1.1 SCOPE:

The work covered by this Bid Item consists of the furnishing and installing and maintaining of all traffic control devices, equipment and labor in accordance with the requirements shown on the plans and the provisions of these specifications and the requirements of the North Carolina Department of Transportation..

1.2 SUPPLEMENTARY SPECIFICATIONS

Except as otherwise noted the STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES as prepared by the State of North Carolina Department of Transportation dated January 1, 1990, or latest revision thereof, shall govern all work to be performed under the Item.

1.3 MATERIALS

Signing, barricades, lighting, traffic control operations used in maintaining traffic shall be in accordance with the applicable provisions of the edition in effect on the date of advertisement of the Manual or Uniform Traffic Control Devices for Streets and Highways, as prepared by the National Joint Committee on Uniform Traffic Control Devices. Any additional traffic control devices utilized shall have been approved by the Engineer.

1.4 INSTALLATION

The installation of this Item and maintenance of all traffic shall be in accordance with the N.C.D.O.T. Standard Specifications for Roads and Structures Section 150.

1.5 METHOD OF MEASUREMENT

Traffic Control will be measured and paid for on a "lump sum" basis.

1.6 BASIS OF PAYMENT

The quantity of Traffic Control measured as provided in Method of Measurement will be paid for at the contract unit price per "lump sum" basis. The payments will be full compensation for all work covered by this Item including but not limited to the furnishing and installing of signing, barricades, lighting, traffic control devices and all necessary labor and equipment for traffic control operations.

Payment for this Bid Item will be made under: Traffic Control per "lump sum".

SECTION 01810 ENCASEMENT PIPE INSTALLATION

1.1 SCOPE

This section shall include casing pipes for pipelines, installed by jacking and boring, in the locations as shown on the Plans.

The Contractor shall inspect the locations at the proposed crossings and shall familiarize himself with the conditions under which the work will be performed, and with all necessary details and the suitability of his equipment and methods for the work required.

1.2 CONSTRUCTION METHOD

Unless otherwise shown or specified, the Contractor shall employ the boring and jacking method of installation.

Installation of the casing pipe shall be carried out without disturbance of the embankment, pavement, tracks, or other railroad or highway facilities and without obstructing the passage of traffic at any time.

The driven portions of the casing shall be advanced from the lower end of the casing unless specific permission to do otherwise is obtained by the Contractor from the Engineer.

1.3 CASING PIPE

Steel encasement pipe shall be spiral welded or smooth-wall seamless, consisting of grade "B" steel with a minimum yield strength of 35,000 PSI and manufactured in accordance with ASTM A139 and A283.

The pipe thickness shall be as specified on the encroachment agreement or plans but in no case be less than 0.250 inches and the ends shall be beveled and prepared for field welding at the circumferential joints. Thicker encasement pipe may be required by the North Carolina Department of Transportation, railroads, or other agencies.

The pipe shall be coated inside and outside, in accordance with AWWA C203 of the North Carolina Department of Transportation or the American Railway Engineering Association's specifications. All encasement pipe must be approved by the appropriate controlling agency (IE NCDOT, RR, Etc.) prior to ordering the material.

1.4 CONSTRUCTION REQUIREMENTS:

All carrier piping shall be slip joint ductile iron and the minimum inside diameter casing shall be eight inches greater than the inside dimension of the carrier pipe as follows:

Carrier Pipe Inside Diameter	Steel Casing Pipe Minimum Inside Diameter
4 Inch	12 Inch
6 Inch	14 Inch
8 Inch	16 Inch
12 Inch	20 Inch
16 Inch	24 Inch

1.5 CASING INSTALLATION

The boring machine shall be accurately aligned before the boring is commenced and the Contractor shall take such necessary steps as are required to accurately place the casing with respect to line and grade.

The leading edge of the steel casing shall be kept as close to the auger head as possible and shall be advanced at the same speed as the earth auger in order to minimize any unsupported holes in the earth.

1.6 PIPELINE INSTALLATION

Before the pipe is installed in the casing, stainless steel casing spacers shall be rigidly fastened to the barrel of the pipe. After completion of the casing, the Contractor shall insert the pipeline in pre-jointed segments. No contact will be permitted between the casing and the sewer or pipeline.

1.7 MEASUREMENT

Measurement of encasement pipe shall be the actual number of lineal feet of encasement pipe installed and accepted.

1.8 PAYMENT

Encasement pipes shall be paid for at the unit contract price per lineal foot for each pipe size and type as shown on the plans, including spacers and all other auxiliary items require to complete the installation as shown on the plans.

SECTION 01900 RIP RAP

1.1 SCOPE

The work covered by the Bid Item consists of installing a protective covering of stone on slopes of embankment, around culvert outlets or inlets, on slopes and bottoms of ditches, around foundations, at such locations as indicated in the Drawings or as directed by the Engineer, for the purpose of preventing scour, erosion, or slipping of embankments.

1.2 SUPPLEMENTARY SPECIFICATIONS

Except as otherwise noted the STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES as prepared by the State of North Carolina Department of Transportation dated January 1, l990, or latest revision thereof, shall govern all work to be performed under the item.

1.3 MATERIALS

GRAVEL: Coarse aggregate consisting of gravel, crushed gravel, crushed stone, or a combination thereof; equal in size to Gradation 67, unless otherwise approved by the Engineer.

STONE: Sound, dense, durable quarry or field stone free of cracks or iron pyrite intrusions, without other structural defects and of such quality that they will not disintegrate on exposure to water or weathering. Use stone suitable in all respect for the purpose intended. At least 60% of the stone pieces shall weigh more than 100 pounds.

Stone weight:	Maximum: 25 pounds
	Maximum: 150 pounds
Stone Size (Except Spalls)	Minimum Dimension 12 inches

1.4 CONSTRUCTION REQUIREMENTS:

INSPECTION: Inspect slopes or ground surface on which rip rap is to be placed. Trim the area to the lines and grades indicated on the Drawings or as directed by the Engineer. Properly compact any earth depressions filled while trimming slopes.

EXCAVATION AND BACKFILL: Excavation and Backfill for the installation of this Bid Item shall be in accordance with Section 02220 of these specifications.

INSTALLATION: RIP RAP: Commence placement of rip rap in a trench one foot in depth to allow the surface of the rip rap to be blended into the surface of the surrounding ground.

Hand place the stone so as to produce a compact, well- graded mass with a minimum percentage of voids. Place the material to its full course thickness, measured perpendicular to the slope, in one operation and in such a manner that the slopes will be disturbed as little as possible. Distribute the larger pieces and place the final layer of rock so that there will be no segregated pockets of small pieces or groups of large pieces which would cause large open voids. Re-arrange the individual pieces, as required, by mechanical equipment or by hand, to the extent necessary to obtain a reasonably well-graded distribution of sizes as specified. The surface of the completed rip rap shall be uniform in appearance, free from humps or depressions.

Unless otherwise noted, provided one foot minimum thickness, of completed rip rap, measured perpendicular to the slope.

1.5 METHOD OF MEASUREMENT

The quantity of rip rap will be the actual number of tons installed as specified on the plans or instructed by the Engineer.

1.6 BASIS OF PAYMENT

The quantity of rip rap will be paid for at the contract unit price "per ton" basis. The payments will be full compensation for all work covered by this Item including; but not limited to furnishing hauling, placing and maintaining a protective cover of stone and the necessary excavation for proper placement.

Payment will be made under:

Rip Rap……. per ton.

SECTION 02220 EXCAVATION AND BACKFILL

1.1 SCOPE:

The extent of excavation and backfill is limited to the areas of construction, and includes (but is not necessarily limited to) stockpiling of topsoil, site grading, excavation of footings and trenches, filling, backfilling, compaction, finish grading, and spreading of topsoil.

Perform all excavation, dewatering, sheeting, bracing, and backfilling in such a manner as to eliminate all possibility of undermining or disturbing the foundations of existing structures.

1.2 QUALITY ASSURANCE

REFERENCED STANDARDS: Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards. Comply with the provisions of the following codes and standards, except as otherwise shown or specified.

ASTM C33 Standard Specifications for Concrete Aggregate

ASTM D698 Standard Test Methods for Moisture- Density Relations of Soils and Soil- Aggregate Mixtures Using 5.5 lb. Rammer and l2 inch Drop

ASTM D3282 Standard Recommended Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

SOIL TESTING AND INSPECTION SERVICE: At the option of the Owner, compaction tests of all fill areas will be made by an independent testing laboratory. Rework any fill areas which fail to meet the compaction requirements as herein specified and perform this work at no additional cost to the Owner. Testing of fill areas will be provided by the Owner and paid for by the Owner, except that test which reveal non-conformance with the Specifications and all succeeding tests for the same area, until conformance with the Specifications is established, shall be at the expense of the Contractor.

JOB CONDITIONS

EXISTING UTILITIES: Locate existing underground utilities in the areas of work. If utilities are to remain in place, provide adequate means of protection during earthwork operations.

Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult the Engineer immediately for directions as to procedure. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of utility companies.

Do not interrupt existing utilities serving facilities occupied and used by others, except when permitted in writing by the Owner, and then only after acceptable temporary utility services have been provided.

Demolish, and completely remove from site, existing underground utilities that conflict with construction and are no longer active. Coordinate with utility companies for shut-off of services if lines are active.

TEMPORARY PROTECTION: Protect structures, utilities, sidewalks, pavements, and other facilities from damages caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

SHEETING AND BRACING: Make all excavations in accordance with the rules and regulations promulgated by the Department of Labor, Occupational Safety and Health Administration, "Safety and Health Regulations for Construction. Furnish, put in place, and maintain such sheeting, bracing, etc., as may be necessary to support the sides of the excavation and to prevent any movement of earth which could in any way diminish the width of the excavation to less than that necessary for proper construction, or could otherwise injure or delay the work, or endanger adjacent structures, roads, utilities, or other improvements.

1.3 MATERIALS:

DEFINITIONS

SATISFACTORY SUBGRADE SOIL MATERIALS: Soils complying with ASTM D 3282, soil classification Groups A-l, A-2-5, and A-3.

UNSATISFACTORY SUBGRADE SOIL MATERIALS: Soils described in ASTM D 3282, soil classification Groups A-2-6, A-4, A-5, A-6, and A-7; also peat and other highly organic soils, unless otherwise acceptable to the Engineer.

COHESIONLESS SOIL MATERIALS: Gravels, sand-gravel mixtures, sands, and gravelly sands.

COHESIVE SOIL MATERIALS: Clayey and silty gravels, sand- clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands.

SOIL MATERIALS

BACKFILL AND FILL MATERIALS: Provide satisfactory soil materials for backfill and fill, free of masonry, rock, or gravel larger than 4 inches in any dimension, and free of metal, gypsum, lime, debris, waste, frozen materials, vegetable, and other deleterious matter. Use only excavated material that has been sampled, tested and certified as satisfactory soil material.

PIPE BEDDING: Crushed stone or crushed gravel meeting the requirements of ASTM C 33, Gradation 67 or suitable native soil, as specified on the Standard Details.

1.4 CONSTRUCTION REQUIREMENTS:

INSPECTION

Examine the areas and conditions under which excavating and backfilling is to be performed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

EXCAVATION, GENERAL

Excavation consists of the removal and disposal of all materials encountered for footings, foundations, pipe work, and other construction as shown on the drawings. Perform all excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

Rock Excavation

(a) The removal of sound, solid rock of whatever nature which occurs in its original position in ledges, bedded deposits or stratified and un-stratified masses within the excavation limits shown on the plans, and which is of such hardness or texture that it cannot be loosened, or broken down and removed without resort to drilling and blasting methods, shall be classified as rock excavation. Likewise, the removal of boulders, pieces of stone and old masonry masses one cubic yard or larger in volume shall be classified as rock excavation.

(b) The removal of hardpan, chert, clay, soft or disintegrated shale, and of other rock materials and boulders less than one cubic yard in volume, shall not be classified as rock excavation although the Contractor may elect to excavate same by drilling and blasting methods. The excavation and removal of all such materials shall be classified as common excavation.

(c) The removal of existing pavements, sidewalks, driveways, manholes and similar structures called for on the plans shall be performed under these specifications and shall not be classified as rock excavation.

Inspection of Rock Surfaces

(a) Where rock is encountered in the process of excavation within the excavation limits shown on the plans, or specified herein, and where payment is to be made for its removal on a unit price basis, it shall be completely uncovered and stripped of all loose material over the entire area, if for a structure, and over a trench length of not less than 50 feet, if for a pipeline; and all such loose material shall be disposed of as herein provided. The Engineer shall then make a detailed examination of the exposed rock surface and shall take surface elevations and measurements as may be necessary to determine ultimately the volume of rock excavated. All material removed from the area prior to examination and authorization by the Engineer shall be considered as common excavation.

Rock in Pipe Trenches

(a) Rock encountered in trench excavation for sewers and other pipelines shall be removed for the over-all width of trench which shall be as shown on the plans. It shall be removed to a depth of six (6) inches below the bottom of the pipe for pipes smaller than twenty-four (24) inches in size; eight (8) inches below the bottom of the pipe for pipes twenty-four (24) inches to thirty-six (36) inches in size; and twelve (l2) inches below the bottom of the pipe for pipes larger than thirty-six (36) inches in size, if rock extends to such depth. Where pipe lines are constructed on concrete cradles, rock shall be excavated to the bottom of the cradle as shown on the plans.

(b) After the Engineer has examined the completed excavation, and had taken the necessary measurements for volume determination, the space below the ultimate pipe grade shall be filled with pipe embedment materials as required, compacted to proper grade and made ready for pipe laying.

Drilling and Blasting

(a) Drilling and blasting methods used in rock excavation shall be optional with the Contractor but shall be conducted with due regard to the safety of persons and property in the vicinity of the work and in strict conformity with all laws, ordinances or regulations governing blasting and the use of explosives. Rock excavation near existing structures of all types shall be conducted with the utmost care, and every precaution shall be taken to prevent damage to such structures. Any damage or injury of whatever nature to persons or property caused directly or indirectly by blasting operations shall be promptly repaired, replaced or compensated for by the Contractor at his own expense and to the entire satisfaction of the persons injured or the owners of the property damaged.

(b) Where future units are adjacent to structures requiring rock excavation, the rock shall be drilled and blasted (not excavated) for a distance of approximately l0

feet from the present construction, as shown on the plans or as authorized by the Engineer.

EXCAVATION CLASSIFICATION: All excavation will be performed as unclassified excavation.

SITE GRADING

GENERAL: Uniformly grade areas within limits of grading under this section, Including adjacent transition areas. Smooth finish the surface within specified tolerances; compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

GROUND SURFACE PREPARATION: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface. Shape the subgrade as indicated on the Drawings by forking, furrowing, or plowing so that the first layer of new material placed thereon will be well bonded to it.

PLACEMENT AND COMPACTION: Place backfill and fill materials in layers not more than 8 inches in loose depth. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to the required percentage of maximum density for each area classification. Do not place backfill or material on surfaces that are muddy, frozen, or contain frost or ice.

In areas not accessible to rollers or compactors, compact the fill with mechanical hand tampers. If the mixture is excessively moistened by rain, aerate the material by means of blade graders, harrows, or other approved equipment, until the moisture content of the mixture is satisfactory. Finish the surface of the layer by blading or rolling with a smooth roller, or a combination thereof, and leave the surface smooth and free from waves and inequalities.

Place backfill and fill materials evenly adjacent to structures, to the required elevations. Take care to prevent wedging action of backfill against structures. Carry the material uniformly around all parts of the structure to approximately the same elevation in each lift.

When existing ground surface has a density less than that specified under the subsection entitled COMPACTION for the particular area classification, break up the ground surface, pulverize, moisture-condition to the optimum moisture content, and compact to required depth and percentage of maximum density.

GRADING OUTSIDE BUILDING LINES: Grade to drain away from structures to prevent ponding of water. Finish surfaces free from irregular surface changes.

PLANTING AREAS: Finish areas to receive topsoil to within not more than one inch above or below the required sub-grade elevations, compacted as specified, and free from irregular surface changes.

WALKS: Shape the surface of areas under walks to line, grade, and cross-section, with the finish surface more than zero inches above or one inch below the required sub-grade elevation, compacted as specified, and graded to prevent ponding of water after rains.

PAVEMENTS: Shape the surface of the areas under pavement to line, grade and cross section, with finish surface not more than l/2-inch above or below the required sub-grade elevation, compacted as specified, and graded to prevent ponding of water after rains. Include such operations as plowing, discing, and any moisture or aerating required to provide the optimum moisture content for compaction.

Fill low areas resulting from removal of unsatisfactory soil materials, obstructions, and other deleterious materials, using satisfactory soil material.

Shape to line, grade, and cross section as shown on the Drawings.

PROTECTION OF GRADED AREAS: Protect newly graded areas from traffic and erosion, and keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

RECONDITIONING COMPACTED AREAS: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather prior to acceptance of work, scarify surface, reshape, and compact to required density prior to further construction.

UNAUTHORIZED EXCAVATION: Unauthorized excavation consists of the removal of materials beyond indicated elevations without the specific direction of the Engineer. Under footings, foundations, bases, etc., fill unauthorized excavation by extending the indicated bottom elevation of the concrete to the bottom of the excavation, without altering the required top elevation. Lean concrete fill may be used to bring elevations to proper position only when acceptable to the Engineer.

Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of the same classification, unless otherwise directed by the Engineer.

DEWATERING: Prevent surface water and subsurface or ground water from flowing into excavated areas by using berms or drainage ditches.

Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, sumps, suction and discharge

lines, and other dewatering system components necessary to convey water away from excavations.

Dispose of all water pumped or drained from the work in a suitable manner without undue interference with other work, damage to pavements, other surfaces or property. Provide suitable temporary pipes, flumes or channels for water which may flow along or across the site of the work.

MATERIAL STORAGE: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

Locate and retain soil materials away from edge of excavations.

Dispose of excess soil material and waste materials at a permitted landfill provided by the Contractor.

BACKFILL AROUND STRUCTURES

GENERAL: Unless otherwise specified or indicated on the Drawings, use suitable material for backfill which was removed in the course of making the construction excavations. Do not use frozen material for the backfill and do not place backfill upon frozen material. Remove previously frozen material before new backfill is placed.

MATERIAL: Approved selected materials available from the excavations may be used for backfilling around structures. Obtain material needed in addition to that of construction excavations from approved off-site borrow pits. Furnish all borrow material needed on the work. Place and compact all material, whether from the excavation or borrow, to make a dense, stable fill. Use fill material which contains no vegetation, masses of roots, individual roots over l8 inches long or more than l/2-inch in diameter, stones over 4 inches in diameter, or porous matter. Organic matter must not exceed minor quantities.

PLACING BACKFILL: Do not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking, or other damage. Make special leakage tests, if required, as soon as practicable after the structures are structurally adequate and other necessary work has been done. Use the best of the excavated materials in backfilling within 2 feet of the structure. Avoid unequal soil pressures by depositing the material evenly around the structure.

Place fill and backfill in layers not more than 6 inches thick, except as specified otherwise herein, and compact each layer evenly to the specified density. Do not backfill against concrete without Engineer's approval.

TRENCH EXCAVATION

GENERAL: Perform all excavation of every description and of whatever substance encountered so that pipe can be laid to the alignment and depth shown on the Drawings.

Brace and shore all trenches, where required, in accordance with the rules and regulations, promulgated by the Department of Labor, Occupational Safety and Health Administration, "Safety and Health Regulations for Construction".

Make all excavations by open cut unless otherwise specified or indicated on the Drawings.

WIDTH OF TRENCHES: Excavate trenches sufficiently wide to allow proper installation of pipe, fittings and other materials and not more than l2 inches clear or pipe on either side at any point. Do not widen trenches by scraping or loosening materials from the sides. Where supports, and sheeting and bracing are required, trench may be of extra width so as to permit the placing of the trench supporting material.

TRENCH EXCAVATION IN EARTH: Earth excavation includes all excavation of whatever substance encountered. In locations where pipe is to be bedded in earth excavated trenches, fine grade the bottoms of such trenches to allow firm bearing for the bottom of the pipe on undisturbed earth. Where any part of the trench has been excavated below the grade of the pipe, fill the part excavated below such grade with pipe bedding material and compact at the Contractor's expense.

TRENCH EXCAVATION IN FILL: If pipe is to be laid in embankments or other recently filled material, first place the fill material to the finish grade or to a height of at least one foot above the top of the pipe, whichever is the lesser. Take particular care to ensure maximum consolidation of material under the pipe location. Excavate the pipe trench as though in undisturbed material.

TRENCH BOTTOM IN POOR SOIL: Excavate and remove unstable or unsuitable soil to a width and depth, as directed by the Engineer, and refill with a thoroughly compacted gravel bedding.

BELL HOLES: Provide bell holes at each joint to permit the joint to be made properly and to provide a continuous bearing and support for the pipe.

TRENCH BACKFILL

GENERAL: Unless otherwise specified or indicated on the Drawings, use suitable material for backfill which was removed in the course of making the construction excavations. Do not use frozen material for the backfill and do not place backfill on frozen material. Remove previously frozen material before new backfill is placed.

Start backfilling as soon as practicable after the pipes have been laid, or the structures have been built and are structurally adequate to support the loads, including construction loads to which they will be subjected, and proceed until its completion.

With the exception mentioned below in this paragraph, do not backfill trenches at pipe joints until after that section of the pipeline has successfully passed any specified test required. Should the Contractor wish to minimize the maintenance of lights, and barricades, and the obstruction of traffic, he may, at his own risk, backfill the entire trench as soon as practicable after installation of pipe, and the related structures have acquired a suitable degree of strength. He shall, however, be responsible for removing and later replacing such backfill, at his own expense, should be ordered to do so in order to locate and repair or replace leaking or defective joints or pipe.

MATERIALS: The nature of the materials will govern both their acceptability for backfill and the methods best suited for their placement and compaction in the backfill. Both are subject to the approval of the Engineer. Do not place stone or rock fragments larger than 4 inches in greatest dimension in the backfill. Do not drop large masses of backfill material into the trench in such a manner as to endanger the pipe line. Use a timber grillage to break the fall of material dropped from a height of more than 5 feet. Exclude pieces of bituminous pavement from the backfill unless their use is expressly permitted.

ZONE AROUND PIPE: Place bedding material to the level shown on the Drawings and work material carefully around the pipe to insure that all voids are filled, particularly in bell holes. For backfill up to a level of 2 feet over the top of the pipe, use only selected materials containing no rock, clods or organic materials. Place the backfill and compact thoroughly under the pipe haunches and up to the mid-line of the pipe in layers not exceeding 6 inches in depth. Place each layer and tamp carefully and uniformly so as to eliminate the possibility of lateral displacement. Place and compact the remainder of the zone around the pipe and to a height of one foot above the pipe in layers not exceeding 6 inches and compact to a maximum density of at least l00 percent as determined by ASTM D-698.

TAMPING: Deposit and spread backfill materials in uniform, parallel layers not exceeding l2 inches thick before compaction. Tamp each layer before the next layer is placed to obtain a thoroughly compacted mass. Furnish and use, if necessary, an adequate number of power driven tampers, each weighing at least 20 pounds for this purpose. Take care that the material close to the bank, as well as in all other portions of the trench, is thoroughly compacted. When the trench width and the depth to which backfill has been placed are sufficient to make it feasible, and it can be done effectively and without damage to the pipe, backfill may, on approval, be compacted by the use of suitable roller, tractors, or similar powered equipment instead of by tamping.

For compaction by tamping (or rolling), the rate at which backfilling material is deposited in the trench shall not exceed that permitted by the facilities for its spreading, leveling and compacting as furnished by the Contractor.

Wet the material by sprinkling, if necessary, to insure proper compaction by tamping (or rolling). Perform no compaction by tamping (or rolling) when the material is too wet either from rain or applied water to be compacted properly.

TRENCH COMPACTION: Compact backfill in pipe trenches to the maximum density as shown on the Drawings, or as listed in the subsection entitled COMPACTION, with a moisture content within the range of values of maximum density as indicated by the moisture-density relationship curve.

COMPACTION

GENERAL: Control soil compaction during construction providing at least the minimum percentage of density specified for each area classification.

PERCENTAGE OF MAXIMUM DENSITY REQUIREMENTS: After compaction, all fill will be tested in accordance with Method "C" of ASTM D-698, unless specified otherwise. Except as noted otherwise for the zone around pipe, provide not less than the following percentages of maximum density of soil material compacted at optimum moisture content, for the actual density of each layer of soil material-in-place.

DRIVES AND PARKING: Top 9" - l00%.

TRENCH BACKFILL (PAVED AREAS): Compact full depth to 95%.

TRENCH BACKFILL (UNPAVED AREAS): Compact full depth to 95%.

ALL OTHER BACKFILL: Compact full depth to 95%.

MOISTURE CONTROL: Where sub-grade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of sub-grade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a satisfactory value, as determined by moisture-density relation tests.

DISPOSAL OF SURPLUS MATERIAL
Upon approval of the Engineer, haul all surplus materials not needed or acceptable for backfill and dispose of at a permitted landfill provided by the Contractor.

CARE AND RESTORATION OF PROPERTY

Enclose the trunks of trees which are to remain adjacent to the work with substantial wooden boxes of such height as may be necessary to protect them from piled material, equipment or equipment operation. Use excavating machinery and cranes of suitable type and operate the equipment with care to prevent injury to remaining tree trunks, roots, branches and limbs.

Do not cut branches, limbs, and roots except by permission of the Engineer. Cut smoothly and neatly without splitting or crushing. In case of cutting or unavoidable injury to branches, limbs, and trunks of trees, neatly trim the cut or injured portions and cover with an application of grafting wax or tree healing paint as directed.

Protect by suitable means all cultivated hedges, shrubs and plants which might be injured by the Contractor's operations. Promptly heel in any such trees or shrubbery necessary to be removed and replanted. Perform heeling in and replanting under the direction of a licensed and experienced nurseryman. Replant in their original position all removed shrubbery and trees after construction operations have been substantially completed and care for until growth is reestablished.

Replace cultivated hedges, shrubs, and plants injured to such a degree as to affect their growth or diminish their beauty or usefulness, by items of kind and quality at least equal to the kind and quality existing at the start of the work.

Do not operate tractors, bulldozers or other power- operated equipment on paved surfaces if the threads or wheels of the equipment are so shaped as to cut or otherwise injure the surfaces.

Restore all surfaces, including lawns, grassed, and planted areas which have been injured by the Contractor's operations, to a condition at least equal to that in which they were found immediately before the work was begun. Use suitable materials and methods for such restoration. Maintain all restored plantings by cutting, trimming, fertilizing, etc., until acceptance. Restore existing property or structures as promptly as practicable and do not leave until the end of construction period.

PROTECTION OF STREAMS

Exercise reasonable precaution to prevent the silting of streams. Provide at Contractor's expense temporary erosion and sediment control measures to prevent the silting of streams and existing drainage facilities.

AIR POLLUTION

Comply with all pollution control rules, regulations, ordinances, and statutes which apply to any work performed under the Contract, including any air pollution control rules, regulations, ordinances and statutes, or any municipal regulations pertaining to air pollution.

During the progress of the work, maintain the area of activity, including sweeping and sprinkling of streets as necessary, so as to minimize the creation and dispersion of dust. If the Engineer decides that it is necessary to use calcium chloride or more effective dust control, furnish and spread the material, as directed, and without additional compensation.

BRIDGING TRENCHES

Provide suitable and safe bridges and other crossings where required for the accommodation of travel; provide access to private property during construction, and remove said structures thereafter.

Bridge or backfill trenches in any portion of the travel lanes of public or private roads, or drives, at the end of each day's operation to provide for safe travel. No additional compensation will be made for this work.

INSTALLATION

All pipe installation shall be in accordance with N.C.D.O.T. Standard Specifications Section 300.

SECTION 02221 ROCK EXCAVATION AND SELECT BACKFILL

1.1 SCOPE:

The work covered by this section consists of the removal and proper disposal of sound, solid rock of whatever nature, which occurs in its original position in ledges, bedded deposits or stratified and unstratified masses within the excavation limits shown on the plans, and which is of such hardness or texture that it cannot be loosened or broken down and removed without resort to drilling and blasting methods. This work shall be classified as rock excavation. Likewise, the removal of boulders, pieces of stone, and old masonry masses, one cubic yard in volume shall be classified as rock excavation.

The work covered by this section shall also include the furnishing, delivery, and placement of select backfill material other than local material that is necessary to replace the rock excavation upon installation of any pipe or structures.

SUPPLEMENTARY SPECIFICATIONS: Except as otherwise noted the STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES as prepared by the State of North Carolina Department of Transportation dated January 1, 1990, or latest revision thereof, shall govern all work to be performed under the Item.

1.2 MATERIALS:

Rock pre-splitting shall be in accordance with N.C.D.O.T. Standard Specifications Section 228.

1.3 CONSTRUCTION REQUIREMENTS:

EXCAVATION: The removal and disposal of the rock after drilling and blasting shall be in accordance with Section 02220 of these Specifications.

INSTALLATION: The installation of select backfill when deemed necessary shall be in accordance with N.C.D.O.T. Standard Specifications Section 300.

1.4 METHOD OF MEASUREMENT:

The quantity of rock excavation will be the actual number of cubic yards of rock removed, by drilling and blasting, and disposed of. There shall be no measurement made for the number of cubic yards of select backfill material as payment for this quantity shall be included in the unit bid price for rock excavation.

1.5 **BASIS OF PAYMENT**:

The quantities of rock excavation measured as provided in section 1.4 will be paid for at the contract unit price "per cubic yard." The payments will be full compensation for work covered by this item including but not limited to: all drilling and blasting, equipment, materials, and labor; the removal and disposal of all rock excavation, and the furnishing and placing of all select backfill material that may be deemed necessary.

Payment will be made under:

Rock Excavation & Associated select backfill ……per cubic yard.

SECTION 02485 VALVES AND APPURTENANCES

1.1 SCOPE:

Provide all labor, material, equipment, and services indicated on the Drawings or specified herein or reasonably necessary for and incidental to a complete job.

This section covers valve boxes, valve pits, and all necessary appurtenances generally associated with piping located outside of major structures and vaults as shown on the Drawings and as specified herein.

1.2 QUALITY ASSURANCE

REFERENCED STANDARDS: Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards.

ANSI A21.11 Rubber Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe and Fittings

ASTM B584 Standard Specification for Copper Alloy Sand Castings for General A Applications

AWWA C509 Standard for Resilient Seat Gate Valves - 3 Inches Through 48 Inches - for Water and Other Liquids

AWWA C800 Underground Service Line , Valves and Fitings.

SUBMITTALS

MANUFACTURER'S CERTIFICATION: VALVES: For information only, submit 2 copies of valve manufacturer's notarized certification that valves furnished for this project are in full compliance with the Referenced Standards and these Specifications.

1.3 MATERIALS:

BALL VALVES

Ball valves shall be installed on existing/new 2" water main and service lines and shall conform to AWWA C800. Valves shall be made of heavy brass components with a PTFE coated ball on a "blow-out" proof stem with double O-ring seals, and shall be rated for 300 psig working pressure. Operating nut shall be "curb key" design for quarter turn open or close and shall open left. Ball valves shall be as required on the Approved Manufacturers Products List.

GATE VALVES

GENERAL: Unless otherwise noted on the Drawing, all valves 4-inches through 10-inches shall be resilient seated gate valves manufactured to meet or exceed the requirements of AWWA C-509 of latest revision, be listed by Underwriters laboratories, Inc. and have Factory Mutual research approval.

All internal surfaces of the valve body and bonnet shall be coated with fusion bonded epoxy to a minimum thickness of 8-mils. Said coating shall be non-toxic --impart no taste to water and shall conform to AWWA C-550 of latest revision. The outside of the valve is to be coated with the same fusion bonded epoxy conforming to AWWA C-550 such that all exposed external surfaces, including end connection bolt holes, body-to-bonnet bolts holes, etc. shall be coated, 8-mils thick minimum.

Resilient seat valves are to be iron body with non-rising stems. The sealing mechanism shall consist of a solid iron gate totally encapsulated with rubber. it shall be designated so that compression-set of the rubber shall not effect the ability of the valve to seal when unbalanced pressure is applied to either side of the gate. The sealing mechanism shall provide zero leakage at 200 PSI working pressure when installed with the line flow in either direction.

Valves larger than 2-inches shall be furnished with a 2- inch square, ductile iron operating nut. The operating nut shall be attached to the stem by either a completely recessed cap nut or by a stainless steel pin. 2-inch valves shall be furnished with a "T Bar" operator.

The gate shall be provided with a drain in the bottom to flush the internal cavity of foreign material each time the valve is opened.

Each valve shall be seal tested, operation tested and shall be tested in accordance with Section 6 of AWWA C- 509. Also, the manufacture shall show evidence that the valves furnished in this order meet the requirements of all tests set out in Section 6 of AWWA C-509.

Valves shall open to the left (counterclockwise) and be so marked.

Valves shall be furnished with mechanical joint ends, complete with all necessary jointing accessories.

TAPPING VALVES:

Resilient seated tapping valves 16-inches diameter and smaller shall be furnished with the tapping flange having a raised face or lip designed to engage the corresponding recess in the tapping sleeve flange in accordance with MSS SP60 and be drilled and faced in accordance with 125 pound standard. The branch outlet of the tapping valve shall be

furnished with mechanical joint ends compatible with standard Mueller tapping equipment. Tapping valves are to be furnished complete with all jointing accessories fully assembled both flanged and M.J. ends.

The interior of the waterway in the body shall be full opening and capable to passing a full sized shell cutter equal to the nominal diameter of the valve.

BUTTERFLY VALVES

GENERAL: Unless otherwise noted on the Drawing all valves larger than 10-inches shall be 250 PSI, mechanical joint, butterfly valves.

Butterfly valves shall be of the iron body design with a high strength stainless steel shaft. The valves shall have an offset disc to allow smooth flow and provide a bubble-tight seal against flow from either direction. A natural rubber, abrasion-resistant disc seat ring shall be molded over a stainless steel ring for support. It shall be secured to the disc with corrosion-resistant, self locking stainless steel hex head screws such that the seat can be adjusted or replaced in the field. The disc shall be held to the shaft with high strength, tapered stainless steel pins which are ringed sealed. All butterfly valves for underground installation shall have mechanical joints ends, a non-rising stem with a 2-inch square operating nut and concrete support pad underneath the valve for valves larger than 12-inches.

The stainless steel valve shaft shall accept the greater torques and forces encountered in disc rotation at 250 PSI working pressure. A balanced pressure shaft design shall be used which prevents pressure from forcing the disc to one side. The lower shaft busing which controls the disc shall be factory set. The butterfly valves shall be rated for 250 PSI working pressure and be in accordance with applicable AWWA standards and shall comply to the Approved Manufacturers Products List.

CHECK_VALVES

GENERAL: Check valves shall be swing-check type conforming to AWWA C508. Valves conforming to AWWA C508 shall have iron body and cover and fully bronze mounted stainless steel hinge pins. Valves shall have clear port opening. Valves shall be spring loaded and shall have flanged ends.

CASTING_MARKINGS: Cast integral with either the bonnet or the body, the manufacturer's identification, the size of valve, the year of manufacture, and the maximum working pressure.

PAINTING: Coat all ferrous parts of the valves, except finished or bearing surfaces, with 2 coats of coal-tar varnish pipe dip or other approved material. After the valves are assembled and tested apply a third coat to the exterior.

TESTING: Test each valve at the manufacturer's plant for performance in watertightness and resistance to distortion under internal pressure. Subject each valve to hydrostatic tests under pressure at the working pressure cast on the valve and at 350 PSI.

AIR RELEASE VALVES:

Air release valves shall be float-controlled automatic air release valves installed at all high points along the water line alignment. Air release valves 2" or smaller shall be installed as per the pertinent standard detail.

FIRE_HYDRANTS

GENERAL: All fire hydrants shall meet or exceed the requirements of AWWA C-502, be listed by Underwriters Laboratories, Inc. and have Factory Mutual Research approval. All hydrants shall be rated 250 PSI working pressure minimum and be tested to 500 PSI minimum. The rated working pressure shall be cast on the hydrant barrel. Hydrants shall be of the compression type, constructed such that the main valve closes with water pressure to assure no loss of water in the event of damage to the upper portion of the hydrant. The diameter of the main valve seat shall be four and one-half inches (4 1/2") minimum. The hydrant shall open counter clockwise against the pressure and close clockwise with the pressure.

The bonnet assembly shall have a lubrication reservoir which is sealed from the waterway and all external contaminants by the use of "O" ring seals. A port to add lubricant to the reservoir, without removal of the bonnet, is required.

Fire hydrant shall be manufactured with 1 1/2-inch Pentagon operating nut and thrust nut made of low zinc bronze complying with ASTM B-61, B-62 or B-96, with thrust bearings located both above and below the thrust collar and with operating nut protected by a cast iron weather shield. In lieu of the bronze operating nut, an integral ductile iron operating nut and weather shield will be acceptable.

Hydrants shall be a 3-way type with two (2) outlet nozzles, two and one-half inches (2 1/2") NST and (1) Steamer nozzle four and one-half inches (4 1/2") NST. All nozzles shall be made of low zinc brass complying with ASTM B-61, B-62 or B-96. All nozzles shall be mechanically locked into the barrel and have "O" ring pressure seals. Caps shall be provided with chains and chain hooks.

The hydrant shall have a traffic "breakaway" coupling which is designed to fracture when the hydrant is impacted by a vehicle. The breakaway coupling shall be made of cast iron or steel and shall allow for 360 degree rotation of the upper barrel to position the nozzles without removing the breakaway coupling or shutting down. All pins, clips, and or retainer rings associated with the "breakaway" coupling shall be stainless steel.

The main valve seat shall have bronze to bronze seating arrangement of low zinc bronze complying with ASTM B-61, B-62 or B-96. A bronze seat ring shall be threaded into bronze sub-seat located in the hydrant elbow. All "O" rings sealing the main valve seat ring shall bear against a non-corrodible low zinc bronze surface.

The main valve assembly shall include double drain valves to operate automatically each time operated without the aid of springs, pins or toggles. The valve upper plate and valve lower plate shall be made of ductile iron or low zinc bronze complying with ASTM B-61, B-62 or B-96. The entire valve and stem assembly must be capable of removal and re-assembly by the use of a small lightweight wrench without disassembly of the upper barrel.

The shoe casting, lower barrel casting, and flanges below ground shall be manufactured in accordance with ASTM A- 126, Class B, Grey Iron or Ductile Iron. All ferrous metal surfaces in the hydrant shoe are to be fully coated with a minimum four (4) mills epoxy not to exclude the lower valve plate assembly.

The hydrant will have three and one-half foot (3 1/2') of bury, unless otherwise noted. The hydrant will have a six inch (6") inlet connection of the (mechanical joint) type, unless otherwise noted. Painting and coating of the hydrant shall be as prescribed in AWWA C-502, latest revision. The color above the ground line flange shall be YELLOW.

Fire hydrants shall be as required in the Approved Manufacturers Products List.

TAPPING SLEEVE

Tapping sleeves shall consist of two piece split cast iron sleeves, jointed by bolts manufactured of high strength cast iron and incorporating a longitudinal compound rubber gasket. The sleeves shall include split end gasket and two piece mechanical joint glands suitable for the class of pipe around which sleeves are to be placed. Glands will be joined by cast iron bolts and fastened to the bell openings of the sleeves to form totally enclosed rubber water tight seals around the periphery of the pipe and along the longitudinal joints. The tapping sleeve shall be of the flanged outlet type designed for attachment to the flanged inlet end of the tapping valve.

1.4 CONSTRUCTION REQUIREMENTS:

INSPECTION

Examine areas and conditions under which valves, hydrants and appurtenances are to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

INSTALLATION

GENERAL: Install valves and appurtenances to the same specification which covers the piping to which these items are connected.

1.5 MEASUREMENT AND PAYMENT:

The quantity of valves and appurtenances to be paid for will be the actual number of each of the items that have been incorporated into the completed and accepted work. Each item will be paid for at the contract unit price as specified in the bidding document.

SECTION 02494 TESTING PIPELINES

1.1 SCOPE:

Provide all labor, materials, equipment, and services indicated on the Drawings, or specified herein, or reasonably necessary for or incidental to a complete job.

The work includes the testing of all pressure water lines and appurtenances constructed in the project. Also included is the testing of connections to existing facilities.

1.2 QUALITY ASSURANCE

REFERENCED_STANDARDS: Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards.

AWWA C600 Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances

1.3 MATERIALS:

WATER: Water for the initial testing will be furnished by the Owner; the Contractor will be responsible for conveying the water to the location required for performing the hydrostatic tests. However, water for subsequent repeat testing, due to test failure by the contractor, may result in charges under the Water Authority's residential water rate for additional water use.

1.4 CONSTRUCTION REQUIREMENTS:

INSPECTION: Examine the areas and conditions under which the testing will be performed. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

TESTING

GENERAL: Perform all hydrostatic testing in accordance with AWWA C600, Section 4, unless otherwise specified. When a section of pipe of a length deemed adequate by the Engineer is ready for testing, blow the line free from air and conduct a leakage test.

All new water service connections, from taps on the main up to and including meter yokes, meter setters and spool piece for meters in vaults, shall be installed and included in the hydrostatic testing and disinfection processes.

BURIED_LINES: Whenever conditions permit in the opinion of the Engineer, test pipelines before the trench is backfilled.
All joints may then be examined during open trench test and all leaks entirely stopped. Should the Contractor wish to minimize the maintenance of lights, and barricades and the obstruction of traffic, he may, at his own risk, backfill the entire trench as soon as practicable after installation of pipe. The Contractor, however, remains responsible for removing and later replacing such backfill, at his own expense, should he be ordered to do so in order to locate and repair or replace leaking or defective joints of pipe.

EXPOSED_LINES: Test all exposed lines prior to field painting.

TEMPORARY_BULKHEADS: Furnish, install and remove all temporary bulkheads, flanges, or plugs necessary to permit the required pressure test. Install corporation stops at all high points on the line for blowing lines free from air. Install corporation stops at the test pump location.

Install a test pump and means for accurate measurement of water introduced into the line during testing. Keep pump, meters, and gages in use during pressure and leakage tests.

TEST_PRESSURE_AND_ALLOWABLE_LEAKAGE: Keep the section to be tested full of water for a period of 24 hours before the pressure and leakage tests are conducted.

Hydrostatic Testing: A section of line which is to be hydrostatically tested, shall be slowly filled with water at a rate which will allow complete evacuation of air from the line. Hand pumps shall not be used for the pressure testing of water mains.

The hydrostatic test shall be witnessed by the Water Engineering Division during the full two hour duration.

The line shall be tested to a minimum pressure of 200 psi with a maximum of 250 psi at the lowest elevation for a duration of 2 hours. The pressure gauge used in the hydrostatic test shall be calibrated in increments of 10 psi or less. Pressure shall be maintained at a minimum of 200 psi +/- 5 psi at the highest point throughout the duration of the test by pumping additional water into the test section as often as necessary. At the end of the test period, the leakage shall be measured with an accurate water meter furnished by the City, or other approved means.

The line to be tested must utilize a backflow prevention assembly as shown on Standard Detail W18. All water for testing must be drawn through this assembly. Prior to connecting to the existing water line the new water line extension shall be pressure tested, disinfected and a clear water sample obtained. Furthermore, all closing requirements outlined in the Design & Construction Manual are to be met before connection.

The allowable leakage shall be no more than 0.56 gallon per inch diameter per mile per day.

All visible leaks are to be repaired regardless of the amount of leakage.

DEFECTIVE_MATERIALS_AND_WORKMANSHIP: Carefully examine all exposed pipe fittings, valves, hydrants, and joints during the test. Locate and repair leaks and replace defective materials if the water loss during the test periods exceeds the allowable leakage.

Make the necessary repairs, replace defective material and repeat the hydrostatic test until the leakage does not exceed the allowable leakage as defined herein.

1.5 MEASUREMENT AND PAYMENT

There will be no separate measurement and payment for work covered under this section. Testing pipelines shall be considered incidental to the installation of water lines.

SECTION 02496 DISINFECTING PIPELINES

1.1 SCOPE:

Provide all labor, materials, equipment, and services indicated on the Drawings, or specified herein, or reasonably necessary for or incidental to a complete job.

This work includes the disinfecting of all potable water pipelines and appurtenances, both existing and new, which have been exposed to contamination by reason of this construction, before being placed into service; subject to approval and supervision of the Engineer.

1.2 QUALITY_ASSURANCE

REFERENCED_STANDARDS: Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards.

AWWA C601 AWWA Standard for Disinfecting Water Mains

1.3 MATERIALS:

WATER: Water required for initial disinfecting procedure will be supplied by the Owner. The Contractor will be responsible for conveying the water to the location required for disinfecting. However, water for subsequent repeat testing, due to test failure by the contractor, may result in charges under the Water Authority's residential rate for additional water use.

1.4 CONSTRUCTION REQUIREMENTS:

INSPECTION

Examine the areas and conditions under which the pipeline disinfection will be performed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

DISINFECTION/FLUSING & SAMPLING_PROCEDURES

All new water service connections, from taps on the main up to and including meter yokes, meter setters and spool piece for meters in vaults, shall be installed and included in the hydrostatic testing and disinfection processes.

All additions or replacements to the water system shall be chlorinated before being placed in service. Such disinfection shall take place under the continuous supervision of the Engineering Department. The maximum total length of water main which may be disinfected at the same time is 3000 linear feet.

Disinfection, flushing and sampling of a completed line shall be carried out in the following manner:

a) Taps with extended copper tubing will be made at the control valve at the upstream end of the line and at all extremities of the line including valves. These additional taps will not be necessary where a suitable permanent tap is already available as approved by the City.

b) Prior to introducing the chlorine solution into the pipe, all blow-offs shall be checked to confirm that all air has been expelled from the pipe and the pipe is filled with water. During the introduction of chlorinated solution into the pipe, the operation of blow-offs shall be carefully controlled to make sure the solution enters all main lines, branch lines, and service lines thoroughly and that no air is introduced.

c) All gauge pressure and residual chlorine field test equipment shall be properly calibrated. All equipment used in the disinfection process shall be cleaned and suitable for potable water application.

d) A solution of water containing high test sodium hypochlorite (70% available chlorine) shall be introduced into the line by regulated pumping at the control-valve tap. The solution shall be of such a concentration that the line shall have a uniform concentration of 50 ppm total chlorine immediately after disinfection. The chart below shows the required quantity of 70% HTH compound to be contained in solution in each 1000 feet section of line to produce the desired concentration of 50 ppm.

Pipe Size (inches)	Pounds High Test Hypochlorite (70%) per 1000 feet of line
6	0.88
8	1.56
10	2.42
12	3.50
14	4.76
16	6.22
20	9.76
24	14.00

e) Once the new main is uniformly chlorinated at the required concentration as confirmed by the Water Engineering Division Inspector, entrances and blow-offs shall be properly secured and the solution shall be retained in the system for a minimum of 24 hours,

during which time all intermediate valves and hydrants shall be operated several times to insure disinfection of the inside faces of these appurtenances. At the end of the 24-hour period, the Inspector shall check entrance points and blow-offs to insure that the pipe is still full of solution without trapped air and the solution at each point checked has retained a chlorine residual of not less than 10 mg/l.

f) Following the 24-hour period, with the approval of the Inspector, the chlorine solution shall be thoroughly flushed from the new main. Flushing shall not be completed until the residual chlorine measured by the Inspector at the end points of the new main has a measured chlorine residual within +/- 0.5 mg/l of the water supplied for flushing from the active water main.

g) Disposal of the chlorinated solution during flushing shall comply with all federal, state, and local regulations. Where a sanitary sewer is located nearby, with the approval of the sewer authority, the chlorinated solution may be discharged to the sanitary sewer with a positive air gap to prevent backsiphonage. Disposal directly to surface waters without removal of chlorine is strictly prohibited.

h) After flushing is completed as described in f) above, the new water mains shall be isolated without introducing air by closing all entrance and blow-off points and allowing the new water mains to sit for another 24-hour period. At the end of this 24-hour period, an authorized employee of the City of Asheville Water Production Division shall collect samples from randomly selected end points of the new water mains and perform bacteriological analysis of the samples in a certified laboratory. Results of the testing shall be documented and certified by the signature of the laboratory technician and Water Production Supervisor or Superintendent. Test results shall be provided to the contractor and Water Engineering Division. The disinfection process is not completed until the results of all testing are certified as negative for bacteriological contamination.

i) If the bacteriological tests fail to produce satisfactory results, the new main shall be reflushed by repeating steps f) through h) above. If bacteriological tests fail the second time, the entire disinfection process shall be repeated.

j) From the date of approval of disinfection, the Developer/Contractor shall have 30 days to complete all remaining work related to the water system, including record drawings and certifications in accordance with the pertinent section of the Asheville Design & Construction Manual and receive a Letter of Acceptance from the Water Engineering Division. If the Developer/Contractor fails to obtain the Letter of Acceptance within 30 days, the previously disinfected line shall be resampled before acceptance to determine if the new water line continues to remain disinfected. If the bacteriological test from the resample indicates the presence of bacteria, the line shall be flushed and resampled again in accordance with subparagraphs f) through h) above. If the test fails a second time, the entire disinfection process shall be repeated prior to acceptance.

For mains required to be immediately returned to service after disinfecting, take a bacteriologic sample after connection or repair to provide a record by which the effectiveness of the procedure used can be determined.

1.5 MEASUREMENT AND PAYMENT:

There shall be no separate measurement and payment for work covered under this section. Disinfecting pipelines shall be considered incidental to the installation of potable waterlines and appurtenances.

SECTION 02498 WATER SERVICE CONNECTIONS

1.1 SCOPE:

Provide all labor, materials, equipment, and services indicated on the Drawings, or specified herein, or reasonably necessary for or incidental to complete job.

The work covered by this Bid Item involves the change over of existing water services to the new waterline to be installed. The work for each change over may vary; but will include some or all of the following: tapping saddle, corporation stop, curb stop, connection to the existing water service or meter box, installation of a new water meter box assembly (complete) per the standard detail, type "K" copper pipe both open cut and augered and connection to the existing water service on the customer's side of the meter.

1.2 METER SETTER MATERIALS:

A. MATERIALS

All new water service fittings in direct contact with water shall be manufactured of "lead free" brass;. The exception to this requirement is brass unions, brass nipples, brass bushings and brass bell couplings which shall be manufactured in accordance with section aii. The use of galvanized iron, steel, or plastic fittings with copper and other higher-grade specified materials shall not be permitted or accepted.

All service line fittings shall be designed for connection to the service line by compression. No solder, brazing and flaring connections will be allowed.

All fittings and valves shall be manufactured in accordance with AWWA Standard C-800, latest revision, and as further specified in these technical specifications.

Exception: Any brass part of the fitting or valve in contact with potable water shall be made of a "No-Lead Brass", defined for this specification as EnviroBrass II, UNS Copper Alloy C89520 per ASTM B30 and ASTM B584 or approved equal. . The Mechanical properties and Chemical composition of the "No-Lead Brass" Alloy shall be certified by an independent testing agency. This "No-Lead Brass" alloy shall contain not more than one fourth of one percent(0.25% or less) total lead content by weight.

Any brass part of the fitting or valve not in contact with potable water shall be made of 85-5-5-5 brass as defined for this specification as UNS Copper Alloy C83600 per ASTM B30, ASTM B62, ASTM B584 and AWWA C-800. The approved manufacturer of these brass parts is Merit. Brass.

All brass fittings and valves shall be certified by an ANSI accredited test lab per ANSI/NSF Standard 61, Drinking Water Components – Health Effects, Section 8..

Proof of product certification shall be furnished with each delivery. Manufacturers specifications and/or product cut sheets shall be acceptable proof. Product packaging shall be clearly marked to identify contents.

Brass fittings and valves shall comply with the Safe Drinking Water Act, and the U.S Environmental Protection Agency.

All brass fittings and valves shall be clearly marked as "no lead" brass alloy, e.g., 'EB2' or "NL". All brass fittings and valves shall be integrally stamped or cast with the manufacturers name or trademark . All markings shall be clear and easily read.

QUALITY CONTROL AND TESTING If requested, an affidavit certifying compliance with these standards and specifications shall be signed and submitted by the manufacturing firm's Quality Assurance or Engineering Manager.

B. PRODUCTS

Ball Valve Corporation Stops The ball valve corporatin stops shall have a PTFE coating approved for use in potable water and be supported by two Buna-N rubber seals that are held and sealed in place with adhesive. The operating stem shall have a head that clearly indicates the flow direction. The stem shall be equipped with an O-ring seal to assure against external leakage and a flange to prevent blowout.

All Ball valve corporation stops shall be designed to have a working pressure of 300 PSIG. The throughway dimension shall be no smaller than the nominal size of the valve. All ball corporation stops must be designed so they can be installed under pressure with standard tapping machines and insertion tools. All threads shall conform to the current AWWA C-800 standard. Inlet threads shall be either AWWA or iron pipe style.

Curb Stops. Curb stop shall be the ball valve type with a padlock wing. The valves internal components shall be removable from the top of the valve body. The Curb Stops shall be designed to receive the service pipe connection with straight coupling nut on the street side and on iron pipe thread connection on the opposite side.

Dual Check Valve. An in-line dual check valve with independent acting checks shall be used downstream of the water meter. The check valve shall have a meter-coupling inlet and shall be contained inside the box. The internal parts of the check valve shall be removable without disconnecting the check valve or the outlet piping.

Meter Yoke. The yoke shall include a threaded expansion wheel on the inlet side to the water meter and a smooth machined brass surface on the outlet side to compress a meter washer into the dual check inlet rated for 250 psi; tightening lugs shall extend from the wheel to allow easy access.

Miscellaneous Parts: Brass unions, brass nipples, brass bushings and brass bell couplings associated with new water service construction shall comply with section of this specification and shall be manufactured by Merit Brass.

All the above parts shall comply to the Approved Manufacturers Products List.

1.3 Tapping Saddles

The Contractor shall furnish and install iron body double strap service saddles complying with the following:

Bodies:	Ductile Iron ASTM-A536
Straps:	5/8-inch AISI C1010 Steel, Zinc plated with Di-chromate seal.
Nuts:	Cold formed heavy hex steel A563, electro-galvanized with dichromate seal.
Gasket:	Buna-N rubber, ASTM-D2000
Finish:	Shop Coat Enamel

Tapping saddles shall be as required by the Approved Manufacturers Products List.

1.4 Copper Service Tubing

Copper Service Tubing shall be type K soft copper tubing per ASTM B88 for service lines up to 1 ½" in size. Two inch (2") service line shall be type "L" copper pipe. The longest available length of service line should be used with no unions. As an example for a 3/4-inch service connection, no union shall be used in the installation of 60 feet or less. For 3/4 inch, only one (1) union will be allowed for each one hundred- (100) foot section or fraction thereof. Unions shall be made with pack joint fitting with a retaining screw.

1.5 Meter Boxes

Meter Boxes for 5/8-inch services shall be of round style and made of Polyvinyl Chloride Plastic with a minimum wall thickness of .375 inches. The box shall be sized to accept a 5/8, 3/4, and 1-inch water meter and shall have a minimum inside diameter of 18-inches with a 30-inch depth. The box shall have a non-locking cast iron lid. Lid & box must comply with the requirements depicted in standard detail 7.01.

Meter boxes for 1-inch to 2-inch service shall be a galvanized steel vault and conform to Standard Detail 7.02. Piping for 1-1/2 inch water meters shall be constructed from brass and copper tubing and shall be equipped with a manufactured setter assembly with a lockable angled check valve outlets and by-pass lockable flangedvalve or by-pass lockable flanged ball valve inlets. There will be an adjustable connection on the by-pass to allow the setter to be customized to the width of the water meter installed.

Meter Vaults for >2 inch services shall conform to Standard Details 7.03 and 7.04. Meter boxes for service greater than 2" shall be constructed by a Contractor for the Owner/Developer for the approval of Water Engineering A strainer shall be provided upstream of the meter on lines greater than 2 inches.

Meter Vaults shall be located off the street right of way outside of travel areas. Vaults shall meet HS-20 loading requirements when located within travel areas. The access door shall be aluminum with a flush drop lift handle, stainless steel hinges and bolts, a stainless steel slam lock, an automatic hold open arm, and compression springs to allow for easy opening. Positive drainage shall be provided for all meter vaults. All vaults shall be provided with remote reading capabilities compatible with City meter reading equipment as per the applicable detail.

Installation: Installation of water service lines shall conform to the Technical Specifications and Standard Details. All water meters 2" and less in size for new service shall be installed (dropped-in) by the Water Resources Department.

1.6 CONSTRUCTION REQUIREMENTS:

EXCAVATION AND BACKFILL

Excavation and Backfill for the installation of this Bid Item shall be in accordance with the applicable section of these specifications.

INSTALLATION

Installation of water service connections shall be coordinated with testing and disinfecting of the new line and abandoning of the old. It is the intent that new water service connections to the new main be made before all testing and disinfecting. The old service line shall be removed from the street side of the meter and the new service line installed. The new 5/8-inch meter boxes shall be installed and existing meter boxes abandoned at locations designated by the Engineer. On all new 5/8-inch meter box installations, the Contractor will be

required to connect the customers service to the meter box outlet. Interruption of water service shall be held to a minimum. Property owners shall be duly notified of the interruption as outlined in these specifications.

1.7 MEASUREMENT AND PAYMENT

METHOD OF MEASUREMENT

The quantity of each item in this Section is to be paid for will be the actual number, "per each" or "per linear foot",according to size, which have been incorporated into the completed and accepted work. Each item will be paid for at the contract unit price as specified in the bidding document.

A. Water Service Transfer: This Item will include furnishing, installing a tapping saddle and corporation on the new water main, furnishing materials and making connection to the existing service line, or the inlet of the existing meter box,
or to the inlet of a new meter box as directed by the Engineer "per each".

B. Type "K" Soft Copper Pipe (OPEN CUT): This Item includes furnishing and installing via open cut Type "K" copper pipe between the new water main and the point of connection to the existing water service "per linear foot".

C. Type "K" Soft Copper Pipe (AUGERED): This Item includes furnishing and installing by augering under the road Type "K" copper pipe between the new water main and the point of connection to the existing water service "per linear foot".

D. Meter Box: This Item will include removal of existing meter box, furnishing and installing a new meter box assembly (complete per detail) and connecting the customer's service line and the meter box outlet "per each".

1.8 BASIS OF PAYMENT:

The quantity of items measured as provided in subsection 1.7 will be paid for at the contract unit price as specified in the bidding document. The payments will be full compensation for all work required for the completion and acceptance of each item.

SECTION 02613 EXTRA PIPE BEDDING

1.1 SCOPE:

The work covered by the Bid Item consists of the furnishing and installing of additional pipe bedding material over and above that called for on the plans. This additional pipe bedding material shall be installed only when designated by the Engineer and at locations and depths designated by the Engineer.

1.2 SUPPLEMENTARY SPECIFICATIONS:

Except as otherwise noted the STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES as prepared by the State of North Carolina Department of Transportation dated January 1, l990, or latest revision thereof, shall govern all work to be performed under the item.

1.3 MATERIALS:

The materials for this Bid Item shall be crushed stone or crushed gravel meeting the requirements of ASTM C-33 Gradation 67.

1.4 INSTALLATION:

The installation of the additional bedding material shall be performed in a manner designated by the Engineer. Amount of additional bedding material shall be decided by the engineer or his/her representative and shall vary based upon field conditions encountered.

1.5 METHOD OF MEASUREMENT:

The quantity of extra pipe bedding will be the actual number of tons authorized by the Engineer to be installed over and above the quantity called for on the plans or contract documents.

1.6 BASIS OF PAYMENT:

The quantity of extra pipe bedding measured as provided in subsection 1.4 will be paid for at the contract unit price "per ton" basis. The payment will be full compensation for work covered by this Item including all necessary equipment to furnish and install the extra pipe bedding authorized by the Engineer. Standard pipe bedding called for on the plans will be considered incidental to any water, sanitary sewer, storm sewer or any other pipe material being specified in the contract documents.

Payment for this Item will be made under:

Extra Pipe Bedding…… per Ton

SECTION 02821 SEEDING, FERTILIZING AND MULCHING

1.1 SCOPE

This section covers the furnishing of all labor, equipment and materials necessary or the landscaping of all areas of the site disturbed by construction operations and all earth surfaces of embankments including rough and fine grading, topsoil if required, fertilizer, lime, seeding and mulching. The Contractor shall adapt his operations to variations in weather or soil conditions as necessary for the successful establishment and growth of the grasses or legumes.

1.2 GRADING

Rough grading shall be done as soon as all excavation required in the area has been backfilled. The necessary earthwork shall be accomplished to bring the existing ground to the desired finish elevations as shown on the Contract Drawings or otherwise directed.

Fine grading shall consist of shaping the final contours for drainage and removing all large rock, clumps of earth, roots and waste construction materials. It shall also include thorough loosening of the soil to a depth of 6-inches by plowing, discing, harrowing or other approved methods until the area is acceptable as suitable for subsequent landscaping operations. The work of landscaping shall be performed on a section by section basis immediately upon completion of earthwork.

Upon failure or neglect on the part of the Contractor to coordinate his grading with seeding and mulching operations and diligently pursue the control of erosion and siltation, the Engineer may suspend the Contractor's grading operations until such time as the work is coordinated in a manner acceptable to the Engineer.

1.3 MATERIALS

A. Fertilizer:

The quality of fertilizer and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and regulations adopted by the North Carolina Board of Agriculture.

Fertilizer shall be 8-8-8 grade. Upon written approval of the Engineer a different grade of fertilizer may be used, provided the rate of application is adjusted to provide the same amounts of plant food.

During handling and storing, the fertilizer shall be cared for in such a manner that it will be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original conditions before being used.

B. *Lime:*

The quality of lime and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and regulations adopted by the North Carolina Board of Agriculture.

During the handling and storing, the lime shall be cared for in such a manner that it will be protected against hardening and caking. Any hardened or caked lime shall be pulverized to its original condition before being used.

Lime shall be agriculture grade ground dolomitic limestone. It shall contain not less than 85% of the calcium and magnesium carbonates and shall be of such fineness that at least 90% will pass a No. 10 sieve and at least 50% will pass a No. 100 sieve.

C. *Seed:*

The quality of seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and regulations adopted by the North Carolina Board of Agriculture.

Seed shall have been approved by the North Carolina Department of Agriculture or any agency approved by the Engineer before being sown, and no seed will be accepted with a date of test more than nine (9) months prior to the date of sowing. Such testing however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these specifications at the time of sowing. When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of seeding sufficiently to obtain the minimum pure live seed contents specified, provided that such an increase in seeding does not cause the quantity of noxious weed seed per square yard to exceed the quantity that would be allowable at the regular rate of seed.

During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents, or other causes.

Seed shall be entirely free from bulblets or seed of Johnson Grass, Nutgrass, Sandbur, Wild Onion, Wild Garlic, and Bermuda Grass. The specifications for restricted noxious weed seed refers to the number per pound, singly or collectively, of Blessed Thistle, Wild Radish, Canada Thistle, Corncockle, Field Bindwee, Quackgrass, Dodders, Dock, Horsenettle, Bracted Plantain, Buckhorn or Wild Mustard; but in no case shall the number of Blessed

Thistle or Wild Radish exceed 27 seeds of each per pound. No tolerance on weed seed will be allowed.

D. Mulch:

Straw mulch shall be threshed straw of oats, rye or wheat free from matured seed of obnoxious weeds or other species which would grow and be detrimental to the specified grass.

1.4 SEEDBED PREPARATION

The Contractor shall cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded. Uneven and rough areas outside of the graded section, such as crop rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil accumulations, and other minor irregularities which cannot be obliterated by normal seedbed preparation operations, shall be shaped and smoothed as directed by the Engineer to provide for more effective seeding and for ease of subsequent mowing operations.

The soil shall then be scarified or otherwise loosened to a depth of not less than six (6) inches except as otherwise provided below or otherwise directed by the Engineer. Clods shall be broken and the top 2 to 3 inches of soil shall be worked into an acceptable seedbed by the use of soil pulverizers, drags, or harrows; or by other methods approved by the Engineer.

On 2:1 slopes a seedbed preparation will be required that is the same depth as that required on flatter areas, although the degree of smoothness may be reduced from that required on the flatter areas if so permitted by the Engineer.

On cut slopes that are steeper than 2:1, both the depth of preparation and the degree of smoothness of the seedbed may be reduced as permitted by the Engineer, but in all cases the slope surface shall be scarified, grooved, trenched, or punctured so as to provide pockets, ridges, or trenches in which the seeding materials can lodge.

On cut slopes that are either 2:1 or steeper, the Engineer may permit the preparation of a partial or complete seedbed during the grading of the slope. If at the time of seeding and mulching operations such preparation is still in a condition acceptable to the Engineer, additional seedbed preparation may be reduced or eliminated.

The preparation of seedbeds shall not be done when the soil is frozen, extremely wet, or when the Engineer determines that it is in an otherwise unfavorable working condition.

1.5 APPLICATION

Seed shall be applied by means of a hydro-seeder or other approved methods. The rates of application of seed, fertilizer and limestone shall be as stated below. All rates are in pounds per acre:

Fertilizer - 1200 lbs. per acre
Lime - 4,000 lbs. per acre
Fescue - 150 lbs. per acre
Rye - 50 lbs. per acre

Equipment to be used for the application, covering or compaction of limestone, fertilizer, and seed shall have been approved by the Engineer before being used on the project. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed. Limestone, fertilizer, and seed shall be applied within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer, but no limestone or fertilizer shall be distributed and no seed shall be sown when the Engineer determines that weather and soil conditions are unfavorable for such operations.

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, limestone and fertilizer shall be distributed uniformly over the prepared seedbed at the specific rate of application and then harrowed, raked, or otherwise thoroughly worked or mixed into the seedbed.

Seed shall be distributed uniformly over the seedbed at the required rate of application, and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. The depth of covering shall be as directed by the Engineer. If two kinds of seed are to be used which require different depths of covering, they shall be sown separately.

When a combination seed and fertilizer drill is used, fertilizer may be drilled in with the seed after limestone has been applied and worked into the soil. If two kinds of seed are being used which require different depths of covering, the seed requiring the lighter covering may be sown broadcast or with a special attachment to the drill, or drilled lightly following the initial drilling operation.

When a hydraulic seeder is used for application of seed and fertilizer, the seed shall not remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted by the Engineer.

Immediately after seed has been properly covered the seedbed shall be compacted in the manner and degree approved by the Engineer.

When adverse seeding conditions are encountered due to steepness of slope, height of slope, or soil conditions, the Engineer may direct or permit that modifications be made in the above requirements which pertain to incorporating limestone into the seedbed; covering limestone, seed, and fertilizer; and compaction of the seedbed.

Such modifications may include but not be limited to the following:

1. The incorporation of limestone into the seedbed may be omitted on (a) cut slopes steeper than 2:1; (b) on 2:1 cut slopes when a seedbed has been prepared during the excavation of the cut and is still in an acceptable condition; or (c) on areas of slopes where the surface of the area is too rocky to permit the incorporation of the limestone.

2. The rates of application of limestone, fertilizer, and seed on slopes 2:1 or steeper or on rocky surfaces may be reduced or eliminated.

3. Compaction after seeding may be reduced or eliminated on slopes 2:1 or steeper, on rocky surfaces, or on other areas where soil conditions would make compaction undesirable.

1.6 MULCHING

All seeded areas shall be mulched unless otherwise indicated in the special provisions or directed by the Engineer.

It shall be spread uniformly at a rate of two tons per acre in a continuous blanket over the areas specified.

Before mulch is applied on cut or fill slopes which are 3:1 or flatter, and ditch slopes, the Contractor shall remove and dispose of all exposed stones in excess of 3 inches in diameter and all roots or other debris which will prevent proper contact of the mulch with the soil.

Mulch shall be applied within 24 hours after the completion of the seeding unless otherwise permitted by the Engineer. Care shall be exercised to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Mulch shall be uniformly spread by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

Mulch shall be held in place by applying a sufficient amount of asphalt or other approved binding material to assure that the mulch is properly held in place. The rate and method of application of binding material shall meet the approval of the Engineer. Where the binding material is not applied directly with the mulch it shall be applied immediately following the mulch operation.

The Contractor shall take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and shall promptly remove any blockage to drainage facilities which may occur.

1.7 MAINTENANCE

The Contractor shall keep all seeded areas in good condition, reseeding and mowing if and when necessary as directed by the Engineer, until a good lawn is established over the entire area seeded and shall maintain these areas in an approved condition until final acceptance of the Contract.

Grassed areas will be accepted when a 95 percent cover by permanent grasses is obtained and weeds are not dominant. On slopes, the Contractor shall provide against washouts by an approved method. Any washouts which occur shall be regraded and reseeded until a good sod is established.

Areas of damage or failure due to any cause shall be corrected by being repaired or by being completely redone as may be directed by the Engineer. Areas of damage or failure resulting either from negligence on the part of the Contractor in performing subsequent construction operations or from not taking adequate precautions to control erosion and siltation as required throughout the various sections of the specifications, shall be repaired by the Contractor as directed by the Engineer at no cost to the Owner.

1.8 METHOD OF MEASUREMENT

The quantity of seeeding and mulching to be paid for will be considered incidental to the utility installation cost.

1.9 PAYMENT

No direct and separate payment will be made for this item. Its cost shall be incidental to the cost of installing the water main.

SECTION 02822 LANDSCAPING

1.1 SCOPE

This section covers the furnishing of all labor, equipment and materials necessary for the landscaping of all areas of the site disturbed by construction operations and all earth surfaces of embankments including rough and fine grading, topsoil if required, fertilizer, lime, seeding and mulching. The Contractor shall adapt his operations to variations in weather or soil conditions as necessary for the successful establishment and growth of the grasses and legumes.

1.2 PROTECTION OF EXISTING TREES AND VEGETATION

Protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to be left standing.

Provide protection for roots over 1-1/2" diameter cut during construction operations. Coat cut faces with an emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out and cover with earth as soon as possible.

The Contractor shall not remove or damage trees and shrubs which are outside the Clearing Limits established by the Owner or those within the Clearing Limits designated to remain.

Repair trees scheduled to remain and damaged by construction operations in a manner acceptable to the Engineer. Repair damaged trees promptly to prevent progressive deterioration caused by damage.

Replace trees scheduled to remain and damaged beyond repair by construction operations, as determined by the Engineer with trees of similar size and species. Repair and replacement of trees scheduled to remain and damaged by construction operations or lack of adequate protection during construction operations shall be at the Contractor's expense.

1.3 GRADING

Rough grading shall be done as soon as all excavation required in the area has been backfilled. The necessary earthwork shall be accomplished to bring the existing

ground to the desired finish elevations as shown on the Contract Drawings or otherwise directed.

Fine grading shall consist of shaping the final contours for drainage and removing all large rock, clumps of earth, roots and waste construction material. It shall also include thorough loosening of the soil to a depth of 6-inches by plowing, discing, harrowing or other approved methods until the area is acceptable as suitable for subsequent landscaping operations. The work of landscaping shall be performed on a section by section basis immediately upon completion of earthwork or pipeline installation.

Upon failure or neglect on the part of the Contractor to coordinate his grading with seeding and mulching operations and diligently pursue the control of erosion and siltation, the Engineer may suspend the Contractor's grading operations until such time as the work is coordinated in a manner acceptable to the Engineer.

1.4 MATERIALS

A. Fertilizer:

The quality of fertilizer and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and regulations adopted by the North Carolina Board of Agriculture.

Fertilizer shall be 10-10-10 grade. Upon written approval of the Engineer a different grade of fertilizer may be used, provided the rate of application is adjusted to provide the same amounts of plant food.

During handling and storing, the fertilizer shall be cared for in such a manner that it will be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original conditions before being used.

B. Lime:

The quality of lime and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and regulations adopted by the North Carolina Board of Agriculture.
During the handling and storing, the lime shall be cared for in such a manner that it will be protected against hardening and caking. Any hardened or caked lime shall be pulverized to its original conditions before being used.

Lime shall be agriculture grade ground dolomitic limestone. It shall contain not less than 85% of the calcium and magnesium carbonates and shall be of such fineness that at least 90% will pass a No. 10 sieve and at least 50% will pass a No. 100 sieve.

C. *Seed:*

The quality of seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and regulations adopted by the North Carolina Board of Agriculture. Seed shall have been approved by the North Carolina Department of Agriculture or any agency approved by the Engineer before being sown, and no seed will be accepted with a date of test more than 9 months prior to the date of sowing. Such testing however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these specifications at the time of sowing. When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of seeding sufficiently to obtain the minimum pure live seed contents specified, provided that such an increase in seeding does not cause the quantity of noxious weed seed per square yard to exceed the quantity that would be allowable at the regular rate of seed.

During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents or other causes.

Seed shall be entirely free from bulblets or seed of Johnson Grass, Nutgrass, Sandbur, Wild Onion, Wild Garlic, and Bermuda Grass. The specifications for restricted noxious weed seed refers to the number per pound, singly or collectively, of Blessed Thistle, Wild Radish, Canada Thistle, Corncockle, Field Bindweed, Quackgrass, Dodders, Dock, Horsenettle, Bracted Plantain, Buckhorn or Wild Mustard; but in no case shall the number of Blessed Thistle or Wild Radish exceed 27 seeds of each per pound. No tolerance on weed seed will be allowed.

D. *Mulch:*

Straw Mulch shall be threshed straw of oats, rye or wheat free from matured seed of obnoxious weeds or other species which would grow and be detrimental to the specified grass.

E. *Tackifier:*

Emulsified asphalt or organic tackifier such as Reclamare R2400 shall be sprayed uniformly on mulch as it is ejected from blower or immediately thereafter. Tackifier shall be applied evenly over area creating uniform appearance. Rates of application will vary with conditions. Asphalt shall not be used in freezing weather.

1.5 SEEDBED PREPARATION

The Contractor shall cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded. Uneven and rough areas outside the graded section, such as crop rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil accumulations, and other minor irregularities which cannot be obliterated by normal seedbed preparation operations, shall be shaped and smoothed as directed by the Engineer to provide for more effective seeding and for ease of subsequent mowing operations.

The soil shall then be scarified or otherwise loosened to a depth of not less than 6 inches except as otherwise provided below or otherwise directed by the Engineer. Clods shall be broken and the top 2 to 3 inches of soil shall be worked into an acceptable seedbed by the use of soil pulverizers, drags, or harrows; or by other methods approved by the Engineer.

On 2:1 slopes a seedbed preparation will be required that is the same depth as that required on flatter areas, although the degree of smoothness may be reduced from that required on the flatter areas if so permitted by the Engineer.

On cut slopes that are steeper than 2:1, both the depth of preparation and the degree of smoothness of the seedbed may be reduced as permitted by the Engineer, but in all cases the slope surface shall be scarified, grooved, trenched, or punctured so as to provide pockets, ridges, or trenches in which the seeding materials can lodge.

On cut slopes that are either 2:1 or steeper, the Engineer may permit the preparation of a partial or complete seedbed during the grading of the slope. If at the time of seeding and mulching operations such preparation is still in condition acceptable to the Engineer, additional seedbed preparation may be reduced or eliminated.

The preparation of seedbeds shall not be done when the soil is frozen, extremely wet, or when the Engineer determines that it is in an otherwise unfavorable working condition.

1.6 APPLICATION

Seed shall be applied by means of a hydro-seeder or other approved methods. The rates of application of seed, fertilizer and limestone shall be as stated in Table I.

Equipment to be used for the application, covering or compaction of limestone, fertilizer, and seed shall have been approved by the Engineer before being used on the project. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed.

Limestone, fertilizer, and seed shall be applied within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer, but no limestone or

fertilizer shall be distributed and no seed shall be sown when the Engineer determines that weather and soil conditions are unfavorable for such operations.

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, limestone and fertilizer shall be distributed uniformly over the prepared seedbed at the specified rate of application and then harrowed, raked, or otherwise thoroughly worked or mixed into the seedbed. Seed shall be distributed uniformly over the seedbed at the required rate of application, and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. The depth of covering shall be as directed by the Engineer. If two kinds of seed are to be used which require different depths of covering, they shall be sown separately.

When a combination seed and fertilizer drill is used, fertilizer may be drilled in with the seed after limestone has been applied and worked into the soil. If two kinds of seed are being used which require different depths of covering, the seed requiring the lighter covering may be sown broadcast or with a special attachment to the drill, or drilled lightly following the initial drilling operation.

When a hydraulic seeder is used for application of seed and fertilizer, the seed shall not remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted by the Engineer.

Immediately after seed has been properly covered the seedbed shall be compacted in the manner and degree approved by the Engineer.

When adverse seeding conditions are encountered due to steepness of slope, height of slope, or soil conditions, the Engineer may direct or permit that modifications be made in the above requirements which pertain to incorporating limestone into the seedbed; covering limestone, seed, and fertilizer; and compaction of the seedbed.

Such modifications may include but not be limited to the following:

1. The incorporation of limestone into the seedbed may be omitted on (a) cut slopes steeper than 2:1; (b) on 2:1 cut slopes when a seedbed has been prepared during the excavation of the cut and is still in an acceptable condition; or (c) on areas of slopes where the surface of the area is too rocky to permit the incorporation of the limestone.

2. The rates of application of limestone, fertilizer, and seed on slopes 2:1 or steeper or on rocky surfaces may be reduced or eliminated.

3. Compaction after seeding may be reduced or eliminated on slopes 2:1 or steeper, on rocky surfaces, or on other areas where soil conditions would make compaction undesirable.

1.7 MULCHING

All seeded areas shall be mulched unless otherwise indicated in the special provisions or directed by the Engineer.

It shall be spread uniformly at a rate of two tons per acre in a continuous blanket over the areas specified.

Before mulch is applied on cut or fill slopes which are 3:1 or flatter, and ditch slopes, the Contractor shall remove and dispose of all exposed stones in excess of 3 inches in diameter and all roots or other debris which will prevent proper contact of the mulch with the soil. Mulch shall be applied within 24 hours after the completion of seeding unless otherwise permitted by the Engineer. Care shall be exercised to prevent displacement of soil or seed or other damage to the seeded area during the mulching operation.

Mulch shall be uniformly spread by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

Mulch shall be held in place by applying a sufficient amount of asphalt or other approved binding material to assure that the mulch is properly held in place. The rate and method of application of binding material shall meet the approval of the Engineer. Where the binding material is not applied directly with the mulch it shall be applied immediately following the mulch application.

The Contractor shall take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and shall promptly remove any blockage to drainage facilities which may occur.

1.8 MAINTENANCE

The Contractor shall keep all seeded areas in good condition, reseeding if and when necessary, until a good lawn is established over the entire area seeded and shall maintain these areas in an approved condition until final acceptance of the Contract.

Grassed areas will be accepted when a 95 percent cover by permanent grasses is obtained and weeds are not dominant. On slopes, the Contractor shall provide against washouts by an approved method. Any washouts which occur shall be regraded and reseeded until a good sod is established.

Areas of damage or failure due to any cause shall be corrected by being repaired or by being completely redone as may be directed by the Engineer. Areas of damage or failure resulting either from negligence on the part of the Contractor in performing subsequent construction operations or from not taking adequate precautions to control erosion and siltation as required throughout the various sections of the specifications, shall be repaired by the Contractor as directed by the Engineer at no cost to the Owner.

1.9 COMPENSATION

All work covered by this section will be considered incidental to other payment items to which it relates and no separate payment will be made therefor.

TABLE I - APPLICATION RATES

A. *Lime and Fertilizer*

In the absence of a soil test, the following rates of application of limestone and fertilizer shall be:

1. 4,000 pounds limestone per acre
2. 1000 pounds 10-10-10 (N-P_20_5-K_20) fertilizer per acre and the remaining quantity applied when vegetation is three inches in height or 45 days after seeding, whichever comes first.

B. *Mulch*

Mulch shall be applied at the following rates per acre:

1. 3,000-4,000 pounds straw mulch, or
2. 1,500-2,000 pounds wood cellulose fiber.
3. 35-40 cubic yards of shredded or hammermilled hardwood bark
4. 1,200-1,400 pounds of fiberglass roving

C. *Seed*

The kinds of seed and the rates of application shall be as contained in this table. All rates are in pounds per acre. See Notes 1 and 2.

1. Fall and Winter (Normally August 1 to June 1)

   80 pounds of Ky-31 tall fescue and 15 pounds of rye grain

2. Summer (Normally May 1 to September 1)

100 pounds of Ky-31 tall fescue

NOTE:

1. On cut and fill slopes having 2:1 or steeper slopes, add 40 pounds of sericea lespedeza per acre to the planned seeding (hulled in spring and summer unhulled in fall and winter) plus 15 pounds of sudangrass in summer seeding or 25 pounds of rye cereal per acre in fall and winter seeding, if seeded September to February.

2. These seeding rates are prescribed for all sites with less than 50 percent ground cover and for sites with more than 50 percent ground cover where complete seeding is necessary to establish effective erosion control vegetative cover. On sites having 50 to 80 percent ground cover where complete seeding is not necessary to establish vegetative cover, reduce the seeding rate at least one-half the normal rate.

SECTION 02825 PLANTING

1.1 SCOPE OF WORK

A complete list of plants, including a schedule of quantities, and sizes is shown below. In the event that discrepancies occur between the quantities of plants indicated in the plant list and as indicated on the Drawings, the plant quantities indicated on the Drawings shall govern.

PLANT NAME	QUANTITY	SIZE	REMARKS
Pyrus Calleryana Bradford (Bradford Callery Pear)	7	3-3 1/2" Cal.	Ball and burlap Single Straight Leader Well-branched Well-matched

1.2 SUBSTITUTIONS

No substitution shall be accepted, except with the written permission of the ENGINEER.

1.3 QUALITY

All plants shall be typical of their species or variety. All plants shall have normal, well developed branches and vigorous root system. They shall be sound, healthy, vigorous, free from defects, disfiguring knots, abrasions of the bark, sunscald injuries, plant diseases, insect eggs, borers, and all other forms of infections. All plants shall be nursery grown. No bare root plants will be accepted.

1.4 MEASUREMENTS

Size and grading standards shall conform to those of the American Association of Nurserymen unless otherwise specified. A plant shall be dimensioned as it stands in its natural position. Plant material furnished shall be a fair average between the minimum and maximum sizes specified. Plants larger than specified may be used if acceptable to the ENGINEER prior to planting. Use of such plants shall not increase the Contract price. Large plants which have been cut back to the specified sizes will not be accepted.

1.5 PREPARATION OF PLANTS

In preparing plants for moving all precautions customary in good trade practice shall be taken. All plants shall be due to retain as many fibrous roots as possible. Balled and

burlaped plants shall have a solid ball of earth held in place securely by burlap and stout rope. Broken or loose balls will be rejected. Securely attach to all plants, bundles, or packages of plants of a single species and size, or plant container, labels stating the correct plant name and size. Labels shall be durable and legible in weather resistant ink.

1.6 DELIVERY

All plants shall be packed, transported and handled with utmost care to ensure adequate protection against injury. Any inspection certificates required by State and Federal Authorities shall accompany each shipment invoice or order of stock, and on arrival, be filed with the ENGINEER.

1.7 INSPECTION

No plant material shall be planted by the CONTRACTOR until it is reviewed by the ENGINEER or his representative at the site of the project. The ENGINEER or his representative shall be the sole judge of the quality and acceptability of the materials. All rejected material shall be immediately removed from the site and replaced with acceptable material at no additional cost to the OWNER.

1.8 TIME OF PLANTING

The CONTRACTOR shall state his planting when other divisions of this work, including placing of topsoil to finish grade, has progressed sufficiently to permit planting. Thereafter, planting operations shall be conducted under favorable weather conditions during the next season or seasons which are normal for such work as determined by accepted practice in the locality of the project. At the CONTRACTOR'S option and full responsibility planting operations may be conducted under unseasonable conditions without additional compensation.

1.9 LAYOUT

Planting shall be located where it is shown on the Drawings except where obstructions overhead or below ground are encountered or where changes have been made in construction. Prior to the excavation of planting areas or placing tree stakes, the CONTRACTOR shall ascertain the location of all utility lines, electric cables, and conduits, so that proper precautions may be taken not to disturb or damage any subsurface improvements. Should obstruction be found the CONTRACTOR shall promptly notify the ENGINEER or his representative who will determine an alternate location for the plant material. Necessary adjustment shall be acceptable to the ENGINEER or his representative.

1.10 SETTING PLANTS

No planting holes shall be dug until the proposed locations have been staked on the ground, by the CONTRACTOR, and until such locations have been reviewed by the ENGINEER'S

representative. Each tree shall be planted in an individual hole as specified for trees. All holes shall be dug with straight vertical sides and crowned bottoms, or as directed. All trees shall be set to ultimate finished grade, so that they will be left in the same relation to the surrounding grade as they stood before being moved. No filling will be permitted around trunks or stems. All ropes, wires, staves, etc., shall be removed from sides and tops of balls and removed from pit before filling in. Burlap shall be properly cut and removed from sides of balls. In the event that "rot proof" burlap or twine is used, the entire amount will be removed from the ball after the plant is set, being careful not to harm the root system. A layer of topsoil three inches thick shall be applied to the bottom of each hole and then lightly tamped. Excess excavation from all holes shall be disposed of by the CONTRACTOR.

1.11 TREES

All trees shall be centrally planted in holes at least two feet greater in diameter than their ball of earth. The depth of the hole shall be at least two feet and as much greater as is necessary to accommodate the roots so that when the tree is placed therein it will not be necessary to bring it to the proper finished grade. Topsoil shall be tamped under the edges of balled trees. Topsoil shall be backfilled in layers of not over nine inches in depth and each layer watered sufficiently to settle before the next layer is put in place. Enough topsoil shall be used to bring the surface to finished grade when settled. A slight "saucer" with a minimum of a 4" lip shall be formed around each tree to hold additional water. The CONTRACTOR shall take care to ensure that all plants shall stand straight and plumb so that all plants especially those trees planted in rows are uniformly vertical.

1.12 GUYING

All trees, shall immediately after setting to proper grade, be guyed with three sets of two strands No. 12 gauge malleable galvanized iron spaced equally about the tree. Each guy shall consist of guying cable attached to a turnbuckle for tightening and fastening to a ground anchor. Wires shall not come in direct contact with the tree, but shall be covered with rubber hose at points of contact. Wires shall be fastened in such a manner as to avoid pulling crotches apart. Stakes shall be of 2" x 2" lumber tree feet long or other material acceptable to the ENGINEER'S representative. All guy stakes shall be placed outside the perimeter of planting pits. Under no circumstances shall a tree be plumbed with extreme tightness of guy wires. Each guy shall be flagged with standard surveyor's plastic tape. The flag when tied in place shall have two tails, each 12" in length.

1.13 WRAPPING

The trunks of all trees shall be wrapped spirally with two thickness of tree wrap. Tree wrap shall be standard wrapping material, manufactured as an arboricultural tree wrapping paper, crepe surface, brown in color, with the two thicknesses being cemented together with bituminous material. Wrapping shall be applied from the base of the tree to the first branches and tied in place at the top, bottom, and at two foot intervals in between. Tie material shall be lightly tarred coarse sisal (lath) yarn.

1.14 MULCHING

After planting has been satisfactorily completed two inches of mulch shall be placed on the finished grade about all trees. The boundaries of this mulch shall be six inches greater in diameter than that of the hole. The mulch shall be mixed hardwood bark, shredded, and free of sticks and foreign material acceptable to the ENGINEER. Mulch shall be of such character as not to be easily displaced by wind.

1.15 PRE-EMERGENT HERBICIDE

Princep or equal shall be used as a pre-emergent herbicide. The premergence herbicide shall be applied evenly on the surface of the mulch at the manufacturer's recommended rate in all tree saucers after the mulch has been applied and firmed in place. Should weed or grass growth exist within these saucers it shall be removed and the soil and mulch smoothed and firmed, then the herbicide shall be placed on the surface, then sprinkled thoroughly with water. The rate of application shall comply with the manufacturer's recommendations.

1.16 WATERING

Thoroughly water each tree immediately after planting. Use water supplied by OWNER, suitable for irrigation, and free of substances harmful to plant life. The CONTRACTOR shall furnish hose and other equipment required for watering. Trees shall stand plumb and uniform after watering.

1.17 PRUNING AND REPAIR

All trees shall be neatly pruned and/or clipped to preserve the natural character of the plants, and in a manner appropriate to the particular requirements of each tree, and to the satisfaction of the ENGINEER. All accidental damage to trees occurring during the course of planting operations, which is not so great as to necessitate replacement of the tree, shall be promptly treated as required in accordance with recognized horticultural practices. No trees shall be clipped or pruned prior to delivery except with the permission of the ENGINEER.

1.18 CLEAN-UP AND SAFETY

During planting operations remove all rope, wire, burlap, empty containers and all other debris daily and deep the site neat at all times. All excess excavated topsoil or other excess soil shall be disposed of by the CONTRACTOR. Take special care to keep access roads and sidewalks cleared and mud and debris tracked by site vehicles. After planting operations are finished clean all paved areas which may have been strewn with soil or other material by washing. The CONTRACTOR shall not leave any plant hold open or unattended when an

unsafe condition exists without proper protective signals, barriers, etc., or in any manner present a hazard to pedestrians or vehicles on the site.

1.19 MAINTENANCE

During planting operations, continuing to initial acceptance, the CONTRACTOR shall maintain the planting in a healthy condition by spraying, weeding, replacing mulch, and exercising all corrective measures required to maintain a quality appearance and good plant vigor. Information necessary for proper maintenance of the installed plant material shall be supplied by the CONTRACTOR to the OWNER. Included shall be information on proper watering, fertilizing, pruning, pest control, maintenance of trees and any other related items necessary for healthy, vigorous and attractive plant growth.

1.20 OBSERVATION FOR BEGINNING THE GUARANTEE PERIOD

Observation of the plant to determine its completion for beginning the guarantee period, will be made by the ENGINEER, upon notice requesting such observation by the CONTRACTOR at least 10 days prior to the anticipated date. All trees must be alive and healthy in order to be considered complete. Successful completion of the planting operations to the ENGINEER'S satisfaction shall constitute initial acceptance.

1.21 FINAL OBSERVATION AND REPLACEMENTS

Observation of the trees to determine final acceptance will be made at the conclusion of the guarantee period by the ENGINEER. No trees will be accepted unless they are alive and healthy. Trees which have lost thirty-three percent of their branches shall be replaced unless, in the opinion of the ENGINEER, they show promise of vigorous growth and recovery. Replacement plant material shall be subject to all requirements and guarantees specified herein. The cost of such replacement(s) shall be borne by the CONTRACTOR and shall be included in his bid price for this section of the work. Upon final acceptance, OWNER will assume responsibility for maintenance of project.

1.22 GUARANTEE

All trees shall be guaranteed to remain alive and healthy for a period of one year after initial acceptance. Replacement shall be guaranteed an additional one year from the date of their satisfactory installation.

1.23 COMPENSATION

All work cover by this section will be considered incidental to other payment items to which it relates. No separate payment will be made therefor.

SECTION 02900 CONCRETE

1.1 SCOPE:

The work covered by this bid item consists of furnishing all the necessary material, labor and equipment for the encasement, the removal and replacement of existing concrete pavement and the construction of restraining blocks at locations called for on the plans or designated by the Engineer.

1.2 SUPPLEMENTARY SPECIFICATIONS:

Except as otherwise noted the STANDARD SPECIFICATIONS FOR ROADS AND STRUCTURES as prepared by the State of North Carolina Department of Transportation dated January 1, 1990, or latest revision thereof, shall govern all work to be performed under the Item.

1.3 MATERIALS

Cement	ASTM C150, Type I
Fine Aggregate	Clean Natural Sand ASTM C33
Coarse Aggregate	Crushed Rock, Washed Gravel, or other inert granular material conforming to ASTM 33
Water	Clean and free from deleterious substances
Air-Entraining Agent	ASTM C260
Reinforcing Steel	
Bars	ASTM C615, Grade 60
Welded Wire Fabric	ASTM A185 or A497
Bar Supports	CRSI Class C, plastic protected, or Class E, stainless steel protected
Forms	
Plywood	PS1, waterproof, resin- bonded, exterior type, Douglas fir

Lumber	Straight, uniform width and thickness and free from knots, offsets, holes, dents and other surface defects.
Form Oil	Light colored paraffin oil or other acceptable non- staining material
Polyethylene Film	PS17, 6 Mil.
Membrane Curing Compound	Fed Spec TT-C-800, Type I, Class 1; min 18 per cent solids; nonyellowing; unit moisture loss 0.039 Gm/Cm {2} max; Gillford- Hill "Sealco 800", ProSoCo "Kure and Seal", Protex "Acrychlor", or Sonneborn "Kure-N-Seal".

1.4 CONSTRUCTION REQUIREMENTS:

PRELIMINARY REVIEW: The source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the Engineer for review before any concrete is placed.

LIMITING REQUIREMENTS: Unless otherwise specified, concrete shall be controlled within the following limiting requirements.

MINIMUM CEMENT FACTORS: The quantity of portland cement, expressed in pounds per cubic yard, shall be not less than that shown in the following table:

	Course Aggregate Size From No. 4 Sieve To		
Concrete Slump	1/2"	3/4"	1"
2 inches	639	602	573
3 inches	658	620	592
4 inches	677	639	611
5 inches	696	658	630
6 inches	714	677	649

AGGREGATES: The maximum total combined aggregate weight and the maximum fine aggregate weight in pounds per hundred pounds of cement shall be as follow:

	Maximum Total Aggregate Coarse Aggregate Size			Maximum Fine
Concrete Slump	1/2"	3/4"	1"	Aggregate
2 inches	457	500	537	229
3 inches	436	479	511	218

4 inches	415	457	489	207
5 inches	394	436	468	202
6 inches	372	415	447	191

Note: The weight stipulated above are maximum and not authorized weights. Actual weights used shall be those necessary to produce consistency.

TOTAL WATER CONTENT: Total water content of concrete shall not exceed 6.5 gallons of water per hundred pounds of cement in the mix.

SLUMP: Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless other wise authorized by the Engineer, slump shall not exceed 4 inches.

TOTAL AIR CONTENT: The total volumetric air content of concrete after placement shall be 6 percent plus or minus one percent.

STORAGE OF MATERIALS: Cement shall be stored in suitable moisture proof enclosures. Cement which has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with ground shall not be used.

Reinforcing steel shall be carefully handled and shall be stored on supports which will keep the steel from contact with the ground.

BATCHING AND MIXING: Concrete shall be furnished by an acceptable ready-mixed concrete supplier and shall conform to ASTM C94.

CONSISTENCY: The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

DELIVERY TICKETS: A delivery ticket shall be prepared for each load of ready mixed concrete. A copy of each ticket shall be handed to the Engineer by the truck operator at the time of delivery. Tickets shall show the quantity delivered, the amount of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

PLACEMENT: Concrete shall be conveyed to the point of final deposit by methods which will prevent the separation or loss of ingredients. During and immediately after placement, concrete shall be thoroughly compacted, worked around all reinforcements and embedments, and worked into the corners of the forms. Concrete shall be compacted

by immersion-type vibrators, vibrating screeds, or other suitable mechanical compaction equipment.

TESTING: An air content test shall be made from one of the first three batches mixed each day. The Contractor shall provide all equipment and supplies necessary for testing.

REINFORCEMENT: Reinforcements shall be accurately formed and positioned and shall be maintained in proper position while the concrete is being placed and compacted. Unless otherwise indicated on the drawings, the details of fabrication shall conform to ACI 315 and 318. In case of conflict, ACI 318 shall govern.

FORMS: Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall be substantial and sufficiently tight to prevent leakage of mortar and shall be maintained in proper position and accurate alignment.

Forms for pavement, curbs, or gutters shall be made of steel and shall be supported on thoroughly compacted earth. The top face of pavement forms shall not vary from a true plane more than 1/4 inch in 10 feet.

Forms shall be thoroughly cleaned and oiled before concrete is placed.

Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 4 inches.

FORM TIES: Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.

EDGES AND CORNERS: Chamfer strips shall be placed in forms to bevel all salient edges and corners except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Unless otherwise noted, bevels shall be 3/4 inch wide.

FORM REMOVAL: Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

FINISHING: Recesses from form ties shall be filled flush with mortar. Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that will be in contact with earth backfill.

Slabs, pavement, curbs, and other unformed surfaces shall be screeded and given an initial float finish followed by additional floating or belting. Unformed surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of surface.

Initial floating shall be followed by belting or a second floating at the time of initial set. The belting or second floating shall produce a finish of uniform texture and color. The completed finish for unformed surfaces shall be the finish produced by the belting or second floating.

CURING: Concrete shall be protected from loss of moisture by water saturation or membrane curing for at least 7 days after placement.

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Unformed surfaces shall be covered with polyethylene film, tarpaulins, or sand to retain the water. Water shall be applied as often as necessary to keep the concrete saturated for the entire curing period.

Chlorinated rubber type membrane curing compound may be used in lieu of water curing on concrete which will not be covered later with mortar or additional concrete. Membrane curing compound shall be spray applied at a coverage of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces before they dry out. curing compound shall be suitably protected against abrasion during the curing period.

Concrete shall be protected against freezing for at least 7 days after placement.

REPAIRING DEFECTIVE CONCRETE: Defects in concrete surfaces shall be repaired to the satisfaction of the Engineer. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

Concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured.

CONCRETE FOR PIPE BLOCKING AND ENCASEMENT: Concrete for buried blocking and encasement of pipe shall conform to the limiting requirements specified

here in before, except that the air-entraining agent may be omitted and the cement factor and total water content may be adjusted to provide a minimum compressive strength of 3000 PSI at 28 days. Concrete shall have a slump of not less than 2 inches nor more than 5 inches when placed.
Concrete for curb, curb and gutter, sidewalks, driveway and concrete medians must have a minimum compressive strength of 4,00o PSI at 28 days.

EXCAVATION: Excavation for the installation of this Bid Item shall be in accordance with the applicable sections of these Specifications.

INSTALLATION: The installation of this bid item shall be in accordance to the requirements outlined in other applicable sections of these specifications and in strict accordance with current requirements and standard details of the City of Asheville.

1.5 METHOD OF MEASUREMENT:

The quantity of concrete will be the actual number of cubic yards and/or square yards which have been incorporated into the completed and accepted work in accordance with all pertinent items included in the bid item list of the contract documents .

1.6 BASIS OF PAYMENT:

The quantity of concrete and the number of reinforced concrete anchors measured as provided in subsection 1.5, will be paid for at the contract unit price for the respective item. The price and payment will be full compensation for all work covered by this section including but not limited to producing, transporting, forming, reinforcing, finishing, curing, maintaining and making any necessary repairs or corrections to the cast-in-place concrete that may become necessary.

Payment will be made under:

A. Misc. 3000 PSI Plain Concrete for pipe blocking & Encasement per cubic yard.
B. Misc. 4000 PSI Structural Concrete per cubic yard.

1.1 SCOPE

This section shall govern for the construction of all types of structures involving the use of structural concrete, except where the requirements are specifically waived or revised by another section of the specifications. All concrete structures shall be constructed in accordance with the design requirements and details shown on the plans, and in conformity with the requirements of this specification and any special provisions pertaining thereto.

1.2 MATERIALS

1.2.1 Concrete: All concrete shall conform to the provisions of Section 02900, Portland Cement Concrete for Structures. The class of concrete for each type of structure, structural element, or concrete item shall be as specified on the plans or in the special provisions.

1.2.2 Expansion Material: Expansion material shall comply with the following requirements for the material involved.

(a) Performed Joint Filler - Performed joint filler shall consist of performed material composed of cane or other fibers of a cellular nature, securely bound together and uniformly saturated with a suitable bituminous binder, and shall comply with the requirements of AASHTO M-213, ASTM D-1751.

(b) Cast-in-Place Rubberized Asphalt Joints - This material shall meet the requirements of AASHTO Specification M173, ASTM D-1190, except as otherwise provided.

(c) Roofing Felt - Where roofing felt is specified it shall be 30-pound type, asphalt saturated roofing felt.

(d) Plastic Waterstops - Flexible waterstops shall be of polyvinylchloride, and shall be of the size and type specified on the plans. Unless otherwise specified on the plans, the material shall conform to the Corps of Engineers' Specifications No. CRD-C572-60A.

1.2.3 Liquid Membrane Forming Compounds: Liquid curing compounds shall conform to ASTM C-309 Type 2 (white pigmented). The method of application shall be in accordance with Subsection 20.4.10.

1.3 EQUIPMENT

1.3.1 Falsework: Detailed plans for falsework, cofferdams, or centering shall be supplied to the Engineer upon request, but in no case shall the contractor be relieved of responsibility for results obtained by the use of said plans.

1.3.2 Vibrators: Vibrators shall be of a type approved by the Engineer and shall be in good operating condition. The contractor shall maintain for each pour not less than two vibrators including two sources of power throughout the pour, in order that one may be available in event of failure of the other.

1.3.4 Tremie: A tremie used in depositing concrete under water shall consist of a metal tube, other than aluminum, having a diameter of not less than 10 inches, constructed in sections having flanged couplings fitting with water-tight gaskets.

1.3.5 Kettles for Cast-in-Place Rubberized Asphalt Joint Material: Kettles shall conform to Section 702.09 of the SCDHPT Standard Specifications for Highway Construction, 1973 edition or latest revision thereof.

1.4 CONSTRUCTION REQUIREMENTS

1.4.1 Falsework: For designing falsework and centering a weight of 150 pounds per cubic foot shall be assumed for green concrete. All falsework shall be designed and constructed so as to provide the desired rigidity. The maximum allowable deflection shall be limited to 1/360 of the span. The Engineer may require the contractor to employ screw jacks, hardwood wedges, and hardwood camber strips to compensate for deflection and settlement in the falsework either before or during the placing of concrete.

Centering and falsework shall be erected with sufficient camber to compensate for settlement under the weight of the concrete, so that the complete structure or part shall have the vertical and horizontal curvature or alignment specified, or indicated on the plans.

Centering shall not be removed until the expiration of periods stated in Subsection 1.4.8

1.4.2 Forms:

(a) General - All forms shall be of wood or metal and shall be built mortar-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. The interior dimensions of the forms shall

be such that the finished concrete shall be of the shape and dimensions shown on the plans. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the lumber. The forms shall be substantial and unyielding and the design shall take into account the effect of vibration of concrete as it is placed and also the rate at which the forms will be filled with concrete.

(b) Wood Forms - Wood forms shall be of dressed lumber or plywood. Dressed lumber shall be of good quality, and free from imperfections which would affect the strength or impair the finished surface of the concrete. The responsibility for their adequacy shall rest with the contractor.

Chamfer strips shall be used at corners; fillets shall be placed in concrete where shown on the plans. All chamfer strips shall be machine surfaced. Forms shall be so designed and constructed that they may be removed without injuring the concrete.

Metal anchors, bolts, struts, etc. to be used within space to be occupied by the concrete shall be designed so that no metal will remain closer than one inch to the surface. Wire form ties of special design with a weakened section not less than 3/4 inch back from the concrete face may be used in places of minor pressure, but such ties shall be proved with wooden or plastic cones 3/4 inch deep so as to assure the breaking of the tie at least 3/4 inch inside the face of the concrete.

Cavities left by washers or cone nuts shall be roughened to provide bond and then plugged with cement mortar and the surface left uniform in color. If the plug shows a crack after setting, it shall be removed with the cavity replugged. The plugged surface shall be floated flush with the adjacent surface. Wire ties in forms other than those described above will not be permitted.

Other devices may be submitted for consideration, but shall not be used without the written approval of the Engineer.

(c) Metal Forms - The foregoing specifications for forms as regards to design, mortar tightness, fillets and chamfers, bracing, alignment, removal, reuse and oiling shall apply with equal force to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow

removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Special care shall be exercised to keep metal forms free from rust, grease or other foreign matter that will tend to discolor the concrete. Metal forms shall be provided with an adjustable metal section or occasional sections where wooden forms may be inserted to compensate for inaccuracies in measurements.

(d) Construction: All forms shall be set and maintained true to the line, and grade until the concrete has gained sufficient strength to permit their removal. Forms shall remain in place for periods which are hereinafter specified. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer may order the work stopped until the defects have been corrected.

Patchwork arrangements of forms, using small pieces, will not be permitted, and joints in all lumber other than plywood shall be staggered.

For narrow walls, columns, etc. where the bottom of the forms or construction joint is inaccessible, the lower form boards shall be left loose so they can be removed for cleaning out extraneous material immediately before placing the concrete, or suitable openings and methods of closing shall be provided for this purpose.

All forms shall be treated with an approved oil or saturated with water immediately before placing the concrete. For rail members or other members with exposed faces, the forms shall be treated with an approved oil to prevent the adherence of concrete. Any material which will adhere to or discolor the concrete shall not be used. Used motor oil is not acceptable for oiling forms.

Forms shall be inspected during construction and prior to placing of the concrete therein. All dimensions shall be checked carefully and any errors, bulges, warping or other defects remedied before any concrete is placed.

1.4.3 Handling and Placing Concrete: All concrete shall be placed during daylight, and the placing of concrete shall not be started unless it can be completed and finished during daylight, except when an adequate lighting system is provided and other arrangements are made beforehand. No concrete shall be placed until the depth, character, and water conditions of the foundations, the adequacy of falsework and forms, the absence of debris in the forms, the

alignment and grade of the forms, the conditions of the construction joints, and the condition and spacing of the reinforcing steel have been inspected and approved by the Engineer.

No concrete shall be deposited under water unless permitted by the plans or special provisions or directed in writing by the Engineer. During the period between April 15 and October 15, the placing of concrete for bridge floor slabs shall begin as soon after daylight as practicable in order that the entire concreting operation can be accomplished during the cooler hours when forms, beams, and reinforcing bars are at ambient air temperature.

Placing concrete shall be so regulated that the pressures caused by the wet concrete shall not cause distortion of the forms.

If any concrete is found to be defective, it shall be removed or repaired as directed by the Engineer without extra compensation.

No concrete shall be used which does not reach its final position in the forms within 75 minutes after water or cement is first added to the mix, except that this time may be extended to two hours where concrete with an approved water reducing retarder is used.

Concrete shall be placed in such a manner as to avoid segregation of the materials and the displacement of the reinforcement. The use of chutes of over 500 feet in length for conveying concrete from the mixer to the forms will be permitted only on written authority of the Engineer.

Open troughs, pipes, and chutes shall be of metal or metal lined (other than aluminum). Where steep slopes are necessary, the chutes shall be equipped with baffle boards or be in short lengths that change the direction of movement.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the concrete already in place.

Concrete shall not be dropped a distance of more than five feet unless flexible metal or rubber-like pipes are used, and special care shall be taken to fill each part of the form by depositing the concrete as near its final position as practicable. The coarse aggregate shall be worked back from the face of the forms and the concrete forced around the reinforcement without displacing the bars.

Concrete shall be compacted by continuous working with a suitable tool or by the use of an internal vibrator. If vibration cannot be done effectively because of the obstruction of reinforcement or other cause, compaction shall be accomplished by vibrating the form in a manner satisfactory to the Engineer.

Concrete shall be placed in horizontal layers not more than 18 inches thick except as hereinafter provided. when less than a complete layer is placed in one operation, it shall be terminated in a vertical plane. To prevent injury to the green concrete and avoid surfaces of separation between the batches, each batch in a layer shall be placed and compacted before the preceding batch has taken initial set.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectional material to a sufficient depth to expose sound concrete. To avoid visible joints as far as practicable upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, inset form work shall be used to form the preceding layer so that the thickness of the edge shall be satisfactory to the Engineer.

Construction joints shall be placed only at the locations shown on the plans or as permitted by the Engineer.

1.4.4 Pumping: Placement of concrete by pumping will be permitted only if specified in the contract or if authorized in writing by the Engineer. The equipment shall be so arranged that vibration will not damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

1.4.5 Vibration: All 3,000 psi, 4,000 psi, and 5,000 psi concrete shall be vibrated by internal vibrators as described below.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and

withdrawn from the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

Vibration shall be performed in a manner that will avoid contact with forms and ties as much as is practicable.

1.4.6 Depositing Concrete Under Water: Concrete when placed under water shall conform to Section 420 of the NCDOT Standard Specifications for Roads and Structures, 1990 edition or latest revision thereof.

1.4.7 Bonding Construction Joints: No construction joints will be permitted except those shown on the plans or those approved by the Engineer. Approved bulkheads and keys shall be provided as specified below:

In joining fresh concrete to that which has already set, the concrete in place and the adjacent forms shall have their surfaces thoroughly cleaned and all chalky, loose, or foreign materials removed, and the reinforcing steel shall be cleaned. In inaccessible places, such as small columns and thin walls, the surface shall be cleaned prior to the setting of the forms. Immediately before placing the new concrete, the forms shall be drawn tight against the concrete already in place, the old surface shall be thoroughly wetting and coated with a thin coating of mortar, a neat cement or other suitable bonding material.

When practicable, the top surface of the concrete in place shall be washed with a strong water jet just after the initial set has taken place, so as to remove the chalky material and leave the aggregates bare and thus eliminate the necessity for cutting over the old surface after final set has taken place.

When shown on the plans, the construction joint shall be made

resistant to shear by the placing of raised keys on the surface of the concrete first poured. In general, the width of the raised key shall be about one-third of the total width of the section and shall occupy about the middle third of the section, and the height of the raised key shall be about one-third of its width. Steel dowels may, at the discretion of the Engineer, be used in lieu of raised keys.

Exposed construction joints shall be chamfered if directed. If required, new concrete deposited above the construction joint shall contain excess mortar for a sufficient depth so as to avoid honeycombed areas.

In the repair of concrete or where necessary to add thin sections of mortar or concrete to old concrete, the use of suitable type of epoxy resin compound to secure an adequate bond of new concrete to old concrete may be required. The type of epoxy compound shall be approved by the Engineer before being used.

1.4.8 Removal of Falsework and Forms: In the determination of the time for the removal of the falsework and forms, consideration shall be given to the location and character of the structure, the weather, and other conditions influencing the setting of the concrete and the materials used in the mix.

Falsework centering and falsework supporting any concrete work shall not be removed or wedges loosened without the consent of the Engineer. Such consent of the Engineer shall not relieve the contractor of full responsibility for the safety of the work.

The following requirements shall govern the removal of the falsework:

(a) With the exception of high early strength concrete, no falsework or supporting forms shall be removed from any girder, slab, arch or other members subject to direct bending stress, and no forms inside the barrels of culverts shall be removed for a period of at least seven days after the concrete is placed, and for such additional times as may be deemed advisable by the Engineer.

As soon as the 7 day period has elapsed and the concrete has developed a compressive strength of 1800 pounds per square inch, or a modulus of rupture of 500 pounds per square inch as determined by laboratory tests of test specimens of the concrete made, cured and tested; falsework, centering and

forms supporting concrete arches, slabs, beams or other members subject to direct bending stress, and forms inside of culvert barrels may be removed when permitted by the Engineer. Specimens of concrete for testing shall be taken from the concrete mix going into the work and shall be taken by the engineer. Test specimens shall be cured under similar and not more favorable conditions than the most unfavorable conditions for the concrete which they represent.

(b) In cases where test beams or cylinders have not been made, and in cases where apparatus is not available for making the test for determining the modulus of rupture or compressive strength, the falsework, centering and forms supporting any girder, slab, beam, arch or member subject to direct bending stress, or forms inside concrete barrels, shall not be removed until the minimum curing time has elapsed as shown in the table below, during which time, the average temperature shall be determined from air temperature readings taken by the Engineer at 7:00 a.m. and 7:00 p.m. each day during the curing period. The curing time shall be reckoned from the time when the last concrete was placed in the member considered.

The number of days of 24 hours each in which the temperature falls below 40 degrees Fahrenheit shall be added to the days shown in the following table to obtain the required curing time. Forms for ornamental work, railings, parapets, columns and vertical surfaces that do not carry loads shall be removed in from 18 to 48 hours, unless otherwise directed or approved by the Engineer.

REQUIRED CURING TIME BEFORE REMOVAL OF FORM AND FALSEWORK*

Portland Cement Concrete
(When no test beams or cylinders are available)

ITEM	AVERAGE TEMPERATURE DURING CURING PERIOD		
	40 Degrees-54 Degrees F.	55 Degrees-69 Degrees F.	70 Degrees or More
Box culverts and arches, Spans 10 feet or less. Incl. floor and steel	18 days	11 days	7 days
Box culverts and arches, Spans			

over 10 ft. to and incl. 20 ft.	18 days	12 days	8 days
Arches over 20 ft. span	21 days	15 days	12 days
Slab and girders, spans 10 ft. or less incl. floors on steel			

ITEM	AVERAGE TEMPERATURE DURING CURING PERIOD		
	40 Degrees- 54 Degrees F.	55 Degrees- 69 Degrees F.	70 Degrees or More
spans	18 days	11 days	7 days
Slab and girder spans, spans over 10 ft. to and incl. 20 ft.	18 days	12 days	8 days
Slab and girder spans over 20 ft. span	21 days	15 days	12 days
Caps of concrete pile bents, and open column piers and abutments	18 days	11 days	7 days
Caps of piers with copings extending 3 ft. or less beyond web walls	7 days	5 days	3 days
Overhanging curbs or slabs on Conc. D.G. span, and rails in handrails	7 days	5 days	3 days
Walls, columns, vertical sides of beams and girders	18 to 48 hours as directed by the Engineer		

* When an approved brand of high early strength cement is used, no falsework or supporting forms shall be removed for a period of at least five (5) days, not counting the days of 24 hours each, in which the air temperature falls below 40 degrees Fahrenheit.

1.4.9 Opening to Traffic: The following requirements shall govern the time of opening a completed structure to traffic, or the application of extraneous loads:

(a) With the exception of high early strength concrete, no structure shall be opened to traffic, and no structure or portion of structures shall be subjected to extraneous loads such as contractor's equipment or

materials for a period of at least 10 days.

As soon after the 10 day period has elapsed and the last concrete placed in the structure (except handrails not designed as load supporting members) has developed a compressive strength of 3000 pounds per square inch, or a modulus of rupture of 500 pounds per square inch, as determined by laboratory tests of test specimens of the concrete made, cured, and tested the structure may be opened to traffic not greater than the design load limits or may be subjected to extraneous loads not exceeding such design load limits, when permitted by the Engineer. Specimens of concrete for testing shall be taken from the concrete mix going into the work and shall be taken by the Engineer. Test specimens shall be cured under similar and not more favorable conditions than the most unfavorable conditions for the concrete which they represent.

(b) In cases where test beams or cylinders have not been made, and in cases where apparatus is not available for making the test for determining the modulus of rupture or compressive strength, the structure shall not be opened to traffic or subjected to extraneious loads until the minimum curing time has elapsed as shown in the following table, during which time, the average temperature shown have prevailed. The average temperature shall be determined from air temperature readings taken by the Engineer at 7:00 a.m. and 7:00 p.m. each day during the curing period. The curing time shall be reckoned from the time when the last concrete was placed in the structure, with the exception of handrails not designed as load supporting members.

REQUIRED AGE OF CONCRETE BEFORE APPLICATION OF EXTRANEOUS LOADS ON CONCRETE STRUCTURES*

(When no test beams or cylinders are available)

ITEM	AVERAGE TEMPERATURE DURING CURING PERIOD		
	40 Degrees-54 Degrees F.	55 Degrees-69 Degrees F.	70 Degrees or More
Box and arch culverts, spans 10 ft. or less	21 days	13 days	10 days
Box and arch culverts, over 10 ft. to and incl. 20 ft.	22 days	14 days	11 days
Arches over 20 ft. span	23 days	18 days	14 days

Slab and girder spans, 10 ft. or less incl. floor on steel spans	21 days	13 days	10 days
Slab and girder spans, over 10 ft. to and incl. 20 ft.	22 days	14 days	11 days

ITEM	AVERAGE TEMPERATURE DURING CURING PERIOD		
	40 Degrees- 54 Degrees F.	55 Degrees- 69 Degrees F.	70 Degrees or More
Slab and girder spans over 20 ft.	23 days	18 days	14 days
Caps on concrete pile bents, open column abutments and piers concentrated loads, as produced by steel super-structures	18 days	11 days	7 days
Distributed loads, as pro-duced by concrete deck super-structures	3 days	2 days	1 day
Concrete piles moved or driven	28 days	21 days	21 days
Concrete (HES) piles, moved or driven	7 days	5 days	3 days
Backfill against abutments or retaining walls	14 days	10 days	7 days

* When an approved brand of high early strength cement is used, the curing time required before the application of extraneous loads on concrete structures may be reduced to 1/2 the number of days shown in the table, with a minimum time of five days, except for 3,000 psi concrete for piles.

The number of days of 24 hours each in which the temperature falls below 40 degrees F. shall be added to the days shown in the table above, to determine the elapsed time after the last concrete was placed in the bridge, or bridge member under consideration, before extraneous loads are applied or the structure opened to traffic. Contractor's equipment used in backfilling and in passing over a structure will be considered as traffic.

Falsework and centering shall be removed in such a manner and sequence as to permit the concrete to uniformly and gradually take the stresses due to its own weight. In general, the order in which wedges and supports are removed shall

provide for the removal of those under floor slabs and transverse beams first, starting at the center of the span and working both ways, and then for the removal of those under longitudinal girders and beams also starting at the center and working both ways simultaneously.Forms shall be removed with care so as not to deface the

structure. Forms shall always be removed from the sides of columns and piers before removing the falsework or centering beneath girders, beams, or other members which they will support, so that the quality of the concrete may be inspected. The side forms for arch rings shall be removed before the members of the structure which they support are poured or placed so that the quality of the concrete may be inspected.

No extension of time to complete the work will be granted due to falsework remaining in place during the curing of the concrete.
Falsework supporting concrete beams, slabs, and brackets that in turn will support sidewalks, concrete railing, etc. shall be struck before the sidewalk, concrete railing, etc. are cast.

1.4.10 Concreting in Cold Weather: No concrete shall be placed when the atmospheric temperature is below 35 degrees Fahrenheit within 48 hours, except upon written permission of the Engineer, and such permission will not be granted until satisfactory provisions have been made to protect the work. Should the temperature drop below 30 degrees Fahrenheit while concrete is being placed or before it had hardened sufficiently to prevent injury from cold, the contractor shall provide sufficient housing and heating apparatus to enclose and protect the structure in such a way that the air surrounding the fresh concrete can be kept at a temperature above 50 degrees Fahrenheit for a period of three days after the concrete is placed.

Should the contractor wish to secure permission to place concrete at his own risk when the temperature threatens to drop below 25 degrees Fahrenheit, he shall supply such housing and heating apparatus as stoves; or steam equipment and the necessary fuel; or he shall provide suitable insulated curing blankets to prevent injury from the cold. When dry heat is used, means of maintaining atmospheric moisture shall be provided. The temperature of the concrete shall be not less than 50 degrees Fahrenheit at the time of placing in the forms. In cases of extremely low temperature, the Engineer may, at his discretion, raise the lower limiting temperatures for water and mixed concrete.

1.4.11 Temperature Requirements: The concrete temperature at the time of placing in the forms shall not be less than 55 degrees Fahrenheit nor more than 90 degrees Fahrenheit. The temperature of heated concrete for use in cold-weather concreting shall not be less than 55 degrees Fahrenheit and not

more than 80 degrees Fahrenheit at the time it is placed in the forms.

1.4.12 Curing Concrete: All freshly placed concrete shall be protected from rapid drying due to wind by installing suitable windbreakers if so desired by the Engineer. Freshly poured surfaces shall be kept saturated with water for at least four days, or shall be covered with cotton mats or burlap mats as soon as practicable after pouring and kept wet for at least four days. For bridge decks where a water reducing admixture is not used, the deck surface shall be cured for a period of at least seven (7) days. If desired by the contractor, freshly poured concrete floor slabs may be cured by covering with one layer of saturated burlap, lapped a minimum of six inches, and covered with burlap-polyethylene curing and kept in place at least four (4) days. Burlap-polyethylene mats shall be made from nine (9) ounce (minimum) burlap suitable for curing concrete and impregnated on one side with a 0.004 inch (minimum film of white opaque polyethylene. Interim precautions to ensure thorough curing of fresh concrete shall be taken by the contractor as directed by the Engineer.

Polyethylene sheeting may be used for curing concrete columns provided extreme care is taken to ensure that the overlapping edges of the adjacent wraps and the excrement edges of the sheeting are sealed and that a saturated humidity is maintained at all times inside the enclosure.

In the curing of miscellaneous concrete items such as culvert slabs and walls, bridge footings and other items not exposed to public view, the contractor may, at his option, use a membrane curing compound complying with the requirements of Subsection 20.2.3. The curing compound shall be applied as soon as the finishing of the concrete surface has been completed and shall be applied uniformly at a rate of at least one gallon to 150 square feet, and until the entire surface has a solid and vapor-tight coating of the curing compound. The compound shall be applied by means of a spray which shall be held not further than two (2) feet from the concrete surface, and the spray protected from the wind, if necessary, by suitable means. Provision shall be made to keep the spray nozzle and other spraying equipment clean at all times.

If rain falls on the newly sprayed surface before the film has sufficiently dried, the surface shall be immediately resprayed to the specified thickness. Where the curing compound is inadvertently applied to surfaces against which new concrete is to be cast, including projecting reinforcing steel, the material shall be completely removed by the use of steel wire brushes or by other means approved by the Engineer.

The sprayed surface film shall be protected from abrasion or damage for at least three (3) days. The placing of forms, lumber, reinforcing steel,

equipment, or unnecessary walking on the surface will not be allowed until the film is at least three days old.

1.4.13 Concrete Joints: Expansion and contraction joints in concrete structures shall be provided as shown on the plans.

a. Friction Joints - When roofing felt is used, the supporting or first formed concrete surface shall be true, smooth, and parallel to the direction of movement. Care shall be taken in cutting, placing, and holding the roofing felt against this surface so that it will lie smooth, fit snug and not become displaced or damaged during concreting. The roofing felt shall be held in place by the forms or by asphalt cement and shall be carried well beyond the area of contact, then cut back after the forms are stripped and all rubbing and finishing near the joint completed; after which the entire joint shall present a neat workmanlike appearance; with absolutely no contact between the concrete on each side of the joint and with the joint free to move in the proper direction and the required distance.

b. Filled Compression Joints - Filled compression joints shall be made with asphalt or premolded filler, or both, as indicated on the plans or in the special provisions or as directed by the Engineer, conforming to the requirements of Subsection 1.2.2.

In all cases the joint filler shall be cut to fit exactly, out of the least number of pieces practicable, and shall completely fill the space shown on the plans. The various pieces in any one joint must be fastened together in an approved manner. Loose fitting or open joints between sections of filler or between filler and forms, or joints made up with small strips will not be permitted. Cracks between sections shall be filled or caulked with suitable material to prevent mortar from entering the joints in the expansion material. The material shall be held in place by asphalt cement or other suitable means.

c. Special Expansion Joints - Special types of expansion joints may be used when so specified on the plans.
The cost of all materials for expansion joints such as asphalt roofing, felt, bituminous felt, neoprene pads, neoprene seals, rubberized asphalt, bronze or other type of expansion plates, joint sealing compound, copper flashing, etc. shall be included in the contract unit price for concrete.

1.4.14 Ordinary Surface Finish: All concrete shall be thoroughly worked during the operation of placing by means of suitable tools. The working

shall be such as to force the coarse aggregate from the surface and thoroughly work the mortar against the forms to produce a smooth finish free from water-pockets, air-pockets, sand streaks, or honeycomb.

As soon as the concrete has set the required time, the forms shall be removed and all depressions resulting from the removal of metal ties, and all other holes and rough places carefully pointed with a mortar of sand and cement. The surface of all such pointed surfaces shall be made flush with the adjacent surface by means of a wooden float before setting occurs.

1.4.15 Rubbed Finish: As soon as the ordinary surface finish has set sufficiently to permit, the entire surface shall be thoroughly wet with a brush and rubbed with a No. 16 carborundum stone or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and projections, producing a smooth, dense surface, without pits or irregularities. The material which, in the above process, is ground to a paste, shall be carefully spread or brushed uniformly over the entire surface and allowed to take a reset. The above described procedure is called the "first rub." Immediately after the first rub is completed, the surface shall be covered and kept covered for at least two days, or until the curing is complete.

The "second rub" to produce the final finish shall be thoroughly wet with a brush and rubbed with No. 30 carborundum stone or an abrasive of equal quality. This rubbing shall continue until the entire surface is of a smooth texture and uniform color. The surface shall then be striped evenly with a brush so as to remove excess paste, and the surface left smooth and with only enough paste to obtain the desired color.

Any part of the structure which is disfigured by the drip from the rubbing shall be thoroughly cleaned.

1.4.16 Alternate Applied Surface Finish

(a) General - If allowed in the contract, a brushed-on surface finish may be applied to all concrete surfaces required to receive the "rubbed" finish, using one brushed-on coat where a one-rub finish is specified, and two brushed-on coats where a two-rub finish is specified. The brushed-on surface finish shall be in lieu of the specified rubbed finish. The same type finish, either the brushed-on or the rubbed finish, shall be used throughout the structure.

(b) Material - The material used for the brushed-on finish shall be predominately of Portland cement, with special additives, and shall meet the requirements of Federal Specifications TT-P-0035. The material shall be specially manufactured for the purpose of

waterproofing exterior concrete surfaces, and also for the purpose of enhancing the appearance of the concrete surface. The final color of the applied finish shall be pearl gray, or near that of good quality cured natural concrete. The proposed material for the brushed-on finish must meet the approval of the Engineer prior to its application.

(c) Application - All surfaces to receive the brushed-on surface finish shall first be given the ordinary surface finish as required in Subsection 1.4.12. The brushed-on finish shall not be used to cover up defects in the concrete surface. All necessary repair work must be done prior to the application of the surface finish. Membrane curing compound shall not be used on surfaces to be finished. The brushed-on finish shall be applied strictly in accordance with the written recommendations of the product manufacturer. The actual application of the material shall be done by workmen who have been instructed in the preparation and application of the material. The final brushing of the material shall be done in such a manner so as to present a uniform and attractive appearance, with the final brushing generally being done in one direction.

1.4.17 Special Surface Finishes: The above specified surface finishes are to govern in ordinary concrete construction. When so specified, special surface finishes may be employed for ornamental panels, copings, and like construction; and in some cases, "rubbed" finish. In general, the method and manner of performing this work will be fully provided for on the plans or in the special provisions. In such cases, the contractor will be required to prepare test or sample panels under the direction of the Engineer, and the method and manner of finish, the choice and selection of the aggregate, and other features affecting the work shall be approved before any finishing work is done.

1.4.18 Location and Class of Finish: All concrete shall receive the ordinary surface which shall be accomplished as soon as the formwork is removed. In addition, the two-rub finish (Class A) shall be used on all exposed surfaces, unless otherwise provided for in the Special Provisions or on the plans. The underside of slabs between beams, unexposed diaphragms, the inner side and bottom exterior beams, and the side and bottom interior deck beams need not be finished by rubbing. The rubbed finish may be discontinued one foot below the final grade line or at the ordinary water surface. For grade separation structures the bottom of rails, of bent caps, and the bottoms of overhanging bridge slabs may be rubbed only sufficiently to attain an appearance not contrasting with the adjacent rubbed surfaces; and for structures over waterways and over railways, these areas need not be rubbed at all.

For culverts and minor structures, all concrete shall receive the ordinary surface finish and, in addition, the rubbed finish on all permanently exposed surfaces, and carried 18 inches back from the edges of all surfaces to be covered with earth. The rubbed finish shall be continued at least two feet inside the barrels of culverts at each end.

1.4.19 Concrete Surface Finishing:

(a) General - the Exposed concrete surfaces for structures on this project shall be given a surface finish in accordance with one of the three (3) following general types. Unless otherwise specified, the type finish to be used shall be at the contractor's option. The three general types of concrete surface finish are:

Type 1 - A rubbed surface finish
Type 2 - A brushed-on surface finish
Type 3 - A sprayed-on surface finish

Regardless of the type surface finish to be used, all exposed concrete shall first be given the ordinary surface finish as specified in Subsection 1.4.14 of the Standard Specifications. The same type finish, either the rubbed, or the brushed-on, or the sprayed-on shall be used throughout the structure. The contractor shall notify the Engineer of the type surface finish he intends to use prior to the start of contract work. Membrane curing compound shall not be used in concrete surfaces to be finished.

(b) TYPE 1 - RUBBED CONCRETE SURFACE FINISH - Concrete surface finishing under this type of finish is divided into three (3) general classifications:

Class A - This is the full two (2) rub finish as specified in Subsection 1.4.15 of the Standard Specifications.

Class B - This is the first rub finish as specified in Subsection 1.4.15 of the Standard Specifications, and does not require a second rub.

Class C - This finish is the ordinary surface finish as specified in Subsection 1.4.14 of the Standard Specifications.

(c) TYPE 2 - BRUSHED-ON CONCRETE FINISH - Concrete surface finishing under this type of finish shall be in accordance with Subsection 1.4.16 of the Standard Specifications.

(d) TYPE 3 - SPRAYED-ON CONCRETE SURFACE FINISH

- Concrete surface finishing under this type of finish consists of a sprayed-on surface finish to be applied to all concrete surfaces specified to receive the "rubbed" finish, using a single spray coat where either the single rub or the two rub finish is specified.

(1) Materials - The material to be used for the sprayed-on finish shall be a factory mixed paint type material to be applied as a single spray coat at the rate found by the Engineer to give sufficient uniform coverage of the desired texture and a finish that is capable of hiding the complete substrate. The material shall be of pearl gray color, unless otherwise specified and shall meet the requirements of the latest edition of Federal Specifications TT-c-555, except that the durability by accelerated weathering testing shall be 5000 hours.

(2) Applications - The sprayed finish shall be applied strictly in accordance with the written instructions of the product manufacturer. The actual application of the material shall be done by an operator who has been specially trained for this work, and who has developed a skill in the application of the finish.

The spray coat shall be applied uniformly to natural concrete surfaces that are dry, clean, and hard. The concrete shall be allowed to cure from three (3) to four (4) weeks, depending on the weather, before application is made. The spray coat may be applied after a shorter period of time provided this is recommended by the manufacturer of the material and approved by the Engineer. Generally, the surface coating shall be applied as the final operation of the bridge construction, and just prior to the final inspection.

(3) Certification of Materials - The contractor shall furnish to the Project Engineer for his approval the manufacturer's certification, with appropriate test results, that the materials proposed to be used for either the brushed-on or sprayed-on concrete surface finish meet the specifications as defined.

Concrete surface finishing shall be divided into general classifications, as defined in Section 1.4.19.

1.4.20 Pipes and Conduits: Pipes and conduits which are to be encased in the concrete will be shown on the plans or called for in the special provisions, and unless otherwise provided shall be furnished and

placed by the contractor without extra compensation.

Where the City has authorized the placement of public utilities on a structure, the necessary devises for supporting such utilities shall be furnished by the owners of the utilities involved, but the placement of such supporting devices shall be done by the contractor without extra compensation.

1.4.21 Drainage and Weep Holes: Drainage and weep holes or grates shall be constructed in the manner and place indicated on the plans or as directed, and no additional allowance will be made for such work, except that no deduction in measurement of concrete will be made for these openings.

1.4.22 Weep Holes and French Drains for Box Culverts: Weep holes and french drains as described herein shall be constructed in box culverts that have inside vertical dimensions of six (6) feet and over, when called for on the plans. Weep holes, three (3) inches in diameter, shall be placed through the outside walls and wings at intervals of about 10 feet at an elevation of about one (1) foot above the estimated normal water elevation. These holes are to be connected with aggregate conforming to Aggregates No. 5 or 57.

1.4.23 Weep Holes and French Drains in Retaining Walls: Weep holes shall be constructed in retaining walls having heights above footing of two (2) feet or more. The holes shall be spaced approximately 10 feet on centers and located at or slightly above finished ground line elevation at exposed side of the wall. The weep holes shall be either three (3) or four (4) inches in diameter and shall be connected to adjacent holes with 12 inch square french drains. In addition, french drains shall extend vertically above each weep hole to within two (2) feet of the top of the retaining wall or as directed by the Engineer. The french drain shall be constructed as set forth in Subsection 1.4.21.

1.4.24 Bridge Sidewalks and Curbings: The utmost care shall be taken in placing and finishing curbs and sidewalks to see that they are placed true to line and grade. The surface shall be screeded and floated as directed by the Engineer.

1.5 MEASUREMENT AND PAYMENT

Measurement and payment for concrete structures will not be specifically made under this section of the specifications. Measurement and payment will be made in accordance with other sections of these specifications which govern the items of

work included in the concrete structure.

SECTION 02920 CONCRETE CURB, CONCRETE GUTTER, CONCRETE CURB AND GUTTER, CONCRETE SIDEWALK, CONCRETE DRIVEWAY, AND CONCRETE MEDIAN

1.1 SCOPE

The work specified in this section consists of the construction of Portland cement concrete curb, Portland cement concrete gutter, Portland cement concrete curb and gutter, Portland cement concrete sidewalk, Portland cement concrete driveway, and Portland cement concrete median in one course on a prepared sub-grade in accordance with these specifications and conforming to the dimensions, typical cross sections, and notes shown on the plans and to the lines, and grades furnished by the Engineer.

This work shall also include the placing of reinforcing steel in the concrete when so indicated on the plans.

1.2 MATERIALS

Portland Cement Concrete: All concrete shall conform with the requirements specified in the applicable sections of these specifications for 4000 psi concrete as shown on the plans. When so stated on the plans, cement used in the concrete for concrete medians shall be white Portland cement, meeting the requirements specified for Type I or Type III Portland cement.

Expansion Joint Material: Expansion joint materials shall meet the requirements specified in Section 20.

Reinforcing Steel: Reinforcing steel shall meet the requirements specified in Section 21.

1.3 CONSTRUCTION REQUIREMENTS

Sub-grade: The sub-grade shall be thoroughly compacted to 95 percent of the standard proctor density and finished to a smooth, firm surface and shall be moist at the time the concrete is placed. Any concrete that settles after placement shall be removed and replaced without additional compensation as directed by the Engineer.

Forms: Forms shall be of wood or metal and of a depth equal to the thickness of the concrete course. They shall be free from warp and of sufficient strength, when staked, to hold the alignment during the concrete placing and finishing operations. All forms shall be cleaned and oiled each

time they are used before concrete is placed against them. Flexible or curved forms shall be used on curves in order to prevent a chord effect in the alignment of the finished work.

Existing Sidewalks and Driveways: Where a portion of an existing sidewalk or driveway is to be reconstructed, the existing section shall be saw cut to a minimum depth of two (2) inches or as directed by the Engineer with a suitable saw at the location designated by the Engineer and the entire section to be reconstructed shall be removed. The new sidewalk or driveway shall join the old work at this line.

Mixing and Placing: The concrete shall be batched and mixed in accordance with the provisions of Section 19.

Unless otherwise indicated on the plans, concrete curbs, gutters, and curb and gutter shall be constructed in uniform sections ten (10) feet in length, except where shorter sections are necessary for closures, but no section shall be less than four (4) feet in length. The sections shall be separated by sheet steel templates or dividing plates set normal to the face and top of the curb. The plates shall be carefully set during the placing of the concrete and allowed to remain in place until the concrete has set sufficiently to hold its shape but shall be removed while the forms are still in place.

Concrete shall be deposited in the forms in such a manner that the forms will not be displaced out of grade or alignment. During the placing operations, the concrete shall be spaded or vibrated throughout the entire mass and especially against the forms and joints. The surface of the concrete shall be tamped, floated, troweled, broomed, corners edged, and finished to the typical section, lines, and grades as soon as practicable after the placing of the concrete. The forms shall be left in place until the concrete has set sufficiently that their removal will not injure the concrete.

Joints

(a) Expansion Joints - Preformed expansion joints 3/4 of an inch thick, extending the full depth of the concrete slab, shall be constructed at the locations indicated on the plans and at other locations as follows:

1. Whenever a sidewalk is constructed between an adjoining substantial structure on one side and a curbing on the other side, an expansion joint shall be formed adjacent to the curbing.

2. An expansion joint shall be placed between the sidewalk and the radius curbing at street intersections.

3. When concrete sidewalks or medians are constructed adjacent to

existing or new concrete pavement or structures, transverse expansion joints shall be placed in the sidewalk or median opposite such joints in the concrete pavement or structure.

4. Where existing structures such as light standards, poles, fire hydrants, etc., are within the limits of the sidewalk or median area, they shall be surrounded with an expansion joint.

5. Transverse expansion joints shall be placed at intervals of not more than forty (40) feet in all concrete shapes.

(b) Contraction Joints - The concrete in sidewalks between expansion joints shall be divided into blocks, four (4) feet in length by scoring transversely after floating operations are completed. Whenever the sidewalk slabs are more than ten (10) teen in width, they shall be scored longitudinally in the center. Transverse and longitudinal scoring shall extend for a depth of one (10 inch, shall not be less than 1/4 inch nor more than 1/2 inch in width, and shall be edged and finished smooth and true to line.

Transverse contraction joints shall be formed as described above at intervals of not more than 25 feet in concrete medians, and shall extend not less than 1/4 the depth of the median.

Final Finish

(a) Curb, and Curb and Gutter - as soon as the concrete has hardened sufficiently, the forms for the exposed surfaces shall be removed and the concrete for the curb face and top shall be floated and troweled as necessary to provide a smooth uniform finish. Templates shall be left in place a sufficient length of time to prevent bonding or distortion at the joint.

After the surface of the gutter has been properly shaped and prepared and the water sheet has disappeared, the final finish shall be by brooming. Brooming shall be transverse to the line of traffic. All joints shall be in a vertical plane perpendicular to the curb face. Joints shall be clean with corners well rounded. All corners shall be edged to conform to the typical cross section. Tool marks shall be eliminated.

(b) Sidewalk, Gutter, Median, and Driveway - The final finish shall be by brooming as outlined in Paragraph (a) above, unless otherwise directed. As soon as the forms are removed from the concrete median, the sides shall be rubbed down to a smooth and uniform finish. Mortar or aggregate particles which spill onto the pavement shall be removed.

(c) As soon as the forms are removed from all concrete shapes, honeycombed places and other minor defects shall be filled with a mortar composed of one part Portland cement and two parts sand. Plastering will not be allowed.

Protection and Curing: The concrete shall be protected and cured in the manner specified for Portland Cement Concrete, Section 20.

Backfilling: After the concrete has set sufficiently and the forms removed, the spaces on both sides shall be backfilled to the required elevation with suitable material which shall be firmly compacted and neatly graded. Concrete gutter shall be backfilled so that the earth materials are a minimum of one (1) inch above the concrete. An earth roll on each side shall be maintained as necessary to prevent undermining of curb and gutter.

1.4 METHOD OF MEASUREMENT

Concrete curb, concrete gutter, concrete curb and gutter, and concrete sidewalk will be measured by the linear foot complete in place and accepted. Curb and gutter will be measured along the roadway face of the curb at the gutter line. Curb and concrete sidewalk will be measured along the roadway at the finished grade elevation. Concrete driveway and concrete median will be measured by the square yard of finished surface complete in place and accepted. Deduction shall be made for drainage structures such as catch basins, drop inlets, etc.

1.5 BASIS OF PAYMENT

The pay quantities will be paid for at the contract price per unit of measurement as applicable. Unless otherwise provided, handicapped ramps will not be paid for directly but shall be considered as included and paid for in the various pay items of the contract.

Payment will be made under:

Pay Item	Pay Unit
Concrete Curb.	Linear Foot
Concrete Gutter.	Linear Foot
Concrete Curb and Gutter	Linear Foot
Concrete Sidewalk.	Linear Foot
Concrete Driveway.	Square Yard

Pay Item	Pay Unit
Concrete Median.	Square Yard

Reinforcement--when specified-backfill, joints and joint material, fine grading and compacting, form work and other related miscellaneous items and work will not be paid for separately, but the cost thereof shall be included in the above pay items.

SECTION 03250 EARTHWORK

1.1 SCOPE

This work consists of the grading of the project area. The work includes:

A. Site clearing and off-site disposal of all debris and unsuitable material.

B. Removal of all topsoil, organically contaminated soil and existing unsuitable fill.

C. Proof rolling, rough grading, fine grading, backfilling and general earthwork of the property and all site improvements to the prescribed elevations.

D. Stockpiling or wasting on site of any excess cut material for providing acceptable material as required to obtain the desired grades.

1.2 SITE INFORMATION

The boring logs and related information depict approximate subsurface conditions only at these specific locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from those reported at the boring locations. It is expressly understood that neither the Owner nor the Engineer will be responsible for interpretations or conclusions drawn from the boring data by the Contractor. The data are made available for the convenience of the Contractor. Additional test borings and other exploratory operations may be undertaken by the Contractor at his own expense provided such operations are acceptable to the Owner.

1.3 UNSTABLE MATERIAL

Organically contaminated soils must be removed from the area of grading operations. At the discretion of the Engineer, topsoil within the area to be stripped shall be stockpiled in a convenient area, selected by the Engineer, for later use in planting area. All topsoil shall be graded by the Engineer as suitable and shall be stockpiled separately as directed by the Engineer in the field.

Soft or excessively yielding material shall be removed and replaced with inert controlled fill.

1.4 FILL MATERIAL

Material to be used for fill shall be approved by the Engineer.

All roots, organic matter, trash, debris, and other unsuitable materials which may find their way into otherwise acceptable fill material shall be removed during the dumping and spreading operations.

Broken rock and boulders larger than 6 inches in any dimension may not be used as fill without the specific approval of the Engineer.

Frozen soil shall not be used for fill.

Fill material shall have a maximum laboratory dry weight, ASTM D-698, of at least 100 pounds per cubic foot unless specifically exempted from this requirement by the Engineer.

1.5 PREPARATION

After removal of all existing topsoil, debris, and other undesirable material, the areas which are to receive fill, which have been cut to the desired grade, or which are at the approximate required sub-grade elevation without additional earthwork, should be proof rolled to locate any soft or yielding area. Proof rolling shall be done with at least four overlapping passes of a heavy duty flat wheel vibratory roller, at least 20 tons, or by its approved equivalent.

Any soft, or excessively yielding material revealed by the proof rolling shall be removed and replaced with inert controlled fill. The Engineer shall be the sole judge of what constitutes soft or excessively yielding material.

Drainage from existing watercourses, springs or other sources should be rerouted out of the earthwork area. The Contractor shall take special care to remove all organically contaminated sediment, saturated soil, and other undesirable material from existing watercourses.

1.6 BLASTING AND DAMAGES

Where blasting is done, it shall be done by qualified personnel and in accordance with all federal, state or local requirements and procedures. The Contractor shall be responsible for any damage done to adjoining properties, or to persons, by reason of the blasting or other earthwork operations. The Contractor shall also be responsible for damage to embankments and cut areas, and sewer, water, gas or other

underground lines which may result from blasting or earthwork operations. All such damage shall be repaired and made good by the Contractor in a timely manner.

1.7 FILLING AND COMPACTION

After a stable non-yielding surface has been established, the surface of the area to be filled shall be scarified with a disc or harrow to a depth of 4 to 6 inches. An initial three inch layer of fill material shall then be spread over the scarified surface and the entire area compacted as specified below.

No fill shall be placed on any area until that area has been inspected and approved by the Engineer. Fill shall not be placed on a snow covered or frozen surface. Fill materials shall be spread in uniform horizontal layers not exceeding 8 inches in un-compacted thickness. Alternating layers of cohesive and granular fill soils shall not be permitted. Spreading and compacting of fill material should be started at the lowest portion of the site. All fill must be placed in horizontal layers. Sloping fill planes will not be permitted. Fill material shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form.

Keyways shall be provided at the toe of each fill slope as shown on the drawings. As each layer of fill meets the natural grade of a slope, a bench, approximately 7 to 8 feet wide, shall be cut into the existing grade with each layer of newly placed fill. If rock is encountered at the face of the natural grade, the original ground shall be cut in vertical steps of 4 to 5 feet and a horizontal bench cut into the rock at the top of each vertical increment. A horizontal plateau, approximately 15 to 20 feet wide, should be provided in the existing slope at vertical intervals of roughly 25 feet. Subsurface drains shall be installed at the toe of the slope and wherever springs or excessive seepage are encountered. Drains should be led to the outside face of the embankment and the water picked up and carried away in such a manner as to avoid softening the embankment or its toe, or producing erosion gullies.

Before compaction begins, the fill shall be brought to a water content that will permit proper compaction. This may require aerating the material if it is too wet, or the addition of water if it is too dry. If additional water is required, it should be uniformly distributed through the use of approved water wagons, and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.

The standard Proctor method of moisture-density relationship test, ASTM D 698 or AASHTO T-99, shall be used to determine the maximum laboratory dry density and the optimum moisture content of the material which is to be used for fill.
Each layer of fill material shall be compacted until its density is not less than 95% of the maximum laboratory dry density for the same material. The moisture content of

compacted cohesive materials shall not vary by more than two percentage points from the optimum moisture content for the same material, providing excessive yielding is not produced within this range of moisture contents. Where, in the opinion of the Engineer, proposed fill material is too wet to permit drying in a reasonable length of time, the Engineer may reject the material and it must be removed from the work area.

The above compaction requirements are to be satisfied for all soil and weathered or soft rock fills. Weathered or soft rock are those which can be broken down and disintegrated under normal compaction procedures and equipment.

At the close of each day's work, or where work is to be interrupted for a period of time, the surface of the site shall be shaped to drain freely, and sealed. If after a prolonged rainfall, the surface of the area to be filled or cut is too wet to work properly, the unsuitable material shall be removed to expose workable soil. The wet material removed may be dried and reused. Construction traffic shall be controlled so as to prevent rutting of graded areas and to avoid over-rolling of any section.

All cut areas shall be rolled and compacted to produce a compaction equal to that of the filled area. If soft or yielding material is encountered in cuts, or fills as a result of trapping water, over-rolling or improper control of construction traffic, and cannot be satisfactorily stabilized by moisture control, compaction or other means approved by the Engineer, the unstable material shall be excavated to the depth required by the Engineer. The excavation shall then be filled with suitable compacted material in accordance with the requirements outlined above.

1.8 GRADING

Elevations shown on the plans are finished ground unless otherwise noted. Grading shall be maintained in such a manner as to provide free surface drainage of the site at all times without any ponding of water.

Provide ditches and swales to the cross-sections and grades shown on the drawings. Cut ditch sub-grades four inches below the grades shown and provide four inches of topsoil where the plans call for seeding or sodding of the ditch. Keep ditches and swales free of accumulations of debris or washed in material until final acceptance of work by the Engineer.

Shape all surfaces to within not more than 0.10 feet above or below the required sub-grade elevations and free from irregular surface changes.

1.9 CONTROL AND TESTING

The services of qualified soils testing personnel may be engaged by the Owner for the making of tests to determine the moisture-density relationships, relative densities, plastic and liquid limits and suitability of materials for compaction and for inspection and control of the site preparation, selection, placing and compaction of the fill. A copy of the testing personnel's daily field report including results of in-place density and moisture content tests should be forwarded to the Owner and the Engineer at the end of each working day.

The Contractor shall cooperate with the testing personnel so as to permit proper inspection and control of the work without unnecessary delays.

1.10 MAINTENANCE

The Contractor shall be responsible during construction and until final acceptance for the maintenance of all embankments made under the Contract.

During construction and until final acceptance; the Contractor shall construct temporary or permanent earth berms along the outer edges of the top surface of the embankment, construct temporary ditches, shape the embankment surface to provide for the drainage of surface runoff along and throughout the length of the embankments, and use any other methods necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion. The Contractor shall construct brush dikes, or install temporary or permanent slope drains or other drainage features to assist in controlling erosion.

The Contractor shall replace, at no cost to the Owner, any portion of embankment which have become displaced or damaged due to carelessness or neglect on the part of the Contractor. Where the work has been properly constructed, completely drained and properly maintained, and damage occurs due to natural causes, the Contractor will be paid at the Contract unit price for the excavated material required to make necessary repairs to such damage.

All embankments shall be brought to the grade and cross section shown on the plans or established by the Engineer, prior to final inspection and acceptance by the Engineer.

1.11 COMPENSATION

All work covered by this section will be paid for as specified in the unit bid item list for each particular project.

1.1 SCOPE

This work shall consist of the construction and preparation of the subgrade on that part of the roadway intended to receive the pavement, sidewalk, curb and gutter, base course, and shoulders.

After all earthwork has been substantially completed and all drains and structures have been completed and backfilled, the subgrade, when compacted to the satisfaction of the Engineer, shall conform to the lines, grades, and cross section shown on the plans or as established by the Engineer.

1.2 CONSTRUCTION REQUIREMENTS

General: All soft, unstable or suitable material which will not compact readily shall be removed and replaced with satisfactory material as directed. All objectionable loose rocks 4 inches in diameter or greater or boulders shall be removed or broken off to a depth of not less than 6 inches below the surface of the subgrade at the contractor's expense. All holes, ruts, or depressions that develop in the subgrade brought to line and grade and compacted. If the subgrade is too dry to compact properly, it shall be wet by sprinkling, if deemed by the Engineer, to secure proper compaction.

The subgrade, between lines 18 inches outside the area to be occupied by standard shoulder width, shall be compacted to not less than 95 percent of maximum density. The compaction shall be accomplished by using suitable construction procedures and while the subgrade is at a suitable moisture content. Maximum densities will be determined by ASTM D-698 method A or C, as applicable.

When any portion of the subgrade is constructed on an old roadbed that conforms to or approximately with the elevation of the subgrade, the existing surface shall be scarified and compacted as directed by the Engineer in order that the subgrade, when compacted, will have a uniform density.

Protection and Maintenance: The subgrade shall be maintained in a smooth and compacted condition, free from ruts and depressions, and shall be adequately drained. In no case shall any base, surface course or pavement be placed on a frozen, muddy, or unstable subgrade. Storing or stockpiling of materials directly on the subgrade will not be permitted

except directly on the subgrade will not be permitted except with the approval of the Engineer.

No base or surfacing materials shall be placed before the subgrade is checked for compaction, string lines, and approved by the Engineer.

1.3 METHOD OF MEASUREMENT

Subgrade work will not be measured for direct payment.

1.4 BASIS OF PAYMENT

Subgrade work will not be paid for directly, but shall be considered as included and paid for in the various pay items of the contract.

Unsuitable material excavated from the subgrade and also material necessary to backfill such areas shall be measured and paid for as Unclassified Excavation.

SECTION-03457 DUCTILE IRON WATER LINE

1.1 SCOPE:

Requirements of the General and Supplemental Conditions apply to all Work in this Section. Provide all labor, materials, equipment and services indicated on the Drawings, or specified herein, or reasonably necessary for or incidental to a complete job, including, but not limited to piping, joints, fittings and appurtenances as indicated on the drawings and per these specifications.

1.2 QUALITY ASSURANCE

REFERENCED_STANDARDS: Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards.

ANSI A21.4 Cement-Mortar Lining for Cast-Iron and Ductile Iron Pipe and Fittings for Water

ANSI A21.10 Gray-Iron and Ductile Iron Fittings, 2 inch Through 48 inch, For Water and Other Liquids

ANSI A21.11 Rubber-Gasket Joints for Cast-Iron and Ductile Iron Pressure Pipe and Fittings

ANSI A21.50 Thickness Design of Ductile-Iron Pipe

ANSI A21.51 Ductile Iron Pipe, Centrifugal Cast, in Metal Molds or Sand Lined Molds for Water or Other Liquids

ASTM C33 Standard Specification for Concrete Aggregates

ASTM A307 Standard Specification for Carbon Steel Externally and Internally threaded Standard Fasteners

MANUFACTURER'S_QUALIFICATIONS: Only the products of a manufacturer regularly engaged in the manufacture of pipe used for the conveyance of water will be acceptable.

INSPECTION_AND_ACCEPTANCE_OF_PIPE: Acceptance will be on the basis of design, material tests, and inspection of the complete product. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to inspection by the Engineer. Inspection may be made at the place of manufacture, or on the job site after delivery, or at both places and the pipe shall be subject to rejection at any

time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected must be immediately removed from the project site by the Contractor.

SUBMITTALS

MANUFACTURER'S_CERTIFICATE;_PIPE_AND_FITTINGS: Submit 2 copies of manufacturer's certificate indicating that the pipe and fittings have been inspected and tested at the foundry and meet the requirements of the Referenced Standards and these Specifications. Submit manufacturer's certification that joints of the type proposed have been hydrostatically tested to 500 psi.

SHOP_DRAWINGS:_JOINT_GASKETS: For Engineer's approval, submit shop drawings for all joint gaskets.

1.3 MATERIALS:

MANUFACTURE_OF_PIPE

GENERAL: Centrifugal cast ductile iron pipe in sand lined or metal molds in accordance with ANSI A21.51. Unless otherwise specified herein or noted on the Drawings, use only new pipe, Class 350, with push-on or mechanical joints. Joint restraint for all pipe 12 inch diameter and smaller shall be with retainer glands.

LINING: Line the interior of the pipe with a cement mortar lining and bituminous seal coat conforming to ANSI A21.4.

COATING: Except where the pipe is to be field painted, coat the exterior of the pipe with a bituminous coating of either coal tar or asphalt base in accordance with ANSI A21.51.

PIPE_LENGTHS: Furnish the pipe in nominal 18 or 20 foot lengths. Shorter lengths may be used where required by construction details or when approved by the Engineer.

MARKING: Cast or stamp the weight, class or nominal thickness, casting period, and the letters "DI" or "Ductile" on the pipe; no pipe will be accepted unless these markings appear on all ductile iron pipe.

FITTINGS: Unless otherwise specified or indicated on the Drawings, use Pressure Rated Class 250 mechanical joint fittings with restrained joints, either ductile iron or gray cast iron, conforming to applicable sections of ANSI A21.10 and A21.11. Use retainer glands on fittings for recommendations.

Furnish fittings in the size indicated on the Drawings, as specified herein, or as required to make connections or changes in horizontal and vertical alignment. Use solid sleeves as closure pieces with plain end pipe.

Line the interior of the fittings with a cement mortar lining and bituminous seal coat conforming to ANSI A21.4. Except where fittings are to be field painted, coat the exterior of all fittings with a bituminous coating of either coal tar or asphalt base in accordance with ANSI A21.l0.

Mark fittings in accordance with ANSI A21.l0, Section l0-9; fittings without these markings will not be accepted.

SPECIAL_FITTINGS:

SOLID_SLEEVES: Long type, mechanical joint conforming to ANSI A21.l0 and ANSI A21.ll.

JOINTING

PUSH_ON_JOINT_PIPE_AND_FITTINGS: Conform to ANSI A21.5l for centrifugal cast pipe and to ANSI A21.ll for rubber- Gasket Joints. Factory-machine the plane end of the pipe to a true circle and chamfer to facilitate fitting the gasket.

MECHANICAL_JOINT_PIPE_AND_FITTINGS: Conform to ANSI A21.5l for centrifugal cast pipe and to ANSI A21.ll for Mechanical Joints. Provide pipe and fittings with sufficient quantities of accessories conforming to the standards previously referenced. Use gaskets, bolts and nuts for mechanical joints which are furnished by the pipe manufacturer.

GASKETS: Make gaskets from a composition which is suitable for exposure to potable water within the pipe.

PIPE_BEDDING

GENERAL: Use native excavated soil if acceptable, in accordance with the appropriate Standard detail.

1.4 CONSTRUCTION REQUIREMENTS:

INSPECTION

Examine the areas and conditions under which the pipe is to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

EXCAVATION

GENERAL: Excavate trenches in accordance with Section 02220, EXCAVATION AND BACKFILL. Except where specifically shown or indicated otherwise, lay all pipe with an earth cover of not less than 3 feet.

PIPE_HANDLING

GENERAL: Transport pipe to the job site and handle in such a manner as not to damage the pipe or pipe coating.

STOCKPILING: Stockpile pipe within the rights-of-way so that no dangerous conditions will exist to life or property. Store pipe so that damage to surfaces and/or structures will be prevented. Provide suitable devices to support pipe when it is lifted.

PIPE_INSTALLATION

GENERAL: Install pipe in accordance with ANSI A2l.50. Unless otherwise shown on the Drawings, install 20 inch and smaller pipe in accordance with laying condition Method l and install 24 inch and larger pipe in accordance with laying condition Method 3. Comply with the rules, regulations of OSHA, Occupational Safety and Health Act.

PRECAUTIONS: Lay pipe in dry trenches only. Keep all trenches completely free of water during bedding, laying and jointing of pipe. Dewater and use sheeting where required by field conditions. Pump or drain all water away from the work and dispose of in a suitable manner so that no damage occurs outside the construction easement. Do not permit water to rise in an unbackfilled trench after pipe has been placed. Promptly repair any damage within the construction easement.

PIPE_LENGTHS: Lay pipe in nominal l8 or 20 foot lengths.

PLACING_PIPE_IN_TRENCH: After delivery alongside the trench, visibly inspect each length of pipe for marking, damaged surfaces, breakage, and conformance to specifications.

Acceptable pipe may be marked with paint or other permanent marking material so that the marks are plainly visible after installation in the trench and before the pipe is covered. Reject, stockpile, and remove from the site all pipe not conforming to Specifications.

See Drawings for Bedding Conditions. Before pipe is placed on the bedding material, excavate suitable bell holes so that after placement of the pipe only the barrel receives

bearing pressure from the supporting material. Support the entire length of the unit as indicated on the Drawings.

Place pipe into its position in the trench in such manner and by such means as approved by the Engineer. Furnish approved devices to support all parts of the pipe unit when it is lifted. Protect pipe during handling against impact shocks and free falls. Do not permit hooks to come in contact with pre-moulded joint surfaces. Lower pipe into position in the trench and joint without disturbing the bedding or adjoining section of pipe.

Handle pipe having pre-molded joint rings or attached couplings so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material. Take care to avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects. Do not subject the bell and spigot sections to direct stress of any kind except that required to effect the jointing.

PIPE_LAYING: Unless otherwise shown on the Drawings, all pipe will be laid in open trench construction. Lay pipe to conform to the lines and grades indicated on the Drawings unless otherwise directed by the Engineer in writing. Lay all pipe according to the latest edition of ANSI A2l.50 for laying condition Type l for pipe 20 inch and smaller and Type 3 for 24 inch and larger - flat bottom trench, without blocks with tamped backfill.

Clean all joint surfaces after the pipe units are aligned in the trench and are ready to be joined. Immediately before jointing the pipe, lubricate the bell or groove in accordance with the manufacturer's recommendations. Then carefully push pipe unit into place without damage to the pipe or gasket. Use suitable devices to force the pipe together so that they will fit with a minimum open recess inside or outside and so that they will have tightly sealed joints. Lay each pipe unit to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.

Immediately after the pipe units are put together, inspect the position of the gasket in the joint using an approved feeler gauge to make sure it is properly positioned. Pull apart and remake all joints, using new gaskets, if the gasket has become damaged or improperly positioned.

Make all joints in accordance with manufacturer's recommendations which are subject to approval by the Engineer. Prior to backfill, fill bell holes with bedding material and compact so that the spigot will not move in the bell of the adjoining pipe under backfill load. Do not permanently support pipe on saddles, blocking or boulders.

PIPELINE_DEFLECTION: The maximum allowable deflection in either the vertical or horizontal plain for pipe with nominal lengths of l8 or 20 feet is listed as follows:

Pipe_Diameter	Angle_of_Deflection (Push-on Joint)	Angle of Deflection (Mechanical Joint)	Angle_of_Deflection (Restrained Joint)
6 inch	4 degree	6 degree	2 degree
8 inch	4 degree	4 degree	2 degree
l0 inch	4 degree	4 degree	2 degree
l2 inch	4 degree	4 degree	2 degree
Pipe_Diameter	Angle_of_Deflection (Push-on Joint)	Angle of Deflection (Mechanical Joint)	Angle_of_Deflection (Restrained Joint)
l4 inch	4 degree	4 degree	2 degree
l6 inch	4 degree	4 degree	2 degree

Make any change in direction exceeding the maximum deflections noted above with standard fittings; offsets, quarter, eighth, sixteen and thirty-second bends.

MECHANICAL_JOINTING: Wash sockets and spigots with soapy water before slipping gland and gasket over spigot. Insert the gasket in the socket full depth. Brush the gasket with soapy water and push into position making sure that the gasket is evenly seated in the socket. Slide the gland into position for compression gasket. Tighten all bolts and nuts "finger tight" after which tighten the bolts to a uniform permanent tightness using a torque wrench for tightening. Tighten bolts alternately l80 degrees apart. Keep sockets, spigots, glands, and bolts clean and wet, with soapy water until each joint is completed. Remake any joints which leak.

PUSH-ON_TYPE_JOINTING: Perform the jointing of push-on type pipe in accordance with manufacturer's recommendations.

RESTRAINED_JOINTING: Provide restrained joint pipe and fittings where shown on the Drawings and in accordance with the restrained joint schedule in the Drawings. Perform the jointing of restrained joint pipe and fittings in accordance with manufacturer's recommendations.

TEMPORARY_PLUGS: At all times when pipe laying is not actually in progress, close the open end of pipe by temporary watertight plugs or by other approved means. If water is in the trench when work is resumed, do not remove the plug until all danger or earth or other material entering the pipe has passed.

THRUST_BLOCKING: Provide thrust blocks at all fittings, and at the ends of capped valves and tees. Construct thrust blocks in accordance with blocking dimensions and details indicated on the Drawings.

BACKFILL: When pipe has been properly bedded and jointed, backfill trenches in accordance with Section 02220, EXCAVATION AND BACKFILL.

STEEL ENCASEMENT

Steel encased pipe shall be installed in accordance with Section 01810, ENCASEMENT PIPE INSTALLATION.

TESTING AND DISINFECTING

TESTING: Test lines for leakage in accordance with Section 02495, TESTING PIPELINES.

REPAIRS: Repair and retest, at the Contractor's expense, any section of pipe failing to meet the leakage test. Perform repairs with capable personnel and with sound materials equal to those materials used in the manufacture of the pipe.

DISINFECTION: Disinfect lines in accordance with Section 02496, DISINFECTING PIPELINES.

MEASUREMENT AND PAYMENT

The unit price bid for water lines shall include the costs for furnishing pipe, trench excavation and backfill, placement of thrust blocks and joint restraints, all tie- ins to existing water lines, abandonment of existing water lines, surface restoration including grassing and all other work associated or required for the placing of water lines for which a separate bid item is not provided.
As noted, the unit price bid for water line installation shall include all costs for clean-up and landscaping. Therefore full payment for water line bid items will not be approved prior to completion of clean-up and landscaping. With each monthly invoice, a twenty percent (20%) retainage will be withheld on water line installation bid items to cover the costs for cleaning-up and landscaping. This retainage will be in addition to the ten percent (10%) retainage already withheld.

Measurement for water lines shall be in linear feet as installed in place at the location shown on the Drawings or as directed by the Engineer.

1.1 Scope

This work shall consist of furnishing pipe of the kind, size, and dimensions indicated on the plans, and installing them in conformity with the plans and these specifications, true to line and grade. This item shall include the furnishing and installing of necessary tee, wye, elbow, and bend joints, and making connections to existing or new structure, including drilling and chipping, as may be necessary to complete the work.

1.2 Materials

General: All materials used shall be those prescribed or used for the several items which constitute the finished pipe culvert. These materials and the finished pipe shall meet the following specifications.

Reinforced Concrete Culvert Pipe: This pipe shall conform to the requirements of AASHTO M-170 and the "Policy for Inspection and Acceptance of Concrete Culvert Pipe" adopted by South Carolina Highway Department for the specified diameters and strength classes, except for the modifications stated herein. When a strength class is not specified, Class III pipe shall be used.

Portland cement shall conform to the requirements of Subsection 19.2. The pipe, unless otherwise permitted, shall be circular pipe with circular reinforcement.

The quality of the aggregates shall be the same as specified in Subsection 19 of these specifications for use in concrete for structures.

The lengths of pipe shall be furnished in manufactured lengths of 4 or 8 feet.

Corrugated Aluminum Alloy Culvert Pipe: This pipe shall conform to AASHTO M-196, AASHTO M-211. The thickness of the pipe shall be in accordance with the plans.
All transverse pipe cuts shall be perpendicular to the centerline of the pipe and shall be machine cut. Cut ends and rough edges shall be ground smooth.

Vitrified Clay Pipe: Vitrified Clay Pipe, as designed herein, shall meet the requirements of AASHTO M-65, ASTM C-700. The pipe shall be extra strength unless otherwise specified in the proposal or on the plans.

Corrugated Aluminum Pipe Coupling Bands

All coupling bands shall be one piece lap type and shall be 12 inches wide for pipe sizes 36 inch diameter and less; 24 inches wide for pipe sizes 42 inches to 72 inches diameter; and 36 inches wide for pipe sizes 78 inch diameter and larger. Such bands shall be constructed to lap an equal portion of each of the pipe sections to be connected. Such bands shall also lap transversely a minimum of 2 inches. Bands may be one standard thickness lighter than that used for the pipe but in no case less than 16 gauge (0.060 inches) thick. The bands shall be connected at the ends by aluminum alloy angles having minimum dimensions of 2 inches by 2 inches by 3/16 inches. The 12 inch bands shall have at least two aluminized or galvanized steel bolts not less than ½ inch diameter. The 24 inch bands shall have at least 4 aluminized or galvanized steel bolts not less than ½ inch diameter.

The 36 inch bands shall have at least six aluminized or galvanized steel bolts not less than ½ inch diameter. Said bolts shall be full threaded and of sufficient length to allow for ease of installation of the band. Pipe coupling bands shall not be paid for separately, but the costs thereof shall be included in the unit price per linear foot for the various pipe sizes specified.

Flared End Section

Flared end sections will be paid for separately, by the unit for each of the types, sizes, classes, and dimensions of pipes called for at each flared end section location.

1.3 Construction Requirements

Trench and Bed for Pipe: The pipe shall be laid in a trench in all cases. Trenches shall be excavated to the required grade and to a width as detailed on the plans. The trench bottom shall give full support to the pipe throughout its length. The trench bottom shall be carefully shaped to conform to the typical details of the plans.

Where pipe culverts are to be placed in new embankments, the embankments shall first be constructed to a height of approximately ½ the diameter of the pipe above the tip of the designated pipe or to such height as directed by the Engineer. The embankment shall be constructed for a distance each side of the pipe location of not less than 5 times the diameter of the culvert, after which the trench shall be excavated as described above.

When a firm foundation is not encountered at the required grade, all such unstable material, under the pipe and for a width of at least one diameter on each side of the pipe, except where widths are restricted by obstructions, shall be removed and the resulting excavation backfilled with suitable material as approved by the

Engineer, and compacted and shall be shaped as described above. No additional payment shall be allowed for said excavation and backfill.

When excavating for pipe culverts, if rock, hard pan, or other unyielding foundation material is encountered, the hard unyielding material shall be excavated below the elevation of the bottom of the pipe or pipe bell to a minimum depth of four (4) inches. The width of the excavation shall be one foot greater than the outside diameter on each side of the pipe and shall be refilled with suitable material and compacted and shall be shaped to form a firm uniform bed. Determination, measurement, and payment for rock, if applicable, shall comply with Section 5 of these specifications.

The contractor shall provide, as may be necessary, for temporary diversion of water or pumping in compliance with Section 4 of these specifications.

Laying Pipe: Each section of pipe shall have a full firm bearing throughout its length, true to line and grade given. Any pipe which settles before final acceptance or which is not in alignment shall be taken up and re-laid by the contractor without extra compensation. Pipe laying shall begin at the downstream end of the culvert with the bell or groove ends and outside laps upstream.

When concrete elliptical pipe with circular reinforcement or concrete circular pipe with elliptical reinforcement is used, the pipe shall be installed in such a position that the manufacturer's marks designating the top or bottom of the pipe shall be not more than 5 degrees from the vertical plan through the longitudinal axis of the pipe. Prior to being lowered into the trench, corrugated pipe sections shall be closely examined and so fitted that they will form a true line of pipe when in place. Sections which do not fit together properly shall not be used. Corrugated pipe shall be laid with the lap downstream.

Distorted circular metal pipes shall be placed with the major axis vertical. If rods, struts, or other means are used to maintain pipe distortion, they shall not be removed prior to the completion of the embankment unless otherwise permitted by the Engineer.

Prior to the laying of the pipe or during the pipe laying operations, adequate outfall ditches and inlets free of obstructions shall be constructed in order that proper drainage is provided.

When pipes are protected by endwalls or connect with drainage structures, the exposed ends shall be placed or cut off flush with the interior face of the structure. Where pipe culverts are constructed in conjunction with existing structures, satisfactory connections shall be made as directed by the Engineer.

Joints: All concrete pipe shall be laid with cement mortar joints or a bituminous

mastic joint sealer. The bituminous mastic joint-sealing compound shall be a smooth, uniform mixture of bituminous cement, solvent, and mineral filler. The mixture shall be readily applicable by means of a trowel or caulking gun without pulling or drawing, and shall not sag or flow when applied to metal, concrete, or vitrified surfaces. Preformed mastic joint seal compound shall be acceptable provided it meets the requirements outlined in this section and is approved by the Engineer.

The compound shall be capable of withstanding freezing and shall not exhibit any tendency to separate or otherwise deteriorate while in storage. When applied to a tinned metal panel or glass plate, in a layer of 1/16 to 1/8 inch thick and cured at room temperature for 24 hours, the compound shall set to a tough, plastic coating and shall not shrink, crack, or loosen from the surface.

In addition, the material shall meet the requirements of ASTM D-1850 and D-1851 as well as the following:

	MINIMUM	MAXIMUM
Grease Cone penetration (ASTM D-217 unworked, 150 gm., 25 degrees C., 5 sec. 1/10 mm.	175	250
Weight per gal., lbs.	9.75	---
Non-volitile (10 gm., 105 degrees C., 24 hours) pct.	75	---
Ash (by ignition), pct.	25	45

The bituminous mastic jointing compound shall be applied to the ends of the pipe sections on the site immediately prior to placement and in the same manner as in the use of mortar except that jointing surfaces shall be thoroughly cleaned, dried, and primed or precoated with a paint-coat of emulsified asphalt type SS-1, conforming to the requirements of AASHTO M-140, diluted with one part water to one part of the emulsion. The primer coat shall cure for at least one hour before the mastic compound is applied. A sufficient amount of the sealer shall be applied so that when the joints are completely meshed, the annular joint space shall be completely filled with a bead of the sealer squeezed out on the inside and outside of the pipe. The excess material shall then be removed so as to form a smooth, flush joint.

The mortar mixture for cement mortar joints shall be one part Portland cement and two parts approved clean sand by volume. The quantity of water in the mixture

shall be sufficient only to produce a stiff, workable mortar and shall in no case exceed 5-1/2 gallons of water per sack of cement. The pipe ends shall be thoroughly cleaned and wetted with water before the joint is made. Stiff mortar shall then be placed in the lower half of the bell or groove of the pipe section already laid.

Next, mortar shall be applied to the upper half of the spigot or tongue of the pipe section being laid. Then the spigot end of the pipe shall be inserted in the groove end of the pipe already laid, the joint pulled up tight so that the joint shall be pressed full. Care shall be taken to see that the inner surfaces of the abutting pipe sections are flushed and even. After the section is laid, the inner circumference of the joints shall be sealed and packed with mortar and finished smooth and flush with the adjacent section of pipe. Additional mortar shall be applied from the outside and forced into the unfilled portion of the bell or groove to fill completely the annular space around the spigot or tongue. Mortar joints shall be made with an excess of mortar to form a bead around the outside of the conduit. Pipes in excess of 36 inches in diameter shall have beads of not less than four (4) inches in width nor less than two (2) inches in thickness. The completed joints shall be protected against rapid drying by suitable covering material. The backfilling operation shall be performed in such manner as not to disturb the mortared joints. After placement of the earth fill, any joints found not filled with mortar due to settlement or other reasons, shall be finished smooth and even with the inside surface of the pipe.

The jointing sections of other types of pipe shall be done in a workmanlike manner in accordance with the standard practice recommended by the manufacturer of the pipe being used, as detailed on the plans, and as directed by the Engineer.

Backfilling: The contractor shall advise the Engineer of the time he expects to begin backfilling operations. The Engineer may require, when he deems necessary, the excavation and recompaction of the backfilling material if he is not properly advised.

The material for backfilling shall either be soil or approved aggregate material which can be readily compacted. It shall not contain large stones, frozen lumps, chunks of highly plastic clay, or any other material which is objectionable.

The backfill material shall be thoroughly compacted at the proper moisture content, in layers not exceeding six (6) inches in compacted thickness. Compaction shall be performed by the use of mechanical tampers with the assistance of hand tamps when necessary. Care shall be exercised to compact thoroughly the backfill under the haunches of the pipe and to ensure that the backfill soil is in intimate contact with the side of the pipe. The backfill shall be brought up evenly on both sides of the pipe for its full length.

Backfill compaction may be supplemented by rolling or operating heavy equipment

longitudinally parallel with the culvert, provided care is taken to avoid displacement or damage of the pipe.

On projects where the original pavement structure is being retained, the pipe shall be laid as herein specified. The portion of the pavement structure, required to be removed due to the excavation of the trench, shall be repaired using the same type materials as was used in the original construction. The Engineer may accept the use of other materials under unusual conditions. The work shall be performed as directed by the Engineer. The cost of the materials used and the labor involved shall be included in the unit bid price for pipe.

Removing Existing Pipe: Existing pipe shall be removed in accordance with the provisions of Subsection 22.4 and 22.5.

Cleaning Out Pipe: The entire length of new and relaid pipe culverts shall be thoroughly cleaned out. Retained pipe culverts shall be maintained in the same condition as existed prior to beginning of work.

Placing Pipe Under Railroads and Other Transportation Facilities: When the plans include the installation of pipe under railroads or other transportation facilities not under the jurisdiction of the City, the contractor shall, unless otherwise provided, in addition to the requirements of these specifications, install the pipe using such methods and procedures required by the owner and no additional payment will be made.

1.4 Method of Measurement

For all pipe, the quantity of the pipe to be measured for payment shall be the actual number of linear feet of pipe culverts of the type and sizes specified, installed complete in place, and accepted.

1.5 Basis of Payment

The footage of new pipe, measured as provided in Subsection 1.4, will be paid for at the contract unit prices per linear foot for each of the types, classes, sizes, and dimensions called for in the bidding document, complete in place and accepted and shall include the costs to provide wyes, tees, risers, bends, adapters, and plugs which price and payment shall be full compensation for furnishing, hauling, and placing all pipe and materials, excavation and backfilling new or existing trench, pipe bedding material, removal of existing pipe to be replaced, constructing connections, removal of old endwalls, unless otherwise provided, cleaning out pipe, disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 04010 STORM DRAINAGE CATCH BASINS, DROP INLETS, MANHOLES, JUNCTION BOXES AND SPRING BOXES

1.1 SCOPE

This work shall consist of the construction or adjustment to grade of catch basins, drop inlets, and junction boxes at the location shown on the plans, or directed by the Engineer in accordance with these specifications and in conformity with the lines and grades shown on the plans or established by the Engineer.

1.2 MATERIALS

Portland Cement Concrete: All concrete shall conform with the requirements specified in Sections 19 and 20.

Concrete Brick: Concrete brick shall conform with the requirements of ASTM C-55 Grade, S-II.

Mortar Materials: Mortar materials shall conform to the requirements specified in Subsections 19 and 26.

Castings: All iron castings for frames, grates, covers, etc., shall conform to the requirements of AASHTO M-105. Unless otherwise indicated on the plans, the class shall be No. 20.

Castings shall be boldly filleted at angles, and the arises shall be sharp and perfect. They shall be true to pattern in form and dimensions; free from pouring defects, sponginess, cracks, blow holes, and other defects affecting their strength and value for the service intended. The castings shall be clean and neatly furnished. Gratings and covers shall fit firmly into their respective frames.

Reinforcing Steel: Reinforcing steel shall conform with the requirements of the applicable section..

Structural Steel: Structural steel shall conform to the requirements of ASTM A-36.

Steps: Steps shall be designed for the installation of a whole brick into the back section for securely holding the step into the wall and shall be heavy cast iron approximately five (5) inches wide and one (1) inch thick. Steps shall be placed to provide vertical alignment of the ladder rungs. Steps shall be similar to Sumter Machinery Company's MH-Step No. 1, Dewey Brothers MH-ST 7, or approved equal.

Precast Manhole Sections: Precast manhole sections, if used, shall conform to ASTM C-478. The minimum wall thickness shall be five (5) inches. Cones shall be of the eccentric type unless otherwise specified. Joints in riser sections shall be gasket type conforming to ASTM C-361. No more than two (2) lift holes shall be cast or drilled in each section. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of the barrel.

1.3 CONSTRUCTION REQUIREMENTS

Excavation: Excavation shall be made to the required depth, and the fountain on which the masonry is to be constructed shall be compacted to a firm, even surface. The excavation shall include the removal of all obstructions and also the removal and replacement of unstable materials necessary for a proper foundation. Excavation will not be measured or paid for as a separate item.

Brick Masonry: Brick Masonry shall be constructed in accordance with Section 26.

Concrete Masonry: Concrete masonry shall be constructed in accordance with Sections 19 and 20. Reinforcing steel, if required, shall be placed in position as shown on the plans. Care shall be exercised to keep all steel in its proper position.

Placing Precast Manhole Sections: Precast sections shall be set on a firm, dry, even, and unyielding base. Each section shall be placed and aligned to provide vertical sides and vertical alignment of the ladder rungs. Precast base sections are acceptable. When cast-in-place bases are used, the first section shall be placed on the monolithic concrete base before the concrete has taken its initial set. The first section shall be carefully adjusted to true grade and alignment with all pipes properly installed so as to form an integral watertight unit. The first section shall be uniformly supported by the base concrete and shall not bear directly on any of the pipes.

All joints between precast elements shall be made with an approved rubber gasket. All lift holes shall be completely filled with bituminous material or grout.

Placing Pipe: Inlet and outlet pipes, of the same size and kind with which they are to be connected, shall be incorporated in the structure at the elevation, direction, and grade required. These pipe connections shall be neatly and substantially placed in the masonry. The inner ends of the pipe shall be placed flush with the inner faces of the walls, unless the Engineer directs otherwise.

Placing Castings: The castings shall be set true to grade in full mortar beds composed of one part Portland Cement to two parts of fine aggregate, meeting the requirements and mixed as specified in Section 26.

Grade Adjustment of Existing Structure: When grade adjustments of existing structures are specified, the frames, covers, and gratings shall be removed and the walls reconstructed as required. The work shall be performed in such a manner as to use salvaged materials when practicable. New materials necessary to complete the adjustment shall be furnished by the contractor.

The existing structure shall be adjusted to the required grade and elevation by carefully removing the grating, removing and adding masonry below or above the existing masonry, and replacing the casting on full mortar beds to the new elevation.

Backfilling: The excavated areas which are not occupied by the structure shall be backfilled with suitable material which shall be placed and thoroughly compacted in layers of not more than six (6) inches.

1.4 METHOD OF MEASUREMENT

Catch basins, drop inlets, manholes, junction boxes, and spring boxes, both new and adjusted as applicable, complete in place and accepted, will be measured by the unit and shall include all frames, gratings, and fittings necessary to complete the unit.

1.5 BASIS OF PAYMENT

(a) The quantities, as measured in Subsection 1.4, will be paid for at the contract unit price each for catch basins, drop inlets, manholes, junction boxes, or spring boxes or the unit price for each adjusted catch basin, drop inlet, manhole, junction box, or spring box as applicable.

(b) Making connection with existing culverts or drains, drainage openings, excavation, backfilling, disposal of surplus material, replacing pavement, reinforcing steel and other miscellaneous items needed to complete the work will not be paid for separately, but the cost thereof shall be included in the cost of the various pay items.

Payment will be made under:

Pay Item		Pay Unit
New Catch Basin	_____ Type	Each
New Drop Inlet	_____ Size	Each
New Manhole	_____ Size	Each

Pay Item		Pay Unit
New Junction Box	_____ Size	Each
New Spring Box	_____ Size	Each
Adjusted Catch Basin	_____ Type	Each
Adjusted Drop Inlet	_____ Size	Each
Adjusted Manhole	_____	Each
Adjusted Junction Box	_____ Size	Each
Adjusted Spring Box	_____ Size	Each

SECTION 05100 AGGREGATE BASE COURSE

1.1 SCOPE

The work covered by this section consists of the construction of a base composed of an approved aggregate material hauled to the site, placed on the site, compacted, and shaped to conform to the lines, grades, depths, and typical sections shown on the plans or established by the Engineer.

1.2 MATERIALS

A. Aggregate base course materials shall consist of crushed stone or uncrushed gravel, or other similar material having hard, strong, durable particles free of adherent coatings.

The Contractor shall furnish aggregate base course material produced in accordance with the requirements indicated herein for Type A, aggregate unless otherwise specified in the special provisions.

All aggregates shall be from approved sources. Sources will not be approved unless the material has satisfactory soundness and satisfactory resistance to abrasion. Satisfactory soundness will be considered to be a weighted average loss of not greater than 15 percent when subjected to five (5) alternations of the sodium sulfate soundness test in accordance with AASHO T104. Satisfactory resistance to abrasion will be considered to be a percentage of wear of not greater than 55 percent when tested in accordance with AASHO T96.

B. Aggregates shall be handled in such a manner as to minimize segregation.

Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground surface shall be firm, smooth, and well drained. A cover of at least three (3) inches of aggregate shall be maintained over the ground surface in order to avoid the inclusion of soil or foreign material. Stockpiles shall be built in such a manner as to minimize segregation. When it is necessary to operate trucks or other equipment on a stockpile in the process of building the stockpile, it shall be done in a manner approved by the Engineer.

Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or else separated by suitable walls or partitions, to prevent the mixing of the aggregates.

Any method of stockpiling aggregates which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted.

Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has been operated, and failure of such samples to meet all grading requirements for the aggregate will be considered cause for discontinuance of such stockpiling procedure.

C. Gradation. All standard sizes of aggregates shall meet the gradation requirements when tested in accordance with AASHO T27.

1.3 HAULING AND PLACING AGGREGATE BASE MATERIALS

The aggregate material shall be spread on the subgrade to a uniform loose depth and without segregation.

Where the required compacted thickness of base is 8 inches or less the base material may be spread and compacted in one layer. Where the required compacted thickness of base is more than 8 inches, the base material shall be spread and compacted in 2 or more approximately equal layers. The minimum compacted thickness of any one layer shall be approximately 4 inches.

Each layer of material shall have been sampled, tested, compacted, and approved prior to placing succeeding layers of base material or pavement.

No base material shall be placed on frozen subgrade or base. Hauling equipment shall not be operated on subgrade or a previously completed layer of base material soft enough to rut or weave beneath the equipment.

The maximum speed of trucks hauling or traveling over any part of the subgrade or base shall be 5 miles per hour.

The Contractor shall utilize methods of handling, hauling, and placing which will minimize segregation and contamination. If segregation occurs, the Engineer may require that changes be made in the Contractor's methods to minimize segregation, and may also require mixing on the road which may be necessary to correct any segregated material. No additional compensation will be allowed for the work of road mixing as may be required under this provision. Aggregate which is contaminated with foreign materials to the extent the base course will not adequately serve its intended use shall be removed and replaced by the Contractor at no additional cost to the Owner. The above requirements will be applicable regardless of the type of aggregate placed and regardless of prior acceptance.

1.4 SHAPING AND COMPACTION

Immediately after the placing of a layer of the base, the Contractor shall begin machining and compacting the layer. Each layer shall be maintained to the required cross section during compaction and each layer shall be compacted to the required density prior to placing the next layer.

Each layer of the base shall be compacted to a density equal to at least 100% of that obtained by compacting a sample of the material in accordance with AASHO T180 as modified by the Owner. Copies of these modified testing procedures are available upon request from the Department of Materials and Tests.

The base material shall be compacted at a moisture content which is approximately that required to produce the maximum density indicated by the above test methods. The Contractor shall dry or add moisture to the material when required to provide a uniformly compacted and acceptable base.

The final layer of the base material shall be shaped to conform to the lines, grades, and typical sections shown on the plans or established by the Engineer. When completed the base course shall be smooth, hard, dense, unyielding, and well bonded. A broom drag shall be used in connection with the final finishing and conditioning of the surface of the base course.

1.5 TOLERANCES

After final shaping and compacting the base, the Engineer will check the surface of the base for conformance to grade and typical section and will determine the base thickness.

The thickness of the base shall be within a tolerance of plus or minus 1/2 inch of the base thickness required by the plans.

1.6 MAINTENANCE

Where the base material is placed in a trench section, the Contractor shall provide adequate drainage through the shoulders to protect the subgrade and base until such time as shoulders are completed. The Contractor shall maintain the surface of the base by watering, machining, and rolling or dragging when necessary to prevent damage to the base by weather or traffic.

1.7 MEASUREMENT

The quantity of Aggregate Base Course to be paid for will be the actual number of square yards of material measured along the surface of the ground at the specified compacted thickness or the actual number of ton , as specified in the bidding document, which have been incorporated into the completed and accepted work.

1.8 BASIS OF PAYMENT

The quantity of Aggregate Base Course, measured as provided in subsection 1.7 will be paid for at the contract unit price as specified in the bidding document. In all cases, regardless of the unit of measure, the contractor shall furnish copies of certified weight tickets for all material placed on the project.

1.1 SCOPE

The work covered by this section consists of the construction of a bituminous plant mix base course composed of a mixture of coarse and fine aggregates, asphalt cement, and mineral filler when required, properly laid upon a prepared surface, in accordance with these specifications and in conformity with the lines, grades, thickness, and typical sections shown on the plans.

1.2 COMPOSITION OF MIXTURE

A. General Requirements:

A combination of graded coarse and fine aggregates will be required which will produce an acceptable mix. The coarse aggregate shall consist of standard sizes No. 1 and No. 13, except that other standard sizes may be used when approved by the Engineer.

At least 1/2 of the fraction passing the No. 200 sieve shall be mineral filler or stone screenings.

The total natural sand or sands in the mixture will be tested in accordance with AASHO T11 to determine the amount of material which can be washed through the No. 200 sieve. The total amount of such washed material shall not exceed 8 percent by weight of the total aggregate in the mixture. The above test will be performed prior to establishing the design mix and, when required by the job mix formula, prior to the entry of the sand into the drier.

B. Job Mix Formula:

A job mix formula will be established by the Engineer for the particular materials the Contractor proposes to use. The job mix formula will be established within the design limits listed in the Table below:

Table
Design Limits

Sieve Designation	Total Percent Passing
2"	100
1-1/2"	90-100
3/4"	60-85
No. 4	25-50
No. 10	20-35
No. 200	0-6
Asphalt Cement Content Range	3.0-6.0%
Temperature Range	250 F. - 300 F.

The completed mix shall conform to the job mix formula within the tolerances shown in the Table below:

Table
Tolerances for Job Mix Formula

Sieve Designation	Tolerance for Percent Passing
2"	0
1-1/2"	(+/-) 5
3/4"	(+/-) 8
No. 4	(+/-) 7
No. 10	(+/-) 5
No. 200	(+/-) 2
Asphalt Cement Content Range	(+/-) 0.5%
Temperature Tolerance	(+/-) 15 F.

When a mix has been tested and has been found to be outside of the design limits, the Engineer may require the removal from the road of any of this mix which has been placed. All such mix which has been removed shall be replaced with plant mix which is within the job mix formula and allowable tolerances at no cost to the Owner.

C. *Stability:*

The fine aggregate material which is to be blended with the coarse aggregate, exclusive of particles retained on a No. 10 sieve but including any added mineral filler, shall have a stability of not less than 800 pounds as determined by the two (2) inch Original Hubbard-Field method of test.

When No. 7 stone is permitted to be used, that portion of this aggregate which passes the No. 10 sieve shall be included in the above stability test.

1.3 CONSTRUCTION REQUIREMENTS

All Bituminous Concrete Base Course Type HB shall be produced, transported to the site, placed and compacted in accordance with the latest requirements of Section 610 of the North Carolina Department of Transportation Standard Specifications for Roads and Structures and Section 05450 of the Contract Documents.

The bituminous plant mix shall be compacted to a density equivalent to at least 92% of the maximum specific gravity determined using AASHTO T 209.

1.4 METHOD OF MEASUREMENT

The quantity of Bituminous Concrete Base Course Type HB (binder) to be paid for will be the actual amount of base course which has been incorporated into the completed and accepted work. The base course unit of measurement will be as specified in the bidding documents.

1.5 BASIS OF PAYMENT

The quantity of Bituminous Concrete Base Course Type HB (binder), measured as specified in Section 1.4, will be paid for at the unit contract price specified in the bidding documents and Contract Special Conditions. In all cases, the Contractor shall furnish copies of certified weight tickets for all Base Course placed on the project.

SECTION 05351 BITUMINOUS TACK COAT

1.1 SCOPE

The work covered by this section consists of treating an existing bituminous or concrete surface with bituminous material in accordance with these specifications.

Tack coat shall be applied beneath each layer of bituminous plant mix base or pavement to be placed except where a prime coat has been applied. Tack coat will not be required beneath an open-graded asphalt friction course unless specified by the Engineer.

1.2 MATERIALS

All materials shall meet the requirements shown below:

Tack coat for bituminous surface treatments:

Asphalt, Grade AC-20
Asphalt, Grade RS-1H
Asphalt, Grade CRS-1H
Asphalt, Grade CRS-1

When tack coat is required beneath an open-graded asphalt friction course the asphalt grade to be used will be specified on the job mix formula.

1.3 WEATHER LIMITATIONS

Tack shall be applied only when the surface to be treated is sufficiently dry and the atmospheric temperature in the shade away from artificial heat is 35 degrees F. or above.

Tack coat shall not be applied when the weather is foggy or rainy.

1.4 SURFACE PREPARATIONS

The surface to which the tack coat is to be applied shall be cleaned of objectionable dust, dirt, clay, and any other deliterious matter prior to placing the tack coat.

The Contractor shall remove grass, dirt and other materials from the edge of the existing pavement prior to the placement of tack coat.

1.5 ACCEPTANCE OF BITUMINOUS MATERIALS

Bituminous materials will be accepted at the source of shipment subject to the following conditions.

All bituminous transport tankers shall have a sampling valve in accordance with the recommendation of the Asphalt Institute and ASTM DI40, or a comparable device acceptable to the Engineer.

Each transport tanker delivering bituminous materials to the project shall keep a running log showing the date, destination, and type and grade of material hauled on each trip. The tanker number shall be printed, stamped, or written in ink on each log book. The log book shall be available for examination upon request of the Engineer at any time.

The Contractor shall furnish with each shipment two (2) copies of the delivery ticket. One copy shall accompany the shipment and be delivered to the Engineer or his representative at the destination. The delivery ticket shall contain the following information: Delivery ticket number, date shipped, state project or purchase order number, destination, name of consignee, trailer number, storage tank or batch number, quantity loaded (pounds or gallons), loading temperature, correction factor used, and net gallons at 60 degrees F.

In addition to the delivery tickets, the Contractor shall furnish a statement of certification which is signed (not initialized or stamped) by an authorized representative of the supplier and which is either stamped, written, or printed on the delivery ticket; or attached thereto. The certification shall be essentially in the following form:

"This is to certify that this shipment of ____ gallons of ____ grade (Asphalt) (tar) meets all requirements of the applicable North Carolina Department of Transportation Specifications, and that the transport tank was clean and free from contaminating materials when loaded. The material transported on the previous load in this tanker was _____."

Signed_____
Authorized Representative of Supplier

Failure to sign the certification will be cause to withhold use of the material until a sample can be taken and tested.

The Engineer reserves the right to sample and test any shipment regardless of whether or not the above conditions have been met and to reject any material not meeting the requirements of the specifications.

1.6 APPLICATION EQUIPMENT

The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface at predetermined and controlled rates. The width of application shall not exceed 20 1/2 feet unless otherwise permitted in writing by the Engineer. Distributor equipment shall include an accurate volume measuring device or a calibrated tank, and a thermometer for measuring the temperature of the tank contents. The distributor shall be equipped with a power driven pump, full circulation spray bars adjustable laterally and vertically, and hand hose for hand application. The volume of the distributor tank shall be calibrated by a commercial laboratory prior to use and the calibration chart shall be kept with the distributor at all times.

1.7 APPLICATION RATES AND TEMPERATURES

Tack coat shall be uniformly applied at a rate from 0.02 to 0.05 gallons per square yard. The exact rate of application will be established by the Engineer. When tack coat is required beneath an open-graded asphalt friction course, the exact rate of application will be specified on the job mix formula and will be within the range of 0.02 to 0.08 gallons per square yard.
The temperature of the material at the time of application shall be within the ranges shown in the table below:

Table
Application Temperatures for Tack Coat

Bituminous Material	Temperature Range
Asphalt Cement AC-20	385 F. - 500 F.
Asphalt, Grade RS-111	90 F. - 150 F.
Asphalt, Grade CRS-1H	90 F. - 150 F.
Asphalt, Grade CRS-1	90 F. - 150 F.

1.8 APPLICATION OF TACK COAT

No more tack coat material shall be applied than can be covered with base, binder, or surface course during the following day's operations.
Tack coat shall be applied only in the presence of and as directed by the Engineer. No base or surface mixture shall be deposited thereon until the tack coat has sufficiently cured.

Contact surfaces of headers, curbs, gutters, manholes, vertical faces of old pavements, and all exposed transverse and longitudinal edges of each course shall be painted or sprayed with tack coat before mixture is placed adjacent to such surfaces.

Bridge floors, curbs and handrails of structures, and all other appurtenances shall be covered to prevent tack coat from being tracked or splattered on the structures or appurtenances.

1.9 MAINTENANCE AND PROTECTION

After the tack coat has been applied, it shall be protected until it has cured for a sufficient length of time to prevent if from being picked up by traffic.

1.10 BASIS OF PAYMENT

There shall be no direct payment for the placement of tack coat but it shall be considered incidental to asphalt paving.

SECTION 05400 BITUMINOUS CONCRETE SURFACE COURSE TYPES I-1 AND I-2

1.1 SCOPE

The work covered by this section consists of the construction of a bituminous plant mix surface course composed of a mixture of coarse and fine aggregates, asphalt cement, and mineral filler when required, properly laid upon a prepared surface, in accordance with these specifications and in conformity with the lines, grades, thickness, and typical section shown on the plans.

1.2 COMPOSITION OF MIXTURE

A. General Requirements:

A combination of graded coarse and fine aggregates will be required which will produce an acceptable mix. The use of crusher run material will not be permitted. The coarse aggregate shall consist of standard size No. 13, except that other standard sizes may be used when approved by the Engineer.

At least 1/2 of the fraction passing the No. 200 sieve shall be mineral filler or stone screenings.

The total natural sand or sands in the mixture will be tested in accordance with ASSHO T11 to determine the amount of material which can be washed through the No. 200 sieve. The total amount of such washed material shall not exceed 8 percent by weight of the total natural sand in the mixture. The above test will be performed prior to establishing the design mix and, when required by the job mix formula, prior to the entry of the sand into the drier.

B. Job Mix Formula:

A job mix formula will be established by the Engineer for the particular materials the Contractor proposes to use. The job mix formula will be established within the design limits listed in the Table below:

Table
Design Limits

		TOTAL PERCENT PASSING	
SIEVE DESIGNATION	TYPE I-1		TYPE I-2
1/2"	100		100
3/8"	---		90 - 100
No. 4	55 - 80		70 - 95
No. 10	40 - 60		55 - 75
No. 40	15 - 35		15 - 45
No. 80	6 - 20		7 - 22
No. 200	3 - 9		3 - 9
Asphalt Cement Content	4.5% - 7.5%		4.5% - 8.5%
Temperature Range	250 F. - 300 F.		250 F. - 300 F.

In addition to the requirements of the Table, the amount of material between any adjacent sieves, except between the 1/2 inch and the 3/8 inch sieves in the case of Type I-2 mixtures, shall not be less than 4 percent.

The completed mix shall conform to the job mix formula within the tolerances shown in the Table below:

Table

Tolerances for Job Mix Formula

SIEVE DESIGNATION	TOLERANCE FOR PERCENT PASSING
1/2"	0
3/8"	(+/-) 5
No. 4	(+/-) 7
No. 10	(+/-) 5
No. 40	(+/-) 5
No. 80	(+/-) 5
No. 200	(+/-) 2
Asphalt Cement Tolerances	(+/-) 0.5%
Temperature Tolerance	(+/-) 15 F.

When a mix has been tested and has been found to be outside of the design limits, the Engineer may require the removal from the road of any of this mix which has been placed and which is represented by the test results. All such mix which has been removed shall be replaced with plant mix which is within the job mix formula and allowable tolerances at no cost to the Owner.

C. *Requirements for Completed Plant Mix:*

The completed mix shall meet the requirements shown in the Table below when tested in accordance with the Marshall Method of Test:

Table

Requirements for Marshall Method of Test

		VALUE	
REQUIREMENT	I-1		I-2
Stability, Minimum	1200 lbs.		600 lbs.
Flow	7 - 14		7 - 14
Void Content	3 - 8		4 - 10

1.3 CONSTRUCTION REQUIREMENTS

Where the surface course is to be placed on Type H binder course, the surface course shall be placed as soon as possible after the binder course has been placed and in all cases during the same paving season. The bituminous plant mix shall be compacted to a density of at least 95% of the laboratory density as determined by the Marshall Method Test.

1.4 METHOD OF MEASUREMENT

The quantity of surface course to be paid for will be the actual amount of surface course which has been incorporated into the completed and accepted work.

1.5 BASIS OF PAYMENT

The quantity of surface course, measured as provided in subsection 1.4 will be paid for at the contract prices as specified in the bidding documents. In all cases, the Contractor shall furnish copies of certified weight tickets for all surface course placed on the project.

SECTION 05450 PAVING

1.1 DESCRIPTION

The work covered by this section consists of the production, delivery, and placement of all types of bituminous plant mixed bases and surface courses to the lines, grades, thickness, and typical section shown on the plans or established by the Engineer.

1.2 MATERIALS

All materials shall meet the requirements referred to in the various sections of the specifications covering the type of plant mix being constructed.

1.3 COMPOSITION OF MIXTURES

The bituminous plant mix shall be composed of a mixture of aggregate, asphalt cement, and mineral filler when required. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of a job mix formula prepared by the Engineer. Materials which will not produce a job mix within the full allowable tolerances required by these specifications will be rejected.

The job mix formula with the allowable tolerances shall be within the design limits specified for the particular type of bituminous mixture. The job mix formula for each mixture will establish a single percentage of aggregate passing each required sieve size, a single percentage of asphalt cement to be added to the aggregate, and a single temperature at which the mixture is to be discharged from the plant.

The job mix formula for each mixture shall be in effect until modified in writing by the Engineer.

All mixtures furnished for the work shall conform to the job mix formula within the tolerance ranges specified for the particular mix involved as specified herein.

Should a change in sources of aggregate materials be made, a new job mix formula will be required before the new mixture is produced.

When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job mix formula.

The asphalt cement for the mixture will be accepted at the source subject to the provisions of these specifications. Silicone shall be added to all asphalt cement used in surface courses and open-graded asphalt friction course, Type J-1, unless otherwise directed by the

Engineer. The amount of silicone added shall range from 1 oz. per 2,000 gallons of asphalt cement to 1 oz. per 2,500 gallons. The addition of the silicone to the asphalt cement shall be in the presence of the Engineer unless it is added at the source and it is so noted on the delivery ticket.

The brand of silicone used shall be from the list published by the N. C. Department of Transportation. A Contractor proposing to use a brand not on the approved list shall submit a sample and manufacturer's data to the Engineer for approval prior to use.

1.4 WEATHER AND TEMPERATURE LIMITATIONS FOR PRODUCING AND PLACING BITUMINOUS MIXTURES

Bituminous mixtures shall not be produced or placed during rainy weather, when the subgrade or base course is frozen, or when the moisture on the surface to be paved would prevent proper bond. Bituminous material shall not be placed when the air temperature, measured in the shade away from artificial heat at the location of the paving operations, is less than the following temperatures:

MATERIAL	THICKNESS OF LAYER BEING PLACED	AIR TEMPERATURE
Bituminous Concrete Base Course, Type HB; Bituminous Concrete Binder Course; or Sand Asphalt Base Course	1-1/2" or Greater	35 Degrees
Bituminous Concrete Bind Course, or Sand Asphalt Base Course	Less Than 1-1/2"	40 Degrees
Surface Course Materials	1" or Greater	40 Degrees (except final layer)
Surface Course Materials	1" or Greater	40 Degrees for Final Layer except 50 Degrees Between Nov. 1 and April 1
Surface Course Materials	Less Than 1"	50 Degrees except 60 Degrees Between No. 1 and April 1

In addition, open-graded asphalt friction course, Type J-1, shall not be placed between November 1 and April 1.

As an exception to the above, when in any day's operations the placement of a layer of bituminous base course material or binder material 1 1/2" or greater in thickness has started, it may continue until the temperature drops to 32 degrees F.

1.5 BITUMINOUS MIXTURE PRODUCTION

The Contractor shall submit a certification that all bituminous production is performed under the exact requirements and specifications used by the North Carolina Department of Transportation. If required by the Engineer, the Contractor shall arrange for an inspection of the production facilities.

1.6 SURGE STORAGE BINS

Surge storage bins may be used providing the mix that is discharged from the bin meets the requirements of the job mix formula.

1.7 HOT MIX SILO STORAGE BINS

Hot mix silo storage bins may be used providing the mix that is discharged from the bin meets the requirements of the job mix formula.

1.8 MIXTURE TICKETS

When required by the Engineer, the automatic weighing and recording system shall be checked by weighing a truck load of mix with an approved set of platform scales. Other means of checking the automatic weighing and recording system will be designated by the Engineer if such checking becomes necessary.

The Contractor will not be permitted to use mixture delivered to the road which is not accompanied by a load ticket signed by the weighman or an automatic printout ticket in accordance with the above requirements.

The original of all tickets, including any voided tickets or tickets for rejected mixture, shall become the property of the Engineer.

1.9 TRANSPORTATION OF BITUMINOUS MIXTURE

The mixture shall be transported from the mixing plant to the point of use in vehicles which have tight, clean, smooth metal beds that have been sprayed with a lime solution, a soap and oil solution, or other approved material, to prevent the mixture from adhering to the beds. Each vehicle shall be covered with a canvas or other suitable material. All covers shall be so constructed and secured as to prevent the entrance of moisture and the rapid loss of temperature. A 3/8 inch diameter hole shall be provided on each side of the vehicle body near the center of the body and 6 inches above the bed of the vehicle for the purpose of inserting a thermometer.

The temperature of the mixture immediately prior to discharge from the hauling vehicle shall be within a tolerance of plus 15 degrees F. to minus 25 degrees F. of the specified job mix temperature.

1.10 SPREADING AND FINISHING

Tack coat shall be applied in accordance with the provisions of Section 05200.

The bituminous mixture shall be spread and struck off to the required grades, cross sections, and thickness by self contained, power propelled pavers. The pavers shall be equipped with an activated screed or strike off assembly which is designed to be preheated, and shall have a sliding shoe attachment which will form a slope on the edge of the mixture which will prevent edge ravelling when the mixture is compacted.

A string line shall be placed by the Contractor for the first lane of each layer of mixture placed to provide alignment control for the paver, except that a string line will not be required when the first layer is placed adjacent to a curb section.

Pavers shall be operated at forward speeds consistent with satisfactory laying of the mixture and plant production in order to provide a uniform and continuous laydown operation. Should unevenness of texture, tearing, or shoving occur during the paving operation due to unsatisfactory methods or equipment, the Contractor shall immediately take such action as may be necessary to correct such unsatisfactory work. Throwing back excessive material will not be permitted.

When placing adjacent lanes of the same course, pavers shall be equipped with a joint matching device which will automatically provide control of the depth of the mixture being placed so that, when compacted, it will match the depth of the existing lane.

When required by the special provisions, pavers shall be equipped with a joint matching device which will automatically provide control of the depth of the mixture being placed so that, when compacted, it will match the depth of the existing lane.

When required by the special provisions, pavers shall be equipped with a control system which will automatically control the longitudinal profile and cross slope of the pavement by the use of either a mobile string line or fixed string line. When a fixed string line is required, the Engineer will furnish grade stakes for the finished pavement grade and the Contractor shall furnish and erect the necessary guide line for the equipment.

The Engineer will waive the requirement for automatic paver controls in areas where the use of such equipment is impractical due to irregular cross section or shape. In the case of malfunction of the automatic control equipment, the Contractor may manually operate the paver for the remainder of the work day only.

The Engineer will waive the requirement for use of pavers for spreading and finishing where irregularities or obstacles make their use impractical and the Contractor shall spread, rake, and lute the mixture by hand methods.

Roadway paving shall be as continuous as possible. Intersections and irregular areas shall be paved after the adjacent roadway has been paved.

1.11 COMPACTION

A. Immediately after the bituminous mixture has been spread, struck off, and surface and edge irregularities adjusted, it shall be thoroughly and uniformly compacted. The degree of compaction required shall be in accordance with the applicable section of the specifications for the type of mixture being placed.

All final wearing surfaces except open-graded asphalt friction course, Type J-1, shall be compacted using a minimum of 2 steel wheel tandem rollers. Steel wheel tandem vibrating rollers may be used provided they are operated without vibration.

Rollers used to compact the mixture shall be in good condition, capable of reversing without backlash. The rollers shall be operated with the drive wheels nearest the paver and at speeds slow enough to avoid displacement of the mixture. Steel wheel rollers shall be equipped with wetting devices to prevent the mixture from sticking to the roller wheels.

The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition.

Rolling for open-graded asphalt friction course shall consist of one coverage with a tandem steel wheel roller weighing a maximum of 10 tons, with additional rolling limited to one coverage with the roller where necessary to improve riding surface.

The use of rolling equipment with results in excessive crushing of the aggregate or excessive displacement of the mixture will not be permitted.

In areas inaccessible to equipment, the mixture shall be thoroughly compacted by the use of hand tampers or hand operated mechanical tampers.

B. The tolerance of the final compacted pavement shall be 1 1/4 inch from the typical cross-sections shown on the plans.

1.12 JOINTS

A. Transverse Joints:

When the laying of the mixture is to be suspended long enough to permit the mixture to become chilled, transverse joints shall be constructed. At the end of the day's operation the Contractor shall construct a sloped wedge ahead of the end of the full depth pavement to provide for proper compaction and protection of the full depth pavement. When directed by the Engineer, the Contractor shall place a paper parting strip beneath this wedge to facilitate joint construction.

Before paving operations are resumed, the Contractor shall remove the sloped wedge and cut back into the previously constructed pavement to the point of full pavement depth. The exposed edge of the previously constructed pavement shall then be lightly coated with tack coat.

When laying of the mixture is resumed at the joint, the construction of the joint shall be completed while the mixture is still in a workable condition.

B. Longitudinal Joints:

Longitudinal joints shall be formed by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. The joint shall be pinched by rolling immediately behind the paver.

When multi-lane multi-layer construction is required, the longitudinal joint in each layer shall offset that in the layer immediately below by approximately 6 inches. The joint in the top layer shall be constructed, where possible, between design travel lanes.

1.13 PAVEMENT SAMPLES

Samples of the mixture shall be taken from the full depth of the course at locations designated by the Engineer.

Where samples have been taken, new material shall be immediately placed and compacted to conform with the surrounding area by the Contractor.

1.14 SURFACE REQUIREMENTS

The surface of the plant mix base or pavement after compaction shall be smooth and true to the required cross section and grade. Any defective areas shall be corrected with satisfactory material which shall be immediately compacted to conform with the surrounding area. Any area showing an excess of asphalt cement shall be removed and replaced.

The surface will be tested by the Engineer at all joints and at other selected locations using a 10 foot straightedge. The variation of the surface from the testing edge of the straightedge,

when applied parallel to the centerline of the surface, shall not exceed 1/8 inch between any two contact points. Areas found to exceed this tolerance shall be corrected by the Contractor by removal of the defective work and replacement with new material unless other corrective measures are permitted by the Engineer. The work and materials required in the correction of defective work shall be provided by the Contractor at no cost.

1.15 COMPENSATION

There will be no direct payment for the work covered by this section.

SPECIFICATIONS

Glass-Coated, Bolted-Steel Potable Water Tank

AWWA Design

1.0 GENERAL

1.1 Scope of Work

1.1.1 Furnish and erect a glass-coated, bolted-steel water storage tank, including foundation, tank structure and tank appurtenances as shown on the contract drawings and described herein.

1.1.2 All required labor, materials and equipment shall be included.

1.2 Qualifications of Tank Supplier

1.2.1 The Engineer's selection of factory applied glass- fused-to-steel bolt together tank construction for this facility has been predicated upon the design criteria, construction methods specified, and optimum coating for resistance to internal and external tank surface corrosion. Deviations from the specified design, construction or coating details, will not be permitted.

1.2.2 The bidder shall offer a new tank structure as supplied from a **U.S.A.** manufacturer specializing in the design, fabrication and erection of factory applied glass-fused-to-steel, bolt together tank systems. The manufacturer shall own and operate its production plant, fabricate and glass coat the tank at one U.S.A. location.

1.2.3 The tank shown on the contract drawings and specified herein is a Model 2028 Aquastore Tank System as manufactured by Engineered Storage Products Company of DeKalb, Illinois.

1.2.4 Alternate glass-fused-to-steel tank products, as provided by other manufacturers, will be considered for prior approval by the Engineer. Manufacturers lacking the experience requirement will not be considered. The Owner's decision or judgment on these matters will be final, conclusive and binding.

1.2.5 Strict adherence to the standards of design; fabrication; erection; product quality; and long term performance, established in this Specification will be required by the Owner and Engineer.

1.2.5.1 Tank or Dome substitutions which cause engineering and contract changes - the tank installation as shown on the plans and specified herein, is based on the equipment furnished by one manufacturer. A tank which is offered as a substitute to the specific requirements of these Specifications and which differs in detail and arrangement from that shown may require changes in design and construction. All costs which result from such changes in design and construction are to be borne entirely and unconditionally by the Contractor; said costs to included but not be limited to structural, piping, mechanical and electrical changes and all engineering costs incurred as a result of the substitution, in the revision of Plans and Specifications, review of design changes by others, preparation of change orders, and any other costs directly resulting from said substitution.

1.2.6 Tank suppliers wishing to pre-qualify shall submit the following to the Engineer/Owner for consideration 14 days prior to bid date.

1.2.6.1 Typical structure and foundation drawing(s).

1.2.6.2 List of tank materials, appurtenances and tank coating specs.

1.2.6.3 List of five (5) tanks presently in **U.S.A.** potable water service, of size and character specified herein, operating satisfactorily for a minimum of five (5) years, including the name and telephone number of Owner and Engineer. The tanks listed shall have been manufactured in the present production facility; not by a predecessor company in a different facility.

1.2.6.4 Certification from tank manufacturer that the tank meets all of tank design standards listed in Section 2.0.

1.2.7 Only bids from **U.S.A.** manufactured tank suppliers who have successfully pre-qualified will be considered.

1.2.8 The Engineer reserves the right to evaluate all bids based on long term, 30 year minimum operation, coating and maintenance costs. Values to be used in this evaluation will be at the discretion of the Engineer, as detailed in this specification and bid tabulation form. The Engineer will add such costs, dependent upon the type of tank offered, to the bidder's bid price to determine the effective low bid for purposes of making the award.

1.3 Submittal Drawings and Specifications

1.3.1 Construction shall be governed by the Owner's drawings and specifications showing general dimensions and construction details, after written approval by the Engineer of detailed erection drawings prepared by the tank bidder. There shall be no deviation from the drawings and specifications, except upon written order from the Engineer.

1.3.2 The bidder is required to furnish, for the approval of the Engineer and at no increase in contract price, _4_ sets of complete specifications and construction drawings for all work not shown in complete detail on the bidding drawings. A complete set of structural calculations shall be provided for the tank structure and foundation. All such submissions shall be stamped by a Registered Professional Engineer licensed in the state of project location, as well as, by a Registered Professional Engineer employed on the tank manufacturer's engineering staff.

1.3.3 When approved, two sets of such prints and submittal information will be returned to the bidder marked "APPROVED FOR CONSTRUCTION" and these drawings will then govern for the work detailed thereon. The approval by the Engineer of the tank supplier's drawings shall be an approval relating only to their general conformity with the bidding drawings and specifications and shall not guarantee detail dimensions and quantities, which remains the bidder's responsibility.

1.3.4 The tank manufacturer's and installing contractor's standard published warranty shall be included with submittal information.

2.0 DESIGN CRITERIA

2.1 Tank Size

2.1.1 The factory coated glass-fused-to-steel, bolt together tank shall have a nominal diameter of _____ feet, with a nominal sidewall height (to roof eave) of ___ feet.

2.2 Tank Capacity

2.2.1 Tank capacity shall be _____ gallons (nominal, U.S. gallons).

2.3 Floor Elevation

2.3.1 Finished floor elevation shall be set at Elevation _____.

2.4 Tank Design Standards

2.4.1 The materials, design, fabrication and erection of the bolt together tank shall conform to the AWWA Standard for "Factory Coated Bolted Steel Tanks For Water Storage" - ANSI/AWWA D103, latest revision.

2.4.2 The tank coating system shall conform solely to Section 10.4 of ANSI/AWWA D103. **NOTE:** Baked-on epoxy painted, stainless steel or galvanized bolt-together tanks are not considered equal.

2.4.3 The vitreous coating on the tank, bolt head encapsulation material, and joint sealant shall have been approved for listing under ANSI/NSF Standard 61 for Indirect Additives.

5.5.2 The tank manufacturer shall be ISO-9001 certified to assure product quality.

2.4.5 The tank manufacturer shall undergo an annual **FM** (Factory Mutual) inspection of their glass-coated, bolted-steel tank factory and provide written proof thereof to assure product quality.

2.5 Design Loads (Complete the blanks)

2.5.1 Specific Gravity _1.05__(Min. design shall be 1.0)
2.5.2 Wind Velocity __100___mph (AWWA D103 Std. 100 mph)
2.5.3 Shape Factor __.6_ (0.6 Std.)
2.5.4 Allowable Soil _3,000_psf (Per Eng.'s Bearing Capacity Soils Report)
2.5.5 Roof Snow Load _25_psf
2.5.6 Seismic per AWWA D103-97 Zone _2A_ Pseudo Dynamic.

3.0 MATERIALS SPECIFICATIONS
3.1 Plates and Sheets **Note**: all steel shall be smelted and produced in the U.S.A.
3.1.1 Plates and sheets used in the construction of the tank shell, tank floor (optional) or tank roof (optional), shall comply with the minimum standards of AWWA D103, Section 2.4.
3.1.2 Design requirements for mild strength steel shall be ASTM A570 Grade 30 with a maximum allowable tensile stress of 15,000 psi.
3.1.3 Design requirements for high strength steel shall be ASTM A607 Grade 50 with a maximum allowable tensile stress of 26,000 psi.
3.1.4 The annealing effect created from the glass coated firing process shall be considered in determining ultimate steel strength. In no event shall a yield strength greater than 50,000 psi be utilized for calculations detailed in AWWA D103, Sections 3.4 and 3.5.
3.1.5 Multiple vertical bolt line sheets and plates of ASTM A607 Grade 50 only shall be manufactured such that holes are staggered in the vertical bolt lines and that no two adjoining holes are in-line horizontally, except at the center of the sheet or plate.
1. Bolt seam design shall generally be in accordance with the requirements of AWWA D103 section 3.5.2; bolt spacing may be adjusted in the vertical bolt lines to increase the net section and improve joint efficiency to a maximum of 85%.
2. Double steel sheeting shall not be permitted to achieve structural requirements.
3.2 Rolled Structural Shapes
3.2.1 Material shall conform to minimum standards of ASTM A36 or AISI 1010.
3.3 Horizontal Wind Stiffeners
3.3.1 Design requirements for intermediate horizontal wind stiffeners shall be of the "web truss" design with extended tail to create multiple layers of stiffener, permitting wind load to transfer around tank.
3.3.2 Web truss stiffeners shall be of steel with hot dipped galvanized coating.
3.3.3 Rolled steel angle stiffeners are not permitted for intermediate stiffeners.
3.4 Bolt Fasteners
3.4.1 Bolts used in tank lap joints shall be 1/2" - 13 UNC- 2A rolled thread, and shall meet the minimum requirements of AWWA D103, Section 2.2.
3.4.2 Bolt Material
3.4.2.1 SAE Grade 2
3.4.2.1.1 Tensile Strength - 74,000 psi Min.
3.4.2.1.2 Proof Load - 55,000 psi Min.
3.4.2.1.3 Allowable shear stress - 18,164 psi (AWWA D103).
3.4.2.2 SAE grade 8/ASTM A325 heat treated to:
3.4.2.2.1 Tensile Strength - 150,000 psi Min.
3.4.2.2.2 Proof Load - 120,000 psi Min.
3.4.2.2.3 Allowable shear stress - 36,818 psi (AWWA D103).
3.4.3 Bolt Finish - Zinc, mechanically deposited.
3.4.3.1 2.0 mils minimum - under bolt head, on shank and threads
3.4.4 Bolt Head Encapsulation
3.4.4.1 High impact polypropylene co-polymer encapsulation of entire bolt head up to the splines on the shank.
3.4.4.2 Natural resin with UV (ultraviolet) light inhibitor. Color to be black.

3.4.5 All tank shell bolts shall be installed such that the head portion is located inside the tank, and the washer and nut are on the exterior.

3.4.6 All lap joint bolts shall be properly selected such that threaded portions will not be exposed in the "shear plane" between tank sheets. Also, bolt lengths shall be sized as to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after torquing will not be permitted.

3.4.7 All lap joint bolts shall include a minimum of four (4) splines on the underside of the bolt head at the shank in order to resist rotation during torquing.

3.5 Sealants

3.5.1 The lap joint sealant shall be a one component, moisture cured, polyurethane compound. The sealant shall be suitable for contact with potable water and meet applicable FDA Title 21 regulations, as well as, ANSI/NSF Additives Standard 61.

3.5.2 The sealant shall be used to seal lap joints, bolt connections and sheet edges. The sealant shall cure to a rubber like consistency, have excellent adhesion to the glass coating, have low shrinkage, and be suitable for interior and exterior exposure.

3.5.3 Sealant curing rate at 73° F and 50% RH

3.5.3.1 Tack-free time: 6 to 8 hours.

3.5.3.2 Final cure time: 10 to 12 days.

3.5.4 The sealant shall be Harvestore Products, Inc. System Sealer No. 98.

3.5.5 Neoprene gaskets and tape type sealer shall not be used.

4.0 GLASS COATING SPECIFICATION

4.1 Surface Preparation

4.1.1 Following the decoiling and shearing process, sheets shall be steel grit-blasted on both sides to the equivalent of SSPC-10. Sand blasting and chemical pickling of steel sheets is not acceptable.

4.1.2 The surface anchor pattern shall be not less than 1.0 mil.

4.1.3 These sheets shall be evenly oiled on both sides to protect them from corrosion during fabrication.

4.2 Cleaning

4.2.1 Sheet edges of sidewall and floor plates shall be **mechanically rounded** and then **flame coated with stainless steel** prior to glass coating. Glass coating of the sheet edges shall be similar to the flat panel surfaces. The process shall be equal to ***EDGECOAT***™ by Engineered Storage Products Company.

4.2.2 After edgecoating and prior to application of the coating system, all sheets shall be thoroughly cleaned by a caustic wash and hot rinse process followed immediately by hot air drying.

4.2.3 Inspection of the sheets shall be made for traces of foreign matter or rust. Any such sheets shall be re-cleaned or grit-blasted to an acceptable level of quality.

4.3 Coating

4.3.1 All sheets shall be primed with catalytic nickel oxide glass ground-coat on both sides, and then air dried per section 10.4.2.1 of AWWA D103.

5.5.2 An intermediate coat to both sides of the sheets, of cobalt blue glass frit, shall be made.

5.5.3 A top coat of titanium enhanced glass *(white color)* shall be applied to the interior surface.

5.5.4 The sheets shall then be fired at a minimum temperature of 1500 degrees F in strict accordance with the manufacturer's quality process control procedures, including firing time, furnace humidity, temperature control, etc.

4.3.5 The finished exterior color shall be the manufacturer's standard cobalt blue.

4.4 Inspection

4.4.1 All coated sheets shall be inspected for mil thickness (Mikrotest or equal).

4.4.2 All coated sheets shall be checked for color uniformity by an electronic colorimeter.

4.4.3 An electrical “holiday” detection test shall be performed on the inside surface after fabrication of the sheet. Sheets with excessive “holidays” shall be rejected so as to minimize field touch up (See Sec. 5.3.4).

4.5 Packaging

4.5.1 All approved sheets shall be protected from damage prior to packing for shipment.

4.5.2 Heavy paper or plastic foam sheets shall be placed between each panel to eliminate sheet-to-sheet abrasion during shipment.

4.5.3 Individual stacks of panels will be wrapped in heavy mil black plastic and steel banded to special wood pallets built to the roll-radius of the tank panels. This procedure eliminates contact or movement of finished panels during shipment.

4.5.4 Shipment from the factory to the job site will be by truck, hauling the tank components exclusively. No common carrier, drop, or transfer shipments.

5.0 ERECTION

5.1 Foundation

5.1.1 The tank foundation is a part of this contract.

5.1.2 The tank foundation shall be designed by the manufacturer to safely sustain the structure and its live loads.

5.1.3 Tank footing design shall be based on __3,000__ psf soil bearing capacity or greater as determined by geotechnical analysis performed by a licensed soils engineer. The cost of this investigation and analysis is not to be included in the bid price. Copies of the soils report are to be provided to the bidder prior to bid date by the Owner or Engineer.

5.1.4 Footing designs for soil bearing strengths less than that specified, and those designs deviating from tank manufacturers standard shall be the responsibility of the Owner and his Engineer based on tank live and dead loading data provided by the tank manufacturer.

5.2 Tank Floor Options: (Select 5.2.1 or 5.2.2)

5.2.1 Concrete Floor **(YES)**

5.2.1.1 The standard floor design is of reinforced concrete with an embedded glass coated steel starter sheet per AWWA D103-97 section 11.4.1.6 and the manufacturer's design, and is an integral element of the tank assembly; therefore the tank foundation and floor slab with embedded starter sheet shall be constructed by the tank supplier using manufacturer trained personnel regularly engaged in this type of tank construction.

5.2.1.2 Leveling of the starter ring shall be required and the maximum differential elevation within the ring shall not exceed one-eighth (1/8) inch, nor exceed one-sixteenth (1/16) inch within any ten (10) feet of length.

5.2.1.3 A leveling plate assembly (per Harvestore Products, Inc. - U.S. Patent No. 4,483,607), consisting of two 18" anchor rods (3/4" dia.) and a slotted plate (3 1/2" X 11" X 3/8" thk) shall be used to secure the starter ring, prior to encasement in concrete. Installation of the starter ring on concrete blocks or bricks, using shims for adjustment, is not permitted. The foundation with anchor bolts/leveling plates shall be a separate pour from the concrete floor.

5.2.1.4 Two water stop seals made of a butyl rubber elastomer special for this application shall be placed on the inside surface of the starter ring below the concrete floor line. These materials shall be installed as specified by the tank manufacturer.

5.2.2 Glass Coated Bolted Steel Floor (not applicable)

5.2.2.1 The floor design is glass-coated, bolted steel. Bolted steel panels shall be either placed over a three (3) inch compacted sand base contained by a steel or concrete ring wall, or a non-extruding and resilient bituminous type filler meeting the requirements of ASTM D1751 if set on a concrete slab.

5.2.2.2 Polyethylene copolymer caps and sealant shall be used to cover the bolts, nuts and washers exposed on the inside of the floor.

5.2.2.3 Leveling of the starter ring shall be required and the maximum differential elevation within the ring shall not exceed one-eighth (1/8") inch, nor exceed one-sixteenth (1/16") inch within any ten (10ft) feet of length.

5.3 Sidewall Structure

5.3.1 Field erection of the glass-coated, bolted-steel tank shall be in strict accordance with the procedures outlined in the manufacturer's erection manual, and performed by an authorized dealer of the tank manufacturer, regularly engaged in erection of these tanks.

5.3.2 Specialized erection jacks and building equipment developed and manufactured by the tank manufacturer shall be used to erect the tanks.

5.3.3 Particular care shall be taken in handling and bolting of the tank panels and members to avoid abrasion of the coating system. Prior to liquid test, all surface areas shall be visually inspected by the Engineer.

5.3.4 An electrical holiday test shall be performed during erection using a nine (9) volt leak detection device. All electrical leak points found on the inside surface shall be repaired in accordance with manufacturer's published touch up procedure using urethane sealer.

5.3.5 The placement of sealant on each panel may be inspected prior to placement of adjacent panels. However, the Engineer's inspection shall not relieve the bidder from his responsibility for liquid tightness.

5.3.6 No backfill shall be placed against the tank sidewall without prior written approval and design review of the tank manufacturer. Any backfill shall be placed according to the strict instructions of the tank manufacturer.

5.4 Roof Options (Select 5.4.1 or 5.4.2)

5.4.1 **(YES)**Tanks with diameters of 14 to 31 ft. shall include a radially sectioned roof fabricated from glass-coated, bolted steel panels, as produced by the tank manufacturer, and shall be assembled in a similar manner as the sidewall panels utilizing the same sealant and bolting techniques, so as to assure a water/air tight assembly. The roof shall be clear span and self-supporting. Both live and dead loads shall be carried by the tank walls. The exterior coating finish shall be cobalt blue glass. The manufacturer shall furnish a roof opening which shall be placed near the outside tank ladder and which shall be provided with a hinged cover and a hasp for locking. The opening shall have a clear dimension of at least twenty-four (24") inches in one direction and eighteen (18") inches in the other direction. The opening shall have a gasketed weather-tight cover.

5.4.2 **(N/A)** Roofs for tanks greater than 31 ft. diameter shall be constructed of non-corrugated triangular aluminum panels which are sealed and firmly clamped in an interlocking manner to a fully triangulated aluminum space truss system of wide flange extrusions, thus forming a spherical dome structure.

5.4.2.1 The dome shall be clear-span and designed to be self-supporting from the periphery structure with primary horizontal thrust contained by an integral tension ring. The dome dead weight shall not exceed 3 pounds per square foot of surface area.

5.4.2.2 The dome and tank shall be designed to act as an integral unit. The tank shall be designed to support an aluminum dome roof including all specified live loads.

5.4.2.3 Materials:

5.4.2.3.1 Triangulated space truss: 6061-T6 aluminum struts and gussets.

5.4.2.3.2 Triangular closure panels: .050"t 3003-H16 aluminum sheet.

5.4.2.3.3 Tension ring: 6061-T6 aluminum.

5.4.2.3.4 Fasteners: 7075-T73 anodized aluminum or series 300 stainless steel.

5.4.2.3.5 Sealant and gaskets: silicone rubber.

5.4.2.3.6 Dormers, doors, vents and hatches: 6061-T6, 5086-H34 or 3003-H16 aluminum.

5.4.2.4 Supplier shall be ESPC (Engineered Storage Products Company) of DeKalb, IL.

5.4.3 Roof Vent

5.4.3.1 A properly sized vent assembly in accordance with AWWA D103 shall be furnished and installed above the maximum water level of sufficient capacity so that at maximum possible rate of water fill or withdrawal, the resulting interior pressure or vacuum will not exceed 0.5" water column.

5.4.3.2 The overflow pipe shall not be considered to be a tank vent.

5.4.3.3 The vent shall be constructed of aluminum.

5.4.3.4 The vent shall be so designed in construction as to prevent the entrance of birds and/or animals by including an expanded aluminum screen (1/2 inch) opening. An insect screen of 23 to 25 mesh polyester monofilament shall be provided and designed to open should the screen become plugged by ice formation.

5.5 Appurtenances (per AWWA D103, Section 5)

5.5.1 Pipe Connections

5.5 Appurtenances (per AWWA D103, Section 5)

5.5.1 Pipe Connections

5.5.1.1 Where pipe connections are shown to pass through tank panels, they shall be field located, saw cut, (acetylene torch cutting or welding is not permitted), and utilize an interior and exterior flange assembly, shall comply with AWWA D103 latest edition. ESPC Sealer No. 98 shall be applied on any cut panel edges or bolt connections.

5.5.1.2 Overflow piping shall be ___ inch diameter Class 350 DIP, extending to 24.00ft above FFE elevation.

5.5.1.3 Inlet piping shall be __ inch diameter Class 350 DIP, extending to 24.00 ft above FFE elevation.

5.5.1.4 Outlet piping shall be _ inch diameter Class 350 DIP, located 0ft FFE elevation with removable silt stop.

.

5.5.1.5 Drain piping shall be ___ inch Class 350 DIP, located 0 ft elevation FFE.

5.5.2 Outside Tank Ladder

5.5.2.1 An outside tank ladder shall be furnished and installed as shown on the contract drawings.

5.5.2.2 Ladders shall be fabricated of aluminum and utilize grooved, skid-resistant rungs.

5.5.2.3 Safety cage and step-off platforms shall be fabricated of galvanized steel.

5.5.2.4 A hinged, lockable gate shall be installed at the base of the ladder safety cage to deter unauthorized access to the to of the tank. The owner shall provide and install the lock.

5.5.3 Sidewall Access Manway

5.5.3.1 One sidewall access manway shall be provided as shown on the contract drawings in accordance with AWWA D-103.

5.5.3.2 Such manway shall be a minimum of 24 inches in diameter and shall include a properly designed reinforcing frame and cover plate. A davit to hold the cover plate, when opened, is required for tanks in excess of 38' tall.

5.5.4 Identification Plate A manufacturer's nameplate shall list the tank serial number, tank diameter and height, and maximum design capacity. The nameplate shall be affixed to the tank exterior sidewall at a location approximately five (5') feet from grade elevation in a position of unobstructed view.

5.5.5 Cathodic Protection

5.5.5.1 The responsibility for determining the need for, the design of and specifications for cathodic protection of the tank shall be the responsibility of the Engineer or Owner.

5.5.5.2 Attachment of rectifier boxes, anodes, or wiring to tank structure shall be approved by tank manufacturer.

5.5.5.3 When cathodic protection is specified, electrical continuity between all tank sidewall or floor panels shall be the responsibility of the tank manufacturer.

6.0 FIELD TESTING

6.1 Hydrostatic

6.1.1 Following completion of erection and cleaning of the tank, the structure shall be tested for liquid tightness by filling tank to its overflow elevation.

6.1.2 Any leaks disclosed by this test shall be corrected by the erector in accordance with the manufacturer's recommendations.

6.1.3 Water required for testing shall be furnished by the owner at the time of tank erection completion, and at no charge to the tank erector. Disposal of test water shall be the responsibility of the owner.

6.1.4 Labor and equipment necessary for tank testing is to be included in the price of the tank.

7.0 DISINFECTION

7.1 Standards

7.1.1 The tank structure shall be disinfected at the time of testing by chlorination in accordance with AWWA Specification C652 "Disinfection of Water Storage Facilities" as modified by the tank manufacturer.

7.1.2 Disinfection shall not take place until tank sealant is fully cured (10 to 12 days at 73° F/50% relative humidity).

7.1.3 Acceptable forms of chlorine for disinfection shall be:

7.1.3.1 Liquid chlorine as specified in AWWA C652.

7.1.3.2 Sodium hypochlorite as specified in AWWA C652.

7.1.3.3 Calcium hypochlorite (HTH) is not acceptable.

7.1.4 Acceptable methods of chlorination per AWWA C652:

7.1.4.1 Section 4.1.1.

7.1.4.2 Section 4.1.2 - chemical feed pump only (4.l.2.l).

7.1.4.3 Section 4.3.

7.1.5 Section 4.2 is acceptable.

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, tools, equipment, and materials, and shall perform all work and services necessary for or incidental to the furnishing and installation of one complete factory-built, package water booster pump station as shown on the drawings and as specified in accordance with provisions of all other trades.

B. All supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, complete, and compatible installation shall be furnished and installed as part of this work.

1.02 SYSTEM DESCRIPTION

The pump station shall utilize a minimum of two (2) pumps arranged in parallel and mounted on a common structural steel base. The pump system shall utilize a common suction and discharge header. All pipe flanges shall be 125 psi.

The station shall utilize a minimum of two (2) pumps (one for standby) with variable frequency drives (VFD's) to supply varying flow and pressure to the receiving ground storage reservoir through communication with proposed pump station SCADA telemetry and Owner's existing telephone telemetry system. Maximum station discharge pressure shall be 200 psi.

1.03 QUALITY ASSURANCE

The manufacturer of this equipment shall be one recognized and established in the design production of factory built water booster pump stations. The booster pump station manufacturer shall maintain regular production facilities at their place of business. Those facilities shall be open for inspection by a representative of the owner at the time during construction testing of this equipment. Equipment manufactured by a fabricator independent of the firm of record on the equipment submittal will not be allowed. Booster pump station manufacturer shall have not less than ten (10) similar installations in the United States and shall have been in business principally manufacturing water booster pump stations under the same name for not less than five (5) years.

1.04 SUBMITTALS

A. SHOP DRAWINGS

a. The approved manufacturer shall submit complete manufacturer's information on all individual items that make up the factory-built water booster pump station. Submit six (6) individually bound booklets for approval.

Submittals shall include the following information, as applicable:

1) Dimensions.
2) Identification of products.
3) Fabrication and installation drawings.
4) Roughing-in and setting diagrams.
5) Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
6) Shopwork manufacturing instructions.
7) Templates and patterns.
8) Schedules.
9) Notation of coordination requirements.
10) Notation of dimensions established by field measurement.
11) Catalog cuts and detailed Bill of Materials for equipment and control panels.

b. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

c. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.

d. Two (2) submittal reviews of this item will be accomplished at no cost to the submitting contractor. However, all subsequent reviews will be charged to the submitting contractor at the design engineer's standard hourly billing rate.

B. OPERATION AND MAINTENANCE MANUALS

The Contractor shall submit at least three (3) copies of operation and maintenance manuals to the Engineer prior to start-up.

1.05 DELIVERY, STORAGE AND HANDLING

All materials and equipment shall be delivered, stored and handled in strict accordance with the manufacturer's recommendations.

1.06 WARRANTY

All materials and equipment shall be warranted by the manufacturer to be free from defects in material and workmanship for a period of one (1) year after start-up.

1.07 MANUFACTURING AND SUPPLIER INFORMATION

A. MANUFACTURER NAMEPLATE

A manufacturer's nameplate shall be securely and permanently mounted to each individual piece of equipment furnished under this Section. The nameplate shall be constructed of a durable, non-corrosive material. Critical information shall be clearly engraved or otherwise permanently stamped on the nameplate, and shall be fully legible. The information contained on the manufacturer nameplate shall include at least the following:

- Manufacturer's Serial Number
- Name, address and telephone number of equipment manufacturer
- Model and/or Part Number, including pump impeller sizes, when applicable
- Performance Criteria (i.e., capacity, design point, etc.)
- Motor size, speed and voltage
- Enclosure Type or Rating
- Any other pertinent information

Note: All equipment shall include a nameplate with a manufacturer serial number validating the equipment as new. Failure to meet these requirements will be cause for rejection of the equipment.

B. SUPPLIER AND SERVICE INFORMATION

A durable nameplate, stamp or sticker shall be adhered to each individual piece of equipment containing the name, address, and telephone number of the local business that supplied the equipment, and the name, address and telephone number of the local business that can provide service and replacement parts for the equipment. A 24-hour emergency service telephone number should also be included.

PART 2: PRODUCTS

2.01 STATION MANUFACTURER

The pumping system shall be manufactured by Dakota, Syncro-Flo, EFI or an equal approved by the engineer prior to the bid opening. The station shall be of the type and capacity described above. For consideration of a proposed equal system, the contractor shall furnish the following data to the engineer at least 10 days prior to the date of the bid opening:

A. A complete specification for the pumping system proposed as an equal.

B. A statement of full conformance to the following specifications signed by a corporate officer of the manufacturer.
C. A general arrangement drawing showing overall dimensions and all piping layouts
D. Complete submittal data for all major equipment (pumps, motors, tank, valves, electrical controls, etc.).
E. An electrical schematic showing power and control wiring.
F. Location of closest factory trained service centers.
G. Manufacturer's system UL (or equal) file number.
H. A copy of manufacturer's certificate of insurance showing as a minimum, a general liability coverage of $1,000,000, and an excess liability coverage of $10,000,000.

If, in the opinion of the engineer, the data submitted shows the pumping system to be an equal to the system specified, the bidding contractors shall be notified not less than 5 days prior to the bid opening date.

2.02 STATION COMPONENTS

A. PUMPS

The main pump(s) shall be horizontal or vertical multi-stage centrifugal type rated at flow and head conditions as defined herein. The pumps shall be manufactured according to the standards of the Hydraulic Institute and to ANSI specification number B58.1. Pumps shall conform to the followings:

a) Cast iron construction with bronze trim & stainless steel shafts.
b) Approved impeller materials include, bronze (ASTM B62) brass or stainless steel completely machined exterior surfaces, statically balanced, keyed to shaft and positively held to center of discharge volute, interior water surfaces uniform and smooth;
c) Wearing rings cast iron (ASTM A48) or bronze (ASTM B62), renewable, running clearances not greater than one mil per inch of ring diameter;
d) Seals of stuffing box design, tapped opening for flushing, non-corrosive hardware;
e) Shaft and shaft sleeves completely machined with maximum deflection on 0.002 in at stuffing box within full head operating range;
f) Pump ring to force water into stuffing box for lubrication and cooling and prevent water flow from stuffing box back into pumped fluid;
g) Tapped openings with plugs for drainage, priming, and venting casing;
h) Grease lubricated anti-friction type bearings, inboard bearing to carry axial and radial loads of pump and driver, outboard bearings to carry radial loads of pump, AFBMA-B-10 rating of 40,000 hours at continuous full load and maximum rpm;
i) Pin and rubber bushed flexible couplings aligned within manufacturer's acceptable tolerance, all metal, grease lubricated grid or oil lubricated gear type;

j) Pressure relief fittings for grease lubricating, drain and fill plugs and taps for oil lubricating;
k) Flange connections to suction and discharge piping.

B. STATION BASE

The pump station base shall be designed and fabricated to provide proper structural support for all attached equipment. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off loading, installation, and operation. Main structural members shall be constructed from heavy weight channel, tubing, or I-beam steel. Provisions shall be made in the station base for off-loading and handling the station at the site of installation. Base shall include ¼" checkered deck plate and 1" steel plate mounted under pump and motor. All ¼" deck plate and 1" steel plate shall be 100% seal welded to main structural members. Skip welding of these plates is not acceptable and systems with skip welded plates shall be rejected. Critical frequency of complete pump station shall be above operating frequencies. Station base shall be suitably anchored to building floor per station manufacturer's recommendations.

C. PUMP STATION BUILDING

Pump station shall be designed for ground level entry to pumping units, internal piping and accessories, and electrical switch-gear and controls, through a standard doorway. The station shall also provide access for equipment removal / installation via double doors or a roll-up door. Pump removal via roof hatches will not be permitted. Building or enclosure shall be a low maintenance material such as brick veneer, concrete, decorative concrete or masonry block. Building shall be designed and constructed in accordance with all applicable local and state building codes.

Appropriately sized overhead beam and crane shall be provided for removal and installation of pump assemblies. Options for alternative pump assembly removal and installation will be considered on a case by case basis.

D. PIPING

All piping shall be constructed from ASTM A105 flanged schedule 40 steel pipe OR stainless steel as required to maintain a 3 to 1 pressure safety factor (including 1/16" corrosion allowance). All piping shall be hydrostatically tested to 150% of maximum shutoff pressure. Schedule 40 steel piping shall be fusion-bonded epoxy coated after fabrication, and flange faces buffed.

E. VALVES

1. PUMP ISOLATION VALVES

Pump isolation valves shall be of the flanged butterfly type. Each butterfly valve shall have a lever operator. Valves shall be sized as shown in the technical data sheet or on the plans. Valve body shall be constructed of ductile iron with a polyphenylene sulfide coating. Valve disc shall be rubber coated ductile iron. Valve shall be rated at 300 PSI and shall be supplied by a reputable manufacturer.

2. PUMP CHECK VALVES

Pump check valves shall be provided on the discharge of each pump and sized per the technical data sheet. They shall be of the silent operating type that begin to close as forward velocity diminishes and be fully closed at zero velocity preventing flow reversal. Check valve shall be the non-slam type. Valve bodies shall be cast from grade 35 cast-iron or better and shall be free from blowholes, sand holes, and other impurities. The valve design shall incorporate a center guided, spring loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe diameter. Internals shall be machined bronze disc, seat, and stem guide. Seat shall be Buna-N to provide resilient sealing. **Dual disc style check valves is not acceptable**. Valves shall be sized to permit full pump capacity to discharge through them without exceeding a pressure drop of 2.5 PSI and shall be supplied by a reputable manufacturer. Valves shall be rated for 300 PSI working pressure and shall minimize water hammer.

F. COMPRESSION COUPLINGS

1. Each pump suction and discharge pump run shall include a compression type, flexible coupling to prevent binding of the pump, pump suction or control valve. Each coupling shall consist of two (2) following rings, a flared middle ring with end flares generous enough to provide adequate gasket seat areas, two (2) resilient rubber gaskets and steel bolts. The coupling when installed shall provide a permanent, leak-proof, flexible installation.

2. In lieu of a compression coupling, a restrained, removable flange such as Uni-Flange or a flanged coupling adapter (FCA) may be used to relieve strain on a pump or control valve. The flanged coupling adapter will be of the same manufacturer as the compression coupling used elsewhere in the equipment capsule and shall be a regular product of that manufacturer.

3. Flanged coupling adapters shall be complete on the flanged end with an integral rubber flange gasket and on the open end with a triangular section rubber follower gasket and follower ring. Bolts for the flanged coupling adapter will be individual to the FCA and be supplied with the FCA.

G. PRESSURE GAUGES

Pressure gauges shall be mounted on a gauge panel and shall include inlet isolation ball valves. Gauges shall be supplied for inlet and outlet header pressures, and for pump discharge pressures. All gauges shall be center back mounted and shall be glycerin filled to reduce wear due to vibration. Accuracy shall be within 1.5%. Gauge diameter shall be 4" minimum. Range shall be at least 30% higher than the highest pressure attainable from the pumps at shutoff head conditions. Gauges shall include stainless steel back & copper alloy internals and shall be supplied by a reputable manufacturer

H. Flow Meter

A turbine water meter, with strainer, meeting the requirements of AWWA C701 and optimally sized for the pumping range shall be placed on the common discharge piping to record total flow pumped. Manufacturer's recommended straight pipe lengths must be provided upstream and downstream of meter and strainer.

I. BOLTS

All bolts used in the assembly of the pumping system shall be zinc plated to retard corrosion.

J. MOTORS

Motor(s) for the main pump(s) shall be of United States manufacture, close-coupled open drip-proof type with rodent screens on all ventilating passages. They shall include a 1.15 service factor, and class F insulation. Motors shall be wound for the starting configuration as called out in the technical data sheet. Design pump brake horsepower at duty point shall not exceed 100% of motor horsepower exclusive of service factor, and service factor shall not be exceeded at any point on the pump head-capacity curve. The motor shaft shall be high-strength steel protected by a bronze or stainless steel shaft sleeve secured to the shaft to prevent rotation. Motors shall be as manufactured by U.S. ELECTRIC, or approved equal.

K. PAINT

Structural steel, attached piping, and supports shall be grit-blasted with #50 steel grit per SSPC-10 to a near white metal condition. The cleaned steel surfaces shall immediately thereafter be primed with an industrial grade primer to a thickness of 2 ½ to 3 mils epoxy primer. The finish coat shall be acrylic enamel to a thickness of no less than 3 mils. The control panel shall be dip cleaned, acid etched and neutralized, iron phosphate coated and painted with a finish coat of 1 ½ to 2 mils of polyurethane.

L. CONTROL SYSTEM

See SECTION 40900 - SCADA INSTRUMENTATION & CONTROL for details of the required SCADA system.

2.03 ELECTRICAL DESIGN, ASSEMBLY & TEST

A. The electrical apparatus and control panel design, assembly, and installation, and the integration of component parts will be the responsibility of the manufacturer of record for this booster pumping equipment. That manufacturer shall maintain at his regular place of business a complete electrical design, assembly and test facility to assure continuity of electrical design with equipment application. Control panels designed, assembled or tested at other than the regular production facilities or by other than the regular production employees of the manufacturer of record for this booster pumping equipment will not be approved.

B. Conformance to Basic Electrical Standards: The manufacturer of electrical control panels and their mounting and installation shall be done in strict accordance with the requirements of UL Standard 508 and the National Electrical Code (NEC) latest revision so as to afford a measure of security as to the ability of the eventual owner to safely operate the equipment. No exceptions to the requirements of these codes and standards will be allowed; failure to meet these requirements will be cause to remove the equipment and correct the violation.

C. U.L. Listing: All service entrance, power distribution, control and starting equipment panels shall be constructed and installed in strict accordance with Underwriter's Laboratories (UL) Standard 508 "Industrial Control Equipment." The UL label shall also include an SE "Service Entrance" rating stating that the main distribution panel is suitable for use as service entrance equipment. The panels shall be shop inspected by UL, or constructed in a UL recognized facility. All panels shall bear a serialized UL label indicating acceptance under Standard 508 and under Enclosed Industrial Control Panel or Service Equipment Panel. In addition, a photocopy of the UL labels for this specific project shall be transmitted to both the project engineer and the contractor for installation within their permanent project files, prior to shipment of the equipment covered under these specifications.

D. E.T.L. Listing: All control panels shall be E.T.L. Listed by Interek Testing Services (ITS) under Category 4 - Industrial Control Equipment. Each completed panel shall bear an E.T.L. listing label. The listing label shall include the station manufacturer's name, address and telephone number. The station manufacturer shall have quarterly inspections performed by ITS at the manufacturer's facilities to ensure that the products being listed comply with the report and procedural guide for that product.

E. Equipment Grounding: Each electrical equipment item in the station shall be properly grounded per Section 250 of the National Electrical Code. Items to be grounded include, but are not limited to, pump motor frames, control panel, transformer, convenience receptacles, dedicated receptacle for heater, air conditioner, dehumidifier, lights, light switch, exhaust fans and pressure switches.

F. All ground wires from installed equipment shall be in conduit and shall lead back to the control panel to a plated aluminum ground buss specific for grounding purposes and so labeled. The ground buss shall be complete with a lug large enough to accept the installing electrician's bare copper earth ground wire. The bus shall serve as a bond between the earth ground and the equipment ground wires.

2.04 ELECTRICAL APPARATUS

A. Control Panel: All circuit breakers, time delay relays and control relays shall be incorporated into one (1) NEMA 12 control panel. The electrical service provided for this station will be 480 volt, 3-phase, 60 cycle, and 4-wire. A main circuit breaker shall be provided to disconnect all power to the control panel.

B. Running time meter**:** A running time meter shall be supplied for each pump to show the number of hours of operation. The meter shall be enclosed in a dust and moisture proof molded plastic case, suitable for flush mounting on the main control panel. The meter dial shall register in hours and tenths of hours up to 99999.9 hours before repeating. The meter shall be suitable for operation from a 115 volt, 60 cycle supply.

C. Phase Monitor: A phase monitor shall be supplied to protect three-phase equipment against phase loss, undervoltage and phase reversal conditions. When a fault is sensed, the monitor output relay opens within two seconds or less to turn the equipment off and/or cause an audio or visual alarm. Both Delta and Wye systems may be monitored. The monitor shall have an automatic reset and shall also include an adjustable voltage delay. The monitor shall have an indicator LED

(glows when all conditions are normal and shall monitor phase sequence: ABC operate (will not operate CBA). The phase monitor shall be UL approved and CSA certified.

D. Surge Arrestor: A secondary surge arrestor shall be provided. Housing shall be Noryl and be ultrasonically sealed. Valve blocks shall be metal oxide with an insulating ceramic collar. Gap design shall be annular. The lead wire shall be permanently crimped to the upper electrode forming part of the gap structure. Arrestors shall be UL and CSA listed Lightning Protective Devices.

E. PLC Operation Description:

The system shall control two (2) booster pumps based upon manual or automatic operation with safety cutouts based upon suction pressure. If low suction pressure is detected and remains low for 60 seconds, the pumps shall stop and the low suction pressure light shall be illuminated. Manual or remote reset shall be required for automatic operation to resume.

Control of pump operation shall be based upon the position of the HAND/OFF/AUTO selector switch. If the selector switch is in the "HAND" position the pump shall run until the selector switch is turn to the "OFF" or "AUTO" position or the safety cutouts operate to stop the pump. If the switch is in "AUTO", the pumps shall be automatically controlled by the SCADA system. The SCADA system shall send a closed contact to start the lead pump (step 1). The lead pump shall stop when this contact opens. The lag pump shall start if step 2 contact from the SCADA system closes. The lead pump shall be alternated on successive closings of step 1 contact from the SCADA system.

The pump station manufacturer shall provide PLC logic to accept inputs and provide outputs required.

See SECTION 40900 – SCADA INSTRUMENTATION & CONTROL for more PLC details. .

F. Low Suction Pressure Alarm/Cutout: The site operation shall have logic that shall suspend the operation of pump calls and activate alarm indicators and outputs in the event the suction pressure of the station falls to a point equal to or less than the low suction cutout setpoint. The pressure must remain equal to or less than the low suction alarm setpoint for a period of no less than 60 seconds, after which the low suction alarm/cutout will latch on. The low suction alarm/cutout will turn off when the suction pressure of the station rises to a point equal to or greater than the low suction cutout/alarm restore setpoint and a period of no less than 120 seconds has elapsed.

G. Variable Frequency Controller:

The station manufacturer shall furnish and install a complete Adjustable Frequency Controller System as described in this specification and as detailed on the applicable drawings. The station manufacturer shall be responsible for the installation and start-up of the equipment covered by this specification. The Adjustable Frequency Controller shall be furnished by a single vendor who has actively been manufacturing Adjustable Frequency Controllers for a period of at least five (5) years.

The Adjustable Frequency Controller shall be UL and CSA certified and shall comply with the latest applicable standards of ANSI, IEEE and NEMA. The controllers shall be rated as for motors indicated in this specification. As a minimum the full load output current of the controller shall be equal to the equivalent motor horsepower as listed by National Electrical Code Table 430-150.

There shall be provided two (2) Variable Frequency Drive (VFD) units. The VFD's shall be capable of having properly sized and rated 480VAC three phase power input to it and output 3 phase power to the load. The system manufacturer shall ensure the size of the VFD is adequate to operate the 3 phase load.

The unit(s) shall tolerate a 10% overvoltage and 15% undervoltage, a line frequency between 57-63 Hz, and have a 100% load rating. The VFD shall operate at 100% rated capacity, without derating, up to 3,300 feet MSL. The unit shall operate in environments of 5%-95% noncondensing humidity, at an ambient temperature between -10 and +40 C (+14 F to +122 F). The VFD shall have a displacement power factor of no less than 95%. The drive shall have a 98% efficiency at FLA.

The VFD shall output a coded pulse width modulation power output to the load over a frequency range of 0-400 Hz, 1Hz stop settings. The drive shall have a frequency regulation of ±0.2% of maximum output frequency.

Inputs shall be provided for the control and option selection of the drive as follows:

1. Digital Inputs: All input and control devices shall be rated for 120VAC control or shall require dry contact closures without the need for external power supplies or interposing relays.

2. On-Off Control shall be 120VAC to avoid potential problems with voltage drop in long control wire runs. The starter shall provide for 2-wire or 3-wire control schemes. Seal-In relay contact for the 3-wire control scheme shall be internal, dedicated to that use and not counted as an output contact. Terminals shall be provided for use in interlocking with programmable output relays or external devices.

3. User Inputs: 4 programmable digital inputs shall be provided. Each input shall accept dry contact closures from external user supplied devices, and can be named for display on the DCU when energized. 2 of these inputs shall be preset as Temperature and Dual Ramp Select, but can be changed by the user. Inputs can be programmed as N.O. or N.C., and programmed with a de-bounce timer of 0 – 60 seconds. Each input can be assigned to operate any of the Programmable Outputs.

4. Analog Input shall be provided for optional Tach Feedback Starting. This input shall accept 4-20ma with adjustable offset and gain.

Outputs shall be provided for the following functions in addition to the seal-in relay used in 3-wire control schemes as mentioned above.

1. Digital Outputs shall be eight (8) Form "C" contact relay outputs, rated for 240VAC, 5AMPS, 1200VA max., with each relay being programmable for any one of the following functions.

2. Indicator Relay programmable to change state on any of the following conditions:
Run / Stop, Start / End of Decel, Timed Output, At Speed / Stop, At Speed / End of Decel, Dual Ramp Selected, Self Test Fail.

3.Fault Trip Relay programmable for each of the following fault conditions: Overload, Phase Imbalance / loss / Reversal, Look Out Inhibits, External Inputs, Short Circuit, Over Current / Shear Pin, Ground fault HISET / LOSET, Over / Under Frequency, I^2t Start Curve, Shorted SCR, Shunt Trip, Over Temp, Under Current / Load Loss.

4.Alarm Relay including the following conditions: Overload Warning, Overcurrent Warning, Ground Fault Warning, Under Current Warning, Imbalance Warning, Thermal Register Warning.

5.RTD Relay (when RTD Input option is ordered) including Stator or Non-Stator Trip and/or Warning, and RTD Failure.

6.Analog Outputs (2) shall be included for providing information to external controls and be programmable as RMS Current or Percentage of Motor FLA.

LCD Display: Each drive unit shall be provided with an energy saving LCD display with the following design specifications:

1. LCD Display: A 2-line 20 character per line LCD display shall be provided.

2. Energy Saver: A programmable LCD energy saving function shall be provided. The energy saver shall allow the LCD to turn off after a pre-programmed amount of time. The energy saver function can be disabled if desired.

3.Adjustments: All adjustments shall be made by a four-button keypad. No binary coded dipswitches shall be used for programming or function selection.

4.Password Protection: Password protection shall be available to prevent unauthorized changes to the programming.

5.Data: All data presented shall be possible to interpret without the use of index tables or manuals. Data should always be presented with a description, the actual value, and the unit of data. A function shall be available for listing all the changed settings and data in the soft starter. Data entered and selections made to the soft starter using the display and keypad shall be stored prior to power loss and shall be retrievable after power loss.

7.LED Indicators: Long life LED's shall provide annunciation of Power ON for indicating that supply voltage is provided, Fault trip, and Protection trip. For a full description of Fault and Protections, see Outputs above.

The drive shall have the following protective features: overcurrent, ground fault, undervoltage, overvoltage, input phase loss, overheating of heatsink, external alarm, overheating internally, overheating of braking resistor, motor 1 overload, motor 2 overload, inverter overload, blown fuse, memory error, keypad panel communication error, CPU error, option error, operating error, output wiring error, and modbus RTU error. The drive shall have a keypad through which operator personnel can manually start/stop drive, manual control speed, job drive motor, and adjust drive parameters.

EMI/RFI Filters: Each variable frequency drive (VFD) unit shall be equipped with an electromagnetic interference/radio frequency interference filter unit. The filter unit shall meet EMC Class A "CE" International Standards. The filter shall be current rated for the application. Filter units shall connect to the line side of the VFD. Filter shall be supplied completely pre-wired to the variable speed drive unit(s) by the station manufacturer of record. Field installation of filter units will NOT be allowed.

Wiring and handling shall be per manufacturer's recommendations. The Adjustable Frequency Controller shall be protected against damage at all times. The controller shall be stored in a clean, dry environment with temperature and humidity within the range as specified by the controller manufacturer. Space heaters shall be energized during storage, as recommended by the manufacturer. Testing, checkout and start-up of the Adjustable Frequency Controller equipment shall be performed under the technical direction of the station manufacturer's service technician. Under no circumstances are any portions of the drive system to be energized without authorization from the station manufacturer's representative.

H. Hand-Off-Automatic Switches: The H-O-A switches shall be oil tight, 3-position maintained and be located on the main control panel door.

I. Indicating Lights: Indicating lights shall be oil tight, with a full voltage pilot light and be provided:
   a. Red – Low Suction Pressure
   b. Green – Pump # 1 in Operation
   c. Green – Pump # 2 in Operation
   d. Red – Pump # 1 Fail
   e. Red – Pump # 2 Fail

J. Nameplates: Nameplates shall be furnished on all panel front mounted switches and lights.

K. Panel Schematic: The control panel door shall be complete on the interior with a stick-on transparency containing an "as-built" reproduction of the electrical control panel schematic. The wiring diagram shall be a corrected "as-built" copy and contain individual wire numbers, circuit breaker numbers, switch designations and control function explanations.

2.05 CONDUIT AND WIRING

A. All wiring outside of the control panel shall be run in conduit except for the watertight flexible conduit and fittings properly used to connect pump drivers, fan motors, solenoid valves, limit switches, etc., where flexible connections are best utilized.

B. Flexible Connections: Where flexible conduit connections are necessary, the conduit used shall be liquid-tight, flexible, totally nonmetallic, corrosion resistant, nonconductive, U.L. listed conduit sized to handle the type, number and size of equipment conductors to be carried - in compliance with Article 351 of the National Electrical Code.

C. Motor Circuit Conductors: Sized for load. All branch circuit conductors supplying a single motor of one (1) horsepower or more shall have an ampacity of not less than 125 percent of the motor full load current rating, dual rated type THHN/THWN, as set forth in Article 310 and 430-B of the National Electrical Code, Schedule 310-13 for flame retardant, heat resistant thermoplastic, copper conductors in a nylon or equivalent outer covering.

D. Control And Accessory Wiring: Sized for load, type MTW/AWM (Machine tool wire/appliance wiring material) as set forth in Article 310 and 670 of the National Electrical Code, Schedule 310-13 and NFPA Standard 79 for flame retardant, moisture, heat and oil resistant thermoplastic, copper conductors in compliance with NTMA and as listed by Underwriter's Laboratories (AWM), except where accessories are furnished with a manufacturer supplied UL approved rubber cord and plug.

PART 3: EXECUTION

3.01 INSTALLATION

All equipment shall be installed as shown on the shop drawings and in accordance with the manufacturer's recommendations.

3.02 QUALITY CONTROL AND FIELD TESTING

A. QUALITY CONTROL

The manufacturer shall furnish the services of a qualified technical representative for two (2) days to inspect the installation and provide start-up, field testing and operator training services.

B. FIELD TESTING

The Contractor and the manufacturer's representative shall demonstrate to the Owner and the Engineer that the equipment operates as designed and specified. Booster pump station equipment in contact with potable water shall be disinfected in accordance with AWWA C653 as applicable.

3.03 SPARE PARTS

The Contractor shall provide one (1) complete set of recommended spare parts from the manufacturer to be conveyed to the Owner. One (1) complete set of spare parts shall be provided for each pump.

END OF SECTION

Section 13220 - Prestressed Concrete Storage Tank.

The following sections within this document may appear shaded and may be changed or modified as necessary:

- The Heading & Footer
- 1.2 Related Sections (A thru D)
- 1.3 References (W)
- 1.4 Submittals (J)
- 1.5B Prequalification (2f)
- 1.7B Design Criteria (1 thru 9)
- 2.2 Concrete (F) Table
- 2.3 Shotcrete (F) Table
- 2.10 Tank Accessories (A thru E)
- 2.11 Coatings (A)
- 3.2H Coatings (1 thru 3)
- 3.4 Cleaning & Disinfection (B)

The remaining sections within the specification are protected. If changes to the remaining sections are required they should be coordinated with your representative from The Crom Corporation.

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section specifies the design and construction of an AWWA D110 Type II, wire-wound prestressed concrete storage tank with steel diaphragm complete including all reinforcing, concrete work, accessories, disinfection and testing directly related to the tank.

B. The tank contractor is responsible for furnishing all labor, materials, tools and equipment necessary to design and construct the prestressed concrete storage tank as indicated on the drawings and as described in this specification.

1.2 RELATED SECTIONS

A. Section 02000 - Earthwork and Excavation.

B. Section 15000 - Piping.

C. Appendix A - Geotechnical Report.

D. *(Insert other related sections here as necessary.)*

1.3 REFERENCES

A. ACI 372R-03 - Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.

B. AWWA D110-04 - Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

C. ACI 506R - Guide to Shotcrete.

D. ASTM A 821/A821M - Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.

E. ASTM A 1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy With Improved Formability.

F. ASCE Standard 7-05 - Minimum Design Loads for Buildings and Other Structures.

G. ASTM C 881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

H. ASTM A 416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

I. ASTM A 884/A884M - Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.

J. ASTM A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

K. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

L. ACI 305R - Hot Weather Concreting.

M. ACI 306R - Cold Weather Concreting.

N. ACI 350 - Building Code Requirements for Environmental Engineering Concrete Structures and Commentary.

O. ASTM C 31/C31M - Test Methods for Making and Curing Concrete Test Specimens in the Field.

P. ASTM C 39/C39M - Test Method for Compressive Strength of Cylindrical Concrete Specimens.

Q. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

R. ASTM C 143 - Standard Test Method for Slump of Hydraulic-Cement.

S. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.

T. ASTM C 33/C33M - Specification for Concrete Aggregates.

U. AWWA C652 - Disinfection of Potable Water Storage Tanks.

V. ASTM D 1056 - Standard Specification for Flexible Cellular Material.

W. *(Insert other references here as necessary.)*

1.4 SUBMITTALS

A. Prequalification Data: Provide prequalification data prior to the bid in accordance with Section 1.5 B. of this specification.

B. Shop Drawings: Provide shop drawings with a minimum size of 18" x 24" with a complete plan, elevation, and sectional views showing critical dimensions as follows:

1. Size, location and number of all reinforcing bars.

2. Thickness of all parts of the tank structure including floor, core wall, dome, and covercoat.
3. Prestressing schedule including number and placement of prestressing wires on the tank wall and total applied force per foot of wall height.
4. Location and details of all accessories required.

C. Concrete Data: Submit concrete design mixes including ingredient proportions, minimum cementitious content, and water/cementitious ratio in accordance with Section 2.2 and 2.3 of this specification.

D. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer in accordance with Section 1.5 A.3 of this specification.

E. Coating Data: Submit color charts for review by the engineer and owner. Once a color is chosen, submit actual drawdown samples for final approval prior to application of coating.

F. Test Reports: Submit concrete strength reports for 7-day and 28-day breaks taken in accordance with the requirements of Section 3.3.A.1.

G. Warranty Document: Submit warranty document in Owner's name in accordance with Section 1.6 A. of this specification.

H. Cleaning and Disinfection Plan: Submit a cleaning and disinfection plan which complies with Section 3.4 of this specification.

I. Project Record Documents: Record actual location layout and final configuration of tank and accessories on shop drawings and submit to engineer after construction of the tank is complete.

J. *(Insert other submittals as required.)*

1.5 QUALITY ASSURANCE

A. Qualifications and Experience:

1. Tank Construction Company: Shall be a firm with ten years of experience in the design and construction of AWWA D110 Type II wire-wound, circular prestressed concrete tanks with satisfactory evidence that it has the skill, reliability, and financial stability to build and guarantee the tank in accordance with the quality required by these specifications. The company constructing the tank shall have built completely in its own name in the past five years, and be presently responsible for, a minimum of ten (10) dome-covered

prestressed composite tanks of equal or greater size than that required for this project which meet these specifications and are now providing satisfactory service.

2. Construction: The entire tank, including all portions of the floor, wall, and roof shall be built by the tank construction company, using its own trained personnel and equipment.
3. Design: All design work for the tank shall be performed by a professional engineer with no less than five years of experience in the design and construction of AWWA D110 Type II wire-wound, circular prestressed concrete tanks. The professional engineer shall be a full-time staff member of the tank construction company and shall be licensed to work in the state where the project is located.
4. The steel shell design and epoxy injection procedure shall have been used in the ten tanks required in Section 1.5 A. of this specification.

B. Prequalification:

1. All tank construction companies must be prequalified and meet the criteria stated in Section 1.5 A. of this specification to be considered an acceptable tank builder.
2. A complete prequalification package shall be submitted to the Engineer for consideration 14 days prior to the date set for receipt of bids. The prequalification submittal shall include the following items:
   a. Complete construction drawings showing the principal sizes, thicknesses, reinforcing size and spacing for all structural members including: floor, wall, dome shell and dome edge.
   b. Complete details of other structural appurtenances as required by the project drawings showing principal sizes, thickness and reinforcing sizes and spacing.
   c. Complete design calculations which address applicable loads provided in Section 1.7 B. of this specification.
   d. Complete experience record for the tanks used to meet the experience requirement of Section 1.5 A. of this specification that have been designed and built in the tank construction company's own name. The record shall include the size of the tank, name, address and telephone number of the Owner, the year of construction and the name and telephone number of the Engineer for the project.
   e. Construction schedule which details the duration for tank construction.
   f. *(Other items required for prequalification submittal should be added here.)*

3. The following are preapproved as acceptable tank construction companies:
   a. The Crom Corporation, Gainesville, Florida.

1.6 WARRANTY

A. Provide a warranty document for workmanship and materials on the complete structural portion of the tank for a five-year period from the date of acceptance of the work. In case leakage or other defects appear within the five-year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank. The tank construction company shall not be responsible for, nor liable for, any subsurface condition. This warranty shall not apply to any accessory, equipment or product that is not a structural part of the tank and is manufactured by a company other than the tank construction company.

1.7 DESIGN CRITERIA

A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R-03 Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, AWWA D110-04 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks, and currently accepted engineering principles and practices for the design of such structures.

B. The following loadings shall be utilized in the design:

1. Capacity: _____ Gallons
2. Dimensions: _____ Inside Diameter
   _____ Water Depth
3. Fluid Loads: Shall be the weight of all liquid when the reservoir is filled to capacity. The unit weight of the liquid material shall be 62.4 lbs/ft^3.
4. Roof Live Loads: Consideration shall be given to all applicable roof design loads in accordance with AWWA D110, Section 3.3 and ASCE 7. The minimum roof live load for the structure shall be _____.
5. Dead Loads: Consideration shall be given to all permanent imposed loads including concrete and steel.
6. Seismic Loads: Seismic load shall be calculated using the effective mass procedure as specified in AWWA D110.
7. Soil Pressure: Earth loads shall be determined by rational methods of soil mechanics. Soil pressure shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.

8. Differential Backfill Loads: Forces from differential backfill loads shall be considered in the design and shall be based on the at-rest coefficient. Passive resistance shall not be used to resist differential backfill loads.
9. Wind Loads: Wind loads shall be considered in the design in accordance with ASCE 7.

C. Floor: The design of the floor for the prestressed concrete tank shall conform to the following:

1. Concrete membrane floors shall be a minimum of 4" thick and have a minimum thickness of 8" of concrete over all pipe encasements and around sumps.
2. A minimum percentage of 0.60% reinforcing steel shall be used in the membrane floor. The minimum percentage shall apply to all thickened sections and shall extend a minimum of 2' into the adjacent membrane floor.

D. Core wall:

1. The wire-wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, steel shell diaphragm.
2. The design of the core wall shall take into account appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design:
   a. The top 2' of core wall shall have not less than 1% circumferential reinforcing.
   b. The bottom 3' of core wall shall have not less than 1% circumferential reinforcing.
   c. Inside Face:
      (1) The inside face of the core wall shall utilize the 26 gauge steel shell diaphragm as effective reinforcing.
      (2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
   d. Outside Face:
      (1) Vertical reinforcing steel in the outside face of the core wall shall be: minimum of #4 bars at 12" center to center.
      (2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
3. The minimum core wall thickness shall be 3½".
4. Reinforcing steel used in the core wall shall be designed using a maximum allowable design tensile stress, f_s, of 18,000 psi.

5. Allowable compressive stress in the core wall due to initial prestressing force, f_{gi}, shall be:
   a. 1250 psi + 75t psi/in. with 0.5 f'_{gi} maximum or less (where f'_{gi} is defined as compressive strength at time initial prestressing force is applied and *t* is the thickness of the core wall in inches).
   b. Maximum of 2250 psi.
6. Allowable compressive stress in the core wall due to final prestressing force, f_g, shall be:
   a. 1250 psi + 75t psi/in. with 0.45 f'_g maximum (where f'_g is defined as compressive strength required for final prestressing force and *t* is the thickness of the core wall in inches).
   b. Maximum of 2000 psi.

E. Dome:

1. The dome roof shall be constructed of reinforced concrete and shall be circumferentially prestressed.
2. Dome shell reinforcement shall consist of reinforcing bars or welded wire fabric meeting ASTM A 185, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic. Wire ties shall be galvanized.
3. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have cross section suitable to accept the applied prestressing forces.
4. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.
5. Overflow outlets or the overflow pipe shall be capable of providing an overflow open area three times the area of the largest influent pipe.
6. Overflow outlets plus the dome ventilator shall be capable of providing an open area three times the area of the largest pipe.
7. The dome shall be designed as a free-span, spherical thin shell with one-tenth rise in accordance with the following:
   a. Typical Dome Design: The typical dome thickness and steel reinforcement shall meet the requirements of AWWA D110-04.
   b. In all cases, the thickness of the dome shall be no less than 3".
   c. Dome Edge Design: The dome edge and upper wall shall be designed to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. The design of the edge region shall conform to the following:

      (1) Dome Edge Thickness:

(a) A determination of the buckle diameter shall be made, as defined by:

$$d_b = 2.5 \cdot \sqrt{r_d \cdot t_d}$$ rounded up to the next foot

Where: d_b = buckle diameter in feet

r_d = dome radius in feet

t_d = typical dome thickness in feet

(b) Dome edge thickening shall begin at a radial location on the dome, defined as s_2 which is at least one buckle diameter away from the tank wall.

(c) A springline haunch shall be provided, which extends radially from the inside face of the tank wall to radial location s_1 which is defined as:

$$s_1 = 0.6 \cdot \sqrt{1.5 \cdot r_d \cdot t_d}$$ rounded up to the next foot

Where: s_1 = distance from inside face of wall to haunch in feet

s_2 = distance from inside face of wall to typical dome thickness in feet.

This springline haunch shall begin at the inside face of the tank wall with a springline thickness as required by paragraph (f) below and shall end at radial location s_1 with the following thickness:

$$t_{d1} = 1.33 \cdot t_d$$

Where: t_{d1} = minimum thickness at s_1 in feet

t_d = typical dome thickness in feet at one buckle diameter from tank wall

(d) Beginning at s_1 and continuing to s_2 the dome shell shall have a uniform straight line taper.

(e) Parameters (b), (c), and (d) above are not required for domes where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

(f) Sufficient concrete thickness at the springline of the dome shall be provided so that no more than 2' of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Compressive stress in this area shall not exceed 1000 psi when

subjected to initial prestressing, offset by dead load only.

(2) Dome Edge Steel Reinforcement:

(a) Throughout the dome edge, the percentage of steel reinforcement, both radially and circumferentially, shall be no less than 0.25% of the gross cross sectional area of concrete.

(b) Along the dome edge, steel reinforcement shall be distributed between the upper and lower layers unless finite element analysis calculations indicate that tensile stress does not exist in the concrete along the bottom face of the dome edge. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the bottom face of the dome edge where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

(c) Where reinforcing bars are required in the bottom layer, they shall be placed near the tank wall to insure adequate development at the intersection between dome and wall.

(d) In all cases, the percentage of circumferential steel reinforcement in the first 2' of the dome edge shall be no less than one percent of the gross cross sectional area of concrete.

(e) Where bottom dome edge steel reinforcement is required, vertical steel reinforcement along the inside face of the tank wall shall be no less than 0.5% of the cross sectional area of wall shotcrete.

F. Prestressing:

1. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM A 821 Type B, placed under high tension.
2. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.
3. The prestressing design shall conform to the following minimum requirements:
   a. Working stress for the tank wall, fs, shall be a maximum of 115,000 psi.
   b. Working stress for the dome ring, fsd, shall be a maximum of 120,000 psi.
   c. The allowable design tensile stress in the prestressing wire before losses, fsi shall be 145,600

psi or no greater than 0.63 fu, where fu is defined as the ultimate strength of the wire.

d. Areas to be prestressed will contain not fewer than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge.

e. A maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed.

G. Wall Openings:

1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall be no less than 18" above the floor slab, and the prestressing wires required at the pipe elevation shall be distributed above and below the opening leaving an unbanded strip around the entire tank.
2. Unbanded strips shall have a vertical dimension of no more than 36" unless an axi-symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacement of the prestressing wires into adjacent bands.

PART 2 PRODUCTS

2.1 PERFORMANCE

A. Performance of the materials used in the tank construction shall conform to the minimum requirements of this specification.

B. Substitutions to the materials in this specification may only be made if submitted in writing and approved by the engineer.

2.2 CONCRETE

A. Concrete shall conform to ACI 301.

B. All concrete shall utilize Type I/II Portland cement.

C. A maximum of 25% of cementitious material may be fly ash.

D. Admixtures other than air-entraining and water reducing admixtures will not be permitted unless approved by the engineer.

E. Course and fine aggregate shall meet the requirements of ASTM C 33.

F. Concrete mixes used in the construction of the tank shall conform to the following:

Mix	Compressive Strength (psi)	Minimum Cement Content (lbs)	Maximum Aggregate Size (in)	Maximum W/C Ratio	Air Content (%)	Slump (in)
Floor	4000	560	¾	0.45		4"+/-1"
Dome	4000	600	⅜	0.45		4"+/-1"

2.3 SHOTCRETE

A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.

B. All shotcrete mixes shall utilize Type I/II cement.

C. A maximum of 25% of cementitious material may be fly ash.

D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.

E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.

F. Shotcrete mixes used in the tank construction shall conform to the following:

Mix	Compressive Strength (psi)	Maximum W/C Ratio	Air Content (%)	Slump (in)	Fiber Reinforcement (lbs/cyd)
Core Wall	4000	0.42		4"+/-1"	-
Covercoat	4000	0.42		4"+/-1"	

2.4 PRESTRESSED REINFORCEMENT

A. The prestressing wire shall conform to the requirements of ASTM A 821, Type B.

B. The prestressing wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".

C. The ultimate tensile strength, fu shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.

2.5 NON-PRESTRESSED REINFORCEMENT

A. Non-prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A 185 with a minimum yield strength, f_y, of 60,000 psi.

B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A 185 with a minimum yield strength, f_y, of 65,000 psi.

2.6 STEEL DIAPHRAGM

A. The steel diaphragm used in the construction of the core wall shall be 26 gauge conforming to the requirements of ASTM A 1008.

B. The steel shell is to be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The sheets of steel diaphragm shall be continuous from bottom to top of wall; horizontal joints or splices will not be permitted.

D. All vertical joints in the diaphragm shall be rolled seamed, crimped and sealed watertight using epoxy injection.

E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

2.7 PVC WATERSTOPS, BEARING PADS AND SPONGE FILLER

A. Plastic waterstops shall be extruded from an elastomeric plastic material of which the base resin is virgin polyvinyl chloride.

B. The profile and size of the waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.

C. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber or polyvinyl chloride.

D. Sponge filler at the floor/wall joint shall be closed-cell neoprene.

2.8 EPOXY

A. Epoxy Sealants:

1. Epoxy used for sealing the steel shell shall conform to the requirements of ASTM C 881.
2. Epoxy used for sealing the steel shell shall be, Type III, Grade 1, and shall be a 100% solids, moisture insensitive, low modulus epoxy system.
3. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.

4. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC and steel.

B. Bonding Epoxy:

1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C 881.
2. Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

2.9 SEISMIC RESTRAINT CABLES

A. When required by design, seismic restraint cables shall be seven-wire strand conforming to ASTM A 416.

B. The strand shall be protected with a fusion-bonded, grit-impregnated epoxy coating conforming to ASTM A 882.

C. The minimum yield strength of the seven-wire strand shall be 270,000 psi.

2.10 TANK ACCESSORIES

A. Minimum of one, 1' 5" x 4' 4" rectangular Type 316 stainless steel wall manhole for access to the interior of the tank. The cover and the bolts shall also be of Type 316 stainless steel. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.

B. Exterior ladder shall be fabricated from 6061-T6 and 6063-T6 aluminum with Type 316 stainless steel fasteners and shall conform with all applicable OSHA standards. The ladder shall have an aluminum safety cage and lockable security gate and/or a safety climbing device as required to meet applicable OSHA standards.

C. Interior ladder shall be fabricated from fiberglass with Type 316 stainless steel fasteners and shall conform with all applicable OSHA standards. The ladder shall have a safety climbing device manufactured from Type 316 stainless steel as required to meet applicable OSHA standards.

D. Roof hatch cover, roof ventilator, and liquid level indicator shall be fabricated from fiberglass with Type 316 stainless steel fasteners.

E. Through-wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular seal units using stainless steel tightening bolts.

2.11 COATINGS

A. Exterior coating system shall consist of the following:

1. Tnemec Series 156 Enviro-Crete Modified Waterborne Acrylate.

PART 3 EXECUTION

3.1 EXAMINATION

A. All subgrade elevations shall be verified prior to starting tank construction.

3.2 INSTALLATION

A. Floor:

1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.
2. A 6-mil polyethylene vapor-barrier shall be placed after subgrade preparation has been completed.
3. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.
4. Plate bolsters shall be used to support reinforcing steel in the construction of the floor to ensure positive control of placement of reinforcing steel.
5. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
6. The floor shall be continuously water cured until tank construction is completed.
7. The floor shall receive a light broom finish.

B. Core Wall:

1. The wall shall be constructed in a predesigned manner utilizing steel shell diaphragm, layers of shotcrete and prestressing wire with each conforming to the following:

a. Diaphragm Erection:
(1) The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the steel shell for erection or other purposes except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an epoxy sealant which complies with Section 2.8 Epoxy.

b. Shotcrete:
(1) All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by

the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.

(2) Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.

(3) No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.

(4) No less than ⅛" thick shotcrete shall separate reinforcing steel and prestressing wire.

(5) The steel shell diaphragm shall be encased and protected with no less than 1" of shotcrete in all locations.

c. Curing:

(1) Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is started.

C. Epoxy Injection:

1. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.
2. Epoxy injection shall proceed only after the steel shell has been fully encased, inside and outside, with shotcrete.

D. Dome:

1. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.
2. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Section 2.8 Epoxy.
3. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control on placement of steel.
4. The exterior surface of the dome shall receive a light broom finish.
5. The dome shall be water cured for 7 days after casting or until dome band prestressing is completed.

E. Prestressing:

1. The initial tension in each wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.
2. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force

and unit compressive force equal to that shown on the design drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.

3. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.
4. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the design and as shown on approved drawings.
5. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall include: electronic direct reading stressometer accurate to within 2%, calibrated dynamometers and a test stand to verify the accuracy of the equipment.
6. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.
7. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ⅛" thick.

F. Covercoat:

1. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1" shall be placed over the prestressing wires.
2. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.
3. The covercoat shall receive a sliced trowel finish.

G. Wall Openings:

1. All wall pipes, sleeves and manholes passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.

H. Coatings:

1. Exterior coatings shall be applied in a minimum of two coats with a thickness of 4.0 to 8.0 MDFT per coat. The minimum total thickness of 10.0 MDFT.

2. All coatings shall be applied a minimum of 28 days after final application of concrete or shotcrete.
3. All application procedures for coatings shall be in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing:

a. Compression Tests:
(1) Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 yards of concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.
(2) Compression test specimens for concrete/shotcrete shall conform to ASTM C 172 for sampling and ASTM C 31 for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.
(3) Compression test shall be performed in accordance with ASTM C 39. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.

b. Air Content Tests:
(1) Air content tests shall conform to ASTM C 231 (Pressure Method for Air Content).
(2) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.

c. Slump Tests:
(1) Slump tests shall be made in accordance with ASTM C 143.
(2) Slump tests shall be made whenever compression test specimens are made.

2. Hydrostatic Testing:

a. On completion of the tank and prior to any specified backfill placement at the footing or wall, the tank shall be tested for watertightness.

b. The testing for watertightness shall be completed as follows:
(1) Fill the tank with water to the maximum water level and let it stand for a minimum of 24 hours.

(2) Inspect the exterior of the tank wall and footing for damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source of which is from inside the tank.

(3) Leakage through the wall or wall-base joint shall be repaired and the tank shall be retested using the above procedure.

3.4 CLEANING AND DISINFECTION

A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing and disinfection.

B. The following disinfection procedure shall be used to disinfect storage tanks used for potable water:

1. Method 2 or 3 will be used for disinfection of the tank in accordance with AWWA C652.
2. When Method 3 is used, the disinfection plan required by Section 1.4 H. shall address any compatibility issues with the form of chlorine used for disinfecting the storage tank with the type of disinfectant used in the normal production of the water used to fill the tank.

END OF SECTION 13220