THE USE OF SOOT FOR SNOW REMOVAL PURPOSES

By
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For many years we have encountered difficulty in early springtime travel over the Kaiser Pass road between Huntington and Florence Lakes. This road is about twenty miles in length and reaches an elevation of 9,300 feet at the pass. Early last year I heard that the Company had cleaned the stacks at one of our steam stations and that disposal of this material seemed to be a problem. I then recalled the days of my youth in the East where snow removal by spreading of furnace ash and cinders was customary.

Accordingly, it was arranged to send some of this soot to Big Creek and experiment with it for acceleration of snow melt. The soot, which is slightly acid and in the presence of moisture will cause rapid deterioration of cloth sacks, was placed in old paper cement sacks. Each sack was filled about half full, and the top rolled down to prevent spilling on the truck haul to Big Creek. I might add that our personnel in the snow country almost melted the snow pack with their remarks when they first heard of the program and received about 400 sacks of soot.

On March 22, 1951, eight 10 foot by 10 foot test plots were marked out on the top of Huntington Lake Dam No. 3, elevation 6,950 feet. The amount of soot spread on each plot was as follows:

Plot No.	Weight of Soot (Approx.)
1	None
2	10 lbs.
3	None
4	5 lbs.
5	1 lb.
6	1/2 lb.
7	1/4 lb.
8	None

The day was exceptionally dry and clear, temperature about 45°F, and wind over plots about 10 m.p.h. The snow depth in the area averaged about 10 inches.

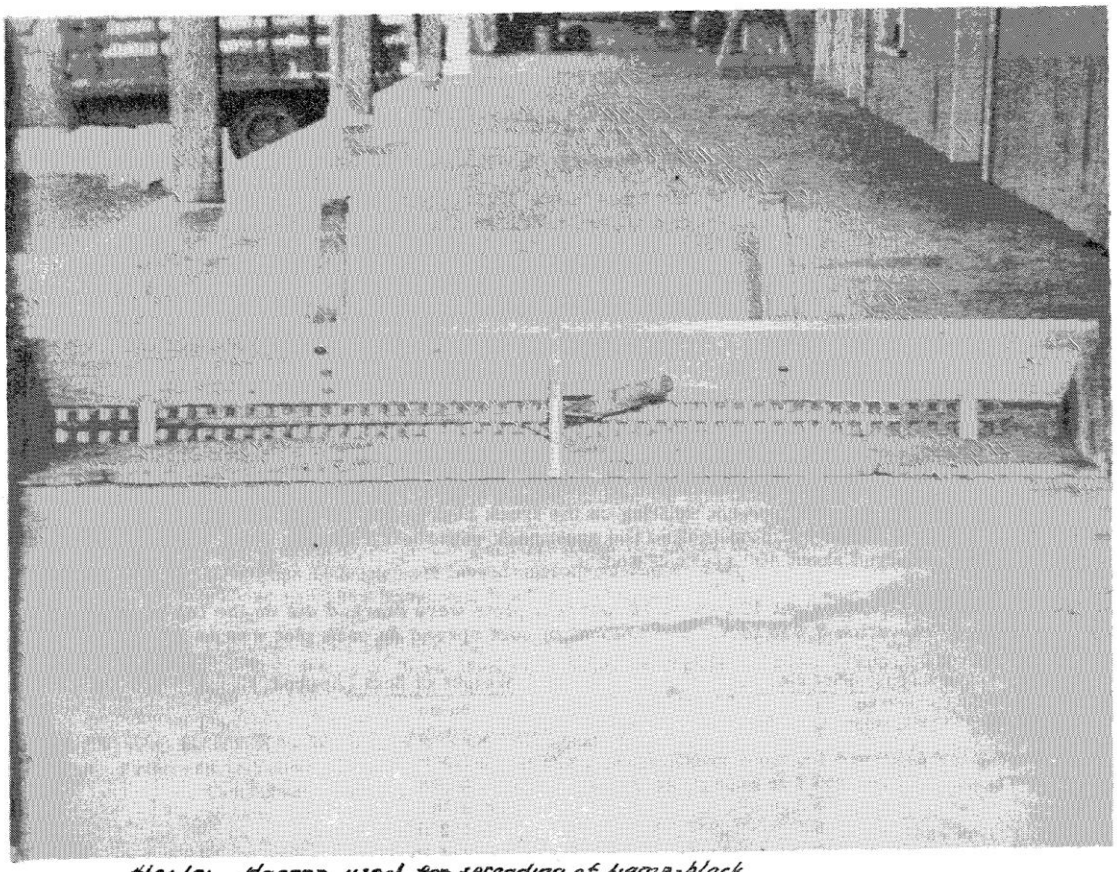
The snow depth and water content were measured with a sampler at the center of each plot (except plot #1 which was sampled at 1/4 way in from each corner) before applying soot and again after four hours. The sooting was done at about 11:00 a.m. It was difficult to spread the lighter amounts of soot evenly and consequently data for plot #6 have not been used because of the unevenness of the spread upon it.

Results of this first test were as follows:

Average decrease in snow depth, sooted plots:	2.5 inches
Average decrease in snow depth, clear plots:	1.3 inches
Average decrease in water content, sooted plots:	0.87 inches
Average decrease in water content, clear plots:	0.90 inches

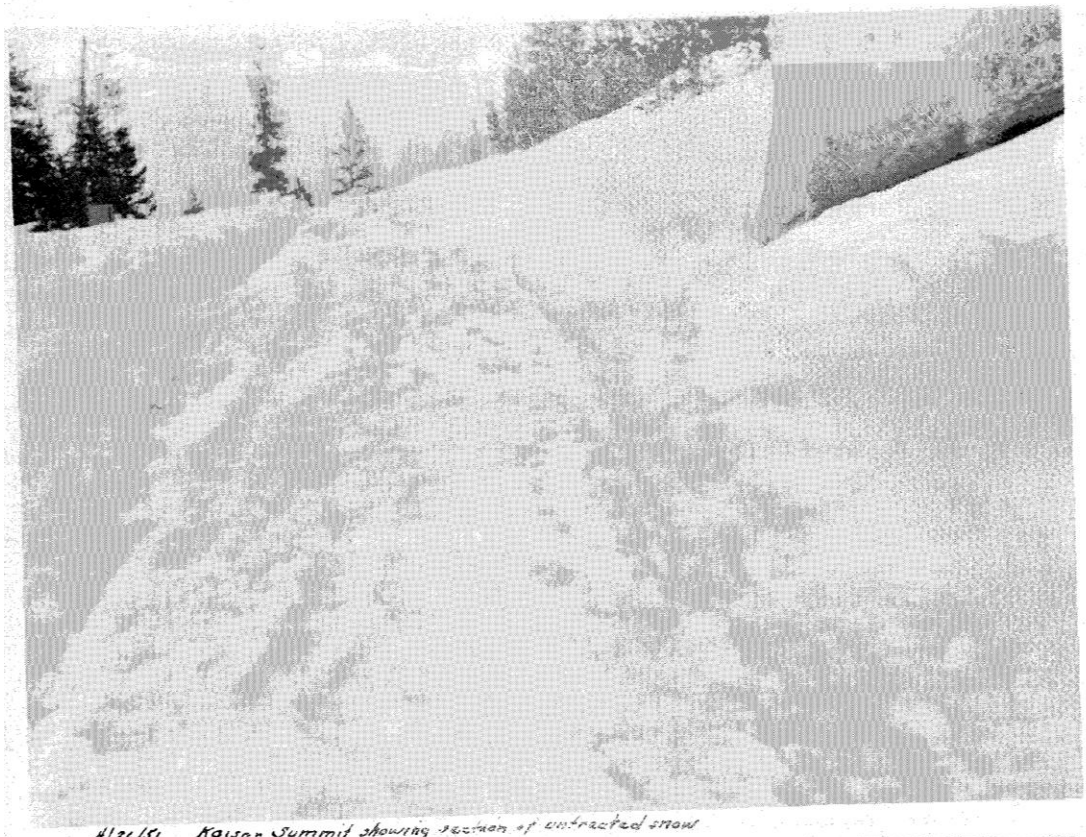
There was not much difference between the various sooted plots, but the greatest decrease in snow depth occurred in plot #5 (1 lb. per 100 square feet). This plot became bare in less than 28 hours, while all treated plots were bare in 31 hours. No intermediate observations were made as no one believed that such a rapid melting rate would continue through the night. During this period, the maximum temperature was 47°F and the minimum temperature was 22° F at Huntington Lake.

From the above results it appears that the rate of decrease in snow depth was almost twice as great on the sooted plots as on the clear plots. Also there was no significant difference in the decrease of water content. Apparently too much soot actually protects the snow to some extent. At 10 lbs. per 100 square feet the plot looked solid black while at 1 lb. it was grey and light grey with lesser amounts.

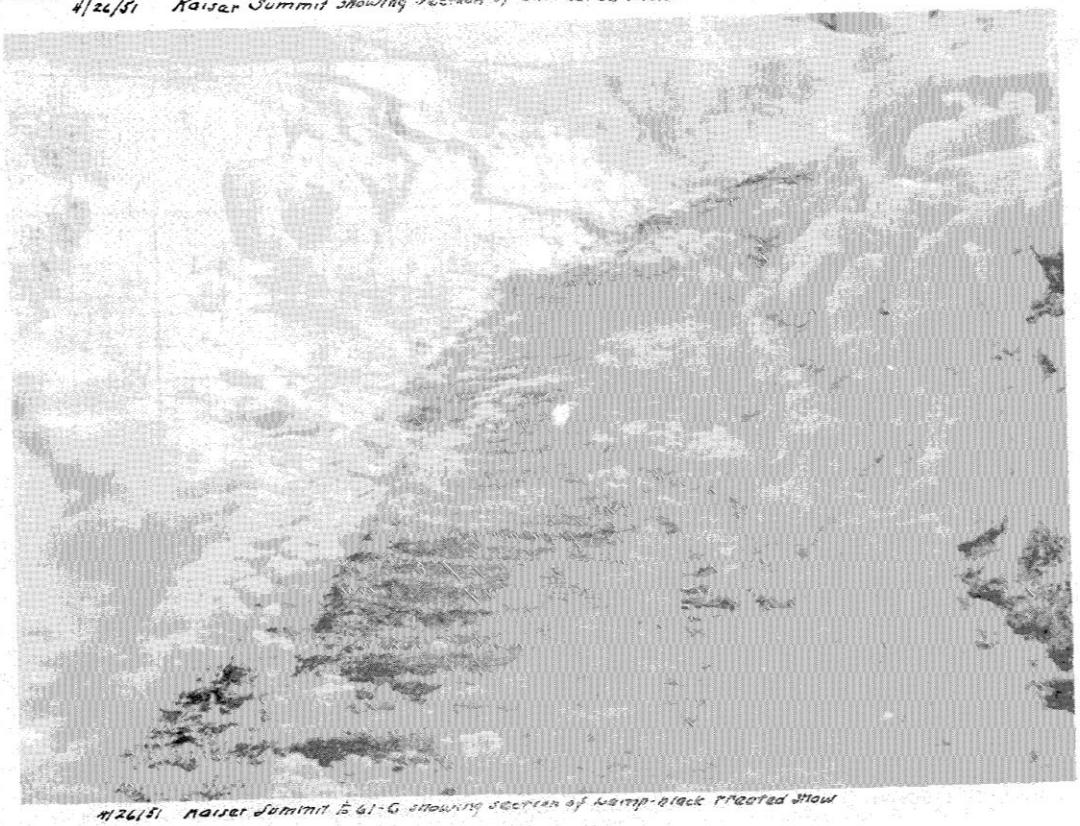


4/26/51 Hopper used for spreading of lamp-black

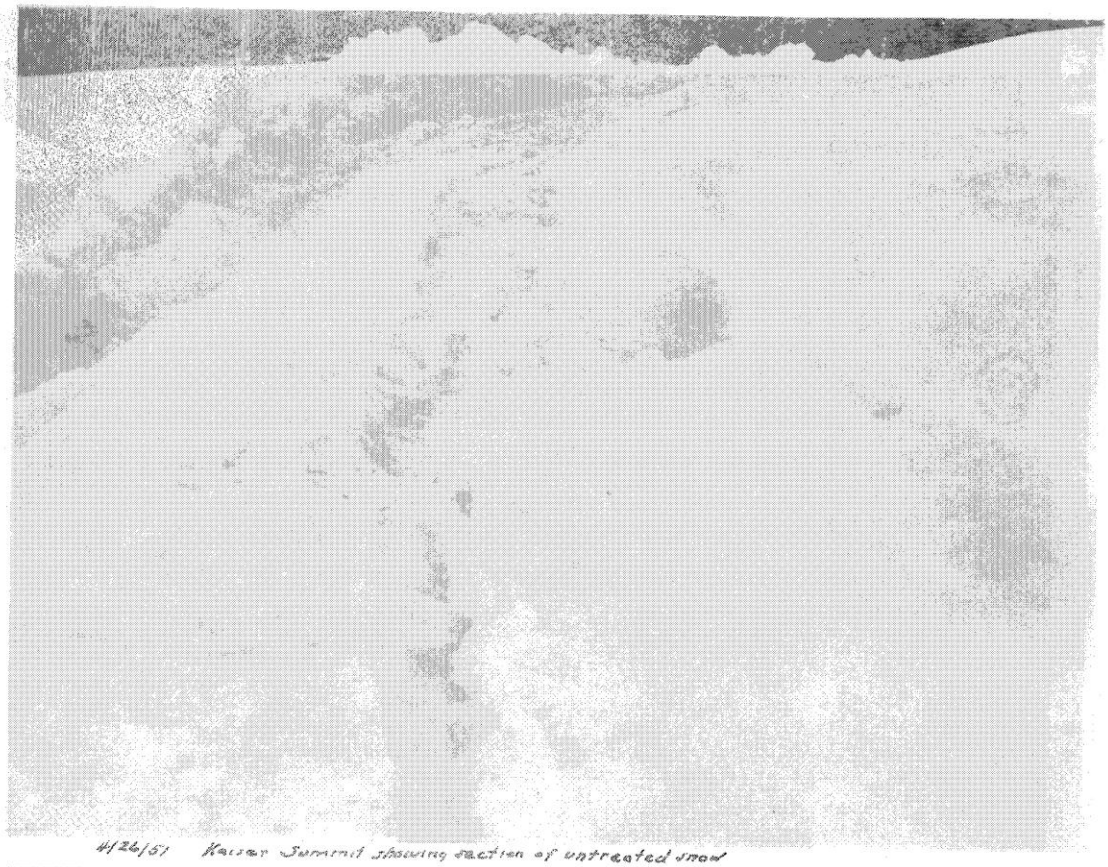
4/26/51 Kaiser Pass to 61-C showing section of lamp-black treated snow



4/26/51 Kaiser Summit showing section of untreated snow

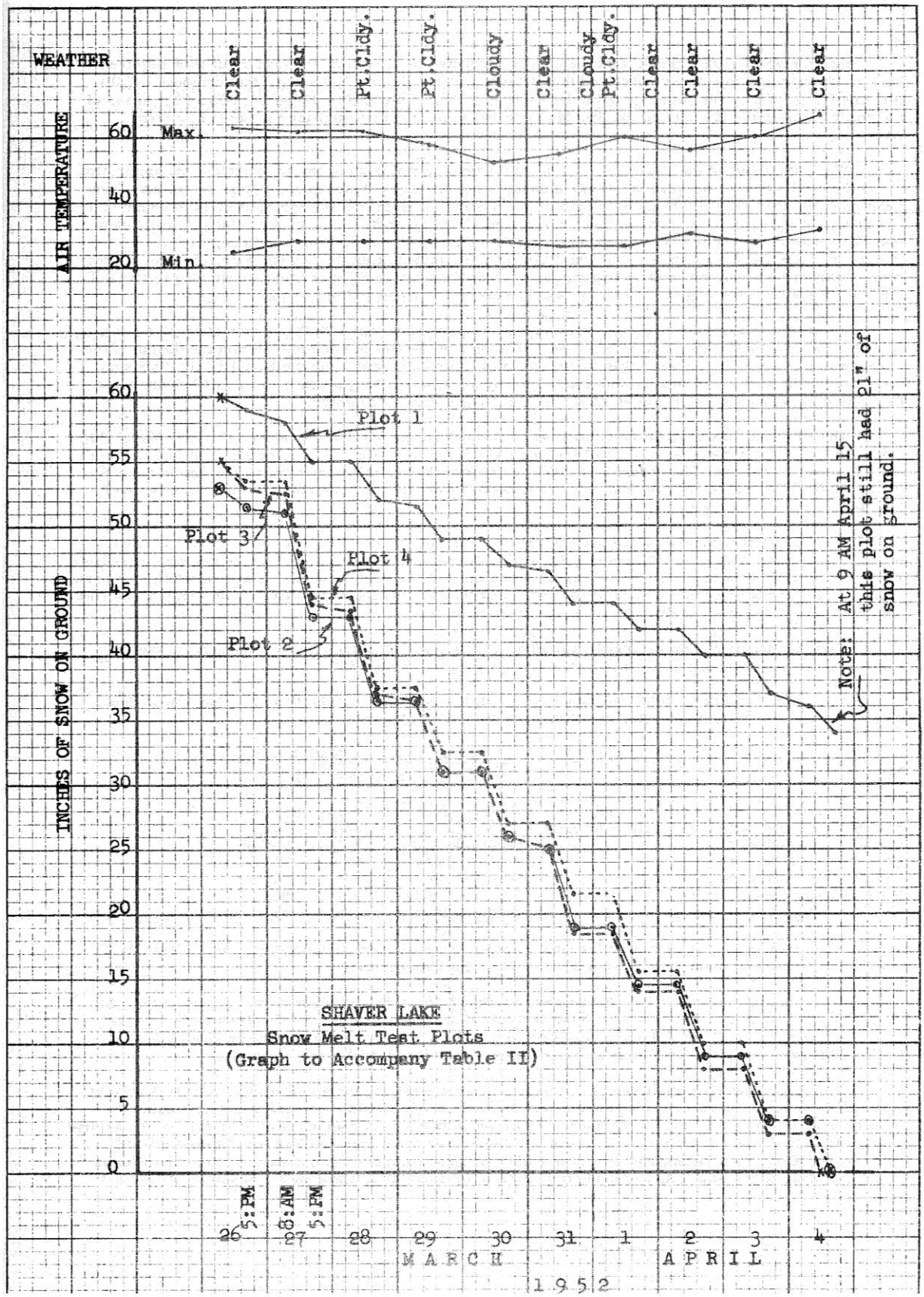


4/26/51 Kaiser Summit # 61-C showing section of wamp-black treated snow



4/26/51 Kaiser Summit showing section of untreated snow

4/26/51 Kaiser Summit to El-C showing section of lamp-black treated snow



SHAVER LAKE
Snow Melt Test Plots
(Graph to Accompany Table II)

Since the above experimental plot tests were conducted to determine the amount of soot required for a road clearing project, we concluded that a density of 1/4 lb. per 100 square feet or about 100 lbs. per mile for a 7-foot swath would give the best results. It was planned to dispense the soot by means of a spreader attached to the back of the Sno-Motor in the same way that fertilizer is spread by farm machinery.

We next contacted the Forest Service and requested permission to try an experimental application on the Kaiser Pass road between our Huntington and Florence Lake Reservoirs. This road climbs from 7,000 to 9,300 feet and then drops back down to the 7,000 foot level. In the spring it is quite common to find that most of the road is open but blocked here and there by drifts or closed by relatively deep snow near the summit. In order to transport men, supplies and equipment to Florence Lake, we have to operate the Sno-Motor as a shuttle over the Pass with unavoidable time delays and extra expense. It was to avoid the above or the alternative expense of road plowing in remote areas that we decided to attempt road clearance by spreading soot on early season Sno-Motor trips over this road.

As soon as Forest Service approval was obtained we proceeded with the construction of a crude spreader (See Photo #1) that could be attached to the rear of the Sno-Motor sled. While the design of the hopper was not too good, we were able to distribute the soot sufficiently for the initial trial. Soot was carried in sacks in the sled and fed into the hopper by workmen making a routine trip to Florence Lake. This was done without reducing the normal speed of travel of the Sno-Motor.

The first and only application of soot on sections of the Kaiser Pass road was made on March 30, 1951, during the first sno-motor trip to Florence Lake for that season. The amount of soot spread was approximately 10 lbs. per 100 square feet. While we knew that satisfactory results could have been obtained using a lesser amount of soot, the crude hopper used for this experiment would not effectively distribute a smaller amount.

Table #1 attached shows a comparison between the rate of snow melt on treated and untreated sections of road for a three-week period. You will note that the treated areas show an average increase in melting rate of about 50 percent. During the third week of this test, 4 inches of new snowfall was found on the control areas while only 1 inch of new snow was found in the treated roadway. No trace of the soot could be found on the ground after the area was clear of snow.

With the abundant snow crop now available, we are planning some other useful applications in addition to further experiments on the road clearance project during 1952.

A preliminary test at Big Creek was begun on March 22, 1952, at 11:40 a.m. when four 3-foot square test plots were laid out. Results of this test were as follows:

		Plot No. and Snow Depth in Inches			
Date	Time	1	2	3	4
3/22/52	11:40 a.m.	19	18-1/2	19	18-1/2
3/24/52	8:00 a.m.	9-1/2	9	9-1/2	15
3/25/52	8:00 a.m.	3-1/2	3	3	11-1/2
3/25/52	1:00 p.m.	1	1/2	0	10
3/25/52	2:00 p.m.	0	0	0	9-1/2
Treatment)	Amount - Quarts	3	1-1/2	3/4	None
)	Weight - Ounces	27	13-1/2	6-3/4	None

The temperature was 43° F at the time of soot application and the maximum ranged from 45°F to 72° F while the minimum ranged from 25° to 36° during this period.

A second test was started at Shaver Lake on March 26, 1952, where four 3-foot square test plots were laid out. Results of this test are shown in Table II attached. This test indicates that the treated snow plots were bared of about 4-1/2 feet of snow while the untreated plot was reduced about 2 feet in depth. The untreated plot still had 21 inches of snow remaining at 9:00 a.m., April 15.

We believe that snow melt can be accelerated considerably by the application of soot (lampblack) to the snow cover in the early spring months and that only small amounts are necessary to obtain the desired results. With redesign of the hopper spreader so that smaller amounts of material can be applied on regular trips of the Sno-Motor, it is hoped that the Kaiser Pass road can be opened to truck traffic at an earlier date with a consequent saving in labor and snow equipment maintenance. Consideration is also being given to the possibility of using this method for controlling snow melt - runoff on watershed

areas.

We, therefore, contemplate continuing our experiments on road clearance and are also using applications of soot to accelerate snow melt at various hydraulic structures to eliminate or reduce the expense involved in digging them out.

TABLE NO. I

RATE OF SNOW MELT - UNTREATED VS. TREATED SNOW

Station	March 30, 1951		April 5, 1951		April 13, 1951		April 20, 1951	
	Untreated Depth Of Snow (Inches)	Treated Depth Of Snow (Inches)	Untreated Depth Of Snow (Inches)	Treated Depth Of Snow (Inches)	Untreated Depth Of Snow (Inches)	Treated Depth Of Snow (Inches)	Untreated Depth Of Snow (Inches)	Treated Depth Of Snow (Inches)
1.) Snow Bend Area 1/4 Mi. 7,500'	33	22	28	0	8	0	0	0
2.)	30	18	28	10	14	6	0	0
3.)	36	30	36	28	25	18	13	6
4.)	44	32	38	30	30	9	12	0
5.)	31	20	30	18	24	10	15	6
6.)	30	20	24	14	12	0	0	0
7.)	31	24	30	18	14	0	0	0
8.) Badger Flat Area 8,500'	36	32	36	24	20	4	15	0
* 9.)	40	30	36	27	18	10	6	0
10.)	36	30	36	28	28	14	20	10
*11.)	40	30	36	28	28	24	24	20
12.) K.P. to 61C Area 9,000'	72	52	68	42	56	18	48	6
13.)	84	65	78	54	72	33	64	24
14.)	78	54	73	48	64	26	60	20
15.)	84	56	80	54	76	46	72	40
Seasonal Precip at Hunt. Lake	35.55		35.57		35.62		36.15	

Untreated Depth = Depth of untreated snow, in inches, located adjacent to road. Rate of melt would be that due to natural causes only.

Treated Depth = Depths in center of roadway resulting from lampblack treatment and compaction caused by Sno-Motor travel. (Since the initial compaction by Sno-Motor on March 30, subsequent trips caused only minor compaction -- one or two inches).

* Stations 9 and 11 - Located where sun time is maximum, and were not treated with lampblack.

W. A. Lang
April 15, 1952

TABLE II

SHAVER LAKE SNOW MELT TEST

MARCH, 1952

Date	Weather	Temperature Max.	Temperature Min.	PLOT #1 Untreated 8:00 A	PLOT #1 Untreated 5:00 P	PLOT #2 3 qts. or 27 oz. 8:00 A	PLOT #2 3 qts. or 27 oz. 5:00 P	PLOT #3 1-1/2 qts or 13-1/2 oz. 8:00 A	PLOT #3 1-1/2 qts or 13-1/2 oz. 5:00 P	PLOT #4 3/4 qt. or 6-3/4oz. 8:00 A	PLOT #4 3/4 qt. or 6-3/4oz. 5:00 P
3/26	Clear	63	25	*60	59	*53	51-1/2	*55	53	*55	53-1/2
3/27	Clear	62	28	58	55	51	43	52-1/2	44	53	44-1/2
3/28	Pt. Cloudy	62	28	55	52	43	36-1/2	43-1/2	37	44-1/2	37-1/2
3/29	Pt. Cloudy	58	28	51-1/2	49	36-1/2	31	36-1/2	31	37-1/2	32-1/2
3/30	Cloudy	53	28	49	47	31	26	31	26	32-1/2	27
3/31	(AM Clear (PM Cloudy (AM Pt. Cldy.	57	26	46-1/2	44	25	19	25	18-1/2	27	20-1/2
4/1	(PM Clear	60	26	44	42	19	14-1/2	18-1/2	14	20-1/2	15-1/2
4/2	Clear	56	30	42	40	14-1/2	9	14	8	15-1/2	10
4/3	Clear	60	27	40	37	9	4	8	3	10	4
4/4	Clear	67	31	36	34	4	(Bare 2 PM)	3	(Bare 11:30 AM)	4	(Bare 2 PM)

* First readings are at 3:00 PM, March 26.

Note: The readings for Plots 2, 3 and 4 have been corrected to ground level datum. Readings for Plot 1 are subject to an unknown correction of approximately 6 inches for depth of stake in ground. At 9:00 AM, April 15, plot #1 snow depth was 21 inches.

W. A. Lang/ca
April 15, 1952

DISCUSSION

By
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The results obtained by Mr. Lang in using one of the procedures recently classified as "Unconventional Methods of Snow Removal" is not only interesting but exceptionally timely as far as the Snow, Ice and Permafrost Research Establishment is concerned. This Establishment has been asked to lead a discussion on "Unconventional Methods of Snow Removal" before a panel of civilian and military personnel representing all branches of the Armed Forces in Washington following this meeting of the Western Snow Conference.

Although the literature on this subject is not very extensive, some of the available reports indicate that covering a snow surface with a foreign material in an effort to increase the heat absorption and hasten melting may actually defeat the intended purpose.

Soot, fine powdered coal and black organic matter in the form of dry muck or peat have thermal conductivities in the order of 10^{-4} gm. cal./cm^2/sec. This is about the same as for a good rock wool insulation commonly used in house construction to prevent passage of heat. If soot is spread too thickly over snow, the solar heat which it absorbs at the surface may never reach the snow. Also, since solar