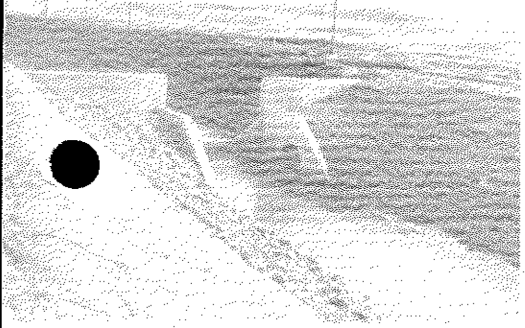

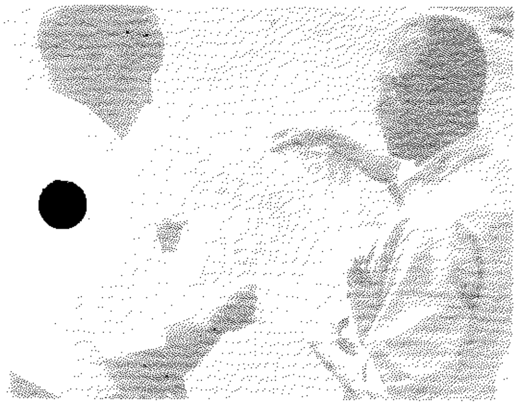

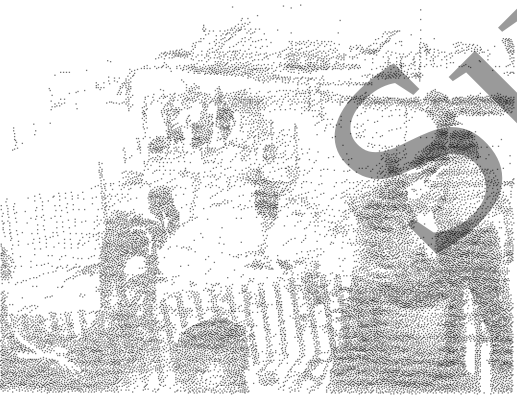

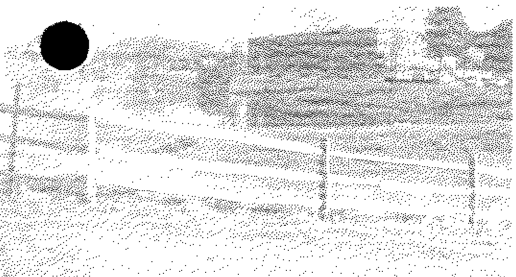

Standards for Soil Erosion and Sediment Control in New Jersey

S T A N D A R D S

for

SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

Revised July 1980

Vegetative and Engineering Standards, pages 3.11 to 4.16.2 inclusive are promulgated as "Standards" pursuant to the Soil Erosion and Sediment Control Act of 1975 as amended (NJSA 4:24-42).

by the

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FOREWORD

As Secretary of the New Jersey Department of Agriculture and Chairman of the State Soil Conservation Committee, I am pleased to present these Standards for Soil Erosion and Sediment Control in New Jersey. When utilized in conjunction with construction and, in fact, with any major land disturbance activities, significant benefits will accrue to the citizens of this State.

Problems of soil erosion and sedimentation, sometimes thought of as related only to agriculture, are actually many times greater as a result of land disturbance activities associated with urbanization. Erosion at the site of such activities generates sediment which finds its way to our streams and rivers to become, by sheer volume, the greatest pollutant of these waterways.

The control and prevention of soil erosion and sedimentation are major objectives of the State Soil Conservation Committee and our 15 soil conservation districts. The development of these Standards has provided an important tool to help implement such controls at all levels of government and by all persons who use the land.

I wish to express sincere thanks to the U.S. Department of Agriculture Soil Conservation Service for providing much of the basic technical information and to the members of the Development Committee listed on page ii who have contributed their time and expertise in the preparation of this outstanding document for use in New Jersey.

Phillip Alampi, Chairman
State Soil Conservation Committee

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PREFACE

The last several decades of rapid suburban development in the State of New Jersey has resulted in a number of undesirable effects. One of the most evident and harmful effects having very serious consequences is the erosion of soil by both wind and water. When soil is displaced unintentionally in this manner, problems are usually created in several areas: the area where the soil comes from; and the area (s) where it is deposited. If a waterway or drainage facility is involved, silting of the stream or drainage facility occurs. The cost of correcting the damage, pollution, and inconvenience this causes is much greater than the cost of preventing soil erosion in the beginning. Fortunately, the technology for preventing soil erosion is well established. Planners, engineers, developers and contractors must begin to utilize these tried and proven methods.

The New Jersey State Soil Conservation Committee under the chairmanship of Secretary of Agriculture Phillip Alampi, recognized a need for developing a comprehensive State wide plan to control these problems of erosion and sedimentation. A Sediment Control Committee was appointed and a copy of their report and recommendations has been published.

Among the recommendations of this group were the development of model ordinances for use by municipalities to regulate land disturbance activities to control erosion and sedimentation. Such model ordinances have been prepared by a committee of representatives from industry, government and concerned groups. Local governmental units should and will be encouraged to use them to establish the proper and necessary controls to reduce soil erosion.

Also recommended was the development of a single source of standards and recommendations to guide local governments, developers and technical personnel with erosion control techniques. Secretary of Agriculture Alampi responded to this recommendation and appointed the committee of knowledgeable persons listed on page ii of this report to develop these standards.

The committee has worked diligently to produce these Standards which are a model of professional excellence. It is their earnest hope that concerned citizens, local governments and their technical advisors will act expeditiously to adopt the needed ordinances and stop the poor practices which have been laying our precious land to waste and ravaging the most valuable and beautiful features of the Garden State.

Thomas Birdsall, Chairman
Committee for Review and
Development of Standards

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INTRODUCTION

Construction projects that involve major land disturbance such as housing and industrial developments, highways and pipelines should be planned and designed with soil erosion and sediment control in mind. The subsequent reduction of soil losses on construction sites and the reduction of associated damages from sedimentation will result in substantial savings to the community, the contractor, the developer and to the landowner as well as providing for enhancement of the environment. The contractor who controls soil erosion during construction will also promote good will in the community.

While erosion and sedimentation controls are important on all sites, particular attention should be given to areas of steep topography and highly erodible soils. The larger the disturbed area and the longer it is left unstabilized, the more serious the problem becomes.

Natural vegetation covers and protects most of our lands from erosion. Its removal necessitates application of alternative protective measures. Establishment of mechanical structures engineered to control water runoff, the application of artifical protective cover or the rapid re-establishment of vegetation are among the methods which are suitable to control erosion and sedimentation.

The purpose of these Standards is to help those responsible for construction to control soil movement through use of these methods. The comprehensive erosion control methods which follow have been developed to provide this help. Interpretive assistance in their application and use is available through the soil conservation district where the land disturbance will take place. A district directory is included in the appendix.

GUIDE LINES

FOR SOIL EROSION AND SEDIMENT CONTROL

Planning

Effective erosion control begins in the project planning stage. Proper planning requires consideration of water control and soils to be encountered in order to reduce erosion problems during and after construction. Steep slopes, potential landslide areas, stream crossings, stream encroachments, and cut and fill sections should be evaluated for construction problems involved in reducing erosion and the resulting sediment damage to streams and water supplies. The evaluation of soils, existing vegetation, geologic and hydrologic data is necessary to define problem areas. Every consideration should be given to assure the successful establishment of vegetation on disturbed areas as quickly as possible in order to minimize erosion and sediment damage.

Design

Proper design includes measures for erosion control and provides for the early establishment of vegetation that will help to avoid erosion problems during and after construction. Alignment, grades, area of disturbed soil and bank slopes should be based on soil erodibility, climatic exposure, geology, proposed vegetative restoration and expected maintenance. The erosion potential from wind or rain, concentrated runoff or snow melt should be evaluated and measures to prevent erosion selected on the basis of both effectiveness of the measure and consequence. Some features involved in earth construction are more vulnerable to erosion than others and require special design considerations.

Guidelines for design of measures and treatment to prevent erosion are as follows:

a. Earth Slopes: Erosion of cut or fill slopes is usually caused by water concentrations at the top of the slope flowing down an unprotected bank. Runoff should be diverted to safe outlets by diversions or other means. Slopes should be protected from erosion by quick establishment of vegetative cover, benches or terraces, slope protection structures, mulches, or a combination of these practices as required.

b. Waterways or Channels: Waterways should be designed to avoid serious erosion problems. Wide channels with flat side slopes lined with grass or other vegetation will usually be free from erosion. Where channel gradients are steep, concrete linings or grade control structures may be required. Space limitations may make it necessary to use concrete or stone linings. Every effort should be made to preserve natural channels.

c. Structures for Erosion Control: Erosion may be controlled by the use of grade control structures, energy dissipators, special culverts, and various types of pipe structures. Structures are expensive and should be used only after it has been determined that recommended vegetation, rock or other measures will not provide adequate erosion control.

d. Detention and Sediment Basins: Small ponds can be constructed to trap sediment. Dams for this purpose are inexpensive and may be permanent or temporary. Detention reservoirs can be designed to reduce peak flows increased by upstream paving to an amount near the original flow. This helps reduce erosion in downstream channels. Dams must be properly designed to avoid failure .

e. Existing Vegetation: Good stands of existing vegetation adequate to control erosion should be preserved wherever possible. Regeneration of wood plants should be encouraged where acceptable.

f. Soil Treatment: The ability of the soil to sustain vegetation intended for erosion control must be ascertained. The admixture of a fine textured topsoil to a coarse textured soil may be warranted to assure success of more attractive, lower maintenance vegetation. Liming and fertilization should be done according to recommendations resulting from soil test information.

g. Seed Bed Preparation: Lime and fertilizer should be incorporated into the soil, where practical, to depth of 4 inches. Soil shall not be too fluffy nor too compacted, but friable to permit proper coverage of seed.

h. Seeding: Seed mixtures, certified as to composition, should be chosen in accordance with standards considering soil drainage, and area usage. Follow recommended rates, dates, and seeding procedures.

i. Mulching: The more adverse the environment, the greater the advantage of mulching according to standards contained herein.

j. Practice Standards: Plans, designs and construction specifications should be in accordance with the standards covering design and installation of erosion control measures as contained herein.

Construction

The plans, specifications, and special provisions of a construction contract should show the location, scope, and manner of performing erosion control measures. Measures left to the discretion of the engineer should be few as practicable and the method of payment for such work should be stated in the contract.

Scheduling of construction operations is an important factor. A construction schedule that meets the requirements for erosion control should be made a part of the construction project proposal or should be submitted by the contractor for approval by the engineer.

Sub-division ordinances and building codes should also provide for adequate erosion control and scheduling of construction as indicated above for contracts.

Permanent soil protection, streets and drainage facilities should be completed as early as practicable, particularly intercepting channels and similar controls that will divert runoff from unprotected soil. The area of exposed soil and the length of exposure should be minimized by proper scheduling. Temporary protection such as fiber mats, plastic, straw, and fast-growing grasses may be required. Partially completed drainage structures should be inspected carefully during construction to prevent erosion.

Fording of streams with equipment should be kept to a minimum, and where frequent crossing are comtemplated, temporary bridges or culverts should be constructed.

Although disturbance of streams, lakes or reservoirs by construction should be avoided, drainage structures, channel changes, and embankment encroachments are sometimes necessary. Specifications and special provisions should include controls of the contractor's operation in performing work in these areas.

Diversions or other protective measures may be needed to avoid sediment problems. Embankment slopes that encroach on stream channels should be adequately protected. Where practicable, a protective area of vegetative cover should be left or established between embankments and adjacent stream channels.

Areas for borrow pits and waste disposal should be selected with full consideration of erosion control and the final treatment or restoration of the area.

When it becomes necessary to locate such areas near or in stream channels, special precautions should be taken to minimize erosion and accompanying sediment problems.

Before borrow or disposal operations are begun, plans for the control of drainage water must include measures to keep sediment from entering streams. Diversion channels, dikes, and sediment traps may be used for this purpose. Topsoil should be saved for use in restoring excavated areas. Final restoration of borrow or waste disposal areas should include grading and establishment of vegetative cover. The restored area should be well drained unless approval is given to convert the pit area into lakes for fish and wildlife, recreation, stock water or irrigation.

Specifications should include adequate control for the prevention of grass and brush fires since burned-over areas are usually highly vulnerable to erosion. In areas where a severe fire hazard exists, fire equipment should be available for ready use. The contract should provide for suspending fire-hazardous operations at the direction of the engineer.

STANDARDS
FOR
TEMPORARY VEGETATIVE COVER
FOR SOIL STABILIZATION

Definition

Establishment of temporary vegetative cover on soils exposed for periods of two to 12 months.

Purpose

To temporarily stabilize the soil and reduce damage from wind and water erosion until permanent stabilization is accomplished.

Where Applicable

On exposed soils that have the potential for causing off-site environmental damage.

Methods and Materials

I. Site Preparation

A. Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application, and mulch anchoring. All grading should be done in accordance with Standards for Land Grading, page 4.11.

B. Install needed erosion control practices or facilities such as diversions, grade stabilization structures, channel stabilization measures, sediment basins and waterways. See Standards 4.2 through 4.16.

II. Seedbed Preparation

A. Apply limestone and fertilizer according to soil test recommendations such as those offered by Rutgers University Soil Testing Laboratory. Soil sample mailers are available from the local Cooperative Extension Service office. If soil testing is not feasible on small or variable sites, or where timing is critical, fertilizer may be applied at the rate of 500 pounds per acre or 11 pounds per 1,000 square feet of 10-20-10 or equivalent. If seed is drilled over banded fertilizer, the rate of fertilizer is reduced 50 percent. Apply limestone (equivalent to 50 percent calcium plus magnesium oxides) as follows:

Soil Texture	Tons/Ac.	Lbs/1000 sq. ft.
Clay, clay loam and high organic soil	3	135
Sandy loam, loam, silt loam	2	90
Loamy sand, sand	1	45

Pulverized dolomitic limestone is preferred for most soils south of the New Brunswick-Trenton line.

B. Work lime and fertilizer into the soil as nearly as practical to a depth of 4 inches with a disc, springtooth harrow or other suitable equipment. The final harrowing or discing operation should be on the general contour. Continue tillage until a reasonably uniform seedbed is prepared.

C. Inspect seedbed just before seeding. If traffic has left the soil compacted, the area must be retilled as above.

D. Soils high in sulfides or having a pH of 4 or less should be mulched only. See Standards for Stabilization with Mulch Only, page 3.31.

III. Seeding

A. Select seed from recommendations in table below:

TABLE 3.1-1

TEMPORARY SEEDING RATES AND DATES

SPECIES	SEEDING RATES (pounds)		OPTIMUM SEEDING DATE[1]			OPTIMUM SEED DEPTH[2]
			Major Land Resource Area[3]			
	Per acre	Per 1000 sq. ft.	144	148	149	(inches)
Annual ryegrass	40	1.0	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15	0.5
Perennial ryegrass	40	1.0	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15	0.5
Oats	86	2.0	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15	1.0
Barley	96	2.2	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15	1.0
Pearl millet	20	0.5	6/1-7/1	5/15-7/15	5/1-8/1	1.0
Sudangrass	30	0.7	6/1-7/1	5/15-7/15	5/1-8/1	1.0
Millet (German or Hungarian)	30	0.7	6/1-7/1	5/15-7/15	5/1-8/1	1.0
Weeping lovegrass	5	0.2	6/1-7/1	5/15-7/15	5/1-8/1	0.25

1/ May be planted throughout summer if soil moisture is adequate or can be irrigated.
2/ Twice the depth for sandy soils.
3/ Major Land Resource Areas:
144 - New England and Eastern New York Upland; Warren, Sussex, Passaic, Bergen, Hudson and Essex Counties.
148 - Northern Piedmont; Morris, Hunterdon, Mercer, Somerset, Union and Middlesex Counties.
149 - Northern Coastal Plain; Monmouth, Ocean, Burlington, Camden, Gloucester, Atlantic, Cape May, Salem and Cumberland Counties.

B. Apply seed uniformly by hand, cyclone seeder, drill, cultipacker type seeder or hydroseeder (slurry including seed and fertilizer). Hydroseedings which are mulched may be left on soil surface.

C. Where feasible, except when a cultipacker type seeder or hydroseeder is used, the seedbed should be firmed following seeding operations with a roller, or light drag. Seeding operations should be on the contour.

IV. Mulching: Required on sites difficult to vegetate (sands, slopes, hydroseedings and off-season operations).

A. Mulch materials should be unrotted salt hay, hay or small grain straw at the rate of 1 1/2 to 2 tons per acre, or 70 to 90 pounds per 1000 square feet. Mulch blowers should not grind or chop the material.

B. Spread uniformly by hand or mechanically so that approximately 75 percent to 95 percent of the soil surface will be covered. For uniform distribution of hand-spread mulch, divide area into approximately 1,000 square feet sections and distribute 70 to 90 pounds within each section.

C. Mulch anchoring should be accomplished immediately after placement to minimize loss by wind or water. This may be done by one of the following methods, depending upon the size of the area, steepness of slopes and costs.

1. Peg and Twine - Drive 8 to 10 inch wooden pegs to within 2 to 3 inches of the soil surface every 4 feet in all directions. Stakes may be driven before or after applying mulch. Secure mulch to soil surface by stretching twine between pegs in a criss-cross and a square pattern. Secure twine around each peg with two or more round turns.

2. Mulch Nettings - Staple paper, jute, cotton or plastic nettings to the soil surface. Use a degradable netting in areas to be mowed.

3. Mulch Anchoring Tool - A tractor-drawn implement especially designed to punch and anchor salt hay or straw mulches into the soil surface. This practice affords maximum erosion control, but its use is limited to those slopes upon which the tractor can operate safely. Tool penetration should be about 3 to 4 inches. The operation should be done on the contour.

4. Liquid Mulch-Binders - May be used to anchor salt hay or straw mulches.

a. Applications should be heavier at edges where wind catches the mulch, in valleys and at crests of banks. Remainder of area should be uniform in appearance.

b. Use one of the following:

(1) Emulsified asphalt - (SS-1, CSS-1, CMS-2, MS-2, RS-1, RS-2, CRS-1 and CRS-2). Apply 0.04 gal./sq. yd. or 194 gal./acre on flat slopes less than 8 feet high. On slopes 8 feet or more high use 0.075 gal./sq. yd. or 363 gal./acre.

(2) Cutback asphalt - rapid curing (RC-70, RC-250, and RC-800) or medium curring (MC-250 or MC-800). Apply 0.04 gal./sq. yd. or 194 gal./acre on flat areas and on slopes less than 8 feet high. On slopes 8 feet or more high use 0.075 gal./sq. yd. or 363 gal./acre

(3) Synthetic or Organic binders - binders such as Curasol, DCA-70, Petro-set and Terra-Tack may be used at rates recommended by the manufacturer to anchor mulch materials.

NOTE: All names given above are registered trade names. This does not constitute a recommendation of these products to the exclusion of other products.

D. Wood-fiber or paper-fiber mulch at the rate of 1,500 pounds per acre may be applied by a hydroseeder. Use is limited to flatter slopes and during optimum seeding periods in spring and fall.

STANDARDS FOR PERMANENT VEGETATIVE COVER FOR SOIL STABILIZATION

Definition

Establishment of permanent vegetative cover on exposed soils where perennial vegetation is needed for long term protection.

Purpose

To permanently stabilize the soil, assuring conservation of soil and water and to enhance the environment.

Where Applicable

On exposed soils that have a potential for causing off-site environmental damage.

Methods and Materials

I. Site Preparation

A. Grade as needed and feasible to permit the use of convential equipment for seedbed preparation, seeding, mulch application and anchoring, and maintenance. All grading should be done in accordance with Standards for Land Grading, page 4.11.

B. Install needed erosion control practices and facilities such as diversions, grade stabilization structures, channel stabilization measures, sediment basins and waterways. See Standards 4.2 through 4.16.

II. Seedbed Preparation

A. Apply limestone and fertilizer according to soil tests such as those offered by Rutgers University Soil Testing Laboratory. Soil sample mailers are available from the local Cooperative Extension Service office. If soil testing is not feasible on small or variable sites, or where timing is critical, fertilizer may be applied at the rate of 500 pounds per acre or 11 pounds per 1,000 square feet using 10-20-10 or equivalent. In addition, 300 pounds 38-0-0 per acre or equivalent of slow release nitrogen may be used in lieu of topdressing (see page 3.27 Section IV). Apply limestone (equivalent to 50 percent calcium plus magnesium oxides) as follows: 1/

Soil Textures	T/Ac.	Lbs./1,000 Sq. Ft.
Clay, clay loam and high organic soil	4	180
Sandy loam, loam, silt loam	3	135
Loamy sand, sand	2	90

Pulverized dolomitic limestone is preferred for most soils south of the New Brunswick-Trenton line.

B. Work lime and fertilizer into the soil as nearly as practical to a depth of 4 inches with a disc, springtooth harrow or other suitable equipment. The final harrowing or discing operation should be on the general contour. Continue tillage until a reasonably uniform, fine seedbed is prepared. All but clay or silty soils and coarse sands should be rolled to firm the seedbed wherever feasible.

1/ Acid soil conditions:

Soils having a pH of 4 or less or containing iron sulfide shall be covered with a minimum of 12 inches of soil having a pH of 5 or more before seedbed preparation. The added soil shall be limed as above.

C. Remove from the surface all stones two inches or larger in any dimension, remove all other debris, such as wire, cable, tree roots, pieces of concrete, clods, lumps or other unsuitable material.

D. Inspect seedbed just before seeding. If traffic has left the soil compacted, the area must be retilled and firmed as above.

III. Seeding

A. Select a mixture from Table 3.2-1 or use mixture recommended by the Cooperative Extension Service or Soil Conservation Service which is approved by the Soil Conservation District.

B. Apply seed uniformly by hand, cyclone seeder, drill, cultipacker type seeder or hydroseeder (slurry including seed and fertilizer). Normal seeding depth is from 1/4 to 1/2 inch. Hydroseedings which are mulched may be left on soil surface. Soil Conservation Districts can require specific techniques for hydroseeding and/or hydromulching in areas with droughty conditions.

C. Where feasible, except where either a cultipacker type seeder or hydroseeder is used the seedbed should be firmed following seeding operations with a roller, or light drag. Seeding operations should be on the contour.

IV. Mulching - Required on sites difficult to vegetate (sands, slopes or hydroseedings and off-season operations).

A. Mulch materials should be unrotted salt hay, hay or small grain straw at the rate of 1 1/2 to 2 tons per acre, or 70 to 90 pounds per 1000 square foot. Mulch blowers should not grind or chop the material.

B. Spread uniformly by hand or mechanically so that approximately 75 percent to 95 percent of the soil surface will be covered. For uniform distribution of hand spread mulch, divide area into approximately 1,000 square feet sections and distribute 70 to 90 pounds within each section.

C. Mulch anchoring should be accomplished immediately after placement to minimize loss by wind or water. This may be done by one of the following methods, depending upon the size of the area, steepness of slopes and costs.

1. Peg and Twine - Drive 8 to 10 inch wooden pegs to within 2 to 3 inches of the soil surface every 4 feet in all directions. Stakes may be driven before or after applying mulch. Secure mulch to soil surface by stretching twine between pegs in a criss-cross and a square pattern. Secure twine around each peg with two or more round turns.

2. Mulch Nettings - Staple paper, jute, cotton or plastic nettings to the soil surface. Use a degradable netting in areas to be mowed.

3. Mulch Anchoring Tool - A tractor-drawn implement especially designed to punch and anchor mulch into the soil surface. This practice affords maximum erosion control, but its use is limited to those slopes upon which the tractor can operate safely. Tool penetration should be about 3 to 4 inches. On sloping land, the operation should be done on the contour.

4. Liquid Mulch-binders - May be used to anchor salt hay, hay or straw mulches.

a. Applications should be heavier at edges where wind catches the mulch, in valleys and at crests of banks. Remainder of area should be uniform in appearance.

TABLE 3.2-1

SOILS, SEED MIXTURES AND DATES FOR PERMANENT SEEDINGS FOR SOIL STABILIZATION

	SOILS 1/		SEED MIXTURES	SEEDING RATES 2/ (pounds)		OPTIMUM SEEDING DATES		
A. Dry to Droughty						Major Land Resource Areas 3/		
	Gravelly & Sandy- (Coarse Texture)	Shallow/Shaley/ Steep/Gravelly- (Medium & Fine Texture)		Per Acre	Per 1,000 Sq. Ft.	144	148	149
(A-1)		X	Perennial ryegrass Crownvetch Spreading fescue	25 12 25	0.6 0.3 0.6	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15
(A-2)		X	Weeping lovegrass Sericea lespedeza (D) 4/	2 20	0.1 0.5	4/1-7/1	3/15-7/15	3/1-8/1
(A-3)		X	Weeping lovegrass Crownvetch	3 12	0.1 0.3	4/1-7/1	3/15-7/15	3/1-8/1
(A-4)	X (hot slopes)	X (hot, sunny slopes)	Weeping lovegrass "Lathco" flatpea	3 30	0.1 0.7	--	3/15-7/15	3/1-8/1
(A-5)		X	Spreading fescue Chewing's red fescue Kentucky bluegrass (low maintenance variety) (D-W)	30 30 30	0.7 0.7 0.7	3/25-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15 (shade & cool sites only)
(A-6)		X (deep soils)	Midland bermudagrass (D-W)	12 Bushel sprigs spaced at 2' to 3' centers		--	--	5/1-7/15
(A-7)		X (deep soils)	Other turf type bermudagrass (D-W)	20 Bushel spaced 12" centers		--	--	5/1-7/15

TABLE 3.2-1 (continued)

SOILS 1/	SEED MIXTURES	SEEDING RATES 2/ (pounds)		OPTIMUM SEEDING DATES		
				Major Land Resource Areas 3/		
		Per Acre	Per 1,000 Sq. Ft.	144	148	149
B. Well Drained and Moderately Well Drained (sands to fine textures)	Mixtures A-1 through A-6 as adapted to soil texture					
(B-1) (sun to open shade)	Kentucky-31 tall fescue Spreading fescue Kentucky bluegrass (low maintenance variety) (D-W)	30 30 30	0.7 0.7 0.7	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15
(B-2) (aesthetics is not important)	Kentucky-31 tall fescue Sericea lespedeza (D)	25 20	0.6 0.4	3/15-6/1 --	3/1-5/15 --	2/15-5/1 8/15-10/15
(B-3) (some restricted drainage soils)	Kentucky-31 tall fescue Birdsfoot trefoil (D)	45 10	1.0 0.2	3/15-6/1	3/1-5/15	--
(B-4) (sun and shade)	Spreading fescue Chewing's red fescue Kentucky bluegrass Perennial ryegrass (D-W)	15 15 25 10	0.3 0.3 0.6 0.2	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15 (shade & cool sites only)
(B-5) (sunny sites) (high maintenance, aesthetic areas)	Kentucky bluegrass (three variety blend) (D-W)	90	2.0	3/15-6/1	3/1-5/15	--
C. Somewhat poorly drained soils -- Seed mixtures B-1, B-3, B-4 and B-5 as adapted to soil texture						

TABLE 3.2-1 (continued)

SOILS 1/	SEED MIXTURES	SEEDING RATES 2/ (pounds)		OPTIMUM SEEDING DATES Major Land Resource Areas 3/		
		Per Acre	Per 1,000 Sq. Ft.	144	148	149
D. Poorly drained soils						
(D-1)	Reed canarygrass	20	0.4	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	1/15-5/1 8/15-10/15
	Redtop	4	0.1	(Be sure Reed canarygrass seed is from new seed crop)		
	Perennial ryegrass	20	0.4			
	(W)					
E. New Jersey Department of Transportation Seed Mixtures						
(E-1) All except sandy, dry soils	Type A					
	Kentucky bluegrass	20	0.4	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15
	Red fescue (Creeping's or Chewing's)	35	0.7			
	Kentucky-31 tall fescue	20	0.4			
	Redtop	10	0.2			
	Perennial ryegrass	10	0.2			
	White clover	5	0.1			
	(D-W)					
(E-2) Sandy, dry soils	Type B					
	Redtop	10	0.2	3/15-6/1 8/1-9/15	3/1-5/15 8/15-10/1	2/15-5/1 8/15-10/15
	Red fescue (Creeping's or Chewing's)	40	0.8			
	Blackwell switchgrass	10	0.2			
	Reed canarygrass	10	0.2			
	Weeping lovegrass	10	0.2			
	Perennial ryegrass	5	0.1			
	Kentucky-31 tall fescue	15	0.2			
	(D-W)					
(E-3) All except sandy, dry soils	Type A-2					
	Spreading fescue (Fortress)	20	0.4	3/15-6/1	3/1-5/15	2/15-5/1
	Chewing's or Hard fescue (Banner)	20	0.4			
	Kentucky bluegrass (Kenblue)	20	0.4			
	(D-W)					

TABLE 3.2-1 (continued)

SOILS 1/	SEED MIXTURES	SEEDING RATES 2/ (pounds)	OPTIMUM SEEDING DATES
			Major Land Resource Areas 3/

1/ See page 3.28 - Classification of New Jersey Soil Series into Site Conditions important to seedings.

2/ The rates contained herein are minimum. Local Soil Conservation Districts may require higher rates because of unique situations.

3/ Major Land Resource Areas:
144 - New England and Eastern New York; Warren, Sussex, Passaic, Bergen, Hudson, and Essex Counties.
148 - Northern Piedmont; Morris, Hunterdon, Mercer, Somerset, Union, and Middlesex Counties.
149 - Northern Coastal Plain; Monmouth, Ocean, Burlington, Camden, Gloucester, Atlantic, Cape May, Salem, and Cumberland Counties.

4/ Designation of seed mixtures which are suitable for stabilization of Diversions (D) and Grassed Waterways (W).

RECOMMENDED VARIETIES: Birdsfoot trefoil (Empire); Bermudagrass (Midland); Chewing's red fescue (Banner, Jamestown); Crownvetch (Chemung, Penngift); Kentucky bluegrass-low maintenance (Kenblue, Delta, Park); Kentucky bluegrass-high maintenance (Adelphi, Touchdown, Baron); Reed canarygrass (Ioreed); Spreading fescue (Fortress, Ruby); Tall fescue (Kentucky-31).

NOTES: (1) Seeding mixtures and/or rates not listed above may be used if recommended by the local Soil Conservation District or the Soil Conservation Service; recommendations of the Cooperative Extension Service may be used if approved by the Soil Conservation District.

(2) Grass seed mixtures checked by the chief of the Bureau of Seed Certification, New Jersey Department of Agriculture, Trenton, New Jersey, will assure the purchaser that the mixture obtained is the mixture ordered.

b. Use one of the following:

(1.) Emulsified asphalt - (SS-1, CSS-1, CMS-2, MS-2, RS-1. RS-2, CRS-1, and CRS-2).

Apply 0.04 gal./sq.yd. or 194 gal./acre on flat slopes and on slopes less than 8 feet high. On slopes 8 feet or more high use 0.075 gal./sq. yd. or 363 gal./acre.

(2.) Cutback asphalt rapid curing (RC-70, RC-250, and RC-800) or medium curing (MC-250 or MC-800).

Apply 0.04 gal./sq. yd. or 194 gal./acre on flat areas and on slopes less than 8 feet high. On slopes 8 feet or more high use 0.075 gal./sq. yd. or 363 gal./acre.

(3.) Synthetic or Organic binders - binders such as Curasol, DCA-70, Petro-set and Terra-Tack may be used at rates recommended by the manufacturer to anchor mulch materials.

NOTE: All names given above are registered trade names. This does not constitute a recommendation of these products to the exclusion of other products.

D. Wood-fiber or paper-fiber mulch at the rate of 1,500 pounds per acre may be applied by hydroseeder. Use is limited to flatter slopes and during optimum seeding periods in spring and fall.

V. Irrigation - (where feasible) - If soil moisture is deficient, and mulch is not used, supply new seedings with adequate water (a minimum of 1/4 inch twice a day until vegetation is well established). This is especially true when seedings are made in abnormally dry or hot weather or on droughty sites.

VI. Topdressing*

A. Spring seedings will require an application of fertilizer such as 10-10-10 or equivalent at 400 pounds per acre or 10 pounds per 1,000 square feet between September 1 and October 15.

B. Fall seedings will require the above between March 15 and May 1.

C. Mixtures dominated by Weeping lovegrass or legumes may not need topdressing.

D. Bermudagrass should be topdressed before August 15.

* If slow release nitrogen (300 pounds 38-0-0 per acre or equivalent) is used in addition to suggested fertilizer, this follow-up of topdressing is not mandatory.

CLASSIFICATION OF NEW JERSEY SOIL SERIES INTO SITE CONDITIONS IMPORTANT TO SEEDING

A. Droughty
B. Well and moderately well drained
C. Somewhat poorly drained
D. Poorly and very poorly drained

Series	Cls.	Series	Cls.	Series	Cls.	Series	Cls.
Abbottstown	C	Coplay	D	Lamington	C	Pope	B
Adelphia	B	Cossayuna	B	Lansdale	B	Portsmouth	D
Adrian	D	Crestmore	B	Lansdowne	B	Preakness	D
Albia	C	Croton	D	Lawrenceville	B	Quakertown	B
Amwell	C	Culvers	C	Legore	B	Raritan	C
Annandale	B	Donlonton	C	Lehigh	C	Raynham	C
Asbury	B	Downer	B	Lenoir	C	Readington	B
Atherton	D	Doylestown	D	Leon	D	Reaville	C
Athol	B	Dragston	C	Lincroft	A	Rhinebeck	C
Atsion	D	Duffield	B	Livingston	D	Ridgebury	D
Aura	B	Dunellen	B	Lyons	D	Riverhead	B
Barclay	C	Dutchess	B	Marksboro	C	Rockaway	B
Bartley	B	Edneyville	B	Marlton	B	Rockport	B
Bath	B	Elkton	D	Matapeake	B	Roe	C
Bayboro	D	Ellington	B	Matawan	B	Rowland	B
Beatty	B	Evesboro	A	Matlock	D	Royce	B
Bedington	B	Fallsington	D	Mattapex	B	Rutlege	D
Berks	B	Fort Mott	A	Meckesville	B	St. Johns	D
Berryland	D	Fredon	D	Middlebury	B	Sassafras	B
Bertie	C	Freehold	B	Minoa	C	Scio	C
Bibb	D	Freneau	D	Monmouth	B	Shrewsbury	D
Biddeford	D	Galestown	A	Mount Lucas	B	Sloan	D
Birdsboro	B	Hackettstown	B	Nassau	A	Stephensburg	B
Boonton	B	Haledon	C	Navesink	B	Swartswood	B
Bowmansville	C	Halsey	D	Neshaminy	B	Tinton	A
Boynton	D	Hammonton	B	Netcong	B	Tioga	B
Braceville	B	Hazen	B	Nixon	B	Townsbury	B
Bridgeville	C	Hazleton	B	Nixonton	B	Tunkhannock	B
Bucks	B	Hero	B	Norton	B	Turbotville	C
Burnham	D	Hibernia	C	Norwich	D	Unadilla	B
Califon	B	Holmdel	B	Oquaga	B	Valois	B
Carlisle	D	Holyoke	A	Osier	D	Wallkill	D
Cattaraugus	B	Hoosic	A	Othello	D	Washington	B
Chalfont	C	Howell	B	Otisville	A	Wassaic	B
Chatfield	B	Keansburg	D	Palmyra	B	Watchung	D
Chenango	B	Kendaia	D	Parker	A	Wayland	D
Chillum	B	Keyport	B	Parsippany	D	Weeksville	D
Chippewa	C	Kistler	B	Pasquotank	D	Wellsboro	C
Cokesbury	D	Klej	A	Pattenburg	B	Westphalia	B
Colden	D	Klinesville	A	Pemberton	A	Whippany	C
Colemanstown	D	Kresson	C	Penn	B	Whitman	D
Collington	B	Lackawanna	B	Phelps	C	Woodglen	D
Colonie	A	Lakehurst	A	Plummer	D	Woodmansie	B
Colts Neck	B	Lakeland	A	Pocomoke	D	Woodstown	B
Comly	C	Lakewood	A	Pompton	C	Wooster	B
						Wurtsboro	B

STANDARDS
FOR
STABILIZATION WITH MULCH ONLY

Definition

Stabilizing exposed soils with non-vegetative materials.

Purpose

To protect exposed soil surfaces from erosion damage and to reduce offsite environmental damage.

Where Applicable

This practice is applicable to areas subject to erosion, where the season and other conditions may not be suitable for growing an erosion-resistant cover or where stabilization is needed for a short period until more suitable protection can be applied.

Methods and Materials

I. Site Preparation

A. Grade, as needed and feasible, to permit the use of conventional equipment for applying and anchoring mulch. All grading should be done in accordance with Standard for Land Grading, page 4.11.

B. Employ needed erosion control practices such as diversions, grade stabilization structures, channel stabilization measures, sediment basins and waterways. See Standards 4.2 through 4.16.

II. Protective Materials

A. Unrotted small-grain straw, hay or salt hay at 2.0 to 2.5 tons per acre is spread uniformly at 90 to 115 pounds per 1000 square feet and anchored with a mulch anchoring tool, liquid mulch binders or netting tiedown. Other suitable materials may be used if approved by the Soil Conservation District.

B. Asphalt emulsion or cutback asphalt is recommended at the rate of 600 to 1,200 gallons per acre. This is suitable for a limited period of time where travel by people, animals or machines is not a problem.

C. Synthetic or organic soil stabilizers may be used - under suitable conditions and in sufficient quantities.

D. Wood-fiber or paper-fiber mulch at the rate of 1,500 pounds per acre may be applied by a hydroseeder or hydromulching.

E. Mulch netting, such as paper jute, excelsior, cotton or plastic, may be used.

F. Woodchips applied uniformly to a minimum depth of 2 inches may be used. Woodchips will not be used on areas where flowing water could wash them into an inlet and plug it.

G. Gravel, crushed stone or slag at the rate of 9 cubic yards per 1000 sq. ft. applied uniformly to a minimum depth of 3 inches may be used. Size 2 or 3 (ASTM C-33) is recommended.

III. Mulch Anchoring - should be accomplished immediately after placement of hay or straw mulch to minimize loss by wind or water. This may be done by one of the following methods, depending upon the size of the area and steepness of slopes.

A. Peg and Twine - Drive 8 to 10 inch wooden pegs to within 2 to 3 inches of the soil surface every 4 feet in all directions. Stakes may be driven before or after applying mulch. Secure mulch to soil surface by stretching twine between pegs in a criss-cross and a square pattern. Secure twine around each peg with two or more round turns.

B. Mulch Nettings - Staple paper, cotton, or plastic nettings over hay or straw mulch. Use a degradable netting in areas to be mowed. Netting is usually available in rolls 4 feet wide and up to 300 feet long.

C. Mulch Anchoring Tool - A tractor-drawn implement especially designed to punch and anchor mulch into the soil surface. This practice affords maximum erosion control, but its use is limited to those slopes upon which the tractor can operate safely. Tool penetration should be about 3 to 4 inches. On sloping land, the operation should be done on the contour.

D. Liquid Mulch-binders

1. Applications should be heavier at edges where wind catches the mulch, in valleys and at crests of banks. Remainder of area should be uniform in appearance.

2. Use one of the following:

(a) Emulsified asphalt - (SS-1, CSS-1, CMS-2, MS-2, RS-1, RS-2, CRS-1 and CRS-2).

Apply 0.04 gal./sq. yd. or 194 gal./acre on flat slopes and slopes less than 8 feet high. On slopes 8 feet or more high use .075 gal./sq. yd. or 363 gal./acre.

(b) Cutback asphalt - rapid curing (RC-70, RC-250 and RC-800) or medium curing (MC-250 or MC-800).

Apply 0.04 gal./sq. yd. or 194 gal./acre on flat areas and on slopes less than 8 feet high. On slopes 8 feet or more high use 0.075 gal./sq.yd. or 363 gal./acre.

(c) Synthetic or Organic binders - binders such as Curasol, DCA-70, Petro-set and Terra-Tack may be used at rates recommended by the manufacturer to anchor mulch materials.

Note: All names given above are registered trade names. This does not constitute a recommendation of these products to the exclusion of other products.

STANDARDS
FOR
PERMANENT STABILIZATION WITH SOD

Definition

Establishing permanent vegetation using sod.

Purpose

To permanently stabilize the soil with an immediate aesthetic covering thus assuring conservation of soil and water and to enhance the environment.

Where Applicable

On exposed soils that have a potential for causing off-site environmental damage where a quick vegetative cover is desired. Moisture is required for success, access to irrigation is essential.

Methods and Materials

1. Cultivated sod is preferred over native or pasture sod. Specify "Certified Sod," or other high quality culitivated sod.

2. Sod should be free of weeds and undesirable coarse weedy grasses.

3. Sod should be of uniform thickness, approximately 5/8 inch, plus or minus 1/4 inch, at time of cutting. (Excludes top growth).

4. Sod should be vigorous and dense and be able to retain its own shape and weight when suspended vertically with a firm grasp from the upper 10% of the strip. Broken pads or torn and uneven ends will not be acceptable.

5. For droughty sites a sod of Kentucky 31 tall fescue and bluegrass is preferred over a straight bluegrass sod.

6. Only moist, fresh unheated sod should be used. Sod should be harvested, delivered and installed within a period of 36 hours.

I. Site Preparation

A. Grade as needed and feasible to permit the use of conventional equipment for liming, fertilizing and soil preparation. All grading should be done in accordance with Standard for Land Grading, page 4.11.

B. Install needed erosion control practices and facilities, such as interceptor ditches, dikes and terraces, erosion stops and desilting basins. See Standards 4.2 through 4.16.

II. Soil Preparation

A. Apply limestone and fertilizer according to soil tests such as those offered by Rutgers University Soil Testing Laboratory. Soil sample mailers are available from local Cooperative Extension Service office. If soil testing is not feasible on small or variable sites, or where timing is critical, fertilizer may be applied at the rate of 500 pounds per acre or 11 pounds per 1,000 square feet using 10-20-10 or equivalent. In addition, 300 pounds 38-0-0 per acre or equivalent of slow release nitrogen may be used in lieu of topdressing. Apply limestone (equivalent to 50 percent calcium plus magnesium oxides) as follows:

Soil Texture	T./Ac.	Lbs./1000 Sq. Ft.
Clay, and clay loam and high organic soil	4	180
Sandy loam, loam, silt loam	3	135
Loamy sand, sand	2	90

Pulverized dolomitic limestone is preferred for most soils south of the New Brunswick-Trenton line.

B. Work lime and fertilizer into the soil as nearly as practical to a depth of 4 inches with a disc, springtooth harrow or other suitable equipment. The final harrowing or discing operation should be on the general contour. Continue tillage until a reasonably uniform, fine seedbed is prepared.

C. Remove from the surface all objects that would prevent good sod to soil contact and remove all other debris, such as wire, cable, tree roots, pieces of concrete, clods, lumps or other unsuitable material.

D. Inspect site just before sodding. If traffic has left the soil compacted, the area must be retilled and firmed as above.

III. Sod Placement

A. Sod strips should be laid on the contour, never up and down the slope, starting at the bottom of the slope and working up. On steep slopes, the use of ladders will facilitate the work and prevent damage to the sod. During periods of high temperature, lightly irrigate the soil immediately prior to laying the sod.

B. Place sod strips with snug even joints that are staggered. Open spaces invite erosion.

C. Roll or tamp sod immediately following placement to insure solid contact of root mat and soil surface. Do not overlap sod. All joints should be butted tightly in order to prevent voids which would cause drying of the roots.

D. On slopes greater than 3 to 1, secure sod to surface soil with wood pegs, wire staples, or split shingles (8 to 10 inches long by 3/4 inch wide).

E. Surface water cannot always be diverted from flowing over the face of the slope, but a capping strip of heavy jute or plastic netting, properly secured, along the crown of the slope and edges will provide extra protection against lifting and undercutting of sod. The same technique can be used to anchor sod in water-carrying channels and other critical areas. Wire staples must be used to anchor netting in channel work.

F. Immediately following installation, sod should be watered until moisture penetrates the soil layer beneath sod to a depth of 4 inches. Maintain optimum mositure for at least two weeks.

IV. Topdressing - If slow release nitrogen (300 pounds 38-0-0 per acre or equivalent) is used in addition to suggested fertilizer, then a follow-up of topdressing is not mandatory.

A. Spring installation of sod will require an application of fertilizer such as 10-20-10 or equivalent at 400 pounds per acre or 10 pounds per 1,000 square feet between September 1 and October 15.

B. Fall installation of sod will require the above between March 15 and May 1.

STANDARDS
FOR
TOPSOILING

Definition

Topsoiling entails the distribution of suitable quality soil on areas to be vegetated.

Purpose

To improve the soil medium for plant establishment and maintenance.

Where Applicable

Topsoil should be used where soils are: sands, gravelly soils, clays, silty clays, very shallow or where they are extremely acid (less than p.H 4.0) or salty (conductivity greater than 1.0 millimhos per centimeter); or where topsoil is available on site and assurance of improved vegetative growth is desired.

Methods and Materials

I. Materials

Topsoil should be friable and loamy, free of debris, objectionable weeds and stones and contain no toxic substance that may be harmful to plant growth. A pH range of 5.0-7.5 is acceptable. Soluble salts should not be excessive (conductivity less than 0.5 millimhos per centimeter). Topsoil hauled in from off-site should have a minimum organic matter content of 2.75%. Organic matter content may be raised by additives.

II. Stripping and stockpiling

A. Field exploration should be made to determine whether quantity and or quality of surface soil justifies stripping.

B. Stripping should be confined to the immediate construction area.

C. Where feasible, lime may be applied before stripping at a rate determined by soil tests to bring the soil pH to 6.5. In lieu of soil tests, see lime rate guide in seedbed preparation for permanent vegetative cover, page 3.21.

D. A 4 to 6 inch stripping depth is common, but may vary depending on the particular soil.

E. Stockpiles of topsoil should be situated so as not to obstruct natural drainage or cause off-site environmental damage.

F. Stockpiles should be vegetated in accordance with standards previously described herein, see 3.1 or 3.2. Weeds should not be allowed to grow on stockpiles.

III. Site Preparation

A. Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application and anchoring, and maintenance. See page 4.1.

B. Subsoil should be tested for lime requirement and limestone, if needed, should be applied to bring soil pH to 6.5 and incorporated into the soil as nearly as practical to a depth of 4 inches.

C. Immediately prior to topsoil distribution, the surface should be scarified to provide a good bond with the topsoil.

D. Employ needed erosion control practices such as diversions, grade stabilizabtion structures, channel stabilization measures, sedimentation basins and waterways. See Standards 4.2 through 4.16.

IV. Applying Topsoil

A. Topsoil should be handled only when it is dry enough to work without damaging soil structure; i.e., less than field capacity (see glossary).

B. A uniform application to a depth of 5 inches (unsettled) is recommended. Soils with a pH of 4.0 or less or containing iron sulfide shall be covered with a minimum depth of 12 inches of soil having a pH of 5.0 or more.

STANDARDS
FOR
MAINTAINING VEGETATION

Definition

The perpetuation of vegetative cover.

Purpose

To assure the continuing function of the vegetative cover in the conservation of soil and water and the enhancement of the environment. It is usually less costly to carry on a maintenance program than it is to make repairs after an extended period of neglect.

Where Applicable

On areas where existing vegetation protects or enhances the environment.

Methods and Materials

A preventive maintenance program anticipates requirements and accomplishes work when it can be done with least effort and expense to insure adequate vegetative cover.

Maintenance should occur on a regular basis, consistent with favorable plant growth, soil and climatic conditions. This involves regular seasonal work for mowing, fertilizing, liming, watering, pruning, fire control, weed and pest control, reseeding and timely repairs.

The degree of preventive maintenance depends upon the category of the vegetation and land; i.e., improved, semi-improved and unimproved grounds.

A. Mowing is a recurring practice and its intensity depends upon the function of the ground cover. On improved areas, such as lawns, certain recreation fields and picnic areas, mowing will be frequent. On semi-improved areas, mowing will be infrequent. Unimproved areas may be left unmowed to permit natural succession.

B. Fertilizer should be applied as needed to maintain a dense stand of desirable species. Frequently mowed areas and those on sandy soils will require more fertilization.

C. Lime requirement should be determined by soil testing every 2 or 3 years. Fertilization increases the need for liming.

D. Weed invasion may result from abusive mowing and inadequate fertilization and liming. Brush invasion is a common consequence of lack of mowing. The amount of weeds or brush that can be tolerated in any protective planting depends upon the land category and its intended use. Drainageways are subject to rapid infestation by weeds and woody plants. These should be controlled since they often reduce drainageway efficiency. Control of weeds or brush is accomplished by using herbicides or mechanical methods.

E. Pest and disease controls are more necessary on improved areas than on unimproved areas.

F. Fire hazard is greater where dry vegetation has accumulated. The taller the vegetation, the greater the hazard.

STANDARDS
FOR
DUNE STABILIZATION

Definition

Controlling surface movement of sand dunes or shifting sand by vegetative or mechanical means.

Purpose

To reduce soil blowing and the encroachment of shifting sands, provide a barrier against tide water and to make the areas useful for other purposes.

Where Applicable

On seashore areas where blowing sands, tide and storm waters may cause damage. Stay at least one hundred feet (horizontal distance) from mean high tide line (MHT) as a minimum.

Methods and Materials

A. Vegetative

1. American beachgrass (*Ammophila breviligulata*-Cape Variety preferred) is best planted between November 15 and April 1 when sand is not frozen. Summer plantings are not recommended. It is important to keep the plants cool and moist.

2. Three stems, which may be joined, are placed in a hole approximately 8 to 9 inches deep.

3. It is recommended that planting stock be cut back to approximately 15 inches high. Roots should be dipped in a mud slurry immediately prior to planting.

4. Plants are spaced on 18 inch centers in rows. Where erosion is severe plants are spaced on 12 inch centers. Plants should be staggered in alternate rows.

5. A common grade of fertilizer equivalent to a minimum of 900 pounds of 10-10-10 is applied per acre. Inorganic fertilizer, when used, is applied on the soil surface. When a slow-release fertilizer is used, it is placed in the holes with the plants.

6. The sand is packed firmly around the transplant to eliminate air pockets.

7. To build dunes, plantings are made to form a continuous band and should consist of at least 10 rows paralleling the shoreline. Rows should be closer together at the center of the dune and wider apart at the edges.

8. Site - Planting is delayed on hydraulic fill until salt has been leached to a low level (conductivity less than 1.5 millimhos per centimeter). Sand placed by earth moving equipment is allowed to be compacted by rains prior to dune planting. Dunes built with aid of sand fence are planted when dune is near top of fence.

9. Plantings are maintained with applications of fertilizer applied as needed, when beachgrass becomes yellow-green, to keep desired density. A minimum annual application of 80 pounds N and 10 pounds $P_2 O_5$ should be applied per acre.

B. Mechanical

1. In frontal areas, dunes may be created by erection of sand fences, brush fences, or cut Christmas trees set in parallel rows 20 to 30 feet apart, parallel to the beach, and well back from the mean high water line at least 100 feet horizontal distance. Barriers are added until the desired height and width of the dune is obtained. The frontal dune should be about 120 feet wide at the base and 12 feet high.

   a. If brush is used, it is lashed to horizontal rails nailed to the line of posts.

   b. If cut Christmas trees are used, they are anchored well in the sand and spaced to touch each other in the row.

2. Dunes are stabilized as in A, above (with vegetation).

3. Where foot or vehicular traffic is appreciable over frontal dunes, it is advisable to direct such traffic over paths of gravel or boards to prevent dune blowout.

STANDARDS FOR SELECTION OF NATIVE AND NATURALIZED VINES, SHRUBS AND TREES FOR CRITICAL AREA PLANTING

Definition

Plants to aesthetically enhance and restore to natural condition disturbed soils.

Where Applicable

Graded or cleared areas subject to erosion, where a permanent, long-lived vegetative cover other than turf is desired.

NATIVE OR ACCEPTABLE EXOTIC PLANT MATERIAL

Although this is by no means a complete listing of the available plant material in these categories, it does include most of that which is commonly used throughout the State of New Jersey.

The services of a Landscape Architect or a Horticulturalist should be utilized for the selection of plant material for specific sites where problems exist due to soil or other ecological conditions.

DECIDUOUS TREES

Latin Name	Common Name
Acer platanoides & varieties	Norway Maple
Acer rubrum & varieties	Red Maple or Swamp Maple
Acer saccharum	Sugar Maple
Aesculus hippocastanum	Horsechestnut
Carya ovata	Shagbark Hickory
Celtis occidentalis	Common Hackberry
Fagus grandifolia	American Beech
Fagus sylvatica & varieties	European Beech
Fraxinus pennsylvanica lanceolata & varieties	Green Ash
Ginkgo biloba (grafted male) & varieties	Ginkgo or Maidenhair Tree (grafted male)
Gleditsia triacanthos & varieties	Honeylocust
Larix decidua	European Larch
Liquidambar styraciflua	Sweetgum
Liriodendron tulipifera	Tulip Tree
Nyssa sylvatica	Black Gum
Platanus acerifolia	London Plane Tree
Populus maximowiczi	Japanese Poplar
Populus alba Bolleana	Bolleana Poplar (Lombardy)
Quercus alba	White Oak
Quercus borealis	Red Oak
Quercus coccinea	Scarlet Oak
Quercus palustris	Pin Oak
Quercus phellos	Willow Oak
Salix babylonica	Babylon Weeping Willow
Tilia americana	American Linden
Tilia cordata & varieties	Littleleaf Linden
Tilia tomentosa	Silver Linden
Zelkova serrata	Japanese Zelkova

SMALL DECIDUOUS TREES

Latin Name	Common Name
Acer campestre	Hedge Maple
Acer ginnala	Amur Maple
Amelanchier canadensis	Shadblow Serviceberry
Betula varieties	Birch
Carpinus betulus	European Hornbeam
Carpinus caroliniana	American Hornbeam
Cornus Florida	Flowering Dogwood
Cornus kousa	Japanese Dogwood
Cornus mas	Cornelian Cherry Dogwood
Cotinus coggygria	Smokebush
Crataegus crusgalli	Cockspur Thorn
Crataegus phaenopyrum	Washington Hawthorn
Elaeagnus angustifolia	Russian Olive
Hibiscus syriacus	Shrub Althea
Magnolia virginiana	Sweetbay Magnolia
Malus varieties	Crabapples
Oxydendron arboreum	Sorrel Tree or Sourwood
Prunus varieties	Cherries
Pyrus calleryana	Callery Pear
Salix caprea	Goat or Pussy Willow

SHRUBS

Aronia arbutifolia	Red Chokeberry
Aronia arbutifolia brilliantissima	Brilliant Chokeberry
Berberis thunbergi	Japanese Barberry
Chaenomeles lagenaria	Flowering Quince
Clethra alnifolia & varieties	Summersweet Clethra
Cornus varieties	Siberian Dogwood
Elaeagnus umbellata	Autumn Elaeagnus
Euonymus alatus & varieties	Winged Euonymus
Forsythia intermedia & varieties	Border Forsythia
Forsythia suspensa	Weeping Forsythia
Hamamelis varieties	Witchhazel
Ilex glabra	Inkberry
Ilex verticilata	Winterberry Holly
Kalmia latifolia	Mountain Laurel
Ligustrum varieties	Privet
Lindera benzoin	Spicebush
Myrica pensylvanica	Northern Bayberry
Rhododendron maximum	Rosebay Rhododendron
Rhus varieties	Sumac
Rosa varieties	Rose
Syringa vulgaris	Common Lilac
Vaccinium corymbosum	Highbush Blueberry
Viburnum varieties	Viburnum

EVERGREEN TREES

Abies concolor	White Fir
Ilex opaca	American Holly
Juniperus virginiana	Eastern Red Cedar
Picea abies	Norway Spruce
Picea pungens	Colorado Spruce
Pinus nigra	Austrian Pine
Pinus strobus	White Pine
Pinus thunbergi	Japanese Black Pine
Pseudotsuga taxifolia	Douglas Fir

GROUND COVERS & VINES

Latin Name	Common Name
Campsis radicans	Trumpetcreeper
Euonymus fortunei vegetus	Wintercreeper Euonymus
Hedera helix	English Ivy
Juniperus conferta	Shore Juniper
Juniperus horizontalis plumosa	Andorra Juniper
Lonicera japonica halliana	Halls Japanese Honeysuckle
Parthenocissus quinquefolia	Virginia Creeper
Parthenocissus tricuspidata	Japanese Creeper
Rosa Max Graf	Ma Graf Rose
Vitis sp.	Grapes sp.
Wisteria floribunda	Japanese Wisteria
Wisteria sinensis	Chinese Wisteria

STANDARDS
FOR
TREE PROTECTION DURING CONSTRUCTION

Definition

Protection of desirable trees from environmental and mechanical injury during construction activities.

Purpose

To protect desirable trees that have value for erosion and sediment control, shade, aesthetics, song birds, other wildlife, dust control, noise abatement and oxygen production.

Where Applicable

On new development sites containing valuable trees.

Methods and Materials

1. Inventory the development site and clearly mark the trees to be saved. Consider relocating streets, houses or other structures if necessary and feasible. It takes nature many years to grow trees,many of which have value in the hundreds of dollars.

   a. Criteria useful in determining the trees to save:

      (1) Freedom from disease and rot - good, healthy trees.

      (2) Life span of trees - for example,red maple is short-lived while sugar maple and oaks are long-lived.

      (3) Aesthetic values - such as autumn foliage, flowering habits, bark and crown appearance, type of fruit, etc.

      (4) Wind firmness - trees that have been growing in a close stand may blow over easily if unprotected.

      (5) Wildlife values - Oaks, hickories and dogwoods have high food value.

      (6) Shade - summer temperatures are generally 10 degrees cooler under stands of hardwoods than under pines or cedars.

      (7) Sudden exposure - to direct sunlight and ability to withstand radiated heat from proposed building and pavement.

      (8) Space needed - for future growth and relationship to electric and telephone lines, water, sewer or gas lines, driveways, etc.

   b. Criteria for protecting remaining trees:

      (1) Mechanical damage - see Figure 3.9-I

      (2) Box trees within 25 feet of a building site to prevent mechanical injury. Fencing or other barrier should be installed at the drip line of the tree branches. See Figure 3.9-I

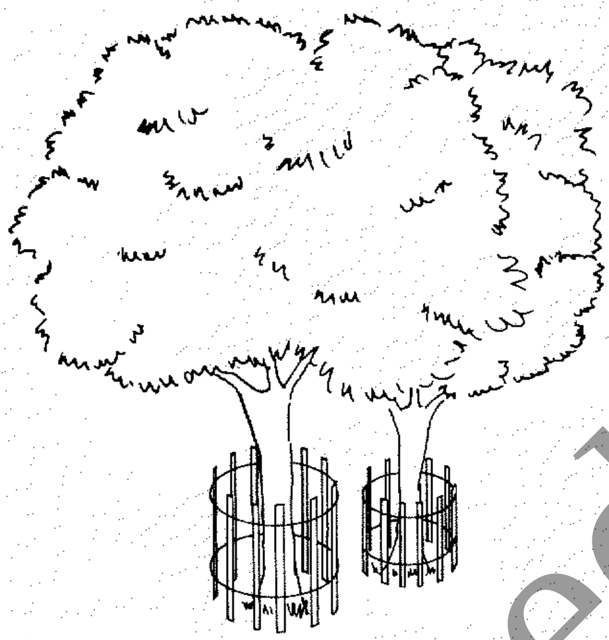
      (3) Boards will not be nailed to trees during building operations.

      (4) Feeder roots should not be cut in an area inside the drip line of the tree branches.

(5) Damaged trunks or exposed roots will be painted immediately with a good grade of "tree paint". Care for serious injury should be prescribed by a professional forester or licensed tree expert.

(6) Tree limb removal, where necessary, will be done flush to trunk or main branch and that area painted with a good grade of tree paint.

NOTE: For more specific data on certain tree characteristics, consult the tree shrub and vine standard in this handbook (Pg. 3.81.) or consult local professional experts. Your local soil conservation district or county agricultural agent can assist you in this.



Incorrect fencing for tree protection

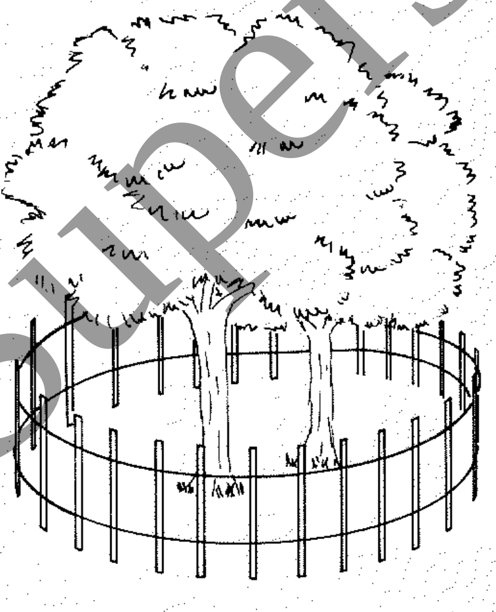
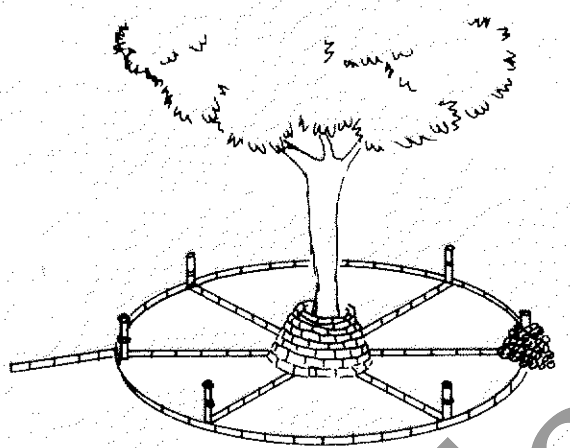
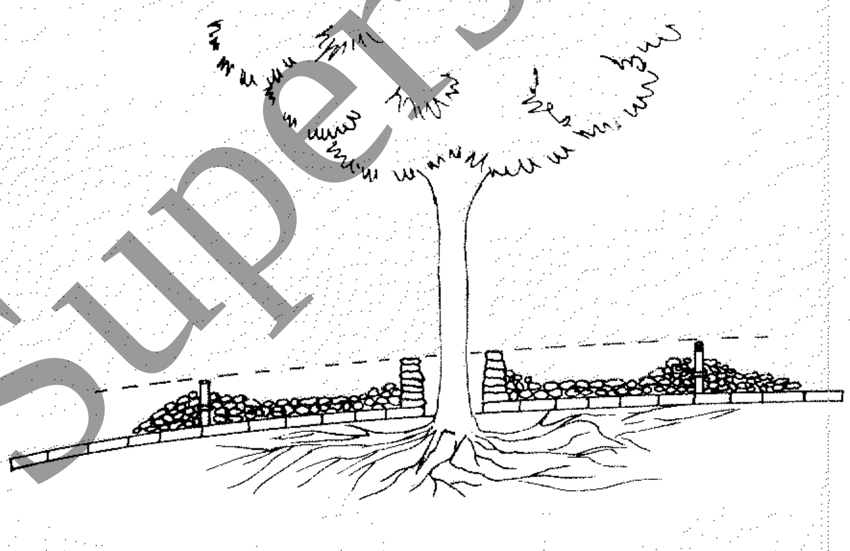


Figure 3.9-I Correct fencing for tree protection



Isometric



Section

Figure 3.9-II Tree protection - tile and gravel will allow air circulation to root zone under a fill

STANDARDS
FOR
LAND GRADING

Definition

Reshaping the ground surface by grading to planned grades which are determined by topographic survey and layout.

Purpose

The practice is for one or more of the following: Provide more suitable sites for land development; improve surface drainage; and control erosion.

Conditions Where Practice Applies

This practice is applicable where grading to planned elevations is practical and it is determined that grading is needed. Grading that involves the disturbance of vegetation over large areas should be avoided.

Planning Criteria

The grading plan and installation shall be based upon adequate topographic surveys and investigations. The plan is to show the location, slope, cut, fill and finish elevation of the surfaces to be graded. The plan should also include auxiliary practices for safe disposal of runoff water, slope stabilization, erosion control and drainage. Facilities such as waterways, ditches, diversions, grade stabilization structures, retaining walls and subsurface drains should be included where necessary.

Erosion control measures should be designed and installed in accordance with the applicable standard contained herein.

The development and establishment of the plan shall include the following:

1. The cut face of earth excavations and fills shall be no steeper than the safe angle of repose for the materials encountered and flat enough for proper maintenance.

2. The permanently exposed faces of earth cuts and fills shall be vegetated or otherwise protected from erosion.

3. Provisions shall be made to safely conduct surface water to storm drains or suitable water courses and to prevent surface runoff from damaging cut faces and full slopes.

4. Subsurface drainage is to be provided in areas having a high water table, to intercept seepage that would adversely affect slope stability, building foundations or create undesirable wetness. See Standard for Subsurface drainage (P. 4.81)

5. Adjoining property shall be protected from excavation and filling operations.

6. Fill shall not be placed adjacent to the bank of a stream or channel, unless provisions are made to protect the hydraulic, biological, esthetic and other environmental functions of the stream.

Installation Requirements

Timber, logs, brush, rubbish, rocks, stumps and vegetable matter which will interfere with the grading operation or affect the planned stability or fill areas shall be removed and disposed of according to the plan.

Topsoil is to be stripped and stockpiled in amounts necessary to complete finish grading of all exposed areas requiring topsoil. See Standard for topsoiling (P. 3.51).

Fill material is to be free of brush, rubbish, timber, logs, vegetative matter and stumps in amounts that will be detrimental to constructing stable fills.

All fills shall be compacted sufficiently for their intended purpose and as required to reduce slipping, erosion or excess saturation.

All disturbed areas shall be left with a neat and finished appearance and shall be protected from erosion. See vegetative standards (PP. 3.11 to 3.71.)

Trees to be retained shall be protected if necessary in accordance with the standard for tree protection during construction (P. 3.91)

STANDARD
FOR
DIVERSION

Definition

A channel with a supporting ridge on the lower side constructed across the slope.

Scope

This standard covers the installation of diversions with drainage areas up to 100 acres.

Temporary

Diversions installed as an interim measure to protect or facilitate some phase of construction. They usually have a life expectancy of one year or less. The failure hazard is low.

Permanent

Diversions installed as an integral part of an overall water management and disposal system and to remain for protection of property.

Purpose

The purpose of this practice is to divert water from areas where it is in excess to sites where it can be used or disposed of safely.

Conditions Where Practice Applies

This practice applies to sites where runoff is damaging: (1) low lying areas, (2) cut or fill slopes or steeply sloping land, (3) critical sediment source areas in construction sites, (4) buildings, residences and streets and (5) active gullies or other erodible areas.

Permanent diversions are not applicable below high sediment producing areas unless land treatment practices or structural measures, designed to prevent damaging accumulations of sediment in the channels, are installed with or before the diversions.

Design Criteria

Capacity and Freeboard

Peak runoff values shall be determined by the method contained in Ref. #9, Appendix A9, the Rational Method (Q=CIA) or by other generally accepted methods. The minimum size shall be that required to confine the peak runoff from the design storm plus required freeboard. The design storm and freeboard shall comply with the following table:

DIVERSION TYPE	TYPICAL AREA OF PROTECTION	DESIGN STORM FREQUENCY	FREEBOARD REQUIRED
Temporary	Construction Areas (structures, roads, pipelines, etc.)	2 years	0.0
	Building Sites	5 years	0.0

DIVERSION TYPE	TYPICAL AREA OF PROTECTION	DESIGN STORM FREQUENCY	FREEBOARD REQUIRED
Permanent	Agricultural Land	25 years	0.3 ft.
	Urban Land Areas, Play Fields, Recreation Areas, Agricultural Buildings, etc.	25 years	0.3 ft.
	Homes, schools, industrial buildings, etc.	50 years	0.5 ft.

Small Diversions

1. Where the diversion channel grade is between 0.25% and 5%, a permanent vegetative cover is planned and the design flow is equal to or less than given below, the dimensions given below for a parabolic channel may be used instead of preparing an individual design for the diversion.

Q (cfs)	CHANNEL DIMENSIONS TOP WIDTH (ft)	DEPTH (ft)
5	12	1.9
10	22	1.9

The depth given above includes 0.3 ft. freeboard and 0.1 ft. settlement. Side slopes shall be 3:1 or flatter, and the ridge top width shall be 4 ft. or wider.

2. Where the diversion will be a temporary diversion to direct water off a graded right of way onto stable areas and the only area draining toward the diversion is the right of way; the following spacings, and the size given above for 5 cfs may be used instead of preparing individual designs for each diversion.

ROAD GRADE (percent)	APPROXIMATE DISTANCE BETWEEN DIVERSIONS (ft)
1	400
2	245
5	125
10	78
15	58
20	47
25	40
30	35

Velocity

The maximum permissible velocity for design flow will be determined by the most erodible soil texture exposed and the type of vegetation expected and maintained in the channel. The following table will be used in selecting maximum permissible velocities:

SOIL TEXTURE	MAXIMUM PERMISSIBLE VELOCITY (ft./sec.)			
	CHANNEL VEGETATION			
	None	Poor	Fair	Good
Sand, silt loam, sandy loam, loamy sand, loam and muck	2.0	2.0	2.0	3.0
Silty clay loam, sandy clay loam	2.0	2.5	3.0	4.0
Clay, clay loam, sandy clay, silty clay	2.5	3.0	4.0	5.0

Vegetated Channels - The minimum capacity and maximum velocity shall be determined by using the appropriate vegetative retardance factors listed below. See Appendix A6 for example and charts for use in design.

RANGE OF VEGETATION HEIGHT DURING DIFFERENT PERIODS OF THE YEAR	VEGETATIVE RETARDANCE FACTORS	
	For Determining Minimum Capacity	For Determining Maximum Allowable Velocity
<u>Good Stand</u>		
between 6" and less than 2"	D	E
between 10" and 2"	C	D
between 24" and 2"	B	D
<u>Fair or Poor Stand</u>		
between 10" and less than 2"	D	E
between 24" and 2"	C	D
between 30" and 2"	B	D

Tables to select channel dimensions are available in Chapter 7 and 9, Ref. #1.

Bare Channels - The minimum capacity and maximum velocity shall be determined by using Manning's formula with an "n"value of 0.03.

<u>Cross Section</u>

The shape of the channel cross section shall be such that the diversion can be properly maintained with modern equipment. The channel may be parabolic, vee-shaped, or trapezoidal.

The side slopes for permanent diversions shall not be steeper than 3:1 for maintenance purposes, and preferably 4:1. Where frequent crossings are expected slopes should be flatter. The back slope of the ridge is not to be steeper than 3:1 and preferably 4:1. The ridge shall include a settlement factor equal to 5 percent of the height. The minimum top width of the diversion ridge after settlement is to be 4.0 feet at the design water elevation.

In determing the cross section for temporary diversions, consideration should be given to soil type, frequency of operation, and type of equipment that is anticipated to be crossing the diversion. In no case shall slopes be steeper than 1 1/2:1.

The top of the constructed ridge shall not be lower at any point than the design elevation plus the specified overfill for settlement.

Location

Diversion location shall be determined by outlet conditions, topography, land use, soil type and length of slope. Consideration must be given to the effects caused by changing natural water courses and putting additional flow into a water course.

Grade

Channel grade may be uniform or variable. Uniform grades are nomally better. The allowable velocity for soil type and vegetative cover will determine maximum grade. Diversions with blocked ends may be used provided adequate pipe outlets are provided.

Protection against sedimentation

When the movement of sediment into the diversion channel is a significant problem.

1. Land treatment or structural measures should be installed to stabilize the source of sediment or trap the sediment.

2. If it is not possible to stabilize or trap the sediment, a filter strip of close growing grass shall be maintained above the diversion channel. The filter strip width measured from the center of the channel shall be at least one-half the channel width plus 15 feet.

Outlet

Each diversion must have an adequate, stable outlet. The outlet may be a: grassed, stone center or lined waterway; vegetated or paved area; grade stabilization structure; storm sewer; stable watercourse or tile outlet.

The outlet, in all cases, must be stable and convey water to a disposal point where damage will not result. Constructed vegetative outlets must be established prior to diversion construction if needed to insure establishment of protective vegetative cover in the outlet channel.

Permanent Cover and Erosion Protection

A permanent vegetative cover shall be established on all diversions in accordance with the Standards for Permanent Vegetative Cover for Soil Stabilization or Standards for Permanent Stabilization with Sod. Where the season and other conditions may not be suitable for growing permanent erosion resistant cover, erosion protection will be provided in accordance with the Standards for Temporary Vegetative Cover for Soil Stabilization or Standards for Stabilization with Mulch Only.

Diversions that are not designed to have a permanent vegetative cover shall be designed for bare channel velocities and with flat side slopes to prevent channel and side slope erosion. Diversions that are designed to have a permanent vegetative cover shall be seeded from the toe of the backslope to the upstream side of the designed channel width plus any required filter strip. Other areas distributed by diversion construction shall also be seeded.

Installation Requirements

All trees, brush, stumps and other objectionable material shall be removed so they will not interfere with construction or proper functioning of the diversion. All ditches or gullies which must be crossed will be filled and compacted prior to or as part of the construction. Fence rows and other obstructions that will interfere with construction or the successful operation of the diversion are to be removed.

Vegetation is to be removed and the base for the ridge throughly disked before placement of fill.

The minimum constructed cross-section is to meet the design requirements.

The top of the constructed ridge is not to be lower than the design elevation plus the specified amount for settlement.

Fertilizing, seeding and mulching shall conform to the recommendations in the Standards for Permanent Vegetative Cover for Soil Stabilization.

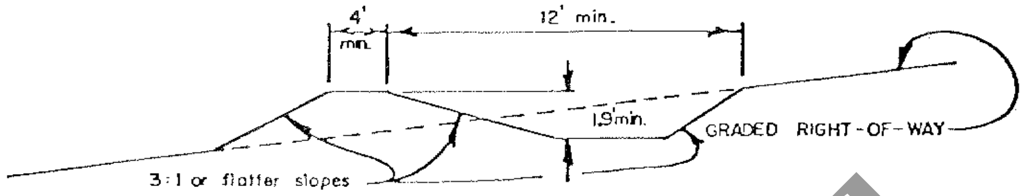
If there is no sediment protection provided on temporary diversions, it should be anticipated that periodic cleanout may be required.

Construction operations shall be carried out in such a manner that erosion and air and water pollution will be minimized. State and local laws shall be complied with.

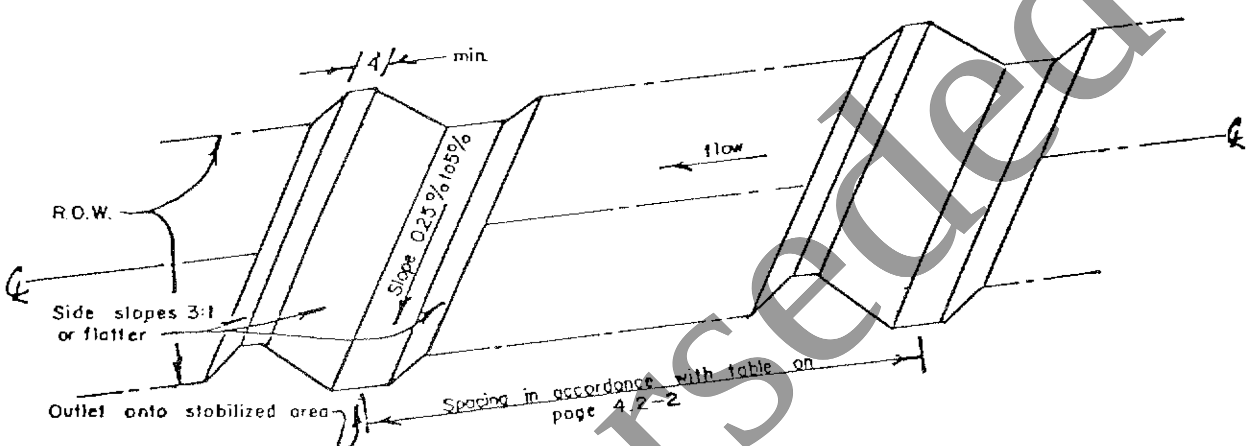
FIGURE 4.2-1

SMALL DIVERSIONS FOR GRADED RIGHT - OF - WAY

For use on graded right-of-way, if the only drainage area is the right-of-way



CROSS — SECTION OF DIVERSION



PERSPECTIVE

DESIGN CRITERIA

Top width - 4 ft. min.
Height - 1.9 ft. min. (height measured from the upslope toe to top of the dike).
Side slopes - 3:1 or flatter (flat enough to allow construction traffic to cross if desired).
Grade - 0.25% to 5%.
Spacing - according to Table on page 4.22.

GENERAL NOTES

1. Top width may be wider and side slopes may be flatter, if desired.
2. Diverted runoff shall outlet onto an undisturbed stable area, or onto an area that has been stabilized.
3. Periodic inspection and required maintenance must be provided.

STANDARD
FOR
GRASSED WATERWAY

Definition

A natural or constructed watercourse shaped or graded in earth materials and stabilized with suitable vegetation for the safe conveyance of runoff water.

Purpose

To provide for the conveyance of excess surface water without damage by erosion or flooding.

Conditions Where Practice Applies

This practice applies to sites with drainage areas less than 200 acres where concentrated runoff requires vegetative protection or stone center lining to control erosion. Some of the other practices that may be required with this practice are: (1) grade control structures, (2) subsurface drainage to permit the growth of suitable vegetation and to eliminate wet spots, (3) a section stabilized with stone or other material within the waterway or (4) buried storm drain to handle frequently occurring storm runoff, base flow or snowmelt.

Design Criteria

Capacity

Peak runoff values shall be determined by the method contained in Ref. #9, Appendix A9; the Rational Method ($Q = CIA$) or by other generally accepted methods.

The minimum capacity shall be that required to convey the peak runoff expected from a 10-year frequency storm.

Velocity

The maximum permissible velocity for design flow will be determined by the most erodible soil texture exposed and the type of vegetation expected and maintained in the channel. The following table will be used in selecting the maximum permissible velocities:

MAXIMUM PERMISSIBLE VELOCITY (ft./sec.)				
	CHANNEL VEGETATION			
SOIL TEXTURE	Poor	Fair	Good	Stone Center
Sand, silt loam, sandy loam, loamy sand, loam and muck	2.0	2.0	3.0	5.0
Silty clay loam, sandy clay loam	2.5	3.0	4.0	5.5
Clay, clay loam, sandy clay, silty clay	3.0	4.0	5.0	6.0

Vegetative Retardance Factors and Manning's "n" Value

The minimum capacity and maximum velocity shall be determined by using the appropriate vegetative retardance factors listed below. See Appendix A6 for example and charts for use in design.

RANGE OF VEGETATION HEIGHT DURING DIFFERENT PERIODS OF THE YEAR	VEGETATIVE RETARDANCE FACTORS	
	For Determining Minimum Capacity	For Determining Maximum Allowable Velocity
Good Stand		
between 6" and less than 2"	D	E
between 10" and 2"	C	D
between 24" and 2"	B	D
Fair or Poor Stand		
between 10" and less than 2"	D	E
between 24" and 2"	C	D
between 30" and 2"	B	D

Tables to select channel dimensions are available in Chapter 7, Ref. #1.

Dimensions

The dimensions of the waterway will be based on: (1) The minimum capacity, the channel slope, the maximum permissible velocity, the vegetation, the soil, (2) ease of crossing and maintenance and (3) site conditions such as water table, depth to rock or possible sinkholes.

The minimum top width of a waterway will be 10 feet. The maximum design top width shall not exceed 100 feet.

The cross section may be parabolic, vee-shaped, or trapezoidal.

Drainage

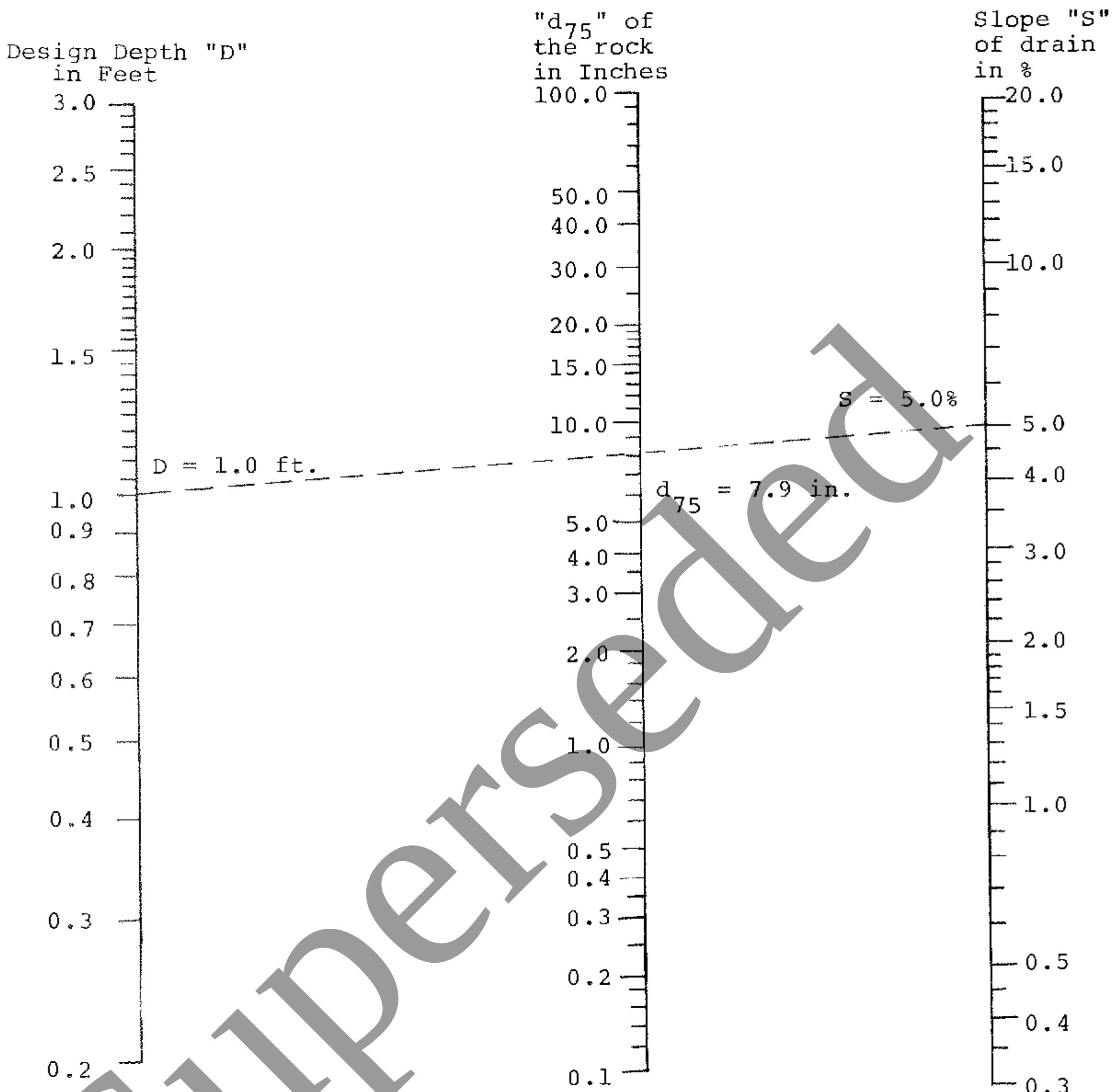
In areas with low flow, high water table or seepage problems, underdrains, stone centers, or other subsurface drainage methods are to be provided. A minimum drainage coefficient of 1/2 inch in 24 hours is to be used for underdrain design. An open joint storm drain may be used to serve the same purpose and also handle frequently occurring storm runoff, base flow or snowmelt. The storm drain shall be designed to handle base flow, snowmelt or the runoff from at least a one-year frequency storm, whichever is greater.

Stone Center

Where a stone center is included in the design, the width of the stone center shall be at least 2/3 of the design top width. The stone center shall have 6 inches of gravel bedding under the stone. The d_{75} size of the stone shall be determined from Figure 4.3-1. The minimum d_{75} size shall be 3 inches. The d_{100} size shall be 1 1/2 times the d_{75} size. The d_{15} size shall be 3 inch or 1/3 the d_{75} size, whichever is larger. The stone center shall have a minimum thickness of 12 inches or the d_{100} size, whichever is larger. The stone shall be hard and durable.

Outlet

The outlet must handle the design flow without flood damage. The outlet must be stable for the 10-year, 24-hour storm discharge.



EXAMPLE - "D" = 1.0 Feet "S" = 5%
Place straight edge at "D" value in Design Depth column and at "S" value in Slope column. Read d_{75} Rock Size in middle column as 7.9 inches; say 8 inches.

FIGURE 4.3-1

DETERMINATION OF ROCK SIZE FOR STONE CENTER WATERWAY

Vegetation

Permanent Cover

A permanent vegetative cover shall be established on all grassed waterways in accordance with the Standards for Permanent Vegetative Cover for Soil Stabilization or Standards for Permanent Stabilization with Sod. Where the season and other conditions may not be suitable for growing permanent erosion resistant cover, erosion protection will be provided in accordance with the Standards for Temporary Vegetative Cover for Soil Stabilization or Standards for Stabilization for Mulch Only. The seeding will extend to at least the design top width.

Installation Requirements

Construction

Trees, brush, stumps and other material in objectional amounts are to be cleared and disposed of so as not to interfere with construction or proper functioning of the waterway.

Fills are to be compacted as needed to prevent unequal settlement that will cause damage in the completed waterway.

Vegetative Lining

Waterways or outlets shall be protected against erosion by vegetative means as soon after construction as practical and before diversions or other channels are outletted into them. Consideration should be given to the use of jute matting, excelsior matting (see Appendix A5), or sodding channels to provide erosion protection as soon after construction as possible.

Seeding, fertilizing, mulching and sodding shall be in accordance with the applicable standards.

STANDARD
FOR
SEDIMENT BASIN

Definition

A barrier, dam, excavated pit or dugout constructed across a waterway or at other suitable locations to intercept and retain sediment.

Basins created by construction of dams or barriers are referred to as "Embankment Sediment Basins" and those constructed by excavation as "Excavated Sediment Basins". Basins resulting from both excavation and embankment construction are classified as "Embankment Sediment Basins" where the depth of water impounded against the embankment at emergency spillway elevation is 3 feet or more.

Scope

The standard covers the installation of sediment basins on sites where:

1. Failure of the sediment basin should not, within reasonable expectations, result in loss of life.

2. Failure of the sediment basin would not result in damage to homes, commercial or industrial buildings, main highways, or railroads; or interrupt the use or service of public utilities.

3. The drainage area is 320 acres or less.

4. The effective height of the dam is 20 feet or less. The effective height of the dam is defined as the difference in elevation in feet between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam becomes the upper limit.

Sediment basins that are not within the above scope shall be designed to meet the criteria in "Earth Dams and Reservoirs, Technical Release 60" (TR60) by the Soil Conservation Service, U.S. Department of Agriculture.

Purpose

To preserve the capacity of reservoirs, ditches, canals, diversions, storm sewers, waterways and streams; to prevent undesirable deposition on bottom-lands and developed areas; to trap sediment originating from critically eroding areas and construction sites; and to reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel and stone.

Conditions Where Practice Applies

This practice applies where physical conditions, land ownership or construction operations preclude the treatment of the sediment source by the installation of erosion control measures to keep soil and other material in place, or a sediment basin offers the most practical solution to the problem.

Design Criteria

Sediment Basin Location

The basin shall be designed to accommodate the individual storm runoff and sediment accumulation from the basin's total drainage area.

The basin should be located as much as possible:

a. To intercept only runoff from disturbed areas.
b. To minimize disturbance from its own construction.
c. To obtain maximum storage benefit from the terrain.
d. For ease of cleanout of the trapped sediment.
e. To minimize interference with other construction activites and construction of utilities.

Sediment Basin Volume

The volume in the sediment basin below the crest elevation of the emergency spillway shall be the larger of:

1. The volume necessary to obtain 70% trap efficiency at the start of the basin's useful life, or

2. The volume necessary to provide sediment storage capacity and provide for temporary floodwater storage from a 2 year frequency 24 hour duration storm.

Principal Spillway Crest Elevation

The principal spillway crest elevation shall be the lower of one (1) foot below the emergency spillway crest elevation or the elevation that provides, between the crest of the principal spillway and the crest of the emergency spillway, the required temporary floodwater storage for a 2 year frequency 24 hour duration storm.

Flood routing to determine the required temporary floodwater storage for a 2 year frequency 24 hour duration storm may be done using the approximate methods in the SCS "Engineering Field Manual," the approximate methods in SCS "Urban Hydrology for Small Watersheds" (TR 55), or other generally accepted methods of flood routing.

Trap Efficiency

Trap efficiency is the amount in percent of the sediment delivered to the sediment basin that will remain in the basin. The sediment basin shall have adequate volume below the crest of the emergency spillway to have an actual trap efficiency of at least 70% at the start of its useful life using Curve 4.4-1 and with

C = total capacity of the sediment basin up to the crest elevation of the emergency spillway in acre feet.

I = average annual surface runoff from Figure 4.4-1 converted to units of acre feet.

For a normally dry sediment basin the actual trap efficiency is reduced 10 percent where the incoming sediment is predominately silt, clay or fine grained. Therefore enter Curve 4.4-1 with 80% trap efficiency to achieve 70% actual trap efficiency. For a normally dry sediment basin the actual trap efficiency is reduced five percent where the the incoming sediment is sand or coarse grained. Therefore, enter Curve 4.4-1 with 75% trap efficiency to achieve 70% actual trap efficiency.

Sediment Storage Capacity

The sediment storage capacity of a sediment basin shall equal the volume of sediment expected to be trapped at the site during the planned useful life of the sediment basin. Where it is determined that periodic removal of sediment is practicable, the sediment storage capacity may be proportionately reduced. Planned periodic removal of sediment shall not be more frequent than once a year. The capacity shall be determined by one of the following methods:

1. Provide 0.07 acre feet of sediment storage volume per acre of total drainage area per year of planned life.

2. Provide sediment storage based on the following formula and figures:

$V = (DA)(A)(DR)(TE)(1/\gamma)(2{,}000 \text{ lbs./tons})(1/43560 \text{ sq. ft./Ac.})$
where:

V = the volume of sediment trapped in Ac. ft./yr.
DA = the total drainage area in acres.

A – the average annual erosion in tons per acre per year using the values below for the listed land use

Land Use	Average Annual Erosion
Wooded areas	0.2 ton/ac/yr
Developed urban areas, grassed areas, pastures, hay fields, abandoned fields with good cover	1.0 ton/ac/yr
Clean tilled cropland (corn, soybeans, etc.)	10 ton/ac/yr
Construction areas	50 ton/ac/yr

DR = the delivery ratio determined from Curve 4.4-2.
TE = the trap efficiency as determined above.
γ = the estimated sediment density in the sediment basin in lbs/cu. ft. (See Table 4.4-1)
γs = the submerged density in a wet sediment pool.
γa = the aerated density in a normally dry sediment pool.

TABLE 4.4-1

SOIL TEXTURE	γs Submerged (lbs/cu. ft.)	γa Aerated (lbs/cu. ft.)
Clay	40-60	60-80
Silt	55-75	75-85
Clay-silt mixtures (equal parts)	40-65	65-85
Sand-silt mixtures (equal parts)	75-95	95-100
Clay-silt-sand mixtures (equal parts)	50-80	80-100
Sand	85-100	85-100
Gravel	85-125	85-125
Poorly sorted sand and gravel	95-130	95-103

3. Provide sediment storage based on the same procedure as 2 above except determine (A) using the Universal Soil Loss Equation (Appendix A1) with on-site conditions.

Shape and Depth

The length, width, and depth are measured at the principal spillway crest elevation. The basin configuration shall be such that the effective flow length is equal to at least two times the effective flow width. This basin shape may be attained by selecting the basin site, by excavating the basin to the required shape or by the installation of one or more baffles.

The minimum width shall be:

$$W = 10\sqrt{Q_5}$$

where:

W = the width in ft.
Q_5 = peak discharge from a five year frequency storm in cfs.

The average depth shall be at least 4 feet.

When downstream damage may be severe, the minimum width should be:

$$W = 10\sqrt{Q_{25}}$$

where:

W = the same
Q_{25} = peak discharge from a 25 year frequency storm in cfs.

The average depth shall be at least 4 feet.

Foundation Cutoff for Embankment Sediment Basin

A foundation cutoff constructed with relativity impermeable materials shall be provided for all embankments. The minimum depth of the cutoff shall be 3 feet. The cutoff trench, as a minimum, shall extend up both abutments to the emergency spillway crest elevation. The minimum bottom width shall be 4 feet but wide enough to permit operation of compaction equipment. The side slopes shall be no steeper than 1:1. Compaction requirements shall be the same as those for the embankment. The trench shall be kept free from standing water during the backfilling operations.

Seepage Control

Seepage control is to be included if seepage may create swamping downstream; if needed to insure a stable embankment; or if special problems require drainage for a stable dam. Seepage control may be accomplished by foundation, abutment or embankment drains, reservoir blanketing or a combination of these and other measures.

Foundation

The area on which an embankment is to be placed shall consist of material that has sufficient bearing strength to support the embankment without excessive consolidation.

Earth Embankment

Top width - The minimum top widths of embankments are shown in Table 4.4-2. When the embankment top is to be used as a public road, the minimum width, guardrails or other safety measures are to meet the requirements of the responsible road authority. The minimum top width will be increased as necessary to accommodate construction equipment.

TABLE 4.4-2

TOTAL HEIGHT OF EMBANKMENT (feet)	MINIMUM TOP WIDTH (feet)
less than 20	10
20 - 24	12

Side Slopes - The combined upstream and downstream side slopes of the settled embankment shall not be less than five horizontal to one vertical (5:1) with neither slope steeper than 2:1. Slopes must be designed to be stable in all cases.

Freeboard - The minimum elevation of the top of the settled embankment shall be 1.0 foot above the water surface in the reservoir with the emergency spillway flowing at design depth.

Allowance for Settlement - The design height of the embankment shall be increased by the amount needed to insure that, after all settlement has taken place, the height of the dam will equal or exceed the design height. This increase shall not be less than ten percent when compaction is by hauling equipment or five percent if compactors are used, except where detailed soil testing and laboratory analysis shows that a lesser amount is adequate.

Compaction - The compaction requirements shall be specified.

<u>Embankments of Other Than Earthfill</u>

Sediment basins with effective heights of 5 feet or less may use materials other than earth for the embankment. These embankments shall be structurally sound, have hydraulic characteristics that will safely handle the principal and emergency spillway design storm.

<u>Principal Spillway</u>

The minimum pipe size shall be 8 inches for corrugated or helical pipe and 6 inches for smooth wall pipe.

Pipe Conduits - Sediment basins shall have pipe conduits with required appurtenances except where a structural spillway is used.

A. The materials and installation for pipe conduits for excavated sediment basins, as defined on page 4.41, shall meet the local municipality requirements for culverts or storm sewers.

B. Pipe conduits for embankment sediment basins as defined on page 4.41 shall meet the following requirements:

The pipe shall be capable of withstanding the external loading without yielding, buckling, or cracking. The following pipe materials are acceptable:

1. Corrugated Steel Pipe - Pipe gage is not to be less than that indicated in Table 4.4-3. The maximum principal spillway barrel size shall be 48 inch. The maximum fill above the pipe shall be 25 feet. The pipe may be helical or riveted fabrication. Riveted pipe shall be close riveted. Riveted pipe 36 inch and larger shall be doubled riveted. <u>Connections between pipe joints must be watertight</u>. Flanges with gaskets or caulking may be used. Rod and lug coupling bands with gaskets or caulking may be used. If the basin is to be left in place after completion of construction, cathodic protection is to be provided where the saturated soil resistivity is less than 4,000 ohms/cm or the pH is lower than 5 and the pipe shall be asphalt coated.

2. Corrugated Aluminum Pipe - Pipe gage is not to be less than that in Table 4.4-3. The maximum principal spillway barrel size shall be 36 inch. The pipe may be helical or riveted fabrication. Riveted pipe shall be close riveted.

   Riveted pipe 36 inch and larger shall be double riveted. The pH of the embankment and water shall be between 4 and 9. Inlets, coupling bands and antiseep collars must be made of aluminum.

   Fittings for aluminum pipe of metals other than aluminum or aluminized steel must be separated from the aluminum pipe at all points by at least two layers of plastic tape having a total thickness of at least 24 mils, or by other permanent insulating material that effectively prevents galvanic corrosion.

   Bolts used to join aluminum and steel must be galvanized, plastic coated, or otherwise protected to prevent galvanic corrosion.

   Bolts used to join aluminum to aluminum, other than aluminum alloy bolts, must be galvanized, plastic coated, or otherwise protected to prevent galvanic corrosion.

   Connections between pipe joints must be watertight. Flanges with gaskets or caulking may be used. Rod and lug coupling bands with gaskets or caulking may be used. Slip seam coupling bands with gaskets or caulking may be used.

3. Plastic pipe - The pipe is to be PVC meeting the requirements of Table 4.4-4. Connections between pipe joints and antiseep collar connections to pipe must be watertight. Pipe joints must be solvent welded or threaded. All fittings and couplings shall meet or exceed the same strength requirements as that of the pipe and be made of material that is recommended for use with the pipe. Connections of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic. The maximum principal spillway barrel size shall be 12 inch.

4. Smooth steel - The minimum wall thickness shall be 3/16 inch. Used pipe shall be in good condition and not have deep rust pits. The maximum principal spillway barrel shall be 48 inch. Pipe joints shall be threaded or welded by a competent welder.

5. Concrete, with rubber gaskets - The pipe shall be laid in concrete bedding. Connections between pipe joints and antiseep collar connections to pipe must be watertight and remain watertight after movement caused by foundation and embankment consolidation.

TABLE 4.4-3

MINIMUM GAGES - CORRUGATED METAL PIPE
(2 2/3 inch x 1/2 inch Corrugations)

STEEL - MINIMUM GAGE

Fill Height Above Pipe (feet)	PIPE DIAMETER (inches)								
							Risers Only		
	8 to 21	24	30	36	42	48	54	60	66
1 15	16	16	14	14	12	10	10	10	10
15 20	16	14	14	12	12	10	10	8	8
20 25	16	14	14	12	10	10	8	8	8

ALUMINIMUM-MINIMUM THICKNESS GAGE (Inches)

FILL HEIGHT ABOVE PIPE (feet)	PIPE DIAMETER (inches)						
					Risers Only		
	8 to 21	8 to 24	30	36	42	48	54
1 - 15	16(.06)	14(.06)	14(.075)	14(.075)	12(.105)	10(.135)	10(.135)
15 - 20	16(.06)	14(.075)	12(.105)	12(.105)	12(.105)	10(.135)	10(.135)
20 - 25	16(.06)	12(.105)	10(.135)	10(.135)	10(.135)	10(.135)	8(.164)

TABLE 4.4-4

ACCEPTABLE PVC* PIPE FOR USE IN SEDIMENT BASINS		
NOMINAL PIPE SIZE (INCHES)	SCHEDULE FOR STANDARD DIMENSION RATION (SDR)	MAXIMUM DEPTH OF FILL OVER PIPE (FEET)
6, 8, 10, 12	Sched. 40 Sched. 80 SDR 26	10 15 10

*Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D 1785 or ASTM D 2241

Inlets for Pipe Conduits - The inlet shall be structurally sound and made from materials compatible with the pipe. The inlet shall be designed to prevent flotation. The inlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated. The inlet materials shall be subject to the same limitations and requirements as pipe conduits.

1. Watertight Riser - The riser shall be completely watertight except for the inlet at the top and one hole 4 inches or less in diameter to dewater the basin.

2. Dewatering the Sediment Basin - Sediment basins with a permanent pool of water trap sediment more effectively than basins that are normally dry and usually create less of a mosquito problem and safety hazard. Therefore, a sediment basin with a permanent pool is usually a better design than a normal dry sediment basin.

   If a normally dry or partially dry sediment basin is planned, the basin shall be dewatered by a 4 inch diameter or smaller hole in the riser or by the use of subsurface drains or by a combination of these two methods.

   If the sediment basin is dewatered by using a hole in the riser:

   a. The elevation of the hole shall be the elevation that results in 50% actual trap efficiency in the basin. The value for C used to determine the 50% actual trap efficiency is the capacity of the basin between the bottom of the hole and crest elevation of the emergency spillway.

   b. The sediment shall be removed from the basin when the sediment reaches the elevation of the bottom of the hole.

   If the sediment basin is dewatered by using a subsurface drain, it shall be in accordance with the Subsurface Drain Standard.

   Appendix A7 shows several methods for dewatering a sediment basin.

Pipe Drop Inlet - Where the pipe is designed for pressure flow:

a. The weir length shall be adequate to prime the pipe below the emergency spillway elevation.

b. For pipe on less than critical slope, the drop inlet shall be at least 2D deep, where D is the conduit diameter.

c. For pipe on critical slope or steeper, the drop inlet shall be at least 5D deep, where D is the conduit diameter.

Antivortex Devices - Sediment basins with the principal spillway designed for pressure flow are to have adequate antivortex devices.

Trash and Safety Guards - An appropriate guard shall be installed at the inlet. The guard shall prevent clogging of the pipe by trash and reduce the safety hazard to people. The guard shall be a type that will not plug with leaves, grass or other debris.

Outlets for Pipe Conduits - The outlets shall be structurally sound and made from materials compatible with the pipe. The outlets shall be deisgned to function satisfactorily for the full range of flow and hydraulic head anticipated. Protection against scour at the discharge end of the spillway shall be provided. Measures may include an impact basin, conduit outlet protection, rock riprap, excavated plunge pools or use of other generally accepted methods.

Antiseep Collars - Antiseep collars are not required for excavated sediment basins. Pipe conduits for embankment sediment basins shall be provided with antiseep collars.

The following criteria are to be used to determine the size and number of antiseep collars.

Let V = projection of the antiseep collar in feet

L = length in feet of the conduit within the zone of saturation, measured from the downstream side of the riser to the toe drain or point where phreatic line intercepts the conduit, whichever is shorter.

n = number of antiseep collars

The ratio of the length of the line of seepage (L + 2 n V) to L is to be not less than 1.15. Antiseep collars should be equally spaced along that part of the barrel within the saturated zone at distances of not more than 25 feet.

The antiseep collars and their connections to the pipe shall be watertight. The collar material shall be compatible with pipe materials.

Emergency Spillways

Emergency spillways are provided to convey large floods safely past sediment basins.

An emergency spillway must be provided for each sediment basin, unless the principal spillway is large enough to pass the routed emergency spillway design storm and the trash that comes to it without overtopping the dam. A closed conduit principal spillway having a conduit with a cross-sectional area of 3 square feet or more, an inlet which will not clog, and an elbow designed to facilitate the passage of trash is the minimum size and design that may be utilized without an emergency spillway.

1. Excavated Sediment Basins - Excavated sediment basins may utilize the natural ground or the fill for the emergency spillway if the downstream slope is 5 to 1 or flatter and has existing vegetation or is immediately protected by sodding, rock riprap, asphalt lining, concrete lining, or other equally effective protection. The spillway shall meet the capacity requirement for embankment sediment basins.

2. Embankment Sediment Basins - Embankment sediment basins shall meet the following requirements:

   a. Capacity - The minimum capacity of the emergency spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4.4-5 less any reduction creditable to conduit discharge and detention storage.

   When discharge of the principal spillway is considered in calculating outflow through the emergency spillway, the crest elevation of the inlet shall be such that full flow will be generated in the conduit before there is discharge through the emergency spillway. The emergency spillway shall safely pass the peak flow or the storm runoff shall be routed through the reservoir. If routed, the routing shall start with the water surface at the elevation of the crest of the principal spillway. The flood routing may be done using the approximate methods in the SCS Engineering Field Manual, or other accepted methods of emergency spillway flood routing.

TABLE 4.4-5

MINIMUM DESIGN STORM		
DRAINAGE AREA (acres)	FREQUENCY (years)	MINIMUM DURATION (hours)
less than 20	10	24
21 - 49	25	24
over 49	100	24

b. Velocity -- Emergency spillways are to provide for passage of the design flow at a safe velocity to a point downstream where the dam will not be endangered. The maximum permissible velocity in the exit channel shall be 4 ft. per second for vegetated channels in soils with a plasticity index of 10 or less and 6 ft. per second for vegetated channels in soil with a plasticity index greater than 10. For exit channels with erosion protection other than vegetation, the velocities shall be in the safe range for the type of protection used.

c. Cross Sections -- Emergency spillways shall be trapezoidal and will be located in undisturbed earth. The side slopes shall be 2 to 1 or flatter. The bottom width shall be 10 feet or wider. The embankment requirement determine elevation differences between crest of the emergency spillway and settled top of dam.

d. Component Parts -- Emergency spillways are open channels and consist of an inlet channel, control section and an exit channel. The emergency spillway should be as long as possible to provide protection from breaching.

(1) Inlet channel - the inlet channel shall be level and straight for at least 20 feet upstream of the control section. Upstream of the level area it may be graded back towards the pond to provide drainage. The alignment of the inlet channel may be curved upstream of the straight portion.

(2) Exit channel - The grade of the exit channel of a constructed spillway shall fall within the range established by discharge requirements and permissible velocities. The exit channel shall carry the design flow downstream to a point where the flow will not discharge on the toe of the dam. The design flow should be contained in the exit channel without the use of dikes. If a dike is necessary, it shall have 2:1 or flatter side slopes, 8 foot top width minimum and be high enough to contain the design flow plus one foot of freeboard.

Structural Spillways Other Than Pipe

Structural spillways other than pipe will have structural designs based on sound engineering data with acceptable soil and hydrostatic loadings as determined on an individual site basis.

When used as a principal spillway they shall pass the storm runoff from a 2 year 24 hour duration storm without flow through the emergency spillway and shall not be damaged by the emergency spillway design storm. When used as an emergency spillway they shall pass the storm runoff from the appropriate storm in Table 4.4-5.

Vegetation

The dam, emergency spillway, spoil and borrow areas, and other disturbed areas above crest of the principal spillway shall be stabilized in accordance with the standards for temporary or permanent vegetative cover, which ever is applicable.

Disposal

The sediment basin plans shall indicate the method(s) of disposing of the sediment removed from the basin. The sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the basin or in or adjacent to a stream or floodplain.

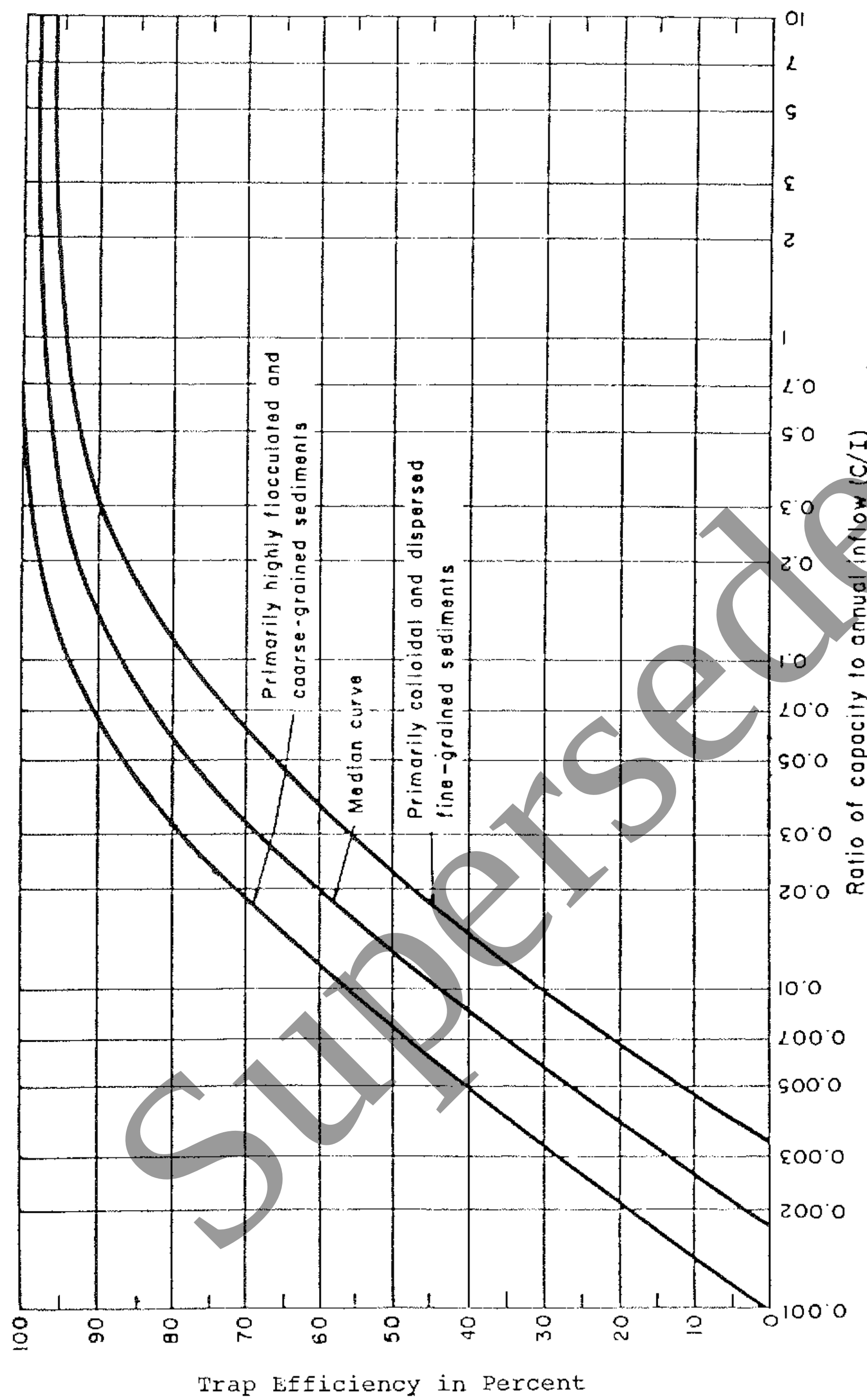
The plans shall also show the method of removal of the sediment basin after the drainage area is stabilized, and shall include the stabilizing of the sediment basin site. Water lying over the trapped sediment shall be removed from the basin by pumping, cutting the top of the riser or other appropriate method prior to removing or breaching the embankment. Sediment shall not be allowed to flush into the stream or drainageway.

Safety

Sediment basins attract children and can be very dangerous. They should be fenced or otherwise made inaccessible to persons or animals unless deemed unnecessary due to the remoteness of the site or other circumstances. In any case, local ordinances and regulations regarding health and safety must be adhered to.

Maintenance

The plans shall indicate who is responsible for operation and maintenance during the life of the sediment basin.



CURVE 4.4-1

TRAP EFFICIENCY OF RESERVOIRS

Reference: Brune, Gunnar M., "Trap Efficiency of Reservoirs", Trans. AGU, Vol. 34, No.3, pp 407-418, June 1953.

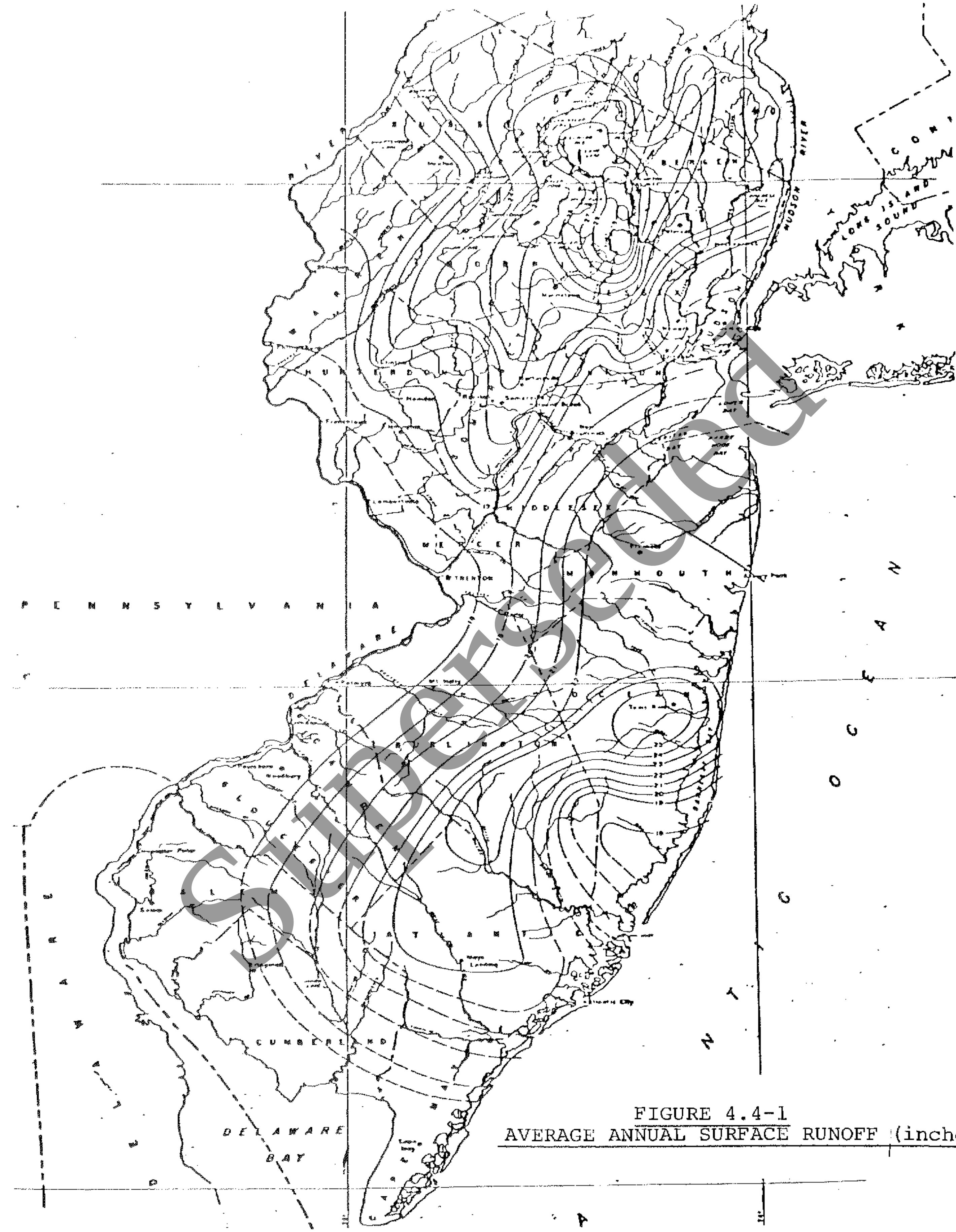


FIGURE 4.4-1
AVERAGE ANNUAL SURFACE RUNOFF (inches)

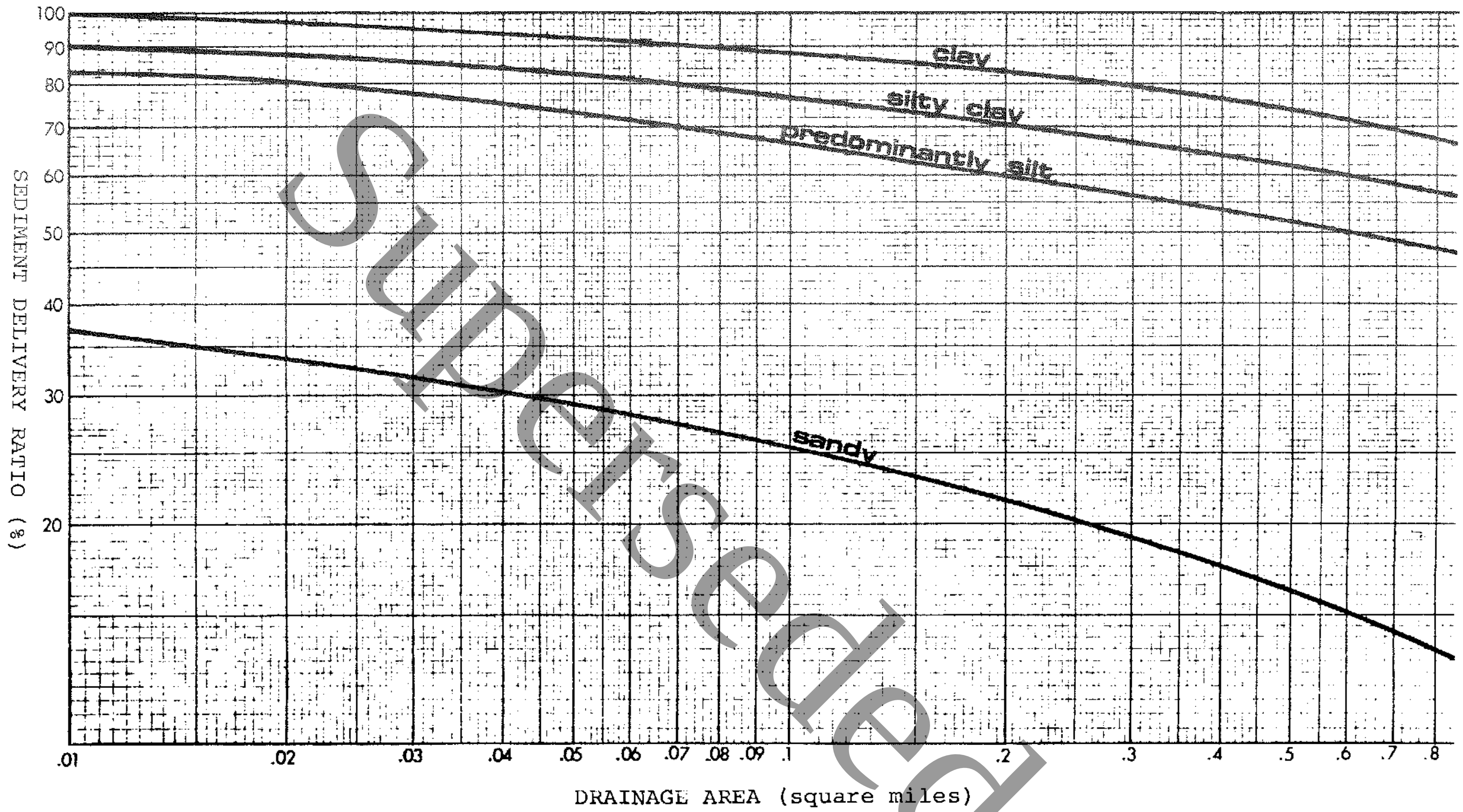


FIGURE 4.4-2
SEDIMENT DELIVERY RATIO VS. DRAINAGE AREA

STANDARDS
FOR
SLOPE PROTECTION STRUCTURES

Definition

Structures to safely conduct surface runoff from the top of a slope to the bottom of the slope.

Purpose

The purpose of this practice is to convey storm runoff safely down cut and fill slopes to minimize erosion.

Conditions Where Practice Applies

Slope protection structures are to be used where concentrated water will cause excessive erosion on cut and fill slopes. Temporary structures should be left in place until adequate vegetation and the permanent drainage system have been installed. Permanent structures are part of the drainage system.

Design Criteria

Open Flumes

Flumes shall be adequately designed to convey runoff water concentrations safely down steep slopes based on a 10-year frequency storm, or sized in accordance with the requirements of Tables 4-5.1 and 4-5.2.

Protection against scour at the discharge end of the open flume shall be provided in the form of an energy dissipator or other measures such as an impact basin, rock riprap revetment or plunge pool.

Recommended dimensions for flumes are defined as follows:

1. b - Is the bottom width of the paved down slope section of a trapezoidal or rectangular flume. The minimum bottom widths and associated maximum drainage areas shall conform to Table 4.5-1.

2. T - Is the top width of parabolic flumes. The minimum top widths and maximum drainage areas shall conform to Table 4.5-2.

3. H - Is the height of the dike at the entrance to the structure and shall be a minimum of 2.5 feet.

4. d - Is the depth of the paved down slope section and shall be a minimum of 10 inches for trapezoidal or rectangular flumes. The depths of parabolic flumes shall be as shown in Table 4.5-2.

5. L - Is the length of the inlet and outlet paved sections and each shall be an minimum of 6 feet.

The above dimensions are illustrated in Figure 4.5-I.

TABLE 4.5-1 FLUMES WITH TRAPEZOIDAL AND RECTANGULAR SECTIONS

Bottom Widths and Drainage Area for Trapezoidal Flumes with Flow Depths Equal 10 Inches	
Bottom Width ft.	Drainage Area Acs.
2	7
4	10
6	13
8	16
10	19
12	24

Bottom Widths and Drainage Area for Rectangular Flumes with Flow Depths Equal 10 Inches	
Bottom Width ft.	Drainage Area Acs.
2	3
4	5
6	10
8	13
10	16
12	20

Dikes to be 2.5 ft. in height above flume entrance

TABLE 4.5-2 FLUMES WITH PARABOLIC SECTIONS

Depth Equal 1 Foot	
Top Width Ft.	Drainage Area Acs.
4	3
6	4
8	5
10	6
12	7
14	8

Depth Equal 1.5 Feet	
Top Width Ft.	Drainage Area Acs.
4	4
6	5
8	5
10	7
12	8
14	10
16	11

Dikes to be 2.5 ft. in height above flume entrance

If a minimum of 75 per cent of the drainage area will have a good grass or woodland cover throuhgout the life of the structure, the drainage areas listed in Tables 4.5-1 and 4.5-2 may be increased by 50 per cent. If a minimum of 75 per cent of the drainage area will have a good mulch cover throughout the life of the structure, the drainage area listed in Tables 4.5-1 and 4.5-2 may be increased by 25 per cent.

Flumes with dimensions and associated drainage areas other than those shown in this standard shall be designed on an individual job basis. Capacities shall be determined by acceptable hydrologic and hydraulic computations.

<u>Pipe Drops</u>

The design capacity shall be as required to pass peak runoff from a 10-year frequency storm. Runoff values shall be determined by the method contained in Chapter 2, Ref. (1), The Rational Method (Q = CIA), or by other accepted methods. Pipe capacities may be determined from charts in Chapter 6, Ref. (1), or other accepted sources.

A hood inlet type entrance should be used as shown in Figure 4.5-II. The pipe drop inlet shall be protected by riprap or concrete.

Flexible Downdrain

Of heavy duty fabric or other material may be used as a temporary or interim structure as shown in Figure 4.5-III. Use of flexible down drains is not recommended during the winter months. Standard metal end sections shall be used.

Outlet protection shall be provided by riprap or other means.

Diversion dikes - shall be used in conjunction with pipe drops. The dike height above the pipe inlet invert shall be adequate to contain a water elevation sufficient to cause full pipe flow plus an allowance of at least 0.5 feet for freeboard. A minimum water depth of 1.8 times the pipe diameter above pipe inlet invert is required to assure full pipe flow.

Installation Requirements

1. The structure shall be placed on undisturbed soil or well compacted fill.

2. The cut or fill slope shall not be steeper than 1 vertical to 1.5 horizontal (1.5:1) and should not be flatter than 20:1.

3. Adequate vegetative protection and drainage works shall be installed.

4. Open Flume

   a. The top of the earth dikes shall not be lower at any point than the top of the lining at the entrance of the structure.

   b. The lining should be placed beginning at the lower end and proceding up the slope to the upper end. The lining shall be well compacted and free of voids.

   c. The entrance floor at the upper end of the structure shall have a slope toward the outlet of 1/4 to 1/2 inch per foot.

5. Hood Inlet Pipe Drops

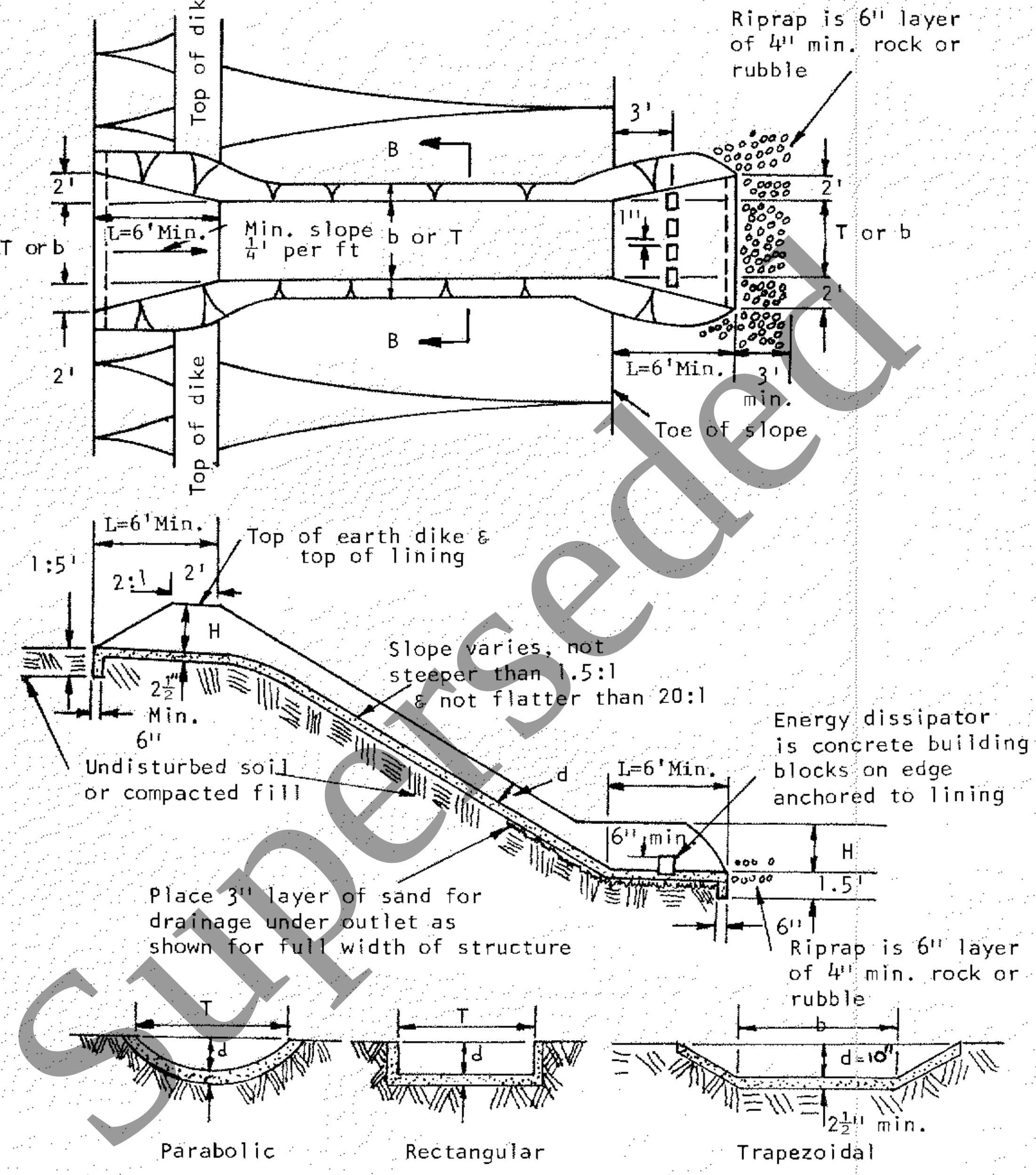
   a. The pipe shall be imbedded in the embankment to a depth that will insure stability.

   b. Protection measures of concrete or riprap shall be installed at the inlet and outlet as needed to protect against erosion.

   c. The pipe may be smooth or corrugated and shall be of the required strength and durability.

   d. Backfill shall be carefully placed in layers and tamped to insure adequate compaction.

FIGURE 4.5-I
TYPICAL OPEN FLUME

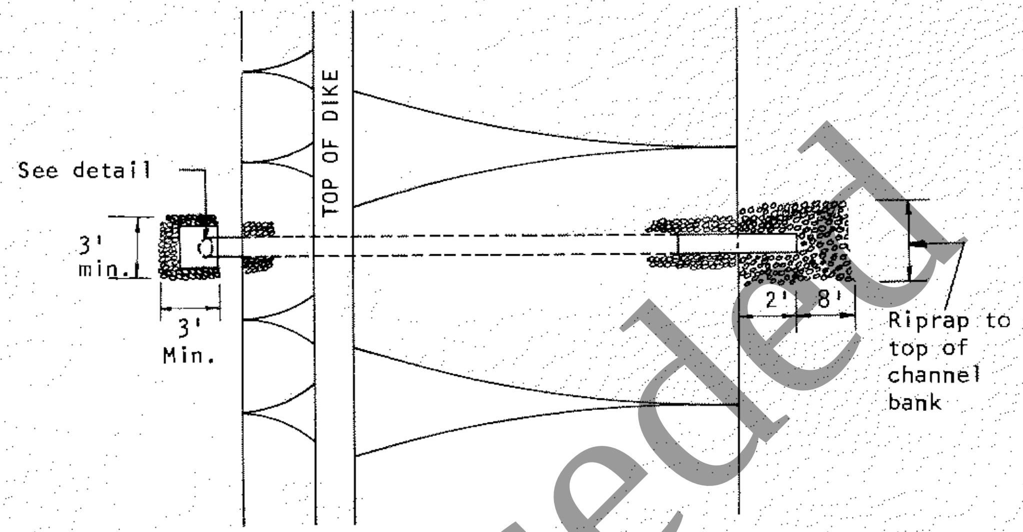


Alternate Sections B-B

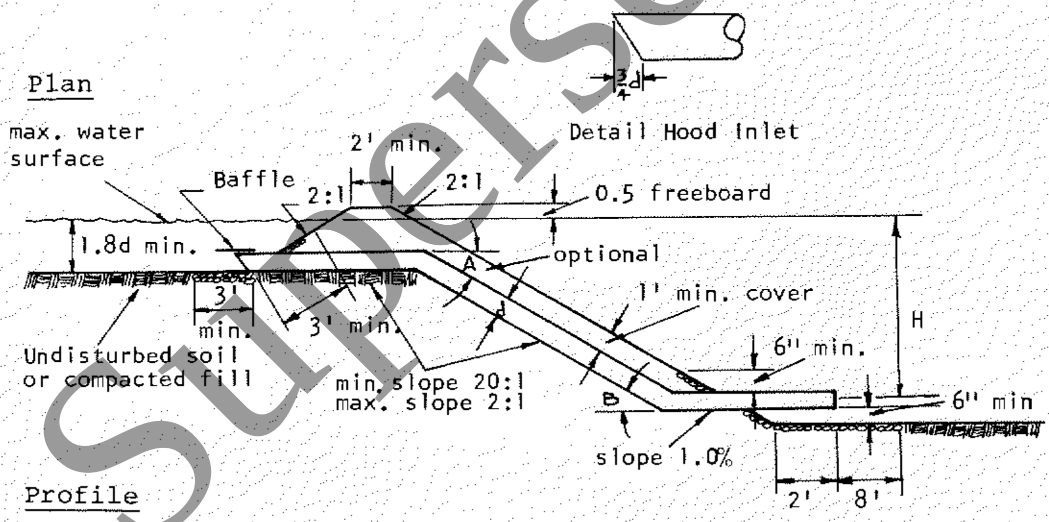
Notes:

1. Lining shall be Portland Cement concrete, bituminous concrete or comparable material.
2. Some type of energy dissipator, such as the one shown above, must be used to prevent erosion at the outlet.
3. The paved down slope section should have side slopes as required by construction methods.

FIGURE 4.5-II
BANK PROTECTION STRUCTURE
Hood Inlet Pipe

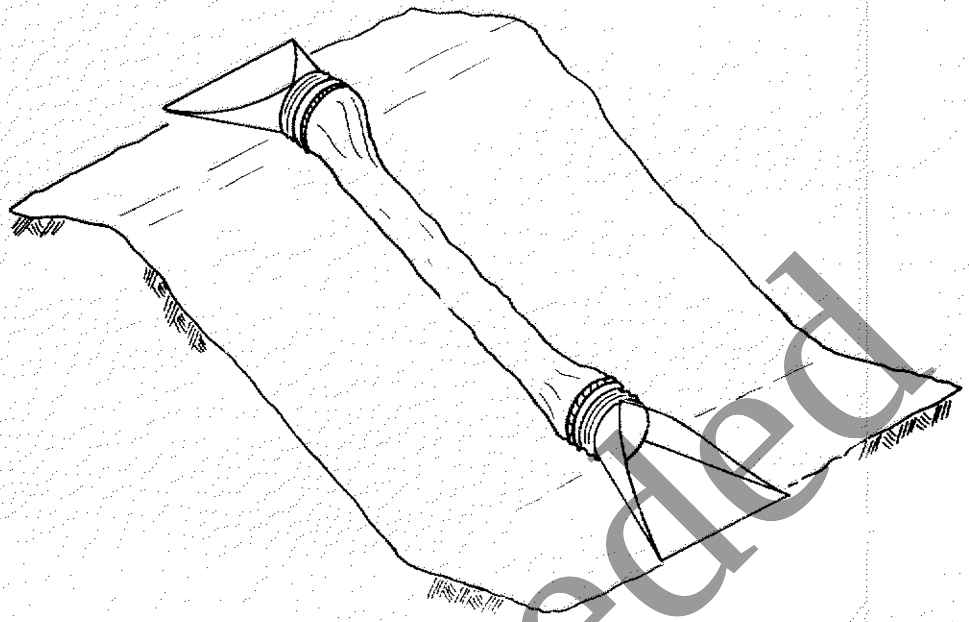


Plan

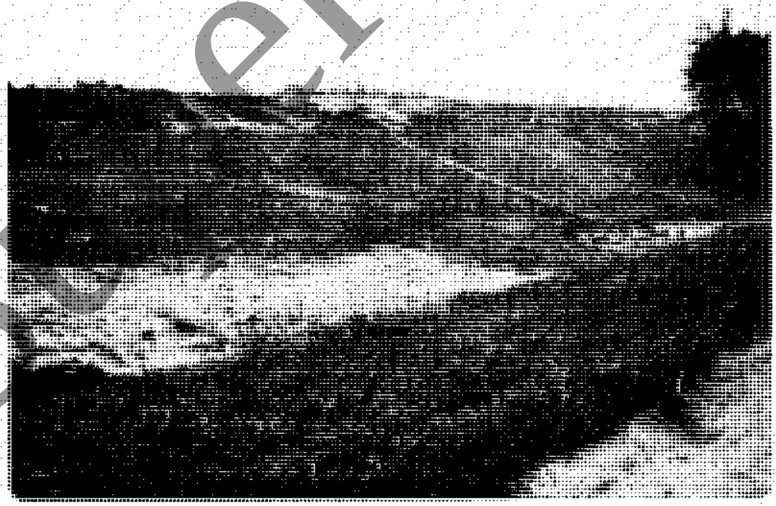


Profile

No scale



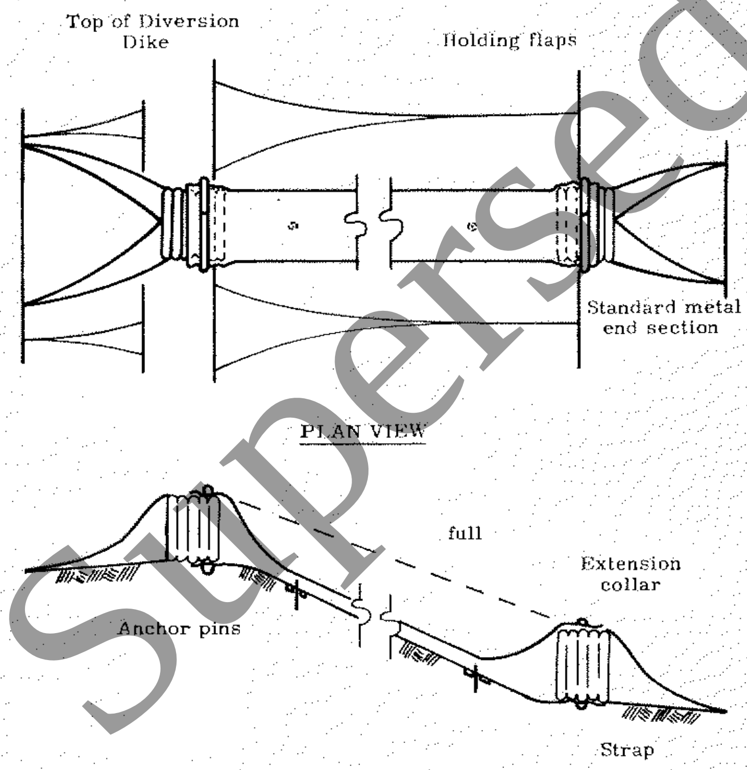
Flexible downdrain - isometric



Flexible downdrain - installed

MAINTENANCE:

Inspect for clogging or damage after each storm. In below freezing weather, check to ensure that sides of collapsed downdrain are not frozen together. Do not allow placement of any material on collapsed downdrain. Inlet section should be checked for indications of piping along metal sections. Anchors should be resecured as necessary.



Flexible downdrain

STANDARD
FOR
CHANNEL STABILIZATION

Definition

Stabilizing a channel, either natural or artifical, in which water flows with a free surface.

Purpose

Open channels are constructed or stabilized to be nonerodible and provide adequate capacity for the conveyance of flood water, drainage, other water management purposes, or any combination thereof.

Conditions Where Practice Applies

This standard applies to the construction and stabilization of open channels, and existing streams or ditches regardless of drainage area. It does not apply to diversions or grassed waterways.

Design Criteria

Planning

The alignment and design of channels shall give careful consideration to the preservation of valuable fish and wildlife habitat. Trees of significant value for wildlife food or shelter shall be preserved whenever possible.

Where channel construction will adversely affect a significant fish or wildlife habitat, mitigation measures should be included in the plan. Mitigation measures may include pools, riffles, flats, cascades, or other similar provisions.

As many trees as possible are to be left considering the requirements for construction, operation, and maintenance. See Standard for Tree Protection During Construction, pg. 3.91.

Realignment

The realignment of channels shall be kept to an absolute minimum.

Channel Capacity

The capacity for open channels shall be determined by the designer and/or the appropriate regulatory authority.

Hydraulic Requirements

Manning's formula shall be used to determine the velocities in the channels.

The "n" values for use in this formula shall be estimated using currently accepted guides along with knowledge and experience regarding the conditions.

Acceptable guides can be found in Refs. 6 and 7.

Channel Side Slopes

Channel side slopes in earth shall be 2:1 or flatter unless the design, using the procedures in Appendix A8, shows that a steeper side slope is stable. Channel side slopes of materials other than earth shall be designed stable.

Channel Stability (General)

All channel construction, improvement and modification shall be in accord with a design which results in a stable channel.

Characteristics of a stable channel are:

1. It neither aggrades or degrades beyond tolerable limits.

2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.

3. Excessive sediment bars do not develop.

4. Excessive erosion does not occur around culverts and bridges or elsewhere.

5. Gullies do not form or enlarge due to the entry of uncontrolled surface flow to the channel.

The determination of channel stability considers bankfull flow. Bankfull flow is defined as the flow in the channel which creates a water surface that is at or near normal ground elevation for a significant length of a channel reach. Excessive channel depth created by cut through high ground, such as might result from realignment of the channel, should not be considered in determinations of bankfull flow.

Channel Stability (Drainage area of one square mile or less)

Channels in this category shall be considered stable if the actual velocity is less than the allowable velocities shown in Table 4.6-1. The actual velocity is defined as the lesser of the:

a. Bankfull velocity
B. 10-year frequency peak discharge velocity

TABLE 4.6-1 ALLOWABLE VELOCITIES FOR VARIOUS SOIL TEXTURES

SOIL TEXTURE	ALLOWABLE VELOCITY ft./sec.
Sand and sandy loam	2.5
Silt loam	3.0
Sandy clay loam	3.5
Clay loam	4.0
Clay, fine gravel, graded loam to gravel	5.0
Cobbles	5.5
Shale	6.0

Channel Stability (Drainage area greater than one square mile)

Channels must be stable under conditions existing immediately after construction (as built condition) and under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As built condition - Bankfull flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50 percent of design discharge.

2. Aged condition - Bankfull flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharges greater than the 100-year frequency.

Stability checks are not required if the actual velocity is 2 fps or less.

Where vegetation can be rapidly established by natural or artifical means, the allowable as-built velocity (regardless of type stability analaysis) in the newly constructed channel may be increased by a maximum of 20 percent. The 20 percent adjustment does not apply to the allowable velocity for aged condition. This increase is justified only if:

1. The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation,

2. Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and

3. The channel design includes detailed plans for establishing vegetation on the channel side slopes.

For newly constructed channels in fine-grained soils and sands, the "n" values shall be determined according to specifications in Appendix A8 and shall not exceed 0.025. The "n" value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

The above stability checks will be made using either tractive stress or allowable velocity procedures given in Appendix A8. The choice of method will depend upon the grain size and cohesiveness of the soil being checked. The following will be used as a guide in choosing the method:

A. Tractive Stress - See Appendix A8
   1. Coarse grained soils
   2. Fine grained noncohesive soils (PI <10)

B. Allowable Velocity - See Appendix A8
   1. Coarse grained soils (tractive stress procedure recommended)
   2. Fine grained cohesive soils (PI > 10)
   3. Fine grained noncohesive soils (PI < 10) (tractive stress procedure recommended)

Stability checks should be made for each significant soil horizon present. Soil sampling and testing is required to determine the grain size distribution and plasticity index of each material to be checked.

Channel Linings and Structural Measures

Where channel velocities exceed allowable velocities the channel must be stabilized.

Channels may be stabilized by using one or more of the following methods:

Rock Riprap Lining shall be designed using the procedures given in Standard for Riprap, pg. 4.12.

Concrete Lining shall be designed according to currently accepted guides for structural and hydraulic adequacy. They must be designed to carry the required discharge and to withstand the loading imposed by site conditions.

Grade Stabilization Structures can be used where excessive grades exist. The structures provide for one or more drops along the channel profile to reduce the channel slope.

They may be constructed of concrete, rock, masonry, steel, aluminum or treated timber.

The structures must be designed hydraulically to adequately carry the channel discharge and structurally to withstand loadings imposed by the site conditions.

Chapter 6, Ref. #8, provides procedures for use in the design of these structures.

Energy Dissipators are employed to force hydraulic jump and its associated turbulence to occur at a location where suitable protection can be provided against bank scour and channel erosion. Construction of energy dissipators is normally at the base of chutes or drop structures and they are usually an integral part of the design of the structure. Sills, baffles, floor blocks, or other obstructions to channel flow may serve as energy dissipators.

Chapter 15, Reference #6 provides design considerations for energy dissipation with the hydraulic jump.

Installation Requirements

1. All trees, brush, stumps and other objectionable materials that would not interfere with the construction or proper functioning of the channel shall be removed.

2. Where possible, trees will be left standing, brush and stumps will not be removed and channels will be excavated from one side leaving vegetation on the opposite side.

3. Construction plans will specifically detail the location and handling of spoils.

4. Seeding, fertilizing and mulching shall conform to the Standards for Permanent Vegetative Cover for Soil Stabilization, pg. 3.21.

5. Vegetation shall be established on all disturbed areas immediately after construction, weather permitting. If weather conditions are such as to cause a delay in the establishment of vegetation, the area shall be mulched in accordance with the Standards for Stabilization with Mulch Only, pg. 3.31.

STANDARDS
FOR
FLOODWATER RETARDING STRUCTURES

Definition

A structure providing for temporary storage of floodwater and for its controlled release.

Purpose

Floodwater retarding structures are installed to reduce erosion and other flood damages downstream by controlling the release rate from flood flows of predetermined frequencies. They may also permit the use of more economical channel improvements or stabilizing structures in the channel downstream and reduce environment hazards and pollution.

Conditions Where Practice Applies

This standard applies to structures where the product of the storage and the height of the dam is less than 3,000, the contributing drainage area is no more than 320 acres, and the height of the dam is less than 20 feet. The storage is measured in acre-feet at the elevation of the crest of the emergency spillway and the height of the dam is measured in feet from the lowest point in the original cross section on centerline to the crest of the emergency spillway.

This practice also applies only to sites meeting all of the following conditions:

1. The construction of the structure is permitted by applicable State statutes and regulations.

2. Topographic, geologic and soils conditions at the proposed site are satisfactory for the development of a feasible dam and reservoir.

3. The sediment yield at the site is not excessive unless adequate provisions are made to remove sediment periodically from the reservoir.

Special attention will be given to maintaining habitat for fish and wildlife and to preserve the environmental integrity.

Design Criteria

Cutoff Trench

A cutoff of relatively impervious material shall be provided under the dam, except in those cases where a layer of such material exists at the surface of the foundation. The layer of impervious material shall be thick enough to provide stability. The cutoff shall extend along the centerline of the dam and its abutments are as required and be deep enough tc extend into a relatively impervious layer.

The cutoff trench shall have a bottom width and side slopes adequate to accommodate the equipment used for excavation, backfill and compaction operations.

Earth Embankment

Top Width - The minimum top width of the dam shall be:

Height of Dam	Top Width
0 - 15 feet	10 feet
15 - 20 feet	12 feet
20 - 25 feet	14 feet

Side Slopes - The side slopes of the settled embankment shall not be less than 2-1/2 horizontal to 1 vertical.

Freeboard - The minimum elevation of the top of the settled embankment shall be 1 foot above the water surface in the reservoir with the emergency spillway flowing at design or a minimum of 2 feet above the crest of the emergency spillway.

Allowance for Settlement - The design height of the dam shall be increased by the amount needed to insure that the design top elevation will be maintained after all settlement has taken place. This increase shall not be less than 5 per cent of the design height of the dam.

Design Discharge - Peak discharge values shall be determined by the method contained in Chapter 2, Ref. (1), The Rational Method (Q = CIA), or by other accepted methods.

Design Hydrographs - May be compiled by the method contained in Chapter 21, Ref. (2).

Drop Inlet Spillway - The drop inlet spillway will consist of a vertical pipe or box. The riser joined to a conduit which will extend through the embankment and outlet beyond the downstream toe of the fill as illustrated in Figure 4.4-1 contained in standards for sediment basins.

The crest of elevation of the riser shall be at least 1.0 foot below the crest elevation of the earth spillway. The size of the pipe and crest elevation of the riser should be such that full flow will be generated in the barrel before there is discharge through the earth spillway. The capacity of the drop inlet spillway should be adequate to discharge, in 10 days or less, the floodwater storage needed to provide the desired level of protection to the downstream benefited area. The determination of capacity must be based on consideration of the benefits that accrue to the reduction in the discharge rate, damages that may result from prolonged outflow, and limitations in water rights or other legal requirements. The discharge through gated outlets shall not be considered in determining the emptying time of the retarding pool.

All component parts of the spillway except attached gates and trash racks shall have an expected service life equal to or greater than the design life of the structure.

The diameter of the conduit used as a drop inlet spillway may be determined from charts contained in Chapter 6, Ref. (1), or from other accepted references. All pipe joints shall be made watertight. Pipes such as asbestos cement, concrete and virtrified clay shall be laid in concrete bedding. The structure shall be capable of withstanding both internal and external loads. Anti-seep collars shall be provided in all cases. Collars and their connection to the pipe shall be watertight. The maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. In no case shall the spacing exceed 25 feet.

An adequate drain pipe with a suitable valve or gate shall be provided.

Sediment Storage Requirements - The storage volume to be provided shall not be less than the expected sediment accumulation during a period equal to the design life, unless adequate provisions are made to remove sediment periodically from the reservoir.

Floodwater Storage Requirements - The retarding storage requirements shall be such as to contain the runoff expected to occur at a frequency consistent with the level of protection to be provided to the downstream benefited area, with proper allowance made for discharge through the drop inlet spillway. The minimum reservoir storage volume and associated spillway design discharge shall be adequate to prevent an unstable downstream channel condition.

Channel stability can be checked by the methods contained in standard for channel stabilization, p. 4.61. The retarding storage capacity shall be sufficient to limit the use of the emergency spillway to a permissible frequency and duration, based upon a consideration of the erosion resistance of the spillway material and the vegetative protection to be provided.

Earth Emergency Spillways - An emergency spillway must be provided for each installation, unless the drop inlet spillway is large enough and of a design which will pass the routed design runoff and the anticipated trash. Earth spillways shall have a minimum bottom width of 8 feet. The crest of the emergency spillway shall be at least 2 feet below the top of the settled embankment. The minimum design capacity of an emergency spillway should be that required to convey the routed runoff from a 100-year frequency storm, or a storm with a frequency equal to the design life of the structure, whichever is greater.

Earth spillway dimensions can be determined by using the method outlined in Chapter 11, Ref. (1), or from other accepted references.

The storm runoff shall be routed through the reservoir starting with the water surface at the elevation of the crest of the drop inlet spillway.

Installation Requirements

Site Preparation

Timber, logs, brush, rubbish, rocks, stumps and vegetable matter under the embankment and any structural works shall be cleared, grubbed and disposed of. In order to facilitate cleanout and restoration, the pool area will be cleared of all brush and excess trees.

Cutoff Trench

A cutoff trench shall be excavated along the centerline of earth fill embankments more than 10 feet high to a minimum depth of 2 feet. The cutoff trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be 4 feet but wide enough to permit operation of compaction equipment. The side slopes shall be no steeper than 1:1. Compaction requirements shall be the same as those for embankment. The trench shall be kept free from standing water during the backfilling operations.

Embankment

The fill material shall be taken from approved designated borrow areas. It shall be free of roots, woody vegetation, stones over 6 inches, or other objectionable material. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material should contain sufficient moisture for proper compaction.

All fills shall be compacted sufficiently for their intended purpose.

Pipe Inlet Spillways

The riser shall be solidly attached to the barrel and all connections shall be water tight. The barrel and riser shall be placed on a firm foundation. The fill material around the drop inlet spillway shall be compacted to at least the same density as the adjacent embankment. A minimum of 2 feet of hand compacted backfill shall be placed over the barrel before crossing it with construction equipment.

Emergency Spillway

The emergency spillway shall be installed in undisturbed earth unless specified otherwise in the plan. The lines and grades must conform to those shown on the plans as nearly as skillful operations of the excavation equipment will permit.

Safety

Signs shall be installed warning the public of harzards of soft sediment and floodwater. Consideration should be given to fencing.

Seeding

All disturbed areas above the crest of the principal spillway shall be seeded or sodded. Seeding, fertilizing and mulching shall conform to the appropriate standard.

Trees

Trees to be retained shall be protected, if necessary, in accordance with the Standard for tree protection during construction. (P.3.91)

STANDARDS
FOR
SUBSURFACE DRAINAGE

Definition

Removal of water through the soil by conduit, such as tile, pipe, or tubing, installed beneath the ground surface to collect and convey drainage water.

Purpose

A drain may serve one or more of the following purposes:

1. Improve vegetation by lowering the water table.
2. Intercept and prevent water movement into a potentially wet area.
3. Relieve artesian pressures.
4. Reduce surface runoff.
5. Serve as an outlet for other drains.
6. Replace natural subsurface drainage patterns which are interrupted by construction operations.

Conditions Where Practice Applies

Drains are used in areas having a high water table where benefits of lowering groundwater or controlling surface runoff justify the installation of such a system.

The soil shall have enough depth and permeability to permit installation of an effective system. On site investigations are required.

An outlet for the drainage system shall be available, either by gravity flow or by pumping. The outlet shall be adequate for the quantity and quality of effluent to be disposed of with consideration of possible damages above or below the point of discharge.

Design Criteria

The design and installation shall be based on adequate surveys and investigations.

Design Inflow

The design inflow can be determined by the use of the method described in reference (9), the use of table 4.8-1 or by other accepted methods.

TABLE 4.8-1

INFLOW RATES FROM DIFFERENT SOIL TEXTURES 1/

Soil Texture	Unified Soil Classification	Inflow Rate Per 10 Ft. of Line in cfs
Coarse Sand & Gravel	GP, GW, SP, SW	0.15 to 1.00
Sandy or Gravelly Loam	SM, SC, GM, GC	0.07 to 0.25
Silt Loam	CL, ML	0.04 to 0.10
Clay and Clay Loam	CL, CH, MH	0.02 to 0.20

1/ Required inflow rates for interceptor lines on sloping land should be increased by 10% for slopes 2% to 5%; 20% for slopes 5% to 12%; and 30% for slopes over 12%.

Size of Drain

The size of drains shall be computed by applying Manning's formula, or by the method contained in Chapter 15 Ref. (1).

The minimum drain shall be equivalent to a 4-inch diameter pipe.

Depth, Spacing and Location

The depth, spacing and location of the drain shall be based on site conditions including soils, groundwater conditions, topography and outlets.

Minimum Velocity and Grade

In areas with no siltation hazard, the minimum grades shall be 0.1 percent. Where it is determined that a siltation hazard exists, velocity of not less than 1.4 feet per second shall be used to establish the minimum grades if site conditions permit. Otherwise, provisions shall be made for prevention of siltation by filters or collection and removal of silt by use of silt traps.

Maximum Grade and Protection

On sites where topographic conditions require the use of drain lines on grades steeper than 2 percent or where design velocities will be greater than indicated in Table 4.8-2, special measures shall be used. These measures shall be specified for each job based on the particular conditions of the job site. Possible protective measures include the following:

1. Lay the drains so as to secure a tight fit with the inside of one section matching that of the adjoining section.

2. Wrap open joints with tar impregnated paper, burlap, or special filter material such as plastic or fiber glass fabrics.

3. Select the least erodible soil available for hand placing on sides and top of conduit which must be tamped before backfilling. Tamped thickness of this material over conduit shall be a minimum of two inches.

4. For continuous pipe or tubing with perforations, completely enclose the pipe with filter material of plastic, fiber glass, or properly graded sand and gravel as specified under filters and filter materials on page 4.86.

5. Install relief vents where changes in grade exceed 0.5 percent.

TABLE 4.8-2

MAXIMUM PERMISSIBLE VELOCITIES IN DRAINS
WITHOUT PROTECTIVE MEASURES

Soil Texture	Velocity - Feet Per Second
Sand and Sandy Loam	2.5
Silt and Silt Loam	4.0
Silty Clay Loam	5.0
Clay and Clay Loam	6.0
Coarse Sand and Gravel	8.0

Materials for Drains

"Drains" include conduits of clay, concrete, bituminized fiber, metal, plastic, or other materials of acceptable quality.

The conduit shall meet strength and durability requirements of the site.

Loading

The allowable loads on drain conduits shall be based on the trench and bedding conditions specified for the job. A factor of safety of not less than 1.5 shall be used in computing the maximum allowable depth of cover for a particular type of conduit.

Filters and Filter Material

Suitable filters shall be used, where required by site conditions, to prevent sediment accumulation in the conduit. The need for a filter shall be determined by the characteristics of the soil materials at drain depth and the velocity of flow in the conduit.

Not less than three inches of filter material shall be used for sand-gravel filters.[1] Filters of organic material such as salt hay, straw, or wood chips shall provide a six inch thickness.

Where fiber-glass material is used, it shall be manufactured from borosilicate type glass and the manufacturer of the material shall certify that it is suitable for underground use. The material shall cover all open joints and perforations.

Envelopes shall be used around drains where necessary to inprove flow characteristics of groundwater into the conduit.

[1]A recommended method of installation is to place filter material to a depth of three inches under the drain, and cover the drain and filter with a sheet of plastic. The filter shall be designed to prevent the material in which the installation is made from entering the drain. Not more than 10 percent of the filter shall pass the No. 60 sieve.

Installation Requirements

All drains shall be laid to line and grade and covered with not less than three inches of approved hand placed backfill and /or filter material. The upper end of all drain lines shall be closed with concrete or other durable material unless connected to a structure.

Earth backfill material shall be placed in the trench in such a manner that displacement of the drain will not occur, and so that the filter material, after backfilling, will meet the requirements of the design.

The gap between drain pipe joints shall not exceed one-fourth inch for mineral soils or one-half inch for organic soils. Openings wider than these shall be covered with fiber glass or other suitable material.

If the conduit is to be placed in a rock-trench, or where rock is exposed in the bottom of the trench, the rock shall be removed below grade deep enough so that the trench may be backfilled, compacted, and bedded so that the conduit is not less than two inches from rock.

When iron sulfide chemical reaction causes sealing of joints or perforations, the drain shall be enclosed in a clean sand-gravel filter. Riser pipes for flushing the line shall be provided at intervals not to exceed 500 feet.

STANDARDS FOR TRAFFIC CONTROL

Definition

The control of on site construction traffic (construction equipment, service vehicles, autos, etc.) during development of a parcel of land.

Purpose

To minimize land disturbance.

Where Applicable

Any area where vehicular traffic disturbs the land to the extent of reducing protective vegetation, compacting soil or otherwise deteriorating the environment.

Planning Criteria

Restrict construction traffic to predetermined routes according to types and numbers of vehicles anticipated. Markers or temporary fencing may be helpful.

Avoid damage to waterways by construction of suitable crossing facilities and avoid traffic in or along streams.

Predetermine steep banks and vegetative areas to be avoided by traffic.

Traffic during wet weather should be minimized.

Provisions should be made to prevent tracking or flowing of mud onto public right-of-way.

The following methods may be among those considered:

A. Exit ramp surfaced with materials such as large size gravel or stone, wood chips, timber, or other material.

B. Inspection and cleaning of vehicles before entering public right-of-way.

STANDARDS
FOR
DUST CONTROL

Definition

The control of dust on construction sites and roads.

Purpose

To prevent blowing and movement of dust from exposed soil surfaces, reduce on and off site damage, health hazards and improve traffic safety.

Where Applicable

This practice is applicable to areas subject to dust blowing and movement where on and off site damage is likely without treatment.

Planning Criteria

The following methods should be considered for controlling dust:

Mulches - See standards for stabilization with mulches only, (P. 3.31.)

Vegetative Cover - See standards for: temporary vegetative cover, permanent vegetative cover and permanent stabilization with sod, (P. 3.61.)

Spray-On Adhesives - On mineral soils (not effective on muck soils). Keep traffic off these areas.

	Water Dilution	Type of Nozzle	Apply Gallons/Acre
Anionic asphalt emulsion	7:1	Coarse Spray	1,200
Latex emulsion	12½:1	Fine Spray	235
Resin in water	4:1	Fine Spray	300

Tillage - To roughen surface and bring clods to the surface. This is a temporary emergency measure which should be used before soil blowing starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, and spring-toothed harrows are examples of equipment which may produce the desired effect.

Sprinkling - Site is sprinkled until the surface is wet.

Barriers - Solid board fences, snow fences, burlap fences, crate walls, bales of hay and similar material can be used to control air currents and soil blowing.

Calcium Chloride - Shall be in the form of loose dry granules or flakes fine enough to feed through commonly used spreaders at a rate that will keep surface moist but not cause pollution or plant damage. If used on steeper slopes, then use other practices to prevent washing into streams or accumulation around plants.

Stone - Cover surface with crushed stone or coarse gravel.

STANDARD
FOR
LINED WATERWAY

Definition

A watercourse with an erosion resistant lining of concrete, stone, or other permanent material. The lined section extends up the side slopes to design flow depth. The earth above the permanent lining shall be vegetated or otherwise protected.

Scope

This standard applies to waterways with linings of non-reinforced, cast in-place concrete; flagstone mortared in place; rock riprap or similar permanent linings. This standard does not apply to grassed waterways with stone centers. The maximum capacity of the lined waterway flowing at design flow depth shall not exceed 100 cfs.

Purpose

Waterways are lined to provide for safe disposal or runoff without damage by erosion or flooding, in situations where grassed waterways would be inadequate.

Conditions Where Practice Applies

This practice applies where the following conditions exist.

1. The water velocity is such that lining is required to control erosion in the waterway.

2. Wetness, prolonged base flow, or seepage, would prohibit establishment of erosion resistant vegetation.

3. The location is such that damage from use by people, vehicles or animals preclude use of vegetated waterways.

4. High value property or adjacent facilities warrant the extra cost to contain design runoff in a limited space.

5. Soils are highly erodible, highly acidic or other soil or climatic conditions preclude using vegetation.

Design Criteria

Capacity

The minimum capacity shall be adequate to carry the peak rate of runoff from a 10-year frequency storm. Capacity shall be computed using Manning's formula with a coefficient of roughness "n" as follows:

LINING	"n" VALUE
Concrete	
Trowel finish	0.012 - 0.014
Float finish	0.013 - 0.017
Gunite	0.016 - 0.022
Flagstone	0.020 - 0.025
Riprap	see the Standard for Riprap

Velocity

Maximum design velocity shall be as shown below. Except for short transition sections, slopes in the range of 0.7 to 1.3 of the critical slope must be avoided unless the channel is straight. Velocities exceeding critical will be restricted to straight reaches.

DESIGN FLOW DEPTH	MAXIMUM VELOCITY
0 - 0.5'	25 fps
0.5 - 1.0'	15 fps
> 1.0'	10 fps

Lined waterways with velocities exceeding critical shall discharge into an energy dissipator to reduce velocity to less than critical.

Cross-Section

The cross-section shall be triangular, parabolic, or trapezoidal. Monolithic concrete may be rectangular.

Freeboard

The minimum freeborad for lined waterways shall be 0.25 feet above design flow depth in areas where erosion resistant vegetation cannot be grown adjacent to the lined side slopes. No freeboard is required where good vegetation can be grown and is maintained.

Side Slope

Steepest permissible side slopes, horizontal to vertical will be as follows:

LINING	STEEPEST PERMISSIBLE SIDE SLOPE
Non-Reinforced Concrete -	
Hand-placed, formed concrete	
Height of lining 1.5 feet or less	vertical
Hand-placed, screeded concrete or mortared in-place flagstone -	
Height of lining less than 2 feet	1 to 1
Height of lining more than 2 feet	2 to 1
Reinforced slip form concrete -	
Height of lining less than 3 feet	1 to 1
Rock riprap	2 to 1

Lining Thickness

Minimum lining thickness shall be as follows:

Concrete - 4 inches
Rock riprap - maximum stone size plus thickness of filter or bedding
Flagstone - 4 inches including mortar bed

Related Structures

Side inlets, drop structures, and energy dissipators shall meet the hydraulic and structural requirements for the site.

Filters or bedding

For non-reinforced concrete flagstone linings, installation shall be made only on low shrink - swell soils that are well drained or where subgrade drainage facilities are installed.

Filters or bedding to prevent piping, prevent erosion, reduce uplift pressure, and collect water will be used and will be designed in accordance with "National Cooperative Highway Research Program Report 108 - Tentative Design Procedures for Riprap-Lined Channels," Soil Conservation Service procedures or other generally accepted methods. Weep holes and drains will be provided as needed.

Concrete or Mortar

Concrete or mortar shall meet N.J.D.O.T. standards, Ref. #10, Appendix A9.

Rock Riprap or Flagstone

Stone used for riprap or flagstone shall be dense and hard enough to withstand exposure to air, water, freezing and thawing. Flagstone shall be flat for ease of placement.

STANDARD
FOR
RIPRAP

Definition

A layer of loose rock, aggregate, bagged concrete, gabions or concrete revetment blocks placed over an erodible soil surface.

Purpose

The purpose of riprap is to protect the soil surface from the erosive forces of water.

Condition Where Practice Applies

This practice applies to soil-water interfaces where the soil conditions, water turbulence and velocity, expected vegetative cover and groundwater conditions are such that the soil may erode under the design flow conditions. Riprap may be used, as appropriate, at such places as channel banks and/or bottoms, road-side ditches, and drop structures.

Design Criteria

Design Storm

The riprap shall be designed to be stable when the channel is flowing at the design discharge or the 25-year frequency discharge, which ever is greater.

Riprap Size and Location

Riprap shall be sized using the design procedures in this Standard or the "National Cooperative Highway Research Program Report No. 108, Tentative Design Procedure for Riprap-Lined Channels." These procedures are for determining a design stone size, such that the stone is stable under the design flow conditions. The design stone size is the d_{50} stone diameter.

Erosive forces of flowing water is greater in bends than in straight channels. If the riprap size (d_{50}) computed for bends is less than 10 percent greater than the riprap size (d_{50}) for straight channels, then the riprap size for straight channels shall be considered adequate for bends. Otherwise the larger riprap size shall be used in the bend. The riprap size to be used in a bend shall extend upstream from the point of curvature and downstream from the point of tangency a distance equal to five times the channel bottom width and shall extend across the bottom and up both sides of the channel.

Riprap for banks shall extend up the banks to the level of the design storm or the top on bank whichever is lower.

In channels where no riprap or paving is required in the bottom, but is required on the banks, the toe of the bank riprap shall extend below the channel bottom a distance at least 8 times the maximum stone size but in no case more than three feet. The only exeption to this would be if there is a non-erodible hard rock bottom.

The channel bank shall not be steeper than 2 horizontal to 1 vertical (2:1).

Riprap Gradation

The riprap shall be composed of a well-graded mixture such that 50% of the mix-ture by weight shall be larger than the d_{50} size as determined from the design procedure. A well-graded mixture as used herein is defined as a mixture composed primarily of the larger stone sizes but with a sufficient mixture of other sizes to fill the progressively-smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the d_{50} size.

The designer after determing the riprap size that will be stable under the flow condition shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area select the size or sizes that equal or exceed the minimum size. The possibility of vandalism shall be considered by the designer in selecting a riprap size.

<u>Thickness of Riprap Lining</u>

Construction techniques, discharge, size of channel, sizes and graduation of riprap, etc., should be taken into consideration when determining the thickness of riprap lining. The thickness of riprap lining shall meet at least one of the following 2 criteria:

1. A thickness of at least three times the d_{50} size if a filter layer is not used.

2. A thickness of at least two times the d_{50} size if a filter layer is used.

The minimum thickness shall be 6 inches.

<u>Filter</u>

Leaching is the process by which the finer base materials beneath the riprap are picked up and carried away by the turbulence that penetrates the interstices of the riprap. Leaching is reduced to a negligible rate by using a properly designed filter under the riprap or by making the riprap layer thick enough and with fine enough interstices to keep erosion currents away from underlying soil.

A filter is required unless the riprap lining has a thickness of at least 3 times the d_{50} size of the riprap. On steep slopes, highly erodible soils, loose sand, or with high water velocities, a filter should be used or riprap thickness increased beyond the minimums.

A filter can be of two general forms. One is a synthetic filter fabric manufactured for that express purpose. Another is a properly graded layer of sand, gravel, or stone.

A sand, gravel or stone filter shall meet the following criteria:

$$\frac{d_{15}\ \text{Riprap}}{d_{85}\ \text{Filter}} < 5 < \frac{d_{15}\ \text{Riprap}}{d_{15}\ \text{Filter}} < 40$$

$$\frac{d_{50}\ \text{Riprap}}{d_{50}\ \text{Filter}} < 40$$

Where d_{15}, d_{50}, and d_{85} are the diameters of riprap and filter material of which 15, 50, and 85 percent are finer by weight. The base material may be used as the filter if it meets the above criteria. The minimum sand gravel or stone filter thickness shall be 6 inches or 3 times the d_{50} size of the filter whichever is greater.

Synthetic filter fabric shall meet the following criteria:

For filter fabric adjacent to granular materials containing 50 percent or less by weight of fines (Minus No. 200 material):

(1) $\frac{\text{85 percent size of material (mm)}}{\text{EOS* (mm)}} \geq 1$

(2) Open area not to exceed 36 percent.

For filter fabric adjacent to all other soils:

(1) EOS* no larger than the opening in the U.S. Standard Sieve No. 70.

(2) Open area not to exceed 10 percent.

NOTE: No cloth specified should have an open area less than 4 percent or an EOS* with openings smaller than the opening in a U.S. Standard Sieve Size No. 100. When possible, it is preferable to specify a cloth with openings as large as allowable by the criteria. It may not be possible to obtain a suitable cloth with the maximum allowable openings which also meets the strength requirements however, due to the limited number of cloths available.

*EOS, Equivalent Opening Size, is defined as the number of the U.S. Standard sieve having openings closest in size to the filter fabric openings.

Synthic filter fabric shall meet the U.S. Army Corps of Engineers Guide Specs., CW02215, November 1977 for strength. Riprap that is 12" and larger shall not be dumped directly onto synthetic filter cloth unless the manufacturer recommends such use for the cloth. Otherwise, a 4-inch minimum thickness blanket of gravel shall be placed over the filter cloth or the riprap shall be placed directly on the filter cloth by hand or by the bucket of the equipment.

<u>Quality</u>

Stone for riprap shall consist of field stone or quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering. The specific gravity of the individual stones shall be at least 2.5.

Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirements of this Standard.

<u>Bagged Concrete</u>

Bagged concrete is made up of bags filled with concrete and placed next to each other. The consistency of the concrete shall be as stiff as satisfactory discharge from the mixer and the process of bagging will permit. The bags shall be filled three-quarters full with concrete and shall be laid in close contact, with staggered joints and tied ends turned in.

Bagged concrete may be used when all the following conditions are met:

1. The design storm, riprap size and location, and filter criteria for riprap are met.

2. The weight of the filled bags is at least equal to the weight of the maximum stone size required for rock riprap.

3. Settlement or lateral movement of foundation soils is not anticipated.

4. Ice conditions are not severe.

5. A filter is used.

6. Slopes somewhat steeper than 2 to 1 may be permitted under special circumstances.

Gabions

Gabions are baskets formed of wire mesh and filled with cobbles or coarse gravel. A thinner version of gabions is known as a Reno mattress.

Gabions may be used when all the following conditions are met:

1. The design storm, riprap size and location, filter and quality criteria for riprap are met.

2. Slopes somewhat steeper than 2 to 1 may be permitted under special circumstances.

3. The design water velocity does not exceed that given below:

GABION THICKNESS (ft.)	MAXIMUM VELOCITY (ft./sec)
1/2	6
3/4	11
1	14

4. The Manning's "n" value used for gabions shall be 0.025.

5. The gabions are not exposed to abrasion from sand or gravel transported by moving water.

6. The pH of the soil and water is above 5 and the soil and water resistivity is more than 4,000 ohms/cm or plastic coated gabions shall be used.

7. A filter is required unless the gabion has a thickness of at least 3 times the d_{50} size of the rock used to fill the gabions.

8. The rock used to fill the gabions shall be larger than the gabion mesh opening.

Concrete Revetment Blocks

Concrete Revetment Blocks are precast concrete grids designed for soil stabilization.

Concrete Revetment Blocks may be used when all the following conditions are met:

1. The design storm, riprap size and location, and filter criterial for riprap are met.

2. The water velocity does not exceed 9 feet per second.

3. The Manning's "n" value used for concrete revetment blocks shall be 0.026.

4. A filter is used.

This design of riprap-lined channels is from the "National Cooperative Highway Research Program Report No. 108, Tentative Design Procedure for Riprap-Lined Channels." It is based on the tractive stress method and covers the design of riprap in two basic channel shapes, trapezoidal and triangular.

NOTE: This procedure is for uniform flow at normal depth in channels and is not to be used for design of riprap energy dissipation devices immediately downstream from such high velocity devices as pipes and culverts. See the Standard for Conduit Outlet Protection, pg. 4.14.1.

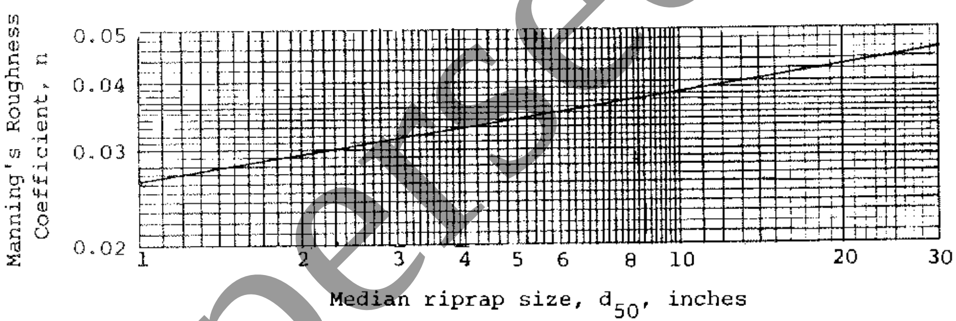
The method in Report No. 108 (design procedure beginning on p. 18) gives a simple and direct solution to the design of trapezoidal channels including channel carrying capacity, channel geometry and the riprap lining.

This procedure is based on the assumption that the channel is already designed and the remaining problem is to determine the riprap size that would be stable in the channel. The designer would first determine the channel dimensions by the use of Manning's equation. The "n" value for use in Mannning's equation is obtained by estimating a riprap size and then determing the corresponding "n" value for the riprapped channel from $n = 0.0395\ d_{50}^{1/6}$ where d_{50} is in feet or by using Curve 4.12-1 below where d_{50} is in inches.

CURVE 4.12-1

MANNING'S "n" FOR RIPRAP-LINED CHANNELS

$n = 0.0395(d_{50})^{1/6}$



When the channel dimensions are known the riprap can be designed (or an already completed design may be checked) as follows:

Trapezoidal Channels

1. Calculate the b/d ratio and enter Curve 4.12-2 to find the P/R ratio.

2. Enter Curve 4.12-3 with S_b, Q, and P/R to find median riprap diameter, d_{50}, for straight channels.

3. Enter Curve 4.12-1 to find the actual "n" value corresponding to the d_{50} from step 2. If the estimated and actual "n" values do not reasonably agree, another trial must be made.

4. For channels with bends, calculate the ratio B_s/R_o, where B_s is the channel surface width and R_o is the radius of the bend. Enter Curve 4.12-4 and find the bend factor, F_B. Multiply the d_{50} for straight channels by the bend factor to determine riprap size to be used in bends. If the d_{50} for the bend is less than 1.1 times the d_{50} for the straight channel.

then the size for straight channel may be used in the bend otherwise the larger stone size calculated for the bend shall be used. The riprap shall extend across the full channel section and shall extend upstream and downstream from the ends of the curve a distance equal to five times the bottom width.

5. Enter Curve 4.12-5 to determine maximum stable side slope of riprap surface. In Curve 4.12-5 the side slope is established so that the riprap on the side slope is as stable as that on the bottom. If for any reason it is desirable to make the side slopes steeper that what is given by Curve 4.12-5, the size of the riprap can be increased and the side slopes made steeper by using the procedures in Report No. 108.

Triangular Channels

1. Enter Curve 4.12-3A with S_b, Q and Z and fine the median riprap diameter, d_{50} , for straight chennels.
2. Enter Curve 4.12-1 to find the actual "n" value. If the estimated and actual "n" values are not in reasonable agreement another trial must be made.
3. For channels with bends, see step 4 under Trapezoidal channels.

Example:

Given:

Trapezoidal channel

Q = 100 cfs.
S = 0.01 ft/ft.
Side slopes = 2.5:1.
Mean bend radius, R_o = 25'.
n = 0.033 (estimated and used to design the channel to find that b = 6' and d = 1.8').
Type of rock available is crushed stone.

Solution:

Straight channel reach

b/d = 6/1.8 = 3.33.
from Curve 4.12-2, P/R = 13.0.
from Curve 4.12-3, d_{50} = 3.4".
from Curve 4.12-1, n (actual) = 0.032, which is reasonably close to the estimated n of 0.033.
Use 5" as maximum riprap size and 8" as riprap layer thickness with a filter.

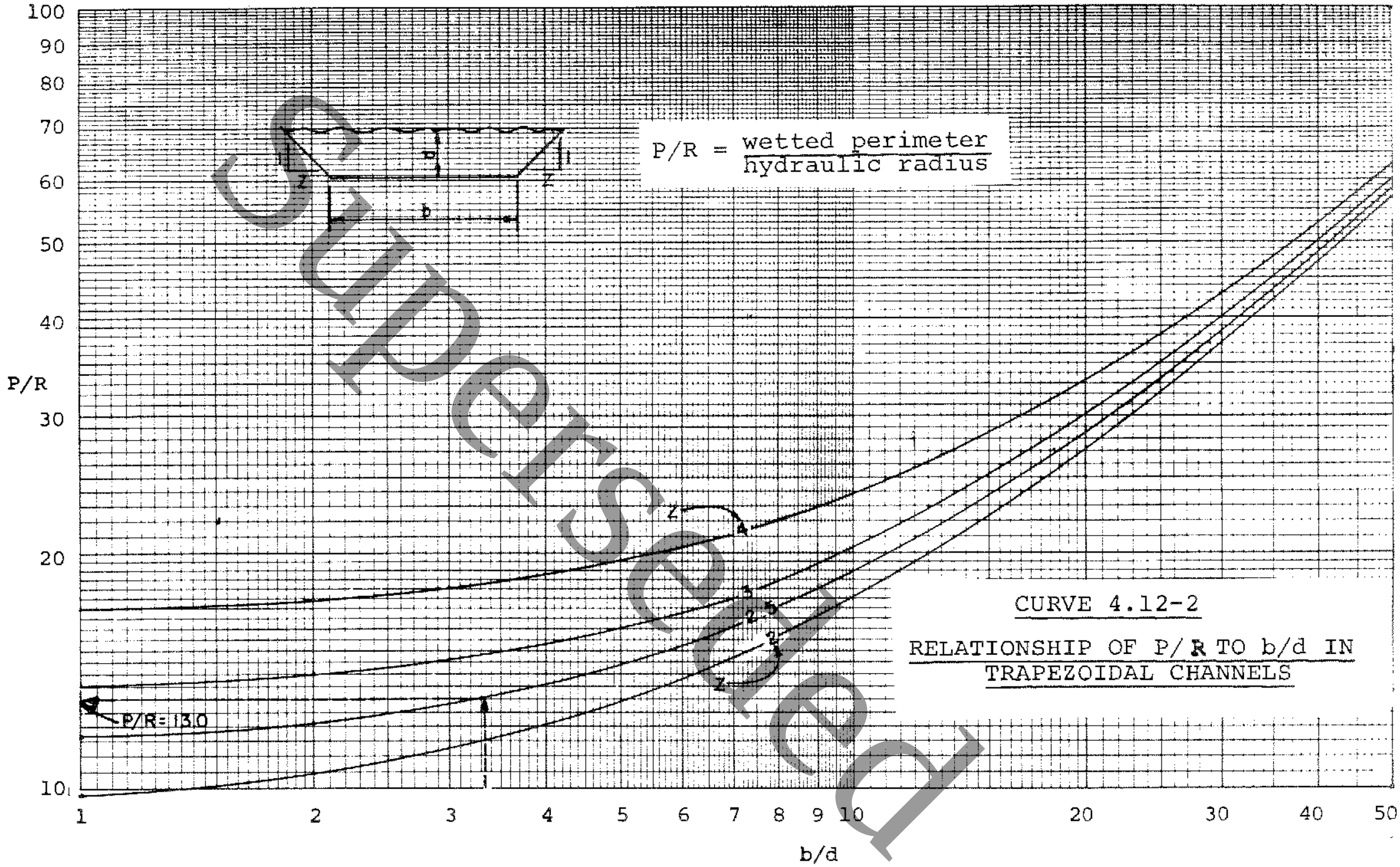
Channel bend

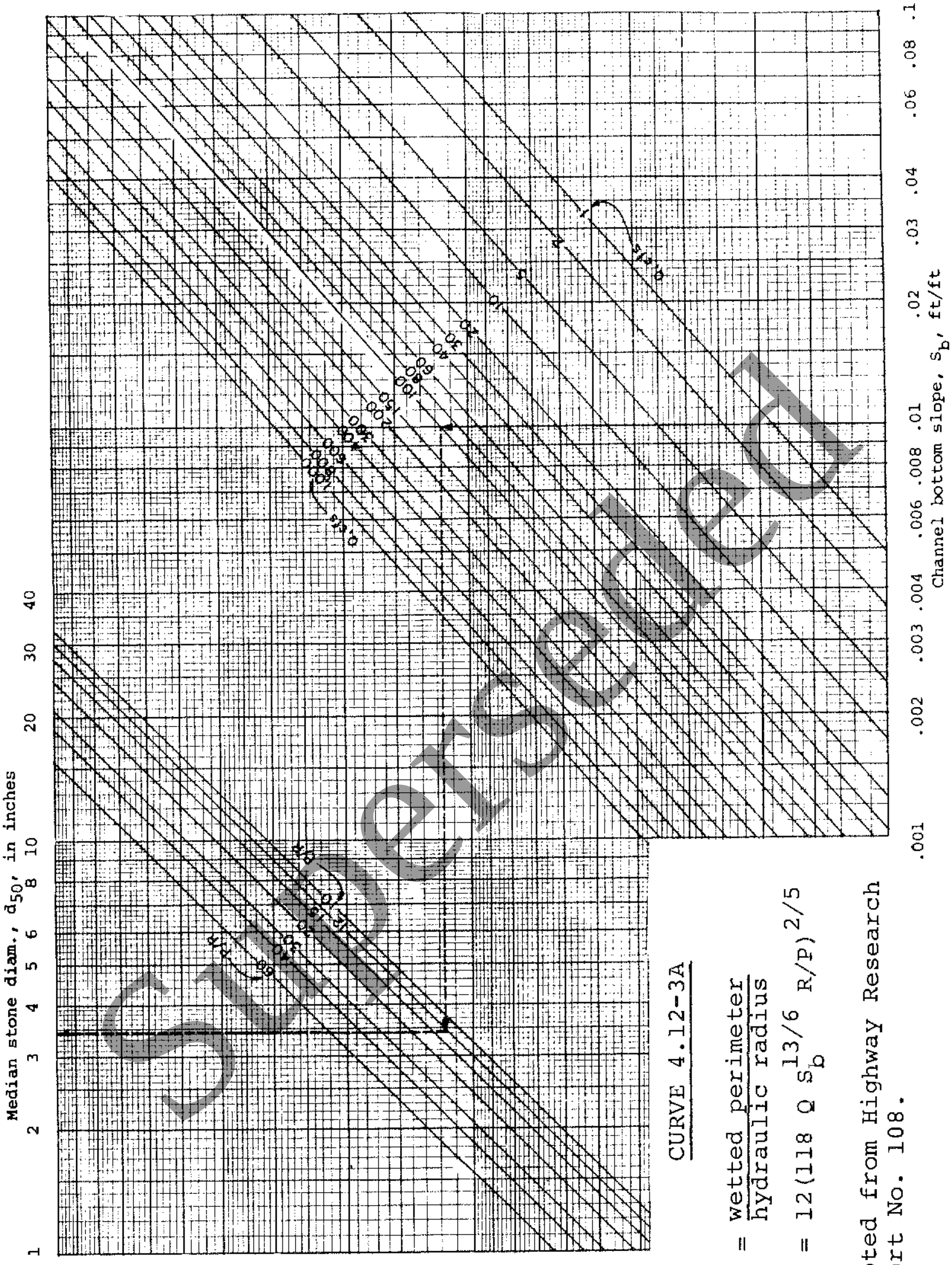
$B_s = b + 2zd = 6 + (2)(2.5)(1.8) = 15'$.
B_s/R_o = 15/25 - 0.60.
from Curve 4.12-4, F_B - 1.33.
F_B = 1.33 > 1.1, therefore the bend factor must be used.
Riprap size in bend, d_{50} = 3.4 x 1.33 - 4.52".

The heavier riprap for the bend shall extend upstream and downstream from the ends of the bend a distance of (5)(6) = 30 feet.

From Curve 4.12-5, it can be found that the riprap for d_{50} = 3.4" and 4.52" will both be stable on a 2.5:1 side slope.

P/R FOR TRAPEZOIDAL CHANNELS





CURVE 4.12-3A

$$P/R = \frac{\text{wetted perimeter}}{\text{hydraulic radius}}$$

$$d_{50} = 12(118\ Q\ S_b^{13/6}\ R/P)^{2/5}$$

Adapted from Highway Research Report No. 108.

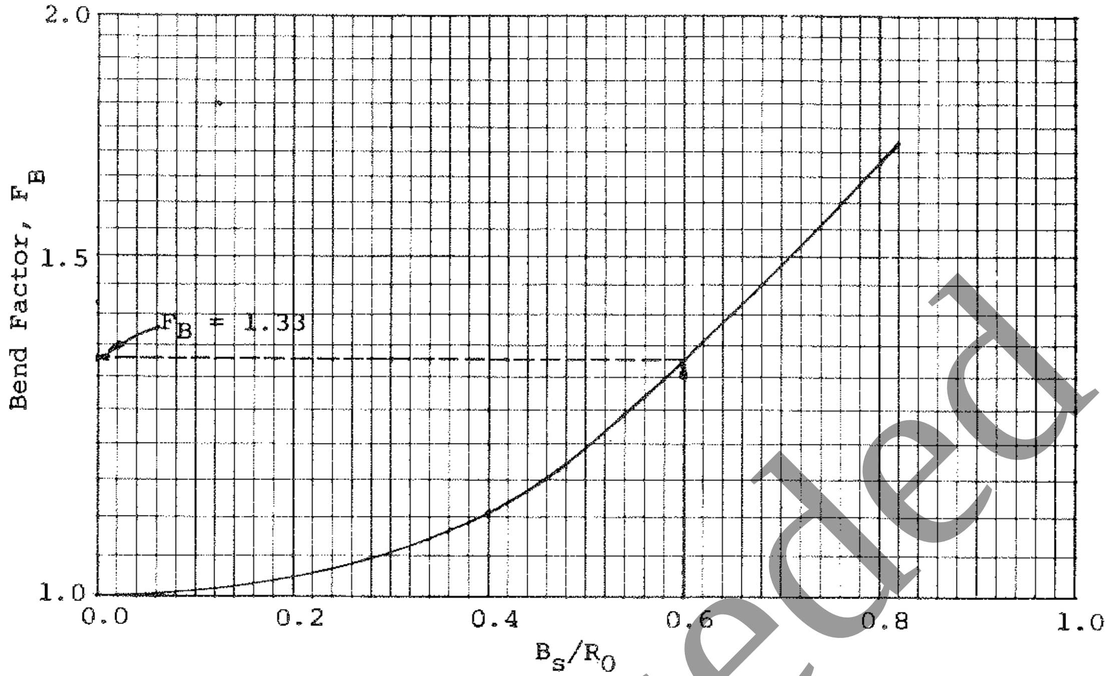
MEDIAN RIPRAP DIAMETER FOR STRAIGHT TRIANGULAR CHANNELS

CURVE 4.12-4

RIPRAP SIZE CORRECTION FACTOR FOR FLOW IN CHANNEL BENDS

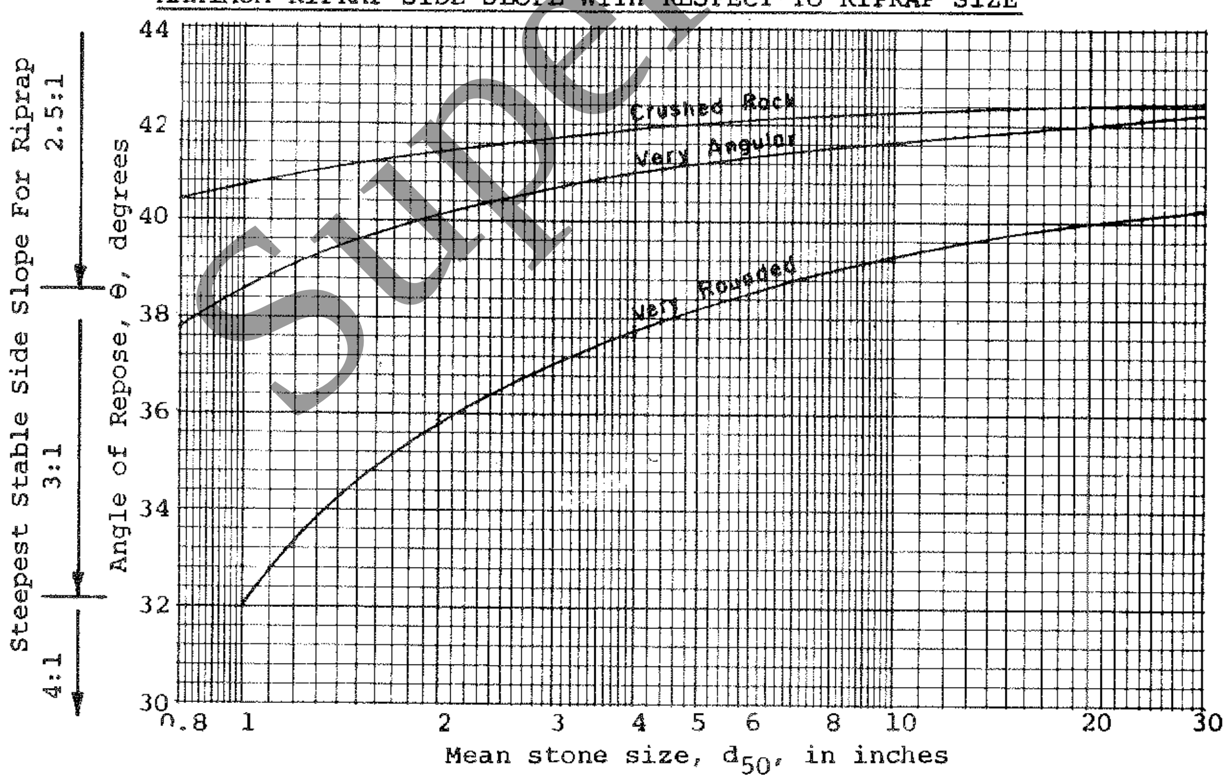
d_{50}(for bend) = d_{50}(for straight) X F_B
B_s = channel surface width
R_o = mean radius of bend

Adapted from Highway Research Report No. 108.



CURVE 4.12-5

MAXIMUM RIPRAP SIDE SLOPE WITH RESPECT TO RIPRAP SIZE



STANDARD
FOR
SEDIMENT BARRIER

Definition

A temporary barrier installed across or at the toe of a slope.

Purpose

The purpose of a sediment barrier is to intercept and detain small amounts of sediment from unprotected areas of limited extent.

Conditions Where Practice Applies

The sediment barrier is used where:

1. No other practice is feasible,
2. There is no concentration of water in a channel or other drainageway above the barrier, and
3. Erosion would occur in the form of sheet and rill erosion.

Design Criteria

A. All types of sediment barriers

1. Contributing drainage area is less than 1 acre and the length of slope above the barrier is less than 150 feet.

2. The slope of the contributing draining area for at least 30 feet adjacent to the barrier shall not exceed 5%.

3. The barrier shall be constructed so water cannot bypass the barrier around the ends.

4. Inspection shall be frequent and repair or replacement shall be made promptly as needed.

5. The barrier shall be removed when it has served its usefullness so as not to block or impede storm flow or drainage.

B. Requirements for bale barrier (i.e., straw, hay or other acceptable vegetative material)

1. All bales shall be securely tied and placed on the contour. See Figure 4.13-1 for details.

2. Bales shall be placed in a row with ends tightly abutting the adjacent bales.

3. Each bale shall be embedded in the soil a minimum of 4 inches.

4. Bales shall be securely anchored in place by two stakes or re-bars driven through each bale. The first stake in each bale shall be driven toward previously laid bale to force bales together.

C. Requirements for silt fence

1. Fence posts shall be spaced 8 feet center to center or closer. They shall extend at least 2 feet into the ground. They shall extend at least 2 feet above ground.

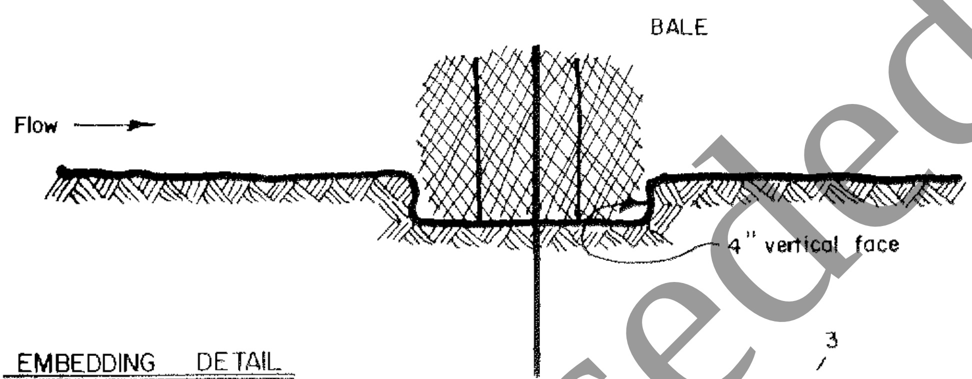
2. A metal fence with 6 inch or smaller openings and at least 2 feet high shall be fastended to the fence posts.

3. A filter fabric, recommended for such use by the manufacturer, shall be fastened to the metal fence. The filter fabric and fence shall be buried at least 4 inches deep in the ground. The filter fabric shall extend at least 2 feet above the ground.

D. Requirements for stone barrier

1. The stone shall be piled to a natural angle of repose with a height of at least 2 feet.

2. The stone shall meet ASTM C-33 size No. 2 or 3.



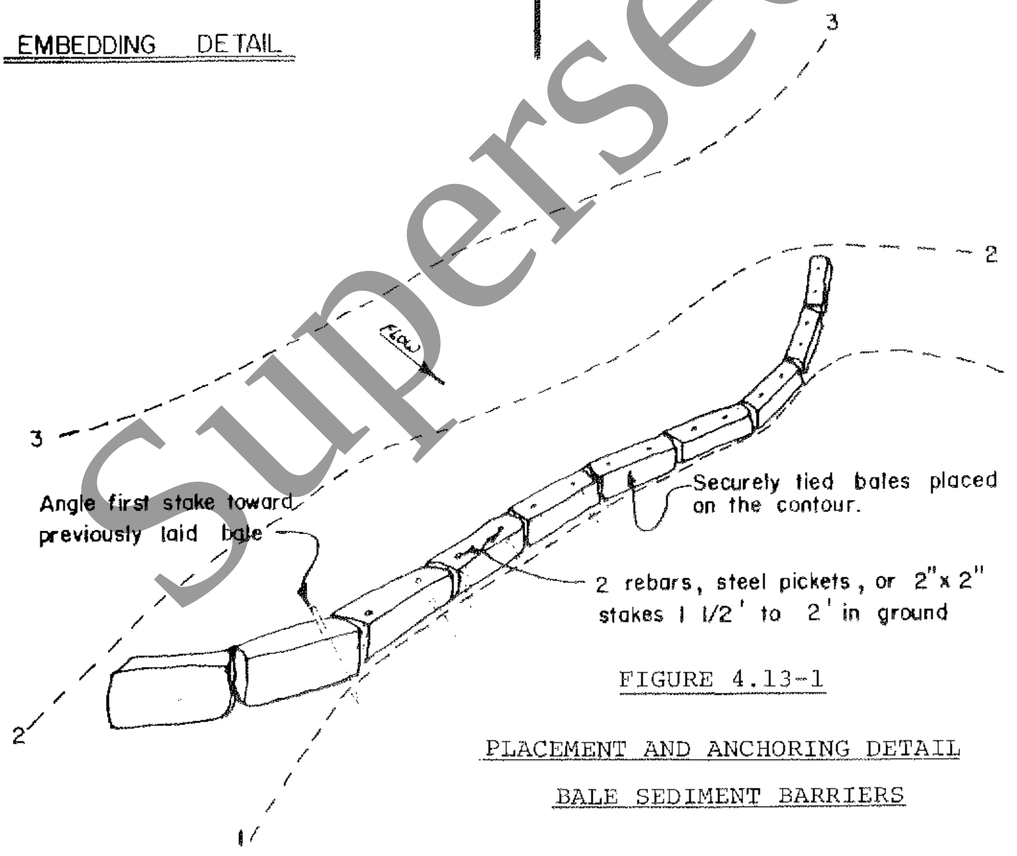


FIGURE 4.13-1

PLACEMENT AND ANCHORING DETAIL

BALE SEDIMENT BARRIERS

STANDARD
FOR
CONDUIT OUTLET PROTECTION

Definition

Conduit Outlet Protection consists of an erosion resistant section between a conduit outlet and a stable downstream channel.

Purpose

To provide a stable area at the outlet of a conduit in which the exit velocity from the conduit is reduced to a velocity consistent with a stable condition in the downstream channel.

Conditions Where Practice Applies

This practice applies to all conduit outlets.

Design Criteria

Determination of Needs

The need for conduit outlet protection shall be determined by comparing the allowable velocity for the soil onto which the conduit is discharging to the velocity in the conduit. The allowable velocity for the soil shall be that given in Table 4.14-1. The velocity in the conduit shall be that which occurs during passage of the conduit design storm or the 25-year frequency storm whichever is greater. When the velocity in the conduit exceeds the allowable velocity for the soil, conduit outlet production will be used.

TABLE 4.14-1 ALLOWABLE VELOCITIES FOR VARIOUS SOILS

SOIL TEXTURE	ALLOWABLE VELOCITY (ft./sec)
Sand and sandy loam (noncollodial)	2.5
Silt loam (also high lime clay)	3.0
Sandy clay loam	3.5
Clay loam	4.0
Clay, fine gravel, graded loam to gravel	5.0
Cobbles	5.5
Shale	6.0

Apron Dimensions

1. The length of the apron, L_a, shall be determined from the formula,

$$L_a = \frac{1.7\ Q}{D_o^{3/2}} + 8\ D_o$$

   where D_o is the maximum inside culvert width in feet, Q is the pipe discharge in cfs for the conduit design storm or the 25 year storm whichever is greater.

2. Where there is no well defined channel immediately downstream of apron, the width, W, of the outlet end of the apron shall be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe, $W = 3 D_o + 0.4 L_a$

For tailwater elevation less than the elevation of the center of the pipe, $W = 3 D_o + L_a$

Where L_a is the length of apron determined from the formula and D_o is the culvert width.

The width of the apron at the culvert outlet shall be at least 3 times the culvert width.

3. Where there is a well defined channel downstream of the apron, the bottom width of the apron shall be at least equal to the bottom width of the channel; and the structural lining shall extend at least one foot above the tailwater elevation but no lower than two-thirds of the vertical conduit dimension above the conduit invert.

4. The side slopes shall be 2:1 or flatter.

5. The bottom grade shall be 0.0% (level).

6. There shall be no overfall at the end of the apron or at the end of the culvert.

Riprap

1. The median stone diameter, d_{50}, in feet shall be determined from the formula,

$$d_{50} = \frac{0.02}{TW} \left(\frac{Q}{D_o^{5/2}} \right)^{4/3}$$

Where Q and D_o are as defined under apron dimensions and TW is tailwater depth above the invert of culvert in ft.

2. Fifty percent by weight, of the riprap mixture shall be smaller than the median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size. The riprap shall be reasonably well graded.

3. The thickness of riprap lining, filter and quality shall meet the requirements in the riprap standard.

4. Concrete paving may be substituted for riprap.

5. Gabions or concrete revetment blocks may be substituted for riprap if the d_{50} size calculated above is less than or equal to the thickness of the gabions or concrete revetment blocks.

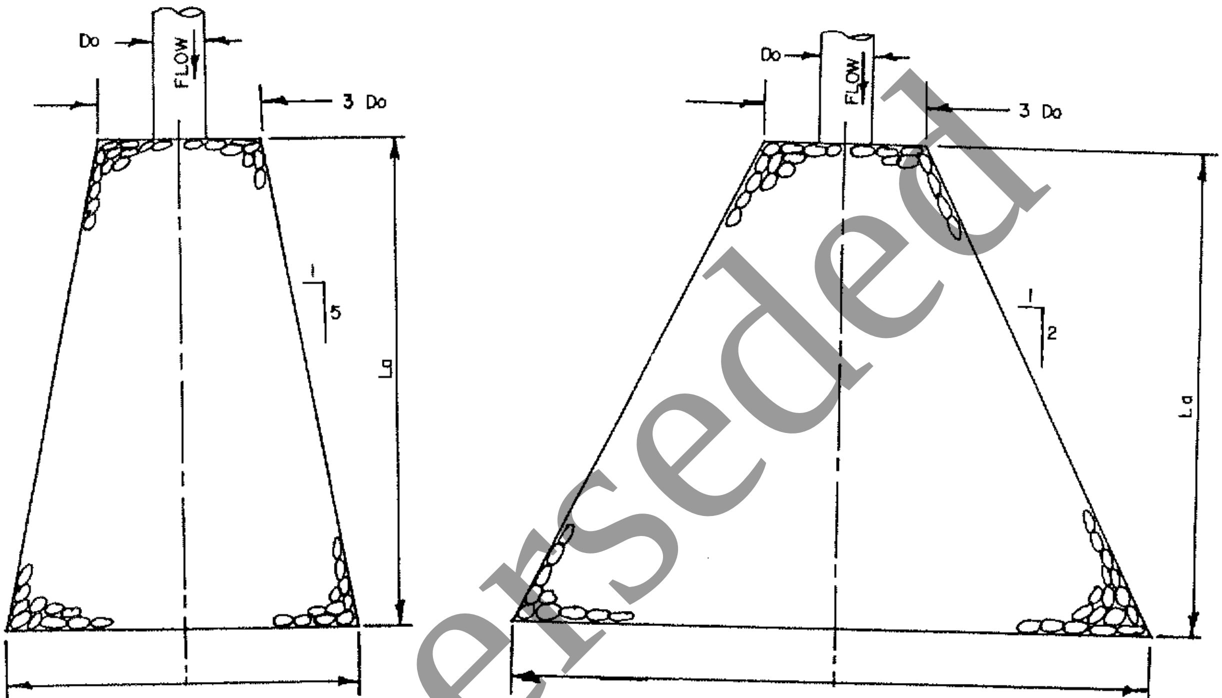
Installation Requirements

1. No bends or curves at the intersection of the conduit and apron will be permitted.

2. There shall be no overfall from the end of the apron to the receiving channel.

References

Fletcher, B.P. and Grace, J. S. Jr., PRACTICAL GUIDANCE FOR ESTIMATING AND CONTROLLING EROSION AT CULVERT OUTLETS, 1972, Corps of Engineers Research Report H-72-5, Waterways Experiment Station, Vicksburg, Mississippi.



$W = 3D_o + 0.4L_a$

(Tailwater $\geq$ 0.5 D_o)

$W = 3D_o + L_a$

(Tailwater $<$ 0.5 D_o)

CONFIGURATION OF CONDUIT OUTLET PROTECTION

(where there is no well defined channel immediately downstream)

STANDARD
FOR
STABILIZED CONSTRUCTION ENTRANCE

Definition

A stabilized pad of crushed stone located at points where traffic will be entering or leaving a construction site.

Purpose

The purpose of a stabilized construction entrance is to reduce the tracking or flowing of sediment onto public rights-of-way.

Conditions Where Practice Applies

A stabilized construction entrance applies to points of construction ingress and egress where sediment may be tracked or flow off the construction site.

Design Criteria

Stone Size - Use ASTM C-33, size No. 2 or 3. Use crushed stone.

Thickness - not less than four (4) inches.

Width - not less than full width of points of ingress or egress.

Length - 50 feet minimum where the soils are sands or gravels or 100 feet minimum where soils are clays or silts, except where the traveled length is less than 50 or 100 feet respectively.

At poorly drained locations subsurface drainage should be installed before installing the stabilized construction entrance.

Maintenance

The entrance shall be maintained in a condtion which will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone or additional length as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, dropped, washed or tracked onto public rights-of-way must be removed immediately.

STANDARD
FOR
STORM SEWER INLET PROTECTION

Definition

A temporary barrier and settling facility installed at a storm sewer inlet.

Purpose

The purpose of storm sewer inlet protection is to intercept and retain sediment thus preventing the entrance of sediment into the storm sewer system.

Conditions Where Practice Applies

1. Contributing drainage area is 3 acres or less.

2. A storm sewer or the outlet channel of a storm sewer needs protection from sediment.

3. Traffic will not destroy or cause constant maintenance of the storm sewer inlet protection.

4. A traffic hazard will not be created.

Design Criteria

A. General - All types of storm sewer inlet protection.

   1. must slow the storm water, provide the coarse sediment particles a chance to settle and provide an area to retain the particles that have settled <u>or</u>;

   2. prevent the storm water from entering the catch basin inlet.

   The following sections provide three methods. Other methods that accomplish the purpose of storm sewer inlet protection may be used if approved by the Soil Conservation District.

   Inspections shall be frequent. Maintenance, repair and replacement shall be made promptly as needed.

   The barrier shall be removed when the area draining toward the inlet has been stabilized.

B. Blocked Inlet - Catch basin inlets may be blocked, until the area draining toward the catch basin is permanently protected from erosion, when:

   1. the material used to block the inlet is prevented from floating or being carried into the inlet and;

   2. an erosion or a flooding problem is not caused by blocking the inlet.

C. Protected Inlet

   1. The perimeter length of the barrier shall be at least four times the perimeter length of the storm sewer inlet. The top of the barrier shall be level and uniform for at least this length.

   2. The barrier shall encircle the inlet.

3. If bales (straw, hay or other acceptable vegetative materials) are used for the barrier, they shall be staked down in accordance with the sediment barrier standard. Where staking is not practical, they shall be tied together to prevent movement or openings in the barrier.

4. If gravel is used for the barrier, it shall be piled at least 1 1/2 ft. high to its natural angle of repose. The gravel shall meet size no. 2 or 3 in ASTM C-33.

D. Inlet with Sediment Trap

1. A screen is placed completely over the inlet.

2. A sturdy protective frame is placed around the inlet and filled with ASTM C-33 size no 2 or 3 stone.

3. A sediment trap is excavated behind the curb at the inlet. The basin shall be at least 12 to 24 inches in depth, approximately 36 inches in width, and approximately seven to ten feet in length parallel to the curb.

4. Storm water will reach the sediment trap via curb cuts adjacent to each side of the inlet structure. These openings shall be at least 12 inches in length. Storm water may also reach the basin via overland flow from land area behind the curb. The curb cuts shall be repaired when the sediment trap is removed.

APPENDIX A1

THE UNIVERSAL SOIL LOSS EQUATION

The Universal Soil Loss Equation may be used to predict soil loss from sheet erosion.

The rate of sheet erosion depends on several factors as follows: (1) rainfall energy and intensity, (2) soil erodibility, (3) land slope and length of slope or topography, (4) condition of the soil surface and land management practices in use and (5) surfact cover involved such as grass, woodland, crops, pavement or no cover at all. These factors may be assigned quantitative values to be used for computing soil loss by the Universal Soil Loss Equation, E = RK (LS) CP, where E is the estimated average soil loss from sheet erosion in tons per acre per year. See Ref. (3).

R, the rainfall factor, is the number of erosion index units in a normal year's rain. The erosion index is a measure of the erosive force of specific rainfall. See figure A1-I for values of R.

K, the soil-erodibility factor, is the erosion rate per unit of erosion index for a specific soil in cultivated continuous fallow on a 9 percent slope 72.6 feet long. See Table A1-2a, A1-2b or A1-2c for values of K and (KR), the product of K and R, for New Jersey soils.

L, the slope length factor, is the ratio of soil loss from the field slope length to that from a 72.6-foot length on the same soil type and gradient.

S, the slope gradient factor is the ratio of soil loss from the field gradient to that from a 9 percent slope. See Table A1-3 for values of (LS)for various slope gradient and length combinations.

C, the cropping management factor, is the ratio of soil loss from a field with specified cropping management to that from the fallow condition on which the factor K is evaluated. This factor is also called the cover index and can be used to represent the effect of land cover or treatment that may be used to protect construction sites. See Table A1-4 for values of the soil cover index Cc for treatment that may be used to protect construction sites.

P, the erosion control practice factor, is the ratio of soil loss with contour stripcropping or terracing to that with straight row farming up and down the slopes. The condition of the soil surface, particularly at construction sites, can also be reflected in the practice factor. See Table A1-5 for soil surface condition factors Pc for construction sites.

The value of E may also be modified by a factor M shown in Table A1-6. M may be used to estimate the soil loss for a portion of a year or for a year and a portion of another year or more. The use of this factor provides a means of estimating the average soil loss on a critical sediment source area that will remain as such for a portion of a year or during the performance time of a construction contract.

The factor R is equal to the average annual value of the erosion index El when the equation is being used to estimate average annual soil loss. This value or the equation may be modified to reflect soil loss probability and individual-storm losses. Estimates of average soil loss, based on probability and single storm losses, can be made by multiplying the equation by the factors shown in Table A1-8. These factors reflect an alteration in the value of R and, therefore, the erosive effect of rainfall. They do not account for such things as snow melt, freezing, thawing and snow cover.

Detailed definitions and explanations for each of these factors are contained in Reference (3).

The soil information contained in Tables A1-2a, A1-2b and A1-2c are of a general nature, useful for planning purposes. It should not be used, without verification, for evaluation of construction sites for erosion control. Where erosion may be expected during construction involving earth moving, on site investigations should include information on soils to be exposed as follows: (1) field identification and classification for both agricultural textures and the unified system, (2) sampling for grain size distribution, Atterburg limits and laboratory classification, and (3) in-place density as determined by a volumeter and the speedy moisture tester or other means.

The soil grain size is useful in determining the value of practices for the control of erosion and particularly sediment. For example, sediment basins will not be very effective for trapping very fine sediment. Soils made up of a high percentage of material with a grain size of 0.05 mm or less have a slow settling velocity in water. Material with a 0.05 mm grain size has a settling velocity close to 0.006 feet per second. This means that, theoretically a detention time of about 15 minutes is required to settle out 0.05 mm material in 5 feet of still water.

Soil loss computed by the universal soil loss equation represents gross sheet erosion. This value plus erosion from rilling, gullies and other sources is the gross erosion. To obtain sediment yield at a point downstream, the gross erosion must be adjusted downward by a delivery rate factor in percent equal to the ratio of sediment yield at the damage area to gross erosion. Delivery rates vary somewhere between 10 percent and 90 percent depending on conditions that end to trap sediment between the source and the damage area.

Water pollution in the form of turbidity or discoloration may be as damaging to water supplies or swimming areas as the accumulation of sediment. Turbid water may be the result of algae or other organisms but generally it is caused by fine silt or clay particles held in suspension. The very fine, divided clay particles found in some soils are difficult to control and may take months to settle out in still water.

Downstream damage from sediment depends on the following conditions:

1. Distance from the construction site to the nearest stream, pond or reservoir along with the condition of the vegetation and the slope of the area between the site and the stream of the reservoir. Areas with flat slopes and dense vegetation will tend to filter out sediment.

2. Once the sediment gets into a stream, the distance downstream to the damage point, such as a pond or water supply intake, is important. Also to be considered is the stream channel gradient and the flood plain width. Wide flat flood plains with dense vegetation will trap more sediment than steep narrow valleys.

3. The use of the stream or reservoir must be considered. It is very important to keep sediment out of streams used for fishing, recreation or water supply.

4. Another factor that should be considered is the size of the construction area and the length of time it will be bare of vegetative cover and subject to erosion. The total sediment expected should be compared with the capacity of the damage area to sustain sediment. If the total sediment to be expected from the site during the entire construction period is greater than can be tolerated in the damage area, considerable effort should be made to reduce it. If this cannot be done, arrangements to alleviate the damage should be made. These arrangements may include cleanout of ponds and reservoirs or restoration of stream channels.

A look at the Soil Loss Equation will show the factors over which man can exercise some control. These are lengths of slope, exposure time, and the total area exposed. Slope length is contained in the equation as part of the (LS) factor and its effect on soil loss can be evaluated. The length of time and time of year of exposure can also be evaluated on a monthly basis using factors in Table A1-6. Total soil loss from different size areas can also be estimated.

The following example illustrates the use of the soil loss equation.

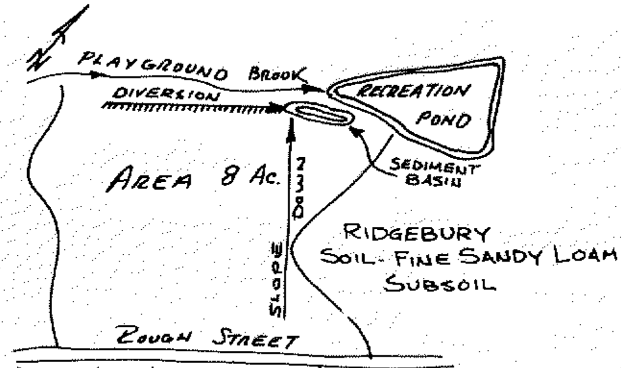
The township engineer has requested an erosion and sediment evaluation of a small construction site just above a recreation pond. The district conservationist made a visit to the site to evaluate the potential damage, verify the information on the soils map, and check topographic data. The construction plans show that 8 acres are to be regraded for the construction of a factory and parking area. The drawings and construction performance time estimates indicate that the B soil horizon is to be exposed on most of the area for about 18 months. The ground surface slope will be about 4 percent. Soil loss computations, findings and recommendations are as shown in the example on page A1.4

EXAMPLE OF SOIL LOSS EVALUATION

Owner *GREENBELT TOWNSHIP* Work Unit *GARDENTOWN* Sh *1* of *1*
Location *GREENBELT TOWNSHIP* Compiled by *E. Z. SILTY* Date *0/0/72*

SOIL LOSS AND SEDIMENT SOURCE EVALUATION

Dowstream Condition *DAMAGE AREA IS VERY CLOSE TO THE CONSTRUCTION SITE, DELIVERY RATE = 0.9* *R = 175* *LRA = 144*



Area sketch not to scale

KR AND LS

S. Area No.	Wt'd KR	L (Ft.)	S (%)
-	53	600	4

Expected Surface Conditions: *ROUGH GRADING*

Time of Exposure: *18 MONTHS START APRIL, END SEPT. OF NEXT YEAR* *M = 1.80*

1 Sub-Area	2 Condition Or Treatment	3 KR	4 LS	5 C_r	6 P_c	7 M	8 E_t* Tons/Ac.	9 Area (acs.)	10 E_T (tons)	11** Yd(lbs/cu.ft)	12 Vol. (Ac. Ft.)
	No Cover, Rough Grading	*53*	*1*	—	—	*1*	*53*	*8*	*424*	*100*	*0.2*
	Loss For 18 Months	*53*	*1*	—	—	*1.80*	*95*	*8*	*760*	*100*	*0.35*
	Saturated Sed. Vol.	→	→	→	→	→	→	→	*760*	*60*	*0.59*
	Reduce L To 100'	*53*	*0.41*	—	—	*1*	*21.7*				
	18 Months	*53*	*0.41*	—	—	*1.80*	*39*	*8*	*312*	*100*	*0.14*
	Saturated Sed. Vol.	→	→	→	→	→	→	→	*312*	*60*	*0.24*
								Totals			

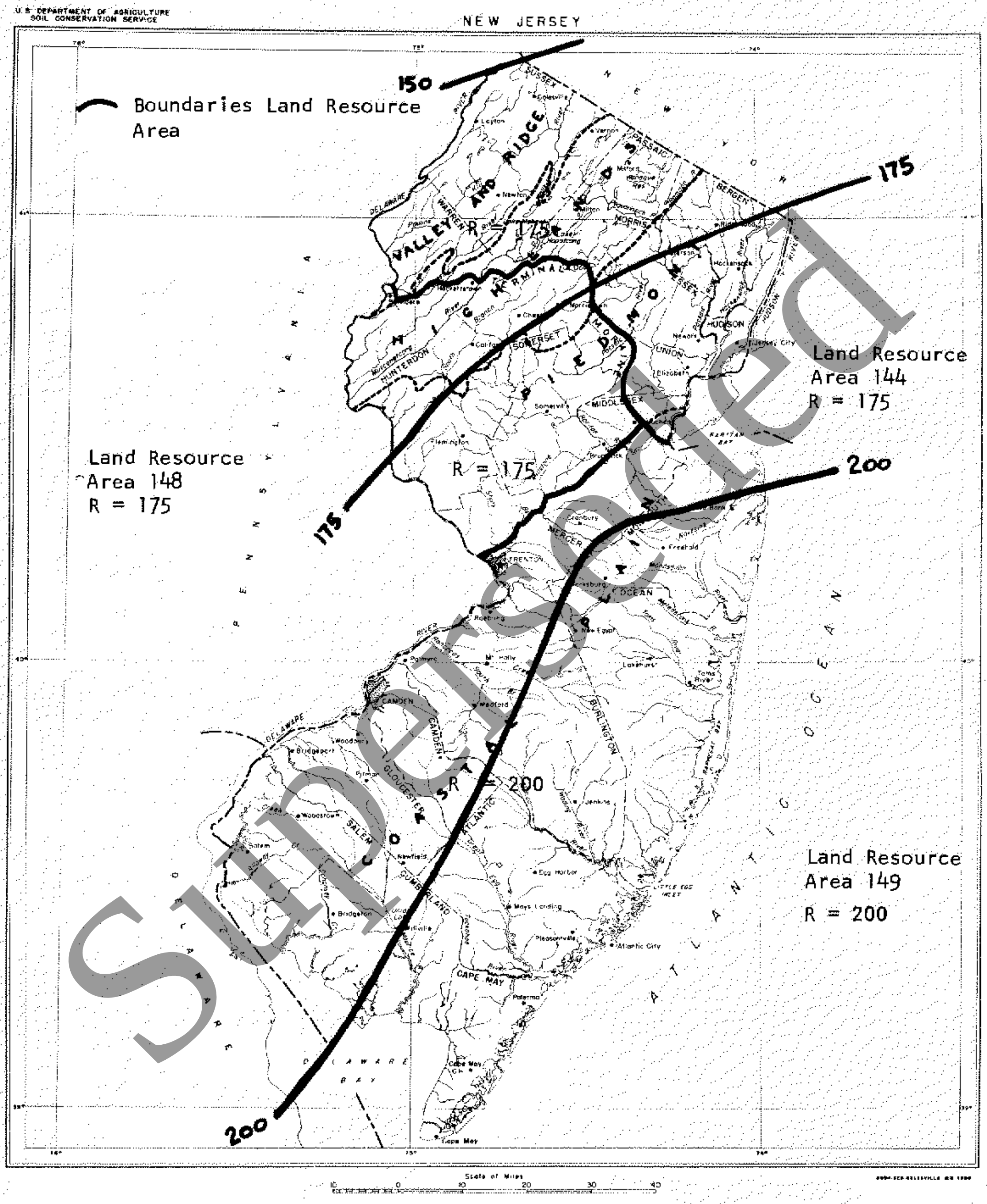
*E_t = KR (LS) C P M = Average soil loss for construction time M in tons/ac.

** From Table A1-7

REMARKS: *THE AREA IS A CRITICAL SEDIMENT SOURCE AREA.*

TOTAL VOLUME OF SOIL LOSS (18 MOS.) IN CU. YDS. = (0.35)(1600) = 560 CU. YDS.
ESTIMATED SEDIMENT VOLUME REACHING THE POND = (0.59)(0.9) = 0.53 AC. FT. OR (0.51)(1600) = 816 CU. YDS.
TO CONTROL SOIL LOSS TO WITHIN REASONABLE LIMITS, SLOPE LENGTHS ON UNPROTECTED AREAS SHOULD BE REDUCED TO 100 FT. OR EXTENSIVE SEEDING, MULCHING OR SODDING SHOULD BE USED TO REDUCE THE TIME OF EXPOSURE. MULCHING AT A RATE OF 2 TONS PER ACRE CAN REDUCE THE SOIL LOSS TO ABOUT 1 TON PER ACRE PER YEAR. A SEDIMENT BASIN SHOULD BE CONSTRUCTED AS SHOWN. CONSTRUCT ACCORDING TO STANDARD FOR SEDIMENT BASIN.

FIGURE A1-1



Rainfall Erosion Factor "R" by Land Resource Areas

TABLE A1-1

USDA TEXTURE ABBREVIATIONS USED IN TABLEA1-2a, A1-2b, A1-2c

c	-	clay, clayey
ch	-	channery
co	-	coarse
e	-	extremely
f	-	fine
g	-	gravelly
k	-	cobbly
l	-	loam, loamy
m	-	muck
r	-	rocky
s	-	sand, sandy
sh	-	shaly
si	-	silt, silty
st	-	stony
v	-	very

SOIL-ERODIBILITY CLASSES

K		class
0.17 - 0.24	-	low
0.28 - 0.37	-	medium
0.43 - 0.49	-	high

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
Adrian		0-42	m	Pt	-	-
		42-60	ls	SP-SM,SM	0.2	35
Albia		0-16	gl,estl	GM,GC,SC	0.24	42
		16-40	gl (pan)	GM,GC,SC	0.4	70
		40-60	gl	GM,GC,SC	0.3	53
Asbury		0-30	sil	GL,ML	2/	-
		30-60	ls,gls,vgls	SM,GM	-	-
Atherton		0-30	l	SM,SC,ML,CL	0.24	42
		30-60	scl	SM,SC	0.2	35
Bartley		0-11	l,g	ML,CL	0.32	56
		11-32	cl,l,scl	ML,CL	0.3	53
		32-42	sl,l	SM,SC	0.2	35
		42-60	sl,l,gsl,gl	SM,SC	0.2	35
Bath		0-28	l,sil	SM,SC	0.24	42
			gl,vstl	GM,GC	0.17	30
		28-48	l,sil	SM,SC	0.2	35
			gl,gsil	GM,GC	0.2	35
		48-60	gsl	SM,SC,GM,GC	0.2	35
Beatty		0-25	l	CL,ML	2/	-
		25-60	ls,gls	SM,GM	-	-
Biddeford		0-8	ml	Pt	-	-
		8-18	sil	ML,CL	-	-
		18-44	sicl,c,cl	CL,CH	-	-
		44-60	sil,cl,sicl	ML,CL	-	-
Boonton		0-6	gl,estl	ML	0.20	35
		6-30	fsl,l,sil, gfsl,gl,gsil	ML,CL	0.2	35
		30-45	fsl,sil,gfsl, gsil	ML,CL,SM,SC	0.2	35
		45-60	gsl	SM	0.2	35
Braceville		0-24	gsl	SM,GM	0.24	42
		24-36	g or vg, l,sl	SM,SC,GM	0.3	53
		36-60	stratified scg	SM,SP,SP-SM,GP	0.2	35
Bridgeville		0-30	sl,gl	SM	0.24	42
		30-60	gl,g,s	SM	0.2	35
Burnham		0-12	l,sil	ML,CL	0.32	26
		12-48	gl	ML,CL	0.3	53
		48-60	stone,g	SM,SC,GM,GC	0.2	35

1/ Mapping units may be inserted on the basis of the local county soil survey.
2/ Alluvial soil, unassigned.

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
Carlisle		0-60	m	Pt	-	-
Cattaraugus		0-20	fsl	SM,ML,CL	0.24	42
			gl	SM,ML,CL	0.17	30
		20-60	fsl(pan)	SM,ML,CL	0.3	53
Chatfield		0-28	l	ML,CL	0.17	30
		28+	gneiss bedrock			
Chenango		0-20	sl	SM	0.24	42
			gfsl,ksl	GM	0.17	30
		20-30	vgsl,gsl	SM,GM	0.2	35
		30-60	g,s,gls	GP-GM,GM	0.2	35
Chippewa		0-13	sil	ML,CL	0.32	56
			chsil,estl	ML,CL	0.24	42
		13-50	l,chsil(pan)	ML,CL,GM	0.4	70
Colden		0-8	sil	ML,CL	0.43	75
		8-45	sicl	ML	0.4	70
Colonie		0-16	lfs,ls	SM,SP-SM	0.24	42
		16-60	fs,ls,lfs	SM,SP-SM	0.2	35
Comly		0-11	sil	ML,CL	0.37	65
		11-20	sicl,l,sil	ML,CL,CH	0.4	70
		20-27	sicl (pan)	ML,CL,CH	0.5	88
		27-40	sil,l,sicl	ML,CL,CH	0.3	53
Coplay		0-10	sil	ML,CL	0.32	56
		10-60	sicl,cl	ML,CL	0.3	53
Cossayuna		0-24	l,vfsl	SM,ML,CL	0.24	42
			gl	SC,GM,GC	0.17	30
		24-48	g,gl (pan)	SC,GM,GC,SM,ML	0.3	53
		48-60	gsl	SM,GM	0.2	35
Crestmore		0-30	l,sil	ML,CL	0.32	56
		30+	bedrock			
Culvers		0-16	fsl	SM,ML,CL	0.28	49
			chsil	SM,ML,CL	0.20	35
		16-45	l	ML	0.3	53
			chsil	ML,CL,GM	0.3	53
Dutchess		0-60	sil,l,shl, shsil	GM,SM	0.20	35
Ellington		0-15	l,fsl	ML,SM	0.24	42
			gl,gsl	ML,SM	0.24	42
		15-38	l,sl	ML,SM	0.3	53
			gl,gsl	ML,SM	0.2	35
		38-60	s,gs	SM,SP-SM,GM	0.2	35

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local 1/ Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
Fredon		0-7	l	ML,CL,SM	0.24	42
		7-30	sl,fsl	SM,ML,CL	0.3	53
			gsl,gfsl	SM,ML,CL	0.2	35
		30-60	s,g	GP-GM,SP-SM	0.2	35
Hackettstown		0-30	sl	SM	0.24	42
			gsl	SM,GM	0.17	30
		30-60	gls,gsl	SM,GM	0.2	35
Haledon		0-10	sil,gsil	ML,CL	0.32	56
		10-46	sil,l,fsl, gsil,gl,gfsl	ML,CL	0.3	53
		46-60	vfsl,sl,gvfsl gsl	SM,SC	0.2	35
Halsey		0-24	l	ML,SM	0.24	42
		24-30	fsl,l,sl	SM	0.3	53
		30-60	g,gs,s & g	GP,GM,SM,SP	0.2	35
Hazen		0-12	gsl,gl	ML,CL	0.17	30
		12-32	gl	ML,CL	0.2	35
		32-60	g & S	SM	0.2	35
Hero		0-10	l	SM,ML,CL	0.24	42
		10-24	fsl,gsl	SM	0.2	35
		24-60	s,gs	SM,GM	0.2	35
Hibernia		0-25	l	ML,CL,SM,SC	0.37	65
			gl,stl,vstl	ML,CL,SM,SC	0.32	56
		25-36	l,scl,sl,	ML,CL,SM,SC	0.3	53
			gl,gscl,gsl	SM,SC,GM,GC	0.3	53
		36-72	gls,gsl,kls	SM,GM	0.2	35
Holyoke		0-17	rsil	ML,CL	0.24	42
		17+	Bedrock			
Hoosic		0-15	gl,gsl	SM,GM,ML,CL	0.17	30
		15-26	gsl,vgsl	GM,SM,ML,CL	0.2	35
		26-60	s & g	SW,GW,SM,GM, SP,GP	0.2	35
Kendaia		0-8	sil,l,fsl	ML	0.28	49
		8-20	sil,l	ML,ML-CL	0.4	70
		20-40	sil,l	ML-CL,ML,SM	0.4	70
				ML-CL,ML,SM GM-GC	0.3	53
Kistler		0-14	shsil	ML,CL	0.24	42
		14-24	vshsil	ML,CL,GM	0.2	35
		24+	slate bedrock			
Lackawana		0-26	l	ML,CL	0.24	42
			chsil	ML,CL	0.17	30
		26-52	chl(pan)	ML,CL	0.3	53

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
Livingston		0-10	si,sicl	ML,CL	0.49	86
		10-50	sic	ML,CL MH,CH	0.5	88
Lyons		0-9	vstsil	CL,ML,SM,SC	0.28	49
		9-18	sil,fsl,sicl	SM,SC,GM,GC, ML,CL	0.4	70
		18-40	fsl,cl	SM,SC,ML,CL	0.4	70
		40-60	gl	ML,CL,GM,GC	0.3	53
Marksboro		0-10	l	ML,CL	0.24	42
			gl	ML,CL,SM,SC	0.24	42
		10-40	l,gsl	SM,SC	0.4	70
Menlo		0-22	l	ML,CL	0.24	42
			gl	ML,CL	0.24	42
		22-40	gl(pan)	SM,SC	0.5	88
Middlebury		0-10	fsl	SM,SC,ML	0.24	42
		10-50	fsl,sil	SM,SC,ML	0.4	70
Minoa		0-30	sil,fsl	ML,CL,SC	0.28	49
		30-60	lfs,sil,lvfs	SM	0.2	35
Nassau		0-7	shsil, chsil, vsil	SM,GM	0.20	35
		7-16	chsil,vchsil shsil,vshsil	SM,SC,GM,GC	0.2	35
		16+	shale bedrock			
Netcong		0-60	gsl,sl	SM,SC	0.24	42
Norwich		0-6	sil	ML,CL	0.32	56
			vstsil	ML,CL	0.28	49
		6-30	chsicl	ML,CL	0.3	53
		30-60	vchsil	ML,CL	0.3	53
Oquaga		0-16	vstsl,estl	SM	0.20	35
		16-26	stsl	SM	0.3	53
		26+	Bedrock			
Otisville		0-10	sl,gsl,gls	SM,SP-SM,GP-GM	0.17	30
		10-60	gls,gs GP-GM	SM,SP-SM,GM,	0.2	35
Palmyra		0-18	sil,gfsl	ML,CL	0.24	42
		18-24	sil	ML,CL	0.2	35
		24-40	g & s	SM	0.2	35

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local 1/ Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
Parsippany		0-7	sil	ML,CL	0.43	75
		7-34	cl,sicl,sic	ML,CL,CH	0.4	70
		34-60	sicl,cl,l	ML,CL,CH	0.4	70
Paulina		0-21	l,shl	ML,CL	0.28	49
		21-38	shl	ML,CL	0.2	35
Phelps		0-21	fsl	SM	0.24	42
		21-45	sl	SM	0.3	53
		45-50	g & s	SM	0.2	35
Pompton		0-28	sl,fsl	SM	0.24	42
		28-60	s & g	SM,GM	0.2	35
Preakness		0-12	sl,l	SM	0.28	49
		12-30	sl	SM	0.2	35
		30-60	ls,sl	SM,SP-SM	0.2	35
			gls	GM,SP-SM	0.2	35
Raynham		0-28	sil	ML,CL	0.49	86
		28-60	sil,vfsl	ML,CL	0.4	70
Red Hook		0-10	fsl	SM,SC	0.24	42
		10-35	sil	ML,CL	0.4	70
		35-60	ls	SM	0.4	70
Rhinebeck		0-12	sil,sicl	ML,CL,OL	0.49	86
		12-30	sicl,sic	CL,ML	0.4	70
		30-40	sicl,sil,vfsl	CL,ML	0.5	88
Ridgebury		0-16	sl,fsl,l	SM,ML,SC	0.24	42
			vstl,estl	SM,ML,SC	0.24	42
		16-40	gl,gsl	SM,SC	0.3	53
		40-60	gs,s	SM,GM	0.2	35
Riverhead		0-9	sl	SM,SC	0.28	49
			gsl	SM,SC	0.20	35
		9-34	fsl,slgsl, gfsl	SM,SC	0.3	53
		34-60	ls,s,gls,gs	SP-SM,SM,GP-GM GM	0.2	35
Rockaway		0-30	l	ML,SM,SC	0.24	42
			gsl,gl,vstl, vstsl,estsl	ML,SM,SC	0.17	30
		30-60	gsl	SM,SC	0.2	35
Rockport		0-10	shsil	ML,CL	0.20	35
		10-36	sicl,sic	ML,CL,MH CH	0.4	70
		Rock				
Roe		0-10	l	ML,CL	0.24	42
		10-36	l,sil	ML,CL	0.3	53
		36-60	fs	SM	0.2	35

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local 1/ Mapping No.	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Scio		0-40	sil	ML,CL	0.49	86
		40-60	sl	SM	0.3	53
Sloan		0-45	sil,sicl	ML,CL	-	-
		45-60	gsl	SM		
Stephensburg		0-19	shl	ML	0.28	49
		19-26	vshl	GM,SM	0.2	35
		26+	shale bedrock		-	-
Swartswood		0-30	gfsl,gls,vstsl	SM,SC	0.17	30
		30-60	gfsl(pan)	SM,SC	0.3	53
Townsbury		0-13	l	SM,ML	0.24	42
			vstl	SM,ML	0.17	30
		13-36	l	SM,ML,SC	0.4	70
			gl	SM,Ml,SC	0.2	53
		30-60	gsl	SM	0.2	35
Tunkhannock		0-18	gl,vgl	SM,GM,ML	0.17	30
		18-32	vgsl	GM,SM	0.2	35
		32-60	s,gs	SM,GMSP,GP	0.2	35
Unadilla		0-10	vfsl	ML,CL	0.49	86
		10-60	sil,vfsl	ML,CL	0.4	70
		60-70	g & s	SP-SM,GP-GM, GW-GM	0.3	53
Valois		0-60	shl	ML,CL	0.17	30
Wallkill		0-8	sil	OL,CL,ML,SM,SC	0.32	56
		8023	sil	CL,ML,SM,SC	0.4	70
		23-60	muck & peak	OL,Pt	0.4	70
Washington		0-9	l,sil	ML,CL	0.32	56
			vstl	ML,CL	0.28	49
		9-60	l,sicl,cl	ML,CL	0.3	53
Wassaic		0-14	sil,l	ML,CL	0.32	56
			gl,gsl	SM,SC,GM,GC	0.24	42
		14-23	l,sl	SM,SC,ML,CL	0.3	53
			gsil	GM,GC	0.2	35
		23+	Bedrock			
Wayland		0-7	sil	OL-ML,CL	0.32	56
		7-38	sil	ML,CL	0.5	88
		38-50	stratified sil & fsl	ML,CL,SC,SM,GM, GC	0.4	70
Wellsboro		0-11	sil,fsl,l	SM,ML,CL	0.28	49
			chsil	SM,ML,CL	0.20	35
		11-22	l,sil	ML,CL	0.3	53
		22-60	fsl,sil,gl (pan)	SM,SC,ML,CL	0.3	53

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2a EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 144, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Whippany		0-9	sil	ML,CL	0.43	75
		9-60	sil,sicl,sic,c	ML,CL,CH	0.4	70
Whitman		0-10	fsl,sl,lvfsl,	OL,SM,ML	0.24	42
			vstl,estsl		0.24	42
		10-40	fsl,sl,l	SM,ML-CL	0.2	35
		40-60	gsl	SM	0.2	35
Woodglen		0-10	l	ML,CL	0.49	86
		10-36	sicl,c	ML,CL,MH,CH	0.4	70
		36-60	l,cl	ML,CL	0.4	70
Wooster		0-32	l,sil,cl	ML,CL	0.32	56
			gl,chl,gsil, chsil,gcl,chcl	ML,CL	0.3	53
		32-60	l,sil,chl, chsil gl,gsil	ML,CL,SM,SC	0.3	53
Wurtsboro		0-18	fsl	SM,SC	0.24	42
			gfsl	SM,SC	0.17	30
		18-60	fsl(pan)	SM,SC	0.3	53
			gfsl	SM,SC	0.2	35

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2b EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 148, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Abbottstown		0-20	sil	ML,CL	0.43	75
		20-38	sil(pan)	ML,CL	0.4	70
		38-48	shsil	ML,CL	0.4	70
			shl	SM,GM	0.3	53
Amwell		0-10	sil	ML,CL,SC	0.32	56
			gsil	ML,CL,SC	0.28	49
		10-23	sil,sicl,gsil	ML,CL	0.3	53
		23-41	gsicl,ksicl	ML,CL	0.3	53
			vgsil	GM,GC	-	-
		41-53	kfsl,gsil, vgsl	ML,CL,GC	0.3	53
Annandale		0-10	l	ML,SM	0.28	49
			gl	SM	0.24	42
		10-32	l,cl,scl	ML,CL	0.4	70
			gl,gcl,gscl	ML,CL	0.3	53
		32-44	same as 7-32 inches with pan		0.5	88
		44-60	sl	SM,ML	0.3	53
			gsl	SM,GM	0.2	35
Athol		0-10	gl	SM	0.32	56
		10-38	sicl,cl	ML,CL	0.3	53
			gcl	SM,SC	0.3	53
		38-60	sicl,cl	ML,CL	0.3	53
			gsl,gl	SM,SC,GM,GC	0.3	53
Bartley		0-11	l,g	ML,CL	0.32	56
		11-32	cl,l,scl	ML,CL	0.3	53
		32-42	sl,l	SM,SC	0.2	35
		42-60	sl,l,gsl,gl	SM,SC	0.2	35
Bedington		0-9	shsil	ML,CL	0.32	56
		9-35	shsil,shl	ML,CL	0.2	35
			sil	ML,CL	0.3	53
		35-66	vshl,vshsil	ML	0.2	35
			shsil	CL	0.3	53
		66-72	wesh	GM	0.2	35
Berks		0-8	shsil,chsil	GM,GC,ML	0.24	42
		8-20	sh to vshsil	SM,GM,GC	0.2	35
		20-30	vshsil	GM,GC,SM	0.2	35
		30+	shattered shale		0.2	35
Birdsboro		0-16	sil,l	ML,CL,SM	0.28	49
		16-48	sicl,cl	CL,ML,SM	0.3	53
		48-60	sl,s,g	GM,GC,SM,GW	0.2	35
			sicl,l	CL,ML	0.3	53
Bowmansville		0-8	sil	ML,CL	0.43	75
		8-32	sil,l,scl	ML,CL	0.4	70
		32-60	sil,scl,sl	ML,CL	0.4	70
			s,g		0.3	53

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2b EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 148, R = 175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Bucks		0-21	sil	ML,CL	0.32	56
		21-36	sicl,sil	ML,CL,MH	0.4	70
		36-52	shsil,vshsil	ML,CL,GM,GC	0.2	35
Califon		0-10	l	ML,SM	0.28	49
			gl,gsil,vstl	SM	0.24	42
		10-32	l,cl,scl	ML,CL	0.4	70
			gl,gcl,gscl	ML,CL	0.3	53
		32-44	same as 10-32 but with pan		0.5	88
		44-60	sl	SM,ML	0.3	53
			gsl	SM,GM	0.2	35
Chalfont		0-18	sil	ML,CL	0.43	75
			vstsil	ML,CL	0.37	65
		18-50	sil,sicl	ML,CL	0.6	105
		50-60	shsil,shl	ML,GM	0.6	105
Cokesbury		0-15	l	ML,CL,SM	0.32	56
			gl,vstl,estl	SM,SC	0.24	42
		15-25	cl,sicl	ML,CL	0.4	70
		25-48	l,sl	ML,SM	0.5	88
		48-60	gl	SM,SC	0.4	70
Croton		0-18	sil	ML,CL	0.43	75
			vstsil	ML,CL	0.37	65
		18-36	sil,sicl	ML,CL,CH	0.5	88
		36-48	shsil,shsicl	ML,CL,SMSC	0.4	70
		48+	Shale bedrock			
Doylestown		0-20	sil	ML,CL	0.43	75
		60-48	sil	ML,CL	0.6	105
			shl	GM,GC	0.4	70
Duffield		0-10	sil	ML,CL	0.32	56
			vsil,vrsil	ML,CL	0.28	49
		10-36	sicl	ML,CL,MH,CH	0.3	53
		36-60	sicl	ML,CL	0.4	70
			shsil	ML,CL	0.3	53
Dunellen		0-15	l,sl	ML,SM	0.24	42
			gl,gsl	ML,SM	0.24	42
		15-38	l,sl	ML,SM	0.3	53
			gl,gsl	ML,SM	0.2	35
		38-60	s,gs	SM,SP-SM,GM	0.2	35
Edneyville		0-11	estl,gl,stl, vstl	ML,SM	0.24	42
		11-39	sl,l,scl	ML,SM,SC	0.4	70
			gsl,gl,gscl	ML,SM,SC	0.3	53
		39-65	gsl	SM,GM	0.2	35
Hazleton		0-9	chl,vstl	SM,GM	0.24	42
		9-40	chl	SM,GM	0.20	35
		40-50	vchl	GM	0.20	35

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2b EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 148, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Klinesville		0-13	shsil,shl, shsil,vshsil	GM,SM,SC,ML	0.20	35
		13-18	vshsil,vshsl	GM,GP	0.2	35
		18+	Shale, Bedrock			
Lamington		0-10	sil	ML,CL	0.43	75
		10-23	sil,sicl	ML,CL	0.4	70
		23-45	cl,sil,l	ML,CL	0.4	70
		45-60	s,sl,sil	SM,SP-SM,ML	0.3	53
Lansdale		0-14	l,sl	SM,SC,ML,CL	0.28	49
			chl,vstl	SM,SC,ML,CL	0.24	42
		14-30	scl,sl	SM,SC	0.3	53
			l	ML,CL	0.4	70
		30-45	chsil,gsl	ML,CL	0.3	53
		45-60	chsl,gsl,fsl	SM,SC	0.2	35
Lansdowne		0-10	l,sil	ML,CL	0.43	75
		10-26	cl,sicl	CL,CH	0.4	70
		26-40	l,sicl	ML,CL	0.4	70
		40-60	shsicl	ML,CL	0.4	70
Lawrenceville		0-28	sil	ML,CL	0.49	86
		28-60	sil	ML,CL	0.6	105
			sl,vfsl	SM,SC	0.6	105
Legore		0-8	gl	SM,GM	0.20	35
		8-24	cl	ML,MH,CL	0.3	53
			gcl,gl,gsicl	SM,SC	0.2	35
		24-66	l,sil,sicl	ML,CL	0.3	53
			gl,vgl,gcl	SM-SC	0.2	35
Lehigh		0-14	sil	ML,CL	0.43	75
			chsil,vstsil	ML,CL	0.37	65
		14-30	chsicl	ML,CL	0.4	70
		30-41	chsicl,vchsil	ML,CL,GM	0.3	53
		41+	Shale Bedrock			
Meckesville		0-10	gl	ML,CL	0.28	49
		10-31	cl,l,scl, sicl(g)	ML,CL,SC	0.4	70
		31-38	l	ML,CL	0.4	70
		38-60	l,scl,(g,k)	ML,CL,SM,SC	0.3	53
Mount Lucas		0-9	sil	ML,CL	0.32	56
			vstsil	ML,CL	0.28	49
		9-32	l,cl,scl,sicl	ML,CL	0.3	53
		32-60	l	ML	0.4	70
			sl	SM-SC	0.3	53
Neshaminy		0-14	sil	ML,CL	0.32	56
			vstsil,gsil	ML,CL	0.28	49
		14-54	sicl,cl	ML,CL	0.3	53
			scl,sl	SM,SC	0.3	53
		54+	Diabase Bedrock			

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2b EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 148, R=175

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Nixon		0-12	sil,l,sl	ML,CL,SM	0.28	49
		12-45	sil,sicl,cl	ML,CL	0.4	70
		45-60	sl,sil,s	SM,ML	0.3	54
			gsil,gs	SM,ML	0.2	35
Norton		0-14	sil,l	ML	0.32	56
		14-63	sicl	ML,CL	0.4	70
		63-70	sil	ML	0.4	70
			vgl,shl	GM	0.3	53
Parker		0-40	vgl,vgsl,gsl, kl estsp	SM,GM,GP	0.17	30
		40-60	vstl,vstls, stsl,stls	GM	0.20	35
Parsippany		0-9	l,sicl,sil	ML	0.43	75
		9-50	sicl,cl	ML,CL	0.5	88
		50-60	sicl,cl	ML,CL,CH	0.4	70
Pattenburg		0-7	l,gl,vgl	ML,SM,GM	0.32	56
		7-30	vgl,l,cl,scl	ML,GM,SM,SC	0.3	53
		30-60	gl,vgl,gsl, vgsl	GM,SM	0.2	35
Penn		0-8	l	ML	0.32	56
			shsil	ML,CL	0.28	49
		8-30	sil	ML,CL	0.4	70
			shsil,sicl	SC-SM	0.3	53
		30+	Shale Bedrock			
Pope		0-12	fsl	SM	-	-
		12-46	fsl,l	SM,SC	-	-
		46-60	s,sl,gs,gsl, vgs,vgsl	SP-SM,SM,GP-GM, GM	-	
Quakertown		0-16	sil	ML	0.32	56
			chsil	ML	0.28	49
		16-32	sicl	ML,CL	0.3	53
		32-48	chsil,cl	ML,CL	0.3	53
		48+	Sandstone Bedrock			
Raritan		0-14	sil	ML,CL	0.43	75
		14-43	cl,sicl	ML,CL,CH	0.3	53
		43-60	stratified	SM,SC	0.2	35
			s,fsl	SP,SM	0.2	35
			c,sil,l	ML,CL,CH	0.3	53
			g	GM	0.3	53

1/ Mapping units may be inserted on the basis of the local county soil survey

TABLE A1-2b EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 148, R=175

Soil Series (Alpha Listing)	Local 1/ Mapping No.	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Readington		0-12	sil	ML,CL	0.43	75
		12-40	sil,sicl	SM,SC,ML,CL	0.4	70
		40-50	sil	ML,CL	0.4	70
			v,sh,sil	GM	0.3	53
		50+	Shale Bedrock			
Reaville		0-13	sil	ML,CL	0.43	75
			shsil	ML,CL	0.37	65
		13-23	shsil	ML,CL	0.3	53
				GM,GC	0.3	53
		23+	Shale and Silstone Bedrock			
Riverhead		0-9	sl	SM,SC	0.28	49
			gsl	SM,SC	0.20	35
		9-34	fsl,slgsl,gfsl	SM,SC	0.3	53
		34-60	ls,s,gls,gs	SP-SM,SM,GP-GM GM	0.2	35
Rowland		0-44	sil,l	ML,CL	0.43	75
			sicl	SM,SC	0.4	70
		44-60	stratified	SM,GM	0.3	53
			s & g	SP,GM	0.2	35
			sil	ML	0.4	70
Tioga		0-9	fsl	ML,CL,SM	0.49	86
		9-24	sil,l,fsl	ML,CL,SM	0.4	70
		24-60	vgls	SM,GM	0.2	35
Turbotville		0-50	l,sil	ML,CL	0.43	75
		50-60	l,sl	ML,SM	0.3	53
Washington		0-9	l,sil	ML,CL	0.32	56
			vstsl	ML,CL	0.28	49
		9-60	l,sicl,cl	ML,CL	0.3	53
Watchung		0-9	sil	ML,CL	0.43	75
		9-46	c,cl,sicl	ML,CL,CH	0.4	70
		46-60	sil,sicl,l	ML,CL	0.4	70
Whippany		0-10	sil	ML,CL	0.43	75
		10-60	sic,c,sicl	ML,CL,CH,MH	0.5	88

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2c EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 149, R =200

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Adelphia		0.14	sl,fsl,l	ML,CL,SM,SC	0.32	64
		14-37	l,scl,fsl	SM,SC,ML,CL	0.4	80
		37-60	sl,ls	SM	0.2	40
Atsion		0-16	s,fs	SP,SP-SM	0.17	34
		16-60	s,ls	SP,SP-SM	0.2	40
Aura		0-13	sl,l	SM,ML,CL	0.43	86
			gl,gsl	SM,SC	0.32	60
			ls	SP-SM,SM	0.28	40
		13-59	scl	SM,SC	0.4	80
			gscl,gsl	GM,GC	0.3	60
		59-72	scl,sl	SM,SC	0.4	80
			gsl,gcl	SM,SC,GM,GC	0.3	60
			ls	SP-SM	0.2	40
Barclay		0-14	fsl,lfs	SM	0.49	98
		14-40	vfsl,fsl	SM	0.4	80
		40-60	fs,lfs	SM,SP-SM	0.3	60
Bayboro		0-14	sl,l,sil	ML	0.37	74
		14-64	c,cl,sic	CH,CL,MH	0.2	40
Berryland		0-12	s,fs	SP,SP-SM	0.17	34
		12-72	s,ls,sl	SP,SP-SM	0.2	40
Bertie		0-14	sil,l	ML,CL	0.37	74
		14-40	sil,sicl,l	ML,CL	0.4	80
		40-60	stratified sl,l,ls	SM,SC,ML	0.3	60
			gsl	SM	0.2	40
Bibb		0-28	sl to sicl	ML,CL,SM	0.32	64
		28-60	highly variable	SM,GM,CL	0.20	40
Chillum		0-28	sil	ML,CL	0.32	64
		28-60	gscl,gl	SM,SC	0.3	60
			gsl	GM	0.2	40
Colemantown		0-14	l	ML,CL,SM	0.43	86
		14-30	sc,scl	CL,CH,MH	0.4	80
		30-60	sl,cl,scl	SC,ML,CL	0.4	80
Collington		0-13	sl,fsl	SM,SC,ML	0.28	56
			ls	SM	0.20	40
		13-32	scl,cl,sl,l	SC,SM,ML,CL	0.4	80
		32-60	sl,ls	SM,SC	0.2	40
Colts Neck		0.14	sl	SM	0.28	56
			ls	SM	0.20	40
		14-34	scl,sl,l	SM,SC	0.4	80
		34-60	sl	SM	0.3	60

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2c EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 149, R=200

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Donlonton		0-12	fsl	ML,CL,SM,SC	0.43	86
		12-40	sc,cl,sic	CH,CL,ML	0.4	80
		40-60	sc,sicl,cl,ls	SM,SC,ML,CL	0.3	60
Downer		0-16	sl	SM,SP-SM	0.28	56
			ls	SM	0.20	40
		16-30	sl	SM	0.3	60
		30-60	s,ls	SP,SP-SM	0.2	40
Dragston		0-14	fsl,sl,lfs	SM,SC,ML	0.28	56
		14-30	sl,scl	SM,SC,CL	0.3	60
		30-60	ls,lfs	SM	0.2	40
Elkton		0-10	sil,sl,l	ML,CL,SM	0.43	86
		10-36	sic,c	CH,CL,MH	0.4	80
		36-60	sic,sicl,scl,c	SC,SM,CL,CH,MH	0.4	80
Evesboro		0-60	ls,s,fs	SM,SP	0.17	34
Fallsington		0-14	sl,fsl,l	SM,SC,ML	0.28	56
		14-35	scl,sl	SM,SC,ML	0.3	60
		35-50	s,ls,sl	SM,SP-SM	0.2	40
Fort Mott		0-24	s,ls	SP-SM,SM	0.20	40
		24-40	sl	SM	0.3	60
		40-60	s	SP-SM,SM	0.2	40
Freehold		0-14	fsl,sl,l	SM,ML	0.28	56
			ls,lfs	SM	0.20	40
		14-32	sl,scl	SM,SC	0.4	80
		32-60	stratified ls,fsl	SM	0.2	40
Freneau		0-60	sl,l	SM,ML	0.28	56
Galestown		0-60	ls,s	SM,SP	0.17	34
Hammonton		0-18	sl	SM	0.28	56
			ls	SP-SM,SM	0.20	40
		18-36	sl	SM	0.3	60
		36-60	s,ls,gs,gls	SP-SM,SM	0.2	40
Holmdel		0-14	fsl,sl,l,lfs	SM,ML	0.28	56
		14-36	sl,scl,l	SM,SC	0.4	80
		36-60	ls,sl	SM	0.2	40
Howell		0-14	fsl,l	SM,ML,CL	0.43	86
		14-35	cl,sicl	CL	0.4	80
		35-60	c,sic,sicl	MH,ML,CL	0.3	60
Keansburg		0-30	sl,fsl,l	SM,ML,SC	0.28	56
		30-60	sl,l	SM	0.3	60

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2c EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 149, R=200

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR	
Keyport		0-10	sil,l,fsl,sl	SM,ML	0.43	86	
		10-44	c,sic,cl	CL,CH,MH	0.4	80	
		44-72	sicl,sic	CL,ML,MH	0.4	80	
Sandy Substratum		44-72	scl,sl	SM,SC,ML,CL	0.3	60	2/
Klej		0-40	ls,fs	SM,SP-SM,SP	0.17	34	
		40-60	ls,fs,lfs,sl	SM,SP-SM,SP	0.2	40	
Kresson		0-10	l,sl,ls,fsl	ML,CL,SM,SP-SM	0.43	86	
		10-45	sc,scl	ML,MH,CL,CH	0.4	80	
		45-60	sl,l	SM,SC,ML,CL	0.3	60	
Lakehurst		0-60	s,fs	SP,SP-SM	0.17	34	
Lakeland		0-60	ls,lfs,s	SM,SP	0.17	34	
Lakewood		0-60	s,fs	SP,SP-SM	0.17	34	
Lenoir		0-10	sil,l,fsl	SM,ML	0.43	86	
		10-60	sicl,c,sic,cl	CL,CH,ML,MH	0.4	80	
Sandy Substratum		40-72	scl,sl	SM,SC,ML,CL	0.3	60	2/
Leon		0-16	s	SP,SP-SM	0.17	34	
		16-60	s,ls	SP,SP-SM	0.2	40	
Lenoir		0-10	l,sil	ML,CL	0.43	86	
		10-40	c,sic,cl	CL,CH,MH	0.4	80	
		40-60	cl,sicl	CL,MH,ML	0.4	80	
Lincroft		0-60	ls,s	SM,SP-SM	0.17	34	
Marlton		0-14	sl,fsl	SM,SC	0.43	86	
		14-45	sc,scl	ML,CL,MH,CH	0.4	80	
		45-60	sl,scl	SM,SC,CL,ML	0.4	80	
Matapeake		0-16	sil,fsl,l	ML-SM,CL	0.32	64	
		16-34	sil,sicl	ML,CL	0.4	80	
		34-60	s,ls,sl,l gs	SM,SC,CL,ML	0.3	60	
Matawan		0-20	sl,ls,fsl	SM,SC	0.32	64	
		20-60	cl,scl,sc,sl	CL,SC,SM	0.4	80	
Mattapex		0-14	sil,l	ML,CL	0.37	74	
		14-40	sicl,sil,cl	ML,CL	0.4	80	
		40-60	sl,ls,s,l gs	SM,SC,CL,ML	0.2	40	
Matlock		0-10	l	ML,CL	0.43	86	
		10-35	sc,scl	ML,CL,MH,CH	0.4	80	
		35-60	sl,l	SM,SC,ML	0.3	60	

1/ Mapping units may be inserted on the basis of the local county soil survey.
2/ Data for sandy substratum.

TABLE A1-2c EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 149, R=200

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Monmouth		0-11	fsl,l,lfs	SM,SC,ML,CL	0.43	86
		11-40	sc,scl	CL,SC	0.4	80
		40-60	sl,scl,sc	SM,SC	0.3	60
Nixonton		0-14	fsl,lfs	SM	0.49	98
		14-40	vfsl,fsl	SM	0.4	80
		40-60	lfs,ls	SM,SP-SM	0.2	40
Osier		0-60	s,fs,ls,lfs	SM,SP-SM	0.17	34
Othello		0-14	sil,l,fsl,sicl	ML,CL	0.37	74
		14-34	sicl,sil	ML,CL	0.4	80
		34-60	sl,ls,scl	SM,SC,CL	0.3	60
Pasquotank		0-30	vfsl,fsl	ML,SM	0.49	98
		30-60	vfsl,sl,ls	ML,SM	0.2	40
Pemberton		0-24	s,ls	SM,SP-SM	0.20	40
		24-34	sl	SM,SC	0.2	40
		34-60	s,ls	SM,SP-SM	0.2	40
Plummer		0-46	s,fs,ls,lfs	SM,SP-SM	0.17	34
		46-60	sl,scl	SM,SC	0.30	60
Pocomoke		0-28	sl,l,fsl,ls, lfs	SM,ML	0.28	56
		28-60	ls,s	SM,SP-SM	0.2	40
Portsmouth		0-26	sil	ML,CL	0.28	56
		26-60	fs,cos	SP,SP-SM	0.2	40
Rutlege		0-18	ls,lfs	SM,SP-SM	0.17	34
		18-60	s,fs,ls,lfs	SP-SM,SP,SM	0.2	40
St. Johns		0-12	s	SP,SP-SM	0.17	34
		12-72	s,ls,sl,gs	SP,SP-SM	0.2	40
Sassafras		0.14	fsl,l,sl	SM,ML	0.28	56
			ls,lfs	SM	0.20	40
			gsl	SM,SP	0.24	48
		14-36	scl,sl,l	SM,SC,CL,ML	0.3	60
		36-60	sl,ls,fsl	SM	0.2	40
			gsl,gls	SM,SP,SP-SM	-	-
Shrewsbury		0-14	sl,fsl,l	SM,ML	0.28	56
		14-30	scl,sl	SC,SM,CL	0.3	60
		30-60	s,ls,sl	SM,SP-SM	0.2	40
Tinton		0-24	s,ls	SM,SP-SM	0.20	40
		24-60	s,ls	SM,SC,SP-SM	0.20	40
Weeksville		0-14	fsl	ML,SM	0.49	98
		14-44	sil,fsl	ML,SM	0.4	80
		44-60	vfsl,fsl,scl	ML,CL,SM	0.4	80

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-2c EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 149, R=200

Soil Series (Alpha Listing)	Local Mapping No. 1/	Typical Profile (Inches)	USDA Texture Range	Unified System	K	KR
Westphalia		0-14	fsl,lfs	SM,ML	0.49	98
		14-28	fsl,lfs, vfsl	SC,SM,ML	0.4	80
		28-60	fs,lfs,fsl	SM,ML,SP-SM	0.3	60
Woodsmansie		0-17	s	SM,SP-SM	0.20	40
		17-30	sl	SM,SC	0.2	40
		30-60	s,ls,sl	SM,SP-SM	0.2	40
Woodstown		0-14	sl,fsl,l	SM,SC,ML	0.28	56
			ls	SM	0.20	40
		14-36	scl,l,sl	SM,CL,SC,ML	0.4	80
		36-60	s,ls,sl	SM,SP-SM	0.2	40
			gsl,gls	SM,SP-SM		

1/ Mapping units may be inserted on the basis of the local county soil survey.

TABLE A1-3

VALUES OF THE TOPOGRAPHIC FACTOR "LS"

Length of Slope (L) Ft.	Percent Slope (S) 0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	25.0	30.0	40.0	50.0	60.0
20	.05	.05	.06	.06	.08	.12	.18	.21	.24	.30	.44	.61	.81	1.0	1.3	1.6	1.8	2.6	4	6	8	10
40	.06	.07	.07	.08	.10	.15	.22	.28	.34	.43	.63	.87	1.2	1.4	1.8	2.2	2.6	3.5	5	8	11	15
60	.07	.08	.08	.08	.11	.17	.25	.33	.41	.52	.77	1.0	1.4	1.8	2.2	2.6	3.0	4.5	6	10	14	18
80	.08	.08	.09	.09	.12	.19	.27	.37	.48	.60	.89	1.2	1.6	2.1	2.5	3.0	3.6	5.5	7	11	16	21
100	.08	.09	.09	.10	.13	.20	.29	.40	.54	.67	.99	1.4	1.8	2.4	2.9	3.5	4.2	6.0	8	13	18	23
110	.08	.09	.10	.10	.13	.21	.30	.42	.56	.71	1.0	1.5	2.0	2.5	3.0	3.7	4.5	6	9	14	19	25
120	.09	.09	.10	.10	.14	.21	.30	.43	.59	.74	1.0	1.5	2.1	2.6	3.3	4.0	4.6	7	9	14	20	26
130	.09	.09	.10	.11	.14	.22	.31	.44	.61	.77	1.2	1.6	2.2	2.8	3.4	4.1	4.9	7	9	15	20	27
140	.09	.10	.10	.11	.14	.22	.32	.46	.63	.80	1.2	1.7	2.3	2.9	3.6	4.3	5.1	7	10	15	21	29
150	.09	.10	.11	.11	.15	.23	.32	.47	.66	.82	1.2	1.8	2.4	3.0	3.7	4.5	5.3	8.	10	16	23	30
160	.09	.10	.11	.11	.15	.23	.33	.48	.68	.85	1.2	1.9	2.5	3.1	3.9	4.7	5.5	8	10	17	24	31
180	.10	.10	.11	.12	.15	.24	.34	.51	.72	.90	1.4	1.9	2.6	3.3	4.1	5.0	6.0	9	12	18	26	33
200	.10	.11	.11	.12	.16	.25	.35	.53	.76	.95	1.4	2.1	2.8	3.6	4.4	5.3	6.3	9	12	18	27	35
300	.11	.12	.13	.14	.18	.28	.40	.62	.93	1.2	1.8	2.7	3.6	4.5	5.6	6.8	8	12	16	25	35	45
400	.12	.13	.14	.15	.20	.31	.44	.70	[illegible]	1.4	2.0	3.2	4.2	5.4	6.7	8.0	10	14	19	30	42	54
500	.13	.14	.15	.16	.21	.33	.47	.76	1.2	1.6	2.2	3.7	4.9	6.2	7.6	9.2	11	16	21	34	47	61
600	.14	.15	.16	.17	.22	.34	.49	.82	1.4	1.6	2.4	4.1	5.4	6.9	8.5	10.3	12	16	24	38	53	68
700	.15	.16	.17	.18	.23	.36	.52	.87	1.4	1.8	2.6	4.5	6.0	7.5	9.3	11.3	13	18	26	41	58	75
800	.15	.16	.17	.18	.24	.38	.54	.92	1.6	2.0	2.8	4.9	6.4	8.2	10.1	12.2	14	20	28	45	58	81
900	.16	.17	.18	.19	.25	.39	.56	.96	1.6	2.0	3.0	5.2	6.9	8.3	10.8	13.1	15	22	30	48	67	87
1000	.16	.18	.19	.20	.26	.40	.57	1.0	1.6	2.2	3.0	5.6	7.4	9.3	11.6	14.0	17	24	32	51	72	93
1100	.17	.18	.19	.20	.27	.41	.59	1.0	1.8	2.2	3.5	5.9	7.8	9.9	12.2	14.8	18	25	34	54	76	98
1200	.17	.18	.20	.21	.27	.42	.61	.10	.18	2.4	3.5	5.2	8.2	10.4	[illegible]	15.6	18	27	36	57	80	104
1300	.18	.19	.20	.21	.28	.43	.62	1.2	2.0	2.4	3.5	6.5	8.6	11.0	13.3	16.4	19	28	38	60	84	109
1400	.18	.19	.21	.22	.29	.44	.63	1.2	2.0	2.6	3.5	6.8	9.0	11.4	14.1	17.1	20	30	40	63	88	114
1500	.19	.20	.21	.22	.29	.45	.65	1.2	2.0	2.6	4.0	7.1	9.4	12.0	14.7	17.8	21	31	41	65	92	119
1600	.19	.20	.21	.23	.30	.46	.66	1.2	2.2	2.6	4.0	7.4	9.8	12.4	14.8	18.5	22	32	43	68	95	123
1700	.19	.21	.22	.23	.30	.47	.67	1.2	2.2	2.8	4.0	7.6	10.1	12.9	15.9	19.2	23	33	44	70	97	128
2000	.20	.22	.23	.24	.32	.49	.71	1.4	2.4	3.0	4.5	8.4	11.1	14.1	17.5	21	25	36	49	77	108	141

When the length of slope exceeds 400 feet and (or) percent of slope exceeds 24 percent, soil loss estimates are speculative as these values are beyond the range of research data.

TABLE A1-4
COVER INDEX FACTOR C_c
CONSTRUCTION SITES

TYPE OF COVER		FACTOR C_c	%*
None (fallow ground)		1.0	0.0
Temporary Seedings (90% Stand):			
Ryegrass (perennial type)		0.05	95
Ryegrass (annuals)		0.1	90
Small grain		0.05	95
Millet or sudan grass		0.05	95
Field bromegrass		0.03	97
Permanent Seedings (90% stand)		0.01	99
Sod (laid immediately)		0.01	99
Mulch:			
Hay rate of application tons per acre:			
	1/2	0.25	75
	1	0.13	87
	1½	0.07	93
	2	0.02	98
Small grain straw	2	0.02	98
Wood chips	6	0.06	94
Wood cellulose	1 3/4	0.1	90
Fiberglass	1/2	0.05	95
Asphalt emulsion (1250 gals/acre)		0.02	98

Fiber matting, excelsior, gravel and stone may also be used as protective cover.

*Per cent soil loss reduction as compared with fallow ground.

TABLE A1-5

PRACTICE FACTOR P_c OR SURFACE CONDITION FOR CONSTRUCTION SITES

SURFACE CONDITION WITH NO COVER	FACTOR P_c*
Compact and smooth, scraped with bulldozer or scraper up and down hill	1.3
Same condition, except raked with bulldozer root rake up and down hill	1.2
Compact and smooth, scraped with bulldozer or scraper across the slope	1.2
Same condition, except raked with bulldozer root rake across the slope	0.9
Loose as a disced plow layer	1.0
Rough irregular surface equipment, tracks in all directions	0.9
Loose with rough surface greater than 12" depth	0.8
Loose with smooth surface greater than 12" depth	0.9

*Values based on estimates

TABLE A1-6

ADJUSTMENT FACTOR M FOR ESTIMATING MONTHLY AND PORTIONS OF ANNUAL SOIL LOSS FOR NEW JERSEY

Starting Months	ENDING MONTHS											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Jan	0	0.02	0.04	0.06	0.10	0.20	0.35	0.55	0.76	0.86	0.93	0.97
Feb	0.98	0	0.02	0.04	0.08	0.18	0.33	0.53	0.74	0.84	0.91	0.95
Mar	0.96	0.98	0	0.02	0.06	0.16	0.31	0.51	0.72	0.82	0.89	0.93
Apr	0.94	0.96	0.98	0	0.04	0.14	0.29	0.49	0.70	0.80	0.87	0.91
May	0.90	0.92	0.94	0.96	0	0.10	0.25	0.45	0.66	0.76	0.83	0.87
June	0.80	0.82	0.84	0.86	0.90	0	0.15	0.35	0.56	0.66	0.73	0.77
July	0.65	0.67	0.69	0.71	0.75	0.85	0	0.20	0.41	0.51	0.58	0.62
Aug	0.45	0.47	0.49	0.51	0.55	0.65	0.80	0	0.21	0.31	0.38	0.42
Sept	0.24	0.26	0.28	0.30	0.34	0.44	0.59	0.79	0	0.10	0.17	0.21
Oct	0.14	0.16	0.18	0.20	0.24	0.34	0.49	0.69	0.90	0	0.07	0.11
Nov	0.07	0.09	0.11	0.13	0.17	0.27	0.42	0.62	0.83	0.93	0	0.04
Dec	0.03	0.05	0.07	0.09	0.13	0.23	0.38	0.58	0.79	0.89	0.96	0

All dates in the table are as of the 1st of each month, read from left to right.
M=1.0 for one full year.

Example: Given KR=70. (LS) = 1.2 What is soil loss for month of July?

E_t=70 x 1.2=84.0 tons per acre per year.

E_t for July=84x0.2=17 tons per acre for July on the average

What is the soil loss if construction begins on the first of May and sod is established on disturbed areas by September 1st?

E_t May to Septmeber=84 x 0.66=55 tons per acre.

TABLE A1-7

APPROXIMATE WEIGHTS OF SOILS IN LBS. PER CUBIC FT. AND CONVERSION FACTORS

Soils	Volume Wt. lb./cu. ft.	Conversion Factors Ac. Inches	Ac. Ft.	Tons to Cu. Yds.
Sands and loamy sands	110	0.005	0.00042	0.67
Sandy loam	105	0.0052	0.00044	0.71
Fine sandy loam	100	0.0055	0.00046	0.74
Loam	90	0.0061	0.00051	0.82
Silt loam	85	0.0065	0.00054	0.87
Silty clay loam	80	0.0069	0.00057	0.93
Clay loam	75	0.0073	0.00061	0.99
Silty, sandy clay and clay	70	0.0079	0.00066	1.06
Aerated Sediment	80*	0.0069	0.00057	0.93
Saturated Sediment	60*	0.0092	0.00077	1.24

*These are the approximate aerated and saturated weights to be used at damage sites. (Streams or reservoirs)

TABLE A1-8

FACTORS FOR MODIFYING THE SOIL LOSS EQUATION TO OBTAIN ESTIMATES BASED ON PROBABILITY AND SINGLE STORM SOIL LOSS

Probability		Single Storm	
One Year In	Factor	Exceeded Once In (Years)	Factor
2	0.9	1	0.2
5	1.25	2	0.3
20	1.70	5	0.4
		10	0.5
		20	0.7

Example: The average annual soil loss from a critical sediment source area was computed to be 100 tons per acre per year.

One year in 5 this loss could be: 100 x 1.25 = 125 tons per acre, or one year in 20 the loss could be: 100 x 1.7 = 170 tons per acre.

A single storm that may take place once in 10 years could cause a soil loss of 100 x 0.5 = 50 tons per acre. If the single storm is one that occurs once in 2 years, the loss might be: 100 x 0.3 = 30 tons per acre.

APPENDIX A-2

REQUIREMENTS, GUIDELINES AND PROCEDURES
FOR
PREPARING AND IMPLEMENTING "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY"

PART I - Information needed by the local Soil Conservation District. A complete application for certification of soil erosion and sediment control plan includes the following items:

1. One copy of:
   a. Complete subdivision or site plan application, including key map, as submitted to the municipality. (Architectural drawings and building plans and specifications not required)
   b. Location of present and proposed drains and culverts with their discharge capacities and velocities and supporting computations, and identification of conditions below outlets.
   c. Delineation of any area subject to flooding from the 100 year storm in compliance with the Flood Plans Act (NJSA 58:16A) or applicable municipal zoning.
   d. Delineation of streams and other significant natural features within the project area.
   e. Soils and other natural resource information used. (Delineation of the project site on soil maps is desirable.)

2. Five copies of the soil erosion and sediment control plan, at a scale to be determined by individual district, to include the following: (this information shall be detailed on the plat.)
   a. Proposed sequence of development including duration of each phase in the sequence.
   b. Site grading plan showing delineation of land areas to be disturbed including proposed cut and fill areas together with existing and proposed profiles of these areas.
   c. Contours at a two foot interval, or other interval as determined by individual district, showing present ground elevation.
   d. Locations of all streams and present and proposed drains and culverts.
   e. Location and detail of all proposed erosion and sediment control structures including profiles, cross sections, appropriate notes and supporting computations.
   f. Location and detail of all proposed nonstructural methods of soil stabilization including rates and types of lime, fertilizer, seed, and mulch to be applied.
   g. Control measures for non-growing season stabilization of exposed areas where the establishment of vegetation is planned as control measure.
   h. For residential development - control measures to apply to dwelling construction on individual lots and notation that such control measures shall apply to subsequent owners if title is conveyed. This notation shall be shown on the final plat.
   i. Plans for maintenance of permanent soil erosion and sediment control measures and facilities during and after construction, also indicating who shall have responsibility for such maintenance.

3. Appropriate fees:

4. Other items required: (Individual districts may require additional items or modifications in the above list.)

PART II - Review Procedure

1. Check plans against soils and other applicable resource data for the following.

   a. Flood plains
   b. Erosion and sediment problems
   c. Wetness or high water table
   d. Slope hazards or stability
   e. Bedrock
   f. Off-site problems
   g. Vegetative establishment and maintenance problems
   h. Structural establishment and maintenance problems
   i. Storm water management needs
   j. Compatability with the surrounding environment

2. Field check apparent trouble spots as needed but not necessarily the whole plan.

3. Identify any needed changes in proposed vegetative or engineering practices.

4. Make notes of changes on the plat itself (preferred) or on an attached sheet.

5. If practices are added, attach or reference these to the applicable sections of "Standards for Soil Erosion and Sediment Control in New Jersey".

6. Review proposed schedule and sequence of implementation and comment.

7. Review off site effects and comment.

8. Review compatability of the development with surrounding environment and comment.

9. Write general notes (how to do it) if they will help clarify recommendations; stick to facts, not opinions.

10. Review maintenance notes and comment.

11. Suggest other reviews that may be required by agencies such as Environmental Protection, Health, Planning, Transportation and others.

PART III - Follow up by reviewing agency

1. Return set of plans and the review summary to the sender.

2. Perform sufficient on site follow-up to determine if review detail is adequate.

3. Determine if training of developers, inspectors or others is required and assist with such training.

4. Enforce implementation of Soil Erosion and Sediment Control Plan on construction site, if necessary.

FOR DISTRICT USE ONLY

Application #____________

Date Appl. Rec'd____________

Fee Received $____________

Received by____________

Disposition____________

FIGURE A2-1

New Jersey Natural Resources Conservation Program

APPLICATION FOR SOIL EROSION AND SEDIMENT CONTROL PLAN CERTIFICATION

The enclosed soil erosion and sediment control plan and supporting information as listed on the reverse side of this form are submitted for certification pursuant to the Soil Erosion and Sediment Control Act, Chapter 251, P.L. 1975 as amended (NJSA 4:24-39 et seq.).

Name of Project____________

Location of Project: Municipality________ Street Address________

Block______ Lot______

Tract size______ Acres. Project size______ Acres. Fee $______

Owner(s) of project____________

Address____________ Phone______

Plans prepared by ____________

Address____________ Phone______

(Engineering related items of the Soil Erosion and Sediment Control Plan MUST be prepared by or under the direction of and be sealed by a Professional Engineer licensed in the State of New Jersey.)

Agent Responsible____________

Address____________ Phone______

Job Supervisor____________

Address____________ Phone______

The applicant hereby certifies that all soil erosion and sediment control measures are designed in accordance with Standards for Soil Erosion and Sediment Control in New Jersey and will be installed in accordance with those Standards and the plan as approved by the Soil Conservation District and agrees as follows:

1. To notify the District in writing at least 48 hours in advance of any land disturbance activity.
2. To notify the District upon completion of the Project (Note: No certificate of occupancy can be granted until a report of compliance is issued by the District.)
3. To maintain a copy of the certified plan on the project site during construction.
4. To allow District agents to go upon project lands for inspection.
5. That any conveyance of this project prior to its completion, will transfer full responsibility for compliance with the certified plan to any subsequent owners.

The applicant hereby acknowledges that Engineering features contained in Soil Erosion and Sediment Control Plans are reviewed for adequacy to reduce offsite soil erosion and sedimentation and not for adequacy of structual design. The applicant shall retain full responsibility for any damages which may result from any construction activity notwithstanding district certification of the subject soil erosion and sediment control plan.

Signature of Applicant____________ Date______

Applicant's Name (Print)____________

Receipt of application, fee, plan and supporting documents is hereby acknowledged:

Signature of District Official____________ Title______

Date______ for______ Soil Conservation District

The Soil Erosion and Sediment Control Plan submitted herewith is hereby determined to be complete:

Signature of District Official____________ Title______

Date______ for______ Soil Conservation District

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APPENDIX A3

GUIDE FOR CONSTRUCTION SPECIFICATIONS

The contractor shall perform all work, furnish all materials and install all measures required to reasonably control soil erosion resulting from construction operations and minimize the flow of sediment from the construction site. Such work may include the installation of water diversion structures, diversion ditches, and sediment basin, and seeding, mulching or sodding critical areas to provide temporary protection. The contractor shall adhere to the plan showing the methods to be used for controlling erosion during construction along with the schedule of construction operations. When no work will be performed on critical areas for more than 60 days, they shall be protected by temporary seeding, mulching, or sodding, or the slope lengths shall be reduced by the installation of diversions or other means. When topography permits, debris basins shall be constructed at points of water concentration from critical area that will remain unprotected longer than 60 days. Earth berms or diversions shall be constructed to intercept and divert runoff water away from critical areas. Diversion outlets shall be stable or shall be stabilized by paving or other means.

Critical areas shall be those areas subject to excessive erosion due to highly erodible soils, slope length and steepness or water concentrations. Concentrations of runoff water, or other reasons, may cause the area to be critical. All areas that may become critical when the vegetation or other soil surface protection is removed as shown or noted on the drawings or otherwise identified.

The permanent restoration of vegetative cover such as seeding or sodding on all areas shall be accomplished within 10 days after final grading operations have been completed. Time extensions beyond the 10 day requirement may be requested in writing and are subject to written approval.

Structural measures for erosion shall be designed and constructed in accordance with the attached Engineering Practice Standards for diversions, waterways and debris basins.

Seeding, mulching and sodding of critical areas shall be in accordance with the attached vegetative standards.

Exposed soil having a pH value of less than 4 shall be covered with a minimum of 12 inches of soil material no coarser than a sandy loam or SM and that can be corrected to a minimum pH of 6.5.

Unless otherwise approved in writing construction operations in rivers, streams, ponds and reserviors shall be restricted to those areas of work shown on the drawings and to those areas which must be entered for the construction of temporary or permanent structures. Rivers, streams, ponds or reservoirs shall be promptly cleared of all temporary false work, piling, debris or other obstructions placed therein or caused by the construction operations.

Excavated soil material shall not be placed adjacent to rivers, streams or bodies of water in a manner that will cause it to be washed away by high water or runoff.

Frequent fording of streams with construction equipment will not be permitted, therefore, temporary bridges, culverts or other structures shall be used wherever stream crossings are necessary. Unless otherwise approved in writing, mechanized equipment shall not be operated in streams except as may be required to construct channel work and temporary or permanent structures.

Pollutants such as chemicals, fuels, lubricants, bituminous, raw sewage and other harmful waste shall not be discharged into or alongside of rivers, streams, impoundments or into natural or man-made channels leading thereto.

The contractor shall comply with applicable State and local regulations relating to the prevention and abatement of pollution.

APPENDIX A4

MAINTENANCE STRUCTURAL MEASURES

Maintenance is the work required to keep practices in, or restore them to, their original physical and functional condition.

Maintenance includes the performance of work and application of measures to prevent deterioration as well as restoring, rebuilding, replacing and putting together parts that have been torn, broken or deteriorated.

All structural measures for the control of erosion, sediment and water disposal must have timely maintenance if the measures are to endure and perform their function. All structures should be inspected at least semiannually and after each heavy rain. Particular attention should be given to temporary structures.

A comprehensive program should be outlined for use of those who have maintenance responsibility. Maintenance items should include but not be limited to those shown for each of the following measures.

<u>Channel Linings</u> (Including slope protection structures)

Check for: cracking; spalling; deterioration from freezing, salt or chemicals; plugging of weep holes; operation of automatic drainage gates; condition of safety fences; channel obstructions; scour at inlet and outlet.

Cracks should be sealed, protective coatings applied when needed, and modification or riprap repairs made where and when necessary.

<u>Earth Channels</u> (Including diversions and waterways)

Check for: points of scour or bank failure and deposition; rubbish or channel obstruction; rodent holes; excessive wear from play, traffic or settling.

Remove deposition and undesirable plant growth. Repair damages from scour, rodents and loss of freeboard.

<u>Dams and Spillways</u>

Check fill for cracks, damage from wave action, rodents, undesirable vegetation growth, and obstructions to principal and emergency spillways. Check gates, trash racks, metal work, anchors, conduits and appurtenances for damage from corrosion, ice and debris.

Filling of scour holes, modification, riprap, repair of damaged vegetative cover, obstruction removal should be on a timely basis.

Valves and gates should be cleaned, lubricated and operated through their full range.

Unauthorized modifications, tampering or vandalism must be controlled.

APPENDIX A5

GUIDE FOR INSTALLING SOIL STABILIZATION MATTING

Soil stabilization matting is used as a mechanical aid to protect the soil from erosion during the critical period of vegetative establishment. It is easier to lay and hold in place against wind. It has the tensile strength and weight to resist water flow and erosion.

Materials

Jute mat shall be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48 inches in width plus or minus 1 inch and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus 5 percent, with approximately 78 warp ends per width of cloth and 41 weft ends per linear yard of cloth. The yarn shall be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than one half of its normal diameter.

Excelsior mat shall be wood excelsior, 48 inches in width plus or minus 1 inch and weighing 0.8 pounds per square yard plus or minus 10 percent. The excelsior material shall be covered with a netting to facilitate handling and to increase strength.

Staples - Staples for anchoring soil stabilization matting shall be made of 12 -to- 20 inch lengths of No. 8 plain iron wire.

Installation Requirements

Site Preparation: Shape and grade the waterway, channel or area to be protected as required by job plans and specifications.

Remove rocks, clods over 1½ inches in diameter, sticks and other material that will prevent contact of the matting with the soil surface.

Seeding: Lime, fertilizer and seed in accordance with the applicable seeding standard except that for jute matting one half of the seed may be applied prior to laying the matting and the remaining seed applied after laying the matting.

Do not cultipack.

Laying the Matting: (If instructions have been followed, the matting will be laid on loose soil. See Figure A5-1.)

Start laying the matting from the top of the channel or slope and unroll downgrade so that one edge of the strip coincides with the channel center. Lay a second strip parallel to the first on the other side of the channel and allow at least a 2-inch overlap for jute matting. Excelsior matting may be butted. If one roll of matting does not extend the length of the channel, continue downhill with additional rolls.

Securing the Matting: Bury the top end of jute strips in a trench 4 inches or more deep. Tamp the trench full of soil. Reinforce with a row of staples driven through the jute about 4 inches downhill from the trench. These staples should be about 10 inches apart. Then staple the overlap in the channel center. These staples should be 3 to 4 feet apart. The outside edges may be stapled similarily at any time after the center has been stapled. Closer stapling along the sides is required where concentrated water may flow into the channel. The edges of excelsior matting should be stapled on 12 to 24 inch centers.

Succeeding strips of matting, farther down the channel or slope, are secured in a similar manner.

Where one roll of jute matting ends and another roll begins, the end of the top strip overlaps the trench where the upper end of the lower strip is buried. Make the overlap at least 4 inches and staple securely. Rolls of excelsior matting may be butted at the ends and securely stapled.

Erosion Stops: At any point, jute matting may be folded for burying in slit trenches and secured as were the upper ends. This checks water flow and erosion that may begin under the matting. It also gives improved tie-down. The procedure is recommended on the steeper slopes of sandy soil and gentler slopes subject to seepage. Spacings vary from 25 to 100 feet.

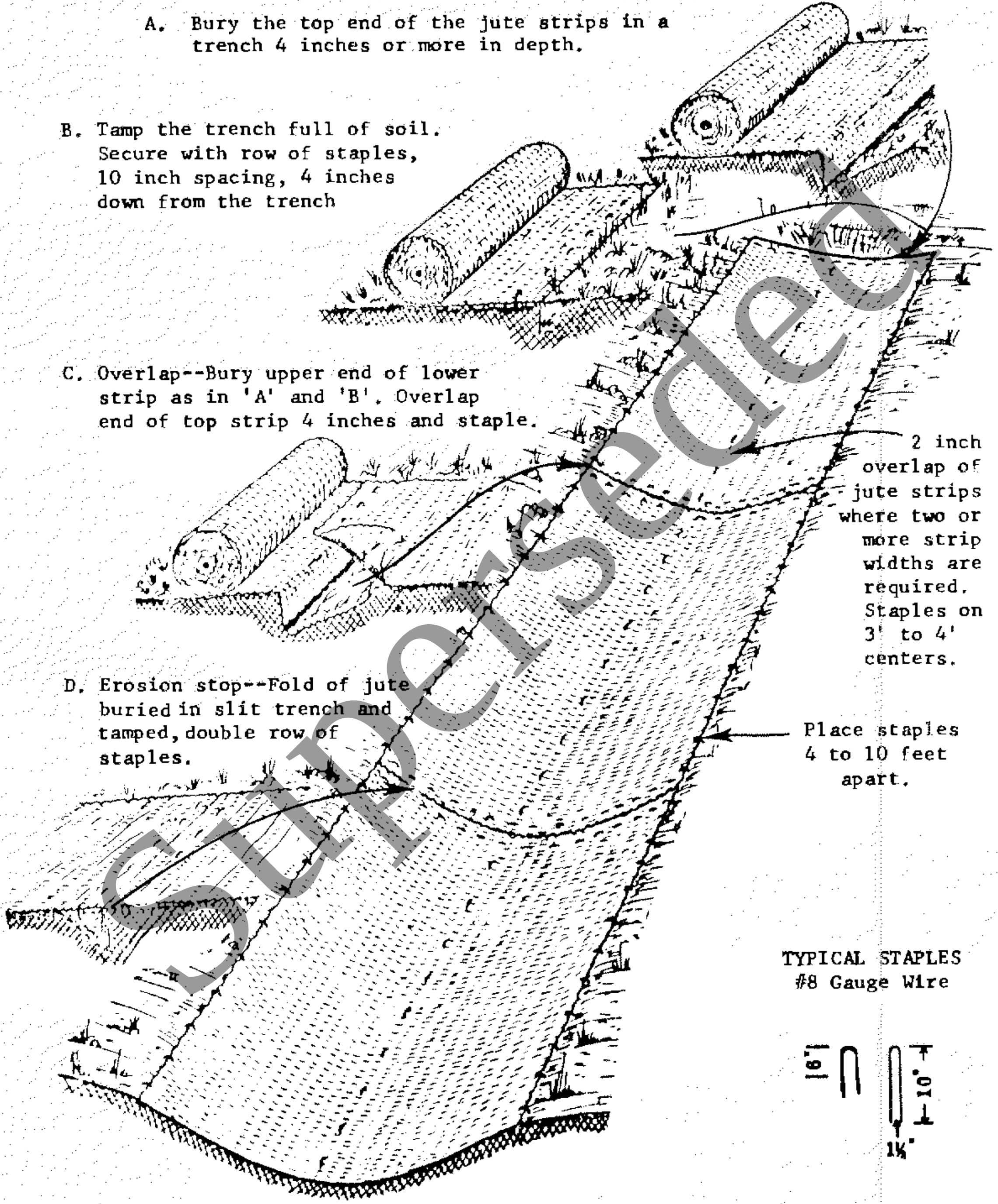
Diversions: Where diversions outlet into the waterway, the outlet should be protected with matting used in the same manner as in the main channel. The matting for the outlet is laid first so that matting in the main channel will overlap the outlet strip.

Matting Soil Contact: Get contact between matting and soil by rolling after laying, stapling and seeding are complete. Perfect contact is vital to keep water flow over - not under - the matting.

Inspection: After job completion, make sure the matting is in contact with the soil at all places and that critical areas are securely stapled down.

FIGURE A5-I

DETAIL FOR STABILIZING WATERWAYS WITH JUTE THATCHING



APPENDIX A6

DIVERSION AND GRASSED WATERWAY EXAMPLE DESIGN PROBLEMS AND CHARTS

Diversion Example Problem:

A permanent diversion is to be constructed upslope of a house to divert runoff away from the house and to protect the house from surface water flooding. The diversion will outlet into a stone center waterway. The area upslope of the diversion location is in woods and is to remain in woods and will not be disturbed. The diversion will be constructed on Rockaway gravelly sandy loam. The diversion will be seeded to a lawn grass mixture. The diversion will be a part of the backyard of the house and is expected to be mowed with the yard. The diversion will have a grade of 1%.

Diversion Example Problem Solution:

The required capacity is a 50 year storm with 0.5 feet freeboard from page 4.22. Using the procedure in "Urban Hydrology for Small Watersheds, TR55," it was determined that the 50 year peak runoff from the watershed draining into the diversion is 40 cfs.

The maximum permissible velocity from page 4.23 for a sandy loam soil with good vegetation in the channel is 3.0 ft. per sec. (fps). In a backyard, it is reasonable to expect good vegetation to be maintained in the diversion channel.

The appropriate vegetative retardance factors are D&E since the diversion is in a backyard where the grass will be mowed regularly and a good stand of grass maintained at a height range between 6 inches and less than 2 inches. Select side slopes of 6 to 1 for the channel and ridge so the diversion can be mowed with a riding lawnmower.

We now have:

Grade of diversion = 1%
Design Capacity (Q) 50 yr = 40 cfs
Maximum allowable velocity = 3.0 fps
Vegetative retardance factors = D and E
Channel side slopes = 6 to 1

First, design for stability using retardance factor E.
Enter Figure A6-4 with V=3.0 fps and slope = 1.0%, find maximum allowable R = 0.54.
The cross sectional flow area required is Q/V = 40/3 = 13.3 sq. ft.
Enter Figure A6-5 with A = 13.3 and R = 0.54, find bottom width equal 16 ft. and depth equal 0.67 ft.

Second, design for capacity using retardance factor D
A trial and error procedure is necessary for a trapezoidal channel with 6:1 side slopes and 16 ft. bottom width on a 1% grade with D retardance.

Trial #1

Try d = 1.0 ft, enter figure A6-5
find R = 0.78
A = 22
enter Figure A6-3
find V = 2.9
Q = VA = (2.9) (22) = 63.8 cfs
required 40 cfs, capacity is larger than required.

Trial #2

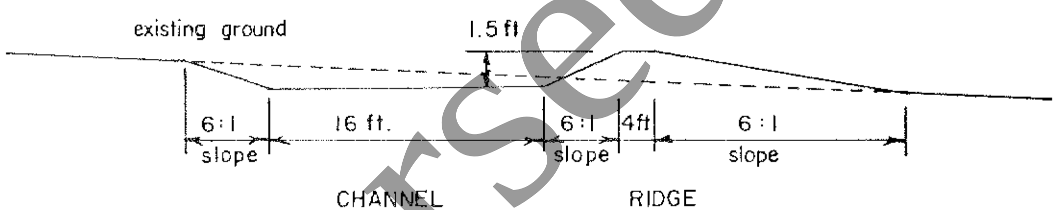
Try d = 0.85 ft., repeat steps in 1st trial
find R = 0.68
A = 17.9
V = 2.3
Q = 41.2 cfs is slightly larger than required Q of 40 cfs. Therefore use these dimensions.

Design Flow Dimensions:

a. Grade = 1%.
b. Side slopes = 6:1.
c. Bottom width = 16 ft.
d. Depth = 0.85 ft. (required flow depth).

Constructed Diversion Dimensions:

a. Grade = 1%.
b. Side slopes of channel is 6:1 both sides, back slope of ridge is 6:1 from the standard and for maintenance reasons, ridge top width is 4 ft. from the standard.
c. Bottom width of the channel is 16 feet.
d. Depth from bottom of the channel to top of ridge is: 0.85 ft. for flow depth plus 0.50 ft. for freeboard plus 0.10 ft. for settlement equals a constructed depth of 1.45 ft., round up to 1.50 feet.



Waterway Example Problem:

A waterway is to be constructed to convey water through an apartment complex. It will be located in an area where the grass will be mowed once a year and needed fertilization and repairs made on an annual basis. From the soil survey report the waterway will be constructed on Reaville silt loam. The waterway will have a grade of 4.5%. The peak flow from the 10 year frequency storm is 63 cfs.

Waterway Example Problem Solution:

The maximum permissible velocity from page 4.32 for a silt loam soil with a good stand of vegetation is 3.0 ft. per second. The appropriate retardance factors are C and D, since during the year the height of the grass will vary between 2 inches immediately after cutting and 10 inches when it has not been cut. A good stand of vegetation will be maintained by annual fertilization and maintenance. Select a parabolic shape for the waterway to keep low flows from meandering and to provide a shape easy to mow and cross with equipment.

We now have:

grade of the waterway = 4.5%
design capacity = 63 cfs
maximum allowable velocity = 3.0 fps
vegetative retardance factors = C and D
channel shape = parabolic.

First, design for stability using retardance factor D.
Enter Figure A6-3 with V = 3.0 fps and slope = 4.5%, find maximum allowable R = 0.39.
The cross sectional flow area required is Q/V = 63/3 = 21.0 sq. ft.
Enter Figure A6-14 with A = 21.0 and R = 0.39, find top width (t) = 55 ft. and depth (d) = 0.58 ft.

Second, design for capacity using retardance factor C
A trial and error procedure is necessary for a parabolic channel with the channel shape determined by d = 0.58 ft. and t = 55 ft. Enter Figure A6-15 and find a point on the pivot line. This point remains fixed for this channel.

Trial #1

Try d = 0.8 ft. for retardance factor C.
From Figure A6-15 using the fixed point on the pivot line for this channel and d = 0.8 ft., find t = 65 ft. From Figure A6-14 find R = 0.55 and A = 35.
Enter Figure A6-2 with R = 0.55 and S = 4.5% and find V = 3.5 fps. Then Q = VA = (3.5)(35) = 122.5 cfs.
This is greater than the required Q of 63 cfs, therefore try a shallower depth.

Trial #2

Try d = 0.7 ft.
From Figure A6-15 using d = 0.70 and the fixed point for this channel, find t = 60.
From Figure A6-14 find R = 0.47 and A = 28.
From Figure A6-2 with R = 0.47 and S = 4.5% find V = 2.5 fps.
Then Q = VA = (2.5)(28) = 70 cfs.
The calculated capacity is slightly greater than required, therefore use these dimensions.

The design channel dimensions are:

grade = 4.5%
parabolic shape with depth (d) = 0.7 ft. and top width, (t) = 60 ft.

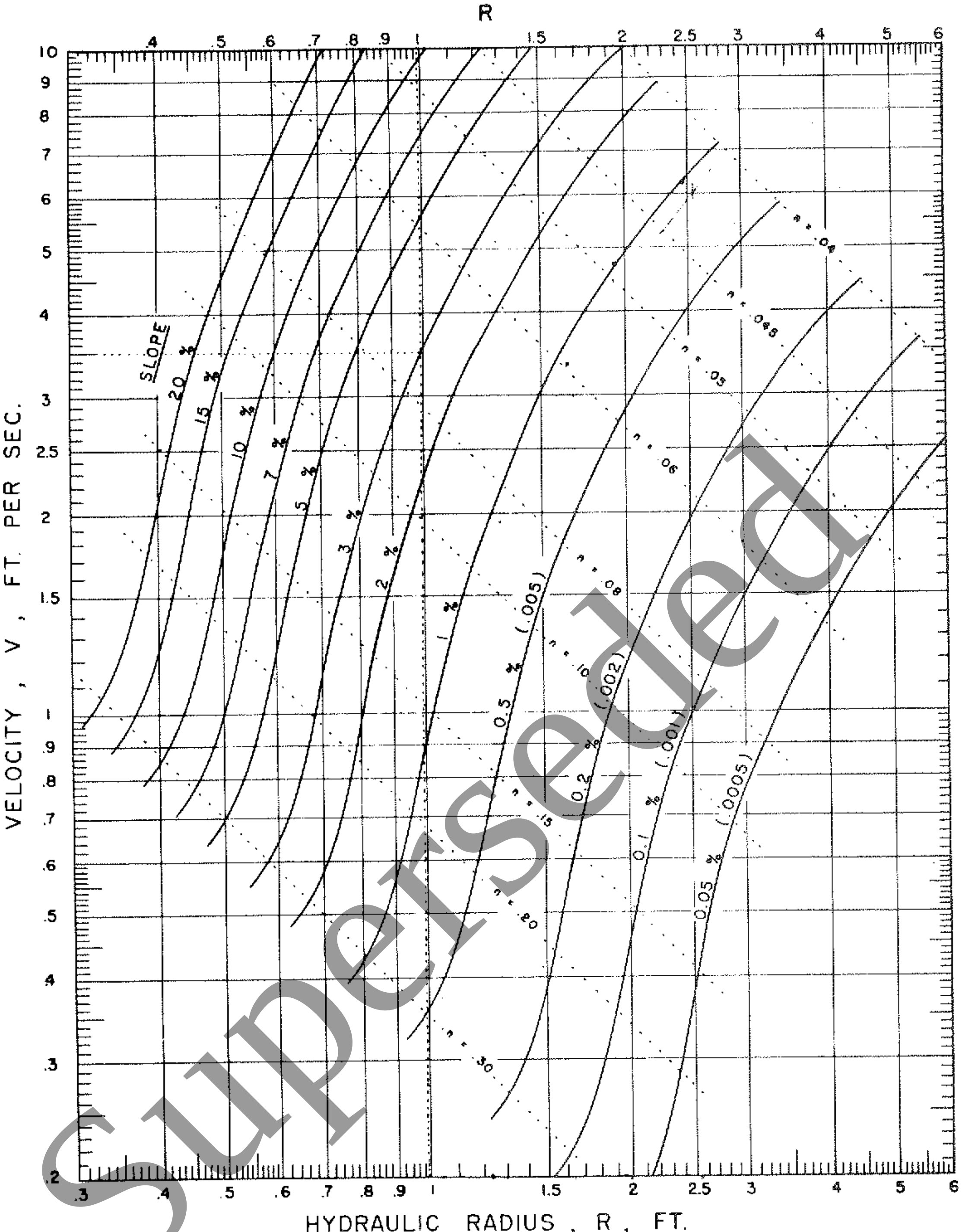


FIGURE A6-1

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE B (HIGH VEGETAL RETARDANCE)

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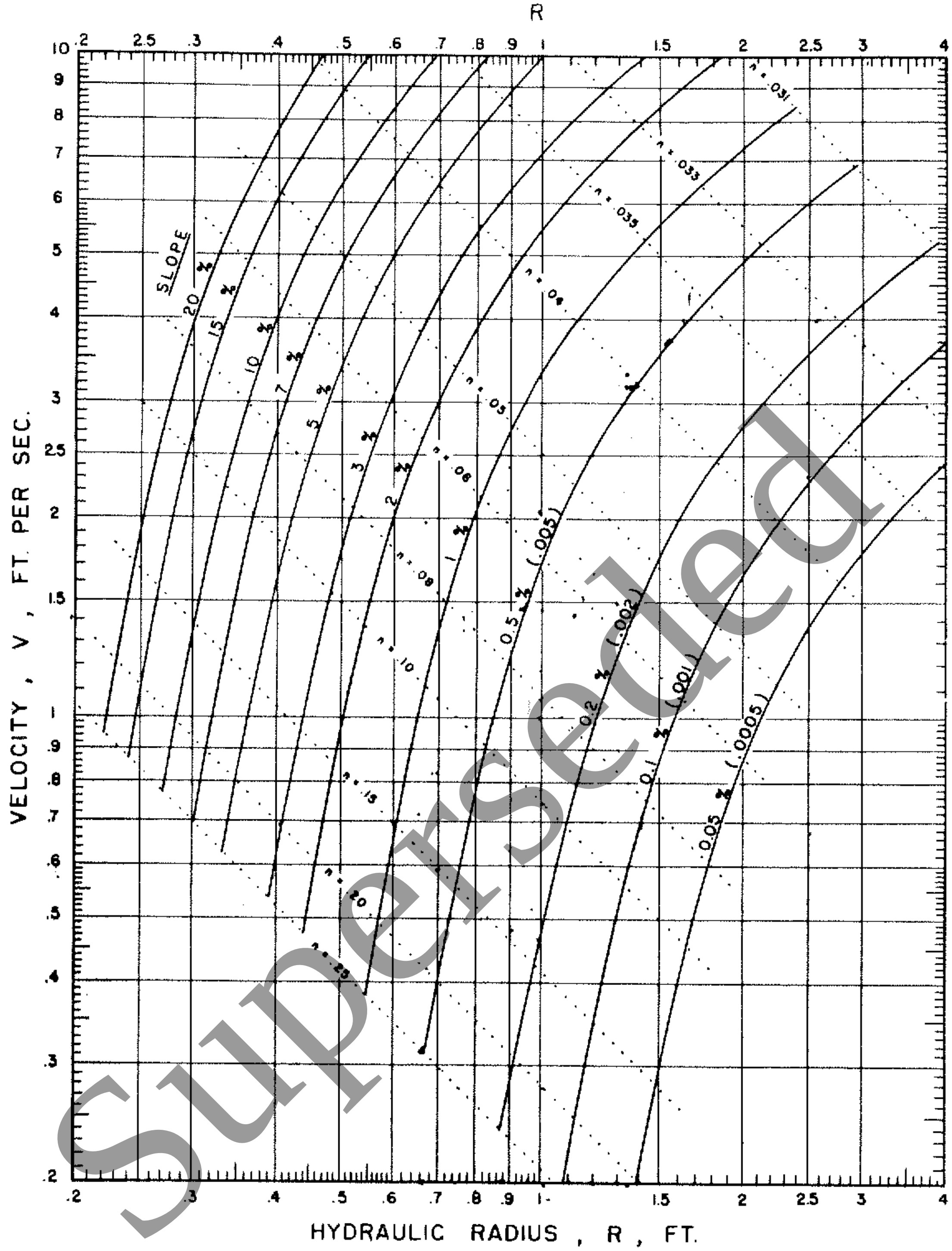

FIGURE A6-2

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE C (MODERATE VEGETAL RETARDANCE)

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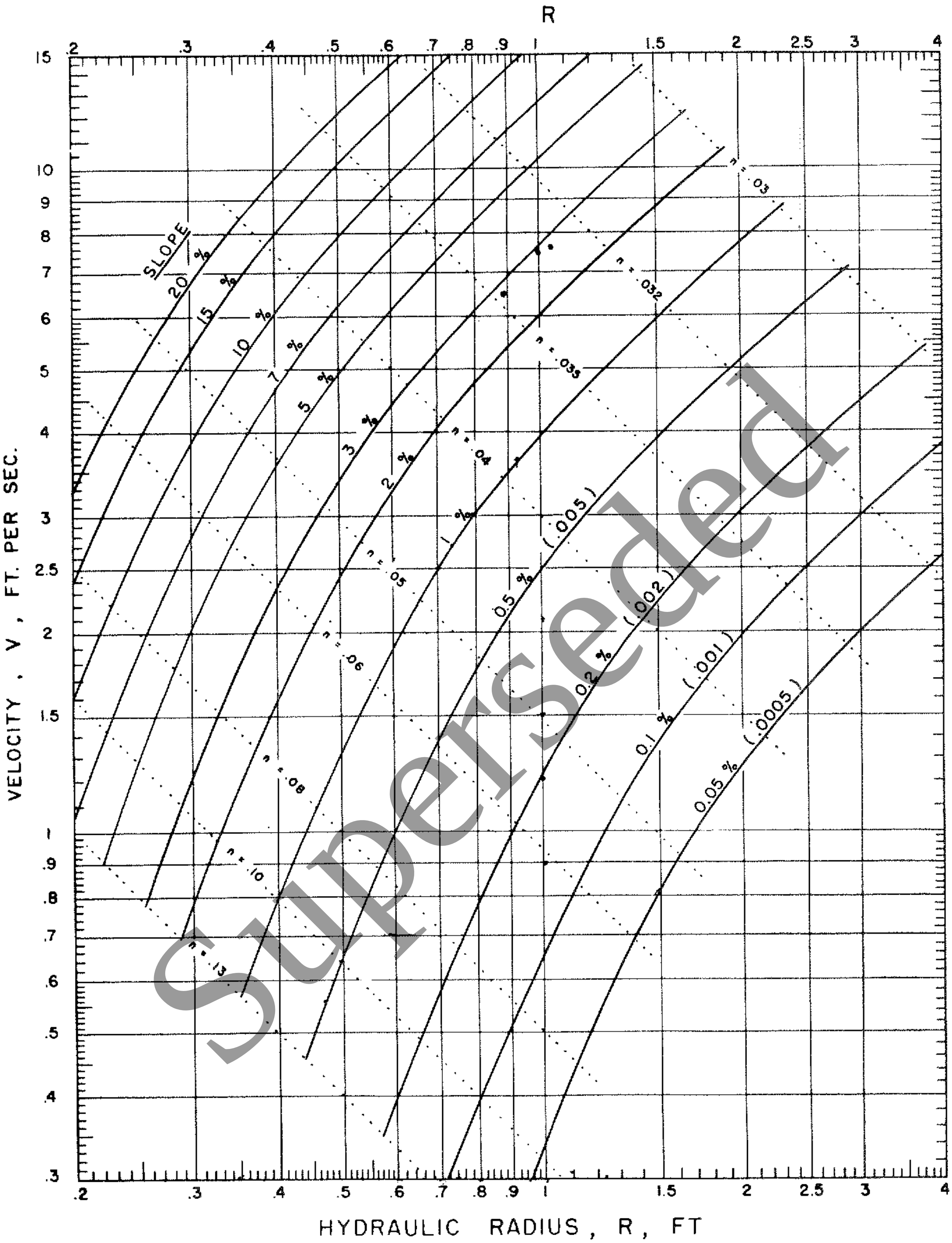


FIGURE A6-3

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE D (LOW VEGETAL RETARDANCE)

 Published July 1980

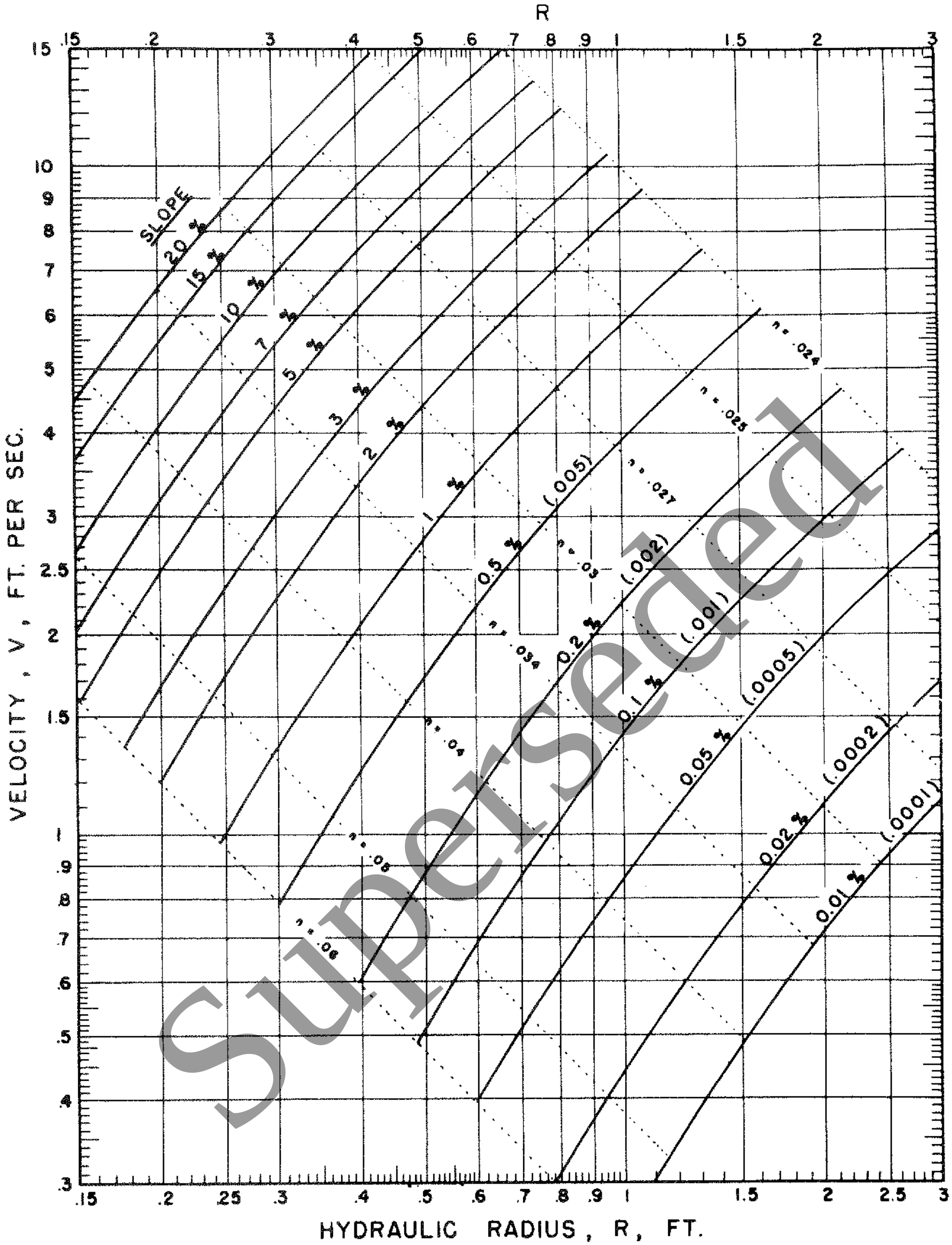


FIGURE A6-4

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE E (VERY LOW VEGETAL RETARDANCE)

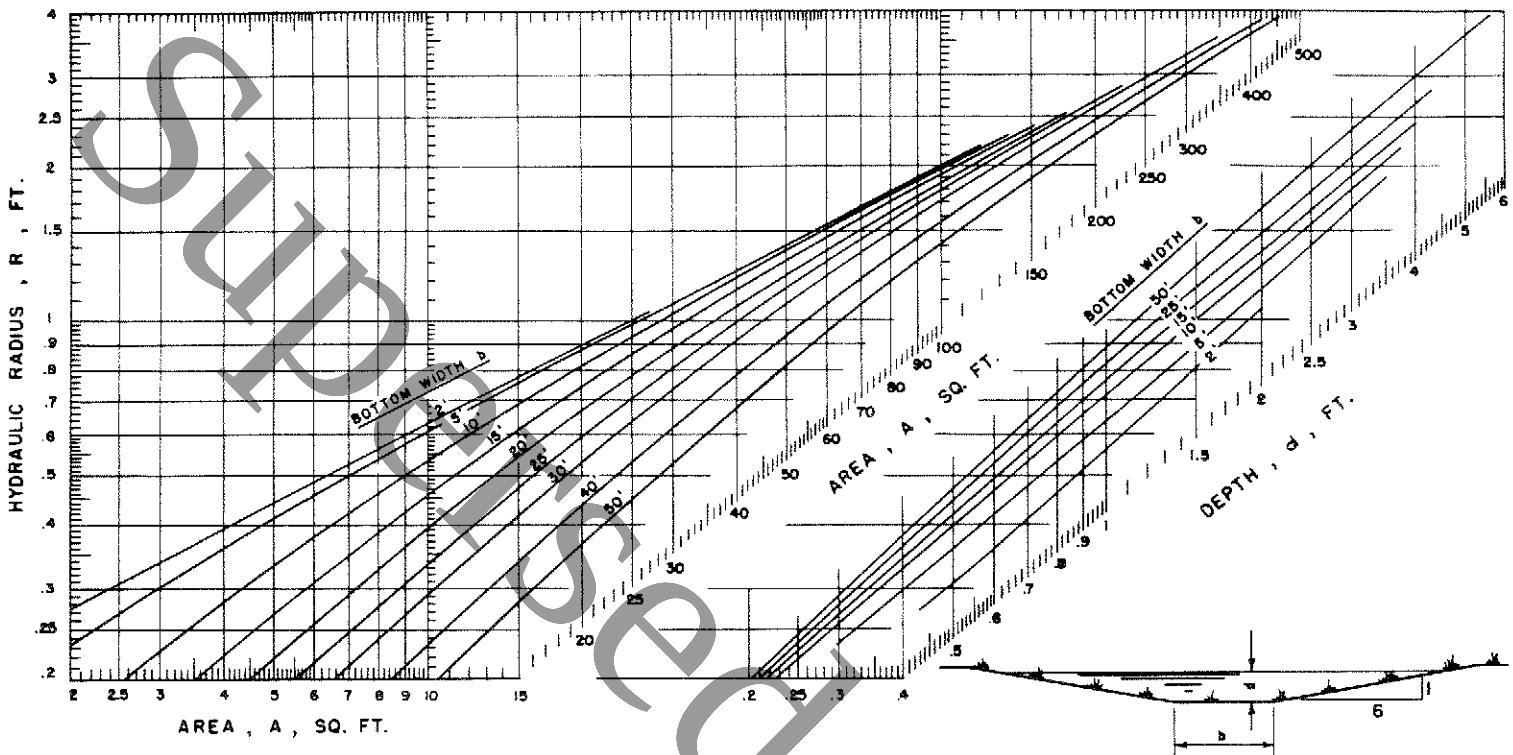


FIGURE A6-5

DIMENSIONS OF TRAPEZIODAL CHANNELS WITH 6 TO 1 SIDE SLOPES

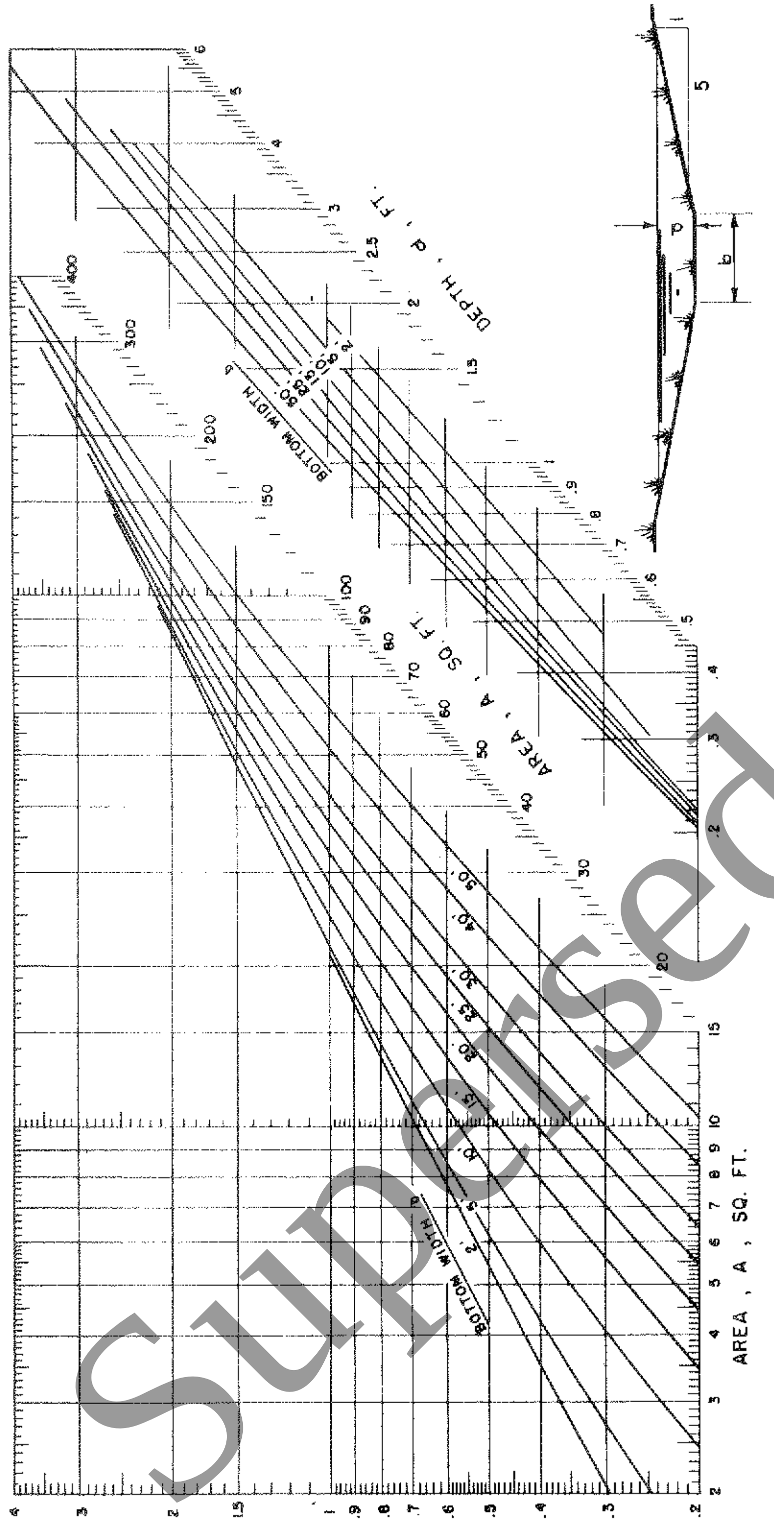


FIGURE A6-6

DIMENSIONS OF TRAPEZIODAL CHANNELS WITH 5 TO 1 SIDE SLOPES

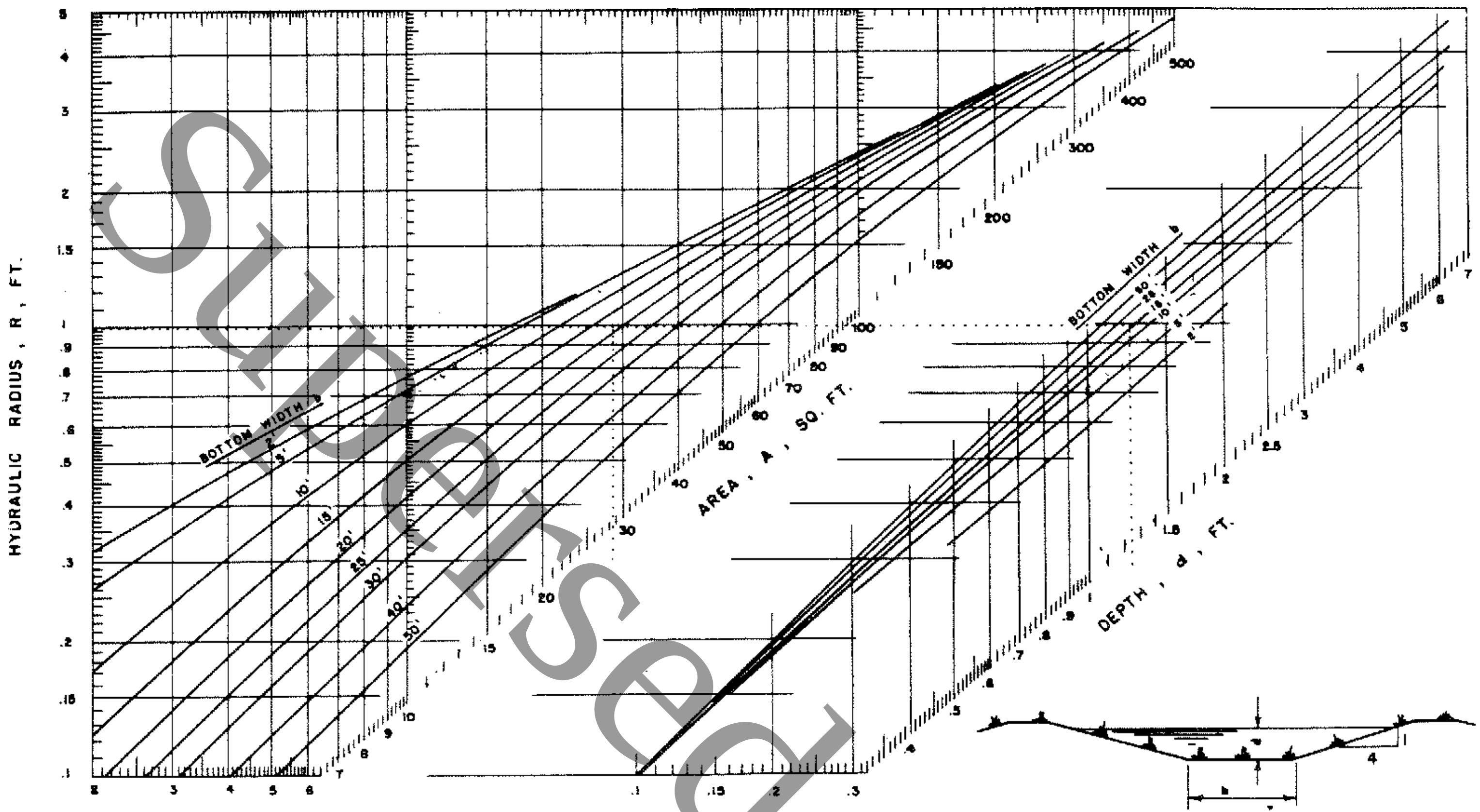


FIGURE A6-7

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 4 TO 1 SIDE SLOPES

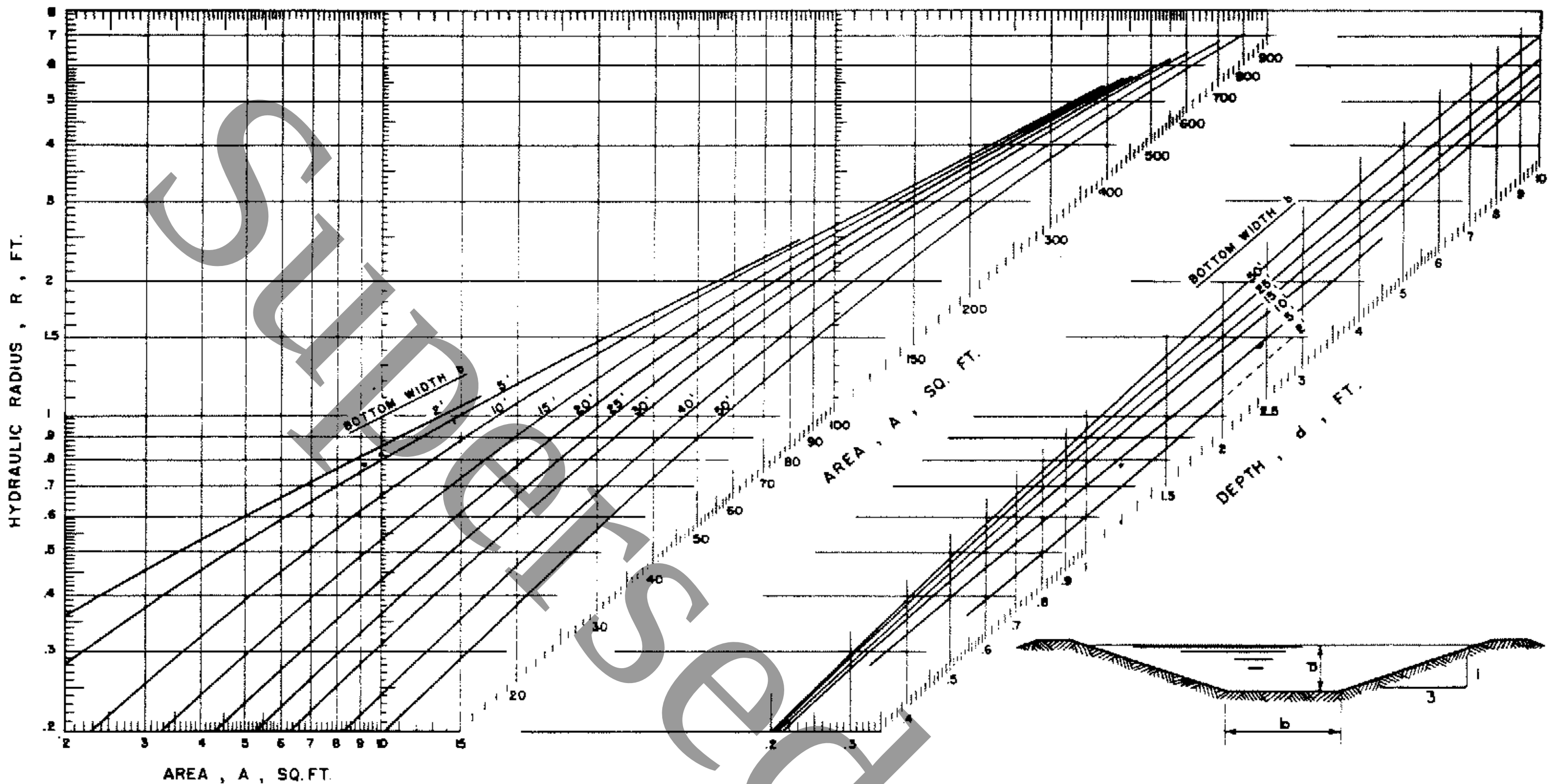


FIGURE A6-8

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 3 TO 1 SIDE SLOPES

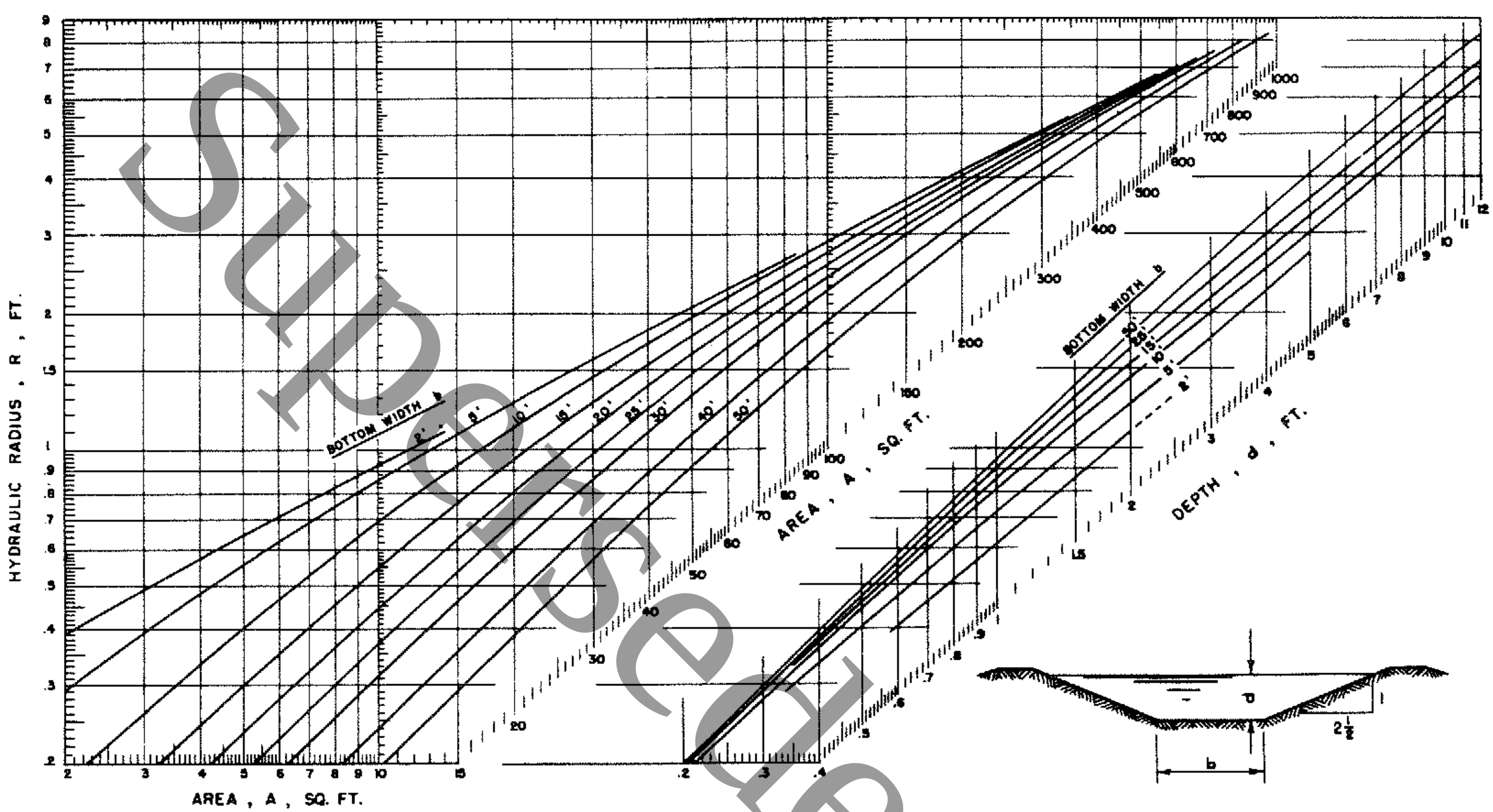


FIGURE A6-9

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 2-1/2 TO 1 SIDE SLOPES

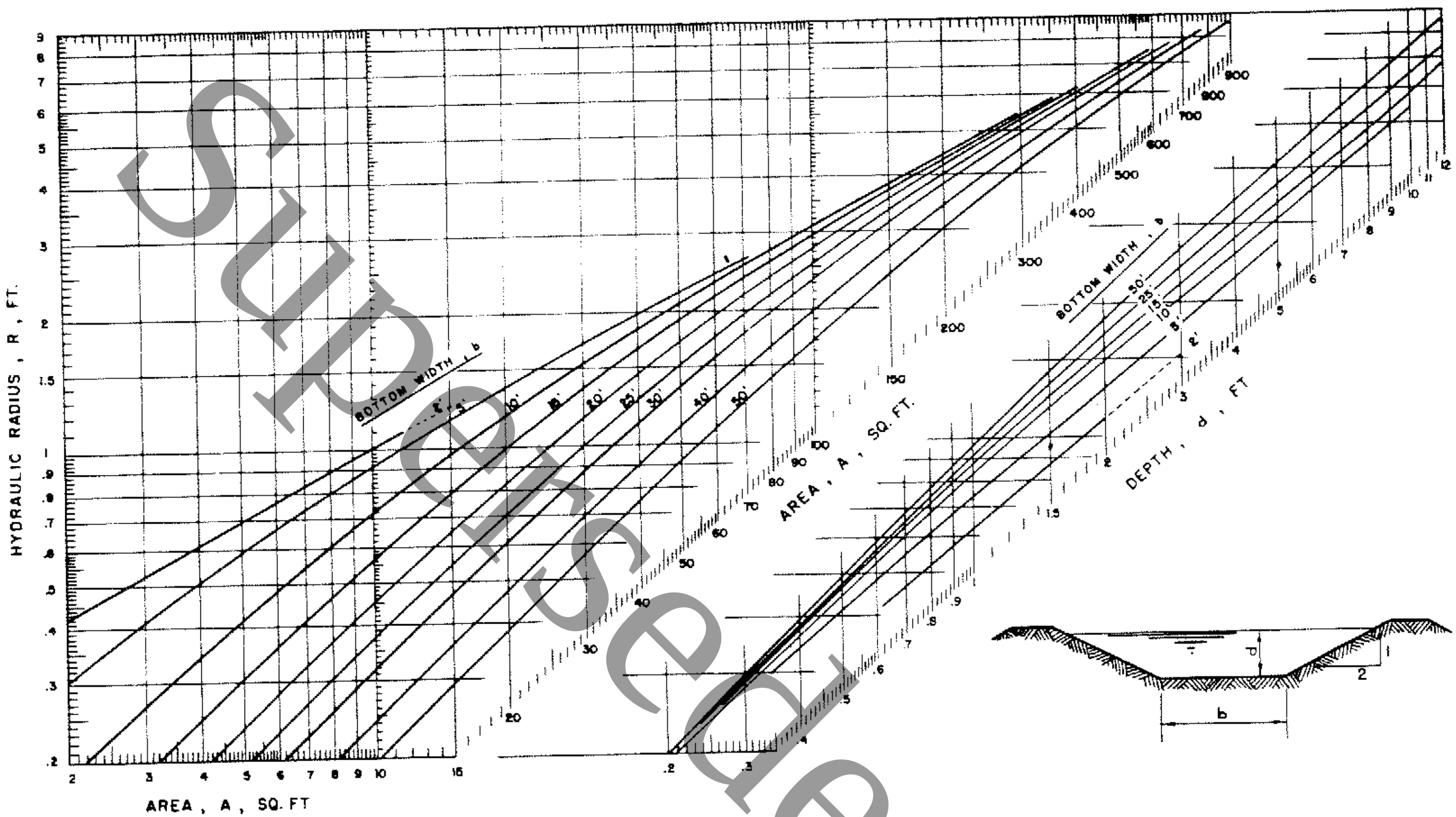


FIGURE A6-10

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 2 TO 1 SIDE SLOPES

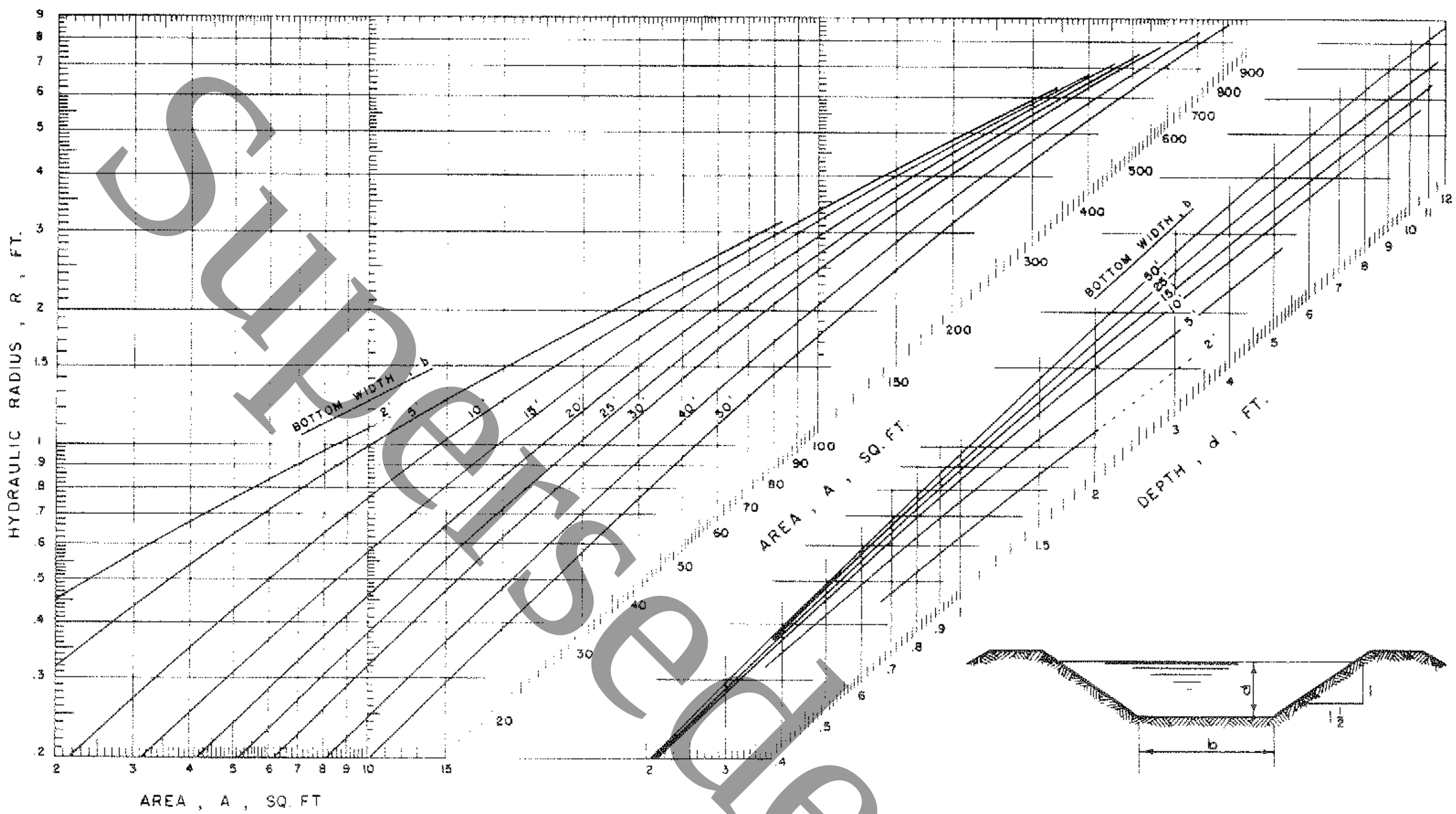


FIGURE A6-11

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 1-1/2 TO 1 SIDE SLOPES

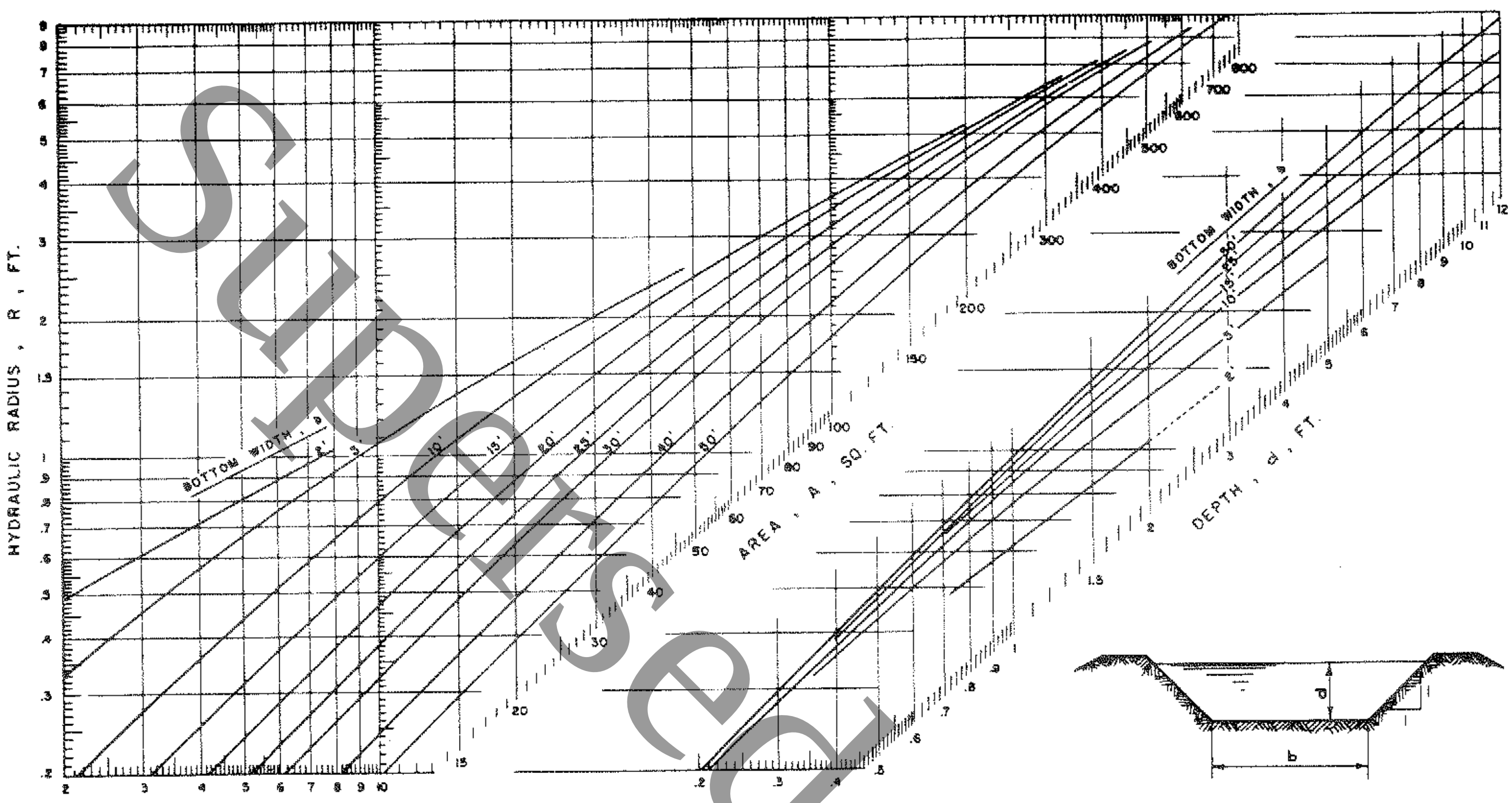


FIGURE A6-12

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 1 TO 1 SIDE SLOPES

Published July 1980

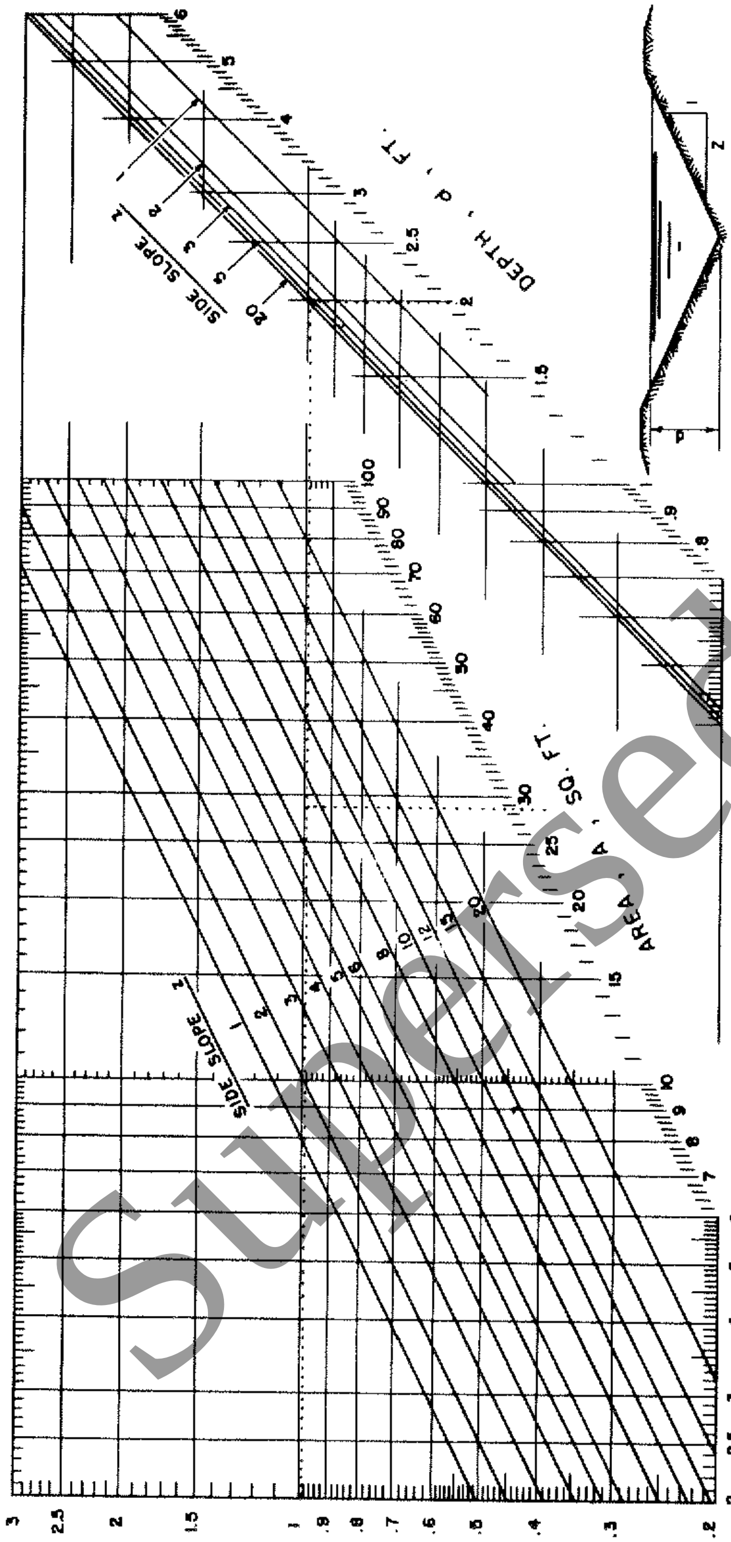
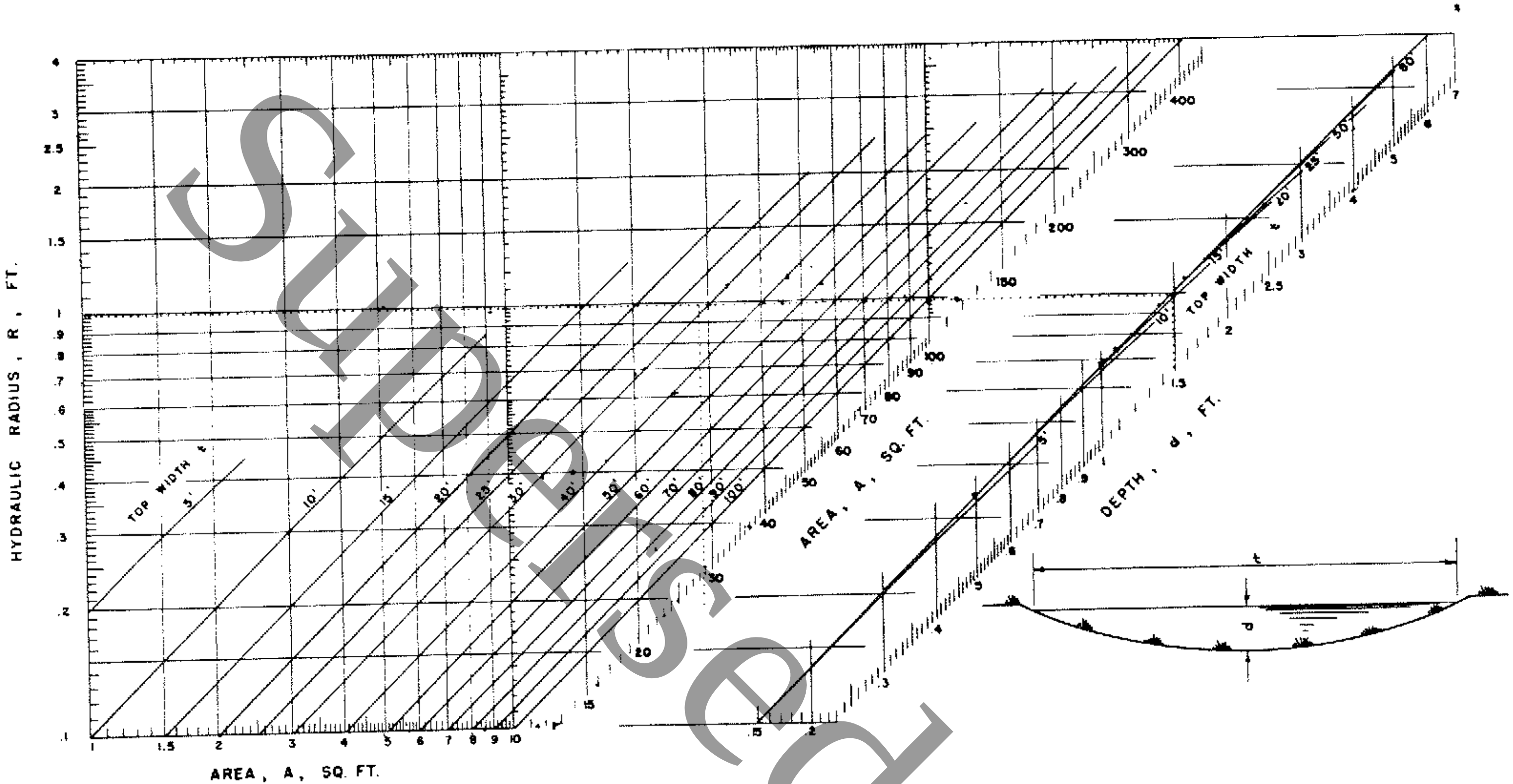


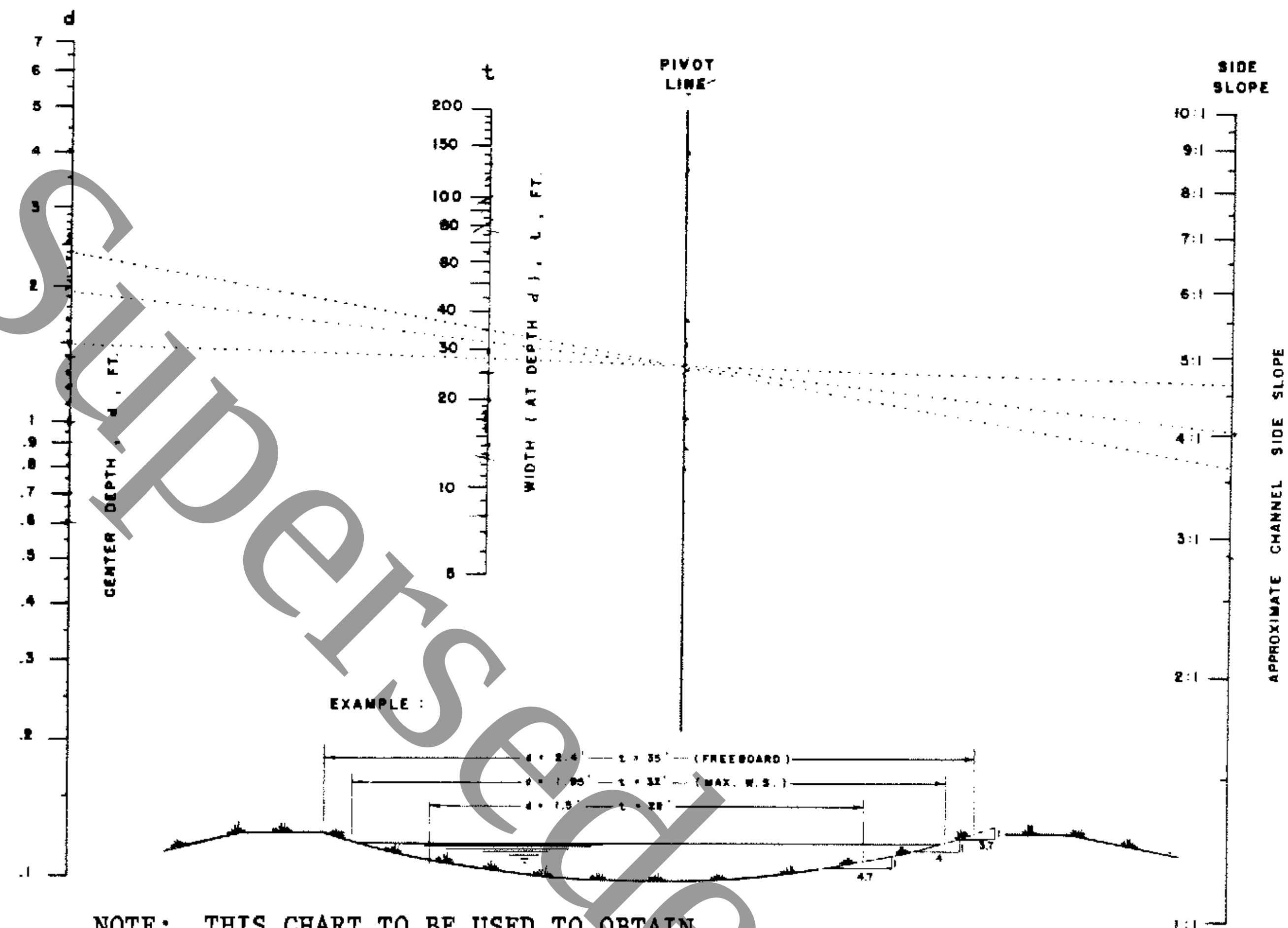
FIGURE A6-13
DIMENSIONS OF TRIANGULAR CHANNELS



NOTE: THIS CHART TO BE USED IN CONJUNCTION WITH THE NOMOGRAPHIC SOLUTION (FIG. A6-15)

FIGURE A6-14

DIMENSIONS OF PARABOLIC CHANNELS



NOTE: THIS CHART TO BE USED TO OBTAIN OTHER DIMENSIONS AFTER t AND d FOR MAXIMUM FLOW HAVE BEEN DETERMINED (FROM FIG. A6-14)

FIGURE A6-15

SOLUTION FOR DIMENSIONS OF PARABOLIC CHANNELS

APPENDIX A7

DETERMINING VOLUME IN A SEDIMENT BASIN TO MEET TRAP EFFICIENCY, SEDIMENT STORAGE AND TEMPORARY FLOODWATER STORAGE REQUIREMENTS

Sample Problem #1

At Toms River in Ocean County, 100 acres drains into a planned sediment basin. Failure of the sediment basin at the planned site will not result in loss of life or damage to buildings, roads, railroads or utilities. 10 acres are to be cleared and developed into houses. 90 acres are in woods and will not be disturbed during the life of the sediment basin. It is estimated it will take 18 months to develop the site. The sediment basin will be installed as the first item of construction and removed as the last item of construction. The owner estimates that the 10 acres to be developed will be bare for 12 months and under roofs, pavement, and sod for the last 6 months of construction. The soils are Woodmansie sand. The sediment pool will be normally dry.

I. Determine minimum basin volume to meet the 70% trap efficiency requirement. Set trap efficiency at 75% to meet actual trap efficiency requirement of 70% for a dry sediment pool with coarse sediment. As required by the standard in the section on Trap Efficiency.

Enter Curve 4.4-1 with 75%. Find C/I = 0.025 using curve for coarse grained sediments. From Figure 4.4-1 average annual surface runoff for Toms River is 25 inches; I = (25 in) (1 ft/12 in) (100 ac)
I = 208.3 Ac ft

C = (208.3 ac. ft.) (0.025)
C = 5.21 ac. ft. = minimum volume in the sediment basin below emergency spillway elevation to obtain 70% trap efficiency with a dry pool.

II. Determine minimum basin volume to meet the requirements for sediment storage and temporary floodwater storage.

1. Determine volume for sediment storage using Method 2 in the standard under Sediment Storage Capacity.

a. Determine, DA and A, Drainage Area and Average Annual Erosion

1st year

Woods
(DA) (A) = 90 ac x 0.2 tons/ac/yr = 18 tons/yr
Construction Area
(DA) (A) = 10 ac x 60 tons = 600 tons/yr
(DA) (A) = 618 tons for the 1st year.

2nd year

Woods(DA) (A) = 90 ac x 0.2 tons/ac/yr = 18 tons/yr
Urban Area
(DA) (A) = 10 ac x 1.0 tons/ac/yr = 10 tons/yr
(DA) (A) = (18 + 10) (1/2) = 14 tons for 2nd year for six month life.
(DA) (A) = 618 + 14 = 632 tons for the life of the basin.

b. Determine DR, delivery ratio

100/640 = 0.16 sq mi from Curve 4.4-2 for a sandy soil, DR = 24%

c. Determine γ, density of the sediment. From Table 4.4-1 the density of aerated sand is 85-100 lbs/ cu ft., Use γ = 90 lbs/cu ft.

d. Determine minimum volume for sediment storage for the planned life of the structure.
V = (DA)(A)(DR)(TE) (1/γ) (2,000 lbs/ton) (1/43,560 sq. ft./ac.)
V = (632)(0.24)(0.70)(1/90)(2,000)(1/43,560)
V = 0.054 Ac. ft.

2. Determine minimum volume for temporary floodwater storage.

a. The standard requires that we have at least 1 foot between the crest of the principal spillway and the crest of the emergency spillway and that the runoff from the 2 year frequency 24 hour duration storm not cause flow in the emergency spillway. See the sections in the standard on Sediment Basin Volume and Principal Spillway.

b. The 2 year 24 hour rainfall is 3.5 inches and the hydrologic soil group for Woodmansie sand is B from reference #1.

c. From, reference #9, Urban Hyrdology for Small Watersheds. The runoff curve number is 58. The runoff is 0.45 watershed inches from a 2 yr 24 hr storm.

d. The size of principal spillway pipe selected will have an effect on the volume of temporary floodwater storage required. For this site we selected a 18" CMP riser with a 12" CMP outlet. From the site survey and the preliminary layout of the principal spillway we found that the capacity of the spillway is approximately 5 cfs.

e. Using the above principal spillway and the approximate flood routing methods in reference 1, we find that 0.2 watershed inches is required for temporary floodwater storage for the 2 yr 24 hr storm.

f. The minimum volume for temporary floodwater storage using the 12 inch CMP principal spillway is 0.2 watershed inches or converting to ac.ft. is 1.67 ac.ft.

3. The minimum basin volume to meet the requirement for sediment storage capacity and temporary floodwater storage is 0.054 ac.ft + 1.67 ac.ft = 1.72 ac.ft.

III. The standard under Sediment Basin Volume requires that we provide volume for the larger of the two values calculated above under I and II.

The volume for 70% trap efficiency is 5.21 ac.ft. The volume for sediment and temporary floodwater storage is 1.72 ac.ft. Therefore we must provide below the cost of the emergency spillway at least 5.21 ac.ft. of volume.

Sample Problem #2

Same as sample problem #1 except location is Morristown and the soils are Parsippany silt loam.

I. Determine, minimum basin volume to meet the 70% trap efficiency requirement. Set trap efficiency at 80% to meet actual trap efficiency requirement of 70% for a dry sediment pool with fine sediment. From Curve 4.4-1 using curve for fine grained sediment C/I = 0.12. From Figure 4.4-1, I = 23-1/2 inches for Morristown.
I = (23-1/2 in) (1 ft/12 in) (100 ac) = 196 ac. ft.
C = 23.5 ac. ft. = minimum volume for 70% trap efficiency.

II. Determine minimum basin volume to meet the requirements for sediment storage and temporary flood water storage.

1. Determine volume for sediment storage using Method 2 in the standard under Sediment Storage Capacity.

   a. (DA)(A) same as in Sample Problem #1
      (DA)(A) = 618 tons for the 1st year
      (DA)(A) = 14 tons for the 2nd year

   b. Determine, DR, delivery ratio
      The Parsippany soil is described in the soil survey report as a silt loam, clay loam, or silty clay loam at different depths. Therefore in Curve 4.4-2 used the curve for silty clay with 0.16 sq. mi. drainage area, DR = 72%.

   c. Determine, γ, density of sediment. γ = 80 lbs/cu ft, using Table 4.4-1 with clay-silt mixture with more silt than clay.

   d. Determine minimum volume for sediment storage for the planned life structure.

      V = (DA)(A)(DR)(TE)(1/γ)(2,000 lbs./ton) (1/43,560 sq.ft./Ac.)
      V = (618 + 14)(0.72)(0.70)(1/80) (2,000)(1/43,560)
      V = 0.18 ac ft

2. Determine minimum volume for temporary floodwater storage.

   a. The standard requires that we have at least 1 foot between the crest of the principal spillway and the crest of the emergency spillway and that the runoff from the 2 year frequency 24 hour duration storm not cause flow in the emergency spillway. See the sections in the standard on Sediment Basin Volume and Principal Spillway.

   b. The 2 year 24 hour rainfall is 3.3 inches and the hydrologic soil group for Parsippany silt loam is D from reference #1.

   c. From reference #9, Urban Hydrology for Small Watershed, the runoff is 1.42 watershed inches from a 2 yr 24 hr storm.

   d. The size of principal spillway pipe selected will have an effect on the volume of temporary floodwater storage required. For this site we selected a 18" cmp riser with a 12" cmp outlet. From the site survey and the preliminary layout of the principal spillway we found that the capacity of this spillway is approximately 5 cfs.

e. Using the above principal spillway and the approximate flood routing methods in reference 1 we find that 0.9 watershed inches is required for temporary floodwater storage for the 2 yr 24 hr storm.

f. The minimum volume for temporary floodwater storage using the 12 inch cmp principal spillway is 0.9 watershed inches or converting to ac.ft. is 7.5 ac.ft.

3. The minimum basin volume to meet the requirement for sediment storage capacity and temporary floodwater storage is 0.18 ac. ft. + 7.5 ac. ft. = 7.68 ac. ft.

III. The standard under Sediment Basin Volume requires that we provide volume for the larger of the two values calculated above under I and II.

The volume for 70% trap efficiency is 23.5 ac.ft. The volume for sediment and temporary floodwater storage is 7.68 ac.ft. Therefore we must provide below the crest of the emergency spillway at least 23.5 ac. ft. of volume.

Conclusions From Sample Problems

To have a reasonable size sediment basin that is effective, two factors are critical. The total drainage area must be small and the sediment must be coarse textured, or the basin becomes excessively large.

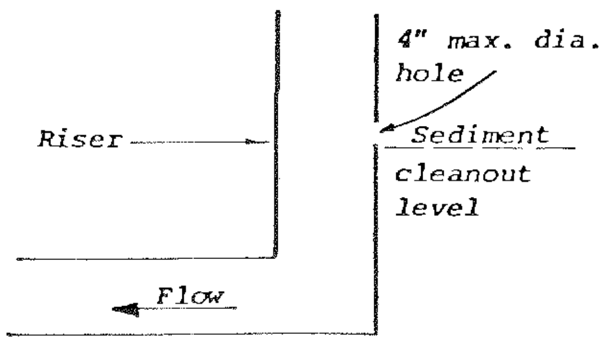
The effect of sediment size is shown by the difference in basin size from sample problem #1 to #2 when changing from a sand typical of South Jersey to a silt-clay typical of North Jersey the minimum basin volume goes from 5.21 ac. ft. to 23.5 ac. ft.

If the soils were silt and clay and the basin was located so the only drainage area was the 10 disturbed acres, the minimum basin volume would be 2.3 ac. ft. With sand sediments and a 10 ac. drainage area, the minimum basin volume would be 0.5 ac. ft.

METHODS OF DEWATERING SEDIMENT BASINS

The dewatering methods shown here are inexpensive and operate automatically.

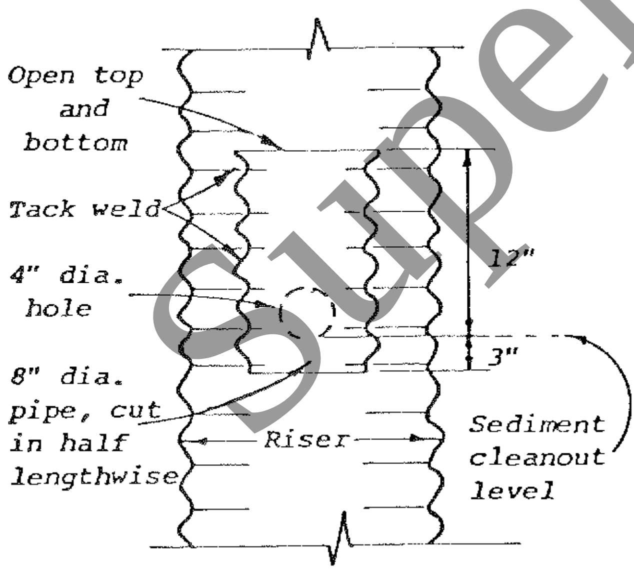
METHOD	COMMENTS
A.	



CROSS-SECTION

Easy to construct
May clog with trash
Non-skimming
Capable of draining down to sediment clean-out level

B. Same as "A" except for skimming device, detailed below:



ELEVATION

Efficient skimmer
Non-clogging
Fairly easy to construct
Capable of draining down to sediment cleanout level

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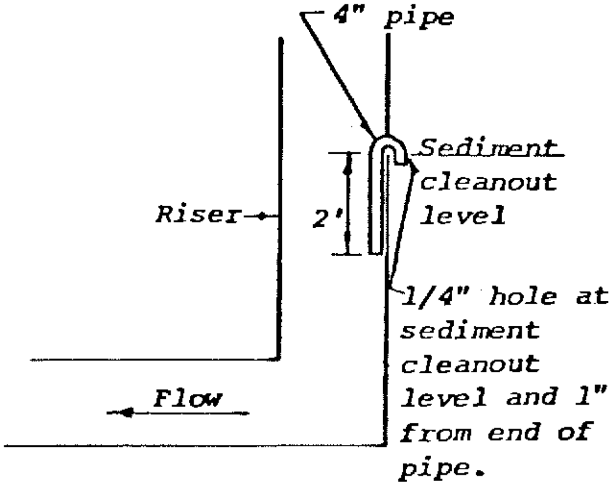
METHOD | COMMENTS

C.

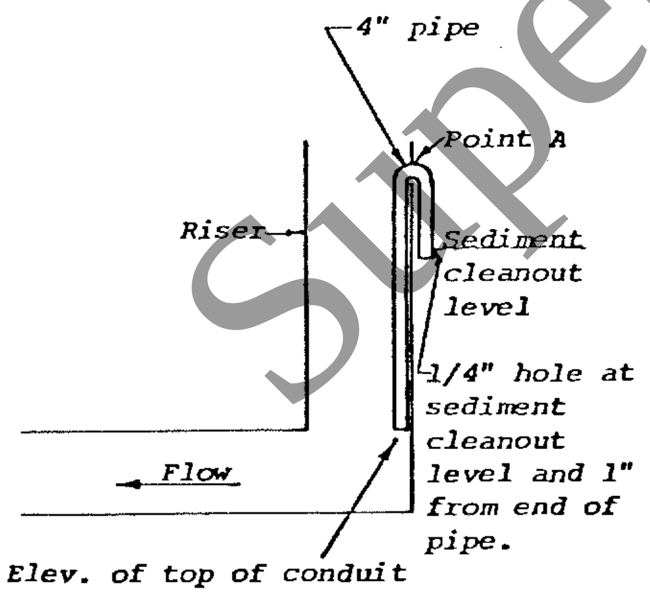


CROSS-SECTION

Efficient skimmer
Capable of always draining down to sediment cleanout level and below

Higher discharge rate than "A" or "B".

D.



CROSS-SECTION

Efficient skimmer
Water must inundate point A to prime siphon. Therefore, small storms will not prime siphon and drain pool down to sediment cleanout level.

Higher discharge rate than "C"

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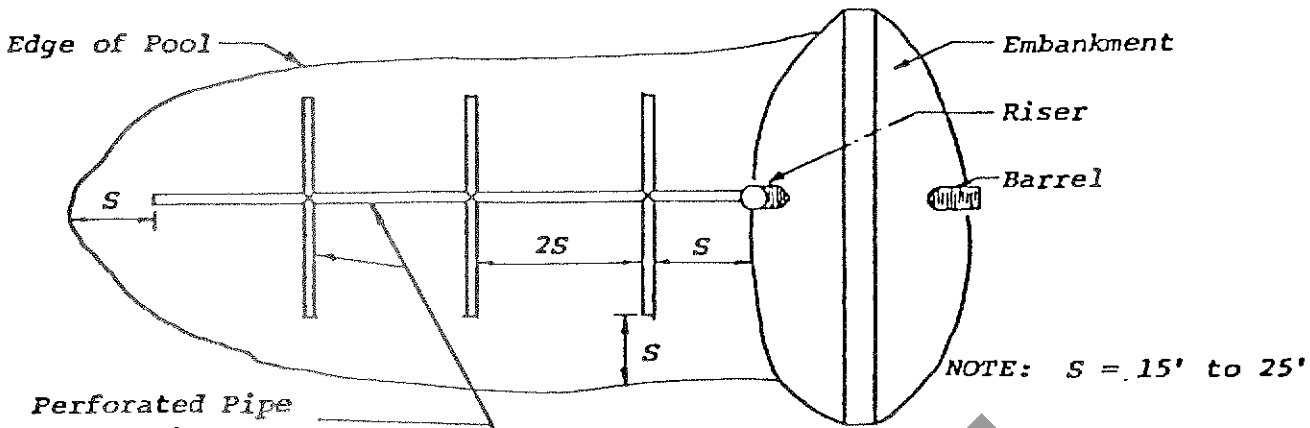
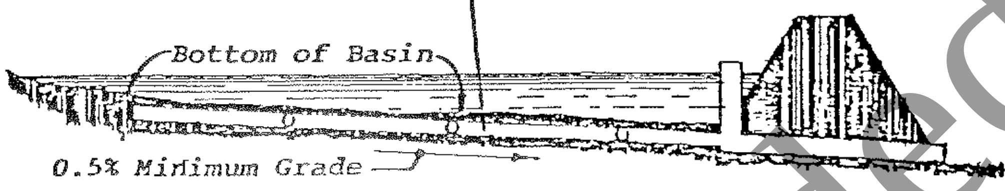
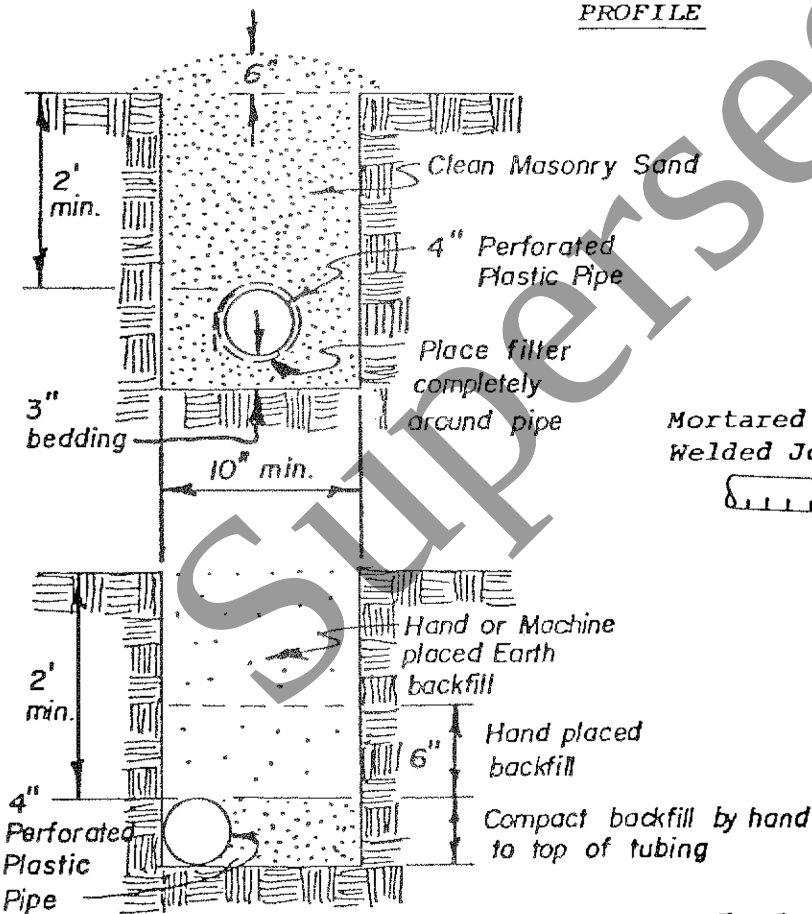
DEWATERING SEDIMENT BASIN WITH SUBSURFACE DRAIN



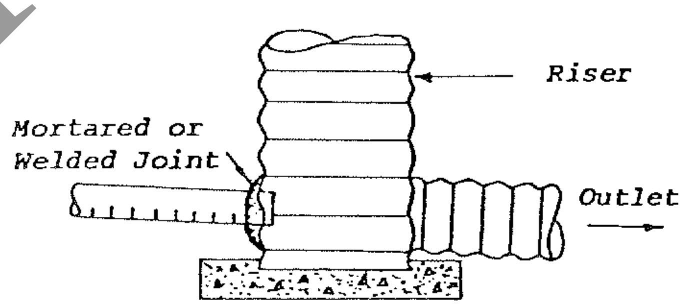
PLAN VIEW



PROFILE



CROSS SECTIONS
DRAIN PIPE IN TRENCH



RISER CONNECTION

Note: For Rapid Dewatering use upper section; When dewatering time is not important, earth may be used for the backfill material as shown in lower section.

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APPENDIX A8
CHANNEL STABILITY EVALUATION

Introduction

The evaluation or design of any water conveyance system that includes earth channels requires knowledge of the relationships between flowing water and the earth materials forming the boundary of the channel, as well as an understanding of the expected stream response when structures, lining, vegetation, or other features are imposed. These relationships may be the controlling factors in determing channel alignment, grade, dimensioning of cross section and selection of design features to assure the operational requirements of the system.

The methods included herein to evaluate channel stability against the flow forces are for bare earth. The magnitude of the channel instability needs to be determined in order to evaluate whether or not structural measures are needed. Where such practices or measures are required, methods of analysis that appropriately evaluate the stream's response should be used.

All terms used in this appendix are defined in the glossary, see page A8.24.

Allowable Velocity Approach

General

This method of testing the erosion resistance of earth channels is based on data collected by several investigators.

Figure A8-1 shows "Allowable Velocities for Unprotected Earth Channels" developed chiefly from data by Fortier and Scobey a1, Lane a2, by investigators in the U.S.S.R. a3, and others.

Stability is influenced by the concentration of fine material carried by the flow in suspension. There are two distinct types of flow depending on concentration of material in suspension.

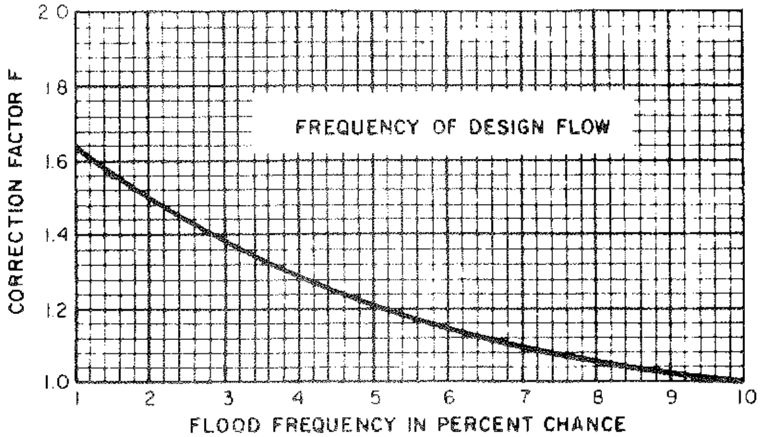
1. Sediment free flow is defined as the condition in which fine material is carried in suspension by the flow at concentrations so low that it has no effect on channel stability. Flows with concentrations lower than 1,000 ppm by weight are treated as sediment free flows.

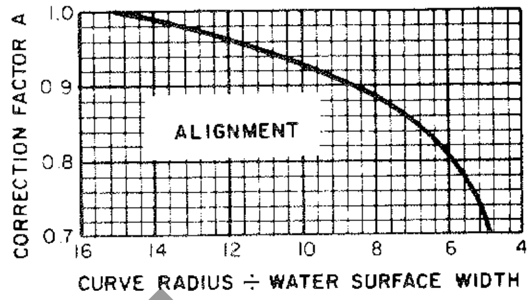
2. Sediment laden flow is the condition in which the flow carries fine material in suspension at moderate to high concentrations so that stability is enhanced either through replacement of dislodged particles or through formation of a protective cover as the result of settling. Flows in this class carry sediment in suspension at concentrations equal or larger than 20,000 ppm by weight.

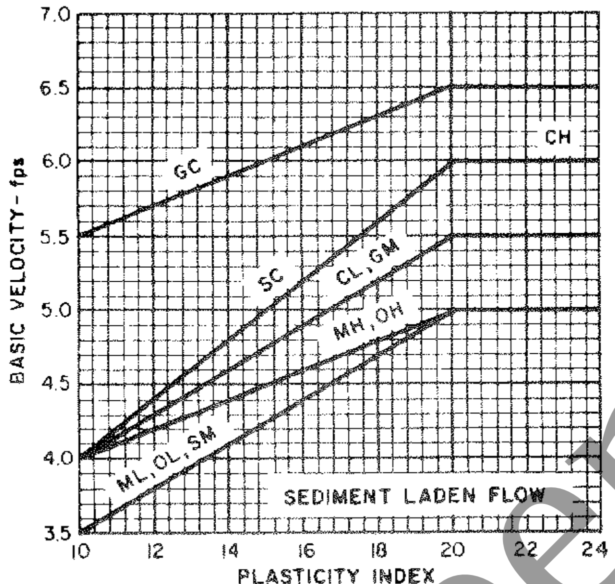
   Sediment transport rates are usually expressed in tons per day. To convert them into concentration use the equation:

$$C = 370 \frac{Qs}{Q} \qquad \text{(Eq. A8-1)}$$

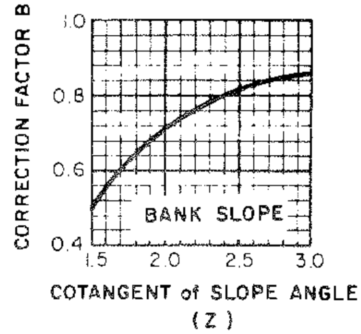
Depending on the type of soil, the effect of concentration of fine sediment (material smaller than 0.074 mm) in suspension on the allowable velocity is obtained from the curves on Figure A8-1.

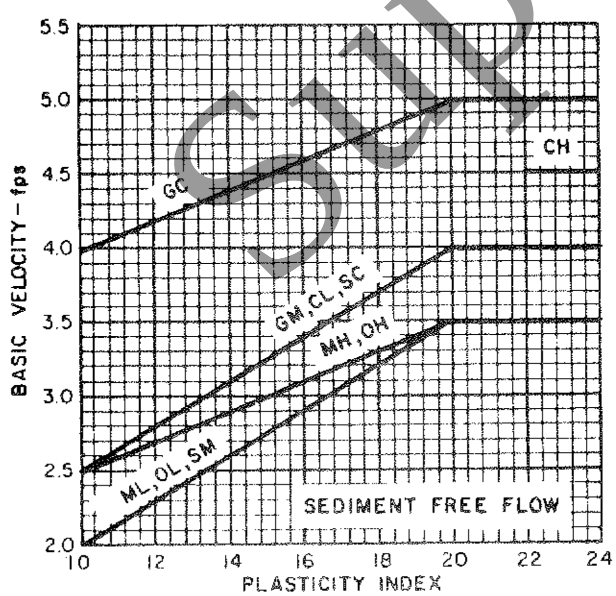




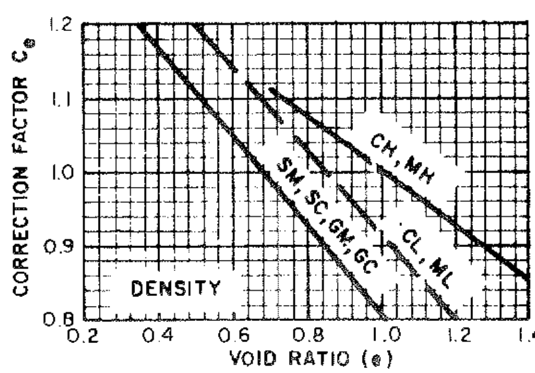


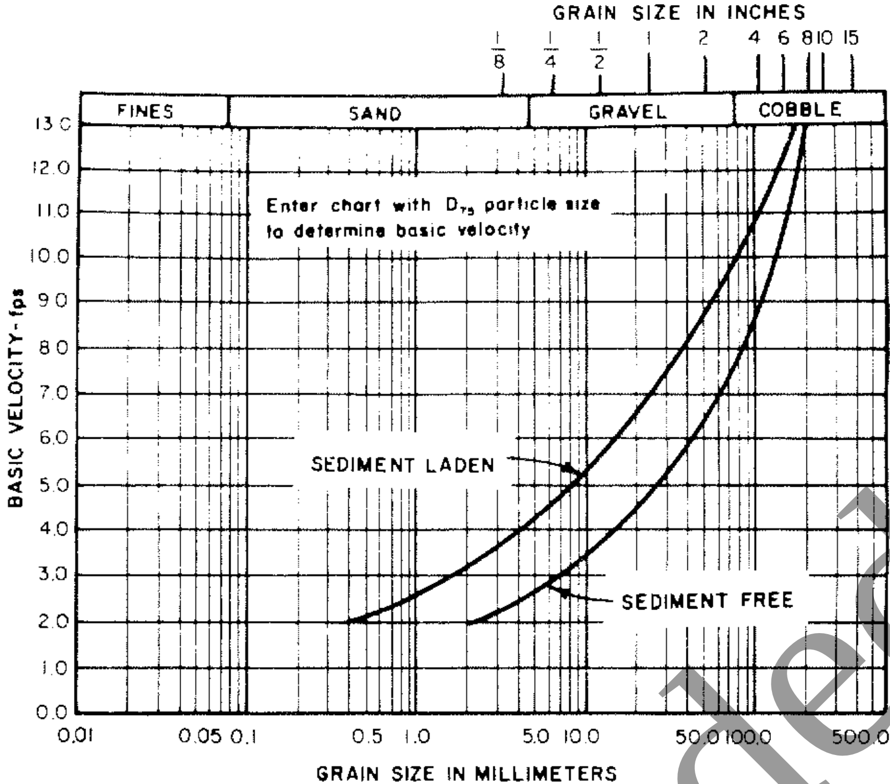
BASIC VELOCITIES FOR COHERENT EARTH MATERIALS (v_b)





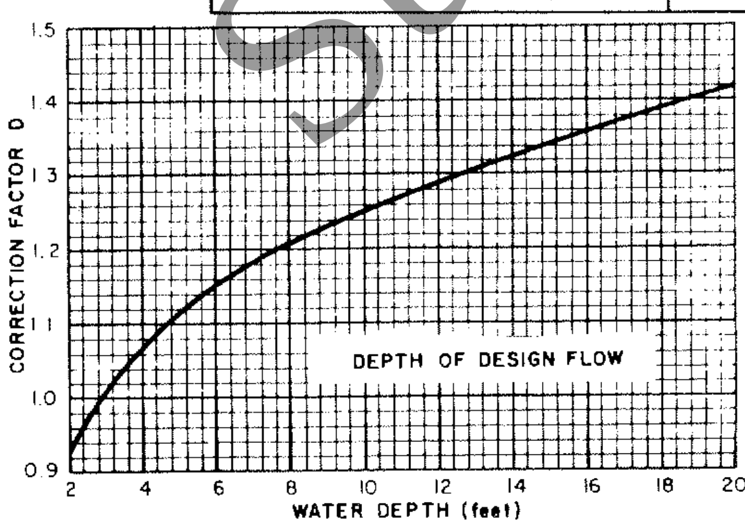
BASIC VELOCITIES FOR COHERENT EARTH MATERIALS (v_b)





BASIC VELOCITY FOR DISCRETE PARTICLES OF EARTH MATERIALS (v_b)

ALLOWABLE VELOCITIES FOR UNPROTECTED EARTH CHANNELS	
CHANNEL BOUNDARY MATERIALS	ALLOWABLE VELOCITY
DISCRETE PARTICLES	
Sediment Laden Flow	
$D_{75} > 0.4$ mm	Basic velocity chart value x D x A x B
$D_{75} < 0.4$ mm	2.0 fps
Sediment Free Flow	
$D_{75} > 2.0$ mm	Basic velocity chart value x D x A x B
$D_{75} < 2.0$ mm	2.0 fps
COHERENT EARTH MATERIALS	
PI > 10	Basic velocity chart value x D x A x F x C_e
PI < 10	2.0 fps



NOTES:

1. In no case should the allowable velocity be exceeded when the 10% chance discharge occurs, regardless of the design flow frequency.

FIGURE A8-1

ALLOWABLE VELOCITIES FOR UNPROTECTED EARTH CHANNELS

If the suspended sediment concentration equals or exceeds 20,000 ppm by weight, use the sediment laden curve on Figure A8-1. If the suspended sediment concentration is 1,000 ppm or less by weight, use the sediment free curve on Figure A8-1. A linear interpolation may be made between these curves for suspended sediment concentrations between 1,000 ppm and 20,000 ppm.

Adjustment in the basic velocity to reflect the modifying effects of frequency of runoff, curvature in alignment, bank slopes, density of bed and bank materials, and depth of flow are made using the adjustment curves on Figure A8-1.

The alignment factor, A, and the depth factor, D, apply to all soil conditions. The bank slope factor, B, applies only to channels in soils that behave as discrete particles. The frequency correction, F, applies only to channels in soils that resist erosion as a coherent mass. The density correction factor, C_e, applies to all soil materials except clean sands and gravels (containing less than 5 percent material passing size #200).

Figure A8-1 gives the correction factors (F) for frequencies of occurrence lower than 10 percent. Channels designed for less frequent flows using this correction factor should be designed to be stable at the 10 percent chance frequency discharge as well as at the design discharge.

If the soils along the channel boundary behave as discrete particles with D_{75} larger than 0.4 mm for sediment laden flow or larger than 2.0 mm for sediment free flow, the allowable velocity is determined by adjusting the basic velocity read from the curves on Figure A8-1 for the effects of alignment, bank slope, and depth. If the soils behave as discrete particles and D_{75} is smaller than 0.4 mm for sediment laden flow or 2.0 mm for sediment free flow the allowable velocity is 2.0 fps. For channels in these soils no adjustments are to be made to the basic velocity of 2.0 fps.

In cases where the soils in the channel boundary resist erosion as a coherent mass, the allowable velocity is determined by adjusting the basic velocity from Figure A8-1 for the effects of depth, alignment, bank slope frequency of occurrence of design flow, and for the density of the boundary soil materials.

Design Procedure for Allowable Velocity Approach

The use of the allowable velocity approach in checking the stability of earth channels involves the following steps:

1. Determine the hydraulics of the system. This includes hydrologic determinations as well as the stage-discharge relationships for the channel considered.

2. Determine the properties of the earth materials forming the banks and bed of the design reach and of the channel upstream.

3. Determine sediment yield to attain and calculate sediment concentration for design flow. In most cases sediment free conditions exist and should be used unless the designer can prove otherwise.

4. Check to see if the allowable velocity procedure is applicable.

5. Compare the design velocities with the allowable velocities from Figure A8-1 for the materials forming the channel boundary.

Examples of Allowable Velocity Approach

Example 1

Given: A channel is to be constructed to convey the flow from a 2 percent chance flood. The hydraulics of the system indicate that a trapezoidal channel with 2:1 side slopes and a 40 foot bottom width will carry the design flow at a depth of 8.7 feet and a velocity of 5.45 fps. Soil investigations reveal that the channel will be excavated in a moderately rounded clean sandy gravel with a D_{75} size of 2.25 inches. Sampling of soils in the drainage area and estimate of erosion and sediment yield indicate that on an average annual basis approximately 1000 tons of sediment finer than 1.0 mm. and 20 tons of material coaser than 1.0 mm are available for transport in channel. The amount of abrasion resulting from the transporting of this small amount of sediment coarser than 1.0mm is considered insignificant. Sediment transport computations indicate all of the sediment supplied to the channel will be transported through the reach. The sediment transport and hydrologic evaluations indicate the design flow will transport the available sediment at a concentration of about 500 ppm. The channel is straight except for one curve with a radius of 600 feet.

Determine:

1. The allowable velocity, V_a, and
2. The stability of the reach.

Solution: Determine basic velocity from Figure A8-1, sediment free curve because sediment concentration of 500 ppm is less than 1,000 ppm.

V_b = 6.7 fps.

Depth correction factor, D = 1.22 (from Figure A8-1).

Bank slope correction, B = 0.72 (from Figure A8-1).

Alignment correction A,

$$\frac{\text{curve radius}}{\text{water surface width}} = \frac{600}{74.8} = 8.02$$

A = 0.89 (from Figure A8-1).

Density correction, C_e, does not apply.

Frequency correction, F, does not apply.

$$V_a \text{ (straight reaches)} = V_b DB = (6.7)(1.22)(0.72) = 5.88 \text{fps}$$

$$V_a \text{ (curved reaches)} = V_b DBA = (6.7)(1.22)(0.72)(0.89) = 5.24 \text{fps}$$

The proposed design velocity of 5.45 fps is less than V_a = 5.88 fps in the straight reaches but greater than V_a = 5.24 fps in the curved reaches. Either the channel alignment or geometry needs to be altered or the curve needs structural protection.

Example 2

Given: A channel is to be constructed to convey the flow from a 2 percent chance flood. The hydraulics of the system indicate that a trapezoidal channel with 2:1 side slopes and a 40 foot bottom width will carry the design flow at a depth of 8.7 feet and a velocity of 5.45 fps. The channel is to be excavated into a silty clay (CL) soil with a Plasticity Index of 18, a dry density of 92 pcf, and a specific gravity of 2.71. Sediment transport evaluations indicate the design flow will have a fairly stable sediment concentration of about 500 ppm with essentially no bed material load larger than 1.0 mm. The channel is straight except for one curve with a radius of 600 feet. The 10 percent chance flood results in a depth of flow of 7.4 feet and a velocity of 4.93 fps.

Determine:

1. The allowable velocity, V_a, and

2. The stability of the reach.

Solution: Sediment concentration of 500 ppm is less than 1,000 ppm therefore it is classed as sediment free flow.

V_b = 3.7 fps (from Figure A8-1)

for the 2 percent chance flood.

Depth correction, D = 1.22 (from Figure A8-1).

Density correction, compute e;

$$e = G \frac{\gamma_w}{\gamma_d} - 1 = \frac{(2.71)(62.4)}{92} - 1 = 0.83$$

C_e = 1.0 (from Figure A8-1).

Frequency correction, F = 1.5 (from Figure A8-1).

Alignment correction A,

$$\frac{\text{Curve radius}}{\text{water surface width}} = \frac{600}{74.8} = 8.02$$

A = 0.89 (from Figure A8-1).

V_a (Straight reach) = $V_b D C_e F$ = (3.7)(1.22)(1.0)(1.5) = 6.77 fps.

V_a (Curved reach) = $V_b D C_e F A$ = (3.7)(1.22)(1.0)(1.5)(0.89) = 6.03 fps.

The design velocity is less than the allowable velocity for the 2 percent chance flow. Check the 10 percent chance flow velocity with no frequency correction against the allowable velocity for the 10 percent chance flow.

V_a (Straight reaches) = $V_b D C_e$ = (3.7)(1.19)(1.0) = 4.40 fps.

V_a (Curved reaches) = $V_b D C_e A$ = (3.7)(1.19)(1.0)(0.90) = 3.96 fps.

The allowable velocity with no frequency correction is exceeded by the 10 percent chance flow velocity. Channel alignment, slope or geometry must be altered or the channel must be protected.

Tractive Stress Approach

General

The tractive force is the tangential pull of flowing water on the wetted channel boundary; it is equal to the total friction force that resists flow but acts in the opposite direction. Tractive stress is the tractive force per uint area of the boundary. The tractive force is expressed in units of pounds, while tractive stress is expressed in units of pounds per square foot. The tractive force in a prismatic channel reach is equal to the weight of the fluid prism multiplied by the energy gradient.

The tractive stress approach to channel stability analysis provides a method to evaluate the stress at the interface between flowing water and the materials in the channel boundary.

The method for obtaining the actual tractive stress acting on the bed or sides of a channel and the allowable tractive stress depends on the D_{75} size of the materials involved. When coarse grained discrete particle soils are involved Lane's a2 method is used. When fine grained soils are involved, a method derived from the work of Keulegan and modified by Einstein a4, and Vanoni and Brooks a5 is used. The separation size for this determination is D_{75} - 1/4 inch.

Coarse-grained Discrete Particle Soils - $D_{75} > 1/4$ inch - Lane's Method

A. Determination of Actual Tractive Stress

1. Actual tractive stress in an infinitely wide channel.

   Generally, Manning's roughness coefficient "n" reflects the overall impedence to flow including grain roughness, form roughness, vegetation, curved alignment, etc. Lane's a2 work showed that for soils with a D_{75}, size between 0.25" (6.35 mm) and 5.0" (127mm) the value of Manning's coefficient n resulting from the roughness of the soil particles is determined by:

   $$n_t = \frac{D_{75}^{1/6}}{39}$$ with D_{75} expressed in inches (Eq. A8-2)

The value of n_t determined by the equation above represents the retardance to flow caused by roughness of the soil grains.

The value of n_t can be used to compute s_t, the friction gradient associated with the particular boundary material being considered.

$$s_t = \left(\frac{n_t}{n}\right)^2 s_e \qquad \text{(Eq. A8-3)}$$

The tractive stress acting on the soil grains in an infinitely wide channel is found by:

$$\tau_\infty = \gamma_w d s_t \qquad \text{(Eq. A8-4)}$$

where the terms are as defined in the glossary.

2. Distribution of the tractive stress along the channel perimeter:

   In open channels the tractive stresses are not distributed uniformly along the perimeter. Laboratory experiments and field observations have indicated that in trapezoidal channels the stresses are very small near the water surface and near the corners of the channel and assume their maximum value near the center of the bed. The maximum value on the banks occurs near the lower third point.

Figure A8-2 and A8-3 give the maximum tractive stresses in a trapezoidal channel in relation to the tractive stress in an infinitely wide channel having the same depth of flow and value of s_t.

3. Tractive stresses on curved reaches:

Curves in channels cause the maximum tractive stresses to increase above those in straight channels. The maximum tractive stresses in a channel with a single curve occur on the inside bank in the upstream portion of the curve and near the outer bank downstream from the curve. Compounding of curves in a channel complicates the flow pattern and causes a compounding of the maximum tractive stresses.

Figure A8-4 gives values of maximum tractive stresses based on judgment coupled with very limited experimental data. It does not show the effect of depth of flow and length of curve and its use is only justified until more accurate information is obtained. Figure A8-5 with a similar degree of accuracy, gives the maximum tractive stresses at various distances downstream from the curve.

B. Allowable Tractive Stress

The allowable tractive stress for channel beds, τ_{Lb}, composed of soil particles with discrete, single grain behavior with a given D_{75} is:

$$\tau_{Lb} = 0.4\ D_{75}$$

When $0.25 \text{ in.} < D_{75} < 5.0 \text{ in.}$ (Eq. A8-5)

The allowable tractive stress for channel sides, τ_{Ls} is less than that of the same material in the bed of the channel because the gravity force aids the tractive stress in moving the materials. The allowable tractive stress for channel sides composed of soil particles behaving as discrete single grain materials, considering the effect of the side slope z and the angle of repose ϕ_R with the horizontal is

$$\tau_{Ls} = 0.4\ K\ D_{75} \ .\ .\ .\ .\ 0.25 \text{ in.} < D_{75} < 5.0 \text{ in.} \qquad \text{(Eq. A8-6)}$$

Where: $$K = \sqrt{\frac{z^2 - \cot^2 \phi_R}{1 + z^2}} \ .\ .\ . \qquad \text{(Eq. A8-7)}$$

Figure A8-6 gives an evaluation of the angles of repose corresponding to the degree of angularity of the material. Figure A8-7 gives values of K from Equation A8-7.

When the unit weight γ_s of the constituents of the material having a grain size larger than the D_{75} size is significantly different than 160 lb/ft^3, the limiting tractive stress τ_{Lb} and τ_{Ls} as given by Equations (A8-5) and (A8-6) should be multiplied by the factor.

$$T = \frac{\gamma_s - \gamma_w}{97.6} \qquad \text{(Eq. A8-8)}$$

<u>Fine Grained Soils - D_{75} < 1/4 inch</u>

A. Determination of Actual Tractive Stress

1. Reference tractive stress -
The expression for reference tractive stress is:

$$\tau = \gamma_w R_t s_e \qquad \text{(Eq. A8-9)}$$

REFERENCE:
Bureau of Reclamation "Progress Report on Results of Studies on Design of Stable Channels" Hyd-352

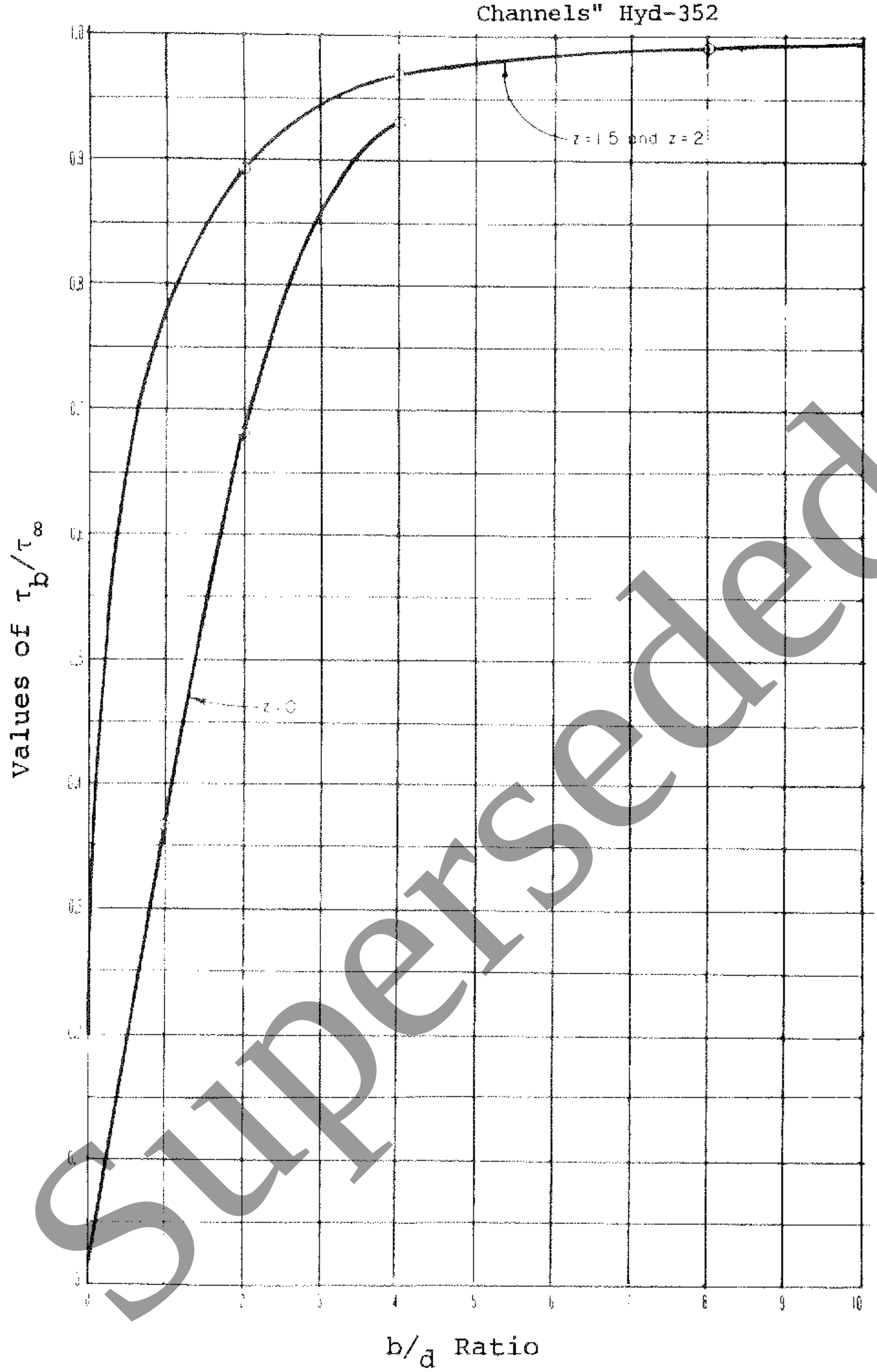


FIGURE A8-2

CHANNEL STABILITY; ACTUAL MAXIMUM TRACTIVE STRESS, τ_b, ON BED OF STRAIGHT TRAPEZOIDAL CHANNELS

REFERENCE
Bureau of Reclamation "Progress Report of Results of Studies on Design of Stable Channels" Hyd-352

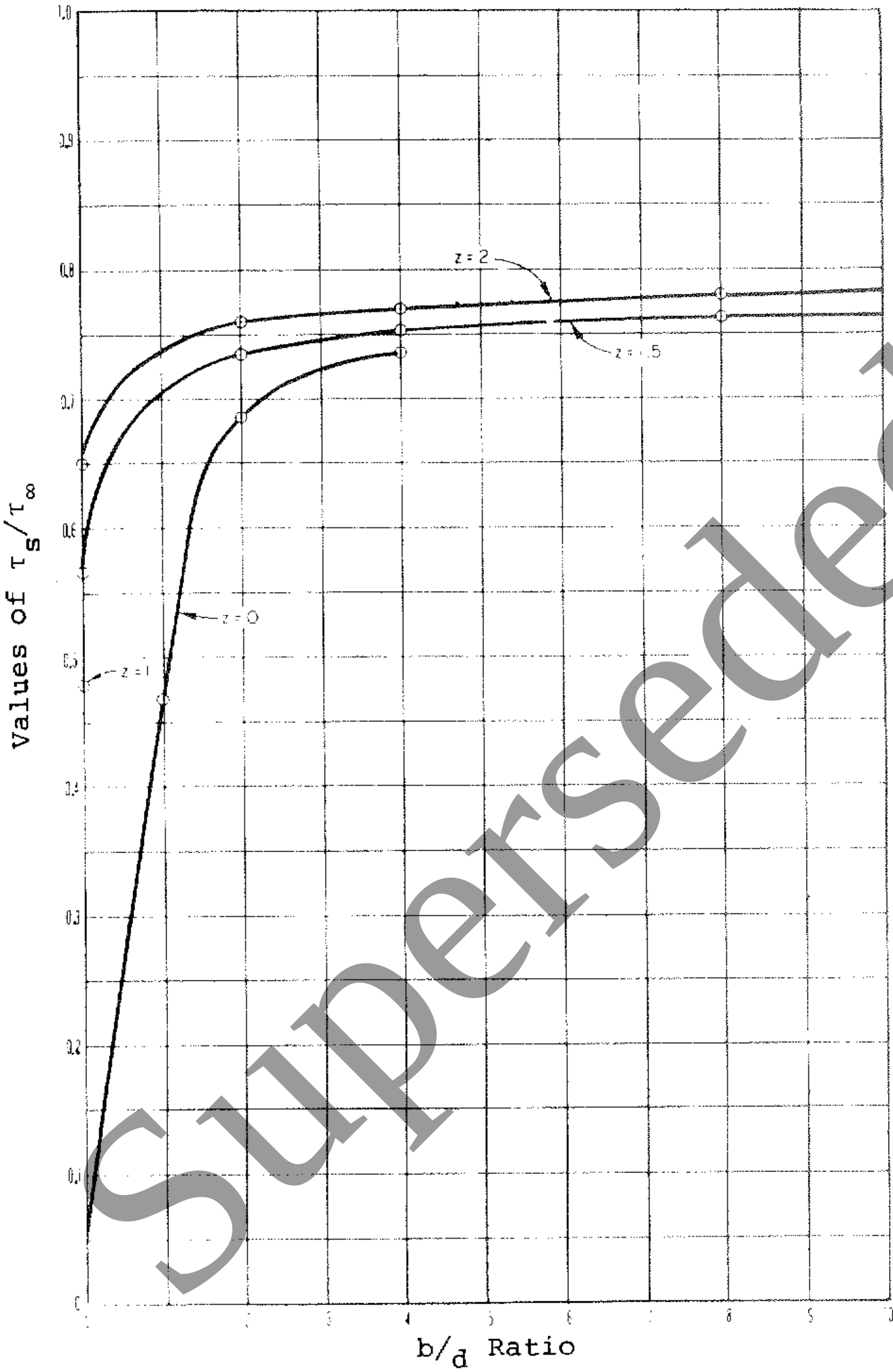


FIGURE A8-3

CHANNEL STABILITY; ACTUAL MAXIMUM TRACTIVE STRESS, τ_s, ON SIDES OF STRAIGHT TRAPEZOIDAL CHANNELS

REFERENCE:
Lane, Emory W., Design of Stable Channels Transaction, A S C E, vol. 120, 1955

Nece, R.E., Givler, G.A., and Drinker, P.A., Measurement of Boundary Shear Stress in an Open Curve Channel with a Surface Pitot Tube: M.I.T. Tech. note (no. 6), Aug. 1959

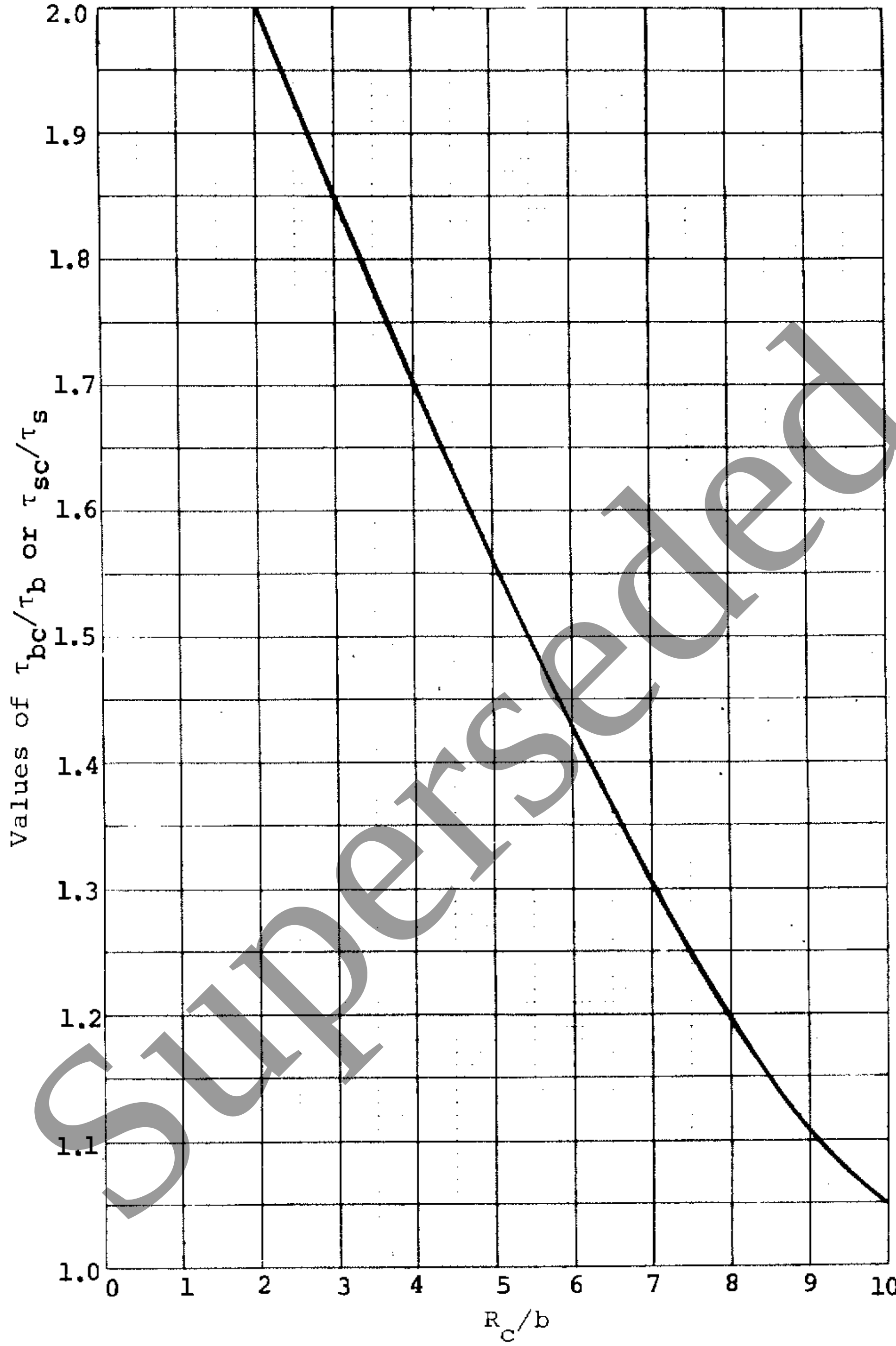


FIGURE A8-4

CHANNEL STABILITY; ACTUAL MAXIMUM TRACTIVE STRESS, τ_{bc} AND τ_{sc}, ON BED AND SIDES OF TRAPEZOIDAL CHANNELS WITHIN A CURVED REACH

Published July 1980

REFERENCE
Nece, R.E., Givler, G.A., and Drinker, P.A., Measurement of Boundary Shear Stress in an Open Curve Channel with a Surface Pitot Tube: M.I.T. Tech note (no.6), Aug. 1959

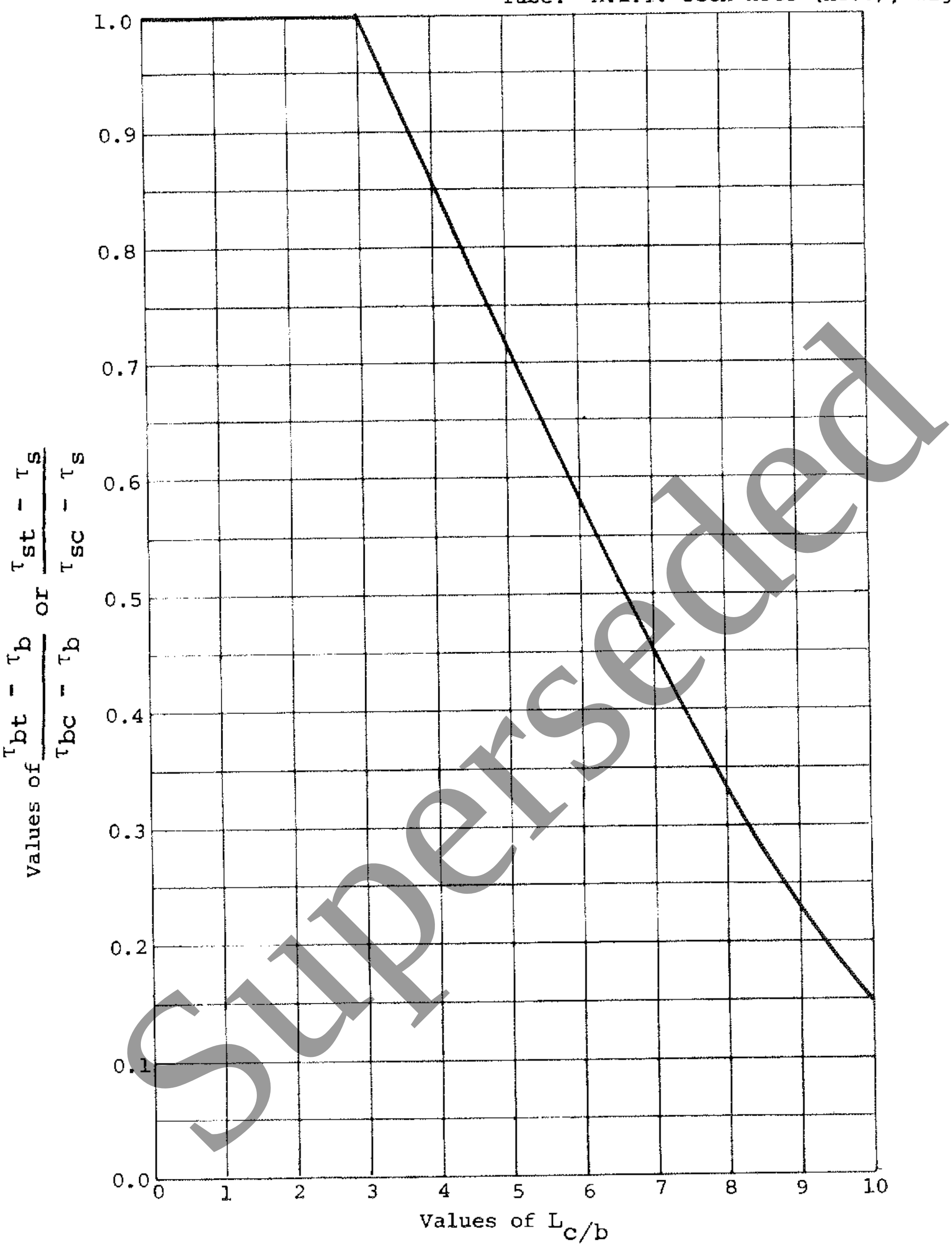


FIGURE A8-5

CHANNEL STABILITY; ACTUAL MAXIMUM TRACTIVE STRESSES τ_{bt} AND τ_{st}, ON BED AND SIDES OF TRAPEZOIDAL CHANNELS IN STRAIGHT REACHES IMMEDIATELY DOWNSTREAM FROM CURVED REACHES

REFERENCE
Bureau of Reclamation Progress Report of Results of Studies on Design of Stable Channels
Hyd-352

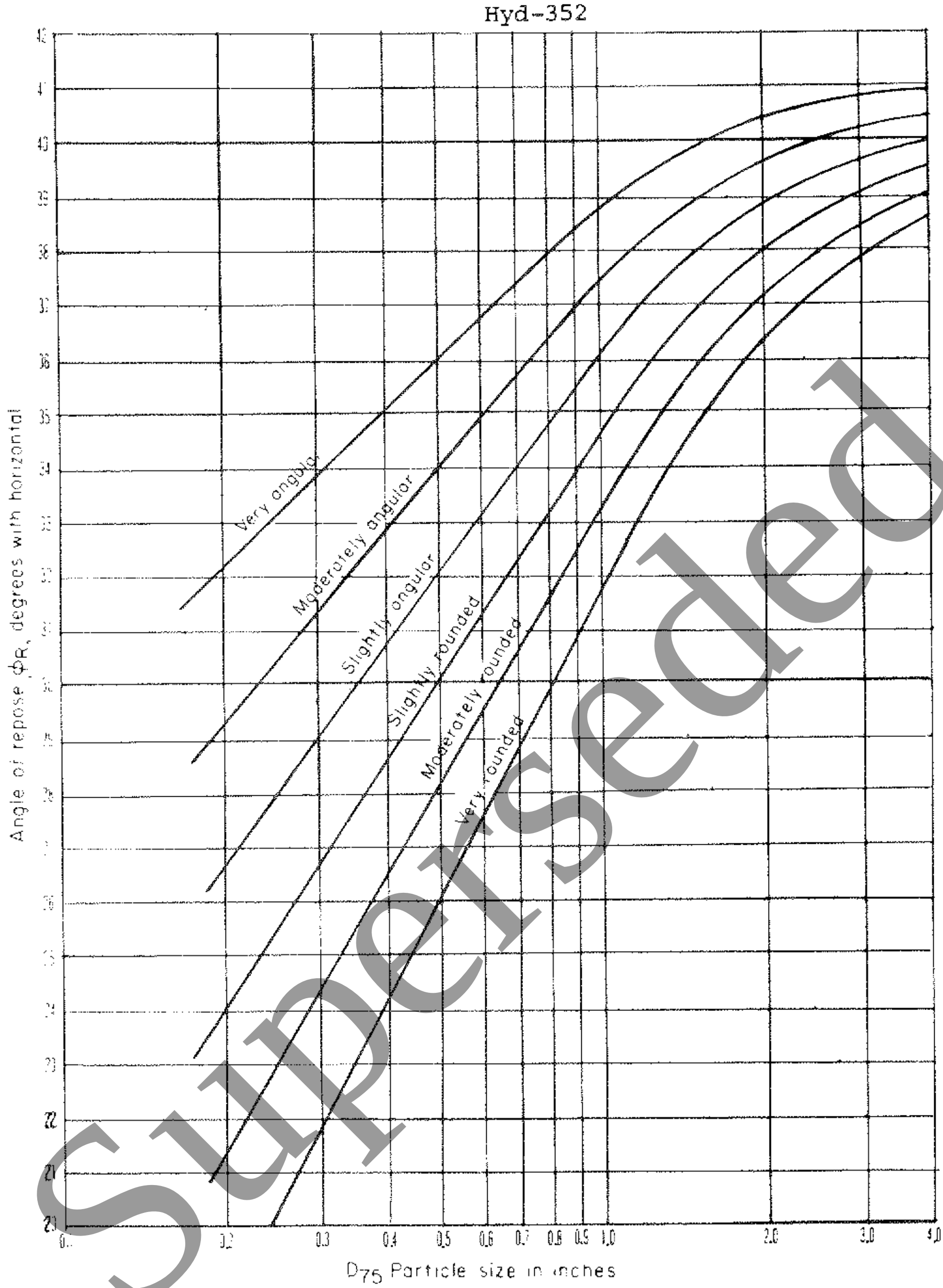


FIGURE A8-6

CHANNEL STABILITY; ANGLE OF RESPOSE, ϕ_R, FOR NON-COHESIVE MATERIALS

Published July 1980

REFERENCE:
Bureau of Reclamation "Progress Report on Results of Studies on Design of Studies Stable Channels"
Hyd-352

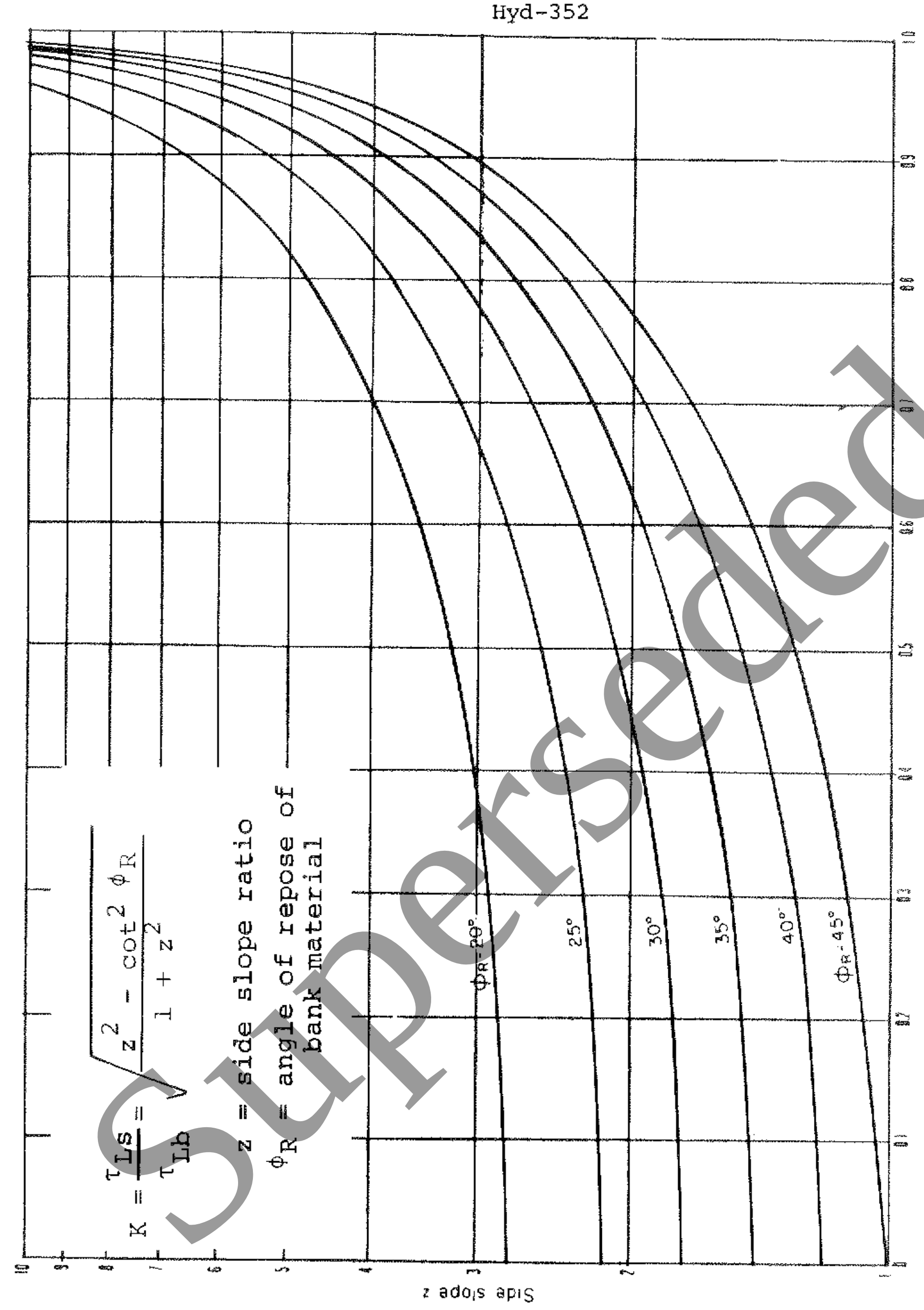


FIGURE A8-7

CHANNEL STABILITY; LIMITING TRACTIVE STRESS τ_{Ls} FOR SIDES OF TRAPEZOIDAL CHANNELS HAVING NON-COHESIVE MATERIALS

Published July 1980

In a given situation γ and s_e are known so that the only unknown is R_t. The value of R_t can be determined from the logarithmic frictional formula developed by Keulegan and modified by Einstein a4.

$$\frac{V}{\sqrt{g R_t s_e}} = 5.75 \log \left(12.27 \frac{R_t x}{k_s}\right) \qquad \text{(Eq. A8-10)}$$

where: K_s is the D_{65} size in ft.

The factor x in Equation A8-10 describes the effect on the frictional resistance of the ratio of the characteristic roughness length k_s to the thickness of the laminar sublayer δ. This thickness is determined from the equation

$$\delta = \frac{11.6 \ \nu}{\sqrt{g R_t s_e}} \qquad \text{(Eq. A8-11)}$$

A relationship between x and k_s/δ has been developed empirically by Einstein a4., and represented by a curve. With the help of this curve and equations A8-10 and A8-11 the value of R_t can be determined provided that V, s_e, k_s and the temperature of the water are known. The computational solution for R_t follows an interative procedure which is rather involved. A simpler graphical solution has been developed by Vanoni and Brooks a5 and the basic family of curves that constitute it, is shown in Figure A8-8. Figure A8-9 shows the extension of the curves outside the region covered in the original publication.

Figure A8-10 gives curves from which values of density ρ and kinematic visocity of the water ν can be obtained.

The computation of reference tractive stress (τ) is facilitated by following the procedure on page A8.20

2. Distribution of the tractive stress along the channel perimeter:

In open channels the tractive stresses are not distributed uniformly along the perimeter. Laboratory experiments and field observations have indicated that in trapezoidal channels the stresses are very small near the water surface and near the corners of the channel and assume their maximum value near the center of the bed. The maximum value on the banks occurs near the lower third point.

The graphs in Figures A8-11 and A8-12 may be used to evaluate maximum stress values on the banks and the bed respectively. These figures are to be used along with τ, the reference tractive stress, to obtain values to obtain values for the maximum tractive stress on the sides and bed of trapezoidal channels in fine grained soils.

3. Tractive stresses in curved reaches:

Figures A8-4 and A8-5 used to determine the maximum tractive stresses in curved reaches for coarse grained soils may also be used to obtain these values for fine grained soils. The values for the maximum tractive stresses on the beds and sides as determined above are used in conjunction with these charts to obtain values for curved reaches.

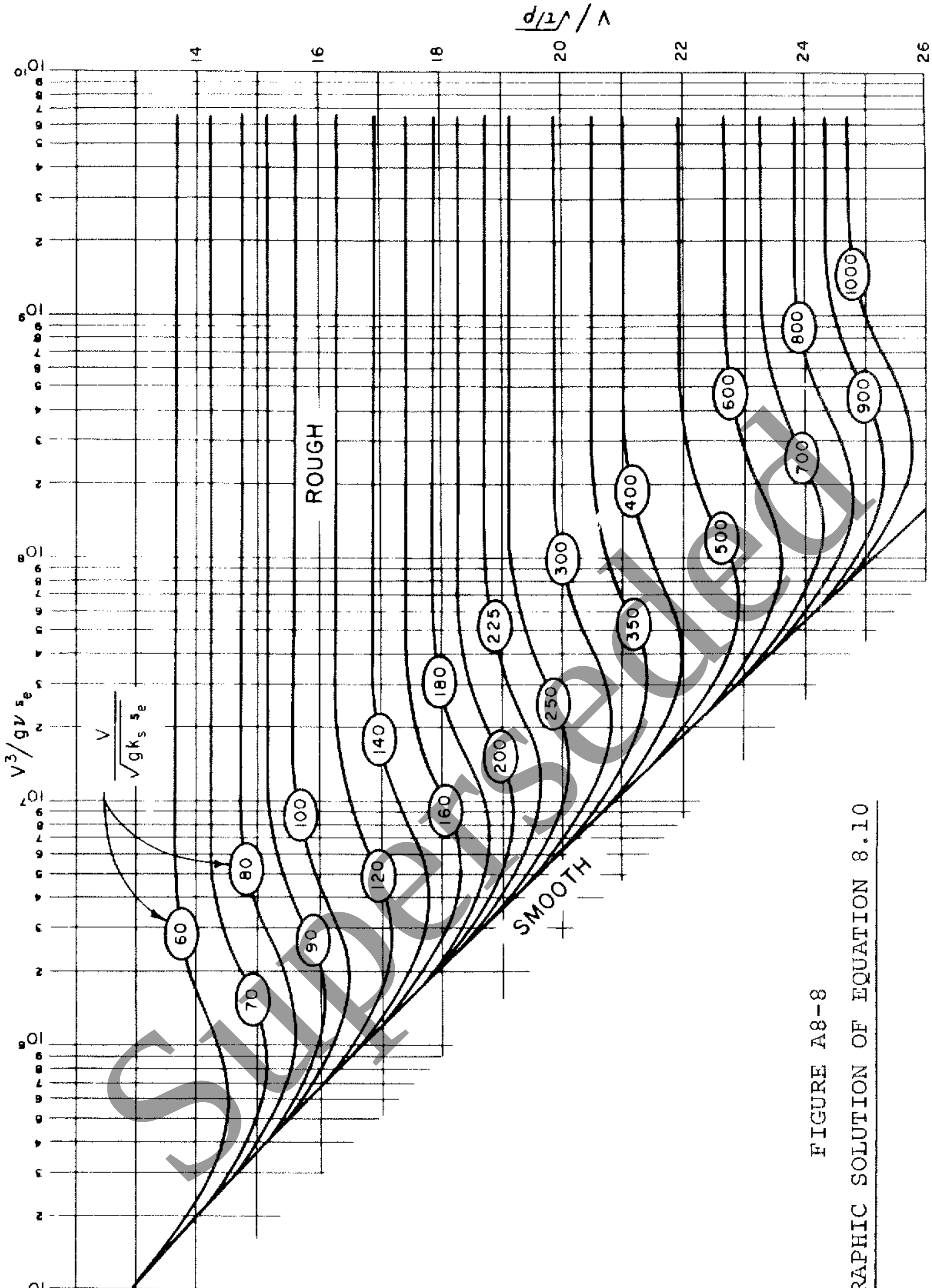


FIGURE A8-8
GRAPHIC SOLUTION OF EQUATION 8.10

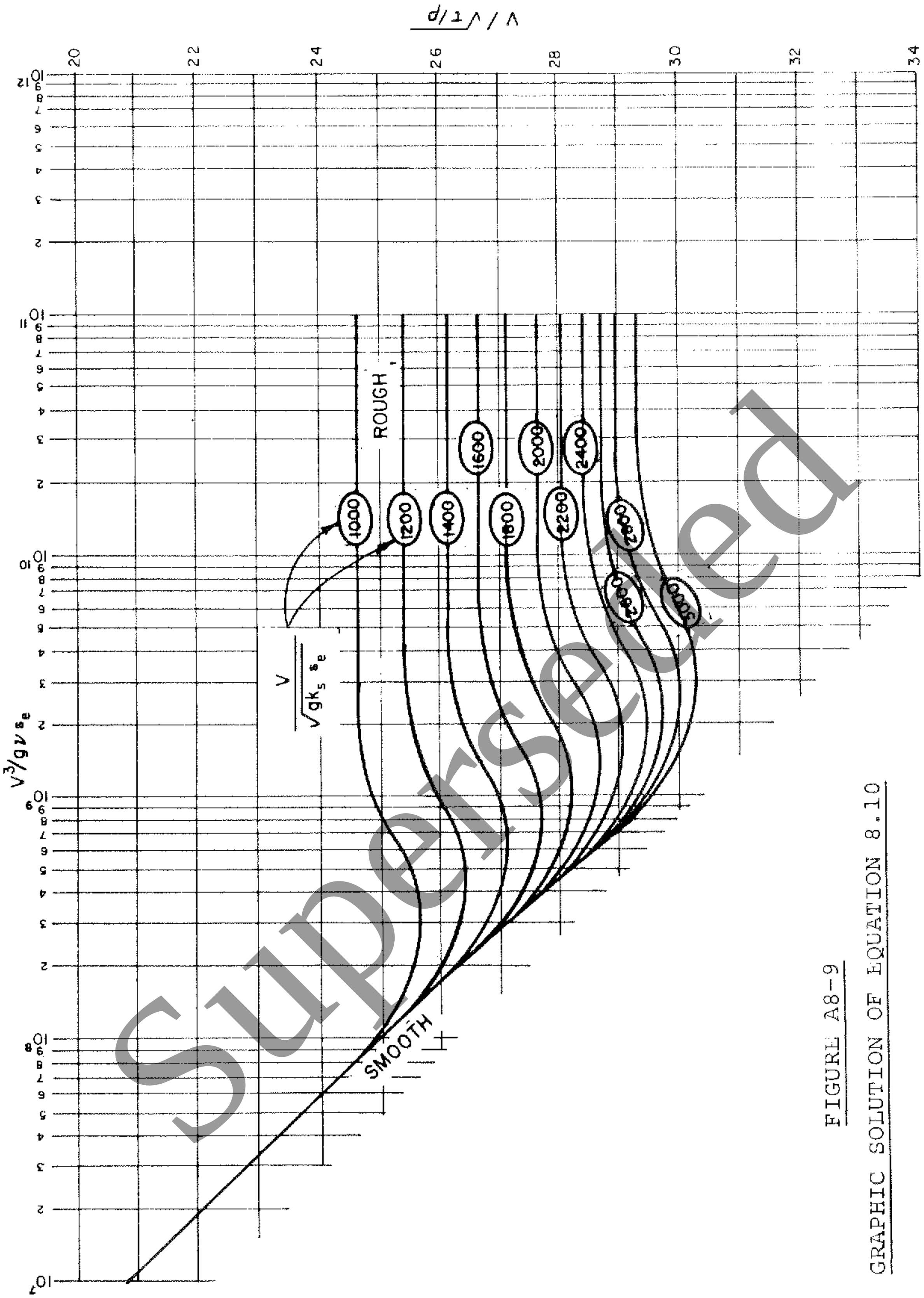


FIGURE A8-9
GRAPHIC SOLUTION OF EQUATION 8.10

Published July 1980

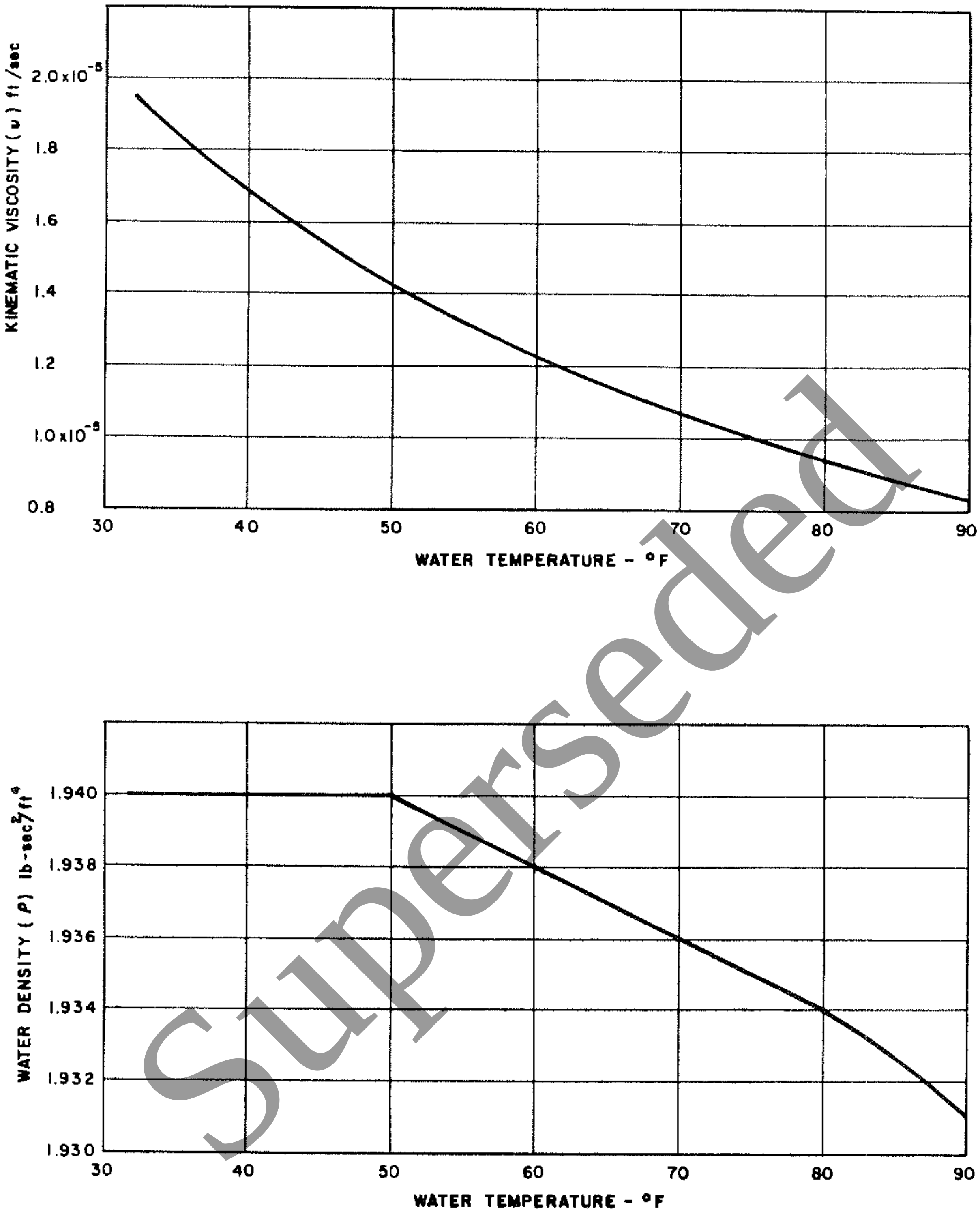


FIGURE A8-10

VALUES OF ρ AND ν FOR VARIOUS WATER TEMPERATURES

Published July 1980

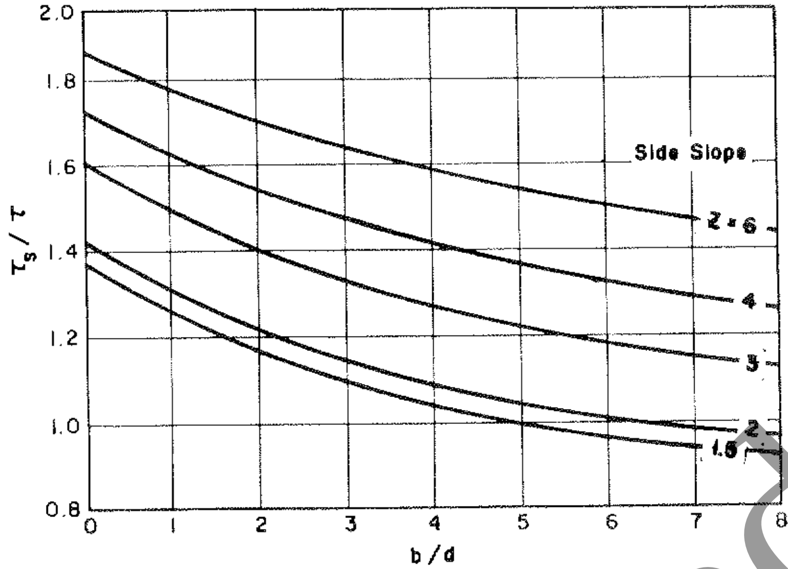


FIGURE A8-11

APPLIED MAXIMUM TRACTIVE STRESS, τ_s,

ON SIDES OF STRAIGHT TRAPEZOIDAL CHANNELS

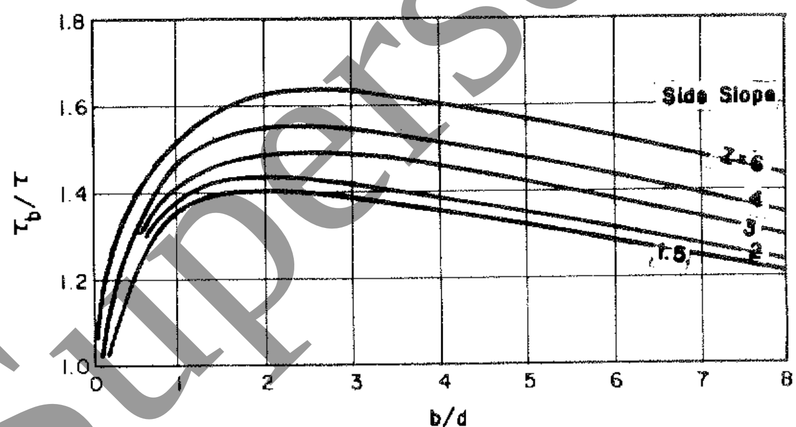


FIGURE A8-12

APPLIED MAXIMUM TRACTIVE STRESS, τ_b,

ON BED OF STRAIGHT TRAPEZOIDAL CHANNELS

Curves reproduced from "Tentative Design Procedure for Riprap Lined Channels" National Cooperative Highway Research Program Report No. 108

 Published July 1980

B. Allowable Tractive Stresses - Fine grained soils

The stability of channels in fine grained soils (D_{75} <0.25") may be checked using the curves in Figure A8-13. These curves were developed by Lane a2. The curves relate the median grain size of the soils to the allowable tractive stress. Curve 1 is to be used when the stream under consideration carries a load of 20,000 ppm by weight or more of fine suspended sediment. Curve 2 is to be used for streams carrying up to 2,000 ppm by weight of fine suspended sediment. Curve 3 is for sediment free flows (less than 1,000 ppm).

When the value of D_{50} for fine grained soils is greater than 5 mm use the allowable tractive stress values shown on the chart for 5mm.

For values of D_{50} less than those shown on the chart (0.1mm) use the allowable tractive stress values for 0.1 mm. However, if this is done 0.1 mm should be used as the D_{65} size in obtaining the reference tractive stress.

Procedure - Tractive Stress Approach

The use of tractive stress to check the ability of earth channels to resist erosive stresses involves the following steps:

1. Determine the hydraulics of the channel. This includes hydrologic determinations as well as the stage-discharge relationships for the channel being considered.

2. Determine sediment yield to reach and calculate sediment concentration for design flow, or assume sediment free water.

3. Determine the properties of the earth materials in the boundary of the channel.

4. Check to see if the tractive stress approach is applicable.

5. Compute the tractive stresses exerted by the flowing water on the boundary of the channel being studied. Use the proper procedure as established by the D_{75} size of the materials.

6. Check the ability of the soil materials forming the channel to resist the computed tractive stresses.

The computation for the reference tractive stress for fine grained soils is facilitated by using the following procedure:

1. Determine s_e and V: Evaluate Manning's n by the method described in Supplement A.

2. Enter the graphs in Figure A8-10 with the value of temperature in °F and read the density ρ and the kinematic viscosity of the water ν.

3. Compute $\dfrac{V^3}{g\nu s_e}$.

4. Compute $\dfrac{V}{\sqrt{g k_s s_e}}$.

5. Enter the graph in Figure A8-8 (or Figure A8-9) with the computed values in steps 2 and 3 above and read the value of $\dfrac{V}{\sqrt{\tau/\rho}}$.

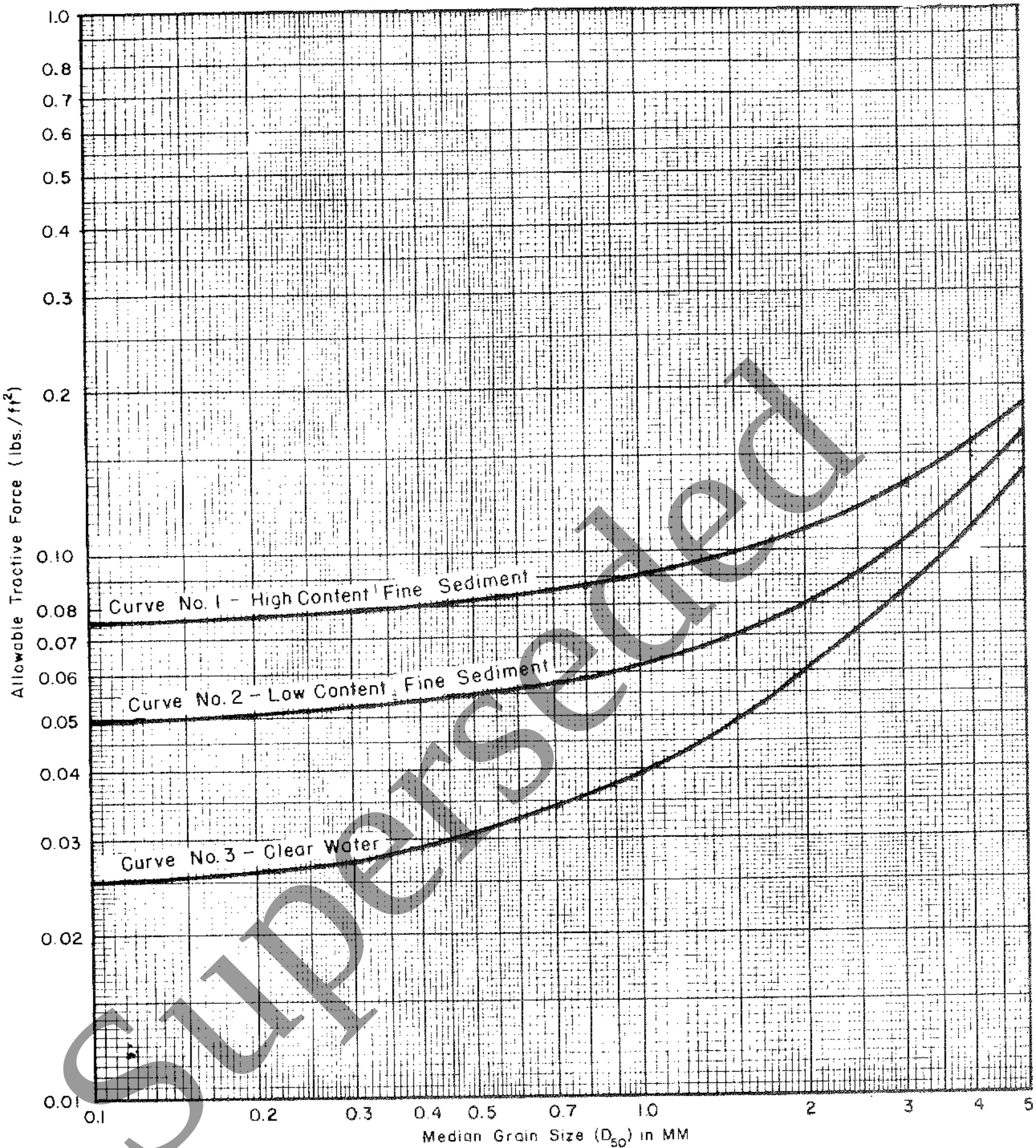


FIGURE A8-13

ALLOWABLE TRACTIVE STRESS -- NON-COHESIVE SOILS, $D_{75} < 0.25"$

REFERENCE: LANE, E.W., "DESIGN OF STABLE CHANNELS", TRANSACTIONS ASCE, VOLUME 120

6. Compute τ from $\frac{V}{\sqrt{\tau/\rho}}$, V and ρ

$$\tau = \frac{V^2\rho}{(V/\sqrt{\tau/\rho})^2}$$

where the terms are defined in the glossary

Examples - Tractive Stress Approach

Example 3

Given: The bottom width of the trapezoidal channel is 18 feet with side slopes of 1 1/2:1. The design flow is 262 cfs at a depth of 3.5 feet and a velocity of 3.23 fps. The slope of the energy grade line is 0.0026. There is one curve in the reach, with a radius of 150 feet. The aged n value is estimated to be 0.045. The channel will be excavated in GM soil that is nonplastic, with D_{75} = 0.90 inches (22.0 mm). The gravel is very angular.

Determine: The actual and allowable tractive stress.

Solution: Since D_{75} > 1/4 inch use the Lane method.

$n_t = (0.90)^{1/6}/39 = 0.0252$ (Eq. A8-1).

From Equation A8-3: $s_t - (n_t/n)^2 s_e = (0.025/0.045)^2 \; 0.0026 = 0.00082$.

actual $\tau_\infty = \gamma_w d s_t = (62.4)\;(3.5)\;(0.00082) = 0.179$ psf.

b/d (ratio of bottom width to depth) = 18/3.5 = 5.14.

from Figure A8-2 and A8-3 $\tau_s/\tau_\infty = 0.76$; $\tau_b/\tau_\infty = 0.98$.

R_c/b (radius of curve/bottom width) = 150/18 = 8.33.

$\tau_{bc}/\tau_b = \tau_{sc}/\tau_s = 1.17$ (Figure A8-4).

Actual $\tau_b = (0.179)\;(0.98) = 0.175$ psf;

actual $\tau_s = (0.179)\;(0.76) = 0.136$ psf

Actual $\tau_{bc} = (0.175)\;(1.17) = 0.205$ psf;

actual $\tau_{sc} = (0.136)\;(1.17) = 0.159$ psf

Solving for allowable tractive stress -

$\phi_R = 38.4°$ (Figure A8-6). K = 0.45 (Figure A8-7).

allowable: $\tau_{Lb} = (0.4)\;(D_{75}) = (0.4)\;(0.90) = 0.36$

allowable: $\tau_{Ls} = 0.4\;KD_{75} = (0.4)\;(0.45)\;(0.90) = 0.162$

Comparing actual with allowable, the channel will be stable in straight and curved sections.

Example 4

Given: Bottom width of the trapezoidal section is 18 feet, side slopes are 1-1/2:1. Design flow is 262 cfs, with a depth of 3.5 feet at a velocity of 3.23 fps. Slope of the hydraulic grade line is 0.0026. The design temperature is 50°F. The channel will be cut in nonplastic SM soil, with a D_{75} size of 0.035 inches, a D_{65} size of 0.01075 inches (0.273 mm) and a D_{50} of 0.127 mm. The n value for the channel is 0.045. There are no curves in the reach. Sediment load is quite light in this locality, in the range of clear water criteria.

Determine: The actual tractive stress and the allowable tractive stress.

Solution: Since the D_{75} size is less than 1/4 inch use the reference tractive stress method.

$\nu = 1.42 \times 10^{-5}$ ft^2/sec., $\rho = 1.940$ lb sec^2/ft^4 (Figure A8-10).

$V^3/g\nu s_e = 3.23^3/(32.2)(1.42 \times 10^{-5})(0.0026) = 2.83 \times 10^7$.

$V/\sqrt{gk_s s_e} = 3.23/\sqrt{(32.2)(0.01075/12)(0.0026)} = 373$

$V/\sqrt{\tau/\rho} = 21.6$ (From Figure A8.8).

$\tau = V^2 \rho/(V/\sqrt{\tau/\rho})^2 = (3.23^2)\ 1.94/(21.6)^2 = 0.0434$ psf.

b/d (ratio of bottom width to depth) = 18/3.5 = 5.14

$\tau_s/\tau \simeq 1.0$; $\tau_b/\tau = 1.31$ (from Figure A8-11 and A8-12).

Actual Tractive Stresses:

$\tau_s = (0.0434)(1.0) = 0.0434$ psf; $\tau_b = (0.0434)(1.31) = 0.0569$ psf

Allowable Tractive Stresses:

$D_{50} = 0.127$ mm; from Figure A8-13 and assuming clear water flow (curve No.3) the allowable tractive force is 0.025 psf. Both the bed and the banks of the channel are unstable.

GLOSSARY OF SYMBOLS

A - alignment factor to adjust the basic velocity because of the effects of curvature of the channel.

A - area of flow. (ft^2)

b - bottom width of a channel (feet).

b_T - water surface width (feet).

B - bank slope factor to adjust the basic velocity because of the effects of different bank slopes.

C - sediment concentration in parts per million by weight.

C_1, C_2, C_3, C_4, C_5 - coefficients used to determine channel proportions and slope when using the modified regime equations.

C_e - Density factor to adjust the basic velocity because of variations in the density of soil materials in the channel boundary.

c_m - cohesion intercept at natural moisture (psf).

d - depth of flow (feet).

d_c - critical depth of flow (feet).

d_m - mean depth of flow (feet).

D - depth factor to adjust basic velocity because of the effects of the depth flow.

D_s - the particle diameter of which s% of the sample is smaller.

F - frequency factor to adjust the basic velocity because of the effect of infrequent flood flows.

F - Froude number = $\frac{V}{\sqrt{gd_m}}$

g - acceleration due to gravity (fps^2).

G - specific gravity.

H_c - depth of tension crack (feet).

k_s - characteristic length of roughness element, for granular material; $k_s = D_{65}$ size in feet.

K - coefficient modifying tractive force for gravitational forces on coarse, noncohesive materials on channel sides.

n - Manning's coefficient.

n_t - Manning's coefficient for roughness of soil grains.

P - wetted perimeter.

PI - Plasticity index.

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q_u - unconfined compressive strength.

Q - discharge (cfs).

Q_s - Sediment transport rate (tons/day)

R - hydraulic radius - feet.

R_c - radius of curvature of central section of compound curve.

R_t - hydraulic radius associated with grain roughness of the soil.

s_o - slope of channel bottom.

s_c - critical slope.

s_e - energy gradient

s_t - rate of friction head loss because of tractive stress acting on bed and side materials.

V - average velocity (fps).

V_a - allowable velocity (fps).

V_b - basic velocity (fps).

V_c - critical velocity (fps).

W_T - top width of flow - ft.

x - factor describing effect of ratio $\frac{k_s}{\delta}$ on flow resistance.

z - cotangent of side slope angle.

T - factor to correct allowable tractive force for materials with $D_{75} > 0.25"$ for unit weights different than 160 pcf.

γ - unit weight of water (pcf).

γ_d - dry unit weight (pcf).

γ_m - moist unit weight (pcf).

γ_s - unit weight of particles larger than 0.25" (pcf).

γ_w - unit weight of water (62.4 pcf).

δ - thickness of laminar sublayer $= \frac{11.6\nu}{\sqrt{gR_t s_e}}$

ϕ - angle of shearing resistance.

ϕ_m - angle of shearing resistance at natural moisture content.

ϕ_r - angle of repose of coarse noncohesive materials.

ν - kinematic visosity of water (ft^2/sec).

ρ - water density ($lb\text{-}sec^2/ft^4$).

τ - reference tractive stress (psf).

τ_∞ - tractive stress in an infinitely wide channel (psf).

τ_b - maximum tractive stress on the channel bed (psf).

τ_s - maximum tractive stress on the channel sides (psf).

τ_{bc} - maximum tractive stress on the bed in a curved reach (psf).

τ_{sc} - maximum tractive stress on the sides in a curved reach (psf).

τ_{Lb} - allowable tractive stress along the bed. (psf)

τ_{Ls} - allowable tractive stress along the sides (psf).

SUPPLEMENT A
Method for Estimating Manning's n

This supplement describes a method for estimating the roughness coefficient n for use in hydraulic computations associated with natural streams, floodways and similar streams. The procedure proposed applies to the estimation of n in Manning's formula. This formula is now widely used, it is simpler to apply than other widely recognized formulas and has been shown to be reliable.

Manning's formula is empirical. The roughness coefficient n is used to quantitatively express the degree of retardation of flow. The value of n indicates not only the roughness of the sides and bottom of the channel, but also other types of irregularities of the channel and profile. In short, n is used to indicate the net effect of all factors causing retardation of flow in a reach of channel under consideration.

There seems to have developed a tendency to regard the selection of n for natural channels as either an arbitrary or an intuitive process. This probably results from the rather cursory treatment of the roughness coefficient in most of the more widely used hydraulic textbooks and handbooks. The fact is that the estimation of n requires the exercise of critical judgment in the evaluation of the surfaces of the channel sides and bottom; variations in shape and size of cross sections; obstructions; vegetation; meandering of the channel.

The need for realistic estimates of n justifies the adoption of a systematic procedure for making the estimates.

Procedure for estimating n. The general procedure for estimating n involves; first, the selection of a basic value of n for a straight, uniform, smooth channel in the natural materials involved; then, through critical consideration of the factors listed above, the selection of a modifying value associated with each factor. The modifying values are added to the basic value to obtain n for the channel under consideration.

In the selection of the modifying values associated with the 5 primary factors it is important that each factor be examined and considered independently. In considering each factor, it should be kept in mind that n represents a quantitative expression of retardation of flow. Turbulence of flow can, in a sense, be visualized as a measure or indicator of retardance. Therefore, in each case, more critical judgment may be exercised if it is recognized that as conditions associated with any factor change so as to induce greater turbulence, there should be an increase in the modifying value. A discussion and tabulated guide to the selection of modifying values for each factor is given under the following procedural steps.

1st step. Selection of basic n value. This step requires the selection of a basic n value for a straight, uniform, smooth channel in the natural materials involved. The selection involves consideration of what may be regarded as a hypothetical channel. The conditions of straight alignment, uniform cross section, and smooth side and bottom surfaces without vegetation should be kept in mind. Thus the basic n will be visualized as varying only with the materials forming the sides and bottom of the channel. The minimum values of n shown by reported test results for the best channels in earth are in the range from 0.016 to 0.018. Practical limitations associated with maintaining smooth and uniform channels in earth for any appreciable period indicate that 0.02 is a realistic basic n. The basic n, as it is intended for use in this procedure, for natural or excavated channels, may be selected from the table below. Where the bottom and sides of a channel are of different materials this fact may be recognized in selecting the basic n.

CHARACTER OF CHANNEL	BASIC n
Channels in earth	0.02
Channels cut into rock	0.025
Channels in fine gravel	0.024
Channels in coarse gravel	0.028

2nd step. Selection of modifying value for surface irregularity. The selection is to be based on the degree of roughness or irregularity of the surfaces of channel sides and bottom. Consider the actual surface irregularity; first, in relation to the degree of surface smoothness obtainable with the natural materials involved, and second, in relation to the depths of flow under consideration. Actual surface irregularity comparable to the best surface to be expected of the natural materials involved calls for a modifying value of zero. Higher degrees of irregularity induce turbulence and call for increased modifying values. The table below may be used as a guide to the selection.

DEGREE OF IRREGULARITY	SURFACES COMPARABLE TO	MODIFYING VALUE
Smooth	The best obtainable for the materials involved.	0.000
Minor	Good dredged channels; slightly eroded or scoured side slopes of canals or drainage channels.	0.005
Moderate	Fair to poor dredged channels; moderately sloughed or eroded side slopes of canals or drainage channels.	0.010
Severe	Badly sloughed banks of natural channels; badly eroded or sloughed sides of canals or drainage channels; unshaped, jagged and irregular surfaces of channels excavated in rock.	0.020

3rd step. Selection of modifying value for variations in shape and size of cross sections. In considering changes in size of cross sections judge the approximate magnitude of increase and decrease in successive cross sections as compared to the average. Changes of considerable magnitude, if they are gradual and uniform, do not cause significant turbulence. The greater turbulence is associated with alternating large and small sections where the changes are abrupt. The degree of effect of size changes may be best visualized by considering it as depending primarily on the frequency with which large and small sections alternate and secondarily on the magnitude of the changes.

In the case of shape variations, consider the degree to which the changes cause the greatest depth of flow to move from side to side of the channel. Shape changes causing the greatest turbulence are those for which shifts of the main flow from side to side occur in distances short enough to produce eddies and upstream currents in the shallower portions of those sections where the maximum depth of flow is near either side. Selection of modifying values may be based on the following guide:

CHARACTER OF VARIATIONS IN SIZE AND SHAPE OF CROSS SECTIONS	MODIFYING VALUE
Changes in size or shape occurring gradually	0.000
Large and small sections alternating occasionally or shape changes causing occasional shifting of main flow from side to side	0.005
Large and small sections alternating frequently or shape changes causing frequent shifting or main flow from side to side	0.010 to 0.015

4th step. Selection of modifying value for obstructions. The selection is to be based on the presence and characteristics of obstructions such as debris deposits, stumps, exposed roots, boulders, fallen and lodged logs. Care should be taken that conditions considered in other steps are not re-evaluated or double-counted by this step.

In judging the relative effect of obstructions, consider: the degree to which the obstructions occupy or reduce the average cross sectional area at various stages; the character of obstructions, (sharp-edged or angular objects induce greater turbulence than curved, smooth-surfaced objects); the position and spacing of obstructions transversely and longitudinally in the reach under consideration. The following table may be used as a guide to the selection.

RELATIVE EFFECT OF OBSTRUCTIONS	MODIFYING VALUE
Negligible	0.000
Minor	0.010 to 0.015
Appreciable	0.020 to 0.030
Severe	0.040 to 0.060

5th step. Selection of modifying value for vegetation. The retarding effect of vegetation is probably due primarily to the turbulence induced as the water flows around and between the limbs, stems and foliage, and secondarily to reduction in cross section. As depth and velocity increase, the force of the flowing water tends to bend the vegetation. Therefore, the ability of vegetation to cause turbulence is partly related to its resistance to bending force. Furthermore, the amount and character of foliage; that is, the growing season condition versus dormant season condition is important. In judging the retarding effect of vegetation, critical consideration should be given to the following: the height in relation to depth of flow; the capacity to resist bending; the degree to which the cross section is occupied or blocked out; the transverse and longitudinal distribution of vegetation of different types, densities and heights in the reach under consideration. The following table may be used as a guide to the selection:

VEGETATION AND FLOW CONDITIONS COMPARABLE TO:	DEGREE OF EFFECT ON n	RANGE IN MODIFYING VALUE
Dense growths of flexible turfgrasses or weeds, of which Bermuda and bluegrasses are examples, where the average depth of flow is 2 to 3 times the height of vegetation.	Low	0.005 to 0.010
Supple seedling tree switches such as willow, cottonwood or salt cedar where the average depth of flow is 3 to 4 times the height of the vegetation.		

Turf grasses where the average depth of flow is 1 to 2 times the height of vegetation. Stemmy grasses, weeds or tree seedlings with moderate cover where the average depth of flow is 2 to 3 times the height of vegetation. Brushy growths, moderately dense, similar to willows 1 to 2 years old, dormant season, along side slopes of channel with no significant vegetation along the channel bottom, where the hydraulic radius is greater than 2 feet.	Medium	0.010 to 0.025
Turf grasses where the average depth of flow is about equal to the height of vegetation. Dormant season, willow or cottonwood trees 8 to 10 years old, inter grown with some weeds and brush, none of the vegetation in foliage, where the hydraulic radius is greater than 2 feet. Growing season, bushy willows about 1 year old intergrown with some weeds in full foliage along side slopes, no significant vegetation along channel bottom, where hydraulic radius is greater than 2 feet.	High	0.025 to 0.050
Turf grasses where the average depth of flow is less than one half the height of vegetation. Growing season, bushy willows about 1 year old, intergrown with weeds in full foliage along side slopes; dense growth of cattails along channel bottom; any value of hydraulic radius up to 10 or 15 feet. Growing season; trees intergrown with weeds and brush, all in full foliage; any value of hydraulic radius up to 10 or 15 feet.	Very high	0.050 to 0.100

<u>6th step</u>. Determination of the modifying value for meandering of channel. The modifying value for meandering may be estimated as follows: Add the basic n for Step 1 and the modifying values of Steps 2 through 5 to obtain the subtotal of n_s.

Let ℓ_s = the straight length of the reach under consideration.

ℓ_m = the meander length of the channel in the reach.

Compute modifying value for meandering in accordance with the following table:

Ratio (ℓ_m/ℓ_s)	Degree of meandering	Modifying value
1.0 to 1.2	Minor	0.000
1.2 to 1.5	Appreciable	0.15 n_s
1.5 and greater	Severe	0.30 n_s

Where lengths for computing the approximate value of ℓ_m/ℓ_s are not readily obtainable the degree of meandering can usually be judged reasonably well.

7th step. Computation of n for the reach. The value of n for the reach is obtained by adding the values determined in Steps 1 through 6. An illustration of the estimation of n is given in Example 1.

Example 1. Estimation of n for a reach.

This example is based on a case where n has been determined so that comparison between the estimated and actual n can be shown.

Channel: Camp Creek dredged channel near Seymour, Illinois; see USDA Technical Bulletin No. 129, Plate 29-C for photograph and Table 9, page 86, for data.

Description: Course straight; 661 feet long. Cross section, very little variation in shape; variation in size moderate, but changes not abrupt. Side slopes fairly regular, bottom uneven and irregular. Soil, lower part yellowish gray clay; upper part, light gray silty clay loam. Condition, side slopes covered with heavy growth of poplar trees 2 to 3 inches in diameter, large willows and climbing vines; thick growth of water weed on bottom; summer condition with vegetation in full foliage.

Average cross section approximates a trapezoid with side slopes about 1.5 to 1 and bottom width about 10 feet. At bankfull stage, average depth and surface width are about 8.5 and 40 feet respectively.

STEP	REMARKS	MODIFYING VALUES
1	Soil materials indicate minimum basic n.	0.02
2	Description indicates moderate irregularity.	0.01
3	Changes in size and shape judged insignificant.	0.00
4	No obstructions indicated.	0.00
5	Description indicates very high effect of vegetation.	0.08
6	Reach described as straight.	0.00
	Total estimated n	0.11

USDA Technical Bulletin No. 129, Table 9, page 96, gives the following determined values for n for this channel: for average depth of 4.6 feet n = 0.095; for average depth of 7.3 feet n = 0.104.

APPENDIX A9

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The following references are cited in the Appendices:

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a2. Lane, E. W. - Progress Report on Results of Studies on Design of Stable Channels, Hydraulic Laboratory Report No. Hyd-352, U. S. Bureau of Reclamation, June 1952.

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APPENDIX B

EXAMPLE FOR SEED SPECIFICATIONS

A. The seed mixtures and specifications shall meet the minimum requirements as specified below.

1. Furnish the kinds and amounts of seed as indicated below to be seeded in all areas designated by the engineer, landscape architect, etc.

(List mixtures and amounts of each species here)

2. The minimum requirements for grass and legume seed used in the vegetative work are as follows:

a. All seed shall be labeled to show that it meets the requirements of the New Jersey State Seed Law.

b. Accumulated bag tags of seed used shall be submitted with the final pay estimate.

c. All seed shall have been tested within the 6 months immediately preceding the date of sowing such material on this job.

d. Inoculant - The inoculant for treating legume seed in the seed mixtures shall be a pure culture of nitrogen-fixing bacteria prepared for the species seeded. Inoculants shall not be used later than the date indicated on the container. Twice the supplier's recommended rate of inoculant will be used when seed is broadcasted; four times the recommended rate if hydroseeded.

e. The quality of the seed used shall conform to the guidelines shown on the following page.

B. Grass seed mixtures checked by the Chief of the Bureau of Seed Certification, New Jersey Department of Agriculture, Trenton, New Jersey, will assure the purchaser that the mixture obtained is the mixture ordered.

TABLE B1-1

QUALITY OF SEED*

LEGUMES	Minimum** Seed Purity (%)	Minimum*** Germination (%)
Crownvetch	95	68
Lespedeza, Korean	97	85
Lespedeza, sericea	98	85
GRASSES		
Bluegrass, Kentucky	80	85
Fescue, red (chewing and creeping)	97	80
Fescue, tall (KY-31)	97	85
Redtop	90	85
Reed canarygrass	96	80
Ryegrass, annual or common	98	85
Ryegrass, Perennial	98	85
Weeping lovegrass	95	87
ANNUALS		
Barley	98	90
Millet	99	80
Oats	98	80
Rye	98	85
Sudangrass	98	80

*Seed containing prohibited or restricted noxious weeds will not be accepted. Prohibited noxious weeds - Bindweed, Canada thistle, quackgrass, hedge bindweed, and horse nettle.
Restricted noxious weeds - Wild garlic, bermudagrass, cheat, wild onion, corn cockle, dodder and wild onion, Johnsongrass, perennial sweet sudangrass, sorghum almum and other perennial sorghum hybrids.

**Seed should not contain in excess of 2.5 percent weed seed.

***Lower germination is allowed if seeding rates are raised to compensate.

APPENDIX B

TABLE B 2-1 GRASS AND LEGUME PLANTING GUIDE

Common Name	Botanical Name	1/ Germ. Time Days	Growth Habit 2/	Season: Cool	Season: Warm	Drainage Class: Dry, (Not Droughty)	Drainage Class: Well Drained	Drainage Class: Mod. Well Drained	Drainage Class: Somewhat Poorly Drained	Drainage Class: Poorly Drained	Annual Cover: Winter	Annual Cover: Summer	pH Range	Flooding Tolerance	Erodible Areas	Waterways & Channels	Shade Tolerance	Foot Traffic	Playgrounds, Lawns Athletic Fields	Beautification	Levels of Maintenance 3/: High	Levels of Maintenance 3/: Medium	Levels of Maintenance 3/: Low
Barley winter	Hordeum vulgare	7	A	X	-	-	X	X	-	-	X	-	5.5 -7.8	-	X	-	-	-	-	-	-	X	-
Bermudagrass	Cynodon dactylon	Plant Veg.	PL RS	-	X	X	X	X	X	-	-	-	4.5 -7.5	X	X	X	-	X	X	X	X	X	X
Bluegrass, Kentucky	Poa pratensis	21-28	PL R	X	-	-	X	X	X	-	-	-	5.5 -7.0	X	X	X	-	X	X	X	X	X	X
Canarygrass, Reed	Phalaria arundinacea	21	PL R	X	-	X	X	X	X	X	-	-	5.0 7.5	X	X	X	-	-	-	-	X	X	X
Fescue, creeping red	Festuca rubra	21-28	PL R	X	-	X	X	X	X	-	-	-	4.5 -7.5		X	X	X	X	X	X	X	X	X
Fescue, Chewings red	Festuca comutata	21-28	PL	X	-	X	X	X	X	-	-	-	4.5 -7.5	X	X	X	X	X	X	X	X	X	X
Fescue, tall (KY-31)	Festuca arundinacea	14	PL BR	X	-	-	X	X	X	-	-	-	5.0 -8.0	X	X	X	X	X	X	X	X	X	-
Lovegrass, weeping	Fragrostis curvula	5-14	Ps B	-	X	X	X	X	X	-	-	-	4.5 -8.0	-	X	-	-	-	-	-	X	X	X
Millet	Setaria & Pennise-tum spp.	7-14	A	-	X	X	X	X	X	-	-	X	4.5 -7.0	-	X	-	-	-	-	-	-	-	X
Oats	Avena sativa	10	A	X	-	-	X	X	-	-	X	-	5.5 -7	-	X	-	-	-	-	-	-	X	-

Notes: 1/ Germination time Days - No. of days required for majority of seeds to germinate and emerge under favorable conditions.

2/ Growth Habit: A - Annual; Bi - biennial; P - perennial; L - long-lived; s - short-lived; R - rhizomatous or spreads by rootstocks; S - stoloniferous; B - bunch

3/ Amount of fertilization and mowing tolerated.

TABLE B 2-1 GRASS AND LEGUME PLANTING GUIDE (cont'd)

Common Name	Botanical	1/ Germ. Time Days	Growth Habit 2/	Season: Cool	Season: Warm	Drainage Class: Dry, (Not Droughty)	Drainage Class: Well Drained	Drainage Class: Mod. Well Drained	Drainage Class: Somewhat Poorly Drained	Drainage Class: Poorly Drained	Annual Cover: Winter	Annual Cover: Summer	pH Range	Flooding Tolerance	Erodible Areas	Waterways & Channels	Shade Tolerance	Foot Traffic	Playgrounds, Lawns Athletic Fields	Beautification	Levels of Maintenance 3/: High	Levels of Maintenance 3/: Medium	Levels of Maintenance 3/: Low
Redtop	_Agrostis alba_	10	Ps B	X	-	X	X	X	X	X	-	-	4.0-7.5	X	X	X	-	X	X	-	-	X	X
Rye, winter	_Secale cereale_	7	A	X	-	X	X	X	-	-	X	-	5.5-7	-	X	-	-	-	-	-	-	X	X
Ryegrass, annual	_Lolium multiflorum_	14	A	X	-	-	X	X	X	-	X	-	5.5-7.5	X	X	-	X	-	-	-	-	X	X
Ryegrass, perennial	_Lolium perenne_	14	Ps B	X	-	-	X	X	X	-	-	-	5.5-7.5	X	X	-	X	X	X	X	X	X	-
Sudangrass	_Sorghum sudanense_	10	A	-	X	X	X	X	X	-	-	X	4.5-7.5	-	X	-	-	-	-	-	-	X	X
Clover, Alsike	_Trifolium hybridum_	7	Ps B	X	-	-	X	X	X	X	-	-	5.0-7.5	-	-	-	-	-	-	X	-	X	X
Crownvetch	_Coronilla varia_	14-21	PL R	X	X	X	X	X	-	-	-	-	5.5-7.5	-	X	-	X	-	-	X	-	X	X
Lespedeza, Korean	_Lespedeza stipulacea_	7-14	A	-	X	X	X	X	X	-	-	X	5.5-7.0	-	X	-	-	-	-	-	-	-	X
Lespedeza, sericea	_Lespedeza cuneata_	7-28	PL B	-	X	X	X	X	X	-	-	-	5.5-7.0	-	X	-	-	-	-	-	-	X	X
Trefoil, birdsfoot	_Lotus corniculatus_	10	PL	X	-	X	X	X	X	-	-	-	5.0-7.5	X	X	-	-	-	-	X	-	X	X
Vetch, hairy	_Vicia villosa_	10-14	A Bi	X	-	X	X	X	-	-	X	-	5.0-7.5	-	X	-	-	-	-	X	X	X	X

Notes: 1/ Germination time Days - No. of days required for majority of seeds to germinate and emerge under favorable conditions.

2/ Growth Habit: A - annual; Bi- biennial; P - perennial; L - long-lived; s - short-lived R - rhizomatous or spreads by rootstocks; S - stoloniferous; B - bun

3/ Amount of fertilization and mowing tolerated.

STATE OF NEW JERSEY

SOIL EROSION AND SEDIMENT CONTROL ACT

CHAPTER 251, P.L. 1975*

(N.J.S.A. 4:24-39 et seq.)

AN ACT providing for soil erosion and sediment control and supplementing chapter 24 of Title 4 of the Revised Statutes.

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

1. This act may be cited and referred to as the "Soil Erosion and Sediment Control Act."

2. The Legislature finds that sediment is a source of pollution and that soil erosion continues to be a serious problem throughout the State, and that rapid shifts in land use from agricultural and rural to nonagricultural and urbanizing uses, construction of housing, industrial and commercial developments, and other land disturbing activities have accelerated the process of soil erosion and sediment deposition resulting in pollution of the waters of the State and damage to domestic, agricultural, industrial, recreational, fish and wildlife, and other resource uses. It is, therefore, declared to be the policy of the State to strengthen and extend the present erosion and sediment control activities and programs of this State for both rural and urban lands, and to establish and implement, through the State Soil Conservation Committee and the Soil Conservation Districts, in cooperation with the counties, the municipalities and the Department of Environmental Protection, a Statewide comprehensive and coordinated erosion and sediment control program to reduce the danger from storm water runoff, to retard nonpoint pollution from sediment and to conserve and protect the land, water, air and other environmental resources of the State.

3. For the purposes of this act, unless the context clearly indicates a different meaning:

a. "Application for development" means a proposed subdivision of land, site plan, conditional use, zoning variance, planned development or construction permit.

b. "Certification" means (1) a written endorsement of a plan for soil erosion and sediment control by the local Soil Conservation District which indicates that the plan meets the standards promulgated by the State Soil Conservation Committee pursuant to this act, (2) that the time allotted in section 7 of this act has expired without action by the district or (3) a written endorsement of a plan filed by the State Department of Transportation with the district.

*as amended by Ch. 264, P.L. 77 and Ch. 459, P.L. 79

c. "District" means a Soil Conservation District organized pursuant to chapter 24 of Title 4 of the Revised Statutes.

d. "Disturbance" means any activity involving the clearing, excavating, storing, grading filling or transporting of soil or any other activity which causes soil to be exposed to the danger of erosion.

e. "Erosion" means the detachment and movement of soil or rock fragments by water, wind, ice and gravity.

f. "Plan" means a scheme which indicates land treatment measures, including a schedule of the timing for their installation, to minimize soil erosion and sedimentation.

g. "Project" means any disturbance of more than 5,000 square feet of the surface area of land (1) for the accomodation of construction for which the State Uniform Construction Code would require a construction permit, except that the construction of a single-family dwelling unit shall not be deemed a "project" under this act unless such unit is part of a proposed subdivision, site plan, conditional use, zoning variance, planned development or construction permit application involving two or more such single-family dwelling units, (2) for the demolition of one or more structures, (3) for the construction of a parking lot, (4) for the construction of a public facility, (5) for the operation of any mining or quarrying activity, or (6) for the clearing or grading of any land for other than agricultural or horticultural purposes.

h. "Sediment" means solid material, mineral or organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water or gravity as a product of erosion.

i. "Soil" means all unconsolidated mineral and organic material of any origin.

j. "Standards" means the standards promulgated by the committee pursuant to this act.

k. "Committee" means the State Soil Conservation Committee in the Department of Agriculture established pursuant to R.S. 4:24-3.

l. "Public facility" means any building; pipeline; highway; electricity, telephone or other transmission line; or any other structure to be constructed by a public utility, municipality, county or the State or any agency or instrumentality thereof.

4. The committee shall have the power, subject to the approval of the Secretary of Agriculture and the Commissioner of Environmental Protection to formulate, promulgate, amend and repeal standards for the control of soil erosion and sedimentation, pursuant to the Administrative Procedure Act, P.L. 1968, c. 410 (C. 52:14B-1 et seq.)

a. Such standards shall be based upon relevant physical and developmental information concerning the watersheds and topography of the State, including, but not limited to, data relating to land use, soils, slope, hydrology, geology, size of land area being disturbed, proximate water bodies and their characteristics.

b. Such standards shall include criteria, techniques and methods for the control of erosion and sedimentation resulting from land disturbing activities for various categories of soils, slopes and land uses.

c. Such standards shall include standards of administrative procedure for the implementation of this act.

5. Approval of an application for development for any project by the State, any county, municipality, or any instrumentality thereof shall be conditioned upon certification by the local district of a plan for soil erosion and sediment control. Any person proposing to engage in any project not requiring approval by the State, any county, municipality, any instrumentality thereof shall, prior to commencing such project, receive certification by the local district of a plan for soil erosion and sediment control. Any public utility, municipality, county or the State or any agency or instrumentality thereof, other than the State Department of Transportation, which proposes a project shall, prior to the construction of such project submit to and receive certification by the district of a plan for soil erosion and sediment control. The State Department of Transporation shall certify a plan for any project that it proposes to construct and shall file such certification with the district. Certification by the Department of Transportation shall be pursuant to soil erosion control standards developed jointly by the Department of Transporation the Department of Environmental Protection and the committee and promulgated by the Department of Transportation.

6. The district shall certify such plan if it meets the standards promulgated by the committee pursuant to this act. The district shall provide written notice to the applicant indicating that:

a. The plan was certified;

b. The plan was certified subject to the attached conditions; or

c. The plan was denied certification with the reasons for denial stated.

7. The district shall grant or deny certification within a period of 30 days of submission of a complete application unless, by mutual agreement in writing between the district and the applicant, the period of 30 days shall be extended for an additional period of 30 days. Failure of the district to grant or deny certification within such period or such extension thereof shall constitute certification. For purposes of this section, a major revision of the plan by the applicant shall constitute a new submission.

8. The district shall adopt a fee schedule and collect fees from applicants for the certification of plans and for on-site inspections of the execution of certified plans. Such fees shall bear a reasonable relationship to the cost of rendering such services.

9. The district or the municipality may issue a stop-construction order if a project is not being executed in accordance with a certified plan.

10. Any municipality, which adopts an ordinance that conforms to the standards promulgated pursuant to this act within 12 months of their promulgation and obtains the approval of the committee thereto, shall be exempt from sections 5 through 9 of this act, until such time as the local district determines that the municipality is not enforcing said ordinance.

11. No certificate of occupancy for a project shall be issued by a municipality or any other public agency unless there has been compliance with provisions of a certified plan for permanent measures to control soil erosion and sedimentation.

12. In those counties where the district does not maintain its central office, the board of freeholders may, by resolution, direct the county planning board to act as an agent of the district within that county and to administer the powers granted to the district pursuant to this act, until such time as a district is established within that county. The committee shall establish guidelines to implement this section.

13. The districts and the committee are authorized to cooperate and enter into agreements with any Federal, State or local agency to carry out the purposes of this act. The districts and the committee are authorized to receive financial assistance from any Federal, State, county or other public or private source for use in carrying out the purposes of this act.

14. The committee is authorized to make grants of State aid to districts and to municipalities to carry out the purposes of this act.

15. If any person violates any of the provisions of this act, any standard promulgated pursuant to the provisions of this act, or fails to comply with the provisions of a certified plan the municipality or the district may institute a civil action in the Superior Court for injunctive relief to prohibit and prevent such violation or violations and said court may proceed in a summary manner. Any person who violates any of the

provisions of this act, any standard promulgated pursuant to this act or fails to comply with the provisions of a certified plan shall be liable to a penalty of not less than $25.00 nor more than $3,000.00 to be collected in a summary proceeding pursuant to the Penalty Enforcement Law (N.J.S. 2A:48-1 et seq.). The Superior Court, County Court, county district court and municipal court shall have jurisdiction to enforce said Penalty Enforcement Law. If the violation is of a continuing nature, each day during which it continues shall constitute an additional separate and distinct offense.

16. This act shall be liberally construed to effectuate the purpose and intent thereof.

17. If any provision of this act or the application thereof to any person or circumstances is held invalid, the remainder of the act and the application of such provision to persons or circumstances other than those to which it is held invalid, shall not be affected thereby.

18. This act shall take effect on January 1, next following its enactment except that section 4 shall take effect immediately.

Appeals - (Section 9, Chapter 459 P.L. 1979, N.J.S.A. 4:24-6.1)

The committee may, on its own motion or at the request of any person aggrieved by any decision by a local district, review and approve, modify or reject any such decision as it deems appropriate.

APPENDIX C.2

SOIL EROSION AND SEDIMENT CONTROL ACT

RULES AND REGULATIONS
pursuant to
Chapter 251, P.L. 1975

Chapter 90
NEW JERSEY ADMINISTRATIVE CODE
Title 2
Department of Agriculture
Subtitle 1 State Soil Conservation Committee

General Provisions

Authority

Unless otherwise expressly noted, all provisions of this subchapter were adopted pursuant to authority of N.J.S.A. 4:24-3 and Chapter 251, Laws of 1975.

2:90-1.1 PURPOSE

These rules and regulations are to implement P.L. 1975, Chapter 251, N.J.S.A. 4:29-39 et seq., hereinafter referred to as the act, to secure timely decisions by the soil conservation districts on application for development as defined therein, to assure adequate public notice of procedures thereunder and to continue effective administration of the law.

2:90-1.2 DEFINITIONS

All definitions in Chapter 251, Laws of 1975, are incorporated in these regulations. The following words and terms, when used in this subchapter, shall have the following meanings, unless the context clearly indicates otherwise.

"Appeal" means a request for review of district function.
"Hearing body" means the State Soil Conservation Committee.

2:90-1.3 STANDARDS

(a) The State Soil Conservation Committee adopts as standards for soil erosion and sediment control those standards presently published in the "Standards for Soil Erosion and Sediment Control in New Jersey", as adopted September 9, 1974 and revised September 1979, by the New Jersey State Soil Conservation Committee. Specifically, these standards include (1) Vegetative Standards as follows:

Temporary Vegetative Cover for Soil Stabilization	3.11
Permanent Vegetative Cover for Soil Stabilization	3.21
Stabilization with Mulch Only	3.31
Permanent Stabilization with Sod	3.41
Topsoiling	3.51
Maintaining Vegetation	3.61
Dune Stabilization	3.71
Trees, Shrubs and Vines	3.81
Protecting Trees During Construction	3.91

(2) Engineering Standards as follows:

Land Grading	4.11
Diversions	4.21
Grassed Waterway	4.31
Sediment Basin	4.41
Slope Protection Structures	4.51
Channel Stabilization	4.61

Copies are available through the State Soil Conservation Committee and each soil conservation district as follows:

1. Bergen County Soil Conservation District;
2. Burlington County Soil Conservation District;
3. Camden County Soil Conservation District;
4. Cape-Atlantic Soil Conservation District (Cape May and Atlantic Counties);
5. Cumberland County Soil Conservation District;
6. Freehold Soil Conservation District (Middlesex and Monmouth Couties);
7. Gloucester County Soil Conservation District;
8. Hudson, Essex and Passaic Soil Conservation District (Hudson, Essex and Passaic Counties);
9. Hunterdon County Soil Conservation District;
10. Mercer County Soil Conservation District;
11. Morris County Soil Conservation District;
12. Ocean County Soil Conservation District;
13. Salem County Soil Conservation District;
14. Somerset-Union Soil Conservation District (Somerset and Union Counties);
15. Sussex County Soil Conservation District;
16. Warren County Soil Conservation District.

(b) The location, address, and telephone numbers of each soil conservation district may be obtained from the State Soil Conservation Committee, P. O. Box 1888, Trenton, New Jersey 08625 609-292-5540.

2:90-1.4 APPLICATION

Applicants shall submit their plans to the district accompanied by an application form as prescribed by the committee. Such application shal indicate the information required to make a decision on certification of plans. Application forms are available at locations listed in section 3 of this subchapter.

2:90-1.5 PROCEDURE

(a) The district shall carry out the provisions of sections 5 through 7 of the act.

(b) No project shall be undertaken by any person, partnership, or corporation, or other private or public agency unless the applicant has submitted to the district with local jurisdiction a plan for soil erosion and sediment control for such project, and the plan has been certified by the district as conforming to the standards promulgated by the New Jersey State Soil Conservation Committee. The plan shall provide for the control of soil erosion and sedimentation and utilize the standards for soil erosion and sediment control adopted by the New Jersey State Soil Conservation Committee.

(c) Approval by a municipal officer or agency for an application for development for any project shall be conditioned upon certification by the district for a plan for soil erosion and sediment control.

(d) The district shall review all soil erosion and sediment control plans submitted with a complete application and provide the applicant with a written notice indicating that:

(1) The plan was certified;
(2) The plan was certified subject to the attached conditions; or
(3) The plan was denied certification with the reasons for the denial stated.

(e) The district shall furnish the municipal planning board a copy of the certification or denial including all conditions and statements.

(f) The district shall grant or deny certification within 30 days from submission of a complete application. The district may be granted an additional 30 day review period through mutual written agreement with the applicant. Failure of the district to grant or deny certification within such period or such extension thereof shall constitute certification.

(g) The district shall require a new submission of the plan and application when a major revision is made.

2:90-1.6 APPEAL PROCESS

(a) The State Soil Conservation Committee may, on its own motion or at the request of any person aggrieved of any action by the district, review the decision of any soil conservation district and make whatever determinations it deems appropriate in the matter. Any person aggrieved of any decision of a soil conservation district shall have ten days to appeal to the State Soil Conservation Committee which shall schedule a hearing and make a determination within 45 days of the petition for review. Any person against whom a stop-construction order is issued by any district shall also have the right to appeal to the State Soil Conservation Committee. Requests for appeal shall be addressed to:

Secretary, State Soil Conservation Committee
P. O. Box 1888
Trenton, New Jersey 08625

(b) The committee shall appoint and utilize the hearing office procedures of the Department of Agriculture for fact finding and recommendations to the committee.

(c) The committee shall send a written notice to the appellant of hearing status:

(1) The application number;
(2) Details of how decisions aggrieves appelant;
(3) Date, time and place of hearing.

2:90-1.7 MUNICIPAL ORDINANCES

(a) Municipalities may adopt soil erosion and sediment control ordinances conforming to the standards promulgated by the committee. Adoption by the municipality of such ordinances must be completed by May 31, 1978, in order to qualify for an exemption from sections 5 through 9 of the act.

(b) Such ordinances adopted by municipalities may provide for the review and certification of plans by the district in accordance with these rules and regulations. In all such cases, there shall be written contracts with the municipalities requesting review and certification and fees shall be charged in accordance with the established district fee schedule.

(c) Municipalities shall obtain the approval of such ordinances by the committee before being exempt from the provisions of this act. The committee may continue after May 31, 1978, to review municipal ordinances enacted before May 31, 1978, and, if it so determines, grant approval to such ordinances.

(d) The committee shall secure review and comment by the district on municipal ordinances submitted to it. The district may recommend approval or disapproval to the committee. Written notification of approval or disapproval shall be sent to the district and municipality by the committee within 60 days.

(e) Municipalities having a soil erosion and sediment control ordinance presently in effect who wish to be exempt from sections 5 through 9 of this Act shall submit such ordinances to the committee for approval before May 31, 1978. Upon written notification of approval, which may be given after May 31, 1978, the municipality shall be exempt from sections 5 through 9 of this act.

(f) Districts shall annually review for compliance all soil erosion and sediment control ordinances enacted by muncipalities within the district. The district shall inform the committee in writing of the results of this review by February 15 of each year. If at any time during the year, the district determines and so notifies the committee that any municipality is not enforcing its soil erosion and sediment control ordinance, the committee shall give written notice to the muncipality that it is no longer exempt from sections 5 thorugh 9 of the act.

(g) Any proposed changes to a municipal ordinance which has received the approval of the committee, and is therefore exempt from sections 5 through 9 of the act, must be submitted to the committee for review and approval prior to enactment of the revised ordinance. For the municipality's exempt status to continue, all such changes must be found to be in accordance with the act and approved as such by the committee. Failure of the municipality to secure written notification of approval will result in discontinuance of municipal exemption from section 5 through 9 of the act.

2:90-1.8 FEES

Reasonable fees shall be set by the soil conservation districts based on cost. The fee schedule proposed by each district shall be approved by the committee before it is adopted by the district. Any person aggrieved of the set fee may appeal to the State Soil Conservation Committee as outlined in section 6 of this subchapter.

2:90-1.9 ENFORCEMENT

(a) Inspection of projects to determine execution in accordance with the certified plan shall be carried out by the district in close coordination with the municipal engineer and building inspector.

(b) The district shall determine whether or not the provisions of the certified plan are being followed by the applicant.

(c) The district shall inform the applicant in writing of observed deviation from the certified plan and request immediate compliance with the plan.

(d) The district or the municipality may issue a stop-construction order if the applicant takes no action to comply with the provision of the certified plan.

(e) When a stop-construction order is issued, no further construction activity may take place until the applicant is in compliance with all provisions of the certified plan.

(f) The municipality shall not issue a certificate of occupancy for a project unless there has been compliance with the provisions of certified plan for permanent measures. The district shall provide the municipality with a report of compliance upon completion of the project.

2:90-1.10 CHANGES

Changes in the certified plan must be submitted to the district for reevaluation and approval.

2:90-1.11 REPORTS

The districts shall submit quarterly reports to the committee giving number of applications, number of certifications, denials and number of reviews.

2:90-1.12 MUNICIPAL ORDINANCES FOR SOIL EROSION AND SEDIMENTATION CONTROL

(a) In order to protect the public interest and welfare and to enable the orderly continuance of municipal government in this State, the New Jersey State Soil Conservation Committee gave temporary approval to all municipal ordinances for soil erosion and sediment control adopted before January 1, 1976.

(b) Such temporary approval will be terminated on May 31, 1978.

APPENDIX C3

CHRONOLOGY OF

STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

TITLE

Preface: Published June 1972
Introduction: Published June 1972
General Guidelines: Published June 1972

Vegetative Standards

Temporary Vegetative Cover for Soil Stabilization: Adopted June 1972, Revised January 1974, September 1979
Permanent Vegetative Cover for Soil Stabilization: Adopted June 1972, Revised January 1974, September 1979
Stabilization with Mulch Only: Adopted June 1972, Revised January 1974, September 1979
Permanent Stabilization with Sod: Adopted June 1972, Revised January 1974, September 1979
Topsoiling: Adopted June 1972, Revised September 1979
Maintaining Vegetation: Adopted June 1972
Dune Stabilization: Adopted June 1972, Revised January 1974, September 1979
Trees, Shrubs and Vines: Adopted January 1974
Protecting Trees During Construction: Adopted January 1974

Engineering Standards

Land Grading: Adopted June 1972, Revised January 1974
Diversions: Adopted June 1972, Revised September 1979
Grassed Waterway: Adopted June 1972, Revised September 1979
Sediment Basin: Adopted June 1972, Revised January 1974, September 1979
Slope Protection Structures: Adopted June 1972, Revised January 1974
Channel Stabilization: Adopted June 1972, Revised January 1974, September 1979
Floodwater Retarding Structures: Adopted June 1972, Revised January 1974
Subsurface Drainage: Adopted January 1974
Traffic Control: Adopted January 1974
Dust Control: Adopted January 1974, Revised September 1979
Lined Waterway: Adopted September 1979
Riprap: Adopted September 1979
Sediment Barrier: Adopted September 1979
Conduit Outlet Protection: Adopted September 1979
Stabilized Construction Entrance: Adopted September 1979
Storm Sewer Inlet Protection: Adopted September 1979

APPENDIX A

The Universal Soil Loss Equation: Published June 1972, Pg A1.24 Revised September 1979
Requirements for a Soil Erosion and Sediment Control Plan: Published June 1972, Revised July 1976

Guide for Construction Specifications: Published June 1972, Revised July 1980
Maintenance, Structural Measures: Published June 1972
Guide for Installing Soil Stabilization Matting: Published June 1972
Diversion and Grassed Waterway Design Procedure: Published July 1980
Sediment Basin Design Procedure: Published July 1980
Channel Stability Analysis Procedure: Published July 1980
References: Published June 1972, Revised January 1974, July 1976, July 1980

APPENDIX B

Example for Seed Specification: Published June 1972
Grass and Legume Planting Guide: Published June 1972

APPENDIX C

Soil Erosion and Sediment Control Act: Published July 1976, Revised July 1980
New Jersey Administrative Code 2:90-1.1 et seq: Published July 1980
Chronology of Standards for Soil Erosion and Sediment Control in New Jersey: Published July 1980

APPENDIX D

Glossary: Published June 1972, Revised July 1980

APPENDIX E

Directory Soil Conservation Districts in New Jersey: Published June 1972, Revised January 1974, July 1976, July 1980.

APPENDIX D1

GLOSSARY

Acre-feet - An engineering term used to denote a volume 1 acre in area and 1 foot in depth.

Aggrade - The alteration of a channel caused by the deposition of sediment.

Anti-seep Collar - A device constructed around a pipe or other conduit placed through a dam, dike, or levee for the purpose or reducing seepage losses and piping failures. (See Figure 4.4-I)

Anti-vortex Device - A facility placed at the entrance to a pipe conduit structure such as a drop inlet spillway or hood inlet spillway to prevent air from entering the structure when the pipe is flowing full. (See Figure 4.4-I)

Barrel - See conduit.

Borrow Area - A source of earth fill materials used in the construction of embankments or other earth fill structures.

Bottomlands - A term often used to define lowlands adjacent to streams (flood plains in rural areas).

Box Inlet Drop Spillway - A form of principal spillway. (See Figure 4.4-III)

Cantilever Outlet - A discharge pipe extending beyond its support.

Cascades or Bedrock - Section of stream without pools, consisting primarily of bedrock with little rubble, gravel, or other such material present. Current usually more swift than in riffles.

Channel - A natural stream that conveys water; a depth or channel excavated for the flow of water.

Chute Spillway - A form of principal spillway. (See Figure 4.4-IV)

Conduit - A closed facility used for the conveyance of water.

Cover Crop - A crop grown primarily for the purpose of protecting soil between periods of permanent vegetative cover.

Cradle - A device usually concrete, used to support a pipe conduit or barrel. (See Figure 4.4-I)

Cutoff Trench - A long, narrow excavation constructed along the center line of a dam, dike, levee or embankment and filled with relatively impervious material intended to reduce seepage of water through porous strata.

Degrade - The alteration of a channel caused by the erosion and scour of the channel bottom.

Design Highwater - The elevation of the water surface as determined by the flow conditions of the design floods.

Design Life - The period of time for which a facility is expected to perform its intended function.

Diversion - A channel with or without a supporting ridge on the lower side constructed across or at the bottom of a slope for the purpose of intercepting surface runoff.

Embankment - A man-made deposit of soil, rock or other materials used to form an impoundment.

Emergency Spillway - A vegetated earth channel used to safely convey flood discharges in excess of the capacity of the principal spillway.

Energy Dissipator - A device used to reduce the energy of flowing water.

Erosion - Detachment and movement of soil or rock fragments by water, wind, ice and gravity.

Field Capacity - The amount of water retained in a soil after it has been saturated and has drained freely. It is usually expressed as a percentage of the overdry weight of the soil. Also called field moisture capacity.

Filter Blanket - A layer of sand and/or gravel designed to prevent the movement of fine-grained soils.

Filter Strip - A long, narrow vegetative planting used to retard or collect sediment for the protection of diversions, drainage basins, or other structures.

Flat - Section of stream with current too slow to be classed as riffle and too shallow to be classed as a pool. Stream bottom usually composed of sand or finer materials, with coarse rubble, boulders or bedrock occasionally evident.

Flood Plain - The relatively flat area adjoining the channel of a natural stream which has been or may be hereafter covered by flood water.

Flood Routing - Determining the changes in the rise and fall of flood water as it proceeds downstream through a valley or through a reservoir.

Flume - A device constructed to convey water on steep grades lined with erosion-resistant materials.

Freeboard - The vertical distance between the elevation of the design highwater and the top of the dam, dike, levee or diversion ridge.

Grade Stabilization Structure - A structure for the purpose of stabilizing the grade of a watercourse, thereby preventing further headcutting or lowering of the channel grade.

Grading - Any stripping, cutting, filling, stockpiling, or any combination thereof and shall include the land in its cut or filled condition.

Grassed Waterway - A natural or constructed channel, usually broad and shallow, covered with erosion-resistant vegetation, used to conduct surface water.

Hood Inlet - A pipe entrance wherein the top edge of the pipe is extended 3/4 of the diameter beyond the bottom invert cut on an angle. (See Figure 4.5-II)

Hydrograph - A graph showing for a given point on a stream or for a given point in any drainage system, the discharge, stage, velocity, or other property of water with respect to time.

Inoculant - A peat carrier impregnated with bacteria which form a symbiotic relationship enabling legumes to utilize atmospheric nitrogen. Most of our legumes require specific bacteria.

Impact Basin - A device used to dissipate the energy of flowing water. Generally constructed of concrete in the form of a depressed and partially submerged vessel and may utilize baffles to dissipate velocities.

Land - Any ground, soil or earth including marshes, swamps, drainageways and areas not permanently covered by water.

Level Spreaders - A shallow channel excavation at the outlet end of a diversion with a level section for the purpose of diffusing the diversion outflow.

Liquid Limit - The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Mannings Formula - A formula used to predict the velocity of water flow in an open channel or pipeline:

$$V= \frac{1.486\ r^{2/3} S^{1/2}}{n}$$

wherein "V" is the mean velocity of flow in feet per second; "r" is the hydraulic radius; "s" is the slope of the energy gradient or for assumed uniform flow the slope of the channel in feet per foot; and "n" is the roughness coefficient or retardance factor of the channel lining.

Mulching - The application of plant residue or other suitable materials to the land surface to conserve moisture, hold soil in place, aid in establishing plant cover and minimize temperature fluctuation.

Outlet - Point of water disposal from a stream, river, lake, tidewater, or artificial drain.

Peak Discharge - The maximum instantaneous flow from a given storm condition at a specific location.

pH - A measure of acidity or basicity with pH 7 being neutral and pH 6.5 being a desirable degree of soil acidity. Basicity above pH 7 is rare in eastern U. S. soils.

Pipe Drop - A circular conduit used to convey water down steep grades.

Plasticity Index - The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic Limit - The moisture content at which a soil changes from a semisolid to a plastic state.

Plunge Pool - A device used to dissipate the energy of flowing water that may be constructed or made by the action of flowing. These facilities may be protected by various lining materials.

Pool - Section of stream deeper and usually wider than normal with appreciably slower current than immediate upstream or downstream areas and possessing adequate cover (sheer depth or physical condition) for protection of fish. Stream bottom usually a mixture of silt and coarse sand.

Principal Spillway - Generally constructed of permanent material and designed to regulate the normal water level, provide flood protection and/or reduce the frequency of operation of the emergency spillway.

Rational Formula - Q=CIA. Where "Q" is the peak discharge measured in cubic feet per second, "C" is the runoff coefficient reflecting the ratio of runoff to rainfall, "I" is the rainfall intensity for the duration of the storm measured in inches per hour, and "A" is the area of the contributing drainage area measured in acres.

Ridge - The bank or dike constructed on the downslope side of a diversion.

Riffle - Section of stream containing gravel and/or rubble, in which surface water is at least slightly turbulent and current is swift enough that the surface of the gravel and rubble is kept fairly free from sand and silt.

Riprap - Broken rock, cobbles or boulders placed on earth surfaces, such as the face of a dam or the channel of a stream, for protection against the action of water.

Risers - The inlet portions of a drop inlet spillway that extend vertically from the pipe conduit barrel and control the water surface.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of orgin by air, water, gravity or ice.

Sediment Basin - A depression formed by the construction of a barrier or dam built at suitable locations to retain rock, sand, gravel, silt or other material.

Soil - The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.

Soil Horizon - A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Stabilized Center Section - An area in the bottom of a grassed waterway protected by stone, asphalt, concrete or other materials to prevent erosion.

Stone Center - A stabilized center section made of stone.

Storm Frequency - An expression or measure of how often a hydrologic event of given size or magnitude should on an average by equaled or exceeded. The average should be based on a reasonable sample.

Straight Drop Spillway - A form of principal spillway. (See Figure 4.4-II)

Straw - The natural dry stem and related material threshed of its seed.

Temporary Protection - Stabilization of erodible or sediment-producing areas.

Toe Drain - A drainage system constructed in the downstream portion of an earth dam or levee to prevent excessive hydrostatic pressures. (See Figure 4.4-I)

Trash Rack - A structure device used to prevent debris from entering a spillway or other hydraulic structure. (See Fegure 4.4-I)

Underdrains - Pipelines of tile with open joints or perforated pipe used for the collection of subsurface water.

Unified Soil Classification System - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

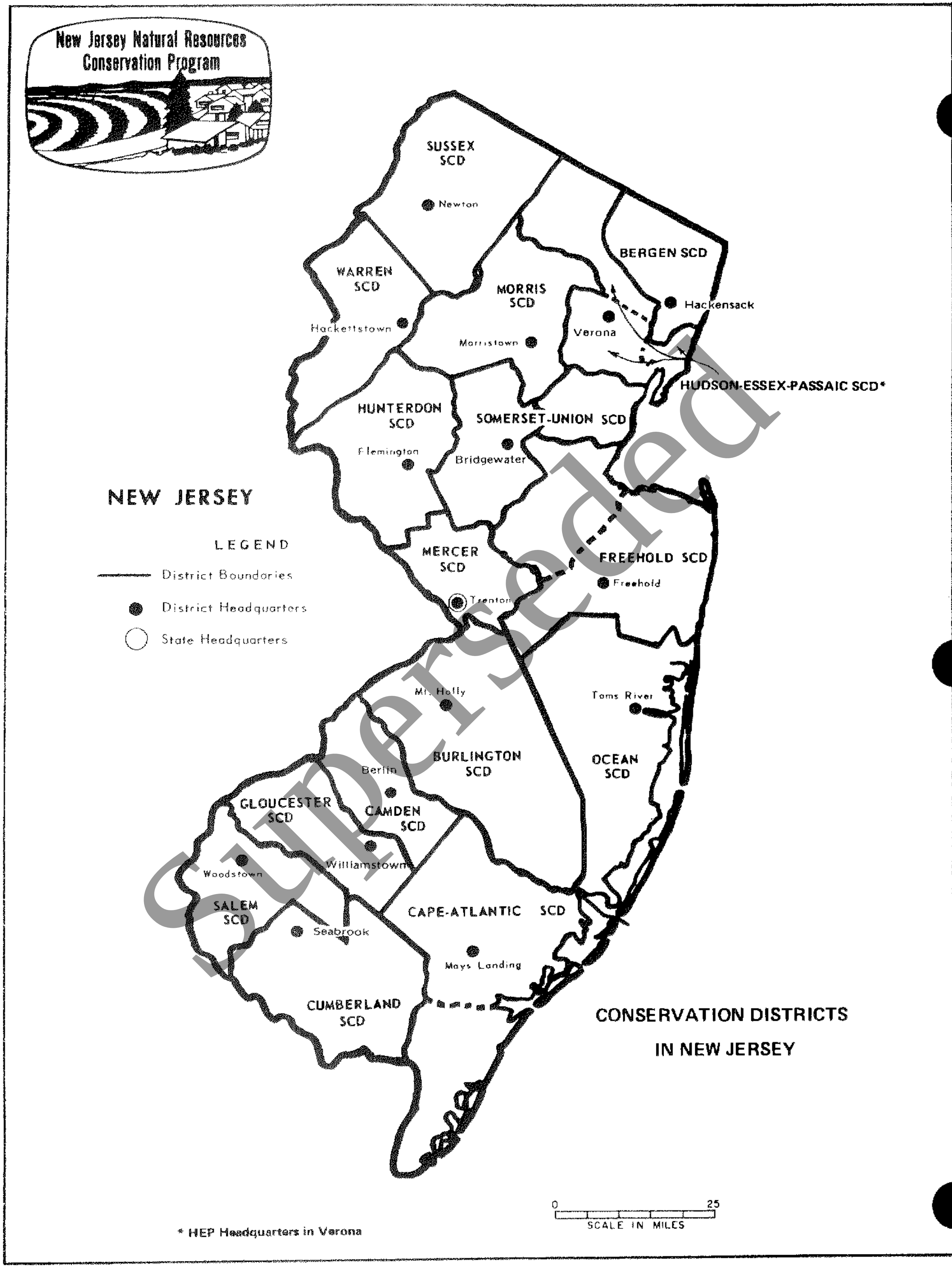
Uplift Forces - Vertical pressures acting upward on a structure, usually caused by a buoyant condition.

Vegetative Protection - Stabilization of erosive or sediment producing areas by covering the soil with:

a. Permanent seeding, producing long-term vegetative cover,

b. Short-term seeding, producing temporary vegetative cover, or

c. Sodding, producing areas covered with a turf of perennial sod-forming grass.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