

NORTH MARIN WATER DISTRICT

STANDARD SPECIFICATIONS

SECTION 02223 TRENCHING, EXCAVATION, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 DESCRIPTION

This section includes materials, testing and installation for trench excavation, backfill, and compaction of piping, conduit, manholes and vaults.

1.02 REFERENCE STANDARDS

The publications listed below form part of this specification to the extent referenced and are referred to in the text by the basic designation only. Reference shall be made to the latest edition of said standards unless otherwise called for.

ASTM C 131	-	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 150	-	Portland Cement
ASTM D 75	-	Practice for Sampling Aggregates
ASTM D 1556	-	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	-	Test Method for Moisture-Density Relations of Soils Using a Modified Effort
ASTM D 2419	-	Test Method for Sand Equivalent Values of Soil and Fine Aggregate
ASTM D 2922	-	Test Method for Density of Soil in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	-	Test Method for Water Content of Soil and Rock in Place by Nuclear Methods
ASTM D 3776	-	Test Method for Mass Per Unit Area (Weight) of Woven Fabric
ASTM D 4253	-	Test Methods for Maximum Index Density and unit weight of Soils Using a Vibratory Plate
ASTM D 4254	-	Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4632	-	Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	-	Test Method for Determining the Apparent Opening Size of a Geotextile
CAL-OSHA	-	Title 8 General Industry Safety Orders
STANDARD SPECIFICATIONS	-	State of California Department of Transportation

1.03 RELATED WORK SPECIFIED ELSEWHERE

NMWD Standard Drawings

NMWD Standard Specifications 01000, 02200, 02202, 02700, 03461, 03462, 15000, 15044, 15056, 15061, 15064, and 15065

1.04 GEOTECHNICAL TESTING

The Developer or Contractor shall engage the services of a geotechnical engineering firm or individual licensed in the State of California to monitor soil conditions during earthwork, trenching, bedding, backfill and compaction operations. Sampling and testing procedures shall be performed in accordance with the Reference Standards and as follows:

- A. The soils technician shall be present at the site during all backfill and compaction operations. Failure to have the soils technician present will subject such operations to rejection.
- B. Density and optimum moisture content of soil shall be determined by the use of the sand cone method, ASTM D 1556, or nuclear density gauge method, ASTM D 2922 & D 3017. Since the composition of the pipe and the walls of the trench can have an effect on the nuclear density gauge output, any tests performed at depths greater than 1 foot below the ground surface shall be performed with a gauge calibrated within the trench at the test depth.
- C. Determine laboratory moisture-density relations of existing soil by ASTM D 1557.
- D. Determine the relative density of cohesionless soils by ASTM D 4253, ASTM D 4254 AND D4564.
- E. Sample backfill material by ASTM D 75.
- F. Express "relative compaction" as a percentage of the ratio of the in-place dry density to the laboratory maximum dry density.

A report of all soils tests performed shall be stamped and signed by the soils firm or individual and shall be submitted by the Developer or Contractor prior to the filing of the Notice of Completion by the District. The report shall document the sampling and testing of materials, the location and results of all tests performed, and shall certify that materials and work are in compliance with this specification.

1.05 PIPE ZONE

The pipe zone includes the full width of the trench from four (4) inches below the bottom of the pipe to twelve (12) inches above the top of the pipe and extends into manhole or vault excavations to the point of connection to or penetration of such structure.

1.06 TRENCH ZONE

The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the pavement zone in paved areas, or to the existing surface in unpaved areas, and extends into manhole or vault excavations above the pipe zone.

1.07 PAVEMENT ZONE

The pavement zone includes the concrete or asphalt concrete pavement and aggregate base section placed over the trench zone and extends into manhole or vault excavations above the trench zone.

1.08 PROTECTION OF EXISTING UTILITIES AND FACILITIES

The Contractor shall be responsible for the care and protection of all existing utilities, facilities and structures that may be encountered in or near the area of the work in accordance with Section 01000.

1.09 PROTECTION OF EXISTING LANDSCAPING

The Contractor shall be responsible for the protection of all the trees, shrubs, fences, and other landscape items adjacent to or within the work area in accordance with Section 01000.

1.10 ACCESS

The Contractor shall provide continuous, unobstructed access to all driveways, water valves, hydrants, or other property or facilities within or adjacent to the work areas.

1.11 SAFETY

- A. Protection of workers within trenches shall be as required by the California Labor Code and in accordance with Section 01000.
- B. All excavations shall be performed in a safe manner and shall be protected and supported in accordance with CAL-OSHA regulations.
- C. Barriers and traffic delineators shall be placed in accordance with the requirements of the agency having jurisdiction.

1.12 BLASTING

Blasting for excavation shall not be performed without the written permission of the District. Submit verification that procedures and methods of blasting shall conform to all Federal, State and local laws and ordinances to District for approval prior to issuance of written permission.

1.13 PIPE JACKING

Pipe jacking may be permitted in accordance with Section 15125. District approval is required in advance of such operations.

1.14 EXCESS EXCAVATED MATERIAL

- A. The Contractor shall remove and legally dispose of all excess excavated material and demolition debris.
- B. It is the intent of these specifications that all surplus material shall be legally disposed of by the Contractor. Before acceptance of the work by District, the Contractor shall provide the District with written releases signed by all property owners with whom the Contractor has entered into agreements for disposing of excess excavated material, absolving the District from any liability connected therewith.

1.15 CHANGES IN LINE AND GRADE

In the event obstructions not shown on the plans are encountered during the progress of the work, and which will require alterations to the plans, the Engineer shall have the authority to change the plans and order the necessary deviation from the line and grade, in accordance with Section 01000. The Contractor shall not deviate from the specified line and grade without prior written approval by the District.

1.16 HYDROSTATIC TESTING

Pre-testing of the piping system may be performed for the Contractor's convenience at any time. However, the final hydrostatic pressure test shall be as described in Section 15044.

PART 2 MATERIALS

2.01 GENERAL

The Contractor shall furnish backfill material as specified below. All materials used in and above the pipe zone shall be capable of attaining the required relative density.

2.02 PIPE ZONE GRANULAR MATERIAL

Granular Material shall be used within the Pipe Zone. Suitable material for pipe zone granular material shall have an ASTM 2487 soil classification of SW, SM, GW, or GM.

Material shall have a sand equivalent value of not less than 30 per ASTM D 2419, a coefficient of uniformity of 3 or greater.

Pipe zone granular material shall be certified to contain less than 1% asbestos by weight or volume and shall conform to the following gradation and requirements:

<u>U. S. Standard Sieve Size</u>	<u>Percent Passing By Weight</u>
¾ inch	100
½ inch	90-100
3/8 inch	80-100
No. 4	50-80
No. 30	10-35
No 200	0-5

<u>Test</u>	<u>Test Method</u>	<u>Requirement</u>
Percentage Wear	ASTM C 131	----
100 Revolutions	----	15 Maximum
500 Revolutions	----	52 Maximum

<u>Test</u>	<u>Test Method</u>	<u>Requirement</u>
Plasticity Index	ASTM D4318	NP-10
Liquid Limit	ASTM D4318	Less than 20
Min. pH	EPA 9040	Greater than 6
Sat. Soil Resistivity	SM 2510	Greater than 3,000(Ohm-cm)
Chloride Concentration	EPA 300	Less than 200 mg/kg

2.04 TRENCH ZONE MATERIAL

Suitable material for trench zone (above the bedding material and below any pavement section) shall have an ASTM 2487 soil classification of SW, SM, SC, GW, GM, or GC and shall be free of organic matter and conform to the following gradation and requirements.

<u>U. S. Standard Sieve Size</u>	<u>Percent Passing By Weight</u>
3 inch	100
1 inch	70-100
3/8 inch	40-100
No. 4	20-90
No. 30	5-50
No. 200	0-40

<u>Test</u>	<u>Test Method</u>	<u>Requirement</u>
Plasticity Index	ASTM D4318	Less than 20
Liquid Limit	ASTM D4318	Less than 40
R-value	Caltrans 301	30 minimum

Imported trench zone material shall be Caltrans Class 1, 2 or 3 Aggregate Subbase or Class 2 Aggregate Base per Sections 25 and 26 of the latest version of Caltran's Standard Specifications.

Excavated spoil from the trenches may be suitable for the trench zone (above the bedding material and below any pavement section) provided it meets the above criteria and approved by the District Engineer.

2.05 SAND-CEMENT SLURRY (CONTROLLED DENSITY, CDF)

Sand-cement slurry shall be Shamrock Mix No. 1503 consisting of two sacks, 188 pounds of Portland cement per cubic yard of sand and sufficient moisture for workability. District approval is required for use of sand-cement slurry as a backfill material.

2.06 TRENCH PLUGS

Trench plugs consisting of compacted impermeable material approved by District Engineer or sand-cement slurry shall be installed on piping systems that are backfilled with crushed rock or placed on slopes steeper than 4:1 (horizontal:vertical).

2.07 ENGINEERING FABRICS

All engineering fabrics used for trench backfill operations shall be in accordance with Section 88 of Caltran's Standard Specifications.

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

- A. Areas where work is to be performed shall be cleared of all trees, shrubs, rubbish, and other objectionable material of any kind, which, if left in place, would interfere with the proper performance or completion of the contemplated work, would impair its subsequent use, or would form obstructions therein.
- B. Organic material from clearing and grubbing operations will not be incorporated in the trench backfill and shall be removed from the project site or retained and incorporated into the topsoil.

3.02 PAVEMENT, CURB, AND SIDEWALK REMOVAL

Bituminous or concrete pavements, curbs, and sidewalks shall be removed and replaced in accordance with the requirements of the agency having jurisdiction.

3.03 DEWATERING

- A. The Contractor shall provide and maintain at all times during construction ample means and devices to promptly remove and dispose of all water from any source entering excavations or other parts of the work. Dewatering shall be performed by methods that will ensure a dry excavation and preservation of the final lines and grades of the bottoms of excavations. Dewatering methods may include well points, sump points, suitable rock or gravel placed as pipe bedding for drainage and pumping, temporary pipelines, or other means, all subject to the approval of the District. The cost of all dewatering activities shall be borne by the Contractor.
- B. Sewer systems shall not be used as drains for dewatering trenches or excavations, nor for disposal of collected or accumulated groundwater, without the approval of the agency of jurisdiction.
- C. Concrete shall not be poured in water, nor shall water be allowed to rise around concrete or mortar until it has set at least four hours.
- D. The Contractor is responsible for meeting all Federal, State, and local laws, rules and regulations regarding the treatment and disposal of water from dewatering operations at the construction site.

3.04 SHORING AND SHIELDING

- A. The Contractor's design and installation of shoring shall be consistent with the rules, orders, and regulations of CAL-OSHA. Unless otherwise specified, Type "C" soils should be assumed for shoring design.
- B. Excavations shall be shored, sheeted, and supported such that the walls of the excavation will not slide or settle and all existing improvements of any kind, either on public or private property, will be fully protected from damage.
- C. The sheeting and shoring shall be arranged so as not to place any stress on portions of the completed work until the general construction has proceeded far enough to provide ample strength.
- D. Care shall be exercised in the moving or removal of trench shields, sheeting, and shoring to prevent the caving or collapse of the excavation faces being supported.

3.05 CORRECTION OF OVEREXCAVATION

Overexcavations shall be corrected by backfilling with approved pipe zone or trench zone material, compacted to 90% relative compaction, as directed by the District.

3.06 FOUNDATION STABILIZATION

- A. When unsuitable soil materials are encountered, the unsuitable material shall be removed to the depth determined necessary in the field by the Soils Engineer, and as acceptable to the District. The sub-grade shall be restored with compacted pipe zone, trench zone material or crushed rock as recommended by the Soils Engineer. Place the appropriate bedding or base material on this restored foundation.
- B. When rock encroachment is encountered, the rock shall be removed to a point below the intended trench or excavation sub-grade as determined necessary in the field by the Soils Engineer, and as acceptable to the District. The sub-grade shall be restored with compacted pipe zone or trench zone material as recommended by the Soils Engineer. Place the appropriate bedding or base material on this restored foundation.
- C. When excessively wet, soft, spongy, or similarly unstable material is encountered at the surface upon which the bedding or base material is to be placed, the unsuitable material shall be removed to the depth determined necessary in the field by the Soils Engineer, and as acceptable to the District. Restore the trench with crushed rock enclosed in filter fabric or rock slope protection fabric as directed by the Engineer. Larger size rocks, up to six (6) inches with appropriate gradation, shall be used if recommended by the Soils Engineer. Place the appropriate bedding or base material on this restored foundation.

3.07 TRENCH EXCAVATION AND PLACEMENT OF BEDDING

- A. Excavate the trench to the lines and grades shown on the drawings with allowance for four (4) inches of pipe bedding material. The trench section shall be as shown on the Standard Drawings.
- B. The maximum length of open trench shall be five hundred (500) feet except by permission of the District. The distance is the collective length at any location, including open excavation and pipe laying, which has not been backfilled to the elevation of the surrounding grade.
- C. Trench walls shall be sloped or shored per the requirements of CAL-OSHA.
- D. The trench bottom shall be graded to provide a smooth, firm, and stable foundation that is free from rocks and other obstructions.
- E. Place the specified thickness of bedding material over the full width of the trench. Grade the top of the pipe base ahead of the pipe laying to provide a firm, uniform support along the full length of pipe.

- F. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint.
- G. Trenches for main pipelines and all appurtenances shall be backfilled with the materials and methods as specified for the Pipe Zone, Trench Zone and Pavement Zone.
- H. Trench widths shall be in accordance with the Standard Drawings.
- I. Trench depth shall be as required to install pipelines in accordance with the Approved Plans and these Standard Specifications. Unless shown otherwise in the Approved Plans, the minimum cover for pipelines shall be as follows:

<u>Pipeline Application</u>	<u>Minimum Cover Required</u>
Potable Water	36 inches
Recycled Water	48 inches
Sewer	60 inches

- J. Excavation and backfill of conduit for telemetering cables shall meet the requirements of this specification.
- K. Final street sub-grade shall be established prior to the excavation of pipeline trenches. Minimum cover above pipe shall be 24 inches for hydrotesting.

3.08 MANHOLE AND VAULTS

- A. The Contractor shall prepare an excavation large enough to accommodate the structure and permit grouting of openings and backfilling operations. The walls of the excavation shall be sloped or shored per the requirements of CAL-OSHA. Assume Type "C" soils unless otherwise specified.
- B. Manholes and vaults shall be placed at the location and elevation shown on the plans, on undisturbed soils and six (6) inches of compacted crushed rock base.
- C. Manhole and vault excavations shall be backfilled with the materials and methods as specified for the Pipe Zone, Trench Zone and Pavement Zone.

3.09 COMPACTION REQUIREMENTS

- A. Compaction shall be accomplished by mechanical means. Consolidation by water settling methods such as jetting or flooding is prohibited.
- B. If the backfill fails to meet the specified relative compaction requirements; the backfill shall be reworked until the requirements are met. All necessary excavations for density tests shall be made as directed by the Soils Engineer, and as acceptable to the Engineer. The requirements of the City or County having jurisdiction shall prevail on all public roads.

- C. Compaction tests shall be performed at random depths, and at random intervals not to exceed one hundred fifty (150) feet, as directed by the Soils Engineer or District.
- D. Relative compaction shall be determined by the impact or field compaction test made in accordance with ASTM D 1557, D2922 and D3017.
- E. Unless otherwise shown on the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:
 - 1. Pipe zone - 90% relative compaction.
 - 2. Trench zone - 90% relative compaction. In paved areas, upper twelve (12) inches 95% relative compaction.
 - 3. Structural section in paved areas - per City or County requirements, 95% minimum.
 - 4. Imported Granular Material for over excavation or foundation stabilization - 90% relative density.
- F. All excavations are subject to compaction tests.

3.10 TRENCH PLUGS

Trench plugs shall be installed at two hundred (200) feet intervals along the entire length of piping systems as specified in Section 2.06 or as shown on the plans. For trench plugs required on sloping terrain, trench plugs shall be placed at every twenty-five (25) feet in vertical elevation. Trench plugs shall be ten (10) feet in length and shall encompass the entire pipe zone. Additional trench plugs may be required as directed by the Engineer.

3.11 PIPE ZONE BACKFILL

- A. Care shall be taken in placing the pipe zone material simultaneously around the main pipeline and appurtenance pipes so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe or on the sides of the pipe. Care shall be taken to place material simultaneously on both sides of the pipe to prevent lateral movement. This area shall be mechanically compacted to attain 90% relative density. Care shall be taken when compacting appurtenance laterals two (2) inches and smaller to prevent the crushing or denting of the copper lateral. Additional lifts of twelve (12) inches or less thickness may be required on sixteen (16) inches or larger diameter pipe to attain complete support of the haunch area. Soils tests may be taken on this layer of backfill.

- B. After the spring line backfill has been approved by the Soils Engineer, backfill of the remainder of the Pipe Zone may proceed. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.
- C. Place and compact the pipe zone material at a maximum of eight (8) inch lifts. Compact all material placed in the Pipe Zone by mechanical methods. Field density tests shall be taken on this layer of backfill.
- D. The use of a backhoe-mounted compaction wheel is prohibited within the pipe zone to twelve (12) inches above the top of the pipe.
- E. Under no circumstances shall consolidation by water settling or water-setting methods (i.e. jetting, diking, etc.) be permitted.

3.12 TRENCH ZONE BACKFILL

- A. After the Pipe Zone material has been placed, compacted, approved by the Soil Engineer and accepted by the District, backfill in the Trench Zone may proceed.
- B. Compaction using vibratory equipment, tamping rollers, pneumatic tire rollers, or other mechanical tampers shall be performed with the type and size of equipment necessary to accomplish the work. The backfill shall be placed in horizontal layers of such depths (not to exceed eighteen (18) inches) as are considered proper for the type of compacting equipment being used in relation to the backfill material being placed. Each layer shall be evenly spread, properly moistened, and compacted to the specified relative density. The Contractor shall repair or replace any pipe, fitting, manhole, or structure damaged by the installation operations as directed by the District.

3.13 PAVEMENT ZONE BACKFILL AND RESTORATION

- A. After the Trench Zone material has been placed, compacted, approved by the Soil Engineer, and accepted by the District; backfill in the Pavement Zone may proceed as necessary in accordance with the requirements of the agency having jurisdiction.
- B. Replace bituminous and concrete pavement, curbs, and sidewalks removed or damaged during construction in accordance with the requirements of the agency having jurisdiction.
- C. Unpaved areas disturbed in any way by trenching and backfilling operations shall be restored to their original condition by the Contractor.

END OF SECTION