

## INTERNAL REPORT 73

### FINDLEY LAKE SOIL TEMPERATURE AND SOIL MOISTURE DATA AUGUST 1972 - AUGUST 1973

Michael J. Singer and F. C. Ugolini  
University of Washington

#### ABSTRACT

Data on soil temperature at two locations and five depths, tensiometer readings, and soil moisture release curves for the soils of Findley Lake are presented in this report.

#### METHODS

##### Soil Temperature

Stainless steel thermistor probes were installed at two sites in the Findley Lake watershed in August 1972. A Simpson model 652 temperature tester adapter was used to collect data periodically. Each probe was calibrated at eight temperatures and a standard curve of Simpson reading versus actual temperature in degrees Celsius was used to obtain the data reported here. There is likely to be some error in data acquisition, but it is not quantitatively known. The reported data should be within 5% of the actual temperature. Site 6 is located 35 meters northwest of the cabin site. Site 12 is 40 meters south of the trail at the top of the ridge before the trail descends to the lake. Readings were taken at each site within two hours of one another whenever possible. Readings were generally taken in the late afternoon between 1500 and 1700 hours.

##### Soil Moisture Tension

Ten soil moisture company porous cup tensiometers were installed at two sites in August 1972. Four were installed at depths of 10, 35, 45, and 55 cm at site 12 and 6; two at 10 and 25; one at 40; and one at 55 cm at site 6. Soil moisture tension from 0.0 to 0.8 atmospheres is read from a vacuum gauge attached to the tensiometer barrel. The tensiometers were removed in November to avoid winter breakage.

#### RESULTS AND DISCUSSION

##### Soil Temperature

Soil temperature data by depth at two sites for a year are shown in Table 1. Air temperature at 50 cm taken at the time the soil temperatures were taken is also shown in Table 1. As in most soils, there is a diurnal and yearly temperature wave which passes through the soil. This wave is damped at depth within the soil. The soil from the lower site (6) approaches point 0°C at the surface but does not go below it. The thick snow pack insulates the soil from freezing. The upper site does freeze, however, and the frost penetrates to at least 40 cm. The lower site warms rapidly in spring while the upper site remains colder longer. The difference in elevation between sites 6 and 12 is approximately 190 meters. The mean annual summer temperature, winter temperature, and

annual temperature for the two sites are shown in Table 2. These are based on the 60-cm soil temperature for site 6 and the 40-cm temperature for site 12. Summer is considered to be July and August, winter November through May.

### Soil Moisture Tension

A limited amount of soil moisture tension data are available for Findley Lake (Table 3). The tensiometer probes were removed for winter storage and have not been functioning since. During the observation period, the soil remained near field capacity or above. The drier summer period was not monitored and it is expected that the soil did go below field capacity during late July and August. This year (1973) because of the light snow pack, the soils had dried out considerably by late June.

### Soil Moisture Release Curves

Figures 1 through 6 are moisture release curves based on data obtained from pressure plate apparatus in the laboratory. There is considerable natural variability in the texture, organic matter content, and structure of the soils of Findley Lake. These parameters are manifested in the variability of the soil moisture release curves. These curves may be used in conjunction with tensiometer readings to estimate the percentage of water remaining in the soil at the time the tensiometer reading was taken. These soils are well drained and porous. They are frequently at or near field capacity (0.1-0.3 atmospheres) during ten months of the year. During July and August, the soils dry out and considerably less water is retained within them. The "available" water which can be defined as water held between 0.3 and 15 atmospheres, tension is shown for each horizon in Table 4. All soil moisture data is based on the oven-dry weights of the soils. The data for the organic horizons (O1 and O2) are the least reliable because of the porous nature of the material. These litter horizons have notoriously high water holding capacities. Because of their low density, they often contain 100-200% of their dry weight in water when saturated.

Table 1. Findley Lake Soil Temperature Summary.

Depth (cm)	8/1	8/2	8/3	8/8	8/22	8/23	9/2	1972									
								9/14	9/20	9/28	10/21	10/27	11/11	11/15	11/16	11/17	12/13
Site 6																	
2	12.8	12.4	14.8	17.0	9.5	12.2	13.0	11.5	3.0	2.5	4.0	1.2	3.5	3.0	3.0	3.0	0.2
10	12.6	11.5	13.5	16.2	8.0	11.0	13.0	10.5	3.5	2.8	5.5	2.5	4.5	3.5	4.0	3.0	0.8*
20	10.5	10.0	10.8	13.5	9.8	9.5	10.5	9.5	4.0	3.0	4.8	2.3	3.0	3.0	3.0	3.0	1.0
40	12.0	10.8	12.0	14.5	10.7	10.2	11.5	10.2	4.5	3.0	5.5	2.0	3.5	2.5	3.5	3.5	2.0
60	10.0	10.5	10.5	12.2	10.0	9.5	10.0	9.5	5.5	4.0	5.0	2.0	2.5	3.0	4.0	3.5	--
Air Temp.	--	--	--	--	--	--	--	16.0	0.0	-1.5	0.0	-3.5	-1.0	-0.5	0.0	-1.0	-10.0
Site 12																	
2	--	10.8	12.8	14.8	--	10.7	11.5	8.7	1.0	0.5	3.0	0.0	-0.5	0.5	2.0	1.0	--
20	--	11.8	13.3	15.8	--	12.2	12.8	11.7	1.0	3.0	6.0	2.3	1.5	1.5	3.5	3.0	--
40	--	5.0	6.5	8.3	--	6.5	7.8	6.0	3.0	1.0	2.0	0.5	0.5	0.0	0.5	0.0	--
Air Temp.	--	--	--	--	--	--	--	9.5	-2.0	-3.5	0.0	-3.5	-2.5	-2.0	-0.5	-2.0	--

Table 1. (Continued)

									1973								
Depth (cm)	3/27	4/13	5/3	5/4	5/17	5/24	6/7	6/14	Depth (cm)	6/21	6/28	7/6	7/13	7/26	8/8	8/28	9/7
Site 6																	
2	1.0	1.0	1.0	--	0.7	1.0	6.7	--	5	11.5	9.5	6.5	9.5	12.0	11.0	9.0	8.0
10	0.5	1.2	-0.8	--	0.7	1.2	6.5	5.5	20	7.0	8.5	6.5	7.0	7.5	8.5	7.0	8.5
20	1.0	1.5	1.0	--	1.0	1.5	4.0	4.5	30	7.5	8.0	6.0	6.2	7.5	8.0	6.7	7.5
40	1.5	2.0	1.5	--	1.5	2.0	2.0	4.0 <sup>†</sup>									
60	--	--	--	--	--	--	--	4.7 <sup>†</sup>	60	4.5	6.5	5.5	5.5	7.0	7.5	7.0	8.5
Air Temp.	-4.5	2.0	0.0	--	10.5	-1.0	3.8	-1.0	Air Temp.	16.5	3.7	0.0	9.5	12.5	15.0	7.5	2.7
Site 12																	
2	--	--	--	0.0	-0.5	0.0	5.7	--		--	9.2	4.5	10.2	13.0	10.5	7.5	5.5
20	--	--	--	1.0	1.0	2.2	7.9	--		--	11.7	7.0	12.2	14.5	13.5	10.5	8.5
40	--	--	--	-2.0	-1.5	-1.5	2.5	--		--	5.0	4.0	5.0	6.5	6.0	5.0	5.0
Air Temp.	--	--	--	-1.5	10.5	-3.0	2.1	--		--	5.0	2.7	18.0	15.0	15.0	7.0	2.7

\* Shifted to 5 cm depth; 60 cm probe removed.

† 40 cm probe shifted to 30 cm depth; 60 cm probe reinstalled.

Table 2. Findley Lake Soil Temperature Averages.

Site	MAST	MAWT	MAT	$\Delta T_1$	$\Delta T_2$	$\Delta T_3$
6	9.3	3.2	6.6	2.7	3.4	6.1
12	5.9	-0.6	2.8	3.1	3.4	6.5

MAST = Mean annual summer temperature

MAWT = Mean annual winter temperature

MAT = Mean annual temperature

$\Delta T_1$  = MAST-MAT

$\Delta T_2$  = MAT-MAWT

$\Delta T_3$  = MAST-MAWT

Table 3. Findley Lake Soil Moisture Tension Data Summary

Depth (cm)	1972											
	8/23	9/2	9/14	9/20	0/28	10/11	10/21	10/27	11/11	11/15	11/16	11/17
Tension (atmospheres)												
Site 6												
10	0.08	0.30	0.12	0.00	0.02	0.04	0.06	0.04	0.00	0.00	0.00	0.00
	0.16	0.22	0.26	0.00	0.00	0.06	0.20	0.04	0.00	0.00	0.00	0.00
25	0.16	0.18	0.16	0.06	0.10	0.12	0.14	0.06	0.10	0.10	0.12	0.12
	0.12	>0.16	0.32	0.14	0.11	0.16	0.21	0.12	0.14	0.18	0.14	0.18
40	0.12	0.28	0.10	0.00	0.02	0.10	0.12	0.04	0.00	0.00	0.00	0.00
55	0.08	>0.60	0.16	0.00	0.06	0.12	0.12	0.12	0.00	0.00	0.00	0.00
Site 12												
10	0.08	0.40	0.00	0.00	0.00	0.04	0.10	0.00	0.04	0.06	0.06	0.02
35	0.28	0.34	0.29	0.26	0.10	0.14	0.16	0.12	0.12	0.14	0.14	0.14
45	0.13	0.26	0.14	0.06	0.12	0.12	0.16	0.10	0.12	0.12	0.14	0.12
55	0.20	0.28	0.18	0.02	0.09	0.12	0.16	0.12	0.00	0.00	0.00	0.00

Table 4. Available Moisture in Horizons of Soils at Findley Lake, Washington.

Site	Soil Type	Horizon	% H <sub>2</sub> O (Oven-dry Weight Basis)
1	Nonforested mixed materials (wet meadow)	A11	100.2
		A12	46.0
		IIA'2	39.9
		IIIA1b	41.7
		IIIBgb	27.9
12	Forested soil of the ridges	02	74.4
		B2	25.9
		B3	27.5
4	Fine material of tallus		99.4
5	Semi-forested soils on mixed materials (avalanche tracks)	02	60.6
		A11	49.0
		IIA'12b	25.5
		IIB'21hirb	34.5
		IIIB'22irb	35.5
		IIIB'3b	32.6
6	Forested soils on mixed materials	02	82.9
		A2	28.9
		IIB2hir	28.4
		IIIB3	102.5
		IVA1b	46.1
10	Unforested soils of the ridges	02	69.8
		A1	42.4

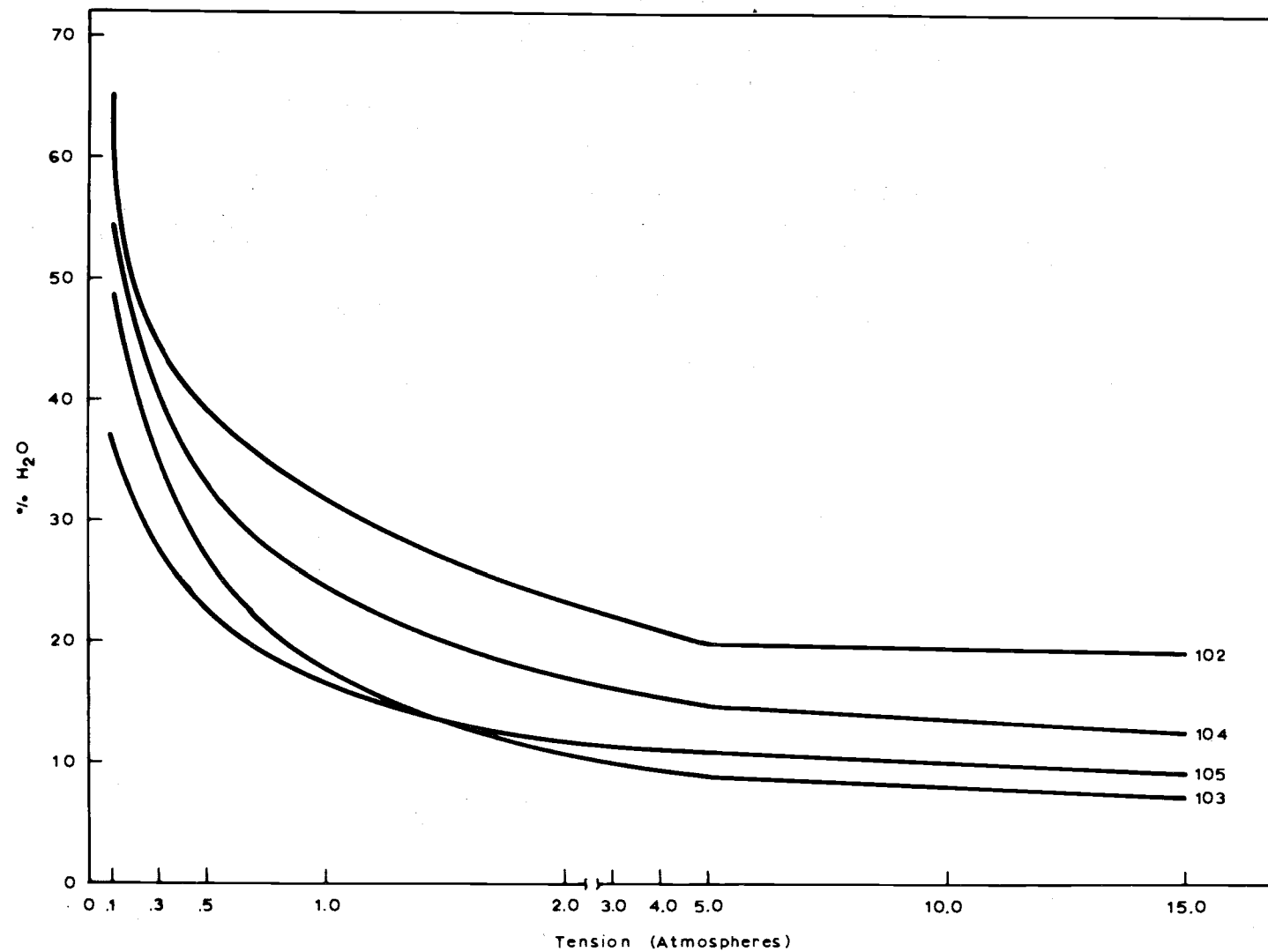


Figure 1. Moisture release curves for mineral horizons of a wet meadow soil, Findley Lake, Washington.



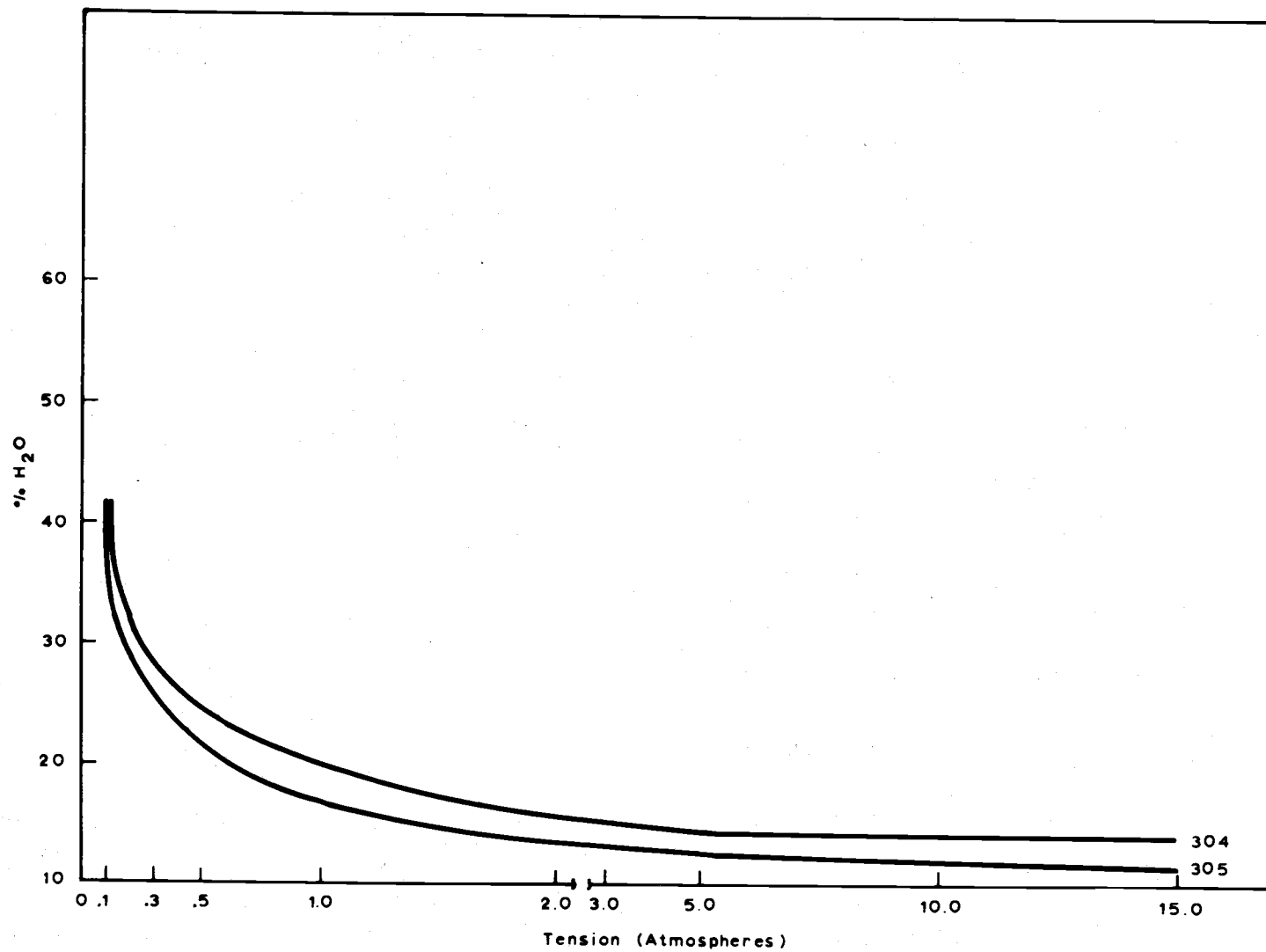


Figure 2. Moisture release curves for mineral horizons of a forested ridge top soil, Findley Lake, Washington.

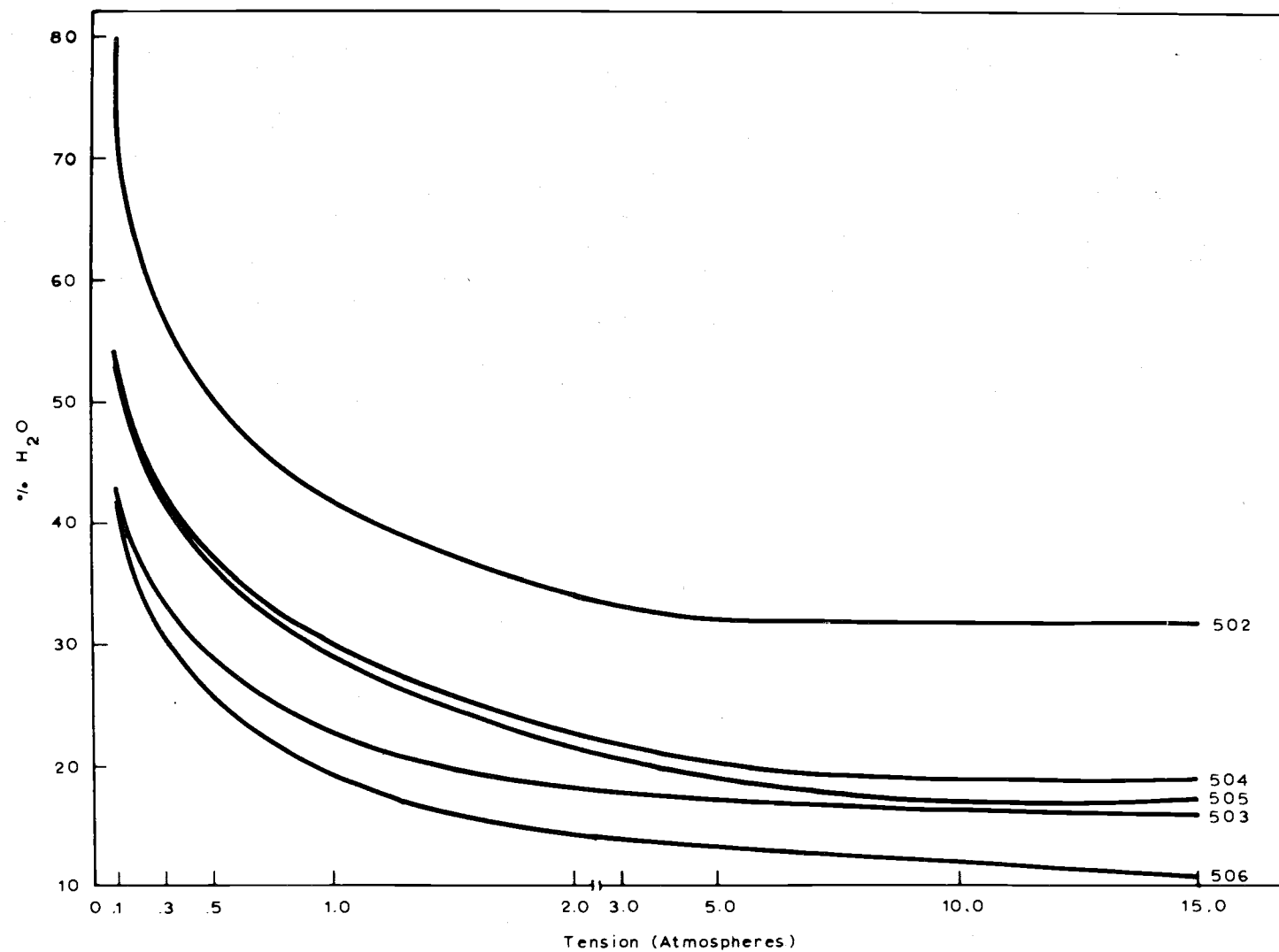


Figure 3. Moisture release curves for mineral horizons of a semiforested soil of mixed materials, Findley Lake, Washington.

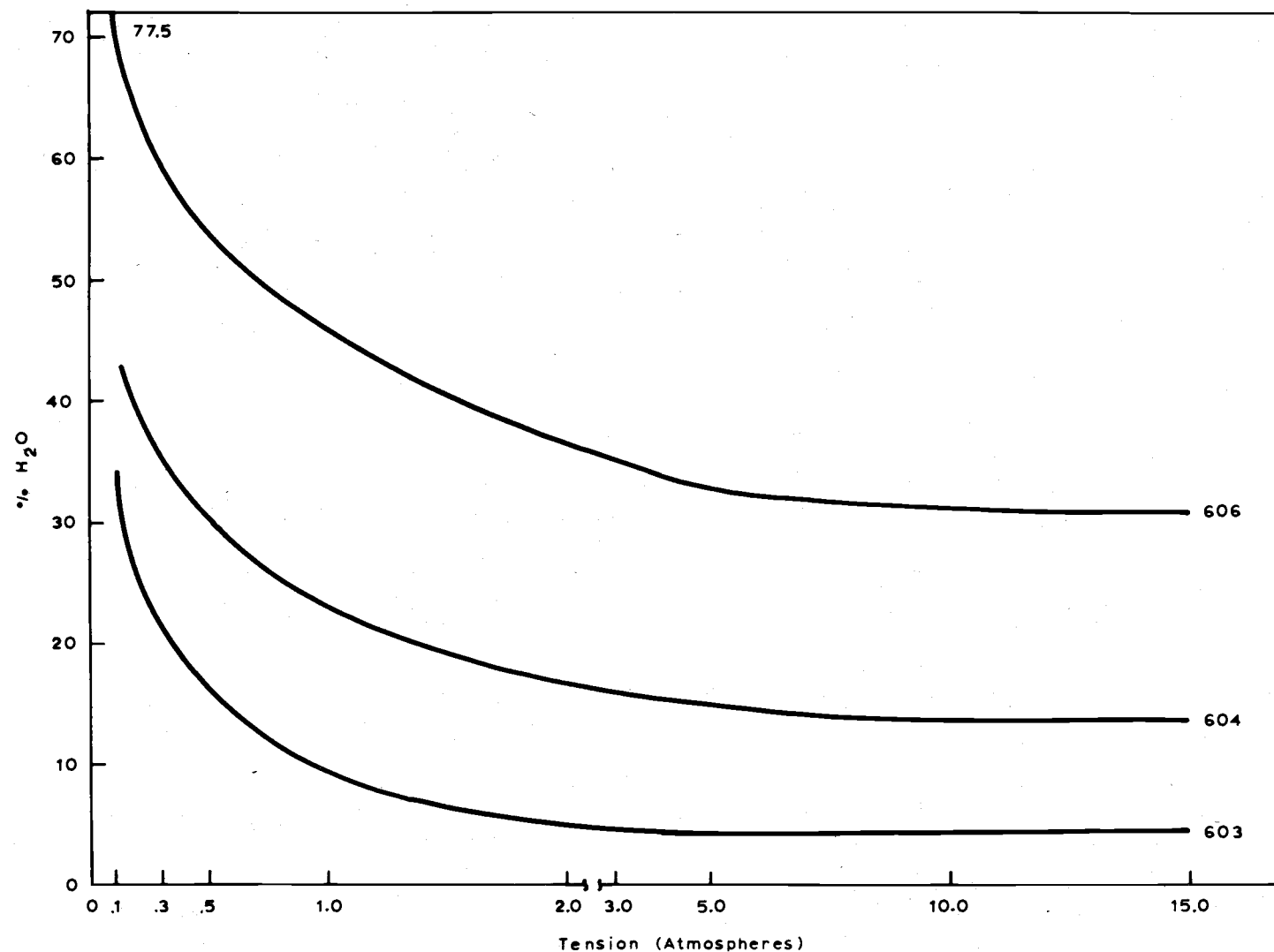


Figure 4. Moisture release curves for mineral horizons of a forested soil of mixed materials, Findley Lake, Washington.

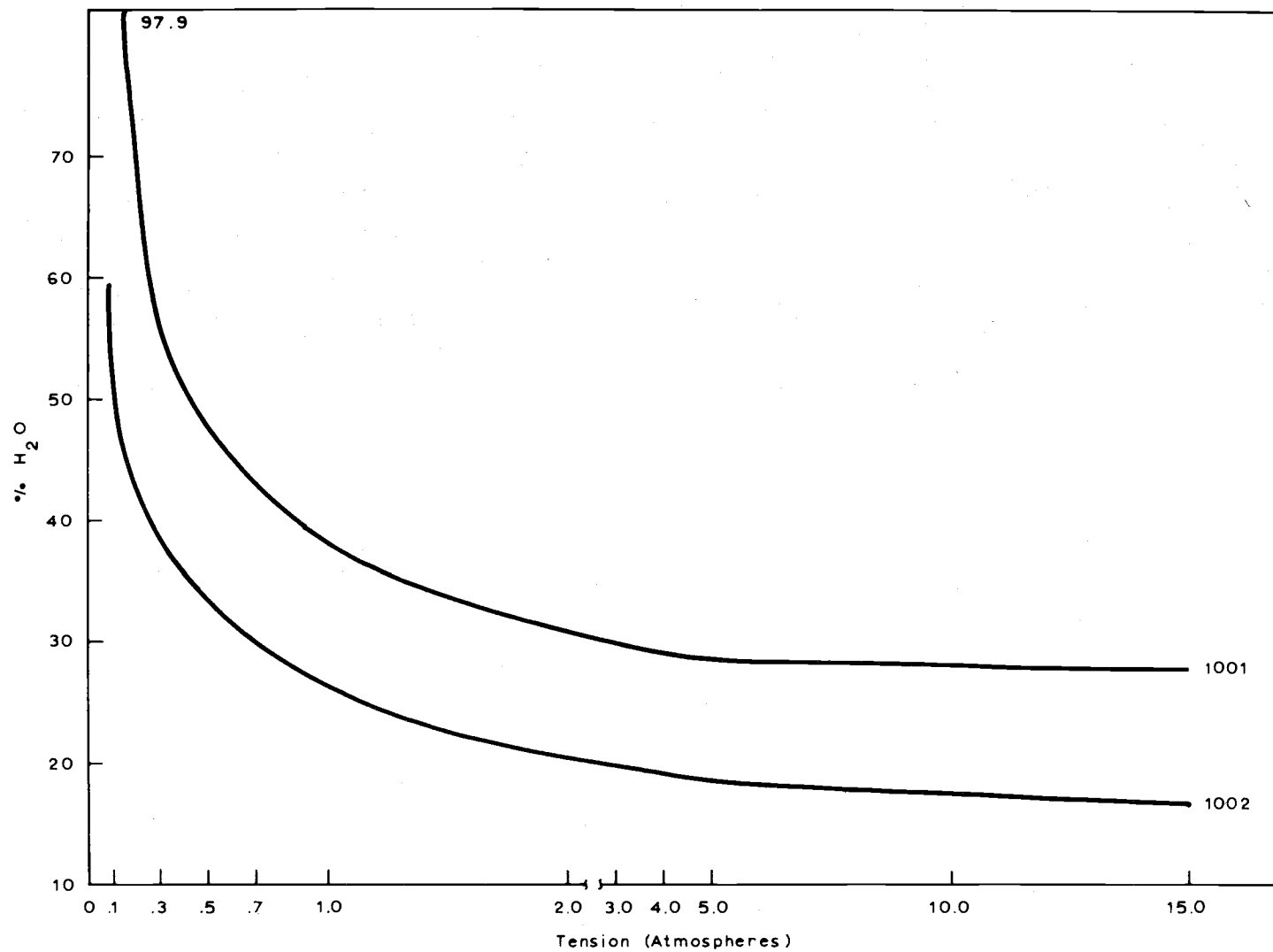


Figure 5. Moisture release curves for mineral horizons of an unforested ridge top soil, Findley Lake, Washington.

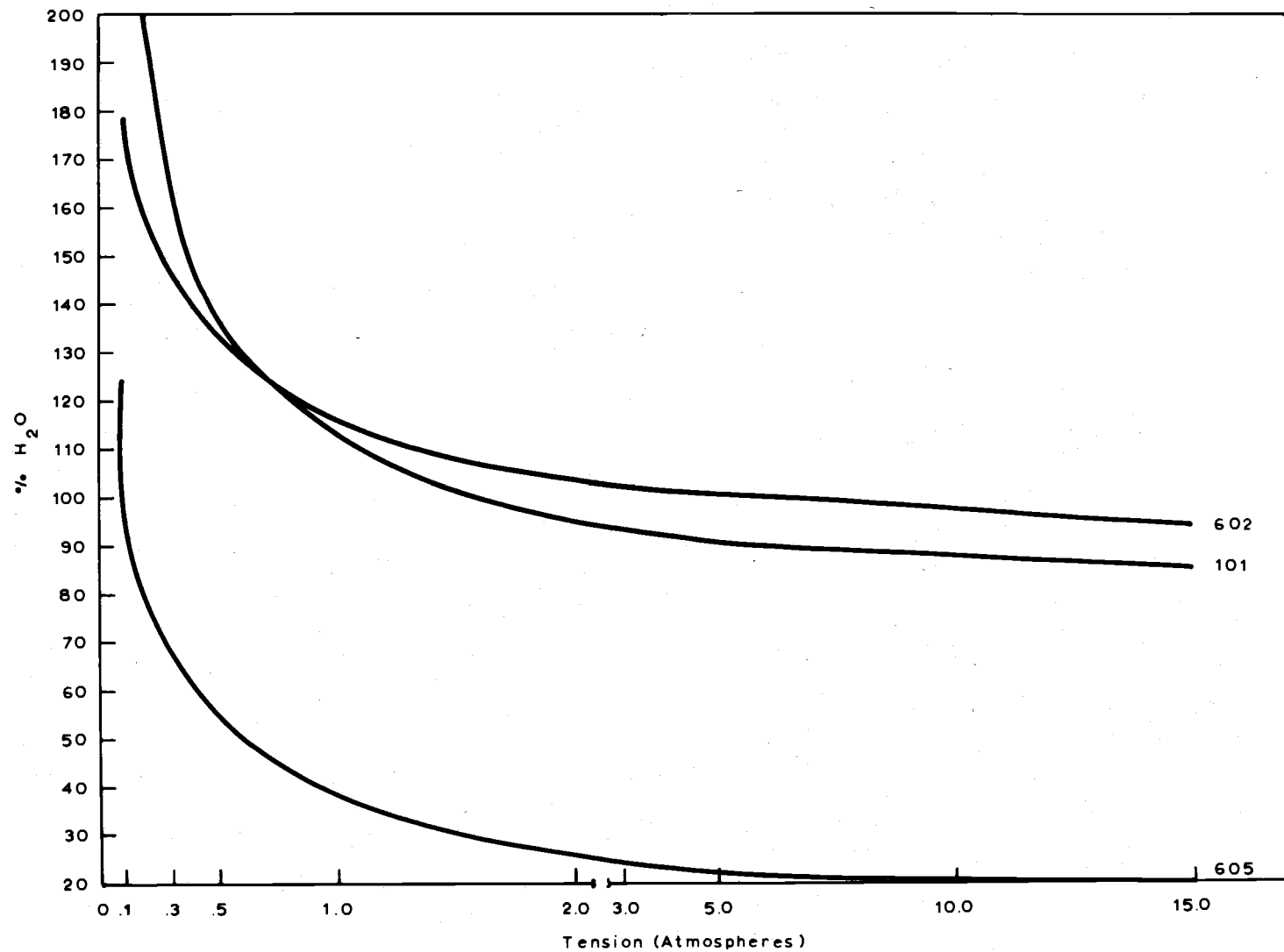


Figure 6. Moisture release curves for O1, O2, and mineral horizons high in organic matter, Findley Lake, Washington.