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UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Conservation Service
7600 West Chester Pike, Upper Darby, Pennsylvania 19082

July 20, 1973

RTSC TECHNICAL NOTE - WATERSHEDS-UD-8 30

RE: RC&D Economics-14-Basic Data
RB Adjustment of Present Urban Damages to Account
WS for Damages to Expected Future Developments
That Will Take Place Without a Project

The purpose of this technical note is: (1) to illustrate a procedure on how to adjust floodwater damages based on present developments to account for damages to future developments that will be installed without a project; (2) to provide a few of the commonly used discount factors; and (3) to illustrate the computation of an applicable discount factor. This Technical Note replaces TSC-Watersheds Memorandum-UD-1, dated June 28, 1966.

Urban damages based on present developments should be adjusted to reflect any changes, increases or decreases, expected in the future without a project. Applicable discounting procedures, as described in Appendix A of the Economics Guide are to be used to convert any change in future damages to average annual values.

If future changes in developments are expected to occur principally at specific locations and elevations, the stage-damage summary data, by reaches, must be adjusted to account for this. If these changes are expected to occur equally throughout the flood plain reach regardless of elevation, then only one adjustment is needed in the average annual damage of the present development to account for damages to future developments at all elevations. Procedures for data collection are contained in RTSC Technical Note - Watersheds-UD-31, dated June 27, 1973. Two methods for estimating the magnitude of future changes and associated damages are illustrated in Attachment No. 1.

Discount factors have been developed for 3 patterns of growth on the following basis: (1) 100-percent increase in flood damages during the first 50 years of a 100-year evaluation period; (2) the degree of projected growth remains constant for the last 50 years of the 100-year evaluation period; (3) employing interest rates varying

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from 3-7 percent for discounting. This is in keeping with the intent of Chapter 15 of the Economics Guide, which recognizes that projections for long periods, a small area, or small aggregates are less reliable than those for short periods, large areas, or large aggregates.

The 3 growth patterns of development over a 100-year evaluation period are given and described as follows:

1. Early Growth

Fifty percent of total increased growth occurs uniformly during the first 5 years, 35 percent occurs uniformly during the next 20 years, and the remaining 15 percent buildup occurs uniformly during the next 25 years, and then remains constant during the last 50 years of the evaluation period.

The development of the early growth pattern discount factor is illustrated in Attachment No. 2.

2. Uniform Growth

The total increased growth is at a uniform rate during the first 50 years of the evaluation period at 2 percent per year and then remains constant during the last 50 years of the evaluation period.

3. Deferred Growth

No increased growth occurs during the first 5 years, 25 percent of the total increased growth occurs uniformly during the next 20 years, and the remaining 75 percent buildup occurs uniformly during the next 25 years and then remains constant during the last 50 years of the evaluation period

The discount factors for the 3 growth patterns are given below and on Attachment No. 3 in graphic form.

DISCOUNT FACTORS

Type of Growth	3½%	5½%	7%
Early	.73	.64	.59
Uniform	.49	.35	.29
Deferred	.37	.23	.17

For fractional rates of interest, estimate applicable discount factor by interpolation. See attached graph.

The average annual damage for future development without project is the product of the applicable discount factor, the magnitude of future changes in damageable values (as a percent of the existing development but expressed as decimal) and the average annual damage to the existing development.

The total average annual damages is the sum of the average annual damage to existing property and the estimated average annual damage to the future development without a project.

Following is an example illustrating how present damages in a reach may be adjusted to estimate damages to future developments "without project".

Problem

What is the average annual increase in future flood damages that will result from a 34 percent increase in damages in 50 years to future properties over a 100-year evaluation period? The present average annual damage is $200,000. What would it be for each of the 3 different patterns of growth?

Solution

1. Compute the average annual increase in value of the damages to future development "without project" by multiplying the appropriate discount factor, the magnitude of change expressed in percent, and the present annual damage of the existing properites. This is illustrated in the table below.

2. The total damage, "without project" for the conditions described, would be the sum of the present damage and the damage to the future development. The total damage is shown in the last column of the following table.

Growth Pattern (1)	Discount Factor 1/ (2)	Percent Magnitude of Change Expressed as Decimal (3)	Average Annual Value Present Damage (4)	Average Annual Damage Value of Future Development Without Project (5)	Total Average Annual Damage Without Project (6)
				(2)x(3)x(4)	(4)+(5)
1 (Early)	.64	0.34	$200,000	$43,520	$243,520
2 (Uniform)	.35	0.34	200,000	23,800	223,800
3 (Deferred)	.23	0.34	200,000	15,640	215,640

1/ Based on a future buildup of 100-percent in 50 years over the present values at 5½% interest rate.

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Head, Engineering and
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Attachments (3)

EXAMPLES ILLUSTRATING HOW THE MAGNITUDE OF FUTURE CHANGE MAY BE ESTIMATED

From the known urban damage data, develop the following information:

1. Average annual damage to the existing development.

2. Acres in the existing development.

3. Acres in the future development.

4. Average annual damage per acre in the existing development.

5. Estimate what percent of the area is occupied by:

   a. Buildings;
   b. Parking lots, driveways, and lawns;
   c. Streets and sidewalks;
   d. Open space;

for the existing development and the future development.

6. Estimate the percent of urban damage that is to buildings and contents and what is to parking lots, lawn, driveways and public facilities.

7. Estimate by type of area (residential, commercial, and industrial) the percent each is of the existing development and in the future development.

8. Estimate the percent of urban damage to each of the above existing areas (residential, commercial, and industrial).

Depending on what information is available, estimates of future changes in damageable values may be determined, and projected to areas expected to be developed in the future. Two situations are illustrated on the attached worksheet table, as follows:

1. Based on adjusting damages due to expected change in density of development only, not in type of properties nor damageable values per property.

2. Based on adjusting damages due to changes in type of properties, not in density nor the damageable values by type of property.

ATTACHMENT NO. 1 - WORKSHEET TABLE

Item	(1) Existing Development: Acres	(2) Existing Development: Damages: Total Amount	(3) Existing Development: Damages: Percent	(4) Existing Development: Per Composite Acre: Damage	(5) Existing Development: Per Composite Acre: Total Area Percent	(6) Existing Development: Per Composite Acre: Adjusted Area 1/	(7) Future Development: Acres	(8) Future Development: Per Composite Acre: Percent	(9) Future Development: Per Composite Acre: Adjusted 1/	(10) Future Development: Conv. Factor	(11) Future Development: Adj. Dam. Comp. Ac.	(12) Future Development: Total Damage	(13) Magnitude of Change
	No.	Dollars	Percent	Dollars	Percent	Percent	No.	Percent	Percent		Dollars	Dollars	Percent
				$\frac{\Sigma 2}{\Sigma 1} \times 3$						(9 ÷ 6)	(10 x 4)	(11 x 4)	(12 ÷ 2)
(CHANGE IN DENSITY)													
Bldg.	-	180,000	90	1,800	39	56	-	23	33	.59	1,062	-	
Lot	-	20,000	10	200	31	44	-	47	67	1.52	303	-	
Streets	-	-	-	-	30	-	-	30	-	-	-	-	
Total	100	200,000	100	2,000	100	100	50	100	100	-	1,365	68,250	34
(CHANGE IN TYPE OF PROPERTIES)													
Resid.	-	40,000	20	400	40	40	-	10	10	.25	100	-	
Com'l.	-	100,000	50	1,000	40	40	-	45	45	1.125	1,125	-	
Indust.	-	60,000	30	600	20	20	-	45	45	2.25	1,350	-	
Total	100	200,000	100	2,000	100	100	50	100	100	-	2,575	128,750	64

1/ Adjusted to area representing damage.

EXAMPLE ILLUSTRATING THE DEVELOPMENT OF THE "EARLY GROWTH" DISCOUNT FACTOR

The following chart and example illustrates "early growth" development as related to time, rate, and amount of development in 50 years over a 100-year evaluation period. See Economics Guide, Appendix A for further details.

The average annual value of periodic increases in damages is determined by computing the capital value of each segment on the chart, converting the capital values of each segment to present values by discounting for lag in accrual, and amortizing these present values over the 100-year evaluation period. The percentage of the average annual damage due to this type of future development, to the damage based on the present development, can be employed as a standard discount factor to adjust damages which will be subject to similar growth conditions.

Employing the data given in the following example, a standard discount factor of 0.44 was computed. The detailed computations for each segment of the chart are given below:

(1) Seven percent interest rate
(2) 100-year evaluation period
(3) An "early growth" development is expected to occur in the flood plain without a project over the first 50 years of the evaluation period.
(4) The average annual damage based on the present development of the flood plain is $10,000, but on the expectation of an "early growth" development pattern, will increase 100 percent or become $20,000 by the end of 50 years. In 5 years, it will increase to $15,000; and by the end of the 25th year, it will increase to $18,500.

A. <u>The Value of the Expected Increase in Damages Occurring in the First 5 Years.</u>

1. The expected increase in damage of $5,000 occurs uniformly over 5 years, or at the rate of $1,000 per year.
2. $1,000 x 11.74686 (present value of an increasing annuity for 5 years at 7 percent) = $11,747.

B. <u>The Amount of Increases in Damages Reached at the End of 5 Years. $5,000 is a Constant Annuity for 95 Years, Delayed 5 Years.</u>

1. $5,000 x 14.26262 (present value of an annuity of 1 per year for 95 years) = $71,313.
2. $71,313 x .71298 (present value of 1, 5 years hence) = $50,845.

C. <u>The Increase in Damages From the 6th Year to the 25th Year (20 Years) is $3,500, or $175 Per Year. It is Delayed for 5 Years.</u>

1. $175 x 88.10307 (present value of an increasing annuity for 20 years) = $15,418.
2. $15,418 x .71298 (present value of 1, 5 years hence) = $10,993.

D. <u>The Additional Increase in Damages of $3,500 is Constant for 75 Years, But is Delayed 25 Years in Beginning.</u>

1. $3,500 x 14.19635 (present value of annuity of 1 for 75 years) = $49,687.
2. $49,687 x .18424 (present value of 1, 25 years hence) = $9,154.

E. <u>The Final Increase in Damages of $1,500 Occurs Over 25 Years, or $60 Per Year, Delayed 25 Years in Beginning.</u>

1. $60 x 112.33006 (present value of an increasing annuity for 25 years) = $6,740.
2. $6,740 x .18424 (present value 1, 25 years hence) = $1242.

F. <u>The Final Increase in Damages of $1,500 is Constant for 50 Years, But is Delayed 50 Years in Beginning.</u>

1. $1,500 x 13.80074 (present value of an annuity of 1 for 50 years = $20,701.
2. $20,701 x .03394 (present value of 1, 50 years hence) = $703.

The discounted values are:

$11,747
50,845
10,993
9,154
1,242
703
$84,684

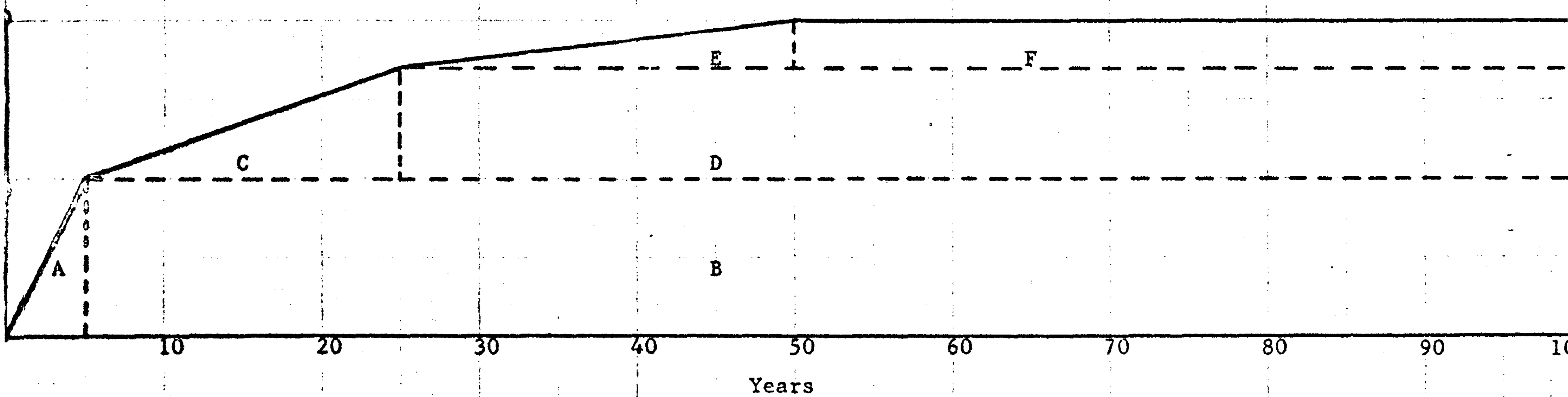
$84,684 x .07008 (amortization factor for 100 years, 7 percent) = $5935.

Thus, $5935 divided by $10,000 equals .59, the discount factor to apply to the average annual damage of existing development, in order to estimate the increase in damages under the above given conditions.

EARLY GROWTH

1. Present average annual damage $10,000
2. Increasing to $20,000 (100 percent increase) over first 50 years of the 100-year evaluation period as follows:

   a. 50 percent increase at uniform rate over first 5 years
   b. 35 percent increase at uniform rate over next 20 years
   c. 15 percent increase (last part of build-up) occurs uniformly over next 25 years, with damages remaining constant thereafter

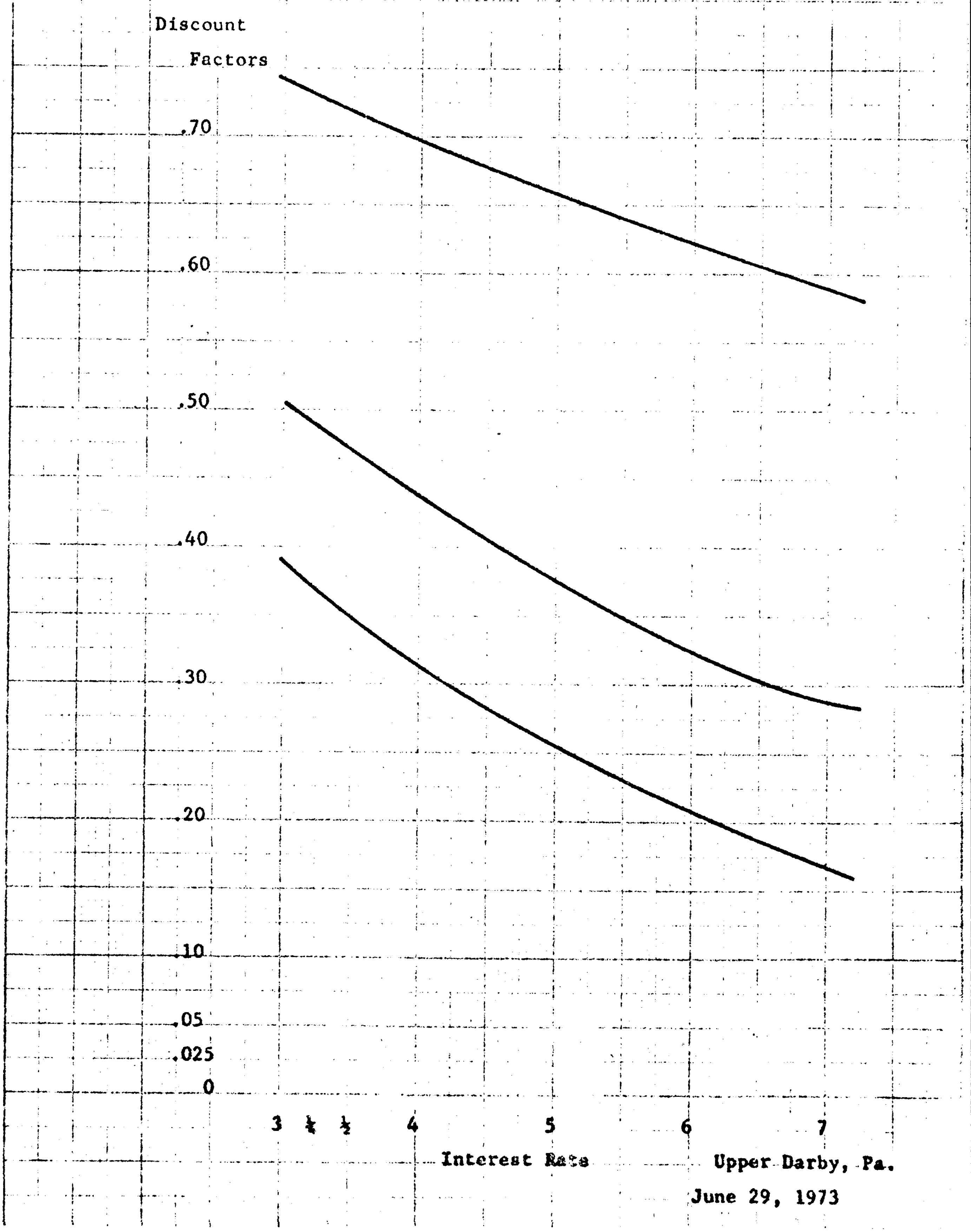


Rates of Increase

A. $1,000 per year
C. $175 per year
E. $60 per year

DISCOUNT FACTORS FOR VARYING INTEREST RATES AND GROWTH PATTERNS

100-YEAR EVALUATION PERIOD



Upper Darby, Pa.

June 29, 1973