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Slate and Johnson Creek
Water Year 2000
Streamflow Analysis

Station SL00-A	**Slate Creek at Slate Lake Outfall**
Station SL00-D	**Slate Creek near Mouth**
Station J000-E	**Johnson Creek at Jualin Mine**

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1.0 Introduction

HDR developed water year 2000 (WY 2000) flow summaries for two stream gage stations on Slate Creek and one stream gage on Johnson Creek. The locations of the gage stations, SL00-A, SL00-D, and J000-E, are shown in Figure 1.

A field crew visits each of the gauging stations approximately once per month. During this visit, a staff gage, permanently positioned at each of the project sites, is used to hand record the water surface elevation in the stream. The field crew measures flow in the stream using a Price AA or pygmy velocity meter. These measurements are used to create rating curves, the relationship between flow and water surface elevation at the gauging site, for each of the gage stations. Water surface elevations using the staff gage are called stage in this report.

A pressure transducer and electronic recorder, located at each of the project sites near the staff gage, is used to continuously record depth of water at one hour intervals. Data is recorded in the form of a height in feet above the transducer and a recording time in minutes. This data is downloaded in the field by Coeur employees approximately once per month and transmitted to HDR in electronic format. Heights recorded by the transducer, called instrument heights in this report, were used to calculate average daily flows at each of the gage stations. S-Plus 2000, a statistical software program, was used to aggregate the instrument measurements into average daily instrument based on the list of recording times and dates.

A correction must be applied to each of the instrument heights before the data can be used to calculate average daily discharge. This correction is the difference in height between the water surface elevation as measured in the field on the staff gage (gage heights) and the corresponding water surface elevation recorded by the pressure transducer. The correction is applied because the rating curves, used to calculate average daily discharge, were developed using stage, not instrument heights.

The water year summaries present discharge in cubic-feet-per-second for each calendar day from station start-up through September 30, 2000 for each of the three gage stations. Also presented are summary statistics such as means, maximums and minimums, and total acre-feet of flow. This data is presented in a format similar to the U.S. Geological Survey Water Resources discharge summaries. This report details how the water year flow summaries for each gage station were created and presents this description as follows:

1. Development of stage-discharge relationships; and
2. Conversion of stage data to flow.

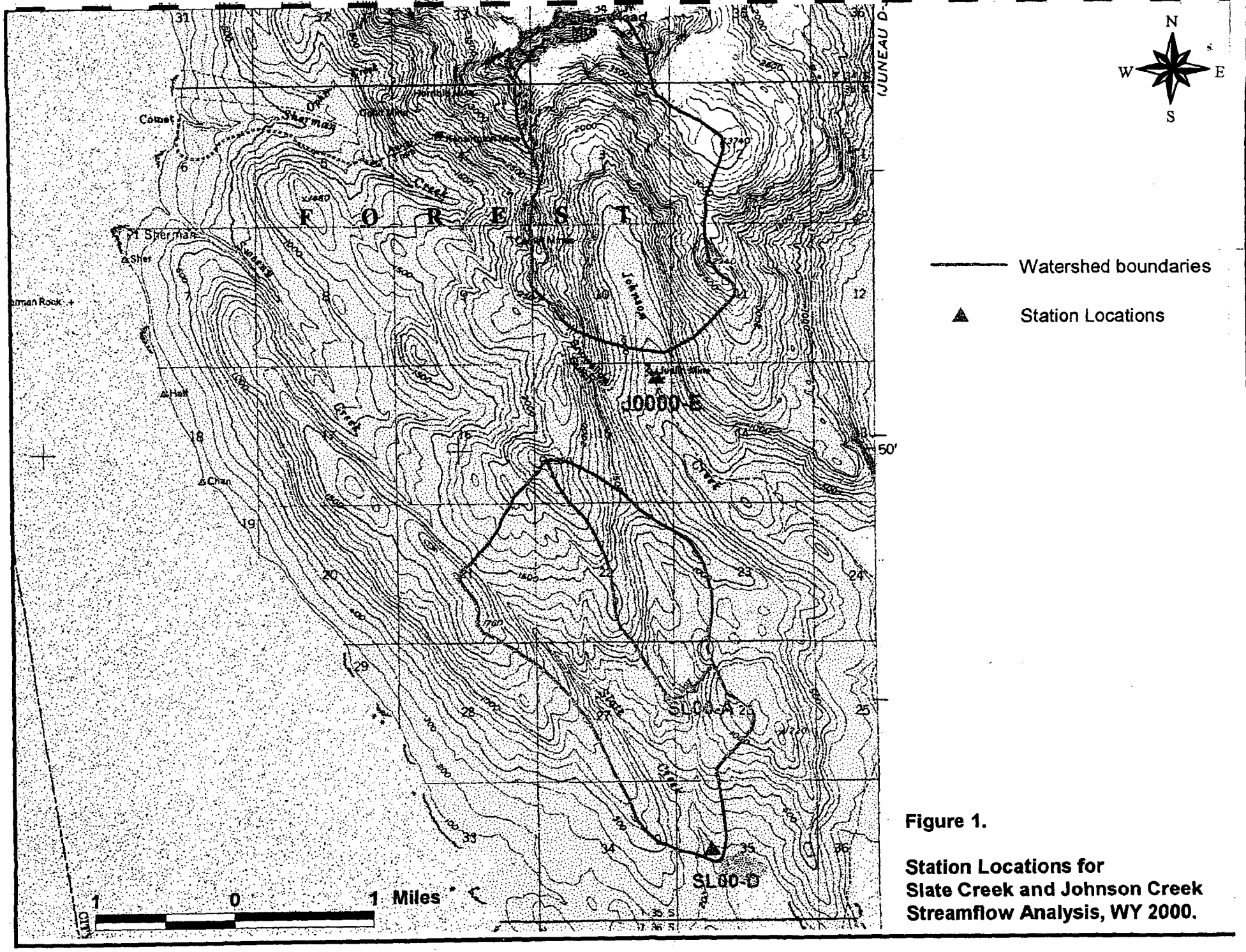

Figure 1.

Station Locations for Slate Creek and Johnson Creek Streamflow Analysis, WY 2000.

2.0 Station SL00-A, At Slate Lake Outfall

Station SL00-A is located on Slate Creek tributary near the mouth of Slate Lake. The Slate Creek tributary flows into Slate Creek, which then flows into Berners Bay, part of the Lynn Canal.

2.1 Development of State-Discharge Relationship

Flow measurements were made approximately on a monthly basis from 6/29/00 to 12/13/00. Table 2-1 lists these measurements for Station SL00-A.

Table 2-1. Summary of measurements used for determining the discharge ratings for Station SL00-A.

Date	Stage (ft)	Flow (cfs)
6/29/00	1.46	6
8/23/00	1.52	7.3
9/13/00	1.45	4.8
10/11/00	1.77	16.8
11/29/00	1.42	3.5
12/13/00	1.32	4.4

The stage and discharge data were log-transformed and plotted. From this plot, one calibration line was evident. Linear regression using the method of the least squares was performed on the data listed in Table 2-1. The regression analysis of the data had a R^2 value of 0.85 and was judged most representative of the WY 2000 data. Table 2-2 summarizes the results of the linear regressions. Figure 2 shows the results of the regression analyses graphically.

Table 2-2. Analysis of Stage-Discharge Relationship for Station SL00-A.

Data	R^2	Equation	Range of Measured Discharge
6/29/00 through 12/13/00	0.85	Flow = $0.5665(\text{depth}^{6.0901})$	3.5 cfs < discharge < 16.8 cfs

- Flow is in cfs; depth is in ft. Depth is stage reading from staff gage.

2.2 Conversion of Stage Data to Flow

The stage-discharge relationship was used to convert the daily stage data to flow estimates. The first step in this conversion was to correct the instrument depth reading based on a comparison of differences between the instrument depth reading and that of the staff gage (see Table 2-3). The median difference of these readings was then applied to the instrument depth readings to obtain a corrected depth from which to convert to flow.

After obtaining the corrected depth, the equation noted in Table 2-2 was used to convert the instrument depth data into flow. A WY 2000 summary of the flow data for Station SL00-A is contained in Appendix A.

Table 2-3. Summary of measurements used to determine the median difference between instrument depth readings and staff gage readings at Station SL00-A for WY 2000.

Date	Recorder (ft)	Staff Gage (ft)	Difference
6/29/00	1.44	1.46	-0.02
9/13/00	1.38	1.45	-0.07
10/11/00	1.67	1.77	-0.10
11/29/00	1.36	1.42	-0.06
12/13/00	1.28	1.32	-0.04
Median Difference			-0.06

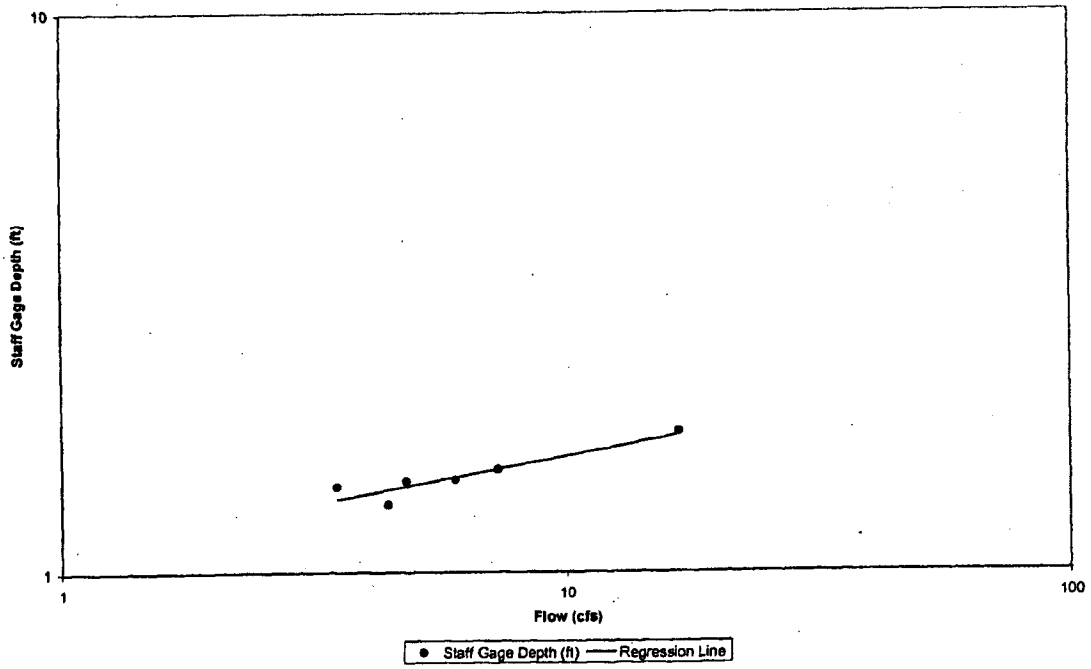

Figure 2. Station SL00-A Stage-Discharge Relationship for WY 2000.

3.0 Station SL00-D, Slate Creek near Mouth

Station SL00-D is located on Slate Creek upstream of its outfall to Berners Bay in Lynn Canal.

Development of State-Discharge Relationship

Flow measurements for development of a stage-discharge relationship have been made approximately on a monthly basis from 6/29/00 to the present. Table 3-1 lists these measurements for Station SL00-D.

Table 3-1. Summary of measurements used for determining the discharge ratings for Station SL00-D.

Date	Stage (ft)	Flow (cfs)
6/29/00	1.31	13.4
7/12/00	1.08	3.6
9/13/00	1.34	15.4
10/11/00	1.73	51.8
11/29/00	1.23	10.6
12/13/00	1.14	6.6

To determine the stage-discharge relationship for Station SL00-D, the stage and flow data were log-transformed and plotted. From this plot, one calibration line was evident. Linear regression using the method of the least squares was performed on all the data, since there were no obvious outliers. The data used is shown in Table 3-1. The data had a R^2 value of 0.98. Table 3-2 summarizes the results of the linear regressions.

Table 3-2. Analysis of Stage-Discharge Relationship for Station SL00-D.

Data	R^2	Equation	Range of Measured Discharge
6/29/00 to 12/13/00	0.98	Flow = $2.9163(\text{depth}^{5.4945})$	3.6 cfs < discharge < 51.8 cfs

* Flow is in cfs; depth is in ft. Depth is stage reading from staff gage.

Figure 3 shows the results of the stage-discharge relationship graphically.

3.1 Conversion of Stage Data to Flow

The daily stage data was converted to flow data. The first step in this conversion was to correct the instrument depth reading based on a comparison of differences between the instrument depth reading and that of the staff gage (Table 3-3). The median difference of these readings was then applied to the instrument depth readings to obtain a corrected depth from which to measure flow.

After obtaining the corrected depth, the equation noted in Table 3-2 was used to convert the instrument depth data into flow. A WY 2000 summary for Station SL00-D of the flow data is contained in Appendix A.

Table 3-3. Summary of measurements used to determine the median difference between instrument depth readings and staff gage readings at Station SL00-D for WY 2000.

Date	Recorder (ft)	Staff Gage (ft)	Difference
6/29/00	1.32	1.31	0.01
9/13/00	1.33	1.34	-0.01
10/11/00	1.72	1.73	-0.01
11/29/00	1.24	1.23	0.01
Median Difference			0

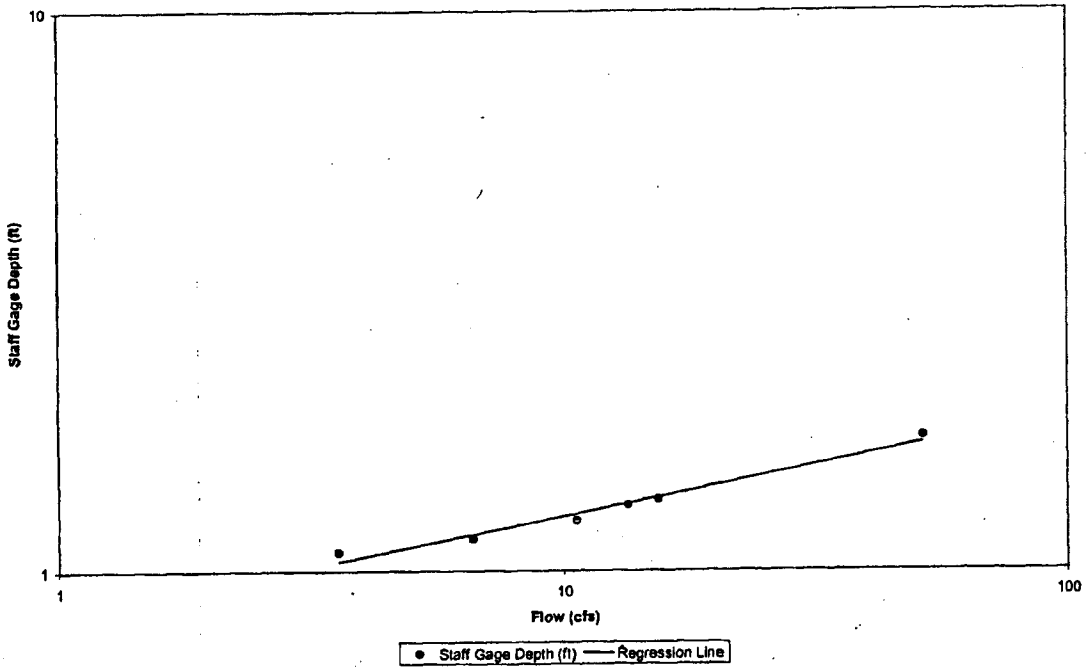

Figure 3. Station SL00-D Stage-Discharge Relationship for WY 2000.

4.0 Station J000-E, Johnson Creek at Jualin Mine

Station J000-E is located on Johnson Creek, right next to the Jualin Mine.

4.1 Development of Stage-Discharge Relationship

Flow measurements for development of a stage-discharge relationship have been made approximately on a monthly basis from 6/30/00 to the present. Table 4-1 lists these measurements for Station J000-E.

Table 4-1. Summary of measurements used for determining the stage-discharge relationship for Station J000-E.

Date	Stage (ft)	Flow (cfs)
6/30/00	1.55	33.1
7/12/00	1.56	34.9
8/23/00	1.58	41.5
9/13/00	1.51	40
11/29/00	1.14	11.7
12/13/00	1.06	13.9

To determine the stage-discharge relationship for Station J000-E, the stage and flow data were log-transformed and plotted. From this plot, one calibration line was evident. Linear regression using the method of the least squares was performed on all the data, since there were no obvious outliers. The data used is shown in Table 4-1. The data had a R^2 value of 0.92. Table 4-2 summarizes the results of the linear regressions.

Figure 4 shows the results of the regression analyses graphically.

Table 4-2. Analysis of Stage-Discharge Relationship for Station J000-E.

Data	R^2	Equation	Range of Measured Discharge
6/30/00 to 12/13/00	0.92	Flow = $9.0627(\text{depth}^{3.2626})$	11.7 cfs < discharge < 41.5 cfs

* Flow is in cfs; depth is in ft. Depth is stage reading from staff gage.

4.2 Conversion of Stage Data to Flow

Having established the stage-discharge relationship to use for WY 2000, the stage data was then converted to flow data. The first step in this conversion was to correct the instrument depth reading based on a comparison of differences between the instrument depth reading and that of the staff gage (see Table 4-3). The median difference of these readings was then applied to the instrument depth readings to obtain a corrected depth from which to measure flow.

After obtaining the corrected depth, the equation noted in Table 4-2 was used to convert the instrument depth data into flow. A WY 2000 summary for Station J000-E of the flow data is contained in Appendix A.

Table 4-3. Summary of measurements used to determine the median difference between instrument depth readings and staff gage readings at Station J000-E for WY 2000.

Date	Recorder (ft)	Staff Gage (ft)	Difference
6/30/00	1.7	1.55	0.15
9/13/00	1.29	1.51	-0.22
11/29/00	0.92	1.14	-0.22
Median Difference			-0.22

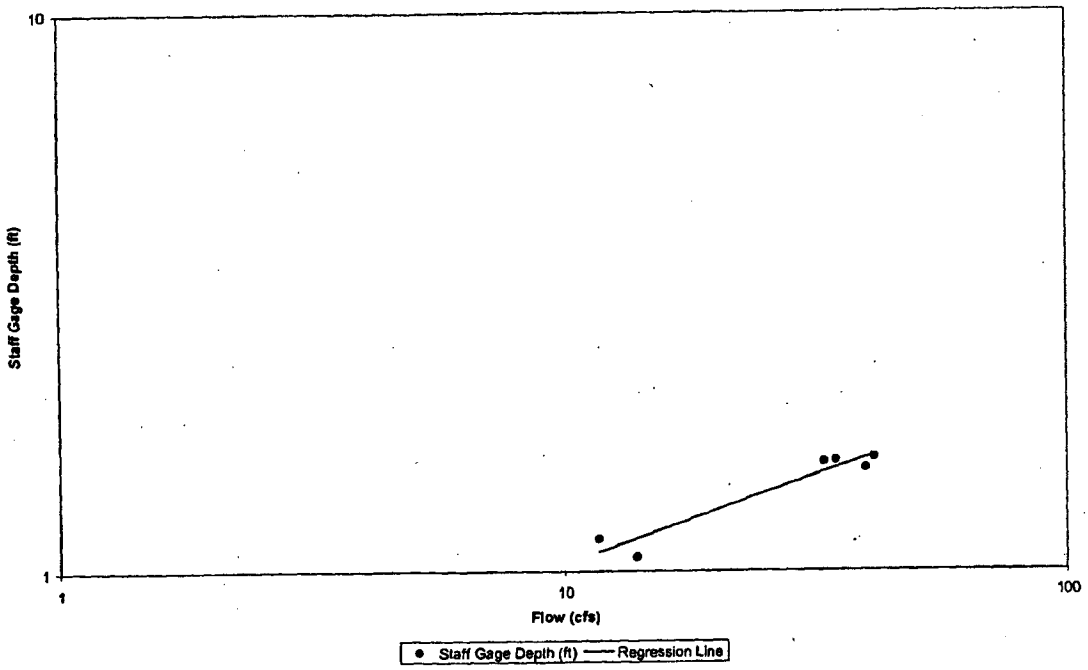

Figure 4. Station J000-E Stage-Discharge Relationship for WY 2000.

5.0 Summary of Stage-Discharge Relationships

5.1 Station SL00-A

Equation 1. Stage-Discharge Relationship used for Station SL00-A, WY 2000.

$$\text{Flow} = 0.5565(\text{depth}^{6.0901})$$

5.2 Station SL00-D

Equation 2. Stage-Discharge Relationship used for Station SL00-D, WY 2000.

$$\text{Flow} = 2.9163(\text{depth}^{5.4945})$$

5.3 Station J000-E

Equation 3. Stage-Discharge Relationship used for Station J000-E, WY 2000.

$$\text{Flow} = 9.0627(\text{depth}^{3.2626})$$

STATION SL00-A
SLATE CREEK AT SLATE LAKE OUTFALL
WATER YEAR 2000

LOCATION: Station SL00-A is located on Slate Creek tributary downstream of the mouth of Slate Lake.

NOTES: An "e" signifies that the data is interpolated.
Station installed June 29, 2000.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1										7.50	5.29	2.52
2										5.05	4.15	2.34
3										3.87	3.43	2.30
4										3.30	3.08	4.30
5										3.00	2.89	9.71
6										2.81	2.80	6.28
7										2.77	2.68	6.93
8										2.64	2.62	5.56
9										2.44	2.53	5.66
10										2.51	2.35	4.61
11										2.57	2.23	7.88
12										2.50	2.16	6.75
13										2.33	2.10	5.56
14										2.22	2.36	22.75
15										2.19	8.55	12.36
16										2.13	7.55	15.97
17										2.46	4.47	42.77
18										2.85	3.38	10.57
19										4.04	3.14	6.85
20										11.20	7.20	5.46
21										5.82	9.76	4.75
22										4.28	11.30	4.27
23										12.66	7.25	4.39
24										21.11	5.12	4.49
25										9.77	4.13	4.17
26										5.59	3.77	3.82
27										4.61	3.45	3.61
28										4.38	3.31	5.79
29									5.48	4.78	3.08	11.37
30									5.10	4.80	2.95	6.04
31										5.19	2.79	
TOTAL									10.58	153.38	131.89	239.64
MEAN									5.29	4.95	4.25	7.99
MAX									5.48	21.11	11.30	42.77
MIN									5.10	2.13	2.10	2.30
AC-FT									20.99	304.32	261.66	475.45
CFSM									3.31	3.09	2.66	4.99
IN.									0.25	3.57	3.07	5.57

STATION SL00-D
SLATE CREEK NEAR MOUTH
WATER YEAR 2000

LOCATION: Station SL00-D is located on Slate Creek just upstream of its outfall to Lynn Canal.

NOTES: An "e" signifies that the data is interpolated.
Station installed June 29, 2000.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1										19.74	12.95	4.50
2										9.27	8.60	4.18
3										6.84	6.83	4.05
4										5.80	6.04	19.36
5										5.24	5.98	23.47
6										4.85	5.50	19.64
7										4.58	5.27	21.63
8										4.38	5.35	13.62
9										4.13	5.14	16.80
10										4.33	4.57	9.49
11										4.23	4.26	31.18
12										4.21	4.02	18.04
13										3.96	3.89	16.69
14										3.80	6.00	102.09
15										3.65	39.64	32.94
16										3.66	17.09	78.21
17										5.58	8.75	130.13
18										7.18	6.34	25.85
19										13.48	6.84	14.99
20										37.60	31.88	11.61
21										11.18	33.92	9.44
22										9.63	31.04	8.19
23										60.77	18.65	9.37
24										72.95	10.57	10.18
25										21.49	7.96	8.34
26										11.88	7.25	7.93
27										9.90	6.31	7.63
28										11.34	6.14	28.80
29									11.82	14.49	5.41	30.40
30									12.26	11.24	5.48	12.93
31										15.51	5.05	
TOTAL									24.08	406.85	332.68	730.45
MEAN									12.04	13.12	10.73	24.35
MAX									12.26	72.95	39.64	130.13
MIN									11.82	3.65	3.89	4.05
AC-FT									47.77	807.20	660.04	1449.21
CFSM									7.52	8.20	6.71	15.22
IN.									0.56	9.46	7.73	16.98

STATION J000-E
JOHNSON CREEK AT JUALIN MINE
WATER YEAR 2000

LOCATION: Station J000-E is located on Johnson Creek, right next to the Jualin Mine.

NOTES: An "e" signifies that the data is interpolated.
Station installed June 29, 2000.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1										54.27	42.90	17.53
2										43.66	32.27	15.71
3										41.85	29.31	14.49
4										51.35	28.10	31.85
5										56.52	38.47	38.80
6										57.36	32.09	46.17
7										43.92	26.56	48.66
8										42.50	25.14	31.97
9										48.41	22.44	29.95
10										46.01	23.79	22.93
11										40.69	23.88	44.51
12										38.33	21.24	45.14
13										33.99	18.71	40.14
14										31.18	32.18	75.81
15										30.72	68.59	44.58
16										34.12	36.36	55.52
17										60.61	26.41	108.05
18										79.19	22.56	51.35
19										66.21	27.86	32.81
20										98.98	56.83	25.46
21										46.74	63.94	21.58
22										53.09	52.34	19.24
23										132.34	39.21	25.77
24										75.11	28.95	35.97
25										48.14	22.51	27.48
26										37.24	24.66	29.95
27										35.43	22.40	29.28
28										49.64	20.34	59.01
29										70.56	18.83	51.06
30									58.72	46.17	20.98	27.19
31										46.66	19.18	
TOTAL										1640.99	967.01	1145.96
MEAN										52.94	31.19	38.20
MAX										132.34	68.59	108.05
MIN										30.72	18.71	14.49
AC-FT										3255.73	1918.55	2273.59
CFSM										33.08	19.50	23.87
IN.										38.14	22.48	26.64