TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

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JUNE 1987

DESIGNING WIND EROSION CONTROL SYSTEMS

Attached is Midwest National Service Center Agronomy Technical Note No.190-L1-14, "Designing Wind Erosion Control Systems." This was the last technical note developed by David L. Hintz, SCS, National Windbreak Forester, who is now retired.

This note provides excellent wind erosion control design concepts that can be utilized into wind erosion control. Previous technical notes on wind erosion control include: AGRONOMY-39/FORESTRY-29, AGRONOMY-40/FORESTRY-30, and AGRONOMY-42/FORESTRY-33.

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NOTE:

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INTRODUCTION

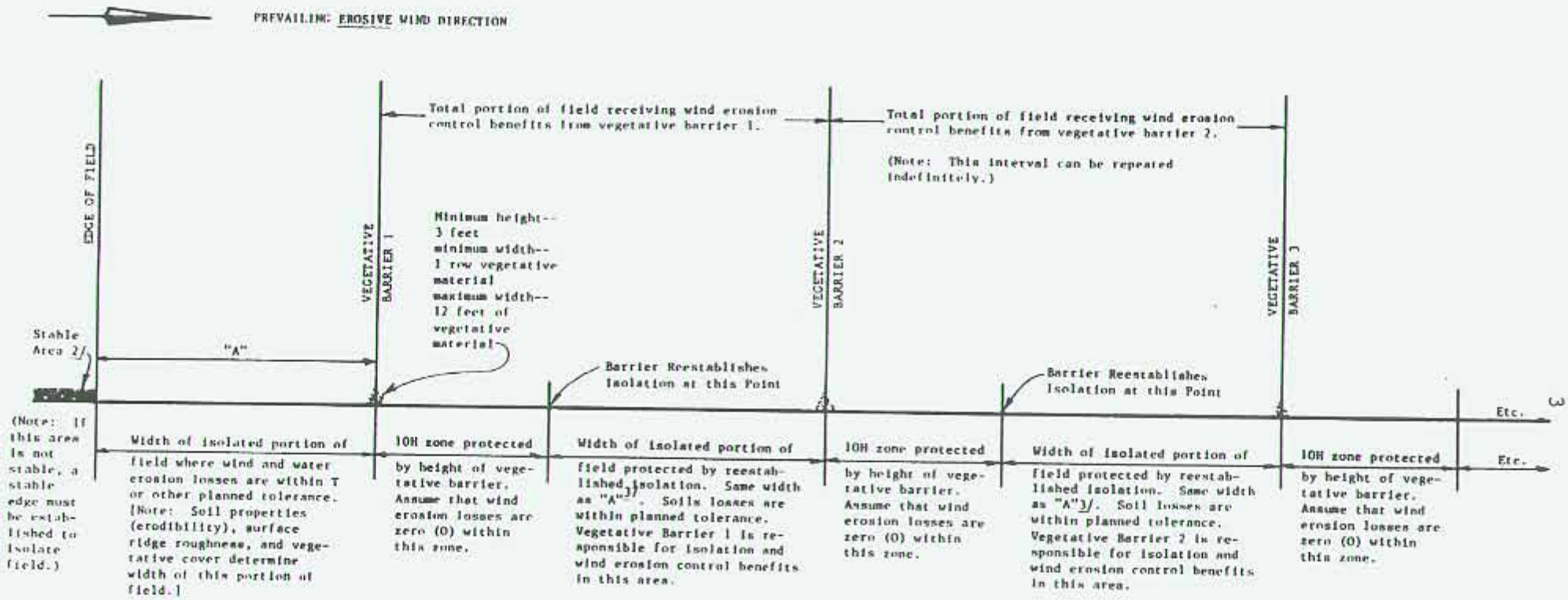
It is obvious that residue management and tillage will not solve all wind erosion or soil blowing problems. This occurs because in many situations the crops do not produce sufficient residues or farming practices are applied that destroy or reduce the effectiveness of residues. This will happen even after our best planning efforts. When this happens, it is critical that we bring more wind erosion control practices into the design of wind erosion control systems.

Fields that are exceeding allowable soil loss tolerances to wind erosion after we have maximized the use of residues and tillage practices have one thing in common. They are <u>too wide</u>. All of the remaining wind erosion control practices (other than residue management and tillage practices) also have one thing in common, they reduce the width of the field. In other words, they effectively subdivide a given field into subfields or a series of subfields. This is done by creating stable borders (areas where the saltation process is stopped) which creates <u>isolated</u> subfields. If designed correctly, they will reduce soil losses within soil loss tolerances or other planned tolerances (protection of plants against the damaging effects of blowing soil particles).

The key to solving wind erosion problems where residue and tillage are not adequate is the creation of the <u>isolated</u> subfields. Stripcropping, trap (buffer) strips, annual barriers, perennial barriers and windbreaks are the practices we use to create <u>isolated</u> subfields.

The following drawings are presented to illustrate how each of these practices function in the design of wind erosion control systems. In some cases key design criteria is provided for guidance. In all cases, a method for determining the area benefiting from a given practice is presented. It is important to note that the area benefited from all of these practices extends well beyond the stable area created by the practice. Also, when the height of the practice is a factor, the benefits can extend well beyond the 10 H zone.

DETERMINING WIND EROSION CONTROL BENEFITS FROM AN EXISTING OR PLANNED VEGETATIVE BARRIER (ANNUAL OR PERENNIAL)[1/]



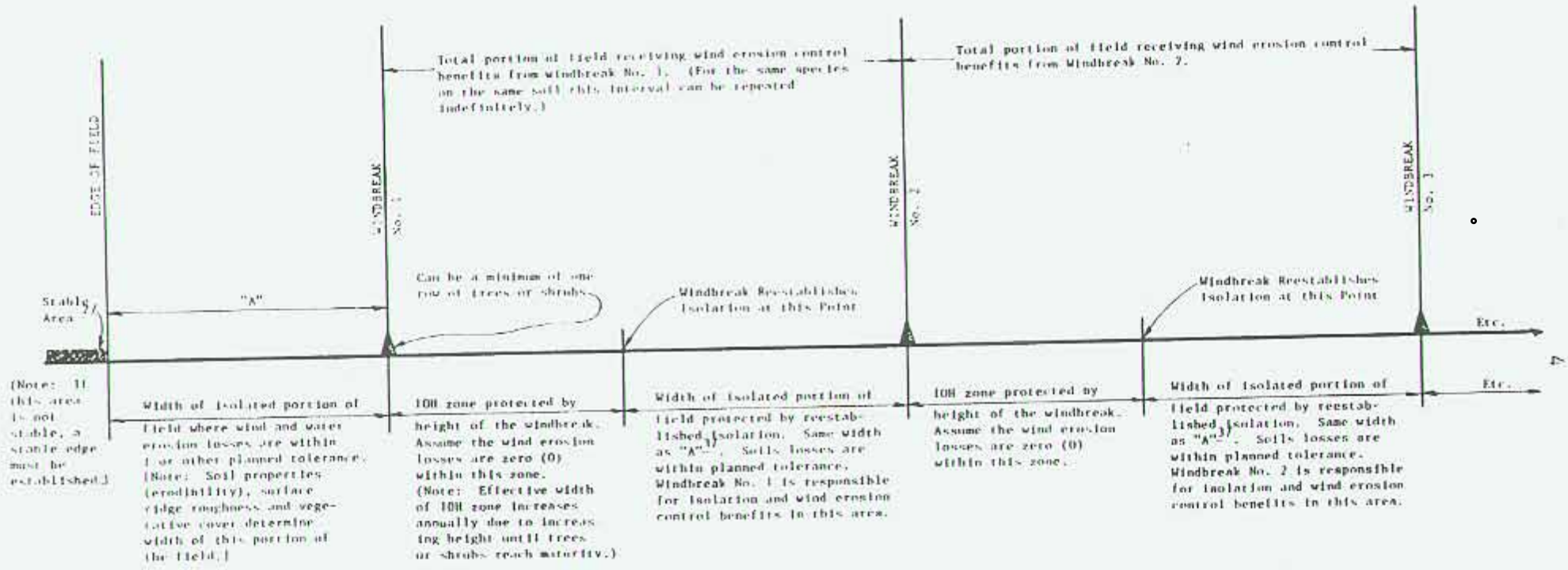
1/ A vegetative barrier is a band of annual or perennial vegetation with sufficient height and density to create a sheltered zone downwind. In the protected zone, wind velocities are reduced enough to prevent saltation from beginning downwind. Vegetative barriers may also act as trap strips but this is not a major function.

2/ Vegetative cover or shelter of any type that will stop all saltating particles.

3/ Assuming that soil and other factors remain the same.

Illustration A. Vegetative barriers

DETERMINING WIND EROSION CONTROL BENEFITS FROM AN EXISTING OR PLANNED WINDBREAK[1/]



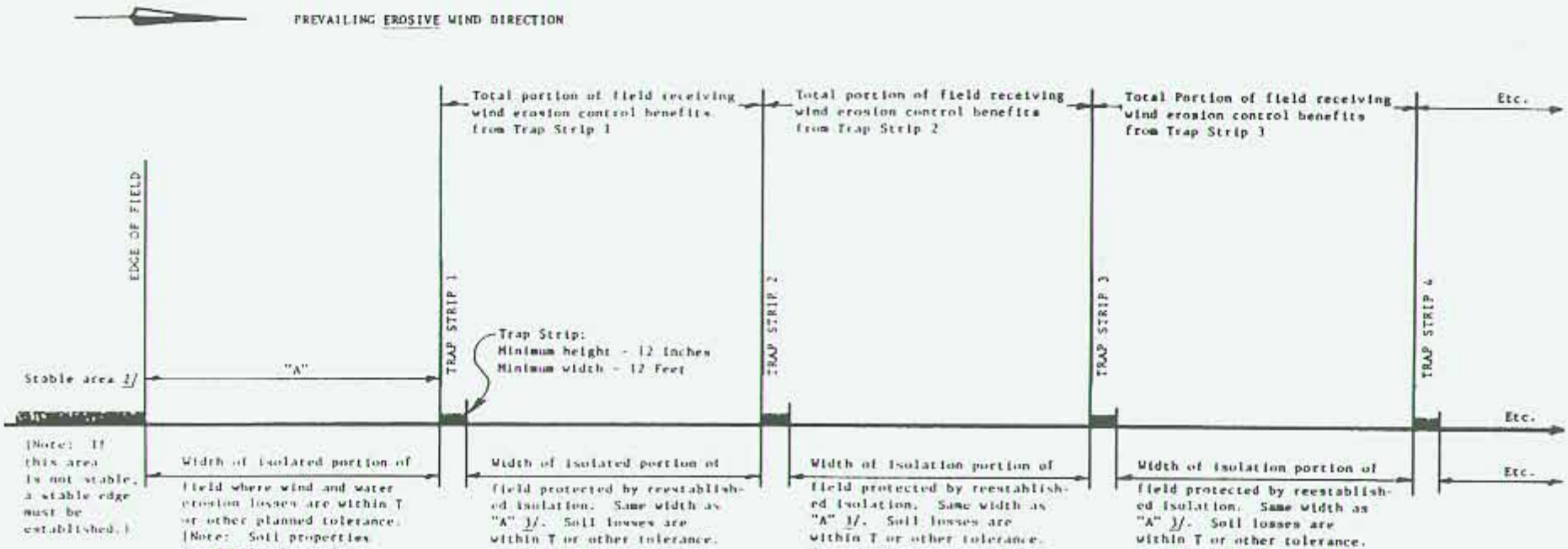
1/ A windbreak is composed of one or more rows of trees and/or shrubs with sufficient density (40% or more) to create a sheltered zone downwind. In the protected zone, wind velocities are reduced enough to prevent saltation of soil particles.

2/ Vegetative cover or shelter of any type that will stop all saltating particles.

3/ Assuming that soil and other factors remain the same.

Illustration B. Windbreaks

DETERMINING WIND EROSION CONTROL BENEFITS FROM AN EXISTING OR PLANNED TRAP (BUFFER) STRIP 1/
(LESS THAN 3 FEET IN HEIGHT)



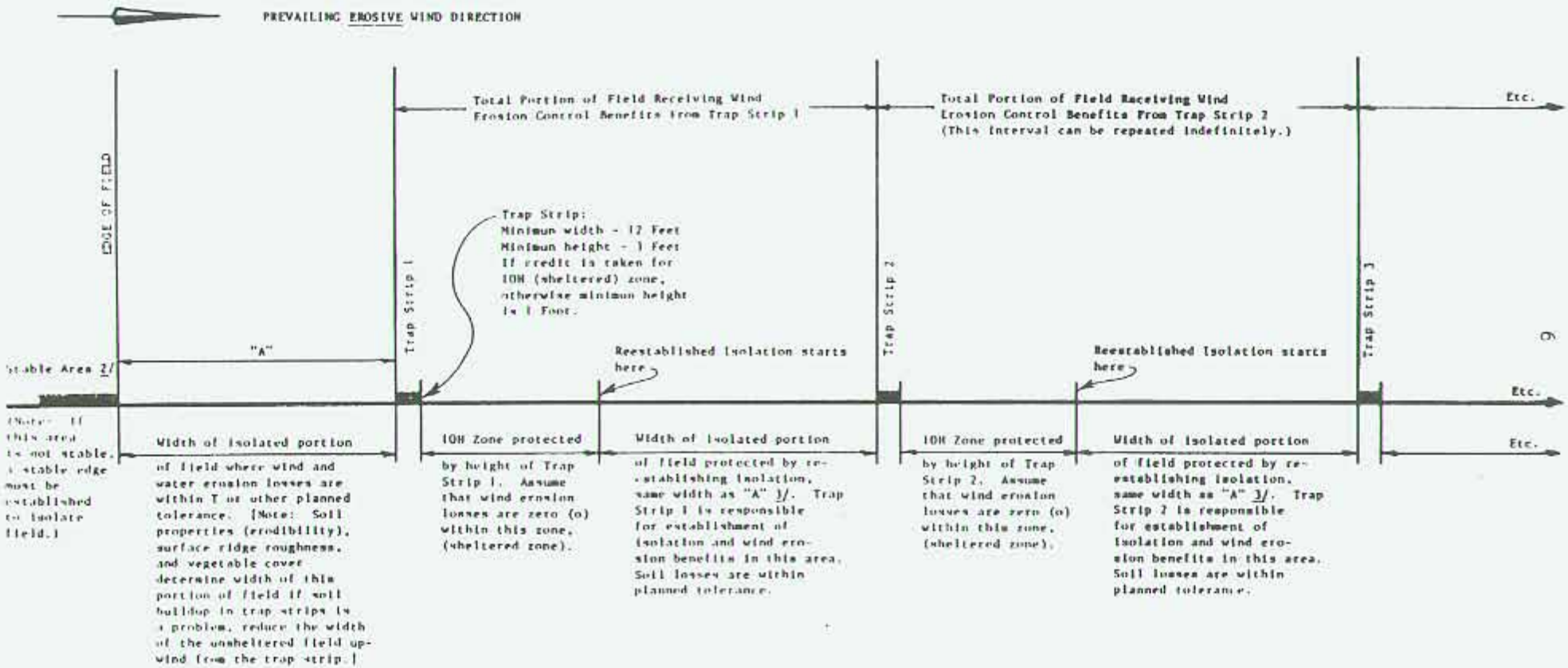
1/ A trap (buffer) strip is a strip of vegetation with sufficient width, height and density to trap saltating soil particles moving from upwind. Trap strips less than 3 feet in height are not tall enough to create significant barrier effects (sheltered zones) downwind. Therefore, no credit is taken for height.

2/ Vegetative cover or shelter of any type that will stop all saltating particles.

3/ Assuming that soil and other factors remain the same.

Illustration C. Trap (Buffer) strips - less than 3 feet in height

DETERMINING WIND EROSION CONTROL BENEFITS FROM A TRAP (BUFFER) STRIP 1/
(THREE FEET OR GREATER IN HEIGHT)



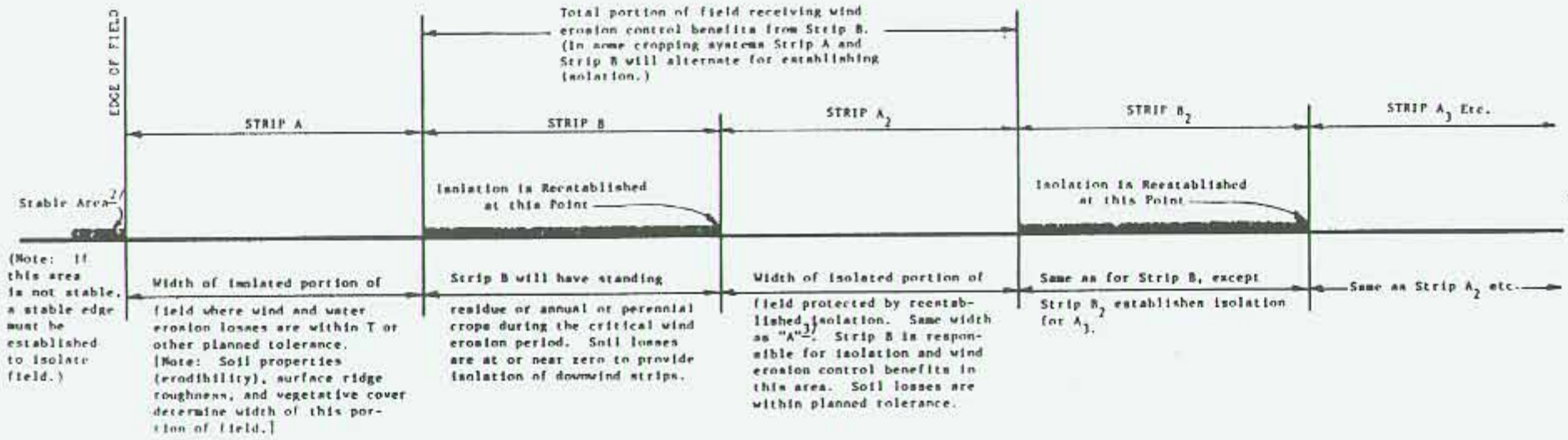
1/ A trap (buffer) strip is a strip of vegetation with sufficient height and density to trap saltating soil particles moving from upwind. Credit can be taken for height and a sheltered zone downwind if the trap strip is 3 feet or higher in effective height.

2/ Vegetative cover or shelter of any type that will stop all saltating particles.

3/ Assuming that soil and other factors remain the same

Illustration D. Trap (Buffer) strips - greater than 3 feet in height

DETERMINING WIND EROSION CONTROL BENEFITS FROM EXISTING OR PLANNED STRIPCROPPING (STANDARD)[1/]



1/ Stripcropping (standard) is composed of alternating strips of annual or perennial close-grown vegetable, usually of equal width with alternating strips of fallow or row crop with sufficient width, height and density to stop all saltating particles.

2/ Vegetative cover or shelter of any type that will stop saltating particles.

3/ Assuming that soil and other factor remain the same.

Illustration E. Stripcropping (standard)

Illustrations A through E demonstrate how the various wind erosion control practices function and how to determine the area benefited by a practice. In many cases it may be desirable or the landowner may want to use combinations of these practices in wind erosion control systems. The following problems and figures are examples of how some of the practices function by themselves or in combinations with other practices within a given field. These are just a few of the alternatives that would be available to solve a given wind erosion problem. It is important to remember that many alternatives can be developed to solve any wind erosion problem.

Field size = 160 acres
I = 86 (WEGS-3, 4, or 4L[1/]
K = 1
C = 30
V = 500 pounds[2/]

Prevailing Erosion Wind Direction = 270° or from due West.
The Soil Loss Tolerance (T) is assumed to be 5 Tons per acre per year.

Water Erosion Losses within this field are assumed to be insignificant

To determine the allowable wind erosion losses, subtract the water erosion losses from (T). In this example, the water erosion losses are assumed to be zero. Therefore, the allowable soil loss for wind = 5 - 0 or 5 - 0 = 5 Tons.

On any field there is an area on the windward side where soil loss is considered to be within T. The width of this area is determined by the soil properties (erodibility), surface ridge roughness and vegetative cover.[3/]

Using this information, assume that through the use of the wind erosion equation or appropriate tables, the I of 86, K of 1 and V of 500 will protect approximately a 160 foot width of given field. The soil losses within this 160 foot width of field would be within (T). Figure 1 illustrates the width of the given field considered protected by the soil properties, surface ridge roughness and vegetative cover. Note: This occurs only if the area on the upwind side of the field is stable creating isolation.

The point within the field where it would be desirable to introduce the first windbreak, wind barrier, wind strip or trap strip would be approximately 160 feet from the windward edge of the field. The windbreaks, wind barriers, wind strips or trap strips should run north to south.

1/ Assume that the soil for the entire field is the same or that the wind erosion control system is designed for the soil with most severe wind erosion hazard.

2/ Flat small grain equivalent.

3/ "Surface resistance" was the term used in previous technical notes for the interaction of these factors.

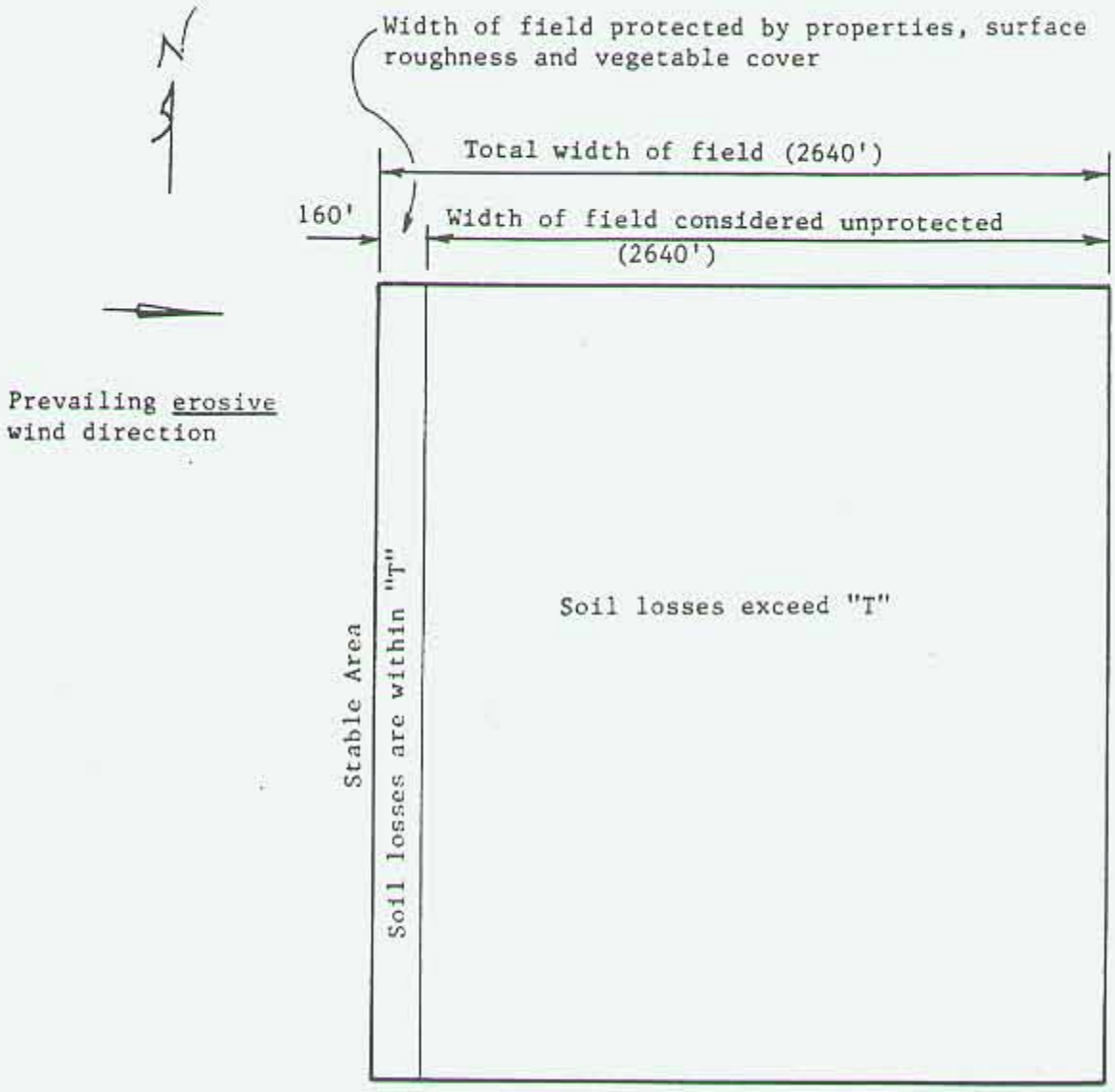


Figure 1 - Existing field with width of field protected by soil properties, surface ridge roughness and vegetative cover.

If it is decided to use tree windbreaks and if they reach 50 feet in height at 20 years of age, it would take four field windbreaks to protect this field. In determining the spacing interval between the windbreak, use 500 feet (the distance considered protected by a windbreak is 10 times the height at 20 years) plus 160 (width of field protected by soil properties, surface ridge roughness and vegetative cover) or 660 feet. The spacing interval between the second and third windbreak and all other windbreaks is also 660 feet. The 660 feet divided into 2,480 feet (total width of the field minus 160 feet) indicates that four windbreaks are needed to adequately protect the field. See Figure 2.

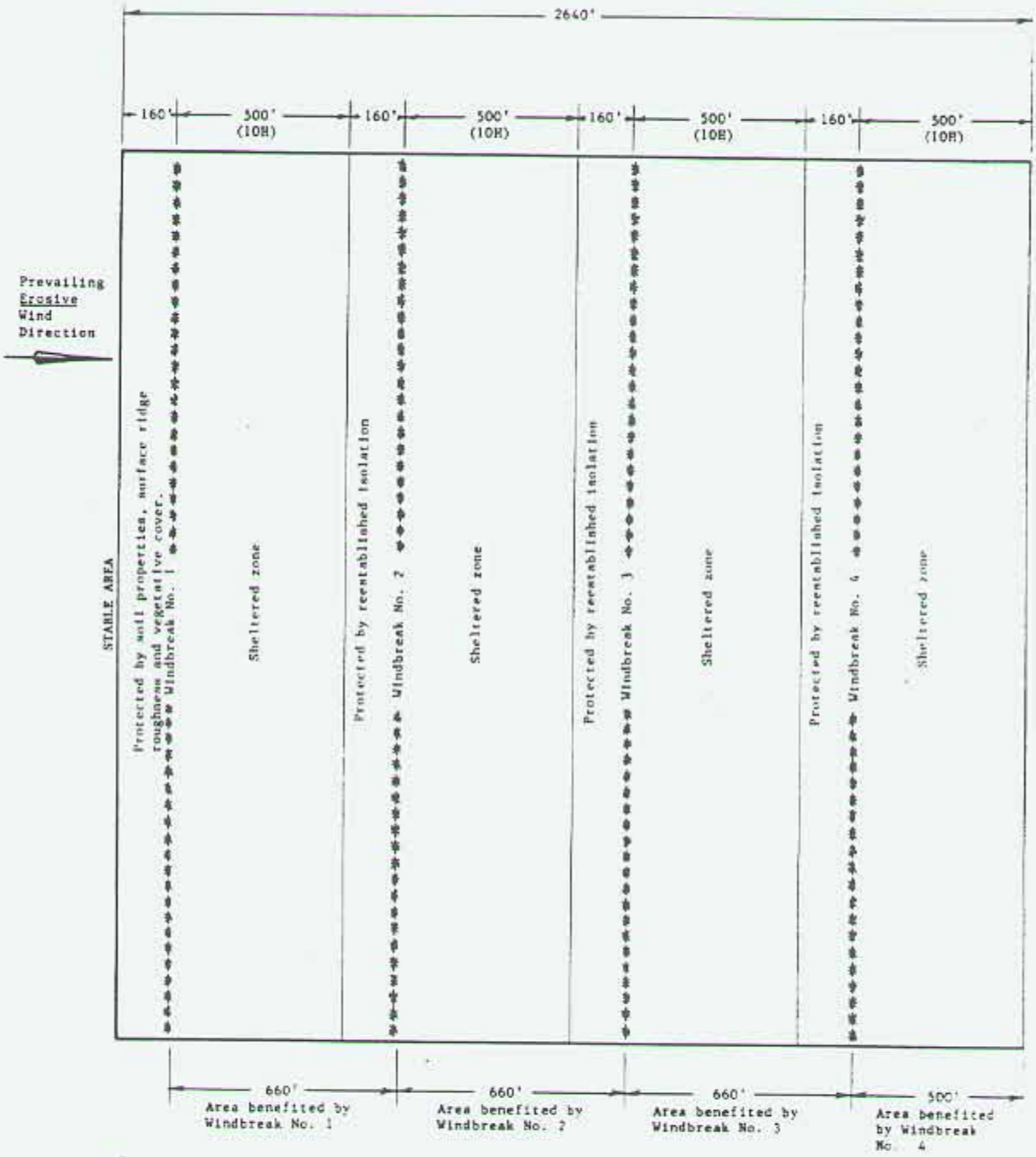


Figure 2 - Effect of using 50 Ft. windbreaks to control erosion.

If it is decided to use perennial grass or annual crop barriers with an effective height of 3 1/2 feet instead of tree windbreaks, the first barrier should be placed at approximately 160 feet from the west edge of field. The spacing interval between the first and second and all remaining barriers is 35 feet (10 times 3 1/2 feet) plus 160 feet (width of field protected by soil properties, surface ridge roughness and vegetative cover) or approximately 195 feet. If 195 feet is divided into the 2,480 feet of field, it would indicate that 13 barriers would be needed to protect the entire field, See Figure 3.

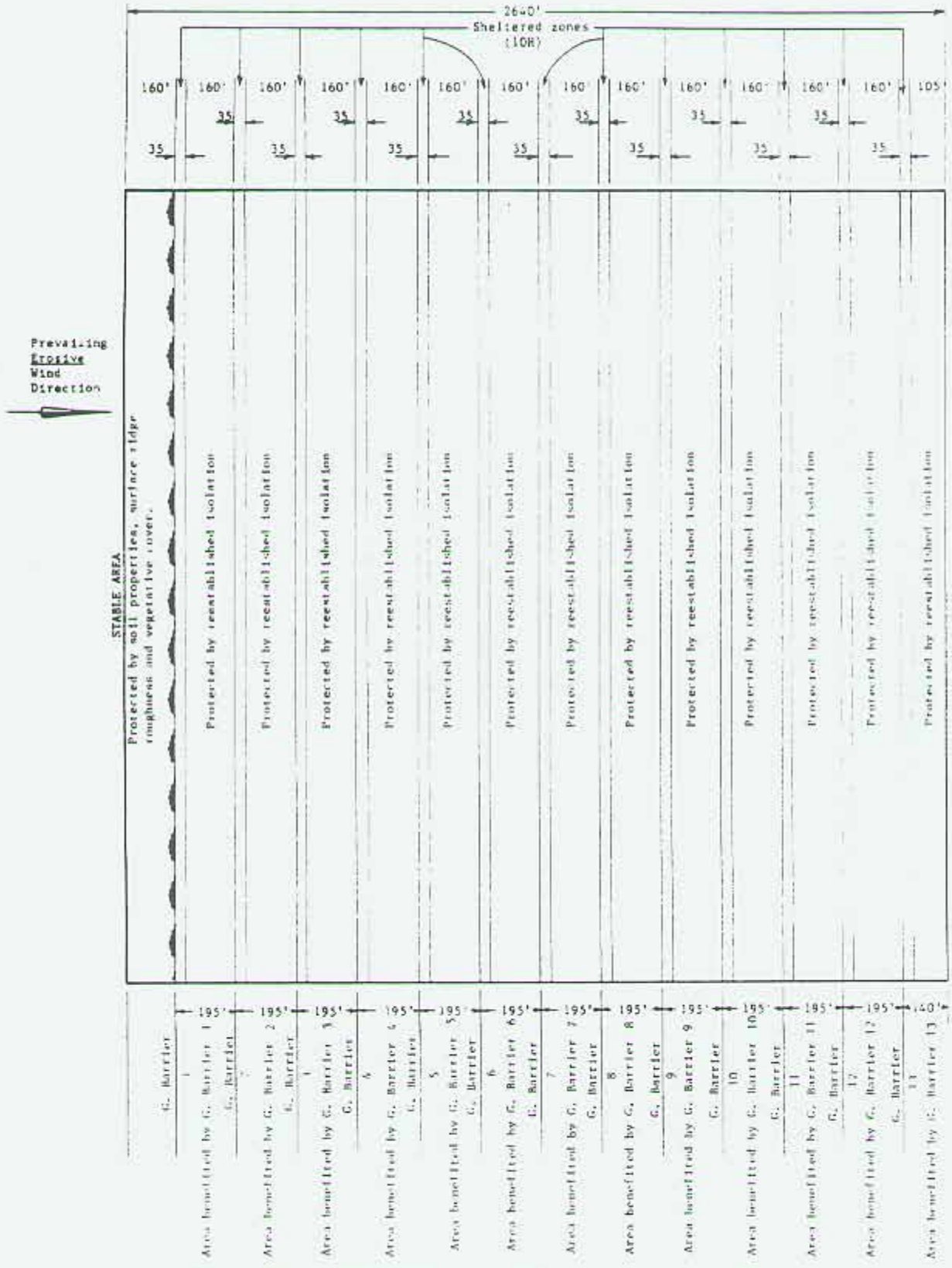


Figure 2 - Effect of using 3 1/2 Ft. perennial grass barriers to control wind erosion.

If it is decided to use 12-foot-wide alfalfa trap strips, it would take 15 trap strips planted at 172-foot intervals. See Figure 4.

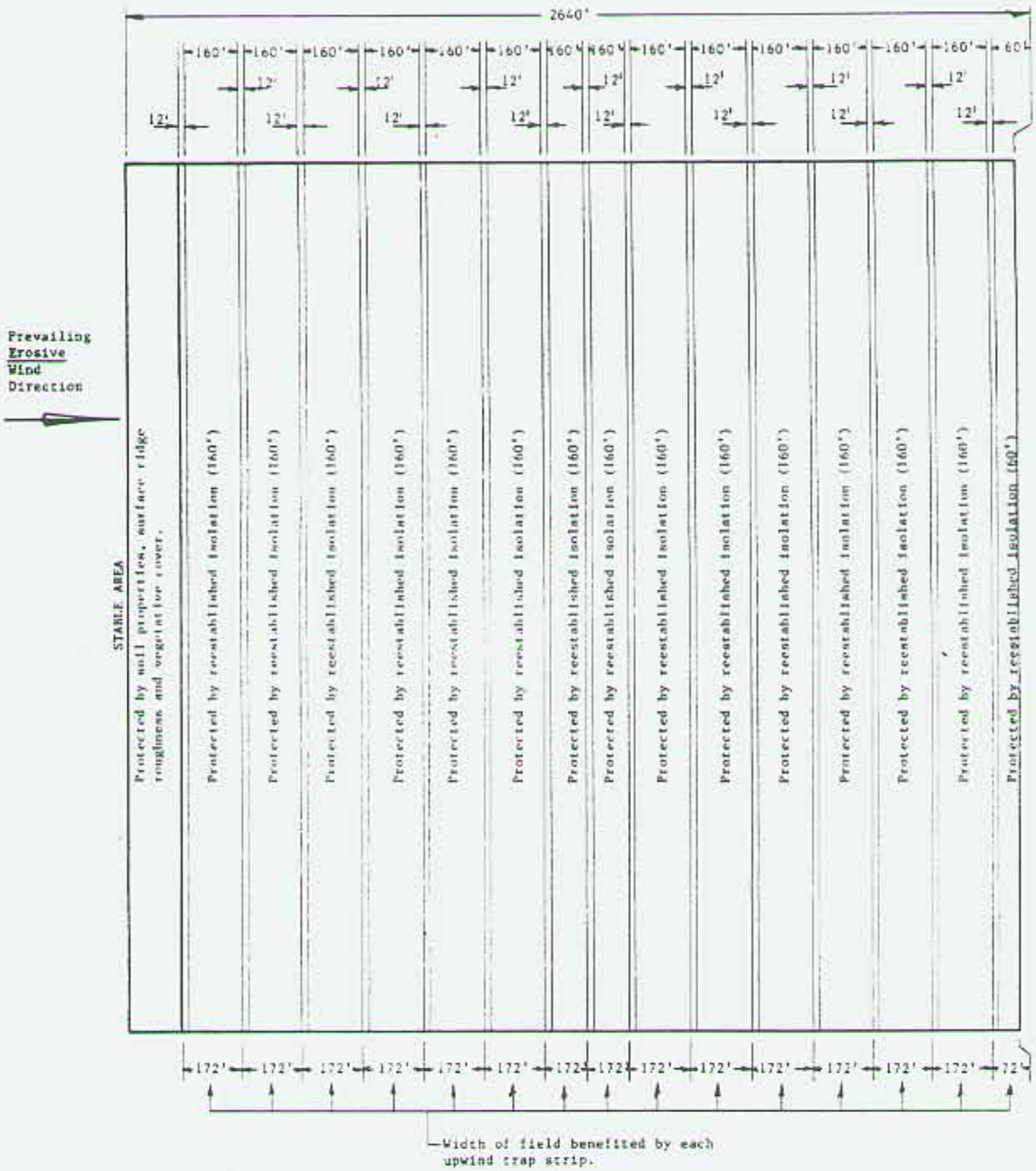


Figure 4 - Effect of using 1 to 1 1/2 Ft. high alfalfa trap strips to control wind erosion.

If stripcropping (standard) is used to protect the entire field it would take 16 strips or 8 pairs to protect the entire field. See Figure 5.

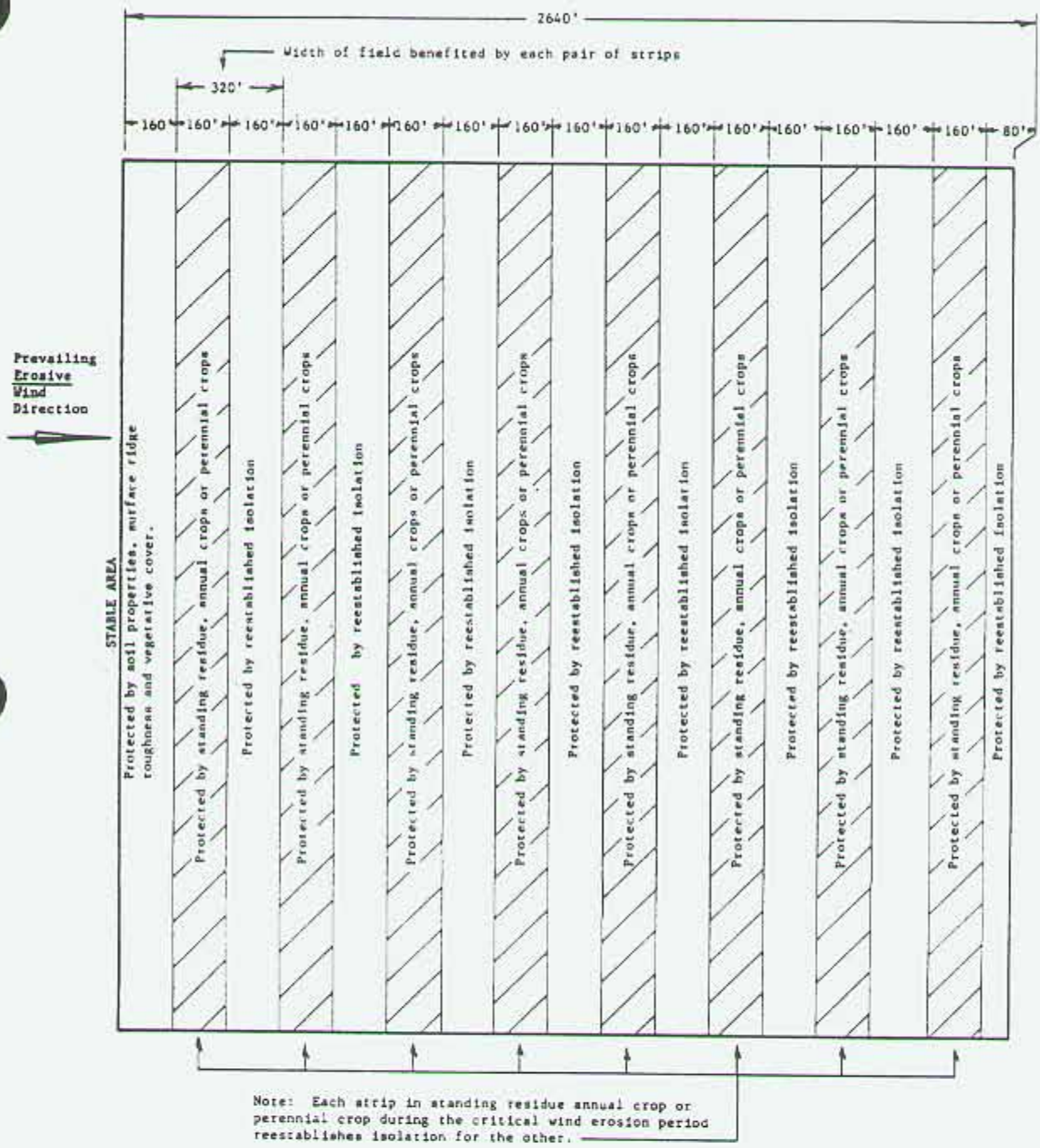


Figure 5 - Effect of using strip cropping to control wind erosion.

A wide variety of combinations of wind erosion control practices can be used in the design of wind erosion control systems. Figure 6 illustrates the use of two 50-foot windbreaks and six 3 1/2-foot-high grass barriers to protect the field.

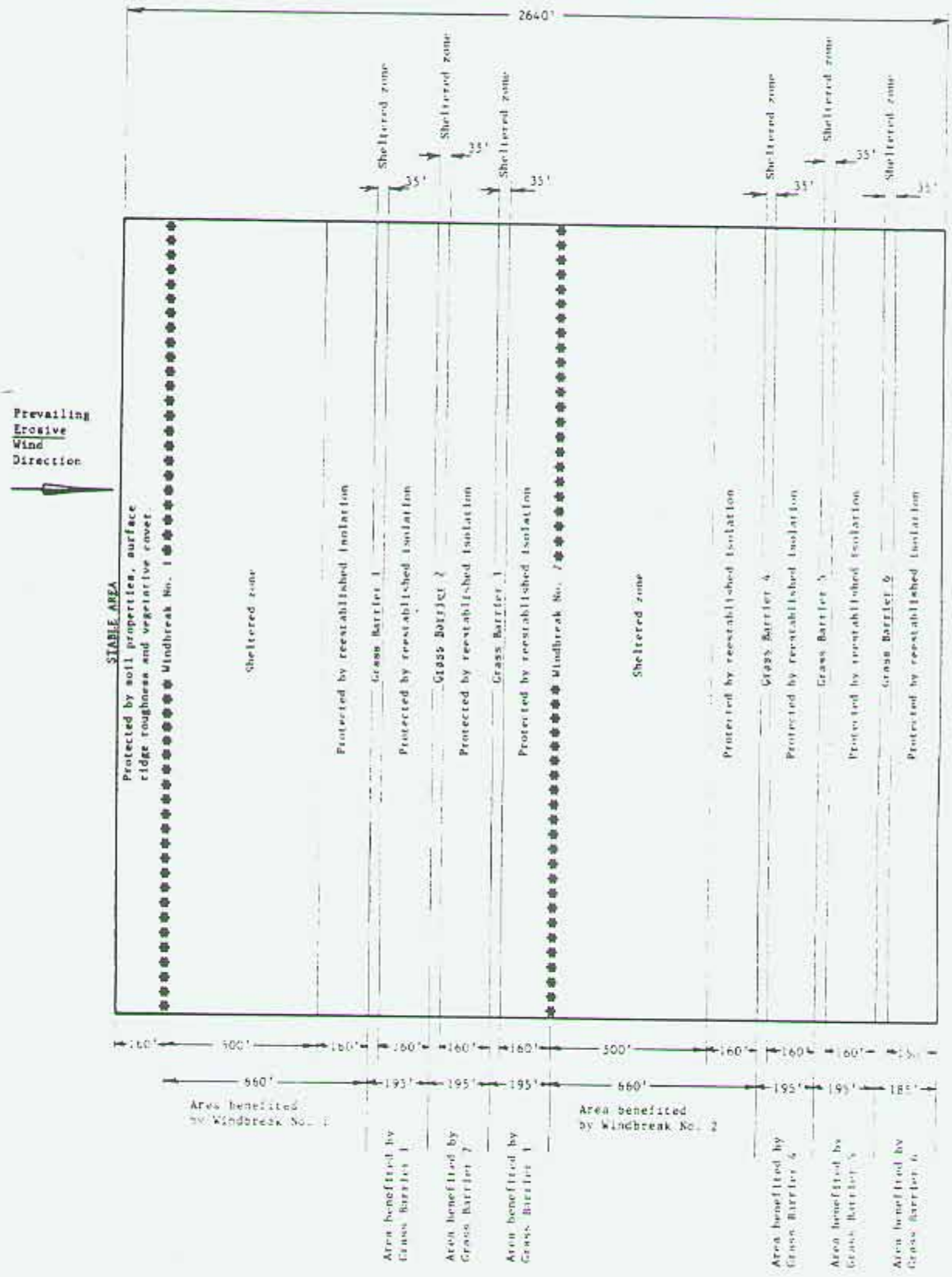
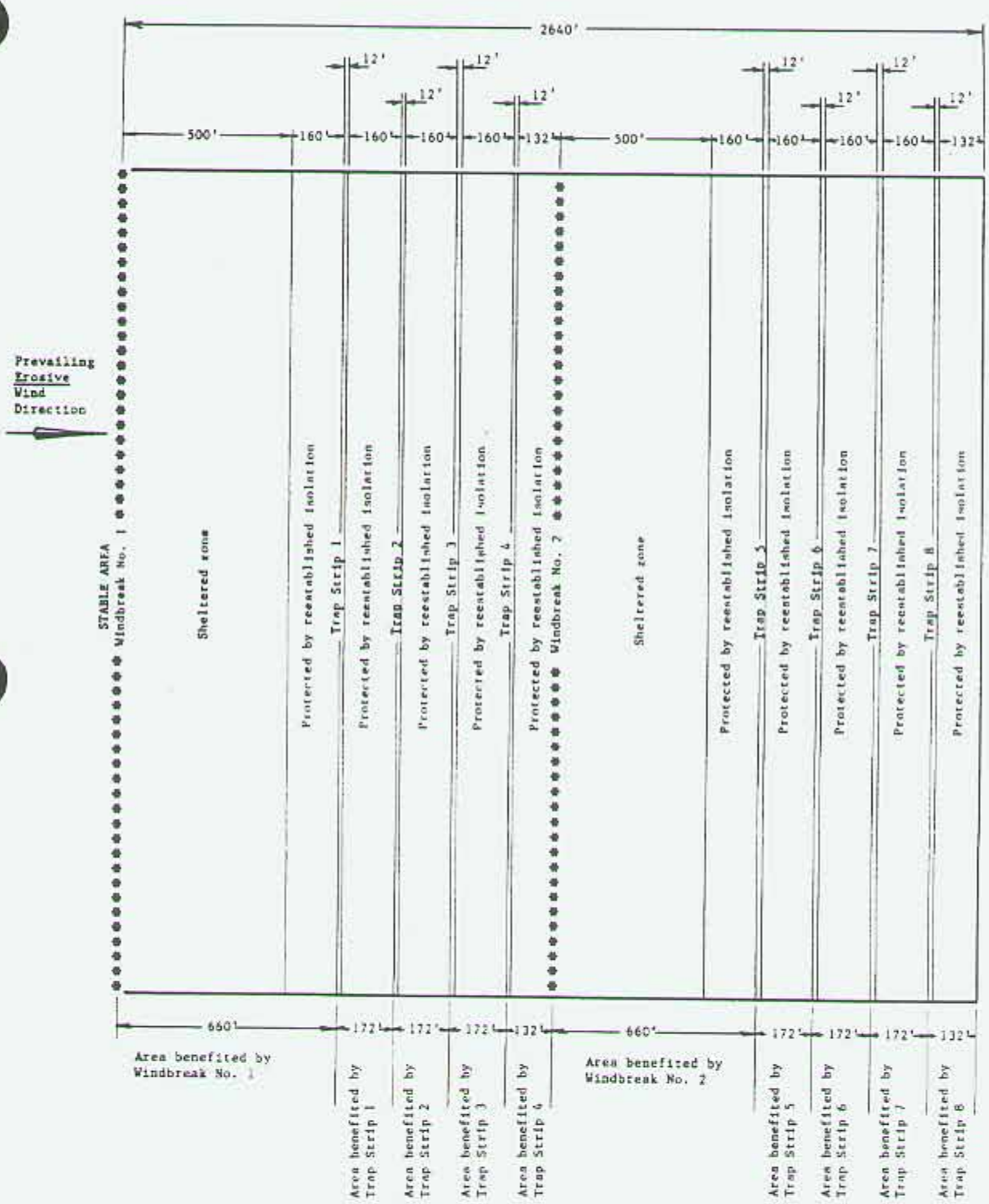


Figure 4 - Effect of using 50 Ft. windbreaks and 3 1/2 Ft. high perennial grass barriers to control wind erosion.

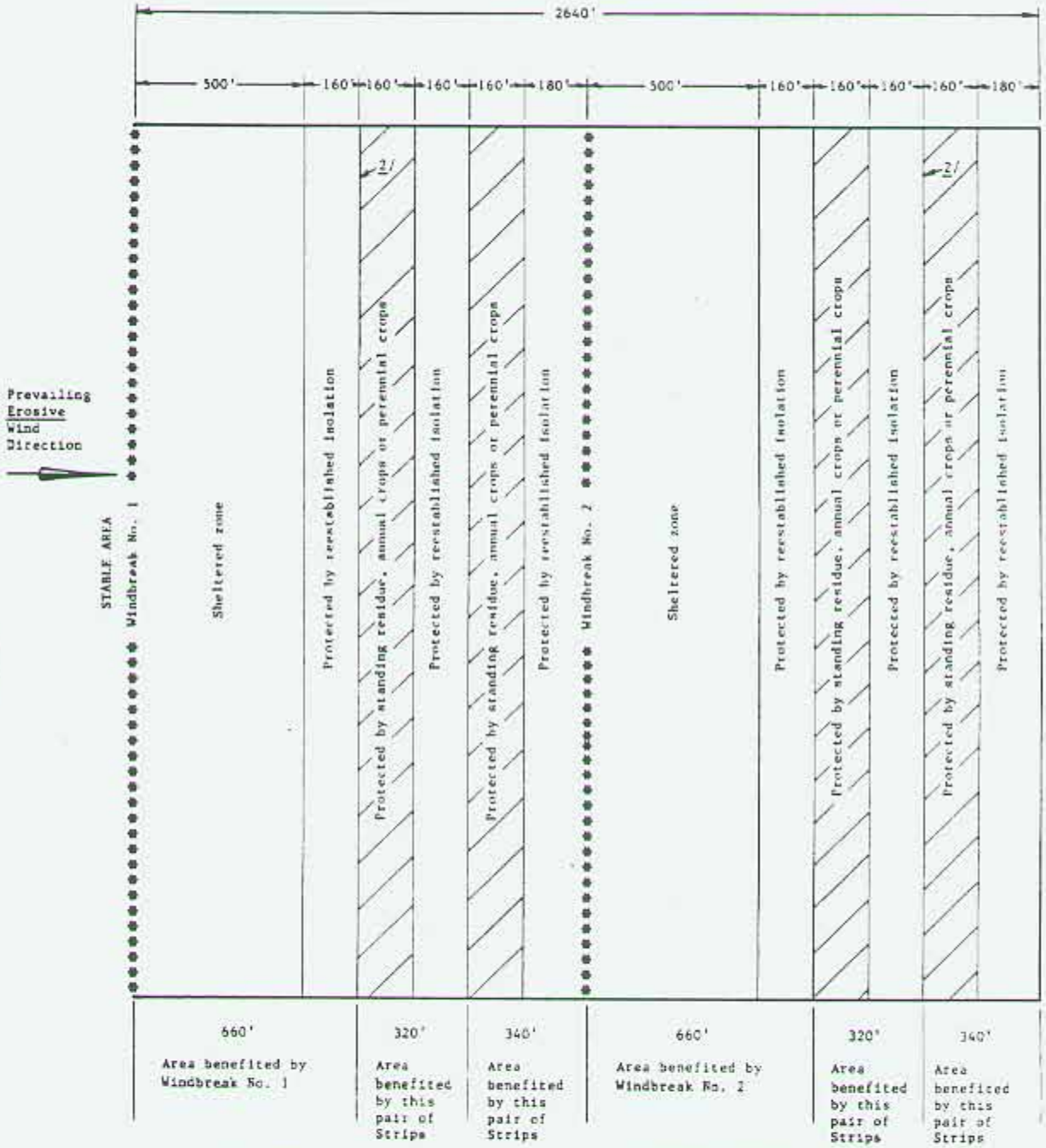
A similar design is illustrated in Figure 7. In this case, two 50-foot windbreaks and eight 12-foot-wide alfalfa trap strips provided the needed protection.



Note: Windbreaks estimated on the windbreak edge and center of field due to wishes of landowner.

Figure 7 - Effect of using 50 Ft. windbreaks and 12 Ft. alfalfa trap strips to control wind erosion.

Strip cropping along with field windbreaks can also provide wind erosion control protection. Figure 8 illustrates how two 50-foot windbreaks and eight strips (4 pairs) can provide the desired level of protection.



1/ This width is slightly wider than recommended by the use of the wind erosion equation. This is a satisfactory design. The extra 20 Ft. would also be distributed over the four strips making them 165 Ft. wide or the 20 Ft. could be made into a narrow strip.

2/ If these two strips are not in permanent vegetation and the cropping on the strips is alternated, it would be desirable to maintain trap strips or other vegetative barriers on the windward edges. This would be needed to maintain isolation on the adjacent strip.

Figure - 8 Effect of using 50 Ft. windbreaks and strip cropping to control wind erosion.

For additional guidance on the development of wind erosion systems consult MNTC Technical Notes:

ECOL SCI-FORESTRY 190 LI-2,
DETERMINING THE EFFECT OF FIELD WINDBREAKS AND WIND BARRIERS ON WIND EROSION (SOIL BLOWING) ON A GIVEN FIELD

ECOL SCI-FORESTRY 190 LI-3,
EXAMPLES OF METHODS OF CONTROLLING WIND EROSION ON A GIVEN FIELD WITH AND WITHOUT WINDBREAKS AND WIND BARRIERS

ECOL SCI-FORESTRY 190 LI-5,
EXAMPLES OF METHODS OF CONTROLLING WIND EROSION (SOIL BLOWING) UNDER CENTER PIVOT IRRIGATION SYSTEMS WITH AND WITHOUT WINDBREAKS

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