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PUBLIC WORKS DEPARTMENT

Modification of or Addition to Improvement Standards and Details

Modification Number: 072505-1

Effective Date of Change: July 28, 2005

Modification:

ROADWAY AND TRENCH BACKFILL STANDARDS

Effect of Modification:

Clarification of standards. The attached standards, ROADWAY AND TRENCH BACKFILL STANDARDS, renders all previous editions and modifications obsolete.

Attachment: ROADWAY AND TRENCH BACKFILL STANDARDS

Request for Modification Initiated By:

David P. Hartgen 7/28/05
Date

Modification Reviewed for Conformity and Consistency to Standards:

Farah B. Gh 7/28/05
Manager – Development Engineering Date

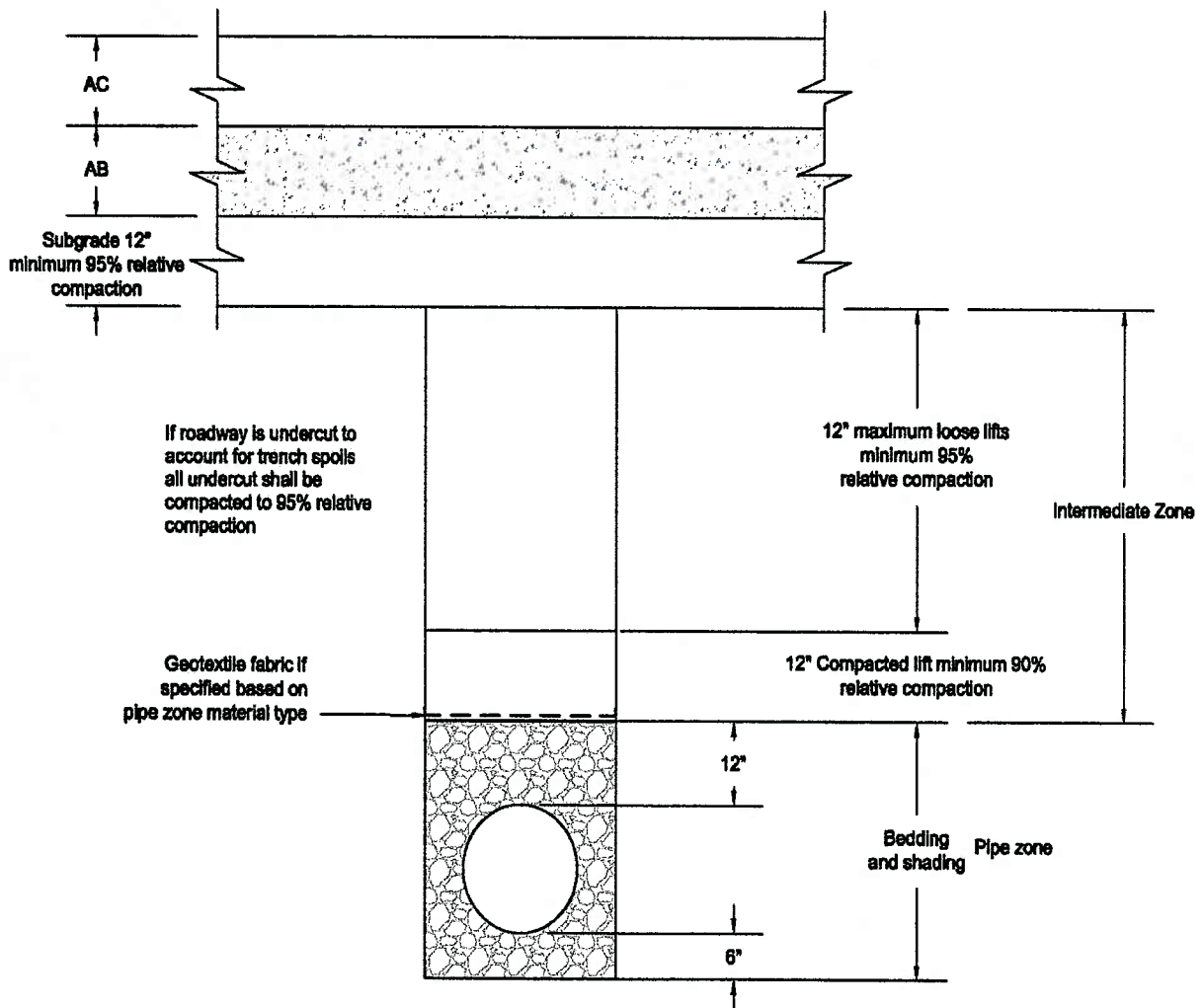
Modification to Improvement Standards Approved:

Robert J. Lee 7/28/05
City Engineer Date



ROADWAY AND TRENCH BACKFILL STANDARDS

The following specifications apply to roadway and utility improvements within the city right-of-way.



Typical Trench Detail

Unsuitable Foundation Soil

When soft, loose, or yielding materials are encountered in the roadway subgrade or trench bottom, the unsuitable material shall be removed to a suitable depth such that aggregate replacement materials will provide adequate support for the overlying pipe and trench backfill or and roadway section. The City Public Works representative should be consulted to evaluate the proper depth of removals during construction. Crushed rock with a maximum dimension of one and one-half inches (1-1/2") shall be used as replacement material. If sand bedding is used for underground installations, this crushed rock layer shall be wrapped in fabric meeting the requirements discussed in the section entitled "Geotextile Fabric."

Pipe Zone Materials

Pipe zone material shall meet the requirements of the governing agency. For storm drains the pipe zone material shall consist of Type "D" Material. For reinforced concrete storm drain pipes greater than 48 inches in inside diameter, the pipe zone material shall extend vertically to at least the spring line of the pipe.

Shovel Slicing

Where crushed rock is allowed as pipe zone backfill for pipes with diameters greater than 12 inches, it shall be placed and shovel sliced as described herein. The crushed rock shall be placed up to the spring line of the pipe and shovel sliced (a procedure used to force material under the haunches of the pipe by the lateral movement of the shovel) to provide proper support of the haunches of the pipe.

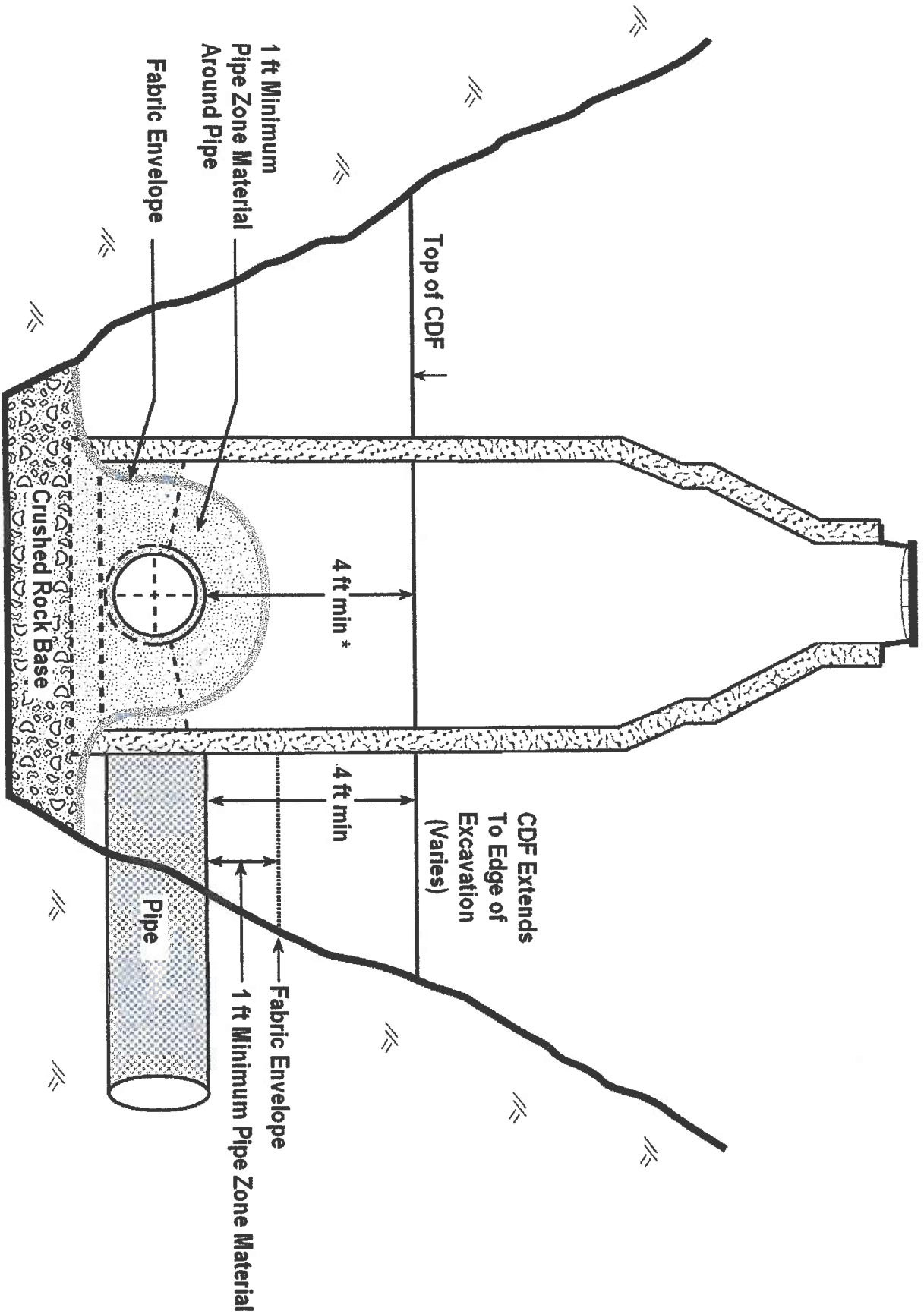
Manhole Pipe Zone Backfill

The pipe zone material surrounding pre-cast concrete manholes and extending out a minimum of 2 feet horizontally from the manhole barrel shall be backfilled with Type "C" material (CDF) up to a level at least 1 foot over the highest associated pipe, unless specified otherwise. The Type "C" backfill shall extend a minimum of 4 vertical feet (or to the base of the conical section of the manhole barrel) above the top of the lowest associated pipe. The material shall extend horizontally to the edges of the manhole excavation where adjoining trenches do not exist. In no case shall the Type "C" backfill material extend above the base of the conical section of the manhole barrel.

For Sacramento County installations, the Type "C" backfill shall be placed above the required pipe zone material (See Manhole Backfill Detail). The pipe zone material shall consist of crushed stone that meets Sacramento County standards extending laterally and vertically at least 12 inches around the pipe in all directions. The pipe zone material shall be covered with a Geotextile Fabric prior to placement of the required Type "C" backfill above it.

Drop manholes will be addressed on a case-by-case basis. See Manhole Backfill Detail.

MANHOLE BACKFILL DETAIL



* or the base of cone, whichever is less. Flattop manholes, CDF to be placed no higher than subgrade.

Cut Off Collars

If crushed rock, Type "E" Material, is selected for pipe zone backfill, a path is created that can allow water flow within the pipe zone material. Trench plugs or cut off collars of Type "C" material (CDF) shall be installed within the pipe zone. Cut off collars, where required, shall be at least 8 inches thick (as measured in the direction of the pipeline) and extend at least one foot (1') laterally beyond the pipe zone backfill into the surrounding soils in all directions in accordance with Sacramento County Standard Detail 7-16. The required pipe sleeves shall be placed a minimum of 2 feet away from all service connections on the main line. The plugs or collars shall be generally placed near the mid point of the pipeline between manholes. However, final placement shall be determined at the mandatory pre-construction meeting with City representatives.

Cut off collars shall also be installed around all services that extend beyond the curb or back of sidewalk at the outside edge of a roadway, including joint utility crossings. The collars may either be installed on the horizontal portion of the main service lateral prior to the elbow or on the vertical portion of the service prior to any plumbing fittings installed by the Contractor. The collar shall be placed behind the back of curb and sidewalk where present. The horizontal collar has the added benefit of being easier to construct and reduces the potential of the pipe shearing by extending horizontally through a rigid structure.

Cast-In-Place Concrete Pipe

The pipe zone of cast-in-place concrete pipe shall be considered the area between the top of the shoulder in contact with the trench and a point that is twelve inches (12") above the top of the pipe. Pipe zone backfill may be native material that is free of debris, organics, or other unsuitable materials, and with a maximum particle size of one inch (1"). Backfill shall commence immediately after written approval by the city representative. Material shall be placed evenly on both sides of the pipe in a manner that does not disturb or damage the pipe. Material shall be placed in lifts no greater than twelve inches (12") in loose thickness and compacted per the typical trench detail. The initial lift shall be compacted to at least 90 percent relative compaction (ASTM D1557) and moisture conditioned to be between 0 and 3 percent above the optimum moisture content. Compaction thereafter shall be to at least 95 percent relative compaction (ASTM D1557) and moisture conditioned to be between 0 and 3 percent above the optimum moisture content. Compaction on the sides of the pipe shall be achieved with hand operated compaction equipment such as jumping jacks or similar equipment. Failure to compact along the sides of the pipe could result in point loading the top of the pipe potentially causing premature cracking of the pipe.

Bedding and Backfill Materials

Type "A" Material

Caltrans Class 2 Aggregate Base (AB).

Type "B" Material

Native material with a maximum particle size not to exceed 4 inches in any dimension. The material shall be completely free from organic material, debris, or other deleterious material.

Type "C" Material

Controlled Density Fill (CDF) for Sacramento County Facilities. CDF shall consist of a workable mixture of aggregate, cementitious material, and water.

- Portland cement shall be Type II.
- Water used for CDF shall be potable.
- Admixtures including mineral admixtures (pozzolan) shall meet the requirements of the State Standard Specifications Section 90-4. The amount of air entraining admixture shall be a minimum of eight percent (8%) and a maximum of twenty percent (20%).
- Coarse aggregate shall consist of a well graded mixture of crushed rock with a maximum aggregate size of three-eighths of an inch (3/8"). One hundred percent (100%) shall pass the one-half-inch (1/2") sieve. Not more than thirty percent (30%) shall be retained on the three-eighths-inch (3/8") sieve and not more than twelve percent (12%) shall pass the No. 200 sieve. All material shall be free from organic matter and not contain more alkali, sulfated, or salts than the native materials at the site of work.
- CDF should have a minimum twenty-eight day (28-day) compressive strength of fifty pounds per square inch (50 psi) and a maximum of one hundred and twenty five pounds per square inch (125 psi).

Materials for CDF shall be thoroughly machine-mixed in a pugmill, rotary drum, or other approved mixer. The material shall be placed within 90 minutes after introduction of the water to the cement and aggregates.

CDF shall be placed in a uniform manner that will prevent voids in, or segregation of, the backfill. Foreign material that falls into the trench prior to or during CDF placement shall be immediately removed. The CDF shall not be excavated, moved, or otherwise disturbed after a period of 120 minutes following the addition of water to the cement and aggregates so as to permit proper curing.

This material shall be used in areas controlled by Sacramento County. A minimum of 48 hours should be allowed for curing prior to subsequent backfill operations. Type "C" material shall not be placed above the base of the conical section of manhole barrels.

Type "D" Material

Sand. Sand bedding shall be free from clay or organic material. 90 percent to 100 percent shall pass a No. 4 sieve and not more than 5 percent shall pass a No. 200 sieve.

Type "E" Material

Clean crushed rock. Material shall meet the following gradation limits (per ASTM D448-03):

Sieve Size	Size No. 7 (1/2" Crushed)	Size No. 6 (3/4" Crushed)	Size No. 5 (1" Crushed)	Size No. 4 (1-1/2" Crushed)
2"	--	--	--	100
1-1/2"	--	--	100	90-100
1"	--	100	90-100	20-55
3/4"	100	90-100	20-55	0-15
1/2"	90-100	20-55	0-10	--
3/8"	40-70	0-15	0-5	0-5
No. 4	0-15	0-5	--	--
No. 8	0-5	--	--	--

Clean crushed rock shall have a minimum Cleanliness Value of 60, as determined by California Test Method 227. Clean crushed rock shall contain at least seventy-five percent (75%) of particles having two (2) or more crushed faces.

Type "F" Material

Controlled Density Fill (CDF) similar to Type "C" above except provide a minimum of 2-sacks of Portland cement per cubic yard of material. Compressive strength is not specified for this material. A minimum of 24 hours should be allowed for curing prior to subsequent backfill operations, unless otherwise authorized in writing by the City Engineer's project representative.

Compaction of Bedding and Pipe Zone Backfill

Pipe bedding and pipe zone backfill materials shall meet the requirements of the governing agency. Bedding and backfill shall be placed in loose lifts not exceeding eight (8) inches and mechanically compacted to a minimum of 90 percent of the ASTM D1557 maximum dry density, and be consistent with the typical trench detail. Where clean crushed rock is used and conventional compaction testing is not practical, the material shall be mechanically compacted until no further yielding of the material is observed under the compactor. Sand should be placed at or above the optimum moisture content, not to exceed 5 percentage points over the optimum moisture content. Pipe zone material shall be leveled to a uniform thickness prior to placement of fabric and intermediate zone backfill.

Geotextile Fabric

A layer of non-woven geotextile fabric shall be placed between the pipe zone backfill and the intermediate zone backfill to reduce fines migration into the pipe zone. Filter fabric shall be laid-out and overlapped according to the manufacturer's recommendations. Recommended minimum filter fabric specifications are presented in the table below:

Table 1: Recommended Filter Fabric Specifications

Property	Requirement	Test Method
Apparent Opening Size (AOS)	#70 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile/Elongation	120 lbs./50%	ASTM D4632
Puncture Strength	70 lb. minimum, Average Roll Value	ASTM D4833

An example of a fabric meeting these specifications is Mirafi 160N or equivalent.

Intermediate Zone Backfill

1. Compaction

The first lift of the intermediate backfill shall be no more than eighteen inches (18") in loose thickness and shall be compacted to achieve a minimum of 90 percent of the ASTM D1557 maximum dry density at a moisture content between 3 and 5 percent above the optimum moisture content. This lift shall be tested for relative compaction prior to continuation of backfill procedures. All subsequent backfill shall be placed in lifts no greater than 12 inches in loose thickness (or less depending on ability of compaction equipment) and compacted to achieve a minimum of 95 percent of the ASTM D1557 maximum dry density. The backfill material within a two foot (2') wide zone surrounding vertical structures shall be mechanically compacted by smaller hand operated or walk behind compactors in addition to the larger trench compaction equipment.

For new and existing street areas where over-compaction of expansive soils is a concern, if native material, used in the upper three feet (3') of trenches, has an Expansion Index (EI) greater than 70 (based on 1997 UBC Test Method 29-2), then the contractor/developer shall submit for approval, alternative methods to either reduce the expansion potential of the native material or replace with suitable non-expansive material. An alternative to conventional trench backfill materials would be Type "C" or "F" CDF.

2. Moisture Content

The moisture content of the backfill shall be between 0 and 5 percent above the optimum moisture content as established by ASTM D1557 unless otherwise specified by the geotechnical report for the specific project. The backfill material shall be uniformly moisture conditioned as needed prior to placement and compaction.

Construction Quality Assurance

1. Field Density Tests

Nuclear moisture content and density testing shall conform to ASTM D2922 and ASTM D3017. Test frequency shall include at least one test per 200 linear feet of trench length and every two feet (2') vertically starting two feet (2') above the pipe. Density tests shall be performed at a

frequency of at least one test for every two feet (2') of backfill vertically for vertical structures (i.e. manholes, valve risers, etc.). Backfill above lateral services shall be tested at least every two feet (2') vertically. Calibration shall be performed for each nuclear gauge on a weekly basis to confirm the accuracy of nuclear density gauge moisture readings. The frequency and location of testing may be revised as needed by a representative of the Public Works Department. Nothing in this Specification prevents the owner's contractor and/or soils engineer from providing additional testing for quality control. However, these tests will not be substituted for those required by the City.

2. Modified Proctor Compaction Curve

Modified Proctor compaction curves (ASTM D1557) shall be performed as needed depending on changes in material types or at a minimum once for every 2,000 cubic yards of material placed.

3. Profile Plots of Test Locations

All compaction tests performed on trench backfill placed in utility trench mainlines, services, and around manholes shall be plotted and individually numbered on a set of record drawings.

Groundwater

If groundwater is encountered in the trench, the Contractor shall design a method to remove the groundwater from the trench allowing the proper installation of the designed pipe. The means and methods of groundwater removal from the trench shall be such that existing underground improvements are not affected by removal of water through the pipe zone materials causing potential settlement of previously placed backfill materials. All adjacent improvements shall be protected during trench dewatering operations.

Backfill within Existing Streets

Backfill operations performed within existing City streets shall be backfilled with Type "A" material (AB). Material shall be compacted to at least 95 percent relative compaction and moisture conditioned to be between 0 and 3 percent above the optimum moisture content. An alternative use of Type "F" material shall be approved in writing by the project's Public Works Inspector.

ROADWAY CONSTRUCTION STANDARDS

Subgrade Soils – Roadway, Curb and Gutter, and Sidewalks

Subgrade soils shall be stable and unyielding, compacted as specified, and graded as designed. All work shall comply with Section 19 of the Caltrans Standard Specifications unless addressed by these specifications.

1. Subgrade Preparation

All subgrade shall be scarified to a depth of twelve inches (12”) and moisture conditioned to between 0 and 3 percent above optimum moisture content as determined by ASTM D3017. If the roadway was undercut by more than twelve inches (12”) during mass grading to account for trench spoils scarification will not be necessary. However, all material placed within the undercut shall be compacted to at least 95 percent of the ASTM D1557 maximum dry density and moisture conditioned to between 0 and 3 percent above optimum moisture content.

2. Compaction

Prepared subgrade soils shall be compacted to at least 95 percent of the ASTM D1557 maximum dry density and moisture conditioned to between 0 and 3 percent above optimum moisture content. Testing shall conform to ASTM D2922 and D3017 for nuclear density testing. Nuclear density tests shall be performed at intervals no greater than 150 linear feet for each of the following, sidewalk, curb and gutter, and roadway. A minimum of 3 density tests shall be performed on each cul-de-sac. Density tests shall also be performed at all curb returns. All tests shall be plotted on the plan views of the record drawings. The moisture content shall be maintained until the placement of AB. If the moisture content is not maintained then steps 1 and 2 shall be repeated prior to placement of AB.

3. Subgrade Stability

The finished subgrade shall be proof rolled prior to aggregate base placement to evaluate the load/deflection characteristics of the finished subgrade materials. Proof rolling shall be performed by a fully loaded 4,000 gallon water truck. Proof rolling shall be performed in each lane of the roadway. If the tested surface shows a visible deflection extending more than 6 inches from the wheel track at the time of loading or a visible crack remains after loading, corrective measures shall be implemented. Corrective measures shall be determined on a case-by-case basis. All corrective measures shall be documented and located on the record drawings.

Bridges and Culverts

All backfill adjacent to bridges and culverts shall be compacted to at least 95 percent (full depth) of the ASTM D1557 maximum dry density and moisture conditioned to between 0 and 5 percent above optimum moisture content. Testing shall conform to ASTM D2922 and D3017 regarding

nuclear density testing. Nuclear density tests shall be performed at intervals no greater than 2 feet in vertical extent and 50 feet in horizontal extent. All tests shall be plotted on the plan views of the record drawings. This specification includes all material disturbed under the approaches to bridges and culverts.