



## Hydrologic Benchmark Network Stations in the Western U.S. 1963-95 (USGS Circular 1173-D)

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# Merced River at Happy Isles Bridge near Yosemite, California (Station 11264500)

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*This report details one of the approximately 50 stations in the Hydrologic Benchmark Network (HBN) described in the four-volume U.S. Geological Survey Circular 1173. The suggested citation for the information on this page is:*

**Mast, M.A., and Clow, David W., 2000, Environmental characteristics and water-quality of Hydrologic Benchmark Network stations in the Western United States, U.S. Geological Survey Circular 1173-D, 115 p.**

*All of the tables and figures are numbered as they appear in each circular. Use the navigation bar above to view the abstract, introduction and methods for the entire circular, as well as a map and list of all of the HBN sites. Use the table of contents below to view the information on this particular station.*

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## Site Characteristics and Land Use

The Merced River HBN Basin is located on the western slope of the central Sierra Nevada, in the Sierra-Cascade Mountains physiographic province in central California ([Figure 6](#). Map showing study area in the Merced River Basin and photograph showing

*the Echo Creek subbasin*). The basin drains an area of 469 km<sup>2</sup> and ranges in elevation from 1,224 to 3,997 m. The landscape in the Merced River Basin is alpine-subalpine-montane and is characterized by broad glaciated valleys with steep-sided walls. Forests and meadows mainly cover the alluvial areas along the valley floors, and the ridges have broad expanses of exposed granite and thin patches of forest. Headwater cirques are alpine in character and have numerous glacial lakes and abundant talus and till deposits. The HBN station is located 3.0 km southeast of the town of Yosemite Village, Calif., at latitude 37°43'54" and longitude 119°33'28". The Merced River is a west-flowing tributary of the San Joaquin River that has a channel length of about 31.9 km upstream from the HBN station and an average stream gradient of 27.3 m/km. The annual hydrograph is driven by melting of a seasonal snowpack that accumulates between October and early April and melts during late April to June. Mean monthly discharge varies from 1.1 m<sup>3</sup>/s in October to 35.4 m<sup>3</sup>/s in May, and average annual runoff from the basin was 66.5 cm from 1916 through 1995 (Hayes and others, 1996). The area has a Mediterranean-type climate with cool, wet winters and warm, dry summers. Average daily air temperatures range from 3°C in January to 22°C in July (National Weather Service at URL <http://www.wrcc.dri.edu/climsum.html>, 1998). Average annual precipitation at the elevation of the HBN station is about 94 cm of which about 25 percent falls as snow between October and April. Precipitation amount increases with increasing elevation up to about 2,000 m and then stabilizes (Stephenson, 1988). Precipitation averages about 140 cm at treeline (~3,200 m) of which as much as 95 percent falls in the form of snow (Stephenson, 1988; Melack and Stoddard, 1991).

The basin is located in the Sierran Steppe-Mixed Forest-Coniferous Forest-Alpine Meadow ecoregion (Bailey and others, 1994) and vegetation is dominated by old-growth pine and fir vegetation types (Rundel and others, 1977). Less than one-half of the basin area is forested and the remainder is covered by lakes, wetlands, meadows, rock outcrops, and talus slopes (Rundel and others, 1977). In the montane zone, which ranges from about 1,500 to 2,700 m, the predominant trees are ponderosa pine, Jeffrey pine, Douglas-fir, sugar pine, white fir, California red fir, and incense cedar. In the subalpine zone (about 2,700 to 3,200 m), the predominant trees include mountain hemlock, California red fir, lodgepole pine, western white pine, and whitebark pine. In the alpine zone, above about 3,200 m, vegetation consists of low-lying tundra plants and alpine meadow vegetation. Soils in the basin are Inceptisols, which mostly developed on alluvial deposits and glacial tills derived from the local bedrock. The soils are usually shallow, coarse textured, dark colored, and acidic and have variable organic-matter content. Most of the soils are highly permeable, except for meadow soils, which are poorly drained. Cryumbrepts form predominantly in granitic colluvium on ledges, on ridge slopes, and in joint systems on large rock outcrops (Huntington and Akison, 1987). These soils usually have a thick, dark-colored surface layer overlying lighter colored substrata that rest on coarse boulders or slightly weathered granite rock at depths ranging from 50 to more than 150 cm. Cryochrepts and Cryorthents are developed on hillslopes above the valley floors, where Cryoboralfs dominate. A typical forest-soil profile has a 10-cm-thick organic-rich surface layer, a 30-cm-thick brown cobbly silty loam, and a 30-cm-thick yellowish-brown cobbly sandy loam sublayer that is underlain by massive granite boulders.

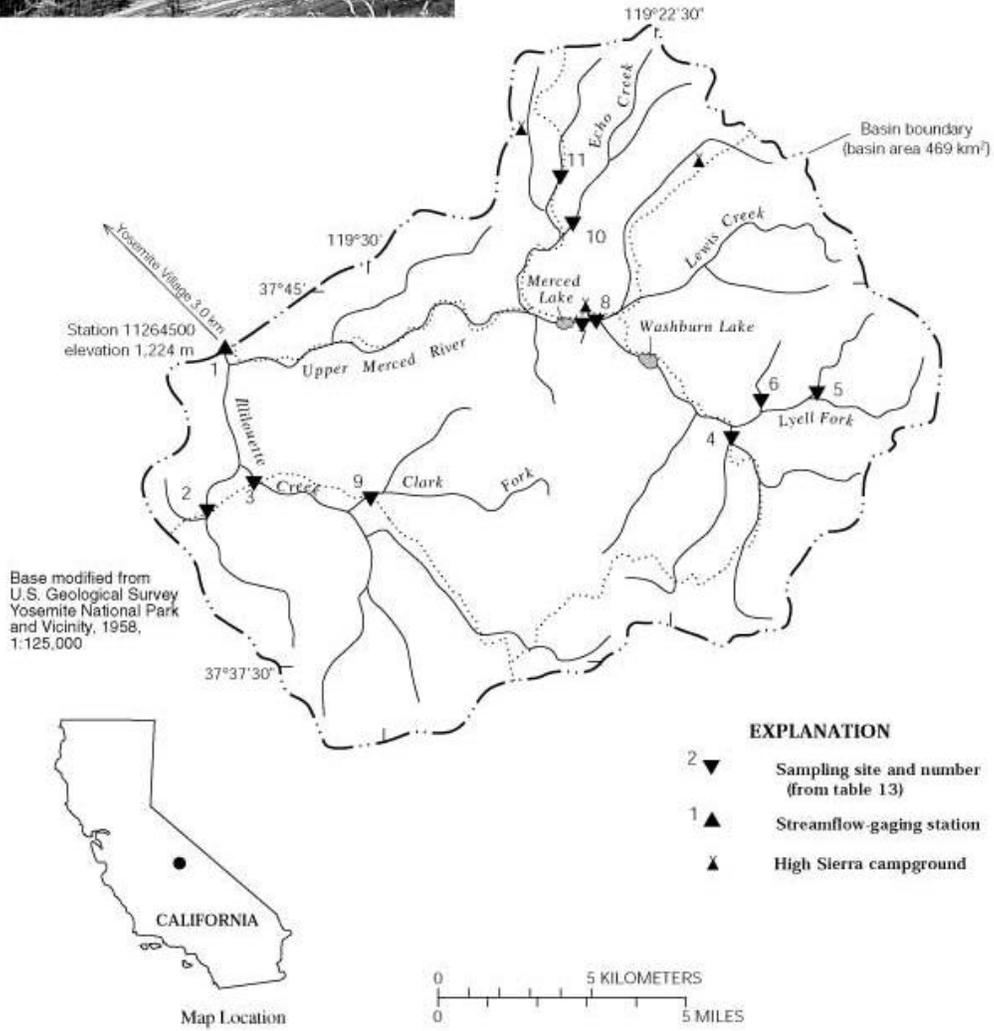


Figure 6. Map showing study area in the Merced River Basin and photograph showing the Echo Creek subbasin

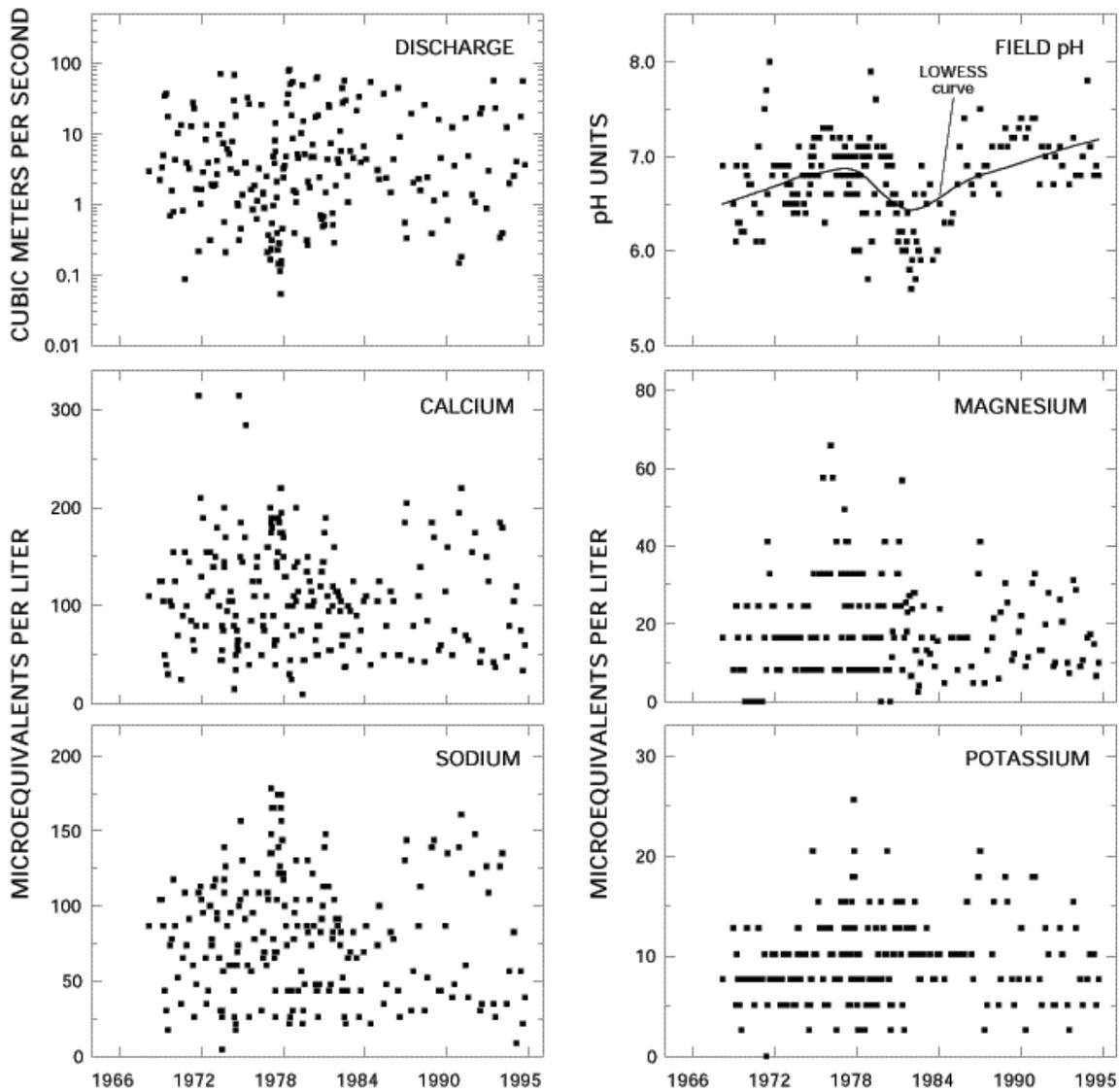
The Sierra Nevada are formed by Cretaceous-age granitic rocks of the Sierra Nevada Batholith (Huber, 1987; Bateman, 1992). Most of the rocks in the upper Merced River Basin are granites and granodiorites that are part of the Tuolumne Intrusive Suite, a group of four concentrically arranged plutons (Huber, 1987). The oldest and most mafic unit forms the margin of the suite and is present in the southwest part of the basin. The rocks are progressively younger and more felsic toward the core of the suite, which underlies the basin near the northern boundary. The predominant minerals in the granodiorites are plagioclase, biotite, and hornblende; the predominant minerals in the granites are plagioclase, quartz, potassium feldspar, biotite, and hornblende. Small outcrops of hornfels and other metavolcanic rocks were probably derived from pyroclastic rocks (tuff and breccia) that underlie the southeastern part of the basin. Limited exposures of metasedimentary rocks and diorite crop out along the eastern margin of the basin. About 20 percent of the basin is underlain by surficial deposits, which primarily include glacial till that covers the valley bottoms as lateral and recessional moraines. Till is particularly extensive in the drainage basin of Illilouette Creek (fig. 6). Talus and colluvium form substantial deposits in high-elevation cirques, especially along the Sierran Divide, which forms the eastern boundary of the basin.

The Merced River HBN Basin drains the eastern parts of Mariposa and Madera Counties in California and is entirely within the boundaries of Yosemite National Park. The only road in the basin follows the western margin of the park, providing access to a scenic overlook. An extensive trail system provides access to much of the basin during the summer, but deep snowpacks limit accessibility during the winter. The trail system and three large campgrounds (capacity of more than 50 people per night) are heavily used during the summer. The campgrounds are operated by concessionaires as semipermanent installations that have showers and water-treatment facilities. The basin is managed solely for wilderness and recreation because of its location in a national park. Forest fires, floods, and landslides are the main natural disturbances in the basin. Possible human effects primarily are trail erosion caused by people and pack animals, which may result in siltation of surface water.

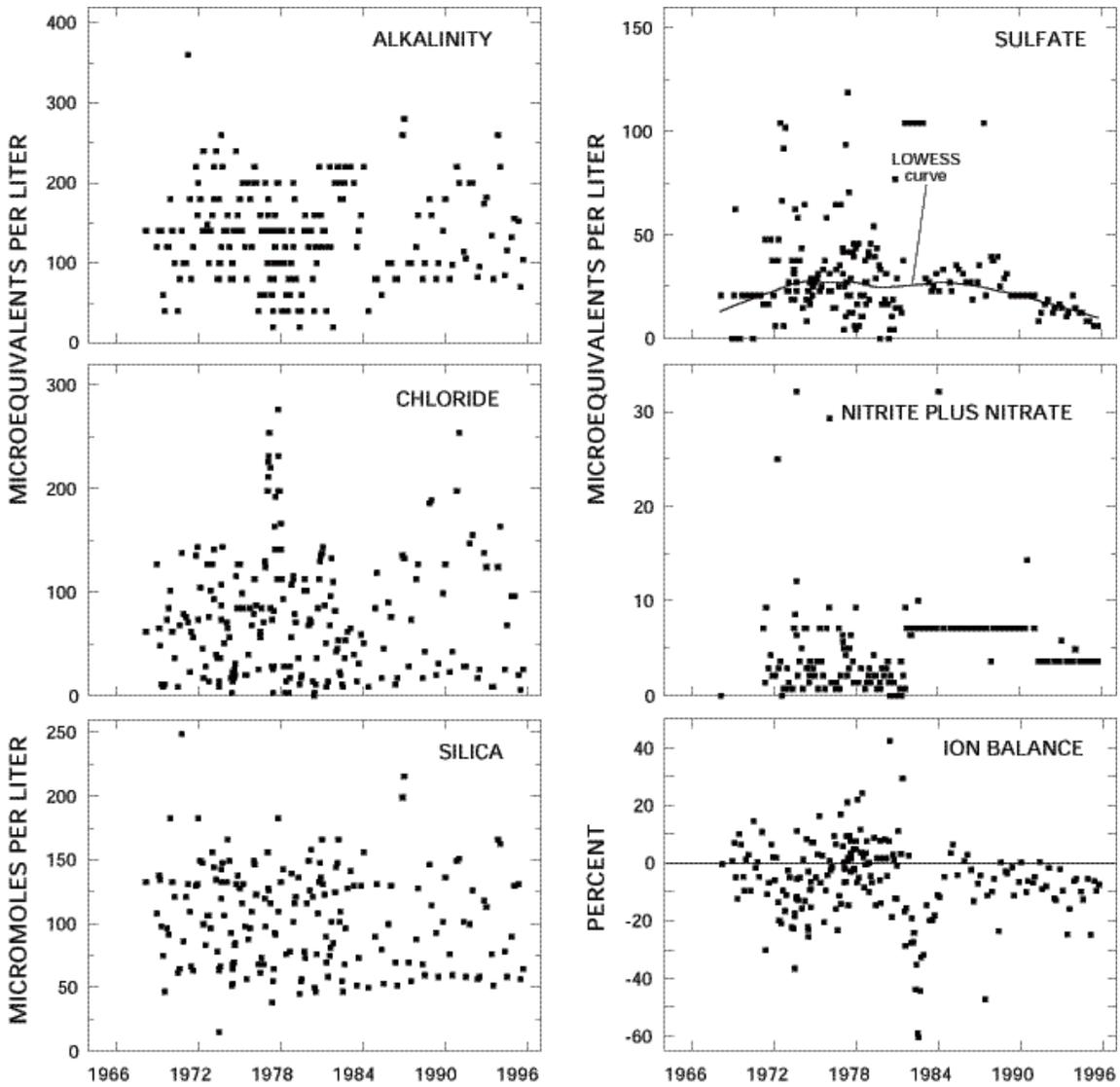
## **Historical Water-Quality Data and Time-Series Trends**

The data set for the Merced River HBN station analyzed for this report includes 212 water-quality samples that were collected from February 1968 through September 1995. Sampling frequency ranged from bimonthly to biweekly from 1969 to 1982, then was decreased to quarterly from 1983 to 1995. Samples from the early part of the period of record probably were analyzed at a USGS district laboratory in Sacramento, Calif. (Durum, 1978). After establishment of the central laboratory system, samples were analyzed at the Salt Lake City, Utah, laboratory from 1973 to 1975 and at the NWQL in Arvada, Colo., from 1976 through 1995. Daily discharge records for the Merced River (station 11264500) are available beginning in August 1915. Daily water temperature at the station was measured from October 1965 to September 1977 and October 1978 to September 1993.

Calculated ion balances for 202 samples that have complete major-ion analyses are shown in [figures 7a](#) and [7b](#). *Graphs showing temporal variation of discharge, field pH, major-ion concentrations, and ion balance in the Merced River, California.* Ion balances ranged from -61 to +42 percent, and only 60 percent of the samples had values within the  $\pm 10$ -percent range. This wide range of ion balances reflects the difficulty in making precise analytical measurements at the low solute concentrations typical of this station. The average ion balance was -6.3 percent, and more than 65 percent of the samples had negative ion balances, indicating an excess of measured anions over cations in solution. Natural water commonly has an excess of cations in solution because of the presence of unmeasured organic anions. An anion excess is more difficult to explain than a cation excess and may indicate a bias in the analytical measurements. The alkalinity determination is often the largest single source of error in major-ion analyses, particularly in dilute water (Fishman and Friedman, 1989). Laboratory alkalinity in HBN samples was determined by a fixed-endpoint titration to pH 4.5. For waters that have alkalinities less than 100 meq/L, however, the endpoint pH is closer to 5.0, and titration to pH 4.5 may overestimate alkalinity by as much as 25 meq/L (Barnes, 1964). Because the average alkalinity and anion excess for the Merced River HBN station were 130 meq/L and 27 meq/L, respectively, a bias in the laboratory alkalinity seems to be a reasonable explanation for the negative bias in the ion balance. Time-series plots of the major dissolved constituents were inspected for evidence of other method-related effects (fig. 7). The most notable pattern was in sulfate concentrations, which decreased considerably in scatter beginning in 1983 and had a period of low concentrations in the 1990's. Although natural variations in stream-water chemistry cannot be completely ruled out, this pattern probably was caused by several changes in the analytical technique for sulfate, including a change to a turbidimetric technique in 1983 (Office of Water Quality Technical Memorandum No. 83.07, Analytical methods: Sulfate determinations, issued February 25, 1983, at URL <http://water.usgs.gov/admin/memo/>) and another method change to ion chromatography in 1990 (Fishman and others, 1994). The period of elevated and uniform sulfate concentrations in 1982 and 1983 is related to an increase in the analytical reporting limit for sulfate to 5 mg/L (104 meq/L) during those 2 years. The temporal pattern in concentrations of nitrite plus nitrate at this station also was affected by changes in the analytical reporting limit for this constituent, as indicated by the stepped pattern in figure 7. High chloride concentrations were measured in several samples collected in late 1977 and early 1978; however, this pattern probably reflects natural variation in stream-water chemistry because the samples were collected during a period of extremely low streamflows.



**Figure 7a.** *Graphs showing temporal variation of discharge, field pH, major-ion concentrations, and ion balance in the Merced River, California*



**Figure 7b.** *Graphs showing temporal variation of discharge, field pH, major-ion concentrations, and ion balance in the Merced River, California - Continued*

**Table 10. Minimum, first quartile, median, third quartile, and maximum values of physical properties and major dissolved constituents measured in water-quality samples from the Merced River, California, March 1968 through September 1995, and volume-weighted mean concentrations in wet precipitation collected in Yosemite National Park, California**

[Concentrations in units of microequivalents per liter, discharge in cubic meters per second, specific conductance in microsiemens per centimeter at 25 degrees Celsius, pH in standard units, and silica in micromoles per liter; n, number of stream samples; VMW, volume-weighted mean; inst., instantaneous; spec. cond., specific conductance; <, less than; --, not reported]

Parameter	Stream Water						Precipitation VMA <sup>a</sup>
	Minimum	First Quartile	Median	Third Quartile	Maximum	n	
Discharge, inst.	0.054	0.96	3.3	13	82	210	--
Spec. cond., field	3.0	14	22	30	65	207	4.5
pH, field	5.6	6.5	6.8	7.0	8.0	206	5.4 <sup>b</sup>
Calcium	10	65	110	150	320	209	2.3
Magnesium	<8.2	8.2	16	25	66	208	1.2
Sodium	4.4	44	78	110	180	211	3.8
Potassium	<2.6	5.1	10	13	26	210	.3
Ammonium	<.7	.7	2.1	4.3	16	100	7.5
Alkalinity, laboratory	20	100	140	180	360	209	--
Sulfate	<4.2	17	23	37	120	209	5.9
Chloride	2.8	25	68	110	280	212	4.1
Nitrite plus nitrate	<.7	2.1	3.6	7.1	32	163	7.7 <sup>c</sup>
Silica	15	70	100	130	250	185	--

<sup>a</sup> Values are volume-weighted mean concentrations for 1982-95.

<sup>b</sup> Laboratory pH.

<sup>c</sup> Nitrate only.

The median concentrations and ranges of major dissolved constituents in stream water collected at the HBN station and VWM concentrations in wet-only precipitation measured at the Yosemite National Park NADP station are presented in table 10. Precipitation chemistry at the NADP station, which is about 25 km northwest of the HBN station at an elevation of 1,408 m, is very dilute and slightly acidic and has a VWM pH of 5.4 for 14 years of record. The predominant cation in precipitation was ammonium, which contributed 39 percent of the total cation charge, and the predominant anion was nitrate, which accounted for 44 percent of the total anions. The predominance of these

ions in precipitation may reflect the influence of agricultural activities in the San Joaquin Valley on the western side of the Sierra Nevada.

Stream water in the Merced River is dilute and weakly buffered; specific conductance ranged from 3.0 to 65 mS/cm, and alkalinity ranged from 20 to 360 meq/L (table 10). The major cations in stream water were calcium and sodium and the major anion was bicarbonate. The predominance of these solutes in stream water is attributed to the weathering of plagioclase and hornblende minerals in the granites and granodiorites of the Sierra Nevada Batholith (Clow and others, 1996). The median chloride concentration (68 meq/L) in stream water was substantially greater than the VWM concentration of chloride (4.1 meq/L) in precipitation, indicating that most stream-water chloride is derived from sources in the basin. In a detailed study of stream-water chemistry in the basin, Clow and others (1996) hypothesized that spring water that had high chloride concentrations and that was discharging from joints and fractures in the granitic bedrock was the only plausible source of chloride to surface water other than precipitation. The median concentration of sulfate in stream water was 23 meq/L compared to the VWM concentration of 5.9 meq/L in precipitation, indicating that some sulfate also seems to be derived from sources other than atmospheric deposition. In contrast, Clow and others (1996) reported a median sulfate concentration of 10 meq/L for surface water in the basin, which was accounted for by atmospheric inputs and evapotranspiration. One possible explanation for this discrepancy is that the median sulfate concentration in table 10 may be overestimated because of positive bias introduced by analytical techniques used in the past. Concentrations of inorganic nitrogen species in stream water were less than the VWM concentrations in precipitation, indicating that most atmospheric nitrogen is retained by vegetation and soils in the basin.

The solute composition of stream water was further evaluated by analyzing correlations between solutes and stream discharge (table 11). Most weathering-derived solutes had strong inverse correlations with stream discharge, particularly calcium ( $\rho = -0.806$ ) and sodium ( $\rho = -0.796$ ). These results are consistent with a hydrologic system where weathering-enriched base flow is diluted by water from shallow or surficial sources during periods of increased discharge, particularly spring snowmelt. Chloride also had a strong inverse correlation with discharge ( $\rho = -0.842$ ), providing additional evidence for the effect of chloride-rich ground-water springs on the chloride concentration of the stream (Clow and others, 1996). For the solutes, the strongest correlations were between calcium and sodium ( $\rho = 0.886$ ), calcium and chloride ( $\rho = 0.901$ ), and sodium and chloride ( $\rho = 0.893$ ). These strong correlations may indicate a common source of these solutes, such as saline springs discharging from joints and fractures in the bedrock. Calcium and sodium also had strong positive correlations with silica, which is consistent with the weathering stoichiometry of plagioclase in the granitic bedrock.

**Table 11. Spearman rank correlation coefficients (rho values) showing the relation among discharge, pH, and major dissolved constituents, Merced River, California, 1968 through 1995**

[Q, discharge; Ca, calcium; Mg, magnesium; Na, sodium; K, potassium; Alk, alkalinity; SO<sub>4</sub>, sulfate; Cl, chloride; Si, silica]

	Q	pH	Ca	Mg	Na	K	Alk	SO <sub>4</sub>	Cl
pH	-0.212	--	--	--	--	--	--	--	--
Ca	-.806	0.178	--	--	--	--	--	--	--
Mg	-.417	.137	.436	--	--	--	--	--	--
Na	-.796	.182	.886	0.479	--	--	--	--	--
K	-.596	.037	.665	.435	0.694	--	--	--	--
Alk	-.458	.087	.591	.317	.561	0.526	--	--	--
SO <sub>4</sub>	-.146	-.202	.116	.129	.109	.246	0.209	--	--
Cl	-.842	.206	.901	.467	.893	.673	.474	0.137	--
Si	-.480	.035	.736	.459	.730	.631	.597	.129	0.632

**Table 12. Results of the seasonal Kendall test for trends in discharge and unadjusted and flow-adjusted pH and major dissolved constituents, Merced River, California, March 1968 through September 1995**

[Trends in units of microequivalents per liter per year, except for discharge in cubic meters per second per year, pH in standard units per year, aluminum, iron, and silica in micromoles per liter per year; <, less than; --, not calculated]

Parameter	Unadjusted		Flow adjusted	
	Trend	p-value	Trend	p-value
Discharge	0.011	0.751	--	--
pH, field	.01	.007	0.01	0.002
Calcium	-.2	.366	-.2	.434
Magnesium	<.1	.762	<.1	.645
Sodium	<.1	.532	.2	.299
Potassium	<.1	.287	.1	.028
Alkalinity, laboratory	<.1	.319	1.0	.091
Sulfate	-.5	.005	-.4	.020
Chloride	.2	.569	.8	.011
Nitrite plus nitrate	( <sup>a</sup> )	--	--	--
Silica	-.5	.033	.4	.051

<sup>a</sup> Insufficient data to calculate trend.

The results of the seasonal Kendall test for trends in discharge and major dissolved constituents are listed in table 12. Statistically significant trends were detected in field pH and unadjusted sulfate concentrations at the 0.01 probability level. Trends were similar for the unadjusted and flow-adjusted field pH, indicating that the pH trend was probably not related to variations in stream discharge. The trend in flow-adjusted sulfate concentrations was not significant at the 0.10 probability level, indicating that the trend in the unadjusted concentrations may have been caused by variations in streamflow. Interpretation of trends in sulfate concentrations at this HBN station, however, is greatly complicated by bias introduced by changes in the analytical technique for sulfate during the period of record. The LOWESS curve in figure 7 shows that the trend in pH primarily was caused by a period of low values in the early 1980's followed by high values near the end of the period of record. The trend in stream-water pH at this station probably was not caused by human activities because the basin is used only for backcountry recreation. Another environmental factor that could affect stream-water chemistry is atmospheric deposition; however, no long-term records of precipitation chemistry are available at this site to confirm such a linkage. A method-related factor is perhaps the most reasonable source of the trend in stream-water pH at this station, particularly considering the rather abrupt decline in pH values in 1980. This pattern may, in part, be explained by changes in electrodes or meters used by field personnel. Some instrument-electrode systems are known to give erroneous readings, particularly when measuring pH in low-conductivity water (Office of Water Quality Technical Memorandum No. 81.08, Electrodes for pH measurement in low- conductivity waters, issued February 10, 1981, at URL <http://water.usgs.gov/admin/memo>).

## **Synoptic Water-Quality Data**

Chemical results of the surface-water synoptic sampling of August 1 through 4, 1991, are listed in table 13, and locations of sampling sites are shown in figure 6. During the synoptic sampling, discharge at the HBN station was 2.0 m<sup>3</sup>/s compared to the median daily discharge of 2.8 m<sup>3</sup>/s for early August (Lawrence, 1987), indicating that the basin was sampled during normal flow conditions for that time of year. Most of the solute concentrations measured at the HBN station (site 1) during the synoptic sampling were between the first-quartile and median values reported for the station during the entire period of record, except for sulfate, which was slightly lower (table 10). Stream water at the upstream sampling sites was similar in composition to stream water at site 1; calcium and sodium were the predominant cations, and bicarbonate was the predominant anion. Ion balances for all the synoptic samples were positive (range 2.1 to 13 percent), indicating that organic anions may have contributed to the ionic content of stream water during the sampling period.

**Table 13. Physical properties and major dissolved constituents from surface-water sampling sites in the Merced River Basin, California, collected August 1-4, 1991**

[Site locations shown in fig. 6; Q, discharge in cubic meters per second; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH in standard units; Ca, calcium; Mg, magnesium; Na, sodium; K, potassium; Alk, alkalinity; SO<sub>4</sub>, sulfate; Cl, chloride; NO<sub>3</sub>, nitrate; Si, silica; concentrations in microequivalents per liter, except silica in micromoles per liter; <, less than; --, not reported]

Site	Station number	Q	SC	pH	Ca	Mg	Na	K	Alk	SO <sub>4</sub>	Cl	NO <sub>3</sub>	Si	Criteria <sup>a</sup>	Remarks
1	11264500	2.0	20	7.1	90	14	65	7.2	--	11	56	2.1	70	--	--
2	374041119340200	.022	32	7.1	170	38	110	51	300	3.1	3.7	<.7	250	BG	Mafic bedrock
3	374113119323500	.22	28	7.6	140	29	91	12	230	10	25	<.7	180	BG	Mafic bedrock
4	374156119200200	--	7.0	6.5	31	4.8	13	2.6	26	10	4.8	2.9	25	BG	Mafic bedrock
5	374237119183900	.099	7.0	6.8	37	8.0	17	3.6	33	10	1.7	7.1	32	BG	Mafic bedrock
6	374239119183900	.027	6.0	7.0	23	4.8	26	3.1	38	4.2	1.4	<.7	83	BG	Felsic bedrock
7	374415119241800	--	18	6.9	80	8.8	52	4.4	59	12	62	2.1	37	MC, LU	Downstream from campground
8	374418119241100	1.6	19	6.6	80	5.6	57	7.9	65	12	68	2.1	37	MC, LU	Upstream from campground
9	374429119255300	.003	9.0	6.1	44	10	22	4.1	51	4.0	5.9	3.6	62	BG	Felsic bedrock
10	374603119245500	--	9.0	7.1	34	11	39	4.1	--	5.8	4.2	<.7	85	BG	Felsic bedrock
11	374702119250200	.014	12	6.7	55	8.0	52	4.4	77	14	4.5	<.7	90	BG	Felsic bedrock

<sup>a</sup> Criteria used in selection of sampling sites: BG = bedrock geology, MC = main channel, LU = land use.

Stream-water chemistry of the synoptic samples collected in the basin varied somewhat in the concentrations of the weathering-derived solutes; for example, alkalinity ranged from 26 to 300 meq/L, and silica ranged 25 to 250 mmol/L (table 13). The highest concentrations of alkalinity and silica were measured at sites 2 and 3 in the Illilouette Creek subbasin. Clow and others (1996) suggested that stream-water concentrations in the Illilouette subbasin were high because the subbasin is covered by a larger percentage of glacial till than other areas of the basin. Variations in the chemistry of the synoptic samples also seem to reflect the spatial distribution of the mapped bedrock geology. For example, streams draining felsic rock types (sites 6, 9, 10, and 11) had lower calcium to sodium ratios than streams draining more mafic rock types (sites 2-5), as would be expected on the basis of the calcium to sodium ratio of plagioclase minerals in these two

bedrock types (Clow and others, 1996). Chloride concentrations also varied somewhat spatially; concentrations ranged from more than 50 meq/L in samples collected from the main stem of the river compared to concentrations less than 6 meq/L at most of the upper tributary sites. Surface-water samples collected during several previous studies also had high chloride concentrations along the main stem and low concentrations in most tributaries (Sorenson and Hoffman, 1981). The high chloride concentrations in the river were unexpected, given the low concentrations in precipitation and in common granitic minerals (Feth, 1981). Wastewater-treatment facilities at the campgrounds could be a source of chloride to surface water; however, there was little difference in chloride concentrations in samples collected upstream from (site 8) and downstream from (site 7) the campground at Merced Lake. Clow and others (1996) suggested that the most likely source of chloride was saline ground water from springs that discharge from joints or faults along the valley floor. Sulfate concentrations were low and uniform throughout the basin, which is consistent with the idea that most stream-water sulfate is derived from atmospheric sources and bedrock contributions are negligible. Nitrate concentrations at all of the sampling sites were low, which is consistent with the minimal amount of human activity in the basin and indicates that the backcountry campgrounds had a negligible effect on nutrient concentrations in the river during the synoptic sampling.

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## Appendix A. List of Map References

### a. U.S. Geological Survey Topographic Maps:

- Hetch Hetchy Reservoir, California (1:62,500), 1956
- Merced Peak, California (1:62,500), 1953
- Tuolumne Meadows, California (1:62,500), 1956
- Yosemite, California (1:62,500), 1956, HBN gaging station on this quadrangle
- Yosemite National Park and Vicinity, California (1:125,000), 1958

### b. Geologic Maps:

- Bateman, P.C., Kistler, R.W., Peck, D.L., and Busacca, A.J., 1983, Geologic map of the Tuolumne Meadows Quadrangle, Yosemite National Park, California: U.S. Geological Survey Geologic Quadrangle Map GQ-1570, scale 1:24,000.
- Calkins, F.C., 1985, Bedrock geologic map of Yosemite Valley, Yosemite National Park, California: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1639, scale 1:24,000.
- Huber, N.K., Bateman, P.C., and Wahrhaftig, Clyde, 1989, Geologic map of Yosemite National Park and vicinity, California: U.S. Geological Survey Miscellaneous Investigations Series Map I-1874, scale 1:125,000.
- Alpha, T.R., Wahrhaftig, Clyde, and Huber, N.K., 1987, Oblique map showing maximum extent of 20,000-year-old (Tioga) glaciers, Yosemite National Park, central Sierra Nevada, California: U.S. Geological Survey Miscellaneous Investigations Series Map I-1885, scale varies with direction, vertical scale 2X the horizontal scale.

### c. Soil Surveys: No soil survey available.

### d. Miscellaneous Maps:

- Alpha, T.R., 1991, Oblique map of Yosemite Valley, Yosemite National Park, central Sierra Nevada, California: U.S. Geological Survey Miscellaneous Investigations Series Map I-2149, scale 1:31,000.
- U.S. Department of the Interior, 1970, Map of Yosemite Valley, Yosemite National Park and Wilderness, California, Mariposa County: U.S. Geological Survey, scale 1:24,000 [shaded relief map].
- U.S. Department of the Interior, 1997, Draft Yosemite Valley implementation plan supplemental environmental impact statement: Yosemite National Park, U.S. Department of the Interior National Park Service, 30 maps.

## Appendix B. NWIS Site-Identification Numbers

**Table B-1.** NWIS site-identification numbers and site names for water-quality sampling sites.

Site	Identification Number	Site Name
1	11264500	MERCED R AT HAPPY ISLES BRIDGE NR YOSEMITE, CA
2	374041119340200	MONO MEADOW TRIB NR YOSEMITE, CA
3	374113119323500	ILLILOUETTE CR NR YOSEMITE, CA
4	374156119200200	UPPER MERCED R NR YOSEMITE, CA
5	374237119183900	HUTCHING CR NR YOSEMITE, CA
6	374239119183900	NORTH FORK LYELL CR NR YOSEMITE, CA
7	374415119241800	MERCED R BELOW HIGH SIERRA CAMP NR YOSEMITE, CA
8	374418119241100	MERCED R ABOVE HIGH SIERRA CAMP NR YOSEMITE, CA
9	374429119255300	CLARK FORK NR YOSEMITE, CA
10	374603119245500	ECHO CR NR YOSEMITE, CA
11	374702119250200	CATHEDRAL FORK NR YOSEMITE, CA