# EARTHWORK, SUBGRADE, AND SUBBASE

## PART 1 - GENERAL

### 1.01 SECTION INCLUDES

A. Clearing and Grubbing

B. Earthwork, Excavation, and Embankment Construction

C. Subgrade Preparation

D. Subbase Construction

E. Topsoil

### 1.02 DESCRIPTION OF WORK

Excavate and construct embankments, subgrades, and subbases.

### 1.03 SUBMITTALS

Follow the General Provisions (Requirements) and Covenants, as well as the following:

Submit results of Standard Proctor and in-place density tests on compactions when required.

### 1.04 SUBSTITUTIONS

Follow the General Provisions (Requirements) and Covenants.

### 1.05 DELIVERY, STORAGE, AND HANDLING

Follow the General Provisions (Requirements) and Covenants.

### 1.06 SCHEDULING AND CONFLICTS

Follow the General Provisions (Requirements) and Covenants.

### 1.07 SPECIAL REQUIREMENTS

If impractical, or if scheduling does not allow the removal of utilities before excavation, work around the utilities.

### 1.08 MEASUREMENT AND PAYMENT

**A. Clearing and Grubbing by Units:** The quantity of clearing and grubbing will be the quantity, in units, shown in the contract documents.

**1. Measurement:**

a. Trees 6 inches in diameter or greater will be counted and the circumference will be measured at a height of 18 inches above the ground. The diameter will be calculated by measuring the circumference to the nearest inch and dividing by 3.14. See Table 2010.01 for identification of units per tree for clearing, grubbing, and clearing and grubbing.

b. Stumps 6 inches in diameter or greater will be counted and the diameter, in inches, calculated by determining the average diameter at cutoff. See Table 2010.01 for identification of units per stump for grubbing.

**1.08 MEASUREMENT AND PAYMENT (Continued)**

c. Logs and down timber 6 inches in diameter or greater will be measured at a point 18 inches from the end of the log with greatest diameter or 18 inches from the base of the tree for down timber for clearing.
d. Hedge rows will be measured in linear feet and converted to units using a rate of 30 units per 100 linear feet of hedge row.
e. Brush will be measured in square feet and converted to units by using a rate of 0.8 units per 100 square feet of brush.
f. Growing corn will be measured in square feet and converted to units by using a rate of 0.2 units per 100 square feet of growing corn.
g. Vegetation removal will not be measured for payment.
h. Field fence removal, included in clearing and grubbing, will be measured in stations and converted to units at a rate of 6.0 units per station of fence.

For each tree or stump counted as identified in Items a, b, and c, units will be determined as identified in the following table:

**Table 2010.01: Tabulation of Units for Removal of Trees and Stumps**

| Size Diameter | Unit | | |
|---|---|---|---|
| | Clearing | Grubbing | Clearing and Grubbing |
| Over 6 in. to 9 in. incl. | 1.1 | 2.8 | 3.9 |
| Over 9 in. to 12 in. incl. | 1.9 | 4.8 | 6.7 |
| Over 12 in. to 15 in. incl. | 2.8 | 6.6 | 9.4 |
| Over 15 in. to 18 in. incl. | 4.7 | 8.8 | 13.5 |
| Over 18 in. to 24 in. incl. | 8.4 | 13.6 | 22.0 |
| Over 24 in. to 30 in. incl. | 11.4 | 17.6 | 29.0 |
| Over 30 in. to 36 in. incl. | 22.0 | 28.0 | 50.0 |
| Over 36 in. to 42 in. incl. | 30.0 | 50.0 | 80.0 |
| Over 42 in. to 48 in. incl. | 40.0 | 80.0 | 120.0 |
| Over 48 in. to 60 in. incl. | 60.0 | 100.0 | 160.0 |
| Over 60 in. to 72 in. incl. | 80.0 | 120.0 | 200.0 |
| Over 72 in. | 120.0 | 160.0 | 280.0 |

2. **Payment:** Payment will be at the unit price per unit.

3. **Includes:** Unit price includes, but is not limited to, placement of backfill in area where roots have been removed, and removal and disposal of all materials.

**B. Clearing and Grubbing by Area:**

1. **Measurement:** Measurement will be the area in acres based on the area shown in the contract documents, computed from a need line, or computed from a right-of-way line if the limits are not shown for this item in the contract documents.

2. **Payment:** Payment will be at the unit price per acre.

3. **Includes:** Unit price includes, but is not limited to, removal and disposal of all materials and placement of backfill in area where roots have been removed.

**C. Clearing and Grubbing by Lump Sum:**

1. **Measurement:** Lump sum item; no measurement will be made.

2. **Payment:** Payment will be the contract lump sum price.

## 1.08 MEASUREMENT AND PAYMENT (Continued)

**D. Topsoil:**

**1. On-site Topsoil:**

**a. Measurement:** Measurement will be in cubic yards of topsoil stripped, salvaged, and spread, and will be computed on the basis of a uniform 8 inch finished thickness, or as specified.

**b. Payment:**

1) Payment will be at the unit price per cubic yard.
2) Topsoil salvaged from excavated areas and paid as topsoil will not be included in excavation quantities for which payment is made.
3) Overhaul will not be paid.

**2. Compost-amended Topsoil:**

**a. Measurement:** Measurement will be the same as for on-site topsoil.

**b. Payment:** Payment will be the unit price per cubic yard.

**c. Includes:** This work includes, but is not limited to, furnishing and incorporating compost.

**3. Off-site Topsoil:**

**a. Measurement:** Measurement will be in cubic yards for furnishing, excavating, hauling, and incorporating the material.

**b. Payment:** Payment will be at the unit price per cubic yard.

**E. Class 10, Class 12, or Class 13 Excavation:**

**1. Measurement:**

a. Measurement for Class 10, Class 12, and Class 13 material excavated from the project site and borrow areas will be the plan quantity in cubic yards, without final field measurement. Adjustments may be made to the plan quantities if agreed to by both the Engineer and the Contractor.

b. If either the Contractor or the Engineer desires actual measurements rather than using contract document quantities, that party must provide written notice to the other party prior to starting work.

1) If actual measurements are used, use cross-section surveys by the Engineer before and after work for the basis of computing the cubic yards of excavation. The extra survey cost will be paid by the party requesting the survey.
2) When the Engineer determines it is impractical to make cross-section surveys, use the truck count method, with a shrinkage factor, resulting in volume per truck type and size determined by the Engineer. Unless otherwise specified, use a shrinkage factor of 1.35 for Class 10 and Class 13 excavation. No shrinkage factor will be used for Class 12.

**2. Payment:**

a. Payment will be at the unit price per cubic yard.

b. Payment will not be made for excavation work done prior to the staking and, if necessary, cross-sectioning.

**3. Includes, but is not limited to:**

a. Site preparation for, and the construction of, embankment, fills, shoulder backfill, and backfill behind curbs.

b. Overhaul.

c. Finishing the soil surface, including roadways, shoulders, behind curbs, side ditches, slopes, and borrow pits.

d. Repair or replacement of any fences that have been unnecessarily damaged or removed.

e. Compaction testing, as specified in the contract documents.

**1.08 MEASUREMENT AND PAYMENT (Continued)**

4. **Does not include:** Stripping, salvaging, and spreading 8 inches of topsoil, unless otherwise specified in the contract documents.

**F. Below Grade Excavation (Core Out):** If unsuitable or unstable soil is encountered below the 12 inches of subgrade, measurement and payment for removal and replacement of such materials is as follows:

1. **Measurement:** Will be measured and paid as extra work, unless otherwise specified in the contract documents.

2. **Payment:** To be considered for payment, the Engineer must order the removal and replacement of the material. Payment will be considered only in previously undisturbed areas and not in existing embankments or following proof rolling operations.

3. **Includes:** Payment includes, but is not limited to, equipment, tools, labor, disposal of unsuitable materials, dewatering, drying, furnishing, and placement of foundation materials as required by the Engineer, compaction and finishing of the excavated area, and all incidental work as may be required.

**G. Subgrade Preparation:**

1. **Measurement:** The area of the proposed pavement under which the subgrade preparation is performed, plus 2 feet on each side, will be measured in square yards.

2. **Payment:** Payment will be at the unit price per square yard.

3. **Includes:** Work includes, but is not limited to, excavating, manipulating, replacing, compacting, and trimming to the proper grade.

**H. Subgrade Treatment:**

1. **Measurement:** The area of the proposed pavement under which subgrade treatment is provided, plus 2 feet on each side, will be measured in square yards.

2. **Payment:**
   a. Payment will be at the unit price per square yard for each type used.
   b. Payment is in addition to subgrade preparation.

3. **Includes:** Work includes, but is not limited to, furnishing, placing, and incorporating the subgrade treatment material (cement, asphalt, fly ash, lime, geogrid, or geotextiles).

**I. Subbase:**

1. **Measurement:** The area of the proposed pavement under which subbase is provided, plus 2 feet on each side, will be measured in square yards.

2. **Payment:** Payment will be at the unit price per square yard.

3. **Includes:** Work includes, but is not limited to, furnishing, placing, compacting, and trimming to the proper grade.

**1.08 MEASUREMENT AND PAYMENT (Continued)**

**J. Removals:**

1. **Structures:**
   a. **Measurement:** Each specified structure removed will be counted.
   b. **Payment:** Payment will be at the unit price for each specified structure removed.
   c. **Includes:** Unit price includes, but is not limited to, removal and disposal of structures.

2. **Culverts:**
   a. **Known Box Culverts:**
      1) **Measurement:** Each type and size of box culvert removed will be measured in linear feet from end to end along the centerline of the flowline.
      2) **Payment:** Payment will be at the unit price per linear foot for each type and size of box culvert removed.
      3) **Includes:** Unit price includes, but is not limited to, removal and disposal of box culverts.
   b. **Unknown Box Culverts:** Removal of unknown box culverts will be measured and paid as extra work.
   c. **Known Pipe Culverts:**
      1) **Measurement:** Each type and size of pipe culvert removed will be measured in linear feet from end to end at the flowline.
      2) **Payment:** Payment will be at the unit price per linear foot for each type and size of pipe culvert removed.
      3) **Includes:** Unit price includes, but is not limited to, removal and disposal of pipe culverts.
   d. **Unknown Pipe Culverts:** Removal of unknown pipe culverts will be measured and paid as extra work.

3. **Pipes and Conduits:**
   a. **Known Pipes and Conduits:**
      1) **Measurement:** Each type and size of pipe and conduit removed will be measured in linear feet from end to end.
      2) **Payment:** Payment will be at the unit price per linear foot for each type and size of pipe and conduit removed.
      3) **Includes:** Unit price includes, but is not limited to, removal, disposal, and capping, if specified, of pipes and conduits.
      4) **Abandoned Private Utilities:** Removal of all private utility lines is the responsibility of the respective utility agency, and will not be measured or paid.
   b. **Unknown Pipes and Conduits:** Removal of unknown pipes and conduits will be measured and paid as extra work.

**K. Filling and Capping of Pipe Culverts, Pipes, and Conduits:**

1. **Known pipe culverts, pipes, and conduits:**
   a. **Measurement:** Each type and size of pipe culvert, pipe, and conduit filled and capped will be measured in linear feet from end to end.
   b. **Payment:** Payment will be at the unit price per linear foot for each type and size of pipe culvert, pipe, and conduit filled and capped.
   c. **Abandoned Private Utilities:** Filling and capping of all private utility lines is the responsibility of the respective utility agency, and will not be measured or paid.

2. **Unknown pipe culverts, pipes, and conduits:** Filling and capping of unknown pipe culverts, pipes, and conduits will be measured and paid as extra work.

## 1.08 MEASUREMENT AND PAYMENT (Continued)

### L. Compaction Testing:

1. The Contractor will not be responsible for compaction testing or payment unless otherwise specified in the contract documents.

2. If the contract documents specify that the Contractor is responsible for compaction testing, performed by an independent testing laboratory hired by the Contractor, measurement and payment will be as follows:
   a. Measurement: Lump sum item; no measurement will be made.
   b. Payment: Payment will be the contract lump sum price.

3. The Contractor will be responsible for payments associated with all retesting resulting from failure of initial tests.

## PART 2 - PRODUCTS

### 2.01 TOPSOIL

Use suitable topsoil of uniform quality, free from hard clods, roots, sod, stiff clay, hard pan, stones larger than 1 inch (1/2 inch for turfgrass seeding), lime cement, ash, slag, concrete, tar residue, tarred paper, boards, chips, sticks, or any undesirable material.

Use on-site topsoil, unless compost-amended or off-site topsoil is specified.

**A. On-site Topsoil:** On-site topsoil material is material excavated from the top 12 inches of the site. Use of on-site topsoil material is subject to the Engineer's approval.

**B. Compost-amended On-site Topsoil:** Amend low-quality on-site topsoil, not meeting the requirements specified for off-site topsoil, with a minimum of 1 inch of compost for every 3 inches of topsoil. Use compost meeting the requirements of mulch for pneumatic seeding in Section 9010, 2.07.

**C. Off-site Topsoil:** Contains at least 3% organic matter, according to ASTM D 2974, has a high degree of fertility, is free of herbicides that prohibit plant growth, has a pH level between 6.0 and 8.0, and meets the following mechanical analysis requirements:

| Sieve | Percent Passing |
|---|---|
| 1" | 100 |
| 1/2" | 95* to 97* |
| 1/4" | 40 to 60 |
| No. 100 | 40 to 60 |
| No. 200 | 10 to 30 |

* 100% for turfgrass

The Engineer will approve the source of off-site topsoil. Surface soils from ditch bottoms, drained ponds, and eroded areas, or soils that are supporting growth of noxious weeds or other undesirable vegetation, will not be accepted. The Engineer will determine if testing is necessary. The Contractor will be responsible for payment of the testing if the off-site topsoil does not meet the above requirements. If the testing verifies the off-site topsoil does meet the above requirements, payment for the testing will be the responsibility of the Jurisdiction.

### 2.02 EXCAVATION MATERIALS

All project site and borrow excavation will be classified as Class 10, Class 12, or Class 13 as defined below, and as indicated in the contract documents.

**A. Class 10 Excavation:**

1. Class 10 excavation includes all normal soil such as loam, silt, gumbo, peat, clay, soft shale, sand, and gravel. It includes fragmentary rock handled in the manner normal to this class of excavation.

2. Includes any combination of the above described materials and any other material not classified as Class 12 or Class 13.

## 2.02 EXCAVATION MATERIALS (Continued)

**B. Class 12 Excavation:**

1. Material deposits so firmly cemented together that they cannot be removed without continuous use of pneumatic tools or blasting.

2. Class 12 excavation includes the actual measured volume of granite, trap, quartzite, chert, limestone, sandstone, hard shale, or slate in natural ledges or displaced masses.

3. Also includes the estimated or measured volume of rock fragments or boulders that occur on the surface or in subsurface deposits mixed with soil, sand, or gravel when their size, number, or location prevents them from being handled in a manner normal to Class 10 excavation.

**C. Class 13 Excavation:**

1. Class 13 excavation includes all materials listed under the definitions of Classes 10 and 12, and any other material encountered, regardless of its nature.

2. This classification covers work commonly referred to as "unclassified excavation."

3. The contract documents will specify the limits for Class 13 excavation. Excavation within these limits will not be classified as Class 10 or Class 12 excavation.

**D. Unsuitable or Unstable Materials:**

1. Material encountered during excavation above or below grade that does not meet the suitable soil requirements in Section 2010, 2.03.

2. Rubbish and debris, including trees, stumps, waste construction materials, scrap metals, and other materials that cannot be buried or used for backfill or topsoil.

3. Moisture content does not determine suitability of materials.

**E. Borrow:** Unless otherwise provided in the contract documents, when the quantity of fill material required is not available within the limits of the project cross-sections or specific borrow areas as indicated, the Contractor should make up the deficiency from borrow areas provided by the Engineer, or furnish equivalent material from other borrow areas.

## 2.03 SUITABLE EMBANKMENT MATERIALS

Meet the following requirements for all soils provided for the construction of embankments:

A. Density of 95 pcf or greater according to ASTM D 698 or AASHTO T 99 (Standard Proctor Density).

B. AASHTO M 145 index of less than 30.

C. Soils not meeting these requirements are considered unsuitable soils.

D. For soils to be placed below water, use clean granular material.

## 2.04 FOUNDATION MATERIALS

### A. Select Subgrade Materials:

1. All soils required for select subgrade materials must be approved by the Engineer. Approval of materials and their use will be based on AASHTO M 145.
   a. Cohesive soils must meet all of the following requirements:
      1) 45% or less silt size fraction.
      2) Density of 110 pcf or greater according to ASTM D 698 or AASHTO T 99 (Standard Proctor Density).
      3) Plasticity index greater than 10.
      4) A-6 or A-7-6 soils of glacial origin.
   b. Granular soils must meet all of the following requirements:
      1) Density of 110 pcf or greater according to ASTM D 698 or AASHTO T 99 (Standard Proctor Density).
      2) 15% or less silt and clay.
      3) Plasticity index of 3 or less.
      4) A-1, A-2, or A-3 (0).

2. Crushed stone, crushed PCC, crushed composite pavement, or RAP; mixtures of gravel, sand, and soil; or uniformly-blended combinations of the above; as approved by the Engineer.

3. The Engineer may authorize a change in select subgrade materials subject to materials available locally at time of construction.

### B. Granular Stabilization Materials:

1. Clean, crushed stone or crushed concrete, with the following gradation:

| Sieve | Percent Passing |
|---|---|
| 2 1/2” | 100 |
| 2” | 90 to 100 |
| 1 1/2” | 35 to 70 |
| 1” | 0 to 20 |
| 1/2” | 0 to 5 |

2. The Engineer may authorize a change in gradation, subject to materials available locally at time of construction.

### C. Subgrade Treatment:

1. **Cement:** Meet the requirements of AASHTO M 85 for portland cement.

2. **Asphalt:** Meet the requirements of AASHTO M 140.

3. **Fly ash:**
   a. Meet requirements of ASTM C 618 or AASHTO M 295.
   b. Either Class C or Class F. For Class C, the pozzolanic activity test with lime will not be required.
   c. Approval of source required.

4. **Lime:** Hydrated lime should meet requirements of ASTM C 207, Type N or AASHTO M 216, and others.

**2.04 FOUNDATION MATERIALS (Continued)**

5. **Geogrid:** Use an integrally-formed grid structure manufactured of a stress-resistant polypropylene material. Use Type 1 geogrid, unless Type 2 is specified. Meet the following minimum physical properties:

**Table 2010.01: Geogrid**

| Property | Test Method | Units | Type 1[1] | Type 2 |
|---|---|---|---|---|
| Aperture stability modulus at 20 cm-kg | Kinney[2] – 01 | cm-kg/deg | 3.2 | 6.5 |
| Minimum true initial modulus in use | | | | |
| Machine direction (MD) | ASTM D 6637-01 | lb/ft | 15,080 | 32,890 |
| Cross Machine direction (CMD) | | | 20,560 | 44,725 |
| Tensile strength, 2% strain | | | | |
| MD | ASTM D 6637-01 | lb/ft | 270 | 410 |
| CMD | | | 380 | 590 |
| Junction efficiency | GRI-GG2-87 | % | 93 | 93 |
| Flexural rigidity | ASTM D 1388-96 | mg-cm | 250,000 | 750,000 |
| Aperture size | | | | |
| Minimum | | in. | 0.5 | 0.5 |
| Maximum | | in. | 2.0 | 2.0 |
| | | | | |

[1] Geogrids meeting the requirements of Iowa DOT Article 4196.01, B and Materials I.M. 496.01 will be acceptable.
[2] Dr. Thomas C. Kinney, P.E. and US Army Corps of Engineers.

6. **Geotextiles:** Use a woven or non-woven permeable fabric, manufactured of polymer fibers, meeting the requirements of ASTM D 4439.

**D. Subbase:**

1. **Special Backfill**:
   a. Comply with Iowa DOT Specifications Section 4132. The quality requirements of Iowa DOT Materials I.M. 210 for recycled pavements are waived.
   b. The Engineer may authorize a change in gradation subject to materials available locally at time of construction.

2. **Granular Subbase:**
   a. Comply with Iowa DOT Specifications Section 4121.
   b. The Engineer may authorize a change in gradation subject to materials available locally at time of construction.

3. **Modified Subbase:**
   a. Comply with Iowa DOT Specifications Section 4123.
   b. The Engineer may authorize a change in gradation, subject to materials available locally at time of construction.

## PART 3 - EXECUTION

### 3.01 CLEARING AND GRUBBING

**A. Notification:** Notify the Engineer prior to start of clearing and grubbing activities.

**B. Removal:** Remove the following items:

1. Trees and stumps, including roots, to a depth of at least 12 inches. Place backfill to fill the hole.
2. Logs and downed timber.
3. Hedge rows, brush, field fence, and agricultural products.
4. Vegetation and rubbish.
5. Other objectionable materials.

**C. Disposal:** Material from clearing and grubbing may be removed according to Iowa Code 335 and must meet local ordinances.

1. Process by chipping logs, downed timber, or brush for mulching material; or salvage logs and downed timber for firewood.
2. Other vegetation, including corn stubble, may be disked into the existing soil if approved by the Engineer.
3. Haul vegetative materials from clearing and grubbing that are not handled on the project to a yard waste disposal site.
4. Remove field fence and other non-vegetative materials from the project.

### 3.02 STRIPPING, SALVAGING, AND SPREADING TOPSOIL

**A. Stripping and Salvaging Topsoil:**

1. Mow all weeds, grass, and growing crops or other herbaceous vegetation close to the ground and remove from the site. Shred sod by shallow plowing or blading and thorough disking. Thoroughly shred to allow the soil to be easily spread in a thin layer over areas to be covered. If allowed by the Engineer, herbicides may be applied, and vegetation may be incorporated into the topsoil.
2. Remove an adequate amount of topsoil from the upper 12 inches of existing on-site topsoil to allow finish grading with a finished grade of 8 inches of salvaged or amended topsoil. The topsoil may be moved directly to an area where it is to be used, or may be stockpiled for future use.

**B. Preparation for Topsoil Placement:**

1. Finish excavation and embankment work according to the specified grades and cross-sections; grade and slope all surfaces to drain away from buildings and prevent ponding. Conform to the grading plan within ± 2 inches.
2. Loosen surface to a minimum depth of 4 inches to reduce compaction.

## 3.02 STRIPPING, SALVAGING, AND SPREADING TOPSOIL (Continued)

**C. Topsoil Spreading and Finish Grading:**

1. Place the topsoil after all grading and trenching activities in the area have been completed.

2. Place topsoil at least 8 inches deep; smooth and finished grade according to the contract documents. If topsoil is being amended with compost, thoroughly blend compost with on-site topsoil at the rate specified in 2010, 2.01.

3. After finish grading the topsoil, remove clods, lumps, roots, litter, other undesirable material, or stones larger than 1 inch (1/2 inch for turfgrass).

## 3.03 EXCAVATION

**A. Notification:** Notify the Engineer prior to start of excavation activities.

**B. Pavement Removal:**

1. Cut surface pavement to full depth as required, and at designated removal lines.

2. Remove all pavement materials.
   a. If specified in the contract documents or allowed by the Engineer, process for re-use.
   b. Dispose of excess material as follows:
      1) Use as unsuitable soil according to this section.
      2) If specified in the contract documents, deliver and stockpile at a site designated by the Engineer.
      3) Otherwise, properly dispose of off-site.

3. Remove pavement material broken or damaged by the Contractor beyond designated removal lines to new line designated by the Engineer, and replaced at the Contractor's expense.

4. Protect subgrade beneath existing pavement removal areas.

**C. Excavation:** Perform Class 10, 12, or 13 grading, as specified in the contract documents, to the prescribed grade.

**D. Shaping of Borrows:**

1. Ensure that borrow areas provided by the Contractor are regular in cross-section to allow accurate measurement.

2. Ensure that care is taken to blend to natural land forms and avoid unnecessary damage to the land.

3. Do not divert natural drainage of surface water onto adjoining owners, and be diligent in draining the surface water in its natural course or channel.

4. Complete excavation in a way consistent with the existing natural drainage conditions.

**E. Drainage:**

1. Provide temporary drainage facilities to prevent damage to public or private interests when necessary to interrupt natural drainage or flow of artificial drains.

**3.03 EXCAVATION (Continued)**

2. Restore original drainage as soon as work allows.

3. The Contractor is responsible for damage resulting from their neglect to provide erosion control or artificial drainage.

**F. Unsuitable or Unstable Materials:**

1. Remove unsuitable or unstable materials to a depth specified in the contract documents, or as directed by the Engineer.

2. The Engineer will determine the need for and type of backfill material, including select soil or granular subbase.

3. Remove all soft areas. Replace with approved materials.

4. If subbase materials are used, provide weight tickets at the time of delivery.

5. Dispose of unsuitable or unstable materials according to the requirements in this section.

**G. Removal of Boulders:** Remove all boulders with a minimum diameter of 6 inches.

**H. Rock Excavation:**

1. When excavation to the subgrade elevation results in a surface consisting of loose or solid rock:
   a. Excavate 1 foot below the finished subgrade elevation.
   b. Construct subgrade with suitable material.
   c. Conduct operations so the Engineer is given the opportunity to measure cross-section before placement of subgrade material.

2. When pre-splitting of rock cuts is necessary, the limits of the area and the procedure used will be subject to the approval of the Engineer.

3. Dispose of rocks and boulders 6 inches in diameter and greater off-site.

**I. Removal or Filling of Pipe Culverts, Pipes, and Conduits:** Remove, cap, and/or fill with flowable mortar, as directed by the Engineer.

**3.04 EMBANKMENT CONSTRUCTION**

**A. Notification:** Notify the Engineer prior to start of embankment activities.

**B. Site Preparation:**

1. Remove all ground cover from the area.

2. When an embankment is placed on or against an existing slope that is steeper than 3:1 and is more than 10 feet high, cut the slope into steps as the construction of the new embankment progresses. The steps should ensure that all sod or other potential sliding surfaces are removed. Cut each step or series of steps to approximate horizontal planes which have vertical slope dimensions of at least 3 feet.

## 3.04 EMBANKMENT CONSTRUCTION (Continued)

### C. Depositing Embankment Material:

1. Except for rock fills and granular blankets, deposit embankment material in horizontal layers no greater than 8 inches in loose thickness. Do not incorporate vegetative materials in embankments. If some otherwise suitable soil contains small amounts of vegetative materials, such soils may be deposited outside of the shoulder line, within the outer 3 feet of the embankment.

2. When the width at the attained height is 30 feet or more, divide the area upon which the layer is to be placed into separate and distinct dump areas, having widths of at least 15 feet. If hauling equipment is operated within a dump area, cover the area with at least one passage of a tandem-axle disk, or two passages with a single-axle disk, prior to compaction.

3. Keep hauling equipment off dump areas of embankments 36 feet or more in width during compaction operations. Within 36 feet of a bridge or other limiting structure, or where the width of the embankment is less than 36 feet at the attained height, empty hauling units may travel on the dump area during compaction operations, as necessary to pass loaded hauling units. If the design width of the embankment is less than 30 feet at the attained height, hauling units will be allowed to travel through areas where compaction operations are in progress. When any hauling equipment is allowed to pass through compaction operations, do not require water, disking, and compacting equipment to deviate from their intended paths.

4. Deposit the material over the dump area as a separate and distinct operation. If the material, as deposited, contains an average of more than one lump per square yard, large enough to have at least one dimension greater than 12 inches, cover the area by at least one passage of a tandem-axle disk, or two passages of a single-axle disk. Use a disk that is designed and operated to cut and stir to the full depth of the layer.

5. After depositing and disking, if required, smooth the material to a uniform depth with a suitable motor patrol, bulldozer, or self-propelled sheepsfoot-type roller with a blade attachment. In addition to the initial smoothing operation, continue this smoothing and leveling of the lift during compaction, as necessary to provide a surface area free from ruts and other objectionable irregularities.

   Use the self-propelled sheepsfoot-type roller (meeting the requirements of Iowa DOT Article 2001.05) under the following conditions:
   a. Leveling must be done according to the prescribed rolling pattern.
   b. Compaction should be the primary function of the unit.
   c. Prevent spinning of the power drums.
   d. When, in the opinion of the Engineer, the unit cannot satisfactorily accomplish both leveling and rolling, use a separate dozer or motor patrol for the leveling operation prior to initiation of compaction.
   e. For embankments constructed primarily of sand or other granular material, the Contractor may substitute a pneumatic-tired roller meeting the requirements of Iowa DOT Article 2001.05.

6. Keep the outer portion of an embankment lower than its center, and wherever construction will be suspended for a period during which rain is likely to occur, roughen the surface to prevent erosion. This can be done by tracking, disking, or scarifying. Stones 6 inches and smaller in diameter may be placed in embankments, but distributed to avoid pockets. No stones larger than 3 inches may be placed within 1 foot of the finished subgrade elevation.

## 3.04 EMBANKMENT CONSTRUCTION (Continued)

**D. Compaction with Moisture and Density Control:** Compact with moisture and density control, unless Type A compaction is specified in the contract documents. See Section 2010, 3.09 for moisture and density requirements.

**E. Type A Compaction:** When Type A compaction is specified in the contract documents, compact as follows:

1. After the surface layer has been smoothed, and before material for the next layer is deposited on it, compact the layer with at least one passage of the sheepsfoot-type roller per inch of loose thickness of the layer, until the roller is supported entirely on its feet. The roller will be considered to be supported entirely on its feet when the tamping feet penetrate no more than 3 inches into an 8 inch lift or layer being compacted.

2. Determine if moisture content of the material is excessive or suitable for satisfactory compaction.
   a. Start rolling operations immediately after the smoothing operation, or delay them, and instead aerate the material in preparation for rolling.
   b. Perform aeration and compaction operations without unnecessary delay.
   c. Rolling operations made prior to any aeration operations for a lift will not be counted as any of the required coverages.

3. If the material is dry to the extent that it will not likely be satisfactorily compacted by rolling, moisten the material.
   a. The Engineer may order the material to be moistened uniformly before it is compacted.
   b. The Engineer may authorize the use of water in the final finishing of the roadbed.
   c. Delays from the ordering of moistening or drying will be at the Contractor's expense.

4. The Contractor may substitute compaction with moisture and density control for Type A Compaction, providing all testing as required, at the Contractor's expense.

## 3.05 USE OF UNSUITABLE SOILS

Unsuitable soils are not allowed in the right-of-way, unless otherwise specified in the contract documents or allowed by the Engineer.

## 3.06 SUBGRADE PREPARATION

Shape and consolidate subgrade in preparation for the placement of pavement.

**A. Uniform Composition:** Provide uniform composition of at least 12 inches below top of subgrade under new paving or subbase, plus 2 feet on each side. Use select subgrade materials unless granular stabilization materials or subgrade treatment is specified.

1. Subgrade Compaction in Fill Sections:
   a. Follow the compaction with moisture and density control requirements in Section 2010, 3.04.
   b. Construct in two 6 inch lifts.

2. Subgrade Compaction in Cut Sections:
   a. Excavate and stockpile the top 6 inches of subgrade.
   b. Scarify, mix, and re-compact the next 6 inches of subgrade.
   c. Replace, mix, and compact the top 6 inches of subgrade.

**3.06 SUBGRADE PREPARATION (Continued)**

3. Remove stones over 3 inches from subgrade.

4. Construct to elevation and cross-section such that, after rolling, surface will be above required subgrade elevation.

**B. Subgrade Stability:**

1. Perform proof rolling with a truck loaded to the maximum single legal axle gross weight of 20,000 pounds or the maximum tandem axle gross weight of 34,000 pounds. Operate trucks at less than 10 mph. Make multiple passes for every lane. The subgrade will be considered to be unstable if, under the operation of the loaded truck, the surface shows yielding (soil wave in front of the loaded tires) or rutting of more than 2 inches, measured from the top to the bottom of the rut at the outside edges.

2. If soft or yielding areas are located, remove unstable materials and replace with suitable foundation materials as approved by the Engineer, meeting Section 2010, 2.03. Compact subgrade materials in cut sections as required by the Engineer. If stabilization material is used, place and compact as required for subbase.

**C. Final Subgrade:** Complete final subgrade by excavation to grade by use of steel-shod template supported on side forms, support rollers, or by use of an automatically-controlled subgrade excavating machine.

**D. Subgrade Check:** Check subgrade elevation and grade by method approved by Engineer prior to paving.

**E. Ruts:** If ruts or other objectionable irregularities form in subgrade during construction, re-shape and re-roll subgrade before placing pavement. Fill ruts or other depressions with material similar to other subgrade material, and compact.

**3.07 SUBGRADE TREATMENT**

**A. Lime, Cement, Fly Ash, or Asphalt:**

1. Incorporate the subgrade treatment material uniformly during subgrade preparation to the depth and rate specified in the contract documents.

2. Place subgrade treatment in the areas specified in the contract documents for the width of the pavement, plus 2 feet on each side.

**B. Geogrid or Geotextiles:**

1. Install according to manufacturer's recommendations, on top of the prepared subgrade.

2. Place in the areas specified in the contract documents for the width of the pavement, plus 2 feet on each side.

**3.08 SUBBASE**

**A. Subgrade:** Compact subgrade and shape smooth before subbase material is placed.

**B. Construction:** Construct the specified type of subbase to the specified depth, plus 2 feet outside the pavement area.

**3.08 SUBBASE (Continued)**

**C. Moisture and Density:** Compact subbase and provide testing according to Section 2010, 3.09.

**D. Final Elevation:**

1. Trim to the design elevation and shape to the final template with an automatically-controlled trimming machine. Excess material may be salvaged and spread for use on any other approved project location or operation.

2. Conform to the design profile and cross-section to the extent that no point is higher than the designated elevation, and no point is lower than 0.05 foot below the design elevation.

3. Ensure that the top 1 inch of the subbase is uniformly moist prior to paving.

4. Do not allow hauling equipment and other traffic on completed subbase.

**3.09 FIELD QUALITY CONTROL**

**A. Compaction Testing:** If it is specified in the contract documents that the Contractor will conduct compaction testing, use the services of an independent testing laboratory approved by the Engineer.

**B. Moisture Content and Density:**

1. Ensure that moisture content falls within a range of optimum moisture to 4% above optimum moisture.

2. Compact cohesive soils to no less than 95% of maximum Standard Proctor Density; and cohesionless soils to no less than 70% of Relative Density.

**C. Testing:**

1. Lab Test: Determine laboratory density of material according to ASTM D 698 or AASHTO T 99 (Standard Proctor Density) or ASTM D 4253 and ASTM D 4254 (Maximum and Minimum Index Density for Cohesionless Soils). Provide at least one analysis for each material type used unless provided by the Engineer.

2. Field Test:
   a. Perform in-place field density and moisture testing according to ASTM D 2922 and ASTM D 3017 (nuclear) or ASTM D 1556 (sand cone) and ASTM D 2216 (moisture content).
   b. Frequency:
      1) Urban Section: Provide one test per lift per 150 feet. If section is less than 300 feet, perform at least two tests per lift.
      2) Rural Section: Provide one test for each 500 cubic yards of material placed, with at least two tests per lift.

3. Test only locations selected by the Engineer.

4. The Engineer may require additional testing if noncompliance or change in conditions occur.

**D. Test Failure:** Rework, recompact, and retest as necessary until required compaction is achieved.

END OF SECTION