SOME EFFECTS OF MT. ST. HELENS ON POTATOES

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On May 18, Mount St. Helens erupted sending many tons of ash across the continental United States including Washington, Idaho, and Montana. The eruption resulted in approximately 12% of the mountain being removed and reduced the elevation of the summit by 1270 feet. This and following eruptions distributed material throughout the state of Washington to various depths, from a trace to several inches deep. The current dry ash depth throughout the state is shown in Figure 1.

This massive redistribution of scenic real estate had considerable effect on agriculture. There was an immediate effect on plants, man and equipment. There are also potential short and long-term effects on agricultural soils. However, the most widely referred to effect of the eruption on plants in the massive destruction of timber from the blast force.

The effects of the eruption and the ensuing fallout can be classified into several categoeies: 1) Direct physical effects on plants due to presence of ash, i.e., physical pressure or direct weight effect and abrasion, 2) Physiological effect due to presence of ash, i.e., a) reduction in rate of photosynthesis due to shading of leaves, b) chemical burning of plant tissue, c) reduced soil temperature due to increased reflectance of light from ash covered soil and the insulation effect of ash cover on soil, 3) Physical effect(s) of ash deposit on soil, i.e., water infiltration, water holding capacity, and erosion.

Physical Effects on Plants:

In the very deep ash fallout areas (see Fig. 1) potato plants were simply mashed down due to the weight of the ash present. This effect was rapidly negated either due to washing effect of sprinkler irrigation application or to plant movement (shaking) from wind. There was no observed detrimental effect from this situation. However, the wetting of leaf surfaces either from rain or sprinkler irrigation resulted in the ash material sticking to the surface of leaves. This material became similar to sandpaper and caused necrotic areas where the leaves rubbed against one another. Although the occurrence of these necrotic areas was quite widespread throughout the fallout area, no real detrimental effect was considered to have resulted.

Physiological Effects on Plants:

Although the physical effect of the ash on potato plants was obvious and easily observable it is reasonable to expect the physiological processes of these same plants to have been altered. This expectation is further enhanced by data from apple leaves obtained by WSU Horticulturist, Dr. Robert Kennedy. [1/] Data from Dr. Kennedy's lab in Pullman shows that apple leaves covered with 1.0 mm (1 inch = 25 mm) of volcanic ash suffered a reduction in photosynthetic rate of 95% (essentially shutting down the plants carbohydrate manufacturing system). An ash thickness of .01 mm reduced photosynthetic rate only 6% and after these lightly covered leaves were washed there was no effect on photosynthetic rate. Very limited measurements of photosynthetic rate of ash covered (amount undetermined) potato leaves vs non-covered, indicated no measurable reduction in rate (Bill Dean - unpublished data, personal communications). Although Dr. Kennedy also reported some longer term effects of the ash fall on apple trees there is no reason to believe that the effect of the ash on potato leaves caused a detrimental effect on the potatoes growing in the fallout area.

Observation also showed that there were occasional incidences in which potato leaves suffered chemical burn due to the presence of ash. This is not surprising since the soluable salt content of the ash ranged from 4.5 to 7.0 millimhos/cm.[2/]

The presence of ash on the soil resulted in a reduction in soil temperature of from 4 to 10°F. [3/] The reduction in temperature resulted from the increased reflectance of light and heat from the soil surface by the light colored ash and from the effect of the ash layer acting as an insulation material. Whether the reduction in soil temperature was detrimental or beneficial to the plants growing in the fallout area depended on whether the crop was a cool or warm season plant. Potatoes are generally considered a cool season plant and would therefore be expected to benefit from a reduction in the high temperatures generally experienced in the Columbia Basin of Washington during a "normal" growing season. However, the 1980 growing season in general was cooler than "normal" and therefore no direct detrimental or beneficial effect of the ash fallout can be assessed.

Physical Effect(s) on Soil:

The May 18th and subsequent eruptions resulted in the soil over many acres of Washington being covered with varying depths of ash (Table 1). A Soil Conservation Service Report[4/] stated that - the ash will probably increase the water holding capacity of most of the soils. The finer textured volcanic ash may hold about 4 inches per foot (0.33 inches per inch of ash) of available water. [5/] The ash layer also acted as a mulch over the ground surface and hindered moisture movement from soil by evaporation. [4/] Both of these aspects would have the effect of reducing the amount of irrigation needed.

The presence of ash cover on the soils (Fig. 1) had an effect on the infiltration rate of water into the soil. Studies show that the fine ash areas of eastern Washington irrigated land (Fig. 2) suffered a 38 percent decrease in infiltration rate while the coarse ash areas (near Yakima) showed a 19 percent decrease in infiltration rate.[4/] Soil Conservation data indicated that unincorporated ash is more erosive than the soil it covers. "Erosion is expected to increase two to nine times in the fine ash areas."[4/] Washington State University reports that runoff and flooding would either be not effected or increased only slightly and that normal conservation tillage should eliminate most of the ash influence on infiltration.[4/] Unincorporated ash is more erosive than the soil it covers.[4/] All of these aspects substantiate the logic of incorporation of the ash material wherever practical to reduce physical effects. "Plow-disking tended to leave the surface free of ash but resulted in a layering or feathering effect depending upon speed of plowing. The layered ash may tend to impede the soil permeability similar to a plow pan."[4/]

Tests of wind erosion potential were conducted in fine and coarse ash areas in irrigated cropland and non-irrigated cropland. The test on irrigated cropland fine ash areas (see Fig. 2) showed that incorporating ash into high wind erosion hazard soils did not have much positive or negative effect. Presence of ash on highly wind erosion hazard sandy soils had little or no effect on wind erosion hazard. Silt loam soils with slight wind erosion hazard did not increase in wind erodibility with ash. This allows one to conclude that ash has less influence on wind erodibility of irrigated soils than effects of management variables such as tillage, timing of farm operations, and moisture content.[4/] In coarse ash irrigated cropland areas depth of ash up to .5 inch did not appear to increase erodibility after incorporation.[4/]

Chemical Effects on Soil:

With the tonnage of ash deposited ranging from a trace to over 100 T/A (Fig. 3) the chemical makeup of the ash and its effect on the nutrient content of the soil it covers, becomes of concern. The general cultural practices employed in the potato industry are such that incorporation of the ash becomes a significant consideration of the effect of the ash. Depth of incorporation will undoubtedly be a major factor to consider. Table 2 indicates the amount of soil that is involved in various depths of incorporation.

When an ash layer is present the incorporation process becomes a dilution of the ash with soil. The dilution effect of incorporating 10T and 100T of ash to three depths is shown in Table 3.

Preliminary greenhouse studies where potato seed pieces were germinated in volcanic ash from both Pullman and Othello showed that 100% ash from either location essentially prevented germination. This ash had not been leached nor had fertilizer been added. Ash and soil at 50 percent reduced germination substantially and ash at 25 percent and soil at 75 percent had no apparent detrimental effect. When this was followed up using ash that had been exposed to irrigation and rain and fertilizer nutrients were added there was no detrimental effect on the germination and growth of greenhouse grown potato plants.[6]

Dr. A. H. Halvorson, WSU Soil Testing Lab, has made some comparisons of the chemical nutrient content of ash compared to the soil on which it was deposited and concluded that in general the makeup is the same.[7] An example is shown in Table 4.

The major differences where ash chemical content is higher than the soil content is Copper (Cu), Boron (B) and Sulfur. All these materials are plant nutrients and all except Copper are a regular part of the fertilizer program for irrigated potato production. Therefore, it appears there is no need to consider the chemical content of the ash to be a hazard.

Given all the information that is currently known about the effect of the ash from the May 18 and following eruptions of Mount St. Helens there is no reason to conclude that there was a detrimental effect on the potato crop produced in Washington in 1980. The fact that the per acre average production of 505 CWT per acre is higher than ever would tend to substantiate that conclusion. Also given what is known about the possible long-term effects on soil there is no anticipated detrimental effect from this aspect either.

References

1. Robert A. Kennedy, "The Eruption of Mount St. Helens: Impact on Agriculture and the Effects of Mount St. Helens Ash on Plants." Scientific Paper; College of Agriculture, WSU.

2. A.R. Halvorson, "Ash Samples." Washington State University Cooperative Extension Service Special Report. June 18, 1980.

3. T.J. Smith, unpublished data; personal communications.

4. Mount St. Helens Ash Fallout Impact Assessment Report. USDA Soil Conservation Service; Spokane, Washington. September 1980.

5. Jerry D. Schwien, Head of Information Staff, Midwest Technical Service Center; SCS Lincoln Nebraska; Soil and Water Conservation News. September 1980, Vol. 1, #6 as cited in citation #4.

6. B.B. Dean, unpublished data; personal communications.

7. A.H. Halvorson, unpublished data; personal communications.

Table 1. Area Covered by Ash in Acres and Tons

Acres Covered by Ash (Ton/Acre)	Acres	Tons
100	1,397,000	140,000,000
100-75	1,027,000	89,862,000
75-50	1,877,000	117,293,000
50-25	2,644,000	99,145,000
25-trace	21,655,000	270,700,000
TOTAL	28,600,000	717,000,000

From: Mount St. Helens Ash Fallout Impact Assessment Report, USDA Soil Conservation Service, Spokane, Washington; September 1980.

Table 2. The Amount of Soil in an Acre Furrow Slice of Various Depths

3" = 1,000,000

6" = 2,000,000

12" = 4,000,000

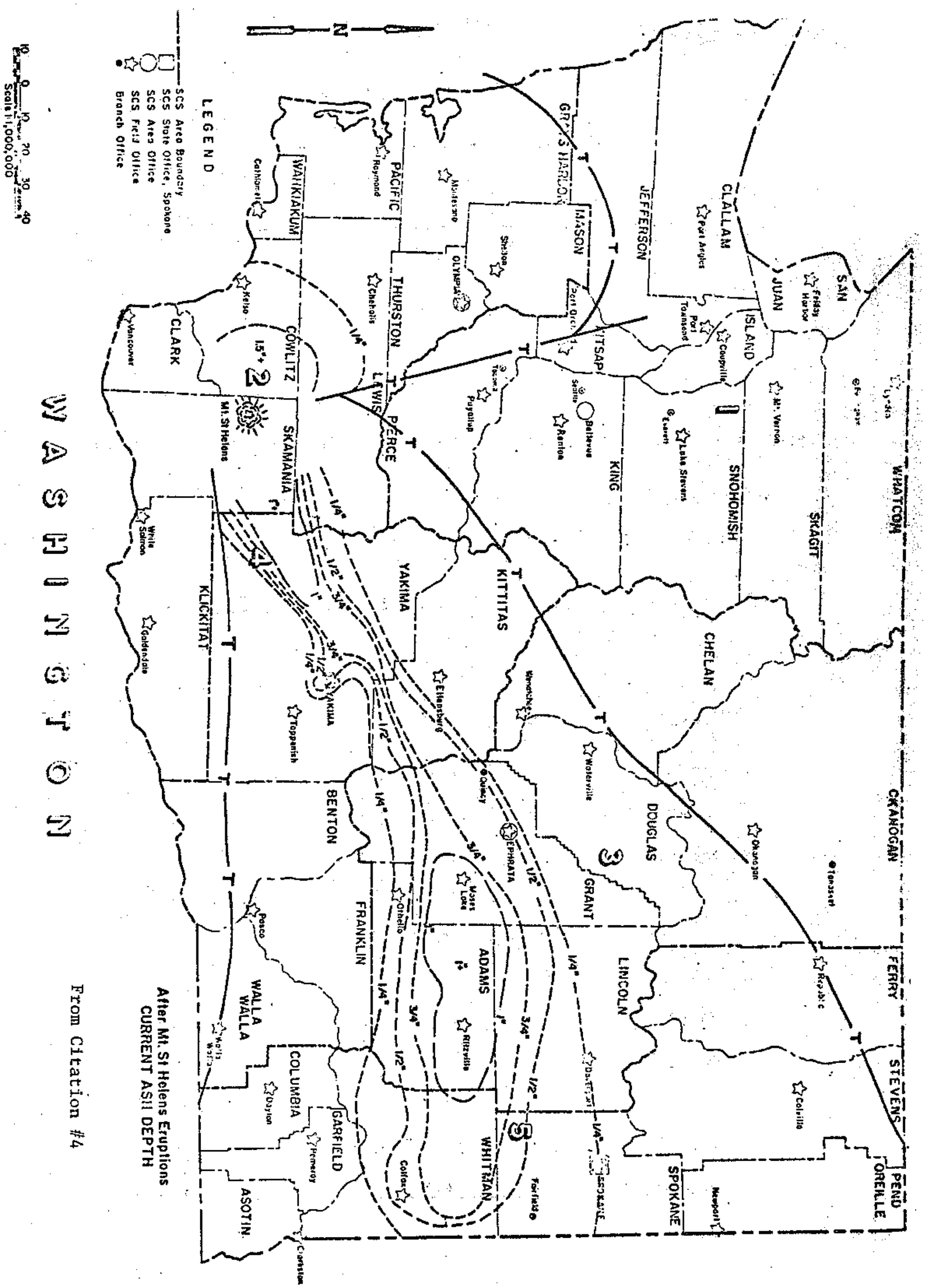
Table 3. Dilution Effect of Incorporating Volcanic Ash Into Soil at Different Depths

	Incorporation Depth		
Ton/A	3"	6"	12"
10	1/50	1/100	1/200
100	1/5	1/10	1/20

Table 4. Chemical Comparison of Content of Ash and Soil near Pullman, Washington

	Ash	Palouse Soil
pH	5.6 - 6.3	5.5 - 6.8
O M%	0	2.5 - 3.5
P (PPM)	1-3	1-12
K (PPM)	90-160	75-300
Ca (Meg/100g)	2.7 - 4.5	7-10
Mg (Meg/100g)	0.4 - 0.7	1-3
Cu (PPM)	3.0 - 5.0	0.5 - 2.0
B (PPM)	0.85- 1.2	0.2 - 0.5
Mn (PPM)	10.0 -16.0	1.0 -20.0
Zn (PPM)	0.5 - 0.8	0.15- 0.8
Fe (PPM)	14.0 -20.0	2-50
Cd (PPM)	0.03- 0.05	0.05- 0.2
S (PPM)	200-450	1-10
Soluable Salts	4.5 - 5.5	0.3 - 0.8

Figure 1.



From Citation #4

Figure 2.

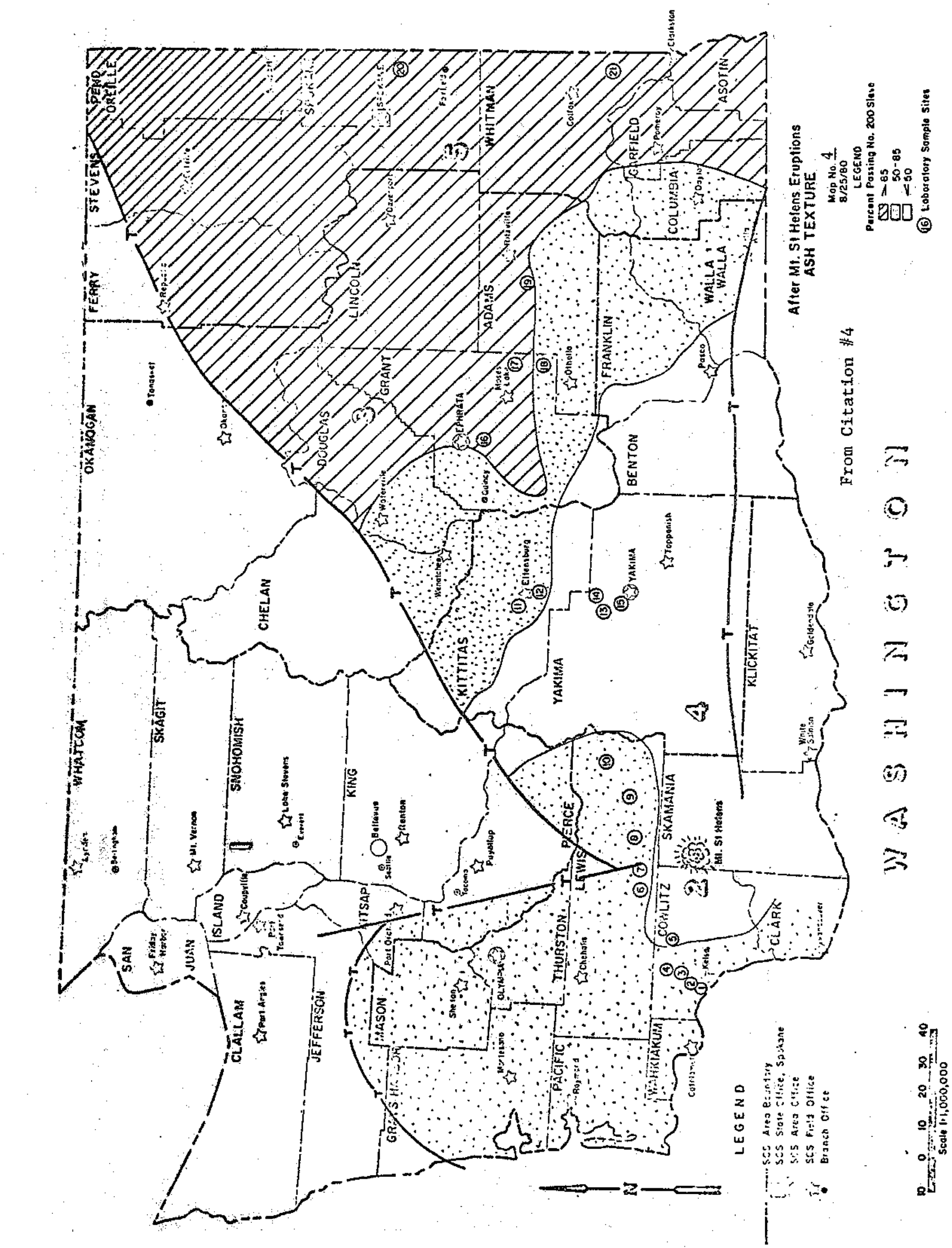
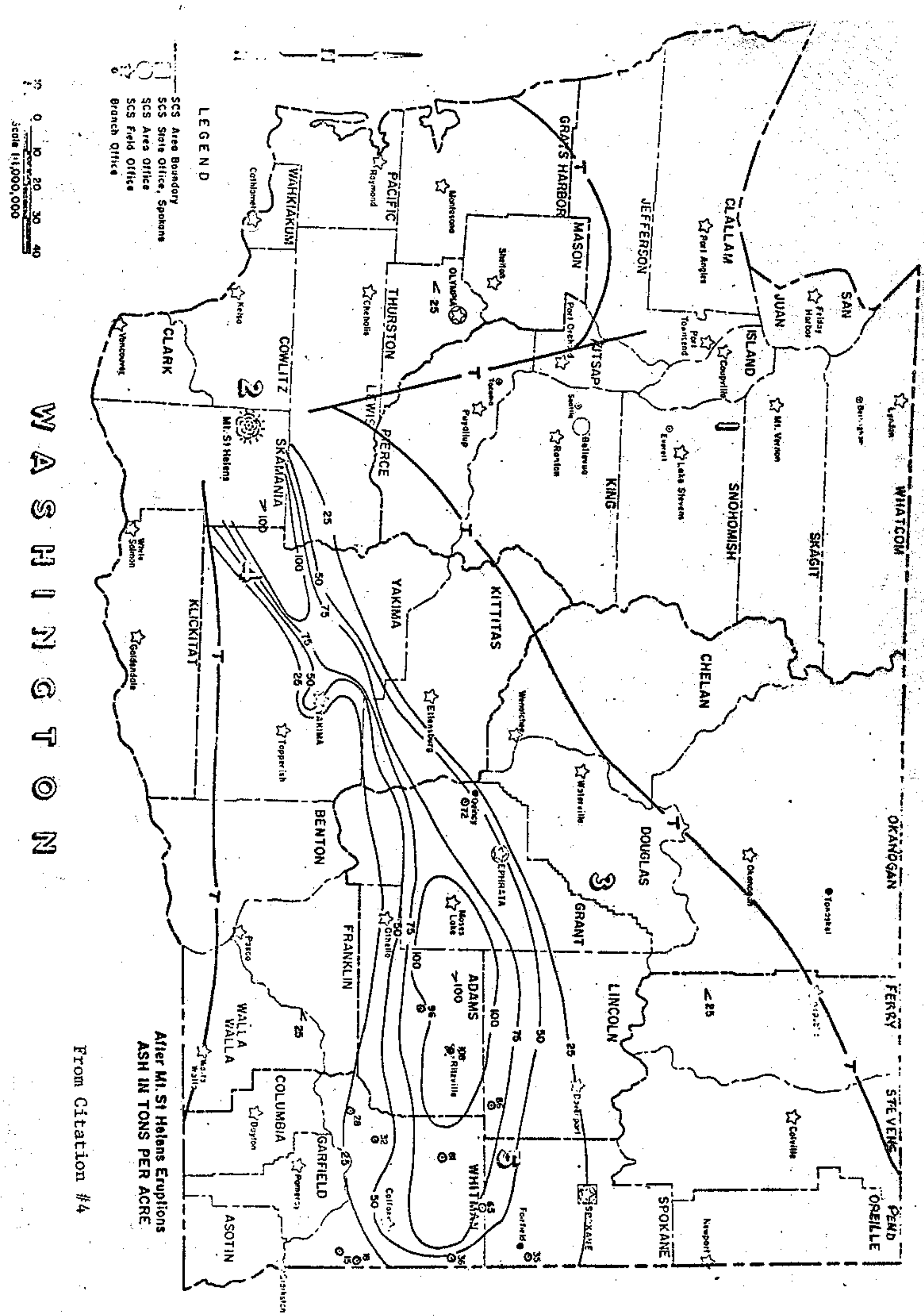

After Mt. St Helens Eruptions
ASH TEXTURE
Map No. 4
8/25/80
LEGEND
Percent Passing No. 200 Sieve
>85
50-85
<50
Laboratory Sample Sites
From Citation #4
WASHINGTON
LEGEND
SCS Area Boundary
SCS State Office, Spokane
SCS Area Office
SCS Field Office
Branch Office
Scale 1:1,000,000
OKANOGAN
FERRY
STEVENS
PEND OREILLE
WHATCOM
SKAGIT
SNOHOMISH
KING
CHELAN
DOUGLAS
GRANT
LINCOLN
ADAMS
WHITMAN
FRANKLIN
BENTON
KITTITAS
YAKIMA
KLICKITAT
SKAMANIA
PIERCE
LEWIS
COWLITZ
CLARK
THURSTON
MASON
PACIFIC
WAHKIAKUM
JEFFERSON
CLALLAM
SAN JUAN
ISLAND
KITSAP
GARFIELD
COLUMBIA
ASOTIN
WALLA WALLA
Mt. St Helens

Figure 3.



From Citation #4