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1.0 GENERAL

1.1 GENERAL

- .1 This section is a reference section specifying the quality of earthwork materials. Requirements for the inclusion of such materials in the Work are specified elsewhere in the Contract Documents.

1.2 DEFINITIONS

- .1 "Effective Particle Size (D_e)" of rock particles is calculated as follows:

$$D_e = \sqrt[3]{\frac{M}{523.6 \times G_s}}$$

Where D_e = Effective particle size measured in metres.

M = Particle mass measured in kilograms.

G_s = Specific gravity of particle = 2.60 unless otherwise measured.

- .2 "Percent Passing by Mass" means the cumulative mass of particles that are finer than a specified size expressed as a percentage of the total mass of the sample.

1.3 REFERENCES

- .1 Provide earthwork materials in accordance with the following standards (latest revision) except where specified otherwise.
- .2 American Society for Testing and Materials (ASTM)
- | | | |
|----|------------|--|
| .1 | ASTM D422 | Standard Method for Particle Size Analysis of Soils. |
| .2 | ASTM D1140 | Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75µm) Sieve. |
| .3 | ASTM D2487 | Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). |
| .4 | ASTM D4318 | Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils. |

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- .3 California Division of Highways
 - .1 CAL. 206 Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - .2 CAL. 229 Method of Test for Durability Index.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M Sieves, Testing, Woven Wire, Metric.
- .5 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1/A23.2 Concrete Materials and Methods of Concrete Construction.
- .6 Prairie Farm Rehabilitation Administration (PFRA)
 - .1 Unified Soils Classification System as Modified by PFRA.

1.4 SUBMITTALS

- .1 Provide the following submittals.
- .2 A listing of the proposed source for each type of imported material at least [30] days prior to delivery to the Site.
- .3 Samples, of suitable quantities of each type of imported material at the Site requested by the Minister for testing purposes prior to placement.
- .4 Results of quality control tests of imported materials taken at the source at least [15] days prior to delivery of such materials to the Site.
- .5 Copies of quality control test results of placed materials with [48] hours of sampling.

1.5 QUALITY CONTROL

- .1 General
 - .1 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. The frequency of quality control testing may be increased as deemed necessary by the Minister until the Contractor consistently meets the specified requirements.

Earthwork Material	Tests	Minimum Testing Frequency
[Impervious Fill Zone 1A	Atterberg Limits Grain Size Analysis	1 per source and 1 per 10000 m3 placed or portion thereof 1 per source and 1 per 20000 m3 placed or portion thereof]
[Random Fill Zone 2A	Atterberg Limits Grain Size Analysis	1 per source and 1 per 10000 m3 placed or portion thereof 1 per source and 1 per 20000 m3 placed or portion thereof]

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Earthwork Material	Tests	Minimum Testing Frequency
[Fine Filter Zone 3A	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source and 1 per 1000 m3 placed or portion thereof]
[Coarse Filter Zone 3B	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source and 1 per 1000 m3 placed or portion thereof]
[Base Gravel Zone 4A	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source]
[Road Gravel Zone 4B	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source]
[Gravel Fill Zone 4C	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source]
[Fine Riprap Bedding Zone 5A	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source]
[Coarse Riprap Bedding Zone 5B	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source]
[Gravel Armour Zone 5C	Soundness	1 per source]
[Cobble Bedding Zone 5D	Grain Size Analysis Soundness	1 per source and 1 per 1000 m3 placed or portion thereof 1 per source]
[Riprap Zone 6A Riprap Zone 6B Riprap Zone 6C Gabion Rock Zone 7A	Specific Gravity Absorption Durability Index	1 per source 1 per source 1 per source]
[Gabion Rock Zone 7A	Grain Size Analysis	1 per source and 1 per 1000 m3 placed or portion thereof]

Notes:

- .1 Perform specific gravity, absorption, and durability index testing of riprap and gabion rock materials within [180] days of the start of production. Perform gradation testing of [Gravel Armour Zone 5C as specified in Section 02371 Gravel Armour Placement] [Riprap Zone 6A, Riprap 6B, Riprap 6C as specified in Section [02372 – Riprap Placement] [Section 02373 – Riprap and Riprap Bedding Placement]].

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- .2 Conduct testing in accordance with the standards listed in clause 1.3 as determined by the Minister.
 - .3 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 earthwork materials.
 - .4 Do not import any materials to the Site that may be contaminated with “Prohibited Noxious” or “Noxious” weeds under the Weed Control Act. [Engage an independent agrologist to inspect the proposed sources of [sand and gravel fill], and verify that they are not contaminated]
 - .5 Transport only suitable materials meeting the specifications to the Site.
- .2 Sources of Sand, Gravel and Rock Materials
- .1 Conduct quality control tests, in addition to those specified in clause 1.5.1, at the source to confirm that it can provide materials that will meet the specified durability requirements prior to commencing processing operations.
 - .2 During processing of sand and rock materials, test materials from the discharge conveyor belt to verify that the material meets the specified gradation requirements. Notify the Minister at least 48 hours prior to starting production of materials intended for incorporation in the Work.
 - .3 Promptly notify the Minister if any test fails to meet the specified requirements, and immediately take corrective measures as required to produce materials that are in accordance with the Contract Documents.
 - .4 Dispose of or, where appropriate, reprocess any material which does not meet the requirements of the Contract Documents.

1.6 QUALITY ASSURANCE

- .1 The Minister will perform testing to assure conformance to the specified requirements after the materials have been placed in its final specified location.
- .2 The Minister may reject earthwork materials at the source, in the transport vehicle, in the stockpile or in place.
- .3 Samples of earthworks materials will be taken by the Minister for quality assurance testing. Testing will be conducted in accordance with the standards listed in clause 1.3 as determined by the Minister. The frequency of quality assurance testing will be as deemed necessary by the Minister. Co-operate with Minister during sampling and testing. Load and dispose of sampled materials when no longer required by the Minister.
- .4 Quality assurance testing of [gravel armour] [riprap] [riprap and riprap bedding] is specified in Section [002371 – Gravel Armour Placement] [002373 – Riprap and Riprap Bedding Placement].

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1.7 MINISTER SUPPLIED MATERIALS

- .1 The following stockpiled materials [are available for use], [are to be used] to the extent required for the Work.

<u>Material</u>	<u>Location of Stockpile</u>	<u>Quantity</u>
[]	[]	[]
[]	[]	[]

- .2 Quality control durability and gradation testing of Minister supplied materials is not required.
- .3 Obtain Minister's authorization for the equipment and methods being proposed by the Contractor for loading, hauling and placing Minister supplied materials prior to proceeding with such work.
- .4 Completely use Minister supplied [] materials before placing Contractor supplied material.
- .5 Provide additional quantities of [] as required to complete the Work. Reload and haul off-Site any excess Contractor supplied materials.

2.0 PRODUCTS

2.1 MATERIALS

- .1 Provide materials in accordance with the following.
- .2 Gradations for earthworks materials except riprap: in accordance with ASTM D422 and ASTM D1140. Specified sieve sizes are based on the nominal sieve opening sizes, in millimetres, under the Canadian Metric Sieve Series in accordance with CAN/CGSB-8.2-M.
- .3 Impervious Fill Zone 1A:
 - .1 Native soils obtained from required excavations or specified borrow areas on Site, that are free from organic materials, deleterious materials, and frozen materials; and
 - .2 Low to medium plasticity clay till as classified by the Unified Soils Classification system as modified by PFRA with a maximum size of 150 mm, [a minimum plasticity index of 7% (as determined by ASTM D4318) and a minimum of 50% passing the 80µm sieve size]. Do not use high plasticity clays with a liquid limit greater than 50% as Impervious Fill Zone 1A.
 - .3 Within 1000 mm of structures and 600 mm of pipes, remove stones larger than 80 mm from the Impervious Fill Zone 1A.
- .4 Random Fill Zone 2A:

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- .1 Native soils obtained from required excavations or specified borrow areas with a maximum size of 150 mm, free from high plasticity clays with a liquid limit greater than 50%, organic materials, deleterious materials, and frozen materials, that do not meet the requirements for Impervious Fill Zone 1A; and
 - .2 Excess quantities of native soils obtained from required excavations meeting the requirements for Impervious Fill Zone 1A. Do not use Impervious Fill Zone 1A as Random Fill Zone 2A until specified Impervious Fill Zone 1A placement has been completed, and authorization to proceed with the use of Impervious Fill Zone 1A has been provided by the Minister.
 - .3 Within 1000 mm of structures and 600 mm of pipes, remove stones larger than 80 mm from the Random Fill Zone 2A.
- .5 Waste Fill:
- .1 Native soils obtained from required excavations or specified borrow areas that do not meet the requirements for Impervious Fill Zone 1A or Random Fill Zone 2A; and,
 - .2 Excess quantities of native soils obtained from required excavations meeting the requirements for Impervious Fill Zone 1A or Random Fill Zone 2A. Do not incorporate excess quantities of Impervious Fill Zone 1A and Random Fill Zone 2A in Waste Fill until specified Impervious Fill Zone 1A and Random Fill Zone 2A placements have been completed, and authorization to proceed has been provided by the Minister.
- .6 Sand and Gravel Fill:
- .1 General:
 - .1 Sound, hard particles, free from silt and clay lumps, soft shale, deleterious materials, organic matter, and foreign substances.
 - .2 Graded as specified with a smooth gradation curve with no excess or deficiency of any particular grain size within the required range.
 - .3 Where blending is required, thoroughly mix the sand and gravel fill materials in a manner that produces a homogeneous fill of the specified gradation prior to placing the material into the Work or stockpiles.
 - .4 Crush, screen, wash, or otherwise process sand and gravel products as required to achieve specified gradations except where specified otherwise.
 - .2 Fine Filter Zone 3A:
 - .1 Well graded sand with a trace of gravel with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

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Sieve Size	Percent Passing by Mass
[10 mm	100%
5 mm	90% – 100%
2.5 mm	70% – 95%
1.25 mm	50% – 80%
630µm	25% – 55%
315µm	10% – 25%
160µm	0% – 10%
80µm	0% – 3%]

.2 Less than 12% loss of weight after 5 cycles in accordance with the requirements of CAN/CSA-A23.2–9A.

.3 Natural sand with no crushed or otherwise manufactured component.

.3 Coarse Filter Zone 3B:

.1 Well graded gravel with sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
[40 mm	100%
20 mm	80% – 100%
10 mm	40% – 80%
5 mm	5% – 40%
2.5 mm	0% – 3%
80µm	0% – 2%]

OR

Sieve Size	Percent Passing by Mass
[28 mm	100%
20 mm	75% – 100%
10 mm	40% – 85%
5 mm	5% – 50%
2.5 mm	0% – 3%
80µm	0% – 2%]

.2 Less than 12% loss of weight after 5 cycles in accordance with the requirements of CAN/CSA-A23.2–9A.

.3 At least [40%] by mass of the particles retained on the 10 mm and larger sieves to have 2 or more fractured faces.

.4 Base Gravel Zone 4A:

.1 Reasonably well graded crushed gravel and sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
[25 mm	100%
20 mm	82% – 97%
16 mm	70% – 94%
10 mm	52% – 79%
5 mm	35% – 64%
1.25 mm	18% – 43%
630µm	12% – 34%
315µm	8% – 26%
160µm	5% – 18%
80µm	2% – 10%]

- .2 At least [60%] by mass of the particles retained on the 5 mm and larger sieves to have 2 or more fractured faces.

.5 Road Gravel Zone 4B:

- .1 Reasonably well graded crushed gravel and sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
[20 mm	100%
10 mm	35% – 77%
5 mm	15% – 55%
1.25 mm	0% – 30%
80µm	0% – 12%]

- .2 At least [40%] by mass of the particles retained on the 5 mm and larger sieves to have 2 or more fractured faces.

.6 Gravel Fill Zone 4C:

- .1 Reasonably well graded gravel and sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
[80 mm	100%
50 mm	55% – 100%
25 mm	38% – 100%
16 mm	32% - 85%
5 mm	20% – 65%
315µm	6% - 30%
80µm	2% – 10%]

- .2 Less than 12% loss of weight after 5 cycles in accordance with the requirements of CAN/CSA-A23.2–9A.

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.7 Fine Riprap Bedding Zone 5A:

- .1 Well graded gravel and sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
40 mm	100%
20 mm	85% – 100%
10 mm	70% – 95%
5 mm	55% – 85%
2.5 mm	40% – 70%
1.25 mm	30% – 55%
630µm	20% – 40%
315µm	10% – 25%
160µm	0% – 10%
80µm	0% – 5%]

- .2 Less than 12% loss of weight after 5 cycles in accordance with the requirements of CAN/CSA-A23.2–9A.

.8 Coarse Riprap Bedding Zone 5B:

- .1 Well graded sand, gravel, and cobbles with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points:

Sieve Size	Percent Passing by Mass
80 mm	100
50 mm	70% - 100%
20mm	45% - 70%
5 mm	25% - 50%
1.25 mm	10% - 30%
160 µm	0% - 10%
80 µm	0% - 5%]

- .2 Less than 12% loss of weight after 5 cycles in accordance with the requirements of CAN/CSA-A23.2–9A.

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.9 Gravel Armour Zone 5C:

- .1 Well graded gravel and cobbles with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Effective Particle or Sieve Size	Percent Passing by Mass
200 mm	100%
150 mm	85% – 100%
100 mm	60% – 85%
40 mm	30% – 55%
20 mm	15% – 30%
10 mm	0% – 15%
5 mm	0% – 5%]

- .2 Less than 12% loss of weight after 5 cycles in accordance with the requirements of CAN/CSA-A23.2-9A.

.10 Cobble Riprap Bedding Zone 5D:

- .1 Well graded sand, gravel, and cobbles with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
250 mm	100%
200 mm	35% – 100%
150 mm	15% – 100%
75 mm	0% – 40%
40 mm	0% – 5%]

.7 Riprap and Gabion Rock:

.1 General

- .1 Sound, hard, durable particles free from silt, clay, shale, sandstone, flaky particles, topsoil, organic matter, and other deleterious materials.
- .2 Meet the following minimum requirements for soundness and durability.

Method of test	Requirements
California Division of Highways, CAL. 206	Minimum Specific Gravity: = 2.60 Maximum Absorption: = 2%
California Division of Highways, CAL 229	Minimum Durability Index: = 52 Durability Index may be less than 52 if DAR* > 23

$$*\text{Durability Absorption Ratio (DAR)} = \frac{\text{Durability Index}}{\text{Absorption \%} + 1\%}$$

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.3 Ratio of maximum dimension to minimum dimension of individual pieces not to exceed 3.0.

.2 Riprap Zone 6A:

.1 With the following gradation:

Effective Particle Size	Percent Passing by Mass
[300 mm	100%
200 mm	30% – 70%
175 mm	20% – 50%
125 mm	Less than 2%]

.3 Riprap Zone 6B:

.1 With the following gradation:

Effective Particle Size	Percent Passing by Mass
[500 mm	100%
400 mm	50% – 90%
300 mm	5% - 20%
150 mm	Less than 2%]

.4 Riprap Zone 6C:

.1 With the following gradation:

Effective Particle Size	Percent Passing by Mass
[800 mm	100%
600 mm	40% – 80%
500 mm	20% – 50%
400 mm	5% - 30%
300 mm	Less than 2%]

.5 Gabion Rock Zone 7A:

.1 With the following gradation:

Effective Particle Size	Percent Passing by Mass
[200 mm	100%
100 mm	0%]

3.0 EXECUTION

3.1 STOCKPILING OF SAND, GRAVEL, AND ROCK MATERIALS AT THE SOURCE

- .1 Temporarily stockpile all sand, gravel, and rock materials that have been processed by washing methods for a minimum of 48 hours to permit drainage of excess water. Do not place recently washed materials on top of or with drier stockpiled materials.
- .2 Use equipment and methods that minimizes the amount of material handling, and that do not cause segregation or material breakdown.

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- .3 Do not stockpile materials where contamination with the underlying soils can occur.
- .4 Do not construct stockpiles by cone piling, [except for Fine Filter Zone 3A].
- .5 For gravel materials, construct temporary stockpiles by first distributing material over the entire base and then by building upwards in successive layers which do not exceed a thickness of 2 m per layer. Construct each layer working from the outer edges toward the centre of the stockpile. Complete each layer over the entire area before starting the subsequent layer. Keep traffic on the materials to a minimum during stockpiling. Do not push or dump gravel material over the edges or down the faces of the stockpile.
- .6 Keep stockpiles neat and regular in form.
- .7 Do not construct stockpiles that are more than 6 m in height.
- .8 Maintain a minimum clearance of 5 m between stockpiles of each material.
- .9 Replace stockpiled material that becomes contaminated, damaged or lost.

3.2 PLACEMENT

- .1 Refer to other sections for subgrade preparation and placement of earthwork materials.

END OF SECTION