

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE - Regional Technical Service Center

7600 West Chester Pike, Upper Darby, Pennsylvania 19082

March 15, 1972

TSC TECHNICAL NOTE - WATERSHEDS - UD-28

Re: Economics - A Manual Procedure to Estimate Annual Crop and Pasture Flood Damages

The purpose of this technical note is to transmit an alternative procedure for estimating annual flood damages to crops and pastures. This procedure utilizes tables, graphs, and the same computational approach as the ECONOMICS 2 computer program. This procedure does not replace the ECONOMICS 2 program. It is an alternate method to the ECONOMICS 2 program and its use should be especially considered in projects where few alternatives are to be considered.

Where standard data, such as contained in TSC TECHNICAL NOTE - WATERSHEDS - UD-16 and 20, is used to compute damages, this procedure generally compares favorably in time, accuracy, and cost with the ECONOMICS 2 computer program. The added advantage is the ability to maintain familiarity with the computation process. Once the graphic or tabular work is completed for the various yields of each crop, non-technical personnel may be used to make all additional computations.

Attached are figures and tables showing the step-by-step use of this procedure using standard data in the example.

The Northeast Watershed, USA example has one damage reach. Reach A, consists of three cross-sections. Flood plain crops include corn grain, corn silage, wheat, oats, hay and pasture. Five percent of the flood plain is in miscellaneous use.

For each crop the floodwater damages as a percent of flood-free gross returns, by months, were taken from crop and pasture standard data contained in TSC TECHNICAL NOTE - WATERSHEDS - UD-16 for 0-2' and over 2' depths for the Southern portion of the Northeast region. Flood-free gross returns were computed as the product of the adjusted normalized price per unit times the yield per acre.

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SOIL CONSERVATION SERVICE
Morgantown, W. Va.

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For each flood depth, the monthly probability of flooding was taken from TSC TECHNICAL NOTE - WATERSHEDS - UD-20. By multiplying each of the monthly damage rates by the flood-free gross returns and thence by the corresponding monthly probability of flooding, a product representing the weighted damage for each crop is obtained by summing the monthly weighted damage estimates separately for each flood depth. This procedure was followed for each crop in the example reach (see TABLES 1-6).

Next, graphs were prepared for each crop by plotting the 100% land use weighted damage estimates for the 0-2' and over 2' depth. A straight line was drawn from the origin through these two points. Because of the direct linear relationship existing between the percent land use and the weighted damage using standard data, no other intermediate calculations are necessary (see Figures 1-6).

It is important to note that each graphed line is applicable for a given yield level only. The applicable flooding depth and yield level should be made explicit by posting this information directly on each of the graph lines.

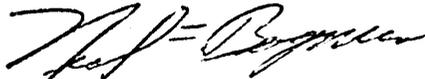
Although not shown on the example graphs, it is recommended that two additional lines representing high and low yield levels be plotted on each graph for maximum use. Damages for other yield levels within this range can be determined by graphic interpolation.

The next step involved listing the percent land use for each cross section to be evaluated in the reach. Assuming homogenous land use for the three cross-sections in the Northeast Watershed, one listing for the reach will suffice. The objective now is to determine the weighted damage for each of the two flood depths taking into consideration the percent land use of each crop. From reading the prepared graphs for each crop, the weighted damage for each applicable percent land use can be estimated for the 0-2' and over 2' depths. Summation for all crops gives a composite weighted damage value for each flooding depth (see TABLE 7). These damage values for 0-2' and over 2' become constants to be applied against each acre inundated within each depth range.

Next, data was obtained from the hydrologist on acres flooded, by depth increments, for various elevations. This data was used in conjunction with elevation-discharge and discharge-frequency information to determine the acres flooded by depth increments by flood frequency events. By applying the damage per acre against acres flooded, by depth increments, and summing for each percent chance flood event, a damage-percent chance relationship is established as shown in TABLE 8.

Average annual damage can be computed directly from one of several methods. In TABLE 9 of the attachment the percent chance-interval method of computing average annual damage was used. The annual damage estimates should be adjusted, as applicable. In the example, the damage estimate was adjusted for reoccurrence of flooding as the partial duration series was used in establishing the percent chance of flood events.

The advantage of using the attached described procedure is that once the weighted damage versus percent land use graph lines are prepared for various yield levels, the composite damage for any combination of cropland or pastureland use in any reach can be obtained without making additional calculations.



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Engineering and Watershed
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Attachment

NORTHEAST WATERSHED, USA
Computation of Weighted Flood Damage
Corn Grain

Yield 100 bushels
Price per bushel \$1.36/bushel in adjusted normalized prices
Gross return flood free \$136.00/acre

0-2' depth

<u>Month</u>	<u>Damage Rate</u> ^{1/}	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods</u> 2/	<u>Weighted Damage/Acre</u>
April	.01	\$136	.13	.18
May	.06	\$136	.07	.57
June	.28	\$136	.06	2.28
July	.21	\$136	.03	.86
August	.08	\$136	.03	.33
September	.03	\$136	.03	.12
October	.02	\$136	.03	.08
				<u>\$4.42</u>

over 2'

<u>Month</u>	<u>Damage Rate</u> ^{1/}	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods</u> 2/	<u>Weighted Damage/Acre</u>
April	.01	\$136	.13	.18
May	.08	\$136	.07	.77
June	.41	\$136	.06	3.35
July	.56	\$136	.03	2.28
August	.26	\$136	.03	1.06
September	.18	\$136	.03	.75
October	.14	\$136	.03	.57
November	.03	\$136	.04	.16
				<u>\$9.12</u>

1/ From TSC Technical Note-Watersheds-UD-16, Table 10 (Southern portion of NE) or as adjusted.

2/ From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.

NORTHEAST WATERSHED, USA
Computation of Weighted Flood Damage
Corn Silage

Yield 20 tons
Price per ton flood free \$8.40/ton in adjusted normalized prices
Gross return \$168.00/acre

0-2' depth

<u>Month</u>	<u>Damage Rate</u> ^{1/}	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods</u> ^{2/}	<u>Weighted Damage/Acre</u>
April	.01	\$168	.13	.22
May	.02	\$168	.07	.24
June	.17	\$168	.06	1.71
July	.22	\$168	.03	1.11
August	.09	\$168	.03	.45
September	.01	\$168	.03	.05
				\$3.78/acre

over 2'

<u>Month</u>	<u>Damage Rate</u> ^{1/}	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods</u> ^{2/}	<u>Weighted Damage/Acre</u>
April	.01	\$168	.13	.22
May	.02	\$168	.07	.24
June	.24	\$168	.06	2.42
July	.58	\$168	.03	2.92
August	.27	\$168	.03	1.36
September	.10	\$168	.03	.50
				\$7.42/acre

^{1/} From TSC Technical Note-Watersheds-UD-16, Table 10 (Southern portion of NE), or as adjusted.

^{2/} From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.

NORTHEAST WATERSHED, USA
 Computation of Weighted Flood Damage
 Winter Wheat

Yield 40 bushels
 Price per bushel flood free \$1.27/bushel in adjusted normalized prices
 Gross return \$50.80/acre

0-2' depth

<u>Month</u>	<u>1/ Damage Rate</u>	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods 2/</u>	<u>Weighted Damage/ Acres</u>
March	.07	\$50.80	.21	.75
April	.27	\$50.80	.13	1.78
May	.39	\$50.80	.07	1.39
June	.48	\$50.80	.06	1.46
July	.21	\$50.80	.03	.32
August	.05	\$50.80	.03	.08
September	.04	\$50.80	.03	.06
October	.05	\$50.80	.03	.08
November	.05	\$50.80	.04	.10
				<u>\$6.02/acre</u>

over 2'

<u>Month</u>	<u>1/ Damage Rate</u>	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods 2/</u>	<u>Weighted Damage/ Acres</u>
March	.10	\$50.80	.21	1.01
April	.41	\$50.80	.13	2.71
May	.61	\$50.80	.07	2.17
June	.72	\$50.80	.06	2.19
July	.36	\$50.80	.03	.55
August	.09	\$50.80	.03	.14
September	.07	\$50.80	.03	.11
October	.09	\$50.80	.03	.14
November	.07	\$50.80	.04	.11
				<u>\$9.13/acre</u>

1/ From TSC Technical Note-Watersheds-UD-16, Table 10 (Southern portion of NE), or as adjusted.

2/ From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.

NORTHEAST WATERSHED, USA
 Computation of Weighted Flood Damage
 Barley and Oats, each

Yield 60 bushels
 Price per bushel flood free \$.77/bushel in adjusted normalized prices
 Gross return \$61.60/acre

0-2' depth

<u>Month</u>	<u>Damage Rate</u> ^{1/}	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods</u> ^{2/}	<u>Weighted Damage/Acres</u>
April	.22	\$46.20	.13	1.32
May	.13	\$46.20	.07	.42
June	.24	\$46.20	.06	.67
July	.20	\$46.20	.03	.28
				\$ 2.69/acre

over 2'

<u>Month</u>	<u>Damage Rate</u> ^{1/}	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods</u> ^{2/}	<u>Weighted Damage/Acres</u>
April	.35	\$46.20	.13	2.10
May	.19	\$46.20	.07	.60
June	.35	\$46.20	.06	.97
July	.30	\$46.20	.03	.42
				\$ 4.09/acre

^{1/} From TSC Technical Note-Watersheds-UD-16, Table 10 (Southern portion of NE), or as adjusted.

^{2/} From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.

NORTHEAST WATERSHED, USA
Computation of Weighted Flood Damage
Hay

Yield 4 tons
Price per ton flood free \$29.48/ton in adjusted normalized prices
Gross return \$117.92/acre

0-2' depth

<u>Month</u>	<u>1/ Damage Rate</u>	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods 2/</u>	<u>Weighted Damage/ Acre</u>
April	.05	\$117.92	.13	.77
May	.20	\$117.92	.07	1.65
June	.21	\$117.92	.06	1.49
July	.15	\$117.92	.03	.53
August	.08	\$117.92	.03	.28
September	.02	\$117.92	.03	.07
				\$ 4.79/acre

over 2'

<u>Month</u>	<u>1/ Damage Rate</u>	<u>Flood Free Gross Return/Acre</u>	<u>Monthly Distribution of Floods 2/</u>	<u>Weighted Damage/ Acre</u>
April	.08	\$117.92	.13	1.23
May	.24	\$117.92	.07	1.98
June	.28	\$117.92	.06	1.98
July	.21	\$117.92	.03	.74
August	.11	\$117.92	.03	.39
September	.03	\$117.92	.03	.10
				\$ 6.42/acre

^{1/} From TSC Technical Note-Watersheds-UD-16, Table 10 (Southern portion of NE), or as adjusted.

^{2/} From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.
~~From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.~~

NORTHEAST WATERSHED, USA
Computation of Weighted Flood Damage
Pasture

Yield 200 cow-acre days
Price per CAD flood free \$.26/CAD in adjusted normalized prices
Gross return \$52.00/acre

0-2' depth

Month	<u>1/</u> Damage Rate	Flood Free Gross Return/Acre	Monthly Distribution of Floods <u>2/</u>	Weighted Damage/ Acre
April	.02	\$52.00	.13	.14
May	.10	\$52.00	.07	.36
June	.12	\$52.00	.06	.37
July	.06	\$52.00	.03	.09
August	.03	\$52.00	.03	.05
September	.05	\$52.00	.03	.08
October	.02	\$52.00	.03	.03
				\$1.12/acre

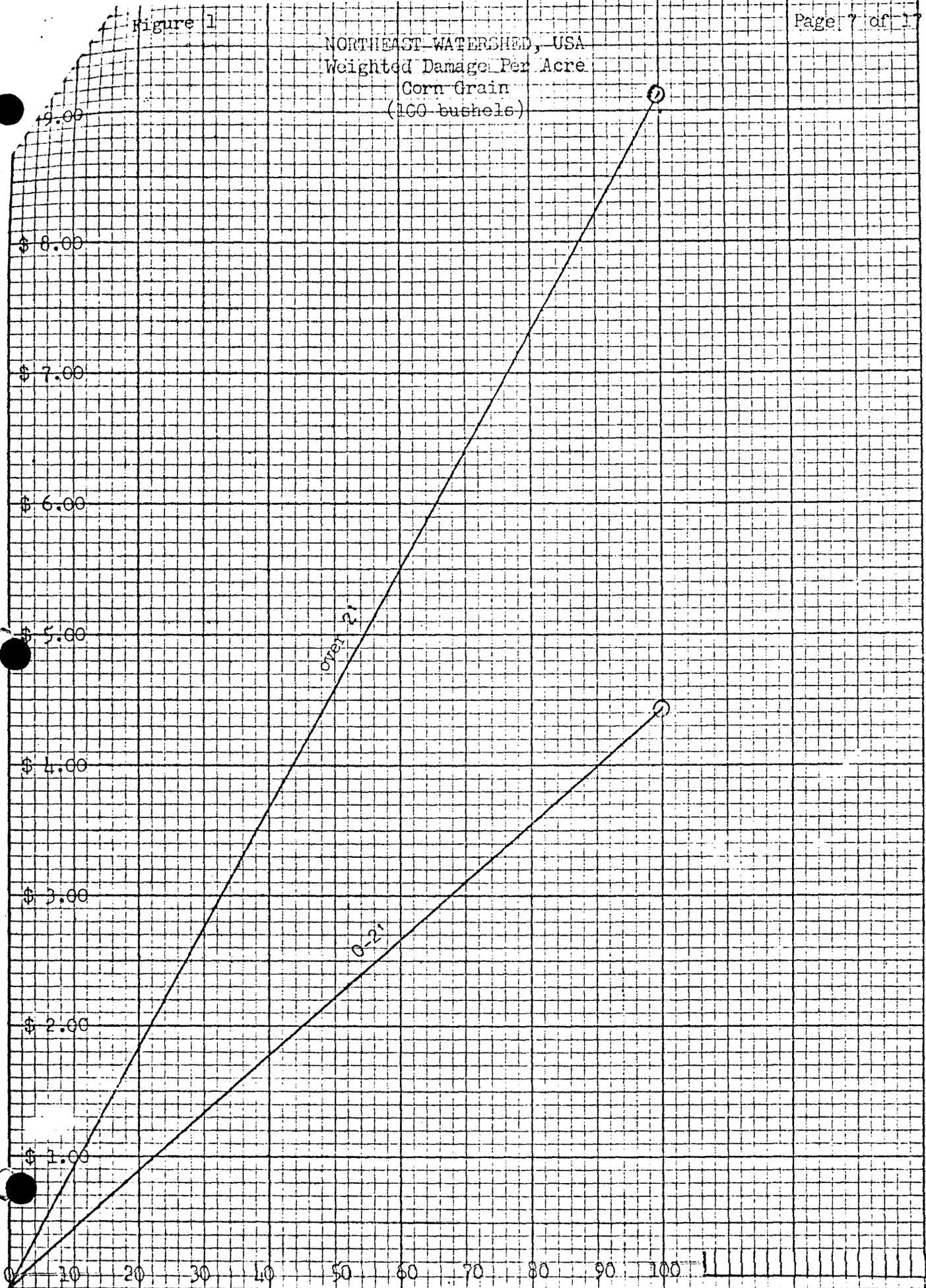
over 2'

Month	<u>1/</u> Damage Rate	Flood Free Gross Return/Acre	Monthly Distribution of Floods <u>2/</u>	Weighted Damage/ Acre
April	.14	\$52.00	.13	.95
May	.15	\$52.00	.07	.55
June	.16	\$52.00	.06	.50
July	.09	\$52.00	.03	.14
August	.06	\$52.00	.03	.09
September	.07	\$52.00	.03	.10
October	.04	\$52.00	.03	.06
				\$ 2.39/acre

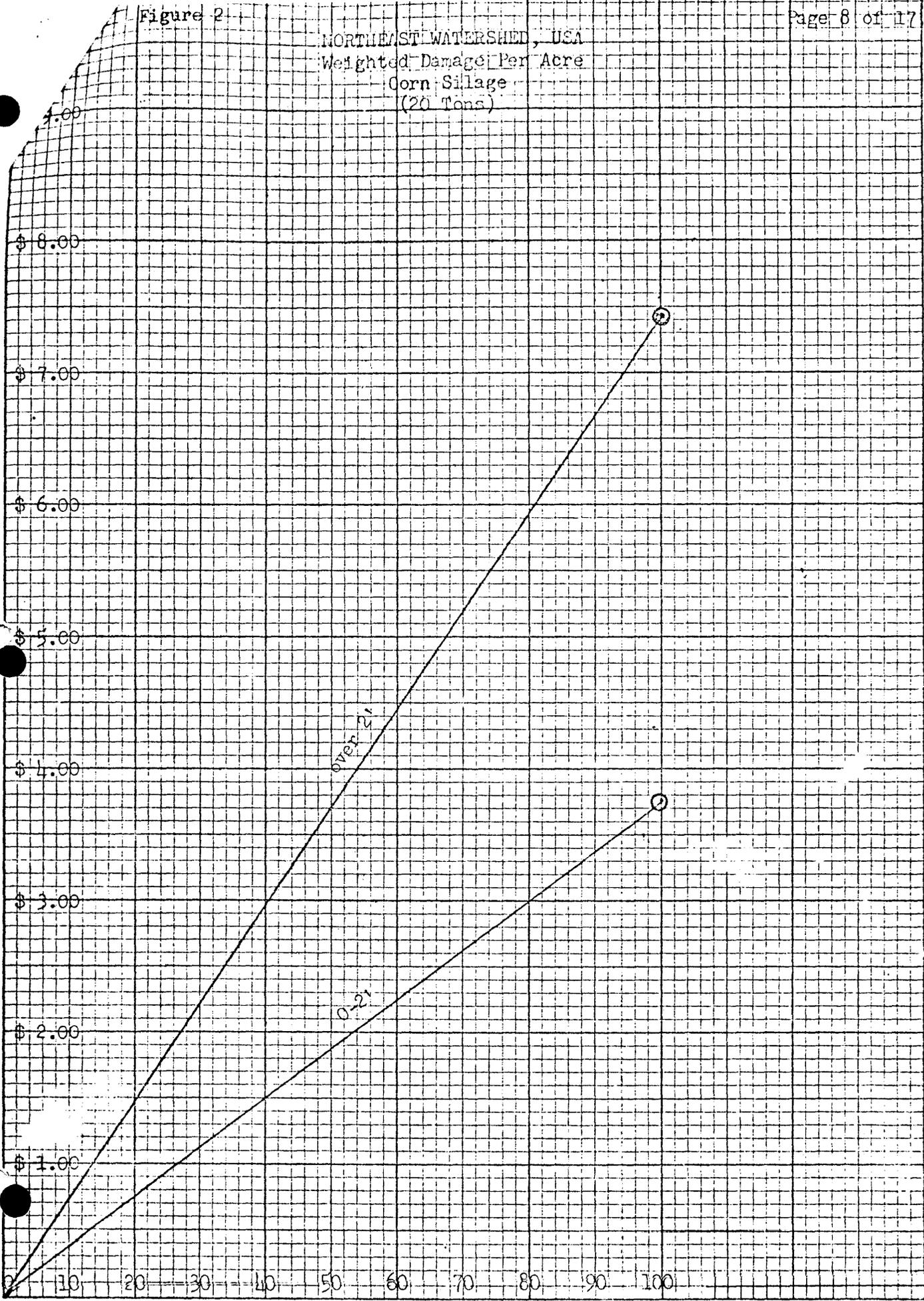
1/ From TSC Technical Note-Watersheds-UD-16, Table 10 (Southern portion of NE), or as adjusted.

2/ From TSC Technical Note-Watersheds-UD-20, (Area 1), or as adjusted.

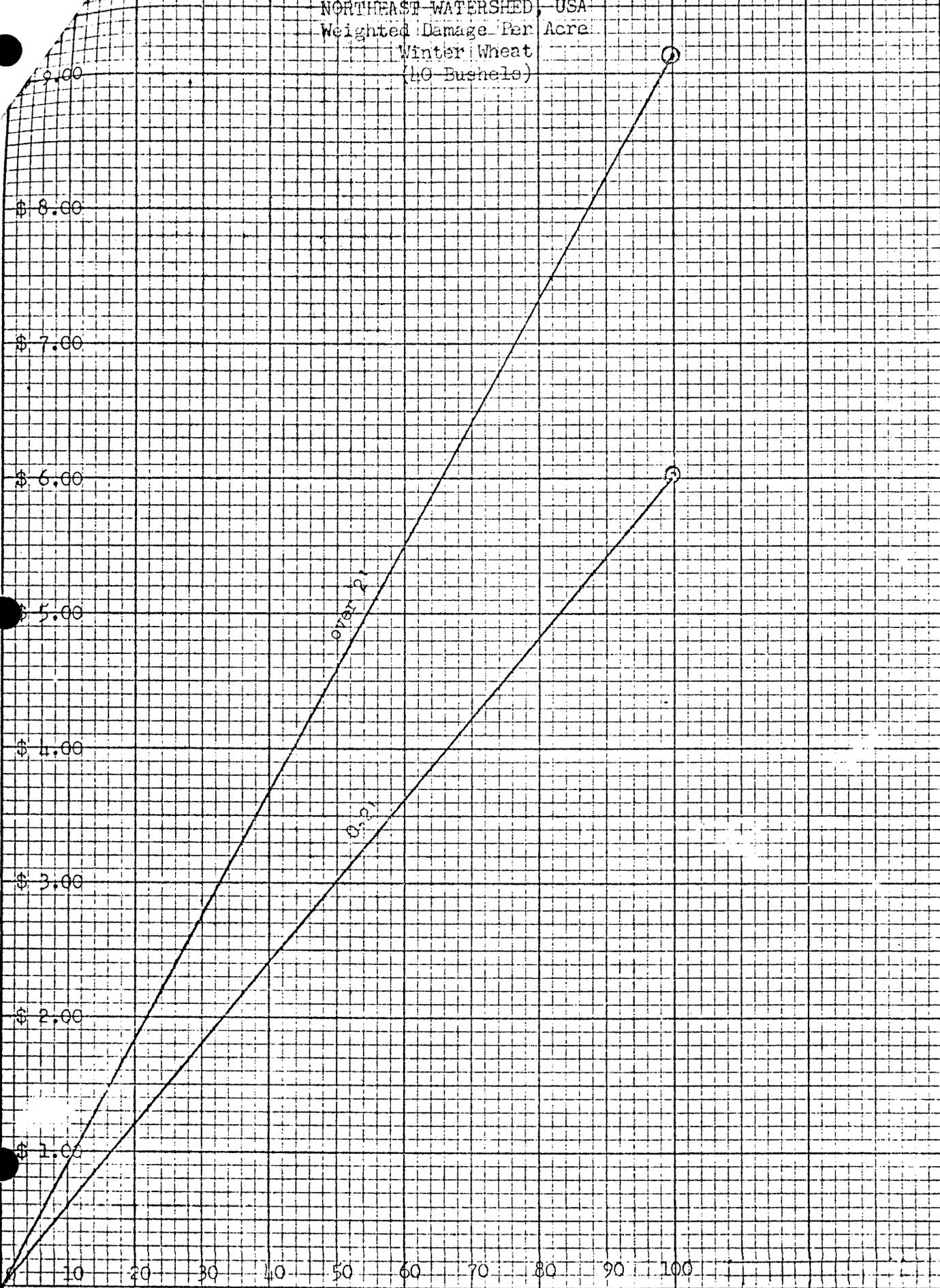
NORTHEAST WATERSHED, USA
Weighted Damage Per Acre
Corn Grain
(100 bushels)



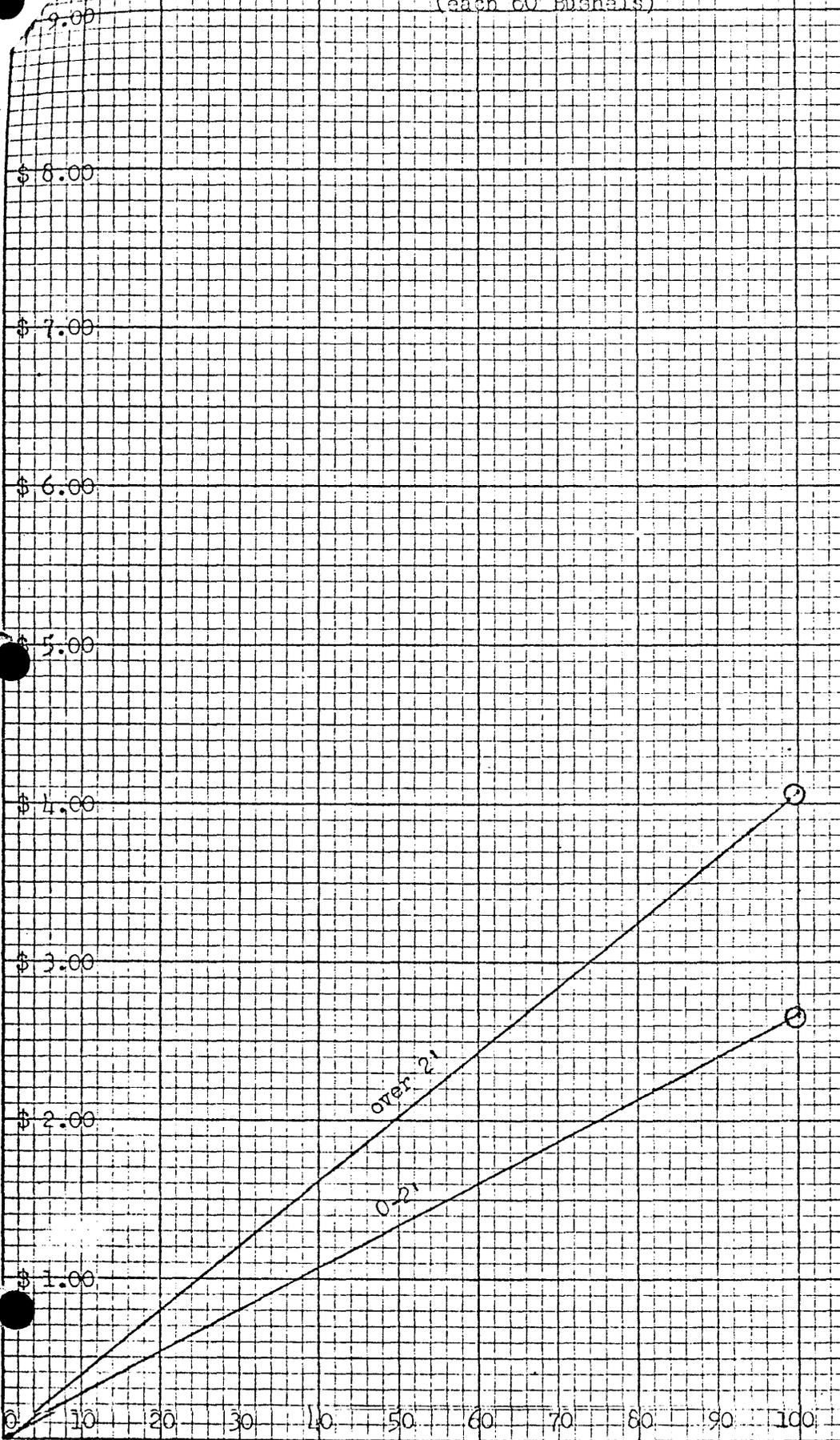
NORTHEAST WATERSHED, USA
Weighted Damage Per Acre
Corn Silage
(20 Tons)



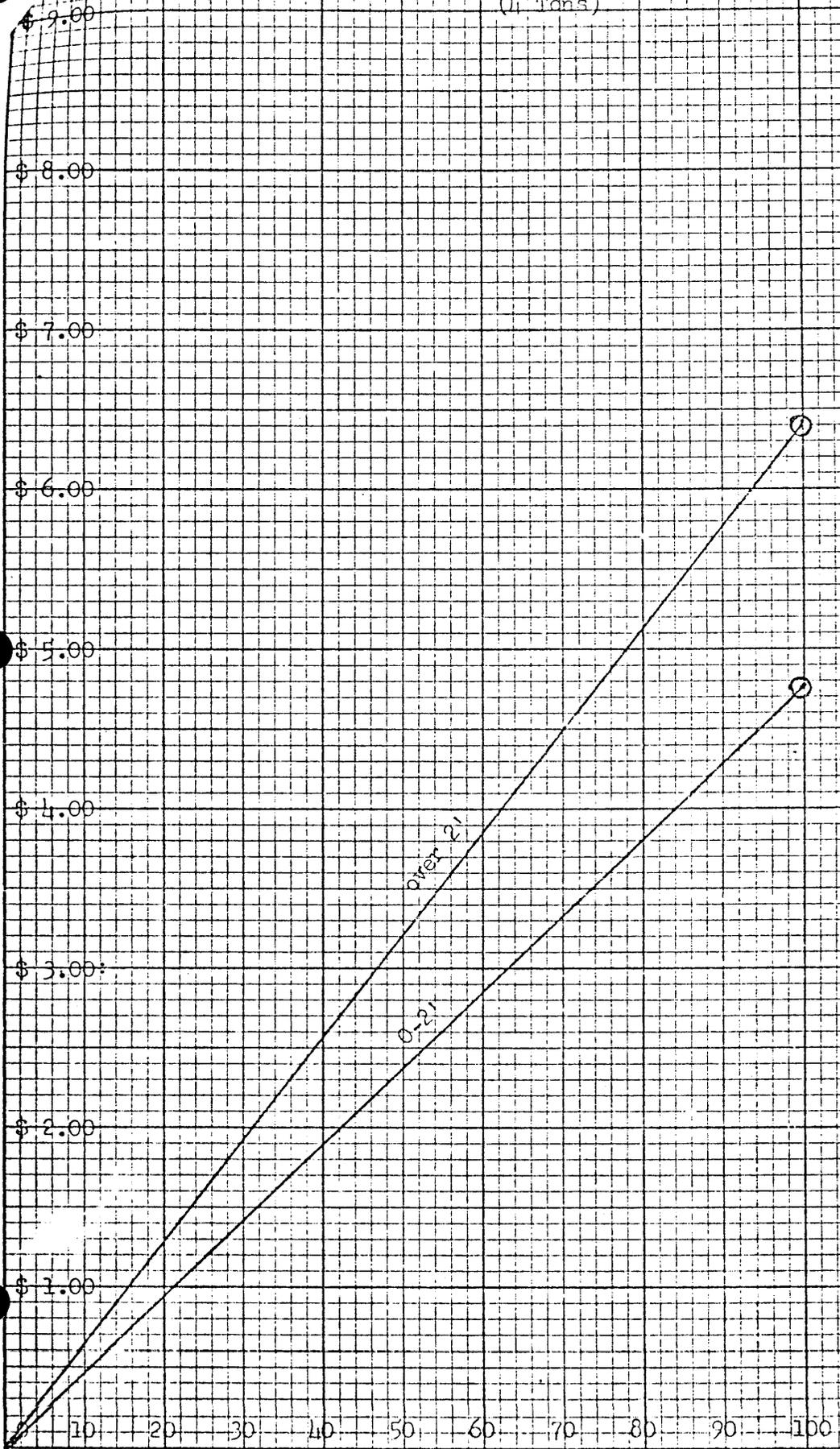
NORTHEAST WATERSHED, USA
Weighted Damage Per Acre
Winter Wheat
(40 Bushels)



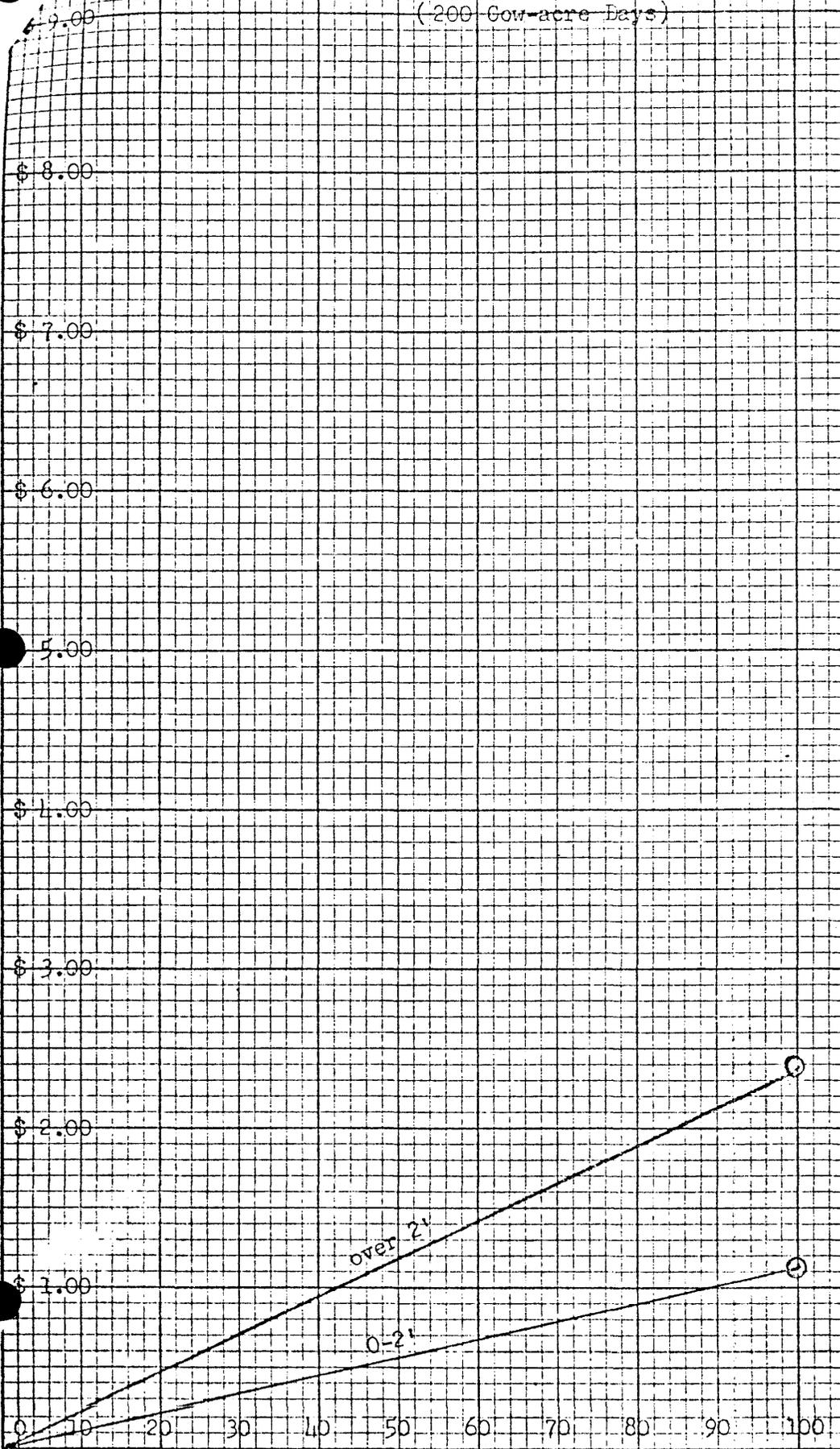
NORTHEAST WATERSHED, USA
Weighted Damage Per Acre
Barley and Oats, each
(each 60 Bushels)



NORTHEAST WATERSHED, USA
Weighted Damage Per Acre
Hay
(11 Tons)



NORTHEAST WATERSHED, USA
Weighted Damage Per Acre
Pasture
(200 Cow-acre Days)



NORTHEAST WATERSHED, USA
 Computation of Composite Acre Weighted Damage
 Reach A, (cross sections 1-C, 2, and 3-C)

<u>Crop</u>	<u>Land Use</u> (%)	<u>0-2'</u> Composite Acre Weighted Damage <u>1/</u>	<u>over 2'</u> Composite Acre Weighted Damage <u>1/</u>
Corn Grain	3	\$.13	\$.27
Corn Silage	10	\$.39	\$.74
Wheat	8	\$.48	\$.73
Oats	11	\$.30	\$.45
Hay	21	\$1.01	\$1.35
Pasture	42	\$.47	\$1.00
Miscellaneous	<u>5</u>	<u>0</u>	<u>0</u>
Weighted Composite Damage/Acre	100%	\$2.78	\$4.54

1/ Determine by using graphs or by multiplying land use percentages by the aggregate weighted damage per acre shown in TABLES 1-6.

NORTHEAST WATERSHED, USA
Computation of Damage-Frequency Data
Reach A, cross section 1-C

Percent Chance Storm Event	Acres Flooded and Dollar Damage				TOTAL ACRES FLOODED	TOTAL DAMAGE
	0-2'		over 2'			
	acres	Total Damage at \$2.78 per composite acre	acres	Total Damage at \$4.54 per composite acre		
1	1.00	2.78	87.00	394.98	88.00	397.76
5	22.08	61.38	63.00	286.02	85.05	347.40
20	39.97	111.12	27.94	126.85	67.91	237.97
50	25.21	70.08	.27	1.23	25.48	71.31
65.6	0	0	0	0	0	0

1/ Point of beginning flooding equals 65.6% chance storm.

NORTHEAST WATERSHED, USA
 Crop and Pasture - Average Annual Damage Computation
 Reach A, cross section 1-C

Percent Chance	$\frac{\Delta \%}{100}$	Damage (\$)	Average Damage (\$)	Average Annual Damage (\$)
	.01		398	3.98
1		398		
	.04		372	14.88
5		347		
	.15		292	47.80
20		238		
	.3		154	46.20
50		71		
	.156		36	5.62
65.6		0		<u>114.48</u>

NORTHEAST WATERSHED, USA
Computation of Average Annual Acres Flooded
Reach A, cross section 1-C

<u>Percent Chance</u>	<u>$\frac{\Delta \%}{100}$</u>	<u>Acres</u>	<u>Average Acres</u>	<u>Average Annual Acres</u>
			88	.88
1		88		
	.04		86	3.44
5		85		
	.15		76	11.40
20		68		
	.3		46	13.80
50		25		
	.156		12	1.87
65.6		0		
				<hr/> 31.39

NORTHEAST WATERSHED, USA
Computation of Composite Acre Weighted Damage
Reach A, cross section 1-C

Computation of adjustment factor for recurrent flooding:

A. From Graphic Method:

$$\frac{31.39 \text{ average annual acres flooded}}{88 \text{ acres flooded by largest evaluated storm}} = .36$$

From TSC Technical Note-WS-24 a ratio of .36 gives a recurrence adjustment factor of .96

$$. . \$114.48 \text{ (computed average annual damage)} \times .96 = \$109.90$$

adjusted for recurrence