



TOWN OF LEADER

Soil Compaction Policy

PURPOSE

The purpose of this Policy is to ensure consistent and adequate compaction of soil during utility backfilling beneath public roadways within the Town of Leader. It establishes a formalized standard that all Applicable Parties shall follow. This Policy will help reduce long-term maintenance issues, improve road safety, and support responsible infrastructure management.

DEFINITIONS

“Applicable Parties” – The people who are performing work and are responsible for adhering to the Policy.

“Backfill” – Material used to refill an excavation after the installation of utilities or structures.

“Bedding” – A specified layer of granular material placed and compacted under and around a pipe to provide structural support and uniform bearing.

“Compaction” – The process of increasing the density of a soil or aggregate by mechanical means to reduce voids and increase stability.

“Haunch” – The area of the trench located on the sides of a pipe, between the bottom of the pipe and the springline (horizontal mid-point).

“Lift” – A single layer of backfill placed and compacted before the next layer is added.

“Moisture Content” – The percentage of water present in the soil by weight, typically compared to the Optimum Moisture Content (OMC) from the Proctor test.

“Optimum Moisture Content (OMC)” – The moisture level at which a soil can be compacted to its maximum dry density using standard Proctor effort.

“Pipe Zone” – The portion of the trench that extends from the bottom of the bedding up to 300 mm above the top of the pipe.

“Proctor Test (Standard Proctor)” – A laboratory compaction test (ASTM D698) used to determine the Maximum Dry Density and Optimum Moisture Content of a soil, which serve as benchmarks for field compaction.

“Sieve Test (Sieve Analysis)” – A laboratory test (ASTM C136 or ASTM D6913) that determines the particle size distribution of soil or aggregate by passing the material through a stack of progressively finer mesh screens.

“Springline” – The horizontal midpoint of a pipe’s diameter. It marks the widest part of the pipe and is a reference point for defining bedding, haunching, and initial backfill zones.

“Standard Proctor Density (SPD)” – The maximum dry density of soil as determined by ASTM D698 laboratory compaction test.

“Subgrade” – The top surface of the backfill that supports a roadway, sidewalk, or other final surface treatment.

“Trench” – A narrow excavation made below the surface of the ground, typically for the installation of utilities such as water or sewer lines.

“Unsuitable Material” – Soil or debris that is not appropriate for backfilling due to excessive particle size, moisture, contamination, organic matter, or poor compaction properties.

APPLICABILITY

Applicability Scenarios: This Policy applies to all excavation and backfilling activities located beneath public roadways, including but not limited to new road construction and the repair or replacement of buried assets within the Town of Leader. This includes paved and unpaved roadways in all developed areas of the municipality.

Minor vs. Major Excavations: For the purposes of this Policy, major excavations are those described in full throughout this document and are subject to all compaction and testing requirements. Minor excavations refer to smaller, localized trenches of similar depth, typically used to access water mains or other sub-grade infrastructure.

Applicable Parties: This Policy must be followed by:

- Town of Leader staff performing excavation or utility work.
- Private contractors hired by the Town or performing work requiring road excavation under permit.
- Utility providers or developers undertaking infrastructure work beneath public roads.
- Testing agencies responsible for performing laboratory and field compaction testing.

All parties are required to adhere to the procedures, standards, and testing and verification methods outlined in this Policy.

Applicability Requirements:

1. **Scope Limitation:** The Policy is applicable only to excavations beneath public roadways. Excavations outside public road surfaces (e.g., boulevards, parks, private property) are excluded unless otherwise stated.
2. **Permitting Compliance:** All excavation and backfilling work must be carried out under a valid utility permit, roadway cut permit, work authorization, or any other municipal or provincial laws from the Town of Leader.
3. **Standard Restoration:** Applicable Parties are responsible for restoring the roadway surface and underlying structure in accordance with the standard set in this Policy.
4. **Use of Approved Materials:** Only backfill materials meeting the specifications outlined in this Policy may be used. Use of native soil or fill dirt is permitted only when the Applicable Parties can prove that the soil condition and moisture content meet the required standards in this Policy.
5. **Compaction Method and Testing:** All compaction must meet the minimum Standard Proctor Density (SPD) as confirmed through approved field-testing methods. Testing must be conducted or approved by Applicable Parties in accordance with the standard set in this Policy.
6. **Weather and Seasonal Adaptation:** Appropriate techniques must be used to account for wet soil conditions, frozen ground, or winter construction scenarios, as outlined in the Policy.
7. **Testing and Verification:** Applicable Parties must carry out or arrange for laboratory and field testing as required. Results must be submitted to the Town within 48 hours and retained for at least 12 months.
8. **Recordkeeping:** Applicable Parties are responsible for maintaining proper records of compaction testing, backfill material sources, and field conditions, to be submitted upon request.
9. **Town Right to Audit:** The Town reserves the right to audit test results, require re-testing, or conduct independent verification at any time.

PROCEDURE

Approved Materials

Only approved backfill materials may be used in utility trench restoration beneath municipal roadways, as outlined in Table 1. When tested in accordance with ASTM C136 Method for Sieve Analysis of Fine and Coarse Aggregates, or ASTM D6913 Method for Particle-Size Distribution (Gradation) Soils Using Sieve Analysis, the material shall meet the following gradation requirements:

Type	Material (ASTM)	ASTM D2321	ASTM D2487		Percentage Passing Sieve Sizes						
					50	40	32	19	4.75	0.625	0.075
1	Trench Bottom (C136)	Manufactured processed aggregates; dense-graded, clean	N/A	Angular crushed stone or other Class IA material and stone/sand mixtures; little or no fines	95-100	-	20-100	0-80	2	-	<5
2	Bedding (C136)	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity	-	-	-	-	95-100	25-60	0-5
3	Granular (C136)	Coarse-Grained Soils, clean	SW	Well-graded sands, gravelly sands; little or no fines	-	-	100	90-100	45-85	-	<5%
4a	Imported Granular Backfill (C136)	Coarse-Grained Soils, clean	GP	Poorly-graded gravels, gravel sand mixtures; little or no fines	100	-	60-100	40-90	25-60	10-25	0-10
4b	Native (In-Situ) and Fill Dirt (D6913)	Coarse-grained soils with fines	GM	Silty gravels, gravel/sand/silt mixtures. Free of boulder > 100mm	80-100	-	60-90	50-85	30-70	-	10-25
5	Sub-Base Coarse (C136)	Coarse-Grained Soils, borderline clean/fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines	-	100	-	-	35-75	-	5-12
6	Base Coarse (C136)	Coarse-Grained Soils, clean	GW	Well-graded gravel, gravel/sand mixtures; little or no fines	-	100	90-100	65-85	35-60	10-25	4-10

Table 1: ASTM Soil Properties

Compaction Method and Field Testing

All backfill must be placed and compacted in uniform layers to prevent settlement and ensure long-term public roadway stability. The following compaction and testing procedure, illustrated in Figure 1, outlines the required compaction approach for each trench zone.

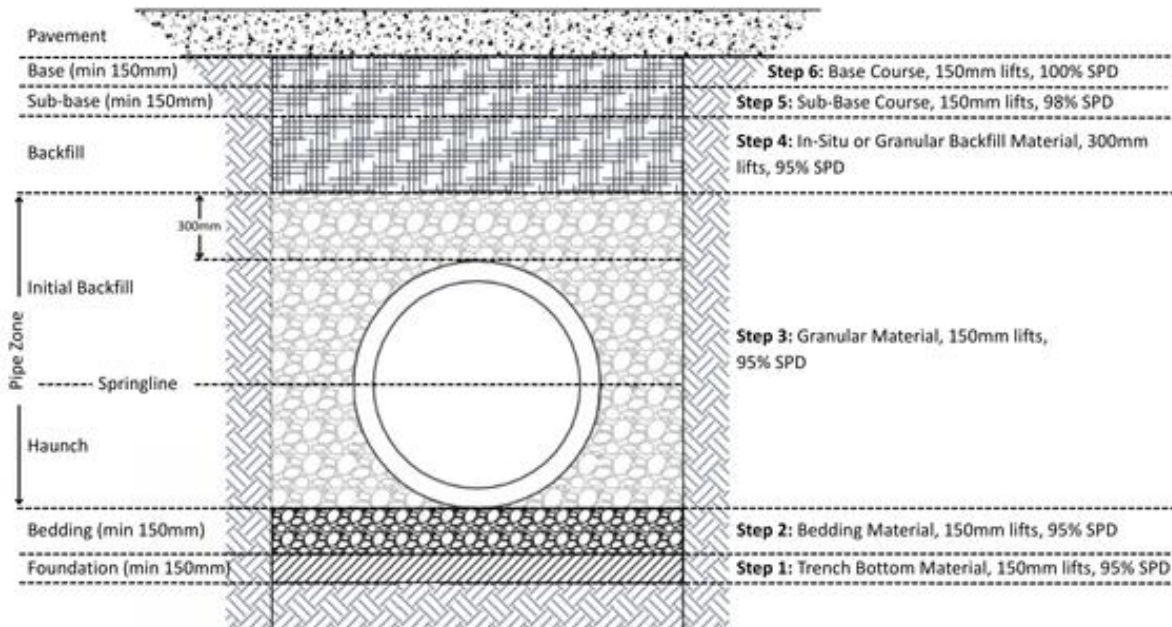


Figure 1: Compaction and Testing Procedure Diagram*

*This diagram is not to scale. The pipe and material layers are intentionally enlarged for clarity to illustrate compaction zones and material layering around the pipe. Actual dimensions and lift thicknesses must follow the Policy and project specifications.

Provision for Minor Excavations

When an excavation meets the definition of a minor excavation as described in the Applicability section, all approved materials, lift thickness, and mechanical compaction methods specified in this Policy must still be followed. For minor excavations, Lightweight Deflectometer Testing (LWD) in accordance with ASTM E2583 may be used in place of other density and moisture testing methods, unless otherwise directed by the Town. The Town reserves the right to require standard field and laboratory testing for any excavation at its discretion.

Compaction and Testing Procedure

1. Trench Bottom Zone
 - Remove all muck, water, loose debris, or unsuitable material.
 - If the base is unstable, over-excavate and replace with trench bottom material.
 - Use approved trench bottom material compacted in 150 mm lifts.
 - Minimum 150mm layer thickness.
 - Compact to 95% SPD using mechanical equipment.
2. Bedding Zone
 - Use approved bedding material compacted in 150mm lifts, placed to the required grade and depth based on the depth requirements of the buried assets.

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- 150mm zone thickness for 12"-36" pipe OD, 300mm zone thickness for >36" pipe OD.
 - Compact to 95% SPD using mechanical equipment.
3. Pipe Zone (From Bedding to 300 mm Above Pipe Crown)
- Use granular material compacted in 150 mm lifts.
 - Compact to 95% SPD using mechanical equipment, taking care to compact evenly on both sides.
 - Use a manual tamper in the haunch zone (up to the springline) to avoid pipe damage.
4. Backfill Zone (Above Pipe Zone up to Sub-Base)
- Use native in-situ soil or granular backfill material compacted in 300 mm lifts.
 - Compact to 95% SPD using mechanical equipment.
5. Sub-base Zone
- Use sub-base coarse material compacted in 150 mm lifts.
 - Minimum 150mm layer thickness.
 - Compact to 98% SPD using mechanical equipment.
6. Base Zone (Final Lift Beneath Paved Surface)
- Use base coarse material compacted in 150 mm lifts.
 - Minimum 150mm layer thickness.
 - Compact to 100% SPD using mechanical equipment.
7. Mechanical Compaction Methods
- Use appropriate equipment for trench size and material type:
 - Vibratory plate compactors or manual tampers for trench bottom and bedding material.
 - Vibratory plate compactors for granular materials in wider trenches.
 - Jumping jacks or trench rammers for cohesive soils or tight trench areas.
 - Excavator-mounted tampers or bucket tamping for large open trenches or deep lifts.
 - Manual tampers in the pipe haunches to compact without causing damage.
 - Pneumatic or vibratory compactors for sub-base and base.
8. Field Density Testing
- Required to confirm compaction compliance.
 - Field density will be tested using one or more of the approved methods as deemed appropriate by the Applicable Parties.
 - Minimum frequency: 1 test per 1000 m² per 150 mm lift, or once per day during active backfilling.
9. Moisture Content Testing
- Required to confirm compaction compliance.
 - Minimum frequency:
 - If using a nuclear gauge (ASTM D6938), moisture is recorded simultaneously.
 - Otherwise, test (ASTM D2216) every 300 m of trench per soil type. At least once per day during backfilling.
10. Moisture Control
- If measuring a compacted lift using a nuclear gauge (ASTM D6938), before progressing to the next lift, verify the material moisture content within $\pm 3\%$ of OMC.
 - If too dry: Add water.
 - If too wet: Delay until moisture is reduced.

- If measuring material before placement in the trench.
 - If too dry: Add water and mix thoroughly.
 - If too wet: Aerate and delay until moisture is reduced.

11. Logging and Submitting Test Results

- All field and lab testing results must be:
 - Documented immediately upon completion of each test.
 - Clearly labelled with location, date, material type, lift depth, test technician, and any other pertinent information.
- Results must be:
 - Submitted to the Town of Leader within 48 hours for QA/QC review.
 - Retained on file by the Applicable Parties for a minimum of 12 months.
- The Town reserves the right to audit or request re-testing where results are inconsistent, missing, or disputed.

TESTING AND VERIFICATION

Laboratory Testing

Laboratory testing is used to establish the baseline values for density and moisture content against which field results will be compared. All testing results must be recorded and submitted to the Town for record-keeping.

Test Type	ASTM Standard	Purpose	Notes / Requirements
Standard Proctor Compaction	D698	Determines Maximum Dry Density and Optimum Moisture Content (OMC) for each backfill material type.	A Standard Proctor and Moisture Content test must be performed for each backfill material type used on site (e.g., bedding, granular, native).
Moisture Content Determination	D2216	Confirms actual water content of soil samples by mass.	Often completed alongside the Proctor test to compare field moisture to laboratory OMC.
Sieve Analysis (Fine and Coarse Aggregate)	C136	Determines particle size distribution to confirm material meets spec.	Required for all imported materials to confirm compliance with gradation limits listed in the Approved Materials section.
Sieve Analysis (In-situ Soil or Fill Dirt)	D6913	Determines particle size distribution to confirm material meets spec.	Used to assess the suitability of native or reused trench material.
In-place Density Testing of Oversized In-situ or Fill Dirt Material*	D4914	Determines in-place density using the Sand Replacement Method in a test pit.	Used when >30% of the material is retained on the 19 mm sieve. Must be approved and conducted by Applicable Parties.
Atterberg Limits Testing	D4318	Determines the plastic limit, liquid limit, and plasticity index of fine-grained soils to assess classification, workability, and volume change potential.	Used when fine-grained soils (silt or clay) are present in native or imported backfill. Commonly performed during soil classification, source approval, or when moisture sensitivity is suspected.

Table 2: ASTM Laboratory Testing

*Oversized Material Handling

If sieve (ASTM D6913) analysis results show that more than 30% of the material is retained on the 19 mm ($\frac{3}{4}$ ") sieve, the material is not suitable for testing using ASTM D698. In such cases, the following options are available, subject to approval by the Town:

- Test Fill and Method Specification: A test section may be constructed on-site to demonstrate compaction using the proposed material and equipment. If approved by the Town, a method specification (e.g., number of passes, lift thickness, moisture range) may be adopted in place of Proctor-based acceptance.
- Material Modification: Oversized material may be screened out or blended to meet the gradation limits required for ASTM D698. A new Proctor test must be completed for the modified material.
- For coarse materials that cannot be adjusted, the Town may approve the use of ASTM D4914 (Sand Replacement Method in a Test Pit) to verify in-place density. This method requires specialized equipment and experienced personnel.

Field Testing

Field testing is used to verify that placed backfill meets compaction and moisture specifications.

Test Type	ASTM Standard	Purpose	Frequency and Target
In-Place Density Testing	D6938	Nuclear Density Gauge. Measures in-situ density and moisture.	Density Testing: Minimum 1 test per 1000 m ² per 150 mm lift, or once per day during active backfilling, whichever is more frequent. Target compaction: • ≥ 95% SPD (general backfill zones) • ≥ 98% SPD (sub-base) • 100% SPD (base)
	D1556	Sand Cone Method. Alternative method to measure unit weight and dry density.	
	D2167	Rubber Balloon. Alternative method for in-place density measurement.	
	E2583	Lightweight Deflectometer Testing. Alternate method strictly for minor excavation to measure compaction quality.	Density Testing: Minimum 1 test per 1000 m ² per 150 mm lift, or once per day during active backfilling, which ever is more frequent.
Moisture Content	D6938	Measures moisture content in conjunction with density test.	Moisture Testing: 1 test every 300 m of trench per lift, or once per day during active backfilling, whichever is more frequent. Moisture content must be within ±3% of OMC.

Table 3: ASTM Field Testing

- All test locations are to be selected by the Applicable Parties responsible for the testing.
- All testing results must be recorded and submitted to the Town for approval and record-keeping.

RESPONSIBILITY

Proper backfilling and compaction are critical to the long-term integrity of municipal roadways. The following Applicable Parties are responsible for ensuring full compliance with this Compaction Policy:

1. Contractors and Utility Providers

- Are fully responsible for ensuring all backfilling, compaction, and testing activities are within the excavation area per the Policy.
- Must ensure that:
 - All backfill materials used meet the requirements of this Policy.

- All compaction is completed in accordance with this Policy.
 - Moisture control and testing are conducted as specified in this Policy.
 - All field and laboratory test results are recorded, labelled, and submitted within required timeframes.
 - Are accountable for any defects or settlement caused by inadequate compaction or use of unsuitable materials.
2. Town of Leader Staff
- Responsible for:
 - Permitting and inspection of all excavation work under public roadways.
 - Reviewing and approving backfill materials, moisture testing procedures, and compaction test reports.
 - Verifying that contractors have fulfilled their responsibilities before final acceptance.
 - Requesting additional testing or remediation if results are missing, inconsistent, or non-compliant.
3. Testing Agencies
- Must carry out all laboratory and field testing in accordance with approved ASTM standards and this Policy, and document results fully and clearly.
 - Shall submit results to both the contractor and the Town for record-keeping and QA/QC review.

Failure to meet the requirements outlined in this Policy may result in denied final acceptance, delayed occupancy or use permits, or corrective work at the Applicable Parties expense.

WEATHER AND SEASONAL ADAPTATION

Special procedures must be followed during cold or wet conditions to ensure proper compaction and prevent future settlement or infrastructure failure.

1. Cold Weather Conditions

- Frozen material must not be used for backfilling.
- Do not place backfill onto frozen trench walls or surfaces.
- Granular backfill is preferred during winter months for its better workability and compaction properties.

If the backfill material is frozen ($\leq 0^{\circ}\text{C}$):

- Heat material indoors or hoard it on-site using tarps and heaters or thermal blankets.
- Measure soil temperature using a thermometer:
 - If material is above 0°C , proceed with compaction per standard procedure.
 - If material remains at or below 0°C , follow temporary winter fill protocol.

Temporary Winter Fill Protocol:

1. Place temporary in-situ soil or fill dirt (or granular backfill if deemed necessary) and compact adequately.
2. Moisture and density tests are not reliable under winter conditions; use best judgement to determine adequate compaction.
3. Top with gravel or recycled asphalt/concrete to protect the surface.
4. Mark the area and log it for follow-up.

5. In spring, when the daily average temperature is $> 5^{\circ}\text{C}$:
 - a. Excavate temporary material.
 - b. Test material in accordance with this Policy.
 - c. If temporary material meets the testing requirements established in this Policy, it can be reused. Otherwise, replace with other approved material.
 - d. Follow the complete Compaction Method and Field-Testing procedures per Policy.
2. Wet Soil or Saturated Conditions
 - Standing water must be removed from the trench bottom prior to backfilling.
 - Pump or bail out water to achieve a stable, dry trench base.
 - Do not use water-saturated native material unless the moisture content can be reduced to acceptable limits ($\pm 3\%$ of OMC).
 - If native soil is too wet or unstable:
 - Replace with approved and tested granular backfill.
 - Fill dirt may be used above the pipe zone.

RESTORATION

Upon completion of backfilling and compaction:

1. Restore roadway surface, underlying structure, and subgrade to equal or better than pre-excavation condition.
2. When performing minor excavations, Applicable Parties are still responsible for ensuring compaction quality and proper restoration, even in the absence of testing requirements.
3. Top of backfill must be compacted to 100% SPD for paved surface preparation.
4. Surface finish (asphalt, gravel, concrete) must match surrounding road and conform to Town standards.
5. Remove and dispose of excess or unsuitable material off-site.
6. Clean up all disturbed areas, including boulevard and drainage paths.
7. Monitor for settlement within warranty/deficiency period; contractor may be held responsible for rework.

POLICIES REPLACED

This Policy replaces and supersedes any prior policy.

REVISION HISTORY