

**SECTION 31 11 00**

**CLEARING AND GRUBBING**

**PART 1 GENERAL**

1.01 SECTION INCLUDES

- A. This WORK consists of clearing, grubbing, removing, and disposing of vegetation and debris within the limits of the PROJECT site as shown on the DRAWINGS and as required by the WORK. Vegetation and objects designated to remain shall be preserved free from injury or defacement.

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 23 00, Excavation and Fill.

**PART 2 PRODUCTS (NOT APPLICABLE)**

**PART 3 EXECUTION**

3.01 GENERAL

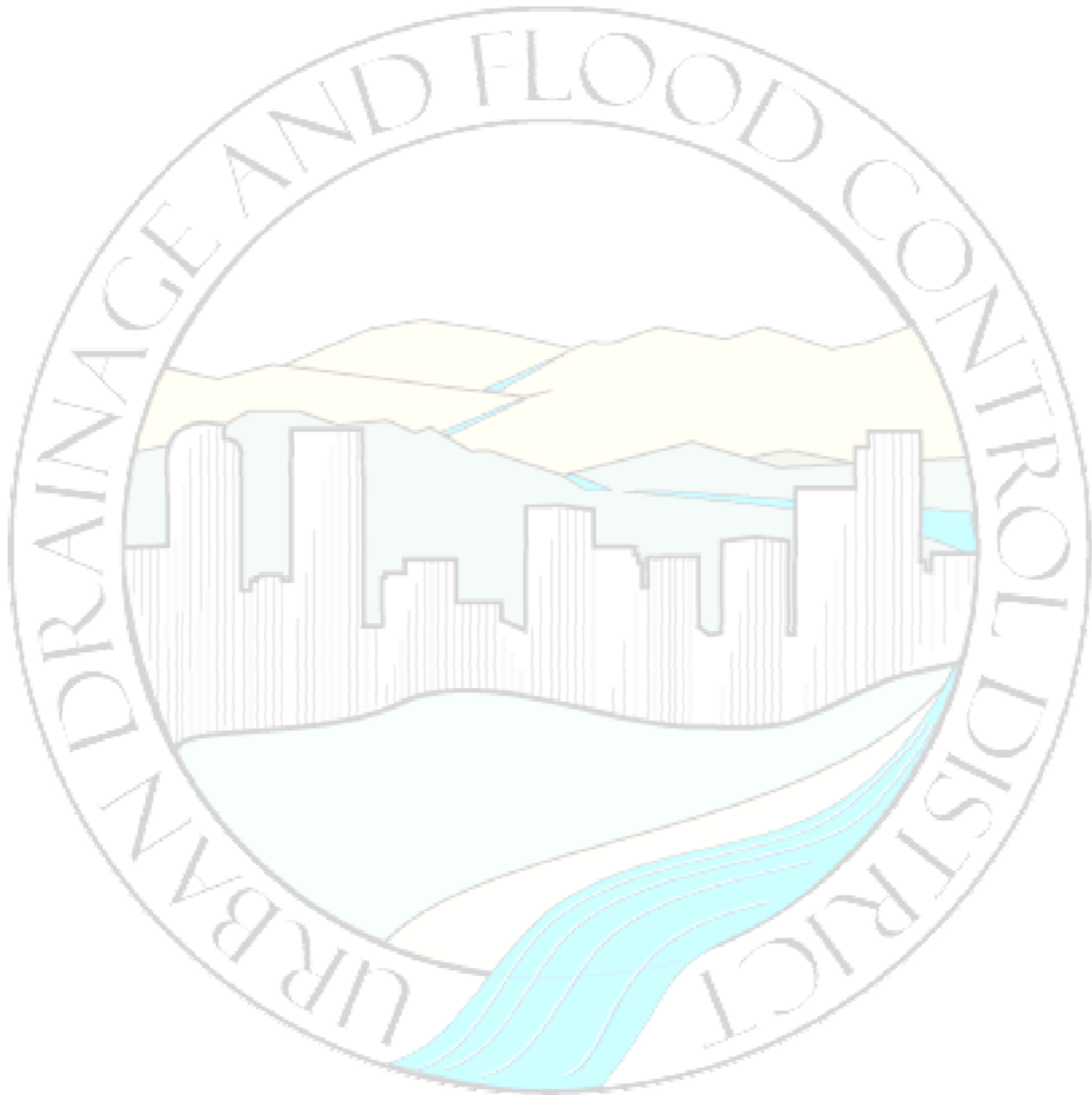
- A. OWNER will designate all trees, shrubs, plants, and other objects to remain. Any object that is designated to remain and is damaged shall be repaired or replaced as directed by OWNER, at CONTRACTOR's expense.
- B. No material or debris shall be disposed of within the PROJECT limits.

3.02 CONSTRUCTION

- A. Clearing and grubbing shall extend to the toe of fill or the top of cut slopes or as designated on the DRAWINGS.
- B. All surface objects, trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and grubbed, including mowing, as required.
- C. Undisturbed stumps, roots, and nonperishable solid objects located two (2) feet or more below subgrade or embankment slope may remain in place.
- D. In areas to be rounded at the tops of backslopes, stumps shall be removed to at least two (2) feet below the surface of the final slope line.
- E. CONTRACTOR shall scalp the areas within the excavation or embankment grading limits. Scalping shall include the removal from the ground surface of sawdust, and other vegetation matter.
- F. Except in areas to be excavated, all holes resulting from the removal of obstructions shall be backfilled with suitable material and compacted in accordance with Section 31 23 00, Excavation and Fill.

- G. All cleared timber shall be removed from the PROJECT and shall become the property of CONTRACTOR.
- H. Branches on trees or shrubs shall be removed as directed. All trimming shall be done in accordance with good tree surgery practices.

**END OF SECTION**



**SECTION 31 14 13**

**TOPSOIL STRIPPING AND STOCKPILING**

**PART 1 GENERAL**

1.01 SECTION INCLUDES

- A. This WORK consists of salvaging and stockpiling topsoil and wetland topsoil and excavating suitable topsoil or wetland topsoil from stockpiles, CONTRACTOR sources, available sources, or from the approved natural ground cover to place on designated areas.

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 11 00, Clearing and Grubbing.
  - 2. Section 31 23 00, Excavation and Fill.
  - 3. Section 31 25 00 Erosion and Sedimentation Control
  - 4. Section 32 91 13, Topsoil

**PART 2 PRODUCTS**

2.01 MATERIALS

- A. Topsoil shall meet the requirements of Section 32 19 13 Topsoil. Topsoil shall consist of natural onsite ground cover or hauled material from offsite sources.
- B. Erosion and Sedimentation Control for Stockpiles shall meet the requirements of Section 31 25 00, Erosion and Sedimentation Control.
- C. Wetland topsoil material shall consist of moist organic soil, including any existing wetland vegetation and seeds. Material shall be excavated from areas as shown on the DRAWINGS, hauled material from offsite sources, or as directed by ENGINEER. All wetland topsoil materials shall meet the requirements of Section 32 19 13, Topsoil.

**PART 3 EXECUTION**

3.01 TOPSOIL

- A. Topsoil within the limits of the PROJECT shall be salvaged prior to beginning excavating, fill or hauling, operations by excavating topsoil and stockpiling the material at designated locations on DRAWINGS or as designated by OWNER in a manner that will facilitate measurement, minimize sediment damage, and not obstruct natural drainage.
- B. Imported topsoil shall be hauled to the site and stockpiled in locations designated by OWNER.

- C. Salvaged topsoil exceeding the quantity required under the CONTRACT shall be disposed of at CONTRACTOR's expense.

### 3.02 STOCKPILE

- A. No soil stockpile shall exceed ten (10) feet in height.
- B. All topsoil stockpiles shall be protected from sediment transport by surface roughening, watering, and perimeter silt fencing.
- C. Any topsoil stockpile remaining longer than 30 days shall be seeded with a sterile temporary cover (such as REGREEN or approved equivalent) or the approved specified final seed mixture.
- D. Upon completion of PROJECT or as approved by OWNER or OWNERS REPRESENTATIVE, remove surplus subsoil and topsoil from site. Grade stockpile area as necessary for planting or seeding.

### 3.03 WETLAND TOPSOIL

- A. Wetland topsoil material shall be excavated from areas designated on the DRAWINGS or as approved by ENGINEER to a minimum depth of eighteen (18) inches, or as otherwise designated, and placed within twenty four (24) hours in the wetland relocation site.
- B. CONTRACTOR shall prepare the wetland relocation site to elevations specified in the DRAWINGS or as approved by ENGINEER prior to excavating the wetlands topsoil. If ENGINEER determines that this is not possible, then CONTRACTOR shall stockpile wetlands topsoil material in an approved area, to remain undisturbed until the relocation site has been prepared.
- C. All wetland topsoil stockpiles shall be protected from sediment transport by surface roughening, watering, and perimeter silt fencing.
- D. Storage time within the stockpile shall be as short as possible.
- E. If deemed necessary by ENGINEER, the stockpile shall be protected in such a manner to preserve the wetland seed bank.
- F. Wetland topsoil material shall be placed over the prepared relocation areas to a depth of eighteen (18) inches, or as otherwise designated.

**END OF SECTION**

## SECTION 31 23 00

### EXCAVATION AND FILL

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. This WORK shall consist of excavation, embankment fill, disposal of excess material, shaping, and compaction of all material encountered within the limits of WORK, including excavation and fill for structures. The excavation shall include, but is not limited to, the native soils which shall be excavated for the PROJECT WORK. All WORK shall be completed in accordance with these SPECIFICATIONS, the lines and grades, and typical cross-sections shown on the DRAWINGS.
- B. All excavation shall be classified, “unclassified excavation,” or “muck excavation” or “rock excavation,” as hereafter described. All embankment shall be classified “embankment material” as hereafter described.

##### 1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 11 00, Clearing and Grubbing.
  - 2. Section 31 23 19, Dewatering.
  - 3. Section 31 23 33, Trenching and Backfilling.

##### 1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

##### 1.04 DEFINITIONS

- A. Embankment Material shall consist of approved material acquired from excavation or from outside sources, hauled and placed in embankments.
- B. Muck Excavation shall consist of the removal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.
- C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of one-half (1/2) cubic yard or more, as determined by

physical or visual measurement. It shall also include replacement with approved material as required.

- D. Unclassified Excavation shall consist of the excavation of all materials of whatever character required of the WORK, obtained within the PROJECT limits.

#### 1.05 QUALITY ASSURANCE

- A. Final topography and/or cross-sections shall be surveyed of areas that are to finished grade and compared to the design section for accuracy.
- B. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

### PART 2 PRODUCTS

#### 2.01 MATERIALS

- A. Embankment Material may consist of approved material acquired from excavations or material hauled from outside the PROJECT limits.
- B. Suitable material identified onsite shall be used first for embankments and backfill.
- C. Excess excavated native soils which are not used as embankment or backfill shall become the property of CONTRACTOR and shall be disposed of offsite by CONTRACTOR, in a location acceptable to ENGINEER.
- D. Muck Excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, onsite or imported soils, or other material, whichever is most suitable for the specific situation encountered.
- E. ENGINEER will determine which type of aggregate or other material which shall be used after observing the specific site conditions.
- F. Structural Backfill:

- 1. When specified on the DRAWINGS or as required by ENGINEER, Class I structural backfill shall meet the following gradation requirements:

Sieve Size	% By Weight Passing Square Mesh Sieves
2-inch	100
No. 4	30 - 100
No. 50	10 - 60
No. 200	5 - 20

- 2. In addition, this material shall have a liquid limit not exceeding thirty five (35) and a plasticity index of not over six (6).
- 3. Impervious structural backfill, where shown or specified, shall consist of material having one hundred percent (100%) finer than two (2) inches in



diameter and a minimum of thirty-five percent (35%) passing a No. 200 U.S. Standard Sieve.

### **PART 3 EXECUTION**

#### **3.01 GENERAL EXCAVATION/EMBANKMENT**

##### **A. General:**

1. The excavation and embankment shall be finished to reasonably smooth and uniform surfaces.
2. Variation from the subgrade plane shall not be more than eight-tenths (0.08) foot in soil or more than eight-tenths (0.08) foot above or one-half (0.50) foot below in rock.
3. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than four-tenths (0.04) foot.
4. Materials shall not be wasted without permission of ENGINEER.
5. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed.
6. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Section 31 11 00, Clearing and Grubbing, of these SPECIFICATIONS.
7. CONTRACTOR shall notify ENGINEER in sufficient time before beginning excavation or embankment such that the necessary topography and/or cross-sections may be taken. CONTRACTOR shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to surveying the site.
8. When CONTRACTOR's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued.
  - a. ENGINEER will contact archaeological authorities to determine the disposition thereof.
  - b. When directed, CONTRACTOR shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities.
  - c. Such excavation will be considered and paid for as extra WORK.

B. Excavation:

1. Unclassified:

- a. All excess suitable material excavated from the PROJECT site and not used for embankment shall be removed from the PROJECT site and become the property of CONTRACTOR.
- b. Where material encountered within the limits of the WORK is considered unsuitable for embankment (fills) on any portion of this PROJECT WORK, such material shall be excavated as directed by ENGINEER and replaced with suitable fill material.
- c. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than six (6) inches in diameter, and boulders shall be hauled from the PROJECT site and disposed of by CONTRACTOR at CONTRACTOR's expense.
- d. Debris is defined as "anything that is not earth which exists at the job site."

2. Muck:

- a. Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, ENGINEER may require CONTRACTOR to remove the unsuitable materials and backfill to the finished graded section with approved material.
- b. Disposal of the unsuitable material and replacement with suitable material shall be at CONTRACTOR's expense.

3. Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

4. Rock:

- a. Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 foot below subgrade within the limits of the channel area, and the excavation shall be backfilled with material shown on the DRAWINGS or as designated by ENGINEER.
- b. Disposal of material and replacement with suitable approved material shall be at CONTRACTOR's expense.

C. Embankment Construction:

1. Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, the placing and compacting of approved material within areas where unsuitable materials have been removed, and the placing and compacting of Embankment Material in holes, pits and other depressions within the PROJECT area.
2. Only approved materials shall be used in the construction of embankments and backfills.



3. Approved materials shall consist of clean onsite cohesive soils or approved imported soils.
4. Onsite cohesive soils or imported soils shall be placed and compacted in horizontal lifts, using equipment and procedures that produce recommended moisture contents and densities throughout the lift and embankment height. Onsite or imported cohesive soils shall be compacted within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content and compacted to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698).
5. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half (1/2) width at a time, the slopes that are steeper than four-to-one (4:1) when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the WORK is brought up in layers.
  - a. Benching shall be well “keyed” and where practical a minimum of eight (8) feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts.
  - b. Material thus cut out shall be recompacted along with the new Embankment Material at CONTRACTOR’s expense.
6. The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of eight (8) inches and recompacting to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%) prior to fill placement.
7. Embankment Material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%).
  - a. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting.
  - b. As the compaction of each layer progresses, continuous leveling and manipulating required to ensure uniform density.
8. For embankments which serve as berms, the downstream portion shall be keyed into the subsurface soils a minimum of three (3) feet to enhance the stability of the slope.
9. Materials which are removed from excavations beneath the water table may be over the optimum moisture content and shall be required to be dried out prior to reusing them.
10. Cross hauling or other action as appropriate will be ordered when necessary to ensure that the best available material is placed in critical areas of embankments,

including the top two (2) feet of all embankments. No additional payment will be made for cross hauling ordered by ENGINEER.

11. Frozen materials shall not be used in construction of embankments.
12. During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.
13. Excavation or embankment (fill), and structural backfill WORK either completed or in a stage of completion that is either eroded or washed away or becomes unstable as a result of either rains, snow, snow melt, channel flows, or lack of proper water control shall be either removed and replaced, recompact, or reshaped as directed by ENGINEER and in accordance with the DRAWINGS and SPECIFICATIONS at CONTRACTOR's sole expense.
14. Removed unsuitable materials shall be hauled away and disposed of at CONTRACTOR's expense. Placing of replacement materials for removed unsuitable materials shall be purchased, placed, and compacted at CONTRACTOR's expense.

D. Proof Rolling:

1. Proof rolling with a heavy rubber tired roller shall be required, if designated on the DRAWINGS or when ordered by ENGINEER.
2. Proof rolling shall be done after specified compaction has been obtained. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompact to the requirements for density and moisture at CONTRACTOR's expense.
3. Proof rolling shall be done with equipment and in a manner acceptable to ENGINEER. Proof rolling as shown on the DRAWINGS or as ordered by ENGINEER shall not be measured and paid for separately, but shall be included in the unit prices bid for the WORK.

### 3.02 EXCAVATION AND BACKFILL FOR STRUCTURES

- A. Poor foundation material for any of the WORK shall be removed, by CONTRACTOR, as directed by ENGINEER.
  1. CONTRACTOR will be compensated for removal and replacement of such materials in accordance with Muck Excavation.
- B. CONTRACTOR is cautioned that construction equipment may cause the natural soils to pump or deform while performing excavation WORK inside and on footings, structural floor slabs, or other structure foundation areas.
- C. CONTRACTOR shall remove and replace at CONTRACTOR's expense any foundation materials which are:
  1. Saturated by either surface or subsurface flows because of the lack of adequate water control or dewatering work by CONTRACTOR;

2. Frozen for any reason; or
  3. Disturbed by CONTRACTOR's WORK or caused to become unacceptable for foundation material purposes by means of CONTRACTOR's equipment, manpower, or methods of WORK.
- D. Dewatering shall not be conducted by pumping from inside footings, structural floor slabs, or other structure foundation limits. This may decrease the supporting capacity of the soils.
- E. Care shall be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete WORK.
- F. Any over-excavated subgrades that are due to CONTRACTOR's actions, shall be brought back to subgrade elevations, as indicated on the DRAWINGS, by CONTRACTOR and at CONTRACTOR's expense in the following manner:
- G. For over-excavations of two (2) inches or less, either backfill and compact with approved granular materials; backfill with one-half (1/2) inch crushed rock; or fill with concrete at the time of the appurtenant structure concrete pour.
- H. For over-excavations greater than two (2) inches, backfill and compact with an approved granular material.
1. All granular footings, structural floor slabs, or other structure areas shall be compacted with a vibratory plate compactor prior to placement of concrete, reinforcing, or bedding materials.
  2. Backfill, and fill within three (3) feet adjacent to all structures and for the full height of walls, shall be selected non-swelling material.
    - a. It shall be granular, well graded, and free from stones larger than two (2) inches.
    - b. Material may be job excavated, but shall selectivity be required as determined by ENGINEER.
    - c. Stockpiled material, other than topsoil from the excavation, shall be used for backfilling unless an impervious structural backfill is specified.
    - d. The backfill material shall consist of either clean onsite granular material free of stones larger than two (2) inches in diameter with no more than twenty percent (20%) passing the No. 200 sieve, or equivalent imported materials.
    - e. All backfill around the structures shall be consolidated by mechanical tamping.
    - f. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard

Proctor Density (ASTM D698) for cohesive soils, or to seventy-five percent (75%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM D4253.

3. Impervious structural backfill shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.

**END OF SECTION**



## SECTION 31 23 19

### DEWATERING

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. The WORK of this section consists of controlling groundwater, site drainage, and storm flows during construction. CONTRACTOR is cautioned that the WORK involves construction in and around drainage channels, local rivers, and areas of local drainage. These areas are subject to frequent periodic inundation.

##### 1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
1. Section 31 23 00, Excavation and Fill.
  2. Section 31 23 33, Trenching and Backfilling.

##### 1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
    - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>

##### 1.04 SUBMITTALS

- A. CONTRACTOR shall submit to the ENGINEER a Water Control Plan 2 weeks prior to execution of the PROJECT. At a minimum, the Water Control Plan shall include:
1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment, methods, standby equipment and power supply, means of measuring inflow to excavations, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
  2. Drawings showing locations, dimensions, and relationships of elements of each system.
  3. Design calculations demonstrating adequacy of proposed dewatering systems and components.
  4. If system is modified during installation or operation, revise or amend and resubmit Water Control Plan.



## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. Onsite materials may be used within the limits of construction to construct temporary dams and berms. Materials such as plastic sheeting, sand bags, and storm sewer pipe may also be used if desired by CONTRACTOR.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. For all excavation, CONTRACTOR shall provide suitable equipment and labor to remove water, and keep the excavation dewatered so that construction can be carried on under dewatered conditions.
  - 1. Water control shall be accomplished such that no damage is done to adjacent channel banks or structures.
  - 2. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.
- B. CONTRACTOR is responsible for investigating and becoming familiar with all site conditions that may affect the WORK including surface water, potential flooding conditions, level of groundwater and the time of year the work is to be done.
- C. CONTRACTOR shall conduct operations in such a manner that storm or other waters may proceed uninterrupted along their existing drainage courses.
  - 1. By submitting a BID, CONTRACTOR acknowledges that CONTRACTOR has investigated the risk arising from such waters and has prepared BID accordingly, and assumes all of said risk.
- D. At no time during construction shall CONTRACTOR affect existing surface or subsurface drainage patterns of adjacent property.
  - 1. Any damage to adjacent property resulting from CONTRACTOR's alteration of surface or subsurface drainage patterns shall be repaired by CONTRACTOR at no additional cost to OWNER.
- E. Pumps and generators used for dewatering and water control shall be quiet equipment enclosed in sound deadening devices.
- F. CONTRACTOR shall remove all temporary water control facilities when they are no longer needed or at the completion of the PROJECT.
- G. All excavations made as part of dewatering operations shall be backfilled with the same type material as was removed and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density (ASTM D698) except where replacement by other materials and/or methods are required.



### 3.02 CONSTRUCTION

#### A. Surface Water Control:

1. Surface water control generally falls into the following categories:
  - a. Normal low flows along the channel.
  - b. Storm/flood flows along the channel.
  - c. Flows from existing storm drain pipelines.
  - d. Local surface inflows not conveyed by pipelines.
2. CONTRACTOR shall coordinate, evaluate, design, construct, and maintain temporary water conveyance systems.
  - a. These systems shall not worsen flooding, alter major flow paths, or worsen flow characteristics during construction. CONTRACTOR is responsible to ensure that any such worsening of flooding does not occur.
  - b. CONTRACTOR is solely responsible for determining the methods and adequacy of water control measures.
3. At a minimum, CONTRACTOR shall be responsible for diverting the quantity of surface flow around the construction area so that the excavations will remain free of surface water for the time it takes to install these materials, and the time required for curing of any concrete or grout. CONTRACTOR is cautioned that the minimum quantity of water to be diverted is for erosion control and construction purposes and not for general protection of the construction site.
  - a. It shall be CONTRACTOR's responsibility to determine the quantity of water which shall be diverted to protect the WORK from damage caused by stormwater.
4. CONTRACTOR shall, at all times, maintain a flow path for all channels.
  - a. Temporary structures such as berms, sandbags, pipeline diversions, etc., may be permitted for the control of channel flow, as long as such measures are not a major obstruction to flood flows, do not worsen flooding, or alter historic flow routes.

#### B. Groundwater Control:

1. CONTRACTOR shall install adequate measures to maintain the level of groundwater below the foundation subgrade elevation and maintain sufficient bearing capacity for all structures, pipelines, earthwork, and rockwork.
  - a. Such measures may include, but are not limited to, installation of perimeter subdrains, pumping from drilled holes or by pumping from sumps excavated below the subgrade elevation.
  - b. Dewatering from within the foundation excavations shall not be allowed.

2. The foundation bearing surfaces are to be kept dewatered and stable until the structures or other types of work are complete and backfilled.
  - a. Disturbance of foundation subgrade by CONTRACTOR operations shall not be considered as originally unsuitable foundation subgrade and shall be repaired at CONTRACTOR's expense.
3. Contractor shall dispose of groundwater as follows:
  - a. Obtain discharge permit for water disposal from authorities having jurisdiction.
  - b. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.
  - c. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.
  - d. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.
4. Any temporary dewatering trenches or well points shall be restored following dewatering operations to reduce permeability in those areas as approved by ENGINEER.

**END OF SECTION**

## SECTION 31 23 23

### FLOWABLE FILL

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. CONTRACTOR shall furnish and place controlled low strength material (CLSM) backfill bedding where shown in the DRAWINGS. The pipeline trench shall be excavated to the proper lines, grades, and dimensions and CLSM placed under, along the sides, and on top of the pipe. Unless otherwise shown in the DRAWINGS, a minimum of one (1) foot of CLSM shall be placed over the crown of the pipe.

##### 1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 23 19, Dewatering.
  - 2. Section 31 23 33, Trenching and Backfilling.

##### 1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. C33, Standard Specification for Concrete Aggregates.
    - b. C94, Standard Specification for Ready-Mixed Concrete.
    - c. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
    - d. C150, Standard Specification for Portland Cement.
    - e. C494/C494M Rev A, Standard Specification for Chemical Admixtures for Concrete.
    - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
    - g. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength (CLSM) Test Cylinders.
    - h. D5971, Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material.
    - i. D6023, Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).

- j. D6024, Standard Test Method for Ball Drop on Controlled Low-Strength Material (CLSM) to Determine Suitability for Load Application.
- k. D6103, Standard Test Method for Flow Consistency of Controlled Low-Strength Material (CLSM).

#### 1.04 SUBMITTALS

- A. A minimum of two (2) days prior to starting CLSM WORK. Provide product data on the following:
  - 1. CLSM mix design
  - 2. Fly Ash
  - 3. Admixtures

### **PART 2 PRODUCTS**

#### 2.01 MATERIALS

- A. General:
  - 1. The CLSM bedding shall consist of a mixture of sand, coarse aggregate, cement and water.
  - 2. Fly ash and approved admixtures may be used to obtain the required properties of the mix.
  - 3. The mix shall have good workability and flowability with self-compacting and self-leveling characteristics.
  - 4. No changes shall be made in the amounts or sources of the approved mix ingredients without the approval of ENGINEER.
  - 5. Product inspection and field-testing of the approved mix may be made by, or on behalf of, OWNER.
- B. Cement: All cement used shall be Type II Portland cement which shall conform to the requirements of ASTM C150.
- C. Fly Ash: Fly ash may be either Class C or Class F. The fly ash shall conform to ASTM C618.
- D. Aggregates:
  - 1. Fine Aggregate: All fine aggregate shall conform to the grading and quality requirements of ASTM C33.
  - 2. Coarse Aggregate: Coarse aggregate shall conform to the grading and quality requirements of ASTM C33 for size No. 476, No. 57, or No. 67.
- E. Water: The batch mixing water and mixer washout water shall conform to the requirements of ASTM C94.

F. Admixtures:

1. Chemical admixtures that do not contain calcium chloride and conform to ASTM C494/C494M for concrete may be used in the CLSM mix.
2. All chemical admixtures shall be compatible with the cement and all other admixtures in the batch.

G. CLSM Proportions:

1. Strength: CLSM shall have a minimum twenty-eight (28) day compressive strength of one hundred (100) psi when molded and cured as in conformance with ASTM D4832.
2. The CLSM shall have a minimum cement content of fifty (50) pounds per cubic yard. The water-cementitious materials ratio of the mix shall not exceed three and one-half to one (3.5:1).
3. Air-Entrainment: All CLSM shall be air entrained to a total air content of approximately five percent (5%).
4. Slump: The minimum slump shall be six (6) inches and the maximum slump shall be eight (8) inches when tested in accordance with ASTM D6103.
5. Aggregate: Fine aggregate shall be between fifty percent (50%) and sixty percent (60%) by volume of the total aggregates in the CLSM mix.
6. Consistency:
  - a. The consistency of the CLSM slurry shall be such that the material flows easily into all openings between the pipe and the lower portion of the trench.
  - b. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CLSM from flowing down the trench.
  - c. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.

**PART 3 EXECUTION**

3.01 GENERAL

- A. CLSM shall be placed as closely behind pipe laying operations as possible.
- B. CLSM shall not be placed, if, in the judgment of ENGINEER, weather conditions are unsuitable.
- C. CLSM shall not be placed when the trench bottom or walls are frozen or contain frozen materials.

- D. CLSM shall not be placed when the air temperature is below forty degrees Fahrenheit (40°F) unless the air temperature is thirty five degrees Fahrenheit (35°F) or more and the temperature is rising.

### 3.02 PLACEMENT

- A. Pipe shall be placed on two (2) sandbags and leveled to the proper grade. Precast or other types of rigid pads that constitute a point load are unacceptable.
- B. CLSM shall be placed under the pipe from one side so that it flows under the pipe until it appears on the other side.
  - 1. CLSM shall be added to both sides of the pipe until it completely fills the space between the pipe and the sides of the trench, to the depths shown in the DRAWINGS.
  - 2. Rodding, mechanical vibration and compaction of CLSM shall be performed to assist in consolidating the CLSM.
- C. When required to prevent uplift, the CLSM shall be placed in two (2) stages as required, allowing sufficient time for the initial set of the first stage before the remainder is placed.
- D. CLSM shall be deposited as nearly as practical in its final position and in no way disturb the pipe trench or cause foreign material to become mixed with the CLSM.
- E. Soil backfill shall not be placed until the CLSM has reached the initial set.
  - 1. If backfill is not to be placed over the CLSM within eight (8) hours, a six-inch (6") cover of moist earth shall be placed over the CLSM surface.
  - 2. If the air temperature is fifty degrees Fahrenheit (50°F) or less, the moist earth cover should be at least eighteen inches (18") thick.

**END OF SECTION**



**SECTION 31 23 33**

**TRENCHING AND BACKFILLING**

**PART 1 GENERAL**

1.01 SECTION INCLUDES

- A. This WORK shall consist of all labor, equipment, and materials necessary for excavation, trenching, and backfilling for utility lines and other related WORK.

1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 23 00, Excavation and Fill.
  - 2. Section 31 23 19, Dewatering.

1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
  - 1. ASTM International (ASTM):
    - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  - 2. Colorado Department of Transportation (CDOT).
  - 3. Occupational Safety and Health Administration (OSHA).

1.04 SUBMITTALS

- A. Submit certification that bedding and pipe zone material meets SPECIFICATION.

**PART 2 PRODUCTS**

2.01 MATERIALS

- A. Muck Excavation:
  - 1. Muck excavation shall also include the replacement of excavated muck with uniformly graded rock ranging from three-quarter (3/4) inch to one and one-half (1-1/2) inches or as required by ENGINEER.
  - 2. ENGINEER shall determine which type of aggregate or other material shall be used after observing the specific site conditions.
- B. Bedding and Pipe Zone Materials:

1. Well-Graded Sand:

Sieve Size	Total Percent Passing by Weight
3/8 - inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10

2. Squeegee Sand:

Sieve Size	Total Percent Passing by Weight
3/8 - inch	100
No. 200	0 - 5

3. CDOT #67:

Sieve Size	Total Percent Passing by Weight
1 inch	100
3/4 - inch	90 - 100
3/8 - inch	20 - 55
No. 4	0 - 10
No. 8	0 - 5

- a. It shall be the responsibility of CONTRACTOR to locate material meeting the SPECIFICATIONS, to test its ability to consolidate to at least seventy-five percent (75%) relative density, and to secure approval of ENGINEER before such material is delivered to the PROJECT.
- b. Relative density shall be determined as stipulated in ASTM D4253.

C. Backfill:

- 1. Use only backfill for trenches which is free from rocks, large roots, other vegetation or organic matter, and frozen material.
- 2. No rocks greater than three (3) inches in diameter shall be allowed.

D. Cut-Off Walls:

- 1. Clay Cut-Off Walls: More than fifty percent (50%) shall pass a No. 200 Sieve. The plasticity index shall be greater than twelve (12).

2. Controlled Low Strength Material Backfill: (Flo-Fill, See Section 31 23 23, Flowable Fill).

### **PART 3 EXECUTION**

#### **3.01 GENERAL**

- A. The following procedures shall be followed by CONTRACTOR in sequencing the WORK:
  1. No more than one hundred fifty (150) feet of trench shall be left open at any time.
  2. The entire trench shall be backfilled to within fifty (50) feet of the open trench upon conclusion of each day's WORK.
  3. The trench shall not be backfilled until the pipe installation is found acceptable by ENGINEER.
  4. Trench shall be backfilled within one hundred (100) feet of the pipe installation at all times.
  5. Clean-up shall be maintained within four hundred (400) feet of the trench excavation.
- B. Prior to placement in the trench, all pipes, fittings, and appurtenances shall be cleaned and examined for defects by CONTRACTOR.
  1. If found defective, CONTRACTOR shall reject the defective pipe, fitting, or appurtenance.
  2. CONTRACTOR shall advise ENGINEER of all defective materials.
- C. Surplus Excavation:
  1. All surplus excavation shall be placed, in an orderly manner.
  2. If material is stockpiled on private property, written permission shall be obtained from the property owner and provided to ENGINEER.

#### **3.02 OBSTRUCTIONS AND DISPOSAL OF WASTE MATERIAL**

- A. CONTRACTOR shall remove obstructions that do not require replacement from within the trench or adjacent areas such as tree roots, stumps, abandoned piling, buildings and concrete structures, frozen material, logs, and debris of all types without additional compensation.
- B. ENGINEER may, if requested, make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the WORK limits without adversely affecting the intended function of the facility.
- C. Excavated materials unsuitable for backfill or not required for backfill shall be disposed of in accordance with local regulations.

### 3.03 TRENCH EXCAVATION

- A. All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line, and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill.
- B. Clearance:
  - 1. The trench shall be excavated so that a minimum clearance of six (6) inches is maintained on each side of the pipe for proper placement and densification of the bedding or backfill material.
  - 2. The maximum clearance measured at the spring line of the pipe shall be eighteen (18) inches regardless of the type of pipe, type of soil, depth of excavation, or the method of densifying the bedding and backfill.
- C. Except as otherwise dictated by construction conditions, the excavation shall be of such dimensions as to allow for the proper pipe installation and to permit the construction of the necessary pipe connections.
- D. Care shall be taken to ensure that the excavation does not extend below established grades.
  - 1. If the excavation is made below such grades, the excess excavation shall be filled in with sand or graded gravel deposited in horizontal layers not more than six (6) inches in thickness after being compacted and shall be moistened as required to within two percent (2%) of the optimum moisture content required for compaction of that soil.
  - 2. After being conditioned to have the required moisture content, the layers shall be compacted to the required density.
- E. CONTRACTOR shall stockpile excavated materials in a safe manner. Stockpiles shall be graded for proper drainage.
- F. CONTRACTOR shall place and grade the trench base to the proper grade ahead of pipe laying. The invert of the trench shall be compacted to provide a firm unyielding support along entire pipe length.
- G. Surplus excavation shall be disposed of by CONTRACTOR at CONTRACTOR's expense.

### 3.04 PROTECTION

- A. Sheeting and Shoring:
  - 1. CONTRACTOR shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures.
  - 2. The latest requirements of OSHA shall be complied with at all times including trenching and confined space entry requirements.

3. CONTRACTOR shall be responsible for underpinning adjacent structures which may be damaged by excavation WORK, including service utilities and pipe chases.

B. Weather and Frost:

1. CONTRACTOR shall protect bottom of excavations and soil adjacent to and beneath foundations from frost.
2. Do not place backfill, fill, or embankment on frozen surfaces.
3. Do not place frozen materials, snow, or ice in backfill, fill, or embankments.
4. Do not deposit, tamp, roll, or otherwise mechanically compact backfill in water.

C. Drainage and Groundwater:

1. The excavation shall be graded to prevent surface water runoff into trench or excavation.
2. Maintain excavations and trenches free from water during construction.
3. Remove water encountered in trenches to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.
4. Divert surface runoff and use sumps, gravel blankets, well points, drain lines, or other means necessary to accomplish the above.
5. Maintain the excavation or trench free from water until the structure, or pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
6. Prevent water from entering into previously constructed pipe.
7. Do not use the pipe under construction for dewatering.

3.05 FOUNDATIONS ON UNSTABLE SOILS

- A. If the bottom of the excavation is soft or unstable, and in the opinion of ENGINEER, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to six (6) inches below grade with rock or other approved material, uniformly graded between three-quarter (3/4) inch and one and one-half (1-1/2) inches to provide a firm foundation for the pipe or structure. From six (6) inches below grade to grade, the appropriate bedding material shall be placed to provide support for the pipe or structure.

3.06 PIPE BEDDING

- A. After completion of the trench excavation and proper preparation of the foundation, six (6) inches of bedding material shall be placed on the trench bottom for support under the pipe.



- B. Bell holes shall be dug deep enough to provide a minimum of two (2) inches of clearance between the bell and the bedding material.
- C. All pipes shall be installed in such a manner as to ensure full support of the pipe barrel over its entire length.
- D. After the pipe is adjusted for line and grade and the joint is made, the bedding material shall be carefully placed and tamped under the haunches of the pipe.
- E. For all types of pipe, the limits of bedding shall be as shown on the trench section details on the DRAWINGS.
- F. Bedding shall be compacted to seventy five percent (75%) relative density in accordance with ASTM D4253. Care shall be exercised to ensure sufficient tamping under the pipe to achieve uniform support.

### 3.07 BACKFILL AND COMPACTION

- A. All muck excavation, bedding, and pipe zone material shall be imported unless otherwise designated by OWNER's geotechnical engineer.
- B. Pipe:
  - 1. The pipe trench shall be backfilled to the limits as shown on the DRAWINGS.
  - 2. The backfill in all areas shall be compacted by vibrating, tamping, or a combination thereof to seventy five percent (75%) relative density for sand material as determined by the relative density of cohesionless soils test, ASTM D4253, or to ninety five percent (95%) of the Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.
  - 3. All backfill shall be brought up to equal height along each side of the pipe in such a manner as to avoid displacement.
  - 4. Bedding shall be distributed in 6-inch (6") maximum lifts over the full width of the trench.
  - 5. Wet, soft or frozen material, asphalt chunks, or other deleterious substances shall not be used for backfill.
  - 6. If the excavated material is not suitable for backfill, as determined by ENGINEER, suitable material shall be hauled in and utilized and the rejected material hauled away and disposed of.
  - 7. Backfilling shall be conducted at all times in a manner to prevent damage to the pipe or its coating and shall be kept as close to the pipe laying operation as practical.
  - 8. Backfilling procedures shall conform to the additional requirements, if any, of appropriate agencies or private right-of-way agreements.
- C. Unsurfaced Areas: All surface cuts shall be, as a minimum, restored to a condition equal to that prior to construction.



D. Surfaced Areas:

1. All surface cuts shall be, as a minimum, restored to a condition equal to that prior to construction.
2. All gravel or paved streets shall be restored in accordance with the regulations and requirements of the agency having control or jurisdiction over the street, roadway, or right-of-way.

E. Grassed or Landscaped Areas:

1. In landscaped or agricultural areas, topsoil, to a depth of twelve (12) inches, shall be removed from the area of general disturbance and stockpiled.
2. After installation of all pipelines, appurtenances and structures and completion of all backfill and compaction, the stockpiled topsoil shall be redistributed evenly over all disturbed areas.
3. Care should be taken to conform to the original ground contour or final grading plans.

3.08 FIELD QUALITY CONTROL

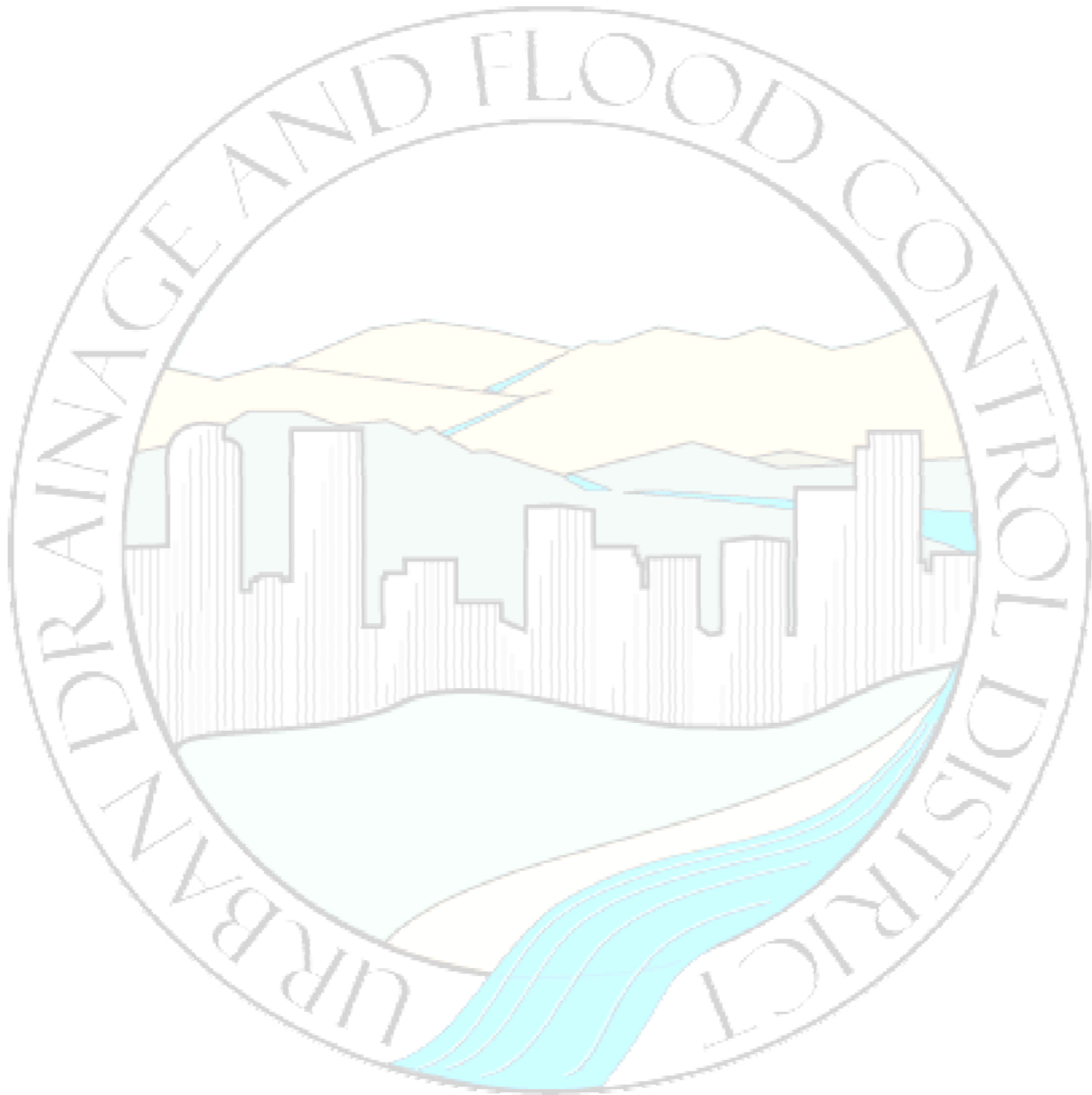
- A. In-place moisture density tests will be performed to ensure trench backfill complies with specified requirements. The following minimum tests will be performed.
1. Trench Bedding: One per two hundred (1 per 200) feet.
  2. Backfill: One per two hundred (1 per 200) feet.
- B. Backfill Compaction Tests:
1. Backfill compaction tests will be performed until compaction meets or exceeds requirements.
  2. The cost of “passing” tests will be paid by OWNER.
  3. Costs associated with “failing” tests shall be paid by CONTRACTOR.
- C. Pipe bedding will be tested prior to placement of backfill.
- D. Testing of all bedding and backfill material will be done in compliance with Occupational Safety & Health Administration (OSHA) - Excavations.

3.09 RESTORATION

- A. Scarify surface, reshape, and compact to required density completed or partially completed areas of WORK disturbed by subsequent construction operations or by adverse weather.
- B. Maintain and correct backfill, fill, and embankment settlement and make necessary repairs to pavement structures, seeding, and sodding which may be damaged as a result of settlement for the guarantee period.

- C. Such maintenance and correction may be performed by subcontract.
- D. Upon completion of the WORK, all plants, rubbish, unused materials, concrete forms, and other like material shall be removed from the job site.
- E. The site shall be left in a state of order and cleanliness.

**END OF SECTION**



**SECTION 31 25 00**

**EROSION AND SEDIMENTATION CONTROL**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. This WORK shall consist of temporary measures needed to control erosion and water pollution. These temporary measures shall include, but not be limited to, berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods. These temporary measures shall be installed at the locations where needed to control erosion and water pollution during the construction of the PROJECT, and as directed by ENGINEER, and as shown on the DRAWINGS.
- B. The Erosion Control Plan presented in the DRAWINGS serves as a minimum for the requirements of erosion control during construction. CONTRACTOR has the ultimate responsibility for providing adequate erosion control and water quality throughout the duration of the PROJECT. Therefore, if the provided plan is not working sufficiently to protect the PROJECT areas, then CONTRACTOR shall provide additional measures as required to obtain the required protection. CONTRACTOR shall include in the BID price for erosion control a minimum of all items shown on the Erosion Control Plan and any additional items that may be needed to control erosion and water pollution.

**1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 23 19, Dewatering.
  - 2. Section 31 11 00, Clearing and Grubbing.
  - 3. Section 31 14 13, Topsoil Stripping and Stockpiling.

**1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. Colorado Department of Public Health and Environment (CDPHE).

**1.04 SUBMITTALS**

- A. Submit the following information:
  - 1. Erosion Control Plan.
  - 2. Construction schedule for Erosion Control per Article Scheduling.
  - 3. Sequencing Plan per Article Scheduling.
  - 4. Plan for disposal of waste material per Article Scheduling.

5. Product data for materials proposed for use.
6. All applicable permits for Erosion Control.

#### 1.05 REGULATORY REQUIREMENTS

- A. 401 Construction Dewatering Industrial Wastewater Permit (Construction Dewatering Permit 401):
  1. CONTRACTOR shall apply for and obtain a Construction Dewatering Permit 401 from the Colorado Department of Public Health and Environment.
  2. All costs for this permit shall be the responsibility of CONTRACTOR.
  3. This permit requires that specific actions be performed at designated times.
  4. CONTRACTOR is legally obligated to comply with all terms and conditions of the permit including testing for effluent limitations.
  5. CONTRACTOR shall allow the Colorado Department of Public Health and Environment or other representatives to enter the site to test for compliance with the permit.
  6. Non-compliance with the permit can result in stoppage of all WORK.
- B. In the event of conflict between these requirements and erosion and pollution control laws, rules, or regulations of other Federal, State, or local agencies, the more restrictive laws, rules, or regulations shall apply.

#### 1.06 SCHEDULING

- A. Sequencing Plan:
  1. CONTRACTOR shall submit a sequencing plan for approval for erosion control in conformance with CONTRACTOR's overall Construction Plan for approval by OWNER.
  2. Changes to the Erosion Control Sequencing Plan may be considered by OWNER only if presented in writing by the CONTRACTOR.
- B. Temporary Erosion Control:
  1. When so indicated in the CONTRACT DOCUMENTS, or when directed by ENGINEER, CONTRACTOR shall prepare construction schedules for accomplishing temporary erosion control WORK including all maintenance procedures.
  2. These schedules shall be applicable to clearing and grubbing, grading, structural WORK, construction, etc.
- C. CONTRACTOR shall submit for acceptance the proposed method of erosion control on haul roads and borrow pits and a plan for disposal of waste material.

- D. CONTRACTOR shall be required to incorporate all permanent erosion control features into the PROJECT at the earliest practicable time as outlined in the accepted schedule. Temporary erosion control measures shall then be used to correct conditions that develop during construction.
- E. WORK shall not be started until the erosion control schedules and methods of operations have been accepted.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS**

- A. All materials shall be submitted for approval prior to installation.
- B. Materials may include hay bales, straw, fiber mats, fiber netting, wood cellulose, fiber fabric, gravel, and other suitable materials, and shall be reasonably clean, free of deleterious materials, and certified weed free.
- C. Grass Seed:
  - 1. Temporary grass cover (if required) shall be a quick growing species, suitable to the area, in accordance with local criteria and permit requirements, which will provide temporary cover, and not compete with the grasses sown for permanent cover.
  - 2. All grass seed shall be approved by ENGINEER and in accordance with local regulations prior to installation.
- D. Fertilizer and soil conditioners shall be approved by ENGINEER and in accordance with local regulations prior to installation.

## **PART 3 EXECUTION**

### **3.01 GENERAL**

- A. All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to ensure continued performance of their intended function.
- B. OWNER will monitor CONTRACTOR's erosion control and WORK methods.
  - 1. If the overall function and intent of erosion control is not being met, OWNER will require CONTRACTOR to provide additional measures as required to obtain the desired results.
  - 2. Costs for any additional erosion control measures shall be paid for at contract unit prices.
- C. The erosion control features installed by CONTRACTOR shall be adequately maintained by CONTRACTOR until the PROJECT is accepted.
- D. Working In or Crossing Watercourses and Wetlands:
  - 1. Construction vehicles shall be kept out of watercourses to the extent possible.

2. Where in-channel WORK is necessary, precautions shall be taken to stabilize the WORK area during construction to minimize erosion.
  - a. The channel (including bed and banks) shall always be restabilized immediately after in-channel WORK is completed.
3. Where a live (wet) watercourse must be crossed by construction vehicles during construction, a Temporary Stream Crossing shall be provided for this purpose.

### 3.02 PROTECTION OF ADJACENT PROPERTIES

- A. Properties adjacent to the site of a land disturbance shall be protected from sediment deposition.
- B. In addition to the erosion control measures required on the DRAWINGS, perimeter controls may be required if damage to adjacent properties is likely, and may include, but is not limited to:
  1. Vegetated buffer strip around the lower perimeter of the land disturbance.
    - a. Vegetated buffer strips may be used only where runoff in sheet flow is expected and should be at least twenty (20) feet in width.
  2. Sediment barriers such as straw bales, erosion logs, and silt fences.
  3. Sediment basins and porous landscape detention ponds.
  4. Combination of above measures.

### 3.03 CONSTRUCTION

- A. Stabilization of Disturbed Areas:
  1. Temporary sediment control measures shall be established within five (5) days from time of exposure/disturbance.
  2. Permanent erosion protection measures shall be established within five (5) days after final grading of areas.
- B. Stabilization of Sediment and Erosion Control Measures:
  1. Sediment barriers, perimeter dikes, and other measures intended to either trap sediment or prevent runoff from flowing over disturbed areas shall be constructed as a first step in grading and be made functional before land disturbance takes place.
  2. Earthen structures such as dams, dikes, and diversions shall be stabilized within five (5) days of installation.
  3. Stormwater outlets shall also be stabilized prior to any upstream land disturbing activities.



- C. Stabilization of Waterways and Outlets:
  - 1. All onsite stormwater conveyance channels used by CONTRACTOR for temporary erosion control purposes shall be designed and constructed with adequate capacity and protection to prevent erosion during storm and runoff events.
  - 2. Stabilization adequate to prevent erosion shall also be provided at the outlets of all pipes and channels.
- D. Storm Sewer Inlet Protection: All storm sewer inlets which are made operable during construction or which drain stormwater runoff from a construction site shall be protected from sediment deposition by the use of filters.
- E. Construction Access Routes:
  - 1. Wherever construction vehicles enter or leave a construction site, a Stabilized Construction Entrance is required.
  - 2. Where sediment is transported onto a public road surface, the roads shall be cleaned thoroughly at the end of each day.
  - 3. Sediment shall be removed from roads by shoveling or sweeping and be transported to a sediment controlled disposal area.
  - 4. Street washing shall be allowed only after sediment is removed in this manner.

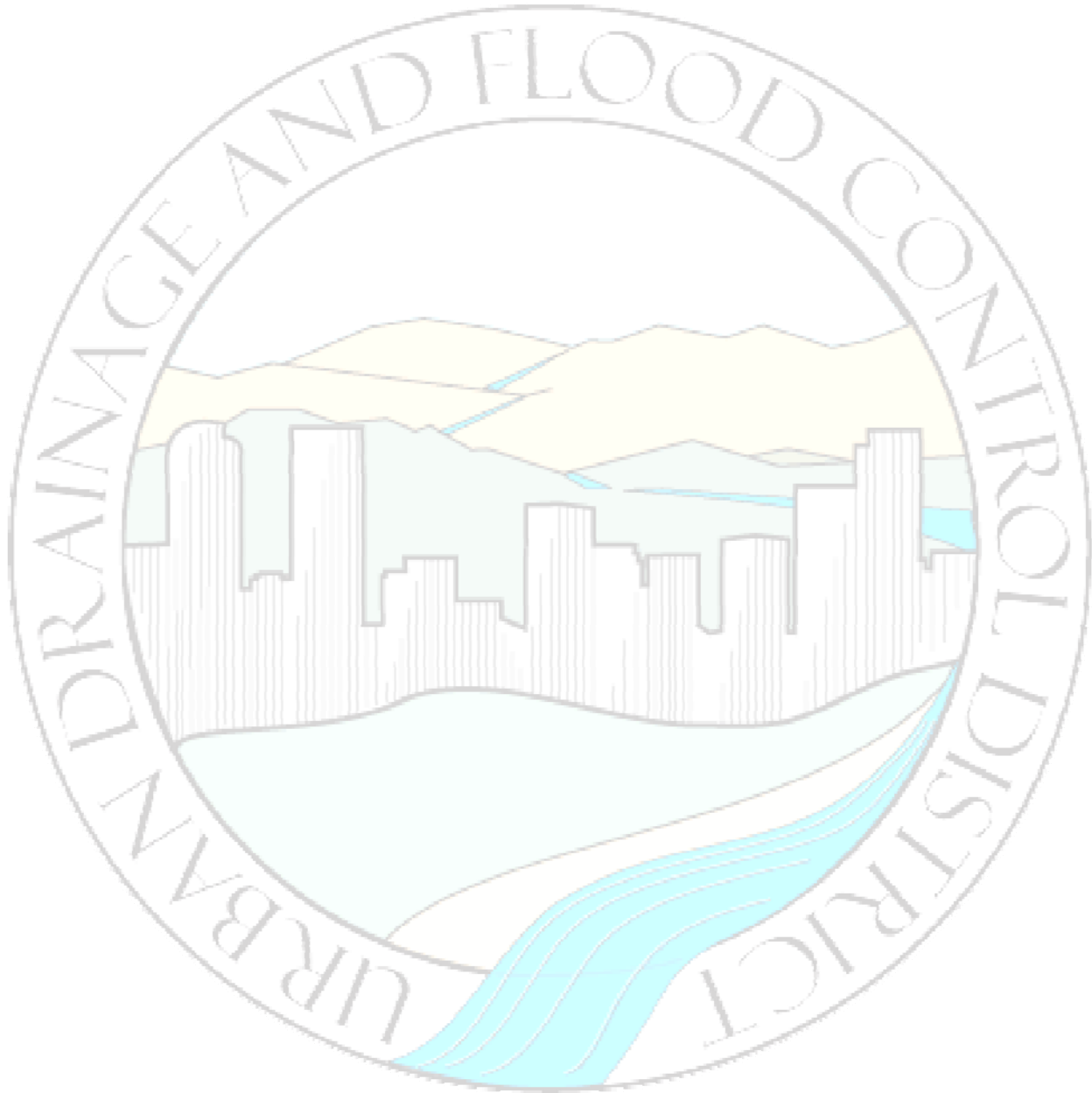
### 3.04 DISPOSITION OF TEMPORARY MEASURES

- A. All temporary erosion and sediment control measures shall be disposed of within thirty (30) days after final site stabilization is achieved or after the temporary measures are no longer needed as determined by OWNER.
- B. Trapped sediment and other disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion.
- C. Substantial Completion of Erosion Control Measures:
  - 1. At the time specified in the CONTRACT DOCUMENTS, and subject to compliance with specified materials and installation requirements, CONTRACTOR shall receive a Substantial Completion Certificate for temporary erosion control measures.
  - 2. Maintenance of Erosion Control Measures after Substantial Completion: CONTRACTOR shall be responsible for maintaining temporary erosion control measures as specified in the DRAWINGS and CONTRACT DOCUMENTS until such time as WORK has been accepted by OWNER as specified in Section 01 77 00, Closeout Procedures.

D. Final Completion and Acceptance of Erosion Control Measures:

1. After ENGINEER and OWNER have determined that the drainage area has stabilized, CONTRACTOR shall remove all remaining temporary erosion control measures.
2. Any damage to the site shall be repaired to the satisfaction of ENGINEER and at no cost to OWNER.

**END OF SECTION**



**SECTION 31 37 00**

**RIPRAP, BOULDERS, SOIL RIPRAP, AND BEDDING**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. The WORK includes excavation, grading, and installation of riprap, boulders, soil riprap, and bedding placed at the locations shown on the DRAWINGS. The materials to be used and the construction of such structures shall be as specified herein.

**1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 23 00, Excavation and Fill.
2. Section 31 23 19, Dewatering.
3. Section 31 23 33, Trenching and Backfilling.
4. Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders, and Grouted Rock Retaining Walls

**1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
  - a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
  - b. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - c. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
  - d. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
  - e. T248, Reducing Field Samples of Aggregate Test Size.
2. ASTM International (ASTM): D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).

1.04 SUBMITTALS

- A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.
- B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

**PART 2 PRODUCTS**

2.01 MATERIALS

A. RIPRAP

- 1. Riprap used shall be the type designated on the DRAWINGS and shall conform to the following:

<b>Riprap Designation</b>	<b>% Smaller Than Given Size By Weight</b>	<b>Intermediate Rock Dimension (inches)</b>	<b>d<sub>50</sub>* (inches)</b>
Type VL	70 - 100	12	6**
	50 - 70	9	
	35 - 50	6	
	2 - 10	2	
Type L	70 - 100	15	9**
	50 - 70	12	
	35 - 50	9	
	2 - 10	3	
Type M	70 - 100	21	12**
	50 - 70	18	
	35 - 50	12	
	2 - 10	4	
Type H	70 - 100	30	18
	50 - 70	24	
	35 - 50	18	
	2 - 10	6	
Type VH	70 - 100	41	24
	50 - 70	33	
	35 - 50	24	
	2 - 10	9	
*d <sub>50</sub> = Mean Particle Size			
**Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.			

- 2. The riprap designation and total thickness of riprap shall be as shown on the DRAWINGS. The maximum stone size shall not be larger than the thickness of the riprap.

3. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.
4. The specific gravity of the riprap shall be two and one-half (2.5) or greater.
5. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
6. The bulk density for the riprap shall be 1.3 ton/cy or greater.
7. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
8. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
9. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
10. Rock shall be free of calcite intrusions.
11. Gradation:
  - a. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.
  - b. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.
  - c. Control of gradation shall be by visual inspection. However in the event ENGINEER determines the riprap to be unacceptable, ENGINEER shall pick two (2) random truckloads to be dumped and checked for gradation.
    - 1) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost.
12. Color:
  - a. The color of the riprap shall be gray with gray/blue hues or other acceptable colors approved by ENGINEER prior to delivery to the PROJECT site.
  - b. Color shall be consistent on the entire PROJECT and shall match the color of rock to be used for all other portions of the WORK.
13. Broken concrete or asphalt pavement shall not be acceptable for use in the WORK.

14. Rounded riprap (river rock) is not acceptable, unless specifically designated on the DRAWINGS.

**B. BOULDERS**

1. Boulders used shall be the type designated on the DRAWINGS and shall conform to the following:

<b>Boulder Classification</b>	<b>Nominal Size (inches)</b>	<b>Range in Smallest Dimension of Individual Rock Boulders (inches)</b>	<b>Maximum Ratio of Largest to Smallest Rock Dimension of Individual Boulders</b>
B18	18	17 - 20	1.50
B24	24	22 - 26	1.50
B30	30	28 - 32	1.50
B36	36	34 - 38	1.50
B42	42	40 - 44	1.50
B48	48	45 - 51	1.50

2. The specific gravity of the boulders shall be two and one-half (2.5) or greater.
3. Boulder specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
4. The bulk density for the boulder shall be 1.3 ton/cy or greater.
5. The boulders shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
6. The boulders shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
7. The boulders shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
8. Rock shall be free of calcite intrusions.
9. Color:
  - a. The color of the boulders shall be gray with gray/blue hues or other acceptable colors approved by ENGINEER prior to delivery to the PROJECT site.



- b. Color shall be consistent on the entire PROJECT and shall match the color of rock to be used for all other portions of the WORK.

C. SOIL RIPRAP

- 1. Rock requirements are to comply with riprap as specified in Article Materials.
- 2. The soil material shall be native or topsoil and mixed with sixty-five percent (65%) riprap and thirty five percent (35%) soil by volume.
- 3. Soil riprap shall consist of a uniform mixture of soil and riprap without voids.

D. BEDDING:

- 1. Gradation for Granular Bedding:

U.S. Standard Sieve Size	Percent by Weight Passing Square-Mesh Sieves	
	Type I (CDOT Sect. 703.01)	Type II (CDOT Sect. 703.09 Class A)
3 inches	-	90 - 100
1½ inches	-	-
¾ inch	-	20 - 90
⅜ inch	100	-
No. 4	95 - 100	0 - 20
No. 16	45 - 80	-
No. 50	10 - 30	-
No. 100	2 - 10	-
No. 200	0 - 2	0 - 3

- 2. Granular bedding designation and total thickness of bedding shall be as shown on the DRAWINGS.
- 3. Granular bedding shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for riprap.
  - a. Broken concrete asphalt pavement or sledge, shall not be acceptable for use in the WORK. Rounded river rock is not acceptable unless specifically designated on the DRAWINGS.
  - b. The requirements for the wear test in AASHTO T96 shall not apply.

E. FEATURE BOULDERS:

1. Feature Boulders shall consist of the same material as boulders, differing only by size.
2. Feature Boulders shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for boulders
3. Feature Boulders shall have a minimum dimension of four (4) feet, or as shown on the DRAWINGS.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. Channel slope, bottom, or other areas that are to be protected with riprap, boulders or soil riprap shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface as shown on the DRAWINGS.
- B. CONTRACTOR shall excavate areas to receive riprap to the subgrade as shown on the DRAWINGS accounting for granular bedding.
- C. CONTRACTOR shall excavate areas to receive boulders or soil riprap to the specified depth (bedding material is not required for boulders and soil riprap).
- D. Subgrade Materials:
  1. The subgrade materials shall be stable.
  2. If unsuitable materials are encountered, they shall be removed and replaced as Muck Excavation in accordance with Section 31 23 00, Excavation and Fill, for subgrade that has been excavated in undisturbed soil.
- E. Additional Compaction:
  1. Additional compaction shall not be required unless specified by ENGINEER.
  2. When subgrade is built up with embankment material it shall be compacted to ninety five percent (95%) maximum density (ASTM D698).
- F. Bedding:
  1. After an acceptable subgrade is established, bedding shall be immediately placed and leveled to the specified elevation on the DRAWINGS.
  2. Immediately following the placement of the bedding material, the riprap shall be placed.
  3. If bedding material is disturbed for any reason, it shall be replaced and graded at CONTRACTOR's expense.
  4. Contamination:

- a. In-place bedding materials shall not be contaminated with soils, debris or vegetation before the riprap is placed.
- b. If contaminated, the bedding material shall be removed and replaced at CONTRACTOR's expense.

### 3.02 PLACEMENT

#### A. RIPRAP

1. Following acceptable placement of granular bedding, riprap placement shall commence as follows:
  - a. Machine Placed Riprap:
    - 1) Riprap shall be placed on the prepared slope or channel bottom areas in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids.
    - 2) Riprap shall be machine placed, unless otherwise stipulated in the DRAWINGS or SPECIFICATIONS.
    - 3) It is the intent of these SPECIFICATIONS to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by ENGINEER, the riprap protection shall be placed in conjunction with the construction of embankment or channel bottom with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected.
  - b. Slope Placement:
    - 1) When riprap is placed on slope, placement shall commence at the bottom of the slope working up the slope.
  - c. The entire mass of riprap shall be placed on either channel slope or bottom so as to be in conformance with the required gradation mixture and to line, grade, and thickness shown on the DRAWINGS.
  - d. Riprap shall be placed to full course thickness at one operation and in such a manner as to avoid displacing the underlying bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.
  - e. All material used for riprap protection for channel slope or bottom shall be placed and distributed such that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.
  - f. The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials.

- g. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the rock layer thickness shall not be allowed.
- h. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism.
- i. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material.
- j. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.
- k. CONTRACTOR shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the DRAWINGS at no additional cost to OWNER. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

2. Hand Placed Riprap:

- a. Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements of PART 2, above.
- b. Hand placed riprap shall also be required when the depth of riprap is less than two (2) times the nominal stone size, or when required by the DRAWINGS or SPECIFICATIONS.
- c. After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown on the DRAWINGS.

3. Soil Replacement Over Riprap:

- a. Where riprap is designated to be buried, place onsite excavated material that is free from trash and organic matter in riprap voids by washing and rodding.
- b. Prevent excessive washing of material into stream.
- c. When voids are filled and the surface accepted by ENGINEER, place a nominal six (6) inches of topsoil over the area, or as designated on the DRAWINGS.
- d. Fine grade, seed, and mulch per the SPECIFICATIONS.

B. BOULDERS

- 1. Following excavation and acceptance of subgrade by ENGINEER Boulder placement shall commence as follows:

- a. Boulders shall be placed on the prepared subgrade in a manner which will minimize voids.
  - b. Voids between boulders exceeding 4" shall be chinked.
2. If Boulders are to be grouted, boulders shall be installed according to Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders and grouted Boulder Retaining Walls.

C. SOIL RIPRAP

1. Adjacent stockpiles of riprap and soil shall be created and mixing done at the stockpile location, not at the location where soil riprap is to be placed.
2. Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.
3. With prior approval of ENGINEER, layering the riprap and soil instead of premixing may be allowed if the native soil is granular.
4. Place a first layer of smaller soil riprap of approximate  $d_{50}$  thickness. Then place the top layer with surface rocks that are largely  $d_{50}$  or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane as described in Paragraph A.
5. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.
6. The soil shall be further wetted to encourage void filling with soil.
7. Any large voids shall be filled with rock and small voids filled with soil.
8. Excessively thick zones of soil prone to washing away shall not be created (for example, no thicknesses greater than six (6) inches).
9. For buried soil riprap, the top surface shall be covered with four (4) inches of topsoil such that no rock points are protruding.
10. The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

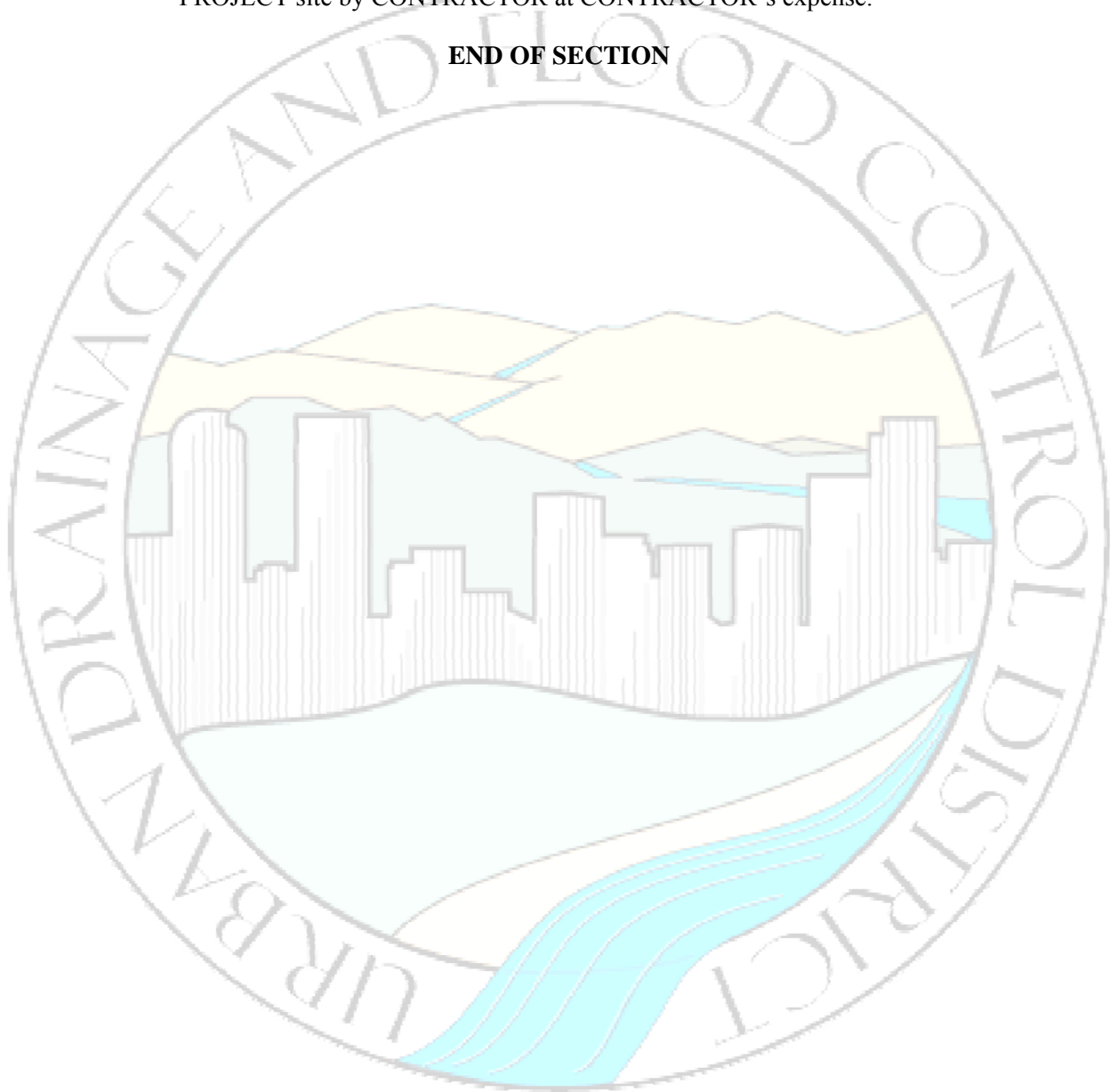
D. FEATURE BOULDERS

1. Feature Boulders serve an aesthetic function and as such shall be placed and rotated into final position as directed by ENGINEER in order to achieve the desired result.

3.03 REJECTION OF WORK AND MATERIALS:

- A. ENGINEER will reject placed riprap, boulders, soil riprap and bedding that do not conform to this section. CONTRACTOR shall immediately remove and re-lay the riprap, boulders, soil riprap and bedding to conform to SPECIFICATIONS.
- B. Riprap, boulders, soil riprap and bedding shall be rejected, which is either delivered to the job site or placed, that does not conform to this section.
- C. Rejected riprap, boulders, soil riprap and bedding shall be removed from the PROJECT site by CONTRACTOR at CONTRACTOR's expense.

**END OF SECTION**





**SECTION 31 37 19**

**GROUTED BOULDERS, STACKED GROUTED BOULDERS, AND GROUTED BOULDER RETAINING WALLS**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. This WORK shall consist of installing grouted boulders, stacked grouted boulders, and grouted rock retaining walls constructed at the location (s) shown on the DRAWINGS.

**1.02 RELATED SECTIONS**

- A. The following is a list of SPECIFICATIONS which may be related to this section:
  - 1. Section 31 23 00, Excavation and Fill.
  - 2. Section 31 23 19, Dewatering.
  - 3. Section 31 23 33, Trenching and Backfilling.
  - 4. Section 31 37 00, Riprap, Boulders, Soil Riprap and Bedding

**1.03 REFERENCES**

- A. The following is a list of standards which may be referenced in this section:
  - 1. American Association of State Highway and Transportation Officials (AASHTO):
    - a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
    - b. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
    - c. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
  - 2. ASTM International (ASTM):
    - a. C39, Standard Test Method for Compressive Cylindrical Concrete Specimens.
    - b. C150, Standard Specification for Portland Cement.
    - c. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).

#### 1.04 DEFINITIONS

- A. Terms “boulders,” and “rock,” may be used interchangeably in this section.

#### 1.05 SUBMITTALS

- A. CONTRACTOR shall submit a mix design in writing to ENGINEER for approval prior to placement of any grout.
- B. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.
- C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

#### 1.06 QUALITY ASSURANCE

- A. Mock-up:
  - 1. Prior to the construction of any grouted rock walls, CONTRACTOR or SUBCONTRACTOR who is constructing the walls for CONTRACTOR shall show ENGINEER an example of similar rock walls that they had constructed previously.
  - 2. After acceptance of this previous WORK, CONTRACTOR or SUBCONTRACTOR shall construct approximately one hundred (100) square feet of grouted rock wall as shown on the DRAWINGS for approval by ENGINEER.
  - 3. If the construction is approved, CONTRACTOR or SUBCONTRACTOR shall construct the rest of the grouted rock wall. If the construction is not approved, CONTRACTOR shall make any changes required by OWNER and ENGINEER to obtain approval, and construct the remainder of the wall as approved.

### **PART 2 PRODUCTS**

#### 2.01 MATERIALS

- A. Boulders
  - 1. Boulders shall meet the requirements of Section 31 37 00 Riprap, Boulders, Soil Riprap and Bedding
  - 2. Rhyolite rock shall not be used for any grouted boulders.
  - 3. Gradation:
    - a. Each load of boulders shall conform to the dimensions specified on the DRAWINGS and in Section 31 37 00 Riprap, Boulders, Soil Riprap, and Bedding
    - b. Boulders for a boulder edge shall have a maximum ratio of largest to smallest rock dimension shall be 1.5 or as shown on the

DRAWINGS. Grouted walls shall be constructed of rock having a mean diameter of nine (9) inches to eighteen (18) inches.

- c. Control of gradation will be by visual inspection.
  - 1) In the event ENGINEER determines the boulders to be unacceptable, ENGINEER will pick two random truckloads to be dumped and checked for gradation.
  - 2) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost to OWNER if the boulders do not meet the specified gradation.
  - 3) If the boulders do meet the gradation specified, OWNER will pay for the equipment and labor required for checking.

4. Color:

- a. The color of boulders shall meet the requirements of Section 31 37 00, Riprap, Boulders, Soil Riprap, and Bedding.

B. Grout:

1. Concrete for the grout shall be an approved batch meeting the following requirements:

- a. All grout shall have a minimum 28-day compressive strength equal to 3,200 psi.
- b. One cubic yard of grout shall contain a minimum of six (6) sacks of Type II Portland cement.
- c. A maximum of 25% Type F Fly Ash may be substituted for the Portland cement.
- d. Aggregate for the grout shall consist of 70% natural sand (fines) and 30% 3/8-inch rock (coarse).
- e. Slump shall be four (4) inches to six (6) inches.
- f. Air entrainment shall be 5.5% - 7.5%.
- g. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.
- h. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.
- i. Color Additive in required amounts shall be used when so specified by contract.

## **PART 3 EXECUTION**

### **3.01 GROUTED BOULDERS AND STACKED GROUTED BOULDERS**

- A. Grouted boulders shall be placed at the locations as shown on the DRAWINGS and installed with the following requirements:

1. Subgrade:

- a. The subgrade to receive each boulder shall be excavated and any unstable material shall be removed.
- b. Grouted Boulders shall be placed on subgrade without granular bedding unless approved by ENGINEER.
- c. Material approved by ENGINEER shall be placed and compacted in a maximum of four-inch (4") lifts to ninety five percent (95%) of Maximum Standard Proctor Density (ASTM D698) to re-establish the subgrade of each boulder.
- d. Unstable material shall be removed from the PROJECT site and disposed of by CONTRACTOR. Removal and replacement of unstable material shall only be completed at the direction of ENGINEER and shall be paid for under Muck Excavation.
- e. Subgrade shall be excavated a minimum of 6" to a maximum of 12" behind boulders.
- f. Backfill behind boulders shall be compacted to ninety five percent (95%) Maximum Standard Proctor Density (ASTM D698). Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder channel edge.
- g. Finished grades and subgrade for boulders shall be determined from the height of each boulder used.

2. Boulders

- a. The top of all boulders shall be as indicated on the DRAWINGS.
- b. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within two (2) inches in top elevation and two (2) inches along the vertical exposed face or channel side of rock.
- c. Boulders shall be placed such that adjacent boulders "touch" each other and voids do not exceed four (4) inches. It is the intent of construction to minimize voids and grout placed between boulders.
- d. CONTRACTOR shall, if deemed necessary, support the boulders from falling over before and during the placement of grout, backfill, and completing compaction WORK on either side of the boulder.

- e. Smaller rocks shall be “chinked in” to fill all voids behind the boulders. Smaller rocks shall also be used to "chink in gaps larger than four (4) inches. Placement shall be approved by ENGINEER prior to grouting.

3. Grouting:

- a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
- b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of twenty-four (24) hours after the grout has been placed.
- c. Keep boulders receiving grout wet at all times prior to receiving grout.
- d. The concrete grout shall be placed by injection methods by pumping under low pressure, through a two- (2") inch maximum diameter hose to ensure complete penetration of the grout into the void area as detailed on the DRAWINGS. The grout mix shall be stiffened and other measures taken to retain the grout between the boulders.
- e. Grout placement shall begin at the bottom of the lowest boulder and proceed upward to ensure no air voids exist between the grout, subbase, and boulders.
- f. Grout shall be placed up to a height of one-half (1/2) of the diameter of the top row of boulders or as directed by ENGINEER and shall be placed in the voids and behind the boulders and not on the surface of the rocks.
- g. A “pencil” vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. The “pencil” vibrator may be used to smooth the appearance of the surface, but CONTRACTOR shall use a wood float to smooth and grade the grout around the boulders.
- h. Grout between boulders shall be recessed one third (1/3) the diameter of the boulders on the side facing the channel.
- i. Grout should be troweled out and finished to minimize visibility.
- j. Clean and wash any spillage before the grout sets so the visual surfaces of boulders will be free of grout to provide a clean, natural appearance, or if washing does not clean off grout residue, CONTRACTOR shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.
- k. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.



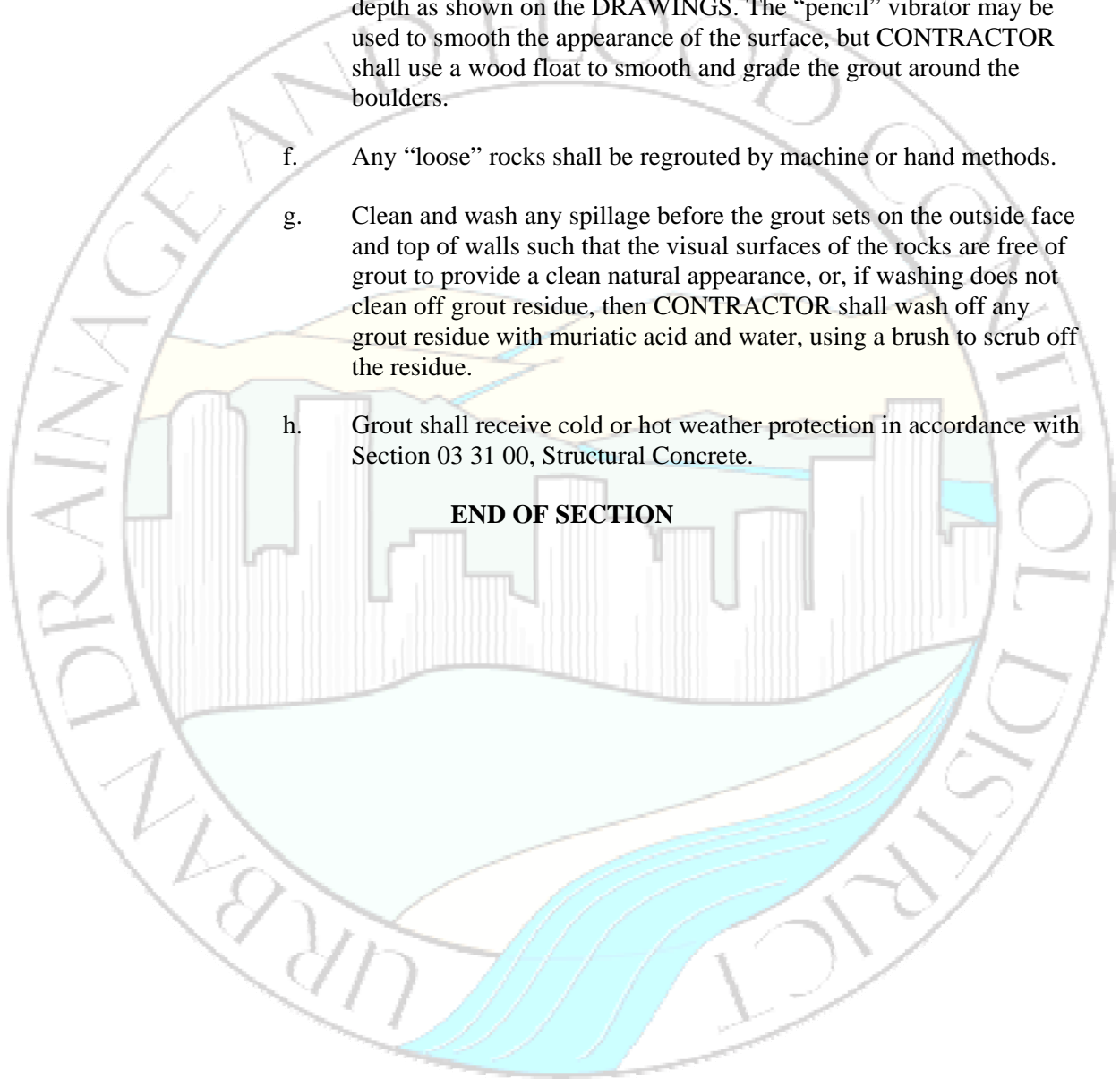
### 3.02 GROUTED BOULDER RETAINING WALLS

- A. Grouted boulder retaining walls shall be placed at locations as shown on the DRAWINGS and installed with the following requirements:
1. The grouted boulder walls shall be constructed to the dimensions shown on the DRAWINGS and shall be constructed with a one (1) horizontal to four (4) vertical batter on the front and back face, with a minimum width of one (1) foot at the top of the wall.
  2. The stone of the wall shall be laid to form substantial masonry presenting a neat, finished appearance.
  3. Headers shall hold the heart of the wall to the face and shall occupy at least twenty percent (20%) of the area and they shall be evenly distributed.
  4. The length of stretchers shall not exceed three (3) times their rise.
  5. Spalls and pinnars shall be used in the backing only where necessary and will not be allowed in the face.
  6. Face Stones:
    - a. Face stones shall be laid to break joints so that each rock laid rests on two beneath it.
    - b. Rock shall be hand graded so that only the larger stones are used in the face.
    - c. All face stones shall be pitched to a string line on straight walls or laid to batter stakes for curved walls such that the batter is consistent with respect to all parts of the wall and shall meet the minimum requirements set forth in the detail.
    - d. The degree of roughness on the exposed face shall be measured with a six-foot (6') straightedge supported between adjacent projections and stone face.
    - e. Variations in excess of three (3) inches, measured from the straight edge to the extreme depression in the stone, will not be permitted.
    - f. Rear faces shall present approximately plane surfaces and shall in general conform to the detail.
  7. Grouting:
    - a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
    - b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and the area will remain dewatered for a period of twenty-four (24) hours after the grout has been placed.

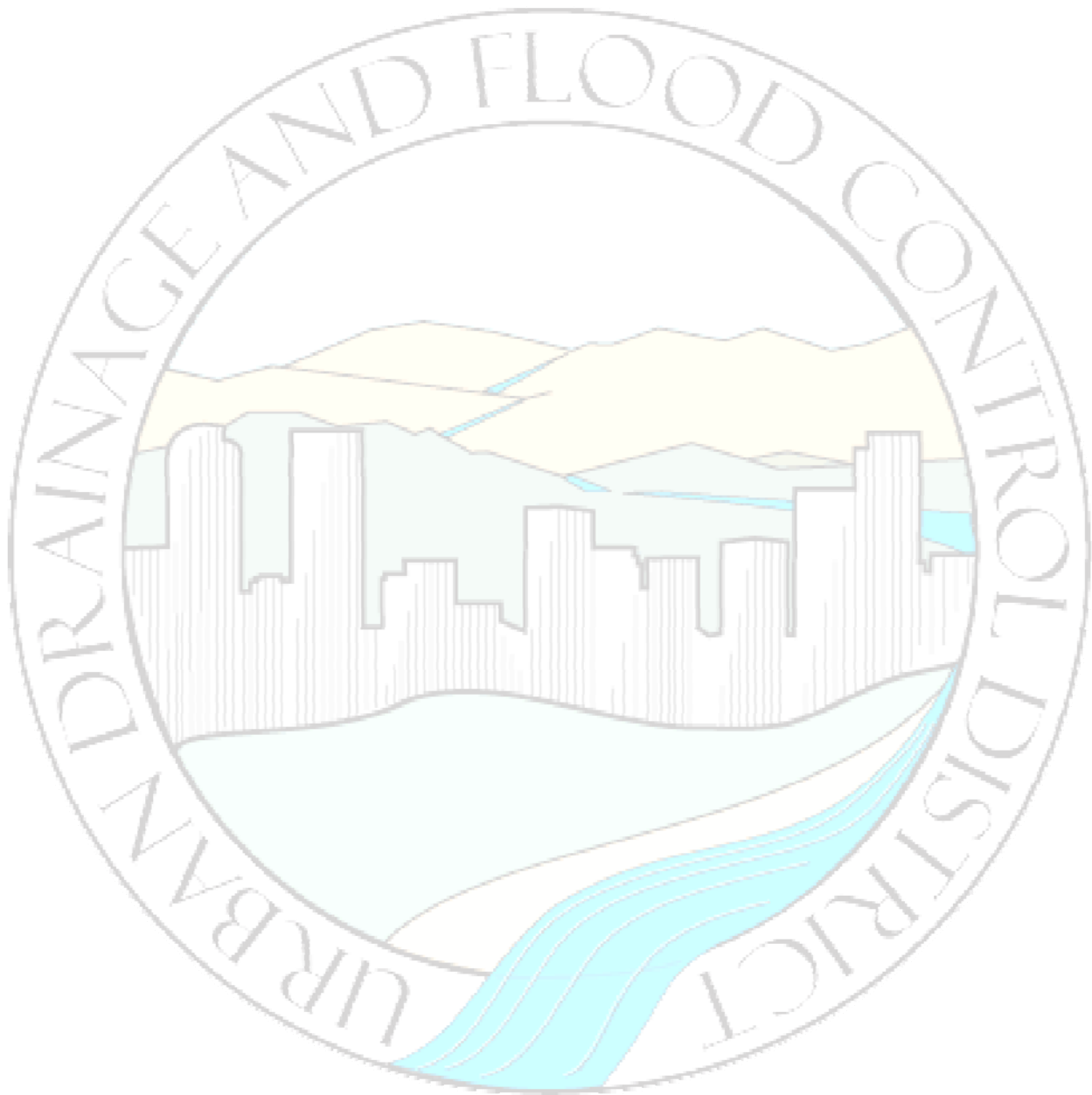


- c. The surface of the boulders receiving grout shall be wet at all times prior to receiving grout.
- d. Grout shall be placed to fill all voids between, under and the throughout the boulder walls and shall be recessed approximately one-third (1/3) the diameter of the boulders from the face of the wall in order to give a “dry stacked” appearance.
- e. A “pencil” vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. The “pencil” vibrator may be used to smooth the appearance of the surface, but CONTRACTOR shall use a wood float to smooth and grade the grout around the boulders.
- f. Any “loose” rocks shall be regouted by machine or hand methods.
- g. Clean and wash any spillage before the grout sets on the outside face and top of walls such that the visual surfaces of the rocks are free of grout to provide a clean natural appearance, or, if washing does not clean off grout residue, then CONTRACTOR shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.
- h. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.

**END OF SECTION**



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## SECTION 31 62 16

### STEEL SHEET PILES

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. This section covers all members to be used in the construction of steel sheet pile. This SPECIFICATION also covers the installation of steel sheet piling and trimming of the sheet pile to the lines and grades shown on the DRAWINGS or as required. This WORK also includes pre-drilling to facilitate driving sheet pile to the designated elevations.

##### 1.02 RELATED SECTIONS

- A. The following is a list of SPECIFICATIONS which may be related to this section:
1. Section 31 23 00, Excavation and Fill.
  2. Section 31 23 19, Dewatering.

##### 1.03 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI): 318/318R, Building Code Requirements for Structural Concrete and Commentary.
  2. American Petroleum Institute (API): Spec 5L, Specification for Line Pipe.
  3. ASTM International (ASTM):
    - a. A36, Standard Specification for Carbon Structural Steel.
    - b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    - c. A139, Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over).
    - d. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.
    - e. A328, Standard Specification for Steel Sheet Piling.
    - f. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
    - g. A690, Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.

- h. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- 4. American Water Works Association (AWWA):
  - a. C200, Steel Water Pipe—6 in. (50 mm) and Larger.
- 5. American Welding Society (AWS):
  - a. D1.1, Structural Welding Code—Steel.

#### 1.04 SUBMITTALS

- A. Provide qualifications of proposed sheet pile installer.
- B. CONTRACTOR shall provide information from the manufacturer that indicates the sheet piling meets or exceeds the SPECIFICATIONS listed in this section.
- C. CONTRACTOR shall submit verification from the manufacturer that the hammer can deliver the required energy.
- D. Splice locations, if necessary, shall be reviewed and accepted by ENGINEER prior to installation.

#### 1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Sheet piling installer shall have, as a minimum, three (3) successful past installations of sheet piling of comparable overall heights and sections and comparable penetration into soils similar to those found on the PROJECT.

### **PART 2 PRODUCTS**

#### 2.01 GENERAL

- A. All steel sheet piling shall be new and unspliced material throughout, unless otherwise reviewed and accepted by ENGINEER.
- B. Steel sheet piles and special fabricated shapes shall be of a design that ensures continuous interlock throughout the entire length when in place.

#### 2.02 MATERIALS

- A. Steel sheet piling shall meet the requirements of ASTM A328, (Grade 50).
- B. Steel corners, tees, wyes, and crosses shall meet the requirements of ASTM A328 or ASTM A690.
- C. Steel sheet piles required for the PROJECT shall be the type and weight shown on the DRAWINGS. Sheet piling shall be constructed with a weathering finish.
  - 1. Additional length beyond those indicated on the DRAWINGS may be required to provide for trimming of tops of sheet piling.

- D. The interlocks between steel sheet pile sections shall be configured such that the average width of the annular space between all contact points of the interlocks shall be a maximum of one-eighth (1/8) inch, as determined by ENGINEER.
- E. Steel sheet piles and interlocks shall not have excessive kinks, camber or twist that would prevent the pile from reasonably free sliding to grade.
- F. All fabricated connections shall be made with the use of angles or bent plates, as necessary, and shall be adequately welded or connected with high strength bolts as accepted by ENGINEER.
- G. Handling Holes:
  - 1. If handling holes are provided, they shall be two (2) standard two and nine-sixteenth (2-9/16) inch diameter handling holes located six (6) inches from one end.
  - 2. The holes shall be plugged by welding a piece of steel over the hole prior to installing any riprap, backfill or drop structure cap.
  - 3. The plated hole shall be watertight.

### 2.03 STORAGE AND HANDLING

- 1. Do not subject piles to damage by impact bending stresses in transporting to and storing piles onsite.
- 2. Store and handle piles such that corrosion protection coating will not be damaged.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Do not begin sheet pile installation until the earthwork in the area where the piles are to be driven has been completed to the extent that the grade elevation is at no more than twelve (12) inches above or below the top of the piling elevation as indicated on the DRAWINGS.

### 3.02 PREPARATION

- A. Any fill along the alignment of the sheet pile must be in place to sub-grade elevations and compacted prior to driving the sheet pile.
- B. Fill material (except riprap, boulders, bedding and grout) is not to be placed around the sheet pile after the sheet pile is in place.

### 3.03 INSTALLATION

- A. General:
  - 1. All welding or gas cutting shall be in accordance with the current standards of the American Welding Society.

2. Virtual Refusal:

- a. Steel sheet piling shall be driven to the depths shown on the DRAWINGS or to virtual refusal.
- b. Virtual refusal is defined as ten (10) blows per inch with an approved pile hammer.
- c. A pile hammer shall be used to determine virtual refusal.
- d. The hammer shall be operating at the manufacturer's recommended stroke and speed when virtual refusal is measured.

B. Sheet Piling Driving:

1. Steel sheet piling shall be assembled before driving and then driven as a continuous wall, progressively in stages to keep the piles aligned correctly and minimize the danger of breaking the interlock between the sheets.
2. Steel sheet piling shall be driven to form a tight bulkhead.
3. A driving head shall be used and any piling which is damaged in driving or which has broken interlocks between sections shall be pulled and replaced at CONTRACTOR's expense.
4. The piling shall be driven within the following tolerances:
  - a. Alignment:
    - 1) Sheet pile shall be driven to form a relatively straight line between the termini points shown on the DRAWINGS.
    - 2) Horizontal deviation of any point from a straight line connecting the two ends of the wall section shall be a maximum of six (6) inches.
  - b. Plumbness: Each individual sheet pile section shall be driven vertical, within a horizontal tolerance of two percent (2%) of any vertical length measured along the pile.
  - c. Elevation:
    - 1) Tops of sheet pile sections shall be within a tolerance of one (1) inch from plan elevations.
    - 2) CONTRACTOR shall not be paid for excess sheet pile trimmed off the end of the pile to meet final grade.

C. CONTRACTOR shall brace and/or provide soil grading as necessary during construction operations in order to provide lateral stability for the sheet pile wall. The sheet pile wall has been designed for the soil grades of the final configuration denoted on the DRAWINGS only. Other temporary configurations during the construction period shall not be allowed.

D. Care shall be taken during driving to keep from causing deformations of the top of the piles, splitting of section, or breaking of the interlock between sections. Care shall



also be taken during driving to prevent and correct any tendency of steel sheet piles to twist or get out of plumb.

- E. Steel Z piling shall be driven with the ball-end leading. Proper care and planning shall be used to allow for this construction procedure in both immediate and possible future walls.
- F. Alternate Z piles shall be reversed end for end for proper interlocking in the “normal” position. Piles shall also be aligned properly to maintain a “normal” driving width.
- G. For sheet piles driven into the native soils, pre-drilled soils, or excavated soils a vibratory driver may be used as long as the required depth is obtained.
- H. For sheet piles being driven into bedrock, an approved hammer utilizing a minimum hammer energy of 19,000 foot-pounds per square inch of steel section shall be used to obtain the required depth or virtual refusal. The hammer shall be clearly marked so that it can be identified at the job site.
- I. Steel sheet pile that is full length as shown on the DRAWINGS and is required to be driven below the specified cutoff elevation shall be spliced with additional steel sheet piling with a full penetration butt weld.

**END OF SECTION**

