WEST VIRGINIA

DEPARTMENT OF NATURAL RESOURCES

DRAINAGE HANDBOOK for SURFACE MINING

DIVISION OF RECLAMATION

DRAINAGE HANDBOOK

FOR

SURFACE MINING

WEST VIRGINIA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF PLANNING AND DEVELOPMENT

AND

DIVISION OF RECLAMATION

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and
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SECTION 1

PRE-PLANNING

Extensive pre-planning is necessary if the conservation of soil and water resources in surface mined areas is to be effectively undertaken. Pre-planning must be done prior to the beginning of surface mining operations with the aim to eliminate or reduce some of the foreseeable problems associated with the specific area to be mined. The problems associated with surface mining are many and varied; however, the primary aim of pre-planning should be to arrive at a satisfactory method of site drainage. Reducing sedimentation loads and preventing acid water discharge are two very important items to consider when working on a comprehensive drainage plan.

Other problems inherent in surface mining that must be considered during the planning stage are land stabilization, geology, and water disposal. Consideration should be given to total environmental effects on air, wildlife, fish, plants, and aesthetics with a desire for improved land use upon completion of mining. Possible detrimental effects of surface mining can be controlled within reasonable time limits if careful pre-planning coupled with good mining practices and effective reclamation work is carried out.

In the following articles, some of the major problems and their possible solutions are discussed. Each should be considered during the pre-planning phase.

1.1 SEDIMENT CONTROL

Sediment is one of the greatest polluters of water and causes more offsite damages and problems than any other aspect of surface mining.

A number of factors influence erosion and sedimentation rates. Among these are (1) type of soil and cover, (2) erodibility of the soil, (3) degree of slope, (4) length of slope, (5) amount and rate of rainfall, (6) climate, (7) distance from source, and (8) degree of filtering between source and sampling point.

Short duration high intensity rains are responsible for much of the erosion. Cover is a very important factor. Well vegetated areas are seldom serious sediment producing sources. Cover is effective in absorbing the energy of rainfall and holding it long enough to infiltrate.

Steepness affects the potential that runoff has to transport sediment and the stability of the particles subject to erosion. The longer the slope, the more likely that runoff will develop rills and gullies thereby greatly increasing the erosion potential.

The physical properties of soil influence erodibility. Some of these properties are: texture, percentage of coarse fragments - especially on the surface-soil structure, mineralogy, amount and type of clay, organic content, and depth of soil. Coarse sands and stoney soils are generally least erosive and shallow fine grained cohesionless soils over impermeable bedrock are most erosive.

The sediment storage value of 0.125 acre-feet per acre of disturbed area is based on studies by the U. S. Forest Service and the Soil Conservation Service. As sediment ponds are intalled and monitored, more knowledge will be gained to provide a better basis for storage values. It is imperative that provisions for cleanout and maintenance of all sediment ponds be provided.

Considerations may be given to lower storage values where the method of mining eliminates the need for downslope protection. Access and available equipment for continuous maintenance is a prerequisite for this consideration.

There are various methods that may be used to eliminate sediment problems provided they are skillfully planned and applied.

1. Sediment dams or excavated sediment ponds shall be installed and maintained to remove sediment from streams and drainageways leaving the disturbed area.
2. The smallest practical area of land should be exposed at any one time

during the mining phase. This means progressive backfilling and reclamation. Exposure should be kept to the shortest practical period of time.

3. Final dressing and grading shall be done progressively and temporary vegetation and/or mulching shall be done where permanent vegetation is delayed.
4. Spoil material shall in all cases be kept out of the stream channel. Stream relocation should be voided if at all possible.
5. Adequate watertight conduits or bridges shall be used where haulage roads must cross natural drainways. Again, care shall be taken to insure that spoil does not get into the stream where such structures are built. Road banks shall be mulched or seeded as soon as construction progresses.
6. Diversions may be installed above the highwall to divert upland runoff around the disturbed area to a suitable crossing of the disturbed areas.
7. Rock-lined or other suitable structures shall be provided where necessary to convey concentrated flows down steep slopes.
8. Toe berms or other acceptable filter devices shall be constructed near the toe of spoil banks to slow down sheet flow and trap sediment before leaving the site. Vigorous vegetation shall be maintained on the berm.
9. Stone check dams and/or log and pole structures may be used to assist in sediment control. However, they will not be considered as substitutes for sediment dams, excavated sediment ponds or other approved storage structures.

The attached standard for sediment dams shall be used only for dams with drainage areas of 200 acres or less. Design assistance is available from the

U. S. Department of Agriculture, Soil Conservation Service for dams exceeding this limitation.

1.2 ACID WATER

The formation of acid water may accompany surface mining activities. The keys to acid formation are: pyrite or other acid-forming compounds, a continuous supply of oxygen, and water to pick up and carry out the acid. Remove one of the keys, oxygen for example, and acid generation normally is halted.

Control methods for the abatment of acid water shall be as follows:

1. Intercept groundwater that may flow into the pit by constructing diversion ditches above the highwall.
2. When acid-producing materials are encountered in overburden, these materials should be handled so as to prevent or minimize the production of acid mine drainage.
3. Water treatment impoundments can be constructed to trap acid water. Treatment may include chemical processes for the neutralization of the acid such as limestone spreaders, limestone drums, etc.

1.3 LAND STABILIZATION

Land stabilization as used here means long-term stability of soil and rock masses against slides, slips, and mud flows. It is only through a long period of time, including a full cycle of wet and dry periods, that true stability can realistically be judged. Unless good stability is established at the start, a poor environment will result for the establishment of grasses and plants and high erosion rates will continue resulting in sustained off-site damages. Stability is controlled by (1) bench width, (2) outer slope of spoil, (3) bench surface drainage, (4) bedrock lithology and stratigraphy, and (5) soil and rock content of the spoil.

Slips and landslides are caused by the top-heavy nature of a soil mass and usually occur when the soil becomes saturated. Uncontrolled spoil placements result in the most unstable situation possible.

The outer slope of spoil has a direct affect on stability. Uncontrolled placement has resulted in slopes varying from about 65% to 100% depending upon the amount and kind of rock and moisture content of the intermixed soil. Based on a study in the Coal River Watershed, the maximum stable slope was found to be about 66%. However, this is in an area with predominantly sandstone bedrock. Areas with predominantly shale will require a flatter slope (50%) to insure stability.

Surface drainage of the bench and spoil by prompt removal of rainfall and runoff will aid in land stabilization. Minimizing the infiltration of rainfall will reduce the tendency of any spoil on a slope to slide. After water has entered the spoil remedial measures for drainage and stability are considerably more expensive. Water trapped on the bench will aggravate slides when the bench is a sandstone or limestone underlain by a shale layer or strata which forces the water to seep out under the cast over spoil.

1.4 GEOLOGY

The geology of the area must be known if a satisfactory plan is to be developed for water control and disposal, sediment pollution control, acid drainage control, and successful establishment of a productive vegetative cover. Geologic factors indicate (1) potential acidity, (2) potential slope stability, (3) potential stoniness of spoil, and (4) dip of coal strata. The strike and dip of the coal strata must be known in order to plan an effective drainage plan.

Drainage plans can be enhanced by taking advantage of the dip (or slope) of coal seams in determining which way to drain the benches. This also permits determining which natural drainways to use.

1.5 WATER DISPOSAL

Collection and delivery of water to a safe and stable outlet is an important aspect in developing a drainage plan. Water will always occur and provisions must be made to handle it at all times. Water disposal usually will be concerned with bench and diversion drainage and the methods of getting this water to a natural drainway.

Water in diversions shall be directed to an adequate outlet. The outlet may be a natural drainway, a vegetated area or some other stable watercourse.

Bench drainage is usually accomplished by waterways draining to an outlet in the direction of bench slope. In no case will the water be discharged over the bench crest unless protected against concentration by use of structural means (pipes, riprap, concrete, etc.). Such waterways shall be located away from the highwall sufficient to prevent future filling by plugging or wall sloughing. The waterway gradients must be flat enough to prevent gullying when located to settle out sediment before the water is released over the bench. The ponds should be constructed to be dry between runoff periods.

Lowering of water from the bench to the valley stream should be accomplished by using the natural drainways available. Since surface mining activities will be suspended 50 feet on either side of a natural drainway, unless valley fill is used, sediment problems should be minimized if haul roads are properly constructed along and across natural drainways. When a natural drainway is not available, structural means will be used. These are by use of pipe, a rock riprap flume, or by grading a channel to underlying rock that is non-erosive.

It must be recognized that all control measures are not equally effective at all sites. Diversions may work well at some locations but may be ineffective at others. Rock-lined chutes, ditches, or pipe drop spillways will be required at many places in lieu of natural or grassed waterways. The methods of controlling erosion and sediment from the outer slopes will vary.

Sediment ponds must be installed on all drainage ways carrying concentrated flows from the disturbed areas. Dry ponds are safer in that the fill and foundation are not subject to constant saturation, they provide for easier cleanout, and do not require a drain. However, they are not as effective as a wet pond in settling out silt-size particles during low flow periods. It must be recognized that ponds of the size which will normally be constructed will not retain the runoff long enough to settle out clay particles and colloidal material.

Where possible sediment ponds should be located before drainage ways reach the main stream. A good rule to remember is to locate them as close to the source as possible. Where feasible, they should be of the diversion type. This will keep sediment storage accumulations out of the main watercourses. After reclamation is complete the diversions can be closed and sediment deposits isolated from further flows. Land disburbed by previous surface mining operations that is not stabilized must be included when determining the disturbed area above sediment ponds.

All overburden materials subject to disturbance should be classified for potential acidity and a plan developed for handling and placing of materials which will result in enough suitable material at the finished surface to support the planned crop or vegetation. Massive rocks and acid-producing strata shall be placed where it is not a part of the finished surface.

The after-mining use possibilities of the area affected should be based upon capabilities of the disturbed area, compatibility with adjacent land uses, and the needs and desires of the landowner.

Water capable of supporting fish and other desirable aquatic life shall be the goal where impoundments occur or are made.

Good planning, design, installation, and maintenance of erosion and sediment control measures will provide for effective control at many sites.

However, it must be recognized that there are locations where the physical characteristics of the land are such that effective erosion and sediment control cannot be provided. This may be for either of the following reasons: (1) control measures are to expensive resulting in an uneconomical operation or (2) it is physically impossible to install the needed measures. When these conditions exist, consideration for surface mining may be denied.

1.6 CERTIFICATION OF DRAINAGE SYSTEM

The installation of the drainage system in accordance with the approved pre-plan shall be under the supervision of the engineer or person approved by the Director designing and submitting the same.

A certificate of approval shall be filed with the Reclamation Division by said party as to the construction of the drainage system in accordance with the approved pre-plan.

SEDIMENT DAMS

EMBANKMENT TYPE

2.1 DEFINITION

A barrier or dam constructed across a waterway or other suitable locations to form a silt or sediment basin.

2.2 PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversions, waterways and streams and to prevent undesirable deposition on bottom lands, in channels or waterways, and other areas by providing basins for the deposition and storage of silt, sand, gravel, stone and other detritus.

2.3 SCOPE

This standard establishes the minimum acceptable quality for the design and construction of sediment dams located in predominantly rural or agricultural areas in West Virginia when:

1. Failure of the structure would not result in loss of life; in damages to homes, commercial or industrial buildings; main highways, or railroads; in interruption of the use of service of public utilities; or damage existing water impoundments; and
2. The contributing drainage area does not exceed 200 acres; and
3. The vertical distance between the lowest point along the ℄ of the dam at the upper toe and top of dam does not exceed 15 feet, and/or does not exceed 10 surface acres; and
4. The sediment dam conforms to all state and local laws and/or regulations pertaining to the storage of water. Structures which exceed 15 feet in vertical height from the natural bed of the watercourse to the top of the dam as measured from the upstream toe and/or those which have a surface area at the emergency spillway crest greater than 10 surface acres must be approved by the Director of

the Department of Natural Resources in accordance with Chapter 20, Article 5D of the Code of West Virginia (Dam Control Act).

2.4 DRAINAGE AREA AND SITE EVALUATION AND LIMITATIONS

The contributing watershed above the site shall have an adequate plan for providing protection against erosion of disturbed areas. This plan shall provide for rapid revegetation of the disturbed areas in order to stabilize the area as quickly as possible after it has been disturbed. It is required to prevent excessive sedimentation from exceeding the design capacity of the sediment dam. All areas disturbed during the mining operation in the watershed shall be revegetated according to West Virginia Division of Reclamation regulations.

Site condition shall be such that the following capacity requirements can be met.

2.4.1 SEDIMENT

The sediment pool shall have a minimum capacity (from the lowest elevation in the reservoir to the crest of the principal spillway) to store 0.125 acre-feet per acre of disturbed area in the drainage area. The disturbed area includes all land affected by previous mining operations (that is not presently stabilized) and all land that will be affected during the surface mining and reclamation work. The basin shall be cleaned out when the sediment accumulation approaches 60% of the design capacity. The design and construction drawings shall indicate the corresponding elevation. Clean to 100% pool prior to grade release.

2.4.2 STRUCTURES IN SERIES

When structures are built in series, the principal spillway and emergency spillway sizes for the lower structure shall be based on the total drainage area above the lower structure. The required storage for sediment for any structure shall be based on the disturbed area in the uncontrolled drainage area above that structure. When an upstream structure exists, a lower structure in series must be designed considering failure of the upstream structure.

Construction must be completed on all downstream structures prior to construction of an upper structure in a series.

2.5 PRINCIPAL SPILLWAYS

2.5.1 CAPACITY

A drop inlet principal spillway will be required on all earth embankment structures. The crest of the principal spillway shall be located at the maximum elevation of the sediment pool.

The minimum size of the principal spillway and drop inlet shall be obtained from Table 1, Minimum Required Spillway Size, Appendix I, Page I-10, and shall be based on the total drainage area above the structure.

2.5.2 LAYOUT

The principal spillway shall be straight in alignment when viewed in plan. The outlet end must extend to an elevation approximately 6 inches above the stable channel bottom and a minimum of 6 feet beyond the toe of the embankment. An adequate outlet structure shall be provided, when needed, to prevent damage to the toe of the embankment. The minimum slope of the pipe conduit shall be 1 percent in order to insure free drainage.

2.5.3 PIPE CONDUITS

All conduits include steel, wrought-iron, cast iron, corrugated metal, asbestos cement, concrete and rubber-gasket vetrified clay.

2.5.3.1 ASBESTOS CEMENT, CONCRETE AND VITRIFIED CLAY

These right conduits must be lain in a concrete bedding. The maximum fill height over vitrified clay pipe cannot be more than 20 feet and it shall not be placed over more than 10 feet of compacted earth fill.

A. <u>Bedding</u>: Concrete bedding shall be placed beneath the pipe at a minimum thickness of 4 inches and extend up on the sides of the pipe for at least 10 percent of the overall height of the conduit. The bedding shall have a base width equal to the outside diameter of the pipe.

B. Joints: Conduit joints are to be designed and constructed to remain watertight. A rubber gasket set in a positive seat which will prevent displacement is to be provided.

2.5.3.2 CORRUGATED METAL PIPE

A. Iron or Steel (Zinc-Coated): Corrugated metal pipe (iron or steel) conform to Federal Specification WW-P-405. It shall be close-riveted and asphalt-coated or helical corrugated with welded seam and can be used only where the pH of the normal stream flow is expected to be greater than 5.0 during the life of the structure. Where the pH of the normal stream flow is expected to be between 4.0 and 5.0 the pipe shall be close riveted asbestos-bonded, bituminous-coated, and have a paved invert. Corrugated metal pipe will not be used where the pH is expected to be less than 4. The minimum thickness of the pipe shall be 16 gage for conduits, 18 inches or less in diameter. For larger sizes, the minimum thickness shall be 14 gage.

Bituminous coating damaged by breaks, scuffs, or welding shall be repaired by the application of two coats of hot asphaltic paint or a coating of cold-applied bituminous mastic.

B. Aluminum: Corrugated aluminum shall conform to Federal Specification WW-P-402. It can be used only in soils having a pH greater than 5 and less than 9. The minimum thickness of the pipe shall be 14 gage.

C. Joints: All corrugated metal pipe shall be connected by a watertight flange-type connection or by a watertight connecting band specifically manufactured for a connecting band (band with rods and lugs). The area between the pipe and connecting bands shall be treated with an asphalt cement during installation to assure a watertight joint.

2.5.3.3 STEEL

Steel pipe may be used where the pH of the normal stream flow during the life of the structure is expected to be 5.0 or greater. It shall be of standard strength and be connected by a watertight mechanical or welded joint.

2.5.3.4 WROUGHT-IRON OR CAST IRON

Iron pipe may be used under all soil and water conditions. It must be of standard thickness or greater and be connected by a watertight mechanical joint.

2.5.4 DROP INLET

The minimum size and height is given in Table 1, Appendix I, Page I-10. The drop inlet may be perforated to provide a gradual drawdown after each storm event.

2.5.4.1 PERFORATIONS

Metal drop inlets when perforated shall be done so throughout the top 2/3 of their length with 3/4-inch diameter holes spaced 8 inches vertically and 12 inches horizontally center to center. Nonmetal drop inlets shall be ported to permit draining the pond (such ports shall be similar to those described for the metal drop inlets).

2.5.4.2 BASE

The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. Two approved bases are: (1) a concrete base 18 inches thick with the riser imbedded 6 inches in the base. The base should be square with each dimension 1 foot greater than the riser diameter; (2) a 1/4-inch minimum thickness steel plate welded all around the base of the riser to form a watertight connection. The plate shall be square with each size equal to 2 times the riser diameter. The plate shall have 2 feet of stone, gravel or tamped earth placed on it to prevent flotation.

2.5.5 DRAINPIPE

A metal drainpipe with a suitable valve or cap shall be provided when the drop inlet is not perforated. The minimum size shall be 3 inches and in no case shall it require longer than 5 days to drain the pond.

2.5.6 ANTI-SEEP COLLARS

All conduits through the embankment are to be provided with a minimum of three anti-seep collars, except when the embankment is 5 feet or less. When the embankment is 5 feet or less, two collars will be required. The collars will be at 15-foot intervals with the middle collar at the centerline of the dam. The anti-seep collars shall extend a minimum of 2 feet from the conduit in all directions. The collars and their connections to the pipe shall be watertight.

2.5.7 ANTI-VORTEX DEVICE

An anti-vortex device shall be installed on the principal spillway inlet.

1. It shall consist of a thin, vertical plate perpendicular to the centerline of the dam and firmly attached to the top of the riser. The plate dimensions shall be: length = diameter of the riser plus 12 inches; height = diameter of the horizontal conduit; or
2. It shall consist of a horizontal circular plate having a diameter 2 feet greater than the drop inlet and firmly mounted 1.5 feet above the crest of the inlet.

2.5.8 TRASH RACKS

A suitable trash rack will be provided where the drainage area will contribute trash to the reservoir.

2.6 EMERGENCY SPILLWAYS

Emergency spillways are provided to convey large flows safely past an earth embankment. They are usually open channels excavated in earth or rock or reinforced concrete.

2.6.1 CAPACITY

The crest elevation of the emergency spillway will be located at a minimum distance of 1.5 feet above the crest elevation of the principal spillway. The emergency spillway shall be designed to safely carry the expected peak rate of discharge from a 10-year frequency storm. There shall be one foot of freeboard between the maximum design flow elevation in the emergency spillway and the top of the dam. The 10-year frequency peak discharge shall be obtained from Figure 3, Appendix I, Page I-5, Emergency Spillway Peak Discharge. The spillway shall be proportioned to pass the peak discharge from Figure 2, at the safe velocity determined for the site. Table 4, Appendix I, Page I-11, Emergency Spillway Hydraulics, shall be used to proportion emergency spillways. Chart No. 1, Appendix I, Page I-1, Emergency Spillway Velocity Chart, shall be used in conjunction with these tables to proportion the emergency spillway.

2.6.2 LAYOUT

The emergency spillway shall be excavated in rock or in earth or may be constructed of reinforced concrete. It shall consist of an inlet channel, a control section, and an exit channel. The capacity and size of the emergency spillway shall be as outlined under CAPACITY. Minimum bottom width shall be 10 feet.

The inlet channel shall be level for a minimum distance of 20 feet upstream from the control section of the Hp in the emergency spillway is equal to or less than 2.5 feet. The level section shall extend 30 feet upstream from the control section if the Hp exceeds 2.5 feet.

The level part of the inlet channel shall be the same width as the exit channel and its centerline shall be straight and coincident with the centerline of the level section. The level section of the inlet channel shall be located so that the projected centerline of the dam will pass through it.

The centerline of the exit channel shall be straight and perpendicular to the control section extending downstream to a point opposite the downstream toe of the dam. Curvature may be introduced below this point if it is certain that the flowing water will not impinge on the embankment should the channel fail at the curve. The slope of the exit channel shall be determined from Chart No. 1, Appendix 1, Page I-1.

The layout will provide that the spillway when cut around the end of the dam in the abutment be in a natural ground (cut) to a depth equal to the maximum design flow for at least the level section and the exit channel to a point opposite the downstream toe of the dam. It is preferable that the flow be confined without the use of levees, but where site conditions are such that the exit channel will not contain the design flow, a levee or dike shall be constructed along the exit channel to a height above the exit channel equal to the depth of flow through the spillway at the control section. The levee shall have a minimum top width of 4 feet and side slopes not steeper than 2 horizontal to 1 vertical. The levee shall be constructed in accordance with the requirements for embankment.

The spillway shall be trapezoidal in shape and the side slopes shall not be steeper than 1/4 horizontal to 1 vertical in rock or 2 horizontal to 1 vertical in earth.

2.6.3 PERMISSIBLE VELOCITIES

2.6.3.1 EARTH EMERGENCY SPILLWAYS

The maximum allowable velocity in the exit channel shall be 5 feet per second for earth emergency spillways. This velocity must not be exceeded in the exit channel of the spillway from the control section to a point in the exit channel opposite the downstream toe of the dam or to a point downstream where a channel failure would not cause the flow to impinge on the toe of the dam. All earth spillways shall be vegetated with the most suitable permanent grass vegetation for the site.

Spillways excavated in earth shall be protected through the level section and the exit channel with durable rock riprap when the exit channel velocity falls between 5 feet per second and 12 feet per second. The rock riprap will be placed in a 1.5 foot thick blanket through the bottom and sides of the level section and exit channel. Twenty-five percent of the rock shall be 18 inches or larger. The remaining seventy-five percent shall be well-graded material consisting of sufficient rock small enough to fill the voids between the larger rocks. SHALE SHALL NOT BE USED FOR RIPRAP.

2.6.3.2 ROCK EMERGENCY SPILLWAYS

The maximum allowable velocity shall be 14 feet per second for rock emergency spillways. A spillway shall be classed as a rock emergency spillway when durable bedrock occurs throughout the level section and in the exit channel to a point opposite the downstream toe of the dam. Durable bedrock is defined as a layer of continuous bedrock equal or greater in thickness than the depth of flow through the spillway at the control section.

2.6.3.3 CONCRETE EMERGENCY SPILLWAYS

This standard establishes the minimum acceptable quality for the design and construction of concrete emergency spillways through the embankment when:

*1. The contributing drainage area for the dam does not exceed 200 acres; or

*2. The 10-year frequency peak discharge does not exceed 660 c.f.s.; or

3. The maximum vertical height of the dam or embankment as measured along the centerline of the embankment to the emergency spillway crest does not exceed 15 feet; or

4. The maximum outlet slope (downstream slope of embankment) does not exceed three horizontal to one vertical; or

5. The sediment control structure be of a temporary nature (life of mining operation only).

(* Items 1 and 2 may be neglected if the structure is an excavated pond with 3 feet or less of water to be impounded against the embankment).

The spillway shall be proportioned in accordance with the table on standard drawing. In any case the Q/B ratio shall not exceed 21.0. The spillway shall be constructed as detailed on the standard drawing. The fill beneath the spillway shall be thoroughly compacted.

2.7 EARTH EMBANKMENT

2.7.1 HEIGHT

The earth embankment shall be high enough to have one foot of freeboard between the maximum design flow elevation in the emergency spillway and the top of the dam.

2.7.2 TOP WIDTH

The minimum top width of earth embankments shall be 14 feet.

2.7.3 SIDE SLOPES

The side slopes of the settled embankment shall be no steeper than 3 horizontal to 1 vertical on the upstream side and 2 horizontal to 1 vertical on the downstream side.

2.7.4 CUTOFF TRENCH

The elevation of the top of a compacted cutoff will not be lower than the crest of the principal spillway. The cutoff trench should have a bottom width adequate to accommodate the construction equipment but shall not be less than 8 feet. The trench shall have a minimum side slopes of 1 to 1. The cutoff trench shall be located on the embankment centerline and be of sufficient depth to extend into a relatively impervious layer of soil or to bedrock.

2.7.5 SETTLEMENT ALLOWANCE

The design height of the embankment shall be increased by 5 percent to allow for settlement.

2.7.6 UTILITIES UNDER EMBANKMENTS

Utilities encountered at dam sites must be relocated away from the site according to the standard criteria and procedure of the utility company involved.

2.7.7 VEGETATIVE PROTECTION AGAINST EROSION

The embankment, spillways, borrow areas and other disturbed areas shall be mulched and vegetated immediately after construction in accordance with Reclamation rules and regulations for revegetation.

2.7.8 SAFETY

The embankment, pool area and vegetated spillway shall be fenced as needed to restrict accessibility for reasons of safety. All fences shall be constructed in accordance with good fencing practices. Warning signs of danger shall be installed where deemed necessary.

2.7.9 PLANS, DESIGN DATA AND SPECIFICATIONS

In addition to the "Proposed Drainage Map", there shall also be submitted the following items concerning sediment dams of the embankment type.

1. A "Structure Proportioning Computations Sheet" to be completed for each proposed dam.
2. Construction plans showing:
   a. A topographic map on a 1" = 50' scale and 4 feet contour intervals showing the reservoir area, embankment and the emergency spillway. Topographic map may be mapped using transit-stadia survey method but nothing with less accuracy.
   b. A profile view of the embankment along the ℄ of the principal spillway showing all pertinent dimensions, elevations, and principal spillway design.
   c. A profile view of the emergency spillway showing the entrance slope, level section and exit channel slope.

d. A cross-section view of the emergency spillway showing the bottom width, side slopes, and the type of material used.

e. A cross-section view taken along the centerline of the dam showing cutoff trench depth, original ground line, unsettled and settled dam heights, length of dam and other pertinent dimensions and elevations.

3. A "Stage-Area-Storage" computations sheet and Stage-Area-Storage curves.

4. Construction Specifications.

2.8 CONSTRUCTION SPECIFICATIONS FOR SEDIMENT DAMS - EMBANKMENT TYPE

2.8.1 SITE PREPARATION

The embankment site shall be cleared of all brush, trees, stumps, roots and other undesirable material. Sod and topsoil shall be stripped from the embankment site and borrow area and stockpiled for use on the emergency spillway and embankment. Brush, trees and other undesirable material shall be cleared from the sediment pool area.

2.8.2 CUTOFF TRENCH

A cutoff trench shall be excavated along the centerline of the embankment. The cutoff trench shall be excavated along the centerline of the embankment. The cutoff trench shall extend into both abutments to an elevation no lower than the crest of the principal spillway. It shall be of sufficient depth to extend into a relatively impervious layer of soil or to bedrock and shall be backfilled with the most impervious material available at the site. The trench shall be kept free of standing water during the backfilling operations. The cutoff trench should have a bottom width adequate to accommodate the construction equipment but shall not be less than 8 feet. The trench shall have minimum side slopes of 1 to 1. Compaction requirements shall be the same as those for the embankment.

2.8.3 EXCAVATION AND BACKFILL OF STREAM CHANNEL

Existing stream channels crossing the foundation area shall be deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots and other objectionable material, and to accommodate compaction equipment. Such channels shall then be backfilled with suitable material as specified for earth embankments. The excavated channels shall be kept free of standing water during backfill operations.

2.8.4 PIPE CONDUIT

The pipe conduit shall be placed in a trench excavated in solid undisturbed ground or formed by compacted earth. The conduit shall be imbedded in a formed trench to a depth no less than 1/10 times the outside diameter of the pipe. Trench sides shall be sloped back no steeper than 1 to 1. Selected impervious backfill material shall be placed around the conduit in 4-inch layers and thoroughly compacted to at least the same density as the adjacent embankment.

Bedding for asbestos cement, concrete or vitrified clay pipe shall be concrete and will be placed beneath the pipe at a minimum thickness of 4 inches and extend up on the sides of the pope for at least 10 percent of the overall height of the conduit. The bedding should have a base width equal to the outside diameter of the pipe.

All pipe joints and anti-seep collar connections to the conduit shall be watertight.

2.8.5 EMERGENCY SPILLWAY

The emergency spillway shall conform to the lines, grades, bottom width and side slopes as shown on the plans.

2.8.6 BORROW AREAS

All borrow excavation will have side slopes no steeper than 2 horizontal to 1 vertical and shall be graded and left in such a manner as to provide suitable drainage.

2.8.7 SELECTION AND PLACEMENT OF EMBANKMENT MATERIALS

The most impervious material shall be used in the cutoff trench and center portion of the dam. When sandy gravelly material is encountered, it should be placed in the outer shell preferably in the downstream portion of the dam. The distribution and gradation of materials throughout the fill shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. Where it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the upstream and center portions of the dam. Very dry or wet material shall not be used. The fill material shall be free of all sod, roots, stones over 6 inches in diameter and other objectionable material. The moisture content of the material should be such that when kneaded in the hand, it will just form a ball that will not readily separate.

The embankment shall be brought up on uniform 6-8-inch layers of approximate uniform elevation over its entire area. Each layer shall be thoroughly compacted by making at least 4 complete passes with a tamping roller or by applying equal compactive effort with rubber-tired equipment.

2.8.8 PROTECTION AGAINST EROSION

The earth embankment, spillways and borrow areas above the sediment pool shall be mulched and vegetated in accordance with Reclamation rules and regulations for revegetation.

SECTION 3

EXCAVATED SEDIMENT PONDS

3.1 DEFINITION

A water impoundment made by excavating a pit or "dugout". The use of a 3-foot earth embankment is permissible to increase capacity. Ponds resulting from both excavation and embankment are classified as SEDIMENT DAMS, EXCAVATED TYPE, where the depth of water impounded against any embankment is 3 feet or less or where the outflow elevation through the exit or emergency spillway is less than 3 feet above the original ground. Consideration will be given to an increase in embankment height if design of spillways are based on a 50-year frequency storm.

3.2 PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversions, waterways and streams and to prevent undesirable deposition on bottom lands, in channels or waterways, and other areas by providing basins for the deposition and storage of silt, sand, stone, gravel and other detritus.

3.3 SCOPE

This standard establishes the minimum acceptable quality for the design and construction of excavated sediment ponds in predominantly rural or agricultural areas in West Virginia.

3.4 LOCATION

Excavated ponds fed by surface runoff may be located on almost any type of topography; however, they are most satisfactory in areas with relatively flat terrain. An excavated pond may be located in a natural or constructed drainway or preferably to one side of a natural or constructed drainway if the runoff can be directed into the pond.

Site conditions shall be such that the following capacity requirements can be met.

3.5 CAPACITY REQUIREMENTS

The excavated sediment pond shall have a minimum capacity (from the lowest elevation in the dugout to the crest of the exit channel or emergency spillway) to store 0.125 acre-feet per acre of disturbed area in the watershed. The disturbed area includes all land affected by previous operations that is not presently stabilized and all land that will be affected during the surface mining and reclamation work. The sediment pond shall be cleaned out when the sediment accumulation approaches 60% of the design capacity. The design and construction drawings shall indicate the corresponding elevation.

When excavated sediment ponds are constructed in series, the required storage for sediment for any pond shall be based on the uncontrolled drainage area above that pond. Construction must be completed on all downstream structures prior to construction of an upper structure in series.

3.6 SEDIMENT POND DIMENSIONS

Excavated sediment ponds may be constructed to any desired shape that will meet sediment capacity requirements. The width and depth of sediment ponds are not limited.

Side slopes of excavated sediment ponds shall be such that they will be stable and shall not be steeper than 2 horizontal to 1 vertical in earth and 1/4 horizontal to 1 vertical in rock.

3.7 ENTRANCE CHANNEL

The entrance channel shall not exceed 4:1 (25%), extending from the bottom of the excavated pond upstream to the original stream bed. The entrance channel shall be protected with a 1.5-foot layer of rock riprap which shall have 25% of the material 18 inches or larger and the remaining 75% well graded with sizes to fill the voids between the larger rocks. Minimum side slopes shall be 2 horizontal to 1 vertical and shall also be protected with rock riprap for a vertical height of 2 feet.

The minimum bottom width of entrance channels shall be 5 feet and shall never have a width less than that of the natural channel.

3.8 EXIT CHANNEL

Pipe principal spillway shall not be required for excavated ponds. The crest of the exit channel will be thoroughly protected with rock riprap to prevent erosion and scouring. The exit channel shall be located as far as possible from the inlet channel with a minimum distance of 50 feet. The minimum width of exit channels shall be 10 feet, but shall never have a width less than that of the natural stream channel. Minimum side slopes shall be 2 horizontal to 1 vertical and shall also be protected with rock riprap for vertical height of 2 feet.

3.9 EMBANKMENT AND EMERGENCY SPILLWAY

An earth embankment may be used to increase the capacity of an excavated sediment pond provided that the depth of water impounded against any embankment is less than 3 feet. An emergency spillway will be required when earth embankments are used. The design of the emergency spillway shall conform to that given under Emergency Spillways in Sediment Dams, Embankment Type.

The emergency spillway will be designed to safely carry the expected peak rate of discharge from a 10-year frequency storm when the contributing drainage area is from 0-200 acres (use Figure 2, Appendix I, Page I-4). The emergency spillway will be designed to safely carry the expected peak rate of discharge from a 25-year frequency storm when the contributing drainage area is from 200-500 acres (use Figure 3, Appendix I, Page I-5). When the contributing drainage area exceeds 500 acres, the expected peak rate of discharge shall be determined with the assistance of the U. S. Department of Agriculture, Soil Conservation Service or registered professional engineering design.

The earth embankment shall be high enough to have one foot of freeboard between the maximum design flow elevation in the emergency spillway and the top of the embankment. The minimum top width shall be 14 feet. The side slopes will be no steeper than 3 horizontal to 1 vertical on the impoundment side and 2 horizontal to 1 vertical on the downstream or outside pond area.

The design height of the embankment shall be increased by 10 percent to allow for settlement. A cutoff trench will not be required.

Excavated ponds without emergency spillways shall have 2 feet of freeboard between the sediment pool elevation and the top of the exit channel.

3.10 UTILTIES UNDER EMBANKMENTS

Utilities encountered at dam sites must be relocated away from the site according to the standard criteria and procedure of the utility company involved.

3.11 DISPOSAL OF WASTE MATERIAL

The waste material from the excavated sediment pond may be spread, used in the embankment or removed from the site as conditions warrant.

The waste material, when not removed from the site, shall be placed in a manner that its weight will not endanger the stability of the pond side slopes and the rainfall will not wash the material back into the pond. Not less than 12 feet should be left between the toe of the waste material and the edge of the pond.

If the waste material is spread, it should be to a height of no more than 3 feet with the surface graded to a uniform slope away from the pond. The pond side slope of the spread material should be no steeper than 2 horizontal to 1 vertical.

If the waste material is to be used in an embankment, it shall be free of all sod, roots, stones over 6 inches in diameter, and other objectionable material.

3.12 SAFETY

The embankment, pool area and vegetated spillway shall be fenced as needed to restrict accessibility for reasons of safety. All fences shall be constructed in accordance with good fencing practices. Warning signs of danger shall be installed where deemed necessary.

3.13 VEGETATIVE PROTECTION AGAINST EROSION

The waste material, spillway, embankment and any other area disturbed during construction shall be mulched and vegetated immediately upon completion of the pond in accordance with Reclamation rules and regulations for revegetation.

3.14 PLANS, DESIGN DATA AND SPECIFICATIONS

In addition to the "Drainage Map", there shall also be submitted the following items concerning excavated sediment ponds:

1. A "Structure Proportioning Computations Sheet" to be completed for each proposed pond.
2. Construction plans showing a plan view and a cross-section view with entrance and exit channels.
3. A cross-section view of the embankment and emergency spillway, if used.
4. Cross-sections plotted at 50-foot intervals from the centerline of the proposed sediment pond showing original ground line and the proposed excavation limits.
5. Construction Specifications.

3.15 CONSTRUCTION SPECIFICATIONS

3.15.1 SITE PREPARATION

The pond site and waste areas shall first be cleared of all woody vegetation. The limits of the excavation and spoil placement areas shall be staked, and the depth of cut from the ground surface to the pond bottom should be indicated on the stakes.

If an embankment is to be constructed, the embankment site shall be cleared of all brush, trees, stumps, roots and other undesirable material. Sod and topsoil shall be stripped from the embankment site.

3.15.2 EXCAVATION

Excavation and placement of the waste material shall be done as near to the staked lines and grades as skillful operation of the equipment will permit. Side slopes of the excavated pond will be no steeper than 2 horizontal to 1 vertical in earth and 1/4 horizontal to 1 vertical to rock.

3.15.3 SELECTION AND PLACEMENT OF EMBANKMENT MATERIALS

If an embankment is constructed, the most impervious material will be used in the center portion. When sandy gravelly material is encountered, it shall be placed in the outer shell, preferably in the downstream portion of the embankment. The fill material shall be taken from approved designated borrow areas. It shall be free of roots, woody vegetation, oversized stones, rocks, or other objectionable material. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material should contain sufficient moisture so that it can be formed into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction.

Fill material will be placed in 6-8-inch layers and shall be continuous over the entire length of the fill. Compaction will be obtained by routing the hauling equipment over the fill so that the entire surface of the fill is traversed by at least one tread track of the equipment, or compaction shall be achieved by the use of a compactor. The embankment shall be constructed to an elevation 10 percent higher than the design height to allow for settlement if compaction is obtained with hauling equipment. If compactors are used for compaction, the overbuild may be reduced to 5 percent.

3.15.4 VEGETATIVE PROTECTION AGAINST EROSION

The waste material, spillway, embankment and any other area disturbed during construction shall be mulched and vegetated immediately upon completion of the pond in accordance with Reclamation rules and regulations for revegetation.

3.15.5 EROSION AND POLLUTION CONTROL

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

SECTION 4

GABION SEDIMENT DAM

4.1 DEFINITION

A barrier or dam composed of rock-filled wire baskets constructed across a waterway to form a silt or sediment basin.

4.2 PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversions, waterways and streams and to prevent undesirable deposition on bottom lands, in channels or waterways, and other areas by providing basins for the deposition and storage of silt, sand, gravel, stone and other detritus.

4.3 SCOPE

This standard established the minimum acceptable quality for the design and construction of gabion sediment dams located in predominantly rural or agricultural areas in West Virginia when:

1. Failure of the structure would not result in loss of life, in damages to homes, commercial or industrial buildings, main highways, or railroads, in interruption of the use of service of public utilities; and
2. The contributing area does not exceed 500 acres; and
3. The vertical distance between the lowest point along the centerline of the dam and the crest of the spillway does not exceed 10 feet.

4.4 DRAINAGE AREA AND SITE EVALUATION AND LIMITATIONS

The contributing watershed above the site shall have an adequate plan for providing protection against erosion of disturbed areas. This plan shall provide for rapid revegetation of the disturbed areas in order to stabilize the area as quickly as possible after it has been disturbed. It is required to prevent excessive sedimentation from exceeding the design capacity of the sediment dam. All areas disturbed during the mining operation in the watershed shall be revegetated according to West Virginia Division of Reclamation regulations.

4.4.1 SEDIMENT

The sediment pool shall have a minimum capacity (from the lowest elevation in the reservoir to the spillway elevation) to store 0.125 acre-feet per acre of disturbed area in the watershed. The disturbed area includes all land affected by previous operations that is not presently stabilized and all land that will be affected during the surface mining and reclamation work. The basin shall be cleaned out when the sediment accumulation approaches 60% of the design capacity. The design and construction drawings shall indicate the corresponding elevation.

4.4.2 STRUCTURES IN SERIES

When structures are built in series, the spillway size for the lower structure shall be based on the total drainage area above the lower structure. The required storage for sediment for any structure shall be based on the disturbed area in the uncontrolled drainage area above that structure.

When an existing upstream structure is not considered adequate or safe according to the specification herein, a lower structure in series must be designed considering failure of the upstream structure. This means that the sediment and spillway shall be based on the total drainage area above the lower structure.

Construction must be completed on all downstream structures prior to construction of an upper structure in a series.

4.5 EMERGENCY SPILLWAY

An emergency spillway will be required on all gabion structures and will be designed to safely carry the expected discharge from a 25-year frequency storm. The crest of the spillway shall be located at the maximum elevation of the sediment pool.

All spillways shall have a rectangular cross-section as viewed along the centerline of the structure.

There shall be 1/2 foot of freeboard between the maximum design flow elevation in the spillway and the top of the dam. The peak discharge shall be obtained from Figure 3, Appendix I, Page I-5, Emergency Spillway Design Peak Discharge. The spillway shall be proportioned to carry the peak discharge by the formula Q = CLh3/2, where Q is the peak discharge, L is the longitudinal length of the spillway, and h is height of the spillway opening minus 0.5 feet. C is a coefficient of discharge which may be found in Table 5, Appendix I, Page I-12.

In no case shall the total design head on the structure exceed 13.0 feet (the sum of maximum distance from the original ground to spillway elevation plus h must be less than or equal to 13.0 feet).

4.6 GABION CROSS-SECTION

In order to establish a uniform yet stable cross-section for this type structure, all gabion sediment dams shall have a step-like cross-section with a 12-inch gabion or a 3-foot thick rock mattress covering the downstream channel and embankment (see Figure 4, Appendix I, Page I-6).

See Figure 4, Appendix I, Page I-6, for acceptable gabion sediment dam cross-section of 3 feet 3 inches by 3 feet 3 inches.

The gabion or rock mattress shall extend out from the downstream toe of structure for the minimum distances shown in Figure 4. The bottom width of the mattress shall be equal to the length of the spillway and in line with it. The channel sides shall be covered by the mattress to a minimum vertical depth of 4 feet.

The upstream face of all gabion structures may be backfilled with material from the pool area. The backfill shall be on a slope of 3 horizontal to 1 vertical.

Cross-sections of additional width other than those shown and without backfill against the upstream face may be used if approved by the Division of Planning and Development of the Department of Natural Resources.

4.6.1 KEY-IN OF FOUNDATION

The gabion dam shall be keyed into the abutment with the channel or valley to a minimum depth of three feet at any point. The bottom of the gabion may be keyed into the channel bottom. After the gabion structure is in place, the key into the abutment shall be backfilled to the embankment's original contour with compactible material. The material shall be mechanically tamped in maximum lifts of 6 inches.

4.6.2 FILLING AND BINDING GABION WIRE BASKETS

The gabion baskets shall be filled with durable limestone, river rock or sandstone of 3-7 inches in size. The stone shall be hand or machine placed in the baskets in such a manner as to prevent sagging or bulging of the basket or baskets. All edges of the baskets must be secured or bounded to the adjacent basket by lacing wire in and out of the mesh openings. The maximum distance between each coil shall not exceed 4 inches.

4.7 MATERIAL SPECIFICATIONS

All perimeter edges of the mesh forming each unit shall be securely selvedged with wire of not less than 0.150-inch diameter so that the joints formed by tying the selvedges have at least the same strength as the body of the mesh.

Lacing wire shall be supplied in sufficient quantity for securing all edges of the gabion baskets and diaphragms and to provide for the necessary internal connection wires in each cell. The wire lacing shall meet or exceed the same specification as the wire used in the mesh.

The wire mesh shall be made of galvanized steel wire having a minimum size of U. S. Steel Wire Gauge No. 14. The tensile strength of the wire shall be in the range of 60,000 to 85,000 p.s.i. The minimum zinc coating of the wire shall be 0.80 ounces per square foot of uncoated wire surface as determined by test conducted in accordance with A.S.T.M. Designation A-90. The maximum linear dimension of the mesh opening shall not exceed 3-1/2 inches and the area of the mesh opening shall not exceed 6 square inches.

Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction - the base, lid, and sides shall be woven into a single unit and the ends shall be connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

Where the length of the gabion exceeds five feet, the gabion shall be divided by diaphragms, of the same mesh and gauge as the body of the gabions, into cells of equal length and width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary.

4.8 PLANS, DESIGN DATA AND SPECIFICATIONS

In addition to the "Proposed Drainage Map", there shall also be submitted the following items concerning gabion sediment dams:

1. A "Structure Proportioning Computations Sheet" to be completed for each proposed gabion sediment dam.
2. Construction Plans showing:
   a. A topographic map on a 1" = 50' scale and 4-foot contour intervals showing the reservoir area and structure. Topographic map is to be made using transit-stadia survey method.
   b. Plan view of structure showing all pertinent dimensions.
   c. A cross-section view of gabion structure at the point where the maximum depth of water will be impounded against the structure showing all pertinent dimensions and elevations.
   d. A cross-section view taken along the centerline of the dam showing all pertinent dimensions and elevations.

e. A "Stage-Area-Storage Computations Sheet" and "Stage-Area-Storage Curves".

f. Construction Specifications.

4.9 CONSTRUCTION SPECIFICATIONS

4.9.1 SITE PREPARATION

Brush, trees and other undesirable material shall be cleared from the sediment pool and dam areas. Sod and topsoil shall be stripped from gabions foundation area.

4.9.2 PREPARATION OF FOUNDATION

Proper excavation shall be made along the foundation of and sides of the gabion structure as shown on the construction plans to assure that the gabion structure will be placed on the planned line and grade.

The key into the abutments shall be excavated as shown on the construction plans. The gabion structure must be keyed into the abutment a minimum of 3 feet at any point as measured in any direction.

The fill material beneath the gabion units along the sides of the structure shall be placed in 6-inch maximum lifts and mechanically tamped.

4.9.3 FILL AND BINDING

Backfilling of the key into the abutments and against the upstream face of the gabion shall progress simultaneously with the filling and binding of the baskets. The key into the embankment shall be backfilled with compactible material to the embankment's original contour. This material shall be placed in 6-inch maximum lifts and mechanically tamped.

Each gabion unit shall be bound together by a continuous piece of connecting wire stitched around the vertical edges with a coil about every four inches. Lacing wire shall be used to join the units together in the same manner. Empty gabion units shall be set to line and grade as shown on the plans.

A standard fence stretcher, chain fall, or steel rod may be used to stretch the wire baskets and hold alignment.

The gabions shall be filled with stone carefully placed by hand or machine to assure alignment and void bulges with a minimum of voids. After a gabion has been filled, the lid shall be bent over until it meets the sides and edges. The lid shall then be secured to the sides, ends and diaphragms with the lacing wire in the manner described above for assembling.

4.9.4 BACKFILLING UPSTREAM FACE

The upstream face of the cribbing may be backfilled with material from the pool area up to the sediment pool elevation behind the spillway and up to the top of dam elevation for the remainder on a slope of 3 horizontal to 1 vertical.

Very dry or wet material shall not be used. The fill material shall be free of all sod, roots, stones over 6 inches in diameter and other objectionable material. The moisture content of the material should be such that when kneaded in the hand, it will just form a ball that will not readily separate.

The embankment shall be brought up on uniform 6-8-inch layers of approximate uniform elevation over its entire area. Each layer shall be thoroughly compacted by making at least 4 complete passes with a tamping roller or by applying compactive effort with rubber-tired equipment.

4.9.5 SPILLWAY

The spillway shall conform to the alignment and dimensions shown on the plans.

4.9.6 DOWNSTREAM CHANNEL PROTECTION

4.9.6.1 GABION MATTRESS

The gabion mattress or apron shall conform to the alignment and grade shown on the plans. The mattress shall be bound in the same manner prescribed for the gabion baskets. Also, the edge of the mattress against the toe of the dam shall be bound to the dam in the same manner prescribed for the gabion baskets.

4.9.6.2 ROCK MATTRESS

The channel bottom and sides downstream of the structure shall be covered to a minimum depth of 3 feet with durable rock of which 50% is 3 feet or larger and the remainder sized to fill the voids with a minimum size of 6 inches. The rock shall not contain more than 10% earth, sand, or soft shale as determined by visual inspection. The rock shall extend out from the toe of the crib structure for a minimum distance of twice the height of the structure. The dumped rock shall form a trapezoidal channel with a bottom width equal or greater than the length of the spillway. The rock shall extend up the embankment sides to a minimum vertical depth of 4 feet.

4.9.7 VEGETATIVE PROTECTION AGAINST EROSION

All disturbed areas outside the pool area shall be mulched and vegetated in accordance with Reclamation rules and regulations for revegetation.

SECTION 5

CRIB SEDIMENT DAM

5.1 DEFINITION

A barrier or dam composed of rock-filled concrete cribbing constructed across a waterway to form a silt or sediment basin.

5.2 PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversions, waterways, and streams and to prevent undesirable deposition of bottom lands, in channels or waterways, and other areas by providing basins for the deposition and storage of silt, sand, gravel, stone and other detritus.

5.3 SCOPE

This standard establishes the minimum acceptable quality for the design and construction of crib sediment dams located in predominantly rural or agricultural areas in West Virginia when:

1. Failure of the structure would not result in loss of life; in damages to homes, commercial or industrial buildings; main highways, or railroads; in interruption of the use of service of public utilities; and
2. The contributing area does not exceed 500 acres; and
3. The vertical distance between the lowest point along the centerline of the dam and the crest of the spillway does not exceed 10 feet.

5.4 DRAINAGE AREA AND SITE EVALUATION AND LIMITATIONS

The contributing watershed above the site shall have an adequate plan for providing protection against erosion of disturbed areas. This plan shall provide for rapid revegetation of the disturbed areas in order to stabilize the area as quickly as possible after it has been disturbed. It is required to prevent excessive sedimentation from exceeding the design capacity of the sediment dam. All disturbed areas in the watershed shall be revegetated according to West Virginia Division of Reclamation regulations.

Site condition shall be such that the following capacity requirements can be met.

5.4.1 SEDIMENT

The sediment pool shall have a minimum capacity (from the lowest elevation in the reservoir to the spillway elevation) to store 0.125 acre-feet per acre of disturbed area in the watershed. The disturbed area includes all land affected by previous operations that is not presently stabilized and all land that will be affected during the surface mining and reclamation work. The basin shall be cleaned out when the sediment accumulation approaches 60% of the design capacity. The design and construction drawings shall indicate the corresponding elevation.

5.4.2 STRUCTURES IN SERIES

When structures are built in series, the spillway size for the lower structure shall be based on the total drainage area above the lower structure. The required storage for sediment for any structure shall be based on the disturbed area in the uncontrolled drainage area above that structure.

When an existing upstream structure is not considered adequate or safe according to the specification herein, a lower structure in series must be designed considering failure of the upstream structure. This means that the sediment and spillway shall be based on the total drainage area above the lower structure.

Construction must be completed on all downstream structures prior to construction of an upper structure in a series.

5.5 EMERGENCY SPILLWAY

An emergency spillway will be required on all crib structures and will be designed to safely carry the expected peak discharge from a 25-year frequency storm. The crest of the spillway shall be located at the maximum elevation of the sediment pool.

All spillways shall have a rectangular cross-section as viewed along the centerline of the structure.

There shall be 1/2 foot of freeboard between the maximum design flow elevation in the spillway and the top of the dam. The peak discharge shall be obtained from Figure 3, Appendix I, Page I-5, Emergency Spillway Design Peak Discharge. The spillway shall be proportioned to carry the peak discharge by the formula, Q = CLh3/2, where Q is the peak discharge, L is the longitudinal length of the spillway, and h is height of the spillway opening minus 0.5 feet. C is a coefficient of discharge which may be found in Table 5, Appendix I, Page I-12.

In no case shall the total design head on the structure exceed 13.0 feet (the sum of the maximum distance from original ground to the spillway elevation plus h must be less than or equal to 13.0 feet).

5.6 CRIB DAM CROSS-SECTION

In order to establish a uniform yet stable cross-section (see Figure 5, Appendix I, Page I-7) for this type structure, all crib sediment dams shall:

1. Be a minimum of 6 feet in width; that is, the distance from inside to inside of headers must be 6 feet or more.
2. Be backfilled with material from the pool area on the upstream face. The slope of the backfill shall be a minimum of two horizontal to one vertical.
3. Have the channel bottom and sides downstream of the structure covered to a minimum depth of 3 feet with durable rock mattress of which 50% is 3 feet or larger and the remainder sized to fill the voids with a minimum size of 6 inches; or have the channel bottom and sides downstream of the structure covered with a 12-inch gabion mattress. The rock or gabion mattress shall extend out from the toe of the structure for a minimum distance of twice the height of the structure.

5.7 KEY-IN ABUTMENTS

The crib dam shall be keyed into the abutments with the channel or valley to a minimum depth of three feet at any point. The foundation of the crib dam shall be keyed into the channel bottom to a minimum depth of one foot. After the crib structure is in place, the key into the abutments shall be backfilled to the embankment's original contour with compactible material. The material shall be mechanically tamped in maximum lifts to 6 inches.

5.8 FILLING OF CRIB UNIT

Crib fill material shall consist of durable limestone, sandstone or river rock. The stone shall be hand or machine placed inside the cribbing in such a manner as to minimize the void space. If open-faced cribbing is used, the stone fill shall have a minimum size of one inch greater than that of the crib's vertical opening. If closed-faced cribbing is used, the stone fill shall be 3-7 inches in size.

5.9 MATERIAL SPECIFICATIONS

5.9.1 CRIB FABRICATION

Reinforced concrete cribbing shall be manufactured of dense, impermeable concrete, developing a compressive strength of not less than 4000 pounds per square inch in 28 days. Crib units shall be made in rigid steel forms and compacted by vibration. The surfaces of all members shall contain no recesses or depressions. Mesh or bar reinforcing shall be used, with the steel placed such as to act integrally with the concrete in resisting design stresses.

5.9.2 CRIB INTERLOCKING

Headers shall be made with reinforced projecting lugs to serve as the locking device. If other types of locking devices are employed, the manufacturer shall furnish proof of strength of such device based on test results from a qualified laboratory.

Concrete crib dams covered by these specifications shall be of the true crib type having stretchers running longitudinally with the wall at both the front and rear, and headers lying transversely to support the ends of the stretchers and tie the structure together.

5.9.3 GROSS VOLUME OF CRIB UNIT

The total volume of concrete contained in all crib units shall represent at least 16% of the gross volume of the crib wall with the filling in place.

5.10 PLANS, DESIGN DATA AND SPECIFICATIONS

In addition to the "Proposed Drainage Map", there shall also be submitted the following items concerning crib sediment dams.

1. A "Structure Proportioning Computations Sheet" to be completed for each proposed crib sediment dam.
2. Construction Plans showing:
    a. A topographic map on a 1" = 50' scale and 4-foot contour intervals showing the reservoir area and structure. Topographic map is to be made using transit-stadia survey method.
    b. Plan view of structure showing all pertinent dimensions.
    c. A cross-section view of crib structure at the point where the maximum depth of water will be impounded, against the structure showing all pertinent dimensions and elevations.
    d. A cross-section view taken along the centerline of the dam showing all pertinent dimensions and elevations.
    e. A "Stage-Area-Storage Computations Sheet" and "Stage-Area-Storage Curves".
    f. Construction Specifications.

5.11 CONSTRUCTION SPECIFICATIONS

5.11.1 SITE PREPARATION

Brush, trees and other undesirable material shall be cleared from the sediment pool and dam areas. Sod and topsoil shall be stripped from cribs foundation area.

5.11.2 PREPARATION OF FOUNDATION

Proper excavation shall be made along the foundation and sides of the crib structure as shown on the construction plans to assure that the crib structure will be placed on the planned line and grade.

The key into the abutments shall be excavated as shown on the construction plans. The crib structure must be keyed into the abutments to a minimum of 3 feet at any point. The crib structure shall be keyed into the channel bottom to a minimum depth of 1 foot.

When the cribbing is on fill material, the fill material beneath the cribbing shall be placed in 6-inch maximum lifts and mechanically tamped.

5.11.3 PLACING CRIB MEMBERS

The prepared foundation bed for the cribbing shall be firm and normal to the face of the cribbing. The crib members shall be taken to insure the correct alignment.

The crib members shall be handled carefully and members that become cracked or otherwise damaged shall be removed and new members substituted.

5.11.4 FILLING CRIB

The filling of the interior, backfilling against the upstream face, backfilling key into embankment, and dumped rock against downstream face shall progress simultaneously with the erection of the cribbing. The interior of the cribbing shall be filled with durable limestone, sandstone, or river bedrock which shall be hand or machine placed inside the cribbing in such a manner as to minimize the void space. If open-faced cribbing is used, the stone fill shall have a minimum size of one inch greater than that of the crib's vertical opening. If closed face cribbing is used, the stone fill shall be 3-7 inches in size.

5.11.5 BACKFILLING UPSTREAM FACE

The upstream face of the cribbing shall be backfilled with material from the pool area up to the sediment pool elevation behind the spillway and up to the top of dam elevation for the remainder on a maximum slope of 3 horizontal to 1 vertical.

Very dry or wet material shall not be used. The fill material shall be free of all sod, roots, stones over 6 inches in diameter and other objectionable material. The moisture content of the material should be such that when kneaded in the hand, it will just form a ball that will not readily separate.

The embankment shall be brought up on uniform 6-8-inch layers of approximate uniform elevation over its entire area. Each layer shall be thoroughly compacted by making at least 4 complete passes with a tamping roller or by applying equal compactive effort with rubber-tired equipment.

5.11.6 BACKFILLING KEY INTO ABUTMENTS

The key into the abutments shall be backfilled to the embankment's original contour with compactible material. This material shall be placed in 6-inch maximum lifts and mechanically tamped.

5.11.7 DOWNSTREAM CHANNEL PROTECTION

5.11.7.1 ROCK MATTRESS

The channel bottom and sides downstream of the structure shall be covered to a minimum depth of 3 feet with durable rock of which 50% is 3 feet or larger and the remainder sized to fill the voids with a minimum size of 6 inches. The rock shall not contain more than 10% earth, sand, or soft shale as determined by visual inspection. The rock shall extend out from the toe of the crib structure. The dumped rock shall form a trapezoidal channel with a bottom width equal or greater than the length of the spillway. The rock shall extend up the embankment sides for a minimum vertical depth of 4 feet.

5.11.7.2 GABION MATTRESS

The channel bottom and sides downstream of the structure shall be covered with a 12-inch gabion mattress. The mattress shall form a trapezoidal channel with a bottom length equal to or greater than the length of the spillway. The mattress shall extend up the embankment to a minimum distance of twice the height of the structure.

Material specifications, binding and filling of gabion mattress baskets shall be as outlined under GABION SEDIMENT DAMS.

5.11.8 VEGETATIVE PROTECTION AGAINST EROSION

All disturbed areas outside the pool area shall be mulched and vegetated in accordance with Reclamation rules and regulations for revegetation.

SECTION 6

EXCAVATED SEDIMENT CHANNEL

6.1 DEFINITION

A channel excavated below the toe of the spoil to form a silt or sediment basin for control of sediment from the outslope.

6.2 PURPOSE

To preserve the capacity of reservoirs, ditches, canals, diversions, waterways and streams and to prevent undesirable deposition on bottom lands, in channels or waterways, and other areas by providing basins for the deposition and storage of silt, sand, gravel, stone and other detritus.

6.3 SCOPE

This standard establishes the minimum acceptable quality for the design and construction of an excavated sediment channel in predominantly rural or agricultural areas in West Virginia when:

1. Failure of the embankment for the channel would not result in loss of life; in damages to homes, commercial or industrial buildings; main highways, or railroads; in interruption of the use of service of public utilities.
2. The slope of the original ground on which the channel is constructed does not exceed 30%.
3. The maximum expected horizontal length of the spoil bank outslope does not exceed 100 feet.

6.4 SEDIMENT CAPACITY

The excavated sediment channel shall form a basin with a capacity to store 0.125 acre-feet per acre of disturbed area formed by the outslope of the spoil bank. The outslope area shall be based upon the maximum expected length of spoil slope. An outline of the predicted outslope area shall be shown on the proposed drainage plan.

The sediment in the channel shall be cleaned out when accumulation approaches 60% of the design capacity. The construction drawings shall indicate the corresponding elevation.

6.5 LIMITATIONS

The excavated sediment channel shall be built on a level grade around the hill or mountainside. Adequate space shall be provided between the toe of spoil bank and the channel to assure that sluffage from the spoil slope will not fill the channel.

Precaution shall be taken to assure that there is no overburden or spoil spillage over the outslope into the channel.

The excavated sediment channel shall have a V-notch cross-sectional appearance. The vertical depth of the inside cut or highwall shall not exceed 5 feet and the slope of the cut shall not exceed 1/2 horizontal to 1 vertical.

The bench formed by the channel shall be a minimum of 14 feet wide, and on a slope of 5 horizontal to 1 vertical towards the cut slope.

The channel fill slope shall be no greater than 1-1/2 horizontal to 1 vertical. Trees shall not be removed from beneath or through the fill slope.

An earthen barrier shall be installed across the channel at 200-foot intervals or less to assure that failure of the embankment or fill portion of the channel would result in release of water or sediment from only a 200-foot segment of the channel at any one time. The top or crest width of the barrier shall be 5 feet. Barrier height shall be 1 foot below the embankment or fill portion of the channel.

Drainage from an area other than the spoil outslope shall not be allowed to enter the channel at any time. The channel shall be terminated 10 feet each side of any drain (natural or constructed) from the bench area. In the event that a drain from the bench down the outslope is deemed necessary after completion of the channel and during the active mining operation at a location where allowance was not made for letting the drainage bypass the channel when the channel was constructed, an earthen barrier shall be installed in the channel, 10 feet on each side of the drain. The embankment or fill shall be eliminated between these two barriers.

6.6 PLANS, DESIGN DATA AND SPECIFICATIONS

In addition to the "Proposed Drainage Map", there also will be submitted the following items:

1. A "Structure Proportioning Computations Sheet"
2. Construction Plans showing:
   a. Plan view drawn to scale of the channel
   b. Profile view drawn to scale of the channel
   c. Cross-section view drawn to scale through the channel showing the maximum existing ground slope on which the channel is to be constructed
   d. Cross-section of barrier as located in channel

   NOTE: The proximity of the toe and top of spoil slope to the excavated channel should be shown on all views.
3. Construction Specifications

6.7 CONSTRUCTION SPECIFICATIONS

6.7.1 STAKE- OUT

Prior to beginning the excavation of the channel, alignment and grade controls shall be established every 100 feet along the channel. Care shall be taken to establish a level, zero percent grade.

6.7.2 EXCAVATION

The channel shall be excavated as shown on the construction plans. A barrier with a 5-foot crest width shall be placed through the channel every 200 feet or less. The channel may be discontinued and restarted above or below the point where discontinued to avoid rock formations. In no case shall the channel be planned or built on a slope which exceeds 30%.

6.7.3 SURFACE RUNOFF

Surface runoff from an area other than the spoil outslope shall not be allowed to enter the channel at any time. The channel shall be terminated 10 feet each side of any drain (natural or constructed) from the bench area.

In the event that a drain from the bench down the outslope is deemed necessary after completion of the channel and during the active mining operation at a location where allowance was not made for letting the drainage bypass the channel when the channel was constructed, an earthen barrier shall be installed in the channel 10 feet each side of the drain. The embankment or fill portion of the channel shall be eliminated between these two barriers.

6.7.4 VEGETATIVE PROTECTION AGAINST EROSION

All disturbed areas created during the construction of the channel shall be seeded and mulched in accordance with Reclamation rules and regulations for revegetation.

SECTION 7

ACCEPTANCE OF EXISTING STRUCTURES FOR SEDIMENT CONTROL

Acceptance of existing structures for sediment control shall be based upon the ability of the structure to meet or exceed the recommended criteria outlined in this handbook. Plans should be submitted for the structure or structures as required in this handbook for that particular type structure.

Sediment control structures built under previous permits may be utilized for sediment control on new permits. A copy of the as-built plans and data as required for the structure shall be submitted with the drainage plan.

SECTION 8

MODIFICATION OF SEDIMENT CONTROL STRUCTURES

No modification of existing sediment control structures after their completion and approval by the Reclamation Division of the Department of Natural Resources shall be allowed without their approval. In no case will it be allowable to increase the capacity of an earthen, crib, or gabion dam by increasing the height of the embankment, cribbing or gabion above the structures designed height.

SECTION 9

ABANDONMENT PROCEDURES FOR SEDIMENT CONTROL STRUCTURES

9.1 SCOPE

This section shall cover the minimum requirements for abandoning sediment control structures prior to total release of bond for the particular permit. These abandonment procedures may be waived if the structure or structures are to be immediately utilized under another permit or the landowner signs a law-binding document stating that he will assume future responsibility for said structure or structures. A copy of this document shall be forwarded to the Department of Natural Resources for their records with the drainage plan.

All abandonment procedures shall be completed before the total bond is released.

9.2 ABANDONMENT PROCEDURES

9.2.1 EXCAVATED SEDIMENT PONDS

There is no required abandonment procedure for excavated sediment ponds unless they have an embankment. If they have an embankment, they shall follow the abandonment procedures for SEDIMENT DAMS - EMBANKMENT TYPE.

9.2.2 SEDIMENT DAMS - EMBANKMENT TYPE

Sediment dams and all accumulated sediment above the dam shall be removed from the natural drainway if they are built across it. Dams adjacent to natural drainways shall be abandoned by diverting the entrance channel to the natural drainways; thus preventing any future surface runoff from entering the impoundment.

When sediment dams are removed, the natural drainway shall be returned to its original profile and cross-section as near as practical. An original profile and cross-section view for the channel shall be submitted with the drainage plan. The channel sides and bottom shall be riprapped with 18 inches of durable stone, 25% of which is 18 inches or larger, and the remainder sized to fill the voids. The riprap shall extend up to the top of the channel. The riprap requirement may be waived where the bottom and sides of the channel consist of bedrock.

9.2.3 CRIB OR GABION SEDIMENT CONTROL STRUCTURES

Crib or gabion sediment control structures and all accumulated sediment above the structure shall be removed from the natural drainway for abandonment. The natural drainway shall be returned to its original profile and cross-section. An original profile and cross-section view of the channel shall be submitted with the drainage plan. The channel shall be riprapped with 18 inches of durable stone, 25% of which is 18 inches or larger, and the remainder sized to fill the voids. The riprap requirement may be waived where the channel bottom and sides consist of bedrock.

9.2.4 EXCAVATED SEDIMENT CHANNEL

There is no required abandonment procedure for excavated sediment channels.

9.2.5 REVEGETATION OF DISTURBED AREAS

All areas disturbed during abandonment of a sediment control structure shall be mulched and vegetated in accordance with Reclamation rules and regulations for revegetation.

9.2.6 DISPOSAL OF WASTE MATERIAL

Waste material shall be spread continuously over an area designated on the drainage plan in accordance with these specifications.

Provisions shall be made for the diversion or safe passage of surface water concentrating on the land side of the spoil bank.

The spoil shall be placed so as not to endanger the stability of the stream bank and shall not exceed 3 feet in height above the natural ground surface, except by special design. Special designs shall be submitted with the drainage plan. The finished surface shall slope away from the edge of the stream or drainway insofar as feasible.

Surfaces of spoil shall not be steeper than 4 horizontal to 1 vertical on the land side, and 3 horizontal to 1 vertical on stream side.

If the spoil is spread to the edge of the stream bank, the stream side slope of the spoil shall be shaped to join the side slope of the stream bank so loose spoil will not slide or erode into the channel.

SECTION 10

VALLEY FILL

10.1 DEFINITION

A controlled earth and rock fill across or through the head of a valley or hollow to form a stable, permanent storage space for surface mine spoil material.

10.2 PURPOSE

The valley fill method was developed to improve aesthetics, reduce landslides, allow for full recovery of one or more coal seams, and produce rolling mountaintop land that is suitable for many uses other than forestry purposes.

The valley fill method provides storage space for spoil from mountaintop removal or as a waste area for overburden from contour benches.

Narrow V-shaped, steep-sided hollows near the ridge top, that are free of underground mine openings or wet weather springs, are selected for valley fills. The size of the selected hollow must be such that the overburden generated by the mining operation will completely fill the treated head of the hollow.

Instead of unstable outslope with its potential for slides and erosion, or islands of isolated land with no access, a large, stable, fairly level area can be constructed with this method.

10.3 DRAINAGE

Drainage for valley fills shall consist of a rock drain constructed through the fill from the original valley floor up to the finished ground line to provide a permanent means of conveying surface runoff past the fill area. The rock core shall be progressively brought up with the remainder of the fill.

During and after construction, the top of the fill shall be graded to drain back to the head of the fill. The maximum slope of the top of the fill shall be 3% in any direction.

A drainage pocket shall be maintained at the head of the fill during and after construction to intercept surface runoff and discharge the runoff through or over the rock core. In no case shall this pocket or sump have a potential for impounding more than 10,000 cubic feet of water.

The top of the rock drain shall form a trapezoidal channel for possible flows over the core instead of through it in the event the pores of the core become blocked by debris or sediment. The minimum base width of the channel shall be 8 feet and the minimum depth of the channel shall be 2 feet.

10.4 DESIGN DATA AND SPECIFICATIONS

In addition to the drainage map, the following items shall be submitted:

1. A three-dimensional sketch of the fill.
2. A profile view of the valley fill showing the original ground line as surveyed in 100-foot stations.
3. A cross-section through the valley fill at the midpoint of the 2:1 outer slope. The existing ground line should be shown as surveyed.
4. A cross-section through the valley fill at the midpoint of the bench. The existing ground line should be shown as surveyed.
5. Construction Specifications

10.5 CONSTRUCTION SPECIFICATIONS

1. All areas upon which valley fill is to be placed, shall first be cleared completely of all trees, brush, shrubs, and other organic material. This material shall be removed from the fill area and may be placed at the toe to catch siltation.
2. A rock core shall be progressively constructed (as the layers are brought up) through the valley fill. The rock core shall be a minimum of 16 feet in width and composed of rock with a minimum dimension of 12 inches. The rock core shall consist of no more than 10% fines as determined by visual inspection - fines being a material with a dimension of less than 12 inches.

3. Depositing and compacting valley fill in layers shall be begun at the toe of the fill. The layers shall be constructed approximately parallel with proposed finish grade. All material shall be deposited in uniform horizontal layers and compacted with haulage equipment.
4. The thickness of the layers shall not exceed the maximum size of the rock; the maximum dimension shall be 4 feet.
5. During and after construction, the top of the fill shall be graded to drain back to the head of the fill on a slope no greater than 3%. A drainage pocket shall be maintained at the head of the fill at all times to intercept surface runoff.
6. The outer slope shall be no steeper than 2 horizontal to 1 vertical. A 20-foot wide, bench shall be installed at a minimum of every 50 feet in vertical height of the fill with a 3% to 5% slope toward the fill area, normal to such, and a 1% slope toward the rock core.
7. When construction of the valley fill is finished, topsoil or other suitable material which will support vegetation shall be spread over the entire surface of the fill excluding the rock core. The top and outer slopes shall then be seeded according to revegetation plan.

SECTION 11

LOG AND POLE STRUCTURES

11.1 DEFINITION

A barrier composed of logs and poles constructed across a natural or constructed drainway.

11.2 PURPOSE

To retard stream flow and catch small sediment loads.

11.3 CONDITIONS WHERE PRACTICE APPLIES

Log and pole structures are to be used only to assist in sediment control and ARE NOT SUBSTITUTES for sediment dams or excavated sediment ponds. When used, log and pole structures will not reduce the required sediment capacity (0.125 acre-feet/acre of disturbed area) of sediment dams or excavated sediment ponds.

They may be used in locations such as:

1. In natural drainways close to the disturbed area to catch initial sediment loads.
2. In channels carrying water off the bench toward a natural drainway.
3. Other locations where small localized sedimentation problems exit.

11.4 DESIGN CRITERIA

A design is not needed for log and pole structures. Generally, they will follow the standard shown in Appendix I, Illustration No. 1, Page I-25. Log and pole structures will not be used on a drainway whose normal discharge is greater than 5 cubic feet per second.

SECTION 12

STONE CHECK DAMS

12.1 DEFINITION

A barrier composed of large stone constructed across a drainway.

12.2 PURPOSE

To retard stream flow and form a small sediment basin in order to assist in sediment control.

12.3 CONDITIONS WHERE PRACTICE APPLIES

Stone check dams may be used only to assist in sediment control. They ARE NOT SUBSTITUTES for sediment dams or excavated sediment ponds. If used above such structures, stone check dams will in no way reduce the required sediment capacity (0.125 acre-feet/acre of disturbed area) of sediment dams and excavated sediment ponds.

Stone check dams will not be used when the drainage area above them exceeds 50 acres. They may be used in locations such as:

1. In natural or constructed drainways close to the disturbed area in order to catch initial sediment loads.
2. In channels carrying water off the bench toward a natural drainway.
3. Other locations where small localized sedimentation problems exist.

12.4 DESIGN CRITERIA

A design is not required for stone check dams; however, the following standard criteria will be used as shown in Appendix I, Illustration No. 2, Page I-26.

1. Twenty-five percent of the rock will be 18 inches or larger. The remaining 75% shall be well graded material consisting of sufficient rock small enough to fill the voids between the larger rocks.
2. The dam will be keyed into the sides and bottom of the channel a minimum depth of 3 feet. Minimum width of the key will be 3 feet.

3. Upstream slope and downstream slope will be 3 horizontal to 1 vertical.
4. A weir the average width of the stream channel and a minimum of 1 foot deep will be positioned at the center of the dam.
5. Maximum height will be 4 feet (from lowest point along centerline of dam to crest of weir).
6. Minimum top width shall be 5 feet.

12.5 MAINTENANCE

Stone check dams shall be cleaned when sediment capacity is approached.

SECTION 13

TOE BERM

13.1 DEFINITION

A berm or "bench" of compacted and vegetated soil constructed at the toe of the outer slope.

13.2 PURPOSE

To control sheet erosion from the outer spoil slope by diminishing the velocity of the runoff and making it possible for sediment to deposit.

13.3 CONDITIONS WHERE PRACTICE APPLIES

The toe term is used at the toe of the outer spoil slope to control excessive erosion until the slope has been properly revegetated and stabilized. The toe berm should be constructed as soon as the toe of the outer spoil slope is established. This shall be done as mining progresses. The berm shall not be built where concentrated flows from the bench area occurs; it shall be built only where runoff is from spoil slope.

13.4 DESIGN CRITERIA

A design is not required for toe berms; however, the following standard criteria will be used:

1. Width of the toe berm will be 10 feet for every 100 feet of spoil slope length.
2. Toe berm will be sloped a minimum of 1% and a maximum of 3% away from the toe of spoil.
3. Outer slope of the toe berm will be 3 horizontal to 1 vertical or flatter.
4. Toe berm will be vegetated immediately after construction and shall cover the outer slope, berm, and shall extend a minimum of 10 feet up the spoil slope. The Ph and nutrient level of the soil shall be such that vigorous stand of vegetation can be established.

5. Toe berm will be compacted using suitable construction equipment. (Refer to Figure 6, Appendix I, Page I-8, for different types of toe berm construction).

SECTION 14

LEVEL SPREADER

14.1 DEFINITION

An outlet constructed at zero percent grade across the slope where concentrated runoff may be spread at non-erosive velocities over undisturbed areas stabilized by existing vegetation.

14.2 PURPOSE

The purpose of the level spreader is to convert a concentrated flow of storm runoff into sheet flow and to outlet it onto areas stabilized by existing vegetation without causing erosion.

14.3 CONDITIONS WHERE PRACTICE APPLIES

Level spreaders may be used where storm runoff is concentrated and diverted from surface mined areas onto undisturbed areas (i.e., at diversion outlets, etc.). This practice applies only in those situations where the spreader can be constructed on undisturbed soil and where the area directly below the level lip is stabilized by existing vegetation.

14.4 DESIGN CRITERIA

A specific design for level spreaders will not be required. However, spreader length will be determined by estimating Q_1 flow from Figure 1, Appendix I, Page I-3, and selecting the appropriate length from Table 7, Level Spreader, Appendix I, Page I-14.

14.5 OUTLETS

Final discharge will be over the level lip onto an area already stabilized by existing vegetation.

SECTION 15

DIVERSION OR CONSTRUCTED DRAINWAY

15.1 DEFINITION

A graded channel constructed across the slope with or without a supporting ridge on the lower side.

15.2 PURPOSE

To divert water away from surface mined areas and thereby reduce acid water and sediment problems.

15.3 CONDITIONS WHERE PRACTICE APPLIES

Diversions may be used above the highwall to keep water out of the pit, below the spoil slopes to direct runoff to sediment ponds, and in other locations as needed.

15.4 DESIGN CRITERIA

15.4.1 CAPACITY

Diversions shall have the capacity to carry at least the peak discharge from the contributing watershed for a one-year frequency storm. This discharge shall be obtained from Figure I, Diversion Design Peak Discharge, Appendix I, Page I-3, Table 8; Appendix I, Page I-15; and Chart 2, Appendix I, Page I-2, will be used to proportion trapezoidal- and triangular-shaped diversion ditches. Table 9, Appendix I, Pages I-16 through I-22, will be used to proportion parabolic-shaped diversions. Trapezoidal- or triangular-shaped ditches are easier than parabolic to construct on slopes exceeding 20 percent. All diversions constructed in earth will be vegetated immediately upon completion according to Reclamation rules and regulations for revegetation.

15.4.2 VELOCITY

Maximum permissible velocities of flow shall be as follows:

MAXIMUM PERMISSIBLE VELOCITIES

Feet per Second

Soil Texture	Vegetated Channel	Rock Riprap
Sand, silt, sandy loam and silty loam	2.5	12
Silty clay loam and sandy clay loam	3.5	12
Clay	4.5	12

Rock riprap, when required, will be placed in a 1.5-foot thick blanket on the bottom and sides of the channel. Twenty-five percent of the rock will be 18 inches or slightly larger. The remaining 75% shall be well-graded material consisting of sufficient rock small enough to fill the voids between the larger rocks.

15.4.3 CROSS-SECTION

The channel shall be approximately parabolic, triangular, or trapezoidal, with side slopes no steeper that 1.5:1. When a ridge is used, it shall have a minimum width of four (4) feet at the design water elevation, and must provide a minimum 0.5 feet for freeboard and settlement above this elevation. Typical cross-sections are shown in Appendix I, Illustration No. 3, Page I-27.

15.4.4 GRADE

Channel grades may be uniform or variable. The allowable velocity for the particular soil type and vegetal cover will determine the maximum grade.

15.4.5 LOCATION

Diversion location shall be determined by outlet conditions, topography, soil type, and length of slope.

15.4.6 PROTECTION AGAINST SEDIMENTATION

When movement of sediment into the channel is a significant problem, a vegetated filter strip shall be used above the diversion.

15.4.7 OUTLETS

Each diversion must have an adequate outlet. The outlet may be a natural drainway, vegetated area, or other stable watercourse. In all cases, the outlet must convey runoff to a point where outflow will not cause damage. Vegetative outlets shall be installed before diversion construction, if needed, to insure establishment of vegetation cover in the outlet channels.

15.4.8 MAINTENANCE

All diversions shall be kept free of sediment and other debris so that the flow of water will remain uninterrupted.

15.5 PLANS, DESIGN DATA AND SPECIFICATIONS

In addition to the "Proposed Drainage Map", there shall also be submitted the following items concerning diversions:

1. A "Diversion Design Computations" to be completed for each proposed diversion. (See Page I-23, Appendix I).
2. Construction Plans showing:
   a. A surveyed profile along the centerline of the diversion showing original ground line and proposed diversion bottom.
   b. Channel cross-sections showing the bottom width, side slopes, and depth of flow.
   d. Type of soil in which diversion will be excavated. The soil shall be SAMPLED and CLASSIFIED at intervals not exceeding 500 feet.
3. Construction and vegetation specifications.

15.6 CONSTRUCTION SPECIFICATIONS

15.6.1 SITE PREPARATION

Obstructions will be removed, as necessary for construction of the diversion.

15.6.2 EXCAVATION AND SHAPING

The completed diversion shall conform to the line, grade, and cross-section as shown on the plans. The top of the constructed ridge or low bank shall not be lower at any point than the designed elevation, including freeboard and the settlement factor. The constructed channel shall be generally free draining and low spots shall not exceed 0.2 feet in depth. All portions of the diversion shall be finished and smoothed as needed for the establishment of vegetative cover.

15.6.3 PROTECTION AGAINST EROSION

The completed diversion shall be mulched and vegetated in accordance with Reclamation rules and regulations for revegetation.

SECTION 16

ROCK RIPRAP FLUME

16.1 DEFINITION

A temporary rock riprap-lined channel to conduct surface runoff from the top of a slope to the bottom of the slope.

16.2 PURPOSE

To convey storm runoff safely down steep slopes without scouring or erosion damage.

16.3 CONDITIONS WHERE PRACTICE APPLIES

Rock riprap flumes shall be used to convey surface water from the bench to a natural drainway and also in other locations where concentrated flows will produce erosion problems.

16.4 DESIGN CRITERIA

16.4.1 CAPACITY

The flume shall be designed to carry the expected peak flow from a one-year frequency storm. This peak flow shall be obtained from Figure 1, Diversion Design Peak Discharge, Appendix I, Page I-3. See Table 2, Appendix I, Page I-10 for the required dimensions.

16.4.2 SLOPE

The maximum allowable slope shall be 50 percent.

16.4.3 ROCK RIPRAP

A 1.5-foot thick blanket of durable rock riprap will be required. Twenty-five percent of the rock will be 18 inches or larger and the remaining 75% shall be well graded material consisting of sufficient rock small enough to fill the voids between the larger rocks. Shale shall not be used for riprap.

See Figure 7, Rock Riprap Flume, Appendix I, Page I-9, for typical cross-section views of rock riprap flume.

PIPE FLOW

17.1 DEFINITION

An enclosed watertight conduit.

17.2 PURPOSE

To convey storm runoff down steep slopes without scouring or erosion damage.

17.3 CONDITIONS WHERE PRACTICE APPLIES

Pipe may be used to convey surface water from the bench to a natural drainway, and in other locations where concentrated flows will produce erosion damage. In all cases, pipe shall be used to carry water beneath haulage roads.

17.4 DESIGN CRITERIA

17.4.1 CAPACITY

The size of pipe used shall be adequate to carry the expected peak flow from a one-year frequency storm. This peak flow shall be obtained from Figure 1, Diversion Design Peak Discharge, Appendix I, Page I-3. See Table 3, Appendix I, Page I-10, for required dimensions.

17.4.2 BEDDING

All pipe shall be placed in a trench excavated in solid undisturbed ground or formed in compacted earth. The pipe shall be imbedded in a formed cradle to a depth no less than 1/10 times the outside diameter of the pipe. Backfill material shall be placed around and over the pipe in 4-inch layers and thoroughly compacted.

SECTION 18

HAULAGEWAYS

A surveyed profile must be submitted accompanied by typical cross-sections of haul road and ditches showing pipes, entrance, exit channels, and sediment control structures to be used on haulageway.

18.1 GRADING

The grading of a haulageway shall be such that:

1. No sustained grade shall exceed 10%;
2. The maximum pitch grade shall not exceed 15% for 300 feet;
3. There shall not be more than 300 feet of maximum pitch grade for each 1,000 feet of road constructed;
4. The surface shall be insloped toward the ditch line at the minimum rate of 1/2 inch per foot of surface width or crowned at the minimum rate of 1/2 inch per foot of surface width as measured from the centerline of the haulageway.

18.2 CUT SLOPES

Cut slopes should not be more than 1:1 in soils or 1/4:1 in rock.

18.3 DITCHES

A ditch shall be provided on both sides of a through-cut and on the inside shoulder of a cut-fill section, with ditch relief cross-drains being spaced according to grade. Water shall be intercepted before reaching a switchback or large fill and led off. Water on a fill or switchback shall be released below the fill, not over it.

18.4 CULVERTS

Ditch relief culverts shall be installed according to the following provisions:

1.

Road Grade in Percent	Spacing of Culverts in Feet
2 - 5	300 - 800
6 - 10	200 - 300
11 - 15	100 - 200

2. The culvert shall cross the haulageway at a 30-degree angle downgrade;
3. The inlet end shall be protected by a headwall of suitable material and the outlet end shall be placed below the toe of the fill with an apron of rock riprap or other approved material.
4. The culvert shall be covered by compacted fill to a depth of one foot or half the culvert diameter, whichever is greater.

18.5 CULVERT OPENINGS

1. Culvert openings installed on haulageways should not be less than one hundred (100) square inches in area, but in any event, all culvert openings shall be adequate to carry storm runoff and shall receive necessary maintenance to function property at all times.
2. If sediment is to be controlled on haul road, then culverts must have a perforated vertical riser on the upstream end and discharge must be controlled to prevent erosion of slopes.

18.6 NATURAL DRAINWAY

Minor alterations and relocations of natural drainways as shown on the reclamation plan will be permitted if the natural drainway will not be blocked and if no damage is ensued to the natural drainway or to adjoining landowners.

18.7 STREAM CROSSINGS

Drainage structures shall be required in order to cross a stream channel. They shall be such so as not to affect the flow of the stream. Consideration will be given to the time of year the stream is crossed and the length of time the channel is used, but in no event, and under no condition will the flow of the stream be affected or the sediment load of the stream increased during construction and/or use.

18.8 WATER BARS

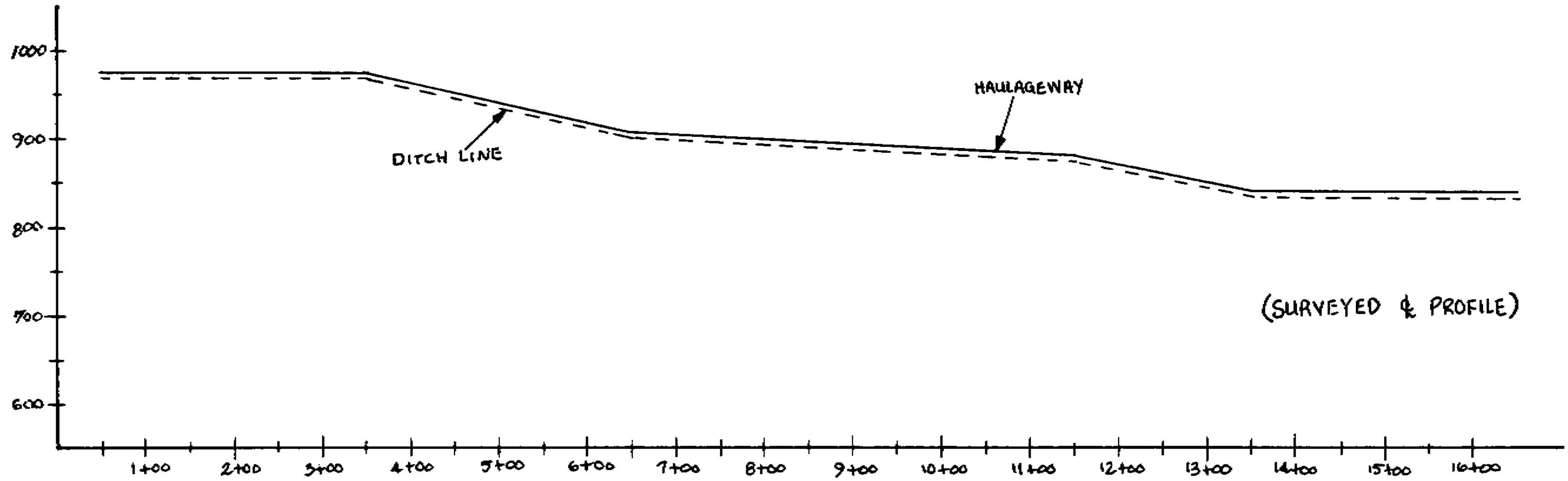
Water barriers shall be installed according to the following table of spacings in terms of percent of haulageway grade prior to the abandonment of a haulageway:

PERCENT OF HAULAGEWAY	SPACING OF WATER BARRIERS IN FEET
2	250
5	135
10	80
15	60
20	45
Above 20	25

Sediment control must be provided for the haulageway by one or more of the methods described in this handbook.

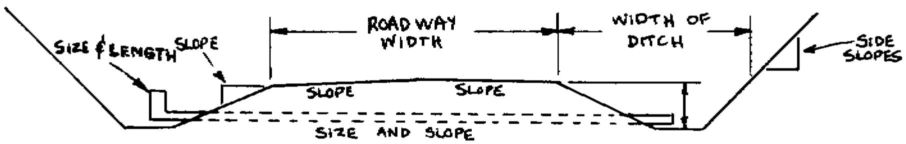
18.9

CENTER LINE PROFILE AND CROSS-SECTION OF HAUL ROAD



CENTER LINE PROFICE OF HAUL ROAD AND DITCH LINE

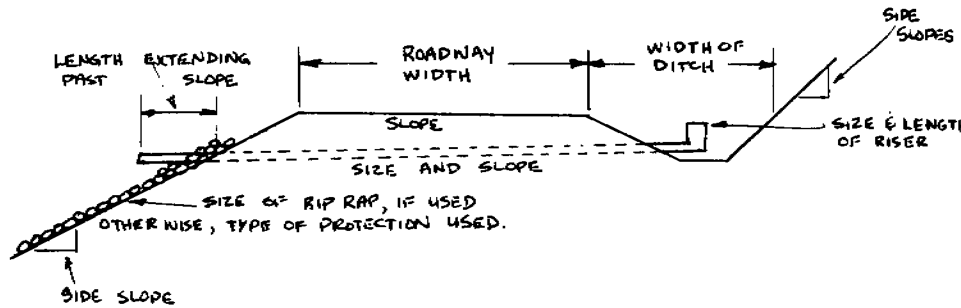
SCALE ______



THROUGH - CUT

CROSS SECTIONAL VIEW OF HAULAGEWAY

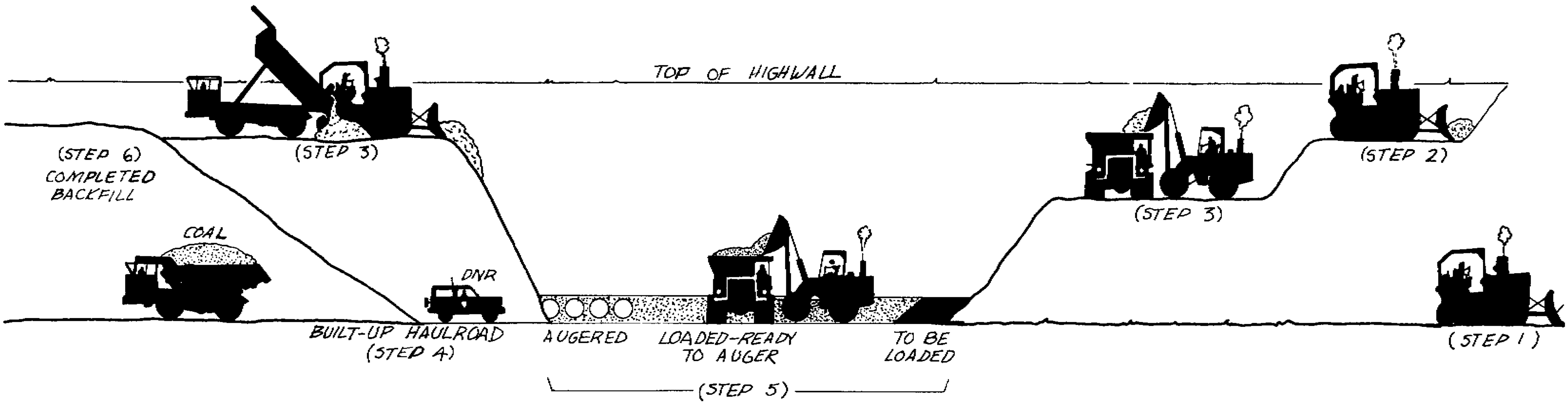
SCALE ______



CUT - FILL

CROSS SECTIONAL VIEW OF HAULAGEWAY

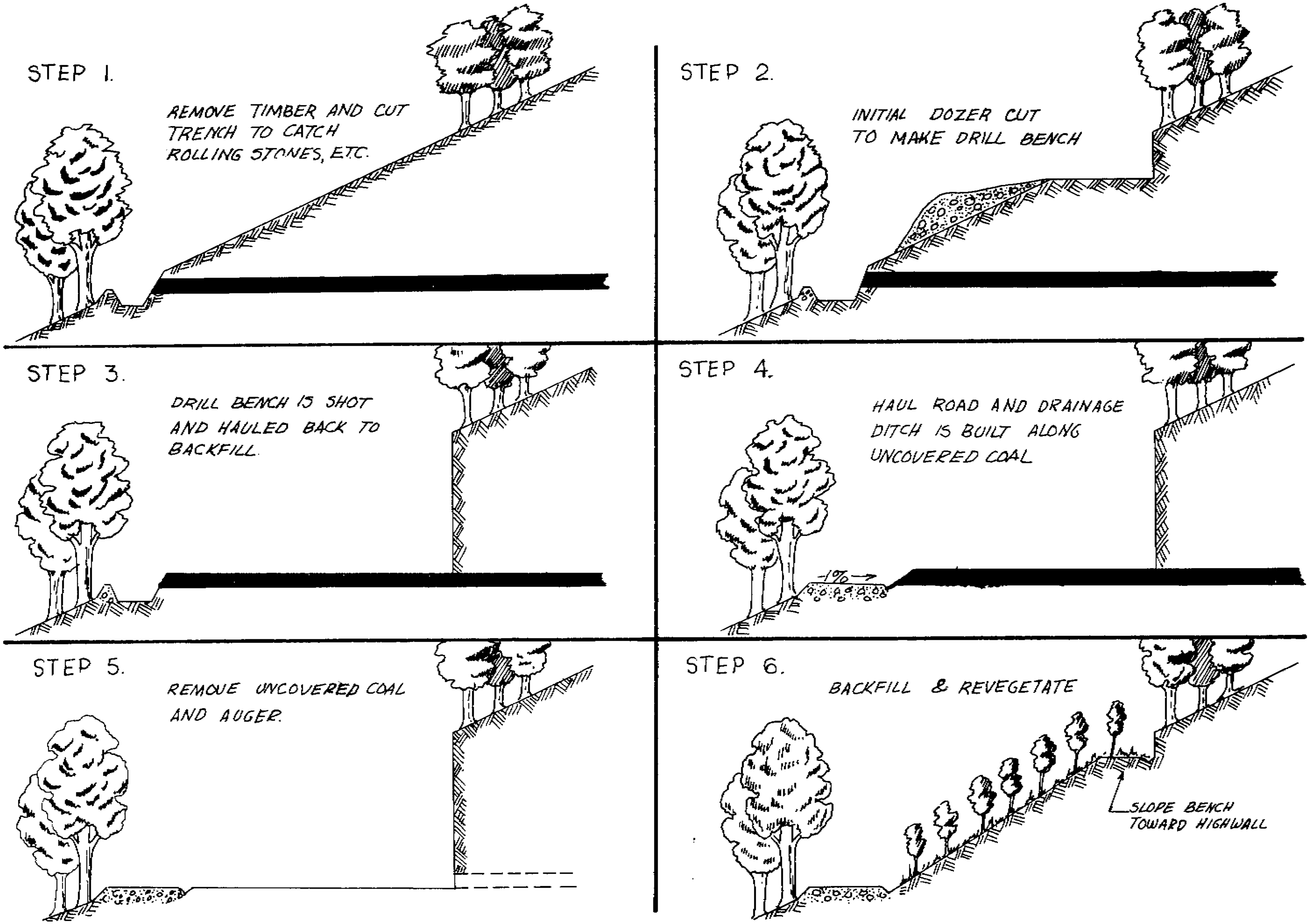
SCALE ______



SURFACE MINING

WEST VIRGINIA

CONTROLLED PLACEMENT OF SPOIL

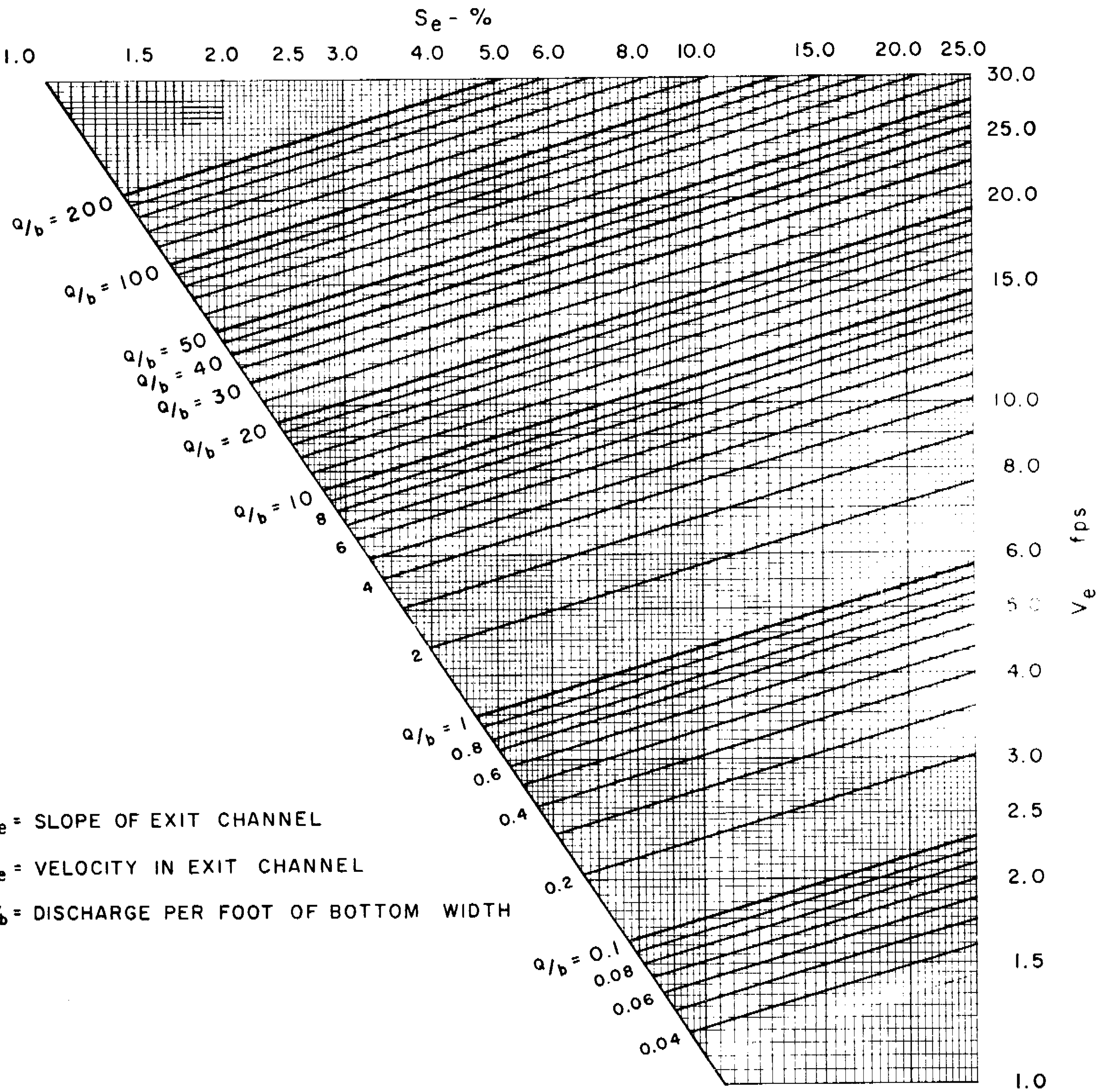

STEP 1.
REMOVE TIMBER AND CUT TRENCH TO CATCH ROLLING STONES, ETC.
STEP 2.
INITIAL DOZER CUT TO MAKE DRILL BENCH
STEP 3.
DRILL BENCH IS SHOT AND HAULED BACK TO BACKFILL.
STEP 4.
HAUL ROAD AND DRAINAGE DITCH IS BUILT ALONG UNCOVERED COAL
-1%
STEP 5.
REMOVE UNCOVERED COAL AND AUGER.
STEP 6.
BACKFILL & REVEGETATE
SLOPE BENCH TOWARD HIGHWALL

APPENDIX I

CHARTS, FIGURES, TABLES, SHEETS AND ILLUSTRATIONS

CHART NO. 1

EMERGENCY SPILLWAY VELOCITY CHART



S_e = SLOPE OF EXIT CHANNEL

V_e = VELOCITY IN EXIT CHANNEL

Q/b = DISCHARGE PER FOOT OF BOTTOM WIDTH

DIVERSION DESIGN CHART
CHART NO. 2

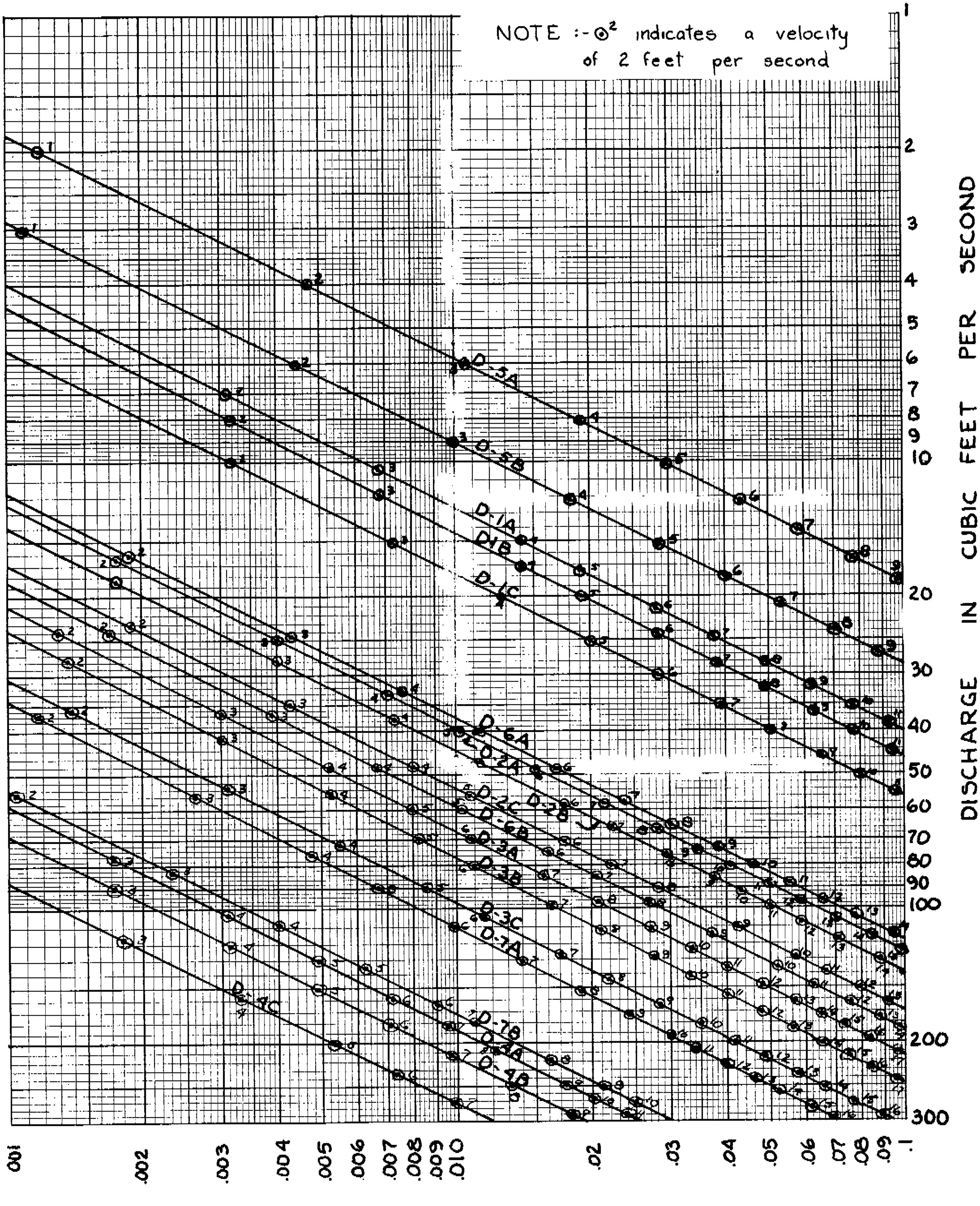


FIGURE 2

EMERGENCY SPILLWAY DESIGN PEAK

DISCHARGE

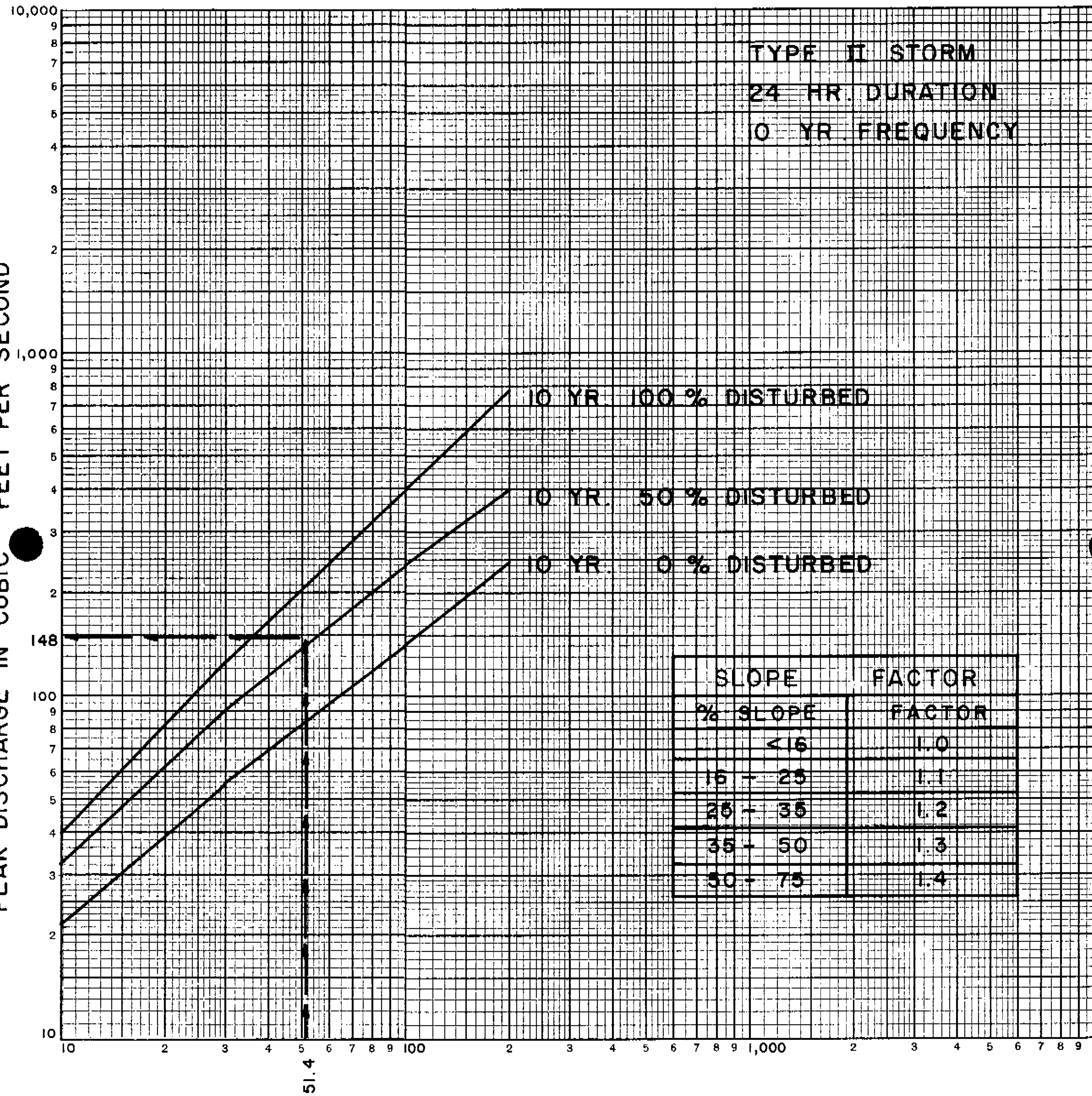
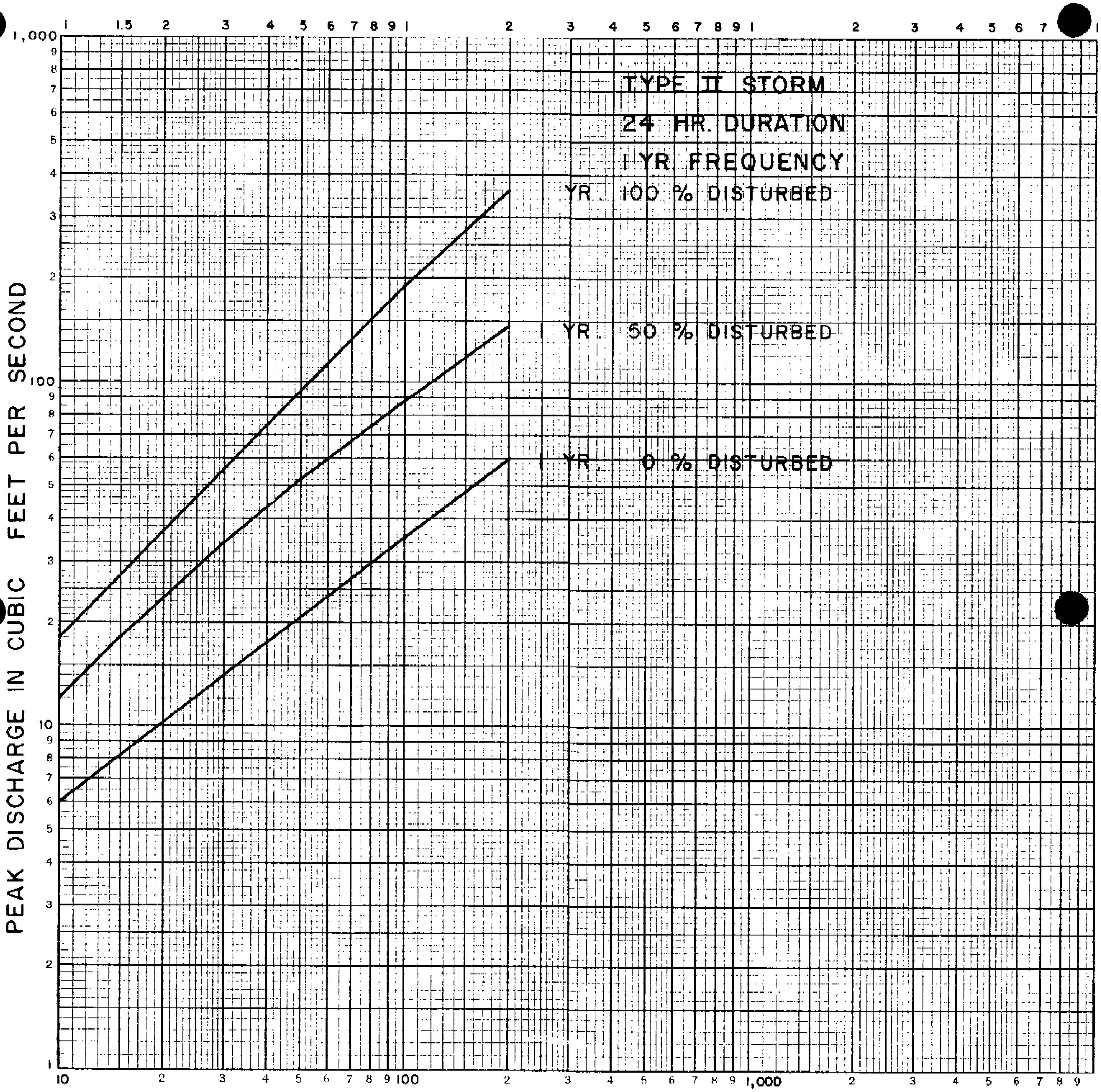


FIGURE I

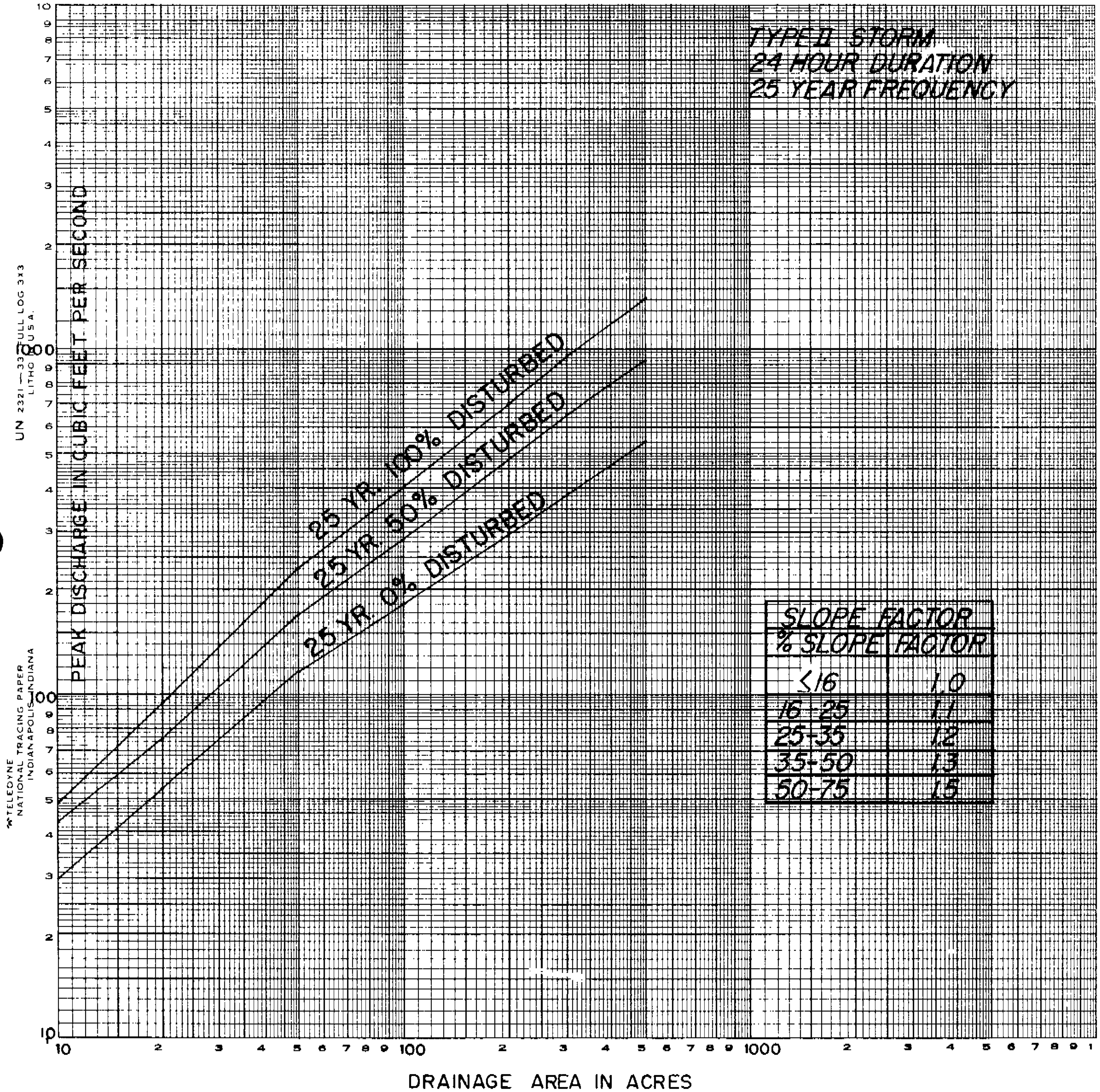
DIVERSION DESIGN PEAK DISCHARGE



DRAINAGE AREA IN ACRES

FIGURE 3

EMERGENCY SPILLWAY DESIGN PEAK DISCHARGE



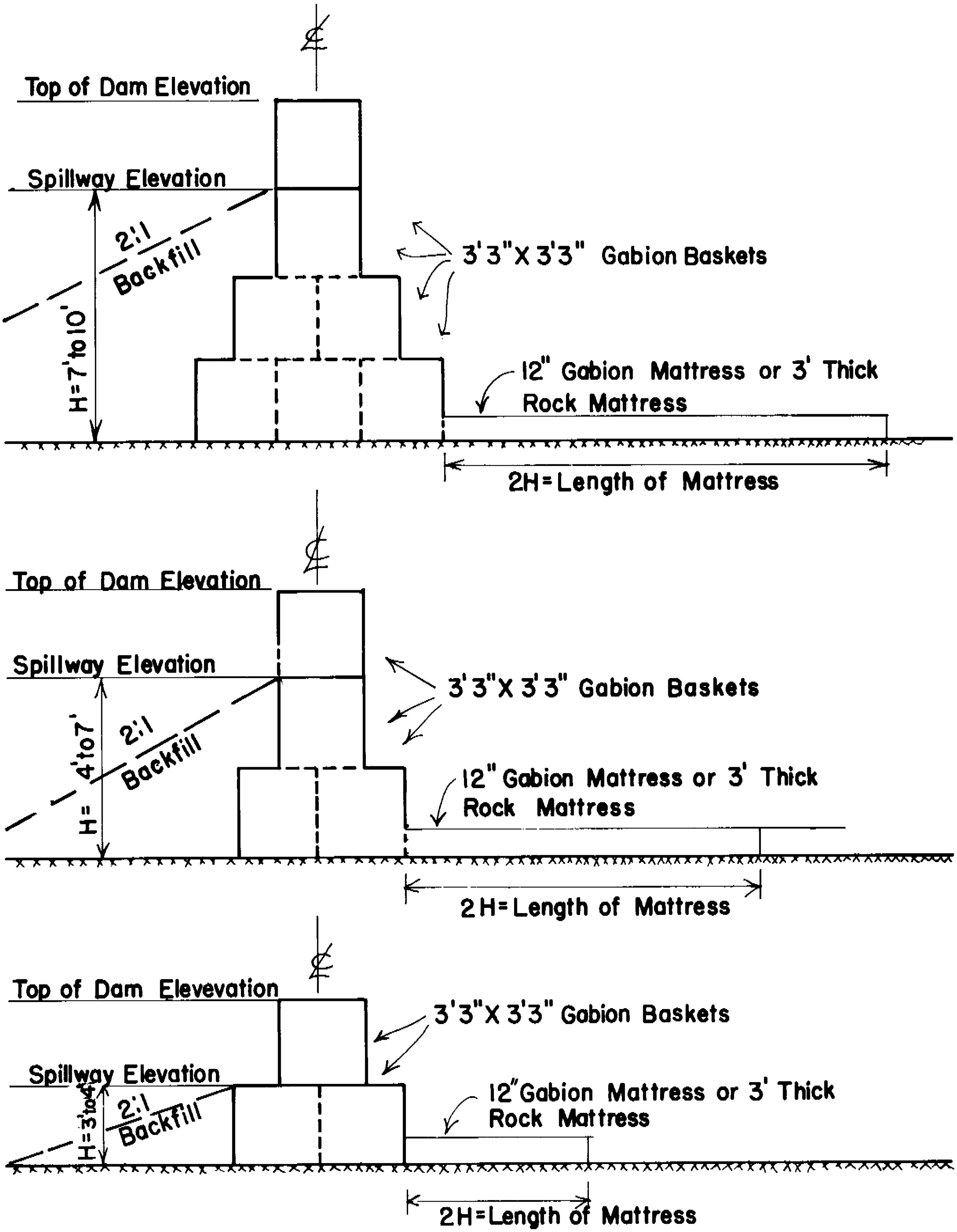


FIGURE 4 ACCEPTABLE CROSS SECTIONS FOR GABION SEDIMENT DAMS

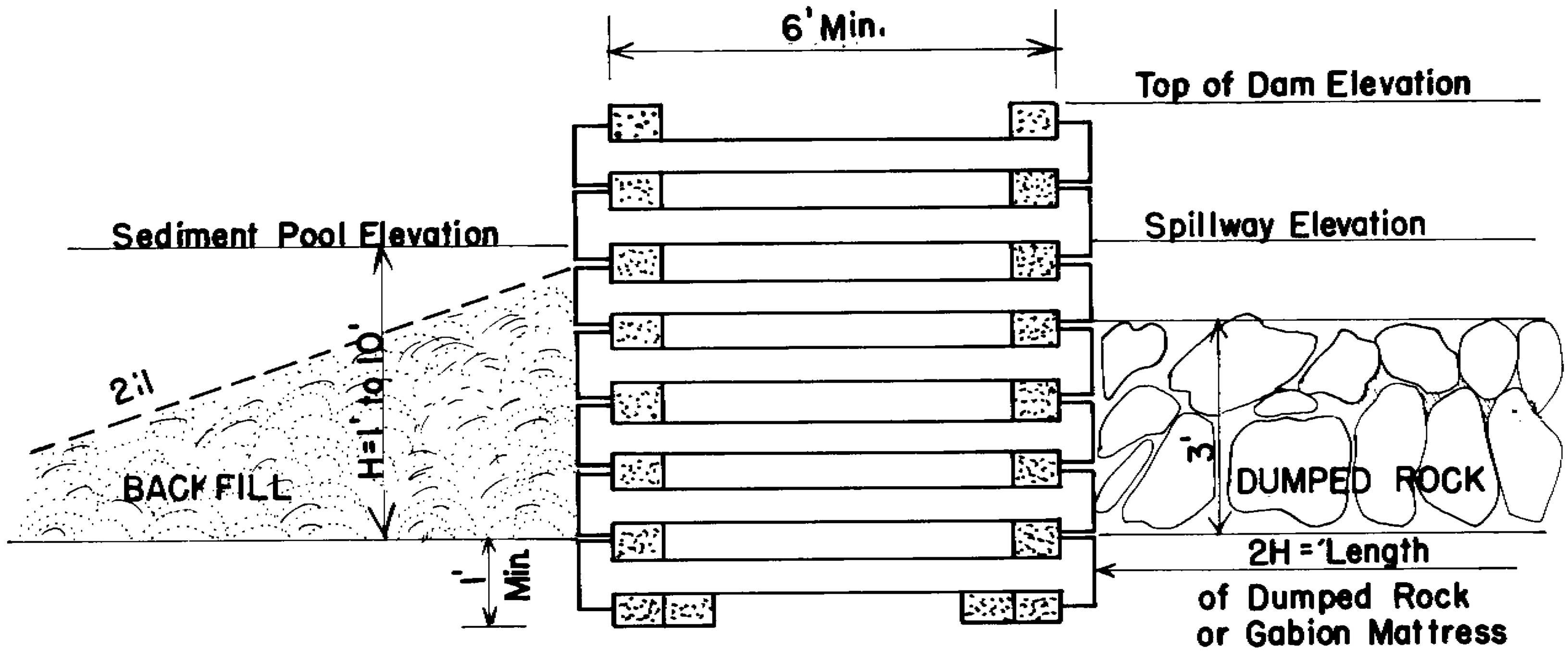
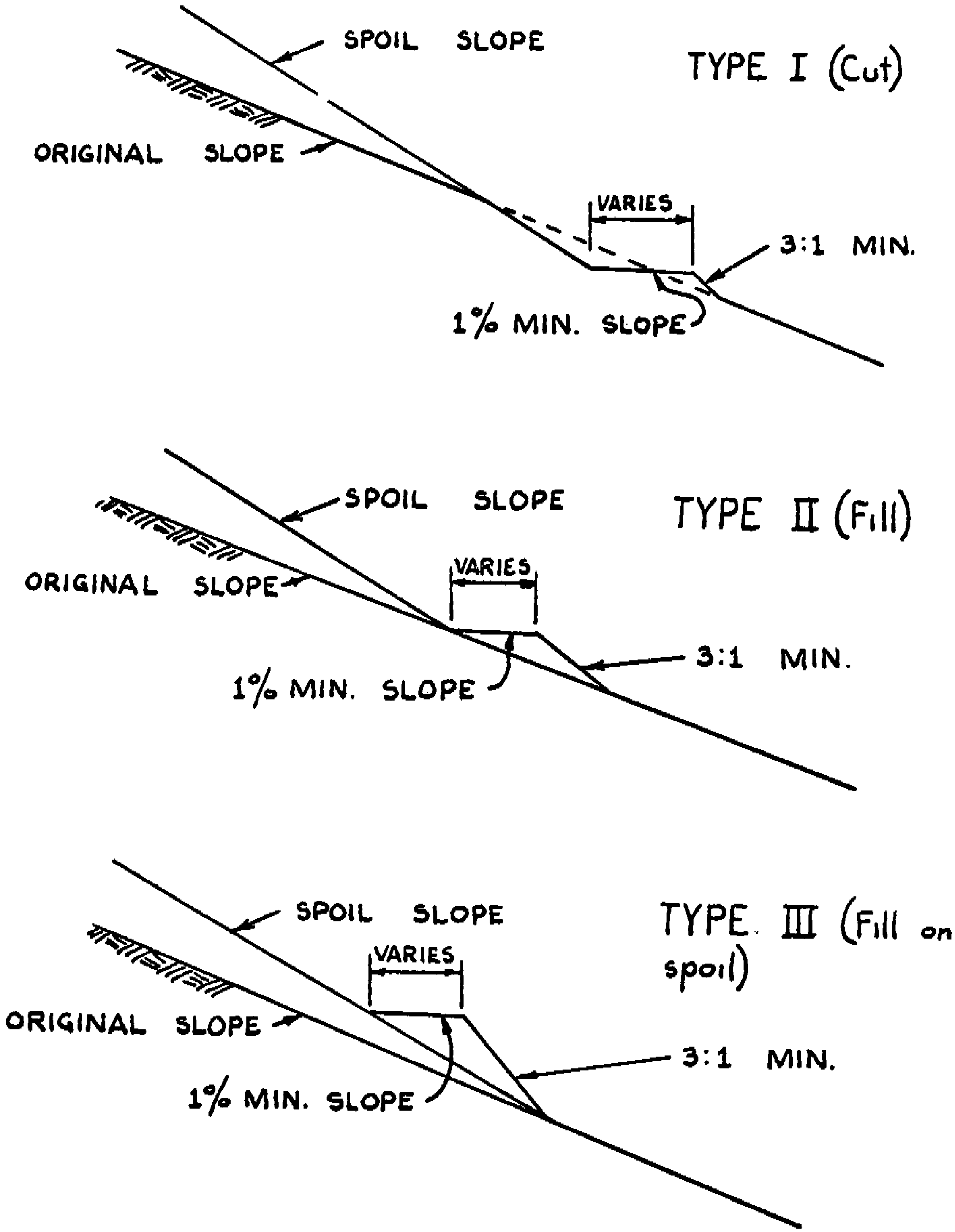


FIGURE 5 ACCEPTABLE CROSS SECTION FOR CRIB SEDIMENT DAMS

TOE BERM

FIGURE 6



NOTE: NO SCALE

Figure 7
ROCK RIP RAP FLUME

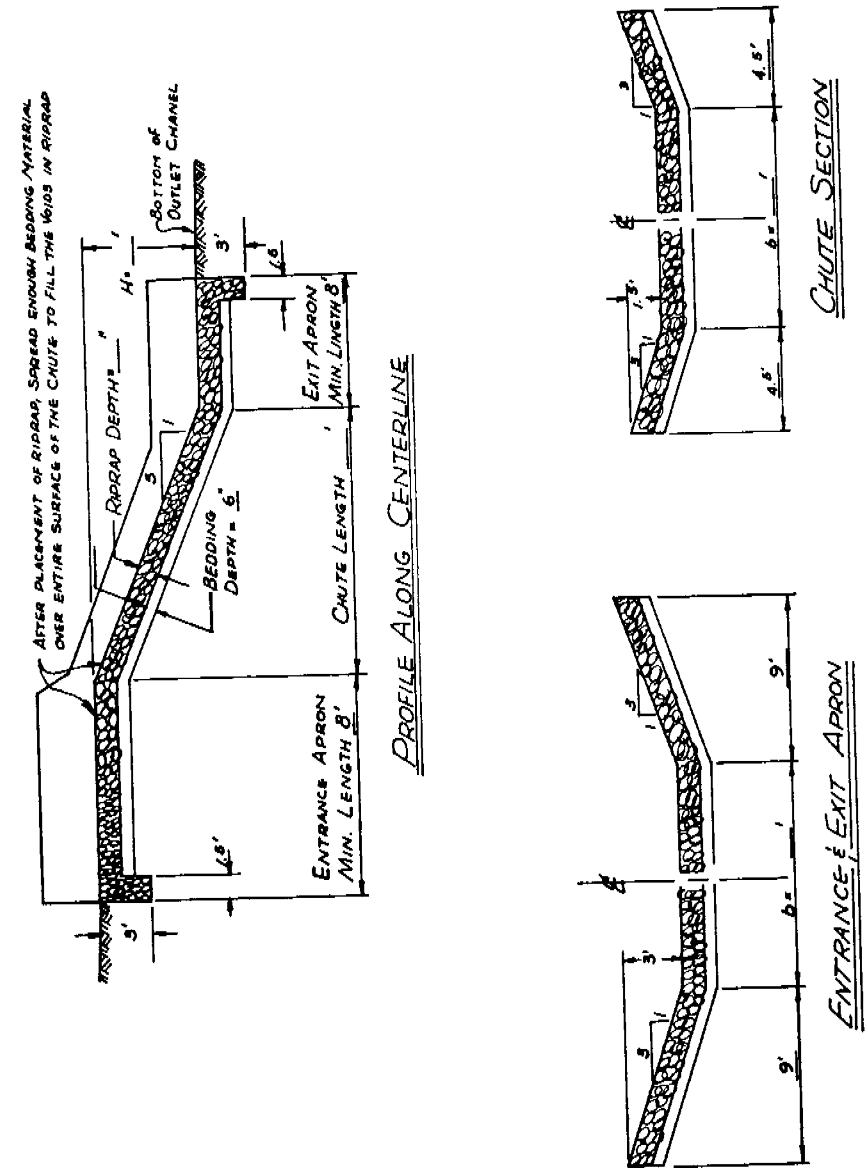


TABLE 1

MINIMUM REQUIRED PRINCIPAL SPILLWAY SIZE

Drainage Area (Ac)	Pipe Conduit Diameter (In)	Drop Inlet Diameter (In)	Square Drop Inlet Dimensions (Ft)	Minimum Drop Inlet Height (Ft)
0- 99	18	30	2 x 2	3.0
100-149	24	36	2.5 x 2.5	4.0
150-200	30	42	3 x 3	5.0

TABLE 2

ROCK RIPRAP FLUME REQUIRED DIMENSIONS

DISCHARGE (cfs)	BOTTOM (ft.)	SIDE SLOPE	CHUTE DEPTH (ft.)	INLET & EXIT DEPTH (ft.)
0 - 30	4	3:1	1.5	3.0
30 - 50	6	3:1	1.5	3.0
50 - 65	8	3:1	1.5	3.0
65 - 80	10	3:1	1.5	3.0
80 - 100	12	3:1	1.5	3.0

TABLE 3

PIPE FLOW REQUIRED DIMENSIONS

DISCHARGE (cfs)	PIPE DIAMETER (Inches)
0 - 10	21"
10 - 20	24"
20 - 40	30"
40 - 60	36"
60 - 100	42"

TABLE 5 VALUES OF C IN THE FORMULA $Q = CLh^{3/2}$

*Height of Weir h	Breadth of weir in feet					
	3.25	4.00	5.00	6.00	10.00	15.00
1.0	2.65	2.67	2.68	2.68	2.68	2.63
1.2	2.65	2.67	2.66	2.67	2.69	2.64
1.4	2.64	2.65	2.65	2.65	2.67	2.64
1.6	2.66	2.66	2.65	2.65	2.64	2.63
1.8	2.66	2.66	2.65	2.65	2.64	2.63
2.0	2.71	2.68	2.65	2.65	2.64	2.63
2.5	2.79	2.72	2.67	2.66	2.64	2.63
3.0	2.77	2.73	2.66	2.66	2.64	2.63
3.5	2.92	2.76	2.68	2.67	2.64	2.63
4.0	3.00	2.79	2.70	2.69	2.64	2.63
4.5	3.21	2.88	2.74	2.72	2.64	2.63
5.0	3.26	3.07	2.79	2.76	2.64	2.63
5.5	3.32	3.32	2.88	2.85	2.64	2.63

*h = Planned height of spillway minus 0.5 feet.

TABLE 4

EMERGENCY SPILLWAY HYDRAULICS

b-Ft / Hp-Ft	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	DISCHARGE CFS													
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.5	6	9	12	15	18	21	24	27	30	33	36	39	42	45
1.0	20	30	40	50	60	70	80	90	100	110	120	130	140	150
1.5	39	59	78	98	118	137	157	176	196	216	235	255	274	294
2.0	64	96	128	160	192	224	256	288	320	352	384	416	448	480
2.5	94	141	188	235	282	329	376	423	470	517	564	611	658	705
3.0	129	194	258	323	387	452	516	581	645	710	774	839	903	968
3.5	169	254	338	423	507	592	676	761	845	930	1014	1099	1183	1268
4.0	212	318	424	530	636	742	848	954	1060	1166	1272	1378	1484	1590
4.5	258	387	516	645	774	903	1032	1161	1290	1419	1548	1677	1806	1935
5.0	305	458	610	763	915	1068	1220	1373	1525	1678	1830			
5.5	364	546	728	910	1092	1274	1456	1638	1820					
6.0	422	633	844	1055	1266	1477	1688	1899						
6.5	482	723	964	1205	1446	1687	1928							
7.0	550	825	1100	1375	1650	1925								
7.5	618	927	1236	1545	1854									
8.0	690	1035	1380	1735										
8.5	764	1146	1528	1910										
9.0	845	1268	1690											
9.5	924	1386	1848											
10.0	1010	1515												

Reference - SCS Technical Release No. 35 (Z=2, n=0.040, L=100 Ft.)

TABLE 6

THREE-HALVES POWERS OF NUMBERS

No.	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
1.5	1.837	1.856	1.874	1.892	1.911	1.930	1.948	1.967	1.986	2.005
1.6	2.024	2.043	2.062	2.081	2.100	2.120	2.139	2.158	2.178	2.197
1.7	2.216	2.236	2.256	2.276	2.295	2.315	2.335	2.355	2.375	2.395
1.8	2.415	2.435	2.455	2.476	2.496	2.516	2.537	2.557	2.578	2.598
1.9	2.619	2.640	2.660	2.681	2.702	2.723	2.744	2.765	2.786	2.807
2.0	2.828	2.850	2.871	2.892	2.914	2.935	2.957	2.978	3.000	3.022
2.1	3.043	3.065	3.087	3.109	3.131	3.153	3.174	3.197	3.219	3.241
2.2	3.263	3.285	3.308	3.330	3.352	3.375	3.398	3.420	3.443	3.465
2.3	3.488	3.511	3.534	3.557	3.580	3.602	3.626	3.649	3.672	3.695
2.4	3.718	3.741	3.765	3.788	3.811	3.835	3.858	3.882	3.906	3.929
2.5	3.953	3.977	4.000	4.024	4.048	4.072	4.096	4.120	4.144	4.168
2.6	4.192	4.217	4.241	4.265	4.290	4.314	4.338	4.363	4.387	4.412
2.7	4.437	4.461	4.486	4.511	4.536	4.560	4.585	4.610	4.635	4.660
2.8	4.685	4.710	4.736	4.761	4.786	4.811	4.837	4.862	4.888	4.913
2.9	4.938	4.964	4.990	5.015	5.041	4.067	4.093	5.118	5.144	5.170
3.0	5.196	5.222	5.248	5.274	5.300	5.327	5.353	5.379	5.404	5.432
3.1	5.458	5.481	5.511	5.538	5.564	5.591	5.617	5.644	5.671	5.698
3.2	5.724	5.751	5.778	5.805	5.832	5.859	5.886	5.913	5.940	5.968
3.3	5.995	6.022	6.049	6.077	6.104	6.132	6.159	6.186	6.214	6.242
3.4	6.269	6.297	6.325	6.352	6.380	6.408	6.436	6.464	6.492	6.520
3.5	6.548	6.576	6.604	6.632	6.660	6.689	6.717	6.745	6.774	6.802
3.6	6.830	6.859	6.888	6.916	6.945	6.973	7.002	7.031	7.060	7.088
3.7	7.117	7.146	7.175	7.204	7.233	7.262	7.291	7.320	7.349	6.378
3.8	7.408	7.437	7.466	7.496	7.525	7.554	7.584	7.613	7.643	7.672
3.9	7.702	7.732	7.761	7.791	7.821	7.850	7.880	7.910	7.940	7.970

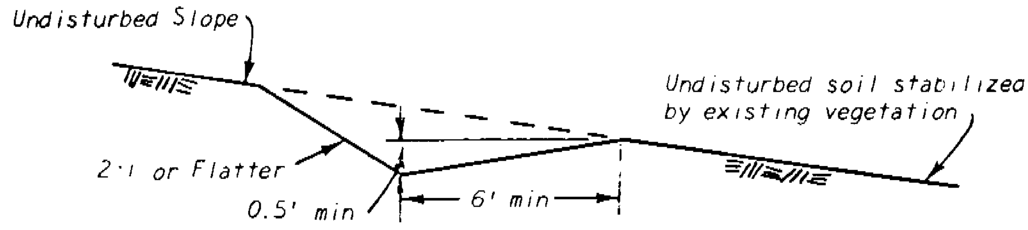
TABLE 6

THREE-HALVES POWERS OF NUMBERS

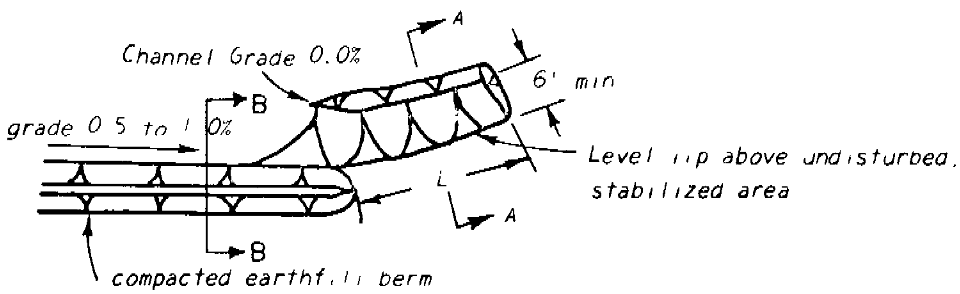
No.	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
4.0	8.000	8.030	8.060	8.090	8.120	8.150	8.181	8.211	8.241	8.272
4.1	8.302	8.332	8.363	8.393	8.424	8.454	8.485	8.515	8.546	8.577
4.2	8.607	8.638	8.669	8.700	8.731	8.762	8.793	8.824	8.855	8.836
4.3	8.917	8.948	8.979	9.010	9.041	9.073	9.104	9.135	9.167	9.198
4.4	9.230	9.261	9.292	9.324	9.356	9.387	9.419	9.451	9.482	9.514
4.5	9.546	9.578	9.610	9.642	9.674	9.706	9.738	9.770	9.802	9.834
4.6	9.866	9.898	9.930	9.963	9.995	10.03	10.06	10.09	10.12	10.16
4.7	10.19	10.22	10.25	10.29	10.32	10.35	10.39	10.42	10.45	10.43
4.8	10.52	10.55	10.58	10.62	10.65	10.68	10.71	10.75	10.78	10.81
4.9	10.85	10.88	10.91	10.95	10.98	11.01	11.05	11.08	11.11	11.15
5.0	11.18	11.21	11.25	11.28	11.31	11.35	11.38	11.42	11.45	11.48
5.1	11.52	11.55	11.59	11.62	11.65	11.69	11.72	11.76	11.79	11.82
5.2	11.86	11.89	11.93	11.96	11.99	12.03	12.06	12.10	12.13	12.17
5.3	12.20	12.24	12.27	12.31	12.34	12.37	12.41	12.44	12.48	12.51
5.4	12.55	12.58	12.62	12.65	12.69	12.72	12.76	12.79	12.83	12.86
5.5	12.90	12.93	12.97	13.00	13.04	13.07	13.11	13.15	13.18	13.22
5.6	13.25	13.29	13.32	13.36	13.39	13.43	13.47	13.50	13.54	13.57
5.7	13.61	13.64	13.68	13.72	13.75	13.79	13.82	13.86	13.90	13.93
5.8	13.97	14.00	14.01	14.08	14.11	14.15	14.19	14.22	14.26	14.29
5.9	14.33	14.37	14.40	14.44	14.48	14.51	14.55	14.59	14.62	14.66
6.0	14.70	14.73	14.77	14.81	14.84	14.88	14.92	14.95	14.99	15.03
6.1	15.07	15.10	15.14	15.18	15.21	14.25	15.29	15.33	15.36	15.40
6.2	15.44	15.48	15.51	15.55	15.59	15.62	15.66	15.70	15.74	15.78
6.3	15.81	15.85	15.89	15.93	15.96	16.00	16.04	16.08	16.12	16.15
6.4	16.19	16.23	16.27	16.30	16.34	16.38	16.42	16.46	16.50	16.53

TABLE 7

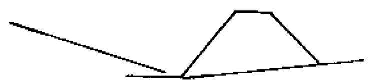
LEVEL SPREADER



SECTION A-A



PLAN VIEW



SECTION B-B

Table

Designed Q (cfs)	Minimum Length ("L" in Feet)
up to 10	15
11 to 20	20
21 to 30	26
31 to 40	36
41 to 50	44

General Notes:

1. All drawings Not to Scale.
2. Construct level lip on zero percent grade to insure uniform spreading of storm runoff (converting channel flow to sheet flow).
3. Level spreaders must be constructed on undisturbed soil (not on fill).
4. Entrance to spreader must be graded in a manner to insure that runoff enters directly onto the zero percent graded channel.
5. Storm runoff converted to sheet flow must outlet onto areas already stabilized by existing vegetation.
6. Periodic inspection and maintenance must be provided to insure intended purpose is accomplished.

TRAPEZOID AND TRIANGULAR SHAPED DIVERSION DITCH PROPORTIONING

TABLE 8

NO.	SIDE SLOPES	BOT. WIDTH B	DEPTH H	TOP WIDTH W	AREA A (ft²)
D-1A	1½ : 1	2'-0"	1'-0"	5'-0"	3.50
D-1B	2 : 1	2'-0"	1'-0"	6'-0"	4.00
D-1C	3 : 1	2'-0"	1'-0"	8'-0"	5.00
D-2A	1½ : 1	3'-0"	1'-6"	7'-6"	7.88
D-2B	2 : 1	3'-0"	1'-6"	9'-0"	9.00
D-2C	3 : 1	3'-0"	1'-6"	12'-0"	11.25
D-3A	1½ : 1	3'-0"	2'-0"	9'-0"	12.00
D-3B	2 : 1	3'-0"	2'-0"	11'-0"	14.00
D-3C	3 : 1	3'-0"	2'-0"	15'-0"	18.00
D-4A	1½ : 1	4'-0"	3'-0"	13'-0"	25.50
D-4B	2 : 1	4'-0"	3'-0"	16'-0"	30.00
D-4C	3 : 1	4'-0"	3'-0"	22'-0"	39.00
D-5A	2 : 1	—	1'-0"	4'-0"	2.00
D-5B	3 : 1	—	1'-0"	6'-0"	3.00
D-6A	2 : 1	—	2'-0"	8'-0"	8.00
D-6B	3 : 1	—	2'-0"	12'-0"	12.00
D-7A	2 : 1	—	3'-0"	12'-0"	18.00
D-7B	3 : 1	—	3'-0"	18'-0"	27.00

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE %	Q cfs	V = 2.0 T	V = 2.0 D	V = 2.5 T	V = 2.5 D	V = 3.0 T	V = 3.0 D	V = 3.5 T	V = 3.5 D	V = 4.0 T	V = 4.0 D	V = 4.5 T	V = 4.5 D	V = 5.0 T	V = 5.0 D	V = 5.5 T	V = 5.5 D	V = 6.0 T	V = 6.0 D
.25	15																		
	20																		
	25	10	2.4																
	30	11	2.3																
	35	13	2.3																
	40	15	2.3	10	2.7														
	45	17	2.2	12	2.6														
	50	19	2.2	13	2.6														
	55	20	2.2	14	2.6														
	60	22	2.2	15	2.5														
	65	24	2.2	17	2.5														
	70	26	2.2	18	2.5	13	3.1												
	75	28	2.2	19	2.5	13	3.0												
	80	29	2.2	20	2.5	14	3.0												
	90	33	2.2	23	2.5	16	3.0												
	100	38	2.2	25	2.5	18	3.0												
.50	15	9	1.6																
	20	11	1.6																
	25	14	1.6	9	1.9														
	30	17	1.6	11	1.9	8	2.2												
	35	20	1.6	12	1.9	9	2.1												
	40	22	1.6	14	1.8	11	2.1												
	45	25	1.5	16	1.8	12	2.0												
	50	28	1.5	18	1.8	13	2.0	10	2.4										
	55	31	1.5	19	1.8	15	2.0	11	2.4										
	60	33	1.5	21	1.8	16	2.0	11	2.4										
	65	36	1.5	23	1.8	17	2.0	12	2.4										
	70	39	1.5	24	1.8	18	2.0	13	2.3										
	75	42	1.5	26	1.8	20	2.0	14	2.3	11	2.7								
	80	44	1.5	28	1.8	21	2.0	15	2.3	12	2.7								
	90	50	1.5	31	1.8	24	2.0	17	2.3	13	2.7								
	100	55	1.5	35	1.8	26	2.0	19	2.3	15	2.6	12	3.0						

Q = Flow in Cubic Feet per second V = Velocity in Feet per Second T = Top Width in Feet
D = Depth in Feet

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE	Q	V = 2.0		V = 2.5		V = 3.0		V = 3.5		V = 4.0		V = 4.5		V = 5.0		V = 5.5		V = 6.0	
%	cfs	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D
.75	15	12	1.3	7	1.6														
	20	16	1.3	9	1.5														
	25	19	1.3	11	1.5	8	1.7												
	30	23	1.3	13	1.5	10	1.7	8	1.9										
	35	27	1.3	15	1.5	11	1.7	9	1.9										
	40	31	1.3	18	1.5	13	1.7	10	1.9										
	45	35	1.3	20	1.5	14	1.7	11	1.8										
	50	38	1.3	22	1.5	16	1.6	13	1.8	9	2.2								
	55	42	1.3	24	1.5	18	1.6	14	1.8	10	2.1								
	60	46	1.3	26	1.5	19	1.6	15	1.8	11	2.1								
	65	50	1.3	28	1.5	21	1.6	16	1.8	12	2.1	10	2.1						
	70	53	1.3	30	1.5	22	1.6	17	1.8	13	2.1	11	2.4						
	75	57	1.3	33	1.5	24	1.6	19	1.8	14	2.1	11	2.3						
	80	61	1.3	35	1.5	25	1.6	20	1.8	15	2.1	12	2.3						
	90	68	1.3	39	1.5	28	1.6	22	1.8	16	2.1	13	2.3	11	2.6				
	100	76	1.3	43	1.5	32	1.6	25	1.8	18	2.1	15	2.3	12	2.6				
1.00	15	13	1.1	8	1.3														
	20	18	1.1	11	1.3	8	1.5												
	25	22	1.1	14	1.3	9	1.5	8	1.6										
	30	27	1.1	17	1.3	11	1.5	9	1.6										
	35	31	1.1	19	1.3	13	1.5	11	1.6	8	1.8								
	40	35	1.1	22	1.3	15	1.4	12	1.6	9	1.8								
	45	40	1.1	25	1.3	17	1.5	13	1.6	10	1.8								
	50	44	1.1	28	1.3	19	1.4	15	1.6	11	1.8	9	2.0						
	55	48	1.1	30	1.3	20	1.4	16	1.5	12	1.8	10	2.0						
	60	53	1.1	33	1.3	22	1.4	18	1.5	14	1.7	10	2.0						
	65	57	1.1	36	1.3	24	1.4	19	1.5	15	1.7	11	2.0	9	2.2				
	70	61	1.1	38	1.3	26	1.4	21	1.5	16	1.7	12	2.0	10	2.2				
	75	66	1.1	41	1.3	28	1.4	22	1.5	17	1.7	13	2.0	11	2.2				
	80	70	1.1	44	1.3	29	1.4	24	1.5	18	1.7	14	2.0	11	2.2				
	90	79	1.1	49	1.3	33	1.4	27	1.5	20	1.7	15	1.9	13	2.2	11	2.4		
	100	87	1.1	55	1.3	37	1.4	29	1.5	22	1.7	17	1.9	14	2.2	12	2.4		

Q = Flow in Cubic Feet per second V = Velocity in Feet per Second T = Top Width in Feet
D = Depth in Feet

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE %	Q cfs	V = 2.0 T	V = 2.0 D	V = 2.5 T	V = 2.5 D	V = 3.0 T	V = 3.0 D	V = 3.5 T	V = 3.5 D	V = 4.0 T	V = 4.0 D	V = 4.5 T	V = 4.5 D	V = 5.0 T	V = 5.0 D	V = 5.5 T	V = 5.5 D	V = 6.0 T	V = 6.0 D
1.25	15	15	1.0	10	1.2	7	1.4												
	20	20	1.0	13	1.1	9	1.3	7	1.5										
	25	25	1.0	16	1.1	11	1.3	8	1.5	7	1.6								
	30	31	1.0	19	1.1	13	1.3	10	1.4	8	1.6								
	35	36	1.0	23	1.1	15	1.3	11	1.4	9	1.6	7	1.8						
	40	41	1.0	26	1.1	17	1.3	13	1.4	11	1.6	8	1.8						
	45	46	1.0	29	1.1	19	1.3	14	1.4	12	1.5	9	1.7						
	50	50	1.0	32	1.1	21	1.3	16	1.4	13	1.5	10	1.7	8	2.0				
	55	55	1.0	35	1.1	23	1.3	18	1.4	14	1.5	11	1.7	9	1.9				
	60	60	1.0	38	1.1	26	1.3	19	1.4	16	1.5	12	1.7	10	1.9				
	65	65	1.0	41	1.1	28	1.3	21	1.4	17	1.5	13	1.7	11	1.9	9	2.2		
	70	70	1.0	45	1.1	30	1.3	22	1.4	18	1.5	14	1.7	11	1.9	9	2.2		
	75	75	1.0	48	1.1	32	1.3	24	1.4	19	1.5	15	1.7	12	1.9	10	2.1		
	80	80	1.0	51	1.1	34	1.3	25	1.4	21	1.5	16	1.7	13	1.9	11	2.1	9	2.3
	90	90	1.0	57	1.1	38	1.3	29	1.4	23	1.5	18	1.7	15	1.9	12	2.1	10	2.3
	100	100	1.0	63	1.1	42	1.3	32	1.4	26	1.5	20	1.7	16	1.9	13	2.1	11	2.3
1.50	15	17	0.9	11	1.1	8	1.2												
	20	23	0.9	15	1.0	10	1.2	7	1.4	6	1.5								
	25	28	0.9	19	1.0	12	1.2	9	1.4	7	1.5								
	30	34	0.9	22	1.0	15	1.2	10	1.3	8	1.5	7	1.6						
	35	40	0.9	26	1.0	17	1.1	12	1.3	10	1.4	8	1.6						
	40	45	0.9	30	1.0	20	1.2	14	1.3	11	1.4	9	1.6	7	1.8				
	45	51	0.9	33	1.0	22	1.1	15	1.3	12	1.4	10	1.5	8	1.8				
	50	56	0.9	37	1.0	25	1.1	17	1.3	14	1.4	11	1.5	9	1.8				
	55	62	0.9	41	1.0	27	1.1	19	1.3	15	1.4	12	1.5	10	1.7	8	1.9		
	60	67	0.9	44	1.0	30	1.1	20	1.3	16	1.4	14	1.5	11	1.7	9	1.9		
	65	73	0.9	48	1.0	32	1.1	22	1.3	18	1.4	15	1.5	11	1.7	10	1.9		
	70	78	0.9	51	1.0	34	1.1	24	1.3	19	1.4	16	1.5	12	1.7	10	1.9	9	2.1
	75	83	0.9	55	1.0	37	1.1	25	1.3	21	1.4	17	1.5	13	1.7	11	1.9	9	2.1
	80	89	0.9	59	1.0	39	1.1	27	1.3	22	1.4	18	1.5	14	1.7	12	1.9	10	2.1
	90	100	0.9	66	1.0	44	1.1	30	1.3	25	1.4	20	1.5	16	1.7	13	1.9	11	2.0
	100	111	0.9	73	1.0	49	1.1	33	1.3	27	1.4	22	1.5	17	1.7	15	1.9	12	2.0

Q = Flow in Cubic Feet per second   V = Velocity in Feet per Second   T = Top Width in Feet
D = Depth in Feet

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE	Q	V = 2.0		V = 2.5		V = 3.0		V = 3.5		V = 4.0		V = 4.5		V = 5.0		V = 5.5		V = 6.0	
%	cfs	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D
1.75	15	19	0.9	12	1.0	9	1.1	6	1.3										
	20	25	0.9	16	1.0	11	1.1	8	1.3	7	1.3								
	25	31	0.9	20	1.0	14	1.1	10	1.2	8	1.3	7	1.5						
	30	37	0.9	24	1.0	17	1.1	12	1.2	10	1.3	8	1.4						
	35	43	0.9	28	1.0	20	1.1	13	1.2	11	1.3	9	1.4	7	1.6				
	40	49	0.9	32	1.0	22	1.1	15	1.2	13	1.3	10	1.4	8	1.6				
	45	55	0.9	36	1.0	25	1.1	17	1.2	14	1.3	12	1.4	9	1.6	8	1.7		
	50	61	0.9	40	1.0	28	1.1	19	1.2	16	1.3	13	1.4	10	1.4	8	1.7		
	55	67	0.9	44	1.0	31	1.1	21	1.2	17	1.3	14	1.4	11	1.5	9	1.7	8	1.9
	60	73	0.9	48	1.0	33	1.1	23	1.2	19	1.3	15	1.4	12	1.5	10	1.7	8	1.9
	65	78	0.9	52	1.0	36	1.1	25	1.2	21	1.3	17	1.4	13	1.5	11	1.7	9	1.9
	70	84	0.9	56	1.0	39	1.1	27	1.2	22	1.3	18	1.4	14	1.5	12	1.7	10	1.9
	75	90	0.9	59	1.0	42	1.1	29	1.2	24	1.3	19	1.4	15	1.5	12	1.7	10	1.9
	80	96	0.9	63	1.0	44	1.1	30	1.2	25	1.3	20	1.4	16	1.5	13	1.7	11	1.9
	90	108	0.9	71	1.0	50	1.1	34	1.2	28	1.3	23	1.4	18	1.5	15	1.7	12	1.9
	100	120	0.9	79	1.0	55	1.1	38	1.2	31	1.3	25	1.4	20	1.5	16	1.7	13	1.9
2.00	15	21	0.8	13	0.9	9	1.0	7	1.2										
	20	28	0.8	17	0.9	12	1.0	9	1.1	7	1.3	5	1.4						
	25	35	0.8	21	0.9	15	1.0	11	1.1	8	1.3	7	1.4						
	30	41	0.8	26	0.9	18	1.0	13	1.1	10	1.2	8	1.3	7	1.5				
	35	48	0.8	30	0.9	22	1.0	15	1.1	11	1.2	9	1.3	8	1.5				
	40	55	0.8	34	0.9	25	1.0	18	1.1	13	1.2	11	1.3	9	1.5	7	1.7		
	45	62	0.8	38	0.9	28	1.0	20	1.1	14	1.2	12	1.3	10	1.4	8	1.6		
	50	68	0.8	42	0.9	31	1.0	22	1.1	16	1.2	13	1.3	11	1.4	9	1.6	8	1.7
	55	75	0.8	46	0.9	34	1.0	24	1.1	17	1.2	14	1.3	12	1.4	10	1.6	8	1.7
	60	82	0.8	51	0.9	37	1.0	26	1.1	19	1.2	16	1.3	13	1.4	11	1.6	9	1.7
	65	88	0.8	55	0.9	40	1.0	28	1.1	21	1.2	17	1.3	14	1.4	11	1.6	10	1.7
	70	95	0.8	59	0.9	43	1.0	30	1.1	22	1.2	18	1.3	15	1.4	12	1.6	10	1.7
	75	101	0.8	63	0.9	46	1.0	32	1.1	24	1.2	20	1.3	16	1.4	13	1.6	11	1.7
	80	108	0.8	67	0.9	48	1.0	35	1.1	25	1.2	21	1.3	17	1.4	14	1.6	12	1.7
	90	121	0.8	75	0.9	54	1.0	39	1.1	28	1.2	23	1.3	19	1.4	16	1.6	13	1.7
	100	134	0.8	83	0.9	60	1.0	43	1.1	31	1.2	26	1.3	21	1.4	17	1.6	15	1.7

Q = Flow in Cubic Feet per second   V = Velocity in Feet per Second   T = Top Width in Feet
D = Depth in Feet

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE %	Q cfs	V = 2.0		V = 2.5		V = 3.0		V = 3.5		V = 4.0		V = 4.5		V = 5.0		V = 5.5		V = 6.0	
		T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D
3.0	15	24	0.7	16	0.8	11	0.8	9	0.9	7	1.0	5	1.2						
	20	31	0.7	22	0.8	15	0.8	12	0.9	9	1.0	7	1.1	6	1.2				
	25	39	0.7	27	0.8	19	0.8	15	0.9	11	1.0	8	1.0	7	1.2	6	1.3		
	30	47	0.7	32	0.8	23	0.8	17	0.9	13	1.0	10	1.1	9	1.2	7	1.2	6	1.4
	35	55	0.7	38	0.8	26	0.8	20	0.9	15	1.0	11	1.1	10	1.1	8	1.2	7	1.4
	40	62	0.7	43	0.8	30	0.8	23	0.9	17	1.0	13	1.1	12	1.1	9	1.2	8	1.4
	45	70	0.7	48	0.8	34	0.8	26	0.9	19	1.0	15	1.1	13	1.1	11	1.2	9	1.3
	50	77	0.7	54	0.8	38	0.8	29	0.9	21	1.0	16	1.1	14	1.1	12	1.2	9	1.3
	55	85	0.7	59	0.8	41	0.8	32	0.9	23	1.0	18	1.1	16	1.1	13	1.2	10	1.4
	60	93	0.7	64	0.8	45	0.8	35	0.9	26	1.0	19	1.1	17	1.1	14	1.2	11	1.3
	65	100	0.7	70	0.8	49	0.8	37	0.9	28	1.0	21	1.1	19	1.1	15	1.2	12	1.3
	70	107	0.7	74	0.8	52	0.8	40	0.9	30	1.0	22	1.1	20	1.1	16	1.2	13	1.3
	75	115	0.7	79	0.8	56	0.8	43	0.9	32	1.0	24	1.1	21	1.1	18	1.2	14	1.3
	80	122	0.7	85	0.8	59	0.8	46	0.9	34	1.0	26	1.1	23	1.1	19	1.2	15	1.3
	90	137	0.7	95	0.8	67	0.8	51	0.9	38	1.0	29	1.1	26	1.1	21	1.2	17	1.3
	100	152	0.7	105	0.8	74	0.8	57	0.9	42	1.0	32	1.1	28	1.1	23	1.2	19	1.3
4.0	15	28	0.6	20	0.7	14	0.7	10	0.8	8	0.9	6	0.9	5	1.1				
	20	37	0.6	27	0.7	19	0.7	14	0.8	11	0.8	8	0.9	6	1.0	6	1.1		
	25	46	0.6	33	0.7	23	0.7	17	0.8	13	0.8	11	0.9	8	1.0	7	1.1	6	1.2
	30	55	0.6	40	0.7	28	0.7	20	0.8	16	0.8	13	0.9	10	1.0	8	1.1	7	1.2
	35	64	0.6	46	0.7	32	0.7	24	0.8	18	0.8	15	0.9	11	1.0	10	1.1	8	1.2
	40	73	0.6	52	0.7	37	0.7	27	0.8	21	0.8	17	0.9	13	1.0	11	1.0	9	1.1
	45	82	0.6	59	0.7	41	0.7	30	0.8	23	0.8	19	0.9	14	1.0	12	1.1	10	1.1
	50	91	0.6	65	0.7	46	0.7	34	0.8	26	0.8	21	0.9	16	1.0	14	1.1	11	1.1
	55	100	0.6	72	0.7	50	0.7	37	0.8	29	0.8	23	0.9	17	1.0	15	1.0	12	1.1
	60	109	0.6	78	0.7	55	0.7	40	0.8	31	0.8	25	0.9	19	1.0	16	1.0	13	1.1
	65	117	0.6	84	0.7	59	0.7	44	0.8	34	0.8	27	0.9	20	1.0	18	1.0	14	1.1
	70	126	0.6	90	0.7	63	0.7	47	0.8	36	0.8	29	0.9	22	1.0	19	1.0	15	1.1
	75	135	0.6	97	0.7	68	0.7	50	0.8	39	0.8	31	0.9	24	1.0	20	1.0	17	1.1
	80	143	0.6	103	0.7	72	0.7	53	0.8	41	0.8	33	0.9	25	1.0	21	1.0	18	1.1
	90	161	0.6	115	0.7	81	0.7	60	0.8	46	0.8	37	0.9	28	1.0	24	1.0	20	1.1
	100	178	0.6	128	0.7	90	0.7	66	0.8	51	0.8	41	0.9	31	1.0	27	1.0	22	1.1

Q = Flow in Cubic Feet per second V = Velocity in Feet per Second T = Top Width in Feet
D = Depth in Feet

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE %	Q cfs	V = 2.0 T	V = 2.0 D	V = 2.5 T	V = 2.5 D	V = 3.0 T	V = 3.0 D	V = 3.5 T	V = 3.5 D	V = 4.0 T	V = 4.0 D	V = 4.5 T	V = 4.5 D	V = 5.0 T	V = 5.0 D	V = 5.5 T	V = 5.5 D	V = 6.0 T	V = 6.0 D
5.0	15	29	0.6	21	0.6	15	0.7	12	0.7	9	0.8	7	0.8	6	0.9	5	1.0		
	20	39	0.6	28	0.6	20	0.7	16	0.7	12	0.8	10	0.8	8	0.9	6	1.0	5	1.1
	25	49	0.6	35	0.6	25	0.7	20	0.7	15	0.8	12	0.8	10	0.9	8	1.0	7	1.0
	30	58	0.6	42	0.6	30	0.7	24	0.7	18	0.8	14	0.8	11	0.9	9	1.0	8	1.0
	35	68	0.6	49	0.6	35	0.7	28	0.7	21	0.8	17	0.8	13	0.9	11	0.9	9	1.0
	40	77	0.6	56	0.6	40	0.7	32	0.7	24	0.8	19	0.8	15	0.9	12	0.9	10	1.0
	45	86	0.6	63	0.6	44	0.7	36	0.7	27	0.8	21	0.8	17	0.9	14	0.9	12	1.0
	50	96	0.6	69	0.6	49	0.7	49	0.7	39	0.8	24	0.8	19	0.9	15	0.9	13	1.0
	55	105	0.6	76	0.6	54	0.7	44	0.7	33	0.8	26	0.8	21	0.9	17	0.9	14	1.0
	60	114	0.6	83	0.6	59	0.7	48	0.7	36	0.8	28	0.8	22	0.9	18	0.9	15	1.0
	65	123	0.6	89	0.6	63	0.7	52	0.7	38	0.8	31	0.8	24	0.9	19	0.9	17	1.0
	70	132	0.6	96	0.6	68	0.7	56	0.7	41	0.8	33	0.8	26	0.9	21	0.9	18	1.0
	75	142	0.6	102	0.6	73	0.7	59	0.7	44	0.8	35	0.8	28	0.9	22	0.9	19	1.0
	80	151	0.6	109	0.6	78	0.7	63	0.7	47	0.8	37	0.8	30	0.9	24	0.9	20	1.0
	90	169	0.6	122	0.6	87	0.7	71	0.7	53	0.8	42	0.8	33	0.9	27	0.9	23	1.0
	100	187	0.6	136	0.6	97	0.7	79	0.7	59	0.8	47	0.8	37	0.9	30	0.9	26	1.0
6.0	15	35	0.5	23	0.6	17	0.6	13	0.7	10	0.7	8	0.8	7	0.8	5	0.9	4	1.0
	20	46	0.5	30	0.6	22	0.6	17	0.7	13	0.7	11	0.7	9	0.8	7	0.9	6	1.0
	25	57	0.5	37	0.6	28	0.6	21	0.7	17	0.7	13	0.7	11	0.8	9	0.9	7	0.9
	30	69	0.5	45	0.6	33	0.6	25	0.7	20	0.7	16	0.7	13	0.8	10	0.9	8	0.9
	35	80	0.5	52	0.6	38	0.6	29	0.7	23	0.7	19	0.7	15	0.8	12	0.9	10	0.9
	40	91	0.5	59	0.6	44	0.6	33	0.7	26	0.7	21	0.7	17	0.8	14	0.9	11	0.9
	45	102	0.5	67	0.6	49	0.6	37	0.7	30	0.7	24	0.7	19	0.8	16	0.9	13	0.9
	50	113	0.5	74	0.6	54	0.6	42	0.7	33	0.7	26	0.7	22	0.8	17	0.9	14	0.9
	55	123	0.5	81	0.6	60	0.6	46	0.7	36	0.7	29	0.7	24	0.8	19	0.8	15	0.9
	60	134	0.5	88	0.6	65	0.6	50	0.7	39	0.7	32	0.7	26	0.8	21	0.8	17	0.9
	65	145	0.5	95	0.6	70	0.6	54	0.7	42	0.7	34	0.7	28	0.8	22	0.9	18	0.9
	70	155	0.5	102	0.6	75	0.6	58	0.7	45	0.7	37	0.7	30	0.8	24	0.9	19	0.9
	75	166	0.5	109	0.6	81	0.6	62	0.7	49	0.7	39	0.7	32	0.8	26	0.8	21	0.9
	80	176	0.5	116	0.6	86	0.6	65	0.7	52	0.7	42	0.7	34	0.8	27	0.9	22	0.9
	90	198	0.5	130	0.6	96	0.6	73	0.7	58	0.7	47	0.7	38	0.8	31	0.8	25	0.9
	100	219	0.5	144	0.6	107	0.6	81	0.7	64	0.7	52	0.7	42	0.8	34	0.9	28	0.9

Q = Flow in Cubic Feet per second V = Velocity in Feet per Second T = Top Width in Feet
D = Depth in Feet

TABLE 9

PARABOLIC WATERWAY DESIGN

GRADE %	Q cfs	V = 2.0 T	V = 2.0 D	V = 2.5 T	V = 2.5 D	V = 3.0 T	V = 3.0 D	V = 3.5 T	V = 3.5 D	V = 4.0 T	V = 4.0 D	V = 4.5 T	V = 4.5 D	V = 5.0 T	V = 5.0 D	V = 5.5 T	V = 5.5 D	V = 6.0 T	V = 6.0 D
8.0	15	37	0.5	27	0.5	19	0.5	15	0.6	12	0.6	9	0.7	8	0.8	6	0.7	5	0.8
	20	49	0.5	35	0.5	25	0.5	20	0.6	16	0.6	13	0.7	10	0.7	9	0.7	7	0.8
	25	61	0.5	44	0.5	31	0.5	25	0.6	19	0.6	16	0.7	13	0.7	11	0.7	9	0.8
	30	73	0.5	53	0.5	37	0.5	30	0.6	23	0.6	19	0.7	16	0.7	13	0.7	11	0.8
	35	85	0.5	61	0.5	43	0.5	35	0.6	27	0.6	22	0.6	18	0.7	15	0.7	12	0.8
	40	97	0.5	70	0.5	49	0.5	40	0.6	31	0.6	25	0.6	21	0.7	17	0.7	14	0.8
	45	109	0.5	78	0.5	55	0.5	45	0.6	35	0.6	28	0.6	23	0.7	19	0.7	16	0.8
	50	120	0.5	87	0.5	61	0.5	50	0.6	38	0.6	31	0.7	26	0.7	21	0.7	17	0.8
	55	132	0.5	95	0.5	67	0.5	55	0.6	42	0.6	34	0.7	28	0.7	23	0.7	19	0.8
	60	143	0.5	103	0.5	73	0.5	60	0.6	46	0.6	37	0.7	31	0.7	25	0.7	21	0.8
	65	155	0.5	111	0.5	79	0.5	65	0.6	50	0.6	40	0.7	33	0.7	27	0.7	23	0.8
	70	166	0.5	120	0.5	85	0.5	69	0.6	53	0.6	43	0.6	36	0.7	29	0.7	24	0.8
	75	177	0.5	128	0.5	91	0.5	74	0.6	57	0.6	46	0.7	38	0.7	31	0.7	26	0.8
	80	188	0.5	136	0.5	96	0.5	79	0.6	61	0.6	49	0.6	41	0.7	33	0.7	28	0.8
	90	211	0.5	152	0.5	108	0.6	88	0.6	68	0.6	55	0.7	46	0.7	37	0.7	31	0.8
	100	234	0.5	168	0.5	120	0.6	98	0.6	75	0.6	61	0.7	51	0.7	41	0.7	34	0.8
10.0	15	45	0.4	33	0.5	23	0.5	17	0.5	13	0.6	11	0.6	9	0.6	7	0.7	.6	0.7
	20	60	0.4	43	0.5	30	0.5	22	0.5	18	0.6	14	0.6	12	0.6	10	0.7	8	0.7
	25	75	0.4	54	0.5	38	0.5	28	0.5	22	0.6	18	0.6	15	0.6	12	0.7	10	0.7
	30	89	0.4	64	0.5	45	0.5	33	0.5	27	0.6	21	0.6	18	0.6	15	0.6	12	0.7
	35	104	0.4	75	0.5	53	0.5	38	0.5	31	0.6	25	0.6	21	0.6	17	0.7	14	0.7
	40	118	0.4	85	0.5	60	0.5	44	0.5	35	0.6	28	0.6	24	0.6	20	0.7	16	0.7
	45	132	0.4	95	0.5	67	0.5	49	0.5	40	0.6	32	0.6	27	0.6	22	0.7	18	0.7
	50	146	0.4	105	0.5	74	0.5	54	0.5	44	0.6	35	0.6	30	0.6	24	0.7	20	0.7
	55	160	0.4	115	0.5	82	0.5	60	0.5	48	0.6	39	0.6	32	0.6	27	0.6	22	0.7
	60	174	0.4	124	0.5	87	0.5	65	0.5	52	0.6	42	0.6	35	0.6	29	0.7	24	0.7
	65	188	0.4	135	0.5	96	0.5	70	0.5	57	0.6	45	0.6	38	0.6	32	0.7	26	0.7
	70	201	0.4	145	0.5	103	0.5	75	0.5	61	0.6	49	0.6	41	0.6	34	0.7	28	0.7
	75	215	0.4	155	0.5	110	0.5	80	0.5	65	0.6	52	0.6	44	0.6	36	0.7	30	0.7
	80	228	0.4	164	0.5	116	0.5	85	0.5	69	0.6	55	0.6	47	0.6	39	0.7	32	0.7
	90	255	0.4	184	0.5	131	0.5	96	0.5	76	0.6	62	0.6	52	0.6	43	0.7	36	0.7
	100	282	0.4	204	0.5	145	0.5	106	0.5	86	0.6	69	0.6	58	0.6	48	0.7	40	0.7

Q = Flow in Cubic Feet per second   V = Velocity in Feet per Second   T = Top Width in Feet
D = Depth in Feet

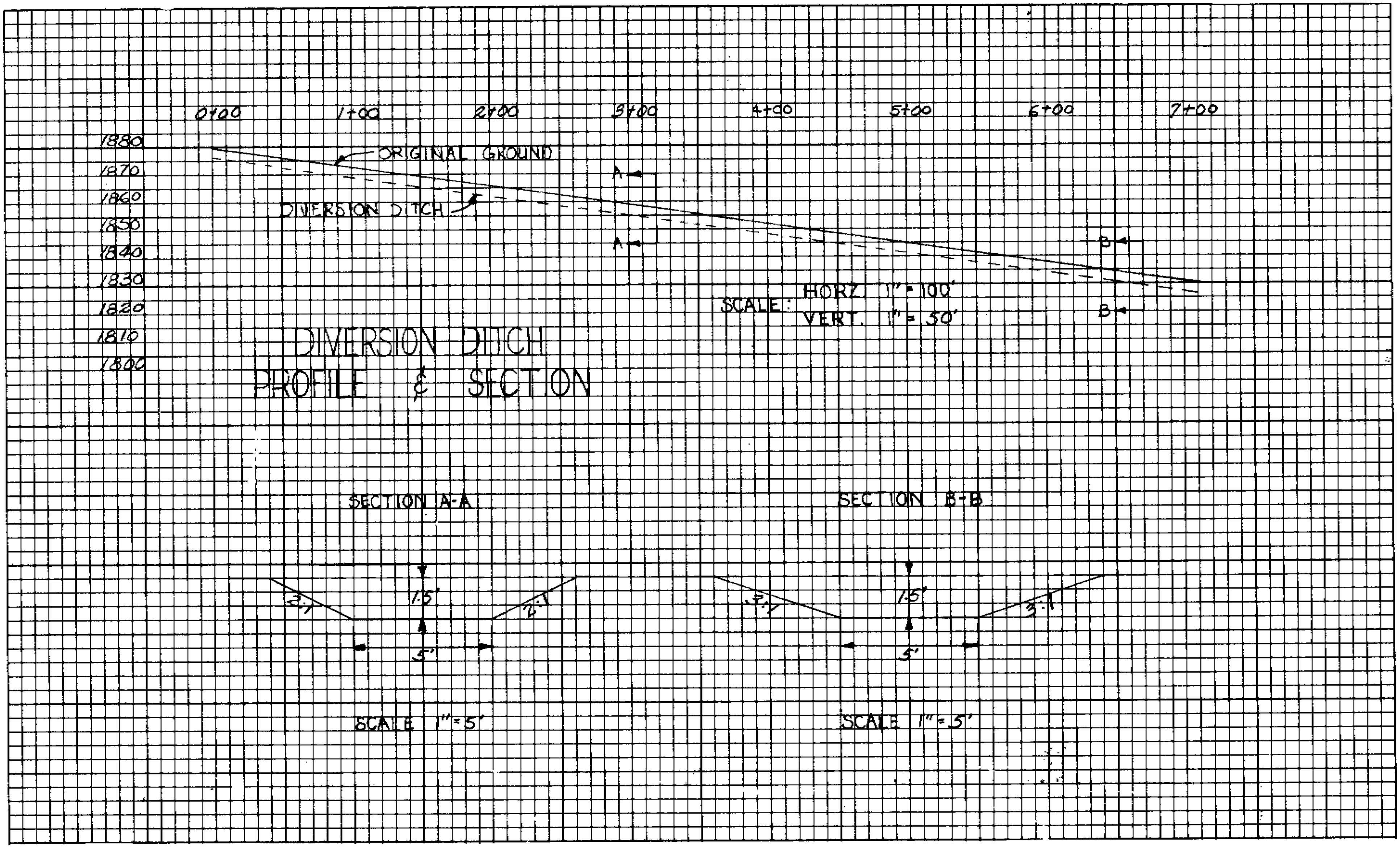
DIVERSION DESIGN COMPUTATION SHEET

LINE	STATIONS	SOIL TYPE	DRAIN AREA (AC)	REQ'D CAP. (cfs)	GRADE (%)	DIMENSIONS DEPTH (FT.)	DIMENSIONS BOTTOM (FT.)	SIDE SLOPES	AVAIL. CAP. (cfs)	VELOCITY DESIGN (ft./sec.)	VELOCITY ALLOW. (ft./sec.)

SEEDING

MATERIALS	KIND	RATE	TOTAL (lbs.)
Seed			
Fertilizer			
Lime			
Mulch			

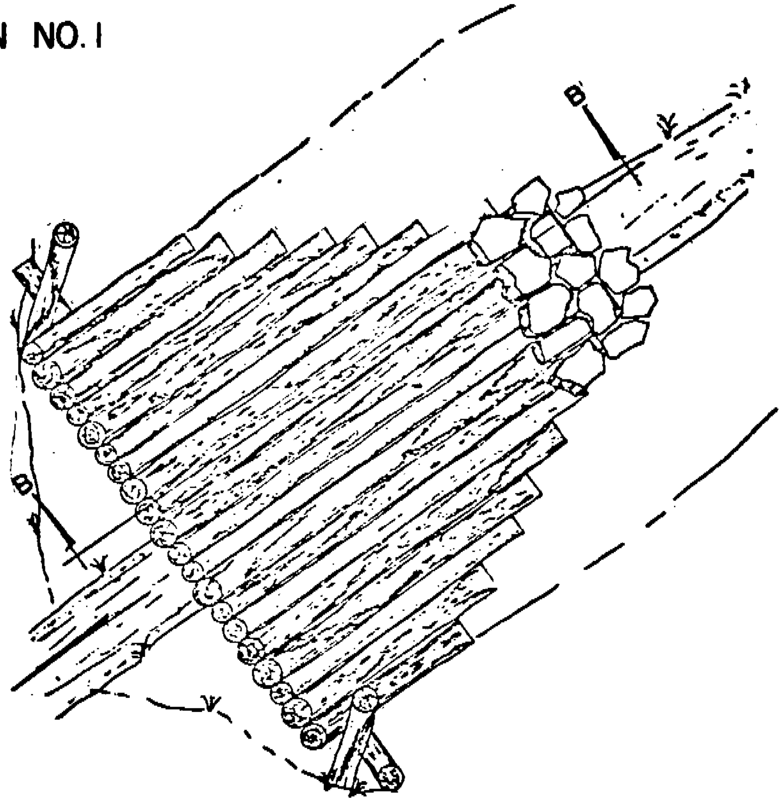
SHEET NO. 1



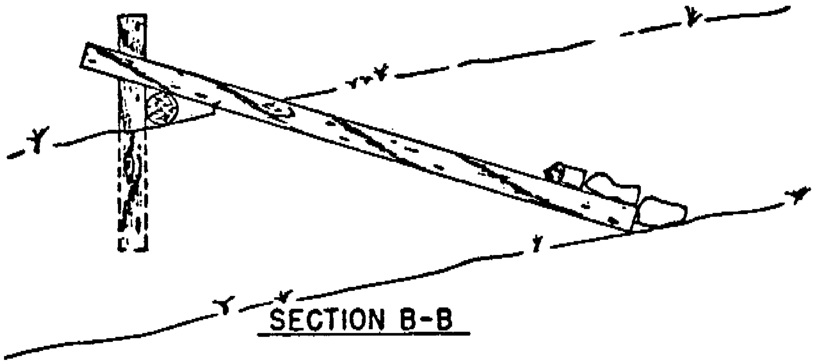
PROFILE ALONG CENTERLINE OF DIVERSION SHOWING CROSS SECTIONS

SHEET NO. 2

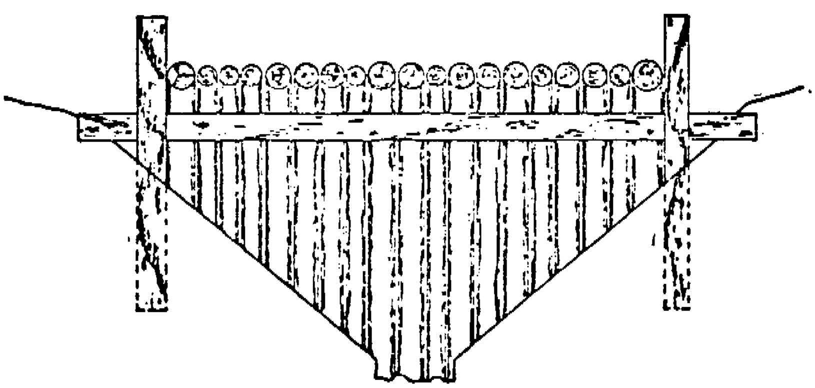
ILLUSTRATION NO. I



LOG & POLE SILT STRUCTURE

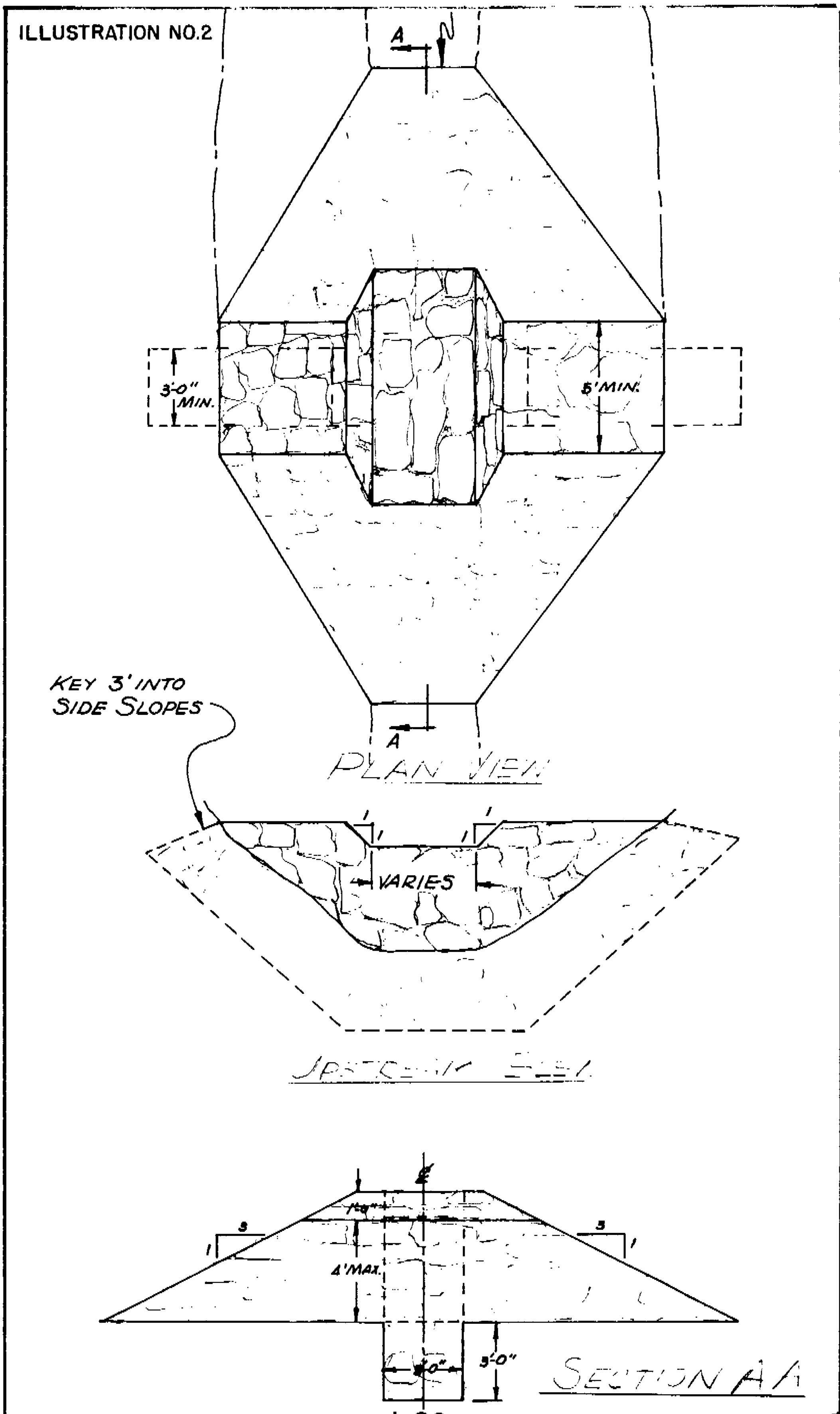


SECTION B-B



UPSTREAM VIEW

ILLUSTRATION NO.2



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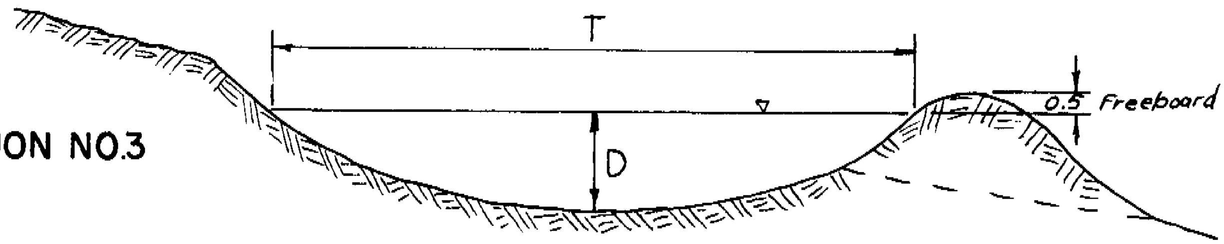
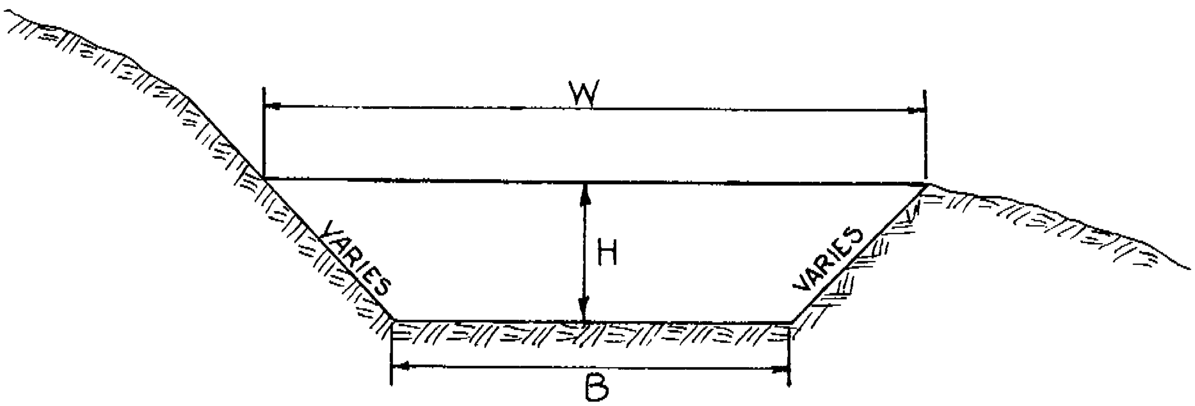
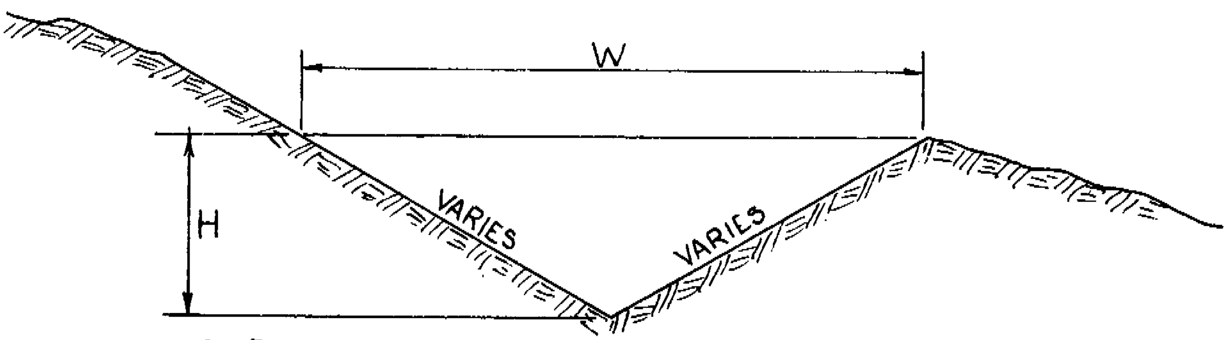


PARABOLIC



D-1, D-2, D-3, D-4 TRAPEZOIDAL



D-5, D-6, D-7 TRIANGULAR

APPENDIX II

SAMPLE DESIGNS OF SEDIMENT CONTROL STRUCTURES

EMBANKMENT SEDIMENT POND

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

DAM NUMBER 3

Sediment Storage Requirements

Drainage Area = 51.4 Ac. Average Land Slope = 45 %
Area Disturbed = 26.6 Ac. = 52 % of drainage area
Sediment Volume = .125 Ac. Ft./Ac. x area disturbed = 3.33 Ac. Ft.
Sediment Pool Elevation = 97.1 Ft. = principal spillway crest

Principal Spillway Design

Principal Spillway Diameter = 18 In.
Type Corrugated Metal Pipe pH ______
Principal Spillway Length 197.0 Ft.
Principal Spillway Slope 3.0 Percent

Drop Inlet

Type Base Concrete Type Riser C.M.P.
Dimensions = 30 In. diameter of ____ $Ft.^2$
Height of Riser (base to crest) = 12.5 Ft.
Perforated X Yes ____ No

Drainpipe N/A

Diameter = ____ In. Type ______
Length = ____ Ft. Height of Riser ____ Ft.

Emergency Spillway Design

Emergency Spillway Elevation = Principal Spillway Elevation + 1.5 Ft.
(min.) = 97.1 + 1.5 = 98.6

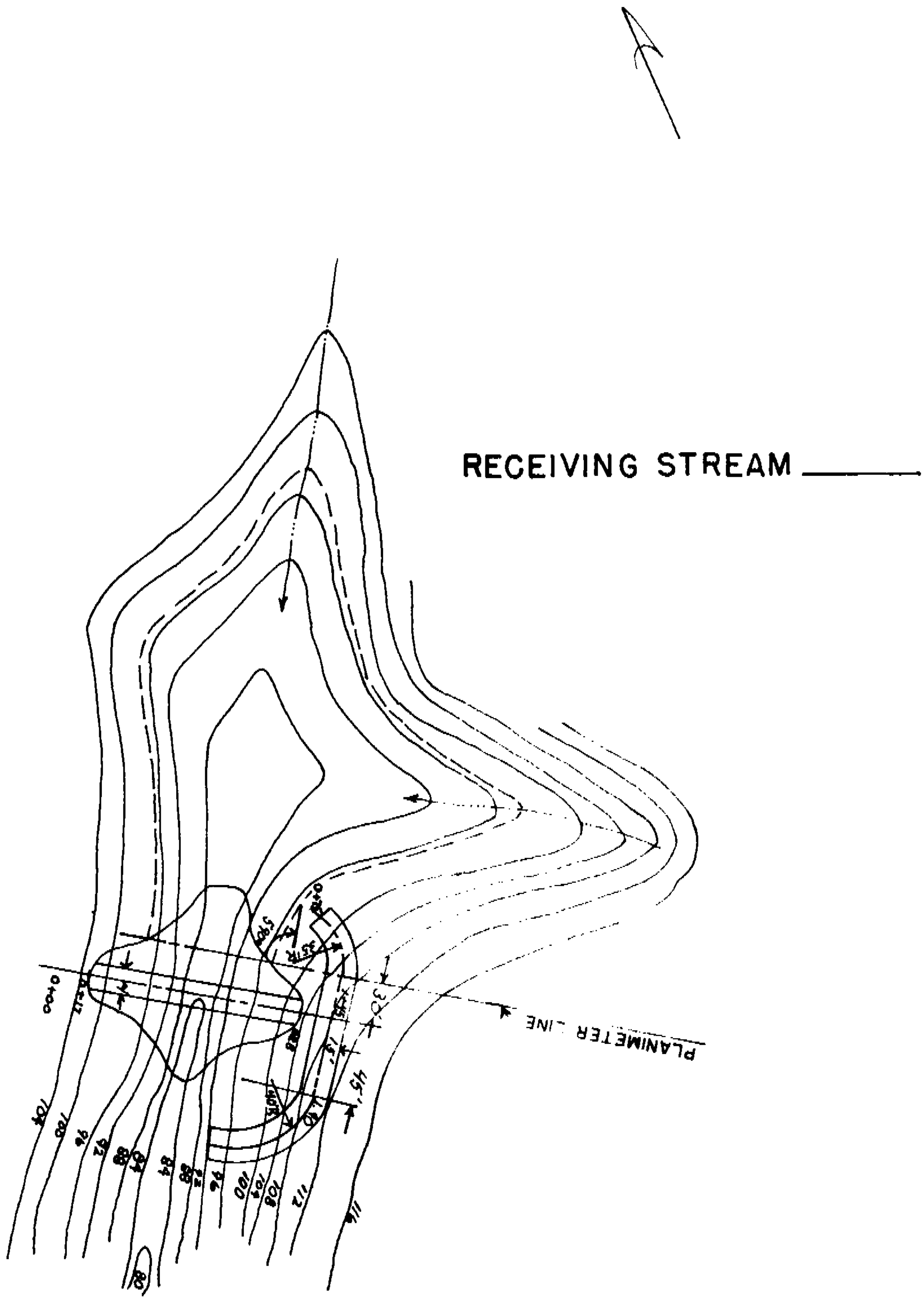
Peak Discharge (Figure 2) = 148 c.f.s. x 1.3 (slope factor) = 192.4 c.f.s.

Emergency Spillway Proportions (Table 2)

Bottom Width, b = 15 Ft.
Emergency Spillway Stage, Hp = 3.0 Ft.

$\frac{\text{Peak Discharge}}{\text{Bottom Width}} = \frac{Q}{b} = 12.8$

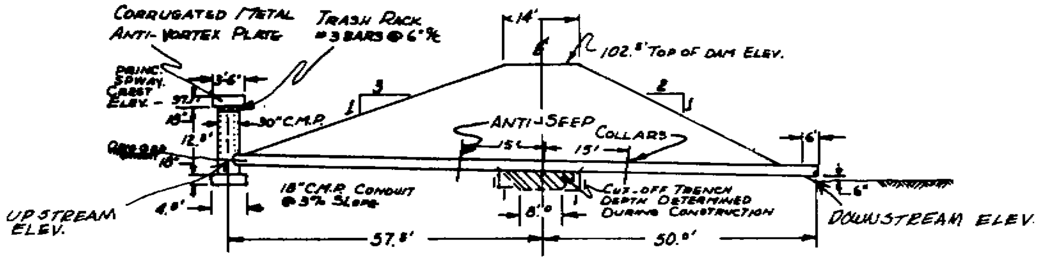
Slope of Exit Channel, S_e = 2.65% (Chart 1)
Velocity in Exit Channel, V_e = 8.2 f.p.s. (Chart 1)
Spillway Material Rock Rip Allowable V_e = 12 f.p.s.
Top of Dam Elevation = Emergency Spillway Elevation + Hp + 1.0 Ft. =
98.6 + 3.0 + 1.0 = 102.6 (Settled Elevation)



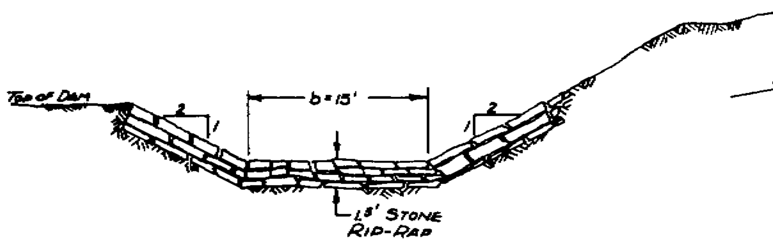
DAM NO.1

SCALE 1" = 50'

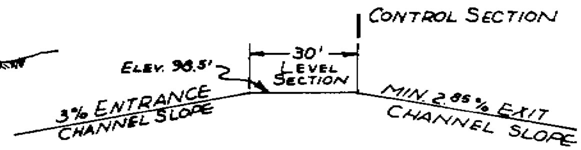
CONTOUR INTERVAL 4'



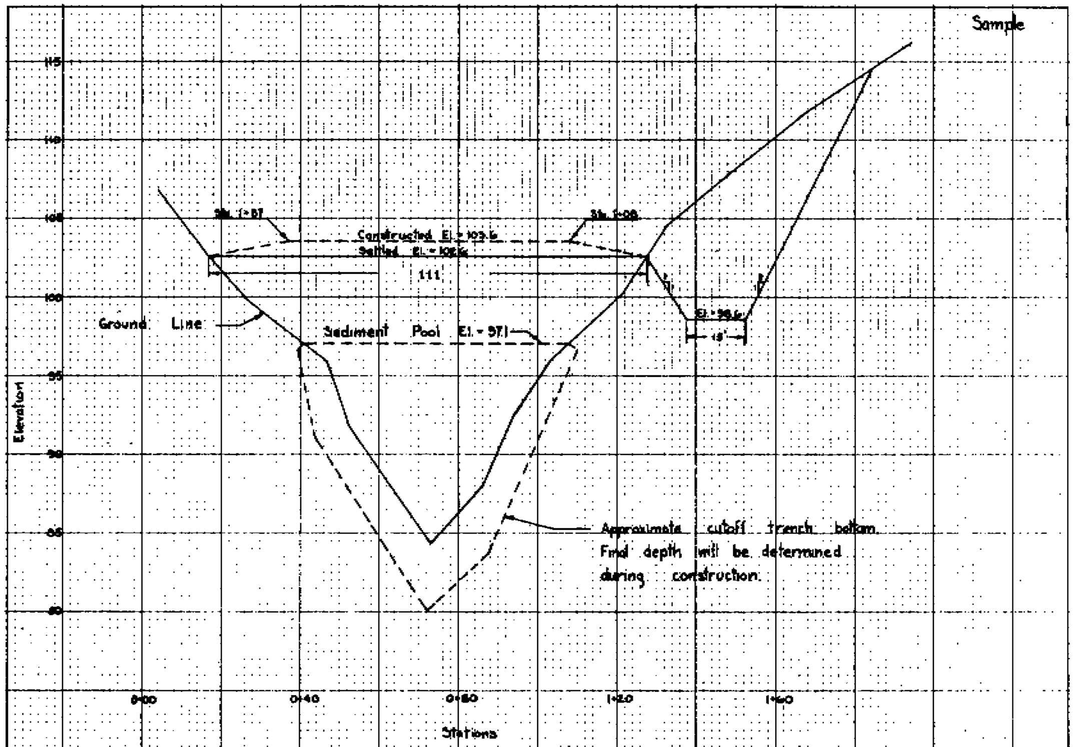
EMBANKMENT PROFILE ALONG PRINCIPAL SPILLWAY ℄



EMERGENCY SPILLWAY SECTION



EMERGENCY SPILLWAY PROFILE



CENTERLINE CROSS SECTION

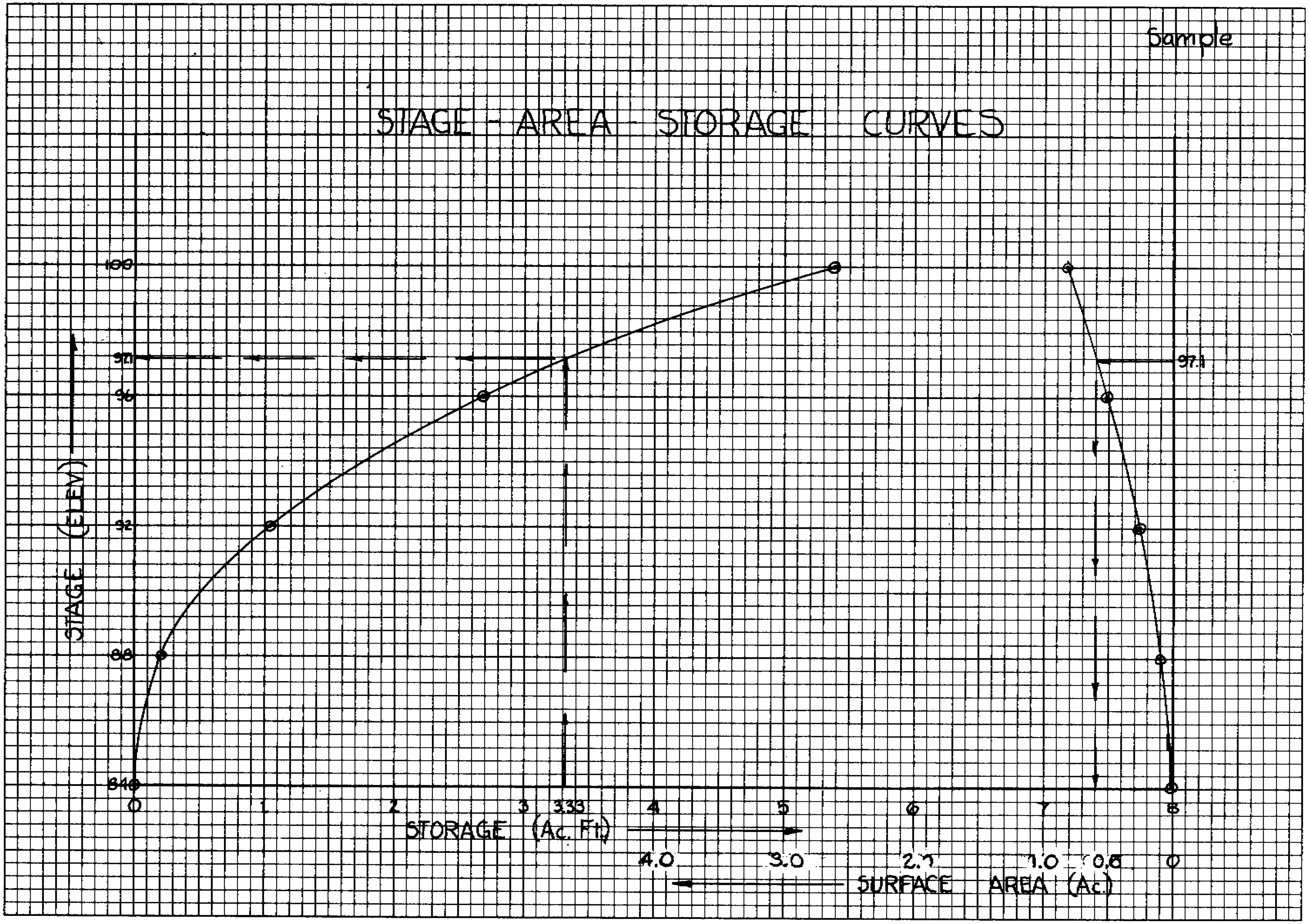
Sample

STAGE-AREA-STORAGE COMPUTATIONS

Dam No. 3

Elev. (ft.)	Area (in.^{2})	Area (Ac.)	Area (Ac.)	Average Area (Ac.)	Diff. in Elev. (ft.)	Storage (Ac. ft.)	Storage (Ac. ft.)
84	0	0					0
			.112	.056	4	.224	
88	1.96	.112					.224
			.410	.205	4	.820	
92	5.20	.298					1.044
			.820	.410	4	1.640	
96	9.10	.522					2.684
			1.355	.678	4	2.712	
100	14.52	.833					5.396

NOTE: 1 in.^{2} = .0573 Ac. for scale of 1" = 50'


Sample
STAGE - AREA - STORAGE CURVES
100
97.1
96
92
88
84
STAGE (ELEV)
0
1
2
3
3.33
4
5
6
7
8
STORAGE (Ac. Ft.)
4.0
3.0
1.0
0.8
0
SURFACE AREA (Ac.)
97.1

EXCAVATED SEDIMENT POND

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

POND NUMBER ____

Sediment Storage Requirements

Drainage Area = 53.0 Ac. Average Land Slope = 15 %
Disturbed Area = 13.5 Ac. = 25.5 % of drainage area
Sediment Volume = ____ .125 Ac. Ft./Ac. x area disturbed = 1.69 Ac. Ft.

Emergency Spillway Design (If Required)

(See EMERGENCY SPILLWAYS - SEDIMENT DAMS, EMBANKMENT TYPE)

Peak Discharge (Figure 2) = 110 c.f.s. x 1.0 (slope factor) = 110 c.f.s.

Emergency Spillway Proportions (Table 2)

Emergency Spillway Elevation = 100.0 Sediment Pool Elevation
Bottom Width, b = 15 Ft.
Emergency Spillway Stage, Hp = 2.14 Ft.

$\frac{\text{Peak Discharge}}{\text{Bottom Width}} = \frac{Q}{b} =$ ____ = 7.3

Slope of Exit Channel, S_e = 30 % (Chart 1)
Velocity in Exit Channel, V_e = 6.8 f.p.s. (Chart 1)
Spillway Material Rock Riprap
Allowable V_e = 12 f.p.s.
Top of Embankment Elevation = Emergency Spillway Elevation + Hp + 1.0 = 100.0 + 2.14 + 1.0 = 103.14 (Settled Elevation)

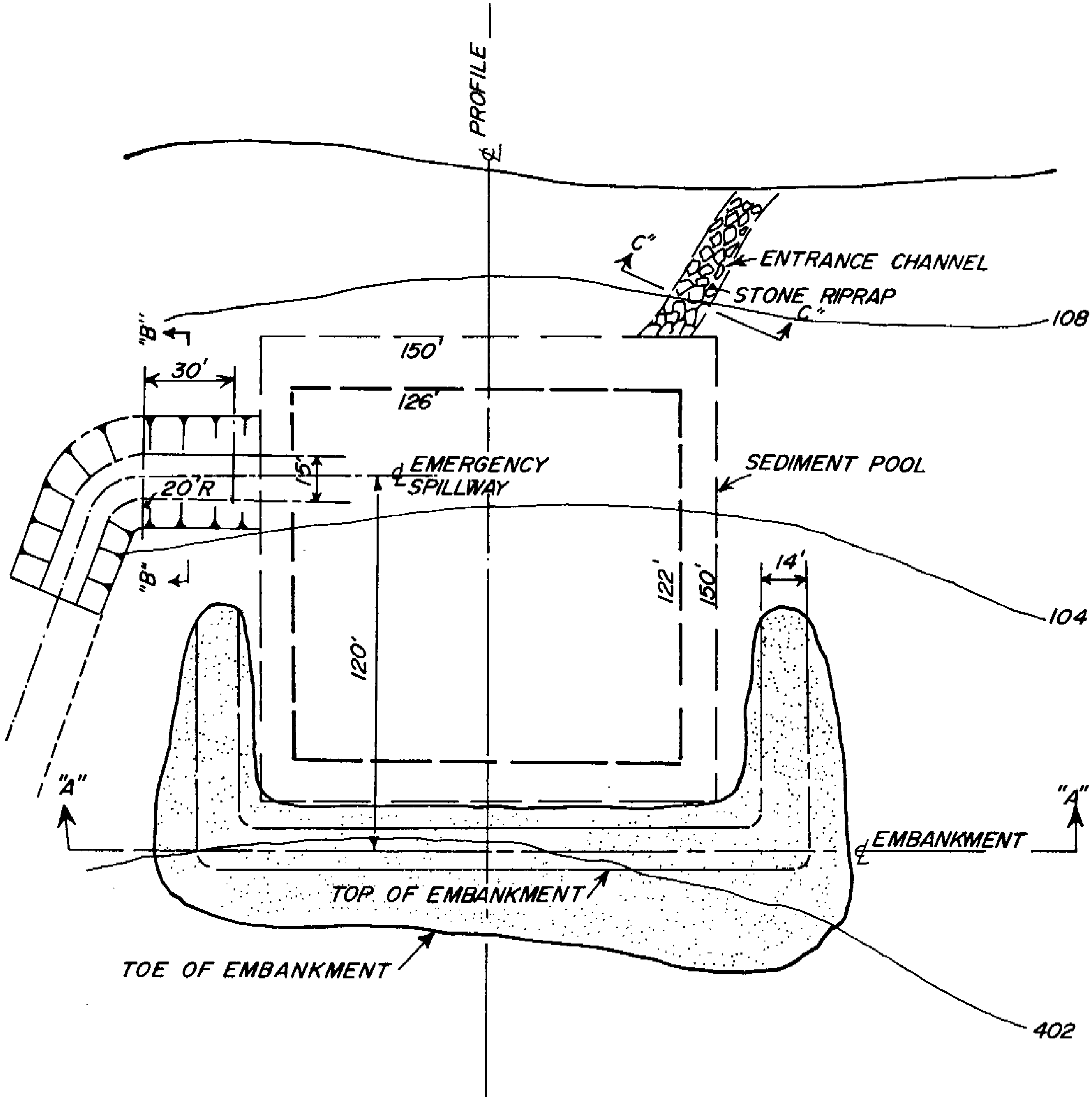
or

Top of Embankment = Sediment Pool Elevation + 2.0' = ____ + ____ = ____ (Settled Elevation)

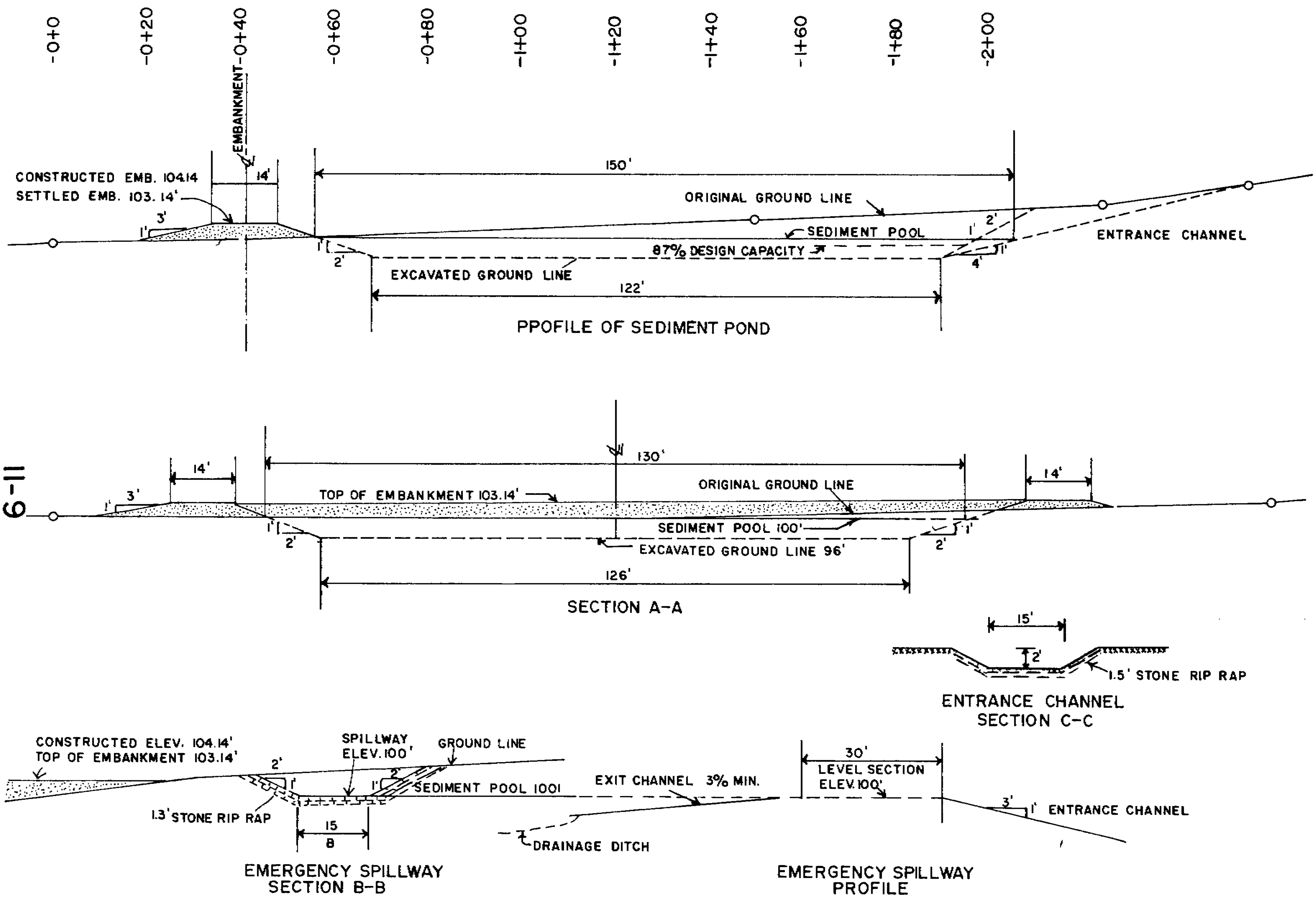
NOTE:

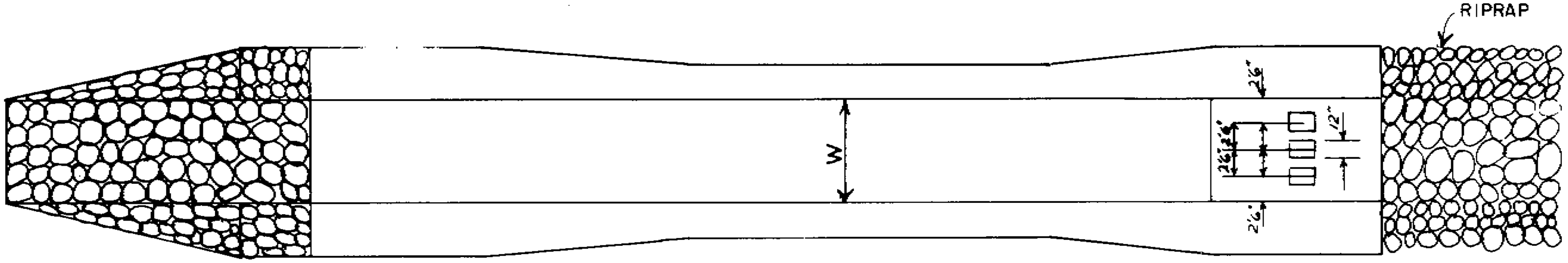
If pond is to be a regular shape and constructed on relatively flat terrain (less than 20% slope), fill in the following:

Bottom Length = 122 Ft.
Bottom Width = 126 Ft.
Water Depth = 4 Ft.
Side Slopes = 2:1 Ft.
Volume (in ft.^{3}, taking into account side slopes) = 75744 Ft.^{3} = 1.74 Ac.-Ft. (1 Acre Foot = 43560 Ft.^{3})



PROFILE
ENTRANCE CHANNEL
STONE RIPRAP
"C"
"C"
108
"B"
"B"
30'
150'
126'
15'
EMERGENCY SPILLWAY
20'R
SEDIMENT POOL
14'
122'
150'
120'
104
"A"
"A"
EMBANKMENT
TOP OF EMBANKMENT
TOE OF EMBANKMENT
402

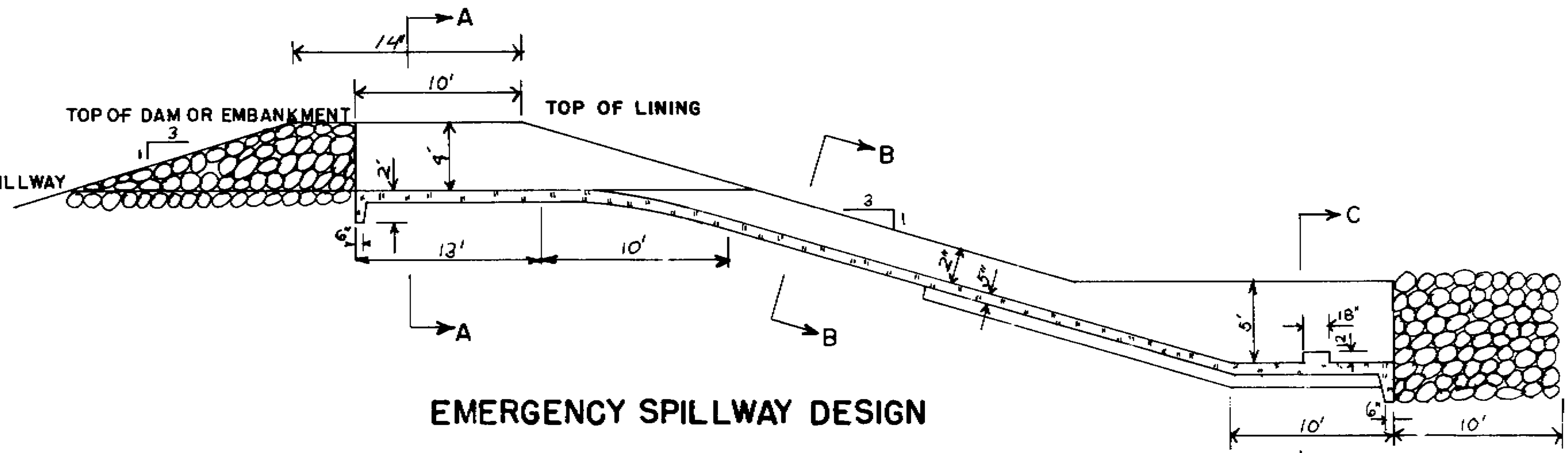

-0+0
-0+20
EMBANKMENT-0+40
-0+60
-0+80
-1+00
-1+20
-1+40
-1+60
-1+80
-2+00
CONSTRUCTED EMB. 104.14
SETTLED EMB. 103. 14'
3'
1'
14'
150'
ORIGINAL GROUND LINE
SEDIMENT POOL
87% DESIGN CAPACITY
ENTRANCE CHANNEL
2'
4'
EXCAVATED GROUND LINE
122'
PPOFILE OF SEDIMENT POND
14'
130'
TOP OF EMBANKMENT 103.14'
ORIGINAL GROUND LINE
SEDIMENT POOL 100'
EXCAVATED GROUND LINE 96'
126'
SECTION A-A
15'
2'
1.5' STONE RIP RAP
ENTRANCE CHANNEL
SECTION C-C
CONSTRUCTED ELEV. 104.14'
TOP OF EMBANKMENT 103.14'
SPILLWAY
ELEV. 100'
GROUND LINE
SEDIMENT POOL 1001
1.3' STONE RIP RAP
15
B
EMERGENCY SPILLWAY
SECTION B-B
EXIT CHANNEL 3% MIN.
DRAINAGE DITCH
30'
LEVEL SECTION
ELEV. 100'
ENTRANCE CHANNEL
EMERGENCY SPILLWAY
PROFILE



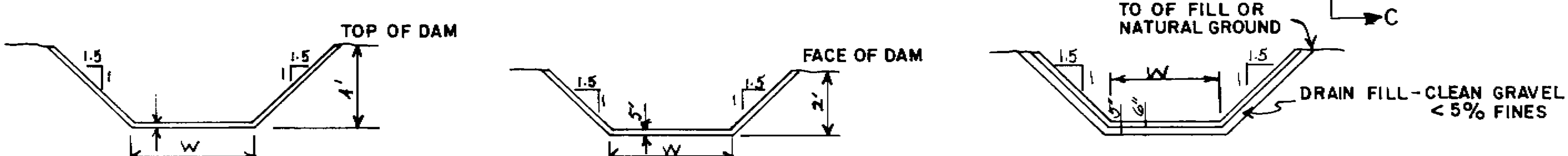
PLAN

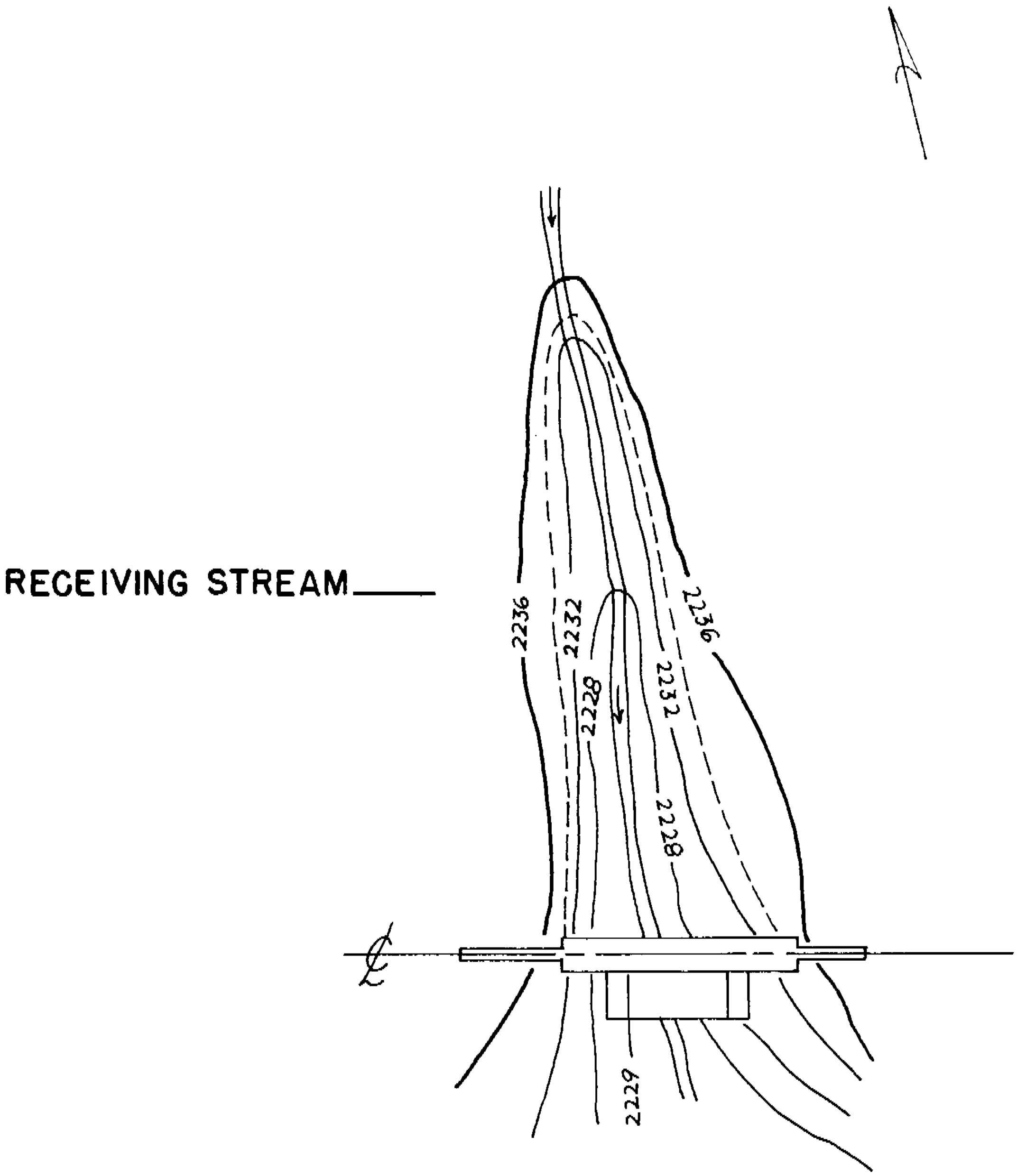
W-FT	Q-CFS
5	110
10	220
15	330
20	440
25	550
30	660

RIPRAP GRADED FROM 1' TO 3' CONCRETE TO BE REINFORCED WITH 6 X 6 X 2 1/2 WELDED WIRE FABRIC OR NO. 3 BARS 12" CENTERS BOTH DIRECTIONS



EMERGENCY SPILLWAY DESIGN





GABION SEDIMENT DAM NO. 4

SCALE 1" = 50'
CONTOUR INTERVAL 4'

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

Gabion Sediment Dam No. 4

Sediment Storage Requirements

Drainage Area = 225 Acres Average Land Slope = 20 %
Area Disturbed = 4.16 Acres = 5 % of Drainage Area
Sediment Volume = .125 Ac. Ft./Ac. x Area Disturbed = 0.52 Act. Ft.
Sediment Pool Elevation = 2233.75 Ft. = Emergency Spillway Elevation = Principal Spillway Crest

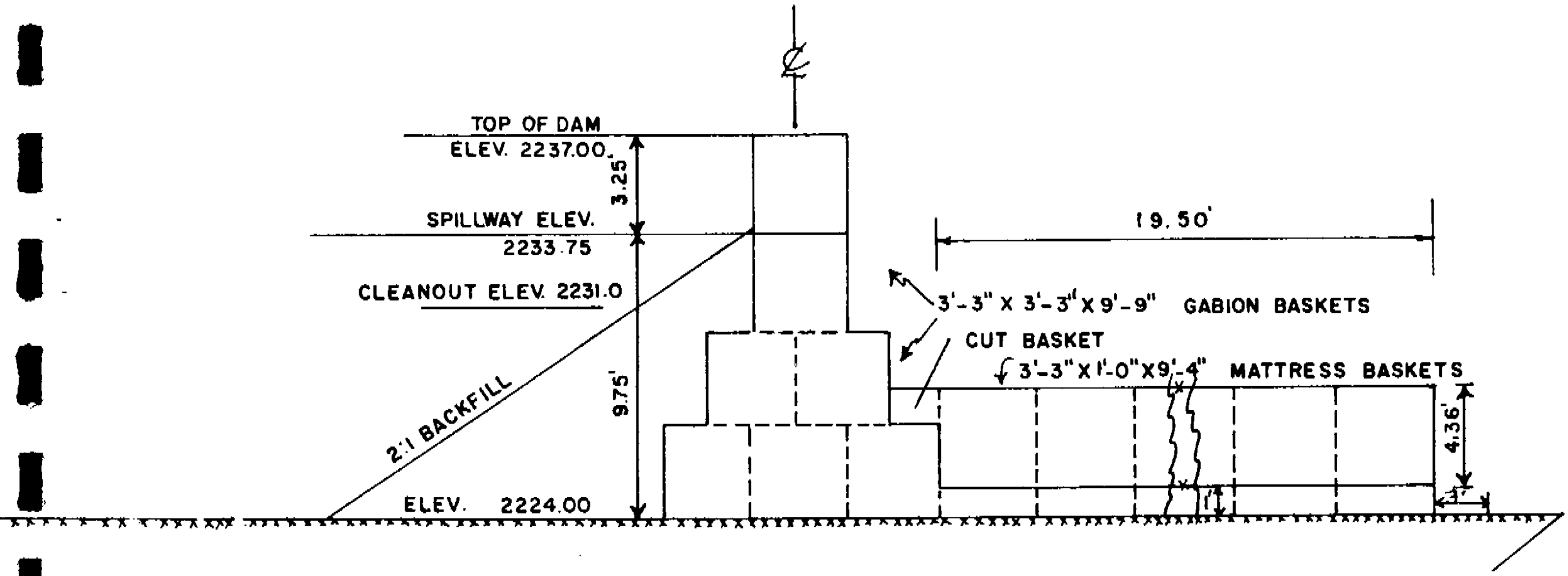
Spillway Design

Peak Discharge, Q (Figure 3) = 320 c.f.s. x 1.1 (slope factor) = 352 c.f.s.

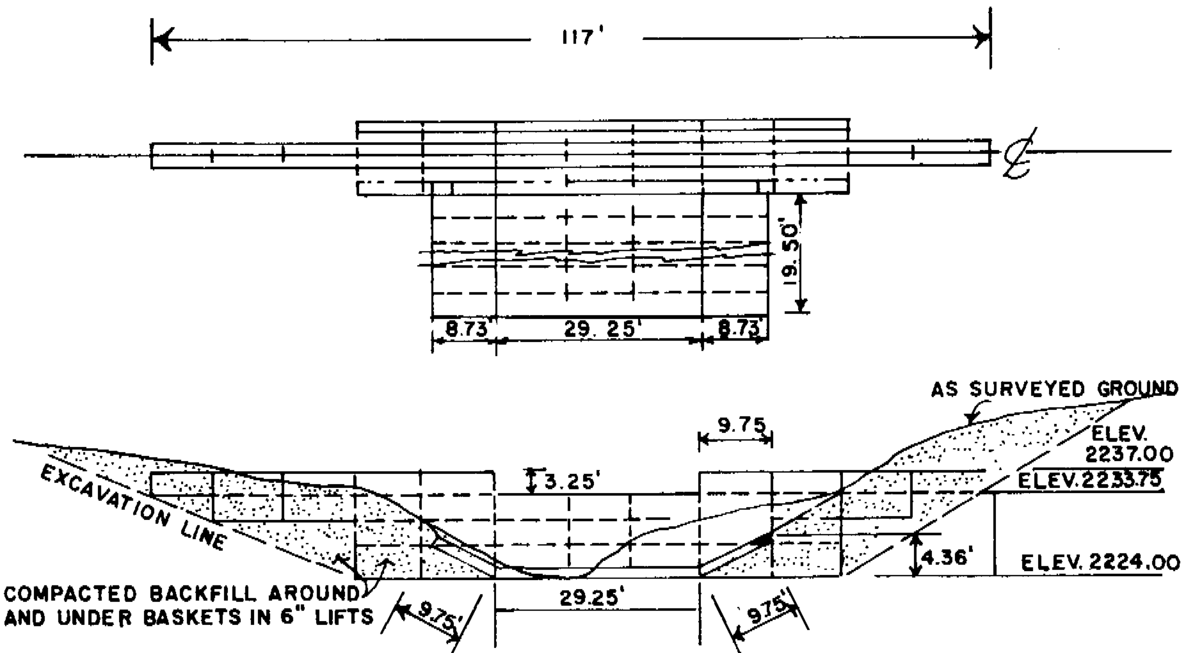
Spillway Breadth = 3.25 Ft.
Spillway Height minus 0.5 ft., h = 3.25 - 0.5 ft. = 2.75 Ft.
Coefficient of Discharge, C (Table 5) = 2.78
Minimum Spillway Length, L = Q/Ch 3/2* = 25.20 Ft.
Planned Spillway Length = 29.25 Ft.
Top of Dam Elevation = Spillway Elevation + Spillway Height =

2233.75 + 3.25 = 2237.00

*The three-halves power of h may be obtained from Table 6, Appendix I.



GABION SEDIMENT DAM NO. 4
CROSS SECTION VIEW



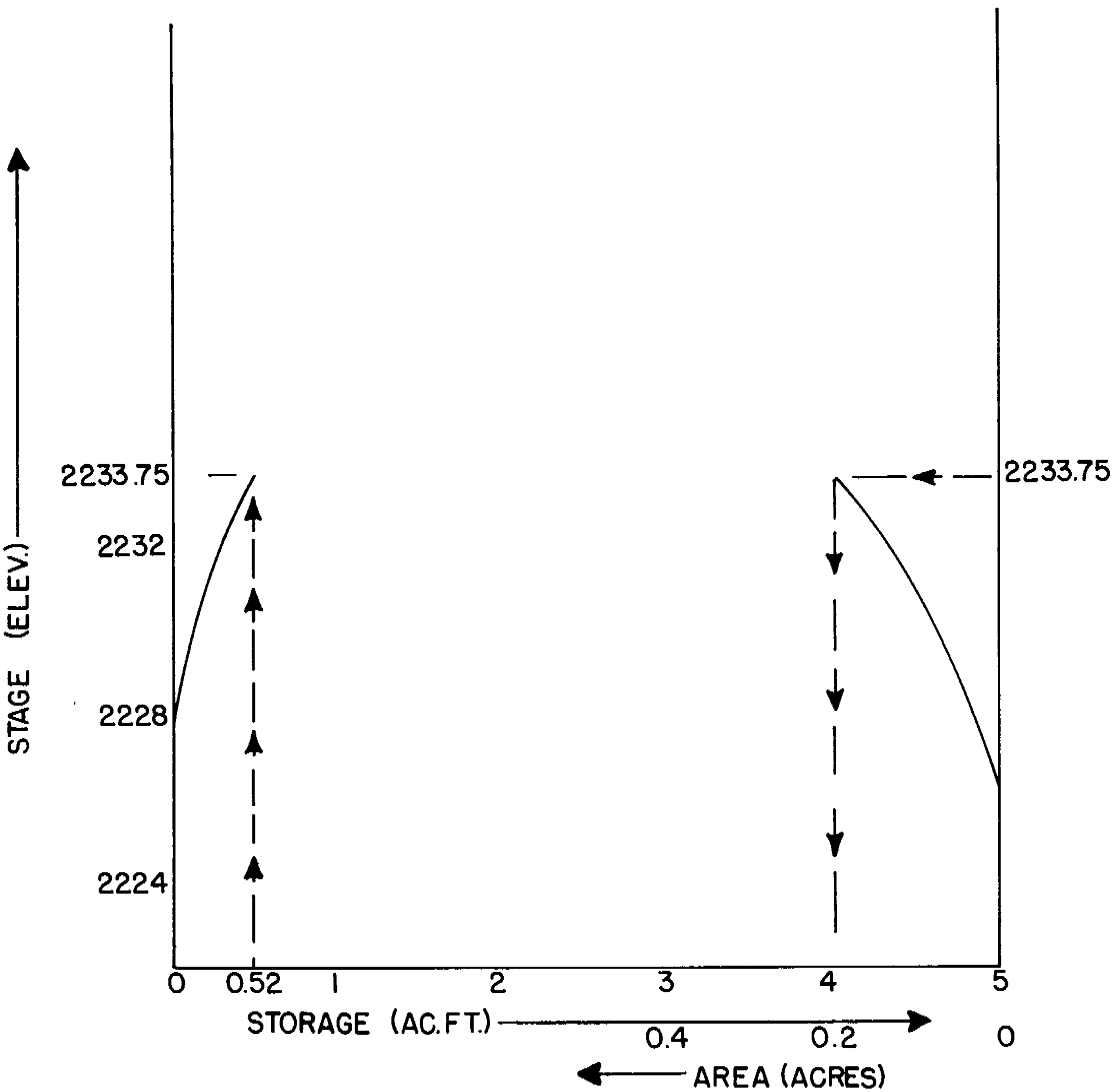
GABION SEDIMENT DAM NO. 4
PLAIN VIEW AND
CENTERLINE CROSS SECTION VIEW

STAGE-AREA-STORAGE COMPUTATIONS

GABION DAM NO. 4

Elev. (Ft.)	Area (In.^{2})	Area (Ac.)	Area (Ac.)	Average Area (Ac.)	Diff. in Elev. (Ft.)	Storage (Ac. Ft.)	Storage (Ac. Ft.)
2224	0	0					0
			.036	.015	4	.072	
2228	.62	.036					.072
			.123	.062	4	.248	
2232	1.51	.087					.320
			.202	.101	2	.202	
2233.75	2.00	.115					.522

NOTE: 1 in.^{2} = .0573 Ac. for scale of 1" = 50'



STAGE AREA STORAGE CURVES
GABION SEDIMENT DAM NUMBER 4

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

Crib Sediment Dam No. 2

Sediment Storage Requirements

Drainage Area = 105 Acres Average Land Slope = 32 %
Area Disturbed = 4.2 Acres = 4 % of Drainage Area
Sediment Volume = .125 Ac. Ft./Ac. x Area Disturbed = 0.53 Act. Ft.
Sediment Pool Elevation = 2310.75 Ft. = Emergency Spillway Elevation = Principal Spillway Crest

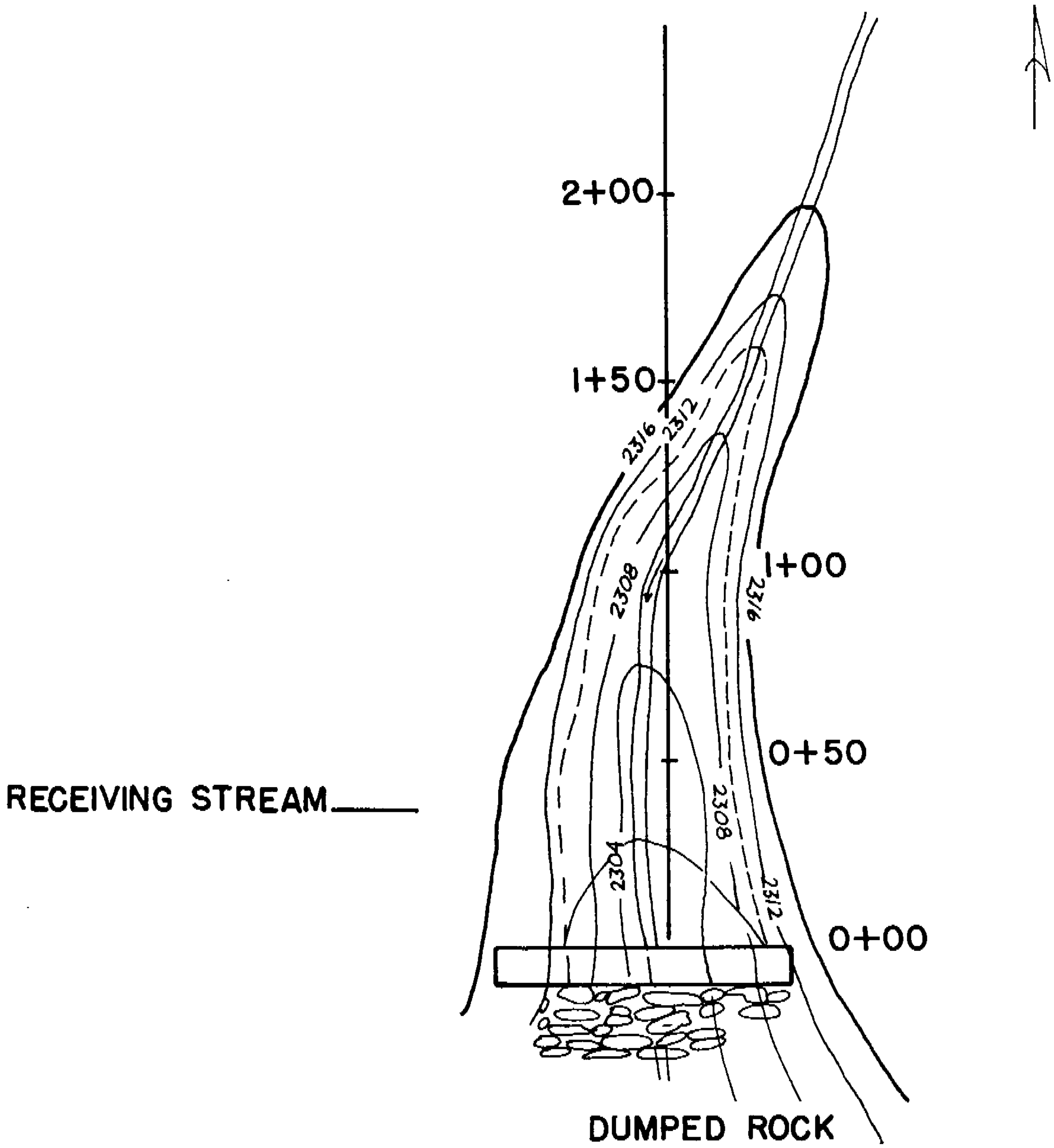
Spillway Design

Peak Discharge, Q (Figure 3) = 150 c.f.s. x 1.2 (slope factor) = 180 c.f.s.

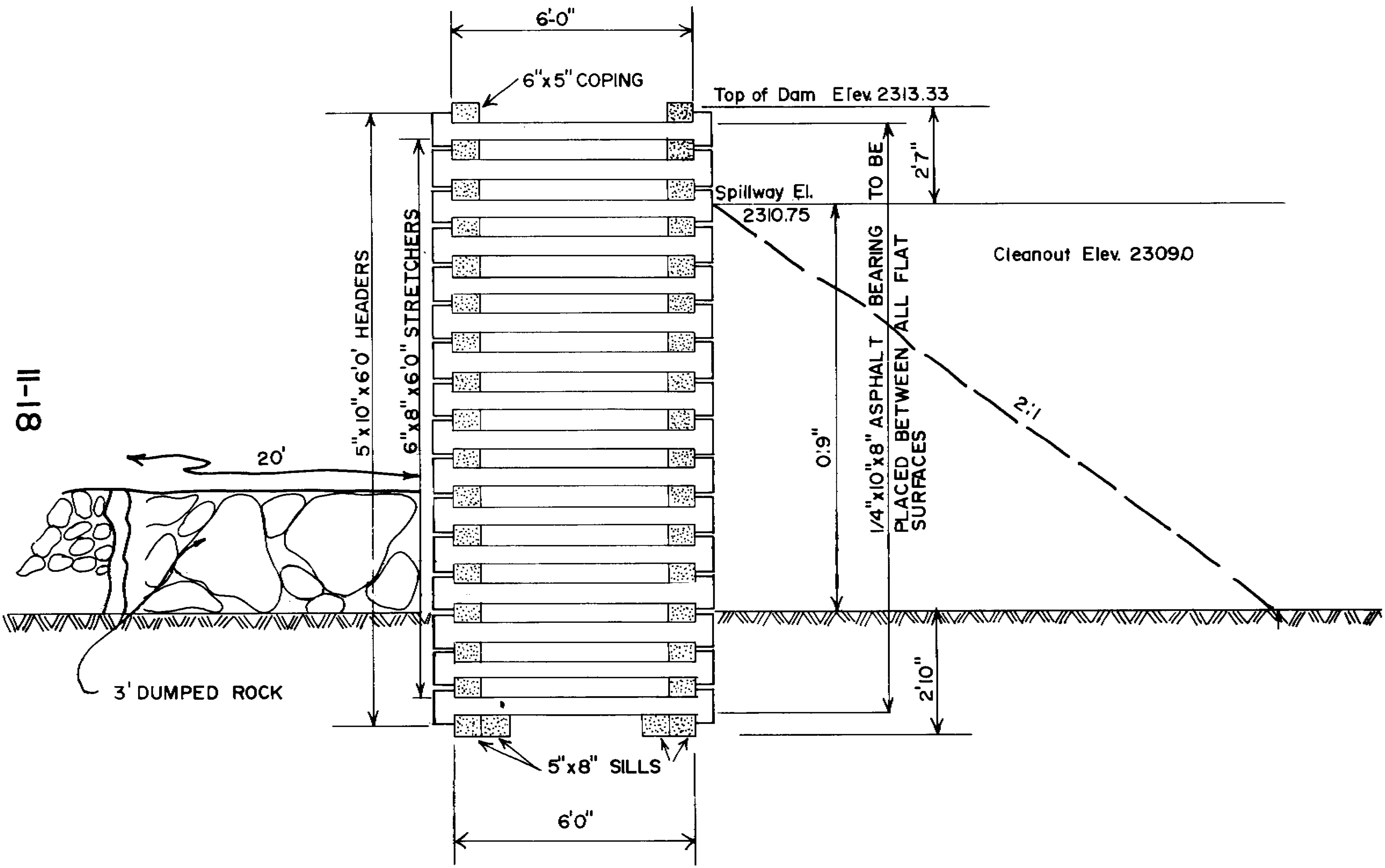
Spillway Breadth = 6.0 Ft.
Spillway Height minus 0.5 ft., h = 2.58 - 0.5 ft. = 2.08 Ft.
Coefficient of Discharge, C (Table 5) = 2.65
Minimum Spillway Length, L = Q/Ch 3/2* = 28.9 Ft.
Planned Spillway Length = 30.0 Ft.
Top of Dam Elevation = Spillway Elevation + Spillway Height =

2310.75 + 2.58 = 2312.33

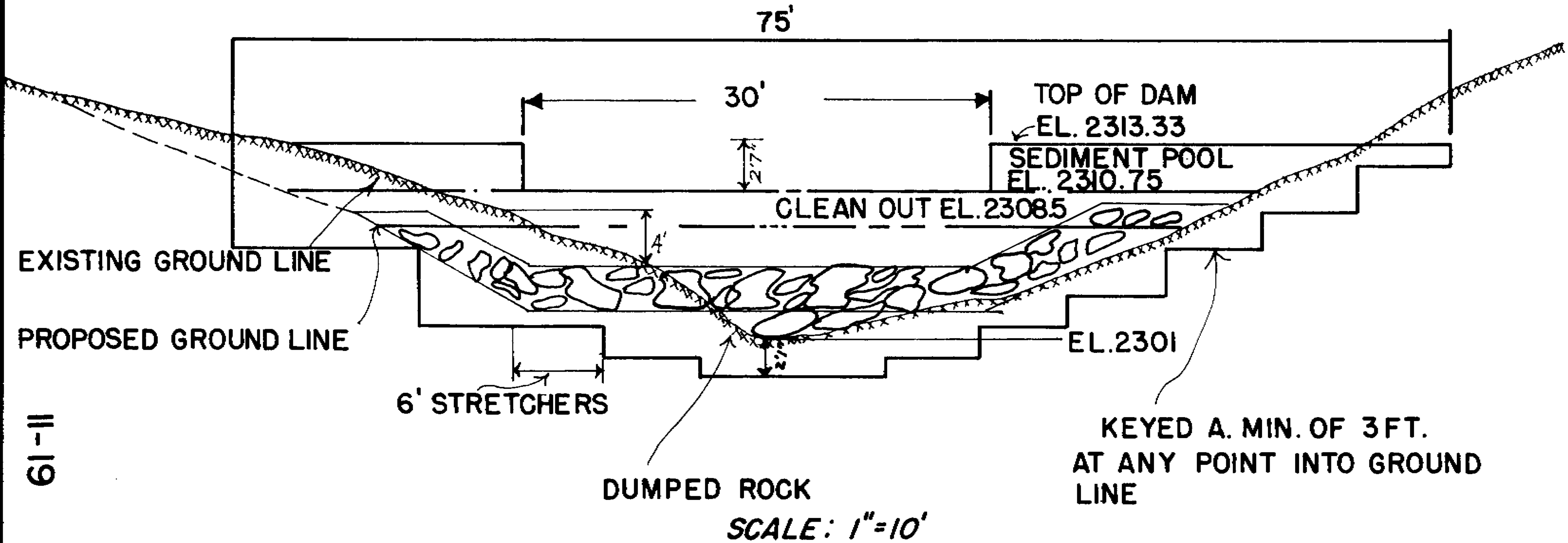
*The three-halves power of h may be obtained from Table 6, Appendix I.

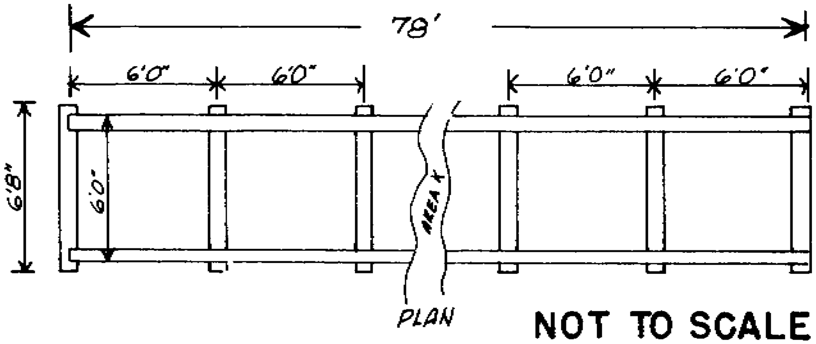


CRIB DAM NO. 2
SCALE 1" = 50'
CONTOUR INTERVAL 4'



CROSS SECTION VIEW OF CRIB DAM NO.2





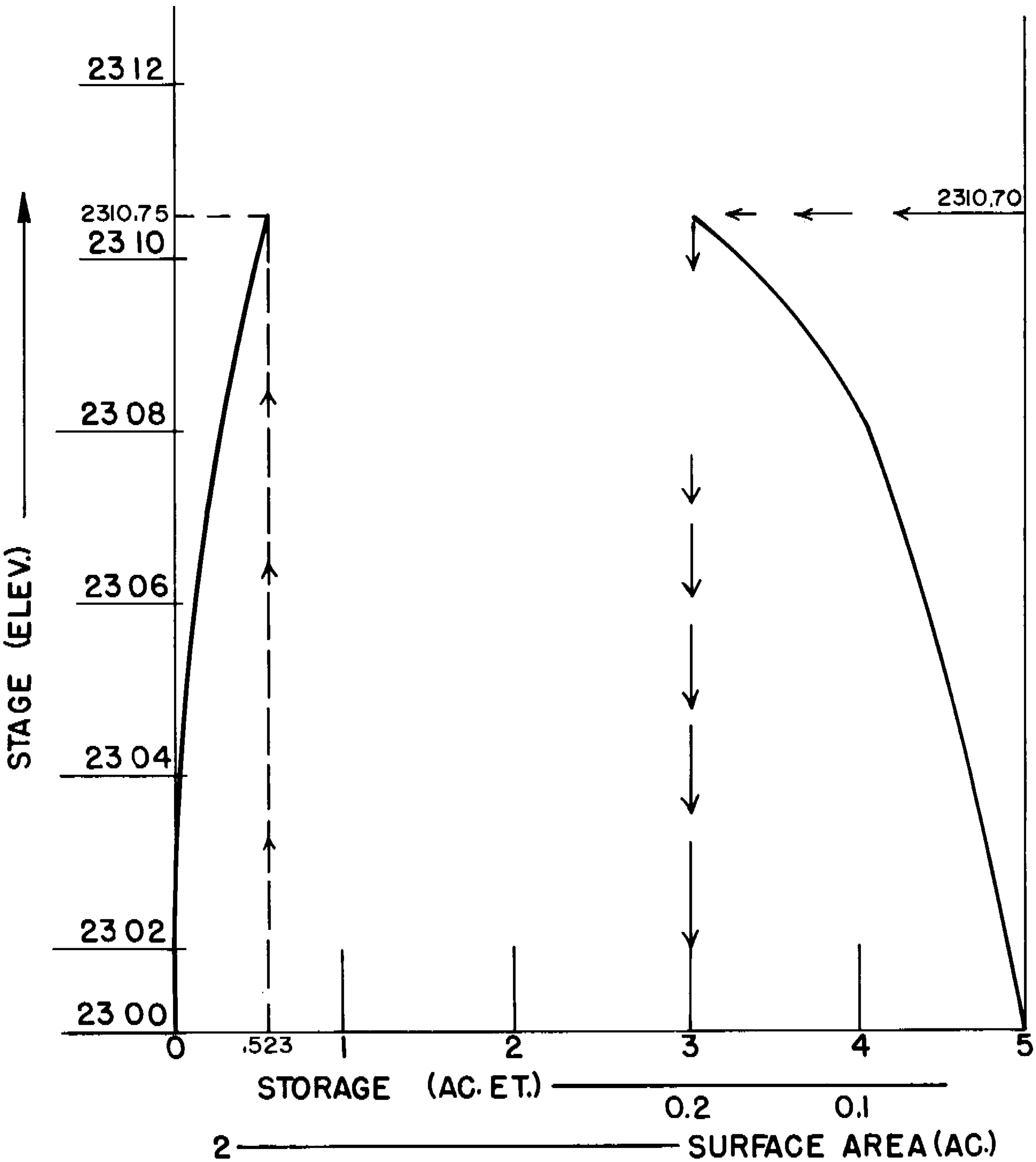
PLAN VIEW
&
CENTERLINE CROSS SECTION
CRIB DAM NO. 2

SURFACE AREA-STORAGE COMPUTATIONS

CRIB DAM NO. 2

Elev. (ft.)	Area (in.^{2})	Area (Ac.)	Area (Ac.)	Average Area (Ac.)	Diff. in Elev. (ft.)	Storage (Ac. ft.)	Storage (Ac. ft.)
2301	0	0					0
			.036	.018	3	.054	
2304	0.62	.036					.054
			.098	.049	4	.196	
2308	1.43	.082					.250
			.201	.101	2.75	.278	
2310/75	2.08	.119					.528

NOTE: 1 in.^{2} = .0573 Ac. for scale of 1" = 50'


2312
2310.75
2310
2308
2306
2304
2302
2300
2310.70
STAGE (ELEV.)
0
.523
1
2
3
4
5
STORAGE (AC. ET.)
0.2
0.1
2
SURFACE AREA (AC.)

CRIB DAM NO. 2

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

Excavated Sediment Channel No. ________

Outslope Disturbed Area = 12.8 Acres

Maximum expected horizontal length of spoil slope = 100 Feet

Maximum existing ground slope on which the channel is to be constructed = 30 %

Required sediment storage capacity per transverse foot of outslope

= Maximum length of spoil slope x .125

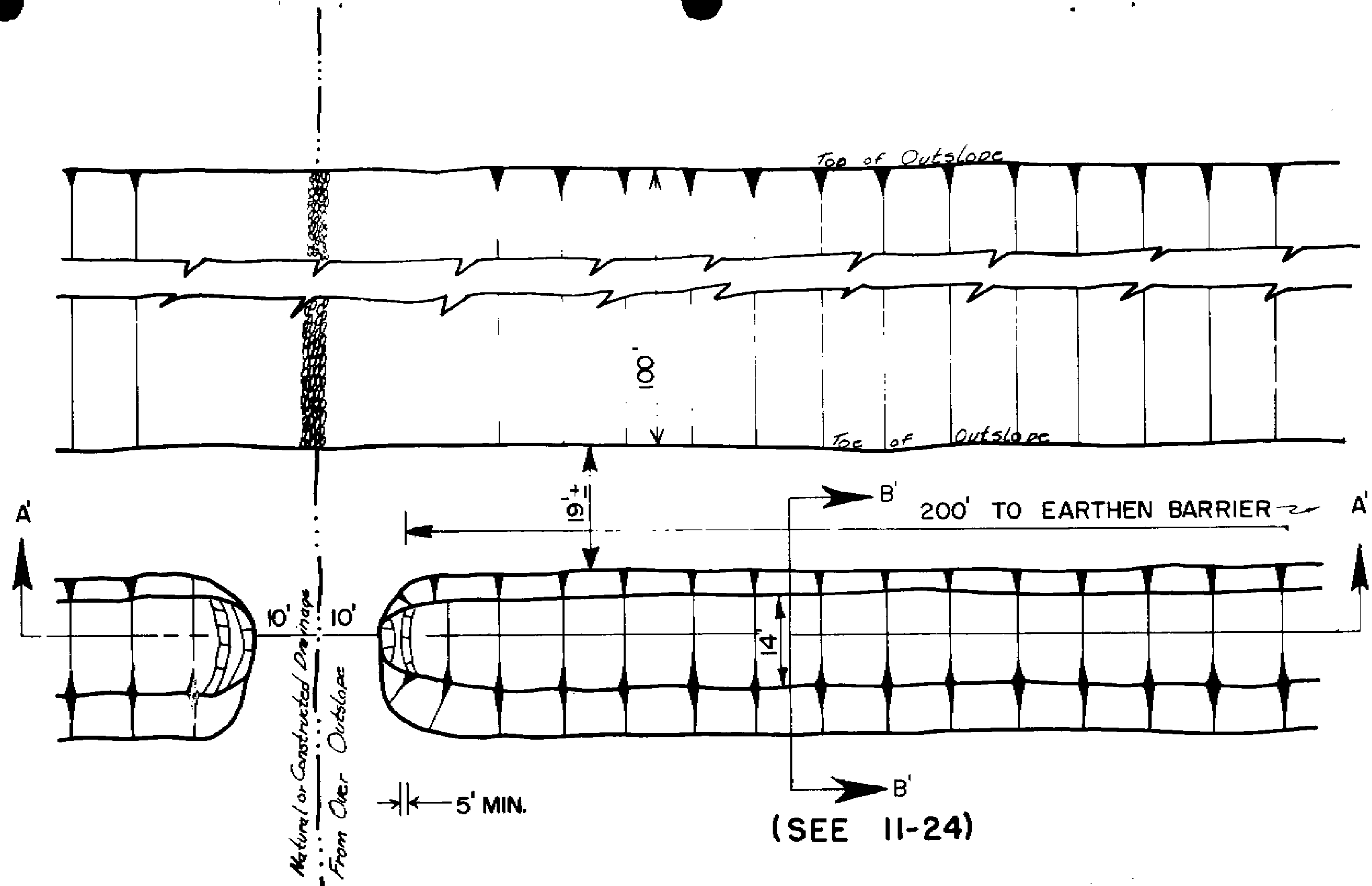
= 100 x .125 = 12.5 Cu. Ft.

Planned sediment storage capacity per transverse foot of outslope, approximately,

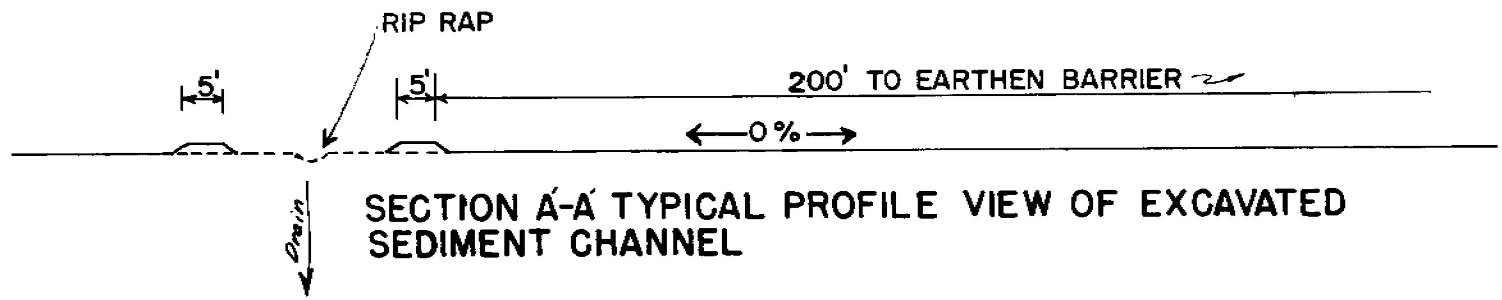
= 1/2 x Depth, Ft. x Width, Ft.

= 1/2 x 2.0 x 14.0

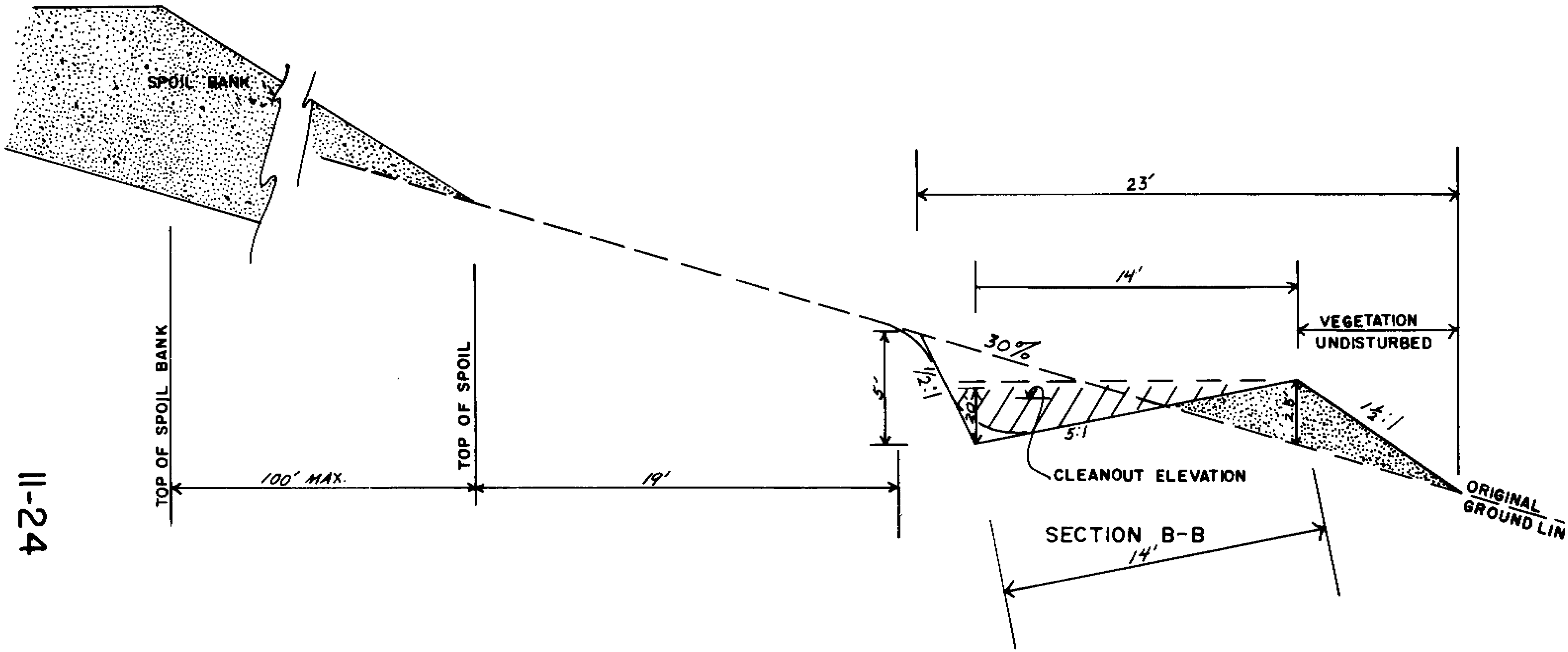
= 14.0 Cu. Ft.



TYPICAL PLAN VIEW OF EXCAVATED SEDIMENT CHANNEL



SECTION A'-A' TYPICAL PROFILE VIEW OF EXCAVATED SEDIMENT CHANNEL



TYPICAL CROSS SECTION OF EXCAVATED SEDIMENT CHANNEL

APPENDIX III

STRUCTURE PROPORTIONING COMPUTATION SHEETS

EMBANKMENT SEDIMENT POND

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

DAM NUMBER ____

Sediment Storage Requirements

Drainage Area = ______ Ac. Average Land Slope = _____%
Area Disturbed = ______ Ac. = _____% of drainage area
Sediment Volume = .125 Ac. Ft./Ac. x area disturbed = ______ Ac. Ft.
Sediment Pool Elevation = ______ Ft. = principal spillway crest

Principal Spillway Design

Principal Spillway Diameter = ______ In.
Type ______________________________ pH ____________
Principal Spillway Length ______ Ft.
Principal Spillway Slope ______ Percent

Drop Inlet

Type Base ________________________ Type Riser ________________________
Dimensions = ______ In. diameter of ______ $Ft.^2$
Height of Riser (base to crest) = ______ Ft.
Perforated ______ Yes ______ No

Drainpipe

Diameter = ______ In. Type ____________________
Length = ______ Ft. Height of Riser ______ Ft.

Emergency Spillway Design

Emergency Spillway Elevation = Principal Spillway Elevation + 1.5 Ft. (min.) = ______ + ______ = ______

Peak Discharge (Figure 2) = ______ c.f.s. x ______ (slope factor) = ______ c.f.s.

Emergency Spillway Proportions (Table 2)

Bottom Width, b = ______ Ft.
Emergency Spillway Stage, Hp = ______ Ft.

$\frac{\text{Peak Discharge}}{\text{Bottom Width}} = \frac{Q}{b} =$ ______

Slope of Exit Channel, S_e = _____% (Chart 1)
Velocity in Exit Channel, V_e = ______ f.p.s. (Chart 1)
Spillway Material ______ Allowable V_e = ______ f.p.s.
Top of Dam Elevation = Emergency Spillway Elevation + Hp + 1.0 Ft. = ______ + ______ + ______ = ______ (Settled Elevation)

EXCAVATED SEDIMENT POND

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

POND NUMBER ____

Sediment Storage Requirements

Drainage Area = ______ Ac. Average Land Slope = ______%
Disturbed Area = ______ Ac. = ______% of drainage area
Sediment Volume = ______ .125 Ac. Ft./Ac. x area disturbed = ______ Ac. Ft.

Emergency Spillway Design (If Required)

(See EMERGENCY SPILLWAYS - SEDIMENT DAMS, EMBANKMENT TYPE)

Peak Discharge (Figure 2) = ______ c.f.s. x ______ (slope factor) = ______ c.f.s.

Emergency Spillway Proportions (Table 2)

Emergency Spillway Elevation = ______ Sediment Pool Elevation
Bottom Width, b = ______ Ft.
Emergency Spillway Stage, Hp = ______ Ft.

$\frac{\text{Peak Discharge}}{\text{Bottom Width}} = \frac{Q}{b}$ = ______ = ______

Slope of Exit Channel, S_e = ______% (Chart 1)
Velocity in Exit Channel, V_e = ______ f.p.s. (Chart 1)
Spillway Material ________________
Allowable V_e = ______ f.p.s.
Top of Embankment Elevation = Emergency Spillway Elevation + Hp + 1.0 = ______ + ______ + ______ = ______ (Settled Elevation)

or

Top of Embankment = Sediment Pool Elevation + 2.0' = ______ + ______ = ______ (Settled Elevation)

NOTE:

If pond is to be a regular shape and constructed on relatively flat terrain (less than 20% slope), fill in the following:

Bottom Length = ______ Ft.
Bottom Width = ______ Ft.
Water Depth = ______ Ft.
Side Slopes = ______ Ft.
Volume (in ft.^{3}, taking into account side slopes) = ______ Ft.^{3} = ______ Ac.-Ft. (1 Acre Foot = 43560 Ft.^{3})

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

Gabion Sediment Dam No. ______

Sediment Storage Requirements

Drainage Area = ____________ Acres   Average Land Slope = __________%
Area Disturbed = ____________ Acres = ____% of Drainage Area
Sediment Volume = .125 Ac. Ft./Ac. x Area Disturbed = ______ Act. Ft.
Sediment Pool Elevation = ____________ Ft. = Emergency Spillway Elevation = Principal Spillway Crest

Spillway Design

Peak Discharge, Q (Figure 3) = ______ c.f.s. x ______ (slope factor) = ______ c.f.s.

Spillway Breadth = ______ Ft.
Spillway Height minus 0.5 ft., h = ______ - 0.5 ft. = ______ Ft.
Coefficient of Discharge, C (Table 5) = ______
Minimum Spillway Length, L = Q/Ch 3/2* = ______ Ft.
Planned Spillway Length = ______ Ft.
Top of Dam Elevation = Spillway Elevation + Spillway Height =

______ + ______ = ______

*The three-halves power of h may be obtained from Table 6, Appendix I.

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

Crib Sediment Dam No. ______

Sediment Storage Requirements

Drainage Area = ____________ Acres   Average Land Slope = ___________%
Area Disturbed = ____________ Acres = ____% of Drainage Area
Sediment Volume = .125 Ac. Ft./Ac. x Area Disturbed = ______ Act. Ft.
Sediment Pool Elevation = ____________ Ft. = Emergency Spillway Elevation = Principal Spillway Crest

Spillway Design

Peak Discharge, Q (Figure 3) = ______ c.f.s. x ______ (slope factor) = ______ c.f.s.

Spillway Breadth = ______ Ft.
Spillway Height minus 0.5 ft., h = ______ - 0.5 ft. = ______ Ft.
Coefficient of Discharge, C (Table 5) = ______
Minimum Spillway Length, L = Q/Ch 3/2* = ______ Ft.
Planned Spillway Length = ______ Ft.
Top of Dam Elevation = Spillway Elevation + Spillway Height =

______ + ______ = ______

*The three-halves power of h may be obtained from Table 6, Appendix I.

STRUCTURE PROPORTIONING COMPUTATIONS SHEET

Excavated Sediment Channel No. _______

Outslope Disturbed Area = _______ Acres

Maximum expected horizontal length of spoil slope = _______ Feet

Maximum existing ground slope on which the channel is to be constructed = _______ %

Required sediment storage capacity per transverse foot of outslope

= Maximum length of spoil slope x .125

= _______ x .125 = _______ Cu. Ft.

Planned sediment storage capacity per transverse foot of outslope, approximately,

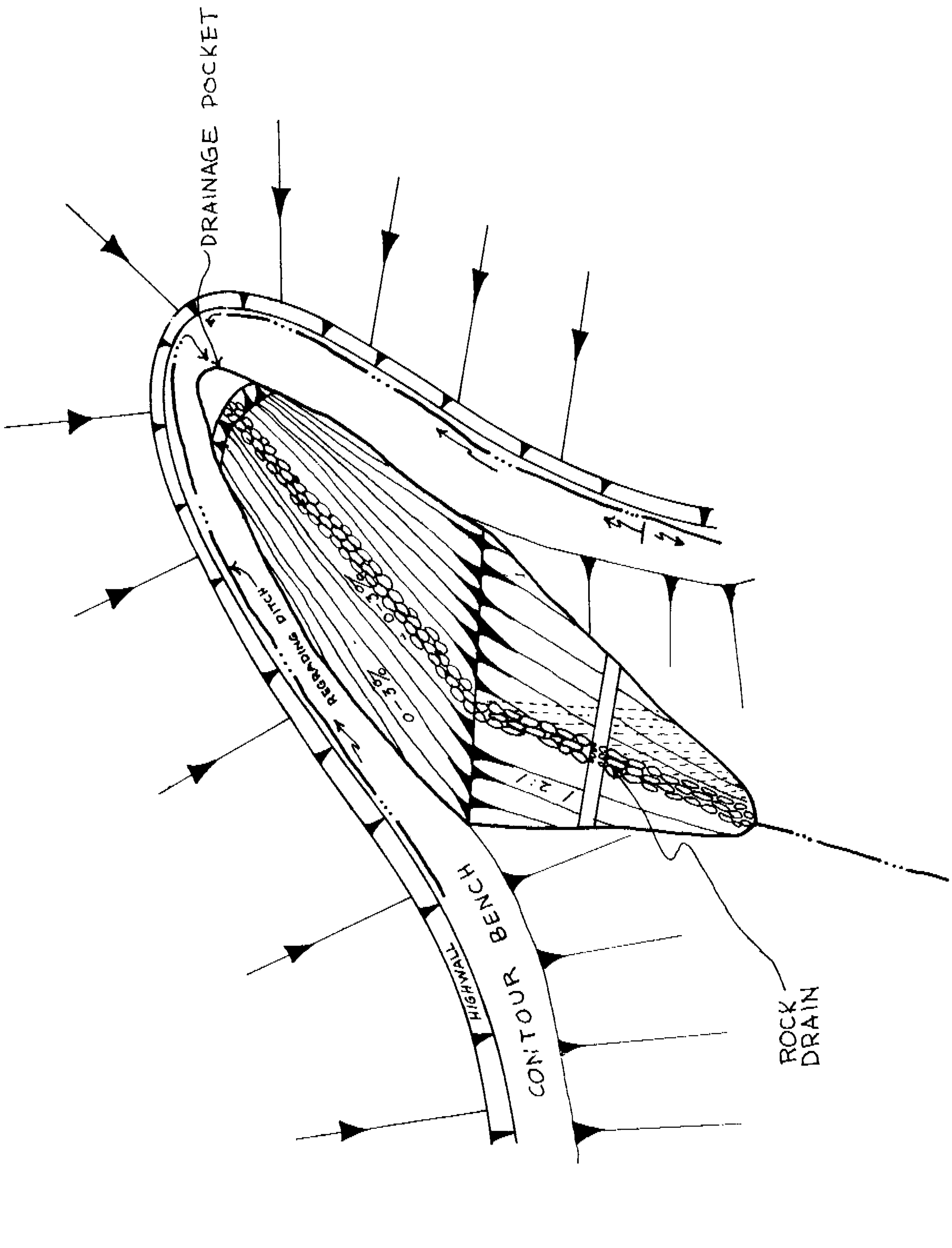
= 1/2 x Depth, Ft. x Width, Ft.

= 1/2 x _______ x _______

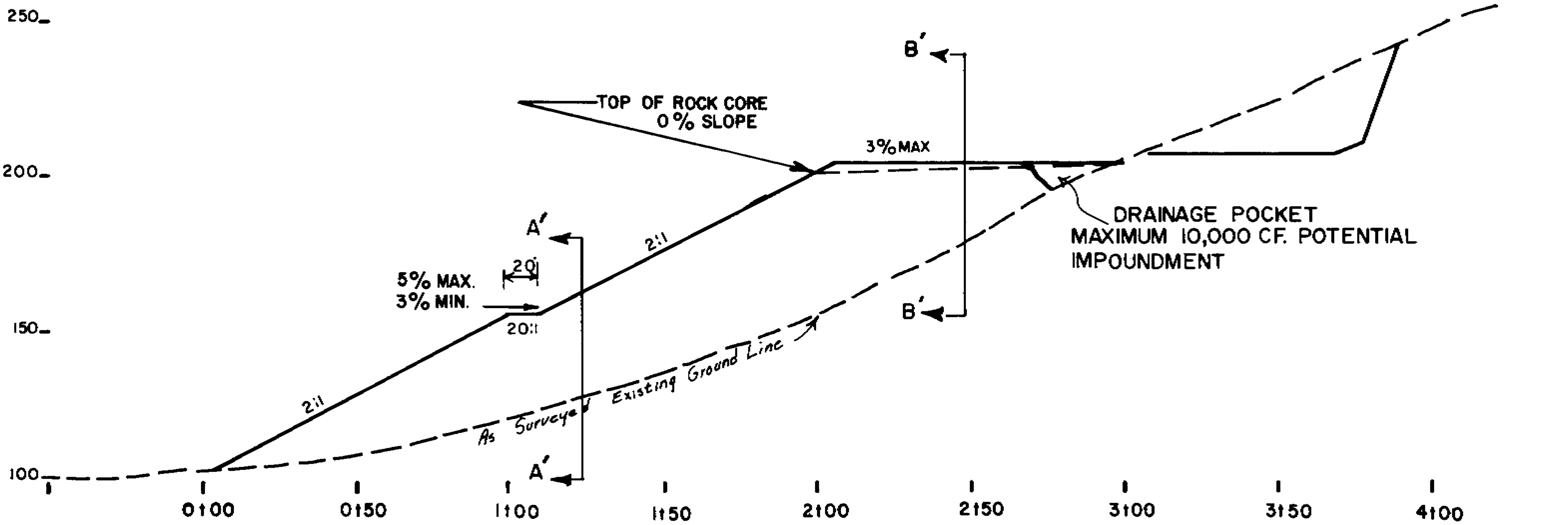
= _______ Cu. Ft.

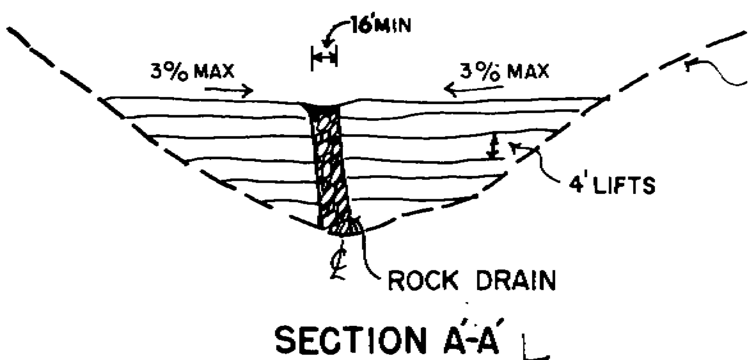
APPENDIX IV

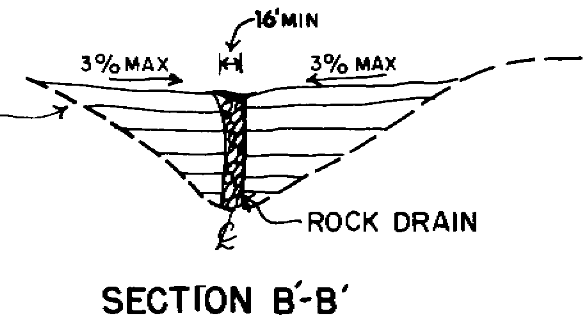
SAMPLE DESIGN OF VALLEY FILL

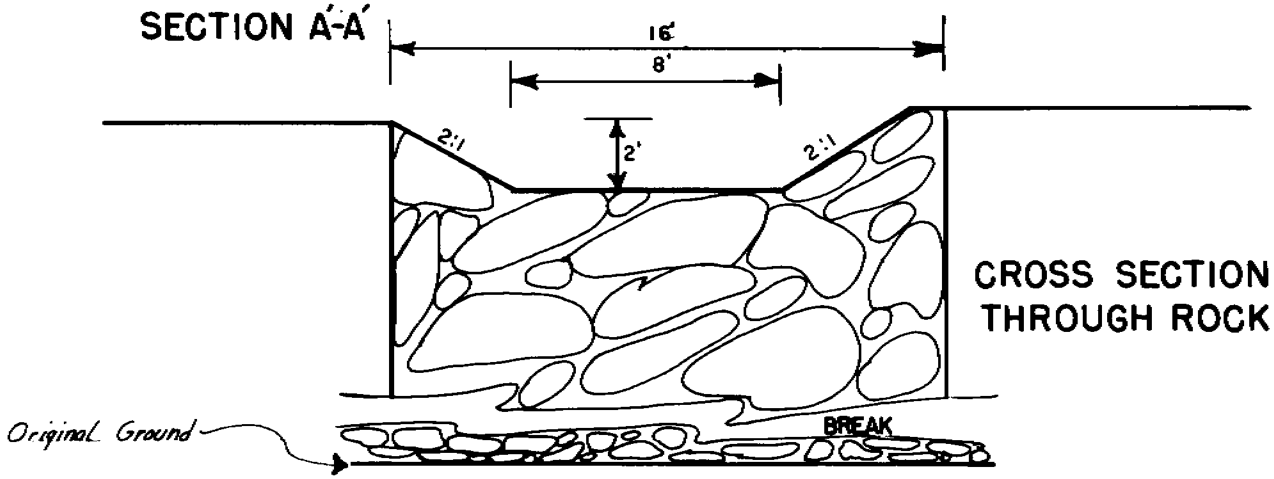


THREE DIMENSIONAL SKETCH OF VALLEY FILL


250
200
150
100
TOP OF ROCK CORE
0 % SLOPE
3% MAX
B′
B′
A′
A′
DRAINAGE POCKET
MAXIMUM 10,000 CF. POTENTIAL
IMPOUNDMENT
5% MAX.
3% MIN.
20′
20:1
2:1
2:1
As Surveyed Existing Ground Line
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
4+00


16′ MIN
3% MAX
3% MAX
4′ LIFTS
ROCK DRAIN
SECTION A′-A′


As Surveyed Existing Ground Line
16′ MIN
3% MAX
3% MAX
ROCK DRAIN
SECTION B′-B′


16′
8′
2′
2:1
2:1
CROSS SECTION
THROUGH ROCK
BREAK
Original Ground

LEGEND

- TOTAL DRAINAGE AREA AFFECTED - 619.8 AC
- TOTAL DISTURBED AREA - 127.3 AC
- DRAINAGE AREA DIVISION
- NATURAL DRAINWAY
- CONSTRUCTED DRAINWAY (DIVERSION DITCH IF BELOW TOE OF SPOIL OR ABOVE HIGHWALL)
- SEDIMENT DAM (EMBANKMENT, GABION, OR CONCRETE CRIB TYPE)
- EXCAVATED POND
- LOG & POLE SILT STRUCTURE
- STONE CHECK DAM
- WATER TEST SITE
- ROCK RIP RAP
- PIPE CULVERTS

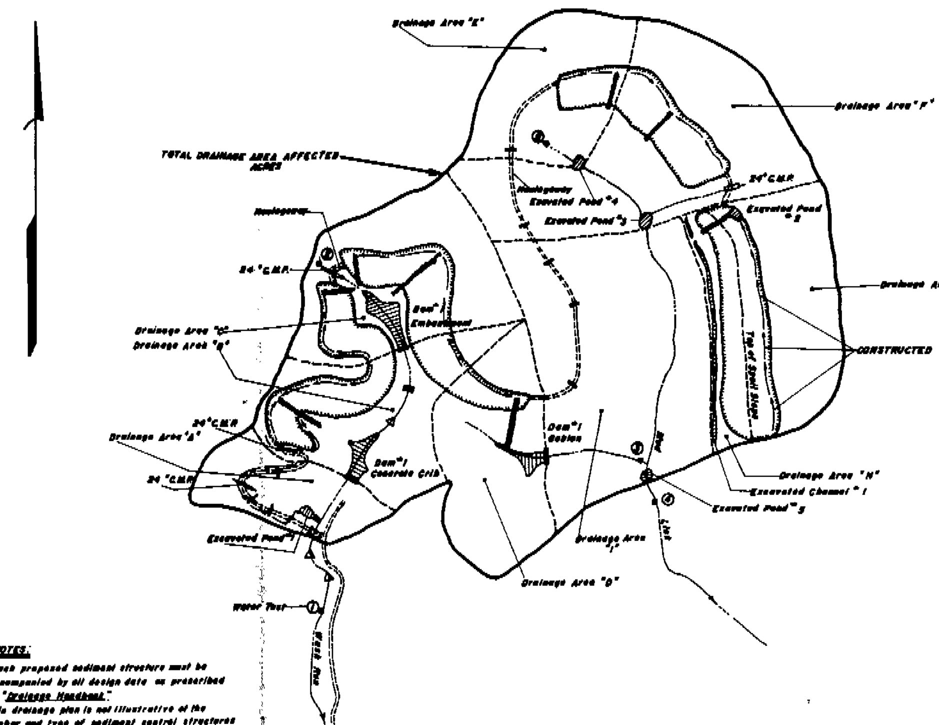
COMPONENT DRAINAGE AREAS

Drainage Area	Acres	Acres Disturbed
"A"	34.4	3.4
"B"	66.7	23.8
"C"	78.4	30.4
"D"	60.8	7.1
"E"	53.4	8.5
"F"	112.5	18.4
"G"	63.5	16.7
"H"	23.8	16.7
"I"	126.3	2.3
TOTALS	619.8	127.3

WATER TEST RESULTS

Test No.	pH	Iron	Turbidity (Jackson Units)
1	7.0	10	150 J.U.
2	6.9	10	130 J.U.
3	6.2	7	100 J.U.
4	6.5	12	175 J.U.
5	6.7	10	150 J.U.

Sediment Control Structure	Total Contributing Drainage Area To Structure. AC	Disturbed Acreage Controlled By Structure. Acres	Required Storage Capacity
Embankment Dam 1	78.4	30.4	3.8 AC-FT
Concrete Crib Dam 1	145.1	23.8	3.0 "
Gabion Dam 1	60.8	7.1	0.9 "
Excavated Pond # 1	34.4	3.4	0.4 "
" " # 2	63.5	16.7	2.1 "
" " # 3	165.9	18.4	2.3 "
" " # 4	53.4	8.5	1.1 "
" " # 5	440.5	2.3	0.3 "
" Channel # 1	23.8	16.7	2.1 "
	TOTALS	127.3	18.0 "



NOTES:

Each proposed sediment structure must be accompanied by all design data as prescribed in "Drainage Handbook."

This drainage plan is not illustrative of the number and type of sediment control structures that would normally be utilized on one particular permit, but rather, is intended to illustrate the plan presentation of each type structure.

The drainage plan has been reduced for illustrations.

All pipe culverts not designated any particular size to have minimum size opening of 100 sq. inches.

RECEIVING STREAM — BUCKHANNON RIVER

SEAL OF REGISTERED ENGINEER

PROPOSED DRAINAGE PLAN

JOHN DOE COAL COMPA

DOE NO. 1 OPERATIO

BUCKHANNON DISTRICT UPSH

APRIL 30, 1971 SCAL

L. B. WILSON

Registered Professional Engineer

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