

1.0 GENERAL

1.1 Scope

1.1.1 This specification refers to trench excavation and backfill for water and sewer mains including appurtenances and structures.

1.2 Related Sections

1.2.1 Section 1300 - Sewer Mains

1.2.2 Section 1325 - Sewage Forcemains

1.2.3 Section 1330 – Manhole and Catchbasin Construction

1.2.4 Section 2500 – Supply of Portland Cement Concrete

1.2.5 Section 02511 - Watermains

1.2.6 Section 02516 - Water and Sewer Service Connections

1.3 Safety

1.3.1 Carry out all operations relating to excavation, shoring and backfill in strict conformance with Saskatchewan Occupational Health and Safety Act and Regulations, and all applicable Legislation, Codes, Standards and Ordinances of authorities having competent jurisdiction.

1.3.2 Blasting for excavation will not normally be permitted. When permitted, blasting methods and procedures must strictly conform to Provincial Statutes and Municipal Ordinances. If there are structures in the vicinity that may be affected by the blasting, engage and pay for the services of a structural engineer and carry out a comprehensive structural investigation with the property Owner(s), Sub-contractor and the Engineer to establish the existing condition of these structures. Provide all damage mitigation measures prescribed. Provide all additional insurance as may be directed by the Owner. Bear all costs for damage and injury resulting from blasting operations.

1.3.3 Work between sunset and sunrise will be allowed only with prior written permission from the Engineer or if necessary to correct Work that is deemed to constitute an immediate hazard to the public or existing utilities. When any Work is carried out at night, supply a sufficient number of electric or other approved and efficient lights to enable the Work to be done in a safe, satisfactory manner. Operations will not be permitted if the Engineer believes there insufficient light to perform the Work safely and satisfactorily.

1.4 Definitions

1.4.1 Trench excavation is an excavation open from ground surface to the full depth of the pipe zone.

1.4.2 The pipe zone is the portion of the trench excavation between the bottom

level of the trench excavation to a specified height above the top of the pipe as indicated on the drawings. For more detail refer to Standard Drawings W-04, S-20 and S-21.

- 1.4.3 Foundation is over excavation in the pipe zone that is required to provide a stable foundation for the bedding.
- 1.4.4 Pipe bedding is that portion of the pipe zone that supports the pipe and other appurtenances.
- 1.4.5 Haunching is that portion of the pipe zone from the bottom of the pipe to the springline of the pipe.
- 1.4.6 Initial backfill occupies the area between the springline of the pipe and a maximum 300 mm above the top of the pipe.
- 1.4.7 Unstable trench bottom is an inadequate bedding condition caused by organic material, "quick" sand or other similar material being present in the bottom of the trench.
- 1.4.8 Drainage ditch excavation is common excavation required for routing of surface or pumped water to a drainage course.
- 1.4.9 Standard Proctor Density (SPD) is the soil density achieved by application of compactive mechanical effort to a soil mass.
- 1.4.10 Classify excavation by the type of material as follows:
 - .1 Common excavation is the excavation of all materials other than rock and shall include hard pan, frozen materials and partially cemented materials that can be ripped and excavated by heavy equipment.
 - .2 Rock excavation is defined as boulders, pieces of concrete or masonry exceeding 1.0 m³ in volume or solid ledge rock, concrete or masonry which requires drilling and blasting or other mechanical means for its removal. No soft or disintegrated rock, concrete or masonry which can be removed with a hand pick or power-operated excavator will be considered rock excavation. No loose, shaken or previously blasted work will be considered rock excavation.
 - .3 Rubble excavation is the removal of broken material resulting from the decay or destruction of a building or other structure.
- 1.4.11 Classify backfill by the type of fill material as follows:
 - .1 In situ material is defined as material excavated from the trench from which all boulders larger than 100 mm in maximum dimension, large roots, stumps or other debris that would prevent consolidation of the backfill have been removed.
 - .2 Low shrink material is a sand/cement/water mixture.
 - .3 Granular material is material such as sand, natural gravel and reclaimed concrete aggregate. Granular material must be free of reclaimed asphalt.

- .4 Bedding material is granular material normally placed below the pipe.
- .5 Coarse gravel is clean angular material required for stabilization of trench bottom due to over excavation of unsuitable trench bottom conditions.
- .5 Drainage material is clean granular material used to provide a drainage for control of water in the trench.
- .6 Topsoil is humus, peat, or other material containing organics, which make up the top layer of the soil.

2.0 PRODUCT

2.1 Insitu Backfill Material

- 2.1.1 Insitu Backfill Material is original trench material that does not contain boulders or rocks larger than 100 mm diameter, organic soils, frozen lumps of earth, rubble or debris from trench excavation.

2.2 Low Shrink Material

- 2.2.1 Shall be in accordance with Section 2500 – Supply of Portland Cement Concrete

2.3 Bedding Material

- 2.3.1 Do not supply or place bedding material until a sieve analysis has been submitted to and approved by the Engineer.
- 2.3.2 Provide bedding material having the following gradation limits:

SIEVE SIZE	PERCENT PASSING
10 mm	100
5 mm	95 - 100
630 µm	25 - 60
80 µm	0 - 5

2.4 Granular Material

- 2.4.1 Provide granular material having the following gradation limits.

SIEVE	PERCENT PASSING
28 mm	100
20 mm	90 - 100
12.5 mm	70 - 100
5 mm	45 - 85
2 mm	30 - 65

800 µm	15 - 40
400 µm	12 - 30
160 µm	9 - 20
80 µm	7 - 15

2.4.2 Do not supply or place imported material until a sieve analysis has been submitted to and approved by the Engineer.

2.5 Coarse Gravel

2.5.1 Do not supply or place coarse gravel until a sieve analysis has been submitted to and approved by the Engineer.

2.5.2 Provide clean angular rock material for stabilization of trench bottom with the following gradation limits:

SIEVE SIZE	PERCENT PASSING
80 mm	100
50 mm	95 - 100
25 mm	20 - 100
20 mm	0 - 80
10 mm	0 - 10
5 mm	2

2.6 Drainage Material

2.6.1 Do not supply or place drainage material until a sieve analysis has been submitted to and approved by the Engineer.

2.6.2 Provide material for drainage with the following gradation limits:

SIEVE SIZE	PERCENT PASSING
40 mm	100
25 mm	75 - 100
20 mm	20 - 80
10 mm	0 - 10
5 mm	0 - 5

Minimum Permeability 1×10^{-4} cm/sec.

2.7 Casings

- 2.7.1 Casings to be steel, mill pipe produced as double submerged arc spiral weld or ERW, standard weight, manufactured to CSA Z245.1-latest edition or ASTM A53B and having a maximum yield stress of 317 MPa. Wall thickness as specified.
- 2.7.2 Casing spacers shall be bolt-on style, with a shell made of at least two halves. Band material shall be 304 stainless steel. Wooden skids will not be permitted.
- 2.7.3 End Seals shall be provided on all casings pipe. End seals shall be pull-on style and made from EPDM or synthetic rubber. Banding shall be 304 stainless steel.

3.0 EXECUTION

3.1 Protection of Existing Utilities and Surface Features

Refer to Clause 1.10 in Section 1010 – General Requirements

3.2 Site Preparation

- 3.2.1 Strip topsoil as shown on the drawings or as directed by the Engineer.
- 3.2.2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.3 Excavation

3.3.1 Location of Excavation

- .1 The Engineer will provide stakes offset from the centreline of the trench to indicate trench alignment.
- .2 Excavate trenches only as far in advance as safety, traffic and weather conditions permit.
- .3 Protect structures, piping and other manmade objects existing within the working area.
- .4 Do not excavate more than 120 m in advance of the pipe laying operation. Allow no more than 15 metres of trench to remain open at the end of each day.

3.3.2 Depth

- .1 Excavate trench to dimensions shown on Drawing W04 or as required to provide sufficient space for pipe bedding and to permit erection of forms, shoring, waterproofing and inspection of foundations. Excavate to clean lines to minimize the quantity of fill required.
- .2 Adhere to City of Regina standards for minimum bury depths unless specifically shown or directed otherwise in the Contract Documents or by the Engineer.

3.3.3 Excavated Trench Material

- .1 Pile material alongside the trench provided working space is adequate and by doing so it does not spill onto private properties disturbing fences, buildings, shrubs, lawns, crops or other items of value.
- .2 Locate spoil pile to minimize blockage of traffic and drainage facilities.
- .3 Where excavated material cannot be piled along the trench, stockpile at locations approved by the Engineer and return for backfilling as required.

3.3.4 Trench Alignment

- .1 Prior to excavation of the trench, establish the pipe installation alignment by setting stakes at 20 m intervals along a line offset from the centreline of the proposed alignment.
- .2 Excavate the trench so that the pipe can be laid to the established alignment and depth with allowance made for specified trench wall clearance and bedding.
- .3 Install the pipe to a predetermined grade according to a grade sheet showing the depth of cut to the invert or top of pipe relative to the grade stake elevation at the respective locations along the pipeline.

3.3.5 Trench Width

- .1 Excavate to produce clearance of not less than 150 mm between the outside of the pipe at its largest section and the trench sheeting or earth wall and not more than 300 mm clearance between the pipe and earth wall regardless of trench support works. Refer to Standard Drawing W-04.
- .2 The above condition governs from the trench bottom to 300 mm above the top of the pipe.
- .3 Excavate widths above this point in conformance with the requirements of the latest edition of the *Occupational Health and Safety Act*.
- .4 Remove ledge rock, boulders and large stones to provide a minimum clearance of 150 mm below the pipe.
- .5 Where the maximum trench width is exceeded provide special bedding or other precautions as directed by the Engineer.

3.3.6 Bracing and Sheeting

- .1 Shore the trench in a manner that conforms to the latest edition of the *Occupational Health and Safety Act*, and as necessary to protect life, property and structures adjacent to the Work, the Work itself, or to maintain trench widths within specified limits.
- .2 Install shoring so that it does not extend below the spring line of the pipe. Do not locate shoring closer than 150 mm to the widest section

of the installed pipe. When it is necessary to place the shoring below the pipe spring line, raise the shoring in 600 mm lifts and compact each lift to fill the void left by the raised sheeting.

- .3 Cut off shoring left in place no higher than 900 mm below the ground surface.
- .4 Remove shoring in a manner which permits backfill compaction.

3.3.7 Dewatering

- .1 Control entry of ground and surface water to the extent that excavation and pipe installation can proceed and the trench bottom condition is not compromised to the detriment of the pipe installation.
- .2 Continuously pump or bail out water from the trench. Do not use the pipe being installed as a drain for such water. Use approved drainage material installed below the pipe to provide drainage of the trench.
- .3 Ensure that dewatering operations do not compromise or damage the foundation of any structure in the vicinity.
- .4 Locate and direct dewatering discharge such that loss, damage, nuisance or injury to the public does not occur. Direct discharge into natural drainage channels, drains or storm sewers.

3.3.8 Trench Bottom Conditions

- .1 Maintain trench conditions to facilitate pipe installation without water, muck, silt, gravel or other foreign material entering the pipe.
- .2 Provide a firm trench bottom capable of supporting the pipe to be installed. Stabilize trench bottom by means of over excavation or special foundation designed to support the pipe.
- .3 Remove all deleterious material from the trench bottom prior to pipe installation.

3.3.9 Over Excavation and Backfill

- .1 Excavate the trench in a manner that provides a uniform and continuous support for the pipe and fittings on solid, undisturbed ground. Over excavate unstable trench bottom to a level at which stable material is encountered.
- .2 Backfill over excavation with coarse gravel material to the level of normal bedding.
- .3 Compact coarse gravel material in lifts having a maximum compacted depth of 300 mm to provide a thoroughly consolidated pipe zone using approved mechanical compactors.

3.3.10 Unstable/Non-Uniform Ground Conditions

- .1 Excavate loose or deleterious material to the width, depth and length as required and backfill with coarse gravel in 300 mm compacted

-
- layers or with insitu backfill material in 150 mm compacted layers. Compaction to 95% Standard Proctor Density.
- .2 Provide and maintain minimum clearance between the pipe and trench walls of not less than 150 mm for pipes up to and including 600 mm O.D. and not less than 200 mm for pipe larger 600 mm O.D.
 - .3 Finish subgrade with hand tools to provide a uniform and continuous support for the pipe bedding.

3.3.11 Trenchless Installation Methods

- .1 Prior to commencing work, the Contractor to submit a written work plan summarizing the procedures to be used for trenchless installation methods. The work plan shall at a minimum provide the schedule, description of the method being used, pipe material specifications, pull forces of equipment being used, pull strength of pipes being installed as well as a plan showing locations of sending and receiving pits.
- .2 Maintain a minimum 1.5 metre clearance from nearest edge of pits to pavement or other utilities, structures, or as directed by the authority having jurisdiction (i.e. Sask Energy, SaskPower, SaskTel, etc.).
- .3 Prior to start of work path shall be surveyed at maximum 15 metre intervals including sending and receiving pit locations. The depth of the pipe from existing ground to the pipe shall be marked on each stake.
- .4 Place silt fence as required to protect wetlands, drainage paths and waterways. Any drill fluids shall be contained using berms, liners or turbidity curtains.
- .5 Carry out shaft or pit excavation and backfill in accordance with the relevant section(s) of the specifications and all safety regulations. Shoring of pits may be required if work is adjacent to roadways, structures or other infrastructure. The Contractor is responsible for any shoring of excavations.
- .6 Carefully establish and maintain line and grade and provide a finished hole which does not vary more than 50 mm vertically or 100 mm horizontally from the established grade.
- .7 When directional drilling is used, a pilot shall be drilled on the bore path, followed by reaming of the bore hole to a minimum of 25% greater than the outside diameter of the pipe.
- .8 Re-core or re-bore any hole that exceeds the specified deviation limits.
- .9 Adequately plug the leading end of pipe inserted in a hole to prevent damage or entrance of foreign material.
- .10 Provide adequate support of pipe within the hole as recommended by the pipe manufacturer and/or as detailed in the contract documents.
- .11 Carry out pipe insertion into holes using techniques and equipment

recommended by the pipe manufacturer and approved by the Engineer.

- .12 Should appreciable loss of ground occur during coring, the voids shall be backfilled promptly to the extent practicable with a material approved by the Engineer.
- .13 Following completion of installation, the Contractor shall provide a plan for as-built depths of the installed line from ground surface to the invert, centreline or top of pipe.

3.4 Trench Backfill and Compaction

3.4.1 Backfill within the Pipe Zone

- .1 Backfill with granular material placed in uniform layers and compacted by mechanical means for the full width of the trench. Backfill in layers not exceeding 150 mm compacted thickness and compact to completely fill spaces under and adjacent to the pipe.
- .2 Place bedding material to lines and depths required. Provide bell and coupling holes along the trench bottom so that the pipe barrel is evenly supported throughout the entire length.
- .3 Mechanically compact the pipe bedding, haunching and initial backfill material to 95% Standard Proctor Density.
- .4 Mechanically compact pipe haunching while exercising care not to contact or damage the pipe. For compaction of haunching on pipe 300 mm and larger, employ pneumatically powered, single leg 'pogostik' tamper or as approved by the Engineer.
- .5 Where specified, backfill with low shrink material such that the material flows into the excavation and fills the entire space under the pipe. Place low shrink material to the springline of the pipe. Ensure that the pipe or pipe bedding is not disturbed during backfill placement and air is not trapped beneath horizontal projections or the other locations within the pipe zone excavation.

3.4.2 Backfill above the Pipe Zone

- .1 Insitu Material
 - .1 Backfill in uniform layers not exceeding the thickness required to obtain the specified density. The maximum allowable compacted layer thickness shall be 150 mm unless otherwise approved by the Engineer. Compact backfill to a minimum 95% Standard Proctor Density.
 - .2 **Control the moisture content of the insitu backfill material to within $\pm 3\%$ of the insitu material in the adjacent trench walls. Supply and add water or dry the insitu backfill material as required to meet the moisture specification.**
 - .3 Areas to be backfilled shall be free from debris, snow, ice,

- water or frozen ground. Backfill material shall not be frozen or contain ice, snow or debris.
- .4 Haul and dispose of all material that is unsuitable for use as backfill. Import and place acceptable material.
 - .5 Import and place acceptable material to make up any shortage of material caused by the construction operation or removal and disposal of rock, boulders or other material.
 - .6 Bear all costs for locating, providing and placing acceptable replacement backfill material.
- .2 Granular Material
- .1 Provide granular material having sufficient moisture content to prevent dust generation during handling.
 - .2 Backfill in uniform layers not to exceed the thickness required to obtain the specified density. The maximum allowable compacted layer thickness shall be 150 mm for granular materials unless otherwise approved by the Engineer.
 - .3 Compact backfill to 95% Standard Proctor Density.
 - .4 Repair and pay for damage resulting from any subsidence or heaving of the backfill occurring within the maintenance period.
- .3 Low Shrink Material
- .1 Place low shrink backfill such that the material flows into the excavations and fills the entire space. Initial depth of material may not exceed one (1) metre. The initial depth must set to a point where the concrete is no longer fluid before additional material may be placed on top of it.
 2. Ensure that the pipe or pipe bedding is not disturbed during low shrink placement and air is not trapped beneath horizontal projections or the other locations within the excavation.
 - .3 Where required, cover low shrink material with steel plates having sufficient strength to support traffic. Maintain this support until the Engineer advises that the low shrink material has developed sufficient strength to allow its removal. Where support of traffic is not required, cover and fence the excavation until the Engineer advises that the low shrink material has developed sufficient strength to allow placement of further material on top of it.
 - .4 Use of low shrink material above the pipe zone requires the approval of the Engineer unless it is specifically indicated on the drawings.

3.4.3 Backfilling of Structures

- .1 Structures include buildings, manholes, vaults and buried valves.
- .2 Backfill structures with in-situ fill or granular material compacted to 95% Standard Proctor Density, in maximum compacted lifts of 150 mm within 5 m of structure. Excavations to be free of ice, snow, debris and water at the time of backfilling.
- .3 Use either hand operated tamper or pneumatically powered, single leg 'pogostik' tamper within 1000 mm of structures. Place and compact backfill around structures so as to keep load distributed evenly around the perimeter.
- .4 Place and compact pipe trench backfill under and within 4 metres of pipe vaults to 95% Standard Proctor Density.

3.4.4 Disposal of Boulders

- .1 Locate a suitable disposal site for boulders and bear all costs for hauling and disposing of them.

3.4.5 Disposal of Excess Common Excavation

- .1 Spread excess material, other than rock, asphalt and concrete, over the entire right-of-way prior to replacement of topsoil. Do not interrupt or alter existing drainage. Remove any remaining material from site.
- .2 Remove and dispose of all site excavated debris.

3.4.6 Surface Maintenance during Construction

- .1 Maintain all trench surfaces and working surfaces affected by construction until the project is accepted by the Engineer.
- .2 Finish berms over trenches as specified prior to acceptance. Provide and place material to fill depressions resulting from the settlement of backfill.
- .3 Maintain gravelled surfaces free of potholes and washboard conditions. Promptly re-grade surfaces when irregularities occur.
- .4 Provide approved traffic hazard warning signage and barricades at all locations which cannot be promptly reinstated to the specified standard. Maintain traffic protection until the defects are rectified.

3.5 Deep Trench Excavation and Backfill

3.5.1 Deep trench installations are defined as those with depth equal to or greater than 5.0 m finished grade to pipe invert.

3.5.2 Deep Trench Excavation

- .1 Unless otherwise noted, excavate trench in accordance with the requirements elsewhere in this section.

-
- .2 Separate the excavated in-situ material, by stock piling in a convenient location adjacent to the trench excavation, to the satisfaction of the Engineer.
 - .3 Separate excavated in-situ materials by primary classifications, such as clay, silty clay, silt, silty sand and sand.

3.5.3 Deep Trench Backfill

- .1 Unless otherwise noted, backfill trench in accordance with the requirements elsewhere in this section.
- .2 Replace and compact the in-situ material in the reverse order of removal, to the satisfaction of the Engineer.
- .3 Compacted thickness of trench backfill not to exceed 150 mm per lift unless the Engineer specifically advises otherwise.
- .4 Moisture condition backfill as required to achieve the density requirements.

4.0 Materials Testing Requirements for Quality Control

- 4.1 The minimum requirement for sieve testing of bedding sand, and other granular materials shall be one sieve test for every 500 tonnes of material supplied.
- 4.2 Determination of Standard Proctor Density of each material shall be completed in accordance with ASTM D698- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort and ASTM D2216 - Standard Test Method for Laboratory Determination of Water (moisture) Content of Soil and Rock by Mass.
- 4.2 Field density will be tested using one or more of the following methods as deemed appropriate by the testing agency:
 - .1 ASTM D6938-Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.
 - .2 ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - .3 ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
- 4.3 Perform a minimum of one test per 1000 m² per 150mm compacted lift, and at least daily during backfilling. Testing locations to be selected by the testing agency under the direction of the Engineer.
- 4.4 Refer to clause 3.4.2.2 regarding moisture requirements for trench backfill. Perform a minimum of one moisture test every 300 metres of trench length.