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RECONNAISSANCE STUDY OF SEDIMENT TRANSPORT BY SELECTED STREAMS IN THE YAKIMA INDIAN RESERVATION, WASHINGTON 1974 WATER YEAR

By

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~~In recognition of a worldwide trend to adoption of the metric system of measurements (SI or System Internationale),~~ The following factors are provided for conversion of English values used in this report to metric values:

Multiply	By	To obtain
Square miles (mi^2)	2.590	square kilometres (km^2)
Acre-feet (acre-ft)	1233.	cubic metres (m^3)
Tons	0.9072	tonnes
Tons per square mile ($tons/mi^2$)	0.3503	tonnes per square kilometre ($tonnes/km^2$)
Cubic feet per second (ft^3/s)	28.32	cubic metres per second (m^3/s)

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ABSTRACT

This was a reconnaissance study for information on suspended-sediment concentrations and basin yields at 21 ~~23~~ sites on selected streams in the Yakima Indian Reservation in Washington, and two sites on nearby streams. Suspended-sediment yields were generally low relative to those ~~that~~ indicated by data for other streams in southeastern Washington, ~~and~~ the southern Cascade Range, and the upper Columbia River basin. The highest long-term sediment yield on the reservation probably is from the Big Muddy Creek basin; the estimated annual yield is about 150 tons per square mile. The suspended sediment transported by this stream is largely from glacial outwash from Mount Adams. Other yields in the basin were estimated to be from 10 to 50 tons per square mile. Mass wasting is considered the principal cause of sediment transport in the streams studied. Some evidence of accelerated sediment production due to road construction was found along Surveyor Creek.

During the flood of January 1974, which has a calculated recurrence interval of more than 100 years, the maximum suspended-sediment observed concentration was 7,830 milligrams per litre, in the North Fork Simcoe Creek. During that flood, an estimated 70,000 tons of sediment was transported from the upper Toppenish Creek basin; this was nearly 600 tons per square mile. However, the long-term average annual yield was estimated to be only about 30 tons per square mile.

INTRODUCTION

During the 1974 water year, suspended-sediment samples were collected at 21 sites on various streams within the Yakima Indian Reservation. Samples also were collected on the North and South Forks of Ahtanum Creek just outside the northern boundary of the reservation. The locations of the sampling sites are shown in figure 1. Most samples

Figure 1 belongs near here.

were collected during the high streamflow periods of winter and during the spring. The reconnaissance nature of this study, with only a few samples collected at each site, required the extrapolation and interpolation of sediment data to areas of limited data coverage. A report by Nelson (1974a) includes some previous sediment-transport data from streams in that part of the reservation drained to the Yakima River, including the North and South Forks of Ahtanum Creek. Streamflow records were available only for the North and South Forks of Ahtanum Creek and the Klickitat River below the West Fork Klickitat River. The sediment-yield data for these streams are therefore probably more reliable than for the other streams.

The study was ~~conducted~~ made by the U.S. Geological Survey under cooperative agreement with the Yakima Tribal Council.

Streams throughout the forested parts of the Yakima Indian Reservation generally have similar characteristics in bed materials and sediment transport. There is only moderate movement of large cobbles and boulders along the streambeds and the streams generally have low to moderate suspended-sediment concentrations. Clearings within the forested areas are usually well covered with vegetal material ~~where exposed.~~ The soils there are generally of a silt loam interspersed throughout with numerous cobbles, and are generally not subject to severe erosion.

The sediment yields determined in this study were low compared to those in the lowlands of southeastern Washington. Three studies by Nelson (1971,1974a, 1974b) of streams draining the western slope of the Cascades and the upper Columbia River basin show that sediment yields there are generally greater than those determined in this study. Data from Nelson's study of the Snohomish River basin during the 1967 and 1968 water years (Nelson, 1971, p. 231) indicated yields of 50 to 1,290 tons/mi^2, with most yields about 100 tons/mi^2 near the Cascades. Nelson's study of the Deschutes and Nisqually River basins during the 1972 and 1973 water years (Nelson, 1974b, p. 12,23) indicated that suspended-sediment yields ranged from 20 to

2,500 tons/mi^2 per year; the latter yield was from the upper Nisqually River basin, with much of the sediment originating in glacial streams draining Mount Rainier.

Current logging practices are not considered to adversely affect sediment yields. However, some evidence from this study and experience in other areas indicate that construction of logging roads can accelerate erosion, and precautionary measures should be taken. There have been numerous studies of the effects of logging roads on sediment transport. A report being prepared by the U.S. Environmental Protection Agency (written commun., 1974) will discuss both the problems and the recommended procedures for minimizing the problems. Mass wasting--the gradual downhill movement of soil, landslides, streambank erosion, and sloughing of road embankments--is considered the principal cause of sediment production in the parts of the reservation studied.

SUSPENDED SEDIMENT

During periods of low streamflow in late summer and early fall, suspended-sediment concentrations were generally less than 5 mg/l (milligrams per litre). The highest observed suspended-sediment concentration was 7,830 mg/l, in the North Fork Simcoe Creek near White Swan (site 5 in fig. 1); this occurred during the flood of January 1974. The observed suspended-sediment concentrations at selected sites in the reservation are listed in table 1.

Table 1 belongs near here.

Observed data indicated a higher sediment yield from the Klickitat River basin above the West Fork Klickitat River than from any other basin in the reservation with the exception of Big Muddy Creek, which drains glaciers on Mount Adams. The estimated sediment yield from the Klickitat River basin above the West Fork Klickitat River (site 16 in fig. 1) is about 50 tons/mi^2 per year. A new road being built above that station, and streams cutting across the road during the spring snowmelt may have been the major sources of sediment during the sampling interval. Because there are no records of sediment concentration for past years, a comparison could not be made to determine if the concentration of sediment sampled during this investigation was greater than normal.

Concentrations of sediment were slightly less in Diamond Fork Creek (site 15 in fig. 1) than in the Klickitat River above the West Fork Klickitat River. The lower concentrations were probably due to little or no road construction along the main channel. However, the long, steep gradients in the basin probably contribute to increased sediment, yield. and the sediment yield from the Diamond Fork Creek basin was estimated to be about 30 tons/mi^2 per year.

Samples taken from Fish Lake Stream (site 17 in fig. 1) indicate that sediment concentrations equaled about one-fifth those of the Klickitat River above the West Fork Klickitat River. A comparison of water discharges and sediment samples of Fish Lake Stream to those of the Klickitat River above the West Fork Klickitat River suggests a yield of about 10 tons/mi^2 per year from the Fish Lake Stream basin. The system of small lakes, which partially trap sediment, and lower gradients in the streams below these lakes probably account for the rather low sediment yield.

Sediment concentrations in Cunningham Creek (site in, fig. 1) were higher than those in Fish Lake Stream, probably because of the much steeper gradient. A yield of about 20 tons/mi^2 per year was estimated for this drainage.

The sediment yield from the forested part of the Big Muddy Creek basin is estimated to be about equal to that from the adjoining Cunningham Creek basin. The total sediment yield from the Big Muddy Creek basin is affected by sediment produced from glacial streams draining Mount Adams. Data are lacking for a good estimate of the total sediment yield from this basin; however, based on the steep gradients in the basin and considering the ~~quantity of~~ sediment transport ~~produced from~~ glacial streams reported for other streams in the Cascade Range, a yield of 150 tons/mi^2 per year is estimated.

The White Creek basin is probably the most highly developed of the forested basins studied during this project. According to the [U.S.] Bureau of Indian Affairs (written commun., 1974) the White Creek basin has the greatest road density and largest areas of logging operations. However, suspended-sediment concentrations were all relatively low. (If this stream had been sampled during the flood of 1974, sediment concentrations would have been much higher than those obtained.) ~~However,~~ It may be that the lesser gradients in this basin and the current logging practices have not adversely affected the sediment yield. A yield of about 20 tons/mi^2 per year was estimated for the White Creek basin.

The sediment yield from the Klickitat River below White Creek is estimated to be about 20 tons/mi^2 per year.

brackets

Samples taken from Toppenish Creek at the [U.S.] Bureau of Indian Affairs gaging station near White Swan (site 4 in fig. 1) indicated only moderate amounts of sediment in transport except during the flood of January 1974. During this storm, an estimated 70,000 tons of sediment--or about 600 tons/mi^2--was transported from the Toppenish Creek above sampling site 4 near Fort Simcoe Historical State Park (fig. 1) basin. However, the long-term sediment yield was estimated from this area to be only about 30 tons/mi^2 per year. The sediment yield from the basin of the South Fork Toppenish Creek above sampling site 3 (fig. 1) was estimated to be about 20 tons/mi^2 per year. The Canyon walls leading to Toppenish Creek are steep but vegetal cover and the rocky soils apparently minimize sediment erosion processes.

Water in the Simcoe Creek basin and water diverted from the Toppenish Creek basin are proposed to be impounded behind a dam to be located in sec. 34, T.11 N., R.16 E. (fig. 1). A report by the [U.S.] Bureau of Indian Affairs (1967) ~~indicates~~ states that the total ~~average annual~~ sedimentation rate in the reservoir will average ~~of~~ 26.69 acre-feet per year or a sediment yield of about 250 tons/mi^2 per year. Data in this report indicates a long-term estimated sediment yield of about 30 tons/mi^2 per year, or about 3 acre-feet per year. of deposition in the reservoir. Based on samples collected at sites 7 and 8 during the flood of January 14-19, 1974, and

interpretation of sediment yields of adjacent streams during this flood, an estimated 160,000 tons--or about 80 acre-feet--of sediment would have been carried into the reservoir area. This flood has a recurrence interval of more than 100 years. It is during such floods that most of the sediment in the reservation ~~basins~~ streams is transported.

Samples taken from streams in the Hunt Creek basin revealed only a moderate amount of sediment in transport. A sediment yield of only 10 tons/mi^2 per year was estimated for the basin (site 9 in fig. 1). The stream at the sampling site flows over a fairly broad plain during high flows. This alluvial plain ~~does~~ did not show signs of any extensive erosion even after the large flood of January 1974. Conditions in the basins of Hunt, Simcoe, and Toppenish Creeks are similar, and erosion processes at present appear to produce relatively small sediment yields compared to those of other streams in the foothills of the Cascade Range.

Washed-out and flooded roads prevented sampling during any major runoff period in the Yatama Creek basin. A yield of 20 tons/mi^2 per year, however, was estimated for that part of the basin above sampling site 12 (fig. 1). Gradients in the basin are fairly steep in places, but the rocky soil type and vegetal cover ~~does not~~ appear to retard erosion. ~~easily.~~

To keep accelerated erosion to a minimum, caution should be used when designing and building roads. During May it was ~~visually noted~~ observed that spring runoff flowing into Surveyors Creek was relatively free of sediment. However, as snow was melting along Signal Peak Road, parallel to the Creek, the runoff formed into small streamlets in the ditch along the road and along and across the road. Visual observations indicated an increase in sediment ~~load~~ transport as these streamlets continued on their course to the creek. Samples obtained farther downstream on Surveyors Creek contained 409 mg/l, while upstream from Signal Peak Road the creek was estimated to have less than 100 mg/l of sediment.

Field observations indicated that some mass wasting has occurred generally where roads have been constructed along steep banks in the reservation.

REFERENCES

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-----1974b, Sediment transport by streams in the Deschutes and Nisqually River basins, Washington, November 1971-June 1973: U.S. Geol. Survey open-file report, 33 p.

[U.S.] Bureau of Indian Affairs, 1967 (revised 1973), Irrigation feasibility report, Toppenish-Simcoe Project, Washington: Portland, Oreg., 102 p.

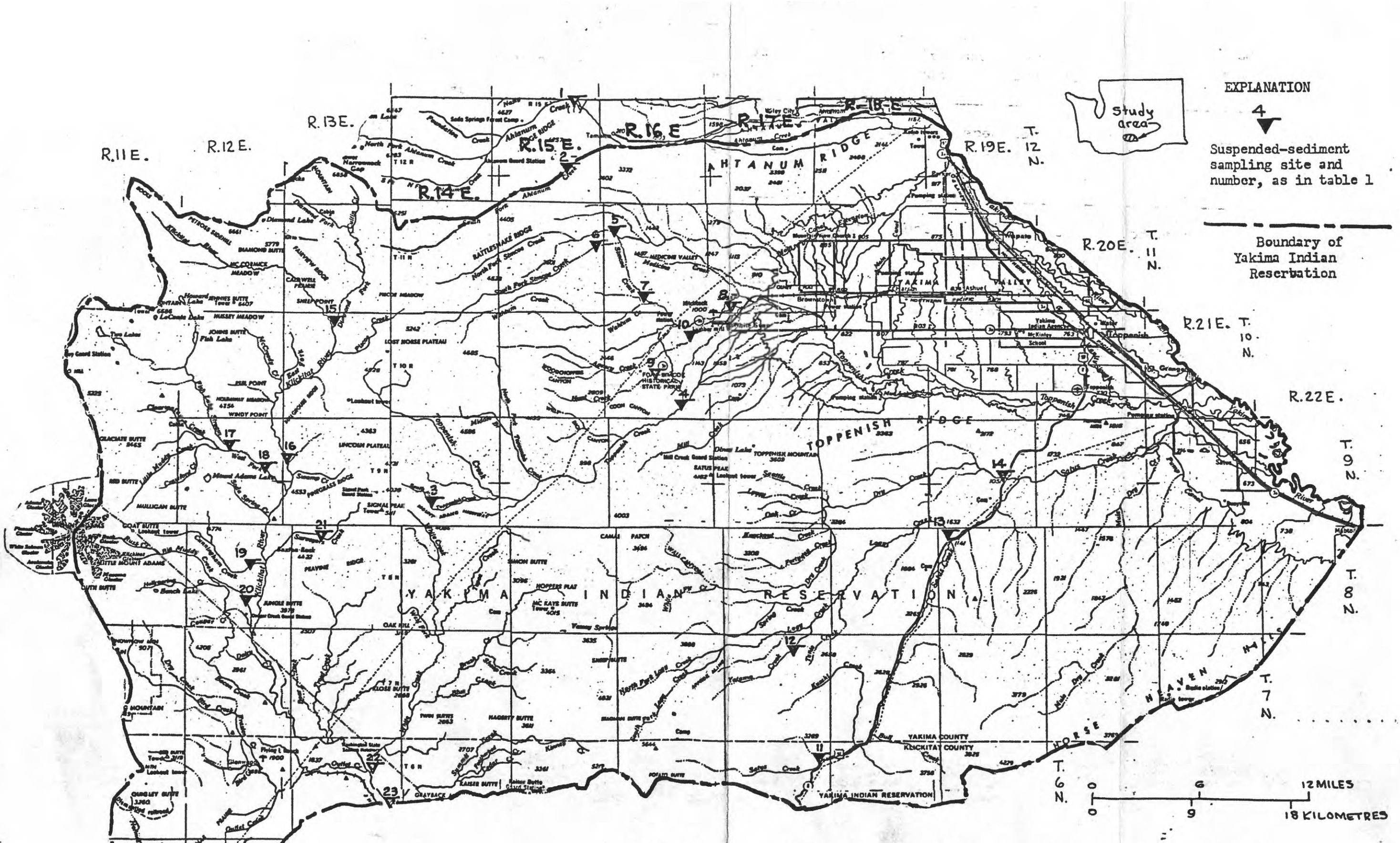

FIGURE 1.--Suspended-sediment sampling sites in and near Yakima Indian Reservation. See table 1 for descriptions and data.

Base from U.S. Geological Survey
Yakima and The Dalles quadrangles,
1:250,000

TABLE 1.--Suspended-sediment data, selected streams in the Yakima Indian Reservation, Washington

Sampling-site no. in fig. 1	Station number and (or) sampling-site location	Stream	Drainage area (mi^2)	Data observation				Average annual sediment yield (tons/mi^2)[1]
				Date	Time	Instantaneous water discharge (ft^3/s)	Suspended-sediment concentration (mg/l)	
1	12500500. NE¼NW¼ sec.2, T 12 N., R.15 E.	North Fork Ahtanum Creek	68.9	11- 6-73	0845	26	0	[a]30
				1-17-74	1340	683	2,240	
				2- 4-74	1345	95	22	
				5- 3-74	0955	255	14	
				5- 9-74	1130	387	180	
				5-10-74	1045	320	33	
				6-16-74	1315	504	214	
2	12501000. SW¼ sec. 23, T.12 N., R.15 E.	South Fork Ahtanum Creek	24.8	11- 6-73	0910	6.3	0	[a]20
				1-16-74	1315	562	1,420	
				2- 4-74	1310	33	2	
				5- 3-74	1155	73	8	
				5- 9-74	1200	95	20	
				5-10-74	1010	87	11	
				6-16-74	1245	134	154	
3	SW¼ sec. 28, T.9 N., R.14 E.	South Fork Toppenish Creek	[2]/4	11-12-73	1555	15	45	[b]20
				4-22-74	1545	27	34	
				5- 3-74	1730	37	30	
				5- 7-74	1510	50	174	
				5- 9-74	1830	45	36	
				6- 6-74	1525	13	16	
4	12506000. SE¼NW¼ sec.35, T.10 N., R.16 E.	Toppenish Creek	122	11-12-73	1210	234	130	[b]30
				11-14-73	1040	146	12	
				11-16-73	1955	246	161	
				1-15-74	1730	--	2,290	
				3-29-74	1035	224	66	
				4-22-74	1830	202	39	
				4-23-74	1145	224	82	
				4-25-74	1115	489	324	
				4-26-74	1030	451	130	
				5- 3-74	1530	398	21	
				5- 7-74	1350	448	358	
				5- 8-74	1735	438	142	
				5- 9-74	1920	388	304	
				8- 6-74	--	--	2	

TABLE 1.--Suspended-sediment data, selected streams in the Yakima Indian Reservation, Washington--Continued

Sampling-site no. in fig. 1	Station number and (or) sampling-site location	Stream	Drainage area (mi^2)	Data observation				Average annual sediment yield (tons/mi^2)[1]
				Date	Time	Instantaneous water discharge (ft^3/s)	Suspended-sediment concentration (mg/l)	
5	12506300. SW¼NE¼ sec.7, T.11, N.,R.16 E.	North Fork Simcoe Creek	24.8	11- 6-73	1210	6	0	[c]30
				11-12-73	1420	34	136	
				11-14-73	0950	15	14	
				11-16-73	1855	26	28	
				1-15-74	1545	[3]1,400	7,830	
				1-16-74	1755	[3]600	2,660	
				2- 5-74	1045	--	4	
				3-29-74	0850	86	40	
				4-22-74	1955	72	18	
				4-23-74	1015	72	14	
				4-25-74	1830	144	158	
				4-26-74	1000	131	74	
				5- 3-74	1440	75	18	
				5- 8-74	1530	100	46	
				6-16-74	1655	[3]5	10	
6	12506330. NW¼NE¼ sec.13, T.11 N., R.15 E.	South Fork Simcoe Creek	16.2	11- 6-73	1250	14	0	[c]30
				11-12-73	1400	30	63	
				11-14-73	1010	19	6	
				2- 5-74	1145	--	4	
				3-29-74	0940	41	43	
				4-22-74	1920	44	30	
				4-23-74	1035	49	36	
				5- 8-74	1505	105	131	
				6-16-74	1645	[3]3	21	
7	NW¼ sec.33, T.11 N., R.16 E.	Simcoe Creek	50	1-15-74	1615	--	5,420	--
8	SW¼ sec.32, T.11 N., R.17 E.	--do--------	129	1-15-74	1700	--	1,240	--
9	NE¼NE¼ sec. 21,T.10 N.,R.16 E.	Hunt Creek	[2]10	11-16-74	1915	[3]8	10	[b]10
				3-29-74	1015	[3]6	4	
				4-22-74	1745	[3]1	2	
				4-25-74	1740	[3]4	4	
10	NE¼ sec.11, T.10 N., R.16 E.	Agency Creek	29	1-15-74	1400	--	1,680	--
11	SW¼SE¼ sec.1, T.6 N., R.17 E.	Satus Creek	36	5- 8-74	0840	[3]170	130	--
12	NE¼NE¼ sec.10, T.7 N.,R.17 E.	Yatama Creek	[2]14	11-13-74	1550	22	16	[b]20
				4-11-74	1515	32	3	
				4-25-74	1500	45	2	
				4-26-74	1810	44	4	
				5- 8-74	1810	28	8	

TABLE 1.--Suspended-sediment data, selected streams in the Yakima Indian Reservation, Washington--Continued

Sampling-site no. in fig. 1	Station number and (or) sampling-site location	Stream	Drainage area (mi^2)	Data observation				Average annual sediment yield ($tons/mi^2$)[1]
				Date	Time	Instantaneous water discharge (ft^3/s)	Suspended sediment concentration (mg/l)	
13	12507950. SE¼NE¼ sec.6, T.8 N.,R.19 E.	Logy Creek	99.6	11- 7-73	1010	--	0	--
				11-13-73	1445	--	22	
				11-16-73	1715	--	130	
14	12508480. SE¼NW¼ sec.23, T.9 N.,R.19 E.	Dry Creek	158	11- 7-73	0910	--	0	--
				11-13-73	1730	--	15	
				11-16-73	1545	--	134	
15	NW¼SE¼ sec.4, T.10 N., R.13 E.	Diamond Fork Creek	[2]/41	5- 9-74	1340	386	38	[b]30
				6- 4-74	1430	552	78	
				6- 6-74	1420	525	46	
				6-24-74	1625	420	20	
16	14107000. NW¼SW¼ sec.18, T.9 N., R.13 E.	Klickitat River above West Fork Klickitat River	151	11-13-73	0910	133	12	a d_{50}
				4-26-74	1500	788	14	
				5- 1-74	1610	898	20	
				5- 3-74	1845	812	15	
				5- 7-74	1730	1,730	238	
				5- 9-74	1205	1,530	98	
				6- 4-74	1340	1,560	78	
				6- 6-74	1345	1,660	73	
				6-14-74	1440	1,090	82	
				6-15-74	1530	2,320	178	
				6-24-74	1600	1,380	31	
17	SE¼SE¼ sec.9, T.9 N., R.12 E.	Fish Lake Stream	47.8	11-13-73	0855	223	4	[e]10
				4-26-74	1515	350	2	
				5- 3-74	1900	302	2	
				5- 7-74	1720	460	6	
				5- 9-74	1420	473	2	
				6- 4-74	1640	810	10	
				6- 6-74	1320	1,000	20	
				6-14-74	1630	840	17	
				6-15-74	1330	890	13	
				6-24-74	1705	770	8	
18	SE¼SE¼ sec.14, T.9 N., R.12 E.	West Fork Klickitat River	88.8	6-14-74	1645	--	30	--
19	NW¼SE¼ sec.15, T.8 N., R.12 E.	Cunningham Creek	[2]/15	11-13-73	0735	30	10	b [e]20
				4-23-74	1525	55	5	
				4-26-74	1540	54	4	
				5- 3-74	1920	55	6	
				5- 7-74	1755	108	54	
				5- 9-74	1515	85	8	
				6- 4-74	1720	85	47	

TABLE 1.--Suspended-sediment data, selected streams in the Yakima Indian Reservation, Washington--Continued

Sampling-site no. in fig. 1	Station number and (or) sampling-site location	Stream	Drainage area (mi^2)	Data observation				Average annual sediment yield (tons/mi^2)
				Date	Time	Instantaneous water discharge (ft^3/s)	Suspended sediment concentration (mg/l)	
19 (continued)				6- 6-74	1255	80	23	
				6-19-74	1700	55	4	
				6-15-74	1300	68	6	
				6-24-74	1730	47	5	
20	14109000. NE¼SW¼ sec.27, T.8 N., R.12 E.	Big Muddy Creek	23.3	11- 7-73	1400	--	13	[b]150
				2- 6-74	1100	--	0	
				4-23-74	1600	121	6	
				4-26-74	1600	121	6	
				5- 3-74	1930	128	4	
				5- 7-74	1510	141	32	
				5- 7-74	1830	[3]/140	42	
				5- 9-74	1545	128	9	
				6- 4-74	1730	173	58	
				6- 6-74	1155	180	22	
				6-14-74	1715	220	116	
				6-15-74	1245	460	61	
				6-24-74	1745	155	73	
				8- 7-74	1250	--	301	
21	SW¼ sec.34, T.9 N., R.13 E.	Surveyors Creek	6	5- 3-74	1815	[3]/40	82	--
				5- 7-74	1605	76	409	
				5- 9-74	1745	74	128	
22	14110800. NW¼ sec.14, T.6 N., R.18 E.	White Creek	130	11- 7-73	1640	[3]/2	0	[b]20
				11-12-73	1835	62	40	
				12- 4-73	1040	--	4	
				2- 4-74	1305	--	4	
				4-11-74	1815	288	7	
				4-23-74	1745	254	18	
				4-26-74	1655	[3]/305	25	
				5- 3-74	2020	[3]/240	23	
				5- 7-74	1920	176	10	
				5- 8-74	1030	[3]/170	12	
				6- 5-74	1745	60	28	
				8- 7-74	1545	--	8	

TABLE 1.--Suspended-sediment data, selected streams in the Yakima Indian Reservation, Washington--Continued

Sampling-site no. in fig. 1	Station number and (or) sampling-site location	Stream	Drainage area (mi^2)	Data observation				Average annual sediment yield ($tons/mi^2$)
				Date	Time	Instantaneous water discharge (ft^3/s)	Suspended sediment concentration (mg/l)	
23	On line between secs. 24 and 25, T.6 N., R.13 E.	Klickitat River below White Creek	752	4-11-74	1835	--	10	[f]30
				5- 7-74	1935	--	145	
				8- 7-74	1415	--	4	

[1] Method of estimating or calculating yields at each site indicated as follows:

[a] From sediment rating curve (suspended-sediment concentration versus water discharge).

[b] From comparison of suspended-sediment concentration with sediment concentrations and yields in nearby basins.

[c] From sediment rating curve and correlation with flow-duration curves for North and South Forks Ahtanum Creeks near Tampico.

[d] From Nelson method (Nelson, 1970).

[e] From sediment rating curve and correlation with flow-duration curve for Klickitat River below West Fork Klickitat River near Glenwood.

[f] Estimated on basis of yields upstream.

[2] Area calculated from map provided by [U.S.] Bureau of Indian Affairs, and rounded to nearest square mile.

[3] Estimated water discharge.