Program
Bulletin No. 3

F.W.A. 8842

FEDERAL WORKS AGENCY.
DIVISION OF DEFENSE HOUSING.

T Y P I C A L

TECHNICAL SPECIFICATIONS FOR UTILITIES SERVING DEFENSE HOUSING PREFABRICATED DEMOUNTABLE HOUSES.

For use in connection with projects
developed under Public No. 849; 76th Congress.

(Lanham Act)

Revised
December 15, 1941.

NOTICE TO ENGINEERS

The following specifications are to be used only as a guide for it is realized that no single standard specifications will cover satisfactorily all variations in local conditions which may prevail for individual jobs. Therefore, the Engineer should give particular attention to the items listed and make such changes as are necessary to meet prevailing physical and economic conditions.

C O N T E N T S

SPECIFICATIONS

COLLECTING SYSTEM
(Sanitary Sewers)

1. Description

This work will include all sewer lines, wyes, specials, clean-outs, lampholes, manholes and all other work embraced in this system. It is the intent of these specifications that this contract shall include all work of every nature, all equipment materials, appurtenances, and services necessary to make this system complete.

1.1 Sewer Pipe

The pipe for this sewer system shall be of bell and spigot type as described herein.

a. Vitrified Pipe

All vitrified pipe shall conform to the Standard Specifications for "Clay Sewer Pipe", A.S.T.M. Serial designation C13-35 with subsequent revisions.

b. Concrete Pipe

All concrete pipe shall conform to the latest approved A.S.T.M. Standard Specifications, Serial designation C14-35, with subsequent revisions.

1.2 Trenching

Unless otherwise directed by the Engineer, all trenches in which pipes are to be laid shall be excavated in open cut, to such depths and widths as will give sufficient space for placing the pipe for drainage, and for proper back-filling. The trenches will be excavated to the depths specified by the Engineer. Before laying the pipe, the trench shall be opened far enough ahead to reveal obstructions. The trench shall be straight and uniform and shall be kept at a uniform distance from the center line of the street or roadway, or as directed by the Engineer.

1.3 Obstructions

In cases where gas, sewer or other pipe is encountered, it shall not be displaced nor molested unless necessary, in which case it shall be replaced in good condition promptly. Materials excavated shall be disposed of so as to interfere as little as possible with public travel, and in all cases the disposition of excavated material

shall be satisfactory to the Engineer. All gas, water and storm sewer lines damaged or molested in the construction shall be replaced or repaired at the Contractor's expense, unless in the opinion of the Engineer such damage was caused through no fault of the Contractor.

At all street crossings and road crossings, only one-half of such street crossings and road crossings shall be excavated before placing temporary bridges over the side excavated, for the convenience of the traveling public. All temporary bridges, barricades, lanterns, and watchmen by night and such other signs and signals by day, as shall be necessary to warn the public of the dangers caused by excavations and other obstruction shall be provided by and at the expense of the Contractor.

1.4 Laying Pipe

The pipe shall be laid accurately in line and grade as furnished by the Engineer. Bell holes shall be dug in advance of the pipe laying. Each pipe shall be so laid as to form a close joint with the next jointing pipe and bring the inverts continuously to the require grade. Supporting of pipe on blocks will not be permitted.

Branches, fittings, and specials shall be provided and laid as indicated on the drawings or as directed by the Engineer. All open ends of pipe and branches shall be sealed with stoppers or bulkheads firmly held in place in a manner acceptable to the Engineer.

At the end of each day's work the open ends of the pipe shall be satisfactorily protected against the entrance of earth or other materials.

No special payment will be made for stoppers or bulkheads.

1.5 Backfilling of Sewer Lines

In the backfilling of the trench, material reasonably free from rock and acceptable to the Engineer shall be used; the backfill material shall be carefully tamped under and around the lower half of the pipe up to the point where the pipe is thoroughly covered. In filling the remainder of the trench, the backfill material may be shoveled into the trench without compacting and heaped over it wherever, in the judgment of the Engineer, this method of backfilling can be done without inconvenience to the traveling public. When so required by the Engineer, the backfilling shall all be done in layers not exceeding 6" and firmly tamped into place by tampers or rammers; mechanical tamping will be required on lines where street pavement is to be replaced, when directed by the Engineer. The Engineer may permit the puddling of ditches to compact the backfill in lieu of

tamping with mechanical tampers. The Engineer may also require puddling where in his judgment it is necessary for proper compaction. Wherever in the opinion of the Engineer it is necessary the Engineer may require the Contractor to use a combination of any or all the above outlined methods for the proper compaction of the backfilling in the trenches. Before final acceptance, the Contractor will be required to level off all trenches where backfilled materials have been piped up, or to bring up the trench to the grade of the roadway where necessary; also to remove from the streets, roadways and private property all excess earth or other material not needed in the work.

1.6 Joints and Caulking

Joints on vitrified clay, or concrete pipe shall be made with cement mortar and a picked oakum gasket. Cement mortar shall consist of one part Portland Cement and one part sand and shall be troweled to a smooth bevel around socket of pipe. Inside of pipe shall be mopped out after joint is made. "Slip Seal" joint will be acceptable in lieu of cement joints, subject to the approval of the Contracting Officer. If Slip Seal joint is to be used it shall be as manufactured by the Universal Sewer Pipe Corporation, or equal, with the provision that the material is used in strict accordance with the manufacturer's specifications.

1.7 House Connections

The Engineer will designate the location and will furnish grades for the points in the collector lines where wyes are to be installed for house connections. This Contractor shall lay the house connecting line from this point to a point approximately 5 feet from each building and connect with sanitary drain from building where same has been previously installed by others. Where house drain line has not been installed the open end of the pipe shall be sealed with stoppers or bulkheads in a manner acceptable to the Engineer. The minimum cover over house connections in traveled streets or alleys shall be 5', unless otherwise specifically authorized by the Engineer.

1.8 Manholes

Manholes shall be installed where shown on the drawings or as directed by the Engineer. They shall be 3' inside diameter. They shall be constructed on a six inch foundation and floor. Inverts to be built as hereinafter specified. The manhole proper shall be constructed of brick masonry. The concrete foundation and other concrete used in connection with the construction of manholes shall be of 2,000 pound concrete.

(a) Brick

Brick used in the construction of manholes shall be grade "A", common, sound, hard burned and shall meet all requirements of the A.S.T.M. Standard Specifications, (C-62-30) with subsequent revisions.

(b) Mortar

Mortar for brick work shall be composed of one part cement and two parts sand, to which a small amount of hydrated lime, not to exceed 10 pounds for each sack of cement, shall be added.

(c) Brick Walls

The brick walls shall be 8" thick and shall be laid all headers with well bonded joints struck off smoothly on the inside. All jointing spaces must be completely filed with mortar. The outside of the manhole shall be plastered with cement mortar.

(d) Invert

The invert shall be constructed of split sewer pipe in straight sewer line. Curved inverts shall be constructed with concrete.

(e) Manhole Frame and Cover

Standard cast iron manhole frame and cover marked "Sewer" shall be furnished for each manhole and thoroughly grouted in place with cement mortar. The frame and cover shall be of the type and dimensions shown on the drawings. The castings shall conform to the Standard Specifications for Gray Iron Castings, A.S.T.M. (serial designation A48-18) with subsequent revisions.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and other defects that would effect the value for the service intended.

(f) Manhole Steps

Manhole steps shall conform to the details shown on the drawings. The steps shall be made of highest grade cast iron, resistant to rust and corrosion. After being set they shall be given one coat of approved protective asphalt paint.

COLLECTING SYSTEM
(Storm Sewers)

2. Storm Water Sewers

(a) This Contractor shall provide storm water drains of sizes noted and run as shown on the drawings or as directed by the Engineer.

(b) Kind of pipe, method of laying, etc., shall be as described and specified for "Sanitary Sewers" except that all concrete pipe of 18" in diameter and over shall conform to A.S.T.M. specifications, serial designation C75-35 with subsequent revisions.

(c) Manholes to be type specified for "Sanitary Sewers".

(d) Catch basins to be standard, flat grill type top as shown on drawings.

EXCAVATION

3. Description

This work shall consist of excavating the roadway, the removal and satisfactory disposal of all materials taken from within the limits of the work, and shall include all excavation, shaping, and sloping necessary for the construction and preparation of the enbankment, subgrade, shoulders, slopes, ditches, intersections, approaches, and private entrances to the required alignment, grade and cross-section as required.

3.1 Construction Methods

All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankment, subgrade and shoulders, and at such other places as directed. No excavated materials shall be wasted without permission and when such material is to be wasted it shall be disposed of as directed by the Engineer. No payment will be made for any excavated material which is used for purposes other than those designated. During the construction of the roadway the roadway bed shall be maintained in such a condition that it will be well drained at all times.

After the earth work has been substantially completed and after all drains have been laid, the subgrade shall be brought to the lines, grades and cross-section shown on the plans. The subgrade shall be thoroughly compacted by rolling, except where sand-clay, topsoil, or gravel surface, or bituminous mixed-in-place base course, is proposed.

All soft and unstable material and other portions of the subgrade which will not compact readily shall be removed as directed. All rock or boulders appearing in the earth excavations or embankments shall be removed or broken off to a depth of not less than six (6) inches below the subgrade. All holes, ruts, or depressions that develop in the subgrade, shall be filled with approved material and the subgrade brought to line and grade and compacted; this additional material as needed shall be obtained as "Excavation". If the subgrade is too dry

to compact properly when being rolled, it shall be thoroughly wet by sprinkling as deemed necessary by the Engineer to secure proper compaction. The rolling of the subgrade as required above shall be done with a power driven roller weighing not less than ten (10) tons.

ROADWAY PAVING
(Waterbound Macadam Base)
Type A

4. (a) Description

Waterbound macadam base shall be placed on the prepared subgrade to the line, grade and thickness shown on the plans and typical cross-section. Side forms or curbs shall be set to the line and grade for the edges of the finished surfacing or pavement and unless otherwise specified shall be 2" x 6" continuous wood plank nailed to 2" x 4" x 1½' stakes placed 4' apart.

(b) Materials

Waterbound macadam base shall be constructed of crushed stone of such character that it will compact and thoroughly lock under watering and rolling, so as to make a stable, well keyed base. If crushed gravel is used, it shall not contain more than five (5) per cent of rounded, uncrushed particles.

All materials shall be free from clay, vegetable matter and other deleterious material.

Stone shall be sound of uniform character and quality.

Rock and screenings shall be uniformly graded from coarse to fine and shall conform to the following requirements:

	Percentage Passing Sieve	
Sieve Size	Rock	Screenings
3"	100	- - -
2½	90-100	- - -
1"	0-10	- - -
3/4"	0-5	100
3/8"	- - -	90-100
No. 200	- - -	5-20

(c) Construction Methods

Crushed rock shall be spread on the prepared subgrade to such depth that when thoroughly compacted it will be of the form and dimensions as shown on the typical cross-section.

If rock is segregated into sizes in handling, it shall be remixed until it presents a uniform appearance.

All rock shall be spread from the vehicle by approved spreader boxes. Dumping in piles on the subgrade will not be permitted.

The macadam shall be rolled lightly to obtain initial compression and develop any irregularities. The surface of the stone shall then be carefully trued up and all high and low spots eliminated.

When smooth and true, the macadam base shall be thoroughly dry rolled until the rock does not creep or move under the weight of the roller.

After rolling, the surface of the stone shall be checked with a straight-edge ten (10) feet long. If the surface varies from the lower edge of the straight-edge at any place by more than one quarter (¼) inch, it shall again be trued up and rerolled and this process shall be repeated until the surface conforms to the above requirements for accuracy.

Screenings shall then be spread in thin layers and each layer rolled dry until no more screenings can be forced into the voids. The surface shall then be sprinkled with water and again thoroughly rolled. All excess screenings on the surface shall be scattered by light sweeping. The sprinkling and rolling shall be continued, and additional screenings shall be applied where bare spots appear, until all the voids are filled, and until a slight wave of excess water and screenings forms a grout in front of the roller. Hand brooms shall be used to sweep the excess screenings into the unfilled voids and to distribute them evenly. The macadam shall be rerolled on succeeding days as may be necessary to bond it thoroughly and secure a satisfactory surface. The quantity of screenings and water to be used shall be sufficient to produce a smooth, hard, well bonded surface.

The complete base shall have a firm, even surface, conforming to the grade for the bottom of the proposed wearing surface and shall be of the specified thickness.

Where the required thickness is five (5) inches or less the macadam base may be placed in one course. Where the required thickness is more than five (5) inches, the macadam base shall be constructed in not less than two (2) courses. Work on each shall be performed in a similar manner.

(d) Rolling

All rolling shall be done with power rollers weighing not less than eight (8) tons and with compression on the rear wheels of not less than three hundred (300) pounds per lineal inch of tire width.

A sufficient number of rollers shall be furnished on the work to provide one (1) roller for each four hundred (400) tons of macadam laid per eight (8) hour day. All rolling shall commence at the outer edges and continue toward the center. Under no circumstances shall the center of the road be rolled first.

Along curbs, headers, and walls, and at all places not accessible to the roller, the mineral aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not less than 100 square inches.

ASPHALTIC SURFACE TREATMENT OF WATERBOUND MACADAM BASE Type A-1

5. Description

(a) This treatment is intended for application to waterbound macadam, clay gravel, sand clay, limestone and similar types.

(1) The base course or existing road surface shall first be brought to uniform contour by patching all depressions and defective areas over three-quarters (3/4) inch in diameter and eliminating in an approved manner bumps or similar irregularities.

(2) The prepared surface shall be treated with a bituminous primer.

(3) Upon the primed surface a treatment of asphalt cement shall be applied and covered with mineral aggregate as hereinafter specified.

(b) All materials and methods of construction shall conform to the requirements of these specifications.

5.1 Materials

(a) The mineral aggregate shall consist of crushed stone, slag or gravel. It shall be of reasonable uniform quality throughout and shall be clean and free from excess of dust.

(b) When tested by means of laboratory screens, the mineral aggregate shall meet the following requirements:

Passing 1½" screen	100 per cent
Passing 1¼" screen	not less than 90 per cent
Passing 3/4" screen	25–75 per cent
Passing ⅜" screen	not more than 10 per cent

5.2 Bituminous Materials

(a) Asphaltic materials for prime coat shall be free from water and shall meet the following requirements for penetration:

Penetration at 77° F., 100 g., 5 sec.-----70–300

(b) Asphalt cement for surface treatment shall be homogeneous and shall not foam when heated to 175° C (347° F). It shall meet the following requirements for penetration:

Penetration at 77 F., 100 g., 5 sec.----200 to 350

(c) Refined tar, viscosity nine to thirteen, may be used in lieu of asphalt cement subject to the approval of the Contracting Officer.

5.3 Application of Asphalt Primer

Upon the prepared base course or existing road surface, asphalt primer shall be applied uniformly as directed by the Engineer, at the rate of from three-tenths (0.3) to eight-tenths (0.8) gallon per square yard at application temperature. It shall be applied only where the surface is dry and, unless otherwise permitted by the Engineer, when the air temperature in the shade is not less than 50° F. The asphalt primer shall be applied for the full width between shoulders or curbs by means of a pressure distributor at a temperature between 50° F. and 150° F. After application of the primer at least twenty-four (24) hours shall elapse before applying the final surface treatment.

5.4 Application of Asphalt Cement

Application of asphalt cement shall be made uniformly at the rate of from four-tenths (0.4) to five-tenths (0.5) gallons per square yard at application temperature by means of an approved pressure distributor. At time of application the asphalt cement shall have a temperature of not less than 275° F., nor more than 350° F.

5.5 Application of Mineral Aggregate

(a) Application of the asphalt cement shall be immediately followed with a cover coat of clean dry aggregate, uniformly distributed by hand or by means of an approved mechanical spreader, at the rate of from 50 to 65 pounds per square yard, as directed by the Engineer. The cover coat shall be applied while asphalt cement is still hot and shall be thoroughly broomed over this surface.

(b) Immediately after spreading and brooming, the mineral aggregate shall be rolled with a power roller weighing not more than eight (8) tons or less than five (5) tons, unless otherwise directed by the Engineer.

Rolling, accompanied by brooming, shall proceed in a longitudinal direction beginning at the outer edge of the treatment and working toward the center, each trip overlapping the prior trip by one-half of the width of the first roll. The first rolling of the mineral aggregate must be completed within one-half hour after it has been spread. Rolling shall be continued only until a smooth, thoroughly compacted surface has been obtained, as directed by the Engineer. Along curbs, headers, and walls, and at all places not accessible to the roller, the mineral aggregate shall be tamped thoroughly with mechanical tampers or with hand tampers. Each hand tamper shall weigh not less than 50 pounds and have a face area of not less than 100 square inches.

(c) Upon completion no loose-aggregate shall be allowed to remain on the pavement.

ROCK ASPHALT WEARING COURSE FOR WATERBOUND MACADAM BASE
Type A-2

6. Description

(a) Rock asphalt wearing course is intended for application to waterbound macadam, clay-gravel, sand clay, limestone and similar types.

(1) The prepared water bound macadam base, as hereinbefore specified, shall first be treated with a prime coat of refined tar.

(2) Upon the primed surface a wearing course of rock asphalt shall be applied as hereinafter specified.

(b) All materials and methods of construction shall conform to the requirements of these specifications.

(1) Material for primer shall contain not less than sixty (60) per cent by volume of refined coal tar base. fluxed with a tar material (Liquid at 60 degrees F) which shall make a homogeneous mixture and shall be of 9 to 13 viscosity.

During hot weather only, and on earth type base surface that is usually porous, a tar mixture of 13 to 18 viscosity shall be used, when directed by the Engineer.

(2) Rock asphalt shall be of uniform quality throughout and shall have an asphalt content of not less than six (6) per cent.

(c) Application of Tar Prime Coat

(1) The tar for the prime coat shall not be heated to a temperature greater than one hundred and fifty (150) degrees F. and shall be applied at a temperature of not less than one hundred and twenty-five (125) degrees F. and at the rate of three-tenths (0.3) to four-tenths (0.4) gallon per square yard of surface.

(2) After the prime coat has been applied the contractor shall keep all traffic off the road until, in the opinion of the Engineer, the tar has penetrated and dried out enough so as not to pick up under traffic. The contractor shall maintain the prime coat in a firm, intact condition until it shall have been covered by the application of the specified wearing course.

(d) Application of Rock Asphalt Wearing Course

(1) Rock asphalt shall be spread on the prepared surface, as hereinbefore specified, to such depth that when thoroughly rolled and compacted it will be of the form and dimensions as shown on the typical cross-section.

(2) Rolling

All rolling shall be done with tandem rollers weighing not less than eight (8) tons. Rolling shall be as directed by the Engineer and shall continue only until a smooth, thoroughly compacted surface has been obtained. If after first rolling has been completed any irregularities in the surface should develop the contractor shall reroll the surface to the satisfaction of the Engineer.

BITUMINOUS ROAD-MIXED SURFACING
Type B

7. Description

Road-mixed surfacing shall be composed of mineral aggregate and liquid asphalt, mixed on the roadbed, and spread and compacted in accordance with these specifications and in conformity with the lines, grades and dimensions shown on the plans and the typical cross-section.

If the contract provides for placing road mix on existing travel ways or bases, the surface of same shall be scarified, watered and rolled and a prime coat of liquid asphalt applied before spreading the mineral aggregate; otherwise the mineral aggregate road-mix shall be placed, in one course, on a prepared sub-grade, omitting the prime course; all as hereinafter specified.

7.1 Materials

(a) Asphalt

Liquid asphalt shall be an oil asphalt or a mixture of refined liquid and refined solid asphalt. It shall be free from admixtures with any residues obtained by the artificial distillation of coal, coal tar, or paraffin oil and shall be homogeneous and free from water. No emulsification or solution shall occur when a thirty (30) gram sample is boiled for two (2) hours with two hundred fifty (250) cubic centimeters of distilled water in a five hundred (500) cubic centimeter Erlenmeyer flask equipped with a reflux condenser.

(b) Grades

Asphalts shall be classified by penetration when tested in accordance with standard methods of tests of American Association of State Highway Officials.

(c) Mineral Aggregate

Mineral aggregate shall consist of any one or a mixture of the following materials: (1) broken stone or crushed gravel, (2) natural material having essentially the same qualities of angularity as broken stone and meeting the requirements for stability when combined within the limits for grading, (3) natural rough surfaced gravel meeting the requirements for stability when combined within the limits for grading.

The mineral shall be tough, durable, and sound, and shall be free from adobe, vegetable matter, and other deleterious substances.

7.2 Grading

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to one of the following gradings. Unless otherwise specified in the special provisions the mineral aggregate shall conform to the grading specified for three-fourths inch (3/4") maximum aggregate.

	Percentage Passing Sieves			
Sieve Size	3/4" Maximum	1/2" Maximum	3/8" Maximum	No. 4 Maximum
1" - - - - - - -	100	- - -	- - -	- - -
3/4" - - - - - -	95-100	100	- - -	- - -
1/2" - - - - - -	- - -	95-100	100	- - -
3/8" - - - - - -	65-85	75-95	95-100	100
No. 4- - - - - -	50-65	55-73	65-85	90-100
No. 16 - - - - -	30-43	30-45	38-52	46-67
No. 50 - - - - -	16-25	18-27	20-30	22-33
No. 200- - - - -	3-8	4-9	5-12	6-14

The gradings within the above tolerances shall be of such uniformity that the fractions of aggregate passing the Nos. 4, 50, and 200 sieves during any day's run will conform to the following limitations:

Maximum variation of percentage of material passing No. 4 sieve - - - - 6

Maximum variation of percentage of material passing No. 50 sieve - - - - 5

Maximum variation of percentage of material passing No. 200 sieve - - - - 4

7.3 Subgrade

Surfacing shall not be placed until the subgrade has been brought to a smooth and well-compacted condition, true to grade and cross-section and free from ruts and inequalities.

7.4 Spreading Aggregate

Coarse and fine aggregate shall be deposited in a single windrow in such quantity and proportions as to provide sufficient total aggregate, conforming to the specified grading, to produce a finished wearing course of specified thickness.

After the proportions of coarse and fine aggregate have been adjusted, the total aggregate shall be thoroughly mixed to the satisfaction of the Engineer, with disc harrow and blader. It shall then be bladed into a single triangular windrow for final measurement and adjustment as may be directed by the Engineer.

7.5 Application of Asphaltic Binding Material

(a) Immediately prior to application of the liquid asphalt binder, the windrow of mixed mineral aggregate shall be bladed across the road to a full uniform cross-section. If wet or damp, it shall first be bladed back and forth until dry and when asphaltic material is applied, shall contain not over one and one-half per cent (1-1/2%) of moisture.

(b) Upon the layer of graded aggregate, the liquid asphalt binder shall be applied uniformly by means of a pressure distributor, at a temperature between 160° and 200° F. and at the rate of approximately one (1) gallon per square yard, so as to produce a final mixture of four per cent (4%) to seven per cent (7%) of asphaltic material.

The treated aggregate shall then be mixed by means of a disc harrow until all free asphaltic material has been mixed into the mineral aggregate. No traffic shall be allowed on the freshly treated surface ahead of the harrow.

As soon as a full width section of the mineral aggregate has its total application of asphaltic material and has been thoroughly disced, mixing shall be continued with special road-mixing equipment, such as multiple blade drags or maintainers, pin mixers or other type mixers approved by the Engineer, until a thoroughly uniform mixture has been produced. If a road blader is used for mixing, the treated aggregate shall first be bladed into a single windrow at one side of the road after which it shall be moved in successive cuts to a windrow on the opposite side of the road, taking care not to bring in untreated base or shoulder material. This operation shall be repeated until the asphaltic material and mineral aggregate are thoroughly mixed into a uniform color, free from fat spots, balls and uncoated particles.

(c) The liquid asphalt binder shall be carefully heated by means of closed steam coils in tank, designed to secure uniform heating of the entire contents. The Contractor shall provide all necessary facilities for determining its temperature during heating and prior to application and shall take all usual precautions incident to handling materials of this nature.

Unless otherwise permitted by the Engineer, it shall be applied when the air temperature in the shade is not less than 50° F.

7.6 Spreading and Compacting Mixture

The asphalt mixture shall be spread for compaction from the windrow produced from the last mixing operation. It shall be bladed from this windrow in a succession of thin layers to a uniform cross-section of correct thickness.

Rolling shall commence at the outside edges and progress toward the center of the roadbed and shall be continuous throughout the spreading operations. During blading and rolling, all lumps or compressed masses of the mixture shall be remixed and again rolled. On completion of blading operation, all loose stone shall be swept to the outside surfaced area and be incorporated in the shoulder or picked up and disposed of.

The complete surface, when ready for acceptance, shall be thoroughly compacted, smooth and even, true to grade and cross-section, and free from irregularities. When a straight edge ten (10) feet long is laid on the surface parallel to the center of the roadway, the surface shall vary in no place more than one-fourth (1/4) of an inch from the lower edge of the straight edge.

Rolling shall be done with a power roller weighing not less than five (5) tons and not more than ten (10) tons. Over areas where materials cannot be placed and properly compacted by means of power equipment, the material shall be spread, raked and compacted by other approved methods.

SOIL - CEMENT ROADWAYS
Type C

8. General

Before construction work is started, complete laboratory analysis and testing of the soils to be used must be performed to determine the amount of cement to be used and the moisture contents of the soil and soil-cement mixtures and the densities of the compacted soil-cement mixtures which will control construction requirements.

8.1 Description

This item shall consist of a roadway composed of a combination of soil and portland cement uniformly mixed, moistened and compacted in accordance with this specification, and shaped to conform to the lines, grades, thicknesses and typical cross-section shown on the plans. Construction shall proceed as follows:

(a) The soil in the roadway shall be pulverized for the necessary depth and the full width to be treated with cement.

(b) Portland cement shall be uniformly spread and mixed with the pulverized soil.

(c) Water shall be added as needed with a pressure distributor and shall be uniformly incorporated in the mixture in the amounts required to attain the optimum moisture content specified by the Engineer for the soil-cement mixture.

(d) The mixture shall be compacted uniformly with sheeps foot rollers in one continuous operation from the bottom of treatment to the surface. The mixture shall be compacted at the optimum moisture content and to the density specified by the Engineer.

(e) After compaction is completed with the sheeps foot rollers, the surface shall be shaped, and then finished with a smooth-wheeled roller.

The equipment used shall be in suitable operating condition and approved by the Engineer. Equipment not satisfactory to the Engineer shall be removed and satisfactory equipment supplied.

8.2 Materials

Portland Cement

Portland cement shall be of a standard brand, and shall conform to the requirements and tests of the latest "Standard Specifications and Tests for Portland Cement", Serial Designation: C9-38, of the American Society for Testing Materials. One (1) cubic foot of portland cement shall be considered as weighing ninety-four (94) pounds.

Contractors, at their option, may use bulk cement, provided the apparatus for handling, weighing and spreading the cement is approved by the Engineer in writing.

Water

The water used in the construction of this roadway shall be free from salt, oil, acid, organic matter or other deleterious substances and shall be subject to the approval of the Engineer.

Soil

The soil for this roadway shall consist of the natural material in the roadway or selected soil which shall be approved by the Engineer.

3.3 Construction Methods

(a) Preparation of the Existing Roadway

Before undertaking other construction operations, the existing roadway shall be graded and shaped to conform with the grades, lines and cross-section required for the completed roadway. Any additional soil needed shall be placed as the Engineer may direct and any unsuitable material shall be removed and replaced with material acceptable to the Engineer.

(b) Pulverizing

Prior to the application of cement, the soil to be treated shall be scarified and pulverized for sufficient width and depth to give the compacted cross-section shown on the plans. Pulverizing shall continue until eighty per cent (80%) of the soil, by dry weight, exclusive of gravel or stone, shall pass a No. 4 sieve, and the soil shall be manipulated until the percentage of moisture in the soil does not exceed by more than two (2) the percentage of moisture specified by the Engineer for the soil-cement mixture before compaction. The length of roadway scarified and pulverized at any time shall not exceed the length which can be completed in accordance with this specification in two (2) working days except by special permission of the Engineer.

(c) Application of Cement

The pulverized soil shall be shaped to the approximate cross-section shown on the plans and the specified quantity of portland cement required for the full depth of treatment shall be uniformly spread over the surface in one operation in a manner satisfactory to the Engineer. No equipment, except that used in spreading and mixing, will be allowed to pass over the freshly spread cement until it is mixed with the soil.

(a) Mixing

Immediately after the cement has been distributed it shall be mixed with the loose soil for the full depth of treatment. Care must be exercised that no cement is mixed below the desired depth. Mixing may be accomplished with field cultivators, gang plows, disc harrows, rotary tillers

or other implements approved by the Engineer and shall be continued for as long a period of time and repeated as may be necessary to insure a thorough, uniform and intimate mix of the soil and cement and until the resulting mixture is homogeneous and uniform in appearance. The mixture shall then be shaped to the approximate lines and grades shown on the plans.

(e) Application of Water

Immediately after mixing of soil and cement is complete, the moisture content of the soil-cement mixture shall be determined by the Engineer and, if required, water shall be uniformly applied in such quantities and at such a rate as directed by the Engineer. A water supply and pressure-distributing equipment shall be provided which will permit the continuous application of all water required on the section of roadway being processed within three (3) hours. Each application or increment of water shall be partially incorporated by field cultivators, gang plows, disc harrows, rotary tillers or other implements approved by the Engineer so as to avoid concentration of water near the surface. After the last increment of water has been added, mixing shall be continued by using field cultivators, gang plows, disc harrows, rotary tillers or other implements approved by the Engineer. This equipment shall be of sufficient size and capacity to distribute the moisture uniformly throughout the full depth of the mixture in one (1) operation. Particular care shall be exercised to insure satisfactory moisture distribution along the edges of the section. When water spreading and mixing is completed, the percentage of moisture in the mixture, on a basis of dry weight, shall not vary from the specified optimum percentage of moisture of the mixture by more than one-tenth. This specified optimum moisture shall be that prevailing in the moist soil-cement at the time of compaction and shall be determined in the field by a moisture-density test. A.S.T.M. Designation: D558-40T, on representative samples of soil-cement mixture obtained from the roadway toward the conclusion of moist mixing operations.

(f) Compaction

Prior to the beginning of compaction, and as a continuation of mixing operations, the mixture shall be thoroughly loosened for its full depth and then shall be uniformly compacted with a sheeps foot roller. Compaction shall begin at the bottom and shall continue until the entire depth of soil-cement mixture is uniformly compacted to the density specified by the Engineer. This specified density shall be that prevailing in the moist soil-cement at the time of compaction and shall be determined in the field by a moisture-density text, A.S.T.M. Designation: D558-40T, on

representative samples of soil-cement mixture obtained from the roadway toward the conclusion of moist mixing operations. The sheeps foot roller shall be of the size, shape and weight specified by the Engineer as best suited to give the required densities in the soil-cement mixture being compacted. The rate of operation and number of rollers shall be sufficient to compact uniformly the section of roadway being processed for the specified width and depth within two (2) hours.

After the mixture is compacted, the surface of the treated roadway shall be moistened and reshaped to the required lines, grades and cross-section and then shall be lightly scarified to loosen any imprints left by the compacting or shaping equipment, until a uniform, even surface mulch of not more than one (1) inch in thickness is obtained that contains the specified optimum moisture. The resulting surface then shall be thoroughly rolled with smooth-wheel tandem and pneumatic-tire rollers of the size specified by the Engineer. When directed by the Engineer, surface finishing methods may be varied from this procedure provided a dense, uniform surface, free of surface compaction planes, is produced. The moisture content of the surface material must be maintained at its specified optimum during all finishing operations. The surface compaction and finishing shall be done in such a manner as to produce, in not over two (2) hours, a smooth, closely-knit surface, free of cracks, ridges or loose material, conforming to the crown, grade and line shown on the plans.

(g) Protection and Cover

After the roadway has been finished as specified herein, it shall be protected against rapid drying for a period of seven (7) days by applying a two (2) inch covering of earth, not less than four (4) pounds of straw or hay per square yard or other materials approved by the Engineer, which will be moistened initially and subsequently as may be necessary. This protection shall be omitted only upon written approval of the Engineer.

Any finished portion of the roadway adjacent to construction which is traveled by equipment used in constructing an adjoining section shall be continuously covered with at least six (6) inches of earth to prevent equipment from marring the surface of the completed work.

8.4 Alternate Method of Construction

If approved by the Engineer in writing, a machine or combination of machines which will meet these specifications for pulverizing the soil, spreading cement or water, mixing the materials, or compacting and finishing the mixture may be used in lieu of the method specified herein. Any machine used shall be provided with means for visibly and accurately gaging the water applications in gallons per

square yard. Machines for mixing soil, cement and water, should preferably be of a type which will mix the material progressively for the entire width of roadway. When a machine is used, precaution must be exercised to obtain the specified depth and straight longitudinal edges conforming to the crown and grade specified on the plans with all materials adjacent to the edges compacted to the same density as the remainder of the roadway. When the machine will handle only part of the roadway width, it shall work forward with successive increments so the roadway may be compacted and finished for full width in one operation. In any event, when machine mixing is used, the resulting soil-cement mixture shall be compacted at the optimum moisture content specified by the Engineer before there is any appreciable moisture loss and the compaction operation shall be a continuation of the mixing operation in such a manner that the moistened soil-cement mixture does not remain undisturbed after mixing and before compacting for more than thirty (30) minutes.

8.5 Construction Limitations

Cement shall be applied only to such an area that all the operations hereinbefore referred to can be continuous, and all but final surface finish completed within six (6) hours after the beginning of water application to the thoroughly mixed soil-cement. No cement shall be applied when the percentage of moisture in the soil in the subgrade immediately beneath the pulverized material exceeds the optimum moisture content specified by the Engineer for that particular soil when the percentage of moisture in the pulverized soil exceeds the optimum moisture of the soil-cement mixture by more than two (2). When any of the operations after the start of the application of water is interrupted continuously for more than thirty (30) minutes for any reason, or when the uncompacted soil-cement mixture is wetted by rain so that the average moisture content exceeds the tolerance hereinbefore given, the entire section shall be reconstructed in accordance with this specification.

8.6 Weather Limitations

During seasons of probable freezing temperatures, no cement shall be applied unless the temperature is at least forty (40) degrees Fahrenheit in the shade and rising.

8.7 Opening to Traffic

The Contractor will not be permitted to drive heavy equipment over completed portions, but pneumatic-tired equipment required for constructing adjoining sections may be permitted after the surface of the completed portion has hardened sufficiently to prevent the equipment marring the surface, provided protection and cover hereinbefore specified are not impaired. Completed portions may be opened to traffic after the seven (7) days' protection hereinbefore specified, provided the surface has hardened sufficiently to prevent marring by traffic.

8.8 Special Provisions

(a) The details of construction for each project involve cement, water, density and roller equipment requirements. It is also necessary to give details of width and depth of treatment. All the supplementary details can be covered by the plans and special provisions for each project.

(b) In soil-cement wearing surface construction, the sheeps foot rollers are removed when about 2 in. of surface mulch remain. Portland cement is then added to the surface mulch, thoroughly mixed in with spike-tooth harrows, broom drags, offset disc harrows or rotary tillers. This procedure also accomplishes the routine operation of removing surface compaction planes.

Water is then added to bring the mixture to the optimum moisture content. The whole is then finished out with sheeps foot rollers, a smooth wheel roller and penumatic rollers to yield a tightly knit surface finish.

The following quantities of portland cement should be added, in addition to the cement incorporated in the mixture as a whole:

For a 1-1/2-in. compacted depth, 4 per cent by volume (equivalent to 0.045 bag per sq. yd. of surface) for A-2 and A-3 soils; 6 per cent by volume (0.067 bag per sq. yd. of surface) for A-4, A-5, A-6 and A-7 soils. One-inch to 2-in. compacted depths with proportionate quantities of cement may be built.

(c) If a bituminous wearing surface should be specified, the bituminous prime and seal can be placed after the protection moisture cover has been removed and the surface has the proper moisture present for the application of the particular bituminous prime that is specified.

(d) When a bituminous cover or wearing surface is to be placed, the roadway is swept thoroughly and all remaining loose material and dust removed with a blower. Be sure that all loose material has been removed. A bituminous prime of light grade material is then applied at the rate of about 0.2 ga. per sq. yd. This is followed by a seal coat of about 0.3 gal. of bituminous material and 25 lb. of stone chips per sq. yd. (The details and methods of applying this surface can conform to the usual practice)

SAND ASPHALT BASE COURSE
Type D

9. Description

This item shall consist of a base course composed of sand asphalt, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical cross section shown on the plans or as directed by the Engineer. The sand asphalt base course shall be composed of a mixture of "Mineral Aggregate" and "Bituminous Material".

9.1 Master Grading

The mineral aggregate for the base course shall be graded to meet one of the following composition limits by weight, the grading to be used being as designated in the special provisions.

	Grading A	Grading B	Grading C
Passing No. 4 Sieve	100%	100%	100%
Retained on No. 10 Sieve	0-10%	0-10%	0-15%
Retained on No. 40 Sieve	10-50%	5-60%	0-60%
Retained on No. 80 Sieve	30-60%	25-75%	20-80%
Retained on No. 200 Sieve	10-40%	5-50%	0-50%
Passing No. 200 Sieve	0-7%	0-10%	0-12%
Clay, by Elutriation, Maximum	6%	8%	10%

9.2 Composition of Mixture

The mineral aggregate and bituminous material shall be combined in such proportions as to produce a mixture conforming to the following composition limits by weight for Grading A, B, or C, whichever is called for in the special provisions:

	Grading A	Grading B	Grading C
Retained on No. 10 Sieve	0-10%	0-10%	0-15%
Retained on No. 40 Sieve	9-48%	4-57%	0-58%
Retained on No. 80 Sieve	27-57%	20-72%	16-77%
Retained on No. 200 Sieve	9-38%	4-48%	0-48%
Passing No. 200 Sieve	0-7%	0-10%	0-12%
Bitumen	5-7%	4-6.5%	4-7%

9.3 Formula for Job Mix

The general composition limits given in the above tabulation are master ranges of tolerance they are maximum and minimum in all cases. Within the above master ranges the job mix formula shall be as designated by the Engineer and shall be held to a uniformity such that the following tolerances will not be exceeded.

Aggregate Retained on No. 40 Sieve	+ or - 10%
Aggregate Retained on No. 80 Sieve	+ or - 10%
Aggregate Retained on No. 200 Sieve	+ or - 10%

9.4 Materials

The bituminous material shall be asphalt made from petroleum or from fluxed natural asphalts. It shall be homogeneous, free from water, and shall not foam when heated to 347°F. and shall meet the following requirements.

	Min.	Max.
Specific Gravity at 77°F	1.000	
Flash Point (Cleveland Open Cup) °F	347	
Penetration at 77°F. (100 g. 5 sec.)	85	100
Ductility at 77°F. (CMS)	100	
Loss on Heating (50 g. 5 hrs. at 325°F) %		1.0
Penetration Residue at 77°F (100 g. 5 sec.)	60% original	
Proportion of Bitumen Soluble in CCL_4 %	99.5	
Total Bitumen Soluble in CS_2 %	99.5	

The mineral aggregate shall consist of sand, composed of clean, hard, durable grains, free from all foreign material and suitable for use in a bituminous mix. The mineral aggregate shall be secured from approved pits and shall be furnished by the Contractor.

9.5 Sources of Supply

Approval of all materials used in the construction of this pavement, under these specifications, shall be obtained from the Engineer prior to the delivery of the material, and samples of each shall be submitted as directed by the Engineer.

9.6 Field Laboratory

The Contractor shall provide a field laboratory in which to house and use the testing equipment, said laboratory to be not less than 10 feet wide, 12 feet long, and 7 feet high, floored, containing not less than 2 windows, and work bench with necessary drawers. This laboratory is to be used exclusively for testing purposes by the Engineer or Inspector, and shall be located as directed by the Engineer.

9.7 Pavement Samples

The Contractor shall furnish for testing, samples cut from the completed work when, and as, required by the Engineer. The areas of base course so removed shall be replaced with new mixture and finished to conform with the surrounding pavement. No additional compensation will be allowed for furnishing test samples and replacing the area with the base course mixture.

9.8 Plant Inspection

For the verification of weights, or proportions and character of materials and determination of temperatures used in the preparation of the mixture, the Engineer or his authorized representative shall have access at any time to all parts of the paving plant, and may at any time check the loads of material for weight, mixture, and temperature.

9.9 Construction Methods

(a) Equipment

All equipment, tools, machinery, and plant used shall be subject to the approval of the Engineer, and must be maintained in a satisfactory working condition at all times.

(b) Paving Plant

The plant used in preparing all bituminous paving mixtures shall be an approved type, capable of mixing in the manner herein specified, and must be provided with separate chambers for heating and mixing the ingredients. The paving shall comply with the following requirements:

The drier shall be of the rotating cylindrical type, suitably designed to heat and dry the aggregates to specification requirements, without any direct flame coming in contact with the aggregate, and to continuously agitate the aggregate during heating. The drier shall be capable of preparing aggregate to the full rated capacity of the pavin, plant.

The plant shall have a weigh box of sufficient capacity to hold the maximum amount of material for one batch. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alignment or adjustment. Said weighing hoppers must be free from contact on all edges, ends or sides with any supporting rods or other equipment that will in any way affect its proper functioning. In addition, there must be sufficient clearance between the hopper and supporting devices so that foreign materials will not accumulate. The discharge gate of the weigh box shall be so hung that the aggregates will not be segregated when dumped in the mixer. If necessary to correct any such tendency, baffles shall be inserted or other means provided to discharge the materials in a blended condition.

All screens shall be so designed, constructed and operated as to screen all aggregates to their specified sizes and proportions, and shall have a capacity, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.

The scales for the aggregates may be either of the beam or springless dial type, and shall be of standard make and design, sensitive to 1/2 of 1 per cent of the maximum load that may be required.

Beam scales shall be equipped with multiple weigh beams for each separate material weighed and for weigh box fare. Beam scales shall be balanced on knife edges and fulcrums, and be so constructed that they cannot be easily thrown out of alignment and adjustment.

Dial scales shall be of standard make and of sufficien size that the numerals on the dial can easily be read. The; shall be substantially constructed and if the scale gets out of adjustment it shall be replaced with other makes when so ordered by the Engineer. All dial scales shall be so located that they will be in plain view of the operator at all times.

Scales for weighing the asphalt cement shall conform to the specifications for the aggregate scales except that beam scales shall be equipped with a tare beam and a full capacity beam. The value of the minimun gradation in any case shall not be greater than two pounds. Dial scales for weighing the asphalt cement shall not have a capacity of more than twice the weight of the material to be weighed and shall read to the nearest pound.

The weighing equipment, in addition to complying with the above requirements, must be constructed with the necessary adjustable devices that will permit any part thereof that gets out of alignment or adjustment to be easily readjusted so that the weighing device will function properly.

The Contractor shall provide and have at hand the necessary number of standard weights for frequent testing of all scales.

The asphalt weigh bucket shall have a capacity equal to 12 per cent of the maximum capacity of the mixer, and it shall be supported on fulcrums and knife edges in the same manner as the weigh box. The use of any other type of asphalt weigh bucket will only be permitted by written permission of the Engineer.

Asphalt tanks for storage of asphalt cement shall have a total capacity sufficient for one day's run, and shall be capable of heating the asphalt cement with an effective and positive control of the heat at all times to a temperature between 250°F and 350°F.

The asphalt circulating system shall be constructed of adequate size to give the proper and continuous circulation of asphalt cement throughout the operating periods.

An armored thermometer reading from 200° F. to 400° F. shall be fixed in the asphalt line at a suitable distance from the weigh box discharge valve.

The plant shall be further equipped with an approved dial scale mercury actuated thermometer, an electric pyrometer or other approved thermometric instrument so placed at the discharge chute of the drier as to automatically register the temperature of the heated aggregates. This device shall also be in full view of the drum fireman or head feeder.

The mixer shall be a batch mixer of a standard twin pug mill type or an approved rotary drum type, steam jacketed, equipped with a sufficient number of paddles or blades and set in proper order to produce properly mixed batches of any material required under these specifications. Where difficulty is encountered in securing proper mixing for the specified mixing time the mixer shall be provided with an approved accurate timing device that will lock the discharge gates of the weigh box after all the materials have been placed in the mixer, and that will not release the gates until the specified time has elapsed. The minimum mixing time shall be 30 seconds, provided that where smaller mixers are approved, no decrease in time of mixing will be allowed, and if sufficient mixing and coating is not secured, the right is reserved to increase the required mixing time as may be judged necessary by the Engineer.

The spreading and finishing equipment shall be of approved type, and shall spread the sand asphalt base course to uniform density and strike a smooth finish, true to cross section and free from inequalities.

The screed or strike off shall be adjustable to the shape of the cross section of the finished base course.

(c) Method of Mixing

The asphalt cement shall be melted at the paving plant in kettles or tanks designed to secure uniform heating of the entire contents, and shall be brought to a temperature of 250° F. to 350° F.

When refined asphalt is to be combined with a flux the mixture shall be thoroughly agitated until a homogeneous asphalt cement of the required penetration is produced. The penetration of the asphalt cement shall be tested at suitable intervals to insure that it is maintained at a uniform consistency throughout the period of use.

(d) Preparation of Mineral Aggregate

The mineral aggregate shall be dried and heated at the paving plant in suitably designed revolving driers. It shall be heated to a temperature of 250° F. to 375° F. as determined on the mixing platform.

(e) Preparation of Base Course Mixture

The hot, dried mineral aggregate, prepared as above prescribed, shall be combined in uniform batches by weighing and conveying into the mixer the amount of aggregate required to give the specified base course mixture. The required quantity of hot asphalt cement for each batch shall be measured by weight, using scales attached to the asphalt bucket. The mixture shall be made by first charging the mixer with the mineral aggregate, then the asphalt cement shall be added and the mixing continued for a period of at least 30 seconds, or longer if necessary, to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated.

The time of mixing shall be that interval from the instant all the ingredients are in the mixer to the opening of the mixer discharge gate.

The ingredients shall be heated and combined in such a manner as to produce a mixture which when discharged shall not vary more than 30° F. from temperature set by the Engineer. Any mixture varying more than 30° F. shall be rejected. Every effort should be made to have the mixture leave the plant as near a constant temperature as possible.

The temperature of the completed mixture when discharged shall not be less than 275° F. nor more than 375° F. at any time.

(f) Transportation of Mixture

The base course mixture shall be transported from the paving plant to the work in tight vehicles previously cleaned of all foreign materials and when directed by the Engineer each load shall be covered with canvas or other suitable material of sufficient size to protect it from weather conditions. The inside of the bodies of the vehicles shall be sprayed lightly with oil to prevent the mixture from adhering thereto, but the use of mops and excess oil will not be permitted. No loads shall be sent out so late in the day as to interfere with spreading and compacting the mixture during daylight unless artificial light, satisfactory to the Engineer, is provided. The mixture shall be delivered at a temperature specified by the Engineer, and shall be between 275° F. and 375° F.

(g) Forms

Timber forms shall be used to hold the roadway material in place. They shall be of long leaf pine, or square edged pine from original growth, cypress, or other lumber which is square edged, and cut true to dimensions. Timber shall be sound, straight and free from warps. They shall be of a thickness and depth as shown on the plans. The length shall be from 10 to 15 feet.

The forms shall be firmly set and staked to correct line and grade and left in place after the pavement is completed. Stakes shall be placed at intervals of 2½ feet, or closer if necessary, and the forms spiked securely thereto. The depth of trench excavated to receive the forms shall not exceed 1/2 inch below the grade line established by the bottom of the form. All the backfill in the form trench shall be firmly compacted by tamping.

Not less than 1,000 feet of forms shall be in place at any one time, nor more than 2 miles, unless specified in writing by the Engineer. All forms in place shall be true to line and grade at the time of laying pavement, and shall be backfilled with suitable material for a distance of at least 2 feet outside.

(h) Placing Base Course Mixture

No base course shall be laid when the temperature is less than 35° F. in the shade away from artificial heat, unless permitted in writing by the Engineer. Prior to the arrival of the base course mixture on the work, the prepared subgrade shall be cleaned of all loose and foreign materials. It shall be placed only upon a subgrade which is dry, and shows no evidence of excess moisture and only when weather conditions are suitable.

The Engineer may permit, however, work of this character to continue when overtaken by sudden rain, up to the amount which may be in transit from the plant at the time, provided the mixture is within temperature limits specified. Upon arrival on the work, the base course mixture shall be dumped on approved steel dump boards outside of the area on which it is to be spread, and shall then be immediately distributed into place by means of hot shovels and struck off by an approved finishing machine, or spread with hot rakes in a uniformly loose layer of correct depth. The use of approved spreader boxes will be permitted in spreading the base course. The depth of this layer shall be gauged at least every three feet by means of a template cut to proper crown and section of roadway as shown on Sheet of Standards, allowing sufficient depth for compression. Any deviation from standard crown and section as indicated by template shall be immediately remedied by placing new or removing surplus material.

Straightedging and back-patching shall be done after initial compression has been secured, and while the material is still hot.

Contact surfaces of headers, curbings, gutters, manholes, etc., shall be painted with a thin, uniform coating of hot asphalt cement or asphalt cement dissolved in naptha just before the base mixture is placed against them.

(i) Compacting Base Course

While still hot, the mixture shall be thoroughly and uniformly compressed. Two 6 to 10 ton tandem rollers shall be used for securing compression. The tandem rollers used shall be kept in good condition and shall weigh not less than 200 pounds to the inch width of tread. Each roller shall be in charge of a competent experienced roller operator, and must be kept in continuous operation as nearly as practicable. Rolling shall start longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 1/2 the width of the roller. The motion of the roller shall at all times be slow enough to avoid displacement of the hot mixture and any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall at once be corrected by the use of rakes and of fresh mixture where required. Rolling shall proceed at an average rate not to exceed 400 square yards per hour per roller, and shall continue until no further compression is possible. To prevent adhesion of the base course to the roller, the wheels shall be kept properly moistened, but an excess of either oil or water will not be permitted.

At all places not accessible to the roller the base course mixture shall be thoroughly compacted with hot tamps to produce sealed joints.

If the Engineer directs, the base course shall be rolled with a hand operated roller immediately after being spread and the rolling with tandem rollers shall be delayed from one to five hours, as directed. When hand rolling is required, the roller shall weigh between 150 and 400 pounds and shall be from 30 to 50 inches wide. The hand roller shall be operated transversely and shall be equipped with a handle of sufficient length to permit the operator to roll the entire width of the base course from a position outside the forms.

(j) Joints

Placing of the base course shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is discontinued for such length of time as to permit the mixture to become chilled. In all such cases, including the formation of joints as hereinafter specified, provision shall be made for bond with new base course

mixture by cutting or trimming back the joint in order to expose an unsealed or granular surface for the full specified depth of the course. When laying of the base course mixture is resumed, the exposed edge of the joint shall be painted with a thin coat of hot asphalt cement thinned with naptha, and fresh mixture shall be raked against the joint, thoroughly tamped with hot tamps and rolled. Such portions of the completed base as are defective in finish, compression, density, or composition, or that do not comply in all respects with the requirements of the specifications, shall be taken up, removed, and replaced with suitable material, properly laid in accordance with these specifications.

(k) Protection of Base Course

If, at the time of laying base course mixture, permanent side supports, such as curbs, timber forms, headers or gutters have not been constructed, planks of suitable thickness shall be laid alongside of the pavement and rigidly supported to prevent the mixture from squeezing out under the roller. The planks shall remain in place until final compaction has been obtained. Sections of newly compacted base courses shall be protected from traffic for at least six hours, or until they have become properly hardened by cooling. No shoulders shall be constructed until base has been covered with wearing surface. No traffic except that in connection with laying the surface course shall be permitted on the base course.

(l) Testing Finished Base

The surface of the base after compression shall be smooth and true to the established crown and grade. Any defective places shall be immediately remedied by removing the base course mixture at such spots, and replacing it with hot fresh base course mixture which shall be immediately compacted to conform with the surrounding area.

The finished surface of the base shall be checked with a 10-foot straightedge, applied parallel to the center of the pavement, and any places that vary more than 1/4 of an inch as measured from the bottom of the straightedge to the finished base shall be corrected by repairing, or, if necessary, by removal and replacing.

The compacted base course shall be tested for thickness by the Engineer at 25 foot intervals throughout the entire length of the project and any portion of the base varying more than 1/2 inch from the designed thickness shown on the plans shall be corrected to that designed at the Contractor's expense.

After the pavement, including base course and surface course, has been completed, and before payment of the final estimate, cores shall be taken through the pavement to determine the thickness as contained in the specifications.

If the base is to be used as a wearing surface, then the base alone shall be cored to determine the thickness.

SAND ASPHALT SURFACE COURSE
Type E

10. Description

This item shall consist of a surface course composed of sand asphalt, constructed on the prepared base or subgrade in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross section shown on the plans or as directed by the Engineer. The sand asphalt surface course shall be composed of a mixture of "Mineral Aggregate" and "Bituminous Material".

10.1 Master Grading

Grading A, B, and C as specified for Sand Asphalt Base Course. Section 9.1.

10.2 Composition of Mixture

The mineral aggregate and bituminous material shall be combined in such proportions as to produce a mixture conforming to the following composition limits by weight for Grading A, B, or C, whichever is called for in the special provisions.

	Grading A	Grading B	Grading C
Ret'd on No. 10 Sieve	0-9%	0-10%	0-15%
Ret'd on No. 40 Sieve	7-47%	4-56%	0-57%
Ret'd on No. 80 Sieve	23-53%	20-70%	12-76%
Ret'd on No. 200 Sieve	7-37%	4-47%	0-48%
Passing No. 200 Sieve	4-12%	0-10%	0-12%
Bitumen	7.5-10%	6-10%	5-10%

10.3 Formula for Job Mix

The general composition limits given in the above tabulation are master ranges of tolerance and they are maximum and minimum in all

cases. Within the above master ranges the job mix formula shall be as designated by the Engineer and shall be held to a uniformity such that the following tolerances will not be exceeded.

Aggregate Retained on No. 40 Sieve	+ or - 10%
Aggregate Retained on No. 80 Sieve	+ or - 10%
Aggregate Retained on No. 200 Sieve	+ or - 10%
Aggregate Passing No. 200 Sieve	+ or - 3%
Bitumen	+ or - 1%

10.4 Materials

The bituminous material and mineral aggregate shall comply with section 9.4 on "Materials" as specified for Sand Asphalt Base Course. The requirements as to sources of supply, field laboratory, pavement samples and plant inspection shall be as specified for Sand Asphalt Base Course. Sections 9.4 to 9.9 inclusive.

10.5 Construction Methods

(a) Equipment

The requirements for the paving plant and equipment, preparation of the mixture, and transportation of the mixture shall be as specified for Sand Asphalt Base Course. Section 9.9.

(b) Placing Surface Course Mixture

Forms as specified for Sand Asphalt Base Course, shall be used to hold the surface course material in place. No surface course shall be laid when the temperature is less than 35°F. in the shade away from artificial heat, unless permitted in writing by the Engineer. Prior to the placing of the surface course, the base course shall be cleaned of all loose and foreign materials and a squeegee coat of hot asphalt cement shall be applied to the base. The squeegee coat shall be applied by an approved asphalt spreader at a uniform rate not to exceed 1/12 gallon per square yard. The asphalt cement shall be applied at a temperature of from 250° to 350°F. as directed by the Engineer. The surface course mixture shall be delivered at a temperature between 275°F. and 375°F., as directed by the Engineer and shall be placed only upon a base which is dry and only when weather conditions are suitable.

The Engineer may permit, however, work of this character to continue when overtaken by sudden rain, up to the amount which may be in transit from the plant at the time, provided the mixture is within temperature limits specified Upon arrival on the work, the surface course mixture shall be dumped on approved steel dump boards outside the area on

which it is to be spread, and shall then be immediately distributed into place by means of hot shovels and struck off by an approved finishing machine. The use of approved spreading machine will be permitted in spreading the surface course. Spreading by hand will not be permitted unless approved in writing by the Engineer. The depth of this layer shall be gauged at least every three feet by means of a template cut to proper crown and section of roadway as shown on the Sheet of Standards, allowing sufficient depth for compression. Any deviation from standard crown and section as indicated by template shall be immediately remedied by placing new or removing surplus material.

Straightedging and backpatching shall be done after initial compression has been secured, and while the material is still hot.

Contact surfaces of headers, curbings, gutters, manholes, etc., shall be painted with a thin, uniform coating of hot asphalt cement or asphalt cement dissolved in naphtha just before the surface course is placed against them. Immediately adjacent to headers, flush curbing, gutters, liners and other structures, the surface course mixture shall be spread uniformly high so that after compaction it will be 1/4 inch above the edges of such structures.

(c) Compacting Surface Course

While still hot, the mixture shall be thoroughly and uniformly compressed. Two 6 to 10 ton tandem rollers shall be used for securing compression. All rollers used shall be kept in good condition and shall weigh not less than 200 pounds to the inch width of tread. Each roller shall be in charge of a competent, experienced roller operator, and must be kept in continuous operation as nearly as practicable. Rolling shall start longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least one-half the width of the roller. The pavement shall then be subjected to diagonal rolling in two directions, the second diagonal rolling crossing the lines of the first. If the width of the pavement permits, it shall in addition be rolled at right angles to the center line. Rolling shall be continued until all roller marks are eliminated. The motion of the roller shall at all times be slow enough to avoid displacement of the hot mixture, and any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall at once be corrected by the use of rakes and of fresh mixture where required. Rolling shall proceed at an average rate not to exceed 500 square yards per hour per roller, and shall continue until no further compression is possible. To prevent adhesion of the surface mixture to the

roller, the wheels shall be kept properly moistened, but an excess of either water or oil will not be permitted.

Along curbs, headers, and similar structures, and all places not accessible to the roller, the surface mixture shall be thoroughly compacted with hot tamps to produce sealed joints.

If the Engineer directs, the surface course shall be rolled with a hand operated roller immediately after being spread and the rolling with the tandem rollers shall be delayed from one to five hours, as directed. When hand rolling is required, the roller shall weigh between 150 and 400 pounds and shall be from 30 to 50 inches wide. The hand roller shall be operated transversely and shall be equipped with a handle of sufficient length to permit the operator to roll the entire width of the surface course from a position outside the forms.

(d) Joints

Placing of the surface course shall be as nearly continuous as possible, and the roller shall pass over the unprotected end of the freshly laid mixture only when the laying of this course is to be discontinued for such length of time as to permit the mixture to become chilled. In all such cases, including the formation of the joints as hereinafter specified, provision shall be made for proper bond with new surface mixture by cutting and trimming back the joint in order to expose an unsealed or granular surface for the full specified depth of the course.

At the end of each day's work on the surface mixture, joints shall be formed by laying and rolling against boards of the thickness of the compacted mixture placed across the entire width of the pavement, or by such other methods as may be approved by the Engineer. When the laying of the surface mixture is resumed, the exposed edge of the joint shall be painted with a thin coat of hot asphalt cement, or asphalt cement thinned with naphtha, and the fresh mixture shall be raked against the joint thoroughly tamped with hot tamps and rolled. Hot smoothing irons may be used for sealing joints, but in such case extreme care shall be exercised to avoid burning the surface. Such portions of the completed pavement as are defective in finish, compression, density, or composition, or that do not comply in all respects with the requirements of the specifications, shall be taken up, removed, and replaced with suitable material, properly laid in accordance with these specifications.

(e) Protection of Pavement

If at the time of laying the surface course mixture, permanent side supports, such as curbs, timber forms, headers or gutters have not been constructed, planks of suitable thickness shall be laid along each side of the pavement and rigidly supported, in order to prevent the

mixture from squeezing out under the roller. These planks shall remain in place until final compaction has been obtained. Sections of newly compacted surface course shall be protected from traffic until it has become properly hardened by cooling. After the construction of the shoulders, the surface of the pavement shall be cleaned of all foreign material.

(f) Testing Finished Surface

The surface of the pavement after compression, shall be smooth and true to the established crown and grade. Any defective places shall be immediately remedied by removing the surface course mixture at such spots and replacing it with fresh, hot surface course mixture, which shall be immediately compacted to conform with the surrounding area.

The finished surface of the pavement shall be checked with a 10-foot straightedge, applied parallel to the center of the pavement, and any places that vary more than 1/4 inch as measured from the bottom of the straightedge to the finished surface shall be corrected by repairing, or if necessary, by removal and replacing.

(g) Testing Finished Pavement

When payment for the pavement is to be made on a square yard basis, cores will be taken from the pavement to check the thickness of the surfacing before payment of the final estimate. It is the intent of these specifications that the pavement shall be constructed strictly in accordance with the thickness shown on the plans.

AUTO PARKING AREAS

11. Description

This work shall consist of the grading and paving of all designated parking areas.

(a) Excavation for parking areas shall be "Excavation" as hereinbefore specified.

(b) A wooden bumper of the type shown on the drawings or as directed by the Engineer shall be constructed on the line between the parking place and the tenant properties.

(c) Paving should be of the type specified for roadway paving, or it may be of traffic bound macadam spread upon the prepared sub-grade to a depth of four inches. After the stone or gravel of traffic bound size has been spread, it shall be dragged and graded until it is brought to the proper cross-section and grade. The grading and dragging shall be continued at intervals as directed, until it is compacted to the satisfaction of the Engineer.

WALKWAYS

12. Description

This item shall include sidewalks, entrance walks, pathways and all other walks shown on the plans.

12.1 Excavation

Walkway excavation shall be "Excavation" as hereinbefore specified.

12.2 Bituminous Surface Treated Macadam

Surface treated macadam shall be constructed in form and manner specified for roadways with the following exceptions:

(a) Asphalt cut-back shall be used instead of asphalt cement.

(b) Sideforms or curbs shall be of 1" x 6" continuous wood plank, nailed to 2" x 4" x 1½' stakes spaced six feet apart.

(c) The thickness of the finished pavement shall be four (4) inches.

12.3 Concrete Walkways

(a) Concrete walkway pavement shall be 3" in thickness as shown on the drawings.

(b) Cement

Portland cement shall be a standard commercial brand, of fresh stock, delivered in original containers and kept dry until used.

(c) Aggregates

Coarse aggregate shall be clean, well graded crushed stone or gravel 3/4" size and smaller, all aggregate to be retained on 1/4" sieve. Sand shall be clean, sharp and well graded. Fine crushed rock screenings will be acceptable as sand.

(d) Water

All water shall be fresh, clean and free from alkali.

(e) Mix

Concrete for walkway pavement shall be 1:3:4 mixture by volume with just enough water to produce a plastic mix.

(f) Expansion Joints

Expansion joints shall be approximately twenty feet apart. Joint filler shall be a premoulded commercial product that will not be affected by extreme temperatures and not less than 3/8 inch thick and of depths required. Concrete walks shall be marked off with jointing tool every four feet.

12.4 Rock Asphalt Wearing Course for Macadam Base

(a) Base

Base for walkways shall be 4 inches thick and shall be of waterbound macadam as specified for "Roadways".

(b) Rock Asphalt

Rock asphalt shall be as hereinbefore specified except as a wearing course for walkways it shall be of a compacted thickness of 1/2 inch.

12.5 Traffic Bound Macadam Walkways

(1) The walks as shown on the drawings shall be formed with 1" x 6" continuous wood plank, nailed to 2" x 4" x 1½" stakes placed 6 ft. apart.

(2) There shall be spread upon the prepared sub-grade 4" of loose limestone or gravel of traffic bound size and it shall then be brought to a true section by tamping and striking off. The top of the walk shall be slightly above the ground level.

GRADING SITE

13. Description

This item shall consist of the required site grading as shown on the plans, and the removal of any existing trees, structures, roadways or utility services that interfere with construction work.

(a) Clearing

All trees, brush and stumps are to be cut, flush with the ground, except trees and stumps that are to be grubbed under the same contract, which may be cut to any height up to 3 feet.

No trees, brush or stumps or other refuse from clearing shall be thrown upon adjacent property, but trees unavoidably falling outside the specified limits shall be removed to within the clearing and disposed of there.

Timber of value shall be limbed up and cut into merchantable lengths and neatly stockpiled on site.

Perishable material to be disposed of shall be burned in small piles within the clearing.

(b) Grubbing

Grubbing shall consist of the excavation, removal and disposal of all stumps, roots, submerged logs, root mats, corduroy and other perishable and objectionable material.

All stumps, roots, logs, etc., shall be grubbed to a depth of not less than 1 foot below subgrade.

Unless otherwise specified on the plans or directed by the Engineer during construction, grubbing shall be done under all embankments of 2 feet or less in height. Where so designated on the plans, grubbing shall be done under embankments regardless of height.

All roots, stumps, logs, and other perishable material shall be burned in small piles within the area cleared and grubbed.

(c) Grading

Remove top soil and pile nearby as directed by the Engineer. Grade earth to slope away from buildings.

WATER DISTRIBUTION SYSTEM

14. Description

This work includes supply lines complete, the distribution system, together with all specials, valves, valve boxes, fire hydrants, meters, meter boxes and fittings and services.

This work shall also specifically include any street, sidewalk, curb and gutter removal and replacement, removal of trees, roots, timber or other obstacles, whether shown on plan or not.

14.1 Specifications

It is intended in these specifications that all cast iron pipe, fittings, and specials furnished under this contract shall conform to the specifications of the American Water Works Association (Manual Pages 650-668), insofar as these can be construed to apply with exceptions regarding the thickness, beads on spigot end and lengths which do not apply to the centrifugal pipe, nor to pipe cast in horizontal moulds; or shall conform to "Federal Stock Specifications WW-P-421.

All pipe is designated on the drawings and in these specifications as A.W.W.A. standard, however, Contractors may use in lieu of the A.W.W.A. standard, pipe conforming to "Federal Stock Specifications WW-P-421, in accordance with the following:

1. Substitution may be made only on pipe 16" or smaller

2. The substitution shall be as follows:

   (a) For Class "A", A.W.W.A. standard, substitute Class 100
   (b) For Class "B", A.W.W.A. standard, substitute Class 150
   (c) For Class "C", A.W.W.A. standard, substitute Class 250

All specials shall be Class "D", A.W.W.A. standard. Flanged fittings, either long or short radius, shall be American Standard for pressure specified on the drawings and shall be faced and drilled to the American Standard. Special pipe, fittings and special drilling shall be furnished as shown on the drawings or as ordered by the Engineer. No "dutchmen" or sleeves shall be used in the pipe lines except as shown on the drawings or permitted by the Engineer.

Special castings shall be Class "D" in all hub and spigot patterns.

Contractor furnishing pipe shall guarantee pipe and special castings against all defects in materials and castings. Should a pipe or casting burst when subjected to a pressure not exceeding one hundred and fifty (150) pounds per square inch, and it is found such failure was not due to climatic conditions or other conditions beyond the Contractor's control, but due to defects inherent in the pipe, or the manner of handling, transporting or installing, then the Contractor furnishing said material shall replace same at no additional cost. The Contractor shall furnish sleeves, if necessary, for making cut into existing lines and make all repairs at no additional cost. The guarantee shall apply for a period of six (6) months after date of final acceptance.

All pipe and castings shall have a coat of coal tar as specified in the manual of Water Works Practice.

14.2 Trenching

Unless otherwise directed by the Engineer, all pipe shall be laid in open trenches excavated to sufficient width to permit proper placing of the pipe, blocking, and back filling under same. In general the pipe shall be laid to a depth, depending on local climatic conditions, sufficient to prevent freezing, but in no event shall the cover be less than 24 inches, except by special permission of the Engineer.

The pipe shall be laid straight and to a fairly uniform grade. Before laying the pipe a sufficient length of trench shall be open to reveal any obstruction, so as to prevent any abrupt break in the grade. Payment of trench excavation (except solid rock) and backfilling shall be included in the unit bid price for installation of the pipe.

14.3 Rock Excavation

Where rock is encountered, same shall be excavated to a depth of 6 inches below the invert of the pipe and to a width of 12 inches on each side of the barrel of the pipe. All material that requires drilling and wedging and/or blasting will be classified as solid rock and payment for same will be paid at the unit bid price of rock excavation.

All other excavated materials will be classified as common excavation and payment for same will be included in the unit bid price for pipe installation.

14.4 Obstruction

In the event that a public utility is encountered, it shall not be displaced or molested, unless necessary, in which case, it shall be replaced in good condition as promptly as possible, at no additional cost. All damage to such utilities shall be paid by the Contractor, unless in the opinion of the Engineer, such damages were no fault of the Contractor. Traffic shall be maintained at all street or road crossing by constructing temporary bridges, roads, or by other means devised by the Contractor. The Contractor shall provide the necessary warning signs, lights, barricades, etc., to protect the public at such locations.

14.5 Laying Cast Iron Pipe

The bed for each piece of pipe shall be graded and shaped so that it will have a firm and uniform bearing throughout the length of the pipe. The pipe shall be laid to uniform line and grade, without sag or kink. Bell holes shall be dug large enough to clear the ground and give ample room for caulking.

Before the pipe is laid in the line it shall be thoroughly swabbed to insure it being clean. Each piece of pipe shall be lowered separately into the trench, and proper care shall be exercised not to injure the pipe coating. This is intended to also apply to the special fittings. No piece of pipe or fitting, that is known to be defective shall be laid in the line. If it is found that a defective pipe or fitting has been laid, same shall be removed and replaced by sound material, at no additional cost. If found necessary to cut a length of pipe, it shall be cut smooth at the end and at right angle to the longitudinal axis of the pipe. All open ends of pipe shall be securely plugged when work is left temporarily or at night. Angles or sharp bends in line shall be blocked against the tendency of movement.

14.6 Jointing and Caulking Bell and Spigot Pipe

Material used for jointing purpose shall be "Leadite" or "Hydrotite" or an approved equal.

In preparing the joints to receive this material the bell and spigot ends of the pipe shall be free of moisture and/or any other foreign matter. These ends shall then be shoved home so as to make a snug joint not less than 2½ inches deep, which shall then be well corked with one continuous piece of closely twisted yarn or oakum, free of oil and grease, wound completely around the spigot end of the pipe. Approved corking tools shall be used in this operation. The joint shall be made by experienced pipe jointers and caulkers. Caulking shall be done from bottom of the joint, toward the gate. After the joint has been made ready to receive the jointing material or compound each pouring gate shall be poured full in one single operation. After this material has thoroughly cooled each joint shall be examined and if no defects are found the protruding cone shaped material contained in the pouring gate shall be broken off flush with the top of the bell of the pipe.

If defective joints are found same shall be cut out and repaired.

The mixing, heating, and pouring of jointing material shall be in accordance with manufacturer's specifications.

14.7 Testing

Before any section of pipe is covered up it shall be subjected to a pressure of 150 pounds per square inch. This pressure shall be maintained for at least thirty minutes. Any joints leaking badly under the pressure test shall be cut out and re-poured. Pipe lines shall be tested between valves or plug end if necessary, in sections of not over 1,500 feet.

Test for water-tightness of joints shall be made after the line has been subjected to work-pressure for three to five days. At this time the section of pipe under test shall be subjected to a leakage test of 100 pounds pressure for at least 2 hours. At this pressure the line shall not show leakage exceeding 200 gallons per 24 hours per inch diameter per mile of pipe. Should any leakage occur, above this tolerance, the contractor shall cut the defective joints and repour them, or stop the leakage by other means.

14.8 Flanged Joints

All flanges, unless otherwise required, shall have American Standard drilling. Gasket shall be Rainbow, or equal, or rubber with cloth insertions or other approved material shall be used. Flanges shall be firmly bolted with machine, stud or tap bolt of proper size. The bolts and nuts are to be of best quality refined bar iron with good, true threads. Bronze bolts shall be used where shown on plans, or required by the Engineer.

14.9 Connecting Existing Line

Connections shall be made with existing lines at such points as may be indicated on the plans. No special payment will be made for the work except that payment will be made at the unit bid price for the material required.

14.10 2 Inch Pipe

Where 2 inch pipe is required the contractor may, at his option, use cast iron or galvanized pipe.

14.11 Galvanized Pipe

Galvanized pipe shall be standard commercial grade steel pipe thoroughly galvanized.

14.12 Jointing Galvanized Pipe

Where galvanized pipe is used, each joint shall be painted one coat of white lead before jointing and shall be securely jointed with standard fittings so as to make a water tight connection.

Where 2 inch cast iron pipe is used the same specifications apply as for large sizes.

14.13 Backfill

The pipe shall be backfilled with fine earth or sand and thoroughly hand tamped under and around the barrel of the pipe until same is covered to a depth of 6 inches above the top. If

suitable material of this nature cannot be obtained along or in the pipe trench, for this purpose, the contractor must secure some elsewhere and install as described above, at no additional expense. The remainder of the trench shall then be backfilled with material reasonably free from rock and thoroughly tamped in 6 inch layers with either mechanical, or hand tamper. Puddling may be substituted for tamping, at the discretion of the Engineer.

Where street surfacing is to be replaced the trench shall be backfilled to a depth of 6 inches above the top of the pipe as above specified. The trench shall then be flushed with water. The remainder of the trench then backfilled with material reasonably free of rock to within approximately 12 inches of the surface and again flushed. After the second flushing the backfilling shall be completed to the bottom of the paving foundation with material and thoroughly tamped to the satisfaction of the Engineer.

Where, in the opinion of the Engineer, conditions warrant such treatment of any section of the trench, flushing or tamping or a combination of both methods for compaction shall be used when directed by the Engineer.

Before final acceptance, the contractor will be required to bring the level of all trenches to the grade of the roadway; and also to remove from the roadway, streets, and private property all excess material not needed in the work.

14.14 Replacement of Existing Street Surface

Where required to excavate or remove existing street surfacing the contractor shall, as promptly as possible after installing the pipe, backfill the trench and replace the pavement with same kind and type pavement as that removed, and to leave the premises in as nearly possible, the same conditions as originally found.

14.15 Valves and Valve Boxes

All valves in the distribution system must be of dimensions and weight to correspond with those specified in the American Water Works Association in their Manual of Water Works Practice, except as may be noted in the specifications or on the drawings. Valves in the distribution system must be constructed to stand a hydraulic pressure of three hundred (300) pounds per square inch.

14.16 Gate Valves

All gate valves shall be of iron body, double gate, non-rising stem, and shall open by turning to the left. All gate valves, except as otherwise specified or shown on drawings, for use in cast iron lines shall be of hub end type. Valves for use

in wrought iron or steel pipe lines shall conform to above specifications on cast iron pipe, except that they shall have screwed ends instead of hub ends.

All valves in the distribution system shall have 2 inch standard valve operating nuts.

14.17 Valve Boxes

Valve boxes shall be cast iron of three-piece adjustable pattern for valves 4" to 12" and two-piece adjustable pattern for valves smaller than 4". They shall each have lid marked "WATER". Valve boxes to be set vertical and adjusted so that the cover will be in the same plane as the finished grade of the roadway, walkway, or property, whichever is applicable.

14.18 Service Connections

At points indicated on the drawing, or at other points directed by the Engineer, service connections from the main to the house shall be either 1 inch galvanized steel pipe with malleable iron banded galvanized fittings, or lead piping complying with recommended standards of the Lead Industries Association, for prevailing pressures. Each tap for building branches to be fitted with a corporation cock. A curb cock with automatic drain and rod socket with extension box shall be installed below the frost line on each building connection, near the lot line; or if main is inside the lot line the valve shall be near the main.

Curb and stop cock shall be as manufactured by the Mueller Company or equal.

14.19 Meter and Meter Boxes

This item shall include the furnishing and setting of the service meters and meter boxes and lids, complete, also backfilling around meter boxes.

Meters for service connections shall be 5/8" or 3/4" disc meters, with connections of the following manufacture and type, or equal. All meters shall be of same make and type.

Pittsburgh Meter Company,	Type "Tropic",	or equal
Hersey Meter Company,	Type "HD",	or equal
Neptune Meter Company,	Type "Trident"	or equal
Badger Meter Company,	Type "Sot",	or equal

All meters shall have oil inclosed trains and circular registers reading in gallons.

Meter boxes shall be of concrete, or plain tile with cast iron lid, and of sufficient size to house the meter or meters, as shown on drawing or directed by the Engineer. Tile or concrete to be slotted on opposite side to permit setting of pipe.

Standard, double strength, vitrified tile, without bell will be used, meeting A.S.T.M. Standards for same. Concrete tile to be of equal strength.

14.20 Fire Hydrants

Fire hydrants shall be constructed of standard grade of material and shall conform to standards of the American Water Works Association, as outlined in their current Manual of practice. The hydrant shall have two (2) hose connection nozzles threaded and sized in accordance with fire hose now in use in locality effected, and have one large nozzle for pumper connection. The valve opening shall be at least 5" for hydrants which have 6" bell ends and not less than 4" for hydrants with 4" bell ends.

The hydrant shall be painted a bright color selected by the Engineer. Each hydrant, before leaving the factory shall be tested by a hydraulic pressure of three hundred (300) pounds per square inch with the valve shut, without developing any leak or sign of weakness.

The hydrants shall be set plumb. They shall not be set with less than two (2) cubic feet of broken stone or crushed gravel about the waste opening to permit proper drainage. They shall be backed up with either a large stone, or a cubic foot of 1:3:6: concrete, placed in such position against solid bank of the trench so as to counteract any thrust caused by the water pressure.

TYPICAL SPECIFICATIONS
WATER DISTRIBUTION SYSTEM
Cement-Asbestos Pipe
(Type-2)

14.21 Description

This work includes supply lines complete, the distribution system; together with all specials, valves, valve boxes, fire hydrants, meters, meter boxes, fittings and services.

This work shall also specifically include any street, sidewalk, curb and gutter removal and replacement, removal of trees, roots, timber or other obstacles, whether shown on the plans or not.

14.22 Specifications

(a) All cement-asbestos pipe furnished under this contract shall conform to Federal Specification SS-P-351, dated August 28, 1940.

(b) This specification covers cement-asbestos pipe of nominal inside diameter as specified: 4 inches to 36 inches inclusive.

(c) Cement-asbestos pipe shall be class 100, 150, or 200; suitable for 100, 150, or 200 pounds per square inch maximum working pressure, respectively, as specified.

14.23 Materials and Workmanship

Cement-asbestos pipe shall be composed of an intimate mixture of cement and asbestos fiber.

(a) Couplings

1. With each length of pipe there shall be furnished one complete coupling, suitable for the specified pressure and pipe size. The coupling shall conform to the standards of the manufacturer of the pipe with which the couplings are to be used unless otherwise specified.

2. The couplings shall provide tight joints when subjected to two and a half times the designated working pressure of the pipe, when pipe and couplings are restrained to maintain proper relative positions.

(b) Pipe

1. Both ends of each length of pipe shall be finished to proper size to receive the couplings furnished by manufacturer.

2. The coupling area of the barrel of each length of pipe shall be free from dents and gouges which will affect the tightness of the joint.

3. The nominal length of pipe shall be 13 feet or more. Unless otherwise specified the following length tolerance shall apply. Not less than 90 per cent of the pipe furnished shall be within plus or minus one inch of the specified nominal length and the remaining 10 per cent shall not be less than 4 feet under the nominal length.

14.24 Installation

(a) All pipe shall be laid in accordance with standard waterworks methods and practice.

(1) Special Fittings

When special fittings are required, connections shall be made according to standard waterworks practice. When bell type fittings are specified they shall be connected to the pipe with either lead or sulphur-base compounds applied as specified for cast iron pipe. Special castings shall be Class "D" A.W.W.A. Standard.

(2) Corporation Stops and Valves

Standard corporation cocks and valves may be inserted into the lines with regular waterworks equipment. Drilling and tapping shall be done in keeping with accepted waterworks methods.

14.25 General

(a) All pipe less than 4 inches in diameter, all fire hydrants, valves, valve boxes, service connections, meters and meter boxes, methods of installation, etc., shall be as described and specified for "Water Distribution System", Paragraph 14, page 38 of these "Typical" specifications.

ELECTRICAL DISTRIBUTION SYSTEM

SPECIAL PROVISIONS

15. "Or Equal Clause"

Whenever a material or article required is specified or shown on the Plans by using the name of a proprietary product or of a manufacturer or vender, any material or article which will perform adequately the duties imposed by the general design will be considered equal and satisfactory providing the material or article so proposed is of equal substance and function.

Where special types, brands, makes, or trade names are mentioned, these shall be construed as being descriptive only of the type and style of material required. Other brands or makes of equal quality and utility may be used by the Contractor.

15.1 Patents

The bid prices without exception are to include all royalties and costs arising from patents, trade marks, and copy rights in anyway involved in the work. The Contractor in all cases shall indemnify and save harmless the Government for any and all claims for infringement by reason of the use of any of such patented design, device, material or processes to be performed under the contract, and shall indemnify the Government for any costs, expenses, and damages which it may be obliged to pay, by reason of any such infringement, at any time during the prosecution or after the completion of the work.

16. Poles

All poles shall be close grain Dense Southern Yellow Pine. All poles shall be in accordance with latest density rules of American Society for Testing Materials as incorporated in the rules of the Southern Pine Association.

All poles shall be made from live, sound trees. Preference shall be given to green poles, but they may be partially air seasoned. The period of exposure to natural atmospheric conditions will be left to the discretion of the creosoter, depending upon the season the poles are cut, but under no circumstances shall the time of air seasoning exceed ninety days. The contractor shall certify as to the length of time the poles have been out and the length of time they have been in storage before treatment.

All poles shall be well proportioned, butt and top shall be sound, straight and free from defects except as stated herein.

Poles shall be free from decay, rot, dote, red heart, dead streaks, brashy wood, cracks, bird holes, insect damage, and any other defects which materially effect the durability and strength of the pole. Blue Sap stain shall not ordinarily be the cause for rejection, but its presence calls for careful scrutiny of the pole for incipient decay. Poles shall be free from all signs and evidence of fungus growth.

The tops of poles shall be free from shakes. Shakes in the butt surface not over one (1) foot depth and extending over not more than one-quarter (1/4) of the circumference are permitted, provided they are at least one (1) inch distant from the circumference of the butt. Shakes over one (1) foot in depth or extending in length over more than one-quarter (1/4) of the circumference shall be permitted only when they fall inside a circle whose center is the pith center of the piece and whose diameter is one-half (1/2) the diameter of the butt.

Checks starting from the pith center of the butt shall not extend to the circumference of the butt surface. The top and side surface of the pole shall be free from large or injurious checks. Scars shall be smoothly trimmed removing all bark and all surrounding wood not completely intergrown with the wood of the body of the pole. Such trimming shall not result in abrupt changes in the contour of the pole surface or have a depth of more than one (1) inch, except where the diameter of the pole at the location of the scar is more than ten (10) inches, then the depth may be one-tenth (1/10) of the diameter. The distance to the axis of the pole from trimmed surfaces located between a point two (2) feet below the ground line and the butt shall not be less than one-half (1/2) the diameter of the pole at a point two (2) feet above the ground line. No scars or catfaces shall be permitted within two (2) feet of the ground line.

The diameter of single knots or knot cavities and the sum of the diameters of all knots or knot cavities shall not exceed the following knot table. Knots or knot cavities under one-half (1/2) inch in diameter may be ignored in applying these limitations.

LIMITATIONS OF KNOT SIZE

Length of Pole, Feet	Maximum Sizes Permitted, Inches: Diameter of any single knot or knot cavity. Classes 4-10	Sum of diameters of all knots and knot cavities in any one (1) foot section. All Classes
45 and Under	3	8
50 and Over	5	10

No loose knots will be allowed. No knots with pith centers will be allowed unless drilled and inspected by the engineers' duly authorized inspector and accepted by him, after which they may be properly plugged with treated wood plugs.

Knot cavities may be accepted if they are shaped so that the water will drain from the hole when the pole is set, and the depth of the cavity is not more than one-fifth (1/5) of the diameter of the pole at that point, and not more than one such cavity present in a pole. The sum of the depth of all cavities in any six (6) inch longitudinal section of a pole shall not exceed one-quarter (1/4) of the mean diameter of that section.

Hollow pith centers shall not be permitted in the butts or tops. But slivering due to falling shall be permitted if the depth from the circumference is not more than one-quarter (1/4) of the butt diameter and the height is not more than one-fifth (1/5) the distance from the butt to the ground line. All poles shall be free from nails, spikes, and other metal. Holes over one (1) inch deep left by the withdrawal of nails or spikes which will not drain water shall be completely filled with creosoted wood plugs. All drilled holes not used shall be filled with tightly fitted creosoted wood plugs.

All poles should be free from short crooks. No pole shall have more than two crooks, and these shall be in the same plane, provided that a straight line connecting the center of the butt with the center of the top does not at any intermediate point pass through the external surface of the pole. On all poles with only one (1) sweep, the sweep shall not exceed one (1) inch for every six (6) feet of length above the ground. The sweep may be measured by a straight line joining the surface of the pole at the ground line and the edge of the pole at the top; the distance from the line to the nearest side of the pole at the widest point shall determine the sweep.

All outer bark shall be completely removed from the surface of all poles. No patch of inner bark left on the pole surface shall be more than one-quarter (1/4) of an inch wide, or four (4) inchs long. No two patches of inner bark of these dimensions shall be separated from each other by less than six (6) inches. Slivers or spots of inner bark of less dimensions shall not be considered in applying the requirements for minimum distance between patches.

All knots shall be trimmed close except completely overgrown knots, which shall be trimmed only when the covering wood extends more than (1) inch above the main surface of the pole. The butts of all poles shall be neatly sawed in substantially a right angle to the axis of the pole.

The top and butt dimensions shall not be less than that specified in the following table for the length and class of pole specified in the purchase order.

Dimensions are in Inches

CLASS	5	6	7
MINIMUM TOP CIRCUMFERENCE	19	17	15
DIAMETER	6	5-3/8	4-3/4

Length of Pole (Feet)	Ground Line Dist. from Butt (Feet)	Minimum Circumference at 6 Ft. from Butt		
25	5.0	26.0	24.0	22.0
30	5.5	28.0	26.0	24.0
35	6.0	30.0	27.5	25.5
40	6.0	31.5	29.0	27.0
45	6.5	33.0	30.5	28.5
50	7.0	34.5	32.0	29.5
55	7.5	36.0	33.5	
60	8.0	37.0	34.5	

All poles shall be framed and drilled on the yard before being treated. All poles shall be roofed with a single cut made at an angle of thirty degrees to a horizontal plane with the pole in a vertical position. All poles shall be drilled and gained as shown on plate #2.

All poles shall be treated by the empty cell process. Either the Rueping or the Lowry Process may be used.

All poles shall be steamed for not less than six (6) hours at a temperature between two hundred and fifty-four (254) degrees and two hundred and fifty-nine (259) degrees Fahrenheit.

The temperature of the preservatives shall be between one hundred and seventy-five (175) degrees and two hundred ten (210) degrees Fahrenheit, and preferably at two hundred (200) degrees during the pressure period. The pressure shall be sufficient to obtain the desired penetration and leave a net retention of not less than twelve (12) pounds of preservative per cubic foot of material treated after vacuum has been applied.

The penetration shall be depth that can be obtained with final retention of not less than twelve (12) pounds of preservative per cubic foot of wood in the charge and not less than three (3) inches or eighty-five (85) per cent of the depth of the sap wood. When the depth of the sap wood is less than three inches, ninety-five (95) per cent of the sap wood shall be impregnated.

The depth of penetration shall be determined from a boring taken approximately midway between the butt and top of every pole of each charge. Every pole that does not meet the above penetration requirements will be rejected. All holes made in taking boring shall be filled with tight fitting creosoted plugs. To secure uniformity of oil in every pole of a charge, each pole in the charge shall be selected for similarity in seasoning, proportion of heart wood, and sap wood, proportion of sizes of spring and summer wood rings, number of rings per inch, and the experience of the creosoter. The volume of the wood in each charge shall be determined by actual measurement of the butt and top of each pole in the charge.

The preservative used shall be a coal tar produce being a creosoted coal tar solution, containing eighty (80) per cent creosote oil, and twenty (20) per cent coal tar. The creosote oil shall be number one (#1) creosote oil in accordance with the standards of the American Wood Preservers Association and the American Railway Engineering Association specifications for number one (#1) creosote oil. No blended product containing any added material whatsoever shall be acceptable in lieu of number one (#1) creosote oil. The coal tar used in the solution shall be refined and filtered coal gas tar or coke oven tar as set up in the requirements of the American Railway Engineering Association and the American Wood Preservers Association specification.

16.1 Test Report

The engineers shall be furnished a complete record of the treatment of each charge of poles furnished on the job, covering all the details herein set out relative to the date of cutting the poles, and all other pertinent details of the specifications.

The water content of the preservative shall never be more than five (5) per cent. Allowance shall be made by computing the net retention on the basis of water-free creosote whenever the water content of the stock is in excess of three (3) per cent.

The Engineer reserves the right to reject at the point of delivery any and all poles not conforming to these specifications.

The purchase of the poles under these specifications shall in no case be construed as relieving the contractor of full responsibility for the furnishing of poles satisfactory for the obviously intended purpose. The contractor shall guarantee the preservative and treatment to conform to these specifications and to be first class in every respect.

16.2 Guarantee

The contractor shall furnish to the Engineer a certificate from the manufacturer guaranteeing to replace f.o.b. to the job site without cost to the Government all poles which deteriorate within five (5) years from the date of purchase.

The manufacturer shall stamp his trademark or insignia, the year the pole was supplied, the length of the pole and the class of the pole on the side of each pole. The marking on the pole shall be of such nature as to be permanent and the lower edge of the trademark shall be ten (10) feet from the butt of each pole. The length of pole and class of pole shall be plainly stamped on the butt of each pole.

When poles are kept in storage either before or after treating they shall be stacked on non-decaying skids and supported without notable distortion of the poles. No part of any pole shall be in permanent water or in contact with underlying soil. After the poles are treated they shall be stacked in close piles. In handling poles care shall be taken to preserve the continuity of the outer treated area. No pointed tool capable of producing indentation of more than one (1) inch in depth shall be used on the poles. Treated poles shall not be dragged along on the ground or over any other roughening surface.

Poles shall be shipped on flat cars and secured thereon in accordance with the rules of the railroad association first receiving the shipment.

The contractor shall see that adequate facilities are provided for an inspection of the poles, the pole treatment, and all materials used in the treatment by an authorized representative of the engineer before the poles are treated, while they are being treated, and at any time after they are treated. All materials shall be previously prepared for inspection to avoid unnecessary delay. The waiving of inspection by the engineer shall not relieve the contractor of the responsibility of conforming to these specifications.

Extra pole gains and drilling which may not be reasonably anticipated before poles are treated may be made when poles are erected.

All pole lines are to follow accurately the alignment shown by the plans or indicated by the stakes set by the engineer.

In straight line work where no uneven strains are encountered alternate poles shall be set with cross-arms facing in opposite directions except on road or street corssings, where arms shall face away from such crossings.

16.3 Rock Holes

Where solid rock is encountered above the bottom limit of the pole depth specified, the rock shall be removed and contractor will be paid unit bid price set forth in the proposal for "Rock Holes".

The dirt shall be replaced and thoroughly tamped the full depth of the pole hole and all surface dirt be tamped around the hole in a conical shape.

17. Cross Arms

Cross-arms may be of Fir or of creosoted Yellow pine.

If of Fir, they shall be of the standard N.E.L.A. dimensions and specifications as elsewhere set out in these specifications under "Cross-Arm Assemblies".

If the Cross-Arms are of Creosoted Pine, they shall be free from loose or unsound knots, loose heart, rot, shakes, wane, or worm-holes. Checks shall not exceed twelve (12) inches in length, three-fourth (3/4) inch in depth or one-sixteenth (1/16) inch in width. Grain shall be parallel with the axis of the arm within five (5) degrees. Knots larger than one-fourth (1/4) inch in diameter shall be avoided. Large pitch pockets shall not be allowed. No sap-wood shall be allowed, they must be all heart. Excessive warp shall not be allowed. Dimensions shall be standard N.E.L.A. as previously noted for Fir Arms.

If Yellow Pine Arms are used they shall have the same preservative treatment as set out in detail under "Pole Specifications".

All Cross-Arms shall be air-dried, or kiln dried before manufacturing.

All Cross-Arms shall be of same kind of material, either all Fir or all Yellow Pine.

Kicker Arms shall be of same material and meet same specifications as Cross-Arms.

18. Secondary Racks.

Secondary Racks shall be as shown elsewhere in these specifications and in the plans.

19. Pins

Wood pins shall be as shown and specified in these specifications and plans.

20. Insulators

Insulators shall be as shown and specified in these specifications and plans. White insulators shall be used for all neutral conductors, and brown insulators for all others. All brown insulators and rack spools shall be of the wet porcelain process.

21. Pole Line Hardware

Pole line hardware shall be as shown elsewhere in these specifications and plans and shall be galvanized by the hot-drip process, as set out in standard A.S.T.M. specifications for pole line hardware.

22. Conductors

All primary conductors, common neutral and street lighting conductors shall be hard drawn, bare, copper. All secondaries and service conductors shall be hard drawn, double braid, weather proof copper.

The specifications for conductors shall be the latest issue of the American Society for Testing Materials for bare copper conductors. The gauges are to be A.W.G. Standard.

Covering on weatherproof wire shall be that specified in the latest issue of American Standard Association for weather-resisting Wire and Cable.

Line wires shall be pulled up to substantially the sags as shown in the following table:

SAG IN INCHES FOR VARYING SPAN LENGTHS

Temperature 00	100' Span	125' Span	150' Span	175' Span	200' Span	225' Span	250' Span
30°	2½"	4"	6"	10"	15"	22"	33"
45°	3"	4½"	7"	11"	17"	25"	37"
60°	3"	5"	8"	12"	19"	28"	41"
75°	3"	5½"	9"	14"	21"	32"	45"
90°	3½"	6"	10"	16"	25"	35"	49"

All lines shall be tightly pulled and slacked back to desired sag. As much as one thousand (1,000) feet of conductor may be sagged at one time and the longest span used as the ruling span.

All conductors in any one span shall be sagged the same amount.

All conductor connections shall be made mechanically and electrically secure by the proper sixes of line splices as set out elsewhere in these specifications.

23. Guys

Stub guys, span or head guys, anchor guys, and pole keying shall be done as shown elsewhere in specifications and plans.

All guy wire shall be Siemens-Martin galvanized stranded steel wire of five-sixteenths (5/16) inch nominal size. Double guys shall be placed where directed by the Engineer.

24. Lightning Arresters

Lightning arresters as specified and shown in plans are to be used if and where conventional type transformers are installed. Other types of transformers, if used, are to be fully protected from lightning and electrical surges as shown on C.S.P. transformers specified, if and where this type transformer is used. All primary metering equipment shall have lightning arresters of type specified and as shown on drawings.

25. Grounds

The common neutral conductor shall be grounded at each transformer installation and in addition there-to, grounds shall be installed as set out elsewhere in these specifications. All ground from transformers and secondary neutrals shall be solid bare copper conductor, not smaller than number four (#4) A.W.G. connected to neutral and grounds as shown in ground assemblies and in plans and specifications.

Ground wires shall be securely attached to the bottom of cross-arms and down the poles by means of one and one-quarter (1-1/4) inch galvanized staples at intervals not exceeding twenty-four (24) inches.

The ground wire shall be enclosed in one-half (1/2) round creosoted streight grain long leaf pine moulding, free from wind shakes, to a height of eight (8) feet above the ground, fastened to pole with two (2) inch galvanized staples at twenty-four (24) inch centers.

All transformer cases shall be grounded to neutral conductor, either directly or through grounding gap, depending upon the type of transformer used.

Primary connections to neutral wire single phase transformers shall be made as shown in plans and specifications.

All three (3) phase auto transformers shall have the neutral wire connected to the neutral or grounded conductor.

All ground rod connections shall be made with standard ground rod connectors and all tap-offs and/or connections to neutral wire by ground conductor shall be made by means of two (2) bolt copper wire clamps, all of which are shown in "Ground Assemblies" in these plans and specifications.

Where ground wire may be attached to wrought iron water pipe not over 4" diameter, and with no meter between connection and water main, this is to be preferred over a ground rod. Engineers are to designate where water pipe ground connections are to be made and contractors will not be required to use more than fifty (50) feet of horizontal underground conductors for pipe grounds. All horizontal underground conductors shall be run not less than eighteen (18) inches under ground surface.

All trenches shall be back-filled and thoroughly tamped. No pavement is to be cut to get to water pipe in lieu of ground rods.

All meters shall be grounded as above specified except ground wire shall be of stranded bare conductor not less than number four (4) A.W.G.

26. Distribution Transformers

Transformers to be supplied under these specifications shall be especially adapted to overhead distribution service. The general design and characteristics shall provide maximum reliability, high "all day" efficiencies, ability to carry overloads over prolonged load periods, high surge strength, and good regulation.

All transformers shall be rated single phase, 60 cycle, 2400/4160 Volt, "Y" Primary with 120/240 Volt secondary windings. Each transformer shall have two (2) 5% primary taps below rated voltage. They shall be oil insulated, self-cooled for outdoor service and shall be capable of operating at full rated loads continuously without excessive temperature rise.

All transformers shall be connected for additive polarity.

All transformers shall have 5000 Volt insulated leads not less than five feet long on the primary side. The secondary terminal shall be of the solderless or clamp type.

Each transformer shall be supplied with at least two lifting lugs designed so that a rounder surface is obtained on the under side which will come in contact with the sling. Lugs presenting sharp edges to the sling will not be permitted. A suitable lifting eye or hook shall also be provided for the core and coil element on all sizes.

All transformers furnished on these specifications shall be from a single manufacturer and of similar characteristics, and this manufacturer must be a nationally known one. Transformers furnished must be equal in every detail with those set out in the proposal.

The contractor shall submit to the engineer for approval before purchase of transformers complete detailed information covering design and construction of the transformers they propose to use and also furnish the engineer with complete detailed performance characteristics such as core loss, total loss, efficiencies at 1/4, 1/2, 3/4 and full loads, regulation at 80% power factor, and unity power factor, and impedence.

The contractor shall furnish to the engineer for approval the guaranteed surge strength of the transformer windings.

If conventional type transformers are furnished, they shall be equipped with ground lugs fastened to cases. If Westinghouse type CSP, or similar type of transformers are furnished they shall be grounded through grounding gaps.

Westinghouse standard CSP type transformers, or Westinghouse standard "S" type transformers, or their equal may be used. If the Westinghouse type "S" (conventional type" transformers are used they shall be installed with cut-outs and lightning arresters coordinated with the transformer insulation, and of the types set out in plans and specifications. In either type (CSP or conventional) one (1) brown standard high-voltage bushing and one (1) white neutral high-voltage bushing (having lower flash-over value than the brown high-voltage bushing) shall be furnished with each transformer. If SCP type transformers are furnished each one of them shall have only one (1) high-voltage De-ion gap. Only one (1) lightning arrester and one (1) cut-out is to be furnished with each conventional type transformer.

All transformers shall have stenciled on the front side in plain colors which contrast with color of the transformers, (1st), the number of each transformer, (2nd) the K.V.A. capacity and (3rd) the letters "K.V.A.". The figures shall all be three (3) inches high and the letters shall be two (2) inches high.

27. Auto Transformers

Westinghouse type "ST" 4000/2300V 3-phase, 60 cycle star connected transformers of capacities specified shall be furnished.

28. Constant Current Transformers

2400/4160 Y Primary to 6.6 ampere secondary and 2400/4160 Y Primary to 20 ampere secondary constant current transformers for street lighting. Service shall be furnished, installed and connected to lighting circuits as specified in plans and specifications.

29. Insulating Transformers

Insulating Transformers for series circuits shall be installed as specified and shown on plans.

30. Services

Customers services are to be installed in units as set out elsewhere in these specifications, and as directed by the Engineer. All service wires are to be pulled as tight as may be reasonably supported by the building structure to which they are run.

31. **Residental Meters**

Meters as shown in plans and specifications are to be furnished.

All residential meters are to be of out-door socket type. They are to be of the capacities and in location on buildings as directed by the Engineer. The load side of each house meter shall be connected to the customers entrance switch.

32. Commercial Meters

Shall be of the socket or conventional types, of the capacities, and in locations on buildings as directed by the Engineer.

33. Primary Power Meters

Are to be installed as shown in the Plans and Specifications. Secondary Power Meters installed shall be of the types, capacities and in location as directed by the Engineer.

Sockets on all socket type meters shall be drilled on under side for ground wire entrance and ground wire attached to neutral lug inside of sockets.

34. Disconnects and Cut-outs

All disconnects and cut-outs are to be of the type capacities and in locations as shown in plans and specifications. Fuse links are to be of the capacities as shown in plans and specifications and as directed by the Engineer.

35. Street Lights

Street lights of the types and sizes, and locations as shown in plans and specifications are to be installed.

A master control time switch, as specified shall be installed as directed by the Engineer and shall control all street lights.

36. Tree Trimming

Tree shall be trimmed where directed by the Engineer. All tree trimmings shall be done by, or under the supervision of, a person skilled and experienced in the trimming. Trees shall be trimmed in a way doing the least harm to the trees and to be the most effective now and in the future for conductor clearance. All cut tree branches one and one-half (1-1/2) inches diameter and larger shall be treated with a suitable protective coating.

37. Repairs to Pavement

Where pavement of any kind is broken for any purpose it shall be replaced with like material of equal thickness and quality.

38. Inspection and Testing of Materials

All poles shall be inspected before treatment, during treatment and after treatment, by a competent inspector to be selected and paid by the City.

Such factory tests and certificates as may be required by these specifications shall be furnished as a non-pay item.

39. Assemblies

It is intended that each assembly on which unit bid prices are asked for in the Proposal comprises a complete unit and it is intended that the unit bid price set forth covers the entire cost of all labor and material necessary to furnish the complete assembly completely installed in place.

In the following pages are set up material lists indicating the maximum quantities of each item required for the various assemblies; however if any item has been omitted which is obviously necessary to make the assembly complete, the Contractor shall furnish and install such necessary item as though it had been listed, and without claim for extra pay.

MATERIAL LIST

Creosoted Poles

The creosoted poles of the length and class as specified are to be furnished and completely installed.

8 Pin Single Crossarm Assembly

1	ea.	8 Pin N. E. L. A. Rainier Fir Crossarms 3 3/4" x 4 3/4" - 10' - 0" Graybar Cat. No. 74
2	ea.	Braces Hubbard #8028 - 28"
1	ea.	Machine Bolt and Nut 5/8" x 14" max.
1	ea.	Lag Screw 1/2" x 4" Graybar #9754
2	ea.	3/8" Machine Bolts and Nuts 4 1/2" long.
2	ea.	Square Washers 2" x 2" x 1/8" for 5/8" bolt.
2	ea.	Round Washers for 3/8" bolt.

8 Pin Double Crossarm Assembly

2	ea.	8 Pin N. E. L. A. Rainier Fir Crossarms 3 3/4" x 4 3/4" - 10'0" Graybar Ct. No. 74.
4	ea.	Braces Hubbard #8028-28"
2	ea.	Lag Screws 1/2" x 4" Graybar #9754
4	ea.	3/8" Machine Bolts and Nuts 4 1/2" long.
10	ea.	Square Washers 2" x 2" x 1/8" for 5/8" bolt.
4	ea.	Round Washers for 3/8" bolt
3	ea.	5/8" Bolts and Nuts 18" max. D. A. Hubbard #9868

6 Pin Single Crossarm Assembly

1	ea.	6 Pin N. E. L. A. Rainier Fir Crossarm 3 1/2" x 4 1/2" - 8'0" Graybar Cat. No. 43
2	ea.	Braces Hubbard #8028 - 28"
1	ea.	Machine Bolt and Nut 5/8" x 14" max.
1	ea.	Lag Screw 1/2" x 4" Graybar #9754
2	ea.	3/8" Machine Bolts and Nuts 4 1/2" long
2	ea.	Square Washers 2" x 2" x 1/8" for 5/8" bolt.
2	ea.	Round Washers for 3/8" Bolt.

6 Pin Double Crossarm Assembly

2	ea.	6 Pin N. E. L. A. Rainier Fir Crossarm 3 1/2" x 4 1/2" - 8'0" Graybar Cat. No. 43
4	ea.	Braces Hubbard #8028 - 28"
2	ea.	Lag Screws 1/2" x 4" Graybar #9754
4	ea.	3/8" Machine Bolts and Nuts 4 1/2" long
10	ea.	Square Washers 2" x 2" x 1/8" for 5/8" bolt.
4	ea.	Round Washers for 3/8" bolt.
3	ea.	5/8" Bolts and Nuts 18" max. D. A. Hubbard #9868

4 Pin Single Crossarm Assembly

1	ea.	4 Pin N. E. L. A. Rainier Fir Crossarm 3 1/2" x 4 1/2" - 5'7" Graybar Cat. No. 42
2	"	Braces Hubbard #8028 - 28"
1	"	Machine Bolt and Nut 5/8" x 14" max.
1	"	Lag Screw 1/2" x 4" Graybar #9754
2	"	3/8" Machine Bolts and Nuts 4 1/2" long
2	"	Square Washers 2" x 2" x 1/8" for 5/8" bolt.
2	"	Round Washers for 3/8" bolt.

4 Pin Double Crossarm Assembly

2	ea.	4 Pin N. E. L. A. Rainier Fir Crossarm 3 1/2" x 4 1/2" - 5'7" Graybar Cat. No. 42
4	"	Braces Hubbard #8028 - 28"
2	"	Lag Screws 1/2" x 4" Graybar #9754
4	"	3/8" Machine Bolts and Nuts 4 1/2" long
10	"	Square Washers 2" x 2" x 1/8" for 5/8" bolt
4	"	Round Washers for 3/8" bolt
3	"	5/8" Bolts and Nuts 18" max. D. A. Hubbard #9868

6 Pin Single Alley Arm Assemblies

1	ea.	6 Pin N. E. L. A. Rainier Fir Crossarm 3 1/2" x 4 1/2" - 8'0"
1	"	Alley Arm Angle Brace, Joslyn 1522 5ft.
1	"	5/8" Machine Bolt and Nut - 14" max.
2	"	Lag Screws 1/2" x 4"
1	"	Machine Bolt and Nut 3/8" x 4 1/2"
2	"	Square Washers 2" x 2" x 1/8" for 5/8" Bolt.
1	"	

Note: Where two single alley arms are on the same pole, one above the other, the material list for the two is given below and the Contractor will be paid for this installation as though he had installed two of the 6 Pin Single Alley Arm Assemblies separately:

2	ea.	6 Pin N. E. L. A. Rainier Fir Crossarm 3 1/2" x 4 1/2" - 8'0"
1	"	Alley Arm Angle Brace-Joslyn 1522 5'0"
2	"	5/8" Machine Bolts and Nuts 14" max.
2	"	Lag Screws 1/2" x 4"
3	"	Machine Bolts and Nuts 3/8" x 4 1/2"
4	"	Square Washers 2" x 2" x 1/8" for 5/8" bolts.
2	"	Round Washers for 3/8" bolt.
1	"	Angle Cross Arm Brace - Joslyn J1536

6 Pin Double Alley Arm Assemblies

2	ea.	6 Pin N. E. L. A. Rainier Fir Crossarms 3/1/2" x 4 1/2" - 8'0"
2	"	Alley Arm Angle Brace - Joslyn 1522 5'0"
4	"	Lag Screws 1/2" x 4"
2	"	Machine Bolts and Nuts 3/8" x 4 1/2"
6	"	Square Washers 2" x 2" x 1/8" for 5/8" bolt
2	"	Round Washers for 3/8" bolt
2	"	5/8" Machine Bolts and Nuts 18" max. D. A.

Note: Where two double alley arms are on the same pole, one above the other, the material list for the two sets is given below, and the Contractor will be paid for this installation as though he had installed two of the 6 Pin Double Alley Arm Assemblies separately:

4	ea.	6 Pin N. E. L. A. Rainier Fir Crossarms 3 1/2" x 4 1/2" - 8'0"
2	"	Alley Arm Angle Braces Joselyn 1522 5'0"
4	"	Lag Screws 1/2" x 4"
6	"	Machine Bolts and Nuts 3/8" x 4 1/2"
12	"	Square Washers 2" x 2" x 1/8" for 5/8" bolt
6	"	Round Washers for 3/8" Bolt
4	"	5/8" Machine Bolts and Nuts 18" max. D. A.
2	"	Angle Crossarm Braces - Joslyn J 1536

Kicker Arm Assembly

1	ea.	Kick Arm Rainier 3 1/4" x 4 1/4" - 15"
2	"	Lag Screws 1/2" x 4"
2	"	Round Washers for 1/2" bolt

4 Spool Secondary Rack Assembly

1	ea.	4 Spool Secondary Racks Hubbard #4848
4	"	Spools - Hubbard #355 (Top Spool White, all others brown)
2	"	5/8" Machine Bolts and Nuts - 10" max.
2	"	Square Washers 2" x 2" x 1/8" for 5/8" bolt
1	pc.	Bare Copper Tie Wire of correct size for specified wire.

3 Spool Secondary Rack Assembly

1	ea.	Pierce 3 Spool Secondary Racks - Hubbard #3848
3	"	Spools - Hubbard #355 (Top Spool White, others brown)
2	"	5/8" Machine Bolts and Nuts 10" max.
2	"	Square Washers 2" x 2" x 1/8" for 5/8" bolt.
1	pc.	Bare Copper Tie Wire of Correct size for specified wire

1 Spool Insulator Bolt Assembly

1	ea.	5/8" Insulator Bolt and Nuts 16 3/4" max. Hubbard 8743
2	"	Round Washers for 5/8" Bolt
1	"	Insulator Hubbard #355 White
1	pc.	Bare Copper Tie Wire of correct size for specified wire

Insulator and Wood Pin Assembly (Side Groove)

1	ea.	Insulator OB 29,207
1	"	Locust Pin N. E. L. A. 1 1/2" x 9"
1	pc.	Bare Copper Tie Wire of correct size for specified wire
1	ea.	10d Nail

Insulator and Wood Pin Assembly (Top Groove)

1	ea.	Insulator OB 9404
1	"	Locust Pin N. E. L. A. 1 1/2" x 9"
1	pc.	Copper tie wire of correct size for specified wire
1	ea.	10d Nail

Insulator and Offset Pin Assembly

1 ea.	Insulator OB 29,207
1 "	Offset Pin - Hubbard 3014
2 "	Machine Bolts 3/8" x 4 1/2"
2 "	Round Washers for 3/8" bolt
1 pc.	Copper tie wire of correct size for specified wire

Insulator and Steel Pole Top Pin Assembly

1 ea.	Insulator OB 29,207
1 "	Steel Pole Top Pin - Hubbard 3034
2 "	5/8" Bolts 10" max.
2 "	Square Washers 2" x 2" x 1/8" for 5/8" Bolt
1 pc.	Copper tie wire of correct size for specified wire

Insulator and Steel Screw Pin Assembly

1 ea.	Insulator OB 29,207
1 "	Lag Screw Steel Pin - Hubbard 988
1 pc.	Copper tie wire of correct size for specified wire

Copper Wire

All conductors shall be of copper wire of the sizes and placed at the location in the manner specified.

Unless otherwise directed by the Engineer all neutral wires and all primary conductors and series sizes #2 and smaller shall be of bare hard drawn solid, and size #1/0 shall be of bare hard drawn, seven strand new copper wire.

Unless otherwise directed by the Engineer, all secondary conductors and services, sizes #2 and smaller shall be of double braided weather proof, mica finish, hard drawn solid, and size #1/0 shall be of double braided weather proof hard drawn seven strand new copper wire.

All line splices shall be made with correct size of Electroline Splice, Cat. No. 2100 Series, for which no extra payment will be made.

All conductors shall be tied to insulators by tie wires of the size and length and in the manner shown on drawings, for which no extra payment will be made. The Contractor must include the cost of this labor and material in the unit bid prices for the various Insulator Assemblies and Secondary Rack Assemblies.

At all double dead ends the Contractor shall furnish and install jumpers of identical wire as each conductor and connected to the correct conductors with correct size of Connector, Electroline Taplok, for which no extra payment will be made. The Contractor must include the cost of this labor and material in the unit bid prices for wire.

No extra payment will be made for the wire included in the various Assemblies and/or Services requiring wire--the cost of the wire as well as the hardware and other material and labor must be included in the unit bid prices for the various Assemblies and/or Services.

All conductor wire will be paid for by the measured distance between supports without allowance for sag splices, ties, jumpers, etc., provided that these measurements do not exceed the dimensions shown by the drawings or given by the instructions of the Engineer.

Primary Dead End Assembly (#2 Wire or Smaller)

1	ea.	5/8" Eye Bolt 16" max.
1	"	Strain Insulator - OB 26,830
1	"	Clevis Flexible Strand L M #880
2	"	Crosby Clips - Joslyn 1038

Primary Dead End Assembly (#1/0 Wire)

1	ea.	Dead End - Electroline Series 3300
1	"	Strain Insulator Jeffry-Dewitt #2555
1	"	5/8" Eye Bolt 16" max.
2	" max.	Square Washers 2" x 2" x 1/8" for 5/8" Bolt

Secondary Dead End Assembly (#2 Wire or Smaller)

2	ea.	Crosby Clips - Joslyn 1058

Secondary Dead End Assembly (#1/0 Wire)

1	ea.	Automatic Dead End - Electroline Series 3400

Neutral Dead End Assembly

1	ea.	Insulated Clevis Joslyn #J093
1	"	Insulator - Hubbard #355 White
1	"	5/8" Machine Bolt and Nut 12" Max.
1	"	Square Washer 2" x 2" x 1/8" for 5/8" bolt
2	"	Crosby Clips - Joslyn 1038

Stub Guy Assemblies

100 ft. max.	5/16" Guy Wire
1 ea.	Strain Insulator OB 25,009 Brown
4 "	3 - Bolt Guy Clamps - Hubbard 7449
1 "	5/8" Thimble Eye Bolt and Nut - 12" max. Hubbard 6500 Series
1 "	Square Washer 2" x 2" x 1/8" for 5/8" Bolt
1 "	Thimble Eye Nut for 5/8" Bolt - Hubbard 7510

Head Guy Assemblies

150 ft. max.	5/16" Guy Wire
1 ea.	Strain Insulator OB 25,009 Brown
4 "	3-Bolt Guy Clamps Hubbard 7449
1 "	5/8" Thimble Eye Bolt and Nut - 12" max. Hubbard 6500 Series
1 "	Square Washer 2" x 2" x 1/8" for 5/8" Bolt
1 "	Thimble Eye Nut for 5/8" Bolt - Hubbard 7510

Head Guy Assemblies (Between Two Primary Poles)

150 ft. max.	5/16" Guy Wire
2 ea.	Strain Insulators - OB 25,009 Brown
6 "	3 - Bolt Guy Clamps - Hubbard 7449
1 "	5/8" Thimble Eye Bolt and Nut - 12" max. Hubbard 6500 Series
1 "	Square Washer 2" x 2" x 1/8" for 5/8" bolt
1 "	Thimble Eye Nut for 5/8" Bolt - Hubbard 7510

Anchor Guy Assemblies

50 ft. max.	5/16" Guy Wire
1 ea.	Strain Insulator OB 25,009 Brown
1 "	Guy Hook - M. I. F. P135 for 5/8" bolt
1 "	Lag Screw 1/2" x 4"
4 "	3 - Bolt Guy Clamps Hubbard 7449
1 "	Never Creep Anchor plate - Hubbard C-820
1 "	6'0" Never Creep Thimble Eye Rod - Hubbard 4316

Note:
1 Chance Socket Type Screw Anchor with Thimble Eye and 3/4" Rod 70" overall- Hubbard Stock No. C3410 may be used in place of the Never Creep Anchor if desired by the Contractor

Poles Keyed Assembly

1 ea.	Creo. Poles 8" dia. x 5'0 (split before treating)
2 "	5/8" Machine Bolts and Nuts 24" max.
4 "	Square Washers 2" x 2" x 1/8" for 5/8" bolts.

Guy Wire Protector

1 ea.	Guy Wire Protector 8 ft. - Hubbard 7558

Lightning Arrester Assembly

1 ea.	Crystal Valve Lightning Arrester, E. S. S. #50927
2 "	Connectors - Electroline Taploks
1 "	Lag Screw 1/2" x 4"
15 ft. max.	#6 Copper Wire DBWP

Pole Ground Assembly

100 ft. max.	Ground Wire - #4 Copper Wire BHD Stranded
20 max.	Galv. Staples 1 1/2" - 24" c to c
5	Galv. Staples 2" - 24" c to c
1 ea.	Connector, Electroline Taplok
1 pc.	Creo. Pine Moulding 1/2" x 8'0"
1 ea.	Ground Clamp, Sherman, Graybar Cat., to fit pipe, if ground is to water pipe
	Note: If ground connection is not to water pipe, use the following instead of the Sherman Ground Clamp:
1 ea.	Copperweld Ground Rod 5/8" x 8'0" - Hubbard 9438
1 "	Copperweld Ground Wire Clamp, Safety Screw Type for 5/8" Rod, Hubbard 9492

The Engineer will designate which connection to use. In either case the Contractor will be paid the unit bid price for Pole Ground Assembly.

Meter Ground Assembly (Secondary)

20 ft. max.	#4 Copper Wire BHD Stranded
10 each max.	Staples 1 1/2" - 24" c to c
1 "	Ground Clamp, Sherman, Graybar Cat., to fit pipe, if ground is to water pipe
	Note: If ground connection is not to water pipe, use the following instead of the Sherman Ground Clamp:
1 ea.	Copperweld Ground Rod 5/8" x 8'0" Hubbard 9438
1 "	Copperweld Ground Wire Clamp, Safety Screw Type, for 5/8" rod - Hubbard 9492

The Engineer will designate which connection to use. In either case the Contractor will be paid the unit bid price for Meter Ground Assembly.

Distribution Transformer Assemblies

1 ea.	Transformer of the size specified *
10 ft. max.	Primary Lead #6 Copper Wire DBWP
1 ea.	Hot Line Clamp - Kearney #3510-1
5 "	Connectors Electroline Taplok for #6 Wire (6 is CSP Transformers are used)
1 "	Galv. Staple 1 1/2"
3 " max.	* Secondary Leads - 6 ft. max. each.

* For 5 KVA Transformers, use #4 Copper Wire DBWPHD
" 10 " " " " #2 " " "
" 15 " " " " #2 " " "
" 25 " " " " #2 " " "
" 37½ " " " " #1/0 " " DBWPHD - 7 Strand
" 50 " " " " #1/0 " " " " "

Auto Transformer Assemblies (3 Phase 4,000 Volts Star to 3 Phase 2,300 Volts Delta)

1 ea.	Auto Transformer as specified*
50 ft. max.	#6 Copper Wire DBWPHD
3 ea.	Hot Line Clamps - Kearney 3510 - 1
5 "	Connectors Electroline Taploks
6 " max.	Galv. Staples 1 1/2"

*150 KVA
200 KVA

Constant Current Transformer Assembly (St. Ltg.) (Cascade Control)

1 ea.	Constant Current Transformer 10KVA 6.6A, Novalux Type ROC, G.E. Cat. No. 3,200,547
1 "	Remote Control Apparatus - Novalux G.E. Cat. No. 4,387,891G7
1 "	Series Protector Novalux G.E. Cat. No. 3045291
5 "	Hot Line Clamp - Kearney #3510-1
15 "	Connectors Electroline Taploks
30 ft. max.	#6 Copper Wire DBDPBHD
	Note: For 110 Volt AC Control --

Deduct:

1 ea.	Remote Control Apparatus - Novalux G.E. Cat. No. 4,387,891G7
1 "	Series Protector Novalux G.E. Cat. No. 3045291

Add:

1 ea.	Remote Control Apparatus - Novalux G.E. Cat. No. 4387892G2
1 "	Series Protector Novalux G.E. Cat. No. 3045295

Transformer Supporting Structure

2 ea.	Channels 8.2# 6" x 13'0" with 13/16" hole 12 ft. c to c.
2 "	3/4" Bolts and Nuts 16" max. D. A.
4 "	Square Washers 2 1/4" x 3/16" for 3/4" bolts
2 "	Steel Cross Arms 3" x 3" x 1/4" x 6'4"
2 "	Bow Brace Standard 40" Angle
4 "	5/8" Machine Bolts and Nuts 14" max.
4 "	Square Washers 2" x 1/8" for 5/8" bolt
4 "	Machine Bolts and Nuts 1/2" x 1"
3 pcs.	Creo. Timber 3 3/4" x 6" x 14'0" with 11/16" holes 12' c to c on 6" face Rough
2 "	Creo. Timber 3 3/4" x 6" x 14'0" Rough
16 "	Creo. Timber 2" x 10" x 6'0" Rough
96 ea.	Nails 20d
2 "	Machine Bolts and Nuts 5/8" x 14"
2 "	Machine Bolts and Nuts 5/8" x 18"
8 "	Square Washers 2" x 1/8" for 5/8" Bolts
4 "	Malleable Floor Flanges for 1 1/4" Pipe
2 pcs.	Pipe 1 1/2" x 6'0" Threaded both ends-drilled in center for 1/4" Bolt.
2 "	Pipe 1 1/4" x 2'8" Threaded both ends
2 ea.	1 1/4" elbows
1 pc.	Pipe 1" x 12'4" not threaded.
2 ea.	J Bolt 1/4" x 3"
16 "	Wood Screws 2" - #12

Customers Service (2-Wire #6-110 Volt)

2 ea.	Wire holders - Pierce - Hubbard 41,144
2 "	Electroline Taploks
2 "	Connectors - Buttin - Burndy Type KP
200 ft. max.	#6 Copper Wire DBWPHD

Customers Service (3-Wire #6-110/220 V.)

3 ea.	Wire holders, Pierce - Hubbard 41,144
3 "	Electroline Taploks
3 "	Connectors, Buttin - Burndy Type KP
300 ft. max.	#6 Copper Wire DBWPHD

Customers Service (4-Wire #6 110/220 Volts 3-Phase)

1 ea.	Pierce 4 Spool Secondary Rack - Hubbard #4848
4 "	Spools Hubbard #355 (Top spool white, others brown)
3 "	Lag Screws 1/2" x 4"
4 "	Connectors Electroline Taploks
4 "	Connectors Burndy-Buttin Type KP
400 ft. max.	#6 Copper Wire DBWPHD

Customers Service (Primary) (3-Wire #6 Above 220 Volts)

450 ft. max.	#6 Copper Wire BHD
9 ea.	Connectors - Electroline Taplok

Customers Service (Primary) (3-Wire #4 Above 220 Volts)

450 ft. max.	#4 Copper Wire BHD
9 ea.	Connectors - Electroline Taplok

Customers Service (Primary) (4-Wire #6 Above 220 Volts)

600 ft. max.	#6 Copper Wire BHD
12 ea.	Connectors - Electroline Taplok

Customers Service (Primary) (4-Wire #4 Above 220 Volts)

600 ft. max.	#4 Copper Wire BHD
12 ea.	Connectors - Electroline Taplok

Meter Assemblies

The meters listed are to be completely installed as directed.

Meter Assembly - Current Transformer Type
(Sangamo H.F.A.)
(5 Amp. 230 Volt 2-Wire Single Phase 60 Cycle)

1 ea.	Watthour Meter, Sangamo Type H.F.A. 5 Amp. 230 Volt 2-Wire Single Phase 60 Cycle for use with Current Transformer
1 "	Current Transformer Indoor, G.E. Type JLF 3 2500 Volts 100 Amp. Max. including Cable Terminals, Bolts, Nuts and Washers.
4 "	Wood Screw 1 1/2" - #10
3 ft.	#12 Tricolor Cable Type A, G.E. - S.I. No. 58021
1 ea.	Test Block 7 Pole, Walker Elec. Company.

Meter Assembly - Current Transformer Only Type
(Sangamo L 2 P T)
(2 1/2 Amp. 240 Volt 3 - Wire 3-Phase 60 Cycle)

1 ea.	Watthour Meter Sangamo Type L 2 PT 2 1/2 Amp. 240 Volt 3-Wire 3-Phase 60 Cycle for use with current transformer
2 ea.	Current Transformer Indoor G.E. Type JLF 3, 5000 Volts, 400 Amp. max. including Cable Terminals, Bolts, Nuts and Washers
4 "	Wood Screws 1 1/2" - #10
6 ft. max.	#12 Tricolor Cable Type A, G.E. - S.I. No. 58021
1 ea.	Test Block 7 Pole Walker Electric Company

Meter Assembly - Current and Potential Transformer Type
(Sangamo L 2 P T)
(2 1/2 Amp. 120 Volt 3-Wire 3-Phase 60 Cycle for 2300 Volt Delta Service)

2 ea.	Outdoor Potential Transformers 2300/115 V., G.E. Type JE-36
2 "	Current Transformers G.E. Type WF-6, 100/5 Amp. max.
1 "	Polyphase Watthour Meter Sangamo L 2 PT 2 1/2 Amp. 120 Volt. 3-Wire 3-Phase 60 Cycle
1 "	Test Block - 7 Pole Walker Electric Co.
1 "	Meter Box - Walker Elec. Co. #WT2024
4 "	Wood Screws 1 1/2" - #10
4 "	3/8" Machine Bolts and Nuts 4"
4 "	Round Washers for 3/8" Bolt
60 ft. max.	Conduit - Galv. 3/4"
2 ea.	Condulets - Graybar Form 7, Cat. No. T27
2 "	Condulets - Graybar Form 7, Cat. No. LR27
4 "	Condulets - Graybar Form 7, Cat. No. E27
4 "	Condulet Covers - Graybar Form 7, Cat. No. 270
4 "	Condulet Covers - Graybar Form 7, Cat. No. 272
14 " max.	Galv. Pipe Straps for 3/4" Conduit
65 ft. "	#12 Tricolor Cable Type A, G.E.-S.I. No. 58021
2 pcs.	Creo. Timber 2" x 4" x 18" with 5/8" hole in center of 4" face.
2 ea.	5/8" Machine Bolts and Nuts 18" Max.
4 "	Square Washers 2" x 2" x 1/8" for 5/8" Bolt
24 ft. max.	#4 Copper Wire DBWP
16 ea.	Connectors Electroline Taploks

Meter Socket and Bushing Assembly (2-Outlet Type)

1 ea.	Meter socket Sangamo 821560 or 838840 as required
2 "	Wood Screws 1 1/2" - #10
2 "	Box Connectors T and B 2300 Series

Meter Socket and Bushing Assembly (3-Outlet Type)

1 ea.	Meter Socket Sangamo 839454 or 839463 as required
2 "	Wood Screws 1 1/2" - #10
2 "	Box Connectors - T & B 2300 Series

Service Entrance Assembly (2-Wire 115 Volts)

20 ft. max.	Service Entrance Cable #6-2 Conductor Anaconda Type S.C.F.
10 ea. max.	Cable Strap - T & B 1344 - 24" c to c.

Service Entrance Assembly (3-Wire 115/230 Volts)

20 ft. max.	Concentric Service Entrance Cable #6-3 Conductor Bare Neutral, Non-metallic
10 ea. max.	Cable Strap - T & B 1344 - 24" c to c.

Primary Disconnect Assembly (200 Amp.)

1 ea.	Primary Disconnect Switch LM Cat. U.S. 66C24 with double crossarm mounting hanger, but without clevises.
6 ft. max.	#2 Copper wire, DBWPHD
2 ea.	Connector - Electroline Taplok

Primary Cutout Assembly (50 Amp.)

1 ea.	Cut out 5000V50A G.E. Cat. No. 9F6A14
2 "	Connectors - Electroline Taplok
1 "	Fuse Link-Kearney Quik-action 60 amp. Max. 6400 Series
5 ft. max.	DBWP Copper Wire #2 Max.

Primary Cutout Assembly (100 Amp.)

1 ea.	Cut out 5000V100A G.E. Cat. No. 9F6A3
2 "	Connectors - Electroline Taplok
1 "	Fuse Link-Kearney Quik-action 100 amp. Max.
5 ft. max.	DBWP Copper Wire #2 Max.

Primary Cutout Assembly (Over 100 Amp.)

1 ea.	D & W Oil Fuse Cutout - G. E. Cat. No. 9F2A3
2 "	Connectors - Electroline Taploks
2 "	Lag Screws 1/2" x 4"
1 "	Fuse Link, Plain Type, 200 Amp. Max. G.E. 295560 Series
5 ft. max.	DBWP Copper Wire #2 Max.

Street Light Assembly (Bracket Type (Std. #2))

1 ea.	6' Pole Bracket G.E. Cat. No. 1,229,475G49
1 "	Reflectolux Jr. Luminaire, High Voltage Series Westinghouse Type LW Cat. No. 889,411
1 "	Lamp 2500 Lumen G.E. Mazda 6.6 Amp.
40 ft. max.	#6 DBWP Copper Wire
2 ea.	Connectors - Electroline Taplok
3 "	Lag Screws 1/2" x 4"

Strain Insulator Assembly (St. Ltg.)

1 ea.	Strain Insulator OB 26,830
4 "	Crosby Clips - Joslyn 1038

Time Switch Assembly (St. Ltg.)

1 ea.	Time Switch Sangamo Model B No. VSWZ-21 with astronomical Dial 35 Amp. 115 Volts, Double Pole Single Throw
1 ea.	Meter Box - Walker Electric Co. No. WT2024
4 "	Wood Screws 1" - #8
2 "	5/8" Machine Bolts and Nuts 18" max.
2 pc.	Creo. timber 2" x 4" x 18" with 5/8" hole in center of 4" face.
4 ea.	3/8" Machine Bolts and Nuts 4"
4 "	Round Washers for 3/8" bolt
2 "	Connectors - Electroline Taploks
2 ft. max.	#6 Copper Wire DBWP
30 ft. max.	#12 Tricolor Cable Type A, G.E. S.I. 58,021
30 ft. max.	Conduit Galv. 3/4"
7 ea.	Galv. Pipe Straps for 3/4" Conduits
1 "	Condulet Graybar Form 7 Cat. No. LR27
1 "	Condulet Graybar Form 7 Cat. No. C27
1 "	Condulet Graybar Form 7 Cat. No. F27
1 "	Condulet Cover Graybar Form 7, Cat. No. 270
2 "	Condulet Cover Graybar Form 7, Cat. No. 271

GAS DISTRIBUTION SYSTEM

40. Description

(a) The local gas company will furnish and install, without cost to Contractor, master meters and regulators located where shown on drawings and the services between these meters and the gas company's mains. These regulators shall be designed to maintain_____ ounces gas pressure on the gas main serving project.

(b) The Contractor shall begin at the low-pressure side of the regulators and install a complete gas distribution system, conforming to these specifications and drawings, and including all necessary trenching, back-filling and piping for mains and branch connections to the headers for servicing the buildings, valves, fittings, and appurtenances necessary for complete and satisfactory operating distribution system.

40.1. Materials

(a) All pipe over 3" in diameter shall be in lapweld random lengths up to 40 feet with plain end beveled 30 degrees for welding.

(b) All three inch pipe and smaller shall be Class "A" (Standard weight) black steel pipe complying with Federal Specifications WW-P-403a, Type 1; pipe smaller than two inch shall have fittings complying to Federal Specification WW-P-521. All three inch and two inch pipe shall be plain end.

(c) All house service lines shall be equipped with cocks conforming to approved standard practice.

(d) In the event any valves larger than 1-1/4" are required in the system they shall be semi-steel lubricated plug valves similar to Nordstrom, figure #23131 for mechanical bolted joints. For installation flanges shall be furnished for welding to the line and the valve bolted to these flanges. Valve boxes shall be of cast iron at least 4" in diameter, furnished with an attached or keyed cast iron cover fitting neatly into box. Boxes shall meet Engineer's approval.

40.2. Installation

(a) Arrange with local gas company for gas services and for all work which it is to perform. Install remainder of system from points where gas company work terminates.

(b) Trenching shall be performed as hereinbefore specified under Water Distribution System, except that the pipe shall be laid to a depth permitting a minimum cover of eighteen inches for all pipe.

(c) Rock excavation and obstruction shall apply as hereinbefore specified under Water Distribution.

(d) Backfill shall be as hereinbefore specified under Water Distribution.

(e) Replacement of Existing Street Surface shall be as hereinbefore specified under Water Distribution.

(f) All pipe two inches and larger in size shall be coupled by welding.

The welds shall be made by the electric weld method. Each weld will consist of at least three beads. The pipe ends and each bead shall be thoroughly cleaned of dirt, scale, slag and paint before the application of the next bead. Size and kind of electrodes used for each bead shall have the approval of the Engineer. The completed weld shall be free from pin holes, nonmetallic inclusions, air pockets, rivers, or any other defects, and shall be built up in excess of the pipe wall thickness to give a reinforcing of at least 1/16th of an inch without thinning of the metal at or near the Joint. The Contractor shall use suitable procedure to prevent and to remove any protrusions within the inside diameter of the pipe. The weld must extend and form a perfect band to the inside diameter of the pipe. The completed weld is to be cleaned free of scale and oxides. The Engineer reserves the right to reject any weld which does not conform to specifications or modern welding practices.

(g) All bends, tees and other connections in lines 2 inch and larger in size shall be fabricated on the job by welding.

(h) All house service lines shall be joined to the distribution system as per details shown in the drawings. This contractor shall make the connection between his work and the building service. Approved valve boxes for house service lines shall be provided and installed at each valve cock. Boxes shall be installed so that lid is flush with ground and valve is easily available. All service lines shall have a minimum of 18" cover, as heretofore specified. Unless otherwise specified by the Engineer, the cock in the house service line shall be installed within eighteen inches of the point of connection to the distribution system.

(i) Provide approved cast iron drip pots at all low places in the line. No gas fitter's cement shall be used, except as fixture joints.

(j) All lines shall be thoroughly blown out before final connections are made.

(k) Apply one coat of hot tar pitch varnish to entire surface of pipe and fittings after installation, cleaning pipe thoroughly before applying.

(l) All low pressure lines shall be tested in the presence of the Engineer, with an air pressure of not less than ten pounds per square inch.

SEEDING

41. Description

This item shall consist of furnishing and placing seed, all in accordance with these specifications, at the locations shown on the plans or designated by the Engineer.

(a) Seed

The varieties of seed and the proportions to be used shall be as shown on the plans for both grass seed and seed of other than the true grasses such as clovers, vetches, rye and lespedeza, and shall be furnished and delivered in separate standard bags. The seed shall be mixed after delivery as directed by the Engineer.

All seed shall comply with applicable State and Federal seed laws, shall meet the requirements for minimum percentage of purity and germination and maximum allowable weed seed content shown on the plans, and shall be reasonably free of noxious weed seed. One-pint samples of seed shall be furnished by the contractor for testing if required by the Engineer.

(b) Manures and Fertilizers

Barnyard or stable manures shall consist of animal droppings mixed with not more than 25 percent by volume of straw or other bedding materials and shall be free of materials toxic to plant growth. Manures shall be well rotted. Samples 1 cubic yard in volume shall be furnished by the contractor for approval prior to delivery.

Where acceptable barnyard or stable manure is difficult to procure, dried blood, tankage, fish scrap, or such organic fertilizers (or equivalent materials) mixed with each other or with commercial chemical fertilizers, shall be considered as equivalent to manure, provided that such mixed organic or organic and chemical fertilizers shall contain the minimum percentages of available nitrogen, phosphorous, and potassium called for as shown on the plans.

42. Construction methods

Seeding operations shall be performed as indicated on the plans, and at the times and seeding periods therein stated.

The contractor shall notify the Engineer at least 48 hours in advance of the time he intends to begin sowing seed and shall not proceed with such work until permission to do so has been granted in writing by the Engineer.

(a) Advance Preparation of Seedbed

Prior to the sowing of seed, the topsoil, and manure (or equivalent material) shall be distributed and spread over the seedbed in the amount or rate indicated on the plans. The surface of the seedbed shall be plowed, harrowed, and raked until it has become loosened and pulverized and until added materials have become incorporated to a depth of not less than 5 inches. The seedbed shall be brought to the lines or grades indicated on the plans or designated by the Engineer, all sticks, litter, stones larger than one inch in diameter, and other foreign materials being removed.

(b) Sowing

Grass or other seeds, separately or in mixture, shall be sown in the required amount, preferably by rotary or other mechanical seeders. No seeding shall be done during windy weather or when the ground is frozen, wet, or is otherwise nontillable. Seeding shall be done in two directions at right angles to each other. The rates of seeding shall be as indicated on the plans.

Leguminous seeds such as clover or vetch shall be suitably innoculated before being sown unless otherwise specified on the plans.

Grass seed mixtures shall be raked in lightly to a depth of approximately one-fourth inch. When mixed seeds other than those of true grasses are specified, such heavy seeds may be sown separately and raked in after sowing to an approximate depth of one-half inch.

As soon as the seed is raked in, the seedbed shall be rolled with a light roller of a weight permitted by the Engineer. On clay soils, rolling shall be done with extreme care. Rolling shall be omitted where, in the Engineer's judgment, compaction of clay soils will tend to prevent seed germination.

The contractor shall water, mow, and otherwise properly maintain to the Engineer's satisfaction, all areas until the acceptance of the contract.

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BID SHEET

Item No.	Approx. Quantity	Description with Unit Bid Price Written in Words	Unit Price	Total Amt. Bid
		COLLECTING SYSTEM (SANITARY)		
		Vitrified Sewer Pipe		
1.		6" V.C. Pipe (Depth 0' to 4') Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
2.		8" V.C. Pipe (Depth 4' to 6') Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
3.		10" V.C. Pipe (Depth 6' to 8') Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
4.		(Vitrified Specials)		
		6" V.C. 1/4 Bends. Complete including backfilling For_____ Dollars_____ Cents, each	$____	$_____
5.		6" V.C. 1/8 Bends. Complete including backfilling For_____ Dollars_____ Cents, each	$____	$_____
6.		6 x 8 V.C. Wyes. Complete including backfilling For_____ Dollars_____ Cents, each	$____	$_____

Item No.	Approx. Quantity	Description with Unit Bid Price Written in Words	Unit Price	Total Amt. Bid
		ALTERNATE (Concrete Pipe)		
1.a		6" Conc. Pipe (Depth 0' to 4') Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
2.a		8" Conc. Pipe (Depth 4' to 6') Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
3.a		10" Conc. Pipe (Depth 6' to 8') Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
4.a		(Concrete Specials) 6" Conc. 1/4 Bends. Complete including backfilling For_____ Dollars_____ Cents, each	$____	$_____
5.a		6" Conc. 1/8 Bends. Complete including backfilling For_____ Dollars_____ Cents, each	$____	$_____
6.a		6 x 8 Conc. Wyes. Complete including backfilling For_____ Dollars_____ Cents, each	$____	$_____

Item No.	Approx. Quantity	Description with Unit Bid Price Written in Words	Unit Price	Total Amt. Bid
		MANHOLES (SANITARY)		
7.		Manholes (Depth 0' to 4') Complete with standard frame and cover For_____ Dollars_____ Cents, each	$____	$_____
8.		Manholes (Depth 4' to 6') Complete with standard frame and cover For_____ Dollars_____ Cents, each	$____	$_____
		COLLECTING SYSTEM (STORM WATER)		
		Vitrified Sewer Pipe		
9.		8" V.C. Pipe Complete Including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
10.		10" V.C. Pipe Complete Including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
		ALTERNATE (CONCRETE PIPE)		
9.a		8" Conc. Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____
10.a		10" Conc. Pipe Complete including backfilling For_____ Dollars_____ Cents, per L. F.	$____	$_____

Item No.	Approx. Quantity	Description with Unit Bid Price Written in Words	Unit Price	Total Amt. Bid
11.		MANHOLES (STORM WATER)		
		Manholes, Complete with standard frame and cover For_____ Dollars_____ Cents, each	$____	$_____
12.		CATCH BASINS		
		Standard Catch Basins. Complete with grating For_____ Dollars_____ Cents, each	$____	$_____
13.		WATER SUPPLY (HOUSE SERVICES)		
		Service Connections. Complete with corporation and curb cock For_____ Dollars_____ Cents, each	$____	$_____
14.		4000 pound cast iron specials and fittings For_____ Dollars_____ Cents, per pound	$____	$_____
		ETC.		
*****		***** *****		*****

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PAYMENTS

1. Basis of Payment

This Contractor shall furnish all necessary labor, machinery, tools, apparatus, materials, equipment, service and other necessary supplies and do and perform all work including all backfilling (without additional compensation except where specifically set out in these specifications) at the unit or lump sum price for the following items:

(a) Sewer Lines

Payment for sewer lines of the various sizes will be made at the contract price per linear foot in place which will include compensation for trenching, jointing stoppers and other fittings required all complete in place. The quantity of straight sewer pipe to be paid for shall be the length of pipe measured along the center line of the completed pipe lines after deducting the length of the branches and other fittings and deducting the manhole inverts.

(b) Sewer Pipe Specials

Specials will be paid for at the contract unit price bid for each furnished, delivered and installed including trenching, jointing and backfilling all to make the line complete as required. Stoppers will not be considered as a bid item. Contractor must furnish the required stoppers and include the cost of same in other items. The quantity of specials to be paid for shall be that number required and set in the pipe lines.

(c) Manholes

Manholes will be paid for at the contract unit price or lump sum price each which will include the manhole complete with cast iron frame and cover, invert and steps as required.

2. Excavation

(a) Excavation for all roadways will be paid for at the unit price bid per cubic yard.

(b) Excavation for all sidewalks and entrance walks shall be paid for at the unit price bid per cubic yard.

THICKNESS AND QUANTITIES FOR TYPICAL TYPES BITUMINOUS PAVEMENTS

Type	Thickness	* Weight Aggregate per Square Yard				Bituminous Material per Square Yard	
		Course Aggregate	Fine Aggregate	Sand	Filler	Primer	Seal
Light Surf. Tr.	1/4" to 1/2"		25 lbs.				0.25 gallon
Heavy Surf. Tr.	1/2" or more		30 to 65			0.5 gallon	0.3
Light R. Mix Seal	1/2" to 1"		50 or more			0.2	0.8
Road-Mix (Mac. Aggregate type)	2"	174 lbs.	18			0.4	1.1 mix and seal
Road-Mix (Dense Graded Type)	2-1/2"	237 total all sizes				20 to 2.4 total	
Pen. Mac. Surface	2-1/2"	217	35			Total 2.4	
Pen. Mac. Base	3"	260	25			Total 1.65	

Thickness of Surface	Type of Base	Thickness of Base	Subgrade Treatment and Remarks
2"	Sand Asphalt base	3"	Selected sand clay soil. This is a sand mixture.
1" to 5"	Sand asphalt, both hot and cold laid. Hot laid in 2 courses 3 to 3½" binder, 1" to 1½" top; cold laid one course 3" to 5".		

* Weight aggregate based on specific gravity of 2.65