

**Residence Time in Brown Creek of Fine
Sediment Eroded From the 101 Bypass**

Progress Report

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May 16, 1990**

INTRODUCTION

The following discussion is based on data collected and analyzed as of May 16, 1990 and reflects our best estimates based on this information. Further sample analysis may produce results that differ from those reported. Attached to this report are sediment concentration data sheets for both reaches.

Site Preparation

Work on the Brown Creek study began on December 20, 1989 with the establishment of the two study reaches. With distance between reaches and accessibility to the sites from Highway 101 being the main criteria, the upper 200 meter reach was located just downstream of the Rhododendron Trail crossing, and the lower 200 meter reach was located immediately upstream of the old South Fork Trail crossing. These placements put the upper reach below the major slope break downstream of the construction sites and the lower reach just upstream of the mouth of South Fork Brown Creek. These placements allowed maximum accessibility and also isolation of the study area from any major tributaries.

The California Conservation Corps (CCC) was hired to construct a temporary shelter at each reach to house the ISCO suspended sediment samplers, data recorders and all necessary field equipment needed during the storm season. The CCC also constructed temporary bridges at each building site to facilitate discharge measurements during flows too high to wade. Pressure transducers, contained in stilling wells, were installed at each building site and connected to the data recorders to automate sampling during storms and continuously record stage. Staff plates were installed at each site to periodically check the accuracy of the electronic equipment. The two sampling sites were located at the top of the upper reach and the bottom of the lower reach.

MEASUREMENT TECHNIQUES AND RESULTS

Water Discharge

The installation of automatic recording equipment at both stations during the first half of February allowed a continuous measurement of stage from both sites. Prior to this time all stage measurements were taken manually during storm flow. The automated system measures the stage at ten minute intervals and transfers the data to a storage unit attached to the recorder. At approximately two week intervals a field technician retrieves the data storage unit for analysis at the lab. Periodic discharge measurements were taken during storm and non-storm events and the results used to develop a stage-discharge relationship for both stations.

The maximum recorded discharge for the upper site was 1.49 cubic meters per second (CMS) with the minimum being 0.07 CMS. Mean discharge at the upper site for this storm season was 0.17 CMS. The stage-discharge relationship for the upper site is shown in figure 1A. The maximum recorded discharge for the lower site was 1.91 CMS and the minimum was 0.02 CMS. Mean discharge at the lower site for this storm season was 0.31 CMS. The stage-discharge relationship for the lower site is shown in figure 1B.

Upper Brown Stage-Discharge Relationship Curve

$$y = 3.8100 + 3.1133x + 0.59087x^2 \quad R^2 = 0.999$$

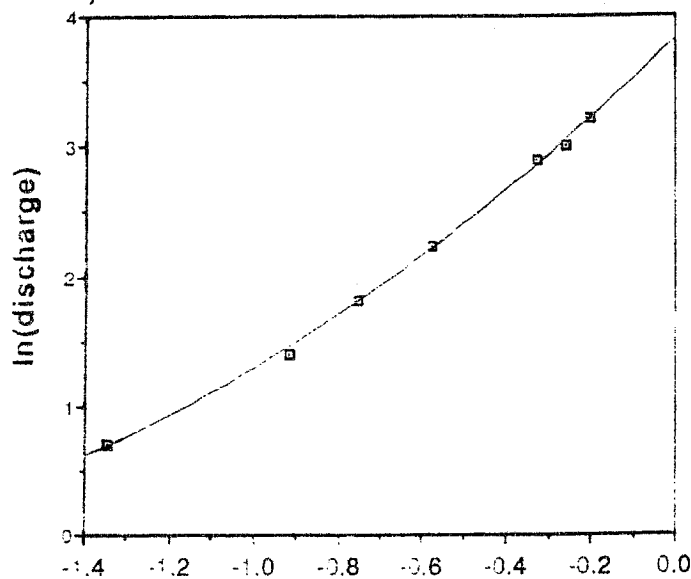


Fig 1A.

ln(stage-3.50)

Subsurface Fines

Lower Brown Stage-Discharge Relationship Curve

$$y = 3.7792 + 2.0302x + 0.25909x^2 \quad R^2 = 0.991$$

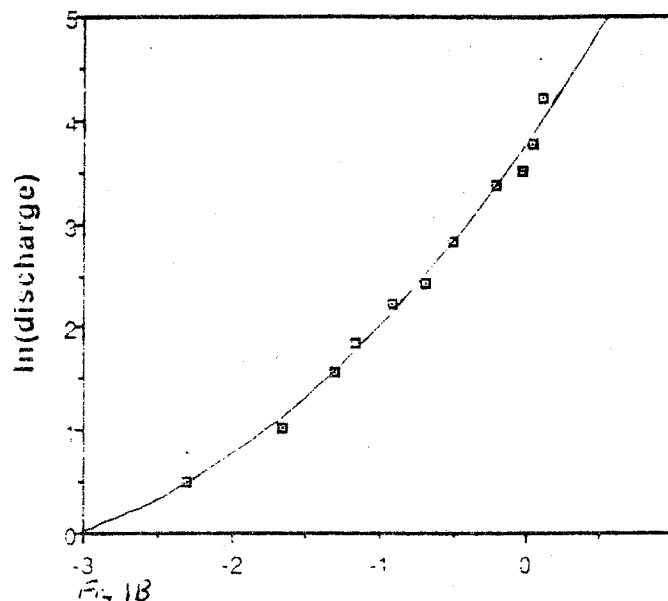


Fig 1B

ln(stage-27.50)

Six locations within the upper reach were randomly chosen as bed material sample-sites. Bed material was cored with a McNeil-Ahnell sampler (McNeil and Ahnell, 1960) and wet sieved in the field. The material greater than 2mm was weighed and saved, to be used at experimental gravel, and the material less than 2mm was bagged and brought to the lab for analysis. Results of this analysis are shown in table 1.

Initial Subsurface Sediment Samples

Sample	Weight (s)						Total Sample weight
	1.0 mm	0.50 mm	0.25 mm	0.125 mm	0.063 mm	<0.063 mm	
R-1	2478.0	2493.0	1486.0	481.07	169.55	290.99	7401.61
R-2	976.0	736.88	474.68	315.34	112.54	176.92	2783.36
R-3	507.0	409.06	256.11	155.93	111.40	166.92	1606.42
P-1	2656.0	1622.0	743.01	290.01	265.17	235.54	5811.73
P-2	1535.5	811.01	464.03	271.10	160.46	167.69	3409.79
P-3	1161.0	766.12	379.34	178.63	82.83	92.85	2660.77
Total weight (g) by size	9304.5	6838.07	3806.17	1692.08	901.95	1130.91	23073.68
Size % of Total Samples	39.30	28.88	16.08	7.15	3.81	4.78	100.0

Table 1. R=riffle P=pool

Rate of infiltration of fine sediment into clean streambeds was measured with "infiltration bags". Collapsed bags were placed in the holes produced during the collection of the initial bed material samples and the experimental gravel placed on top to bed surface level. Because the bags were folded accordian-style at the bottom of the holes they didn't affect the infiltration of fine sediment into the experimental gravel. At the end of the storm season five of the six bags were removed. The sixth bag was left in the streambed to be sampled after the summer season. The fine sediment was extracted from the bags using the same process as in the original samples and brought to the lab for analysis. Results of this analysis are shown in table 2. The infiltration rate of fines into the clean streambed per storm day are shown in table 3.

Infiltration Bag Samples

Sample	Weight (s)						Total Sample weight
	1.0 mm	0.50 mm	0.25 mm	0.125 mm	0.063 mm	<0.063 mm	
R-1	122.0	94.62	78.79	70.70	102.40	280.90	749.41
R-2	163.0	105.17	103.34	98.12	63.76	79.47	612.86
R-3	216.0	54.12	26.79	23.70	23.40	74.90	418.91
P-1	561.0	304.08	162.23	146.28	175.05	350.32	1698.96
P-2	350.50	319.12	168.79	92.20	62.40	116.40	1109.41
Total weight (g) by size	1412.50	877.11	539.94	431.0	427.0	901.99	4589.55
Size % of Total Samples	30.78	19.11	11.77	9.39	9.30	19.65	100.0

Table 2. R=riffle P=pool

Four freeze cores were taken of the streambed to determine the depth of infiltration of fine sediment. A three-pronged apparatus was pounded into the streambed to a depth of 45 cm. Pressurized CO₂ was then injected into the hollow prongs effectively freezing to the prongs the adjacent bed material. The core was then winched from the bed and placed on a row of collection trays. The stratigraphy was noted before the core began to melt into these trays. After the core melted, the sampled material was returned to the lab for analysis. From the bed surface to 15 cm depth the fines-filled interstices ranged from 45% at the upper reach to 30% at the lower reach. Below the 15 cm depth all the cores exhibited fines-filled interstices of 90 - 100%—visual estimate.

Fines Infiltration Rate / Storm Day

Sample	# Storms Sampled	# Storm Days	infiltration rate (g/day) by size						Infiltration rate g/day total sample
			1.0 mm	0.50 mm	0.25 mm	0.125 mm	0.063 mm	<0.063 mm	
R-1	8	15	8.13	6.31	5.25	4.71	6.83	18.73	49.96
R-2	3	9	18.11	11.69	11.48	10.90	7.08	8.83	68.09
R-3	3	4	54.00	13.53	6.70	5.93	5.85	18.73	104.74
P-1	3	15	37.40	20.27	10.82	9.75	11.67	23.35	113.26
P-2	6	9	38.94	35.46	18.75	10.24	6.93	12.93	123.25

Table 3. R=riffle P=pool

Surface Fines

The volume of fine sediment on the bed surface for each reach was measured at the beginning of the project and again at the end of the storm season. Each reach was divided into five meter segments. The surface sediment volumes for each segment were then visually estimated. Using a thin wire sediment probe, volumes for 20% of the reach segments were then intensively measured with probability of segment selection proportional to total estimated sediment volume. The total volume of surface sediment for each reach and standard error were then estimated using SALT (Thomas, 1985). Results of these calculations are shown in Table 4.

Estimates of Surface Fines Volume

Reach	Initial Volume Estimate (m³)	Standard Error (m³)	Final Volume Estimate (m³)	Standard Error (m³)
<i>Upper</i>	6.520	2.553	4.677	2.163
<i>Lower</i>	14.171	3.764	14.611	3.822

Table 4.

Unglazed ceramic floor tiles were placed on the bed surface in a variety of locations throughout both reaches. This was done to aid in quantifying the distribution of sediment during the course of multiple storm seasons. The tiles were cleaned twice during the storm season and the samples brought to the lab for analysis. As of this writing no samples have been analyzed but observations in the field indicate sediment, once deposited into backwater areas, does not easily wash out during subsequent storm flow but tends to be reworked within the confines of the backwater area. Higher flows than those experienced may alter this tendency.

Suspended Sediment Discharge

Suspended sediment samples were taken manually at the beginning of the storm season and then, after installation, with automatic pumping samples. Sampling was initiated by computers linked to pressure transducers and programmable data recorders that also recorded stage. Preselected random sampling schemes were first fed to the pumping samplers. Threshold stages were fed to the computers. These stages were selected based on stage at the time of programming and predicted storm intensity. Once the stage surpassed the sampling threshold, the computer activated the pumping sampler which in turn began the random sampling process. If the stage dropped below the sampling threshold, the computers would signal the pumping samplers to suspend sampling. Only a rising stage or a threshold change by field technicians would reactivate the postponed sampling scheme. Periodic depth-integrated samples, withdrawn from one point in the flow, were used to calibrate the automatic samplers. This method of suspended sediment assured unbiased sampling for the duration of the storm season.

Suspended sediment concentrations varied widely from storm to storm and for the

entire season. Concentrations for the upper reach ranged from a low of <3 milligrams per liter to a high of 1900 milligrams per liter. Concentrations for the lower reach range from a low of <3 milligrams per liter to a high of 1300 milligrams per liter. Total estimated sediment inflow at the upper reach is 21.79 metric tons and total estimated sediment outflow at the lower reach is 33.84 metric tons. These estimates are at best conservative in that they do not include sediment transported during non-storm intervals or sediment transported during storms too small to effectively measure.

CONCLUSION

Transportation of surface fine sediment is occurring but at a slow rate. Initial surface surveys indicate 19.03 metric tons were deposited on the bed surface^{for 20.6 m² ?? what's conversion? n} End of season surveys indicate 17.74 metric tons of sediment remained. If the present winter weather patterns continue it is estimated the complete removal of surface fines will take 14-15 years. If there is an increase in winter storm activity, specifically greater rainfall amounts with subsequent higher streamflow, the removal of surface fines may take less time.

Storage of fine sediment in the bed subsurface appears to be consistent for both reaches. Scour and fill is occurring but actual amounts are not known at this time. Field observations, based on scour chains located at the infiltration bag sites, indicate minor amounts of scour and fill. Based on this years winter storm activity, impaction of fine sediment below 15cm depth coupled with observed bedload transport indicate long term storage. Further field measurements and sample analysis will quantify the amount of sediment stored in this reservoir.

REFERENCES

- McNeil, W.J., and W.H. Ahnell, Measurement of gravel composition of salmon stream beds, Circular No. 120, Fisheries Research Institute, University of Washington, Seattle, 4pp.
Thomas, R.B., 1985, Estimating total suspended sediment yield with probability sampling. Water Resources Research, 21(9), 1381-1388.