

3.16
EMULSION SLURRY SEAL

3.16.1 Description: The slurry seal surface shall consist of a mixture of emulsified asphalt, mineral aggregate, and water; properly proportioned, mixed, and spread evenly on the surface as specified herein and as directed by the Project Engineer. The cured slurry shall have a homogenous appearance, fill all cracks, adhere firmly to the surface and have skid resistant texture.

3.16.2 Materials:

- A. Asphalt Emulsion. The emulsified asphalt shall conform to the requirements of ASTM of ISSA Specification, for type SSLh, CSSlh or QUICK SETTING, MIXED GRADE EMULSION.
- B. Aggregate. The mineral aggregate shall consist of natural or manufactured sand, slag, crusher fines, and others, or a combination thereof. Smooth-textured sand of less than 1.25 percent water absorption shall not exceed 50 percent of the total combined aggregate. The aggregate shall be clean and free from vegetable matter and other deleterious substances. When tested by AASHTO T-176 of ASTM D-2419, the aggregate blend shall have a sand equivalent of not less than 45. When tested according to AASHTO T10-4 or ASTM C-88 the aggregate shall show a loss of not more than 15%. When tested according to AASHTO T-96 or ASTM C-131 the aggregate shall show a loss of not more than 35.

Mineral fillers such as portland cement, limestone dust, fly ash, and other shall be considered as part of the blended aggregate and shall be used in minimum required amounts. They shall meet the gradation requirements of ASTM D-242. Mineral fillers shall be used if needed to improve the workability of the mix or gradation of the aggregate.

The combined mineral aggregate shall conform to the following gradation when tested:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8	100
No. 4	70-90
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 50	12-25
No. 100	7-18
No. 200	5-15

Theoretical Asphalt

Content % Dry

Aggregate	17%	15%
Acceptable Variance	+ 2%	2%

- C. Water. All water used with the slurry mixture shall be potable and free from harmful soluble salts.

3.16.3 Equipment: All equipment, tools and machines used in the performance of this work shall be maintained in satisfactory working order at all times. Descriptive information on the slurry mixing and applying equipment to be used shall be submitted to the City for approval not less than five (5) days before the work starts.

- A. Slurry Mixing Equipment. The slurry mixing machine shall be a continuous flow mixing unit and be capable of delivering accurately a predetermined proportion of aggregate, water and asphalt emulsion to the mixing chamber and to discharge the thoroughly mixed product on a continuous basis. The aggregate shall be prewetted immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients together. No violent mixing shall be permitted. The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method to introduce a predetermined proportioned of mineral filler into the mixer at the same time and location that the aggregate is fed. The fines shall be used whenever added mineral filler is a part of the aggregate blend.
- B. Slurry Spreading Equipment. Attached to the mixer machine shall be a mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor. It shall be maintained so as to prevent loss of slurry on curving grades and crown by adjustments to assure uniform spread. There shall be a steering device and a flexible strikeoff.

The spreader box shall have an adjustable width. The box shall be kept clean, and build-up of asphalt and aggregate on the box shall not be permitted. The use of burlap drags or other drags shall be approved by the City Engineer.

- C. Cleaning Equipment. Power brooms, power blowers, air compressors, water flushing equipment, and hand brooms shall be suitable for cleaning the surface and cracks of the old surface.

3.16.4 Preparation of Surface: Immediately prior to applying the slurry, the surface shall be cleaned of all loose material, silt spots, vegetation, and other objectionable material. Any standard cleaning method used to clean pavements will be acceptable, except water flushing will not be permitted in areas where considerable cracks are present in the pavement surface. The City shall give final approval of the surface.

3.16.5 Composition and Rate of Application of the Slurry Mix: The amount of asphalt emulsion to be blended with the aggregate shall be that as determined by the laboratory report after final adjustment in the field. A minimum amount of water shall be added as necessary to obtain a fluid and homogeneous mixture. The rate of application shall be a minimum of 18 lbs. of dry aggregate per square yard.

3.16.6 Weather Limitations: The slurry seal surface shall not be applied if either the pavement or air temperature is 55° F. or below and falling, but may be applied when the air and also the pavement temperature is 45° F. or above and rising.

3.16.7 Application of the Slurry Surfaces:

- A. General. The surface may be prewetted by fogging ahead of the slurry box. The slurry mixture shall be of the desired consistency when deposited on the surface and no additional elements shall be added. Total time of mixing shall not exceed four minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that complete coverage is obtained. No lumping, balling or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry will be removed from the pavement. No excessive breaking of the emulsion will be allowed in the spreader box. No streaks such as caused by oversized aggregate will be left in the finished pavement.
- B. Joints. No excessive build-up nor unsightly appearance shall be permitted on longitudinal or transverse joints.
- C. Hand Work. Approved squeegees shall be used to spread slurry in non-accessible areas to the slurry mixer. Care shall be exercised in leaving no unsightly appearance from hand work.

3.17
PORTLAND CEMENT CONCRETE

3.17.1 Scope: This section of the specifications defines materials to be used in all portland cement concrete work and requirements for mixing, placing, finishing, and curing.

3.17.2 Materials: Materials used in portland cement concrete and reinforcing of portland cement concrete shall meet the following requirements:

A. Cement:

1. ASTM C-150, Type II (moderate). Type I may be used in above grade structure if approved.
2. An air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to ASTM C-175 and C-260.

B. Water:

1. Clean, nonstaining and nondetrimental. Comply with AASHTO T-26.

C. Aggregates - General:

1. Gravel, crushed slag, crushed stone, or other inert materials, composed of hard, strong durable particles free of injurious coatings. Complying with ASTM C-33 Specifications for Concrete Aggregate.
3. The materials passing the No. 200 sieve shall not exceed 1.75 percent by weight in the combined coarse and fine aggregate.

D. Coarse Aggregate:

1. Sieve Analysis: Graded in accordance with ASTM C-33, as indicated in Table No. 1.
2. Gradation limits of Table No. 1 may be changed if, in the judgement of the ENGINEER, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids and the maximum aggregate size does not exceed the following requirements:
 - a. 1/5 of narrowest dimension between forms.
 - b. 1/3 of depth of slabs.
 - c. 3/4 of minimum clear spacing between reinforcing bars.
3. Deleterious Substances: Maximum percentage by weight.
 - a. Soft Fragments: 2.0 percent.
 - b. Coal and Lignite: 0.3 percent.
 - c. Clay Lumps: 0.3 percent.
 - d. Other Deleterious Substances: 2.0 percent.

TABLE 1
Master Grading Band Limits
for Coarse Aggregate

Sieve Sizes	<u>COARSE AGGREGATE</u>					
	<u>Percent Passing by Weight</u>					
	Grade 467		Grade 57		Grade 67	
	Min.	Max.	Min.	Max.	Min.	Max.
2 inch	100	-	-	-	-	-
1-1/2 inch	95	100	100	-	-	-
1 inch	-	-	95	100	100	-
3/4 inch	35	70	-	-	90	100
1/2 inch	-	-	25	60	-	-
3/8 inch	10	30	-	-	20	55
No. 4	0	5	0	10	0	10
No. 8	-	-	-	5	0	5

E. Fine Aggregate:

1. Sieve Analysis: Graded in accordance with ASTM C-33, as follows:

TABLE 2
Master Grading Band Limits for Fine Aggregate

Sieve Sizes	<u>FINE AGGREGATE</u>	
	<u>Percent Passing by Weight</u>	
	Min	Max
3/8 inch	100	-
No. 4	95	100
No. 16	45	80
No. 50	10	30
No. 100	2	10

2. Deleterious Substances: Maximum percentage by weight:
 - a. Coal and Lignite: 0.3 percent.
 - b. Clay Lumps: 0.5 percent.
 - c. Other Deleterious Substances: 2.0 percent.

F. Soundness and Reactivity of Aggregate:

1. Determine coarse and fine aggregate soundness in accordance with ASTM C-88.

- a. For Coarse Aggregate: Weight loss; not exceeding 12 percent by weight when subjected to 5 cycles of sodium sulfate or 18 percent by weight when subjected to 5 cycles of magnesium sulfate.
 - b. For Fine Aggregate: Weight loss; not exceeding 10 percent by weight when subjected to 5 cycles of sodium sulfate or 15 percent by weight when subjected to 5 cycles of magnesium sulfate.
2. Determine alkali-silica reactivity in accordance with ASTM C-289. Do not use aggregates determined either potentially or actually deleterious unless service records have shown the aggregates to be innocuous and ENGINEER approves.

G. Admixtures:

- 1. Air Entrainment: ASTM C-260.
- 2. Water Reducing and Set Retarding Agents: ASTM C-494.
 - a. Type A: Set water reducing.
 - b. Type B: Set retarding.
 - c. Type C: Set accelerating.
 - d. Type D: Water reducing and set retarding.
 - e. Type E: Water reducing and set accelerating.
 - f. Type F: High range water reducing (super plasticizer).*
 - g. Type G: High range water reducing and set retarding.*

*The relative durability factor of water reducing admixtures shall not be less than 80 and the chlorides content (as Cl-) shall not exceed 1 percent by weight of the admixtures.

- 3. Calcium Chloride: None allowed.
- 4. Pozzolan: Pozzolan conforming to the requirements of ASTM C-618, Class F, is allowed as a Portland cement replacing agent under the following conditions:
 - a. The maximum percentage of Portland cement replacement is:
 - 1. 15 percent, for concrete exposed to weather.
 - 2. 20 percent, for interior concrete.
 - b. The ratio of replacement by weight of Pozzolan to cement shall be 1.25 to 1.0.
 - c. The minimum cement content shall be used in the design formulas before replacement is made.
 - d. Loss of ignition of pozzolan is less than 3 percent and the water requirement does not exceed 100 percent.
 - e. All other requirements of this section still apply.
 - f. Mix designs including trial batches are required for each aggregate source and for each concrete class.

H. ACI Mix Design:

1. The amount by which the average strength of a concrete mix exceeds the specified compressive strength shall be based upon no more than 1 in 100 random individual strength tests falling more than 500 psi below the specific strength.
 2. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the properties or limitations of Table No. 3.
- I. Hand Mixing:
1. Do not hand mix batches exceeding 0.5 cubic yards.
 2. Hand mix only on watertight platform. Mix cement and aggregate prior to adding water.
 3. Ensure all stones are thoroughly covered with mortar and mixture is of uniform color and consistency.
- J. Heating, Water and Aggregate:
1. Do not allow products of fuel combustion to contact the aggregate.
 2. Heat mixing water to 150 degrees F maximum. Heat aggregates prior to adding water.
 3. Do not mix cement with water and aggregate at a mix temperature greater than 100 degrees F.

TABLE 3
Concrete Mix Properties

Concrete Properties	CONCRETE CLASSIFICATIONS					
	Class 7000	Class 6000	Class 5000	Class 4000	Class 3000	Class 2000
Specified Compressive Strength at 28 days, min., psi	7000	6000	5000	4000	3000 (f)	2000 (f)
Compressive Strength at 7 days, psi, min. (a)	4690	4020	3350	2680	2010	1340
Cement content (94 lb. sacks of cement per cubic yard of concrete), min. (b)	(c)	(c)	(c)	6.0	5.5	4.5
Entrained air -content, (% by volume)	(d)	(d)	(d)	6/+1	6/+1	4.5+/1.5
Slump Range, in. (e)	2-4	2-4	2-4	2-4	2-4	2-5

- (a) Used for monitoring purposes only.
 - (b) Includes pozzolan replacements.
 - (c) Cement content shall be appropriate to produce a mixture meeting the requirements for water/cement ratio and workability for the specific job conditions.
 - (d) Air content shall be appropriate to the exposure conditions.
 - (e) Not more than 8 inches after adding high range water reducing admixture (super-plasticizer) at site.
 - (f) Not allowed if concrete is exposed to freezing and thawing temperatures. Use Class 4000 or higher compressive strength and 6+/-1.0 percent air entrainment.
- K. Reinforcing Steel: All bar material used for reinforcement of concrete shall be 60 ksi yield grade steel conforming to the requirements of ASTM Designation A-615.
- L. Welded Wire Fabric: Welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A-185.
- M. Expansion (Through) Joints: Preformed joint filler for use in expansion (through) joints shall conform to the Standard Specifications for Preformed Expansion Joint Filler for Concrete, ASTM D-1751.

3.17.3 Concrete Mix: For the purpose of practical identification, concrete has been divided into three classes: Class A, B, and C. Basic requirements and use for each class are as defined below:

Class	Minimum Cement (sacks/c.y.)	Minimum 28 day Compressive Strength	Primary Use
A	6-1/2	4000	Reinforced Structural Concrete
B	6	3500	Sidewalks, curbs and gutters, cross gutters, pavements and unreinforced footings and foundation
C	5	2500	Thrust blocks, anchors, mass concrete

All concrete shall also comply with the following requirements:

- A. Aggregates: The maximum size of the aggregate shall be not larger than one-fifth of the narrowest dimension between forms within which the concrete is to be cast, nor larger than three-fourths of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For unreinforced concrete slabs, the maximum size of aggregates shall not be larger than one-fourth the slab thickness.

- B. Water: Sufficient water shall be added to the mix to produce concrete with the minimum practicable slump. The slump of mechanically vibrated concrete shall not exceed four inches. No concrete shall be placed with a slump in excess of five inches.

The maximum permissible water-cement ratio (including free moisture on aggregates) shall be 5 and 5-3/4 gallons per bag of cement respectively for Class A and B air entrained concrete.

- C. Air-Entraining: Air content for air-entrained concrete shall comply with the following:

<u>Coarse Aggregate Size (in.)</u>	<u>Air Content (%)</u>
1-1/2 to 2-1/2	5±1
3/4 or 1	6±1
3/8 or 1/2	7±1

The air entraining agent shall be added as liquid to the mixing water by means of mechanical equipment capable of accurate measurement and control.

- 3.17.4 Design of the Concrete Mix:** At least 21 days prior to any placement of concrete the contractor shall inform the Engineer in writing of the source and grading of aggregates and the brand and type of cement and the brand and type of admixture, if any, he proposes to use for each class of concrete, and shall furnish certificates or other evidence satisfactory to the Engineer that the proposed materials meet the requirements of these Specifications.

When acceptable sources, types and gradings of aggregates are designated in the Contract Documents, certifications for such aggregates will not be required.

After the job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand of cement or admixture shall be changes without prior notice to the Engineer.

If such changes are necessary, no concrete containing such new or altered materials shall be placed until the Engineer has designated a revised job mix.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75° F, a water-reducing, set-retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

- 3.17.5 Inspecting and Testing:** The CONTRACTOR will be responsible for collecting samples and having all tests indicated below performed. The following tests will be performed by the methods indicated:

<u>Test</u>	<u>Method (ASTM Designation)</u>
Sampling	C 172*
Slump Test	C 143*
Air Content	C 231* or C 173*
Compression Test Specimens	C 31* or C 42*

Compressive Strength
Unit Weight, Yield

C 39 or C 42
C 138

*Tests of a portion of a batch may be made on samples representative of that portion for any of the following purposes:

- (1) Determining uniformity of the batch.
- (2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.
- (3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than a full batch.
- (4) Slump tests shall be run on each truck load or fraction thereof.
- (5) Compression test specimens shall be collected for running a test for compressive strength in 7 days and in 28 days for every 40 cubic yards or fraction thereof for each section poured.

The engineer shall have free entry to the plant and equipment furnishing concrete under the Contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes and to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

3.17.6 Handling and Measurement of Materials: Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes. Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentages of the required batch weights:

Cement	- plus or minus 1.0 percent
Aggregates	- plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Except as otherwise provided in Section 3.17.7, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

3.17.7 Mixers and Agitators: Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods. Agitators may be truck mixers or track agitators.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the work. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing. For this purpose the testing program and uniformity requirements shall be as set forth in ASTM C-94, under supervision of the Engineer.

A. **Stationary Mixers:** For concrete mixed at the site of the work with paving mixers or stationary mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1 minute for mixer capacities of one cubic yard or less, plus 15 seconds for each cubic yard or fraction thereof of additional capacity.

The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

When used for complete mixing of concrete, stationary mixers shall have controls provided to insure that the batch cannot be discharged until the required mixing time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply.

B. **Volumetric Batching and Continuous Mixing at the Site:** Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted if approved by the Engineer. The batching and mixing equipment shall conform to the requirements of ASTM C-685 (AASHTO 241) and shall be demonstrated prior to placement of concrete, by tests with the job mix, as producing concrete meeting the specified proportioning and uniformity requirements.

- C. Ready-mixed Concrete: Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods (as per ACI 304 - Chapters 4 and 5):
1. Truck-mixed concrete: Mixed completely in a truck mixer.
 2. Shrink-mixed concrete: Mixed completely in a stationary mixer, and the mixing completed in a truck mixer.
 3. Central-mixed concrete: Mixed completely in a stationary mixer and the mixed concrete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitated speed or in non-agitating equipment.

Concrete shall be delivered and deposited in its final position within 90 minutes after adding the cement and water to the mixture.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready-mixed concrete is furnished, the supplier shall furnish the Engineer a state-of-delivery ticket showing the time of loading, and the quantities of materials used for each load of concrete, amount and types of admixtures, bags of cement in lieu of batch weights, and all quantity of water added on site.

- D. Truck-mixed Concrete: Concrete that is completely mixed in a truck mixer shall be agitated at the mixing speed designed by the manufacturer from 70 to 100 revolutions to produce a uniformity of concrete as indicated in Appendix XI of ASTM C-94. Mixing in excess of 100 revolutions shall be allowed only to reblend stagnant spots, 10 to 15 revolutions at mixing speed has shown to be adequate. Revolutions in excess of 115 must be at agitation speeds only.

The volume of mixed concrete shall not exceed 63% of the total volume of the drum or container. Exceeding this capacity is cause for rejection of the load unless performance tests for the mixer are provided.

A minimum of 30 revolutions shall be used at mixing speeds to blend the additional water added, at the job site, to bring the slump, of the concrete, to that specified. However, the water/cement ratio of the mix design should never be exceeded.

Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

If trucks are found to be loaded beyond mixer capacity this shall be deemed as cause for rejection of the entire load.

- E. Dry-Batched Concrete-Float Delivery: When the cement is batched as the last ingredient with the drum stopped and not rotated until mixing is performed at the job site, delays of

three hours will be acceptable if the mixed concrete shows no signs of hydration and the mix is uniform and consistent.

Load size should be reduced by 10 to 20 percent to avoid spilling of the dry cement.

It should be noted that extreme care is required to load the cement for this type of an operation and this method is to be used only as a last resort.

Mixing is in accordance with truck mixed concrete and all phases of this procedure are to follow ACI 304, 5.23, ACI 305, 3.3.1.1, 3.3.1.2, 3.3.2.

- F. Shrink-mixed Concrete: When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Absolute volume of all ingredients batched shall not exceed 13% of the drum volume.

- G. Central-mixed Concrete: For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batch mixing at the site. When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of non-agitating equipment to transport concrete to the work site will be permitted only if the uniformity and consistency of the concrete is shown to be such as will maintain the integrity for which it was designed.

Equipment should meet the requirements outline in ACI 304 5.3.

- 3.17.8 Forms:** Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a non-staining form oil before being set into place.

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed to view when the structure is completed shall be chamfered, unless finished with molding tools as specified in Section 3.1.19.

- 3.17.9 Preparation of Forms and Subgrade:** Prior to placement of concrete the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar or other harmful substances or coating. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Rock surfaces shall be cleaned by air-water cutting, wet sandblasting

or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Subgrade soils must be moist and uniformly compacted to the minimum required in the specifications. Placement of concrete on mud, dried earth, uncompacted fill or frozen subgrade will not be permitted.

Unless otherwise specified in the Contract Documents, when concrete is to be placed over drain fill, the contact surface of the drain fill shall be covered with a layer of asphalt-impregnated building paper or polyvinyl sheeting prior to placement of the concrete.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls shall be formed with nonferrous materials.

3.17.10 Conveying: Conveying should be accomplished as rapidly as practicable without segregation or loss of material. Metal or metal lined chutes should be used with adequate baffling and hoppers.

Belt conveyors shall conform to ACI 304 Chapter 3 of Placing Concrete with Belt Conveyors.

Conveying by pumping methods shall conform to ACI 304 Chapter 3 of Placing Concrete by Pumping Methods.

3.17.11 Placing: All phases of placing concrete shall conform to the recommended practices as outlined in ACI 304 Chapter 6 of Measuring, Mixing, Transporting, and Placing.

No concrete shall be placed until forms, subgrade, reinforcing steel and all other preparations have been checked for compliance with the related specifications. All concrete is to be placed in the presence of the City Engineer or his duly authorized representative.

The concrete shall be deposited in such a manner as will prevent the segregation and aggregates and the rate regulated to maintain a plastic state of the mix.

Tremens shall be used and at no time shall the free fall of the concrete exceed 4 feet in height.

For monolithic construction successive layers should be placed while the underlying layer is still responsive to vibration.

Internal stays and braces used for form alignment and shape retention shall be removed when the concrete has been placed to render their service unnecessarily.

If placement is interrupted to allow the formation of "cold joints," the Contractor shall stop the placement of concrete and form a construction joint as per Section 3.1.14 or he may continue at the direction of the Project Engineer.

The depth of the horizontal layer shall not exceed the form design limits or usually be limited to 4 feet in walls up to 12 inches thick.

If placing is discontinued prior to the completion of a layer, vertical bulkheads shall be formed as per the Engineer's direction.

3.17.12 Consolidation: Unless otherwise specified in the Contract Documents, concrete shall be consolidated with an approved type mechanical vibrator. Internal type, form and surface (screed) vibrators are all acceptable so long as the size and shape of the vibrator is matched to the mass and design of the concrete.

The location, manner, and duration of the vibratory device shall be such as to thoroughly consolidate the concrete without causing settlement of the coarse aggregate, sand streaking or less of air entrainment and form deflection.

Vibrators should be inserted vertically at uniform spacing over the entire area of placement. Distance between insertions should generally be about 1-1/2 times the radius of action or such that the area clearly overlaps the adjacent just-vibrated area by a few inches.

Previous layers should be penetrated by a minimum of six inches and held momentarily to insure knitting.

Under no circumstances should the vibrator be used to transport concrete along the conveying system or the forms.

3.17.13 Construction Joints: Construction joints shall be made at the locations shown on the Approved Plans. If construction joints are needed which are not shown on the Approved Plans, they shall be placed in locations approved by the Engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours, or until the concrete is no longer plastic.

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, latency, coatings, stains or debris by either wet sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete had hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate, but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively unaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-water jets will not be permitted and the wet sandblasting method will be required after the concrete has hardened.

The surfaces shall be kept moist for at least one hour prior to the placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

3.17.14 Expansion and Contraction Joints: Expansion and contraction joints shall be made as shown on the Approved Plans.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

3.17.15 Waterstops: Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

3.17.16 Removal of Forms: Forms shall be removed only when the Engineer is present and shall not be removed without his approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Forms, supports, and housings shall not be removed until the concrete has attained the strength specified for this purpose. The strength will be determined by compression testing of test cylinders cast by the Engineer for this purpose and cured at the work site in the manner specified in ASTM C-31 for determining form removal time.

3.17.17 Finishing Formed Surfaces: All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.

Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgement of the Engineer will adversely affect the appearance or function of the structure shall be removed. All form bolts and ties shall be removed to a depth of at least 1 inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned. The interior surfaces of the cavities shall be coated with a bonding agent or kept continuously wet for at least 3 hours, then carefully packed with a non-shrink grout mixed not richer than 1 percent cement to 3 parts sand.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All patched areas shall be cured as specified in Section 3.1.19.

3.17.18 Finishing Unformed Surfaces: All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished, unless specified otherwise by the Contract Documents or at the direction of the Engineer.

Excessive floating or troweling while the concrete is soft will not be permitted.

The addition of dry cement or water to the surface of the screeded concrete to expedite finishing will not be allowed.

Joints and edges on unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

3.17.19 Curing and Coatings: Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period or until curing compound is applied as specified below. Moisture shall be maintained by sprinkling, flooding or fog spraying, or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms (except plywood) left in place during the curing period shall be kept wet. The floor slab shall be cured by flooding. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

Except as otherwise specified in the Contract Documents, and except for construction joint surfaces, concrete may be coated with curing compound in lieu of the continued application of moisture.

The curing compound shall be thoroughly mixed immediately before applying, and shall be applied at a uniform rate of 150 to 200 square feet per gallon. It shall form a uniform, continuous, adherent film that shall not check, crack or peel, and shall be free from pin holes or other imperfections.

Curing compound shall not be applied to surfaces requiring bonding with subsequently placed concrete, as at construction joints, shear plates, reinforcing steel, and other embedded items.

Exterior surfaces which are to be backfilled against shall be coated with a waterproofing membrane. The membrane shall be Hunt's No. 120 black or an acceptable alternate. Surfaces shall be thoroughly cleaned and free of foreign material before application. The application rate shall be one gallon per 225 square feet.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

3.17.20 Removal or Repair: When concrete is honeycombed damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair.

Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for making the repair. Such approval shall not be considered a waiver of the City's right to require a complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present.

Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Except as otherwise approved by the Engineer, the appropriate methods described in the ACI Manual of Concrete Practice shall be used. If approved in writing by the City, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Curing as specified in Section 3.1.19 shall be applied to repaired areas immediately after the repairs are completed.

3.17.21 Concreting in Cold Weather: When the atmospheric temperature may be expected to drop below 40° F at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

- A. The temperature of the concrete at time of placing shall not be less than 50° F nor more than 70° F. The temperature of neither aggregates and mixing water prior to mixing with the cement shall be in accordance with "Recommended Practice for Cold Weather Concreting," ACI Standard 306.
- B. When the daily minimum temperature is less than 40° F, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50° F nor more than 90° F for the duration of the curing period.
- C. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting," ACI Standard 306.
- D. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound as specified in Section 3.1.19 or is covered tightly with an approved impervious material.

3.17.22 Concreting in Hot Weather: When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90° F at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions also shall apply:

- A. The Contractor shall maintain the temperature of the concrete below 90° F during mixing, conveying, and placing. Methods used shall conform to "Recommended Practice for Hot Weather Concreting," ACI Standard 305.
- B. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed until only time enough remains to accomplish it before the concrete is placed.
- C. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or otherwise protected from drying during the time between placement and finishing, and after finishing.
- D. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay.

- E. Concrete surfaces exposed to the air shall be covered as soon as the concrete has hardened sufficiently and shall be kept continuously wet for at least the first 24 hours of the curing period, and for the entire curing period unless curing compound is applied as specified in subsection g, below.
- F. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g,. below.
- G. If moist curing is discontinued before the end of the curing period, a curing compound shall be applied immediately, following the procedures specified in Section 3.1.09.

3.18
CONCRETE PAVEMENT

3.18.1 Description: The work covered in this section of Specifications pertains to the construction of Portland cement concrete pavements in streets, alleys and public rights-of-way.

3.18.2 Materials: Cement and other concrete materials, joint filler, curing materials and reinforcing steel, required by the Approved Plans and Specifications, shall conform to the requirements of Section 3.17. The job concrete mix shall be that shown in the Special Conditions. Ordinarily, the slump of the concrete when placed by machine methods shall be between one half (½) inch and three (3) inches.

3.18.3 Construction:

- A. Subgrade: The preliminary subgrade before the setting of forms shall be graded and compacted as required under Section 3.6.

If subgrade paper or polyethylene sheeting is required it shall be placed in such a manner to protect it from tearing or puncturing. Minimum side lap is four (4) inches while minimum end lap is twelve (12) inches.

After the forms have been securely set to grade and alignment, the subgrade between the forms shall be brought to true cross-section. Where thickened edges for pavements are required, the subgrade shall be excavated and shaped to provide for the standard section.

Wherever possible, vehicles shall be kept off the finished subgrade. If vehicles must travel on the subgrade ahead of the paving, a power drag shall be carried immediately ahead of placing concrete. Irregularities in the subgrade caused by trucks during the placement of concrete shall be smoothed out and compacted immediately ahead of placing the concrete.

The subgrade as finally completed shall be maintained by the Contractor at required density and an optimum moisture content by wetting with water until the concrete is actually placed.

- B. Forms: Forms may be of wood or metal or any other material at the option of the Contractor, provided the forms as constructed result in a pavement of specified thickness, cross-section, grade and alignment as shown on the Approved Plans. Slip form construction may be used subject to the approval of the City Engineer.

Forms shall be adequately supported to prevent deflection or movement. Forms shall be used which will result in concrete pavement conforming with the Approved Plans and Specifications. When checked for straightness, forms should not vary by more than 1/8" in 10 feet from the true plane surface on top and 1/4" in 10 feet on the face of the form. Flexible or curved forms are highly recommended for use when the curve has a radius of 100 feet or less. The forms may be removed the day after pouring if the concrete is sufficiently set to withstand removal without danger of chipping or spalling. When forms are removed before the expiration of the curing period, the edges of the concrete shall be protected with moist earth or sprayed with curing compound immediately. All forms shall be cleaned, oiled, and examined for defects before they are used again.

- C. Compaction of Subgrade: Covered in Section 3.5.
- D. Placing Concrete: The concrete shall be placed upon the prepared subgrade between the forms to the required depth and cross-section in a continuous operation between construction or expansion joints.

The concrete shall be thoroughly consolidated against and along all forms or adjoining pavements by such means as will prevent gravel pockets along the edges of the finished pavement. Any gravel pockets found after removing the forms shall be repaired.

When integral curb is being constructed with the pavement, fresh concrete for the integral curb shall be placed at such time as will enable the top section of the curb to be consolidated, finished, and bonded to the pavement slab while the concrete is plastic.

Where curb is not being placed integral with the pavement slab, reinforcing steel dowels or keyways shall be placed in the base section for the curb.

Prior to placing concrete around manholes, catch basins, gate chambers, etc., a temporary cover fitting below the rim of the ring casting shall be provided to prevent the concrete from flowing into them.

1. Placing Concrete at Expansion Joints: Concrete placement around expansion joints shall be such that the expansion joint assembly will not be disturbed and that it will remain in a straight line perpendicular to the subgrade, as shown on the Approved Plans. The concrete shall then be spaded thoroughly or vibrated along the entire length of the joint to consolidate the concrete and leave no rock pockets anywhere at the joint. If any rock pockets are exposed, they shall be repaired.
2. Placing Concrete With Reinforcing Steel Bars or Wire Mesh: When reinforcing is to be used, concrete shall be placed in one lift with an adequate method used to position and secure the reinforcing bars or wire mesh at the designated locations in the slab.

Reinforcement shall be free of dirt, mill scale, oil, grease, or other foreign material that may impair bond. Steel, coated with some rust, may be used if the oxidations are not deep or loose coated in the opinion of the City Engineer.

Successive mats of steel or wire mesh shall be securely lapped together and tied. Longitudinal bars will lap a minimum of 30 bar diameters. Wire mesh will lap 6 to 12 inches, and provided one complete series of square mesh is incorporated in the overlap.

Reinforcing steel or wire mesh shall be laid as a continuous mat. Continuity shall be maintained between expansion joints. Steel shall terminate within two to six inches of the joint.

3. Slip-Form Construction: At the option of the contractor and with the approval of the Engineer, concrete pavement may be constructed by the use of slip-form paving equipment.

Slip-form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape, and strength to support the concrete laterally for a sufficient period of time during placement to produce pavement of the required cross-section; the equipment shall spread, consolidate, screed, and float-finish the freshly placed concrete in such a manner as to provide a dense and homogenous pavement.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads to avoid breaking or cracking the pavement edge.

After the concrete has been given a preliminary finish by the finishing devices in the slip-form paving equipment, the surface of the fresh concrete shall be checked with a straight edge to comply with the tolerances and finished as specified in the following Section H-5.

Final finishing of slip-form pavement shall be as specified in the following Section H-4.

E. Compacting Concrete: Concrete may be compacted by (1) hand methods, (2) machine methods and (3) combined machine and vibrators method at the option of the contractor. The hand method will be limited to irregular areas, irregular sections, alleys and pavements placed in confined work areas.

1. Hand Compacting: Concrete shall be spread evenly with shovels and spaded along the forms with a perforated spade after which it shall be struck off with a rigid metal shod tamping rod. The strike-off rod shall be operated with a combined tamping, crosswise and sawing action to produce a smooth surface free from depressions or inequalities. A small amount of mortar must be kept ahead of and extending substantially along the entire length of the rod. Excessive swinging of the rod will not be permitted.
2. Machine Compacting: The machine used for compacting shall be self-propelled and designed to run on the side forms. Movable parts shall be capable of adjustment and they shall be adjusted so as to produce accurately the roadway sections shown on the Approved Plans. The machine shall be equipped with two reciprocating screeds. The tops of the forms shall be kept clean with a suitable device attached to the machine.

The travel of the machine on the forms shall be maintained true without lift, wobble or other variations which might prevent a precise strike off.

The machine shall be put in forward motion as soon as concrete is deposited on the subgrade. On the first pass, a roll of concrete shall be carried ahead of the screed. Screeds and tampers shall be operated so as not to disturb expansion joints and caps.

Machines shall be operated prior to placing longitudinal and transverse dummy joints.

Machines shall be operated as many times as may be necessary to compact concrete free from rock pockets and to a section that can be finished properly.

Care must be exercised not to overwork the concrete and bring an excess of mortar to the surface.

3. Combined Vibration and Machine Compacting: The combined vibration and compaction equipment shall be demonstrated to the satisfaction of the Engineer as being capable of consolidating the concrete across the full width of the pavement into a homogeneous mass, free of rock pockets, and without separation of mortar and aggregates.

The equipment shall consist of the machine described in Section 3.18.3E2, or an approved spreading machine to which is attached a vibrating unit composed of individual internal vibrators. The vibrators shall be spaced equidistantly, and the distance from the side forms to the nearest vibrator shall not exceed 14 inches.

The vibrating unit shall not rest upon the side forms nor impart vibration to the strike-off screeds. The individual vibrators shall be attached to a frame in a manner which will permit adjustment of both the depth of penetration into the concrete and the angle of the vibrator with the horizontal.

The vibrators shall be capable of vibrating at rates between 8,000 and 12,000 impulses per minute when inserted in the concrete.

On the first trip over the freshly placed concrete the vibration equipment shall be submerged in the concrete to ensure adequate consolidation. Unless otherwise directed by the Project Engineer, the vibration equipment shall be operated on the first pass only.

After the first pass with vibration, one or more trips without vibration shall be made as described in Section 3.18.3E2.

As often as the Engineer may require, the Contractor shall make trial runs with concrete containing the full amount of cement as specified in Section 3.17.3, Concrete Mixes, or as specified in the Special Conditions, compacting with and without vibration to determine the relative water contents required.

4. Vibrating Screed Concrete Pavement Construction: The type of vibrating screed with the contractor proposes to use, whether roller or beam, shall be subject to approval by the Engineer. Upon request by the Engineer a test section of pavement shall be placed for the purpose of demonstrating the capabilities of the screed to satisfactorily compact and strike off the concrete to the established grade and section.

Concrete shall be uniformly distributed between the forms and it shall then be compacted and screeded to the level of the top of the forms by means of the vibrating screed. Supplemental compaction by hand spading or mechanical vibration of the concrete adjacent to the forms will be required if the concrete cannot otherwise be adequately compacted.

The vibrating screed shall be operated over the freshly placed concrete in successive passes only a sufficient number of times to obtain maximum compaction. Over-

vibration of the concrete, resulting in an excess of mortar at the surface of the pavement, will not be permitted.

After the final passage of the vibrating screed, the surface of the concrete shall be at the established pavement grade and cross-section and shall be sufficiently smooth as to require only a very moderate amount of hand finishing for smoothness to meet approval of the Project Engineer.

- F. Water: Water for pavement construction will be furnished as provided in Section 3.8.
- G. Joints: Transverse and longitudinal joints for street pavement may be contraction joints, construction or expansion joints as shown in the Standard Drawing numbers 531A and 531B and as called for in these Specifications. When the pavement abuts an existing pavement, the locations of the joints in the new pavement shall coincide with the joints in the existing pavement unless otherwise shown in the Contract Documents.

- 1. Formed Transverse Contraction Joints: Standard spacing of transversely formed contraction joints shall be at intervals of fifteen (15) feet or less across the full width of the pavement and at right angles to the center line of the roadway. On horizontal curves the spacing of fifteen (15) feet shall be along the outer edge of the pavement.

For intersections and other irregular areas, the arrangement of contraction joints shall be placed in accordance with standard intersection patterns. The area of any one irregular pattern formed by contraction joints in intersections shall not exceed two hundred twenty-five (225) square feet and the greatest dimension thereof shall not exceed fifteen (15) feet.

When paving a second lane adjacent to the previously paved lane, the contraction joints shall be matched with the former; except on curves where resultant panel would be less than twelve and one-half (12-1/2) feet, measured longitudinally.

Where uncontrolled cracks are existing in the first lane, they shall be matched as nearly as possible in the second lane. Should the uncontrolled cracks in the existing paved lane be too frequent or in random locations and impossible to match with a uniform spacing in the second lane, then in that event the two lanes shall be completely separated by 3/16-inch joint material extending from the surface to one (1) inch below the bottom of the concrete being placed.

Where integral curb or doweled curb is placed along with the concrete pavement, premolded joint filler material shall be placed in the full section of the curb in true alignment with the pavement joint and in perpendicular position.

- 2. Construction of Formed Contraction Joints: Formed construction joints shall be constructed by embedding preformed joint material. The filler shall be cut to the exact sections of the joint.

Transverse contraction joints (dummy joints) shall be placed after compaction and finishing of concrete have been completed and before initial set. A groove shall be cut into the surface at the location of joint, using a tool provided with stops (tee iron) to prevent cutting the groove deeper than the planned depth of the joint filler. The

joint filler shall then be forced into the groove until the top is flush with the pavement surface.

After the joint filler has been imbedded in the concrete, the surface of the pavement shall be finished against the filler strip with hand floats to restore the surface finish. While performing this operation, the filler strip must be maintained in a vertical or normal position, true to alignment. After finishing, the entire area of the joint shall be true to grade and smoothness without any irregularities.

3. **Sawed Contraction Joints:** Sawed contraction joints shall be constructed by sawing a vertical groove in the hardened concrete on an approved schedule after placing and before development of random cracks in the concrete slab. Transverse contraction joints shall be sawed before the longitudinal joints are sawed.

Sawed longitudinal joints in general are not critical as to a specific time schedule after hardening of the concrete and may be delayed under favorable conditions before an incidence of longitudinal random cracking begins. Sawing of the joints shall begin as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking occurs. If necessary, the sawing operations shall be carried on both day and night until completed, regardless of weather conditions, as directed by the Engineer.

Two or more sawing units may be required to accomplish the sawing in order to minimize random cracking. Standby equipment shall be on the job to ensure continuous sawing as specified regardless of any breakdown of equipment.

Where curing membrane is used, the area disturbed by sawing of joints shall be resprayed immediately upon completion of the sawing and sealing operation and care shall be exercised to prevent the curing compound from getting into the groove. Joint sealing compound will not adhere to concrete if curing compound is present.

The depth of sawed transverse and longitudinal contraction joints shall be not less than one-fourth (1/4) the depth of the slab.

After the curing period the joints shall be cleaned and sealed with joint sealants. Excess scaling material shall be cleaned off the surface of the pavement before opening to traffic.

4. **Transverse Construction Joints:** Transverse construction joints of the type shown in the Standard Drawings shall be placed whenever the placing of concrete is suspended for more than 30 minutes. A butt joint with dowels or a thickened-edge joint shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tie bars shall be used if the joint occurs at any other location.
5. **Transverse Expansion Joints:** Transverse expansion joints are placed only where shown on the Approved Plans or where directed by the Project Engineer.

Transverse expansion joints shall be constructed with premolded material, one-half inch (1/2") in thickness. They shall extend the full width of the pavement and from one inch (1") into the subgrade to the one inch (1") below the top of the pavement. The joint alignment must be at right angles to the pavement center line unless otherwise specified.

The expansion joint filler shall be held in a vertical position. An approved installing bar or other device shall be used if necessary to ensure proper grade and alignment during placing and finishing of the concrete. The device must be in place long enough to prevent sagging of the material, especially on streets having steep grades.

Finished joints shall not deviate in horizontal alignment more than 1/4 inch from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

In multiple lane construction, the joints shall be matched so as to form a continuous alignment over all lanes. Expansion joints shall extend continuously through all curbs, where curbs are integral, special care being exercised to preserve alignment perpendicular to the pavement in the curb section.

6. Sealing Expansion Joints: After the pavement is cured and before any traffic, the space above the top of expansion joint filler strip shall be thoroughly cleaned of all loose material. The one-half inch (1/2") wide groove shall be completely free of any projecting concrete from the sides and the groove shall be continuous across the slab to each edge. It shall then be filled level with the pavement surface with joint sealant.

The joint sealant material shall be heated and placed in complete accord with the manufacturer's instructions. Burned material will be rejected. The expansion joint groove shall be dry at the time of pouring the sealing compound.

7. Longitudinal Contraction Joints: The joints shall be constructed in true alignment with respect to their proper location on center line or parallel thereto as is shown in a succeeding subsection.
8. Standard Location for Longitudinal Joints: Standard location of longitudinal joints, whether contraction or construction, shall conform to Portland Cement Association recommendations.
9. Longitudinal Expansion Joints: Longitudinal expansion joints shall be as shown on the Approved Plans or where required for concrete pavement between or along retaining walls, curbs or other structures. They shall be placed to conform to Portland Cement Association recommendations.
10. Longitudinal Construction Joints: Longitudinal construction joints shall be as shown on the Standard Drawings. The Contractor may use an approved keyed joint in lieu of thickened edge for longitudinal construction joint. The Contractor shall submit plans for the keyed joint for approval by the Engineer prior to construction.

- H. Finishing Concrete: Hand finishing or machine finishing of the entire pavement surface will be permitted unless otherwise provided in the Special Conditions.

On all vertical curves and at irregular intersections, modified tools shall be provided as necessary to secure a smooth, uniform contour and surface.

All tools shall be kept in first-class working order and shall be inspected daily. Worn or defective tools will not be permitted. A sufficient number of tools shall be provided for the work to proceed efficiently.

1. Hand Finish: After the concrete has been struck off and consolidated, it shall be smoothed by longitudinal floating. Floating shall continue until all irregularities are removed.

After the final passage of the longitudinal float, transverse floating shall be continued with long handled floats operated from outside the pavement slab.

After floating, the surface shall be scraped with a grout rod at least town (10) feet in length with a long handle for operating at the edge of the pavement. The grout rod shall be operated to correct irregularities in the pavement surface and remove water and laitance.

2. Machine Finishing: The finishing machine shall be of a type approved by the Project Engineer. The machine shall be adjustable to both crown and plane of the finished pavement surface. The screed shall oscillate longitudinally during its travel transversely across the pavement.

The finishing machine shall be moved over the pavement as many times as is necessary to give the pavement a smooth even-textured surface, conforming to the exact crown and cross-section specified on the Approved Plans.

3. Edging: Before final finishing is completed and before the concrete has taken the final set, the pavement shall be edged as indicated below.

<u>LOCATION</u>	<u>RADIUS</u>
Edge of Pavement	One-Eighth (1/8) Inch
Formed Longitudinal Contraction Joints	One-Eighth (1/8) Inch
Longitudinal Construction Joints	One-Eighth (1/8) Inch
Transverse Construction Joints	One-Eighth (1/8) Inch
Formed Transverse Contraction Joints	One-Eighth (1/8) Inch
Expansion Joints - Type A	One-Eighth (1/8) Inch
Curbs--Back Edge	One-Half (1/2) Inch
Curbs--Front Edge	One (1) Inch

Particular attention shall be given to edge at the appropriate time. The concrete shall have attained a partial set and all free water shall have disappeared so that the edged joints will be clearly defined, with no tearing or slump of the edges.

4. Final Finish: A burlap drag or broom shall be used for final finishing. The burlap drag shall be at least 3 ft. wide and long enough to cover the entire pavement width.

It shall be kept clean and saturated with water while in use. It shall be laid on the pavement surface and dragged in the direction in which the pavement is being placed. For a broom finish, a stiff bristled broom shall be drawn from the center to the edge of the pavement with adjacent strokes slightly overlapping to produce surface corrugations of uniform appearance and about 1/16 inch in depth.

Before using either the drag or the brush, the concrete shall have set sufficiently that the surface is not grooved or gouged in the finishing operation.

5. Surface Smoothness: After all finishing is complete, the surface smoothness shall be checked with a straightedge ten (10) feet long, mounted to a long handle to permit operation from outside the pavement. The straightedge shall be placed on the surface of the pavement parallel to the center line and at intervals of no more than five (5) feet across the full width of the pavement. At conclusion of the finishing operation the surface of the pavement shall not vary from a true surface, more than one-eighth (1/8) inch in 10 feet.

In no case shall the grade in the gutter be such that it will allow ponding of water. If the surface smoothness of the pavement after curing is found to exceed the tolerance permitted, the high spots shall be ground until they meet the tolerance. If the surface tolerance cannot be met satisfactorily by grinding, then in that event the pavement shall be removed and be replaced in conformance with the Specifications at the expense of the Contractor.

- I. Curing and Protection: The concrete pavement shall be protected against excess loss of moisture, rapid temperature change, rain, water and mechanical injury during and immediately following the placing and finishing operations.

Concrete shall be cured by protecting it against loss of moisture, rapid temperature change, and mechanical injury for at least 7 days after placement. Moist curing, waterproof paper, white polyethylene sheeting, white liquid membrane compound, or a combination thereof may be used. After finishing operations have been completed, the entire surface of the newly placed concrete shall be covered by a curing medium approved by the Engineer. The edges of concrete slabs exposed by the removal of forms shall be protected immediately to provide these surfaces with continuous curing treatment equal to the method selected for curing the slab and curb surface.

The Contractor shall have at hand and ready to install before actual placement begins the equipment needed for adequate curing.

1. Moist Curing: Moist curing shall be accomplished by a covering of burlap or other approved fabric mat used singly or in combination. Curing mats shall be thoroughly wet when applied and kept continuously wet and in intimate contact with the pavement surface for the duration of the moist-curing period. Burlap or fabric mats shall be long enough to cover the entire width and edges of the pavement lane and lapped at joints to prevent drying between adjacent sheets.
2. Waterproof Paper or White Polyethylene: Waterproof paper or white polyethylene sheets shall be in pieces large enough to cover the entire width and edges of the slab and shall be lapped not less than 18 inches. The paper or polyethylene shall be

adequately weighted to prevent displacement or billowing due to wind, and material folded down over the side of the pavement edges shall be secured by a continuous bank of earth. Tears or holes appearing in the paper or polyethylene during the curing period shall be immediately repaired.

3. Membrane: The membrane method of curing shall be applied behind the final finishing operation after all free water has disappeared from the surface. Complete and uniform coverage at the minimum rate of 150 sq. ft. per gallon shall be required. The compound shall be kept agitated to prevent the pigment from settling, and it shall be applied to the pavement edges immediately after the forms have been removed. Membrane curing will not be permitted in frost-affected areas on paving that will be exposed to de-icing chemicals within 30 days after completion of the curing period.
4. Cold-Weather Protection: Except by specific written authorization, by the City Engineer, concreting shall cease when the descending air temperature in the shade and away from the artificial heat falls below 40°F. It shall not be resumed until the ascending air temperature in the shade and away from artificial heat rises to 35°F.

When concrete has been placed in cold weather and the temperature may drop below 35°F., straw, hay, insulated curing blankets, or other suitable material shall be provided along the line of work. Whenever the air temperature may reach the freezing point during the day or night, the material shall be spread over the concrete deep enough to prevent freezing of the concrete. Concrete shall be protected from freezing temperatures until it is at least 10 days old. Concrete injured by frost action shall be removed and replaced at the Contractor's expense.

5. Curing in Hot Weather. In periods of low humidity, drying winds, or high temperatures, a fog spray shall be applied to concrete as soon after placement as conditions warrant in order to prevent the formation of shrinkage cracks. The spray shall be continued until conditions permit the application of a liquid curing membrane or other curing media. The Project Engineer shall make the decision when the use of a fog spray is necessary.
- J. Opening Pavements to Traffic: The pavement shall not be opened to truck traffic until the field-cured concrete has attained a flexural strength of 550 psi, or a compressive strength of 3,500 psi. If such tests are not conducted, the pavement shall not be opened to automobile traffic until 3 days after the concrete was placed. Likewise, it shall not be open to truck traffic until 14 days after the concrete is placed. Before opening to traffic, the pavement shall be cleaned.
 - K. Cleanup: In addition to the cleanup specified in Section 553, the Contractor shall, before final acceptance of the work, flush the pavement clean and remove the debris. He shall also clean out all open culverts and drains, inlets, catch basins, manhole and water main valve chambers, within the limits of the project, of dirt and debris of any kind. The cleaning and disposal of such waste material shall be considered as incidental to the construction and all costs thereof shall be included in the unit contract prices of various items of the work.

3.19

CONCRETE CURB AND GUTTER, CONCRETE GUTTER AND DRIVEWAYS

3.19.1 Description: The construction of concrete curb and gutter and concrete gutter shall be in conformance with these Specifications and with the Standard Drawings.

- A. High-Back Curb and Gutter (Type A): This type of curb and gutter is predominantly used on major streets in Wellsville. Unless otherwise specified and approved, this type shall be installed along all City streets.
- B. Depressed Curb (Handicap Ramp): At intersections where new concrete curbs are to be constructed, the contractor shall construct handicap curbs. The depressed curbs shall be constructed in accordance with the attached Standard Drawing.
- C. Drain Gutter: In intersections where water is to surface drain through the intersection drain gutters shall be used.
- D. Concrete Driveways: Concrete driveways shall conform to Standard Drawing.

3.19.2 Materials and Forms:

- A. Concrete: The portland cement concrete, joint filler, reinforcing steel and curing materials shall conform to these Specifications, Portland Cement Concrete--Materials. Concrete mix for curbs shall conform to the requirements for Class 4000. Slump of the concrete mix shall not exceed three and one-half (3-1/2) inches and the air content shall be 6% ± 1.
- B. Preformed Expansion and Dummy Joint Filler: See Section 3.18.
- C. Curing Compounds: See Section 3.18.
- D. Forms: See Section 3.18.

3.19.3 Construction Details:

- A. Excavation: All excavation for curb and gutter construction shall be the responsibility of the curb and gutter Contractor. All excess excavated material shall be removed from the site within seven days after completion of the curb and gutter construction. After said time, the City may have such excess excavated material removed at the expense of the responsible Contractor.
- B. Bedding: All concrete curb and gutter, concrete drain gutter and concrete driveway shall be bedded with a minimum of five inches and not over 8 inches of untreated base course.
- C. Entrances: All driveways, alleys and other entrances disturbed by the curb and gutter construction shall be returned to a satisfactory usable condition with 95% subgrade compaction and surfacing equal to or better than the original.
- D. Placing and Finishing: While the concrete is being placed and consolidated, the face of the curb shall be formed with a fixed or moving form conforming to the dimensions shown on

the Wellsville City Standard Drawings. After placement, the concrete shall be consolidated by spading or vibration. The concrete shall be struck off and finished true to cross-section. As soon as the concrete has attained sufficient hardness, face forms, if used, shall be removed and the concrete finished with a wood float and trowel. Final finish shall be obtained with a brush. After final finishing, gutters and curb shall be tested with a ten-foot straightedge to see that the finished gradient is uniform. Irregularities of more than one-quarter inch in ten feet shall be corrected. No honey combing will be permitted.

E. Contraction Joints:

1. Curb and gutter shall be divided into sections of length by contraction joints.
2. A contraction joint formed by division plates shall be used in such a manner so the curb and gutter shall be divided into uniform sections of ten feet except where shorter sections are necessary for closures, but no section shall be less than four feet in length.
3. The plates shall be one-eighth inch thick, fit neatly into the forms and be set perpendicular to the surface of the concrete and shall project through the curb head and no more than one-third of the depth of the gutter slab. The shape of the divider plate shall conform to the curb and gutter section with the exception that the lower two-thirds depth of the divider plate shall be removed.
4. This joint may be constructed by other methods that would obtain the same desired results if written authorization is first obtained from the City.

F. Expansion Joints: Non-extruding premolded expansion joint material of one- inch thickness conforming to ASTM D-1751 shall be placed at the junction of new concrete with existing concrete or existing structures at the tangent points of all alley and intersection returns as directed by the Engineer.

G. Backfilling: In fill sections a five-foot wide berm shall be constructed and compacted to 90% against the back of the curb and against the face of the gutter and sloped to the existing ground at a four to one slope. In cut sections the backfill shall be brought to the top of the curb and against the face of the gutter and compacted to 90% so as to fill the area excavated during construction. No areas within a street right-of-way may be sloped steeper than 2 to 1. No areas within 5 feet of the back of gutter may be sloped steeper than 10 to 1. Cut and fill slopes shall be rounded into existing surfaces in accordance with the Approved Plans. The Contractor shall take precautions to prevent drainage water from running or pooling behind or around the new curb and gutter.

H. Monolithic Construction: For all new construction the curb and gutter shall be constructed as one unit. For all areas where the curb heretofore has been constructed to the proper curb grades as established for such street, the gutter shall be constructed adjacent to such curb, but before placing such gutter the face of the curb shall be thoroughly scraped and brushed clear of all deleterious material. If in the opinion of the City the existing curb is in need of repair, the City may order it removed and the combined curb and gutter installed.

I. Driveway Installations:

1. All driveways constructed of concrete shall conform to the requirements of these Specifications and Standard Drawings.
 2. When constructed of concrete the thickness shall not be less than seven inches in residential area and not less than eight inches in commercial areas and public alleys.
 3. The subgrade shall be compacted to 95% of maximum density.
 4. Driveways abutting a curb, gutter and sidewalk combination or drive over curb and gutter or driveway gutter pan or any cross gutter shall have a strip of non-extruding expansion joint material one-half inch thick, conforming to the cross-sections of the driveway, placed between the driveway and the sidewalk or curb or cross gutter so as to provide for the expansion of the sidewalk or curb or cross gutter and the concrete driveway.
 5. All aforementioned expansion material shall conform to ASTM D 1751.
- J. Allowable Curb Cuts: Curb cuts will be allowed with authorization from the Engineer. The Engineer may permit valley gutter or any other types of curb cuts which, in his opinion best serve the property owner.

3.20
CONCRETE SIDEWALKS

3.20.1 Description: Concrete sidewalks shall be constructed in compliance with these Specifications and the Standard Drawings. The particular type of sidewalk to be used will be that specified in the Contract Documents.

3.20.2 Materials: The portland cement concrete, joint filler, reinforcing steel and curing materials shall conform to the requirements specified in Section 3.17, Portland Cement Concrete. The concrete mix for sidewalk shall conform to the requirements for Class 4000. Slump of the concrete mix shall not exceed three and one-half (3-1/2) inches and the air content shall be 6% ± 1.

3.20.3 Construction Details:

- A. **Excavation and Subgrade:** All excavation and subgrade preparation for sidewalk construction shall be the responsibility of the Contractor. The subgrade shall be compacted to 95% of maximum density.
- B. **Bedding:** All sidewalks are to be bedded with a minimum of four (4) inches of untreated base course unless authorized in writing by the City.
- C. **Forms:** The forms shall be wood or metal and shall be free from warp. Straight wood forms shall have a thickness not less than one and five-eighths inches. The forms shall be so set that the walk shall have a slope toward the street of one-quarter inch for each foot of width.
- D. **Thickness:**
 - 1. All walks shall be constructed of concrete and shall have a minimum thickness of four inches.
 - 2. At residential driveways, the sidewalk thickness shall be six inches.
 - 3. In commercial areas and public alleys the sidewalk thickness shall be increased to eight inches.
- E. **Placing and Finishing:**
 - 1. In all cases the walks shall be constructed in one course.
 - 2. B. The surface shall be struck off to the established grade by means of a straightedge. The surface shall then be finished true to grade with a wooden float followed by a steel trowel, and afterwards roughened lightly with a broom or brush.
 - 3. The walk shall be cut with a marking tool forming a groove at least one-half inch deep so that the walk is divided into sections, each section not longer than five feet.
 - 4. In no case shall a walk section exceed twenty-five square feet in area unless approved by the Engineer.

5. Care should be exercised not to over work the concrete and bring an excess of mortar to the surface.
 6. The slabs shall be rounded on all surface edges to a radius of one-quarter inch.
 7. The surface shall be brushed with a fiber hair brush of an approved type in a transverse direction except that at driveway and alley crossings it shall be brushed longitudinally.
 8. At intersections all sidewalks shall transition into handicap ramps.
- F. Adjustments: Whenever any adjustments of the grade slope, or slab marking is necessary or advisable in order to have the walk conform to existing abutting walk or other abutting structures, the adjustment shall be made only with the permission of and under the direction of the City Engineer or his representative.
- G. Expansion Joints: Strips of premolded non-extruding expansion joint material one-half inch thick conforming to ASTM D1 751 shall be placed between the side forms and to the full depth of the walk at least once in every 100 feet of walk, or as directed by the City Engineer. Similar joints shall be provided when new walk abuts other concrete walk or structures.
- H. Protection from Traffic: When completed, the walk shall be protected from foot traffic and the elements for at least 72 hours, except alley and street crossings which shall be protected from light vehicular traffic for at least five (5) days and from trucks of more than one-ton gross weight for seven days.
- I. Curing and Protection: The curing materials and procedures outlined in Section 3.18 shall prevail, except that white pigmented curing compound shall not be used on sidewalks. The curing agent shall be applied immediately after brushing and be maintained for a period of five (5) days.

The Contractor shall have readily available sufficient protective covering, such as waterproof paper or plastic membrane, to cover the pour of an entire day in event of rain or other unsuitable weather.

The sidewalk shall be protected against damage or defacement of any kind until it has been accepted by the City. Sidewalk which is not acceptable to the City because of damage or defacement, shall be removed and replaced at the expense of the Contractor.

Additional requirements for curing in hot weather shall be as outlined in Section 3.18. Additional requirements for curing in cold weather shall be as outlined in Section 3.18.

3.21
STREET LIGHTING AND SIGNING

3.21.1 Description: The work to be performed consists of furnishing and installing all necessary materials to complete in place the street lights as shown on the Standard Drawings. In-place street signs shall conform to the Standard Drawings.

- A. Street lights, wiring and appurtenances for new subdivisions must be installed by a qualified electrical contractor at the developer's expense. A lighting plan must be submitted to Rocky Mountain Power for approval prior to construction. All work must be accomplished per the latest version on the International Electrical Code and Rocky Mountain Power's approval.
- B. All electrical equipment shall conform to the latest standards of the National Electrical Manufacturer's Association (NEMA) or the Radio Manufacturer's Association, whichever is applicable. In addition to the requirements of these Specifications, the Approved Plans and the Special Conditions, all material and work shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code and the American Society for Testing Materials (ASTM).

3.21.2 Materials:

- A. General: Unless otherwise indicated on the Approved Plans or specified in the Special Conditions, all materials shall be new. The major components of the street light shall consist of the products specified in Sections of these Specifications or an equivalent product. The major components of the street sign shall comply with those specified on the attached Standard Drawings.
- B. Inspection: All material shall be subject to inspection after delivery to the site and during installation in the work. Failure of the Project Engineer to note faulty material during construction shall not relieve the Contractor of the responsibility for removing or replacing any such material at his own expense.

Inspection or sampling of certain materials may be made at the factory or warehouse prior to delivery to the site, when required by the City.

Material which has been rejected previous to delivery shall not be delivered to the work, and all material which has been rejected at the work shall be immediately removed from the site.

As-built drawings shall be kept by the Contractor showing exact locations of all underground conduit and connections, as well as all street lights and street signs. The as-built drawings shall be forwarded to the City upon completion of work.

- C. Street Light Components:
 - 1. Luminaire: Luminaires shall consist of an American Electric Lighting, American Revolution #247-Cutoff, four-sided lantern with black housing, 100-watt, 120-volt.
 - 2. Pole: Poles shall consist of a fiberglass pole, 16-foot mounting height (20-foot overall height), smooth-tapered, direct burial .

3.21.3 Construction Details:

- A. General: All electrical construction shall be carried out by competent crews under the direction of a licensed electrical contractor, or by the manufacturer's representatives where so required in the Special Conditions. All workmanship shall be complete and in accordance with the latest accepted standards of the industry, as determined by the City.

Failure of the City to note faulty workmanship during construction shall not relieve the Contractor of the responsibility for correcting the faults at his own expense.

- B. Placement: Street lights and signs shall be placed in accordance with the Approved Plans. Conduit and power cables shall be placed as necessary to serve the street lights. All underground conduit and cable shall have a brightly-colored warning tape buried at least twelve inches directly above the underground conduit or cable.

3.22 TOPSOIL

3.22.1 Description: These Specifications shall apply where the Approved Plans or Special Conditions require the procurement of top soil by the Contractor for the surface finishing of an area, or where the removal and replacement of existing top soil is required for the finishing of a specific construction area, generally in lawns or planting strips.

3.22.2 Materials:

- A. Topsoil: The topsoil shall be friable surface soil typical of the topsoil common to the area, free from materials toxic to plant growth, noxious weed seeds, sage brush, rhizomes, roots, subsoil, stones, and other debris. It shall be capable of sustaining healthy plant life. One hundred percent of the topsoil shall pass through a one inch screen, unless otherwise stipulated on the Plans.

The maximum allowable percentage of gravel retained on a No. 4 inch screen shall not exceed 20 percent by volume. Of the material passing the No. 4 inch screen, the maximum allowable percentage of gravel retained on a Number 10 screen shall not exceed 10 percent by weight.

The topsoil shall be shown to be within allowable levels of toxic mineral contaminants, said levels to be set by the City Engineer or by the Building Official in cooperation with the Utah State Board of Health.

3.22.3 Construction Details:

- A. Placement of Topsoil: Immediately prior to placing topsoil, the surface area upon which it is to be placed shall be cleaned of objectionable matter and the area smoothed and compacted to 85% maximum density. After compaction and immediately prior to spreading topsoil, the subgrade surface shall be scarified by raking or harrowing.

Topsoil shall be placed where shown on the Approved Plans and to depths provided for in the Special Conditions, or direction of the Project Engineer. In level or slightly sloped areas the topsoil shall be leveled, raked, and compacted to 85% maximum density so as to provide a well shaped and uniform appearance. On steep slopes, the topsoil shall be left rough and uncompacted.

- B. Removal and Replacement of Topsoil: Whenever it is necessary to remove topsoil with the purpose of later replacing it in the same area, the Project Engineer will direct the limits of the area and the depth of topsoil to be removed. The topsoil shall be removed in a uniform depth and be stored in such manner that it will not become mixed with unsatisfactory soils. The stored topsoil shall be replaced at a uniform depth in its original area. The topsoil shall then be shaped, leveled, and compacted to blend with the contour of adjacent ground.

In the event that additional topsoil is required and is procured from a source other than the construction area, the Contractor shall furnish and place it in compliance with Section 3.22.3A and the intent of this subsection. Additional topsoil shall be of similar texture as native Soil.

3.23
SEEDING, LAWN REMOVAL AND REPLACEMENT

3.23.1 Description:

- A. Sod Removal and Replacement by Seeding: In many areas the existing lawn is such that the removal and replacement of existing sod is not feasible. In these areas, where seeding is a part of the project and is included in the bid proposal, the Contractor shall seed all lawn areas which are damaged during construction and plant lawn where shown on the Approved Plans and/or as directed by the City.
- B. Sod Removal and Replacement by New Sod: In many areas the existing lawn is such that the removal and replacement of existing sod is not feasible. In these areas, where lawn repair, using new sod, is part of the project, the Contractor shall replace all lawn areas which are damaged during construction with new sod where shown on the Approved Plans and/or as directed by the City.
- C. Sod Removal and Replacement: The work shall consist of the removal and replacement of existing lawn turf by cutting the sod to be removed into convenient sized squares or strips, cutting to uniform thickness, piling and storing in a dampened condition, and finally replacing the sod in its original position. Removal and replacement shall be completed within a 24-hour period. Removed sod shall be protected from direct sunlight and intensive heating conditions. This work will be performed wherever the Special Conditions provide for such work.

The Contractor may at his option use sod brought in from an outside source in lieu of replacing existing sod. If the Contractor so elects to use sod from an outside source, this source of supply must be approved by the Project Engineer.

3.23.2 Materials:

- A. Topsoil: The soil material shall conform to the requirements of Section 3.22.
- B. Replacement by Seeding:
 - 1. Seed: Grasses, legumes, or cover crop seed of the type hereinafter specified shall conform to the standards for "Certified" grade seed or better. Seed shall be furnished in standard containers on which shall be shown the following information:
 - (1) Seed Name
 - (2) Lot Number
 - (3) Net Weight
 - (4) Percentage of Purity
 - (5) Percentage of Germination
 - (6) Percentage of Weed Seed Content in Inert Material Clearly Marked for Each Kind of Seed in Accordance with the Applicable State and Federal Laws.

Upon request, the Contractor shall furnish to the Project Engineer, duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested

by a recognized seed testing laboratory within six (6) months before the date of delivery on the project. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

Seed mix and rate of application shall be as specified in the Special Conditions.

2. Fertilizer: Fertilizer shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified herein. All fertilizers shall be furnished in standard unopened containers with weight, name of plant nutrients and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws. Fertilizer shall be stored in a dry and elevated location.

Acceptable commercial fertilizer may be supplied in one of the following forms:

(a) A dry free-flowing granular fertilizer suitable for application by agricultural fertilizer spreader.

(b) A soluble fertilizer ground to a fineness that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

(c) A granular or pelleted fertilizer, suitable for application by blower equipment.

(d) A non-volatile liquid fertilizer.

Commercial fertilizer formulation and rate of application shall be as specified in the Special Conditions.

3. Mulch: All mulch material shall contain a tackifier or it shall be crimped into the surface.
4. Straw: All straw mulch material shall be in an air dried condition free of noxious weeds, weed seeds, and other materials detrimental to plant life. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.
5. Wood Cellulose Fiber: Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture.

Each package of the cellulose fiber shall be packed by the manufacturer to show the air dry weight content. All fiber shall be kept dry before mixing. All mulch material must be acceptable to the Project Engineer.

6. Tackifier: The proposed tackifier shall be of a readily available commercial type manufactured specifically for the purpose of tacking seed or mulch to soils. The type of tackifier, its manufacturer, and its supplier shall be submitted for approval by Project Engineer if requested by Engineer.
7. New Sod: All sod shall comply with the State and Federal laws, including quarantines, with respect to inspection, plant diseases and insect infestation. Sod

shipments shall have a certificate of origination and/or certification of approved treatment when shipment originates in known infested areas.

All sod shall be guaranteed to survive in a healthy condition through an establishment period on ninety (90) days. The establishment period shall commence on the date of acceptance of placed sod by the Engineer. All sod which, in the opinion of the Engineer, is not in a healthy growing condition at the end of the establishment period, shall be removed and replaced by the Contractor at his own expense. Sod that is replaced shall be of the same mixture and grade as the surviving sod.

Sod shall be mature, densely-rooted grass and shall possess the following characteristics:

- a. Uniformity.
- b. Acceptable Color.
- c. Freedom from Serious Weeds and Weed Seeds.
- d. Adequate Sod Strength for Handling.
- e. A Minimum Amount of Thatch.

3.23.3 Construction Details:

A. Seeding:

1. Preparation: All areas shall be scarified to a depth of two (2) inches unless otherwise specified immediately prior to topsoil distribution.

Cultivation of the soil shall be done at right angles to the natural flow of water on the slopes. All cost and expense incurred in performing the work herein specified shall be considered incidental.

Remove all visible rocks, clods and debris three (3) inches or larger in any dimension. Any exposed tree roots in cut slopes shall be neatly pruned at the finished grade of the slope and the cut treated with an approved sealer.

2. Placement of Topsoil: Topsoil shall be evenly spread over the specified areas to a minimum depth of four inches unless shown otherwise on the Approved Plans. After the topsoil has been spread, all large clods, hard lumps, rocks and litter shall be raked up, removed and disposed of by the Contractor.

Topsoil shall not be placed when the ground or topsoil is frozen or excessively wet.

All damage occurring to existing roadbeds, shoulders, walks, curbs or other existing adjacent structures or areas due to the Contractor's operation in hauling and placing the topsoil shall be repaired by the Contractor at his own cost and expense.

3. Compaction: All topsoil shall be compacted to 85% maximum density unless otherwise specified. Compaction shall be by sheepsfoot roller, cleated crawler tractor or similar equipment. Equipment shall be so designed and constructed to produce a uniform surface ready for sodding or seeding and mulching, and which

will bond the topsoil to the underlying material. Compaction equipment shall be operated parallel to the natural flow of water on the slopes unless otherwise ordered by the Project Engineer.

4. Seeding: Seeding shall not be done during windy weather or when the ground is frozen. Seed shall be placed at the rate and mix specified in the Special Conditions. A tackifier shall be used when seeding slopes steeper than 4H:1V. Seed may be sown by one of the following methods:
 - (a) An approved type, hydro-seeder which utilizes water as the carrying agent, and maintains continuous agitation. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry. When only hydro-seeding is to be used the seed shall be raked into the surface. When hydro-mulching is used, a two step process of hydro-seeding followed by mulching shall be utilized.
 - (b) Approved blower equipment with an adjustable disseminating device capable of maintaining a constant measured rate of material discharge that will insure an even distribution of seed at the rates specified. A tackifier shall be added to the seed mixture when blown on.
 - (c) Approved power-drawn drills or seeders.

Areas inaccessible to above method of application shall be seeded and fertilized by approved hand methods. Distribution of the material shall be uniform and at the rates specified.

It shall be the Contractor's responsibility to provide qualified personnel experienced in all phases of seeding and fertilizing operation, equipment and methods as herein specified.

5. Fertilizing: Fertilizer shall be applied by mixing with the mulch at the rates and analysis specified. The fertilizing and mulching shall be done separately from seeding.
6. Spreading Mulch: Tackifier and mulch material of the type herein specified shall be furnished, hauled, and evenly applied at the rates indicated, and shall be spread on seeded areas within forty-eight (48) hours after seeding unless otherwise spread.
7. Contractor's Responsibility for Work: The Contractor shall be responsible for all work herein described and the following requirements as directed by the Project Engineer.
 - (a) Protect all areas involved against vehicles with barricades.
 - (b) Reseed and fertilize areas failing to show a uniform stand of grass after germination of seed or damage through any cause before final inspection.

Maintenance and protection during a suspension of work shall be as herein described and as directed by the Engineer.

7. Final Inspection and Acceptance: Acceptance of areas receiving seed, fertilizer and mulch as herein specified shall be based on a uniform stand of vegetation at the time of final inspection. Areas failing to show uniform stand of vegetation after germination, or damage through any cause prior to final inspection shall be reseeded as herein specified at the contractor's expense. Final inspection shall not be done before 90 days during which the temperature reaches or exceeds 40°F. On each of the 90 days,

- B. Sod Removal and Replacement: The sod shall be removed to a uniform depth of approximately two (2) inches with an approved type of sod cutter. This operation shall be performed in such manner as to insure uniform thickness of sod throughout the operation.

As the sod scalping proceeds, the sod strips shall be placed in neat piles at convenient locations and from then on they shall be maintained in a damp condition continuously until the sod strips are replaced on the lawn. In no case shall the sod remain in piles longer than 24 hours before replacement on the lawn. Sod shall be kept shaded.

Prior to replacing the strips of sod, the scalped area shall be carefully shaped to proper grade, rototilled to a depth of six (6) inches, watered, raked smooth, and lightly compacted.

After rototilling, shaping and lightly compacting the finished grade, the topsoil shall be thoroughly dampened and fertilized prior to and immediately before replacing the sod. The sod shall be replaced to the required grade, taking care to butt each piece tightly against the adjacent one. Upon completion, the sod shall be dampened and rolled with a lawn roller.

All tools used shall be of a type specially designed for the work and be satisfactory to the Engineer. In no case shall sod be removed by the use of a mattock or other tool which will not meet requirements specified herein.

Wherever the construction operations have resulted in the placement or exposure of unsuitable or poorer soils in the area to be resodded, the surface shall be left low and covered with topsoil meeting all requirements of Section 3.22. Topsoil placement and replacement of the existing sod shall then be performed in the same manner as that set forth in Section 3.23.

- C. New Sod:

1. Grading:

- (a) Existing Subsoil Suitable for Sod Installation: Areas to receive sod shall be cleared, grubbed and leveled to a depth of four (4) inches below grade. Two (2) inches of topsoil shall be evenly spread over and cultivated into the top six (6) inches of existing subsoil and compacted so that the compacted surface is two (2) inches below finished grade.
- (b) Existing Subsoil is Poor: Areas to receive sod shall be cleared, grubbed and leveled to a depth of six (6) inches below grade. Four (4) inches of topsoil

shall be evenly spread over the existing subsoil and compacted so that the compacted surface is two (2) inches below finished grade.

2. Fertilizer: A 16-16-8 fertilizer shall be rototilled into the top four (4) inches of the soil at a rate of three (3) pounds per 1000 square feet. Fertilizer shall be applied no less than two (2) days prior to sod placement.
3. Sod Placement: Sod shall be placed in accordance with standard horticultural practices. Dry soil shall be moistened by sprinkling. All butt joints shall be staggered. On sloped areas the sod shall be laid with the long dimension parallel to the toe or top of slope. After placing, the sod shall be rolled and heavily watered by sprinkling.
4. Establishment: The contractor shall be responsible for watering and fertilizing the sod during the establishment period of 90 days. Watering shall be scheduled to prevent drying of joints between sod strips. 16-16-8 fertilizer shall be applied at three (3) week intervals at the rate of six (6) pounds per 1000 square feet per application.

3.24
LANDSCAPING

3.24.1 General: This work shall consist of furnishing and planting trees, shrubs, and ground covers where shown on the plans or as established by the City, all in accordance with specifications and accepted horticultural practices. Two trees, having a minimum diameter of 2 inches (measured 12 inches above the ground), will be required for each approved subdivision lot.

3.24.2 Materials:

- A. Planting soil, fertilizer, organic material and seeds used for landscaping and erosion control shall meet the requirements specified in Sections 3.22 and 3.23.
- B. Plants and trees: All plants and trees shall be nursery grown, healthy, vigorous, well-rooted, and shall be true to type or name as shown on the plans and shall conform to the American Standard for Nursery Stock, No. 1 grade, American Association of Nurserymen, Inc., latest edition, ASA Spec. Z 60.1 and shall be tagged in accordance with the most recent standard practice recommended by the American Association of Nurserymen and to the latest edition of Standardized Plant Names, American Joint Committee on Horticultural Nomenclature.

All plant and trees shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Inspection certificates required by law shall accompany each shipment of plants, and all plant shipments shall be inspected and passed by the Department of Agriculture. All shipments of pine nursery stock shall meet all applicable State and Federal quarantine regulations.

- C. Nomenclature: Nomenclature for varieties of plants and trees shall be in accordance with the latest edition of "Standardized Plant Names" as prepared by the American Joint Committee on Horticultural Nomenclature.
- D. Quality of Plant and Tree Materials: It is the intent of these Standard Specifications that all materials meet the standards as set forth herein, throughout the life of the contract. During inspections, as set forth hereinafter, all plant and tree material will be judged and rejections shall be based upon these standards.

In determining the quality of plants and trees, the following elements shall be evaluated:

- 1. Root condition.
- 2. Size (above ground).
- 3. Insect and disease free condition.
- 4. General appearance (color, shape, prior pruning).

All container grown plants and trees specified in the plans shall be established in the container in which they are sold, and grown in that container sufficiently long for the new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

Balled and burlapped plants and trees shall be dug with the ball of earth in which they are growing. Ball sizes shall be of a diameter and depth required to contain enough fibrous root system for the full recovery of the plant. The ball shall be firm and unbroken.

Pruning of plants and trees shall not be done prior to delivery to the planting site except by approval of the Engineer. Pruning, when found necessary to remove damaged branches and to improve the shape and form when approved by the City, shall be accomplished after completion of individual planting operations.

- E. Handling and Shipping: Plants and trees shall be packed for shipment according to standard practice for the type being shipped. The root system shall not be permitted to dry out at any time. Plants and trees shall be protected against heat and freezing temperatures, sun, wind, climatic, or seasonal conditions during transit. Plants and trees specified balled and burlapped (B & B) shall be handled by the ball of earth. Broken or “made” balls will not be acceptable. Container grown plants and trees shall be well developed with sufficient root development to hold the earth intact after removal from the container without being root bound.
- F. Inspection: The Contractor shall inform the City as soon as possible, of the source of plants or trees for the project. At the City’s option an inspection of all materials at the source may be required prior to shipping of plants and trees from the nursery. This inspection shall coordinate the judgement areas regarding size and quality of plant material between the Contracting Agency, the Contractor and the nursery. However, there will be no acceptance of any plant or tree during this inspection.

All plants and trees will be inspected by the City on arrival at the site or storage area for quality. These inspections shall determine the acceptance or rejection of the plants and trees based on quality as specified in Subsection D, “Quality of Plant and Tree Materials”. This inspection is for quality only and does not constitute final acceptance. Plants which are rejected shall be immediately removed from the holding area and replaced by acceptable plants at the Contractor’s expense.

All plants and trees will be continually inspected during planting and through the establishment period. Plants and trees may be individually rejected during this time based on mechanical damage, quality or physical change of the plant which is not normal to the plant or to the season of the year. Plants and trees which are rejected shall be immediately removed from the project and replaced by the Contractor at his expense.

3.24.3 Construction:

- A. Site Preparation: This work shall consist of all work necessary, as set forth in the contract documents, such as roadway construction, drainage facilities, grading, cleaning, etc., to prepare the area for the actual landscaping work. All work as set forth herein shall be completed and approved by the City prior to beginning any preparation of the planting areas.
- B. Layout of Planting: The Contractor will designate, by means of stakes or other approved markings, the ground location of each random placed plant and tree. Areas of massed or uniform solid plantings shall be marked at their outer extremes only. The City’s approval of stakeout will be required prior to the commencement of the preparation of planting areas.

In mixed planting areas, trees shall be planted first, followed by the larger shrubs, low shrubs, and the final planting of ground covers.

- C. Preparation of Planting Areas: During the preparation of planting areas, all clods, rocks, or other debris over one (1) inch (2.5 centimeters) in dimensions shall be removed from both cultivated areas and backfill material, and disposed of.
- D. Planting Beds: The soil preparation shall not be initiated until all grading has been completed and the irrigation system has been installed, tested, adjusted, and accepted by the City. The ground surface within the area shall then be loosened and thoroughly pulverized to a depth of six (6) inches (15 centimeters). When required, organic matter, commercial fertilizer, or agricultural minerals and other additives shall be incorporated at the rate specified in the contract documents, and shall be thoroughly and uniformly tilled into the soil to a depth of six (6) inches (15 centimeters). The area shall then be brought to a plane in conformance to the elevations shown on the plans.
- E. Planting Holes: Prior to drilling holes, the proposed location of the irrigation lines shall be designated by means of stakes or other approved markings. In the event of conflict between individual planting holes and irrigation line, the planting holes in question shall be relocated.

All holes shall be drilled with a power auger to the dimensions specified by the Supplier. Holes shall be drilled at the location of each individual plant, the stake or marking being considered the center of the hole. The holes shall have vertical walls and horizontal bottoms.

When required, organic matter, commercial fertilizer, or agricultural minerals and other additives shall be incorporated at the recommended rates and shall be thoroughly and uniformly mixed with the material removed from the holes prior to backfilling. After backfilling the holes, the material shall be saturated with water to the full depth of the hole and until ponding appears in the basin. Sufficient backfill material shall be placed so that after planting and settlement has taken place, the basin will conform to the section as shown in the plans.

- F. Planting: No planting shall be done in any area until the Contractor has received the City's approval that the area concerned has been satisfactorily prepared.

No more plants or trees shall be distributed within the project area on any one day than can be planted and watered on that day.

Any planting done in soil that is too wet or too dry or not properly conditioned as provided herein will not be accepted.

Nursery stakes supporting plants and trees in containers shall be removed and the plant pruned, if necessary, as specified herein, after planting.

Containers shall be cut, three times, from top to bottom and plants shall be removed from the containers in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as hereinafter specified immediately after removal from the containers. Containers shall not be cut prior to delivery of the plants to the planting areas.

Balled and burlapped material shall have all strings or cords cut, and the burlap shall be laid back from the top half of the ball. This shall be done only after the plant is placed in its final position and before completion of the backfill.

Roots of plants and trees not in containers shall be kept moist and covered at all times and shall not be exposed to the air except while actually being placed in the ground.

Plants and trees shall be planted in such a manner that the roots will not be restricted or distorted. Soil shall be firmed around the roots or ball of the plant during planting operations by foot tamping or saturation with water.

Plants and trees shall be watered immediately after planting.

- G. Staking and Guying: All staking and guying shall be done concurrently with the planting operation.

The method of attaching the ties to stakes and trees shall provide firm connection, but the trunk loop shall be sufficiently loose to prevent damage to the bark. It may, on occasion, be considered necessary to use number 10 gauge galvanized wire encased in at least one-half (½) inch (1.27 centimeters) rubber hose as tree ties, in which case all connections shall be twisted.

- H. Pruning: Pruning shall be done as determined by the City after plant materials are planted.

Pruning of evergreen coniferous plants will not be permitted except under the direction of the City.

- I. Watering: The Contractor shall make his own arrangements for furnishing and applying water and shall pay all costs involved.

Valves at meters shall be kept closed at all times, except while the irrigation system is actually in use.

Precautions shall be taken during times when the irrigation system is on to prevent water from wetting vehicles, pedestrians, and pavement. Any erosion, slippage, or settlement of the soil caused by watering shall be repaired by the Contractor at his expense.

Compliance with the provisions in this section shall not relieve the Contractor of his responsibility for the replacement of plants as provided herein.

- J. Tree List: Only Ash, Maples, Ginkgo, Hackberry, Linden, London Plane or other long-lived shade trees acceptable to the City Tree Commission shall be planted.

3.25
RIP-RAP

3.25.1 Description: This item shall consist of furnishing and hand placing or placing loose rip-rap in accordance with these specifications, at the locations indicated, and in conformity with the lines, grades, and dimensions shown on the Approved Plans or as directed by the City.

3.25.2 Materials: Rip-rap shall consist of durable, angular field or quarry stone of approved quality, sound, hard, and free from seams, cracks, or other structural defects.

- A. Hand-Placed Rip-Rap: When hand-placed methods are used, 75% of the rock shall not be less than one-third of a cubic foot in volume nor less than 3 inches in thickness. The stones shall be graded so that a reasonably dense mass is obtained.
- B. Loose Rip-Rap: The greatest dimension of 50% of the loose rip-rap stone shall be at least two-thirds but not more than one and one-half times the thickness of rip-rap specified in the Contract Documents. The stones shall be graded in size so as to produce a reasonably dense mass. Not more than 10% of the rock shall have dimension less than 0.1 the thickness of rip-rap.

3.25.3 Construction Details:

- A. Hand-Placed Rip-Rap:
 - 1. Placing: Slopes where rip-rap is used shall not be steeper than the angle of repose of the abutting material, unless otherwise indicated in the Contract Documents or as directed by the Engineer. The rocks shall be hand-placed and bedded, one against the other, and as far as practicable shall be keyed together. Any large irregularities between the stones shall be filled with spells of suitable size rammed tightly into place.
 - 2. Finished Surface: The finished surface of the rip-rap shall present an even, tight surface, true to the lines, grades, and sections specified. The rip-rap shall extend sufficiently below ground surface, as directed by the Engineer, to secure a firm foundation.
- B. Loose Rip-Rap:
 - 1. Placing: Slopes to be protected shall be free of brush, trees, stumps and other objectionable material and dressed to a reasonably smooth surface. The stone shall be dumped into place so as to secure a rock mass with the minimum thickness and height as specified. The rock shall be manipulated to secure a regular surface of graded sizes and mass stability. Excavation as shown in the Contract Documents or as directed by the Engineer, shall be made at the toe of the slope to provide a firm foundation and protection against undercutting.

3.26
REMOVAL OF EXISTING STREET IMPROVEMENTS

3.26.1 Description: The work shall consist of the removal and disposal of various existing improvements, such as pavements, structures, pipe, curb, curb and gutter, gutter and other items necessary for the accomplishment of the improvement.

Removal of items or things not contained in this section or in other sections of these Specifications shall be considered as incidental to the construction.

3.26.2 Construction Details:

A. General: The removal of street improvements shall be conducted in such a manner as not to injure utilities and any portion of the improvement that is to remain in place. Any deviation in this matter will obligate the Contractor at his own expense, to repair, replace or otherwise make proper restoration to the satisfaction of the Project Engineer.

When sawing of concrete or combinations of rigid materials is called for in the Approved Plans or in the Special Conditions, the Contractor will be paid therefor at the unit contract price for the quantity involved.

B. Removal of Pavement: The pavement removal shall consist of those instances where portions or all of existing pavements are being removed in conjunction with street construction and for the placing of utilities such as sewers. Because of variable underground conditions, the limits of the pavement removal cannot be accurately determined prior to actual construction.

Pavement removal shall also consist of the removal required for narrow and shallow utility cuts in order to install light cables, conduits and similar shallow utilities.

The Contractor shall remove existing permanent type pavement and driveway pavement shown on the Approved Plans or as directed by the Project Engineer. Permanent type pavements will be classified according to their composition and thickness as defined below, unless the Contract Documents provide otherwise.

In the event a pavement, classified as described below, shall average more than the maximum thickness specified for its class, an additional payment will be made to cover the extra thickness removed at a mutually agreed to price or as stipulated in the Special Conditions. Where pavement removal is located in future planting areas, all pavement material and compacted base material shall be entirely removed to the native material. Prior to filling or topsoiling the subgrade shall be scarified to a minimum of 12 inches.

1. Pavement Removal, Class A: Class A pavement removal shall apply to all cement concrete pavement having average thickness between four (4) inches and ten (10) inches.
2. Pavement Removal, Class B: Class B pavement removal shall apply to all pavements which have a wearing surface of asphalt concrete upon a cement concrete pavement or cement concrete base, and for which the total combined thickness of the pavement will average between seven (7) inches and twelve (12) inches.

3. Pavement Removal, Class C: Class C pavement removal shall apply to early type pavement of a cement concrete base upon which is a brick or cobblestone wearing surface (or perhaps an additional layer of asphalt concrete upon that), and for which the total combined thickness of pavement will average between ten (10) inches and twenty (20) inches.
- C. Removal of Asphalt Concrete Pavement: Removal of existing pavements such as asphalt concrete, bituminous road mix, multiple lift bituminous surface treatments and any other combinations of above described components, placed upon an earth or granular subgrade located within the roadway excavation area shall be removed. The roadway excavation area is defined as the area 1 foot back of new curbs on either side and all areas in between.

Side street approaches to the project and street approaches at each end of the project paved with asphalt concrete having a depth of greater than two inches, on an earth or granular base and which are to be removed.

- D. Removal of Curbs: Existing curbs shall be removed where shown on the Approved Plans or where encountered in the work and designated by the Project Engineer. When pavement is being removed, the curb shall be considered as pavement removal. Precast curbs and curbs of other materials which are to be removed will be further identified on the Approved Plans.
- E. Removal of Curb and Gutter: Curb and gutter to be removed may be of cement concrete, or may be a cement concrete curb with a brick gutter on a cement concrete base, or may be other combinations of rigid materials. In any event it is intended that the full section shall be removed.

When curb and gutter is removed, provisions shall be made by the Contractor to channel any runoff which would normally flow in the gutter into existing drainage structures to reduce undermining and erosion during construction.

- F. Removal of Cement Concrete Sidewalks: All concrete slabs that average four (4) inches or less in thickness and which are to be removed, shall be considered as sidewalk removal. Pavement breakers used for this purpose shall meet the requirements outlined for pavement removal. Where concrete sawing is required, the provisions previously described shall apply. Sidewalk aprons and private walks on street grading and paving projects shall be removed to the extent necessary to provide for construction of pavements and curbs. After the curbs and pavement have been constructed, the Contractor will be required to provide proper connections and grades, as determined by the Project Engineer.
- G. Removal of Catch Basins, Manholes, Curb Inlets, Sumps, Etc.: Where structures or installation of concrete, brick, blocks, etc., interfere with the construction, they shall be removed and all pipe openings shall be properly plugged watertight with Class 4000 psi (3/4), Type II concrete.

Where the structures are removed, the voids shall be backfilled with suitable job excavated material and compacted as the Project Engineer may direct, and such compaction work shall be considered as incidental to the removal work.

If the Project Engineer determines the job excavated material to be unsuitable for backfill and he, therefore, specifies or directs that backfill from another source shall be used, the payment therefore will be made at a mutually agreed to price.

The removal and disposal of wooden structures shall be considered as incidental to the work.

- H. **Salvage:** Unless otherwise indicated in the Approved Plans or in the Special Conditions, all castings, pipe and other material or recoverable value taken from the discarded facilities shall be carefully salvaged and delivered to the Owner in good condition and in such order of salvage as the City may direct. Materials and items deemed of no value by the City shall be removed by the Contractor and become his property to be disposed of as he wishes.
- I. **Waste Disposal:** Unless otherwise provided in the Approved Plans, the Contractor shall provide the waste site for disposal of materials not required for the construction.

3.27

PLACEMENT AND ADJUSTMENT OF NEW AND EXISTING UTILITY STRUCTURES TO FINISH GRADE

3.27.1 Description: This work consists of constructing and/or adjusting all new and existing utility structures encountered on the project to finished grade.

3.27.2 Contractor to Schedule Work: The Contractor shall schedule his work and cooperate to the fullest extent so that structure adjustments by others can be satisfactorily accomplished. The Contractor shall do all pavement patching which may be necessary after adjustment of structures, and the cost thereof shall be considered as incidental to the adjustment of the various structures, except as modified hereinafter, and except that private utilities shall reimburse the Contractor for such patching.

3.27.3 Construction Details:

A. Adjusting of Manholes, Catch Basins, and Similar Structures:

1. General: Manholes shall be brought to proper finished grade by utilizing the same methods of construction as required for manhole construction.
2. Cement Concrete Paving Projects: Manholes, catch basins and similar structures shall be constructed. The final adjustment shall be made and cast iron frame be set after forms have been placed and checked. In placing the concrete pavement, extreme care shall be taken not to alter the position of the casting in any way.
3. Asphalt Concrete Paving Projects: On asphalt concrete paving projects, the manholes shall be adjusted prior to paving unless otherwise requested by the Project Engineer.
4. Asphalt Resurfacing Projects: Adjustment of manholes on asphalt resurfacing projects shall meet the requirement of the previous Section. Existing pavement shall be removed to the extent necessary to remove the manhole casting.
5. Storm and Sanitary Sewer or Water Projects: Manholes, catch basins, gate valve structures and other similar type structures being constructed in conjunction with sewer or water projects on graded or paved streets shall be brought to final grade as outlined previously in these Specifications.

B. Adjustment of Inlets: The final alignment and grade of cast iron frames for new and old inlets to be adjusted to grade will be established from the forms or adjacent pavement surfaces. The final adjustment of the top of the inlet will be performed in similar manner to that described for manholes.

C. Adjustment of Monuments and Cast Iron Frame and Cover: Monuments and monument castings shall be adjusted to grade in the same manner as for manholes.

D. Adjustment of Valve Box Castings: Adjustment of valve box castings shall be made in the same manner as for manholes.

- E. **Furnishing Castings:** Where adjustment of existing manholes, catch basins, inlets, valve boxes, etc. are required and the existing castings are discarded or ordered to be salvaged by the City Engineer, the Contractor shall furnish new castings of the type specified and payment therefor will be made as specified in the Contract Documents and will be in addition to payment for making the adjustment. Ring extensions shall be in accordance with the Standard Drawings.

3.28
PAVEMENT PATCHING

3.28.1 Description: This work shall consist of the patching of various types of pavement cuts, the performance of which shall be in accordance with the requirements outlined hereinafter and as shown on Wellsville Standard Drawings.

3.28.2 Materials: All materials shall conform to the requirements specified for material in other sections of these Standard Specifications.

3.28.3 Construction Details:

- A. General: Pavement patching shall be scheduled to accommodate the demands of traffic and shall be performed as rapidly as possible to provide maximum safety and convenience to public travel.

The patching and compaction of the trench backfill, and the preparation and compaction of the subgrade shall be in accordance with the requirements of the various applicable sections of these Specifications.

Before the patch is constructed all pavement cuts shall be trued so that the marginal lines of the patch will form a trapezoidal section with straight edges and slightly undercut faces. The use of a concrete saw may be required upon request by the City.

Proper signs, barricades, lights and other warning devices, as may be required by the City, shall be maintained all 24 hours of the day until the patch is completed and ready for traffic. The expense of these materials and effort shall be borne by the Contractor.

- B. Cement Concrete Pavements: After the subgrade for the pavement has been compacted and constructed to line and grade, the cement concrete pavement patch shall be placed, compacted and struck off to the grade of the adjacent pavement in accordance with the pertinent provisions of Section 3.28. The Contractor shall submit for approval the type of curing compound to be used at the time of permit application. The approved curing compound shall be placed on the finished concrete immediately after finishing.
- C. Asphalt Concrete Streets on Granular Base: After the subgrade has been prepared as shown on the Standard Drawings, or as directed by the Engineer, asphalt concrete pavement shall be placed to a minimum thickness of 8 inches or to the thickness of the existing asphalt pavement depth plus 1 inch, whichever is greater. The edges of the existing asphalt pavements and castings shall be painted with hot asphalt cement or asphalt emulsion immediately before placing the asphalt patching material. The asphalt concrete pavement shall then be placed, leveled, and compacted to 98% of maximum density to conform to the adjacent paved surface. Immediately thereafter, all joints between the new and original asphalt pavement shall be painted with hot asphalt or asphalt emulsion and be covered with dry paving sand before the asphalt solidifies. The material for tacking the bottom and sides of patches for asphaltic concrete shall be CRS-2 emulsion. For sealing the edges after placing the asphaltic concrete patch, RC70 cutback shall be used, the surface shall be sanded to prevent tracking.

- D. Oil Mat Streets: The existing oil mat shall be uniformly trimmed to a straight line. After the subgrade has been prepared as shown on the Standard Drawing, or as directed by the Engineer, a minimum of three (3) inches of asphalt concrete pavement shall be placed and completed in the same manner as specified above.
- E. Responsibility for Pavement Patching: The Contractor shall perform all work backfilling of excavations made under existing pavements, and the restoration of pavement cuts and patching, in accordance with these Specifications unless otherwise provided in the Contract Documents.

3.29
FINISHING AND CLEANUP

3.29.1 **Description:** After all other work embraced in the Contract is completed and before final acceptance of the Contract, the entire roadway including the roadbed, planting, sidewalk areas, shoulders, driveways, alley and side street approaches, slopes, ditches, utility trenches, and construction areas shall be neatly finished to the lines, grades, and cross-sections shown on the Approved Plans and as hereinafter specified.

3.29.2 **Construction Details:** Slopes, sidewalk areas, planting areas, and roadway shall be smoothed and finished to the required cross-section and grade by means of a grading machine insofar as it is possible to do so without damaging existing improvements, trees, and shrubs. Machine dressing shall be supplemented by hand work to meet requirements outlined herein, to the satisfaction of the Project Engineer.

Upon completion of the cleaning and dressing the project shall appear uniform in all respects. All graded areas shall be true to line and grade as shown on the typical sections and as required by the Project Engineer. Where the existing planting is below sidewalk and curb, the areas shall be filled and dressed out to the walk regardless of limits shown on the Approved Plans. Wherever fill material is required in the planting area it shall be left higher to allow for final settlement but, nevertheless, the raised surface shall present a uniform appearance.

Trash of all kinds resulting from clearing and grubbing or grading operations shall be removed and legally disposed of and not placed in areas adjacent to the project. Where machine operations have broken down brush and trees beyond the lateral limits of the project, the Contractor shall remove and dispose of same at his own expense. Damage to existing vegetation shall be repaired by a qualified tree surgeon at the Contractor's expense. Pruning shall maintain the natural shape of the plant.

Drainage facilities such as inlets, catch basins, culverts, and open ditches shall be cleaned of all debris which is the result of the contractor's operations, unless the Specifications of any particular section or the Contract Documents provide otherwise.

Where, by permission, soil is dumped on private property, the Contractor will not be required to perform any work beyond that described in the Contract Documents.

All pavements and oil mat surfaces, whether new or old, shall be thoroughly cleaned. Existing improvements such as Portland cement concrete curbs, curb and gutters, walls, sidewalks, and other facilities which have been sprayed by the asphalt cement shall be cleaned to the satisfaction of the Engineer. Castings for manholes, monuments, water gates, lamp poles, vaults, and other similar installations which have been sprayed with the asphalt material shall be cleaned to the satisfaction of the Engineer.

The Contractor shall sweep the street at the conclusion of the work unless otherwise provided in the Contract Documents. Sidewalks shall be hand broomed.

On sewer and water distribution projects where all or portions of the construction is in undeveloped areas, the entire area which has been disturbed by the construction shall be shaped so that upon completion the area will present a uniform appearance, blending into the contour of the adjacent

properties. All other requirements outlined previously shall be met, except that it will not be necessary to pick up more surficial rocks than is necessary to result in the appearance of adjacent undisturbed areas unless so provided in the Contract Documents.

3.29.3 Chip and Seal: Within 6 to 18 months after replacing asphalt, chip and seal all replaced asphalt. Overlap the chip and seal at least 2 feet on each side over the old asphalt.

Water Mains and Service
Installation

DIVISION 4

4.1
MATERIAL REQUIREMENTS

Unless specifically designated otherwise in each case, all materials and equipments furnished for permanent installation in the work shall conform to applicable standard specifications and shall be new, unused and undamaged when installed or otherwise incorporated in the work. No material or equipment shall be used by the Contractor for any purpose other than that intended or specified. All materials not conforming to these specifications shall be specifically approved in writing by the City prior to delivery to the jobsite. Any material or equipment found not conforming with City Standards and Specifications is subject to rejection.

4.2
PIPE FOR WATER MAINS

4.2.1 General: These specifications cover the pipe and fittings normally used for water distribution systems. Special considerations will be covered in the Approved Plans and Special Conditions.

4.2.2 Pipe:

- A. Ductile Iron Fittings and Rubber Gasket Joints: All joints under this specification shall be short body cast iron fittings conforming to ANSI/AWWA C110 or Ductile Iron Compact MJ fittings conforming to ANSI/AWWA C153. Pressure Rating of 350 psi.
- B. Ductile Iron Pipe: Ductile Iron Pipe shall be of Pressure Class 50 meeting the requirements of AWWA C151. Pipe and fittings shall be manufactured in the United States of America.
- C. Welded Steel Pipe: The work of this section consists of furnishing and installing all steel pipe and fittings as described in the Approved Plans. This pipe may be used only when special permission has been obtained from the City.

All steel pipe and material shall be in accordance with AWWA Standard C200, for "Steel Water Pipe 6 Inches and Larger."

Fabrication Specifications shall comply with Section 3 of AWWA C200. Pipe fabricated from steel sheets shall conform to the requirements of ASTM A570, Grade 30 or plates conforming to ASTM A283, Grade C. The diameter of the pipe and steel wall thickness shall be as shown on the Standard Drawings. The nominal diameter shall be O.D. for 28 inches and under and I.D. for 30 inches and over.

All pipe shall be shop tested to a hydrostatic pressure conforming to AWWA Specification C200. Pipe shall be designed and manufactured so as to conform, when laid, with the lines and grades as shown on the Approved Plans and profile with outlets, connections and appurtenances as shown on the Approved Plans.

- D. Coatings for Steel Pipe: Types of protective treatment shall be as follows:
 - 1. Fusion Epoxy Lining and Coatings per AWWA C213.
 - 2. Cement Mortar Lining and Coatings per AWWA C205.
 - 3. Coating the Exterior of Above Ground Steel Water Pipelines and Fittings AWWA C218
- E. Couplings for Steel Pipe: All steel pipe 6 inches and larger shall be coupled by the following:
 - 1. Dresser coupling type 38, or equal.
 - 2. Bell and spigot with O-ring gaskets which provides unrestricted flow in either direction.
 - 3. Flanges shall conform to AWWA Standard C207.
 - 4. Other types as approved by the City Engineer.
 - 5. Couples shall be coated same as the pipe.

Steel pipe used within the interior of a building shall be fabricated from steel sheets and plates. Approved Plans shall show the sizes and general arrangements of all pipe and appurtenances. Responsibility for furnishing exact length of the various sizes of pipe for proper make-up rests with the Contractor. The pipe shall be shop fabricated. Field welding will be allowed only with the written permission of the Engineer.

6. Fittings: Steel fittings for pipe 4 inches and larger shall conform to AWWA C208. Pressure Class shall be at least the same as pipe. Fittings shall be coated the same as pipe. The Contractor shall supply certifications from supplier and/or manufacturer that the fittings meet all steel pipe specifications.
- A. Polyvinyl Chloride Plastic Water Pipe: This specification covers rigid Polyvinyl Chloride pipe, hereinafter called PVC pipe, the type of materials to be used and the method of application to this system. All PVC pressure pipe and fittings shall conform to AWWA C900 Pressure Class 200 or better.

The rigid PVC pipe shall bear the seal of approval and “NSF Mark” of the National Sanitation Foundation Testing Laboratory, Inc., which has qualified the pipe for potable water service.

Pipe shall be produced in standard and random lengths. At least 85% of the total footage of any class and size shall be furnished in standard lengths. The remaining 15% may be in random lengths.

1. Standard lying lengths shall be 20 feet plus or minus one inch for all sizes.
2. Random lengths shall not be less than 10 feet long.

Each standard and random length of pipe shall be marked on the outside surface with the trade name with the appropriate designation code (e.g. PVC 1120), DR, nominal size, pressure classification and date of manufacture.

Samples of pipe, physical and chemical data sheets, may be required to be submitted to the Engineer for approval and approval may be required before the pipe is purchased. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform in color as commercially practical.

The rigid PVC pipe used in the municipal water distribution system shall be composed of PVC compounds meeting the requirements of ASTM D1784.

4.3 VALVES FOR WATER MAINS

4.3.1 Description: The valves shall be suitable for an ordinary waterworks service. It is intended that the valves will be installed in a normal position on buried pipe lines for water distribution systems. All valves shall be Mueller with non-rising stem valves.

The minimum requirements for all gate valves shall, in design, material and workmanship, conform to the standards of AWWA C509 for Resilient-Sealed Gate Valves. All materials used in the manufacture of waterworks gate valves shall conform to the AWWA Standards designed for each material listed. All gate valve operating stems shall be equipped with a two (2) inch operating nut. All gate valves shall open counterclockwise.

The minimum requirements for all butterfly valves shall, in design, material and workmanship conform to the standards of the AWWA C504. Any water valve 12 inches or larger shall be butterfly-type. Also, any water line with working pressure greater than 150 psi shall have only butterfly-type valves installed.

Where static line pressure exceeds 125 psi, only 250 psi working-pressure valves shall be used.

4.3.2 Materials:

- A. **Manufacture and Marking:** The valves shall have the name or mark of the manufacturer, year valve casting was made, size and working pressure plainly cast in raised letters on the valve body.
- B. **Type and Mounting:** The valve bodies shall be ductile iron, mounted with approved non-corrosive metals, All wearing surfaces shall be bronze or other approved non-corrosive material. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable.
- C. **Valve Seats:** Resilient seats shall be applied to the gate and shall seat against a corrosion-resistant surface. The surface may be either metallic or non-metallic, applied in a manner to withstand the action of line fluids and the operation of the sealing gate under long-term service. A metallic surface shall have a corrosion resistance equivalent to or better than bronze. A non-metallic surface shall be in compliance with ANSI/AWWA C550. Resilient seats shall be bonded or mechanically attached to the gate. The method used for bonding or vulcanizing shall be proved by ASTM D429; either method A or method B. For method A, the minimum strength shall not be less than 250 psi (1,725 kPa). For method B, the peel strength shall not be less than 75 lb/in. (9.3 kg/m).

All exposed mechanical attaching devices and hardware used to retain the resilient seat shall be made of a corrosion-resistant material.

- 1. **End Connections:** The dimensions push-on end connections shall conform to the dimensions of the AWWA Standard C111/A21.11. The dimensions for the mechanical joint connections shall conform to the ANSI/AWWA C111/A21.11.

The end flanges of flanged valves shall conform in dimensions and drilling to the standard ANSI B16.1 for ductile iron flanges and flanged fittings, Class 125, unless specifically provided otherwise. The bolt holes shall straddle the vertical center line.

2. Gate Valve Stem Seals: Unless otherwise designated in the Approved Plans, all gate valves up to and including 12-inch in size shall be furnished with O-ring Stem Seals. Number, size and design shall conform to the AWWA Standards for gate valve O-Ring Stem Seals. For all valves over 12", the stem seals shall be conventional type stuffing-box with graphited packing per AWWA Standard No. C600-18.1.
3. Tapping Valves: Tapping valves shall be furnished with flanged inlet end connections having a machined projection on the flanges to mate with a machined recess on the outlet flanges of the tapping sleeves and crosses. The outlet ends shall conform in dimensions to the AWWA Standards for hub or mechanical joint connections, except that the outside of the hub shall have a large flange for attaching a drilling machine. The seat opening of the valves shall be larger than normal size to permit full diameter cuts.
4. Hydrostatic Test Pressure of Valves at Factory: Each gate valve shall be tested at the factory for performance and operation prior to painting, in conformance with Section 6 of AWWA Standard C509.
5. Installation of Gate Valves: All gate valves shall be inspected upon delivery in the field to insure proper working order before installation. They shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connection ends furnished. The valves shall also be carefully inspected for injury to the outer protective coatings.

Valves 12-inch and under shall be installed in a vertical position and be provided with a standard valve chamber or ductile iron gate box so arranged that no shock will be transmitted to the valve. The box shall be centered over the operating nut, and the cast iron box cover shall be set one-half (1/2) inch below the roadbed or finished paved surface. All valve boxes must be brought to this elevation prior to the placement of asphalt, unless otherwise approved by City Engineer.

After installation, all valves shall be subjected to the field test for piping as outlined in Section 4.8.14 of these specifications. Should any defects in design, materials or workmanship appear during these tests, the Contractor shall correct such defects with the least possible delay and to the satisfaction of the Engineer. Should the Contractor fail to do this within a reasonable period of time in the judgement of the Engineer, he may cause such defects to be corrected and take appropriate action to receive payment for the work.

6. Butterfly Valves: Butterfly valves shall be cast iron or ductile iron body, rubber seated, tight closing type butterfly valves conforming to AWWA Specification C504. Other types may be used if specified or approved by the Engineer.

Valves shall be fitted with Class 125 or Class 250 flanges conforming to ASME/ANSI B16-1 or ANSI/AWWA C110/A21.10.

The valve body shall be high strength cast iron ASTM A126 Class B with 18-8 Type 304 stainless steel body seat. Valve vane shall be high strength cast iron ASTM A48 Class 40, having rubber seat mechanically secure with an integral 18-8 stainless steel clamp ring and 18-8 stainless steel nylon locked screws.

Rubber seat shall be a full circle 360° seat not penetrated by the valve shaft. Valve shaft shall be one piece, extending full size through the entire valve and operator with no neckdown, keyways or holes to weaken it. Valve shaft shall have 304 stainless steel journals rotating in reinforced teflon bearing. Packing shall be “triple-seal” rubber designed for permanent duty in service.

Certification of performance, leakage and hydrostatic tests as described in Section 5 of AWWA Specification C504 shall be furnished. Valves shall be the product of a manufacturer having a minimum of five years experience in the manufacture of waterworks and distribution valves. Butterfly valves shall be as manufactured by Henry Pratt, Dresser, Mueller or approved equal.

7. Ball Valves: Ball valves shall conform to ANSI/AWWA C507 Standard for Ball Valves 6-inch through 48-inch.
8. Check Valves: Check valves shall be of the Lever-Weight Type, conventional flanged style as manufactured by Mueller Company, or approved equal, conforming to ANSI/AWWA C508 Standard for check valves 2-inch through 48-inch.

The plug, which shall be guided at both ends with a through integral shaft, will be opened by the flow velocity and closed by a lever and weight which can be adjusted to any position on the lever and which returns the plug to the seat before reversal of flow occurs.

All check valves shall have a maintenance pit of a size as approved by the City Engineer to provide access.

9. Air Relief/Vacuum Relief Valves: Air Relief Valves shall be CLA valves or equal of the type and model shown on the Approved Plans or as specified in the Contract Documents.
10. Valve Boxes and Covers: All valves not in a vault as per the attached Standard Drawing shall be provided with a cast iron valve box of the extension sleeve type, and the correct adjustable height to bring the top of the valve box flush with the finished surface. The valve box shall not be less than 5 inches in diameter, and shall have a minimum thickness of 3/16 inch, and shall be provided with suitable base and cover. The work “Water” shall be cast on the cover. Valve boxes shall be equal to Mueller H-10357 with No. 6 or No. 8 round base as needed. There shall also be furnished to the City Water Department, 1 “T” handle operating wrench for each 5 new valves installed on the project.

4.4 WATER SERVICE CONNECTIONS AND FIRE LINES

4.4.1 General: Service connections will be made by the Contractor, in accordance with these Specifications and Standard Drawings. This includes furnishing and installing service connection at the main, service line, yoke and box. The City will furnish and install the meter. All connections to the Wellsville water system including fire lines shall be metered unless otherwise approved by the City. In the case of connections serving only a fire system, the cost of the meter vault and appurtenances shall be borne by the developer while the meter shall be provided at no additional cost by Wellsville City. All service connections including fire lines shall be constructed in accordance with the provisions of this section up to the first shut-off valve within the building.

New water mains must be backfilled, tested and flushed before service lines are connected.

Service connections will be activated only after inspection, testing, chlorination and flushing of all new water line facilities, and also only after acceptance of the main line, unless otherwise approved by Wellsville City.

Each culinary service connection must be pressure tested in accordance with Section 4.8.14 except that the test pressure shall be not less than 225 pounds per square inch. Each fire line shall be pressure tested in accordance with Section 4.8.14 except that the test pressure shall not be less than 225 psi.

Water service connections shall be installed in accordance with the attached applicable Standard Drawings.

4.4.2 Materials:

- A. Service connections at the main shall be a Mueller Insta-tite (IPS) connection.
- B. Corporation Stops: Corporation Stops will be of brass with ball type, Mueller 110 Compression Connection in accordance with AWWA Standard C800.
- C. Service Clamps: All service taps shall be equipped with bronze service saddles with stainless steel double-strap, teflon-coated service clamps.
- D. Pipe Materials: All service lines will be Class 200 Polyethylene (PE) tubing conforming to AWWA Standard C901 being installed without any connections or appurtenances between the corporation stop and the meter yoke except the curb stop.
- E. Meter Yoke: Meter yokes will be Mueller "copper setter" of molded copper tubing with reinforcing bars and angle type dual check valve, meter fittings will be standard threads, copper tubing fittings to be copper flair in accordance with AWWA Standard C700. All meter yokes must include a center support.
- F. Meter Box: Meter boxes will be 21-inch diameter for 3/4-inch meter installation, 24-inch diameter for 1-inch meter installation and 48-inch diameter for 1-1/2-inch meter installation. The box will be ABS Pipe, concrete, or approved equal. Meter box shall be located as per the approved drawings and is subject to approval by the City.

Standard length of the box will be 48 inches unless otherwise approved. Prior approval by the City is required in these cases.

- G. Meter Box Lid: Meter box lids will be of cast iron or cast aluminum. The lid shall be secured with standard nut. All meter lids must have a 2-inch hole for remote reading and be approved by the City.
- H. Curb Stop and Curb Box: Curb Stops will be of brass with ball type Mueller Insta-tite connection. For curb stops outside of the meter box, include a curb valve and cast iron extension-type curb box with arch pattern base with cast iron foot piece as manufactured by Mueller. Prior approval by City required for substitution.
- I. Meters: Meters shall be Precision (multi-jet type) for services of 2 inches or smaller or Precision (turbine or compound type) for services of 4, 6 or 8 inches or an approved alternate, in accordance with AWWA Standard C702 and AWWA C701. Acquisition, calibration, and distribution will be at the City's discretion.

4.4.3 Construction: Taps shall be made and pipe laid at a right angle to the water main. The tap shall be made on the middle of the main at an angle between 45° and 60° from the vertical plane, on the side of the main to which service is to be extended.

The water main shall be tapped by machine drilling a hole in it the size to fit the corporation for the service line. The drilling machine and method of tapping shall be approved by the City. A representative of the City shall inspect the main and tap prior to backfilling. In the event the tap is covered before it is inspected, it shall be uncovered by the Contractor to allow for inspection. If the tap or water main is damaged during the process of locating, it shall be repaired immediately by the Contractor in a manner acceptable to the City.

The service line shall be constructed 5-feet from the uphill side of the lot and on the shortest and straightest route possible. No service line may be constructed through, or in front of any adjoining property.

All service lines installed across and under existing roads that are paved shall be installed by boring or pulling the pipe. No open cuts will be permitted.

If the line is not to be connected initially to a meter yoke, the end of the service line shall then be sealed shut to keep rocks and dirt out of the line. Every precaution shall be taken to prevent foreign material, including trench water from entering the pipe.

Where existing services are to be transferred from old to new mains, the Contractor shall plan and coordinate his work with that of the City so that service will be resumed with the least possible inconvenience to consumers.

Whenever the Contractor is required by the Approved Plans and Special Conditions to remove an existing water main, the Special Conditions will state whether or not the salvage of pipe, valves, hydrants and fittings will be required, and the method of payment therefore.

All meter installations will be located 5-feet from the uphill property line in front of the building, and shall not occur in a sidewalk or driveway. If it is impossible to construct the meter box at this location, approval to relocate must first be secured from the City.

All meter installations will be installed so that the meter box lid is at grade with a tolerance of +1/2".

All irrigation sprinkling systems will be connected on the customer side of the meter, but not within the meter box.

The Contractor shall not in any case remove old pipe until all service connections have been transferred to the new main. Adequate provisions shall be made by the Contractor during construction for the care and protection of mains or services in use.

Where salvage of pipe, valves, hydrants and fittings is required under the contract, salvage methods shall be used which will save all materials intact and undamaged. Salvaged material shall be stored at the City's yard, unless otherwise provided.

If salvage is not specified, the materials therefrom shall become the property of the Contractor and shall be promptly removed from the site for disposal as he sees fit.

To supply customers with water during the construction of a water main project where any section of the pipe has passed a satisfactory hydrostatic and bacteriological test, the City reserves the right to install a corporation stop into the section of a new main and install service connections at such locations as the City may elect, at no expense to the Contractor. The attaching of any such service connections by the City shall not be construed by the Contractor as an acceptance by the City for any part of the work required under the Contract.

4.5
FIRE HYDRANTS

4.5.1 General: These Specifications are to be used in conjunction with the AWWA Standard C502 or the latest revision thereof for fire hydrants for ordinary water works service.

4.5.2 Materials:

- A. Material for Hydrants and Appurtenances: All materials used in the production of fire hydrants for ordinary service shall conform to the specifications designated for each material listed in AWWA Standard C502.
- A. Hydrant Size and Type: Hydrants shall be 5-inch minimum size with 2-1/2 inch hose nozzles and 1 - 4-1/2 inch pumper nozzle. Hydrants shall be supplied with O-Ring seals and a 6-inch ASA 125 pound flanged inlet. Each hydrant shall be supplied complete with a flanged mechanical joint auxiliary gate valve with box. They shall be Mueller Super Centurion or Clow Medallion. A hydrant key shall be provided to the Public Works Department for each five hydrants installed.
- B. Auxiliary Valve: Per Section 4.3 of these Specifications.
- D. End Connections: The dimensions of hub or bell end connections shall conform to the dimensions of the AWWA Standard No. 100. The dimensions of the mechanical joint connection shall conform to the USASI Specification No. A21.11.

The flanged lateral connection shall be faced and drilled to conform to the American Standard for 125-lb. W. P. flanged fittings when static pressures do not exceed 125 pounds. 250 pounds working pressure, flanged fittings shall be used when working pressure is greater than 125 pounds. Flanges shall be machine finished to a true surface. Bolt holes shall straddle the vertical center line.

- E. Sidewalk Flange Construction: Hydrants shall be provided with a sidewalk flange. Breaking devices shall be at the sidewalk flange which will allow the hydrant barrel to separate at this point with a minimum breakage of hydrant parts in case of damage. There shall also be provided at this point a safety stem coupling on the operating stem that will shear at the time of impact. Unless otherwise specified, all hydrants shall be equipped with O-Ring stem seals.
- F. Factory Hydrostatic Test: All hydrants installed shall have certification of being subjected to an internal hydrostatic test of 300 pounds per square inch with the hydrant valve in a closed position and again with the hydrant valve in an open position upon request by the City Engineer.

4.5.3 Construction Details:

- A. Setting Hydrants: Hydrants shall be installed in accordance with the detail shown on the enclosed drawing in the location specified in the Approved Plans or as designated by the City.

All hydrants shall be inspected in the field upon arrival to ensure proper working order. After installation, they shall be subjected to a hydrostatic test not to exceed the factory test pressure. New hydrants are to be marked by a red-painted snow stake approved by the City. Hydrants shall not be operated for the purpose of obtaining water for normal construction purposes. Any hydrant so operated shall be replaced by the Contractor.

- B. Hydrant Connections: Hydrant laterals shall consist of a section of mechanical joint ductile iron 6-inch pipe from the main to the hydrant and shall include an auxiliary gate valve set vertically and placed in the line as indicated in the Standard Drawings for hydrant settings.
- C. Relocating Existing Hydrants: When shown on the Approved Plans or when directed by the City, existing hydrants shall be moved. When the existing tee is moved to a new hydrant location, a new tee shall be inserted and the open part of the abandoned tee shall be securely sealed and blocked. When the existing hydrants are blocked to the main line, the same method shall be used to anchor the hydrants at their new locations. The work shall conform in all respects to hydrant settings as described elsewhere in these Specifications.
- D. Hydrant Extensions: The minimum requirements for all flanged hydrant barrel extensions, operating stems and flanged adaptors for hydrant lateral connections shall, in design, material and workmanship, conform to the AWWA Standards for such castings. The drilling of the flanges on the extensions shall match the drilling of the flanges on the hydrant. The drilling of the adaptor flanges shall match those of the hydrant foot flange and the auxiliary gate valve flange.
- E. Testing of Fire Hydrants: Fire hydrants shall be subjected to a hydrostatic test at a hydraulic pressure of 200 psi for a period of one hour, after being connected to the main water line and after concrete anchor blocks at all thrust points are in place. Testing shall be made with the whole interior of the hydrant under pressure with the auxiliary valve and the foot valve open and the hose nozzles and pumper connections closed. Under the test procedure, there shall be no leakage through the main valve or stuffing box, nor through the castings or the joints of the assembled hydrant. Under the test conditions, the leakage through the drain valve shall not exceed four fluid ounces per minute. Other leakage or other imperfections found in either test shall be corrected before the hydrant is accepted. At the option of the Contractor, he may test each fire hydrant separately or he may choose to test fire hydrants along with the water line hydrostatic pressure test.

4.6

WATER MAIN AND SERVICE LINE CONSTRUCTION

- 4.6.1 General:** All water mains and service line construction within the Wellsville City water system or intended to be connected to the Wellsville City water system shall be accomplished in accordance with the requirements of these Specifications. In all cases construction must conform to Utah's Drinking Water Regulations. All water lines, connections, and appurtenances on the customer's side of the meter or beyond a point five feet beyond the edge of the nearest all-weather roadway, whichever creates the greater distance, of private line shall be privately maintained. No public water mains shall be accepted by the City until there is sufficient usage through the line to prevent wintertime freezing. No landscape irrigation line shall be connected to the City system without a backflow preventer similar to attached drawings.
- 4.6.2 Approved Plans:** Water main construction shall be done in accordance with the Contract Documents for the work, prepared under the direction of a Professional Engineer licensed in Utah and approved by the City Engineer and Wellsville City.
- 4.6.3 Licenses and Permits Required:**
- A. All water mains and service line construction shall be done by a General Utility Contractor licensed and bonded in Utah.
 - B. When construction is required within the public right-of-way, a permit shall be secured by the Contractor from Wellsville City at least 48 hours before initiating construction. When construction necessitates, shutting down a segment of public water main for a connection, the connection shall be made between the hours of 2:00 a.m. and 7:00 a.m. local time unless otherwise approved by the City.
 - C. A cash bond shall be posted to guarantee the work for a period of one year.
 - D. An indemnity bond shall also be posted to guarantee that work will conform to the City's Standard Specifications and to guarantee that Wellsville City will not be liable for any accidents, property damage or physical damage to any individual related to acts of the Contractor.
 - E. The City shall be notified 48 hours minimum before the planned construction is to commence and also before starting up Whenever construction is interrupted for any reason.
 - F. A plumbing permit is required from the City prior to connecting landscape irrigation lines to the City water system.
- 4.6.4 Inspection:** All work shall be inspected by a City authorized Inspector who shall have the authority to halt construction when, in his opinion, construction is being performed contrary to the Contract Documents. Whenever any portion of these Specifications is violated, the City Manager, by written notice, may order that portion of construction which is in violation of the Contract Documents to cease until such violation is corrected. A copy of the order shall be filed with the Contractor's license application for future review. If deficiencies are not corrected, performance shall be required of the Contractor's Surety.

4.7

TRENCH EXCAVATION AND BACKFILL FOR WATER MAINS

- 4.7.1 General:** The Specifications in this section, and those of sections 4.2 through 4.6, shall apply to the construction of water distribution mains and appurtenances in sizes up to and including twenty-four inches (24") in diameter for both temporary and permanent installation under ordinary conditions.

Water mains will be constructed on locations as shown on the Approved Plans.

Where grading is required, rough grading or excavation and embankment shall be completed before excavation of the water main trench.

Guarantee: Unless otherwise provided by the Special Conditions, the Contractor shall guarantee that the design, materials, workmanship and performance of the pipe, valves, hydrants, valve chambers, boxes, fittings and accessories furnished by him will be as specified, and that they and the installation of them will be satisfactory to the Owner for the purpose intended for a period of two years after final acceptance of the installation.

- 4.7.2 Ungraded Streets:** On streets, when grading is not provided in the contract schedule, the depth of trench excavation shall be as shown on the Approved Plan and Profile and as staked by the Engineer.

Where the Approved Plans show the pipe is to be laid above the existing ground surface, an embankment fill shall be made and compacted to conform with the section shown on the Approved Plans and the water main trench shall be excavated therein. That portion of the embankment below the bottom of the pipe shall be compacted with rollers or mechanical compactors under controlled moisture conditions.

- 4.7.3 Clearing and Grubbing in Ungraded Streets:** The area to be excavated or filled shall be cleared and grubbed by the Contractor. This work shall consist of the removal and disposal of all logs, stumps, roots, brush and other refuse. All such material shall be removed and disposed of as directed by the City.

- 4.7.4 Removal and Replacement of Pavement From Driveways and Sidewalks:** Removal and replacement of existing street improvements shall be performed as specified in the City's standards and shall be considered as incidental to the construction and the costs shall be included in the installation of the water line.

The removal of material from pavement, driveway and sidewalk and the disposal thereof shall be considered as incidental to the construction.

- 4.7.5 Grade and Alignment:** Grade and alignment on ungraded streets will be given from hubs set parallel to the line of the pipe, and on graded streets the grade and alignment shall be taken from established points on the existing curbs or sidewalks, when directed by the Engineer. Trenches for the pipe shall be opened in accordance with the lines and grades given or to the standard minimum cover of four (4) feet, depending on elevation and future surface treatment, whichever is greater. The Contractor shall transfer lines and grades to the pipe from hubs set by the Engineer or from existing concrete curbs or sidewalks as an incidental part of his work.

Sequence of operations, traffic requirements, or restrictions on the amount of open trench, if any, will be provided in the Special Conditions.

- 4.7.6 Trench Excavation:** The Contractor shall perform all excavation of every description and of whatsoever substances encountered to the depth indicated on the Standard Drawings or specified herein. All excavations shall be made by open cut unless otherwise provided in the Contract Documents. The banks of the trenches shall be kept in accordance with Utah Occupational Health and Safety Division (UOSHA) requirements. To protect adjacent structures the trench shall be properly sheeted and braced.

Work shall comply with the "Utah Occupational Safety and Health Rules and Regulations" for the Utah State Industrial Commission.

All grading and other excavations nearby shall be controlled to prevent surface water from flowing into the excavations. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance away from the edges of trenches to avoid overloading and to prevent slides or cave-ins. Unsuitable material, or that in excess to the needs for embankments or backfill, shall be removed and disposed of by the Contractor.

The Contractor shall exercise sound engineering and construction practices in excavating the trench and maintaining it so that no damage will occur to any foundation, structure, utility pole, pipe line, or other facilities because of slough, slopes, or from any other cause. If, as a result of the excavation, there is disturbance of the ground such as to endanger other property, the Contractor shall immediately take remedial action at his own expense. No act, representation or instruction of the Engineer or his representatives shall in any way relieve the Contractor from liability for damages or costs that result from trench excavation.

Care shall be taken not to excavate below the depth indicated, and excavation below that depth shall be backfilled with selected backfill material and compacted to the satisfaction of the City Engineer at the Contractor's expense.

The bottom of trenches shall be accurately graded to provide uniform bearing and support for each length of pipe or undisturbed or compacted soil at every point along its entire length, except at the joints. Bell holes shall be excavated to an extent sufficient to relieve bearing pressure at the bell joint.

- 4.7.7 Protecting Existing Services:** The Contractor shall carefully do all necessary excavation to fully expose such services. If the Contractor elects to excavate the trench without first exposing the services, he shall be responsible for any and all damages incurred to the services by reason of his operations and shall immediately arrange for replacement of all damaged services. All additional costs incident to such work by the Contractor shall be considered as incidental to the construction.

- 4.7.8 Solid Rock Excavation:** Solid rock shall include solid rock formations requiring systematic drilling and blasting with explosives and any boulders or broken rock larger than one-half cubic yard in volume. Hardpan or cemented gravel, even though it may be advantageous to use explosives in its removal, shall not be classified as solid rock excavation. Solid rock shall be excavated to a width equal to the outside barrel diameter of the pipe plus 24 inches, and to a grade line not less than six inches below bottom of the pipe bell. Bottom of the trench shall be brought up to grade by backfilling with selected backfill material. The material shall be compacted to the satisfaction of the Engineer.

The Contractor shall notify the City and the local Police Department at least 24 hours prior to any blasting. All blasting shall be done in accordance with local, county and state regulations governing this class of work. Any damage to persons or property resulting from blasting operations shall be the sole responsibility of the Contractor and his surety.

4.7.9 Extra Excavation: Changes in grades of the water main from those shown in the Contract Documents may be necessary because of unplotted utilities, or for other reasons. If, in the opinion of the Engineer, it is necessary to adjust, correct, relocate or in any way change the line and grade, such changes shall be made by the Contractor under the terms of these Specifications.

4.7.10 Unforeseen Buried Objects Encountered in Trench Excavation on Graded Streets: Where streets have been graded, it is presumed that stumps, railroad ties, buried pavements, etc., will have been removed in the original grading work. Where such unexpected objects are encountered in trench excavation for water mains, they shall be removed and disposed of by the Contractor. In cases where they can be removed by the same equipment or method at hand for excavating, and where it is unnecessary to employ special equipment or to install shoring and bracing, or to increase the trench width or depth more than two feet for any one object, then in that event the removal of such obstructions shall be considered as an incidental part of the Contractor's work.

4.7.11 Removal of Unsuitable Materials: Wherever in excavating the trench for water mains the bottom of the trench exposes peat, soft clay, quicksand or other material which is unsuitable in the opinion of the City Engineer, such material shall be removed and disposed of by the Contractor. The material thus removed shall be replaced by suitable surplus material obtained from trench excavation within the limits of the project which shall be deposited and compacted in eight-inch layers by mechanical compaction. If surplus material is not available within the limits of the project the Contractor shall furnish suitable material.

4.7.12 Pipe Bedding: Pipe bedding material shall consist of road base or graded granular sand and gravel of which 100% will pass the U.S. Standard one-inch opening and not more than 3% will pass the U.S. No. 200 (wet sieve). Pea gravel or similar gravel products predominantly of one size shall not be used without prior approval of City Engineer. Bedding material will be placed in accordance with the attached Standard Drawing.

Under no circumstances shall mine tailings containing traces of arsenic, lead, strontium, rubidium, or radium be used as bedding material.

4.7.13 Backfilling Trenches: Backfilling of trenches shall be made with the same materials excavated from the trenches unless these materials are found to be unsuitable by the Engineer.

Prior to backfilling, all form lumber and debris shall be removed from the trench. Sheeting used by the Contractor shall be removed just ahead of the backfilling unless it is ordered by the Engineer to be left in place.

The initial backfill up to 12 inches over the top and both sides of the pipe shall be evenly and carefully placed, using sand or material free of rocks larger than one (1) inch, hard clods, frozen material or other debris capable of damaging the pipe or its coating. The balance of the material may be placed in uniform layers.

A minimum of 6-inch sand cushion shall be placed between the water main and existing pipelines or other conduits when encountered during construction and as directed by the Engineer.

4.7.14 Compaction of Backfill: On graded streets without pavement or on roadway shoulders and unimproved areas, compaction of backfill may be by mechanical tamping or wheel rolling. Compaction by water settling may be done under the conditions stipulated in Section 4.7.14A. On all graded streets, the backfill shall be compacted to 95% of the maximum density as determined by the Compaction Control Tests specified in AASHTO T-180 and verified by the methods specified in ASTM D2922 (AASHTO T-238) or ASTM D1556 (AASHTO T-191). The compaction can be reduced to 90% for areas where vehicle traffic will never occur.

- A. **Water Settling of Trenches:** Water settling is only allowed in sandy soil conditions where no clays are present and in other soil conditions under full time inspection by a City Inspector. Where water settling of trenches is used, the jetting method shall be utilized. Jets shall be inserted throughout the length of the backfilled area and shall be slowly forced down to the bottom of the trench and then slowly withdrawn until the trench backfill is saturated with water. The jetting operations shall be completed as close behind the pipe laying and backfilling as practicable.

After the water-settled trench has set for several days, any depression in the trench shall be filled and mounded up over the trench, and then further compacted by the use of heavy rubber-wheeled equipment or equivalent as approved by City Engineer.

- B. **Equipment for Water Settling Trenches:** The Contractor shall furnish all hose and equipment necessary for jetting operations. The minimum size of hose and equipment shall be such as to provide not less than thirty-five (35) pounds per square inch pressure at the discharge. The jet shall be a rigid iron pipe with a minimum diameter of one (1) inch.
- C. **Source of Water for Water Settling:** Source of water will depend upon local conditions and shall be as provided in the Special Conditions. Where no provision for water is made in the Special Conditions, the Contractor shall make his own arrangements for it.
- D. **Compaction of Backfill under Special Conditions:** At locations where paved streets, driveways or sidewalks will be constructed or reconstructed over the trench, or where provided for in the Special Conditions or directed by the Engineer, the backfill shall be spread in layers and be compacted by mechanical tampers. In such cases the backfill material shall be placed in successive layers, not exceeding eight (8) inches in loose thickness and each layer shall be compacted with mechanical tampers to the density directed by the Engineer.

4.7.15 Gravel Base Course for Trench Backfill: Selected backfill material shall consist of gravel base course with 100% of the material passing the 1-1/2" square opening.

4.7.16 Boring: Water lines and service lines installed across and under existing pavement shall be bored or pulled unless authorized by the City to install by open trenching.

4.8

PIPE INSTALLATION FOR WATER MAINS

4.8.1 General: Pipe shall be installed in accordance with the manufacturer's specifications and instructions for installing the type of pipe used unless modified or changed in the Special Conditions. The Contractor shall provide all tools and equipment including any special tools designed for installing each particular type of pipe used.

4.8.2 Construction:

- A. Dewatering of Trench: Where water is encountered in the trench, it shall be removed during pipe-laying operations and the trench so maintained until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Trench water shall not be allowed to enter the pipe at any time.
- B. Handling of Pipe: All types of pipe shall be handled in such manner as will prevent damage to the pipe, pipe lining or coating. Damage to pipe, pipe lining or coating shall be repaired to the satisfaction of the Engineer or the damaged pipe shall be removed from the job and methods of handling corrected to prevent further damage.
Threaded pipe ends shall be protected by couplings or other means until laid.

The pipe and fittings shall be inspected for defects and cast iron pipe, while suspended above grade, shall be rung with a light hammer to detect cracks.

Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned and relaid. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other effective seal approved by the City Engineer to ensure absolute cleanliness inside the pipe.

- C. Laying of Pipe on Curves: Long radius curves, either horizontal or vertical, may be laid with standard pipe by deflections at the joints. If the pipe is shown curved on the Approved Plans and no special fittings are shown, the Contractor cannot assume that the curves can be made by deflection of the joints with the standard lengths of pipe. The Contractor is responsible for verifying the maximum degree of curvature allowed according to AWWA for the type and size of pipe he is installing. If shorter lengths are required, the Approved Plans shall indicate maximum lengths that can be used.

Maximum deflections at pipe joints and laying radius for various pipe lengths are as found in the following standards:

Ductile Iron Pipe Mechanical Joints	AWWA C600, Table 6
Ductile Iron Pipe Push-On Joints	AWWA C600, Table 5
Concrete Cylinder Pipe	AWWA C303, Section 4.3
Steel Pipe O-Ring Joints	See Manufacturer's Recommendations
Steel Pipe Welded Joints	See latest AWWA Specifications

When rubber gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. Trenches shall be made wider on curves for this purpose.

The City Engineer may require the Contractor to run a mandrel through each section of curved water line to verify maximum deflection.

4.8.3 Laying Ductile Iron Pipe:

- A. Joints for Ductile Iron Pipe: Joints for ductile iron pipe shall consist of one of the two following types unless otherwise provided in the Special Conditions:
 - 1. Mechanical joints
 - 2. Rubber gasket joints (Push-On)

4.8.4 Jointing Mechanical Joint Pipe: The outside diameter of the spigot end of bell-and-spigot pipe varies with the type, size and class of pipe. There is only one joint size for each diameter of mechanical joint pipe. Thus, difficulty may be met when attempts are made to connect existing bell-and-spigot pipe to mechanical joint pipe. When such a connection must be made, an adapter having a fitting bell and a mechanical joint socket shall be used.

- A. Cleaning and Assembling Joint: The last 8 inches outside of the spigot and inside of the bell of mechanical joint pipe shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating), and other foreign matter from the joint, and then painted with a soap solution made by dissolving one-half cup of granulated soap in one gallon of water. The ductile iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket or bell end. The rubber gasket shall be painted with the soap solution and placed on the spigot end with the thick edge toward the gland.
- B. Bolting of Joint: The entire section of the pipe shall be pushed forward to seat the spigot end of the bell. The gasket shall then be pressed into place within the bell, being careful to have the gasket evenly located around the entire joint. The ductile iron gland shall be moved along the pipe into position for bolting, all of the nuts inserted, and the nuts screwed up tightly with the fingers. All nuts shall be tightened with a torque wrench. The torque for various sizes of bolts shall be as follows:

Size <u>Inch</u>	Range of Torque <u>Ft.-Lbs.</u>
5/8	40 - 60
3/4	60 - 90
1	70 - 100
1-1/4	90 - 120

Nuts spaced 180 degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland.

4.8.5 Jointing Rubber Gasket Joint Pipe:

Cleaning and Assembling Joint: The inside of the bell shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating) and other foreign matter from the joint. The circular rubber

gasket shall be flexed inward and inserted in the gasket seat provided in the socket and released with the gasket fitting over the bead in a gasket seat.

A thin film of gasket lubricant shall be applied to the inside surface of the gasket. Gasket lubricant shall be a solution of vegetable soap or other solution supplied by the pipe manufacturer and approved by the City Engineer. Per Utah Division of Drinking Water R309-550-6, all materials which may contact drinking water such as gaskets and lubricants shall be ANSI certified as meeting the requirements of NSF Standard 61. All such items must be appropriately stamped with the NSF logo to permit field verification.

The spigot end of the pipe shall be cleaned and entered into the rubber gasket in the socket, using care to keep the joint from contacting the ground. The joint shall then be completed by forcing the plain end to the bottom of the socket, using a forked tool or jack-type tool or other device approved by the City Engineer. Pipe which is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint.

Field cut pipe lengths shall be filed or ground to resemble the spigot end of manufactured pipe.

4.8.6 Laying Steel Pipe:

- A. Threaded Steel Pipe in Sizes up to and Including 3-1/2 Inch: All steel pipe in sizes up to and including 3-1/2 inch shall be connected with malleable iron screwed couplings in accordance with USASI Specification B16.3. Couplings shall be galvanized. Unions or flanges shall be used on all equipment and valves. Steel pipe shall only be used in vaults or other areas where it shall not be in contact with soil.
Exposed threads, after jointing, shall be brush-coated with an asphalt coating approved by the Engineer.
- B. Coupled Pipe 4-Inch and Larger: All steel pipe 4-inch and larger for use in underground services shall be coupled by either one of the following methods:
 - 1. Dresser Couplings, Style 38 or approved equal.
 - 2. O-Ring rubber gasket joint of a design approved by the City Engineer and having the following basic design:
 - a. One end expanded to form a bell.
 - b. The other, or spigot end, shall have a rolled groove to accommodate a round rubber gasket of proper diameter and cross-section.
 - 3. All parts shall be thoroughly cleaned before assembly and a vegetable soap solution shall be brushed on the inside of the bell just prior to assembly.
 - 4. All component parts of couplings, rings, bells, etc., shall receive a protective coating in the same manner as specified for steel pipe. Bolts and nuts, exposed edges, flanges, etc. shall, after installation, be covered with a heavy hot pour of coal tar enamel.

5. All steel pipe 4-inches and larger for above ground service shall be coupled with flanges, dresser type or victaulic type couplings. All flanges for steel pipe shall conform to AWWA Standard C207, Class B for working pressures up to 86 psi, Class D for working pressures up to 150 psi, and Class E for working pressures up to 275 psi.
6. Pipe for outdoor service above ground shall be protected with one coat primer and one coat coal tar paint approved by the Engineer.
7. Pipe for indoor service shall be protected with a liquid epoxy coating system supplied and applied in conformance with AWWA Standard C210.

4.8.7 Laying Reinforced Concrete Pressure Pipe: Reinforced concrete pressure pipe with steel joint rings, or concrete non-cylinder pipe when called for in the Contract Documents shall be laid to conform with requirements that follow:

Cleaning and Assembling Joint: All parts of the joint, both bell and spigot ends, shall be thoroughly brushed and cleaned to remove oil, grit and other foreign matter. The circular rubber gasket provided with the pipe shall be stretched and snapped into the groove provided on the spigot end. It shall be lifted and released at several points on the circumference to equalize tension and remove twist in the gasket.

The bell end of the pipe shall be lubricated with a solution of vegetable soap and water or other prepared solution supplied by the pipe manufacturer and approved by the Engineer. The pipe shall then be jacked home until it stops.

The outside annular space at the joint shall be filled with cement mortar.

The grouting of the outside joints shall be made by wrapping the joint with two bands of strong waterproof sisal kraft paper or visqueen. The bands of paper or visqueen shall then be tightly strapped to the pipe with 3/8-inch box strapping, using tools recommended by the manufacturer of the strapping. Hand-tamped backfill shall be built up around the band to the horizontal diameter of the pipe. The joint shall then be filled with mortar from one side only until the mortar appears on the other side of the pipe. Mortar shall be mixed with the least amount of water that will permit placing by the method described. Flexible wires shall be worked around the joint to assist grouting and ensure proper filling on the joint. The top of the pipe shall then be grouted and the paper band laid over the entire joint to protect it while curing.

The inside annular space shall also be filled with cement mortar and troweled flush. Mortar shall consist of one part Portland cement and two parts of plaster sand. Mortar for inside joints shall be mixed with only enough water for "dry packing."

No grouting of joints will be allowed within three joints of laying operations. A representative of the Engineer shall be present when outside joints are being poured.

4.8.8 Laying PVC Pipe: Only persons competent in the opinion of the City Engineer or Public Works Director at laying plastic pipe shall be employed on this phase of the work, and complete suitable equipment necessary for the execution of same is required. Any incompetency observed by the Engineer must be rectified at his request, and where improper equipment or lack of same appears to be impairing the quality or speed of the work, such adjustments in same shall be made to the Engineer's satisfaction.

The pipe, fittings, and valves shall be placed in the trench with care. Under no circumstances shall pipe or other materials be dropped or dumped into the trench. The pipe shall not be dropped in a manner which would cause scratching of the pipe surface. An excessive amount of scratching of the surface of the pipe will be considered cause for rejection.

When requested by the Engineer, all PVC pipe will be tested after laying and backfilling by pulling a deflection detection device. The device shall verify less than 5% deflection in all pipe sections.

4.8.9 Connections to Existing Mains:

- A. All connections to water mains in use shall be made by the Contractor unless otherwise provided in the Special Conditions.
- B. The Contractor shall notify the City at least 48 hours in advance of such connections.
- C. Existing City water lines can only be shut down by crews authorized by the City.
- D. The Contractor shall also provide written notice giving the date of the notice, the date and time of the shutdown, and the duration of the shutdown. Major shutdowns shall only occur between 2:00 a.m and 7:00 a.m.
- E. The maximum time allowed for shutdown shall be 4 hours. If the Contractor should need more than the above limit, it shall be necessary to turn on the water for at least 1 hour before the next period of shutdown begins.

All crosses or other special fittings required to be inserted in any main already in use shall be furnished and set by the Contractor. The Contractor shall furnish the special, as shown on the Approved Plans, and all other material required. He shall make all necessary excavations to assure gradual transition between the new and existing water main, and he shall perform all necessary backfilling to the requirements of Sections 4.7.12 and 4.7.13.

4.8.10 Disruption of Service: Where the connection of new work to old requires interruption of service and notification of customers affected, the City, the Engineer, and the Contractor shall mutually agree upon a date for connections which will allow ample time to assemble labor and materials, and to notify all customers affected. The Contractor will be required to notify all affected customers and the City 24 hours in advance of service being interrupted.

4.8.11 Wet Tap Connections: Where connections are made between new work and existing pipe lines, such connections shall be made in a thorough, neat manner using suitable and proper fittings to suit the conditions encountered. Each connection with an existing water line shall be made at a time under conditions which will least interfere with normal user consumption and as authorized by the City. Suitable facilities shall be provided for proper dewatering, drainage and disposal of all water removed from the dewatered lines and excavations without damage to adjacent property. Where bolted flexible couplings or transitions are required, they shall be constructed of material corresponding to the pipe indicated in the following table:

<u>TYPE OF PIPE</u>	<u>COUPLING MATERIAL</u>
Steel Pipe	Ductile Iron or Steel
Ductile Iron Pipe (earth covered or inaccessible)	Ductile Iron or Cast Iron

to periodic inspection) Ductile Iron Pipe (accessible to periodic inspection and painted)	Ductile, Cast Iron or Steel
Polyvinyl Chloride	PVC or Ductile Iron

Couplings shall be equal to Smith-Blair, Dresser, Blair, or Rockwell.

Great care shall be taken to prevent line contamination when dewatering, cutting, or making connection with existing pipes used for conveyance or distribution of potable water for domestic or public use. The Contractor shall conduct his operations in such a manner that no trench water, mud, or other contaminating substances are permitted to get into the connected line or lines at any time during the progress of the work.

- 4.8.12 Contracted Repair Work:** Certain repair work may be specified in the Contract Documents as part of a Contract. This work shall be done as specified/contracted and in accordance with this section.
- 4.8.13 Accidental Repair Work:** If, for any reason, the Contractor accidentally cuts an existing water line or in any way disrupts water service, he shall notify the City immediately. It shall be the Contractor's responsibility to immediately repair or replace the damaged pipe at no additional cost to the City.
- 4.8.14 Testing and Disinfecting Field Tests:** All pipe and appurtenances shall be subjected to a hydrostatic test after they are laid. The Contractor shall be responsible to assure that each section of pipe between valves shall be tested as soon as possible after laying, or when directed by the Engineer.

At points where pressure reaction and movement may occur, such as at bends, tees and plugs the pipe shall be properly blocked or braced.

Where permanent blocking is not required, the Contractor shall furnish and install temporary blocking and remove it after testing. All costs to the Contractor for installing temporary blocking shall be borne by the Contractor. The Contractor shall furnish all pumping apparatus, labor, tools, pressure gauges and other equipment for making the tests.

Where the City has water available for testing, it may be furnished without charge upon arrangement with the City. All costs of tapping and piping shall be borne by the Contractor unless otherwise specified in the Special Conditions. Where water is not available from the City, the Contractor shall provide water from an approved source for testing.

Hydrostatic tests shall be performed on every complete section of water main between two gate valves or equivalent (in the determination of the City Engineer), and each valve shall withstand the same test pressure as the pipe, with no pressure active in the section of pipe beyond the closed gate valves.

All water service connections, for whatever purpose and at whatever time, shall be included in the pressure test. A visual inspection shall be made of each and every connection made to an existing main when, in the determination of the City Engineer, the test procedure specified in this section cannot be accomplished.

Each section of pipe line to be tested shall be slowly filled with water so that the specified test pressure is reached at the highest point in the section of pipe line under test. This pressure shall be

corrected to the elevation of the test gauge by means of a pump connected to the pipe in a manner satisfactory to the Engineer.

The Contractor shall subject the pipe to a hydrostatic pressure 50 percent higher than the highest working pressure, but not less than 225 psi, for a period of not less than 1 hour.

All exposed pipes, fittings, valves and joints shall be carefully examined during the test. Any cracked or defective pipes, fittings and valves discovered during the pressure test, shall be removed and replaced by the Contractor with sound material and the test repeated as required, at the expense of the Contractor. All testing shall be done in the presence of a duly authorized representative of the City.

- A. Leakage Test: After the pressure test has been satisfactorily completed, the Contractor shall continue testing the water lines for leakage. The Contractor shall furnish all pumping apparatus, labor, tools, pressure gauges, measuring devices for leakage test, and other equipment required for making the test.

The duration of the leakage test shall be for not less than 2 hours, and during the leakage test, and piping shall be subjected to a minimum hydrostatic pressure 50% higher than the highest working pressure of the pipe, but not less than 225 psi, based on the elevation of the highest point of the section of pipe line under test and corrected to the elevation of the test gauge. Leakage shall be defined as the quantity of water that must be supplied into any section of newly laid pipe line, or any valved section thereof, to maintain pressure within .5 psi of the specified test pressure after the air in the pipe line has been expelled and the pipe has been filled with water.

The allowable leakage in the water lines shall not exceed that specified in the latest revision of AWWA Standard C600 "Installation of Ductile Iron Water Mains and Appurtenances" or the latest revision of AWWA C900 (PVC), or the latest revision of AWWA C200 (Steel). Should any test of the pipe disclose leakage greater than that specified above, the Contractor shall, at his own expense, locate and repair defective joints, disinfect and retest until the leakage is within the specified allowance.

- B. Records and Documentation: Both the pressure tests and leakage tests shall be recorded by the Inspector. Records shall contain the length of pipe tested, size of pipe, type of pipe, rated working pressure of pipe, time and duration of test(s), pressure(s) used, complete list of test equipment used, list of personnel performing the test(s), and any comments about the test. Three sets of test records shall be submitted to the City bearing the name and signature of the Contractor's authorized test supervisor(s).
- C. Testing Section with Hydrants Installed: When hydrants are included with the section of main pipe to be tested, the testing shall be done as specified in Section 4.5.09.
- D. Testing Extensions from Existing Mains: The Contractor shall be responsible for following these procedures. Where an existing water main is extended with new pipe to a new valve, the connection of the new pipe to existing pipe shall not be made until after hydrostatic tests have been made to the required pressure in both directions against the new gate valve. This shall be accomplished by a temporary cap or plug installed on the end of the new pipe, beyond the new gate, as close as possible to the existing pipe for testing purposes.

The short length of pipe between the temporary cap or plug end with the new gate valve in the closed position, with no hydrostatic pressure active on the opposite side of the gate valve, shall be subjected to the required test pressure. The same test shall be made against the other side of new gate valve when that section of pipe is tested with no hydrostatic pressure active in the short section of pipe toward the existing main pipe.

- E. Disinfection of Water Lines: Before being placed in service, all new water lines and repaired portions or extensions of, existing mains shall be chlorinated in accordance with these standards or AWWA Standard C651 except the disinfecting water shall contain a minimum of 50 ppm of chlorine. The water shall be tested in the presence of the City Inspector to verify the 50 ppm of chlorine.
- F. Flushing: Sections of pipe to be disinfected shall first be flushed to remove any solids or contaminated material that may have become lodged in the pipe. A tap shall be provided at the end of the main (where applicable) large enough to develop a velocity of at least 2.5 fps. in the main. One 2-1/2 inch tap will, under normal pressure, provide this velocity in pipe sizes up to and including 12-inch. The tap shall be provided with a ground-level hose connection with a shutoff valve. Care shall be taken to see that the disinfecting solution is flushed thoroughly from the water supply and the water mains.
New water mains must be flushed and disinfected prior to connecting service lines.
Taps required by the Contractor for chlorination or flushing purposes shall be provided by him as a part of the construction of water mains.

Where dry calcium hydrochlorite is used for disinfection of the pipe, flushing shall be done after disinfection.

Care shall be taken to see that the heavily chlorinated water used for disinfecting the water lines shall be flushed thoroughly from the water supply lines and the water mains. The environment into which the chlorinated water is to be discharged shall be inspected and if there is a possibility that the chlorinated discharge will cause damage, a neutralizing chemical shall be applied to the water to be wasted to thoroughly neutralize the chlorine residual remaining in the water. No heavily chlorinated waters shall be permitted to mix with "live" waters such as streams, rivers or lakes.

- G. Requirement of Chlorine: Before being placed into service, all new mains and repaired portions of, or extensions to, existing mains shall be chlorinated so that a chlorine residual of not less than 25 ppm remains in the water after standing 24 hours in the pipe. The initial chlorine content of the water shall be not less than fifty (50) parts per million. The two above tests shall be made in the presence of the City Inspector and records made for the City's file.
- H. Form of Applied Chlorine: Chlorine shall be applied by one of the methods which follow, to give a dosage of not less than 50 ppm of available chlorine. Calcium Hypochlorite granules must not be used on solvent welded plastic pipe or on threaded-joint steel pipe.
- II. Dry Calcium Hypochlorite: As each length of pipe is laid, sufficient high test calcium hypochlorite (65-70% chlorine) shall be placed in the pipe to yield a dosage of not less than 50 ppm available chlorine, calculated on the volume of the water which the pipe and appurtenances will contain.

The following table gives the amount of calcium hypochlorite (70% available chlorine) to be used for each 20 foot length of pipe to give a concentration of 50 ppm of available chlorine.

Amount of Calcium Hypochlorite for:

Diameter of Pipe	Each 20 foot Length in Tablespoonfuls	Pounds Per 1000' of Pipe
4-inch	½	0.5
6-inch	1-1/2	1.0
8-inch	2-1/2	1.6
10-inch	4	2.5
12-inch	6	3.6
14-inch	8	---

- J. Liquid Chlorine: A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device, or the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas, or the gas itself, must provide means for preventing the backflow of water into the chlorine.
- K. Chlorine-Bearing Compounds in Water: A mixture of water and high-test calcium hypochlorite (65-70% CI) may be substituted for the chlorine gas-water mixture. The dry powder shall first be mixed as a paste and then thinned to a 1 percent chlorine solution by adding water to give a total quantity of 7.5 gallons of water per pound of dry powder. This solution shall be injected in one end of the section of main to be disinfected while fitting the main with water in the amounts as shown in the table which follows.

Chlorine Requirements for 100-Ft.
Lengths of Various Sizes of Pipe

Pipe Size (inches)	Volume of 100 ft. length (Gallons)	Amount Required to 100% Chlorine (lb)	Give 50 ppm Cl. 1% Chlorine - Water Solution in Gallons
4	65.3	0.027	1/3
6	146.5	0.061	3/4
8	261.0	0.108	1-1/3
10	408.0	0.170	2
12	588.7	0.240	3

- L. Sodium Hypochlorite: Sodium Hypochlorite, commercial grade (15% CI) or in the form of liquid household bleach (5% CI) may be substituted for the chlorine gas-water mixture. This liquid chlorine compound may be used full strength if diluted with water and injected into the main in correct proportion to the fill water so that dosage applied to the water will be at least 50 ppm.
- M. Point of Application: The preferred point of application of the chlorinating agent is at the beginning of the pipe line extension or any valved section of it, and through a corporation

stop inserted by the utility in the horizontal axis of the pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap made by the utility on the pressure side of the gate valve controlling the flow into the pipe line extension. Alternate points of application may be used when approved or directed by the Engineer.

- N. Rate of Application: Water from the existing distribution system, or other source of supply, shall be controlled to flow very slowly into the newly laid pipe line during application of the chlorine. The rate of chlorine gas-water mixture or dry gas feed shall be in such proportion to the rate of water entering the newly laid pipe that the dosage applied to the water will be at least 50 parts per million.
- O. Preventing Reverse Flow: Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves may be used if desired.
- P. Retention Period: Treated water shall be retained in the pipe at least twenty-four (24) hours. After this period, the chlorine residual at pipe extremities and at other representative points shall be at least 25 parts per million.
- Q. Chlorinating Valves and Hydrants: In the process of chlorinating newly laid pipe, all valves or other appurtenances shall be operated while the pipe line is filled with the chlorinating agent and under normal operating pressure.
- R. Final Flushing and Testing: In the process, chlorine treated water shall be thoroughly flushed from the newly laid pipe until the replacement water throughout its length shows, upon test, the absence of chlorine. In the event chlorine is normally used in the source of supply, then the tests shall show a residual not in excess of that carried in the system.

After flushing, the Engineer will arrange for taking samples by the utility or by health authorities.
- S. Bacteriological Samples: The Contractor shall take 3 bacteriological samples from the installed pipe line with the Engineer present. The locations of the samples shall be at intervals along the pipe line as directed by the Engineer. The sampling bottles and methods used shall be in accordance with the Department of Environmental Quality, Division of Drinking Water, "Public Drinking Water Regulations," or other similar applicable regulating agencies. Sample results shall be sent to the City Manager and City Engineer.
- T. Records and Documentation: All disinfection operations shall be recorded by the Contractor. Records shall contain the length of pipe disinfected, size of pipe, type of pipe, location of pipe, date, time and duration of disinfecting operations, complete list of equipment used and personnel performing the disinfection, and any comments about the disinfection operations. Three sets of these records shall be submitted to the City, bearing the name and signature of the persons performing the disinfection.
- U. Repetition of Flushing and Testing: Should the initial treatment result in an unsatisfactory bacterial test, the original chlorination procedure shall be repeated by the Contractor until satisfactory results are obtained. Failure to get a satisfactory test shall be considered as failure of the Contractor to keep the pipe clean during construction, or to properly chlorinate the main, and no additional payment will be made for reflushing and rechlorinating.

- V. Blow-off Hydrants: Blow-off hydrants shall be non-freezing, self-draining type, with an overall length of 4.5 feet set underground in a 36" valve box. Hydrants will be furnished with a 2" FIP inlet, a non-turning operating rod, and open to the left. All working parts shall be of bronze-to-bronze design, and be serviceable from above grade with no digging. The outlet shall be a 2-inch FIP coupling with plug. The blow-off hydrant shall be equal to #77 Mainguard Hydrant manufactured by Kupferle Foundry Company.

- W. Concrete Blocking: Concrete thrust blocking shall be placed at bends, tees, and crosses or as directed by the Engineer. Blocking shall be Class 2000 (1-1/2" minus aggregate) concrete mix poured in place.

Concrete blocking, when placed as indicated on the Standard Drawing, shall be bearing against solid undisturbed earth at the sides and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints of the pipe or fittings. Payment for blocking will be included in the unit price for water line installed.

