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LATE PLEISTOCENE AND HOLOCENE ENVIRONMENTAL CHANGES IN FISH LAKE VALLEY, NEVADA-CALIFORNIA: GEOMORPHIC RESPONSE OF ALLUVIAL FANS TO CLIMATE CHANGE

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ABSTRACT

Coring and mapping of proximal and distal fan deposits and adjacent marsh and peat deposits on the Leidy Creek fan in Fish Lake Valley, Nevada-California, provide unequivocal evidence that fan deposition in this valley has been extensive in the Holocene and suggest that soils were forming on stable fan surfaces with no debris-flow deposition during the late Wisconsin. Seven cores up to 12 meters long, taken along the axis of Leidy Creek fan, have been correlated by radiocarbon dates, tephra layers, and stratigraphy. Radiocarbon ages and tephra layers indicate a record of peat deposition spanning the last 12,000 years and fluvial sedimentation extending to at least 24,240 yr B.P.

INTRODUCTION

It is well known that surficial processes in arid and semi-arid regions are highly sensitive to changes in climate. However, the timing and climatic conditions that control alluvial fan sedimentation have not been adequately investigated due to the general lack of datable material in alluvial-fan deposits of arid lands. Coring and trenching was initiated in Fish Lake Valley to investigate the relationship between fan sedimentation and climate, and to correlate basin deposits to the sedimentary record naturally exposed in proximal-fan deposits. A detailed paleoclimate record will be reconstructed from pollen, diatoms, and ostracodes in the cores. Funding for this study was provided by the Global Change and Climate History Program of the U.S. Geological Survey in order to improve the understanding of the links between climate variation and surficial processes in arid and semi-arid regions. The authors are cooperating with other researchers from the U.S. Geological Survey and the Desert Research Institute, Reno, Nevada.

This report presents the results to date of drilling and trenching performed in the summer of 1991, including procedures, detailed core descriptions, and sampling intervals, in order to provide a foundation for future interpretive papers. Table 1 provides general site information including site elevation, corehole depth, number of reconstructed segments and percent recovery for each corehole.

Table 1. Site elevations, corehole depths, number of reconstructed segments, and percent recovery for Fish Lake Valley cores

Core	Elevation (m)	Depth Drilled (m)	No. of Reconstructed Core Segments	Percent Recovery
1	1459	11.44	2	97
2	1459	7.17	1	99
3	1460	10.98	4	98
4	1467	10.22	0	92
5	1473	11.88	2	95
6	1476	12.33	0	90
7	1483	10.07	1	99

Geographic Setting

Fish Lake Valley is a nearly closed valley in the Basin and Range physiographic province. The valley is bordered by the White Mountains to the west, the Silver Peak range on the east, and the Volcanic Hills to the north (fig. 1). The western margin of Fish Lake Valley is bounded by the Furnace Creek fault zone, an active right-lateral oblique-slip fault system, which forms the eastern margin of the White Mountains. The northern part of this fault zone is referred to as the Fish Lake Valley fault zone (Sawyer, 1990).

Elevations of the valley floor range from about 1,585 m above sea level near its southern end to about 1,430 m at its northern end (Rush and Katzer, 1973). The climate is arid; the valley receives an average rainfall of only 12 cm per year. Mean annual temperature on the valley floor is about 10.5°C (National Climatic Data Center, 1986). A permanent spring-fed pond (Fish Lake) is located at the east-central edge of the valley and is bordered by marsh deposits. A series of springs occur in the northeast part of the valley, aligned along the flank of the Silver Peak Range as far south as far Fish Lake. Large tributary valleys drain eastward into Fish Lake Valley from the White Mountains and smaller valleys drain westward from the Silver Peak Range. Drainage out of Fish Lake Valley is partially blocked on the north by the Volcanic Hills (fig. 1), and terminates in a playa lake in the northeastern part of the valley. Flood lakes on the playa floor intermittently overflow north into Columbus Salt Marsh (Beaty, 1968). Fish Lake Valley contains abundant groundwater, which is largely recharged by surface and subsurface flow from the White Mountains and discharges at springs and other areas of high water table in the northeastern part of the valley (Rush and Katzer, 1973). Much of the valley floor has been farmed. A dam was constructed in 1984 near the center of the marsh for water storage and irrigation.

Alluvial-fan and Lacustrine Deposits

Thick accumulations of alluvial fan deposits cover much of the valley floor and are well exposed in fanhead trenches and incised fault scarps along the White Mountains on the west side of Fish Lake Valley in the Leidy Creek drainage (fig. 2) and throughout Fish Lake Valley. The deposits consist mainly of superposed, matrix-supported, bouldery debris flows (Slate, 1992); maximum clast size decreases downfan to small pebbles and coarse sand. Based

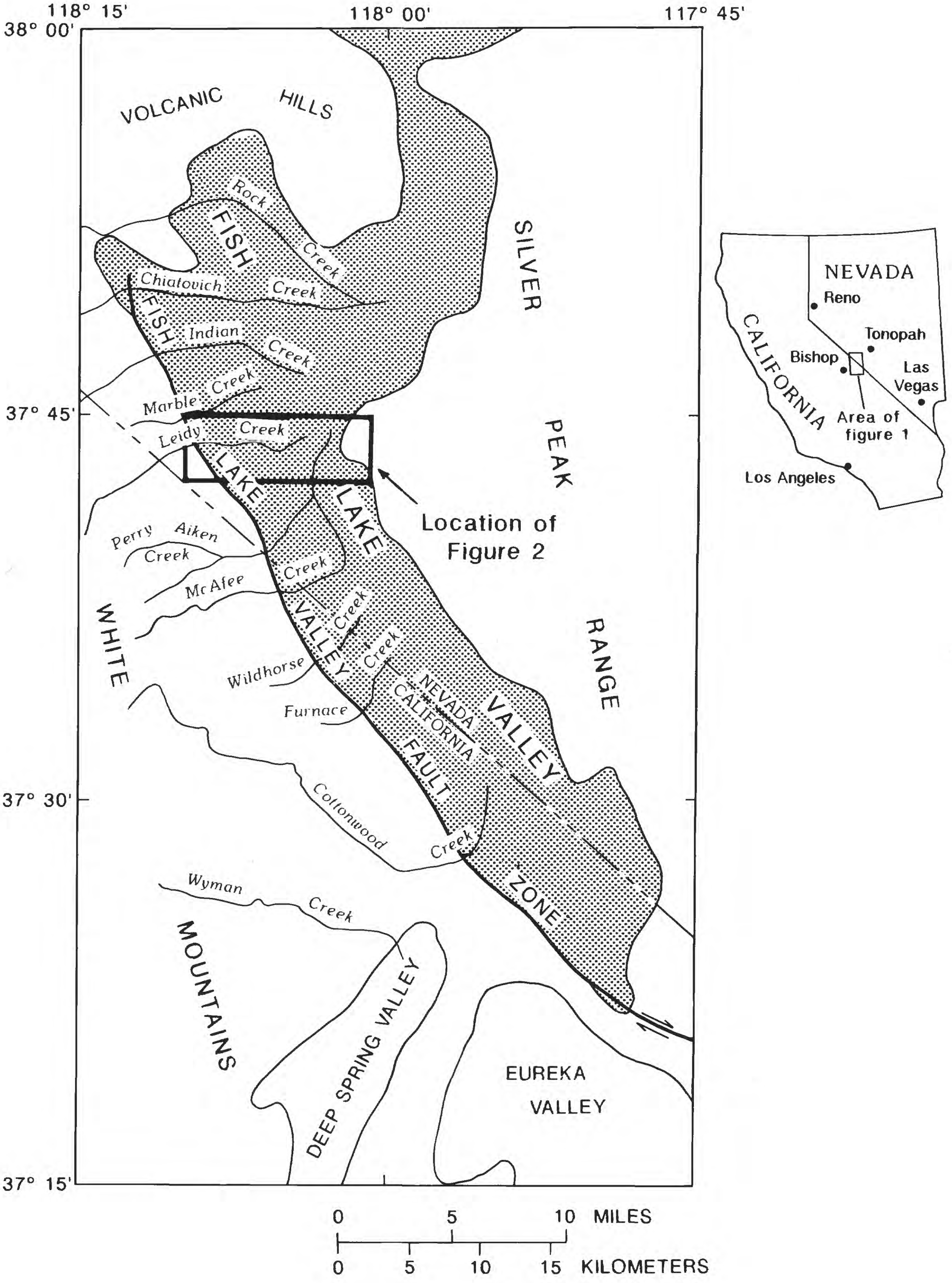

Figure 1.--Index map of the Fish Lake Valley drainage basin.

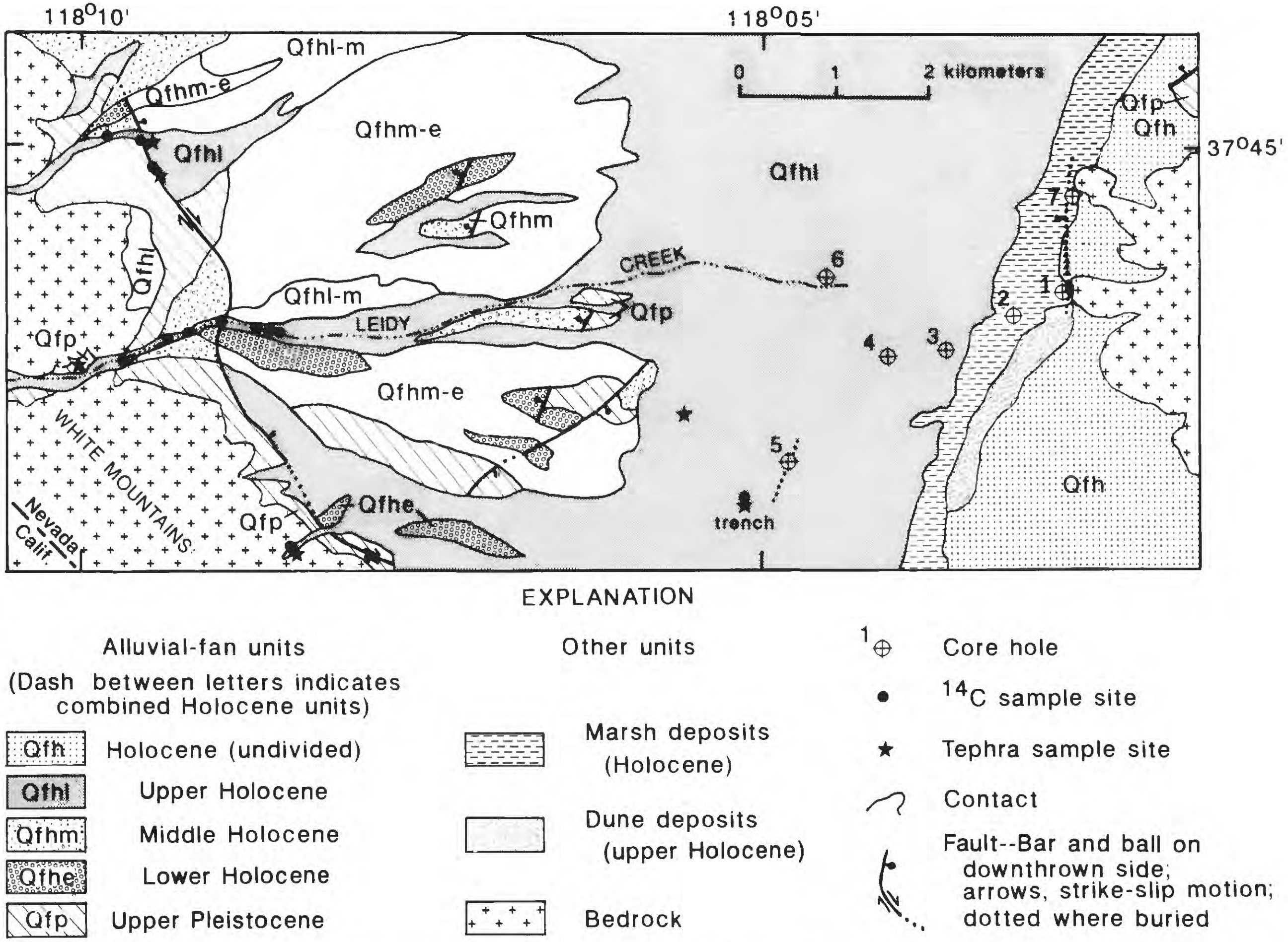

Figure 2.--Generalized geologic map of Leidy Creek fan and vicinity, Fish Lake Valley, Nevada, showing locations of cores and trench. Holocene alluvial-fan units locally combined for convenience; for example, Qfhm-e represents an area of mixed middle and early (lower) Holocene deposits.

on surface and soil characteristics (Slate, 1992; Reheis and others, 1993), the alluvial fan deposits have been subdivided into units of late, middle, and early Holocene and late Pleistocene age (older deposits are also abundant elsewhere in the valley). The Holocene fan deposits are most extensive at the surface and merge downfan with fine-grained distal fan alluvium and valley fill. These units on figure 2 have been simplified from those in Reheis and others, (1993 and unpub. data). The ages of the map units actually span only parts of the time intervals by which they are named on figure 2; for example, the late Holocene unit here includes two map units of different ages (fig. 2; Reheis and others, 1993, and unpub. data). The combined units show areas where deposits of distinctly different ages were combined for convenience of display. For example, Qfcl-m indicates an area with three intermixed mapping units, two of late Holocene age (Qfcl, upper Holocene) and one of middle Holocene age (Qfcm, middle Holocene). The late Pleistocene unit is well-exposed only along the range front and is mostly buried by Holocene deposits to the east, but can locally be mapped at the surface several kilometers downfan.

The exposed Holocene units have been dated in many parts of the valley using both radiocarbon analysis of charcoal and buried logs and by tephrochronology. The ages of these deposits cluster into groups that suggest intervals of debris-flow deposition throughout the valley separated by intervals of nondeposition (Slate, 1992; Reheis and others, 1993). Despite the abundance of datable material (more than 20 radiocarbon ages and more than 20 correlated tephra layers), no ages have been obtained from the proximal fan deposits inferred to be Holocene in age based on soil and surface properties, that are older than 10,000 years. However, a few late Pleistocene ages (10,000-35,000 years) have been obtained from fine-grained alluvium within the mountains that apparently accumulated behind a landslide or shutterridge (Reheis and others, unpub. data).

The age of the late Pleistocene unit is not well constrained, but based on a thermoluminescence age (Slate, 1992) and identification of two tephra layers, this unit appears to be early late Pleistocene in age. Attempts to constrain the age of this unit further using ^{10}Be and thermoluminescence techniques are in progress. From both the available dates and soil and surface properties, the age of the late Pleistocene unit is estimated to range from 50,000 to 125,000 years (Reheis and others, 1993, and unpub. data). Thus, it appears that no deposition occurred in the proximal fan areas between about 10,000 and 50,000 yr B.P.

Recent mapping in Fish Lake Valley (Reheis, 1991, 1992; Reheis and others, 1993) documents a Pliocene to middle Pleistocene pluvial lake in Fish Lake Valley whose 770-ka shoreline has been vertically offset across the Furnace Creek fault zone as much as 240 m (Reheis and McKee, 1991).

CORING AND LOGGING METHODS

Core samples were collected from seven drill sites (fig. 2), including four sites from the distal part of the Leidy Creek fan, two sites from a peat bog at the toe of the fan, and a site within marsh deposits adjacent to the peat bog. The sites were cored using a 10-ton truck mounted drill rig, hollow-stem augers, and 3-foot long, 3-inch diameter sampling barrels to obtain a continuous record. Sediment records as long as 12 meters were recovered at the site. Overall core recovery was 96 percent. A 5 meter-wide, 5 meter-long trench was excavated by backhoe on the distal part of the Leidy Creek fan, about 0.5 km southeast of site 5 (fig. 2). The trench was mapped using a 1-meter grid system, placed over the trench wall.

Each core consists of segments representing each separate drive into the borehole. The depth of the top of each segment is determined by the driller's depth for that segment. Selected core segments were extruded on site with a piston extruder into a hard plastic casing that had been split lengthwise. Each extruded core segment was wrapped in plastic film to retain moisture, labeled, and the ends of the casing were covered with plastic caps. Casings and plastic caps were secured with fiber tape, and the segments were placed into labeled cardboard boxes.

Core segments not extruded on site were labeled on the core barrel whose ends were covered with plastic caps secured by fiber tape. A piston extruder was used to extrude these segments in the laboratory. A few sediment cores that were very sandy could not be mechanically extruded. For these, the sediment was hammered out of the barrels, logged, and bagged in intervals. Because much of the sediment was dry and friable, the cores were not split lengthwise.

One half of the surface of each sediment core was scraped clean; each segment was then photographed and described. Appendix 1 provides a detailed description of each core. Surfaces of dry cores were spritzed with water prior to photographing.

Surface and buried soil in the cores and the trench were recognized on the basis of characteristic properties that differentiate soils from unweathered sediment (Soil Survey Staff, 1975, p. 3-70; Birkeland, 1984, p. 3-34). Soil horizons were described following standard terminology (Guthrie and Witty, 1982; Birkeland, 1984). The soil properties observed in the Leidy Creek samples include, but are not limited to: (1) Darkening due to accumulation of organic matter (A horizon) near a former ground surface; (2) accumulation of silt and clay (Bw or Bt horizon), commonly just below an A horizon; (3) accumulation of secondary $CaCO_3$ (Bwk, Btk, or Bk horizon) below the A horizon; (4) soil structure; and (5) concentrations of carbon-lined root traces. Reddish colors commonly associated with soils were not diagnostic in the cores, apparently because of post-burial alteration. Vesicular A horizons, common in the surface soils of Fish Lake Valley (Sawyer, 1990; Slate, 1992), are rarely observed in the cores because the fragile pores are readily destroyed by the weight of overlying sediment.

After logging, magnetic susceptibility measurements were recorded, generally at 5 cm intervals, using a handheld susceptibility meter with an air-cored coil sensor and a digital readout. Irregularities in the sediment interval, such as fractures or rough surfaces, were avoided when measuring. Measurements also could not be taken on the bagged sediments. The magnetic susceptibility measurements are recorded in Appendix 1, adjacent to the interval at which they were measured.

The length of sediment present in the barrel was measured before and after extrusion (assuming no gaps in the sediment interval) in order to determine the amount of expansion or compression caused by drilling and extrusion. Many core segments expanded or compressed slightly (up to 4 cm) during drilling and extrusion; the segments usually compressed more during extrusion.

Because a few cores expanded or compressed significantly during drilling or extrusion, the lengths of core segments exhibiting greater than 10 percent compression or expansion were reconstructed. Reconstruction was accomplished by using a linear scale factor to recalculate the length of each core segment. This procedure effectively stretches or compresses the sediment core back uniformly along its length to reflect the actual stratigraphic interval sampled. In addition, in order to insure maximum depth accuracy, a few core segments were reconstructed which had been compressed or expanded less than 10 percent. These core segments contain significant horizons, such as tephra layers or buried soil horizons. If the sediment length was less than the driller's drive but the cause of the missing sediment could not be determined, or if the sediment was disturbed or suspected to be out of place, the segments were not reconstructed.

A total of 10 core segments was reconstructed (table 1). The cores were reconstructed after logging, and prior to sampling. Reconstructed depths are reflected in Appendix 1. Sampling intervals were also reconstructed to correspond to reconstructed core segment depths.

SAMPLING METHODS

Over 800 samples for geochronologic, paleontologic, sedimentologic, and geochemical analysis have been removed from the cores and the Leidy Creek trench. Sampling methods and intervals differed depending on the type of analysis.

Geochronologic Samples

Tephra and radiocarbon samples (table 2) were removed for correlation studies and age determinations. In addition to radiocarbon and tephra dating, 10-cm long sections of core were removed from the buried soils in cores 3 and 5 for thermoluminescence and optical-spin luminescence dating. Sample intervals for these samples are shown in Appendix 1. Channel samples were removed from buried soil horizons in core 5 for ^{10}Be analysis. Splits from three tephra samples were submitted for deuterium analysis.

Paleontologic Samples

In order to study the paleoenvironmental record preserved in the sediments, samples for pollen, diatoms, and ostracodes were taken at regularly spaced intervals in cores 1, 2, and 7 (generally every 20 centimeters), and at or near boundaries of lithologic changes. Fewer samples were removed from cores 3, 4, 5 and 6, on the distal part of the Leidy Creek fan, due to the abundance of coarser-grained sediments deemed unfavorable for fossil preservation. In addition to pollen analysis, plant macrofossils will be identified from pollen sample splits to document the vegetative character of the immediate surroundings.

Samples for pollen and diatom analyses were removed from the same 2-cm-thick stratigraphic intervals using a spatula. Each sample filled a spoon whose volume equals 2.5 cm^3, in order to take volumetric samples. Two-cm-thick slices (about 85 cm^3) were also collected from the cores for ostracode analysis. In most cases, ostracode samples were removed from the same intervals as pollen and diatom samples. Mollusks were sampled wherever they were noted during logging and additional mollusk samples were separated from washed ostracode residues. A record of all paleontological samples taken from the cores, listed by core and depth, is included in Appendix 2, which also includes estimated abundances of ostracodes, diatoms, and mollusks, based on preliminary examination of some samples.

Sediment and Geochemical Samples

Representative samples from the cores and trench, including samples from buried soil horizons, were analyzed for grain-size distribution and other physical properties (tables 3, 4). Thirty-six samples were analyzed for major oxides by x-ray fluorescence spectrometry (Taggart and others, 1987), and for minor elements by inductively coupled plasma spectroscopy (Lichte and others, 1987; tables 5, 6). X-ray diffraction analysis of additional clay samples is in progress.

Table 2. Radiocarbon analyses from sediments in Fish Lake Valley cores

Sample[1] Number	Core/ Segment	Sample Depth (m)	Material dated	Pretreatment[2]	^{14}C Age (yr B.P.)
			CORE SAMPLES		
WW98	1.1	0.70-0.72	peat	None	3,080 ± 150
WW78	1.2	1.47-1.49	silty peat	None	3,990 ± 70
W-6413	1.3	2.08-2.11	silty peat	AAA	6,125 ± 90
WW79	1.5	3.18-3.20	organic-rich clay	AAA	6,730 ± 30
W-6412	1.5	3.86-3.88	silty peat	AAA	8,270 ± 140
W-6411	1.8	5.67-5.68	silty peat	AAA	11,180 ± 250
WW77	1.12	8.18-8.20	dispersed organics in sand and clay	None	24,240 ± 330
WW80	2.6	4.12-4.14	organic-rich clay	AAA	8,810 ± 80
WW82	2.7	4.64	organic-rich silt, A horizon	None	9,630 ± 80
WW81	3.6	4.68-4.70	organic-rich silty clay, A horizon	Acid only	8,900 ± 80
WW85	4.12	8.95-8.97	dispersed organics in silty sand, A horizon	None	9,900 ± 80
WW99	7.1	0.75	organic-rich silt	None	590 ± 140
WW90	7.2	0.92-0.94	silty peat	None	1,740 ± 70
WW91	7.3	1.75-1.77	organic-rich silt	None	3,860 ± 70
WW92	7.4	2.35-2.37	organic-rich clayey silt	None	5,780 ± 80
WW93	7.4	2.90-2.92	organic-rich silty clay	None	7,110 ± 100
WW94	7.6	4.22-4.24	organic-rich silty clay	None	9,440 ± 80
WW95	7.7	4.73-4.75	peat	None	10,130 ± 140
WW96	7.7	5.25-5.27	peat	None	11,380 ± 90
WW97	7.8	5.72-5.74	organic-rich silty clay	None	12,330 ± 200

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[1] Sample numbers with "W" prefix designate conventional radiocarbon age determinations by Meyer Rubin, U.S. Geological Survey. Samples numbers with "WW" prefix designate age determinations by Accelerator Mass Spectrometry (AMS), Lawrence Livermore National Laboratory.

[2] AAA refers to an acid treatment, followed by a base treatment, followed by an acid treatment to remove carbonates and humic acids.

Table 3. Physical properties of sediments from cores and Leidy Creek trench, Fish Lake Valley, Nevada

CORE SAMPLES

					percentage of <2-mm fraction[5]												
Core/	Depth[1]				sand					silt			clay		Total	Total	Total
Segment	(m)	%O.M.[2]	%CaCO$_3$[3]	%>2mm	vco	co	med	fi	vfi	co	med	fi	co	fi[4]	sand	silt	clay
1.2	1.08	5.72	7.29	0.00	0.00	0.00	0.13	2.03	5.69	10.96	16.64	38.37	15.83	10.35	7.85	65.97	26.18
1.3	1.91	15.48	0.98	0.00	0.00	0.00	0.11	2.13	10.39	12.25	14.29	37.97	10.61	12.25	12.63	64.51	22.86
1.5	3.22	4.53	4.65	0.00	0.03	0.02	0.05	0.05	0.25	0.63	7.99	44.16	19.10	27.72	0.40	52.78	46.82
1.7	5.16	27.30	0.76	0.00	0.00	0.11	0.06	0.26	2.15	1.33	6.68	42.03	23.36	24.02	2.58	50.04	47.38
1.8	5.77	7.17	0.85	0.00	0.17	0.97	4.70	17.22	42.13	7.28	3.91	9.05	6.93	7.64	65.19	20.24	14.57
1.9	6.68	0.27	0.29	43.29	28.81	26.05	29.69	10.95	1.97	0.33	0.33	0.48	0.17	1.22	97.47	1.14	1.39
1.12	8.31	0.82	0.49	0.00	0.34	0.39	1.40	15.39	38.01	12.02	11.87	15.17	3.01	2.40	55.53	39.06	5.41
1.12	8.58	0.90	0.46	10.30	14.45	12.58	19.65	14.61	15.95	4.82	4.15	8.14	3.32	2.33	77.24	17.11	5.65
1.13	8.83	0.59	0.55	0.57	2.30	9.21	60.37	21.58	1.36	0.60	0.85	1.35	1.11	1.27	94.82	2.80	2.38
1.16	11.10	3.18	0.47	0.00	0.08	0.17	0.25	1.01	8.29	3.34	6.40	31.49	24.55	24.42	9.80	41.23	48.97
2.2	1.26	5.45	20.18	0.00	0.00	0.04	0.11	0.58	4.67	4.56	5.59	34.36	25.66	24.43	5.40	44.51	50.09
2.6	4.43	2.47	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.24	52.28	18.70	25.78	0.00	55.52	44.48
2.7	5.13	4.16	31.68	0.00	0.24	0.51	2.46	13.67	23.57	7.46	8.19	18.44	14.93	10.53	40.45	34.09	25.46
2.7	5.19	3.22	8.63	0.00	0.27	1.12	8.11	25.01	29.42	8.51	10.19	11.50	2.87	3.00	63.93	30.20	5.87
2.8	5.59	2.57	14.64	0.20	1.06	1.36	3.48	10.09	14.52	6.73	8.29	23.32	8.93	22.22	30.51	38.34	31.15
2.8	5.99	1.58	0.32	0.00	0.08	0.75	3.38	13.05	40.26	10.27	8.06	11.08	5.95	7.12	57.52	29.41	13.07
2.9	6.75	0.68	0.60	17.70	14.51	26.74	35.24	12.39	3.05	0.94	1.31	2.35	0.84	2.63	91.93	4.60	3.47
2.9	6.95	0.82	1.00	9.45	14.13	51.43	25.79	5.39	1.34	0.09	0.29	0.29	0.10	1.15	98.08	0.67	1.25
3.1	0.71	3.75	3.61	0.00	0.01	0.81	2.60	5.78	16.15	8.91	11.37	33.39	9.09	11.89	25.35	53.67	20.98
3.2	1.07	3.80	15.36	0.00	0.00	0.01	0.04	0.58	5.57	5.00	8.76	43.14	16.26	20.64	6.20	56.90	36.90
3.3	2.01	1.02	0.60	0.00	0.00	0.01	0.16	4.81	49.25	19.07	11.92	7.63	1.43	5.72	54.23	38.62	7.15
3.3	2.20-2.28	2.80	0.42	0.00	0.00	0.02	0.05	0.54	4.38	5.94	10.35	42.94	14.01	21.77	4.99	59.23	35.78
3.5	3.67	2.95	0.44	0.00	0.00	0.01	0.01	0.02	0.05	0.19	2.20	56.20	14.87	26.45	0.09	58.59	41.32
3.8	5.71	0.72	0.34	0.00	0.64	4.64	16.91	26.24	26.87	6.46	5.21	6.08	2.73	4.22	75.30	17.75	6.95
3.9	6.37	0.42	0.34	0.00	0.03	1.42	19.94	49.82	21.75	2.42	1.32	1.54	0.33	1.43	92.96	5.28	1.76
3.9	6.88	1.44	0.32	0.00	0.00	0.45	2.27	4.39	8.07	6.10	18.94	43.50	6.11	10.17	15.18	68.54	16.28
3.10	7.42	0.85	0.37	0.00	3.40	8.63	16.17	15.26	16.34	7.87	9.46	14.47	3.76	4.64	59.80	31.80	8.40
3.11	8.43	0.99	0.35	0.00	0.43	1.52	3.65	5.05	16.07	12.46	21.34	29.09	5.48	4.91	26.72	62.89	10.39

Table 3. Physical properties of sediments from cores and Leidy Creek trench, Fish Lake Valley, Nevada (cont.)

CORE SAMPLES cont.

					percentage of <2-mm fraction[5]												
Core/	Depth[1]				sand					silt			clay		Total	Total	Total
Segment	(m)	%0.M.[2]	%$CaCO_3$[3]	%>2mm	vco	co	med	fi	vfi	co	med	fi	co	fi[4]	sand	silt	clay
3.12	8.75	0.43	1.20	0.00	2.20	13.54	47.05	28.04	4.89	0.58	0.81	1.04	0.46	1.39	95.72	2.43	1.85
3.12	8.94	0.84	0.84	0.00	0.57	4.93	18.67	34.04	30.57	2.97	1.39	3.71	0.74	2.41	88.78	8.07	3.15
3.13	9.54	1.83	6.40	0.96	5.23	10.95	18.79	13.13	16.57	6.01	9.32	14.29	1.35	4.36	64.67	29.62	5.71
3.13	9.89	2.06	5.34	0.00	0.44	4.36	18.96	30.17	30.10	3.55	3.14	6.14	1.23	1.91	84.03	12.83	3.14
3.14	10.52	0.82	4.24	0.00	0.36	3.03	21.20	37.27	23.56	4.29	3.06	4.78	0.98	1.47	85.42	12.13	2.45
3.14	10.95	1.00	4.27	0.00	0.17	1.92	10.14	19.16	20.86	8.57	14.34	18.89	2.63	3.32	52.25	41.80	5.95
4.1	0.62	4.25	9.62	0.00	0.03	0.18	1.00	1.65	4.03	3.84	12.08	52.50	8.78	15.91	6.89	68.42	24.69
4.2	1.26	1.02	2.00	0.00	0.07	0.32	0.88	6.01	35.49	19.74	16.28	11.20	2.01	8.00	42.77	47.22	10.01
4.3	1.52-1.62	0.61	3.09	5.80	13.04	23.93	21.19	16.48	10.48	2.74	2.89	3.76	0.14	5.35	85.12	9.39	5.49
4.5	3.56	1.19	2.14	0.00	0.44	0.94	2.66	8.80	18.77	11.17	18.21	27.33	3.95	7.73	31.61	56.71	11.68
4.5	3.74	0.6	2.80	0.74	2.85	6.96	19.37	23.40	18.82	5.66	6.07	9.49	1.05	6.33	71.40	21.22	7.38
4.6	4.27	1.44	8.77	0.23	0.40	0.85	1.44	3.54	19.46	15.83	19.49	23.36	5.40	10.23	25.69	58.68	15.63
4.6	4.40	0.40	4.73	3.50	9.04	21.36	32.30	21.39	8.28	1.43	1.22	1.52	0.10	3.36	92.37	4.17	3.46
4.8	5.73	1.72	6.91	0.00	0.19	0.71	1.75	4.23	11.87	7.64	12.88	43.03	5.23	12.47	18.75	63.55	17.70
4.9	7.02	2.57	5.26	0.00	0.03	0.04	0.15	0.38	1.47	1.26	7.56	56.32	15.98	16.81	2.07	65.14	32.79
4.10	7.68	0.41	2.75	26.10	13.51	22.05	33.40	20.61	5.31	0.80	0.57	0.91	0.23	2.61	94.88	2.28	2.84
4.11	8.52	0.48	2.03	53.63	33.83	21.01	8.65	14.69	12.17	2.33	1.27	1.52	0.11	4.42	90.35	5.12	4.53
4.12	8.84	0.59	3.54	10.81	15.92	21.92	23.50	18.37	8.66	1.55	1.91	3.54	0.72	3.91	88.37	7.00	4.63
5.2	1.34-1.52	0.79	8.89	0.00	9.22	18.12	29.00	23.00	9.57	1.58	1.69	3.27	1.28	3.27	88.91	6.54	4.55
5.4	2.60-2.64	0.83	4.17	0.00	26.51	16.61	14.88	16.21	11.38	2.29	2.77	5.34	1.34	2.67	85.59	10.40	4.01
5.4	2.84	1.45	4.23	0.00	0.83	1.85	3.60	9.43	18.90	11.76	18.50	24.09	3.87	7.17	34.61	54.35	11.04
5.6	4.37-4.55	0.47	7.00	0.00	10.54	21.00	28.45	19.05	11.11	2.78	2.02	2.65	0.38	2.02	90.15	7.45	2.40
5.10	7.00-7.10	0.32	1.99	0.00	9.10	19.12	33.96	24.76	8.46	0.99	0.87	1.21	0.00	1.53	95.40	3.07	1.53
5.10	7.21	1.43	2.85	0.00	0.00	0.00	0.03	0.30	3.45	9.30	31.33	42.85	5.46	7.28	3.78	83.48	12.74
5.11	7.97-8.09	0.62	1.99	0.00	4.82	4.75	11.70	21.13	23.33	10.17	11.65	8.68	1.37	2.40	65.73	30.50	3.77
5.11	8.09-8.30	0.40	2.97	0.00	10.67	12.24	23.31	24.39	16.01	4.13	3.79	3.57	0.33	1.56	86.62	11.49	1.89
5.14	10.14	0.93	2.09	0.00	0.32	1.45	5.46	25.60	33.12	8.11	7.98	12.47	2.87	2.62	65.95	28.56	5.49

Table 3. Physical properties of sediments from cores and Leidy Creek trench, Fish Lake Valley, Nevada (cont.)

CORE SAMPLES cont.

					percentage of <2-mm fraction[5]												
Core/	Depth[1]				sand					silt			clay		Total	Total	Total
Segment	(m)	%O.M.[2]	%CaCO$_3$[3]	%>2mm	vco	co	med	fi	vfi	co	med	fi	co	fi[4]	sand	silt	clay
6.2	1.37	1.65	1.28	1.29	4.60	12.78	22.72	16.83	13.24	4.28	5.28	11.85	3.14	5.28	70.17	21.41	8.42
6.9	5.99-6.12	1.35	5.13	0.00	0.28	0.90	3.04	9.43	6.35	13.67	24.12	31.33	5.14	5.74	20.00	69.12	10.88
6.9	6.24-6.34	0.49	2.01	0.00	0.20	1.84	18.33	46.29	20.09	3.89	2.55	4.14	0.73	1.94	86.75	10.58	2.67
6.9	6.44-6.53	0.41	2.13	3.75	3.20	4.95	11.52	39.75	28.98	3.22	2.51	2.66	1.11	2.10	88.40	8.39	3.21
6.13	9.24-9.42	1.25	3.81	52.24	24.99	23.35	21.73	18.64	3.81	1.67	1.58	2.03	0.70	1.50	92.52	5.28	2.20
6.17	12.23-12.33	0.50	0.30	22.23	11.62	17.13	23.21	18.19	13.42	4.63	4.06	5.00	1.04	1.70	83.57	13.69	2.74
7.2	0.86	3.79	0.31	0.00	0.00	0.00	0.06	0.29	2.14	8.44	22.98	35.38	11.67	19.04	2.49	67.10	30.71
7.2	1.30	5.96	0.38	0.00	0.04	0.04	0.08	0.97	8.12	4.35	6.76	38.13	20.03	21.48	9.25	49.24	41.51
7.3	1.63	4.03	0.44	0.00	10.81	7.23	4.43	4.51	9.80	2.89	10.86	31.61	6.52	11.34	36.78	45.36	17.86
7.4	2.87	7.33	0.50	0.00	0.13	0.45	0.58	1.29	7.23	4.61	7.81	39.85	23.03	15.02	9.68	52.27	38.05
7.5	3.20	5.08	0.30	0.00	0.04	0.44	0.85	2.21	9.47	5.87	8.75	36.62	17.00	18.75	13.01	51.24	35.75
7.7	5.04	23.10	0.98	0.00	0.00	0.13	0.14	0.80	1.87	0.83	4.98	38.99	22.40	29.86	2.94	44.80	52.26
7.8	5.73	3.38	0.32	0.00	9.26	20.27	17.90	17.86	11.55	3.03	2.66	7.98	5.06	4.43	76.84	13.67	9.49
7.8	5.97	0.45	0.33	0.78	11.42	48.89	30.87	4.95	1.51	0.09	0.35	0.79	0.17	0.96	97.64	1.23	1.13
7.9	7.51	0.40	0.50	68.46	36.16	29.94	19.00	8.13	2.78	0.37	0.47	1.02	0.37	1.76	96.01	1.86	2.13
7.10	8.28	4.76	0.45	0.00	0.00	0.01	0.01	0.14	1.28	0.62	1.49	22.06	26.91	47.48	1.44	24.17	74.39
7.12	10.01	3.21	4.20	0.00	0.01	0.07	0.10	0.40	3.44	5.27	12.01	43.56	14.26	20.88	4.02	60.84	35.14

Table 3. Physical properties of sediments from cores and Leidy Creek trench, Fish Lake Valley, Nevada (cont.)

TRENCH SAMPLES

					percentage of <2-mm fraction[5]									
Sample	Depth[1]				sand					silt			Total	Total silt
No.	(m)	%0.M.[2]	%CaCO$_3$[3]	%>2mm	vco	co	med	fi	vfi	co	med	fi[4]	sand	and clay
A1	0.00	–	7.34	1.00	5.43	11.61	17.78	22.10	24.73	4.68	3.07	10.60	81.65	18.35
A3	0.65	–	8.37	0.50	1.25	4.13	11.15	29.94	41.63	2.81	1.95	7.14	88.10	11.90
A4	0.95	–	10.38	0.20	4.73	11.73	14.77	18.95	23.99	5.82	5.81	14.20	74.17	25.83
A6	1.85	–	4.30	0.60	3.15	9.51	34.37	34.12	13.24	1.26	1.27	3.08	94.39	5.61
A8	2.45	–	2.43	0.20	0.50	0.91	1.82	14.31	44.05	16.90	10.89	10.62	61.59	38.41
A9	2.55	–	5.61	4.40	8.38	12.39	14.58	15.80	19.43	6.41	6.98	16.03	70.58	29.42
A10	3.30	–	10.26	5.60	7.20	9.45	20.48	19.73	22.77	6.16	4.26	9.95	79.63	20.37
A10A	3.30	–	9.43	0.10	0.29	2.23	11.66	21.91	32.66	10.80	7.08	13.37	68.75	31.25
A10B	3.30	–	9.41	19.00	17.02	16.13	18.89	17.64	14.30	4.33	3.29	8.40	83.98	16.02
A11A	4.00	–	12.09	3.80	6.15	6.54	14.92	18.70	23.69	8.23	7.16	14.61	70.00	30.00
A11B	4.00	–	14.52	24.90	19.81	18.43	15.18	11.29	15.18	4.57	4.48	11.06	79.89	20.11
A12	4.15	–	8.58	0.00	1.49	12.71	20.01	17.07	18.92	6.50	6.60	16.70	70.20	29.80
A13	4.30	–	2.22	0.90	3.69	8.88	18.07	19.09	20.17	6.18	8.11	15.81	69.90	30.10
A14	4.75	–	1.58	2.40	4.25	8.77	14.40	14.48	17.65	7.56	10.08	22.81	59.55	40.45

[1] Depths are approximate due to channeling and depositional irregularities in unit contacts.

[2] For core samples, analysis was determined by Loss on ignition; –, not determined.

[3] Determined by Chittick method.

[4] Clay size is < 0.5 microns for core samples. For trench samples refers to fine silt and clay (clay fractions not analyzed due to lab error).

[5] Sieve analysis by phi (ϕ) scale.

Table 4. Physical properties of buried soils from Fish Lake Valley cores and Leidy Creek trench

CORE SAMPLES

						percentage of <2-mm fraction[5]												
Core/	Depth[1]	Soil				sand					silt			clay		Total	Total	Total
Segment	(m)	horizon	%0.M.[2]	%CaCO$_3$[3]	%>2mm	vco	co	med	fi	vfi	co	med	fi	co	fi[4]	sand	silt	clay
2.7	4.66	A	2.27	0.25	0.00	0.36	0.40	1.03	7.43	12.84	16.28	16.02	12.81	17.75	15.08	22.05	45.12	32.83
2.7	4.75	Btk	1.35	25.59	0.00	0.33	0.61	2.01	10.43	12.58	13.26	14.68	25.58	12.47	8.05	25.95	53.52	20.53
2.7	4.86	Bk1	0.81	46.90	0.00	0.24	0.39	1.14	8.19	10.47	42.77	12.45	15.36	5.43	3.57	20.43	70.57	9.00
2.7	5.05	Bk2	0.36	30.65	0.00	0.26	0.56	3.38	27.78	22.27	22.66	8.08	6.50	5.63	2.89	54.24	37.24	8.52
3.6	4.71	A	0.58	5.69	0.00	1.02	1.60	8.49	21.78	15.39	12.63	11.64	9.19	11.77	6.50	48.27	33.47	18.26
3.7	4.75	Btk	0.37	21.60	0.00	1.08	2.43	10.80	19.71	9.34	18.32	7.06	9.58	8.14	13.53	43.36	34.97	21.67
3.7	5.05	Bk1	0.19	14.26	0.00	0.15	0.69	4.12	15.25	18.97	31.71	8.95	6.23	6.57	7.36	39.19	46.88	13.93
3.7	5.44	2Bk2	2.60	3.66	0.00	0.00	0.06	0.16	0.50	2.84	2.99	8.77	46.44	9.70	28.54	3.56	58.20	38.24
4.12	8.99	A	0.27	9.90	0.32	1.46	3.03	11.99	29.03	16.83	10.06	13.63	6.27	4.00	3.68	62.35	29.97	7.68
4.12	9.09	Bwk	0.22	18.88	0.20	0.58	2.92	11.29	35.94	21.84	17.34	1.93	2.38	2.38	3.40	72.57	21.65	5.78
4.12	9.31	Bk1	0.20	23.00	0.13	0.67	2.95	11.32	32.50	20.02	18.21	2.71	3.36	4.91	3.36	67.45	24.28	8.27
4.12	9.39	Bk2	0.08	9.85	1.06	2.84	7.01	17.53	29.56	14.17	8.63	9.47	3.47	3.19	4.13	71.11	21.57	7.32
5.14	10.55	A	0.08	2.72	0.00	0.00	0.09	0.16	3.42	4.16	8.48	30.66	19.67	17.74	15.62	7.83	58.81	33.36
5.15	10.65	Btk1	0.17	6.77	0.00	0.00	0.04	0.14	2.39	6.15	16.11	23.70	15.18	18.70	17.59	8.71	55.00	36.29
5.15	10.72	Btk2	0.43	16.86	0.00	0.00	0.07	1.47	11.23	11.36	16.24	23.38	12.48	14.86	8.91	24.13	52.10	23.77
5.15	11.05	Bk1	0.32	48.50	0.00	0.19	0.88	3.70	19.40	17.45	33.58	3.63	9.38	5.44	6.35	41.62	46.58	11.80
5.16	11.75	2Bk3	0.20	38.39	4.48	0.15	1.10	3.12	18.72	18.55	27.74	3.92	9.16	11.25	6.28	41.65	40.82	17.53
6.16	11.56	A	0.16	7.87	1.11	1.06	3.09	8.06	15.51	10.90	11.33	22.50	9.44	11.33	6.77	38.63	43.27	18.10
6.17	11.72	Btk	0.20	8.55	1.14	1.15	3.04	9.17	17.76	13.26	13.01	20.82	8.13	8.29	5.37	44.38	41.96	13.66
6.17	11.93	Bk1	0.16	16.73	2.69	3.31	8.20	17.26	29.55	15.76	8.32	5.14	4.40	0.73	7.34	74.07	17.86	8.07
6.17	12.15	Bk2	0.07	3.63	5.82	2.93	8.54	21.84	26.46	9.96	5.88	11.12	3.96	4.28	5.03	69.74	20.96	9.30

Table 4. Physical properties of buried soils from Fish Lake Valley cores and Leidy Creek trench (cont.)

TRENCH SAMPLES

Sample[8] No.	Depth[1] to top (m)	Soil horizon	%0.M.[2]	%CaCO$_3$[3]	% >2mm	percentage of <2-mm fraction[5]												
						sand					silt			clay		Total	Total	Total
						vco	co	med	fi	vfi	co	med	fi	co	fi[4]	sand	silt	clay
FLV-A	0.34	Avb1	0.01	8.08	1.52	3.21	7.99	16.60	20.29	26.19	10.22	4.95	2.74	2.85	4.95	74.28	17.92	7.80
(Unit 2)*	0.41	Bwkb1	0.02	3.86	17.49	16.31	17.06	15.23	13.20	14.12	9.39	6.75	1.55	1.82	4.56	75.93	17.69	6.38
	0.64	Cb1	0.02	4.44	24.55	19.57	16.83	14.20	13.42	14.02	8.78	5.82	1.54	0.71	5.10	78.05	16.13	5.82
FLV-A	1.08	Bwkjb2	0.04	7.24	0.00	0.12	0.70	4.05	9.63	23.68	21.49	19.40	4.47	4.61	11.86	38.18	45.35	16.47
(Unit 5)	1.22	Cb2	0.03	6.78	0.01	0.15	1.89	7.41	20.15	35.66	15.32	7.66	2.68	3.19	5.87	65.26	25.67	9.07
FLV-A	1.85	Avb3	0.03	3.24	4.84	4.30	7.57	12.42	13.72	19.03	15.66	15.41	3.13	2.88	5.89	57.04	34.19	8.77
(Unit 7)	1.95	Bwjb3	0.02	2.91	4.93	5.16	9.76	16.04	18.27	18.10	11.76	11.91	2.61	1.31	5.08	67.33	26.28	6.39
	2.01	Cb3	0.03	2.24	2.98	4.98	11.33	16.67	15.56	17.57	12.71	13.07	3.15	1.69	3.27	66.10	28.94	4.96

*Refer to Figure 5 (trench diagram).

[1] For core samples, depth is below surface; for trench samples depth is to top of soil horizon.

[2] For core samples, analysis was determined by Loss on ignition; for trench samples analysis was determined by Walkley-Black titration.

[3] Determined by Chittick method.

[4] Clay size is < 0.5 microns.

[5] Sieve analysis by USDA scale.

Elemental analyses by inductively coupled plasma spectrometry of sediments from Fish Lake Valley cores

Core/ segment	Depth (m)	P (%)	AG	A	AU	BA	BE	BI	CD	CE	CO	CR	CU	EU	GA	HO	LA	LI	MO	NB	ND	NI	PB	C	N	R	TA	TH	U	V	Y	YB	ZN
			parts per million																														
1.3	1.90	0.05	< 2	21	< 8	310	1	< 10	< 2	29	5	57	9	< 2	9	< 4	17	21	55	6	13	8	8	4	< 5	240	40	5	100	56	7	1	30
1.5	3.21	0.09	< 2	20	< 8	600	3	< 10	< 2	93	19	56	35	< 2	23	< 4	51	67	14	14	39	33	14	15	< 5	320	40	17	100	95	21	2	90
1.8	5.76	0.07	< 2	29	< 8	570	3	< 10	< 2	67	7	67	13	< 2	16	< 4	39	23	28	11	28	9	16	6	< 5	380	40	11	100	58	18	2	44
1.16	11.09	0.11	< 2	< 10	< 8	690	4	< 10	< 2	120	16	59	49	< 2	26	< 4	72	90	< 2	17	49	28	20	14	< 5	290	40	22	100	120	25	2	120
2.2	1.25	0.10	< 2	22	< 8	740	3	< 10	< 2	110	17	47	56	< 2	22	< 4	66	100	< 2	14	45	26	14	13	< 5	1100	40	20	100	99	24	2	110
2.7	4.65	0.10	< 2	16	< 8	670	3	< 10	< 2	78	13	33	84	< 2	18	< 4	43	77	18	13	30	23	18	8	< 5	290	40	17	100	84	23	2	78
2.7	4.85	0.06	< 2	11	< 8	400	2	< 10	< 2	34	6	14	24	< 2	13	< 4	20	41	11	8	20	9	9	3	< 5	450	40	10	220	41	12	1	33
2.8	5.58	0.09	< 2	10	< 8	790	3	< 10	< 2	86	16	48	26	< 2	28	< 4	51	50	6	13	38	33	13	10	< 5	430	40	15	100	79	20	2	67
2.8	5.93	0.10	< 2	< 10	< 8	730	3	< 10	< 2	99	11	43	15	< 2	20	< 4	57	37	8	14	40	21	16	9	< 5	490	40	14	100	77	21	2	54
3.4	2.63	0.15	< 2	< 10	< 8	1200	3	< 10	< 2	110	13	39	33	< 2	20	< 4	63	42	< 2	14	46	18	12	12	< 5	310	40	18	100	92	25	3	71
3.6	4.70	0.12	< 2	10	< 8	1200	3	< 10	< 2	81	11	28	41	< 2	17	< 4	50	45	< 2	12	33	15	13	7	< 5	380	40	14	100	54	20	2	57
3.7	4.74	0.08	< 2	< 10	< 8	1100	3	< 10	< 2	77	11	26	33	< 2	16	< 4	45	43	< 2	9	33	15	10	7	< 5	650	40	15	100	57	19	2	47
3.7	5.04	0.05	< 2	< 10	< 8	1200	3	< 10	< 2	100	10	36	28	< 2	18	< 4	59	38	< 2	11	42	14	11	9	< 5	410	40	17	100	70	23	2	52
3.9	6.36	0.09	< 2	< 10	< 8	1000	3	< 10	< 2	66	7	30	15	< 2	16	< 4	38	17	< 2	10	26	13	12	6	< 5	300	40	11	100	42	16	1	33
3.9	6.65	0.11	< 2	< 10	< 8	1200	4	< 10	< 2	140	20	51	55	< 2	25	< 4	86	54	< 2	16	59	29	13	16	< 5	270	40	23	100	110	30	3	100
3.11	8.42	0.11	< 2	< 10	< 8	1300	4	< 10	< 2	110	13	41	35	< 2	21	< 4	67	32	< 2	13	47	19	15	11	< 5	240	40	19	100	71	24	2	71
3.14	10.51	0.09	< 2	< 10	< 8	1100	3	< 10	< 2	79	8	39	16	< 2	16	< 4	47	19	< 2	11	32	16	10	7	< 5	360	40	12	100	52	18	2	36
3.14	10.94	0.10	< 2	< 10	< 8	1000	3	< 10	< 2	96	11	50	23	< 2	18	< 4	57	32	< 2	12	42	22	8	10	< 5	340	40	14	100	68	23	2	54
4.6	4.26	0.10	< 2	< 10	< 8	1000	3	< 10	< 2	88	16	46	37	< 2	20	< 4	52	53	< 2	14	39	21	10	12	< 5	370	40	16	100	89	21	2	80
4.9	7.01	0.10	< 2	< 10	< 8	1300	4	< 10	< 2	140	22	41	60	< 2	26	< 4	86	60	< 2	16	60	24	19	16	< 5	220	40	27	100	120	32	3	120
4.12	8.98	0.09	< 2	< 10	< 8	920	3	< 10	< 2	67	9	23	27	< 2	17	< 4	39	38	< 2	11	29	10	15	6	< 5	410	40	13	100	45	18	2	46
4.12	9.30	0.06	< 2	< 10	< 8	1000	2	< 10	< 2	60	8	22	19	< 2	14	< 4	35	30	< 2	9	26	10	11	5	< 5	620	40	9	100	39	15	2	32
5.13	9.51	0.09	< 2	< 10	< 6	1000	4	< 10	< 2	140	19	49	63	< 2	24	< 4	84	77	< 2	16	58	26	18	17	< 5	250	40	27	100	120	30	3	120
5.14	9.95	0.12	< 2	< 10	< 8	1200	3	< 10	< 2	100	14	33	36	< 2	20	< 4	62	43	< 2	14	44	19	16	12	< 5	300	40	18	100	80	25	2	81
5.14	10.54	0.08	< 2	10	< 8	940	4	< 10	< 2	130	22	56	66	< 2	26	< 4	83	76	< 2	18	58	31	21	17	< 5	270	40	25	100	120	31	3	120
5.15	10.64	0.08	< 2	< 10	< 8	730	4	< 10	< 2	110	23	72	60	< 2	25	< 4	65	81	< 2	16	51	36	16	17	< 5	290	40	22	100	120	24	2	110
5.15	10.71	0.10	< 2	< 10	< 8	620	3	< 10	< 2	74	14	41	47	< 2	18	< 4	44	75	< 2	13	33	21	12	9	< 5	480	40	15	100	63	20	2	74
5.15	11.04	0.05	< 2	< 10	< 8	550	2	< 10	< 2	36	5	16	13	< 2	12	< 4	21	37	< 2	7	20	8	7	4	< 5	750	40	9	100	33	10	1	29
6.2	1.36	0.11	< 2	< 10	< 8	1200	3	< 10	< 2	93	12	30	29	< 2	19	< 4	56	35	< 2	13	37	16	15	10	< 5	380	40	13	100	68	21	2	67
6.9	5.99	0.10	< 2	< 10	< 8	990	3	< 10	< 2	110	13	32	39	< 2	18	< 4	62	40	< 2	11	47	17	9	11	< 5	310	40	19	100	78	23	2	70
6.9	6.24	0.10	< 2	< 10	< 8	1100	3	< 10	< 2	82	9	24	16	< 2	18	< 4	49	20	< 2	11	35	10	11	7	< 5	330	40	13	100	52	19	2	38
6.16	11.55	0.08	< 2	< 10	< 8	1200	3	< 10	< 2	93	13	30	37	< 2	20	< 4	55	44	< 2	13	37	15	14	9	< 5	330	40	17	100	66	22	2	66
7.7	5.03	0.02	< 2	100	< 8	170	1	< 10	< 2	29	5	170	30	< 2	5	< 4	16	11	96	< 4	12	15	6	3	< 5	160	40	5	510	360	8	1	17
7.8	5.72	0.06	< 2	31	< 8	830	2	< 10	< 2	64	7	55	6	< 2	16	< 4	38	22	49	9	26	9	13	5	< 5	430	40	10	100	34	15	2	34
7.8	5.96	0.04	< 2	< 10	< 8	1100	2	< 10	< 2	37	2	10	3	< 2	16	< 4	24	11	< 2	6	15	2	17	2	< 5	560	40	4	100	18	7	1	11
7.12	10.00	0.09	< 2	< 10	< 8	710	4	< 10	< 2	100	20	72	33	< 2	26	< 4	60	88	< 2	16	44	31	18	14	< 5	330	40	18	100	110	21	2	120

Table 6. Major oxide analysis (weight percent) of sediments from Fish Lake Valley cores by wavelength-dispersive x-ray fluorescence spectromety

Core/ Segment	Depth (m)	SiO_2	Al_2O_3	$FeTO_3$	Mgo	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO
1.3	1.90	–[1]	–	–	–	–	–	–	–	–	–
1.5	3.21	–	–	–	–	–	–	–	–	–	–
1.8	5.76	64.9	12.5	2.63	0.71	2.33	3.26	2.96	0.37	0.15	0.05
1.16	11.09	57.4	16.9	6.53	3.29	1.72	1.76	3.71	0.69	0.26	0.13
2.2	1.25	44.9	14.2	5.66	5.63	8.54	2.03	3.42	0.56	0.22	0.11
2.7	4.65	60.5	13.2	5.23	2.90	2.25	1.95	2.91	0.44	0.22	0.1
2.7	4.85	32.9	6.61	2.01	1.64	27.2	1.22	1.65	0.18	0.14	0.19
2.8	5.58	53.9	13.6	4.53	2.61	8.18	2.34	2.76	0.58	0.20	0.63
2.8	5.98	64.9	15.0	4.30	1.82	2.89	3.26	2.95	0.60	0.23	0.07
3.4	2.63	62.8	15.8	5.49	2.18	2.24	3.98	3.27	0.79	0.33	0.07
3.6	4.70	60.8	13.4	3.71	3.02	4.58	3.23	2.90	0.46	0.28	0.07
3.7	4.74	49.0	11.4	3.57	2.67	13.3	2.76	2.58	0.41	0.19	0.07
3.7	5.04	55.4	13.4	4.32	2.10	8.46	3.48	2.82	0.59	0.13	0.05
3.9	6.36	69.0	14.8	3.02	1.02	1.76	5.14	2.73	0.48	0.21	0.05
3.9	6.65	57.7	17.5	6.91	3.09	1.70	3.14	3.73	0.83	0.25	0.13
3.11	8.42	63.5	15.7	4.85	2.15	1.52	4.33	3.46	0.67	0.26	0.08
3.14	10.51	65.2	14.0	3.85	1.63	3.57	4.28	2.84	0.56	0.21	0.06
3.14	10.94	56.5	13.7	4.35	2.20	7.86	3.26	3.18	0.63	0.23	0.07
4.6	4.26	56.1	15.1	5.60	3.12	5.46	3.11	3.35	0.72	0.25	0.10
4.9	7.01	56.2	17.4	7.11	3.14	2.05	2.99	4.02	0.83	0.23	0.17
4.12	8.98	61.1	12.5	2.99	2.61	6.12	3.30	3.08	0.40	0.20	0.07
4.12	9.30	53.4	10.8	2.68	2.57	12.1	3.03	2.36	0.35	0.14	0.06
5.13	9.51	54.8	17.3	7.46	3.31	2.48	2.65	3.88	0.83	0.22	0.10
5.14	9.95	60.3	15.6	5.40	2.51	3.08	3.67	3.43	0.73	0.28	0.09
5.14	10.54	53.4	17.4	7.55	3.51	3.10	2.16	3.67	0.85	0.20	0.12
5.15	10.64	50.5	16.4	7.72	3.94	5.15	1.61	3.19	0.83	0.19	0.12
5.15	10.71	50.7	11.9	4.32	5.47	9.31	1.65	2.61	0.51	0.23	0.09
5.15	11.04	35.4	6.81	1.61	3.98	24.5	1.30	1.56	0.22	0.12	0.11
6.2	1.36	62.1	15.2	4.68	2.26	3.10	3.69	3.37	0.64	0.26	0.07
6.9	5.99	45.4	12.6	4.79	2.56	14.1	2.70	2.84	0.63	0.23	0.11
6.9	6.24	66.1	14.4	3.84	1.37	2.85	4.60	2.93	0.60	0.24	0.07
6.16	11.55	58.4	13.8	4.40	2.80	5.51	3.15	3.15	0.54	0.19	0.13
7.7	5.03	–	–	–	–	–	–	–	–	–	–
7.8	5.72	–	–	–	–	–	–	–	–	–	–
7.8	5.96	74.1	13.6	0.86	0.24	1.74	3.61	3.80	0.21	0.10	0.02
7.12	10.0	54.9	17.9	6.49	3.04	3.23	1.67	3.65	0.78	0.22	0.1

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[1] –, not analyzed.

RESULTS

Stratigraphy and Sedimentology

The sediment in cores 1, 2, and 7 is commonly organic-rich. In cores 1 and 7, taken from the peat bog, about 5.7 meters of peat and organic-rich silt overlie about 2 meters of interbedded moderately sorted silty sand, pebbly sand, and gravel. The sand and gravel beds consist of angular to subrounded grains of feldspar, quartz, and biotite and clasts of granitic, volcanic, and metasedimentary rocks. This lithologic distribution suggests sources both in the Silver Peak Range and the White Mountains (figs. 1 and 2). Below the sand and gravel are 2.5-4 meters of fine-grained deposits consisting in part of massive green silty clay or clay, interpreted to have been deposited in a shallow wetland. In core 1, these basal deposits are mostly poorly sorted pebbly sand and silt interbedded with silty clay, whereas in core 7 they are mostly stiff green silty clay. Core 2, taken from the marsh, consists mostly of locally organic-rich, calcareous silt and clay. Many intervals in cores 1, 2, and 7 contain tephra in poorly defined layers or intermixed with the sediment, in amounts varying from less than 1 percent to as much as 50 percent.

The moderately sorted sand and gravel beds in cores 1 and 7 are clearly not alluvial fan deposits, as suggested by Macke and others (1990), because they are too well sorted and bedded and because the sediment was probably derived from both sides of the valley. The sand and gravel beds could be interpreted as beach deposits because they overlie fine-grained sediment that could be lacustrine in origin. However, we interpret these beds as fluvial deposits for two main reasons: (1) The oscillatory ripples, laminations, and excellent sorting (and commonly excellent rounding) that are characteristic of beach deposits (Pettijohn and others, 1973) were not observed in the cores. (2) Similar beds of sand and gravel do not exist at appropriate depths in cores 2 and 3 where projection of a hypothesized shoreline elevation derived from the elevation of the sand and gravel in cores 1 and 7 should intersect cores 2 and 3.

A buried escarpment reported by Macke and others (1990) from hand-auger transects across marsh deposits in the vicinity of cores 1 and 7 also supports a fluvial origin for the sand and gravel beds in cores 1 and 7. These cores were drilled just east (on the low side) of a 1-m-high scarp, interpreted by Macke and others (1990) to be a buried north-striking fault scarp in alluvial fan deposits. Small north-striking faults offset older late Pleistocene deposits south of Fish Lake (Reheis and others, unpub. data). However, the presence of moderately sorted sand and gravel, not alluvial fan deposits, in the cores adjacent to the escarpment and the absence of similar deposits at the same depth in cores 2 and 3 to the west (fig. 2) suggest that the escarpment may represent a shallow stream channel buried under the peat deposits. If so, the northerly trend of the scarp and the probable fluvial deposits in cores 1 and 7 suggest the presence of an axial stream that probably flowed north following the modern valley-floor gradient.

Cores 3 through 6 on the distal fan consist of beds of poorly sorted clay, silt, pebbly sand, and gravel that we interpret as debris flow deposits. These cores all show coarsening trends both upward in each core and in an upfan direction (fig. 3). Each core contains three or more weak buried soils in the upper few meters; these buried soils are closely spaced in core 3, but are separated by progressively thicker sediment intervals in cores 4, 5, and 6.

A strongly developed buried soil is present near the base of cores 2 through 6. The depth from the surface to this buried soil increases regularly upfan, from about 4.6 m in core 2 to about 11.5 m in core 6. These strong paleosols permit stratigraphic correlation among the cores taken along the distal part of the fan.

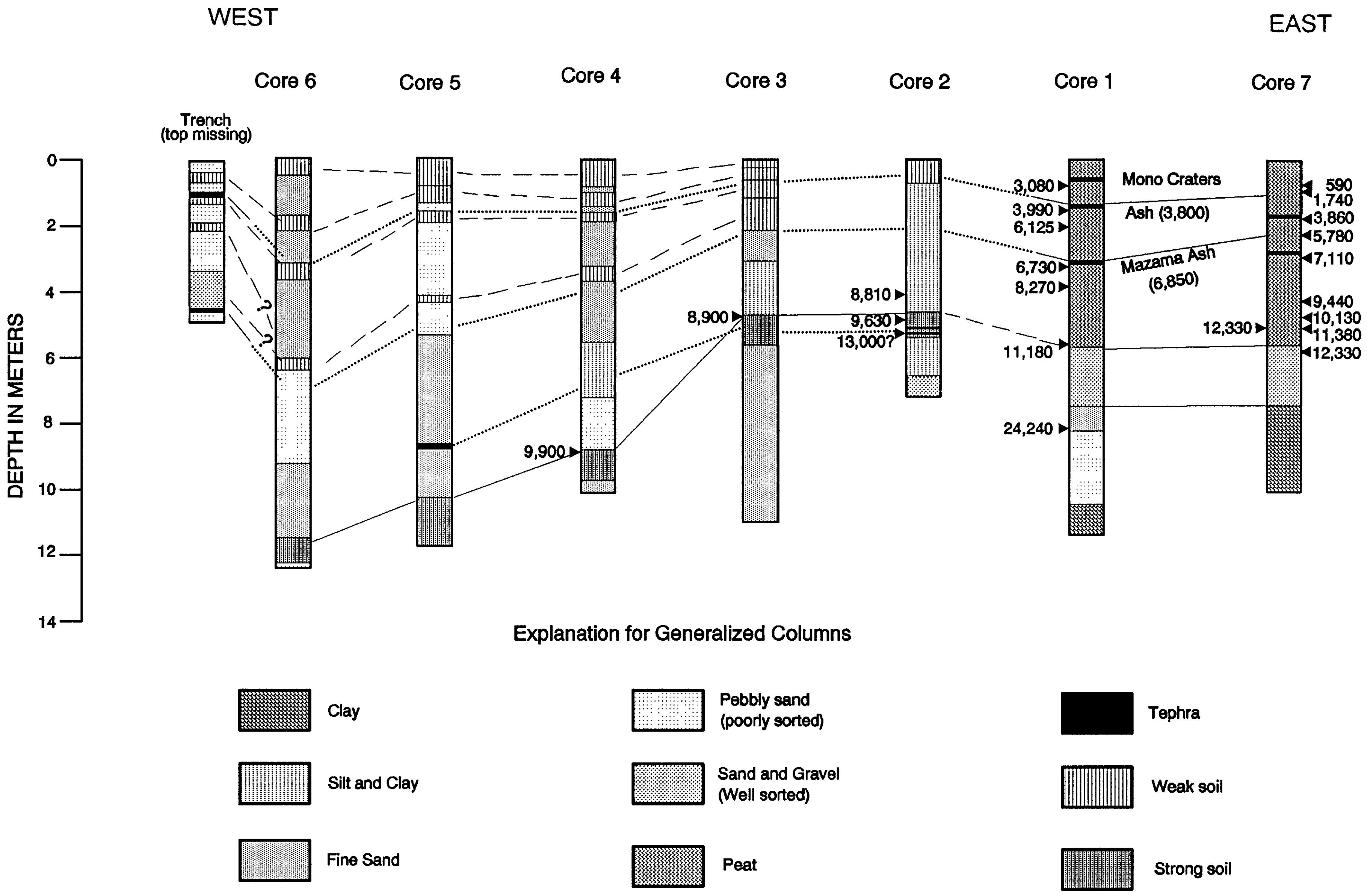

Figure 3. Correlation of sediments in Fish Lake Valley cores and Leidy Creek trench.

The strongly developed paleosols in each core have an organic A horizon about 10-30 cm thick, commonly an argillic Bt horizon as much as 20 cm thick, and a Bk horizon over 30 cm thick with strong accumulations of $CaCO_3$ ranging from 15-50 percent (fig. 4). In some cores, the A horizon appears to be cumulic, suggesting that soil formation kept pace with slow sedimentation. In the southern Great Basin, strongly developed soils such as these probably require at least several tens of thousands of years to develop (Reheis and others, 1989, 1992; Harden and others, 1991). Moreover, preliminary data on the accumulation of cosmogenic ^{10}Be in the strong buried soil in core 5 indicate a minimum of 40,000 years of surface exposure (M. J. Pavich, oral commun., 1993). Thus, it appears that the distal part of the Leidy Creek fan was apparently stable, with no deposition, during at least the late and possibly the middle Wisconsin. If so, the deposit on which the soil formed is early Wisconsin in age or older and hence is probably correlative with unit Qfp (fig. 2).

Fourteen depositional units were recognized in the Leidy Creek trench (fig. 5). The trench exposes three weak buried soils, separated by eolian and fluvial sands. A Mono Craters ash (localities 208A, B, C-LC) was identified from discontinuous sand drapes within buried coppice dunes near the top of the trench (A. M. Sarna-Wojcicki, written commun., 1992). A tephra layer (locality 206-LC) near the bottom of the trench has been identified as the Mazama ash (A. M. Sarna-Wojcicki, written commun., 1992). The tephra layers and a radiocarbon date (to be obtained) from charcoal found in the buried soil formed on unit 7 (fig. 5) will permit correlation with the cores.

Dating and Correlation

The cores and trench have been dated by radiocarbon analyses and tephrochronology. Radiocarbon age determinations (table 2) have been completed on twenty-one samples. Analysis of additional radiocarbon samples is in progress; their locations are shown in Appendix 1. Most samples were dated by accelerator mass spectrometry, but three samples were dated by conventional radiocarbon age determination. Several samples were dated by both methods as a cross-check. The ages to date are stratigraphically consistent within and between each core.

Several tephra layers have been matched by comparison of the chemical composition of glass with tephras from elsewhere in the Great Basin (A. M. Sarna-Wojcicki, written commun., 1992). Tephra layers found at 1.58 m in core 1, at 1.70 m in core 7, and at about 0.8-1.0 m in the trench have been correlated with a Mono Craters ash bracketed at 3,300-3,800 yr B.P. The Mazama ash (6,850 yr B.P.) has been identified at 3.14 m and 2.80 m in cores 1 and 7, respectively, and at about 4.5 m in the Leidy Creek trench. In addition to these tephras, several intervals from cores 1, 2, 3 and 7 contained reworked shards similar to those from several Pleistocene and Tertiary volcanic sources. These sources include the Bishop ash and, in core 2 (fig. 3), a tephra that has been tentatively identified as a Mono Craters ash (about 13,000 yr B.P.) similar to those in the Wilson Creek beds (A. M. Sarna-Wojcicki, written commun., 1993).

Age estimates provided by these tephra layers are consistent with the radiocarbon dates (table 2). Radiocarbon analyses just above and below the 3,300-3,800-yr Mono Craters ash layer in core 1 yield dates of 3,080 and 3,900 yr B.P. A date of 3,860 yr B.P. was reported from organic-rich silts just below the same ash in core 7. Similarly, radiocarbon determinations from organic-rich clays a few centimeters below the Mazama ash layers yield dates of 6,730 and 7,110 yr B.P. The base of the peat has been dated by both conventional and accelerator mass spectrometer methods at 11,180 (core 1) and 12,330 yr B.P (core 7). A radiocarbon analysis from below the peat in core 1 at 8.18 m yields a date of 24,240 yr B.P.

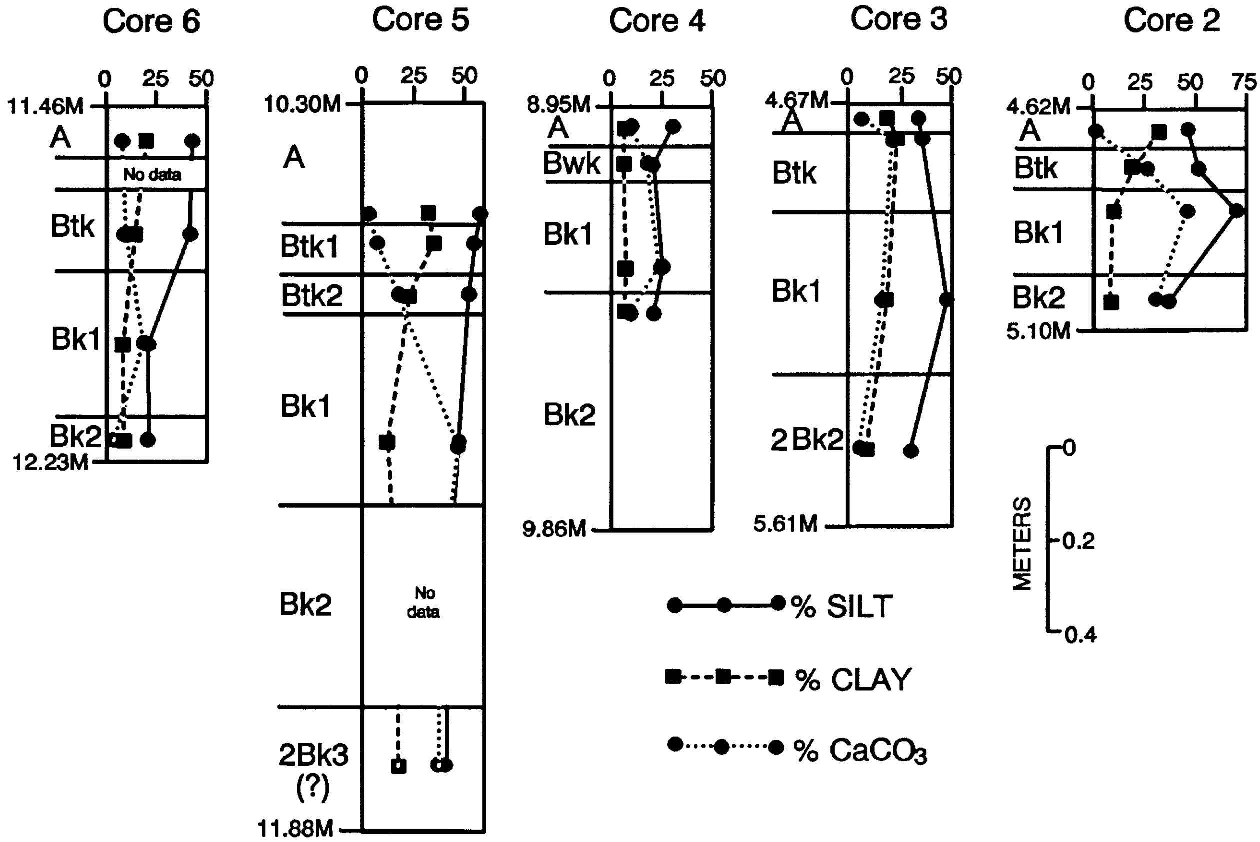

Figure 4. Percentages of silt, clay and $CaCO_3$ from strong buried soil horizons in Cores 2 - 6, Fish Lake Valley, Nevada. Soils described according to Guthrie and Witty (1982), and Birkeland (1984).

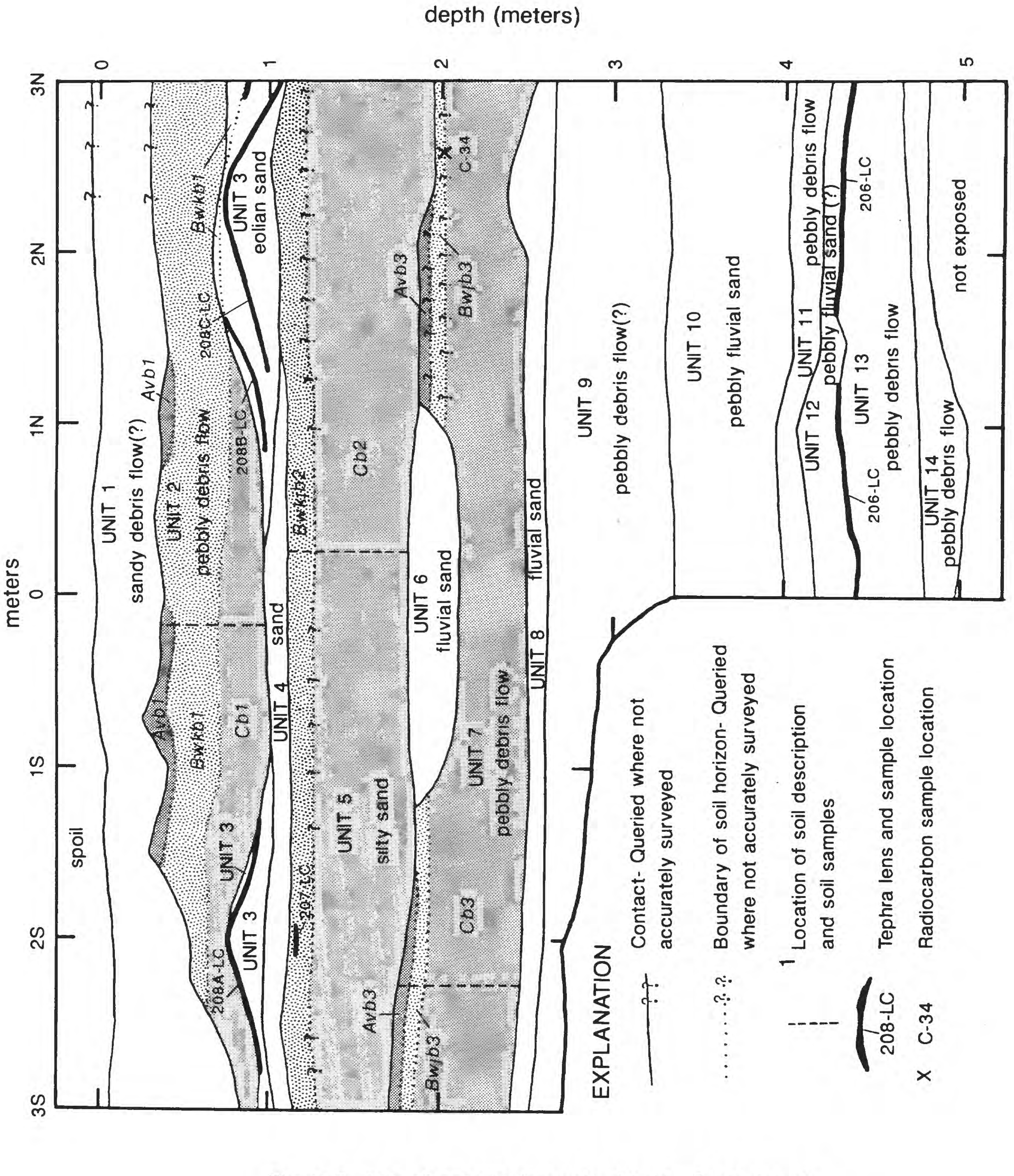

Figure 5.--Log of east-facing wall of Leidy Creek trench.

DEPOSITIONAL UNITS RECOGNIZED IN THE LEIDY CREEK TRENCH

UNIT 1	Massive, moderately sorted medium to coarse sand with a few floating clasts. Where channeled into underlying unit to south, consists of poorly sorted silt, sand, and pebbles. Remnants of former surface soil disturbed by gravel operation and mostly obscured by spoil.
UNIT 2	Poorly sorted silt, sand, and pebble gravel. Mostly massive, but appears stratified on north edge. Contains buried soil in upper two-thirds of unit, locally developed into underlying eolian sand. Apparently a single debris flow that buried coppice dunes without significant erosion.
UNIT 3	Steeply crossbedded (small dune-scale), well sorted fine to medium sand with some layers of coarse sand. Morphology is that of coppice dunes. Constructed on top of underlying unit but locally merges with it. Locally contains tephra laminae (208A,B,C-LC) up to 1 cm thick, dated between 3,300 and 3,800 years B.P. by chemical correlation (A.M. Sarna-Wojcicki, 1993, written commun.)
UNIT 4	Massive, fining upward, moderately sorted silt to medium sand. Orange mottles at top.
UNIT 5	Weakly bedded, moderately sorted fine to coarse sand with silt layers. Weak buried soil at top. At north end, Bwjkb2 horizon contains small pod of tephra (207-LC) that is chemically the same as tephra in the stratigraphically higher coppice dunes; possibly reworked down by burrowing animals.
UNIT 6	Ripple crossbedded, moderately sorted fine to coarse sand. Fluvial deposit, channeled into underlying debris flow.
UNIT 7	Massive, moderately sorted silt to coarse sand with floating pebbles; probable single debris flow. Weak buried soil at top.
UNIT 8	Finely laminated and crossbedded, very well sorted fine sand; fluvial deposit.
UNIT 9	Mostly massive, moderately sorted silt to medium sand with floating pebbles. Locally contains lenses of well sorted fine sand.
UNIT 10	Well bedded, moderately sorted sand and gravel. Consists of interbedded layers, 4-10 cm thick, of silty fine sand, fine to medium sand, and medium sand to pebble gravel. Each layer finely stratified and crossbedded. Fluvial deposit.
UNIT 11	Massive, poorly sorted silt to pebble gravel; moderately indurated. Single debris flow.
UNIT 12	Moderately sorted fine to coarse sand and some pebble gravel. Locally finely stratified and crossbedded. Fluvial deposit (?).
UNIT 13	Massive, poorly sorted silt to fine pebble gravel; single debris flow. At top is nearly continuous tephra layer (206-LC), 1 mm to 1 cm thick; apparently not reworked, possibly an airfall deposit. Identified as Mazama ash (6,850 years B.P.) by A.M. Sarna-Wojcicki (1993, written commun.).
UNIT 14	Massive, poorly sorted silt to fine pebble gravel; single debris flow. Separated from overlying debris flow by very thin layer of silt and clay with preserved mudcracks.

[1] Soils described according to Guthrie and Witty (1982), and Birkeland (1984).

Figure 5. continued

The A horizons of the strongly developed paleosols in cores 2, 3, and 4 provide radiocarbon ages of 9,630, 8,900, and 9,900 respectively. This constrains the age of the buried soil and confirms that it is a consistent stratigraphic marker. The 1,000 year variation in the three dates is reasonable because the dates represent average ages of organic material (mean-residence-time ages) in the upper parts of the buried A horizons. In core 2, organics in the base of the deposits that bury the soil are 8,810 yr B.P.

These dates confirm that peat deposition at the toe of the Leidy Creek fan, in the axis of Fish Lake Valley, spans the last 12,000 years. During most of this time (the last 10,000 years), the fan was aggrading by debris-flow and distal fan sedimentation. Within this time interval the thickness of the fan sediments decreases from about 12 m at the apex to 5.5 m at the fan toe. Thus, the Holocene was and is a time of rapid fan sedimentation on the Leidy Creek fan, although deposition was clearly episodic as indicated by the presence of weak buried soils in the Holocene sediment.

Based on thicknesses of peat and organic-rich sediment between radiocarbon data points in cores 1 and 7, the accumulation rates varied considerably within the Holocene peats. These dates suggest that the peat accumulated at a fairly constant rate of about 62-78 cm/kyr between about 8,000 and 10,000-11,000 yr B.P; the average accumulation rate for the past 6,000-7,000 years, in contrast, is about 35-38 cm/kyr. Therefore, the early Holocene was wetter (had higher peat accumulation rates) than the late Holocene.

Although age dates are not yet available from cores 5 and 6, buried soils and lithologic changes permit tentative correlation with the other cores. We think that the deposits on which the strong buried soils formed correlate to the late Pleistocene alluvial-fan deposit of unit Qfp exposed on the proximal part of the Leidy Creek fan on the basis of soil development and projection of the surface slope of unit Qfp to the east (fig. 2).

Fluvial sand and gravel beds beneath the peat deposits in cores 1 and 7 are bracketed by radiocarbon ages of about 12,000 and 24,000 yr B.P. (fig. 3). Their age and occurrence in these cores and their absence from cores 2 and 3, along with evidence for a north-trending buried escarpment associated with the sand and gravel presented by Macke and others (1990), suggest that an axial stream flowed at the toe of the fan in the late Wisconsin, presumably north down the modern valley-floor gradient. The presence of coarse sediment derived from the White Mountains in the sand and gravel beds also suggests, but does not prove, that stream channels could have extended down the Leidy Creek fan and other fans in Fish Lake Valley and delivered sediment to the axial stream. Deposits of late and middle Wisconsin age were not found in the cores on the Leidy Creek fan; rather, this time interval is spanned by development of the strong buried soil. It is possible that fan deposition was occurring at this time on the northern, uncored part of the fan (fig. 2); if so, deposits of this age were not preserved at the surface. From the evidence in the cores, we currently believe that debris-flow deposition was not occurring on the Leidy Creek fan in the late Wisconsin and perhaps the middle Wisconsin and slopes were stable, presumably because the climate was moist enough to increase the vegetative cover.

Biostratigraphy

Preliminary analysis of some paleontological samples has been completed. Initial results indicate that pollen, diatom, and ostracode analyses will provide detailed paleoclimate information.

Sediment samples for pollen analysis from cores 1 and 7 (analyzed by Peter E. Wigand and Martha L. Hemphill of the Desert Research Institute in Reno, Nevada) have yielded pollen of variable quality. Their preliminary results include the following: (1) In general, pollen preservation is better in the lower portions of both cores and pollen diversity also increases downward in the cores; (2) over-representation of pine pollen (long distance transport) near the top of the peat section (middle to late Holocene) of both cores indicates that local pollen production thus was considerably lower than that during the lower (late Pleistocene) portion of the cores, clearly reflecting drier local conditions during the Holocene; and (3) juniper pollen is much more abundant in the lower portion of the cores, suggesting that juniper was present locally, though in relatively low numbers and well dispersed upon the landscape.

The occurrence of different aquatic pollen types in the upper and lower portions of cores 1 and 7 suggests different local depositional environments. Although both upper and lower portions of the cores contain sedge pollen, cat-tail pollen is much more abundant in the lower portion of the record (9.9 m of core 7), where both cat-tail pollen of monad-type (*Typha domingensis* or *T. angustifolia*) and tetrad-type (*Typha latifolia*) occur. The latter type indicates a marsh with cooler, fresher water conditions than are presently found in Fish Lake Valley. The occurrence of pond weed (*Potamogeton* sp.) pollen suggests standing water depth of at least a meter or so. The total absence of acid resistant algae in all the samples examined thus far may indicate that water chemistry or the marsh habitat was not conducive to growth of acid resistant algae.

Preliminary examination of smear slides from cores 1 and 7 by J. Platt Bradbury (written commun., 1993) indicates a sporadic diatom record (fig. 6). Diatoms are abundant throughout the peat sections in cores 1 and 7, where diatomite or diatom-rich layers are common. Samples examined from core 1 below 7 m depth were barren of diatoms. Notably, diatoms were absent from the silty clay between 10.8 and 11.4 m in core 1, interpreted to be equivalent to the clay in core 7 between 8.5 and 9.8 m, which does contain diatoms. This clay interval in core 1 may represent a facies or a separate environment in which diatoms were either not produced or preserved.

Most of the samples from core 7 contain common to abundant diatoms, and all samples, with the exception of one at 8.71 m, contain a similar flora that is characterized by *Rhopalodia gibba*, *Epithemia* species, *Pinnularia* species, and commonly *Surirella spiralis*. This assemblage indicates shallow-water, alkaline, marshy environments. The water was fresh (probably below 3 ppt TDS). The species of *Epithemia* live attached to the submerged stems of aquatic plants, such as *Scirpus* or *Typha* and so indicate the presence of this or similar vegetation in the marsh. *S. spiralis* is characteristic of spring habitats (but also in carbonate-rich lakes) of mountain regions of Europe, but is not widely reported from the United States.

The sample from core 7 at 8.71 m is characterized by *Biddulphia laevis*. *B. laevis* has a fairly wide distribution and apparently tolerates moderate levels of salinity with elevated levels of sodium, chloride, and sulfate (but still fresh water) and generally high turbidity. *B. laevis* is found in the southern part of Lake Michigan, the Missouri River, and several of its tributaries in the Colorado Plains. It is also present along the Florida and New Jersey coasts, and occasionally in springs of the proper temperature and chemical composition. Because *B. laevis* is not found commonly in mountain regions, many authors consider it to be a warm water species.

The co-occurrence of *S. spiralis* and *B. laevis* in the sample is unusual, given what is known about their ecology. They may have lived in separate, spring-controlled habitats and became sedimented together, or their co-occurrence may suggest some non-analog situation. Because *B. laevis* does not appear in stratigraphically lower samples so far examined, it possibly represents a unique hydrological or environmental change of short duration.

Ostracodes were found by C.K. Throckmorton and R.M. Forester in 51 out of 109 samples from cores 1, 2, and 3. Ostracode occurrences in these cores are restricted to the Holocene sediments where they are found primarily in silty peats or organic-rich silts and clays that

depth[1]	conc[2]	Rho-gib	Rho-gbr	Epi -adn	Epi-turg	Epi-arg	Nv-cusp	Nv-obl	Sur-spr	Sur-oval	Pinn	Cymb	Dip	Eun	Coc-pla	Sta-pho	spic	Neid	Syn-uln	Syn-acus	Bid-laev	Mrd-crc	Fr-br	Au	Nz-dent
0.9	CD	1	1		1	1	1	1	1		1	1													
0.98	CD	1	1	1	1	1			1		1		1	1	1										
1.08	CD	1			1			1	1		1	1				1									
1.11	RD	1		1	1	1			1	1	1														
1.22	CD	1		1	1				1		1	1				1									
1.48	CD	1	1		1	1			1	1															
1.52	CD	1		1	1						1	1			1		1								
2.01	RD			1					1		1						1								
2.14	BOD																								
2.22	RD	1			1				1		1														
2.29	AD	1			1				1		1														
2.84	VAD	1			1				1		1														
3.18	CD	1		1	111						1														
3.26	CD	1		1	1			1	1		1					1	1	1							
3.44	CD	1		1	1				1							1									
3.8	CD	1			1				1		1					1	1								
4.41	RD	1		1	1	1					1			1											
4.52	CD	111			1																				
4.72	VAD	1			1										1		1		1						
5.24	CDpp	1			1						1	1													
8.42	RD	1									1	1													
8.71	CD								1	1		1		1	1		1			1	111	1	1	1	1
9.12	VAD	1		1	1			1	1	1		1	1		1				1					1	
9.25	RD								1		1														

[1] Depth is below surface, recorded in meters

[2] conc = concentration; symbols in column denote diatom abundances. BOD = barren of diatoms, RD = rare diatoms, FD = few diatoms, CD = common diatoms, CDpp = common diatoms, poorly preserved, AD = abundant diatoms, VAD = very abundant diatoms

Abbreviations in columns 3-26 represent the following:

Rho-gib = *Rhopalodia gibba*
Rho-gbr = *Rhopalodia gibberula*
Epi-adn = *Epithemia adnata*
Epi-turg = *Epithemia turgida*
Epi-arg = *Epithemia argus*
Nv-cusp = *Craticula cuspidata*
Nv-obl = *Navicula oblonga*
Sur-spr = *Surirella spiralis*
Sur-oval = *Surirella ovalis*
Pinn = *Pinnularia* spp.
Cymb = *Cymbella* spp.
Dip = *Diploneis* spp.
Eun = *Eunotia* spp.
Coc-pla = *Cocconeis placentula*
Sta-pho = *Stauroneis phoenicentron*
spic = sponge spicules
Neid = *Neidium*
Syn-uln = *Synedra ulna*
Syn-acus = *Synedra acus*
Bid-laev = *Biddulphia laevis*
Mrd-crc = *Meridion circulare*
Fr-br = *Fragilaria brevistriata*
Au = *Aulacoseira* spp.
Nz-dent = *Nitzschia denticula*

Multiple digits (e.g. "111) indicate dominance or considerable abundance

Figure 6. Diatoms in Core 7, Fish Lake Valley

comprise the upper half of cores 1 and 2, and clayey silts near the top of core 3. Ostracodes in this sample set are absent from the fluvial sediments and the fine-grained deposits (probably freshwater wetland deposits) comprising the lower part of the cores.

Ostracodes are common inhabitants of modern day wetland environments throughout the Great Basin where their calcareous valves often make up a large portion of a sediments sand sized fraction. In general, however, the fine-grained, presumably wetland deposits in the lower part of cores 1 and 7 are not calcareous (see appendix 1) and are barren of ostracodes. Two likely explanations for the absence of ostracodes are: (1) The water was very dilute and undersaturated with respect to calcite and therefore produced no inorganic carbonate. Biogenic carbonate would have dissolved upon the death of the organism. Or (2), the water column produced both inorganic and biogenic carbonate, but both are subsequently dissolved by diagenesis (e.g. ground water movement or other reactions with the sediment). However, the interpretation from the paleolimnologic reconstruction based on the diatoms (see above) indicates somewhat elevated salinity. This condition would seem to favor the latter explanation of post depositional solution of all carbonates from the sediment. Alternatively, ostracodes may not have lived at the core sites because anoxia prevailed near the sediment water interface. Although possible, this alternative seems less likely because a shallow water body should be readily oxygenated by wave action generated by wind.

The ostracodes that were found represent several species that are common in fresh to slightly saline waters in wetlands, springs, or both environments. Some taxa (candonids) found in the core are presently more common as one progresses north of Fish Lake to higher elevations. Though more detailed paleoenvironmental reconstructions are forthcoming, the species occurrences imply a generally wetter and colder climate than occurs at Fish Lake today.

Gastropods occur only in cores cores 1 and 2, taken in the peat bog and marsh. Residue from processed ostracode samples, taken at 20 cm intervals, confirms their spotty distribution throughout these cores. They occur at several horizons between 1.05 and 4.71 m. In core 2, they occur from near the top of the core to a depth of 5.16 m. Their occurrences almost always coincide with ostracode occurrences. The gastropod taxa, identified by Emmett Evanoff (University of Colorado Museum at Boulder) are shown in Figure 7. Evanoff provided the following additional information.

> "The taxa are all freshwater pulmonates, lung-bearing aquatic snails that can withstand occasional complete drying of their habitat. However, this fauna is not like those of most Nevada spring marshes, that typically include a mixture of aquatic and land snails (see Mifflin and Quade, 1988). This data suggests that Fish Lake was slightly larger at some time during the late Holocene and that standing water was present in the vicinity of core 1 probably throughout the year during most or all of the Holocene."

The initial results from pollen and diatom analyses are consistent in their interpretation of different environmental conditions during Holocene and Late Pleistocene time. Further analysis of pollen, diatoms, and ostracodes is needed to refine the paleoclimate record.

	Fish Lake Valley Core/Segment Numbers and Depths										
Taxa	1.2 (1.05-1.07m)	1.3 (2.22-2.24m)	1.4 (2.37-2.39m)	1.4 (2.72-2.74m)	1.5 (3.34-3.36m)	1.5 (3.47-3.49m)	1.5 (3.52-3.54m)	1.7 (4.7m)	2.1 (0.29-0.31m)	2.2 (0.95-0.97m)	2.2 (1.15-1.17m)
Phylum Mollusca											
Class Gastropoda											
Subclass Pulmonata											
Order Lymnophila											
Family Lymnaeidae											
Fossaria spp.		x		x	x	x		x			
Fossaria?[1] spp.							x				
Stagnicola elodas (Say 1821)						x					
Stagnicola spp.		x			x	x					
Gen. & sp. indeterminant	x		x						x	x	x
Family Planorbidae											
Gyraulus circumstriatus (Tryon 1866)		x				x					
Gyraulus sp.	x				x		x	x	x		
Gyraulus? sp.			x	x						x	x
Promenetus sp.				x	x						

[1] ? following generic name refers to uncertain identification to the genus because of poor preservation

Figure 7. Gastropod taxa from cores near Fish Lake Valley

SUMMARY

A detailed record of changes in depositional environments during the late Pleistocene and Holocene is included within cores from Fish Lake Valley. Interpretation of the radiocarbon ages, tephra correlations, stratigraphic relations, and preliminary paleontological data yields the following conclusions: (1) Both cores 1 and 7 show relatively rapid rates of accumulation of organics in the early Holocene and lower rates of accumulation in the late Holocene. This suggests that the early Holocene was wetter (had higher accumulation rates) than the late Holocene. Standing water was present around Fish Lake throughout the Holocene, based on the presence of diatoms, ostracodes, gastropods, pollen, and plant macrofossils. (2) Throughout the period of peat deposition, the fan was aggrading by debris-flow and distal fan sedimentation. Thus, latest Quaternary fan sedimentation on the Leidy Creek fan is restricted to the Holocene. However, the weak buried soils in the upper parts of the distal-fan cores suggest that deposition rates fluctuated and were slower in the middle(?) to late Holocene than in the early Holocene. (3) Prior to about 12,000 yr B.P., the climate was wet enough that an axial stream (represented by the fluvial deposits beneath the peat in cores 1 and 7) apparently flowed at the toe of the fan. Thus, fluvial deposition occurred in latest Pleistocene time, perhaps corresponding to the end of the Tioga glaciation. Deposits of this age however, do not occur in the cores; this time span is represented by the strong buried soils in the cores. We interpret the degree of development of most of these buried soils to require several tens of thousands of years. If these inferences are correct and can be extended to the rest of the fan, then the Leidy Creek fan (and by extension other fans in Fish Lake Valley) was stable, with little no deposition, during at least the late and probably the middle Wisconsin when the climate was relatively moist and vegetative cover was more extensive. Due to the distribution of the coreholes, however, it is possible that deposition could have occurred on the northern part of the fan during the late Wisconsin (fig. 2). Further coring or shallow seismic techniques could address this possibility. (4) At and before 24,000 yr B.P., a freshwater wetland existed at the toe of Leidy Creek fan as evidenced by the fine-grained deposits beneath the fluvial unit and the presence of diagnostic species of pollen and diatoms. (5) We tentatively correlate the deposit on which the strong buried soil formed to the proximal-fan deposits of unit Qfp (fig. 2), believed to be between 35,000 and greater than 80,000 years based on soil correlation and projection of surface and buried-soil gradients.

ACKNOWLEDGMENTS

The authors wish to acknowledge Janet L. Slate (NORCUS, Washington State University) whose ideas on Holocene climatic control of proximal alluvial-fan deposition in Fish Lake Valley led to this project. Our thanks to Michael J. Bennett for coring operations, and Angela Vasquez and Thomas Rennie (University of Nevada, Reno) for skillful field assistance. Meyer Rubin provided radiocarbon dates and Andrei M. Sarna-Wojcicki, Charles E. Meyer and Elmira Wan provided the tephrochronology. Peter E. Wigand and Martha L. Hemphill (Desert Research Institute, Nevada) provided pollen information based on results to date. J. Platt Bradbury provided preliminary information on diatoms. Richard M. Forester consulted with the authors on ostracodes. Emmett Evanoff (University of Colorado Museum, Boulder, Colorado) identified gastropod taxa and provided environmental analysis. Geochemical analyses were performed by P.H. Briggs, J.S. Mee, and D.F. Siems (Branch of Geochemistry). Priscilla L. FitzMaurice analyzed sediment samples for grain size and for $CaCO_3$ and organic-matter content. Ramon E. Sabala provided computer graphics assistance. Mr. and Mrs. James Boyce of Dyer, Nevada provided access to their property and generously gave our drilling crew free accommodations. John Cady cooked and cleaned for the crew.

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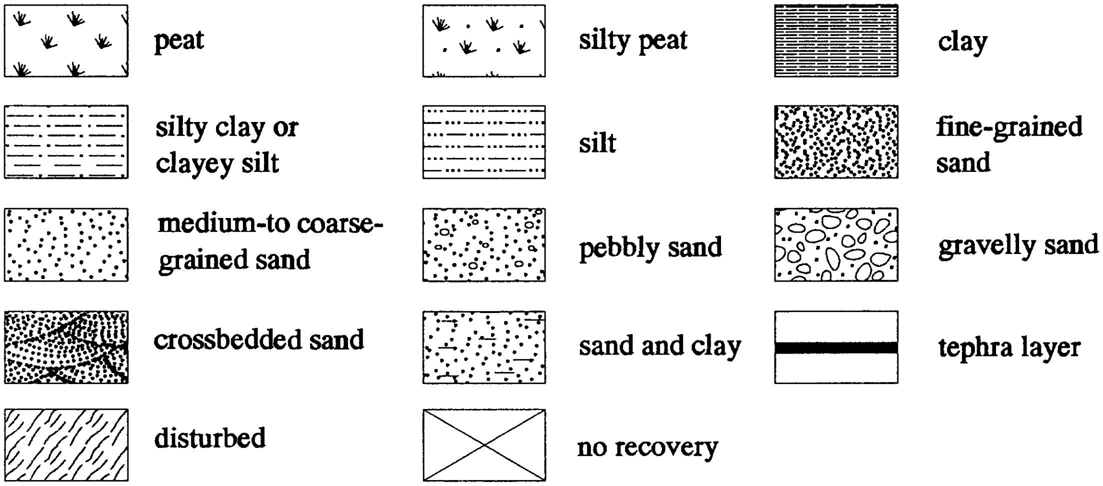
Appendix 1. Core descriptions for Fish Lake Valley cores

EXPLANATION

The patterns in the Lithology column reflect the dominant lithology within the interval.



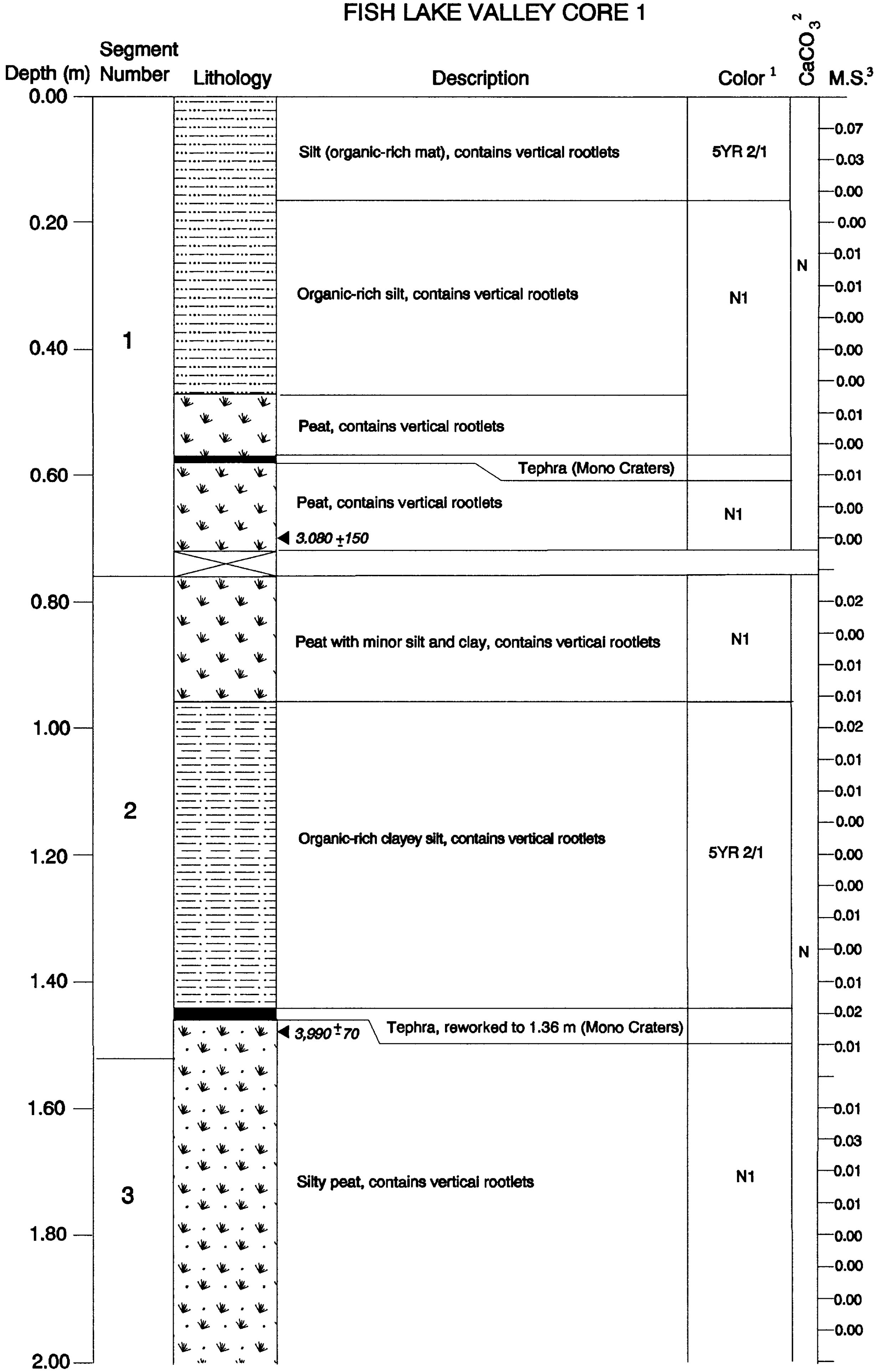
- - - - - - -	Dashed line separating lithologic descriptions (core 4, segments 3, 4; core 6, segments 8, 10) indicates intervals where sediment was hammered from core barrels, thus lithologic units may be mixed and boundaries are approximate.
◀ 3,080±150	Radiocarbon date (see table 2). ^{14}C identifies intervals where radiocarbon samples have been sampled for possible future analysis.
} TL Sample	Interval sampled for thermoluminescence and optical-spin luminescence dating

[1] Colors were determined from wet sediment. Color designations are from the Munsell Soil Color Chart (Munsell, 1973). Two or more numbers in a single interval designate the presence of two or more colors throughout the interval. The first color listed is the most prevalent.

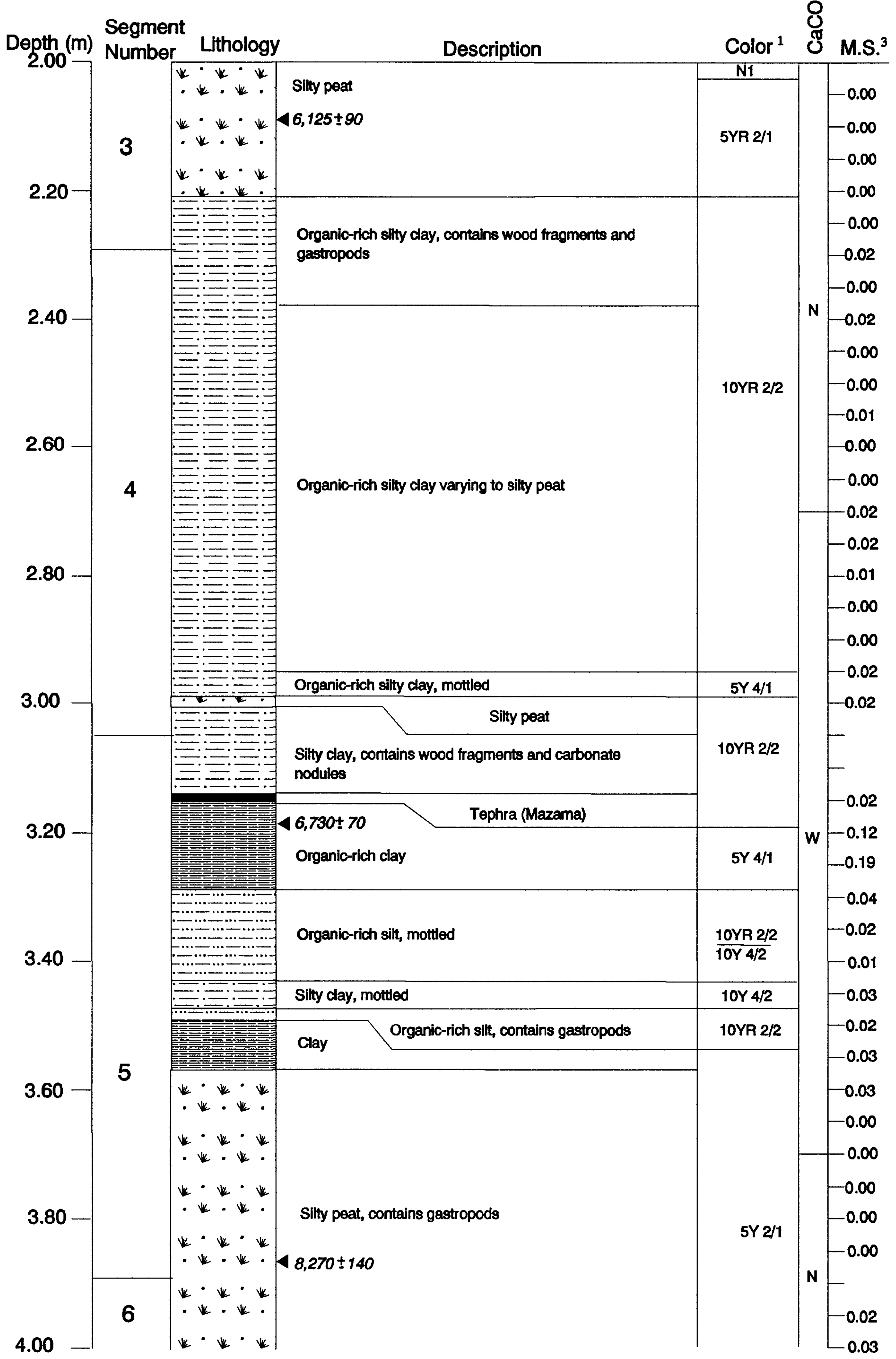
[2] Symbols in columns represent the following: N= noncalcareous, W= weakly calcareous, M= moderately calcareous, S= strongly calcareous. Two or more symbols in a single interval reflect a range in the amount of carbonate throughout the interval.

[3] Magnetic susceptibility measurements (measuring range is 0.00 to 999 x 10^{-3}). Mn to right of measurement indicates the presence of a manganese-rich layer. Measurements were not taken in areas where core surfaces were rough or fractured.

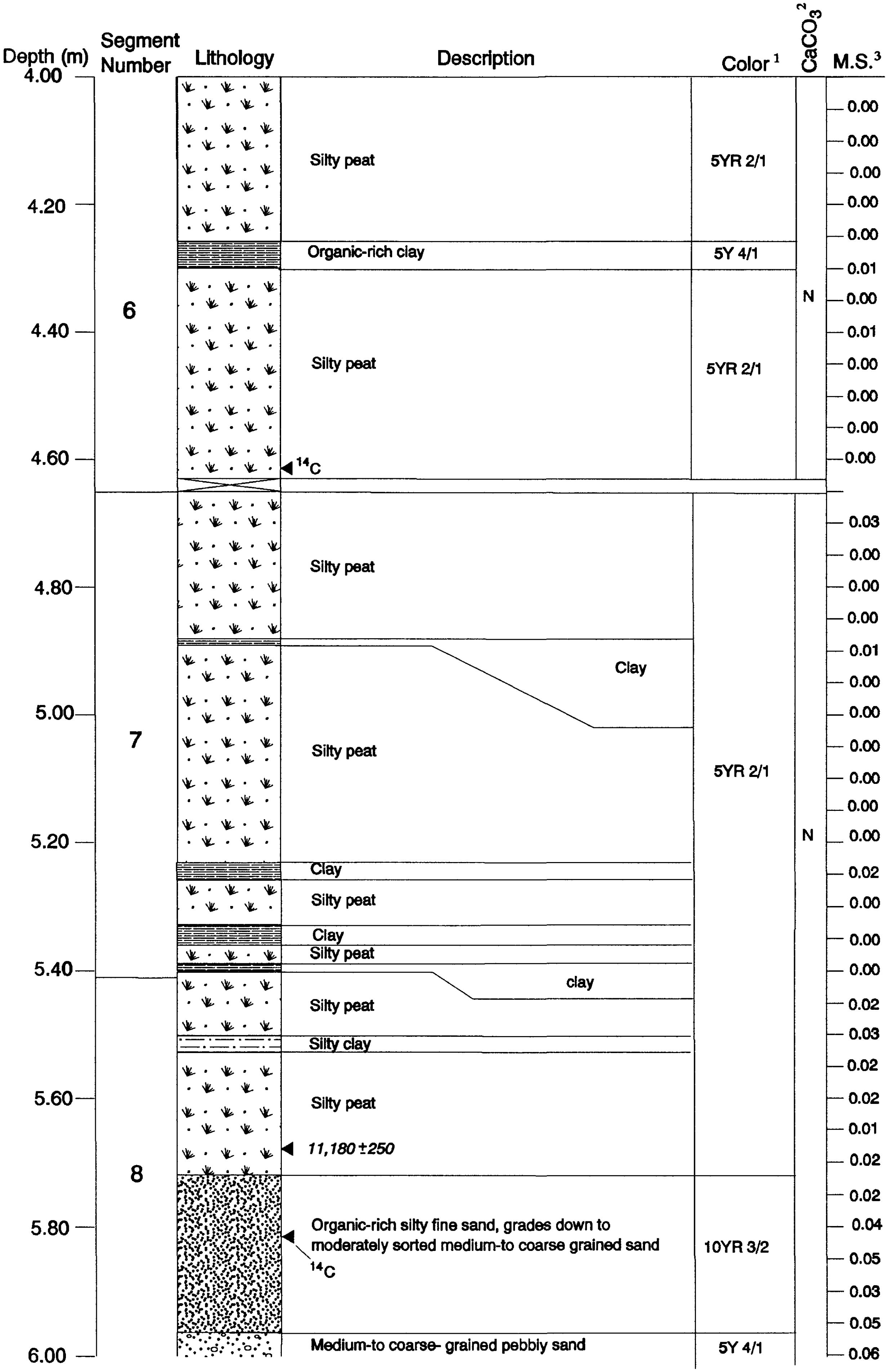
FISH LAKE VALLEY CORE 1



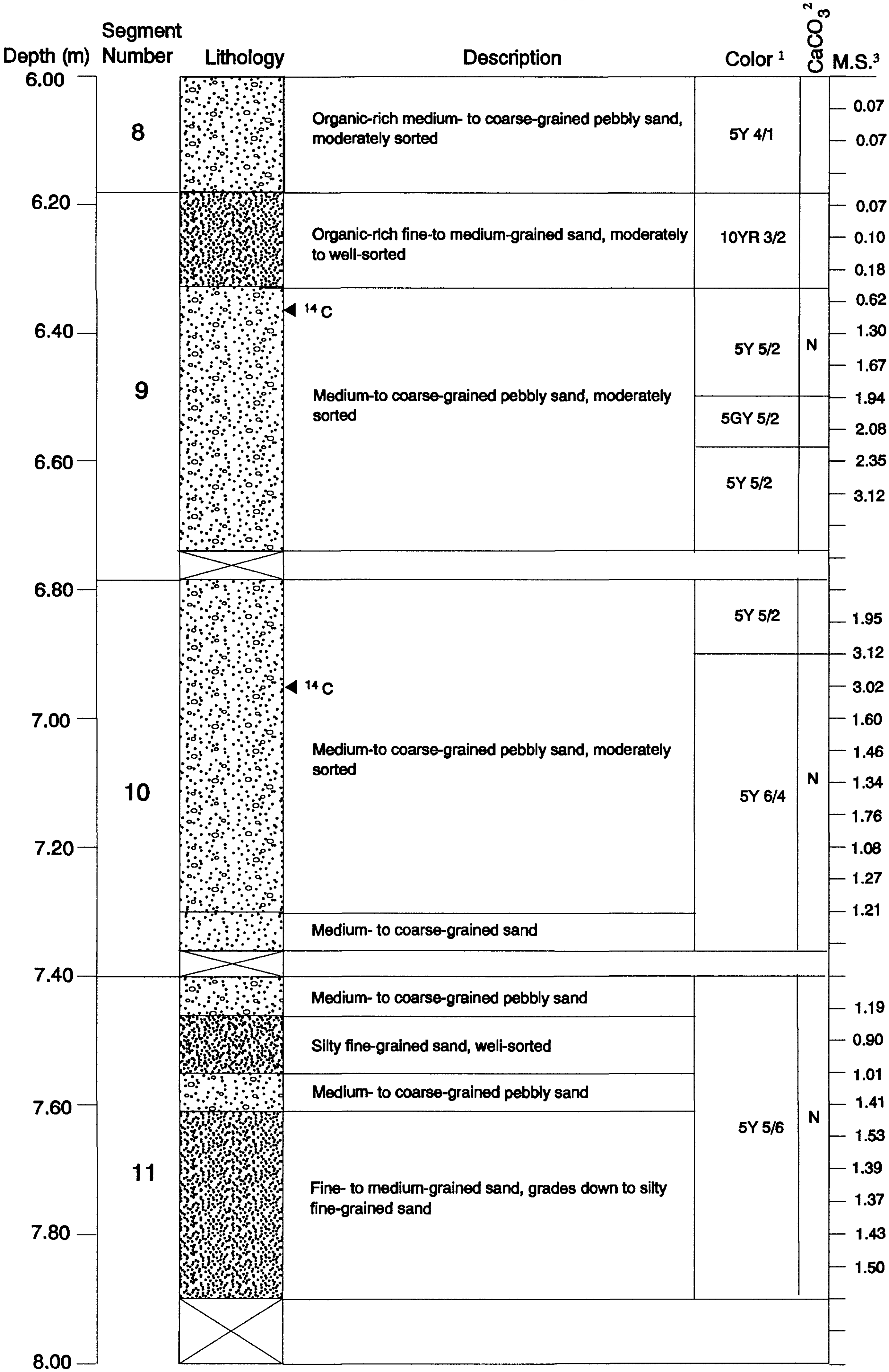
FISH LAKE VALLEY CORE 1



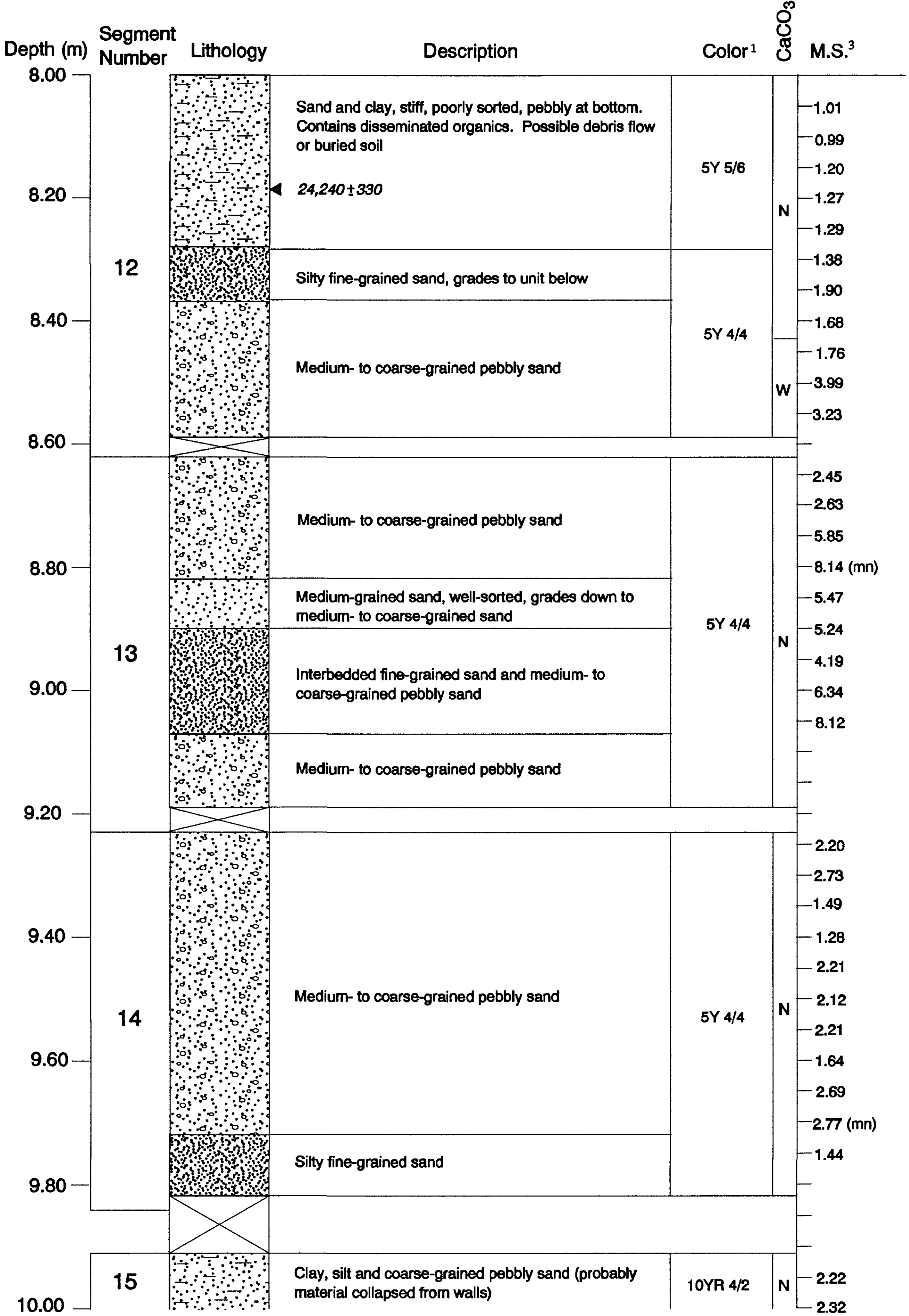
FISH LAKE VALLEY CORE 1



FISH LAKE VALLEY CORE 1



FISH LAKE VALLEY CORE 1



Sand and clay, stiff, poorly sorted, pebbly at bottom. Contains disseminated organics. Possible debris flow or buried soil

24,240±330

Silty fine-grained sand, grades to unit below

Medium- to coarse-grained pebbly sand

Medium- to coarse-grained pebbly sand

Medium-grained sand, well-sorted, grades down to medium- to coarse-grained sand

Interbedded fine-grained sand and medium- to coarse-grained pebbly sand

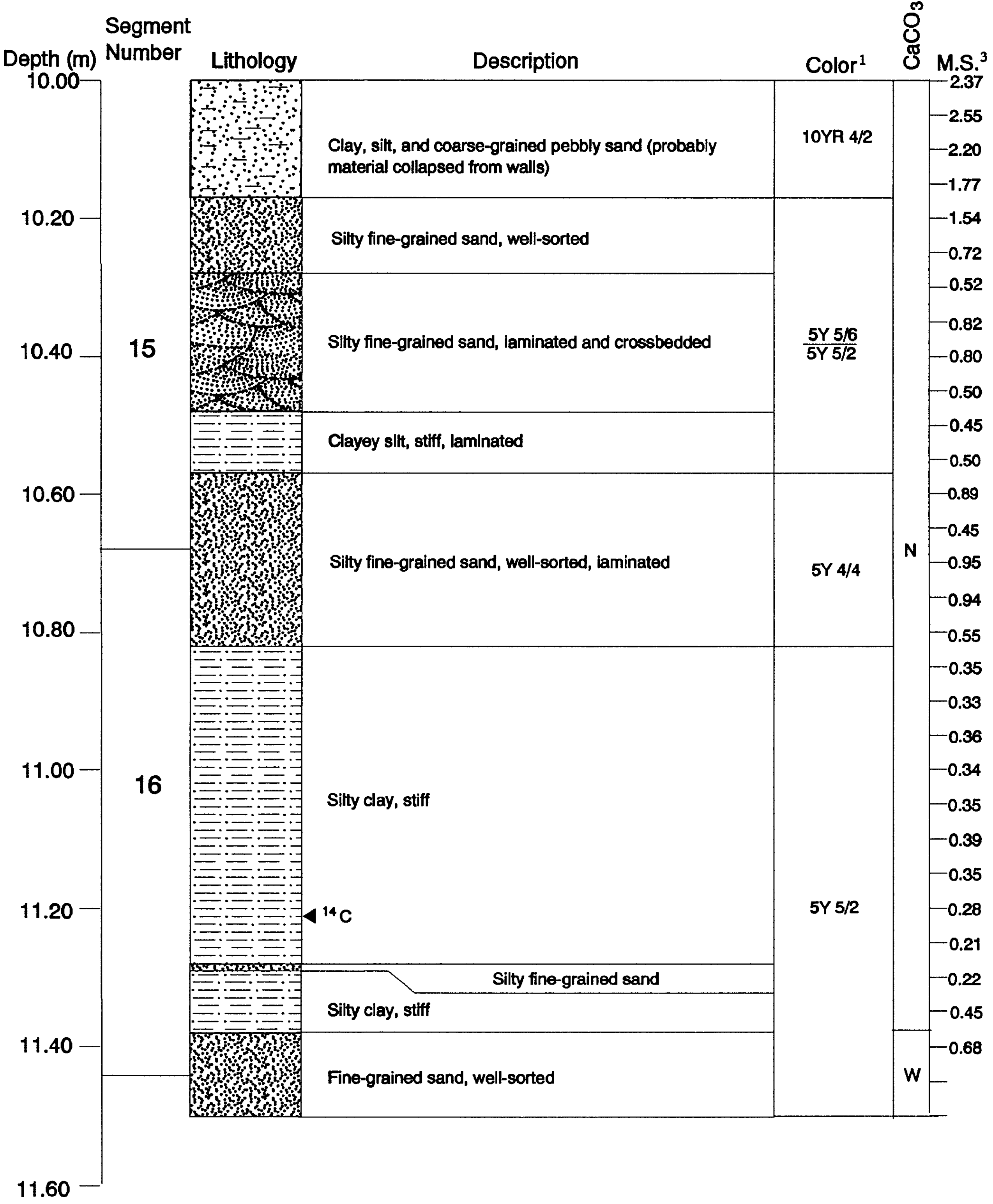
Medium- to coarse-grained pebbly sand

Medium- to coarse-grained pebbly sand

Silty fine-grained sand

Clay, silt and coarse-grained pebbly sand (probably material collapsed from walls)

FISH LAKE VALLEY CORE 1



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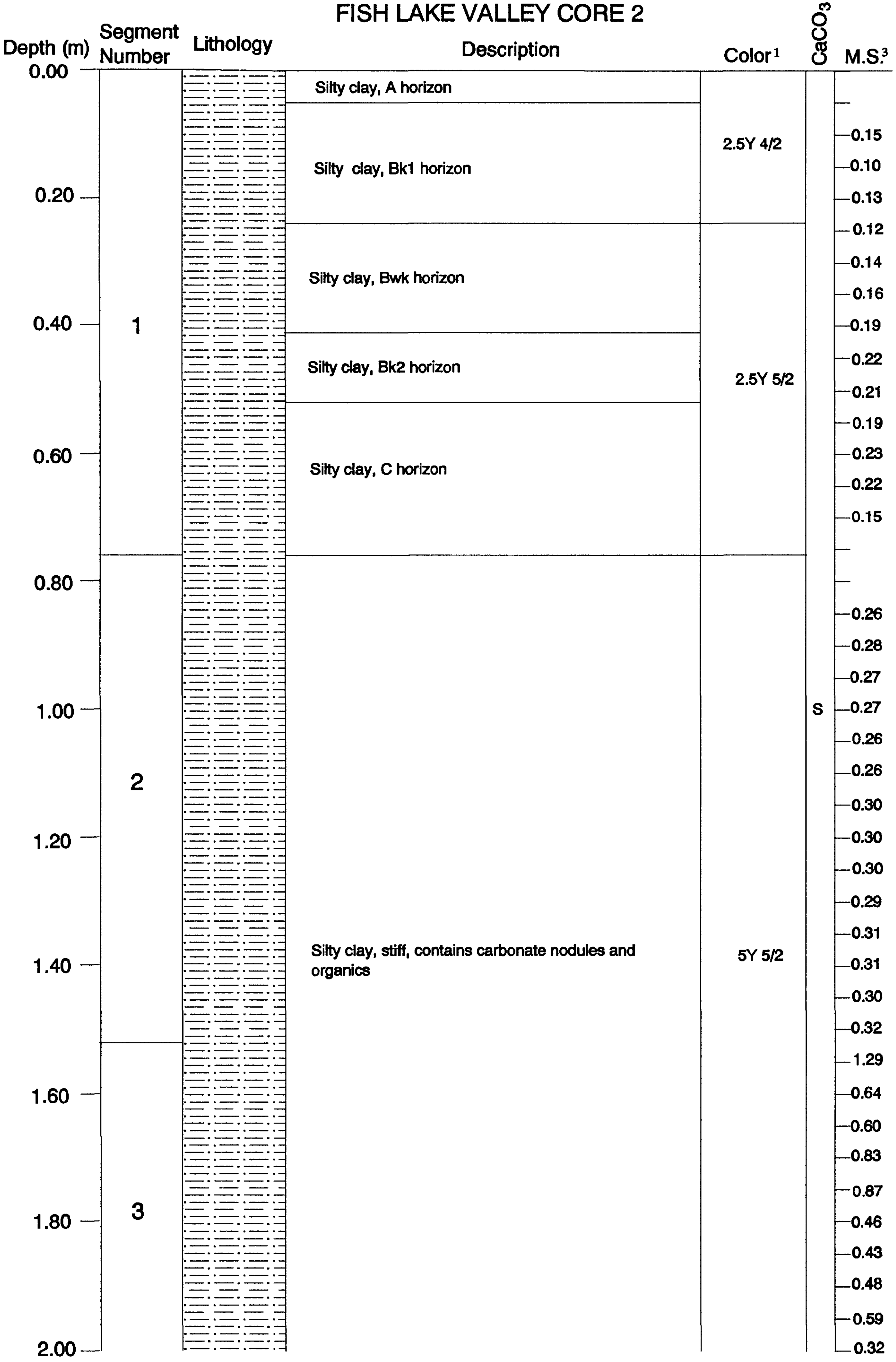
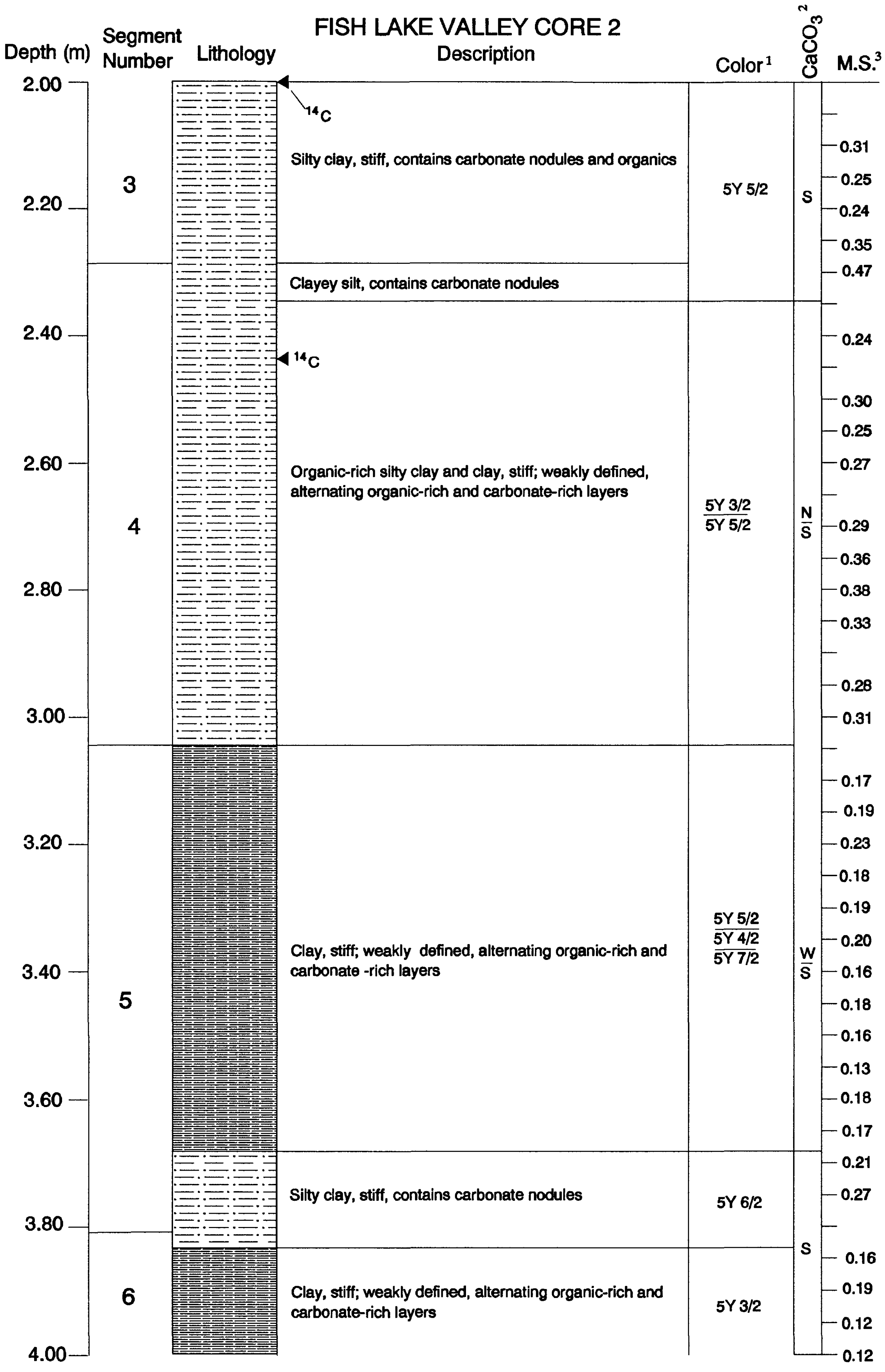




FISH LAKE VALLEY CORE 2

Silty clay, stiff, contains carbonate nodules and organics

Clayey silt, contains carbonate nodules

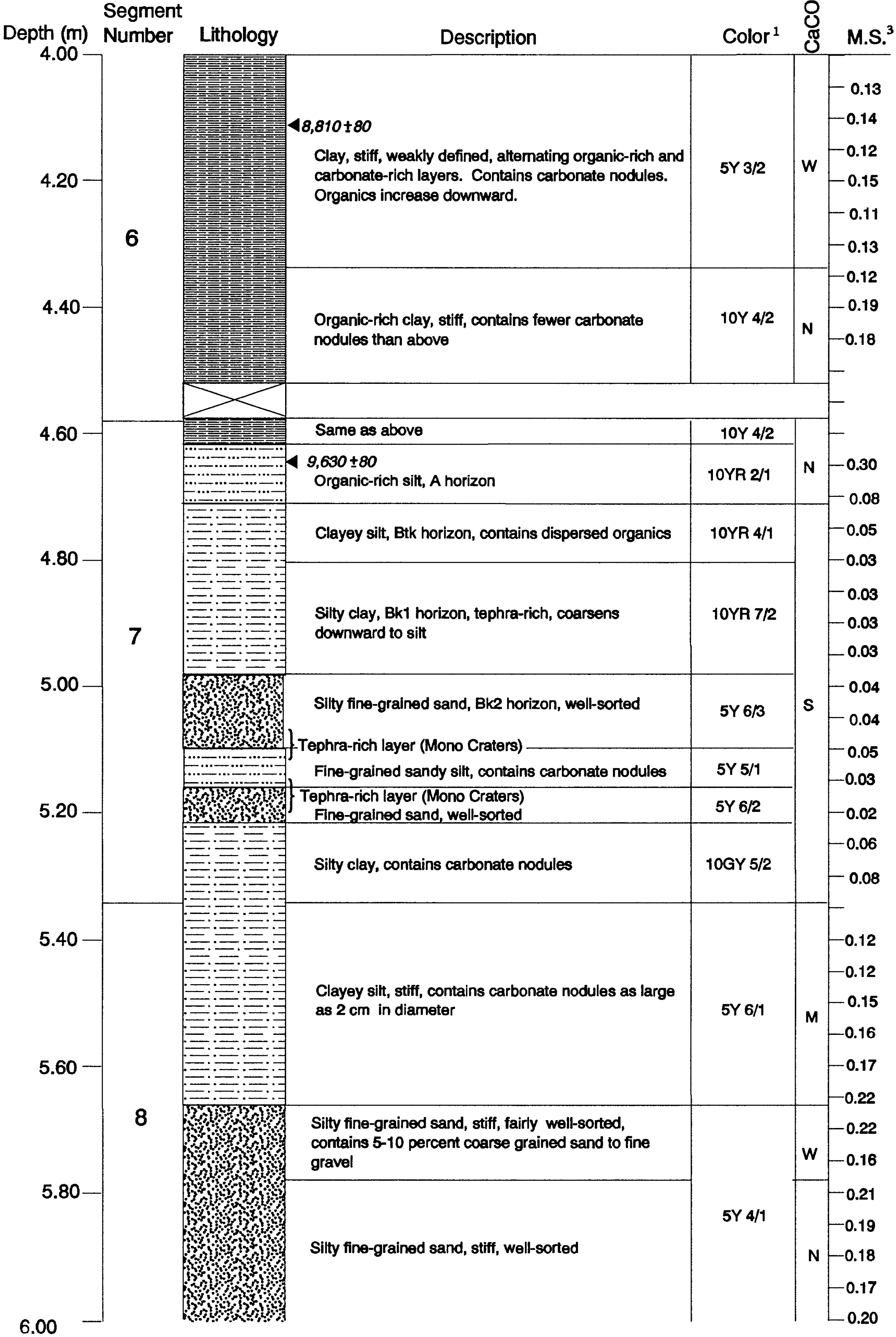
Organic-rich silty clay and clay, stiff; weakly defined, alternating organic-rich and carbonate-rich layers

Clay, stiff; weakly defined, alternating organic-rich and carbonate -rich layers

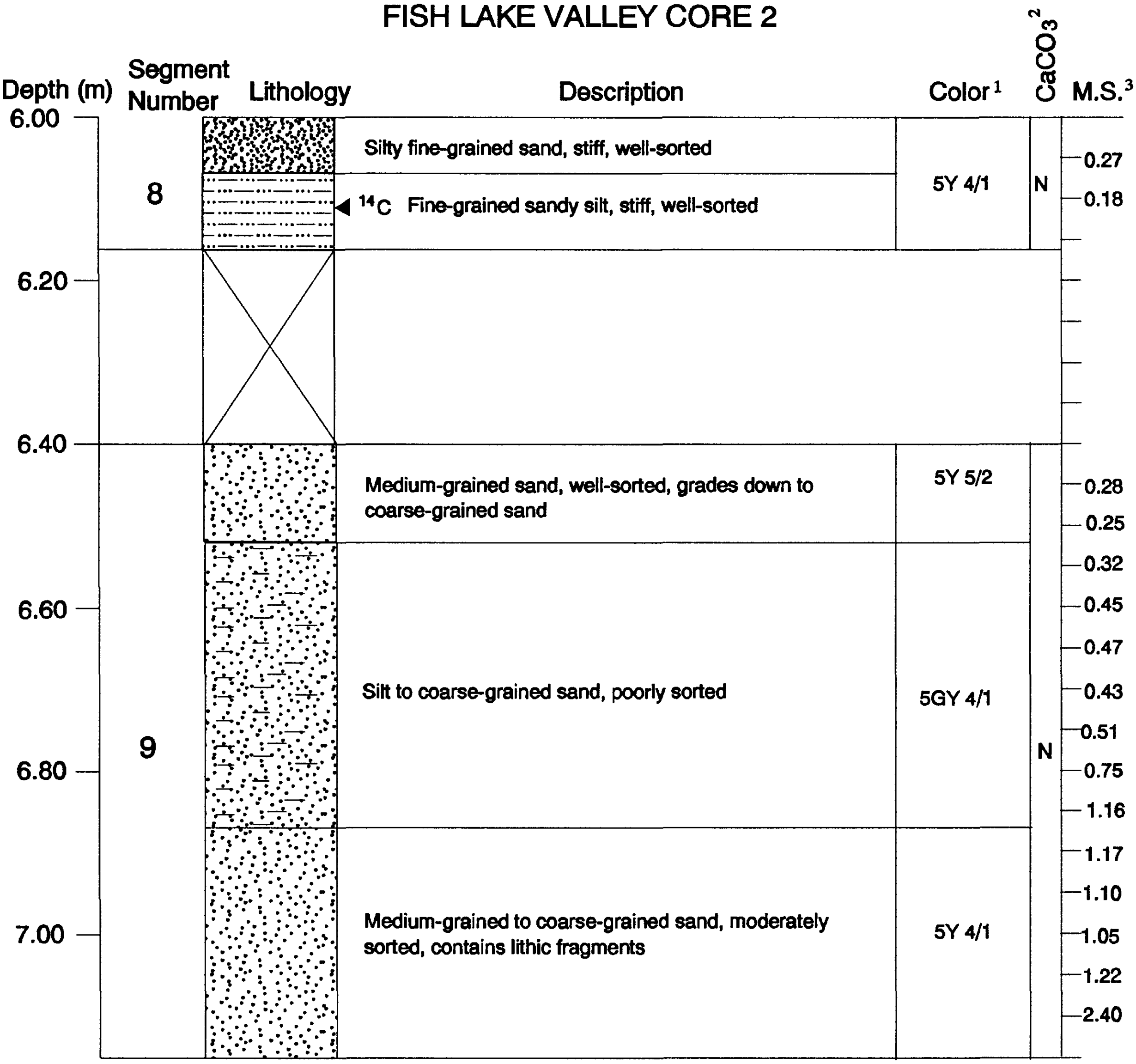
Silty clay, stiff, contains carbonate nodules

Clay, stiff; weakly defined, alternating organic-rich and carbonate-rich layers

FISH LAKE VALLEY CORE 2



FISH LAKE VALLEY CORE 2



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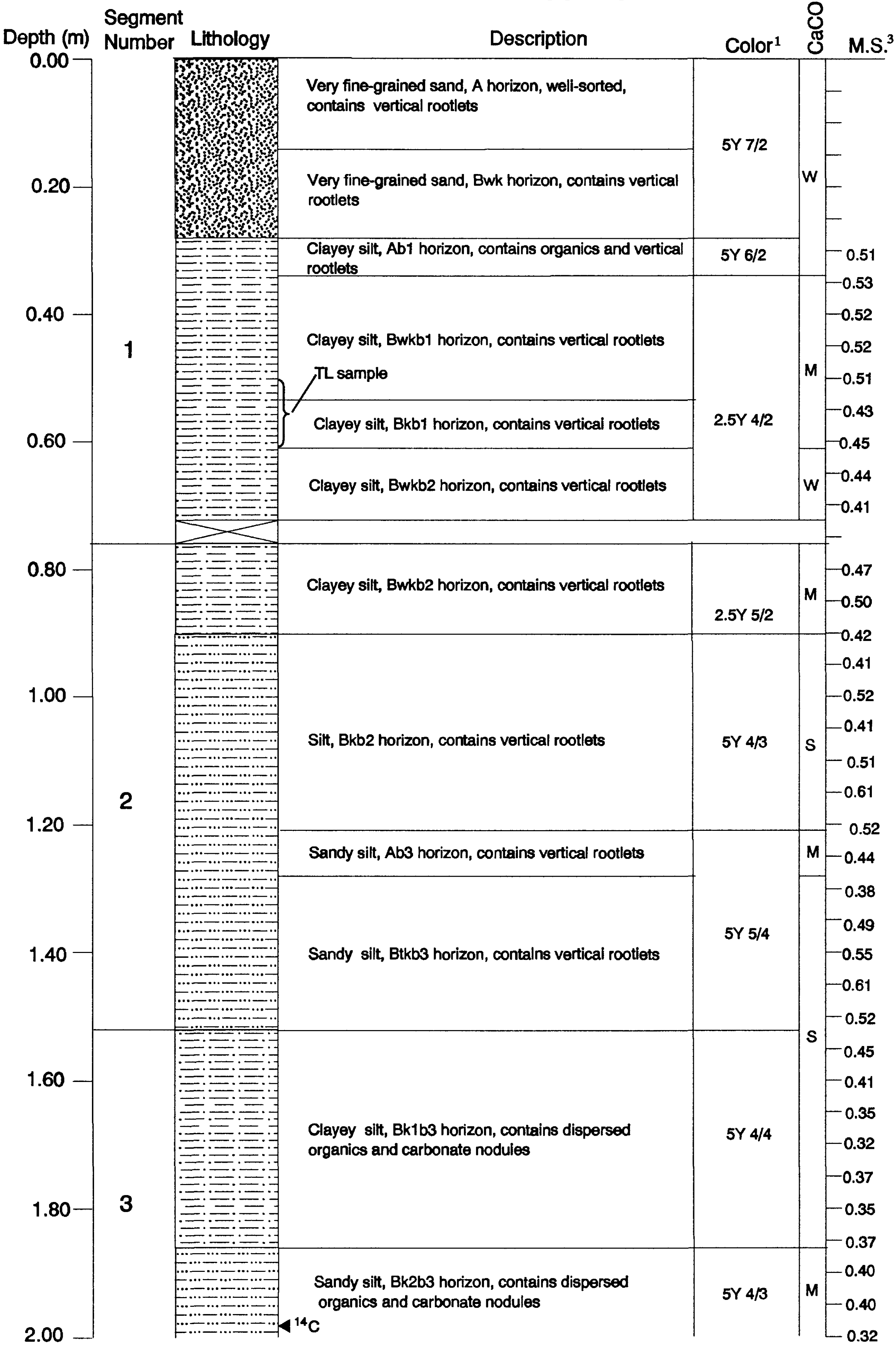
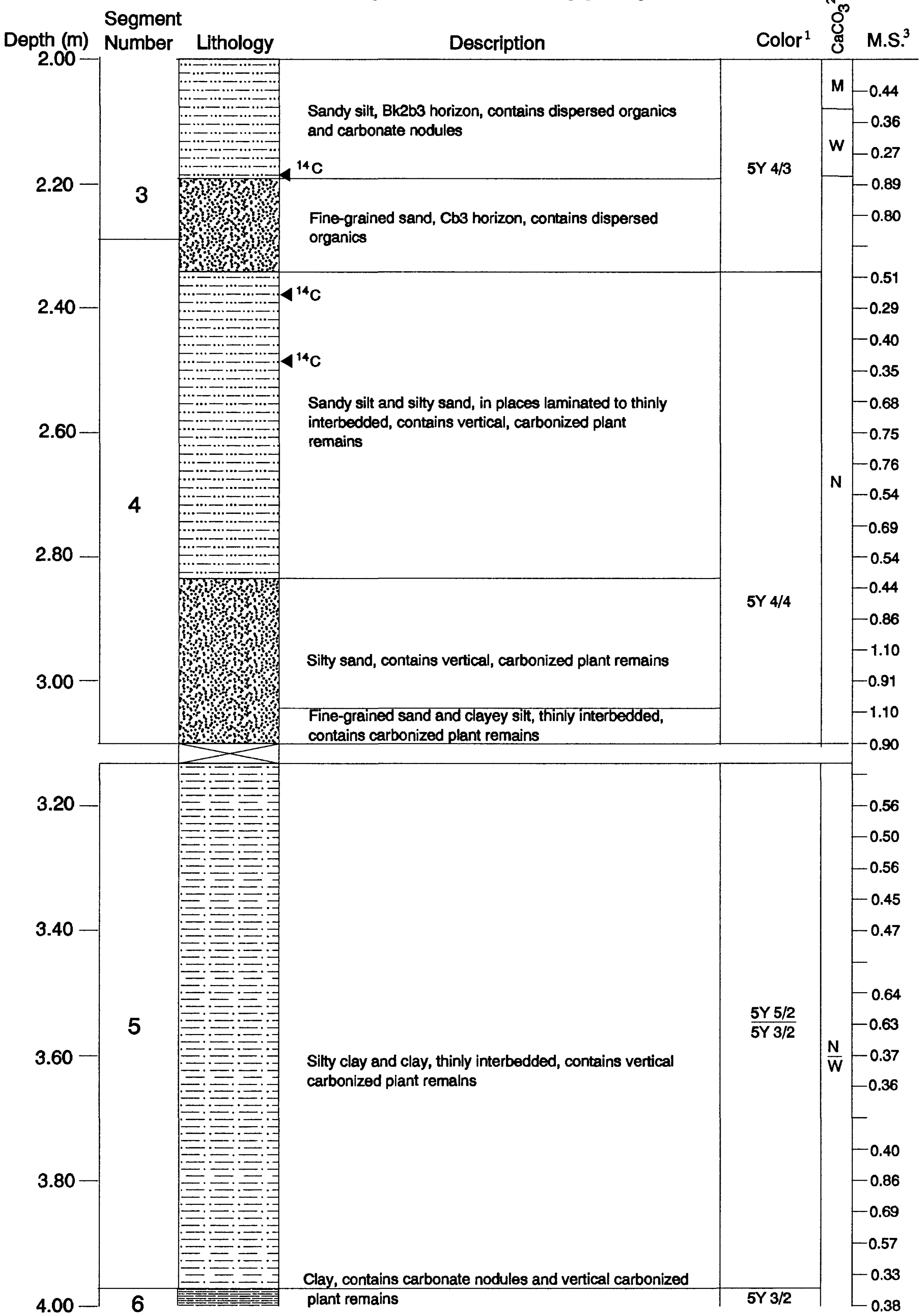


FISH LAKE VALLEY CORE 3



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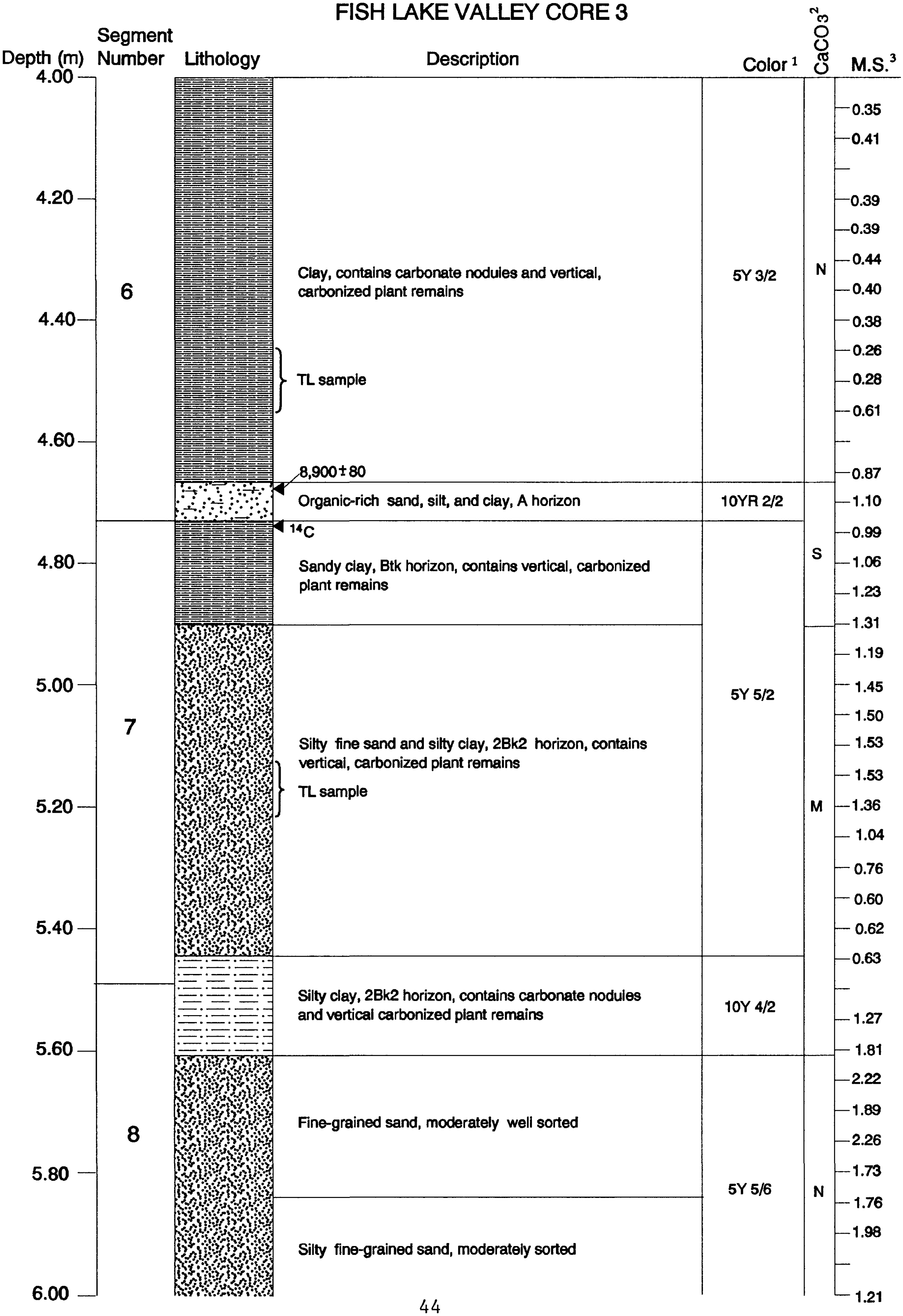

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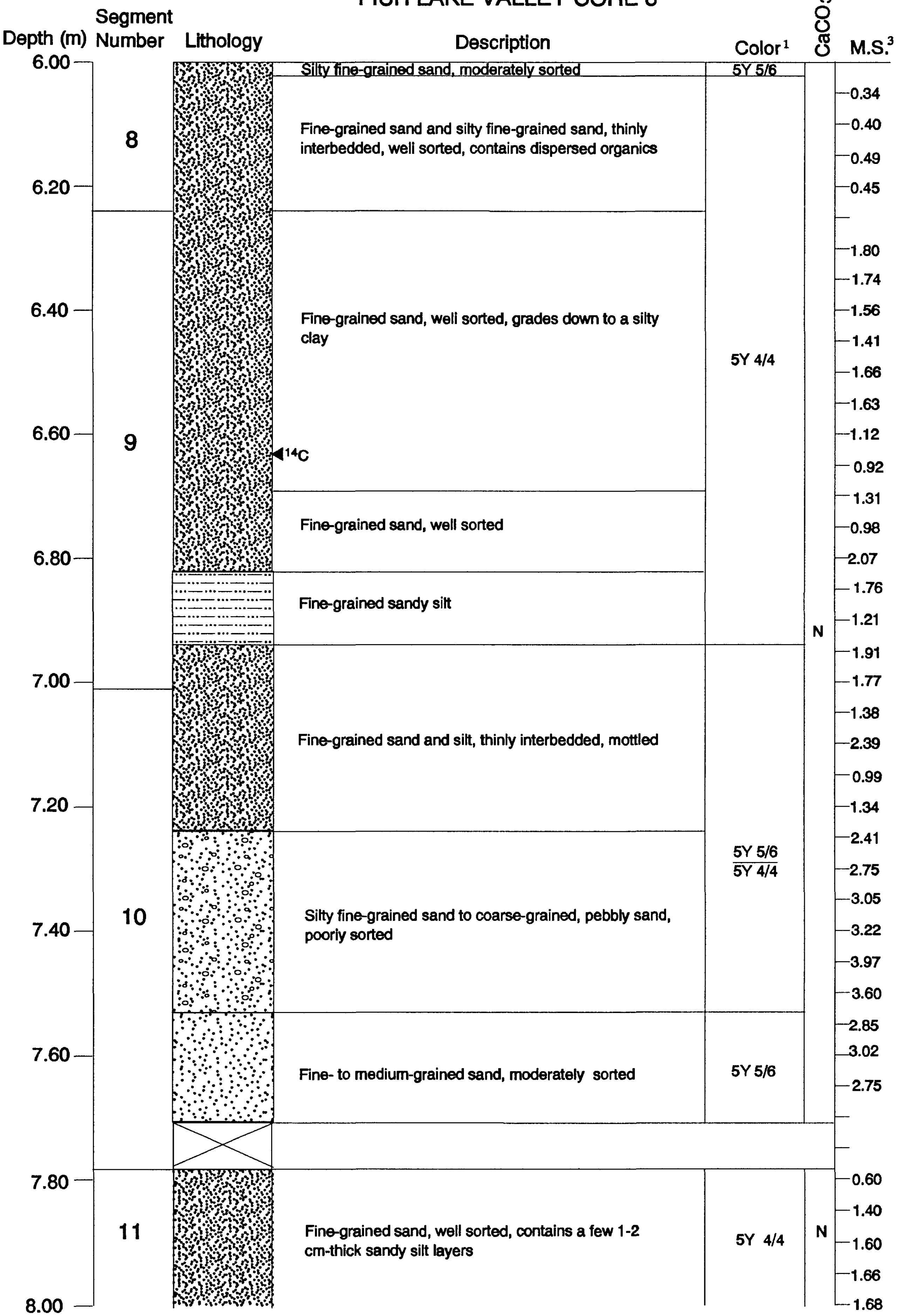
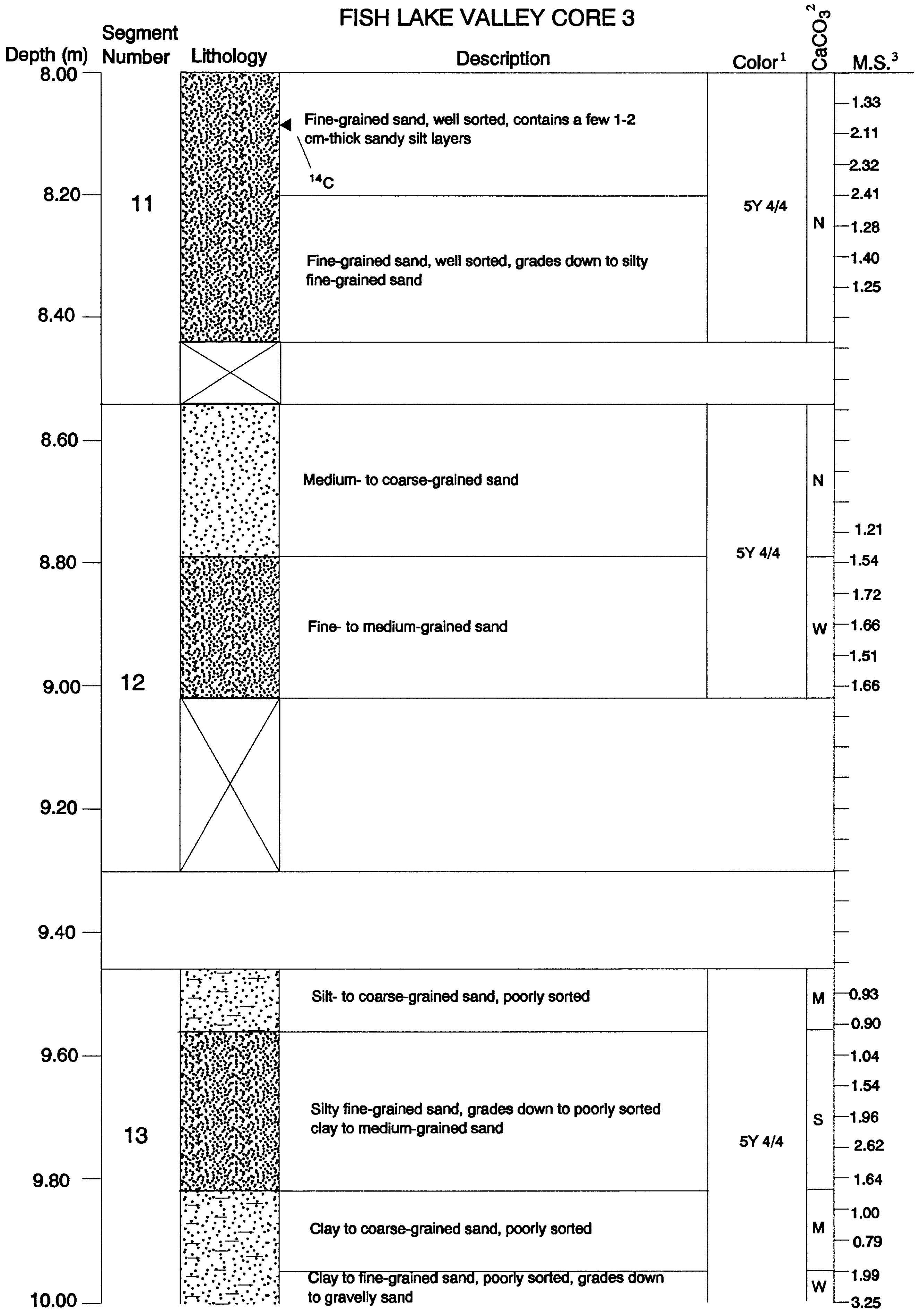
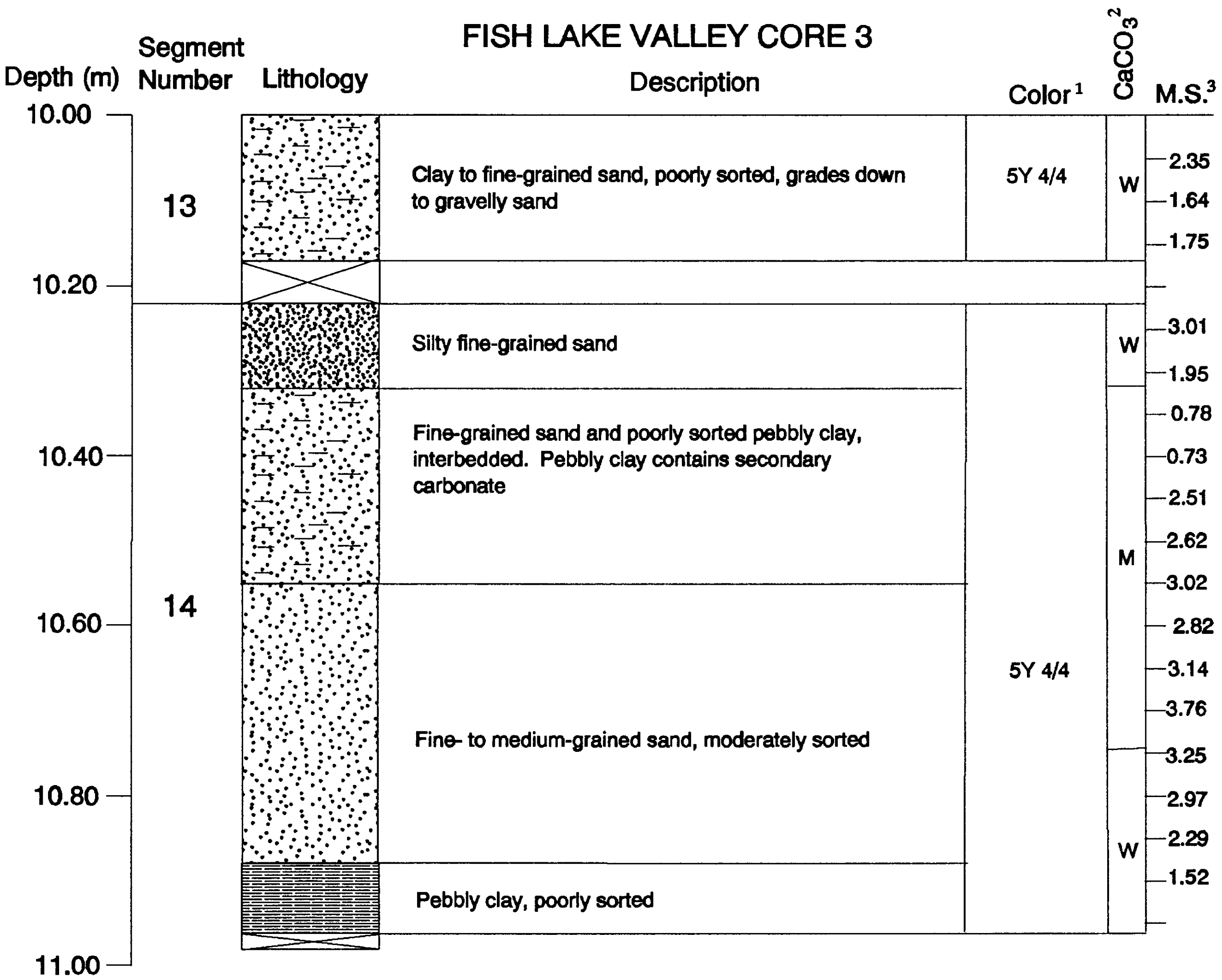


FISH LAKE VALLEY CORE 3



FISH LAKE VALLEY CORE 3



Clay to fine-grained sand, poorly sorted, grades down to gravelly sand

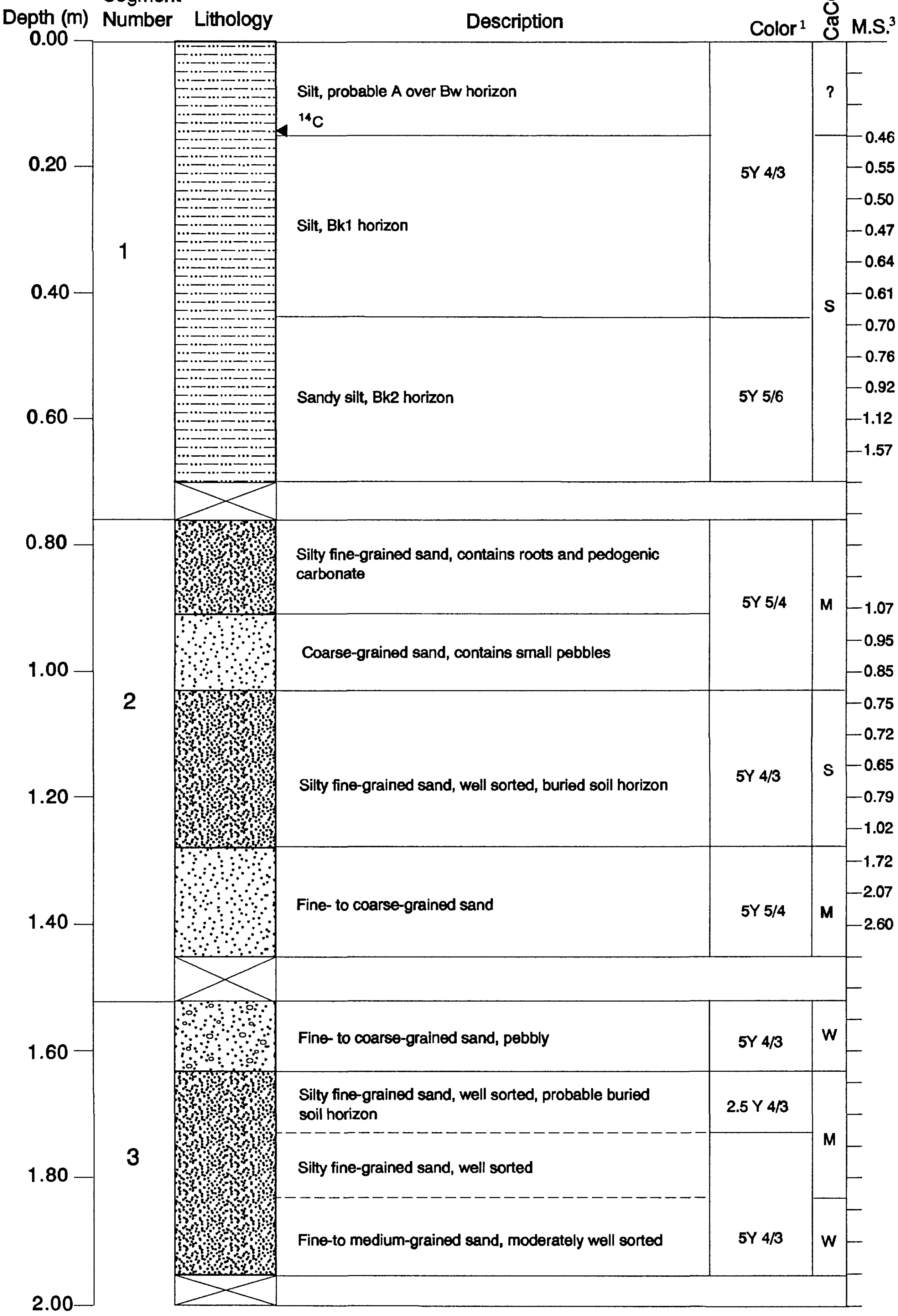
Silty fine-grained sand

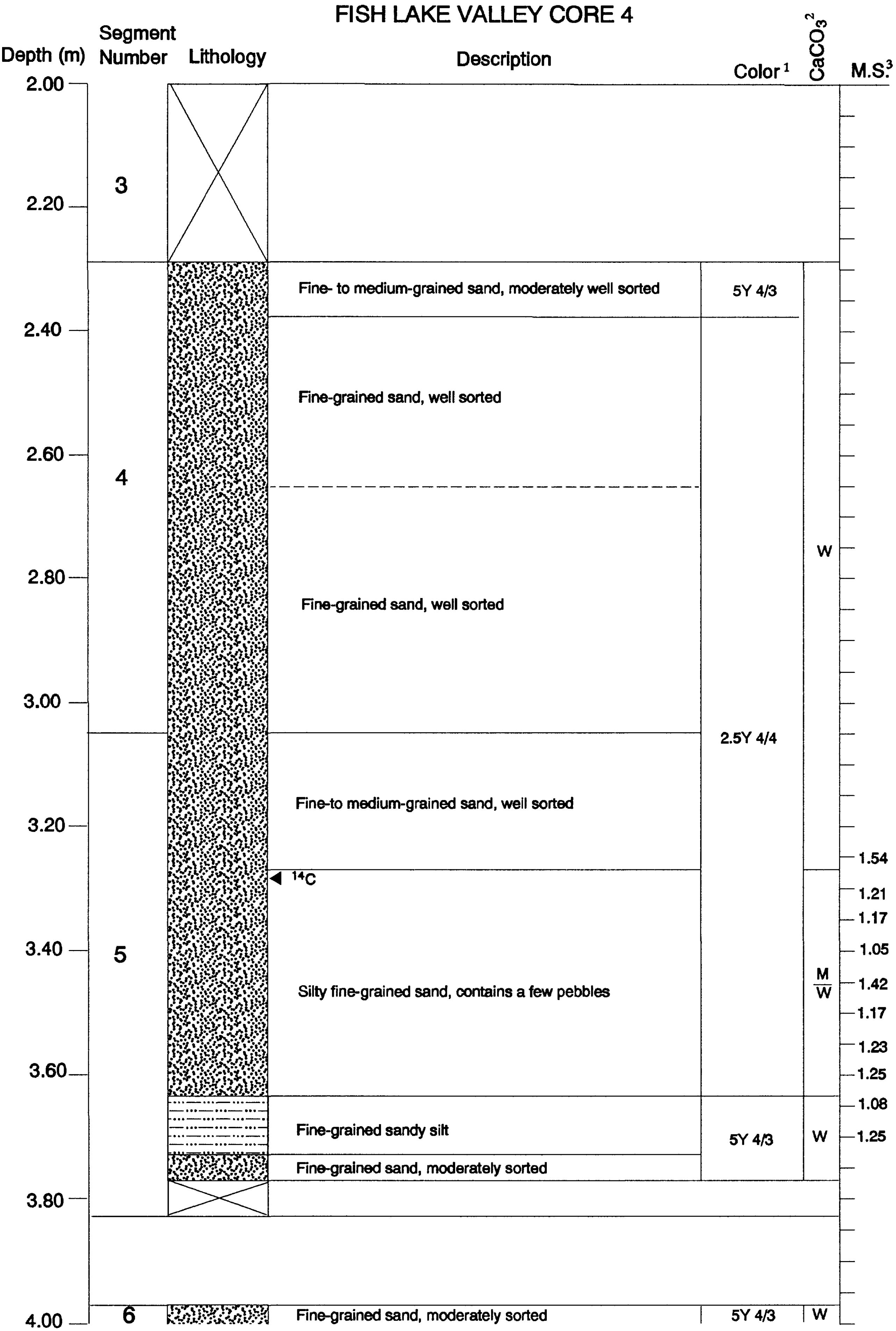
Fine-grained sand and poorly sorted pebbly clay, interbedded. Pebbly clay contains secondary carbonate

Fine- to medium-grained sand, moderately sorted

Pebbly clay, poorly sorted

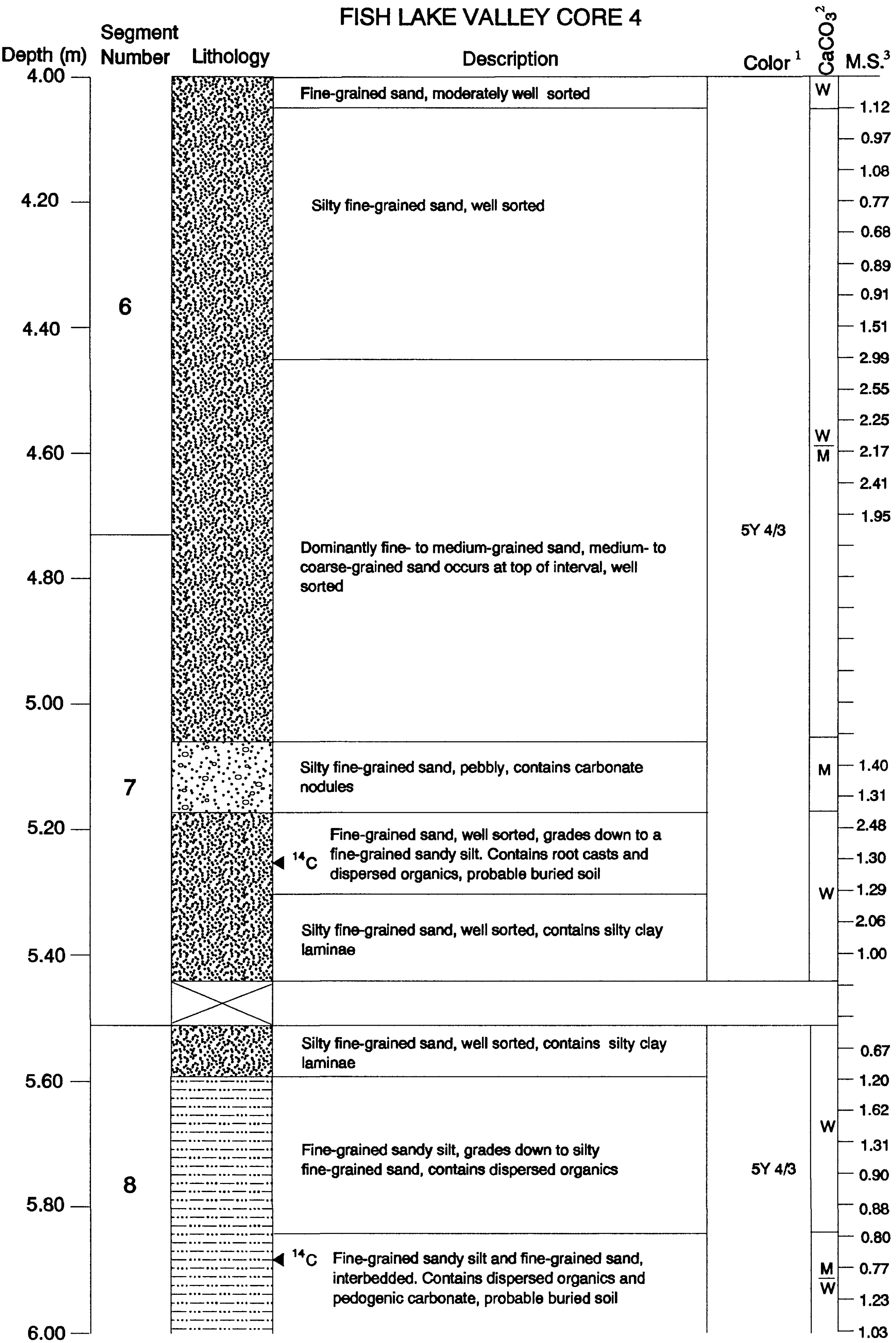
FISH LAKE VALLEY CORE 4





FISH LAKE VALLEY CORE 4

FISH LAKE VALLEY CORE 4



Fine-grained sand, moderately well sorted

Silty fine-grained sand, well sorted

Dominantly fine- to medium-grained sand, medium- to coarse-grained sand occurs at top of interval, well sorted

Silty fine-grained sand, pebbly, contains carbonate nodules

^{14}C Fine-grained sand, well sorted, grades down to a fine-grained sandy silt. Contains root casts and dispersed organics, probable buried soil

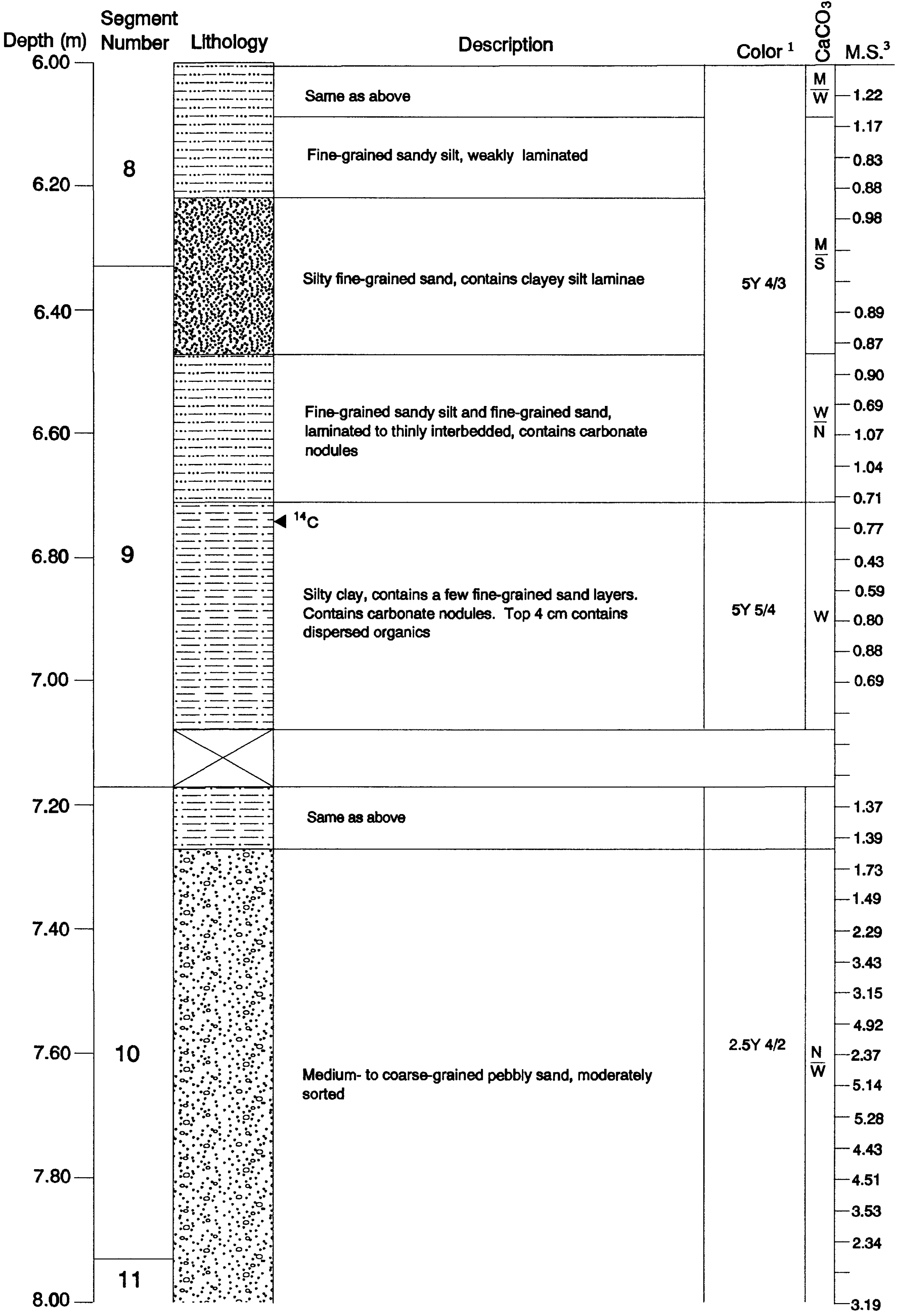
Silty fine-grained sand, well sorted, contains silty clay laminae

Silty fine-grained sand, well sorted, contains silty clay laminae

Fine-grained sandy silt, grades down to silty fine-grained sand, contains dispersed organics

^{14}C Fine-grained sandy silt and fine-grained sand, interbedded. Contains dispersed organics and pedogenic carbonate, probable buried soil

FISH LAKE VALLEY CORE 4



Same as above

Fine-grained sandy silt, weakly laminated

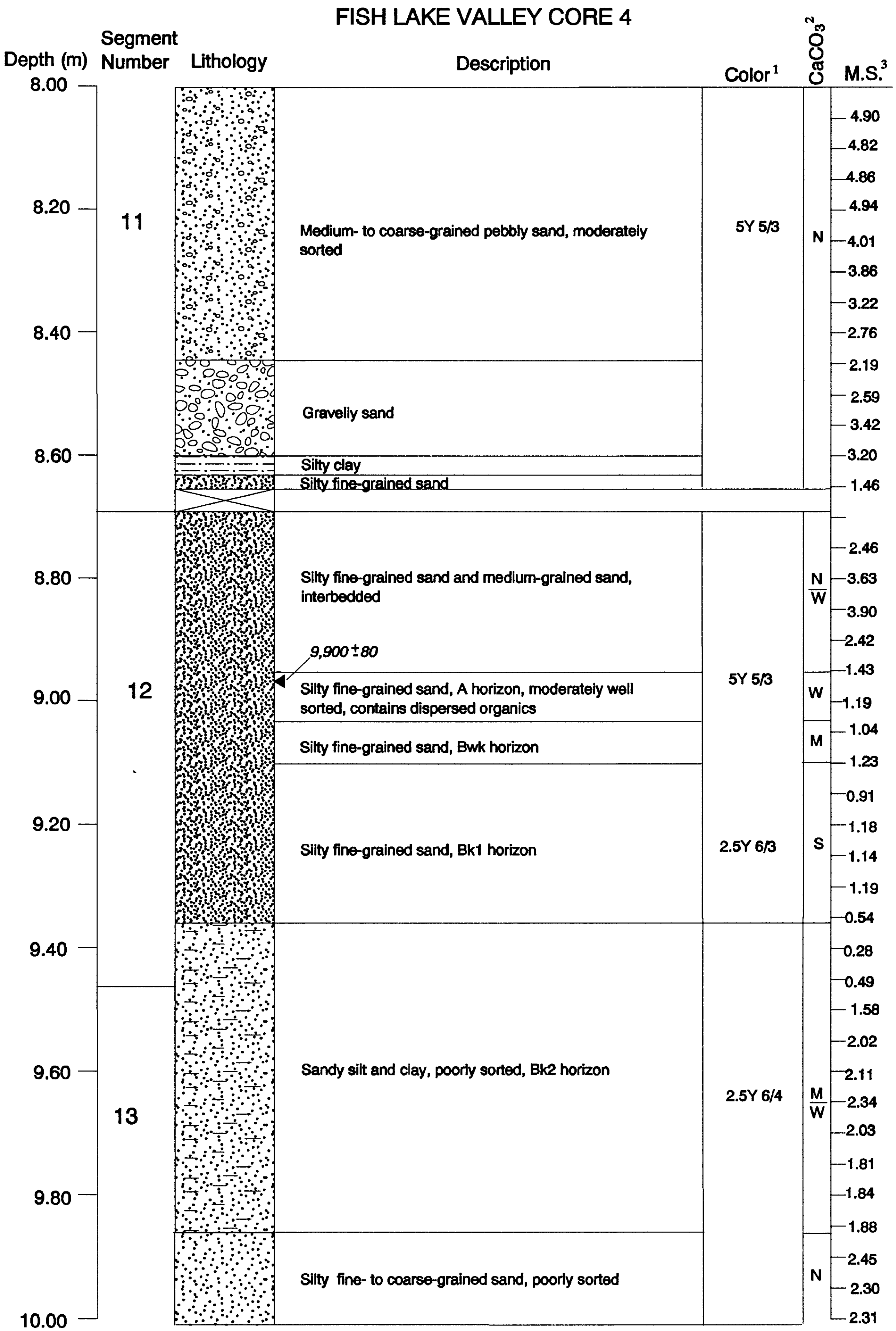
Silty fine-grained sand, contains clayey silt laminae

Fine-grained sandy silt and fine-grained sand, laminated to thinly interbedded, contains carbonate nodules

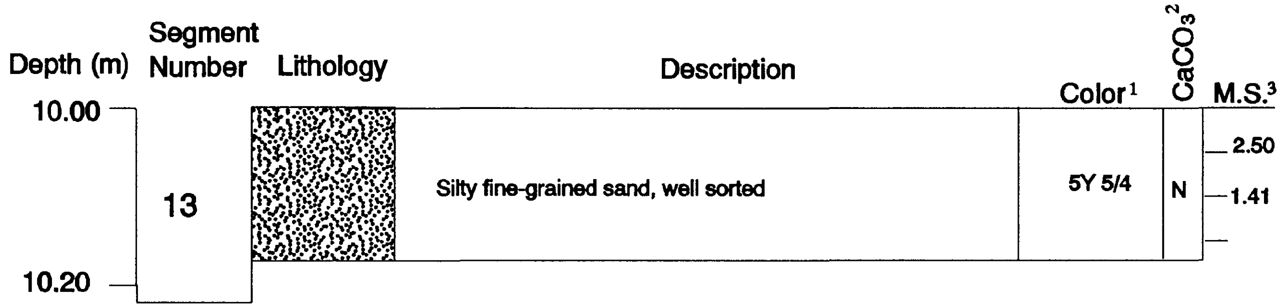
Silty clay, contains a few fine-grained sand layers. Contains carbonate nodules. Top 4 cm contains dispersed organics

Same as above

Medium- to coarse-grained pebbly sand, moderately sorted

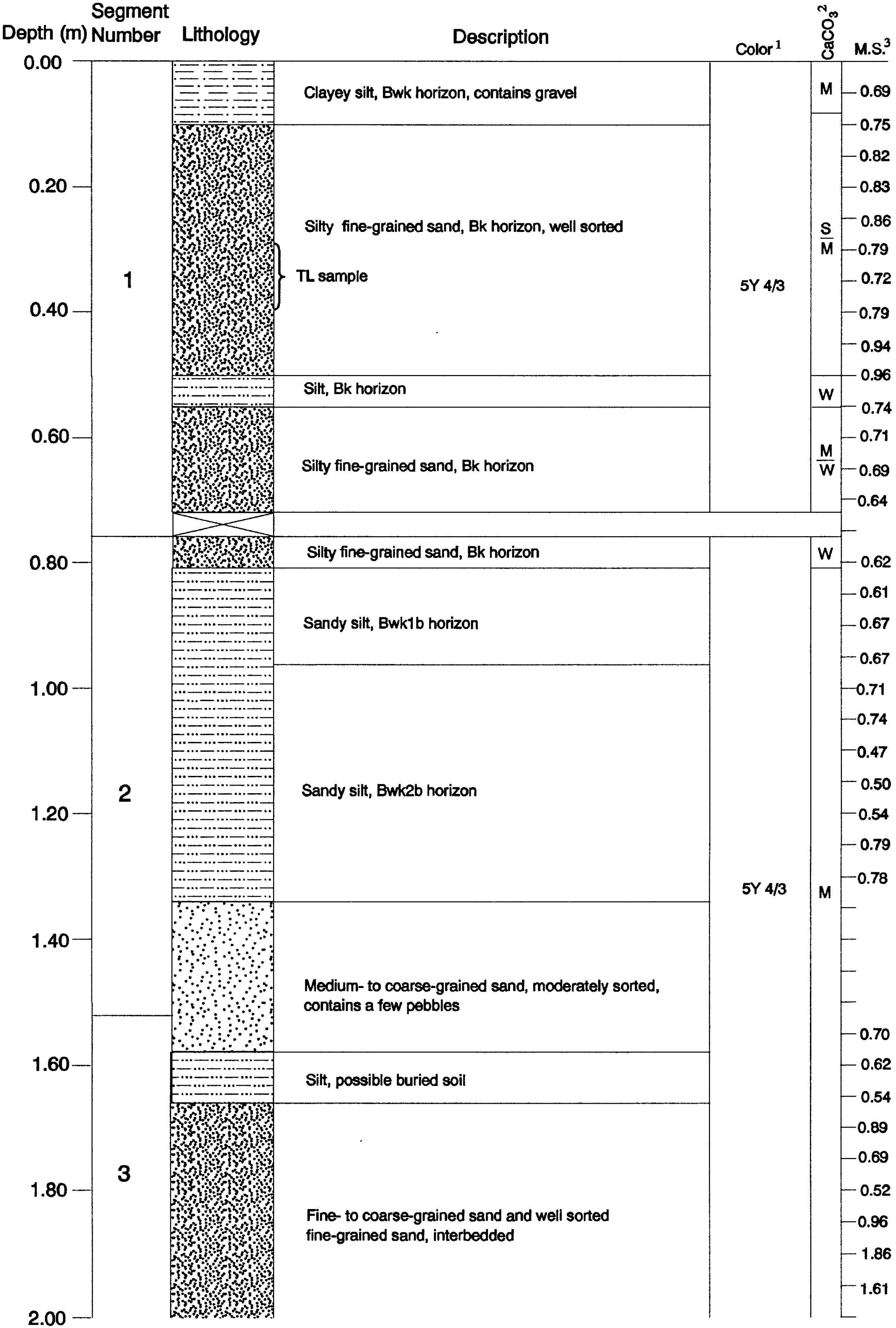

FISH LAKE VALLEY CORE 4
Depth (m)
Segment Number
Lithology
Description
Color¹
CaCO₃²
M.S.³
8.00
8.20
8.40
8.60
8.80
9.00
9.20
9.40
9.60
9.80
10.00
11
12
13
Medium- to coarse-grained pebbly sand, moderately sorted
5Y 5/3
N
Gravelly sand
Silty clay
Silty fine-grained sand
Silty fine-grained sand and medium-grained sand, interbedded
N/W
9,900±80
Silty fine-grained sand, A horizon, moderately well sorted, contains dispersed organics
5Y 5/3
W
Silty fine-grained sand, Bwk horizon
M
Silty fine-grained sand, Bk1 horizon
2.5Y 6/3
S
Sandy silt and clay, poorly sorted, Bk2 horizon
2.5Y 6/4
M/W
Silty fine- to coarse-grained sand, poorly sorted
N
4.90
4.82
4.86
4.94
4.01
3.86
3.22
2.76
2.19
2.59
3.42
3.20
1.46
2.46
3.63
3.90
2.42
1.43
1.19
1.04
1.23
0.91
1.18
1.14
1.19
0.54
0.28
0.49
1.58
2.02
2.11
2.34
2.03
1.81
1.84
1.88
2.45
2.30
2.31

FISH LAKE VALLEY CORE 4

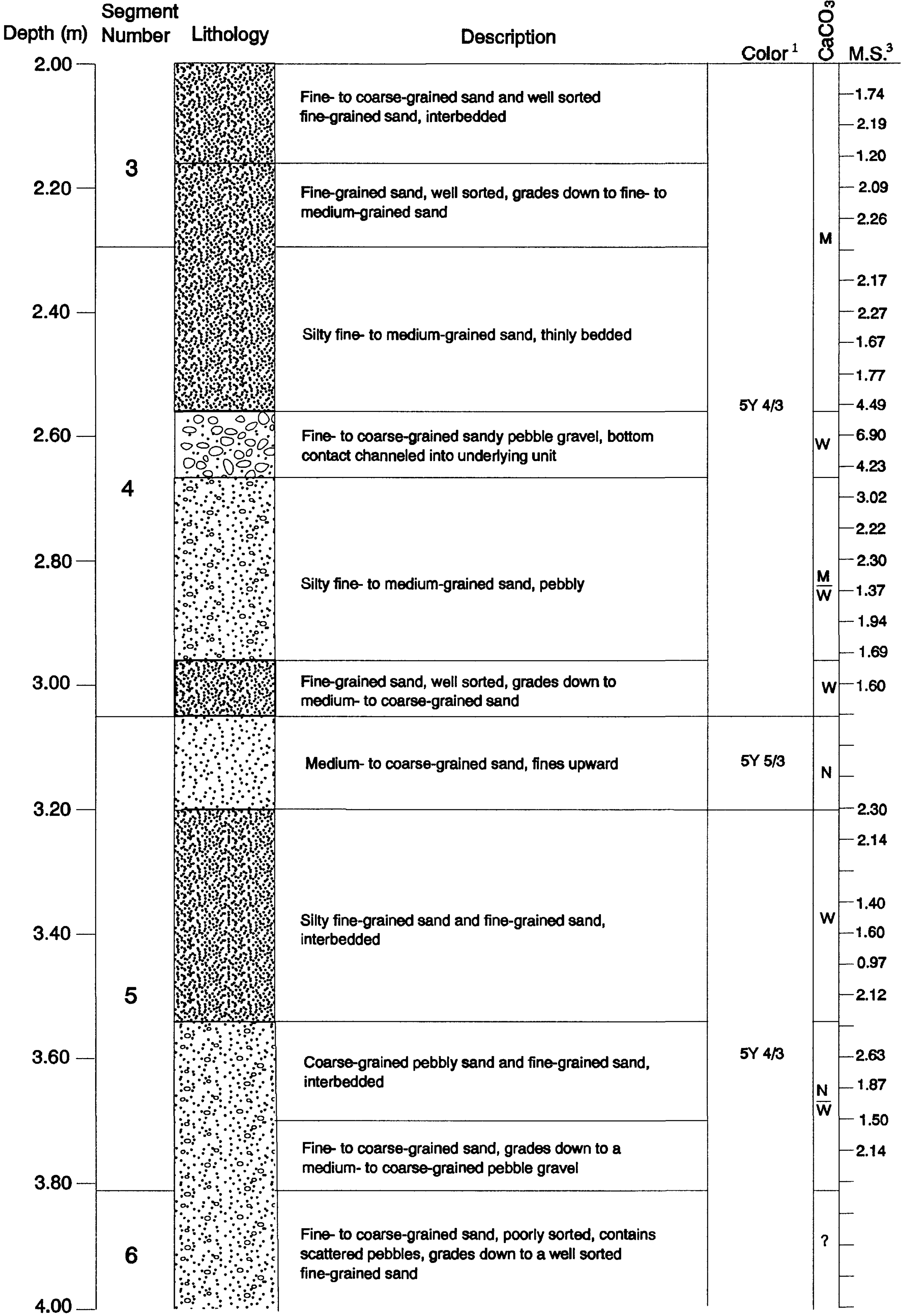


Depth (m)	Segment Number	Lithology	Description	Color[1]	$CaCO_3$[2]	M.S.[3]
10.00 10.20	13		Silty fine-grained sand, well sorted	5Y 5/4	N	2.50 1.41

FISH LAKE VALLEY CORE 5

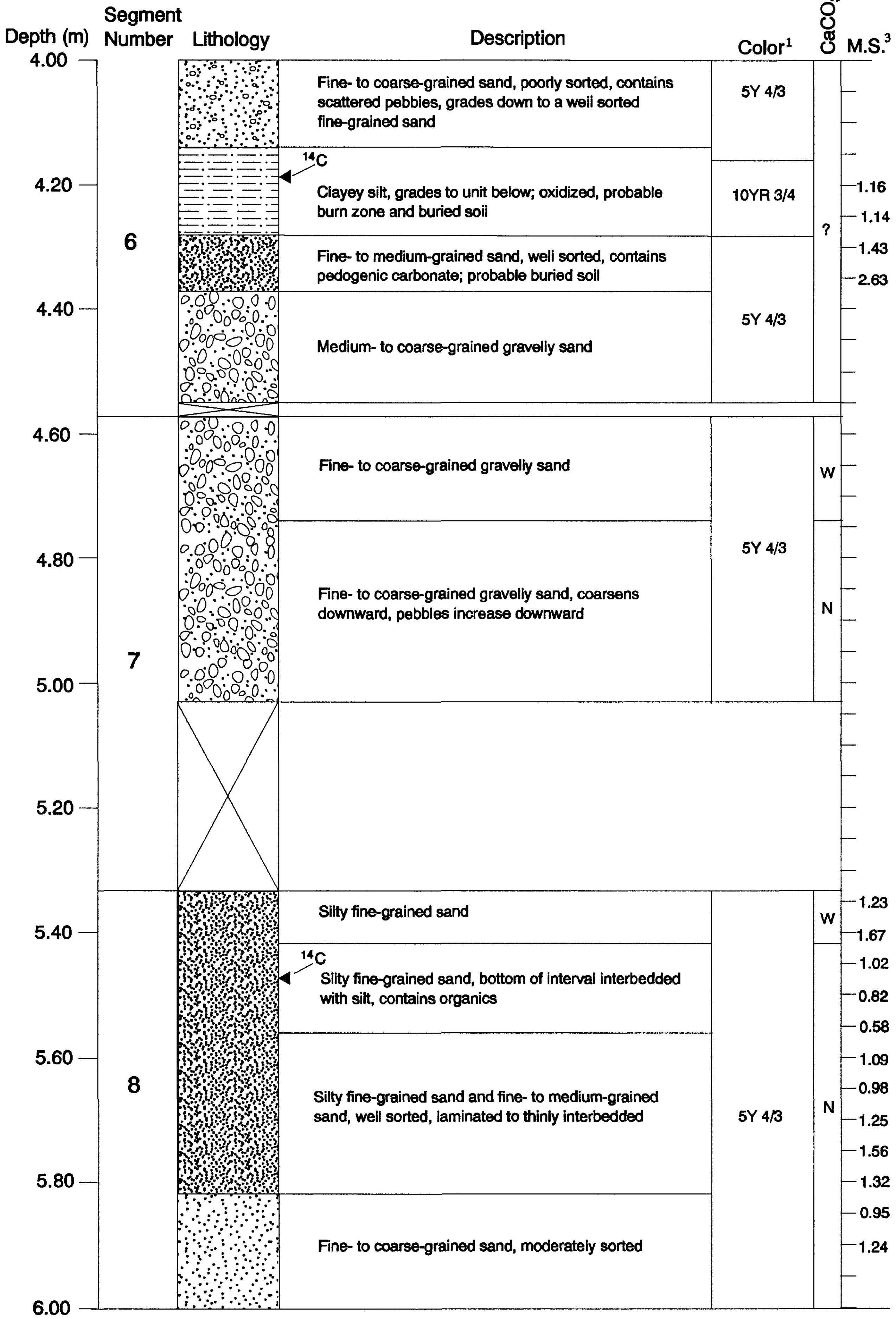


FISH LAKE VALLEY CORE 5



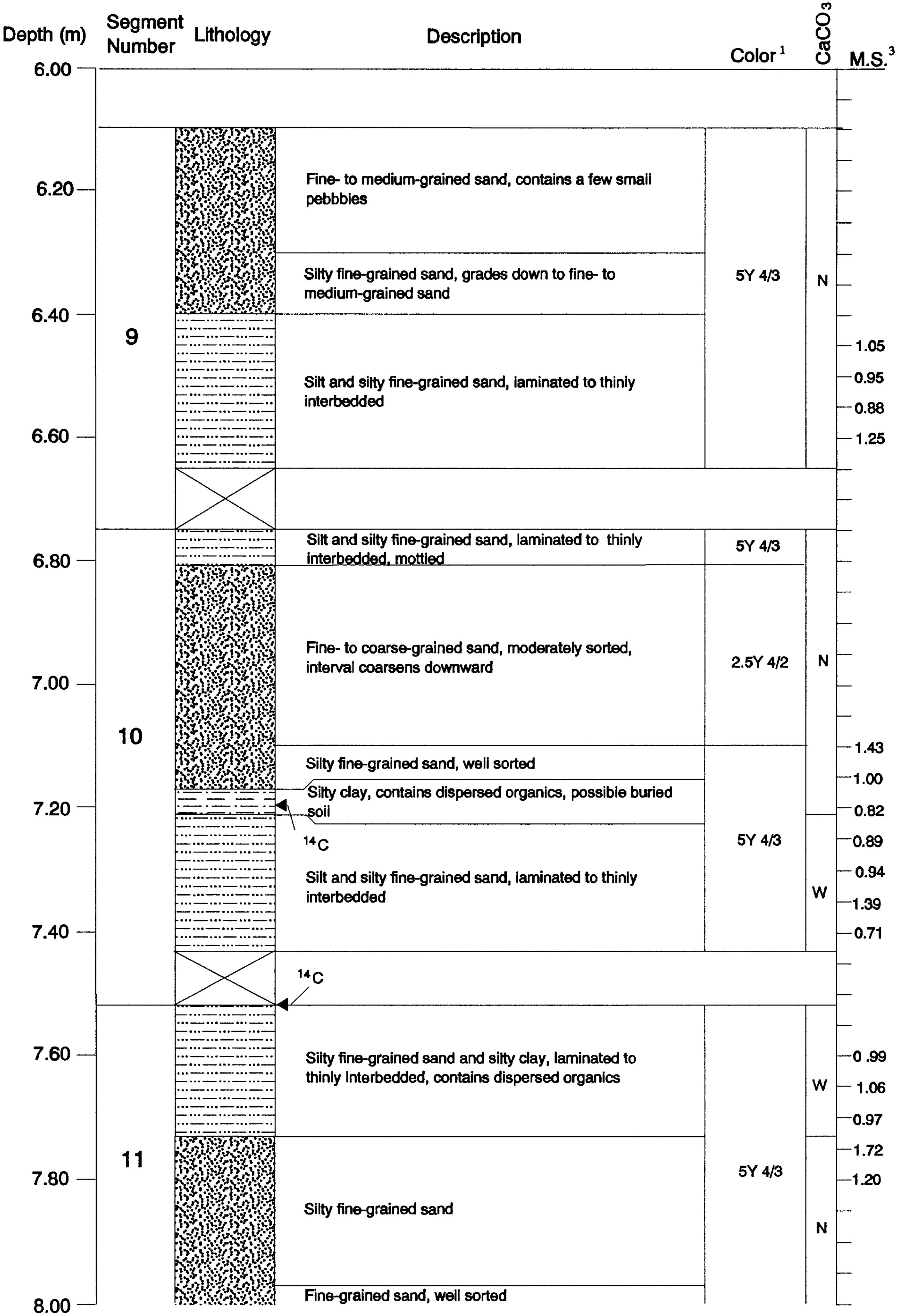
Segment Number	Description	Color[1]	$CaCO_3$[2]
3	Fine- to coarse-grained sand and well sorted fine-grained sand, interbedded	5Y 4/3	M
	Fine-grained sand, well sorted, grades down to fine- to medium-grained sand		
4	Silty fine- to medium-grained sand, thinly bedded		
	Fine- to coarse-grained sandy pebble gravel, bottom contact channeled into underlying unit		W
	Silty fine- to medium-grained sand, pebbly		M/W
	Fine-grained sand, well sorted, grades down to medium- to coarse-grained sand		W
5	Medium- to coarse-grained sand, fines upward	5Y 5/3	N
	Silty fine-grained sand and fine-grained sand, interbedded	5Y 4/3	W
	Coarse-grained pebbly sand and fine-grained sand, interbedded		N/W
	Fine- to coarse-grained sand, grades down to a medium- to coarse-grained pebble gravel		
6	Fine- to coarse-grained sand, poorly sorted, contains scattered pebbles, grades down to a well sorted fine-grained sand		?

FISH LAKE VALLEY CORE 5



Segment Number	Description	Color[1]	$CaCO_3$[2]
6	Fine- to coarse-grained sand, poorly sorted, contains scattered pebbles, grades down to a well sorted fine-grained sand	5Y 4/3	?
	Clayey silt, grades to unit below; oxidized, probable burn zone and buried soil	10YR 3/4	
	Fine- to medium-grained sand, well sorted, contains pedogenic carbonate; probable buried soil	5Y 4/3	
	Medium- to coarse-grained gravelly sand		
7	Fine- to coarse-grained gravelly sand	5Y 4/3	W
	Fine- to coarse-grained gravelly sand, coarsens downward, pebbles increase downward		N
8	Silty fine-grained sand	5Y 4/3	W
	Silty fine-grained sand, bottom of interval interbedded with silt, contains organics		N
	Silty fine-grained sand and fine- to medium-grained sand, well sorted, laminated to thinly interbedded		
	Fine- to coarse-grained sand, moderately sorted		

FISH LAKE VALLEY CORE 5



Fine- to medium-grained sand, contains a few small pebbbles

Silty fine-grained sand, grades down to fine- to medium-grained sand

Silt and silty fine-grained sand, laminated to thinly interbedded

Silt and silty fine-grained sand, laminated to thinly interbedded, mottled

Fine- to coarse-grained sand, moderately sorted, interval coarsens downward

Silty fine-grained sand, well sorted

Silty clay, contains dispersed organics, possible buried soil

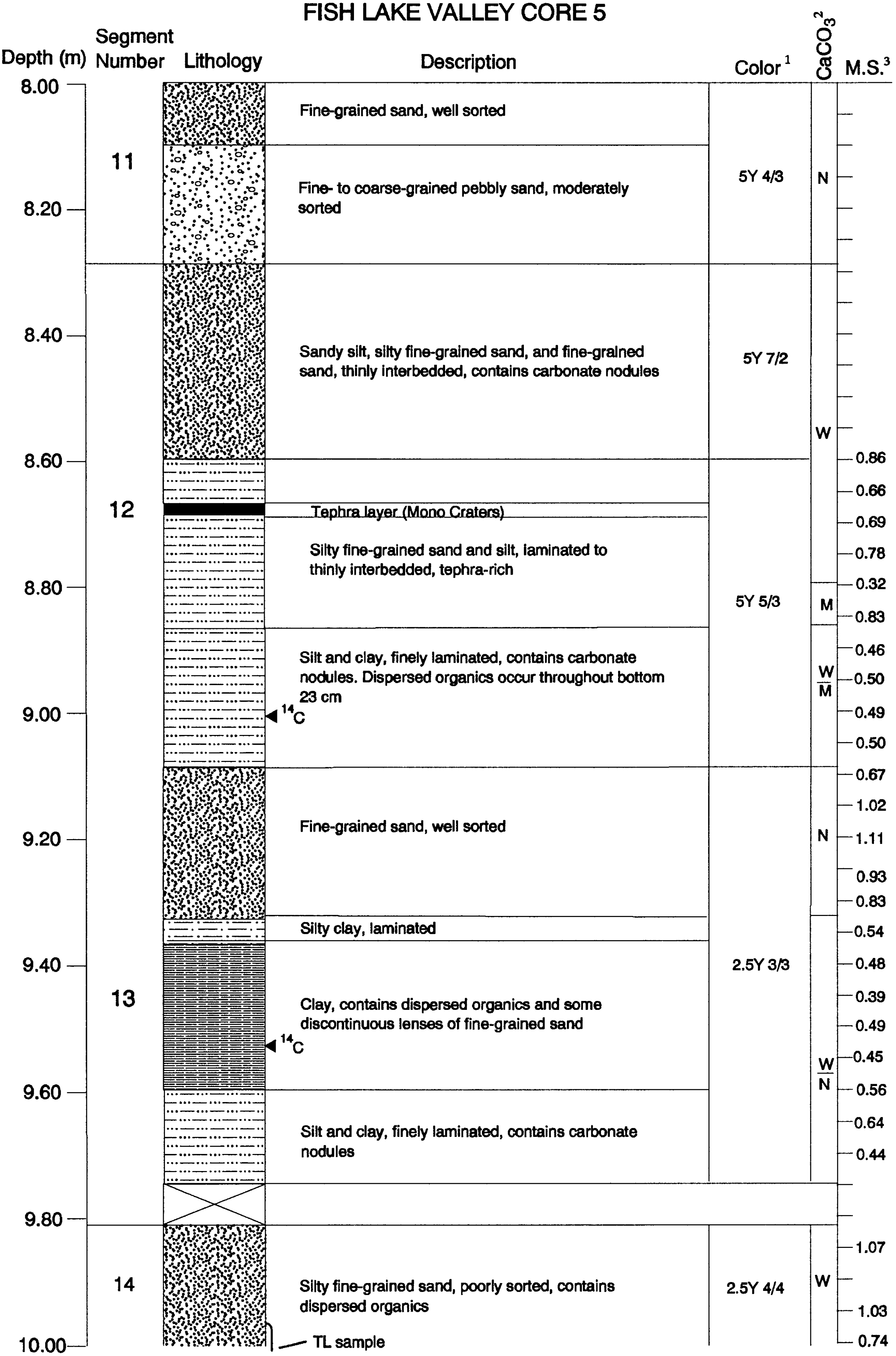
Silt and silty fine-grained sand, laminated to thinly interbedded

Silty fine-grained sand and silty clay, laminated to thinly Interbedded, contains dispersed organics

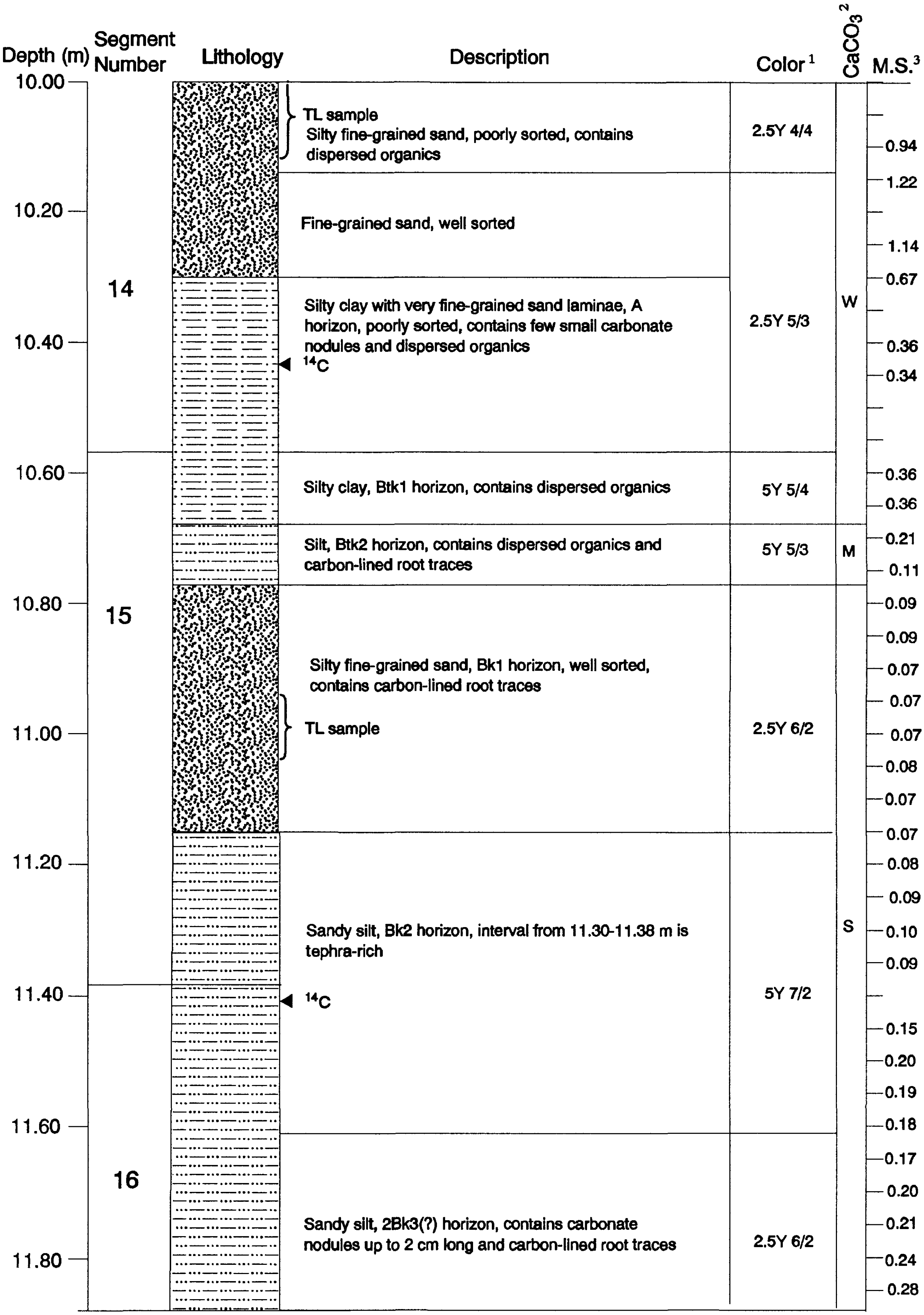
Silty fine-grained sand

Fine-grained sand, well sorted

FISH LAKE VALLEY CORE 5

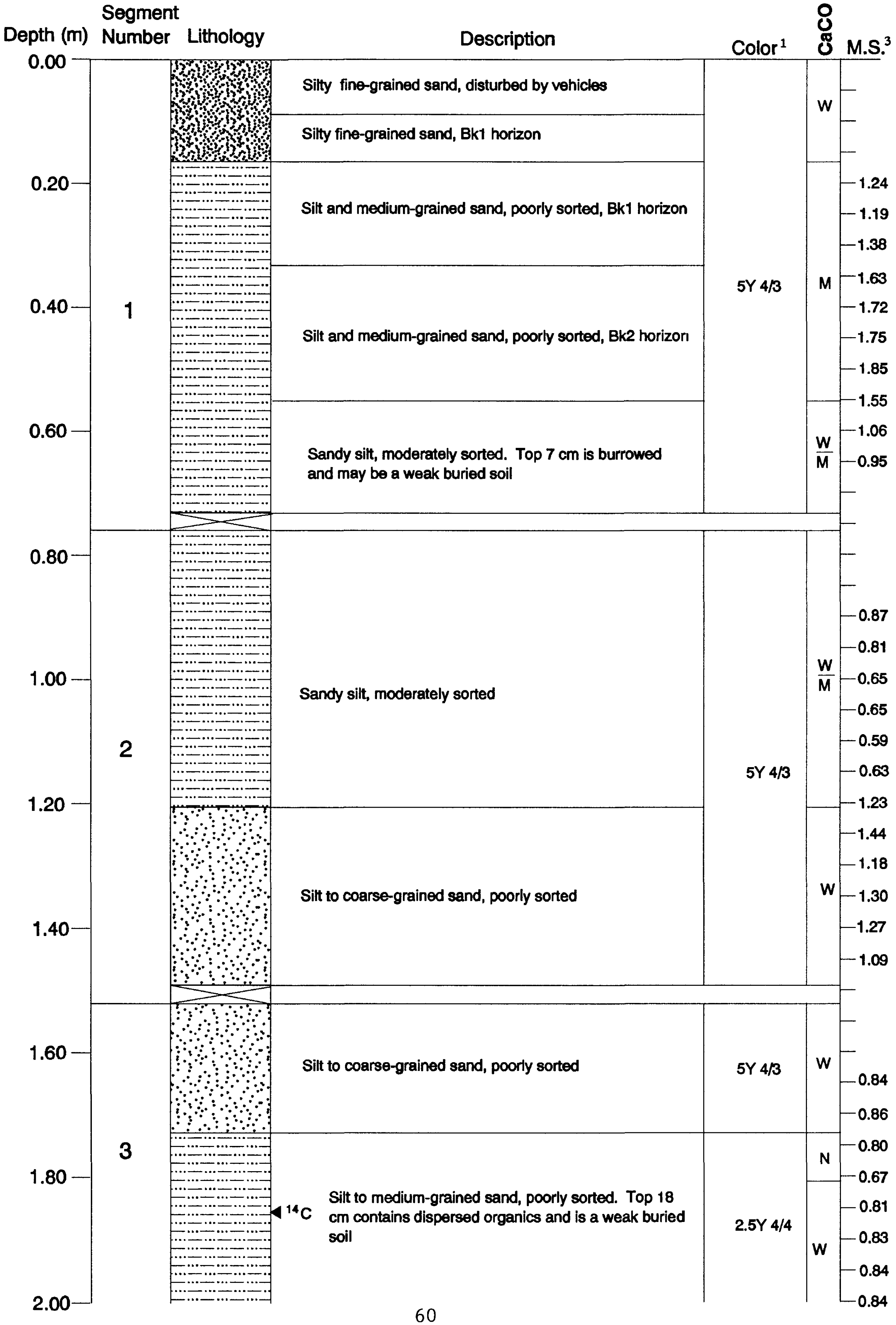


FISH LAKE VALLEY CORE 5



Description	Color[1]	$CaCO_3$[2]
TL sample Silty fine-grained sand, poorly sorted, contains dispersed organics	2.5Y 4/4	W
Fine-grained sand, well sorted	2.5Y 5/3	
Silty clay with very fine-grained sand laminae, A horizon, poorly sorted, contains few small carbonate nodules and dispersed organics ^{14}C		
Silty clay, Btk1 horizon, contains dispersed organics	5Y 5/4	
Silt, Btk2 horizon, contains dispersed organics and carbon-lined root traces	5Y 5/3	M
Silty fine-grained sand, Bk1 horizon, well sorted, contains carbon-lined root traces TL sample	2.5Y 6/2	S
Sandy silt, Bk2 horizon, interval from 11.30-11.38 m is tephra-rich ^{14}C	5Y 7/2	
Sandy silt, 2Bk3(?) horizon, contains carbonate nodules up to 2 cm long and carbon-lined root traces	2.5Y 6/2	

FISH LAKE VALLEY CORE 6



Silty fine-grained sand, disturbed by vehicles

Silty fine-grained sand, Bk1 horizon

Silt and medium-grained sand, poorly sorted, Bk1 horizon

Silt and medium-grained sand, poorly sorted, Bk2 horizon

Sandy silt, moderately sorted. Top 7 cm is burrowed and may be a weak buried soil

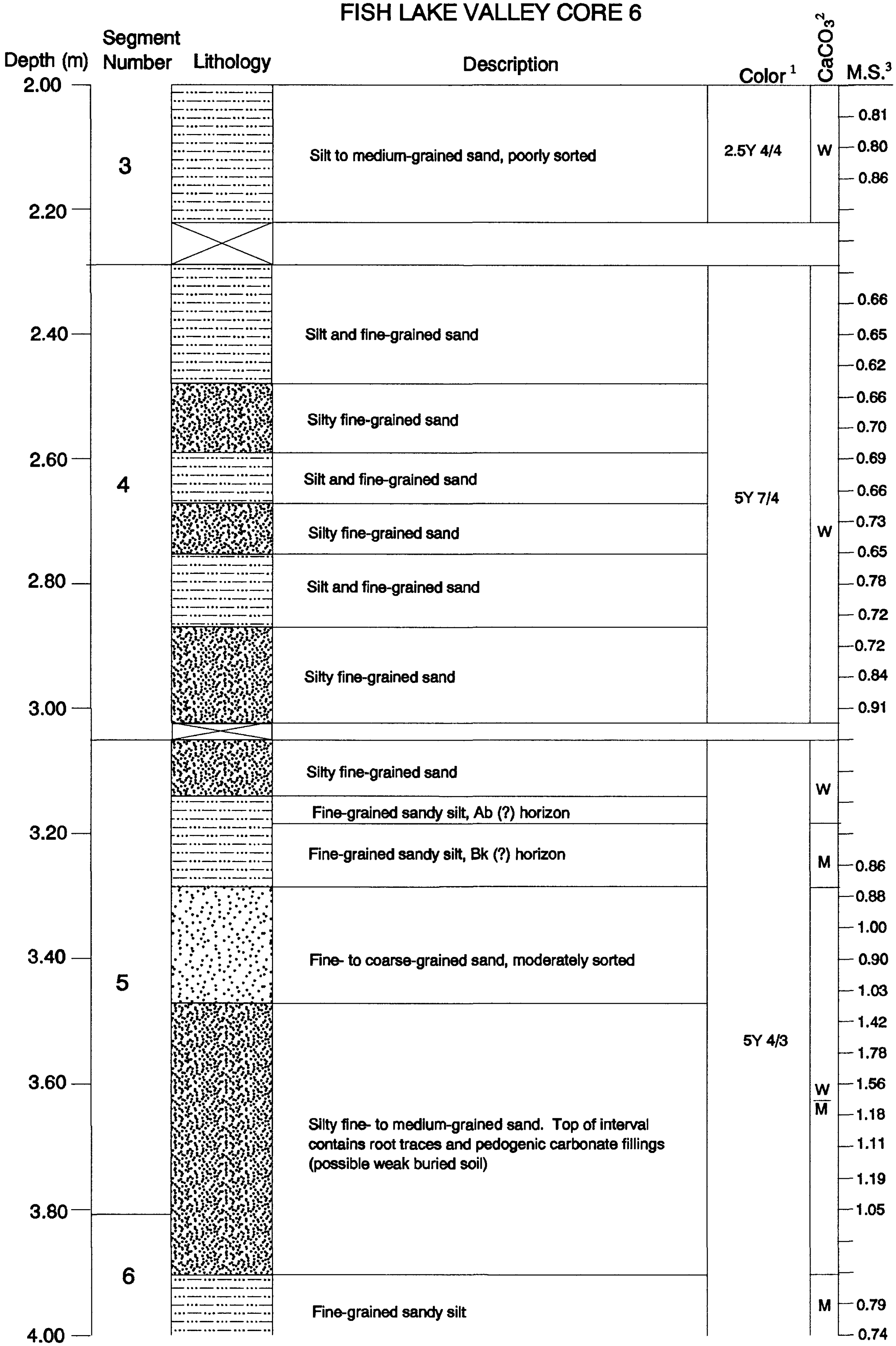
Sandy silt, moderately sorted

Silt to coarse-grained sand, poorly sorted

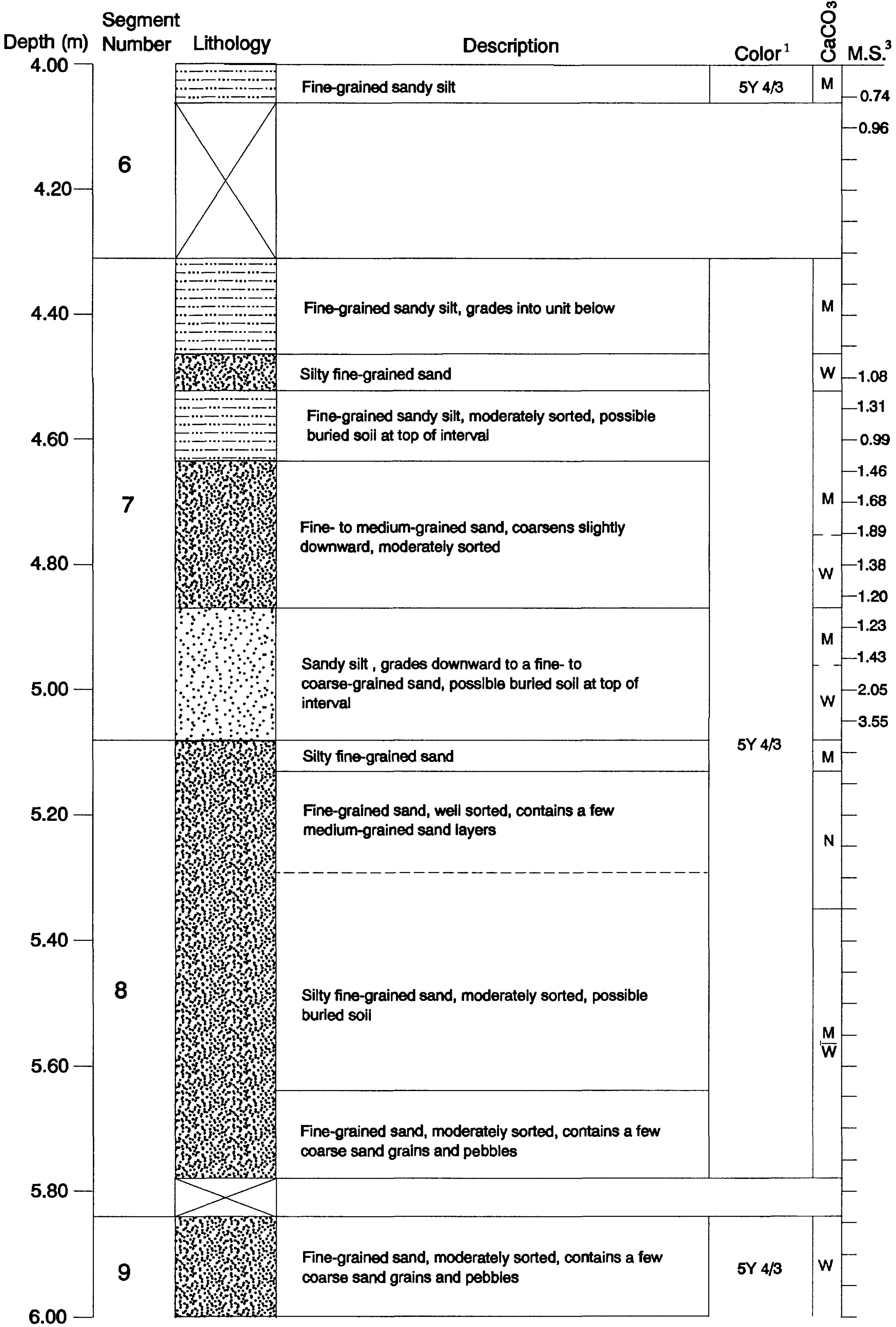
Silt to coarse-grained sand, poorly sorted

Silt to medium-grained sand, poorly sorted. Top 18 cm contains dispersed organics and is a weak buried soil

FISH LAKE VALLEY CORE 6

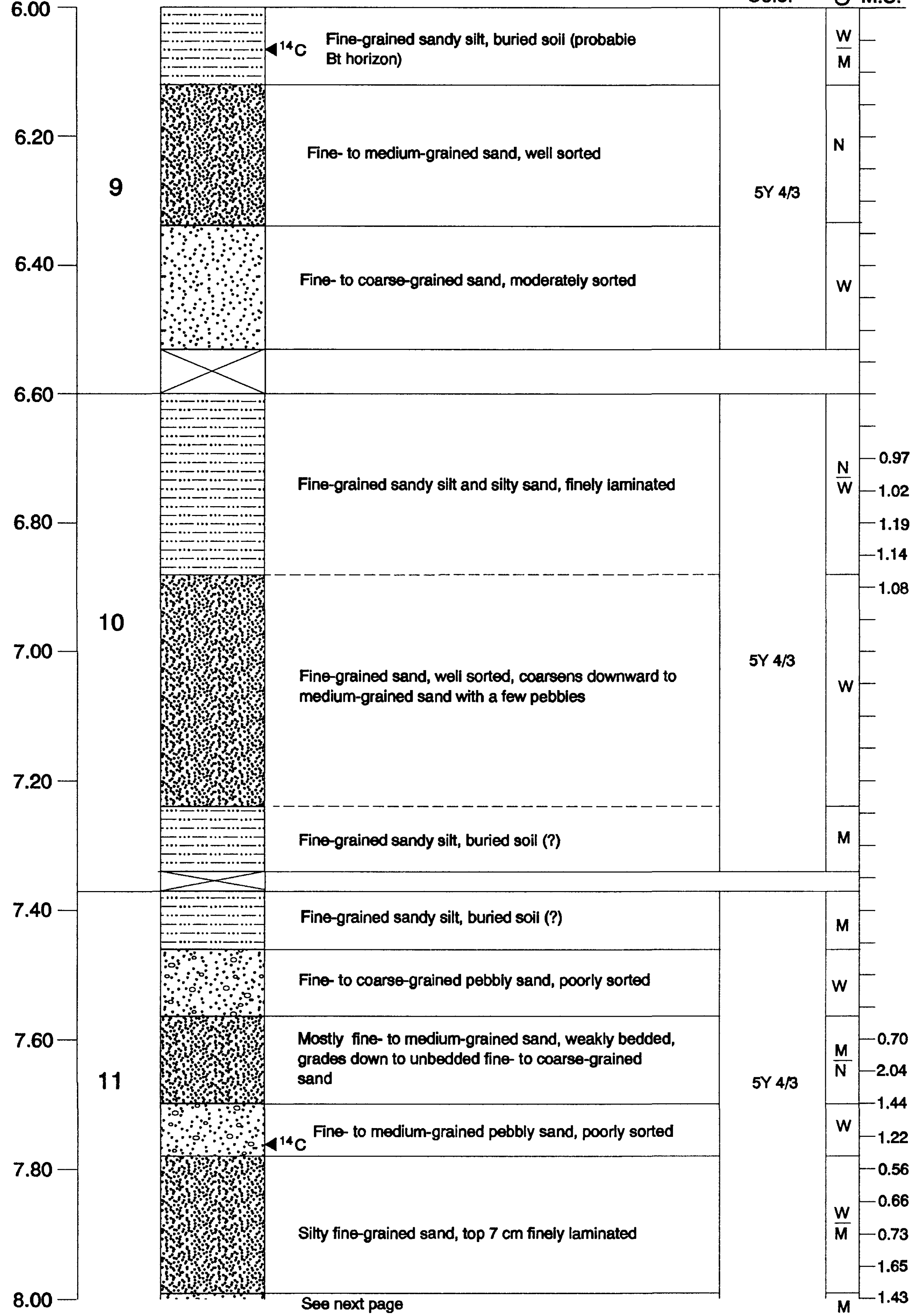


FISH LAKE VALLEY CORE 6



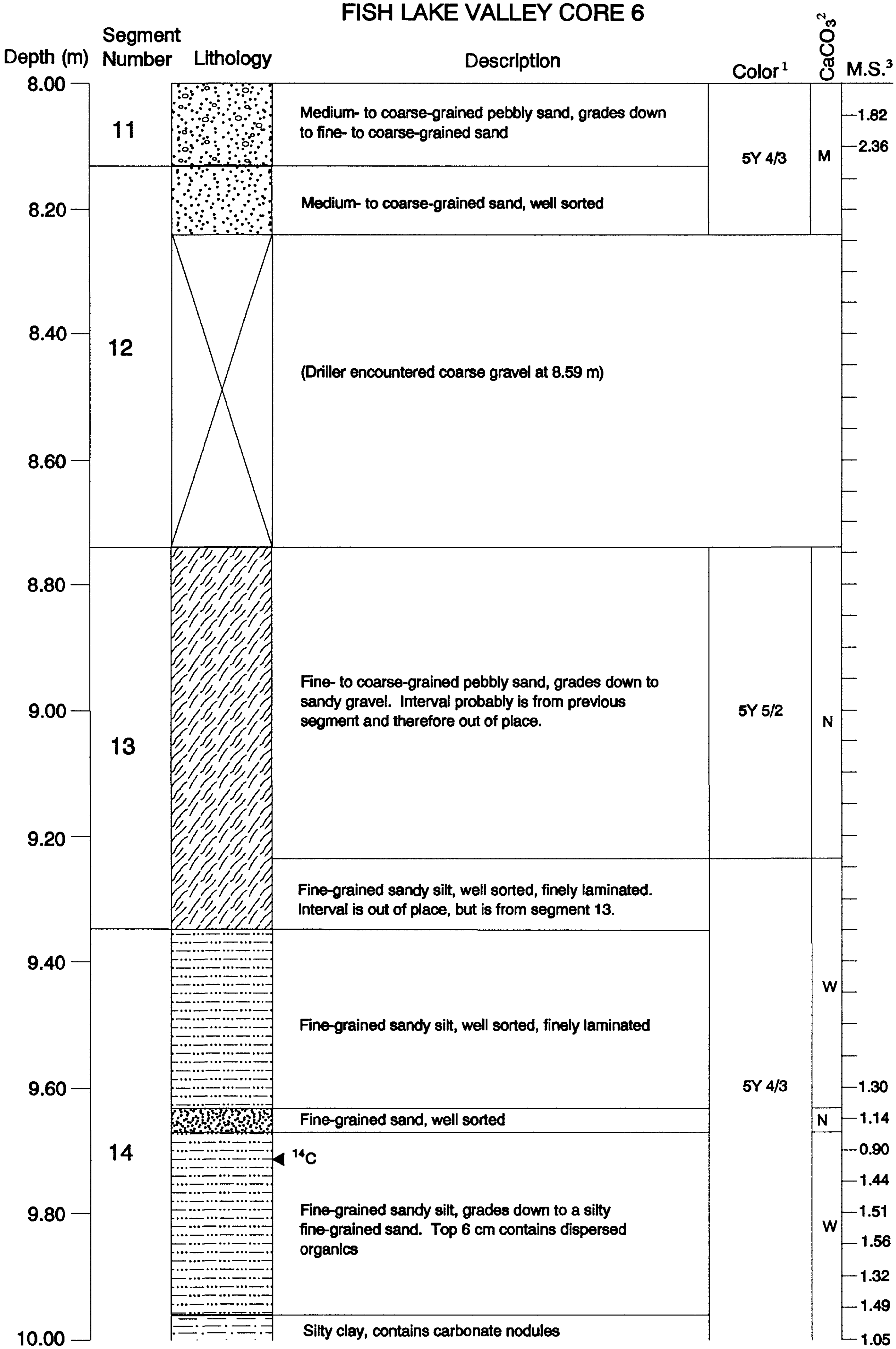
Segment Number	Description	Color¹	$CaCO_3$²
6	Fine-grained sandy silt	5Y 4/3	M
7	Fine-grained sandy silt, grades into unit below	5Y 4/3	M
	Silty fine-grained sand		W
	Fine-grained sandy silt, moderately sorted, possible buried soil at top of interval		
	Fine- to medium-grained sand, coarsens slightly downward, moderately sorted		M W
	Sandy silt , grades downward to a fine- to coarse-grained sand, possible buried soil at top of interval		M W
8	Silty fine-grained sand		M
	Fine-grained sand, well sorted, contains a few medium-grained sand layers		N
	Silty fine-grained sand, moderately sorted, possible buried soil		M/W
	Fine-grained sand, moderately sorted, contains a few coarse sand grains and pebbles		
9	Fine-grained sand, moderately sorted, contains a few coarse sand grains and pebbles	5Y 4/3	W

FISH LAKE VALLEY CORE 6



Segment Number	Description	Color[1]	CaCO$_3$[2]
9	Fine-grained sandy silt, buried soil (probable Bt horizon)	5Y 4/3	W/M
	Fine- to medium-grained sand, well sorted		N
	Fine- to coarse-grained sand, moderately sorted		W
10	Fine-grained sandy silt and silty sand, finely laminated	5Y 4/3	N/W
	Fine-grained sand, well sorted, coarsens downward to medium-grained sand with a few pebbles		W
	Fine-grained sandy silt, buried soil (?)		M
11	Fine-grained sandy silt, buried soil (?)	5Y 4/3	M
	Fine- to coarse-grained pebbly sand, poorly sorted		W
	Mostly fine- to medium-grained sand, weakly bedded, grades down to unbedded fine- to coarse-grained sand		M/N
	Fine- to medium-grained pebbly sand, poorly sorted		W
	Silty fine-grained sand, top 7 cm finely laminated		W/M
	See next page		M

FISH LAKE VALLEY CORE 6



Medium- to coarse-grained pebbly sand, grades down to fine- to coarse-grained sand

Medium- to coarse-grained sand, well sorted

(Driller encountered coarse gravel at 8.59 m)

Fine- to coarse-grained pebbly sand, grades down to sandy gravel. Interval probably is from previous segment and therefore out of place.

Fine-grained sandy silt, well sorted, finely laminated. Interval is out of place, but is from segment 13.

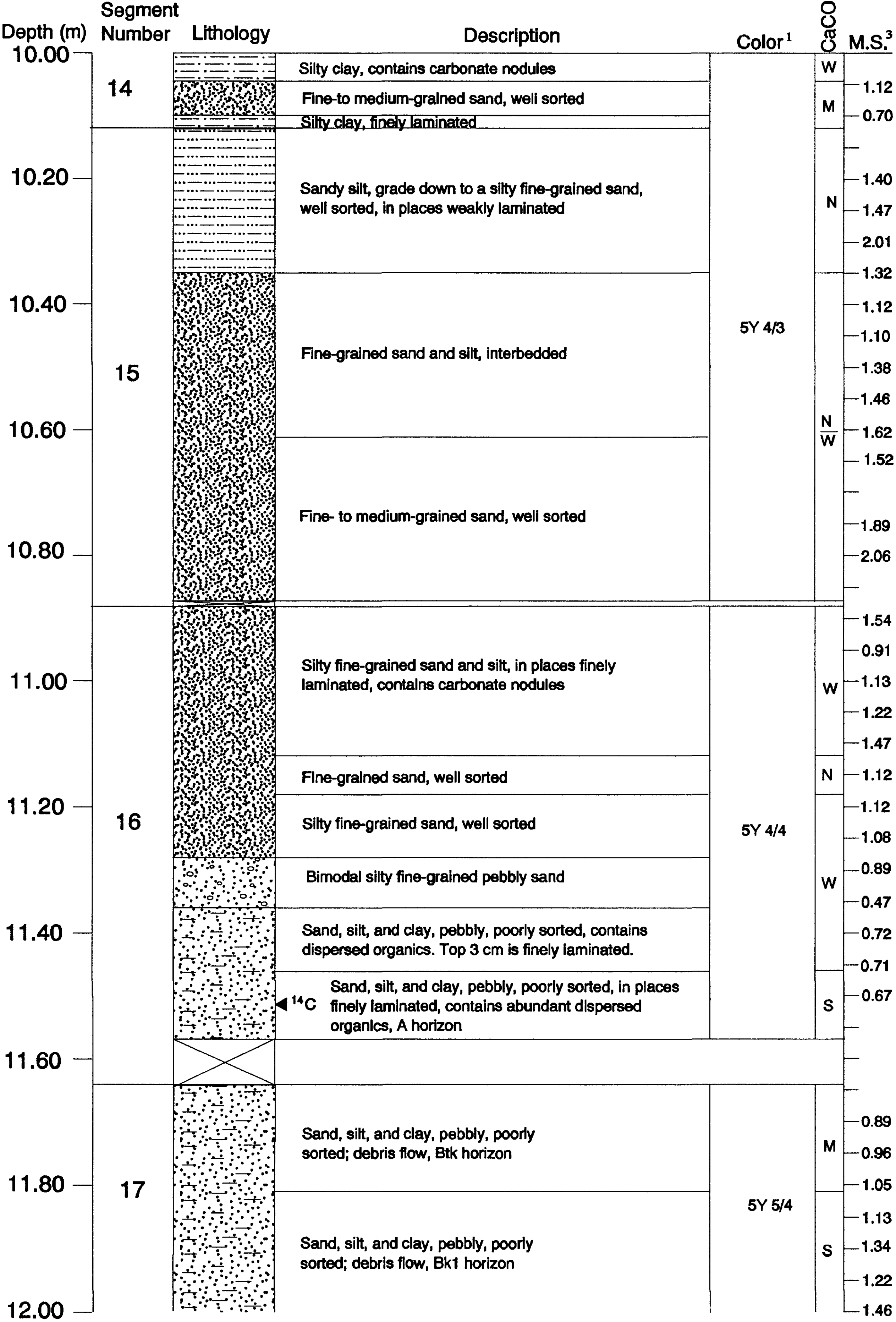
Fine-grained sandy silt, well sorted, finely laminated

Fine-grained sand, well sorted

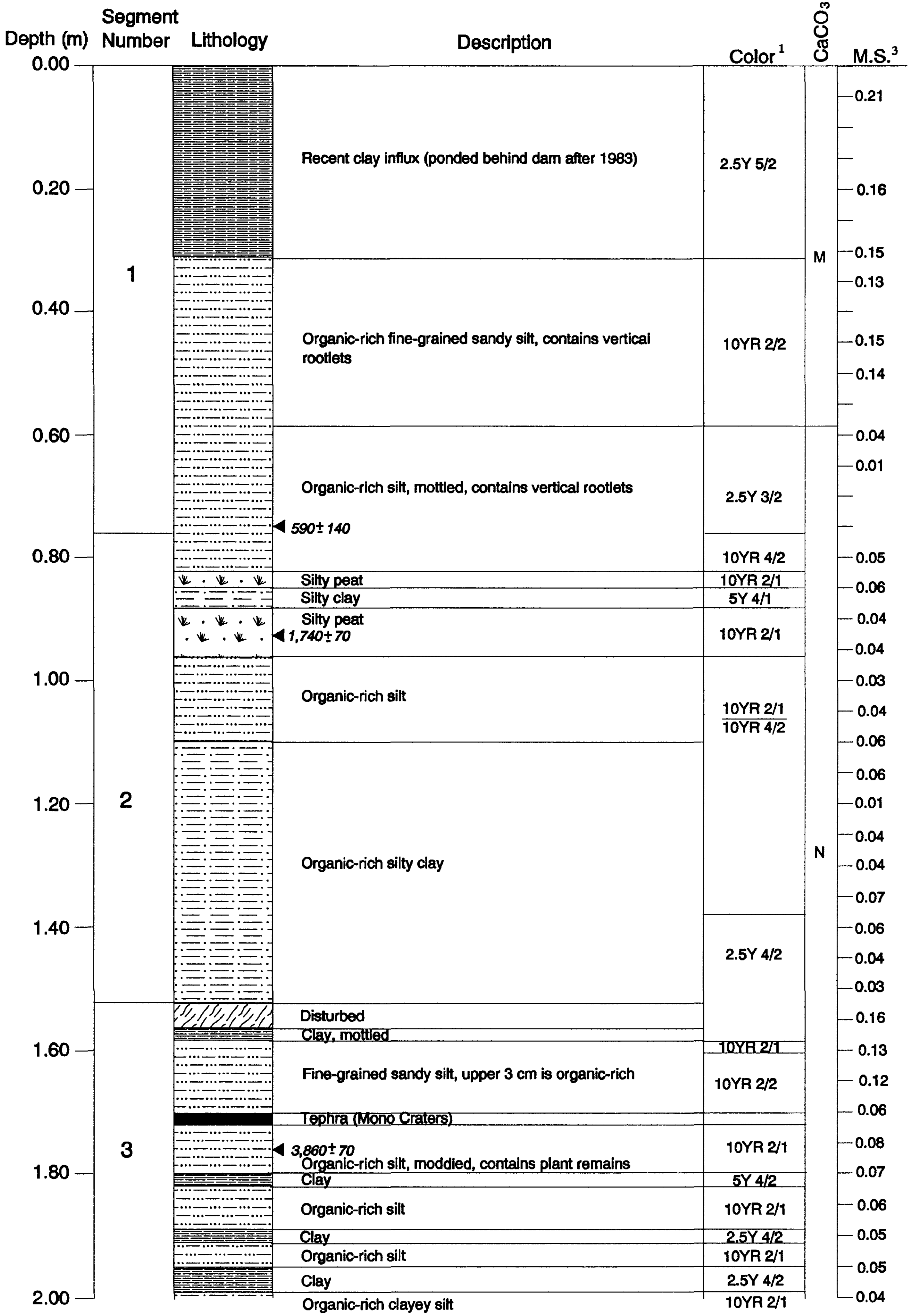
Fine-grained sandy silt, grades down to a silty fine-grained sand. Top 6 cm contains dispersed organics

Silty clay, contains carbonate nodules

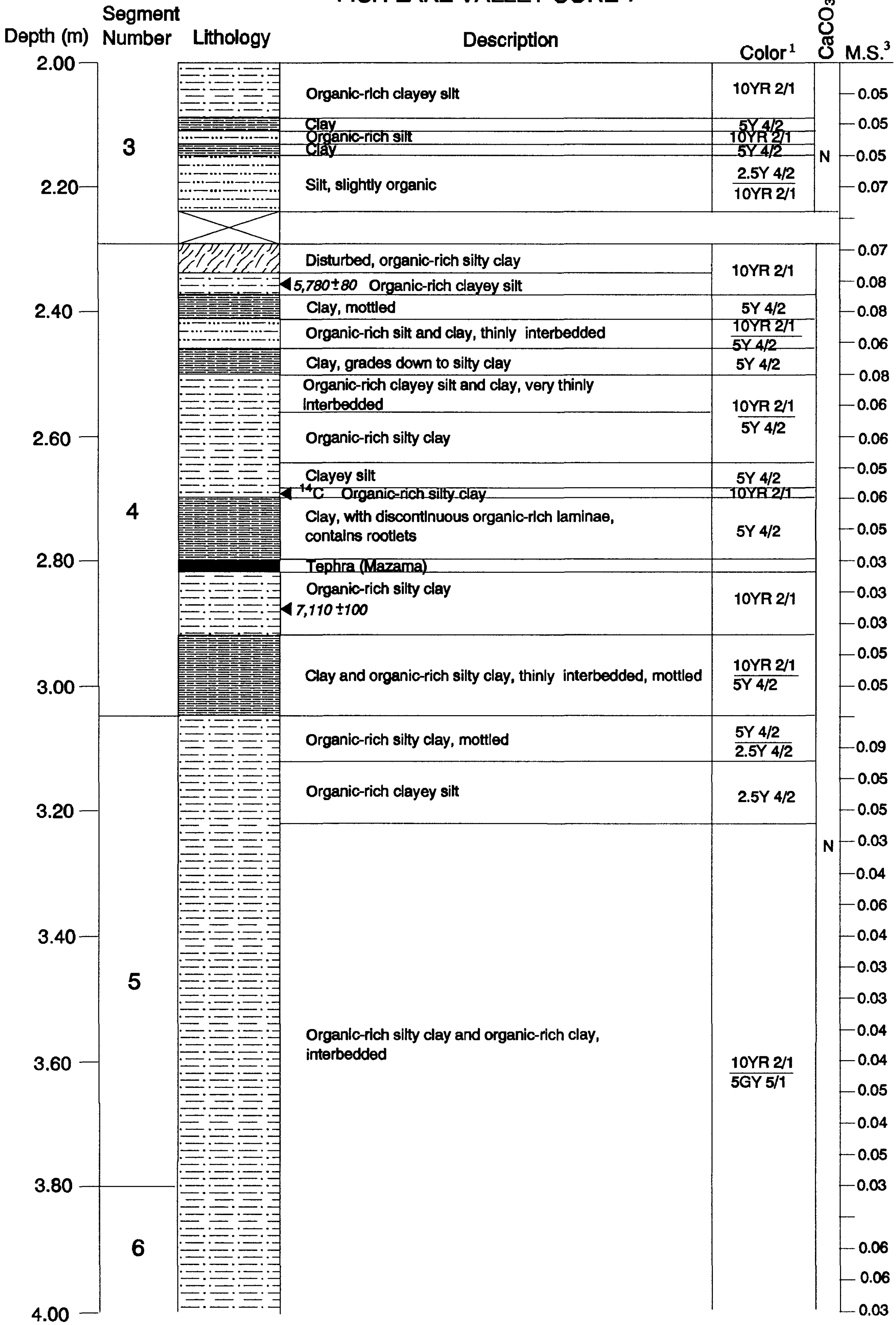
FISH LAKE VALLEY CORE 6



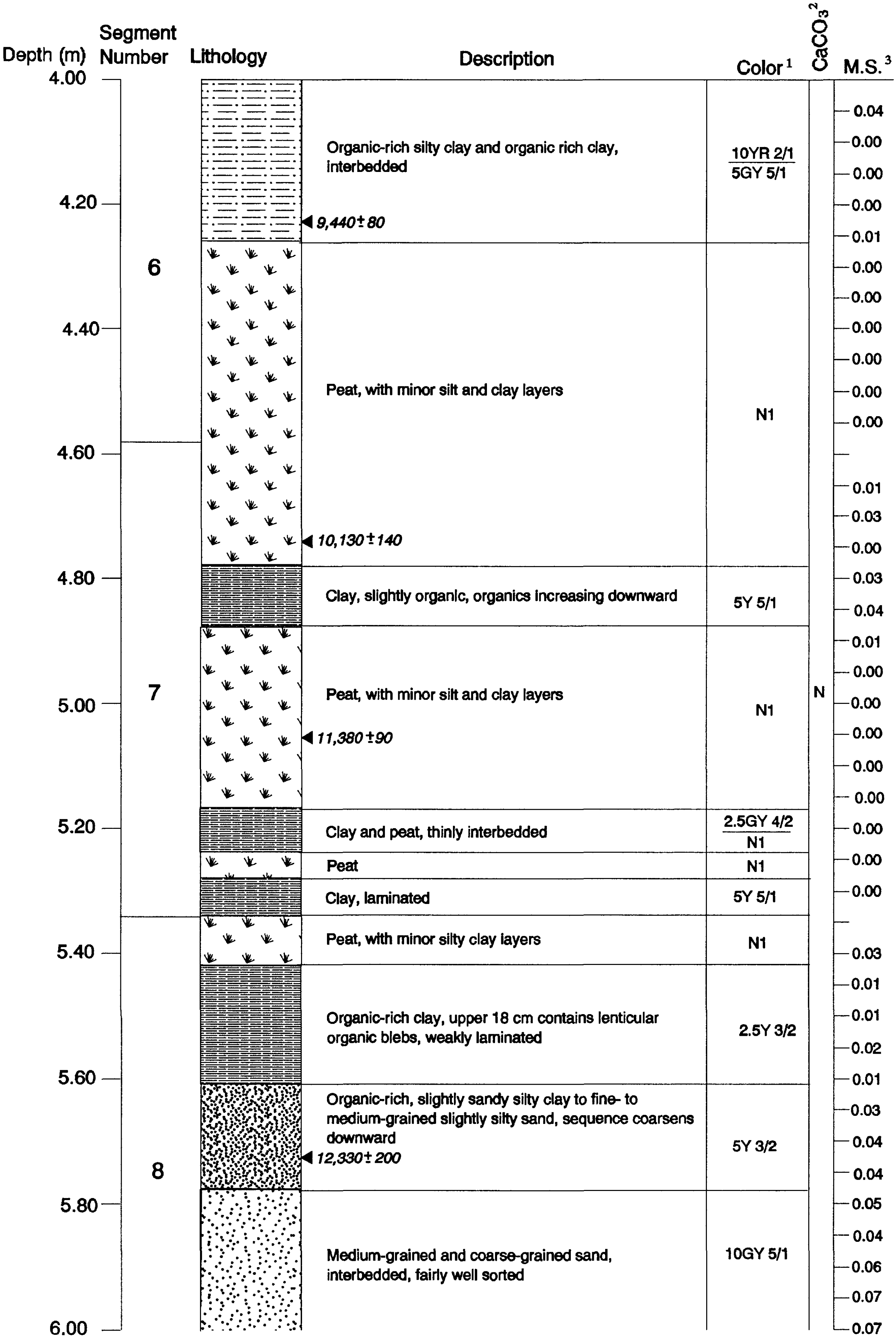
FISH LAKE VALLEY CORE 7



FISH LAKE VALLEY CORE 7

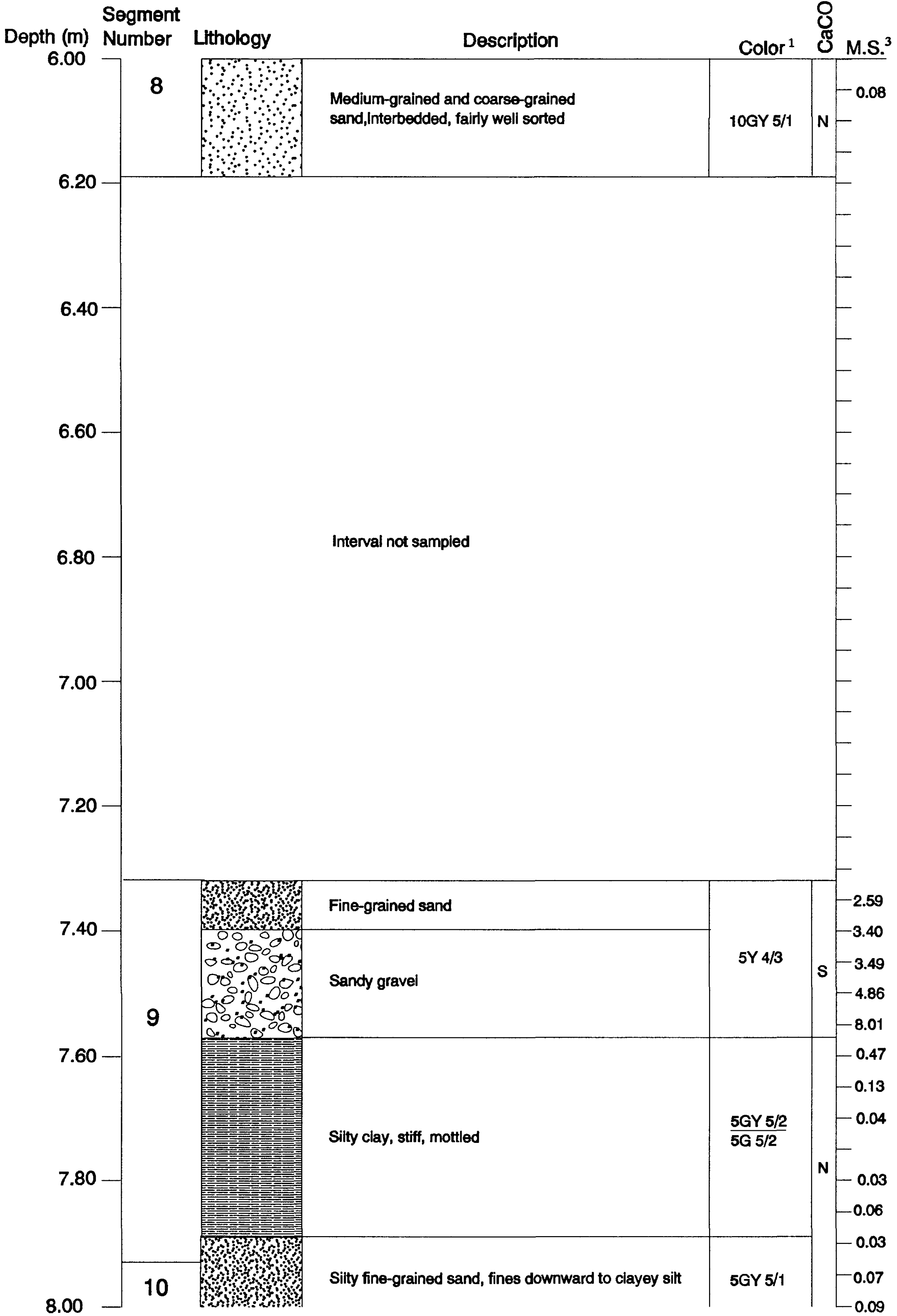


FISH LAKE VALLEY CORE 7



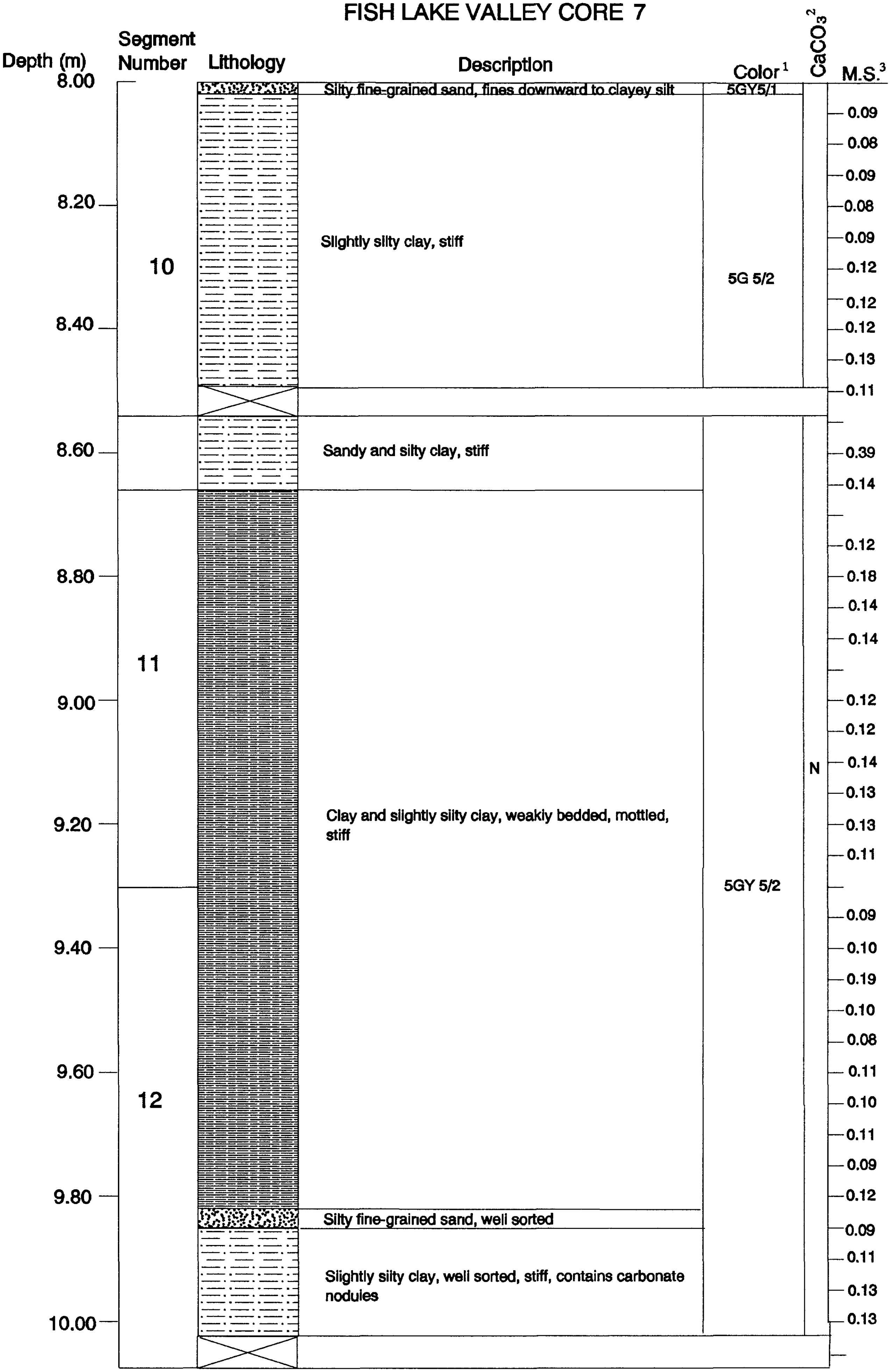
Description	Color¹
Organic-rich silty clay and organic rich clay, interbedded	10YR 2/1 5GY 5/1
Peat, with minor silt and clay layers	N1
Clay, slightly organic, organics increasing downward	5Y 5/1
Peat, with minor silt and clay layers	N1
Clay and peat, thinly interbedded	2.5GY 4/2 N1
Peat	N1
Clay, laminated	5Y 5/1
Peat, with minor silty clay layers	N1
Organic-rich clay, upper 18 cm contains lenticular organic blebs, weakly laminated	2.5Y 3/2
Organic-rich, slightly sandy silty clay to fine- to medium-grained slightly silty sand, sequence coarsens downward	5Y 3/2
Medium-grained and coarse-grained sand, interbedded, fairly well sorted	10GY 5/1

FISH LAKE VALLEY CORE 7

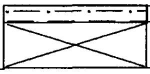


Segment Number	Description	Color[1]	$CaCO_3$[2]	M.S.[3]
8	Medium-grained and coarse-grained sand,Interbedded, fairly well sorted	10GY 5/1	N	0.08
	Interval not sampled			
9	Fine-grained sand	5Y 4/3	S	2.59
	Sandy gravel			3.40 3.49 4.86 8.01
	Silty clay, stiff, mottled	5GY 5/2 5G 5/2	N	0.47 0.13 0.04 0.03 0.06
10	Silty fine-grained sand, fines downward to clayey silt	5GY 5/1		0.03 0.07 0.09

FISH LAKE VALLEY CORE 7



FISH LAKE VALLEY CORE 7

Depth (m)	Segment Number	Lithology	Description	Color[1]	$CaCO_3$[2]	M.S.[3]
10.00	12		Slightly silty clay, stiff, well sorted	5GY 5/2	N	

Appendix 2. Log of paleontologic samples removed from the Fish Lake Valley cores

EXPLANATION

Column headings:

CORE = Core number

SGMT = Segment number

ST_DEPTH = Starting depth of sample interval from the top of core; numbers recorded in meters

END_DEPTH = Ending depth of sample interval from the top of core; numbers recorded in meters

COD = Ostracode occurrences

DIATOM = Diatom occurrences

PO = Pollen occurrences

MOLL = Mollusk occurrences

Columns:

X in column denotes removal of sample; sample analysis forthcoming

NONE, RARE, FEW, PRES (PRESENT);, COMM, (COMMON), ABUN, (ABUNDANT) indicate rank of abundance by initial examination

Log of paleontologic samples from Fish Lake Valley core 1

CORE	SGMT	ST_DEP	END_DEP	COD	DIATOM	PO	MOLL
1	1	0.00	0.01		X	X	
1	1	0.09	0.11	NONE	ABUN	X	NONE
1	1	0.19	0.21		COMM	X	
1	1	0.29	0.31	NONE	ABUN	X	NONE
1	1	0.39	0.41		ABUN	X	
1	1	0.49	0.51	NONE	ABUN	X	NONE
1	1	0.59	0.61		RARE	X	
1	1	0.67	0.69	NONE			NONE
1	1	0.69	0.71	NONE	RARE		NONE
1	2	0.85	0.87	NONE	ABUN	X	NONE
1	2	0.95	0.97			X	
1	2	1.05	1.07	NONE	RARE	X	FEW
1	2	1.15	1.17			X	
1	2	1.25	1.27	NONE	ABUN	X	NONE
1	2	1.35	1.37			X	
1	2	1.45	1.47	NONE	ABUN	X	NONE
1	2	1.53	1.55			X	
1	3	1.62	1.64			X	
1	3	1.73	1.75	NONE	ABUN	X	NONE
1	3	1.85	1.87			X	
1	3	1.96	1.98	NONE	ABUN	X	NONE
1	3	2.07	2.09			X	
1	3	2.18	2.20	NONE	ABUN	X	PRES
1	3	2.22	2.24	ABUN			ABUN
1	3	2.26	2.28	ABUN		X	ABUN
1	4	2.29	2.31	ABUN			RARE
1	4	2.35	2.37	ABUN	ABUN		NONE
1	4	2.37	2.39	ABUN	ABUN	X	RARE
1	4	2.45	2.47			X	
1	4	2.48	2.50	ABUN			COMM
1	4	2.54	2.56	NONE	ABUN	X	NONE
1	4	2.62	2.64			X	
1	4	2.72	2.74	ABUN	COMM	X	ABUN
1	4	2.80	2.82			X	
1	4	2.89	2.91	NONE	COMM	X	NONE
1	4	2.95	2.97	NONE	COMM	X	NONE
1	4	2.98	3.00			X	
1	5	3.12	3.14	ABUN			COMM
1	5	3.16	3.18			X	
1	5	3.24	3.26	PRES	NONE	X	RARE
1	5	3.29	3.31	COMM			PRES
1	5	3.34	3.36	ABUN	PRES	X	ABUN
1	5	3.39	3.41	COMM			PRES
1	5	3.44	3.46		ABUN	X	
1	5	3.47	3.49	ABUN			ABUN
1	5	3.52	3.54	ABUN	ABUN	X	PRES
1	5	3.63	3.65	COMM			
1	5	3.64	3.66		PRES	X	
1	5	3.74	3.76	NONE	COMM	X	NONE
1	5	3.83	3.85	NONE		X	NONE
1	6	3.98	4.00	NONE	ABUN	X	NONE
1	6	4.08	4.10			X	
1	6	4.18	4.20	NONE	ABUN	X	NONE

Log of paleontologic samples from Fish Lake Valley core 1

PAGE: 2

CORE	SGMT	ST_DEP	END_DEP	COD	DIATOM	PO	MOLL
1	6	4.28	4.30			X	
1	6	4.38	4.40	NONE	ABUN	X	NONE
1	6	4.48	4.50			X	
1	6	4.58	4.60	NONE	ABUN	X	NONE
1	7	4.65	4.67	PRES			FEW
1	7	4.69	4.71	RARE	ABUN	X	RARE
1	7	4.75	4.77	NONE			NONE
1	7	4.80	4.80			X	
1	7	4.89	4.91	NONE	ABUN	X	NONE
1	7	4.99	5.01			X	
1	7	5.09	5.11	NONE	ABUN	X	NONE
1	7	5.19	5.21			X	
1	7	5.29	5.31	NONE	ABUN	X	NONE
1	7	5.34	5.36		ABUN		
1	7	5.39	5.41			X	
1	7	5.43	5.45		X		
1	8	5.49	5.51	NONE	PRES		NONE
1	8	5.50	5.52			X	
1	8	5.60	5.62			X	
1	8	5.69	5.71	NONE	PRES		NONE
1	8	5.70	5.72			X	
1	8	5.80	5.82		PRES	X	
1	8	5.90	5.92	NONE		X	NONE
1	8	6.00	6.02		RARE	X	
1	8	6.10	6.12			X	
1	9	6.29	6.31		RARE	X	
1	9	6.39	6.41	NONE	NONE	X	NONE
1	9	6.49	6.51		X		
1	10	7.30	7.32	NONE			NONE
1	11	7.47	7.49		NONE	X	
1	11	7.87	7.89		X		
1	11	7.88	7.90	NONE		X	NONE
1	12	8.01	8.03		NONE	X	
1	12	8.11	8.13	NONE		X	NONE
1	12	8.21	8.23		NONE	X	
1	12	8.30	8.32		X		
1	12	8.31	8.33			X	
1	12	8.39	8.41	NONE			NONE
1	12	8.41	8.43		NONE	X	
1	12	8.71	8.73		NONE	X	
1	13	8.81	8.83		NONE	X	
1	13	8.91	8.93		NONE		
1	13	8.99	9.01	NONE			NONE
1	13	9.01	9.03		NONE	X	
1	14	9.77	9.79	NONE	NONE	X	NONE
1	15	10.30	10.32	NONE		X	NONE
1	15	10.50	10.52	NONE	NONE	X	NONE
1	15	10.52	10.54	NONE			
1	15	10.60	10.62			X	
1	15	10.66	10.68			X	
1	15	10.67	10.69		X	X	
1	16	10.77	10.79			X	
1	16	10.87	10.89	NONE	NONE	X	NONE

Log of paleontologic samples from Fish Lake Valley core 1

CORE	SGMT	ST_DEP	END_DEP	COD	DIATOM	PO	MOLL
1	16	10.97	10.99		NONE	X	
1	16	11.07	11.09	NONE	NONE	X	NONE
1	16	11.09	11.11		X		
1	16	11.17	11.19			X	
1	16	11.22	11.24	NONE			NONE
1	16	11.27	11.29		NONE	X	
1	16	11.42	11.44			X	

Log of paleontologic samples from Fish Lake Valley core 2

PAGE: 1

CORE	SGMT	ST_DEP_	END_DEP	COD	DIATOM	PO	MOLL
2	1	0.09	0.11			X	
2	1	0.29	0.31	RARE		X	ABUN
2	1	0.49	0.51	RARE		X	COMM
2	1	0.69	0.71	RARE		X	NONE
2	2	0.85	0.87		X	X	
2	2	0.95	0.97	RARE			ABUN
2	2	1.05	1.07	RARE		X	FEW
2	2	1.15	1.17	RARE			PRES
2	2	1.25	1.27	RARE	X	X	PRES
2	2	1.35	1.37	RARE			PRES
2	2	1.45	1.47	RARE		X	PRES
2	3	1.66	1.68	RARE	X	X	RARE
2	3	1.86	1.88	RARE	X	X	RARE
2	3	2.06	2.08	RARE		X	RARE
2	3	2.16	2.18	NONE			NONE
2	3	2.26	2.28		X	X	
2	4	2.29	2.31	RARE			RARE
2	4	2.47	2.49		X	X	
2	4	2.48	2.50	NONE			NONE
2	4	2.68	2.70	RARE			RARE
2	4	2.72	2.74		X	X	
2	4	2.80	2.82	RARE			NONE
2	4	2.91	2.93	RARE			RARE
2	4	2.98	3.00		X	X	
2	4	3.03	3.05	FEW			FEW
2	5	3.14	3.16	RARE	X	X	NONE
2	5	3.24	3.26	RARE			RARE
2	5	3.34	3.36	RARE	X	X	RARE
2	5	3.44	3.46	RARE			RARE
2	5	3.54	3.56	FEW	X	X	RARE
2	5	3.64	3.66	RARE			NONE
2	5	3.74	3.76	RARE	X	X	RARE
2	6	3.90	3.92	COMM			FEW
2	6	3.95	3.97	RARE	X	X	RARE
2	6	4.00	4.02	RARE			RARE
2	6	4.13	4.15	RARE	X	X	NONE
2	6	4.23	4.25	NONE	X	X	NONE
2	6	4.43	4.45	NONE	X	X	NONE
2	7	4.65	4.67		X	X	
2	7	4.67	4.69	NONE			RARE
2	7	4.74	4.76		X	X	
2	7	4.85	4.87		X	X	
2	7	5.04	5.06	RARE	X	X	NONE
2	7	5.12	5.14		X	X	
2	7	5.14	5.16	RARE			RARE
2	7	5.28	5.30	RARE			NONE
2	8	5.38	5.40		X	X	
2	8	5.56	5.58	NONE			NONE
2	8	5.58	5.60		X	X	
2	8	5.78	5.80		X	X	
2	8	5.98	6.00		X	X	
2	8	6.01	6.03	NONE			

Log of paleontologic samples from Fish Lake Valley core 3

```
                                                                  PAGE: 1
CORE     SGMT     ST_DEP_      END_DEP      COD      DIATOM   PO       MOLL
------   ------   ----------   ----------   ------   ------   ------   ------
3        1              0.26         0.28            X        X
3        1              0.36         0.38   NONE     X        X        NONE
3        1              0.46         0.48            X        X
3        1              0.66         0.68            X        X
3        2              0.85         0.87            X        X
3        2              1.05         1.07            X        X
3        2              1.07         1.09   NONE                       NONE
3        2              1.25         1.27            X        X
3        2              1.45         1.47            X        X
3        3              1.56         1.58            X        X
3        3              1.66         1.68   RARE                       NONE
3        3              1.76         1.78   RARE     X        X        NONE
3        3              1.86         1.88   RARE                       NONE
3        3              1.96         1.98   NONE     X        X        NONE
3        3              2.16         2.18            X        X
3        4              2.43         2.45            X        X
3        4              2.63         2.65            X        X
3        4              2.83         2.85            X        X
3        5              3.18         3.20            X        X
3        5              3.36         3.38   NONE                       NONE
3        5              3.42         3.44            X        X
3        5              3.54         3.56   NONE                       NONE
3        5              3.66         3.68            X        X
3        5              3.69         3.71   NONE                       NONE
3        5              3.91         3.93            X        X
3        6              4.02         4.04            X        X
3        6              4.24         4.26            X        X
3        6              4.26         4.28   NONE                       NONE
3        6              4.41         4.43            X        X
3        6              4.58         4.60            X        X
3        6              4.69         4.71            X        X
3        7              4.73         4.75   NONE                       NONE
3        7              4.82         4.84            X        X
3        7              5.02         5.04            X        X
3        7              5.02         5.04   NONE                       NONE
3        7              5.27         5.29            X        X
3        7              5.40         5.42   NONE                       NONE
3        7              5.47         5.49            X        X
3        8              5.59         5.61            X        X
3        8              6.10         6.12            X        X
3        9              6.66         6.68            X        X
3        9              6.86         6.88            X        X
3        11             8.42         8.44                     X
```

```
Log of paleontologic samples from Fish Lake Valley core 4
                                                                    PAGE: 1
CORE     SGMT     ST_DEP_       END_DEP       COD      DIATOM   PO       MOLL
------   ------   ----------    ----------    ------   ------   ------   ------
4        4              3.00          3.09    NONE                       NONE
4        6              4.24          4.26    NONE                       NONE
4        8              5.49          5.51    NONE                       NONE
4        9              6.87          6.89    NONE                       NONE
```

```
Log of paleontologic samples from Fish Lake Valley core 5
                                                                PAGE: 1
CORE      SGMT      ST_DEP_       END_DEP       COD       DIATOM    PO        MOLL
------    ------    ----------    ----------    ------    ------    ------    ------
5         12              9.03          9.05    NONE                          NONE
5         13              9.56          9.58    NONE                          NONE
```

Log of paleontologic samples from Fish Lake Valley core 7

CORE	SGMT	ST_DEP	END_DEP	COD	DIATOM	PO	MOLL
7	1	0.06	0.08		RARE	X	
7	1	0.14	0.16		RARE		
7	1	0.43	0.45		ABUN		
7	1	0.58	0.60	NONE	ABUN		NONE
7	1	0.65	0.67			X	
7	1	0.73	0.75			X	
7	2	0.80	0.82			X	
7	2	0.85	0.87	NONE	RARE	X	NONE
7	2	0.90	0.90		COMM		
7	2	0.90	0.92			X	
7	2	0.95	0.97			X	
7	2	0.97	0.98		COMM		
7	2	1.05	1.07	NONE	COMM	X	NONE
7	2	1.08	1.08		COMM		
7	2	1.10	1.12			X	
7	2	1.11	1.12		RARE		
7	2	1.15	1.17			X	
7	2	1.22	1.22		COMM		
7	2	1.25	1.27	NONE	COMM	X	NONE
7	2	1.35	1.37			X	
7	2	1.45	1.47	NONE	COMM	X	NONE
7	2	1.48	1.48		COMM		
7	2	1.50	1.53		COMM		
7	3	1.56	1.58	NONE	PRES	X	NONE
7	3	1.65	1.67			X	
7	3	1.76	1.78	NONE	RARE	X	NONE
7	3	1.86	1.89			X	
7	3	1.96	1.98	NONE	RARE	X	NONE
7	3	2.01	2.03		RARE		
7	3	2.06	2.08			X	
7	3	2.14	2.14		NONE		
7	3	2.19	2.21	NONE	RARE	X	NONE
7	3	2.20	2.22		RARE		
7	4	2.29	2.30		ABUN		
7	4	2.38	2.40		COMM	X	
7	4	2.48	2.50	NONE	COMM	X	NONE
7	4	2.58	2.60		RARE	X	
7	4	2.68	2.70		ABUN	X	
7	4	2.71	2.73	NONE			NONE
7	4	2.73	2.75	NONE	RARE	X	NONE
7	4	2.83	2.85		ABUN	X	
7	4	2.84	2.86	NONE			NONE
7	4	2.89	2.91		PRES	X	
7	4	2.98	3.00	NONE	COMM	X	NONE
7	5	3.14	3.16			X	
7	5	3.18	3.18		COMM		
7	5	3.24	3.26	NONE	COMM	X	NONE
7	5	3.26	3.26		COMM		
7	5	3.34	3.36			X	
7	5	3.44	3.44		COMM		
7	5	3.44	3.46	NONE	ABUN	X	NONE
7	5	3.54	3.56			X	
7	5	3.64	3.66	NONE	ABUN	X	NONE

Log of paleontologic samples from Fish Lake Valley core 7

CORE	SGMT	ST_DEP	END_DEP	COD	DIATOM	PO	MOLL
7	5	3.74	3.76			X	
7	5	3.80	3.80		COMM		
7	6	3.85	3.87			X	
7	6	3.95	3.97	NONE	ABUN	X	NONE
7	6	4.06	4.06			X	
7	6	4.15	4.17	NONE	ABUN	X	NONE
7	6	4.25	4.27			X	
7	6	4.35	4.37	NONE	ABUN	X	NONE
7	6	4.41	4.42		RARE		
7	6	4.45	4.47			X	
7	6	4.50	4.52		ABUN		
7	6	4.52	4.53		COMM		
7	6	4.55	4.57	NONE			NONE
7	6	4.56	4.56			X	
7	7	4.67	4.69			X	
7	7	4.72	4.73		ABUN		
7	7	4.77	4.79	NONE	ABUN	X	NONE
7	7	4.87	4.89			X	
7	7	4.97	4.99	NONE	ABUN	X	NONE
7	7	5.07	5.09			X	
7	7	5.17	5.19	NONE	COMM	X	NONE
7	7	5.24	5.25		COMM		
7	7	5.27	5.29			X	
7	8	5.41	5.43	NONE	COMM	X	NONE
7	8	5.53	5.55	NONE	COMM	X	NONE
7	8	5.63	5.65			X	
7	8	5.73	5.75	NONE	PRES	X	NONE
7	8	5.93	5.95	NONE	NONE	X	NONE
7	8	6.03	6.05			X	
7	9	7.51	7.53	NONE	NONE		NONE
7	9	7.61	7.63			X	
7	9	7.71	7.73	NONE	X	X	NONE
7	9	7.81	7.83			X	
7	9	7.91	7.93	NONE	X	X	NONE
7	9	7.94	7.96	NONE	X	X	NONE
7	10	7.97	7.99	NONE	X	X	NONE
7	10	8.07	8.09			X	
7	10	8.17	8.19	NONE	X	X	NONE
7	10	8.27	8.29		X		
7	10	8.37	8.39	NONE	X	X	NONE
7	10	8.42	8.42		RARE		
7	10	8.47	8.49			X	
7	11	8.71	8.71		COMM		
7	11	8.71	8.73	NONE		X	NONE
7	11	8.83	8.85			X	
7	11	8.95	8.97	NONE	X	X	NONE
7	11	9.07	9.09			X	
7	11	9.12	9.16		ABUN		
7	11	9.18	9.20	NONE	RARE	X	NONE
7	11	9.25	9.25		RARE		
7	12	9.39	9.41	NONE	RARE	X	NONE
7	12	9.49	9.51			X	
7	12	9.59	9.61	NONE	X	X	NONE

```
Log of paleontologic samples from Fish Lake Valley core 7
                                                                  PAGE: 3
CORE     SGMT     ST_DEP       END_DEP      COD      DIATOM   PO       MOLL
------   ------   ----------   ----------   ------   ------   ------   ------
7        12             9.69         9.71                     X
7        12             9.79         9.81   NONE     X        X        NONE
7        12             9.99        10.01            X        X
```