Section 2552. Trench Excavation and Backfill

2552.01 DESCRIPTION.

This section was developed in conjunction with Section 3010 of the SUDAS Standard Specifications, with modifications to suit the needs of the Department.

A. Excavate trench for pipe installation.

B. Stabilize trench and install pipe bedding materials.

C. Place backfill material in trench.

2552.02 MATERIALS.

A. Materials Excavated from a Trench.

1. Standard Trench Excavation.
All materials encountered during trench excavation, except rock and over-excavation.

a. Suitable Backfill Material.
Class II, Class III, Class IVA, or Class IVB as defined in Article 2552.02, B.

b. Unsuitable Backfill Material.
Includes, but is not limited to:

1) Soils not classified as suitable backfill material, as defined in Article 2552.02, B.
2) Individual stones or concrete chunks larger than 6 inches (150 mm) and averaging more than one per cubic foot (0.03 cubic meters) of soil.
3) Frozen materials.
4) Stumps, logs, branches, and brush.
5) Trash, metal, or construction waste.
6) Soil in clumps or clods larger than 6 inches (150 mm) and without sufficient fine materials to fill voids during placement.
7) Environmentally contaminated soils.
8) Materials removed as rock excavation or over-excavation.

c. Topsoil.
Class V material. Apply Article 2552.02, C.

2. Rock Excavation.
Boulders or sedimentary deposits that cannot be removed from the trench without continuous use of pneumatic tools or blasting.

3. Over-Excavation.
Excavation of unsuitable or unstable material in trenches below the pipe zone.

B. Bedding and Backfill Material.

1. Class I Material.

a. Crushed stone complying with the following gradation:

Sieve	Percent Passing
1 1/2 inch (37.5 mm)	100
1 inch (25 mm)	95 to 100
1/2 inch (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

b. The Engineer may allow the use of gravel or authorize a change in gradation subject to materials available locally at the time of construction

c. The Engineer may authorize the use of crushed PCC for pipe sizes up to 12 inches (300 mm).

d. Use aggregates having a percentage of wear, Grading A or B, not exceeding 50%, determined according to AASHTO T 96.

2. **Class II Material.**
   Manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse grained natural soils (clean) with little or no fines. Comply with Table 2552.02-1 in the Appendix.

3. **Class III Material.**
   a. Natural coarse-grained soils with fines. Comply with Table 2552.02-2 in the Appendix.
   b. Do not use where water conditions in trench may cause instability.

4. **Class IVA Material.**
   a. Natural fine grained inorganic soils. Comply with Table 2552.02-3 in the Appendix.
   b. The Engineer will determine if material is not suitable for use as backfill material under deep fills, surface applied wheel loads, heavy vibratory compactors, tampers, or other conditions.
   c. Do not use where water conditions in trench may cause instability.
   d. Material is suitable for use in dry trench conditions only.

5. **Class IVB Material.**
   a. Natural fine grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%. Comply with Table 2552.02-4, in the Appendix.
   b. When approved by the Engineer, material may be used as final trench backfill in a dry trench.
   c. Do not use in the pipe embedment zone.

C. Class V Material (Topsoil).
1. Organic soils. Comply with Table 2552.02-5, in the Appendix.
2. Use only as topsoil outside of the pavement, unless specified otherwise or allowed by the Engineer.
3. Do not use in the pipe embedment zone.

D. Stabilization (Foundation) Materials.

1. Clean 2 1/2 inch (63.5 mm) crushed stone with the following gradation:

Sieve	Percent Passing
2 1/2 inch (63 mm)	100
2 inch (50 mm)	90 to 100
1 1/2 inch (37.5 mm)	35 to 70
1 inch (25 mm)	0 to 20
1/2 inch (12.5 mm)	0 to 5

2. The Engineer may authorize a change in gradation subject to materials available locally at time of construction.

3. Crushed concrete may be used, if approved by the Engineer, if it is within ± 5% of the gradation for each size of material.

E. Special Pipe Embedment and Encasement Material.

1. **Concrete Cradle, Arch, or Encasement.**
   Minimum 3000 psi (21 MPa) compressive strength.

2. **Flowable Mortar.**
   Apply Section 2506.

3. **Controlled Low Strength Material (CLSM).**
   a. Approximate quantities per cubic yard (cubic meter):
   1) Cement — 50 pounds (30 kg)
   2) Fly ash — 250 pounds (150 kg)
   3) Fine aggregate — 2910 pounds (1729 kg)
   4) Water — 60 gallons (296 L)

b. A compressive strength of at least 50 psi (345 kPa) at 28 calendar days can be expected.

2552.03 CONSTRUCTION.

A. Trench Excavation.

1. Notify the Engineer prior to the start of excavation activities.

2. Remove topsoil to a minimum depth of 12 inches (300 mm) and stockpile.

3. Excavate trench to required elevations and dimensions.
- **a.** Protect existing facilities, trees, and shrubs during trench excavation.
- **b.** Place excavated material away from trench.
- **c.** Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

4. Unsuitable backfill material:
- **a.** If unsuitable backfill material is encountered, notify the Engineer.
- **b.** Remove rock, rubbish, boulders, debris, and other unsuitable backfill materials at least 6 inches (150 mm) below and on each side of the pipe.
- **c.** Keep unsuitable backfill material separated from suitable backfill material and topsoil.
- **d.** Restore trench to design dimensions using bedding or stabilization material.

B. Rock or Unstable Soils in Trench Bottom.

1. Notify the Engineer prior to over-excavation.

2. The Engineer will determine the need for over-excavation and trench foundation stabilization prior to installation of pipes and structures.

3. Refer to the contract documents for details of over-excavation of rock and wet or soft foundations.

C. Trench Protection.

1. Install adequate trench protection (sheeting, shoring, and bracing) to prevent ground movement or damage to adjacent structures, pipelines, and utilities.

2. Move trench boxes carefully to avoid disturbing pipe, bedding, or trench wall.

D. Dewatering.

Submit a dewatering plan to the Engineer for approval.

1. Maintain water levels below the bottom of trench excavation.

2. Perform the dewatering operation according to the dewatering plan approved by the Engineer. Dewatering plan may be modified to meet actual field conditions, with approval of the Engineer.

3. Ensure operation of the dewatering system does not damage adjoining structures and facilities. Cease dewatering operations and notify the Engineer if damage is observed.

4. Discharged water:
- **a.** Do not discharge water into sanitary sewers.
- **b.** Discharging water into storm sewers requires the Engineer's approval.
- **c.** Obtain permission of adjacent property owner prior to discharging water onto their property.
- **d.** Maintain and control water discharge as necessary to prevent a safety hazard for vehicular and pedestrian traffic.
- **e.** Direct water discharge away from electrical facilities or equipment.
- **f.** Use dewatering equipment that will minimize disturbance from noise and fumes.
- **g.** Protect discharge points from erosion. Provide sediment control for sediment contaminated water discharged directly from trench.

E. Pipe Bedding and Backfill Material.

1. **General.**
   - **a.** Bedding and backfill material used for pipe installation will depend on:
     - **1)** Type of installation (water main, sanitary sewer gravity main, sanitary sewer force main, or storm sewer).
     - **2)** Pipe material.
     - **3)** Depth of bury.
     - **4)** Pipe diameter.
   - **b.** After pipe installation, place remaining bedding material and immediately place backfill material in trench.
   - **c.** Adjust the moisture content of excessively wet, but otherwise suitable, backfill material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.
   - **d.** Adjust the moisture content of excessively dry, but otherwise suitable, backfill material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.
   - **e.** Hydraulic compaction (flooding with water) is not allowed unless authorized by the Engineer.

2. **Pipe Bedding.**
   - **a. Granular Material.**
     - **1)** Class I granular material is required for all gravity mains. Use when specified for pressure pipes.
     - **2)** Place bedding material in the bottom of the trench in lifts no greater than 6 inches (150 mm) thick. Consolidate and moderately compact bedding material.
     - **3)** Shape bedding material to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe. Excavate for pipe bells.
     - **4)** Install pipe and system components.
     - **5)** Place, consolidate, and moderately compact additional bedding material adjacent to the pipe to a depth equal to 1/6 the outside diameter of the pipe.
   - **b. Suitable Backfill Material.**
     - **1)** Only use with pressure pipe.
     - **2)** Use suitable backfill material to shape trench bottom to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe. Excavate for pipe bells.
   - **c. Special Pipe Embedment and Encasement Materials.**
     - **1)** If required in the contract documents, use concrete, flowable mortar, or CLSM in lieu of other bedding materials.
     - **2)** Secure pipe against displacement or flotation prior to placing concrete, flowable mortar, or CLSM.

3. **Haunch Support.**
   Place from the top of the pipe bedding to the springline of the pipe.
   - **a. Granular Material.**
     - **1)** Place Class I material in lifts no greater than 6 inches (150 mm) thick.
     - **2)** Consolidate and moderately compact by slicing with a shovel or using other approved techniques.
   - **b. Suitable Backfill Material.**
     - **1)** Place in lifts no greater than 6 inches (150 mm) thick.
     - **2)** For Class II backfill material, consolidate and moderately compact by slicing with a shovel or using other approved techniques.
     - **3)** For Class III and Class IVA backfill materials, compact to at least 90% of Standard Proctor Density. Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.
   - **c. Special Pipe Embedment and Encasement Materials.**
     - **1)** If required in the contract documents, use concrete, flowable mortar, or CLSM in lieu of other haunch materials.
     - **2)** Secure pipe against displacement or flotation prior to placing concrete, flowable mortar, or CLSM.

4. **Primary and Secondary Backfill.**
   a. **General.**
      1) For primary backfill, place from the springline of the pipe to the top of the pipe.
      2) For secondary backfill, place from the top of the pipe to 1 foot (300 mm) above the top of the pipe.
   b. **Granular Material.**
      1) Place in lifts no greater than 6 inches (150 mm) thick.
      2) Compact to at least 65% relative density.
   c. **Suitable Backfill Material.**
      1) Place in lifts no greater than 6 inches (150 mm) thick.
      2) For Class II backfill material, compact to at least 65% relative density.
      3) For Class III and Class IVA backfill materials, compact to at least 95% of Standard Proctor Density. Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.
   d. **Special Pipe Embedment and Encasement Materials.**
      1) If specified in the contract documents, use concrete, flowable mortar, or CLSM in lieu of other primary or secondary backfill materials.
      2) Secure pipe against displacement or flotation prior to placing concrete, flowable mortar, or CLSM.

5. **Final Trench Backfill.**
   a. Place suitable backfill material from 1 foot (300 mm) above the top of the pipe to the top of the trench.
      1) Use no more than 8 inch (200 mm) thick lifts for backfill areas more than 3 feet (1 m) below the bottom of pavement.
      2) Use no more than 6 inch (150 mm) thick lifts for backfill areas less than or equal to 3 feet (1 m) below the bottom of pavement.
   b. Place backfill material after recording locations of connections and appurtenances or at the Engineer's direction.
   c. Class I and Class II backfill material:
      1) Compact to at least 65% relative density within right-of-way.
      2) Compact to at least 50% relative density outside right-of-way.
   d. Class III and Class IVA backfill material:
      1) Compact to at least 95% of Standard Proctor Density within right-of-way.
      2) Compact to at least 90% of Standard Proctor Density outside right-of-way.
      3) Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.
   e. In areas to remain unpaved, terminate backfill material 8 inches (200 mm) below finish grade. Use topsoil for the final 8 inches (200 mm) above trench backfill material.
   f. Terminate backfill material at subgrade elevation in areas to be paved.

F. **Trench Compaction Testing.**

1. **General.**
   When trench compaction testing is specified in the contract documents as the Contractor's responsibility, provide testing of trench backfill material using the services of an independent testing laboratory approved by the Engineer.

2. **Soil Testing.**
   a. **Cohesive soils.**
      1) Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.
      2) Determine in-place density and moisture content. Use ASTM D 1556 (sand-cone method) and D 2216 (laboratory moisture content), or use ASTM D 6938 (nuclear methods for density and moisture content).
   b. **Cohesionless soils.**
      1) Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254.
      2) For Class I granular bedding material, determine gradation according to ASTM C 136.

3. **Field Testing.**
   a. **Testing Frequency and Locations.**
      Perform testing of the final trench backfill, beginning at a depth of 2 feet (600 mm) above the top of the pipe, as follows:
      1) Coordinate the timing of testing with the Engineer.
      2) The Engineer will determine the location of testing.
      3) For each 2 vertical feet (600 mm) of consolidated fill, provide tests at a maximum horizontal spacing of 200 feet (60 m) and at all street crossings.
      4) Additional testing may be required by the Engineer in the event of non-compliance or if conditions change.
      5) If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill material and recompact.
   b. **Test Failure and Retesting.**
      Rework, recompact, and retest as necessary until specified compaction and moisture content is achieved in all areas of the trench. In the event of failed tests, the Engineer may require retesting as deemed necessary.

2552.04 METHOD OF MEASURMENT.

A. Rock Excavation.
Measurement will be by cubic yards (cubic meters) of rock removed.

B. Trench Foundation.
Measurement will be in tons (megagrams) for the quantity of stabilization material required to replace material removed by over-excavation. Measurement will be based on the scale tickets for the material delivered and incorporated into the project. Trench foundation required to correct unauthorized over-excavation will not be measured.

C. Replacement of Unsuitable Backfill Material.
Measurement will be in cubic yards (cubic meters) for the quantity of backfill material required to replace unsuitable backfill material remove during standard trench excavation. Measurement will be based on compacted material in place.

D. Special Pipe Embedment or Encasement.
Measurement will be by the linear foot (meter) along the centerline of pipe for each type of special embedment or encasement.

E. Trench Compaction Testing.

1. The Contractor is not responsible for trench compaction testing or payment unless specified otherwise in the contract documents.

2. If the contract documents specify that the Contractor is responsible for trench compaction testing performed by an independent testing laboratory hired by the Contractor, measurement will be a lump sum.

2552.05 BASIS OF PAYMENT.

A. General.
The following items are incidental to the underground utility being installed and will not be paid for separately:

1. Standard trench excavation.

2. Removal and disposal of unsuitable backfill material encountered during standard trench excavation.

3. Removal of abandoned private utilities encountered during trench excavation.

4. Furnishing and placing granular bedding material.

5. Placing and compacting backfill material.

6. Dewatering.

7. Sheeting, shoring, and bracing.

8. Adjusting the moisture content of excavated backfill material to the range specified for placement and compaction.

B. Rock Excavation.
Payment will be at the contract unit price per cubic yard (cubic meter) for the quantity of rock removed.

C. Trench Foundation.

1. Payment will be at the contract unit price per ton (megagram) for the quantity of stabilization material furnished and placed.

2. Payment is full compensation for:
   - Removal and disposal of over-excavated material required to stabilize trench foundation, and
   - Furnishing, hauling, and placing stabilization material.

D. Replacement of Unsuitable Backfill Material.

1. Payment will be at the contract unit price per cubic yard (cubic meter) for the quantity of backfill material furnished.
2. Payment is full compensation for furnishing, hauling, and placing backfill material.

E. Special Pipe Embedment or Encasement.

1. Payment will be at the contract unit price per linear foot (meter) for each type of special pipe embedment or encasement.

2. Payment is full compensation for furnishing and placing all required special pipe embedment or encasement materials.

F. Trench Compaction Testing.

1. If the contract documents specify that the Contractor is responsible for trench compaction testing performed by an independent testing laboratory hired by the Contractor, payment will be at the contract unit price for the lump sum.

2. The Contractor will be responsible for payments associated with all retesting resulting from failure of initial tests.