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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, Gravel Armour, Riprap, Riprap Bedding, and Gabion Rock.].

1.2 REFERENCES

- .1 Provide fill placement in accordance with the following standards (latest revision) except where specified otherwise.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM D698 Standard Test Methods for Moisture–Density Relations of Soils and Soil Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12” (305 mm) Drop.
 - .2 ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
 - .3 ASTM D4253 Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
 - .4 ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

- .1 “Authorized Fill Placement” means the placement of fill materials, as requested by the Minister, to replace Authorized Structure Over-Excavation.

1.4 SUBMITTALS

- .1 Provide the following submittals.
- .2 Specifications for the proposed compaction equipment prior to commencing fill placement.
- .3 Copies of quality control test results of compacted materials within [48] hours of sampling.

1.5 QUALITY CONTROL

- .1 Perform quality control tests of fill materials as specified in Section 02330 – Earthwork Materials.
- .2 Transport only suitable materials to the Site.

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.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, and any additional testing or measures as required by the Contractor, during fill placement. The frequency of quality control testing may be increased as deemed necessary by the Minister until the Contractor consistently meets the specified requirements for fill placement.

.1 Moisture Density Relations (Proctors) Tests:

Frequency: Minimum of 1 test for each type of material or borrow source, and additional tests based on material and volume as follows:

[Impervious Fill Zone 1A: 1 test per [15000] m3 for the first [300000] m3 placed and every [30000] m3 placed thereafter.]

[Random Fill 2A: 1 test per [15000] m3 for the first [300000] m3 placed and every [30000] m3 placed thereafter.]

.2 Maximum Vibrated Density Tests:

Frequency: Minimum of 1 test for each type of material or source, and additional tests based on material and volume as follows:

[Fine Filter Zone 3A: 1 test per [1000] m3 for the first [20000] m3 placed and every [5000] m3 placed thereafter.]

[Coarse Filter Zone 3B: 1 test per [1000] m3 for the first [20000] m3 placed and every [5000] m3 placed thereafter.]

[Base Gravel Zone 4A: 1 test per [1000] m3 for the first [20000] m3 placed and every 5000 m3 placed thereafter.]

[Gravel Fill Zone 4C: 1 test per [1000] m3 for the first [20000] m3 placed and every [5000] m3 placed thereafter.]

.3 .3 Field Density and Moisture Content Tests – Fill Placement in Embankments:

[Impervious Fill Zone 1A: Minimum of 2 tests for compacted material placed during 1 shift.]

[Random Fill Zone 2A: Minimum of 2 tests for compacted material placed during 1 shift.]

[Fine Filter Zone 3A] [and Coarse Filter Zone 3B]: 1 test per [500] m3 of each type of compacted material placed during 1 shift.

[Base Gravel Zone 4A] [and Gravel Fill 4C]: 1 test per [500] m3 of each type of compacted material placed during 1 shift.

Conduct field density tests using nuclear densometer and moisture content tests by oven drying samples.

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

[Impervious Fill Zone 1A: Minimum of 1 test for compacted material placed during 1 shift, and 1 test for every 2 lifts of compacted material placed.]

[Random Fill Zone 2A: Minimum of 1 test for compacted material placed during 1 shift, and 1 test for every 2 lifts of compacted material placed.]

[Fine Filter Zone 3A] [and Coarse Filter Zone 3B]: Minimum of 1 test for each type of compacted material placed during 1 shift, and 1 test for every 2 lifts of each type of compacted material placed.

[Base Gravel Zone 4A] [and Gravel Fill 4C]: Minimum of 1 test for each type of compacted material placed during 1 shift, and 1 test for every 2 lifts of each type of compacted material placed.

Conduct field density tests using nuclear densometer and moisture content tests by oven drying samples.

- .4 Conduct testing in accordance with the ASTM Standards listed in clause 1.2.2 as determined by the Minister.
- .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 test fill materials.

1.6 QUALITY ASSURANCE

- .1 The Minister may test fill materials at any time to assure suitability for the intended uses.
- .2 The Minister will perform any testing of fill material to assure conformance with the specified requirements after the material has been placed and compacted.
- .3 Density and moisture content tests will be performed by the Minister during fill placement. Testing will be conducted in accordance with the ASTM Standards listed in clause 1.2.2 as determined by the Minister. Co-operate with the Minister during sampling and testing. The frequency of density and moisture content testing will be determined by the Minister.
- .4 The Minister may reject fill material during excavation, in the borrow areas, in the stockpiles, in the transport vehicle, or in place.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Provide materials in accordance with the following.
- .2 Fill Material: Includes [Impervious Fill Zone 1A, Random Fill Zone 2A, Fine Filter Zone 3A, Coarse Filter Zone 3B, Base Gravel Zone 4A, Road Gravel Zone 4B, and Gravel Fill Zone 4C]. Refer to Section 02330 – Earthwork Materials for material specifications.

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3.0 EXECUTION

3.1 PREPARATION

- .1 Perform stripping as specified in Section 02234 – Topsoil and Subsoil Stripping.
- .2 Remove debris, snow, ice, water, and loose material prior to starting fill placement. Do not place fill material when the material, the foundation, or the surface on which it would be placed is frozen.
- .3 Moisten if required, and scarify the foundation surface to a minimum depth of 200 mm to obtain a good bond prior to placing the first lift of fill. [Scarification of bedrock foundation surfaces is not required.]
- .4 Grade and compact the scarified foundation surface to the same density specified for the overlying fill.

3.2 PROTECTION

- .1 Suspend fill placement operations at any time when, in the opinion of the Minister, 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, slope the fill surface as specified and roll with rubber tire equipment or smooth cylindrical roller so as to leave the surface area in a smooth, even condition for drainage.
- .3 Protect compacted fill and foundation surfaces that have been prepared for receiving fill from freezing by using a temporary layer of soil or insulating materials, or other means authorized by the Minister. Remove protection only when ready to place fill, and authorization is provided by the Minister.
- .4 If deemed necessary by the Minister, condition, rework, and re-compact or remove and replace any portion of the fill or foundation that has suffered a reduction in quality due to drying, frost, rain, or any other reason to the specified requirements before placing succeeding layers.
- .5 Reroute construction traffic away from or stabilize areas to the satisfaction of the Minister where the fill or ground surfaces begin to rut or exhibit instability.
- .6 Do not allow construction traffic, including foot traffic, to cross [Fine Filter Zone 3A and Coarse Filter Zone 3B] unless adequate measures, acceptable to the Minister, are in place to prevent contamination, degradation, and over compaction of these materials.

3.3 FILL PLACEMENT

- .1 Do not place fill material on any surface until the prepared surface has been inspected by the Minister. Rectify any defects, including any identified by the Minister.

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- .2 Provide [Impervious Fill Zone 1A and Random Fill Zone 2A] from material excavated from areas of [Common Excavation, Borrow Area Excavation, Structure Excavation and Wet Excavation]. Schedule, sequence, and conduct operations to make the best use of all excavated materials, protect and prevent suitable materials from becoming unsuitable, and minimize the volume of Borrow Area Excavation.
- .3 Construct fill zones at the locations, and to the lines, grades, slopes, and elevations specified in the Contract Documents, or as established by the Minister, using fill materials that are placed, conditioned, and compacted to the specified requirements.
- .4 Overbuild final fill slopes and then trim them to the lines, grades, slopes, and elevations specified in the Contract Documents.
- .5 Maintain the top surface of fill zones approximately horizontal. During spreading and compaction, provide the surface of the fill zone with a gentle transverse gradient of 3% to 5% so that water from precipitation will drain freely toward the extremities of the fill zone but away from any filter materials.
- .6 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.
- .7 Place, spread and compact fill materials in a continuous operation to avoid freezing of the materials before the specified compaction can be achieved.
- .8 Place and spread [Impervious Fill Zone 1A and Random Fill Zone 2A] for the [specified area] in a direction parallel to the [] centreline to minimize the potential for formation of preferential seepage paths.
- .9 Use discs prior or during fill placement operations to mix or blend as required to obtain a consistent fill material, and to scarify, blend, and break up [Impervious Fill Zone 1A and Random Fill Zone 2A] materials to the full depth of the uncompacted lift. Use a heavy disc offset plough with 900 mm diameter discs with the offset or opening of the plough operated by hydraulic cylinder controlled by the operator. Replace discs that are worn by more than 25% of the depth of the serrations or notches when new.
- .10 Commence placement of fill materials at the lowest elevation of the foundation, and progress in an upslope direction.
- .11 Moisten each previously placed lift, if necessary, and work with discs to a minimum depth of 50 mm to provide a bonding surface prior to placing the overlying lift of fill material except when, in the opinion of the Minister, such work cannot be performed because of cold weather.
- .12 Place fill materials in layers not exceeding the loose thickness specified in clause 3.6.
- .13 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.
- .14 Do not place fill material adjacent to cast-in-place concrete structures until at least 14 days after concrete placement or until 75% of the specified compressive concrete strength has been achieved.

- .15 Place fill material equally on all sides of structures and pipes to minimize unbalanced loading.
- .16 Apply compaction effort for a minimum horizontal distance of 600 mm on each side of joints in the fill zones.
- .17 During placement and compaction operations, direct the movement of equipment to obtain uniform coverage. Disc and re-compact areas of non-uniformly compacted ridges or troughs resulting from placement or spreading equipment.
- .18 Unless otherwise authorized by the Minister, maintain no more than 1000 mm maximum difference in elevation between adjacent fill zones, and maintain the temporary slopes within fill zones no steeper than 5H:1V.
- .19 Place, condition, and compact Authorized Fill Placement materials to the specified requirements for the fill material used. Authorized Fill Placement will be valued in accordance with Section 00725 – General Conditions, clause 8.3 - Valuation of Changes in the Work.

3.4 MOISTURE CONTROL

- .1 Compact each layer of fill material within the moisture content limits specified in clause 3.6.
- .2 Add water to the fill material when its moisture content is below that specified. Use 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 limits, 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 Place [Fine Filter Zone 3A and Coarse Filter Zone 3B] fill materials in a moist condition to reduce the potential for segregation.
- .5 Add sufficient quantities of water to sand and gravel fill materials during compaction, even when moisture content limits have not been specified, to achieve the required densities.
- .6 Do not add water to the fill material or perform drying operations such as spreading, discing, and harrowing when, in the opinion of the Minister, such work cannot be performed because of cold weather.
- .7 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 consistent 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.

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- .2 Unless otherwise authorized by the Minister, use the following types of equipment to compact the corresponding fill materials:
 - .1 Self-propelled compactor for [].
 - .2 [Sheepsfoot roller for [Impervious Fill Zone 1A and Random Fill Zone 2A]. [Use a sheepsfoot roller consisting of two or more non-vibratory drums with each drum at least 1500 mm in diameter and having a fully ballasted operating mass of at least 6000 kg/m of drum length. Provide individual roller drums between 1500 mm and 2000 mm in length, with the space between drums not exceeding 400 mm. Provide roller feet that are between 230 mm and 280 mm long with a minimum centre-to-centre spacing of 230 mm, and spread uniformly over the surface of the drum with at least 1 foot for each 60000 mm² (0.06 m²) of roller surface. The end area of each foot is not to exceed 6400 mm². Tow the roller at a speed not exceeding 5 km/h, using equipment that does not leave compacted surfaces that prevent uniform penetration by the roller feet.]]
 - .3 Vibratory padfoot roller for [Impervious Fill Zone 1A and Random Fill Zone 2A] with a minimum operating mass of 10000 kg and capable of exerting a minimum vibratory centrifugal force of 230 kN. Use a vibratory padfoot roller in areas that are inaccessible to the sheepsfoot roller.
 - .4 Vibratory smooth drum roller with a minimum operating mass of 1000 kg, and a maximum operating mass of 6000 kg for [Fine Filter Zone 3A and Coarse Filter Zone 3B].
 - .5 Medium-duty vibratory smooth drum roller with a minimum operating mass of 4000 kg for [Road Gravel Zone 4B and Gravel Fill Zone 4C].
- .3 In areas that are not accessible to the specified compaction equipment or which are within 1000 mm of structures and 600 mm of pipes, or other items 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.

3.6 COMPACTION SCHEDULE

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

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Fill Material	Maximum Loose Lift Thickness ⁽¹⁾ (mm)	Moisture Content Limits ⁽²⁾	Minimum Number of Passes ⁽³⁾	Density Limits ⁽⁴⁾
[Impervious Fill Zone 1A	200	-2% to +1%	6	≥97% SPMDD]
[Random Fill Zone 2A	200	-3% to +1%	4	≥95% SPMDD]
[Fine Filter Zone 3A	300	N/A	2	88% to 92% MVD]
[Coarse Filter Zone 3B	300	N/A	2	≥93% MVD]
[Base Gravel Zone 4A	300	N/A	4	≥95% MVD]
[Road Gravel Zone 4B	100	-2% to +1%	2	N/A]
[Gravel Fill Zone 4C	300	N/A	4	≥95% MVD]

- (1) For areas specified in clause 3.5.3, reduce loose lift thickness to 100 mm and compact each lift using pneumatic or mechanical hand tamping equipment.
- (2) Moisture content range above (+) or below (-) Optimum Moisture Content (ASTM D698). Moisture content as determined by ASTM D2216.
- (3) 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. Achieve both specified density and the specified minimum number of passes with compaction equipment.
- (4) Standard Proctor Maximum Dry Density (SPMDD) as determined by ASTM D698. Maximum Vibrated Density (MVD), as determined by ASTM D4253.

3.7 PLACEMENT TOLERANCES

- .1 Provide finished fill surfaces that are smooth, regular, and uniform.
- .2 For [Impervious Fill Zone 1A and Random Fill Zone 2A], 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 dam, dykes and canal banks and the invert of the canal]. [For the top of dam, dykes and canal banks, a deviation measured normal to the finished surface, of 0 mm to +100 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 Minister.] [For the invert of the canal, a deviation measured normal to the finished surface, of -150 mm to 0 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 Minister.]
- .3 Provide [Fine Filter Zone 3A, Coarse Filter Zone 3B, Base Gravel Zone 4A, and Gravel Fill Zone 4C] to the specified minimum thickness and within a deviation of [+50] mm of the lines, grades, slopes, and elevations specified in the Contract Documents.

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- .4 Provide Road Gravel Zone 4B to the specified minimum thickness and within a deviation of [+25] mm of the lines, grades, slopes, and elevations specified in the Contract Documents.
- .5 Limit the maximum rate of change in deviation from the specified grade of any surface to a ratio of height to length of 1:50. The height and length of the gradual irregularity will be measured normal and parallel, respectively, to the specified grade.

3.8 FILL PROTECTION DURING WINTER STOPPAGE

- .1 When stoppage in the placement of [fill zones] for winter is specified in the Contract Documents, roll the fill surfaces smooth and grade to shed water to the outside of the fill zone. Place a [500 mm] thick sacrificial layer of [] fill over the exposed fill material.
- .2 Upon authorization by the Minister, when ready to begin placement of [] fill in the spring of [], remove the sacrificial layer of [], along with [50 mm] of the underlying fill material, taking all reasonable precautions to prevent contamination of the underlying fill material.
- .3 Dispose of the removed material in specified waste disposal areas.
- .4 The Minister will inspect the exposed [] fill surfaces to determine if remedial measures, in addition to the fill surface preparation measures specified in the Contract Documents, will be required before fill placement proceeds.

END OF SECTION