

**Amendment to OPSS 501 (Apr 2013) –  
Construction Specification for  
Compaction**

**OPSS 501.05 MATERIALS**

**OPSS 501.05.01 Granular Material**

Subsection 501.05.01 of OPSS 501 is deleted in its entirety and replaced with the following:

Granular material shall be according to TS 1010.

**OPSS 501.08 QUALITY ASSURANCE**

**OPSS 501.08.01 General**

Subsection 501.08.01 of OPSS 501 is amended by the addition of the following paragraphs:

Granular and soils shall be compacted according to Method A and according to the field compaction requirements specified in Table A.

The quality assurance consultant is responsible for field testing and quality assurance laboratory testing of soil and granular materials to determine the optimum moisture content and standard proctor maximum dry density (SPMDD), for materials to be incorporated into the works.

The quality assurance laboratory testing results according to LS-706 shall be provided to the Contract Administrator at least 48 hours prior to the placement and compaction of the subject material in the field.

The Contractor shall provide at least 48 hours notice to the Contract Administrator of their intent to place and compact material(s).

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**OPSS 501.08.02 Method A**

Subsection 501.08.02 of OPSS 501 is amended by deleting the second and third paragraph in its entirety and replacing it with the following:

Soil and granular materials which satisfies the Contract Document requirements shall be placed and compacted using the appropriate equipment to achieve the maximum dry densities provided in Table A.

**Table A: Minimum field compaction requirements**

<b>Material type</b>	<b>Applicant</b>	<b>Minimum target density</b>
earth backfill	boulevards and sidewalks	95% SPMDD
granular bedding and cover material	utility cut restorations and trenching works in pavement	98% SPMDD
granular base and subbase	pavements, curbs, sidewalks, boulevards and utility cut restorations	100% SPMDD

The frequency and locations of compaction testing for quality assurance are as follows:

- One test per 0.3 m of testing for each increment or fraction of 150 linear metres of backfill for sewer and water main for embedment, bedding and cover materials.
- One test per lift for each increment or fraction of 500 square metres for granular base/subbase, on each lane, curb or sidewalk.

The Contract Administrator can specify additional test locations, if in the opinion of the Contract Administrator additional testing for quality assurance is required for a specified test section.

**OPSS 501.08.02 Method A**

Subsection 501.08.02 of OPSS 501 is amended by the addition of the following clause:

**OPSS 501.08.02.01 Compaction**

The acceptance of compaction test results for a specified test section or location shall be based on the minimum specified target densities provided in Table A.

The Contract Administrator may verify that the target density established for a specified test section is based on the use of suitable compaction equipment. Provided that the maximum dry density and optimum moisture content values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

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However, if the test section or location is rejected based on compaction testing or demonstrates errors in quality assurance reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include any of the following:

- re-compaction of the test location(s)
- retesting by the quality assurance consultant
- establishment of a new target density by control strip
- re-inspection of the gauge or operator or both by the Owner.
- recalibration of the gauges
- removal of unsuitable materials

Subsequent lifts including hot mix asphalt and concrete layers may not be placed until quality assurance testing has been successfully completed for the test section and the results have been provided to the Contract Administrator.



**CONSTRUCTION SPECIFICATION FOR  
COMPACTING**

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**501.01 SCOPE**

This specification covers the requirements for compaction of earth and granular materials.

**501.01.01 Specification Significance and Use**

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

## **501.01.02 Appendices Significance and Use**

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

## **501.02 REFERENCES**

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

### **Ontario Provincial Standard Specifications, Construction**

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 506	Dust Suppressants

### **Ontario Provincial Standards Specifications, Materials**

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
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### **Ontario Ministry of Transportation Publications**

MTO Laboratory Testing Manual:

LS-706	Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop
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MTO Forms:

PH-CC-009	Field Compaction Report
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**ASTM International**

D 6938-10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**501.03 DEFINITIONS**

For the purpose of this specification, the following definitions apply:

**Backfill Material** means as defined in OPSS 401.

**Bedding Material** means as defined in OPSS 401.

**Cover Material** means as defined in OPSS 401.

**Earth** means as defined in OPSS 206.

**Embedment Material** means as defined in OPSS 401.

**Rut** means a sunken track or groove made at the surface by the passage of vehicles.

**Utility Structures** means maintenance holes, catch basins, valve chambers, ditch inlets, and other similar structures used to access services such as sewer, water, electric, and telephone to carry out maintenance and repair work.

**501.05 MATERIALS**

**501.05.01 Granular Material**

Granular material shall be according to OPSS 1010.

**501.05.02 Water**

Water shall be according to OPSS 506.

**501.06 EQUIPMENT**

**501.06.01 Compaction**

**501.06.01.01 General**

The type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required, and space available.

Compaction equipment for control strips shall have a minimum static weight of 9,000 kg.

**501.06.01.02 Hand Operated Vibratory Equipment**

Hand operated vibratory equipment shall have a power output no greater than 9.9 kW.

**501.06.02 Water**

Equipment for applying water shall be capable of uniform distribution with proper flow control.

### **501.06.03 Nuclear Moisture and Density Gauge**

Each nuclear moisture and density gauge (gauge) shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent against certified density and moisture reference blocks. In addition, the Density Standard Count and the Moisture Standard Count shall be within 2.0% and 4.0% respectively, of the most recent calibration values. The registered owner of the gauge shall maintain a valid Radioisotope License for each gauge.

## **501.07 CONSTRUCTION**

### **501.07.01 General**

The method of placing and lift thickness of earth or granular material shall be according to the specifications that govern the Work. When field tests indicate that the required degree of compaction cannot be obtained with the equipment in use or the procedure being followed, the operations shall be modified so that the equipment and procedures will produce the required results.

### **501.07.02 Restricted Zones**

Hand operated vibratory type compaction equipment shall be used behind all retaining structures to compact fill material within restricted zones as follows:

#### a) Abutments and Retaining Walls

An area within a plane extending from the base of the back face of the wall, where it contacts the footing, upwards at a slope of 1H:1.5V, to a maximum distance of 2.5 m from the wall.

#### b) Wingwalls

An area within 1.5 m from the back face of the wall.

### **501.07.03 Water for Compaction**

Water shall be applied as necessary to achieve the degree of compaction required.

When the Contract includes a separate item for water for compaction, the water shall be applied with the approval of the Contract Administrator.

### **501.07.04 Quality Control**

#### **501.07.04.01 General**

Quality Control (QC) testing shall be carried out to ensure that earth and granular materials used in the Work are compacted according to the specified compaction requirements.

The two methods for conducting QC for compaction are referred to as Method A and Method B. Method A shall be used when Method B is not specified in the Contract Documents.

Field density and field moisture determinations shall be made according to ASTM D 6938.

#### **501.07.04.02 Method A**

The Contractor is responsible for establishing QC procedures.

**501.07.04.03 Method B**

**501.07.04.03.01 General**

When Method B is specified in the Contract Documents, QC compaction testing shall be based on material placed and compacted in the Work on a lot-by-lot basis according to the Lot Testing clause.

Compaction acceptance shall be according to the Acceptance clause and shall be based on target densities established according to the Target Density clause, QC compaction field test results, and, where applicable, a statistical analysis of those results.

**501.07.04.03.02 Submission of Test Data**

Prior to construction of a control strip, a copy of all QC laboratory test results for LS-706 required by the Control Strip clause to determine optimum moisture content (OMC) of the control strip material shall be delivered to the Contract Administrator.

All field test results and information relating to control strip, target density, lot location, lift thickness, probe depth, moisture content, and wet density shall be recorded at the time of testing. All of this data, as well as the QC lot compaction calculations, shall be submitted to the Contract Administrator within 2 Business Days following completion of a lot and prior to placement of any subsequent lift using the most recent version of MTO form PH-CC-009.

**501.07.04.03.03 Test Equipment and Operator Training**

**501.07.04.03.03.01 General**

Field density and field moisture measurements for QC compaction testing of earth and granular materials shall be carried out using gauges and ancillary equipment.

Only qualified operators using properly-calibrated gauges shall conduct QC compaction testing.

**501.07.04.03.03.02 Nuclear Moisture and Density Gauge Requirements**

A copy of a valid calibration certificate, including the make, model number, and serial number for each gauge, shall be given to the Contract Administrator prior to use of the gauge in compaction testing.

In addition, the Contract Administrator may request that the operator perform a standardization procedure according to ASTM D 6939.

If the gauge does not meet the standardization requirements or exhibits malfunctions of any kind, the gauge shall be replaced.

**501.07.04.03.03.03 Operator Requirements**

Each operator shall have been trained in the safe operation, transportation, and handling of the gauge.

Prior to conducting QC compaction testing, the operator shall provide acceptable proof of proficiency in the use of a gauge and the correct procedures to determine lot and subplot sizes, field dry density, percent relative compaction, mean, standard deviation, and the Quality Index of a compacted lot of material by submitting one of the following:

- a) a gauge operator certification document or card from a training program acceptable to the Owner and conducted within the Province of Ontario within the last 2 years; or



- b) a document (e.g., instruction notice or letter) signed by the Owner showing that the operator has demonstrated proficiency on a contract either constructed or being constructed for the same Owner within the same construction year as the compaction testing being carried out for this Contract.

If the operator cannot provide either of the two documents stated above, then at the Contract Administrator's discretion, the operator shall demonstrate his or her proficiency to the Owner. In this case, arrangements shall be made with the Contract Administrator regarding the schedule, location, and materials for such demonstrations. The first two demonstrations may include up to five operators and five gauges and shall be carried out at no charge. Additional demonstrations shall be charged at the rate of \$500. Where a demonstration is carried out, acceptability of the operator shall be valid for the current calendar year only.

#### **501.07.04.03.04 Target Density**

New target densities shall be established for each separate component of the Work (e.g., backfilling of a trench, construction of a granular base or placement of cover) at the following times:

- a) For earth and granular materials:
  - i. At the time of initial use of each source.
  - ii. When there is a perceptible change in the appearance or gradation of materials or both.
  - iii. At least once per calendar year on all carry-over Contracts.
- b) For earth, after each 10 QC lots of material have been completed, whether accepted or rejected, on the basis of one set of target density values.
- c) For granular materials, after each 25 QC lots of material have been completed, whether accepted or rejected, on the basis of one set of target density values.

The target density shall be established by the construction of a control strip according to the Control Strip clause.

When a control strip cannot be reasonably constructed or is impractical, with the consent of the Contract Administrator, the target density shall be based on the maximum dry density (MDD) as determined by LS-706, no more than 14 Days prior to placing the material. In this case, the MDD used for the new target density shall be based on the average of all individual MDD's calculated from a minimum of 3 independent samples selected from materials to be used in the Work.

#### **501.07.04.03.04.01 Control Strip**

Prior to construction of a control strip, the Contractor shall:

- a) Give a minimum notice of 24 hours to the Contract Administrator.
- b) Determine the optimum moisture content (OMC) according to LS-706.

Each control strip shall consist of a single uniform lift not more than 0.30 m in depth and covering at least 400 m<sup>2</sup> in area.

During construction of the control strip the average field moisture content shall be maintained within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material.

After initial placement of the material, the compaction equipment for that operation shall make six passes over the entire surface of the control strip. The field wet density and field moisture content shall be determined at a minimum of three randomly-selected locations. The dry density shall be calculated for each of these locations and the average dry density and moisture content values used as the initial values for dry density and moisture content.

The compaction equipment shall then make two additional passes over the entire surface of the control strip.

All passes of the compaction equipment for the control strip shall be carried out in vibratory mode at a speed of no more than 5 km/hour.

A minimum of three separate random field density and moisture content determinations shall then be made and a new average dry density and moisture content shall be calculated.

If the new average dry density exceeds the previous value by more than  $0.030 \text{ t/m}^3$ , additional passes of the equipment shall be carried out as described above. If the new average dry density does not exceed the previous value by more than  $0.030 \text{ t/m}^3$ , the compaction of the control strip shall be considered satisfactory and complete.

Upon satisfactory completion of the control strip, an additional seven field wet density and moisture content tests shall be taken at random locations and the dry density and moisture content values determined. The final dry density and moisture content of the control strip shall be the average of these seven values plus the three most recent values that were obtained upon completion of the control strip. If the final moisture content lies within the allowable range of the OMC specified above, then the final dry density that was determined shall be the target density of the control strip.

#### **501.07.04.03.05            Lot Testing**

For compaction control, a unique set of lots distinguished from each other by an appropriate letter or number designation, shall be established for each of the following:

- a) Each separate component of the Work (e.g., backfilling a structure or a trench or construction of a granular base).
- b) Materials from different sources.
- c) Materials with different compaction properties.
- d) When recompaction is carried out following restoration, scarification, or placement of additional material onto previously tested and accepted lots.
- e) When directed by the Contract Administrator.

The individual lots within each unique set of lots shall be consecutively-numbered and with no duplication. Lot sizes shall not exceed the limits listed in Table 1.

All visibly soft or loose areas shall be compacted prior to testing.

For the situations described in Table 1, Part IV, a minimum of two field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into four equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each subplot and the results used to calculate the Quality Index according to the Quality Index clause.

In addition, regardless of the situation, when a lot of material is split between both sides of a pipe, sewer, or culvert, at least one field density and moisture content test shall be taken on each side of that pipe, sewer, or culvert.

The nuclear gauge probe shall extend to the full depth of the lift unless otherwise allowed by the Modified Layer Compaction Method according to OPSS 206. The probe shall not extend beyond the lift being tested.

For each test, the field wet density value and moisture content shall be immediately recorded on Form PH-CC-009. The dry field density of each subplot shall then be calculated as a percentage of the target density, to the nearest 0.1%. The mean and the standard deviation and Quality Index, where applicable, of the field dry density values shall be calculated to the nearest 0.1% and recorded for each lot.

**501.07.04.03.06 Quality Index**

The Quality Index ( $Q_i$ ), shall be calculated from the mean ( $\bar{x}$ ) and standard deviation ( $s$ ) of the per cent target density which has been determined from all sublots within a QC compaction lot. The values for Quality Index, lot mean, and lot standard deviation shall be computed as follows:

- a) For materials placed in embankments within 50 m of a structure; placed as bedding, embedment, cover, or backfill material to pipes, sewers, or culverts; or placed as backfill to structures, utility structures, or small foundations (e.g., anchor blocks, sign posts, and formwork):

For earth materials:  $Q_i = \frac{\bar{x} - 95}{s}$                       For granular materials:  $Q_i = \frac{\bar{x} - 98}{s}$

- b) For materials placed in all other situations:

For earth materials:  $Q_i = \frac{\bar{x} - 90}{s}$                       For granular materials:  $Q_i = \frac{\bar{x} - 95}{s}$

Where:

$Q_i$  = Quality Index, calculated to two decimal places.

$\bar{x}$  = Lot mean, the statistical value that describes the arithmetic average of subplot test results (dry density expressed as a percentage of the target density). Lot mean is the sum of individual subplot test results divided by the number of test results, calculated to 0.1%, as follows:

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4}{4} = \frac{1}{4} \sum_{i=1}^4 x_i$$

$S$  = Lot standard deviation ( $\sigma_{n-1}$ ), the statistical value that describes the distribution of subplot test results (dry density expressed as a percentage of the target density) about the lot mean. Standard deviation is the square root of the sum of the squares of the difference between each subplot test result and the lot mean divided by the number of test results minus one. It is calculated to 0.1% using the following expression:

$$s = \sqrt{\frac{\sum_{i=1}^4 (x_i - \bar{x})^2}{3}}$$

#### **501.07.04.03.07 Acceptance**

For the situations described in Table 1, Part IV, acceptance or rejection of a QC lot for compaction shall be based on two or more random field density and moisture content tests taken within the lot. For a lot to be acceptable, all tests shall be at least 100% and 98% of the target density established for granular and earth materials, respectively. Otherwise, the QC lot shall be rejected for compaction.

For all other situations, acceptance or rejection of a QC lot for compaction shall be established by calculation of the Quality Index, according to the Quality Index clause. When  $Q_i$  has a value equal to or greater than 1.47, the QC lot shall be accepted; otherwise, the lot shall be rejected for compaction.

Accepted QC lots damaged by vehicular traffic shall be restored prior to placement of any overlying material. Surfaces of accepted QC lots with ruts greater than 50 mm in depth in earth or 25 mm in depth in granular materials shall be regraded and the upper lift recompacted to meet the specified compaction requirements. Materials that cannot be successfully recompacted shall be removed and replaced with new material.

#### **501.07.04.03.07.01 Rejected Lots**

If a QC lot is rejected for compaction, the lot shall be recompacted with adjustment to the moisture content as required until satisfactory compaction is achieved. The recompacted lot shall be retested and a decision made, as described in the Acceptance clause.

When compaction of a QC lot does not meet the acceptance criteria and when the Contract Administrator has been satisfied that this is not a result of the Contractor's operation or equipment, a new target density shall be established for that operation.

#### **501.07.05 Management of Excess Material**

Management of excess material shall be according to the Contract Documents.

### **501.08 QUALITY ASSURANCE**

#### **501.08.01 General**

Field density and field moisture determinations shall be made in accordance with ASTM D 6938.

When Method B is specified for the QC of compaction, then Method B shall be used for quality assurance (QA).

#### **501.08.02 Method A**

The MDD shall be determined using LS-706.

Granular materials shall be compacted to a density of 100% of the MDD and all earth materials shall be compacted to a density of 95% of the MDD.

The frequency and location of testing for QA shall be as determined by the Contract Administrator.

**501.08.03                      Method B**

**501.08.03.01                  General**

The Contract Administrator shall conduct random testing or inspection of QC records or both, to establish the acceptability of the QC compaction testing and verification of the field moisture content, field dry density, OMC, MDD, target density, and the Quality Index, where applicable.

The Contract Administrator may verify that the target density established for a control strip is based on the use of suitable compaction equipment. Provided that the MDD and OMC values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

Reasonable access to a control strip or to compacted QC lots shall be provided prior to placement of subsequent lifts of material. Subsequent lifts, including HMA, may not be placed until QA testing has been conducted or waived by the Contract Administrator.

**501.08.03.02                  Gauge Verification**

Gauge verification QA shall consist of taking four random field density and moisture content measurements of a compacted lot or control strip and the subsequent calculation of the average dry density. Provided that the average dry density determined by QC test results for the same material is within  $139 \text{ kg/m}^3$  for granulars and  $150 \text{ kg/m}^3$  for earth when compared with the QA average dry density, the QC test results shall be considered valid.

**501.08.03.03                  Compaction**

For the situations described in Table 1, Part IV, compaction QA shall consist of taking two or more random field density and moisture content measurements of each compacted lot and the subsequent determination of per cent target density.

For all other situations, compaction QA shall consist of taking four random field density and moisture measurements of a compacted lot or control strip and the subsequent calculation of the Quality Index for the lot.

Provided that the lot is acceptable, according to the requirements given in the Acceptance clause, no further action shall be taken.

However, if the lot is rejected based on compaction testing or demonstrates errors in QC reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include, but is not limited to, any of the following:

- a) Recompaction of the lot.
- b) Retesting of the lot by the Contractor.
- c) Establishment of a new target density by control strip.
- d) Re-inspection of the gauge or operator or both by the Owner.
- e) Recalibration of the gauges.
- f) Removal of unsuitable materials.

**501.08.03.04                      Quality Control Records Inspections**

QC records of the lot or control strip selected by the Contract Administrator shall be inspected for calculation errors, missing test data, or improper lot quantities. If errors or omissions are found that identify insufficiently compacted or improperly or untested lots, the Contractor shall make all such lots available and recompact or retest these lots or both so that they comply with the specified compaction requirements.

**501.08.03.05                      Charges**

The Contract Administrator shall charge the Contractor \$450.00 for each lot that requires retesting which has been identified through QA compaction testing or a review of QC records. In addition, immediately following the discovery of a discrepancy or inadequate compaction, all new lots shall be subjected to QA compaction testing prior to acceptance. If any of the new lots do not meet the specified compaction requirements, the Contractor shall be charged a fee of \$450.00 for each lot. These conditions shall continue until three consecutive new lots have met the specified compaction requirements.

**501.09                                      MEASUREMENT FOR PAYMENT**

**501.09.01                                  Actual Measurement**

**501.09.01.01                              Water for Compaction**

Measurement of water for compaction shall be in cubic metres using one of the following methods:

- a) The mass of the water shall be determined by weighing as specified in the Contract Documents. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 m<sup>3</sup>.
- b) The water tank shall be measured and its volume computed in cubic metres.
- c) The water shall be measured through a water meter of approved design.

**501.10                                      BASIS OF PAYMENT**

**501.10.01                                  Compaction**

Payment at the Contract price of the appropriate tender item requiring compaction of earth and granular materials shall be full compensation for all labour, Equipment, and Material to do the work of compacting, including the water used for compaction, unless the Contract contains a separate tender item for Water for Compaction.

Any work required to repair or remove and replace damaged QC lots accepted using Method B shall be at no extra cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density using Method B shall be at no extra cost to the Owner.

Replacement of a gauge shall be at no extra cost to the Owner.

Any work required to recompact or retest material as a result of QA compaction testing or QC records inspection shall be at no extra cost to the Owner.

**501.10.02 Water for Compaction - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for water for compaction, the Contract price for the tender item in which the water for compaction is used shall include full compensation for all labour, Equipment, and Material to do the work.

**TABLE 1**  
**Compaction Lot Size**

<b>Part</b>	<b>Construction</b>	<b>Lot Size</b>
I	Earth embankments, granular base, granular subbase, and granular shoulders.	Every lift, 500 m maximum length (Note 1)
II	Structure approach fill for earth.	Every lift, 50 m maximum length
III	Bedding, embedment, cover, or backfill material for pipe and sewer sections > 20.0 m in length that are being placed in one operation, earth or granular.	Every lift, 200 m maximum length
IV	Bedding, embedment, cover, or backfill material for pipes and sewer sections ≤ 20.0 m in length that are being placed in one operation or backfill to utility structures or small foundations (e.g., anchor blocks, sign posts, and formwork), earth or granular.	Every lift, 20 m maximum length
V	Structure backfill and culvert bedding, embedment, cover, or backfill material, granular.	Every lift for every stage of construction.
<p>Note:</p> <p>1. The width of the lot shall be the limits established for the placement of current material only and shall not include adjacent material to be placed at a future date.</p>		



**Appendix 501-A, April 2013  
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

**Note:** This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

**Designer Action/Considerations**

The designer should determine if the following is required and if so, specify it in the Contract Documents:

- Use of Method B. (501.07.04.01)

Method A is based on laboratory testing to determine optimum moisture content and maximum dry density and is generally used by municipalities.

Method B is a statistically based end result method that recognizes the variability of materials and testing and is generally used by the Ministry of Transportation of Ontario.

If the form in Appendix 501-B is to be used for submission purposes rather than the MTO form, it needs to be invoked by reference in the Contract Documents and a special provision should be written to delete the MTO form from the specification. (501.07.04.03.02)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

**Related Ontario Provincial Standard Drawings**

No information provided here.

**Appendix 501-B, April 2013  
FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS**

**Note:** This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

**FIELD COMPACTION REPORT**

**MATERIAL:** \_\_\_\_\_  
**SOURCE:** \_\_\_\_\_  
**GAUGE (make/model):** \_\_\_\_\_  
**Serial No.:** \_\_\_\_\_

**CONTRACT NO.:** \_\_\_\_\_  
**LOCATION:** \_\_\_\_\_  
 **QC**  
 **QA**

Standard Readings		
Calibration	Reference	Difference (%)
Density		(± 2.0% max)
Moisture		(± 4.0% max)

Target Density	
Control Strip, t/m <sup>3</sup>	
Proctor, %	
MDD, t/m <sup>3</sup>	
OMC, %	

Quality Index, $Q_i$	
For embankments within 50 m of a structure; bedding, embedment, cover, or backfill material to pipes, sewers, or culverts; or backfill to structures, utility structures, or small foundations (e.g., anchor blocks, sign posts; and formwork):	
Earth: $Q_i = \frac{\bar{x}-95}{s}$	Granular: $Q_i = \frac{\bar{x}-98}{s}$
For materials placed in all other situations:	
Earth: $Q_i = \frac{\bar{x}-90}{s}$	Granular: $Q_i = \frac{\bar{x}-95}{s}$

Test		Location								Lift Thickness cm	Probe Depth cm	Moisture Content %	Density			Relative Compaction			Accepted (A) Rejected (X) Retest (R)
Lot	Sublot	Grade	Structure	Foundation	Pipe	Sewer	Culvert	Other	Station				Offset	Count/ minute	Wet Density, tonnes/m <sup>3</sup>	Dry Density, tonnes/m <sup>3</sup>	% Target Density	Lot Mean - x	
	1																		
	2																		
	3																		
	4																		
	1																		
	2																		
	3																		
	4																		
	1																		
	2																		
	3																		
	4																		

**NOTES:** a) Where  $Q_i \geq 1.47$ , then 99% of the lot will have compaction above the specified limits, otherwise, the lot is rejected and shall be recompacted and retested.  
b) Retested areas should be indicated with "R" using the original lot number.

**REMARKS:**

**TECHNICIAN:** \_\_\_\_\_  
PRINT NAME

Copies to: Contract Administrator  Contractor

\_\_\_\_\_  
SIGNATURE DATE