

# The Board Of Water Commissioners Denver Water

## Engineering Standards Chapter 7 – Earthwork

### 7.01 EARTHWORK DEFINED:

Earthwork shall include clearing, grubbing, grading, excavation, fill, backfill, excess excavation, bedding and pipe zone material, borrow material, and surface restoration that may be required to complete the work.

### 7.02 EXPLORATORY EXCAVATION:

Underground utilities and structures that may interfere with construction shall be exposed and the location verified sufficiently in advance to permit necessary relocations without delays.

### 7.03 EXCAVATION TO LINE AND GRADE:

Excavations shall be made to the lines and grades as established by the approved plans. Pipe trenches shall be excavated to a minimum depth of 6 inches below the bottom of the pipe. Deviation from grades will be allowed when approved by Denver Water, in accordance with [8.06](#) and [8.07](#).

### 7.04 TRENCHING OPERATIONS:

**A. Trench Width:** Existing asphalt or concrete surfacing shall be cut vertically in a straight line, and removed from the jobsite prior to starting the trench excavation. This material shall not be used in any fill or backfill.

The trench shall be excavated so that a minimum clearance of 6 inches shall be maintained on each side of the pipe for proper placement and densification of the bedding and pipe zone or backfill material. The maximum trench width, measured at the top of the pipe shall be the outside diameter plus 24 inches regardless of the type of pipe, type of soil, depth of excavation or the method of densifying the bedding and backfill. See [Sheet 10](#) of the [Standard Drawings](#).

**B. Trench Support:** The trench shall be adequately supported and the safety of workers provided for as required by OSHA.

Sheeting and shoring shall be utilized where required to prevent any excessive widening or sloughing of the trench, which may be detrimental to human safety, to the pipe or appurtenances being installed, to existing utilities, to existing structures, or to any other existing facility or item.

Excavated material shall not be placed closer than 2 feet from the top edge of the trench. Heavy equipment should not be used, or placed, near the sides of the trench unless the trench is adequately braced.

**7.05 EXCAVATION FOR STRUCTURES:**

Except as otherwise dictated by construction conditions, the excavation shall be of such dimensions as to allow for the proper installation and removal of concrete forms, or pre-cast slabs and panels, and to permit the construction of the necessary pipe connections. Care shall be taken to insure that the excavation does not extend below established grades. If the excavation is made below such grades, the resulting excess excavation shall be filled in with sand or graded-gravel, deposited in horizontal layers not more than 6 inches in thickness after being compacted, and shall be moistened to within 2 percent of the optimum moisture content required for compaction of that soil. After being conditioned to have the required moisture content, the layers shall be compacted to the density as specified in [7.11.B](#).

**7.06 SURPLUS EXCAVATION MATERIAL:**

Surplus excavation shall be removed from the jobsite and disposed of properly. If the surplus excavation is disposed of on private property, written permission shall be obtained from the owner and a copy given to Denver Water.

**7.07 BLASTING:**

In general, blasting will be allowed in order to expedite the work if a permit by the local authority having jurisdiction is granted. Explosives and appurtenances shall be transported, handled, stored and used in accordance with the laws of the local, state, and federal governments, as applicable.

Blasting shall be controlled so as not to injure any existing structure or facility. The hours of blasting shall be fixed by Denver Water. Owners or occupants of nearby structures or facilities shall be notified at least 72 hours in advance of blasting, in writing. The notice shall state the date, the time of blasting and who is responsible for the blasting.

Blasting shall be controlled so as not to make any excavation unduly large or irregular as to shatter the rock on the bottom or sides of any excavation or surface upon or against which concrete is to be placed. If, in the opinion of Denver Water, blasting is liable to damage rock foundations or supports, concrete or structures, all blasting shall be terminated and excavation shall be continued by jackhammering, barring, wedging or other methods.

Blasting in a trench shall not be done until the trench walls have been shored or braced in a manner satisfactory to Denver Water. Liability for blasting shall be placed solely on the person or persons conducting the blasting operation.

**7.08 DEWATERING:**

Pipe trenches or structure excavation shall be kept free from water during pipe laying and other related work. The method of dewatering shall provide for a completely dry foundation at the final lines and grades of the excavation and shall conform to NPDES permitting requirements.

Dewatering shall be accomplished by the use of well points, sump pumps, rock or gravel drains placed below subgrade foundations or subsurface pipe drains. Water shall be disposed of in a suitable manner without being a menace to public health or causing public inconvenience in accordance with any required permit. No water shall be drained into other work being completed or under construction.

The dewatering operation shall continue until such time as it is safe to allow the water table to rise in the excavations. Pipe trenches shall contain enough backfill to prevent pipe flotation of the carrier or casing pipe. When pipe is laid in a casing or

tunnel longer than 30 pipe diameters, the pipe inside said casing or tunnel shall be secured so flotation does not occur when the pipe is empty.

Water shall not be allowed to rise until the concrete has set a minimum of 24 hours, and the forms have been removed. Water shall not be allowed to rise unequally against unsupported structural wall.

**7.09 FOUNDATIONS ON UNSTABLE SOIL:**

If the bottom of the excavation is soft or unstable, and in the opinion of Denver Water, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to 6 inches below grade with rock uniformly graded between 3/4 inch and 1-1/2 inch.

**7.10 PIPE BEDDING AND PIPE ZONE MATERIAL:**

**A. Installation of Bedding and Pipe:** After completion of the trench excavation and proper preparation of the foundation, 6 inches of bedding material shall be placed on the trench bottom for support under the pipe. Bell holes shall be dug deep enough to provide a minimum of 2 inches of clearance between the bell and bedding material. All pipe shall be installed in such a manner as to insure full support of the pipe barrel over its entire length. After the pipe is adjusted for line and grade, and the joint is made, the pipe zone material shall be carefully placed and tamped under the haunches of the pipe and in the previously dug bell holes.

Tamping is herein defined as the act of placing approved pipe zone material under the haunches of the pipe, paying particular attention to voids, bell hole, and sling holes. The purpose of tamping is to ensure uniform support for the pipe.

The limits of bedding and pipe zone material shall be from 6 inches below the bottom of the pipe to 6 inches above the top of the pipe. Approved backfill may then be installed to the ground line. For backfill and compaction of backfill; see [7.11](#).

Compaction of bedding is not required. The only requirement is sufficient tamping to achieve uniform support under the pipe. See [Sheet 10](#) of the [Standard Drawings](#) for a typical trench cross section.

**B. Type of Bedding and Pipe Zone Material:** The bedding and pipe zone material shall be a clean, free draining well-graded sand or squeegee sand and shall conform to the following limits when tested by means of laboratory sieves:

**Well Graded Sand**

<u>Sieve Size</u>	<u>Total Percent Passing by Weight</u>
3/8 inch	100
No. 4	70-100
No. 8	36- 93
No. 16	20- 80
No. 30	8- 65
No. 50	2- 30
No. 100	1- 10
No. 200	0- 3

### Squeegee Sand

<u>Sieve Size</u>	<u>Total Percent Passing by Weight</u>
3/8 inch	100
No. 200	0-3

Approved bedding and pipe zone material shall be stockpiled on the jobsite. Denver Water reserves the right to require the use of the specified bedding and pipe zone material at any time.

#### 7.11 BACKFILL AND COMPACTION:

- A. Pipes:** The pipe trench shall be backfilled to the limits as shown on [Sheet 10](#) of the [Standard Drawings](#). The backfill shall be compacted by vibrating, tamping, or a combination thereof, to 70% relative density for sand material as determined by ASTM D 4253 and D 4254, or to 95 percent of maximum dry density for cohesive soils as determined by ASTM D 698 within 2% of optimum moisture content for meeting ASTM D 698 requirements for compaction.

It is expected that the trench excavation will provide suitable backfill material. Wet, soft, or frozen material, asphalt chunks, or other deleterious substances shall not be used for backfill. If the excavated material is not suitable for backfill, as determined by Denver Water, suitable material shall be hauled in and utilized, and the rejected material hauled away and disposed of properly. Backfilling shall be conducted at all times in a manner to prevent damage to the pipe or its coating and shall be kept as close to the pipe laying operation as possible. Backfilling procedures shall conform to the additional requirements, if any, of appropriate agencies or private right-of-way agreements.

- B. Structures:** Backfill and fill within 3 feet adjacent to all structures, and for full height of the walls, shall be selected nonswelling material. It shall be relatively impervious, well graded, and free from stones larger than 3 inches. Material may be job excavated, but selectivity will be required.

Stockpiled material, other than topsoil from the excavation, shall be used for backfilling unless an impervious structural backfill is specified. The backfill material shall be free from rubbish, stones larger than 3 inches, clods, and frozen lumps of soil. All backfill around the structures shall be consolidated by mechanical tamping. The material shall be placed in 6 inch loose lifts within a range of 2% above to 2% below the optimum moisture content and compacted to 95% of maximum dry density for cohesive soils as determined by ASTM D 698 or to 70% relative density as determined by ASTM D 4253 and D 4254.

Impervious structural backfill, where shown or specified, shall consist of material having 100% finer than 3 inches in diameter and a minimum of 20% passing a No. 200 U.S. Standard sieve. The material shall be placed in 6 inch loose lifts within a range of 2% below the optimum moisture content, and compacted to 95% of maximum dry density as determined by ASTM D 698.

- C. **Composite Meter Pits:** Backfill and fill within 1 foot around a composite meter pit and to the level of the bottom of the top one-foot ring shall be with squeegee sand. The sand shall be carefully placed and mechanically compacted to assure that the meter pit does not deform more than one inch out of round at any point of its depth. Compaction using the wheels of construction equipment is not permitted.

**7.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM):**

Permission to use CLSM commonly called "Flow Fill", "Flowable Concrete Backfill" or "Flash Fill" shall be requested from Denver Water for backfill in pipe zone and other backfill locations. The request to use CLSM shall be in writing and include a mix design from a ready-mixed concrete producer. CLSM shall conform to [MS-21](#).

**7.13 CLEANUP:**

Upon completion of the work, all rubbish, unused materials, concrete forms and other like material shall be removed from the jobsite. All excess excavation shall be disposed of as specified and the areas shall be left in a state of order and cleanliness.

**7.14 SURFACE RESTORATION:**

- A. **Unsurfaced Areas:** Surface cuts shall be, as a minimum, restored to a condition equal to that prior to construction. All streets shall be restored in accordance with the regulations and requirements of the agency having control or jurisdiction over the street, roadway, or right-of-way.
- B. **Surfaced Areas:** Surface cuts shall be, as a minimum, restored to a condition equal to that prior to construction. All gravel or paved streets shall be restored in accordance with the regulations and requirements of the agency having control or jurisdiction over the street, roadway, or right-of-way.
- C. **Easements, Cultivated or Agricultural Areas:** In easements, cultivated or agricultural areas, topsoil, to a depth of 8 inches, shall be removed from the area of general disturbance and stockpiled. After installation of all pipelines, appurtenances and structures, and completion of backfill and compaction, the stockpiled topsoil shall be redistributed evenly over disturbed areas. Care should be taken to conform to the original ground contour or final grading plans.

**7.15 SUBGRADE AND ROAD PREPARATION:**

Prior to installation of water mains in dedicated streets, road construction must have progressed to at least the subgrade stage. Subgrade elevation is defined as an elevation which lies no more than 7 inches below the finished street grade. The road surface shall be smooth, clear of debris and free from deep holes, ruts, and large rocks which may hamper main installation.

Mains shall be laid where the ground surface is near its final elevation, whether it is located in a dedicated street or not.