An evaluation of suspended sediment and turbidity in Cow Creek, Oregon

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CONVERSION FACTORS FOR INCH-POUND SYSTEM AND INTERNATIONAL SYSTEM OF UNITS (SI)

[For use of those readers who may prefer to use metric units (SI) rather than inch-pound units, the conversion factors for the terms used in this report are listed below]

To convert from	to	Multiply by
	Length	
inch (in.)	millimeter (mm)	25.4
foot (ft)	meter (m)	0.3048
mile (mi)	kilometer (km)	1.609
	Area	
acre	square meter (m^2)	4,047.
	hectometer (hm^2)	0.4047
square mile (mi^2)	square kilometer (km^2)	2.59
	Volume	
gallon (gal)	liter (L)	3.785
million gallons (Mgal)	cubic meters (m^3)	3,785.
cubic foot (ft^3)	cubic meter (m^3)	0.02832
acre-foot (acre-ft)	cubic meter (m^3)	1,233.
	Specific combinations	
cubic foot per second (ft^3/s)	cubic meter per second (m^3/s)	0.2832
foot per day (ft/d)	meter per day (m/d)	0.3048
acre-foot per year (acre-ft/yr)	cubic meter per year (m^3/yr)	1,233.
	Temperature	
degree Fahrenheit (°F)	degree Celsius (°C)	5/9 after subtracting 32 from °F value
	Mass	
ton (t)	metric ton	0.9074

AN EVALUATION OF SUSPENDED SEDIMENT AND TURBIDITY IN COW CREEK, OREGON

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By David A. Curtiss

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ABSTRACT

During a 6-month period from December 1980 through May 1981, samples were collected from Cow Creek near Azalea, Oreg., and analyzed for suspended sediment, particle-size distribution, and turbidity. Of the estimated suspended-sediment discharge of 4,270 tons for the 1981 water year, 95 percent (4,050 tons) was transported during a major storm event, December 2-4, 1980. The 1981 water year suspended-sediment discharge of 4,270 tons is well below the average annual suspended-sediment discharge of 22,000 tons reported earlier by Curtiss (1974).

A clay-sediment transport curve was used in conjunction with the flow-duration curve to estimate average annual clay discharge of 3,700 tons for Cow Creek near Azalea.

Turbidity in Cow Creek near Azalea is estimated to be equal to or less than 15 NTU (nephelometric turbidity units) 90 percent of the time.

A method for predicting turbidity values in a hypothetical impoundment is presented in this report. This method utilizes a suspended-sediment transport curve of the fine (<0.002 mm) material and measures residual-turbidity values. This method probably could be used to assess the impact of proposed reservoirs on stream turbidities in basins similar to that of Cow Creek basin.

INTRODUCTION

Douglas County is studying the feasibility of developing a water-storage project on Cow Creek east of Azalea, Oreg.

The county requested the U.S. Geological Survey (USGS) to cooperate in a study that would aid in assessing the impact that the proposed Galesville Reservoir would have on suspended-sediment concentration and turbidity in Cow Creek. As part of this study, Douglas County personnel conducted a 6-month sampling program during the period December 1980 through May 1981. This report is a presentation and interpretation of the data collected.

The Cow Creek basin above the proposed Galesville Dam site is in the extreme southern part of Douglas County (fig. 1). The Galesville site is 1 1/2 miles upstream from the USGS streamflow station, Cow Creek near Azalea, Oreg. The drainage area at the gaging station is 78.0 mi^2. The proposed reservoir at full capacity will cover an area of 620 acres and have a storage of 38,000 acre feet.

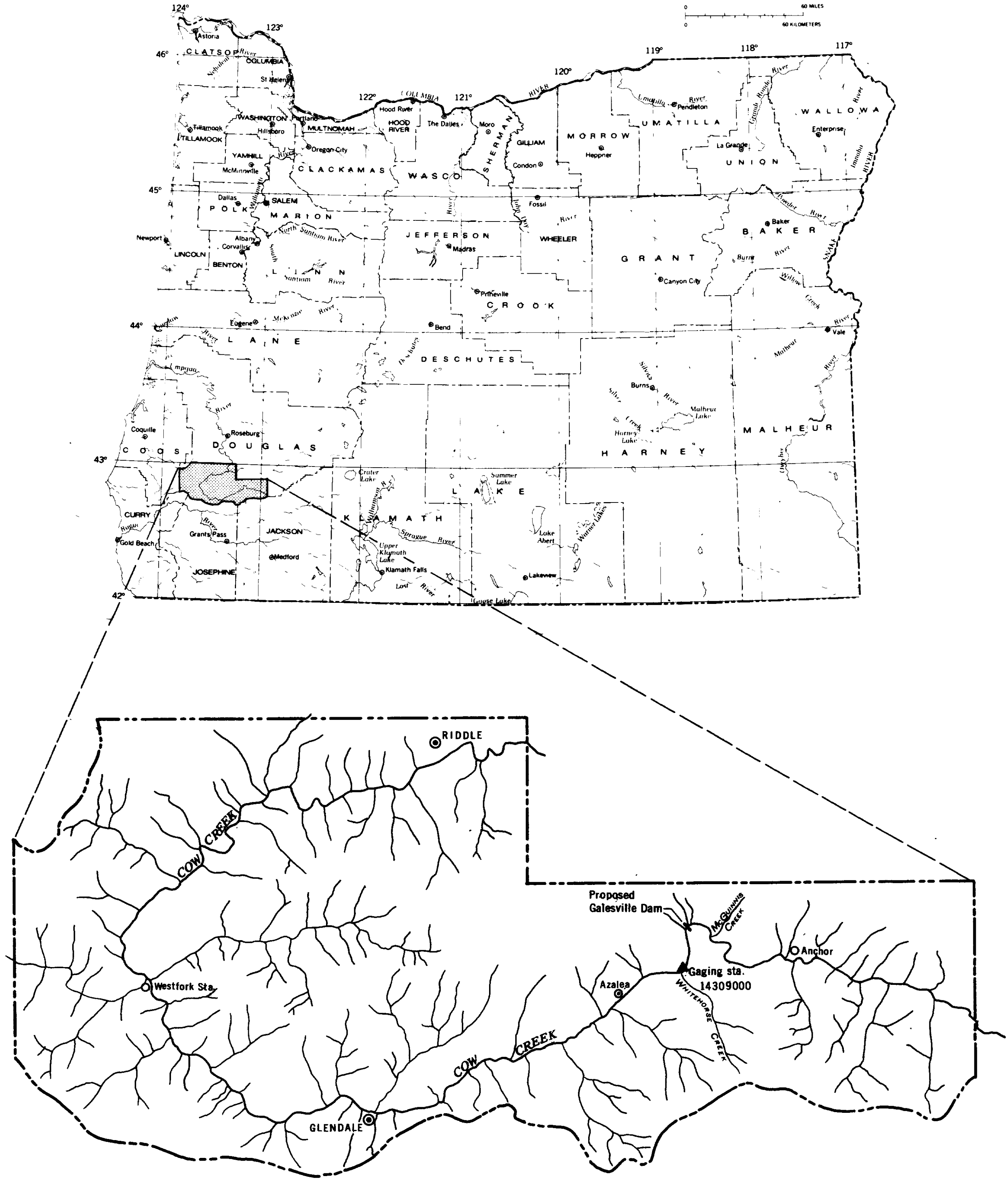

FIGURE 1. – Location of Cow Creek basin, Oreg.

Purpose and Scope

The purposes of this report are to (1) determine the baseline suspended-sediment concentrations and turbidity values in Cow Creek near Azalea, (2) determine the suspended-sediment concentrations and loads and turbidity values for selected storms for Cow Creek near Azalea, and (3) present a method for estimating turbidity in the proposed reservoir.

All samples were collected from Cow Creek near Azalea (station number 14309000), where the USGS operates a streamflow recorder. Because of Douglas County's immediate need to assess the impact of the proposed Galesville Reservoir on the sediment and turbidity regimens in Cow Creek, samples were collected only from December 1980 through May 1981.

Previous Studies

Douglas County personnel collected suspended-sediment data from 1956 to 1967 at 10 sites in the Umpqua River basin, including Cow Creek near Azalea. Those data were reported and the results of estimated sediment yields summarized in a report by Onions (1969). Additional suspended-sediment data were collected from 1969 to 1973 at the same 10 sites and a report was published by Curtiss (1975) that updated estimates of sediment yields reported earlier by Onions.

DATA COLLECTION

All samples were collected and analyzed using standard USGS procedures (Guy, 1969 and 1970). Tables 2, 3 and 4 include all the data collected from Cow Creek during the 6-month collection period. Table 4 shows the mean daily flow, sediment concentration, and sediment discharge for the same period. Sediment discharge was estimated for those days when samples were not collected. The sediment discharge for days of rapidly changing flow or sediment concentration was computed by the subdivided-day method that results in a time discharge-weighted load for the day (Porterfield, 1972).

Samples were collected two to three times per week and analyzed for sediment concentration and turbidity in order to define baseline conditions. During major storm events, samples were collected every 3 to 6 hours. Samples containing an adequate amount of sediment were analyzed for particle-size distribution. Turbidity values for the samples collected prior to January 28, 1981, were determined in the Geological Survey laboratory in Portland, Oregon. After that date, turbidity values were determined on site at the time of collection by Douglas County personnel using an instrument similiar to the one used by the USGS.

The only major storm event that occurred during the sampling period was December 2-4, 1980. Much of the interpretation in this report is based on data collected during that storm. Figure 2 shows the storm hydrograph and the suspended-sediment-concentration graph. The sampling program began on December 2, 1980, which coincided with the date of the peak flow for the year. The magnitude of peak flow for the storm was 4,020 ft^3/s, which based on information from a report by Harris and others (1979), equals an exceedance probability of 0.3, or a recurrence interval of 4 years. The sediment discharge for the December 2-4 storm event was 4,050 t and was equivalent to 95 percent of the total estimated load of 4,270 t for the entire 1981 water year.

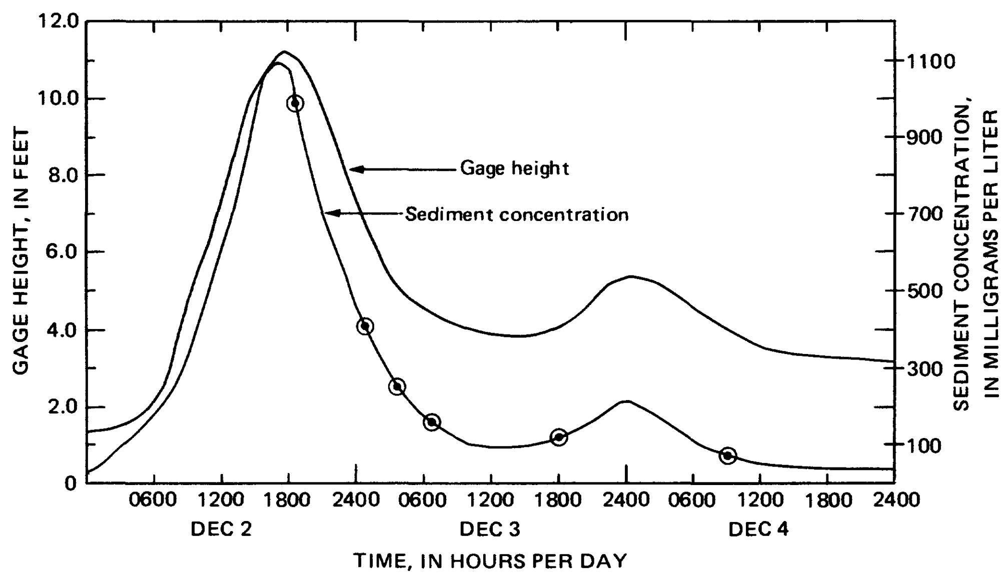

FIGURE 2. – Storm hydrograph with sediment concentration curve for Cow Creek near Azalea, Dec. 2-4, 1980.

Although the magnitude of the December 2 flood was significant, the monthly mean flow for the data-collection period was below normal, except for December (fig. 3).

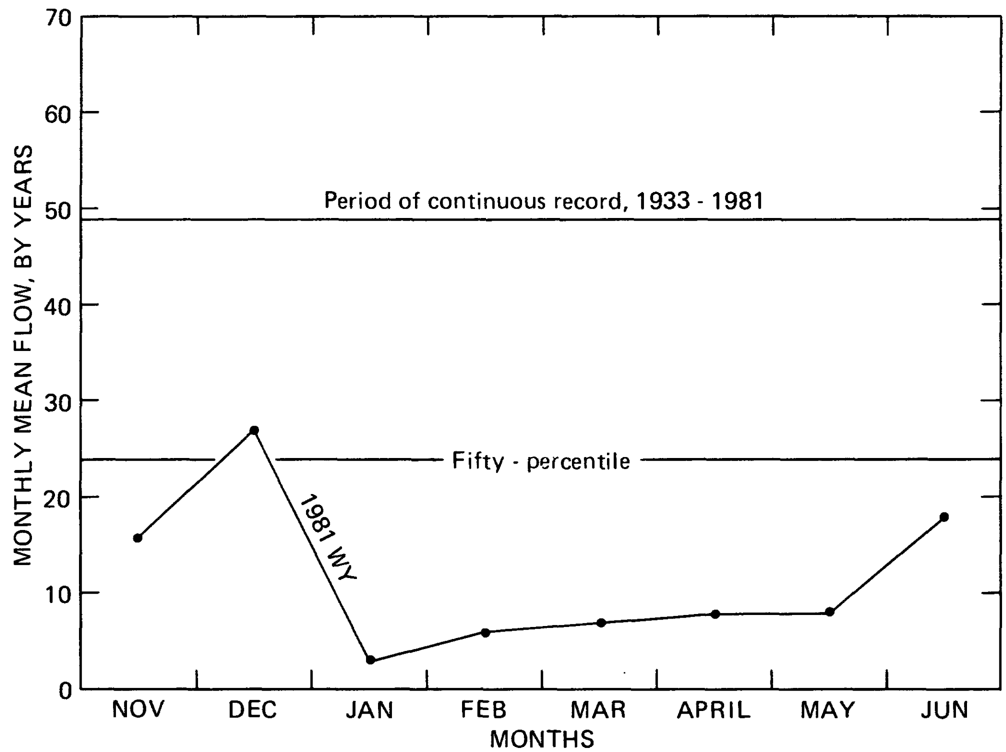

FIGURE 3. – 1981 water year ranking of monthly mean flow, by years, from lowest to highest.

DATA ANALYSIS

Historical Comparison

Earlier investigations by Onions (1969) and Curtiss (1975) estimated annual suspended-sediment loads of 26,500 and 22,000 tons, respectively, for the Cow Creek near Azalea site. For comparative purposes, the sediment-transport curve used by Curtiss (1975) and based on 240 data points is shown in figure 4 along with the plotting of instantaneous samples collected December 2 and 3, 1980. The 1981 water year instantaneous data points plot to the right of the sediment-transport curve; however, the points approximate the sediment-transport curve and, in particular, the slope. This indicates that the characteristics controlling the sediment regimen have not changed appreciably since the analyses by Curtiss and that the data collected in 1981 water year are in close agreement with the historic data.

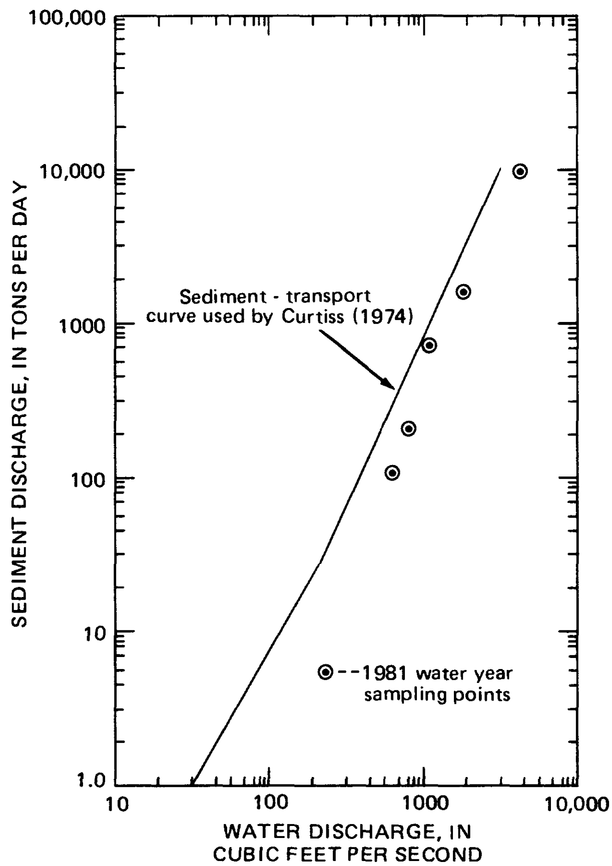

FIGURE 4. – Comparison of 1981 water year high-flow sediment discharges to sediment-transport curve used by Curtiss (1975).

Clay-Size Fraction

In the past, investigations primarily were concerned with the impact of a stream on a proposed reservoir. Today we are becoming more concerned with the impact of a reservoir on a stream. This concern is directly associated with the persistent high-turbidity water being released by some existing reservoirs throughout the United States. Clay-size particles generally are believed to be the major factor causing persistent high-turbidity water.

The Geological Survey describes the clay-size fraction as particles having a fall diameter equal to or less than 0.004 mm (millimeter). The fall diameter is determined using Stoke's law and is directly correlated to fall velocity (Guy, 1969).

Results of particle-size analysis of samples taken from Cow Creek near Azalea are plotted in figure 5. Two values, ≤0.062 mm and ≤0.004 mm, are plotted for each sample.

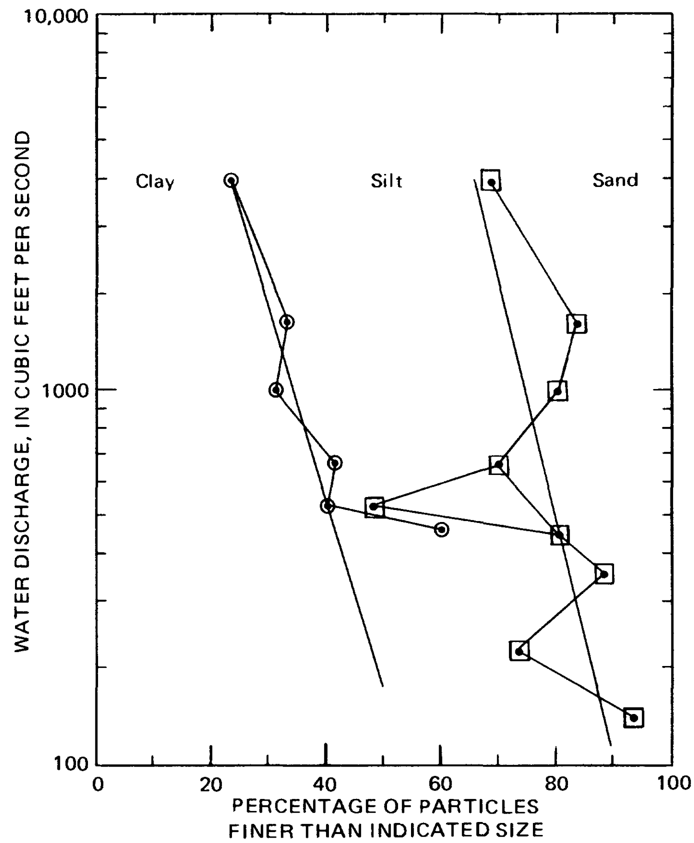

FIGURE 5. – Particle size versus water discharge, 1981 water year.

Lines connecting the plotted points define the breaks between sand, silt, and clay. The lines serve only to define general boundaries and indicate possible trends.

A clay-size sediment-transport curve was developed by multiplying the percent-finer-than 0.004 mm values by the measured suspended-sediment discharge value for each of the six samples analyzed for the December 2-4 storm (table 3) and plotting those values against water discharge (fig. 6).

If the transport curve for clay sizes is applied to the computations used to determine measured suspended-sediment load, (table 3) a clay load can be estimated for the 1981 water year. Only those days with significant sediment loads were used to compute the clay load; and the subdivided-day method was used for December 2-4.

The dates and corresponding clay discharges are listed below.

Date (1980)	Clay load (tons per day)
Dec. 2	900
3	85
4	65
25	16
(1981)	
Feb. 14	9
Total	1,075

Estimate for 1981 water year - 1,100 tons

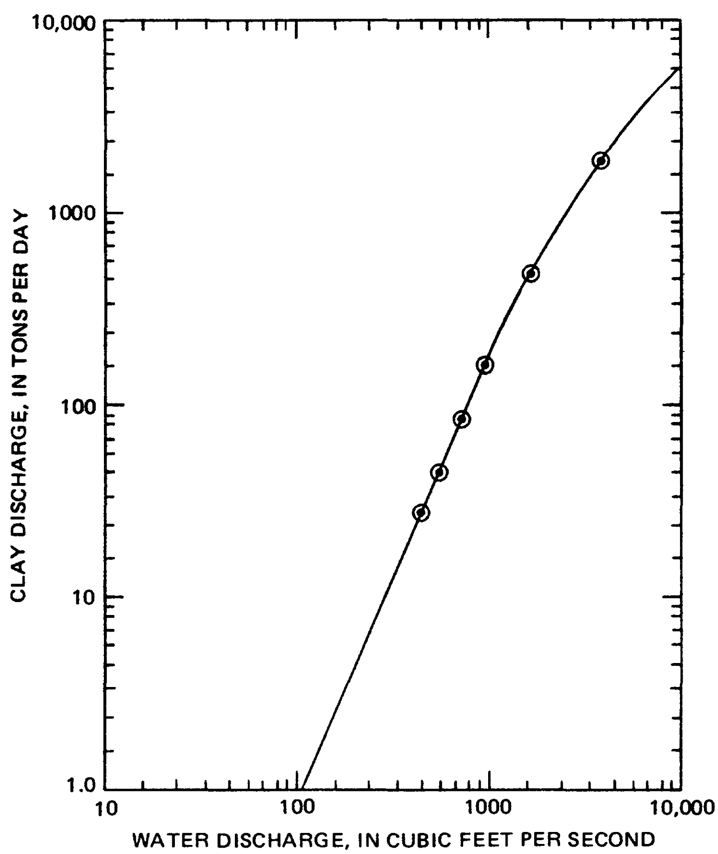

FIGURE 6. – Clay-transport curve for Cow Creek near Azalea, 1981 water year.

Ninety-seven percent of the total measured suspended-sediment load was transported during the 1981 water year on the days listed above. The estimated annual clay load represents 26 percent of the total measured suspended-sediment load for the 1981 water year.

An estimated average annual suspended-clay discharge, based on 49 years of streamflow records, can be made by the flow-duration sediment-transport curve method described by Miller (1951). The suspended-sediment transport curve can be substituted for the clay-sediment transport curve that is shown in figure 6. Table 1 shows the computations used to estimate the mean annual clay discharge. Information in columns 1, 2, 3, and 4 was taken from the flow-duration curve shown in figure 7. Column 5 shows the clay discharge that corresponds to the water discharge taken from the duration curve.

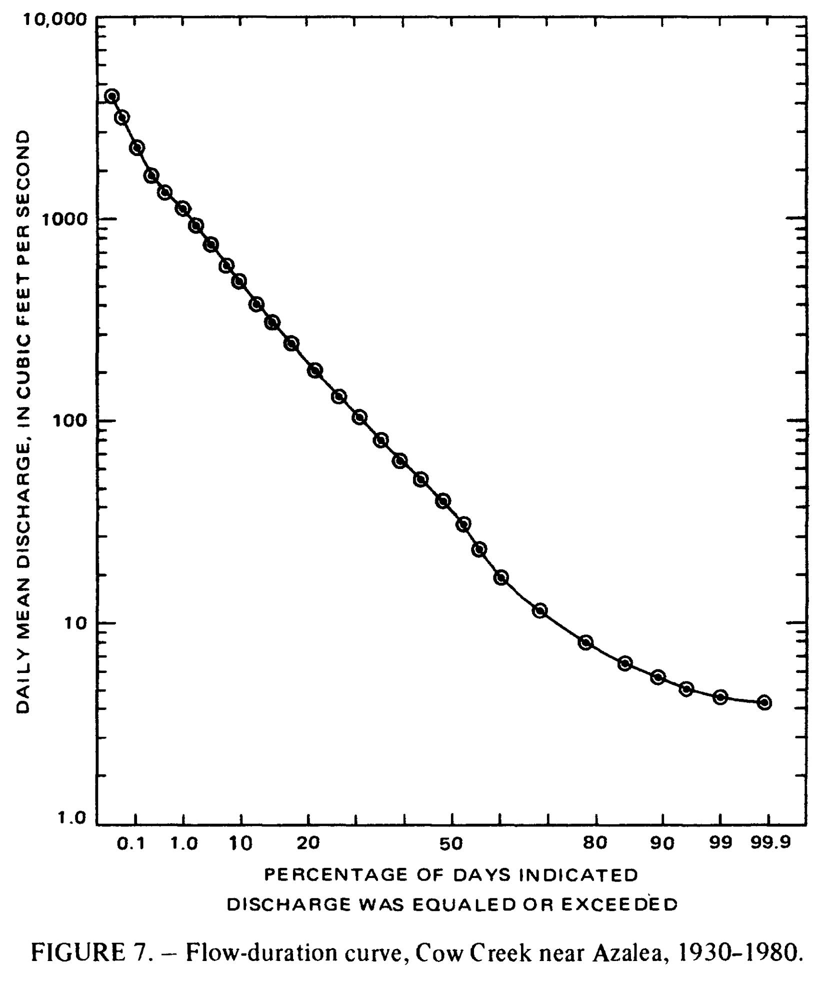

FIGURE 7. – Flow-duration curve, Cow Creek near Azalea, 1930-1980.

Table 1.--Computation of mean annual clay discharge

Cumulative time (percent) (1)	Time in increments (percent) (2)	Mean of increment (percent) (3)	Streamflow (cubic feet per second) (4)	Clay discharge (tons per day) (5)	Mean daily clay discharge (tons) (6)
0.00					
	0.02	0.01	5,100	3,200	0.64
.02					
	.02	.03	3,900	2,150	.43
.04					
	.04	.06	2,900	1,500	.60
.08					
	.04	.10	2,300	1,100	.44
.12					
	.10	.17	1,900	760	.76
.22					
	.21	.32	1,600	560	1.18
.43					
	.31	.58	1,300	360	1.12
.74					
	.36	.92	1,070	240	.86
1.1					
	.50	1.4	830	140	.70
1.6					
	.90	2.0	690	95	.86
2.5					
	1.0	3.0	540	50	.50
3.5					
	1.6	4.3	440	32	.51
5.1					
	2.3	6.2	350	19	.44
7.4					
	3.2	9.0	280	11	.35
10.6					
	4.1	12.6	225	6.5	.27
14.7					
	4.6	17.0	180	3.6	.17
19.3					
	4.6	21.6	145	2.1	.10
23.9					
	5.8	26.8	115	1.2	.07
29.7					
	4.2	31.8	96	.8	.04
33.9					
		Total mean daily clay discharge			10.04
		Mean annual clay discharge (rounded)			3,700

Note: Only those days having streamflow greater than 96 ft^3/s are used.

When each figure in column 5 is multiplied by the percentage of time (column 2), the product is the estimated mean daily clay discharge (column 6). The sum of column 6 multiplied by the number of days in a year (365.25) is the estimated mean annual clay discharge.

As stated earlier in this report and illustrated in figure 3, the flow during the 1981 water year in Cow Creek was below normal. Similarly, the estimated 1981 water year clay-sediment discharge (1,100 t) was about one-third the estimated mean annual discharge of 3,700 t.

Turbidity

Rainwater and Thatcher (1960, p. 289) define turbidity as "the optical property of a suspension with reference to the extent to which the penetration of light is inhibited by the presence of insoluble material." Less precisely, turbidity is a measurement of the cloudiness of water. The units used to report turbidity are nondimensional, making it difficult to quantitatively analyze the data. Turbidity is caused primarily by suspended mineral and organic sediments. Phytoplankton and other micro-organisms are major causes of turbidity during summer months, particularly in water being released from lakes and reservoirs. During winter months, turbidity is caused almost entirely by suspended mineral sediment, and persistent turbidity is caused by the fine clay-size mineral and/or organic sediments.

The instantaneous turbidity values obtained during the project period for Cow Creek near Azalea were plotted against discharge. Flow-duration values (fig. 8) were taken from the curve shown in figure 7 and superimposed on the x-axis. If the assumption is made that the correlation between discharge and turbidity is stable, then an estimate can be made of percentage of time a turbidity value can be expected to occur in Cow Creek. Using the example shown in figure 8, 90 percent of the time flow will be 260 ft^3/s or less and the turbidity will be equal to or less than 15 NTU.

Construction of a dam on Cow Creek upstream from the sampling site would undoubtedly change the correlation between discharge and turbidity. To assess the impact of the proposed reservoir a postconstruction correlation between discharge and turbidity could be made and compared to the correlation shown in figure 8.

Settling Characteristics and Residual Turbidities

In addition to the standard sediment and turbidity analyses that are included in tables 2 and 3, a test that measured residual turbidities in suspension was run on samples collected on December 3, 1980, from Cow Creek. The samples were composited into a graduated cylinder and mechanically dispersed with a churn for 1 minute.

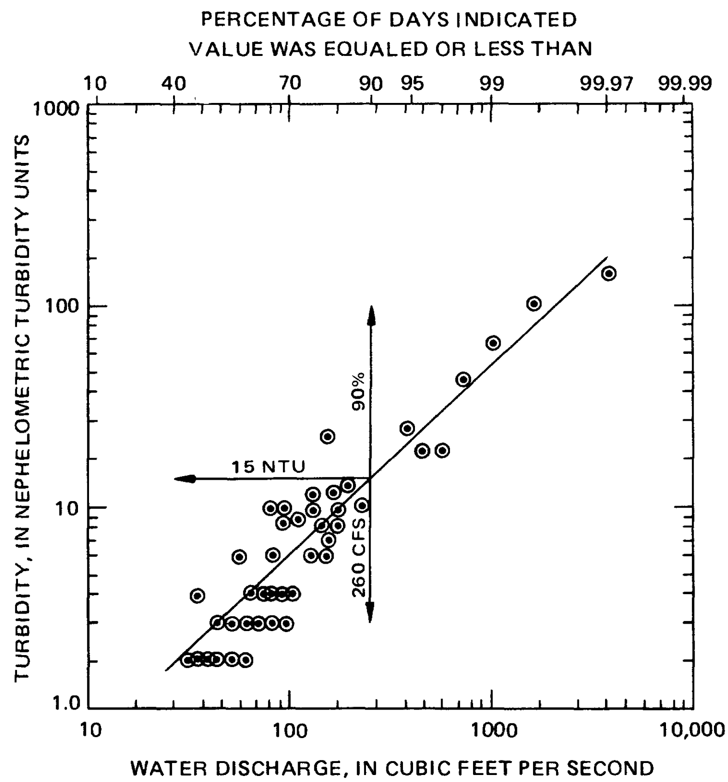

FIGURE 8. – Relation between water discharge and turbidity for 1981 water year and flow duration for period 1930-1980.

Sediments were allowed to settle under quiescent conditions, subsamples were withdrawn at selected time intervals at 5-cm depth, and turbidity was measured. The graphs in figures 9 and 10 show the results of the test.

The method used to determine residual turbidity of fine sediment is similar to the pipet method outlined by Guy (1969) for particle-size analyses, except that no dispersion agent nor harsh mechanical dispersion was used and the settling medium was native water. If the basic assumption is made that the particles in the sample follow Stokes law, then fall diameters can be applied to settling velocities in the residual-turbidity graph. Figure 10 shows the relation between turbidities and time, with different particle sizes superimposed via time.

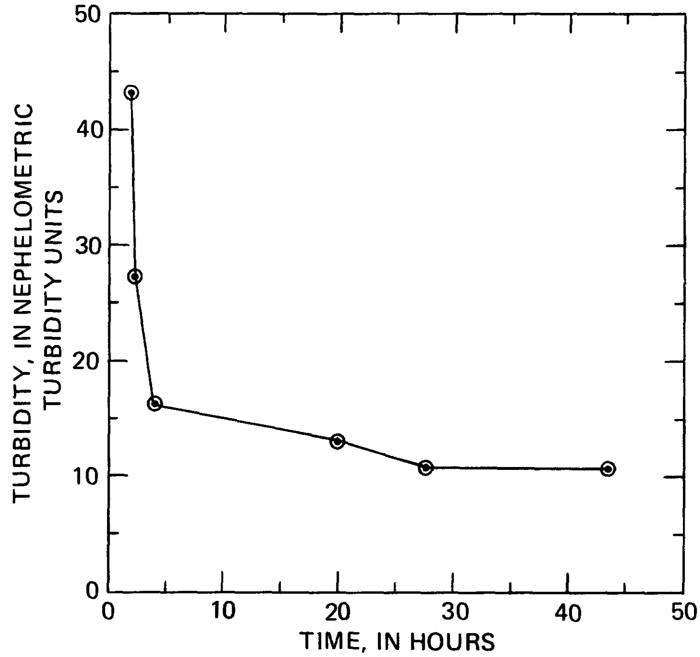

FIGURE 9. – Residual turbidity for Cow Creek near Azalea, Dec. 3, 1980, at 0615 hours, suspended-sediment concentration equals 122 milligrams per liter.

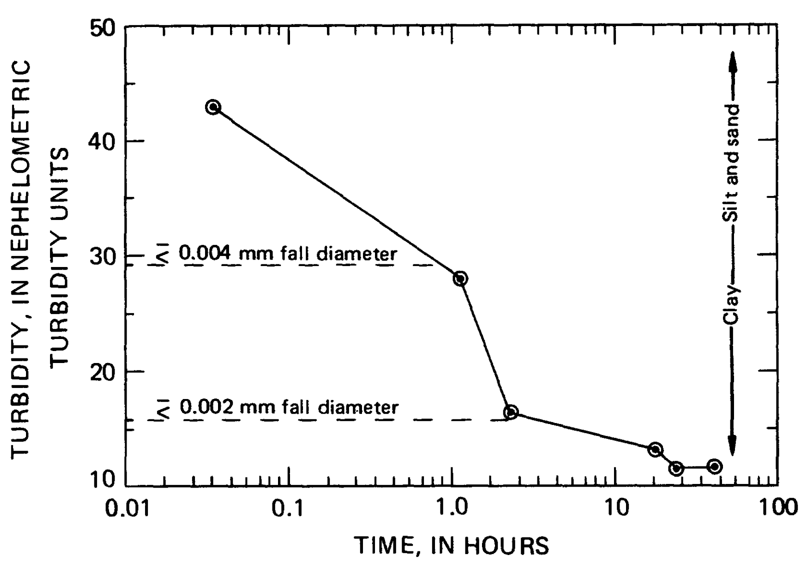

FIGURE 10. – Residual turbidity for Cow Creek near Azalea, Dec. 3, 1980, at 0615 hours, suspended-sediment concentration equals 122 milligrams per liter.

Preliminary evidence from the study indicates that a correlation exists between persistent turbidity and the 0.002-mm clay fraction of the suspended sediment over a range of concentrations. This correlation, coupled with a transport curve of the 0.002-mm size sediments, could be used to quantitatively assess turbidity in the proposed reservoir. To correspond with the residual-turbidity test, the particle-size analyses used for defining the 0.002 mm transport curve may have to be run without using a dispersing agent or mechanical disperser. Because settling characteristics vary with different native waters, results from this type of procedure are not necessarily transferable to any other site.

The settling time for different size particles can be computed by using the following transformation of Stoke's law (Rinella and McKenzie, 1982):

$$t = \frac{(0.1113)\ (V)\ (X)}{d^2}$$

where

t = the fall time, in seconds;
X = the fall distance in millimeters;
d = the diameter of the spherical particle, in millimeters; and
V = the viscosity of water, in poises at the water temperature.

Assume that the viscosity of the low-conductivity water of Cow Creek is equivalent to that of distilled water.

Figure 11 shows the settling distances, under quiescent conditions, of sediment particles with different fall diameters after 30 days. The graph clearly illustrates the persistence of the particles of 0.002 mm and less in diameter. In pools of less than 100 ft depth, the particles with diameters greater than 0.004 mm generally can be expected to settle out after 30 days.

Where the settling rates and the amount of different sized particles are known, concentrations of sediments from different storm events can be examined as though they were in a hypothetical impoundment. For example, if all the flow during December 2-4, 1980, from Cow Creek were impounded, the water and sediment were well mixed, and the water temperature was 10°C, the theoretical concentration of sediment at a 62-foot depth (after 20 days) in the hypothetical pool would be about 90 mg/L. This is based on a settling rate of 3.2 ft/d for 0.004 mm diameter particles and takes into account the dilution from inflow, assumes no other sediment input during the 20 days, and assumes quiescent pool conditions. Obviously, the pool will not be quiescent and factors such as wind and wave action and thermal stratification will tend to keep the sediment particles in suspension.

In the example cited above, the actual concentration would probably be greater than 90 mg/L and would represent sediments with fall diameters of 0.004 mm or less.

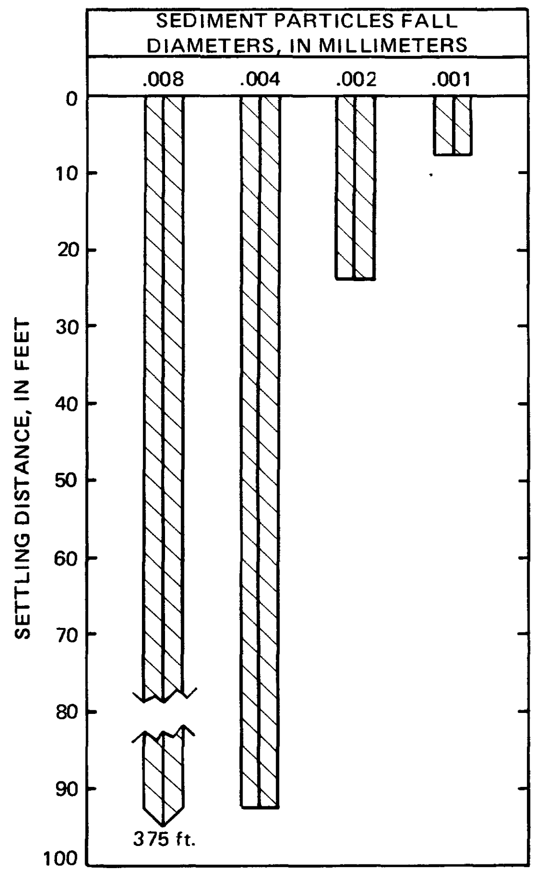

FIGURE 11. – Graph showing settling distances of different-size particles of sediment in water at 10°C after 30 days.

It may be that those particles that cause persistent turbidity do not obey Stoke's law, and will remain in suspension longer than theoretically calculated. These particles are defined by their fall-diameter size, can be quantitatively accumulated by transport curves, and the resulting concentration can be correlated to a turbidity value. With more data and refinement of correlations, it may be possible to assign a rate of decrease to the persistent turbidity.

SUMMARY AND CONCLUSIONS

For this report, suspended-sediment load was calculated for the 6-month sampling period from December 1980 through May 1981 and estimated for the remaining 6-month period to arrive at the 1981 water-year total of 4,270 tons. Ninety-five percent of the 1981 annual sediment load was transported in a 3-day period, December 2-4, 1980. From the samples collected during that storm, a clay-transport curve was developed and used to estimate both the 1981 water year clay load and a long-term average annual clay load.

For this study, not enough particle-size analyses were made to develop a transport curve nor to make a quantitative assessment of the 0.002-mm fraction of the sediment load that most likely causes persistent turbidity. A hypothetical discharge-weighted concentration in an impoundment could be computed for various times and depths after a storm event if the following data were available: (1) load values for the different particle-sized classes, (2) accumulative streamflow runoff, and (3) water temperature.

A computed theoretical concentration of the less than 0.002-mm sediment in a hypothetical impoundment would give some indication of the possibility of a persistent turbidity problem, but would not in itself relate directly to a turbidity value or range of values. However, residual-turbidity tests made on a number of samples over a range of concentration may show a good correlation between the less than 0.002-mm sediment concentration and persistent turbidity and that this correlation could be used to convert the computed discharge-weighted concentration to a turbidity value. This estimated turbidity value possibly would be better expressed as a range of values based on the confidence of the computations. This method of estimating would, however, provide an analytical tool in assessing the persistent turbidity potential of a hypothetical impoundment on a stream.

ADDITIONAL STUDIES

In this report a method of predicting the effect of hypothetical reservoir on stream turbidity was conceived that utilizes residual turbidity tests and a transport curve of the less than 0.002 mm sediments.

The following additional studies are suggested:

1. Continue storm sampling of Cow Creek before, during, and after construction of Galesville Reservoir.
2. Assess the effects of the proposed Galesville Reservoir on Cow Creek turbidity from data collected before and after construction of Galesville Reservoir.

The method described in this report for assessing turbidity applies the quantitative principles of sedimentation to predict a qualitative value for turbidity. The method, if verified, would provide an invaluable and inexpensive tool in determining potential turbidities in reservoirs where similar conditions exist.

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Table 2.--Instantaneous suspended-sediment and turbidity analyses for Cow Creek near Azalea, 1981 water year

14309000 - COW CREEK NEAR AZALEA, OREG.

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	SED. SUSP. SIEVE DIAM. % FINER THAN .062 MM	TUR-BID-ITY (NTU)
DEC						
02...	1645	4020	946	10300	--	180
02...	2220	1620	409	1790	--	110
03...	0100	1020	250	688	80	68
03...	0615	671	122	221	70	41
03...	1915	525	87	123	49	23
04...	0900	469	50	63	81	23
05...	1400	224	8	4.8	73	10
06...	1420	167	3	1.4	89	10
07...	1100	124	3	1.0	71	6.0
08...	1120	99	1	.27	100	4.0
09...	1120	82	1	.22	--	6.0
10...	1100	73	1	.20	--	4.0
11...	1050	69	1	.19	--	4.0
12...	1140	64	1	.17	--	4.0
15...	1000	53	1	.14	--	3.0
17...	1035	60	1	.16	--	4.0
19...	1330	50	1	.13	--	2.0
21...	1450	56	1	.15	--	3.0
22...	1115	69	1	.19	--	4.0
25...	1515	388	58	61	87	26
26...	1310	197	6	3.2	--	8.0
29...	0912	95	1	.26	--	4.0
31...	0945	74	2	.40	--	4.0
JAN						
02...	1040	62	2	.33	--	3.0
03...	1450	62	1	.17	--	2.0
05...	0955	49	1	.13	--	2.0
07...	0945	44	2	.24	--	2.0
09...	1025	38	4	.41	62	2.0
12...	1050	33	4	.36	60	2.0
14...	1025	31	6	.50	71	--
16...	1010	30	2	.16	--	--
19...	1005	27	2	.15	--	--
21...	1015	27	2	.15	--	--
23...	1025	36	2	.19	--	--
27...	1000	54	4	.58	60	--
28...	1050	80	6	1.3	68	10
30...	1140	90	4	.97	70	10
FEB						
04...	1010	51	2	.28	100	2.0
06...	0955	54	4	.58	--	6.0
09...	1450	44	1	.12	--	3.0
11...	1000	41	1	.11	--	2.0
13...	1015	42	2	.23	50	3.0
16...	0950	132	5	1.8	85	12
18...	1035	167	3	1.4	100	13
20...	1050	199	6	3.2	92	14
23...	1435	119	2	.64	100	6.0
25...	1435	129	1	.35	100	8.0
27...	0955	101	2	.55	100	4.0
MAR						
03...	1035	70	1	.19	--	5.0
05...	1050	104	4	1.1	71	6.0
09...	1415	74	2	.40	--	6.0
11...	1420	67	1	.18	100	3.0
13...	1430	141	15	5.7	94	34
16...	1020	130	4	1.4	100	10
20...	1035	105	8	2.3	80	9.0
23...	1020	76	2	.41	--	4.0
25...	1015	85	5	1.1	63	6.0
27...	1100	102	3	.83	80	6.0
30...	1015	125	6	2.0	80	6.0
APR						
01...	1505	134	6	2.2	76	7.0
03...	1035	122	3	.99	67	6.0
06...	1520	94	2	.51	65	3.0
08...	1035	81	4	.87	90	4.0
10...	1545	79	4	.85	60	3.0
13...	1350	87	4	.94	65	4.0
15...	1210	76	4	.82	90	3.0
17...	1210	66	2	.36	80	4.0
20...	1035	57	2	.31	80	3.0
22...	1030	54	1	.15	--	2.0
24...	1000	49	1	.13	--	2.0
27...	1000	57	2	.31	--	3.0
29...	1045	47	1	.13	--	3.0
MAY						
01...	1500	41	1	.11	--	3.0
04...	1055	39	1	.11	--	2.0
06...	1330	41	3	.33	--	2.0
08...	1025	35	4	.38	58	4.0
11...	1210	31	3	.25	76	2.0
13...	1055	30	4	.32	68	2.0
15...	1010	35	5	.47	62	3.0
18...	1055	47	9	1.1	51	4.0
20...	1010	90	4	.97	66	8.0
22...	1025	59	1	.16	--	3.0
27...	1020	45	1	.12	--	2.0
29...	1010	38	1	.10	--	2.0

Table 3.--Particle-size analyses for Cow Creek near Azalea, 1981 water year

14309000 - COW CREEK NEAR AZALEA, OREG.

WATER QUALITY DATA, WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SEDI-MENT, SUS-PENDED (MG/L)	SEDI-MENT, DIS-CHARGE, SUS-PENDED (T/DAY)	TUR-BID-ITY (NTU)	SED. SUSP. FALL DIAM. % FINER THAN .002 MM	SED. SUSP. FALL DIAM. % FINER THAN .004 MM	SED. SUSP. FALL DIAM. % FINER THAN .008 MM
DEC								
02...	1645	4020	946	10300	180	15	23	31
02...	2220	1620	409	1790	110	24	32	44
03...	0100	1020	250	688	68	--	31	--
03...	0615	671	122	221	41	--	41	--
03...	1915	525	87	123	23	--	40	--
04...	0900	469	50	63	23	--	60	--

DATE	SED. SUSP. FALL DIAM. % FINER THAN .016 MM	SED. SUSP. FALL DIAM. % FINER THAN .031 MM	SED. SUSP. FALL DIAM. % FINER THAN .062 MM	SED. SUSP. FALL DIAM. % FINER THAN .125 MM	SED. SUSP. FALL DIAM. % FINER THAN .250 MM	SED. SUSP. FALL DIAM. % FINER THAN .500 MM	SED. SUSP. FALL DIAM. % FINER THAN 1.00 MM
DEC							
02...	44	57	67	74	80	94	100
02...	58	74	82	87	92	100	--
03...	--	--	--	--	--	--	--
03...	--	--	--	--	--	--	--
03...	--	--	--	--	--	--	--
04...	--	--	--	--	--	--	--

Table 4.--Mean daily flow, sediment concentration, and sediment discharge for Cow Creek near Azalea, 1981 water year

SEDIMENT DISCHARGE, SUSPENDED (TONS/DAY), WATER YEAR OCTOBER 1980 TO SEPTEMBER 1981

DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L	SEDIMENT DISCHARGE (TONS/DAY)
		DECEMBER.			JANUARY			FEBRUARY	
1	32	---	.10	67	---	.35	64	---	.40
2	1740	483	3750	62	2	.33	59	---	.30
3	668	120	210	57	1	.17	55	---	.30
4	563	60	90	52	---	.15	51	2	.28
5	240	8	4.8	49	1	.13	51	---	.30
6	171	3	1.4	46	---	.20	53	4	.58
7	125	3	1.0	44	2	.24	48	---	.40
8	98	1	.27	42	---	.30	45	---	.30
9	82	1	.22	39	4	.41	44	1	.12
10	74	1	.20	37	---	.40	43	---	.10
11	69	1	.19	35	---	.40	41	1	.11
12	64	1	.17	33	4	.36	40	---	.10
13	60	---	.16	32	---	.40	50	2	.23
14	59	---	.15	31	6	.50	269	---	40
15	53	1	.14	30	---	.30	159	---	4.0
16	60	---	.15	30	2	.16	214	5	1.8
17	59	1	.16	31	---	.16	232	---	2.0
18	54	---	.14	30	---	.16	163	3	1.4
19	51	1	.13	27	2	.15	177	---	2.0
20	51	---	.14	26	---	.15	199	6	3.2
21	57	1	.15	27	2	.15	163	---	2.0
22	71	---	.19	34	---	.19	139	---	1.0
23	63	---	.16	37	2	.20	121	2	.64
24	72	---	.17	44	---	.20	132	---	.50
25	320	56	48	40	---	.20	125	1	.35
26	205	6	3.2	40	---	.20	113	---	.40
27	144	---	1.5	63	4	.41	99	2	.55
28	114	---	.80	85	6	1.3	90	---	.40
29	95	1	.26	107	---	1.5	---	---	---
30	82	---	.30	89	4	.97	---	---	---
31	74	2	.40	73	---	.50	---	---	---
TOTAL	5670	---	4114.65	1439	---	11.24	3039	---	63.76

DAY	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)	MEAN DISCHARGE (CFS)	MEAN CONCEN-TRATION (MG/L)	SEDIMENT DISCHARGE (TONS/DAY)
		MARCH			APRIL			MAY	
1	82	---	.30	137	6	2.2	40	1	.11
2	75	---	.20	127	---	1.2	40	---	.10
3	72	1	.19	119	3	.99	40	---	.10
4	117	---	2.0	108	---	.80	39	1	.11
5	104	4	1.1	98	---	.60	39	---	.20
6	91	---	.80	94	2	.51	38	3	.33
7	85	---	.60	86	---	.60	37	---	.30
8	80	---	.50	81	4	.87	36	4	.38
9	74	2	.40	84	---	.90	35	---	.30
10	71	---	.30	77	4	.85	33	---	.30
11	67	1	.18	74	---	.70	31	3	.25
12	67	---	.20	84	---	.80	30	---	.30
13	150	15	5.7	85	4	.94	30	4	.32
14	105	---	1.5	80	---	.85	29	---	.30
15	97	---	.80	74	4	.82	35	5	.47
16	124	4	1.4	68	---	.50	40	---	.50
17	113	---	.80	64	2	.36	35	---	.50
18	101	---	.90	60	---	.30	47	9	1.1
19	91	---	1.0	57	---	.30	98	---	1.5
20	102	8	2.3	56	2	.31	81	4	.97
21	89	---	.80	55	---	.20	64	---	.50
22	85	---	.60	52	1	.15	54	1	.16
23	76	2	.41	49	---	.15	50	---	.10
24	72	---	.40	47	1	.13	52	---	.10
25	97	5	1.1	47	---	.20	57	---	.20
26	110	---	1.5	59	---	.30	49	---	.10
27	99	3	.83	55	2	.31	43	1	.12
28	91	---	.60	49	---	.20	39	---	.10
29	104	---	1.0	46	1	.13	36	1	.10
30	119	6	2.0	43	---	.10	35	---	.10
31	125	---	2.0	---	---	---	34	---	.10
TOTAL	2935	---	32.41	2215	---	17.27	1346	---	10.12