	0.02	
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	
n	4,4	
18. Flow length, L	ft	
19 $T_r = 1$ Compute T.	br 0.00	
3600 V	111 U.U2 +	= 0.02
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19	hr 0.24

0.24

0.38

#### TR 55 Worksheet 3: Time of Concentration (T<sub>c</sub>) or Travel Time (T<sub>t</sub>) Project: Riverton Storm Drain Master Plan \_\_\_\_\_ Designed By: K. Ballentine Date: 3/9/10 Location: Riverton, Utah \_\_\_\_\_ Checked By: M. Stayner Date: 3/9/10 Check one: Present ✓ Developed Check one: ✓ T<sub>c</sub> Tr through subarea SF2 NOTES: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments. Sheet Flow (Applicable to T<sub>c</sub> only) Segment ID 1. Surface description (Table 3-1) ..... Dense Grass 2. Manning's roughness coeff., n (Table 3-1) ..... 0.24 3. Flow length, L (total L ≤ 100 ft) ..... ft 30 4. Two-year 24-hour rainfall, P2..... in 1.3 5. Land slope, s ..... ft/ft 0.010 6. $T_t = 0.007 (nL)^{0.8}$ Compute T<sub>1</sub>.....hr 0.19 + -0.19 $P_2^{0.5} s^{0.4}$ Shallow Concetrated Flow Segment ID 7. Surface description (paved or unpaved) ..... Paved 8. Flow length, L ..... ft 400 9. Watercourse slope, s ..... ft/ft 0.010 10. Average velocity, V (Figure 3-1) ..... ft/s 2.0 11. $T_1 = \_L$ Compute T<sub>1</sub> ..... hr 0.06 + = 0.06 3600 V Channel Flow Segment ID 12. Cross sectional flow area, a ..... ft<sup>2</sup> 3.1 13. Wetted perimeter, Pw ..... ft 6.3 14. Hydraulic radius, r = a Compute r ..... ft 0.5 Pw 15. Channel Slope, s ..... ft/ft 0.005 16. Manning's Roughness Coeff., n ..... 0.02 17. V = $1.49 r^{2/3} s^{1/2}$ Compute V ..... ft/s 4.4 n 18. Flow length, L ..... ft 2,100 19. $T_1 = L$ Compute T<sub>t</sub>.....hr 0.13 + = 0.13 3600 V

Project: Riverton Storm Drain Master Plan	Designed	By: <u>K. Ballentine</u>	Date:	3/	/9/09
Location: <u>Riverton</u> , Utah	Checked	By: <u>M. Stayner</u>	Date:	3/	/9/10
Check one: Present 🖌 Developed					
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>SH</u>					
NOTES: Space for as many as two segments per flow type or description of flow segments.	oe can be u	sed for each workshe	eet. Include a n	nap, s	schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Segr	nent ID				
1. Surface description (Table 3-1)		Dense Grass			
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	30			
4. Two-year 24-hour rainfall, P2	in	1.3			
5. Land slope, s	ft/ft	0.010			
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.19 +		=	0.19
$P_2^{0.5} s^{0.4}$	1				0.10
Shallow Conservated Flow					
Station Concernated Flow Segin	ient ID				
7 Surface description (payed or uppayed)	1				
8 Elow length 1	£1	Paved			
0. Wetereourse close a	IL	650			
10 Average velocity V (Figure 2.4)	IV/IL	0.010			
11. T = 1	tt/s	2.0		F	
$II. I_t = \underline{L} \qquad Compute I_t \dots$	hr	0.09 +		=	0.09
3000 V					
Channel Flow Segme	ent ID				
	L				
12. Cross sectional flow area, a	ft <sup>2</sup>	1.8			
13. Wetted perimeter, P <sub>w</sub>	ft	4.7			
14. Hydraulic radius, r = <u>a</u> Compute r	ft	0.4			
P <sub>w</sub>	L				
15. Channel Slope, s	ft/ft [	0.005	1		
16. Manning's Roughness Coeff., n		0.02			
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	3.6			
n	L				
18. Flow length, L	ft [	0 1	]		
19. T <sub>1</sub> = <u>L</u> Compute T <sub>1</sub>	hr F	ĭ		=	
3600 V					
20. Watershed or subarea $T_{\rm c}$ or $T_t$ (add $T_t$ in steps 6, 11, a	and 19		١	٦r	0.28

Project: Riverton Storm Drain Master Plan	_ Designed	d By: <u>K. Ballentine</u>	Date: 3/9/10
Location: <u>Riverton</u> , Utah	_ Checked	By: M. Stayner	Date: 3/9/10
Check one: Present ✓ Developed			
Check one: $\checkmark$ T <sub>c</sub> T <sub>t</sub> through subarea <u>S</u>	NK24		
NOTES: Space for as many as two segments per flow or description of flow segments.	type can be i	used for each workshee	t. Include a map, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Se	egment ID		
1. Surface description (Table 3-1)		Dense Grass	
2. Manning's roughness coeff., n (Table 3-1)		0.24	
3. Flow length, L (total L $\leq$ 100 ft)	ft	30	
4. Two-year 24-hour rainfall, P2	in	1.3	
5. Land slope, s	ft/ft	0.020	
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.14 +	= 0.14
$P_2^{0.5} s^{0.4}$			
Shallow Concetrated Flow Se	gment ID		
7. Surface description (paved or unpaved)		Payed	
8. Flow length, L	ft	400	
9. Watercourse slope, s	ft/ft	0.010	
10 Average velocity V (Figure 3-1)	ft/e	0.010	
$11 T_{i} = 1$		2.0	
3600 V		0.06	= 0.06
Channel Flow Segn	ment ID		
12 Cross sectional flow area a	ft <sup>2</sup>	2.1	
13 Wetted perimeter P	ft	6.2	
14 Hydraulic radius r = a Compute r	ft	0.5	
P.,.		0.5	
15. Channel Slope s	ft/ft	0.005	1
16 Manning's Roughness Coeff n		0.003	
$17 V = 1.49 r^{2/3} s^{1/2}$	ft/c	0.02	
n		4.4	
18 Flow length 1	£4	4.000	
	Il		
$13 \cdot 1 - \underline{L}$ Compute $1_t$	nr	0.06 +	= 0.06
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11	, and 19		hr 0.26

Project: <u>Riverton Storm Drain Master Plan</u>	_ Designed I	By: <u>K. Ballentir</u>	ie	_ Date:	3/9/10
Location: <u>Riverton</u> , Utah	_ Checked B	y: <u>M. Stayner</u>		Date:	3/9/10
Check one: Present 🗸 Developed					
Check one: ✔ T <sub>c</sub> T <sub>t</sub> through subarea SN	K25				
NOTES: Space for as many as two segments per flow ty or description of flow segments.	/pe can be us	ed for each wo	rksheet. Ind	clude a map	, schematic,
Sheet Flow (Applicable to T <sub>c</sub> only) Seg	Iment ID				
1. Surface description (Table 3-1)	<u> </u>	Dense Grass	1		
2. Manning's roughness coeff., n (Table 3-1)		0.24			
3. Flow length, L (total L $\leq$ 100 ft)	ft	30	-		
4. Two-year 24-hour rainfall, P2	in	1.3			
5. Land slope, s	ft/ft	0.010			
6. $T_t = 0.007 (nL)^{0.8}$ Compute $T_t$	hr	0.19	+	=	0.19
P <sub>2</sub> <sup>0.5</sup> s <sup>0.4</sup>	L		L		0.10
Shallow Concernated Flow	mont ID [		1		
		1 X			
7 Surface description (payed or uppayed)	Г	Daviad	1		
8 Flow length 1		Paved			
0. Wetersource close a	IL	300			
10 Average velocity V (Figure 2.1)		0.010			
11. T = 1	tt/s	2.0			
$11. I_1 = \underline{L} \qquad Compute I_1 \dots$	hr	0.04	+	=	0.04
3000 V					
Channel Flow Segm	ent ID		1		
				J	
12. Cross sectional flow area, a	ft <sup>2</sup>	3.1			
13. Wetted perimeter, P <sub>w</sub>	ft	6.3			
14. Hydraulic radius, r = <u>a</u> Compute r	ft 📙	0.5	-		
Pw	L				
15. Channel Slope, s	ft/ft	0.005	T		
16. Manning's Roughness Coeff., n		0.02			
17. V = $1.49 r^{2/3} s^{1/2}$ Compute V	ft/s	4.4			
n	L				
18. Flow length, L	ft	300			
19. Tr = L Compute Tr	hr –	0.02	+		
3600 V		0.02			0.02
20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11,	and 19			hr	0.25