3.0 RESULTS

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3.0 RESULTS

This section presents the results of the analysis performed on the collected data from the five sample locations.

3.1 Flood Discharge

Natural basin data and computed flood discharge values for all study areas are provided in Tables 3-1 through 3-5. A comparison of the flood discharge values indicates that regional analysis estimates vary from approximately 0.7 to 7 times greater than discharge estimates obtained using rainfall-runoff simulation.

3.2 Hydraulic Parameters

Based on the computed flood discharge values and using surveyed cross section and slope values, hydraulic parameters (flow area, velocity, depth, and topwidth) based on normal flow conditions at each cross-section for the various flood events were calculated. These results are presented in Tables 3-6 through 3-10 for the various study areas.

3.3 Channel Bed Sediment

Channel bed sediment data analyzed from the Powder River Basin Area are presented in Table 3-11 and range from well graded gravels to inorganic silt and clay soils.

3.4 Regression Analysis and Confidence Intervals

Regression analysis was performed on all five study areas to assess the use of basin parameters (drainage area, basin slope, and AGI) to predict measured channel slope and computed 10 and 100-year hydraulic parameters (flow area, velocity, depth, and topwidth). Of the independent parameters examined, drainage area and AGI typically provided the smallest standard errors of estimate. By including basin slope in a multiple regression with drainage area in many instances did not increase the predictive accuracy of the regressions significantly due to the often highly correlated nature of basin slope with drainage area.

TABLE 3-1. ROCK SPRINGS AREA DATA

BASIN PARAMETERS

DRAINAGE		Drainage Area (mi2)	Mean Basin Slope BS (ft/mi)	AGI (1) (Acres)	Rainfall Runoff Analysis: Curve Number	Rainfall Runoff Analysis: Minimum Infiltration Rate (in/hr)	Regional Analysis (2): Avg. Ann. Precip. Pr (in)	Regional Analysis (2): Geo-graphical Factor Gf
RAINBOW/	3	0.010	733.33	0.89	83	0.15	9	0.8
COLONY	4	0.073	571.43	5.06			9	0.8
	5	0.033	700.00	2.80			9	0.8
	6	0.122	441.18	6.52			9	0.8
	7	0.093	675.88	7.62			9	0.8
	7a	0.008	578.95	0.56			9	0.8
	7'	0.026	769.23	2.42			9	0.8
	12a	0.005	892.31	0.42			9	0.8
	12b	0.001	777.78	0.09			9	0.8
	13	0.022	676.47	1.80			9	0.8
	15	0.073	417.91	3.70			9	0.8
	16	0.088	448.28	4.78			9	0.8
	16a	0.013	1411.76	2.22			9	0.8
	24	0.031	962.96	3.62			9	0.8
	25	0.014	500.00	0.85			9	0.8
	26	0.020	478.26	1.16			9	0.8
	31	0.005	763.16	0.46			9	0.8
BRIDGER	9-5MW	3.100	199.63	75.01			9	0.8
	LTD	37.300	64.04	289.56			9	0.8
	MDW	29.300	54.73	194.38			9	0.8
	NW	17.400	84.09	177.35			9	0.8
	TDT	8.100	100.78	96.94			9	0.8
	UDT	12.100	88.05	129.14			9	0.8

(1) AGI is the product of Drainage Area and mean Basin Slope

(2) Parameters Pr and Gf after Lowham (1988)

FLOOD DISCHARGES

DRAINAGE		Rainfall Runoff Analysis: Max 10-Year Discharge (cfs)	Rainfall Runoff Analysis: Max 100-Year Discharge (cfs)	Regional Analysis: 10-Year Discharge (cfs)	Regional Analysis: 100-Year Discharge (cfs)	Ratio of Computed Discharges: 10-Year Regional/ Rainfall-Runoff	Ratio of Computed Discharges: 100-Year Regional/ Rainfall-Runoff
RAINBOW/	3	1.20	4.90	4.4	16.3	3.63	3.33
COLONY	4	6.20	30.50	16.8	57.1	2.71	1.87
	5	3.20	14.90	10.0	35.2	3.12	2.36
	6	8.00	43.30	23.3	77.1	2.91	1.78
	7	8.50	40.40	19.6	65.9	2.31	1.63
	7a	0.90	3.80	3.7	14.0	4.12	3.70
	7'	2.70	12.10	8.5	30.3	3.15	2.51
	12a	0.60	2.50	2.6	10.2	4.37	4.07
	12b	0.10	0.50	0.7	3.2	7.44	6.34
	13	2.10	9.70	7.6	27.3	3.61	2.81
	15	4.60	25.90	16.8	57.1	3.50	2.20
	16	6.20	33.00	18.9	63.8	3.05	1.93
	16a	1.50	6.50	5.2	19.4	3.50	2.99
	24	3.30	14.50	9.6	33.9	2.90	2.34
	25	1.50	6.50	5.5	20.4	3.69	3.13
	26	2.00	9.10	7.1	25.7	3.55	2.82
	31	0.60	2.40	2.6	10.2	4.37	4.24
BRIDGER	9-5MW	173.60	474.20	145.6	422.5	0.84	0.89
	LTD	913.10	2640.20	475.7	1266.6	0.52	0.48
	MDW	545.30	1630.10	427.4	1147.2	0.78	0.70
	NW	523.40	1520.80	337.3	921.2	0.64	0.61
	TDT	300.70	860.70	235.0	658.8	0.78	0.77
	UDT	388.30	1104.20	284.7	787.1	0.73	0.71

TABLE 3-2. HANNA AREA DATA

BASIN PARAMETERS

DRAINAGE		Drainage Area (mi2)	Mean Slope BS (ft/mi)	AGI (1) (Acres)	Rainfall Runoff Analysis: Curve Number	Rainfall Runoff Analysis: Minimum Infiltration Rate (in/hr)	Regional Analysis (2): Avg. Ann. Precip. Pr (in)	Regional Analysis (2): Geo-graphical Factor Gf
HANNA/ELMO	1	0.069	635.45	5.31	80	0.15	9.5	1.4
	1a	0.007	967.74	0.82			9.5	1.4
	2	0.160	473.53	9.18			9.5	1.4
	3	0.052	543.48	3.43			9.5	1.4
	4	0.030	589.29	2.14			9.5	1.4
	5	0.084	363.01	3.70			9.5	1.4
	6	0.022	650.00	1.73			9.5	1.4
	7	0.047	612.50	3.49			9.5	1.4
	8	0.004	409.09	0.20			9.5	1.4
	9	0.004	346.15	0.17			9.5	1.4
ROSEBUD	BS4	3.200	129.03	50.05			9.5	1.4
	PD4	1.500	146.23	26.59			9.5	1.4

(1) AGI is the product of Drainage Area and mean Basin Slope

(2) Parameters Pr and Gf after Lowham (1988)

FLOOD DISCHARGES

DRAINAGE		Rainfall Runoff Analysis: Max 10-Year Discharge (cfs)	Rainfall Runoff Analysis: Max 100-Year Discharge (cfs)	Regional Analysis: 10-Year Discharge (cfs)	Regional Analysis: 100-Year Discharge (cfs)	Ratio of Computed Discharges: 10-Year Regional/ Rainfall-Runoff	Ratio of Computed Discharges: 100-Year Regional/ Rainfall-Runoff
HANNA/ELMO	1	12.90	48.40	29.78	102.25	2.31	2.11
	1a	1.80	5.80	6.17	23.76	3.43	4.10
	2	22.80	92.30	50.52	166.90	2.22	1.81
	3	10.30	37.60	24.79	86.24	2.41	2.29
	4	6.80	23.40	17.20	61.44	2.53	2.63
	5	13.10	52.00	33.78	114.91	2.58	2.21
	6	4.90	17.10	13.92	50.51	2.84	2.95
	7	9.80	35.10	23.20	81.10	2.37	2.31
	8	1.00	3.30	4.07	16.14	4.07	4.89
	9	1.00	3.30	4.07	16.14	4.07	4.89
ROSEBUD	BS4	90.00	405.10	271.81	794.50	3.02	1.96
	PD4	44.60	286.80	182.66	549.57	4.10	1.92

TABLE 3-3. KEMMERER AREA DATA

BASIN PARAMETERS

DRAINAGE		Drainage Area (mi2)	Mean Basin Slope BS (ft/mi)	AGI (1) (Acres)	Rainfall Runoff Analysis: Curve Number	Rainfall Runoff Analysis: Minimum Infiltration Rate (in/hr)	Regional Analysis (2): Avg. Ann. Precip. Pr (in)	Regional Analysis (2): Geo-graphical Factor Gf
P&M	T2	2.13	240.94	62.21	75	0.1	9.5	0.8
	T4	1.96	316.95	75.30	81	0.1	9.5	0.8
	M11	3.65	212.35	93.95	79	0.1	9.5	0.8

(1) AGI is the product of Drainage Area and mean Basin Slope
(2) Parameters BS and Gf after Lowham (1988)

FLOOD DISCHARGES

DRAINAGE		Rainfall Runoff Analysis: Max 10-Year Discharge (cfs)	Rainfall Runoff Analysis: Max 100-Year Discharge (cfs)	Regional Analysis: Max 10-Year Discharge (cfs)	Regional Analysis: Max 100-Year Discharge (cfs)	Ratio of Computed Discharges: 10-Year Regional/ Rainfall-Runoff	Ratio of Computed Discharges: 100-Year Regional/ Rainfall-Runoff
P&M	T2	39.20	147.70	125.7	373.2	3.21	2.53
	T4	80.30	395.90	120.4	358.4	1.50	0.91
	M11	110.70	355.50	166.1	483.2	1.50	1.36

TABLE 3-4. POWDER RIVER AREA DATA

BASIN PARAMETERS

DRAINAGE		Drainage Area (mi2)	Mean Basin Slope BS (ft/mi)	AGI (1) (Acres)	Rainfall Runoff Analysis: Curve Number	Rainfall Runoff Analysis: Minimum Infiltration Rate (in/hr)	Regional Analysis (2): Basin Slope SB (ft/mi)	Regional Analysis (2): Geo-graphical Factor Gf
Russel Draw	0500	3.13	127.61	48.42	70	0.15	230.6	1.3
	05B0	1.80	157.80	34.41			1071.7	1.3
Unnamed Trib.	07E0	1.29	143.02	22.31			1006.7	1.3
Rawhide Creek	07D3	0.11	279.80	3.73			677.5	1.3
	07D4	0.35	297.43	12.61			715.7	1.3
Lone Tree Prong	12B0	0.68	158.86	13.16			331.7	1.3
	12B1	0.30	174.13	6.42			725.9	1.3
	12B2	0.13	454.45	7.00			1137.2	1.3
Windmill Draw	0900	3.18	119.88	46.27			824.3	1.3
	09D1	0.16	227.31	4.27			682.0	1.3
Unnamed Trib.	19A1	0.17	201.38	4.15			641.4	1.3
Bone Pile Creek	19A2	0.43	221.96	11.65			641.4	1.3
	19B2	0.16	227.21	4.53			932.1	1.3
Theilen Draw	22B0	0.66	148.76	11.90			396.4	1.3
	22C0	0.64	136.67	10.60			173.8	1.3
	22B1	0.09	290.57	3.33			734.6	1.3
	22B2	0.09	212.67	2.43			640.5	1.3
	22C2	0.48	144.98	8.52			533.6	1.3
Unnamed Trib.	30A0	0.27	211.11	6.91			687.6	1.3
Belle Fourche	30B0	0.31	173.65	6.59			722.3	1.3
	30A1	0.08	259.21	2.62			668.9	1.3
E. Fk. Hay Ck	36A0	0.47	143.97	8.18			533.7	1.3
H A Creek	4700	4.99	52.28	31.62			446.3	1.3
	47C0	1.03	131.67	16.39			279.2	1.3
	47C2	0.27	212.50	6.95			438.0	1.3
	47C3	0.10	245.73	3.13			874.6	1.3
Horse Creek	5400	1.25	99.66	15.04			320.7	1.3
	54A2	0.10	194.06	2.36			467.1	1.3
School Creek	64B0	0.49	223.48	13.21			147.9	1.3
	64B1	0.28	190.19	6.36			582.7	1.3
	64B2	0.05	164.94	1.03			499.2	1.3

(1) AGI is the product of Drainage Area and mean Basin Slope

(2) Parameters BS and Gf after Lowham (1988)

TABLE 3-4 (Continued)

FLOOD DISCHARGES

DRAINAGE		Rainfall Runoff Analysis		Regional Analysis		Ratio of Computed Discharges	
		Max 10-Year Discharge (cfs)	Max 100-Year Discharge (cfs)	Max 10-Year Discharge (cfs)	Max 100-Year Discharge (cfs)	10-Year Regional/ Rainfall-Runoff	100-Year Regional/ Rainfall-Runoff
Russel Draw	0500	217.0	813.9	404.4	1230.5	1.86	1.51
	05B0	152.8	589.7	371.7	1346.0	2.43	2.28
Unnamed Trib.	07E0	100.9	377.4	304.9	1100.0	3.02	2.91
Rawhide Creek	07D3	18.8	78.2	58.2	206.4	3.09	2.64
	07D4	52.1	220.7	130.6	459.9	2.51	2.08
Love Tree Prong	12B0	68.5	278.5	179.3	576.0	2.62	2.07
	12B1	36.1	153.0	119.3	421.7	3.31	2.76
	12B2	25.4	104.7	69.5	260.5	2.74	2.49
Windmill Draw	0900	248.5	942.9	487.7	1707.0	1.96	1.81
	09D1	27.6	115.8	74.5	263.7	2.70	2.28
Unnamed Trib.	19A1	34.7	130.7	78.9	276.9	2.27	2.12
Bone Pile Creek	19A2	75.2	286.5	147.6	512.6	1.96	1.79
	19B2	31.5	117.3	81.2	297.1	2.58	2.53
Theilen Draw	22B0	120.3	404.7	179.8	589.6	1.49	1.46
	22C0	102.9	345.1	157.2	470.9	1.53	1.36
	22B1	29.9	97.2	52.6	188.6	1.76	1.94
	22B2	26.8	89.0	51.4	181.8	1.92	2.04
	22C2	81.3	276.3	154.6	525.4	1.90	1.90
Unnamed Trib.	30A0	38.3	159.4	109.4	384.7	2.86	2.41
Belle Fourche	30B0	37.8	158.4	121.6	429.2	3.22	2.71
	30A1	14.0	58.2	47.3	168.4	3.38	2.89
E. Fk. Hay Ck	36A0	81.5	302.5	151.3	514.5	1.86	1.70
H A Creek	4700	226.3	889.7	563.4	1836.1	2.49	2.06
	47C0	86.4	351.2	223.4	701.6	2.59	2.00
	47C2	36.2	161.2	102.7	343.7	2.84	2.13
	47C3	15.8	69.5	58.3	212.8	3.69	3.06
Horse Creek	5400	101.8	360.6	254.9	811.2	2.50	2.25
	54A2	16.5	64.7	51.6	175.9	3.13	2.72
School Creek	64B0	59.0	259.6	129.7	382.8	2.20	1.47
	64B1	33.7	148.3	108.4	374.3	3.22	2.52
	64B2	7.9	34.5	31.2	108.3	3.96	3.14

TABLE 3-5. GLENROCK AREA DATA

BASIN PARAMETERS

DRAINAGE	Drainage Area (mi2)	Mean Basin Slope BS (ft/mi)	AGI (1) (Acres)	Rainfall Runoff Analysis: Curve Number	Rainfall Runoff Analysis: Minimum Infiltration Rate (in/hr)	Regional Analysis (2): Basin Slope SB (ft/mi)	Regional Analysis (2): Geo-graphical Factor Gf
SS-1	2.80	130.58	44.32	80	0.1	498.95	1.1
SS-2	2.90	139.44	49.02			420.19	1.1
SS-3	0.30	276.42	10.05			940.03	1.1
SS-4	0.60	302.48	22.00			442.01	1.1
SS-5	0.30	200.00	7.27			663.20	1.1
SS-6	0.10	326.53	3.96			508.9	1.1
SS-7	3.40	124.63	51.36			64.17	1.1
SS-8	2.80	131.15	44.51			560.42	1.1
SS-9	5.90	123.97	88.66			497.05	1.1
SS-10	2.90	137.72	48.41			604.28	1.1
SS-11	1.10	169.93	22.66			581.54	1.1
SS-12	0.50	229.51	13.91			595.34	1.1

(1) AGI is the product of Drainage Area and mean Basin Slope
(2) Parameters Pr and Gf after Lowham (1988)

FLOOD DISCHARGES

DRAINAGE	Rainfall Runoff Analysis: Max 10-Year Discharge (cfs)	Rainfall Runoff Analysis: Max 100-Year Discharge (cfs)	Regional Analysis: 10-Year Discharge (cfs)	Regional Analysis: 100-Year Discharge (cfs)	Ratio of Computed Discharges: 10-Year Regional/ Rainfall-Runoff	Ratio of Computed Discharges: 100-Year Regional/ Rainfall-Runoff
SS-1	419.28	1158.33	359.44	1191.76	0.86	1.03
SS-2	477.23	1328.42	357.50	1162.74	0.75	0.88
SS-3	83.26	227.53	103.73	377.17	1.25	1.66
SS-4	171.46	466.31	145.68	483.83	0.85	1.04
SS-5	80.14	220.52	98.79	345.67	1.23	1.57
SS-6	40.68	105.96	44.08	151.78	1.08	1.43
SS-7	466.93	1286.60	298.75	789.10	0.64	0.61
SS-8	408.74	1142.05	365.34	1226.88	0.89	1.07
SS-9	778.97	2152.02	526.01	1732.05	0.68	0.80
SS-10	410.49	1140.13	376.15	1273.31	0.92	1.12
SS-11	245.40	684.12	218.11	741.95	0.89	1.08
SS-12	133.89	366.95	135.49	465.88	1.01	1.27

TABLE 3-6. ROCK SPRINGS AREA HYDRAULIC DATA

			Rainfall Runoff Analysis								Regional Analysis							
			Max 10-Year Event				Max 100-Year Event				10-Year Event				100-Year Event			
	DRAINAGE	Channel Slope	FLOW AREA	VEL	DEPTH	TOPWID	FLOW AREA	VEL	DEPTH	TOPWID	FLOW AREA	VEL	DEPTH	TOPWID	FLOW AREA	VEL	DEPTH	TOPWID
RAINBOW/	3	0.072	0.51	2.37	0.30	2.90	2.05	2.39	0.62	11.65	1.82	2.42	0.60	10.06	5.21	3.13	0.82	18.20
COLONY	4	0.077	1.72	3.60	0.63	4.30	5.79	5.27	1.35	6.82	3.69	4.55	1.02	5.87	9.63	5.93	1.85	8.90
	5	0.134	0.92	3.49	0.63	2.43	2.92	5.10	1.28	3.67	2.16	4.64	1.06	3.26	5.70	6.18	1.93	4.87
	6	0.038	2.03	3.94	0.63	4.22	7.23	5.99	1.59	6.57	4.51	5.17	1.14	5.47	11.37	6.78	2.16	8.08
	7	0.051	2.21	3.85	0.66	4.76	6.53	6.19	1.49	5.56	3.92	5.00	1.00	5.15	9.29	7.09	1.97	5.97
	7a	0.070	0.39	2.28	0.27	2.40	1.10	3.45	0.53	2.99	1.08	3.42	0.52	2.97	2.86	4.89	1.03	4.02
	7'	0.048	0.83	3.24	0.63	2.63	2.69	4.50	1.15	4.38	2.04	4.16	1.00	3.90	5.21	5.81	1.68	5.16
	12a	0.128	0.26	2.29	0.21	1.68	0.77	3.24	0.46	2.40	0.80	3.25	0.47	2.44	2.25	4.54	0.96	3.49
	12b	0.131	0.07	1.47	0.11	0.96	0.23	2.17	0.24	1.59	0.30	2.34	0.28	1.79	1.30	2.46	0.61	7.01
	13	0.087	0.68	3.09	0.47	2.33	2.14	4.53	0.98	3.40	1.77	4.29	0.87	3.16	4.67	5.85	1.61	4.49
	15	0.049	1.36	3.52	0.53	3.64	4.88	5.31	1.28	5.71	3.55	4.74	1.03	5.09	10.15	5.63	2.00	10.41
	16	0.026	1.91	3.24	0.94	5.04	6.75	4.89	1.73	9.18	3.99	4.73	1.32	5.76	11.72	5.43	2.15	13.74
	16a	0.058	0.57	2.61	0.36	2.83	1.81	3.59	0.69	4.55	1.53	3.40	0.63	4.31	4.25	4.56	1.14	6.74
	24	0.049	1.08	3.05	0.51	3.86	3.18	4.56	0.98	4.92	2.35	4.09	0.80	4.58	5.90	5.74	1.48	5.89
	25	0.100	0.53	2.84	0.33	2.15	1.54	4.21	0.74	2.84	1.37	4.01	0.67	2.73	3.67	5.56	1.37	3.89
	28	0.078	0.93	2.16	0.20	6.29	2.52	3.62	0.45	6.58	2.16	3.28	0.39	6.52	5.20	4.94	0.84	7.03
	31	0.075	0.27	2.24	0.30	1.77	0.78	3.09	0.53	2.61	0.81	3.20	0.55	2.65	2.34	4.36	1.01	4.02
BRIDGER	9-5MW	0.017	22.94	7.81	2.93	13.57	53.02	10.48	4.76	19.36	20.44	7.28	2.75	12.97	47.96	10.14	4.49	18.52
	LTD	0.004	179.91	5.12	3.35	73.84	467.00	7.37	5.55	221.99	118.33	4.02	2.42	63.43	226.79	5.79	3.94	85.51
	MDW	0.010	59.14	9.65	4.64	17.78	189.21	12.53	8.60	64.84	50.47	8.75	4.15	17.20	100.73	12.82	6.68	27.34
	NW	0.009	60.27	9.51	4.65	20.42	276.29	11.08	7.99	124.16	44.54	8.00	3.74	15.91	128.75	10.51	6.44	66.83
	TDT	0.010	46.23	6.51	3.57	22.89	100.34	8.58	5.52	32.62	38.46	6.11	3.22	21.14	82.36	7.97	4.95	29.74
	UDT	0.010	67.93	5.72	2.60	42.92	134.55	8.21	4.06	48.22	55.80	5.10	2.31	41.88	107.23	7.34	3.48	46.12

TABLE 3-7. HANNA AREA HYDRAULIC DATA

			Rainfall Runoff Analysis								Regional Analysis							
			Max 10-Year Event				Max 100-Year Event				10-Year Event				100-Year Event			
		Channel	FLOW				FLOW				FLOW				FLOW			
	DRAINAGE	Slope	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID
HANNA/ELMO	1	0.016	3.70	3.48	0.96	6.77	10.35	4.67	1.65	12.20	7.21	4.13	1.372	10.27	17.28	5.91	2.184	13.7
	1a	0.106	0.59	3.07	0.47	2.05	1.47	3.94	0.81	3.11	1.54	4.02	0.829	3.15	4.25	5.6	1.542	4.44
	2	0.047	5.06	4.51	1.29	8.32	14.44	6.39	2.23	11.71	9.19	5.49	1.74	9.97	22.81	7.32	2.875	14.03
	3	0.082	2.74	3.75	0.63	6.40	7.37	5.10	1.22	9.21	5.32	4.62	0.987	8.12	13.93	6.19	1.843	11.94
	4	0.109	2.35	2.89	0.61	9.61	6.03	3.88	0.93	13.38	4.76	3.61	0.835	12.21	12.68	4.84	1.357	17.97
	5	0.057	3.12	4.20	0.82	5.78	8.95	5.81	1.63	8.70	6.4	5.28	1.315	7.54	16.7	6.88	2.395	11.58
	6	0.198	1.60	3.06	0.43	5.62	4.19	4.08	0.81	8.13	3.53	3.94	0.727	7.46	9.87	5.12	1.366	12.2
	7	0.090	3.17	3.10	0.51	10.91	7.96	4.41	0.89	13.48	5.94	3.9	0.736	12.91	14.47	5.6	1.343	15.13
	8	0.053	0.41	2.42	0.27	2.32	1.03	3.21	0.49	3.27	1.22	3.37	0.546	3.52	3.44	4.68	1.058	5.11
	9	0.097	0.36	2.77	0.37	1.56	0.87	3.78	0.65	2.01	1.03	4	0.723	2.11	2.89	5.56	1.449	3.04
ROSEBUD	BS4	0.012	23.21	3.88	2.29	28.88	62.63	6.47	3.46	35.64	48.62	5.59	3.063	34.53	96.79	8.21	4.392	37.83
	PD4	0.009	13.42	3.32	1.53	17.45	57.15	6.14	2.90	46.05	40.08	5.22	2.486	37.06	99.6	7.65	3.652	67.91

TABLE 3-8. KEMMERER AREA HYDRAULIC DATA

			Rainfall Runoff Analysis								Regional Analysis							
			Max 10-Year Event				Max 100-Year Event				10-Year Event				100-Year Event			
		Channel	FLOW				FLOW				FLOW				FLOW			
	DRAINAGE	Slope	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID
P&M	T2	0.017	12.05	3.25	0.74	26.36	27.46	5.38	1.31	27.84	24.72	5.08	1.21	27.58	56.52	7.03	2.18	56.90
	T4	0.026	17.55	4.58	1.11	28.16	54.95	7.20	2.30	34.99	23.47	5.13	1.32	29.35	51.21	7.00	2.19	34.37
	M11	0.025	29.14	3.80	1.52	67.41	69.41	5.12	2.05	78.80	39.27	4.23	1.66	75.98	86.39	5.59	2.26	79.93

TABLE 3-9. POWDER RIVER BASIN AREA HYDRAULIC DATA

			Rainfall Runoff Analysis								Regional Analysis							
			Max 10-Year Event				Max 100-Year Event				10-Year Event				100-Year Event			
		Channel	FLOW				FLOW				FLOW				FLOW			
	DRAINAGE	Slope	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID	AREA	VEL	DEPTH	TOPWID
WESCHE																		
Russel Draw	0500	0.0142	37.89	5.73	1.94	31.10	100.08	8.13	3.54	48.47	59.13	6.84	2.57	37.00	137.85	8.93	4.26	56.55
	05B0	0.0112	34.01	4.49	2.03	33.46	93.90	6.28	3.38	55.60	66.38	5.60	2.84	46.75	252.21	5.34	4.78	193.31
Unnamed Trib.	07E0	0.0226	22.85	4.42	1.09	37.88	59.05	6.39	1.95	46.48	50.10	6.09	1.75	44.54	130.04	8.46	3.29	59.64
Rawhide Creek	07D3	0.0100	12.81	1.47	0.36	62.83	31.16	2.51	0.64	68.44	25.87	2.25	0.56	66.87	58.17	3.55	1.01	75.96
	07D4	0.0340	15.77	3.30	0.39	47.20	43.73	5.05	0.93	55.45	29.98	4.36	0.68	51.55	74.33	6.19	1.45	63.25
Love Tree Prong	12B0	0.0070	23.41	2.93	1.33	31.10	59.85	4.85	2.34	39.56	44.81	4.00	1.95	37.55	97.19	5.93	3.23	44.14
	12B1	0.0091	18.68	1.93	0.53	56.40	46.81	3.27	0.99	63.85	39.89	2.99	0.88	62.10	90.28	4.67	1.63	72.67
	12B2	0.0119	13.22	1.92	0.44	49.36	36.70	2.85	0.80	75.58	28.55	2.43	0.69	73.93	64.46	4.04	1.15	78.58
Windmill Draw	0900	0.0115	39.78	6.25	3.06	23.31	99.07	9.52	5.24	30.54	62.79	7.77	3.97	26.66	152.24	11.21	6.85	35.58
	09D1	0.0210	12.17	2.27	0.64	53.51	29.26	3.96	0.95	56.32	22.25	3.35	0.83	55.19	50.07	5.27	1.31	59.57
Unnamed Trib.	19A1	0.0168	10.79	3.21	0.96	26.27	26.50	4.93	1.48	33.79	18.79	4.20	1.24	30.48	46.05	6.01	2.01	41.02
Bone Pile Creek	19A2	0.0187	16.63	4.52	1.61	23.73	41.89	6.87	2.55	29.13	25.90	5.70	1.96	25.86	64.96	7.89	3.29	34.09
	19B2	0.0273	8.14	3.87	0.73	17.73	20.21	5.80	1.38	19.68	15.65	5.19	1.14	18.97	40.14	7.40	2.30	23.93
Thellen Draw	22B0	0.0118	26.01	4.29	1.44	30.45	68.21	5.93	2.49	46.13	37.66	4.77	1.73	34.86	90.54	6.51	2.94	53.27
	22C0	0.0208	16.36	6.29	1.91	13.62	63.32	5.45	3.44	63.62	22.68	6.93	2.35	15.50	75.33	6.25	3.62	66.79
	22B1	0.0395	7.20	4.15	0.91	13.77	17.97	5.41	1.53	20.30	11.16	4.70	1.17	16.66	29.79	6.33	2.06	24.46
	22B2	0.0362	6.02	4.45	0.95	9.96	15.13	5.88	1.69	14.39	9.95	5.17	1.31	12.25	27.07	6.72	2.42	19.41
	22C2	0.0126	22.71	3.58	0.87	34.51	50.71	5.45	1.61	40.71	34.55	4.48	1.20	37.26	78.56	6.69	2.25	46.07
Unnamed Trib.	30A0	0.0255	9.60	3.99	1.00	19.84	26.51	5.59	1.77	29.51	21.34	5.13	1.51	26.24	56.24	6.84	2.57	39.69
Belle Fourche	30B0	0.0208	6.36	5.95	1.78	4.85	29.87	5.30	3.47	34.16	22.88	5.31	3.24	26.06	64.24	6.68	4.30	47.46
	30A1	0.0299	4.93	2.84	0.46	20.35	14.22	4.09	0.84	27.93	12.19	3.88	0.77	26.32	31.57	5.33	1.36	36.38
E. Fk. Hay Ck	36A0	0.0117	19.40	4.20	1.36	21.67	46.83	6.46	2.48	27.14	29.32	5.16	1.79	23.80	67.37	7.64	3.19	30.60
H A Creek	4700	0.0014	71.58	3.16	6.18	20.47	190.43	4.67	11.35	23.50	136.92	4.11	9.06	23.50	294.06	6.24	15.77	23.50
	47C0	0.0045	24.25	3.56	2.34	15.98	62.67	5.60	4.53	18.60	45.94	4.66	3.62	17.94	101.62	6.90	6.62	18.60
	47C2	0.0200	14.51	2.49	2.33	52.69	38.58	4.18	2.72	64.73	29.05	3.53	2.57	62.43	62.88	5.47	3.06	70.25
	47C3	0.0109	6.63	2.38	0.59	16.56	17.37	4.00	1.18	19.92	15.44	3.77	1.06	19.36	37.16	5.73	2.07	24.67
Horse Creek	5400	0.0132	21.80	4.67	1.71	22.91	61.60	5.85	2.90	46.84	46.04	5.54	2.53	37.57	107.41	7.55	3.78	54.82
	54A2	0.0346	4.51	3.66	0.59	11.07	13.01	4.97	1.20	17.28	10.90	4.73	1.07	15.95	28.69	6.13	1.94	25.07
School Creek	64B0	0.0076	14.87	3.97	1.97	12.60	44.78	5.80	3.79	21.46	26.21	4.95	2.77	15.88	69.17	5.53	4.65	35.98
	64B1	0.0134	7.90	4.26	1.29	9.35	22.74	6.52	2.57	13.64	18.26	5.94	2.23	12.55	62.34	6.00	4.42	43.54
	64B2	0.0325	2.75	2.87	0.55	10.80	8.76	3.94	0.95	18.77	6.11	3.85	0.91	18.26	21.15	5.12	1.50	26.68

TABLE 3-10. GLENROCK AREA HYDRAULIC DATA

			Rainfall Runoff Analysis								Regional Analysis							
			Max 10-Year Event				Max 100-Year Event				10-Year Event				100-Year Event			
	DRAINAGE	Channel Slope	FLOW AREA	VEL	DEPTH	TOPWID	FLOW AREA	VEL	DEPTH	TOPWID	FLOW AREA	VEL	DEPTH	TOPWID	FLOW AREA	VEL	DEPTH	TOPWID
JOHNSTON	SS-1	0.0114	132.34	4.68	4.21	105.37	354.30	5.68	5.44	256.61	115.38	4.52	4.03	89.71	363.82	5.71	5.47	261.15
	SS-2	0.0099	76.77	6.22	3.01	43.85	169.25	8.73	4.47	88.85	64.21	5.57	2.72	42.38	147.16	8.54	4.21	79.24
	SS-3	0.0229	23.28	3.58	1.27	30.78	44.94	5.06	1.93	35.10	26.83	3.87	1.39	31.56	63.01	5.99	2.42	38.08
	SS-4	0.0189	38.52	4.45	1.87	38.06	77.31	6.03	2.76	48.16	34.47	4.23	1.76	36.71	79.23	6.11	2.80	48.54
	SS-5	0.0193	30.36	3.38	3.31	28.44	70.75	4.25	4.32	50.17	36.43	3.56	3.51	31.92	99.50	4.66	4.87	54.63
	SS-6	0.0416	14.63	2.78	1.24	20.33	27.90	3.80	1.83	24.50	15.42	2.86	1.27	20.61	35.93	4.22	2.14	26.70
	SS-7	0.0133	58.77	7.94	3.00	30.62	127.70	10.08	4.92	41.21	42.12	7.09	2.43	27.45	87.58	9.01	3.87	35.43
	SS-8	0.0142	62.08	6.58	2.00	46.96	139.60	8.30	3.37	72.01	57.34	6.37	1.90	45.72	149.34	8.40	3.50	76.00
	SS-9	0.0080	398.26	2.17	4.20	146.05	847.31	3.01	6.48	271.65	305.34	1.93	3.56	142.90	710.91	2.80	5.94	234.69
	SS-10	0.0166	59.79	6.87	2.62	42.70	151.64	8.27	4.25	94.19	56.71	6.63	2.55	41.47	178.62	8.22	4.51	113.39
	SS-11	0.0210	37.44	6.55	3.46	21.42	94.73	7.84	5.15	68.62	34.00	6.42	3.30	19.98	109.87	7.70	5.35	82.72
	SS-12	0.0244	52.96	2.53	2.62	43.39	104.55	3.65	3.60	61.31	53.43	2.54	2.63	43.59	124.29	3.98	3.91	66.75

TABLE 3-11. SIEVE ANALYSIS RESULTS, POWDER RIVER BASIN PREMINED CHANNELS

BASIN	X-SEC	SOIL CLASSIFICATION*	% Passin #200	D50 (mm)
Unnamed Trib. Rawhide Creek	07D3	SP	42.50	0.130
	07D4	ML	59.20	0.055
Theilen Draw	22B0	SP	46.10	0.084
	22C0	SP	45.50	0.088
	22B1	ML	84.90	0.037
	22B2	ML	51.60	0.069
	22C2	ML	53.40	0.067
Unnamed Trib. Belle Fourche	30A0	SP	35.10	0.140
	30B0	ML	50.10	0.075
	30A1	ML	51.70	0.070
East Fork Hay Creek	36A0	SP	13.90	0.300
H A Creek	4700	GW	1.40	6.900
	47C0	SW	1.70	4.100
	47C2	SP	25.90	0.210
	47C3	ML	69.70	0.040
Horse Creek	54A2	SP	2.90	0.350
School Creek	64B0	SP	3.70	4.300
	64B1	SW	4.00	1.900
	64B2	SP	14.80	0.730

NOTES:

* SOIL CLASSIFICATION DESCRIPTION
GW - Well-graded gravels and gravel-sand mixtures, little or no fines
ML - Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
SP - Poorly graded sands and gravelly sands, little or no fines
SW - Well-graded sands and gravelly sands, little or no fines

"% Passing #200" represents the percent of sample passing the #200 standard sieve
"D50" represents median grain size in millimeters

During regression analysis, it was noted that drainage area could serve equally as well as an independent basin parameter as AGI; drainage area is simpler to derive than AGI and gave strong correlations with channel slope and hydraulic parameters. Confidence intervals are plotted about the mean regression line and provide a range of acceptable design criteria for the stability test. The stability test is described in an example application in a later section.

3.4.1 Rock Springs Area

The results of the regression analysis for the Rock Springs area are presented in Table 3-12. Figures presenting these results graphically, including one- and two-tailed confidence bands as described in the Methods section, are included in Appendix A.

As can be seen from the correlation coefficients and the graphics, both the rainfall-runoff and regional analyses show very good correlation, with correlation coefficients in the 0.80 to 0.99 range. Of the more important design parameters, (channel slope, flow area, and flow velocity) flow area consistently shows the highest degree of correlation with drainage basin parameters. Nevertheless, good results were also obtained for flow velocity and channel slope as well as the channel shape variables of flow depth and topwidth. It would have been desirable to have a continuous range of drainage basin sizes but the availability of data from mine permit applications limited the selection of drainage basins.

3.4.2 Hanna Area

The results of the regression analysis for the Hanna area are presented in Table 3-13. Appendix B contains figures presenting these results graphically along with one and two-tailed confidence bands.

The Hanna area results mirror those found for the Rock Springs area. Excellent correlation exists between the drainage basin parameters of drainage area and AGI against the hydraulic channel parameters. Flow area, again, exhibits the strongest relationships. However, very high correlation coefficients also were found for channel slope and flow velocity. Similar again to the Rock Springs data set, a more continuous range of drainage basins sizes would have been desirable.

TABLE 3-12. REGRESSION RESULTS FOR ROCK SPRINGS AREA (1)

where, DA = Drainage Area ($mi.^2$)
AGI = Area Gradient Index (acres)

and $Y = Bo * (X)^{B1}$

Dependent Parameter, Y	Independent Parameter, X	B0	B1	Correlation Coefficient, r
Channel Slope	DA	0.021	-0.302	0.95
	AGI	0.474	0.943	0.90
RAINFALL-RUNOFF ANALYSIS				
10-Year Flow Area	DA	10.138	0.685	0.996
	AGI	0.478	0.938	0.99
10-Year Flow Velocity	DA	4.957	0.147	0.94
	AGI	2.557	0.205	0.95
10-Year Flow Depth	DA	1.483	0.339	0.97
	AGI	0.323	0.471	0.98
10-Year Flow Topwidth	DA	10.875	0.340	0.96
	AGI	2.396	0.463	0.94
100-Year Flow Area	DA	29.725	0.668	0.996
	AGI	1.507	0.916	0.99
100-Year Flow Velocity	DA	6.895	0.139	0.92
	AGI	3.689	0.194	0.94
100-Year Flow Depth	DA	2.742	0.312	0.97
	AGI	0.676	0.433	0.98
100-Year Flow Topwidth	DA	21.197	0.400	0.94
	AGI	3.603	0.541	0.92
REGIONAL ANALYSIS				
10-Year Flow Area	DA	13.082	0.510	0.99
	AGI	1.341	0.700	0.99
10-Year Flow Velocity	DA	5.257	0.085	0.80
	AGI	3.568	0.121	0.82
10-Year Flow Depth	DA	1.731	0.227	0.95
	AGI	0.624	0.316	0.96
10-Year Flow Topwidth	DA	11.706	0.270	0.91
	AGI	3.524	0.367	0.90
100-Year Flow Area	DA	30.946	0.469	0.99
	AGI	3.805	0.643	0.98
100-Year Flow Velocity	DA	7.186	0.093	0.81
	AGI	4.702	0.132	0.83
100-Year Flow Depth	DA	2.954	0.205	0.95
	AGI	1.177	0.285	0.95
100-Year Flow Topwidth	DA	18.523	0.266	0.88
	AGI	5.723	0.356	0.85

(1) n = 23 drainages

TABLE 3-13. REGRESSION RESULTS FOR HANNA AREA (1)

where, DA = Drainage Area ($mi.^2$)
AGI = Area Gradient Index (acres)

and $Y = Bo * (X)^{B1}$

Dependent Parameter, Y	Independent Parameter, X	B0	B1	Correlation Coefficient, r
Channel Slope	DA	0.019	-0.355	0.76
	AGI	1.032	1.186	0.73
RAINFALL-RUNOFF ANALYSIS				
10-Year Flow Area	DA	13.981	0.598	0.98
	AGI	1.137	0.739	0.99
10-Year Flow Velocity	DA	3.907	0.056	0.65
	AGI	3.066	0.076	0.72
10-Year Flow Depth	DA	1.608	0.287	0.95
	AGI	0.487	0.348	0.94
10-Year Flow Topwidth	DA	19.113	0.379	0.92
	AGI	3.899	0.470	0.93
100-Year Flow Area	DA	44.071	0.647	0.98
	AGI	2.946	0.793	0.99
100-Year Flow Velocity	DA	6.276	0.010	0.89
	AGI	4.139	0.122	0.89
100-Year Flow Depth	DA	2.774	0.279	0.95
	AGI	0.867	0.338	0.94
100-Year Flow Topwidth	DA	31.615	0.414	0.93
	AGI	5.576	0.511	0.94
REGIONAL ANALYSIS				
10-Year Flow Area	DA	29.201	0.573	0.99
	AGI	2.696	0.689	0.98
10-Year Flow Velocity	DA	5.304	0.067	0.81
	AGI	4.025	0.079	0.78
10-Year Flow Depth	DA	2.233	0.212	0.94
	AGI	0.825	0.282	0.90
10-Year Flow Topwidth	DA	27.023	0.387	0.93
	AGI	5.377	0.472	0.93
100-Year Flow Area	DA	66.648	0.534	0.99
	AGI	1.309	0.641	0.97
100-Year Flow Velocity	DA	7.513	0.075	0.87
	AGI	5.510	0.087	0.82
100-Year Flow Depth	DA	3.393	0.195	0.92
	AGI	1.519	0.227	0.87
100-Year Flow Topwidth	DA	37.617	0.378	0.92
	AGI	7.768	0.459	0.91

(1) n = 12 drainages

3.4.3 Kemmerer Area

As only three basins were available for study in existing permits, the Kemmerer area has insufficient data to develop regression relationships. These data were used to test differences between study areas which are discussed in a later section.

3.4.4 Powder River Basin Area

In addition to the standard regression analyses performed to assess the use of basin parameters to predict measured channel slope and computed hydraulic parameters, channel bed sediment data were available for 19 of the 31 basins. To be consistent, results obtained from the entire data set of 31 basins, without the benefit of bed sediment data will be presented first. Subsequent sections will discuss results based on the use of bed sediment data.

3.4.4.1 General Regressions

The results of the regression analysis are presented in Table 3-14. Figures presenting these results graphically, including confidence bands, are contained in Appendix C.

Regressions for the Powder River Basin show good results for the determination of flow area and flow depth. In contrast with results from previously presented study areas, regression coefficients are less strong for channel slope and flow velocity, and this is reflected in the wider confidence bands determined for these relationships. Very poor regressions were found for the determination of flow topwidth. A portion of the poor relationships encountered may be explained by the fact that this data set encompasses, by far, the largest geographical area of the data sets studied.

The inherent assumption in the regression relationships thus far derived is that the unaccounted for sources of variation within each data set are minimized by selecting basins within a relatively close geographical area. This assumption breaks down when large geographical areas are used.

To this end, methods of dividing the Powder River Basin data set into distinct areas were investigated. The most recent work related to this effect is provided in Jensen (1994) and Anderson (1994). In these related studies, the morphology of drainage basins (shape and size) were found to be influenced primarily by the lithologic unit into which the channels are cut. To

TABLE 3-14. REGRESSION RESULTS FOR POWDER RIVER BASIN AREA (1)

where, DA = Drainage Area ($mi.^2$)
AGI = Area Gradient Index (acres)

and $Y = Bo * (X)^{B1}$

Dependent Parameter, Y	Independent Parameter, X	B0	B1	Correlation Coefficient, r
Channel Slope	DA	0.011	-0.362	0.61
	AGI	0.036	-0.415	0.55
RAINFALL-RUNOFF ANALYSIS				
10-Year Flow Area	DA	24.437	0.556	0.91
	AGI	3.124	0.718	0.91
10-Year Flow Velocity	DA	4.138	0.148	0.49
	AGI	2.484	0.173	0.45
10-Year Flow Depth	DA	1.741	0.448	0.79
	AGI	0.385	0.508	0.69
10-Year Flow Topwidth	DA	24.683	0.084	0.16
	AGI	15.535	0.181	0.27
100-Year Flow Area	DA	65.958	0.550	0.94
	AGI	8.722	0.705	0.94
100-Year Flow Velocity	DA	5.902	0.138	0.58
	AGI	3.605	0.170	0.56
100-Year Flow Depth	DA	3.105	0.449	0.82
	AGI	0.683	0.510	0.72
100-Year Flow Topwidth	DA	37.057	0.099	0.23
	AGI	22.848	0.184	0.34
REGIONAL ANALYSIS				
10-Year Flow Area	DA	44.291	0.491	0.92
	AGI	7.326	0.626	0.91
10-Year Flow Velocity	DA	5.216	0.127	0.54
	AGI	3.366	0.149	0.49
10-Year Flow Depth	DA	2.466	0.415	0.79
	AGI	0.620	0.462	0.68
10-Year Flow Topwidth	DA	30.733	0.061	0.14
	AGI	21.510	0.142	0.25
100-Year Flow Area	DA	110.800	0.487	0.94
	AGI	18.516	0.623	0.93
100-Year Flow Velocity	DA	6.952	0.106	0.56
	AGI	4.820	0.124	0.51
100-Year Flow Depth	DA	4.195	0.405	0.81
	AGI	1.082	0.454	0.71
100-Year Flow Topwidth	DA	47.329	0.099	0.23
	AGI	28.698	0.192	0.35

(1) n = 31 drainages

discuss differences in near surface geology of Powder River Basin channels, a classification of A, B, and C was developed (termed "stratum" by Jensen (1994) and Anderson (1994)). "Stratum A" was applied to channels dominantly within the Fort Union formation with a broad range of basin sizes (0.48-7.43 square miles), "Stratum B" indicates Wasatch and Fort Union formation combined, with smaller basin areas (less than 2.6 square miles), and "Stratum C" was assigned to large basins solely in the Wasatch formation (2.58 to 8.65 square miles).

The "stratum" classification system was tested to see if stronger regression relationships could be derived on the basis of drainage basin lithology. The data set contains nine Strata A basins, nine Strata B basins, and 13 Strata C basins. Only the Strata C basins were significantly different from the rest of the Powder River Basin data. Regression results obtained by splitting the data set along Strata A/B and Strata C division lines show improved correlation coefficients for the Strata A/B data set, but reduced correlation coefficients for the Strata C.

3.4.4.2 Regressions with Channel Bed Sediment Data

Channel bed sediment data were derived for 19 of the 31 basins in the Powder River Basin study area. An analysis of the bed sediment results according to basin strata are summarized below.

	n	Mean D_{50} (mm)	Std. Dev.	Mean % passing #200 sieve	Std. Dev.
Strata A	7	2.60	2.59	17%	25%
Strata B	5	0.19	0.13	31%	22%
Strata C	7	0.08	0.03	55%	14%

These results show the differences between strata found by Anderson (1994) and Jensen (1995), are apparent in the bed sediment data. The Strata A basins have predominantly larger sized bed sediment material, the Strata B consists of a fairly consistent band of mid-sized bed sediments and the Strata C basins contain, quite uniformly, the smallest bed sediment materials.

This may help to explain the previously mentioned findings, that regression correlation coefficients significantly improved with the removal of the Strata C basins and that poorer relationships existed amongst the remaining Strata C basins when considered alone. As the amount of silt and clay material increases in soils, cohesive forces which are difficult to characterize, become more significant.

To test this theory, the 19 basins with bed sediment data were divided according to those with 20% of material passing the #200 sieve. These result are presented in Table 3-15. Correlation coefficients above 0.97 were found for channel slope, flow area and flow depth. Correlation coefficients for flow velocity and topwidth, however, showed marked declines.

Another approach to include bed sediment in the predictive process is to include a bed sediment parameter as an independent variable in a multiple regression. These regression results are also presented in Table 3-15. The resulting correlation coefficient values show the strength of the derived relationships improved with the addition of D_{50} data and statistical test confirmed the significance of this parameter in predicting channel slope, flow area and flow depth. However, good relationships ($R^2 < 0.50$) were not found for flow velocity or flow topwidth.

These results, taken together, seem to support channel sediment as an important parameter in the formation of channels in the Powder River Basin; this probably holds true of all of the study areas. However, differences in channel sediments in smaller geographical areas, typical of the other study areas examined, were insufficient to detract from the strength of the resulting correlation coefficients.

3.4.5 Glenrock Area

The results of the regression analysis are presented in Table 3-16. Figures presenting these results graphically, including one and two-tailed confidence bands are presented in Appendix D. Good correlations were found for channel slope and flow area. Acceptable regression results were obtained for flow depth and topwidth. Flow velocity, however did not show good correlation with either drainage area or AGI. A larger spread of drainage basin sizes may have helped this situation.

TABLE 3-15. REGRESSION RESULTS FOR POWDER RIVER BASIN AREA WITH BED SEDIMENT DATA

Results with channels with less than 20% of bed sediment material passing the #200 sieve (n=7)

where, DA = Drainage Area (mi.^{2})

and $Y = Bo * (X)^{B1}$

Dependent Parameter, Y	Independent Parameter, X	B0	B1	Correlation Coefficient, r
Channel Slope	DA	0.005	-0.734	0.98
RAINFALL-RUNOFF ANALYSIS				
10-Year Flow Area	DA	24.301	0.722	0.99
10-Year Flow Velocity	DA	3.657	0.006	0.06
10-Year Flow Depth	DA	2.455	0.547	0.99
10-Year Flow Topwidth	DA	16.042	0.157	0.72
100-Year Flow Area	DA	65.467	0.683	0.99
100-Year Flow Velocity	DA	5.495	0.030	0.24
100-Year Flow Depth	DA	4.653	0.548	0.99
100-Year Flow Topwidth	DA	20.829	0.064	0.43

Results using D50 of bed sediment material as independent parameter (n=19)

where, DA = Drainage Area (mi.^{2})
D_{50} = Median Grain Size (mm)

and $Y = Bo * (X_1)^{B1} * (X_2)^{B1}$

Dependent Parameter, Y	Independent Parameter, X	B0	B1	B2	Correlation Coefficient, r
Channel Slope	DA, D50	0.006	-0.481	-0.162	0.84
RAINFALL-RUNOFF ANALYSIS					
10-Year Flow Area	DA, D50	25.017	0.699	-0.076	0.93
10-Year Flow Velocity	DA, D50	3.859	0.119	-0.045	0.36
10-Year Flow Depth	DA, D50	2.288	0.465	0.089	0.82
10-Year Flow Topwidth	DA, D50	18.804	0.172	-0.124	0.33
100-Year Flow Area	DA, D50	70.426	0.690	-0.066	0.97
100-Year Flow Velocity	DA, D50	5.445	0.089	-0.017	0.39
100-Year Flow Depth	DA, D50	4.230	0.473	0.090	0.87
100-Year Flow Topwidth	DA, D50	28.981	0.220	-0.176	0.56

TABLE 3-16. REGRESSION RESULTS FOR GLENROCK AREA (1)

where, DA = Drainage Area ($mi.^2$)
AGI = Area Gradient Index (acres)

and $Y = Bo * (X)^{B1}$

Dependent Parameter, Y	Independent Parameter, X	B0	B1	Correlation Coefficient, r
Channel Slope	DA	0.017	-0.318	0.91
	AGI	0.065	-0.426	0.90
RAINFALL-RUNOFF ANALYSIS				
10-Year Flow Area	DA	51.172	0.564	0.84
	AGI	4.778	0.763	0.85
10-Year Flow Velocity	DA	4.345	0.158	0.46
	AGI	2.326	0.201	0.43
10-Year Flow Depth	DA	2.482	0.219	0.68
	AGI	1.069	0.272	0.62
10-Year Flow Topwidth	DA	40.078	0.305	0.67
	AGI	10.759	0.423	0.68
100-Year Flow Area	DA	112.344	0.611	0.87
	AGI	8.834	0.819	0.86
100-Year Flow Velocity	DA	5.710	0.141	0.45
	AGI	3.229	0.184	0.43
100-Year Flow Depth	DA	3.681	0.246	0.79
	AGI	1.410	0.309	0.73
100-Year Flow Topwidth	DA	67.174	0.427	0.75
	AGI	11.509	0.568	0.74
REGIONAL ANALYSIS				
10-Year Flow Area	DA	48.124	0.467	0.79
	AGI	6.818	0.629	0.79
10-Year Flow Velocity	DA	4.240	0.117	0.35
	AGI	2.707	0.145	0.32
10-Year Flow Depth	DA	2.389	0.167	0.57
	AGI	1.288	0.199	0.50
10-Year Flow Topwidth	DA	39.148	0.273	0.62
	AGI	12.105	0.378	0.63
100-Year Flow Area	DA	122.276	0.485	0.79
	AGI	16.574	0.644	0.77
100-Year Flow Velocity	DA	5.864	0.089	0.31
	AGI	4.121	0.114	0.29
100-Year Flow Depth	DA	3.823	0.174	0.68
	AGI	1.975	0.213	0.61
100-Year Flow Topwidth	DA	69.690	0.383	0.69
	AGI	14.467	0.506	0.68

(1) n = 12 drainages

3.5 Geographic Transferability of Regression Results

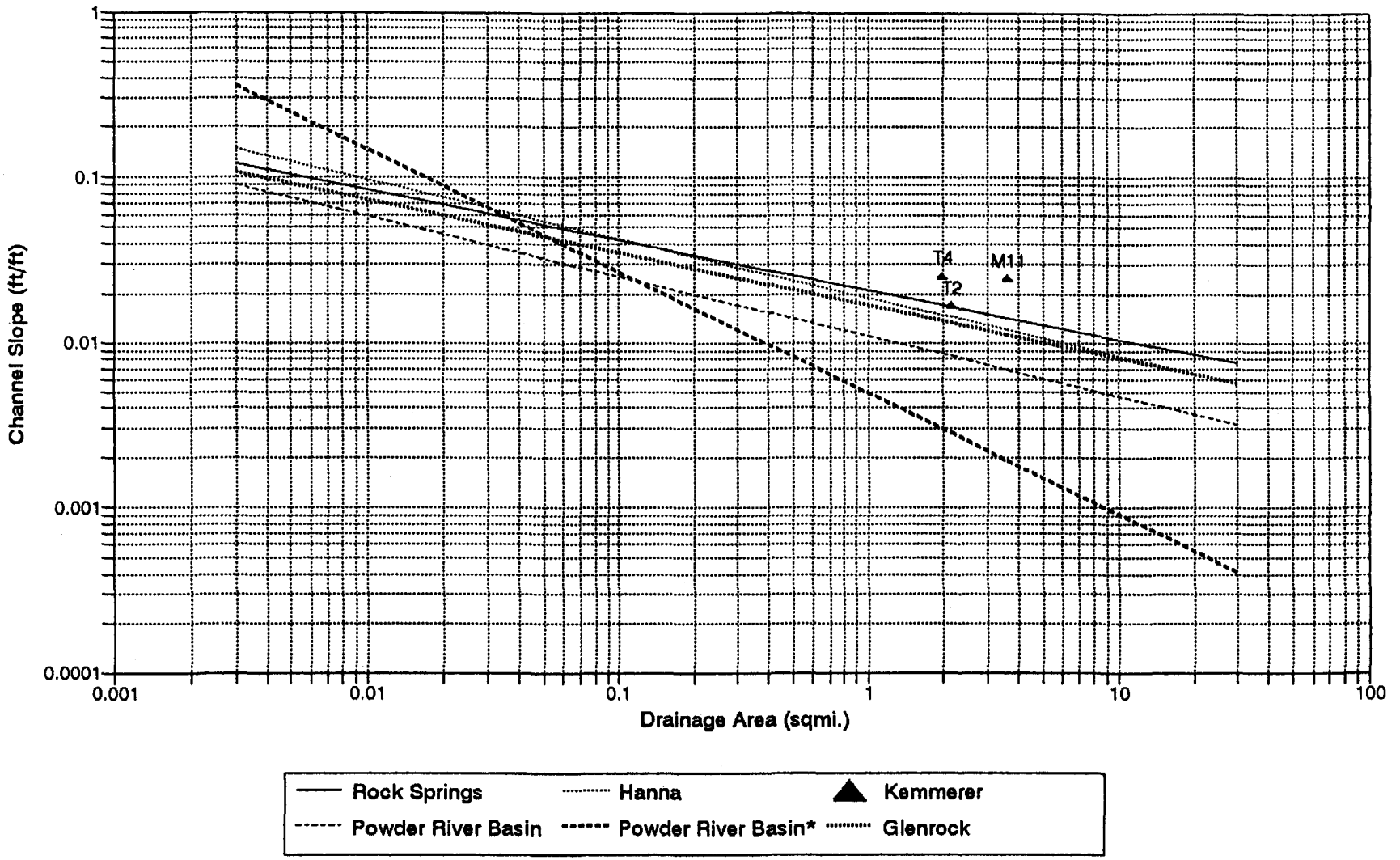
In WWC's 1993 work it was found that there were no significant differences between natural channel data for the Rock Springs and Hanna areas and, therefore, the two sites could be considered one population. Analyses were performed to test whether or not regression equations are applicable to larger areas. Figure 3-1 presents the results for each of the four study areas using drainage area to predict channel slope. As can be seen, and as was borne out in the performance of statistical tests, only the Powder River Basin area is significantly different from the derived relationships for the other study areas (Rock Springs, Hanna, and Glenrock).

Checks of the significance of geographical factors for the remaining hydraulic parameters revealed a variety of results which, in general, showed the existence of differences between study sites, especially where very strong local regression relationships were found.

In general, these results indicate that when available, data from nearby channels is preferred. This result was not completely unexpected. Differences between study sites probably are manifested in a continuous manner. The inherent assumption in the relatively simple relationships thus far derived is that unaccounted for sources of variation within each data set are minimized by selecting basins within a relatively close geographical area. As basins from further distances are grouped together, more opportunities exist for variation. The results presented in Figure 3-1 shows the relationships between drainage area and channel slope to be similar for Rock Springs, Hanna, Kemmerer and Glenrock.

Since the Kemmerer study site lacked sufficient data to determine local regression coefficients, Kemmerer data were tested with the Rock Springs data set to determine the existence of statistical differences. The limited Kemmerer data were not statistically different from the Rock Springs data. Until better local equations are determined for the Kemmerer area, the regression equations and graphs derived for the Rock Springs area be used as a guide to the selection of appropriate ephemeral channel design values for the Kemmerer area.

Figure 3-1. Regression Lines for Channel Slope by Study Area



* Powder River Channels with less than 20% passing the #200 sieve

3.6 Channel Design Example and Stability Evaluation

To illustrate the use of our stability assessment of a channel design based on regression results, a hypothetical example is provided. Suppose a mine in the Powder River Basin is faced with reclaiming an ephemeral channel. The basin to be reclaimed is situated within the range of premined ephemeral channel information presented in this report, has a drainage basin area of 0.5 mi^2, and no bed sediment data are available. Using the graphs presented in Appendix C (Figures C-1 through C-5), the following characteristics are determined based on varying levels of confidence for the 100-year event determined by rainfall-runoff analysis.

	Confidence Level		
Parameter	99%	90%	50%[1]
channel slope, (ft/ft)	.011	.013	.014
flow area, (ft^2)	52	49	45
flow velocity, (fps)	4.8	5.1	5.4
flow depth, (ft)	--	--	2.3
flow topwidth, (ft)	--	--	35

[1] As depicted by mean regression line

Depending on the level of confidence determined suitable for the channel to be reclaimed, then the above parameters represent the criteria to which the complete reclaimed channel design should conform. To complete the design, the designer should also examine hydraulic performance during the 10-year event and consider the suitability of a low-flow guide channel.