

## PART 1 - GENERAL

- 1.1 Summary .1 This section defines correction to maximum dry density to take into account aggregate particles larger than 4.75 mm.
- 1.2 REFERENCES .1 American Society for Testing and Materials International (ASTM)
- .1 ASTM C 127-04, Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
  - .2 ASTM D 698-00, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m<sup>3</sup>)).
  - .3 ASTM D 1557-02, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (2,700 kN-m/m<sup>3</sup>)).
  - .4 ASTM D 4253-00, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- 1.3 DEFINITIONS .1 Corrected maximum dry density is defined as:
- .1  $D = F1 \times D1 + 0.9 \times D2 \times F2$
  - .2 Where: D = corrected maximum dry density kg/m<sup>3</sup>. F1 = fraction (decimal) of total field sample passing ASTM 4.75 mm sieve. F2 = fraction (decimal) of total field sample retained on ASTM 4.75 mm sieve. D1 = maximum dry density, kg/m<sup>3</sup> of material passing ASTM 4.75 mm sieve determined in accordance with Method A of ASTM D 1557-91 (regardless of %oversize fraction F2) for granular base, subbase and backfill material and to ASTM D 698-00a for clay subgrades and backfill materials. D2 = bulk density, kg/m<sup>3</sup> of material retained on ASTM 4.75 mm sieve, equal to 1000 G where G is bulk specific gravity (dry basis) of material when tested to ASTM C 127-88(1993)e1.
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PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

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| <u>1.1 REFERENCES</u>                    | .1 | American Society for Testing and Materials (ASTM)<br>.1 ASTM D 4791-99, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.  |
| <u>1.2 SAMPLES</u>                       | .1 | Submit samples in accordance with Section 01 33 00 - Submittal Procedures.  |
|  | .2 | Allow continual sampling by Departmental Representative during production.  |
|  | .3 | Provide Departmental Representative with access to source and processed material for sampling.  |
|  | .4 | Install sampling facilities at discharge end of production conveyor, to allow Departmental Representative to obtain representative samples of items being produced. Stop conveyor belt when requested by Departmental Representative to permit full cross section sampling. |
|  | .5 | Acceptance of a material at source does not preclude future rejection if it is subsequently found to lack uniformity, or if it fails to conform to requirements specified, or if its field performance is found to be unsatisfactory.                                       |
|  | .6 | Pay cost of sampling and testing of aggregates which fail to meet specified requirements.   |
|  | .7 | Provide water, electric power and propane to Departmental Representative laboratory trailer at production site.   |
| <u>1.3 WASTE MANAGEMENT AND DISPOSAL</u> | .1 | Divert unused granular materials from landfill to local quarry or facility as required by local and provincial authorities and approved by Departmental Representative.   |
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PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.
- .2 Flat and elongated particles of coarse aggregate: to ASTM D4791.
  - .1 Greatest dimension to exceed five times least dimension.
- .3 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
  - .1 Natural sand.
  - .2 Manufactured sand.
  - .3 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
- .4 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:
  - .1 Crushed rock.
  - .2 Gravel and crushed gravel composed of naturally formed particles of stone.
- .5 Beach gravels shall not be acceptable sources.
- .6 Salt water submerged deposits shall not be acceptable sources.

2.2 SOURCE QUALITY CONTROL

- .1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling at least 4 weeks prior to commencing production.
  - .2 If, in opinion of Departmental Representative, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
  - .3 Advise Departmental Representative 2 weeks in advance of proposed change of material source.
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2.2 SOURCE QUALITY .4 Acceptance of material at source does not  
CONTROL  
(Cont'd)

preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

PART 3 - EXECUTION

3.1 PREPARATION .1 Processing

.1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.

.2 Blend aggregates, if required, to obtain gradation requirements, percentage of crushed particles, or particle shapes, as specified. Use methods and equipment approved by Departmental Representative.

.3 Wash aggregates, if required to meet specifications. Use only equipment approved by Departmental Representative.

.4 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate.

.2 Handling

.1 Handle and transport aggregates to avoid segregation, contamination and degradation.

.3 Stockpiling

.1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Departmental Representative. Do not stockpile on completed pavement surfaces.

.2 Stockpile aggregates in sufficient quantities to meet Project schedules.

.3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.

.4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into Work.

.5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.

.6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Departmental Representative within 48 h of rejection.

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3.1 PREPARATION  
(Cont'd)

- .3 (Cont'd)
- .7 Stockpile materials in uniform layers of thickness as follows:
- .1 Max 1.5 m for coarse aggregate and base course materials.
  - .2 Max 1.5 m for fine aggregate and sub-base materials.
  - .3 Max 1.5 m for other materials.
- .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
- .9 Do not cone piles or spill material over edges of piles.
- .10 Do not use conveying stackers.
- .11 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.2 CLEANING

- .1 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.
- .2 Leave any unused aggregates in neat compact stockpiles as directed by Departmental Representative.

PART 1 - GENERAL

1.1 MEASUREMENT  
PROCEDURES

- .1 Common Excavation.
  - .1 Measure in cubic metres calculated from cross sections taken in areas of excavation. Excavation of Base and sub Base granular material is common excavation.
  - .2 Removal of existing granular materials to design subgrade elevations and hauling to designated area or hauling and placing, grading and compacting that material in low pavement areas will be measured as one time common excavation in cubic meters.
- .2 Placing of new sub-base material up to sub grade elevations will be paid as sub base material.
- .3 No measurement will be made for pavement subgrade compaction include cost in related items.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM C 117-04, Test Method for Materials Finer Than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing.
  - .2 ASTM C 136-06, Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .3 ASTM D 422-63(1998), Method for Particle-Size Analysis of Soils.
  - .4 ASTM D 4318-05, Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

1.3 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
  - .1 Rock Excavation: excavation of material from solid masses of igneous, sedimentary or metamorphic rock which, prior to its removal, was integral with its parent mass, and boulders or rock fragments having individual volume in excess of 1 m<sup>3</sup>.

1.3 DEFINITIONS  
(Cont'd)

- .1 (Cont'd)
- .2 Common Excavation: excavation of materials of whatever nature, which are not included under definition of rock excavation, including dense tills, hardpan and frozen materials.
- .2 Compaction classes: two classes of soil are recognized for compaction purposes;  
cohesionless and cohesive soil:
  - .1 Cohesionless soil:
    - .1 Soils which have less than 20% passing 0.075 mm sieve, when tested to ASTM C 117, regardless of plasticity of fines.
    - .2 Soils containing between 20% to 50% passing 0.075 mm sieve and having liquid limit less than 25 and plasticity index less than 6 when tested to ASTM D 4318.
  - .2 Cohesive soil: soil not having properties to be classified as cohesionless.
- .3 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- .4 Waste material: excavated material unsuitable for use in work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of work.
- .6 Pavement structure: combination of layers of unbound or stabilized granular sub-base and base materials.
- .7 Subgrade elevation: elevation immediately below pavement structure.
- .8 Unsuitable materials:
  - .1 Weak and compressible materials under pavement areas.
  - .2 Frost susceptible materials under pavement areas.
  - .3 Frost susceptible materials:
    - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D 4318, and gradation within limits specified when tested to ASTM D 422 and ASTM C 136: Sieve sizes to CAN/CGSB-8.1.

1.3 DEFINITIONS  
(Cont'd)

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- .8 Unsuitable materials:(Cont'd)  
.3 Frost susceptible materials:(Cont'd)

Sieve Designation	% passing
2.00 mm	100
0.10 mm	45-100
0.02 mm	10-80
0.005 mm	0-45

.2 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.

1.4 WASTE  
MANAGEMENT AND  
DISPOSAL

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- .1 Separate and recycle waste materials.  
.2 Dispose of unused rock and granular materials at location offsite in accordance with local and provincial authorities as directed by Departmental Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

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- .1 Fill materials: to approval of Departmental Representative.

PART 3 - EXECUTION

3.1 EXCAVATING

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- .1 General:  
.1 Advise Departmental Representative at least 7 days in advance of excavation operations for initial cross sections to be taken.  
.2 Excavate to lines, grades, elevations and dimensions as indicated..  
.3 Ensure drainage of excavated areas and maintain crowns and cross slopes to provide surface drainage.  
.4 Notify Departmental Representative whenever unsuitable materials are encountered in cut sections, remove unsuitable materials as directed and replace with material approved by Departmental Representative to depth and extent as directed.  
.5 Dispose of waste material as directed by Departmental Representative off project limits.

3.1 EXCAVATING  
(Cont'd)

- .2 Rock excavation:
  - .1 During excavation: when material appearing to conform to classification for rock is encountered, notify Departmental Representative in sufficient time to enable measurements to be made to determine volume of rock.
  - .2 Provide drainage to ditches, leaving no undrained pockets in foundation.
- .3 Common excavation:
  - .1 Excavate to subgrade depths required below finish grade elevation of work area.
  - .2 Haul and place the excavated material in low areas up-to subgrade elevations, Stockpile extra material in locations as directed by Departmental Representative.
- .4 If excavated material volume is not enough to grade existing surface to sub grade elevations, use sub base material.
- .5 Do not disturb foundation materials of adjacent pavements or structures which are to remain in place.

3.2 SUBGRADE  
COMPACTION IN  
PAVEMENT AREAS

- .1 Fill area: do not place stones and boulders exceeding 150 mm maximum dimension within 0.5 m of subgrade elevation.
- .2 Remove stones and boulders, in cut areas, exceeding 150 mm maximum dimension within specified depth, for subgrade compaction.
- .3 Scarify and mix pavement subgrade surface, after grading has been completed, to required depth of subgrade compaction.
- .4 Compact top 150 mm of cohesive subgrade soils minimum 98 % of corrected maximum dry density.
- .5 Compact top 300 mm of cohesionless subgrade soils minimum 98 % of corrected maximum dry density.
- .6 Break soil down to sizes suitable for compaction and mix for uniform moisture and soil conditions to full depth of layer.
- .7 Bring moisture content of soil to level required to achieve specified compaction. Add water or aerate as required.

- 3.2 SUBGRADE  
COMPACTION IN  
PAVEMENT AREAS  
(Cont'd)
- .8 Shape subgrade to required cross section and grade.
- .9 Remove upper portion to depth necessary, when subgrade preparation and compaction can not be achieved to requirement in single layer, to achieve requirement. Remove, replace and compact such materials at no extra cost to Departmental Representative.
- 3.3 FINISHING AND  
TOLERANCES
- .1 Blade finished surfaces in cut and fill areas free from ruts, depressions, rocks in excess of 25 mm.
- .2 Roll finished surfaces to tight dense condition.
- .3 Finish pavement subgrade within 25 mm of design elevations, but not uniformly high or low.
- .4 Finish graded area within 25 mm of design elevations, but not uniformly high or low.
- .5 Surfaces free from depressions exceeding 25 mm in 5 m.
- 3.4 MAINTENANCE
- .1 Maintain finished surfaces in a condition in accordance with this Section until succeeding material is applied or until acceptance by Departmental Representative.

## PART 1 - GENERAL

- 1.1 Measurement for .1  
Payment
- Work performed under this Section will be incidental to work involved in other Sections except as mentioned below.
- .2 Shoring, bracing, cofferdams, underpinning and de-watering of excavation will be incidental to work and will not be measured separately.
- .3 Replacement of unsuitable trench bottom material authorized by the Departmental Representative will be measured in tonnes of material replaced. Payment will be under granular base.
- .4 If required, Unshrinkable fill will be paid as extra in cubic meters of material installed.

- 1.2 REFERENCES
- .1 American Society for Testing and Materials International (ASTM)
- .1 ASTM C 117-04, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
- .2 ASTM C 136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .3 ASTM D 422-632002, Standard Test Method for Particle-Size Analysis of Soils.
- .4 ASTM D 698-00, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m<sup>3</sup>).
- .5 ASTM D 1557-02, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (2,700 kN-m/m<sup>3</sup>).
- .6 ASTM D 4318-05, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
- .1 CAN/CSA-A3000-03, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
- .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.

- 1.2 REFERENCES (Cont'd)
- .3 (Cont'd)
- .2 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .4 U.S. Environmental Protection Agency (EPA)/Office of Water
- .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.
- 1.3 DEFINITIONS
- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
- .1 Rock : solid material in excess of 1.00 m<sup>3</sup> and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m<sup>3</sup> bucket. Frozen material not classified as rock.
- .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .4 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .5 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .6 Unsuitable materials:
- .1 Weak, chemically unstable, and compressible materials.
- .2 Frost susceptible materials:
- .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D 4318, and gradation within limits specified when tested to ASTM D 422 and ASTM C 136: Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.
- .2 Table:
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### 1.3 DEFINITIONS (Cont'd)

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- .6 Unsuitable materials:(Cont'd)
- .2 Frost susceptible materials:(Cont'd)

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

- .3 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.
- .7 Unshrinkable fill: To section 03 30 00.

### 1.4 WASTE MANAGEMENT AND DISPOSAL

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- .1 Separate waste materials for reuse and recycling.
- .2 Divert excess aggregate materials from landfill to local quarry recycling facility in accordance with local and provincial authorities regulations as directed by Departmental Representative.

### 1.5 Protection of Existing Features

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- .1 Existing buried utilities and structures:
  - .1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
  - .2 Prior to commencing any excavation work, notify applicable owner or authorities, establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during work. For Airport cables and utilities apply for dig permit minimum 48 hours prior to excavation to allow airport staff to locate and mark (only) Airport utilities and cables.
  - .3 Confirm locations of buried utilities by hand digging or careful test excavations, in presence of Departmental Representative. Hand dig all cables one metre either side of the cables.
  - .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain direction of Departmental Representative before moving or otherwise disturbing utilities or structures.
  - .5 Record location of maintained, re-routed and abandoned underground lines.

#### 1.5 Protection of Existing Features (Cont'd)

- .2 Existing buildings and surface features:
  - .1 Conduct, with Departmental Representative condition survey of existing buildings, service poles, wires, paving, survey bench marks and monuments which may be affected by work.
  - .2 Protect existing buildings and surface features which may be affected by work from damage while work is in progress and repair damage resulting from work.
- .3 Underground cables:
  - .1 Before commencing work, establish location and extent of existing underground cables in area of excavation.
  - .2 Contractor to apply for site dig permit minimum of 48 hours prior to excavation and co-ordinate with the Departmental Representative, site electrical and/or site communications personnel. Notify Departmental Representative of work areas sufficiently in advance of operations so that underground facilities can be verified.
  - .3 Where unknown cables are encountered, immediately advise Departmental Representative and confirm findings in writing.
  - .4 Clearly mark all existing underground cable in work area to prevent disturbance during excavation.
  - .5 Maintain and protect existing underground cables in area of excavation.
  - .6 Hand dig 1 metre either side of location stakes to prove locations of all underground cables prior to machine excavation.
  - .7 Record locations of maintained, re-routed and abandoned underground cables in work area.
  - .8 Make good and pay for damage to existing underground cables resulting from work at no cost to the Departmental Representative.

#### 1.6 Shoring, Bracing and Underpinning

- .1 Comply with safety requirements and applicable local regulations to protect existing features.
- .2 Engage services of qualified professional engineer who is registered in Nunavut to design and inspect cofferdams, shoring, bracing and underpinning required for work.
- .3 At last 2 weeks prior to commencing work, submit design and supporting data.

1.6 Shoring, Bracing and Underpinning (Cont'd)	.4	Design and supporting data submitted to bear the stamp and signature of qualified professional engineer registered in Nunavut.
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1.7 Samples	.1	At least 2 weeks prior to commencing work, inform Departmental Representative of proposed source of backfill, bedding and filter materials and submit samples of each to Departmental Representative for approval.
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<u>PART 2 - PRODUCTS</u>	.2	Class 1 Material:Use traffic 19 mm size base material as bedding, surround, and backfill unless other shown on drawings.
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### PART 3 - EXECUTION

3.1 SITE PREPARATION	.1	Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
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3.2 PREPARATION/PROTECTION	.1	Keep excavations clean, free of standing water, and loose soil.
	.2	Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.
	.3	Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
	.4	Protect buried services that are required to remain undisturbed.

3.3 STOCKPILING	.1	Stockpile fill materials in areas designated by Departmental Representative. .1 Stockpile granular materials in manner to prevent segregation.
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| 3.3 STOCKPILING<br>(Cont'd)                             | .2 | Protect fill materials from contamination.  |
|   | .3 | Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.   |
| 3.4 COFFERDAMS,<br>SHORING, BRACING<br>AND UNDERPINNING | .1 | Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Health and Safety Act for the Province.  |
|   | .2 | Obtain permit from authority having jurisdiction for temporary diversion of water course.   |
|   | .3 | Construct temporary Works to depths, heights and locations as indicated or directed by Departmental Representative.   |
|   | .4 | During backfill operation: <ul style="list-style-type: none"> <li>.1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.</li> <li>.2 Do not remove bracing until backfilling has reached respective levels of such bracing.</li> <li>.3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.</li> </ul> |
|   | .5 | When sheeting is required to remain in place, cut off tops at elevations as indicated.  |
|   | .6 | Upon completion of substructure construction: <ul style="list-style-type: none"> <li>.1 Remove cofferdams, shoring and bracing.</li> <li>.2 Remove excess materials from site and restore watercourses as indicated and as directed by Departmental Representative.</li> </ul>  |
| 3.5 DEWATERING AND<br>HEAVE PREVENTION                  | .1 | Keep excavations free of water while Work is in progress.   |
|   | .2 | Provide for Departmental Representative's review approval details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.  |
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3.5 DEWATERING AND  
HEAVE PREVENTION  
(Cont'd)

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- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
  - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in manner not detrimental to public and private property, or portion of Work completed or under construction.
  - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .6 Submit for Departmental Representative's approval details of proposed dewatering methods, such as dikes and well points.

3.6 EXCAVATION

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- .1 Excavate to lines, grades, elevations and dimensions as indicated as directed by Departmental Representative.
  - .2 Excavation must not interfere with bearing capacity of adjacent foundations.
  - .3 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
  - .4 Restrict vehicle operations directly adjacent to open trenches.
  - .5 Dispose of surplus and unsuitable excavated material off site.
  - .6 Do not obstruct flow of surface drainage or natural watercourses.
  - .7 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
  - .8 Notify Departmental Representative when soil at bottom of excavation appears unsuitable and proceed as directed by Departmental Representative.
  - .9 Obtain Departmental Representative approval of completed excavation.
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3.6 EXCAVATION  
(Cont'd)

- .10 Remove unsuitable material from trench bottom to extent and depth as directed by Departmental Representative.
  - .1 Replace excavated material with compacted granular base material compacted to 95% corrected maximum dry density.
- .11 Where required due to unauthorized over-excavation, correct as follows at Contractor's expense:
  - .1 Backfill with granular base material compacted to 95% corrected maximum dry density.
- .12 Hand trim, make firm and remove loose material and debris from excavations.
  - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.

3.7 BACKFILLING

- .1 Do not proceed with backfilling operations until completion of following:
    - .1 Departmental Representative has inspected and approved installations.
    - .2 Departmental Representative has inspected and approved of construction below finish grade.
    - .3 Inspection, testing, approval, and recording location of underground utilities.
    - .4 Removal of concrete formwork.
    - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.
  - .2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
  - .3 Do not use backfill material which is frozen or contains ice, snow or debris.
  - .4 Place backfill material above pipe surround in uniform layers not exceeding 150 mm compacted thickness for cohesive fill and 300 mm compacted thickness for non-cohesive backfill. Compact each layer before placing succeeding layer.
  - .5 Backfilling around installations:
    - .1 Place bedding and surround material as specified and as indicated on drawings.
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3.7 BACKFILLING  
(Cont'd)

- .5 Backfilling around installations:(Cont'd)
  - .2 Place layers simultaneously on both sides of installed Work to equalize loading.
- .6 Place unshrinkable fill in areas as directed, if required.
- .7 Consolidate and level unshrinkable fill with internal vibrators.

3.8 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris, trim slopes, and correct defects as directed by Departmental Representative.
- .2 Reinstate pavements disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .3 Clean and reinstate areas affected by Work as directed by Departmental Representative.
- .4 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .5 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

## PART 1 - GENERAL

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|-----------------------------|-----|---|
| 1.1 MEASUREMENT AND PAYMENT | .1  | Fuel Impermeable Geomembranes(Liner) will be measured in square metres of surface covered by material. No allowance will be made for seams and overlaps.                    |
|                             | .2  | Nonwoven fuel resistant Geotextile for drainage pipe will not be measured separately include cost in Sub-drainage pipe item under section 33 46 17 Sub-drainage.            |
| 1.2 REFERENCES              | .1  | ASTM International  |
|                             | .1  | ASTM C920 (2011) Standard Specification for Elastomeric Joint Sealants.   |
|                             | .2  | ASTM D2136 (2002; R 2007) Coated Fabrics Low-Temperature Bend Test  |
|                             | .3  | ASTM D3776/D3776M (2009ae1e2) Standard Test Method for Mass Per Unit Area (Weigh t) of Fabric   |
|                             | .4  | ASTM D413 (1998; R 2007) Rubber Property - Adhesion to Flexible Substrate.  |
|                             | .5  | ASTM D4355 (2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.   |
|                             | .6  | ASTM D4491 (1999a; R 2009) Water Permeability of Geotextiles by Permittivity.   |
|                             | .7  | ASTM D4533 (2011) Trapezoid Tearing Strength of Geotextiles.  |
|                             | .8  | ASTM D4632 (2008) Grab Breaking Load and Elongation of Geotextiles.   |
|                             | .9  | ASTM D4751 (2004) Determining Apparent Opening Size of a Geotextile.  |
|                             | .10 | ASTM D4833 (2007) Index Puncture Resistance of Geotextiles and Geomembranes.  |
|                             | .11 | ASTM D5261 (2010) Measuring Mass Per Unit Area of Geotextiles.  |
|                             | .12 | ASTM D5641 (1994; R 2011) Geomembrane Seam Evaluation by Vacuum Chamber.  |
|                             | .13 | ASTM D696 (2008) Standard Test Method for Coefficient of Linear r Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vit reous Silica Dilatometer. |
|                             | .14 | ASTM D751 (2006; R 2011) Coated Fabrics   |
|                             | .15 | ASTM E96/E96M (2010) Standard Test Methods for Water Vapor Transmission o f Materials.  |
|                             | .16 | ASTM G152 (2006) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.   |

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| 1.2 REFERENCES<br>(Cont'd)                 | .1 (Cont'd)   | .17 ASTM G153 (2004; R 2010) Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.   |
|  | .2 U.S. Environmental Protection Agency (EPA) / Office of Water | .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.   |
| 1.3 ACTION AND SUBMITTALS<br>INFORMATIONAL | .1  | Submit in accordance with Section 01 33 00 - Submittal Procedures.  |
|  | .2  | Product Data:   |
|  | .1  | Submit manufacturer's instructions, printed product literature and data sheets for geomembranes and include product characteristics, performance criteria, physical size, finish and limitations. |
|  | .3  | Samples:  |
|  | .1  | Submit 4 weeks minimum before beginning Work samples as follows:  |
|  | .1  | Minimum 2 m length of standard width membrane.  |
|  | .2  | Minimum of 1 m seam with at least 300 mm of membrane on both sides of seam.   |
|  | .4  | Certificates:   |
|  | .1  | Submit 2 copies of manufacturer's mill test data 4 weeks minimum before beginning Work.   |
|  | .2  | Submit certificates, including test results 2 weeks before delivery to job site.  |
| 1.4 DELIVERY, STORAGE AND HANDLING         | .1  | Deliver, store and handle materials in accordance with Section 01 6100 - Common Product Requirements and with manufacturer's written instructions.  |
|  | .2  | Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.   |
|  | .3  | During delivery and storage, protect geo-membranes from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.   |
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- 1.4 DELIVERY, STORAGE AND HANDLING (Cont'd)
- .4 Storage and Handling Requirements:
- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Replace defective or damaged materials with new.

## PART 2 - PRODUCTS

- 2.1 MATERIALS
- .1 Fuel Impermeable Liner.
- .1 Provide an internally reinforced, flexible membrane liner that is factory fabricated into widths that are designed to minimize field fabricated seams. Factory seams shall be made with a 50 mm overlap plus or minus 6 mm. Liner shall meet the following physical properties as a minimum.
- .2 Physical Properties Of Fuel Impermeable Liner:
- .1 Retard the growth of mildew and be compatible with the fuel to be contained.
- .2 Minimum Overall Finished Thickness: Provide a minimum 0.762 mm overall finished thickness as measured in accordance with ASTM D751.
- .3 Base Fabric Material: Construct base fabric material of aramid fibre, polyester, or nylon that has a minimum weight of 233 g/m<sup>2</sup> as measured in accordance with ASTM D3776/D3776M.
- .4 Adhesion of Coating to Fabric: Provide a minimum adhesion of the coating to the fabric of 2 .63 N/mm when tested in accordance with ASTM D751 or ASTM D4 2.2 .
- .5 Breaking Strength: Provide a minimum breaking strength of 2890 N both the warp and fill directions when tested in accordance with ASTM D751, Grab Test Method.
- .6 Bursting Strength: Provide a minimum bursting strength of 4226 N when tested in accordance with ASTM D751, Ball Tip Method.
- .7 Hydrostatic Resistance: Provide a minimum hydrostatic resistance of 4137 kPa when tested in accordance with ASTM D751, Procedure A.
- .8 Trapezoid Tearing Strength Provide a minimum trapezoid tearing strength of 222 N in both the warp and fill directions when tested in accordance with ASTM D4533.

## 2.1 MATERIALS (Cont'd)

- .2 (Cont'd)
- .9 Low Temperature Bend Test: Provide material flexibility down to a minimum temperature of -34 degrees C when tested in accordance with ASTM D2136.
- .10 Permeability (Fuel Resistance): Provide a minimum permeability of 3.42 g/Sqm over a 24-hour period when tested in accordance with ASTM E96/E96M, Procedure BW, Inverted Water Method, using kerosene instead of water.
- .11 Coefficient of Thermal Expansion: Provide a maximum coefficient of thermal expansion of 0.0001444mm/mm/degree C when tested in accordance with either ASTM E228 or ASTM D696.
- .12 Bonded Seam Strength: Provide a minimum bonded seam strength of 2890 N when tested in accordance with ASTM D751.
- .13 Dead Load Seam Shear Strength: Provide a minimum dead load seam shear strength of 1183 N at 21 degrees C and 591 N at 71 degrees C when tested in accordance with ASTM D751
- .14 Weathering Resistance: Provide no appreciable changes, stiffening or cracking of coating for a minimum of 8000 hours when tested in accordance with either ASTM G152 or ASTM G153.
- .3 Nonwoven fuel resistant Geotextile for drainage pipe.
- .1 Provide a fuel resistant nonwoven, polypropylene, needle punched geotextile fabric. Geotextile shall meet the following physical properties as a minimum.
- .4 Physical properties for Nonwoven Geotextile for drainage pipe.
- .1 Retard the growth of mildew and be compatible with the soil in contact. Material to be fuel resistant.
- .2 Nominal Unit Weight: Provide a nominal unit weight of 210g/sq.m as measured in accordance with ASTM D5261.
- .3 Grab Tensile Strength: Provide a minimum grab tensile strength of 600 N when tested in accordance with ASTM D4632.
- .4 Grab Tensile Elongation: Provide a minimum grab tensile elongation of 60 percent when tested in accordance with ASTM D4632.
- .5 Puncture Strength: Provide a minimum puncture strength of 778 N when tested in accordance with ASTM D4833.

- 2.1 MATERIALS .4 (Cont'd)
- (Cont'd)
- .6 Trapezoid Tear Strength: Provide a minimum trapezoid tear strength of 512 N when tested in accordance with ASTM D4533.
- .7 Mullen burst strength: to CAN/CGSB-4.2, method 11.1, minimum 1200 kPa, wet condition.
- .8 Ultraviolet (UV) Resistance: Maintain 70 percent of its original strength after 500 hours of testing in accordance with ASTM D4355.
- .9 Permittivity: Provide a maximum permittivity of 0.9 se c-1 when tested in accordance with ASTM D4491.
- .10 Allowable Water Flow Rate: Allow a maximum water flow rate of 2649 L/min/m2 when tested in accordance with ASTM D4491.
- .11 Apparent Opening Size (AOS): Provide an AOS of 0.1 mm to 0.22 mm when tested in accordance with ASTM D4751.

### PART 3 - EXECUTION

- 3.1 EXAMINATION .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for geomembranes installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.
- 3.2 INSTALLATION .1 Maintain area of installation free of water and snow accumulations.
- .2 Do not proceed with material placement and seaming when ambient temperatures are below minus 5 degrees C or above 40 degrees C, during precipitation, in presence of excessive moisture (i.e. fog, dew), nor in presence of high winds.
- .3 Place and seam material in accordance with manufacturer's recommendations on graded

3.2 INSTALLATION  
(Cont'd)

- .3 (Cont'd)  
surface in orientation and locations indicated. Minimize wrinkles, avoid scratches and crimps to geomembranes and avoid damage to supporting material.
- .4 Protect installed membrane from displacement, damage or deterioration before, during and after placement of material layers.
- .5 Replace damaged, torn or permanently twisted material to approval of Departmental Representative. Remove rejected damaged panels from site.
- .6 Keep field seaming to minimum. Locate field seams up and down slopes.
- .7 Keep seam area clean and free of moisture, dust, dirt, debris and foreign material.
- .8 Test field seams as seaming work progresses by non-destructive methods over their full length. Repair seams which do not pass non-destructive test. Reconstruct seam between failed location and any passed test location, until non-destructive testing is successful.
- .9 Repair minor tears and pinholes by patching until non-destructive testing is successful. Patches to be round or oval in shape, made of same geomembrane material, and extend minimum of 75 mm beyond edge of defect.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION .1 Do not permit vehicular traffic directly on  
membrane.