NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

SCOPE

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel. It does not apply to structures designed to control the rate of flow or to regulate the water level in channels, Structure for Water Control (587).

PURPOSE

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

DESIGN CRITERIA

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting, grading may be necessary.

Design criteria is provided for embankment dams, full-flow open structures, island type structures and side inlet drainage structures. Select the type of structure which fits the site conditions and use the appropriate design criteria.

Embankment dams. Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 feet in overall fill height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60). See Section 520.22, National Engineering Manual, for definition of classes of dams.

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an overall height of 35 feet or less shall meet or exceed the requirements specified for Pond (378), except as modified in this standard.

The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no auxiliary spillway, the top of dam is the upper limit. Overall height is the difference in elevation in feet between the low point in the top of dam and the lowest elevation on the downstream toe.

Dams with an overall height of 35 feet or more shall meet the requirements of the Missouri Division of Geology and Land Survey (DGLS) Dam and Reservoir Safety Program.

The minimum capacity of the principal spillway and auxiliary spillway shall be that required to pass the peak flow expected from the design storms of the frequency and duration shown in Table 1, less any reduction for creditable detention storage.

An auxiliary spillway must be provided for each dam or the principal spillway made large enough to pass the auxiliary spillway minimum design storm. Where there is no auxiliary spillway, the minimum cross sectional area of the conduit shall be 3 sq. ft. and at least 1 foot of freeboard will be added to determine the minimum top of dam elevation.

An exception to criteria in Table 1 are grade stabilization structures with overall height of less than 10 feet and 10-year frequency, 24-hour storm runoff less than 10 acre-feet These structures shall be designed to control the 10-year frequency storm without overtopping. An auxiliary spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm. The embankment and mechanical spillway may be designed to meet the requirements for Water and Sediment Control Basin (638) rather than the requirements for Pond (378).

A suitable trash rack, as needed, is required to prevent the conduit from plugging and for safety. Drop inlets shall have trash racks or guard rails to prevent accidental injury to livestock and humans. This may be accomplished by using a horizontal antivortex baffle, trash rack or guard rail.

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the National Engineering Handbook (NEH) Part 650, Engineering Field Handbook for Conservation Practices; the National Engineering Handbook; and other applicable NRCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any creditable reduction for detention storage. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure stable reentry of bypassed storm flows into stream channel.

Toe wall drop structures can be used if the vertical drop is 4 feet or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The capacity of drop boxes associated with road culverts shall be large enough to pass the greater of the flows shown below, less any reduction for creditable detention storage:

1. Flow from the total capacity storm shown in the applicable table or flow equal to the present culvert capacity with water at the surface of the road, whichever is less.
2. Flow required by the responsible road authorities.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel flowing full or the 2-year, 24-hour storm or the design drainage runoff curve, whichever is greater. The minimum auxiliary spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 or Table 3 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provisions must be made for safe reentry of bypassed flow into stream channel as necessary.

Side-inlet drainage structures The design criteria for pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 3.

The structure should be a component of a water management plan. Other components may include Surface Field Ditch (607), Surface Main or Lateral (608), Structure for Water Control (587), or Irrigation Land Leveling (464). The crest of the spillway must be set at an elevation that stabilizes upstream headcutting and provides adequate surface drainage for the drainage area.

Embankment side slopes shall be 3:1 or flatter on the upstream field side slope and 2:1 or flatter on the downstream side slope. Back slope may be steeper in order to match the existing receiving ditch side slope if it can be shown that the slope will be stable.

Conduits for pipe structures shall have a minimum diameter of 4 inches if a suitable trash rack is included and 15 inches if no trash rack is included and the drainage ditch is not likely to transport debris that would clog the inlet.

The conduit shall have a positive slope towards the outlet after consolidation occurs to ensure free drainage through the conduit. The conduit shall extend at least 1 foot beyond the downstream toe of the fill except that the conduit may extend less than 1 foot beyond the side slope of the embankment fill where it exits the slope if required to limit interference with normal operation and maintenance of the receiving channel. The

invert of a pipe outlet shall be located between 0.5 and 1.0 feet above the normal static water level in the outlet channel or a maximum of 1 foot above the channel bottom if the receiving channel is normally dry.

Cantilevered pipe outlets shall have pipe supports provided if the pipe strength is not sufficient to withstand the cantilever loading.

Where ditches flow bank full and design tailwater elevations are difficult to determine, then full pipe flow with 0.5 foot design head and submerged outlet conditions shall be used to determine structure capacity. The tables shown in the Missouri Supplements to the National Engineering (NEH) Part 650, Engineering Field Handbook, Chapter 3 may be used to determine capacity of structures using pipe spillways.

The flow capacity of a weir box inlet will be designed to equal or exceed the flow capacity of the pipe with a maximum water depth over the weir of 0.5 foot with the stoplogs installed to the planned stabilization elevation. Design must evaluate the buoyant forces acting on the inlet and pipe.

Smooth steel pipe may be used in any soil type and inlet configuration. Corrugated metal pipe (CMP) may be used in any soil but must be polymer coated when installed in soils that are rated moderate and high for risk of corrosion for uncoated steel; and CMP may not be used where weir box inlets are installed or may be installed in the future. Refer to the “Soil and Water Features” table in the appropriate Soil Survey for the county to determine the risk of corrosion.

An anti-seep collar shall be used on pipe structures installed in soils classified as SM according to the Unified Soil Classification System or in any soils that have demonstrated past seepage and washout failures. When needed, anti-seep collars shall be installed around the pipe conduit in the normal saturation zone.

Anti-seep collars and their connections to the pipe shall be watertight. The collar material shall be compatible with the pipe materials. The maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but shall not exceed 25 feet. Minimum collar projection is 1.0 foot. For design considerations, see Missouri supplement to the National Engineering Handbook (NEH) Part 650, Engineering Field Handbook.

If a side-inlet drainage structure outlets into a channel controlled by a legal drainage district, the top width of the embankment shall be that required by the legal drainage district or Pond Standard (378), whichever is greater.

The minimum length of the embankment fill to either side of the structure pipe shall be 3 times the total height of the fill or 10 feet which ever is greater. The elevation of the top of the settled fill shall meet the following criteria:

1. For structures on flat land where storage and/or auxiliary overflow width are unlimited, the top of fill shall be the highest of:
   a. 1 foot above the crest of the riser,
   b. 1 foot above the top of the conduit at the inlet,

      or,

   c. 0.5 foot above the elevation of the unlimited overflow area
2. For structures where the auxiliary overflow width is limited or where an auxiliary spillway is constructed, the top of the settled fill shall be at least 1 foot above the auxiliary spillway elevation.
3. For structures located in a permanent water management levee for a field, the minimum elevation of the settled fill at the structure shall be the top elevation of the existing field levee.

In all cases the depth of soil cover over the top of the conduit shall meet the requirements of National Engineering Handbook Part 650 (EFH) Chapter 14, MO-14-27 Appendix A.

Drainage gates shall be installed when required by state or local units of government. The connection of the gate frame to the pipe shall be watertight and compatible with the type of pipe used. Pipes with drainage gates shall be located so water current or debris will not affect the gate operation.

Structures shall have a stable outlet condition in the receiving ditch or channel. Additional outlet structures, devices or armoring may be required.

Structures that drain into a public roadway or drainage district ditch must have the written concurrence of the appropriate entity.

Landscape resources. In highly visible public areas and those associated with recreation, careful consideration should be given to landscape resources. Landform, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflectiveness and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

General criteria. Earth embankment and auxiliary spillways of structures for which criteria are not provided under the standard for Pond (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, the mechanical spillway plus auxiliary spillway must be designed to handle the total capacity flow indicated in Tables 1, 2 or 3 plus 1 foot freeboard above maximum water surface. Discharge from the structure shall be sufficient that no crop damage results from flow detention. The foundation preparation, compaction, top width, and side slopes shall meet the requirements specified for Pond (378) or Water and Sediment Control Basin (638) as applicable.

Conduits shall meet the requirements specified for Pond (378) or Water and Sediment Control Basin (638) as applicable. The pipe materials used shall be commensurate with the intended design life of the structure.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

The earth embankment structures are potentially hazardous and safety precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed. Fence materials and fence installation shall be as outlined in the standards and specifications for Conservation Practice Fence (382).

If the structure has a permanent pool and the adjacent area is used for grazing or open to livestock, the pool area, earthfill, and vegetated spillways shall be fenced to exclude livestock. Where watering ramps are constructed to provide access to water in the pool, the fence shall permit livestock access to the ramp area only. When near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

Vegetation. Vegetation shall be established on all dams, channel slopes, berm, spoil, and other disturbed areas according to the NRCS standards for Critical Area Planting (342). Side inlet structures installed where farming practices (such as rice fields) or drainage ditch maintenance prevents the establishment of permanent vegetation, the structure does not require seeding.

On sites located in cropland a minimum 50 foot wide strip of vegetation shall be installed around pool to filter out sediment.

PLANS AND SPECIFICATIONS

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

Drawings and general construction specifications shall be provided to the landowner or representative with sufficient copies for the contractor. Detailed construction specifications shall be prepared for the more complex sites. National guide specifications in NRCS handbooks shall be utilized in preparing these specifications. Missouri Construction Specification 378-A applies to dams associated with grade stabilization structures, 378-B applies to principal spillway conduits through embankment dams, 410-A applies to small full flow grade stabilization structures with fill height of 10 feet or less, and 410-B applies to grade stabilization structures in drainage systems.

OPERATION AND MAINTENANCE

The following University of Missouri Agricultural Guide provides information on operating and maintaining structures with embankment dams:

1548 “Maintaining Small Dams

”

Table 1

Minimum design capacity of principal and auxiliary spillways
for embankment dams used for grade stabilization structures.

This standard does not apply to sites with overall dam height more than 35 feet.

Drainage Area (Acres)	Effective Height of Dam (Feet)	Storage 1/ (Acre-Ft)	Condition of Vegetated Spillway 2/	Principal Spillway Minimum Design Storm Frequency 3/ (Years)	Auxiliary Spillway Minimum Design Storm Frequency 3/ (Years)
20 or less	20 or less	Less than 50	Good	1	10
			Fair or Poor	2	
	Greater than 20	Less than 50	All	2	25
21 to 100	20 or less	Less than 50	Good	1	25
			Fair	2	
			Poor	5	
	Greater Than 20	Less than 50	Good	1	50
			Fair	5	
			Poor	10	
101 to 200	20 or less	Less than 50	Good	1	25
			Fair	2	
			Poor	5	
	Greater Than 20	Less than 50	Good or Fair	5	50
			Poor	10	
201 to 400	20 or less	Less than 50	Good	2	25
			Fair or Poor	5	
ALL OTHERS (WITH OVERALL HEIGHT 35 FEET OR LESS)				10	50

1/ Total storage below crest of auxiliary spillway or top of dam if an auxiliary spillway is not provided.

2/ Good, Fair, and Poor describe condition from end of constructed auxiliary spillway to main channel or gully downstream from the dam.
Good - Stable, uniform grade from spillway exit to outlet channel, good sod.
Fair - Uniform grade with small drops, good sod; or uniform grade with small drops, fair vegetation, and shrubby banks.
Poor - Steep grades or raw gully banks, sparse vegetation.

3/ Type II, 24-hour duration.

Table 2

Minimum capacity for Full Flow Drop Spillways, Chute Spillways,

Box Inlet Drop Spillways and Toe Wall Drop Structures

Drainage Area (acre)	**Vertical Drop** (feet)	**Minimum Frequency** 1/	
		Structural Spillway Capacity (years)	**Total** 2/ **Capacity** (years)
250 or less	5 or less	5	10
500 or less	10 or less	10	25
All others		25	100

1/ Type II, 24-hour duration.

2/ Structure may carry total capacity.

Table 3

Minimum capacity for side inlet drainage structures

To be used where overflow can spread out and the structure, including pipe drop and hood inlets, carries only the flow delivered to it by the channel.

Drainage Area (acre)	Vertical Drop (feet)	Principal Spillway Capacity (cfs)	Total Capacity Frequency 1/2/ (years)
250 or less	5 or less	Design Drainage Curve 3/	---
450 or less	10 or less	Design Drainage Curve 3/	10
900 or less	10 or less	Design Drainage Curve 3/	25
All Others		Larger of : (a) Design Drainage Curve 3/ or (b) Bank Full Channel Capacity	50

1/ Capacity of principal spillway plus auxiliary spillway without overtopping structure. This requirement will be met without floodrouting on flat land where for all practical purposes storage is unlimited and top of settled fill meets requirements in this specification.

2/ Type II, 24-hour duration.

3/ Refer to NRCS standards, "Surface Drainage" (607) or "Main or Lateral" (608) for appropriate curve.

NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION

FOR

GRADE STABILIZATION STRUCTURE

DROP INLET, BOX INLET AND CHUTE SPILLWAYS

(410-A)

General

Construction operations shall be carried out in a manner and sequence that erosion and air and water pollution are minimized and held within legal limits.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

Site preparation

All trees, stumps, brush, and similar materials are to be removed from the construction area and disposed of in a manner consistent with environmental concerns and proper functioning of the structure. Topsoil shall be conserved if needed.

Materials

Materials required and fabrication details shall be as specified on the drawings and as shown below.

Concrete and reinforcing steel shall conform to Construction Specification 750.

Rock riprap and bedding shall be sound, durable rock conforming to gradation shown on drawings. Geotextile may be used in lieu of riprap bedding. Timber, metal, concrete blocks, and drain materials shall be as shown on the drawings.

Geotextile fabric shall be non-woven, needle punched conforming to the following requirements:

Tensile strength ----------120 lbs min
Bursting strength ----------210 psi min
Elongation at failure ---------- 50% min
Ultraviolet resistance ---------- 70% tensile strength retained
Puncture----------60 lbs min
AOS-Standard sieve opening ----#40 to #70
Permittivity----------0.70/sec

Excavation

To the extend needed, all suitable materials removed from the specified excavation shall be used in the construction of the earth fill areas of the structure. All spoil material deposited adjacent to the structure shall have a positive grade to drain to a stable outlet.

Earthfill placement

The material placed in the fill shall be free of detrimental amounts of sod, frozen soil, stone over 6 inches in diameter (except for rock fills) and other objectionable material. To the extent they are suitable, excavated materials are to be used in the permanent fill. The distribution, moisture content, and gradation of materials 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. Foundation areas shall be kept free of standing water when fill material is being placed on them.

The placing and spreading of the fill shall be started at the lowest point of the foundation and the fill shall be brought up in approximately horizontal layers not to exceed 9 inches in thickness. Each layer shall be spread, processed, and shall be compacted by one of the following methods, as specified on the drawings:

Dozer - Complete coverage by tread or track of hauling or spreading equipment. Each lift shall not exceed 5 inches in thickness.

Roller - two passes of standard tamping type roller over the entire area to be compacted. Complete coverage by the treads of loaded

hauling equipment is considered equivalent to two (2) passes of tamping roller. Each lift shall not exceed 9 inches in thickness.

The tamping-type roller shall have tampers or feet projecting not less than six (6) inches from the surface of the drum and shall have a minimum static load on each tamper of 250 pounds per square inch of tamping area. Tamping rollers with minimum static load on each tamper of 125 pounds per square inch of tamping area may be used if the number of passes is increased to four (4) or the thickness of lifts is reduced to four (4) inches. (Sheepsfoot or wedgefoot drum rollers are considered tamping rollers.)

Embankment shall be constructed to the lines and grades shown on the drawings.

Finish shall be smooth, uniform, and ready for seedbed preparation.

Moisture control

The moisture content of the fill material and foundation shall be such that the required compaction can be obtained. The minimum moisture content of fill material and foundation shall be such that when kneaded in the hand, the fill material will form a ball which does not readily separate. The maximum moisture content is when conditions are too wet for efficient use of the hauling and compaction equipment.

Finish and cleanup

The disturbed area and the designated spoil areas will be finished in a relatively smooth condition ready for seeding. All rocks 3 inches in diameter or larger and roots shall be removed from the surface areas prior to seeding.

Vegetation

Topsoil shall be added, if needed, to establish vegetation. Refer to JS-AGRON-25 for seeding and mulching recommendations or equivalent.

Additional Details: _____

_____

_____

_____

_____

_____

_____

NATURAL RESOURCES CONSERVATION SERVICE

OPERATION AND MAINTENANCE

FOR

GRADE STABILIZATION STRUCTURE

DROP, DROP INLET, BOX INLET AND CHUTE SPILLWAYS

(410-A)

A maintenance program shall be established by the land user to maintain capacity and vegetative cover. Items to consider are as follows:

1. Do not graze seeded areas during establishment and when soil conditions are too wet.

2. Protect structure from damage by farm equipment and vehicles.

3. Maintain structure inlet and outlet areas free of any obstructions.

4. Repair structure as soon as possible after damage is noted.

5. Reestablish vegetative cover immediately where erosion has removed established seeding.

6. Maintain effective erosion control of the contributing watershed to prevent siltation and the resulting loss of capacity.

Additional Details: _____

_____

_____

_____

_____

_____

_____

PAGE LEFT BLANK ON PURPOSE

NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION

FOR

GRADE STABILIZATION STRUCTURE

LOW HEAD WATER CONTROL STRUCTURES

(410-B)

Use this construction specification for full flow structures and for surface drainage structures with fill heights of 10 ft or less.

General

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution are minimized and held within legal limitations. Construction methods that enhance fish and wildlife will be used where practical. Trees stumps, and brush removed from the construction area may be piled for fish and wildlife habitat when approved by the landowner.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

Foundation preparation

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod and rubbish. A minimum 3 inches of topsoil and sod shall be stripped from foundation area. Existing ditch channels crossing the foundation area shall be sloped 1 1/2:1 1:1 or flatter and made deeper and wider as necessary to remove unconsolidated sediment, stumps, roots, and other objectionable material and to accommodate compaction equipment.

Excavation

To the extent needed, all suitable materials removed from the specified excavation shall be used in the construction of the earth fill. All spoil material deposited adjacent to the structure shall have a positive grade to drain to a stable outlet.

Materials

Materials required and fabrication details shall be as specified on the drawings and as shown below.

Concrete and reinforcing steel shall conform to Construction Specification 750.

Rock riprap and bedding shall be sound, durable rock conforming to gradation shown on drawings. Geotextile may be used in lieu of riprap bedding. Metal, concrete blocks, and drain materials shall be as shown on the drawings.

Treated lumber shall be No. 2 grade or better, pressure treated with 0.4 pounds per cubic foot of Copper Chromate Arsenate (CCA) or equivalent. All other lumber shall be as shown on drawings.

Geotextile fabric shall be non-woven, needle punched conforming to the following requirements:

Tensile Strength.....120 lbs min
Elongation at failure.....50% min
Ultraviolet resistance.....70% tensile
Bursting strength..... .....210 psi min
strength retained
Puncture.....60 lbs min
AOS-Standard sieve opening.....#40 max
Permitivity.....0.70/sec

Corrugated metal pipe shall conform to the requirements of ASTM A760, A762, A885, B745, or B790 as appropriate. Plastic pipes through a dam shall be polyvinyl chloride pipe, PVC 1120 or 1220 conforming to ASTM D1785, ASTM D2241, AWWA C900 or equivalent. The SDR or DR of PVC pipe shall be 26 or less for fill heights 10 feet or less.

Corrugated tubing shall be polyethylene heavy duty tubing conforming to ASTM F405 or equivalent. Welded steel pipe shall be new, new reject, or high quality used pipe. Anti-seep collars shall be of materials compatible with the pipe.

Installation

Pipe conduits shall be placed on a firm foundation to the lines and grades shown on the drawings. Installation shall be conducted in a skillful and workmanlike manner.

Anti-seep collars are to be installed at locations shown on the drawings with watertight connections. The pipe foundation shall be covered with 1 inch of loose, moist, friable ML or CL soil material immediately prior to pipe placement.

Selected backfill of friable ML or CL material shall be placed around structures, pipe conduits and anti-seep collars at approximately the same rate on all sides to prevent unequal pressures. Water packing is permitted for conduits 36 inches or less in diameter. Rubber tire, hand, or manually directed power tamper will be used on backfill around all conduits or structures where water packing is not permitted or used. A maximum of 4 inches lifts shall be used for hand compaction and 6 inches lifts for rubber tired and manually directed power tampers. Extreme caution must be exercised in backfill and compaction around structures or conduits to prevent damage, movement or deflection. Compaction on the bottom half of conduits must be firm to fill all voids and supply lateral support. Light weight conduits may need to be held in place to prevent uplift during compaction.

Equipment shall not be operated over any structure or conduit until there is sufficient backfill to prevent damage. This minimum cover is 3 feet for PVC pipe.

If coated CMP is to be used, it shall be handled in such manner as to avoid damage to the coating. All damaged areas of the pipe coating shall be repaired in accordance with the manufacturer's recommendations.

Earthfill placement

The material placed in the fill shall be free of detrimental amounts of sod, frozen soil, stone over 6 inches in diameter (except for rock fills) and other objectionable material. To the extent they are suitable, excavated materials are to be used in the permanent fill. The distribution, moisture content, and gradation of materials 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. Foundation areas shall be kept free of standing water when fill is being placed on them.

The placing and spreading of the fill shall be started at the lowest point of the foundation and the fill shall be brought up in approximately horizontal layers not to exceed 9 inches in thickness. Each layer shall be spread, processed, and shall be compacted by one of the following methods, as specified on the drawings:

Dozer - Complete coverage by tread or track of hauling or spreading equipment. Each lift shall not exceed 5 inches in thickness.

Roller - two passes of standard tamping type roller over the entire area to be compacted. Complete coverage by the treads of loaded hauling equipment is considered equivalent to two (2) passes of tamping roller. Each lift shall not exceed 9 inches in thickness.

The tamping-type roller shall have tampers or feet projecting not less than six (6) inches from the surface of the drum and shall have a minimum static load on each tamper of 250 pounds per square inch of tamping area. Tamping rollers with minimum static load on each tamper of 125 pounds per square inch of tamping area may be used if the number of passes is increased to four (4) or the thickness of lifts is reduced to four (4) inches. (Sheepsfoot or wedgefoot drum rollers are considered tamping rollers.)

Embankment shall be constructed to lines and grades shown on the drawings. Finish shall be smooth, uniform, and ready for seedbed preparation.

Moisture control

The moisture content of the fill material and foundation shall be such that the required compaction can be obtained. The minimum moisture content of fill material and foundation shall be such that when kneaded in the hand, the fill material will form a ball which does not readily separate. The maximum moisture content is when conditions are too wet for

efficient use of the hauling and compaction equipment.

Borrow areas

All borrow areas shall be graded and left so they are well drained, protected from erosion, and may be seeded. Borrow areas inside the pool area shall have side slopes of 2:1 or flatter.

Drainage gates

Drainage gates, when specified on the drawings, shall be installed without distorting the flange or damaging the gate or seat. The connection shall be water tight and the gate shall close tightly and operate freely in all positions.

Vegetation

Topsoil shall be added, if needed, to establish vegetation. Refer to JS-AGRON-25 for seeding and mulching recommendations or equivalent.

Additional Details: _____

_____

_____

_____

_____

_____

_____

PAGE LEFT BLANK ON PURPOSE

NATURAL RESOURCES CONSERVATION SERVICE
OPERATION AND MAINTENANCE

FOR

GRADE STABILIZATION STRUCTURE

LOW HEAD WATER CONTROL STRUCTURES

410-B

Operation and Maintenance

The following University of Missouri Agricultural Guide provides information on operating and maintaining structures with embankment dams:

1548 "Maintaining Small Dams"

Additional Details: _____

_____

_____

_____

_____

_____

_____