

PART 00300 - ROADWORK

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Section 00310 - Removal of Structures and Obstructions

Description

00310.00 Scope - This work consists of removing and disposing of man-made materials and cleaning up areas they occupy. See Section 00501 for removal of bridges..

00310.01 Areas of Work - Perform removal work in the same areas as specified in 00320.01.

If a building to be removed lies partly within the right-of-way, remove the entire building unless otherwise shown or directed.

00310.02 Exclusions - Removal work does not include removal or disposal of materials which are:

- Designated to remain.
- Included in earthwork as given in 00330.41.
- Specifically indicated by the Specifications, plans, or Special Provisions to be removed incidental to other items of work under the Contract.
- Owned or controlled by third parties.

Construction

00310.40 Restrictions on Removal Work:

(a) Guardrail, Median Rail, and Concrete Barrier - In those areas where guardrail, median rail, or concrete barrier are to be removed and replaced with new or salvaged rail or barrier, do one of the following:

- Install the new or salvaged units the same working shift the existing unit is removed.
- Protect the area with temporary, precast concrete barrier units with appropriate end treatment satisfactory to the Engineer, until the new or salvaged unit is installed.

(b) Milepost Markers - Throughout construction, protect and maintain all milepost markers affected by the work at locations visible to the traveling public. This may require removing and relocating the milepost markers to maintain visibility throughout construction. When construction is completed, reinstall the milepost markers in their original location in a manner satisfactory to the Engineer, unless new milepost markers are to be installed according to Section 00840.

00310.41 Removal Work:

(a) General - Where an abutting structure or part of a structure is to be left in place, make clean, smooth, vertical cuts with a saw or other approved cutting device. Avoid operations that may damage any portion of the remaining structure.

(b) Guardrail Posts - Remove posts completely and backfill holes with selected granular backfill material meeting the requirements of 00330.14.

(c) Drainage Structures - Remove drainage structures, such as box culverts, down to a depth 2 feet below ground, slope or waterway bed. Remove culverts, sewers, siphons, and other conduits according to 00330.41(a-7).

(d) Materials Within Construction Areas:

(1) General - Remove materials within construction areas entirely or break down the materials to an elevation at least 2 feet below subgrade or slope surface as allowed below.

(2) Bituminous Treated Surfaces - Scarify and break up existing bituminous treated surface when it lies under subgrade and is not salvaged. Incorporate the scarified material into the embankment. Pieces of existing pavement shall not exceed 15 inches in any dimension.

(3) Concrete Floors, Slabs and Walls - Before placing material in basements or over concrete slabs, remove or break through the floors, slabs, and walls so no fragments of the floors, slabs, and walls have a dimension in excess of 15 inches and there is no protruding reinforcement.

(e) Materials Outside of Construction Areas - Remove materials which lie outside of construction areas to an elevation at least 2 feet below the surface elevation to which the affected area is to be finished.

00310.42 Salvaging Drainage Structure Fittings - Metal grates, frames, rings, covers, and other metal fixtures or fittings for drainage structures may be salvaged and used on new structures if the Engineer determines they are reusable.

00310.43 Disposal of Material - Dispose of materials according to 00290.20(c).

00310.44 Earthwork in Connection with Removal - Excavation required to perform removal of structures and obstructions will be considered incidental to the removal work, unless it is within the measurement limits for an excavation Contract pay item.

Backfill holes according to 00330.45. The backfill will be measured for payment according to 00330.82, when there is an embankment measure basis pay item for earthwork and that material is used for backfilling, otherwise no separate payment will be made for this work.

Maintenance

00310.60 Repair of Damages - Repair promptly any breakage or damage to materials or items not intended to be removed. Complete replacement of the affected materials may be required if the Engineer determines it is necessary. Make all repairs and replacements at no additional cost to the Agency.

Measurement

00310.80 Measurement - The quantities of removal of structures and obstructions work performed under this Section will be measured according to the following:

- **Lump Sum Basis** - Under this method, no measurement of quantities will be made.
- **Separate Item Basis** - Under this method, the quantities of work performed on a separate item basis will be measured as follows:
 - **Length and Area** - The length or area of the structure or item actually removed, will be measured along the line and grade of the structure or item for each continuous structure or item removed. Measurement will be on the length or area basis, limited to the neat lines shown or directed.
 - **Each** - Items will be measured on a unit basis of units removed.

Payment

00310.90 Payment - The accepted quantities of work done under this Section will be paid for at the lump sum basis or separate item basis according to 00310.91 and 00310.92 as applicable.

Payment will be payment in full for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for barriers used for temporary protection where guardrail, median rail, or concrete barriers have been removed.

No separate or additional payment will be made for protecting and maintaining milepost markers and reinstall them at their original location.

When the Contract Schedule of Items does not indicate payment for work performed under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this work is required.

00310.91 Lump Sum Basis - The accepted quantities of removal work done on a lump sum basis will be paid at the Contract lump sum amount for the following items:

Pay Item	Unit of Measurement
(a) Removal of Structures and Obstructions	Lump Sum
(b) Removal of _____	Lump Sum

Item (a) includes all removal work done on a lump sum basis, except as covered under pay items given in the form of (b).

In item (b), the specific kind or description of removal work will be inserted in the blank.

00310.92 Separate Item Basis - The accepted quantities of removal work done on a separate item basis will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Removal of Pipes	Foot
(b) Removal of Curbs	Foot
(c) Removal of Walks and Driveways.....	Square Yard
(d) Removal of Surfacing.....	Square Yard
(e) Removal of Inlets	Each
(f) Removal of Manholes	Each

Item (d) includes the removal of all surfacings, except for walks and driveways, as defined in 00110.20 under "Existing Surfacing".

Section 00320 - Clearing and Grubbing

Description

00320.00 Scope - This work consists of removing and disposing of vegetation and buried matter within a specified area or as directed. The work also includes preserving vegetation and objects designated to remain in place and cleanup of the work area.

00320.01 Areas of Work - The areas to be cleared and grubbed are shown on the plans, or if not shown on the plans, the clearing lines are 10 feet outside the following:

- Top of side slopes of ditches and channel changes.
- Top of cut slope.
- Top of cutbank rounding if rounded.
- Toe of fill slope.
- Outside edge of structure.
- Other work areas shown on the plans, such as material sources, borrow areas and road connections.
- Tree, plant, or natural areas to be preserved.

00320.02 Definitions:

(a) Clearing - Clearing consists of:

- Preserving trees and other vegetation designated to remain in place.
- Salvaging marketable timber, when required by the Special Provisions.
- Cutting and removing vegetation, such as weeds, grasses, crops, brush, and trees.
- Removing down timber and other vegetative debris.

(b) Grubbing - Grubbing consists of removing:

- Brush stems remaining above the ground surface after the clearing work.
- Tree stumps.
- Roots and other vegetation found below ground surface.
- Partially buried natural objects.

(c) Clear Zone - The clear zone is the roadside border area, starting at the edge of the traveled way, available for safe use by an errant vehicle. The minimum clear zone line, for purposes of this Section, is 30 feet from the edge of the traveled way, but this distance may vary depending on design speed, horizontal alignment and side slope requirements.

Construction

00320.40 Clearing Operations:

(a) Clearing Trees and Other Vegetation - Remove and dispose of noxious weeds and Specified Weeds according to Section 01030 prior to beginning clearing of trees and other vegetation.

Cut trees and brush so they fall into the areas specified to be cleared.

Cut off tree stumps, not required to be grubbed under 00320.41 as follows:

- Flush with the ground surface if within the clear zone.
- No higher than 4 inches above the ground surface if between the clear zone and the clearing line.

Remove all evidence of clearing matter and debris. This work includes removal of:

- Sod, weeds and dead vegetation.
- Down timber, brush and other vegetation.
- Sticks and branches with diameters greater than 1/2 inch.
- Dead trees, down timber, stumps, and specified trimmings from areas where live trees and other vegetation are designated to remain.

(b) Preserving and Trimming Vegetation:

(1) Within the Work Areas - Avoid injuring vegetation designated to remain in place. Preservation of this vegetation includes protection and special care.

(2) Outside the Work Areas - Avoid injuring any vegetation. Confine operations which may injure vegetation to areas that have no vegetation or to the work areas.

Remove hazardous, dead and damaged trees outside the clearing limit as directed.

(3) Tree Trimming - Trim trees according to good tree surgery practices and as directed to remove safety hazards such as:

- Unsound branches of trees to remain in place.
- Branches over roadways and bridges to provide at least 20 feet of clearance above the roadway surface.
- Branches over walks to provide at least 8 feet of clearance above the walk surface.
- Branches obstructing sight distance at intersections or impairing visibility of signs.

Preserving vegetation includes keeping equipment and materials off of the critical root zone as directed.

(4) Trees To Be Saved - When trees are to be saved, the Engineer will identify and mark them. Provide and place orange plastic mesh fencing, from the QPL, around critical root zones of marked trees or tree groups as directed. Do not begin construction activity or move equipment into existing tree areas until the plastic mesh fencing is in place.

Do not work within the critical root zone of marked trees unless written approval is obtained from the Engineer. Be responsible for all damage to or for removal of marked trees. Tree damage will be determined by a certified arborist selected by the Engineer.

00320.41 Grubbing Operations - Within excavation limits, remove tree stumps, roots, and other vegetation to a depth of at least 6 inches below excavation subgrade or sloped surfaces.

Within embankment limits, remove tree stumps, roots, and other vegetation.

00320.42 Disposal of Matter - Dispose of all matter and debris according to 00290.20.

00320.43 Backfilling Holes - Except in areas to be excavated, backfill holes remaining after grubbing operations with clean fill (see 00290.20(c-2)) according to 00330.45.

Measurement

00320.80 Measurement - The quantities of clearing and grubbing work performed under this Section will be measured according to the following:

- **Lump Sum Basis** - Under this method, no measurement will be made.
- **Area Basis** - Under this method, measurement will be the ground surface, limited to the areas shown or directed.

Payment

00320.90 Payment - The accepted quantities of clearing, grubbing, disposal, and cleanup work will be paid for at the Contract lump sum amount or the Contract unit price, per acre, for the item "Clearing and Grubbing".

Payment will be payment in full for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for plastic mesh fencing.

When the Contract Schedule of Items does not indicate payment for work performed under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this work is required.

Section 00330 - Earthwork

Description

00330.00 Scope - This work consists of excavation, ditching, backfilling, embankment construction, grading, leveling, borrow, and other earth-moving work required in the construction of the Project, excepting such work specifically included and provided for as:

- A pay item elsewhere in the Contract Specifications.
- Incidental work in the detailed Specifications for other Contract pay items.

The term "earthwork" will be used as a general term to designate the work included within the scope of this Section.

00330.01 Lines, Grades, and Cross Sections - All earthwork shall conform to the lines, grades and cross sections established.

Roadbed cross sections shall be subject to variation from the typical sections shown on the plans, if directed, to:

- Provide superelevation on curves.
- Take care of special conditions at intersections and elsewhere.
- Balance earthwork quantities.

00330.02 Definitions:

Abandoned Pipes and Miscellaneous Matter - Sewers, pipes, conduits, logs, timbers, concrete and other structures, materials, objects, and matter encountered in the work, excepting only items identified for removal or preservation.

General Excavation - All excavation covered by this Section, except foundation, toe trench, and borrow excavation.

Overbreak - Material beyond and outside of the slope limits established by the Engineer, which becomes displaced or loosened during excavation and is excavated.

Selected Materials - Those materials with pertinent characteristics that are preserved and sorted as directed from specified excavations and handled for specific uses.

Stone Embankment Material - Rock used in specific embankment applications including buttresses, inlays, shear keys, and erosion control applications.

00330.03 Basis of Performance:

(a) General - Except as provided in 00330.00, all earthwork shall be performed on either an excavation basis or on an embankment basis. The basis of performance for each earthwork pay item will be indicated in the Special Provisions and the Contract Schedule of Items.

(b) Excavation Basis - Earthwork performed under this provision including excavation, haul, and embankment construction, unless otherwise specified, will be paid for by excavation measurement. (see 00330.80 and 00330.81)

(c) Embankment Basis - Earthwork performed under this provision, including excavation, haul and embankment construction, unless otherwise specified, will be paid for by embankment measurement. (see 00330.80 and 00330.82)

00330.04 Sources of Borrow:

(a) Agency Furnished Borrow - Use materials obtained from Agency furnished sources lying outside of, separated from and independent of planned roadbed excavations, or other required excavations within the Project limits, only when called for by the Contract or when specifically directed. (see 00330.41(d))

(b) Contractor Furnished Borrow - Unless otherwise specified or directed, all borrow shall be furnished by the Contractor. Sources shall lie wholly outside of and beyond the limits of Agency-controlled lands. Acquire at Contractor's own expense. The provisions of 00160.60 and 00160.80 shall apply.

Materials

00330.10 Selected Materials - When the Contract contains a pay item "Extra for Selected _____ Material", furnish the material from required excavations. The Specifications for the selected materials will be in the Special Provisions, if different than specified in these Specifications. If other provisions of this Section call for selecting or sorting material for various parts of the work, select and sort the materials to meet the directed requirements.

00330.11 Selected Topsoil - Furnish topsoil selected for use according to 00330.10 meeting the requirements of 01040.14.

00330.12 Borrow Material - Furnish borrow materials for general embankment construction with soil that is free of unsuitable materials or other characteristics detrimental to the construction of firm, dense and sound embankments. Furnish borrow materials for other uses meeting the specified requirements for the use intended.

00330.13 Selected General Backfill - Soil, selected as directed from specified excavations, and containing no particle with any dimension greater than 3 inches, or other unsuitable material.

00330.14 Selected Granular Backfill - Durable sand, gravel or combinations of these, selected as directed from specified excavations, and containing no particle with any dimension greater than 3 inches or other unsuitable material. Reclaimed glass meeting the requirements of Section 02695 may be substituted for selected granular backfill.

00330.15 Selected Stone Backfill - A combination of durable sand, gravel and cobbles, selected as directed from specified excavations, which contains no particle with any dimension greater than 6 inches, and no unsuitable material. Reclaimed glass meeting the requirements of Section 02695 may be substituted for selected stone backfill.

00330.16 Stone Embankment Material:

(a) Requirements - An unweathered, hard, angular, durable, free draining material, visibly well graded from coarse to fine with the maximum size between 15 inches and 3 inches. Rock fragments larger than 15 inches but not larger than 36 inches may be included if placed as directed in 00330.42(c-2).

If the 1" - 0 portion exceeds 10 percent of the total volume by the Engineer's visual examination, the 1" - 0 material will be randomly sampled for testing. The wet sieve test, according to

AASHTO T 11, will be performed on the sampled material. The amount of material passing the No. 200 sieve shall not exceed 5.0 percent by weight.

(b) Control Sample - Provide, at a location acceptable to the Engineer, in close proximity to the Project, at least a 5 cubic yards sample of stone embankment meeting the gradation specified. This sample will be used as a frequent reference for judging the gradation of the material supplied.

(c) Sampling and Testing Assistance - If the Engineer visibly determines the material furnished justifies sampling and testing, dump and check the gradation of two random loads of stone embankment material. Provide a sorting site, mechanical equipment and labor to assist in checking gradation at no additional cost to the Agency.

00330.17 Quality Control - Provide quality control according to Section 00165.

Equipment

00330.20 Tamping Foot Rollers - If specified, use tamping-foot rollers with a weight of at least 15 tons, with each tamping-foot protruding from the drum at least 4 inches.

00330.21 Vibratory Rollers - If specified, use vibratory rollers having a smooth drum, exerting a dynamic force of at least 30,000 pounds per impact and operating at a frequency of at least 1,000 vibrations per minute. Limit roller speed to no more than 1 1/2 mph.

Labor

00330.30 Quality Control Personnel - Provide technicians having CEBT and CDT technical certifications.

Construction

00330.40 General:

(a) Quantities - Quantities and locations of earthwork materials indicated on the plans are approximate only. Make sure there is enough suitable material available to complete embankments and other required fillings before disposing of any excavated materials. Make up any shortage of materials caused by premature disposal at no additional cost to the Agency.

The Agency makes no guarantee or representation by implication or otherwise, that any material available on the Project site is suitable for incorporation into any portion of the Project. No material will be considered unsuitable on the sole basis that special or additional processing or handling is required to make it suitable for incorporation into the Project.

(b) Preservation of Existing Surfacing - In addition to the cautions in Section 00150 and Section 00170, protect existing surfacings of all types which are to remain in place from being damaged or fouled with undesirable material. Repair or replace damaged or fouled surfaces as directed at no additional cost to the Agency.

(c) Avoidance and Correction of Detrimental Operations - Perform all operations involved in excavating, hauling and placing of earthwork materials so no damage or detriment to the completed or partially completed work results. At all times provide sufficient drainage of completed or partially completed earthwork to prevent damage or loss due to rainfall, surface water or any other cause. In all cases, take proper precautions to ensure that embankment construction and filling does not move, endanger or cause undue strain or stress to any structure or adjacent ground. Temporary and final embankment slopes within any cross section shall not be constructed steeper than the slope staked for that cross section.

Recondition or remove unstable materials resulting from improper operations, inadequate drainage or over watering, and restore or replace with stable material at no additional cost to the Agency.

00330.41 Excavations - Perform excavation of earthwork as indicated on the plans, as directed and according to the following:

(a) General:

(1) Selection and Sorting of Excavated Materials - All materials available from excavations, including borrow materials, are subject to selection and separate handling for their best utilization in various parts of the work. Select the types of materials to be used according to 00330.42, 00330.44, 00330.45, 00330.47, the Special Provisions, and as directed. Select and sort excavated materials, as necessary, to meet Contract requirements.

(2) Selected Topsoil - Stockpile and place selected topsoil according to 01040.43.

(3) Unsuitable Materials - Unsuitable materials encountered in required excavations shall be classed as waste material and disposed of according to 00330.41(a-5).

(4) Excess Materials - If the quantities of excavated materials are greater than required to construct embankments and to do all filling and backfilling, the remaining materials shall be classed as waste materials and be disposed of according to 00330.41(a-5).

(5) Waste Materials - Unless otherwise specifically allowed and subject to the requirements of 00280.05, dispose of materials, classed as waste materials in 00330.41(a-3) and 00330.41(a-4), outside and beyond the limits of the Project and Agency controlled property according to 00290.20. Do not dispose of materials on wetlands, either public or private, or within 300 feet of rivers or streams.

(6) Excavation of Existing Surfaces - Unless otherwise specified, earthwork includes excavating, hauling and depositing of existing surfacings which are within the limits of the excavation work.

If an abutting roadway or structure, or part of a roadway or structure, is to be left in place, make cuts according to 00310.41(a).

(7) Abandoned Pipes and Miscellaneous Matter - Remove and dispose of abandoned pipes and miscellaneous matter encountered in the work as a part of the earthwork, unless otherwise specified.

Remove ends of remaining abandoned pipe or portions of other miscellaneous matter remaining exposed in slopes or at subgrade after excavation work to at least 2 feet back of the finished slope or below subgrade.

Place a watertight cap or plug in the inlet ends of remaining abandoned pipes. Leave outlet ends open. Place free draining cover material and/or take other measures as directed to allow for free passage of drainage at remaining outlet ends. Shape and finish the affected area so no evidence of their existence is apparent upon completion of the work.

(8) Ditches, Channel Changes, Approaches, Connection, Etc. - Perform excavations to construct ditches, channel changes, approach roadways, road connections, and other items, as required.

(9) Excavation Below Grade:

a. Rock - If directed, excavate rock found in roadbed excavation to a depth of 12 inches below subgrade or as directed. Backfill to subgrade elevation with selected granular backfill material as directed.

b. Selected Material - Where the plans indicate the placement of a selected material below subgrade in excavation areas, excavate to the depth necessary to place the material to its specified compacted thickness.

c. Unstable Subgrade Material - Where unstable material is encountered below subgrade in roadbed excavations, excavate such material below subgrade as directed. Dispose of these unstable materials according to 00330.41(a-5). Backfill with selected general backfill, or selected granular backfill material to provide a firm roadbed as directed. A geotextile may be required before backfilling.

(10) Protection of Excavation Side Slopes - Use methods in making roadbed excavations that will not shatter or loosen excavation slopes, avoid overbreaks, and leave slopes accurately and smoothly trimmed. As far as practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line. Overbreak is incidental to the work except in cases where the Engineer determines that such overbreak was unavoidable.

After the main excavation in rock or rocky cuts is completed, thoroughly test the slopes with bars or by other approved means and remove all loose, detached, broken, or otherwise unstable material. Remove jutting points and bring the entire cut slope area to a safe, trim, neat and stable condition. Dispose of the materials removed under this provision in the same manner as other excavated material. Remove all exposed roots, debris and all stones more than 3 inches in size which are loose or could become loosened.

(11) Rounding of Cutbanks - As part of the earthwork, blend the tops of cutbanks with the adjacent ground by rounding as called for by the plans. Rounding will not be required when rock requiring blasting to excavate extends to the top of cutbanks, and makes rounding impractical.

(12) Outside Earthwork Limits - Outside earthwork limits but within the clear zone, (see 00320.02(c)), remove partially buried natural objects, such as boulders, which the Engineer determines would be dangerous to an errant vehicle. Place them within embankments as specified or dispose of them as directed.

(b) Foundation Excavation - Excavate unsuitable materials in embankment foundations and elsewhere as designated. This work will be classed as "Foundation Excavation". Dispose of these materials according to 00330.41(a-5) and replace with selected general backfill, selected granular backfill or other suitable materials as directed.

(c) Toe Trench Excavation - Excavate trenches at the toe of slopes that are to be protected with stone embankment, riprap or other protective material, as shown or directed, to provide a suitable foundation. Maintain the toe trenches until the geotextile or filter blanket, if any, and stone embankment, riprap or other protective materials are placed.

(d) Borrow Excavation - Whenever the Specifications or Contract plans call for an Agency furnished borrow source for earthwork materials, the material excavated from such source and used in the work as earthwork materials will be classed as "Borrow Excavation". Excavate and use these materials according to the Contract provisions, or as directed.

(e) Blasting - Avoid the use of explosives as far as practical. If blasting is necessary and is not included in the Contact Schedule of Items, perform blasting according to following:

(1) General - Use blasting methods that do not shatter or loosen backslopes, that produces smooth and uniform excavation slopes at the specified slope angles, and satisfactorily loosens the rock for excavation. Do not use tunnel blasting methods.

(2) Methods - Follow the requirements of 00335.40(b) through 00335.40(h) and 00335.43.

00330.42 Embankment, Fills, and Backfills - Consider the nature, characteristics, and qualities of the materials to be selected before performing embankment, fill, and backfill work. Select and use excavated materials in various parts of the work according to 00330.41(a). Use all materials originating from required excavations, as far as practical, in the formation of embankments and subgrade, and for bedding, backfilling and other purposes shown on the plans, as directed, and according to the following:

(a) Embankment Foundation Preparation - In addition to the excavation and replacement of unsuitable materials as provided in 00330.41(b), and before constructing embankments, prepare the areas on which embankments are to be constructed as follows:

(1) Unstable Areas - Where the embankment foundation will not support hauling or compaction equipment and only if directed, place an initial layer of selected materials. Place the initial layer by dumping successive loads in a uniformly distributed layer of a thickness not greater than necessary to support the equipment and not greater than 3 feet, unless otherwise authorized. Do not place the initial layer higher than 3 feet below subgrade. Commence consolidation of the initial layer by routing construction equipment uniformly over the entire layer. The initial layer shall meet the compaction requirements of 00330.43 except for layer thickness. Subsequent layers shall meet all requirements of 00330.43.

(2) Ends of Abandoned Pipe - Place a watertight cap or plug in the inlet ends of remaining abandoned pipes. Place a screen over the outlet ends of remaining abandoned pipes, and if directed, place free draining cover material and/or take other measures as directed to allow for free passage of drainage.

(3) Drainage - Provide drainage and drainage structures as called for by the plans or as directed.

(4) Backfilling Inside Roadbed Limits - Break up concrete or asphalt floors, slabs, or walls, as specified in 00310.41(d), before backfilling or placing embankment. Backfill basements, trenches and holes within embankment limits with selected stone backfill material. Backfill material placed in basements may include pieces of broken concrete and masonry not exceeding 15 inches in any dimension provided they are placed and compacted according to 00330.42(c). The broken concrete and masonry shall not have protruding reinforcement.

(5) Existing Surfacing - Scarify and break up existing surfacings according to 00310.41(d) before placing embankment material.

(6) Roughen Ground Surface - Break up, roughen or scarify the ground surface if the slope is 1V:5H, or less, to positively bond embankment materials with the existing ground with benching allowed as a supplement.

(7) Foundation Benching - If existing ground surfaces or existing embankment surfaces are steeper than 1V:5H, bench the existing ground or embankment.

Make the bottom bench at least 10 feet wide. Each succeeding bench shall penetrate the slope at least 3 feet horizontally beyond the vertical side of the previous bench, and be wide enough to operate placing and compaction equipment. Each bench and embankment layer surface shall be brought to a slope flatter than 1V:10H. The benching, placing and compaction operation shall be performed simultaneously from the bottom up.

Place and compact the bench excavation material combined with new embankment material in layers to the thickness and compaction required in 00330.43.

(8) Compact Existing Ground - After roughening the existing ground surface and/or benching, compact the top 1 foot of existing ground and embankment in place to the density specified and with compaction equipment specified, according to 00330.43.

(b) Excess Moisture - Do not place material in final position in embankments or as backfill until excess moisture has been removed to within minus 4 percent to plus 2 percent of optimum moisture as required in 00330.43. Remove excess moisture by manipulation, aeration, drainage, rehandling or other means, at no additional cost to the Agency.

(c) Embankment Construction:

(1) General - Except as provided in 00330.42(a-1), do not construct embankments or fillings when the embankment material, the foundation or the embankment on which it would be placed is frozen, not stable or not compacted, unless otherwise directed.

Make roadbed embankment slopes as smooth, safe, and slightly as practical with the materials used to construct the embankments.

Route hauling equipment over the full width of embankments. Traveling over the same areas repeatedly will not be allowed unless approved by the Engineer as unavoidable.

Place embankments and all fillings in nearly horizontal layers not more than 8 inches thick, except as provided in 00330.42(c-2). Compact each layer separately and to the density required in 00330.43.

Place slope berms, if required, according to 00280.

(2) Rock in Embankment Construction:

a. General - Retrieve cobbles and boulders that fall or roll outside embankment limits and place them within embankments as specified, or dispose of them as directed.

b. Limited Quantities of Rock - If embankment materials contain up to 50 percent rock, sort the materials until they can either be placed in 8 inches layers, or meet the requirements of and be placed according to 00330.42(c-2-c).

c. Oversize Durable Rock Fragments - Placing isolated individual durable rock fragments having dimensions greater than the specified layer thickness will be allowed if:

- Clearance between adjacent fragments provides adequate space for placement and compaction equipment between rock fragments to place materials in horizontal layers as specified and for compaction according to 00330.43.
- No part of the fragment comes within 36 inches of subgrade.

d. Durable Rock - If embankment materials contain more than 50 percent durable rock, distribute and manipulate the rock so that the voids between the larger pieces are filled with

smaller pieces forming a dense and compact mass. Durable rock is defined in 00110.20. In the absence of two cycle slake durability test results, the rock durability will be visually evaluated.

When such embankments cannot be placed in 8 inches horizontal layers, place the embankment in nearly horizontal layers of the thickness directed, but not more than 15 inches.

If the visible quantity of silt and clay materials passing the No. 200 screen is less than 20 percent by volume, as determined by the Engineer, the maximum rock fragment size and layer thickness may be increased to 36 inches, but the layer thickness shall not exceed the average maximum size of the rock fragments.

e. Nondurable Rock - In the absence of two cycle slake durability test results, the Engineer will visually evaluate if the rock is potentially degradable. If embankment materials contain more than 50 percent nondurable rock, as defined in 00110.20, process the material as follows:

- Pulverize nondurable rock to 12" - 0 size and place in nearly horizontal layers not more than 12 inches thick.
- Water to promote slaking and breakdown of the nondurable material according to Section 00340.
- The moisture content of the material at the time of compaction shall be within the requirements of 00330.43.
- Compact the material to density/deflection requirements specified in 00330.43 with a tamping-foot roller that meets the requirements of 00330.20. Each embankment layer shall receive a minimum of three coverages with the tamping-foot roller. Operate the roller at a uniform speed not exceeding 3 mph. No additional compensation will be made for additional roller coverages to meet the requirements of 00330.43.

(3) Embankment Slope Protection - Construct outer portions of embankments exposed to erosion by stream flow or other erosive action with rock fragments, or other desirable materials, if directed, and such are available in the excavations. Also, if directed, place similar material as a protective layer on the outside of the regular embankment slopes as embankment widening. Placement shall closely follow construction of the embankment when directed. Protective materials placed as embankment widening need not be compacted but shall present a reasonably smooth surface, resistant to washout or slippage.

(4) Embankments for Approaches, Connections, Etcetera - Construct embankments as required and as directed to provide a complete Project. Construct according to 00330.42(c) and 00330.42(d).

(5) Embankment Construction Around Minor Structures - Backfill prior excavations in the vicinity of curbs, walks, driveways, inlets, manholes and other such minor structures with selected general backfill, or selected granular backfill material as directed with no particles larger than 1 inch and that is compatible with the adjacent material, unless otherwise specified. The material shall have a moisture content as specified in 00330.43, be placed in layers according to 00330.42(c-1), and compacted according to 00330.43.

(6) Embankment Construction at Pipes - Before installing any pipes with 72 inch or smaller, inside nominal diameter that will protrude above the existing ground surface:

- Provide temporary drainage at no additional cost to the Agency, unless provided for in Section 00240.

- Construct specification embankments at least five pipe diameters each direction from the pipe centerline and to a height equal to the following:
 - 12 inches minimum above the outside top of pipe elevation.
 - A higher height if called for on the plans or directed.
- Then trench, bed, and install the pipe, and backfill around all pipes according to 00445.45.

(7) Embankment Construction at Bridge Ends - At the ends of bridges and for a distance of at least 100 feet from the bridge, place and compact the embankments before beginning bridge construction, unless otherwise directed. Unless the embankment is constructed according to 00330.42(c-8), provide and place selected stone backfill material, meeting the requirements of 00330.15 when such is available from excavations, in all embankments within 100 feet of bridges, or as directed.

(8) Engineered Fills - In areas designated on the plans as "Engineered Fills", place selected stone backfill material in maximum 8 inch lifts from the existing ground up to the base of granular structure backfill. Compact to 95 percent maximum density according to 00330.43.

If the existing ground line is within the limits of the granular structure backfill, subexcavate the area beneath the footing in order to place the full depth of granular structure backfill shown or specified.

Place the granular structure backfill, meeting the requirements of 00510.13, in maximum 6 inch lifts and compact to 100 percent maximum density from the top of the selected stone backfill to the footing elevation shown. The thickness and extent of these materials shall be according to the details shown or as directed.

The foundation compaction requirements in 00330.43 shall be subject to the higher requirements of this provision. Compact according to the percentages required above.

(d) Stone Embankment - If the Contract plans or Specifications require embankments, or parts of embankments, to be constructed of stone embankment material, furnish and place the stone embankment material according to this provision and as directed. Furnish materials from Contractor provided sources which conform to the requirements of 00330.16, unless otherwise specified.

Construct these embankments according to the other provisions of 00330.42, unless otherwise specified or directed, and as follows:

- Material placed in the upper 1 foot of embankments or within 1 foot of a culvert or other structure, shall not be more than 3 inches in size.
- If placement in water is allowed, construct the first layer of embankment to an elevation 2 feet above water. Continue thereafter as specified or directed.
- Some rock fragments larger than 15 inches, but not larger than 36 inches may be placed provided they are placed and compacted according to 00330.42(c-2-c).

00330.43 Earthwork Compaction Requirements:

(a) General - Compact natural ground, embankment foundations, foundations for structures, each layer of embankment, fills, and backfills, the upper 1 foot of roadbeds in cuts and other earthwork which is to support any part of the roadbed prism according to this subsection.

Unless otherwise specified, compact in place the entire surface of each layer of all specified materials with a minimum of three coverages, using equipment made specifically for compaction. Select compaction equipment based on the type of material being compacted and the layer thickness. Normal compaction equipment consists of sheeps-foot rollers, tamping-foot rollers, grid rollers, pneumatic-tired rollers, and vibratory rollers. Routing of hauling and grading equipment will not be accepted as adequate to achieve compaction, except as provided in 00330.42(a-1).

In the immediate vicinity of minor structures as provided in 00330.42(c-5), in holes, around and under isolated individual rock fragments, and elsewhere where embankment and filling materials can or cannot be reached by normal compaction equipment, compact with machine-operated pneumatic or mechanical tampers, or by hand methods if allowed, as required to ensure intimate contact between the backfill material and the structure or fragment and provide thorough compaction.

(b) Moisture-Density Testable Materials:

(1) Test in-place materials for compaction according to the MFTP.

(2) In-place materials shall meet the following moisture content, density, and deflection requirements, each of which has equal weight and each of which shall be satisfied:

a. Moisture Content - Moisture content at the time of compacting the materials shall be prepared to within minus 4 percent to plus 2 percent of optimum moisture content. Material which does not contain sufficient moisture to obtain proper compaction shall be wetted and thoroughly mixed as directed. Material containing an excess of moisture shall be dried by manipulation, aeration, drainage or other means before being compacted.

b. Density - After compaction of each layer the density shall be at least:

- 95 percent of maximum density in roadbed cuts, to a depth of 1 foot below established subgrade elevation.
- 95 percent of maximum density in embankments, fills, backfills, and specified portions of existing ground.

c. Deflection Requirement - In addition to moisture-density testing, conduct at least one deflection test according to ODOT TM 158 for each 3 feet, or portion of 3 feet, of embankment placed. If the layer being tested exhibits any yielding, deflection, reaction or pumping, rework the area to provide acceptable test results prior to placement of any additional material.

Conduct deflection tests, witnessed by the Engineer, on the finish grade of all subgrades. During placement of subbase, base aggregates, or ACP, if deflection is observed, remove the ACP, base, and subbase aggregates and correct the deflecting areas at no additional cost to the Agency.

Provide a signed test report to the Engineer at the end of each shift after completing the required testing. At no additional cost to the Agency, remove and replace embankment constructed thicker than 3 feet that was not deflection tested.

(c) Non-Moisture-Density Testable Materials - When material is not moisture-density testable because rock fragments in the material prevent moisture-density testing, place and compact the material as follows:

- Place non-moisture density testable material in nearly horizontal layers with thickness not exceeding 12 inches.
- Water or aerate the material to ensure each layer can be compacted to form a dense mass, free of pumping.
- Compact each layer uniformly with a minimum of four full coverages using a smooth drum vibratory roller.
- Conduct at least one deflection test according to ODOT TM 158 for each layer of embankment placed. If the layer being tested exhibits any yielding, deflection, reaction or pumping, rework the area to provide acceptable test results prior to placement of any additional material.

(d) Small, Irregular Fill Areas - The density requirements of 00330.43 do not apply to irregular fill areas that have a total volume of no more than 150 cubic yards outside of the travel lanes. Construct these areas according to the following:

- Place embankment material in nearly horizontal layers with thickness not exceeding 8 inches.
- Water or aerate the material to ensure each layer does not deflect under the action of the roller used for compaction.
- Compact each layer using a roller appropriate to the material being placed and as directed. Use a smooth drum vibratory roller for sands and gravels; use a sheepsfoot or tamping foot roller for silts and clays. The Engineer will determine the classification of the embankment soil
- Compact each layer uniformly with a minimum of five full coverages of the specified roller.
- In areas not accessible to rollers, use compaction equipment suitable for the area and compact each layer with sufficient coverages to produce a firm unyielding surface.

00330.44 Buttress, Inlay, or Shear Key - Remove the designated materials and construct the buttress, inlay or shear key as follows:

(a) Preparation - Do not start excavation for each segment until a stockpile of stone embankment material is immediately available at or near the site. Locate the stockpile at a site approved by the Engineer. The size of the stockpile shall be sufficient to fill one excavated segment.

(b) Sequence of Construction - Excavate the area according to 00330.40 and 00330.41 to provide a backslope to the lines, slopes and details indicated on the plans or as directed. Excavate and backfill in segments to minimize aggravating stability conditions. Each segment shall not exceed 75 feet in length as measured across the top of each open excavation segment, unless otherwise specified or directed.

(c) Unsuitable Materials - Sort and dispose of unsuitable materials as waste material according to 00330.41(a-5).

(d) Foundation - Excavate to a depth of at least 5 feet into firm, stable, undisturbed materials as shown on the plans or as directed. Remove soft or loose materials. The Engineer will verify sufficient excavation into firm, stable, undisturbed materials in each segment before allowing the backfill. Where called for in the plans or as directed, place riprap geotextile against the

excavated backslope. Remove water from the excavation before placing stone embankment material.

(e) Drainage - Provide drainage as shown or as directed.

(f) Placement of Stone Embankment - After excavation of each segment according to 00330.44(b) and 00330.44(d), place the stone embankment material to fill the excavated segment before excavating the next segment. Backfill all segments on the same day they are excavated. Place and manipulate the stone embankment material in the buttress, inlay or shear key to provide a dense and well-filled mass to the lines, slopes and cross-sections indicated on the plans or as directed.

00330.45 Filling of Holes - Backfill holes outside the limits of required excavation or embankment construction that result from grubbing and removal work, basements, trenches and other such holes as directed. Smooth and shape to blend with the surrounding area. If the basis of performance is the excavation basis, no separate payment for this work will be made. If the basis of performance is the embankment basis, payment for this work will be made according to 00330.94.

00330.46 Watering of Materials - Water materials as directed to provide compaction and required density to embankments and backfills and to alleviate dust nuisance according to Section 00340.

00330.47 Specified Selected Courses or Layers of Materials - In addition to the requirements of 00330.42, select, sort, and place courses or layers of materials if included in the Contract Schedule of Items. Select and sort the materials obtained from required excavations and place in locations and thicknesses specified or as directed.

Place and construct selected courses or layers to conform to the requirements of 00330.42 and 00330.43, unless otherwise specified.

The work covered by this provision may include, but is not limited to:

- Selected Embankment Material
- Selected Subgrade Material
- Selected Stone Embankment Material
- Selected Topsoil

00330.49 Construction Slide Removal and Repair - Remove construction slide materials and repair construction slide damages to the work according to Specifications, or as directed, and as follows:

(a) Definition - For the purposes of this provision:

(1) Slide - A slide is a lateral movement of earth materials.

(2) Construction Slide - A slide outside the designated limits of excavations, or below the foundation within designed limits of embankments or within embankments, which occur after excavation or embankment construction starts and before final acceptance of the Contract.

(3) Slide Materials - Materials displaced as the result of a slide.

(b) Remove Construction Slide Materials - Within the limits of established or reestablished lines, grades and slopes, do the following:

- Excavate and remove construction slide materials.

- Sort and dispose of unsuitable materials.
- Use excavated slide materials, to the extent practical, in embankments, fills, backfills, widenings, and for flattening slopes within the Project limits.
- Dispose of excess material according to 00330.41(a-4).

(c) Construction Slide Repair - Reconstruct or restore subgrade and slopes to the established or reestablished lines, grades and slopes. Reconstruct or repair damaged structures or facilities within construction slide areas.

(d) Responsibility For Construction Slide Removal and Repair:

(1) Contractor Responsibility - Perform construction slide removal and repair work at no additional cost to the Agency when caused by any of the following:

- Embankment foundation conditions or pre-existing subsurface conditions that were reasonably anticipated in the Contract.
- Contractor's method and manner of operations.
- Contractor's failure to perform or to protect the work according to plans and Specifications.

(2) Agency Responsibility - Slide removal and repair work will be paid for according to 00330.90 when all of the following apply:

- Caused by embankment foundation conditions or pre-existing subsurface conditions that were not reasonably anticipated in the Contract.
- Not caused by Contractor's method and manner of operation.
- Not caused by Contractor's failure to perform or to protect the work according to plans and Specifications.

Finishing and Cleaning Up

00330.70 General - Immediately before completing the earthwork:

- Blend the tops of cutbanks with the adjacent terrain.
- Trim and finish all roadbeds, ditches, waterway channels, and other excavations and embankments to the lines, grades, and cross sections established.
- Clean up debris and foreign matter of all kinds on the entire right-of-way area. Dispose of materials as directed.
- Finish the subgrade to be within a tolerance of plus or minus 3/4 inch and to be free of ruts, depressions and irregularities.
- In planting and seeding areas, remove all rocks, boulders, and vegetative matter.
- Remove all litter, debris and obstructions.

Measurement

00330.80 Measurement - The quantities of earthwork will be measured according to one or more of the following:

- Volume basis, based on the Agency's digital terrain model (DTM) calculated by Triangular Volume, Average End Area Volume, or by other methods of equivalent accuracy.

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- Volume basis, computed by the average end area method from cross section measurements, or by other methods of equivalent accuracy. When specified, corrections for curvature will be made.

Measurement will only be for those items listed in 00330.93 and 00330.94 that are actually included as an item in the Contract Schedule of Items.

Structure excavation will be measured according to 00510.80(b).

Materials subexcavated from beneath footings as required by 00330.42(c-8) will be measured according to 00510.80(b).

Granular structure backfill will be measured according to 00510.80(d).

Watering of materials required by 00330.46 will be measured according to 00340.80.

00330.81 Excavation Basis Measurement - When measurement of earthwork is on the excavation basis, the materials will be measured in their original positions before excavation. Measurement will be limited to the lines, grades, and slopes as established.

The quantities of excavation measured for payment will include the volumes of:

- Abandoned pipe and miscellaneous matter within excavation limits.
- Materials removed below subgrade in roadbed excavations according to 00330.41(a-9) and 00330.91(d).
- Overbreak determined to be unavoidable according to 00330.41(a-10).

The following earthwork items will be measured on the excavation basis:

- Borrow Excavation
- Ditch Excavation
- Foundation Excavation
- General Excavation
- Toe Trench Excavation

Embankments required or necessary to perform earthwork on the excavation basis will not be measured separately.

00330.82 Embankment Basis Measurement - When measurement of earthwork is on the embankment basis, the materials will be measured in their final embankment position. Measurement will be limited to the lines, grades, and slopes of the original ground contours established before the Contractor begins any Work on the Project.

The quantities of embankment measured for payment will include the volumes of materials used to backfill excavations below subgrade and holes when shown or directed.

The quantities of embankment measured for payment will not include the volumes of:

- Any additional quantities required due to subsidence, settlement of the ground or base, settlement within embankments, or to shrinkage, settlement, washout, slippage, or loss regardless of cause, subject to 00170.80 or 00170.82.
- Any additional quantities required due to compaction efforts that are required in 00330.43.

- Any additional quantities required due to clearing and grubbing operations.
- Slide materials paid for according to 00195.20.
- Any materials for which payment is made for completed embankments or backfills under other Contract provisions.

The following earthwork items will be measured on the embankment basis:

- Embankment In Place
- Stone Embankment
- Extra For Selected _____ Material

Excavations, including cutbank rounding, overbreak whether avoidable or not, and foundation benching, required or necessary to perform earthwork on the embankment basis, and retrieval or removal of cobbles and boulders according to 00330.42(c-2-a) will not be measured separately.

When an excavation basis item is included in the Contract Schedule of Items and selected materials are obtained from the excavation for use as "Extra for Selected _____ Material", measurement will be made for both items.

Payment

00330.90 Payment - The accepted quantities of earthwork performed under this Section will be paid for at the Contract unit price, per unit of measurement, for each item that appears in the Contract Schedule of Items.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Structure excavation will be paid for according to 00510.90(b).

Materials subexcavated from beneath footings as required by 00330.42(c-8) will be paid for according to 00510.90(b).

Granular structure backfill will be paid for according to 00510.90(d).

Watering of materials required by 00330.46 will be paid for according to 00340.90.

Slide removal and repair work determined under 00330.49(d-2) to be Agency responsibility will be paid for according to 00195.20.

No separate or additional payment will be made for work that is required to be done under these Specifications that does not appear as a separately listed item in the Contract Schedule of Items.

No separate or additional payment will be made for blasting done according 00330.41(e) unless a blasting item is listed in the Contract Schedule of Items.

00330.91 Kinds of Pay Excavation - The kinds of pay excavation on the Project will be indicated by the items listed in the Contract Schedule of Items and are defined as follows:

(a) Ditch Excavation:

- Limited to the lines, grades, and cross sections shown or established with bottom widths of 8 feet and less that lie outside of and separate from roadbed cross sections.

- Includes canals, channels, and inlet, outlet, diversion, drain, and other open ditches to carry water.

(b) Foundation Excavation:

- Limited to the lines, grades, and cross sections shown or established.
- To remove soft materials for preparation and stabilization of areas below embankments.

(c) Toe Trench Excavation:

- At the toe of riprap slopes as shown and elsewhere as directed to provide a suitable foundation toe trench on which to place riprap geotextile or filter blanket, and riprap material.

(d) General Excavation:

- Other than ditch, trench, structure, foundation, toe trench, and borrow excavation.
- Includes cut ditches, borrow ditches, and roadside ditches in the roadway section as staked or established, or shown as being a part of the typical roadway cross sections.
- Includes other ditches with bottom widths greater than 8 feet.
- Includes unsuitable material excavated below subgrade in roadbed excavations according to 00330.41(a-9), when determined that such excavation is neither more nor less difficult to remove than the material above subgrade in the whole of the cut. When determined that such excavation is either more or less difficult to remove than the material above subgrade in the whole of the cut, payment will be according to 00195.20.

(e) Borrow Excavation:

- Obtained from specifically designated and authorized sources lying outside of, separated from, independent of, and beyond the roadway cross sections, unless otherwise directed.

00330.92 Kinds of Incidental Earthwork - No separate or additional payment will be made for the following:

- Removal of overburden from pits and quarries.
- Excavation of rock and other material for use in surfacings or structures.
- Excavation for haul roads.
- Other excavation (borrow excavation excepted) which is not directly a part of the finished work.
- Blend tops of cutbanks with adjacent ground according to 00330.41(a-11).
- Overbreak, except on excavation basis earthwork and the Engineer determines that overbreak was unavoidable.
- Foundation benching performed according to 00330.42(a-7).
- Rock excavated below the excavation plane established by 00330.41(a-9) and the specified backfill required to fill up to the excavation plane, to the satisfaction of the Engineer.
- Smooth and maintain foundations, roadbeds, and haul roads.
- Material handled, removed, placed, or used contrary to Specifications or directions.
- Rehandling and reshaping of materials previously excavated, except where called for in the Specifications, Plans, or Contract change orders.

- Excavation for forms to construct curbs, gutters, walks and other similar structures unless specified.
- The volume of any free water or liquid.
- Hauling, moving, or transporting earthwork materials.
- Removal of excess moisture according to 00330.42(b).
- Retrieval or removal of cobbles and boulders according to 00330.42(c-2-a).
- Constructing outer portions of embankment with suitable material for slope stabilization.
- Additional quantities of materials required due to clearing and grubbing operations and compaction requirements within embankment limits.

00330.93 Excavation Basis Payment - When listed in the Contract Schedule of Items, the following items will be paid for on the excavation basis:

Pay Item	Unit of Measurement
(a) Ditch Excavation	Cubic Yard
(b) Foundation Excavation	Cubic Yard
(c) Toe Trench Excavation	Cubic Yard
(d) General Excavation.....	Cubic Yard
(e) Borrow Excavation	Cubic Yard

These items include excavating, selecting, handling, hauling, placing, and compacting the materials as specified.

00330.94 Embankment Basis Payment - When listed in the Contract Schedule of Items, the following items will be paid for on the embankment basis:

Pay Item	Unit of Measurement
(a) Embankment In Place.....	Cubic Yard
(b) Stone Embankment	Cubic Yard
(c) Extra For Selected _____ Material.....	Cubic Yard

Item (a) includes excavating, selecting, handling, hauling, placing, and compacting of the materials as specified and all other costs incurred in furnishing required embankment materials.

Item (b) includes furnishing, selecting, handling, hauling, placing, and compacting the material as specified.

In item (c), the type of material will be inserted in the blank.

Item (c) includes preserving, sorting, stockpiling, and handling of the specified selected materials as described in 00330.41(a-1) and 00330.41(a-2), selected and placed according to 00330.42, 00330.47, and the Special Provisions.

Unless a specific pay item in the form of item (c) appears in the Contract Schedule of Items, no separate or additional payment will be made for preserving, sorting and handling selected materials. However, earthwork materials obtained from excavations and incorporated into specified embankments will be paid for at the applicable item, if listed in the Contract Schedule of Items.

Excavation of unstable material that is below subgrade in roadbed excavation areas, according to 00330.41(a-9), will be paid for according to 00195.20.

Section 00331 - Subgrade Stabilization

Description

00331.00 Scope - This work consists of excavating and disposing of unstable materials in excavation areas only and placing subgrade geosynthetic, stone embankment, and aggregate backfill to the lines and grades as shown or directed.

Materials

00331.10 Materials - Furnish materials meeting the following requirements:

Aggregate Base	02630
Aggregate Subbase.....	00641.10(b)
Stone Embankment.....	00330.16
Subgrade Geotextile, Certification Level B.....	02320
Subgrade Reinforced Geogrid, Certification Level B.....	02320
Water.....	00340

00331.16 Acceptance of Backfill - The backfill material will be accepted based on visual inspection. The Engineer may perform tests if deemed necessary.

Equipment

00331.20 General - Provide all equipment necessary to perform the work according to Sections 00330, 00340, 00350, and 00641.

Construction

00331.40 Excavation - Excavate unstable material to the lines and grades as shown or directed. Dispose of the excavated material according to 00330.41(a-5).

00331.41 Geosynthetic:

(a) Geotextile - Place geotextile as shown.

(b) Subgrade Reinforcement Geogrid:

(1) Placement - Prepare the surface receiving geogrid to a smooth, uncompacted condition to the depth shown and as follows:

- Orient the geogrid rolls parallel to the roadway centerline.
- Unroll the geogrid in the same direction as aggregate base placement. If the geogrid shifts or becomes misaligned, realign it and anchor it according to the manufacturer's recommendations.

(2) Overlaps - Overlap the geogrid a minimum of 24 inches. Overlap the geogrid in the same direction as aggregate base placement with the preceding layer lapped on top of the following layer.

(3) Protection of Geogrid - Drive rubber tired equipment on the geogrid at no more than 5 mph. Drive tracked equipment on the geogrid only after placing a minimum of 6 inches of aggregate base on top of the geogrid. Do not turn or make sudden stops or starts on the geogrid or the aggregate base.

During installation cover the geogrid with the aggregate base as soon as possible. Do not leave uncovered for more than 5 calendar days.

(4) Repair - Repair or replace damaged or torn geogrid according to manufacturer's recommendations at no cost to the Agency.

00331.42 Backfill - Place the backfill material to lines and grades as shown or directed, to provide a homogeneous mixture. Compact the backfill until there is no reaction or yielding under the compactor.

Measurement

00331.80 Measurement - The quantities of subgrade stabilization will be measured on the area basis of subgrade surface area stabilized to the full depth as shown. The surface area will be determined by horizontal measurements. In areas where directed to stabilize to a depth other than shown, the areas will be adjusted by converting to an equivalent number of square yards on a proportionate volume basis.

Payment

00331.90 Payment - The accepted quantities of subgrade stabilization will be paid for at the Contract unit price, per square yard, for the item "_____ inch Subgrade Stabilization".

The depth of stabilization will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for excavation, geosynthetic, stone embankment or aggregate backfill material, or water.

Section 00335 - Blasting Methods and Protection of Excavation Backslopes

Description

00335.00 Scope - This work consists of excavating in rock using controlled blasting methods to achieve smooth, uniform and unfractured backslopes, and produce a free surface or shear plane in the rock along the specified excavation backslope, and production blasting to facilitate excavation.

00335.01 Definitions:

Buffer Row - In multiple row blasts in which perimeter control blasting techniques are used, the first row of production holes immediately adjacent to and drilled along a plane parallel to the perimeter control blast line. The buffer row is located between the production holes and the perimeter controlled blast line.

Perimeter Controlled Blasting - The use of explosives and blasting accessories in carefully spaced and aligned drill holes. Perimeter controlled blasting techniques include presplitting and trim (cushion) blasting.

Presplitting - A perimeter control blasting method in which the perimeter row of blast holes are drilled along the plane of the specified final excavation backslope and which utilizes reduced drill hole spacing and reduced diameter explosives decoupled from the drill hole wall, and whose initiation precedes the initiation of the adjacent production holes by a minimum of 25 milliseconds.

Production Blasting - Fragmentation blasting in the main excavation area, usually using more widely spaced drill holes than controlled blast holes

Trim (Cushion) Blasting - A perimeter control blasting method in which the initiation of the perimeter row of blast holes drilled along the plane of the specified final excavation backslope follows the initiation of the adjacent production holes within 25 to 75 milliseconds, if production holes are being employed in the blast.

Materials

00335.10 Materials - Furnish all explosives and blasting caps that are no more than 1 year old. Each blasting cap period shall come from one lot number.

Construction

00335.40 Blasting Methods:

(a) General - Use methods in making excavations that do not shatter or loosen the backslopes and that produce smooth and uniform excavation slopes at the specified slope angles. These include:

- **Perimeter Controlled Blasting** - Use on the entire length of cut section in rock or cemented materials which have backslopes of 1V:0.75H or steeper, even if the main excavation can be ripped.
- **Production Blasting** - Blasting in the mass of rock to be excavated shall be designed to control flyrock, minimize ground vibration and air blast, and result in loosened and fragmented in-place rock of a size that can be removed, transported, or crushed to produce specified products. Lay out production blast holes in a consistent pattern that does not affect the perimeter control blast holes. Where production blast holes are made adjacent to highways with specified closure restrictions, the volume of material blasted shall not exceed

the Contractor's ability to remove the blasted material from the adjacent highway within the specified closure time.

(b) Safety and Flyrock Control - Use techniques that effectively limit and control flyrock. Clear the site of all boulders or other material as directed prior to beginning blasting work. Following every blast, observe the entire blast area for a minimum of 5 minutes before reentering or commencing work in the area.

Be responsible for the storage, transportation, and handling of explosives, their use, and the results of all blasting operations according to 00170.94.

Cover all blast areas that are within 200 feet of residences, facilities or above ground utilities using appropriate blast containment mats or an approved equivalent method.

Discontinue blasting operations, as directed, if it is apparent that the methods employed are not producing acceptable results or the safety of the public, the Contractor's employees or adjacent property is being jeopardized.

(c) Preblast Survey - Offer, in writing, to perform a preblast survey for owners and occupants of all buildings, structures, and utilities within the distance of the blast specified in 00335.40(e). If the offer is accepted, use an Agency approved survey form, signed and completed by an independent third party, and submitted to the Engineer and Contractor at least 72 hours before blasting begins. Deliver a copy of the survey form and copies of any photos taken to the owners and occupants.

(d) Blasting Plan - Provide a separate blasting plan for each cut that requires blasting, prepared by a person qualified and experienced in blasting work. Each plan shall cover individual major rock cut areas or rock production from a material source. Similar minor rock cut areas of less than 50 cubic yards, as well as utility and culvert trenches, may be covered as a group in one generalized blasting plan.

Submit the blasting plans for the Engineer's review at least 7 calendar days before beginning drilling and blasting work for excavations of 3,000 cubic yards or smaller, and 14 calendar days for drilling and blasting work requiring any perimeter controlled blasting and or excavations of more than 3,000 cubic yards.

The blasting plans will be reviewed for conformance with the Specifications and any concerns will be discussed with the Contractor. Submit any proposed changes to the blasting plans in writing to the Engineer for review before implementation. Submittal of blasting plans is for quality control and record keeping purposes.

Review of blasting plans by the Engineer does not relieve the Contractor of full responsibility for the accuracy and adequacy of the plans and the resulting safety when implemented in the field.

Each blasting plan shall contain the full details of the drilling and blasting patterns, vibration, flyrock, and noise reduction methods, blast area security measures and traffic control that the Contractor proposes to use, and the following information:

- Station limits of proposed shot.
- Removal of overburden.
- Plan and cross section diagrams of proposed drill pattern for controlled and production blast holes including buffer rows, free face, burden, blast hole spacing, blast hole diameters, blast hole angles, lift height and sub drill depth. Accurately draw to scale and show each cut area to be blasted.

- Loading diagram showing the type, amount and specific gravity of explosives, primers, and initiators, and location depth, and type of stemming.
- Initiation sequence of production and controlled blast holes including delay times and delay system.
- Manufacturer's product data sheets for all explosives, primers and initiators to be used in the work.

(e) Blasting Notification - Notify all owners and occupants of buildings, structures, and utilities that are within the following distances of the blasting areas:

- 300 feet for shots using less than 50 pounds of explosives per time delay of 15 milliseconds.
- 600 feet for shots using between 50 and 250 pounds of explosives per time delay of 15 milliseconds.
- 1,250 feet for shots using more than 250 pounds of explosives per time delay of 15 milliseconds.

Provide notification, in writing, once, at least 48 hours before blasting begins, and again on the day the blasting operations occurrence

Do not begin detonation of the blast until the Agency representative is ready to videotape the blast, or until the Engineer is prepared to witness the blast.

(f) Blasting Test Sections - Demonstrate the adequacy of each proposed blasting plan by means of test shots in each cut or excavation before beginning full scale blasting. Do not proceed with remaining drilling and blasting until acceptable test blast results have been demonstrated to the satisfaction of the Engineer.

In areas where perimeter controlled blasting techniques are being employed, drill and blast short representative test sections not exceeding 100 feet in length. Excavate a section not less than 20 feet wide exposing the full height of the lift for examination. In areas where no perimeter controlled blasting techniques are being employed, determine effectiveness of the test section based on the material placement, cut slope stability, fragmentation and control of ground vibration, air blast and fly rock.

Do not drill ahead of the test blast area, except as provided in 00335.41(a-6), until the test section has been evaluated. The Contractor may be directed to use test section lengths less than 100 feet.

If the results of the test shots are unacceptable revise the methods, techniques and procedures, at no additional cost to the Agency, so that the results achieved will be acceptable. No further drilling and blasting will be allowed until the revised methods are reviewed according to 00335.40(d) and verified by additional test shots.

If, during the progress of the work, the methods of drilling and blasting do not produce acceptable results within the tolerances specified, drill, blast and excavate additional test sections until a technique is determined that will produce acceptable results.

(g) Blasting According to Plan - After the Engineer has reviewed the blasting plan and determined that test sections have demonstrated acceptable results, perform all perimeter controlled and production blasting according to the plan that produced acceptable results. Notify the Engineer when any changes in conditions or results are observed. On the day of each blasting occurrence and before detonation of the blast, the supervisor or blasting specialist in

charge shall certify, in writing, that the shots being carried out are consistent with the reviewed blasting plan.

(h) Blasting Report - Submit a blasting report detailing the blast outcome within 48 hours of making each blast. Include in the report the following:

- Drill logs, drilling remarks, loading, and timing variables used in the blast.
- All blast monitoring documentation.
- A comment section that includes the Contractor's evaluation of the blast performance.
- All damage incurred and details of all neighbor's complaints or comments.

00335.41 Controlled Blasting Methods:

(a) Presplitting:

(1) Attach mechanical devices to all drilling equipment used to drill the presplit holes to determine, within an accuracy of 1°, the angle at which the drill steel enters the rock.

(2) Do not drill presplit holes more than 3 inches in diameter.

(3) Start presplit drill holes along the presplit line within 3 inches of the dimensions shown on the blasting plan. Holes located beyond this tolerance will be rejected. Completely fill the rejected holes with stemming material at no additional cost to the Agency. Drill new presplit holes with the proper spacing. Rejected holes will not be measured for payment.

(4) Control the drilling operations to ensure that presplit hole alignment does not vary from the plane of the planned slope by more than 9 inches either parallel or normal to the slope. Presplit holes exceeding these limits will not be paid for unless, in the Engineer's opinion, satisfactory slopes are being obtained.

(5) The length of presplit holes for any individual lift shall not exceed 30 feet unless the Contractor can demonstrate to the Engineer's satisfaction that hole alignment can be maintained within the above tolerances. Upon satisfactory demonstration, and with written permission of the Engineer, the length of holes may be increased to a maximum of 60 feet. If more than 5 percent of the presplit holes are misaligned in any one lift, reduce the height of the lifts until the 9 inch alignment tolerance is met.

(6) Drill presplit holes a minimum of 30 feet longitudinally beyond the limits of the production holes to be detonated or to the end of the cut. Unless otherwise allowed by the Engineer in writing, remove all overburden, including any loose or decomposed rock, before drilling the presplitting holes.

(7) When the cut height will require more than one lift, a maximum offset of 18 inches between lifts will be allowed to allow for drill equipment clearance. Adjust the slope angle of lower lifts to compensate for drill offsets and any drift which may have occurred in upper lifts.

(8) Use only explosives manufactured specifically made for presplitting in the presplit holes. The maximum diameter of explosives used in presplit holes shall not be greater than half the diameter of the presplit hole. Bulk ammonium nitrate and fuel oil (ANFO) will not be allowed in the presplit holes.

(9) Determine that the presplit hole is free of obstructions for its entire depth before placing charges. Exercise all necessary precautions so the placing of the charges will not cause caving of material from the walls of the holes.

(10) Detonation of explosives in each hole in a presplit shot may be delayed, providing the hole-to-hole delay is no more than 25 milliseconds.

(b) Trim (Cushion) Blasting - When the horizontal distance from the new proposed slope face to the existing rock face is less than 15 feet, the Contractor may trim blast instead of presplitting. The requirements in 00335.41(a) for presplitting also apply to trim blasting, by changing the words presplit and presplitting to trim blasting. If trim blasting burdens are less than 6 feet or zones of weakness in the rock are observed, submit a hole loading diagram that reflects the site conditions.

(c) Buffer Row - Locate the buffer hole line a minimum of 3 feet away from the perimeter control blast line, or 1 foot for every inch of buffer hole diameter, whichever is greater. Space buffer row holes 3 to 5 feet center to center. The explosive load in buffer holes shall not exceed 50 percent of the full explosive load that could be placed in a 3 inch production hole. Initiation of the buffer holes shall be on a delayed sequence toward a free face.

00335.42 Production Blasting - Do not drill any row of production blast holes closer than 6 feet to the perimeter controlled blast line. Where necessary to minimize damage to the rock backslope, a row of buffer holes may be drilled between the perimeter controlled blast line and the production blast holes. Except for the bottom lift, do not extend production holes below the bottom of the controlled blast holes. Do not exceed 6 inch diameter for production holes. Detonate production holes on a delay sequence documented in the blasting plan.

00335.43 Scaling - Remove all loose, hanging, or potentially dangerous rock on the excavated surface by scaling during the completion of the excavation of each lift. Do not begin drilling the next lift until this work has been completed, as directed.

Scale the slopes throughout the Contract at the frequency required to remove loose or overhanging material.

Use a suitable standard steel mine scaling rod to hand scale the slopes. Other methods such as machine scaling, hydraulic splitters or light blasting may be used instead of, or to supplement, hand scaling, if allowed.

Measurement

00335.80 Measurement - The quantities of perimeter controlled blast holes will be measured on the length basis and will be determined by dividing the cut slope surface area by the perimeter controlled blast hole spacing. The cut slope surface area will be determined by cross section measurement from the top of the blasted rock to the finished ditch bottom elevation.

The quantities shown in the Contract Schedule of Items have been computed from a theoretical plan length using 30 inch hole spacing. The actual quantities will depend on field conditions and results from blasting test sections.

Payment

00335.90 Payment - The accepted quantities of perimeter controlled blast holes will be paid for at the Contract unit price, per foot, for the item "Perimeter Controlled Blast Holes".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for blasting, scaling, or loosening materials for excavation.

When the Contract Schedule of Items does not indicate payment for work performed under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this work is required.

Section 00340 - Watering

Description

00340.00 Scope - This work consists of furnishing and applying water or combinations of water and additives for:

- Compacting and preparing roadbed excavations, roadbed embankments, backfills, subgrades, subbases, bases and surfacings.
- Preventing or alleviating dust nuisance originating within the highway right-of-way and the Project limits, which is not caused by Contractor operations at the Contractor's plants or plant setups.
- Other watering when ordered.

00340.01 Definitions:

Additives - Emulsified asphalt, magnesium chloride or other materials added to water for the purpose of aggregate binder or dust control.

00340.02 Exclusions - Watering which is specified as Incidental and included in payment for other items or parts of work is excluded from measurement under this Section.

Materials

00340.10 Water - Furnish water free of silts and other matter harmful to the quality of the material to which it is applied or with which it is mixed.

Comply with Chapter 537 of the "Oregon Water Laws", which is administered by the Water Resources Department, covering the appropriation of water.

Most adjudicated water may be limited to agricultural uses, so it should not be assumed that there will be any water sources in the immediate area of the Project available for the Contractor's use.

00340.11 Water Mixtures:

(a) Use of Additives - When called for by the Special Provisions, or ordered, perform watering with a mixture of water and additives. Use an additive from the QPL and mix according to the manufacturer's recommendations.

(b) Magnesium Chloride - When required, furnish Magnesium Chloride ($MgCl_2$) in brine solution at 28 to 35 percent concentration by weight.

Equipment

00340.20 Watering Equipment - Perform uniform and controlled application of watering by one or more of the following methods:

- Tank trucks equipped with spray bars
- Hose and nozzle
- Wetting materials in stockpile or in excavation areas before excavating
- Other means, as directed

The use of splash boards will not be allowed without prior approval. When required, provide a metering device for water measurement.

Construction

00340.40 Watering:

(a) General - Make all necessary arrangements to obtain water and pay all costs involved in its procurement. Maintain an adequate supply of water at all times.

Perform watering only when and where directed at an approved rate and manner of application. Water at any hour of the day, and on any day of the week, as directed, for proper performance or protection of the work and for alleviation of dust nuisance.

(b) Use of Additives - If an additive is combined with water in the watering work, mix it in the proportions and manner specified, and use in the work as directed.

Maintenance

00340.60 Avoidance of Detrimental Operations - Avoid wasting water or watering detrimental to other work. Cease such operations until corrective measures are directed.

Measurement

00340.80 Measurement - The quantities of water will be determined by the following methods:

- Weight or volume, or both
- In tanks or tank trucks of predetermined capacity
- By approved meters

Measurement will be M-gallons (1,000 gallons = 1 M-gallon) not including the additives used in the watering as specified or ordered. For conversion purposes, water weighs 8.34 pounds per gallon or 62.4 pounds per cubic foot. Only quantities acceptably used in the work, as specified, will be measured.

Quantities of additives combined with water for watering purposes will be determined separately from the water and will be measured on the volume basis in gallons.

Payment

00340.90 Payment - The accepted quantities of water and additives will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Watering.....	M-Gallon
(b) _____ in Watering.....	Gallon

Item (a) includes furnishing and developing the water supply, hauling and applying the water.

In item (b), the name of the additive will be inserted in the blank.

Item (b) includes furnishing the specified additive, for combining and mixing it with the water, and for all extra costs involved in the use of the additive in the watering work not included in item (a).

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

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No separate or additional payment will be made for obtaining permits, water rights, or any other costs related to complying with the "Oregon Water Laws".

When the Contract Schedule of Items does not indicate payment for work performed under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this work is required.

00340.91 Quantity Variations - Payment for watering items performed beyond 25 percent of the quantity shown in the Contract Schedule of Items will be made at the Contract unit price if the Engineer determines that the Contract unit price does not exceed the value of the work according to Section 00197. If the Engineer determines that the Contract unit price exceeds the value of the work, payment for the additional work will be made according to 00195.20.

Section 00344 - Treated Subgrade

Description

00344.00 Scope - This work consists of treating the upper layer of subgrade with water and either lime, chloride, or portland cement to form a stabilized course of material at the locations and to the lines, grades, thicknesses, and cross section shown or directed.

00344.01 Definitions:

Treated Subgrade - Subgrade which is improved by the addition of soil stabilizing materials.

Materials

00344.10 Soil Stabilizing Materials - Furnish soil stabilizing materials meeting the following requirements:

Material	Type	Requirements
Hydrated Lime	AASHTO M 216, Type 1	Grade A
Granular Quicklime (CaO)	AASHTO T 27 and AASHTO T 219 (grading and hydroxide content)	100% passing 3/8" sieve 15% max. passing No. 100 sieve min. 85% Calcium Hydroxide
Calcium Chloride	AASHTO M 144 (sampling) AASHTO T 143 (testing)	-
Sodium Chloride	AASHTO M 143	-
Portland Cement	AASHTO M 85	Section 02010

Store materials according to 00165.75.

00344.11 Water - Furnish water meeting the requirements of Section 00340.

Construction

00344.40 Preparation - Before starting subgrade work, including backfill, complete all underground work contemplated in the area of the subgrade. This requirement includes work by the Contractor, by the owner or by others. Drain all depressions or ruts which contain water.

00344.41 Addition of Stabilizing Material - Apply stabilizing materials at a uniform rate as specified using equipment and methods that will ensure uniformity of distribution. The use of blade graders to distribute lime will not be allowed. Allow only equipment that is used for watering, applying and mixing the stabilizing material to pass over the material until after it is mixed into the soil. Add water, if necessary, during mixing operations to provide optimum moisture content.

00344.42 Mixing - Perform mixing operations until the treated subgrade material is uniform and free of streaks or pockets and all material, other than stones, will pass a 1 inch sieve. Do not allow the content of stabilizing material to vary by more than plus or minus 1 percent from the amount specified.

00344.43 Finishing - Immediately after mixing the treated subgrade, grade the mixture to specified line, grade and cross section and compact the mixture to the specified density. Compact and finish within 12 hours after compaction begins. If the Contractor has not compacted and finished the material within 12 hours, loosen the mixture and add stabilizing material and water as directed. Remix the freshened material, regrade and recompact, at no additional cost to the Agency. During

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compaction, maintain the mixture at proper grade and cross section and at optimum moisture content.

00344.44 Curing - Limit traffic over treated subgrade to equipment which do not cause any damage to the subgrade and which do not visibly deflect, ravel or wear the surface. Keep the finished surface moist and protect from rutting, spalling, displacement and disfiguration for a period of 7 days, or until a subsequent course of material is placed which will prevent drying of the mixture by evaporation or absorption.

00344.45 Compaction:

(a) Achieve the required density of treated subgrade materials as specified in 00330.43(b).

(b) Compact the subgrade until it is firm and unyielding. Unyielding means no more than 1/4 inch deflection of the subgrade when proof-rolled with a fully loaded 10 to 12 cubic yard dump truck. Test and proof-roll within 24 hours prior to placing base material on the subgrade.

(c) Over-excavate areas of visible deflection to a depth of 12 inches or more below subgrade, as directed. Place fabric, backfill the over-excavated subbase area up to the subgrade elevation with a single lift of 1 1/2" - 0 crushed rock and compact. Apply the compactive effort until the density of the top 6 inches of the subbase rock is as specified in 00641.44(a). In addition, proof-roll these areas to verify they are firm and unyielding as specified above.

(d) Notify the Engineer if the specified compaction is not attained. The Contractor may be required to use a modified compaction procedure or apply additional compactive effort. If approved materials meeting the specifications cannot be compacted to the required density regardless of compactive effort or method, the engineer may reduce the required density or direct that alternative material be used. Do not proceed with finishing or compaction of the subgrade until the Contractor is able to compact the material to the satisfaction of the Engineer.

00344.46 Tolerances:

(a) Rework areas found to be deficient in thickness by more than 1/2 inch, and add fresh stabilizing material in an amount equal to one-half the original amount.

(b) Finish the surface of the treated subgrade so that it does not vary by more than 1/2 inch from the established grade and cross section at any point. When tested with a 12 foot straightedge, the maximum variation of the finished surface from the testing edge is 1/2 inch.

Measurement

00344.80 Measurement - The quantities of treated subgrade will be measured on the area basis, measured along the lines and grades of the area actually treated.

The quantities of soil stabilizing materials will be measured on the dry weight basis. Packaged materials will be accepted at the net weight shown by the manufacturer, subject to periodic verification and approval. Provide a certificate with each shipment together with a certified copy of the weight of each delivery. Measurement of stabilizing material will not include any which is lost, displaced, used in reworking, used in restoration work or used contrary to direction.

Payment

00344.90 Payment - The accepted quantities of treated subgrade and soil stabilizing materials will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Treated subgrade, ___ inches Thick.....	Square Yard
(b) Lime	Ton
(c) Portland Cement	Ton
(d) Calcium Chloride.....	Ton
(e) Sodium Chloride	Ton

In item (a), the depth of the treated subgrade will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- draining water from the subgrade
- soil stabilization work
- smoothing the subgrade in preparation for staking
- blading, shaping and compacting the subgrade, including roadbed materials, to final line, grade and cross section

Section 00350 - Geosynthetic Installation

Description

00350.00 Scope - This work consists of furnishing and placing geotextile in drains, under embankments, for embankment reinforcement, under riprap, buttresses, inlays, shear keys, over roadbed subgrades, and beneath pavement overlays as shown or directed.

00350.01 Definitions - Terms not defined in this subsection may be found in ASTM D 123 and ASTM D 4439. If there is a conflict, definitions in this subsection take precedence.

Cross-Machine Direction - The direction in the plane of the fabric perpendicular to the direction of manufacture.

Drainage Geotextile - For installation as a filter in subsurface drains or other drainage locations.

Embankment Geotextile - For installation as a reinforcement within embankments and/or as a separator under embankments.

Geosynthetics - A planar product manufactured from polymeric material used with soil, rock, earth or other geotechnical, engineering related material as an integral part of a man-made product, structure or system.

Geogrid - A geosynthetic used for reinforcement which is formed by a regular network of tensile elements with apertures of sufficient size to allow strike-through of surrounding soil, rock or other geotechnical material.

Geotextile - A permeable geosynthetic comprised solely of textiles.

- **Nonwoven Geotextile** - A textile produced by bonding and/or interlocking of fibers by mechanical, heat or chemical means.
- **Woven Geotextile** - A textile comprising of two or more sets of filaments or yarns interlaced in such a way that they result in a uniform pattern.

Machine Direction - The direction in the plane of the fabric parallel to the direction of manufacture.

Pavement Overlay Geotextile - For installation as a reinforcement beneath an asphalt concrete overlay.

Riprap Geotextile - For installation as a filter and/or separator behind or beneath riprap, buttresses, inlays, shear keys and/or erosion control applications.

Roll - Unit of continuous geosynthetic without transverse seams as furnished by the manufacturer. Roll sizes may vary between manufacturer's and types of geosynthetics.

Roll Values:

- **Average Roll Value** - The average roll value for each property is determined by testing a representative number of samples in a roll according to the test methods specified in Section 02320. An average of these tests becomes the average roll value for each roll tested.

- **Minimum Average Roll Value** - The minimum average roll value for each property is the mean of the average roll values for all rolls tested minus two standard deviations, all as determined by the manufacturer. The minimum average roll value for each property is determined by testing a representative number of rolls in a production run according to ASTM D 4354 sampling procedures and the test methods specified in Section 02320.
- **Minimum Value** - The minimum value is the specified value for each geosynthetic property that shall be met or exceeded by the manufacturer's minimum average roll value for the production run and, if sampled and tested by the Agency, by the average roll value for any roll.

Seam Allowance - The minimum distance from the edge of a geotextile to the stitch line nearest to that edge.

Seam Type - A designation relating to the essential characteristics of geotextile positioning and rows of stitching in a specified sewn seam as shown on the plans.

Selvage - The finished edge of a geotextile parallel to the machine direction.

Stitch Type - A designation relating to the essential characteristics of the interlacing of sewn threads in a specified seam as shown on the plans.

Subgrade Geotextile - For installation as a separator and/or reinforcement on subgrades and in other material separation applications.

Ultraviolet Rays - Direct radiation from the sun during daylight hours, even on cloudy days.

Ultraviolet Stability - The ability of a geosynthetic to resist deterioration when exposed to UV radiation.

Materials

00350.10 Materials - Furnish materials meeting the requirements of Section 02320.

Equipment

00350.20 Field Seam Stitching Equipment - Use field seam stitching equipment that provides an acceptable lock-type stitch as recommended by the geotextile manufacturer and approved by the Engineer.

00350.21 Asphalt Distributor - Design, equip, maintain, and operate the asphalt distributor according to 00730.22.

Construction

00350.40 General - Provide geosynthetic as furnished by the manufacturer and protect against damage and deterioration. Prevent excessive mud, wet concrete, epoxy and like materials from coming in contact with the geosynthetic. Store all geosynthetics in a dry place and off the ground at all times according to ASTM D 4873. Cover all geosynthetics with a dark protective covering when received. The geosynthetic will be rejected for use if the Engineer determines it has defects or deterioration, or has been damaged.

00350.41 Geotextile Installation Requirements:**(a) General:****(1) Placement:**

a. Surface Preparation - Prepare the surface receiving the geotextile to a smooth condition free of obstructions, depressions and debris unless otherwise directed. Do not drag the geotextile on the ground or mishandle in any way.

Loosely place the geotextile without wrinkles so placement of the overlying material will not tear the geotextile. Lap or sew the geotextile at the ends and sides of adjoining sheets as specified.

b. On Slopes - Place the geotextile with the machine direction oriented up-down the slope. Lap the upper sheets over the lower sheets. When the geotextile is placed on a slope steeper than 6V:1H, securely anchor the laps to the ground surface with pins or stakes as necessary to prevent the slippage and tearing of the geotextile. Start placement of fill material on the geotextile at the toe of the slope and proceed upwards.

c. Where Exposed To Water - If geotextiles are placed under water or in areas where water will flow, the geotextile may be placed with the machine direction parallel to the direction of water flow instead of the placement direction specified in 00350.41(a-1-b). Overlap sheets so the upstream sheet is placed over the top of the downstream sheet. Adequately secure the geotextile to prevent slippage. As the geotextile is placed under water, place the backfill material on it to the required thickness. Do not place geotextile more than 50 feet ahead of the specified cover material.

(2) Overlaps - Minimum overlap requirements for geotextiles are:

Application	Minimum Overlap Requirements (Inch)
Drains	12
Embankment Stabilization	24
Pavement Overlays	*
Riprap and Rock Buttresses	24
Roadbed Subgrade Stabilization	24

* Use sufficient overlap to ensure closure, but not more than 6 inches.

If the Engineer determines the specified overlap is not sufficient, increase the overlap to provide adequate coverage or, if approved by the Engineer, sew the geotextile together in the field. If field sewn, the provisions of 00350.20 and 00350.41(a-3) apply.

(3) Field Seams:

a. General - When field sewn seams are required, make them as follows:

Sew field seams with polymeric thread consisting of polypropylene, polyester or kevlar, and as resistant to deterioration as the geotextile being sewn. Use a color of thread that contrasts with the geotextile being sewn so the stitches are exposed for inspection when the geotextile is placed. Seams shall meet the testing requirements of 02320.11(b).

b. Stitch Requirements - Use two rows of lock-type stitching, Type 401, to make the seams, as shown. The two rows of stitching shall be 1/2 inch apart with a tolerance of plus or minus 1/4 inch and not cross except for restitching.

c. Minimum Seam Allowance - The minimum seam allowance (the minimum distance from the edge of geotextile to the nearest stitching) is:

Seam Type (See Plans)	Minimum Seam Allowance (Inch)
Flat or Prayer Seam, Type SSa-1	1 1/2
"J" Seam, Type SSn-1	1
Butterfly-folded Seam, Type SSd-1	1

d. Seam Type - Obtain the geotextile manufacturer's recommendation for the type of seam and stitch to be used. If the Contractor does not obtain and provide the foregoing technical information use a "J" seam with at least three stitches per 1 inch. The flat, or prayer, seam may be used for repair of damaged in-place geotextile.

(4) Protection of Geotextile - Protect the geotextile at all times from ultraviolet (UV) rays, contamination by surface runoff and construction activities.

Traffic or construction equipment will not be allowed directly on the geotextile except as authorized in 00350.41(f-5) or as directed.

During installation cover the geotextile with specified cover material as soon as possible. Do not leave in uncovered condition for more than 5 days.

Place cover material on the geotextile in such a manner that the geotextile is not torn, punctured or shifted. Use a minimum 6 inch thick cover layer or twice the maximum aggregate size, whichever is thicker. Do not end-dump cover material directly on geotextiles other than riprap geotextile.

Limit construction vehicles in size and weight so rutting in the initial layer above the geotextile is not more than 3 inches deep or half the layer thickness, whichever is lesser. Do not turn vehicles on the first layer.

(5) Repair of Geotextile - Repair or replace all torn, punctured or contaminated geotextiles during construction at no cost to the Agency. Repair by placing a patch of the specified geotextile over the affected area. Overlap the existing geotextile with the patch according to 00350.41(a-1). Where geotextile seams are required to be sewn, repair any damaged sheet by sewing unless otherwise indicated on the plans or Special Provisions, or as directed.

(b) Drainage Geotextile - When used in trenches for drains, place the geotextile in the trench as shown on the plans to loosely conform to the shape of the trench with no wrinkles or folds.

(c) Embankment Geotextile - Construct embankment stabilization according to details shown on the plans. Place the geotextile layers so the geotextile machine direction is transverse to the embankment centerline. Spread the geotextile so all slack and wrinkles are eliminated. Construct embankment in uniform layers according to Section 00330.

(d) Riprap Geotextile - Place geotextile behind and beneath riprap, buttresses, inlays, shear keys and erosion control applications according to the details shown. Demonstrate to the satisfaction of the Engineer that the combination of the rock-fill drop height and the thickness of any aggregate cushion, when specified or required, is adequate to prevent puncturing or damaging the geotextile when placing the riprap or stone embankment material. If an aggregate cushion is used, place according to 00350.41(a-4). In addition, the following limits apply:

Maximum Drop Height (Feet)

Size of Rock	Onto Geotextile Material	Onto an Aggregate Cushion Blanket
Greater than 200 pounds	0	3
200 pounds or less	3	3

After placing the riprap, backfill all voids in the riprap face so the geotextile is completely covered and not visible.

(e) Subgrade Geotextile - For roadbed subgrade separation, prepare the subgrade according to Section 00330.

Correct geotextile failures, as evidenced by soil pumping or roadbed distortion, by removing any covering material in the affected area and placing a geotextile patch on the exposed geotextile according to 00350.41(a-5). Cover the patch with the specified cover material and compact before proceeding.

(f) Pavement Overlay Geotextile:

(1) General - Place geotextile and pavement overlay in four basic steps:

- Surface preparation
- Sealant application
- Geotextile placement
- Overlay placement

(2) Weather Limitations - Do not place sealant and geotextile unless the weather limitations of 00745.40 are met, as appropriate, except the minimum air temperature shall be 50° F for paving grade asphalt sealant placement and 60° F for asphalt emulsion sealant placement.

(3) Surface Preparation - Prepare the pavement surface on which the sealant is to be placed according to 00730.42 and the following:

- Clean and fill cracks exceeding 1/8 inch width with a bituminous crack filler from the QPL.
- Repair minor irregularities or depressions as directed.
- Allow crack filling material to cure before placing geotextile.
- Where the pavement is severely cracked, rutted, deformed or otherwise distressed, place a leveling course as directed instead of extensive surface preparation.

(4) Sealant Application - Use a normal paving grade asphalt. A cationic or anionic emulsion may be used as approved. Do not use cutbacks or emulsions that contain solvents.

Uniformly spray the asphalt sealant at normal application temperature by means of a pressure distributor conforming to 00350.21 on the prepared dry pavement surface. Apply at the rate of 0.20 - 0.30 gallon per square yard, or as recommended by the geotextile manufacturer or as directed.

If using emulsions, increase the application rate 50 percent or as directed. Some underlying surfaces may require a higher application rate. Within street intersections, on steep grades or in other zones where vehicle speed changes are commonplace, reduce the normal application rate by 20 percent or as directed.

The target width of the sealant application shall be the geotextile width plus 6 inches. Apply the sealant only as far in advance of the geotextile installation as appropriate to ensure a tacky

surface at the time of geotextile placement. Place the geotextile the same day as the sealant. Do not allow traffic on the sealant. Clean excess asphalt from the road surface.

(5) Geotextile Placement - Place the geotextile into the sealant using mechanical or manual laydown equipment capable of providing a smooth installation with a minimum amount of wrinkling or folding from the water (break) before placing the geotextile.

Slit wrinkles or folds exceeding 1 inch and lay flat. Shingle-lap not more than 6 inches in the direction of the paving. Broom and/or pneumatic roll to maximize geotextile contact with the pavement surface. Additional hand-placed sealant material may be required at laps as determined.

Limit traffic to necessary construction equipment and emergency vehicles on the geotextile before and during paving unless otherwise directed. Turn the paver and other vehicles gradually. Keep turning to a minimum to avoid geotextile movement and damage. Avoid abrupt starts and stops.

(6) Overlay Placement - Place the overlay the same day the geotextile is placed. Remove sealant that bleeds through the geotextile. Do not windrow asphalt concrete material on the geotextile ahead of the paving machine. Do not use an asphalt concrete material pickup machine.

Measurement

00350.80 Measurement - The quantities of each geosynthetic installation will be measured on the area basis along the lines and grades of the surface area actually covered as shown or as required, except for drainage applications.

The quantities of drainage geotextile will be measured on the area basis, computed by multiplying the length of the trench where geotextile is used by the perimeter of the trench as determined from the neat lines shown, or as directed.

Payment

00350.90 Payment - The accepted quantities for geosynthetics will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Drainage Geotextile, Type ____	Square Yard
(b) Embankment Geotextile.....	Square Yard
(c) Riprap Geotextile, Type ____	Square Yard
(d) Subgrade Geotextile	Square Yard
(e) Pavement Overlay Geotextile	Square Yard

In items (a) and (c), the type of geotextile will be inserted in the blank.

Item (e) includes preparation work, sealant, and geotextile.

Payment will be payment in full furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for constructing laps, seams, joints, and patches unless the Engineer orders additional amounts over the minimum. For laps wider than the minimum or specified width, payment will be made for the added lap width at the Contract unit price.

00350

If the Engineer orders geosynthetics with properties more stringent than specified, a price adjustment will be allowed only for the difference in material cost.

Section 00360 - Drainage Blankets

Description

00360.00 Scope - This work consists of furnishing and placing drainage blanket material to the lines, grades and dimensions shown on the plans or as directed.

Materials

00360.10 Sand Drainage Blanket - Furnish sand drainage blanket material meeting the following gradation limits determined by AASHTO T 27 and AASHTO T 11:

Sieve Size	Percent Passing
No. 10	95 - 100
No. 40	50 - 100
No. 60	20 - 40
No. 200	0.0 - 5.0

00360.11 Granular Drainage Blanket - Furnish granular drainage blanket material that is clean, free draining, durable crushed or uncrushed rock, meeting the following gradation limits determined by AASHTO T 27:

Sieve Size	Percent Passing
6"	100
4"	90 - 100
1/2"	60 - 80
No. 10	0 - 10
No. 100	0 - 5

Granular drainage blanket material will be accepted without testing if the Engineer visually determines the material meets the above requirements.

00360.12 Reclaimed Glass - Reclaimed glass meeting the requirements of Section 02695 may be used as a substitute for sand drainage blanket and granular drainage blanket material.

00360.15 Quality Control - Provide quality control according to Section 00165.

Equipment

00360.20 General - Use equipment capable of hauling, spreading and compacting the material to specified density without segregation.

If drainage blanket material is used to drain areas described in 00360.41, hauling with end dump trucks and spreading with bulldozers and other appropriate equipment will be allowed.

Labor

00360.30 Quality Control Personnel - Provide technicians having CEBT, CAgT, and CDT technical certifications.

Construction

00360.40 Planned Locations - On prepared excavations or embankments constructed as shown on the plans or as directed, place the drainage blanket as follows:

- Spread and compact to required depth with no layer exceeding 3 feet.
- If a subsurface drain system is installed immediately under or adjacent to the drainage blanket, place the drainage blanket directly against the subsurface drain system.
- Prevent contamination of drainage blanket material.

00360.41 Other Locations - When used to drain an unstable or wet area, excavate or trench the existing low areas as directed for positive drainage before placement of drainage blanket material.

00360.42 Compaction and Density Requirements - Compact the drainage blanket according to 00330.43.

Measurement

00360.80 Measurement - The quantities of sand and granular drainage blanket material will be measured on the volume basis in place and will be limited to the neat lines, grades, and dimensions shown or directed, or on the weight basis.

Payment

00360.90 Payment - The accepted quantities of sand and granular drainage blankets will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Sand Drainage Blanket	Cubic Yard or Ton
(b) Granular Drainage Blanket.....	Cubic Yard or Ton

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00370 - Finishing Roadbeds

Description

00370.00 Scope - This work consists of the following:

- **Within Roadbed Cross Section** - Trimming, shaping, and finishing the subgrade, ditches, slopes, and other graded surface areas to the lines, grades, cross sections, and condition specified.
- **Outside Roadbed Cross Section** - Obliterating surfacings by removing existing paved surfaces, and loosening, breaking up, and spreading the existing bases lying outside the new roadbed cross section and blending into the adjacent terrain.

If existing paved surfaces and bases are to be excavated and removed, then performance, measurement, and payment of the work will be according to Section 00330.

Construction

00370.40 Within Roadbed Cross Section - After the roadbed earthwork has been substantially completed, do the following:

(a) Subgrade:

- Remove vegetative growth.
- Excavate unstable subgrade material, and backfill according to 00330.41(a-9).
- Trim and shape the entire subgrade to be free of ruts, depressions and irregularities.
- Compact all fills according to 00330.43.
- Finish the surface to within a tolerance of plus or minus 3/4 inch or as directed.

(b) Ditches:

- Remove all litter, debris and obstructions.
- Trim and shape to neat lines all ditches, channels and canals provided for waterways.

(c) Slopes:

- Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.
- Make roadbed embankment slopes as smooth, safe and slightly as practical with the materials used to construct the embankments.
- Trim and shape all excavation and embankment side slopes.

(d) Structure Sites:

- Clean out all sewers, culverts, drains, and their appurtenances constructed under the Contract.
- Remove all extraneous matter in the vicinity of bridge ends, culvert ends, inlets, walls, and other areas.
- Trim and shape the cleaned areas.

(e) Disposal of Materials - Dispose of all materials removed in 00370.40(a) through 00370.40(d) according to 00290.20.

00370.41 Outside Roadbed Cross Section - Remove existing paved surfaces, if any, loosen the remaining bases and surfacings by scarifying, plowing, vibrating, rolling and/or other means, to a depth of at least 12 inches, or to solid rock, whichever is the lesser depth.

- Break the loosened materials into fragments having no dimension greater than 3 inches, unless the aggregate in the original material exceeds that size.
- Spread and mix the loosened and broken materials, and blend them into the adjacent terrain as directed.

Maintenance

00370.60 Maintenance - Maintain the finished work in its finished condition until final completion of the Contract work, or until it is covered with a subsequent course of material placed under the Contract.

Measurement

00370.80 Measurement - No measurement of quantities will be made for work performed under this Section.

Payment

00370.90 Payment - The accepted work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Finishing Roadbeds	Lump Sum
(b) Obliterating Surfacing.....	Lump Sum

Item (a) includes trimming, shaping and finishing the subgrade, ditches, and slopes, including areas occupied by approach roads, road connections, interchanges, ramps, frontage roads, multiple lanes, and any other areas on which earthwork is performed under this Contract.

Item (b) includes removing existing paved surfaces, and loosening, breaking up, spreading, and mixing the old bases lying outside the new roadbed cross section and blending into the adjacent terrain.

Payment will be payment in full for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Excavation of unstable subgrade material and backfill will be paid for according to 00330.90.

When the Contract Schedule of Items does not indicate payment for the work under this Section, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this work is required.

Section 00390 - Riprap Protection

Description

00390.00 Scope - This work consists of furnishing and placing an erosion resistant cover material for protecting slopes and basins at locations shown or as directed.

00390.01 Definitions:

Riprap Geotextile - A geotextile placed between the area prepared for it and the riprap.

Filter Blanket - A layer of graded granular material placed between the area prepared for it and the riprap.

Riprap Backing - An option of using either riprap geotextile or a filter blanket placed between the area prepared for it and the riprap.

Loose Riprap - Specified classes of graded rock placed on prepared slope, riprap geotextile or filter blanket, as specified.

Keyed Riprap - Loose riprap placed on prepared slope, riprap geotextile or filter blanket, as specified, and keyed in place by slapping the surface with a piece of armor plating.

Grouted Riprap - Loose riprap with all or part of the spaces filled with Portland cement mortar.

Riprap Basin - Energy dissipater consisting of loose riprap placed at pipe outlets as specified.

Materials

00390.10 Riprap Geotextile - Furnish riprap geotextile meeting the requirements of Section 02320.

00390.11 Riprap Requirements:

(a) **General** - Furnish rock for loose riprap meeting the following requirements:

- Meet the test requirements of 00390.11(b).
- Be angular in shape. Thickness of a single rock shall not be less than one-third its length. Rounded rock will not be accepted unless authorized by the Engineer.
- Meet the gradation requirements for the class specified.
- Be free from overburden, spoil, shale and organic material. Non-durable rock, shale or rock with shale seams is not acceptable.

(b) **Test Requirements** - Furnish the rock meeting the following test requirements:

Material Test	Requirement
Apparent Specific Gravity (AASHTO T 85)	2.50 Minimum
% Absorption (AASHTO T 85)	6.0 Maximum
Degradation (ODOT TM 208)	
Passing No. 20 Sieve	35.0% Maximum
Sediment Height	8.0" Maximum
Soundness (AASHTO T 104)	
Average Loss of 2 1/2" - 1 1/2" and 1 1/2" - 3/4" fraction after 5 alternations	16.0% Maximum

(c) Gradation Requirements - Grade loose riprap by class and weight of rock according to the following:

Class 50	Class 100	Class 200	Class 700	Class 2000	Percent (by Weight)
Weight of Rock (Pounds)					
50 - 30	100 - 60	200 - 140	700 - 500	2000 - 1400	20.0
30 - 15	60 - 25	140 - 80	500 - 200	1400 - 700	30.0
15 - 2	25 - 2	80 - 8	200 - 20	700 - 40	40.0
2 - 0	2 - 0	8 - 0	20 - 0	40 - 0	10.0 - 0

Uniformly grade each load of riprap from the smallest to the largest weight specified. Control of gradation will be by visual inspection.

(1) Control Sample - If directed, provide, at a satisfactory location near the Project, a rock sample of at least 5 tons meeting the gradation for the class specified. This sample will be used as a frequent visual reference for judging the gradation of the riprap supplied.

(2) Sampling and Testing Assistance - Any difference of opinion between the Engineer and the Contractor shall be resolved by dumping and checking the gradation of two random truck loads of rock. Mechanical equipment, a sorting site and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Agency.

00390.12 Grouted Riprap - Furnish rock for grouted riprap meeting the requirements of 00390.11, and furnish the Portland cement grout meeting the requirements of 02080.40.

00390.13 Filter Blanket - Furnish filter blanket materials meeting the following requirements according to riprap class:

Riprap Class	Filter Blanket
Class 2000	16 inch layer of Class 50 riprap conforming to 00390.11
Class 700	9 inch layer of 6" - 0 stone embankment meeting the test requirements of 00330.16
Class 200	6 inch layer of 4" - 0 stone embankment meeting the test requirements of 00330.16
Class 100	No filter blanket required
Class 50	No filter blanket required

Construction

00390.40 Preparation - Remove brush, trees, stumps and other organic material from slopes to be protected by riprap and dress to a smooth surface. Remove all unsuitable material to the depth shown or directed and replace with approved material. Compact filled areas as specified in Section 00330.

Provide riprap protection as early as the structure foundation construction permits. Prepare the surfaces to be protected as shown. Maintain the trench slopes, riprap geotextile or filter blanket until the riprap is placed.

00390.41 Riprap Geotextile - If required, install riprap geotextile according to the requirements of Section 00350 and as shown or directed.

00390.42 Filter Blanket Construction - If required, place the filter blanket on the prepared area to the full specified thickness in one operation, using methods which will not cause segregation. The surface of the finished layer shall be reasonably even.

00390.43 Riprap Backing - When allowed in the Special Provisions or indicated on the plans, the Contractor shall have the option of placing either riprap geotextile or a filter blanket behind the riprap. Install the backing according to 00390.41 or 00390.42.

00390.44 Riprap:

(a) General - Unless otherwise directed, place the riprap protection as the embankment is constructed. Its placement shall lag behind embankment construction only as necessary to allow proper embankment construction and prevent mixture of embankment and riprap material.

(b) Loose Riprap - Place riprap on the prepared area:

- With a clam-shell, orange-peel bucket, skip or similar approved device which will contain the riprap material to its final destination. Do not open the bucket until it has been lowered to the slope on which the material is being placed.
- To its full course thickness in one operation.
- According to 00350.41(d), if riprap is placed on geotextile.
- By methods that do not cause segregation of riprap or displace the underlying material.
- To produce a compact riprap protection in which all sizes of material are placed in their proper proportion.
- With some hand placing, or rearranging of individual stones by mechanical equipment, or some other approved means to provide a smooth finished surface.

Where filter material and/or riprap are placed under water, increase their thicknesses as shown or as directed.

(c) Keyed Riprap - After placing loose riprap material according to 00390.44(a) and 00390.44(b), key the riprap into place by slapping the surface with a piece of armor plating (approximately 4 feet x 5 feet in size weighing approximately 5,000 pounds) or other approved means which will produce a nearly smooth surface.

(d) Grouted Riprap - Place loose riprap material according to 00390.44(a) and 00390.44(b). If the depth specified for grouting is more than 12 inches, place the riprap in lifts of 12 inches or less and grout each lift before placing the next lift. Construct and grout the succeeding lifts before the grout in the previous lift has hardened.

Thoroughly moisten the stones and sluice any excess fines to the underside of the riprap before grouting. Deliver the grout to the place of final deposit by any means that will ensure uniformity and prevent segregation of the grout. Spade or rod the grout into the spaces to completely fill the voids in the riprap. Control pressure grouting and do not unseat the stones. Penetration of the grout shall be to the depth shown on the plans. If a rough surface is specified, brush the stone

until 25 to 50 percent of the depth of surface stone is exposed. For a smooth surface, grout the crevices to within 5/8 inch of the surface.

Provide weep holes through the riprap as shown or as directed.

Place and cure grout according to 00440.40(d) and 00440.40(e) except as provided above.

(e) Riprap Basins - Excavate, backfill and construct riprap basins, without a riprap geotextile or filter blanket, at pipe outlets with Class 50 riprap as shown or as directed.

Maintenance

00390.60 General - Maintain the riprap protection until accepted. Replace any material displaced by any cause at no additional cost to the Agency.

Measurement

00390.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Filter Blanket - Filter blanket will be measured on the area basis of the finished surface, limited to the neat lines shown or directed.

(b) Riprap Backing - Riprap backing will be measured on the area basis of the finished geotextile or the filter blanket surface, limited to the neat lines shown or directed.

(c) Riprap - Riprap will be measured on the volume basis in place or on the weight basis.

When measurement of riprap is on the volume basis in place and the Engineer determines that this basis is impractical, the pay volume will be determined by loose measure in the hauling vehicles on the basis that 1.00 cubic yard, vehicle measure, is equivalent to 0.70 cubic yard in place.

(d) Riprap Basins - Riprap basins will be measured on a unit basis of basins constructed.

Payment

00390.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Filter Blanket.....	Square Yard
(b) Riprap Backing.....	Square Yard
(c) Loose Riprap, Class ____.....	Cubic Yard or Ton
(d) Grouted Riprap, Class ____.....	Cubic Yard or Ton
(e) Keyed Riprap, Class ____.....	Cubic Yard or Ton
(f) Riprap Basins.....	Each

In items (c), (d), and (e), the class of riprap will be inserted in the blank.

Item (d) includes the grout.

Riprap geotextile will be paid for according to 00350.90, except when it is included in item (b).

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00396 - Shotcrete Slope Stabilization

Description

00396.00 Scope - This work consists of constructing pneumatically applied shotcrete stabilization blankets onto slope surfaces at locations shown or as directed.

00396.01 Definitions, Standards, and Requirements:

Requirements - Design the shotcrete mix and be responsible for the quality of shotcrete used in the work.

Shotcrete - Either dry-mixed or wet-mixed material composed of portland cement, fine and coarse aggregate, water and reinforced with either welded wire fabric or steel fibers.

Standards - Construct shotcrete according to these Specifications and applicable sections of the latest edition of the American Concrete Institute's "Guide to Shotcrete" (ACI 506).

Materials

00396.10 Materials - Furnish materials meeting the following requirements:

Bar Reinforcement	02510.10
Cement (Type I or II)	02010.10
Chemical Admixtures	02040
Coarse Aggregate	02690.20
Curing Materials	02050.10
Fine Aggregate.....	02690.30
Grout.....	02080.20
PVC Pipe.....	02415
Water.....	02020
Welded Wire Fabric.....	02510.40

00396.11 Prepackaged Product - Premixed and prepackaged concrete products, with or without steel fibers, manufactured as a shotcrete product may be used for on-site mixed shotcrete if the materials meet this specification and if approved.

00396.12 Aggregates - Combined fine and coarse aggregates shall meet the following grading requirements as determined by AASHTO T 27:

Sieve Size	Percent Passing (by Weight)
1/2"	100
3/8"	90 - 100
No. 4	70 - 85
No. 8	50 - 70
No. 16	35 - 55
No. 30	20 - 35
No. 50	8 - 20
No. 100	2 - 10

00396.13 Steel Fiber Reinforcement - If steel fiber reinforced shotcrete is required, the steel fibers shall:

- Be between 1/2 inch and 1 1/2 inches long.

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- Meet the requirements of ASTM A 820 Type 1, Deformed.
- Have a length to diameter ratio of less than 80.
- Have a minimum tensile strength of 160,000 psi.

Only steel fibers manufactured specifically for use in shotcrete applications will be allowed. The steel fiber content shall not be less than 100 pounds per cubic yard of shotcrete.

00396.14 Acceptance Sampling and Testing:

(a) General - Prepare shotcrete test panels on vertically supported open face molds. The molds shall:

- Have internal dimensions of at least 18 inches x 18 inches x 4 inches.
- Be rigid, nonabsorbent and nonreactive with cement.

Place the shotcrete in the molds utilizing the same shotcrete mix, air and water pressure, and nozzle tip that will be used in the actual placement of shotcrete on production surfaces. Protect the panels for at least 24 hours or until final set has taken place.

(1) Preproduction Testing - Prepare at least two test panels for each mix design for testing. Cure the test panels in a manner similar to the anticipated field conditions. Provide a copy of the mix design and the compressive strength test results to the Engineer at least 7 calendar days before starting any production work. Do not begin production shotcrete work until satisfactory test results are obtained.

(2) Production Testing - Prepare, in the presence of the Engineer, at least two test panels daily for each nozzle person during shotcrete operations, plus one test panel shot whenever the nozzle equipment is changed during the daily work period. Cure the shotcrete panels under the same conditions as the production shotcrete.

(b) Compressive Strength Tests:

(1) Compressive Test Cores - Obtain 3 inch diameter test cores from the cured shotcrete test panels prepared according to 00396.14(a-1) and 00396.14(a-2). Use a 3 inch inside diameter core bit to obtain cores.

(2) Shotcrete Compressive Strength - The shotcrete cores shall attain 2,500 psi compressive strength at 7 calendar days (1,800 psi at 3 calendar days) as determined by AASHTO T 22. The production testing cores obtained by the Contractor will be tested by the Agency.

(c) Failure Of Shotcrete - If any shotcrete section is deficient in any of the specified criteria, remedy that section as directed at no additional cost to the Agency. The remedies may include, but are not limited to, removal and replacement of the deficient section.

Equipment

00396.20 General - Provide mixing equipment capable of thoroughly mixing the materials in sufficient quantity to maintain uniform and continuous application.

00396.21 Pump System - The pump system that conveys premixed shotcrete ingredients shall deliver a uniform and continuous flow of material, without segregation or loss of the ingredients.

00396.22 Air Compressor - The air compressor shall be capable of providing:

- A supply of clean air adequate for maintaining sufficient nozzle velocity for all parts of the work and for the simultaneous operation of a blow pipe for clearing away rebound.
- A minimum of 250 cubic feet per minute per operating nozzle.

00396.23 Dry-Mix Delivery Equipment - Dry-mix delivery equipment shall be capable of discharging the aggregate-cement mixture into the delivery hose and deliver a continuous stream of uniformly mixed material to the discharge nozzle. Equip the discharge nozzle with a manually operated water injection system (water ring) for directing an even distribution of water through the aggregate-cement mixture. The water valve shall be capable of ready adjustment to vary the quantity of water, and be convenient to the nozzle person. Provide greater water pressure than the operating air pressure at the discharge nozzle to assure that the water is thoroughly mixed with the other materials. Use steady, nonpulsating water pressure. Regularly inspect and replace equipment parts, especially the nozzle liner and water ring, as necessary or directed.

When prepackaged material is used, predampening (also referred to as premoisturizing) equipment shall be used.

00396.24 Wet-Mix Delivery Equipment - Wet-mix delivery equipment shall be capable of discharging the premixed materials into the delivery hose and delivering a continuous stream of uniformly mixed material to the discharge nozzle. Follow the manufacturer's recommendations on the type and size of nozzle to be used, and on cleaning, inspection and maintenance of the equipment.

Labor

00396.30 Qualifications - At least 7 calendar days before beginning shotcrete work, provide written evidence that the on-site supervisor, nozzle operator, and delivery equipment operator have performed satisfactory work in similar capacities elsewhere for a sufficient length of time to be fully qualified to perform their duties.

The on-site supervisor shall have not less than 2 year's full-time experience as a shotcrete nozzle operator. The nozzle operator and delivery equipment operator shall have served at least 1 year of full-time apprenticeship on similar applications with the same type of equipment. Before starting shotcrete work, the nozzle operator shall, in the presence of the Engineer, demonstrate their ability to apply shotcrete on a mold for a test panel according to 00396.14. The nozzle operator, before permission is given to place shotcrete in permanent construction, shall make one satisfactory test panel for each mix used during the course of the work.

Construction

00396.40 Surface Preparation - Before applying shotcrete to rock surfaces, remove all loose material and vegetation and clean with air, water jets or other approved means. Remove loose material from soil surfaces with air jets.

Do not place shotcrete on any surface which is frozen, spongy or where there is free water. Dampen the surface before applying shotcrete.

00396.41 Shotcrete Blanket Thickness Control - Control shotcrete blanket thickness by installing noncorrosive pins, nails or other gauging devices normal to the face so that they protrude the required shotcrete thickness outside the face. Place the pins on a maximum 5 foot square pattern. When welded wire fabric reinforcement is used, place at least a 1 inch cover of shotcrete over the wire fabric.

00396.42 Anchor Bars - Clean and blow clear all drilled holes before installing the anchor bars. Fill drilled holes using a grout tube extending to the bottom of the hole.

00396.43 Welded Wire Fabric - Place welded wire fabric as shown or directed. Overlap sheets at least 8 inches and secure with tie wire.

00396.44 Weep Holes - Do not drill holes larger than 3 inches in diameter. Install the drain pipe before applying shotcrete. Extend the end of the pipe 1 inch to 3 inches outside the slope. Protect pipe ends during shotcreting and clean weep holes after shotcrete is placed.

00396.45 Batching and Mixing Shotcrete:

(a) Dry-Mix Process - Batch cement/aggregate mix by weight or volume. Predampen the dry-mix after it flows out of the packaging but before it flows into the main hopper in order to ensure that the premix will flow at a uniform rate. Do not use predampened cement/aggregate mix in the work if it is allowed to stand more than 45 minutes.

(b) Wet-Mix Process - Batch and mix wet-mix shotcrete according to ASTM C 94.

00396.46 Batching and Mixing Steel Fibers - Determine the procedure for adding steel fibers to the shotcrete. Obtain Engineer's approval. Demonstrate the procedure in the field for approval before production operation begins. If fibers are added at the nozzle, uniformly distribute the fibers throughout the mortar matrix without isolated concentrations. If fibers are added to the dry or wet mix process, use a screen having a mesh of 1 1/2 inch to 2 1/2 inches to prevent any fiber balls from entering the shotcrete line, unless it is demonstrated that fiber balls are not being formed without a screen. Do not add fibers to the dry or wet mix at a rate faster than can be blended with the other ingredients without forming balls or clumps. Bulk fibers that have a tendency to tangle together shall pass through a vibrating screen or be sifted into the mix so they enter it as individual elements and not as clumps.

00396.47 Shotcrete Application - Apply shotcrete from the lower portion of the area to the top so rebound does not accumulate on the portion of the surface that still has to be covered. Hold the nozzle at a distance and at an angle approximately perpendicular to the working face so rebound material will be minimal and compaction will be maximized. Shotcrete shall emerge from the nozzle in a uniform and continuous flow. When, for any reason, the flow becomes intermittent, divert the nozzle from the work until uniform and continuous flow resumes. A nozzle person's helper, equipped with an air blowout jet, shall attend the nozzle person at all times during the placement of shotcrete to keep the working area free from rebound.

Do not work rebound material into the finished product. Rebound is defined as the shotcrete constituents which fail to adhere to the surface to which the shotcrete is being applied. Do not salvage it or include it in later batches.

Shooting will be suspended if:

- High wind prevents the nozzle person from proper application of the material.
- The temperature is below 40° F.
- External factors, such as rain, wash cement out of the freshly placed material or cause sloughs in the work.

Taper construction joints over a distance of at least 12 inches to a thin edge. Thoroughly wet the surface of such joints before any adjacent section of shotcrete is placed. Do not use square construction joints.

Remove dummy areas, sags, or other defects and replace with a new layer, at no additional cost to the Agency. Replace any fabric reinforcement that is damaged with lapped and tied wire fabric.

Allow previous layers of shotcrete to take initial set before applying additional layers of shotcrete. Clean all loose material before applying additional layers.

00396.48 Finishing and Curing - Leave the shotcrete surface in a natural gun finish.

Apply Type 2, white-pigmented curing compound immediately after gunning to cure the shotcrete. Keep shotcrete surfaces from freezing for at least 7 calendar days after application. Any curing compound in contact with exposed welded wire fabric, anchor bars and previous shotcrete surfaces shall be sandblasted before placing subsequent shotcrete.

Measurement

00396.80 Measurement - The quantities of shotcrete will be measured on the area basis along the finished shotcrete surface area.

Payment

00396.90 Payment - The accepted quantities of shotcrete will be paid for at the Contract unit price, per square yard, for the item "Shotcrete Slope Stabilization".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00398 - Rock Slope Stabilization and Reinforcement

Description

00398.00 Scope - This work consists of furnishing and installing rock slope stabilization and reinforcement items as shown or specified in close conformity to the lines, grades, and dimensions shown or established.

Definitions

00398.02 Definitions:

Barrier Mounted Rock Protection Screen - A system of screening and concrete barrier designed to intercept small falling rocks.

Post-Supported Rock Protection Screen Behind Barrier/Guardrail - A gabion wire mesh screen placed at the highway shoulder edge and supported by posts up to 8 feet high to intercept rocks generally less than 2 feet in diameter.

Post-Supported Wire Mesh Slope Protection - Gabion wire mesh suspended above the ground with support posts and draped over a rockfall slope area. Post-supported wire mesh is used to intercept occasional falling rock generally less than 2 feet in diameter from slopes above the installation and the draped portion is used to prevent rocks from reaching the travel lanes.

Rock Reinforcing Bolts - Steel rods inserted into predrilled holes in rock and tensioned to a required load and bonded in place with grout.

Rock Reinforcing Dowels - Untensioned steel rods inserted into predrilled holes in rock and bonded in place with grout or polyester resin.

Rockfall Net System - A proprietary rockfall system constructed of interlocking steel rings or interlaced cable panels suspended from wide-flange support posts and incorporating braking elements. The system is designed to withstand high energy rockfall with minor maintenance required.

Wire Mesh Slope Protection - Gabion wire mesh draped over a rockfall slope area and anchored with soil or rock anchors. Wire mesh is used where rocks are generally less than 2 feet in diameter and to prevent rocks from reaching travel lanes.

00398.03 Rockfall Net System Submittals - Submit unstamped working drawings, field construction manuals, and product brochures prepared by the manufacturer of proprietary rockfall net systems, as necessary, according to 00150.35. Submit this information at least 30 calendar days before beginning fabrication or construction of the rockfall net system. Do not begin installation prior to receipt of the Engineer's written approval.

(a) Working Drawings - Provide working drawings that included at least the following information:

- **General Notes** - Necessary information on the design and construction of the rockfall net system.
- **Materials and Quantity Summary List** - All items of each net system.

- **Plan and Elevation Views** - The net system alignment and offsets to construction centerline, locations of support posts and footings, all end, lateral, top and bottom support ropes, anchor ropes and braking elements, net height, and section lengths.
- **Typical Sections** - Net system footings, footing-to-post connections, net connections, anchor type, retaining rope and braking element connections, and anchor locations.
- **Structural and Geometric Details** - The following minimum structural and geometric details:
 - Footing and leveling pad details
 - Rock and soil footing details
 - Anchor details
 - End, lateral, and intermediate support rope details
 - Support column details, including column plate details, breakaway connections and cable guide assemblies

(b) Field Construction Manual - Provide a field construction manual, prepared by the manufacturer of the proprietary rockfall net system, including step-by-step directions for constructing the rockfall net system.

00398.04 Rock Reinforcing Bolts and Rock Reinforcing Dowels Submittals - Submit a detailed work plan to the Engineer 10 calendar days prior to the preconstruction conference. Include the following:

- Construction schedule and sequence.
- Drilling methods and equipment.
- Components for rock reinforcing bolts and rock reinforcing dowels, couplers, bearing plates, rock reinforcing bolt mechanical anchorage system (if used), flat washers, and beveled washer specifications including the manufacturer's data sheets.
- Drill hole diameter.
- Grout mix or polyester resin from the QPL, including manufacturer's data sheets. Include the procedures for placing the grout and resin.
- Corrosion protection, either galvanizing or epoxy coating, for the rock reinforcing bolts and rock reinforcing dowels.
- Installation, stressing procedures, torque wrench, test jack, and pressure gauge to be used.
- Calibration data for each torque wrench, test jack, and pressure gauge to be used. An independent testing laboratory shall have performed the calibration tests within 60 calendar days of the date submitted. The torque wrenches shall have a capacity at least 20 percent greater than the rock reinforcing bolt manufacturer's recommended torque to achieve the design and test loads. The torque wrench shall have an accuracy of at least ± 2 percent of the full-scale reading, and a resolution of at least 1 percent of the full-scale reading.

The Engineer will respond within 21 calendar days after receipt of the work plan. Do not proceed with the work until the Engineer has approved the work plan in writing.

Materials

00398.10 Anchors:

(a) Steel Anchor Bolts - Furnish 1 inch diameter continuously threaded or deformed, Grade 75 steel anchor bolts, complete with keyhole plate, grout tube, washer and nut, meeting the requirements of AASHTO M 31 (ASTM A 615). Provide anchor bolts made of one continuous bar. Welding and couplers will not be allowed. Galvanize all steel anchor bolts according to AASHTO M 232 (ASTM A 153). Provide grout tubes, grout sealers, and other grouting accessories for grouting anchor bolts of type recommended by the manufacturer and as approved.

(b) Steel Plates, Washers, and Nuts - Furnish steel plates, washers, and nuts for steel anchor bolts meeting the requirements of ASTM F 432. Provide 3/8 inch flat steel plates that provide not less than 6 inch by 6 inch area for each bolt. Provide steel or malleable iron beveled washers and hardened steel machine washers. Provide heavy-hexagonal type nuts. Galvanize all plates, washers, and nuts according to AASHTO M 232 (ASTM A 153), Class C, except castings shall be Class A and forgings shall be Class B.

(c) Wire Rope Anchors - Furnish cable for wire rope anchors meeting the current requirements of Federal Specification RR-W-410 and ASTM A 1023. Provide general purpose, 3/4 inch diameter, 6 x 19 IWRC, galvanized wire rope, with the wire rope core made from extra improved plow steel. Minimum breaking force shall be 58,800 pounds. Attach ferrules to the cable to prevent pullout of the cable from the encapsulating concrete during testing as described in 00398.42(e). Galvanize all ferrules and thimbles according to AASHTO M 232 (ASTM A 153).

(d) Concrete - Furnish concrete for anchors, support posts, and brace footings meeting the requirements of Section 00440 except the minimum strength shall be 4,000 psi.

(e) Cement Grout - Furnish non-epoxy cement grout for anchors in rock from section 02080.20 of the QPL. Follow the manufacturer's recommendations for water-cement ratio, mixing and set times.

(f) Polyester Resin - Furnish high strength (HS) or low strength (LS) polyester resin for post anchors in rock from section 00535 of the QPL.

00398.11 Posts, Braces, and Appurtenances - Furnish 4 inch outside diameter, Schedule 40, hot-dip galvanized post and braces made from steel pipe according to ASTM A 53, Grade B. Furnish 4.5 inch O.D. pipe size (to accommodate post), Schedule 40, hot-dip galvanized post sleeves made from steel pipe according to ASTM A 53, Grade B. Furnish post caps, strap clamps, bolts, and nuts that are hot-dip galvanized according to AASHTO M 232 (ASTM A 153). Repair all cutting, welding, and drilling as well as other damage to the galvanizing according to 02420.10(d).

00398.12 Top Horizontal Support Rope and Support Post Retaining Rope - Furnish top horizontal support rope and support post retaining rope of the sizes shown and meeting the current requirements of Federal Specification RR-W-410 and ASTM A 1023. Provide Type 1, general purpose, Class 2, 6 x 19 IWRC, galvanized wire rope, with the wire rope core made from extra improved plow steel.

00398.13 Hardware - Furnish all rings and eyes of drop-forged steel that has been heat treated after forging. Furnish wire rope thimbles and clips that are sized for the wire rope shown. Galvanize all rings, eyes, thimbles, wire rope clips, U-bolts and miscellaneous hardware according to AASHTO M 232 (ASTM A 153), Class C, except castings shall be Class A and forgings shall be Class B.

00398.14 Wire Mesh Materials:

(a) Gabion Wire Mesh Fabric - Furnish gabion wire mesh fabric meeting the requirements of ASTM A 975, Style 1, 8 by 10 mesh type with Class 3 coating, soft temper.

(b) PVC Coated Gabion Wire Mesh Fabric - Furnish PVC coated gabion wire mesh fabric meeting the requirements of ASTM A 975, Style 3, 8 by 10 mesh type with Class 3 coating, soft temper. The color of the PVC coating shall be approved by the Engineer.

(c) Gabion Wire High Tensile Steel Fasteners and Lacing Wire - Furnish 11 gauge high tensile steel fasteners meeting the requirements of ASTM A 975 and ASTM A 764. Provide Class 3 zinc coating according to ASTM A 641. Install the fasteners as shown and as recommended by the manufacturer. Provide minimum panel to panel connection strengths meeting the requirements of ASTM A 975.

If stainless steel fasteners are required for corrosive environmental conditions, provide them according to ASTM A 313, Type 302.

Provide lacing wire with the same coating material as the gabion wire mesh fabric furnished on the order and conforming to ASTM A 641 and ASTM A 975. If PVC coating is required, provide the same color as the gabion wire mesh fabric.

00398.15 Rock Reinforcing Bolts and Rock Reinforcing Dowels - Furnish rock reinforcing bolts, rock reinforcing dowels, and all hardware that is galvanized or epoxy coated prior to installation. Cement grout or polyester resin will not be allowed as a substitute for the required protective coatings.

(a) Rock Reinforcing Bolts - Provide rock reinforcing bolts, including mechanical anchorage system, plates, washers, and nuts from the QPL. If mechanical anchorage is not selected, use a rock reinforcing bolt system from a manufacturer regularly engaged in the manufacturer of rock reinforcing bolts.

Provide grout tubes, grout sealers, and other grouting accessories for grouting rock reinforcing bolts of types recommended by the manufacturer and as approved.

(b) Rock Reinforcing Dowels - Provide rock reinforcing dowels, plates, washers, and nuts from a manufacturer regularly engaged in the manufacturer of rock reinforcing dowels. Provide grout or polyester resin meeting the requirements of this Section.

If polyester resin is selected, use a proven non-shrink polyester resin for rock reinforcing dowels capable of permanently developing the bond and internal strength between the rock reinforcing dowel and rock. Use a single speed cartridge system to anchor the dowel in rock. Select the cartridge diameter as recommended by the manufacturer to ensure complete encapsulation of the rock reinforcing dowel and satisfactory in-hole mixing. Select a polyester resin with a gel time which is consistent with rapid installation. Polyester resin to be incorporated into the rock reinforcing dowel installation shall be within the shelf-life period stated by the manufacturer. Provide samples of the polyester resins for testing upon request of the Engineer. Store polyester resins according to the manufacturer's recommendations.

00398.16 Rockfall Net Systems - For proprietary rockfall net systems, provide products from the selected company according to the company's specifications and these applicable material Specifications. If there is a conflict between the company's specifications and the Agency's Specifications, the Agency's Specifications will take precedence. Obtain all materials for the

selected proprietary rockfall net system from the same company. Use only one proprietary rockfall net system on the Project unless different proprietary rockfall net systems are specified.

Equipment

00398.20 Anchor, Bolt, and Dowel Equipment - Provide all equipment necessary to establish the steel bolt anchors, wire rope anchors, rock reinforcing bolts, and rock reinforcing dowels in the holes at the locations and depths shown and by the Engineer, and to tighten nuts, eyes and other hardware to the required tension according to the instructions of the manufacturer subject to the approval of the Engineer.

Provide and maintain in good working condition the necessary torque wrenches and related equipment for the installation of steel bolt and wire rope anchors, rock reinforcing bolts, and rock reinforcing dowels.

Labor

00398.30 Measurement Assistance - Furnish labor, at no additional cost to the Agency, to assist with the measurement of actual quantities of wire mesh slope protection, post-supported wire mesh slope protection, and shotcrete slope stabilization placed on the slopes.

00398.32 Rock Reinforcing Bolts and Rock Reinforcing Dowels Personnel Qualification - Furnish personnel skilled in the installation of rock reinforcing bolts and rock reinforcing dowels. Experience shall be relevant to anticipated rock conditions and size of rock reinforcing bolts and rock reinforcing dowels being installed. The on-site supervisor and drill operator shall have no less than 2 years of demonstrated experience in rock reinforcing bolt and rock reinforcing dowel installation. Submit experience documentation to the Engineer 10 calendar days prior to the preconstruction conference. Include current reference names and phone numbers, project names, locations, and the year of actual construction.

The Engineer will respond within 21 calendar days after receipt of the submittal. If, after checking references submitted by the Contractor, it is in the judgment of the Engineer that the proposed employees are not qualified; they will not be allowed to work on the Project. Do not proceed with the work until the Engineer has approved the submittal in writing.

Construction

00398.40 Lines, Grades, and Preparation Work - Clear, grub, and prepare the area of slope protection. Remove all shrubs, brush, snags, downed timber, float rock, and other obstacles, including trees up to 6 inches in diameter which interfere with construction. If directed, preserve trees and geographic features at the top of the wire mesh and cable mesh by varying the post and anchor locations to miss them.

Excavate for concrete footings to reasonably neat lines, but not less than the specified dimensions in soil or rock. Do not disturb the original ground at the sides and bottom of the excavation.

Dispose of materials, including excess excavation, according to 00290.20.

00398.41 Rock Slope Protection - Construct the kinds and types of rock slope protection at the locations shown or directed. Verify existing ground elevations, anchor locations, footing locations, elevations, and alignments prior to construction. The Contractor may encounter a variety of foundation conditions during construction of the rock slope protection items. Be prepared to install rock slope protection items in all types of materials including soil, mixed rock and soil, and solid rock.

00398.42 Support Posts, Sleeves, Braces, and Footings - Space support posts equidistant at intervals not exceeding those shown. Measure the interval parallel to the grade of the post line and in the line of the posts from center to center of the posts. Set the end support posts at the beginning and end of each continuous length and at abrupt changes in vertical and horizontal alignments. Place all support posts in a vertical position, plumb and in line unless otherwise directed.

Securely fasten diagonal braces to the end support posts or intermediate support posts as shown. Excavate and place concrete as shown for the brace footing.

Dimension, place, backfill, and strike off support post sleeves according to 00398.45.

00398.43 Centralizers - Install centralizers that adequately support the bolt or cable in the center of the hole and place within 1 foot of each end of the anchor according to the following:

- (a) **Wire Mesh Slope Protection** - Use centralizers in all anchor holes.
- (b) **Post-Supported Wire Mesh Slope Protection** - Use centralizers in all end anchor holes.
- (c) **Post-Supported Rock Protection Screen Behind Barrier/Guardrail** - Use centralizers in all end anchor holes.

00398.44 Anchors in Solid Rock - Where solid rock is encountered without an overburden of soil, install steel anchor bolts and wire rope anchors according to the following:

- (a) **Wire Mesh Slope Protection** - 6 feet into the solid rock or as shown for all anchors.
- (b) **Post-Supported Wire Mesh Slope Protection** - 3 feet into solid rock or as shown for post anchors. 6 feet into solid rock or as shown for end anchors and support post retaining rope anchors.
- (c) **Post-Supported Rock Protection Screen Behind Barrier/Guardrail** - 6 feet into solid rock or as shown for all anchors.

Place grout according to the manufacturer's recommendations and as directed.

00398.45 Anchors in Soil and Mixed Soil and Rock - Where an overburden of soil, loose rock, or surfacing materials covers solid rock, install the anchors according to the following:

- (a) **Wire Mesh Slope Protection** - 6 feet for all anchors. If solid rock is encountered before this depth is reached, install anchors in the solid rock according to 00398.44(a) unless otherwise directed.
- (b) **Post-Supported Wire Mesh Slope Protection** - 3 feet for post anchors. 6 feet for end anchors and support post retaining rope anchors. If solid rock is encountered before these depths are reached install anchors in the solid rock according to 00398.44(b) unless otherwise directed.
- (c) **Post-Supported Rock Protection Screen Behind Barrier/Guardrail** - 6 feet for all anchors. If solid rock is encountered before these depths are reached install anchors in the solid rock according to 00398.44(c) unless otherwise directed.

Place grout according to the manufacturer's recommendations and as directed.

Dimensions of footings shall not be less than shown and shall fill the excavated areas. Moisten the sides of the excavation to a depth of 2 inches and remove all loose soil and rock in the hole prior to placement of concrete. If the hole is overexcavated fill the entire cavity with concrete. Place the concrete with contact against firm soil at the sides and bottom and tamp around the steel anchor bolts, wire rope anchors, or post sleeves while the steel anchor bolts, wire rope anchors, or post sleeves are held firmly in proper position. Strike off, slope or crown and smooth the surface of the concrete at the ground level to shed water.

Allow concrete to cure for at least 5 calendar days before the support ropes and retaining ropes are attached and subjected to strain.

00398.46 Anchor Testing - Anchors shall have a minimum pullout capacity of 20,000 pounds per foot. Field verify pullout capacity by testing not less than 25 percent of the total number of anchors installed. The Engineer will determine which anchors will be tested. Replace failed anchors at no additional cost to the Agency.

Perform testing against a temporary yoke or load frame. Do not allow any part of the yoke or load frame to bear within 3 feet of the anchor. Determine applied test loads with either a calibrated pressure gauge or a load cell. Use pressure gauges or load cells commonly used in the testing of rock bolts and anchors.

A pullout test consists of loading the anchor assembly to the minimum pullout capacity. The anchor is acceptable if it sustains this load for 10 minutes with no loss of load.

00398.47 Gabion Wire Mesh Installation - Install gabion wire mesh so that the bottom of the fabric rests on the slope as shown and according to the following:

(a) Wire Mesh Slope Protection - Place gabion wire mesh with the fabric curl toward the slope. Loop the fabric over the top horizontal support rope and attach to itself with high tensile steel fasteners or lacing wire as shown. Do not tension the fabric in any direction. It is to remain loose to increase its dampening effect on rolling rocks.

Lap the gabion wire mesh fabric as shown. If horizontal laps are needed, overlap the lower fabric so it is on top and away from the slope to avoid the possibility of falling material hanging up. Locate the bottom of the fabric so material dislodged under the fabric can drain freely from the bottom, yet will not flow or bounce onto the roadway. Secure the ends of all lacing wires to the fabric with a minimum of 1.5 turns.

(b) Post-Supported Wire Mesh Slope Protection - Place gabion wire mesh for post supported wire mesh slope protection according to 00398.44(a). In addition, adjust the turnbuckles at the ends of the top horizontal support rope for a maximum sag of 1 inch between any two support posts.

(c) Post-Supported Rock Protection Screen Behind Barrier/Guardrail - Attach the gabion wire mesh to the support posts and top horizontal support rope as shown. Lap the gabion wire mesh fabric as shown. Do not tension the fabric in any direction. Adjust the turnbuckles at the ends of the top horizontal support rope for a maximum sag of 1 inch between any two support posts.

00398.48 Top Horizontal Support Rope and Support Post Retaining Rope Attachment - For post-supported wire mesh slope protection and post-supported rock protection screen behind barrier/guardrail, install top horizontal support ropes on the posts as shown. Ensure that the top horizontal support rope will move freely in the U-bolt hangers. Use one continuous length of cable for each complete section of screen. Attach the top horizontal support rope to the end anchors as shown. Tension the rope so that when the gabion wire mesh fabric is in place, it will be fully

supported. Take up additional tension with turnbuckles. Ensure that a minimum of 4 inches of take-up remains in the turnbuckle when full tension has been applied.

In addition, for post supported wire mesh protection, install the post retaining ropes to the anchors and support posts as shown. Tension the ropes with the turnbuckles so that the cable is taut but does not bend the support post toward the slope when the gabion wire mesh fabric is installed. Ensure that a minimum of 2 inches of take-up remains in the turnbuckle when full tension has been applied.

00398.49 Barrier Mounted Rock Protection Screen - Install concrete barrier according to Section 00820 and as shown. Attach protective screen to the concrete barrier as shown.

00398.50 Rock Reinforcing Bolts and Rock Reinforcing Dowels - Protect rock reinforcing bolts and rock reinforcing dowels at all times from damage and corrosion. Corrosion, pitting or damage to the rock reinforcing bolt may be cause for rejection. Damage includes, but is not limited to, abrasions, cuts, nicks, welds, and weld splatter. Prior to installation, remove all mill scale, flaking rust, and grease.

Drill holes to the diameter and depth recommended by the manufacturer. Unless otherwise directed, align drill holes normal to the rock face or as specified. Clean the drill holes of all drill cuttings and debris prior to installing the rock reinforcing bolts and rock reinforcing dowels and install and proof test as follows:

(a) Rock Reinforcing Bolts:

(1) Installing Bolts - Install and tension each rock reinforcing bolt to the design load before grouting. Conduct proof testing of each bolt as described below. Place grout in the drill hole to ensure the filling of the entire space between the bolt and sides of the drill hole, and the full encapsulation of the bolt. If necessary, control leakage of grout into rock seams using accepted methods and as directed. Pump the grout to the far end of the drill hole and continue pumping until grout is forced out of the de-airing tube at the face of the hole. After testing and grouting, cut the bolt off, if necessary, so that no more than 3 inches extends beyond the nut.

(2) Proof Testing Bolts - Tension each production rock reinforcing bolt installed to 120 percent of the design load using a calibrated hollow ram hydraulic jack. Hold that tension for a minimum of 10 minutes. The Engineer will analyze the rock reinforcing bolt test results and determine whether the rock reinforcing bolt is acceptable. If no loss of load occurs in this time period, the rock reinforcing bolt is accepted. If a rock reinforcing bolt fails this test, the rock reinforcing bolt will be rejected and a replacement bolt installed in a separate hole adjacent to the failed bolt. Test the new rock reinforcing bolt. The Engineer may require additional proof testing if any rock reinforcing bolts fail. No additional payment will be made for failed rock reinforcing bolts or for additional proof testing.

After tensioning and testing, lock off at 100 percent of the design load and grout the bolt. Carry out grouting within 3 days of tensioning the rock bolt to provide corrosion protection and lock the tension stress permanently into the system.

(b) Rock Reinforcing Dowels:

(1) Installing Dowels - Place the grout mix or resin cartridges in the drill hole according to the manufacturer's recommendations. Ensure that resin cartridges are placed at a sufficient spacing to cause excess resin to be forced out the face of the hole when the rock reinforcing dowel is spun into place. Failure of resin to be extruded from the face of the hole may be cause for rejection of the bolt installation. After installation of the plate and nut, torque the nut to a nominal 100 foot-pounds to ensure proper seating against the rock surface. Conduct

proof testing of rock reinforcing dowels as described below. After testing, cut the bolt off, if necessary, so that no more than 3 inches extends beyond the nut.

(2) Proof Testing Dowels - Proof test at least 10 percent, but not less than three each, of installed rock reinforcing dowels. The proof test shall be conducted by the Contractor and the Engineer will interpret the results. Tension the rock reinforcing dowel to 10 kips with a calibrated hollow ram hydraulic jack. Hold the load for 10 minutes with no loss of load. A rock reinforcing dowel will be considered to have failed if any movement of the dowel occurs. The Engineer may require additional proof testing beyond the 10 percent if any rock reinforcing dowels fail. Replace failed rock reinforcing dowels with a separate rock reinforcing dowel installed in a separate hole. No additional payment will be made for failed rock reinforcing dowels or for additional proof testing.

00398.51 Rockfall Net Systems - Provide for a field representative from the selected proprietary rockfall net system to be present at the start of the rockfall net system construction. Supervisory personnel of the Contractor, the company field representative, and any subcontractors who are involved in the construction of the rockfall net system shall meet with the Engineer for a rockfall net system preconstruction conference. At this conference, discuss methods of accomplishing all phases of the work required to construct the rockfall net system. If all representatives are not in attendance the rockfall net system preconstruction conference and start of net construction will be rescheduled.

In addition to the rockfall net system preconstruction conference, the company field representative shall be available as needed during the construction of the rockfall net system to provide instructions and recommendations, and to assist the Contractor or Engineer. Follow instructions and recommendations of the representative if approved by the Engineer.

Measurement

00398.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Wire Mesh Slope Protection - Wire mesh slope protection will be measured on the area basis, along the surface area of wire mesh fabric on the slope.

(b) Post-Supported Wire Mesh Slope Protection - Post-supported wire mesh slope protection will be measured on the area basis, along the surface of the wire mesh from center to center of end posts.

(c) Post-Supported Rock Protection Screen Behind Barrier/Guardrail - Post-supported rock protection screen behind concrete barrier and guardrail will be measured on the length basis, from center to center of end posts along the line and grade of each separate run.

(d) Barrier Mounted Rock Protection Screen - Barrier mounted rock protection screen will be measured on the length basis, from center to center of end posts along the line and grade of each separate run.

(e) Rock Reinforcing Bolts and Rock Reinforcing Dowels - Rock reinforcing bolts and rock reinforcing dowels will be measured on the length basis, along the entire length of each rock reinforcing bolt and rock reinforcing dowel (embedded and protruding).

(f) Rockfall Net Systems - Rockfall net systems will be measured on the length basis, from center to center of end posts along the line and grade of each separate run.

Payment

00398.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) Wire Mesh Slope Protection.....	Square Foot
(b) Post-Supported Wire Mesh Slope Protection.....	Square Foot
(c) Rock Protection Screen Behind Concrete Barrier and Guardrail	Foot
(d) Barrier Mounted Rock Protection Screen.....	Foot
(e) Rock Reinforcing Bolt	Foot
(f) Rock Reinforcing Dowel.....	Foot
(g) Rockfall Net System.....	Foot

Item (d) includes the concrete barrier.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for rock and soil anchors, wire rope, rail, concrete, grout, polyester resin, steel posts, and hardware.