

## **1.0 GENERAL**

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- .1 This section specifies placement requirements for fill materials specified in Section 02330 – Earthwork Materials, except for Waste Fill, Riprap, and Riprap Bedding. Due to project specific requirements, this section has been significantly revised from the Alberta Transportation Civil Works Master Specifications template.

### **1.2 REFERENCES**

Provide fill placement in accordance with the following standards except where specified otherwise.

- .1 American Society for Testing and Materials (ASTM)
  - .1 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>)) (Standard Proctor)
  - .2 ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
  - .3 ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

### **1.3 SUBMITTALS**

Provide the following submittals:

- .1 Specifications for the proposed compaction equipment at least 7 days prior to commencing fill placement.
- .2 Copies of all quality control testing results within 48 hours of testing.

### **1.4 QUALITY CONTROL**

- .1 Perform quality control tests of fill materials at the borrow source(s) as specified in Section 02330 – Earthwork Materials.
- .2 Transport only suitable materials to the Site. Transportation of unsuitable materials to Site will not be compensated for. If material transported (and/or placed) to site is deemed to be unsuitable it shall be removed from Site and disposed of at the Contractor's expense.
- .3 Provide a quality control program to ensure that the specified requirements will be consistently attained throughout the Work. Provide the following quality control testing at the Site, and any additional testing or measures as required by the Contractor, Owner,

and/or Engineer of Record during the Work. Quality control testing at the Site shall be completed in accordance with the prescribed frequencies outlined below. The frequency of quality control testing may be increased as deemed necessary by the Engineer of Record until the Contractor consistently meets the specified requirements and/or based on variability of material throughout fill placement. The quality control testing, outlined below, is in addition to the quality control testing required at each borrow source per Section 02330 – Earthworks Materials.

.1 Standard Proctor Tests:

Impervious Fill Zone 1A: As required based on material variability or as required by the Engineer of Record. Contractor should account for a minimum of 1 on-site test per borrow source.

Retaining Wall Reinforced Fill Zone and Foundation: As required based on material variability or as required by the Engineer of Record. Contractor should account for a minimum of 1 test for the two Downtown Dike retaining walls. If multiple borrow sources are used, the Contractor should account for a minimum of 1 test per borrow source.

Base Gravel Zone 4A and Road Gravel Zone 4B: As required based on material variability or as required by the Engineer of Record.

.2 Field Density and Moisture Content Tests – Fill Placement in Embankments:

Impervious Fill Zone 1A: Minimum 1 test per 50 linear meters per lift or if lift is less than 50 linear meters, minimum 1 test per lift.

Retaining Wall Reinforced Fill Zone and Foundation: Refer to the Engineer of Record's Issued for Tender (IFT) "Downtown Dike Redi Rock Retaining Walls Design" drawing package for detailed testing requirements.

Base Gravel Zone 4A and Road Gravel Zone 4B: Minimum 1 test per 50 linear meters per lift or if lift is less than 50 linear meters, minimum 1 test per lift.

Conduct field density and moisture content tests using a certified nuclear densometer.

.3 Field Density and Moisture Content Tests – Fill Placement Adjacent to Structures, Pipes, and Components Thereof:

Impervious Fill Zone 1A: Minimum 1 test per 20 linear meters per lift per structure or if lift is less than 20 linear meters, minimum 1 test per lift per structure.

Base Gravel Zone 4A: Minimum 1 test per 20 linear meters per lift per structure or if lift is less than 20 linear meters, minimum 1 test per lift per structure.

Conduct field density and moisture content tests using a certified nuclear densometer.

.4 Conduct testing in accordance with the ASTM Standards listed in clause 1.2.1 as determined by the Owner.

.5 Engage an independent CSA certified and qualified earthworks materials testing laboratory, with a permit to Practice in the Province of Alberta to sample and/or test fill materials.

## **1.5 QUALITY ASSURANCE**

- .1 The Owner's selected testing agency will perform testing of fill materials at any time to assure suitability for the intended uses.
- .2 The Owner's selected testing agency will perform testing of fill material to assure conformance with the specified requirements, at the Site, prior to, during, and after the material has been placed and compacted.
- .3 Density and moisture content tests will be performed by the Owner's selected testing agency during fill placement. Testing will be conducted in accordance with the ASTM Standards listed in clause 1.2.1 as determined by the Owner and Engineer of Record. The Contractor is to cooperate with the Owner's selected testing agency and Engineer of Record during sampling and testing. The frequency of density and moisture content testing will be determined by the Owner, the Owners selected testing agency, and the Engineer or Record. It should be anticipated that, at a minimum, Quality Assurance field density and moisture content tests will be performed every 250 linear meters of dike per lift.
- .4 The Owner and Engineer of Record may reject fill material at the borrow source(s), in stockpiles, in the transport vehicle, or in place. Rejected material shall be disposed of accordingly, by the Contractor, at their own expense.

## **2.0 PRODUCTS**

### **2.1 MATERIALS**

Provide materials in accordance with the following:

- .1 Fill Material: Includes Impervious Fill Zone 1A, Retaining Wall Reinforced Fill Zone, Drain Rock, Base Gravel Zone 4A and Road Gravel Zone 4B. Refer to Section 02330 – Earthwork Materials for material specifications.

## **3.0 EXECUTION**

### **3.1 PREPARATION**

- .1 Beneath New Dike Fill:
  - .1 Perform stripping as specified in Section 02234 – Topsoil and Subsoil Stripping.
  - .2 Remove debris, organics, snow, ice, water, and loose material prior to starting fill placement. Do not place fill material when the material, the subgrade material, or the surface on which it would be placed is frozen or over saturated.
  - .3 Scarify and moisture condition (if required) the existing subgrade surface to a minimum depth of 150 mm prior to recompacting and placing the first lift of fill.
  - .4 Grade and recompact the scarified subgrade surface with a minimum of 6 passes with adequate compaction equipment as outlined in clause 3.5 of this Section.
  - .5 Where soft subgrade areas are encountered, they are to be sub-cut and backfilled with

suitable Impervious Fill Zone 1A material per the direction of the Engineer of Record and in accordance with Fill Placement specifications outlined in clause 3.3.

- .6 Do not place fill material on any surface until the prepared surface has been inspected by the Engineer of Record. Rectify any defects, including any identified by the Engineer of Record. The Engineer or Record shall be onsite to witness the scarification, moisture conditioning, and recompaction of existing subgrade.
  - .7 When required by the Engineer of Record, the Contractor shall supply and operate a loaded test vehicle of 8200 kg axle load to proof roll the prepared existing subgrade. Where proof rolling indicates areas that are defective, the Contractor shall remove and replace the material with suitable compacted material.
- .2 Trenched Infrastructure:
- .1 Perform stripping and excavation/trenching as specified in Section 02234 – Topsoil and Subsoil Stripping and Section 02315 – Excavation.
  - .2 Remove debris, organics, snow, ice, water, and loose material prior to starting bedding and fill placement. Do not place bedding or fill material when the subgrade material, or the surface on which fill soils are to be installed is found to be frozen or over saturated.
  - .3 Moisture condition (if required), grade, and compact the existing subgrade surface with a minimum of 6 passes with adequate compaction equipment prior to placing the first lift of bedding or fill material. Hand operated compaction equipment may be used as outlined in clause 3.5.
  - .4 Where soft subgrade areas are encountered, they are to be sub-cut and backfilled with suitable Impervious Fill Zone 1A material per the direction of the Engineer of Record and in accordance with Fill Placement specifications outlined in clause 3.3.
  - .5 Do not place bedding or fill material on any surface until the prepared surface has been inspected by the Engineer of Record. Rectify any defects, including any identified by the Engineer of Record. The Engineer or Record shall be onsite to witness the moisture conditioning (if required) and compaction of trenched subgrade.
  - .6 Bedding material and placement shall conform to the specifications outlined in the City of Calgary Standard Specifications Sewer Construction.
  - .7 The aforementioned surface preparation for trenched infrastructure may not be applicable for shallow utilities. Consult with the Engineer of Record if surface preparation for shallow utilities is required.

### **3.2 PROTECTION**

- .1 Suspend fill placement operations at any time when, in the opinion of the Owner or Engineer of Record, work cannot be performed in accordance with the specifications on account of rain, flooding, cold weather, or other unsatisfactory conditions.
- .2 Immediately prior to any suspension in fill operations (including at the end of each workday), slope the fill surface to promote positive drainage (minimum 2% slope) and roll with rubber

tire equipment or smooth cylindrical roller to leave the surface area in a smooth, even condition to minimize ponding and saturation of the subgrade and fill material.

- .3 If deemed necessary by the Engineer of Record, condition, rework, and recompact or remove and replace any portion of the fill or subgrade that has suffered a reduction in quality due to drying, frost, rain, or any other reason to the specified requirements before placing succeeding layers.
- .4 Where the fill or ground surfaces begins to rut or exhibit instability, reroute construction traffic away from this area to the satisfaction of the Engineer of Record. Either strip the area of disturbed, rutted soils, and replace the stripped material with suitable fill, or scarify, moisture condition, and recompact the area of instability to achieve the required compaction.

### **3.3 FILL PLACEMENT**

- .1 Provide Impervious Fill Zone 1A and Retaining Wall Reinforced Fill Zone from pre-qualified Contractor supplied borrow sources. Schedule, sequence, and conduct operations to make the best use of all excavated materials and to protect and prevent suitable materials from becoming unsuitable.
- .2 Construct fill zones at the locations, and to the lines, grades, slopes, and elevations specified in the Contract Documents, or as established by the Engineer of Record, using fill materials that are placed, conditioned, and compacted to the specified requirements.
- .3 Overbuild final fill slopes and then trim them to the lines, grades, slopes, and elevations specified in the Contract Documents.
- .4 During spreading and compaction, provide the surface of the fill zone with a transverse gradient of approximately 2% so that water from precipitation will drain freely toward the extremities of the fill zone. Maintain a smooth and even surface to minimize ponding water and saturation of the fill material.
- .5 Place and spread fill materials in continuous and approximately horizontal layers of uniform thickness in such a manner as to prevent segregation and stratification and to obtain a homogeneous mass.
- .6 Place and spread Impervious Fill Zone 1A for the dike in a direction parallel to the dike centreline to minimize the potential for formation of preferential seepage paths, except at retaining wall locations.
- .7 Retaining Wall Reinforced Fill Zone material is to be placed and compacted starting from the back of the drainage gravel blanket behind the walls, working toward the ends of the geogrid reinforcements. Placing and compacting the reinforced fill material in this manner is critical to maintaining adequate tension on the geogrid reinforcements throughout fill placement. Refer to the Engineer of Record's Issued for Tender (IFT) "Downtown Dike Redi Rock Retaining Walls Design" drawing package for further direction regarding retaining wall reinforced zone fill placement.
- .8 If required, use discs or equivalent methods prior to or during fill placement operations to mix or blend to obtain a consistent fill material, and to scarify, blend, and break up existing subgrade and Impervious Fill Zone 1A material.

- .9 Commence placement of fill materials at the lowest elevation of the dike, and progress in an upslope direction. The Contractor will be required to terrace into the existing dike slope to allow for proper placement and compaction of Impervious Fill Zone 1A material.
- .10 Place fill materials in layers not exceeding the loose thickness specified in clause 3.6.
- .11 Join new fill onto all natural, excavated, or fill slopes by terracing or stepping into the slopes. Stagger fill joints to minimize the potential for preferred seepage paths in any direction.
- .12 Do not place fill material adjacent to cast-in-place concrete structures until at least 14 days after concrete placement or until  $\geq 75\%$  of the specified compressive concrete strength has been achieved.
- .13 Place fill material in equal thickness lifts on all sides of structures and pipes to minimize unbalanced loading.
- .14 During placement and compaction operations, direct the movement of equipment to obtain uniform coverage. Scarify (disc) and recompact areas of non-uniformly compacted ridges or troughs resulting from placement or spreading equipment.
- .15 Unless otherwise authorized by the Engineer or Record, maintain no more than 800 mm maximum difference in elevation between adjacent fill zones.

### **3.4 MOISTURE CONTROL**

- .1 Compact each layer of fill material within the moisture content ranges specified in clause 3.6.
- .2 Add water to the fill material when its moisture content is below the specified range. Use moisture conditioning methods that permit water to be added in controlled amounts and which do not cause finer materials to be washed out. Work the water into the fill material until the specified moisture content is uniformly obtained throughout the material.
- .3 When the moisture content of the fill material exceeds the specified range, dry the fill material prior to compaction by spreading, discing, and harrowing the fill material until the specified moisture content is uniformly obtained throughout the material.
- .4 Do not add water to the fill material or perform drying operations such as spreading, discing, and harrowing when such work cannot be performed because of inclement weather.
- .5 Mixing of suitable materials having different in situ moisture contents to obtain the required moisture content is permitted. Use discs or other methods to obtain a homogeneous material with the required uniformity of moisture content.

### **3.5 COMPACTION EQUIPMENT**

- .1 Use compaction equipment of the type, size, and efficiency capable of achieving the densities specified in clause 3.6. Within the dike footprint and open areas, a minimum 10-ton compactor is to be utilized.

- .2 Where fill soils are being placed within 2 m of structures (specifically existing building foundations), use only static compaction methods when utilizing ride on equipment or use hand operated pneumatic or mechanical tamping equipment at these locations.
- .3 In areas that are not accessible to ride on equipment, or which are within 2000 mm of structures and 600 mm of pipes (or other structures susceptible to compaction induced damage), reduce the lift thickness, remove stones larger than 80 mm, and compact fill materials with hand operated pneumatic or mechanical tamping equipment. The lightest permissible hand operated equipment is a 200 kg vibratory plate tamper or approved equivalent.

### 3.6 COMPACTION SCHEDULE

- .1 Lift thickness, moisture content limits, and compaction requirements and densities to conform to the following:

Fill Material	Maximum Loose Lift Thickness (mm)	Moisture Content Limits <sup>(1)</sup>	Minimum Number of Passes <sup>(2)</sup>	Density Limits <sup>(3)</sup>
Existing Subgrade/Fill	N/A	-2% to +2%	6	N/A
Impervious Fill Zone 1A	300	-1% to +3%	6	≥97% SPMDD
Retaining Wall Reinforced Fill Zone	300	-2% to +2%	6	≥98% SPMDD
Drain Rock	300	N/A	4	N/A
Base Gravel Zone 4A	300	-2% to +4%	4	≥98% SPMDD
Road Gravel Zone 4B	300	-2% to +4%	4	≥98% SPMDD

- (1) Moisture content range above (+) or below (-) Optimum Moisture Content (ASTM D698). Moisture content as determined by ASTM D2216.
- (2) A single pass means the complete coverage of the fill lift. Overlap required for complete coverage will not be considered to provide any portion of a subsequent or previous pass. Minimum numbers of passes may be adjusted based on observed nuclear densometer results during initial fill placement.
- (3) Standard Proctor Maximum Dry Density (SPMDD) as determined by ASTM D698.

### 3.7 PLACEMENT TOLERANCES

- .1 Provide finished fill surfaces that are smooth, regular, and uniform.
- .2 For Impervious Fill Zone 1A, a deviation, measured normal to the finished surface, of +/-50 mm will be permitted between the finished surfaces and the lines, grades, slopes, and elevations specified in the Contract Documents, excluding the top of the dike. For the top of dike, a deviation measured normal to the finished surface, of 0 mm to +50 mm will be permitted between the finished surface and the lines, grades, slopes, and elevations specified in the Contract Documents or as established by the Engineer of Record.

- .3 For Retaining Wall Reinforced Fill Zone material, a deviation, measured normal to the finished surface, of +/-50 mm will be permitted between the finished surfaces and the lines, grades, slopes, and elevations specified in the Contract Documents, excluding the top of the dike. For the top of dike, a deviation measured normal to the finished surface, of 0 mm to +50 mm will be permitted between the finished surface and the lines, grades, slopes, and elevations specified in the Contract Documents or as established by the Engineer of Record. For the retaining wall leveling pad foundation and drainage gravel blanket, a tolerance of +/-25 mm of the specified thickness will be permitted.
- .4 Provide Base Gravel Zone 4A and Road Gravel Zone 4B to the specified minimum thickness and within a deviation of 0 mm to +25 mm of the lines, grades, slopes, and elevations specified in the Contract Documents.

**END OF SECTION**