SECTION 5 – SUPPLEMENT TO DENVER WATER ENGINEERING STANDARDS

CHAPTER 7 – EARTHWORK

5.1. SECTION 7.04 – TRENCHING OPERATIONS – (LIMITS OF EXCAVATION)

Length - Except by expressed written permission of the District the maximum length of open trench shall be 600 feet or the distance necessary to accommodate the amount of pipe installed in a single day, whichever is smaller. The distance is the collective length at any location, including open excavation, pipe laying, appurtenance, construction, and backfill. The trench shall not be left open when the Contractor has left the project site and is not engaged in construction operations. Traffic Barriers shall be placed as required by the representative City or County, or as stipulated by local conditions, to ensure construction safety at all times.

5.1.1. FOUNDATIONS AND SUBGRADE

General

All vault foundations and pipe subgrade installation shall be in a stable condition. Any and all questions relative to foundation and subgrade stability shall be coordinated through District and the Developer's Geotechnical Engineer. The Geotechnical Engineer will be responsible for determining if the foundation and/or subgrade are stable prior to the utility installation.

Stable Foundations and Subgrade

The trench bottom shall be excavated six inches (6") below the invert of the pipe unless otherwise designated on the plans. Before the pipe is laid, the foundation shall be prepared by backfilling with bedding material conforming to these specifications. The bedding shall be thoroughly tamped to achieve a relative density of 70% as determined by ASTM D-2049.

5.2. SECTION 7.09 – FOUNDATIONS ON UNSTABLE SOIL

When excessively wet, soft, spongy, or similarly unsuitable materials is encountered at the surface upon which the bedding material is to be placed, dewatering shall be performed and unsuitable materials shall be removed to a depth as determined in the field by the Owner's Geotechnical Engineer and the District.

The degree of soil instability will determine the limits of over excavation. In general, over excavation will be required, and stabilization rock shall be installed as indicated on the "Special Bedding" detail until the foundation and/or subgrade is stable as determined by the Owner's Geotechnical Engineer and the District.

5.2.1. FOUNDATIONS IN ROCK

Where rock is encountered, it shall be removed below grade. The trench shall be backfilled with clean imported bedding material to provide a compacted foundation cushion. The minimum clearance between rock and the pipe shall be nine inches (9").

5.3. SECTION 7.10 - PIPE BEDDING AND PIPE ZONE MATERIAL

General

All pipe bedding materials for stable and unstable installation conditions shall be reviewed by the Owner's Geotechnical Engineer and the District prior to delivery of bedding to the construction site. The area indicated in the bedding details from the trench bottom to twelve inches (12") above the pipe shall be referred to as the "pipe zone". Bedding materials and installation shall meet or exceed the requirements of this section.

Bedding Material

The pipe bedding, using either clean imported sand, squeegee, or 3/4-inch gravel conforming to these specifications shall be placed in the pipe zone and compacted to the requirements set forth in this section. The following classes of bedding are permitted:

Class A Bedding

Class A bedding shall be used for the bedding of water mains at normal depths of cover (i.e. 4.5 feet to 10 feet of cover). Class A bedding shall consist of placing select bedding material (known as "squeegee") as defined below, from the pipe foundation to a point twelve inches (12") above top of pipe.

Class A bedding material shall conform to the following limits:

Class A Bedding (Squeegee)	
Sieve Size	**Total % Passing by Wt.**
3/8”	100%
No. 8	65-100%
No. 50	10-30%
No. 100	0-10%
No. 200	0-5%

Class B Bedding

Class B bedding shall be reviewed for use by the District for bedding of PVC or ductile iron water lines when depths of cover exceed ten feet (10’). Class B bedding shall consist of placing crushed aggregate, as defined below, from the pipe foundation to a point twelve inches (12") above the top of the pipe in accordance with the provisions of this section. Class B bedding shall be clean crushed aggregate conforming to ASTM D 448, as follows:

Class B Bedding	
Sieve Size	**Total % Passing by Wt.**
1”	100%
3/4”	90-100%
3/8”	20-55%
No. 4	0-10%
No. 8	0-5%

Bedding Installation

The pipe shall be bedded as indicated on the "Standard Bedding" and "Special Bedding" details, found in the Standard Construction Drawings. The Contractor shall accurately shape the pipe subgrade to fit the bottom of the pipe. The intent is to relieve the bell of the pipe of all loading and provide continuous bearing of the pipe barrel on the bedding. Use of a drag template shaped to conform to the outer surface of the pipe will be required if other methods do not give satisfactory results.

The pipe shall be centered in the trench, adjusted to line and grade and bedding shall be simultaneously placed on both sides of the pipe so as not to disturb alignment and grade. The bedding material shall be sliced under the haunches of the pipe to fill all voids. The slicing shall be performed when the bedding material covers approximately one-third (1/3) of the pipe's diameter.

Bedding Compaction

All bedding material shall be compacted to a minimum Relative Density of 70%, as determined by ASTM D2049. Each lift shall be solidly tamped with the proper tools so as not to injure, damage, or disturb the pipe. Backfilling shall proceed simultaneously on each side of the pipe. Water settling for compaction is not permitted.

Bedding Testing Requirements

Bedding material shall be tested by the Owner's Geotechnical Engineer for gradation requirements set forth herein, and test reports shall be submitted to the District prior to delivery of any bedding material to the project site. Bedding compaction shall be tested using the "Sand Cone Method" in conformance with ASTM D1556 or other methods reviewed by the District. Compaction test results shall be submitted to the District on the working day following the test. If test results do not meet these specifications, the area shall be reworked and retested until these specifications are met. The location and frequency of bedding compaction testing will be determined by the District on a case-by-case basis.

5.4. SECTION 7.11 – BACKFILL AND COMPACTION

General

All trenches shall be backfilled after pipe, fittings and appurtenances have been installed and reviewed by the District and Denver Water.

When a compaction requirement is specified herein, the optimum moisture content and density shall be determined in accordance with the appropriate ASTM specification.

Backfill Material

Backfilling shall be done with on-site material, sand or gravel. No oil cake, bituminous pavement, concrete, rock or other lumpy material shall be used in the backfill unless these materials are scattered and do not exceed 3" in any dimension. Material or perishable, organic, spongy, frozen debris, or otherwise unacceptable nature shall not be used in

backfilling. No material greater than 3" in any dimension shall be placed within 1 foot of any pipe, manhole or structure. Backfill material shall be subject to the review of the District.

Within the street right-of-way, the road subgrade and final grade, including base course and asphalt placement, shall be replaced in strict accordance with the appropriate jurisdictional City or County.

Backfill Installation

In street rights-of-way, the portion of the trench above the "pipe zone" to the finished roadway surface shall be backfilled, compacted, and/or consolidated by methods reviewed by the District to obtain a Standard Proctor Density of 95% (ninety-five percent) or equivalent relative density. In easements and other areas outside street rights-of-ways, the portion of the trench above the "pipe zone" shall be backfilled, compacted and/or consolidated by methods reviewed by the District's geotechnical consultant to obtain a Standard Proctor Density of 90% (ninety percent) or equivalent relative density.

Backfill to be compacted by heavy compaction equipment shall be placed in uniform horizontal lifts not exceeding 12" or as specified by the District.

Heavy compaction equipment shall not be used closer than three feet to walls at the top of any structure nor closer than three feet to the top of the pipe. Before each lift is compacted, the material therein shall be brought within 1% above or 3% below the optimum moisture content for the specified compaction.

Flooding, pooling, or jetting shall not be allowed for consolidation of backfill.

Any damage to the pipe as a result of the Contractor's backfill and compaction operation shall be repaired and/or replaced by the Contractor.

Backfill Compaction Tests

Compaction tests shall be performed by a qualified testing laboratory at locations acceptable to the District. All expenses involved in these tests shall be borne by the Contractor or Developer.

Copies of test results shall be provided to the District. In all cases where the tests indicate sub-standard compaction, additional compaction effort and tests will be required until these specifications are met. Final acceptance of the lines by the District will be contingent upon satisfactory compaction results. Testing of water lines, as outlined in Chapter 8 of the Denver Water Engineering Standards, shall not be allowed until backfill compaction meets the standards set forth within these specifications.

The location and frequency of compaction testing shall be per the City, County, or District Specifications, whichever is more stringent. The minimum testing interval is as follows:

Minimum Testing Interval		
Location	**Horizontal Interval**	**Vertical Interval**
Water Line Trench	250 feet	Every 1 foot
Water Line Structure	Every Structure	Every 1 foot
Service Line	Random Representation	Every 1 foot

5.5. SECTION 7.13 – CLEAN-UP

Prior to project acceptance, the contractor shall clean street right-of-ways and easements of all rubbish, excess materials, temporary structures and equipment and shall leave the same areas to plus or minus 1/10 of a foot from the elevations that existed prior to construction or the final grades as shown on the reviewed and signed construction plans.