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State Soil Conservation Committee




The Standards for Soil Erosion and Sediment Control In New Jersey

7th Edition, January 2014

Cover: Restoration of 800 feet of the Ramapo River bank after damage by Hurricane Irene in August 2011. Restoration by the Boro of Oakland, Bergen County NJ Spring 2013 (completed). Technical and funding assistance from the USDA Natural Resources Conservation Service. Erosion Control oversight by the Bergen County Soil Conservation District.

STANDARDS

FOR

SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY

Adopted
December 2013

Vegetative and Engineering Standards, chapters 1 - 32 inclusive are promulgated as "Standards" pursuant to the Soil Erosion and Sediment Control Act of 1975 as amended (N.J.S.A. 4:24-39 et seq.) and New Jersey Administrative Code (N.J.A.C. 2:90-1.1 et seq.).

By the

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FOREWORD AND ACKNOWLEDGMENTS

2014 marks the 38th year of service to New Jersey by the Soil Erosion and Sediment Control Program administered by the Department of Agriculture and the New Jersey Soil Conservation Districts. Since the inception of the idea to apply conservation practices to urban development in 1976, New Jersey has significantly evolved in its approach to erosion control. From simple hay bales for filtering runoff, to advanced computer simulations which model watershed runoff, New Jersey's erosion control practices have taken advantage of developing technologies. Periodically the Department, and Soil Conservation Districts update the "*Standards for Soil Erosion and Sediment Control* " to reflect the ongoing emergence of science and technology.

The *Standards* are a blend of agronomic science and state of the art engineering practices, embodied in 32 individual design chapters and detailed appendices that enable developers to successfully design erosion control practices for construction sites. Soil loss prevention is addressed both during as well as after construction to safeguard New Jersey's natural resources.

Since 1976, more than 920,000 acres of land have been protected from erosion by the application of construction site best management practices to control erosion. This equates to more than 28 million tons of soil that have been prevented from entering the state's waterways. Erosion protection allows for the continuation of recreational opportunities, aids in flood prevention efforts and minimizes the need for water treatment.

The seventh edition of the *Standards* has been revised to include additional guidance for assessing downstream stability, rip rap design, the use of infiltration and additional options for vegetation used in the Pinelands National Reserve. Future revisions are planned to enhance the quality of soil used in establishing vegetation for stabilization of development sites.

The New Jersey Department of Agriculture acknowledges its long-time partners - the United States Department of Agriculture – Natural Resources Conservation Service, the state's 15 Soil Conservation Districts, Rutgers University and the New Jersey Department of Environmental Protection for their assistance in developing these *Standards*. Additionally, the Department appreciates the valued expertise of the New Jersey Pinelands Commission, the New Jersey Department of Transportation and the many representatives of the New Jersey Builders Association and Professional Consulting Engineers who assisted in this project. These partnerships have achieved great success in the minimization of damage due to excessive stormwater runoff and related soil loss from construction sites while at the same time promoting concepts of good stewardship of the state's resources to all of New Jersey's residents.

Douglas H. Fisher
Secretary, New Jersey Department of Agriculture
January 2014

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Developing a Successful Plan to Control Soil Erosion on Construction Sites

"He who fails to plan, plans to fail…." is an oft-quoted proverb. Its original author is unknown, but it is frequently attributed to such famous individuals as Benjamin Franklin, Abraham Lincoln and Winston Churchill. Regardless of who coined the phrase, failure to plan (properly) is never more evident than in a poorly thought out erosion and sediment control plan. Once a slope has eroded, or an infiltration basin has failed, it is too late to 'plan'. It is only time to react and correct. And usually, it costs more to do something twice, than to do it right the first time.

Though not an exhaustive list, the following represent many of the primary design considerations and constraints in preparing an effective erosion control plan. Effective erosion control should be integrated into planning for stormwater management, and not done as an after-thought. A properly developed plan should address the following aspects of site construction when designing for erosion control:

General Considerations-

1. Design report included and submitted to the district
2. Table of Contents for the design report denoting location of erosion control designs
3. Plan drawn at proper scale (usually not less than 1:50)
4. Erosion Control Plan sheets labeled, signed and sealed by a NJ Licensed Engineer or Architect
5. Pre and post construction contours clearly labeled and depicted
6. Limits of disturbance clearly delineated and corresponding to area of disturbance on the application form
7. Temporary controls such as sediment barriers, inlet filters graphically depicted on plan sheets
8. Details for erosion control applications clearly shown on a 'detail sheet'; dimensions correspond to deign report
9. District notes, vegetative stabilization specifications and other notes shown on the detail page
10. Soil delineations shown on the erosion control plan sheets
11. Other natural features, such as streams, wetlands and buffers delineated on plan sheets
12. Permanent structures graphically depicted on plan sheets (piping, basins, rip rap outlets, swales, basins etc)
13. Offsite improvements (sewer, water, storm drainage, electrical utilities) shown and included in area calculations
14. Proposed staging and stockpile areas depicted (on and off site).

Construction Disturbance Considerations-

1. Phasing of disturbed areas (minimizing open soil areas)
2. Sequence of construction specific to the site (avoid generic sequencing)
3. Stormwater management on a construction site
    a. Temporary sediment basins with design support and appropriate details
    b. Diversions & swales
    c. Grading
    d. Filtering via pumped discharge
    e. Dewatering excavations and points of discharge
4. Temporary stabilization with vegetation, mulch, man-made materials etc.
5. Location of temporary controls such as inlet filters, sediment barriers, construction entrances
6. Soil movement – cuts, fills, removal, stockpiles and importation shown on plans
7. Minimization of soil compaction – restrict vehicle travel, avoid working wet soils, restore if needed

Hydrologic Design Considerations-

1. Correct application of hydrologic analysis both onsite and within the local drainage area
    a. Correct unit hydrograph (i.e., Delmarva for coastal plain areas)
    b. Pre and post drainage area maps with Tc flow paths and POI's identified
    c. Realistic sheet flow length in time of concentration (in all cases, not to exceed 100')
    d. Correct pre and post development runoff coefficients
    e. Influence of geology (esp. limestone prone areas)
    f. Submission of electronic modeling files to the district
    g. Submission of Hydrologic Summary forms for each basin
2. Assessment of pre and post development flows for the 2, 10 and 25 (rip rap) year storm events

3. Determination of soil types and their associated limitations (i.e., depth to ground water, slope stability) using the Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm)
4. Final points of discharge from the site and stability at those locations
5. Discharging to agricultural fields (generally not permitted due to stability concerns)
6. Infiltration and failure analysis for stability
7. Impact of discharge beyond the limits of the project (off site stability)
8. Stability of slopes – both from overland flow as well as impacts due to infiltration saturation
9. Proper use of permanent vegetative cover – species selection, irrigation, soil quality, maintenance
10. Use of turf reinforcement matting on steep slopes or channel lining
11. Rock rip rap sizing, gradation and availability; alternate use of gabions or reinforced concrete
12. Grass water way designs using vegetative retardance (D & E) factors, soil conditions, velocity, proper vegetation and reinforcement mating

Requirements of Other Agencies-

1. NJ Department of Environmental Protection-
   a. Stormwater Rules
   b. Wetlands
   c. Highlands
   d. Stream Encroachment
2. Residential Site Improvement Standards
3. NJ Department of Transportation
4. NJ Pinelands Commission
5. County and municipal construction codes

When preparing an erosion control plan, one resource which should not be overlooked is New Jersey's 15 Soil Conservation Districts. With a broad spectrum of expertise in the areas of erosion and sediment control, agronomy, horticulture and stormwater management, District staff are available to assist designers with development of reliable and effective strategies for controlling erosion from construction sites. A list of New Jersey Soil Conservation District contact information is found in Appendix E of the Standards.

Procedure for the evaluation of new erosion control technologies, products and services for compliance with the Standards for Soil Erosion and Sediment Control in New Jersey

In order to address opportunities to utilize new and innovative technologies, products and services (TPS) for sediment and erosion control, the New Jersey Department of Agriculture, State Soil Conservation Committee (SSCC) has adopted the following evaluation process which is intended to provide compliance with the Standards.

The Standards include, where appropriate and necessary, design and performance specifications so that any TPS which meets these specifications would be acceptable for use on construction sites in New Jersey for compliance with the Act without the need for extensive (and expensive) laboratory testing. A new TPS which differs from design or performance standards, or which attempts to define a non-standardized practice must be field tested in New Jersey prior to acceptance.[1]

Field performance will be monitored by Soil Conservation District personnel as well as the NJDA State Erosion Control Engineer (as needed). The process for TPS field evaluation is as follows:

1. The vendor will provide a written request for evaluation to the State Engineer and the local Soil Conservation District where the product is to be evaluated. The request must include a physical/chemical description of the product, design limitations (if any), what function the product is intended to perform, and which Standard it is to be used in compliance for. Laboratory or other supplier-derived test data may also be submitted if desired.

2. The State Engineer will review the request and consult with the respective district or districts to verify that the TPS being proposed is appropriate for the intended application and site location. Alternative locations may be suggested if the proposed location is not deemed adequate for a complete evaluation. Written permission and agreement for allowing the evaluation must be secured from the site owner and is the responsibility of the vendor, with a copy provided to the district and State Engineer.[2] The State Engineer can provide written confirmation to the site owner that for testing and evaluation purposes, the owner is assisting the State in its evaluation of a new product and will not be liable for a lack of erosion control compliance with their certified plan due to product failure as long as the product is properly installed and is provided with the appropriate routine maintenance, as would be the case for the use of any erosion control product.

3. The State Engineer will advise the SSCC and other districts of the request for testing at the next SSCC meeting.

4. Once a proper location is secured, the vendor will oversee and provide training (if necessary) for proper installation of the product to ensure an adequate evaluation is performed. During the evaluation, District staff and/or the State Engineer will monitor and observe the performance of the TPS and maintain observations in project record notes as part of routine inspections. The TPS must be properly installed and in good working order during a test event to be considered as a viable test. Unintentional damage or improper installation and subsequent failure will not count as a viable test. The State Engineer may consult with other experts, as needed, to ensure comprehensive evaluation. The vendor will be notified if any product failure or damage occurs so that corrective action may be taken, if appropriate, to restore proper functioning of the TPS.

5. TPS's which are intended to secure against erosion by resisting the forces of water and/or wind will be evaluated for 3 discrete events, each of which must meet the minimum event criteria (such as minimum precipitation depth, flow rate, velocity, etc.) prescribed by the vendor or as stipulated in the applicable Standard. For TPS's intending to promote or enhance vegetative stabilization an evaluation period of two consecutive growing seasons will be observed to determine product performance.

6. The State Engineer will review notes, photos, etc. and present findings and conclusions to the SSCC with recommendations. These recommendations may be:

   (1) the TPS is acceptable for use anywhere in NJ;

   (2) the TPS is acceptable for use only in particular locations in NJ

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1 Not every Standard is based on design and/or performance criteria. Certain Standards require computation or specific materials in their application for compliance.

2 Neither the Soil Conservation District nor the State Engineer may compel a project owner to allow the use of a new product for testing on his or her site. Assistance is strictly voluntary on the part of the owner.

(3) the TPS is acceptable for use only for particular site and/or weather conditions

(4) the TPS is not acceptable for use in NJ.

The SSCC may, at is pleasure and discretion, accept, accept with modifications or reject the recommendations.

7. A TPS that is found to be acceptable for use in NJ (with or without conditions) will be identified in a TPS Bulletin (PSB) to be maintained and published by NJDA-SSCC. Conditions or limitations of the TPS will be identified in the bulletin, which will be published on the Department's website and will be available for public download. The vendor will be provided a copy of the findings and conclusions along with a copy of a TPS Bulletin, if one is issued.

8. Once a TPS Bulletin is issued, no further written approval or requests for use will be required for inclusion on soil erosion and sediment control plans or as an equivalent substitute to controls that are already shown on a plan. All manufacturer installation details, maintenance requirements and limitations must be included on the plan adjacent to the installation details.

Compliance with the Standards is required by N.J.S.A. 4:24-39 et seq. for all construction sites in New Jersey which meet the definition of a soil disturbance 'project' as defined in the Act. As a result, the specific inclusion of proprietary, manufactured products, product names, technologies or services is prohibited in that this may constitute the endorsement of one product over another by the State. Generic products which have historically been used for controlling erosion and are considered to be in the public domain may be generically referenced in the Standards without the use of trade-marked ™ names.

State Soil Conservation Committee

Standards For Soil Erosion and Sediment Control in New Jersey

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Appendix A1

THE UNIVERSAL SOIL LOSS EQUATION *

Determining Sediment Yield from Construction Sites and Development

Introduction

Sediment, a common term for eroded soil, is the most massive pollutant of surface water. Our growing population and high standards of living require construction of more houses, shopping centers, highways, waterways, and other facilities that involve clearing of vegetation and massive movement of soil. These activities expose the soil directly to the erosive actions of rain and flowing water. As a result, an enormous amount of soil is lost from these sites causing high turbidity to the water that carries it and damaging the site where it is finally deposited.

The Universal Soil Loss Equation, commonly known as the USLE, is a valuable technique for estimating erosion rates and evaluating various conservation practices for controlling erosion and sedimentation (deposition).

The Soil Erosion - Sedimentation Process

Since soil erosion and sedimentation by water are complex processes, a better understanding of them provides a sound basis for developing improved predictions and control methods. Soil erosion and sedimentation by water include detachment from the soil mass, transport downslope, and subsequent deposition. Soil is detached by raindrop impact and runoff shear forces, but man's activities that loosen and pulverize soil often promote accelerated erosion. Downslope transportation of eroding soil particles is primarily by channelized runoff. Generally, three distinct forms of erosion are seen in the upland areas. These are sheet erosion, rill erosion and gully erosion. Sheet erosion, also known as interrill erosion, takes place uniformly between rills or gullies. Sheet erosion results primarily from raindrop impact. The erosive potential of rain depends on its raindrop size, fall velocity and total mass at impact. Unless the soil surface is protected against raindrop impact by vegetation, mulches, or other cover, these raindrops can detach great quantities of soil and cause serious unnoticed interrill erosion.

Rill erosion is much more noticeable than interrill erosion. It is primarily the result of soil detachment by concentrated runoff, it causes intensive soil movement from a limited part of the land surface. Rills, which are small channels that can be easily smoothed, may first develop due to topographic variations, tillage marks, or random irregularities on the land surface. Rills carry both runoff from interrill areas and the rain that falls directly on them. Rill erosion increases rapidly as the slope steepens or lengthens and runoff rate increases.

Gully erosion is massive removal of soil by large concentrations of runoff. Gullies often start as rills and enlarge until they cannot be crossed by vehicles such as trucks and tractors. If permitted to form, gullies may yield tremendous volumes of sediment.

*Pages A1.1-A1.20 written by Dr. Devah Borah and presented at Cook College, Rutgers University, Sediment and Erosion Control Short Course, Spring 1986.

The quantity and size of material transported is a function of runoff velocity and turbulence, and these increase as the slope steepens and the flow increases. The larger the eroding material, the greater must be the flow velocity and turbulence to transport it. When the velocity or turbulence decreases, some of the eroded sediment may deposit. The largest and densest particles settle first while the finer particles are carried farther downslope or downstream.

Estimating Sediment Yield

The rate of sheet erosion depends on several factors as follows: (1) rainfall energy and intensity, (2) soil erodibility, and (3) land slope and length of slope or topography, (4) condition of the soil surface and land management practices in use and (5) surface 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 soil loss from sheet erosion in tons per acre per year. See ref. (3).

R, the rainfall factor, is the number of erosion index 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 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 the construction site. 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 the contour strip cropping 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 E may also be modified by a factor M shown on Table A1-6. M may be used to estimate the soil loss for a portion of 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 EI when the equation is being used to estimate average annual soil loss. This value of 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 general nature, useful for planning purposes. It should 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 agriculture 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 the 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 loss equation represents gross sheet erosion. This value plus erosion from the rilling, gullies and other sources is the gross erosion. To obtain sediment yield at the 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 tend 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 the 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 soil loss from different size areas, can also be estimated.

"LS" Factor for Composite Slopes

LS values given in Table A1-3 predict the average soil loss for the entire length of a slope. Such a slope length is measured from the point where surface flow originates (usually the top of the ridge) to the outlet channel or a point down slope where deposition begins. When a slope steepens or flattens significantly toward the lower end, or is composed of a series of convex and concave segments, its overall average gradient and length do not correctly indicate the topographic effect on soil loss. Neither can successive slope segments be evaluated as independent slopes when runoff flows from one segment to the next. For irregular slopes values read from the aforementioned table must be adjusted to account for effects of the gradient changes.

The irregular slope is divided into a small number of equal-length segments in such a manner that, for practical purposes, the gradient within each segment can be considered uniform. The LS values corresponding to the steepness of each of the slope segments are read from table A1-3. While reading these values, the entire length of the irregular slope is taken. These LS values are multiplied by the corresponding factors given in the following table (Wischmeier, 1974). Each individual product is an estimate of LS value for the corresponding slope segment and the average of the products is an estimate of the effective LS value for the entire irregular slope. The procedure is valid only for situations where upslope deposition is not possible.

FACTORS TO ADJUST "LS" VALUES FOR COMPOSITE SLOPES

Segment No. (Top to Bottom)	Adjustment Factors for Given Number of Equal-length Segments			
	2	3	4	5
1	0.71	0.58	0.50	0.45
2	1.29	1.06	0.91	0.82
3		1.37	1.18	1.06
4			1.40	1.25
5				1.42

"C" Values for Various Mulches Table A1-4 gives C values and slope-length limits or various nonseeded and seeded mulches used in controlling soil erosion. This table is taken from Meyer and Ports (1976). By using these values in the USLE, the effectiveness of various mulches can be determined in controlling soil erosion.

Sediment Delivery Ratio

Since the USLE predicts only the soil loss by rill and interrill erosion from the field-size areas, sediment yields from larger areas of watersheds must be estimated by adding additional erosion from gullies and streambanks along the flow path and subtracting eroded soil that is deposited at the base of a slope and elsewhere within the watershed. If additional gully or channel-type erosion is significant, it should be estimated and added to the predicted upland erosion to give the gross erosion occurring in the watershed above the location of interest. Deposition of eroded soil is accounted by simply using a sediment delivery ratio which is defined as the ratio of the sediment leaving the watershed to the estimated gross erosion on the watershed. Delivery ratios are generally much less than 1, because most natural slopes tend to flatten along their lower portions, which encourages deposition, and heavy vegetation often traps sediment below the upland slopes. However, urban erosion sources often lack locations where deposition is likely to occur and, in such cases, the delivery ratio will approach 1. Figure 2-4-2 gives delivery ratios for different soil texture and drainage areas. A general guide to sediment delivery ratios from construction sites is given as follows:

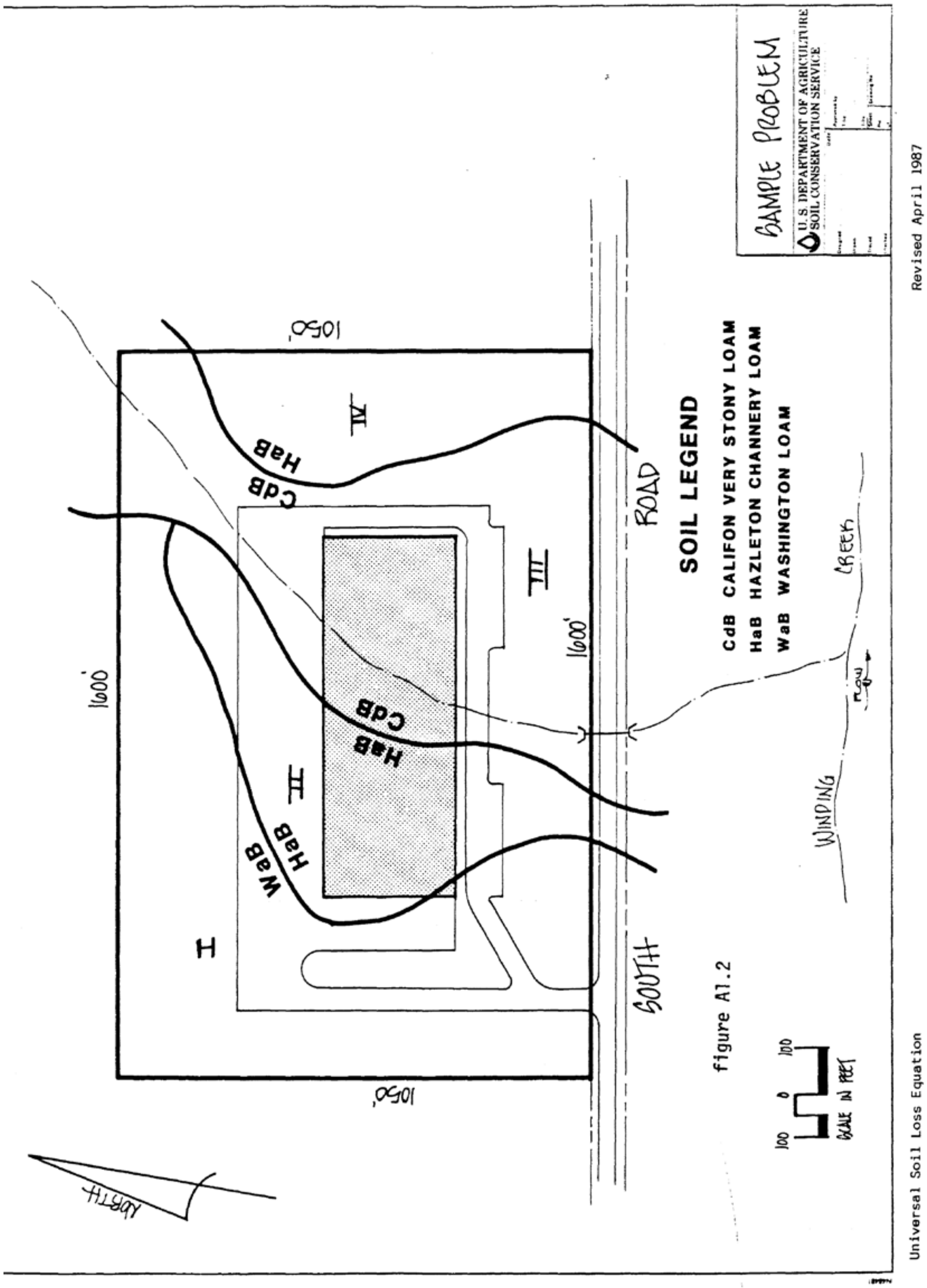
Guide To Delivery Ratio For Sediment From Construction Sites

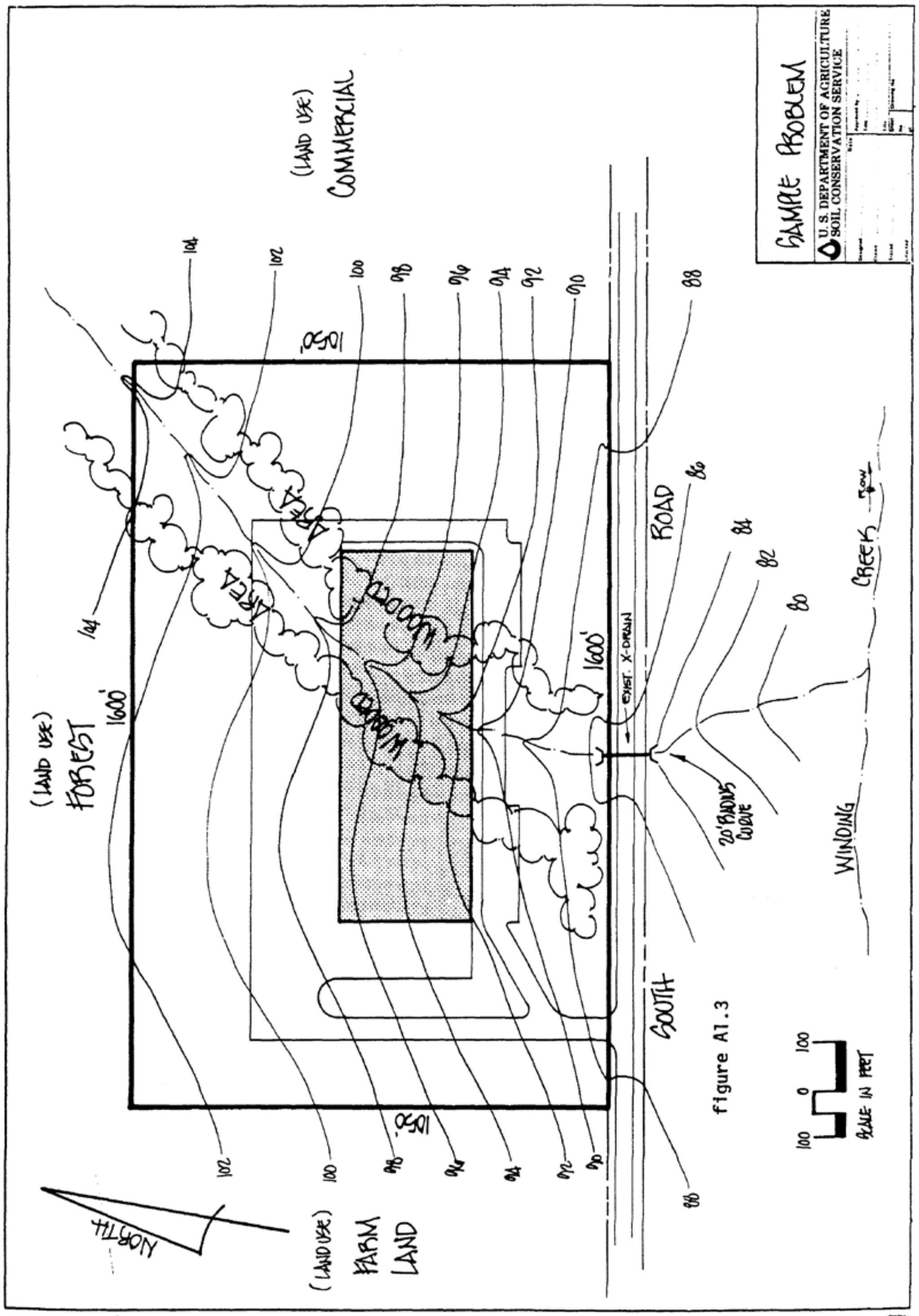
Damage Area Condition (Reservoir, stream reach or other area that could be damaged by sediment)	Estimated Delivery Rates \1
Less than 300 feet from the down slope boundary of the construction site.	.90

More than 300 feet down slope from the construction site but not downstream any appreciable distance	.70
Less than 1 mile downstream from the construction site (stream flows through or less than 300 feet from the slope boundary of site)	.60
Damage area more than 1 mile downstream or less.	.50

\1 New Jersey State Soil Conservation, "Sediment Pollution and Erosion Control Guide for Resource Conservation", Technical Guide, 1971. The values are based on judgement only. They should be considered as a general guide.

The Universal Soil Loss Equation has been widely adapted for use in estimating erosion rates and selecting sediment control practices for urban areas. It is a valuable design tool when properly applied, but its misuse can cause serious problems.


SAMPLE PROBLEM
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Revised April 1987
SOIL LEGEND
CdB CALIFON VERY STONY LOAM
HaB HAZLETON CHANNERY LOAM
WaB WASHINGTON LOAM
1050'
1600'
1600'
1050'
I
II
III
IV
CdB
HaB
WaB
SOUTH ROAD
WINDING CREEK
FLOW
NORTH
100 0 100
SCALE IN FEET
figure A1.2
Universal Soil Loss Equation



SAMPLE PROBLEM
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Revised April 1987
(LAND USE)
COMMERCIAL
(LAND USE)
FOREST
(LAND USE)
FARM
LAND
NORTH
WOODED
AREA
WOODED
AREA
1600'
1600'
1050'
1050'
EXIST. X-DRAIN
20' RADIUS
CURVE
SOUTH
ROAD
WINDING
CREEK
FLOW
100 0 100
SCALE IN FEET
Universal Soil Loss Equation

figure A1.3

Sample Problem

Consider the following sample construction site. The site is located in the land resource area 148 of New Jersey. The land will be prepared for construction and will be exposed during an eighteen-month construction period starting from April 1 and ending on September 30 of next year. Assume that the upper edge of the site is a ridge so that there will be no overland flow contributing from the outside areas.

1. Required: For this site find the weighted soil erodibility factor.

Solution: Estimate the soil erodibility factor "K" as follows

Sub Area	Soil Series	Soil[1] Profile (inches)	Area "a" (ac)	K (t/ac)	Area in Subarea "A" (ac)	Weighted[1] K in subarea $\frac{ak}{A}$ (t/ac)	AK tons
I	WaB	0-9	10.4	0.28			
		9-52	4.1	0.32	14.5	0.29	4.2
II	HaB	0-6	1.7	0.17			
		6-56	5.1	0.15	6.8	0.16	1.1
III	CdB	0-10	6.9	0.17			
		10-50	5.7	0.30[2]	12.6	0.23	2.9
IV	HaB	0-6	4.7	0.17	4.7	0.17	0.8
					Total:	38.6	9.0

Weighted $K = \frac{\sum AK}{\sum A}$ = 9/38.6 = 0.23 t/ac (answer)

Note:
The soil interpretation record of each soil series is used. In absence of these records, Table A1-2 can be used. Since the construction site has several soil series with different surface areas (Figure A1.2) and different K values, the composite K value must be weighted. Also, the soil profile which will be exposed for construction will be different at different locations (Figure A1.3). These differences must also be accounted for by further weighing.

[1] Assumed that the building and parking area is leveled around 95-ft contour

[2] (0.32 + 0.28)/2 = 0.30

NJ0045 SOIL INTERPRETATIONS RECORD

MLRA(S): 144A, 148
REV. MLM-WCK, 5-81
TYPIC FRAGIUDULTS, FINE-LOAMY, MIXED, MESIC

CALIFON SERIES
STONY

THE CALIFON SERIES CONSISTS OF DEEP, MODERATELY WELL AND SOMEWHAT POORLY DRAINED SOILS ON UPLANDS. THEY FORMED IN GLACIAL TILL OR COLLUVIAL MATERIAL. TYPICALLY THESE SOILS HAVE A DARK BROWN VERY STONY LOAM SURFACE LAYER 10 INCHES THICK. THE SUBSOIL LAYERS FROM 10 TO 23 INCHES ARE STRONG BROWN LOAM AND CLAY LOAM. A VERY FIRM AND BRITTLE MOTTLED FRAGIPAN FROM 23 TO 50 INCHES IS MAINLY STRONG BROWN AND YELLOWISH-BROWN LOAM. THE SUBSTRATUM FROM 50 TO 75 INCHES IS YELLOWISH-BROWN SANDY LOAM. SLOPES RANGE FROM 0 TO 15 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-10	STV-L	CL	A-4, A-6	3-10	80-100	60-95	55-80	50-70	20-30	7-12
10-23	L, CL, GR-L	ML, SM-SC, CL, CL-ML	A-4, A-6	3-10	85-100	60-95	55-90	45-70	23-40	9-15
23-50	L, CL, GR-SL	SM, ML, CL, SC	A-4, A-6, A-2	3-10	85-100	65-95	40-90	25-70	23-40	3-15
50-60	SL, CL, GR-LS	SM, ML, CL, SC	A-2, A-4, A-1, A-6	3-10	75-95	65-95	35-90	15-75	15-40	3-15

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-10			0.6-2.0	0.16-0.20	4.5-5.5	-	LOW	.17	3	-		HIGH	HIGH
10-23			0.6-2.0	0.10-0.20	4.5-5.5	-	LOW	.32					
23-50			0.06-0.2	0.06-0.10	4.5-5.5	-	LOW	.28					
50-60			0.6-2.0	0.14-0.18	4.5-5.5	-	LOW	.28					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			0.5-2.5	PERCHED	DEC-MAY	-		>60		-		C	HIGH

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	SEVERE-WETNESS,PERCS SLOWLY
SEWAGE LAGOON AREAS	0-2%: SLIGHT 2-7%: MODERATE-SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	SEVERE-WETNESS
SANITARY LANDFILL (AREA)	SEVERE-WETNESS
DAILY COVER FOR LANDFILL	0-8%: FAIR-LARGE STONES,SMALL STONES 8-15%: FAIR-SLOPE,LARGE STONES,SMALL STONES

CONSTRUCTION MATERIAL (B)

ROADFILL	POOR-FROST ACTION
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-LARGE STONES

BUILDING SITE DEVELOPMENT (B)

SHALLOW EXCAVATIONS	SEVERE-WETNESS
DWELLINGS WITHOUT BASEMENTS	SEVERE-WETNESS,FROST ACTION
DWELLINGS WITH BASEMENTS	SEVERE-WETNESS
SMALL COMMERCIAL BUILDINGS	0-8%: SEVERE-WETNESS,FROST ACTION 8-15%: SEVERE-SLOPE,WETNESS,FROST ACTION
LOCAL ROADS AND STREETS	SEVERE-FROST ACTION
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: MODERATE-LARGE STONES,SMALL STONES, WETNESS 8-15%: MODERATE-SLOPE,LARGE STONES,WETNESS

WATER MANAGEMENT (B)

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-8%: MODERATE-SEEPAGE,SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING,WETNESS
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	LARGE STONES,PERCS SLOWLY,WETNESS
IRRIGATION	LARGE STONES,PERCS SLOWLY,WETNESS
TERRACES AND DIVERSIONS	LARGE STONES,PERCS SLOWLY,ROOTING DEPTH
GRASSED WATERWAYS	LARGE STONES,PERCS SLOWLY,ROOTING DEPTH

REGIONAL INTERPRETATIONS

CALIFON SERIES
STONY

NJ0045

RECREATIONAL DEVELOPMENT (C)

CAMP AREAS	0-8%: MODERATE-WETNESS,LARGE STONES 8-15%: MODERATE-SLOPE,WETNESS,LARGE STONES	PLAYGROUNDS	0-6%: SEVERE-SMALL STONES,WETNESS 6+%: SEVERE-SLOPE,SMALL STONES,WETNESS
PICNIC AREAS	0-8%: MODERATE-WETNESS 8-15%: MODERATE-SLOPE,WETNESS	PATHS AND TRAILS	MODERATE-WETNESS,LARGE STONES

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY		PASTURE (AUM)													
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-3%	5S		6.0													
3-15%	6S		6.0													

WOODLAND SUITABILITY (C)

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
0-15%	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT		YELLOW-POPLAR NORTHERN RED OAK WHITE OAK BLACK OAK WHITE ASH		EASTERN WHITE PINE NORWAY SPRUCE YELLOW-POPLAR

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY (C)

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-3%	V. POOR	POOR	GOOD	GOOD	GOOD	-	POOR	POOR	POOR	GOOD	POOR	
3-8%	V. POOR	POOR	GOOD	GOOD	GOOD	-	POOR	V. POOR	POOR	GOOD	V. POOR	
8-15%	V. POOR	POOR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	POOR	GOOD	V. POOR	

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT): FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A ESTIMATES OF ENGINEERING PROPERTIES BASED ON TEST DATA OF 1 PEDON FROM MORRIS COUNTY, NEW JERSEY.
B RATINGS BASED ON GUIDE FOR INTERPRETING ENGINEERING USES OF SOILS, NOV. 1971.
1 RATINGS BASED ON NORTHEAST REGIONAL CRITERIA, MARCH 1966.
C RATINGS BASED ON SOILS MEMOS 69, OCT. 1968; 26, SEPT. 1967; OR 74, JAN. 1972.

NJ0032

SOIL INTERPRETATIONS RECORD

MLRA(S): 144A
REV. WCK, 9-79
ULTIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

WASHINGTON SERIES
STONY

THE WASHINGTON SERIES CONSISTS OF DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN GLACIAL TILL. TYPICALLY THESE SOILS HAVE A DARK YELLOWISH BROWN VERY STONY LOAM SURFACE LAYER 9 INCHES THICK. THE STRONG BROWN SUBSOIL FROM 9 TO 17 INCHES IS LOAM AND FROM 17 TO 52 INCHES IS CLAY LOAM. THE SUBSTRATUM FROM 52 TO 72 INCHES IS BROWNISH YELLOW LOAM GRADING TO GRAVELLY SILT LOAM WITH DEPTH. BEDROCK IS AT 72 INCHES. SLOPES RANGE FROM 0 TO 35 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	STV-L, STV-SIL	CL, SC, SM, ML	A-4, A-6	2-15	80-90	70-80	60-70	40-60	25-40	3-15
9-52	CL, SICL, GR-L	CL, SC, ML, SM	A-4, A-6	0-5	75-100	60-95	50-90	35-85	25-40	3-15
52-72	CL, SIL, GR-L	CL, SC	A-4, A-6, A-2, A-1	0-15	75-95	35-95	30-85	15-75	25-35	8-15
72	UWB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-9	15-25	1.25-1.45	0.6-2.0	0.18-0.22	5.6-7.3	-	LOW	.28	4	-	1-4	MODERATE	LOW
9-52	25-35	1.30-1.60	0.6-2.0	0.16-0.20	5.6-7.3	-	LOW	.32					
52-72	15-30	1.40-1.65	0.6-6.0	0.12-0.16	5.6-7.3	-	LOW	.28					
72													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		>60		-		B	MODERATE

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SLOPE,SEEPAGE
SANITARY LANDFILL (TRENCH)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SLOPE,SEEPAGE
SANITARY LANDFILL (AREA)	0-15%: SEVERE-SEEPAGE 15+%: SEVERE-SLOPE,SEEPAGE
DAILY COVER FOR LANDFILL	0-8%: FAIR-TOO CLAYEY,SMALL STONES 8-15%: FAIR-SLOPE,SMALL STONES,TOO CLAYEY 15+%: POOR-SLOPE

BUILDING SITE DEVELOPMENT (B)

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-FROST ACTION 8-15%: MODERATE-SLOPE,FROST ACTION 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: MODERATE-LARGE STONES,SMALL STONES 8-15%: MODERATE-SLOPE,LARGE STONES, SMALL STONES 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL (B)

ROADFILL	0-25%: POOR-LOW STRENGTH 25+%: POOR-SLOPE,LOW STRENGTH
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-15%: POOR-LARGE STONES,SMALL STONES 15+%: POOR-SLOPE,LARGE STONES,SMALL STONES

WATER MANAGEMENT (B)

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-8%: MODERATE-SLOPE,SEEPAGE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	MODERATE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	0-3%: FAVORABLE 3+%: SLOPE
IRRIGATION	0-3%: FAVORABLE 3+%: SLOPE
TERRACES AND DIVERSIONS	0-8%: FAVORABLE 8+%: SLOPE
GRASSED WATERWAYS	0-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

WASHINGTON SERIES
STONY

NJ0032

RECREATIONAL DEVELOPMENT (C)

CAMP AREAS	0-8%: MODERATE-LARGE STONES,SMALL STONES, DUSTY 8-15%: MODERATE-SLOPE,LARGE STONES, SMALL STONES 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-6%: SEVERE-SMALL STONES,LARGE STONES 6+%: SEVERE-SLOPE,LARGE STONES,SMALL STONES
PICNIC AREAS	0-8%: MODERATE-SMALL STONES,LARGE STONES, DUSTY 8-15%: MODERATE-SLOPE,SMALL STONES, LARGE STONES 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: MODERATE-LARGE STONES,SMALL STONES, DUSTY 15-25%: MODERATE-SLOPE,LARGE STONES, SMALL STONES 15+%: SEVERE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY NIRR	CAPABILITY IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-3%	5S		-		-		-		-		-		-		-		-	
3-25%	6S		-		-		-		-		-		-		-		-	
25-35%	6E																	

WOODLAND SUITABILITY (C)

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
0-15%	1O	SLIGHT	SLIGHT	SLIGHT	SLIGHT		NORTHERN RED OAK	85	EASTERN WHITE PINE
15-35%	1R	SLIGHT	MODERATE	SLIGHT	SLIGHT		YELLOW-POPLAR	95	EUROPEAN LARCH
									BLACK WALNUT
									YELLOW-POPLAR
									NORWAY SPRUCE

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY (C)

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-8%	V. POOR	POOR	GOOD	GOOD	GOOD	-	POOR	V. POOR	POOR	GOOD	V. POOR	-
8-35%	V. POOR	POOR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	POOR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT): FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A ESTIMATES OF ENGINEERING PROPERTIES BASED ON TEST DATA OF 10 PEDONS FROM PENNSYLVANIA.
B RATINGS BASED ON NSH, PART II, SECTION 403, 3-78.
C RATINGS BASED ON SOILS MEMO 26, SEPT. 1967 AND REGIONAL CRITERIA. SITE INDEX VALUES + OR -5 OR MORE.
D WILDLIFE RATINGS BASED ON SOILS MEMO 74, JAN. 1972.
1 EXCESSIVE PERMEABILITY RATE MAY ALLOW POLLUTION OF GROUND WATER.

PA0080 **SOIL INTERPRETATIONS RECORD**

MLRA(S): 147, 148, 126, 127, 124
REV. GHL, 9-83
TYPIC DYSTROCHREPTS, LOAMY-SKELETAL, MIXED, MESIC

HAZLETON SERIES

THE HAZLETON SERIES CONSISTS OF DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN MATERIAL WEATHERED FROM SANDSTONE. TYPICALLY, THESE SOILS HAVE A DARK BROWN SANDY LOAM SURFACE LAYER, 6 INCHES THICK. THE SUBSOIL BETWEEN 6 AND 32 INCHES IS REDDISH-YELLOW TO STRONG BROWN CHANNERY AND VERY CHANNERY SANDY LOAM. THE SUBSTRATUM FROM 32 TO 56 INCHES IS REDDISH-YELLOW VERY CHANNERY SANDY LOAM. SANDSTONE BEDROCK IS AT A DEPTH OF 56 INCHES. SLOPES RANGE FROM 0 TO 80

HAZLETON SERIES PA0080

RECREATIONAL DEVELOPMENT (B)

CAMP AREAS	0-8% SL,L,FSL: SLIGHT 0-8% CN: MODERATE-SMALL STONES 8-15% SL,L,FSL: MODERATE-SLOPE 8-15% CN: MODERATE-SLOPE,SMALL STONES 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2% SL,L,FSL: SLIGHT 2-6% SL,L,FSL: MODERATE-SLOPE 6+% SL,L,FSL: SEVERE-SLOPE 0-6% CN: SEVERE-SMALL STONES 6+% CN: SEVERE-SMALL STONES,SLOPE
PICNIC AREAS	0-8% SL,L,FSL: SLIGHT 0-8% CN: MODERATE-SMALL STONES 8-15% SL,L,FSL: MODERATE-SLOPE 8-15% CN: MODERATE-SLOPE,SMALL STONES 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY		CORN (BU)		WHEAT (BU)		OATS (BU)		ALFALFA HAY (TONS)		GRASS-LEGUME HAY (TONS)		PASTURE (AUM)		CORN SILAGE (TONS)	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-3%	1		125		45		75		4.5		3.5		8.0		25	
3-8%	2E		125		45		75		4.5		3.5		8.0		25	
8-15%	3E		115		40		70		4.5		3.5		8.0		23	
15-25%	4E		110		35		60		4.0		3.0		7.5		22	
25-35%	6E		-		-		-		-		-		7.0			
35+%	7E		-		-		-		-		-		-			

WOODLAND SUITABILITY (C)

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
0-15%	3F	SLIGHT	SLIGHT	SLIGHT	SLIGHT	MODERATE	NORTHERN RED OAK	70	JAPANESE LARCH
15-35% NORTH	3F	SLIGHT	MODERATE	SLIGHT	SLIGHT	MODERATE	YELLOW-POPLAR	80	EASTERN WHITE PINE
35+% NORTH	3F	MODERATE	SEVERE	SLIGHT	SLIGHT	MODERATE			NORWAY SPRUCE
									AUSTRIAN PINE
									BLACK CHERRY
15-35% SOUTH	4F	SLIGHT	MODERATE	MODERATE	SLIGHT	SLIGHT	NORTHERN RED OAK	60	JAPANESE LARCH
35+% SOUTH	4F	MODERATE	SEVERE	SEVERE	SLIGHT	SLIGHT	BLACK OAK	60	EASTERN WHITE PINE
									NORWAY SPRUCE
									AUSTRIAN PINE
									BLACK CHERRY

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
ALL	SIBERIAN PEASHRUB	7	TATARIAN HONEYSUCKLE	8	AMUR HONEYSUCKLE	8	LILAC	8
	AUTUMN-OLIVE	9	WASHINGTON HAWTHORN	10	RADIANT CRABAPPLE	12	EASTERN REDCEDAR	14
	JACK PINE	16	AUSTRIAN PINE	18	RED PINE	18	EASTERN WHITE PINE	20

WILDLIFE HABITAT SUITABILITY (C)

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
0-8%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
8-15%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	GOOD	GOOD	V. POOR	-
15-25%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	FAIR	V. POOR	-
25-35%	V. POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	FAIR	V. POOR	-
35+%	V. POOR	POOR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	POOR	FAIR	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT): FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A ESTIMATES OF ENGINEERING PROPERTIES BASED ON TEST DATA OF 16 PEDONS FROM PENNSYLVANIA.
B RATINGS BASED ON NSH, PART II, SECTION 403, 3-78.
C RATINGS BASED ON SOILS MEMOS 26, SEPT. 1967; OR 74, JAN. 1972.

2. Required: For this site, estimate the Topographic Factor "LS"

Solution:

"LS" for Subarea "A" (11.6 acres)

Segment No.	Slope %	"LS" form Table A1-3	Adjustment Factor	Segment "LS"
1	1	0.21	0.71	0.15
2	2	0.33	1.29	0.43
			Average LS:	0.29

Subarea A will have original slope

"LS" for Subarea "B" (27.0 acres)

Segment No.	Slope %	"LS" form Table A1-3	Adjustment Factor	Segment "LS"
1	1	0.27	0.45	0.12
2	2	0.41	0.82	0.34
3	0.2 *	0.17	1.06	0.18
4	0.2 **	0.17	1.25	0.21
5	5	1.70	1.42	2.41
			Average LS:	0.65

Weighted LS = [(0.29)(11.6) + (0.65)(27.0)]/38.6 = 0.54 (answer)

Note:

Subarea B will be reshaped for construction. Assume that the building area is almost horizontal around 96-ft. elevation.

3. Required: Estimate the annual soil erosion rate from the construction site without any control measure. At what rate will this sediment be arriving at the Winding Creek?

Solution:

1. Using the Universal Soil Loss Equation E = R K LS C P

R: from Figure A1-1, R value in Hunterdon County is 175

K: weighted K value previously calculated is 0.23 t/ac

1. (cont'd)

LS: weighted LS factor previously calculated is 0.54

C: no cover, therefore C is 1.0

P: no control practices, P = 1.0

2. The estimated average soil loss from sheet erosion (E) in tons per acre per year is:

E = (175) (0.23) (0.54) (1.0) (1.0)
22 tons/acre/year

3. The erosion from the entire site (sediment yield)

22 tons/acre/year X 38.6 acres = 849 tons/year

4. Delivery Ratio (DR): The Winding Creek is about 600 feet downstream of the construction site. Based on the values
given previously assume DR = 0.7

5. Sediment reaching the Winding Creek is:

0.7 X 849 tons/year = 594 tons/year (answer)

4. Required: What would the soil erosion be for an extreme year of one in 20 years and for a major single storm of one in 20 years?

Solution:

1. Soil erosion for an extreme year of one in 20 years can be determined as follows:

a. Probability factor of one in 20 years (Table A1-8) is 1.7

b. Soil erosion for this year is 1.7 X 849 tons/year or 1443 tons/year (answer)

2. Soil Erosion for a major storm of one in 20 years can be determined as follows:

a. The factor in table A1-8 is 0.7, therefore the soil erosion for the storm is 0.7 X 849 tons/year or 594 tons/year (answer).

5. Required: What would the reduction of annual soil erosion be (in percent) if the slope length is divided into five equal slope lengths by using diversions? What would the reduction be if straw or hay mulch at a rate of 1.5 T/ac is properly used in each of the above slope length segments?

Solution:

1. Divide the slopes into five equal slope lengths (Figure A1-2) and determine the effect of the slope length change:

Each slope-length will be 210 feet. "LS" factor, as well as the erosion rate, for each slope-length is computed individually.

Erosion from Subarea A

Segment No.	Slope (%)	"LS" from Table A1-3	Area A (acres)	Annual Soil Loss ARKLS (tons/year)
1	1	0.16	2.32	14.9
2	1	0.16	2.32	14.9
3	2	0.25	2.32	23.3
4	2	0.25	2.32	23.3
5	2	0.25	2.32	23.3

Total from Subarea A is 100 tons/year

Erosion from Subarea B

Segment No.	Slope (%)	"LS" from Table A1-3	Area B (acres)	Annual Soil Loss ARKLS (tons/year)
1	1	0.16	5.4	34.8
2	2	0.25	5.4	54.3
3	0.2	0.10	5.4	21.7
4	0.2	0.10	5.4	21.7
5	5	0.78	5.4	169.5

Total from Subarea B is 302 tons/year

Therefore the total soil loss is 100 + 302 = 402 tons/year. The percent reduction would therefore be (849-409)/849 X 100 = 53 percent (answer)

2. The soil loss reduction from the slope length change and from adding mulch is as follows:

   a. From table A1-4 for slopes that are < 5 percent and lengths less than 300 feet, the cropping management factor (C) is 0.12

   b. Soil loss with straw or hay mulch (1.5 tons/year) on the five equal segments is 402 tons/year X 0.12 = 48 tons/year

   c. Reduction of annual soil loss (849-48)/849 X 100 or 94 percent (answer)

6. Required: Assume that the only control measure adopted in this site is a sediment basin which will be constructed at the downstream edge of the property. For what sediment volume will this basin be designed?

Solution:

1. Since the sediment basin will be built at the downstream edge of the site, DR = 1.0

2. The rate of sediment which will enter the basin is 849 tons/year.
3. The adjustment factor, M (Table A1-6), for the 18 month construction period (April 1, 1986 to September 30, 1987):

April 1, 1986 to March 1, 1987: M = 0.98
March 1, 1987 to October 1, 1987 M = 0.82

Total M = 1.80

4. Total sediment which will arrive at the basin during the construction period is Et = 849 tons/year X 1.80 or 1528 tons.

5. Using Table A1-7, the saturated sediment volume for which the sediment basin will be designed is:

1528 X .00077 = 1.18 acre-feet
or
1528 X 1.24 = 1895 cu. yd. (answer)

FIGURE A1-1

RAINFALL EROSION VALUES "R"

NEW JERSEY MAP

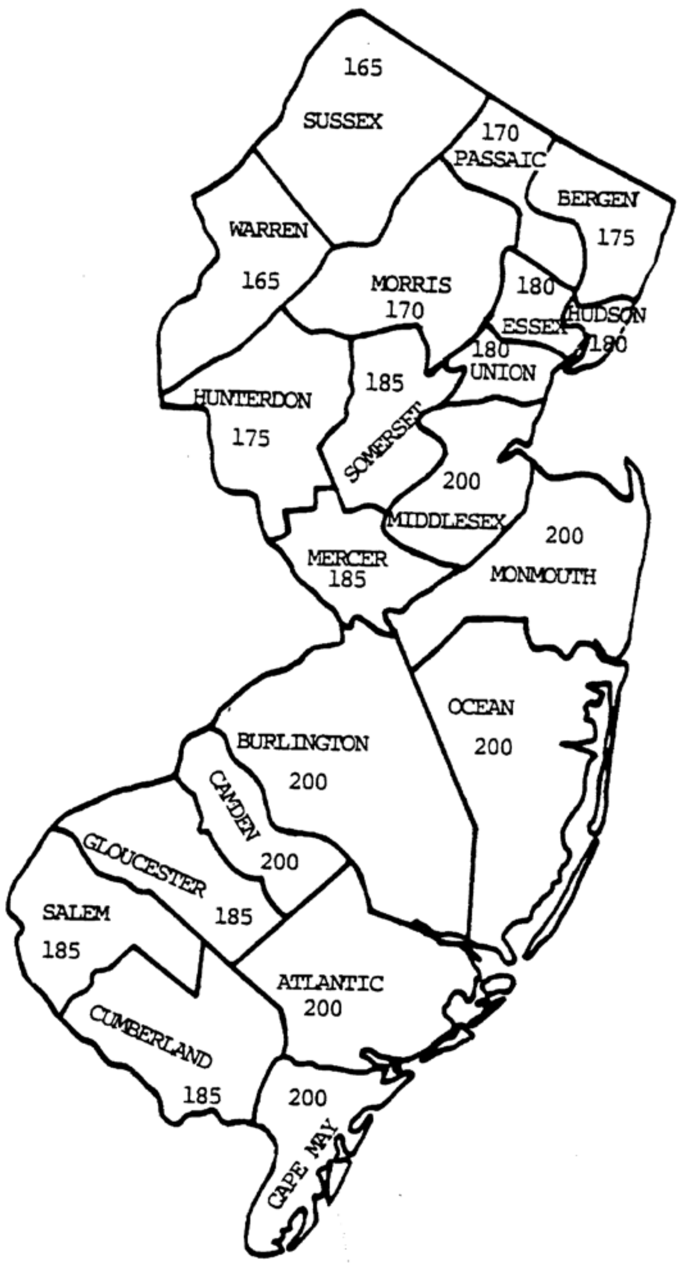


TABLE A1-1

USDA TEXTURE ABBREVIATIONS USED IN TABLE A1-2a, 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[i] Mapping No.	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	**ii**	--
		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,gs	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

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

Soil Series (Alpha Listing)	Local[i] Mapping No.	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
		20-60	gl	SM,ML,CL	0.17	30
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

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

Soil Series (Alpha Listing)	Local[i] Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
			gl,gsl	ML,SM	0.2	35
		38-60	s,gs	SM,SP-SM,GM	0.2	35
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	ML,CL	0.3	53
			gsil,gl,gfsl			
		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
				ML-CL,ML,SM	0.4	70

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

Soil Series (Alpha Listing)	Local[i] Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
				ML-CL,ML,SM	0.3	53
				GM-GC		
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
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	0.4	70
				ML,CL		
		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,M	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	SM,SC,GM,GC	0.2	35
			shsil,vshsil			
		16+	shale bedrock			
Netcong		0-60	fsl,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

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

Soil Series (Alpha Listing)	Local[i] Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
		26+	Bedrock			
Otisville		0-10	sl,gsl,gls	SM,SP-SM,GP-GM	0.17	30
		10-60	gls,gs	SM,SP-SM,GM	0.2	35
				GP-GM		
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
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
		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	SM,SC	0.3	53
		34-60	ls,s,gls,gs	SP-SM,SM,GP-GM	0.2	35

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

Soil Series (Alpha Listing)	Local[i] Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
				GM		
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	shsil	ML,CL	0.24	42
		10-36	l,sil	ML,CL	0.3	53
		36-60	fs	SM	0.2	35
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
			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	much & peak	OL,Pt	0.4	70

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

Soil Series (Alpha Listing)	Local[i] Mapping No.	Typical Profile (inches)	USDA Texture Range	Unified System	K	KR
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	ML,CL,SC,SM,GM	0.4	70
			sil & fsl	GC		
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	SM,SC,ML,CL	0.3	53
			(pan)			
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		
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	ML,CL	0.3	53
			chsil,gcl,chcl			
		32-60	l,sil,chl,chsil	ML,CL,SM,SC	0.3	53
			gl,gsil			
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

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
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	ML,CL,GC	0.3	53
			vgsl			
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
Beddington		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

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
		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
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

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
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
Klinesville		0-13	shsil,shl, shsil,vshsil	GM,SM,SC,ML	0.20	35
		13-18	vshsil,vshsl	GM,GP	0.2	35
			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
		35-60	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

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
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
		14-20	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	l	ML	0.3	53
			scl,sl	SM,SC	0.3	53
		54+	Diabase Bedrock			
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

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
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
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

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
			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

TABLE A1-2c EROSION PROPERTIES OF SOILS IN NEW JERSEY
LAND RESOURCE AREA 149, R= 200

Soil Series (Alpha Listing)	Local [1/] Mapping No.	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	SM,SC,ML	0.3	60
			sl,l,ls			

		gsl	SM	0.2	40
Bibb	0-28	sl to sicl	ML,CL,SM	0.32	64
	28-60	highly variable	SM,GM,CL	0.29	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
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
Dragson	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	SM	0.2	40
		ls,fsl			
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

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[iii]	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
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**3**	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	SM,SC,CL,ML	0.3	60
		gs			

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	1	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
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
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		

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	2.6	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	1.6	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	1.0	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	5.0	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	8.8	10.8	13.1	16	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

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

C Values and Slope-Length Limits for Various Mulches \1

Type	T/ac	Slope %	C Value	Max Length
1. No Mulch or Seeding	---	All	1.0	---
2. Straw or Hay tied	1.0	≤5	. .20	200
		6-10	.20	100
	1.5	≤5	.12	300
		6-10	.12	150
	2.0	≤5	.06	400
		6-10	.06	200
		11-15	.07	150
		16-20	.11	100
		21-25	.14	75
		26-33	.17	50
		34-50	.20	35
3. Crushed Stone (1/4"- 1 1/2")	135	≤15	.05	200
		16-20	.05	150
		21-33	.05	100
		34-50	.05	75
	240	≤20	.02	300
		21-33	.02	200
		34-50	.02	150
4. Woodchips	7	≤15	.08	75
		16-20	.08	50
	12	≤15	.05	150
		16-20	.05	100
		21-33	.05	75
	25	≤15	.02	200
		16-20	.02	150
		21-33	.02	100
		34-50	.02	75

Table A1-4

C Values and Slope-Length Limits for Various Mulches \1

Type	T/ac	C Value: Through First 6 Weeks of Growing	C Value: After 6 Weeks of Growth
5. Temporary (grain or fast growing grass)	NONE	.70	.10
	Straw 1 T/ac	.20	.07
	Straw 1.5 T/ac	.12	.05
	Straw 2.0 T/ac	.06	.05
6. Permanent Seeding, 2nd Year		--	.01
7. Sod		.01	.01

\1 Based on research data and field experience; prepared at a workshop of personnel from USDA Agriculture Research Service, Soil Conservation Service and various Maryland State and local agencies

TABLE A1-5

PRACTICE FACTOR Pc FOR SURFACE CONDITION FOR CONSTRUCTION SITES

SURFACE CONDITION WITH NO COVER	FACTOR Pc*
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	ENDING MONTHS											
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.

Notes:

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

ii. Alluvial soil, unassigned.

iii. Data for sandy substratum.

APPENDIX A2

REQUIREMENTS, GUIDELINES AND PROCEDURES FOR PREPARING AND IMPLEMENTING "STANDARDS FOR SOIL EROSION AND SEDIMENT CONTROL IN NEW JERSEY"

An application for certification of a soil erosion and sediment control plan shall include the following items.

1. One copy of the complete subdivision, site plan or construction permit application, including key map as submitted to the municipality (Architectural drawings and building plans and specifications not required.) which includes the following:
   a. Location of present and proposed drains and culverts with their discharge capacities and velocities and support computations and identification of conditions below outlets.
   b. Delineation of any area subject to flooding from the 100-year storm in compliance with the Flood Plains Act (NJSA 58:16A) or applicable municipal zoning.
   c. Delineating of streams, wetlands, pursuant to NJSA 13:9B and other significant natural features within the project area.
   d. Soils and other natural resource information used. (Delineation of the project site on soil map is desirable utilizing the USDA Web Soil Survey.)
   e. Land cover and use of area adjacent to the land disturbance.
   f. All hydraulic and hydrologic data, describing existing and proposed watershed conditions and HEC HMS, HEC RAS, TR-55 and similar models, and other electronic input files, if used, of existing and proposed conditions and a completed copy of the Hydraulic and Hydrologic Data Base Summary Form, SSCC 251 HDF1.

2. Up to four copies of the soil erosion and sediment control plan* at the same scale as the site plan submitted to the municipality or other land use approval agency 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 (an interim grading-erosion control plan may be required for large sites with extensive cuts and fills).
   c. Contours at a two foot (or smaller) interval, showing present and proposed ground elevation.
   d. Locations of all streams and existing and proposed drains and culverts.
   e. Stability analysis of areas below all points of stormwater discharge which demonstrates a stable condition will exist or there will be no degradation of the existing condition.
   f. Location and detail of all proposed erosion and sediment control structures including profiles, cross sections, appropriate notes, and supporting computations.
   g. Location and detail of all proposed nonstructural methods of soil stabilization including types and rates of lime, fertilizer, seed, and mulch to be applied.
   h. Control measures for non-growing season stabilization of exposed areas where the establishment of vegetation is planned as the final control measure.
   i. 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.
   j. Plans with a notation 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.

Appropriate fees. (As adopted by the individual district.)

Additional items as may be required.

*Individual districts may require modifications in the above list.

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 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.) An application for certification of a soil erosion and sediment control plan shall include the items listed on the reverse side of this form.

Name of Project		Project Location: Municipality	
Project Street Address		Block	Lot
Project Owner(s) Name		Email	Phone # Fax #
Project Owner(s) Street Address (No P.O. Box Numbers)		City	State Zip
Total Area of Project (Acres)	Total Area or Land to be Disturbed (Acres)	No. Dwelling or other Units	Fee $
Plans Prepared by*			Phone # Fax #
Street Address		City	State Zip

*(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 or Architect licensed in the State of New Jersey, in accordance with NJAC 13:27-6.1 et. seq.)

Agent Responsible During Construction	Email
Street Address	
City State Zip	Phone Fax #

The applicant hereby certifies that all soil erosion and sediment control measures are designed in accordance with current **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. Failure to provide such notification may result in additional inspection fees.
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 or portion thereof prior to its completion will transfer full responsibility for compliance with the certified plan to any subsequent owners.
6. To comply with all terms and conditions of this application and certified plan including payment of all fees prescribed by the district fee schedule hereby incorporated by reference.

The applicant hereby acknowledges that structural measures contained in the Soil Erosion and Sediment Control Plan are reviewed for adequacy to reduce offsite soil erosion and sedimentation and not for adequacy of structural 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. It is understood that approval of the plan submitted with this application shall be valid only for the duration of the initial project approval granted by the municipality. All municipal renewals of this project will require submission and approval by the district. In no case shall the approval extend beyond three and one half years at which time resubmission and certification will be required. Soil Erosion and Sediment Control Plan certification is limited to the controls specified in the plan. It is not authorization to engage in the proposed land use unless such use has been previously approved by the municipality or other controlling agency. It is further understood that all documents, site plans, design reports etc. submitted to the district shall be made available to the public (upon request) pursuant to the Open Public Records Act, N.J.S.A. 47:1A-1 et seq.

1. Applicant Certification* Signature Date Applicant Name (Print)	3. Plan determined complete: Signature of District Official Date
2. Receipt of fee, plan and supporting documents is hereby acknowledged: Signature of District Official Date	4. Plan certified, denied or other actions noted above. Special Remarks: Signature of District Official Date

***If other than project owner, written authorization of owner must be attached.** **SSCC251 AP10 1/2014**

____________ SOIL CONSERVATION DISTRICT
ADDENDUM TO APPLICATION

APPLICATION BY CORPORATION, PARTNERSHIP OR ORGANIZATION

OWNERSHIP DISCLOSURE CERTIFICATION

__________ Soil Conservation District requests that all applicants submit a complete list of ownership for purposes of determining conflicts of interest between the applicant and the board of members or their professionals. Attach Rider if necessary.

Disclosure of owners of organization and property subject to application. Any organization making an application for development under this act shall list the names and addresses of all members, stockholders, or individual partners (collectively, "interest holders"), including any other organization holding at least a 10% ownership interest in the organization, and shall also identify the owner of the property subject to the application, including any organization holding at least a 10% ownership interest in the property.

Listing of names and addresses of interest holders of applicant and owner organization. If an organization owns an interest equivalent to 10% or more of another organization, subject to the disclosure requirements hereinabove described, that organization shall list the names and addresses of its interest holders holding 10% or greater interest in the organization.

Disclosure of all officers and trustees of a non-profit organization. A non -profit organization filing an application of development under this act shall list the names and addresses of all officers and trustees of the non-profit organization.

This disclosure requirement is continuing during the Certification period and transfer of ownership of more than 10% must be disclosed.

Organization or non-profit organization failing to disclose: fine. Any organization or non-profit organization failing to disclose in accordance with this certification may be subject to a fine of $25.00 to $3,000, which shall be recoverable in the name of the governmental entity in a court of record in the State in a summary manner pursuant to the "Penalty Enforcement Law" of 1999(N.J.S.A. 2A:58-10 et seq.)

Name and Address of Applicant:

____

____

____

(If Corporation, Name and Address of Registered Agent and Officers, Trustees):

____
____
____
____
____

Stockholders / Members / Partners:

____
____
____
____
____
____
____

I certify that the above statements made by me are true. I am aware that if any of the foregoing statements made by me are willfully false, I am subject to punishment.

____
Print Name of Authorized Signatory & Title

_________________ ________________________________
Date Authorized Signature

____
Witness

New Jersey Department of Agriculture

Hydrologic Modeling Database – Data Entry Form

Project Site Details

Chpt. 251 Application Number: ________________________

Start Date (if known): _____________________

County: ____

Street Address: ____

Municipality: ____

Block: _____________________

Lot: ______________________

NJDEP Anderson Landuse Code (4 digits):

Landuse description: ____

Site Centroid Location (NJ State Plane Feet): [1]

Northing: ____________________ Easting: ____________________

Project Contact Details

Applicant: ____

Address: ____

Phone: ______________________

Email: ____

Post Construction Operation & Maintenance:[2]

Party Name: ____

Address: ____

Phone: ___________________________

Email: ____

Party type: __________________________________

New Jersey Department of Agriculture

Hydrologic Modeling Database – Data Entry Form

Basin Details:[3]

Basin Centroid (NJ State Plane Feet):[4]

Northing: ___________________ Easting: ___________________

Basin Type: ____

Construction: ____

Status phase:[5] Design ☒ As-built ☐

Dam Height: (ft) _________ top width: (ft) ___________

Dam Classification: ___________________________

Drainage Area(s) to Basin [note- include any bypass areas][6]

Drainage Area Name	Drainage Area (acres)	Post-Development CN#	Percent Impervious	Time of Concentration (min)

Basin Outlet Structure(s)[7]

ID:

End of Pipe Location:[8] Northing: Easting:

Discharge Type[9] (weir, orifice, etc)	Dimensions (diameter, length)	Elevation (USGS)	Discharge[10] Coefficient	Equation Used[11]

New Jersey Department of Agriculture

Hydrologic Modeling Database – Data Entry Form

Basin Outlet Structure(s)

ID:

End of Pipe Location: Northing: Easting:

Discharge Type (weir, orifice, etc)	Dimensions (diameter, length)	Elevation (USGS)	Discharge Coefficient	Equation Used

Basin Stage-Discharge Rating Table[12]

Elevation (USGS Feet)	Storage (Acre-Ft)	Total Outlet Structure Discharge (cfs)

NJDEP BMP Water Quality Structures[13]

Type (rain garden, green roof, seepage pit etc)	Size	Size Units (cu ft, sq ft etc)	Northing (SPF)	Easting (SPF)

New Jersey Department of Agriculture

Hydrologic Modeling Database – Data Entry Form

Explanatory Notes-

[1] Approximate location of center of site, coordinates in state plane feet
[2] Indicate who will be responsible for permanent operation and maintenance
[3] Additional Basin Detail Pages can be used for more than one basin in a project.
[4] Approximate location of center of basin, coordinates in state plane feet
[5] Indicate "design" for basins not yet constructed
[6] Drainage areas which are modified by construction, but not directed to the basin should still be listed and described
[7] "Outlet structure" means the control box, outlet headwall, FES etc. This does not refer to an individual control on the structure such as a weir or orifice. There are two tables for more than one outlet structure
[8] Approximate location of terminal discharge end of basin outfall, coordinates instate plane feet
[9] Indicate the type of outlet – weir, orifice, hydro brake, etc.
[10] Discharge Coefficient specific to the type of outlet control i.e., 0.6 for circular orifice
[11] List the discharge equation for each outlet (weir, orifice etc) used
[12] For basins with dead storage below the primary outlet, indicate 0 cfs discharge until the lowest outlet is reached. Routing table should begin at the lowest basin elevation.
[13] Describe NJDEP BMP Manual water quality devices such as seepage pits, rain gardens etc. Size is appropriate for device – cubic feet, square feet or linear feet. Location of device using state plane feet coordinates.

APPENDIX A3

GUIDE FOR CONSTRUCTION SPECIFICATIONS

The following are examples of requirements that may be used for preparing construction specifications. Incorporation of such requirements will help assure protection of disturbed areas especially where critical soil erosion problems may exist.

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 loss of sediment from the construction site. The contractor shall adhere to the certified soil erosion and sediment control plan showing the methods to be used for controlling erosion during construction which includes sequence of construction operations. When no work will be performed on critical areas for more than 14 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.

The contractor shall install erosion controls on all disturbed critical areas or disturbances adjacent to critical areas.

Critical areas are any area subject to excessive erosion due to highly erodible soils, slope length, steepness, water concentration or other factors. Areas may become critical when the vegetation or other soil surface protection is removed.

The permanent 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.

Exposed soil having a pH value of less than 4 shall be treated in accordance with the standard for Management of Highly Acid Soil, pg. 1-1.

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. Excess borrow material removed from the construction site shall be stabilized at the site of placement.

The contractor shall comply with applicable State and local regulations for prevention and abatement of pollution.

APPENDIX A4

MAINTENANCE OF EROSION CONTROL MEASURES

Maintenance is the work required to keep practices in, or restore them to, their original physical and functional condition.

Maintenance as it applies to this section is divided into two periods; that which is necessary to allow for continuing performance of erosion controls during the construction period and long term maintenance, following completion of construction, for the life of structural measures.

Maintenance During Construction Phase

All structural measures for control of soil erosion and sedimentation must have timely maintenance if the measures are to endure and efficiently perform their design function. Particular attention should be given to temporary structures.
Sediment barriers such as silt fence and haybales can accumulate large quantities of sediment, particularly after a heavy storm. The same is true for stormsewer inlet protection, which should be frequently inspected for blockage.

Construction entrances composed of loose aggregate may become impacted with sediments scoured from the tires of construction vehicles. When soil begins to track onto paved surfaces, the aggregate must be replaced or new aggregate added on top of the old.

Maintenance Following Completion of Construction

At the completion of construction and final stabilization responsibility for lifetime maintenance of structural measures is usually transferred to a subsequent owner such as the homeowner, municipality, homeowner association, etc. A comprehensive maintenance program should be prescribed for use of those who will accept such responsibility. All structures should be inspected at least semiannually and following intensive rainfalls.

Maintenance items should include but not be limited to those shown for each of the following examples.

Channel Linings (include slope protection structures)

Check for: Cracking; spalling; deterioration from freezing, salt or chemicals; channel obstructions; scour at inlet and outlet.

Corrective Action: cracks should be sealed, protective coatings applied when needed, and modification or riprap repairs made where and when necessary.

Earth Channels (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.

Corrective Action: remove sediment deposition and undesirable plant growth such as woody vegetation, weeds, etc. Repair damages from scour, rodents and loss of freeboard.

Dams and Spillways

Check fills 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. Check for unauthorized modifications, tampering or vandalism.

Corrective Action: fill and reseed eroded areas or riprap, removal of obstructions should be performed on a timely basis. Valves and gates should be cleaned, lubricated and operated through their full range.

Maintenance and inspection of dam and outlet structures may be subject to the requirements of the New Jersey State Dam Safety Standards, NJAC 7:20.

Water Quality Practices: Various structures and practices are designed to treat stormwater runoff by filtering in some manner. Practices such as sand filters and vegetative filter strips can become clogged with debris and sediment and will loose their ability to treat runoff. Periodic inspection and cleaning is needed to maintain filtration capacity. Other types of treatment practices rely on settlement of suspended solids, such as on-line stormsewer devices and wet or extended detention ponds. Over time, debris and sediment may accumulate in these devices and reduce the available volume needed to treat runoff. Periodic inspection and removal of debris is needed to maintain functioning.

Vegetative Maintenance: Vegetation is used as both a temporary and permanent erosion control practice. During establishment it is highly susceptible to damage both from natural and man-made causes. See the Standard for Maintaining Vegetation, pg. 3-1 for complete requirements.

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 has the tensile strength and weight to resist water flow and erosion. Matting materials may be synthetic or natural (or a combination of the two), and may be permanent or bio/photo degradable over time. Matting may serve to provide a mulch-like cover to enhance germination in areas where straw, hay or other similarly applied much materials may not stay in place. Matting may also serve as a root anchor substrate to facilitate vegetation establishment where flowing water conditions may be encountered.

Materials

Matting is manufactured from a variety of materials including plastics, paper and natural fibers such as coir (coconut shell husks), wood shavings and jute. Matting is often constructed by using various combinations of materials such as natural fibers for germination bonded with man made materials for durability and anchoring. The material selected should be adequate to handle the expected environmental, engineering and agrinomic stresses. For the purposes of implementing the various Standards which incorporate the use of stabilization matting materials, the evaluation and ratings provided by the Texas Department of Transportation (TDOT) have been adopted for use in the New Jersey Standards for Soil Erosion and Sediment Control. The TDOT hydraulics laboratory tests and rates matting materials for use in channel lining and general slope protection applications. Materials are evaluated for shear stress, soil loss and vegetative establishment.

General Installation Requirements

Site Preparation: Shape and grade the waterway, channel or area to be protected are required by job plans and specifications, including topsoiling. Remove rocks, clods over 1 ½ 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.

Do not cultipack.

Laying the Matting: (See Figure A5-1 for general installation guidelines.) The following guidelines may be used for general purpose installation. However, manufacturer's installations instructions must be followed when special materials or techniques are required:

When the matting width is narrower than the channel width, start laying the matting from the top of the channel or slope and unroll downgrade so that one edge of the matting 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. Where one roll of 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. Overlap the matting at lease 4 inches and staple securely. Rolls of wood-shaving matting may be butted at the ends and securely stapled

Securing the Matting: Bury the top of the matting in a trench 4 inches or more deep. Tamp the trench full of soil. Reinforce with a row of staples driven through the matting about 4 inches downhill from the trench approximately 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 similarly 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 wood-shaving matting should be stapled on 12 to 24 centers. Succeeding strips of matting, farther down the channel or slope, are secured in a similar manner.

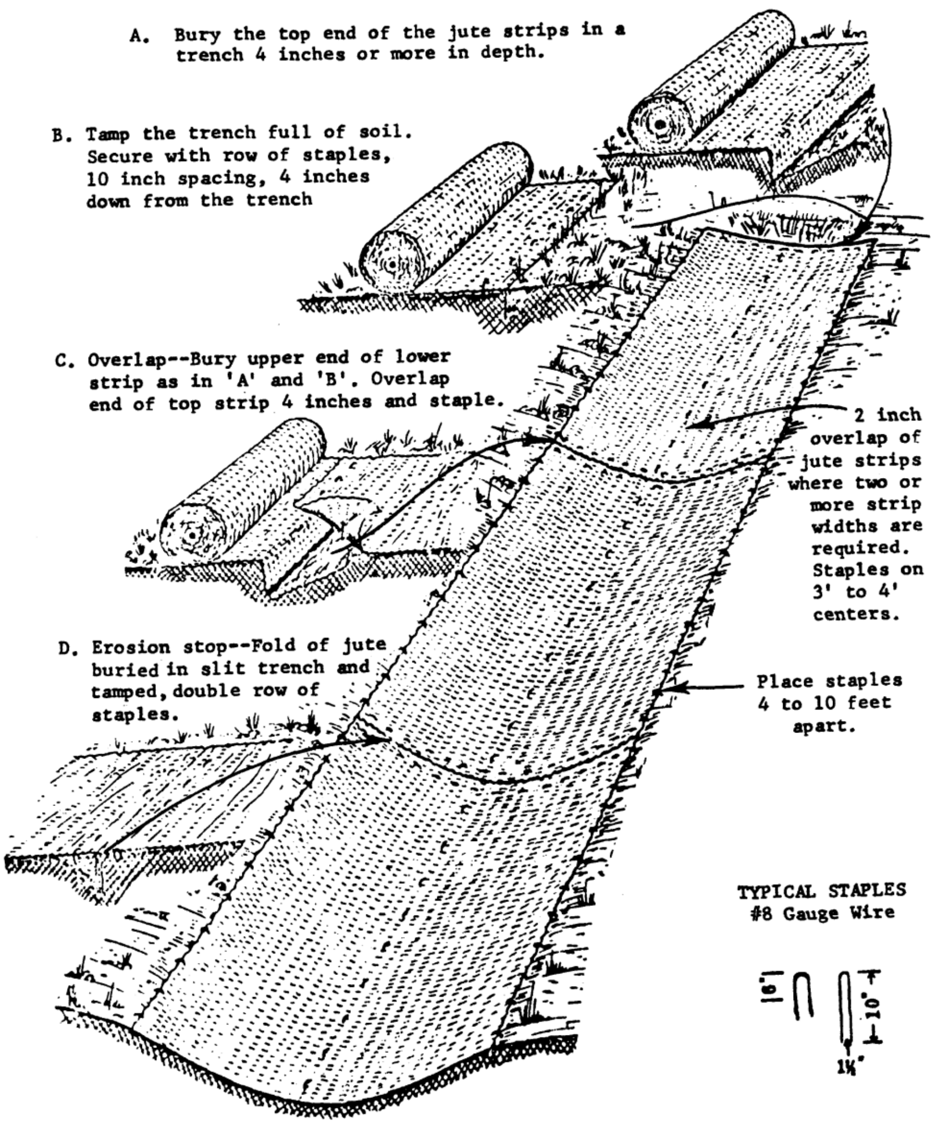
Erosion Stops: At any point, matting may be folded for burying in slit trenches and secured as were the upper ends. This checks water flow and erosion that may begin under the matting. It also gives improved tie-down. The procedure is recommended on the steeper slopes of sandy soil and gentler slopes 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: Ensure contact between matting and soil by rolling after laying, stapling and seeding are complete. Perfect contact is vital to keep water flowing 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 A5-1: Typical Installation Detail Using Jute Matting



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 it from surface water flooding. The diversion will outlet into a grassed waterway. The area upslope of the diversion is in woods which will be preserved. The diversion will be constructed on Rockaway gravelly sandy loam and will be seeded to a lawn grass mixture. It will be a part of the backyard of the house and is expected to be mowed. It will have a grade of 1 percent.

Solution:

The required capacity is the runoff from a 50 year storm. The required freeboard is 0.5 feet from page 15-2, the Standard for Diversions**.** Using the procedure in "Urban Hydrology for Small Watersheds, TR55," it was determined that the 50 year peak runoff rate from the watershed draining into the diversion is 20 cfs.

The grass will provide protection of the soil bed, thereby checking the erosion on the diversion. In comparison to a non-vegetated diversion, a grassed diversion will retard the flow of water. Manning's coefficient of roughness for a grassed diversion is related to the retardance. Retardance varies with the product of the mean velocity of flow and the hydraulic radius. The classification for the degree of retardance is based on the type of vegetation and condition of growth.

The maximum permissible velocity from page 15-5 for a clay loam soil with vegetation in the channel is 3.0 feet per second (for purposes of this example, a flexible channel liner will not be used). In a back yard, vegetation in the diversion channel can be expected to be maintained.

The appropriate vegetative retardance factors are E & D. The height of the grass will range between 6 inches and less than 2 inches. Select side slopes of 5 to 1 for the channel and ridge so that the diversion can be mowed with a lawn mower. Failure to maintain the grass by periodic maintenance results in weeds and destruction of the grass cover leaving the channel bare in the winter.

During the period of establishing the grass, the diversion will gradually be stabilized under a condition of very low retardance. The diversion will not reach its maximum capacity until the grass cover is fully developed and well established. Therefore, the hydraulic design of a grassed diversion consists of two stages.

The first stage is to design the cross-section of the diversion for stability under very low retardance (E). Stability of the diversion is based on allowable velocity for the soil type as shown on page 15-5

The second stage is to design the diversion for capacity under a higher retardance (D). The design of the cross-section of the diversion is now based on the capacity of the diversion to take the design flow (Q).

We now have:

Grade of diversion = 1%
Design Capacity (Q) = 20 cfs
Maximum allowable velocity = 3.0 fps
Vegetative retardance factors = E and D
Channel side slopes = 5 to 1

First, design for stability using retardance factor E. Enter Figure A6-4 with 3.0 fps and slope = 1.0%, find the maximum allowable R = 0.53.
The cross sectional flow area required is Q/V = 20/3 = 6.7 sq. ft.
Enter Figure A6-6 with A = 6.7 and R = 0.53, find bottom width equal 5 feet and depth equal 0.8 feet.

Second, design for capacity using retardance factor D. A trial and error procedure is necessary for a trapezoidal channel with 5:1 side slopes and 20 foot bottom width on a 1% grade with D retardance.

Trial #1

Try d = 1.0 feet, enter Figure A6-6
find R = 0.62
A = 9 enter Figure A6-3
find V = 2
Q = VA = (2) (9) = 18 cfs
required 20 cfs capacity is larger.

Trial #2

Try d = 1.2 feet, repeat steps in 1st trial
find R = 0.76
A = 13
V = 2.8
Q = 36.4 cfs is larger than required.

Trial #3

Try d=0.96 feet,
find R = 0.64
A = 9.4
V = 2.13
Q = 20 cfs

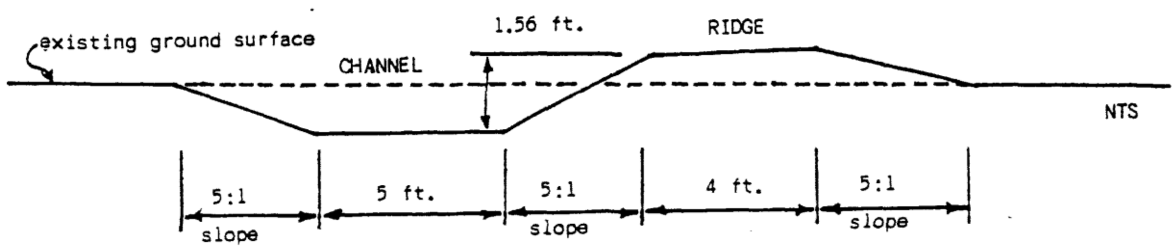
Design Flow Dimensions:

a. Grade = 1%
b. Side slopes = 5:1
c. Bottom width = 5 feet
d. Depth = 1.1 feet (required flow depth)

Constructed Diversion Dimensions:

a. Grade = 1%
b. Side slopes of channel is 5:1 both sides, back slope of ridge is 5:1 and, for maintenance reasons, ridge top width is 4 feet from the standard.
c. Bottom width of the channel is 5 feet
d. Depth from bottom of the channel to top of ridge is: 0.96 feet

for flow depth plus 0.50 feet for freeboard plus 0.1 feet for settlement equals a constructed depth of 1.56 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 at least once a year and needed fertilization and repairs will be 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 0.5%. The peak flow from a 10 year frequency storm is 40 cfs.

Waterway Example Problem Solution:

The maximum permissible velocity from page 18-2 for a silt loam with a good stand of vegetation is 2.0 feet per second. The appropriate retardance factors are E 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 which is easy to mow and traverse with equipment.

We now have:

Grade of the Waterway = 0.5%
Design Capacity = 40 cfs
Maximum allowable velocity = 2.0 fps
Vegetative Retardance factors = E and D
Channel Shape = parabolic

First, design for stability using the retardance factor E. Enter Figure A6-4 with V = 2.0 fps and slope = 0.5%, find maximum allowable R = 0.57 The cross sectional flow area required is Q/V = 40/2 = 20 sq ft. Enter Figure A6-14 with A = 20.0 and R = 0.57, find top width (t) = 35.7 feet and depth (d) = 0.84 feet

Second, design for capacity using retardance factor D. A trial and error procedure is necessary for a parabolic channel with the channel shape determined by d = 0.84 feet and t = 35.7 feet. Enter Figure A6-15 and find a point on the pivot line. This point remains fixed for this channel.

After several iterations:

Try d = 1.06 feet for retardance factor D. From Figure A6-15 using the fixed point on the pivot line for this channel and d = 1.06 feet , find t = 40 feet. From Figure A6-14 find R =.70 and A = 28.2. Enter Figure A6-3 with R = 0.70 and S = 0.5% and find V = 1.42 fps. Then Q = VA = (1.42)(28.2) = 40 cfs.

This meets the required Q of 40 cfs, therefore use these dimensions. The design channel dimensions are: Grade = 0.5% and Parabolic shape with a depth (d) = 1.06 feet and top width (t) = 40 feet.

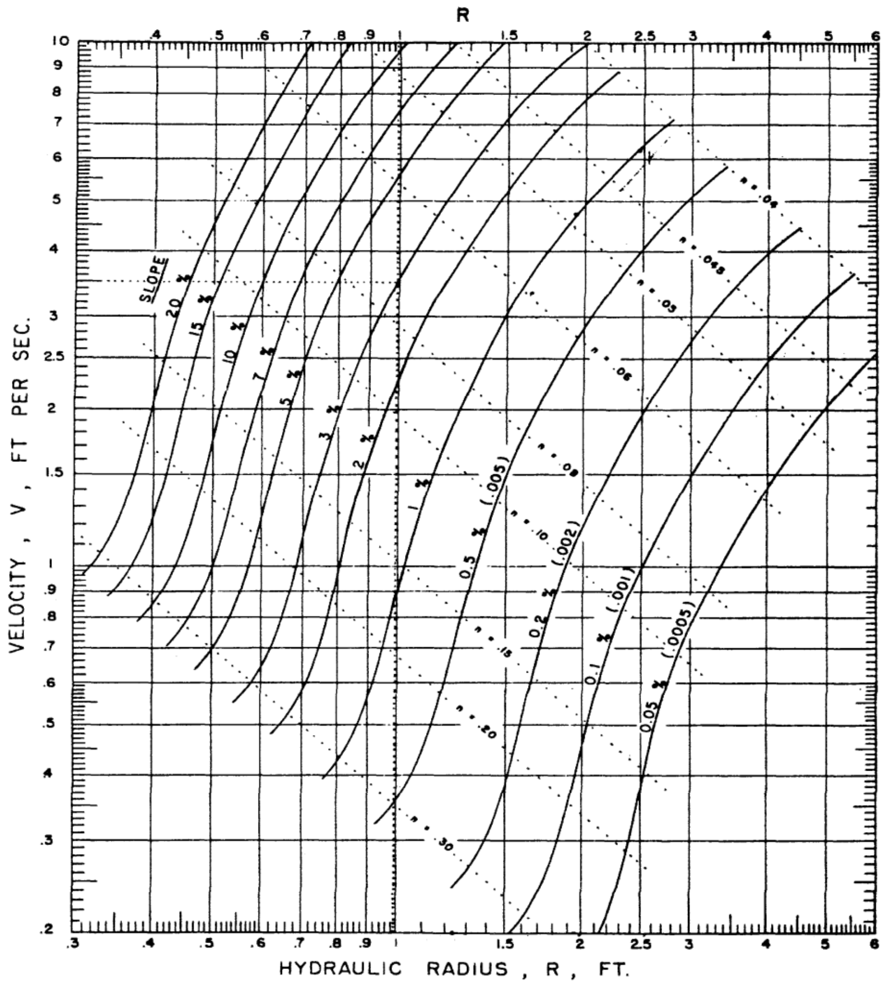


FIGURE A6-1

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE B (HIGH VEGETAL RETARDANCE)

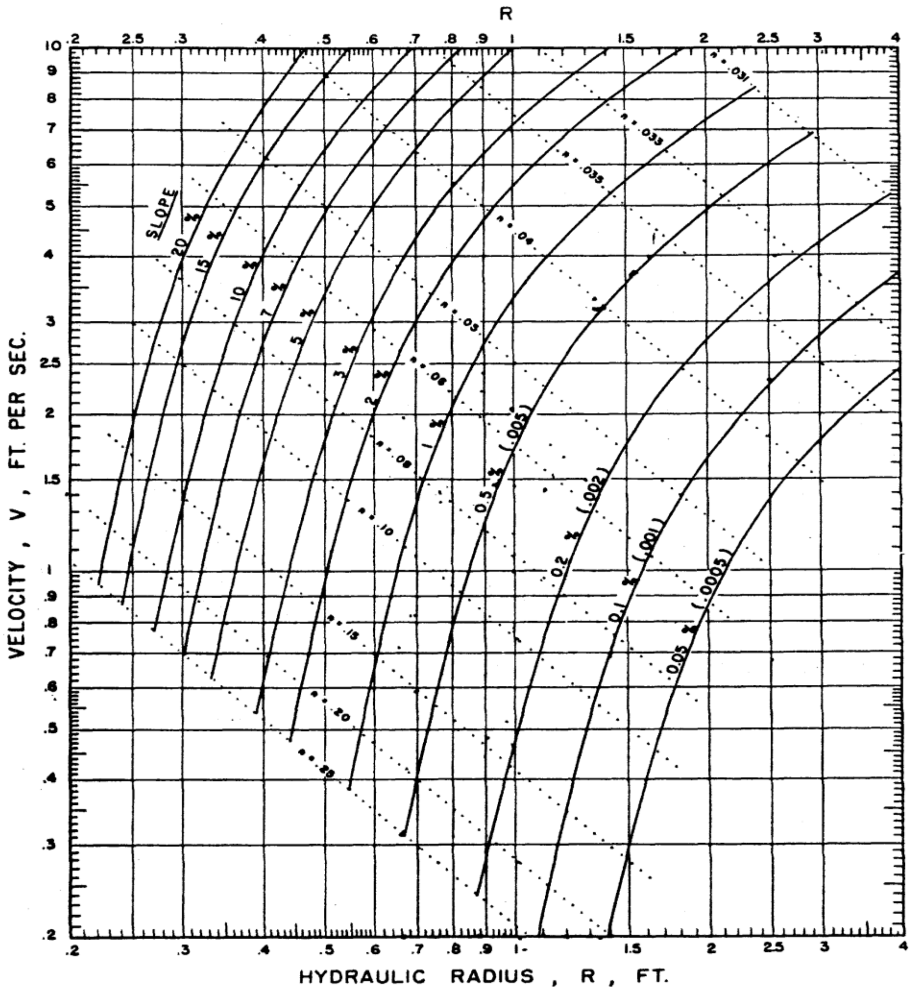


FIGURE A6-2

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE C (MODERATE VEGETAL RETARDANCE)

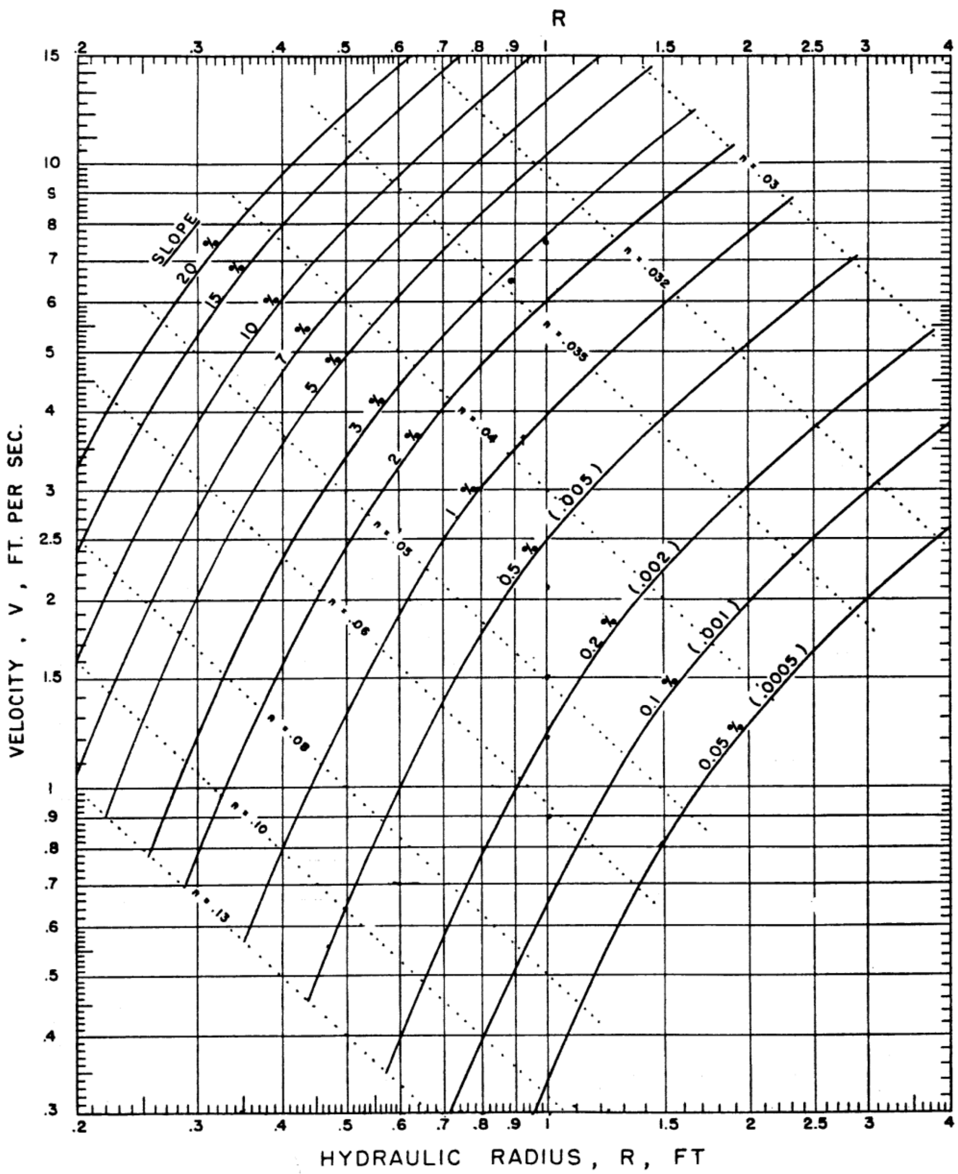


FIGURE A6-3

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE D (LOW VEGETAL RETARDANCE)

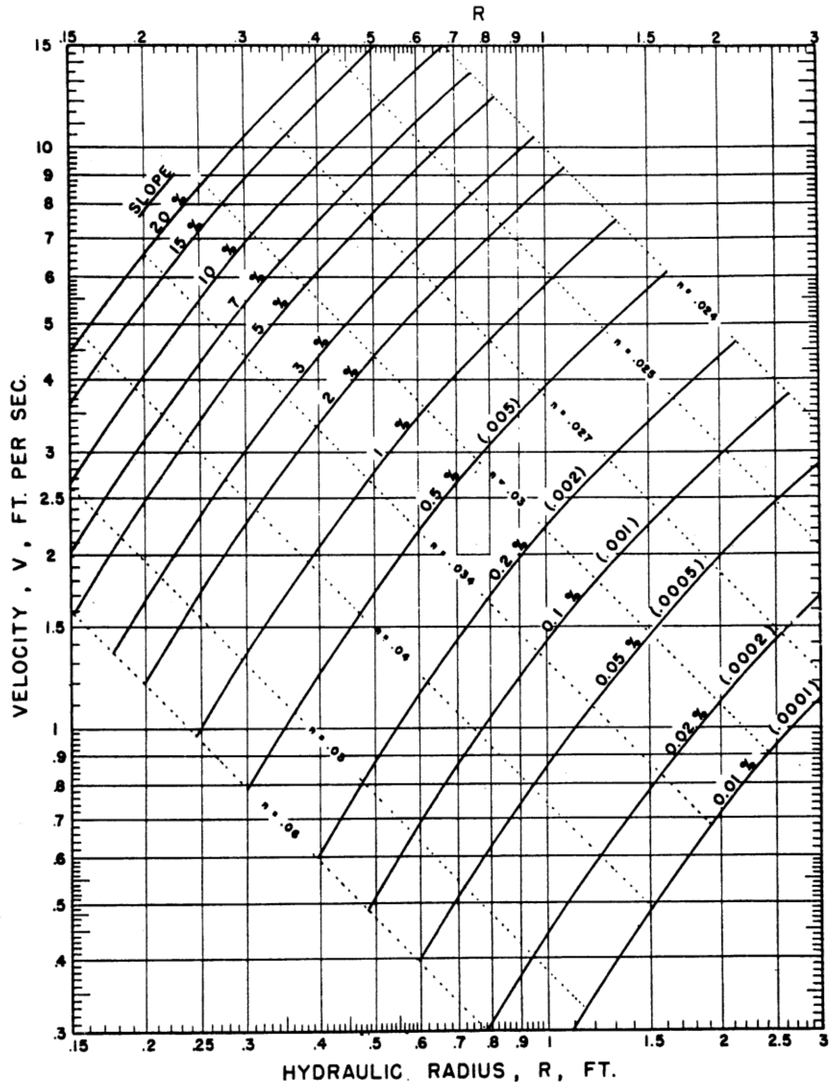


FIGURE A6-4

SOLUTION OF THE MANNING FORMULA FOR RETARDANCE E (VERY LOW VEGETAL RETARDANCE

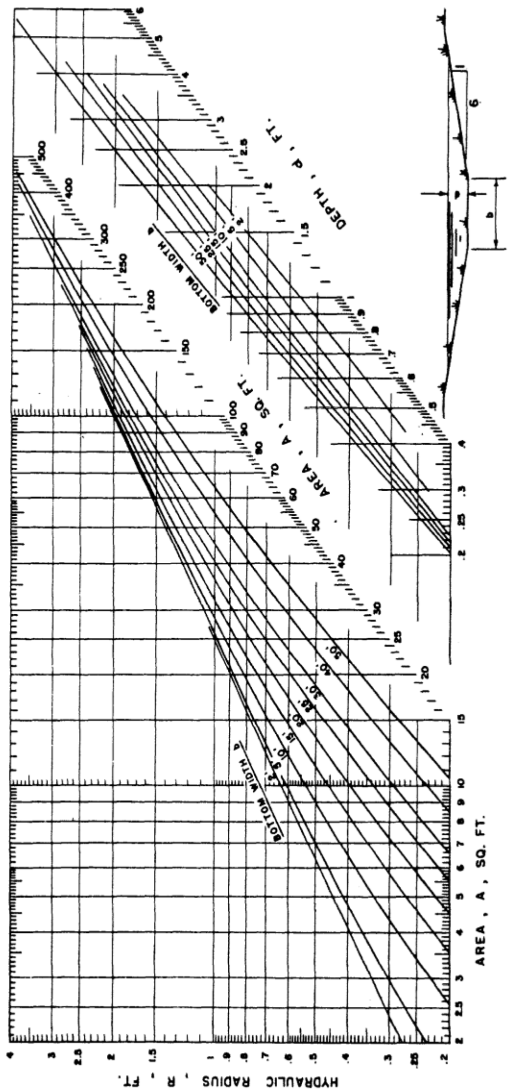


FIGURE A6-5

DIMENSIONS OF TRAPEZIODAL CHANNELS WITH 6 TO 1 SIDE SLOPES

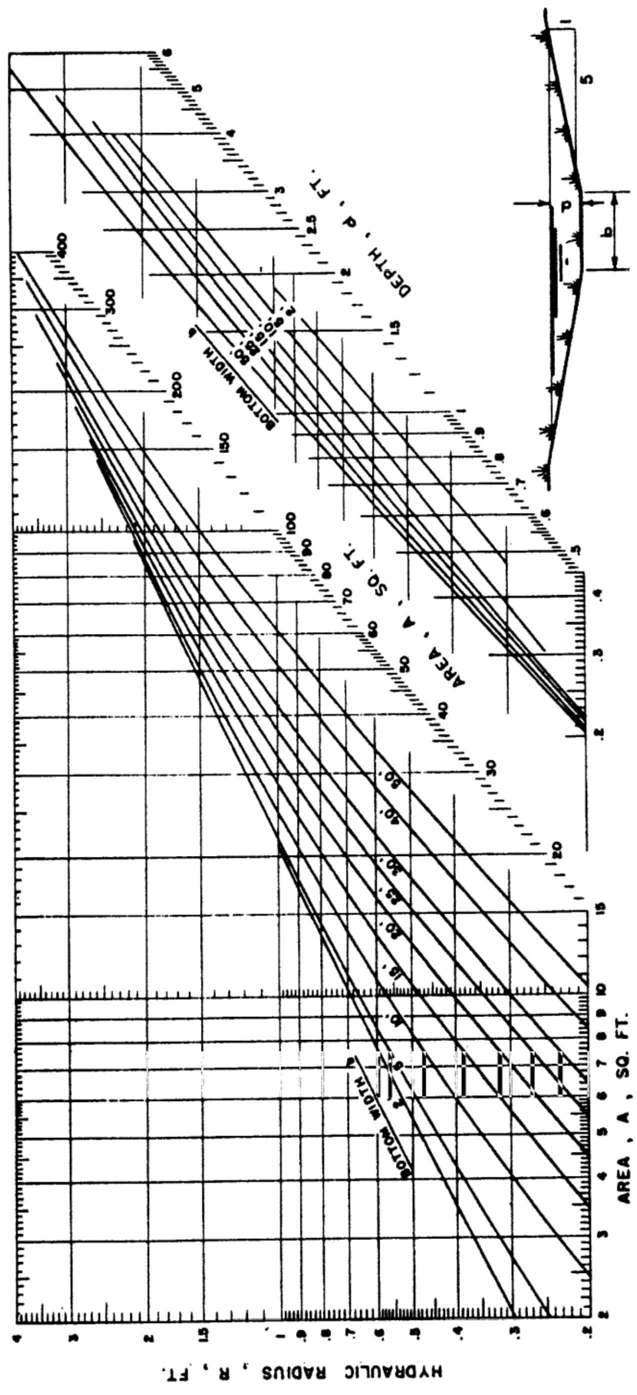


FIGURE A6-6

DIMENSIONS OF TRAPEZIODAL CHANNELS WITH 5 TO 1 SIDE SLOPES

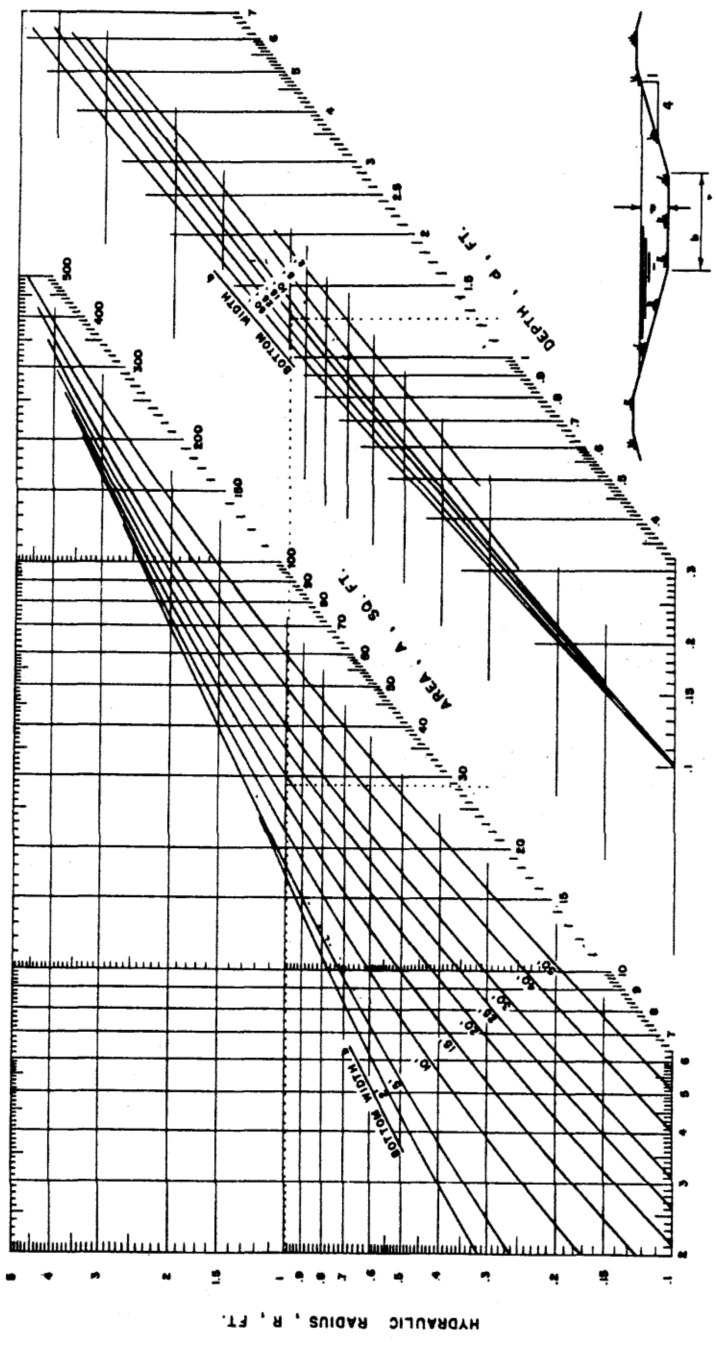


FIGURE A6-7

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 4 TO 1 SIDE SLOPES

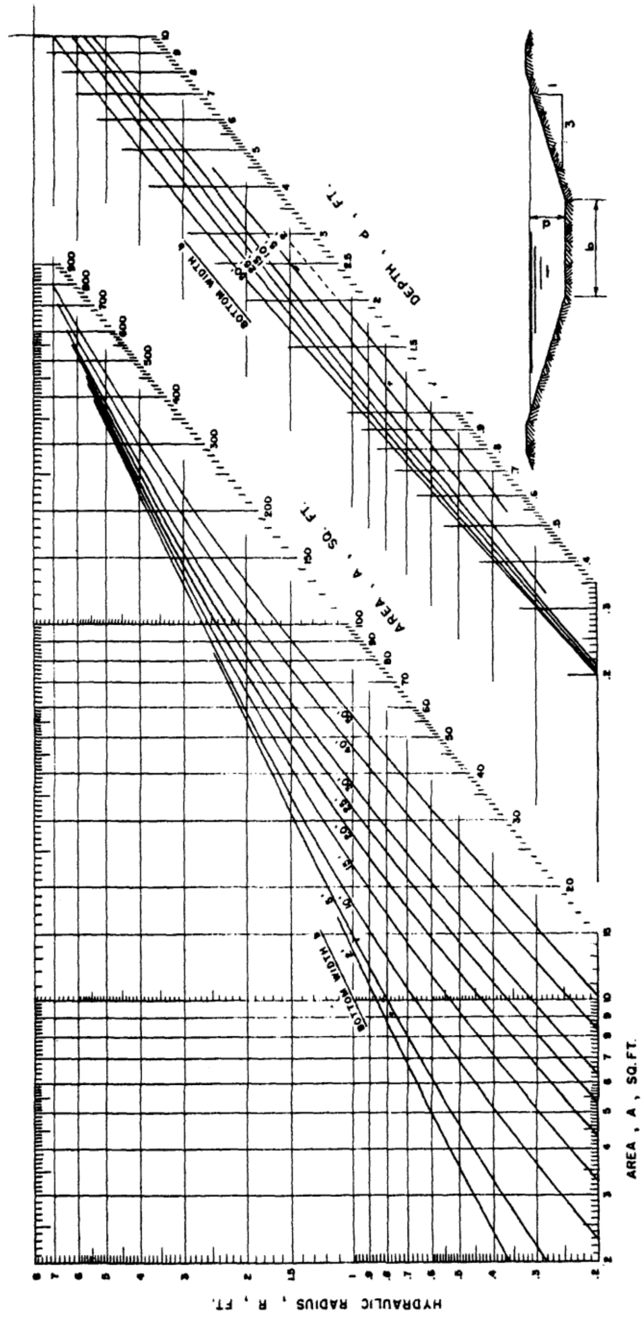


FIGURE A6-8

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 3 TO 1 SIDE SLOPES

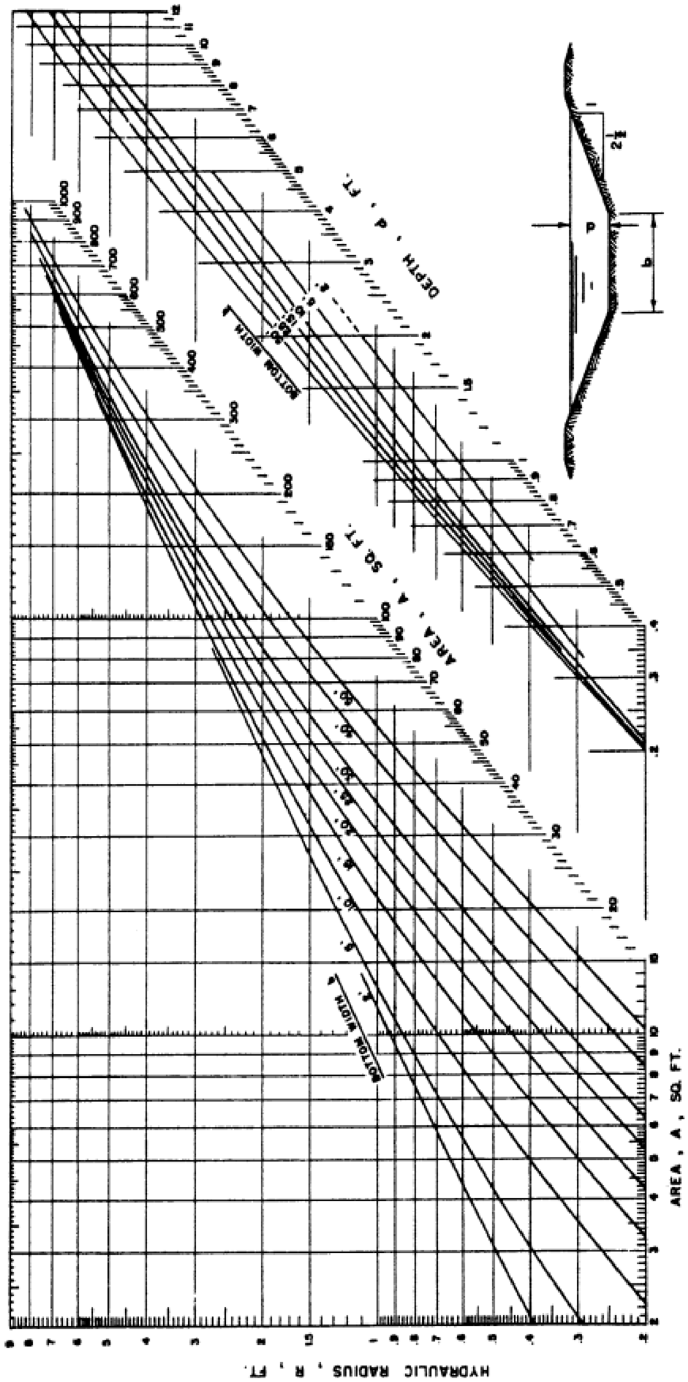


FIGURE A6-9

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 2-1/2 TO 1 SIDE SLOPES

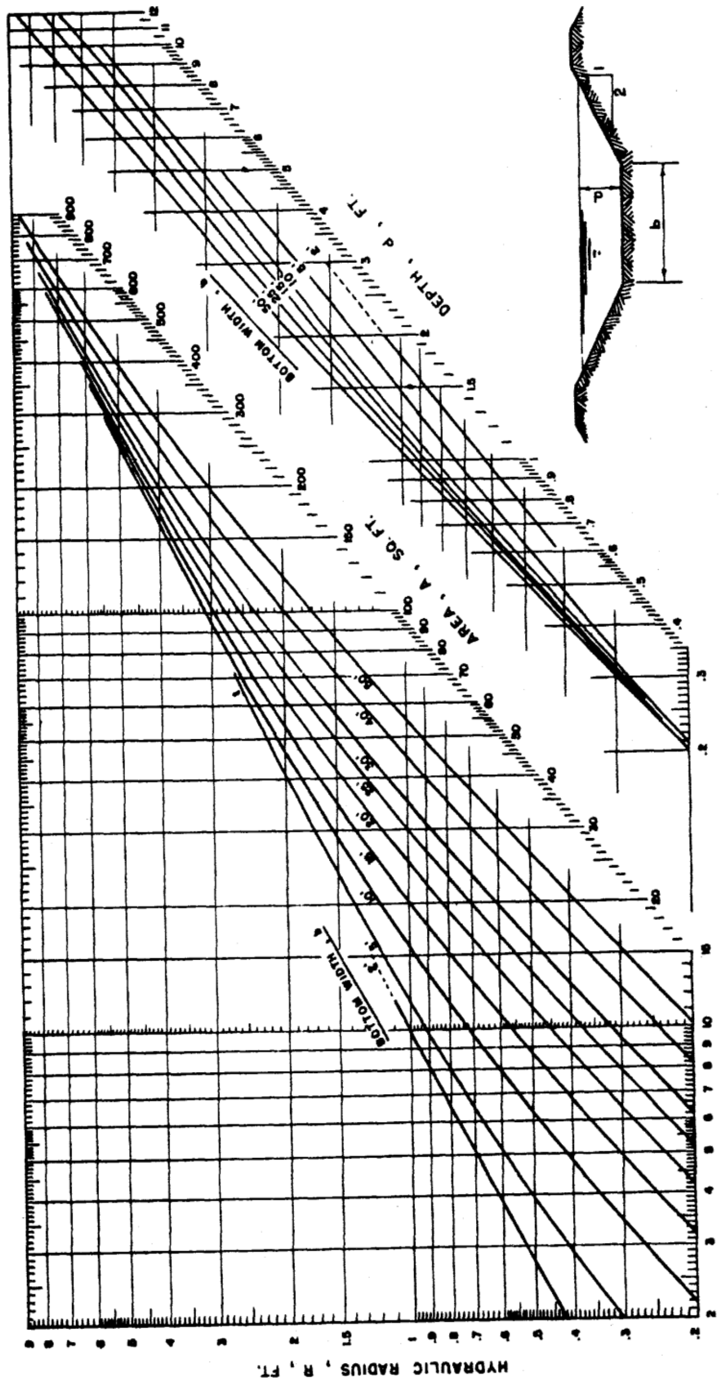


FIGURE A6-10

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 2 TO 1 SIDE SLOPES

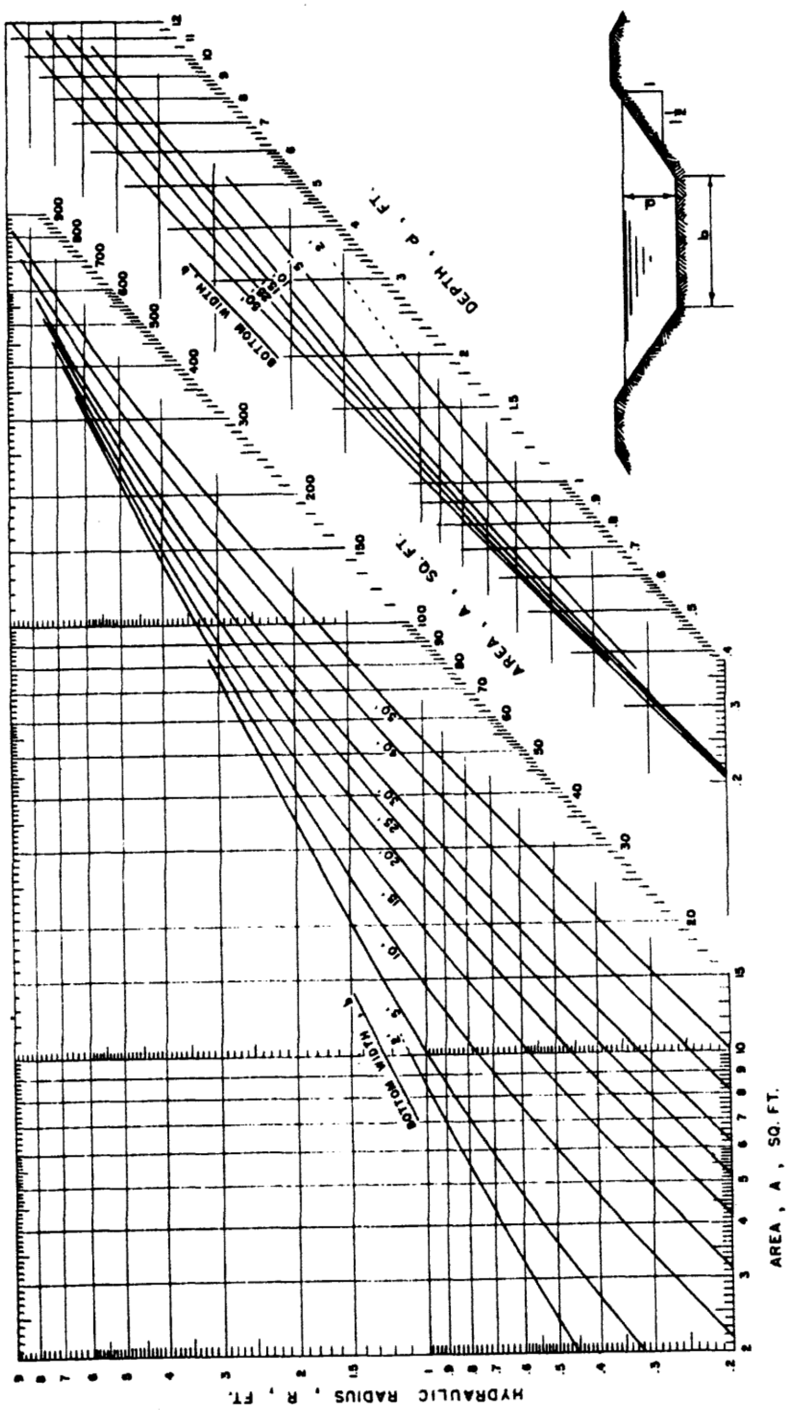


FIGURE A6-11

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 1-1/2 TO 1 SIDE SLOPES

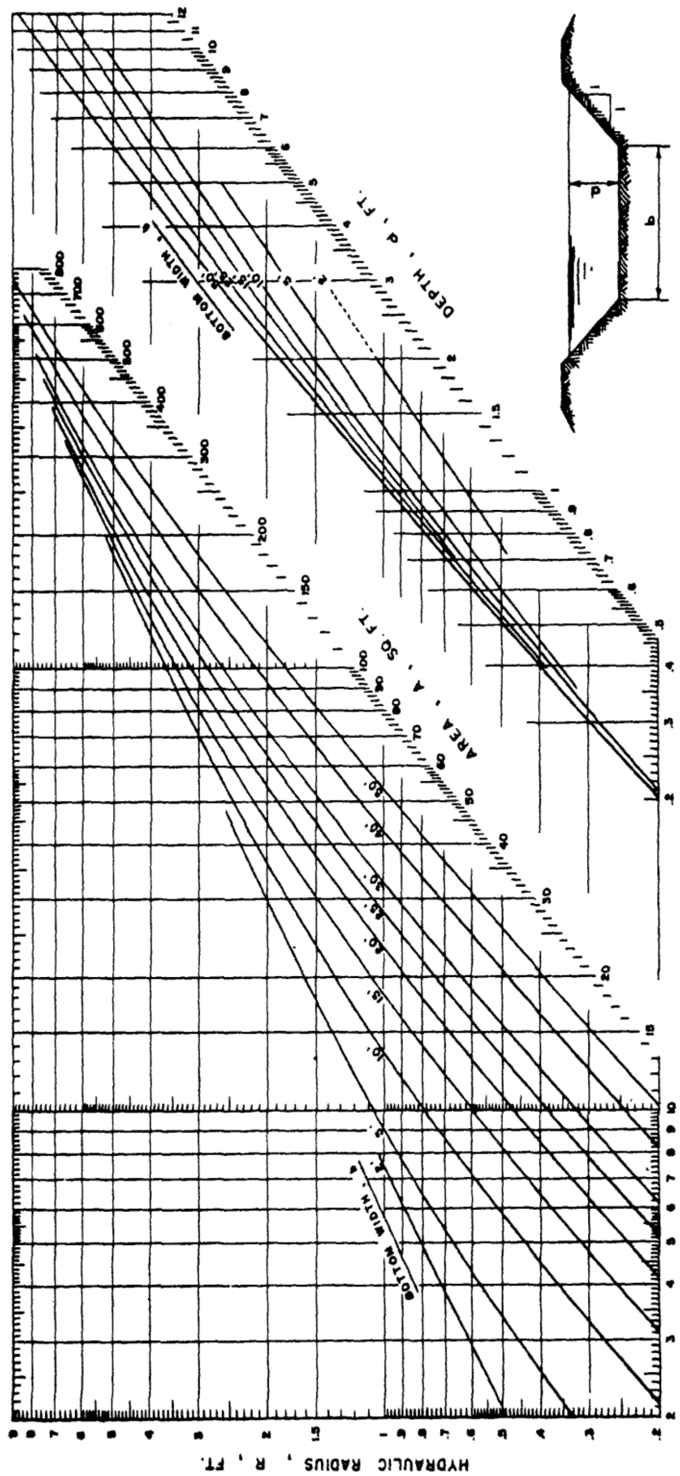


FIGURE A6-12

DIMENSIONS OF TRAPEZOIDAL CHANNELS WITH 1 TO 1 SIDE SLOPES

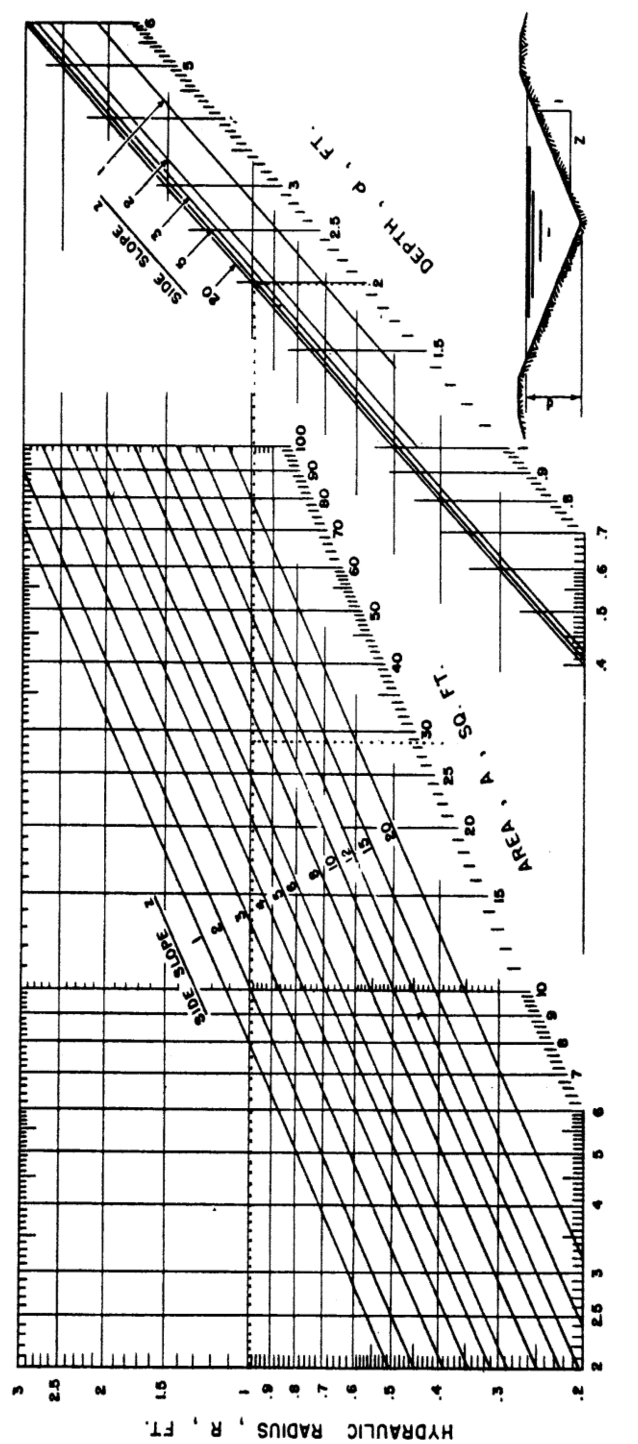
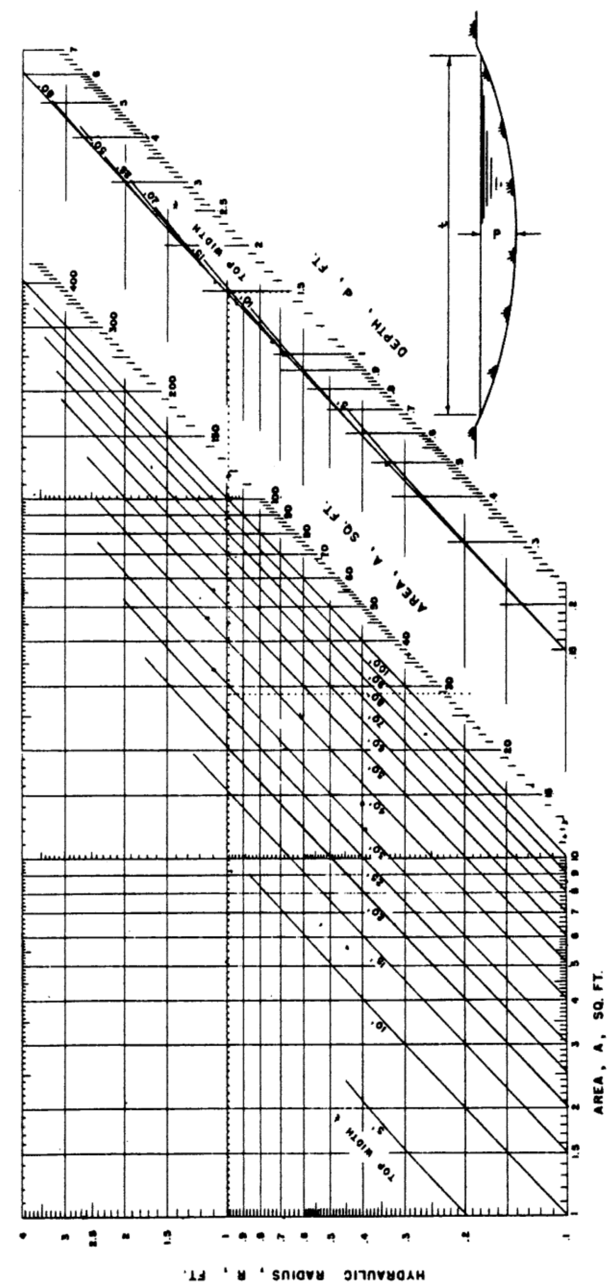


FIGURE A6-13
DIMENSIONS OF TRIANGULAR CHANNELS



NOTE: THIS CHART TO BE USED IN CONJUNCTION WITH THE NOMOGRAPHIC SOLUTION (FIG. A6-15)

FIGURE A6-14
DIMENSIONS OF PARABOLIC CHANNELS

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. Ten acres are to be cleared and developed into houses. Ninety 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 Figure 4.4-2 for a sandy soil, <u>DR = 24%</u>

c. Determine , density of the sediment. From Table 4.4-1 the density of aerated sand is 85-100 lbs/ cu ft., Use = 90 lbs/cu ft.

d. Determine minimum volume for sediment storage for the planned life of the structure.
V = (DA) (A) (DR) (TE) (1/) (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 <u>Sediment Basin Volume and</u> <u>Principal Spillway.</u>

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 Hydrology 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 = <u>1.72 ac. ft.</u>

III. The standard under <u>Sediment Basin Volume</u> 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 crest 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 Figure 4.4-2, use the curve for silty clay with 0.16 sq. mi. drainage area, DR = 72%.

c. Determine, , density of sediment. = 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 of the structure.

V = (DA) (A) (DR) (TE) (1/) (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" cm 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. = <u>7.68 ac. ft.</u>

III. The standard under <u>Sediment Basin Volume</u> 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.

<u>Conclusions From Sample Problems</u>

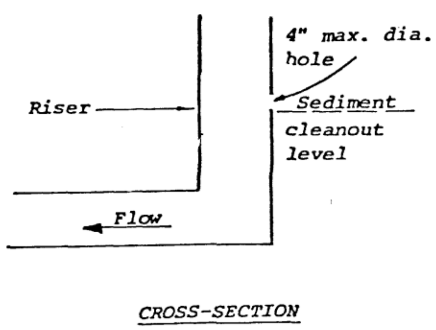
To have a reasonably sized sediment basin that is effective, two factors are critical. The total drainage area must be small and the sediment must be coarse textured, or the basin becomes excessively large.

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 siltclay typical of North Jersey, the minimum basin volume goes from 5.21 ac. ft. to 23.5 ac. ft.

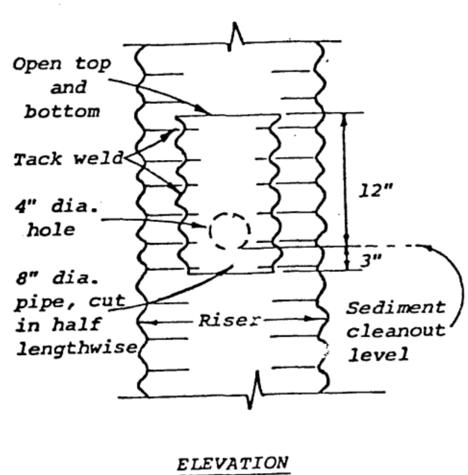
If the soils were silt and clay and the basin was located so that the only drainage area was the 10 disturbed acres, the minimum basin volume would be 2.3 ac. ft. With sand sediments and a 10 ac. drainage area, the minimum basin volume would be 0.5 ac. ft.

METHODS OF DEWATERING SEDIMENT BASINS

The dewatering methods shown here are inexpensive and operate automatically.

METHOD	COMMENTS
A.	
	Easy to construct May clog with trash Non-skimming Capable of draining down to sediment clean-out level

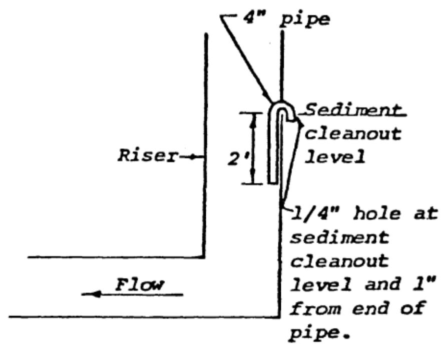
B. Same as "A" except for skimming device, detailed below:



Efficient skimmer
Non-clogging
Fairly easy to construct
Capable of draining down to sediment cleanout level

METHOD	COMMENTS

C.

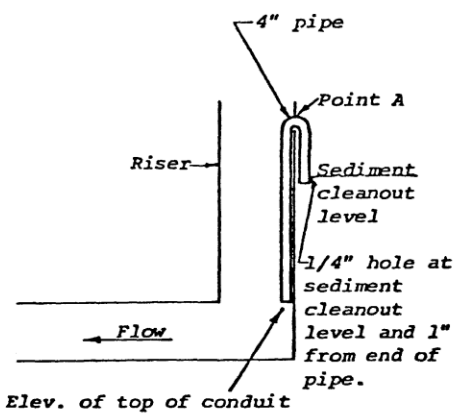


CROSS-SECTION

Efficient skimmer
Capable of always draining down to sediment cleanout level and below

Higher discharge rate than "A" or "B".

D.

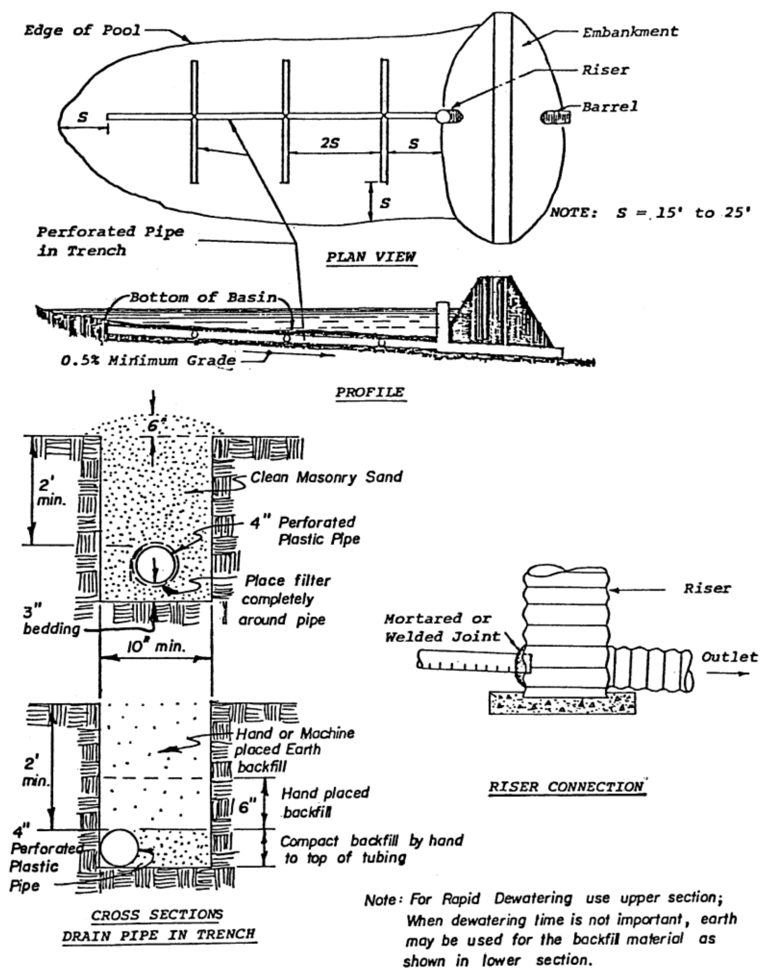


CROSS-SECTION

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"

DEWATERING SEDIMENT BASIN WITH SUBSURFACE DRAIN



Dewatering with Skimmers

Skimmer-type dewatering devices may be considered to improve sediment trapping efficiency. Since skimmers operate at the surface of the ponded water, they will not draw sediment laden water from the submerged volume of the basin. Skimmers are mechanically more complex and will require frequent inspection and maintenance in order to operate as designed. Skimmers may not work during winter months when surface waters freeze, preventing the skimmer from moving downward.

Skimmers must be removed once the sediment trapping function of the basin is completed and the basin is ready for permanent stormwater control.

When connecting the skimmer to the outlet structure where the outlet orifice is larger than the PVC pipe diameter, the orifice may require a temporary plate, reducer-coupling or mortar plug to form a flexible, watertight connection.

APPENDIX A8

CHANNEL STABILITY ANALYSIS PROCEDURE

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 determining 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, pg. D-1.

Allowable Velocity Approach

General

This method of testing the erosion resistance of earth channels is based on data collected by several investigators.

Figure A4-1 shows "Allowable Velocities for Unprotected Earth Channels" developed chiefly from data by Fortier and Scobey al., 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.

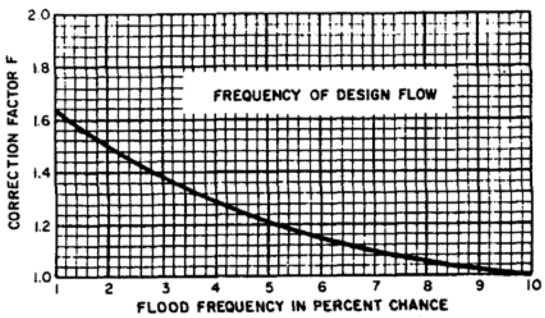
1. Sediment free flow is defined as the condition in which fine material is carried in suspension by the flow at concentrations so low that it has no effect on channel stability. Flows with concentrations lower than 1,000 ppm by weight are treated as sediment free flows.

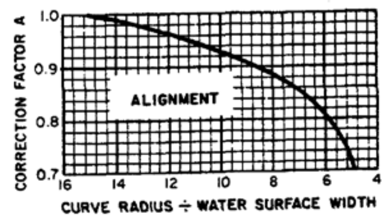
2. Sediment laden flow is the condition in which the flow carries fine material in suspension at moderate to high concentrations so that stability is enhanced either through replacement of dislodged particles or through formation of a protective cover as the result of settling. Flows in this class carry sediment in suspension at concentrations equal or larger than 20,000 ppm by weight.

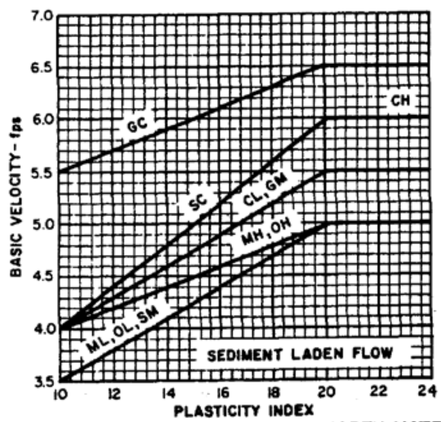
   Sediment transport rates are usually expressed in tons per day.
   To covert them into concentration use the equation:

$$C=370\left(\frac{Q_s}{Q}\right) \quad \text{(Eq. A8-1)}$$

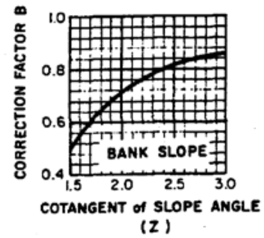
Depending on the type of soil, the effect of concentration of fine sediment (material smaller than 0.074 mm) in suspension on the allowable velocity is obtained from the curves on Figure A8-1.

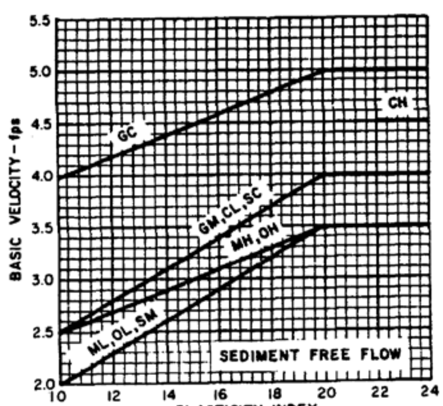




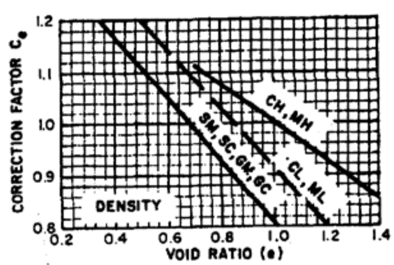


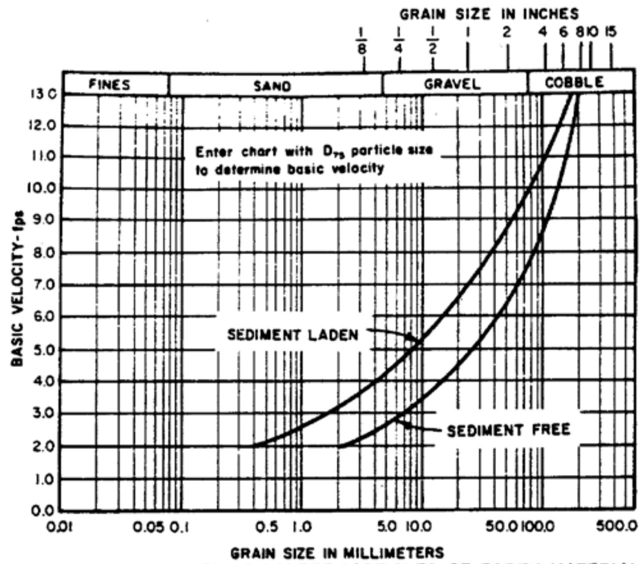
BASIC VELOCITIES FOR COHERENT EARTH MATERIALS (v_b)





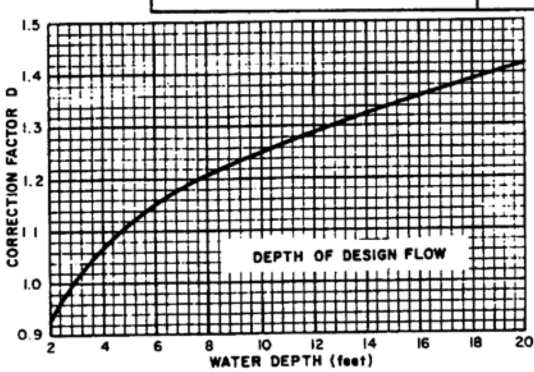
BASIC VELOCITIES FOR COHERENT EARTH MATERIALS (v_b)





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.
2. The maximum permissible velocity for bare sand channels is 1.75 fps.

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, Ce, 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 a an average annual basis, approximately 1000 tons of sediment finer than 1.0 mm. and 20 tons of material coarser 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 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, Ce, does not apply.

Frequency correction, F, does not apply.

V_a (straight reaches) = V_bDB = (6.7) (1.22) (0.72) = 5.88fps

V_a (curved reaches) = V_bDBA = (6.7) (1.22) (0.72) (0.89) = 5.24fps

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 1.0mm. 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;

$$e = G\left(\frac{\lambda_w}{\lambda_d}\right) - 1 = \frac{(2.71)(62.4)}{92} - 1 = 0.83$$

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_bDC_eF = (3.7)(1.22)(1.0)(1.5) = 6.77 fps.

V_a (Curved reach)=V_bDC_eFA=(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_bDC_e = (3.7)(1.19)(1.0) = 4.40 fps.

V_a (Curved reaches)=V_bDC_eA=(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.

<u>Tractive Stress Approach</u>

<u>General</u>

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 unit 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.

<u>Coarse-grained Discrete Particle Soils - $D_{75} \geq$ 1/4 inch - Lane's Method</u>

A. Determination of Actual Tractive Stress

1. Actual tractive stress in an infinitely wide channel.

   Generally, Manning's roughness coefficient "n" reflects the overall impedance 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:

$$n_t = \frac{(D_{75})^{1\spadesuit 6}}{39}$$ 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 st, the friction gradient associated with the particular boundary material being considered.

$$s_t = (\frac{n_t}{n})\text{N?2}s_e$$ (Eq. A8-3)

The tractive stress acting on the soil grains in an infinitely wide channel is found by:

$$\tau_4 = \gamma_w d s_t$$ (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.

   Figures 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, $_{Lb,}$ composed of soil particles with discrete, single grain behavior with a given D_{75} is:

$$\tau_{Lb} = 0.4D_{75} \quad \text{When } 0.25 \text{ in} < D_{75} < 5.0 \text{ in.} \qquad \text{(Eq. A8-5)}$$

The allowable tractive stress for channel sides, 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 $_R$ with the horizontal is

$$\tau_{Ls} = 0.4KD_{75}. \ldots .0.25. < 5.0. \qquad \text{(Eq. A8-6)}$$

Where: $$K = \sqrt{\frac{z^2\text{-}\cot^2\Phi_R...}{1+z^2}} \qquad \text{(Eq. A8-7)}$$

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.

$$T = \frac{\gamma_s - \gamma_w}{97.6} \qquad \text{(Eq. A8-8)}$$

Fine Grained Soils - D_{75} < 1/4 inch

A. Determination of Actual Tractive Stress

1. Reference tractive stress -
   The expression for reference tractive stress is: $\tau = \gamma_w R_t s_e$ (Eq. A8-9)

REFERENCE:
Bureau of Reclamation "Progress Report on Results of Studies on Design of Stable Channels" Hyd-352

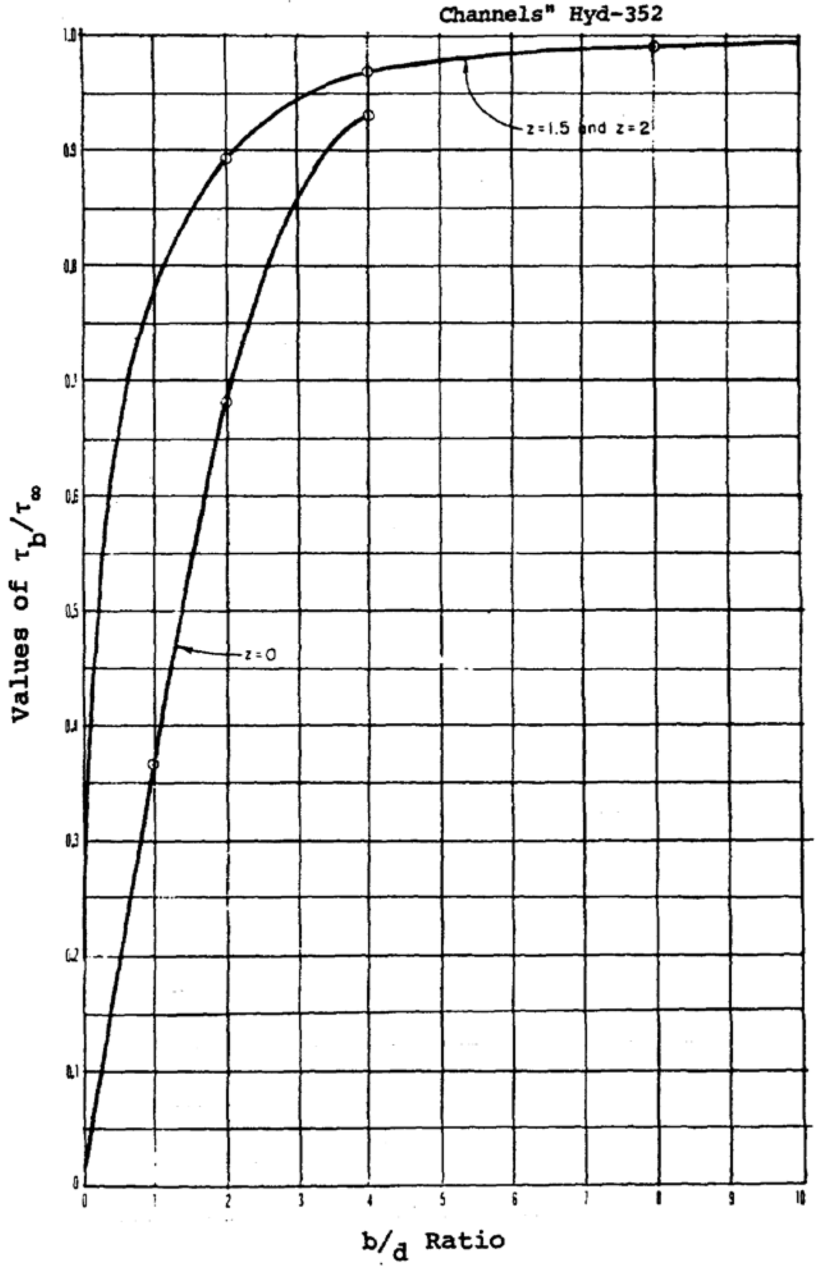


FIGURE A8-2

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

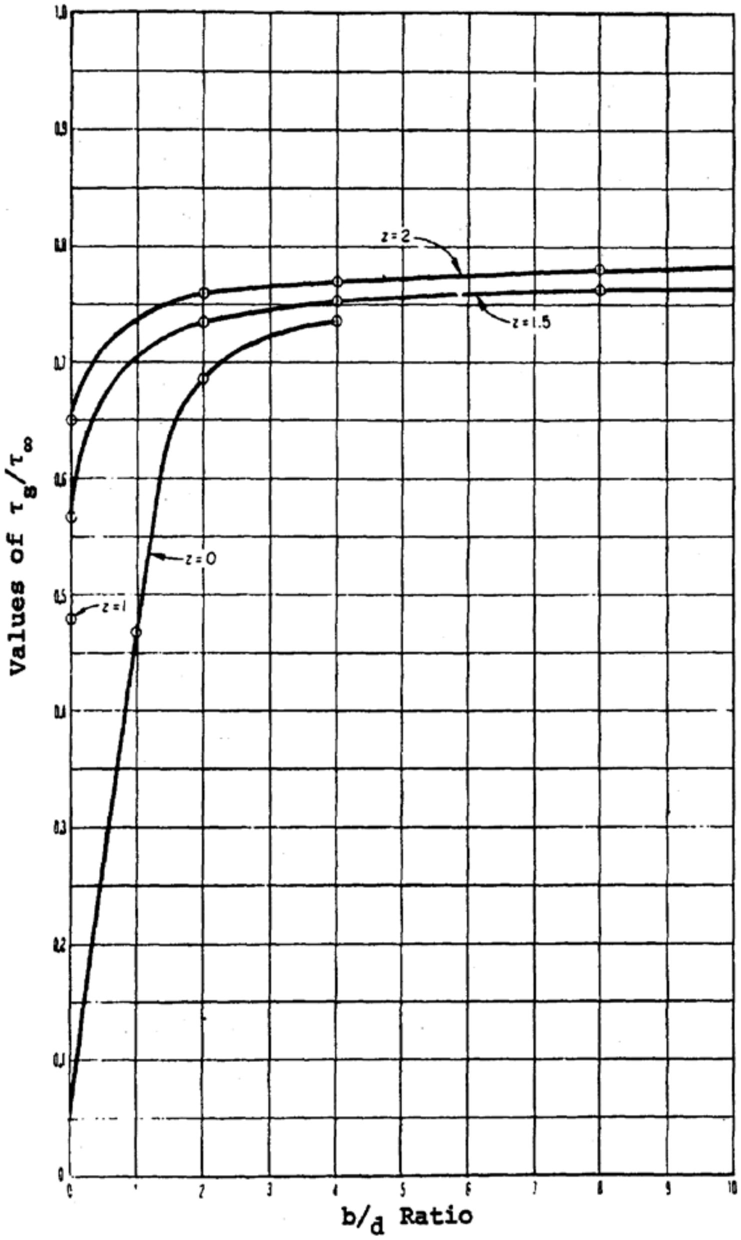


FIGURE A8-3

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

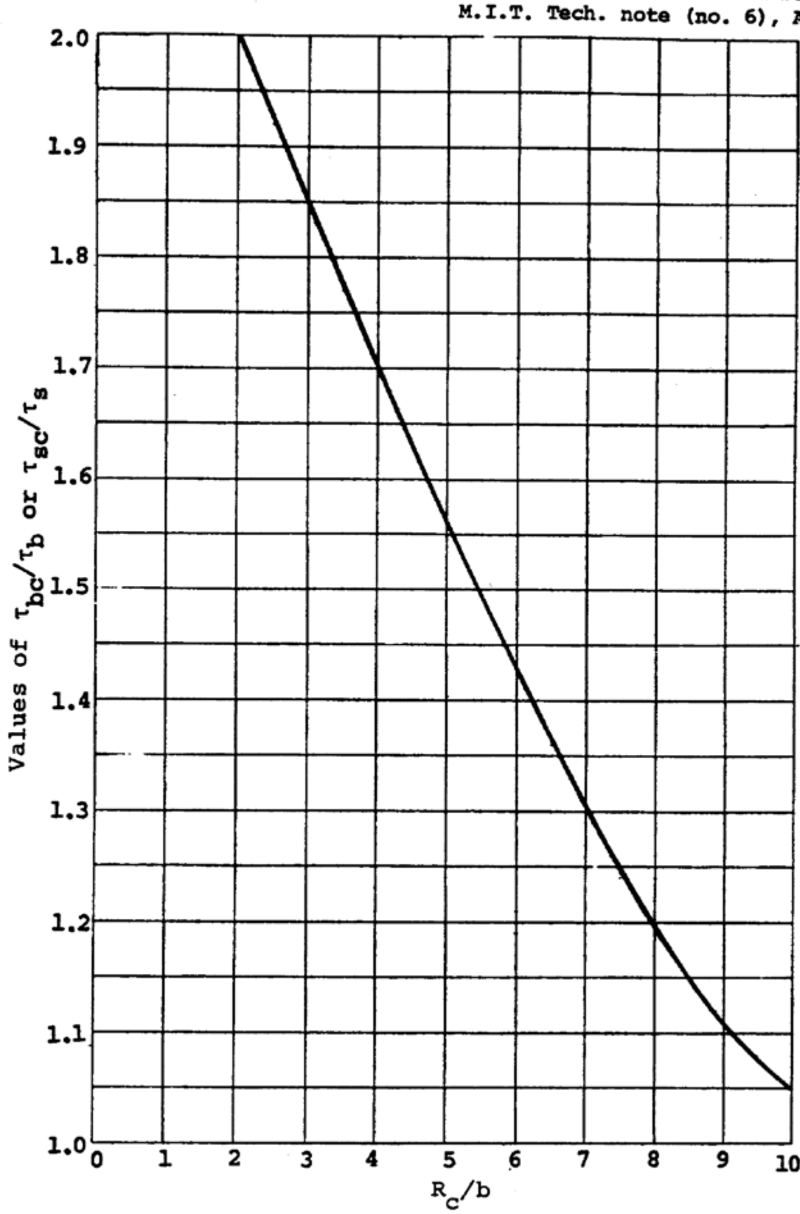


FIGURE A8-4

CHANNEL STABILITY; ACTUAL MAXIMUM TRACTIVE STRESS, τ_{bc} AND τ_{sc}, ON BED AND SIDES OF TRAPEZOIDAL CHANNELS WITHIN A CURVED REACH

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

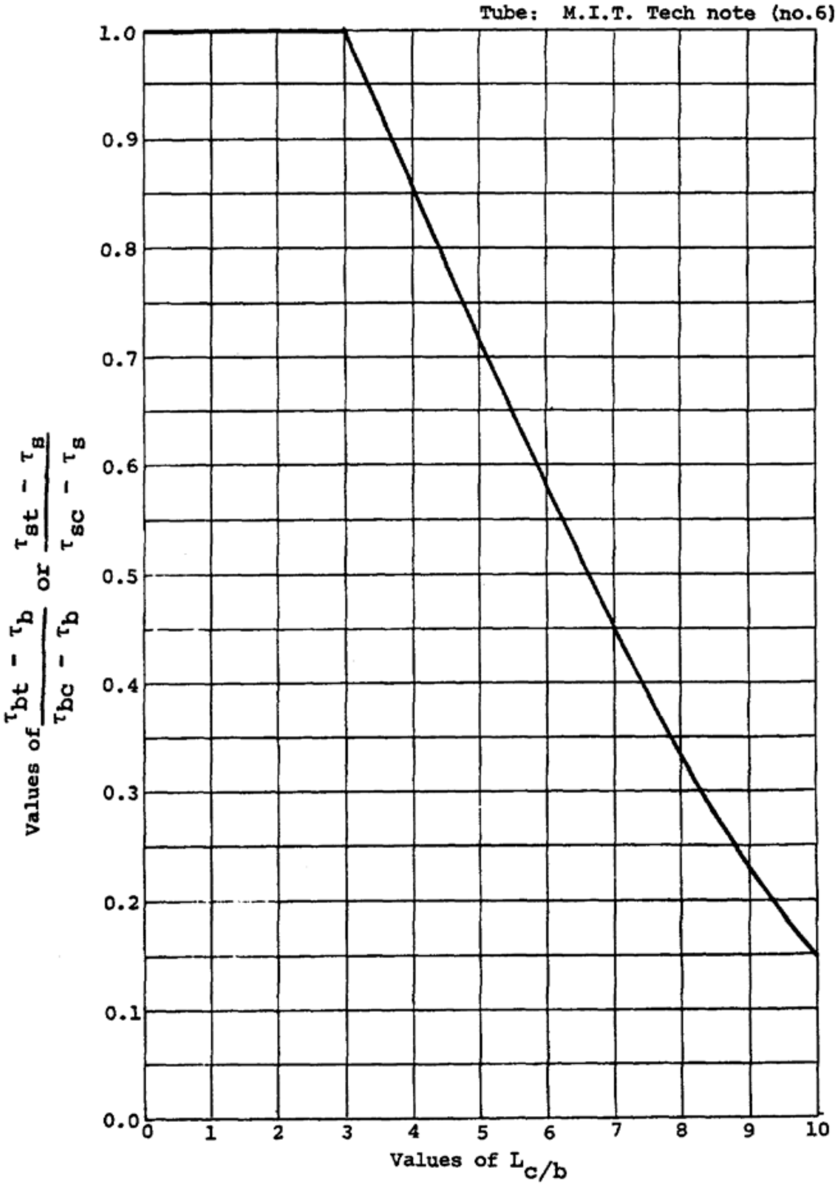


FIGURE A8-5

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

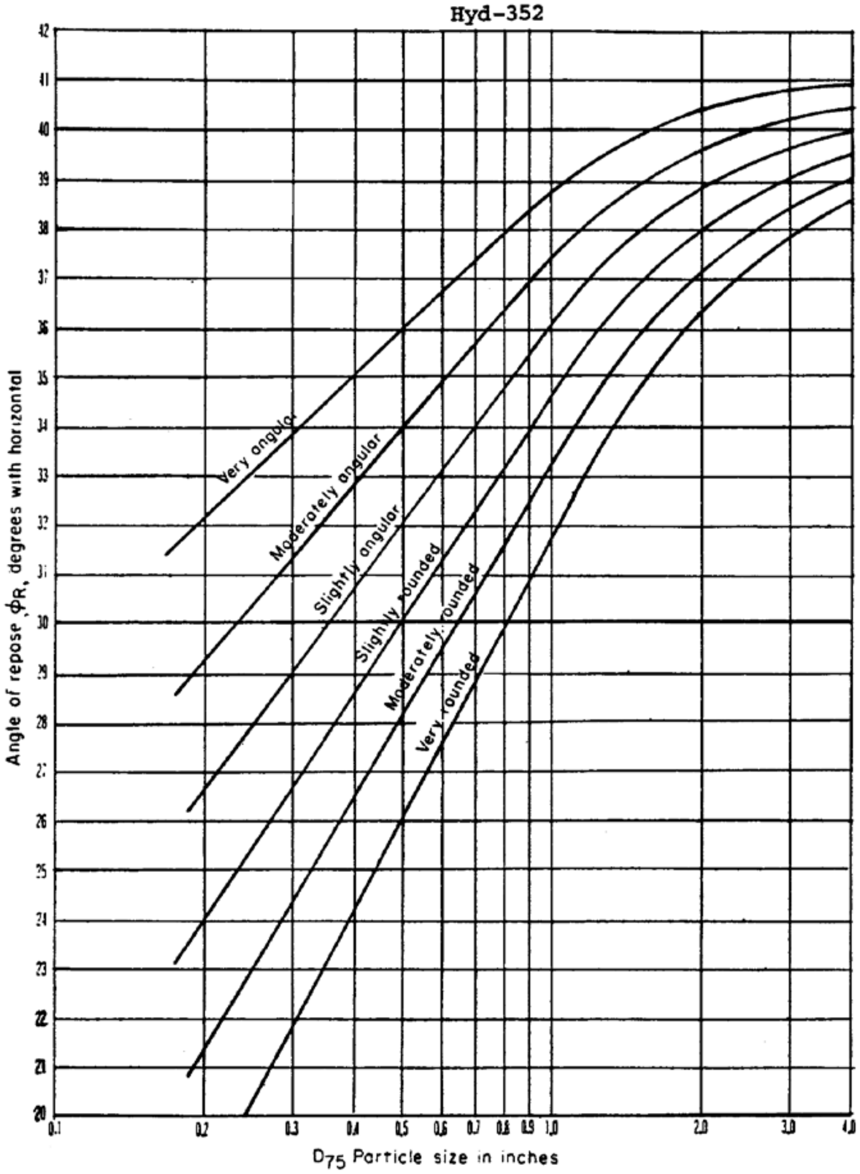


FIGURE A8-6

CHANNEL STABILITY; ANGLE OF RESPOSE, Φ_R, FOR NON-COHESIVE MATERIALS

REFERENCE:
Bureau of Reclamation "Progress Report on Results of Studies on Design of Studies Stable Channels" Hyd-352

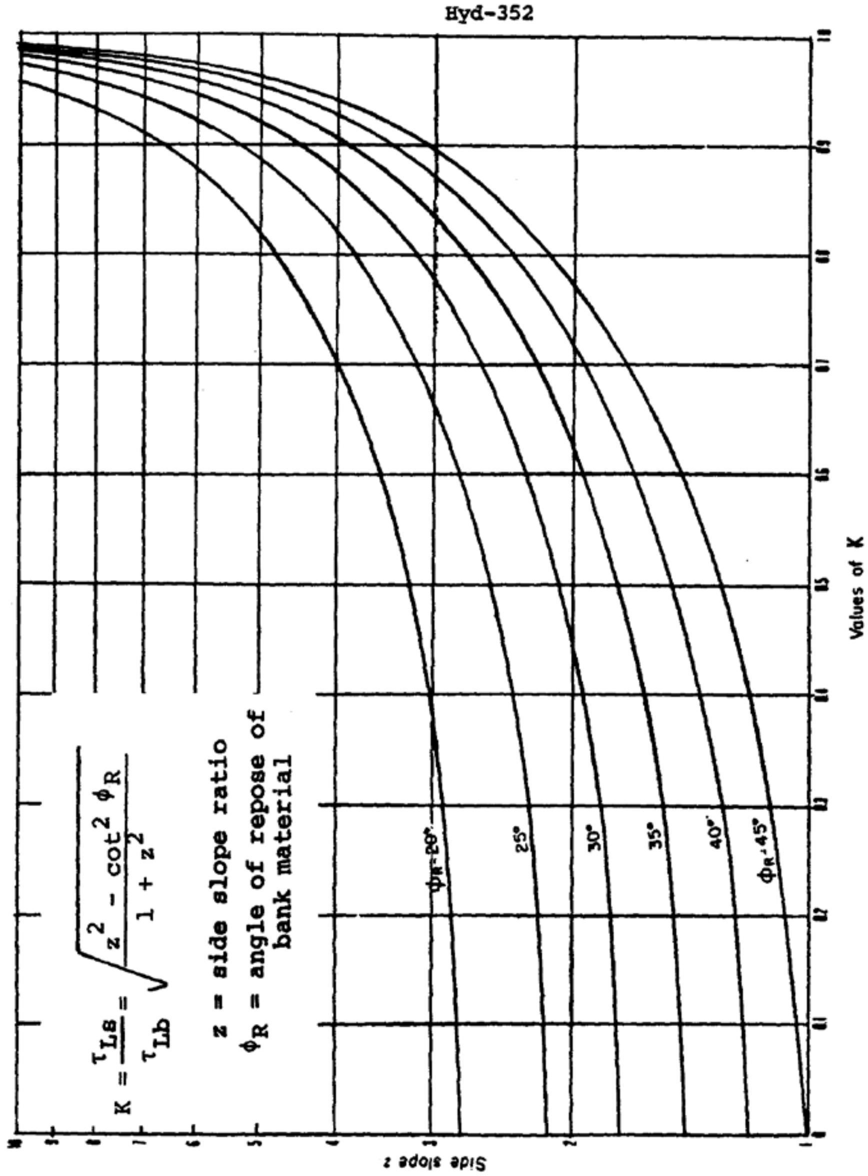


FIGURE A8-7

CHANNEL STABILITY; LIMITING TRACTIVE STRESS τ_{Ls} FOR SIDES OF TRAPEZOIDAL CHANNELS HAVING NON-COHESIVE MATERIALS

In a given situation y 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.

$$\frac{v}{\sqrt{gR_t s_e}} = 5.75\log(12.27\frac{R_t x}{k_s}) \qquad \text{(Eq. A8-10)}$$

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 This thickness is determined from the equation:

$$\delta = \frac{11.6v}{\sqrt{gR_t s_e}} \qquad \text{(Eq. A8-11)}$$

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 interactive 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 and kinematic viscosity of the water 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 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.

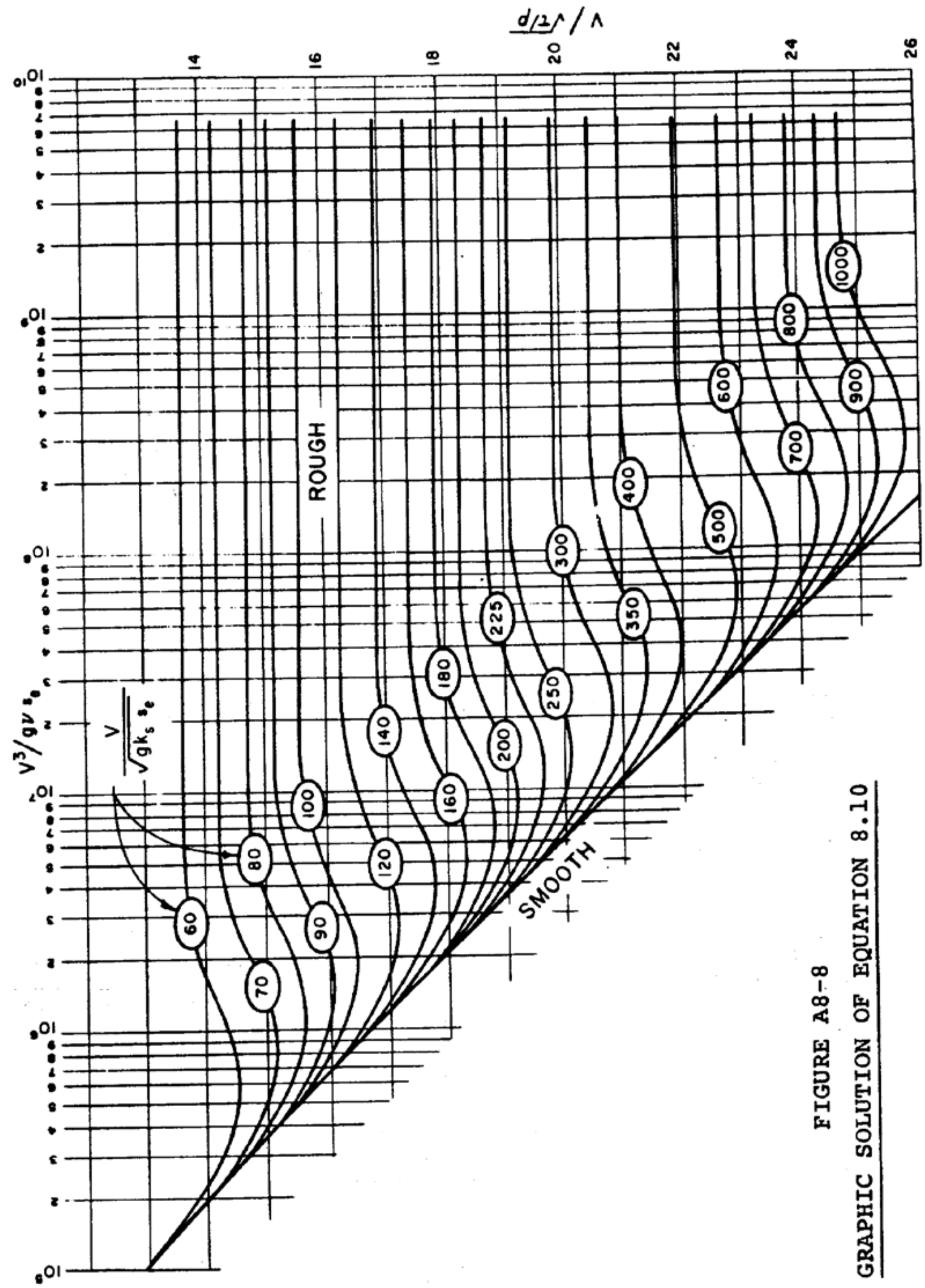


FIGURE A8-8

GRAPHIC SOLUTION OF EQUATION 8.10

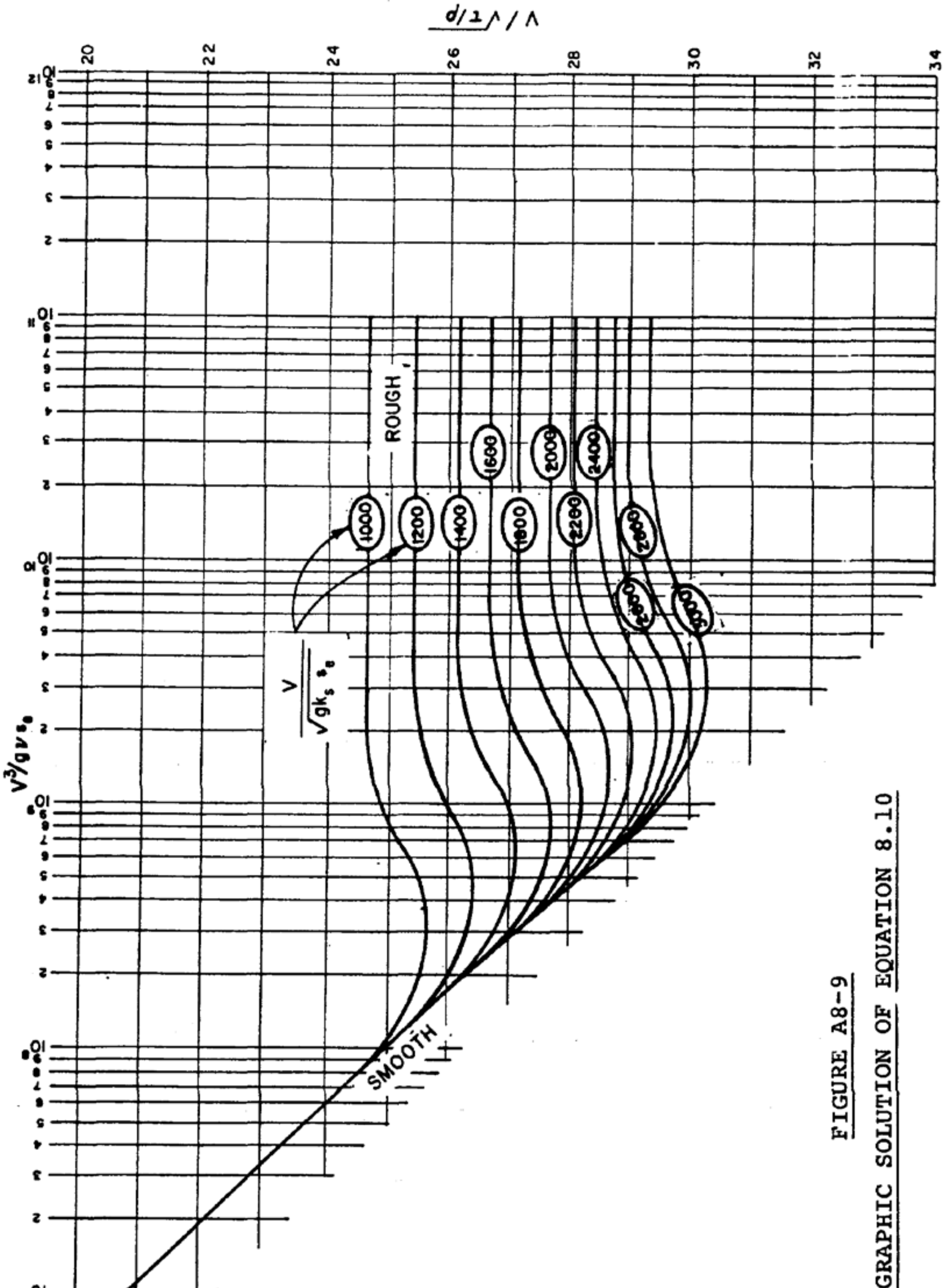
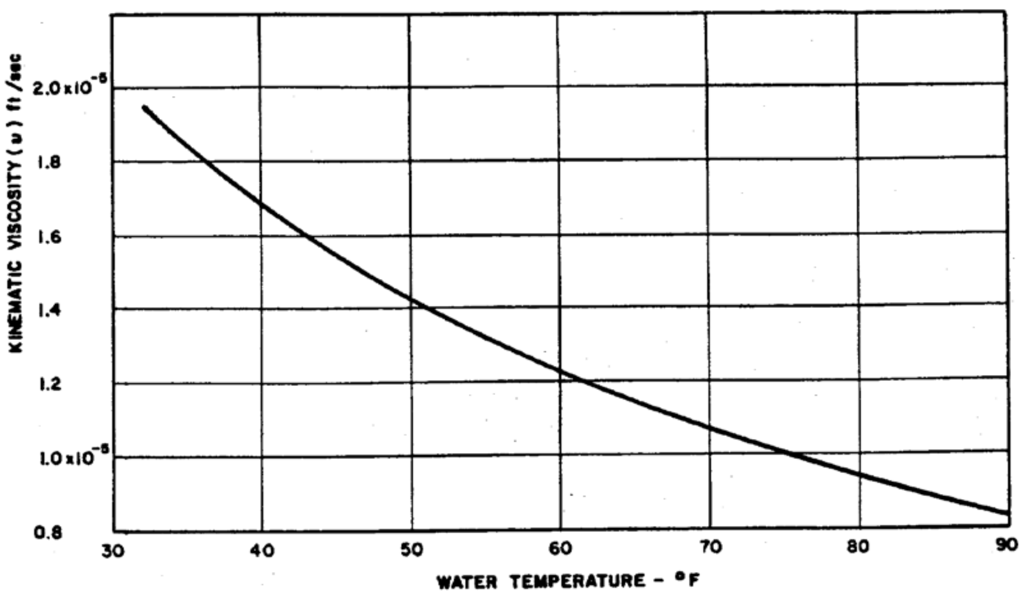


FIGURE A8-9

GRAPHIC SOLUTION OF EQUATION 8.10



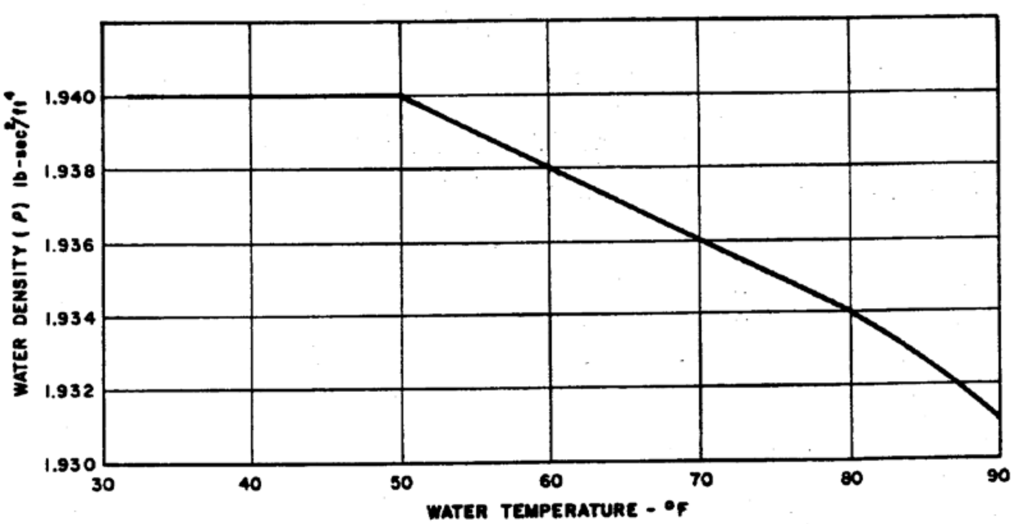


FIGURE A8-10

VALUES OF ρ AND ν FOR VARIOUS WATER TEMPERATURES

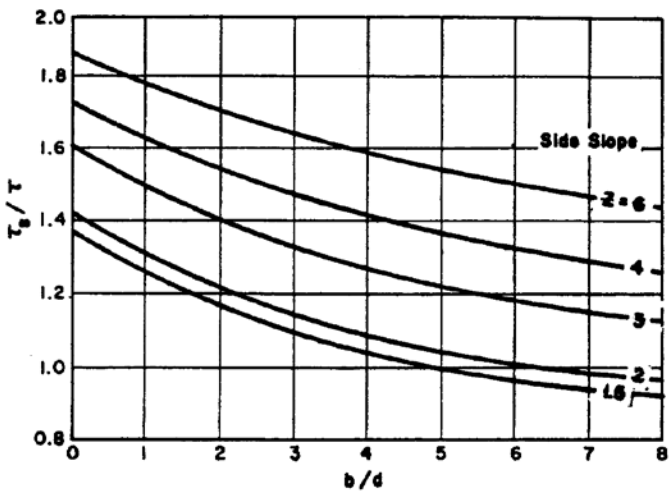


FIGURE A8-11
APPLIED MAXIMUM TRACTIVE STRESS, τ_s,
ON SIDES OF STRAIGHT TRAPEZOIDAL CHANNELS

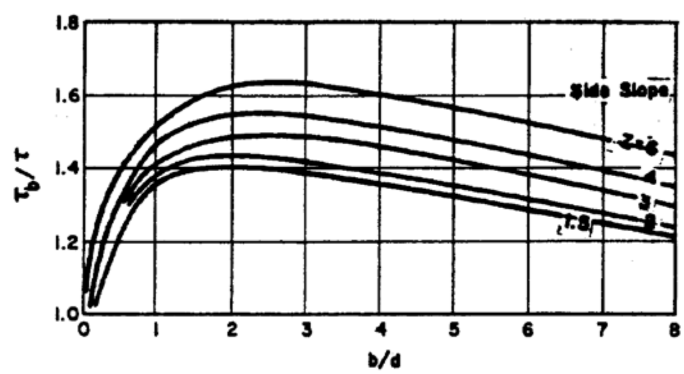


FIGURE A8-12
APPLIED MAXIMUM TRACTIVE STRESS, τ_b,
ON BED OF STRAIGHT TRAPEZOIDAL CHANNELS

Curves reproduced from "Tentative Design Procedure for Riprap Lined Channels" National Cooperative Highway Research Program Report No. 108

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.

<u>Procedure - Tractive Stress Approach</u>

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 EF and read the density ρ, and the kinematic viscosity of the water υ.

3. Compute $\frac{V^3}{g \hat{\iota} + \_\_\_}$

4. Compute $\frac{V}{\sqrt{g k_s s_e}}$

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 $\frac{V}{\sqrt{\tau ♠ \rho}}$

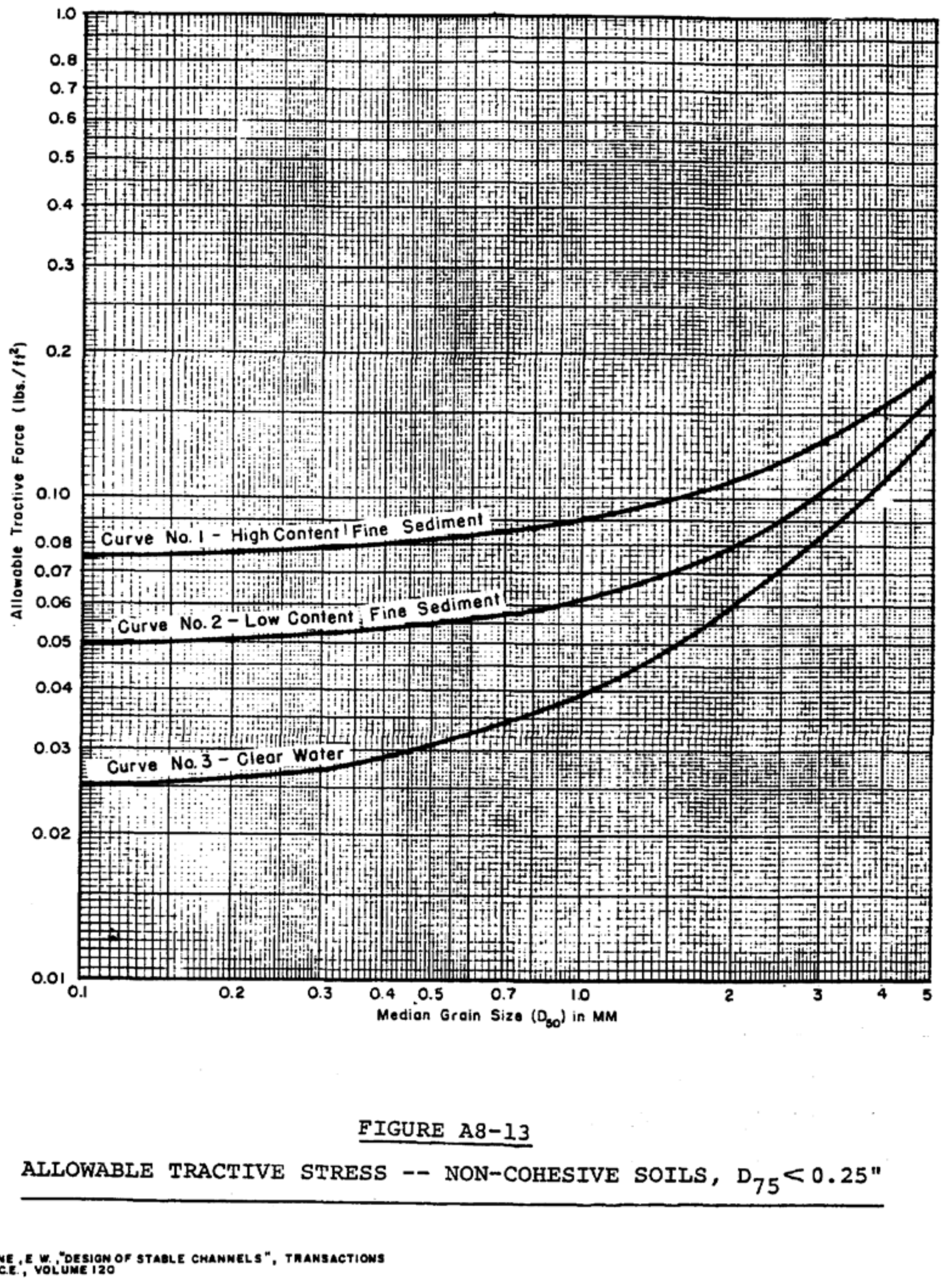


FIGURE A8-13

ALLOWABLE TRACTIVE STRESS -- NON-COHESIVE SOILS, $D_{75} < 0.25"$

REFERENCE: LANE, E. W., "DESIGN OF STABLE CHANNELS", TRANSACTIONS A.S.C.E., VOLUME 120

6. Compute $\frac{v}{\sqrt{\tau/\rho}}$ from v and p

$$\tau = \frac{V^2}{\left(V/\sqrt{\tau/\rho}\right)^2}$$ 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: st - $(n_t/n)^2 s_e$ = $(0.025/0.045)^2\, 0.0026 = 0.00082$.

actual $\tau_4 = \gamma_w d s_t = (62.4)(3.5)(0.00082) = 0.179$ psf.

b/d (ratio of bottom width to depth) = 18/3.5 = 5.14.

from Figure A4-2 and A4-3 $\tau_s/\tau_4 = 0.76$; $\tau_b/\tau_4 = 0.98$.

R_c/b = (radius of curve/bottom width) = 150/18 = 8.33.

τ_{bc}/τ_b = sc/ 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 -

$^{\varphi}R = 38.4E$ (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.

$v = 1.42 \times 10^{-5}\ ft^2/sec.$, $\rho = 1.940\ lb\ sec^2/ft^4$ (Figure A8-10).

$V^3/gv\,s_e = 3.23^3/(32.2)(1.42 \times 10^{-5})(0.0026) = 2.83 \times 10^7$.

$V/\sqrt{gk_s s_e} = 3.23/\sqrt{(32.2)(0.01075/12)(0.0026)} = 373$

$V/\sqrt{\tau/\rho} = 21.6$ (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

$\tau_s/\tau \approx 1.0$ $\tau_b/\tau =$ 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 A4-13 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.

P_I - Plasticity index.

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_d - unit weight of water (pcf).

γ - 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 = $\dfrac{11.6v}{\sqrt{gR_t s_e}}$

φ - angle of shearing resistance.

φ_m - angle of shearing resistance at natural moisture content.

φ_r - angle of repose of coarse noncohesive materials.

v - kinematic viscosity of water (ft^2/sec).

ρ - water density (lb-sec2/ft^4).

T - reference tractive stress (psf).

τ_4 - 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; and 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 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 indicated 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 dredge 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 sur faces 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 OR 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 of 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 and 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. 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.	Low	0.005 to 0.010
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	Medium	0.010 to 0.025
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. Turf grasses where the average depth of flow is about equal to the height of vegetation. Dormant season, willow or cotton wood 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	.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 to 15 feet.	Very High	0.050 to 0.100
Growing season; trees intergrown with weeds and brush, all in full foliage, any value of hydraulic radius up to 10 to 15 feet .		

6th step. 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 $_s$ = the straight length of the reach under consideration.

$_m$ = the meander length of the channel in the reach.

Compute modifying value for meandering in accordance with the following Table:

Ratio (m/ 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 m/ 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, give the following determined values for NJDOT for this channel: for average depth of 4.6 feet "n" = 0.095; for average depth of 7.3 feet n = 0.104.

Appendix A-9

Modified Rational Method

The Soil Conservation Service Technical Release No. 55, (TR-55), Urban Hydrology for Small Watersheds, methodology can determine peak flows from areas of up to five (5) square miles, provide a hydrograph for times of concentration of up to 2 hours, and estimate the required storage for a specified outflow. However, there is another method which can estimate peak flows and the required storage. For small drainage areas up to one-half square mile, the Rational Method (Q=CIA, where Q is the runoff in cfs, "I" is the intensity of rainfall in inches/hour for the time of concentration of the drainage area, ■A• is the area in acres, and ■C• is a dimensionless runoff coefficient) can determine the peak flow rate only. The Modified Rational Method (MRM) as discussed in the American Public Works Association's Special Report 43, can give an approximate storage volume and triangular and trapezoidal hydrographs. This method is applicable for uniform areas up to twenty (20) acres.

THEORY

The area under a hydrograph equals the volume of runoff. For the Modified Rational Method, this area is equal to the peak discharge rate times the duration of the storm. A uniform rainfall intensity for the entire rainfall period is assumed here. This is highly unlikely.

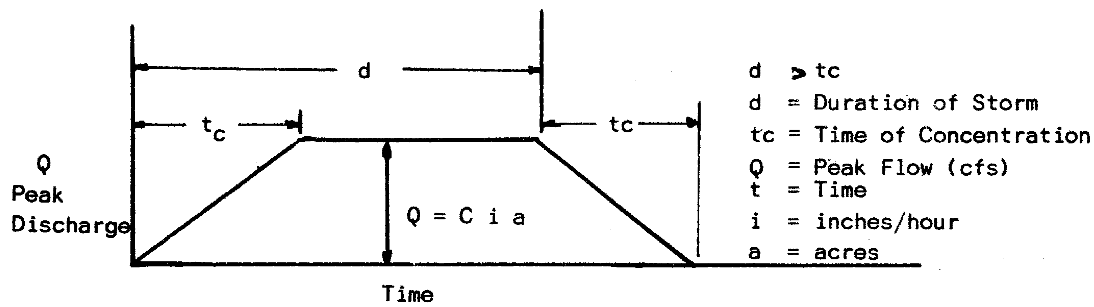
The MRM recommends that a coefficient be used in order to account for the antecedent moisture conditions of storms greater than those with a twenty-five (25) year recurrence intensity (Q=ca x c x i x a). This attempts to predict a more realistic runoff volume which is characteristic of higher frequency storms. The maximum product of ca x c cannot be greater than one.

Recommended Antecedent Precipitation
Factors for the Rational Method

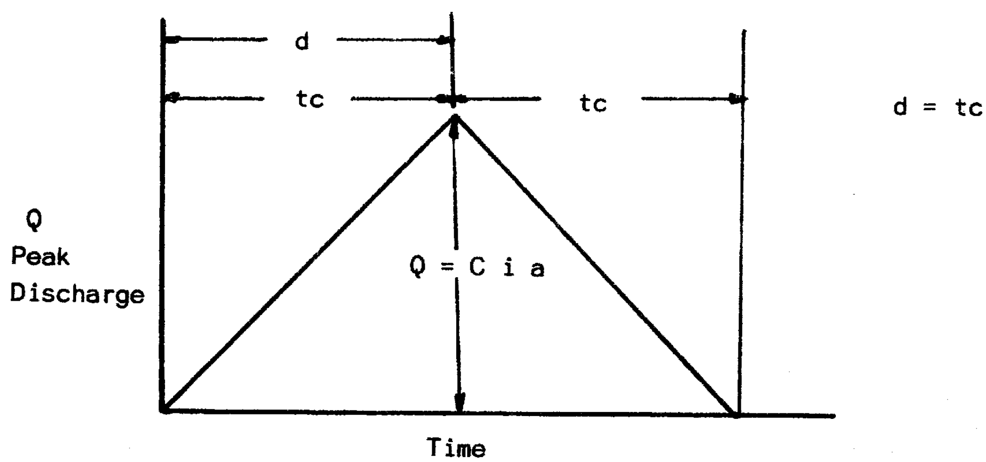
Recurrence Interval (years)	ca
2 to 10	1.0
25	1.1
50	1.2
100	1.25

The time of concentration (tc), which is the time of travel from the most remote point (in time of flow), determines the largest peak discharge. Therefore, there are two possible approximate hydrographs that can be used for runoff and storage requirements.

FIRST CASE: If the rainfall duration is greater than the tc, then the approximate hydrograph is a trapezoid.



SECOND CASE If the rainfall duration is equal to the time of concentration (assuming the tc is the same as in the first case), then the approximate hydrograph is a triangle.



To find the required volume, the MRM uses a trial method to find the critical storage for a given drainage area. For instance, the peak rate for a 25 year storm is the product of the runoff coefficient times the drainage area in acres times the intensity of a 25 year storm for a given time of concentration. However, the critical storage volume may be that of a different duration.

There are three steps in the MRM. The first step is to collect the physical data for the drainage area. This is the drainage area, the time of concentration, the runoff coefficient, and the allowable release rate. The second step is to obtain the proper recurrence interval for the design storm and the intensity-duration relationship for the design frequency. Then calculate a series of peak flows and runoff volumes beginning with the time of concentration of the drainage area and for increased storm durations. The third step is to compute the release volume and the required storage until the maximum or critical storage is found.

EXAMPLE

First Step. A site to be developed has a ground cover of forest with light underbrush. The soil type for the site is Evesboro soil (sand), hydrologic soil group A. The predeveloped site drains into two drainage areas. The southern portion consists of 6.39 acres. The northern portion consists of 8.07 acres. In order to minimize the effect of increased storm water runoff downstream, possibly resulting in soil erosion and sedimentation damage, an onsite detention basin is proposed for the developed condition. Grading of the site will cause the southern drainage area to increase to 11.88 acres. Since the NJDEP curves do not contain the 2 year frequency, the intensity-duration curves for New York City were used in the analysis. A summary of the times of concentration and drainage areas is as follows:

Southern Portion

Storm (years)	Predeveloped Condition					Postdeveloped Condition				
	Acres	tc	C	I	Q	Acres	tc	C	I	Q
2	6.39	0.35	0.22	2.5	4.4	11.88	0.25	0.7	2.9	24
10	6.39	0.35	0.22	4.0	7.1	11.88	0.25	0.7	4.7	39

where tc is hours, i is inch/hour, and Q is cfs .

Second step. Stability is demonstrated offsite by analyzing the velocity for storm water runoff for the two and ten year storms over a defined waterway. These frequencies are chosen because of their high probability of occurrence. Outflow from a detention basin must meet the Conduit Outlet Protection (pg. 12-1), Slope Protection (pg. 27-1), and Channel Stabilization (pg. 11-1) Standards. Stability to the point of discharge to a stream or body of water should be shown in all cases. In this example it was assumed that it was not possible to obtain a drainage easement to accomplish this and therefore the discharge from the proposed outlet at the detention basin must match the predevelopment peak flow at that point. The allowable release rate is therefore the predevelopment peak flow for the 2 and 10 year frequency storms at the proposed point of discharge.

tc = 10 minutes
C = 0.18 for the predeveloped drainage area
at that point of future discharge
a = 0.93 acres (not 8.07 acres)
i = 5.5 inches per hour (10 year frequency)

Q = C x i x a

= 0.18 x 5.5 x 0.93
= 0.92 cfs predevelopment peak at the point of discharge which is the allowable release rate.

Third step. Construct a series of hydrographs for each selected duration of the storm as shown in figure A9.1, Modified Rational Method Hydrographs. The estimated critical storage for this site is 88,858 cubic feet. Since the inflow volume must equal the outflow volume of 98,794 cubic feet, the time to the end of the release rate is 30.3. To reach zero outflow approximately 0.5 hours must be added so the total dewatering time will be about 30.3 hours. The outflow hydrograph reaches maximum flow at the intersection with the falling limb of the hydrograph resulting from a storm with a duration equal to the time of concentration.

Table A9.2

Storage-Duration Values

Duration of Storm (hr) (1)	Intensity I (in/hr) (2)	Peak Flow Q (cfs) (3)	Volume of Runoff (cuft) (4)	Release Flow Volume (cuft) (5)	Required Storage Volume (cuft) (6)
0.25	4.8	39.9	35,925	828	35,097
0.50	3.4	28.3	50,894	1,656	49,238
0.75	2.7	22.5	60,624	2,484	58,140
1.00	2.3	19.1	68,856	3,312	65,544
1.50	1.7	14.1	76,341	4,968	71,373
2.00	1.4	11.6	83,825	6,624	77,201
3.00	1.1	9.1	98,794	9,936	88,858 << Maximum Storage Volume Required
3.50	0.9	7.5	94,303	11,592	82,711

Column (3) Peak Flow = Q = c i a
example : 0.7 X 4.8 X 11.88 = 39.9 cfs

Column (4) Runoff Volume = Q (col 3) X Duration of Storm (col. 1) X 3600
example : 39.9 cfs X 0.25 hrs X 3600 = 35,925 cuft

Column (5) Release Volume = 0.92 cfs X Duration of Storm (col. 1) X 3600
example : 0.92 X 0.25 X 3600 = 828 cuft

Column (6) Required Storage = Runoff Volume (col. 4) - Release Volume (col 5)
example : 35,925 - 828 = 35,097

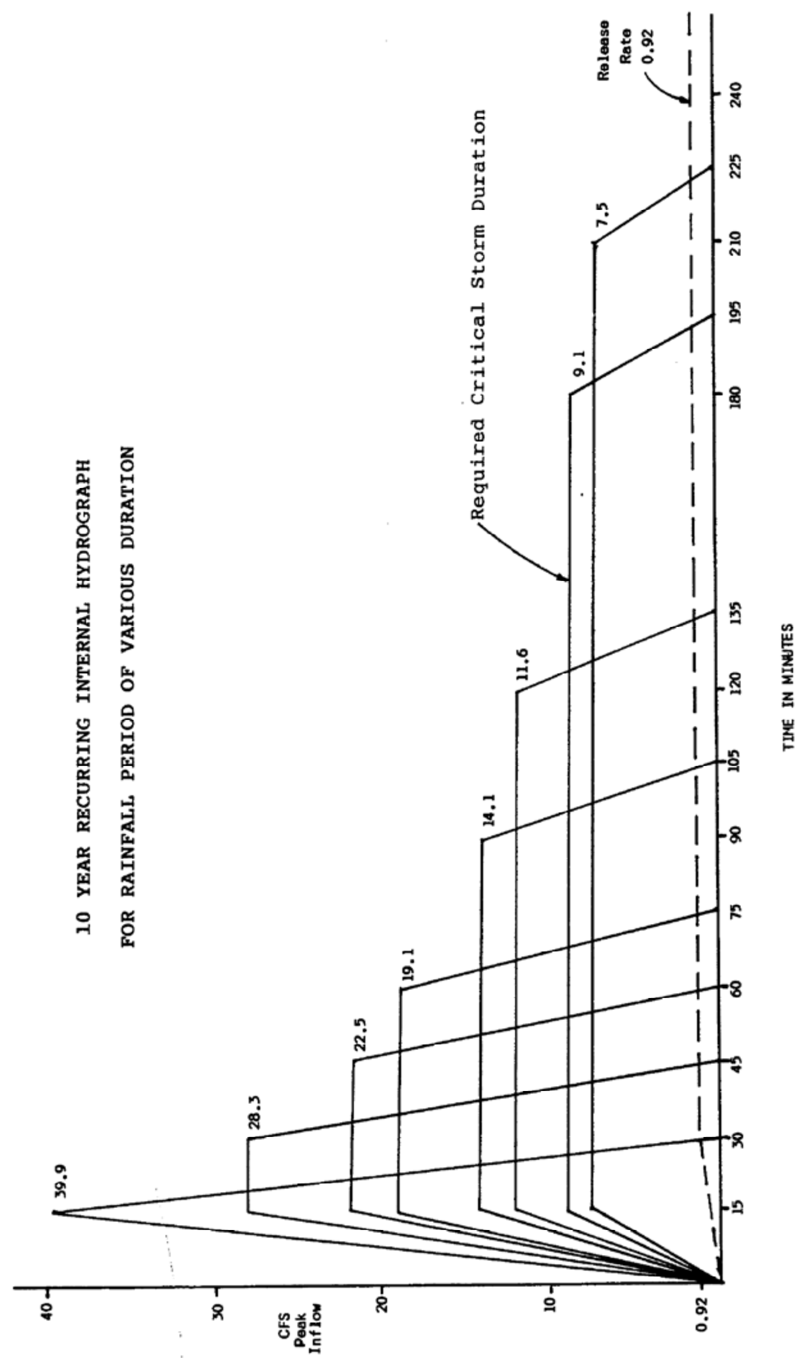

10 YEAR RECURRING INTERNAL HYDROGRAPH
FOR RAINFALL PERIOD OF VARIOUS DURATION
Required Critical Storm Duration
Release
Rate
0.92
39.9
28.3
22.5
19.1
14.1
11.6
9.1
7.5
40
30
20
10
0.92
CFS
Peak
Inflow
15
30
45
60
75
90
105
120
135
180
195
210
225
240
TIME IN MINUTES

Figure A9.1

APPENDIX A10

Modified Structural Guidelines for Stormwater Management Basins
Natural Resource Conservation Service
Pond Standard No. 378

Definition:

A water impoundment made by constructing a dam or embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at spillway elevation is 3 feet or more.

<u>Purpose</u>

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality.

<u>Scope</u>

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in the loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruptions of the use or service of public utilities.

2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is 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 is the upper limit.

3. The effective height of the dam is 35 feet or less and the dam is hazard class "a" (Low hazard).

<u>Conditions Where Practice Applies</u>

<u>Site Conditions.</u> Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and the emergency spillway or (3) a principal spillway.

<u>Drainage Area.</u> The drainage area above the pond must be protected against erosion to the extent that expected sediment will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and ground water flow will maintain an adequate supply of water in the pond. The quality shall be suitable for the water's intended use.

Ratios of drainage area to normal pond area greater than 1000 to 1 will normally have excessive sedimentation, unless the drainage area is flat or has good cover.

If the surface water is the only source of water the ratio of drainage area to normal pond area shall be at least 10 to 1.

Ponds shall be protected from the contamination from the barnyards, septic tanks, storm and sanitary sewers or other sources.

Reservoir Area. The topography and soils of the site shall permit storage of water at a depth and volume that ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be a type that sealing is practicable.

Design Criteria For Embankment Ponds

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up to abutments to the emergency spillway crest elevation and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a minimum bottom width of 4 feet and adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical. Compaction requirements shall be the same as those for embankments. The trench shall be kept free from standing water during the back-filling operation.

The minimum depth shall be at least 3 feet.

Seepage Control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

Earth Embankment. 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. The minimum top width for a dam is shown in table A10-1. If the embankment top is to be used as a public road, the minimum width shall be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures shall meet the requirements of the responsible road authority.

Table A10-1 Minimum Top Width for Dams

Total Height of Embankment (feet)	Top Width (feet)
10 or less	6
10-15	8
15-20	10
20-25	12
25-35	14
35 or more	15

The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter sides slopes are required.

If needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided (USDA Soil Conservation Service, Technical Release Nos. 56 and 69).

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 the design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top width of the dam shall be 2 feet for all dams having more than a 20 acre drainage area or more than 20 feet in effective height.

The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dams equals or exceeds the design height. This increase shall not be less than 10% when compaction is by hauling equipment or 5% 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.

Embankments of Other than Earthfill

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

Principal Spillway. A pipe conduit, with needed appurtenances, shall be placed under or through the dam, except where rock, concrete, or other types of mechanical spillways are used, or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

The crest elevation shall be no less than 0.5 feet below the crest of the emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 foot for those having a drainage area of more than 20 acres.

When the design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. The pipe diameter shall be no less than 4 inches. If the pipe conduit diameter is larger than 10 inches, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

For sediment basins, the minimum principal spillway pipe size shall be 8 inches for corrugated or helical pipe and 6 inches for smooth wall pipe.

Pipe conduits under or through the dam shall meet the following requirements: The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with the maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

For dams 20 feet or less in effective height, acceptable pipe materials are cast-iron, steel, corrugated steel or aluminum, concrete, plastic, vitrified clay with rubber gaskets, and cast-in-place reinforced concrete. Concrete and vitrified clay pipe shall be laid in a concrete bedding. Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to less flexible pipe or structure must be designed to avoid stress concentrations that could rupture the plastic.

For dams more than 20 feet in effective height, conduits shall be plastic, reinforced concrete, corrugated steel or aluminum, or welded steel pipe. The maximum height of fill over any principal spillway steel or aluminum pipe must not exceed 25 feet. Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Concrete pipe shall have concrete bedding or a concrete cradle if required. Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet. Protective coatings of asphalt coated, or vinyl coating on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe should be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohmscm, or where soil pH is lower than 5.

Specifications in tables A10-2 and A10-3 are to be followed for polyvinyl chloride (PVC), steel, and aluminum pipe.

Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if mounting indicates the need.

Seepage control along a pipe conduit spillway shall be provided if any of the following conditions exists:

1. The effective height of the dam is greater than 15 feet.
2. The conduit is of smooth pipe larger than 8 inches in diameter.
3. The conduit is of corrugated pipe larger than 12 inches in diameter.

Table A10-2 :Acceptable PVC Pipe For Use in Earth Dams[1]

Normal Pipe Size (inches)	Schedule for Standard dimension ratio (SDR)	Maximum depth of fill over pipe (feet)
4 or smaller	Schedule 40 Schedule 80 SDR 26	15 20 10
6, 8, 10, 12	Schedule 40 Schedule 80 SDR 26	10 15 10

1. Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM-1785 or ASTM-D-2241.

Table A10-3: Minimum Gauge for Corrugated Metal Pipe
(2-2/3-in x 1/2-in Corrugations)[1]

Fill height (ft)	Minimum gauge for steel pipe with diameter (in) of-21 and less	24	30	36	42	48	Minimum thickness (in) of aluminum pipe /2 with diameter (in) of- 21 and less	24	30	36
1-15	16	16	16	14	12	10	0.06	0.06	0.075	0.075
15-20	16	16	16	14	12	10	.06	.075	.105	.105
20-25	16	16	14	12	10	10	.06	.105	.135	/3

1. Pipe with 6-, 8-, and 10-diameter has 1-1/2-in x 1/4-in corrugations.
2. Riveted or helical fabrication.
3. Not permitted

Seepage along pipes extending through the embankment shall be controlled by the use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

The drain shall be minimum of 2 feet thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam.

The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe to where it exists in the embankment. Protecting drain fill from the surface erosion will be necessary.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with the pipe materials. The antiseep collar (s) shall increase by 15% the seepage path along the pipe.

Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by state law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1-1/4 inches.

The minimum diameter principal spillway pipe for a dam which raises the water height by more than 5 feet measured from the downstream toe of the dam to the emergency spillway crest is 18 inches. A principal spillway shall be used except where:

1. The drainage area is 10 acres or less, there is no spring or seep flow and the emergency spillway exit channel is on stable grade all the way back to the existing channel. .

2. The drainage area is 10 acres or less, there is spring or seep flow and the emergency spillway exit channel is on a stable grade all the way back to the existing channel. For this condition a trickle tube shall be used in accordance with pages 11-13 and 11-16 of USDA, Soil Conservation Service, Engineering Field Manual.

Design Storm. Storage and effective height are defined under Scope.

1. Table A10.4 defines minimum design storm for the principal spillway.
2. Table A10.5 defines minimum design storm for the emergency spillway.

Table A10-4 Principal Spillway Minimum Design Storms [4]

Type [1]	Raised[2] Water Height (ft)	Product of the storage times the effective height of the Dam[3]	Drainage Area (acres)	Principal Design Storm Design
All	≤5	≤ 300	< 320	1 yr 24 hr
Agriculture	>5	≤ 300	< 320	1 yr 24 hr
Non-Agriculture	>5	≤ 300	< 320	25yr 24 hr
All	≥5	301 - 3000	< 320	2 yr 24 hr
Agriculture	>5	301 - 3000	< 320	2 yr 24 hr
Non-Agriculture	>5	301 - 3000	< 320	25yr 24 hr
All	<5	< 300	> 320	1 yr 24 hr
All	>5	> 300	≥ 320	25yr 24 hr
All	≤5	301 - 3000	≥ 320	2 yr 24 hr
All	>5	301 - 3000	≥ 320	25yr 24 hr

1. Agriculture is defined as being used in connection with the production of crops or livestock.
2. Measured from the usual, mean low water height to the water surface during the emergency spillway design storm.
3. As defined under "Scope".
4. Spillway Storm is Type III.

Table A10-5 Emergency Spillway Minimum Design Storms[5]

Type[1]	Raised[2] Water Height (feet)	Total Storage[3]	Drainage Area (Acres)	Emergency Spillway Design Storm[4]
All	< 5	< 50	≤ 20	10 yr 24 hr
Agriculture	5.1-20	< 50	≤ 20	10 yr 24 hr
Non-Agriculture	5.1-20	< 50	≤ 20	100 yr 24 hr
Agriculture	> 20	< 50	≤ 20	25 yr 24 hr
Non-Agriculture	> 20	< 50	≤ 20	100 yr 24 hr
All	≤ 5	≥ 50	≤ 20	50 yr 24 hr
Agriculture	5.1-20	≥ 50	≤ 20	50 yr 24 hr
Non-Agriculture	5.1-20	≥ 50	≤ 20	100 yr 24 hr
Agriculture	> 20	≥ 50	≤20	50 yr 24 hr
Non-Agriculture	> 20	≥ 50	≥ 20	100 yr 24 hr
All	≤ 5	< 50	21-320	25 yr 24 hr
Agriculture	5.1-20	< 50	21-320	25 yr 24 hr
Non-Agriculture	5.1-20	< 50	21-320	100 yr 24 hr
Agriculture	> 20	< 50	21-320	50 yr 24 hr
Non-Agriculture	< 20	< 50	21-320	100 yr 24 hr
All	≤ 5	≥ 50	21-320	50 yr 24 hr
Agriculture	5.1-20	≥ 50	21-320	50 yr 24 hr
Non-Agriculture	5.1-20	≥ 50	21-320	100 yr 24 hr
Agriculture	> 20	≥ 50	21-320	50 yr 24 hr
Non-Agriculture	> 20	≥ 50	21-320	100 yr 24 hr
All	≤ 5	all	> 320	50 yr 24 hr
All	> 5	all	> 320	100 yr 24 hr

1. Agriculture use is defined as being used in connection with the production of crops or livestock.
2. Measured from the usual, mean low water height to the water surface during the emergency spillway design storm.
3. Measured below the crest of the emergency spillway.
4. Any pond for which a state stream encroachment permit is required must use a minimum design storm of 100 yr 24 hr type III for the emergency spillway.
5. Design storm is the type III.

Pipe Conduit

1. Corrugated Steel Pipe - The pipe may be helical or riveted fabrication. Riveted pipe shall be closed riveted. Riveted pipe 36 inches or larger shall be doubled riveted. Pipe strength is not to be less than that indicated in table A10-7.

   If corrugated metal pipes are used on embankments which raise the water height by more than 5 feet, the fill height over the pipe may not exceed 15 feet, and cathodic protection must be provided.

2. Corrugated Aluminum Pipe - The maximum effective fill height, as defined under Scope, shall be 20 feet or less. The pipe may be helical or riveted fabrication. Riveted pipe shall be closed riveted. Riveted pipe 36 inches or larger shall be double riveted. Pipe strength is not to be less than that indicated in table A10-8.

Fittings for aluminum pipe materials other than aluminum or aluminized steel must be separated from the aluminum pipe at all points by 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, other than aluminum alloy bolts, must be galvanized, plastic coated, or otherwise protected to prevent galvanic action.

3. Plastic Pipe - PVC becomes brittle after years of exposure to sun and is susceptible to damage from impact, especially during periods of low temperature. Provisions should be made for protection from impact where necessary. Thicker walled pipe has greater resistance to damage from the ultraviolet rays of the sun. PVC pipe exposed to the sun should be protected by paint or by shielding to screen the ultraviolet rays. Use a good grade of water based paint. Paints with other based material might have an adverse effect on the plastic pipe. Repainting should be required as needed to retain the integrity of this ultraviolet protection.

   Numerous other plastic materials are available but deterioration from sunlight, damage from impact, or susceptibility to fire make these less desirable for applications involving these exposures.

4. Smooth Steel - The maximum fill over the pipe shall not exceed 25 feet. The minimum wall thickness shall be 3/16 inch. The maximum size principal spillway barrel shall be 48 inches. Pipe joints shall be threaded or welded.

5. Vitrified Clay Pipe - The maximum effective fill height as defined under Scope, shall be 20 feet or less. The maximum principal spillway barrel size shall be 36 inches.

6. Concrete and Cast in Place Reinforced Concrete - The principal spillway shall meet the requirements of USDA, SCS Technical Release 60, Earth Dams and Reservoirs.

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

1. The materials and installation for pipe conduits for excavated sediment basins shall meet the local municipality requirements for culverts or storm sewers.
2. Conduits for embankment sediment basins shall meet the following requirements:

   a. The pipe shall be capable of withstanding the external loading without yielding, buckling or cracking.

b. All joints shall be watertight.

Inlet for Pipe Conduit

The inlet shall be structurally sound and made from materials compatible with the pipe. The inlet shall be designed to prevent flotation.

1. Hood Inlet - If the pipe is designed for pressure flow, the stage in the pond below the emergency spillway elevation shall be adequate to prime the pipe. For smooth wall pipe this is 1.4D. For corrugated pipe this is 1.8D. D is the inside diameter of the pipe.

2. Drop Inlet - If the pipe is designed for pressure flow:

   a. The weir length shall be adequate to prime the emergency spillway elevation. See USDA, Soil Conservation Service, Engineering Field Manual for conservation practices page 6-43.
   b. For pipe on less 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 5 D deep, where D is the conduit diameter.

3. Outlet for Pipe Conduit - Conduits larger than 18 inch shall have one of the following types of outlets:

   1. SAF stilling basin
   2. Impact Basin
   3. Cantilever outlet with the stilling basin. The invert of the cantilever outlet shall be above the water surface of the downstream channel when the principal spillway is flowing at the design capacity.

The cantilever outlet will be supported on a bent or pier and will extend a minimum of 8 feet beyond the bent or pier. The bent or pier will extend below the lowest elevation anticipated in the scour hole or to unweathered, sound rock. Guidance on the design of stilling basins is a USDA's SCS Design Note No. 6. Armored Scour Hole for Cantilever Outlet.

4. Conduit Outlet Protection - In accordance with the "Standards for Conduit Outlet Protection•, pg. 12-1.

Antiseep Collars

When antiseep collars are used in lieu of a drainage diaphragm, the following criteria are to be used to determine the size and number of antiseep collars.

Let V = vertical projection and minimum horizontal projection of the antiseep collar feet

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

Let n = number of antiseep collars.

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

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

Emergency Spillways.

Emergency spillways convey large flood flows safely past earth embankments.

An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of closed conduit principal spillway without an emergency spillway:

A conduit with a cross-sectional area of 3 square feet or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table A10-6, less than reduction creditable to conduit discharge and detention storage.

Table A10-6: Minimum Spillway Capacity

Drainage area (acre)	Effective height of dam[1] (feet)	Storage (acre-ft)	Minimum design storm[2] Frequency (year)	Minimum duration (hour)
20 or less	20 or less	Less than 50	10	24
20 or less	More than 20	Less than 50	25	24
More than 20	20 or less	Less than 50	25	24
All others			50	24

1. As defined under "Scope".
2. Select rain distribution based on climatological region

The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall either start with water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days drawdown, whichever is higher. The 10 day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillway shall provide for passing the design flow at safe velocity to a point downstream where the dam will not be endangered.

Constructed emergency spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. For dams having an effective height exceeding 20 feet, the emergency spillway shall have a bottom width of not less than 10 feet.

Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation through the inlet shall be such that full flow will be generated in the conduit before there is discharge through the emergency spillway.

Emergency spillways shall 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 feet per second where only sparse vegetative cover can be expected and maintained, and 6 feet per second where excellent vegetative cover, a vigorous sod, can be expected and maintained.

Cross-section side slopes shall be 2 to 1 or flatter. Component parts of the emergency spillway are as follows;

1. Inlet Channel - The inlet channel shall be level for at least 20 feet upstream of the control section.
2. Exit Channel - The design flow should be contained in the exit channel without the use of dikes. If a dike is necessary it shall have at least 2:1 side slopes, 8 feet top width and be high enough to contain the design flow. The exit channel shall be straight for at least 50 feet downstream of the control section.

The exit channel shall carry the design flow downstream to a point where the flow will not discharge on the toe of the embankment.

<u>Structural Emergency Spillways.</u>

If chutes or drops are used for the principal spillways or principal emergency or emergency spillways, they shall be designed according to the principles set forth in USDA, Soils Conservation Service Engineering Field Manual for Conservation Practices and the National Engineering Handbook - Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table A10.6, less any reduction creditable to conduit discharge and detention storage.

<u>Visual Resource Design.</u>

The visual resource design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that is generally curvillinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

<u>Components for Visual Design Ponds are as follows:</u>

<u>Drains</u> - All ponds which raise the water height more than five feet must be provided with a device to permit draining of the reservoir. All pipe conduits used as drains must meet the same requirements as the pipe conduit for the principal spillway.

<u>Vegetation</u> - The dam, emergency spillway, spoil and borrow areas, and other disturbed areas above normal water level shall be planted in accordance with the standard for critical area (see also SSCC Standard for Temporary (3.1) and Permanent (3.2) Vegetative Cover. A grass strip or other suitable protection shall be provided around the pond to protect against sedimentation and erosion.

<u>Construction Inspection</u> - Embankments which raise the water height (measured at the emergency spillway crest) more than five feet must have constant inspection during construction by a licensed professional engineer. A monthly written

report of construction shall be prepared and submitted to the New Jersey Department of Environmental Protection Dam Safety Section.

Fencing - The embankment, spillway, and pond shall be fenced where necessary to protect the vegetation or for safety.

Dam Inspections - Dams which raise the water height by more than five feet shall have regular inspections performed every two years and a formal inspection performed every six years. An informal inspection shall be performed on the off year from the regular inspections. In the year of the formal inspection, regular and informal inspections need not be performed.

"Formal Inspection" means the inspection by a New Jersey licensed professional engineer to re-evaluate the safety and integrity of the dam and appurtenant structures to determine if the structure meets current design criteria, including a field inspection and a review of the records on project design, construction, and performance.

"Regular Inspection" means the visual inspection of a dam by a New Jersey licensed professional engineer to detect any signs of deterioration in material, developing weaknesses or unsafe hydraulic or structural behavior.

"Informal Inspection" means the visual inspection of the dam by the dam owner or operator to detect apparent signs of deterioration or other deficiencies of the dam structure or function.

Operation and Maintenance - An operation and maintenance manual will be developed for each pond which raises the water height by more than five feet.

The purpose of the manual is to provide guidance and instruction for the proper operation and maintenance of the pond and dam. The manual shall be composed of two parts. Part One must include the introduction, project description, project authorizations, project history, and list of project contracts. Part Two must contain the operation and maintenance instructions for major project facilities and equipment.

Ponds which raise the water height by five feet or less shall have an operation and maintenance schedule included in the design and made part of the farm plan. A yearly inspection shall include but not be limited to the following items plus any item unique to the particular pond:

a. Plugged and deteriorating trash rack, riser, and water control gates.
b. Damage to water pipe, valve, and watering facilities.
c. Damage to pipe outlets and animal guards.
d. Unstable wet areas below earthfills.
e. Damaged or deteriorating fences.
f. Wave damage to shoreline.
g. Muskrat damage to the embankment or shoreline.
h. Keep vegetation healthy and trim on the dam and earth spillway by liming, fertilizing, and mowing periodically. This also helps control undesirable brush and vegetative growth.
i. Do not permit trees to grow on the dam.

Design Criteria for Excavated Ponds

Runoff.

Runoff flow pattern shall be considered when locating the pond and placing the spoil.

Provisions shall be made where needed for a principal spillway, emergency spillway, and embankment in accordance with the embankment criteria (see table A10-6).

Side Slopes.

Side slopes of the excavated ponds shall be stable and shall not be steeper than two horizontal to one vertical above the normal water level and 1 1/2 horizontal to one vertical below the normal water level. If livestock will water directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than 5 horizontal to one vertical. The watering ramp shall have a gravel or paved surface.

Perimeter Form.

If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

Inlet Protection.

If surface water enters the pond in a natural or excavated channel, the side slope of the pond shall be protected against erosion.

Excavated Material.

The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to height that does not exceed 3 feet with the top grade to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment and leveling.
5. Hauled away.

The side slopes, spoiled material, and other disturbed areas above normal water level shall be planted in accordance with the critical area planting standard (see Also Standard for Temporary (pg. 7-1) and Permanent (pg. 5-1) Vegetative Cover).

Plans and Specifications. Plans and specifications for installing ponds shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Table A10-7 Minimum Gage for Corrugated Metal Pipe Risers
2 2/3 - inch x 1/2 inch Corrugations
Steel - Minimum Gage

Fill Height Above Pipe (feet)	Risers Only		
	54	60	66
1 - 15			
15 - 20	10	8	8
20 - 25	8	8	8

Table A10-8 Aluminum Minimum Gage (inches)

	Risers Only		
	42	48	54
	12(.105)	10(.135)	10(.135)
Risers Only	12(.105)	10(.135)	10(.135)
10(.135)	10(.135)	10(.135)	10(.135)

Construction Specifications For Embankment Ponds

<u>Foundation Preparation</u>

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod and rubbish. If needed to establish vegetation, the topsoil and sod shall be stockpiled and spread on the completed dam and spillways. Foundation surfaces shall be sloped no steeper than a ratio of one horizontal to one vertical. The foundation area shall be thoroughly scarified before placement of the fill material. The surface shall have moisture added, or it shall be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundation.

The cutoff trench and any other required excavation shall be dug to the lines and grades shown on the plans or as staked in the field. If they are suitable, excavated materials may be used in the permanent fill. Existing stream channels in the foundation area shall be sloped no steeper than a ratio of one horizontal to one vertical. They shall be deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

Foundation areas shall be kept free of standing water when fill is placed on them.

Fill Placement

The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones more than 6 inches in diameter (except rock fills) and other objectionable material.

Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench or by keeping the drain at least one foot above the adjacent earthfill.

Selected drainfill and backfill material shall be placed around structures, pipe conduits, and antiseep collars at about the same rate on all sides to prevent damage from unequal loading.

Fill material shall be placed and spread beginning at the lowest point in the foundation and then bringing it up in horizontal layers thick enough that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers. If openings or sectionalized fills are required, the slope of the bonding surfaces between the embankment in place and the embankment to be placed shall not be steeper than the ratio of three horizontal to one vertical. The bonding surface shall be treated the same as that specified for the foundation to insure a good bond with the new fill.

The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material shall differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Moisture Control

The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall be wetted and mixed until the requirement is met.

Compaction

Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction.

If a minimum required density is specified, each layer of fill shall be compacted as necessary to obtain that density.

Fill adjacent to structures, pipe conduits, and drainfill or antiseep collars shall be compacted to a density equivalent of that of the surrounding fill by hand tamping or by using manually directed power tampers or plate vibrators. Fill adjacent to concrete structures shall not be compacted until the concrete has had time to gain enough strength to support the load.

Protection

A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway, and borrow area if soil and climatic conditions permit. If soil and climatic conditions preclude the use of vegetation and protection is needed, non-vegetated cover such as mulches or gravel may be used. In some places, temporary vegetation may be used until permanent vegetation can be established. The embankment and spillway shall be fenced if necessary to protect the vegetation.

Preparing the seedbed, seeding, fertilizing, and mulching shall comply with instructions in technical guidelines.

Principal Spillway

Corrugated metal pipe shall conform to the requirements of Federal Specifications WW-P-402 or WW-P-405, as appropriate. Other pipe materials shall conform to the appropriate specifications. Antiseep collars shall be made of materials compatible with that of the pipe and shall be installed so that they are watertight. The pipe shall be installed according to the manufacturer's instructions. It may be firmly and uniformly bedded throughout its length and shall be installed to the line and grade shown on the drawings.

Concrete

The mix design and testing of concrete shall be consistent with the size requirements of the job. Mix requirements or necessary strength shall be specified. The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing shall be specified. Reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement. Subgrades and forms shall be installed to line and grade, and the forms shall be mortar tight and unyielding as the concrete is placed.

Foundation and Embankment Drains

Foundation and embankment drains, if required, shall be placed to the line and grade shown on the drawings. Detailed requirements for drain material and any required pipe shall be shown in the drawing and specifications for the job.

Excavated Ponds

The compacted excavation shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Embankment and Excavated Ponds

Construction operations shall be carried out so that erosion and air and water pollution are minimized and held within legal limits. All work shall be conducted in a skillful manner. The completed job shall present a workman like appearance.

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Fencing and cover to control erosion shall be established as needed. Appropriate safety measures, such as warning signs, rescue facilities, and fencing shall be provided as needed.

APPENDIX A11

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The following references are cited in the Appendices:

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LAND USE LAND COVER CLASSIFICATION SYSTEM

(Derived from: A Land Use and Land Cover Classification
System for Use with Remote Sensor Data, U. S. Geological
Survey Professional Paper 964, 1976; edited by NJDEP,
OIRM, BGIA, 1998, 2000, 20001. Note: Classes used in NJDEP mapping programs shown in **bold**.

1000 URBAN OR BUILT-UP LAND

1100 RESIDENTIAL

1110 Residential (High Density or Multiple dwelling)

1111 Single Unit, High Density

1112 Multiple Dwelling, Low Rise (3 stories or less)

1113 Multiple Dwelling, High Rise (4 stories or more)

1120 Residential (Single Unit, Medium Density)

1130 Residential (Single Unit Low Density)

1140 Residential (Rural, Single Unit)

1150 Mixed Residential

1200 COMMERCIAL & SERVICES

1201 Central Business District (CBD)

1202 Commercial Strip Development

1203 Isolated Commercial Establishments for Goods and/or Services

1204 Isolated Commercial Office Buildings

1205 Shopping Centers

1206 Resorts, Hotels, Motels & Related facilities

1207 Educational Institutions

1208 Health Institutions

1209 Correctional Institutions

1210 Government Centers

1211 Military Installations

1212 Other Institutional

1213 Mixed Commercial & Services

1214 Former Military; Indeterminate Use

1300 INDUSTRIAL

1310 Light Industrial

1320 Heavy Industrial

1330 Power Generation

1400 TRANSPORTATION, COMMUNICATION & UTILITIES

1410 Limited Access Highways

1420 Railroad Facilities

1430 Bus and Truck Terminals

1440 Airports

1450 Port Facilities

1460 Power Facilities

1461 Wetland Rights-of-Way

1470 Water Treatment Facilities

1480 Sewage Treatment Facilities

1490 Other Transportation, Communication and Utilities

1500 INDUSTRIAL & COMMERCIAL COMPLEXES

1510 Industrial and Commercial Parks

1600 MIXED URBAN OR BUILT-UP

1610 Predominantly Residential - (>50%, but <66% of the use can be identified as Residential).

1620 Predominantly Commercial/Service - (>50%, but <66% of the use can be identified as Commercial/Service).

1630 Predominantly Industrial - (>50%, but <66% of the use can be identified as Industrial).

1640 Predominantly Transportation/Communication/Utilities - (>50%, but <66% of the use can be identified as Transportation/Communication/Utilities).

1650 Heterogeneous Mixture - (No single use in the intermixture comprises more than 50%).

1700 OTHER URBAN OR BUILT-UP

1710 Cemeteries

1720 Undeveloped Land Within Urban Areas

1730 Inactive Land With Street Patterns

1740 Open Areas

1750 Managed Wetland in Maintained Lawn Greenspace

1800 RECREATIONAL LAND

1801 Golf Courses

1802 Picnic and Camping Parks

1803 Marina and Boat Launches

1804 Community Recreation Areas

1805 Parks

1806 Swimming Pools

1807 Swimming Beaches

1808 Formal Lawns, Arboretums and Landscaped Areas

1809 Open Areas in Parks

1810 Stadium, Theaters, Cultural Centers, and Zoos

1811 Other Recreational

1850 Managed Wetland in Built-up Maintained Rec Area

2000 AGRICULTURAL LAND

2100 CROPLAND AND PASTURELAND

2110 Harvested Cropland

2120 Pastureland

2130 Inactive Cropland

2140 Agricultural Wetlands

2150 Former Agricultural Wetlands- Becoming Shrubby, not Built-up

2200 ORCHARDS, VINEYARDS, NURSERIES AND HORTICULTURAL AREAS

2210 Orchards

2220 Vineyards

2230 Nurseries

2240 Floriculture

2250 Sod and Seed Farms

2260 Cranberry Farms

2270 Inactive

2280 Blueberry Farms

2300 CONFINED FEEDING OPERATIONS

2310 Cattle and Swine Feedlots

2320 Poultry Farms

2330 Specialty Farms

2400 OTHER AGRICULTURE

2410 Experimental Agriculture Fields

2420 Isolated Structures for Crop or Equipment Storage

2430 Horse Farm

2440 Agricultural Dikes/Roadways

3000 RANGELAND

4000 FORESTLAND

4100 DECIDUOUS

4110 Deciduous, 10-50% Crown Closure

4120 Deciduous > 50% Crown Closure

4200 CONIFEROUS

4210 Coniferous, 10-50% Crown Closure

4220 Coniferous, > 50% Crown Closure

4230 Plantation

4300 MIXED DECIDUOUS/CONIFEROUS

4310 Mixed with Coniferous Prevalent (> 50% Coniferous)

4311 Mixed with Coniferous Prevalent (10%-50% Crown Closure)

4312 Mixed with Coniferous Prevalent (> 50% Crown Closure)

4320 Mixed with Deciduous Prevalent (> 50% Deciduous)

4321 Mixed with Deciduous Prevalent (10%-50% Crown Closure)

4322 Mixed with Deciduous Prevalent (> 50% Crown Closure)

4400 BRUSHLAND/SHRUBLAND (Height<20 feet)

4410 Old Field (<25% Brush Covered)

4420 Deciduous Brush/Shrubland (>25% Brush Covered with Deciduous Species Predominant > 75%)

4430 Coniferous Brush/Shrubland (>25% Brush Covered with Coniferous Species Predominant > 75%).

4440 Mixed Deciduous/Coniferous Brush/Shrubland (>25% Brush Covered with a Mixture of Deciduous Coniferous Species; <75% of One Type)

4500 SEVERE BURNED UPLAND VEGETATION

5000 WATER

5100 STREAMS & CANALS

5110 Streams

5120 Canals

5200 NATURAL LAKES

5210 Small Lakes

5220 Medium Lakes

5230 Large Lakes

5300 ARTIFICIAL LAKES & RESERVOIRS

5310 Artificial Lakes

5320 Multiple Use Reservoirs

5330 Restrictive Use Reservoirs

5400 BAYS, ESTUARIES & OTHER TIDAL WATERS

5410 Tidal Rivers, Inland Bays and Other Tidal waters

5411 Open Tidal Bays

5420 Dredged Lagoon, Artificial

5430 Atlantic Ocean

6000 WETLANDS

6100 COASTAL WETLANDS

6110 Saline Marshes

6120 Freshwater Tidal Marshes

6130 Vegetated Dune Communities

6200 INTERIOR WETLANDS

6210 Deciduous Wooded Wetlands

6220 Coniferous Wooded Wetlands

6221 Atlantic White Cedar Wetlands

6230 Brush-Dominate and Bog Wetlands

6231 Decidous Brush and Bog Wetlands

6232 Coniferous Brush and Bog Wetlands

6233 Mixed Brush and Bog Wetlands with Deciduous Dominant

6234 Mixed Brush and Bog Wetlands with Coniferous Dominant

6240 Non-Tidal Marshes

6250 Mixed Wooded Wetlands

6251 Mixed Wooded Wetland with Deciduous Prevalent

6252 Mixed Wooded Wetlands with Coniferous Prevalent

6500 SEVERE BURNED WETLANDS

7000 BARREN LAND

7100 BEACHES

7110 Open Beach

7120 Unvegetated Dune Communities

7130 Other Sandy Areas

7200 BARE EXPOSED ROCK, ROCK SLIDES, ETC.

7210 Rock Faces, Rock Slides, Cliffs

7220 Exposed Rock

7300 EXTRACTIVE MINING

7310 Stone Quarries

7320 Sand and Gravel Pits (Borrow Pits)

7330 Other Mining

7340 Abandoned Mining Sites

7400 ALTERED LANDS

7410 Solid Waste Disposal Areas

7420 Dredge Material Disposal Sites

7430 Disturbed Wetlands

7500 TRANSITIONAL AREAS

7510 Single Unit Residential Under Construction

7520 Multiple Unit Residential Under Construction

7530 Commercial/Service Under Construction

7540 Industrial Under Construction

7550 Transportation/Communication/Utilities Under Construction

7560 Industrial/Commercial Parks Under Construction

7570 Unknown Use Under Construction

7580 Abandoned Structures (Non-Urban)

7600 UNDIFFERENTIATED BARREN LAND

8000 MANAGED WETLANDS

1/22/01 2:21 PM

APPENDIX B

EXAMPLES OF SEED SPECIFICATIONS

A. The seed mixtures and specifications shall meet the following minimum requirements.

1. Furnish the kinds and amounts of seed as indicated below to be seeded in all areas designated by the engineer, landscape architect in the certified soil erosion and sediment control plan.

   (List mixtures and amounts of each species here)

2. The minimum requirements for grass and legume seed used for temporary and permanent vegetative stabilization work are as follows:

   a. All seed shall be labeled to show that it meets the requirements of the New Jersey State Seed Law N.J.S.A. 4:17-13 et. seq. and rules promulgated thereto.

   b. Accumulated bag tags of seed used shall be submitted with the final pay estimate and may be requested by the Soil Conservation District for a report of compliance.

   c. All seed shall have been tested within the 9 months immediately preceeding the date of seeding such material on this job.

   d. Inoculant - The innoculant for treating legume seed in the seed mixtures shall be a pure culture of nitrogen-fixing bacteria prepared for the species seeded. Inoculant 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 amount of all warm season grass to be planted for temporary and permanent stabilization shall be adjusted to reflect the amount of pure live seed (PLS) by reducing the weight of inert matter, non viable and undesirable seed as expressed on the seed tag. The adjustment is made by multiplying the weight of the seed bag x % seed purity x % germination = amount of PLS. No adjustment is required for cool season grasses.

      Example: A 50 lb bag of seed with 95% purity and 60% germination = 28.5 lbs. of PLS.

   f. (The Quality of Seed table on the following page may be used to specify the minimum seed purity and germination of seed to be used on the project.)

B. Grass seed mixtures can be tested by the State Seed Analyst, New Jersey Department of Agriculture, Trenton, New Jersey, to verify to the purchaser that the mixture or % germination conforms with the label pursuant to the rules of the State Seed Law, NJAC 2:21-1 et. seq.

TABLE B -1

QUALITY OF SEED*

Cultivors	Minimum** Seed Purity (%)	Minimum Germination (%)
PERENNIAL LEGUME		
Clover, White	98	90
Crownvetch	95	75
Lespedeza, Sericea	98	85
PERENNIAL GRASSES		
Bentgrass, Creeping	98	85
Bermudagrass	98	85
Bluegrass, Kentucky	98	85
Fescue, Hard	98	85
Fescue, red (chewing and (creeping)	98	85
Fescue Sheep	90	95
Fescue, tall (KY-31)	98	85
Redtop	92	85
Reed Canarygrass	96	80
Ryegrass, Perennial	98	90
Weeping lovegrass	95	87
Zoysiagrass	90	80
Barley	98	90
Millet	99	80
Oats	98	80
Rye	98	85

*Seed containing prohibited or restricted noxious weed seeds as listed in the rules for the State Seed Law, NJAC. 2:21-4.1 et. seq., will not be accepted.
Prohibited noxious weed - Bindweed, Canada thistle, quackgrass, hedge bindweed, and horse nettle.

Restricted noxious weed seed - Wild garlic, bermudagrass, cheat, wild onion, corn cockle, dodder and wild onion, Johnsongrass, perennial sweet sudangrass, sorghum almum and other perennial sorghum hybrids, grant required, but cucumber.

**Seed shall not contain in excess of 1.0 percent weed seed.

Table B-2 Grass, Legume and Shrub Planting Guide

COMMON NAME	SCIENTIFIC NAME	GROWTH HABIT 1/.	GROWTH SEASON 2/.	SOIL DRAINAGE TOLERANCE 3/.	pH RANGE	FLOOD TOLERANCE	SHADE TOLERANCE	SALT TOLERANCE	FOOT TRAFFIC	MAINTENANCE LEVELS 4/.
GRASSES										
Barley	*Hordeum vulgare*	Annual	cool	WD-MWD	5.5-7.8	No	No	Low	No	Moderate
Beachgrass, american	*Ammophila breveliqulata*	PsR	cool	WD	5.5-7.5	Yes	No	High	No	Low
Bentgrass, creeping	*Agrostis stolonifera*	PsR	cool	MWD-PD	5.5-7.0	Yes	No	Low	No	High
Bermudagrass	*Cynodon dactylon*	PlS	warm	EXDR-SWPD	4.5-7.5	Yes	No	High	Yes	Moderate
Bluegrass, Canada	*Poa compressa*	PlR	cool	EXDR-SWPD	4.5-9.5	No	Yes	Low	Yes	Moderate-low
Bluegrass, Kentucky	*Poa pratensis*	PlR	cool	WD-SWPD	5.5-7.0	Yes	No	Mod.	Yes	High-low
Bluegrass, Rough	*Poa trivialis*	PsS	cool	MWD-SWPD	5.5-7.0	Yes	Yes	Low	Yes	Moderate-low
Bluestem, big	*Andropogon gerardii*	PIB	warm	EXDR-MWD	5.0-7.5	No	No	Low	No	Low
Bluestem, little	*Schizachyrium scoparium*	PlB	warm	EXDR-MWD	5.5-7.5	No	No	Low	No	Low
Canarygrass, reed	*Phalaris arundinacea*	PlR	cool	WD-PD	5.0-7.5	Yes	No	Low	No	Moderate-low
Coastal panicgrass	*Panicum amarulum*	PlB	warm	EXDR-PD	4.5-7.5	Yes	No	Mod.	No	Low
Cordgrass, saltmeadow	*Spartina patens*	PlR	warm	WD-PD	5.0-7.5	Yes	No	High	No	Low
Cordgrass, smooth	*Spartina alternifolia*	PlR	warm	PD	5.0-7.5	Yes	No	High	No	Low
Deertongue	*Dichanthelium clandestinum*	PlR	warm	EXDR-SWPD	3.8-5.0	Yes	No	Low	No	Low
Fescue, creeping red	*Festuca rubra*	PlR	cool	WD-SWPD	4.5-9.5	Yes	Yes	Low	Yes	Moderate-low
Fescue, hard	*Festuca longifolia*	PlB	cool	EXDR-WD	4.5-7.5	No	Yes	Low	Yes	Low
Fescue, tall	*Festuca arundinacea*	PlB	cool	WD-SWPD	5.0-8.0	Yes	Yes	Mod.	Yes	Moderate-low
Indiangrass	*Sorghastrum nutans*	PlB	warm	EXDR-WD	5.0-8.0	No	No	Low	No	Low
Lovegrass, sand	*Eragrostis trichodes*	PlB	warm	EXDR-WD	4.5-8.0	No	No	Low	No	Low

COMMON NAME	SCIENTIFIC NAME	GROWTH HABIT 1/.	GROWTH SEASON 2/.	SOIL DRAINAGE TOLERANCE 3/.	pH RANGE	FLOOD TOLERANCE	SHADE TOLERANCE	SALT TOLERANCE	FOOT TRAFFIC	MAINTENANCE LEVELS 4/.
Lovegrass, weeping	*Eragrostis curvula*	PsB	warm	EXDR-WD	4.5-8.0	No	No	Low	No	Low
Millet, pearl	*Pennisetum americanum*	Annual	warm	WD-SWPD	4.5-7.5	No	No	Low	No	Low
Millet, German (foxtail)	*Setaria italica*	Annual	warm	WD-SWPD	4.5-7.5	No	No	Low	No	Low
Oats	*Avena sativa*	Annual	cool	WD-SWPD	4.5-7.0	No	No	Low	No	Low
Redtop	*Agrostis gigantea*	PsR	cool	WD-PD	4.5-7.5	Yes	No	Low	Yes	Low
Rye, cereal	*Secale cereale*	Annual	cool	WD-MWD	4.5-7.0	No	No	Low	No	Low
Ryegrass, perennial	*Lolium perenne*	PsB	cool	WD-SWPD	5.5-7.5	No	No	Mod	No	High-Moderate
Saltgrass, alkali	*Puccinella distans*	PsB	cool	WD-SWPD	5.5-8.0	No	No	High	No	Moderate-Low
Switchgrass	*Panicum virgatuin*	PlB	warm	EXDR-PD	4.5-7.5	Yes	No	High	No	Low
Wildrye	*Elymus virginicus*	PlB	cool	MWD-PD	5.0-7.0	Yes	Yes	Mod	No	Low
Zoysiagrass	*Zoysia japonica*	PlS	warm	WD-MWD	5.0-7.0	No	No	High	Yes	Low
LEGUMES										
Birdsfoot trefoil	*Lotus corniculatus*	PlR	cool	EXDR-SWPD	5.0-7.5	Yes	No	Low	No	Low
Clover, white	*Trifolium repens*	PlR	cool	WD-SWPD	5.5-7.5	No	No	Low	Yes	Low
Crownvetch	*Coronilla varia*	PlR	cool	WD-MWD	5.5-7.5	No	No	Low	No	Low
Flatpea	*Lathyrus sylvestris*	PlR	cool	EXDR-MWD	4.0-7.0	No	No	Mod.	No	Low
Lespedeza, serecia	*Lespedeza cuneata*	PlB	warm	EXDR-MWD	5.5-7.0	No	No	Low	No	Low
Partridge pea	*Cassia fasciculata*	Annual	warm	EXDR-MWD	5.0-7.0	No	No	Mod.	No	Low
SHRUBS										
Dogwood, redosier	*Cornus serecia*	PlR	N/A	MWD-PD	4.5-7.0	Yes	Yes	Low	N/A	Low
Dogwood, silky	*Cornus amomum*	PlR	N/A	WD-PD	4.0-7.0	Yes	Yes	Low	N/A	Low
Willow, purpleosier	*Salix purpurea*	PlR	N/A	WD-PD	4.5-7.5	Yes	No	Low	N/A	Low

COMMON NAME	SCIENTIFIC NAME	GROWTH HABIT 1/.	GROWTH SEASON 2/.	SOIL DRAINAGE TOLERANCE 3/.	pH RANGE	FLOOD TOLERANCE	SHADE TOLERANCE	SALT TOLERANCE	FOOT TRAFFIC	MAINTENANCE LEVELS 4/.
Willow, dwarf	*Salix cottetii*	PlR	N/A	WD-PD	4.5-7.0	Yes	No	Low	N/A	Low

FOOTNOTES

1/. Growth Habit:

P-perennial
l-long-lived
s-short-lived
R-rhizomatous
S-stoloniferous
B- bunch

2/. Growth Season:

Cool - major portion of growth during early spring and early fall

Warm - major portion of growth during summer months

3/. Soil Drainage Tolerance:

EXDR - excessively drained

WD - well-drained

MWD - moderately well-drained

SWPD - somewhat poorly drained

PD - poorly drained

4/.Maintenance Levels:

Low - requiring infrequent mowing and little or no fertilizer or lime for long-term persistence

Moderate - requiring some mowing and medium amounts of fertilizer and lime for long-term persistence

High - requires frequent mowing and high levels of fertilizer and lime for long-term persistence

CHAPTER 24 OF TITLE 4, REVISED STATUTES OF NEW JERSEY

SOIL CONSERVATION

ARTICLE 1. DECLARATION OF POLICY

4:24-1. Legislative policy declared

It is hereby declared to be the policy of the legislature to provide for the conservation of the soil and soil resources of this state, and for the control and prevention of soil erosion.

4:24-1.1 Prevention of damage by flood water or sediment; conservation of water for agricultural purposes

The purposes of soil conservation and the control and prevention of soil erosion to be furthered by the State Soil Conservation Committee and of the soil conservation districts shall include, wherever applicable, the prevention of damage to soil and soil resources by floodwater or by sediment and the furtherance of conservation of water for agricultural purposes.

L 1959,c. 129, §3, p. 570. eff. July 1, 1959

ARTICLE 2. DEFINITIONS

4:24-2. Words and phrases defined

Wherever used or referred to in this chapter, unless a different meaning clearly appears from the context:

a. "District" or "soil conservation district" means a governmental subdivision of this state, and a public body corporate and politic, organized in accordance with the provisions of this chapter, for the purposes, with the powers, and subject to the restrictions hereinafter set forth;

b. “Supervisor” means one of the members of the governing body of a district, appointed in accordance with the provisions of this chapter;

c. “Committee” or “state soil conservation committee” means the agency created in article three of this chapter;

d. “Petition” means a petition filed under the provisions of article 4 of this chapter (§4:24-7 et seq.) for the creation of a district;

e. “State” means the state of New Jersey;

f. “Agency of this state” includes the government of this state and any subdivision, agency, or instrumentality, corporate or otherwise, of the government of this state;

g. “United States” or “agencies of the United States” includes the United States of America, the soil conservation service of the United States department of agriculture, and any other agency or instrumentality, corporate or otherwise, of the United States of America;

h. “Government” or “governmental” includes the government of this state, the government of the United States, and any subdivision, agency or instrumentality, corporate or otherwise, of either of them;

i. “Landowner” includes any person, firm or corporation who shall hold title to any lands lying within a district organized under the provisions of this chapter;

j. “Due notice” means notice published at least twice, with an interval of at least seven days between the two publication dates, in a newspaper or other publication of general circulation within the appropriate area, or if no such publication of general circulation be available, by posting at a reasonable number of conspicuous places, within the appropriate area, such posting to include, where possible, posting at public places where it may be customary to post notices concerning county or municipal affairs generally. At any hearing held pursuant to such notice, at the time and place designated in such notice, adjournment may be made from time to time, without the necessity of renewing such notice for such adjourned dates.

L 1959, c. 139, §201, p. 319.

ARTICLE 3. STATE SOIL CONSERVATION COMMITTEE

4:24-2.1 Transfer of functions, powers and duties to Department of Agriculture

The State Soil Conservation Committee and all of its functions, powers and duties are hereby transferred to the Department of Agriculture.

L 1959, c. 129, p.570, eff July 1, 1959.

4:24-3 Committee established; membership, records; seals; hearings; rules and regulations

There is hereby established, to serve as an agency of the State and to perform the functions conferred upon it in this chapter, the State Soil Conservation Committee. The committee shall consist of 11 members: The Director of the New Jersey Agricultural Experiment Station, the associate director of the Cooperative Extension Service in Agriculture and Home Economics, the State Secretary of Agriculture, the commissioner of the Department of Conservation and Economic Development or a representative designated by any 1 of these individuals, and 1 member appointed by the Governor to serve at his pleasure. Six members shall be soil conservation district supervisors, who shall be elected at the annual meetings of soil conservation district supervisors, for terms of 3 years and until their successors are appointed and qualified. Three supervisors shall be elected from the northern region which is composed of the counties of Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Morris, Passaic, Somerset, Sussex, Union and Warren and 3 supervisors shall be elected from the southern region which is composed of the counties of Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Mercer, Ocean and Salem. Of the first 3 members from each region 1 shall be elected for 1 year, 1 for 2 years, and 1 for 3 years. The committee shall invite the secretary of agriculture of the United States of America to appoint 1 person, a resident of the State of New Jersey, to serve with the above-mentioned members. The committee shall keep a record of its official actions, shall adopt a seal, which seal shall be judicially noted, and may perform such acts, hold such public hearings, and promulgate such rules and regulations as may be necessary for the execution of its functions under this chapter.

L 1937, c. 139, §301, p. 321, amended by L 1959, c. 130. §1., p. 571.

4:24-3.1 Election of Members

The first election for members of the State Soil Conservation Committee, established under this act, shall be held by the State Soil Conservation Committee in office on the effective date of this act. This election shall be held within 10 days after the effective date of this act.

L 1959, c. 130, §3, p.572, eff. June 18, 1959.

4:24-4 Administrative officer and employees; legal services; cooperative agreements

The State Soil Conservation Committee my employ, subject to the rules of the State Civil Service Commission, a qualified administrative officer and such technical experts and such other agents and employees, permanent and temporary, as it may require, and shall determine their qualifications, duties and compensation of all employees. The committee shall call upon the Attorney General for such legal services as it may require for the purpose of carrying out any of its functions. The committee may enter into a cooperative agreement with any other State agency. The members of the committee who are soil conservation district supervisors shall not vote on or participate in the employment or selection of any officers, agents or employees, and for such purpose the membership of the committee shall be deemed to be 5.

L 1937, c. 139, §302, p. 321, amended by L 1959, c. 130, §2, p. 572, eff June 18, 1959.

4:24-5 Organization; term of members; quorum; expenses; surety bonds for employees; records; audit

The committee shall designate its chairman, and may, from time to time, change such designation. A member of the committee shall hold office so long as he shall retain the office by virtue of which he shall be serving on the committee. A majority of the committee shall constitute a quorum, and the concurrence of a majority in any matter within their duties shall be required for its determination. The chairman and members of the committee shall receive no compensation for their services on the committee, but shall be entitled to expenses, necessarily incurred in the discharge of their duties on the committee. The committee shall provide for the execution of surety bonds for all employees and officers who shall be instructed with funds or property; shall provide for the keeping of a full and accurate record of all proceedings and of all resolutions, regulations, and orders issued or adopted; and shall provide for an annual audit of the accounts of receipts and disbursements.

L 1937, c. 139, §303, p. 321.

4:24-6. Powers and duties of committee

In addition to the duties and powers hereinafter conferred upon the state soil conservation committee it shall have the following duties and powers:

a. To accept from the United States or any of its agencies, contributions in services, materials, money or otherwise, and to use or expend such contribution in the formulation of comprehensive plans for the conservation of soil resources and the prevention of soil erosion within the state and to conduct surveys, investigations, demonstrations, and research relating to soil erosion and the preventive measures needed in areas subject to erosion by wind and water, to publish results of any such surveys, investigations or research and to disseminate information. In order to avoid duplication of research, demonstration, and the dissemination of information, no program of such activities shall be carried on except in cooperation with the state agricultural college and the state agricultural experiment stations, or such other state agency as may be dealing with allied problems;

b. To offer such assistance to the supervisors of soil conservation districts, organized as provided hereinafter as may be appropriate in the carrying out of any of their powers and programs;

c. To coordinate the programs of the several soil conservation districts organized hereunder;

d. To secure the cooperation and assistance of the United States and any of its agencies; and of agencies of this state, in the work of such districts;

e. To disseminate information throughout the state concerning the activities and programs of the soil conservation districts organized hereunder, and to encourage the formation of such districts in areas where their organization is desirable.

L 1937, c. 139, §4, p. 33.

4:24-6.1 Review and approval, modification, or rejection of decision

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.

L 1979, c. 459, § eff. February 27, 1980.

ARTICLE 4. CREATION OF SOIL CONSERVATION DISTRICTS

4:24-7 through 4:24-17 Repealed by L 1977, c. 264, §4.

ARTICLE 4A. SOIL CONSERVATION DISTRICTS: DIVISION INTO SEPARATE DISTRICTS AND CONSOLIDATION OF DISTRICTS

4:24-17.1 Public hearings

Whenever the supervisors of a soil conservation district which has been created for more than one year determine it advisable to divide the district into two or more separate districts, or whenever the supervisors of two or more contiguous districts determine it advisable to combine such districts, the supervisors or the district or districts shall call a public hearing on such proposal.

L 1966, c. 77 §1, eff. June 14, 1966.

4:24-17.2 Resolution requesting approval; procedure upon approval

Following such public hearing the supervisors of the district or districts may adopt a resolution requesting such approval by the State Soil Conservation Committee of a division of the district or the combination of separate districts into a single district, the proposed boundaries of the proposed district or districts being annexed to said resolutions. If the State Soil Conservation Committee approves the proposal and so notifies the supervisors, the supervisors shall file with the Secretary of State a statement or statements setting forth the revised name of names and boundaries of the district or districts so approved and the date upon which such changes are to become effective.

L 1966, c. 77 §2, eff. June 14, 1966.

4:24-17.3 New supervisors; appointment; time of taking office

Upon the effective date of a division of a district or the combination of two or more districts, the terms of office of the supervisors theretofore in office shall terminate and new supervisors, appointed by the State Soil Conservation Committee in accordance with Revised Statutes 4:24-12, shall take office as the governing body of the district or districts so created.

L 1966, c. 77 §3, eff. June 14, 1966.

4:24-17.4 Continuance of contracts, liabilities, regulations and other matters; assumption by new district

The State Soil Conservation Committee shall make such provisions as are necessary for the continuance in effect of all contracts, liabilities, regulations and other matters of the district or districts to be divided or combined and shall designate the manner in which these contracts, liabilities, regulations and other matters are to be assumed by the districts simultaneously with its granting of approval for divisions or combining of a district.

L 1966, c. 77 §4, eff. June 14, 1966.

4:24-17.5 County and multi-county soil conservation districts; creation

The whole area of the State shall, at all times, be covered by a soil conservation district. Each soil conservation district shall cover the whole area of one or more counties. A tri-county soil conservation district shall serve the counties of Hudson, Essex and Passaic to be known as the Hudson, Essex and Passaic Soil Conservation District. Bi-county soil conservation districts shall serve the following pairs of counties: Middlesex-Monmouth, Somerset-Union, and Cape May- Atlantic, to be known as the Freehold, Somerset-Union, and Cape-Atlantic Soil Conservation Districts respectively. Every other county in the State shall be served by its own soil conservation district to be known as "the .... County Soil Conservation District: with the name of each such county inserted. The State Soil Conservation Committee shall work with the supervisors of the multi-county soil conservation districts to encourage the formation of a soil conservation district in each county of the State, pursuant to the procedures contained in P.L. 1966, c. 77 (C. 4:24-17.1 et seq.).

L 1979, c. 264, §3, eff. October 18, 1977.

4:24-17.6 Appropriation of funds by counties

Any board of chosen freeholders may appropriate such funds as it deems necessary to the soil conservation district serving that county for the purpose of providing district services to the people of that county.

L 1979, C. 459, §5, eff. February 27, 1980.

4:24-17.7 Legal services to district by Attorney General

The Attorney General, on his own initiative, or the respective county counsel, with the approval of the board of chosen freeholders, may provide any and all legal services to any district.

L 1979, c. 459, §5, eff. February 27, 1980.

ARTICLE 5. APPOINTMENT, QUALIFICATIONS AND TENURE OF SUPERVISORS

4:24-18. Governing body of district; supervisors; appointment

The governing body of the district shall consist of five supervisors, appointed by the State Soil Conservation Committee. The five supervisors shall be legal residents of the district.

L 1937, c. 139, §501, p. 330, amended by L 1966, c. 77, eff. June 14, 1966, amended by L 1977, c. 264, §1, eff. October 18, 1977.

4:24-19. Supervisors; chairman; term of office; quorum; per diem

The supervisors shall designate a chairman and may, from time to time, change such designation. The term of office of each supervisor shall be at the pleasure of the State committee. The selection of successors shall be made in the same manner in which the retiring supervisor shall have been selected. A majority of the supervisors shall constitute a quorum and the concurrence of a majority in any matter within their duties shall be required for its determination. A supervisor shall be entitled to expenses, and a per diem in an amount to be established by the State committee within the limits of available appropriations, when engaged in the performance of his duties.

L 1937, c. 139, §502, p. 330, amended by L 1979, c. 459, §6, eff. Feb. 27, 1980.

4:24-20. Officers and employees; information to state committee

The supervisors may employ, subject to the approval of the state committee, technical experts, and such other officers, agents, and employees, permanent and temporary, as they may require, and shall determine their qualifications, duties, and compensation. The supervisors may delegate to their chairman, to one or more supervisors, or to one or more agents, or employees, such powers and duties as they may deem proper. The supervisors shall furnish to the State Soil Conservation Committee, upon request, copies of such ordinances, rules, regulations, orders, contracts, forms, and other documents as they shall adopt or employ, and such other information concerning their activities as it may require in the performance of its duties under this chapter.

L 1937, c. 139, §503, p. 330.

4:24-21. Surety bonds for officers and employees; records; annual audit

The supervisors may provide for the execution of surety bonds for any employees and officers who shall be entrusted with funds or property; shall provide for the keeping of a full and accurate record of all proceedings and of all resolutions, regulations, and orders issued or adopted' and shall provide for an annual audit of the accounts of receipts and disbursements.

L 1937, c. 139, §504, p. 330.

ARTICLE 6. POWERS OF DISTRICTS AND SUPERVISORS

4:24-22. District a governmental subdivision and body corporate; enumeration of powers of districts and supervisors

A soil conservation district organized under the provisions of this chapter shall constitute a governmental subdivision of this State, and a public body corporate and politic, exercising public powers, and such district, and the supervisors thereof, shall have the following powers, in addition to others granted in other sections of this chapter:

a. To conduct surveys, investigations, and research relating to the character of soil erosion and the preventive and control measures needed, to publish the results of such surveys, investigations, or research, and to disseminate information concerning such preventive and control measures; provided, however, that in order to avoid duplication of research program except in cooperation with the agricultural experiment stations or any other agency of this State, as may be dealing will allied problems;

b. To conduct in cooperation with existing State agencies, projects within the district on lands owned or controlled by this State or any of its agencies, with the cooperation of the agency administering and having jurisdiction thereof, and on any other lands within the district upon obtaining the consent of the owner thereof, or those who have rights or interests in such lands, in order to demonstrate methods of soil erosion control;

c. To carry out preventive and control measures within the district including but not limited to, engineering operations, methods of cultivation, the growing of vegetation, changes in use of land, on lands owned or controlled by this State or any of its agencies, with the cooperation of the agency administering and having jurisdiction thereof, and on any other lands within the district;

d. To cooperate, or enter into agreements with, and within the limits of appropriations duly made available to it by law, to furnish financial or other aid to, any agency, governmental or otherwise, or any owner of lands within the district, in the carrying on of erosion control and prevention operations within the district, subject to such conditions as the supervisors my deem necessary to advance the purposes of this chapter;

e. To acquire machinery and other necessary personal property, to make provision for it safekeeping and to dispose of said property when no longer needed;

f. To make available, on such terms as it shall prescribe, to landowners within the district, agricultural and engineering machinery and equipment, as will assist such landowners to carry on operations upon their lands for the conservation of soil resources and for the prevention and control of soil erosion;

g. To construct, improve, and maintain such structures as may be necessary or convenient for the performance of any of the operations authorized in this chapter;

h. To develop comprehensive plans for the conservation of soil resources and for the control and prevention of soil erosion within the district, which plans shall specify in such detail as may be possible, the acts, procedures, performances, and avoidances which are necessary or desirable for the effectuation of such plans, including the specifications of engineering operations, methods of cultivation, the growing vegetation, cropping programs, tillage practices, and changes in use of land; and to publish such plans and information and bring them to the attention of owners of lands within the district;

i. To develop site plans for the construction, operation and maintenance of proposed leaf composting facilities located on agricultural or horticultural required pursuant to Section 7 of P.L. 89, c. 151 and to conduct an annual inspection of each operational facility within the district authorized by the Department of Environmental Protection in order to certify to the department that the facility is in compliance with the rules and regulations adopted by the department therefor and is operating in conformance with recommended agricultural management practices;

j. To act as agent for the United States, or any of its agencies, or for this State or any of its agencies, in connection with any soil-conservation, erosion-control, or erosion-prevention project within its boundaries; to accept payments, donations, gifts, and contributions in money, services, materials, or otherwise from the United States or any of its agencies, or from this State or any of its agencies, or from any governmental subdivision or its agencies or from any corporation, association, group or individual, and to use or expend such moneys, services, materials, or other contributions in carrying out its operations;

k. To sue and be sued in the name of the district; to have a seal, which seal shall be judicially noticed; to have perpetual succession unless terminated as hereinafter provided; to make and execute contracts and other instruments, necessary or convenient to the exercise of its powers; to make, and from time to time amend and repeal, rules and regulations, not inconsistent with this chapter, to carry into effect its purposes and powers;

l. To acquire, by gift, devise, purchase or condemnation, any real property located within the district, or any interest or estate therein, which is required for the proper exercise by the district of its powers; provided, however, that the district shall not acquire any real property, or interest or estate therein, by condemnation without first obtaining the approval of the Secretary of Agriculture and the Commissioner of Environmental Protection;

m. As a condition to the extending of any benefits under this chapter, to, or the performance of work upon, any lands not owned or controlled by this State or any of its agencies, the supervisors may require contributions in money, services, materials, or otherwise to any operations conferring such benefits and may require landowners to enter into and perform such agreements or covenants as to the permanent use of such lands as will tend to prevent or control erosion thereon;

n. To borrow money for the purchase of equipment, either with or without security;

o. No provision with respect to the acquisition, operations, or disposition of property by other public bodies shall be applicable to a district organized hereunder unless the Legislature shall specifically so state.

L 1937, c. 139, §601, p. 331, amended by L 1957, c. 48, §1, p. 90;
L 1960, c. 20, §1, p. 79; L 1966, c. 77, §6, eff. June 14, 1966;
L 1989, c. 151, §7.

4:24-22.1 Site plan for leaf composting facility; contents; certification; annual inspections

a. Every Soil Conservation District shall develop a site plan for each proposed leaf composting facility to be located on agricultural or horticultural land, or on lands owned or operated by a recognized academic institution, within the district. The site plan shall include such information as may be prescribed by the Department of Environmental Protection and shall be certified in a manner as may be prescribed by the department.

b. Every Soil Conservation District shall conduct an annual inspection of each operational leaf composting facility located on agricultural or horticultural land, or on lands owned or operated by a recognized academic institution, within the district and authorized by the department in order to certify to the department that the facility is operated and maintained in compliance with the rules and regulations adopted by the department therefore and the site plan developed by the district, and in conformance with recommended agricultural management practices.

L 1898, c. 151, §7, eff. August 9, 1989.

4:24-22.2 Leaf composting facility located on agricultural or horticultural land or on lands of academic institution; method of operation

Each leaf composting facility located on agricultural or horticultural land, or on lands owned or operated by a recognized academic institution, shall operate in accordance with the conditions specified in the program of agricultural management practices developed by the New Jersey Cooperative Extension Service of Rutgers, The State University, and approved by the department.

L 1989, c. 151 §8, eff. August 9, 1989.

(Editorial Note: In Sections 22.1 and 22.2 the word department means the New Jersey Department of Environmental Protection)

ARTICLE 7. ADOPTION OF LAND-USE REGULATIONS

4:24-23. Supervisors to formulated regulations; public hearings; submission to state committee; objections by landowners

The supervisors of any district shall have the authority to formulate regulations governing the use of lands within the district in the interest of conserving soil and soil resources and preventing and controlling soil erosion. The supervisors shall conduct such public meetings and public hearings upon tentative regulations as may be necessary to assist them in this work. After such hearings the supervisors shall draft such land-use regulations as seem to them necessary to carry out the provisions of this chapter. These regulations shall then be submitted to the State Soil Conservation Committee which may within thirty days suggest amendments thereto for consideration by the supervisors. Thereinafter the supervisors shall give due notice of the regulations by publication and by posting. Any landowner may, for a period of sixty days thereafter, file with the supervisors his objections to the adoption of said regulations, said objections shall be made upon a form to be furnished by the supervisors. If objections are filed by owners of at least twenty-five percent of the acreage of the district, the supervisors shall not have the authority to enact said regulations, otherwise the supervisors shall thereupon take such affirmative action as may be necessary to make such land-use regulations effective. Land-use regulations adopted pursuant to the provisions of this article shall be binding on all landowners within such district.

L 1937, c. 139, §701, p. 333

4:24-24. Amendment, etc., of regulations

Any owner of land within such district may at any time file a petition with the supervisors asking that any or all of the land-use regulations adopted by the supervisors under the provisions of this article shall be amended, supplemented, or repealed. Land-use regulations adopted pursuant to the provisions of this article shall not be amended, supplemented, or repealed except in accordance with the procedure prescribed in this article for adoption of land-use regulations.

L 1937, c. 139, §702, p. 334.

4:24-25. Provisions which may be included into regulations

Regulations to be adopted by the supervisors under the provisions of this article may include:

a. Provisions requiring the construction of terraces, terrace outlets, check dams, dikes, ponds, ditches, and other necessary structures:
b. Provisions requiring observance of particular methods of cultivation including contour cultivating, contour furrowing, lister furrowing, sowing, planting, strip cropping, seeding, and planting of lands to water-conserving and erosion-preventing plants, trees and grasses, forestation and reforestation;
c. Specifications of cropping programs and tillage practices to be observed;
d. Provisions limiting the cultivation of highly erosive areas or of areas on which erosion may not be adequately controlled if cultivation is carried on;
e. Provisions for such other means, measures, operations and programs as may assist conservation of soil resources and prevent or control soil erosion in the district.

L 1937, c. 139, §704, p. 335.

4:24-26. Regulations to be uniform; printing of copies

The regulations shall be uniform throughout the territory comprised within the district except that the supervisors may classify the lands within the district with reference to such factors as soil type, degree of slope, degree of erosion threatened or existing, cropping and tillage practices in use, and other relevant factors, and may provide regulations varying with the type or class of land affected, but uniform as to all lands within each class or type. Copies of land-use regulations adopted under the provisions of this article shall be printed and made available to all owners and occupiers of lands lying within the district.

L 1937, c. 139, §704, p. 335.

ARTICLE 8. ENFORCEMENT OF LAND-USE REGULATIONS

4:24-27. Authority of supervisors; suit for damages by landowner for violations

The supervisor shall have authority to go upon any lands within the district to determine whether land-use regulations adopted under the provisions of article seven of this chapter (§4:24-23 et seq) are being observed. Any landowner who shall sustain damages from any violation of such regulations by any other landowner may sue to recover damages in a civil action from such other landowner for such violation.

L 1937, c. 139, §801, p. 335, amended by L 1953, c. 5, §100, p. 56.

ARTICLE 9. PERFORMANCE OF WORK UNDER REGULATIONS BY SUPERVISORS

4:24-28. Nonobservance of land-use regulations; action

Where the supervisors of any district shall find that any of the provisions of land-use regulations adopted in accordance with the provisions of article seven of this chapter (§4:24-23 et seq.) are not being observed on particular lands, and that such nonobservance tends to increase erosion on such lands and is interfering with the prevention or control of erosion on other lands within the district, the supervisors may bring an action in the Superior Court and the said court therein may grant appropriate relief.

L 1937, c. 139, §901, p. 335, amended by L 1953, c. 5, §101, p. 56.

4:24-29. Repealed by L 1953, c. 5, §102, p. 56.

ARTICLE 10. BOARD OF ADJUSTMENT

4:24-30. Members; appointment, term, removal, etc., expenses

Where the supervisors of any district organized under the provisions of this chapter shall adopt land-use regulations in accordance with the provisions of article 7 of this chapter (§4:24-23 et seq.), they shall further provide for the establishment of a board of adjustment. Such board of adjustment shall consist of three members, each to be appointed for a term of three years, except that the members first appointed shall be appointed for terms of one, two and three years, respectively. The members of each such board of adjustment shall be appointed by the State Soil Conservation Committee, with the advice of the supervisors of the district for which such board has been established, and shall be removable, upon notice and hearing, for neglect of duty or malfeasance in office, but for no other reason, such hearing to be conducted by the State Soil Conservation Committee. Vacancies in the board of adjustment shall be filled in the same manner as original appointments, and shall be for the unexpired term. Members of the State Soil Conservation Committee and the supervisors of the district shall be ineligible to appointment as members of the board of adjustment during their tenure of such other office. The members of the board of adjustment shall receive no compensation for their services, but they shall be entitled to expenses, necessarily incurred in the discharge of their duties. The supervisors shall pay the necessary administrative and other expenses incurred by the board, upon the certificate of the chairman of the board.

L 1937, c. 139, §1001, p. 337.

4:24-31. Rules by board; organization; meetings; oaths and witnesses; records

The board of adjustment shall adopt rules to govern its procedures, which rules shall be in accordance with the provisions of this chapter. The board shall designate a chairman from among its members, and may, from time to time, change such designation.

4:24-32. Petition by landowner to board for variance in land-use regulations; procedure

Any landowner may file a petition with the board of adjustment alleging that there are great practical difficulties or unnecessary hardship in the way of his carrying out upon his lands the strict letter of the land-use regulations approved by the supervisors, and praying the board to authorize a variance from the terms of the land-use regulations in the application of such regulations to the lands of the petitioner. Copies of such petition shall be served by the petitioner upon the chairman of the supervisors of the district within which his lands are located and upon the chairman of the State Soil Conservation Committee. The board of adjustment shall fix a time for the hearing of the petition and cause due notice to be given. The supervisors of the district and the State Soil Conservation Committee shall have the right to appear and be heard at such hearing. Any owner of lands lying within the district who shall object to the authorizing of the variance prayed for may intervene and become a party to the proceedings. Any party to the hearing before the board may appear in person, by agent, or by attorney. If, upon the facts presented at such hearing, the board shall determine that there are great practical difficulties or unnecessary hardship in the way of applying the strict letter of any of the land-use regulations, in their application to the lands of the petitioner, as will relieve such great practical difficulties or unnecessary hardship and will not be contrary to the public interest, and such that the spirit of the land-use regulations shall be observed, the public health, safety, or welfare secured, and substantial justice done.

L 1937, c. 139, §1003, p. 338.

4:24-33. Review of order of board

Any petitioner aggrieved by an order of the board granting or denying, in whole or in part, the relief sought of the supervisors of the district, or any intervening party, shall be entitled to a review of such order in the Superior Court by a proceeding in lieu of prerogative writ.

L 1937, c. 139, §1004, p. 339, amended by L 1953, c. 5, §103, p. 56.

ARTICLE 11. COOPERATION WITH STATE AGENCIES

4:24-34. Duty of state agencies, counties, etc., to cooperate

It shall be the duty of all agencies of this state which shall have jurisdiction over, or be charged with the administration of, any state-owned lands, and of any county, or other governmental subdivision of the state, which shall have jurisdiction over, or be charged with the administration of, any county-owned or other publicly owned lands, lying within the boundaries of any district organized hereunder, to cooperate to the fullest extent compatible with the purposed for which such lands are held.

L 1937, c. 139, §1101, p. 339.

ARTICLE 12. DISCONTINUANCE OF DISTRICTS

4:24-35 THROUGH 4:24-38 Repealed by L 1977, c. 264, §4.

ARTICLE 13. SOIL EROSION AND SEDIMENT CONTROL

4:24-39. Short title

This act may be cited and referred to as the "Soil Erosion and Sediment Control Act."

L 1975, c. 251, §1, eff. January 1, 1976.

4:24-40. Legislative findings

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.

L 1975, c. 251, §2, eff. January 1, 1976.

4:24-41. Definitions

a. "Application for development: means a proposed subdivision of land, site plan, conditional use zoning variance, planned unit 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 (§4:24-45) has expired without action by the district; (3) a written endorsement of a plan filed by the State Department of Transportation with the district.

c. "District" means a Soil Conservation District organized pursuant to chapter 24 of Title 4 of the Revised Statutes (§4:24-39 et seq.)

d. "Disturbance" means any activity involving the clearing, excavation, 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 time 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 accommodation 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 or 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.

L 1975, c. 251, §3, eff. January 1, 1976, amended by L 1977, c. 264, §2, eff. October 18, 1977, L1979, c. 459, §1, eff. February 27, 1980.

4:24-42. Standards for control of soil erosion and sedimentation; promulgation, amendment and repeal

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 Procedures 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, soil, 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.

L 1975, c. 251, §4, eff. November 12, 1975, amended by L 1979, c. 459, §2, eff. February 27, 1980.

4:24-43. Certification of plan by district; development of projects

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, or 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 Transportation 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 Transportation, the Department of Environmental Protection and the committee and promulgated by the Department of Transportation.

L 1975, c. 251, §5, eff. January 1, 1976, amended by L 1979, c. 459, §3, eff. February 27, 1980.

4:24-44. Certification of plan; criteria; notice

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.

L 1975, c. 251, §6, eff. January 1, 1976.

4:24-45. Limitation on time for grant or denial of certification

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 and 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.

L 1975, c. 251, §7, eff. January 1, 1980.

4:24-46. Fees

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.

L 1975, c. 251, §7, eff. January 1, 1976.

4:24-47. Stop-construction order; failure to comply with certified plan

The district or the municipality may issue a stop-construction order if a project is not being executed in accordance with a certified plan.

L 1975, c. 251, §9, eff. January 1, 1976.

4:24-48. Exempt municipalities

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 (§4:24-43 to 4:24-47), until such time as the local district determines that the municipality is not enforcing said ordinance.

L 1975,c. 251, §10, eff. January 1, 1976.

4:24-49. Certificate of occupancy for project; conditions for issuance

No certificate of occupancy for a project shall be issued by a municipality or any other public agency unless there has been compliance with the provisions of a certified plan for permanent measures to control soil erosion and sedimentation.

L 1975, c. 251, §11, eff. January 1, 1976, amended by L 1979, c. 459, §10, eff. February 27, 1980.

4:24-50. County planning board as agent for district

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.

L 1975,c. 251, §12, eff. January 1, 1976.

4:24-51. Cooperation with and authorization to receive financial aid from governmental units or private sources

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.

L 1975,c. 251, §13, eff. January 1, 1976.

4:24-52. State aid

The committee is authorized to make grants of State aid to districts and to municipalities to carry out the purposes of this act.

L 1975,c. 251, §14, eff. January 1, 1976.

4:24-53. Violations, injunction; penalty; enforcement

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 nor more than $3,000 to be collected in a summary proceeding pursuant to the Penalty Enforcement Law (N.J.S. 2A:58-1 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 continues shall constitute an additional separate and distinct offense.

L 1975,c. 251, §15, eff. January 1, 1976.

4:24-54. Liberal construction

This act shall be liberally construed to effectuate the purpose and intent thereof.

L 1975,c. 251, §16, eff. January 1, 1976.

4:24-55. Severability

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.

L 1975,c. 251, §17, eff. January 1, 1976.

CHAPTER 113

AN ACT concerning soil restoration measures and amending and supplementing P.L.1975, c.251.

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

1. Section 3 of P.L.1975, c.251 (C.4:24-41) is amended to read as follows:

C.4:24-41 Definitions.

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 unit 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.

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, or compaction of soil which degrades soil so as to make it less conducive to vegetative stabilization.

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, and which specifies the soil restoration measures, consistent with the standards established by the committee pursuant to section 2 of P.L.2010, c.113 (C.4:24-42.1).

g. "Project" means any disturbance of more than 5,000 square feet of the surface area of land (1) for the accommodation 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.

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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.

m. “Soil restoration measures” means those measures taken to ensure, to the maximum extent possible, cost-effective restoration of the optimal physical, chemical, and biological functions for specific soil types and the intended land use.

C.4:24-42.1 Adoption of standards.

2. The committee shall, within one year after the date of enactment of P.L.2010, c.113 (C.4:24-42.1 et al.), and in consultation with the New Jersey Agricultural Experiment Station at Rutgers, the State University, the Secretary of Agriculture and the Commissioner of Environmental Protection, adopt standards pursuant to the “Administrative Procedure Act,” P.L.1968, c.410 (C.52:14B-1 et seq.), which shall modify the existing soil erosion and sediment control standards to include soil restoration measures.

3. This act shall take effect on the first day of the 13th month after the date of enactment.

Approved January 5, 2011.

AGRICULTURE
STATE SOIL CONSERVATION COMMITTEE
Soil Erosion and Sediment Control Act Rules
Adopted Rules: N.J.A.C. 2:90-1
Effective Date: February 20, 2014
Expiration Date: December 8, 2017

SUBCHAPTER 1. SOIL EROSION AND SEDIMENT CONTROL ON LAND DISTURBANCE ACTIVITIES

2:90-1.1 Purpose and scope

(a) The rules in this subchapter are to implement P.L. 1975, c.251, N.J.S.A. 4:24-39 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 to provide for inspection, compliance and enforcement and to continue effective administration of the law. The rules in this subchapter clarify the long standing provisions of the act prescribing the authorities, roles and responsibilities related to implementation of the act for the State Soil Conservation Committee and soil conservation districts. Such authorities, roles and responsibilities include, but are not limited to, the following:

1. For the State Soil Conservation Committee:
   - i. Develop and promulgate rules and technical and administrative standards;
   - ii. Provide program oversight and training, on its own motion or upon request;
   - iii. Conduct appeals from district decisions;
   - iv. Conduct investigations;
   - v. Provide technical assistance;
   - vi. Institute policies and procedures and guidance;
   - vii. Conduct studies;
   - viii. Provide State aid to districts;
   - ix. Approve district fee schedules;
   - x. Discontinue municipal ordinances addressing soil erosion and sediment control;
   - xi. Provide program related interpretative assistance; and
   - xii. Enter into agreements with public agencies; and

2. For soil conservation districts:
   - i. Make determinations and apply the requirements or grant exemption from the act;
   - ii. Review and certify or deny certification of plans;
   - ii. Perform inspections and take enforcement actions, including violation notices, stop construction orders and seek court remedies or fines for violations;

iv. Issue or withhold reports of compliance, conditional reports of compliance, or final reports of compliance;
v. Coordinate with municipalities, counties, State and Federal agencies and instrumentalities thereof;
vi. Conduct appeals from aggrieved parties;
vii. Adopt or modify a fee schedule and assess fees;
viii. Monitor the performance of municipalities implementing erosion control ordinances and recommend discontinuance of municipal ordinances when such performance is unsatisfactory; and
ix. Enter into agreements with public agencies.

2:90-1.2 Definitions

All definitions in P.L. 1975, c. 251 are incorporated into the rules of this subchapter. The following words and terms, when used in this subchapter, shall have the following meanings, unless the context clearly indicates otherwise.

"Act" means the Soil Erosion and Sediment Control Act of 1975, N.J.S.A. 4:24-39 et seq.
"Appeal" means a request for a review of district action.
"Agriculture and horticulture" means the utilization of land for the production of food, fiber, animals and related activities customary to agricultural and horticultural production and operations.
"Certified plan" means a plan and any revisions thereto reviewed and approved by the district or exempt municipality as conforming to the standards promulgated by the Committee.
"Committee" means the State Soil Conservation Committee.
"Complete application" means an application and all required items as set forth in N.J.A.C. 2:90-1.4 for soil erosion and sediment control plan certification and that are administratively and technically sufficient for district or exempt municipality certification.
"Conservation plan" means a site specific plan which prescribes needed land treatment and related conservation and natural resource management measures deemed by the district to be practical and reasonable for the conservation and protection of agricultural or horticultural productivity and the control and prevention of nonpoint source pollution. Such plan is designed in accordance with the United States Department of Agriculture, June 1, 2005 Field Office Technical Guide, incorporated herein by reference, as amended and supplemented. To obtain a copy of the Field Office Technical Guide, see N.J.A.C. 2:90-1.8(b).
"Demolition" means the demolition of one or more structures including the disturbance of all land area necessary to accomplish the work.
"Exempt municipality" means any municipality that has secured soil erosion and sediment control ordinance approval for implementing N.J.S.A. 4:24-43 through 47 from the Committee prior to May 31, 1978.
"Hearing body" means the State Soil Conservation Committee.
"Major revision" means modifications to the soil erosion and sediment control plan which require the district to reevaluate the adequacy of erosion controls for the project and compare the plan to the standards.
"Minor revision" means modifications which require minimal examination of the submittal and do not impact the integrity of the previously certified soil erosion control measures as determined by the district.
"Sequence of construction" or **"sequence"** means a site specific chronology of proposed erosion

control plan components including temporary and permanent soil erosion and sediment control measures, integrated with site development related land disturbances that minimizes erosion and sedimentation.

"Withdrawn plan" means a plan for soil erosion and sediment control which the applicant or their agent has rescinded from further action by the district.

2:90-1.3 Standards for Soil Erosion and Sediment Control

(a) The State Soil Conservation Committee adopts and hereby incorporates into the rules of this subchapter by reference as standards for soil erosion and sediment control those standards published in the "Standards for Soil Erosion and Sediment Control in New Jersey" and identified as revised on July 11, 2011 as the technical basis for local soil conservation district certification of soil erosion and sediment control plans. Specifically, these standards include the following:

1. Vegetative Standards:

2. Engineering Standards

THIS IS A COURTESY COPY OF THIS ADOPTION. THE OFFICIAL VERSION WILL BE PUBLISHED IN THE JANUARY 20, 2014, NEW JERSEY REGISTER. SHOULD THERE BE ANY DISCREPANCIES BETWEEN THIS TEXT AND THE OFFICIAL VERSION OF THE ADOPTION, THE OFFICIAL VERSION WILL GOVERN.

3. Copies of the Standards may be obtained by contacting the State Soil Conservation Committee at 609-292-5540, www.state.nj.us/agriculture, or any of the soil conservation districts as follows:

   i. Bergen County Soil Conservation District;
   ii. Burlington County Soil Conservation District;
   iii. Camden County Soil Conservation District;
   iv. Cape-Atlantic Soil Conservation District;
   v. Cumberland-Salem Soil Conservation District (Cumberland and Salem Counties);
   vi. Freehold Soil Conservation District;

vii. Gloucester County Soil Conservation District;
viii. Hudson, Essex and Passaic Soil Conservation District;
ix. Hunterdon County Soil Conservation District;
x. Mercer County Soil Conservation District;
xi. Morris County Soil Conservation District;
xii. Ocean County Soil Conservation District;
xiii. Somerset-Union Soil Conservation District;
xiv. Sussex County Soil Conservation District; and
xv. Warren County Soil Conservation District.

(b) Where it can be satisfactorily demonstrated by the applicant that unique or innovative control measures or procedures not specified in this chapter may be applicable to specific sites, such measures may be proposed for consideration and utilized subject to approval by the soil conservation district and the State Soil Conservation Committee. To secure such approval, a written request shall be sent to the soil conservation district and State Soil Conservation Committee describing the unique or innovative control measure or procedure and its proposed function or use on the project. Such approval may be granted only where it is determined that strict application of the standards are herein specified will not result in the most practical and effective control of soil erosion, sedimentation and stormwater damage.

(c) The location, address, and telephone and number of the local soil conservation district may be obtained from the State Soil Conservation Committee, PO Box 330, Trenton, New Jersey 08625-0330. 609-292-5540.

2:90-1.4 Application

(a) Application for soil erosion and sediment control plan certification shall be made to the local district utilizing standard application forms adopted by the Committee. Such application shall indicate the information required to make a decision on certification of plans. Application forms are available at locations listed at N.J.A.C. 2:90-1.3.

(b) Applications for certifications of soil erosion and sediment control plans shall include the following items:

1. One copy of the complete subdivision, site plan or construction permit application, including key map as submitted to the municipality (architectural drawings, plans and specifications for buildings not required) which includes the following:

i. The location of present and proposed drains and culverts with their discharge capacities and velocities and supporting computations and identification of conditions below outlets;

ii. A delineation of any area subject to flooding from the 100-year storm in compliance with the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq., or applicable municipal zoning;

iii. A delineation of streams and wetlands pursuant to N.J.S.A. 13:9A-1 et seq. and 13:9B-1 et seq., and other significant natural features within the project area;

iv. The soils and other natural resource information used (delineation of the project site on soil map is desirable);

v. The land cover and use of area adjacent to the land disturbance; and

vi. All hydraulic and hydrologic data describing existing and proposed watershed conditions and a completed copy of the Hydraulic and Hydrologic Data Base Summary Form SSCC 251 HDF1. Where computer simulation models (such as HEC-HMS, HEC-RAS, TR-55, or other similar models) are used to analyze or predict hydrologic or stream flow responses to project development, a copy of such input files shall be submitted to the district. The Data Base Summary Forms and information regarding these computer programs are available at the locations listed at N.J.A.C. 2:90 1.3;

2. Up to four copies of the soil erosion and sediment control plan at the same scale as the site plan submitted to the municipality nor other land use approval agency which includes the following information detailed at the plat:

i. The proposed sequence of development including duration of each phase in the sequence;

ii. A site grading plan delineating land areas to be disturbed including proposed cut and fill areas together with existing and proposed profiles of these areas;

iii. Contours at a two foot interval, showing present and proposed ground elevation;

iv. The locations of all streams and existing and proposed drains and culverts;

v. A stability analysis below all points of stormwater discharge which demonstrates that a stable condition will exist or there will be no degradation of the existing condition;

vi. The location and detail of all proposed erosion and sediment control structures including profiles, cross sections, appropriate notes, and supporting computations;

vii. The location and detail of all proposed nonstructural methods of soil stabilization including types and rates of lime, fertilizer, seed and mulch to be applied;

viii. Erosion control measures for non-growing season stabilization of exposed areas where the establishment of vegetation is planned as the final control measure;

ix. For residential development, erosion control measures which apply to dwelling construction on individual lots with notation on the final plat that requirement for installation of such control measures shall apply to subsequent owners if title is conveyed; and

x. Plans for maintenance of permanent soil erosion and sediment control measures and facilities during and after construction, which include the designation of persons or entity responsible for such maintenance;

3. An Ownership Disclosure Affidavit Form to determine potential conflicts of interest between the applicant and soil conservation district supervisor or staff.

i. A corporation must indicate its registered agent and officers.

ii. A corporation, partnership, or limited liability corporation (LLC) shall list the names and addresses of all stockholders or individual partners owning at least 10 percent of its stock of any class, or at least 10 percent of the interest in the partnership.

iii. Any transfer of ownership of more than 10 percent must be disclosed to the district;

4. Appropriate fees as adopted by the individual district and approved by the Committee (see N.J.A.C. 2:90-1.12); and

5. Additional information as may be required by the district depending upon the scope, topography and complexity of the project.

(c) The applicant shall certify and agree that the applicant shall:

1. Certify that all soil erosion and sediment control measures are designed in accordance with current Standards for Soil Erosion and Sediment Control in New Jersey as promulgated by the Committee and found at N.J.A.C. 2:90-1.3 and will be installed in accordance with the plan as approved by the district;

2. Acknowledge that structural measures contained in the soil erosion and sediment control plan are reviewed for adequacy to reduce offsite soil erosion and sedimentation and not for adequacy of structural design;

3. Retain full responsibility for any damages which may result from any construction activity notwithstanding district certification of the soil erosion and sediment control plan;

4. Require that all engineering related items of the soil erosion and sediment control plan be prepared by or under the direction of and be sealed by a professional engineer or architect licensed in the State of New Jersey in

accordance with N.J.A.C. 13:27-6;

5. Assure that any conveyance of the project or portion thereof is conditioned upon transfer of full responsibility for compliance with the certified plan to any subsequent owners;

6. Maintain a copy of the certified plan on the project site during construction;

7. Allow district agents to go upon project lands for inspection; and

8. Notify the district in writing at least 48 hours in advance of any land disturbance activity and upon completion of the project.

(d) If the person submitting the application is not the project owner, a notarized authorization by the owner or authorized corporate officer must be submitted with the application. For public agency projects, such authorization shall be made by the principal executive officer or elected official of the agency.

(e) All requests for determination that the act does not apply to land disturbance activity shall be submitted to the district by the owner or their authorized representative. Non-applicability requests shall be in writing and include a plot or site plan depicting all proposed areas of disturbance and a resolution from the municipality or other suitable documentation indicating the date the lot was created. Hardship exemptions or waivers shall not be authorized. The act does not apply to the following activities:

1. Land disturbance activities 5,000 square feet or less; and

2. Single-family dwelling lots not regulated under N.J.A.C. 2:90- 1.5.

(f) Any land disturbance activity to which the act was initially determined not to apply but which subsequently falls within the definition of project, as defined in N.J.S.A. 4:24-41g, shall be subject to the rules of this subchapter.

(g) Any application for development for a project that was approved by the State, any county, municipality, or any instrumentality thereof, without the condition that the application for development comply with the act pursuant to N.J.S.A. 4:24-43 and this subchapter, shall not be relieved of the obligation to conform to the act and this subchapter. A successor in title shall be subject to this subchapter.

2:90-1.5 Single-family dwelling unit lots

(a) An application for a construction permit for any single-family dwelling unit, on any lot that has arisen from a subdivision approved after January 1, 1976 comprising two or more contiguous or non-contiguous single-family dwelling lots, the construction of which would disturb greater than 5,000 square feet, including associated offsite improvements, is subject to the act, and the applicant/owner shall secure certification of a soil erosion and sediment control plan. The act shall also apply if any lots in the subdivision are conveyed to separate owners or if construction is by the same or a separate applicant, owner, builder or contractor.

(b) The concurrent construction of two or more single-family dwelling units, by the same applicant, owner, builder or general contractor on lots that were part of a preexisting subdivision approved prior to January 1, 1976, shall be subject to the act and this subchapter provided that the proposed cumulative land disturbance, including associated offsite improvements, is greater than 5,000 square feet.

2:90-1.6 Mining and quarrying activities

Certification of a soil erosion and sediment control plan shall be required for the operation of all mining or quarrying activities regardless of proposed or actual related agricultural or horticultural use. Mining or quarrying activities shall include the extraction and removal of soil and/or sediment, as defined in N.J.S.A. 4:24-41, from the proposed site.

2:90-1.7 Demolition activities

Any demolition activity of one or more structures and any associated new disturbance activity involving more than 5,000 square feet in size including the construction of one single-family dwelling or other project shall obtain soil erosion and sediment control plan certification.

2:90-1.8 Clearing or grading of land

(a) Except as provided in (b) and (c) below, a person proposing to engage in or who is engaging in clearing or grading of more than 5,000 square feet of land shall be subject to the act unless such land disturbance is for agricultural or horticultural purposes. To demonstrate to the district that such activity is related to proposed agricultural or horticultural activities, the owner shall provide proof that the land is enrolled in a farmland preservation program, eligible for farmland assessment, qualifies for right-to-farm protections, or possesses a farm conservation plan or forest management plan, timber harvest sale contract or other proofs deemed appropriate by the district. Anyone seeking to provide a farm conservation plan as proof of agricultural or horticultural use must waive confidentiality under the Federal Freedom of Information Act. The district shall determine if the proofs demonstrate an agricultural or horticultural activity or is subject to the act and this subchapter.

(b) Certification of a soil erosion and sediment control plan shall be required for the construction of agricultural structures, involving the disturbance of greater than 5,000 square feet of land unless the disturbance is incorporated into a farm conservation plan approved by the district as conforming to the United States Department of Agriculture, June 1, 2005 Field Office Technical Guide, which is hereby adopted and incorporated by reference, as amended and supplemented.

1. Copies of the New Jersey Field Office Technical Guide are available from the NRCS Field Offices and the State Office at 220 Davidson Ave., 4th Floor, Somerset, NJ 088873.

2. An electronic copy of the New Jersey Field Office Technical Guide is available at http://www.nrcs.usda.gov/technical/efotg/.

3. A copy of this document is on file in the NJDA Office of the Director, Division of Agricultural and Natural Resources, Health and Agriculture Building, Market and Warren Streets, Trenton, NJ 08625.

(c) Disturbances on agricultural land greater than 5,000 square feet in size other than for agricultural or horticultural purposes, may be subject to the act and this subchapter or may be incorporated into the farm conservation plan when so determined by the district.

2:90-1.9 Procedure

(a) The district shall carry out the provisions of N.J.S.A. 4:24-43 through 47.

(b) No project shall be undertaken by any person, partnership, corporation, or limited liability corporation (LLC) 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 adopted by the Committee.

(c) Approval by a municipality 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 that the applicant or their agent 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 include in the notice of certification or on the certified plan the following clause: "This certification is limited to the controls specified in this plan. It is not authorization to engage in the proposed land use unless such use has been previously approved by the municipality, county, State agency or other controlling agency."

(f) The district shall furnish the municipal planning board, municipal construction official, and municipal engineer, or other responsible official or entity in the case of a county, State or other agency, a copy of the certification or denial including all conditions and statements.

(g) 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. When the applicant fails to respond to two or more written requests by the district for additional information, the application may be denied. If the district denies an application for soil erosion and sediment control plan certification, the applicant may resubmit the plan at any future time for review and certification.

(h) The applicant may withdraw an application or a certified plan by written request to the district. The applicant may subsequently resubmit the plan for certification.

(i) District certification of a soil erosion and sediment control plan for any project shall be valid only for the duration of the initial project approval granted by the municipality or other land use approval agency but in no case shall exceed three and one-half years. All such municipal or other agency renewals of the project will require resubmission of the project plan and recertification approval by the district. Certification of the plan is conferred upon the project and may be transferred or conveyed.

(j) The current project owner shall notify the district in writing if there is a change of ownership during implementation of the plan.

(k) By formal action, a district may delegate jurisdiction over a project to another district. An applicant proposing a project that requires certification by more than one district shall secure certification from each respective district unless full jurisdiction is transferred to one district.

(l) The sequence of construction shall be an integral component of the certified plan and shall be followed by the applicant or their agent during all phases of the project. The sequence shall incorporate the installation of temporary and permanent controls, and shall include, but not be limited to, clearing and grading, cuts and fills, temporary diversions, sediment basins, tracking controls, temporary and permanent stabilization and dust control. The sequence of construction may be revised and shall be resubmitted to the district for approval during construction to address site concerns.

(m) At its discretion, the district may require an interim clearing and grading plan on a project for critical area stabilization during construction due to the presence of erodable soils, slopes or water quality concerns for mitigating existing, emerging or anticipated erosion hazards.

2:90-1.10 Revisions to the certified plan

(a) A district may require a new submission of the plan, supporting documentation, application and fee when a major revision is made. The district may require submission of a revised plan**,** supporting documentation and a fee where minor revisions are needed.

(b) Revisions to the certified plan shall be submitted to the district for reevaluation and certification prior to implementation of the change. Such changes shall be in accordance with the standards in effect on the date that revisions to the plan are being submitted to the district.

(c) Revisions to a plan required during construction shall be submitted to the district for certification. No report of compliance or conditional report of compliance shall be issued if the district determines that a revision to the plan is required.

2:90-1.11 Exempt municipality ordinances and implementation

(a) Adoption by the municipality of soil erosion and sediment control ordinances for approval by the Committee must have been completed by May 31, 1978, in order to qualify for an exemption from N.J.S.A. 4:24-43 through 47. Such exempt municipalities shall enforce the provisions of the ordinance in conformance with district policies and procedures for consistency between municipal and district erosion control programs Statewide.

(b) Exempt municipal ordinances may specifically require municipal certification of demolition, parking lot construction, land clearing or grading or mining and quarrying activities. Where such projects are not encompassed in the ordinance, the municipality shall not exercise jurisdiction until the ordinance is amended and approved by the Committee. No exempt municipality shall exercise jurisdiction over plan certification on any county or a State project; or where municipal regulation of a municipal project would constitute a conflict of interest or the appearance of a conflict of interest. In all such cases, such projects shall be referred to the district for certification and enforcement.

(c) No exempt municipality or any other municipality shall implement a soil erosion and sediment control ordinance or provision that is more restrictive than the definition of project in the act. No exempt municipality may grant a waiver of the requirements or grant an exemption for a project as defined in the act or rules promulgated thereto.

(d) Soil erosion and sediment control ordinances adopted by exempt municipalities may provide for the review and certification of plans, inspection and enforcement by the district in accordance with this subchapter. In all such cases, there shall be written contracts with the municipality, the district and the Committee. The district shall utilize its fee schedule for collection of fees from applicants.

(e) Exempt municipalities implementing ordinances approved by the Committee shall utilize the Committee's standard application form, letter of certification form, reports of compliance form, quarterly report form and Hydraulic and Hydrologic Basin Summary form.

(f) Exempt municipal officials enforcing the provisions of the ordinance shall be knowledgeable in natural resources management and qualified to review plans and inspect project sites. Municipal staff shall attend Committee approved training courses, no less than once every two years.

(g) Exempt municipalities implementing ordinances approved by the Committee shall provide reports to the district and provide information as follows:

1. Verification of municipal certification of the soil erosion and sediment control plan for the Construction General Permit 5G3 for eligible activities: at the end of each business week;

2. A copy of the Hydraulic and Hydrologic Basin Summary form for all newly certified stormwater basins and stormwater outfalls within 15 days following the end of each calendar-year quarter; and

3. The following information shall be provided to the local district by March 15 of each year:

i. The current soil erosion and sediment control ordinance; and

ii. The municipal agent contracts responsible for implementing the erosion control ordinance and training classes attended.

(h) Failure by any exempt municipality to satisfactorily implement the ordinance as determined by the district or conform with this section, may result in action by the Committee to revoke the ordinance.

(i) Districts shall annually review for compliance all soil erosion and sediment control ordinances enacted by exempt municipalities within the district. The municipality shall cooperate with the district to demonstrate the manner of municipal implementation of the erosion control ordinances. The district shall inform the committee in writing of the results of this review by April 15 of each year. If at any time during the year, the district determines and so notifies and provides proof to the Committee that any exempt municipality is not enforcing its soil erosion and sediment control ordinance, the Committee shall consider the proofs given and the Committee shall provide written notice to the municipality that it is no longer exempt from N.J.S.A. 4:24-43 through 47. The Committee, at its discretion, may schedule a hearing to review revocation of exempt status.

(j) Any proposed changes to an exempt municipal ordinance which has received the approval of the committee, and is therefore exempt from N.J.S.A. 4:24-43 through, 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 N.J.S.A. 4:24-43 through 47.

2:90-1.12 Fees

(a) Ordinary fees: Reasonable fees shall be set by the districts based on the costs for providing services. The district shall establish fee categories based on the types and sizes of construction projects and an hourly rate for assessing fees. The fee schedule provisions proposed by each district shall be approved by the committee before it is implemented by the district. Any person aggrieved on the set fee may appeal to the Committee as outlined in N.J.A.C. 2:90-1.16.

(b) Extraordinary fees: The district fee schedule may include the assessment of fees for reimbursement of extraordinary expenses resulting from enforcement actions taken. The district may seek reimbursement for litigation expenses including court costs and attorney's fees from the adverse party as part of a negotiated settlement agreement or where the district prevails in any litigation action.

(c) Interest income derived from fee reserve balances may be utilized by the district for implementing district education programs for applicants, contractors, municipal officials and the public.

(d) Fee for certain federal projects: Certain federal project activities that are precluded from making fee payments directly to a district, based on applicable federal and state laws shall remit fees payable to "Treasurer, State of New Jersey" to the local district in which the project is to be undertaken. The fee shall be submitted in conjunction with the plan for soil erosion and sediment control certification. The fee shall be in accordance with the following fee schedule based on the land surface area to be disturbed:

Federal Project Fee Schedule

Disturbance Area*	Review Fee**	Inspection Fee***
1 to 5 acres	$950	$325 per acre
6 to 10 acres	$1,600	$260 per acre
11 to 25 acres	$2,300	$200 per acre
26 to 50 acres	$3,000	$180 per acre
51 acres and greater	$3,500	$160 per acre

* For projects greater than one (1) acre, partial acres are to be rounded to the nearest whole acre.

**Major revisions to a previously certified plan are subject to ½ the original review fee.

***Reinspection Fee: A fee of $150 may be assessed (a) when the contractor has failed to provide the district with a 48 hour advance written notice of the start of construction, or (b) when the second or subsequent district inspection was conducted and there was a failure to address the same problem identified in the first written notice of non-compliance issued to the applicant/contractor, or (c)when the contractor requested an inspection for receiving a Report of Compliance and such district inspection was performed, but the site was not in compliance with the certified plan and the Standards. A copy of all written violation notices shall be issued to the contractor with a copy provided to the local controlling federal agency.

2:90-1.13 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 and sequence of construction 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. Failure of the applicant to adequately correct deficiencies in the time frame set forth in the district letter to the applicant shall result in the issuance of a violation notice. Failure of the applicant to correct the deficiencies in the violation notice may result in the issuance of a stop construction order.

(d) The district or the municipality may issue a stop-construction order if the applicant fails to take a majority of identified actions to comply with the provisions of the certified plan. The district or municipality may issue a stop-construction order if a person initiates land disturbance prior to securing plan certification or fails to renew plan certification on an active project within 30 days of receiving notice of pending expiration from the district or municipality.

(e) When a stop-construction order is issued, no further construction activity or any other work may take place on the project except for implementation of erosion controls as required by the district, until such time the project is in compliance with all provisions of the certified plan.

2:90-1.14 Reports of Compliance

(a) A district having certified a soil erosion and sediment control plan for a project pursuant to N.J.S.A. 4:24-39 et seq. shall issue a written Final Report of Compliance (FROC) in accordance with this section, upon the district's determination that the project is in full and complete compliance with the requirements and provisions of the certified plan such that all permanent measures to control soil erosion and sedimentation are in effect for the entire project.

(b) A Report of Compliance (ROC) shall be issued when the District determines that a project or portion thereof is in full compliance with the certified plan and the Standards for Soil Erosion and Sediment Control in New Jersey (see N.J.A.C. 2:90-1.3), and that the permanent measures to control soil erosion and sedimentation are in effect for the area encompassed by the ROC.

(c) A Report of Compliance with Conditions (CRC) shall be issued when the District determines that the project or portion thereof is not yet in full compliance with the certified plan but is in satisfactory compliance to the extent practicable and in accord with the sequence of development and requirements thereof, such that the issuance of a temporary and conditional approval is appropriate with such conditions as may be imposed by the District. Satisfactory compliance means temporary measures and appropriate permanent measures for soil erosion and sediment control have been implemented according to the Standards including provisions for stabilization, site work and that no other site specific concerns exists.

(d) Upon written request from the applicant, the District may issue a ROC or CRC on a lot-by-lot or section-by-section basis for a project when lots or sections are part of the project.

(e) The district may withhold an ROC, CRC, or FROC for any project that has not secured discharge authorization of the stormwater general permit 5G3 where an NJPDES permit is required for stormwater discharges associated with a construction activity pursuant to N.J.A.C. 7:14A-24.2.

(f) All fees shall be paid to the district prior to issuance of the ROC, CRC, or FROC.

(g) A standard Report of Compliance form approved by the State Soil Conservation Committee shall be utilized by the district and shall allow for the district's issuance of a CRC, ROC or FROC. The district shall complete the standard Report of Compliance form in accordance with the requirement set forth in (g) 1 through 4 below.

1. The district shall identify on the standard Report of Compliance form the block and lot, street address (if known), municipal location, the District application number and the date of issuance of the ROC.

2. The district shall state on the standard Report of Compliance form that the project or applicable portion thereof is in compliance with permanent measures to the extent determined by the district.

3. In order for the district’s issuance of a ROC to be valid and effective, the standard Report of Compliance form shall be signed by an authorized district official, the district chairman or designee, and specify its effective date.

4. In order for the district's issuance of a CRC to be valid and effective, the district shall comply with the requirements set forth in (g) 1 through 3 above, and shall state in the standard Report of Compliance form all conditions that are to be satisfied to assure compliance with the requirements of the certified plan, as well as the date for completion of such conditions.

(h) Copies of the ROC, CRC or FROC shall be distributed by the district to the applicant; the municipal construction code official having construction code jurisdiction for the project, if applicable; and/or in the case where a construction permit is not required for a project (such as for mining and land clearing projects among others), the municipal official having jurisdiction over such project, if any.

1. The district may also issue a copy of a ROC or CRC, to such other persons or

entities, as the district deems necessary or appropriate in its discretion. This includes, without limitation, and county, state and Federal agency, or instrumentality thereof, exercising any jurisdiction over the project.

2. In the case where a municipality authorized under N.J.S.A. 4:24-48 is the issuing agent, a copy of all ROC's and CRC's shall be submitted to the local District.

(i) No certificate of occupancy (CO) for a building or structure on a project, or any portion thereof, shall be issued by a municipality or any other public agency unless there has been an ROC or FROC issued by the district indicating compliance with the provisions of the certified plan for measures to control soil erosion and sedimentation. The district shall provide the municipality or other public agency with an ROC or FROC in accordance with (h) above.

(j) No temporary certificate of occupancy (TCO) for a building or structure on a project, or any portion thereof, shall be issued by a municipality or any other public agency unless a CRC or ROC is issued by the district. The district shall provide the municipality or other public agency with a copy of the CRC, ROC or FROC.

(k) During the non-growing season, as defined in the Standards for Soil Erosion and Sediment Control in New Jersey (the Standards), or where seasonal or weather related constraints exist, or where the applicant's scheduling has prevented or delayed final stabilization (for example, completed site work during winter), the District may issue a CRC or ROC in accordance with (k) 1 through 3 below.

1. Where the applicant has completed temporary stabilization and provided temporary erosion control measures in compliance with the certified soil erosion and sediment control plan, the applicant may request a CRC or ROC from the District. The District may also require the applicant to provide a performance deposit and enter into a performance agreement with the District to assure completion of final stabilization. In such instance, the District, at its option, may issue the CRC or ROC subject to the requirement that final stabilization be completed by the date indicated on the performance agreement such as, by the end of the next growing season, as defined in the Standards or such reasonable time period established by the District.

2. Upon receipt of the signed performance agreement and cash performance deposit, the District shall deposit the performance deposit into an interest escrow account with interest to accrue to the benefit of the applicant. The applicant shall sign and deliver to the District, any and all forms required by the District or its bank to open and maintain such interest bearing escrow account.

3. Upon completion of final stabilization by the applicant, the District shall return such performance deposit with interest to the applicant minus the administrative costs assessed by the District pursuant to (i)6 below.

4. Upon the failure of the applicant to timely or satisfactorily implement the permanent

stabilization in accordance with performance agreement and this section, the District shall provide written notification of such failure to the applicant together with a demand that such failure be fully cured within 10 calendar days of the date of such notification to the District's satisfaction or a later date established by the District.

If after such 10 calendar day period, or agreed-to time frame, such failure is not fully and properly cured to the District's satisfaction the District may utilize the applicant's performance deposit in order to contract for all work necessary or required to cure such failure and to complete all permanent measures in accordance with the performance agreement.

5. The District's rights and remedies pursuant to this subsection are in addition to all of its other rights and remedies under the law including N.J.S.A. 4:24-39 et seq.

6. The District may charge a fee in connection with the processing and administration of the performance agreement and performance deposit, which shall be listed in the District fee schedule, approved by the Committee.

(1) Any exempt municipality authorized by the Committee pursuant to N.J.S.A. 4:24-48, and implementing an approved ordinance thereunder shall implement these provisions.

2:90-1.15 Reports

The districts shall submit quarterly reports to the committee giving number of applications, number of certifications, denials and number of reviews and other information as required by the Committee. Reports shall be submitted to the Committee within 15 days after the end of each quarter. A copy shall be retained by the district.

2:90-1.16 Appeal process

(a) Any person aggrieved by a decision or action of the district shall first submit a written request for reconsideration to the district within 10 working days of the action taken. The district shall convene a meeting and make a determination on the request within 35 calendar days of the request unless additional time is mutually agreed upon by the district and the aggrieved person. All such proceedings shall be memorialized in the district minutes.

(b) To appeal the determination of the district, the aggrieved person shall subsequently petition the Committee in writing within 10 working days of the determination by the district. The Committee shall schedule a hearing and make a determination within 90 calendar days of the petition for review and notify the appellant pursuant to (c) below unless additional time is mutually agreed upon by the Committee and the aggrieved person. The Committee may appoint and utilize the hearing office procedures of the Department of Agriculture for fact-finding and recommendations to the Committee. The Committee may alternatively pursue an informal resolution of the matter contested. Any person against whom a stop-construction order is issued by any district shall also have the right to appeal directly to the

Committee. Requests for appeal shall be addressed to:

State Soil Conservation Committee
PO Box 330
Trenton, New Jersey 08625

(c) The Committee shall send a written notice to the appellant of the hearing stating:

1. The hearing application number; and
2. The date, time and place of the hearing.

(d) The 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.

(e) Any party who disagrees with the determination of the Committee may request a hearing pursuant to the Administrative Procedure Act, N.J.S.A. 52:14B-1 and 52:14F-1 et seq.

Chronology of Standards For Soil Erosion And Sediment Control in New Jersey

VEGETATIVE STANDARDS

Acid Soils Management: Adopted July 1999, July 2011
Dune Stabilization: Adopted June 1972, Revised January 1974, September 1979, April 1987, July 1999, July 2011
Maintaining Vegetation: Adopted June 1972, July 1999, July 2011
Permanent Vegetative Cover for Soil Stabilization: Adopted June 1972, Revised January 1974, September 1979, April 1987, July 1999, April 2013
Stabilization With Mulch Only: Adopted June 1972, Revised January 1974, September 1979, July 1999 , July 2011
Stabilization with Sod: Adopted June 1972, Revised January 1974, September 1979, July 1999, July 2011
Temporary Vegetative Cover For Soil Stabilization: Adopted June 1972, Revised January 1974, September 1979, April 1987, April 2013
Topsoiling: Adopted June 1972, Revised September 1979, July 1999,
Tree Protection During Construction: Adopted January 1974, Revised April 1987, July 1999, July 2011
Trees, Shrubs and Vines: Adopted January 1974, Revised July 1999, July 2011

ENGINEERING STANDARDS

Channel Stabilization: Adopted June 1972, Revised January 1974, September 1979, April 1987, July 1999, July 2011
Conduit Outlet Protection: Adopted September 1979, Correction November 1980, Revised April 1987, July 1999, July 2011
Detention Structures Formerly: Basin, Formerly Floodwater Retarding Structure. Revised April 1987, July 1999, July 2011
Dewatering: Adopted July 1999, Revised July 2011
Diversions: Adopted June 1972**,** Revised September 1979, April 1987, July 1999, July 2011
Dust Control: Adopted January 1974, Revised September 1979, April 1987, July 1999
Floodwater Retarding Structures: Adopted June 1972, Revised January 1974, July 1999, Changed to Detention Basin and Revised April 1987, July 1999
Grade Stabilization Structure: Adopted April 1987, July 1999, July 2011
Grassed Waterway*:* Adopted June 1972, Revised September 1979, April 1987, July 1999, July 2011
Land Grading: Adopted June 1972, Revised January 1974, April 1987, July 1999
Lined Waterway: Adopted September 1979, Revised April 1987, July 1999, July 2011
Off-Site Stability Analysis: Adopted July 1999, July 2011
Parking Lot Storage: Adopted April 1987, July 1999, Combined with Detention Structures, July 2011
Riprap: Adopted September 1979, Revised April 1987, July 1999, July 2011
Rooftop Storage: Adopted April 1987, July 1999, Combined with Detention Structures , July 2011

Sediment Barrier: Adopted September 1979, Revised April 1987, July 1999, July 2011
Sediment Basin: Adopted June 1972, Revised January 1974, September 1979, April 1987, July 1999, July 2011
Slope Protection Structures: Adopted June 1972, Revised January 1974, April 1987, July 1999, July 2011
Soil Bioengineering: Adopted July 1999, Revised July 2011
Stabilized Construction Entrance: Adopted September 1979, Revised April 1987, July 1999, July 2011
Storm Sewer Inlet Protection: Adopted September 1979, Revised April 1987, July 1999, July 2011
Stream Crossing: Adopted July 1999, July 2011
Traffic Control: Adopted January 1974, Revised April 1987, July 1999, July 2011
Turbidity Barrier: Adopted July 1999, July 2011
Underground Tanks: Adopted April 1987, July 1999, combined with Detention Structures , July 2011

RUNOFF TREATMENT STANDARDS
(merged into NJDEP Stormwater Best Management Practices Manual 2004)

Preface to the Runoff Treatment Standards: Adopted July 1999, Rescinded 2004
Dry Wells: Adopted July 1999, Rescinded 2004
Extended Detention Basin: Adopted July 1999, Rescinded 2004
Infiltration Structures: Adopted July 1999, Rescinded 2004
On Line Water Quality Storm Sewer Catch Basin: Adopted July 1999, Rescinded 2004
Sand Filters: Adopted July 1999, Rescinded 2004
Vegetative Filter Strips: Adopted July 1999, Rescinded 2004
Wet Ponds: Adopted July 1999, Rescinded 2004

APPENDIX A

The Universal Soil Loss Equation: Published June 1972, Revised September 1979, April 1987 , July 1999
Requirements for a Soil Erosion and Sediment Control Plan: Published June 1972, Revised 1976, November 1982, April 1987, July 1999, July 2011
Guide for Construction Specifications: Published June 1972, Revised July 1980, November 1982, April 1987, July 1999
Maintenance of Structural Measures: Published June 1972, Revised April 1987, July 1999
Guide for Installing Soil Stabilization Matting: Published June 1972, July 1999
Diversion and Grassed Waterway Design Procedure: Published July 1980, Revised April 1987, July 1999
Sediment Basin Design Procedure: Published July 1980, July 1999
Channel Stability Analysis Procedure: Published July 1980, Revised April 1987 Modified Rational Method: Published April 1987, July 1999

Structural Guidelines for Detention Basin. Published April 1987 REFERENCES: Published June 1972, Revised January 1974, July 19676, July 1980, April 1987 , July 1999, Karst Remediation Measures separated as a stand-alone document July 2011

APPENDIX B

Example for Seed Specifications Published June 1972, Revised July 1999
Grass and Legume Planting Guide: Published June 1972, Revised July 1999

APPENDIX C

Soil Erosion and Sediment Control Act Effective January 1, 1976, Amended October 18, 1977, February 27, 1980, January 5, 2011
New Jersey Administrative Code 2:90-1.1 et seq: Effective January 1, 1976, Amended January 5, 1978, July 3, 1980, Readopted June 24, 1985, Amended April 6, 1987, Revised July 1999, January 2006, June 2008, February 2014
Chronology of Standards for Soil Erosion and Sediment Control in New Jersey: Published July 1980, Revised November 1982, April 1987, July 1999, July 2011

APPENDIX D

Glossary: Published June 1972, Revised July 1980, April 1987, July 1999

APPENDIX E

Directory Soil Conservation Districts in New Jersey: Published June 1972, Revised January 1974, July 1976, July 1980, November 1982, April 1987, July 1999, July 2011

APPENDIX K

Investigation, Design and Remedial Measures for Areas Underlain by Cavernous Limestone
Revised as a stand-alone appendix July 2011

APPENDIX D
G L 0 S S A R Y

Acre-feet - An engineering term used to denote a volume 1 acre in area and 1 foot in depth.

Acid Soil - (high acid producing)Soil containing iron sulfide material, which on exposure to air, results in the production of sulfuric acid and is accompanied by pH levels falling to 3 or below. Treatment with limestone only provides a short term buffering effect with burial at a minimum of 12" of non acid producing soil is the only effective treatment .

Aggrade - The alteration of a channel caused by the deposition of sediment.

Allowable velocity - the velocity of flowing water within a defined channel or landform which will not scour and transport surface soil. Non-scouring velocities differ with different soil types.

Anti-seep Collar - A device constructed around a pipe or other conduit placed through a dam, dike, or levee for the purpose of reducing seepage losses and piping failures.

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.**

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.

Cabled Concrete (articulated concrete block)- Blocks of concrete (typically 1' x 1') strung together with a non-corroding metal cable. Used for lining of waterways, shorelines etc.

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.

Conduit - A closed facility used for the conveyance of water.

Cool Season Mixture - Grasses or legumes which maximize growth at temperatures below 85 degrees F.

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.

Crimper - (mulch anchoring coulter tool) A tractor drawn implement, somewhat like a disc harrow designed to push or cut some broadcast, long fiber mulch, such a straw, into the soil 3 to 4 inches so as to anchor it to the soil.

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 an the lower side constructed across or at the bottom of a slope for the purpose of intercepting surface runoff.

Dune - A mound or ridge of sand which has been formed by wave or wind action.

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 Dissipater - 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 ovendry weight of the soil. Also called field moisture capacity.

Filter Blanket - A layer of sand, gravel, or synthetic fabric designed to prevent the movement of fine grained soils.

Filter Strip -A strip of planted or indigenous vegetation used to filter pollutants from surface runoff before reaching a body of water or stormwater management structure

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.

Flexible Channel Liner - An open-textured, three-dimensional rolled product manufactured from non-degradable materials which is laid on the prepared soil surface to act as a substrate for the establishment of grass cover in open waterways.

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.

Froude Number - The ratio of inertial to gravity forces in flowing water. It is used to classify the flow as subcritical, critical or supercritical (e.g. Nf >1, Nf = 1 or Nf<1) Froude number is expressed as:

$$N_f = \frac{V_{channel}}{\sqrt{2gd}}$$ Where d is the hydraulic flow depth

Geotextile - A broad range of ■fabric• type materials which contain or filter soil or water. Fabrics may be permeable or impermeable and may or may not be degradable.

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 there-of 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.

Hydraulic Conductivity - A coefficient describing the rate at which water can move through a permeable medium.

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.

Hydroseeding - The application of a seed - fertilizer liquid slurry to the soil surface of the prepared seedbed using an apparatus consisting of a storage tank, pump and hose.

Inoculant - A peat carrier impregnated with bacteria and applied in powder or slurry form to legume seed at the time of planting, which form a symbiotic relationship enabling legumes to utilize atmospheric nitrogen for plant growth. Most 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.

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.

Liquid Mulch Binder - Organic, synthetic and asphaltic based materials which are physiologically harmless to plant growth and not result in a phytotoxic effect, mixed with water and applied to straw, hay mulch or salt hay to anchor mulching materials together and prevent movement.

Mannings Formula - A formula used to predict the velocity of water flow in an open channel or pipeline:

$$V = \frac{1.49}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

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.

Mulch Netting - Paper, jute, cotton or plastic netting materials applied to seeded and mulched areas, usually on slopes or critical areas to prevent erosion and promote seedling establishment.

Mulch Blanket - Plastic netting lined with straw or excelsior fibers, placed and anchored onto seeded areas, usually on slopes or critical areas to prevent erosion and promote seedling establishment.

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.

Pelletized Mulch - Compressed and extruded paper or wood fiber product which may contain copolymers, tackifiers, fertilizer and coloring agents, applied a dry form to seed bed and activated with water to form a mulch mat. Uniform distribution and adequate initial watering of the mulch is critical to optimum results.

pH - A measure of acidity or basicity of soil with pH 7 being neutral and pH 6.5 being a desirable degree of soil acidity for growth of grasses and legumes. Basicity above pH 7 is rare in eastern U.S. soils.

Pipe Drop - A circular conduit used to convey water down steep grades.

Plant Hardiness Zone - Geographic regions differentiated by climate and growing conditions.

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.

Preformed Scour Hole - An area at the outlet end of a storm drain at an elevation essentially the same as the outlet invert which has been excavated and lined with stone which provides both vertical and lateral expansion downstream of the outlet to permit dissipation of excess kinetic energy in turbulence.

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.

Pure Live Seed - The desired amount of any warm season grass seed to be planted for temporary and permanent stabilization which excludes the weight of inert matter, non viable and undesirable seed as expressed on the seed tag. A practical adjustment is made by multiplying the weight of the bag of seed x per cent purity x per cent germination = the amount of pure live seed contained in the bag.

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.

Retention Basin - A stormwater management basin which provides storage for a permanent pool of water below the stormwater management storage volume elevation.

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 - Angular broken rock placed on earth surfaces, such as the face of a dam or the channel of a stream for protection against the action of water.
Riser - The inlet portion of a drop inlet spillway that extend vertically from the pipe conduit barrel and control the water surface

Scour Hole - See preformed scour hole.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin 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 Bioengineering - The use of native plant species together with natural materials (rocks, logs, and vegetative byproducts such as coconut fiber) and hydrologic, hydraulic and soil engineering principles to provide restoration to streambanks, slopes and open water shorelines which are subject to the forces of wind and water erosion.

Soil Horizon - A layer of soil, approximately parallel to the surface. that has distinct characteristics produced by soil-forming processes.

Spillway - A form of principal spillway.

Stability - A condition within a channel or on a landform such that flowing water will not erode the soil surface.

Stabilized Center Section - an area in the bottom of a grassed waterway protected by stone, asphalt, concrete or other materials to prevent erosion.

Storm Frequency - An expression or measure of how often a hydrologic event of given size or magnitude should on an average be equaled or exceeded. The average should be based an a reasonable sample.

Straight Drop Spillway - A form of principal spillway.

Straw - The natural dry stem and related material threshed of its seed.

Tailwater - The depth of the receiving water at the end of the apron.

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.

Trash Rack A device used to prevent debris from entering a spillway or other hydraulic structure.

Topdressing - The application of additional nitrogen based fertilizer to vegetation as a follow-up to initial fertilizer applications to help combat nitrogen deficiency.

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, placement of cultivated sod onto prepared topsoil causing instant soil stabilization.

Velocity - The rate of flow measured in feet per second.

Warm Season Mixture - Grasses or legumes which maximize growth at temperatures below 85 degrees F.

Waterway - A natural course or constructed channel for the flow of water. See grassed waterway.

Watershed - a geographic area defined by topographic high points such that precipitation falling within the boundaries of the high points drains to a single outlet, such as a mouth of a stream, lake or river.

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**Investigation, Design and Remedial Measures for Areas
Underlain by Cavernous Limestone**

Introduction

Carbonate rocks, including limestone, dolomite and marble, underlie the land surface in many areas of northwestern New Jersey (FigureA10- 1). Carbonate rocks primarily occur in valleys, because they are easily eroded. Soil erosion processes in areas underlain by carbonate bedrock are unique, because carbonates are highly susceptible to chemical erosion ("solutioning") and their associated soils subject to collapse. Weak acids formed by the combination of infiltrating ground water and carbon dioxide in the soil attack carbonate rocks, causing the formation of voids, known as solution cavities, in these otherwise competent rocks. . Sinkholes, caves, disappearing streams, springs, bedrock pinnacles, and "blind valleys" develop on soluble carbonate rock. These features are characteristic of a type of landscape known as "karst."

Percolation of surface water can cause a migration of soil into solution cavities, forming "sinkholes" at the surface. Sinkholes cause instability of the land surface and must be given serious consideration in the development of soil and sediment erosion control plans. Sinkhole formation is often accelerated by construction activities that modify a site's hydrology or disturb existing soil and bedrock conditions. Ground failure in karst areas is most often caused by the alteration of drainage patterns, emplacement of impervious coverage, excessive grading, and increased loads from site improvements.

An awareness of the limitations to site development posed by karst features can prevent problems, including damage to property, structures and life, and contamination of ground water. Appropriate site testing, planning, design, and remediation help to prevent sinkhole formation during site development. Conventional methods of design and engineering may be inappropriate for karst areas. Often minor modifications in the approach to site testing and design can prevent persistent and costly post-development problems.

Site testing for detection of potential karst-related problems

The most effective and economical approach to designing and installing a successful soil erosion and sediment control system in karst areas is to evaluate the potential for ground failure by first collecting easily obtainable information on surface and subsurface conditions prior to construction activities. Applicants filing for certification of Soil Erosion and Sediment Control Plans are encouraged to determine if their site lies within an area underlain by carbonate bedrock. Figure 1 shows the occurrence of carbonate units in northern New Jersey. To obtain more detailed geologic maps, applicants may contact the New Jersey Geological Survey at the following address:

> New Jersey Geological Survey
> P.O. Box 427
> Trenton, N.J. 08625
> 609-292-2576 or 292-1185

Various methods are available to collect information about the bedrock and soil conditions at a proposed development site. These can range from inspecting topographic and geologic maps and aerial photographs of the site, to drilling test borings at the location of planned facilities. Professionals involved with projects in karst areas should make a special effort to observe signs of ground subsidence during development

Site evaluation for karst features is usually carried out in two phases: (1) *preliminary site investigation*, done prior to site design and development, and (2) *site-specific investigation*, conducted once the decision is made to design a site plan and proceed with development.

Preliminary site investigation includes a review of topographic and geologic maps, soil surveys, aerial photography, and any previous technical reports prepared for the site. This phase of investigation should include a site visit, where the experienced professional studies the site terrain in an effort to locate any obvious features, such as rock outcrops, sinkholes, springs, caves, etc. The purpose of the preliminary investigation is to identify areas of concern that may require additional investigation, and to review the preliminary site design in relationship to potential problem areas. The preliminary site investigation will often result in immediate changes to the site layout to avoid future problems.

Site-specific investigation includes collecting subsurface information at sites identified as potential problem areas during the preliminary investigation. During the site-specific investigation process the professional may examine subsurface soil and geologic conditions using test pits, test borings, and geophysical instruments to evaluate the stability of soil and rock at locations of proposed site facilities. If unstable subsurface conditions are encountered, a decision can be made to proceed to remediate prior to construction or to modify the site layout to avoid problem areas. The record of findings during this phase of the investigation includes logs of test pits, probes and borings, noting evidence of cavities in soil and rock, loss of air pressure or drilling fluid during drilling, and the condition of soil and bedrock from samples collected.

Table K-1 lists the steps in the preliminary site investigation and the site-specific investigation, methods of collecting data, objectives of each step, and the application of information obtained. A discussion of the various site investigation methods follows:

Geologic maps: Geologic maps contain information on the physical characteristics and distribution of the bedrock and/or unconsolidated surficial deposits in an area. Geologic features such as the strike and dip of strata, joints, fractures, folds, and faults are usually depicted. The orientation of strata and geologic structures generally controls the location and orientation of solution features in carbonate rock. Geologic contacts, faults, and certain fractures sets may be more prone to solution than others. The relationship between topography and the distribution of geologic units may reveal clues about the solubility of the specific rock units. Geologic maps are often available at various scales, the most common being 1:24,000. Digital geologic data may be available as well.

Aerial photography: Aerial photos are a simple, quick method of site reconnaissance. Inspection of photos can quickly reveal vegetation and moisture patterns that provide indirect evidence of the presence of cavernous bedrock. Piles of rock or small groups of brush or trees in otherwise open fields can indicate active sinkholes or rock pinnacles protruding above the ground surface. Circular and linear depressions associated with sinkholes and linear solution features and bedrock exposures are often visible when viewed in stereo image. Inspecting photos taken on more than one date can be especially valuable in revealing changes that take place over time. Images defined at wavelengths other than visible light can be useful in detecting vegetative or moisture contrasts.

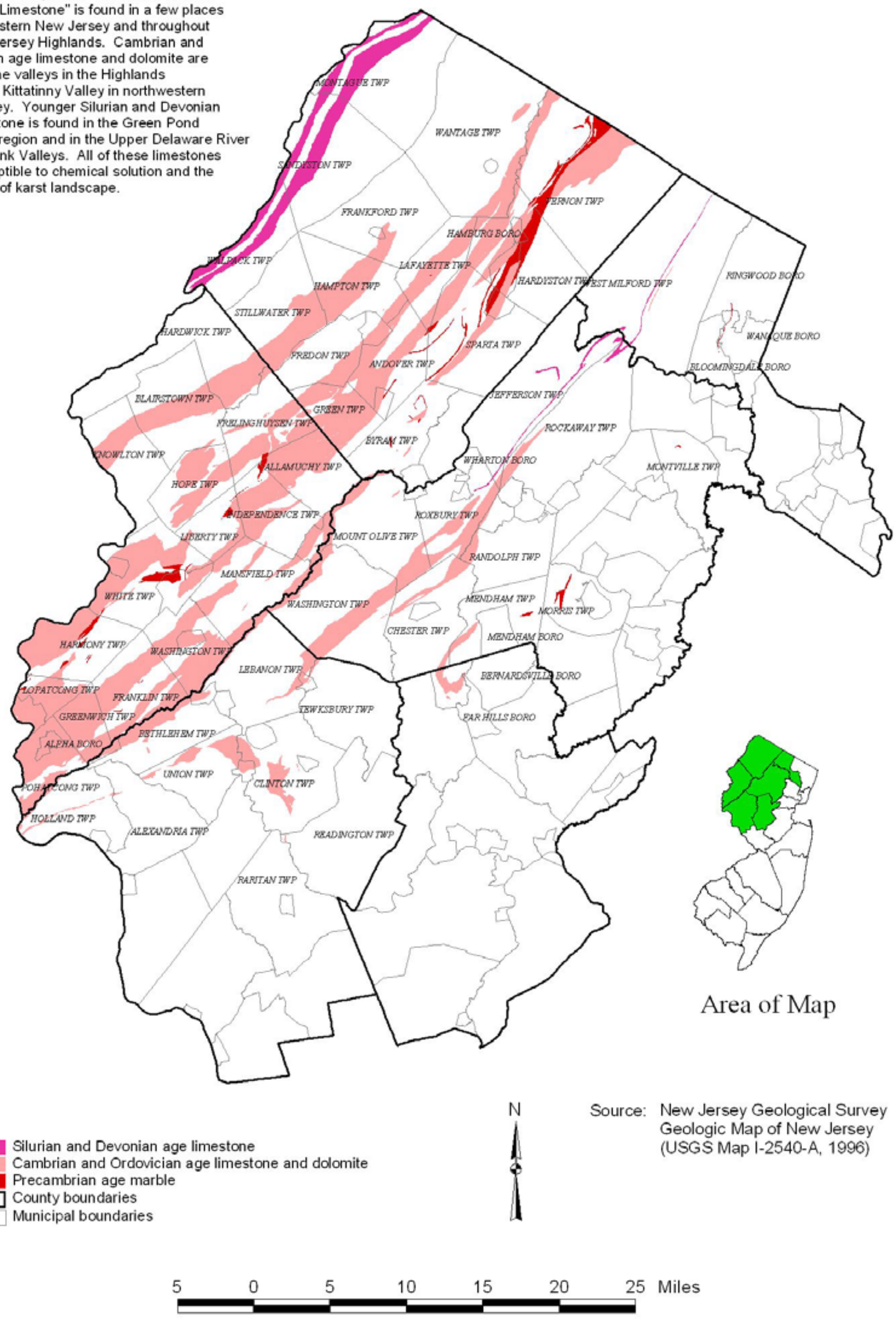
Site visit: An on-site reconnaissance is an inexpensive, important step in finding potential site constraints. Although many karst features are obvious to the eye, it is an advantage to conduct the site visit with an individual knowledgeable in karst geology. Prior to the site visit field personnel should review geologic maps, topographic maps, and air photos to help anticipate where problems might be found. It is important to review drainage patterns, vegetation changes, depressions, and bedrock outcrops to look for evidence of ground subsidence. Sinkholes in subdued topography can often only be seen at close range. Disappearing streams are common in karst areas, and bedrock pinnacles that can be a problem in the subsurface will often protrude above the ground surface. A particularly simple and often overlooked part of the site visit is to interview the property owner. Often property owners can recount a history of problems with ground failure that may not be evident at the time of the site evaluation. The location of karst features should be noted on the site map for later reference. These can be compared to other information collected to assess the risk potential for karst-related problems.

Figure K-1

Limestone Geology of Northern New Jersey

Limestone bedrock is found throughout northern New Jersey. The term limestone can be used to refer to rocks that include marbel, dolomite, or true limestone. Marble or "White Limestone" is found in a few places in northeastern New Jersey and throughout the New Jersey Highlands. Cambrian and Ordovician age limestone and dolomite are found in the valleys in the Highlands and in the Kittatinny Valley in northwestern New Jersey. Younger Silurian and Devonian age limestone is found in the Green Pond Mountain region and in the Upper Delaware River and Minisink Valleys. All of these limestones are susceptible to chemical solution and the formation of karst landscape.

Note: Depth from surface to formations varies greatly throughout the region.



Test pits: Test pit excavations are a simple, direct way to view the condition of soils that may reveal the potential for ground subsidence, and to inspect the condition and variability of the limestone bedrock surface where bedrock is sufficiently shallow. Soil texture is an important indicator of soil strength and, therefore, the ability of soils to bridge voids. An inspector should look for evidence of slumping soils, former topsoil horizons, and fill (including surface boulders, organic debris, and other foreign objects) in the test pit. Voids in the soil or underlying bedrock can be revealed. The presence of organic soils at depth is an indicator of potentially active sinkhole sites. Leached or loose soils may also indicate areas of existing or potential ground subsidence. Observations of this type should be recorded in the soil log.

Test probes: Test probes are performed by advancing a steel drill bit into the ground using an air-percussion-drilling rig. Probes can be installed rapidly and are an effective way to quickly test subsurface conditions. Penetration depths are usually less than 50 feet. During the installation of a test probe the inspector should be aware of the rate of advance of the drill bit, sudden loss of air pressure, soft zones, free-fall of the bit, and resistant zones. These observations can provide clues to the competency of the bedrock and the presence of cavities in soil or bedrock. The volume of fluid cement grout needed to backfill the probe hole can yield a measure of the size of subsurface voids encountered during drilling.

Test borings: Test borings often yield virtually complete and relatively undisturbed soil and rock samples. Borings may provide direct evidence of the presence and orientation of fractures, weathering, fracture fillings and the vertical dimensions of cavities, and provide undisturbed samples that can be subjected to laboratory testing. Use of a split inner core barrel in rock coring provides the most meaningful results, because this method collects a relatively undisturbed sample in the core barrel. Losses of drilling fluid can indicate the presence of soil or rock cavities. When drill holes are sealed, the volume of fluid cement grout placed in the drill hole can also yield a measure of the size of openings in the subsurface. All borings must be performed by a well driller or test borer licensed by the New Jersey Department of Environmental Protection under N.J.S.A. 58:4A-4.1 et seq. Borings should be sealed after completion. Borings less than 25 feet deep may be sealed with cuttings from the boring. Borings in excess of 25 feet must be sealed according to procedures published by the NJDEP Bureau of Water Allocation (609-292-2957).

Geophysical methods: Geophysical methods can serve as a rapid reconnaissance tool to detect physical anomalies in the subsurface that may be caused by karst features. These methods are especially suited to surveying linear corridors, and are non-disruptive to the land. Geophysical data are often useful for extrapolating between locations where other sampling methods are used. Generally it is advisable to apply more than one geophysical technique, owing to the variability in physical properties of karst terrain. Geophysical methods require an experienced professional to interpret the data collected. The properties of weathered limestone, including a highly variable bedrock surface and soils with high clay content, often hinders the depth of penetration and resolution of geophysical signals and can compromise the effectiveness of geophysical surveys. Despite these limitations, geophysics can sometimes provide a cost-effective, relatively rapid means of determining the potential for problems with karst features, including the location of shallow bedrock and significant cavities in the soil or bedrock. Geophysical anomalies should be targeted for additional direct testing procedures.

Table K-1: Investigative Methods for Sites Underlain by Carbonate Bedrock

Tool	Sources	Subject of Interest	Significance
Phase 1 - Preliminary site investigation			
Geologic maps	New Jersey Geological Survey (1)	Is carbonate rock present	Indicates karst risk present
	United States Geological Survey (2)	Risk level based on geologic unit(s) present	Indicates possible extent of problem
	County planning agencies	Presence and location of faults and folds	Indicates condition of rock, location of high-risk areas
	Township environmental resources inventory	Orientation of strata and joints	Indicates relationship of karst features to one another
	Original report for site by qualified geologist		
Aerial photography	U.S.D.A. Natural Resource Conservation Service (3)	Land cover for site	Significance of previous land use
	N.J.D.E.P. Land Use Regulation Program (4)	Location of hedge rows	High probability areas for sinkhole
	New Jersey Geological Survey (1)	Presence of vegetation in cultivated fields	High probability areas for sinkholes and outcrops
	United States Geological Survey (5)	Circular patterns	High probability areas for sinkholes
	Private aerial survey firms	Linear patterns	Presence of "sags," outcrops, faults, fracture zones
		Differential shading	Subsurface drainage patterns
Topographic maps	United States Geological Survey (2)	Site relief	Presence of steep slopes
	New Jersey Geological Survey (1)	Site drainage patterns	Natural of modified drainage
	Private camping stores, bookstores	Natural depressions	High probability areas for sinkholes
		Land cover	Significance of previous land use
Site field visit	Observations of reconnaissance party	Previous experiences with sinkholes, springs, et	History of karst-related problems
	Observations of previous owners or land users	Land-use changes over time	Controlling factors on land use
		Drainage patterns	Surface drainage patterns; disappearing streams, springs
		Identification of features on maps, photos	Identification of potential karst hazards, test sites
Phase 2 - Site-specific investigation			
Test pits	Previous logs collected at site	Presence of voids in soil	High probability areas for sinkholes
	Logs performed on site	Presence of soft or organic soils	Previous sinkhole activity; high risk for reactivation
		Depth to shallow bedrock	Obstacles to underground facilities; pollution hazard
		Voids in bedrock	High probability areas for sinkholes; pollution hazard
		Condition of shallow bedrock	Risk to excavation, loads
		Bedrock topography	Need for excavation, blasting.
Test probes	Private drilling or blasting firms (percussion probe)	Thickness of unconsolidated overburden	Potential for or potential size of, subsidence features
		Competency of unconsolidated overburden	Potential for ground subsidence
		Presence of voids in soil	High probability areas for sinkholes; need for foundation elements
		Presence of voids in bedrock	High probability areas for sinkholes; need for foundation elements
		Condition of bedrock	Foundation element design
		Circulation of air in rig	Presence of voids
Test borings	Private drilling firms (coring rig)	Condition of unconsolidated overburden	Potential for subsidence; foundation design
		Voids in unconsolidated overburden	Potential for or potential size of subsidence features
		Condition of bedrock	Sinkhole risk; foundation element design
		Voids in bedrock	Presence and size of voids/sinkhole risk
		Water circulation	Presence and size of voids in overburden or bedrock
Geophysical surveys	Private geotechnical firms	Geophysical anomalies	Potential location and size of karst features Location for additional subsurface data collection
		Bedrock topography	Need for excavation, blasting.

(1) New Jersey Geological Survey, P.O. Box 147, Trenton, NJ 07825, 609-292-2576, 609-633-1004 (fax), URL: http://njgs.state.nj.us

(2) U.S. Geological Survey, Information Services, Box 25286, Denver, CO 80225, 1-800-USA-MAPS, 303-2-2-4693 (fax), URL: http://mapping.usgs.gov/esic/to_order.html (local dealers also available)

(3) USDA Natural Resources Conservation Service, State Soil Scientist, 732-246-1171, ext. 170

(5) U.S. Geological Survey, EROS Data Center, Customer Services, Sioux Falls, SD 57198, 605-594-6151, 605-594-6589 (fax),
e-mail: custserv@edcmail.cr.usgs.gov, URL: http://edcwww.cr.usgs.gov/eros-home.html

Procedures to follow if karst features are identified during investigation

The site investigations described above may reveal the location of suspected areas of ground subsidence. These findings should be compared to the proposed layout of site facilities. Wherever possible, facilities should be sited to avoid suspected areas of potential ground subsidence. Where relocation of facilities is not practical, remedial measures and design standards can be employed to minimize future ground failure. Remedial sealing of voids in the soil or bedrock and /or compaction of soil and rock voids may be a viable in some areas.

Site Design and Construction General Guidelines

Site design and construction procedures can be important in reducing the risk of sinkhole development. Sinkholes most often form in areas where storm-water runoff is concentrated, where bearing loads are concentrated, and where ground water is pumped in large volumes. When development is proposed consideration should be given to the following general guidelines to minimize the risk of ground failure:

Minimize site disturbance, including cuts and fills and drainage alteration.

Minimize impervious surface so as to minimize the volume of surface runoff generated.

Employ storm-water management measures that minimize flow velocities and ponding to avoid erosion of over-saturation of soils.

Waterproof pipefittings and pipe-to-basin fittings to minimize underground leaks. Leaks weaken and erode soils around underground conduits.

Place foundations on sound bedrock.

Soil Erosion and Sediment Control Facilities General

The selection, design, and implementation of soil erosion and sediment control practices in karst areas should be guided by the following objectives and should incorporate the following design elements:

The site should be designed to take maximum advantage of topography. Modifications of site topography should be minimized.

Changes to the existing soil profile, including cuts, fills, and excavations, should be minimized.

Where practical, drainage facilities should consist of embankments at or above grade. Excavation into the existing soil profile to construct swales and basins should be minimized to the degree possible.

Temporary and final grading of the site should provide for drainage of storm-water runoff away from structures.

All storm-water management facilities, including grassed waterways, diversions and lined waterways, should be designed to disperse the flows across the broadest channel area possible. This reduces the level of soil saturation and reduces the potential for soil movement. Shallow trapezoidal channel cross sections are preferred over parabolic or v-shaped channels.

Sedimentation and detention basins should be used as a last resort for sediment control in karst areas, and should be used only after other designs have been considered and rejected. Consideration should be given to constructing basins required for permanent storm-water detention at the end of the project, after the site has been stabilized. Vegetative cover should be established as rapidly as possible over exposed areas. Construction scheduling should strive to minimize the time that soil excavations are open and non-vegetated. This reduces the time that the site is exposed to periods of concentrated flows as well as preventing excessive drying of soils.

Utility trenches should be back filled with in-situ soils or low permeability fill material to discourage sub-surface water flow along the trench. Clay dams may be used at intervals along the trench excavation to impede subsurface flow along the trench. Trench backfill should be compacted to prevent future settlement and ponding. Backfill densities for open areas should exceed 90% of ASTM D-1557 maxima. Densities for areas supporting structures such as roadways should equal or exceed 95% ASTM D-1557 maxima. All underground piping should have water -tight fittings. The piping should be designed to withstand some limited displacement due to the probable ground settling and/or downward migration of trench bedding material into solution features.

Storm-water facilities design waterways

Storm-water conveyance structures to be used in karst areas should be designed in such a way as to dissipate overland flow over the largest area possible. Every attempt should be made to avoid concentration of flows and ponding. Grassed waterways can be effective storm-water-diversion structures in karst areas. Particularly effective are waterway designs that are shallow and broad, providing maximum bottom width and wetted perimeter to disperse flow over the greatest area. Grassed waterways in karst areas should be designed in accordance with standards provided in "Standard for Grassed Waterways" (pg. 18-1).

Storm-water facilities design sedimentation and detention basins

Sedimentation and detention basins in karst areas have a poor performance history. Collapse of the basins and basin inlet and outlet structures is common. Detention basins are particularly vulnerable to collapse in karst areas, because they are designed to concentrate and detain surface-water runoff. Ponding and associated soil saturation occur where surface-runoff is concentrated. Saturation of fine-grained soils that develop on weathered limestone can cause reduction in soil strength and erosion into bedrock voids.

Methods traditionally used to reduce or eliminate excessive seepage from an impounded area may have limited success in limestone areas. Traditional sealing methods include compaction, clay blankets, bentonite treatment and flexible membrane liners. The sealing of the solution channels in bedrock beneath the basin area can reduce seepage and soil displacement into underlying voids.

When they function properly, detention basins can be effective in removing contaminants commonly found in storm water, including heavy metals, nutrients, herbicides, pesticides, solids, and bacteria. Most of these contaminants are attenuated by sedimentation and soil filtration in the basin bottom. Sinkholes undermine the beneficial effects of basins on water quality by allowing introduction of untreated surface runoff directly to ground water. They "short-circuit" the hydraulic benefits of basins by allowing bypassing of outlet structures.

Detention basin sites can be evaluated and facilities designed and retrofitted to guard against sinkhole formation and improve performance from a water-quality perspective. Testing procedures and design elements recommended to minimize detention basin failure include:

Minimize the coverage of the site by impervious surfaces, so that detention basin size will be minimized.

Evaluate soil texture. The basin should be constructed to minimize excessive seepage (Fig. K-2). Highly cohesive soils such as silt and clay loams may require minimum preparation of basin bottoms. Soils with low cohesive strength, such as sandy loams may require compaction and/or replacement or modification by the addition clay binders or by installation of liners. Acceptable practices for installing liners are summarized in Table K-2.

Investigate soils and bedrock below the basin for presence of voids. Repair existing voids and/or perform preventative grouting of basin substrate.

- Basin profiles should be broad and flat to allow maximum dispersion of detained flow.
- Basin bottoms should be smooth to avoid ponding.

- Inlet and outlet structures should be designed to provide diffuse discharge of water; avoid concentration of flows. Under drains are preferred to provide gradual discharge of water and to avoid prolonged ponding of water. Refer to Appendix A-7 for sediment basins for design and installation of under drains.

- Repair sinkholes that occur in basin after construction.

Table K-2. Appropriate liners for sedimentation and detention basins

Practice Standard (1)	**Practice**
521-A	Pond sealing or lining - Flexible membrane
521-B	Pond sealing or lining - Soil dispersant
521-C	Pond sealing or lining - Bentonite sealant
521-D	Pond sealing or lining - Cationic emulsion waterborne sealant
521-E	Pond sealing or lining - Asphalt sealed fabric liner

(1) USDA National handbook of conservation practices, IV. Standards and practices.

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Figure K-2 Determination of Specific Discharge

Determination of Specific Discharge:

1. Given: $Q = K \cdot (h/d) \cdot A$ (Darcy's Law)

2. Where: Q = discharge (seepage)
   K = hydraulic conductivity of soil (this is the permeability "k" commonly used in soil engineering)
   (h/d) = hydraulic gradient
   h = maximum vertical distance measured between the top of the manure and the bottom of the soil liner
   d = depth of soil liner
   A = cross-sectional area of flow

3. Rearranging terms:
   $Q/A = K \cdot (h/d)$

4. Or: $K \cdot (h/d) = v$

5. Where: v = specific discharge, or seepage per unit area; v has the dimensions of velocity, ie, distance/time. \1

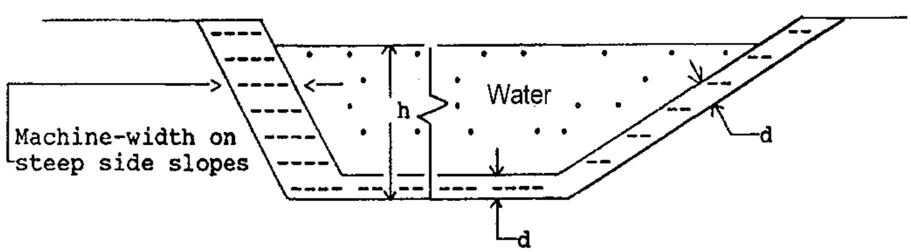

Figure 1: Schematic Relationship of Liner to Hydraulic Gradient

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\1 Specific discharge with units of velocity is a theoretical velocity through the full cross-sectional area (comprised of pores and solids alike). Actual flow moves only through the soil pores, the area of which can be computed by multiplying the full cross-sectional area (A) by porosity (n). A seepage front moves at the rate of specific discharge divided by porosity (v/n). In compacted fine grained soil porosity will usually range from 0.3 to 0.5. This gives an average linear velocity of the seepage front approximately 2 to 3 times the specific discharge.

REF: NRCS, AWMFM Amend. N3
March 1988

Blasting

Rock blasting with explosives can cause soil collapse and cavern collapse, leading to sinkhole development. Specific guidance should be developed in accordance with applicable state and federal laws. For further information on applicable state laws contact the New Jersey Department of Labor, Office of Safety Compliance (609-292-2096). Blasting guidelines are designed to protect structures against damage. Mobilization of unstable soils or rock in karst areas may be brought about at velocities lower than those specified in the regulations.

Response and remediation of sinkholes occurring during construction

It is common for sinkholes to form during construction of a project. Sinkholes that occur during construction should be repaired immediately to prevent their enlargement and associated adverse impacts. When sinkholes occur during construction the site supervisor should take the following steps:

- Report the occurrence to the Soil Conservation District within twenty-four (24) hours of discovery;
- Halt construction activities in the immediate area of the sinkhole until it is stabilized. Secure the sinkhole area.
- Direct the surface water away from the sinkhole area, if possible, to a suitable storm-water drainage system.
- Select a remedial measure from Section 2 (following). Communicate proposed remediation plan to the Soil Conservation District. Some jurisdictions may have local requirements for notification and review as well.
- Repair any damage to soil erosion and sediment control improvements and restore ground cover and landscaping;
- In those cases where the hazard cannot be repaired without adversely affecting the soil erosion and sediment control plan design, the applicant should arrange a conference with the Soil Conservation District to discuss modifications to the plan.

The type of repair chosen for any sinkhole depends on its location, the extent and size of the void, the type of infrastructure planned for the sinkhole area, and the financial and technical resources available to the developer of the site. Sinkhole sealing methods can include the use of available on-site materials, dry or wet grout, filter material and geotextiles.

Treatment methods for repairing sinkholes can be found following the bibliography of selected references.

All sinkhole remediation activities should be under the direct supervision of a geologist, or geotechnical engineer with experience in limestone investigations and remediation practices. A certified professional should perform all borings.

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(USDA manuals and handbooks can be obtained through the National Technical Information Service Research Department, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA, 22161, 703-487-4780, 703-321-8541 (fax))

Section 2 - Sinkhole Treatment

Definitions

A sinkhole is a surface depression caused by collapse of soil or bedrock into cavities in soluble bedrock. Sinkhole treatment is the cleaning out, excavation, and back filling of a sinkhole, and treatment of the associated drainage area to prevent its expansion or recurrence.

Purpose

The purpose of sinkhole treatment measures is to repair sinkholes by addressing their cause, which is typically a solution cavity in bedrock. Objectives include stabilization of the ground surface at the site of the sinkhole and prevention of ground-water pollution.

Applicability

Sinkhole treatment practices should be applied where geologic conditions have resulted in the development of sinkholes, where contaminated water and/or soils have the opportunity to enter sinkholes and pollute ground water, and where land management measures can be made more effective by treating sinkholes. Considerations for selecting the appropriate treatment measure include:

geologic conditions, including depth to bedrock and size of cavernous zone(s);

dimensions of sinkhole;

presence or absence of open "throat";

existing and planned land use;

sinkhole drainage area;

quality and volume of surface-water runoff;

need for filter strip or other water-quality measure;

nature of "clean-out" material;

availability and quality of materials;

project budget;

safety of labor and equipment during and after treatment.

proximity to permanent structures.

Planning Considerations

A systematic approach should be used in treating both the sinkhole and its drainage area. A determination must be made as to whether the sinkhole should continue to receive surface-water runoff, or if runoff should be diverted from the treated area. A sinkhole treated in such as way as to continue to receive runoff may be referred to as a "drainage sinkhole." Drainage sinkholes are appropriate where the drainage area is small, water quality is high, or control of the watershed is not feasible. Drainage sinkholes should work in conjunction with water-quality improvement practices, such as conservation cropping systems, nutrient management practices, filter strips, and conservation practices that control sheet, rill, and gully erosion.

The treatment design should not result in ponding of surface water or high soil moisture conditions. Diverting surface water from a sinkhole should be considered if runoff is contributing to its formation or expansion, or if the quality of the runoff entering the sinkhole is unsatisfactory. Surface water can be excluded by sealing the sinkhole and/or diverting runoff away it. Sinkholes can be sealed by effective compaction of backfill material that minimizes infiltration. The drainage area contributing runoff to the sinkhole area should be minimized to the extent practical through the use of diversions, waterways, graded terraces, surface inlets, or outlets, as required.

Site Investigation Prior to Treatment

A site investigation should be extensive enough to determine if the sinkhole could be treated effectively for the intended purpose. The site investigation should address geology, soils, hydrology and water quality. An area larger than the extant sinkhole may need to be addressed to prevent future sinkhole development.

The geologic investigation of the sinkhole site should be extensive enough to determine the following:

depth to bedrock;

susceptibility of bedrock to solution;

depth to suspected void(s);

presence of or potential for other sinkholes in the treatment area.

The minimum site-specific soil investigation should be extensive enough to define the following:

filter requirements of the soil;

availability of backfill;

compaction requirements of the backfill;

moisture changes that may affect stability.

The minimum hydrologic and hydraulic considerations include:

drainage area to the sinkhole area;

design runoff rates to the sinkhole if water is to be diverted;

stable outlets for proposed waterways, diversions, etc.

The minimum water quality considerations include:

present and future water quality impairments of the inflow;

identification of and nature of the receiving water body and/ or aquifer.

Treatment Methods, Designs, and Procedures

A. Preparation of Sinkhole Prior to Treatment: All Methods

Preparation of the sinkhole is required to insure success using all treatment methods. All needed filter and backfill materials must be on site during preparation of the sinkhole. The following steps are necessary to prepare sinkholes for any of the treatment methods selected:

(1) Clean out

All foreign materials in and around the sinkhole should be removed and properly handled. A landfill disruption permit from the State Department of Environmental Protection may be required prior to disturbing the site. Other county and/or municipal laws, rules or regulations may apply.

(2) Excavation:

Loose soil material should be excavated from the sinkhole in an attempt to expose the cavity in the bedrock. Potable water may be used to flush the soil and expose the void(s). Any weak, exposed bedrock should be intentionally collapsed into the cavity. The sinkhole may have to be enlarged for safety purposes and for the proper placement of backfill or filter materials.

(3) Bridging

All exposed cavities are to be bridged with a material suited to the treatment method planned:

For a drainage sinkhole, rock which is 50 percent larger than the opening should be placed in a layer over the cavity.

For a sinkhole plug, concrete or rock may be used. Where concrete is used, a low slump and/or quick set mix is recommended.

For a sinkhole treatment at site to be used for structures, concrete or grouted rock is required.

B. Sinkhole Treatment Method - Drainage Sinkhole

(1) Application

A drainage sinkhole method should be used where the sinkhole(s) is an integral part of the existing drainage system for the site, such as for sinkholes occurring in swales, watercourse, and receiving depressions. Drainage sinkholes should not be used within the foundation area of a structure. The design consists of placing layers of graded material to bridge the void, allow infiltration of surface water, and percolation of ground water through the layers without causing erosion. Geotextiles may be used as a filter layers if seepage quantities are low and clogging is not suspected to be a problem. The geotextile shall be designed for the anticipated infiltration rate.

(2) Procedure

(a) Preparation: Sinkhole preparation as per Preparation of Sinkhole Prior to Treatment-All Methods (above). Rocks should be used to bridge the sinkhole throat. Excess spoil from the excavation must be disposed of in a proper way (fig. K-3).
(b) Inverted filter: Installation of inverted filter designed to function as a combined filter and drain in accordance with standard engineering practice (fig. K-4). Each filter or drainage layer will consist of a specific gradation of sand, gravel and/or rock, depending on the gradation of the adjoining layer. An acceptable design method is currently contained in the USDA-NRCS National Engineering Handbook,

Chapter 26, Gradation Design of Sand and Gravel Filters.

Typical design: If the base soil is fine grained and the sinkhole is in a low-risk situation (i.e. removed from structures), the typical inverted filter design as shown in figure 1 may be used.

C. Sinkhole Treatment Method - Sinkhole Plug with Inverted Filter

(1) Application

The sinkhole plug method should be used for areas that are not an integral part of the drainage system for the site. It is suitable for areas that shed runoff. It should not be used for sites that will support structures.

The inverted filter design permits percolation of soil moisture while preventing internal erosion. The method employs readily available materials to plug the void. The surface of the finished plug is graded to prevent ponding of surface water.

(2) Procedures

(a) Sinkhole preparation: The sinkhole area should be prepared as per Preparation of Sinkhole for Treatment: All Methods (above). Any method of bridging may be employed. Suitable excavated material should be salvaged for use as backfill.

(b) Inverted filter: The inverted filter shall be designed in accordance with standard engineering practice. Each filter layer will consist of a specific gradation of sand, gravel, or rock, depending on the gradation of the adjoining layer. An acceptable design method is contained in the USDA-NRCS National Engineering Handbook, Chapter 26, Gradation Design of Sand and Gravel Filters.

Typical design: If the base soil is fine grained and the sinkhole is in a low-risk situation, the typical inverted filter design as shown in figure K-2 may be used. A geotextile may be used between the fill layers to prevent migration of materials between layers. This fabric should permit percolation of ground water. The geotextile shall be designed for the anticipated infiltration rate and selected to prevent clogging.

D. Sinkhole Treatment Method - Remedial Grouting

(1) Application

Remedial grouting should be used to treat sinkholes in areas that are near or are intended to support structures, where internal drainage is not a concern. Grouting can be used as a means of sealing the sinkhole throat in connection with sinkhole plugs, as described above. Three types of grouting methods are appropriate for karst areas: slurry grouting, compaction grouting, and "cavity treatment grouting."

Grout is a mix of cement and additives to reduce shrinkage and accelerate or reduce hardening time. Slurry grouting is the filling of a cavity with cement. Compaction grouting is high-pressure injection of grout to fill cavities and displace and/or compress surrounding soils to achieve greater strength. Cavity treatment grouting is a combination of slurry and compaction grouting. Since the grouting methods seal voids, grouting is not recommended in combination with the drainage sinkhole design, except to supplement it by stabilizing areas surrounding the drainage sinkhole.

(2) Procedures

In all grouting methods a hole is drilled into the subsurface cavity(s) in the bedrock or soil and a grout mixture is introduced. The grout mixture is selected based on conditions encountered during treatment. The grout is introduced by pumping via a hose or by gravity via a chute. Backfill of the remaining sinkhole after grouting should follow the above procedures for sinkhole plugging.

(a) Sinkhole preparation: The sinkhole area should be prepared as per Preparation of Sinkhole for Treatment: All Methods (above). Suitable excavated material should be salvaged for use as backfill.

(b) Introduction of grout - slurry grouting (fig. K-5).: A lean cement mix (1:1:1 water/mason sand/cement) with an appropriate anti-shrinkage agent (e.g. bentonite) is placed into the void(s) in the soil and/or bedrock in the area of concern (figure 3). Slurry grout can be placed in stages with the use of down-hole packers.

Introduction of grout - compaction grouting: Inject a low-slump (less than 2 inches) grout to displace and/or compress the surrounding soils to achieve greater strength. The grout mix should consist of cement (ASTM C150-97e1 Portland cement Type I), fine aggregate (mason sand, ASTM C144-97), and water with an anti-shrinkage agent (e.g., bentonite) and appropriate accelerators and/or thickeners. The mix should have a slump of less than 4 inches (ASTM C143/C143M-97). The mix should start at 1:5:1 cement: mason sand: water by weight with an anti-shrinkage agent. The mix may be varied as conditions warrant. The low-slump grout placement may be controlled in such a way as to provide structural support for inlet/outlet structures or to close a sinkhole void at depth.

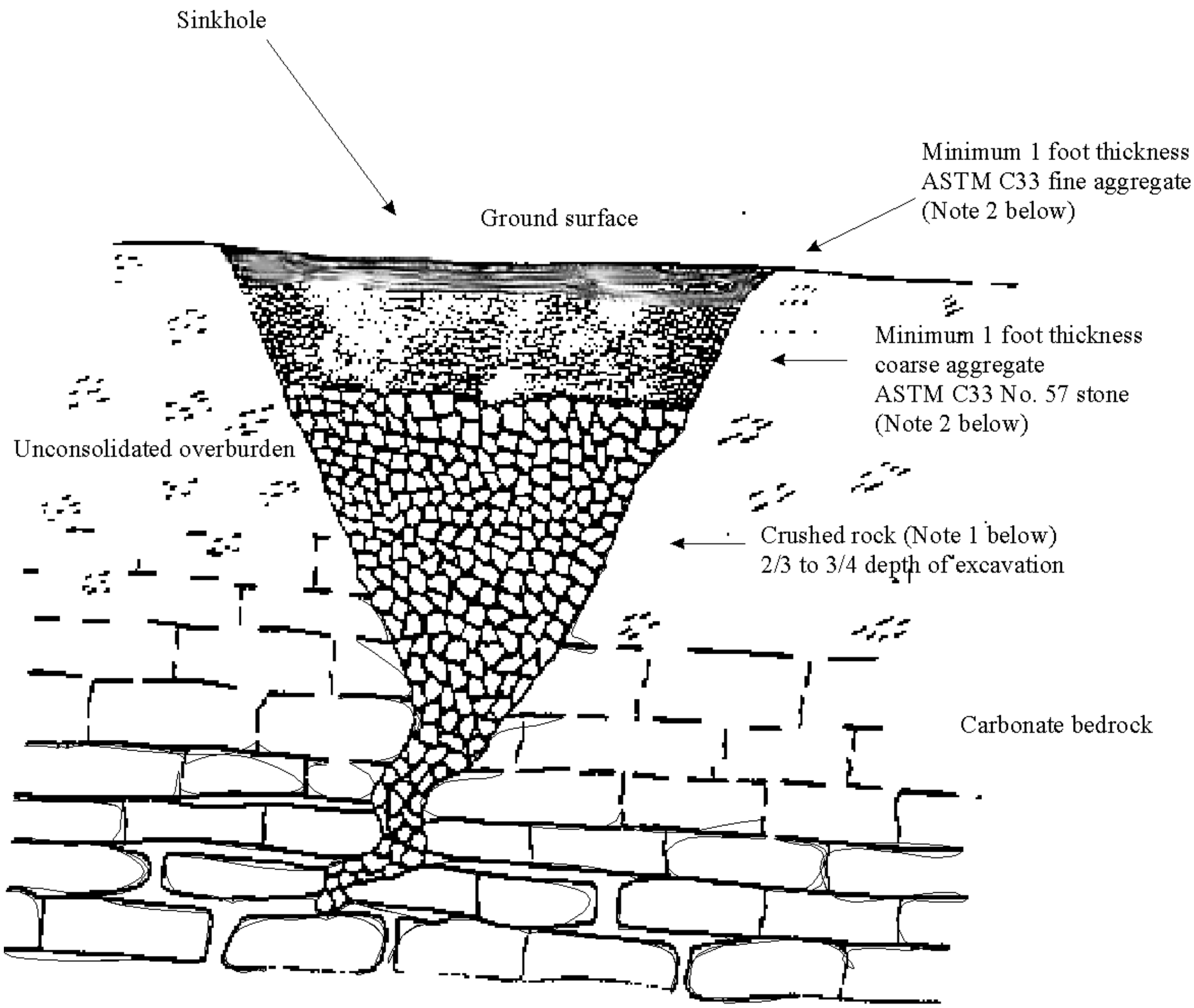
(d) Introduction of grout - cavity treatment grouting (fig. K-6): In this method fluid grout and/or grouted concrete columns are used to fill voids in the bedrock . A good understanding of the subsurface geology of the site is needed to undertake this method. In cavity treatment grouting the decision on the best method to treat the void based on its size and the expertise and equipment available to carry out the remedy. Options include:

(1) the void is small enough to fill economically with cement grout slurry;

(2) the void requires the grout columns within the cavity to reinforce the cavity roof and seal the opening. The columns are installed atop sound rock using cement thickeners, sand or gravel pyramids, and/or accelerating additives.

After grouting a grout seal should be placed over the entrance to the underlying solution cavity to prevent soil erosion into the cavity.

Figure K-3: Drainage Sinkhole - Typical Design



Note 1: National Crushed Stone Association R-3 Stone with little or no fines, maximum size 6 inches; average size 3 inches; minimum size 2 inches. Locally referred to as "gabion rock."

Note 2: ASTM C33 Grading Requirements, % Finer by Weight

	Sieve size									
Material	1 1/2 in.	1 in.	3/4 in.	1/2 in.	#4	#8	#16	#30	#50	#100
No. 57 Stone	100	95-100		25-60	0-10	0-5				
Fine aggregate			100		95-100	80-100	50-85	25-60	10-30	2-10

Drainage Sinkhole - Typical Design

Figure K-4: Sinkhole Plug with Inverted Filter – Typical Design

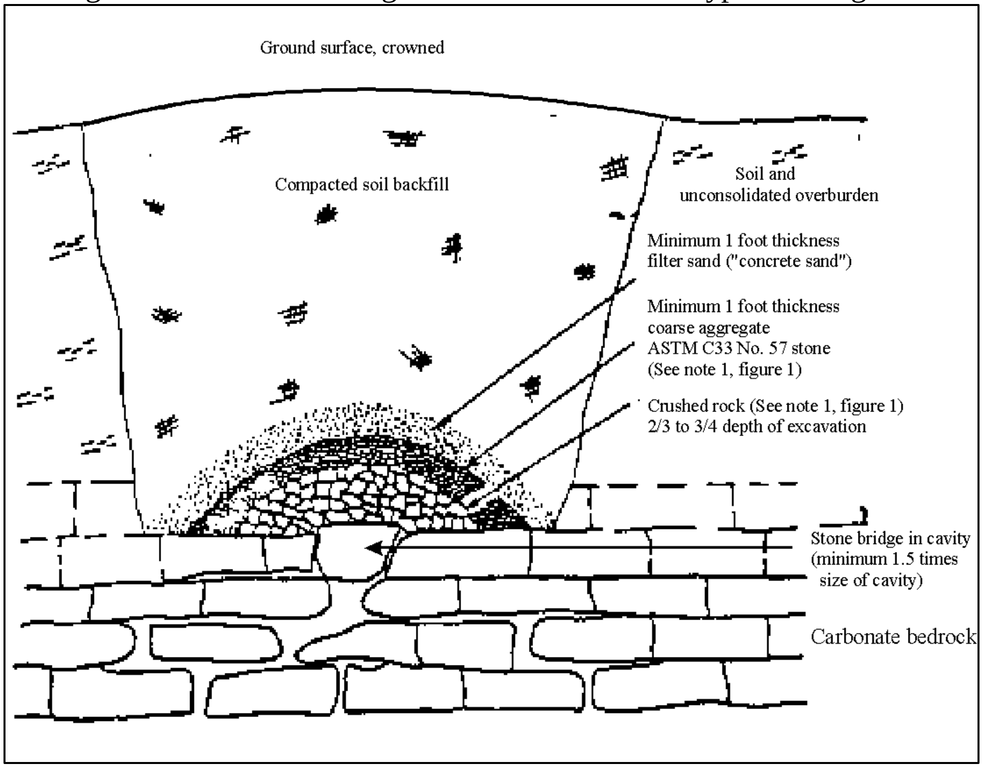


Figure K-5: Slurry Grouting Treatment Method

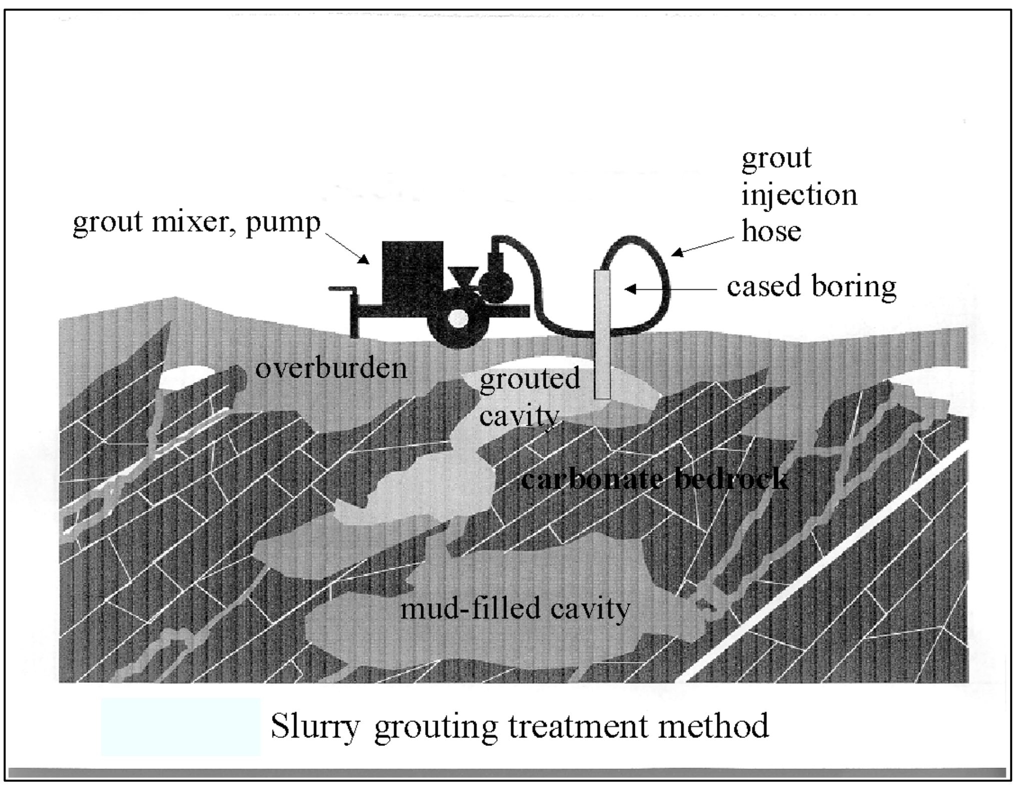
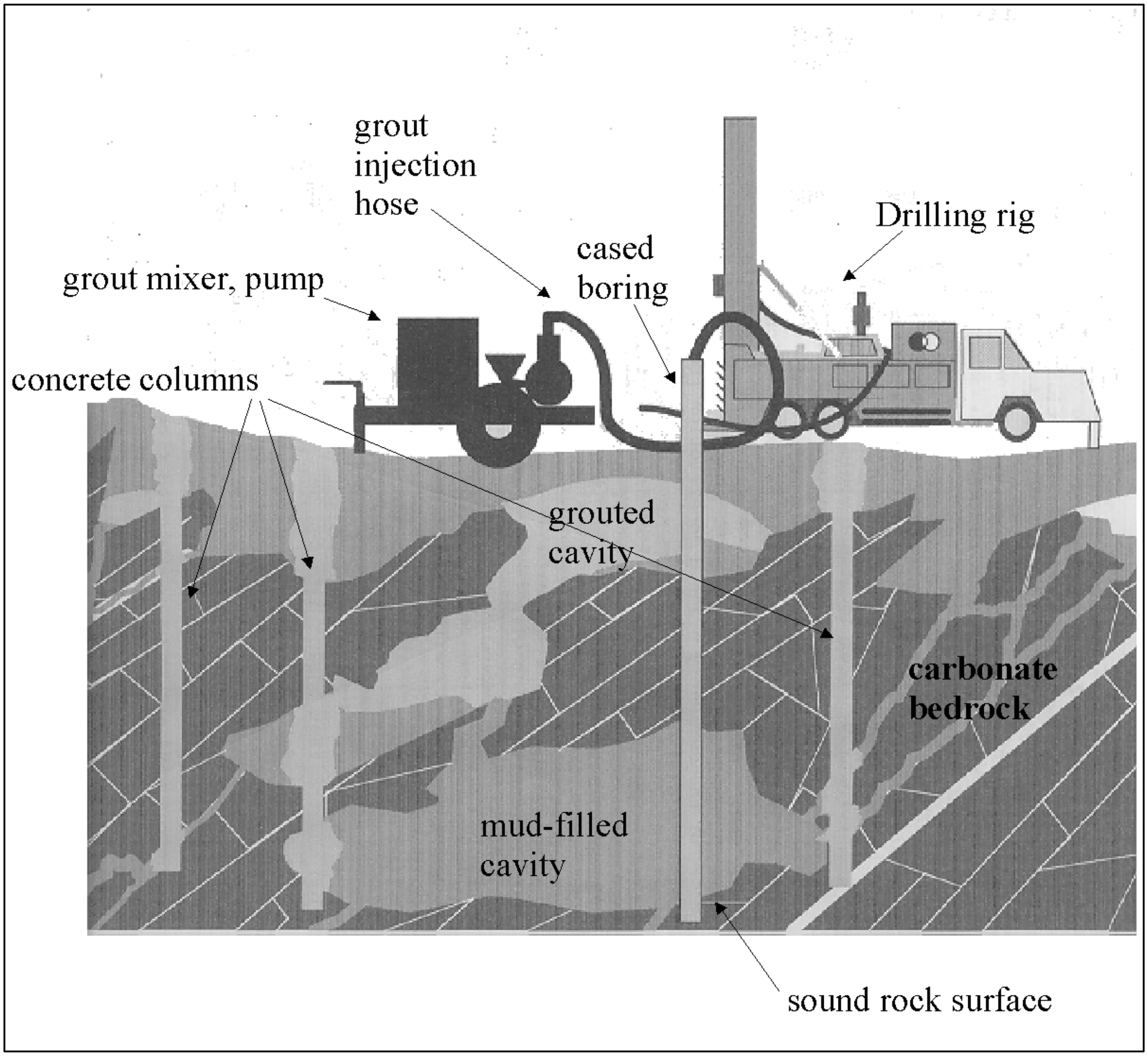


Figure K-6: Cavity Treatment Grouting Method



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