Lenexa
KANSAS

Technical Specifications

2024 Edition

CITY OF LENEXA

Community Development Department

www.lenexa.com

CITY OF LENEXA
TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

ADMINISTRATIVE ITEMS

S-100 SCOPE OF WORK: The work provided for in these Specifications shall consist of furnishing all labor, materials, appliances, and equipment, and performing all work and operations in connection with the construction of items and all other incidental and related work as set forth in these Specifications and as directed by the Engineer to make a complete and finished job.

S-101 <u>DEFINITION AND TERMS</u>: Wherever in these Specifications or in other Contract Documents the following terms are used, the intent and meaning shall be interpreted as follows:

A. ABBREVIATIONS:
Wherever the following abbreviations are used in these Specifications or in other Contract Documents, they are intended to represent the following organizations, agencies, and/or their respective publications, standards, etc.:
A.A. - Aluminum Association
A.A.N. - American Association of Nurserymen
A.A.R. - Association of American Railroads
A.A.S.H.T.O. - American Association of State Highway and Transportation Officials
A.C.I. - American Concrete Institute
A.C.P.A. - American Concrete Pavement Association
A.G.C. - Associated General Contractors of America
A.I.A. - American Institute of Architects.
A.I.S.C. - American Institute of Steel Construction
A.I.S.I. - American Iron & Steel Institute
A.N.S.I. - American National Standards Institute
A.O.S.A. – Association of Official Seed Analysts
A.R.A. - American Railway Association
A.R.E.A. - American Railway Engineering Association
A.R.T.B.A. - American Road and Transportation Builders Association
A.S.C.E. - American Society of Civil Engineer
A.S.L.A. - American Society of Landscape Architects
A.S.T.M. - American Society of Testing and Materials
A.W.G. – American Wire Gage
A.W.P.A. - American Wood Preservers' Association
A.W.S. - American Welding Society
A.W.W.A. - American Water Works Association
B.W.G. – Birmingham Wire Gage
C.F.R. - Code of Federal Regulations
C.R.S.I. - Concrete Reinforcing Steel Institute
E.E.O. - Equal Employment Opportunity
F.A.R. - Federal Acquisition Regulations
F.H.W.A. - Federal Highway Administration - US Department of Transportation
F.S.S. - Federal Specifications and Standards, General Services Administration
G.S.A. - General Services Administration
I.T.E. - Institute of Transportation Engineers
K.A.R. - Kansas Administrative Regulations
K.C.M.M.B. – Kansas City Metro Materials Board
K.D.O.T. - Kansas Department of Transportation
MIL - Military Specifications
M.U.T.C.D. - Manual on Uniform Traffic Control Devices
N.B.S. - National Bureau of Standards
N.E.C. - National Electrical Code
N.E.M.A. - National Electrical Manufacturers Association
N.F.P.A. - National Forest products Association
O.S.H.A. - Occupational Safety and Health Association
P.C.A. - Portland Cement Association
P.C.I. - Prestressed Concrete Association
P.T.I. - Post Tensioning Institute

S.A.E. - Society of Automotive Engineers
S.S.P.C. - Steel Structures Painting Council
T.A.I. - The Asphalt Institute
T.A.R. - Transportation Acquisition Regulations
U.L. - Underwriter's Laboratory

B. DEFINITIONS:

1) BRIDGE: A single or multiple span structure, including supports, erected over a depression or an obstruction, such as water, a highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having an opening measured along the center of the roadway of more than 20 feet (6 meters) between under-copings of abutments or spring lines of arches or extreme ends of openings of multiple boxes. If there are no abutment copings or fillets, the 20 foot (6 meters) measurement shall be between points six inches (150mm) below the bridge seats or, in the case of frame structures, immediately under the top slab. A bridge may include multiple pipes where the clear distance between openings is less than half of the smaller contiguous opening. All measurements shall include the width of intervening piers or division walls.
2) BRIDGE LENGTH. The greater dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between ends of the bridge floor.
3) BRIDGE ROADWAY WIDTH. The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.
4) CENTER LINE OF HIGHWAY: A line equidistant from the edges of the median separating the main traveled ways on a divided highway, or the center line of the main traveled way on a nondivided highway.
5) CHAIN LINK FENCE FABRIC: A material made from wire helically wound and interwoven in such a manner as to provide a continuous mesh without knots or ties except in the form of knuckling or of twisting to form the selvage of the fabric.
6) CONTROLLED ACCESS FACILITY: A highway, road or street especially designed to expedite and control through and local traffic; and over, from or to which highway, road or street, owners or occupants of abutting property shall have only a controlled right of easement of access, light, air or view.
7) CULVERT: Any structure which provides an opening under the roadway but which does not meet the classification of a bridge.
8) DETOUR: A temporary route for traffic around a closed portion of a road.
9) ENGINEER: Engineer shall mean City Engineer or his qualified designee for the City of Lenexa., unless the Contract Documents identify an individual or entity which has been contracted with by the City for the performance of professional architectural or engineering services with the Project.
10) EQUIPMENT: All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and tools and apparatus necessary for the proper construction and acceptable completion of the work.
11) FIELD ENGINEER: Field Engineering Supervisor or any other Inspector under the supervision of the Field Engineering Supervisor. See Engineer.
12) GUARD RAIL TERMINAL DEVICE: The device placed at the termination of the guard rail, whether the entry or exit end, to protect the driver from striking the end of the rail.

13) GENDER REFERENCES: Whenever the words "he", "she", "him", or "her" occur in these Specifications or elsewhere in the Contract Documents, no particular gender is intended by use of such words.
14) KNUCKLING: The selvage obtained by interlocking adjacent pairs of wire ends and bending the wire back into a loop.
15) LABORATORY: The testing laboratory designated by the Engineer.
16) MATERIALS: Any substance specified for use in the construction of the project and its appurtenances.
17) MEDIAN: The portion of a divided highway or street separating the traveled ways for traffic moving in opposite directions.
18) PAVEMENT STRUCTURE: The combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.
    i) Subgrade - The top surface of a roadbed upon which the pavement structure and shoulders, including curbs, are constructed.
    ii) Subgrade treatment - Modification of roadbed material by stabilization.
    iii) Subbase - The layers of specified or selected material of designed thickness placed on a subgrade to support a base course.
    iv) Base course - The layer or layers of specified material of designed thickness placed on a subbase or a subgrade to support a surface course.
    v) Surface course - One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which acts as a friction course, resists traffic abrasion and resists the disintegrating effects of climate. The top layer is sometimes called "Wearing Course".
19) PLANS: The approved plans, profiles, typical cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be performed.
20) PROFILE GRADE: The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.
21) RIGHT-OF-WAY: A general term denoting land, property, or interest therein acquired for or devoted to transportation purposes.
22) ROAD: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.
23) ROADBED: The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.
24) ROADSIDE: A general term denoting the area adjoining the outer edge of the road. Extensive areas between the traveled ways of a divided street may also be considered roadside.
25) SHOULDER: The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.
26) SIDEWALK: That portion of the roadway primarily constructed for the use of pedestrians.
27) STABILIZATION: Modification of soils or aggregates by incorporating materials that will increase load bearing capacity, firmness and resistance to weathering or displacement.
28) STREET: A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

29) STRUCTURES: Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, headwalls, buildings, sewers, service pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classified herein.
30) SUBGRADE: The top surface of a roadbed upon which the pavement structure and shoulders, including curbs, are constructed.
31) SUBSTRUCTURE: All that part of a structure below the bearing of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, wingwalls and wing protection railings.
32) SUPERSTRUCTURE: All that part of a structure above and including the bearing of simple and continuous spans, skewbacks of arches and top of footings of rigid frames, excluding backwalls, wingwalls, and wing protection rails.
33) TITLES (OR HEADINGS): The titles or headings of the sections and subsections therein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.
34) TRAVELED WAY: The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.
35) TWISTING: The type of selvage obtained by twisting adjacent pairs of wire ends together in a close helix of 1.5 machine turns, which is the equivalent to three full twists and cutting the wire end at an angle.
36) WORK: The furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

S-102 SPECIFICATIONS: The work shall conform to these Specifications and to the "Standard Specifications" where reference is made herein. Where reference is made in these Specifications to "Standard Specifications," it shall mean that the reference is made to the latest edition of the Standard Specifications for State Road and Bridge Construction, Kansas Department of Transportation with such revisions, amendments, and supplements as are contained herein. The “Standard Specifications” shall govern all work not covered by these Specifications.

S-103 EQUIPMENT REQUIREMENTS: Unless otherwise noted, equipment shall conform to the requirements specified in Division 150 of the "Standard Specifications", or as specified herein.

A. The Engineer shall have the right to limit the gross vehicle weight of all vehicles in order to protect the pavement section. For purposes of this section, the pavement section shall include the subgrade.

B. METHOD OF PAYMENT: The City retains the right to measure, certify, or calibrate any of the equipment used by the Contractor on the project. Conformance with this section will be usually measured by the compliance of the installed work with the applicable section of these Specifications.

C. PAYMENT: No separate payment will be made for any equipment unless otherwise noted in these Specifications.

S-104 MATERIAL REQUIREMENTS AND SUBMITTALS: Unless otherwise noted in these Specifications, all material shall conform to the requirements specified in the Material Division of the KDOT Standard Specifications for State Road and Bridge Construction. All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents.

A. SUBMITTALS: An electronic copy (pdf.) of ALL submittals shall be tendered to the Engineer, and approved prior to installation or incorporation of ANY material into the construction. All submittals, regardless of origin, shall be stamped with the approval of Contractor and identified with the name and number of this Contract, Contractor's name, and references to applicable Specification paragraphs and Contract Drawings. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. Contractor's stamp of approval is a representation to Owner that Contractor accepts full responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, and similar data, and that he has reviewed and coordinated each submittal with the requirements of the Work and the Contract Documents. Contractor shall accept full responsibility for the completeness of each submission. When an item consists of components from several sources, Contractor shall submit a complete initial submittal including all components. All deviations from the Contract Documents shall be identified on each submittal and shall be tabulated in Contractor's letter of transmittal. The current list of required submittals is shown on the next page of this specification.

B. Certain material, such as ring and covers for manholes and storm sewer structures, street lighting, signal poles and equipment, sealants, concrete mixes, asphalt mixes, rolled erosion control products, etc. are pre-approved for use on public improvements. The list of pre-approved materials is available at the office of the City Engineer. To add additional material to the list, submit specifications and/or catalog cuts of the proposed addition to the City Engineer.

C. Unless Mobilization is listed as a separate bid item, the City of Lenexa does not consider Mobilization as a separate bid item. Any costs associated with mobilization of the Contractor’s forces, equipment, and material will be subsidiary to other items in the bid.

ITEM NO.	ITEM DESCRIPTION	TYPE SUBMITTAL	SUBMIT TO
1	List of Subcontractors	List--Note 1	ENGR
2	Construction Schedule	PERT Chart	ENGR
3	Concrete Mix Design	Schedule No. 3	ENGR
4	Asphalt Mix Design	Schedule No. 3	ENGR
5	Fly Ash, Cement, or Lime for Modified Subgrade	Certificate No. 2	ENGR
6	Certificate on Rebar and Other Reinforcement	Delivery Ticket	INSPCTR
7	Certification by Test Lab of Brick Pavers	Certificate No. 1	ENGR
8	Certification of Pipe Material, Class, Gage, etc.	Certificate No. 2	ENGR
9	Masonry Stone Class I/VI Certificate	Certificate No. 3	ENGR
10	Shop Drawings for all Structures	Drawings—No. 1	ENGR
11	Material Certification for Guard Rail	Certificate No. 2	ENGR
12	Delivery Ticket for Fertilizer	Delivery Ticket	INSPCTR
13	Herbicide Schedule	Schedule No. 1	ENGR
14	Herbicide Certificate	Certificate No. 2	ENGR
15	Biological Planting Schedule	Schedule No. 2	ENGR
16	Biological Soil Preparation Schedule	Schedule No. 2	ENGR
17	Biological Planting Certificate	Certificate No. 4	ENGR
18	Standard Seeding Certificate	Delivery Ticket	INSPCTR
19	Street Lighting Schedule	Schedule No. 3	ENGR
20	Storm Sewer Structure Hardware Schedule	Schedule No. 3	ENGR
21	Signal Schedule	Schedule No. 3	ENGR
22	Certification of Sign Facing Material	Certificate No. 2	ENGR
23	Certification of Sign Blank Material	Certificate No. 2	ENGR
24	Thermo-plastic or Cold-Plastic Marking Material	Certificate No. 2	ENGR
25	Glass Beads	Certificate No. 2	ENGR
26	Certification of Rolled Erosion Control Products	Cert 2/Sched. 3	ENGR

27	Certification of Park Benches, Ped. Bridges., Playground Equip., Other Park Equip.	Certificate No. 2	ENGR
28	Certification of Gabions, BioGabions	Schedule No. 3	ENGR
29	Certification of Fencing Material	Certificate No. 2	ENGR
30	Certification of Irrigation Material	Schedule No. 3	ENGR
31	Aggregates	Submit Gradation	ENGR
32	Borrow Material	MEMO to File	By INSPCTR
33	Select Soil	MEMO to File	By INSPCTR
34	Crack Filling Material	Certificate No. 2	ENGR
35	Crack Repair Membrane	Certificate No. 2	ENGR
36	Slurry Seal Mix Design	Submit Mix Design	ENGR
37	Tack Coat	Delivery Ticket	INSPCTR
38	Handicap Ramp Marking Panels	Certificate No. 2	ENGR
39	Underdrain Pipe/Water Line Pipe	Certificate No. 2	ENGR
40	Pre-Cast Concrete Box Culverts	Submit Shop Drwgs. & Laying Schedule	ENGR
41	Sanitary Sewer Main Line and Service Lines	Certificate No. 2	ENGR
42	Landscaping Products--as specified (Incl. Bonded Fiber Matrix, Hydro-seeding Products, Mulch, etc.)	Certificate No. 2	ENGR
43	Miscellaneous Products--as specified (Incl. GeoCellular Confinement Products, Modular Wall Products, Monument Boxes, Product Signs, Paint, etc.)	Certificate No. 2	ENGR
44	Other material not listed above	Certificate No. 2 or As specified by Engr.	ENGR

SCHEDULE NO. 1
List of Equipment
Herbicide License
All Materials, by Brand Name and Generic Name, (Incl. Source, Quant.)

SCHEDULE NO. 2
List of Equipment to be used on the Project
List of Material to be used on the Project:
Material Source, Quantity, Quality--Per Indust. Std., (Incl. Wt. Of Metal Components, and Nomenclature)

SCHEDULE NO. 3
Pre-Approved Material List, Marked, (Marked w/Items to be used)

NOTE NO. 1
List Each Subcontractor, the point of contact name, a phone number, an address, and what portion of the work the Sub will perform--by description and %.

CERTIFICATE NO. 1
Letter from supplier certifying that the material meets or exceeds the specification. Sample will be included with the Certificate.
Submit Sample of Ea. Size, Type, Component

CERTIFICATE NO. 2
Letter from supplier certifying that the material meets or exceeds the specification. Letter should include Mfr. Name, Address, Model/ Product Number

CERTIFICATE NO. 3
Certificate from the supplier as to which geological ledge the masonry material comes from. Paola and Argentine Ledges are acceptable, among others.

CERTIFICATE NO. 4
Letter from Supplier Certifying That the Material Meets or Exceeds the Specification.
Certificate shall include:

Native Seed:	Plants/Trees:
Date of Harvest, Mo. & Yr.	Date of Harvest
Location of Harvest (Gen. Area)	Location of Harvest (Gen. Area)
Genus species Identification	Genus species Identification
Common Name	Common Name
Seed Lot #	Caliper/Size
Packaged Quantity (Bulk)	Supplier Name & Address
Identification of Seed Supplier	State of Supplier Registration

Supplier Certification Number
State of Supplier Registration
Percent PLS Per Seed Lot
Percent Germination
Percent Hard Seed
Percent Foreign Matter (Inert)
Percent Weed Seed
I.D. & % of Noxious Weed Seed
Date of Seed Testing
Identification of Seed Testing Company

Certificate shall bear the signature of a person holding a Bachelor of Science degree in horticulture from an ABET accredited college. Grass seed shall be tested by a registered seed technologist per AOSA requirements, and certification provided to the Engineer.

S-105 SAMPLING AND TESTING: All sampling and testing deemed necessary by the Engineer shall be performed by the City or by a Testing Laboratory selected by the City on Federally or City funded projects, unless otherwise specified. The costs of all such tests, showing compliance with the Specifications, shall be paid by the City. However, in the event that any test indicates non-compliance with the Specifications, additional testing will be paid for by the Contractor to determine acceptability of the material or methods.

A. Following this page is a list of tests to be performed and the frequency of each test.

TYPE	TEST REQUIRED	METHOD	FREQUENCY
COMPACTION OF EARTHWORK	SHEEPS FOOT, PROOF ROLL, FIELD DENSITY	Sheep's Foot "Walks Out", Tandem Axle Dump Truck, 25 tons (50,000 lbs.) ,KT-13, KT-51	Both tests conducted with Construction Inspector present.Required for sub grade for curbs and pavement 2 per day per lift when visual determination is not possible.
BACKFILL	VISUAL INSPECTION, FIELD DENSITY	Jumping Jack or Vibra-Plate Compactor, KT-13, KT-51	Maximum of 6 inch lifts – Continuous Inspection, 1 per structure minimum (each side)
MOISTURE, (MR-90, or MR-5)	MOISTURE TEST (AT ENGINEERS DISCRETION) VISUAL	KT-11, KT-51	2 per day per lift when visual determination is not possible.
SUBGRADE MODIFICATION	VISUAL INSPECTION	Visual	Continuous
COMPACTION, (AAA, AA, or A)	FIELD DENSITY, MOISTURE TESTS, PROOF ROLL	KT-11, KT-51 Tandem Axle Dump Truck, 25 tons (50,000 lbs.)	Engineer's Discretion
AGGREGATE BASE	SHEEPS FOOT, PROOF ROLL	KT-13, KT-51 Sheep's Foot "Walks Out", Tandem Axle Dump Truck, 25 tons (50,000 lbs.)	2 per day per lift. Both tests conducted with Construction Inspector present. Required for sub grade for curbs and pavement
STABILIZED SHOULDERS	SHEEPS FOOT, PROOF ROLL	Sheep's Foot "Walks Out", Tandem Axle Dump Truck, 25 tons (50,000 lbs.)	Both tests conducted with Construction Inspector present. Required for sub grade for curbs and pavement
EMBANKMENT	VISUAL INSPECTION		Engineer's Discretion
GRANULAR BASE	SHEEPS FOOT, PROOF ROLL	Sheep's Foot "Walks Out", Tandem Axle Dump Truck, 25 tons (50,000 lbs.)	Both tests conducted with Construction Inspector present.Required for sub grade for curbs and pavement

TYPE	TEST REQUIRED	METHOD	FREQUENCY
SURFACE OR RESURFACING AGGREGATE	CERTIFICATE	NA	NA
FLY ASH, CEMENT, LIME AND LIME KILN DUST FOR STABILIZATION	MOISTURE TESTS, FIELD DENSITY TESTS AND GRADATIONS	KT-11, KT-51, KT-13, KT-2	Engineer's Discretion (See Fly Ash Specification)
CONCRETE PAVEMENT	SLUMP AIR CONTENT CYLINDERS MASS/YIELD TEMPERATURE PROFILOGRAPH	KT-21 KT-18, KT-19 or KT-20 KT-22 KT-20 KT-46	Minimum of 1 set per each half day and/or 4000 yd^2 Type Inspection must equal "ACI" when recording for acceptance Type Inspection must equal "ACI" when recording for acceptance 1 set of 3 on initial pour. 1 set per pour and/or mix change Testing by Testing Lab, results reviewed by City Minimum of 1 in AM and 1 in PM during mixing operations See Standard Specifications Initially 1 complete transverse profile, thereafter 5 per day
CONCRETE BRICK PAVERS	CERTIFICATE	NA	Can be on Pre-Approved Material List
JOINT FILLER	CERTIFICATE	NA	NA
BITUMINOUS CONSTRUCTION, (PLANT MIX)	CERTIFICATE	NA	NA
BITUMINOUS MIXTURES	DENSITY, VOIDS, STABILITY, FLOW, GRADATION, ASPHALT CONTENT, VMA, VFA	KT-14, KT-34 & KT-57	Daily Quality Control shall be run when 500 tons will be place on a project. Testing performed by contractor.
SLURRY SEAL	CERTIFICATE	NA	NA

TYPE	TEST REQUIRED	METHOD	FREQUENCY
BITUMINOUS SEAL	CERTIFICATE	NA	NA
PAINT	CERTIFICATE	NA	NA
REINFORCING STEEL BARS AND OTHER REINFORCING MATERIAL	DELIVERY TICKET	NA	NA
STONE FOR RIPRAP, WASH CHECKS & OTHER MISC. USES	CERTIFICATE	NA	NA
AGGREGATE FOR CONCRETE	CERTIFICATE	NA	NA
MASONRY STONE	CERTIFICATE	NA	NA
UNDERDRAIN AGGREGATE	CERTIFICATE	NA	NA
LIQUID MEMBRANE FORMING COMPOUNDS	CERTIFICATE	NA	NA
PORTLAND CEMENT, BLENDED HYDRAULIC CEMENT, FLY ASH FOR USE IN CONCRETE	KC METRO MATERIALS BOARD, (KCMMB)	KCMMB Requirements	Prior to Approval
INDIVIDUAL AGGREGATE	KC METRO MATERIALS BOARD, (KCMMB)	KCMMB Requirements	Prior to Approval
DRAINABLE BASE	SIEVE ANALYSIS OF AGGREGATE, (1% OF MASS)	KT-2	1 in AM and 1 in PM or each 500 Tons
EPOXY	CERTIFICATE	NA	Can be on Pre-Approved Material List
PRE-FORMED THERMO-PLASTIC	CERTIFICATE	NA	Can be on Pre-Approved Material List
THERMOPLASTIC	CERTIFICATE	NA	Can be on Pre-Approved Material List
THERMOPLASTIC SPRAY	CERTIFICATE	NA	Can be on Pre-Approved Material List
GLASS BEADS	CERTIFICATE	NA	NA
FLOWABLE FILL	CERTIFICATE	NA	Can be on Pre-Approved Material List
HDPE OR RC PIPE, ALL USES	CERTIFICATE	NA	Can be on Pre-Approved Material List
GUARD RAIL	CERTIFICATE	NA	NA
FERTILIZER, HERBICIDES	CERTIFICATE	NA	NA

TYPE	TEST REQUIRED	METHOD	FREQUENCY
BIOLOGICAL PLANTINGS	CERTIFICATE	NA	NA
SEED, TURF GRASSES	CERTIFICATE	NA	NA
SIGN BLANKS AND FACING	CERTIFICATE	NA	NA
ROLLED EROSION CONTROL PRODUCTS	CERTIFICATE	NA	Can be on Pre-Approved Material List
PARK BENCHES, PED. BRIDGES., PLAYGROUND EQUIP., OTHER PARK EQUIP.	CERTIFICATE	NA	NA
GABIONS, BIOGABIONS	CERTIFICATE	NA	NA
FENCING MATERIAL	CERTIFICATE	NA	NA
IRRIGATION MATERIALS	CERTIFICATE	NA	NA
AGGREGATES	CERTIFICATE	NA	NA
CRACK FILLING MATERIAL	CERTIFICATE	NA	NA
CRACK REPAIR MEMBRANE	CERTIFICATE	NA	NA
HANDICAP RAMP MARKING PANELS	CERTIFICATE	NA	NA
PRECAST CONCRETE BOX CULVERTS	CERTIFICATE	NA	NA
SANITARY SEWER LINES & SERVICE LINES	CERTIFICATE	NA	NA
LANDSCAPING PRODUCTS (INCL. BONDED FIBER MATRIX, HYDRO-SEEDING PRODUCTS, MULCHES, ETC.	CERTIFICATE	NA	NA
MISCELLANEOUS PRODUCTS (INCL. GEOCELLULAR CONFINEMENT PRODUCTS, MODULAR WALL PRODUCTS, MONUMENT BOXES, PROJECT SIGNS, ETC.	CERTIFICATE (CERT. Hereafter)	NA	NA
SOIL SAMPLE FOR SOIL AMENDMENTS	NITROGEN, POTASSIUM, PHOSPHORUS CONTENT—ASTM	PERTINENT ASTM/AASHTO TEST	PRIOR TO ADDING FERTILIZER UNDER DRIP LINE OF TREES.
OTHER MATERIALS NOT LISTED ABOVE	CERT., OR AS SPECIFIED BY ENGR.	NA	NA

EARTHWORK

S-200 <u>BACKFILLING FOR STRUCTURES</u>: This work shall consist of backfilling structures according to the following specifications.

A. GENERAL: Only approved materials that will produce a dense, well-compacted backfill shall be used.
   1. Backfill procedures should be performed by working parallel with the structure when possible.
   2. No backfilling shall be placed against any structure without permission of the Engineer. In general no concrete structure shall be subjected to the pressures of backfilling or to live loads until three days after the expiration of the period designated for the removal of forms. At the direction of the Engineer this period may be extended if subnormal curing conditions exist. Adequate provisions shall be made for thorough drainage and not less than two cubic feet (0.06 cubic meters) of crushed stone or sand gravel shall be placed at each weep hole. Backfill, placed around culverts, abutments and piers, shall be deposited on both sides to approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the structure. The slopes bounding the excavation shall be stepped when necessary, to prevent such wedge action.
   3. Jetting of fills, or other hydraulic methods, involving or likely to involve liquid or semi-liquid pressure shall be prohibited.
   4. When the Plans or Contract provide for "Compaction of Earthwork" the material shall be placed in layers and compacted by means of suitable equipment, exclusive of tracked laying equipment, or by tamping with mechanical tampers or hand tampers. Each layer shall be compacted to a density equal to or greater than 90 percent of the Standard Compaction of the soil except when Type "C" compaction is shown. Each successive layer shall contain only that amount of material which will insure proper compaction, but in no case shall any layer be greater than six inches (loose measurement) in depth. The moisture content of the soil to be used for backfill shall be uniform and shall be within the moisture range designated on the Plans for the embankment adjacent to the structure. If no moisture range is designated, the moisture content of the soil to be used shall be uniform and shall be such that a density of 90 percent of Standard Compaction can be obtained. When the Plans or Contract do not provide for compaction or when Type "C" compaction is shown, compaction of backfill will be performed in accordance with Type "C" compaction requirements. Lift thickness shall be as determined by the Engineer. Backfill for storm sewer inlets under the roadway shall be flowable fill, unless the work conforms to the “Trenching in Paved Areas (Deep Fill)” standard detail and the Contractor chooses to use this method. In that case, the backfill adjacent to the structure shall be hand-tamped to achieve adequate compaction.
   5. Water shall be drained from the areas to be backfilled whenever practical, except for piers when backfill compaction is not required. In cases where it is not practical to drain the areas to be backfilled, the backfill material shall be deposited in the water in thin layers and compaction will not be required until the backfilling has progressed to the point where all water has been absorbed in the backfill material.
   6. In no case shall surplus material be dumped in the channel of the stream but shall be disposed of in the embankments or as directed.
   7. The Contractor shall continue the compacted backfill until reaching the lines and grades shown on the Plans. If required on the Plans, the portion of the backfill next to the surface of the substructure shall be composed of coarse gravel or crushed stone.

8. On large diameter metal pipes (48 inches and larger) backfill techniques should be used and deflection control measures maintained to see that the original shape of the pipe remains intact.
9. Backfilling operations that permit "peaking" or "rolling" of the pipe should be avoided. Plumb bobs should be used or periodic measurements taken to detect distortion. Distortion indicates that equipment is working too close to the pipe and creating unequal pressure on each side. Hand tamping operations may be required adjacent to the pipe to prevent distortion.
10. When it is necessary for heavy construction equipment to travel over metal pipe, the structure shall be protected by adequate cover to prevent damage.

B. METHOD OF MEASUREMENT: No separate measurement shall be made for "Backfill of Structures".

C. BASIS OF PAYMENT: No separate payment shall be made for "Backfill of Structures". This item shall be subsidiary to installation of the structure.

S-201 <u>BASE REPAIR</u>: This work shall consist of saw cutting, excavating, and backfilling of designated areas to be patched, in accordance with the following specifications. The Contractor shall saw cut the pavement along the lines, marked in the field by the Engineer, to the full depth of the pavement, and remove the existing pavement within the saw cut lines. Contractor shall remove all unsuitable subbase material found within the saw cut lines and shall extend the area of subbase and pavement removal as directed by the Engineer in order to remove all unsuitable subbase material. When all of the unsuitable material has been removed, the repair area shall be trimmed to approximately straight lines so that the bottom of the repair area is roughly parallel to the existing pavement surface, so that there are only four (4) sides to the repair, and so that all four (4) sides have an approximately vertical face. Pavement will be removed for a distance of one (1) foot outside of the limits of the repair. The Engineer will then measure the volume of subbase removed. After the Engineer measures the volume and area as stated above, the Contractor shall backfill the repair area to 8", 9", 11", or 12" below the level of the existing surface on residential, collector, secondary arterials, or primary arterials respectively, with pugged AB-3, using lifts of 6" depth or less. Each lift shall be compacted using rollers and/or hand tampers per the requirements of the Section of these Specifications titled “Compaction of Earthwork”. The unsuitable subbase material from the roadway area and disposed of by the Contractor.

Whenever a utility cuts the pavement, the backfill for the utility cut shall be flowable fill.

A. METHOD OF MEASUREMENT: Base repair shall be measured by the cubic yard per the dimensions measured by the Engineer prior to backfilling. Removal of the existing pavement shall be subsidiary to pavement patching.

B. BASIS OF PAYMENT: Base repair shall be paid for at the contract unit price per cubic yard of completed and accepted work.

S-202 <u>BRACING AND SHORING</u>: It shall be the Contractor's responsibility to brace and shore existing structures and utilities during construction. Any additional damage to or collapse of existing structures during the Contract period shall be the sole responsibility of the Contractor.

A. The Contractor shall brace and shore all trenches in full accordance with Occupational Safety and Health Standards.

B. METHOD OF MEASUREMENT: No separate measurement shall be made for "Bracing and Shoring".

C. BASIS OF PAYMENT: No separate payment shall be made for "Bracing and Shoring". This item shall be subsidiary to other bid items.

S-203 CLEARING AND GRUBBING: This work shall consist of the felling and cutting up of trees, stumps, roots, shrubs, hedges and other protruding obstructions not designated to remain. Perimeter erosion and sediment controls must be in place before clearing or grubbing activities begin. Whenever possible, the Contractor shall leave an undisturbed strip of existing grass or other vegetation in place around the perimeter of the construction site.

A. Clearing shall consist of the felling and cutting up of trees, shrubs, hedges, sod, grass, residue or agricultural crops, decayed vegetative matter, lumber, waste dumps, trash, and other protruding obstructions not designated to remain, together with downed timber, rubbish, snags, mowing, and brush found on or above the surface within the areas to be graded, and disposal of same. In performing the Clearing operations, the Contractor should not remove more earth than is necessary. Trees and other vegetation within the areas to be cleared shall be completely removed, including roots as specified hereinafter. Except in areas to be excavated, stump holes and other holes from which obstructions are removed, shall be backfilled with suitable material and compacted in accordance with the best standard practice for the area and type of soil encountered. The method of disposal shall be accomplished in accordance with all applicable Federal, State and local ordinances. Clearing shall not include removal of man-made structures, or demolition of buildings.
B. Grubbing shall consist of removing and disposing of all vegetative matter such as stumps, roots, buried trees, and brush encountered below the surface of the ground or subgrade, whichever is lower, except as provided in the specification for “Removal of Existing Structure, and Demolition”. In performing the Grubbing operations, the Contractor should not remove more earth than is necessary. The vegetative matter shall be removed to a minimum depth of 12” below ground line or subgrade, whichever is lower. Grubbing shall not include removal of man-made structures, or demolition of buildings.
C. The limits of clearing and grubbing shall extend to the limits of the construction unless otherwise shown on the plans. Clearing should only occur in those areas required for construction within a two month period. Where possible, large projects should be cleared and grubbed as construction progresses. Mass clearing and grubbing should be avoided. An undisturbed strip of not less than 25 feet in width of existing grass or other vegetation should be kept in place around the perimeter of the construction site, where possible, and protected from damage. The Contractor shall clear and grub only those areas necessary for construction of the project.

D. METHOD OF MEASUREMENT: This work shall be measured by the lump sum.

E. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price for lump sum "Clearing and Grubbing".

S-204 COMPACTION OF EARTHWORK: This work shall consist of the compaction of earthwork by rolling or tamping or any combination of these methods in accordance with the requirements specified for the Type and Moisture Range designated on the Plans or ordered by the Engineer.

A. GENERAL: The provisions of the section of this specification titled “Embankments” shall apply to the construction of embankments that are to be compacted except as specifically superseded herein relative to preparation of the areas upon which the embankment is to be placed and to the thickness of the layers of embankment being placed.
   1. Compacting operations shall include adequate blading with motor graders to insure uniformity of the lifts or layers of embankments being compacted. The number of blades and rollers in use shall be sufficient to blade and compact adequately all materials being delivered to the embankment. The Engineer shall have full authority to suspend the delivery of materials to the embankment until previously delivered materials are properly placed and satisfactorily compacted.
   2. Foundation Treatment: All sod and vegetable matter shall be removed from the surface upon which the embankment is to be placed, and the cleared surface shall be completely broken up by plowing, scarifying or stepping to a minimum depth of six inches. The material of which the foundation is composed shall be adjusted to a moisture content within the moisture range and compacted to the type of compaction to which the subsequently placed embankment is to be constructed as designated on the Plans. If the original surface upon which embankment is to be placed is an old roadbed, the surface shall be plowed, scarified, or broken up. Contractor shall meet all applicable regulations concerning environmental considerations.
   3. Compaction in Cuts: When required on the Plans or ordered by the Engineer, the soil below grade line in cut sections shall be scarified, broken up, adjusted to a moisture content within the designated moisture range and compacted to the designated type of compaction.
   4. When the depth of compaction in cut sections is shown to be more than six inches, all material shall be removed to within six inches of the lower limit of the compaction. The layer of material left in place shall be scarified, broken up, adjusted to a moisture content within the designated moisture range and compacted to the designated type of compaction. This process shall be repeated until the cut section is compacted to the grade shown on the Plans.
   5. Allowance for compaction in cut sections will be made only for that material that is removed and backfilled. No allowance will be made for compaction of the bottom layer that was left in place. Compaction of this layer shall be considered similar to foundation treatment and shall be subsidiary to other items of the Contract.
   6. Moisture Control Requirements: The moisture content of the soil at the time of compaction shall be within the moisture range designated on the Plans, unless it is determined by the Engineer that the soil is unstable in the designated moisture range.
   7. When the moisture content of the embankment soil does not fall within the required moisture range, water shall be added or the material shall be aerated, whichever is needed to adjust the soil to the proper moisture content. Water may be added to the soil in the borrow and cut areas before hauling or may be added to the soil on the embankment after hauling, so long as the moisture content of the soil at the time of compaction is uniform and within the designated moisture range.
   8. The amount of water to be added shall be only that amount that will provide a moisture content in the soil to be within the required range plus a reasonable amount to compensate for evaporation and other unavoidable losses.

9. The moisture content of the soil being compacted shall be considered as being too high to insure compaction when after repeated rolling with the sheepsfoot roller, the roller continues to pick up excessive amounts of soil and refuses to "build up" so that the tamping feet eventually ride the compacted surface. When heavy clay soils are encountered actual moisture content of the soil shall be no more than two percentage points above the lower plastic limit of that soil during compaction.
10. When other types of rollers are used, the moisture content of the soil shall be considered as excessive when "bridging" or building up" of the soil occurs in front of, or behind the wheels of such rollers, and/or when earth hauling equipment produces excessive ruts in the rolled surfaces.
11. Pre-watering: The Contractor may pre-water in excavation areas. This shall be done by use of a sprinkler system, flooding of the area, or other approved methods.
12. The Contractor shall furnish a sketch for each area to be pre-watered showing the pre-watering layout, including nozzle size, spacing of nozzles, number of lines to be used, and other equipment to be used. The Contractor must have the approval of the Engineer for each pre-watering layout prior to each pre-watering operation.
13. The Contractor shall provide adequate drilling equipment to obtain samples for moisture determinations.
14. Pre-watering shall not be allowed on frozen ground or when the ambient air temperature is 32° F (0° C) or below.
15. Compaction Control Requirements (Earth): Roadway embankment of earth material shall be placed in horizontal layers not exceeding six inches (loose measurement) unless otherwise approved by the Engineer, and shall be compacted as specified before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating by a motor grader will be required to assure uniform density. Water shall be added or removed, if necessary, in order to obtain the required density. Construction equipment shall be routed uniformly over the entire surface of each layer. A motor grader shall be used on the embankment at all times to level and manipulate the material during the placing and compacting of the earth material. The thickness of the lift of earth material over unstable areas may be increased as directed.
16. Compaction of Embankments Containing Rock: Embankments required by the Plans and Contract to be compacted which are predominately rock may be placed in the embankment in layers not exceeding in thickness the approximate average size of the larger rocks, except that no layer shall exceed 24 inches of loose measurement. Whenever possible, such material shall be placed to form the base of embankments for the full width of the embankment. When rock and other embankment materials are excavated at the same time, the rock shall be placed in the outside portion of the embankment and the other material shall be placed in the central portion of the embankment. During this construction, the elevations of both portions shall be substantially the same, but the elevation of the layers of other material shall at all times be sufficiently above the rock layers to allow for satisfactory compaction of the layers of other material. Before rock is placed on compacted embankment constructed of other material the top of the embankment shall be sloped from the centerline to the sides. Under no circumstance shall pockets of rock be built into the embankment in such a way that water cannot drain freely to the outside surface of the embankment. This requirement shall not exclude the use of select soil when required by the Plans and Contract. Where a grass median is to be constructed, no rock will be permitted in the top 18 inches of the median area.The rock shall be carefully placed so that all large stones will be reasonably well

distributed and the voids completely filled with smaller stones, earth, sand or gravel to form a solid embankment. Each layer shall be bladed or leveled with a motor grader, bulldozer or similar equipment capable of shifting and forming the layer into a neat orderly condition. Compact each lift by routing construction traffic over the lift until no further consolidation under the traffic is visible. When shown in the Contract Documents to construct the top 12 inches with rock excavation, finish the grade with crushed stone for backfill compacted to Type B, MR-90, SECTION 204. No shale is allowed in the top 12 inches. Conformance to these provisions will be considered as fulfillment of the requirements for the type of compaction shown on the Plans without additional rolling, tamping or the addition of moisture.

19. Embankments, required by the Plans and Contract to be compacted, which are formed of material that contains rock, but also contains sufficient compactable material other than rock or other hard material to make rolling feasible, shall be placed and compacted in the manner provided for Type B compaction. This provision shall apply regardless of the type of compaction designated on the Plans. Conformance to this provision will be considered as fulfillment of the requirements for the type of compaction shown on the Plans.
20. Tamping: Whenever embankments are placed adjacent to structures or at a location where it is not practical to use a roller, the embankment materials shall be tamped by the use of mechanical rammers or tampers. Each layer shall be compacted to a density equal to or greater than that obtained under the above rolling procedure for the type of compaction designated. Each successive lift shall contain only that amount of material which will insure proper compaction but in no instance shall any layer be greater than eight inches (loose measurement) in depth, unless otherwise approved by the Engineer. When the quantity of work is small, a hand tamper may be used with the permission of the Engineer.
21. Compaction of Earthwork in Subgrade: When the Plans designate previously placed subgrade to be compacted, the subgrade, within the dimensions and locations shown on the Plans shall be compacted to the type of compaction within the moisture range designated on the Plans.
22. The exact locations of compaction required shall be determined by the Engineer at the time of the construction.

B. METHOD OF MEASUREMENT: "Compaction of Earthwork" shall be based on plan quantities, provided the project is constructed essentially to the lines and grades shown on the Plans. Where the Plans have been altered or in case of disagreement between the Contractor and Engineer as to the accuracy of the plan quantities, either party shall have the right to request and cause the quantities involved to be measured by the average end area method. When the quantities are measured for payment the original cross sections or contour data plotted on the Plans shall be used as original field cross sections, unless errors have been found or the original ground has been disturbed prior to commencing work. Additional original cross sections may be interpolated or determined by other means, at certain points where necessary to more accurately determine the quantities. Other methods of measurement may be acceptable when agreed upon by both the Contractor and the Engineer. Foundation treatment under fills will not be measured or paid for directly but shall be considered subsidiary to the item of "Compaction of Earthwork" of the various types. When the depth of compaction through cut areas is shown on the Plans or ordered by the Engineer to be greater than six inches, the material actually excavated to gain access to and to scarify and compact the lower six inch layer to designated type of compaction, shall be included in the measurement of "Unclassified Excavation".

C. BASIS OF PAYMENT: “Compaction of Earthwork” shall be paid for at the contract unit price per cubic yard (cubic meter), measured as stated above for “Compaction of Earthwork”.

S-205 CONTRACTOR FURNISHED BORROW: This work shall consist of furnishing any borrow needed to complete the earthwork or select soil. The Contractor shall furnish material from an off-site source as approved by the Engineer. Prior to beginning excavation for the borrow material, the borrow area shall be Cleared and Grubbed in accordance with the section of this specification titled "Clearing and Grubbing".

A. METHOD OF MEASUREMENT: "Contractor Furnished Borrow" shall be based on plan quantities, provided the project is constructed essentially to the lines and grades shown on the Plans. Where the Plans have been altered or in case of disagreement between the Contractor and Engineer as to the accuracy of the plan quantities, either party shall have the right to request and cause the quantities involved to be measured by the average end area method. When the quantities are measured for payment the original cross sections or contour data plotted on the Plans shall be used as original field cross sections, unless errors have been found or the original ground has been disturbed prior to commencing work. Additional original cross sections may be interpolated or determined by other means, at certain points where necessary to more accurately determine the quantities. Other methods of measurement may be acceptable when agreed upon by both the Contractor and the Engineer.

B. BASIS OF PAYMENT: Contractor Furnished Borrow shall be paid for at the contract unit price per cubic yard, measured as stated above for "Contractor Furnished Borrow."

S-206 EMBANKMENTS: This work shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the right-of-way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits and other depressions within the roadway area, in accordance with the Specifications, as shown on the Plans or established by the Engineer.

A. GENERAL: Only approved materials shall be used in the construction of embankments and backfills. When "Embankment (Contractor Furnished)" is shown on the Plans, the Contractor shall furnish this material from sites provided by the Contractor and approved by the Engineer as to suitability and location. Locations that in the opinion of the Engineer will leave an unsightly appearance will not be approved.
   1. When frozen soil exists in either the surface of the original ground or the surface of a partially constructed embankment, work shall not proceed until such time that the frozen soil has completely thawed or been removed in a manner that is approved by the Engineer.
   2. Rocks, broken concrete or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.
   3. When an embankment is to be placed against a hillside or existing embankment whose slopes are steeper than 4:1; the existing slope shall be continuously benched and the new embankment constructed in uniform lifts. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material at the Contractor's expense.
   4. All sod and vegetable matter shall be removed from the surface upon which the embankment is to be placed, and the cleared surface shall be completely broken up by plowing, scarifying or stepping to a minimum depth of six inches. This area shall then be recompacted. If the original surface upon which embankment is to be placed is an old roadbed, the surface shall be plowed, scarified, or broken up.
   5. If the embankment can be deposited on one side only of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure.
   6. When an embankment is to be constructed over an area previously occupied by a building basement, cellar, silo pit or other such construction that will not permit the use of normal compaction equipment, the embankment construction shall conform to the backfilling requirements specified in the section on "Backfilling of Structures" until the normal compaction equipment can be used.
   7. Embankments not required to be compacted and formed of material consisting largely of rock, shall be placed in uniform, horizontal layers not exceeding 24 inches in thickness over the full width of the embankment. The material shall be carefully placed so that all large stones are well distributed and the voids completely filled with smaller stones, earth, sand or gravel, to form a solid embankment. Each layer shall be thoroughly leveled with suitable leveling equipment until relatively smooth and uniform before the succeeding layer is placed. Whenever possible, such material shall be placed to form the base of embankments for the full width of the embankment. When rock and other embankment materials are excavated at the same time, the rock shall be placed in the outside portion of the embankment and the other material shall be placed in the central portion of the embankment. During this construction, the elevations of both portions shall be substantially the same, but

the elevation of the layers of other material shall at all times be sufficiently above the rock layers to allow for satisfactory compaction of the layers of other material.

8. Before rock is placed on compacted embankment constructed of other material the top of the embankment shall be sloped from the centerline to the sides. Under no circumstances shall pockets of rock be built into the embankment in such a way that water cannot drain freely to the outside surface of the embankment. This requirement shall not exclude the use of select soil when required by the Plans and Contract. No rock larger than three inches in any dimension shall be placed in the top twelve inches of embankment. Unless otherwise noted on the Plans, no shale shall be placed in the upper twelve inches of the embankment.
9. The thickness of the first lift over unstable areas may be increased as directed by the Engineer.
10. Material for the embankments is to be obtained from the roadway, channels and borrow pits as designated on the Plans or when “Embankment (Contractor Furnished)” is shown on the Plans the Contractor shall furnish this material from sites provided by the Contractor and approved by the Engineer as to suitability and site location. Locations that in the opinion of the Engineer will leave an unsightly appearance will not be approved.
11. When the Plans and Contract show the item “Embankment (Contractor Furnished)”, excavation for embankments shall conform to all of the requirements of the section titled “Clearing and Grubbing”, and the section titled “Unclassified Excavation”.
12. Unless shown otherwise on the Plans, the Contractor shall arrange his construction procedures so that the top one foot of the shoulder slopes and fill slopes contains suitable material for the growth of normal vegetation. Such material shall meet the approval of the Engineer.
13. Embankments required by the Plans and Contract to be compacted shall be constructed in accordance with the section titled “Compaction of Earthwork”. Foundations for embankments and compaction in cut sections shall be compacted to the specified requirements.
14. The Contractor shall have in operation a sufficient number of motor graders to properly smooth and maintain the surface of each layer of freshly placed embankment prior to and during rolling and compacting operation.
15. The Engineer shall have full authority to require at any time, the suspension of delivery of material to the embankment until previously delivered materials are properly placed and preceding layers are satisfactorily smooth and uniform.
16. Embankments shall not be constructed by means of a dragline except with the permission of the Engineer and when provisions are made to keep the lifts uniform and the embankment level and well drained at all times.
17. In order to ensure proper compaction, wherever storm sewers are to be placed in a fill, the fill shall be placed to the level of the top of the proposed pipe. Once the fill is in place, the trench shall be excavated in the fill and the pipe installed per the plans and these specifications.
18. The Contractor shall be responsible for the stability of all constructed embankment, and shall replace at his own expense any portion which, in the opinion of the Engineer, has been displaced due to carelessness or negligent work on the part of the Contractor.
19. When unsuitable material is encountered, the unsuitable material will be excavated and the excavation backfilled with suitable material.
20. All loose rock within the right-of-way which will interfere with mechanical mowing shall be picked up and satisfactorily disposed of.

21. At the end of each days construction, the Contractor shall insure that the site will drain, and that water will not pond anywhere on the subgrade.

B. METHOD OF MEASUREMENT: No measurement shall be made for “Embankment”.

C. BASIS OF PAYMENT: No payment shall be made for “Embankment”. All work under this section shall be subsidiary to “Compaction of Earthwork” or “Unclassified Excavation”.

S-207 EXCAVATION FOR STRUCTURES: This work shall consist of excavating whatever material is encountered to the lines and grades shown on the Plans.

A. The foundation pits shall be excavated according to the outlines of the footings as shown on the Plans and shall be of sufficient size to permit the placing of the full widths and lengths of the footing shown with full horizontal beds. Rounded or undercut corners and edges of footings will not be permitted.
   1. The excavation shall be carried to the elevation shown on the Plans or as established by the Engineer.
   2. Where rock bottom is secured, the excavation shall be done in such manner as to allow the solid rock to be exposed and prepared in horizontal beds or properly serrated for receiving the concrete. All loose and disintegrated rock and thin strata shall be removed.
   3. When blasting is necessary in any one pier or abutment after part of the concrete is poured in a column of that pier or abutment, the size of the charge used shall be limited to insure against damage to the previously placed portion of the structure.
   4. Where rock is encountered in the toe wall excavation for box bridges, concrete box culverts, concrete head walls for pipe culverts, or end sections for pipe culverts and the rock is of such quality that will prevent erosion, part of the toe wall may be eliminated in the rock strata as directed, but the toe wall shall be keyed into the rock strata.
   5. When unstable or other unsuitable material is encountered below foundation elevation of reinforced concrete box structures the Contractor shall excavate such material and replace with suitable and stable backfill material. The foundation stabilization, including the degree of instability of the existing material, necessary depth of excavation, and suitability of the proposed backfill material shall be approved by the Engineer prior to the work.
   6. Where foundation piles are used, the excavation of each pit shall be completed before the piles are driven. All the foundation piling shall be driven in any one pier or abutment before concrete is poured in any column of that pier or abutment. After the driving is completed, all loose and displaced material shall be removed at the Contractor's expense, leaving a smooth solid bed to receive the concrete.
   7. Suitable and practically watertight cofferdams shall be used whenever water-bearing strata are encountered above the elevation of the bottom of the excavation. They shall be sufficiently large to give easy access to all parts of the foundation form.
   8. Cofferdams shall be sunk to a depth well below the bottom of the excavation or to an elevation as near the bottom of the excavation as foundation conditions will permit; shall be substantially braced in all directions, and of such construction as will permit them to be pumped free of water, and kept free until the concrete has been placed. They shall be such that leakage can be kept out of the concrete or masonry area. Unless otherwise shown on the Plans or agreed upon, cofferdams and all sheeting or bracing shall be removed after the completion of the concrete or masonry. When the bottom is of sandy or porous material which will not permit the footing to be poured in the dry, it shall be sealed up to the bottom of the footing elevation with the type of concrete specified for the footings so that it may be pumped dry. Other satisfactory methods of sealing out the water may be approved. Under ordinary circumstances the cement content for the seal concrete shall be increased approximately ten percent and the slump of the concrete shall be approximately six inches. A seal course shall not be used unless shown on the Plans or authorized in writing by the Engineer. If the necessity for a seal course is due to inadequate or improper cofferdam construction, he may order the removal and/or reconstruction of the

cofferdam, or permit the placing of a seal course at the Contractor's expense. If a seal course is not called for on the Plans or in the Contract Documents, the Contractor may elect to install a seal course at the Contractor's expense. After the seal course has set, the cofferdam shall be cleared of water and work completed in the dry. When weighted cribs are employed and the weight utilized to overcome partially the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal.

9. Placing limited amounts of granular material onto the foundation to create firm footing shall be permitted, but shall be at the Contractor's expense.
10. Seven copies of the detailed drawings (maximum size 24" x 36") of cofferdams and cribbing to be used on work adjacent to a railroad track shall be submitted by the Contractor for approval by the Railroad Company and the Engineer. These drawings shall be designed and sealed by a registered professional engineer.
11. Pipe bedding shall be of the class shown on the Plans and according to the standard details.
12. Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the bottom of the structure as ordered by the Engineer for a depth of twelve inches and full width of the channel. This extra depth excavation shall be backfilled with suitable material obtained from roadway excavation or other approved sources.
13. When a firm foundation is not encountered at the grade established due to soft, spongy or other unstable soil, unless other construction methods are called for on the Plans, all of such unstable soil under the pipe and for a width equal to the width of the channel shall be removed and replaced with suitable material. If a suitable granular material is not available in the roadway excavation for this backfill, the Engineer will designate material to be used as foundation stabilization.

B. METHOD OF MEASUREMENT: No separate measurement will be made for “Excavation for Structures”.

C. BASIS OF PAYMENT: No payment shall be made for “Excavation for Structures”. “Excavation for Structures” shall be subsidiary to the structure or to its component bid items where applicable.

S-208 MOISTURE CONTENT AND COMPACTION REQUIREMENTS: This work shall consist of meeting the requirements set out below:

A. MOISTURE CONTENT REQUIREMENTS:
   1. The Moisture Range requirements are as follows:

      - Moisture Range 0-5 (MR-0-5). The moisture content of the soil at the time of compaction shall be uniform and shall be not higher than five percentage points above the optimum nor less than the optimum of the soil involved. If the soil is unstable at this moisture range, the moisture shall be lowered to the point it is stable as determined by the Field Engineer.
      - Moisture Range 3-3 (MR-3-3). The moisture content of the soil at the time of compaction shall be uniform and shall not be lower than three percentage points below the optimum moisture content nor higher than three percentage points above the optimum moisture content of the soil involved.
      - Moisture Range 5-5 (MR-5-5) The moisture content of the soil at the time of compaction shall be uniform and shall be not lower than five percentage points below the optimum moisture content nor higher than five percentage points above the optimum moisture content of the soil involved.
      - Moisture Range 90 (MR-90). The moisture content of the soil at the time of compaction shall be uniform and shall be such that the soil can be compacted to the requirements of the type of compaction designated on the Plans.

   2. If Type B compaction is specified with this moisture control, the moisture content shall be sufficient to produce a uniform mixture of the soil and moisture. It will be determined by visual inspection that satisfactory compaction and moisture content is obtained.

B. COMPACTION REQUIREMENTS:
   1. The compaction requirements are as follows:

      - Type AAA - Compacted density of the soil shall be equal to or greater than 100 percent of standard density.
      - Type AA - Compacted density of soil shall be equal to or greater than 95 percent of standard density.
      - Type A - Compacted density of soil shall be equal to or greater than 90 percent of standard density.
      - Type B - Compacted density of soil to be such that the tamping or sheeps foot roller, while rolling the layer or lift will walk-out of the material and ride the top portion of the lift. Compaction of low plasticity or nonplastic fine-grained materials shall be considered adequate when additional passes of the roller do not bring the tamping feet closer to the surface of the lift, provided the entire weight of the roller is supported on the tamping feet and none by material directly in contact with the drum. Sand and gravel which cannot be compacted satisfactorily with a sheep's foot roller shall be rolled with a pneumatic-tired roller or other approved types. Each lift shall be rolled until no further consolidation is evident.
      - Type C - Material being compacted shall be brought to satisfactory moisture content during placing, shaping and rolling as required by the Engineer. After placing and shaping, the material shall be firmly and satisfactorily compacted.

2. The Engineer will determine by visual inspection that satisfactory compaction is being obtained for all types of compaction. The visual inspection shall be conducted by first walking the sheep's foot roller out, and then driving a tandem axle dump truck of at least 50,000 lbs. gross weight over the roadbed. Blading will be required while rolling is being performed.

C. METHOD OF MEASUREMENT: No measurement shall be made for "Moisture Content" or "Compaction".

D. BASIS OF PAYMENT: No payment shall be made for "Moisture Content" or "Compaction". All work under this section shall be subsidiary to "Compaction of Earthwork" or "Unclassified Excavation".

S-209 REMOVAL OF EXISTING STRUCTURES: This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings and foundations, footings, concrete floors, aprons, structures, fences, headwalls, retaining walls, and other obstructions, any portions of which are on the right-of-way which are not designated or permitted to remain, except utilities, and shall include any items which may not be specifically listed in the Plans but are in conflict with the new construction or are otherwise designated for removal, and which would normally be encountered upon a careful examination of the site of the work, except for the obstructions to be removed and disposed of under other items in the Contract. Structures may be designated for removal on City owned properties which are not in the right of way. Such structures shall be removed in accordance with this specification.

A. GENERAL: When the structure to be removed is a building or habitation, an asbestos survey will be conducted prior to demolition. The Contractor must properly abate all asbestos materials in accordance with all applicable federal, state, and local laws and regulations. The Contractor shall provide all notices required by any federal, state, or local agency, and comply with all applicable laws and ordinances.
   1. In addition to the asbestos survey, an inspection shall be performed regarding the presence of rats on the premises. The inspection shall be performed by qualified personnel, and a certificate provided to the City stating that the site is free of rats. Should rats be found on the site, the Contractor will be responsible for treating the site and removing the rats. Once this is accomplished and additional survey and certification shall be provided to the City.
   2. All material to be salvaged, as designated on the Plans, shall be removed, without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored by the Contractor at specified places within the project limits. Unusable perishable material shall be destroyed. Non-perishable material may be disposed of outside the limits of view from the project with written permission of the property owner on whose property the material is placed. Copies of all agreements with property owners are to be furnished to the Engineer prior to placing of waste material.
   3. When a building or habitation is to be removed, any material within or part of the structure shall become the property of the Contractor. The Contractor may salvage this material for his use or benefit. The Contractor shall be responsible for terminating all utilities serving each structure. The method of termination shall be in accordance with the requirements for the respective utility.
   4. Easements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the prism of construction, shall be compacted to the type of compaction and within the moisture range designated on the Plans, or in the Special Conditions.
   5. Salvaged pipe culverts or other structures shall be stored at designated and accessible points on the project and shall remain the property of the City as applicable.
   6. Bridges, culverts and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.
   7. Concrete slabs, sidewalks, driveways, and other concrete flatwork shall be removed in their entirety from the site.
   8. Unless otherwise directed, the substructures of existing structures shall be removed to the natural stream bottom and those parts outside of the stream shall be removed to one foot below natural ground surface or one foot below new finished lines, whichever is at the lowest elevation. Where such portions of existing structures lie wholly in or part within the limits of a new structure, they shall be removed as

necessary to accommodate the construction of the proposed structure. When a building or habitation is to be wholly removed (razed), all foundations, slabs, and floor slabs must be broken up so as to permit drainage through the slabs. Basement walls are to be broken off/broken over, crumbled and left on site; provided, however, that none of these materials are to be within three feet of the surface. Any area or areas outside the right of way where said foundations, slabs and basement walls are broken off/broken over, crumbled, and left on site shall be covered with clean, select soil, satisfactorily compacted and graded to promote proper drainage characteristics. When the basement falls within the right of way of a street, the basement walls, slab, and foundation shall be removed in their entirety. Grading, compaction, etc. within the right of way shall be in accordance with the plans and the appropriate sections of these specifications.

9. Disturbed areas shall be seeded unless otherwise shown in the plans.
10. Steel bridges and wood bridges as designated on the Plans shall be carefully dismantled without unnecessary damage. Steel members shall be match marked, unless such match marking is waived by the Engineer.
11. Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.
12. Unless otherwise provided, all pipe, regardless of whether it is designated as salvage on the Plans, shall be carefully removed and every precaution taken to avoid breaking or damaging the pipe. The Contractor shall be held responsible for the satisfactory removal of such structures in a usable condition, providing the pipe was determined to be in a usable condition prior to removal. The Contractor shall clean usable pipe of mud, debris, etc., in order to permit satisfactory drainage and store it at locations on the project designated by the Engineer.
13. In case these provisions are violated, all material to be salvaged that is damaged in removal and which would impair its future use will be charged to the Contractor at 60 percent of the current quoted price, delivered to the project, of an equal amount of new material. This amount of money shall be deducted from any money due or to become due the Contractor.

B. METHOD OF MEASUREMENT: This work shall be measured by the lump sum.

C. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price for lump sum “Removal of Existing Structures”.

S-210 SELECT SOIL: This work shall consist of placing select soil or furnishing and placing selected embankment material on the finished slopes and other areas to be seeded or sodded, in accordance with these Specifications, as shown on the Plans or as directed by the Engineer.

A. GENERAL: Select soil shall consist of surface soil (top soil) or other suitable soil as stipulated in Section 2100 of the Standard Specifications regarding Select Soil, and as approved by the Engineer. The select soil shall be not excessively acid or alkaline (acceptable pH range of 5.5 to 7.0), nor contain toxic substances which may be harmful to plant growth and human habitation.
   1. Select Material shall be placed on all roadway and embankment areas. Slopes and disturbed areas to be covered with Select Material shall be scarified as directed by the Engineer.
   2. In general, all areas to be seeded or sodded shall consist of a minimum of 6”-8” of select soil, free from clods, rocks (1” or larger), trash, and other debris. If suitable topsoil is not available on site to meet this requirement, suitable topsoil shall be imported. Harrowing, disking, or both will be required as necessary in breaking down clods and lumps. If the area has been severely compacted by heavy trucks or other equipment, it shall be cultivated to a depth of 6”-8” by tilling or disking. At locations where excavation to final grade results in material unsuitable for vegetation, as determined by the Engineer, the Contractor shall undercut and remove the material and place select soil.
   3. All areas indicated as “garden” on the Plans and disturbed by construction activity shall have select soil placed on the top 18 inches of the garden. Such soil shall be free of granular materials used in construction and excavated rock. Existing unsuitable soil shall be properly disposed of by the Contractor.
   4. The Contractor shall make every reasonable effort to stockpile existing top soil prior to deep excavations and reuse it as select soil in the same general locations. No direct payment shall be made for undercutting and removing unsuitable materials in cut sections, or stockpiling and placement of select soils, as this work shall be considered subsidiary to other bid items.

B. METHOD OF MEASUREMENT: “Placing Select Soil” shall be subsidiary to “Seeding” or “Sodding”.

C. BASIS OF PAYMENT: “Placing Select Soil” shall not be paid for separately, but shall be subsidiary to “Seeding” or “Sodding”.

S-211 UNCLASSIFIED EXCAVATION: This work shall consist of all excavation, removal, and/or satisfactory disposal of all materials within the scope of the work, as shown on the Plans or established by the Engineer.

A. GENERAL: Rock, shale, and other unsuitable roadbed material encountered in cuts shall be excavated to the lateral limits and depth indicated on the Plans or as otherwise directed. Any over breakage below the depth shown on the Plans will not be paid for. If the backfill of the over breakage is designated on the Plans to be of material obtained through normal excavation, the material shall have the same density requirements as specified on the Plans and the compaction shall be at the expense of the Contractor. If the backfill of the over breakage is designated on the Plans to be a crushed aggregate or other special aggregate, the entire cost of the backfill of the over breakage shall be at the expense of the Contractor. When crushed stone backfill is designated on the Plans, layers of earth or shale shall not be permitted between the surface of rock that has been over broken and the bottom of crushed material used for backfill. Undrained pockets shall not be left in the surface of the rock.
   1. Where excavation to the finished graded section results in a subgrade or slopes of unsuitable soil, the Engineer may require the Contractor to remove the unstable material and backfill to the finished grade section with approved material. The Contractor shall conduct his operation in such a way that the Engineer can take the necessary cross-sectional measurements before the backfill is placed.
   2. The Engineer may designate as unsuitable those soils that cannot be properly compacted in embankments. All unsuitable materials shall be disposed of as directed.
   3. When the location of unstable soils is shown on the Plans or encountered during construction, the removal and replacement shall be as shown or directed by the Engineer.

B. METHOD OF MEASUREMENT: “Unclassified Excavation” shall be measured by the cubic yard of material excavated. The method of measurement shall be the double end area method. The original cross sections or contour data plotted on the Plans shall be used as original field cross sections, unless errors have been found or the original ground has been disturbed prior to commencing work. Additional original cross sections may be interpolated or determined by other means, at certain points where necessary to more accurately determine the quantities. Other methods of measurement may be acceptable when agreed upon by both the Contractor and the Engineer. Such measurement will include over breakage. Authorized excavation of unsuitable material (as directed and measured by the Engineer) shall be measured per the cubic yard, prior to any backfill, unless Surge Rock is to be installed. When Surge Rock is to be installed, the excavation and removal of the unsuitable material shall be subsidiary to the installation of the Surge Rock.
   1. When the depth of compaction through cut areas is shown on the Plans or ordered by the Engineer to be greater than six inches, the material actually excavated to gain access to and to compact the lower six-inch layer to the designated type of compaction, shall be included in the measurement of “Unclassified Excavation”.
   2. No measurement will be made for water used in dust control on haul roads, around plant installations, etc. The Contractor shall meet all applicable regulations concerning environmental considerations.

C. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit prices per cubic yard of “Unclassified Excavation”.

S-212 SUBGRADE: Subgrade is defined as the area upon which curb and gutter or pavement is to be placed. The subgrade limits for streets extend one foot on each side beyond the back of curb or edge of pavement, whichever is appropriate. Subgrade limits for drive entrances and sidewalks extend to the edge of the entrance or walk.

The subgrade shall be free of organic material, trash and debris, and rocks larger than 3 inches in any dimension, and shall not be frozen while construction is in progress.

A. SUBGRADE PREPARATION: A geotechnical report that provides site-specific recommendations for construction of Public Streets must be submitted for all street or road functional classifications (major arterials, minor arterials, collectors, local collectors and locals). The report must be approved before the project will be released for construction. Prior to construction plan approval, the Project Engineer will require three (3) approved copies of the geotechnical report, sealed by a Kansas licensed Professional Engineer or a Kansas licensed Geologist. At a minimum, the following items must be addressed in the report.
   1. Suitable material shall be defined as entirely imperishable with that portion passing the No. 40 Sieve having liquid limit not exceeding 40 and a plasticity index not exceeding 25 when tested in accordance with ASTM D-4318. The liquid limit is the water content of the soil at the change between the liquid and the plastic states and shall be tested in accordance with ASTM D-4318. The plastic limit is the water content at the boundary between the plastic and semi-solid states as stated in ASTM D-4318-83. The plasticity index is the numerical difference between the liquid limit and the plastic limit. If the on- site soils do not meet these requirements, the geotechnical report must specify how the on-site soils will be modified to achieve these requirements. As an alternative, the geotechnical engineer may specify alternative liquid limits and/or plastic indices for consideration, provided adequate justification is given.
   2. The report must identify the soils to be used for fill (excluding any material being brought on-site. The report must contain an evaluation of the soils proposed to be used. The evaluation must include all the following as a minimum:

      a. Sieve analysis
      b. USCS classification
      c. Atterburg limits
      d. Maximum dry density (ASTM D-698)
      e. Optimum moisture density
      f. Moisture density curve (Standard Proctor)

      The geotechnical report must also indicate the methods to be used for placement and compaction of the subgrade. The subgrade for all streets shall be treated with fly ash, cement, lime kiln dust, lime, or other approved material per section S-1106 Modified Subgrade or KDOT Standard Specifications, latest edition. The geotechnical report shall detail the treatment, placement, incorporation and compaction procedures to be used. The contractor is responsible for regulating the sequence of work, processing a sufficient quantity of material, providing full depth as specified on the plans, using proper amounts of fly ash, cement, lime kiln dust, lime or approved material, maintaining the work, and reworking areas necessary to meet requirements. The contractor shall cover the treated subgrade before it is subject to

freezing. Proof-rolling with a loaded tandem dump truck which has a minimum GVW of 15 tons (30,000 lbs) will be required before acceptance of finish grade.

3. The subgrade soil shall be uniform in quality and gradation, and shall be approved by the Engineer. Details not specifically covered in the geotechnical report shall conform to the requirement specified in the latest edition of the “Standard Specifications for State Road and Bridge Construction”, Kansas Department of Transportation. The subgrade shall be trimmed to grade with a machine having electronic elevation controls. Other methods for trimming must be approved by the Engineer.
4. Stringline shall be installed prior to Modified Subgrade operations. Grade checks shall be completed at a minimum of 50’ intervals and the Contractor shall assist the Engineer in performing the grade checks. Tolerance prior to Modified Subgrade shall be +/- 0.10’, tolerance for finished subgrade shall be +/- 0.05’.

B. METHOD OF MEASUREMENT: No measurement shall be made for “Subgrade”.

C. BASIS OF PAYMENT: No payment shall be made for “Subgrade”. All work under this section shall be subsidiary to “Compaction of Earthwork” or “Unclassified Excavation”.

ASPHALT CONSTRUCTION AND MATERIALS

S-300 <u>ASPHALTIC CONCRETE</u>: This specification sets forth requirements for all KCMMB asphalt mixtures which include KCMMB A1, KCMMB A2, and KCMMB A3. Unless specified otherwise in the Contract Documents, KCMMB asphaltic concrete shall meet the requirements of this specification. KDOT's 2015 Standard Specifications for State Road and Bridge Construction, Sections 109, 601, 611 (Class A), 1201, 1202, and 1203 shall govern the asphaltic concrete work except as otherwise modified herein. All testing required by this specification including mix design and field verification of the mix shall be the responsibility of the Contractor. The mix design shall be modified/redesigned and resubmitted to the Owner's engineer whenever a material source changes, a quarry starts producing from a different geological unit, or a major change is made to the asphalt plant.

A. MATERIALS

1. Asphalt Cement shall conform to the requirements of the Performance Graded Asphalt Binder as listed in the table below. The grade of the asphaltic binder shall comply with Sections 1201 and 1202 of KDOT's Standard Specifications. With approval by the Owner's Engineer, the grade of the asphaltic binder may be changed without a laboratory redesign. Each shipment of asphalt to the asphalt plant shall have a bill of lading stating the asphalt cement meets the specifications referenced above. Copies of the bill of lading shall be submitted to the Owner's Engineer.

Table 1: Asphalt Binder Grade Requirements			
	KCMMB A1	KCMMB A2	KCMMB A3
Performance Grade	PG 64-28	PG 58-28	PG 58-28

   a. Asphalt Mix Type Use Guidance

      i. KCMMB A1: Surface and Intermediate asphalt on Arterials and Major Collectors.

      ii. KCMMB A2: Surface and Intermediate asphalt on Minor Collectors and Local/Residential Streets.

      iii. KCMMB A3: Base pavement below the top four inches of pavement. This mix type is not recommended for use as surface pavement on Arterials or Collectors.

      **Intermediate asphalt shall be the last lift of asphalt between the Base pavement and the Surface pavement.*

   b. Asphalt Content for KCMMB asphalt mixes shall be tested in accordance with AASHTO T 164, AASHTO T 287, or AASHTO T 308. Asphalt Content for field produced asphalt shall not deviate more than ± 0.3% from the design asphalt content.

2. Recycled Asphalt Shingles (RAS) or Reclaimed Asphalt Pavement (RAP) that contains RAS is not allowed. Documentation shall be provided on the Superpave Asphaltic Concrete Test to report if visual evidence is found of fiberglass retained on the #2 sieve.

3. Fractionated Reclaimed Asphalt Pavement (FRAP) shall be used as an aggregate source. FRAP is Recycled Asphalt Pavement which is processed into coarse and fine fractions. The fine FRAP stockpile shall contain only material passing the ¼ inch screen. The coarse FRAP stockpile shall contain milled material retained on the ¼ inch screen and passing the ¾ inch screen. FRAP may be comprised of coarse or fine FRAP or a combination thereof. Utilize a separate cold feed bin for each stockpile of FRAP used. Do not blend coarse and fine FRAP, either in the stockpile or in a cold feed bin. Add FRAP to the mix through the RAP collar. Sources and types of FRAP shall be recorded and submitted to the Owner's Engineer. The FRAP used in production shall be similar in composition (extracted gradation and asphalt content) to the source used for design. The maximum

allowable combined percentage of FRAP by total mix weight for each KCMMB mix design is listed in the following table.

Table 4: Allowable Combined FRAP Percentage			
	KCMMB A1	KCMMB A2	KCMMB A3
Minimum FRAP by Total Mix Weight (%)	15	21	31
Maximum FRAP by Total Mix Weight (%)	20	30	40

4. FRAP shall be prequalified in accordance with the current KCMMB Asphalt Material Submittal Requirements.

5. Aggregates: The virgin aggregate shall be listed on the most current, active KDOT web published list “Hot Mix Aggregate Specific Gravity Values” at the following link: https://www.ksdot.gov/htmxAggravValu.asp. If aggregate is only to be used in Missouri, currently approved MoDOT aggregate sources may be submitted for approval. The resultant aggregate composite specific gravity value of each aggregate material shall be used in all specific gravity related calculations. The total aggregate (coarse aggregate, fine aggregate, and the material passing the No. 200 sieve) shall contain not less than 85 percent crushed material. Coarse aggregate (plus #4 material) shall be tested in accordance with KT-31, ASTM D5821, or AASHTO TP 61. Aggregate shall contain not more than 8% of flat and elongated particles by weight (5:1) as tested in accordance with ASTM D4791. The Sand Equivalent value of the total fine aggregate portion (minus #4 material) of the virgin aggregate shall be tested in accordance with ASTM D2419 or AASHTO T 176. The measured Sand Equivalent values of the virgin aggregate shall be a minimum of 40.

   a. Aggregate Gradation Requirements for KCMMB Asphalt Mixes:

Table 3: Gradation Requirements for KCMMB Asphalt Mixes				
Sieve Size	KCMMB A1 KCMMB A2		KCMMB A3	
	Percent Passing 12.5 mm Nominal Size Control Points		Percent Passing 19 mm Nominal Size Control Points	
25 mm (1 in.)	-	-	-	100
19 mm (3/4 in.)	-	100	90	100
12.5 mm (1/2 in.)	90	100	-	90
9.5 mm (3/8 in.)	75	90	-	-
4.75 mm (No. 4)	-	-	-	-
2.36 mm (No. 8)	34	48	35	49
1.18 mm (No. 16)	-	-	-	-
600 µm (No. 30)	-	-	-	2
300 µm (No. 50)	-	-	-	-
150 µm (No. 100)	-	-	-	-
75 µm (No. 200)	2	8	2	8

i. The exact gradation shall be determined by the Contractor's laboratory. Natural Sand is limited to a maximum 15.0% of the total aggregate blend.

ii. KCMMB A1 mixes shall meet the following minimum requirement. Fifteen percent of the minus No. 4 sieve material and 15 percent of the total aggregate shall be chat, crushed sandstone, crushed gravel, crushed steel slag, or crushed porphyry (rhyolite, basalt, granite, and Iron Mountain Trap Rock are examples of crushed porphyry).

6. Aggregate test results shall not exceed the following percentages by weight:

Table 4. Aggregate Quality Testing	
	Max. Allowable %
ASTM C131 LA Abrasion	
% Loss	40.0%
ASTM C88 Sulfate Soundness ($MgSO_4$) Weighted % Loss	
% Loss (5 cycles)	18.0%

7. Superpave Asphaltic Concrete Mix Design Method:

Table 5: Superpave Design and Testing Properties			
	KCMMB A1	KCMMB A2	KCMMB A3
$N_{initial}$ (gyrations)	6	6	6
N_{design} (gyrations)	60	60	60
G_{mm} at N_{ini} (%)	85 – 91	85 – 91	85 – 91
Design Air Voids (%)	3.2	3.4	3.0
Production Allowable Air Voids (%)	2.5 - 3.9	2.7 - 4.1	2.3 – 3.7
[1] Minimum Design VEA (%)	10.8	10.6	10.0
Production VEA Minimum (%)	9.8	9.6	9.0
Dust to Binder Ratio (%)	0.5 - 1.4	0.5 - 1.5	0.5 - 1.6
Maximum Temperature of the Mixture (°F)	315	315	315
[2]Tensile Strength Ratio (min %)	80	80	80

f[1] *VEA% = Volume of Effective Asphalt (%) which is the numerical difference between VMA and Air Voids. KCMMB A1 and A2 use a minimum VMA of 14.0. KCMMB A3 uses a minimum VMA of 13.0.*
f[2] *Refer to paragraph "Resistance of Compacted Bituminous Mixture to Moisture Induced Damage".*

a. The job mix formula (JMF) shall meet the control points as displayed in Table 5. It shall be noted that when the gradation of extracted plant produced mix varies appreciably from the JMF, the test properties of the mix will be out of specifications. The Contractor shall submit a complete mix design report annually to the Owner's Engineer, prior to asphalt placement at the start of the KCMMB year (April 1st). This report shall contain the calculations as described in the following sections and shall contain material certifications for all materials

used in the asphaltic concrete. All aggregate quality tests must have been run within 12 months of the submission date of a mix design or a volumetric test report.

b. Mixing plants shall meet the requirements of KDOT's latest specification in effect when this project's bids are received by the Owner, except the mixture discharged from the plant shall not exceed 157.2°C (315°F).

c. The finished mixture shall meet the requirements described below when prepared in accordance with AASHTO T 312 (using 6 inch nominal size molds) and the volumetric properties of compacted paving mixtures as calculated using Chapter 4 of Superpave Mix Design, Superpave Series No. 2 (SP-2), Third Edition 2001 Printing, Published by the Asphalt Institute referred hereafter as "SP-2", unless otherwise specified. The procedure shall be as specified in Chapter 5 and 6 of the SP-2.

d. Theoretical Specific Gravity (G_{mm}) shall be determined in accordance with AASHTO T 209, and the Bulk Specific Gravity of the Compacted Asphalt Mixture (G_{mb}) shall be determined in accordance with AASHTO T 166.

e. The material for the theoretical specific gravity (Gmm) and the material for the Gyratory Compactor specimens (pucks) shall be cured at 140+/-3º C (285+/-5º F) for four hours in a closed oven after the mix is produced in the laboratory. Also, the plant-produced mixture shall cure for four hours prior to testing.

f. The mixture shall be transported to the laboratory in an insulated container and then stored in a laboratory oven at 140 +/-3° C (285 +/-5° F) minimum temperature for the remainder of the curing period. The curing oven shall be the forced air type and may be operated at a temperature not to exceed the maximum temperature at which the mixture may be discharged from the plant as specified in Section 6.

g. This procedure shall be used when the water-absorption as determined by ASTM C127 and ASTM C128 of any individual aggregate stockpile in the aggregate blend exceeds 1.25 percent. The mixture shall be compacted at 140 +/-3° C (285 +/-5° F).

h. The theoretical specific gravity (Gmm) shall be performed using the Type E-A 4500ml metal vacuum pycnometer with a clear polymethyl methacylate PMMA lid. The vacuum shall be applied for 15 minutes to gradually reduce the residual pressure in the vacuum vessel to 28 mm Hg.

i. The Gse of the FRAP material shall be used as aggregate Gsb in volumetric calculations provided that the asphaltic cement content of the FRAP fraction is determined through the use of AASHTO T 164 Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot-Mix Asphalt (HMA) (ASTM Designation: D2172/D2172M). The AASHTO Specification shall be used when references are made to the AASHTO number.

j. When the aggregate absorption is high, the produced mixture will be tender until the asphalt is absorbed into the aggregate. Therefore, it may be beneficial to silo the mixture at the plant for a time before delivering to the project site. This is more important when the truck haul is short.

k. **Superpave Asphaltic Concrete Testing:** A daily quality control Superpave Asphaltic Concrete Test shall be run when over 500 tons of material will be placed on a project.

l. The Owner's Engineer may request a quality acceptance companion sample to be sampled in conjunction with the Producer and tested by the Owner's laboratory.

m. All sampling of materials shall be obtained at the asphalt plant for quality control (QC) and quality acceptance (QA) testing purposes.

n. All sampling of materials shall be coordinated between the producer and respective QC and QA laboratories in order to obtain a safe and representative material sample and ensure the delivery of materials for testing to the respective laboratory.

8. Resistance of Compacted Bituminous Mixture to Moisture Induced Damage: The index of retained strength must be greater than 80 percent as determined by AASHTO T 283 (using a 6 inch nominal size mold). Specimens shall be conditioned by freezing and thawing.

    a. Anti-Stripping Agent: All bituminous mixtures shall contain an anti-stripping agent. Anti-stripping agents shall be used within the manufacturer's recommended dosage. Anti-stripping agents approved for use are limited to those products listed on MoDOT's PAL: Bituminous Liquid Anti-Strip Agent. Copies of the bill of lading shall be submitted to the Owner's Engineer.

    b. When the index of retained strength is less than 80, the amount of anti-stripping agent may have to be adjusted. No additional payment will be made to the Contractor for addition of anti-stripping agent required.

    c. Refer to the current KCMMB Asphalt Material Submittal Requirements for testing requirements and testing frequency for determining the retained strength of plant-produced mixtures.

9. Pavement Density Requirements: Samples of finished pavement shall be obtained by the Contractor or the Contractor's laboratory. A minimum of one test (three cores) shall be taken for each tonnage lot represented by a Superpave Asphaltic Concrete test. Lots larger than 1,200 tons shall have one set of (three cores) for each 1,000 tons placed or as directed by the Engineer. The core samples shall be taken at random locations throughout the tonnage lot. The locations shall not be previously marked. The core locations shall be marked by the Owner's Engineer after each tonnage lot placement is completed. Cores shall be at least 4 inches in diameter. The average density the of the three cores shall be 93% to 96% of max theoretical specific gravity of the Superpave Asphaltic Concrete test. When the average density of the compacted course is not between 93% and 96%, the layer may be removed at the discretion of the Engineer. No core shall be less than 90%.

B. CONSTRUCTION REQUIREMENTS

1. Asphalt mixtures having temperatures less than 113°C (235°F), when dumped into the mechanical spreader will be rejected.
    a. All bituminous mixtures shall be delivered to the paver at a temperature sufficient to allow the material to be placed and compacted to the specified density and surface tolerance.
    b. All delivery trucks shall be totally covered with a waterproof tarpaulin at the asphalt plant and shall not be uncovered until they are next in line to unload.

2. Asphaltic Concrete Pavement Lift Placement Requirements: Unless approved by the Owner's Engineer, KCMMB asphaltic concrete mixes shall be placed in compacted lifts meeting the requirements as listed in the following table:

Table 6: Lift Placement Requirements				
		KCMMB A1	KCMMB A2	KCMMB A3
Surface Pavement	Min. / Max. Single Lift Placement Depth (in.)	2	2	-
Intermediate Pavement	Min. / Max. Single Lift Placement Depth (in.)	2 / 3*	2 / 3*	-
Base Pavement	Minimum Single Lift Placement Depth (in.)	-	-	3
	Maximum Single Lift Placement Depth (in.)	-	4	4

**Only permitted on Industrial, Commercial, and Collector.*

3. Placing Asphaltic concrete intermediate course shall not be placed in compacted lifts greater than 4" inches deep, asphaltic concrete surface courses shall not be placed in compacted lifts greater than 2 inches deep; except when otherwise indicated on maintenance project plans. Asphaltic concrete surface course shall not be placed thinner than 2 inches deep. Asphaltic concrete intermediate course used as surface shall not be placed thinner than 2 inches. Interim layers of intermediate course shall not be left uncovered by the subsequent course for more than 5 days, weather permitting. Material trucks hauling materials other than asphaltic concrete or tack coat shall not travel on previously constructed layers of asphaltic intermediate course until the final course of the intermediate is constructed.

    a. The Contractor shall schedule and route his hauling operation to minimize hauling over a final course as much as feasible.

    b. Material Transfer Devices: A material transfer device (MTD) shall be used for the placement of asphalt during surface paving operations. An MTD, however, is not required for paving in parking lots, on driveways, and on residential streets. The MTD equipment shall be approved by the Engineer prior to its use. Remix pavers will NOT be allowed. Refer to KDOT Standard Specifications, latest edition, for more information. The Engineer may waive this requirement for short placements.

    c. Bituminous-Materials Spreaders shall be the self-propelled type equipped with hoppers, tamping, or vibrating devices, distributing screws (augers), adjustable screeds operated either manually or automatically, equipment for heating the screeds and equalizing devices. The spreader shall be capable of spreading hot bituminous mixtures without leaving indented areas, tearing, shoving, or gouging and capable of confining edge of strips to true lines without use of stationary side forms and capable of placing the course to the required thickness. It shall also be capable of producing a finished surface conforming to the smoothness requirements specified. Spreaders shall be designed to operate forward at variable speeds and in reverse at traveling speeds of not less than 100 feet per minute. If an automatic grade control device is used on the spreader for two-lane paving operations, it shall consist of sensing device for control of one end of the screed and a slope-control mechanism for control of the other end of the screed, or a sensing device on each side of the paving machine. Where the paver is used on multiple paving lanes (more than two paving lanes), sensing devices shall be used on each side of the spreader for control of the screed. The slope-control mechanism shall not be used for grade control in multiple paving lane operations.

1. When the contractor chooses to pave lanes through the project wider than 12 ft. the spreader (paver) shall be equipped with auger extensions.

2. Through lanes shall be paved before left turn lanes and side street intersections. Through lane pavers shall not stop for other areas to be paved.

d. Special Procedures to Prevent Segregation The wings of the spreader hopper shall not be emptied (flipped or folded) between truck loads. The depth of the material in the screed auger champer shall be kept approximately three-fourths (3/4) full - all the way out to the end gate. The augers should be running automatically and the vibrating screed turned on. The hopper conveyor shall always have approximately 6 inches of material covering it and not be allowed to run out of material. Whenever the paver is run empty (conveyor exposed) the area behind the paver should be checked for a segregated spot. If a spot exists the paver should be stopped and the segregated spot repaired before it is rolled.

e. Joints between old and new pavements or between successive day's work shall be cut back vertical with a saw. Other joints shall be sawed vertical as directed by the City Engineer. All joints shall be cleaned and tacked and shall be made carefully to insure continuous bond between old and new sections of the course. All joints shall have the same texture, density, and smoothness as other sections of the course. The tack shall be overlapped onto the previous pavement 1 inch to 2 inches. Contact surfaces of previously constructed pavements, curbs, gutters, manholes, etc., shall be tacked. Surfaces that have become coated with dust, sand, or other objectionable material shall be cleaned by brushing or cut back with an approved power saw, as directed. The surface against which new material is to be placed shall be sprayed with a thin, uniform coat of bituminous material conforming to the requirements of paragraph TACK COAT stated hereinafter. The material shall be applied far enough in advance of placement of the fresh mixture to insure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

1. Edges of previously placed pavement that have cooled and are irregular, honeycombed, poorly compacted, damaged, or otherwise defective unsatisfactory sections shall be cut back to expose a clean, sound surface for the full thickness of the course as directed by the City Engineer.

2. Transverse Joints - The roller shall pass over the unprotected end of freshly placed mixture only when placing of the course is discontinued or when delivery of mixture is interrupted to the extent that unrolled material may become cold. In all cases, the edge of the previously placed course shall be cut back to expose an even, vertical surface the full thickness of the course. In continuing placement of the strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling which conforms to the required density and smoothness specified herein. A string line shall be used to set pavement elevations twenty-five feet after a beginning at a transverse joint or twenty-five feet before an ending at a transverse joint.

3. Offsetting Joints in Intermediate and Surface Courses - The surface course shall be placed so that longitudinal joints of the surface course will not coincide with joints in the intermediate course by approximately 9 inches. Care shall be taken when possible to offset longitudinal joints in a manner that the final surface course joint is in the center of the pavement or at the location shown on the plans. Transverse joints in the surface course shall be offset by at least two feet from transverse joints in the intermediate course.

4. Special Requirements for Placing Paving Lanes Succeeding Initial Lanes - In placing each succeeding lane after the initial lane has been placed and compacted as specified hereafter, the screed end gate of the mechanical paver shall overlap the previously placed lane slightly and shall be approximately 1.25 times thicker than the existing compacted lane to allow for compaction roll down and produce a smooth compacted joint with the specified density. Mixture placed on the edge of the previously placed lane by the mechanical paver shall be pushed back (tucked) to the edge of the lane being placed by use of a lute (rake). The pushed back material shall form a ridge on the uncompacted lane along the edge of the previously placed lane. The height of the ridge above the uncompacted lane should be approximately equal to the thickness being allowed for roll down during compaction. These procedures shall be used to facilitate getting a smooth joint with density. Excess mixture shall be removed and wasted. Excess material shall not be spread over the uncompacted mat.

f. Steel-drum rollers shall be self-propelled, tandem (two-axle) with both drums the same size, powered by both drums, vibratory types, weighing not less than 20,000 pounds static weight and not less than 150 lbs/in of drum. Drums shall be equipped with adjustable scrapers, water tanks, and sprinkling apparatus for keeping the drums wet, thereby preventing the bituminous mixture from sticking to the wheels. Rollers shall be capable of reversing without backlash and free from worn parts. Roller drums with flat and pitted areas or projections that leave marks in the pavement will not be permitted.

g. Heavy pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted an odd number of pneumatic-tired wheels. The roller shall have at least nine pneumatic-tired wheels in such manner that the rear group of wheels will not follow in the tracks of the forward group but spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth, inflated to 90 p.s.i.. Construction of the roller shall be such that each wheel can be loaded to a minimum of 2,300 pounds. Combination rollers are not allowed, except that they may be permitted in cul-de-sacs at the Engineer's discretion.

h. Blowers and brooms shall be power type and suitable for cleaning the surface to be paved. Open faced brooms may only be used when approved by the City Engineer. If the roadway is too contaminated with mud patties or other debris, the area to be paved must be cleaned by pressure washing or compressed air to sufficiently clean the pavement. If pressure washing is performed, the roadway must dry sufficiently prior to placing cure and the next lift of asphalt.

4. The contractor is responsible for the development of a compaction procedure that will obtain the required density. The following paragraphs describe a procedure that generally obtains density. The contractor shall determine the exact amount of rolling (coverages needed) to obtain a density meeting paragraph: “Density and Density Test”. The ideal density is an average density between 93% and 96%.

    a. The surface of the placed material shall be corrected if necessary before compaction begins. Compaction of the mixture shall be accomplished using a minimum of two steel-drum rollers and a pneumatic-tired roller as specified above. Breakdown rolling shall be as close behind the paver as possible. The break down roller shall be a steel-drum and operated in the vibratory mode on the first forward pass and may be operated in vibratory made on subsequent passes either forward or back. Delays in rolling freshly spread mixture will not be permitted. The pneumatic-tired roller shall be used as an intermediate roller; however, it shall also roll closely behind the break down roller. The pneumatic-tired roller shall always be kept moving in order to keep its tires warm. The second steel-drum roller shall be used as a final finish roller. Rollers shall not travel faster than 3 mph. Steel-drum rollers shall not be used in the vibratory mode except for initial breakdown rolling. When steel-drum rollers are used in the vibratory mode they shall be operated at maximum frequency and minimum amplitude. Rolling shall be continued until density is obtained in all portions of each course.

    b. The speed of rollers shall be slow enough at all times to avoid displacement of the hot mixture. Displacement of the mixture resulting from reversing the direction of the roller or from any other cause shall be corrected at once by raking or removing and replacing fresh mixture when necessary. Alternate passes of the roller shall be varied slightly in length. During rolling, the wheels of steel-drum rollers and plates of vibro plate compactors shall be moistened to prevent adhesion of the mixture to the drums or plates, but excess water will not be permitted. The use of diesel is not permitted. Tires of heavy pneumatic roller shall be moistened with soapy water when required to prevent mixture from sticking to tires during rolling. Rollers shall not be permitted to stand on finished courses until the courses have thoroughly cooled. The contractor shall supply ample rollers to obtain the specified density. Places inaccessible to rollers shall be thoroughly compacted with hot hand-tampers or vibro plate compactors.

    c. Break Down Rolling - Rollers shall be operated as specified above. The unconfined edge or low side edge of the paving lane shall be broken down first. The other edge shall be broken down second and the middle broken down last. This is considered one coverage. Steel-drum break down rollers shall not hang over the free edge of the mat or stay back from it even though they are going to back up for the adjoining lane. The entire lane shall be broken down at the same temperature.

        1. Intermediate Rolling - The rubber tired roller shall be close behind the break down roller after the mat has cooled a few degrees. The rubber tired roller shall roll the same pattern making the same coverage as the breakdown. The rubber tired roller should stay the thickness of the lift from the free edge.

2. The number of coverage's shall be determined by the contractor. This will change with temperature, humidity and thickness of the lift.

3. Longitudinal Joint Break Down Rolling of Paving Lanes Succeeding Initial Lanes - The break down roller in the vibratory mode shall lap over the tucked joint approximately six inches (6") on to the previously placed compacted lane. As part of the break-down rolling and immediately after the break-down roller completes its first passes, the longitudinal joint shall be pinched to ensure compaction with the pneumatic-tired roller. The rubber tired roller shall make at least one complete pass (forward and backward) operated on the hot lane with the outside tire pinching the joint. After the rubber tired roller rolls the joint, it shall make at least one pass over the rest of the mat and then drop back to its intermediate rolling. The steel drum roller in static mode shall immediately smooth out the rubber tired marks.

4. Finish rolling should start when the mat has cooled down 20°F to 40°F below the intermediate rolling (This could be approximately 225°F). The steel wheeled roller in static mode shall immediately smooth out the rubber tired marks using the same pattern making the same type coverages as the breakdown roller. Do not roll until cracks appear, let it cool. Finish rolling can continue until the temperature reaches 175°F to 150°F. The finish rolling shall continue until the pavement is smooth and has the density specified above.

d. Placement of bituminous material shall not be permitted within 24 hours of a rain event. Do not place asphalt mixtures on any wet or frozen surface or when weather conditions otherwise prevent the proper handling and finishing of the mixture.

Asphalt Placement Temperature Limitations			
Paving Course	Compacted Thickness (inches)	Air Temperature (°F)	Road Surface Temp. (°F)
Surface	All	55	60
Subsurface	2	50	55
Subsurface	3	40	45
Subsurface	4	30	35

e. When the bituminous mixture is placed on an existing bituminous surface, the surface shall be cleaned of all foreign material and broomed as necessary to remove dust. Areas shown on the plans or designated by the City Engineer to be patched shall be excavated to a depth directed by the City Engineer, filled with bituminous mixture and compacted. When the contract does not provide for a patching item, an amount two and one-half times the unit price for the bituminous mixture shall be used. The excavation required will not be paid for directly but will be considered subsidiary. In addition to brooming, a high pressure type water truck, capable of washing all fines, dirt, and debris from the surface, may be required prior to overlaying as directed by the City Engineer. Equipment compliance with this specification shall be visual observation by the City Engineer at the commencement of washing operations with sufficient

advanced notice that these operations are being performed. Unless specified, no direct payment shall be made for this item, as it shall be considered subsidiary to other bid items.

f. Emulsified Asphalt CSS-1h meeting the requirements of Section 1203 of the Standard Specifications shall be used for tack coat. All existing and new asphaltic concrete surfaces shall receive a tack coat not more than six hours prior to placing an asphaltic concrete paving course. Tack shall be placed prior to any lift of asphalt. Surfaces previously tack coated and not covered with new asphaltic concrete for more than six hours shall be retacked. The rate of application shall be 0.05 gal./sy to 0.12 gal./sy, or as otherwise directed by the City Engineer. At locations where asphalt is being placed on top of existing concrete pavement where temperatures warrant, the emulsified asphalt shall be diluted 10 percent with water versus the normal 50 percent dilution with water. Tack coat shall not be paid for directly but shall be considered subsidiary to other bid items.

g. The surface course, upon completion of final rolling, shall be smooth and true to grade and cross-section. When a 12-foot straightedge is laid on the surface parallel with the centerline, the surface shall not vary more than 1/8 inch from the straightedge. When the 12-foot straightedge is laid on the surface transverse to the centerline between the crown and edge of pavement, the surface shall not vary more than 1/4 inch from the straightedge. Low or defective areas shall be immediately corrected by cutting out the faulty areas and replacing with fresh hot mixture and compacting the area to conform to the remainder of the pavement. Testing for plan grade conformance and surface smoothness shall be performed by the Contractor in the presence of a representative of the City Engineer. Tests shall be made at intervals as directed by the City Engineer. The City Engineer may direct the contractor to diamond grind areas that are out of tolerance in lieu of above replacement.

C. METHOD OF MEASUREMENT: Asphaltic concrete shall be measured by the square yard of “Asphaltic Concrete Base”, “Asphaltic Concrete Intermediate Course”, and “Asphaltic Concrete Surface” (of the type and thickness specified) in place as designated on the plans. The Asphaltic Concrete Base which extends under the curb and gutter on Major Streets shall not be measured, but shall be subsidiary to “Curb and Gutter”. Removal of an existing pavement shall be subsidiary to “Asphaltic Concrete Base” and shall not be measured separately. Asphalt cement shall be subsidiary to “Asphaltic Concrete Surface” or “Asphaltic Concrete Intermediate Course” or “Asphaltic Concrete Base”. Whenever the plans require an existing pavement to be removed to the full depth of the existing pavement, the removal shall be subsidiary to installation of the asphaltic concrete base.

D. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit prices per square yard of ”Asphaltic Concrete Base”, “Asphaltic Concrete Intermediate Course” and ”Asphaltic Concrete Surface” of the type and thickness specified in the plans and Bid Documents.

S-301 BITUMINOUS SEALING: This work shall consist of an application of bituminous material followed by an application of cover material, in accordance with these Specifications, as shown on the Plans, or as established by the Engineer.

A. COVER MATERIAL: Cover material shall meet the requirements of the Standard Specifications for crushed limestone and the gradation requirements shown below after removal of all deleterious substances:

Percent Retained - Square Mesh Sieves (1)			
1/2"	3/8"	4	8
0	0-15	45-100	95-100

All of the cover material shall be washed and coated with 1.25% bituminous material, meeting the requirements of the Standard Specifications for MC-250.

B. BITUMINOUS MATERIAL: Bituminous material for the sealing shall be homogeneous and shall conform to the following requirements:

1. CRS-1 or CRS-1H per the Standard Specifications; or CRS-2P or EA-90P per the following specifications:

	CRS-2P		**EA-90P**	
TEST (Note 1)	**MIN.**	**MAX.**	**MIN.**	**MAX**
Viscosity, SSF @ 122° F (50° C)	100	400	100	400
Storage Stability Test (Note 2), 24 hour, percent	1		1	
Classification Test	Pass			
Particle Charge Test	Positive			
Sieve Test, 20 mesh (850 *u*m), percent			0.3	0.3
Demulsibility, 0.02 N $CaCl_2$, percent		30		
Distillation:				
Oil Distillate by volume of emulsion, percent	3		3	
Residue from Distillation, (Note 3) percent	65		65	
Tests on Residue from Distillation:				
Penetration, 77°F(25°C), 100 g., 5 sec.	100	200	100	200
Ductility, 39.2°F(4°C), 5 cm/minute, cm	30		25	
Ash (Note 4), percent		1		1
Float Test at 140°F (60°C), sec.			1200	
Elastic Recovery, percent (Note 5)	58		58	

NOTE 1: All tests are performed in accordance with AASHTO T59-88I except as noted.
NOTE 2: In addition to AASHTO T59; upon examination of the test cylinder, after standing undisturbed for 24 hours, the surface shall show no appreciable white, milky colored substance and shall be a homogeneous brown color throughout.
NOTE 3: AASHTO T59 modified to maintain a 400°F ± 10°F (204°C ± 4°C) maximum temperature for 15 minutes.
NOTE 4: AASHTO T111-83, Ash in Bituminous Materials

C. INSTALLATION: Before applying bituminous material, the surface to be treated shall be cleaned of all foreign material and broomed as necessary to remove dust.

1. Temperature of Bituminous material at the time of application shall be between 100°F and 180°F (38°C and 82°C). Bituminous material shall be applied at the rate of 0.25 to 0.40 gallons per square yard of residual asphalt by means of an approved pressure distributor in a uniform, continuous spread.
2. A strip of building paper, at least three feet in width and at least one foot longer than the spray bar, shall be used at the beginning and end of each spread. The end of the curb returns on the side streets shall be considered the end of a spread and building paper shall be used. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper speed when the spray bar is opened, unless the distributor is equipped to apply the specified rate from a standing start. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface.
3. The spread length of bituminous material shall not exceed that which can be covered immediately. Under no circumstance shall more than 100 feet of the bituminous material remain uncovered. The spread width of bituminous material shall not exceed the spread width of the cover material by more than six inches.
4. Any overlap into an adjoining spread shall be swept back onto the completed spread. Any bituminous material deposited on the concrete curb shall be removed from the concrete.
5. The distributor shall be equipped and operated to prevent bituminous material from dripping on the pavement.
6. Distribution of the bituminous material shall be so regulated to insure a uniform distribution of bituminous material. In no case should the distributor be allowed to "blow".
7. The angle (30 degrees) of the spray nozzles and the height of the spray bar shall be adjusted and frequently checked to insure uniform distribution. If the rise of the spray bar as the load is removed is excessive and contributes to drilling and streaking, the distributor shall be modified so it will maintain a constant spray bar height. Should any nozzle malfunction, distribution shall cease immediately. Any deficiencies shall be corrected before distribution can be resumed.
8. All pavements within the project area shall be sealed, including intersection out to the curb returns, and auxiliary lanes. Entrances shall not be sealed. Bituminous material and cover material for this work are included in the Contract quantities.
9. The surfaces of all structures and other roadway appurtenances shall be protected to prevent them from being damaged or splattered with bituminous material. If any appurtenances are damaged or splattered the Contractor shall at his own expense, restore the appurtenances to their original condition.
10. Immediately following the application of the bituminous material, cover material shall be spread with a self-propelled aggregate spreader at the rate of 16 to 22 lbs./sq.yd, unless modified in writing by the Engineer. At no time shall the spreader be operated at a distance greater than 100 feet behind the leading edge of freshly applied bituminous material.
11. At no time shall the tires of the trucks or aggregate spreader come in contact with the fresh bituminous material.
12. At the time of delivery to the roadway, the moisture content of the cover material shall not exceed three percent by weight plus 1/2 the water absorption of the aggregate. In no case shall free moisture be draining from the truck.
13. Any operation of equipment which results in displacement of the cover material or damage to the seal course is prohibited.

14. Spreading equipment shall be so equipped and operated to insure complete coverage. No brooming, dragging or blading of the cover material shall be permitted prior to initial rolling.
15. Any rearrangement of the cover material shall be by hand methods. Overlapping applications of cover material shall be avoided and all spillage shall be removed from the surface. The bituminous material shall be uniformly covered before rolling.
16. Immediately following the application of cover material it shall be embedded by pneumatic rolling. A sufficient number of pneumatic rollers shall be furnished so the initial complete roller coverage shall be completed within 5 minutes after the application of cover material. A minimum of two pneumatic rollers shall be furnished. Pneumatic rolling shall continue until a total of five complete coverage's are obtained. The speed of the rollers shall be such that aggregate displacement will be minimized. Weight of the rollers shall be varied as directed to obtain the most satisfactory embedment of the cover material.
17. The Engineer may allow the use of a steel roller for one of the coverage's, provided that crushing of the cover material does not occur.
18. The rolling sequence shall be controlled so it will be unnecessary for one roller to turn out to permit another roller to pass. Turning of rollers on the sealed surface is prohibited.
19. Additional cover material shall be applied and rolled with the pneumatic rollers as directed by the Engineer.
20. All rollers shall be self-propelled.
21. The loose cover material shall be broomed from the surface of the travel way as soon as the bituminous material has cured enough to prevent damage by brooming or vehicular traffic. Brooming shall continue periodically until all loose aggregate has been removed. All seals shall receive, as a minimum, one light brooming of the cover material before opening to traffic. Additional brooming may be required before opening to traffic to prevent the cover material from being picked up by moving vehicles.
22. All work, including installation and removal of traffic control signs, will be completed during the working hours specified in the general conditions.
23. Bituminous sealing shall be done only between May 15 and October 1 when the ambient air temperature is 60° F. (15.5° C.) and rising. Bituminous sealing shall not be performed when the relative humidity exceeds 80%. When aggregate retention is unsatisfactory, sealing shall be suspended.
24. The Engineer may modify, in writing, the seasonal and temperature limits, but in no case shall the work be done when the pavement is wet, or the weather is rainy or foggy.

D. METHOD OF MEASUREMENT: **"**Bituminous Sealing" shall be measured by the square yard of completed and accepted work.

E. BASIS OF PAYMENT: **"**Bituminous Sealing" shall be paid for at the Contract Unit Price per square yard of completed and accepted work.

S-302 <u>CRACK REPAIR MEMBRANE</u>: This work shall consist of cleaning out cracks and applying crack repair membrane. Material for Crack Repair Membrane shall consist of a heavy duty membrane with the properties specified below.

A. GENERAL: The Repair Membrane shall be delivered in the manufacturer's original sealed containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealant, and the manufacturer's batch or lot number.
   1. Repair Operations: The cracks shall be thoroughly dry and cleaned of all foreign material (oil, asphalt, sealant, adhesives, etc.) by means of a high pressure air compressor. The cracks shall be sealed with crack sealer material as shown on the Plans and as specified in the Section of these specifications titled “Crack Sealing”. Once the “Crack Sealing” operation is complete, the Contractor shall apply the Crack Repair Membrane in accordance with the manufacturer’s recommendations. The Crack Repair Membrane shall have the following properties:

PROPERTIES	TEST METHOD(1)	UNITS	VALUE(1)
Strip Tensile Strength	ASTM D-882(2)	Lb/in.	50
Puncture Resistance	ASTM E-154	Lb	200
Peel Adhesion	ASTM D-413	Lb/in.	0.7
Heat Stability	-		Passes(3)

a. Minimum Average Roll Values unless otherwise noted.
b. Using 12 in./min. test speed and a 1” initial distance between grips.
c. Using 180º Bend on ¼” mandrel at -25º F (13.9º C).

   2. Traffic: Traffic shall not be permitted over the Crack Repair Membrane until the manufacturer’s recommendation would allow traffic on the Membrane.
   3. Traffic control shall be in accordance with traffic control sheets as shown on the Plans. If plans do not include a traffic control sheet the Contractor shall submit a traffic control plan for the repair operations.

B. METHOD OF MEASUREMENT: “Crack Repair Membrane” shall be measured by the linear foot of completed and accepted work.

C. BASIS OF PAYMENT: “Crack Repair Membrane” shall be paid for at the contract unit price for completed and accepted work as measured above.

S-303 CRACK SEALING: This work shall consist of cleaning out cracks and applying crack sealer and blotting material. Material for Crack sealing shall consist of Crafco AR+, Koch 9000, Koch 9000 HV, Durafill 320 or equal as approved by the Engineer, for all crack sealing as shown on the Plans. The sealant shall be formulated to provide a material, which will not flow from the cracks or be picked up by vehicle tires at summer temperatures and which will remain bonded to the pavement at low temperatures. The sealant shall be capable of being heated to application temperatures and then applied to the pavement through a pressure feed applicator wand, in a manner that cracks at least 3/8 inches wide are completely filled and without damage to the material.

A. GENERAL: Sealant shall be delivered in the manufacturer's original sealed containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the sealant, the manufacturer's batch or lot number, the recommended pouring temperature and the safe heating temperature. Individual packages shall be cardboard boxes with a plastic liner to facilitate easy removal of the sealant from the container.
   1. Sealing Operations: The cracks shall be thoroughly cleaned of all foreign material (oil, asphalt, sealant, adhesives, etc.) by means of a high-pressure air compressor. The cracks shall be sealed with crack sealer material as shown on the Plans.
   2. Equipment: This shall consist of suitable sweepers, hand brooms, air compressor, pouring buckets, rubber-edged squeegees, cutting knives, and distributor, or melting kettle. All hand tools shall be in a clean condition.
   3. Proper sealing equipment must be used for the specific material listed in accordance with the manufacturer's recommendations and/per the Standard Specifications. The equipment for hot applied sealing compounds shall be a melting kettle of the double boiler, indirect heating type, using oil as a heat-transfer medium. The kettle shall have an effective mechanically operated agitator and shall be equipped with a positive thermostatic temperature control. Manufacturer's recommendations for application temperature should be followed. Overheating shall not be permitted. Minimum size of the kettle shall be 200 gallons.
   4. Where installation procedures of any part thereof are required to be in accordance with recommendations of the manufacturer of sealing compounds, the Contractor shall submit catalog data and copies of recommendations before installation of the materials is commenced.
   5. Sealant compound shall not be placed unless the crack is dry, clean and free of dust. The face of the crack shall be surface dry and the atmosphere temperature and pavement temperature shall both be at least 50° F at the time of application of the sealant. Installation of the sealant shall be such that the in-place sealant shall be well bonded to the concrete or asphalt and free of voids or entrapped air. The crack shall be sealed in a neat and workmanlike manner. The Contractor shall "spot up" or refill all low cracks before final acceptance. Any excess of material on the surface of the pavement shall be removed and the pavement surface shall be left in a clean condition.
   6. After a crack has been sealed, all surplus sealant or other residue on the pavement or structure surfaces shall be promptly removed.
      Traffic: Traffic shall not be permitted over sealed cracks, until the sealant is tack free and until debris from traffic does not embed into the sealant. A sand application may be used over the sealer to prevent traffic from tracking sealant.
   7. This shall be subsidiary to other bid items. Traffic control shall be in accordance with traffic control sheets as shown on the Plans.

B. METHOD OF MEASUREMENT: “Crack Sealing” shall be measured by the linear foot of completed and accepted work.

C. BASIS OF PAYMENT: “Crack Sealing” shall be paid for at the contract unit price for completed and accepted work as measured above.

S-304 MODIFIED SLURRY SEAL: This work shall consist of spreading a properly proportioned mixture of emulsified asphalt, mineral, mineral aggregate and water on a prepared surface in accordance with this specification and as directed by the Engineer.

A. GENERAL: The Engineer shall approve all materials and methods of mixing and stipulate the proportions of the mixture. The mixture shall have a thick, creamy consistency and shall be relatively free-flowing. Immediately prior to applying the slurry seal the surface shall be thoroughly cleaned of all foreign materials and pre-wetted as required. A sufficient amount of slurry shall be carried in the spreader box at all times to obtain complete uniform coverage. No lumping, balling or unmixed aggregate shall be permitted. The seam, where two passes join, shall be neat in appearance and all excess material shall be removed immediately from ends of each run. Approved hand tools shall be used to spread the mixture where machine spreading is not possible.

1. Modified Slurry Seal shall be installed between May 1 and October 15 and shall be placed only when the ambient temperature is 60° F. or above (15.5° C.) and the weather is not foggy or rainy.
2. Maintenance of traffic shall be in accordance with the section of this specification titled Traffic Control and the following. One flagger shall be stationed immediately ahead of the application of the modified slurry material and one flagger immediately behind the section being cured. Suitable speed limit signs and “fresh oil’ signs shall be displayed and the signs shall be moved forward with the flaggers as the work progresses. Adequate means shall be provided to protect the modified slurry seal from damage by traffic until such time that the mixture has cured sufficiently so that the modified slurry seal will not adhere to or be picked up by the tires of vehicles. The Contractor shall provide signs, barricades and flaggers necessary to control traffic around the area under construction. Modified Slurry Seal work shall be so scheduled that the residents and/or businesses shall not be without use of their entrances for more than 4 hours. Any damage done by traffic to the modified slurry seal shall be repaired by the Contractor at the Contractor’s expense.
3. Aggregate shall meet the material requirements of Section 1000 of the Standard Specifications regarding aggregate for slurry seal and modified slurry seal, except that the gradation shall meet the following requirements:

Sieve Size								
	3/8” (9.5 mm)	No.4 (4.75 mm)	No.8 (2.36 mm)	No. 16 (1.18 mm)	No. 30 (600 *u*m)	No. 50 (420 *u*m)	No. 100 (150 *u*m)	No. 200 (75 *u*m)
% Retained	0	0 - 10	10 - 35	30 - 55	50 - 70	70 - 82	79 – 90	85 – 95

The emulsified asphalt shall be Cationic Type CSS-1H and shall conform to the requirements specified in Section 1200 of the Standard Specifications regarding Emulsified Asphalt. It shall show no separation after mixing. A minimum of 2.5% latex content, certified from an approved source, along with special emulsifiers, shall be milled into the asphalt emulsion by an approved emulsion manufacturer. The latex modified emulsified asphalt shall be so formulated that when the paving mixture is applied at a thickness of one inch with relative humidity at not more than 50% and ambient air temperature of at least 75° F.
(24° C.) it will cure sufficiently that rolling traffic can be allowed in two hours with no damage to the surface.”

4. When “Rut Leveling” is required by the plans the Contractor shall use an approved rut box(es). The rut box shall have adjustable width, and a separate rut box shall be used for each wheel rut. More than one wheel rut may be leveled with one pass of the modified slurry seal.

B. METHOD OF MEASUREMENT: “Modified Slurry Seal” shall be measured by the square yard of slurry seal in place as designated on the plans, except that the initial pass of the machine to fill the ruts (Rut Leveling) shall be paid for by the square yard as a separate item from the modified slurry seal as designated in these Specifications.

C. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per square yard of “Modified Slurry Seal” and the contract unit price per square yard of “Rut Leveling”.

S-305 MILLING: This work will consist of the removal of the existing surface to the depth and limits shown on the Plans or established by the Engineer. It shall also include the loading and stockpiling, if required, of the milled material, and temporary striping.

A. GENERAL: The nature and condition of the milling equipment and the manner of performance of the work shall be such that the finished milled surface of the pavement is not torn, gouged, shoved, broken, oil coated or otherwise injured by the milling operation. Sufficient passes or cuts shall be made to achieve a depth and width as shown on the Plans. The milling operation shall provide a smooth profile and cross section that does not require a leveling course prior to the overlay operation. Prior to opening to two-lane traffic, no unevenness within a lane shall exist. If over-milling or unevenness occurs due to the contractor negligence in not controlling the milling, the corrective actions including the placement of a leveling type course will be solely at the contractor's expense. The maximum tolerance for milling in a longitudinal direction shall be 1/2" under a 10' straight edge and shall be 3/8" under an 8' straight edge in a transverse direction.

1. The milling operation shall provide for a windrowing of cuttings, pick-up and elevation into dump trucks, all in a single lane operation. Use of front-end loaders as the primary means of pick-up will not be construed as a single lane operation, nor will side loading of dump trucks be permitted. During the milling operation, the Contractor shall remove all cuttings and debris from the street by use of a self-propelled street sweeper with hopper. Recompacted milled materials and all other materials not picked up by the street sweeper shall be removed by other means by the Contractor. No material shall remain that would recompact or leave an unsuitable surface for subsequent overlay operations. Streets scheduled for overlaying that day will be swept by the Contractor's street sweeper prior to the tack coat application.
2. At all other times the project site shall be kept clean, neat and orderly. The Contractor shall keep all streets in a dust free condition. At any time the Engineer may require additional sweeping to maintain the required dust free surface. Stockpiling of debris and unsuitable materials beyond normal working hours shall not be permitted. Immediately after construction operations are complete, all equipment, debris and unsuitable materials shall be completely removed from the site in order to minimize the damage to finished work and inconvenience to the public and adjoining property owners.
3. All side streets, driveways, and ingress and egress points shall be ramped.
4. The Contractor shall supply an adequate number of dump trucks and qualified drivers to accept cuttings in a manner set forth above. All milled material shall be the property of the Contractor, unless otherwise stated in the Plans or Special Conditions. Milling material has a value and the Contractor shall reduce his bid price to reflect this value.
5. Milling work shall be limited to 500 running foot maximum lane length operation. This running distance shall be from the milling machine to the last operated piece of equipment in said lane or where circumstances warrant. Operation distance may be increased with the approval of the Engineer. In the event two (2) machines are used in one direction, they will be run in series so as to occupy only one lane.
6. On all arterials and collectors the Contractor shall install and maintain temporary striping as directed by the Engineer.

B. METHOD OF MEASUREMENT: "Milling" shall be measured by the square yard of accepted work.

C. BASIS OF PAYMENT: “Milling” shall be paid for at the contract unit price per square yard, measured as stated above.

S-306 PAVEMENT PATCHING: This work shall consist of saw cutting, removing pavement and patching concrete pavement and asphaltic concrete pavement in accordance with the Specifications and as shown on the Plans, the Standard Details, in the Contract, or as designated in the field by the Engineer.

A. GENERAL: The type of patching shall be that type shown on the Plans or in the Contract.
   1. Detouring of traffic for this work will not be provided for or permitted without approval of the Engineer. Unless otherwise provided for, operations shall be restricted to one traffic lane at all times in order to permit the unrestricted use of the other lane(s) for traffic and all operations shall be conducted in a manner to cause the least possible inconvenience to traffic.
   2. When work is started at one location the construction procedure of removing the existing pavement, preparing the subgrade and placing and finishing the concrete or bituminous mixture shall so progress that no excavated areas shall remain unfilled overnight. In case of unavoidable delays which make it impossible to place the concrete or bituminous mixture on the same day that the excavation is completed, the Contractor shall fill such excavations with temporary bituminous mixture and shall thoroughly compact the backfill material before nightfall. Temporary bituminous mixture shall not be paid for but will be subsidiary to other items of the Contract.
   3. The old pavement and previously placed patching material shall be removed to the limits designated on the Plans, in the Contract or as marked in the field by the Engineer. Edges of the excavation shall be vertical. All pavements shall be removed to the limits marked for patching. The waste material shall be removed from the area of the roadway the same day of removal and disposed of by the contractor in accordance with all local, state, and federal regulations.
   4. Unsuitable or unstable subgrade shall be removed to a minimum depth of 12 inches, or as needed to provide a stable, well-compacted subgrade, able to withstand paving and grading equipment without rutting or pumping. The subgrade shall be adjusted to grade to permit the thickness of pavement indicated on the Plans or in the Contract. The subgrade shall be thoroughly and uniformly recompacted by hand tamping or rolling.

B. ASPHALTIC CONCRETE PATCHING: The bituminous mixture shall be prepared in accordance with applicable requirements specified in section S-300 Asphaltic Concrete of this specification (KDOT BM-2 is only allowed when specified in the Plans or Contract or when approved by the Engineer).
   1. If the Plans or Contract call for the existing pavement to be sawed prior to the removal of the old pavement, it shall be sawed full depth unless otherwise indicated on the Plans or in the Contract. If the plans do not describe the removal method the pavement shall be sawn to full depth of the existing pavement depth with a clean vertical edge. The patch area shall be squared up with clean longitudinal and transverse edges.
   2. Prior to placing the bituminous mixture in the area to be patched, the exposed edges of the existing pavement shall be cleaned of dirt and other foreign matter and shall be painted or sprayed with a thin tack coat. These sections shall then be repaved with bituminous mixture of the type designated on the Plans or in the Contract. The bituminous mixture shall be deposited in uniformly spread layers not to exceed four (4) inches for the first lift and three (3) inches in thickness for any other lift. Furthermore, each layer shall be thoroughly compacted. Care shall be taken to protect the various layers and any dirt shall be removed before the next layer of material is added. A tack coat shall be applied between each lift.

C. CONCRETE PATCHING: The type and size of patch will be shown on the Plans or Contract or shall be marked in the field by the Engineer and shall meet the applicable following requirements:

1. The handling of material, mixing, placing, and finishing concrete will conform to the requirements of the section of this specification titled Concrete Construction, except for the following:
2. The maximum slump of the concrete at the time of depositing will be 2 1/2 inches. All concrete in pavement patching will be Class KCMMB-4K.
3. The concrete in the patch will be thoroughly consolidated, struck off, finished with wooden floats or other approved methods. All concrete patches will be sawed full depth with a diamond or carborundum saw making sure not to damage the subgrade. Removal of slabs in one piece is recommended provided damage to remaining concrete does not occur. If PCCP is to be overlayed the same construction season a rock saw may be used. Sawing ahead in preparation of patching shall not be more than three working days ahead of the normal patching operation.
4. Tie bars and dowel bars shall be fixed in place with an epoxy or Portland cement grout in accordance with the section of this specification titled Concrete Construction. The size, number and spacing shall be designated on the Plans or in the Contract.
5. Edges of all patches shall be sawed or formed to create a Type 1, 2, or 3 joint, as shown on the plans or as designated by the Engineer. Patches shall be a minimum of six feet measured in longitudinal direction by full lane width wide.
6. If the concrete remaining at an individual joint shows deterioration after slab removal as directed by the Engineer, the repair area may be extended to include the deterioration and additional saw cuts shall be made.
7. At the time of depositing concrete, the subgrade and exposed surface of existing pavement will be sufficiently moist so that it will not absorb moisture from the concrete, but not to the extent that the subgrade will be muddy or have free water standing thereon.
8. All edges not abutting remaining concrete pavement shall be formed for the full depth of the patch.

   Normal Cure: In areas where pavement repair and patching can be cured a minimum of 24 hours, the following shall apply:

   - A minimum of eight sacks (752 lbs.) of either Type I or Type II cement will be used.
   - The minimum length of time after placement of the concrete patches before opening the pavement to traffic will be 24 hours when the minimum ambient temperature in that period is 60º F. (15.5º C.) or above.
   - If the ambient temperature falls below 60º F. (15.5º C.) during the cure period, opening to traffic shall be delayed an additional 24 hours.
     Accelerated Cure
   - When conditions are such that an accelerated cure is necessary, the following shall apply: Quickrete - fast set cement mix or equal shall be used. The minimum length of time after placement of the concrete patches before opening the pavement to traffic will be two (2) hours.

D. CURING OF CONCRETE PATCHES:
Extra precaution or time will be required if the ambient air temperature, after placement of the concrete, falls below 60º F. (15.5º C.)

- Hot weather precautions should be observed if the ambient air temperature reaches 90º F. (32º C.) before placement of concrete.

2. The concrete will be cured with a curing membrane in the same manner as specified for concrete pavement in the section of this specification titled Concrete Construction or with Emulsified Asphalt (SS-1H) whichever is designated by the Engineer. If emulsified asphalt is used it will be applied at a rate to obtain adequate coverage as determined by the Engineer. In most cases where there are plans to overlay the concrete pavement in the near future the Emulsified asphalt (SS-1H) will be used for curing.
3. No patching will be performed when the ambient air temperature is below 40º F. (4º C.).

E. METHOD OF MEASUREMENT: "Pavement Patching" shall be measured by the square yard, complete and accepted, of the type shown on the Plans or in the Contract.

F. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per square yard for "Pavement Patching".

S-307 PERFORMANCE GRADED ASPHALT BINDER: This work shall consist of furnishing, storing, handling, shipping, weighing, sampling, and inspection of performance graded asphalt binders (PGAB) in accordance with these Specifications.

A. GENERAL: Provide material that complies with the applicable requirements of AASHTO M 320 and this specification.
B. All binders shown in **TABLE 1** must be polymer modified.

TABLE 1

	PG 64-28	PG 70-22	PG 70-28	PG 70-34	PG 76-22	PG 76-28	PG 82-22	PG 82-28
Separation, ASTM D5976, Sec. 6, 163°C, 48 hrs. Difference in R&B from Top to Bottom, "C max. Run on Original Binder	2	2	2	2	2	2	2	2
Elastic Recovery, ASTM D6084, 25°C, 10 cm elongation, % min. Run on RTFO Residue	45	45	65	70	65	75	75	75

C. Provide the grade of material designated in the Contract Documents. The City will not make changes in the grade of asphalt. The Contractor may substitute PGAB's that meet or exceed the upper and lower grade designations for the grade specified. For example, if a maintenance overlay specifies a PG 58-22, a PG 64-22 or a PG 58-28 will also be accepted. Such substitutions require advance approval by the Engineer and a no-cost change order.
D. Storing and Heating: Storage tanks, pipe lines and loading facilities for bituminous materials shall be provided with adequate heating equipment that will not be injurious to the material.
E. Sampling and Inspection:
    1. General: The sampling of bituminous materials will be performed at the plant by the Engineer. The producer shall permit inspection of all tanks, blending units, and other items relating to the production and loading of bituminous materials being supplied for City work.
    2. Tests by Producer: The minimum quality control testing requirements for any City project is as follows for Asphalt Cement (AC) and Performance Graded Asphalt Binder (PGAB) Definition of Tests:

Complete AASHTO Specification Compliance (SC) test for AC:

- Viscosity, 140°F (60°C)
- Viscosity, 275°F (135°C)

- Penetration, 77°F (25°C)
- Flash Point, COC
- Solubility

Tests on Residue from TFOT

- Loss on heating
- Viscosity, 140°F (60°C)
- Ductility, 77°F (25°C)

Complete AASHTO Specification Compliance (SC) test for PGAB:

Original Binder:

- Flash Point (COC)
- Brookfield Viscosity, 275°F (135°C)
- Dynamic Shear
- Separation Test 325°F (163°C), 48 hours (Polymer modified only)

Rolling Thin Film Oven Residue:

- Mass Loss
- Dynamic Shear
- Elastic Recovery, 77°F (25°C) (Polymer modified only)

Pressure Aging Vessel Residue

- Dynamic Shear
- Creep Stiffness, S, 60s
- Slope, m

Viscosity, 140°F (60°C)

Penetration, 77°F (25°C)

Quality Control (QC) Tests for AC and unmodified PGAB:

- Viscosity @ 140°F (60°C) (AC and unmodified PGAB)
- Penetration, 77°F (25°C) (AC and unmodified PGAB)
- Original Binder DSR (unmodified PGAB only)
- Brookfield Viscosity, 275 and 330°F (135 and 165°C) (unmodified PGAB only)

Quality Control (QC) Tests for modified PGAB:

- DSR on Original Binder
- DSR after TRFO
- Any other tests the producer has found to provide useful information for quality control of the product

Emulsions and Asphalt Rejuvenating Agents: Perform one complete AASHTO test each time a batch of material is produced. A tank must be tested each time new material is added to it. A complete AASHTO test for Emulsions is defined as follows:

- Saybolt Furol Viscosity, 77 or 122°F (25 or 50°C)
- Residue by Distillation
- Oil Distillate
- Settlement, 5 day
- Storage Stability, 1 day

- Sieve Test
- Demulsibililty-WHEN REQUIRED
- Particle Charge-WHEN REQUIRED
- Tests on Distillation Residue:
- Penetration, 77°F (25°C)
- Ductility, 39°F or 77°F (4°C or 25°C)
- Saybolt Furol Viscosity, 180 (82.2°C) CMS-1 ONLY
- Elastic Recovery, ST-1P ONLY

A complete AASHTO test for asphalt rejuvenating agents is defined as follows:

- Saybolt Furol Viscosity, 77°F (25°C)
- Residue by Evaporation
- Sieve Test
- Tests on Residue
- Kinematic Viscosity, 140°F (60°C)
- Asphaltenes
- Maltenes Ratio

Cutbacks and Hot Recycling Agents: For a tank being filled and emptied before more material is added, perform one complete AASHTO test per tank, and weekly tests for 140°F (60°C) viscosity. For a tank being continually filled while continuous shipping is made from the tank, perform one complete AASHTO test per week, and daily tests for 140°F (60°C) viscosity. When blending directly into a tanker, sample every third truck for 140°F (60°C) viscosity, and perform one complete AASHTO test per week.

A complete AASHTO test for cutback asphalt is defined as follows:

- Kinematic Viscosity, 140°F (60°C)
- Flash Point, TOC
- Water
- Distillation Test:
  - Distillates
  - Residue
- Tests on Distillation Residue:
  - Vacuum Viscosity, 140°F (60°C) or Penetration, 77°F (25°C)
  - Ductility, 77°F (25°C) or 60°F (15.6°C)
  - Solubility

A complete AASHTO test for hot recycling agents is defined as follows:

- Vacuum Viscosity, 140°F (60°C)
- Flash Point, TOC
- Tests on Residue from TFOT
  - Loss
  - Viscosity Ratio
- Chemical Analysis
  - Maltenes Ratio
  - Saturates

F. For all types of products discussed above, submit latest testing results with the mix design, and submit quality control testing upon request of the Engineer.

G. Testing by the Engineer: Samples for testing will be obtained at random, at a frequency established by the Engineer, from tanks at the asphaltic concrete producer's facilities, or from the plant at the asphaltic concrete producer's facilities.
H. TEST METHODS: Test according to the applicable provisions of ASTM D4402, D5976, D6084 and AASHTO T48, T 313 and T 315.

I. METHOD OF MEASUREMENT: Performance Graded Asphalt Binder shall not be measured separately, but shall be subsidiary to "Asphaltic Concrete" of the type specified in the plans.

J. BASIS OF PAYMENT: Performance Graded Asphalt Binder shall not be paid for separately, but shall be subsidiary to "Asphaltic Concrete" of the type specified in the plans.

S-308 SLURRY SEAL: This work shall consist of spreading a properly proportioned mixture of emulsified asphalt, mineral, mineral aggregate and water on a prepared surface in accordance with this specification and as directed by the Engineer.

A. GENERAL: The Engineer shall approve all materials and methods of mixing and stipulate the proportions of the mixture. The mixture shall have a thick, creamy consistency and shall be relatively free-flowing. Immediately prior to applying the slurry seal the surface shall be thoroughly cleaned of all foreign materials and pre-wetted as required. A sufficient amount of slurry shall be carried in the spreader box at all times to obtain complete uniform coverage. No lumping, balling or unmixed aggregate shall be permitted. The seam, where two passes join, shall be neat in appearance and all excess material shall be removed immediately from ends of each run, and from the gutter section. Approved hand tools shall be used to spread the mixture where machine spreading is not possible.
   1. Slurry seal shall be constructed between May 1 and October 15 and shall be placed only when the ambient temperature is 60° F. (16° C) or above and the weather is not foggy or rainy. Slurry seal shall not be constructed when the ambient air temperature is 95° F (35° C) or above, nor when the pavement temperature is 110° F (44° C) or above. Slurry seal shall not be placed when the relative humidity is above 90%.
   2. Maintenance of traffic shall be in accordance with the section of this specification titled “Traffic Control” and the following. One flagger shall be stationed immediately ahead of the application of the slurry material and one flagger immediately behind the section being cured. Suitable speed limit signs and “fresh oil’ signs shall be displayed and the signs shall be moved forward with the flaggers as the work progresses. Adequate means shall be provided to protect the slurry seal from damage by traffic until such time that the mixture has cured sufficiently so that the slurry seal will not adhere to or be picked up by the tires of vehicles. The Contractor shall provide signs, barricades and flaggers necessary to control traffic around the area under construction. Slurry Seal work shall be so scheduled that the residents and/or businesses shall not be without use of their entrances for more than 12 hours. Any damage done by traffic to the slurry seal shall be repaired by the Contractor at the Contractor’s expense.
   3. Prior to installing the slurry seal, the Contractor shall remove all pavement markings from the street surface.
   4. The Contractor shall sweep the street in the area where the slurry seal was installed when directed to do so by the Engineer. Sweeping will not occur until the slurry has cured for 72 hours, and sweeping will cease if the slurry seal is damaged by the sweeping.
   5. Aggregate shall meet the material requirements of Section 1100 of the Standard Specifications regarding Slurry Seal and Modified Slurry Seal, except that the gradation shall meet the requirements of the Asphalt Handbook for Type II Slurry unless otherwise stated in the plans or bid documents.
   6. Emulsified Asphalt shall meet the requirements of Section 1200 of the Standard Specifications, regarding Emulsified Asphalt, for CSS-1H.

B. METHOD OF MEASUREMENT: “Slurry Seal” shall be measured by the square yard of slurry seal in place as designated on the plans.
C. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per square yard of “Slurry Seal”.

S-309 <u>TACK COAT</u>: This work shall consist of applying emulsified asphalt tack coat as specified below. Emulsified Asphalt (CSS-1H) shall be required prior to placing Asphaltic Concrete Surface. The rate of application shall be 0.05 to 0.12 gallons per square yard of CSS- 1H, or as otherwise directed by the Engineer. At locations where asphalt is being placed on top of existing concrete pavement uncut emulsified asphalt (SS-1H) shall be used. Tack shall be applied as far in advance of the paving train as necessary to allow evaporation time for the tack to "break" before asphalt paving will be allowed. Tack material that is removed by construction traffic shall be re-applied to the required rate as specified above. Tack Coat is required between each lift of asphaltic concrete.

A. METHOD OF MEASUREMENT: Tack Coat shall not be measured separately.

B. BASIS OF PAYMENT: Tack Coat shall be subsidiary to "Asphaltic Concrete Surface" or "Asphaltic Concrete Base".

S-310 <u>TEMPORARY ASPHALTIC CONCRETE SURFACING</u>: This work shall consist of aggregate and bituminous material mixed in central plant, spread, compacted and removed in accordance with this Specification and in reasonably close conformity with the lines, grades, thickness and typical cross section shown on the Plans or established by the Engineer.

A. GENERAL: The bituminous mixture shall be approved by the Engineer. This approval will in general be based upon the following conditions:
   1. All materials shall be furnished by recognized producers.
   2. The hot mix plant shall be of a recognized type.
   3. The mixture produced shall be a commercial mixture in general use in the area that has a satisfactory service record.
   4. The mixture shall be workable and capable of being spread without tearing or flushing.
   5. Asphalt for tack may be any asphalt approved by the Engineer.

B. Rolling of the mixture shall be accomplished using a minimum of two rollers. On incidental and miscellaneous work the Engineer may waive the minimum roller requirements if conditions warrant. All compaction will be performed using standard and recognized techniques. Except for variations approved by the Engineer, final rolling shall be completed while the temperature of the mixture is approximately 175° F. (80° C.) or above. Tacking between lifts shall be as directed by the Engineer.

C. Bituminous plant mixtures shall not be placed on any wet or frozen surface or when the weather conditions otherwise prevents the proper handling or finishing of the bituminous mixtures. The Engineer may waive the weather limitations if warranted.

D. METHOD OF MEASUREMENT: "Temporary Asphaltic Concrete Surfacing" shall be measured by the square yard of completed, in-place, and accepted work.

E. BASIS OF PAYMENT: "Temporary Asphaltic Concrete Surfacing" shall be paid for at the contract unit price measured as stated above.

CONCRETE CONSTRUCTION AND MATERIALS

S-400 CONCRETE BRICK PAVERS: This work shall consist of furnishing and placing all materials, including bedding, for the installation of concrete brick pavers as shown on the Plans, and/or Standard Details.

A. GENERAL: Pavers shall meet the requirements of ASTM C936 and shall be certified as meeting such requirements by an independent testing lab.
   1. Concrete pavers shall conform to the Standard Detail for "Median Paver Detail", Color: Per Plans.
   2. Each type of unit paver, joint material, and setting material shall be obtained from one source. The product source shall have resources to provide materials and products of consistent quality in appearance and physical properties.
   3. Submit four full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
   4. Bedding and joint sand shall be clean, non-plastic and free from deleterious or foreign matter. The sand shall be natural or manufactured from crushed rock. Grading of samples shall be done according to ASTM C136. The particles shall be sharp and conform to the grading requirements of Bedding Sand and Joint Sand as shown below:
   5. Grading Requirements for Bedding and Joint Sand

Bedding Sand	
Sieve Size	**Percent Passing**
3/8	**100**
No. 4	**95 - 100**
No. 8	**80 - 100**
No. 16	**50 - 85**
No. 30	**25 - 60**
No. 50	**5 - 30**
No. 100	**0 - 10**

Joint Sand	
Sieve Size	**Percent Passing**
3/8	**100**
No. 4	**100**
No. 8	**100**
No. 16	**90-100**
No. 30	**70-100**
No. 50	**35-65**
No. 100	**10-22**

6. Concrete pavers shall be delivered to the site in steel banded, plastic banded or plastic wrapped cubes capable of transfer by fork lift or clamp lift. Unload pavers at job site in such a manner that no damage occurs to the project.
7. Sand shall be covered with waterproof covering to prevent exposure to rainfall or removal by wind. The covering shall be weighted to resist removal by wind.
8. Do not install sand or pavers during rain or snowfall. Do not install on frozen sand.
9. Concrete pavers will have spacer bars on the sides of each unit. These ensure a minimum joint width between each unit in which the sand is placed. Spacer bars help prevent contact of the edges with adjacent pavers and subsequent spalling. Spacer bars should be a minimum of 1/16 inch thick.
10. For installation on a compacted gravel base and soil subgrade, the specifier should be aware that the top surface of the pavers after vibration may be 1/8 to 1/4 in. above the final elevations. This difference in initial and final elevation is to compensate for possible minor settling. Drain holes shall be incorporated into the pavement when the pavers are installed over concrete at the low point of the concrete base and at various locations throughout the concrete base not to exceed a 10-foot maximum spacing. Concrete base shall be floated or finished and have a smooth, level surface free of irregularities. Vertical edges, where the pavers are adjacent to a concrete curb or sidewalk, shall have a plumb vertical edge. Geotextile fabric shall be placed on top of the entire concrete base, free of wrinkles and gaps and trimmed 1 inch to 2 inches above the concrete base. The geotextile fabric shall extend up the sides of the curb and gutter. In no case shall the fabric be left higher than the brick pavers. The fabric shall not be folded or laid over the sand bedding, allowing water to drain between the concrete and brick. The fabric shall keep water from washing the sand into the contraction joints, causing uneven settlement of the pavers. Special care shall be taken to have sufficient fabric at locations where there is a saw joint in the curb to keep the sand from washing out from under the brick and causing paver settlement. Splices in fabric are to be no less than 8 inches overlapped. Bedding and joint sand shall be placed on top of the geotextile fabric and then smoothed and leveled, allowing for the pavers to be flush with the adjoining pavement.
11. Prior to installation, the base must be dry and compacted according to the Standard Detail, and the pavers must be free of foreign material.
12. Fill gaps at the edges of the paved area with cut pavers or edge units. Pavers shall be cut by an experienced brick layer, and only a table type saw shall be used. Chop saws, cut-off saws or quickie saws shall not be permitted to cut the bricks.
13. Only a double-bladed splitter or masonry saw shall be used to cut pavers that are to be placed along the edge.
14. Use a low amplitude, high frequency plate vibrator capable of 3000 to 5000 psi centrifugal compaction force to vibrate the pavers into the sand.
15. Vibrate the pavers, sweeping dry sand into the joints and vibrating until they are full. This will require at least two or three passes with the vibrator. Do not vibrate within three feet of the unrestrained edges of the paving units. Brick pavers are not to be left for more than 48 hours after initial placement without being vibrated and sand swept in all crevices multiple times and the area is completed. No paver edge restraints shall be placed on unstable soils. A concrete edge shall be placed in these locations.
16. All work within three feet of the laying face must be left fully compacted with sand filled joints at the completion of each day. Cover the remaining uncompacted edge of the laying face and sand with waterproof covering.
17. Sweep off excess sand when the job is complete.

18. The final surface elevations shall not deviate more than 3/8 in. under a 10 foot long straightedge, except when contours exceed this tolerance.
19. The surface elevation of pavers shall be 1/8 in. to 1/4 in. above adjacent drainage inlets, concrete collars or channels.

B. METHOD OF MEASUREMENT: “Concrete Brick Pavers” shall be measured by the square foot of completed and approved work. Testing, bedding, spacer bars, concrete base, sand base, and excavation shall be subsidiary to "Concrete Brick Pavers".

C. BASIS OF PAYMENT: “Concrete Brick Pavers” shall be paid for at the contract unit price, measured as stated above.

S-401 CONCRETE CONSTRUCTION: All concrete construction shall meet the requirements of the Kansas Department of Transportation (KDOT) Standard Specifications regarding concrete construction, or as hereafter presented. Vibration will be required for all construction, including, but not limited to, sidewalk, residential or industrial drives, and curb and gutter. Concrete shall consist of a mixture of Portland Cement, Water, fine aggregate and coarse aggregate with air entraining or other admixtures. Admixtures will not be allowed unless approved by the Engineer at the time of review of the design mix. When used, admixtures, for other than air entrainment, shall be entirely at the expense of the Contractor.

A. GENERAL: Any construction for concrete structures, not specifically addressed in this "Concrete Construction" specification, shall meet the requirements of the Kansas Department of Transportation (KDOT) Standard Specifications.
   1. The actual mix proportions of the concrete mix shall be the responsibility of the Contractor and the mix shall be designed in accordance with the requirements of the Kansas City Metropolitan Materials Board. Changes made by the Contractor in mix proportioning, previously approved, and must be approved by the Engineer. Failure of the mixed concrete to meet specifications as determined by the Engineer will be grounds to reject the concrete. This includes, but is not limited to, the plant not showing the exact number of gallons per yard being withheld, or if the exact proportioning of the concrete delivered can't be determined by the Inspector or the Engineer's representative or by visual inspection.
   2. Materials shall conform to the requirements of the Kansas City Metropolitan Materials Board.
   3. The mix designs shall be submitted to the Kansas City Metropolitan Materials Board 14 days in advance of placement to allow for adequate review and approval of materials. The mix designs must be approved by the Kansas City Metropolitan Materials Board at least 2 working days prior to placement in order to allow time for distribution of the mix designs to the project inspector. The Engineer may elect to require testing of materials during the course of the work in which event the Contractor shall deliver such samples as required at the time and place designated by the Engineer. Any contemplated revision of materials or equipment which has been previously accepted shall be cause for the Engineer to require the Contractor to submit a redesigned mix and a revised schedule of operations. The cost of retesting shall be entirely at the expense of the Contractor.
   4. Cementitious materials shall meet the current requirements of the Kansas City Metropolitan Materials Board.
   5. Aggregate for concrete shall meet the requirements of the Kansas City Metropolitan Materials Board.
   6. Ready-mixed concrete shall be mixed and placed in accordance with the requirements of the Standard Specifications, except that ready-mixed concrete shall be transported with agitation. All concrete shall meet the slump requirements specified, and the Engineer will require additional slump tests if, in his opinion, it appears that excessive water has been added. Concrete which does not meet this requirement will be rejected.
   7. A diligent effort shall be made by the Contractor and the ready-mix concrete producer to deliver concrete at regular intervals, and to maintain a uniform mix throughout each concrete pour. Concrete shall be delivered at intervals frequent enough to prevent any cold joints.
   8. The Contractor shall provide 24 hours' notice of his intention to place concrete to allow for adequate inspection and testing.

9. Class KCMMB-5K Concrete Construction: All concrete used in construction of reinforced box culverts shall be classified as Class KCMMB-5K unless otherwise stated in the plans.
10. Class KCMMB-4K Concrete Construction All concrete used in construction of curbs and gutters, retaining walls, culvert aprons, inlets, junction boxes, yard inlets, manholes, ditch liners, sidewalks, and integral sidewalk retaining walls shall be classified as Class KCMMB-4K unless otherwise stated in the plans.
11. All Concrete shall meet the requirements of the Kansas City Metropolitan Materials Board for the Class of Concrete specified.
12. All materials proposed for use in concrete and all concrete mix designs shall be approved by the Kansas City Metropolitan Materials Board prior to use. Such materials include coarse and fine aggregates, cementitious materials, admixtures and water. Material certifications for all materials and compression test reports for concrete test cylinders shall be performed by a qualified testing laboratory and submitted by the concrete supplier with all mix designs. Mix designs shall be submitted for each combination of materials and differing proportions of mixes and water/cement ratios. Admixtures for water reduction, set acceleration or set retardation may be shown as optional provided the mix design shows the allowable application rates or dosages for each optional admixture. Mix designs should include strength, proportions of all materials, gradations of all aggregates, unit weight at the design air content, slump and allowable slump range.
13. The water/ cement ratio and air content specified herein will be verified. Maximum limits shown shall include free water in aggregates but exclude water of absorption of the aggregates.
14. The percent air to be used for the design of air-entrained concrete shall be at the middle of the range of the class of concrete as designated in these specifications. Occasional deviations below the specified cement content will be permitted if it is due to the air content of the concrete exceeding the designated air content, but only up to the plus two percent tolerance in the air content. Continuous operation below the specified cement content for any reason will not be permitted.
15. Mortar for laying stone for grouted stone riprap, grouted stone wash checks or grouted stone ditch lining shall be composed of one part Portland cement and three parts of fine aggregate by volume with sufficient water added to make a workable and plastic mix of such consistency as to perform properly the functions required for the work being done. Mortar for laying brick or concrete blocks shall be composed of ½ part of masonry cement, ½ part of Portland cement, and three parts of fine aggregate, either commercially produced masonry sand or FA-M (from the Standard Specifications). The sand used will be visually inspected for acceptance. The components shall be measured by volume with sufficient water added to make a workable mix of such consistency that will perform properly the functions required for the work being done. Air-entraining agents shall not be used in mixing mortar for masonry work. Any recognized brand of Portland cement and masonry cement that is free of lumps may be accepted upon visual inspection.
16. As the work progresses, the Engineer reserves the right to require the Contractor to change the proportions from time to time if conditions warrant such changes to produce a satisfactory mix. Any such changes may be made within the limits of the Specifications at no additional compensation to the Contractor.
17. Measurement for Proportioning Materials:

    - The cement shall be measured as packed by the manufacturer. A sack of cement is considered as one cubic foot weighing 94 pounds net. Bulk

cement shall be measured by weight. In either case, the measurement shall be accurate to within 0.5 percent throughout the range of use.

- Fly Ash and slag proportioning and batching equipment shall be subject to the same controls as required for cement. Fly ash and slag may be weighed cumulatively with the cement or separately. If weighed cumulatively, the cement shall be weighed first.

- The mixing water shall be measured by weight or by volume. In either case the measurement shall be accurate to within one percent throughout the range of use.

- The aggregates shall be measured by weight. The measurement shall be accurate to within 0.5 percent throughout the range of use.

- Liquid admixtures shall be measured by weight or volume. When liquid admixtures are used in small quantities in proportion to the cement as in the case of air-entraining agents, readily adjustable mechanical dispensing equipment capable of being set to deliver the required amount and to cut off the flow automatically when this amount has been discharged shall be used. The measurement shall be accurate to within three percent of the quantity required.

18. Assembly and Handling of Materials:

- Prior to batching of concrete, aggregate from each source shall be sampled and tested by an independent testing lab to determine compliance with these specifications. Batching will not be permitted until the Engineer has determined that the aggregates will meet specifications. Acceptance sampling shall be at the batching site.

  After initial testing is complete and the Engineer has determined that the aggregate is satisfactory, the aggregates may be used concurrently with sampling and testing as long as tests indicate compliance with specifications. During batching operations, aggregates may be accepted at the batch plant by testing aggregate samples taken from the stream as the storage bins or weigh hoppers are loaded. If test results indicate that an aggregate does not comply with specifications, concrete production using that aggregate shall cease. Additional aggregate from that source and specified gradation will not be used until subsequent sampling and testing of that aggregate indicate compliance with specifications, unless a tested and accepted stockpile for that aggregate is available at the batch plant. Segregated material shall not be used until they have been thoroughly remixed and the resultant pile is of uniform and acceptable gradation at any point from which a representative sample is taken.

- Cement and Fly Ash in storage or stockpiled on the site shall be protected from any damage by climatic conditions which would change the characteristics or usability of the material.

- The moisture content of the aggregates shall conform to the Standard Specifications insofar as measurement and consistency are concerned.

19. Mixing and Delivery:

- All concrete delivery tickets shall include the plant name, design w/c ratio, batch weights per cubic yard, total batched weight of all materials for quantity delivered, time batched, design slump, water withheld (2 gal/yd. maximum), allowable slump range, moisture correction for aggregates, and dosages of all approved admixtures. Tickets must be clear, concise and accurate as to the quantities of each material added. If the ticket shows an entry for water in a field other than those specified and the material appears questionable, it may be rejected. Ready-mix trucks shall reset the drum revolution counter to zero before batching. Precast concrete manufactures shall keep concrete delivery tickets on file for one year. Certifications for the precast concrete shall be provided when the product is delivered to the job site.

- Concrete shall be mixed in quantities required for immediate use. Concrete shall not be used which has developed initial set. Concrete must be in place 1½ hours after the water has been added when the ambient air temperature at the time of batching is 74° F. (23° C) or less. When the ambient air temperature at the time of batching is between 75° F (24° C) and 89° F (32° C) concrete must be in place within one hour after the water has been added unless an approved set retarding admixture is used. Use of such a retardant must be approved by the Engineer prior to use. When a set retarding admixture is used, the concrete must be in place within 1½ hours after the water has been added. The use of an approved set retarding admixture shall be at the Contractor's expense. When the ambient air temperature is 90° F (32° C) or above, concrete shall be in place within 45 minutes after introduction of water to the cement.

- In all cases, if the temperature of the concrete at time of placement is 90° F (32° C) or above, the concrete will be rejected.

- Concrete shall be discharged without delay and when discharged shall be of the consistency and workability required for the job. The rate of discharge of the plastic concrete from the mixer drum shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

  Adding water to the concrete shall not be permitted, except when concrete is delivered in truck mixers. Water, not to exceed two gallons per cubic yard of concrete, may be withheld from the load at the batch site, and if needed, added at the construction site to control the slump to meet the specified requirements. The need for addition of water shall be determined as soon as possible after the load has arrived at the construction site. The adjustment shall be made to the entire load as much as possible, to assure the water-cement ratio has not been exceeded. After additional water is added, the drum or blades shall be turned an additional 20 to 30 revolutions at mixing speed. Additional water will not exceed the amount withheld from any load. Adding water shall be under the Engineers supervision and shall be permitted no more than one time per load and only after the initial revolutions at mixing speed have been completed. Calibrated water measuring devices shall be

used for dispensing water. In no case shall the water-cement ratio exceed the design water-cement ratio. Concrete that is not within the specified slump limits at the time of placement shall not be used.

- The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum.

- Plant capacity and delivery capacity shall be sufficient to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall provide for the proper handling, placing, and finishing of the concrete.

- When drum mixed at the site of the work or in a central mixing plant, the mixing time shall not be less than 60 seconds and a maximum of five minutes with the total mixing revolutions not to exceed 60 revolutions. Mixing time begins after all solid materials are in the drum and ends when the discharge chute opens. Transfer time in multiple drum mixers is included in the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

- If necessary to increase the mixing periods in order to control the entrainment of the required amount of air, the required mixing time will be set by the Engineer.

- The mixer shall be operated at a drum speed as shown on the manufacturers name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer; except that an overload up to ten percent above the mixer's nominal capacity for other than truck mixers may be permitted provided concrete test data for strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

  The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period.

- When a truck mixer is used for complete mixing, each batch of concrete shall be mixed for not less than 70 or more than 100 revolutions of the drum or blades at mixing speed. All rotation after mixing shall be at agitating speed. The total revolutions (mixing and agitating) shall not exceed 300 revolutions.

- Unless the mixing unit is equipped with an accurate and dependable device which will indicate and control the number of revolutions at mixing speed, the mixing shall be done at the proportioning plant and the mixing unit shall be operated at agitating speed while traveling from the plant to the job site.

- When a truck mixer or truck agitator is used in transporting concrete that has been completely mixed in a stationary central mixer, agitating during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed. The total revolutions (additional remixing and agitating) shall not exceed 200 revolutions.

- When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within the maximum time allowed in this section after the addition of the cement to the water. Each batch of concrete delivered at the job site will be accompanied by a time of charging of the mixer drum with cement and aggregates, except that on paving projects and other high volume work, the Engineer may determine the haul time and thereafter make random checks, and tickets for every load will not be required.

- Non-agitating equipment shall not be used for transportation of concrete.

20. Form Removal: The removal of forms shall be accomplished in such a manner as will prevent injury to the concrete. Forms shall not be removed before the expiration of the minimum time indicated below, except when specifically authorized by the Engineer. During cold weather the time limits may be increased at the discretion of the Engineer depending upon the amount of protection provided. Permission to remove forms shall not constitute authority to backfill structures. Backfill shall proceed only upon approval of the Engineer and shall be based on concrete attaining 75% of design strength.

    Pavement, Curb and Slabs ----------12 hours*
    Walls and Vertical Faces----------2 days*
    Columns ----------7 days
    Unsupported Beams & Slabs:
    Spans less than 10'----------4 days*
    Spans from 10' to 20'----------7 days
    Spans over 20' ----------10 days
    *Curing of surfaces exposed by form removal is required.

21. Hot Weather Concreting:

    - Place Concrete within the time and temperature conditions shown in TABLE 20-1.

TABLE 20-1 AMBIENT AIR TEMPERATURE AND AGITATED CONCRETE PLACEMENT TIME		
T = Ambient Air Temperature at Time of Batching (°F)	**Specimen Age Time Limit agitated concrete must be placed within, after the addition of cement to water**	**Admixtures**
T < 75	**1 ½ hrs.**	**None**
75≤ T < 90	**1 hrs.**	**None**
75≤ T < 90	**1 ½ hrs.**	**Set Retarder***
90 ≥ T	**45 Min.**	**Set Retarder***

*Set Retarders must be approved through KCMMB and noted on KCMMB approved mix design.

- During hot weather, proper attention shall be given to materials, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that impairs required strength or serviceability of the member or structure.

- The temperature of the concrete, when placed, shall not be high enough to cause excessive loss of slump, flash set, or cold joints. Do not use concrete that has developed its initial set. In no case shall the temperature of the concrete, when placed, exceed 90°. Regardless of the speed of delivery and placement, the Engineer will suspend the concreting operations until corrective measures are taken, if there is evidence that the concrete cannot be adequately consolidated.

- Forms, reinforcing and subgrade surfaces against which the concrete is to be placed, shall be wetted with a fine mist immediately before placement. Refer to Section 408. E. 15. for use of finish water for all concrete work.

- The initial sealing membrane (curing compound) shall be applied within 5 minutes of completing the finishing operation on the portion of the concrete being installed.

22. Concreting in Cold Weather and Night Concreting:

- No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated. Unless authorized by the Engineer, mixing and concreting operations shall be discontinued when the descending ambient air temperature reaches 40° F (4 ° C), and not resumed until an ascending ambient air temperature reaches 35° F (2 ° C) with a forecasted high temperature of at least 40° F (4 ° C). Concrete shall be protected from freezing by covering and insulating the concrete or by heating an enclosed area surrounding the concrete whenever the temperature is expected to drop below **35° F** (0° C). The concrete shall be protected immediately after

placement, and for 3 days after placing the concrete. The cold weather curing and protection will be such that a temperature of at least 40 degrees will be maintained along the surface of the concrete for a minimum of 3 days. Refer to Section 408. E. 15. for use of finish water for all concrete work.

- When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. Aggregates may be used which are heated in bins, by steam-coil or water-coil heating, or by other methods not detrimental to the aggregates. The use of live steam on or through binned aggregates will not be permitted. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50° F (10° C) and not more than 90° F (32° C) at the time of placing it in forms. Under no circumstances shall concreting operations continue when the ambient temperature is less than 20° F (-7° C).

- If the ambient air temperature is 35° F (2° C) or less at the time of placing concrete, the Engineer may require the water and/or the aggregates to be heated to not less than 70° F. (21° C) nor more than 150° F (66° C). No concrete shall be placed on frozen subgrade nor shall frozen aggregates be used in the concrete.

23. High early strength concrete shall be proportioned in the same manner as specified for Portland cement concrete in the preceding articles for various classes of concrete except Type III cement shall be required.
Concrete Admixtures may be required in all classes of concrete construction when the placing and finishing properties of the concrete are adversely affected by unfavorable weather or other conditions. The use of the admixtures will be with the approval of the Engineer. Any admixtures proposed for use must be approved at the time of review and approval of the mix design. Continued use will be based upon performance. It is the Contractor's responsibility to ensure that the admixture will work as intended without detrimental effects. The amount of the admixture to be used in the mix shall be determined at the time of review and approval of the mix design. Variations from the amount shown in the mix design must be approved by the Engineer. The Contractor shall be responsible for all labor and equipment necessary for the proper mixing, measuring and dispensing of the admixture. No additional compensation will be allowed for furnishing and incorporating the admixture in the mix. Admixtures shall be added at the plant, and not at the site, unless approved by the Engineer for the specific project.

23. Cracks in concrete that have vertical or horizontal displacement in the crack, as determined by the Engineer, shall be removed and replaced at the Contractor's expense. The Engineer reserves the right to have the defective concrete removed and replaced prior to the project final or to wait through the warranty period for possible removal and replacement if it is deemed necessary, by the Engineer, prior to the end of the warranty period. Chips or broken edges in concrete that do not affect the structural integrity of the concrete or the cosmetic appearance, as determined by the Engineer, may

be repaired with Unitex Pro Proxy ADP or approved equal. This specification shall apply to all types of concrete work.

B. METHOD OF MEASUREMENT: No separate measurement shall be made for “Concrete Construction”.

C. BASIS OF PAYMENT: Concrete shall be subsidiary to other items. No separate payment shall be made for “Concrete Construction”.

S-402 <u>CONCRETE MEDIAN NOSES</u>: This item includes construction of median noses at locations shown on the Plans. Median noses shall conform to the requirements of "Concrete Construction" and "Reinforcing Steel", and the Standard Details.

A. METHOD OF MEASUREMENT: "Concrete Median Noses" shall be measured per each completed and accepted item.

B. BASIS OF PAYMENT: "Concrete Median Noses" shall be paid for per each item measured as stated above.

S-403 CURBS AND GUTTERS: This work shall consist of the construction of curb, gutter or combination curb and gutter in accordance with the Specifications and Standard Details and as shown on the Plans or established by the Engineer.

A. GENERAL: Mechanical finishers shall be capable of molding and satisfactorily compacting concrete mixtures to form a section, true to line, grade and cross section. The machine shall be self-powered and compaction may be obtained by an extrusion process. It shall be equipped with adequate steering devices, guide lines or rails to insure straight, neat lines and be approved by the engineer prior to use. Tolerance from a straight line in the vertical or horizontal direction shall be ¼" maximum, all tolerance's shall apply to the top, face and gutter portion. Tolerance from a curved line in the vertical or horizontal direction shall also be ¼" maximum. When existing curb and gutter is to be removed, sufficient control will be established prior to curb removal to insure proper grade and alignment is maintained.

1. The subgrade for curb and gutter shall be excavated to the grades and sections shown on the Plans. If the section is not indicated, the width to be excavated shall be twelve inches each side of the outside edges of the curb or gutter. The subgrade shall be of uniform density. Rock, shale, or soft and yielding material shall be excavated six inches below subgrade elevation and replaced with suitable backfill material. The backfill material shall be compacted to meet the requirements of Type A Compaction as specified in the section on "Compaction of Earthwork". All subgrade shall be rolled or compacted to provide a smooth surface. A leveling course of AB-3 will be allowed (no other gradation or composition will be allowed), however, the maximum thickness of the leveling course shall be 1". When used the AB-3 must be moist (5-8% moisture range), and compacted.
2. Forms for curb and gutter shall preferably be of steel but with the permission of the Engineer, may be of wood for curb or gutter of unusual section or when small quantities are involved. All forms shall be sufficiently strong and rigid and securely staked and braced to obtain a finished product correct to the dimensions, line and grade required. Forms that are warped, uneven, broken or bent, have holes, or excessive build-up of concrete shall be rejected. Forms shall be cleaned and oiled before each use. Slip form equipment may be approved by the Engineer and used on a satisfactory performance basis. Forms may be removed after 24 hours, and the curb may be backfilled after 3 days. Cure shall be placed on all exposed surfaces when forms are removed prior to the expiration of the curing time frame. In no case shall the street pavement be placed prior to backfilling the curb.
3. Concrete for curb and gutter shall be placed upon the previously prepared and moistened subgrade. The concrete shall be consolidated with an approved internal type vibrator or by hand spudding and tamping. Honeycombed areas will be considered defective work and will be grounds for removal and replacement of the curb and gutter, unless the Engineer allows grouting of the voids. The surface shall be shaped by use of a steel tool shaped to produce the cross section shown on the Plans. The edges shall be rounded with edgers to form the radii indicated. Unless the plans specifically require a steel trowel or rubbed finish, the surfaces of curbs and gutters shall be finished with a medium broom finish. Drilled holes for type 2 joints must be blown out and cleaned prior to placing bars and epoxy. See the City's standard detail for joints and median noses. Finish water will not be allowed under normal circumstances, but when authorized by the Engineer, shall be applied in the form of a fine fog mist in very small quantities to assist in the finish operation. Excessive use of finish water will be reason for rejection of the concrete work. Any tie or dowel bars are to be placed level and parallel to the ground. Bars are not to be laid in at an angle or in a diagonal direction.

4. Curb and gutter shall be cured immediately after the concrete is finished and hardened sufficiently to prevent detrimental marring, as set out in the Standard Specifications. Curing compound shall be applied to all surfaces exposed at the time of placement, and regardless of the ambient air temperature at the time of placement. Cure is to be applied in a uniform manner without bare or uneven areas. If the sprayer cannot perform the coverage in an even spray pattern, this will cause for the rejection of the spraying device or nozzle. The rejected device shall be replaced immediately before more concrete can be placed. Joints shall be sawed or trowelled to D/4 into the curb as soon as the concrete has hardened sufficiently to allow sawing or trowelling. Joints must be placed prior to the appearance of shrinkage cracks in the concrete. Any trowelled joint not meeting the D/4 requirement shall be saw cut.
5. When existing curb is to be removed, the removal shall be accomplished in accordance with the Standard Detail for the Type of Removal specified in the plans. Repair of the asphalt shall be subsidiary to "Curb and Gutter". The curb shall be removed to the nearest joint, and the joint shall be cut to full depth (with a concrete saw meeting the requirements of the Standard Specifications) prior to removal. When “Complete Removal” is specified, the joint will still need to be saw cut, but no saw cut will be required in the pavement. No more than 1,000 feet of existing curb may be removed prior to pouring the replacement curb, unless approved by the Engineer.

B. METHOD OF MEASUREMENT: “Curb and Gutter” shall be measured by the linear foot of completed and accepted work, of the type indicated on the Plans. Curb transitions for inlets are not paid as curb and gutter, it is subsidiary to the storm structure. When the Plans indicate removal of existing curb and gutter, the removal shall be subsidiary to the new curb and gutter.

C. BASIS OF PAYMENT: “Curb and Gutter” shall be paid for at the contract unit price, measured as stated above. Removal of existing curb and gutter (if applicable) shall be subsidiary to “Curb and Gutter”.

S-404 HANDICAPPED RAMPS: This work shall be constructed in accordance with the Standard Details, the requirements of Sections 400, 700, and 800 of the Standard Specifications and as hereafter presented, and shall include all items necessary to furnish a completed product.

A. Vibration will be required for all “Handicapped Ramp” construction.

B. Ramps that do not have truncated domes shall be paid as a sidewalk quantity.

C. METHOD OF MEASUREMENT: “Handicapped Ramps” shall be measured per each completed and accepted item.

D. BASIS OF PAYMENT: “Handicapped Ramps” shall be paid for at the contract price bid per each, measured as provided above, which prices shall be full compensation for all material, excavation, forming, and for all labor, tools, equipment, and incidentals necessary to complete the work.

S-405 INTEGRAL SIDEWALK RETAINING WALL WITH FORMLINER: This work shall consist of constructing sidewalk retaining walls of reinforced concrete at locations shown on the Plans and in accordance with the Standard Details. Concrete and reinforcing steel shall meet the requirements herein under “Concrete Construction” and “Reinforcing Steel”.

A. All form ties used for construction of retaining walls shall be of an approved type so as to have a minimum break back of 1/2". All tie holes shall be grouted and all form marks shall be removed with a diamond bit grinder or approved equal. The finish wall surface shall be fully rubbed with cement grout to provide a smooth, uniform appearance. Slump shall not exceed 4 inches. Grade shall be compacted and true to line and grade prior to placing concrete. Concrete for walls and sidewalk shall be consolidated using a hand spud vibrator. If the wall requires a stain, the contractor shall provide the manufacturers recommendations and the stain shall be applied in accordance with these specifications. Manufacturer’s recommendations shall be submitted and approved prior to their use.

B. Form liner shall be 1515 SC Ashlar or approved equal. Penetrating stain shall be Sherwin Williams concrete stain solid color water based or approved equal tinted to match; Orange- Federal Standard 30257, Basic Limestone - Federal Standard 33510 (Base Color), Dark Gray 2 - Sherwin Williams 6151 Quiver Tan, Dark Gray - Federal Standard 30318, Yellow - Federal Standard 33448, Gray Joint Color - Federal Standard 36440.

C. METHOD OF MEASUREMENT: “Integral Sidewalk Retaining Wall With Formliner” shall be measured per square foot of wall face and per square foot of sidewalk of completed and accepted work.

D. BASIS FOR PAYMENT: Payment for retaining walls shall be made at the contract unit price bid per square foot for “Integral Sidewalk Retaining Wall With Formliner”, measured as stated above.

S-406 PORTLAND CEMENT CONCRETE OVERLAY: This work shall consist of constructing a Portland Cement Concrete Overlay (hereinafter called "Overlay") on an asphalt base course in accordance with these Specifications, Plans or as established by the Engineer. The limits of the placement of the Overlay shall be marked in the field by the Engineer. The nominal thickness of the pavement shall be three (3) inches, unless otherwise directed by the Engineer.

A. GENERAL: The requirements of the sections of this specification titled "Concrete Construction" and "Portland Cement Concrete Pavement" shall apply to the work involved with the Overlay except as modified hereafter. Portland Cement shall be Type I or Type II Cement. The Contractor shall provide a concrete mix design which will achieve 3000 psi compressive strength in 24 hours at 72° F. (22º C). A maturity curve shall be established for the design used. Significant deviations from the mix design will require the preparation of a new maturity curve. Minor adjustments to compensate for environmental changes at the job site will be permitted. Air Entrainment will be required. An accelerating admixture may be required at the Engineer's discretion. Coarse aggregate for this work shall meet the requirements of ASTM C33 and of the section of this specification titled Concrete Construction. The water/cement ratio for the mix shall not exceed 0.40. A plasticizer may be used to increase workability and to facilitate placement. An evaporation retardant, such as Confilm, may be permitted or required, at the sole discretion of the Engineer. Fibrous Concrete Reinforcement shall be incorporated into the mix at the rate of three (3) pounds per cubic yard.
B. The Engineer will verify the uniform depth and cross slope of the milled surface before any concrete is placed.
C. The Contractor shall clean the milled surface of all loose material, dirt, mud and foreign objects. Power brooms will not be acceptable for cleanup work without adequate dust control procedures. Prior to placing the Overlay, the Contractor shall clean the surface with an air blast. The Engineer shall visually inspect the pavement prior to placing the Overlay to determine if there are any base problems. The visual inspection shall be conducted by driving a tandem axle dump-truck of at least 50,000 lbs. gross weight over the milled surface.
D. Contact surfaces of the Overlay with curb and gutters, inlets, and other similar structures shall be sprayed or painted with a suitable bond breaker satisfactory to the Engineer.
E. If weak areas or failures begin to develop in the milled surface during the Overlay operation, the Contractor shall cone off or barricade the affected areas and route the trucks used to deliver the concrete around the affected areas. If the weak areas or failures persist, or if the previous weak areas or failures enlarge, the Contractor shall reduce or lighten the loads delivered by the trucks. Pavement patching of unsound areas, if any are found, will be accomplished by others as provided elsewhere in these Specifications prior to placing the Overlay.
F. Contraction joints shall be sawed longitudinally along pavement centerline and generally at quarter points of each lane, with transverse sawed joints equally spaced to create a pattern in the Overlay of square panels with uniform dimensions of approximately three (3) to three and a half (3.5) feet. All sawed joints shall be cleaned as provided in Section 400 and/or Section 700 of the Standard Specifications. A "typical" joint pattern for the Overlay is shown in the plans. However, the pattern will be adjusted in the field as directed by the Engineer.

G. METHOD OF MEASUREMENT: "Portland Cement Concrete Overlay" shall be measured per the square yard of completed and accepted work.

H. BASIS OF PAYMENT: “Portland Cement Concrete Overlay” shall be paid for at the contract unit price per square yard, measured as stated above.

S-407 PORTLAND CEMENT CONCRETE PAVEMENT: This work shall consist of constructing a concrete pavement with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these Specifications, Plans or as established by the Engineer.

A. Both the subgrade and the granular or treated subbase shall be brought to the lines, grades, and typical sections shown on the Plans or designated by the Engineer.
B. Before placing any surfacing material on any section, the ditches and drains along that section shall be completed to drain the roadway effectively. In handling materials, tools, equipment, etc., the Contractor shall protect the subgrade from damage. If ruts are formed, the subgrade shall be reshaped and rerolled. At all times the subgrade shall be kept in such condition that it will drain readily. Until the subgrade has been checked and approved, no material shall be deposited thereon.
C. Storing or stockpiling of materials on the subgrade will not be allowed. The placing of materials or laying of pavement will not be permitted upon a frozen or muddy subgrade.
    1. Fine Grading for Subgrade or Granular or Treated Subbase: A subgrade or subbase must be trimmed or fine graded prior to being overlaid with concrete pavement. For slip form paving, unless otherwise authorized by the Engineer, the subgrade or subbase shall be trimmed to grade by the use of an automated, electronically controlled machine. The control of grade and cross slope shall be accomplished by use of sensors actuated by a taut reference line. This line shall be true to line and grade, so as to assure vertical control during the subgrade or subbase trimming and subsequent paving operations. The reference line shall be erected and maintained by the Contractor.
    2. All high areas in the grade shall be trimmed to the proper elevation. Low areas shall be filled and compacted with suitable subbase material. The Contractor shall maintain the finished grade in a smooth and compacted condition until the concrete pavement is placed. All trimming equipment must operate far enough in advance of the paving operation that ample opportunity is given to check the grade and make corrections if need be.
D. Concrete Consistency: The consistency of the concrete when delivered to the paving train shall be between 1" and 2-1/2" slump.
E. Slip Form Paving: When paving is performed with a slip form paving unit, the equipment shall consist of a concrete spreader or placing machine followed by a separate paving unit. The concrete spreader or placing machine requirement may be waived with the approval of the Engineer only when it is demonstrated that a quality product and riding surface can be attained without the use of an independent spreader. Traffic will not be allowed on the completed subbase without the approval of the Engineer.
    1. No tractive forces shall be applied to the slip form paver except that which is controlled from the machine. The subgrade or surface of the subbase over which the tracks of the paver will travel should be trimmed to grade. The surface shall not be disturbed by other equipment. The paver shall be operated in a continuous operation. Frequent starting and stopping of the paver shall not be allowed. If it is necessary to stop the forward movement of the paver, the vibrator and tamping elements shall be stopped immediately.
    2. The number of paving units and work capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery to the placing units.
    3. Concrete shall not be placed when stormy or inclement weather prevents good workmanship. The subgrade or subbase shall be sprinkled lightly with water so that it will be in a thoroughly moistened condition when the concrete is deposited thereon. Care must be taken to avoid puddling water on the grade, creating a muddy grade.

4. Once the paving operation has started, the amount of equipment and supply of materials shall be sufficient to insure that placing will be continuous for any given working period. All concrete conveying equipment shall be kept clean.
5. The concrete shall be deposited on the grade in successive batches in a manner which will require as little rehandling as possible. Concrete shall be placed over and against any joint assemblies in such a manner that the joint assembly is retained in its correct position.
6. Spreading shall be done by approved mechanical spreaders in a manner that will prevent segregation and separation of the materials.
7. Necessary hand spreading shall be done with shovels, not rakes. Workmen shall not be allowed to walk in the fresh concrete with boots or shoes coated with earth or foreign substances.
8. After the concrete is struck off by the spreader there shall be sufficient concrete in place to allow the final shaping by the use of screeds, templates and pan, depending on make, model and type of machines approved for use in the paving train. The paving units shall be adjusted for the required final cross section in such a manner that the need to carry back concrete by hand to fill voids or depressions is minimized. Screeds shall carry a uniform roll of concrete, with each screed or template being so adjusted that the uniform roll of concrete extends the full length of the screed or template and allows just enough concrete to pass under the unit to properly feed the next machine. Screeds or templates should not shove large volumes of concrete. Adjusting a screed or template to maintain a uniform cross section is required.
9. Should any concrete materials fall on or be worked into the surface of the plastic concrete it shall be removed immediately by approved methods.
10. Placement of concrete ahead of the initial spreader strike off shall not be more than 30 minutes ahead of the final spreader strike off. If concrete is placed in one lift, the placement of concrete shall not be more than 30 minutes ahead of the spreader strike off.
11. Screeds and pans shall be of the adjustable type capable of being adjusted in suitable increments to conform to the transition from plane surface to fully crowned surfaces while the machine is in motion.
12. When construction of more than two lanes wide is to be paved by slip form methods, and a cold construction joint is required due to the Contractor's method of operation the slip form paver will include a device to shape, punch and place a sheet metal open trapezoid as a female key way joint. Bent tie bars or two piece tie bars shall be inserted into the hole provided.
13. The paver shall be equipped with traveling side forms of sufficient dimensions, shape and strength to support the concrete laterally for sufficient time to produce pavement of the required cross section. Any edge slump of the pavement exclusive of edge rounding, in excess of 0.02 foot shall be corrected before the concrete has hardened. Excessive edge slumping will be sufficient reason to discontinue paving until machinery is properly adjusted or removed from the project.
14. A longitudinal finisher designed to eliminate small surface irregularities shall be utilized in the final finishing operation unless otherwise authorized by the Engineer.
15. Under normal working conditions moisture shall not be applied to the surface of the concrete pavement. The use of additional water on the surface of the fresh concrete to lubricate the float of the longitudinal finisher will be allowed only with the express permission of the Engineer. If unusual weather conditions require the addition of superficial water to the surface of the concrete, it shall be applied only in the form of a fine fog mist, in small quantities. Excessive use of finish water will be reason for rejection of the concrete work.

F. Placing Reinforcement: Except for irregular areas, pavement reinforcement shall be placed as shown on the Plans. All dowel bars and tie bars required by the Plans shall be held in proper position by sufficient approved metal bar supports or pins. Longitudinal joint tie bars and dowel bars may be installed mechanically by means of equipment and methods approved by the Engineer. The satisfactory placement of the bars shall depend upon the ability of the Contractor's equipment to place the bars in their true position. The Engineer may require, when satisfactory placement is not obtained by mechanical means, that the tie bars and dowel bars be installed ahead of placing the concrete and that they be securely staked and tied if necessary to hold them in their exact position. All horizontal reinforcement shall be supported on plastic or metal supports or spacers as indicated on the plan sheets; for Supports and Spacers for Reinforcing Steel. The use of small stones, concrete or wood blocks for supporting reinforcement will not be permitted. The use of removable devices, supporting the bars from the forms will not be permitted.

1. Following the placing of concrete, it shall be struck off to conform to the cross section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the Plans. When reinforced concrete is placed the reinforcement may be positioned in advance of the concrete placement or it may be placed in the plastic concrete, after spreading, by mechanical or vibratory means.
2. Where two layers of wire mesh reinforcement are required, as at bridge approaches, the bottom layer shall be supported in the required position with bar chairs; separators shall be used for the top layer if the strike-off cannot be properly used for the operation. Laps in adjacent sheets or mats of reinforcement shall be as shown on the Plans. Laps parallel to the centerline of the pavement will not be permitted except for unusual widths of pavement lanes or for irregular areas. If the Plans do not show dimensions for laps, the minimum lap either perpendicular or parallel to the centerline of the pavement shall be six inches. The adjacent sheets shall be fastened or tied together to hold all parts of the sheets in the same plane. The wire mesh reinforcement shall be placed in the pavement at the elevation as shown on the Plans.
3. The appearance of a "wire pattern" on the surface of the fresh pavement will be cause to remedy this particular situation and immediately modify placement procedures.
4. Reinforcing steel shall be free from detrimental amounts of dirt, oil, paint, grease, loose mill scale, and loose or thick rust which could impair bond of the steel with the concrete.

G. Consolidation and Finishing: Consolidation of the concrete shall be attained by the use of approved vibrators or other approved equipment. The concrete shall be sufficiently and uniformly vibrated across the full width and depth of the pavement so that the density of pavement concrete shall be not less than 98 percent of the rodded unit weight. The 98 percent density requirement may be eliminated on such miscellaneous areas as entrance pavement, median pavement, gore areas, etc. Consolidation of these areas shall be attained by the use of approved vibrators.

1. Vibrators, either of the surface type (pan or screed) or the immersion type (tube or spud) may be attached to the spreader, paver, or the finishing machine, or may be mounted on a separate carriage. The vibrators shall be operated only when the machine to which they are attached is moving forward. In no case shall hand vibrators be operated longer than 15 seconds or less than five seconds in any one location unless approved otherwise by the Engineer. Vibrators shall be placed in and withdrawn vertically from concrete in a slow deliberate manner.

2. Care shall be taken to see that a uniform, continuous roll of concrete over the vibrators ahead of the strike-off is being maintained. The height of the roll should be approximately the same thickness as the pavement being vibrated.
3. In order to insure concrete consolidation in the vicinity of joint assemblies, the Engineer may require that these areas be hand vibrated with an immersion spud vibrator.
4. In the event the specified density is not attained, paving operations shall cease and necessary adjustment be made to produce concrete to conform to the density requirements.
5. The Engineer shall use an approved nuclear density measuring device to monitor in place density. A moveable bridge shall be furnished and moved to test locations by the Contractor, as required, to allow the inspector to work over the fresh concrete.
6. On projects or areas within projects where the use of conventional equipment is impractical, other consolidating and finishing equipment, approved by the Engineer may be used in lieu of the equipment designated above.

H. Fixed Form Paving: At the option of the Contractor the fixed form paving method may be used.

I. Forms: Straight forms shall be of metal having adequate thickness to support the equipment and shall be furnished in sections not less than ten feet in length. Forms shall have a depth equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width at least equal to the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 150 foot radius or less except, approved straight forms of five feet lengths may be used for curves of a radius from 75 feet to 150 feet. Flexible or curved forms shall be of a designed acceptable to the Engineer. The Engineer may approve the use of wood forms in areas requiring hand finishing. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 of the height of the form. Forms with battered top surface, and bent, twisted or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Buildup forms shall not be used except where the total area of pavement of any specified thickness on the project is less than 2,000 square yards. The top face of the form shall not vary from a true plane more than 1/8 inch in ten feet, and the upstanding leg shall not vary more than 1/4 inch. The forms shall contain provisions for locking the ends of abutting form sections together tightly, and for secure setting.
1. Base Support: The foundation under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade.
2. Form Setting: Forms shall be set sufficiently in advance of the point where concrete is being placed so that line and elevation can be checked. After the forms have been correctly set, the grade shall be thoroughly tamped, mechanically, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than three pins for each ten foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch at any point. No excessive settlement or springing of forms under the finishing machine will be permitted. Forms shall be cleaned and oiled prior to the placing of concrete.
3. Grade and alignment: The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked. The requirements for placing concrete,

reinforcement, consolidation and finishing, and other incidental items concerning concrete paving shall be as outlined and specified for slip form paving.

4. Removing Forms: Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least twelve hours, except auxiliary forms used temporarily in widened areas. Forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as specified for the surface. Major honeycombed areas will be considered as defective work and shall be removed and replaced. Any area or section so removed shall not be less than six feet in length or less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than ten feet in length, shall also be removed and replaced.
5. Texturing: As soon as all excess moisture has disappeared and while the concrete is still plastic enough to make a granular surface possible, a drag shall be used which shall consist of a seamless strip of damp burlap, artificial turf or cotton fabric, which shall produce a uniform surface of gritty texture after dragging it longitudinally along the full width of pavement. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted. Following the dragging operation, unless designated otherwise on the Plans, a final finish or texture shall be made by giving the surface of the plastic pavement a transverse rough broomed finished.
6. Prior to texturing, the exposed edge of the pavement shall be finished with an edger to a radius of 1/4 inch. The interior longitudinal joints on multiple-lane pavement shall be edged to a radius of 1/8 inch. Any tool marks appearing on the slab adjacent to the joints or edge of slab shall be eliminated. The rounding of the corner of the slab is to be disturbed as little as possible.

J. Joints shall be constructed in accordance with the details shown on the Plans and these Specifications and with the best of workmanship. Failure to construct the joints called for in the best possible manner will be cause for suspension of work until the cause of the defective work is remedied.

1. If existing pavement of any type is required to abut with the new pavement, and the termination of the removal is not at an existing joint, the new joint shall be made by sawing the existing pavement not less than two inches deep before removal.
2. All contraction joints shall be sawed before uncontrolled cracking occurs. When extreme conditions could exist which make it impracticable to prevent erratic cracking by sawing the joints early, methods should be devised at the onset of the project by the Contractor with the cooperation of the Engineer to control this cracking. The principal objective is to create or form a plane of weakness in the fresh concrete no wider than the initial saw cut and to a depth of D/3 + 1/4". The "wet cut" should be straight and well defined in order that it may be "sawed out" by the saw crew.
3. Any transverse joint requiring hand finishing and edging shall be edged with a tool having a radius of 1/8 inch unless otherwise directed by the Engineer. The horizontal surface of the edger should not indent the surface of the pavement.
4. Concrete shall be placed so that it will not displace or disarrange the joint assembly. The location of contraction joints shall be marked in such a manner as to assure the joints are sawed in the proper location.

   A butt construction joint shall be made perpendicular to the center line of the pavement at the close of each day's work and also when the process of depositing concrete is stopped for a length of time such that the concrete will have taken its initial set. This joint shall be formed by using a clean header having a nominal

thickness of two inches, a depth of not less than the thickness of the pavement and length of not less than the width of the pavement lane unless approved otherwise by the Engineer. The header shall be cut true to the crown of the finished pavement and shall be accurately set and held in place in a plane at right angles to centerline and perpendicular to the surface of the pavement.

5. The top surface of the header shall be protected with steel. On the face of the header along the center of the header there shall be securely held in place a trapezoidal piece of metal or wood the full length of the header approximately two inches wide and at least one inch depth to form a grooved or keyed type joint. This joint shall be tied keyed construction.
6. Unless shown otherwise on the Plans, no construction joint shall be placed within ten feet from an expansion, contraction, or other construction joint.
7. Special Joints shall be constructed as shown on the Plans or as ordered by the Engineer around drainage, utility and other structures located within the concrete pavement boundaries. Temporary forms used in constructing the joints shall be held securely in place during the concrete placement operation.
8. All joints shall be wet sawed and constructed as shown on the Plans.
9. Widening of the relief (“wet cut”) joints to full width shall not be performed until the concrete is at least 48 hours old and shall be delayed longer when the sawing causes raveling of the concrete. If sawing is performed prior to completion of the curing period, the Contractor shall maintain the cure by use of curing tapes, plastic devices, or other materials approved by the Engineer. Membrane curing damaged during the sawing operation shall be repaired by the Contractor as directed by the Engineer.
10. The joint groove shall be centered over the relief (“wet cut”) cut and sawed to the specified dimensions shown on the Plans.
11. Should any spalling of the sawed edges occur which would detrimentally affect the joint seal; it shall be patched with an approved epoxy patching compound and allowed to harden prior to installation of the joint material. Each patch shall be true to the intended neat lines of the finished cut joint.
12. Cleaning Freshly Cut Sawed Joints. Immediately after sawing the joint, the resulting slurry shall be completely removed from the joint and the immediate area by flushing with a jet of water under pressure, and by the use of other tools as necessary.
13. Just prior to sealant being applied, a final cleaning of the joint shall be made by sandblasting the joint, followed by an air blast to clean incompressible from the joint.
14. Sealing Joints. The location, size, and configuration for joint sealant shall be shown on the Plans. Joint Sealant shall be Hot Type Joint Sealant. Joints shall be sealed prior to opening to traffic.
15. Filling the Joint. Joints shall not be sealed until they are thoroughly clean and dry and the pavement is at least seven days old unless otherwise stipulated in the manufacturers publications and approved by the Engineer. Sealant shall not be applied to wet or damp concrete or installed during inclement weather. The sealer shall be placed in reasonably close conformity with dimensions shown on the Plans. Any unreasonable deviation will be cause for rejection of the joint until satisfactory corrective measures are taken. Joint sealant application will not be permitted when the ambient air temperature is less than 40° F. (4.4° C.) or as specified in the manufacturer's publications.
16. The joint sealer shall be applied by an approved mechanical device from inside the joint in such a manner as to cause it to wet the joint surfaces. Any failure of the joint material in either adhesion or cohesion will be cause for rejection, and the joint shall be repaired to the Engineer's satisfaction at the Contractor's expense.

17. After a joint has been sealed, all surplus joint sealer on the pavement or structure surfaces shall be promptly removed.
18. Traffic shall not be permitted over sealed joints until the sealer is tack free, or until debris from traffic does not imbed into the sealant.

K. Header Boards: Immediately after the forms are removed, exposed ends of new concrete pavement shall be protected, by use of a wooden header board, from both temporary construction traffic and permanent future traffic. Temporary header boards may be removed when the Contractor abuts the joint with a permanent type surfacing. If the joint is not abutted with a permanent type surfacing, the header board shall remain in place until future construction renders it unnecessary.
1. A header board having dimensions of not less than three inches (nominal) by eight inches (nominal) shall be bolted securely to the end of the pavement in a manner to protect the edge of the pavement from damage. The header board shall extend the full roadway width, but may be in two sections. At the time of placing the concrete, six 1/2 inch by eight inch bolts (three for each lane) shall be embedded in the end of the pavement in a manner that will hold the header board securely. The header board shall be shaped to conform to the crown of the pavement and shall be installed flush with the concrete pavement surface. The finishing and installing of the header board shall be considered subsidiary work pertaining to the other items of the Contract and will not be paid for directly.

L. Hand Finishing: Unless otherwise specified hand finishing methods should be held to the minimum. Generally, hand methods of placement and finishing will be permitted as follows:

- For pavement when a breakdown of some portion of the paving train occurs, necessitating the hand finishing of that portion of the concrete already in place.
- For pavement lanes that may be too narrow or a length too short to accommodate a full paving spread.
- For all irregular shaped area.
- For special approach sections to bridges, widened portions at bridges, intersection, and sections widened beyond traffic lanes.
- When the dimensions of the work make the use of a complete power operated paving train impossible or impracticable.
- Handwork comprised of paving uniform width areas or transition width areas using false forms shall be finished, whenever possible, with a mechanical finishing machine and/or approved vibrating screed.
- Approved spud hand vibrators shall be used on any area considered impractical to vibrate with a vibrating screed. Approved metal or wood floats may be used if needed to help close an open or porous surface condition.
- The operation of consolidation and screeding or striking off the concrete shall continue until the concrete is uniformly consolidated and the surface is true to line, grade and cross section.
- After the concrete has been properly struck off, the surface of the pavement shall be straight-edged for trueness and finished. A drag shall be used to remove surface straightedge marks. The drag may be pulled by hand, and the results should be similar to that on the mainline pavement.

M. Protection and Curing of Concrete: The pavement shall be cured by the following method: Liquid membrane-forming compounds. Failure to provide proper curing will be considered as sufficient cause for immediate suspension of the concreting operations.
1. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the slab shall be completely coated and sealed with a uniform layer of white membrane curing compound. The compound shall be

applied in one application at a rate of not less than one gallon per 150 sq. feet of surface. The curing compound shall be thoroughly mixed at all times during usage. Thinning the white membrane compound will not be permitted.

2. If the newly coated film is damaged in any way, the Contractor will be required to apply a new coat of material to the affected areas equal in curing value to that specified for the original coat. The treated surface shall be protected by the Contractor from injury for a period of at least four days.
3. Immediately after the forms are removed, (fixed form and slip form) the entire area of the sides of the slab shall be coated with curing compound at the rate specified for the pavement surface regardless of whether or not further concrete placement will be made against the pavement edge. Approved hand-spray equipment will be permitted only for the application for the curing compound on the sides of the slab and for repairing damaged areas and for hand finished areas.
4. No motorized traffic shall be allowed on the pavement until ten days after addition of the curing media.
5. Cold Weather Limitation and Curing: Unless otherwise authorized in writing by the Engineer, concrete placement operations may be started when the ambient air temperature is 35° F (2° C.) and rising, and when the surface temperature of the area to be paved is 35° F. (2° C.) and above. Paving shall be discontinued when the ambient air temperature falls below 35° F.(2° C.) Concrete pavement will not be placed when it is raining or snowing; neither will it be placed on wet, muddy or frozen grade.
    - When the ambient air temperature is expected to drop below 35° F. (2° .) anytime during the curing period precautions shall be taken. A sufficient supply of approved moisture barrier material (in addition to Liquid Curing Compound), and suitable blanketing material, such as straw, hay, and burlap, shall be close by and available as required to cover the pavement with a moisture barrier material and protect with blanketing material all pavement less than four days old. This cold weather curing and protection will be such that a temperature of at least 40° F. (4.5° C.), as measured along the surface of the concrete, will be maintained for at least four days after placing. Concrete damaged by cold weather, as determined by the Engineer, shall be removed, disposed of, and replaced at the Contractor's expense.
    - If authorized in writing by the Engineer to place concrete pavement when the ambient air temperature is below 35° F. (2° C.), the cold weather specifications as outlined in these Specifications shall govern.
6. Early Strength Concrete Curing: The curing period for early strength concrete pavement shall conform to the requirements specified for concrete pavement. Traffic may use this pavement after the four-day curing period. Joints will be completed in accordance with the manufacturer's recommendations for Early Strength Concrete Pavement.

N. Protection of Pavement Against Rain: Prior to beginning a Portland cement concrete pavement project the Contractor shall review with the Engineer his plan to protect the pavement in the event of rain. This plan will include the type and amount of protective materials as well as the methods proposed to protect the pavement. The plan will be submitted in writing to the Engineer for his approval prior to commencing paving operations.
    1. As a minimum, the Contractor's plan will include protective covering and side forms available at the project site at all times to protect the surface and edges of the newly placed concrete pavement should it rain. Polyethylene, burlap or other covering materials may be used. Side forms may be of wood or steel and must have a depth not less than the thickness of the pavement. The location of the

Contractor's storage site shall be specified in order that a review of the protective materials may be conducted by the Engineer in company with the Contractor's Representative.

2. When rain appears imminent, all paving operations shall stop and the Contractor shall initiate his Protection Plan. The covering shall extend back to the point where the rain will not indent the surface. Care should be exercised to prevent unnecessary damage to the surface with the covering.

O. Pavement Smoothness: On pavement surfaces not subject to the profilograph test the surface will be tested using a ten foot straightedge at locations selected by the Engineer. The variation of the surface from the testing edge of the straightedge between any two contact points, longitudinal or transverse, with the surface, shall not exceed 1/8 inch. Irregularities exceeding the specified tolerance by an amount not to exceed 1/2 inch shall be corrected by and at the expense of the Contractor with an approved profiling device or by other means as approved by the Engineer. Irregularities exceeding the specified tolerance by an amount exceeding 1/2 inch shall be corrected by removing the defective work and replacing it with new material or by other means satisfactory to the Engineer. Following correction the areas will be retested to verify compliance with the specified tolerance. All necessary corrections shall be at the expense of the Contractor.

P. Profilograph Test: The smoothness of the pavement will be determined by using a profillograph over the surface finish of the mainline pavement, side roads, auxiliary lanes and ramps when specified in the Special Conditions.

1. Equipment: The Contractor shall provide and operate a California-type profilograph with computerized recorder to determine the profile. Other types of profilographs and recorders that produce compatible results may be used if approved by the Kansas Department of Transportation Bureau of Materials and Research. The Contractor’s operator shall be certified according to Kansas Test Method KT-46.
2. Surface Test: The Contractor shall furnish paving equipment and employ methods that produce a riding surface having an average profile index of 30 inches per mile or less per 0.1 mile section, except as provided for in subsequent paragraphs. Pavement profiles will be taken for each lane in accordance with Kansas Test Method KT-46. Additional profiles may be taken only to define the limits of an out-of-tolerance surface variation. The profilograph shall be taken after final rolling and before the surface is opened to traffic.
3. Smoothness Evaluation: The Contractor shall furnish the profilogram and his evaluation to the Engineer. Results shall be furnished to the Engineer within two working days after any corrections are made. The Contractor shall determine a profile index (in./mi.) for each section of finished pavement surface. A pavement section is defined as a continuous area of finished pavement 0.1 mile in length and one lane (12 ft. nominal) in width. A partial section resulting from an interruption of the continuous pavement surface (i.e. Bridge Approaches, side road tie-ins, etc.) is subject to the same evaluation as a whole section.
4. Corrective Action: Each section of pavement will be evaluated using the profilograph to determine if corrective action is necessary. Each individual profilogram trace will be evaluated (not the average of multiple traces) to determine areas where corrective action is needed. All areas within each section having high or low points (bumps or dips) with deviations in excess of 0.40 inches in a length of 25 feet shall be corrected regardless of the profile index value. Pavement surfaces having an initial profile index greater than 30 in./mi. per individual trace shall be corrected to reduce the profile index to 30 in./mi. or less per section for that trace. Pavement surfaces having an initial profile index for any section in excess of 40 in./mi. shall be corrected regardless of the average profile index for the full length of the pavement.

When profile corrections are required, the Contractor shall use one or more of the following corrective methods:

- Diamond Grinding or use of other profiling devices,
- Removing and replacing the entire pavement thickness,
- Use of other methods that will provide the desired results.

The corrective methods chosen by the Contractor shall be subject to the approval of the Engineer and shall be performed at the Contractor's expense. The Contractor shall retest any section where corrections were made to verify that the corrections have produced a profile index of 30 in./mi. or less per section for each trace, and that the profile index for none of the individual sections exceeds 40 in./mi.

5. Repair of Defective Pavement Slabs: It shall be the responsibility of the Contractor to replace any defective panels. A panel shall be considered defective as follows when any defect in the slab exists that would, in the opinion of the Engineer, impair the capacity of the slab to perform its function under anticipated traffic conditions or when any defect in the slab exists that would, in the opinion of the Engineer, degrade the appearance of the slab.

Q. METHOD OF MEASUREMENT: "Portland Cement Concrete Pavement" shall be measured by the square yard of completed and accepted work.

R. BASIS OF PAYMENT: "Portland Cement Concrete Pavement" shall be paid for at the contract unit price measured as stated above.

S-408 REINFORCING STEEL: This work shall consist of furnishing and placing reinforcing steel in accordance with these Specifications and conformity with the Plans.

A. All bars furnished under this specification shall be deformed unless specified otherwise on the Plans or in the Contract. All bars furnished under this specification shall be Grade 60 unless specified otherwise on the Plans or in the Contract.
B. Epoxy coated bars shall, in all other respects, meet the requirements of AASHTO M284 except that the mandrel diameters shown in Table 1 for bar nos. 3, 4 and 5 shall be 3", 4" and 5" respectively, the protective epoxy coating shall be applied to the reinforcing steel bars by the electrostatic spray method or electrostatic fluidized bed method.
C. Billet steel bars shall conform to the requirements of ASTM A615. Rail steel bars shall conform to the requirements of ASTM A616. Axle steel bars shall conform to the requirements of ASTM A617.
    1. Protection and Storage: Reinforcing steel shall be protected at all times from damage and stored above the ground on platforms, skids, or other supports. It shall be stored in such a manner and adequately marked to facilitate inspection and checking. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil or other foreign substance.
    2. Bending and Cutting: All cutting and bending of reinforcement bars shall be performed by competent workers and with appropriate equipment. All reinforcement bars shall be bent cold. Unless shown otherwise on the Plans or written approval is obtained from the Engineer, all reinforcement bars shall be cut and bent in a fabricating shop before shipment to the project. Bars partially embedded in concrete shall not be field bent except as shown on the Plans.
    3. Placing, Supporting and Fastening: All reinforcing steel shall be accurately placed and firmly held by approved supports in the position shown on the Plans. Placing tolerances shall be in accordance with ACI-117. Reinforcing bars shall be securely fastened together. Reinforcement placed in any member shall be inspected and approved immediately prior to any concrete being placed. Laying or driving bars into the concrete after placement will not be permitted. All horizontal reinforcement shall be supported on metal supports or spacers as indicated on the plan sheets for Supports and Spacers for Reinforcing Steel. The use of small stones or concrete or wood blocks for supporting reinforcement will not be permitted. The reinforcement shall be held securely in place at the proper position and spacing as indicated on the Plans by the use of wire ties at bar intersections and tying to the supports and spacers. All wire ties in the top mat of steel shall be bent downward. The adequacy of the supports and ties to secure the reinforcement properly shall be subject to the approval of the Engineer. No welding of reinforcing steel will be permitted except as shown on the Plans.
    4. In order to protect the coated reinforcement from damage, the Contractor shall use padded or non-metallic slings and padded straps. Bundled bars shall be handled in a manner which will prevent excessive sagging of bars which may damage the coating. The bundled bars shall not be dropped or dragged and must be stored on wooden cribbing. If, in the opinion of the Engineer, the coated bars have been extensively damaged, the material will be rejected. The Contractor may propose, for the approval of the Engineer, alternate precautionary measures.
    5. Fabrication and Placement: The bars shall be fabricated and placed as shown on the Plans and as specified herein. Placing tolerances shall be in accordance with ACI-117. All bending should be performed around nylon coated pins or wooden mandrels. The rate of bending may have to be reduced for some bar sizes to minimize cracking or debonding of the coating. Any visible evidence of cracking or

debonding of the coating in the bent area of bars bent in accordance with the Plan requirements shall be patched with approval of the Engineer, except that a hairline crack, 0.003 inch or less, at the base of the deformation will not be cause for rejection nor will patching of these cracks be required. All patching shall be done promptly after bending. Bars shall not be shipped until patching material has lost all tackiness.

- On bridges where all deck steel is epoxy coated, metal bar chairs, spacer frames or other bars in contact with epoxy coated bars shall be either plastic coated or epoxy coated in its entirety.
- On bridges where only the top mat and hubguard/handrail is epoxy coated, metal bar chairs or other bars in contact with epoxy coated bars shall be plastic where in contact with the coated bar.
- Plastic-coated tie wires approved by the Engineer shall be used in the assembly of the coated bars in the structure to protect them from physical damage.

6. Patching material shall be applied to all sheared ends and contact areas for hangers or couplers. Patching materials shall be applied to all damaged areas at the points of occurrence, such as the initial application, fabrication, destination or installation points with the following exception. Damaged areas of coating not more than 0.2 inches across at the widest point of exposed area of bare steel and occurring no more than six inches in any lineal foot of coated bar need not be repaired.
7. Areas to be patched shall be clean and free of surface contaminants. They shall be promptly treated in accordance with the resin manufacturer's recommendations and before detrimental oxidation occurs.
8. Whenever it is necessary to splice reinforcement at points other than those shown on the Plans, drawings showing the location of each splice shall be submitted to the Engineer for approval before the reinforcing steel is ordered. Splices shall be avoided at points of maximum stress. They shall, where possible, be staggered, and shall be designed to develop the strength of the bar without exceeding the allowable unit bond stress. Bars shall be lapped in accordance with details shown on the Plans. Splicing of reinforcing steel by welding will be permitted only if shown on the Plans. Lapped splices in reinforcement shall not be used for bar sizes larger than No. 11. Where the bar size exceeds a No. 11 bar, welded splices or other positive connections shall be used with the approval of the Engineer. The welding of direct butt splices shall be made in accordance with the requirements of the American Welding Society Publication "Reinforcing Steel Welding Code" AWS D12.1. A certified welder will be required.
9. Reinforcing Bar Trusses: Bar trusses shall be placed, supported and secured in proper position before beginning the placement of the concrete. Unless the bar trusses are so designed and fabricated with outstanding legs to be in contact with the forms they shall be supported on metal supports and spacers. If the weight of the trusses cause the supporting legs of trusses to indent into the forms, bar supports shall be used as auxiliary support for the truss legs.
10. Mesh reinforcement for Structures: Mesh reinforcement shall be of the size and spacing of bars and sheets as shown on the Plans. The sheets of mesh shall be lapped as indicated on the Plans. The method of placing the mesh and securing it in proper position shall be approved by the Engineer.
11. Box Culvert reinforcing: All reinforcing steel for road culverts and reinforced concrete box bridges shall be grade 60 unless otherwise noted on the Plans.

D. METHOD OF MEASUREMENT: No separate measurement shall be made for “Reinforcing Steel”.

E. BASIS OF PAYMENT: “Reinforcing Steel” shall be subsidiary to the bid item for the structure into which it is incorporated.

S-409 <u>RESIDENTIAL, COMMERCIAL & INDUSTRIAL DRIVES</u>: This work shall consist of constructing a concrete apron to a private drive in accordance with the requirements below: This work shall be constructed in accordance with the Standard Details. This item shall be constructed at the entrance to each private drive as indicated on the Plans. Pavement shall receive a non-slip finish obtained by a wood float and hairbrush or broom applied transverse to the center of the entrance. Slump shall not exceed 5 inches. Grade shall be compacted and true to line and grade prior to placing concrete.

A. METHOD OF MEASUREMENT: "Residential Drive" or "Industrial Drive" shall be measured by the square yard.

B. BASIS OF PAYMENT: "Residential Drive" or "Industrial Drive" shall be paid for at the contract unit price per square yard of Portland cement concrete – 6" Residential, 8" Commercial.

S-410 SAWING: This work shall consist of performing sawing in accordance with the Plans, these Specifications, and the Standard Specifications. All sawing including curb and gutter, removal and replacement, and any other sawing shall be sawed to the full depth of the item to be sawed.

A. METHOD OF MEASUREMENT: "Sawing" shall not be measured but shall be subsidiary to the other items.

B. BASIS OF PAYMENT: "Sawing" shall not be paid for separately but shall be subsidiary to other items.

S-411 CONCRETE SIDEWALK/TRAIL CONSTRUCTION: This work shall consist of excavating, forming, placing concrete, backfill, and other items necessary to install a complete sidewalk/trail. All sidewalk/trail construction shall comply with the Standard Details.

A. The subgrade shall be uniformly compacted and evenly graded to the required subgrade elevation. All loose or extraneous material shall be removed from the subgrade and soft spots shall be uniformly recompacted prior to placement of concrete. The Contractor shall have available adequate hand or mechanical compaction equipment to accomplish the compaction as set forth in these Specifications.
B. The dimensions of any sidewalk/trail repair shall be the same as that being replaced, and the dimensions of new sidewalk/trail construction shall be as shown in the Standard Detail. The minimum allowable thickness shall be 4" for sidewalks and 6" for trails.
C. Concrete shall not be placed on frozen subgrade.
D. Subgrade shall be properly moistened prior to placing concrete.
E. Sidewalk/trail slabs shall be cured by liquid membrane seal. The curing period shall be a minimum of five (5) days. Curing shall be commenced as soon as possible after the finishing operation and when the concrete has set sufficiently so that it will not be damaged in the process.
F. Sidewalk/trail panels that are cracked shall be considered defective. These areas shall be removed and replaced as directed by the Engineer, and sawed to provide a neat and straight joint. The Contractor will be responsible for any damage to existing sidewalk/trail resulting from his operations beyond the limits marked or designated by the Engineer or his authorized representative, and shall satisfactorily repair any such damage at his own expense. All disturbed areas shall be restored to their original condition, which includes backfilling, sod, driveways, underground sprinkler systems, and any other items damaged by the Contractor.
G. The grade or slope along the length of the sidewalk/trail repair shall be a uniform transition between ends of undisturbed sidewalk/trail unless otherwise directed by the Engineer. The standard cross slope for sidewalk shall be ¼" per foot and shall slope toward the street. When the existing sidewalk/trail does not have standard cross-slope, a uniform transition shall be made to existing sidewalk/trail.

H. METHOD OF MEASUREMENT: "Concrete Sidewalk/Trail Construction" shall be measured per square foot of completed and accepted work. When an existing sidewalk/trail is removed as part of the work, the removal shall be subsidiary to the installation of the new sidewalk/trail.

I. BASIS OF PAYMENT: "Concrete Sidewalk/Trail Construction" shall be paid for at the contract unit price, measured as stated above.

S-412 STABILIZED SHOULDERS: This work shall consist of furnishing and placing one or more courses of aggregate and additives, if required, on a prepared surface in accordance with these Specifications, as shown on the Plans or established by the Engineer.

A. Subgrade Preparation:
   1. Unless other subgrade preparation is called for in the Contract the Contractor shall, as a part of the work and prior to the delivery of materials for the base, or shoulders, prepare the roadbed or shoulder surface by sprinkling, blading, rolling, and lightly scarifying where necessary, until the proper shape or crown is obtained.
   2. Vegetation on the shoulders shall be eliminated by discing, scarifying or blading. Excess material shall be disposed of as shown in the Contract documents or as directed by the Engineer. Any additional embankment material that may be needed for shaping the shoulder surface or roadbed shall be obtained from areas provided for in the Contract.
   3. At all grade control points, namely, existing pavements, grade bridges, etc., the subgrade shall be excavated to such depth that the proper thickness of base may be constructed flush with the existing surface. The transition from normal to special section shall be of sufficient length to present no abrupt or noticeable change of grade and shall be excavated in accordance with the grades and lines shown in the Contract Documents. Excess excavation material shall be disposed of as directed. The roadbed at these points shall be excavated prior to any subgrade treatment and the subgrade modification or compaction as designated on the Plans shall be applied through these areas after being excavated. If the Contract Documents do not provide for separate subgrade preparation, these areas shall be compacted, after excavating, to meet the requirements of “Type B” Compaction and MR-90 Moisture Range. The depth of the compaction on the roadbed at these locations shall be six inches below the subgrade as excavated. The roadbed and shoulders shall be kept well drained at all times. It shall be the Contractor's responsibility to maintain the subgrade as prepared.

B. Mixing:
   1. The materials and water shall be mixed in an approved mixer. Water shall be added during the mixing operation in the amount necessary to provide the approximate moisture content as determined by the Engineer for compacting. After mixing, the materials shall be transported to the job site while it contains the proper moisture.

C. Placing and Compacting:
   1. If the required compacted depth of the base course or shoulder exceeds six inches, they shall be constructed in two or more layers of approximate equal thickness. The maximum compacted thickness of any one layer shall not exceed six inches. When vibrating or other approved types of special compacting equipment are used, the compacted depth of a single layer may be increased to eight inches upon approval of the Engineer.
   2. No hauling of material will be permitted when, in the judgment of the Engineer, the surface of the road will be damaged. Dumping or mixing of any shouldering material on any paved surface constructed for traffic lanes will not be permitted. All mixed material will be laid full lane width or shoulder width by means of an approved aggregate spreader. Immediately after placing, the material shall be compacted.
   3. The Engineer will determine by visual inspection that satisfactory compaction of stabilized shoulders is being obtained. Blading may be required while rolling is being performed.
   4. If the material for the shoulder is laid and compacted in more than one layer, the Contractor shall plan and coordinate his work in such a manner that the previously

placed and compacted layers are allowed ample time for curing and development of sufficient stability before vehicles hauling materials for the succeeding layers, or other heavy equipment are permitted on the base. Prior to placing the succeeding layers of material, the top of the lower layer shall be made sufficiently moist to insure a strong bond between the layers. The edges and edge slopes of the base shall be bladed or otherwise dressed to conform to the lines and dimensions shown in the Contract Documents and present straight, neat lines and slopes as free of loose material as practicable. If, after completed compaction, there are areas above or below proper grade and elevation, such areas shall be loosened and after having had additional materials added or excess material removed, as the case may require, shall be reconstructed as described above.

D. Surface Drop-off Treatment:

1. On projects that carry traffic through construction, the following criteria shall be considered a minimum for treatment of surface drop-offs adjacent to traffic lanes not physically separated by acceptable positive barrier. A surface drop-off is defined as the vertical distance between the top of the lift being constructed or riding surface to the top of the existing shoulder or adjacent lane.
2. Shoulder Treatment
    - All lifts regardless of thickness shall be constructed with an edge slope of 1:1 or flatter. Appropriate signing and delineation as shown in the Contract Documents will be required.
    - When the surface drop-off is greater than three inches, a temporary or permanent wedge shall be constructed against the pavement edge to provide a 3:1 or flatter slope. For unusual and justifiable conditions, the Engineer may modify this requirement to permit the use of drums, barricades, or other channelizing devices in lieu of the wedge to alert drivers of the drop-off condition. Surface drop-offs greater than three inches shall not be left unprotected overnight without the wedge or channelizing devices in place. An obstruction free recovery area should be provided to the extent possible.
    - For multi-lift projects with lifts greater than three inches, shoulders may be considered in conjunction with the placement of all lifts or the vertical drop-off shall be treated as stated previously.
    - When used, wedges shall be constructed of a material acceptable to the Engineer and constructed with a final maximum slope of 3:1 or flatter. Construction of the wedge or the use of alternate channelizing devices shall be considered as subsidiary to other items of the Contract.
    - The grade of entrances and side roads shall be raised to meet the edge of the stabilized shoulder. In raising the grade of the entrance or side road, sufficient embankment materials shall be added to provide a roadway width equal to that of the approaching roadway with adequate shoulder slopes and shoulder radii adjacent to the shoulder of the project. Approach grades shall slope slightly away from the edge of the stabilized shoulder and the surface shall be adequately crowned, bladed, and consolidated to present a smooth surface with uniform lines and a neat appearance. The embankment material for this purpose shall be obtained from adjacent slopes or ditches or other sources approved by the Engineer.

E. METHOD OF MEASUREMENT: “Stabilized Shoulders” shall be measured per square yard of completed, in-place, and accepted work.

F. BASIS OF PAYMENT: “Stabilized Shoulders” shall be paid for at the contract unit price, measured as stated above. Work on shoulders, shoulder slopes, entrances, and side roads shall not be paid for directly but shall be considered as subsidiary work pertaining to the item of stabilized shoulders.

S-413 STONE MASONRY: This work shall consist of installing stone masonry according to these Specifications, the Plans, and the Contract Documents. Stone masonry, as here specified, shall include the classes commonly known as coursed, random, and random range work and shall consist of roughly squared and dressed stone laid in cement mortar.

A. Stone for mortar or dry masonry shall be of approved quality, sound and durable, and free from segregations, seams, cracks, and other structural defects or imperfections tending to destroy its resistance to the weather. It shall be free from rounded, worn, or weathered surfaces. All weathered stone shall be rejected.
B. All stone used in this work shall be obtained from quarries and beds designated by the Kansas Department of Transportation as meeting durability requirements of Class I or Class VI and so shown on the current listing on file in the office of the City Engineer.
C. The stone shall be kept free from dirt, oil, or any other injurious material that may prevent the proper adhesion of the mortar.
D. The mortar used shall be composed of one part of Portland cement and three parts of sand.
E. Individual stones for gravity retaining wall construction shall have a thickness of not less than 8 inches and a width of not less than 1 1/2 times the thickness. No stones, except headers, shall have a length less than 1 1/2 times their width. Stones shall decrease in thickness from bottom to top of wall.
F. Individual stones for stone veneer fascia shall have the dimensions required by the Plans.
G. Headers shall hold in the heart of the wall the same size shown in the face and shall extend not less than 12 inches into the core or backing. They shall occupy not less than one-fifth of the face area of the wall and shall be evenly distributed. Headers in walls 2 feet or less in thickness shall extend entirely through the wall. Headers shall not be used in stone veneer fascia. The stones shall be roughly squared on joints, beds, and faces. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls. If specified, all corners or angles in exterior surfaces shall be finished with a chisel draft.
H. The top stone of a stone retaining wall shall have cap stones as the top course. The cap stones shall be the full width of the wall and shall not be less than 12 inches long or less than 4 inches thick.
I. All shaping or dressing of stone shall be done before the stone is laid in the wall, and no dressing or hammering which will loosen the stone will be permitted after it is placed.
J. Stone masonry shall not be constructed in when the ambient temperature is below 35º F (2º C), nor when the temperature of the stone is below 35º F (2º C) or when the stone contains frost, except by written permission of the Engineer and subject to such conditions as he may require.
K. The masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material.
L. Each stone shall be cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be clean and well moistened. All stones shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls will be permitted in the beds. Joints and beds shall have an average thickness of not more than 1 inch.
M. Whenever possible the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of 2 inches before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing.
N. The vertical joints in each course shall break with those in adjoining courses within at least 6 inches. In no case shall a vertical joint be so located as to occur directly above or below a header.

O. Tolerance from the plane specified for the top of the wall shall be ¼"/20' and tolerance from the planes specified for the face and back of the wall shall be ¼"/10'.
P. Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least 3 days after completion.
Q. After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition.
R. Cold Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace masonry damaged by frost or freezing conditions. Comply with the following requirements:
    1. Cold Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:

        - 40 to 32 deg. F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg. F.
        - 32 to 25 deg. F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg. F. Maintain mortar and grout above freezing until used in masonry.
        - 25 to 20 deg. F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg. F. Heat grout materials to produce grout temperatures between 40 and 120 deg. F. Maintain mortar and grout above freezing until used in masonry. Heat masonry material to 40 deg. F if grouting. Use heat on both sides of the structure/wall under construction.
        - 20 deg. F and below: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg. F. Heat grout materials to produce grout temperatures between 40 and 120 deg. F. Maintain mortar and grout above freezing until used in masonry. Heat masonry material to 40 deg. F. Provide enclosures and use heat on both sides of structures/walls under construction to maintain temperatures above 32 deg. F within the enclosures.

    2. Cold Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection:

        - 40 to 32 deg. F: Cover masonry with a weather-resistant membrane for 48 hours after construction.
        - 32 to 20 deg. F: Cover masonry with insulating blankets or provide enclosure and heat for 48 hours after construction to prevent freezing. Install wind breaks when wind velocity exceeds 15 mph.
        - 20 deg. F and below: Provide enclosures and use heat to maintain temperatures above 32 deg. F within the enclosures for 48 hours after construction.

    3. Cold Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg. F and above and will remain so until masonry has dried out, but not less than 7 days after completion of cleaning.

S. METHOD OF MEASUREMENT: "Stone Masonry" shall be measured by the square foot of completed and accepted vertical wall face of any stone masonry retaining wall, stone masonry headwall, stone masonry tree well, or stone veneer fascia. Concrete used as a

base for the stone masonry retaining wall, stone masonry headwall or stone masonry tree well shall be subsidiary to the stone masonry item.

T. BASIS OF PAYMENT: “Stone Masonry” shall be paid for at the contract unit price, measured as stated above.

S-414 <u>TEMPORARY SURFACING</u>: This work shall consist of the placing and spreading of aggregate on areas designated by the Engineer to be temporary crossings and temporary routes of ingress and egress to residences and places of business adjacent to or near the project.

A. Temporary surfacing material will have no requirements as to standard methods of testing of aggregates except that it shall be approved by the Engineer and of such quality that when spread will allow vehicular travel during wet and rainy periods.
B. Cross roads, side roads, approach roads, culvert or bridge detours and temporary roads to residences or places of business when ordered by the Engineer shall be shaped to a reasonable cross section to prevent ponding of water. The surface shall be smoothed by blading and temporary surfacing material uniformly spread on locations ordered by the Engineer in the amount and at the time that will allow vehicular travel during wet and rainy weather.

C. METHOD OF MEASUREMENT: “Temporary Surfacing” shall be measured by the ton, in place. Contractor shall furnish weight tickets.

D. BASIS OF PAYMENT: “Temporary Surfacing” shall be paid for at the contract unit price measured as stated above.

DRAINAGE IMPROVEMENT CONSTRUCTION AND MATERIALS

S-500 <u>BIORETENTION FACILITY</u>: Bioretention facilities are small landscaped basins intended to provide water quality management by filtering stormwater runoff before release into stormdrain systems. This work shall consist of installing bioretention facilities as specified in the Contract Documents, including all materials, equipment, labor and services required to perform the work.

A. Bioretention Soil Mixture: The Bioretention Soil Mixture (BSM) is a mixture of planting soil, mulch, and sand consisting of the following:

ITEM	COMPOSITION BY VOLUME	REFERENCE
Planting Soil	30%	See below.
Organic Compost	20%	See below.
Sand	50%	ASTM C33 Fine Aggregate

B. Planting Soil: The USDA textural classification of the Planting Soil for the BSM shall be LOAMY SAND OR SANDY LOAM. The Planting Soil shall be the best available on site material or furnished. Additionally, the Planting Soil shall be tested and meet the following criteria or as approved by the engineer:

ITEM	PERCENT BY WEIGHT	TEST METHOD
Sand (2.0 – 0.050 mm)	50 – 85%	AASHTO T88
Silt (0.050 – 0.002 mm)	0 – 50%	AASHTO T88
Clay (less than 0.002 mm)	2 – 5%	AASHTO T88
Organic Matter	3 – 10%	AASHTO T194

The textural analysis for the Planting Soil shall be as follows:

ASTM E11 SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
2 in.	100
No. 4	90
No. 10	80

At least 45 days prior to the start of construction of bioretention facilities, the Contractor shall submit the source and testing results of the Planting Soil for the BSM to the Engineer for approval. No time extensions will be granted should the proposed Planting Soil fail to meet the minimum requirements stated above. Once a stockpile of the Planting Soil has been sampled, no material shall be added to the stockpile.
Organic Compost: Compost is a homogeneous and friable mixture of partially decomposed organic matter, with or without soil, resulting from composting, which is a managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase. Compost is deemed acceptable if it meets 2 of the following requirements:

- C/N ratio <= 25;
- Oxygen uptake rate <= 150 mg O_2/kg volatile solids per hour; and
- Compost must not contain more than 1 percent foreign matter.

Foreign matter is defined as:

"Any matter over a 2 mm dimension that results from human intervention and having organic or inorganic constituents such as metal, glass and synthetic polymers (e.g. plastic and rubber) that may be present in the compost but excluding mineral soils, woody material and rocks."

Foreign matter less than 1 percent by weight must not exceed 12.5 mm in any dimension.

C. The Bioretention Soil Mixture (BSM) shall be a uniform mix, free of plant residue, stones, stumps, roots or other similar objects larger than two inches excluding mulch. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations.

1. The Bioretention Soil Mixture shall be tested and meet the following criteria:

Item	Criteria	Test Method
Corrected pH	5.5 – 7.5	ASTM D4972
Magnesium	Minimum 32 ppm	*
Phosphorus (Phosphate - P_2O_5)	not to exceed 60 ppm plant available phosphorus	*
Potassium (K_2O)	Minimum 78 ppm	*
Soluble Salts	Not to exceed 500 ppm	*

* Use authorized soil test procedures.

Should the pH fall outside of the acceptable range, it may be modified with lime (to raise) or ammonium sulfate (to lower). The lime or ammonium sulfate must be mixed uniformly into the BSM prior to use in bioretention facilities.
Should the BSM not meet the minimum requirement for magnesium, it may be modified with magnesium sulfate. Likewise, should the BSM not meet the minimum requirement for potassium, it may be modified with potash. Magnesium sulfate and potash must be mixed uniformly into the BSM prior to use in bioretention facilities.
Planting soil and/or BSM that fails to meet the minimum requirements shall be replaced at the Contractor's expense. Mixing of the corrective additives to the BSM is incidental and shall be at the Contractor's expense.
Mixing of the BSM to a homogeneous consistency shall be done to the satisfaction of the Engineer. Upon approval of all requirements and testing above, the BSM shall be stockpiled, and no material shall be added to the BSM in the stockpile or during transport to the bioretention facility.

2. Other materials:

MATERIAL	SPECIFICATION
No. 57 Aggregate	ASTM D448
No. 7 Aggregate	ASTM D448
4-inch HDPE Plastic Pipe Underdrain	AASHTO M252
Geotextile Fabric	AASHTO M288
Mulch, 2x Shredded Hardwood Bark	See below.
Water	See below.
Lime	ASTM C25
Ammonium Sulfate	See below.
Magnesium Sulfate	See below.
Potash	See below.

Shredded hardwood mulch shall be aged a minimum of 6 months and consist of the bark and wood (50/50) from hardwood trees which has been milled and screened to a maximum 4 in. particle size and provide a uniform texture free from sawdust, clay, soil, foreign materials, and any artificially introduced chemical compounds that would be detrimental to plant or animal life.

No. 7 and No. 57 Aggregate shall be double-washed to reduce suspended solids and potential for clogging. The aggregate shall be placed as shown in the Contract Drawings.

Water used in the planting, establishing, or caring for vegetation shall be free from any substance that is injurious to plant life.

Lime shall contain not less than 85 percent calcium and magnesium carbonates. Dolomitic (magnesium) lime shall contain at least 10 percent magnesium as magnesium oxide and 85 percent calcium and magnesium carbonates. Lime shall conform to the following gradation:

SIEVE SIZE	MINIMUM PERCENT PASSING BY WEIGHT
No. 10	100
No. 20	98
No. 100	50

Ammonium sulfate shall be a constituent of an approved horticultural product produced as a fertilizer for supplying nitrogen and as a soil acidifier.

Magnesium sulfate shall be a constituent of an approved horticultural product produced as a fertilizer.

Potash (potassium oxide) shall be a constituent of an approved horticultural product produced as a fertilizer.

D. Bioretention facilities shall not be constructed until all contributing drainage areas are permanently stabilized against erosion and sedimentation as shown on the Contract Plans and to the satisfaction of the Engineer. Any discharge of sediment that affects the

performance of the cell will require reconstruction of the cell to restore its defined performance. No heavy equipment shall operate within the perimeter of a bioretention facility during underdrain placement, backfilling, planting, or mulching of the facility.

1. Excavation: If the bioretention facility is to be used as a sediment basin the bioretention facility shall be excavated to the dimensions, side slopes, and 1 foot above the bottom of the Bioretention Soil Mixture elevations shown on the Contract Plans. Any sediment from construction operations deposited in the bioretention facility shall be completely removed from the facility after all vegetation, including landscaping within the drainage area of the bioretention facility, has been established. The excavation limits shall then be final graded to the dimensions, side slopes, and final elevations shown on the Contract Plans. Excavators and backhoes, operating on the ground adjacent to the bioretention facility, shall be used to excavate the facility if possible. Low ground-contact pressure equipment or, if approved by the engineer, by excavators and/or backhoes operating on the ground adjacent to the bioretention facility. Low ground-contact pressure equipment is preferred on bioretention facilities to minimize disturbance to established areas around perimeter of cell. No heavy equipment shall be used within the perimeter of the bioretention facility before, during, or after the placement of the BSM. Excavated materials shall be removed from the bioretention facility site. Excavated materials shall be used or disposed of in conformance with the project specifications. After placing the underdrain and aggregate and before the BSM, the bottom of the excavation shall be roto-tilled or scarified to a minimum depth of 6 inches to alleviate any compaction of the facility bottom. Any substitute method for roto-tilling must be approved by the Engineer prior to use. Any ponded water shall be removed from the bottom of the facility and the soil shall be friable before roto-tilling. The roto-tilling shall not be done where the soil supports the aggregate bed underneath the "Underdrain for Bioretention". (See "Underdrain for Bioretention" specifications below.)
2. The underdrain system, aggregate bed, and geotextile fabric shall be placed according to dimensions shown on the Contract Plans. Observation wells/cleanouts of 4-inch non-perforated HDPE pipe shall be placed vertically in the bioretention facility as shown on the Contract Plans. The wells/cleanouts shall be connected to the perforated underdrain with the appropriate manufactured connections as shown on the Contract Plans. The wells/cleanouts shall extend 6 inches above the top elevation of the bioretention facility mulch, and shall be capped with a screw cap.
3. Storage and mixing of bioretention soil mix: bioretention soil mix that is delivered to the site to be stockpiled shall be stored on a clean impervious surface. If any of the of the adjacent land drains towards the stockpile, it shall be protected from runoff with appropriate erosion control measures. If the soil is to be mixed on site, then the components shall be stored as described above. In the event that there is no impervious location for storage and mixing, care shall be taken not to contaminate the soil components with the underlying native soil.
4. Placement of the Bioretention Soil Mixture: The Bioretention Soil Mixture (BSM) shall be placed and graded using low ground-contact pressure equipment or, if approved by the engineer, by excavators and/or backhoes operating on the ground adjacent to the bioretention facility. Low ground-contact pressure equipment is preferred on bioretention facilities to minimize disturbance to established areas around perimeter of cell. No heavy equipment shall be used within the perimeter of the bioretention facility before, during, or after the placement of the BSM. The BSM shall be placed in horizontal layers not to exceed 12 inches for the entire area of the bioretention facility. The BSM shall be saturated over the entire area of the

bioretention facility after each lift of BSM is placed until water flows from the underdrain to lightly consolidate the BSM mixture. Water for saturation shall be applied by spraying or sprinkling in a manner to avoid separation of the BSM components. Saturation of each lift shall be performed in the presence of the Engineer. If the BSM becomes contaminated during the construction of the facility, the contaminated material shall be removed and replaced with uncontaminated material at the Contractor's expense. Final grading of the BSM shall be performed after a 24-hour settling period. Upon final grading the surface of the BSM shall be rototilled to a depth of 6". Final elevations shall be within 2 inches of elevations shown on the Contract Plans.

5. Mulching: Once grading is complete, the entire bioretention facility shall be mulched to a uniform thickness of 3 inches. Mulching shall be complete within 24 hours to reduce the potential of silt accumulation on the surface. Well aged shredded hardwood bark mulch is the only acceptable mulch. Mulching shall be done immediately after grading to reduce potential of any silt accumulation on the surface.
6. Plant Installation: Trees, shrubs, and other plant materials specified for Bioretention Facilities shall be planted as specified in the Contract Plans and applicable landscaping standards with the exception that pesticides, herbicides, and fertilizer shall not be applied during planting under any circumstances. Furthermore, pesticides, fertilizer, and any other soil amendments shall not be applied to the bioretention facility during landscape construction, plant establishment, or maintenance.

F. METHOD OF MEASUREMENT: Bioretention Facilities will be measured by the square foot and will be paid for at the Contract Unit Price.

G. BASIS OF PAYMENT: The payment will be full compensation for all material, labor, equipment, tools, and incidentals necessary to satisfactorily complete the work. Biological Plantings will be paid for separately under other items of the contract.

S-501 CURED IN PLACE PIPE (CIPP) SEWER LINING

A. General

1. Work Included
   - Cured In Place Sewer Lining
2. Quality Assurance
   - Referenced Standards: American Society for Testing and Materials (ASTM)
     - **a.** C581, Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used In Glass Fiber Reinforced Structures, Intended for Liquid Service.
     - **b.** D543, Test Method for Resistance of Plastics to Chemical Reagents.
     - **c.** D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
     - **d.** D1600, Standard Terminology for Abbreviated Terms Relating to Plastics.
     - **e.** F1216, Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
     - **f.** F1743-96, Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP).
   - Qualifications
     a. Manufacturer:
        i. Manufacturer shall have a minimum of five years' experience in the manufacture of the proposed CIP lining system.
        ii. Manufacturer shall be licensor of the CIP lining system.
     b. Contractor:
        i. Contractor's on-site superintendent shall be certified by the manufacturer that they have completed a training program for installation of the lining system.
        ii. Contractor's on-site superintendent shall have installed a minimum of 10,000 ft. of the proposed lining system.
3. Submittals
   - Quality Control
     a. Manufacturer's Quality Control Program
     b. Name of Manufacturer's Quality Control Manager.
     c. Factory test reports
   - Shop Drawings:
     a. See General Condition 26 (GC-26) – Shop Drawings and Samples, page C-18.
     b. Product technical data including:
        i. Manufacturer's installation instructions.
        ii. Physical properties datasheet.
     c. Wall Thickness Design Calculations.
   - Certifications:
     a. Manufacturer certification of Contractor's on-site superintendent.
     b. Manufacturer certification that products submitted meet requirements of standards referenced.
   - Video Inspections
     a. Pre-installation inspection video and computer reports.
     b. Post-installation inspection video and computer reports.
   - Phasing Plan including:
     a. Bypass pumping procedure
     b. Order of construction

c. Traffic control plan
- Installation Reports

B. Products

1. Acceptable Manufactures
   - Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
     a. Insituform
     b. Masterliner
     c. Liner Products
     d. Pre-approved equal.
   - Submit request for substitutions in accordance with General Condition 17 (GC-17) – Substitute or Equivalent Items, page C-14.
2. Materials
   - Fabric Tube:
     a. Tube material shall consist of one or more layers of absorbent non-woven felt or woven fiberglass.
     b. The tube material shall meet the requirements of ASTM F1216, Section 5.1.
     c. The tube shall have uniform thickness that when compressed at installation pressures will meet or exceed the design thickness.
     d. The outside layer of tube (before wetout) shall be plastic coated with a translucent flexible material that clearly allows inspection of the resin impregnation (wetout) procedure. This plastic coating shall not delaminate after curing of the CIP liner.
     e. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers.
     f. The wall color of the interior surface of the tube shall be light reflective to facilitate closed circuit video inspection.
     g. Dimensions:
        i. Length: Sufficient to span the distance between entry and exit manholes. Distances to be field-verified by Contractor prior to manufacturing.
        ii. Outside Diameter: Fabricated to a size that will tightly fit the internal circumference of the original pipe. Allowance should be made for circumferential stretching during inversion.

   - Resin:
     a. The resin system shall be a corrosion resistant polyester, vinylester or epoxy system including all necessary catalysts, initiators and hardeners.
     b. The resin system shall meet the requirements of ASTM F1216 and F1763 including the physical properties herein.

     c. PET/Isophthalic polyester resins are not allowed. Polyester may be either all isophthalic acid or all teraphthalic acid but not a combination of both.
   - Structural Requirements:
     a. The CIP liner thickness shall be designed in accordance with ASTM F1216, Appendix X1. The design parameters shall be as follows:

i. Pipe Condition: Fully Deteriorated
ii. Depth of Existing Pipe Invert: 5' Max
iii. Soil Modulus: 500 psi
iv. Height of Groundwater Above Top of Pipe: N/A
v. Ovality of Existing Pipe: 2%
vi. Soil Load: 120 lbs/ft3
vii. Live Load: Highway H20
viii. Long Term Flexural: 50% of ASTM D-790 value
ix. Maximum Deflection: 5%
x. Minimum Safety Factor: 2.0
xi. Resin Migration: 5%

b. The cured CIP liner shall have the following minimum structural properties:

	Test Method	**Minimum Value**
Modulus of Elasticity	**ASTM D-790**	**400,000 psi**
Flexural Stress	**ASTM D-790**	**4,500 psi**

c. Contractor shall provide wall thickness design calculations for Engineer's approval prior to resin impregnation of the liner.
d. The finished CIPP liner shall yield the minimum wall thickness as calculated by ASTM F1216.

C. Execution

1. Installation Preparation

- The Owner shall be responsible for the following:
  i. Locating and opening all manhole access points for the work.
  ii. Providing right-of-way to access the manhole locations.
  iii. Providing free water from nearby sources, such as fire hydrants, for process of the work. Contractor shall make every effort to conserve water.
- Cleaning of Sewer Line – Debris which would interfere with the installation of the liner shall be removed. The Contractor shall dispose of debris in a location approved by the Owner and in accordance with all Federal, State and Local regulations.
- Line Obstructions – The line shall be cleared of obstructions such as solids, dropped joints, protruding service connections or collapsed pipe that may prevent pipe installation. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then a point repair excavation shall be made to uncover and remove or repair the obstruction. Such point repair shall be approved in writing by the Owner's representative prior to commencement of the work and shall be considered as a separate pay item.
- Service Locations - The Contractor shall be responsible for confirming the locations of all active branch connections prior to installing liner.
- The Contractor shall verify that the diameter of the pipeline to be rehabilitated is the same as that specified on the drawings. In the event that the size & type is not consistent with the plans, the Engineer shall be notified before proceeding.

D. Television Inspection

1. General
   - Pre-Lining TV Inspection: Prior to liner installation, Contractor shall visually inspect pipe sections by means of closed circuit television camera to identify any unknown defects or obstructions and to accurately locate active sewer services.
   - Post-Liner TV Inspection: Contractor shall re-inspect lined pipe sections after the completion of lining to verify the integrity of the liner and restored service connections.
2. Equipment:
   - The television camera shall be specifically designed and constructed to perform sewer inspections. The camera shall have a minimum sensitivity of 3 lux, with remote focus, iris, and light intensity control. The camera shall be operative in 100 percent humidity conditions and have a head that will rotate 180 degrees on axis and 360 degrees on arc to give full view of laterals, joints and any defects.

- Lighting for the camera shall minimize reflective glare.
- A remote reading footage counter, accurate to two-tenths of a foot, shall be used.
- The camera shall be mounted on skids or a robotic tractor with wheels suitably sized for each pipe diameter.

3. Procedure:
   - The camera shall be moved through the line at a speed no greater than 30 feet per minute.
   - The camera shall pan and tilt at all sewer defects and lateral connections to provide a video of each location. This is required for pre- and post-liner inspections.
   - If during the inspection the television camera will not pass through the entire sewer section, the Contractor shall perform the inspection from the opposite manhole. If again the camera fails to pass through the entire sewer section, the inspection shall be considered complete.
   - Footage measurements shall begin at the centerline of the upstream manhole, unless otherwise specified by the Owner or Engineer. Footage shall be shown on the streaming video view at all times and manually checked by use of a walking meter, roll-a-tape, or other suitable device.
   - Provide video showing full circumference of pipe inlet, pipe outlet, and every lateral.
4. Documentation:
   - Color video recordings shall be made of the television inspections and shall be supplied to the Owner.
   - Computer generated inspection reports shall include the following:
     i. Fault Report showing a picture of each fault or service connection along with the footage to their location.
     ii. Log Report showing a schematic drawing of the sewer run. This report shall indicate the severity of the fault and its footage location. The severity of the faults shall be indicated by a color coding system.

E. Pipe Liner Installation

1. CIP liner installation shall be in accordance with ASTM F1216, Section 7, or ASTM F1743 and the manufacturer's recommendations. Either the inversion or pull-in method is acceptable.
2. Liner Insertion:
   - Make all point repairs and clear all obstructions, as identified during initial video inspection, prior to pipe lining.
   - Inversion Method:
     i. Wetout tube shall be inverted into the existing sewer line through an existing manhole using hydrostatic water pressure or air pressure.
     ii. Inversion pressures shall be kept below the maximum values recommended by the liner manufacturer. Contractor shall take care to use the minimum pressure that causes the inversion to progress to prevent stretching of the liner.
   - Pull-In Method:
     i. Use a power winch and steel cable connected to a pulling head as recommended by the manufacturer to advance the pipe liner.
     ii. Insert pipe liner into entry manhole and slowly feed from the supply reel, while simultaneously pulling pipe liner at the exit manhole. Maintain two-way communication between personnel at entry and exit manholes to coordinate the rate of pipe liner supply and pulling operations.

iii. Contractor shall inform the Engineer of the maximum allowable pulling force that can be used to insert the liner. This maximum force shall be provided by the liner manufacturer and shall prevent stretching or rupturing of the liner. The pulling force shall be measured and monitored at all times during the insertion process.

3. Liner Curing and Processing:
   - Curing shall be accomplished by utilizing hot water under hydrostatic pressure or pressurized saturated steam.
   - The heat source for the curing process shall be fitted with suitable monitors to gauge the incoming and outgoing heating fluid.
   - Install temperature and pressure gauges at entry and exit manholes to monitor internal conditions during pipe liner curing.
   - Introduce hot water or pressurized steam to develop and maintain conditions inside pipe liner in strict accordance with manufacturer's recommendations. Curing equipment shall allow Contractor to introduce cold water or air to control the temperature of the curing process.
   - Contractor shall maintain constant pressure on the liner during the curing process to keep the liner in tight contact with the existing pipe.
   - Once the exothermic process begins to take place, the Contractor shall control the temperature of the curing process to prevent overheating of the liner.
   - The curing process shall continue until the exothermic reaction is completed and the liner is cooled to below 100 degrees.

4. Installation Documentation - Contractor shall complete an Installation Report for each section of lining that includes the following information:
    - Owner Name
    - Project Location
    - Installation Date
    - Superintendent's Name
    - Weather Conditions
    - Section Length
    - Pipe Diameter
    - Pipe Composition
    - Street Name
    - Liner Number and Length
    - Up and Downstream Manhole Numbers
    - Time to Insert in Liner
    - Pull Force
    - Curing Time
    - Time of Exothermic Reaction
    - Time, Temperature and Pressure during Liner Processing
    - Cool Down Time
    - Description of any problems during installation
5. Service Lateral Reinstatement:
    - Reinstate existing service connections using remote controlled methods as approved by the manufacturer or otherwise approved by the Engineer.
    - After creating a hole in the liner, polish the edges of the hole to remove sharp edges and improve flow conditions. The clear opening in the liner for the service lateral shall provide a minimum of 90 percent of the capacity of the lateral pipe.
6. Manhole Sealing and Benches:
    - Provide a watertight seal at the insertion and termination points in the manholes, in accordance with the liner manufacturer's recommendations.

F. Testing and Inspection
1. CIP Liner Field Samples – When requested by the Engineer, the Contractor shall submit test results from other field installations of the same resin system and tube materials as proposed for this project. These test results must verify that the CIP liner physical properties are as previously specified.
2. Post-Installation video per Section 3.2 shall be provided by the contractor.

G. Safety
1. The Contractor shall carry out his operation in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving entering and working in confined spaces.
2. All trenches shall be sloped and/or shored in accordance with applicable OSHA standards.

H. Clean Up

1. After the installation has been completed, the project area affected by the Contractor's operation shall be reinstated to its original condition.
2. Any sidewalk, driveways, street surfacing disrupted shall be restored to original condition.
3. No separate payment will be made for restoration but shall be considered incidental to the items of the Bid.

METHOD OF MEASUREMENT: Cured In Place Pipe shall be measured per linear foot of completed and accepted work measured from inside face of adjoining structures. Said measurement shall include all labor, material, and equipment necessary for the complete installation.

BASIS OF PAYMENT: "Cured In Place Pipe (CIPP)" shall be paid for at the contract unit price, measured as stated above. Work performed such as street patching, by-pass pumping, temporary encasement pipes, dewatering, and other activities not listed on the Bid Form shall not be paid for directly but shall be considered subsidiary to the items of the Bid.

S-502 DITCH LINER: This work shall consist of the construction of stone or concrete ditch lining, in accordance with these Specifications and as shown on the Plans or established by the Engineer.

A. Concrete Ditch Liner:
   1. The subgrade for the ditch lining shall be excavated to a smooth surface parallel to the proposed finished surface and to a depth sufficient for the full thickness of the lining. Soft, unstable subgrade material shall be removed and replaced with suitable materials. The subgrade shall be firm and well-compacted.
   2. The concrete shall be placed beginning at the lower end of the portion of the ditch to be lined and progressing toward the upper end.
   3. If required on the Plans the concrete shall be reinforced with the type of reinforcement and in the manner indicated.
   4. Contraction or construction joints shall be spaced and formed as indicated on the Plans.
   5. The surface shall be finished with a wooden float. A light brooming may be required for a more acceptable finish. Bridges shall be used to avoid walking in the freshly laid concrete.
   6. Immediately after the finishing operations are completed the concrete shall be protected and cured in conformance with the requirements specified in Section 701 of the Standard Specifications as modified by this specification in the section on "Concrete Construction".

B. Stone Ditch Lining—Plain:
   1. For stone ditch lining, the stones shall be placed in rows transversely to the centerline of the ditch in the manner indicated on the Plans. The stones shall be placed with ends and sides abutting and the joints between stones in each row breaking with the joints in the preceding row. The larger spaces between stones shall be filled with spalls. The stones shall be rammed or compacted to give them firm bearing and stability.

C. Stone Ditch Lining—Grouted:
   1. After the surface has been inspected and approved, the spaces between stones shall be completely filled with a grout composed of one part of Portland cement and three parts of fine aggregate mixed with sufficient water to produce a plastic mortar. The grout shall be brushed or broomed into the spaces to insure proper filling.
   2. The grout shall be cured in the manner provided above for concrete ditch lining.

D. METHOD OF MEASUREMENT: "Ditch Liner" shall be measured by the square yard of inside face of walls and top surface of base slab of completed and accepted work in place.

E. BASIS OF PAYMENT: "Ditch Liner" shall be paid for at the contract unit price, measured as stated above.

S-503 <u>UNDERDRAIN AND SUMP PUMP CONNECTION</u>: This work shall consist of installing underdrain and sump pump connection(s) according to these Specifications, the Plans, and the Contract Documents. New underdrains, existing foundation drains, roof drains, and sump pump drains shall be connected to the proposed storm sewer system, edgedrain or ditch liner at locations indicated on the Plans or as directed by the engineer. Connections to an existing shall be made by coring a hole in the side or back of the structure that is 2" larger in diameter than the connecting pipe. The edge of the cored hole shall be a minimum of 6" from the inside wall of the box. The area around the connecting pipe shall be filled with non-shrink hydraulic cement. Connection to the storm sewer pipe shall be made by coring a clean hole in the upper 1/3 of the pipe and securing an Insert A-tee or other device as approved by the engineer. Connections to an edgedrain shall be made with a 4"X4" HDPE tee. Grouting the drain tile onto the storm sewer pipe shall not be acceptable.

A. METHOD OF MEASUREMENT: No separate measurement shall be made for "Underdrain and sump pump connection".
B. BASIS OF PAYMENT: "Underdrain and sump pump connection" shall not be paid for separately, but shall be subsidiary to the installation of "Underdrain".

S-504 END SECTIONS FOR STORM SEWERS: This work shall consist of the furnishing and installation of storm sewer end sections at the outfall of storm sewers in accordance with these Specifications and as shown on the Plans, the Standard Details, or established by the Engineer. This work shall include a toe wall for the end section and all the necessary excavation and backfilling for such installations.

A. Material for "End Sections" shall be of like material to the Storm Sewer Pipe to which it is to be attached. Metal End Sections shall not be accepted except for use with CMP Pipe in accordance with the plans. For large diameter HDPE pipe where HDPE end sections are not readily available, concrete end sections may be substituted and a concrete collar shall be used to connect to the pipe. Material for the toe wall shall be Class KCMMB 4K concrete unless the End Section has an integral toe wall of sufficient size to meet the requirements of the Standard Detail for End Sections.
B. The excavation for End Sections and toe wall shall be performed in accordance with the requirements of the section titled “Excavation for Structures”. End Sections shall not be laid until the foundations have been approved by the Engineer.
C. All End Sections should be installed with the area under the haunches well compacted and all voids filled as well as possible. The backfilling shall conform to the requirements of the section titled “Backfilling for Structures”.

D. METHOD OF MEASUREMENT: “End Sections” shall be measured per each of the size and type specified in the Plans (i.e.; 36” RCP, 24” ADS N-12, etc.). Excavation, installation, backfill and toe wall will be subsidiary to “End Section” of the specified size and type.

E. BASIS OF PAYMENT: “End Sections” shall be paid for at the contract unit price bid for each, measured as stated above.

S-505 GABIONS: This work shall consist of construction and installation of gabions in accordance with this Specification, as shown on the Plans or directed by the Engineer.

A. Material for Gabions shall comply with requirements shown in the Standard Specifications as amended in this Specification. Within 30 days after award of contract, and before any of the materials of this section are delivered to the job site, submit complete shop drawings and catalog cuts to the Engineer, as required by the section titled “Material Requirements” in these Specifications. Along with the shop drawings, submit two copies of the manufacturer’s current recommended method of installation.
B. Stone for filling the gabions shall comply with the quality and process control requirements of stone for Riprap shown in the Standard Specifications. The size of the stone shall comply with the gradation shown below:

U.S. Standard Square Mesh Sieve:	Percent Passing by Weight
10 in.	100
8 in.	85-100
6 in.	0-15
4 in.	0-10
3 in.	0

C. CONSTRUCTION REQUIREMENTS:
   1. Gabions shall be assembled and wired together. Each gabion unit shall be assembled by tying all untied edges, including diaphragms, with lacing wire. The lacing procedure consists of cutting a length of lacing wire approximately one and one-half times the distance to be laced (not to exceed five feet), securing one end of the wire at the corner by looping and twisting lacing with single and double loops at approximately five inch intervals, and securing the other end of the wire to selvedges by looping and twisting.
   2. Gabions shall be placed on a prepared subgrade that has been graded to a tolerance of +/- one inch and to the lines and grades shown on the plans. Soft, unstable subgrade material shall be removed and replaced with suitable materials. The subgrade shall be firm and well compacted. The gabions shall be securely tied to each adjoining gabion with lacing wire along the perimeter of all vertical contact surfaces in the same manner as described above for assembly. Gabions on other gabions shall be laced to the lower gabion with lacing wire along the front, back, and ends.
   3. Each gabion shall be removed from the bundle, unfolded flat on the ground, and all kinks and bends flattened.
   4. The gabion unit shall then be assembled individually, by erecting the sides (front and back); ends and diaphragm(s), ensuring that all creases are in the correct position and the tops of all sides’ level.
   5. The four corners of the gabion unit shall be laced first, followed by the edges of internal diaphragm(s) to the side.
   6. The assembled gabion units shall be carried to the job site and placed in their proper locations. Care shall be taken in placing the gabion baskets to insure that the filter fabric is not damaged. For structural integrity, all adjoining empty gabions must be laced along the perimeter of their contact surfaces in order to obtain a monolithic structure.
   7. The following method applies to 3’-3” high gabions; once the gabion units are laced together, they shall be stretched to effective alignment. This operation shall be

carried out after several empty gabion units have been positioned. The first gabion in the line shall be partially filled to provide the necessary anchorage. Any stretching shall be carried out using a come-along or other means of at least 1 ton capacity. For gabions less than 3'-3" in height, the above procedures shall be modified in accordance with instructions provided by the manufacturer and approved by the Engineer.

8. While under tension, the gabion joints shall be carefully controlled against any possible unraveling.
9. The PVC coating on the wire shall be continuous. A coating compound material, recommended by the manufacturer of the gabions and approved by the Engineer, shall be on hand and applied where any PVC coating is broken because of abrasion during shipment or during construction. Excessively damaged gabions will be rejected.
10. Each empty cell shall be first filled to a depth of twelve inches for 3'-3" deep gabions, nine inches for 18" deep gabions, and completely for one foot or less deep gabions.
11. Two parallel connecting wires shall be uniformly spaced and securely fastened to each outer face of each cell, at a height of twelve inches above the base for 3'-3" deep gabions, and nine inches for 18" deep gabions. Wire shall extend a minimum of 4" past the face of the gabion on each side, and the 4" of wire shall pass around one of the gabion mesh wires and twisted at least 3 times around itself. Inner tie wires in the interior of the structure where all sides of each cell will be supported by the rock fill in the adjacent cell will not be required.
12. Cells shall be filled to a further depth of twelve inches (completely for an 18" deep gabion), and connecting wires shall be similarly tied at this level in the 3'-3" deep gabions and to each outer face of each cell as in (2).
13. Rock shall be placed in gabions by mechanical equipment or by hand, except that along all visible faces of the completed structure the stone shall be carefully placed and packed by hand to ensure proper alignment and a neat, compact, square appearance.
14. If a given group of gabions must be completed prior to the completion of the structure, they will constitute a temporary perimeter and must have the inner tie wires installed. The cells around the perimeter, when half full, shall have inner tie wires installed to prevent bulging of the unsupported outer faces.
15. Each filling, incremental or otherwise, shall contain stone of such size that not less than two layers of stone are required to complete the filling.
16. All connecting wires shall be looped around two mesh openings and the ends of the wires shall be securely twisted to prevent their loosening and all loose edges and projecting ends of wires shall be turned into the gabion.
17. Cells in the row shall be filled in stages such that the depth of rock fill in any cell does not exceed the depth in an adjoining cell by more than one foot.
18. Compression Rings consisting of overlapping stainless steel fasteners may be used in lieu of lacing wire for basket assembly and installation. The spacing of the fasteners during all phases of assembly and installation shall be in accordance with spacing based on 1,200 lbs. pull apart resistance for PVC coated mesh and with a nominal spacing of 4 inches, and not to exceed 6 inches.
19. Stainless Steel Fasteners: diameter: 0.120 inch, according to ASTM A313, Type 302, Class I. Tensile strength: 222,000 to 253,000 psi in accordance with ASTM A313-92.
20. Proper installation of rings: A properly formed fastener shall have a nominal overlap of one inch after closure.

21. Lid Closure: When the gabion has been overfilled (approximately two inches) to allow for future settlement of the rock, the lid shall be bent and stretched until it meets the perimeter edges of the front and end panels.
22. The lid shall then be tightly laced with lacing wire to the edges of the front and end panels and the top of diaphragms in the same manner as described above for assembling. To assist in closing and lacing, a pinch bar or special closing tool shall be used. Lacing adjacent lids to the vertical panels in one operation is acceptable. PVC coatings or other damage of the lids must be repaired as approved by the gabion manufacturer.
23. Where shown on the Plans or otherwise directed by the Engineer, the gabion mesh shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent gabion face. The cut edges of the mesh shall be securely laced together with lacing wire in the manner described above for assembling.
24. The assembling, installation, filling, and lid closing of the re-shaped gabions shall be carried out as specified above.
25. Clean graded backfill for stone-filled gabion baskets shall be CA-4. Granular backfill shall be brought up evenly in lifts not to exceed 12 inches. Do not dump over the side of the trench in any manner that will bring earth into the granular fill area. Compact granular backfill using vibratory compaction to a minimum compaction of 95% of maximum density.

D. METHOD OF MEASUREMENT: The quantity to be measured under this item will be the number of cubic yards of stone required to fill the gabions in accordance with the dimensions shown on the plans. Gabion concrete curb, granular backfill, earth backfill, filter fabric, removal of unsuitable material, Compaction of Earthwork, Unclassified Excavation, and Contractor Furnished Borrow will not be measured separately, but shall be subsidiary to “Gabions”.

E. BASIS OF PAYMENT: The completed and accepted work, measured as provided above, shall be paid for at the Contract unit price per cubic yard for “Gabions”, which price shall be full compensation for all excavation, backfilling, for furnishing and placing all materials including filter fabric, for all labor, tools, equipment and incidentals necessary to complete the work.

S-506 PRECAST CONCRETE BOX CULVERT: This work shall consist of furnishing and placing precast reinforced concrete box barrels and cast in place wing walls and soil savers. Precast reinforced concrete culvert barrels shall be furnished in accordance with the requirements of ASTM C 1577 for less than 2 feet of cover with live loads and greater than 2 feet of cover. Design shall be based on AASHTO HS-20 loading. In addition, specific design requirements for culvert barrels shall be as indicated on the Plans. Reinforcing steel shall be Grade 60 in accordance with Section 1600 of the Standard Specifications. Concrete and reinforcing steel shall meet the requirements of these Specifications as described in "Concrete Construction", "Reinforcing Steel", and "Aggregate For Concrete". Shop drawings shall be required for precast sections and for required modifications to wing walls, toe walls, and hub guards.

A. A minimum length section of the RCB adjacent to the wing walls shall be poured in place with hub guards and toe walls shown on the Plans. KCMMB 5K concrete shall be used. This section length shall be as indicated on the Plans or as determined by the project engineer. The end barrel segments of the precast RCB will be constructed with a key and tie steel of an adequate length and bar size for a lap with the toe wall and hub guard reinforcing steel in the poured in place section. Pipe blockouts shall be cast into the RCB barrel sections at the locations shown on the Plans, with the reinforcing steel running through the blockout to be cut out in the field. Extra reinforcement as per the Plans shall be installed around the blockout and shall be so indicated on the shop drawings.
B. The last three barrel sections on each end will be connected with a minimum of four tie bolts per joint, unless another joint system is approved by the Engineer.
C. Excavation and backfill for precast culverts shall be in accordance with the requirements of these Specifications as described in "EXCAVATION FOR STRUCTURES". A granular bedding shall be placed to provide an even surface of uniform density. The placing of precast barrel segments shall be started at the outlet end, with barrel segments placed with ends tightly abutting and true to line and grade. Barrel segments shall be match cast to each other or shall be otherwise formed at the joints with such precision as to limit joint openings in the installed position to not more than 3/4 inch wide. The completed barrel shall form a smooth uniform invert. The space between parallel segments in a multiple RCB shall be filled with grout or aggregate backfill, as indicated on the Plans. An approved mastic joint filler shall be applied to the joints prior to placement of the barrel segments. All precast barrel joints shall be wrapped in an external sealing band meeting the requirements of ASTM C 1577 and installed in accordance with the manufacturer's requirements.

D. METHOD OF MEASUREMENT: "Precast Concrete Box Culvert" shall be measured per linear foot of completed and accepted work, measured horizontally along the centerline of the box. No measurement shall be made for concrete, reinforcing steel, aprons, wire mesh, wing walls, headwalls, soil saver, excavation, or backfill. These items shall be subsidiary to the RCB.

E. BASIS OF PAYMENT: "Precast Concrete Box Culvert" shall be paid for at the contract unit price, measured as stated above.

S-507 REINFORCED CONCRETE BOX CULVERT: This work shall consist of furnishing and placing Portland cement concrete and reinforcing steel in accordance with these Specifications and as shown on the Plans or established by the Engineer.

A. Construction shall meet the requirements of “Concrete Construction” and “Reinforcing Steel”. Reinforced Concrete Box Culverts shall be designed to utilize KCMMB 5K concrete.

B. METHOD OF MEASUREMENT: “Reinforced Concrete Box Culvert” shall be measured per linear foot of completed and accepted work, measured horizontally along the centerline of the box. No measurement shall be made for concrete, reinforcing steel, aprons, wire mesh, wing walls, headwalls, soil saver, excavation, or backfill.

C. BASIS OF PAYMENT: “Reinforced Concrete Box Culvert” shall be paid for at the contract unit price, measured as stated above.

S-508 STONE RIPRAP: This work shall consist of the construction of riprap composed of approved stone or grouted stone in accordance with these Specifications and as shown on the Plans or established by the Engineer.

A. MATERIALS: Stone for riprap and grouted riprap shall consist of quarried rock and be sound, durable, and angular in shape. No more than 10 percent shall have an elongation greater than 3:1, and no stone shall have an elongation greater than 4:1. Material shall be free from cracks, seams, or other defects. Shale and stone from shale seams are not acceptable.
   1. Not more than 10 percent of the stone shall exhibit splitting, crumbling, or spalling when subject to 5 cycles of the sodium sulfate soundness test in accordance with ASTM C 88.
   2. Stone for riprap shall have the following gradation based on the Class of Riprap specified in the plans:

Stone For Riprap*

	Percent Heavier Than												
Class	8 Ton	4 Ton	2 Ton	1 Ton	1/2 Ton	1/4 Ton	250 lbs.	200 lbs.	180 lbs.	75 lbs.	60 lbs.	10 lbs.	5 lbs.
Heavy Series													
8 Ton	50+	95+											
4 Ton	0	50+	95+										
2 Ton		0	50+	95+									
1 Ton			0	50+	95+								
1/2 Ton				0	50+	95+							
1/4 Ton					0	50+				90+			
Light Series													
Light 24"						0		50+					90+
Light 18"							0		5-15		50-70	85-100	

* Percent of total sample weight which is composed of pieces heavier than the indicated weight.

B. The area upon which the riprap is to be placed shall be excavated to the required grades and lines and the surface shall be smoothed and compacted. Geotextile material shall be laid on the compacted surface prior to placing the riprap. Sheeting shall be used for forming the toe wall for concrete riprap, if necessary, in order for the concrete to be placed on dry subgrade. The Geotextile material shall meet the requirements of Section S-513 GEOTEXTILE.
C. The larger spaces between stones shall be filled with spalls of suitable size and all spalls shall be rammed thoroughly in place. The entire surface shall be rammed and compacted to obtain a tight surface. The finished surface shall present an even surface conforming to the lines, grades, and sections given.
D. When grouted stone riprap is indicated, the spaces between stones of grouted riprap shall be filled with grout consisting of one part Portland cement and three parts of fine aggregate with sufficient water to form a plastic mix. The grout shall be poured and broomed into the spaces until they are completely filled.
E. The grout shall be cured in the manner provided for concrete in the section of this specification titled Concrete Construction.

F. METHOD OF MEASUREMENT: This work shall be measured by the square yard of "Riprap" complete in place as measured along the finished surface. Compaction of the subgrade, furnishing and placement of the geotextile material, excavation, and other labor, material, and equipment necessary for the installation shall be subsidiary to installation of the riprap.

G. BASIS OF PAYMENT: The amount of completed and accepted work, measured as stated above, shall be paid for at the contract unit price bid for "Riprap" of the type designated, complete and in place. Excavation for the riprap shall be subsidiary to "Riprap".

S-509 STORM INLETS AND MANHOLES: This work shall consist of constructing inlets, manholes and junction boxes in accordance with the Specifications and as shown on the Plans, the Standard Details, or established in the field by the Engineer.

A. The method of excavation shall conform to the requirements of “Excavation for Structures”, in this specification.
B. Construction shall be in conformance with the Standard Details for “Inlets” or “Manholes” or “Junction Boxes”.
C. The Contractor shall, before any fabrication is begun, submit shop drawings to the Engineer for review and approval.
D. Backfilling of structures shall be by hand tamping with a jumping jack or other hand held device or small roller in 6”-8” lifts around the structure. Using the hoe bucket or other large equipment or a plate compactor will not be allowed. The contractor may submit an alternate method such as placing flow fill around the structure or placing pugged and compacted AB-3 or clean aggregate adjacent to the structure where mechanical methods of compaction are not feasible. Backfilling shall not occur for a minimum of 12 hours after placement of concrete for collars.

E. METHOD OF MEASUREMENT: Inlets, manholes, and junction boxes shall be measured per each structure completed and accepted. Installation, backfill, curb transitions, and connection of storm sewers to the structure shall be subsidiary to the structure.

F. BASIS OF PAYMENT: Inlets, manholes and junction boxes shall be paid for at the contract unit price per each.

S-510 STORM SEWERS: This work shall consist of the construction of storm sewers for the removal of water from collection points, in accordance with these Specifications and as shown on the Plans, the Standard Details, or established by the Engineer.

A. Pipe, including joints, for “Storm Sewer” shall be either Reinforced Concrete meeting the requirements of Section 1900 of the Standard Specifications or Corrugated Polyethylene Pipe (Type S) meeting the requirements of AASHTO M294. Concrete pipe shall be Class III pipe unless stated otherwise on the plans.
B. The trench shall be excavated beginning at the outlet end and proceeding toward the upper end, true to line and grade shown on the Plans or as established by the Engineer. The width of the trench shall be sufficient to lay and backfill the pipe satisfactorily but in no case shall be less than the external diameter of the pipe times two (2). When necessary, the trench shall be adequately shored or sheeted to insure safe and satisfactory construction and backfilling. If tunneling under a railroad or existing street or highway is required, it shall be done by methods which will insure that the railroad, street, or highway is undisturbed during and after the construction and such methods shall be approved by the Engineer before work is begun. If it is necessary to remove an existing street or highway surface in constructing the sewer the surface shall be repaired according to the Standard Details D-105 Utility Trenching. In no case shall backfill be placed on frozen ground. In no case shall frozen material be used for backfill.
C. The trench shall be backfilled per Standard Details D-105 Utility Trenching and D-302 Storm Sewer 1. All pipes shall be backfilled per Standard Detail D-302 Table 1, unless otherwise shown on the plans. Minimum cover of soil over the top of the pipe shall be 2 feet.
D. Bedding material shall be pared or molded to give full support to each pipe as shown in the Standard Details. Notches shall be cut to receive the bell (when bell and spigot pipe is used).
E. The pipe shall be supported for its full length and anchored to prevent floating, if necessary, for concrete encasement.
F. The trenches for all sewers that lie within the roadbed, or beneath entrances, side roads, sidewalks, and other intersecting traveled ways, or which are so designated on the Plans, shall be backfilled to the required grade in accordance with the Standard Details.
G. The laying of pipes in finished trenches shall be started at the outlet end so that the spigot ends (when bell and spigot pipe is used) point to the direction of flow. All pipes shall be laid with ends abutting and true to line and grade. They shall be fitted and matched so that when laid in the trench, they will form a sewer with a smooth, uniform invert. Bell ends (when bell and spigot pipe is used) shall be carefully cleaned before pipes are lowered into the trenches. Pipes shall be so lowered as to avoid unnecessary handling in the trench.
H. Plastic joint compound or O-rings shall be used to joint the sections of RCP’s and applied in accordance with the manufacturer's recommendations.
I. Concrete pipes used as outlet pipes from wetponds, wetlands and lakes, shall use synthetic rubber “O-ring” gasketed joints (APWA-KCMO 2602) O-ring type, circular cross section or “Profile” gasketed joints, non-circular section, conforming to ASTM C1619.
J. Sections of Corrugated Polyethylene Pipe (Type S) shall be joined with a coupler of the bell and spigot type. All joints shall be soil tight.
K. Reinforced concrete box storm sewer shall be constructed of the class of concrete designated on the Plans and the work shall conform to the requirements specified in sections 400 and 700 of the Standard Specifications in regards to “Classification and Proportioning” of concrete, and to “Concrete Structure Construction”.
L. Backfilling of reinforced concrete box storm sewer shall conform to the requirements specified in the section of this specification titled “Backfilling for Structures”.

M. METHOD OF MEASUREMENT: “Storm Sewers” shall be measured by the linear foot of the size of conduit specified in the Plans (i.e. 36", etc.) measured from inside face of structure. Excavation, installation, backfill, flowable fill, street restoration (all types), and restoration of any disturbed areas will be subsidiary to “Storm Sewer” of the specified size.

N. BASIS OF PAYMENT: “Storm Sewer” shall be paid for at the contract unit price, measured as stated above.

S-511 <u>UNDERDRAINS</u>: This work shall consist of constructing underdrains using pipe, granular filter material, geotextile fabric, underdrain pipe outlets, and blanket drains using granular material and geotextile fabric in accordance with the KDOT Standard Specifications for State Road and Bridge Construction Section 822 and Section 1907 except as otherwise modified herein, and as shown on the Plans or established by the Engineer.

A. The type of pipe shall be Type H or K (per the Standard Specifications), but with a nonwoven geotextile sock which shall be a 100% continuous filament polyester nonwoven needle punched engineering fabric or as specified on the Construction Drawings. Prefabricated edge drains shall be used for residential streets and shall conform to the requirements for Class B Geocomposite as defined in ASTM D7001-06. This geocomposite product shall be composed of a flat pipe design consisting of a full circumference polyethylene core wrapped with a nonwoven Class II geotextile. Although selection of the appropriate geotextile specifications is site soil specific, a commonly used geotextile for filtration will have an Apparent Opening Size ranging between U.S. Sieve Sizes 70 to 100 and a minimum unit weight of 5.0 oz./square yard. The coefficient of permeability will typically range between 0.16 to 0.24 in./second. All underdrain shall be installed with flowlines a minimum of 1.25 foot below the existing gutter grade. The underdrain pipes shall have a nominal minimum inside diameter of four inches unless shown otherwise on the Plans. If the installation of the underdrain causes the relocation of any water or sewer lines, the relocation of the water or sewer line shall be subsidiary to the underdrains. Installation of geotextile fabric and backfill shall be in accordance with the plans and with these specifications.
B. Granular filter material shall meet the requirements of Table 1.

TABLE 1						
% RETAINED-SQUARE MESH SIEVES						
	1"	3/4"	1/2"	3/8"	No. 4	No. 8
BEDDING MATERIAL	0	0-20	-	40-70	75-100	95-100

C. The exact location and layout of underdrains as shown on the Plans shall be subject to revision by the Engineer as determined during construction.
D. Trenches for all lateral and longitudinal interceptor drains shall be excavated to the dimensions, depths and elevations, as shown on the Plans or ordered by the Engineer. When necessary, the trench shall be adequately shored or sheeted to insure safe and satisfactory construction and backfilling. Trench bottoms for perforated pipe in firm material (no mucky or soupy condition existing) shall be constructed to permit the placing of three inches of aggregate for pipe underdrains underneath the pipe.
E. If unstable material is encountered in the bottom of the trench, the drain pipe shall be placed upon an insulating course of aggregate for pipe underdrains of sufficient thickness (maximum of three inches to insure proper movement of water without danger of sealing or mudding off the underdrain and to maintain proper alignment and grade of the pipe. Insulating courses of aggregate will be permitted under perforated pipe only. If the unstable material is also permeable to the extent that water is lost through the bottom of the trench as determined by the Engineer, the drain shall be lowered into impermeable material.
F. Minimum trench width is 18”.
G. Surplus excavated material shall be disposed of by the Contractor.
H. Excavation for blanket underdrains shall be in accordance with the location, lines, grade and elevations as indicated on the Plans or as ordered by the Engineer. The blanket drain shall rest upon the bedrock or other suitable material as indicated on the Plans or as determined

by the Engineer. Irregularities on the bedrock surface shall be so shaped that undrained pockets are not formed. In suitable material the roadbed surface to receive the blanket drain shall be rolled and shaped to the proper crown. Pipe underdrains constructed in connection with the blanket underdrains shall be constructed to the lines, grades and elevations as shown on the Plans or in accordance with field conditions as ordered by the Engineer prior to placing the aggregate for blanket underdrains.

I. All underdrain pipes shall be laid carefully to line and grade. All pipes shall be laid on a minimum grade of one percent unless otherwise shown on the Plans. All dead ends of pipe underdrains shall be completely closed.

J. All junctions and turns shall be made with wyes, tees, and bends. Perforations shall be laid down unless otherwise indicated on the Plans.

K. All outlet pipes shall be laid on a minimum of one percent grade unless otherwise shown on the Plans. Outlet pipe shall be laid only on stable impermeable material.

L. Backfilling the trenches of lateral and longitudinal underdrains shall not be started until approved by the Engineer. The trenches shall be backfilled to the elevations shown on the Plans with aggregate for pipe underdrains. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench. Overbreakage due to blasting of rock in trench excavation and widening due to caving of trench walls or overbreakage at construction outcrops shall be backfilled with aggregate for underdrains.

M. Where a portion of the trench above the underdrain backfill aggregate is to be filled with earth it shall be filled with material that will compact satisfactorily. This material shall be placed in layers and compacted to a density equal to or greater than that required for the adjacent material with a minimum of 90 percent of standard compaction of the soil used.

N. Backfilling of blanket underdrains shall not be started until the pipe underdrain installation and the foundation for the blanket underdrain are approved by the Engineer. The blanket shall be backfilled to elevations shown on the Plans with aggregate for blanket underdrains or with the type of aggregate specified in the Plans. All irregularities of the bedrock surface shall be backfilled with aggregate for blanket underdrains. At no point shall the blanket underdrain be less than twelve inches thick.

O. When blanket underdrains are constructed over lateral or longitudinal underdrains all earth, mud, etc. that may have collected in the top portion of the pipe underdrain backfill shall be removed so that the aggregate of the blanket underdrain will be in direct contact with the aggregate backfill of the lateral or longitudinal underdrains.

P. The lateral drain trench under the blanket underdrain shall be backfilled and rounded to an elevation of approximately six inches above the top of the trench and shall be maintained at the rounded elevation free from mud or other objectionable material until the aggregate for the blanket underdrains is placed thereon.

Q. If necessary, in order to form a stable layer or course, the aggregate shall be sprinkled with water during the process of spreading and rolling. The sprinkling shall be performed in such a manner that the force of the water will not wash the finer material to the bottom of the lift.

R. When concrete pavement or earth backfill material is to be placed over the blanket underdrain, the top four inches of the underdrain shall be composed of fine aggregate or other approved granular aggregate provided these fine aggregates do not have more than 2% passing the No. 200 sieve (wash).

S. Pipe outlets shall be connected to a storm sewer structure unless otherwise shown on the Plans or directed by the Engineer.

T. METHOD OF MEASUREMENT: “Underdrains” shall be measured by the linear foot along the centerline of the underdrains from the end of the pipe to the end or the center of junctions, complete and accepted. No measurement shall be made for excavation, disposal

of surplus excavated materials, aggregate for underdrains required to fill the trenches, connection to storm sewer structures, concrete outlet structures, or geotextile required for installation of the underdrain. Such work shall be considered as subsidiary work pertaining to the item of pipe underdrains.

1. Aggregate for blanket underdrains shall be measured by the cubic yard of aggregate as shown in the Contract.
2. The excavation for blanket underdrains shall not be measured but shall be subsidiary to the cubic yard of aggregate shown in the Contract.

U. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price, per linear foot for the various sizes of “Underdrains”, and per cubic yard for “Aggregate for Blanket Underdrains”.

S-512 GEOTEXTILE: The work shall consist of furnishing all equipment, labor and material for placing geotextile as specified herein and shown on the contract drawings.

A. MATERIALS: Geotextile shall meet the requirements of AASHTO M-288-00 except as modified herein.

The geotextile shall be a nonwoven sheet of plastic yarn as defined by ASTM D 123 and conform to the criteria presented in Table 1. These requirements shall be based on the Minimum Average Roll Value (MARV) which is defined as the value that can be expected, with 95 percent confidence, to be the minimum test average obtained on a roll sampled and tested in accordance with ASTM D 4759.

TABLE 1 PHYSICAL REQUIREMENTS

Geotextile Class 1*			
Physical Property	**ASTM Test Procedure**	**Minimum Acceptance Criteria**	
		English	Metric
Grab strength tensile	D 4632	200 lbs	890 N
Grab Elongation at Break	D 4632	50%	50%
Puncture Strength	D 4833	80 lbs	355 N
Mullen Burst Strength	D 3786	260 psi	1790 Kpa
Trapezoidal Tear	D 4533	90 lbs	355 N
Apparent Opening Size (AOS)	D 4551	70-100 US Std. Sieve	150-212 µm
Geotextile Class 2**			
Physical Property	**ASTM Test Procedure**	**Minimum Acceptance Criteria**	
Grab strength tensile	D 4632	120 lbs	530 N
Grab Elongation at Break	D 4632	60%	60%
Mullen Burst Strength	D 3786	90 psi	620 Kpa
Apparent Opening Size (AOS)	D 4551	60/70 US Std Sieve	250/212 µm

*Underdrains, Blanket Underdrains, Modular Concrete Retaining Walls and Stone Rip Rap shall be Class 1 Geotextile.
**Landscaping Items and Bioretention Facilities shall be Class 2 Geotextile.

B. METHOD OF MEASUREMENT: No separate measurement shall be made for “Geotextile”.

C. BASIS OF PAYMENT: No separate payment shall be made for “Geotextile”. This item shall be subsidiary to installation of “Underdrains”, “Aggregate for Blanket Underdrains”, “Stone Rip Rap”, “Modular Concrete Retaining Walls, “Landscaping Items” and “Bioretention Facilities”.

EROSION AND SEDIMENT CONTROL

S-600 COIR FIBER LOGS: Work included in this section consists of the installation of coir fiber logs. All provision of S-608 "Temporary Erosion and Sediment Control" shall apply to this section.

A. The Contractor must provide the owner certification from the manufacturer that the material meets the requirements of the specification.
B. Coir logs shall meet the following requirements:

Material	Component	Requirement
Coir Logs (Humus Granular Integrated Prior to Construction)	Material of Construction	Coconut Mattress Coir Fiber/Plant Source Humus
	Density	5 pounds per linear foot
	Maximum Length	10 feet
	Diameter	12" +/- (300 mm +/-)
	Reinforcement Material	Polypropylene 5 x 5 mm mesh netting with attachment sock at one end
	Humus Granular	GroPower 12-8-8 CRF, 5 bulk pounds per linear foot.
Stakes	Material of Construction	Hard wood
	Dimensions	1.5 x 1.5 x 24 inches

C. INSTALLATION:
The Contractor shall excavate a 6" deep trench along toe of the slope for placement of coir logs.
D. The coir logs shall be secured in the trench with a minimum of two hardwood stakes/wire loops on the uphill side of each log. Each log must abut and attach to the next and shall be installed in a contour following the stream bank. Coir logs shall be located as noted in the plans.
E. In areas where Turf Reinforcing Matrix (TRM) or wire-reinforced TRM is to be applied, the material shall be anchored under the coir logs in the following manner:
F. Hardwood stakes shall be installed with a minimum of two stakes per coir log, and shall be placed in the following manner or as directed by the Engineer:
    1. The TRM should be placed prior to the installation of the coir logs.
    2. Coir logs shall be placed on top of the bottom edge of TRM or wire-reinforced TRM, and anchored to the streambed with the wire loop circling the coir log.
    3. Stakes shall be pounded flush with the ground, through the TRM on the uphill side of the coir log. The stake should point downwards and slightly away from the coir log.

G. METHOD OF MEASUREMENT: "Coir Fiber Logs" shall be measured per the lineal foot of completed and accepted work.

H. BASIS OF PAYMENT: "Coir Fiber Logs" shall be paid for at the contract unit price bid per lineal foot of completed and accepted work, measured as stated above.

S-601 DITCH CHECK: This work shall consist of the construction of erosion control ditch checks, in accordance with these Specifications and as shown on the Plans or established by the Engineer. All provision of S-608 “Temporary Erosion and Sediment Control” shall apply to this section.

A. The ditch checks can be constructed as Rock Ditch Checks, Triangular Silt Dike ™ Ditch Checks, Geo-Ridge® Ditch Checks, or other Ditch Check products and materials approved by the Engineer. The Ditch Checks shall be constructed in accordance with the manufacturer’s recommendation, in accordance with these specifications, as shown on the plans, or as established by the Engineer.
B. Subgrade for the ditch checks shall be excavated to a smooth surface parallel to the proposed finished surface, as required by the manufacturer, as show on the plans, or as established by the Engineer. Filter Fabric shall be placed prior to placing rock.

C. METHOD OF MEASUREMENT: "Ditch Check" shall be measured per each of completed and accepted work in place. Said measurement shall include all labor, material, equipment, and other incidentals necessary for the installation.

D. BASIS OF PAYMENT: "Ditch Check" shall be paid for at the contract unit price, measured as stated above.

S-602 FILTER BERM/TUBES: This work shall consist of installing sediment control filter berms/filter tubes. The filter berms/tubes shall be constructed using material detailed in this specification and in the Standard Details. All provision of S-608 "Temporary Erosion and Sediment Control" shall apply to this section.

A. MATERIALS: Filter Berm/Filter Tube Mulch: Where used without seeding or planting, use material derived from weed free bark/wood mulch that conforms to the following:

- PH of 5.0 to 8.0
- Particle Size:
  1" Sieve 99% Passing
  ¾" Sieve 90% Passing
  3/8" Sieve Not more than 30% Passing
- 98% of the material shall be less than 3" in length
- Moisture Content <60%
- Organic Matter >70%
- Foreign Matter <1% by dry weight
- Sample shall be submitted to Engineer for approval prior to use.
- Material must comply with local, county, and state regulations.

B. Filter Berm/Filter Tube Compost: Where seeding or planting is planned or where biological filtration may be desired, use compost material derived from well decomposed organic matter source, or in combination with filter berm mulch (maximum of 50%). The compost material shall be produced by the aerobic (biological) decomposition of organic matter. The organic matter may include, but is not limited to, a wide variety of trimmings, Class A Biosolids (as defined in Federal Regulations 40 CFR Part 503), food scraps, composted manures, paper fiber, wood, bark or combinations of these products. The compost shall be free of any refuse, contaminants or any material toxic to plant growth. All compost material supplied shall be processed to meet the US Composting Council's Seal of Testing Assurance Program, or equivalent, for control of noxious weeds, pathogen and vector attraction, and disclosure of heavy metals, nutrient levels and maturity level of compost. All lab analysis to follow testing procedures of the US Composting Council's TMECC Manual. (Information available on-line at www.compostingcouncil.org).

1. Filter berm/Filter Tube compost shall conform to the following:

- PH 5.5 to 8.0
- Particle Size:
  1" Sieve 99% Passing
  ¾" Sieve 90% Passing
  3/8" Sieve Not more than 60% Passing
- 98% of the material shall be less than 3" in length.
- Moisture Content <60%
- Organic Matter >70%
- Foreign Matter <1% by dry weight
- Sample shall be submitted to Engineer for approval prior to use.
- Material must comply with local, county, and state regulations.

C. Filter Tube: When the filter tube is used, the tube shall be composed of jute fabric, or other bio-degradable fabric approved by the engineer. The fabric shall bio-degrade within 10 months of placement if it is to remain in place. Where the tube is to be removed, a more

permanent fabric may be used. The tube shall be filled with compost when it is to remain and with mulch where it is to be removed.

D. Requirements:
   1. The Contractor shall maintain the erosion control filter berm/filter tube in a functional condition at all times and it shall be routinely inspected. The Contractor shall immediately correct all deficiencies. The Contractor shall make a daily review of the location of the berm in areas where construction activity causes drainage runoff to ensure that the berm is properly located for effectiveness. Where deficiencies exist, additional berm/tube material shall be installed immediately.
   2. The Contractor shall remove sediment retained by the berm/tube once it has reached 1/3 of the exposed height of the berm, or as directed by the Engineer.
   3. The berm shall be dispersed when no longer required, as determined by the Engineer. At the Engineer's discretion, berm/tube material may be left to decompose naturally, or distributed over an adjacent area for additional use as a soil amendment or ground cover.

E. METHOD OF MEASUREMENT: "Filter Berm/Tubes" shall be measured per linear foot of completed and accepted "Filter Berm" or "Filter Tube".

F. BASIS OF PAYMENT: "Filter Berm/Tubes" shall be paid for at the unit price bid per linear foot of completed and accepted "Filter Berm" or "Filter Tube", measured as stated above, which price shall be full compensation for all excavation, backfilling, for furnishing and placing all materials, for all labor, tools, equipment and incidentals necessary to complete the work.

S-603 INLET PROTECTION: This work shall consist of installing and maintaining any one of a variety of devices or procedures used to allow water to enter a stormwater inlet while filtering or temporarily impeding the flow sufficiently to reduce the quantity of sediment carried. All provision of S-608 “Temporary Erosion and Sediment Control” shall apply to this section.

A. MATERIALS: When used, wattles, foam dike, silt fence, rock ditch checks and gravel bags shall meet the material requirements given by other items of this specification. All other material specifications are as shown in the Standard Details or on the plans.

B. CONSTRUCTION REQUIREMENTS: Unless otherwise indicated by the Engineer, any of the inlet protection systems given in the Standard Details or plans may be used where appropriate. The project plans may limit the use of particular inlet treatments or specify greater detail on their use. The appropriate details for a given inlet will change during the progress of the job and adjustments shall be made as inlet construction progresses. Each inlet shall be protected continuously from initial construction until final stabilization. The General cases of inlet protection and the performance expected from each are as follows:
   1. All Inlets at Sump Conditions: Inlets at sump conditions shall remain accessible for flow at all times. Small barriers, depressions and/or filters are used to screen larger sediments and initiate settlement of the water prior to it entering the inlet by creating a ponding zone. Generally, stormwater will enter the inlet via weir flow over the top of the barrier. Such water is generally the least-sediment laden as it is decanted from the top of the ponded area.
   2. Street Inlets on Grade: On-grade inlet shall be converted into a localized sump condition by installing a barrier downstream and around the inlet of sufficient height to produce ponding and prevent bypass, while a barrier, depression, and/or filter in front of the inlet induces settlement of solids. Bypassing of water at the on-grade inlet shall not be allowed and the inlet shall remain open to accept flow without causing excessive flooding.
   3. Selected Inlets Closed to Flow: In select locations, the plans may designate certain inlets as “closed to flow.” In those situations, the objective is to provide sufficient blockage of permanent and temporary openings to prevent entry of stormwater into the inlet. Such locations will be clearly indicated on the plans, and the closed condition for flow may be designated for only a portion of the construction period. The Contractor shall notify the Engineer if they believe that the closure of such inlets would result in an increased risk of flooding or downstream erosion, and such concerns shall be resolved before closing an inlet to flow.

C. MAINTENANCE: Sediment shall be removed from each inlet after every rainfall event that exceeds ½” or which results in a visible accumulation of sediment. Particular attention shall be paid to prevent blockage of inlets or cases where re-suspension of captured sediment is likely. Specific maintenance issues unique to each inlet protection type shall be addressed as outlined in the detail.

D. METHOD OF MEASUREMENT: “Inlet Protection” will be measured per each inlet protected for completed and constructed work. Each inlet will be measured only one time for the duration of the project regardless of the number of phases or protection methods used to protect a single inlet.

E. BASIS OF PAYMENT: “Inlet Protection” shall be paid at the contract price bid per each measured as provided above, which prices shall be full compensation for all material, labor,

tools, equipment, and incidentals necessary to complete the work. Contract price also includes maintenance or Inlet Protection as described above.

S-604 POLYACRYLIMIDES: Work included in this section consists of applying/installing Polyacrylamides to soil. Anionic Polyacrylamide (PAM) is a product that is to be land applied as a temporary soil-binding agent to reduce erosion. All provision of S-608 “Temporary Erosion and Sediment Control” shall apply to this section.

A. Only the anionic form of PAM shall be used. Cationic PAM is toxic and shall not be used. This temporary practice is not intended for direct application to surface waters of the state. Polyacrylamides shall meet the requirements of ANSI/NSF Standard 60 for Drinking Water Treatment Chemicals. Never add water to PAM, add PAM slowly to water.
B. Anionic PAM in pure form shall have less than or equal to 0.05 percent acrylamide monomer by weight, as established by the Food and Drug Administration and the environmental Protection Agency.
C. To maintain less than or equal to 0.05 percent of acrylamide monomer, the maximum application rate of PAM, in pure form, shall not exceed 200 pounds/acre/year. Do not over apply PAM. Excessive application of PAM can lower infiltration rate or suspend solids in water, rather than promote settling. PAM will be applied per the specific manufacturer’s recommended rate, not to exceed the above specified maximum rate per acre per year.
D. Users of anionic PAM shall obtain and follow all Material Safety Data Sheets required and manufacturers’ recommendations. The manufacturer or supplier shall provide written application methods for PAM and PAM mixtures. The application method shall insure uniform coverage to the target and avoid drift to non-target areas including waters of the State. The manufacturer or supplier shall also provide written instructions to insure proper safety, storage, and mixing of the product.
E. PAM are soil specific and will not provide the desired effect if applied to the wrong soil. The Contractor shall obtain a soil sample from the site—at a location designated by the Engineer—for submittal and analysis by the manufacturer. The manufacturer shall recommend the appropriate product from their offerings for the specific site soil. PAM shall be delivered to the site in the manufacturer’s containers.

F. METHOD OF MEASUREMENT: “Polyacrylamides” shall be measured per the acre of installed product, complete and accepted. Such measurement shall include all labor, tools, equipment, and incidentals necessary to complete the work.

G. BASIS OF PAYMENT: “Polyacrylamides” shall be paid for at the contract unit price bid per acre of “Polyacrylamides”, which price shall be full compensation for all labor, tools, equipment, and incidentals necessary to complete the work.

S-605 <u>ROLLED EROSION CONTROL PRODUCTS</u>: Work included in this section consists of providing and installing rolled erosion control products including erosion control blanket and turf reinforced matrices. All provision of S-608 “Temporary Erosion and Sediment Control” shall apply to this section.

A. GENERAL: The Contractor must provide the owner documentation from the manufacturer that each lot of rolled erosion control product meets or exceeds the required specifications. The contractor shall also submit samples of each type of fastener to be used with the rolled erosion control products.
   1. Rolled erosion control products shall meet the following requirements by category of rolled product:

EROSION CONTROL BLANKET (ECB):

PROPERTY	TEST METHOD	TYPICAL ROLL VALUES
Interior Fill Material	Observed	Straw, Coir, or Excelsior
Netting	Observed	Double Reinforced, Polypropylene, 0.5”x 0.5” openings, sewn on 2” max. grid
Thickness	ASTM D-1777[2]	0.25”
Tensile Strength	ASTM D-5035	75 ft-lb x 75 ft-lb
Elongation	ASTM D-5035	25%
Mass/Unit Area	ASTM D-5261	8.5 oz./yd^2
Functional Longevity	Observed	Up to 10 mos.

TURF REINFORCED MATRIX (TRM):

PROPERTY	TEST METHOD	TYPICAL ROLL VALUES
Flexible, 3-dimensional, woven polyester yarn w/PVC Coating or polyolefin fibers with double netting	Observed	Mechanically stitched or independently formed, depending on manufacturer.
Carbon Black Content	Certificate	Present
Thickness	ASTM D-1777	0.5” (12.5 mm) min.
Tensile Strength	ASTM D-5035	220 x 165 lbs/ft. (3.2 x 2.4 kN/m)
Tensile Elongation	ASTM D-5035	10% to 40%
Mass/Unit Area	ASTM D-5035	14 oz./yd^2 (475 g/m^2) min.
Ultraviolet Stability	ASTM D-4355	80% min.

EXTREME DUTY TRM:

Flexible, 3-dimensional, woven polyester yarn w/PVC Coating or polyolefin fibers	Observed	Independently formed, dimensionally stable configuration
Carbon Black Content	Certificate	Present
Thickness	ASTM D-1777	0.5” (12.5 mm) min.
Resiliency	ASTM D-1777	80%
Tensile Strength	ASTM D-5035	3200 x 2200 lbs/ft. (45 x 30 kN/m) min.
Tensile Elongation	ASTM D-5035	55% max.
Mass/Unit Area	ASTM D-5035	14 oz./yd^2 (475 g/m^2) min.
Ultraviolet Stability	ASTM D-4355	80% min.

2. The Contractor shall provide staples and pins per the manufacturer's recommendation. The Contractor shall also provide geotextile pins (comprised of no less than No. 12 gauge (American Wire Standard), 18 inches in length, with fender washers).
3. The Contractor shall install rolled erosion control products as shown in the plans and/or as directed by the Engineer. Biological site preparation must be complete prior to the placement of rolled products. Rolled products shall be installed in a directional manner as recommended by the manufacturer. If the Contractor disturbs any soil with a slope greater than 6:1, the contractor is required to place erosion control blankets.
4. Any area disturbed within the stream construction easement but absent from the plans as an engineered improvement shall be biologically prepared, seeded, and protected with erosion control blanket. The specific seed blend to be utilized shall be in accordance with the specifications for the adjacent area or as directed by the Engineer.
5. Stitch patterns shall provide staples on 12 inch centers. Minimum fastener patterns shall be as follows:

   Erosion Control Blanket: 3 staples per yd^2 plus staple stitch pattern in trench
   Turf Reinforced Matrix: 3 pins per yd^2 plus staple stitch pattern in trench
   Extreme Duty TRM: 3 pins per yd^2 plus staple stitch pattern in trench

6. The Contractor shall assume a 20% scrap factor (overlap and burial loss) for all rolled products. Material will be trenched at the top of each bank, and shall be installed to match the final graded contour of the soil surface. The contractor shall account for all scrap and trench-secured quantities in their quotation. Such quantities are considered incidental and non-payable for the project.
7. The Contractor shall fill TRM and extreme duty TRM with Select Soil even with the top of the rolled product where directed in the plans. Seeding shall be performed as specified in the sections of this specification titled "Hydroseeding", "Native Seeding" and "Seeding". All areas to be covered with erosion control blanket shall be covered immediately after seeding. Erosion Control Blankets shall be used for ground cover and erosion control only.
8. Turf Reinforced Matrix shall be used as a slope and channel lining for slopes steeper than 4:1 and for velocities up to 10 feet per second. Extreme Duty TRM shall be used as a slope and channel lining for slopes steeper than 3:1 and for velocities up to 14 feet per second.
9. When velocities exceed 14 feet per second, the channels must be redesigned to achieve lesser velocities, or other measures must be provided to protect the channel bottom and sides.

B. METHOD OF MEASUREMENT: "Rolled Erosion Control Products" shall be measured per the square yard of each type of Rolled Erosion Control Product, according to the category of product, as listed below, complete and installed:

   Erosion Control Blanket
   Turf Reinforced Matrix (TRM)
   Extreme Duty TRM

C. BASIS OF PAYMENT: "Rolled Erosion Control Products" shall be paid for at the contract unit price per each type of product, measured as stated above. Said price shall be full

compensation for all labors, materials, tools, equipment, excavation, installation and incidentals necessary to complete the work.

S-606 SEDIMENT FENCE: This work shall consist of installing silt fence in accordance with the specifications, as shown on the Plans, or as established by the Engineer. All provision of S-608 "Temporary Erosion and Sediment Control" shall apply to this section.

A. Materials shall be in accordance with the following:
Synthetic woven fabric with the following properties:

Property	Unit	Test Method	Value (Min. Avg. Roll Value)
Grab Tensile Strength	LBS.	ASTM-4632	120 (0.534)
Elongation	%	ASTM-4595	15 (15)
Trap Tear Strength	LBS.	ASTM-4533	65 (0.289)
Burst Strength	PSI	ASTM-3786	340 (2344)
Permeability	Cm/sec	ASTM-4491	0.001 (0.001)
Water Flow Rate	GPM	ASTM-4491	10 (7)
UV Resistance @ 500 hrs.	%	ASTM-4355 ASTM-4632	70 (70)
AASHTO M-288 Specs.	NA	NTPEP	YES

B. Installation by sediment fence installation machine is acceptable, so long as the finished installation meets the dimensions shown on the City Standard details or on the plans and the loose soil at the toe of the fence is recompacted.

C. Wire reinforced sediment fence shall also be allowed.

D. METHOD OF MEASUREMENT: "Silt Fence" shall be measured per linear foot of completed and accepted. Installation, backfill, and maintenance of the silt fence shall be subsidiary to the installation.

E. BASIS OF PAYMENT: "Silt Fence" shall be paid for at the contract unit price per linear foot.

S-607 SEDIMENT TRAP: This work shall consist of installing sediment traps in accordance with the specifications, as shown on the Plans, or as established by the Engineer. All provision of S-608 "Temporary Erosion and Sediment Control" shall apply to this section.

A. Sediment Traps shall be constructed in accordance with the following Standard Detail for a Sediment Trap. Other methods and materials may be used with prior approval of the Engineer.
B. Wire reinforced sediment fence shall also be allowed.

C. METHOD OF MEASUREMENT: "Sediment Traps" shall be measured per each Sediment Trap completed and accepted.

D. BASIS OF PAYMENT: "Sediment Traps" shall be paid for at the contract unit price, per each, for "Sediment Trap", and shall include all materials, labor, equipment, tools, and incidentals necessary to complete the item. Maintenance and sediment removal are subsidiary to "Sediment Traps".

S-608 TEMPORARY EROSION AND SEDIMENT CONTROL: This work shall consist of temporary control measures as shown on the Plans or ordered by the Engineer during the life of the Contract to control water pollution, through use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

A. GENERAL: The Contractor shall be responsible for the creation and updating of the Storm Water Pollution Prevention Plan (SWPPP) based on the Contractors' means and methods. Any fines for noncompliance issued by local, county, state, or federal agencies shall be the sole responsibility of the Contractor.
   1. The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features specified elsewhere in the Contract to the extent practical to assure economical, effective and continuous erosion control throughout the construction and post construction period.
   2. All materials shall meet commercial grade standards and shall be approved by the Engineer before being incorporated into the project.
   3. The Contractor will be required to incorporate all permanent pollution control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.
   4. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds or other areas of water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut slopes shall be seeded and mulched as the excavation proceeds to the extent considered desirable and practicable. In no case shall any area remain open for longer than 14 days unless the contractor is actively working on the area. If, on the 15th day, the contractor is not working the area, the area shall either be seeded or treated with some other erosion control measure as approved by the Engineer.
   5. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent pollution control features can follow immediately thereafter if the project conditions permit; otherwise, temporary pollution control measures may be required between successive construction stages.
   6. The Engineer will limit the area of excavation, borrow and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary pollution control measures shall be taken immediately to the extent feasible and justified.
   7. In the event of conflict between these requirements and pollution control laws, rules or regulations of other Federal, state or local agencies, the more restrictive laws, rules or regulations shall apply.
   8. In the event that temporary pollution control measures are required due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work as schedules and are ordered by the Engineer, such work shall be

performed by the Contractor at his own expense. Temporary pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the Engineer.

9. Temporary pollution control may include construction work outside the right-of-way where such work is necessary as a result of roadway construction such as borrow area operations, haul roads and equipment storage sites.
10. The pollution control features installed by the Contractor shall be acceptably maintained by the Contractor. The pollution control features so installed shall be paid for only one time. Failure of the Contractor to maintain the features shall not be cause for additional payment.

B. METHOD OF MEASUREMENT: "Temporary Erosion Control", complete in place and accepted shall be measured as follows:

- Sediment Fence: Per Linear Foot measured along the centerline of the silt fence (including all stakes, backfilling, excavation, and other appurtenances, labor equipment, and material necessary for the installation).
- Inlet Protection: Per each installation/location noted in the plans (including all bags, tubes, rock, closures for the bags, lumber, and other appurtenances, labor, equipment, and material necessary for the installation).
- Ditch Check: Per each installation/location noted in the plans (including all rock, premanufactured devices, filter fabric, lumber, and other appurtenances, labor, equipment, and material necessary for the installation).
- Sediment Trap: Per each installation/location noted in the plans (including all rock, filter fabric, lumber, and other appurtenances, labor, equipment, and material necessary for the installation).
- Filter Berm: Per the Section of that title in these Technical Specifications.
- Rolled Erosion Control Products: Per the Section of that title in these Technical Specifications.
- Polyacrylamides: Per the Section of that title in these Technical Specifications.

C. BASIS OF PAYMENT: "Temporary Erosion Control" shall be paid for at the contract unit price for the various Erosion Control measures, measured as stated above, which price shall be full compensation for furnishing all labor, equipment, and materials necessary or incidental to the construction of complete "Temporary Erosion Control".

S-609 TEMPORARY SEEDING: This work shall consist of the furnishing and planting of seed at the locations, in reasonable close conformity with those shown on the Plans or as designated by the Engineer and in accordance with these Specifications. The work shall also include the preparation of the ground for the seedbed in accordance with the type of seeding required.

A. GENERAL: All grass species shall be supplied as pure live seed. The Contractor shall submit the lab germination test results to the City for review.

1. Packaged seed materials shall be delivered in original sealed, labeled and undamaged containers showing weight, analysis and name of manufacturer. Materials shall be protected from deterioration during delivery and while stored at the project site. Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerances shall be provided. Seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum of 1% of weed seed shall be provided. The Contractor shall not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
2. The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with the type and operation of equipment being used. Said person shall direct all work performed under this section. Preparation of the seedbed shall be to the satisfaction of the Contractor. Should the seed fail to germinate and stabilize the soil, the Engineer may require other stabilization techniques in addition to Temporary Seeding. During the process of soil preparation, extreme care shall be exercised to avoid injury to small trees that have been designated by the Engineer to be saved.
3. The Engineer may designate local areas of desirable native perennial grasses to be saved during the soil preparation. Areas of annual grasses such as cheat, crab grass, triple-awn, etc., shall be treated in accordance with the section of this specification entitled, "Herbaceous Species Removal". Seed shall be applied by hand broadcasting, mechanical broadcasting, or with a seed drill. After seeding, areas with less than a 4:1 slope shall be covered with straw mulch and shall be crimped in by use of a notched disc. Areas with slopes greater than 4:1 will require double-sided straw blanket or approved equal. Seeded areas will be acceptable provided a healthy, uniform, close stand of the specified grass is established, free of disease. All bare areas over 5 ft^2 shall be re-seeded or other erosion control added.
4. The Contractor shall seed or hydroseed in accordance with the City's technical specification for seeding and/or hydroseeding.
5. Seed Mixture shall be as follows:

    - 50% Sterile Wheat
    - 50% Annual Rye

    Total Application Rate shall be 400 pounds/acre.
6. The seeded areas shall be inspected by the Engineer two to four weeks after seeding for adequate seed germination, erosion control and weed control. Repairs and reseeding shall be performed by the Contractor at the direction of the Engineer, at no additional cost to the City. If vegetative measures are not effective within this timeframe, Contractor may be required to reseed or employ a non-vegetative option to stabilize the disturbed area. If seeding is not effective, additional straw mulch shall be uniformly applied at a rate of 2 tons/acre and crimped into the soil with a weighted notched disc or a mulch anchoring tool to punch the straw into the soil, or other approved method.

7. There shall be no particular season for application of Temporary Seeding. Temporary Seeding shall be applied at any time of the year when the disturbed area is not being actively worked on for a period of at least 14 days.
8. In order to protect finished grading work from erosion, the seeding contractor may be required to perform the seeding work on a project at several different periods of time.

B. METHOD OF MEASUREMENT: This work shall be measured per acre or part thereof of completed and accepted “Temporary Seeding” work.

C. BASIS OF PAYMENT: “Temporary Seeding” shall be paid for at the contract unit price, measured as stated above. Seeding shall include the preparation of the ground for the seedbed, furnishing and planting all seeds, nitrogen fixing bacteria, fertilizer, and mulching required by this specification.

S-610 <u>WATTLES/LOGS</u>: Work included in this section consists of the installation of wattles/logs.

1. Wattles or logs shall meet the following requirements:

Material	Component	Requirement
Wattles/Logs	Material of Construction	Open weave containment material filled with straw, rice or wheat, excelsior, coir, or coconut
	Density	5 pounds per linear foot
	Minimum Length	10 feet
	Diameter	8” +/-
	Reinforcement Material	Jute or other mesh netting with attachment sock at one end
Stakes	Material of Construction	Hard wood
	Dimensions	1.0 x 1.0 x 24 inches

2. The Contractor shall excavate a 4” deep trench for placement of logs.
3. The wattles/logs shall be secured in the trench with a minimum of two hardwood stakes/wire loops on the uphill side of each wattle/log. Each wattle/log must abut and attach to the next and shall be installed in a contour following the slope. Wattles/logs shall be located as noted in the plans.
4. Stakes shall be placed at each end of the log and every four feet.

A. METHOD OF MEASUREMENT: “Wattles/Logs” shall be measured per the lineal foot of completed and accepted work.

B. BASIS OF PAYMENT: “Wattles/Logs” shall be paid for at the contract unit price bid per lineal foot of completed and accepted work, measured as stated above.

LANDSCAPING INSTALLATION AND MATERIALS

S-700 <u>BONDED FIBER MATRIX</u>: The Bonded Fiber Matrix (BFM) shall be manufactured to be hydraulically applied, and upon drying, adhere to the soil in the form of a continuous, 100 percent coverage, biodegradable, erosion control blanket.

A. GENERAL: The Bonded Fiber Matrix shall be comprised of long strand, wood fibers, produced from thermo-mechanical methods. The fibers shall be joined together by a high-strength non-toxic adhesive to create a continuous three-dimensional blanket that adheres to the soil surface when hydraulically applied. The product shall be composed of 90% wood fiber and 10% blended hydrocolloid-based binder, all by total weight. The formed matrix shall meet the following requirements:

- When dry, it shall not dissolve or disperse upon rewetting.
- Shall have minimum water holding capacity of 10 times its dry weight.
- Shall not form a crust that inhibits water infiltration.
- Shall not inhibit the germination or growth of plants.
- Shall be 100% biodegradable and non-toxic to fish and wildlife.
- Shall be a minimum of 1/8" thick over the entire surface.
- Shall have no holes > 1 mm in size.

1. The Bonded Fiber Matrix (BFM) shall be installed in accordance with the manufacturer's recommendations.
2. Bonded Fiber Matrix shall be applied at a minimum rate of 3,000 lbs/acre dry weight of bonded fiber matrix. Additional material will be applied at the direction of the Engineer. The Contractor shall utilize standard hydraulic seeding equipment in successive layers to achieve 100% coverage of all exposed soil. Successive layers shall be applied in alternating directions. The BFM shall not be applied immediately before, during or after rainfall, such that the matrix will have opportunity to dry for up to 24 hours after installation. The hydraulic equipment shall conform to the requirements of the section of this specification titled "Hydroseeding". The performance of hydraulic seeding and application of bonded fiber matrix must proceed unabated until the designated area is completed. Any erosion of the applied bonded fiber matrix prior to drying/curing shall be repaired by the Contractor at no additional cost to the Owner.
3. Damage to any area of cured mulched area shall be repaired by the Contractor, at no additional cost to the Owner.
4. Where Native Grasses and Wildflower seed is to be applied and Bonded Fiber Matrix is also to be applied, the seed shall be applied prior to application of the Bonded Fiber Matrix

B. METHOD OF MEASUREMENT: "Bonded Fiber Matrix (BFM)" shall be measured by the square yard (square meter) of completed and accepted work. This work shall be paid for at the contract price, measured as stated above.

C. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per square yard (square meter) for "Bonded Fiber Matrix (BFM)", which price shall be full compensation for all excavation, for all soil preparation, for furnishing, transporting, placing, firming, watering, fertilizing, mulching, and cultivating, and for all labor, tools, equipment, and incidentals necessary to complete the work.

S-701 <u>BIOLOGICAL SOIL PREPARATION</u>: Work included in this section consists of the preparation of the soil for biologic plantings and seeding through manipulation of the soil and the installation of the specified soil conditioners and other products. Soil preparation shall be completed prior to installation of any seeding or planting in the designated areas.

A. GENERAL:

1. The latest revisions of the following standards shall apply to work hereunder:

   - Environmental Protection Agency (EPA 6010, 8080, 8140, 8150, SW- 846)
   - American Society of Agronomy (ASA9)
   - State of Kansas Dept. of Agriculture Specification Ref. #KSA (1996 Supp.) 2-1201

2. Prior to performing the Biological Soil Preparation, the Contractor shall perform Herbaceous Species Removal, Woody Brush Removal, and Clearing and Grubbing per the plans and specifications.
3. Soil inoculum shall be shipped to the Contractor immediately before use.
4. The Contractor must provide the owner documentation that each lot of organic fertilizer meets the required specifications. An independent laboratory certified to analyze organic compost per the standards listed above must perform testing.
5. The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work, and who shall be thoroughly familiar with the type and operation of equipment being used. Said person shall direct all work performed under this section.
6. The Contractor shall field demonstrate to the Engineer the capability of the broadcast implement to uniformly spread the organic soil conditioner over the specified area. The Engineer shall reserve the right to inspect the asset prior to the start of construction and approve/reject the asset for use.
7. The Contractor shall perform all inoculation with an asset designed to accommodate such products.
8. Upon acceptance of grade and shape by the Engineer, and prior to seeding and planting, the contractor shall disc or cultivate the soils to a depth of 1 inch to produce a fine seedbed. On small areas, a rotary tiller or other similar approved equipment shall be required for seedbed preparation. A landscape box will be required for proper leveling of the seedbed when designated by the Engineer. Tractor mounted equipment may, however, be used in areas which are of sufficient size to facilitate use of such equipment when approved by the Engineer. The seedbed shall be firm, smooth and reasonably free of rocks, clods and other debris sufficiently to permit mowing with lawn maintenance type equipment.
9. Soils shall not have a measured compaction greater than five pounds per square inch, based on Cone penetrometer measurements, at the time of seeding or planting unless otherwise stated on the plans or in the specifications. The areas to be prepared for seeding shall be divided into 10’ x 10’ grids. Two penetrometer readings shall be made in each grid. If ten percent or more of the total number of penetrometer readings are greater than five pounds per square inch, disc, cultivate, and/or chisel plow said areas as necessary to reduce compaction. Re-check soil compaction as described above after tillage. Repeat treatment until ninety percent or more of penetrometer readings are less than five pounds per square inch. Remove all foreign matter larger than one inch in any dimension from the areas to be seeded and/or planted. Add additional Select Soil when indicated on the plans.

10. The Contractor shall broadcast the organic soil conditioner onto the biologically prepared site at the rate of 400 pounds per acre. The broadcast shall be performed with equipment approved by the Engineer.
11. The Contractor shall provide Organic Compost/Microbes/Fertilizers with Micronutrients per the following requirements:

Organic Soil Conditioning	
Compost Source:	Plant Materials Only. No More Than 10% (w/w) derived from wood products.
Compost State:	No Less Than 40% Humus (below fiber stage)
Particle Size/ Uniformity:	Uniform homogenous matrix.
% Nitrogen:	2.00%, minimum
% Phosphate ($P_2 0_5$):	No less than 6 %.
% Potassium (K_2O):	No less than 2 %.
Humic Acids:	All derived from compost, no less than 25%.
Microbes:	No less than 60000/100g aerobic/anaerobic bacteria, yeast, and mold. No less than 50 strains of soil microbes, comprised of three stains of Trichoderma, two strains of Gliocladium, fifteen strains of Bacillus, five strains of Pseudomonas, ten strains of Streptomyces, five species of ectomycorrhizal fungus, seven species of ectomycorrhizal fungus Propagules (spores, fragments of fungal mycelium, and pieces of mycorrhizal roots capable of colonizing host plant roots) of the vesicular arbuscular mycorrhizal species Glomus intraradices, Glomus ageratum, Glomus mosseae, combined with other species and/or additional genera including, Sclerocyctis, Gigaspora, Scutellospora, Entrophospora, and Acaulospora. Ectomycorrhiza include Pisolithus and 4 species of Rhizopogon. Live propagule count of 6.5/55 million per bulk pound of carrier.
Micronutrients**:**	No less than 1.00% Iron No less than .05% Manganese No less than .05% Zinc.

ORGANIC FERTILIZER REQUIREMENTS (OTHER)				
The Following Elements Shall Not Be Present in Amounts Greater Than Those Specified Below:				
Test	**Method**	**Limits**	**UNITS**	**OTHER**
ELEMENTS				
Lead	SW-846 6010	<50.0	MG/KG	
Mercury	SW-846 6010	<.0004	MG/KG	BDL
The Following Elements Shall Not Be Present:				
Organochlorine Pesticides ND=None Detected BDL=Below Detection Limits				
Test	**Method**	**Limits**	**UNITS**	**OTHER**
Chlordane	EPA 8080	ND	UG/KG	BDL
4,4'-DDT	EPA 8080	ND	UG/KG	BDL

B. METHOD OF MEASUREMENT: "Biological Soil Preparation" shall not be measured separately.

C. BASIS OF PAYMENT: "Biological Soil Preparation" shall be subsidiary to "Plantings" or to "Seeding" or to "Native Seeding".

S-702 BIOLOGICAL PLANTINGS: This work shall consist of providing biological and herbaceous plantings according to the Plans and these Specifications. Biological Plantings shall include furnishing all labor, plants, equipment, and materials and performances of all operations in connection with furnishing and installation of the following at the locations shown on the Plans: fertilizers, trees, shrubs, native grasses, forbs, bulbs, tubers, plugs, sprigs, cuttings, dormant root stock, ground cover and miscellaneous accessories.

A. GENERAL: All planting shall conform to the criteria of the latest edition of the City of Lenexa Uniform Development Code, unless otherwise specified in the Plans.

1. Provide quality, size, genus, species, and variety of trees, shrubs, and other plants indicated, complying with applicable requirements of ANSI Z60.1 “American Standard for Nursery Stock”, and of Horticultural Standards Number One Grade Nursery stock as adopted by the American Association of Nurserymen, applicable requirements of the State of Kansas Department of Agriculture Specification Reference #KSA 2-1415, or applicable requirements of the American Organization of Seed Analysts (AOSA).
2. Plant material provided shall have been grown in the same hardiness zone as the Kansas City Metropolitan area. All plugs, forbs and container plant species native to Kansas shall be supplied from within a 300-mile (485km) radius of the project site, as approved by the Engineer. Any plants which die prior to expiration of the maintenance bond shall be removed by the Contractor within two weeks of notification of the dead plant material. The dead plant material shall be replaced with live plant material during the current planting season for that material, or in the next planting season if the current time is not within a planting season.
3. The Planting Contractor (Contractor) shall exhibit significant experience and successful work in projects similar in scale, design, material and level of quality. The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with the type and operation of equipment being used. Said person shall direct all work performed under this section.
4. Plants shall be subject to inspection and approval by the Engineer upon delivery for conformity to specifications. To ensure quality and uniformity of plant material, Contractor shall obtain individual species from one source. Plant materials which experience excessive growth during storage period are unacceptable. Bare root plant materials that have broken dormancy are unacceptable.
5. Substitutions of plant materials will not be permitted unless authorized in writing by the Engineer. If proof is submitted that any plant specified is not obtainable, a proposal will be considered for use of the nearest equivalent size and variety without adjustment of Contract price. These provisions shall not relieve Contractor of the responsibility of obtaining specified materials in advance if special growing conditions or other arrangements must be made in order to supply specified materials.
6. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage or obstructions, notify the Engineer before planting. All plant materials shall be viable and free from insects and disease.
7. Plants shall be delivered freshly dug. The Contractor shall not prune before delivery, except as approved by Engineer. Plants shall be protected from sunscald, drying, sweating, whipping and other handling and tying damage. The Contractor shall not bend or bind-tie trees or shrubs during delivery. Plant materials shall not be dropped during delivery. The Contractor shall handle balled and burlapped stock by the root

ball and shall handle containerized plants by container. When deciduous trees or shrubs are moved in full-leaf, the Contractor shall spray with anti-desiccant at nursery before moving. The Contractor shall apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage.

8. The Contractor shall deliver plants after preparations for planting have been completed and shall be installed immediately after inspection. If planting is delayed more than 4 hours after delivery, the Contractor shall set planting materials in shade, protect them from weather and mechanical damage, and keep the roots moist.
9. The Contractor shall perform herbaceous species removal; treat all undesirable species with an approved herbicide. Herbicide application instructions given on the label shall be followed at all times. Undesirable species include plant species not native to Kansas. (This shall not apply to trees and shrubs.) Care shall be taken not to affect surrounding vegetation. The Contractor may be required to replant any vegetation affected by herbicide outside of targeted species. Herbicides shall be applied in accordance with the section of the specifications entitled, “Herbicides”. For bidding purposes, the Contractor shall provide costs for three herbicide control treatments over an owner-specified number of acres.
10. The Contractor shall determine the location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate as required.
11. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage or obstructions, the Engineer shall be notified before planting.
12. The Contractor shall coordinate the installation of planting materials during normal planting seasons for each type of plant material required. Normal planting season for each type of Biological Planting shall be in accordance with the following table:

Planting Type	**SPRING Season**	**FALL Season**
Trees	1 March-1 May	1 Sept.-1 Dec.
Shrub	1 March-1 May	1 Sept.-1 Dec.
Ground Cover	1 March-1 May	1 Sept.-31Oct.
Forbs	15 Apr. – 15 June	NA
Containerized Plants	1 March-1 May	1 Sept.-31Oct.
Bulbs	1 March – 15 June	NA
Tubers	1 March – 15 June	NA
Sprigs	15 Apr. – 15 June	NA
Cuttings	15 Feb. – 15 Apr.	NA
Dormant Root Stock	15 Feb. – 15 Apr.	NA
Plug	15 Apr. – 15 June	NA

13. The Contractor shall furnish nursery-grown trees and shrubs, unless otherwise specified, with healthy root systems developed by transplanting or root pruning. The Contractor shall provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun-scald, injuries, abrasions, and disfigurement.
14. The Contractor shall provide trees and shrubs of sizes and grades conforming to ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Engineer, with a proportionate increase in size of roots or balls. Plant materials of the same species and caliper size must be consistent in

form, canopy size and growth height. Nursery grown plants larger than 1½" caliper shall have been transplanted or root pruned at least once in the past 3 years.

15. All trees must have straight trunks with a single leader intact unless specified as multi-trunk trees in plan documents, in which case each trunk shall have a viable leader. Trees shall not be accepted which have had their leaders cut or broken.
16. All plants, trees and shrubs shall be balled and burlapped or container-grown. Other plants shall be container-grown or in other approved configurations.
17. Plant materials shall be true to name. Each plant shall be labeled with securely attached, waterproof tag bearing legible designation of botanical and common name.
18. Soil Amendments for trees and shrubs, and container-grown plants:

    - Sand: clean, washed, natural or manufactured sand, free of toxic materials.
    - Organic Compost: (with a pH range of 6 to 7.5).
    - Herbicides: EPA registered and approved, of type recommended by manufacturer. See section S- 707 Acceptable Alternatives.
    - Water: potable.
    - Slow release fertilizer: granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
    - Mulch: organic mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of shredded hardwood.
    - Stakes and guys: reference Plans.
    - Mycorrhizal inoculant in granular form.
    - Antidesiccant: water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's instructions.
    - Amended planting soil: soil used for backfilling all plants and for planting beds shall consist of 3 parts soil, excavated from the hole or bed, mixed with 2 parts organic compost and one part sand prior to backfilling.

19. Soil Amendment for native grass and wildflower plantings shall be in accordance with the Organic Soil Conditioner specified in the section titled "Biological Soil Preparation".

B. CONSTRUCTION REQUIREMENTS: The Contractor shall examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. The Contractor shall not proceed with installation until unsatisfactory conditions have been corrected.

1. The Contractor shall prepare and layout individual tree and shrub locations and areas for multiple plantings. The Contractor shall stake locations, outline areas, and secure Engineer's acceptance before the start of planting work. The Contractor shall make minor adjustments, as may be required.

2. Below is the amended planting soil preparation procedure:

   - Prepare amended planting soil for planting areas. Before mixing, clean existing soil/select soil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

   - Mix soil amendments with select soil or existing soil at rates indicated. Mix fertilizer at rate specified by manufacturer. Delay mixing fertilizer if planting does not follow placing of amended planting soil within a few days.

   - For tree pit or trench backfill, mix amended planting soil before backfilling and stockpile at site.

   - For planting beds, mix amended planting soil either prior to planting or apply on surface of select soil and mix thoroughly before planting. Apply phosphoric acid fertilizer, other than that constituting a portion of complete fertilizers, directly to subgrade before applying amended planting soil and tilling.

3. Below is the ground cover and plant bed preparation procedure:

   - Remove soil to a minimum depth of 8 inches and replace with amended planting soil mixture.

   - Loosen subgrade of planting bed areas to a minimum depth of 6 inches. Remove stones larger than 1-½ inches in any dimension and sticks, roots, rubbish and other extraneous materials.

   - Spread amended planting soil mixture to depth required meeting thickness, grades and elevations shown, after light rolling and natural settlement. Place approximately ½ the thickness of amended planting soil mixture required. Work into top of loosened subgrade to create a transition layer and then place remainder of amended planting soil mixture.

4. Excavation for Trees and Shrubs:

   - Excavate tree pits and trenches with vertical sides and with bottom of excavation slightly raised at center to assist drainage. Loosen hard subsoil in bottom of excavation. Scarify sides of tree pit.

   - For balled and burlapped trees and shrubs, excavate approximately 1-½ times as wide as ball diameter and equal to ball depth.

   - Dispose of excess subsoil removed from landscape excavations.

   - Obstructions: notify Engineer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

   - Drainage: notify Engineer if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

5. Planting Trees and Shrubs:

   - Shrubs – Top of ball or top of plant grade in containers shall be set flush or level with finished grade of surrounding area.

- Trees – Set top of ball flush or level with grade. Trunk/Root flare must be visible at the top of root ball as indicated in the Standard Details.

- Place stock on setting layer of compacted amended planting soil.

- Remove burlap and wire baskets from top of ball after tree is placed in hole. Carefully remove containers so as to not damage root balls. Remove pallets, if any, before setting. Do not use planting stock if ball is cracked or broken before or during planting operation.

- Apply mycorrhizal inoculant in granular form onto the bottom and sides of the root ball, just prior to planting.

- Backfill with amended planting soil around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately ½ backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

- Dish and tamp top of backfill to form a 3-inch high mound around the rim of the pit. Do not cover top of root ball with backfill.

- Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures required.

Plants shall not be pruned before planting; they shall be pruned upon installation. The Contractor shall prune, thin, and shape trees and shrub according to standard horticultural practice. The Contractor shall prune trees to retain required height and spread otherwise directed by Engineer. Tree leaders shall not be cut and only injured or dead branches shall be removed from flowering trees. The Contractor shall prune shrubs to retain natural character. Shrub sizes indicated are the size after pruning.

6. The Contractor shall stake trees of 2” through 5” caliper. The Contractor shall stake trees of less than 2” caliper only as required to prevent wind tip-out. A minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade shall be used. Vertical stakes shall be set and spaced to avoid penetrating balls or root masses. The Contractor shall support trees with two strands of tie wire encased in hose sections at contact points with the tree trunk. Allow enough slack to avoid rigid restraint of tree.
7. Planting Ground Cover, Forbs, and Containerized Plants:

- Space ground cover and plants as indicated in Plans.

- Apply mycorrhizal inoculant in granular form onto the bottom and sides of the root ball, just prior to planting.

- Dig holes large enough to allow spreading of roots, and backfill with amended planting soil. Work soil around roots to eliminate air pockets and leave a slight saucer indention around plants to hold water. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

- Mulch backfilled surfaces of pits, trenches, planted areas, and other areas indicated. Apply 3-inch average thickness of organic mulch and finish level with adjacent finish grades. Do not place mulch against trunks or stems. Installation of Miscellaneous Materials:

- Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage. When deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving and again 2 weeks after planting.

- When planting in a wetland area, the shipping container shall be removed from the plant prior to planting.

8. Native Grasses and flowers shall be planted in accordance with the section of this specification entitled, “Native Seeding”.
9. When planting bulbs and tubers, the top of the plant shall be cut 0.25 inches above the roots immediately prior to planting. Plants may be planted individually in a suitably hand-excavated hole, trench or bed excavated to the proper depth. Generally, planting depth should equal three times the bulb’s diameter. Individual planting holes and trenches should be U-shaped. The base of bulb should be in contact with the soil. After placement, bulbs should be covered with soil and immediately and thoroughly watered. When planting tubers in a wetland area, all tubers are to be pre-weighted by the supplier. The tuber shall be dropped into water and then pushed into the bottom soil about one or two inches.
10. When planting plugs, the top of the plant shall be cut 0.25 inches about the roots immediately prior to planting. Plugs shall be installed on 1’ centers or as shown in the plans. Soil should be placed firmly around plant roots. Each plant shall be planted in a suitably hand-excavated hole and immediately watered. Wood chip and bark mulches shall not be used in conjunction with plugs.
11. When planting sprigs, the top of the plant shall be cut 0.25 inches about the roots immediately prior to planting. Each plant shall be planted in a suitably hand-excavated hole and immediately watered. Woody cuttings shall be soaked 24 hours prior to planting. Cuttings should have leaves stripped off half of their length. The leafless half is then dipped into rooting hormone; the excess soil is tapped off and is then inserted in the soil. The plant shall be watered thoroughly. Foliage and stems should be sprayed with anti-desiccant
12. When planting trees, shrubs, ground cover, and containerized plants, the plantings are to be placed in areas which are to be covered by rolled erosion control products, a suitable size hole shall be cut in the rolled erosion control product, each plant shall be planted in a suitably hand-excavated hole and immediately watered. Rolled product shall be re-secured as recommended by the material manufacturer.
13. When planting forbs, bulbs, tubers, plugs, and sprigs, the top of the plant shall be cut 0.25 inches above the roots immediately prior to planting. Each plant shall be planted in a suitably hand-excavated hole and immediately watered. The Rolled Product shall be installed immediately after planting and watering.
14. When planting cuttings, the cuttings shall be installed through the previously placed rolled erosion control product. Prior to placing each plant into the excavated hole, a suitable quantity of mycorrhizal tablets, controlled-release fertilizer tablets, and hygroscopic soil polymer shall be included by the contractor. Because these materials impact the warranty of the specified plant materials, the Contractor shall select the products and application rate per the manufacturer’s recommendations.
15. Products to be supplied shall be in accordance with the plans:

- APM denotes Air Prune Method of propagation.

- Plugs shall be Lumen Aire deep cell or approved equal. Deep cells must be provided with a feature to prevent root spiraling during growth.

C. **ESTABLISHMENT (YEARS 1-2)**: After the plant is placed, it shall be watered at a minimum rate of 3" per week (170 gallons per 10 square yards) in five or six applications per week beginning immediately after the plant is placed, and continuing until the roots of the plant are anchored in place, the plant is growing, and the project is accepted. Whether the minimum amount of water has been applied or not, the plant shall be watered until the ground under the plant is at 80% of saturation to a depth of 6". The 80% saturation shall be maintained until the project is accepted.

1. In addition to watering the plants, the Contractor shall remove any weeds including noxious weeds as defined by Kansas Statutes Annotated 2-1314(b) or any amendments thereto from the planting areas. The weed removal may be by cultivation, hand removal, or spraying. At the time of acceptance the planting beds shall be free of weeds.
2. Any plant material that dies shall be removed from the project and replaced within 14 days of the time the Contractor is notified of the dead plant material. Should the time of year be outside the planting season for the particular plant, the Contractor shall replace the dead material within 14 days of the beginning of the next planting season. This shall apply to all types of plantings including but not limited to trees, shrubs, native grasses, forbs, bulbs, tubers, plugs, sprigs, cuttings, dormant root stock, and ground cover.
3. Plant spacing and ratios shall be in accordance with the plans and the special conditions.
4. The Contractor shall be fully responsible for the condition of the seed work, including mowing, until written notification that his/her obligation to maintain the seeding is terminated and the project has been accepted.

D. METHOD OF MEASUREMENT: "Biological Planting" shall be measured per each plant according to the category of planting, as listed below, complete and installed:

- Shade Trees, 2" caliper (or other caliper size as stated)
- Ornamental Trees, 2" caliper (or other caliper size as stated)
- Evergreen Trees, 6' to 7' (or other height as stated)
- Evergreen Trees, 10' to 12' height (or other height as stated)
- Shrubs, #5 B&B or Container (or other container size as stated)
- Groundcover, #1 Container (or other container size as stated)
- Forbs, Ea.
- Bulbs and Tubers, Ea.
- Plugs, Ea.
- Sprigs, Cuttings, and Dormant Root Stock, Ea.
- Plant lists for each category of planting are shown in the plans.

E. BASIS OF PAYMENT: "Biological Planting" shall be paid for at the contract unit price per each type of planting. Said price shall be full compensation for all labors, materials, tools, equipment, excavation, installation and incidentals necessary to complete the work.

S-703 FENCING (AGRICULTURAL): This work shall consist of the installation of agricultural use fence and gates where shown on the Plans or as directed by the Engineer.

A. GENERAL: Fence materials shall be as shown on the plan or as designated by the Engineer. The material in all cases shall be either woven wire or barbed wire.
   1. Barbed Wire fencing shall be of the construction shown below unless otherwise noted on the Plans or specified in the contract. Zinc-Coated Steel Barbed Wire shall conform to the requirements of ASTM A121 except the minimum weight of zinc coating shall be 0.80 ounce per square foot. The wire shall have interlocked four point barbs spaced at five inch centers and a minimum strand breaking strength of 950 lbf. The barbs shall not be wrapped around both line wires. The direction of twisting shall be in one direction only. Aluminum-Coated Steel Barbed Wire shall conform to the requirements of ASTM A585
   2. The spacing of the barbs for Zinc-Coated Steel Barbed Wire and Aluminum-Coated Steel Barbed Wire shall be established by measuring the spacing of individual barbs in a 25-foot length of barbed wire. The average spacing shall not exceed the specified spacing and no individual spacing shall exceed the specified spacing by more than ¾".
   3. Woven Wire: The height of fabric and design shall be as shown on the Plans or specified in the contract. Zinc-Coated Woven Wire fabric shall conform to the requirements of ASTM A116 except the minimum weight of zinc coating shall be 0.80 ounces per square foot and the wire shall have a minimum line breaking strength of 950 lbf. Aluminum-Coated Steel Barbed Wire shall conform to the requirements of ASTM A584.
   4. Tension Wire shall be of the gauge shown on the Plans or specified in the contract. Tension wire shall be either galvanized to conform to the requirements of ASTM A116, Class 3 coating, or it shall be coated with aluminum alloy applied at the rate of not less than 0.30 oz. per square foot of wire surface.
   5. Posts and braces shall be of the type, weight, and size shown on the Plans. Weight tolerance on steel posts and braces shall be –3.5% and +10.0%. Pipe posts and braces shall meet the weight and dimensional requirements of ASTM F669, Group 1A or Group 1C for Heavy Industrial Fence.
   6. All steel fence posts and braces shall be galvanized by the hot dip process and the zinc coating shall average not less than 1.80 ounces per square foot, with no individual specimen having less than 1.60 ounces per square foot. Pipe posts and braces may be coated in accordance with AASHTO M181 for Grade 2 Posts. Round steel posts and bracing may be punched and drilled after fabrication. Punching and drilling of other types of posts shall be performed prior to galvanizing. Punched tabs will not be permitted.
   7. Gate frames shall be constructed of galvanized pipe to the dimensions and weights shown on the Plans or specified in the contract documents. The frames shall be welded at all joints to provide watertight construction or the pipe shall be connected with watertight heavy malleable-iron corner fittings. All weld-damaged areas shall be painted with organic zinc rich paint. The organic zinc rich paint shall be a one-component material manufactured as a coating for steel and have a minimum of 85% zinc by weight in the dried film. Truss rods shall be provided as shown on the Plans. The pipe used in the manufacture of gate frames shall be of the size shown on the Plans and conform to the weight and dimensional requirements of ASTM F1083. The weight of the pipe gate frames shall not vary more than –5% from the weight specified on the Plans. The weight of the frames shall be determined on the galvanized pipe.
   8. All gates shall be equipped with approved hinges, latches, stops, locking devices and satisfactory fittings for padlocking. All fittings shall be of industrial/commercial quality.

Means shall be provided for securing double vehicular gates to a concrete foundation at the center while closed and for securing and supporting the free ends of vehicular gates in an open position. All gate fittings shall be malleable iron or pressed or forged steel.

9. All fittings shall be hot-dipped galvanized in accordance with ASTM A153. Bolts and nuts may be mechanically galvanized. When supplied, bolts and nuts ½ “in diameter or larger shall be coated in accordance with ASTM A153. Bolts and nuts smaller than ½” in diameter shall be coated with sufficient zinc to produce a gas evolution time averaging not less than 12 seconds with no individual value less than six seconds. The stripping solution shall be as specified in the Kansas Department of Transportation Standard Specifications, latest edition.
10. The same type of fabric shall be used in the gate as is used in the construction of the fence in which the gate is to be installed unless otherwise specified on the plans or in the contract documents.
11. Brace Wire shall be of the gauge shown on the Plans. Tie wire and wire clips for fastening fabric to posts shall be of the size and type recommended by the manufacturer.
12. Brace wire, tie wire and staples shall be galvanized to conform to the requirements of ASTM A116, Class 3 coating, or they shall be coated with aluminum alloy applied at the rate of not less than 0.40 ounce per square foot of wire surface. Equivalent galvanized or aluminum coated steel clips or aluminum wires or aluminum clips may be substituted for galvanized or aluminum coated tie wires.
13. Miscellaneous fittings, including stretcher bars, post arms, post caps, eye bolts, etc., shall be steel and galvanized to conform to the requirements of ASTM A153 or shall be aluminum alloy. All fittings shall be of industrial/commercial quality. Bolts and nuts may be mechanically galvanized. Bolts and nuts may be mechanically galvanized. When supplied, bolts and nuts ½ “in diameter or larger shall be coated in accordance with ASTM A153. Bolts and nuts smaller than ½” in diameter shall be coated with sufficient zinc to produce a gas evolution time averaging not less than 12 seconds with no individual value less than six seconds. The stripping solution shall be as specified in the Kansas Department of Transportation Standard Specifications, latest edition.
14. When existing fence is removed as part of the project, the existing fence shall be disposed of by the Contractor. Removal of the fence shall be subsidiary to “Fencing (Agricultural)”.

B. INSTALLATION:

1. Holes for wooden posts shall be of sufficient size to permit adequate compaction of backfill around the post.
2. The corner posts and support posts shall be set and securely braced and wired prior to setting the intermediate posts. The intermediate posts shall be evenly spaced apart but no further than the plan distance apart. The posts shall be set plumb, firm and true to the lines established. The backfill around the posts, if not concrete, shall be placed in thin layers and thoroughly compacted.
3. If metal posts are used for the intermediate posts, they shall be driven with an approved mechanical device. They shall be driven to the depth as shown on the plans.
4. Wood braces shall be toe nailed to the posts with 2-10d nails in each end of the brace. When wood posts are used, both ends of all tension wire shall be wrapped around the posts twice and stapled in place.
5. Barbed wire shall be drawn taut with an approved mechanical device and securely fastened to each post with at least 1 fence staple or approved wire clip. The wire shall

be looped around the end and corner posts and fastened with sufficient staples to anchor the wire securely.

6. The tension for stretching the fence shall be applied by use of mechanical fence stretchers and with single wire stretchers designed and manufactured for that purpose, and in accordance with the fence manufacturer's recommendations.
7. All splices in the fabric shall be securely made in accordance with the best practices and the fence manufacturer's recommendation and by the use of tools designed for that purpose.

C. ELECTRICAL GROUNDS:

1. All fences shall be grounded by a galvanized or copper coated rod eight feet long and a minimum of 5/8 inch in diameter driven vertically until the top is approximately six inches below the top of the ground. A No.6 solid copper conductor shall be brazed or attached by an approved clamp to the rod and to the fence in such a manner that each element of the fence is grounded as shown on the plans, and immediately below where a power line passes over the fence. The ground rod shall be installed immediately below the point of crossing. No special payment will be made for electrical grounds and the cost thereof shall be included in the prices bid for the various items.

D. METHOD OF MEASUREMENT: "Fencing (Agricultural)" shall be measured per the lineal foot of completed and accepted work, less the linear foot of gates. Gates shall be measured per each gate, complete, in place, and accepted. Removal of any existing fence shall not be measured separately, but shall be subsidiary to "Fencing (Agricultural)". Any temporary fencing required to contain animals on the property shall be subsidiary to "Fencing, (Agricultural)".

E. BASIS OF PAYMENT: "Fencing (Agricultural)" shall be paid for at the contract unit price bid per lineal foot (lineal meter) of completed and accepted work, measured as stated above. Gates shall be paid for at the contract unit price bid per each gate, measured as stated above.

S-704 FENCING (CHAIN LINK): This work shall consist of installing new chain link fence where shown on the plans, or as directed by the Engineer.

A. GENERAL: Chain link fencing shall conform to this specification and to the details shown on the plans. When existing chain link fencing is removed as part of the project, the existing fence shall be stored, and reinstalled once project operations permit. Removal and storage of the existing fencing shall be subsidiary to "Fencing, (Chain Link)". The Contractor shall take care not to damage the fencing materials during this operation and shall be fully responsible for any damage to the fencing materials caused by the Contractor's operations. Any material damaged, lost, or stolen during or after removal operations or material which is judged by the Engineer to be unusable shall be replaced by the Contractor and at the Contractor's sole expense with new material equal to that from which the fence was constructed. Concrete footings shall be required for all posts.

B. MATERIALS: Base metal for chain-link fence fabric shall be steel of such quality and purity that, when drawn to the size of wire specified and coated as specified, the finished fabric shall be of uniform quality and have the properties and characteristics as prescribed in this specification.

1. WIRE:

a. Wire used for the manufacture of fabric that is zinc-coated, aluminum-coated, or PVC-coated before weaving shall meet the requirements of this specification and shall be capable of being woven into fabric without the coating cracking, flaking, or peeling to such an extent that any of the coating material can be removed by rubbing with the bare fingers.

b. Wire used for zinc-coated chain-link fence may be coated before or after weaving into fabric. Fabric that is zinc-coated after weaving may be hot-dip galvanized in a continuous process and the coating shall not be applied to the fabric in roll form. Wire that is zinc-coated before weaving into fabric may be either electrolytically zinc-plated or hot-dip galvanized. Wire used for aluminum-coated steel chain-link fabric shall be coated before weaving into fabric. Wire used for PVC-coated chain-link fence shall be coated before weaving into fabric.

2. TENSION WIRE:

a. The tension wire shall have the following properties:

- Breaking Strength of 2500 lb-f +/- 500 lb-f
- Diameter of 0.177 in. +/- 0.005 in.
- Zinc Coating of 2.0 oz./ft^2 OR
- Aluminum coating of 0.4 oz./ft^2
- Where PVC coating is specified, the minimum metallic mass of coating on PVC-coated fabric shall be not less than 0.3 oz./ft^2, and the thickness of the PVC coating shall be not less than 0.02 in.

3. COATINGS:

    a. Loosening or detachment during the adhesion test of superficial, small particles of zinc, aluminum, or PVC formed by mechanical polishing of the surface of the coated wire should not be considered cause for rejection.

    b. Zinc used for hot-dip galvanized or electrolytically zinc-plated coatings shall be of any grade of zinc conforming to the requirements of AASHTO Specification M-120.

    c. Ingot or pig aluminum used for coating shall conform to the following impurity limits:

        - Copper, max percent 0.10
        - Iron, max, percent 0.50

    d. Vinyl used for coatings shall be polyvinyl chloride (PVC). The PVC shall be plasticized and thoroughly compounded so there is full dispersement of pigments, stabilizer, and other components.

4. SLATS:

    a. Polyethylene privacy slating shall be installed on the chain link fencing where indicated on the plans and according to the manufacturer's instructions. The slating shall be of a redwood color. The slating shall be locked into place according to the manufacturer's recommendations to prevent removal of the slats after installation. Both top and bottom of slats shall form a smooth straight edge. Slating shall meet the specifications shown in Table 3.

5. FOOTINGS:

    a. Concrete footing shall be Class KCMMB-4K Concrete.

    b. Concrete footings shall be 6" in diameter, un-reinforced, and shall extend from the ground surface to 6" below the bottom of the post.

6. FABRIC:

    a. The wire shall be woven throughout in the form of approximately uniform square mesh, having parallel sides and horizontal and vertical diagonals of approximately uniform dimensions. The top and bottom of the fabric shall be knuckled or twisted as specified in Section 69.7. A typical diamond count for each standard height is shown in Table 1. Other diamond counts are permissible provided they are consistent within a lot, and approved by the Engineer prior to ordering. The mesh size shall be 2".

    b. Wire constituting the fabric shall have a breaking strength of 1290 lb-f when tested in accordance with AASHTO Test Method T 68.

c. Chain-link fabric shall be fabricated from 9-gauge wire, (0.148 inch). The diameter of the wire shall be determined as the average of two readings taken at right angles to each other on the straight portion of the parallel sides of the mesh and measured to the nearest 0.001 in. The permissible variation from the specified diameter of the wire shall be +/- 0.005 in. On metallic coated wire, the tolerances apply to uniform areas of coated wire. Irregular deposits of coating shall be ignored.

d. For zinc and aluminum coated wire, the specified diameter is the coated wire diameter. Measurement shall be made on the coated wire and allowed tolerance applied to the coated diameter. For PVC coated wire, the specified diameter is the metallic coated core wire diameter, and the PVC coating shall not be used when determining wire size. The allowed tolerance, Section 69.5.1, shall be applied to the metallic coated core wire diameter.

e. Chain-link fabric shall be furnished in the standard heights shown in Table 1. Fabric for mesh under 72" shall be knuckled at both selvages. Fabric 72" or higher shall be knuckled at the bottom selvage and twisted at the top selvage. The mass of coating on galvanized fabric shall be not less than 2.0 oz./ft^2. The mass of coating on aluminum-coated fabric shall be not less than 0.4 oz./ft^2. The minimum metallic mass of coating on PVC-coated fabric shall be not less than 0.3 oz./ft^2, and the thickness of the PVC coating shall be not less than 0.02 in.

7. POSTS:

a. Steel posts, rails, and gate frames shall be of a shape approved by the Engineer and shall be commercial quality or better weld-able steel produced by the open hearth, electric furnace, or basic oxygen process. Aluminum alloy posts, rails, and gate frames shall be produced of alloy 6063 and shall conform to the requirements of ASTM Specification B 429, Schedule 40. Miscellaneous fittings and hardware to be metallic coated shall be commercial quality steel, or better, or cast or malleable iron as appropriate to the article. The steel or iron shall have sufficient strength to provide a balanced design. Miscellaneous aluminum alloy fittings and hardware shall be of extruded wrought iron or cast aluminum alloy conforming to the requirements set forth in Table 2. When approved in writing by the Engineer, aluminum alloy fittings and hardware may be substituted for metallic coated steel or cast or malleable iron fittings and hardware. Zinc, aluminum, or vinyl used for coating posts, rails, expansion sleeves, gate frames, hardware, or miscellaneous fittings shall comply with the same requirements as the fabric coatings.

f. For any type and shape of post, rail or gate frame, the product of the yield strength and the section modulus shall not be less than the product of the section modulus of size pipe specified in ASTM F 1083 Schedule 40 Table 1 multiplied by 25000 psi. The yield strength of round pipe shall be determined in accordance with AASHTO Method T 68, 0.2 percent offset method.

g. The following tolerances are permitted for steel posts, rails, or gate frames:

- Tolerance from specified weight +/- 10%
- Tolerance from specified dimensions +/- 5%

h. A tolerance from the specified dimensions for aluminum alloy posts, rails, and gate frames will be allowed in accordance with ANSI H35.2.

i. Hot-dipped galvanized coating applied to steel posts and rails shall be applied uniformly to all surfaces. The mass of zinc coating shall not be less than 1.8 oz./ft^2, +/- 0.1 oz./ft^2. Aluminum coated posts and rails shall have a mass of coating not less than 0.65 oz./ft^2, +/- 0.05 oz./ft^2. All aluminum surfaces shall have a uniform chromate chemical treatment. The minimum metallic mass of coating on PVC-coated fabric shall be not less than 0.3 oz./ft^2, and the thickness of the PVC coating shall be not less than 0.02 in.

j. Finished posts, rails, hardware, and fittings shall show good workmanship and be reasonably free from defects. All burrs at the ends of posts and rails shall be removed. Coatings shall be uniform and free of voids or excessive roughness.

k. The posts and braces shall be set sufficiently in advance of placing the fence to allow the concrete time to obtain its strength. The concrete shall extend slightly above the ground line and shall be steel troweled to a smooth finish with a slope to drain away from the post.

TABLE 1

Specified Diameter of Coated Wire	Mesh Size	Diamond Count Fabric Height, In.[1]								
In.	In.	36	42	48	60	72	84	96	108	120
0.148	2	10.5	12.5	13.5	17.5	20.5	24.5	27.5	31.5	34.5

TABLE 2

		ALUMINUM ALLOY	
NOMENCLATURE	MATERIAL TYPE	ALLOY AND TEMPER	ASTM DESIGNATION
Rail and Brace Ends, Post Tops and Turnbuckles	Castings	356.0-T6, 712.0-T5, 713.0-T5, A360.0, 360.0, 413.0	B 26, B 85, B 108
Gate Hinges, Barbed Wire Extension Arms, and Other Fittings	Castings	Same as Above	
Stretcher Bars and Bands	Bar	6063-T6	B221
Truss or Brace Rods		6061-T6	B221
Flat Band Ties	Sheet	3003-H14	B209
Bolts		6061-T6	F468
Nuts		6061-T6	F467

TABLE 3

SPECIFICATION	VALUE	SLAT NAME	SLAT WIDTH	MESH SIZE	WIRE GAGE	FEET BAG
Low Temperature Brittleness ASTM D746	-76°F (-94°C)	11 Gauge	1-1/8”	2”	11	10
Tensile Strength ASTM D638	3850 psi	9 Gauge	1”	2”	9	10
Density ASTM D1505	0.95	Wide	2-3/8”	3”X5”	9	20
Melt Index ASTM D1238	0.39	12 Gauge	1-1/4”	2-3/8”	11-1/2 12	10
Flexural Stiffness ASTM D747	120,000 psi	6 Gauge	7/8”	1-3/4”	6	10
Heat Resistance	125°C					
Wall Thickness	0.030” (+/- 0.004”)					

B. METHOD OF MEASUREMENT: “Fencing (Chain Link)”, shall be measured per the linear foot of completed and accepted work, less the linear foot of gates. Gates shall be measured per each gate, complete, in place, and accepted. Removal and storage of any existing fencing shall not be measured separately, but shall be subsidiary to “Fencing (Chain Link)”.

C. BASIS OF PAYMENT: “Fencing (Chain Link)”, shall be paid for at the contract unit price bid per linear foot of completed and accepted work, measured as stated above. Gates shall be paid for at the contract unit price bid per each gate, measured as stated above.

S-705 FENCING (DECORATIVE): This work shall consist of constructing decorative fencing in locations as illustrated on the approved plans. The fencing shall be constructed utilizing only those materials as depicted on the fencing plan and related details.

A. When existing decorative fencing is removed as part of the project, the existing fence shall be stored, and reinstalled once project operations permit. Removal and storage of the existing fencing shall be subsidiary to “Fencing (Decorative)”.
B. The Contractor shall take care not to damage the fencing materials during this operation and shall be fully responsible for any damage to the fencing materials caused by the Contractor’s operations. Any material damaged, lost, or stolen during or after removal operations or material which is judged by the Engineer to be unusable shall be replaced by the Contractor and at the Contractor’s sole expense with new material equal to that from which the fence was constructed.

C. METHOD OF MEASUREMENT: “Fencing (Decorative)”, shall be measured per the lineal foot of completed and accepted work less the linear feet of any gates. Gates shall be measured per each completed and accepted gate. Removal and storage of any existing fencing shall not be measured separately, but shall be subsidiary to “Fencing (Decorative)”.

D. BASIS OF PAYMENT: “Fencing (Decorative)”, shall be paid for at the contract unit price, per lineal foot measured as stated above.

S-706 FERTILIZER: This work shall consist of the furnishing, preparing and placing of commercial fertilizers, in reasonable close conformity with the quantities and the locations shown on the Plans and in accordance with these Specifications or as directed by the Engineer.

A. NON-NATIVE VEGETATION AREAS: Commercial fertilizers shall be applied to the areas to be fertilized by drilling into the previously prepared soil with a fertilizer attachment to seed drills. Fertilizers may be spread by hand methods over areas on which it is impracticable to operate seed drills. Fertilizer shall be spread uniformly after the seed bed is prepared. The fertilizer shall be an analysis as listed in Table 1, listed on the City of Lenexa's Pre-Approved Material List or an approved comparable starter fertilizer as determined by the Engineer spread at the rate of 1 pound per 1000 square feet.

Nitrogen		**Phosphate**		**Potash**	
Min.	Max.	Min.	Max.	Min.	Max.
9	18	13	24	6	13

B. NATIVE VEGETATION AREAS:
   1. Trees, shrubs, and other native plant materials shall be planted as specified in the Contract Plans and applicable landscaping standards with the exception that pesticides, herbicide, and fertilizer shall not be applied under any circumstances during planting, in water quality features that experience inundation or intermittent flow.
   2. Any fertilizer application must be based on soil test results and manufacturer's or label recommendations.
   3. Fertilizer type and application rate must be approved by qualified City designee.
   4. This section shall apply to all native vegetation installations, excluding Buffalo Grass.

C. METHOD OF MEASUREMENT: "Fertilizer" shall not be measured separately, but shall be subsidiary to other items.

D. BASIS OF PAYMENT: "Fertilizer" shall be subsidiary to "Seeding" or "Sodding".

S-707 HERBICIDES: This work shall consist of furnishing all equipment labor, and materials necessary to apply herbicides to eradicate herbaceous material from the site, as directed by the Engineer, as shown on the Plans, and/or as shown on the Standard Details.

The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with this type of work and the type of materials being used. Said person shall be competent at identification of plant materials to be eradicated and to be preserved. Said person shall also direct all work performed under this section.

Prior to any herbicide use the Contractor shall submit to the Owner a current copy of the State of Kansas commercial pesticide applicator's license, with certification in the appropriate categories, for each person who will be applying herbicide at the project site. A copy of each commercial pesticide applicator's license must be maintained on site at all times during completion of the work.

A. NON-NATIVE VEGETATION AREAS:

1. Herbicide to be used for Woody Brush Removal:

   - Basal applications: triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester, trade name Garlon 4 or equivalent as approved in writing by the owner.
   - Foliar applications: triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester, trade name Garlon 3 or equivalent as approved in writing by owner.

2. Herbicide to be used for Plant Removal:

   - Herbaceous species to be removed in areas without standing water or saturated soils shall be treated with Glyphosate, N-(phosphonomethyl) glycine, trade name Roundup or equivalent as approved in writing by Owner.
   - Herbaceous species to be removed in areas with standing water or saturated soils shall be treated with Glyphosate, N-(phosphonomethyl) glycine in a form approved for aquatic applications such as Rodeo or equivalent as approved in writing by Owner.

3. Selective grass herbicides and other specialty herbicides may also be used in appropriate locations.
4. All materials used during this portion of the work shall meet or exceed applicable federal, state, county and local laws and regulations. The use of any herbicide shall follow directions given on the herbicide label. In the case of a discrepancy between these specifications and the herbicide label, the label shall prevail.
5. All herbicide application shall be applied or overseen by a Licensed Commercial Applicator, present at the time of application.
6. Prior to the application of an herbicide, the applicator shall submit a supplier certificate to the City for inspection. See Section S-104 MATERIAL REQUIREMENTS AND SUBMITTALS for the certificate requirements.
7. A supply of chemical absorbent shall be maintained at the project site. Any chemical spills shall be properly cleaned up and reported to the owner within 24 hours.

8. The Contractor shall maintain copies at the project site of all current pesticide applicator's licenses, herbicide labels, and Material Safety Data Sheets (MSDS's) for all chemicals utilized during completion of the work.

B. NATIVE VEGETATION AREAS:

1. Herbicides applied in native vegetation areas shall be of the type and used for the purposes specified in the following table:

HERBICIDES FOR NATIVE GRASS ESTABLISHMENT			
HERBICIDES	TRADE NAME(S)	TYPE	USES
Imazapic	Plateau	Selective, pre & post emergent	For weed control, native grass establishment (most WSGs and some forbs)
Salt of Diflufenzopyr, salt of dicamba	**Overdrive**	**Selective, post emergent**	**Annual weed and broadleaf control**
Glyphosate	RoundUp	Non-selective	Site preparation for WSG planting, spot applications
Isopropylemine salt of Imazapyr	Habitat	Selective, pre & post emergent	Control of undesirable emergent and floating aquatic vegetation in and around standing and flowing water
Sulfosulfuron	**Outrider**	**Selective**	**Use to control Johnsongrass in native grasses, spot applications if forbs are present**
Triisopropanolamine salt	**Momentum**	**Selective, post emergent**	**Established buffalograss only**
Fenoxaprop-p-ethyl	**Acclaim**	**Selective, post emergent**	**Johnsongrass control in established plantings**
Always follow the precautions and instructions for use for the pesticide that is being used. **It is the responsibility of the contractor to follow all applicable state and federal regulations regarding the use of pesticides.**			

WSG = warm season grass

C. METHOD OF MEASUREMENT: This work shall not be measured separately, but shall be subsidiary to other items.

D. BASIS OF PAYMENT: This work shall not be paid for directly but shall be considered subsidiary to other items.

S–708 HERBACEOUS SPECIES REMOVAL: Work included in this section consists of eradication of herbaceous species, including grasses and forbs. This work will occur in the areas designated on the plans for installation of all planting areas, ornamentals, native grasses, and wildflowers, including, but not limited to wetland plants and wildflowers.

A. Qualifications of workmen: provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with this type of work and the type of materials being used. Said person shall be competent at identification of plant materials to be removed and to be preserved during the season (summer, winter) work is to be completed. Said person shall also direct all work performed under this section.
B. All herbicide application shall be applied or overseen by a Licensed Commercial Applicator, present at the time of application.
C. The Contractor will treat all herbaceous vegetation within targeted areas with an approved herbicide. Herbicide application instructions given on the label shall be followed at all times. Targeted areas may be shown on plans or located in the field by the Owner. Care shall be taken not to affect vegetation outside of target areas. Herbicide may be applied using a backpack sprayer, a hand-held wick applicator, or a vehicle mounted high-pressure spray unit.
D. The Contractor guarantees not more than 10% vegetative cover within the treated area at any time prior to installation of Seeding, Herbaceous perennial planting, and/or tree and shrub planting in the targeted area.
E. After completion of herbaceous species removal, the Contractor shall schedule with the Engineer an inspection of the work. After inspection of the areas of herbaceous species removal, the Contractor shall conduct monthly inspections of work areas until the end of the current growing season. The Contractor shall notify the Engineer one week prior to each inspection. The Engineer shall have a representative at each monthly inspection. Within five business days of the inspection, the Contractor shall notify the Engineer in writing of the results of the inspection. The Contractor will remove any of the targeted species found in the target area during each of these inspections. The removal shall take place within 14 calendar days after the inspection is conducted.
F. The Contractor and the Engineer shall conduct an inspection of the site approximately one year after acceptance of the project. The Contractor will remove any of the targeted species found in the target area during this inspection. The removal shall take place within 14 calendar days after the inspection is conducted. The following table shows the targeted species:

Common Name	Scientific Name
Velvet Leaf	*Abutilon spp.*
Pigweed (All species)	*Amaranthaceae family*
Ragweed (All)	*Ambrosia spp.*
Parsely	*Anthriscus spp.*
Burdock	*Arctium spp.*
Mustard	*Brassicaceae family*
Bromegrass	*Bromus spp.*
Hemp	*Cannabis spp.*
Musk Thistle	*Carduus spp.*
Knapweed	*Centaurea spp.*
Lamb's Quarters	*Chenopodium spp.*
Water Hemlock	*Cicuta spp.*
Thistles (All)	*Cirsium spp.*
Poison Hemlock	*Conium spp.*
Horseweed	*Conyza spp.*
Crown Vetch	*Coronilla spp.*
Wooly Croton	*Croton spp.*
Orchardgrass	*Dactylis spp.*
Jimson Weed	*Datura spp.*
Teasel	*Dipsacus spp.*
Fescue	*Festuca spp.*
Gaura	*Gaura spp.*
Common Sunflower	*Helianthus spp.*
Fireweed, Mexican	*Kochia spp.*
Prickly Lettuce	*Lactuca spp.*
Sericea lespedeza	*Lespedeza spp.*
Birdsfoot Trefoil	*Lotus spp.*
Sweet Clover	*Melilotus spp.*
Biennial gaura	*Oenethera spp.*
Evening Primrose	*Oenethera spp.*
Canarygrass	*Phalaris spp.*
Timothy	*Phleum spp*
Bluegrass	*Poa spp.*
Dock (All species)	*Rumex spp.*
Sow Thistle	*Sonchus spp.*
Johnsongrass	*Sorghum spp.*
Sorghum hybrids	*Sorghum spp.*
True Clovers	*Trifolium spp.*
Vetch	*Vicia spp.*
Cocklebur	*Xanthium spp.*
Barnyard Grass	
Foxtail Grass	

G. The Engineer will conduct an inspection of the site prior to expiration of the 2-year maintenance bond for the project. Upon notification by the Engineer, the Contractor shall remove any of the targeted species found in the target area during this inspection. The removal shall take place within 30 calendar days after the inspection is conducted.

H. METHOD OF MEASUREMENT: This work shall not be measured separately but shall be subsidiary to other items. Treatment of the target areas after the one-year and two-year inspections shall be subsidiary to the initial treatment.

I. BASIS OF PAYMENT: This work shall not be paid for separately but shall be considered subsidiary to other items.

S-709 HYDROSEEDING: This work shall consist of the furnishing and hydraulic planting of seed at the locations, in reasonable close conformity with those shown on the Plans or as designated by the Engineer and in accordance with these Specifications. This work shall include hydro-seeding of lawns, native grass and wildflower areas.

A. This work shall also include the preparation of the ground for the seedbed, as described in the sections of this specification titled “Seeding”, and “Biological Soil Preparation”. In case of conflict, the section on “Biological Soil Preparation” shall govern.
B. All disturbed areas shall be hydroseeded in the next planting season after construction. Seeding will not wait for completion of construction of the entire project, but shall take place in accordance with the approved erosion control plan for the project.
C. All machines used for hydraulic seeding operations shall have mechanical agitation of the slurry mixture during seeding operations. The machines shall have pressure to force seed and mulch material to the right of way line of most typical street sections. The machine shall have tank capacity of not less than 250 gallons. The hydraulic asset shall be equipped with suitable spray tips to ensure distribution of the material at the rate specified in the plans and/or specifications. If not specified, the rate of application shall be 3000 pounds/acre. Paper Mulch (up to two (2) bags or 100 pounds) may be added to the seed slurry mixture for the purpose of “Marking” where the seed has been applied. Hydromulching shall be a separate operation. The Contractor shall submit the hydraulic tips for inspection by the Engineer. The Engineer reserves the right to direct a change of the tips if the machine is not making proper distribution of the material, and to stop installation until the Contractor demonstrates proper distribution. The Contractor shall install the seed in a minimum of two passes, each pass perpendicular to the last pass.

D. METHOD OF MEASUREMENT: “Hydroseeding” shall not be measured separately, but shall be subsidiary to “Seeding” or Temporary Seeding.

E. BASIS OF PAYMENT: “Hydroseeding” shall be subsidiary to “Seeding” or “Native Seeding”.

S-710 <u>IRRIGATION SYSTEMS</u>: This work shall consist of installing or repairing irrigation systems in accordance with these Specifications and as shown on the Plans or established by the Engineer. Within ten (10) calendar days after the Contractor has received the Owner's Notice to Proceed, the Contractor shall submit:

- A materials list of items to be provided in the contract.
- Manufacturer's Specifications and other data needed to assure compliance with the specified requirements.
- Manufacturer's recommended installation procedures.

Where product names and/or numbers are specified, other products may be submitted for review by the City Engineer as an "Equal" to the product specified.

A. PLASTIC PIPE: Use Class 200 IPS, SDR-21 polyvinyl chloride, marked 1120-1220, and bearing the seal of the National Sanitation Foundation (N.S.F.).
   1. Fittings: Use Schedule 40 polyvinyl chloride, type I-II, bearing the seal of the N.S.F., and complying with ASTM D2466.
   2. For joining, use a fast-acting Hi-tech primer, color: purple, meeting ASTM F-656 and a medium body solvent cement, color: clear, meeting ASTM D-2564, and recommended by the manufacturer's name, pipe size, schedule number, type of material, and code number.
   3. Plastic pipe identification: Continuously and permanently mark with manufacturer's name, pipe size, schedule number, type of material, and code number.

B. POLYETHYLENE PIPE: All pipe 1-1/4" and smaller shall be flexible non-toxic polyethylene pipe made from 100% virgin material meeting N.S.F. standard #14 for use in pressure potable water applications, for 800 design stress.
   1. All sizes shall have a minimum 100 psi working pressure rating. Pipe shall conform to ASTM D-2239 and D-1248 (3C5PE34) or latest revision. All polyethylene pipes shall be continuously and permanently marked with manufacturer's name, pipe size, and schedule number, type of material and code number.
   2. Fittings: Plastic type PVC or nylon insert fittings and/or saddle tees, where applicable, shall be used. All main line connections shall be double clamped. All clamps shall be stainless worm gear types or stainless steel crimp clamps.

C. RISERS:
   1. Lawn heads: Use standard cut-off risers or flexible polypipe (funny pipe) with barb fittings. Secure fittings with proper size stainless steel Oeiteker clamps.
   2. Shrub heads: Use Schedule 80 PVC nipples.
   3. Quick coupling valves: Use Schedule 80 PVC risers with multiple swing joint assembly of nipples and elbows to permit readjustment of valve angle. Flexible polypipe may be used with Engineer's approval.

D. VALVES:
   1. Gate valves: Use Mueller 125 lbs. rated valves, or approved equal, of size required for the line shown on the plan, with "O" ring and operating nut, adaptable to the pipe without AC adapters.
   2. Quick coupling valves: Provide quick coupling valves, all brass, of size required according to the plan, with locked top, to fit single, lug couplers. Deliver to the owner the following items, all matching the approved quick coupling valves:

a. Three keys for locked top.
b. Three couplers.
c. Three hose swivels.

E. Backflow Preventer: Installed irrigation systems require a double-check type backflow preventer, approved by Water One standards.
F. Automatic Irrigation Controller: Irrigation controllers shall be Calsense Satellite, with stand. The approved controller shall provide 117 V input, 26.5 V output, with the number of valve stations and of the type and model number stated in the plans.
G. Field Wiring: Use 14-gauge copper wire with UF insulation. Valve common wire shall be white and valve wire shall be red. Provide one (1) separate wire, blue in color, to the farthest valve. All materials and work on the electrical system shall meet the requirements of the National Electrical Code.
H. Remote Control Valves: Use valves of the same manufacturer as the approved automatic irrigation controller, slow opening and slow closing, globe pattern, in type and model numbers as shown on the schedule in the plans, brass construction, 24 V, with epoxy sealed solenoid coils and throttling system. Remote controlled valves shall be installed within a 10” round valve box, approved by the City.
I. Wire Splices: Waterproof all wire splices with 3M DBY, Scotchlock or equivalent.
J. Rain Sensor: Provide a mini-CLIK rain sensor installed and mounted so as to have free access to rainfall.
K. PIPE INSTALLATION:
   1. Surface Conditions: Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to the timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected. Keep stones, debris, scraps of pipe, etc., picked up to maintain a professional and workman-like appearance on the site.
   2. Field Measurements: Make necessary measurements in the field to ensure precise fit of items in accordance with the approved design.
   3. Trenching and Backfilling: Trench depth shall be as required for specified cover over the pipe. Trench width shall be the minimum necessary as approved by the Engineer to facilitate installation of the system. Trenches shall be backfilled with excavated material. Unless directed otherwise by the Engineer, pipe shall be “mudded in”. This consists of backfilling trenches halfway and flooding with water. After the water has soaked in, the remainder of the trench is backfilled as approved by the Engineer.
   4. Alignment and Depth: The piping system shall be laid in accordance with the alignment shown on the plans. No pipe, valves, valve boxes or wire shall be buried within 24 inches of the curb or roadway. Irrigation system main lines, located within islands, shall be installed as near the center of the island as possible. Where piping is shown on the plans to be under paved areas, but running parallel and adjacent to planted areas, the intention is to install the piping in the planted areas. All pipes shall be buried a minimum of 12 to 18 inches deep, unless otherwise shown on the plans.
   5. Pipe under Existing Pavement: Piping may be installed under existing pavement by boring. Where removal of the existing pavement is necessary, the pavement removal and replacement shall be done in accordance with City of Lenexa Standards and at no additional cost to the owner.

6. Inspection of Materials: Carefully inspect pipe and fittings before installation, removing dirt, scale, and burrs, and reaming as required. Install pipe with markings up for visual inspection.
7. Plastic Pipe: Exercise care in handling, loading, unloading and storing plastic pipe and fittings. Store under cover until ready to install. Transport only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external loads.
    a. Repair dented and damaged pipe by cutting out and discarding the dented or damaged section, and rejoining with a coupling.
8. In jointing, use only the specified solvent and make joints in accordance with the manufacturer's recommendations as approved by the Engineer. Give solvent welds at least 15 minutes set-up time before moving or handling, and 24 hours curing time before filling with water.
9. Center load plastic pipe with a small amount of backfill to prevent arching and whipping under pressure.

L. EQUIPMENT INSTALLATION: Install manual control valves where indicated on the plans and in accordance with the manufacturer's recommendations, as approved by the Engineer. Install remote control valves within approved plastic valve boxes where indicated on the plans.
1. Field Wiring: All wires shall be bundled together and taped every fifty (50) feet. The wires shall be installed in the trench, under the main irrigation line. Enclose wire splices in approved plastic valve boxes.
2. Quick Coupling Valves:
    a. Install in lawn areas with the top flush with finish grade, and 8" from pavements and heads.
    b. Install in planting areas with tops 2" above grade and 8" from pavement and heads.
    c. Stake each quick coupling valve with 2" x 2" knot-free redwood stake set at least 24" into the earth, and extend sufficiently above the surface to ensure stability of the riser.
    d. Secure the riser to the stake with an adjustable stainless steel geared clamp.
3. Lawn Sprinkler Heads:
    a. Install where indicated on the drawings and in accordance with the manufacturer's recommendations as approved by the Engineer.
    b. Upon completion, the heads shall be flush with the grade and firmly anchored with soil.
4. Shrub Spray Heads: Install where indicated on the plans and in accordance with the manufacturer's recommendations as approved by the Engineer.
    a. Set tops of heads 6" above grade. Install part-circle 12" apart from curbs and 8" from sidewalks. Set heads along curbs in parking areas 2" above the top of curb.
    b. Stake each shrub head with #6 reinforcing steel bar and secure with adjustable stainless steel geared clamp to ensure stability.
5. Backflow Preventer:
    a. Install where indicated on the plans in accordance with Water One specifications and regulations, and the manufacturer's recommendations as approved by the Engineer.
    b. The backflow preventer shall be installed with two removable brass unions to facilitate removal in the winter. Provide a quick-coupler with purple (non-

potable) lid for blow out. Install fitting between the water meter and the backflow preventer.

c. The backflow preventer shall be buried, in accordance with Water One regulations and specifications, in an appropriate sized polymer concrete type box, a minimum of 18" below finished grade, centered vertically within the box, with adequate room to perform routine maintenance.

M. TESTING AND INSPECTION: Do not allow or cause any work of this Section to be covered up or enclosed until it has been inspected, tested, and approved by the Engineer. Before backfilling the main line, and with control valves in place, but before lateral pipes are connected, completely flush and test the main line.

- Repair leaks
- Flush out each section of lateral pipe before sprinkler heads are attached

5. Testing: Make necessary provision for thoroughly bleeding the line of air and debris.
   c. Before testing, fill the line with water for a period of at least 24 hours.
   d. After valves have been installed, test live water lines for leaks at a pressure of 50 psi for a period of two hours, with couplings exposed and with pipe sections center loaded.
   e. Provide required testing equipment and personnel.
   f. Repair leaks, and retest until acceptance by the Engineer.
6. Final Inspection: Clean, adjust and balance all systems. Verify that:

- Remote control valves are properly balanced.
- Heads are properly adjusted for radius and arc coverage.
- The installed system is workable, clean, and efficient.

N. OPERATING INSTRUCTIONS: Attach a typewritten legend inside each controller door, stating the areas covered by each remote control valve. After the system has been completed, inspected, and approved, instruct the owner's maintenance personnel in the operation and maintenance of the system. Provide the City with two (2) keys to the controller.

5. Provide the City a reproducible "as-built" drawing of the irrigation layout including:

- Any variance from the original plan.
- Measurements to all valves, quick couplers, and wire splices.
- Clear identification of the wire route.
- Expanded drawings and measurements of details not clearly shown at plan scale.

O. METHOD OF MEASUREMENT: "Irrigation Systems" shall be measured per linear foot of completed and accepted work, for the various sizes of pipe specified in the plans, measured horizontally along the centerline of the irrigation system pipes; and per each controller, valve, sprinkler head, meter box, and connection to the public water main. Excavation, backfill, tracer wires, electrical wires, and/or other appurtenances required to install the Irrigation System shall be subsidiary to the installation of the irrigation system.

P. BASIS OF PAYMENT: "Irrigation Systems" shall be paid for at the contract unit price, measured as stated above.

S-711 MULCHING: This work shall consist of furnishing, placing and securing mulching materials as designated on the Plans and Details or directed by the Engineer and the work shall be performed in accordance with these Specifications.

A. MATERIALS:

1. The mulching material shall be organic mulch, free from deleterious materials and suitable for top dressing of trees, shrubs, and seeded areas and shall consist of the following:

Type of Material	Approx. Depth (Loose Measurements)	Approx. Tons per Acre (Metric Ton/hectare) Required for Depth Shown
Prairie Hay, Wheat Straw, or Bromegrass	1.5” (37 mm)	1.75 to 2.25 (3.9 to 5.0)
Shredded Hardwood	3.0” (75 mm)	-
Hydromulch	0.25” (6.4 mm)	1.5 Minimum

2. Contractor shall submit sample of shredded hardwood mulch in labeled plastic bag for Engineer’s approval.

B. CONSTRUCTION REQUIREMENTS:

1. The mulching material as specified or permitted shall be placed over the designated areas after planting and fertilizing has been completed. The mulching material shall be spread uniformly to the approximate depths shown below or as indicated on the Plans.
2. The above rates are to be considered as a guide. It will be at the Engineer’s discretion to determine what rate is sufficient for adequate protection of the seeded areas.
3. Prairie Hay or Bromegrass: Hay shall be used only for areas with temporary seeding.
4. The prairie hay, wheat straw, or brome grass mulching material shall be punched into the soil so that it is partially covered. The punching operation shall be performed longitudinally with a mulching puncher. Care shall be exercised to obtain a reasonably even distribution of mulch partly incorporated into the soil. It may be necessary to use weights or hydraulic pressure to ensure that the mulch is punched into the soil.
5. On slopes too steep for disking, tackifier shall be hydraulically applied. Soil from the top of slope areas shall be placed by hand methods on the mulching material to reduce loss due to wind.
6. The length of hay or other mulching material is important in order for the mulch to interlace and bind together. Short-stemmed mulching material is more vulnerable to wind action than long-stemmed mulching material. When mulch is applied with a straw blower, it may be necessary to remove cutting knives to prevent cutting too much too short.
7. The Contractor shall arrange his work so that the mulch can be placed and punched immediately after each slope area is seeded. Mulching operations shall not lag behind seeding operations more than 24 hours during clear weather. When rain is threatening, the Contractor shall make every effort to mulch areas

the same day as seeded. Mulch shall be replaced before seeds germinate when re-mulching wind or rain damaged areas.

C. SHREDDED HARDWOOD:

1. Shredded Hardwood mulch, when required by Plans and Details, shall be applied with hand methods unless permitted otherwise by the Engineer. Shredded hardwood mulch shall be free from deleterious materials and suitable as a top dressing of trees and shrubs.

   Shredded hardwood mulch material shall be placed over the designated areas after planting and fertilizing has been completed in accordance with the notes and details shown on the Plans or as directed by the Engineer. The mulch shall be spread uniformly over the areas to a thickness of approximately 3 inches (75 mm), loose measurement, unless indicated on the Plans. The application shall provide for even coverage without clump, or bare spots. The mulch shall not be punched into the soil. The mulch shall be patted down with forks or other suitable tools as it is placed.

D. HYDROMULCH:

1. Seed shall be applied prior to the application of Hydromulch.
2. Hydromulch material shall be manufactured to be hydraulically applied and must be provided from City's list of pre-approved materials or an equal as approved by the Engineer.
3. Hydromulch shall be applied in accordance with the manufacturer's recommendations.
4. Hydromulch shall be applied in a minimum of 2 passes, each pass perpendicular to the last pass to form 100% coverage. Tackifier may be added at any time to the mulch/slurry mix or may be included in the mulch from the manufacturer. Any eroded areas shall be repaired by the contractor within seven (7) days of notice from the Engineer at no cost to the owner.

E. METHOD OF MEASUREMENT: No separate measurement shall be made for "Mulching".

F. BASIS OF PAYMENT: "Mulching" shall be subsidiary to other items and shall include all materials, labor, equipment, tools, and incidentals necessary to install the "Mulching".

S-712 <u>NATIVE SEEDING</u>: This work shall consist of the furnishing and planting of seed at the locations, in reasonable close conformity with those shown on the Plans or as designated by the Engineer and in accordance with these Specifications. The work shall also include the preparation of the ground for the seedbed in accordance with the section of this specification titled “Biological Soil Preparation”.

A. GENERAL: All grass species shall be supplied as pure live seed. Submit to the Engineer lab germination test results. Seed of all species native to Kansas shall be from within a 300-mile radius of the project site, or as approved by the Engineer. Packaged seed materials shall be delivered in original sealed, labeled, and undamaged containers showing weight, analysis, and name of distributor. Protect materials from deterioration during delivery and while stored at site. Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts’ “Rules for Testing Seeds” for purity and germination tolerances shall be provided. Seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed as indicated on the plans or Contract Documents shall be provided. The Contractor shall not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
   1. Seeding shall be installed in accordance with the plans, per the zone and seed mix specified in the plans or in the Special Conditions for the particular project. Zone Seeding shall be applied with an acceptable seeding machine, or other equipment of the “Slit Seeder” type approved by the Engineer, at a depth of 1/4 inch, in a uniform manner and at the prescribed rate. Drills shall be set 8 inches apart. Subcontractor shall make 2 passes in the same direction to place rows 3” to 5” apart. Broadcasting and hand raking to a depth of 1/8 inch will only be used on areas where it is impossible to operate a seed drill. When a slit type seeder is not used, the seed shall be covered to a depth of 1/4 to 1/2 inch with a shallow-set spike tooth harrow or other approved methods. The areas shall be firmed by rolling. After seed is placed, areas with less than a 6:1 slope shall be covered with straw and shall be crimped in. Areas with greater than a 6:1 slope will require double-sided biodegradable straw blanket or approved equal. Seeded areas will be acceptable provided all requirements of these specifications have been complied with, and a healthy, uniform, close stand of the specified grass is established, free of weeds, undesirable grass species, disease, and insects.
   2. The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with the type and operation of equipment being used. Said person shall direct all work performed under this section.
   3. The area to be seeded in all Zones shall be prepared for seeding in accordance with the section titled “Biological Soil Preparation”.
   4. All legumes shall be inoculated with proper rhizobia at the appropriate time prior to planting. The Contractor shall provide inoculant from a pure culture of nitrogen-fixing bacteria specific for each type of leguminous seed. The containers of inoculant shall be plainly marked with the expiration date for use and the manufacturer’s directions for inoculating seed.
   5. Seeding shall be conducted as a late fall dormant seeding or in early spring as described below. The Engineer reserves the right to delay the seeding of any seeds due to weather or soil conditions or for other causes.

6. Where Native Grasses and Wildflower seed is to be applied and Bonded Fiber Matrix is also to be applied, the seed shall be applied prior to application of the Bonded Fiber Matrix.
7. Regardless of the method of seeding, all bare areas larger than 12 in^2 shall be reseeded. Bare areas will be measured by the Engineer six weeks after start of the growing season during which the seed is applied. In the case of dormant seeding, the Engineer shall measure the bare areas six weeks after the start of the growing season following the dormant seeding. Any weeds growing at the time of this measurement shall be removed by the Contractor at the Contractor's expense.
8. An acceptable native grass stand will contain no less than five (5) healthy mature or developing plants per square foot with a population distribution per 10,000 square feet representative of ratios in the original blend. The result of maintenance shall be that weeds are being controlled through competition with desired plants, and that mowed bio-mass is not accumulating in such a manner to be detrimental to existing plant materials as determined by the Engineer and/or Landscape Architect. An acceptable native grass stand shall control erosion through root mass development. The occurrence of rills and gullies shall not be acceptable.
9. After the seed is placed, it shall be watered at a minimum rate of 1 inch per week (60 gallons per 10 square yards) in five or six applications per week beginning immediately after the seed is placed, and continuing until the roots of the plant are anchored in place, the plant is growing, and the project is accepted. Whether the minimum amount of water has been applied or not, the plant shall be watered until the ground under the plant is at 80% of saturation to a depth of 6". The 80% saturation shall be maintained until the project is accepted.
10. In addition to watering the plants, the Contractor shall remove any weeds from the planting areas. When vegetation reaches 10 inches in height, mow down to 6 inches, up to three times per year. Do not remove clippings. Mowing is to be conducted so that disturbance to the ground surface and vegetation is minimized. The weed removal may be by cultivation, hand removal, or spraying. Only noxious weeds shall be spot sprayed.
11. The Contractor shall be fully responsible for the condition of the seed work, including mowing, until written notification that his/her obligation to maintain the seeding is terminated and the project has been accepted.

B. METHOD OF MEASUREMENT: This work shall be measured per acre or part thereof of completed and accepted "Native Seeding" work. Seeding shall include the preparation of the ground for the seedbed, furnishing and planting all seeds, and biological soil preparation.

C. BASIS OF PAYMENT: "Native Seeding" shall be paid for at the contract unit price, measured as stated above.

S-713 PRUNING: This work shall consist of the pruning, shaping and treating of existing trees and hedges in reasonably close conformity to the best arboricultural practices, the notes on the Plans, and in accordance with these Specifications or as directed by the Engineer.

A. Trees and shrubs within or overhanging into the easements that will be damaged during the construction operations shall be pruned. Pruning should be done only where absolutely necessary and no trees shall be pruned without prior approval of the Engineer. All pruning, repair, and replacement of trees and plants shall be performed by certified arborists.
B. Limbs larger than one inch in diameter shall be removed with a minimum of two cuts. The cut preceding the final cuts shall be made approximately twelve inches to 24 inches from the trunk of the tree. The limb shall first be undercut and then cut from the top in such a manner that there is no tearing when the limb snaps off. The limb stub shall be removed by making a shallow undercut flush with the tree trunk prior to making the final downward cut. Avoid leaving a shoulder when making the final cut. Heavy limb stubs should be supported while cutting. When required, limb scars shall be pointed at top and bottom and roughened or torn wood and bark shall be neatly cut off with sharp tools.
C. All dead limbs and such live limbs as the Engineer directs shall be removed. Small branches growing close to each other shall be thinned out as directed by the Engineer.
D. Large limbs shall not be allowed to crash through lower branches but shall be lowered with ropes. Ropes shall be carefully attached or placed over other branches to facilitate carefully lowering the cut limbs.
E. Should special cavity work or other special tree surgical work be required in addition to the items of work listed above, the word “Special” shall follow the unit bidding item, “Pruning Existing Trees” (Example-“Pruning Existing Trees-Special”). In addition, a description of the work required shall be noted on the Plans.
F. Pruning existing hedge shall be performed as outlined above for other trees. Thinning out of branches and clearing the lower tree trunks of branches shall be performed as directed by the Engineer. Should the hedge trees require shearing or trimming to fence height, in addition to the items of work listed above, a description of the work required shall be noted on the Plans.
G. All brush and debris resulting from the pruning of trees and hedge shall be disposed of in such a manner that the right of way and adjoining property will be left with a neat, presentable appearance.

H. METHOD OF MEASUREMENT: This work shall be measured according to the number of existing trees pruned and according to the linear feet (slope measurement) of existing hedge pruned.

I. BASIS OF PAYMENT: The completed and accepted work, measured as provided above, shall be paid at the contract unit price per each for “Pruning Existing Trees”, or “Pruning Existing Trees-Special” and per linear foot for “Pruning Existing Hedge”. Should severe damage be done to a tree or trees by making improper cuts which allow the limb or limbs to tear into the tree trunk or trunks or if severe damage is done by allowing large limbs to crash through lower branches, there shall be no pay for the work done on the tree or trees which are thus damaged. Completion of the work done on such trees, by removing broken limbs, rimming limbs and painting limb scars, will be required.

S-714 SALVAGE: This work shall consist of digging up trees, shrubs, bushes, flowers, or other plantings in such a manner as to prepare them for replanting in accordance with these Specifications. All trees, shrubs, bushes, flowers or any other plantings to be removed by the construction shall become the property of the property owner. In the event the property owner does not want to remove the trees, shrubs, bushes, flowers or any other plantings, prior to clearing operations, or salvage of plantings, the plantings shall become the property of the Contractor and he shall be responsible for the disposal thereof.

A. METHOD OF MEASUREMENT: No separate measurement shall be made for "Salvage".

B. BASIS OF PAYMENT: No separate payment shall be made for "Salvage". Work performed for "Salvage" shall be subsidiary to "Clearing and Grubbing".

S-715 SEEDING: This work shall consist of the furnishing and planting of seed at the locations, in reasonably close conformity with those shown on the Plans or as designated by the Engineer and in accordance with these Specifications. The work shall also include the preparation of the ground for the seedbed and fertilizer per S-706 Fertilizer in accordance with the type of seeding required.

A. GENERAL: All grass species shall be supplied as pure live seed. Submit to the Owner lab germination test results. Seed of all species native to Kansas shall be from within a 300-mile radius of the project site, or submit seed source for approval.
   1. Packaged seed materials shall be delivered in original sealed, labeled, and undamaged containers showing weight, analysis, and name of manufacturer. Materials shall be protected from deterioration during delivery and while stored at site. Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerances shall be provided. Seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum of 1% of weed seed shall be provided. The Contractor shall not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
   2. The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work, who shall be thoroughly familiar with the type and operation of equipment being used. Said person shall direct all work performed under this section.
   3. The entire area to be seeded shall be properly prepared prior to seeding. The soil preparation shall be accomplished by disking, harrowing and grading. Plowing will also be required if so indicated on the Plans. The minimum depth of soil preparation shall be 1 inch, except on newly constructed shoulders, where the maximum depth of soil preparation should be 2 inches. Existing weed stubble, small weeds and grass that can be disked shall be cut by the disk and partially incorporated into the soil. Several disking's and harrowings over some areas may be required to provide a satisfactory seedbed. Areas too steep or otherwise inaccessible for disking shall be prepared by hand methods. All rocks 2 inches or larger shall be removed.
   4. The soil preparations on all slope areas shall be performed with disks and harrows unless demonstration shows such methods impracticable and that hand methods must be used, except for the following: in situations on lawns and other small, similar areas a rotary tiller or other similar approved equipment shall be required for seedbed preparation. A landscape box will be required for proper leveling of the seedbed when designated by the Engineer. Tractor mounted equipment may, however, be used in areas which are of sufficient size to facilitate use of such equipment when approved by the Engineer. The seedbed shall be firm, smooth and reasonably free of rocks, clods and other debris sufficiently to permit subsequent mowing with lawn maintenance type equipment.
   5. In general, all disturbed areas should have a minimum of 6 inches of select soil uniformly placed. All disturbed areas shall be seeded in the next planting season following construction.
   6. During the process of soil preparation, extreme care shall be exercised to avoid injury to small trees that have been designated by the Engineer to be saved.
   7. The Engineer may designate local areas of desirable native perennial grasses to be saved during the soil preparation. Areas of annual grasses such as cheat,

crab grass, triple-awn, etc., shall be treated in accordance with the section of this specification titled, “Herbaceous Species Removal”.

8. Approval of the seed bed shall be obtained from the Engineer before seeding is started. Seed shall be applied with an acceptable seed drill, or other equipment of the “Cultipacker” type approved by the Engineer, at a depth of 1/2 inch, in a uniform manner and at the prescribed rate. Drills shall be set 4 inches apart. Subcontractor shall make 2 passes in the opposite direction to place rows 3 inches to 5 inches apart. Broadcasting and hand raking to a depth of 1/2 inch will only be used on areas where it is impossible to operate a seed drill. When a cultipacker type seeder is not used, the seed shall be covered to a depth of 1/4 to 1/2 inch with a shallow-set spike tooth harrow or other approved methods. The areas shall be firmed by rolling. After seed is placed, areas with less than a 6:1 slope shall be covered with straw and shall be crimped in. Areas greater than a 6:1 slope will require a double-sided biodegradable straw blanket or approved equal. Seeded areas will be acceptable provided all requirements of these specifications have been complied with, and a healthy, uniform, close stand of the specified grass is established, free of weeds, undesirable grass species, disease, and insects. All bare areas over 12 in^2 shall be re-seeded.
9. The seed mixture shall be as shown below, unless otherwise shown in the Plans:

    - Minimum 20% Each of Any 4 varieties of Turf Type Fine Leaf Fescue
        - Total Application Rate shall be 8 pounds/1000 Square Feet.

    - Minimum 10% of Perennial Rye
        - Total Application Rate shall be 1 pound/1000 Square Feet.

10. The two general “Seeding Seasons” shall be Spring Seeding Season – March 15 to April 20, and Fall Seeding Season – August 15 to September 30.
11. The permissible seeding seasons for individual seeds or combinations of seeds may be determined by the Engineer. The seeding period may be extended a few days in special cases when mulching is specified to follow the drilling of seeds and fertilizer. The Engineer reserves the right to delay the drilling or seeding of any seeds or to vary the permissible seeding seasons listed above due to weather or soil conditions or for other causes.
12. In order to protect finished grading work from erosion, the seeding contractor may be required to perform the seeding work on a project at several different periods of time.
13. At the discretion of the Engineer, if the grading work has progressed sufficiently, the Contractor will be expected to start the work of seeding on the backslopes, ditches and fill slopes or other areas as directed by the Engineer. All permanent seeding work shall be performed within the requirements of the “Seeding Season”.
14. After the seed is placed, it shall be watered at a minimum rate of 3 inches per week (170 gallons per 10 square yards) in five or six applications per week beginning immediately after the plant is placed, and continuing until the roots of the plant are anchored in place, the plant is growing, and the project is accepted. Whether the minimum amount of water has been applied or not, the plant shall be watered until the ground under the plant is at 80% of saturation to a depth of 6 inches. The 80% saturation shall be maintained until the project is accepted.

15. In addition to watering the plants, the Contractor shall remove any weeds from the planting areas. The weed removal may be by cultivation, hand removal, or spraying. At the time of acceptance the planting beds shall be free of weeds.
16. The Contractor shall be fully responsible for the condition of the seed work, including mowing, until written notification that his/her obligation to maintain the seeding is terminated and the project has been accepted.

B. METHOD OF MEASUREMENT: This work shall be measured per acre or part thereof of completed and accepted “Seeding” work.

C. BASIS OF PAYMENT: “Seeding” shall be paid for at the contract unit price, measured as stated above. Seeding shall include the preparation of the ground for the seedbed, furnishing and planting all seeds, nitrogen fixing bacteria, fertilizer, and mulching.

S-716 SODDING: This work shall consist of furnishing and placing living sod in reasonably close conformity with the locations indicated on the Plans or as designated by the Engineer and in accordance with these Specifications.

A. All sod provided shall be grown within 100 miles of the project site. Contractor shall provide delivery tickets showing species, and total square yards delivered.
B. Where the width of the disturbed area to be sodded exceeds the width of a sod roll, the area shall be widened to a uniform size by removing enough existing turf from behind the disturbed area, creating an area whose width is a multiple of the width of a sod roll. A clean edge should be established at the outer limits of the area to be sodded, so that good contact can be made between the new sod and the established turf.
C. Where the width of the disturbed area is less than the width of one sod roll, enough existing turf shall be removed to create an area of uniform width, not less than six (6") inches wide.
D. All backfill shall consist of soil suitable for vegetation. The area shall be prepared such that sodding can be placed on bare soil. This will consist of cultivating, smoothing, removing of clods, surface stones 1" in diameter or larger, and weeds. All excavation and backfilling shall be subsidiary to other bid items.
E. Area to be sodded shall consist of a minimum of 6"-8" of top soil, free from clods, rocks, trash, and other debris. If the area has been severely compacted by heavy trucks or other equipment, it shall be cultivated to a depth of 6"-8" by tilling or disking. Backfill areas shall be compacted to a sufficient density to prevent excessive settling after placement of sod. If footprints left by an adult walking across the area are more than 1/2" deep, the compaction is not sufficient.
F. Grade of the area shall be approximately 1" below desired final grade, to allow for the thickness of the sod.
G. All materials shall conform to the requirements of these Specifications. The Contractor shall retain a person knowledgeable of the different types of sod to ascertain prior to bidding, the location and types of existing sods. Sod shall be fine leaf fescue turf type (3-5 type blend), unless otherwise specified on the Plans, or unless the specified type does not match the type growing in the adjacent lawn; in which case the new sod shall match the type already growing in the adjacent lawn. Sod shall be of best quality, not more than two years old, shall conform to the quality standards of Nursery Grown Sod as defined by the American Sod Producers Association, and shall meet the following standards:
    1. Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 1 inch, $\pm$ 1/4 inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch.
    2. Pad Size: Individual pieces of sod shall be cut to the supplier's standard width and length as approved by the Engineer. Maximum allowable deviation from standard widths and lengths shall be $\pm$ 1/2 inch on width and plus or minus 5 percent on length. Broken pads and torn or uneven ends will not be acceptable.
    3. Strength of Sod Sections: Standard size sections of sod shall be strong enough to support their own weight and should retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.
    4. Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) will adversely affect its survival.
    5. Mowing Height: Before stripping, sod shall be mowed uniformly at a height of 2 to 3 inches.

6. Thatch: Sod shall be relatively free of thatch, up to 1/2 inch allowable (uncompressed).
7. Diseases, Nematodes, and Insects: Sod shall be reasonably free of diseases, nematodes, and soil-borne insects. State nursery and/or plant materials' laws require that all sod entering inter-state commerce be inspected and approved for sale. The same applies to sod being shipped intra-state. The inspections and approval must be made by the state agricultural department, office of the state entomologist.
8. Weeds: Sod shall be free of objectionable grassy and broad leaf weeds. Sod shall be considered free of such weeds if less than 5 such plants are found per 200 square feet of area. Sod will not be acceptable if it contains any of the followings weeds: quackgrass, Johnson grass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, wild garlic, ground ivy, perennial sorrel, bromegrass, and bentgrass.

H. Bluegrass and Fescue sod may be planted during the periods of March 1 to May 15 and September 1 to November 15. Bluegrass and Fescue sod may be planted during the period, November 15 to March 1, when the soil and sod is workable and with the approval of the Engineer. If sod is planted between November 15 and March 1, the Contractor will maintain the sod until 20 days after the beginning of the spring sodding season. The Engineer reserves the right to delay the sodding of all types of sod or to vary the permissible sodding seasons, due to weather, soil conditions, or for other causes. Zoysia sod may be planted during the period April 1 to October 15.

I. Fertilizer shall be placed per section S-706 prior to laying sod. Sod strips shall be laid parallel with the ends staggered in a running bond pattern. Each successively laid strip shall be pressed firmly up against the one next to it or up against the edge of the existing turf, to ensure good contact with no overlapping. Sod shall be staked in places where the slope exceeds 3:1. Sod shall be staked with a minimum of two to four stakes per square yard or roll, as determined by the Engineer. Stakes shall be of lath or similar materials, or shall be metal sod staples, and shall be driven six inches into the ground, leaving approximately 1/2 inch of the top of the lath above the sod line or leaving the metal staples flush with the surface of the earth/root mass of sod.

J. After placing sod, the area shall be tamped with a hand tamp or rolled with a lawn roller half filled with water. Rolling shall be done in a direction perpendicular to the direction in which the sod lengths were laid.

K. After sod is placed, it shall be watered at a minimum rate of 3" per week (16,800 gallons per 1000 square yards) in five or six applications per week beginning immediately after sod is placed, and continuing until the roots of the sod are anchored in place, and the sod is growing and the project is accepted. Whether the minimum amount of water has been applied or not, the sod shall be watered until the ground under the sod is saturated at the interface between the sod and the existing earth.

L. All sodded areas shall be kept thoroughly watered by the Contractor after laying as often as required, until completion of other items of work in the Contract. If sodding is the last item of work to be performed, the Contractor shall continue watering until all sod is growing and the project is accepted. Sodded areas shall be mowed to a height of 3” at least once prior to acceptance of the project.

M. The Contractor shall be fully responsible for the condition of the sod work, including mowing, until written notification that his obligation to maintain the sod is terminated, and the project has been accepted.

N. Water used in this work shall be furnished by the Contractor and will be suitable for irrigation and free from ingredients harmful to plant life. All watering equipment required for the work shall be furnished by the Contractor. Under no circumstances shall the Contractor use water except that metered from adjacent fire hydrants or public water lines.

O. METHOD OF MEASUREMENT: “Sodding” shall be measured by the number of square yards (slope measurement) of surface area planted.

P. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit prices per square yard for the various kinds of “Sodding”, which prices shall be full compensation for all excavation, for all soil preparation, for furnishing, transporting, placing, firming, watering, fertilizing, mulching, cultivating, and maintaining the sod and for all labor, tools, equipment, and incidentals necessary to complete the work.

S-717 <u>SURFACE ROUGHENING</u>: The work consists of providing a rough soil surface with horizontal depressions created by operating a tiller or other suitable implement on the contour or by leaving the slopes in a roughened condition by not fine-grading them. Surface Roughening shall only be used as a temporary measure to stabilize slopes until seeding can be installed.

A. All slopes steeper than 3H:1V require surface roughening by stair-step grading, grooving, furrowing, or tracking. Areas that have been graded and will not be stabilized immediately shall be roughened to reduce runoff velocity until seeding takes place. Slopes with a stable rock face do not require roughening or stabilization.
B. Stair-step grading may be carried out on any material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading. The ratio of the vertical cut distance to the horizontal distance shall be less than 1:1 and the horizontal portion of the step shall slope toward the vertical wall. Individual vertical cuts shall not be more than 30 inches in soft soil materials and not more than 40 inches in rocky materials.
C. Grooving consists of using machinery to create a series of ridges and depressions that run perpendicular to the slope (on the contour). Grooves may be made with any appropriate implement that can be safely operated on the slope and that will not cause undue compaction. Suggested implements include discs, tillers, spring harrows, and the teeth on a front-end loader bucket. Such grooves shall not be less than 3 inches deep, nor spaced more than 15 inches apart.
D. Fill slopes with a gradient steeper than 3H:1V shall be grooved or allowed to remain rough as they are constructed. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface.
E. Roughening with tracked machinery: Roughening with tracked machinery on clayey soils is not recommended unless no alternatives are available. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely and may be tracked. In no case is tracking as effective as the other roughening methods described. When tracking is the chosen surface-roughening technique, it shall be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes of the machinery as possible shall be made to minimize compaction.
F. At no time shall slopes be bladed or scraped to produce a smooth hard surface.
G. Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth.
H. Periodically check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

I. METHOD OF MEASUREMENT: “Surface Roughening” shall not be measured separately, but shall be subsidiary to “Compaction of Earthwork” or “Unclassified Excavation”.

J. BASIS OF PAYMENT: “Surface Roughening” shall not be paid for separately, but shall be subsidiary to “Compaction of Earthwork” or “Unclassified Excavation”.

S-718 <u>TREE AND PLANT PROTECTION</u>: This work shall consist of protecting trees and other vegetation from damage by the construction activities in accordance with these Specifications, the Plans, and the Contract Documents. No trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the drawings. All trees and plants not removed shall be protected against injury from construction operations.

A. GENERAL: Contractor shall take extra measures to protect trees designated to be preserved, by erecting construction fencing around the trees at the drip line of the tree. No equipment or material shall be stored within the drip line of the tree (See City Standard Detail). The drip line of the tree shall be defined as a vertical line from the outer limits/furthest extent of any living portion of the tree (above ground) to the ground.

   Fires shall not be permitted within 100 feet of the drip line of any trees designated to remain. Fires shall be limited in size to prevent adverse effects on trees and kept under surveillance (per the burning permit).

B. METHOD OF MEASUREMENT: No separate measurement shall be made for “Tree and Plant Protection”.

C. BASIS OF PAYMENT: No separate payment shall be made for “Tree and Plant Protection”. All work required under this section shall be subsidiary to “Clearing and Grubbing”.

S-719 <u>TREE RELOCATION</u>: This work shall consist of relocating trees as shown on the Plans and by an accepted method as approved by the Engineer.

A. GENERAL: Contractor shall take extra measures to protect the tree during the relocation by erecting barricades, staking, trimming, etc. as required. All trees to be relocated shall be performed by certified arborists. Tree relocation shall be performed between October 15th and April 15th.

B. METHOD OF MEASUREMENT: "Tree Relocation" shall be measured per each tree relocated, in place and accepted.

C. BASIS OF PAYMENT: Payment for this work shall be made at the contract unit price bid per each for "Tree Relocation".

S-720 TREE WELL: This work shall consist of the construction of mortar uncoursed rubble masonry tree wells in accordance with these Specifications and in reasonably close conformity with the dimensions and locations as shown on the Standard Details or as established by the Engineer.

A. GENERAL: Tree wells shall be constructed not later than 30 days prior to placing embankment around the tree, or performing excavation adjacent to the drip line. The tree well shall be placed slightly beyond the drip line. Following excavation, all tree roots that are exposed or damaged shall be trimmed cleanly, painted with tree paint, and covered with moist peat moss, burlap, or other suitable material to keep them from drying out. The Contractor shall apply fertilizer and water thoroughly. Fertilizer shall be applied in accordance with the section of these specifications titled “Fertilizer”. Water shall be applied at the rate of 1” per day for the first 20 days after the excavation. After the first 20 days the Contractor shall apply water as needed. Contractor responsibility for the tree shall end with acceptance of the project by the City.

   All stones shall be laid in mortar with all spaces between stones completely filled and with the stones carefully settled in the mortar beds before the mortar has set. The mortar shall conform to the requirements of Division 400 of the KDOT Standard Specifications for the State Road and Bridge Construction. In general the larger stones shall be used shall be used in the bottom of masonry wall and the thickness of the stones shall decrease from the bottom of the wall to the top. The masonry shall be constructed in a workmanlike manner and the top of the wall shall fit the embankment slope. The mortar shall be protected from the direct rays of the sun and shall be cured for three days with wet burlap or wet cotton mats. The backfill around the wall shall be carefully placed and the finished construction shall present a neat appearance.

C. METHOD OF MEASUREMENT: “Tree Well” shall be measured per each completed, in place, and accepted. Subsidiary work shall include installation and materials for the porous material, excavation, backfill, installation, and materials for stone masonry and grout, and any other materials, labor and equipment required to install the “Tree Well”.

D. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per each for “Tree Well”.

S-721 WOODY BRUSH REMOVAL: This work shall consist of the selective cutting and disposal of woody brush including trees and shrubs.

A. The Contractor shall provide at least one person who shall be present at all times during execution of this portion of the work who shall be thoroughly familiar with this type of work and the type of materials being used. Said person shall be competent at identification of plant materials to be cut and to be preserved. Said person shall also direct all work performed under this section.
B. The Contractor will cut all woody species designated for removal with tools including, but not necessarily limited to, gas powered chain saws, gas-powered clearing saws, bow saws, and loppers. Stumps shall be removed unless removal will damage vegetation designated to remain. The Engineer shall mark in the field all stumps which are not to be removed. All stumps which the Engineer designates to remain in place shall be cut flat with no sharp points, and to within two inches of surrounding grade. All stumps designated by the Engineer to remain shall be treated with an approved herbicide mixed with a marking dye.
C. Remove all dead and fallen trees/debris within the construction easement.
D. Species designated for removal are:

COMMON NAME	SCIENTIFIC NAME	DISPOSITION
Tartarian Honeysuckle	*Lonicera tatarica*	Remove all
Amur Honeysuckle	*Lonicera maackii*	Remove all
Showy fly honeysuckle	*Lonicera x bella*	Remove all
Elm Species	*Ulmus spp.*	Reduce by 50%
Autumn olive	*Elaeagnus umbellate*	Remove all
Black locust	*Robinia psuedo-acacia*	Reduce by 50%
Marrow's honeysuckle	*Lonicera morrowii Gray*	Remove all
Japanese honeysuckle	*Lonicera japonica*	Remove all
Multiflora rose	*Rosa multiflora Thunb. Ex Murray*	Reduce by 50%
Osage orange	*Maclura poninfera*	Reduce by 50%
Smooth sumac	*Rhus glabra*	Reduce by 50%

E. After completion of woody brush removal, the Contractor shall schedule with the Engineer an inspection of the work. Any stumps that re-sprout during construction of the project shall be re-treated with herbicide.
F. Application of herbicides shall be in accordance with the section of these Technical Specifications titled "Herbicide".
G. The Contractor and the Engineer shall conduct an inspection of the site approximately one year after acceptance of the project. The Contractor shall apply herbicide to any stumps that have re-sprouted at the time of the inspection.
H. The Engineer will conduct an inspection of the site prior to expiration of the 2-year maintenance bond for the project. Upon notification by the Engineer, the Contractor shall re-treat any stumps that have re-sprouted at the time of this inspection. Re-treatment shall take place within 30 days after notification by the Engineer.

I. METHOD OF MEASUREMENT: “Woody Brush Removal” shall be measured per acre, of completed and accepted work.

J. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per acre of “Woody Brush Removal”.

TRAFFIC IMPROVEMENTS AND MATERIALS

S-800 TRAFFIC SIGNALS: This work shall include the furnishing of all labor, materials and equipment for the installation of a complete operational traffic signal installation in accordance with the plans and these Specifications. A complete list of pre-approved traffic signal materials is available at the office of the City Engineer or can be found on the City of Lenexa's website at ***www.lenexa.com***.

A. MATERIALS AND EQUIPMENT: Unless otherwise noted in the plans, all equipment, materials and incidental parts shall be new and of similar manufacturer. All incidental parts which are not shown on the plans or described in these Specifications and which are necessary to complete the traffic signal installation, shall be furnished and installed as though such parts were shown on the plans or described in these Specifications. The cost shall be included in the traffic signal installation lump sum bid price.

1. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA). In addition to the requirement of these Specifications, all material shall conform to the requirements of the National Electrical Code (NEC), the Standards of the American Society of Testing Materials (ASTM), the American Standards Association (ASA) and local ordinances.
2. All concrete supplied for the work shall be Class KCMMB-4K and conforming to the section of these Specifications entitled "Concrete Construction".
3. All reinforcing steel shall meet the requirements of steel bars for concrete reinforcement in the section of this specification titled "Reinforcing Steel".
4. Traffic Signal Poles shall conform to these Specifications, the plans and the 2013 edition of AASHTO's Standard Specifications for Structural Supports for Signs, Luminaires and Traffic Signals. The pole and arm shall be a round, tapered monotube made only of one length of the best grade, structural steel sheet of not less than 7 Manufacturing Standard Gauge. Only one longitudinal weld and no transverse welds shall be permitted in the fabrication of the shaft or arm. The steel anchor base of adequate strength, shape and size shall be secured to the lower end of the shaft by welding in such manner as to develop the full strength of the adjacent shaft section to resist bending action. The steel poles shall be galvanized to ASTM A-123 standards. All accessories shall be galvanized to ASTM A-153 standards. The tapered steel shaft shall include high strength anchor bolts and nuts that meet the following requirements:

Tensile Strength (minimum)		75,000 psi
Yield Strength at 0.2% offset (minimum)		55,000 psi
Elongation:	8" min.	18%
	2" min.	21%

5. The anchor bolts shall be hot dipped galvanized on the threaded end after threading. The galvanizing shall include all threads and not less than six inches of the adjacent unthreaded portion of the bolts. Anchor bolts shall be threaded to a length shown on the plans or in the Standard Details. Threads shall be Coarse Thread Series as specified in ANSI B1.1 and may be formed by cutting or rolling. Nuts for anchor bolts shall be Heavy Hex leveling nuts and Heavy Hex nuts as specified in ANSI B18.2.2. Nuts shall comply with the proof load or Brinell hardness requirements of ASTM A307. After galvanizing, the thread fit of the bolt-nut combination shall be snug and shall be such that the nuts can be turned

on the bolts without the application of excessive torque. The Engineer may conduct proof load tests on the bolt-nut combination to check the thread fit.

6. The pole shaft shall also include a hand hole and cover, cast pole top, a J-hook wire support, and a suitable bolt-on type device for attaching the mast arm to the shaft as shown on the Traffic Signal Detail sheets in the accompanying plans. The tapered steel arm shall include a removable end cap.
7. Where a combination lighting/signal pole is specified on the plans, the above applies with the luminaire arm to be mounted in the same vertical plane as the signal arm (except where otherwise noted on the plans). The vertical shaft of the combination lighting/signal pole shall be a one-piece design and shall contain an additional hand hole located 4 inches above the mast arm on the opposite side of the pole from the mast arm. See Detail 2 on the Traffic Signal Structures standard detail sheet for more information.
8. When fully loaded with all equipment as shown on the plans, all mast arms shall be between horizontal (level) to one and one-half degrees (1-1/2°) above horizontal. No perceptible bending of the arm shall be observed when fully loaded, as determined by a visual inspection by the Engineer.
9. All traffic signal poles shall be detailed on shop drawings by the manufacturer indicating pole and arm dimensions and attachment method along with signal weight, projected areas, and type of mounting that it is designed to accommodate.
10. Aluminum pedestals shall consist of aluminum, die cast or sand cast square base and a 4” diameter shaft for mounting vertical signal heads or a standard controller cabinet. The pedestal shall be capable of withstanding wind loadings of 100 mph.
11. The cast aluminum bases shall meet the requirements of ASTM B108 Alloy 356-T6, ASTM B-26, SG70A-T6, S5A.F, or ASTM B-108, SG70A-T6. The base and post shall be joined by welded connections. The aluminum shaft shall be spun from one piece of seamless tubing, meeting the requirements of ASTM Alloy 6063-T6 and having a minimum nominal 0.125” wall thickness. The shaft shall have no longitudinal welds, nor circumferential welds. The shaft shall have a uniform polished finish. Each shaft shall be tire-wrapped with a heavy water-resistant paper for protection during shipment and installation.
12. Each vehicle signal head shall be a weather tight assembly of one or more signal faces of the sizes shown on the plans. All brackets and fittings necessary for proper mounting with the type of signal support designated on the plans shall be furnished. Banding for signal heads shall be 3/4” stainless steel. Each signal face shall consist of one or more signal sections, rigidly and securely fastened together, capable of being positively positioned to control the movement of one direction of traffic. Each signal section shall be a self-contained assembly consisting of an optical unit with housing, housing door, and visor. Tie rods shall not be used to fasten signal sections together to form a signal face. All signal heads on a project shall be the product of one manufacturer and shall be a single model number for like items. For signal modification projects, new signal heads shall match existing signal heads with respect to manufacturer and model. Terminal blocks of suitable size shall be placed in the middle section of the signal head.
13. The housing for each signal section shall be made of a durable polycarbonate and shall be yellow in color, unless otherwise specified on the plans. It shall be clean, smooth and free from flaws, cracks, blowholes, and other imperfections. It

shall be designed as a self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together. It shall be equipped with round openings in the top and bottom so that it may be rotated between waterproof supporting brackets and thus be capable of being directed at any angle in the horizontal plane. It shall be equipped with positive locking devices to maintain a specific angle of direction when in place. The doors shall be black in color and consist of polycarbonate construction. They shall be suitably hinged and held securely to the body of the housing by simple stainless steel locking devices. All other door parts, such as hinge pins, lens clips, screws, etc., shall also be of stainless steel material.

14. The visors for each signal section shall be durable polycarbonate, black in color, not less than 0.05 inches in thickness and shall be tunnel-type. It shall be designed to fit tightly against the door, and shall not permit any perceptible filtration of light between it and the housing door. Visors shall be at least 9.5 inches long for 12" diameter signals and shall angle slightly downward.
15. The optical unit and visor shall be designed as a whole so as to eliminate the return of outside rays entering the unit from above the horizontal.
16. Lenses shall meet the requirements of ANSI D-10.1-1966 optical specifications and shall be glass for incandescent style. Lettering shall not appear on lenses. Nominal 12" diameter signal lenses shall be furnished, unless otherwise shown on the accompanying plans.
17. All traffic signal indications for new signal installations as well as signal modification projects shall be LED displays. LED indications shall be 12" diameter, 120-volt LED's in a self-contained enclosure with a 10-year life expectancy. LED indications shall comply with the latest edition of ITE's Interim Purchase Specification – Vehicle Traffic Signal Control Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules.
18. The construction materials and colors for pedestrian signal heads shall conform to those listed in the previous section with the following additions outlined below. The LED module shall display a solid Portland orange hand and lunar white man and two Portland orange countdown numbers, and shall be a single-section with clamshell mounting. LED indications shall comply with the latest edition of ITE's Interim Purchase Specification – Vehicle Traffic Signal Control Heads, Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules. The legends shall conform to the ITE Specification Pedestrian Traffic Control Signal Indications.
19. The pedestrian signal door and visor shall be black in color. The pedestrian signal housing shall be 16 inches by 16 inches and shall have tunnel visors. All visors shall be a minimum of 0.06 inches thick.
20. The countdown indications shall be 120-volt LEDs in self-contained enclosures and shall have a 10-year life expectancy.
21. Vertical bracket mounted signal heads, as shown on the plans, shall be supported by a one-piece mounting bracket watertight assembly made entirely of a durable polycarbonate and be yellow in color. Each bracket shall be either plumb or level, symmetrically arranged and securely assembled. Each bracket shall have serrations for positioning traffic signals in increments of 5^{o}. Construction shall be such that conductors are concealed within the assembly. Brackets shall be attached to the pole or pedestal by approved stainless steel banding and brackets.

22. Mast arm signal head assemblies shall be rigid mounted utilizing a universally adjustable bracket consisting of both top and bottom brackets with a center vertical extruded aluminum support tube attached to the mast arm by means of a clamp kit with stainless steel cable. The vertical support tube shall allow wire entry at any point and be equipped with a vinyl insert that conceals the wiring. The lower bracket arm shall be accessible for wiring entry into the signal head.
23. Where shown on the plans, 5” one-piece back plates shall be furnished and attached to the signal section to provide a dark background for signal indications. Back plates shall be attached to the signals as per the manufacturer's recommended practice.
24. Pedestrian push buttons shall be audible and shall be direct-push, contact-type with a bull-dog style. Each push button shall be a removable contact assembly mounted in a durable yellow case. Contacts shall be normally open, entirely insulated from the case and operating button, and have connecting terminals. The operating button shall be brass or another corrosion resistant metal alloy and shall be sturdy. The operating voltage shall not exceed 18 volts. The entire assembly shall be weatherproof, vandal-resistant**,** secure against electrical shock to the user, and of such construction as to withstand hard usage. The pedestrian push button shall be mounted directly to the pole in a watertight assembly and shall be the large button type meeting ADA requirements. If the reach for the pedestrian buttons exceeds 10 inches, the contractor shall use a pushbutton extender.
25. Multi-conductor signal cable shall conform to Specification 19-1 of the latest edition of the International Municipal Signal Association, Inc. (IMSA) requirements, except all conductors supplied shall be stranded copper with a minimum size of No. 14 AWG. The number and size of conductors per cable shall be as shown on the plans.
26. The detector loop wire shall be No. 14 AWG, stranded copper, conforming to IMSA Specification 51-5 (Single conductor PVC/Nylon with tube jacket).
27. Sealant for loop detectors shall be prepared and installed in accordance with the manufacturer's instructions. The Contractor shall submit the manufacturer's instructions to the Engineer for review and approval. Regardless of the manufacturer’s instructions, the sealant shall be squeegeed into the saw cuts. All curb cuts shall be sealed with duct seal.
28. The detector lead-in cable shall be No. 18 AWG 4-conductor, stranded and shielded cable. The conductor and drain wires shall be tinned copper wires with conductors shielded by a layer of aluminized polyester. All wires shall be insulated with cross-linked polypropylene or polyethylene and provided with a vinyl jacket.
29. Power lead-in cable shall be of the sizes and number of conductors as shown on the plans. The power lead-in cable shall be for operation on a 600 volt maximum and suitable for use at conductor temperatures not exceeding 75° C. Material, construction, and tests shall be in accordance with the applicable requirements of the IPCEA Standard S-66-524 "Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy".
30. This item shall govern the above ground radar presence detector (RPD) equivalent to the Wavetronix SmartSensor Matrix. The RPD shall present real-time presence data in 10 lanes. The RPD shall support a maximum of eight zones and shall support four channels and have user-selectable channel

assignments. The RPD shall use OR logic to combine multiple zones to a channel output, and shall have channel output extend and delay functionality. The RPD algorithms shall mitigate detections from wrong way or cross traffic. The RPD system shall have fail-safe mode capabilities for contact closure outputs if communication is lost. With regards to detection area and range, the RPD shall be able to detect and report presence in lanes with boundaries as close as 6 ft. from the base of the pole on which the RPD is mounted. The RPD shall be able to detect and report presence in lanes located within the 100-foot arc from the base of the pole on which the RPD is mounted. The RPD shall be able to detect and report presence for vehicles within a 90 degree field of view. The RPD shall be able to detect and report presence in up to 10 lanes and shall be able to detect and report presence in curved lanes and areas with islands and medians. For each approach to be detected, one RPD corner radar shall be used.

Each RPD shall have a traffic cabinet preassembled back plate with the following:

- AC/DC power conversion
- Surge protection
- Terminal blocks for cable landing
- Communication connection points

The preassembled back plate for the RPD shall be a cabinet side mount or rack mount. The RPD shall use contact closure input file cards with 2 or 4 channel capabilities. The contact closure input file cards for the RPD shall be compatible with industry standard detector racks.

The RPD shall not require cleaning or adjustment to maintain performance. The RPD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement. Once the RPD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes.

The RPD shall not exceed 4.2 lbs. in weight and shall not exceed 13.2 inches by 10.6 inches by 3.3 inches in its physical dimensions. All external parts of the RPD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration. The RPD shall be enclosed in a Lexan EXL polycarbonate. The enclosure shall be classified “f1” outdoor weather ability in accordance with UL 746C. The RPD shall be classified as watertight according to the NEMA 250 Standard. The RPD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External Icing (NEMA 250 clause 5.6)
- Hose-down (NEMA 250 clause 5.7)
- 4X Corrosion Protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

The RPD shall be able to withstand a drop of up to 5 ft. without compromising its functional and structural integrity. The RPD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections. The RPD shall consume less than 10 W. The RPD shall operate with a DC input between 9 VDC and 28 VDC. The RPD shall have two communication ports, and both ports shall communicate independently and simultaneously. Two independent communication ports allow one port to be used for configuration, verification and traffic monitoring without interrupting communications on the dedicated data port. The RPD shall support the upload of new firmware into the RPD's non-volatile memory over either communication port. The RPD shall support the user configuration of the following:

- Response delay
- Push port

The communication ports shall support a 9600 bps baud rate. The RPD shall be designed with a matrix of radars. The matrix of radars enables the sensor to provide detection over a large area and to discriminate lanes. The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally generated signal.

This specification ensures that, during operation, the RPD strictly conforms to FCC requirements and that the radar signal quality is maintained for precise algorithmic quality. Analog and microwave components within an RPD have characteristics that change with temperature variations and age. If the output transmit signal is not referenced to a stable frequency source, then the RPD is likely to experience unacceptable frequency variations which may cause it to transmit out of its FCC allocated band and thus will be non-compliant with FCC regulations.

The RPD shall not rely on temperature compensation circuitry to maintain transmit frequency stability. Temperature-based compensation techniques have been shown to be insufficient to ensure transmit frequency stability. One reason this type of technique is not sufficient is that it does not compensate for frequency variations due to component aging.

The bandwidth of the transmit signal of the RPD shall not vary by more than 1% under all specified operating conditions and over the expected life of the RPD. The bandwidth of an RPD directly affects the measured range of a vehicle. A change in bandwidth causes a direct error in the measured range, i.e., a 5% change in bandwidth would cause a range error of 10 ft. for a vehicle at 200 ft. If the bandwidth changes by more than 1% due to seasonal temperature

variations and component aging, then the RPD will need to be frequently reconfigured to maintain the specified accuracy.

The RPD antennas shall be designed on printed circuit boards. Printed circuit board antennas eliminate the need for RF connectors and cabling that result in decreased reliability. Printed circuit antennas are less prone to physical damage due to their extremely low mass. The vertical beam width of the RPD at the 6dB points of the two-way pattern shall be 65 degrees or greater. The antennas shall cover a 90 degree horizontal field of view. The sidelobes in the RPD two-way antenna pattern shall be -40dB or less. Low sidelobes ensure that the performance from the antenna beam widths is fully achieved.

The RPD shall transmit a signal with a bandwidth of at least 245 MHz. The bandwidth of the transmit signal translates directly into radar resolution, which contributes directly to detection performance. For example, an RPD that transmits at a low bandwidth will have low radar resolution, which could cause it to count a single vehicle as two vehicles in adjacent lanes. As another example of the adverse effects of low radar resolution, the response from a sign or other radar target in the roadway may spill over into the lanes of travel and desensitize the radar. In order to achieve the specified detection accuracy in a variety of conditions, the unwindowed radar resolution cannot be larger than 2 ft. (0.6 m) at the half-power level, which requires a bandwidth of 240 MHz. The high radar resolution reduces the problem of vehicle responses getting drowned out by brighter vehicles in adjacent lanes and improves performance for moving and stopped vehicles near roadway targets. The RPD shall provide at least 8 RF channels so that multiple units can be mounted in the same vicinity without causing interference between them.

The RPD shall have a self-test that is used to verify correct hardware functionality. The RPD shall have a diagnostics mode to verify correct system functionality. The RPD shall have a method for automatically defining traffic lanes, stop bars and zones without requiring user intervention. This auto-configuration process shall execute on a processor internal to the RPD and shall not require an external PC or other processor. The auto-configuration process shall work under normal intersection operation and may require several cycles to complete. The auto-configuration method shall not prohibit the ability of the user to manually adjust the RPD configuration. The RPD shall support the configuring of lanes, stop bars and detection zones in 1-ft. increments. When lanes have variable widths or have variable spacing (e.g. gore between lanes), precise resolution is necessary.

The RPD shall include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic representation. A visual representation of traffic patterns allows an installer to quickly associate specific detections with corresponding vehicles, and it facilitates verification of RPD performance. The graphical interface shall operate on Windows Mobile, Windows XP and Windows Vista in the .NET framework. The software shall support the following functionality:

- Operate over a TCP/IP connection

- Give the operator the ability to save/back up the RPD configuration to a file or load/restore the RPD configuration from a file
- Allow the backed-up sensor configurations to be viewed and edited
- Provide zone and channel actuation display
- Provide a virtual connection option so that the software can be used without connecting to an actual sensor
- Local or remote sensor firmware upgradability

The RPD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk. RPD operation shall continue in snow or in rain up to 1 in. per hour. The RPD shall be capable of continuous operation over an ambient temperature range of -40°F to 165.2°F (-40°C to 74°C). The RPD shall be capable of continuous operation over a relative humidity range of 5% to 95% (noncondensing).

Each RPD shall be Federal Communications Commission (FCC) certified under CFR 47, Part 15, Section 15.249 as an intentional radiator. The FCC certification shall be displayed on an external label on each RPD according to the rules set forth by the FCC. The RPD shall comply with FCC regulations under all specified operating conditions and over the expected life of the RPD.

The RPD shall comply with the applicable standards stated in the NEMA TS2-2003 Standard. Third party test results shall be made available for each of the following tests:

- Shock pulses of 10g, 10 ms half sine wave
- Vibration of 0.5 Grms up to 30 Hz
- 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage

Cold temperature storage at -49°F (-45°C) for 24 hours

- High temperature storage at 185°F (85°C) for 24 hours
- Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC
- Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
- High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
- High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

The RPD shall be manufactured and assembled in the U.S.A. The internal electronics of the RPD shall utilize automation for surface mount assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies. The RPD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of duration 48 hours or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided for each purchased RPD by serial number, upon request. The RPD manufacturer shall provide both training and technical support services. The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, configuration, and use of the RPD to ensure accurate RPD performance. The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training. Classroom lab training shall involve presentations outlining and defining the RPD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual RPD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- Knowledgeable trainer or trainers thoroughly familiar with the RPD and its processes.
- Presentation materials, including visual aids, printed manuals and other handout materials for each student.
- Computer files, including video and raw data, to facilitate the virtual configuration of the RPD.
- Laptop computers or Windows CE handheld devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual configuration of the RPD.

Field training shall provide each trainee with the hands-on opportunity to install and configure the RPD at roadside. Training shall be such that each trainee will mount and align the RPD correctly. Manufacturer-provided technical support shall be available according to contractual agreements, and a technical representative shall be available to assist with the physical installation, alignment, and auto-configuration of each supplied RPD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of RPDs should such services be required. RPD documentation shall include an instructional training guide and a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide. The RPD manufacturer shall supply the following documentation and test results at the time of the bid submittal:

- FCC CFR 47 certification (frequency compliance)
- IED 6100-4-5 class 4 test report (surge)

The RPD shall be warranted free from material and workmanship defects for a period of two years from date of shipment. The RPD shall be mounted directly onto a mounting assembly fastened to a mast arm, pole or other solid structure. The RPD mounting assembly shall provide the necessary degrees of rotation to ensure proper installation. The RPD mounting assembly shall be constructed of weather-resistant materials and shall be able to support a 20-lb. load. The RPD shall be mounted at a height that is within the manufacturer's recommended mounting heights. The RPD shall be mounted at an offset from the first lane that is consistent with the RPD's minimum offset. The RPD shall be mounted so that

at least 20 feet along the farthest lane to be monitored is within the field view of the RPD. The RPD shall be mounted with its cable connector down and shall be tilted so that the RPD is aimed at the center of the lanes to be monitored. Typically, the RPD is tilted off of vertical by 20–30 degrees. The RPD shall be mounted on a vertical signal pole or on the horizontal mast arm. The RPD shall be mounted so that its field of view is not occluded by poles, signs or other structures. RPDs that are mounted within 20 ft. of each other or that are monitoring the same intersection shall be configured to operate on different RF channels regardless of the pointing direction of the RPDs. It is recommended that the manufacturer be consulted to verify final RPD placement if the RPD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway.

The cable end connector shall meet the MIL-C-26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells. The cable shall be the Orion Wire Combo-2204-2002-PVCGY or an equivalent cable that conforms to the following specifications:

- The RS-485 conductors shall be a twisted pair.
- The RS-485 conductors shall have nominal capacitance conductor to conductor of less than 71pF/Ft at 1 Khz.
- The RS-485 conductors shall have nominal conductor DC resistance of less than 16.5 ohms at 68°F (20°C).
- The power conductors shall be one twisted pair with nominal conductor DC resistance of less than 11.5 ohms at 68°F (20°C).
- Each wire bundle or the entire cable shall be shielded with an aluminum/mylar shield with a drain wire.

The cable shall be terminated only on the two farthest ends of the cable. The cable length shall not exceed 2000 ft for the operational baud rate of RS-485 communications. If 12 VDC is being supplied for the RPD then the cable length shall not exceed 110 ft. If 24 VDC is being supplied for the RPD then the cable length shall not exceed 600 ft. Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

The RPD shall be installed using the SmartSensor Matrix Preassembled Traffic Cabinet Backplate or an equivalent that provides input power surge suppression, sensor cable surge suppression, AC to DC power conversion (if necessary), and terminal blocks. The surge protection devices shall meet or exceed the EN 61000-4-5 Class 4 specifications. If needed, the RPD shall be installed using the Click! 202, Click! 204 or an equivalent AC to DC power converter that meets the following specifications:

- The power converter shall be power rated at 48 W for temperatures less than 140°F (60°C) with a 5% power decrease for each degree increase up to 158°F (70°C).
- The power converter shall operate in the temperature range of to -29.2°F to +165.2°F (–34°C to +74°C).
- The power converter shall operate in the humidity range of 5% to 95% at 77°F (25°C) non-condensing.
- The power converter shall accept an input voltage of 85 VAC to 264 VAC or 120 VDC to 370 VDC.
- The power converter shall operate at an input frequency of 47 Hz to 63 Hz.
- The power converter shall produce an output voltage of 24 VDC ±4%.
- The power converter shall withstand a voltage across its input and output of 2 kV. The power converter shall withstand a voltage across its input and ground of 1.5 kV.
- The power converter shall conform to safety standards UL 60950 and EN60950.
- The power converter shall conform to EMC standards EN55022 Class B and EN61000-3-2, 3.

In brown-out conditions (i.e. <85VAC input), the output voltage of the power converter shall be less than 1 VDC. The terminal blocks shall be color-coded insulation displacement terminal blocks. The terminal blocks shall be prewired to the other in-cabinet equipment so that no wiring other than cable terminations, connecting input power and connecting input file cards shall be required during installation.

The Click! 114, Click! 112 or an equivalent that meets the following specifications shall be used. The input file cards shall be compatible with 170, 2070, NEMA TS1, and NEMA TS2 style input racks. The input file card shall translate data packets from the RPD into contact closure outputs. The input file card shall support presence detection. The input file card shall receive data packets over an RS-485 bus at a baud rate of 9600 bps. The input file card shall autobaud and auto-detect an RPD over wired and wireless communication channels that have a maximum latency of 500 ms. The input file card shall comply with the NEMA TS2-1998 Traffic Controller Assemblies with NTCIP Requirements (Section 2.8 specification).

31. This item shall govern the above-ground continuous tracking advance detector (CTAD) equivalent to the Wavetronix SmartSensor Advance™. The CTAD shall detect range, speed, vehicle estimated time of arrival (ETA) to the stop bar for vehicles or clusters of vehicles moving in the user-selected direction of travel. The CTAD shall also detect instantaneous roadway efficiency. The CTAD shall be able to simultaneously detect and report information from up to 25 vehicles on the roadway when they are serially sequenced between the near and far boundaries. The CTAD shall turn on a zone output when the range, speed, ETA, and qualified count or instantaneous roadway efficiency requirements for that zone are satisfied. The CTAD shall turn on an alert output on when the user-defined zone output combinational logical is satisfied. The CTAD shall turn on a normal channel output when any of the channel's alerts is on and the channel's

delay and extend time constraints are satisfied. The CTAD shall turn on a latched channel output when the on alert is turned on and the delay time is satisfied. The CTAD shall turn off a latched channel output when the off alert is turned on or the max timer expires and the extension time is satisfied. Channel outputs are used to create contact closures which can be used as inputs into a traffic controller. The CTAD shall provide vehicle call and extend data on up to eight channels that can be connected to contact closure modules compliant with NEMA TS 1, NEMA TS 2, 170, and 2070 controller cabinets. The CTAD shall be capable of providing data for each tracked detection over the serial ports. When vehicular track file data is available on the serial ports, the data is then available on the communications network without the use of a traffic controller or a contact closure data recorder. Vehicular track file data is useful for traffic study applications and for performing comparisons between traffic sensors.

The CTAD shall be able to detect and report vehicle information when mounted within 50 ft. of the center of the lanes of interest. The CTAD shall be able to detect and report vehicle information when mounted at heights up to 40 ft. above the road surface. The CTAD shall be able to detect and report information on the roadway located with the near boundary at 50 ft. from the base of the pole on which the CTAD is mounted. The CTAD shall be able to detect and report information on the roadway located with the far boundary at 500 ft. from the base of the pole on which the CTAD is mounted. For incoming traffic, 95 percent of large vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. from the sensor. For incoming traffic, 90 percent of all motor vehicles within the line-of-site of the CTAD shall be detected and reported before they arrive 400 ft. from the sensor. The CTAD shall detect at least 98 percent of large vehicles like truck-trailer combinations and at least 95 percent of all motor vehicles within the line-of-sight of the CTAD sensor where multiple detections of multi-unit vehicles are not considered false detections and merged detections of adjacent lane vehicles are not considered missed detections.

The CTAD shall provide range measurements in which 90% of the measurements are accurate within 10 ft. when the vehicle is tracked independently. The CTAD shall provide per vehicle speed measurements in which 90% of the measurements are accurate within 5 mph when tracked independently. The CTAD shall provide estimated time-of-arrival (ETA) measurements in which 85% of the measurements are accurate within one second, when the detected vehicles are tracked independently at a constant speed above 40 mph and are within 2.5 and 5.5 seconds of the stop bar.

The CTAD shall not require cleaning or adjustment to maintain performance. The CTAD shall not rely on battery backup to store configuration information, thus eliminating any need for battery replacement. Once the CTAD is calibrated, it shall not require recalibration to maintain performance unless the roadway configuration changes. The mean time between failures shall be 10 years, which is estimated based on manufacturing techniques.

The CTAD shall not exceed 4 lbs. in weight. The CTAD shall not exceed 14 inches × 11 inches × 4 inches in its physical dimensions. All external parts of the CTAD shall be ultraviolet-resistant, corrosion-resistant, and protected from fungus growth and moisture deterioration. The CTAD shall be enclosed in a

Lexan polycarbonate. The enclosure shall be classified “f1” outdoor weatherability in accordance with UL 746C. The CTAD shall be classified as watertight according to the NEMA 250 standard.

The CTAD enclosure shall conform to test criteria set forth in the NEMA 250 standard for type 4X enclosures. Test results shall be provided for each of the following type 4X criteria:

- External icing (NEMA 250 clause 5.6)
- Hose-down (NEMA 250 clause 5.7)
- 4X corrosion protection (NEMA 250 clause 5.10)
- Gasket (NEMA 250 clause 5.14)

The CTAD shall be able to withstand a drop of up to 5 ft. without compromising its functional and structural integrity. The CTAD enclosure shall include a connector that meets the MIL-C-26482 specification. The MIL-C-26482 connector shall provide contacts for all data and power connections.

The CTAD shall consume less than 4 W @ 12 VDC. The CTAD shall operate with a DC input between 12 VDC and 28 VDC. The CTAD shall have onboard surge protection. The CTAD shall have two communication ports, and both ports shall communicate independently and simultaneously. Two independent communication ports allow one port to be used for configuration, verification and traffic monitoring without interrupting communications on the dedicated data port. The CTAD shall support the upload of new firmware into the CTAD’s non-volatile memory over either communication port. The CTAD shall support the user configuration of the following:

- Baud rate
- Communication port response delay
- Contact closure output frequency

Both communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200 bps. The contact closure output frequency shall be user configurable as short as 10 ms, with a default near 130 ms for compatibility. Contact closure data shall be reliably communicated over homerun cable connections as long as 600 ft. with latency from the time of channel requirement satisfaction to the eventual reporting of the detections on the back edge of the contact closure card in 15 ms or less. Contact closure data latency is dependent on baud rate and output frequency settings. The required minimum must be achievable when the baud rate is set to a high value and the output frequency is set to a frequent value.

The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time. All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally

generated signal. This specification ensures that, during operation, the CTAD strictly conforms to FCC requirements and that the radar signal quality is maintained for precise algorithmic quality. Analog and microwave components within a CTAD have characteristics that change with temperature variations and age. If the output transmit signal is not referenced to a stable frequency source, then the CTAD is likely to experience unacceptable frequency variations which may cause it to transmit out of its FCC allocated band and thus will be non-compliant with FCC regulations. The CTAD shall not rely on temperature compensation circuitry to maintain transmit frequency stability. Temperature-based compensation techniques have been shown to be insufficient to ensure transmit frequency stability. One reason this type of technique is not sufficient is that it does not compensate for frequency variations due to component aging. The bandwidth of the transmit signal of the CTAD shall not vary by more than 1% under all specified operating conditions and over the expected life of the CTAD. The bandwidth of a CTAD directly affects the measured range of a vehicle. A change in bandwidth causes a direct error in the measured range, i.e., a 5% change in bandwidth would cause a range error of 10 ft. for a vehicle at 200 ft. If the bandwidth changes by more than 1% due to seasonal temperature variations and component aging, then the CTAD will need to be frequently reconfigured to maintain the specified accuracy.

The CTAD antennas shall be designed on printed circuit boards. Printed circuit board antennas eliminate the need for RF connectors and cabling that result in decreased reliability. Printed circuit antennas are less prone to physical damage due to their extremely low mass. The vertical beam width of the CTAD at the 6 dB points of the two-way pattern shall be 65 degrees or greater. This enables the CTAD to provide simultaneous detection from the nearest to the farthest ranges. The vertical beam width of a CTAD determines the field of view in which it can detect traffic. The horizontal beam width of the CTAD at the 6 dB points of the two-way pattern shall be 11 degrees or less. A narrow horizontal beam width narrows the field of view of the CTAD to the lanes of interest and helps to exclude the traffic traveling in the opposite direction. The sidelobes in the CTAD two-way antenna pattern shall be -40 dB or less. Low sidelobes ensure that the performance from the antenna beam widths is fully achieved.

The CTAD shall provide at least four RF channels so that multiple units can be mounted in the same vicinity without causing interference between them. The CTAD shall have a method for automatically configuring the sensitivity of detection in at least 5-ft. increments. This allows the sensor to quickly and accurately record the intensity of roadside clutter and set appropriate rejection thresholds to avoid false detections at different ranges. The auto-configuration method shall not prohibit the ability of the user to manually adjust the CTAD configuration. The CTAD shall support the configuration of up to eight channel outputs with up to four alerts per channel and up to four zones per alert, resulting in 32 configurable alerts and 128 configurable zones.

The CTAD shall support the configuring of zones in 5-ft. increments. The CTAD shall support detection zones as long as 450 ft. The ability to define one large zone simplifies and enhances configuration when compared to point detection schemes. The CTAD shall support user configurable high-speed and low-speed detection filters for each zone. The CTAD shall support the configuring of speed

filters in 1-mph increments. The speed thresholds can be used to provide superior gap management for green extension applications at signalized intersections, especially when a high-speed traffic stream presents a limited number of opportunities to gap out. For example, when the operational objective is to increase safety by extending the green light for law-abiding high-speed drivers, reporting of low-speed vehicles is not desirable. On the other hand, when the operational objective is to increase efficiency by extending the green light for clearance of a low-speed traffic queue, reporting of high-speed vehicles is not desirable. In addition, these speed filters can be configured to screen outreporting of detections that may adversely impact operational objectives. For example, low speed filters can also be used to screen out detection of low-speed clutter like unwanted detection of turn-only bays, pedestrians, swaying trees, and vibrating signs. The CTAD shall support user configurable upper and lower estimated time-of-arrival (ETA) filters for each zone. The CTAD shall support the configuring of ETA filters in increments of 0.1 seconds. The ETA thresholds can be used to provide superior gap management for green extension applications at signalized intersections, especially when a high-speed traffic stream presents a limited number of opportunities to gap out. For example, when the operational objective is to increase safety by extending the green light for law-abiding high-speed drivers, reporting of vehicles upstream of 5.5 seconds and downstream of 2.5 seconds may not be desirable. Vehicles with 2.5 to 5.5 seconds are commonly considered to be in the driver dilemma zone when the light turns yellow. However, motorists closer than 2.5 seconds can easily clear the intersection and those beyond 5.5 seconds can be expected to stop. Dilemma zone protection has been shown to reduce red-light running and rear-end collisions. ETA filtering provides a dynamic form of dilemma zone protection that adapts when traffic speeds rise above or fall below design assumptions used with traditional methods of fixed-point detection. ETA filtering also constrains reporting of detections to provide more gap out opportunities, avoid the likelihood of reaching maximum green, and maximize the effective use of green by timing clearance of the last vehicle. Therefore, ETA filtering also provides practical efficiency benefits. The CTAD shall provide configurable upper and lower count filters that help determine if a required number of qualified detections are present. The CTAD shall support the configuring of qualified count filters in increments of one. These filters can be to provide superior gap management for green extension applications at signalized intersections, especially when a high-speed traffic stream presents a limited number of opportunities to gap out. Qualified count is tied to the number of vehicles that meet the range, speed and ETA requirements of a zone. For example, for green extension it may be required that there are two vehicles detected within 2.5 to 5.5 seconds of the stop bar traveling above 35 mph (56 kph), instead of just one. The logic is that if only one vehicle is in the dilemma zone, this is not as threatening as if there are two vehicles (one following the other). The following vehicle may incorrectly assume that the lead vehicle will try to clear the intersection and cause a rear-end collision. Rear-end collisions are the most common form of collision at a signalized intersection.

The CTAD shall include graphical user interface software that displays the current traffic pattern using a graphical traffic representation. A visual representation of traffic patterns allows an installer to quickly associate specific detections with corresponding vehicles, and it facilitates verification of CTAD

performance. The graphical user interface shall also display all configured alerts and provide visual representation of their actuation. The graphical user interface shall provide a means of logging the vehicular track files with an update rate of greater than five times per second.

The user configured baud rate will affect the rate at which log files are logged. This requirement must be met at higher baud rates. The graphical interface shall operate on Windows Mobile, Windows XP, Windows Vista, and Windows 7 in the .NET framework. The software shall support the following functionality:

- Automatically find the correct baud rate
- Automatically find the correct serial communication port
- Operate over a TCP/IP connection
- Provide a virtual sensor connection for software usability without a sensor
- Give the operator the ability to save/back up the CTAD configuration to a file or load/restore the CTAD configuration from a file

The CTAD shall maintain accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light, including direct light on sensor at dawn and dusk. CTAD operation shall continue in rain up to 4 in. per hour. The CTAD shall be capable of continuous operation over an ambient temperature range of -40°F to 165°F (-40°C to 74°C). The CTAD shall be capable of continuous operation over a relative humidity range of 5% to 95% (non-condensing).

Each CTAD shall be Federal Communications Commission (FCC) certified under CFR 47, part 15, section 15.245 or 15.249 as an intentional radiator. The FCC certification shall be displayed on an external label on each CTAD according to the rules set forth by the FCC. The CTAD shall comply with FCC regulations under all specified operating conditions and over the expected life of the CTAD. The CTAD shall comply with the applicable standards stated in the NEMA TS2-1998 Standard. Third party test results shall be made available for each of the following tests:

- Shock pulses of 10 g, 11 ms half sine wave
- Vibration of 0.5 g up to 30 Hz
- 300 V positive/negative pulses applied at one pulse per second at minimum and maximum DC supply voltage
- Cold temperature storage at -49°F (-45°C) for 24 hours
- High temperature storage at 185°F (85°C) for 24 hours
- Low temp, low DC supply voltage at -29.2°F (-34°C) and 10.8 VDC
- Low temp, high DC supply voltage at -29.2°F (-34°C) and 26.5 VDC
- High temp, high DC supply voltage at 165.2°F (74°C) and 26.5 VDC
- High temp, low DC supply voltage at 165.2°F (74°C) and 10.8 VDC

The CTAD shall be manufactured and assembled in the USA. The internal electronics of the CTAD shall utilize automation for surface mount and wave solder assembly, and shall comply with the requirements set forth in IPC-A-610C Class 2, Acceptability of Electronic Assemblies. The CTAD shall undergo a

rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include the following:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of 48 hours' duration or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided for each purchased CTAD by serial number, upon request. The CTAD manufacturer shall provide both training and technical support services.

The manufacturer-provided training shall be sufficient to fully train installers and operators in the installation, auto-configuration, and use of the CTAD to ensure accurate CTAD performance. The manufacturer-provided training shall consist of comprehensive classroom labs and hands-on, in-the-field, installation and configuration training. Classroom lab training shall involve presentations outlining and defining the CTAD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual CTAD. To facilitate the classroom presentation and hands-on labs, the manufacturer-provided training shall include the following items:

- Knowledgeable trainer or trainers thoroughly familiar with the CTAD and its processes
- Presentation materials, including visual aids, printed manuals and other handout materials for each student
- Computer files, including video and raw data, to facilitate the virtual configuration of the CTAD
- Laptop computers or Windows CE handheld devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual configuration of the CTAD

Field training shall provide each trainee with the hands-on opportunity to install and configure the CTAD at the roadside. Training shall be such that each trainee will mount and align the CTAD correctly.

The manufacturer-provided technical support shall be available according to contractual agreements and a technical representative available to assist with the physical installation, alignment, and configuration of each supplied CTAD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of CTADs should such services be required.

CTAD documentation shall include a comprehensive user guide as well as an installer quick-reference guide and a user quick-reference guide. The CTAD manufacturer shall supply the following documentation and specification test results at the time of the bid submittal:

- Detection accuracy
- Range accuracy

- Earliest range of detection
- Speed accuracy
- ETA accuracy
- FCC CFR 47 certification
- NEMA 250 standard for Type 4X Enclosure third-party test data
- NEMA TS 2-1998 standard third-party test data

The CTAD shall be warranted free from material and workmanship defects for a period of two years from date of shipment.

The CTAD shall be mounted directly onto a mounting assembly fastened to a pole, overhead mast arm, or other solid structure. The CTAD mounting assembly shall provide the necessary degrees of rotation to ensure proper installation. The CTAD mounting assembly shall be constructed of weather-resistant materials and shall be able to support a 20-lb. load. The CTAD shall be mounted at a height that is within the manufacturer's recommended mounting heights. The CTAD shall be mounted at an offset from the center of the lanes of interest that is consistent with the CTAD's maximum offset. The CTAD shall be mounted in a forward-fire position, looking towards either approaching or departing traffic. The CTAD shall be mounted so that it is pointed within 10 ft. of the target point as defined by the manufacturer's table of target points for mounting offsets and mounting heights. The CTAD shall be mounted so that its vertical center line is within 5 degrees of the lanes of interest as described the manufacturer's documentation. Aligning the CTAD's center line with the roadway ensures that the antenna beam of the CTAD is positioned along the roadway. Two CTAD units shall not be mounted so that they are pointed directly at each other. CTADs that are mounted within 20 ft. of each other shall be configured to operate on different RF channels regard-less of the pointing direction of the CTAD. The CTAD shall not be installed in areas with overhead structures. For example, overhead sign bridges, tunnels and overpasses should be avoided. The CTAD shall be mounted at least 30 ft. to the side of any such overhead structures.

The cable end connector shall meet the MIL-C-26482 specification and shall be designed to interface with the appropriate MIL-C-26482 connector. The connector backshell shall be an environmentally sealed shell that offers excellent immersion capability. All conductors that interface with the connector shall be encased in a single jacket, and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series, and recommended backshells are Glenair Series 37 cable sealing backshells. The cable shall be Wavetronix # WX-SS-704, Allied Wire & Cable #091102-WGP-12 or an equivalent cable that conforms to the following specifications:

- The RS-485 conductors shall be a twisted pair.
- The RS-232 and RS-485 conductors shall have nominal capacitance conductor to conductor of less than 45 pF/ft at 1 kHz.

- The RS-232 and RS-485 conductors shall have nominal conductor DC resistance of less than 16.5 ohms/1000 ft. (304.8 m) at 68°F (20°C).
- The power conductors shall be one twisted pair with nominal conductor DC resistance of less than 11.5 ohms/1000 ft. (304.8 m) at 68°F (20°C).
- Each wire bundle or the entire cable shall be shielded with an aluminum/mylar shield with a drain wire.

The cable should be a single continuous run with no splices. Splicing, when deemed necessary, shall be done using a waterproof insulation displacement connector, such as 3M ScotchLok. The cable shall be terminated only on the two farthest ends of the cable. The cable length shall not exceed the following limits for the operational baud rate of RS-485 communications:

Baud Rate Cable Length (NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.)

115.2 Kbps 300 ft.

57.6 Kbps 600 ft.

38.4 Kbps 800 ft.

19.2 Kbps 1000 ft.

9.6 Kbps 2000 ft.

If communication is conducted over the RS-232 bus, then the RS-232 driver must be able to source and sink ±7 mA or more. The cable length shall not exceed the following limits for the operational baud rate of RS-232 communications:

Baud Rate Cable Length (NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.)

115.2 Kbps 40 ft.

57.6 Kbps 60 ft.

38.4 Kbps 100 ft.

19.2 Kbps 140 ft.

9.6 Kbps 200 ft.

If 12 VDC is being supplied for the CTAD then the cable length shall not exceed 110 ft. If 24 VDC is being supplied for the CTAD then the cable length shall not exceed 600 ft. If a cable length of 600 ft. to 2000 ft. is required, the power cable shall be an ANIXTER 2A-1402 or equivalent cable that meets the following requirements:

- 10 AWG conductor size/gauge

- 2 conductor count
- Stranded cable type
- Bare copper material
- 600 V range
- 194°F (90°C) temperature rating
- PVC/nylon insulation material
- PVC—polyvinyl chloride jacketing material
- 25 A per conductor

Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

The CTAD shall be installed using lightning surge protection devices that meet or exceed the EN 61000-4-5 Class 4 specifications. The lightning surge protection unit shall be the Wavetronix Click!™ 222 or equivalent.

POWER SUPPLY: The CTAD shall be installed using the Click! 201, Click! 202 or an equivalent AC to DC power converter that meets the following specifications:

- The power converter shall be power rated at 15 W or greater at 77°F (25°C) and 10 W or greater at 165°F (74°C).
- The power converter shall operate in the temperature range of to -29°F to 165°F (-34°C to 74°C). The power converter shall operate in the humidity range of 5% to 95% at 77°F (25°C) non-condensing.
- The power converter shall accept an input voltage of 85 to 264 VAC or 120 to 370 VDC.
- The power converter shall operate at an input frequency of 47 Hz to 63 Hz.
- The power converter shall produce an output voltage of 24 VDC ±4%.
- The power converter shall have a hold-up time of greater than 20 ms at 120 VAC.
- The power converter shall withstand a voltage across its input and output of 2 kV. The power converter shall withstand a voltage across its input and ground of 1.5 kV.

- The power converter shall conform to safety standards UL 60950 and EN 60950.

- The power converter shall conform to EMC standards EN 55022 Class B and EN 61000-3-2, 3.

- In brown-out conditions (i.e. < 85 VAC input), the output voltage of the power converter shall be less than 1 VDC.

If input file cards are used in the detection system, then the Click! 112, Click! 114 or an equivalent that meets the following specifications shall be used.

1. The input file cards shall be compatible with 170, 2070, NEMA TS 1, and NEMA TS 2 style input racks.

2. The input file card shall translate data packets from the CTAD into contact closure outputs.

3. The input file card shall support actuation mode (passage detection output in real time) of operation.

4. The input file card shall receive data packets over an RS-485 bus at any of the following baud rates: 9600, 19200, 38400 and 57600 bps.

5. The input file card shall autobaud and auto-detect a CTAD over wired and wireless communication channels that have a maximum latency of 500 ms.

6. The input file card shall comply with the NEMA TS 2-1998 Traffic Controller Assemblies with NTCIP Requirements (Section 2.8 specification).

32. Tracing wire shall be installed on the inside of all empty conduits or conduits with only fiber optic cable to facilitate the locating of buried cable. The wire shall be either a No. 10 AWG stranded copper Type USE or THWN cable or a No. 12 AWG Copperhead cable. The trace wire shall be installed without splices. At each service or junction box, the trace wire shall be connected to a light duty Snake Pit device with an orange cap. Connection between the Snake Pit and the box shall be made with a 1-1/2” or 2” conduit sweep.
33. Conductors for power lead-in cable shall be stranded, annealed coated copper. Copper wire, before insulating or stranding, shall meet the requirements of the latest edition of ASTM B-33 (for coated wire). Stranding shall be Class B, in accordance with the latest edition of ASTM B-8.
34. Insulation for power lead-in cable shall consist of cross-linked thermosetting polyethylene, meeting the requirements of column B of IPCEA and listed by UL as Type USE RHW-75° C.
35. The service enclosure shall be a combination meter socket breaker box, raintight enclosure equipped with a 100-amp main breaker and a 50-amp traffic signal breaker to be operated at 120 volts AC. The unit shall be capable of receiving 120/240 volt AC electrical line service. The unit shall be equipped with separate lockable compartments for the meter socket and the breaker box. Corbin locks

shall be installed for parts of the enclosure that are accessed by the City. The unit shall be UL listed and the enclosure shall be natural aluminum. As per Evergy requirements, the Contractor shall install the power cable and conduit from the Evergy service point to the meter.

36. In addition to the requirements above, the service enclosure shall be equipped with a 240-volt, 30-amp street light circuit breaker, photocell and mercury contactor, test switch and appropriate terminal blocks for street light circuit connection when street lights are powered through the signal controller or when LED overhead street name signs are specified. The enclosure shall be specified on the Plans.
37. All conduit shall be as specified in the section of these Specifications entitled "Conduit". Additionally, all signal conduits shall have a spare 1000 lb. or higher run of mule tape installed continuously through all conduits (box to box, box to controller, and box to pole base) and shall be tied off securely at each point. Any time new wire is installed in any existing signal conduits, a spare 1000 lb. or higher run of mule tape shall be installed continuously through the existing conduits (box to box, box to controller, and box to pole base) and shall be tied off securely at each point.
38. Service boxes shall be fiberglass reinforced polymer concrete boxes of the size and shape as shown on the Standard Detail sheet in the accompanying plans. Service box material shall be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material must have the following mechanical properties:

Compressive Strength	20,000 psi
Tensile Strength	1,700 psi
Flexural Strength	7,500 psi

39. Service boxes with an adjustable top ring shall not be permitted.
40. Junction boxes shall be Type I, Type II or Type III as shown on the plans and shall be fiberglass reinforced polymer concrete of a size and shape as indicated on the Standard Detail sheet in the accompanying plans. Junction box material to be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material must have the following mechanical properties:

Compressive Strength -	20,000 psi
Tensile Strength -	1,700 psi
Flexural Strength -	7,500 psi

41. The actuated controller shall be a Rack Mount ATC Cobalt-C controller manufactured by Safetran and shall include the current firmware that is compatible with Operation Green Light (OGL).
42. All signalized intersections shall include a battery back-up system.
43. The Contractor shall provide a power transfer switch and shall attach it to the cabinet. The power transfer switch shall be manufactured by Gen Tran, Model No. FS300130, or approved equal.
44. The Contractor shall provide a rack-mounted power strip. The power strip shall have 12 power outlets – six front outlets and six rear outlets for ease of use. Power outlets shall be at a right angle and well-spaced so wall warts can easily

be plugged into the power strip. The power strip shall also have an on/off switch that is protected to prevent it from being accidentally turned off. The power strip shall be manufactured by Tripp-Lite, Model No. RS-1215-RA, or approved equal.

45. The cabinet shall be a Model 332D and shall include an 8-inch riser. A Model 332 or 336 may be used only if specified in the accompanying plans. The cabinet shall be equipped with the appropriate number of the following equipment to allow for the traffic signal operation as shown in the accompanying plans:

    Model 200 switch pack
    Model 204 flasher

    Model 420 flash transfer relay
    Model 242 two-channel isolator
    Loop detectors
    Model 2018 conflict monitor

    The cabinet shall be equipped with a combined power supply and power distribution assembly (PDA #2).

46. The output file back panel shall be handwire instead of printed circuit board. An auxiliary output file shall be provided where necessary.

47. The flasher program plug shall be accessible without dropping the output file back panel.

48. A red monitor board assembly shall be attached to the rear panel of the output file. A 20-conductor cable assembly for monitoring the red outputs of all signal load switches shall be provided and attached to the red monitor board assembly. The cable is to be routed to the front of the output file and plugged into the connector provided in the front of the conflict monitor.

49. A means of selecting the active red monitor channel shall be provided on the red monitor board assembly. Selection is accomplished by a two-position jumper (shunt) with the center position wired to a red monitor input and a select of 115 VAC to the right and the red load switch output to the left. Moving the jumper to the right will provide a continuous red input and override, while moving the jumper to the left will attach the monitor channel to the corresponding load switch output.

50. The jumper assembly shall be accessible while the intersection is in operation. Twelve selectors (12) shall be provided; eight phase selections and four overlap selections.

51. Two pull-out, hinged-top drawers having sliding tracks with lockout and quick-disconnect features, shall be provided as shown in the cabinet drawings. The pull-out drawer shall extend a minimum of 14 inches in order to facilitate removal of the processor by providing the processor with an aluminum platform covered by a Formica-type, chemical-proof plastic sheet while the rear connector is being removed. It shall be possible to lift this hinged platform in order to gain access to the interior of the drawer. Minimum interior dimensions of the drawer shall be 1 inch high, 13 inches deep and 16 inches wide. The drawer shall be capable of supporting a 40 lb. controller when fully extended. One drawer shall be located on each side of the cabinet. On the open side of the cabinet, two shelves shall be provided in addition to the pull-out drawer.

52. The Actuated Controller Operating Software shall be the latest version of Cobalt Rackmount firmware, as specified on the City's pre-approved list of materials,

and shall already be programmed in the controller. Licensure of the program shall be included and made part of the controller unit in the name of the City of Lenexa, Kansas.

53. The cabinet and doors shall be fabricated from 0.125” minimum thickness unpainted aluminum. The cabinet shall be supplied with CORBIN #2 locks. Four 15-watt LED light fixtures and bulbs shall be provided, two each near the top front and back of the cabinet. The light shall be activated by an automatic switch activated when the door is open. The light fixture shall have a cold-weather type ballast. The cabinet shall be provided with lightning protection on the power input. A 1U 20A power strip shall be provided to power the PTZ cameras and switch, this power strip shall be plugged into a separate 120V (NEMA) 5-20P outlet receptacle.

54. In addition to the standard specifications, the conflict monitor shall be capable of monitoring the red signal outputs as described below:

- Any dark signal head (that is loss of signal output to field terminals) shall cause the monitor to trip.
- The green, yellow and red indications for each phase shall be brought into the monitor individually and shall be monitored separately with respect to a loss of signal on any of the three (3) inputs per channel.
- The monitor shall have the required circuitry to allow the early detection of a conflict caused by a green or yellow signal "hang up" (that is any green or yellow output which shall remain on when the controller has transferred to a yellow or all red output respectively) by starting the fault timers as soon as a yellow appears with the corresponding green still energized. The monitor shall not wait until a conflicting green is displayed to time the conflict. This shall preclude the presentation of a conflicting signal display at the intersection.
- During the "All Red" clearance period, the monitor shall check all inputs for faulty signal display and shall react to these faulty indications during the all red clearance period. Since the only inputs that should be active during this period would be the reds, the monitor shall detect any faults such as red/green, red/yellow, green/yellow and green/red/yellow.
- The monitor shall be capable of monitoring for incorrect signal applied at the field terminals of each vehicular movement (green, yellow, red). Should a voltage be present on more than one, or none, of the inputs (green, yellow, red) of a channel, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 milliseconds, the unit shall not trigger. If this condition exists for 1,000 milliseconds or more, the unit shall trigger. If this condition exists for 700 milliseconds or more, but less than 1,000 milliseconds, the unit may or may not trigger.
- When the unit triggers, it shall cause the output relay contacts to transfer. These contacts shall remain in this state until the unit is reset by the activation of the panel control or the activation of the external reset input. Power interruption shall not reset the conflict monitor when it has been triggered by detection of a faulty load switch output.
- The monitor shall be compatible with LED and flashing yellow arrow technology and be capable of testing on an ATSI PCMT 2600 model tester.

55. The minimum indicators shall be as follows:

- Power - Shall be illuminated when the +24 VDC input from the controller is present and AC+ is applied to the monitor.
- Watch Dog Error - Shall illuminate when the monitor detects a watch dog error, and shall be a 1.5 second watch dog circuit.
- Conflict - Shall illuminate when a conflict has been detected by the monitor.
- Red Failure - Shall illuminate when a red failure has been detected by the monitor.
- Switch Fail - Shall illuminate when a faulty load switch has been detected by the monitor.
- PCA - Shall illuminate when the program board is not installed or not installed properly.
- PIAF - Shall illuminate when the unit has detected a failure, and then experiences a power interruption.

56. The monitor shall include signal status indicators. These indicators (one per channel) shall illuminate when a signal is present on the corresponding channel during normal operation. If the unit trips due to a conflict, the signal status shall lock up, displaying the status of each channel at the time the conflict occurred. Should the monitor trip due to the absence of red or a faulty load switch output, the signal status indicators shall display the channel (channels) which is (are) at fault. If the monitor detects a load switch fault condition, the switch failure indicator shall be illuminated on and the signal status indicators will display the exact channel of the load switch that failed. The red inputs shall be brought into the monitor via a front panel connector. The Red Enable shall be brought into the monitor via the same front panel connector as the red inputs.
57. The Contractor shall furnish and install Opticom emergency preemption equipment Opticom Model 764 phase selector as shown in the plans and as specified in the Traffic Signal Quantities. The cable shall be run continuous from the detector to the controller cabinet with no splices. The detector shall be installed as shown in the plans or by a method approved by the Engineer. The Contractor shall be responsible for the proper alignment of the detector to ensure maximum detection time for the emergency preemption equipment. This opticom equipment shall be programmable to restrict use by unauthorized users and shall have the capability to connect to the TCP/IP network.
58. The video detection system shall be Autoscope Solo Pro, Iteris or approved equal. The equipment shall include high-resolution color video image sensors, image sensor interface panels, detector port masters, and any other appurtenances necessary for the installation of a complete, operational, TCP/IP networkable video detection system. When specified in plans, the system shall include necessary hardware to allow for an Ethernet connection to a TCP/IP network via RJ-45 connection, and have the ability to be addressed using a four-octet address in accordance with TCP/IP (e.g. 255.255.255.255). System software shall allow for connection to the video detection system via Internet and/or private intranet connection.
59. The primary communications link media shall be a six pair minimum 18 AWG, 24 VCD or 115 VAC camera power cable. Continuous field communications links shall be used. Splices of any type are prohibited.
60. Lightning and transient surge suppression devices shall be installed on the processor side of the field communications link to protect the peripheral devices. Solid-state suppression devices shall be used that present high impedance to,

and do not interfere with, the communications lines during normal operation. Suppression devices shall be used that do not allow the peak voltage on any line to exceed 300 percent of the normal operating peak voltage at any time. Devices with a response time that does not exceed five nanoseconds shall also be used.

61. All necessary software, modems, Ethernet cards and cables will be supplied at the central control location and on a portable laptop computer for the City of Lenexa providing the ability to monitor the operation and modify detector placement and configuration parameters. The computer will be provided by the City.
62. For each Pan, Tilt, and Zoom (PTZ) camera, four-way fixed video camera, and/or license-plate reader camera, the camera data wiring for each camera shall be Cat6a Shielded, installed no longer than 330 feet, performance-tested after install with Fluke DSX CableAnalyzer (or similar), and shall deliver a performance report for each cable showing that the installed cable meets Ethernet specifications. Cabling shall be terminated at the camera with Cat6a shielded RJ45 end. Cable shall be terminated in the traffic signal cabinet in a 1U Cat6a Shielded patch panel.
63. All lighting equipment including, but not limited to luminaires, lamps and poles shall conform to the City of Lenexa's Design Criteria and Plan Requirements as well as the Specifications.
64. All wood span wire poles, messenger cable, tether cable, guy wires, down guy anchors and cable clamps shall be as listed on the accompanying plans.
65. All permanent traffic signing and traffic control signing shall conform to the requirements of the Manual on Uniform Traffic Control Devices (MUTCD). All signs shall be fabricated from standard aluminum blanks utilizing high intensity reflective sheeting as called for in the accompanying plans, with the exception of LED-illuminated overhead street name signs. Sign banding shall be 3/4" stainless steel.
66. Overhead street name signs shall be provided and installed on all mast arm poles and shall be either LED-illuminated overhead street name signs or signs constructed of 0.125" aluminum sheeting, as indicated on the plans. Minimum size requirements for any overhead street name sign shall be 18" x 60". All signs shall have the legends centered on the face with the letters or numbers spaced to produce a readable, professional quality sign. Sign legends shall contain an initial uppercase letter followed by lowercase lettering and shall be 12" series E lettering or numbers, unless otherwise stated on the plans. In addition, all lettering and numbers shall be white in color. Actual size drawings of the proposed signs shall be submitted to the Engineer for approval.
67. All aluminum sign faces shall be high intensity prismatic reflective sheeting. Aluminum signs shall have a white 0.75" wide border and shall have green backgrounds. Bolt hole locations shall be field located and drilled or punched for proper installation. Signs shall be mounted to the mast arms using Astro-Brackets. There shall be a minimum of two brackets per sign placed no more than 3 feet apart with a maximum of 1 foot from the edge of the sign.
68. LED overhead street names signs shall have a white border and a green background. The sign fixture shall be designed and constructed to prevent deformation or failure when subject to wind loads in conformance with the requirements of the AASHTO publication, Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals, and all associated

updated amendments. All materials used in fabrication shall be new and of good quality.

69. All LED-illuminated sign materials furnished by the manufacturer/vendor/contractor shall be in accordance with the NEC and shall conform to the requirements shown below. The manufacturer shall supply shop drawing submittals for the fixtures, sign, sign message and mounting hardware. The LED-illuminated sign frame/housing shall be formed and manufactured out of extruded aluminum alloy with a minimum tensile strength of 20,000 ksi. The sign frame shall be painted flat black with a durable powder coat process. The sign frame/housing shall incorporate stainless steel fasteners provided at all the corners of the sign panel frame to secure the sign in the closed position. Weep holes shall be located at strategic points at the bottom of the housing to allow drainage of any condensation. The design of the housing shall afford provisions for continuous gasketing between housing and sign frame members to resist entrance of moisture, dirt and insects. Gaskets between sign panel frame and panel shall be closed cell neoprene rubber installed in the frame channel to prevent the gasket from moving or slipping out of position. The sign panel shall be slide-mounted in the frame, as shown on the plans. The entire surface of the sign panel shall be evenly illuminated. The light transmission factor of the sign panel shall provide a letter to background brightness ratio, which is adequate for nighttime legibility. The sign panels shall be translucent panels of high impact and UV resistant plastic/acrylic material. All surfaces shall be free from blemishes in the plastics or coating that might impair the surface or detract from the general appearance and color of the sign.
70. The LED-illuminated sign shall be mounted to the mast arm attached to the signal pole, as shown on the plans and in accordance with manufacturer's recommendations. Unless otherwise shown on the plans or required in this specification, all fasteners and screws in or on the fixture shall be stainless steel type 302 or 305, brass or aluminum. All steel nuts, bolts and hardware for sign attachment shall be stainless steel type 303 or 305.
71. The LED-illuminated sign light source shall be comprised of white LEDs projecting light into the border of an optically coupled light panel. The light panel redirects the light to create a uniform illuminated plane. Each sign shall use combinations of 12" x 1" printed circuit boards which incorporate 20, 25, or 30 white InGAN 5mm "ULTRA BRIGHT: LEDs. For each linear foot of sign, a combination of one top and one bottom printed circuit board format shall be used. Each board shall be replaceable and interconnected by locking male and female dual pin connectors. The operational life of the LEDs shall be a minimum of 10 years at 50% duty cycle.
72. The LED-illuminated sign shall be powered by 120 volts AC. The photocell on the Myers MET2-VLM-LTS service enclosure shall be used for the LED overhead street name signs. The manufacturer shall warranty workmanship and defects of the LED-illuminated sign under this specification for a period of five years.
73. All wiring connections within the sign fixture shall terminate through a UL approved junction box. All conductors inside the sign fixture and on the load side of the power shall be UL listed appliance material (AWM) stranded copper wire with thermoplastic insulation. All printed circuit boards shall be conformably coated for moisture resistance. The sign shall incorporate over-current protection through the use of an in-line fuse. The fuse rating and type shall be appropriate for varying size and power configurations.

74. Before commencing the installation of the traffic signal installation, a complete schedule of materials and equipment proposed for installation shall be submitted to the Engineer for approval. This schedule shall include catalog cuts, diagrams, drawings, and other such descriptive data that may be required by the Engineer.
75. All submittals shall include the manufacturer brand name and part number where applicable. Where more than one item is present on a submittal sheet, the appropriate item or items shall be circled, not highlighted. All submittals shall be organized as much as practical in order with the summary of quantities sheet in the plans. One electronic copy of each submittal shall be supplied to the City for review and approval. In the event that any materials or equipment contained in the schedule fail to comply with specification requirements, are not circled, or submittals are not packaged, such items may be rejected. New submittals on rejected items shall be supplied to the Engineer for approval.
76. When it is required by these specifications that a test be made of the material to be used on the project, the Contractor shall furnish the Engineer a certified copy of such test prior to the installation of such material. When any reference is made in these specifications to any specification such as ASTM, IPCEA, AIEE, etc., or a related specification referred to by reference therein, or revision thereof which states that a certain test, or tests are to be made only at the request of the purchaser, it shall be considered that the Engineer does request such test or tests to be made at the Contractor's expense and one certified copy of same be furnished as above mentioned.

B. CONSTRUCTION REQUIREMENTS:
1. Within twenty (20) days following execution of a contract, the Contractor shall submit to the Engineer for approval the shop drawings as required in the "MATERIALS AND EQUIPMENT" section above.
2. A pre-construction conference shall be held with the Contractor and the Engineer as directed by the Engineer.
3. The vehicle detection system shall be maintained by the Contractor throughout the project and shall be fully operational and functional at all times except for a short time period while the existing signal is switched over to the new signal.
4. At the earliest possible time, all electrical conduit, service boxes, pole foundations and junction boxes shall be installed at the correct grade.
5. Traffic signal heads shall remain covered with ORANGE bags during construction until the entire installation is placed in operation. Black bags shall not be used to cover the new signal heads during construction. Signal heads are to be covered to convey to drivers that they are not operational, as approved by the Engineer.
6. The Contractor is hereby advised that the work to be done shall be completed with full knowledge of the schedule made available to the Engineer. The Engineer may, at his option, cause any work completed without his knowledge or inspection, to be dismantled and inspected.
7. Any requested deviation from the "ORDER OF WORK" established herein must be approved by the Engineer or his representative.
8. No new fixture shall be constructed as part of this contract which is in conflict with any existing utility facility, or the code required thereby, unless approved by the Engineer.
9. Service and junction boxes shall be installed as shown on the plans and on the Standard Detail sheets and at such additional points as the Contractor, at his

own expense and with the approval of the Engineer, may desire to facilitate the work. Unless otherwise directed by the Engineer, all service and junction boxes shall be installed level to 1 inch above the finish grade.

10. Conduit shall be installed as shown in the plans and the Standard Detail sheets and in conformance with the section of these Specifications entitled “Conduit”.
11. The Contractor shall perform all excavations for installing underground conduits, cable, boxes and pole bases in whatever substances encountered, to the depths indicated on the drawings or as otherwise approved. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the excavation to avoid slides. Excavated materials shall be kept off sidewalks and out of the street where possible. Excavated material that is piled on sidewalks or in streets shall be removed by the end of the same working day. The Contractor shall pile excavated materials such that drivers' visibility will not be obstructed. All excavated materials not required or unsuitable for backfill shall be removed and wasted on a site obtained by the Contractor. Excavations and trenches shall not be larger or wider than necessary for the proper installation of the foundations or electrical appliance. Excavation shall not be performed until immediately before the installation of conduit, bases or other appliances. All excess excavated material shall be removed at the earliest possible time or as directed by the Engineer.
12. All areas excavated shall be backfilled and compacted in accordance with these Specifications. Backfill shall be deposited in not over 6” layers and tamped to 95 percent density $\pm$3 percent of optimum moisture. The top 6 inches of backfill shall be select soil suitable for sodding. All areas excavated shall be backfilled at the earliest possible time or as directed by the Engineer. After backfilling, all disturbed areas shall be kept well filled and maintained in a smooth and well drained condition until permanent repairs are made. Where trenches are excavated in established sod areas, the area shall be backfilled the same day excavation occurs by a method approved by the Engineer. Approved methods are intended to reduce damage to the established sod area.
13. The bottom of the concrete foundations shall rest on firm ground; foundations shall be poured monolithic except the top 6” pole cap. The exposed portions shall be formed to present a neat appearance. Forms shall be true to line and grade. The top of concrete foundations, except special foundations, shall be finished to either sidewalk grade or 1 inch above finished grade, as directed by the Engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position, to proper heights, and held in place by means of a template until the concrete sets. Each anchor bolt shall be provided with 2 hex head nuts, 2 flat washers and 1 lock washer. Both forms and ground which will contact the concrete shall be thoroughly moistened before placing concrete. All conduits shall be securely covered prior to pouring concrete. All threaded portions of anchor bolts shall be taped during the concrete pour. Any concrete splashed on poles when pouring the pole cap shall be immediately cleaned off.
14. Installation of wiring shall be in accordance with the plans and specifications and appropriate articles of the National Electrical Code. In addition, allowable pulling tensions on wiring in conduits shall be as per the cable manufacturer's recommendations. Approved pulling lubricants shall be used when pulling wiring in conduits. No splicing of cables will be permitted unless shown on the plans or approved by the Engineer. Where splices are allowed, they shall be made by a

method approved by the Engineer. Wire nuts shall be used in the base of any signal pole for wire connections.

15. Where practical, color codes shall be followed so that the red insulated conductor connects to the red indication terminal, orange to yellow, green to green and white to neutral. In addition, signal cable shall also be color-coded as follows:

    - Cable runs for northbound traffic: Color code BLUE
    - Cable runs for southbound traffic: Color code PURPLE
    - Cable runs for eastbound traffic: Color code YELLOW
    - Cable runs for westbound traffic: Color code RED
    - Cable runs for northbound left-turning traffic: Color code BLUE with ORANGE
    - Cable runs for southbound left-turning traffic: Color code PURPLE with ORANGE
    - Cable runs for eastbound left-turning traffic: Color code YELLOW with ORANGE
    - Cable runs for westbound left-turning traffic: Color code RED with ORANGE

16. A minimum of one (1) turn of each cable shall be left in every service or junction box for slack. In addition, slack shall be left in all poles and the controller cabinet. All slack cable shall be neatly dressed using nylon cable ties.
17. Bonding jumpers shall be No. 6 AWG bare copper wire or equally connected by approved clamps. Grounding of neutral at service point shall be accomplished as required by the National Electric Safety Code, except bonding jumpers shall be No. 6 AWG or equal. Ground electrodes shall be provided at each signal pole and pedestal and at the controller as detailed on the plans. The controller requires an equipment ground as indicated on the Standard Detail sheets in the plans.
18. All poles and pedestals are to be installed as shown in the plans and the Standard Detail sheets. All attachments are to be located in the field and all wire entrances shall be drilled or punched in the field. All drilled or punched surfaces shall be carefully reamed and/or deburred or threaded as appropriate before an application of one field coat of cold galvanizing. The Engineer shall confirm the location and mounting heights of all pole and pedestal attachments located in the field. Should field adjustment of any attachment be necessary after the Engineer confirms the locations, the Contractor shall be responsible for plugging any holes caused by the initial installation. Hole plugging methods shall be approved by the Engineer.
19. Mast arms on mast arm poles shall be installed after the mast arm poles are erected. In some instances and depending upon the final locations of the signal poles, a short section of the mast arm(s) may need to be cut off, as directed by the Engineer, in order to accommodate varying field conditions.
20. Signal heads shall be installed as shown on the plans and the Standard Detail sheets. The Engineer shall approve the location, mounting and mounting height of all signal heads. Signal heads shall not be installed at any intersection until all other signal equipment, including the controller cabinet, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic (refer to the beginning of “ORDER OF WORK”)

21. The signal heads shall be adjusted in the field such that a person standing on the pavement, a distance of four times the speed limit (mph) in feet (0.8 times the speed from the stop bar, shall see the brightest image of the red section. All heads shall be plumbed as viewed from the direction in which they face.
22. Loop detector installation shall conform to the details and notes shown on the plans and the Standard Detail sheets. All loop conductors shall be wound in the same direction with the start and end clearly marked on the conductors at the junction or service box. Conductors of all loops shall run continuous to and from the nearest junction or service box. The loop conductors for each loop shall be spliced in the junction or service box to a detector lead-in cable running from the box to a sensor unit mounted in the controller cabinet.
23. When construction of a loop is started, it shall be completed the same construction day. Should the Contractor start a loop installation and fail to satisfactorily complete it, the entire loop may be subject to replacement at the discretion of the Engineer. Construction of loops shall only be started when the ambient air temperature is 40° F. and rising.
24. Saw cuts for loop wires shall be made with a self-propelled saw with a water-cooled blade. The water is used to cool and lubricate the blade and eliminate blowing saw dust. Water shall be provided by the Contractor. All jagged edges or sharp corners and protrusions shall be removed using a small chisel and hammer. The saw cut shall be cleaned to remove cutting dust, grit, oil and other contaminates. The saw cut and entire loop area shall be flushed clean with water and dried with compressed dry air immediately after cutting. Care shall be taken during the cutting and cleaning operation to avoid blowing debris at passing pedestrians and vehicles or onto private property. All corners of loops will be drilled with 1.5 inch to 2 inch hole drill to the depth of saw cut.
25. Detector loops shall be installed in the asphalt base course prior to the placement of the asphalt surface course.
26. Wire shall be installed so as to minimize stress at corner locations. Wire shall be kept dry when installing in the saw slot and shall be inserted by use of a blunt, preferably nonmetallic, flat paddle.
27. After conductors are installed in the slots cut in the pavement, the slots shall be filled with the approved sealant to within 1/8 inch of the pavement surface. The sealant shall be prepared and installed in accordance with the manufacturer's recommendations, as approved by the Engineer. The sealant shall be between 1-1/2 inches and 2-1/4 inches thick above the top conductor in the saw cut as determined by the saw cut depth and as indicated in the plans. Before setting, surplus sealant shall be removed from the adjacent road surfaces without the use of solvents.
28. The Contractor shall allow time to let the sealant set before opening the lane(s) to traffic. Approved absorbent material shall be spread over the sealant if traffic is allowed over the loop before the sealant is completely set, as determined by the Engineer.
29. The video detection system shall be installed according to the manufacturer’s requirements and the Contract Documents. The Engineer shall be provided with three (3) copies of the manufacturer’s written requirements. The video detection system configuration consists of the number of cameras and video detection systems shown in the Contract Documents. The actual quantity and proposed location of the equipment to be furnished installed and made fully-functional as a complete video detection system by the Contractor is shown in the Contract

Documents. The supplier of the video detection system shall supervise the installation and testing of the video and computer equipment. A factory-certified representative from the supplier must be on-site during installation. In the event that the filed-setup computer is provided by the owner, the installation and testing shall be done at the time that training is conducted.

30. A two-year manufacturer's warranty covering the entire Video Detection System shall be provided. The warranty period will begin upon acceptance of the video detection system by the Engineer. The warranty shall cover ongoing software support by the supplier to include updates of the video detection system processor unit, modular cabinet interface unit and supervisor software (if a field setup computer is required for setup). These updates must be provided free of charge during the warranty period. The update of the video detection system software shall be compliant with the NEMA TS2, the Cal Trans 170 or 2070, and National Transportation Communication Interface Protocol (NTCIP). The supplier shall maintain a program for technical support and software updates following expiration of the warranty period. This program shall be made available to the owner in the form of a separate agreement for continuing support.
31. The signal turn-on shall be performed by City personnel and the Engineer. The Contractor shall be present for signal turn-on and be prepared to respond to any technical difficulties that may be encountered due to construction of the traffic signal. The signal turn-on shall not occur on Fridays, holidays or weekends and shall be completed between the hours of 9:00 a.m. and 2:00 p.m. unless otherwise noted in the plans or directed by the Engineer. At locations without previous traffic signal control, the new traffic signal shall flash for a period of two to three business days prior to full signal system turn-on.
32. All traffic signal installation elements shall function properly as a complete system for a minimum period of fifteen (15) calendar days before acceptance by the City.
33. The traffic signal shall function under normal conditions for a fifteen (15) calendar day continuous time period. During this fifteen (15) day test period, the signal operations shall be continuous without malfunctions. Any malfunction observed or recorded shall stop the test period as of the time of the malfunction and the test period shall not resume until all components are satisfactorily operating.
34. The Contractor shall be present to assist and participate in inspections of the traffic signal installation prior to final acceptance.
35. The work included in this project may involve modification of existing traffic signal equipment at locations which are presently controlled by operating traffic signals. If portions of the existing traffic installations are to be incorporated in the proposed signal installations, the following policies are to be observed during the installation of the proposed modifications and improvements:
36. The existing signal controls shall be kept in operation during installation of the proposed signal modifications and improvements, except for shutdowns to allow for alterations as required for installation of the proposed improvements.
37. Some periods of disruption to existing signal operations can be tolerated during installation of the proposed improvements. However, the Contractor shall coordinate planned disruptions of signal operations with the Engineer a reasonable time in advance of such disruption of operations. The Contractor shall be responsible for maintaining adequate traffic control during any period of disruption to the existing signal.

38. All existing wiring within existing controller cabinets shall be identified by the Contractor and each conductor properly labeled prior to de-energizing the existing controller to install the proposed modifications and improvements.
39. Planned disruptions of signal operations shall be restricted during off-peak time periods as directed by the Engineer. The signal controls shall be operable during all other periods.
39. All existing salvageable equipment, as determined by the Engineer, (i.e. signal heads, brackets, luminaires, poles, arms, controllers and cabinets) that is in excess of the requirements of this project shall be completely removed from the project. The Contractor shall deliver same equipment to the City of Lenexa Municipal Services Traffic Division. The Contractor shall be responsible for any damage or loss of salvageable equipment. All new equipment purchased as spare parts under the requirements of this project shall be delivered new and undamaged to the City of Lenexa Municipal Services Traffic Division, and stockpiled as per the instructions of the Engineer. The Contractor shall exercise care in the removal and delivery of any existing or new equipment to be delivered to the City. All salvaged equipment shall be re-usable, including Astro-brackets. All non-salvaged items of existing equipment shall become the property of the Contractor.
40. All concrete bases removed shall be broken up and removed to a depth of twenty-four (24) inches below grade. Holes resulting from this operation shall be filled to the proper grade with suitable material approved by the Engineer.
41. Specifications regarding traffic control for signal installations can be found in the section of these Specifications entitled “Traffic Control”.

C. METHOD OF MEASUREMENT: “Traffic Signal” installation as indicated on the plans, complete-in-place and accepted, will be measured as a unit lump sum quantity for all work necessary.

D. BASIS OF PAYMENT: “Traffic Signal” installation, measured as provided above, will be paid for at the contract lump sum price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete traffic signal installation and for all equipment, tools, labor and incidentals necessary to complete the work.

S-801 <u>PAVEMENT MARKINGS</u>: This work shall consist of the marking of pavement with various widths of lines and various symbols with extruded thermoplastic, spray thermoplastic, preformed thermoplastic, epoxy or painted materials furnished in yellow and white as described in the plans and in these Specifications. A complete list of pre-approved pavement marking materials is available at the office of the City Engineer or can be found on the City of Lenexa's internet website at ***www.lenexa.com***.

A. CONSTRUCTION REQUIREMENTS:
   1. Pavement markings that are installed in parking lots shall be white in color and shall consist of a thermoplastic material, unless otherwise specified by the Engineer.
   2. Prior to the installation of the pavement markings, the Contractor shall remove all existing pavement markings not designated to remain (removal to be by shot blasting or grinding, as directed by the Engineer). All blasting and grinding debris, including dust, shall be immediately removed and hauled away, as directed by the Engineer. Any appreciable damage or different appearance from the surrounding surface shall be repaired by the Contractor, at his expense, by methods approved by the Engineer. In addition, any existing markings that are damaged or obscured by the construction process shall be repaired or replaced, as directed by the Engineer.
   3. The surface shall be dry and all dust, debris and other foreign matter shall be removed from the road surface prior to the application of the pavement marking material. A rough-textured surface shall be cleaned by air blast. A smooth-textured surface may be cleaned by brooming, but if there is any doubt about the resulting cleanliness, the Engineer can require the use of air blast. Portland cement concrete pavement shall be ground with an abrasive grinder to a depth of 1/8-inch, and for the full width of the pavement marking in the location where the pavement marking is to be placed. After grinding, the surface shall be cleaned by air blast.
   4. All beads shall be packed in 50-pound burlap or multi-wall Kraft bags, and shall conform to the requirements of the section of this specification titled Glass Beads. Bags shall be leak-proof, moisture-resistant and of sufficient strength to insure safe delivery, handling and storage of the beads prior to and during their use. For identification purposes, each bag shall be marked with a lot number assigned by the producer.
   5. Those sections of pavement where extra dust and grime collects, such as gore areas and adjacent to raised islands, may require a water wash and scrubbing in addition to brushing and air blast.
   6. On those sections of pavement where no previously applied markings are available to serve as a guide, the proposed markings shall be laid out in advance of the marking application.
   7. Markings shall be applied at the locations and to the dimensions and spacing's shown on the plans. Markings shall not be applied until the layout and conditions of the surface have been approved by the Engineer.
   8. Summarized on the following page is a table illustrating the type of pavement marking material that should be used depending upon the age and type of surface. Thermoplastic material shall meet the requirements of AASHTO M249-79.

PAVEMENT MARKING GUIDELINES

Pavement Marking	Pavement Type		
	Asphalt (2)	**Concrete**	**Slurry Seal**
WHITE lane line	Thermo	Multi-Component	Thermo
WHITE channelization line	Thermo	Multi-Component	Thermo
WHITE crosswalk lines	Thermo	Multi-Component	Thermo
WHITE stop bar	Thermo	Multi-Component	Thermo
WHITE diagonal	Thermo (1)	Multi-Component	Thermo
YELLOW solid centerline	Thermo	Multi-Component	Thermo
YELLOW broken centerline	Thermo	Multi-Component	Thermo
YELLOW diagonal	Thermo (1)	Multi-Component	Thermo
ARROWS	Preformed Thermo	Multi-Component	Thermo
ONLY	Preformed Thermo	Multi-Component	Thermo
RR Crossing	Preformed Thermo	Multi-Component	Thermo

(1) Preformed thermoplastic may be substituted for extruded thermoplastic.
(2) Binder-sealer will be required on asphalt older than two months.

B. EXTRUDED THERMOPLASTIC MATERIAL:

1. Thermoplastic material shall be applied to the pavement by the extrusion method wherein one side of the shaping die is the pavement and the other three sides are contained by, or a part of, suitable equipment for heating and controlling the flow of material.
2. The equipment used to install hot thermoplastic materials under this Specification shall be constructed to provide mixing and agitation of the materials. Conveying parts of the equipment between the main material reservoir and the shaping die shall be so constructed as to prevent accumulation and clogging. All parts of the equipment that come in contact with the material shall be so constructed as to be easily accessible and exposable for cleaning and maintenance.
3. The equipment shall be constructed so that all mixing and conveying parts up to and including the shaping die will maintain the materials at a temperature not less than 375^{o} F.

4. To assure that the thermoplastic does not fall below the minimum temperature, the shaping die shall be heated by means of a gas-fired infrared heater or a heated, oil-jacketed system.
5. The equipment shall be so constructed as to insure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off square stripe ends and shall provide a method of applying "skip" lines. The use of pans, aprons or similar appliances that the die overruns will not be permitted under this Specification. The equipment shall be so constructed as to provide for varying die widths and to produce varying widths of traffic marking.
6. A special kettle shall be provided for melting and heating the thermoplastic material. The kettle must be equipped with a thermostat so that heating can be done by controlled heat transfer liquid rather than by direct flame, so as to provide positive temperature control and prevent overheating of the material. The heating kettle and applicator shall be so equipped and arranged as to meet the requirements of the National Board of Fire Underwriters, of the National Fire Protection Association, of the state and local authorities.
7. Glass beads applied to the surface of the completed strip shall be applied by an automatic bead dispenser attached to the striping machine in such a manner that the beads are dispensed almost instantaneously upon the installed line. The glass bead dispenser shall be equipped with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.
8. The equipment shall be so arranged as to permit preheating of the pavement immediately prior to application of the thermoplastic material if preheating is recommended by the thermoplastic manufacturer. The applicator shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.
9. The applicator shall be capable of containing a minimum of 125 pounds of molten material.
10. To insure proper adhesion, the Contractor shall apply the binder-sealer over the application area prior to the actual thermoplastic installation. The binder-sealer shall be applied by spraying, shall form a continuous wet film of approximately 2 to 3 mils thickness and shall be at least 2 inches wider than the applied thermoplastic so as to ensure adhesion at the edges. The binder-sealer shall be allowed to set long enough for the solvent to evaporate and become tacky. This can be as much as one hour or longer but not less than 30 minutes. If there is doubt, the longer time shall be used even though some tackiness might be lost.
11. For bituminous surfaces less than two months old and having less than 20% bare, exposed aggregate, the application of binder-sealer may be waived.
12. Bubbles forming in the applied thermoplastic is evidence that solvent remains in the binder-sealer. Rather than reduce the rate of application of the binder-sealer, more time should be allowed for evaporation of the solvent before continuing.
13. To insure optimum adhesion, the pavement and ambient air temperature shall be not less than 55^{o} F. and the thermoplastic material shall be applied in a melted state at a temperature of 375^{o} F. to 450^{o} F. The temperature of the thermoplastic in the shaping die shall be maintained at the manufacturer's recommended application temperature, but in no case shall the temperature fall below 375^{o} F.
14. The finished lines shall have well defined edges and be free of waviness. The minimum thickness of thermoplastic lines as viewed from a lateral cross section

shall be not less than 3/32-inch near the edges, nor less than 1/8 inch at the center.

15. Measurements shall be taken as an average throughout any 36” section of the line.
16. A device for gauging the thickness of the material shall be furnished to the Engineer for use on the project. The gauge shall be easy to read and shall readily indicate excessive variations.
17. The drop on glass beads shall be applied at a rate of one pound per 20 square feet of line.
18. All thermoplastic lines shall be of uniform thickness with well-defined edges and squared off beginnings and endings of all lines. All lines will have minimal dribbles, runs and overlaps. In the event that thermoplastic long lines must stop and then continue, the restart shall line up to within 0.5 inches of the existing long line and maintain a totally straight line. Hand pushcarts shall be used when doing crosswalks and stop bars. When the crosswalk or stop bar cannot be laid continuous, the overlap in the marking material shall be kept to a minimum. A maximum of two passes can be made in order to achieve the desired width of stop bars. The application equipment shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Asphalt shingles or other overrun cutoff material may be used for continental style crosswalks with prior approval, provided they are removed while the material is sufficiently hot to prevent lifting or tearing of the thermoplastic. Thermoplastic material will not properly adhere to pavement if moisture is present. Should rainfall occur within 24 hours prior to application, the surface moisture test (plastic wrap or roofing paper method as approved by the Inspector) must be performed and approval obtained from the Inspector.

C. COLD PLASTIC MATERIAL:

1. Pavement to be striped with Cold Plastic Marking shall be broomed and cleaned prior to application. When markings are to be applied where new pavement is to be installed, application shall be made by placing the marking on the pavement surface immediately behind the laydown machine, and embedding it into the new surface course by a steel roller during the final rolling.
2. Turn arrows, letters, stop bars, cross bars, etc., shall be applied by utilizing an adhesive recommended and supplied by the manufacturer of the pavement marking material. Word and symbol markings shall conform to the applicable shapes and sizes as outlined in the latest revision of the Manual on Uniform Traffic Control Devices (MUTCD).
3. When applied to existing or cold surfaces, the pavement temperature shall be not less than 70° F., and the ambient air temperature shall be not less than 60° F. to ensure optimum adhesion.
4. A minimum of three passes with a tamping cart shall be used to ensure bond of the marking material to the pavement. The tamping cart shall weigh a minimum of 200 pounds. Tamping with tires of an automobile or truck in lieu of the tamping cart shall not be permitted.
5. Applied material must adhere fully and completely to road surface with straight edges and squared ends and shall lay smooth on surface with no warps, folds, creases, waves, bubbles or rips. Color and beading must be uniform and consistent. No overlap of materials is allowed. Ends or sides matched to

existing markings must not exceed 0.125 inches in separation. Applied material shall be in alignment with existing markings and of consistent size.

D. SPRAY THERMOPLASTIC MATERIAL:
   1. The Contractor shall furnish to the Engineer a manufacturer's certification that the material provided complies with all the requirements of this Specification.
   2. Glass beads shall be both intermixed and drop on. Intermixed glass beads shall be uncoated and uniformly mixed throughout the thermoplastic material at a rate of not less than 25 percent by weight (retained on the No. 100 sieve) of the thermoplastic material.
   3. All equipment for application of thermoplastic marking materials shall be of such design and maintained in such condition as to properly heat, mix and apply the materials. The melting kettle shall be capable of heating the thermoplastic material to its recommended application temperature without scorching and shall be capable of maintaining that temperature. The heating kettle shall have a heat transfer medium and the flame shall not come in direct contact with the material container surface. A temperature gauge shall be visible on the outside of the kettle to indicate the temperature of the thermoplastic material. The melting kettle shall have a continuous mixer or agitator capable of thoroughly mixing the material at such a rate as to maintain homogeneity of material and uniformity of temperature throughout.
   4. The dispensing equipment shall be capable of applying molten thermoplastic material at the temperature recommended by the manufacturer of the thermoplastic material in lines from 4 inches to 6 inches wide at a 30 mil thickness. Dispensing devices shall be of the spray type.
   5. The thermoplastic dispenser shall be equipped with a drop-on type glass bead dispenser. The glass bead dispenser shall be located so as to drop the glass beads immediately after the molten thermoplastic material is applied. The glass bead dispenser shall be adjustable to regulate flow of the beads and shall uniformly dispense the glass beads over the entire width of the line. The application rate shall be a minimum rate of 8 pounds per 100 square feet. The beads shall adhere to the cured thermoplastic or all marking operations shall cease until corrections are made.
   6. The pavement surface on which the thermoplastic material is to be placed shall be clean and dry. Pavement surfaces shall be inspected for cleanliness and any dirt, debris, or other contaminants on the surface to be marked shall be removed.
   7. The pavement surface where the thermoplastic material is to be placed shall have a minimum temperature of 55º F. The air temperature shall be at least 50º F. during marking operations. The pavement surface temperature and air temperature shall be determined before the start of each day of marking operation and at any other time deemed necessary by the Engineer.
   8. A primer is not required on new bituminous surfaces unless recommended by the manufacturer of the thermoplastic material. If primer is recommended, it shall be applied and cured in accordance with the recommendations of the manufacturer of the thermoplastic material.
   9. The temperature of the thermoplastic material at the time of application shall be a minimum of 350º F. and a maximum of 425º F. The temperature of the thermoplastic material shall be checked at the point of deposition with a calibrated thermometer at the beginning of each day's marking, after material is

added to the dispensing device, after delays in the marking operation, and any time deemed necessary by the Engineer.

10. Pavement striping shall comply with the standard striping practices as shown on the plans. The Contractor shall begin center line and lane line striping at the beginning of the last existing 10-foot stripe in order to maintain a 40-foot cycle along the entire pavement.
11. Finished markings shall have well-defined edges and lateral deviation shall not exceed one inch in 100 feet. The minimum thickness of thermoplastic markings shall be 30 mils and the maximum shall be 50 mils. The thickness will be measured as a wet film except the Engineer may measure cured film by placing a tape or other bond breaker prior to placing the thermoplastic material and then removing a section of cured line and measuring thickness.
12. Damage to pavement marking caused by the Contractor's operation shall be repaired or replaced at his expense.
13. The applied thermoplastic markings should be inspected continually for overall workmanship. Markings shall have clean cut edges. The glass beads shall appear uniform on the entire marking surface. Adhesion to the pavement surface shall be checked with a stiff putty knife or similar instrument. The marking should not be removable from a concrete surface. The marking can be removed from a bituminous surface. However, residue of the bituminous substrate shall be stuck to the marking material.
14. If the thermoplastic line does not provide initial nighttime reflectivity or, if the marking does not have the required minimum thickness, the Contractor shall at his expense, apply additional thermoplastic material to the total thickness specified to the surface of the deficient portion of the marking. If the marking does not meet the required color, the Contractor shall, at his expense, remove the marking in a manner approved by the Engineer and re-apply the material. If the markings do not comply with the Specifications for any other reason, the Engineer may require complete removal or correction at the Contractor's expense.

E. PREFORMED THERMOPLASTIC MATERIAL:

1. Preformed thermoplastic material shall be applied to existing asphalt pavement by means of heat fusion. The markings shall be fusible to the asphalt pavement by means of the normal heat of a propane type of torch. Adhesives, primers or sealers shall not be used prior to the preformed markings application. The applied markings shall be very durable, oil and grease impervious and provide immediate and continuing retroreflectivity.
2. The preformed marking material shall consist of a resilient white or yellow polymer thermoplastic with uniformly distributed glass beads throughout its entire cross section. Preformed words and symbols shall conform to the applicable shapes and sizes prescribed in the latest revision of the MUTCD.
3. The markings shall conform to the pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics and be capable of fusing to itself and previously applied worn hydrocarbon and/or alkyd thermoplastic pavement markings. The markings shall not be brittle and must be sufficiently cohesive and flexible at temperatures exceeding 40° F. for one person to carry without the danger of fracturing the material prior to application.

4. The retroreflective pliant polymer thermoplastic pavement markings shall consist of a homogeneous mixture of high quality polymeric thermoplastic binders, pigments, fillers and glass beads. The thermoplastic material must conform to AASHTO designation M249-79 (86) with the exception of the relevant differences due to the material being supplied in a preformed state. The markings shall be suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.
5. When properly applied, in accordance with the manufacturer's instructions, the pavement markings shall be neat and durable. The markings shall remain retroreflective and show no fading, lifting, shrinkage, tearing, roll back or other signs of poor adhesion. Applied material must adhere fully and completely to the road surface with straight edges and squared ends and shall lay smooth on the surface with no warps, folds, creases, waves, bubbles or rips. Color and beading must be uniform and consistent. No overlap of materials is allowed. Ends or sides matched to existing markings must not exceed 0.125 inches in separation. Applied material shall be in alignment with existing markings and of consistent size.
6. The pavement surface where the thermoplastic material is to be placed shall have a minimum temperature of 40º F. The air temperature shall be at least 40º F. during marking operations. The pavement surface temperature and air temperature shall be determined before the start of each day of marking operation and at any other time deemed necessary by the Engineer.

F. MULTI-COMPONENT PAVEMENT MARKING MATERIAL:
1. All curing compounds and laitance shall be removed by shot or sand blasting. Multi-component liquid materials shall be applied closely behind the surface cleaning procedures. Before mixing the components of the pavement marking material, the individual components shall be heated to the temperature ranges recommended by the manufacturer of the material. The maximum recommended temperature shall not be exceeded at any time.
2. The multi-component liquid pavement marking material shall be applied at the thickness recommended by the manufacturer on concrete surfaces. Glass beads shall be applied immediately (via the double drop system) to the multi-component liquid pavement marking material at the rate recommended by the manufacturer to obtain the required level of retroreflectivity and equally divide between the large and regular bead gradations. The large beads shall be applied on the first drop and the regular beads shall be applied on the second drop.

G. CONTRAST PAVEMENT MARKING MATERIAL FOR CONCRETE PAVEMENT:
1. Contrast pavement marking material shall be used on concrete pavement. The contrast tape shall be installed in a groove and shall have a black preformed patterned film border, bonded to the edges to form a continuous roll. These films shall be manufactured without the use of lead chromate pigments or other similar, lead-containing chemicals. The total width of the preformed contrast tape shall be an additional three inches wider than the standard width specified. The additional three inch width shall be black non-reflective film with one and half inches on both sides of the white or yellow film. Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the Manual on Uniform Traffic Control Devices (MUTCD).

2. No direct measurement will be made for the contrast pavement marking material, completed in place in accordance with the plans and Specifications and as accepted by the Engineer.
3. No direct payment will be made for the contrast pavement marking material. This item shall be subsidiary to the respective pavement marking bid items for concrete pavement and shall be full compensation for the furnishing of all materials, labor, equipment, tools and incidentals necessary to complete the work.

H. EPOXY PAVEMENT MARKING MATERIAL:
1. If no traffic is present and for edge lines under any condition of traffic, a slower curing epoxy material (40 minutes) may be used. If the application is taking place under traffic, a fast-setting (10 minutes) epoxy material for centerlines and skip lines shall be used. Epoxy shall be applied closely behind the surface cleaning procedures.
2. In the absence of manufacturer's recommendations, the markings shall be applied when the ambient and pavement surface temperatures are 50° F. and rising. Pavement marking operations shall be ceased when the ambient or the pavement surface temperature drops to 50° F.
3. Before mixing the components of the pavement marking material, the individual components shall be heated to the temperature ranges recommended by the manufacturer of the material. The maximum recommended temperature shall not be exceeded at any time.
4. The epoxy pavement marking material shall be applied at a thickness of 0.02 in. ±0.0002 in. on the Portland cement concrete. The glass beads shall be applied immediately to the epoxy pavement marking material at a rate of 25 lbs/gal, equally divided between the large and regular bead gradations. The large beads shall be applied on the first drop and the regular beads on the second drop.

I. WATERBORNE TRAFFIC PAINT MATERIAL:
1. Pavement marking paint shall only be used with prior approval, when specified and approved by the Engineer as temporary pavement markings when ambient and surface temperatures prevent the Contractor from properly installing permanent pavement markings, as directed by the Engineer. Once the proper ambient and surface temperatures are reached, the Contractor shall remove the temporary pavement markings and shall install permanent pavement markings as illustrated on the plans. Pavement markings that are installed in parking lots shall be white in color and shall have a minimum 4" width.
2. The pavement marking paint shall be a rapid dry paint and shall provide optimum adhesion for glass spheres when both binder and glass spheres are applied in the recommended quantities. When applied at a wet film thickness of 15 mils with a top dressing of 6 lbs to 10 lbs of glass spheres per gallon of paint and when the ambient temperature is 35° F. and rising, the wind-chill temperature is 35° F. and above, and the relative humidity does not exceed 80%, the binder shall dry to a no-tracking condition in a minimum of 20 seconds and a maximum of 60 seconds. The ambient temperature shall remain at 35° F. and above for at least 10 hours after the paint has been applied in order to ensure adequate drying time at above-freezing temperatures. These dry times shall not be exceeded when the paint is applied with specialized equipment so as to have the pigmented binder at a temperature of 150° F. to 170° F. at the spray gun.

3. The no-tracking condition shall be determined by passing over the applied line in a simulated passing maneuver with a passenger car traveling 35 mph. There shall be no visual deposition of the paint to the pavement surface when viewed from a distance of 50 feet. Furthermore, the pigmented binder, without glass spheres, shall dry to no-tracking condition in 180 seconds or less when tested in accordance with ASTM D-711-67.
4. The paint shall show no cracking, flaking, blistering, appreciable loss of adhesion, softening, coagulation, discoloration and have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952B. The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.
5. The line shall be uniform thickness across the entire cross section of the line with well-defined edges. Heavy inner thickness and thin edges or vice-versa will not be accepted. Glass beads shall be spread uniformly over the entire length of the line. Beginnings and ends of lines shall be clean cut and perpendicular to the centerline of the street. Pavement marking paint materials shall not be applied when pavement temperatures are below 50° F. or when the surface of the pavement shall show evidence of moisture. Temperatures should be at least 50° F. and rising.

H. RAISED PAVEMENT MARKERS:
1. Raised pavement markers may be used as a temporary pavement marking in instances such as before a roadway is slurry sealed. Raised pavement markers shall be subsidiary to the TRAFFIC CONTROL bid item.

I. GLASS BEADS - Glass beads furnished under this Specification shall be transparent, colorless, clean and free of foreign matter, and shall conform to the requirements set forth herein. The beads shall be designated as: Type A-Standard Clear
MATERIAL REQUIREMENTS:
1. Glass bead size:

Sieve Size	**% Passing**
No. 20	100%
No. 30	75-88%
No. 40	40-50%
No. 50	10-25%
No. 80	0-03%

2. Imperfect Beads: Not more than 30 percent of the beads shall be imperfect. See the subsection entitled “Method of Test”.
3. Moisture Resistance: Beads shall pass the “Free Flow Test”. See the subsection entitled “Method of Test”.
4. Index of Refraction: The beads shall have a minimum index of refraction of 1.50 when tested by the oil immersion method under tungsten light at 77° F.
5. Packaging: All beads shall be packed in 50-pound burlap or multi-wall Kraft bags. Bags shall be leak-proof, moisture-resistant and of sufficient strength to insure safe delivery, handling and storage of the beads prior to and during their use. For identification purposes, each bag shall be marked with a lot number assigned by the producer.

J. GLASS BEADS - METHOD OF TEST:

1. Sieve Analysis: Split out a representative sample of glass beads of approximately 200 grams (20+/- grams). Weigh to the nearest 0.1 gram and place on the No. 30 sieve equipped with a pan. If preferred, the entire series of sieves (See Subsection 106.1) may be stacked for a preliminary shaking of one minute before continuing with each individual sieve. If the stacking method is used, unbind the first sieve by inverting over a “bread” pan or other suitable shallow pan and brushing with a brass bristle brush. Weigh the beads and return to the sieve with an empty pan attached. Hold the sieve in one hand in a slightly inclined position so that the sample will be well distributed over the sieve, at the same time striking the side of the sieve about 150 times per minute against the palm of the other hand on the upstroke. Turn the sieve every 25 strokes about one-sixth of a revolution in the same direction. At the end of a minute of continuous shaking, remove the beads from the pan and weigh. Put these beads on the next sieve. If the weight of beads collected in the pan amounts to more than 1% of the beads on the sieve at the beginning of the sequence, the sieve is again unblended and the beads are weighed and returned to the sieve. Repeat the procedure for each sieving sequence, using the new weight to determine the percent passing. Continue sieving and weighing until not more than 1% of the beads passes the sieve during any sequence. Repeat the procedure until each sieve in the stack has been used. Weigh and record the final amount retained on each sieve to the nearest 0.1 gram.
2. Subtract the weight of beads retained on each sieve from the weight of the beads on the sieve at the beginning of the sequence. Calculate the percentage of beads passing each sieve. The original sample weight will be used in all calculations for percentage passing each sieve.
3. The sum of the weights of beads retained and the weight of the beads passing the last sieve must be within 0.8 grams of the original sample weight for the analysis to be considered a valid test. If the amount lost during sieving is more than 0.8 grams, that analysis must be discarded. A new sample is then split from the retained portion of beads and the procedure above is repeated, taking care that loss of beads is kept to a minimum.
4. Imperfect Beads: Imperfect beads are defined as beads which are ovate or otherwise non-spherical in shape, two or more beads fused together, opaque bead or pitted beads. Imperfect beads will be determined by visual inspection on a representative sample of not less than 300 beads using a 45 power magnification. All particles retained on a 100 mesh screen regardless of shape will be counted; particles passing a 100 mesh screen will be disregarded and not counted either as perfect or imperfect beads.
5. Moisture Resistance - Free Flow Test:

    - Required Apparatus: Standard one pint screw cap mason fruit jars with two piece covers consisting of a flat cover plate with sealing gasket attached and a screw ring to hold the cover plate on the jar. Special 60° Brass Funnel with a four inch stem. Inside diameter of the stem shall be 0.25 inches plus or minus 0.004 inches. The top funnel shall be soldered to one of the screw rings from a jar cover so that the funnel can be screwed to the top of the jar. The inside surface of the funnel shall be kept polished smooth. Measuring pipette, Mohr Type, capacity 0.100 ml with graduation line at intervals of 1/100 ml or an automatic pipette of similar capacity.

- Procedure: Using a sample splitter, obtain a representative 300 gram sample of the beads. Transfer the sample to one of the pint jars and place the uncovered jar and samples in an air oven at 221° to 230° F. for 16 hours. Remove the jar from the oven immediately and seal it with one of the jar cover plates and screw rings. Allow to cool to room temperature.
- If, after cooling, the beads have stuck together forming lumps, shake the jar violently until all lumps are broken up. This must be done without removing the cover. After breaking up lumps, remove the cover and quickly add 0.090 ml of distilled water from the measuring pipette. Immediately seal the jar with the cover and screw ring and shake jar and contents violently for 20 seconds. Let stand for four hours, shake and tumble the beads in the sealed jar for 20 seconds at the end of the first, second, and third hour of standing.
- At the end of the fourth hour, without shaking, remove the cover and quickly screw the special funnel to the top of the jar. Invert the jar and support it in a vertical position. The beads shall flow from the jar through the stem of the funnel. It is permissible to tap the funnel to keep the bead flow. But if it is necessary to keep tapping the funnel to keep the beads flowing, the beads do not pass the test. A small amount of beads sticking to the sides of the jar shoulder shall not be cause for rejection.

6. Basis of Acceptance:
   - Acceptance of glass beads will be made on the basis of a Type “D” certification. Type “D” certification shall be prepared by the manufacturer and shall state that the materials meet the applicable specifications. Those specifications shall be listed by number, section reference or other appropriate identification.
   - Visual inspection of performance and consistency on the job site

K. METHOD OF MEASUREMENT: Pavement Marking, except as noted above, will be measured by the linear foot of each width of line, and per each for symbols and text letters, complete in place in accordance with the plans and Specifications and as accepted by the Engineer.

L. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, will be paid for at the Contract unit price bid for each width of "Pavement Markings" and per each symbol or text letter, which price shall be full compensation for the furnishing of all materials, for all labor, equipment, tools and incidentals necessary to complete the work. Removal of existing pavement markings shall be subsidiary to the installation of the new pavement markings.

S-802 TRAFFIC SIGNAL INTERCONNECT/FIBEROPTIC COMMUNICATIONS: This work shall consist of furnishing and installing all necessary equipment and materials to complete a traffic signal interconnect system in accordance with these Specifications and as shown on the plans or established by the Engineer. The system shall include all equipment as listed in the traffic signal interconnect summary of quantities and as shown in the plans and shall include any incidental items necessary for the satisfactory operation of the system. A complete list of pre-approved materials is available at the office of the City Engineer or can be found on the City of Lenexa's internet website at ***www.lenexa.com***. The Engineer's approval or acceptance of materials or work performed shall in no way lessen the Contractor's responsibility to provide a fully-functioning system.

A. SINGLE-MODE FIBEROPTIC CABLE: The Contractor shall furnish and install fiber optic cable as shown on the Plans and in accordance with the requirements specified herein. All fiber shall be shipped on reels of marked continuous length. No splices shall be permitted within the fiber jacket. No point discontinuities of greater than 0.10 dB shall be permitted. All fiber shall be labeled with the length at a minimum of every three feet. After installation, the distance markings at each end of each run shall be logged and provided to the Engineer in a form acceptable to the Engineer. After installation, each run of fiber optic cable shall be marked within one foot of each splice and/or termination with the location that the cable goes to. A plastic tag with waterproof ink shall be used to mark the cable. This nomenclature shall be submitted to the Engineer for approval prior to its use. The nomenclature shall be used on the Optical Time Domain Reflectometer (OTDR) sweep test results specified separately.
   1. The following standards are applicable to this bid item and are hereby incorporated by reference:

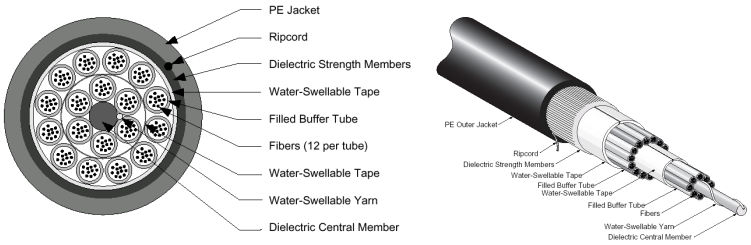
ORGANIZATION	STANDARD	APPLICABILITY
RUS	PE-90	Cable Construction
TIA/EIA	598B-01	Color Coding
TIA/EIA	472D000	Fiber Optic Cable
TELCORDIA	GR-20	Optical Characteristics

   2. Single-mode cable shall consist of 6, 12, 24, 48, 72, 96, 144 or 288 fiber counts as shown in the Plans, arranged in color-coded buffer tubes of six or 12 individually color coded fibers. Standard Trunk Fiber is 144 ct. LAN Applications industry standard fiber used to support campus and building backbone cabling systems comprising local area networks (LANs).
   3. The loose tube cable shall meet these fiber specifications: A germania-doped silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD). The optical fiber refractive index profile shall be step index.
   4. Each fiber shall be proof-tested by the fiber manufacturer at a minimum of 100 kpsisw. The fiber shall be coated with a dual acrylate protective coating and the coating shall be in physical contact with the cladding surface.
   5. The single-mode fiber shall meet EIA/TIA-492CAAA, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers," and ITU-T G.652, "Characteristics of Single-mode Optical Fiber Cable." Fiber shall have a mode field diameter of 9.20 + 0.40 μm at 1310 nm and 10.40 + 0.80 μm at 1550 nm. Fiber core-clad concentricity shall be ≤ 0.5 μm. Fiber cladding diameter shall

be125.0 + 0.7 μm. Fiber cladding non-circularity shall be ≤ 1%. Fiber coating diameter shall be 245 + 5 μm.

6. The attenuation specification shall be a maximum value for each cabled fiber at 23 + 5oC on the original shipping reel. The cabled fiber attenuation shall be ≤ 0.4 dB/km at 1310 nm and ≤ 0.3 dB/km at 1550 nm. The attenuation at the water peak (1383 nm) shall not exceed 2.1 dB/km. The attenuation due to 100 turns of fiber around a 50 + 2 mm diameter mandrel shall not exceed 0.05 dB at 1310 nm and 0.10 dB at 1550 nm. There shall be no point discontinuities greater than 0.10 dB at either 1310 nm or 1550 nm.
7. The maximum dispersion shall be ≤ 3.2 ps/ (nm•km) from 1285 nm to 1330 nm and shall be < 18 ps/ (nm•km) at 1550 nm.
8. The cabled fiber shall support laser-based Gigabit Ethernet (GbE) operation according to the 1000Base-LX (1310 nm) specifications up to 5000 meters, in accordance with the GbE standard. The cabled fiber shall support 10 Gigabit Ethernet (10GbE) operation according to the 10GBASE-LX4 (1300 nm region), 10GBase-L (1310 nm) and 10GBase-E (1550 nm) specifications for distances of 10 km, 10 km and 40 km, respectively. The cabled optical fiber shall support industry-standard multi-gigabit Fiber Channel physical interface specifications. **Primary Applications:** Outside plant cable for outdoor duct installation.

ALTOS® All-Dielectric Cable, 2-288 Fibers



9. Cable shall be all-dielectric, stranded loose tube design with Dry™ cable waterblocking technology for outdoor duct and aerial installations in fiber counts from two to 288. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598B, "Optical Fiber Cable Color Coding." The fibers shall be colored with ultraviolet (UV) curable inks. Buffer tubes shall be made from polypropylene, filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel and be manufactured to a standard 3.0 mm in size, regardless of fiber count, to reduce the number of required installation and termination tools. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598B. Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm. Buffer tubes in a hybrid cable (cable containing more than one type of fiber) shall contain only one fiber type. Identification of fiber types in a hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598B. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation stranding process. Two polyester yarn binders shall be applied contra helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage. Water swellable yarn(s) shall be applied longitudinally along the

central member during stranding. For dual-layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter. Cable shall be comprised of water-swellable yarns and/or tapes, dielectric strength members (as required), ripcord(s) and an MDPE jacket containing carbon black to provide ultraviolet light protection while inhibiting the growth of fungus. Cable jacket shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code (NESC), fiber count and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm. Cable shall contain reverse oscillation lay (ROL) markings as needed. Cable shall have a storage temperature range of -40° to 70°C, an installation temperature range of -30° to 70°C, and an operating temperature range of -40° to 70°C. Cable shall have a short-term tensile rating of 2700 N. No fiber strain shall occur over the service life of the cable when subjected to a maximum, long-term tensile rating of 890 N. Cable shall be listed with Rural Utilities Service (RUS) 7 CFR 1755.900 and be fully compliant with ICEA S-87-640. Manufacturer shall be ISO 9001 and TL 9000 registered. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support.

10. All fiber shall be installed in underground conduit. Pulling in place shall be by hand or by an approved mechanical pulling machine. If a mechanical pulling machine is used, it must be equipped with a monitored or recording tension-meter. At no time shall the manufacturer's recommended maximum pulling tension be exceeded. Where pulling through pull boxes, approved pulleys and sheaves shall be used or the excess cable must be coiled in a figure eight and fed by hand. If sheaves are to be used, the Contractor shall provide the Engineer with a drawing of the proposed layout showing that the cable shall never be pulled through a radius less than the manufacturer's minimum bending radius. One Hundred feet of spare fiber shall be looped neatly in splice boxes, 50 feet on each side of the splice enclosure. At each termination point, 50 feet of spare fiber shall be looped neatly in an adjacent pull box. At pull boxes 30 feet of spare fiber shall be neatly coiled. This fiber is for future additions or repairs to the fiber network.

B. FIBER OPTIC CABLE SPLICING: All fibers shall be spliced by the fusion method. The Contractor shall use a fusion splice machine for this purpose. The splice machine shall be equipped with a method for estimating the achieved splice loss. Either the "Local Injection Detection" or "Core Alignment Loss Estimation" system is acceptable. The machine used shall be new from the factory or serviced and certified by the factory or its authorized representative within the previous six months from the commencement of its use on the project. The Contractor shall provide to the Engineer a letter from the manufacturer or his authorized agency certifying that this requirement is met. Splice

loss shall not exceed a bi-directional average of 0.10 dB per splice for a complete fiber run or a maximum of 0.15 dB from each direction for any single splice. At each splice location where cables are joined, 60 feet of fiber (30 feet on each side of the splice) shall be coiled to allow future access to the cable at a distance from the splice point to accommodate a van or tent for the purpose of keeping the splice machine and craft-person out of the weather.

1. Where a fiber cable is to be accessed for signal insertion or drop, only the buffer tube containing the fiber(s) to be accessed shall be opened. For a continuous cable run, only the actual fiber to be accessed shall be cut. For a drop fiber cable, all fibers shall be cut to a length equal to that of the fiber to be used and the spare neatly laid into the splice tray. At least one and one-half revolutions of the splice tray of fiber shall be left on each end of fiber after splicing. All fiber cable sizes called out in the Plans must be continuous for the entire length of the run.
2. At each splice point, splice organizer trays shall be provided to contain and protect the bare fibers and splices.
3. Splice trays shall be easily attachable and accessible. Splice tray raceways shall include a raceway for excess fiber storage that shall accommodate the minimum bend radius of single-mode fiber without causing excessive signal losses due to bending or fiber damage.
4. The splice trays shall have a means to affix the buffer tube rigidly in place, and space and guides to allow “race tracking” of the fiber and guides to locate the splice protectors.
5. The splice trays shall be layered above the transition/storage compartment and shall be easily slipped into place on two studs and secured with a hold down strap. Splice trays shall have fixed rigid slots for fiber placement.
6. Each tray shall be made of injection-molded plastic and have a hinged clear plastic cover for maximum fiber protection that allows for visible inspection of the fibers. The covers shall have a lock mechanism to hold them in place.
7. All splices shall be protected with a heat-shrink sleeve containing a stainless steel strength rod or protective sleeve and housing. Completed splice protectors shall be held in place with RTV silicone or adhesive tape. No more than 12 splices shall be placed in one tray.

C. FIBER OPTIC TERMINATIONS:

1. Closet Splice Housings shall be mountable in an EIA-310 compatible 465- or 592-mm rack. Housings shall be available in several sizes, including 3U and 5U. One EIA rack space or panel height (denoted as 1U) is defined as being 44.45 mm in height. The splice housings shall provide individual tray access with minimal disturbance to neighboring trays and fibers. The unit shall meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0. Manufacturer shall be ISO 9001 and TL 9000 registered. Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. Installation fasteners shall be included and shall be black in color. The unit shall be available in different sizes to accommodate different splice count requirements. Available sizes, with their correspondingcapacities, are given below.

Unit Size	Splice Tray Capacity	Minimum Splice Capacity
Front Access Units		
3U	12 (5.1-mm-tall trays)	144
3U	7 (10.2-mm-tall trays)	84
5U	22 (5.1-mm-tall trays)	264
5U	14 (10.2-mm-tall trays)	168
Rear Bay Units		
2U	4 (5.1-mm-tall trays)	48
2U	3 (10.2-mm-tall trays)	36
3U	9 (5.1-mm-tall trays)	108
3U	6 (10.2-mm-tall trays)	72

The unit shall include a clamshell-type cable clamping mechanism to provide cable strain-relief. The cable clamp shall accept one cable from 9.5 to 28.6 mm in diameter. The cable clamp mechanism shall also handle multiple smaller fiber count cables when used with the multiple cable insert. The total cable capacity per clamp shall be five cables (10.2 mm OD) when used with the multiple cable insert. Housing cable clamp capacity shall be four clamps for the 3U and 5U housings. Additional cable clamps shall be available as an accessory kit. The splice housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606. The front and rear doors shall be lockable when used with an optional key lock kit. Brackets shall be available that allow wall mounting of the rack-mountable hardware. Brackets shall include space for jumper management panels.

2. The Closet Connector Housing panels shall be offered in 6-, 8-, 12-, 16- and 24-fiber panels for use with the LANscape® Solutions hardware products. The panels shall be able to be used with field-installable connectors or in applications where the preconnectorized cables are routed directly from the equipment to the interconnect hardware. The 6-fiber panels shall be offered in ST® compatible, D4, FC, LC, SC duplex and simplex and the MT-RJ multifiber connectors. The 8- and 12-fiber versions shall include ST compatible, LC, SC duplex and simplex and the MT-RJ multifiber connectors. For high-density applications, the MT-RJ and LC panels shall be available in 16- and 24-fiber versions. The panels shall be available with a variety of industry-standard connector types. The Closet Connector Housing Panels shall be designed for applications where specified labeling and connector identification is required. This shall be accomplished by the use of colored icons with different symbols molded into the icon. The colored icons shall be offered in a variety of colors. As a minimum, these icons shall be available with the following symbols: computer terminals (for fiber-to-the-desktop), telephones, video cameras, CATV, satellite dish or CAT 5. The icons shall also be available in a variety of colors, including blue, yellow, red, white, electric ivory, ash, green, purple, gray, black, brown and orange. All the icons and colors shall be compliant with the TIA/EIA-606 labeling standard. Panels that accept icons shall come standard with the “blank red” icon. Rack- and wall-mountable connector housings shall accept an interchangeable connector panel. Copper jack panels shall be available and accept up to four copper jacks. The panel shall be attached with two push-pull latches to allow quick installation and removal. Blank connector panels shall be available to fill unused space within the housings. The blank connector panel shall be attached with at least two push-pull latches to allow quick installation and removal. The blank panels shall be

manufactured from injection-molded polycarbonate and shall be finished with a wrinkled black texture to match the housing. Panels shall be manufactured from 16-gauge cold rolled steel or injection-molded polycarbonate for structural integrity. Panels shall be finished with a wrinkled black texture to match other hardware. All connectors shall be SC type unless otherwise noted.

3. Underground Splice Enclosures: It shall be the responsibility of the Contractor to determine where underground splice enclosures are required for the termination of underground cable at the end of a cable reel. Underground splice enclosures for end-of-reel splicing shall not be spaced less than two miles unless otherwise approved by the Engineer. The cost of the enclosure used for this purpose shall be considered subsidiary to the lump sum bid item “Traffic Signal Interconnect”.
4. Underground splice enclosures shall be used for cable splicing. Splice enclosures shall be designed to be easily accessible for testing and maintenance with the necessary vehicles and equipment to perform the task. The fiber optic splice enclosures shall be capable of accommodating splice organizers to facilitate fiber management and accept mechanical, single fiber fusion splices. The splice enclosure shall provide fiber optic cable penetration end caps on one end to accommodate at least three fiber optic cables. Water-blocking techniques shall be used to ensure that the enclosure and cable entry locations do not leak when immersed in 19 feet of water for 30 days. The enclosure end caps should be factory drilled to the proper diameter to accept and seal the fiber optic cable entry (ies). The end caps shall use a slotted end plate and split seal to allow for access to cables without service interruption. Cable entry locations shall accommodate an assortment of fiber optic cable outer diameters ranging from 0.4 inches to 0.7 inches (± 10 percent) without jeopardizing its waterproof characteristics. Hinged splice enclosures with stainless steel latching devices shall be utilized. The enclosure shall allow for a minimum of 16 feet of expressed buffer tube storage/management. All fiber optic splice enclosures shall meet the requirements of Telcordia Technologies GR-771-CORE and shall comply with all applicable NEC requirements.
5. Splice enclosures may encounter high water table conditions. Splice enclosures shall be non-filled (no encapsulate), airtight and prevent water intrusion, able to accommodate pressurization and have the capability to be reentered without requiring specialized tools or equipment. Splice enclosures shall also be supplied with all hardware necessary to provide solid mounting to wall structures. All enclosures (both underground and aboveground) and associated facilities provided under this Contract shall include a quality assurance/quality control inspection for materials, workmanship and compliance of the product to meet these specifications. The Contractor shall provide to the Engineer an executed Certificate of Compliance from the manufacturer indicating that the splice enclosures meet the requirements included herein.
6. All splice enclosures must employ a complete fiber management system consisting of splice trays and a stress relief system. Each enclosure shall be designed to accommodate future expansion and contain modular splice organizers/trays capable of handling splices in a neat and distinguishable fashion.
7. Spare splicing trays shall be provided at all splice locations unless otherwise noted to allow for an additional number of splices equal to the number to be spliced initially in the enclosure. Trays shall be easily attachable and accessible. Tray raceways shall include a raceway for excess fiber storage that

accommodates the minimum bend radius of single-mode fiber without causing excessive signal losses due to bending or fiber damage. Splice enclosures shall have provisions for storing fiber splices and non-spliced fiber/buffer tubes.

8. The splice enclosure shall be sized to accommodate a minimum of 12 fiber splices. The cost for the splice trays and for splicing the required fibers shall be included in the cost of the enclosure. No additional compensation shall be given for these items.

D. PRE-TERMINATED INTERFACE PANEL – GATOR PATCH:

1. The Contractor shall utilize pre-terminated interface panels to maintain the expandability of the infrastructure and lessen maintenance costs. The pre-terminated interface panels shall be specifically designed for ITS applications. The drop cable and patch panel assembly shall be supplied complete as one unit. The drop cable and patch panel assembly shall be manufactured at the factory using customized lengths of drop cable specific to each installation location. It shall be the complete responsibility of the Contractor to verify the length requirement for each pre-terminated drop assembly as defined by the location of each independent ITS device cabinet and the trunk cable.
2. The Contractor shall provide a drop cable assembly comprised of a factory terminated drop cable integrated into a protective housing and a custom length of drop cable. The patch panel shall be built of an ABS plastic, and shall have eight SC connections with ceramic ferrule.
3. The inside of the housing shall be filled with an environmentally and temperature stable epoxy to permanently secure the connectors and the cable on the inside of the housing and to protect the fiber optic components from vibration and shock. The epoxy shall be thermally stable from -4 to + 165 degrees F. The housing shall incorporate a 2.5-inch minimum strain relief boot around the exiting drop cable to provide bend radius protection and short-term cable retention of at least 200 lbs/ft. The housing shall have integrated mounting notches for field mounting.
4. Each assembly shall be provided with factory test results for reflectance and insertion loss. This test report shall reference the serial number of the assembly. The test report shall be provided to the Engineer prior to installation.

Insertion Loss	15 Typical
Reflectance	<-40 dB SPC

5. The assembly shall be shipped coiled or on a spool. In either case, the free end of the cable shall be on the top end of the coil or spool.

F. FIBER OPTIC COMMUNICATION TESTS:

1. Pre-installation Test: The Contractor shall test all fiber optic cable prior to installation. Cable delivered to the job site shall be tested on the reels prior to installation. This test shall consist of a single direction sweep of each individual fiber with an OTDR that has been calibrated for the index of refraction of the fiber to be tested. Verification of the fiber length and attenuation shall be made. Attenuation shall not exceed 0.56 dB/mile at 1310 nm and 0.19 dB/mile at 1550 nm and no point discontinuities greater than 0.1 dB shall be allowed. If the cable fails to meet these requirements, the Contractor shall replace the entire reel at no additional cost. Printouts of the OTDR trace with the identification of the fiber and the attenuation and length noted on the printout shall be provided. This test may be eliminated at the Contractor's option if the manufacturer has done these

tests at the factory and after the cable is placed on the reel and provides a typical OTDR trace together with a table of all attenuations and lengths of each fiber on a reel. If the Contractor elects to forgo this test, it shall in no way relieve him of the obligation to replace any cable, which after installation and testing, proves not to meet the specifications. Cable replacement shall be done at no additional cost to the City.

2. Post-installation Test: After installation, the Contractor shall test all fibers from both ends with an OTDR. The terminated branch fibers shall be tested between the nodes and the first drop point in each direction, and between every drop point in each direction. The fibers being used for the trunk cable shall be tested between all of the distribution cabinets, including the TOC, along the cable in both directions. In addition, all fibers shall be tested using the insertion loss method with the loss set (light source and power meter). The fibers shall be tested in both directions at both wavelengths. All results shall be recorded and submitted. Those fibers that are not terminated at the time shall be tested using a bare fiber adapter. A pair of traces for each fiber shall be placed in a notebook and presented to the Engineer. A loss table shall be included with each trace showing each splice or termination. No active devices shall be connected for this test and all MTRJ connectors shall be capped. The Contractor shall investigate any discontinuities greater than those specified for the fiber in Section 1.2 (plus connector loss of 0.25 db per mated pair) and repair them or replace the cable section at no additional cost to the City. At the Contractor's option, the required traces may be delivered on CD or computer diskettes (3.5-inch, 1.44 mb). All traces must be arranged in logical directories with a printed list of directories and filenames referenced to the fiber location provided. The Contractor shall provide (at no additional compensation) licensed software compatible with Microsoft DOS or Windows (latest versions) to allow viewing and printing of the traces.

I. 10/100 ETHERNET SWITCH:

1. All network switches must support TACACS+ and RADIUS. All Ethernet network switches must support RSPAN, which allows a network administrator to locally monitor a switch in a Layer 2 switch network from any other switch in the same network. A 10/100/1000Mbps Ethernet switch is an active electronics device used for connecting devices to the Gigabit Ethernet backbone. The 10/100/1000 Mbps Ethernet switch must Internet Group Management Protocol (IGMP) version 3 in hardware. Cisco IE 3000-8TC satisfies these requirements
2. All switches must be detectable via CDP (Cisco Discovery Protocol) to be compliant with EST network management and network discovery tools. Cisco switch model IE 3000-8TC satisfies these requirements.
3. IE-3000 network switches are capable of being upgraded from Layer 2 switches to Layer 3 adding all IETF routing protocols. This can be done in the field or remotely.
4. All network switches must be easily setup and managed using the Cisco Device Manager Web interface and supporting tools, including Cisco Network Assistant and CiscoWorks (Cisco Prime).
5. All network switches must be easily replaced and configurable using removable memory, allowing the user to replace a switch without having to reconfigure manually.
6. All IE-3000 network switches must conform to Cisco's Resilient Ethernet Protocol (REP) provides network redundancy of up to 200 nodes at a convergence speed of 50ms or less.

7. All network switches must be capable of MAC address notification allows administrators to be notified of users added to or removed from the network.
8. All connections for the 10/100/1000Mbps Ethernet switch shall be as indicated in the Fiber Drawings in the Plans. For each intersection, the 10/100 Base-T output port of the controller shall be connected to one of the six 10/100 Base-T ports of the 10/100/1000Mbps Ethernet switch located in the controller cabinet. The first 100 Base-FX Ethernet port of the 10/100Mbps Ethernet switch at each intersection on that branch shall be connected to a pair of single-mode fiber strands. These strands shall be connected to one of the two 100 Base-FX Ethernet ports of the 10/100 Mbps Ethernet switch at the next intersection on that same branch. At the intersection that is closest to the TOC on that branch, the second 100 Base-FX Ethernet port of the 10/100 Mbps Ethernet switch shall be connected to one of the six 100 Base-FX Ethernet ports of the Gigabit Ethernet at the TOC. The second 100 Base-FX Ethernet port of the 10/100 Mbps Ethernet switch at the last intersection on that branch shall be connected to a pair of single-mode fiber strands. The fiber cable shall be connected as shown in the fiber drawings in the Plans.
9. The switch shall be provided to the City at least one week prior to installation for programming.

J. TRAINING: The Contractor shall, as a minimum, provide training on the 10/100/**1000** Mbps Ethernet switch. The Contractor shall address the theory of operation and the technical and practical aspects of each component. Specific and thorough attention should be given to day-to-day operation, programming, testing, fault-diagnosis and repair of each component. Training related to specific hardware components shall include hands-on demonstrations utilizing sample components identical to those components installed in the field. Training on the proper use of specific tools utilized during installation, testing and maintenance of various system components shall be addressed.
   1. The subject shall include all pertinent information required for the operation and maintenance of the 10/100/1000 Mbps Ethernet Switch, and shall include a minimum of six hours of instruction. This information shall include basic operation of the switch; configuration, and interconnection with other cabinet hardware. The switch configuration software shall also be covered. It shall also include the various diagnostic/troubleshooting tools available to the user. The Contractor shall include basic removal, inspection, disassembly and reinstallation techniques for maintenance of the switch. The Contractor shall discuss and provide what is considered usual and customary scheduled maintenance procedures for the Ethernet network. The Contractor shall expect that class attendees shall have familiarity with the use of computer network equipment but no other specific experience or knowledge regarding this subject.

K. GIGABIT ETHERNET SWITCHES:
   1. Unless otherwise determined, all fiber connectivity will be aggregated at city hall or other city facility as designated. Aggregation switches in the field will only be installed in environmentally controlled cabinets. Cabinet installed AG switches must be 19" rack mountable, capable of full “IP Services” (Layer 3, OSPF, RIP, BGP, EIGRP, IS-IS, etc.) and work homogenously in the City of Lenexa’s accepted network standard. All AG switches shall be a WS-C3750X-12S-E or WS-C3750X-24S-E for 12 or 24 SFP ports; plus options for: Network Modules with Four GbE, Two 10GbE SFP+ Interfaces, Two 10GB-T and Service Module

with Two 10GbE SFP+ Interfaces. All GbE SFP ports must be capable of SM, MM, or copper based gigabit Ethernet transceivers.

L. CCTV CAMERA ASSEMBLY:

1. This specification establishes the requirements for the Closed Circuit Video Assembly. This equipment consists of cameras with remotely controlled pan-tilt-zoom (PTZ), and the ability to acquire video images of the various sections of the roadway in the City of Lenexa. The camera, camera enclosure, PTZ control, housing unit, mounting bracket, etc. shall be an integral unit manufactured and/or supplied by a single manufacturer.
2. The Contractor shall provide the latest technology outdoor dome cameras that provide color rendition during bright ambient lighting conditions and revert to monochrome under low light conditions. The minimum illumination shall be 0.04 lux in the B/W mode. The cameras shall have a zoom lens of 20x optical with a focal length from 4.7 to 94mm, with 12x digital resulting in total zoom of 240x. The cameras shall be capable of high resolution 1080p 1920x1080 with up to 30 frames per second. Video encoding shall be H.264 format and encoding and PTZ control shall be compatible with Omnicast video display system. Operating temperature range shall be -40° C to +50° C. The PTZ control shall be capable full rotating 360° with of speed up to 450° per second enabling setting to different viewing positions very quickly. Communication and power to the camera shall be through PoE or High PoE using Rj-45 connectors. A mid span box will be required in the cabinet which will plug into 120V outlet and inject the power to the camera and connect to the switch. The switch will not provide the PoE. The camera enclosure shall be aluminum metal casing with an acrylic clear dome rated NEMA 4x or better. The mounting bracket shall be for pole mount unless otherwise specified in the plans. All external housing elements shall be painted white in color unless indicated on the plans. Axis Q6035-E model camera meets these requirements.

M. SURGE SUPPRESSION: The Contractor shall provide surge suppression on all conductors entering the camera enclosures and equipment cabinets. The video suppressors shall meet or exceed the following specifications:

Maximum Operation Voltage:	7.5 Volts DC
Maximum Leakage Current:	<5µ amps
Maximum Insertion Loss:	<1 dB
Weatherproof:	Yes
Connectors:	BNC Female/Female BNC Female/BNC Male
Specifications – Electronic:	
Maximum Surge Current (8 x 20us):	500 Amps
Maximum Surge Voltage (1.2 x 50us):	6,000 Volts
Capacitance:	< 1.20pf
Clamping Voltage:	7.5 Volts
Clamping Response Time:	<5 Nanoseconds
Current:	Non-load Bearing Voltage Sensitive
Pass Voltage-ANSI/IEEE B3 Ring-wave:	<15 Volts Peak
Power Dissipation (8 x 20µs):	3,000,000 VA

1. The Contractor shall provide surge suppression on all conductors entering the cabinet. Video and data surge suppression shall utilize hybrid technology, employing an evacuated gas discharge tube and a silicon avalanche diode. Power conductor surge suppressors shall utilize the gas discharge tube and metal oxide varistors. Individual surge suppressor elements shall be isolated from each other with inductors. Resettable fuses shall be installed in series with all low-voltage surge suppressors.

N. ELECTRICAL SERVICE: Electrical service shall be provided to each camera via the composite cable from the electrical service present in the controller or distribution cabinet. All connections and components shall comply with all applicable NEC requirements.

O. VIDEO ENCODER:
1. This specification establishes the requirements for the video encoders. The Contractor shall provide an encoder in a local cabinet for each analog camera assembly installed (not required for the PTZ camera). The encoders shall be H.264 compliant and provide near real-time video at 4CIF greater than 25 frames per second. These units digitize and compress the NTSC video for transmission via the fiber optic Ethernet network.
The video encoder shall be a SmartSight 1700e model number S1970e-T-TX-12VDC manufactured by Verint or Bosch VIP-X1XF. These encoders are compatible with the city's decoding/viewing system nDVR Omnicast by Genetec. The contractor will not need to provide any decoding equipment.
2. Power supplies for any equipment in the cabinet shall be included. Power supplies shall be capable of continuously providing 150 percent of the required power of the equipment at the required voltage tolerance as specified by the manufacturer of the equipment being powered. Units requiring the same DC voltage may be powered by a common power supply provided that the power supply meets or exceeds the 150 percent of the cumulative requirements of all connected equipment. For the equipment sharing a common power supply, an in-line cartridge type of fuse rated at the manufacturer's specification shall be provided in the supply line to each piece of equipment. Thus, if the equipment sharing the common power supply shorts, the in-line fuse shall blow and protect the common power supply.
3. Power supplies shall be rated for operation at the environmental conditions specified for other equipment in the cabinet.
4. If there are different DC voltage requirements for different equipment, multiple DC power supplies shall be used. Power supplies shall be permanently wired into the cabinet's 110 VAC system. No plug-in power supplies are allowed.
5. For each camera, a video encoder shall be required at a local cabinet. The 10/100BaseT output port of the encoder shall be connected to the input port of a 10/100BaseT Ethernet switch in the controller cabinet.

P. TRAINING:
1. The Contractor shall, as a minimum, provide training on the subjects listed below for the CCTV camera assembly. The Contractor shall address the theory of operation and the technical and practical aspects of each component. Specific and thorough attention should be given to day-to-day operation, programming,

testing, fault-diagnosis and repair of each component. Training related to specific hardware components shall include hands-on demonstrations utilizing sample components identical to those components installed in the field. Training on the proper use of specific tools utilized during installation, testing and maintenance of various system components shall be addressed.

2. The subject shall include all pertinent information required for the operation and maintenance of the CCTV camera equipment, and shall include a minimum of 12 hours of instruction. This information shall include basic operation of the camera; PTZ mechanism; and Ethernet encoder. The camera control software shall also be covered. It shall also include the various diagnostic/troubleshooting tools available to the camera user. The Contractor shall include basic removal, inspection, disassembly and reinstallation techniques for maintenance of the camera. The Contractor shall discuss and provide what is considered usual and customary scheduled maintenance procedures for the camera system. The Contractor shall expect that class attendees shall have familiarity with the use of CCTV equipment but no other specific experience or knowledge regarding this subject.

Q. TESTING:

1. Each camera assembly furnished and installed by the Contractor shall be tested as defined in this section of this specification. The tests shall be conducted at the local cabinets and at the TOC.
2. Local Control Tests: These tests shall be conducted on each camera at the local cabinet where the camera's local control capability is installed. The following shall be tested at these locations:

    - Demonstration that the pan/tilt speed, presets and extent of movement meet requirements.
    - Observing the camera output on a computer while exercising the pan, tilt, zoom, focus, iris and power on/off functions.
    - Measuring the video signal level at the MPEG-4 encoder input with a waveform/vector scope to demonstrate that the camera video output meets NTSC Standards.
    - TOC: Each camera shall be tested at the TOC to demonstrate that the pan/tilt speed, presets and extent of movement meet all requirements. Each camera shall be tested at the TOC to demonstrate that the picture provided meets all requirements.

R. FIBER OPTIC DISTRIBUTION CABINET:

1. Distribution cabinets shall be weatherproof aluminum enclosures and shall meet the requirements of CALTRANS Type 332, or 332D Cabinet Specifications as indicated in the plans. Distribution cabinets shall be installed at the locations called out in the Plans. The Contractor shall submit design/drawing details of the distribution cabinet wiring and hardware to be furnished for the cabinets to the Engineer for approval prior to installation. The cabinet shall have a main door which shall be equipped with a keyed lock. The lock and key shall be Corbin #2, the same type as supplied with the controller cabinets. One key shall be furnished for each lock supplied. The cabinet door shall be provided with a mechanical stop to limit the extent of the door opening. The stop shall be provided with a catch, which can be operated when the door reaches the 90- and

180-degree positions and shall hold the door at these positions securely until released.

S. INSTALLATION:

1. The cabinet shall be mounted on a concrete foundation constructed of poured-in-place KCMMB 4K concrete. Conduit stubs for cable entry and exit shall be placed in position and plugged prior to pouring the foundation. The cabinet shall be secured to the foundation by means of angle brackets and anchor bolts imbedded in the concrete after all cables which enter the cabinet have been installed in their conduits.
2. All conduit entrances shall be secured with duct seal after cable installation to exclude moisture. A caulking compound shall be placed between the cabinet and concrete slab foundation to prevent dust, dirt and water from entering the cabinet. Concrete bollards shall be installed around the cabinet if there are any concerns about the susceptibility to knock down.
3. The location of each distribution cabinet shall be reviewed and approved by the Engineer to ensure that it shall be mounted in an area which will reduce its susceptibility to knock-down damage.
4. All cable entrances shall be through conduit in the bottom of the cabinet, through the concrete foundation except where approved by the Engineer. Entrances to cabinets shall be via wide sweep conduit bends.
5. Cable wiring within the cabinets shall be neatly arranged, clamped and laced in raceways. Raceways and cable clamps must be mechanically secured to the cabinet. Stick-on clamps shall not be used. Conduit mounted strain relief must be provided for the cables entering the cabinet to secure the cable from pull down stress in the conduits.
6. The cable terminations shall meet the specifications defined in this specification. Sufficient positions shall be provided to individually accommodate all incoming and outgoing fibers. All fiber optic patch panels shall be clearly labeled per column and row. Each cable shall have permanent tags identifying the cable number and direction (north/south/east/westbound) and active and spare data pairs.
7. A ground bus shall be provided in each cabinet. It shall be connected to the approved grounding rod in the cabinet.
8. The Contractor shall equip each cabinet with a rack-mounted power strip. The Contractor shall also equip each cabinet with a combined power supply and power distribution assembly (PDA#2) that is consistent with City of Lenexa specifications.
9. If specified on the plans for an environmentally controlled distribution cabinet, the Contractor shall provide an air conditioner in the distribution cabinet that is appropriately sized for the equipment that will be installed in it. The Contractor shall coordinate with the Traffic Department, the IT department and the Police Department to determine these loads prior to installation. The air conditioner shall be of the bypass type and shall re-circulate the cabinet air while cooling it. The unit shall be fitted so that air movement shall circulate from the top of the unit and return through a plenum from the bottom of the unit. The enclosure shall be environmentally sealed and insulated to prevent the mixing of outside air with the inside air of the enclosure. The enclosure temperature shall be regulated by a temperature control module that turns the cooling on at 26ºC ±2ºC and off at 18ºC ± 2ºC.

T. FIBER OPTIC CONDUIT:

1. The conduit shall be orange in color. Unless otherwise specified, all signal interconnect cable shall be installed in smooth, continuous, pre-lubricated 2” conduit as shown in the plans and as approved by the Engineer.
2. Tracing wire shall be installed on the inside of all empty conduits or conduits with only fiber optic cable to facilitate the locating of buried cable. The wire shall be either a No. 10 AWG stranded copper Type USE or THWN cable or a No. 12 AWG Copperhead cable. The trace wire shall be installed without splices. At each service or junction box, the trace wire shall be connected to a light duty Snake Pit device with an orange cap. Connection between the Snake Pit and the box shall be made with a 1-1/2” or 2” conduit sweep.
3. Underground warning tape shall be installed in all trenches where conduit is installed. The warning tape shall be installed approximately 12 inches above the conduit. The tape shall be 4” wide polyethylene material, at least 0.004 inches thick. The tape shall be orange with black letters that say "Caution - Buried Fiber Optic Cable". The message shall be repeated continuously along the length of the tape. Other legends may be tendered for approval.
4. The conduit shall be installed in a 36” deep trench with a 24”to 30” cover. The trace wire shall be installed inside the conduit. Consecutive six-inch layers of approved backfill soil or backfill material (free of any rocks or debris) shall be compacted in the trench in accordance with the Specifications. A 4-inch wide underground warning tape shall be laid in the trench, in a continuous run from one service box to the next, approximately 12 to 18 inches above the conduit. Service and/or junction boxes shall be spaced at approximately 500 feet apart.

U. FIBER OPTIC SERVICE BOXES:

802.23.1. Fiber optic service boxes shall be fiberglass reinforced polymer concrete boxes of the size and shape as shown on the Standard Detail sheet in the accompanying plans. Service box material shall be an aggregate consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material must have the following mechanical properties:

- Compressive Strength – 20,000 psi (137,895 KPa)
- Tensile Strength – 1,700 psi (11,722 KPa)
- Flexural Strength – 7,500 psi (51,713 KPa)

V. SUBMITTALS AND PRELIMINARY ITEMS:

1. Before commencing work, a complete schedule of materials and equipment proposed for installation shall be submitted to the Engineer for approval. This schedule shall include catalog cuts, diagrams, drawings, and other such descriptive data that may be required by the Engineer. All submittals shall include the manufacturer brand name and part number where applicable.
2. Where more than one item is present on a submittal sheet, the appropriate item or items shall be circled, not highlighted. All submittals shall be organized as much as practical in order with the summary of quantities sheet in the plans. Two (2) copies of each submittal shall be supplied, with one copy of each submittal included in a submittal package (2 packages total). In the event that any materials or equipment contained in the schedule fail to comply with specification requirements, are not circled, or submittals are not packaged, such items may be

rejected. New submittals on rejected items shall be supplied to the Engineer for approval.

3. When it is required by these specifications that a test be made of the material to be used on the project, the Contractor shall furnish the Engineer with a certified copy of such test prior to the installation of such material. When any reference is made in these specifications to any specification such as ASTM, IPCEA, AIEE, etc., or a related specification referred to by reference therein, or revision thereof which states that a certain test, or tests are to be made only at the request of the purchaser, it shall be considered that the Engineer does request such test or tests to be made at the Contractor's expense and two (2) certified copies of same be furnished as above mentioned.

W. METHOD OF MEASUREMENT: Individual items shall be measured as follows:

- Conduit – per horizontal lineal foot installed. Backfilling and surface restoration shall be subsidiary to conduit installation.
- Service box – per each installed
- Fiber optic cable – per lineal foot installed
- Underground splice enclosure – per each installed
- Fiber optic fusion splices – per each splice. Unused fibers in the bundle shall be left intact.
- Gator patch – per each installed
- Fiber optic distribution cabinet – per each installed which shall include concrete base and all internal equipment as described in the specifications.
- CCTV camera – per each installed for complete installation including mounting brackets, cable, video encoder and cabinet
- Ethernet switch – per each installed by type

The completion of these items shall provide a complete system. Minor items including cables, connectors, etc. shall be subsidiary to the items above.

X. BASIS OF PAYMENT: The amount of completed and accepted work measured as stated above shall be paid for at the contract price bid for each item which price shall be full compensation for furnishing all materials, labor, equipment, tools and incidentals necessary to complete the work.

S-803 PERMANENT SIGNING: All signs shall conform to the requirements of the current editions of the Manual on Uniform Traffic Control Devices (MUTCD), and Standard Highway Signs by U.S. Department of Transportation, Federal Highway Administration. A complete list of pre-approved sign materials is available at the office of the City Engineer or can be found on the City of Lenexa's internet website at ***www.lenexa.com***.

A. MATERIALS AND EQUIPMENT: Sign blanks shall be aluminum and shall conform to ASTM B 209. The aluminum material shall be one of the following alloys: 6061-T6, 6063-T6, 5154-H38 or 5052-H38. Sign material thickness shall be 0.125" for signs larger than 30" x 30". Signs 30" x 30" and smaller shall be 0.080" thick. Guide sign blanks shall be 0.125" thick.
   1. All signs shall be fully reflectorized with high intensity prismatic sheeting or better. Screen-printed signs are not acceptable and shall not be used. Signs containing black lettering and/or symbols shall no longer be made of black vinyl. Instead, signs containing black, blue, red or green lettering and/or symbols shall be made with EC Film. All sign hardware shall be galvanized or zinc. Sign banding shall be 3/4" stainless steel. If the sign is mounted to a black or a brown pole, the sign banding shall be stainless steel and both the banding and the back of the sign shall be powdercoat-painted, as per manufacturer specifications, to match the color of the pole. Sign and post hardware shall be subsidiary to the Permanent Signing bid item.
   2. With the exception of the advance street name signs, all sign posts shall be 2" square galvanized steel with 3/8" diameter holes at 1" spacing's on all sides. All 2" posts shall include one 2.25" square by 36" long steel anchor and one 2.5" square by 18" long steel sleeve and special bolt and nut combination to allow 90° installation. Anchors for stop sign assemblies that will include street name signs including Stop, Yield or street name signs by themselves will be 2.25" square by 48" long. Sign posts for advance street name signs shall be 2.5" and shall be manufactured by Xcessories brand sign posts, or approved equal. All post components when assembled shall form an approved breakaway system. All components shall be galvanized. See pre-approved list of materials for more information.
   3. Sign posts for STOP signs shall be 12 feet long. STOP signs shall be mounted such that the top of the sign is placed 25 inches below the top of the sign post with a minimum of 7' from the bottom of the sign to the ground line. This extra extension above the STOP sign will be used to mount the street name signs.
   4. When end of road markers are used, the signs shall be mounted to Telespar posts, not u-channel posts.
   5. When advance street name signs (i.e. Next Signal signs) are used, the signs shall be mounted to Xcessories brand sign posts, or approved equal. Refer to the City's most current pre-approved list of materials for information regarding posts mounted in the soil or posts mounted in concrete. Prior to the installation of the advance street name signs, the Contractor shall discuss the location of these signs with the Project Inspector to ensure that the signs are placed within the right-of-way and do not conflict with sidewalks and trails. If the greenspace between the back of curb and the edge of the sidewalk is not wide enough to accommodate the advance street name sign and if there is minimal right-of-way behind the sidewalk to place the sign, the advance street name sign shall then straddle the sidewalk. The sign posts shall be located at least one foot (1') from the edge of the sidewalk to the sign posts. Additionally, the bottom of the sign

shall be a minimum of 8 feet from the top of the sidewalk to the bottom of the sign. Circular or square forms shall be used to set the anchors and the concrete finished to avoid any standing water near the anchor assembly.

6. On Capital Improvement Program (CIP) projects, the Contractor shall be responsible for the fabrication and installation of street name signs, as shown on the plans. The Contractor shall submit scaled shop drawings of the proposed street name signs prior to fabrication for review and approval by the City. The shop drawings shall include details such as sign and lettering dimensions as well as type of font. On non-CIP projects (i.e. public improvement projects driven by private development), the Contractor shall purchase the street name signs from the City at a cost of $125 per street name sign. The City will then install the permanent street name signs. The contractor shall provide and install the sign posts for these City installed street name signs.
7. The Contractor shall maintain all existing signs within the project limits that are not to be disturbed and are to remain, whether they're shown on the plans or not. Any sign that is disturbed as part of the project shall be replaced with a new sign. Resetting existing signs is prohibited. At the onset of the project, the Contractor should verify and document the condition of each sign that is to remain in place. The Contractor shall be responsible for the appropriate care of all existing signs that are to remain in place throughout the duration of the project. Any signs that are damaged, lost or stolen shall be replaced by the Contractor with new signs at the Contractor's expense. Any existing street name signs that are damaged, lost or stolen shall also be replaced with new signs by the Contractor at the Contractor's expense. For non-CIP projects, the Contractor will be required to purchase the street name signs from the City at a cost of $75 each to replace a permanent street name sign.
8. Whether the road has been officially opened to traffic or not, temporary street name signs shall be installed and maintained by the Contractor prior to any type of pavement being constructed. "Any type of pavement" includes a single lift of asphaltic concrete base. Temporary street name signs shall consist of minimum 6" white lettering on green background mounted a minimum of 7 feet from the top of the nearest edge of pavement to the bottom of the sign at or near each intersection. Street name signs shall be double-sided. The minimum height of the sign shall be 12 inches and will vary in length. The sign may be made of wood, metal or plastic and shall be mounted on wood or metal posts. The street names shall match the names on the approved plat. The Contractor shall maintain these signs through the duration of the project.
9. For sign assemblies that are mounted in the medians, the Contractor shall core drill a 6" diameter hole and utilize Xcessories Squared part no. HDA200-30-G anchors, or approved equal. Anchors shall be set in concrete using a circular or square form so the finished grade of the concrete matches the grade of the median.

B. METHOD OF MEASUREMENT: “Permanent Signing” (for all signs with the exception of advance street name signs) shall be measured per each completed and accepted installation in place. For sign assemblies, signs shall be measured on a per each basis, not per sign assembly basis. Sheeting, blanks, nuts, bolts, posts, excavation and backfill, driving, labor, equipment, tools, and other items necessary to complete the installation shall be subsidiary to “Permanent Signing” and shall not be measured separately. For advance street name signs, the bid item “Advance Street Name Sign” shall be measured per each completed and accepted in place. Sheeting, blanks, nuts, bolts, posts, excavation and backfill, concrete, driving, labor, equipment, tools and other items necessary to complete the installation shall be subsidiary to “Advance Street Name Sign”.

C. BASIS OF PAYMENT: “Permanent Signing” and/or “Advance Street Name Sign” shall be paid for per each sign, measured as stated above, except in the case of a Traffic Signal Installation project wherein the signing costs will be subsidiary to the Lump Sum cost of the Traffic Signal Installation.

S-804 STREET LIGHTING: This work shall consist of furnishing all labor, materials and equipment to complete, in place, the street lighting system as shown on the plans and as specified in these Specifications. A complete list of pre-approved street lighting materials is available at the office of the City Engineer or can be found on the City of Lenexa's internet website at ***www.lenexa.com***.

All appurtenances shall be located as shown on the plans. Any deviations must be approved by the Engineer. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA). In addition to the requirements of these Specifications and the plans, all material and work shall conform to the requirements of the National Electrical Code and local ordinances. No new fixture shall be constructed as part of this contract which is in conflict with any existing utility's facility or the code required thereby, unless approved by the Engineer.

A. MATERIAL SPECIFICATIONS: All materials used in the fabrication or assembly of the items listed below shall comply with the applicable parts of these Specifications with the additions stated herein. All lighting equipment shall be new and of the best grade and shall be approved by the Engineer.
   1. The aluminum light standard including anchorage with luminaire properly installed shall be in accordance with the 2013 American Association of Highway and Transportation Officials (AASHTO) for 90 MPH wind and a luminaire size of 1.3 sq. ft. min. effective projected area weighing 55 lb min. The Light Standard shaft shall be spun from one piece of seamless tubing, Aluminum Association Alloy 6063; and after fabrication, it shall have mechanical strength of not less than T6 temper. The cross section of the shaft shall be round and shall be fabricated in a continuous true taper. The shaft shall have no longitudinal or circumferential welds, except at the lower end joining the shaft to the base.
   2. Aluminum light standards shall meet the following dimensions:

Pole Designation	Mounting Height	Base O.D.	Top O.D.	Min. Wall Thickness	Shaft Length	Bolt Circle
14*	14	6"	3.0"	0.156"	14'-0"	9.50"
20	20	6"	4.5"	0.188"	19'-8"	9.50"
30-A-6	30	7"	4.5"	0.188"	27'-6"	11.00"
30-A-8	30	7"	4.5"	0.188"	27'-6"	11.00"
30-A-10	30	8"	6.0"	0.188"	26'-8"	11.00"
30-A-8-8	30	8"	4.5"	0.188"	27'-6"	11.00"
30-A-10-10	30	8"	6.0"	0.219"	26'-8"	11.00"
40-A-6	40	8"	4.5"	0.219"	37'-6"	11.00"
40-A-8	40	8"	4.5"	0.219"	37'-6"	11.00"
40-A-10	40	8"	6.0"	0.219"	36'-8"	11.00"
40-B-12	40	8"	6.0"	0.219"	36'-8"	11.00"
40-B-15	40	8"	6.0"	0.219"	36'-8"	11.00"
40-B-8-12	40	10"	6.0"	0.219"	36'-8"	14.50"
40-B-12-12	40	10"	6.0"	0.219"	36'-8"	14.50"
40-B-15-15	40	10"	6.0"	0.219"	36'-8"	14.50"

***Use of this pole requires special approval by the Engineer.**

3. An opening shall be furnished near the top of the shaft to provide a cable entrance from the shaft into the bracket arm. Bracket arms shall be securely fastened to the shafts with stainless steel bolts and rivnuts. The top of the shaft shall be equipped with a cast aluminum removable shaft top held securely in place by means of set screws. Lighting standard shafts shall have a minimum 4" x 6" hand hole with frame and cover and a grounding lug opposite the hand hole. Standards shall have internally-mounted vibration dampers. The manufacturer, supplier and Contractor shall guarantee that the shafts and arms provided on this project shall remain without defect for a period of five (5) years.
4. The 20-foot round, tapered shaft and davit shall be made from a round seamless tube of aluminum alloy 6063-T6, free from longitudinal welds and with a duranodic (anodized dark bronze) finish. All aluminum parts and accessories for the 20-foot pole shall also receive the duranodic finish.
5. The aluminum breakaway anchor base shall be fabricated from extrusions of aluminum alloy 6061-T6. The fabricated extrusions will act as an anchor base meeting structural requirements and breakaway criteria specified in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals and shall be approved by the FHWA as meeting the change in velocity and stub height breakaway requirements adopted by AASHTO and the FHWA. The breakaway base shall be as indicated in the Standard Details. The hand hole cover will be secured to the pole shaft by means of a keeper chain. A grounding lug capable of accommodating up to a No. 2 AWG ground wire shall be provided on the inside of the shaft adjacent and accessible to the hand hole.
6. Single member-type mast arms shall consist of a tapered aluminum arm, elliptical in shape at the shaft end and tapering to 2-3/8" O.D. at the luminaire end, made of Aluminum Association Alloy 6063-T6 tubing.
7. Truss-type mast arms shall consist of an upper and lower member securely joined by means of vertical struts. The lower member shall be 2-inch IPS aluminum pipe, Aluminum Association Alloy 6060-T6. The upper member shall be tapered aluminum, elliptical in shape at the pole end and tapering to 2-3/8" O.D. at the luminaire end.
8. All hardware (bolts, nuts, washers, but not including anchor bolts) not otherwise specifically designated in these specifications shall be stainless steel. Handhold covers shall be attached with stainless steel hex head screws. Hand hole covers shall not be threaded. All materials not otherwise specifically designated in these specifications or on the plans shall be furnished in natural aluminum color. The shaft shall be furnished with a polished surface. The shaft shall have a factory applied protective paper wrapper conforming to the manufacturer's standard practice and shall be removed after delivery.
9. The 14-foot round, tapered shaft and davit shall be made from a round seamless tube of aluminum alloy 6063-T6, free from longitudinal welds and with a ground satin surface finish. Lighting standards shall have an oval hand hole (minimum size 4" x 6") and a grounding lug facing hand hole opening. The 14-foot round, tapered shaft shall have a 3-inch O.D. slip-fitter end and a 6-inch O.D. shaft base dimension with 0.156-inch wall thickness. The four-bolt shoe base for the attachment of the lighting standard to the concrete foundation or to the screw-in base shall be made of a casting in aluminum alloy 356.0 T6. The shoe base casting shall be fastened to the shaft of the lighting standard by means of two circumferential fillet welds, one externally at the top of the shoe base and the other internally at the bottom of the shaft tube. The shoe base flange shall have

four oval holes for anchorage. Four removable bolts shall be provided when the screw-in base is used and shall be 1" x 3" steel bolts with one nut each and two flat washers all galvanized to ASTM-153 standards. Four bolts, four nuts and eight washers shall be provided with each pole.

10. Screw-in foundations may be used, as shown on the plans, except when installed in the sidewalk or within 18 inches from the center of the pole to the edge of the sidewalk, and the KCMMB mix design shall be used for these foundations. In those cases, concrete foundations shall be used. If screw-in foundations cannot be used for any reason, concrete foundations shall be installed at the Contractor's expense. The foundations shall be of the size and type required in the details based on the pole mounting height. The anchors shall be screwed into the ground. Pre-drilling of holes for the anchor is prohibited, unless otherwise approved by the Engineer. The foundation shall be screwed straight into the ground and the baseplate shall be level. Minor leveling adjustments may be made with the use of leveling shims or washers. Shims and washers shall be galvanized or cadmium-plated steel no more than 0.25" thick. Only one shim or washer will be allowed at any one anchor bolt with a maximum of two on any pole.
11. For all new street light pole base installations, the conduit shall extend 2 inches above the top of the handhole opening – approximately 24 inches on poles without breakaway bases and 33 inches on all poles with breakaway bases. The 3 lug connectors should be made up and installed before the pole is installed on the base. The 3 lug connectors shall be placed above the top of the handhole with the No. 14 AWG pole and bracket cable installed and shall extend down the pole to be connected in the handhole opening. All street light poles requiring a breakaway base shall have the City of Lenexa approved anti-theft device installed between the pole and the breakaway base.
12. Cobrahead-style luminaires shall be LED and shall be classified as Type A, B, C, D, E, F or Z as per the City's design criteria and plan requirements document. The luminaires shall have a housing of single piece aluminum alloy casting with integral slip fitter for a 2-inch bracket mounting. The mounting device shall allow the luminaire to be mounted absolutely level and shall have no more than four (4) fasteners serving both the leveling and clamping functions. It shall allow one man to install the luminaire by simultaneously holding it in position and tightening the fasteners such that the luminaire will be properly level at the first attempt. The housing finish for the Types A, B, C, D, E and Z luminaires shall be natural/silver, unless otherwise directed by the City. The housing finish for the Type F luminaire shall typically be finished with Bronze Integral Color, Aluminum Association Class I Anodizing (Duranodic or Kalcolor) and shall be mounted to the 20' pole with a tenon mounting arm. However, there are instances when the Type F luminaire will be approved by the City for installation on a natural aluminum light pole. In those instances, the Type F luminaire shall include a natural/silver housing finish. With the exception of the Type F luminaire, all luminaires shall have a correlated color temperature (CCT) of 4000K with a minimum color rendering index (CRI) of 70. Type F luminaires shall have a CCT of 3000K with a minimum CRI of 70. The driver shall be multi-volt capable of operating between 120V and 277V and rated for greater than 100,000 hours at 25 degrees C. The driver shall be capable of providing less than 1000mA to the LED chips and shall be dimmable. The fixture shall have a built-in surge protection device (SPD) rated 10kV/5kA. The SPD shall have a fuse that

protects the fixture by disconnecting the luminaire from the power at the end of life. The fixture shall have an ANSI 7 pin photocell receptacle. The distribution shall be a roadway Type II. A label with an approximate size of 3”X3” shall be affixed to the underside of the luminaire housing to clearly indicate the type designation as described above. The fixture shall carry a 10-year warranty. The Contractor shall refer to the City’s most current list of approved products for luminaire manufacturer information.

13. The post-top luminaire housing shall be constructed of cast aluminum and painted black. Post-top luminaires shall be LED and shall carry a 10-year warranty. The fixture shall have an ANSI 7 pin photocell receptacle. The color temperature (CCT) shall be 3000K with a minimum CRI of 70. The Contractor shall refer to the City’s most current list of approved products for luminaire manufacturer information.
14. A luminaire smart control node shall be installed on each luminaire. The node shall be attached and connected via the 7 pin photocell receptacle.
15. Distribution cable shall be stranded annealed copper, single conductor cable for operation at 600 volts maximum and shall be the AWG size as listed on the plans. Cable shall be color-coded black/red/white. Material shall meet the applicable requirements of IPCEA Standard S-19-81, with thermoplastic insulation of GRS-Rubber base meeting Appendix K (A) of IPCEA and listed by UL as Type USE for direct burial; or material shall meet the applicable requirements of IPCEA Standard S-66-524, interim standard No. 2 with thermo setting insulation of cross link polyethylene meeting requirements of Column "A" of IPCEA and listed by UL as Type USE RHW-75° C.
16. Pole and bracket cable above hand hole in pole to luminaire(s) shall be No. 14 AWG 2-conductor stranded copper conforming to IMSA Specification 19-1.
17. Tracing wire shall be installed on the inside of all empty conduits or conduits with only fiber optic cable to facilitate the locating of buried cable. The wire shall be either a No. 10 AWG stranded copper Type USE or THWN cable or a No. 12 AWG Copperhead cable. The trace wire shall be installed without splices. At each service or junction box, the trace wire shall be connected to a light duty Snake Pit device with an orange cap. Connection between the Snake Pit and the box shall be made with a 1-1/2” or 2” conduit sweep.
18. The feed point pedestal/control center shall be an underground service type, rated for 100 amps, 240 volts. The pedestal shall be a brushed aluminum rain tight construction with individual meter, panel, contractor, and rear service pull "compartments". Meter and panel compartments shall have piano-hinged doors. The cabinet shall be supplied with CORBIN #2 locks. Meter base shall be of the type used by the local utility. Panel board shall have copper buss and shall accept 12 one-inch plug-in breakers manufactured by GE, Westinghouse, or ITE. The panel board compartment shall contain a photocell and a test switch. All factory-installed wire shall be copper. One 3” conduit shall be installed from the feed point pedestal to a Type II junction box that is installed adjacent to the cabinet. All distribution cable for each of the lighting circuits shall be routed through this conduit to the junction box.
19. In cases where a proposed secondary service point requires the installation of a new transformer by Evergy, the contractor shall pour the concrete transformer pad prior to Evergy’s installation of the transformer. Additionally, the contractor shall also be responsible for the installation of service cable and conduit from the secondary service point to the street lighting control center. The work and

materials associated with the service cable from the secondary service point to the control center shall be subsidiary to the control center bid item.

20. Conduit shall be as specified in the section of these technical specifications entitled “Conduit”.
21. Fuses shall be breaker-type.

B. SUBMITTALS: Before commencing work, a complete schedule of materials and equipment proposed for installation shall be submitted to the Engineer for approval. This schedule shall include catalog cuts, diagrams, drawings, and other such descriptive data that may be required by the Engineer.
   1. All submittals shall include the manufacturer brand name and part number where applicable. Where more than one item is present on a submittal sheet, the appropriate item or items shall be circled, not highlighted. All submittals shall be organized as much as practical in order with the summary of quantities sheet in the plans. An electronic copy in PDF format of each submittal shall be supplied. In the event that any materials or equipment contained in the schedule fail to comply with specification requirements, are not circled, or submittals are not packaged, such items may be rejected. New submittals on rejected items shall be supplied to the Engineer for review.
   2. When it is required by these specifications that a test be made of the material to be used on the project, the Contractor shall furnish the Engineer a certified copy of such test prior to the installation of such material. When any reference is made in these specifications to any specification such as ASTM, IPCEA, AIEE, etc., or a related specification referred to by reference therein, or revision thereof which states that a certain test, or tests are to be made only at the request of the purchaser, it shall be considered that the Engineer does request such test or tests to be made at the Contractor's expense and one certified copy of same be furnished as above mentioned.

C. CONSTRUCTION REQUIREMENTS: Street lighting shall be constructed according to the plans, the Standard Details and these Specifications.
   1. Conduit shall be as shown in the plans and shall conform to the section of this specification titled “Conduit”. Each lighting circuit shall be contained in a separate conduit, except between the controller and the adjacent junction box. Lighting systems that contain more than one circuit per conduit will not be accepted.
   2. All concrete bases that are to be removed shall be broken up and removed to a depth of twenty-four (24) inches below grade. Screw-in foundations shall be removed entirely. Holes resulting from these operations shall be filled to the proper grade with suitable material approved by the Engineer.
   3. Junction boxes shall be installed at the locations shown on the plans. However, boxes shall not be located in sidewalks and driveways. In the unlikely event that a box is placed in a sidewalk or a driveway, a traffic-rated box shall be used. See the pre-approved list of materials for approved traffic-rated boxes. A junction box shall also be installed at each end of a conduit run that crosses the road. The Contractor may install, at his own expense, additional boxes as may be desired to facilitate the work upon approval of the Engineer. Junction boxes shall be installed on 12 inches of crushed rock as shown on the plans or as directed by the Engineer. Unless otherwise directed by the Engineer, boxes shall be installed level to 1 inch above the finish grade.

4. The roadway lighting distribution system shall consist of street lighting cable in conduit, wired and installed as a 240-volt system where indicated and as required. Wiring shall conform to the appropriate articles of the National Electrical Code. No splices of cable will be permitted in conduit.
5. The Contractor shall attempt to install conduit at a constant offset from the back of curb or edge of pavement, preferably at the same distance as the pole setback unless a common trench is being used. Powdered soapstone, talc or other approved lubricants shall be used when inserting conductors in conduit. All cable to be installed in conduit shall be pulled by the Contractor in one operation, and all ends shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached. The ends of spare conductors shall be taped.
6. Splices may be made with approval by the Engineer. All splices in junction boxes shall be made with set screw connectors enclosed in a reusable gel-filled waterproof kit. One foot of slack shall be left at all control centers and junction boxes for splicing and connecting wires. Wiring within boxes shall be neatly arranged and laced up. Wires shall be color-coded (black = hot; white = ground) and circuits permanently identified in accordance with the designation used on the plans. All circuit cables in boxes and poles shall be identified with color-coded tape as follows:

   From controller: Tape color code RED
   Into Light Pole: Tape color code RED
   Out of Light Pole: Tape color code BLUE
   Ground Cable: Tape color code WHITE

   When cable is numbered, the cable with the highest number shall be the ground cable.
7. All splices in light pole bases shall be made with multiple tap connectors. All leads shall be covered with a plastic boot or an enclosed connector. The Contractor shall install breaker-type fuses in each pole. Fuses shall be 8-amp high interrupting fuses. The multiple tap connectors and fuse holders shall be installed convenient to the hand hole at the base of the pole. Eighteen inches of surplus cable shall be coiled at the line side of the multiple tap connector and on the load side of the fused disconnect. One foot of surplus cable shall be coiled between the multiple tap connector and the fused disconnect.
8. All poles shall be bonded to form a continuous system. At each multiple service point, a ground electrode shall be installed. The electrode shall be a copper rod not less than one-half (½) inch in diameter and 10 feet in length, unless otherwise noted on the plans. The rod shall be driven to a depth where the top of the rod is 6 inches below the surface of the ground. The service equipment shall be bonded to the driven ground rod by a minimum No. 6 AWG copper wire enclosed in a 1-inch diameter conduit.
9. Prior to the terminations of the connections, the Contractor shall contact the Engineer for an electrical inspection of the above-ground terminations. The Contractor shall also contact the Engineer for an electrical inspection as soon as the control center(s) is (are) ready. Evergy should be notified in advance as to when the system needs to be energized. The street light control center address shall be verified with the power company prior to installation. The power company will furnish source location at this time. In addition, the Contractor may

be required to pour a transformer pad if Evergy is installing a new transformer to energize the street lighting system. The transformer pad will be included in the plans as a bid item in this situation. The Contractor shall also be required to furnish and install the 2” conduit and service cable from the meter to the secondary service point, as per Evergy requirements.

10. All street lighting system elements shall function properly as a complete system and under normal conditions for a minimum period of fifteen (15) consecutive calendar days. During this fifteen (15) day test period, the lighting operations shall be continuous and without malfunctions. Any malfunction observed or recorded shall stop the test period as of the time of the malfunction, and the test period shall start over when all components are satisfactorily operating. The Contractor shall be responsible for any repairs to the lighting system, including the replacement of burned out lamps, etc., until the project has been accepted by the City.
11. All existing salvageable equipment (i.e. light poles, luminaires, control centers), as determined by the Engineer, in excess of the requirements of this project shall be completely removed from the project, and the Contractor shall deliver same equipment to the location determined by the Engineer. The Contractor shall be responsible for any damage or loss of salvageable equipment. The Contractor shall exercise care in the removal and delivery of any existing or new equipment to be delivered to the City. All salvaged equipment shall be re-usable. All non-salvaged items of existing equipment shall become the property of the Contractor.
12. All new equipment purchased as spare parts under the requirements of this project shall be delivered new and undamaged to the City of Lenexa Municipal Services Traffic Division and stockpiled as per the instructions of the Engineer.

D. METHOD OF MEASUREMENT: The "Street Lighting" installation as indicated on the plans, complete-in-place and accepted, will be measured as follows:
   1. Poles: per each (including base, luminaire and/or tenon mounting arm, luminaire, luminaire smart control node, lamp, fuses, connectors, wire, bolts, nuts, and other appurtenances necessary for installation of the pole and functioning of the lighting fixture), installed and accepted. In addition, street light pole removal is subsidiary to the Street Light Pole bid item.
   2. Cable: measurement for 3-1 c #4 USE distribution cable should be per linear foot for the bundle of cable consisting of three wires. Cable should be measured from the center of pole, junction box or control center to the center of pole, junction box or control center. Additional cable quantities are added to account for sweeps, to provide slack and to make connections. The additional length is computed as follows: add 5' of slack at each pole; add 5' of slack at each junction or service box for each circuit contained within; add 5' of slack at each control center for each circuit contained within. Pole and bracket cable shall be subsidiary to the pole, installed and accepted.
   3. Control Center: per each, (including concrete pad, electronic/electrical components and other components required for the proper functioning of the control center, service cable from service point to control center), installed and accepted.
   4. Junction/Service Boxes: per each, installed and accepted.
   5. Street Lighting Conduit: per linear foot measured from the center of one appurtenance to the center of another appurtenance plus additional lengths for

conduit sweeps. Conduit elbows, conduit fittings or couplings shall be considered subsidiary to the conduit. Add 4' of conduit to the center to center distance between two street light poles; add 3' of conduit to the center to center distance between a street light pole and a junction box; add 2' of conduit to the center to center distance between a street light pole and a service box; add 3' of conduit to the center to center distance between a control center and a junction box; add 2' of conduit to the center to center distance between two junction boxes; add O' of conduit to the center to center distance between two service boxes; add 3' per conduit up the pole for anti-theft device, installed and accepted.

6. Transformer Pad: per each, installed and accepted.

E. BASIS OF PAYMENT: The "Street Lighting" installation measured as provided above will be paid for at the contract unit price bid for each of the measured components, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete "Street Lighting" installation and for all equipment, tools, labor and incidentals necessary to complete the work. In the case of a Traffic Signal Installation, all costs are to be subsidiary to the Lump Sum cost for the Traffic Signal Installation.

S-805 <u>TRAFFIC CONTROL</u>: This work shall consist of furnishing, erecting, moving, cleaning, replacing, maintaining and removing signs, barricades, lights and other traffic control devices as shown on the plans, the Traffic Control Plan, or as required by the Engineer or as proposed by the Contractor and approved by the Engineer. The Contractor shall provide, erect, remove, relocate, clean, replace and maintain at all times during the progress or temporary suspension of the work, suitable signs, barricades, fences or other necessary traffic control devices in accordance with details shown on the plans, the Traffic Control Plan, or as directed by the Engineer. The Contractor shall remove, store in a safe place, and reset any existing signs that are determined to be in conflict with the construction sequences, regardless of whether these signs are specifically addressed in the plans or not. If these signs are damaged, lost or stolen during their storage, the signs shall be replaced with new signs at the Contractor's expense. If any of the existing signs are determined to be no longer necessary, the signs shall be returned to the City in the same condition as when they were first removed. If these signs are lost, damaged or stolen, a new replacement shall be made and given to the City at no additional expense to the City.

The Contractor responsible for erecting, removing, relocating and maintaining the traffic control devices shall be properly trained and certified. The American Traffic Safety Services Association (ATSSA) is an approved certification program.

A. GENERAL: The traffic control requirements shown on the plans are minimum requirements only and do not attempt to address in depth the variety of situations that may occur once construction has begun. In no way do the requirements shown on the plans relieve the Contractor of his responsibility for selecting the proper traffic control devices and implementation procedures that will assure the safety of motorist, pedestrians and workers at all times. Any additional quantities of traffic control devices necessary to complete the contract or as ordered installed by the Engineer shall be considered subsidiary to the contract lump sum bid price. The Contractor may develop an alternate Traffic Control Plan to be submitted to the Engineer for approval prior to its use. The Contractor who develops the alternate traffic control plan shall be properly trained in developing traffic control plans and shall be certified.
    1. The safe and satisfactory movement of traffic through the project is of paramount importance and shall be the responsibility of the Contractor. At the onset of the project, the Contractor shall provide the Engineer with the name and telephone number of an individual who shall be available on a 24-hour basis to repair, replace, remove, relocate, clean and maintain any traffic control device required or as directed by the Engineer. The Contractor shall be responsible for maintaining all traffic control devices on an around-the-clock basis, whether or not work is actively being pursued and any deficiencies noted shall be corrected immediately.
    2. When the plans specifically provide that traffic be carried through construction, no detour will be provided for traffic during the construction of the project and the Contractor shall not route traffic on a detour without the written permission of the Engineer.
    3. The Contractor shall furnish changeable message boards for a minimum time period of seven (7) days prior to any closure or traffic disruption for all traffic approaches that are impacted when a road is being closed or when traffic is significantly impacted by construction, as directed by the Engineer. These message boards shall be installed at each point of closure. Messages displayed shall be approved by the Engineer prior to use.

4. The Contractor shall furnish all necessary posts, skids, easels and supports as may be required for proper installation of traffic control devices. The size, shape, color, and placement of all signs, barricades, mountings and devices shall comply with the details shown on the plans, and/or the Traffic Control Plan, or the current edition of the Manual on Uniform Traffic Control Devices (MUTCD). The size and layout of the message on the signs shall comply with the latest edition of Standard Highway Signs and Standard Alphabets for Highway Signs as approved by the AASHTO and the FHWA, US DOT.
5. Temporary signs used during construction for traffic control purposes, etc. shall not be mounted to existing street light and/or traffic signal poles.
6. Supports used for mounting signs or devices for temporary conditions shall be constructed to yield upon impact to minimize hazards to the motorists. Additional supports may be placed on the back side of signs in the form of bracing for resisting wind currents. Guy wires and tie-downs will not be allowed.
7. When temporary signs are removed, the Contractor shall completely remove the sign post as well. The Contractor is prohibited from cutting the sign post off and leaving a portion of the post in the ground.
8. All signs, barricades, drums and markers shall be retroreflectorized with high intensity sheeting. The message and border shall be opaque color as required for daytime use unless shown otherwise on the plans or Traffic Control Plan.
9. All detours signed by the Contractor shall utilize high intensity sheeting unless otherwise shown on the plans.
10. Traffic cones and tubular markers shall be a minimum of 28 inches in height with a broadened base and may be constructed of polyethylene or other material to withstand impact without damage to themselves or to vehicles. Orange shall be the predominant color on the cones and tubular markers. The Contractor shall keep them clean and bright for maximum target value. For nighttime use, tubular markers shall be reflectorized with high intensity sheeting and, in some instances, equipped with lighting devices for maximum visibility. High intensity sheeting shall have a smooth, sealed outer surface which will display the same approximate color day and night.
11. Retroreflectorization on tubular markers shall be placed as shown in the MUTCD.
12. Traffic cones should be used only during temporary activities where portability is advantageous and where there is adequate surveillance to see that they remain in place. Traffic cones shall not be used for nighttime operation.
13. All signs, barricades and traffic control devices shall comply with the current edition of the MUTCD and shall be approved by the Engineer prior to erection on the project. They shall be furnished by the Contractor and shall remain the property of the Contractor upon completion of the project, unless otherwise noted on the plans. No signs and/or traffic control devices are to be furnished or sold to the Contractor by the City.
14. All Type III barricades placed across a street shall be suitably distributed across the roadway and protected at night by approved yellow flashing lights unless noted otherwise on the plans or the Traffic Control Plan. The posts for the Type III barricades shall be Telespar posts and the remaining parts of the barricade shall be made of plastic (not wood). The lights shall be kept burning from sunset to sunrise. Other barricades and signs shall be protected by approved yellow steady-burn or flashing lights and drums, used singly, shall be protected by flashing lights all in accordance with the details shown on the plans or as directed by the Engineer. In cases where no details are shown, the MUTCD shall govern.

15. Type I or II barricades left in place at night shall be equipped with Type A or Type C warning lights as directed by the Engineer, unless noted otherwise on the plans or the Traffic Control Plan.
16. With regards to Type A or Type C warning lights, each brand, model and type of warning light proposed for use shall be prequalified. The manufacturer's name, type and model number shall be clearly shown on the outside of each unit used on the project. Warning lights shall be of the type or types shown on the plans and shall comply with the latest edition of the Institute of Traffic Engineers (ITE) Purchase Specification for Flashing and Steady-Burn Warning Lights for Type A – Low intensity flashing warning light and Type C – Steady-burn warning light. The warning lights shall be composed of an electric circuit system using a battery or batteries providing a manufacturer-rated voltage or greater for the circuit systems as follows:

    - Type A – 6 volt or 12 volt
    - Type C – 6 volt

17. When it is necessary for residents living along the road to use the road which is closed to through traffic, suitable means (including the use of temporary surfacing material) shall be provided for their entrance or exit, but the general traveling public shall be excluded.
18. The Contractor's responsibility for the maintenance of traffic control devices on any individual item of work included in the Contract shall extend throughout the duration of the contract unless specifically released in writing by the Engineer.
19. All signs and traffic control devices shall be moved ahead as the work progresses. Devices which are necessary only when work is actually being performed shall be removed from the road or completely covered with an opaque weatherproof material during periods when no work is in progress.
20. All appropriate permanent signs and pavement markings shall be in place prior to opening the road. When permanent signs cannot be installed immediately, temporary signs shall be installed in their place until the permanent signs can be installed. Permanent street name signs will be installed by the City at each intersection, with the exception of signalized intersections and roundabouts, and CIP projects, once the project has been completed and accepted. At signalized intersections, street name signs shall be installed on the traffic signal mast arms by the Contractor, as shown in the plans. Whether the road has been officially opened to traffic or not, temporary street name signs shall be installed and maintained by the Contractor once any type of pavement has been placed on the roadbed and the passage of vehicles is allowed. "Any type of pavement" includes a single lift of asphaltic concrete base. Temporary street name signs shall consist of minimum 6" white lettering on green background mounted a minimum of 7 feet from the top of the nearest edge of pavement to the bottom of the sign at or near each intersection. Street name signs shall be double-sided. The minimum height of the sign shall be 12 inches and will vary in length. The sign may be made of wood, metal or plastic and shall be mounted on wood or metal posts. The street names shall match the names on the approved plat. The Contractor shall maintain these signs through the duration of the project.
21. During non-working hours, all lanes of traffic in all directions shall be maintained. During non-peak traffic hours, the Contractor may, with the authorization of the Engineer, close traffic lanes necessary to facilitate construction. The Contractor

shall not perform any work that will restrict traffic in any way between the hours of 7:00 a.m. and 8:30 a.m. or 4:00 p.m. and 6:00 p.m. Monday through Friday.

22. The Engineer shall approve the final location of all traffic control devices.
23. Existing signs in conflict with the traffic control plans or the final lane configuration shall be covered or removed and either reset or stored on site for retrieval by the owner as directed by the Engineer. If the signs are damaged or lost during their storage, the signs will be replaced and set or given to the City in new condition at the Contractor's expense.
24. Existing signs necessary for traffic during construction shall be adjusted (and later reset) as necessary and as directed by the Engineer to provide proper visibility.
25. Excavation adjacent to the roadway shall be separately delineated with Type I or II barricades and protected as directed by the Engineer. Pedestrian fencing shall be installed when excavation involves sidewalk or pedestrian areas.
26. Type I or Type II barricades shall be placed end to end to close driveways.
27. Type B warning lights shall be mounted on all warning signs left in place during hours of darkness. Type A or Type C warning lights shall be erected on all drums and barricades in place during hours of darkness, in accordance with the MUTCD.
28. The Contractor shall close the appropriate lane whenever working in the street including any parking, loading or unloading of equipment or materials or any related construction. Construction equipment and materials should be stored as far from the roadways as possible.
29. For any lane closure or transition which lasts more than three (3) days, the Contractor shall provide temporary pavement markings, as directed by the Engineer, to help guide traffic.
30. The signing of the project shall conform to the details included in the plans and/or the Traffic Control Plan. The Contractor may be permitted to erect additional informative signs, provided the signs are not contrary to standard procedure. The legend "Travel at Your Own Risk" or anything similar on any sign is prohibited.
31. Construction signs as well as construction vehicles parked along streets shall not restrict sight distance for vehicles exiting any streets or driveways. Reasonable access to and egress from property adjacent to the project shall be maintained at all times throughout the duration of the project.
32. Two-way traffic on a normal two-way street shall be provided whenever practicable and all operations shall be conducted in a sequence that will reduce the necessity for one-way traffic.
33. When a one-lane, two-way temporary traffic control zone is necessary, the Contractor shall provide courteous, competent flaggers to direct traffic and to provide for the satisfactory operation of one-way traffic. All flaggers shall be properly trained and certified. (ATSSA is an approved certification program.) Flaggers shall be equipped with STOP/SLOW hand-signaling paddles and must wear distinctive uniforms while directing or flagging through construction upon the streets. Flaggers shall wear a minimum of ANSI 107 Class 2 attire for daytime work and ANSI 107 Class 3 attire for nighttime work. The retroreflective material shall be orange, yellow, white, silver, and yellow-green or a fluorescent version of these colors and shall be visible at a minimum distance of 1000 feet. The retroreflective clothing shall be designed to clearly identify the wearer as a person. Flaggers' hand-signaling signs shall be as specified in the latest edition

of the MUTCD. A Contractor may use uniformed law enforcement officers as flaggers in lieu of the above uniformed flaggers. A law enforcement officer, when used as a flagger by the Contractor, shall wear high-visibility clothing as described above. All flaggers shall understand and follow the flagger procedures outlined in the most current edition of the MUTCD. The flaggers' uniforms and hand-signal signs shall be provided by the Contractor. When flaggers are required and used, they shall not be paid for separately but shall be considered subsidiary to the contract.

34. Pilot cars when used shall be light "pickup" trucks or other approved vehicles, preferably carrying the Contractor's monogram or company insignia, equipped with signs reading "Pilot Car-Follow Me". The sign shall be mounted in a conspicuous position on the rear of the vehicle used for guiding one-way motor vehicle traffic through or around a temporary traffic control zone.
35. Where specified, the Contractor shall furnish, install and maintain an advance warning flashing or sequencing arrow panel. It shall be mounted on a portable chassis and shall be operated continuously when necessary to divert traffic. Operational ability of the advance warning flashing or sequencing arrow panels shall comply with the MUTCD. The lamp intensity for the advance warning flashing or sequencing arrow panel shall be adjusted to prevent an unnecessary blinding effect and to compensate for daytime and nighttime light conditions so that the arrow panel message is legible for a minimum distance of ½ mile. The lamp intensity, for flashing or sequencing arrow panels, shall be controlled by an automatic solar cell switch, backed by a manual switch, capable of dimming 50% from the rated lamp voltage for nighttime operation. The flashing rate of the lamps shall not be less than 25 nor more than 40 flashes per minute. Minimum lamp "on time" shall be 50% for the flashing arrow and 25% for the sequential chevron. The arrow panel lamps or lenses shall be recess-mounted or equipped with an upper hood of not less than 180º, and the color of the light emitted shall be yellow.
36. Fully reflectorized non-metallic drums used for channelizing traffic, lane closures and the marking of specific projects shall meet the requirements of the most current edition of the MUTCD.
37. Type A warning lights shall be installed on drums used singly as required and as directed by the Engineer, unless noted otherwise on the plans or the Traffic Control Plan.
38. Type A or Type C warning lights used on traffic control devices shall be kept lighted from sunset to sunrise and when conditions exist, as determined by the Engineer, which tend to obscure vision. All warning lights shall be used and installed in accordance with details shown on the plans, the Traffic Control Plan or in accordance with the MUTCD. The Contractor shall check warning lights weekly and replace batteries immediately upon notification.
39. On bituminous base course and/or surface course projects, and/or after milling, the Contractor shall furnish temporary striping by placing a nominal four inch wide by approximately four feet long retroreflectorized stripe on the centerline of the street or lane line of multi-lane streets at approximately 50' centers, or in the case of severe curvature, approximately 25' centers after each lift of bituminous material has been placed, unless noted otherwise on the plans and/or the Traffic Control Plan. The Contractor shall maintain this striping until covered with the next lift or until the project is accepted. Placement of temporary striping will be as soon as practical after each lift is placed or as directed by the Engineer. The

color of the striping used shall be in accordance with the most current edition of the MUTCD. Temporary striping is required when permanent markings cannot immediately be installed.

40. Temporary marking and striping tape shall be applied mechanically or manually. Foil-back pavement marking material is prohibited. The street surface shall be clean and dry and the material shall be applied as recommended by the manufacturer.
41. Where temporary pavement markings are to be placed on a surface which has existing lines or markings, the incorrect lines or markings shall be removed to the fullest extent possible without damage to the pavement surface. Equipment used for the removal of the markings shall be any type that will not appreciably damage the surface or texture of the pavement. All material deposited on the pavement as a result of the removal operation shall be removed as the work progresses. Where blast cleaning is used for the removal of pavement markings and such removal operation is being performed within 10 feet of the traveling public, the residue, including dust, shall be removed immediately by methods approved by the Engineer.
42. Any appreciable damage or different appearance from the surrounding surface shall be repaired by the Contractor, at his expense, by methods approved by the Engineer. The Contractor shall treat, at his expense, the affected areas with any permanent or lasting material to blend in and match as well as practical, the appearance of the surrounding area.
43. During periods of inclement weather or during periods of unusually heavy traffic, the Engineer may require all operations to cease in order to adequately handle the traffic. The Engineer reserves the right to require the suspension or delay of certain operations, or the speeding up of other operations to insure a proper sequence of operations and thus aid the satisfactory movement of traffic.
44. The Engineer may require additional barricades, lights, flaggers, watch persons or other traffic control devices at any time or at any place that, in his opinion, are necessary for proper protection of traffic and workers. However, approval by the Engineer of the Contractor's method of operation shall not relieve the Contractor of the responsibility of protecting the traffic.
45. Periodic checks of traffic control devices will be made at night by the Contractor in accordance with requirements determined by the Engineer.
46. Temporary traffic signals and all associated appurtenances shall be subsidiary to the Traffic Control bid item.
47. Lane closures lasting longer than three (3) consecutive days shall be considered a long term closure. As a result, temporary pavement marking tape shall be required. Temporary pavement marking tape shall be subsidiary to the lump sum Traffic Control bid item.
48. Use Shoulder Drop-off signs (W9-9A and W7-3A) per the MUTCD and construct a 1:1 wedged slope when the dop-off at the edge of pavement is greater than 2 inches but less than 4 inches. Any drop-off of 4 inches or greater shall be wedged at a slope of 3:1 using Modified AB-3 aggregate base or asphalt as directed by the Engineer.

B. METHOD OF MEASUREMENT: Traffic Control will be measured as a unit lump sum quantity for all work necessary.

C. BASIS OF PAYMENT: Traffic Control measured as provided above will be paid for at the contract lump sum price bid.

S-806 CONDUIT: This work shall include the furnishing of all labor, materials and equipment for the installation of conduit in accordance with the plans and these Specifications. The size of the conduit used shall be as shown on the plans. It shall be the privilege of the Contractor, at his own expense, to use larger size conduit if desired, as approved by the Engineer. Where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted. A complete list of pre-approved materials is available at the office of the City Engineer or can be found on the City of Lenexa's internet website at ***www.lenexa.com***.

A. MATERIAL SPECIFICATIONS: All conduits for traffic signal and street lighting installations shall be either Schedule 40 polyvinyl chloride (PVC) conduit or Schedule 40 high density polyethylene (HDPE) conduit. PVC conduit shall bear an Underwriters' Laboratories (UL) label.

1. HDPE conduit shall exhibit good workmanship and be free from holes, blisters, inclusions, cracks, and homogenous throughout. There should not be any foreign particles embedded in the plastic as a result of the extrusion process. There should not be any surface distortions that penetrate either internally or externally into the conduit wall greater than 10% of the minimum wall thickness. The conduit shall be constructed of polymeric materials which are lightweight, flexible, corrosion resistant and nonconductive. The base material shall be clean, virgin grade high-density polyethylene (HDPE) which conforms to ASTM D3350, most recent edition, Type III. Any regrind material shall be non-wide specification, reworked from the same virgin material from the same manufacturer as the original conduit. The conduit shall have a controlled outside diameter with the cross-sectional dimensions meeting SDR 13.5 manufactured to ASTM D3035 specifications and having a minimum ASTM cell classification 334480EB. The conduit shall be smooth walled inside and out with a minimum coefficient of friction of 0.35. The conduit shall meet the following minimum requirements:

Tensile Strength	> 3000 psi	ASTM D-638
Density	> 0.940 g/cc	ASTMD-1505
Melt Index	0.4 gm/10 min.	ASTM D-1238(E)
Flexural Modulus	>80,000 psi	ASTMD-790
Slow Crack Growth		
ESCR (Bell Test)	10% Igepal	ASTM D-1693
Test Duration	192 hours minimum	ASTM D-1693
Failure	10% max	ASTM D-1693
Molded Plaque	3	ASTM D-1693
Hydrostatic Strength Class	NPR	ASTM D-2837
Color and UV Stabilizer	E > 2%	ASTM D-3350
Ultimate Elongation	> 400%	ASTM D-638

Minimum wall thickness shall be in accordance with the following table:

Diameter	Wall Thickness
1 ½" SDR 13.5	0.141"
2" SDR 13.5	0.176"
3" SDR 13.5	0.259"
4" SDR 13.5	0.333"

B. CONSTRUCTION REQUIREMENTS:

1. Traffic Signal Conduit: Conduit shall be installed as shown in the plans, on the Standard Detail sheets and in conformance with appropriate articles of the National Electric Code and the National Electrical Safety Code. In addition, wherever a conduit passes beneath a curbed street, aluminum conduit markers shall be installed in the curb immediately over the conduit location. Conduit markers shall be furnished by the Contractor as detailed on the Standard Detail sheets in the plans and shall be installed in the top of the curb by drilling the curb and epoxying the conduit marker in place. Conduit markers shall be inset into the curb so that the top of the marker is flush with the curb.
2. All signal conduits shall have a spare 1000 lb. or higher run of mule tape installed continuously through all conduits (box to box, box to controller, and box to pole base) and shall be tied off securely at each point. Any time new wire is installed in any existing signal conduits, a spare 1000 lb. or higher run of mule tape shall be installed continuously through the existing conduits (box to box, box to controller, and box to pole base) and shall be tied off securely at each point.
3. Tracing wire shall be installed on the inside of all empty conduits or conduits with fiber optic cable to facilitate the locating of buried cable. The wire shall be either a No. 10 AWG stranded copper Type USE or THWN cable or a No. 12 AWG Copperhead cable. The trace wire shall be installed without splices. At each service or junction box, the trace wire shall be connected to a light duty Snake Pit device with an orange cap. Connection between the Snake Pit and the box shall be made with a 1-1/2” or 2” conduit sweep.
4. The ends of all conduits shall be well-reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof.
5. An approved factory coupling shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit. The coupling shall be of high density polyethylene. The coupling shall have individual reverse-locking threads with a built-in center stop. The ends of the conduit shall be grooved with a grooving tool to match the reverse-locking threads of the coupling to provide for greater pull-out resistance. The coupling shall be installed with a factory recommended coupling tool to ensure an airtight and watertight lock.
6. Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit bends shall be made without crimping or flattening, using the longest radius practicable and utilizing an appropriate conduit bending tool.
7. Conduit shall be installed under street pavement sections at a depth not less than 48 inches below the bottom of the curb, and under other pavement sections at a depth not less than 24 inches; and where laid in trenches on shoulders and in park areas, conduit shall be laid to a depth of 24 to 30 inches below natural ground level or finish grade.
8. The conduit shall be installed continuous from outlet to outlet or as otherwise shown on the plans. With respect to HDPE conduit, no couplings or joints will be allowed at intermediate points unless approved by the Engineer. The conduit may be directional bored to minimize disruption to the existing improvements or may be trenched.
9. Conduit shall be placed under existing pavement by approved pushing or drilling methods. Pavement shall not be disturbed without the written permission of the

Engineer and then only in the event insurmountable obstructions are encountered. Pushing or drilling pits shall be kept 2 feet clear of the edge of any type of pavement wherever possible. Excessive use of water such that pavement might be undermined or subgrade softened, will not be permitted.

10. Conduit set in concrete bases shall extend approximately 3 inches above the foundation vertically. Conduit entering through the bottom of a junction box shall be located near the ends to leave the major portion of the box clear. Conduit entering a service or junction box and extending upward through an elbow shall have a minimum distance of 6 inches from the bottom of the service/junction box lid to the top of the conduit. At all outlets, conduit shall enter from the direction of the run. Conduit entering or exiting a service or junction box shall be grouted.
11. HDPE conduit entering equipment shall be continuous into the service box, junction box and control center. A factory 90° PVC conduit elbow shall be used for installation into a control center foundation. At a traffic signal service box or junction box, the conduit shall enter and exit the sides of the box tangentially such that the cable can enter, be coiled, and exit without exceeding an 8-inch bending radius. For straight through connections, the conduit shall enter one side of the box and exit the opposite side of the box. For changes in direction, the conduit shall enter tangentially and exit tangentially at a 90° angle to the entrance.
12. Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air.
13. Conduit runs shown on the plans are for bidding purposes only and may be changed with permission of the Engineer to avoid underground obstructions. The conduit shall generally be installed parallel to the street lighting conduit or direct-buried cable. Installation in the same trench is acceptable.

C. CONSTRUCTION REQUIREMENTS:

1. Street Lighting Conduit: Installation shall conform to the appropriate articles of the National Electrical Safety Code.
2. The conduit shall be installed continuous from outlet to outlet or as otherwise shown on the plans. With respect to HDPE conduit, no couplings or joints will be allowed at intermediate points unless approved by the Engineer. It is desirable that the conduit be directional bored to minimize disruption to the existing improvements.
3. Tracing wire shall be installed on the inside of all empty conduits or conduits with only fiber optic cable to facilitate the locating of buried cable. The wire shall be either a No. 10 AWG stranded copper Type USE or THWN cable or a No. 12 AWG Copperhead cable. The trace wire shall be installed without splices. At each service or junction box, the trace wire shall be connected to a light duty Snake Pit device with an orange cap. Connection between the Snake Pit and the box shall be made with a 1-1/2” or 2” conduit sweep.
4. The ends of all conduits shall be well-reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full diameter thereof.
5. An approved factory coupling shall be used for connection of the HDPE conduit to a 90° factory PVC elbow or between two lengths of HDPE conduit. The coupling shall be of high density polyethylene. The coupling shall have individual reverse-locking threads with a built-in center stop. The ends of the conduit shall be grooved with a grooving tool to match the reverse-locking threads of the

coupling to provide for greater pull-out resistance. The coupling shall be installed with a factory recommended coupling tool to ensure an airtight and watertight lock.

6. The location of ends of all conduits shall be marked by an approved conduit marker placed directly above the conduit, in the top of and flush with the curb. In the absence of a curb, the conduit ends shall be marked as approved by the Engineer. All conduit ends will be sealed with duct seal.
7. Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, conduit bends shall be made without crimping or flattening, using the longest radius practicable.
8. Conduit shall be bored under pavement sections at a depth not less than 24 inches below the top of pavement. Where laid in trenches on shoulders and in park areas, conduit shall be laid to a depth of not less than 24 inches below natural ground level.
9. Conduit shall be placed under existing pavement by approved boring or drilling methods. Pavement shall not be disturbed without the written permission of the Engineer and then only in the event insurmountable obstructions are encountered. Boring or drilling pits shall be kept 2 feet clear of the edge of any type of pavement wherever possible. Excessive use of water such that pavement might be undermined or subgrade softened, will not be permitted.
10. Conduit set in standard bases shall extend approximately 3 inches above the foundation vertically. Conduit entering through the bottom of a junction box shall be located near the ends to leave the major portion of the box clear. Conduit entering a service or junction box and extending upward through an elbow shall have a minimum distance of 6 inches from the bottom of the service/junction box lid to the top of the conduit. At all outlets, conduit shall enter from the direction of the run. Conduit entering or exiting a service or junction box shall be grouted.
11. HDPE conduit entering equipment shall be continuous into the junction box, light pole and control center. A factory 90° PVC conduit elbow shall be used for installation into a control center. At a light pole or junction box, a factory 90° PVC elbow may be used. Or, as per the approval of the Street Lighting Inspector, the HDPE conduit may be “swept” into the junction box/light pole.
12. Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air.
13. Conduit runs shown on the plans are for bidding purposes only and may be changed with permission of the Engineer to avoid underground obstructions.

D. METHOD OF MEASUREMENT: All “Conduit” shall be measured by the linear foot of completed and accepted work, of the type indicated on the plans except in the case of a Traffic Signal Installation project wherein the conduit costs will be subsidiary to the Lump Sum cost of the Traffic Signal Installation. Conduit shall be measured by horizontal measurement only, from device to device. No payment shall be made for the conduit inside poles, hand holes, cabinets, etc. These runs will be subsidiary to the devices they are entering or exiting or to the lump sum Traffic Signal Installation bid item. Street Lighting Conduit shall be measured per linear foot measured from the center of one appurtenance to the center of another appurtenance plus additional lengths for conduit sweeps. Conduit elbows, conduit fittings or couplings shall be considered subsidiary to the conduit. Add 4' of conduit to the center to center distance between two street light poles; add 3' of conduit to the center to center distance between a street light pole and a

junction box; add 2' of conduit to the center to center distance between a street light pole and a service box; add 3' of conduit to the center to center distance between a control center and a junction box; add 2' of conduit to the center to center distance between two junction boxes; add O' of conduit to the center to center distance between two service boxes; add 3' per conduit up the pole for anti-theft device, installed and accepted.

E. BASIS OF PAYMENT: "Conduit" shall be paid for at the contract unit price, measured as stated above.

PARKS CONSTRUCTION AND EQUIPMENT

S-900 PARK BENCH: This work shall consist of the furnishing of all required equipment, materials and labor necessary to install park bench equipment at the locations shown on the plans. Park Bench to be furnished under this specification shall be that equipment, by the part number specified in the plans, manufactured by Litchfield Industries, Inc. (Current Year Catalog) model number 3535, or approved equal. Litchfield Industries, Inc., can be contacted at the following address:

Litchfield Industries, Inc.
4 Industrial Drive
Litchfield, MI 49252

A. The model number 3535 bench shall have the optional Recycled Plastic slats (2" x 4") with the additional support post. Bench length shall be 6' unless stated otherwise on the plans. The 3535 shall be provided with the standard 4 slat seat and 2 slat back. Steel components shall be black. All hardware components shall be stainless steel.
B. All park bench installations shall be in strict compliance with the manufacturer's specifications.

C. METHOD OF MEASUREMENT: Park Bench shall be measured per each park bench completed and accepted. Installation shall be subsidiary to the park bench.

D. BASIS OF PAYMENT: Park bench shall be paid for at the contract unit price per each. The Park Bench equipment measured a provided above will be paid for at the contract unit price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the installation of the complete park bench and for all equipment, tools, labor and incidentals necessary to complete the work.

S-901 PARK GRILL: This work shall consist of the furnishing of all required equipment, materials and labor necessary to install park grill equipment at the locations shown on the plans. Park grills to be furnished under this specification shall be that equipment, by the part number specified in the plans, manufactured by Litchfield Industries, Inc. (Current Year Catalog) model number 9608, or approved equal. Litchfield Industries, Inc. can be contacted at the following address:

Litchfield Industries, Inc.
4 Industrial Drive
Litchfield, MI 49252

A. GENERAL: The park grill shall be 15" deep x 20" wide with 10" high walls. It shall be fabricated with 7 gauge (3/16") hot rolled steel plate, electrically welded to for the firebox. The bottom plate has holes in the rear corners for drainage. The front edge of this bottom plate has a formed lip to serve as an ash retainer. All corners and vertical edges are eased to a 1 ½" radius.
   1. The cooking grate is 15" x 20" providing a 300 square-inch cooking area. It is fabricated with ½" diameter solid steel bars electrically welded 1 1/8" on center. This grate is welded to two 5/8" diameter solid steel support bars equipped with non-conductive spring grips. The grate is non-removable from the firebox and can be adjusted with the firebox to four different height settings.
   2. The pedestal support pipe is made of 3 ½" O.D. iron pipe. The pedestal is equipped with an anti-theft locking device preventing the removal of the grill unit but allowing 360-degree rotation for draft control. This permanent pedestal is 40" long with the bottom expanded for retention into a concrete footer.
   3. The entire unit is painted with non-toxic, heat resistant, baked on black enamel.
   4. All park grill installations shall be in strict compliance with the manufacturer's specifications.

B. METHOD OF MEASUREMENT: Park Grill shall be measured per each park grill completed and accepted. Installation shall be subsidiary to the park grill.

C. BASIS OF PAYMENT: Park Grill shall be paid for at the contract unit price per each Park Grill.

S-902 <u>FROST FREE HYDRANT</u>: This work shall consist of the furnishing of all required equipment, materials, fittings, connections and labor necessary to install frost free hydrant equipment at the locations shown on the plans. Frost free hydrant to be furnished under this specification shall be that equipment, by the part number specified in the plans, manufactured by Simmons Manufacturing Company (Current Year Catalog) model number 4800, or approved equal. Simmons Manufacturing Company can be contacted at the following address:

Simmons Manufacturing Company
Conyers Road
McDonough, Georgia 30253
(770) 957-3976

A. All frost-free hydrant installations shall be in strict compliance with the manufacturer's specifications.

B. METHOD OF MEASUREMENT: Frost free hydrant shall be measured per each frost free hydrant completed and accepted. Installation shall be subsidiary to the frost-free hydrant.

C. BASIS OF PAYMENT: Frost free hydrant shall be paid for at the contract unit price per each. The Frost free hydrant equipment measured a provided above will be paid for at the contract unit price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the installation of the complete frost free hydrant and for all equipment, tools, labor and incidentals necessary to complete the work.

S-903 PEDESTRIAN BRIDGE: This work shall consist of furnishing and placing (a) prefabricated pedestrian bridge(s) and the concrete abutments to support the bridge(s).

A. GENERAL: The Pedestrian Bridge(s) shall be of the type specified on the Plans. . The Hand Rail shall be a minimum height of 42" from the top of the deck to the top of the rail, and shall have one (1) diagonal per panel. Horizontal steel safety rails shall be provided as part of the hand rail, with 4" maximum vertical opening between rails. A wooden rub rail shall be provided. The bridge deck shall be of nominal 2" x 10" pressure treated wood.
   1. All steel members shall be fabricated from enhanced atmospheric corrosion resistant steel (A588). All fabrications will be produced from high strength, low alloy, atmospheric corrosion resistant ASTM A847 cold-formed welded square and rectangular tubing, and ASTM A588, ASTM A606 or ASTM A242 plate and structural shapes. All wood members shall be pressure treated in compliance with the American Wood Preservers' Association Standard C14.
   2. The bridge(s) shall be capable of supporting a 100 pound per square foot uniform live load, or a 10,000 pound vehicle load, whichever produces the greatest stress in the bridge members.
   3. The bridge(s) will be delivered in one (1) piece with the decking in place. The bridge(s) shall be designed in accordance with the "Manual of Steel Construction, Load Resistance Factor Design", as adopted by the American Institute of Steel Construction (AISC) – most current edition, or other applicable standards if approved by the Engineer. The City may require welds to be X-ray tested.
   4. All structural steel, after fabrication, will be blast cleaned in accordance with Steel Structures Painting Council Surface Preparation Specifications No. 6 Commercial Blast Cleaning, SSPC-SP6-latest edition.
   5. Concrete for the abutments shall be Class KCMMB-5K, unless otherwise specified in the plans. If the dead load for the bridge provided exceeds that shown in the plans, the contractor shall provide calculations (Signed and Sealed by an Engineer Licensed in the State of Kansas) demonstrating that the abutment provided will support the total load specified for the bridge.
   6. Excavation and backfill for the abutments shall be in accordance with the requirements of these Specifications as described in "EXCAVATION FOR STRUCTURES".

B. METHOD OF MEASUREMENT: "Pedestrian Bridge" shall be measured per lump sum of completed and accepted work. Construction and installation of the abutment shall be subsidiary to the "Pedestrian Bridge".

C. BASIS OF PAYMENT: "Pedestrian Bridge" shall be paid for at the contract lump sum price, measured as stated above.

S-904 PLAYGROUND EQUIPMENT: This work shall consist of furnishing all labor, materials and equipment necessary to install playground equipment at the locations shown on the plans. Playground Equipment to be furnished under this specification shall meet the requirements of ASTM standard F1487, and shall be that equipment, by the part number specified in the plans, manufactured by Landscape Structures Inc. (Current Year catalog), or equal. Landscape Structures, Inc., can be contacted at the following address:

Landscape Structures, Inc.
601 7th Street South
Delano, MN. 55328
1-800-328-0035

A. GENERAL: All playground installations shall be in strict compliance with manufacturer's specifications.
   1. Contractor shall not be responsible for clearing the site. The City shall present the Contractor with a cleared site, generally at the proper grade for installation. The Contractor shall be responsible for final grade preparation of the installation pad, to include any minor grade adjustments necessary to meet the manufacturer's specifications for the installation.
   2. Orientation of the playground equipment shall be dictated by the Engineer.
   3. As part of the installation, the Contractor shall erect and maintain protective fencing around the entire work site during so as to protect the public from injury.

B. METHOD OF MEASUREMENT: Playground Equipment shall be measured per each playground equipment completed and accepted. Installation shall be subsidiary to the playground equipment.

C. BASIS OF PAYMENT: Playground equipment shall be paid for at the contract unit price per each. The Playground Equipment measured as provided above will be paid for at the contract unit price bid, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the installation of the complete Playground Equipment and for all equipment, tools, labor and incidentals necessary to complete the work.

S-905 PLAYING SURFACE: This work shall consist of the cleaning of pavement surface, repair of any depressions in the surface, and installation of a playing surface using the Plexipave Color Finish System (hereinafter referred to as “The System”), or approved equal, in accordance with the manufacturers recommendations. The System consists of two filler coats of Plexipave Acrylic Filler, One coat of Plexichrome, and Plexicolor Line Paint applied at the locations shown on the plans. The System shall be installed in two colors, one color for the playing area and a second color for the aprons (See plans for playing area color and location, and for apron color and locations). The line paint shall be white.

A. GENERAL: Prior to applying The System, the surface shall be flooded and the surface marked for any depressions. Any depression greater than 1/4” shall be repaired. The System shall not be applied until the surface to which it is to be applied has been in place for a minimum of seven days. After depressions have been repaired, and after the seven day waiting period, the surface shall be cleaned of all dirt and foreign matter.
   1. After cleaning the surface, the Contractor shall apply two coats of Plexipave Acrylic Filler at a rate of not less than 0.08 gallons per square yard total for the two coats. If the surface is not covered to a uniform, even texture free of all porosity, a third filler coat shall be applied, at no additional cost to the City. The first coat shall be applied in the direction of the longest dimension of the surface, and the second coat crosswise to the longest dimension of the surface. Dilution rate will not exceed 1 part water to 2 parts filler coat.
   2. After application and curing of the filler coats, the Contractor shall apply one coat of Plexichrome to the surface, at a rate of 0.04 gallon per square yard. The application shall be applied in the direction of the longest dimension of the surface. The Plexichrome shall be applied with a wide-hair type push broom and shall produce a uniform color throughout when viewed from a distance of 25 feet from any edge of the court at midday. Dilution rate shall not exceed 1 part water to 1 part finish coat.
   3. When the Plexichrome has cured, the Plexicolor Line Paint shall be applied.

B. METHOD OF MEASUREMENT: Playing Surface shall be measured per the square yard of completed and accepted work.

C. BASIS OF PAYMENT: Playing Surface shall be paid for at the contract unit price for Playing Surface, measured as stated above.

S-906 PROTECTIVE MEMBRANE: The material to be used is the PHILLIPS 66 PETROMAT NONWOVEN FABRIC, and it shall be laid over the entire tennis and basketball court existing surface. The Contractor shall follow manufacturer's recommendations for its application on this project.

A. GENERAL: Mechanical laydown equipment must be capable of handling full rolls of fabric, and shall be capable of laying the fabric smoothly, without excessive wrinkles and/or folds. When manual laydown is required, a length of standard one inch pipe, together with suitable roll tension devices, is required for proper roll handling. Information pertaining to availability of laydown equipment can be obtained from a Petromat sales representative. Stiff bristle brooms to smooth the fabric and scissors or blades to cut the fabric shall be provided.
   1. The fabric shall be placed onto the bituminous tack coat with a minimum of wrinkles so that the bearded (fuzzy) side is unwound into the tack coat, thus providing optimum bond between fabric and pavement during the construction process. As directed by the Engineer, wrinkles severe enough to cause folds shall be slit and laid flat. Brooming or pneumatic rolling will maximize fabric contact with the pavement surface.
   2. Overlap of fabric joints should be a minimum of 1 inch to insure full closure of the joint. Transverse joints should be shingled in the direction of paving to prevent edge pick-up by the paver.
   3. Placement of the asphalt overlay shall closely follow fabric laydown.

B. METHOD OF MEASUREMENT: No separate measurement will be made for Protective Membrane.

C. BASIS OF PAYMENT: No separate payment will be made for Protective Membrane. Payment for Protective Membrane will be subsidiary to the asphaltic concrete surface.

S-907 RESTROOM: This work shall consist of the furnishing of all required equipment, materials, labor, tools, roofing materials, electrical fixtures and devices, plumbing fixtures, foundation, paint, mirrors and all necessary appurtenances to construct the shelter at the location shown on the plans. Restroom to be furnished under this specification shall be that equipment specified in the plans, by the manufacturer and part number specified, or approved equal.

A. All restroom construction shall be in strict compliance with the plans and these specifications. Equipment to be furnished with the restroom shall be in accordance with the plans and as follows:

Description	Manufacturer	Part No.

B. The number of pieces of each item of equipment to be supplied shall be as noted in the plans.

C. METHOD OF MEASUREMENT: Restroom shall be measured per each restroom completed and accepted and shall include foundation, building materials and all equipment and personnel necessary to construct restroom as required to complete this project as intended by the Plans.

D. BASIS OF PAYMENT: Restroom shall be paid for at the contract unit price per each Restroom. Payment shall be full compensation for furnishing and installing all equipment, materials, tools, and labor and all appurtenant work required to allow the construction of the project as planned.

S-908 SHELTER: This work shall consist of the furnishing of all required equipment, materials, labor, roofing materials, foundation and all necessary appurtenances to construct the shelter at the location shown on the plans. Shelter to be furnished under this specification shall be that equipment, by the part number specified in the plans, manufactured by Litchfield Industries, Inc. (Current Year Catalog) model number 1700, or approved equal. Litchfield Industries, Inc., can be contacted at the following address:

Litchfield Industries, Inc.
4 Industrial Drive
Litchfield, MI 49252

A. GENERAL: Shelter shall be supplied with Litch-top Pre-cut metal roof or equal, unless otherwise stated on the plans. Litch-top metal roofing consists of 29 gauge, 36" wide, ¾" deep metal, Fy = 80 ksi.
   1. All shelter installations shall be in strict compliance with the manufacturer's specifications.

B. METHOD OF MEASUREMENT: Shelter shall be measured per each shelter completed and accepted and shall include foundation, building materials and all other equipment and personnel necessary to construct shelter as required to complete this project as intended by the Plans.

C. BASIS OF PAYMENT: Shelter shall be paid for at the contract unit price per each. Payment shall be full compensation for furnishing and installing all equipment, materials, tools, and labor and all appurtenant work required to allow the construction of the project as planned.

S-909 TENNIS COURT EQUIPMENT: This work shall consist of the furnishing of all required equipment, materials and labor and the installation of tennis net posts, tennis nets, and other related accessories as designated, in accordance with these specifications and Plans, or as established by the Engineer.

A. GENERAL: Each tennis court shall have two (2) 3-inch O.D. galvanized steel posts installed to support the tennis net at each end, one tennis net, and one eye-bolt set in concrete to restrict movement of the tennis net. The steel posts shall be capped on top to seal out water. The steel posts shall be set in a concrete footing as shown in the plans. The net posts shall be a Game Time Inc., Model Number 541 with a Model Number 155 Reel or an approved equal conforming to the requirements as set forth herein. The net shall be a Game Time Inc. Model Number 329 or approved equal. The eye-bolt shall be a 3/8 inch diameter x 12 inches long eye-bolt with standard SAE threads, and provided with a hex nut. Threads shall extend from the shank of the eye-bolt for a minimum of 4” toward the eye of the eye-bolt. The inside eye diameter of the bolt shall be not less than 3/4 inch or more than 1-1/2 inch. The eye-bolt shall be embedded in a concrete footing as shown in the plans, and shall be placed by core drilling after placing the asphaltic concrete surface.

B. METHOD OF MEASUREMENT: "Tennis Court Equipment" shall not be measured separately, but shall be subsidiary to other bid items. When removal of existing posts is required, the removal of the existing posts and footing shall be subsidiary to other items as well.

C. BASIS OF PAYMENT: "Tennis Court Equipment" Shall not be paid for separately, but shall be subsidiary to other bid items.

S-910 <u>TRASH RECEPTACLE</u>: This work shall consist of the furnishing of all required equipment, materials and labor necessary to install trash receptacle equipment at the locations shown on the plans. Trash Receptacle to be furnished under this specification shall be that equipment, by the part number specified in the plans, manufactured by Litchfield Industries, Inc. (Current Year Catalog) Series 5400, 32 gallon size, permanent ground mounted, with recycled plastic slats, or approved equal. Litchfield Industries, Inc., can be contacted at the following address:

Litchfield Industries, Inc.
4 Industrial Drive
Litchfield, MI 49252

A. GENERAL: Metal components shall be gloss brown enamel, and tamper-proof hardware shall be furnished. Lid shall be the structural plastic dome with a self-closing door -- gray color.
   1. All trash receptacle installations shall be in strict compliance with the manufacturer's specifications.

B. METHOD OF MEASUREMENT: Trash Receptacle shall be measured per each trash receptacle completed and accepted. Installation shall be subsidiary to the trash receptacle.

C. BASIS OF PAYMENT: Trash Receptacle shall be paid for at the contract unit price per each Trash Receptacle, measured as stated above.

UTILITY CONSTRUCTION AND MATERIALS

S-1000 <u>ADJUSTMENT OF MANHOLE AND VALVES</u>: This work shall consist of the adjustment of existing manholes, catch basins or curb inlets, or valves in accordance with these Specifications and as shown on the Plans or established by the Engineer.

A. GENERAL: Existing storm water manholes, catch basins, curb inlets, and valves, shall be adjusted to the elevation, grade, or dimensions shown on the Plans or as ordered by the Engineer. Structural steel or cast fixtures shall be carefully removed and reinstalled or stored by the Contractor for future use by the owners as indicated. If the height of brick walls is to be increased the addition may be of brick, concrete blocks, KCMMB-5K Concrete or pre-cast adjustment ring, unless shown otherwise on the Plans.
   1. The placing of the masonry, concrete, pre-cast concrete, and castings shall conform to the requirements for “MANHOLES”.
   2. Adjustment of sanitary manholes and water valves shall be according to the Specifications of Johnson County Wastewater District and Water District Number One of Johnson County, respectively.

B. METHOD OF MEASUREMENT: Measurement quantities for this work shall be as a unit for the adjustment of a single structure and no measurement of the separate items such as excavation, concrete and cast iron will be made except that if the Contractor is required to furnish new structural steel or cast fixtures, these items shall be measured by the pound.

C. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per unit for “Adjustment of Catch Basins”, “Adjustment of Manholes”, or “Adjustment of Curb Inlets”, as the case may be. New structural steel cast fittings furnished by the Contractor shall be paid for at the contract unit prices per pound or “Structural Steel”, “Cast Steel”, or “Cast Iron”.

S-1001 <u>SANITARY SEWER</u>: This work shall consist of the construction of sanitary sewer in accordance with these Specifications and as shown on the Plans or established by the Engineer.

A. GENERAL: Pipe for “Sanitary Sewers” shall conform to the requirements of the Johnson County Wastewater District.
   1. The trench shall be excavated beginning at the downstream end and proceeding toward the upper end, true to line and grade shown on the Plans or as established by the Engineer. The width of the trench shall be sufficient to lay and backfill the pipe satisfactorily but in no case shall be less than the external diameter of the pipe plus 6 inches on each side. When necessary, the trench shall be adequately shored or sheeted to insure safe and satisfactory construction and backfilling. If tunneling under a railroad or existing street or highway is required, it shall be done by methods which will insure that the railroad, street, or highway is undisturbed during and after the construction and such methods shall be approved by the Engineer before work is begun. If it is necessary to remove an existing street or highway surface in constructing the sewer the surface shall be repaired according to the Standard Details for a "Trench Under Pavement". In no case shall backfill be placed on frozen ground. In no case shall frozen material be used for backfill.
   2. The trench shall be backfilled per the requirements of the Johnson County Wastewater District, and/or the City Standard Detail for “Trench Under Pavement”.
   3. The manholes shall be backfilled per hand tamping methods in loose lifts of not more than 6”-8” lifts. Using the hoe bucket for compaction will not be allowed. Flow fill or aggregate backfill around the manholes will be allowed at the Engineers discretion.
   4. Installation of the pipe shall be in accordance with the requirements of the Johnson County Wastewater District.
   5. Pipe and accessories shall be handled in such manner as to insure delivery on the work in sound, undamaged condition. Particular care shall be taken not to injure the any pipe coating. No other pipe or material of any kind shall be placed inside of a pipe or fitting after the coating has been applied.
   6. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized by the Engineer, cutting shall be done by means of an approved type of mechanical cutters. Wheel cutters shall be used when practicable.
   7. While suspended in the sling and before lowering into the trench, the pipe shall be inspected for defects and tapped with a light hammer to detect cracks. Defective, damaged, or unsound pipe will be rejected.
   8. Backfilling shall be performed in accordance with the requirements of the Johnson County Wastewater District and per Lenexa Specs whichever is more stringent.

B. METHOD OF MEASUREMENT: This item shall be measured by the linear foot (linear meter) of the various sizes of sanitary sewer. Measurement shall be along the centerline of the pipe complete in place from the end of pipe to the inside face of walls of manholes. Concrete used for cradling of sewers, Excavation for sanitary sewers, and Cement mortar for grouting joints (or other materials used in caulking joints) shall not be measured separately, but shall be subsidiary to “Sanitary Sewers”.

C. BASIS OF PAYMENT: “Sanitary Sewers” shall be paid for at the contract unit price, measured as stated above.

S-1002 SANITARY SEWER ENCASEMENT: This work shall consist of installing storm sewer encasement in accordance with these Specifications, the Plans, the Standard Details, and the Contract Documents. Sanitary sewers at locations shown on the Plans shall be encased with a minimum of 6" Class KCMMB 5K concrete. This encasement shall extend a minimum of 5' past each side of any storm sewer, and shall terminate within 6” of a joint in the sanitary sewer line, as approved by the Engineer. All other dimensions for the encasement shall conform to Type A bedding in the Standard Details.

A. METHOD OF MEASUREMENT: “Sanitary Sewer Encasement” shall be measured by the linear foot of completed and accepted work. No separate measurement will be made for excavation or backfill.

B. BASIS OF PAYMENT: “Sanitary Sewer Encasement” shall be paid for at the contract unit price, measured as stated above.

S-1003 SANITARY SEWER SERVICE LINE: This work shall consist of installing sanitary sewer service lines at locations shown on the Plans and in accordance with the Plans or Standard Details. The work shall include installing all saddles, connections, joints, cleanouts, and other appurtenances necessary to complete the service line.

A. This work shall be performed in accordance to the Building Officials and Code Administrators National Plumbing Code and Johnson County Unified Wastewater District as approved by the Engineer.

B. METHOD OF MEASUREMENT: "Sanitary Sewer Service Line" shall be measured per linear foot of service line of completed and accepted work. Saddles, connections, joints, cleanouts, and other appurtenances necessary to complete the service line shall be subsidiary to installation of the Sanitary Sewer Service Line.

C. BASIS FOR PAYMENT: Payment for "Sanitary Sewer Service Line" shall be made at the contract unit price bid per linear foot for "Sanitary Sewer Service Line", measured as stated above.

S-1004 SANITARY SEWER SERVICE LINE ADJUSTMENT: The work of this section shall consist of relaying or connecting miscellaneous small drain lines or sanitary sewer service lines which may be encountered during construction.

A. GENERAL: Where the locations or grades of items described are shown on the Plans, the information is considered approximate only, and no guarantee is made as to the accuracy or completeness thereof. It is anticipated that unknown items not shown on the plans will also be uncovered during excavations and shall require adjustment as specified herein.
   1. It is anticipated that sanitary sewer house service pipes and miscellaneous small drain- pipes will be encountered in excavation for storm sewers and structures. Locations are generally unknown and, generally, no attempt has been made to show them on the plans. These pipes, whether shown on the plans or not, shall be re-laid as directed, furnishing all necessary materials, to provide satisfactory cover and grade. Sanitary sewage shall not be allowed to run uncontrolled over the ground or into any watercourse. The sanitary sewage shall be directed back into the sanitary sewer system.
   2. The Contractor is responsible for the maintenance of service of all sewer lines and small drain lines encountered or damaged by the Contractor's operations.
   3. All work and materials required to install, relay, and connect small miscellaneous drain pipes shall conform to the details on the Plans and to the section of this specification titled “Sanitary Sewers”.

B. METHOD OF MEASUREMENT: “Sanitary Sewer Service Line Adjustment” shall be measured per each adjustment, of completed and accepted work in place.

C. BASIS OF PAYMENT: “Sanitary Sewer Service Line Adjustments” shall be paid at the contract unit price, per each, measured as previously stated.

S-1005 <u>WATER SERVICE LINE</u>: Service water line as shown on the plans shall be installed as required to construct the proposed improvement. The work shall include installing all taps, connections, and other appurtenances necessary to complete the service line.

A. This work shall be performed in accordance to the Building Officials and Code Administrators National Plumbing Code and Water District Number One of Johnson County as approved by the Engineer.

B. METHOD OF MEASUREMENT: "Water Service Line" shall be measured per linear foot of completed and accepted "Water Service Line". Taps, connections, joints, and other appurtenances necessary to install the water service line shall be subsidiary to installation of the "Water Service Line".

C. BASIS OF PAYMENT: "Water Service Line" shall be paid for at the contract unit price, measured as stated above. Said prices shall be full compensation for excavation, installation, backfill, and for all labor, tools, equipment and incidentals necessary to complete the work.

S-1006 <u>WATER METER</u>: This work shall consist of the furnishing of all required equipment, materials, labor, meter box, connections, valves, fittings and all necessary appurtenances to construct the water meter at the location shown on the plans. Water meter to be furnished under this specification shall be the size shown on the plans, and obtained from Water District Number One of Johnson County, Kansas. Contractor shall make application for the service connection and shall be responsible for any fee associated with the service connection/water meter.

A. All water meter installations shall be in strict compliance with Water District Number One of Johnson County, Kansas specifications.

B. METHOD OF MEASUREMENT: "Water Meter" shall be measured per each "Water Meter" completed and accepted and shall include meter box, materials, equipment, tools and all other equipment and personnel necessary to construct water meter as required to complete this project as intended by the Plans.

C. BASIS OF PAYMENT: "Water Meter" shall be paid for at the contract unit price, per each. Payment shall be full compensation for furnishing and installing all equipment, materials, tools, labor, and all appurtenant work required to allow the construction of the project as planned.

MISCELLANEOUS CONSTRUCTION AND MATERIALS

S-1100 <u>BASE STABILIZATION</u>: This work shall consist of pulverizing an existing surface, and furnishing and placing one or more courses of aggregate and additives, if required, in accordance with these Specifications, as shown on the Plans or established by the Engineer.

A. PULVERIZE EXISTING SURFACE: The Contractor shall pulverize the existing surface using a traveling pulverizor/mixer. The pulverizor/mixer shall have the capability of metering water into the pulverized surface, and of pulverizing the existing surface so that the maximum size particle after pulverizing shall be 1.5 inches. The pulverizor/mixer shall accomplish the pulverization in a maximum of 2 passes.
   1. Prior to beginning pulverization, vegetation on the shoulders shall be eliminated by disking, scarifying or blading. Excess material shall be disposed of as shown in the Contract documents or as directed by the Engineer. Any additional embankment material that may be needed for shaping the shoulder surface or roadbed shall be obtained from areas provided by the Contractor.
   2. At all grade control points, namely, start and end of project, existing pavements, bridges, etc., the pulverizor shall make one lateral pass so as to obtain a vertical edge at the existing pavement. Existing grade shall be maintained throughout the project in order to match existing driveways and side streets. Excess excavation material shall be disposed of as directed.
   3. Once the existing surface is pulverized, the pulverized material shall be compacted to Type AA MR5-5 requirements. The depth of the pulverization and compaction on the roadbed shall be as indicated on the plans. The roadbed and shoulders shall be kept well drained at all times. It shall be the Contractor's responsibility to maintain the subgrade as prepared.

B. MIXING: The additives and water shall be mixed with an approved pulverizor/mixer. Water shall be added during the mixing operation in the amount necessary to provide the approximate moisture content as determined by the Engineer for compacting

C. PLACING AND COMPACTING: If the required compacted depth of the base course or shoulder exceeds six inches, they shall be constructed in two or more layers of approximate equal thickness. The maximum compacted thickness of any one layer shall not exceed six inches. When vibrating or other approved types of special compacting equipment are used, the compacted depth of a single layer may be increased to eight inches upon approval of the Engineer.
   1. No hauling of material will be permitted when, in the judgment of the Engineer, the surface of the road will be damaged. Dumping or mixing of any shouldering material on any paved surface constructed for traffic lanes will not be permitted. All mixed material will be laid full lane width or shoulder width by means of an approved aggregate spreader. Immediately after placing, the material shall be compacted.
   2. The Engineer will determine by inspection and testing that satisfactory compaction is being obtained. Blading may be required while rolling is being performed.
   3. If the material is laid and compacted in more than one layer, the Contractor shall plan and coordinate his work in such a manner that the previously placed and compacted layers are allowed ample time for curing and development of sufficient stability before vehicles hauling materials for the succeeding layers, or other heavy equipment are permitted on the base. Prior to placing the succeeding layers of material, the top of the under layer shall be made sufficiently moist to insure a strong bond between the layers. The edges and edge slopes of the base shall be bladed or otherwise dressed to conform to the

lines and dimensions shown in the Contract Documents and present straight, neat lines and slopes as free of loose material as practicable. If, after completed compaction, there are areas above or below proper grade and elevation, such areas shall be loosened and after having had additional materials added or excess material removed, as the case may require, shall be reconstructed as described above.

D. SURFACE DROP-OFF TREATMENT: On projects that carry traffic through construction, the following criteria shall be considered a minimum for treatment of surface drop-offs adjacent to traffic lanes not physically separated by acceptable positive barrier. A surface drop-off is defined as the vertical distance between the top of the lift being constructed or riding surface to the top of the existing shoulder or adjacent lane.

E. SHOULDER TREATMENT: All lifts regardless of thickness shall be constructed with an edge slope of 1:1 or flatter. Appropriate signing and delineation as shown in the Contract Documents will be required.

1. When the surface drop-off is greater than three inches, a temporary or permanent wedge shall be constructed against the pavement edge to provide a 3:1 or flatter slope. For unusual and justifiable conditions, the Engineer may modify this requirement to permit the use of drums, barricades, or other channelizing devices in lieu of the wedge to alert drivers of the drop-off condition. Surface drop-offs greater than three inches shall not be left unprotected overnight without the wedge or channelizing devices in place. An obstruction free recovery area should be provided to the extent possible.
2. For multi-lift projects with lifts greater than three inches, shoulders may be considered in conjunction with the placement of all lifts or the vertical drop-off shall be treated as stated previously.
3. When used, wedges shall be constructed of a material acceptable to the Engineer and constructed with a final maximum slope of 3:1 or flatter. Construction of the wedge or the use of alternate channelizing devices shall be considered as subsidiary to other items of the Contract.

F. SHOULDERS, ENTRANCES, AND SIDE ROADS: The grade of shoulders, entrances and side roads shall be raised to meet the edge of the base stabilization. In raising the grade of the shoulder, entrance or side road, sufficient embankment materials shall be added to provide a roadway width equal to that of the approaching roadway with adequate shoulder slopes and shoulder radii adjacent to the shoulder of the project. Approach grades shall slope slightly away from the edge of the stabilized base and the surface shall be adequately crowned, bladed, and consolidated to present a smooth surface with uniform lines and a neat appearance. The embankment material for this purpose shall be obtained from adjacent slopes or ditches or other sources approved by the Engineer.

G. METHOD OF MEASUREMENT: "Base Stabilization" shall be measured per square yard of completed, in-place, and accepted work.

H. BASIS OF PAYMENT: "Base Stabilization" shall be paid for at the contract unit price, measured as stated above. Work on shoulders, shoulder slopes, entrances, and side roads shall not be paid for directly but shall be considered as subsidiary work pertaining to the item of Base Stabilization.

S-1101 BORING: This work shall consist of installing a utility crossing, conduit, or other appurtenance at some time after the pavement is in place on a public street, in accordance with the Specifications and Standard Details and as shown on the Plans or established by the Engineer. The facility being installed shall be hereinafter referred to as the "Product".

A. All boring installations shall conform to the requirements of "Horizontal Directional Drilling—Good Practices Guidelines" by the HDD Consortium, latest edition, and to the requirements of this specification.

B. The installation shall be made by boring under the full width of the pavement, including the curb and gutter, at a minimum depth of 48". Bore pits shall not be dug within three feet of the curb and gutter. Bore pits shall generally have vertical walls, unless otherwise approved by the Engineer. Pits shall be braced and shored in accordance with the section of these specifications titles "Bracing and Shoring". The boring shall be accomplished with directional boring equipment of such type that the material is removed from the boring hole by the boring head. "Moles" and other equipment which displaces the soil, but does not remove the soil from the hole, shall only be permitted outside of the roadway. The directional boring equipment shall create the bore hole by drilling a pilot hole smaller than the Product being installed. The hole shall then be enlarged by a back-reaming process. More than one pass may be required for the back-reaming, depending on the size of the final hole required, the size of the pilot hole, and the type of soil/rock encountered. When formations cannot be penetrated with reamers, or if stalling or over-torqueing of the reamer occurs, hole openers should be used. The final bore diameter shall be larger than the Product diameter to reduce frictional backpull loads and to facilitate the flow of drilling fluids around the Product. As a rule of thumb, the diameter of the final bore hole shall be in accordance with the following table:

PRODUCT DIAMETER	REAMED DIAMETER
<8"	Diameter of Product + 4"
8"-24"	Diameter of Product x 1.5
>24"	Diameter of Product + 12"

C. Upon completion of the installation, the voids around the Product shall be completely filled with appropriate drilling fluids. The drilling fluid shall solidify within four hours of installation to a bearing pressure at least equal to the surrounding soils. All entry and exit pits shall be cleaned of drilling fluids and cuttings and backfilled with native soil or select backfill. Backfill shall be compacted to Type AA MR-5 Compaction. Sod shall be installed to restore the site to its prior condition. Any plants, shrubs, trees, fences, etc. disturbed by the installation shall be replaced in kind and size. Any damage caused to the pavement by the boring operation shall be repaired at the Contractor's cost. Methods of repair shall be at the discretion of the Engineer.

D. Right of Way Excavation Permits will be required on all privately funded projects.

E. METHOD OF MEASUREMENT: "Boring" shall be measured by the Linear Foot of completed and accepted work.

F. BASIS OF PAYMENT: "Boring" shall be paid for at the contract unit price bid, measured as stated above.

S-1102 <u>BOUND DRAINABLE BASE</u>: This work shall consist of installing an open-graded drainable base composed of mineral aggregate and a binder of asphalt cement, Portland cement or fly ash. The aggregates and binder shall be uniformly mixed and placed on a prepared foundation in accordance with these specifications and shall conform to the lines, grades, thickness and typical cross sections shown on the plans.

A. This specification is intended to allow contractors the widest latitude in selecting a drainable base that will meet the drainage needs for the project. Contractors are to select the binder type that is best suited to provide a working platform commensurate with the Contractor's individual needs or desires. The Contractor shall assume full responsibility for the suitability of the mix design to provide a stable working platform for subsequent paving operations.
B. MATERIALS: Materials shall comply with the requirements specified in the Standard Specifications and the latest supplemental conditions thereto.
   1. Mix Design: The drainable base mix design shall comply with the permeability and strength requirements that follow:

      - Permeability for the mixture shall be 1000 feet per day or greater.
      - Permeability test specimens shall be prepared and permeability tests shall be performed in accordance with KDOT laboratory test method KT-MR5, Permeability for Base Course Materials.
      - The acceptable range of seven (7) day compressive strengths for mix designs bound with fly ash or Portland cement shall be 600 psi to 1200 psi. The test specimens shall be 6" X 6" cylinders prepared and tested in accordance with KT-MR1 procedures, modified to account for the rapid curing of the sample.

      Drainable bases that are bound with asphalt cement shall have a minimum Marshall stability value of 400 lbs. The test specimens shall be prepared and tested in accordance with KT-14.
      Tests to determine compliance of the mix design with the above requirements shall be the responsibility of the Contractor and shall be performed by a qualified laboratory.
      The Contractor shall submit the final mix design, permeability test results, and compressive strength or Marshall stability results as appropriate to the City Engineer for approval prior to placing the drainable base material on the project. The City may choose to verify any or all of the Contractors test results prior to approving the mix design. After approval of the mix design, any proposed changes to the approved mix design must be submitted to the City Engineer for approval prior to implementing such changes. The City Engineer may require the contractor to provide permeability test results before approving any design changes.
      Note: The Engineer may choose to test the permeability of the actual mix being used on the project. If it is determined that the permeability is less than the specified minimum, then the Engineer may require the Contractor to suspend placement of the drainable base material and submit a new mix design.
C. CONSTRUCTION REQUIREMENTS: Construction requirements shall be in accordance with the standard specifications except for the following:

1. Spreading of the Base Material: The base material shall be spread to the lines and grades shown on the plans. Any material which becomes mixed with soil or other contaminants shall be removed and replaced with fresh mixture.
2. Compaction of the Drainable Base Material: After spreading and/or trimming, the base material shall be uniformly compacted by making a minimum of two coverage's with a steel wheeled roller. The compaction process may be adjusted on the project by the Contractor with approval of the Engineer to assure uniform compaction of the drainable base material. In areas not accessible by the roller, the base material shall be compacted by hand methods.
3. If, after spreading and compacting the base is not to the required lines and grade, the contractor shall trim the base by means of an electronically controlled machine utilizing string line controls for grade. The Engineer reserves the right to direct the Contractor to suspend all operations if the Contractor produces excessive fines in the trimming process which are viewed by the Engineer to be detrimental to the permeability of the base. Appropriate corrections to the trimming process shall be made by the contractor prior to beginning again.
4. After compaction of the drainable base, the Contractor shall protect the surface from damage and/or contamination. If, during any time prior to placement of the succeeding pavement course the integrity of the drainable base is disturbed, the area shall be removed and replaced with new material and compacted to conform to the original lines and grades. Any removed material shall not be reincorporated into the drainable base or other drainage features.
5. Curing of the Drainable Base Material: If the Contractor chooses to use fly ash or Portland cement as a binder, then uniform curing procedures will be necessary. The Contractor will be required to provide a curing plan to the Engineer so that the Engineer can monitor the procedures to assure that the drainable base is receiving a uniform cure throughout the project.

NOTE: Very open mixes may necessitate that the contractor supply additional concrete since the surface voids of the drainable base will create an additional concrete demand. The Contractor may at his expense, choose to place a permeable separation fabric/paper over the base to reduce the need for additional concrete.

D. METHOD OF MEASUREMENT: Drainable base shall be measured by the square yard complete in place.

E. BASIS OF PAYMENT: The amount of completed and accepted work, measured as provided above, shall be paid for at the contract unit price per square yard for "Drainable Base (Bound) (*)", which price shall be full compensation for furnishing all aggregates, binder, water, preparation, mixing, placing, and curing of the drainable base and for all labor, equipment, tools and incidentals necessary to complete this item. "*" shall be the thickness of the Bound Drainable Base.

S-1103 STONE STABILIZED PAD: This work shall consist of installing a “Construction Entrance” in accordance with the City Standard Details.

A. METHOD OF MEASUREMENT: “Stone Stabilized Pad” shall be measured per each of “Stone Stabilized Pad” completed and accepted.

B. BASIS OF PAYMENT: “Stone Stabilized Pad” shall be paid for at the contract unit price per each. Payment shall be full compensation for furnishing and installing all equipment, materials, tools, and labor and all appurtenant work required to install the “Stone Stabilized Pad”.

S-1104 CONTRACTOR CONSTRUCTION STAKING: This work shall consist of setting all stakes needed to establish the lines and grades, according to the Plans. The Contractor shall set construction stakes establishing all lines, slopes, continuous profile-grades, centerlines, and benchmarks necessary to control and perform the work.

A. Before any construction activity starts in the immediate area of an endangered Public Land Survey System (PLSS) corner, recover all endangered section corners and accessories of the PLSS on the project. Endangered PLSS corners are those defined by the Kansas Statues and/or shown in the Contract Documents as lying within the range from the project centerline to a distance 100 feet (30m) outside the construction limits, throughout the length of the project. Establish a minimum of 6 reference ties for each endangered PLSS corner. Each reference tie must be a direct measurement to a precise (hard defined) point. (Specify Slope or Horizontal Measurement) Complete a Land Survey Reference Report marked as a “Notice of Endangered Activity” for each endangered PLSS corner. File the reports with the appropriate governmental custodian responsible for maintaining those records, as required by Kansas Statues. Provide the engineer with copies of the completed reports.
B. The Contractor shall locate all existing property corners within the project limits prior to commencing construction. All property corners that can be saved shall be marked and protected. Property corners anticipated to be disturbed during construction shall be located by ties and shall be reset by the Contractor at the termination of construction activities. All boundry and PLSS corner surveys shall be performed by a qualified land surveyor registered in the State of Kansas.
C. The Contractor shall submit to the Engineer copies of any land corner references ties and other material which is required to be submitted to the State of Kansas or to Johnson County (Kansas) according to State law. Failure to submit appropriate material will be cause for reporting the surveyor to the State Board of Technical Professions, and may be considered a breach of contract for the Contractor. The Contractor is responsible for replacing destroyed monuments and referenced bench marks set by the county or state. This work will be subsidiary to the contractor staking bid item, unless there is a separate bid item for these items.
D. The Contractor shall set cut stakes for all rough swale grading and shall maintain or reset such stakes for checking of the grade as required by the Engineer. Final grade for the swales and berms shall be established by "blue top" surveying or other approved method, and grade devices shall be maintained for inspection by the Engineer prior to sodding.
E. The contractor shall be responsible for producing and maintaining as-built plans on all projects. As-built plans annotate and field changes that differ from the original design. Unless otherwise stating in the contract documents, the Contractor shall be responsible for providing as-built survey data from a licensed surveyor.
F. Errors or omissions found on the construction drawings shall be reported to the Engineer for clarification prior to commencing the work.

G. METHOD OF MEASUREMENT: Construction staking shall be measured as a percentage of lump sum of completed and accepted work, upon completion of all staking.

H. BASIS OF PAYMENT: Payment for this work shall be made at the percentage of the contract lump sum price bid for "Contractor Construction Staking", which shall include all staking and property corner resetting.

S-1105 FIELD OFFICE: This work shall consist of providing a field office according to these Specifications, and the Plans. The field office shall be provided at the work site by the Contractor. The office may be a part of the Contractor's own office space provided the requirements of the appropriate section of the Standard Specification regarding field office and laboratories for Type C office are met and provided the Engineer's field office space is separate and exclusively for the Engineer's use. In addition to the requirements for a Type C office, the following additional services shall be provided:

A. The Contractor shall furnish a satisfactory and dependable source of electricity for power and lights (110 Volts A.C.). There shall be a minimum of six (6) electrical outlets spaced throughout the building and two (2) light fixtures that are so spaced that they will uniformly light the entire interior.
B. The field office shall have sufficient heat and air conditioning which shall be maintained at all times.

C. METHOD OF MEASUREMENT: The "Field Office" shall be measured per each completed and accepted item, based on the percentage of the project completed.

D. BASIS OF PAYMENT: The “Field Office” shall be paid for per each item, measured as stated above.

S-1106 MODIFIED SUBGRADE: This work shall consist of constructing one or more courses of a mixture of soil, fly ash or cement, and water, in accordance with these specifications. All fly ash or cement materials and water used for modified subgrade shall conform to the requirements of Section 2005 of the KDOT Standard Specifications for State Road and Bridge Construction.

A. GENERAL: The purpose of this specification is to secure a completed section of treated material which contains a uniform mixture of fly ash or cement and pulverized material with no loose or segregated areas, has a uniform density and moisture content, and is well bound for its full depth. Proof-rolling with a loaded tandem dump truck which has a minimum GVW of 25 tons (50,000 lbs) will be required immediately prior mixing operations. It shall be the responsibility of the Contractor to regulate the sequence of his work; to process a sufficient quantity of material to provide full depth as shown on the Plans, or as directed by the Engineer; to use the proper amounts of fly ash or cement; to maintain the work; and to rework areas as necessary to meet the above requirements. It may be necessary to repeat the mixing process with one or more passes with the mixer to achieve the desired uniformity of the material for appropriate pulverization and for sufficient moisture for the entire length of the area being manipulated.

1. Fly ash or cement mixing operations shall not be performed when the subgrade is frozen or when the ambient air temperature is less than 40° F. The Contractor shall be responsible for the protection and quality of the modified subgrade mixture under any weather conditions.
2. The subgrade shall be brought within reasonably close conformity to the line and grade shown on the Plans. The subgrade material shall be pulverized through use of the equipment specified in Section 303 of the KDOT Standard Specifications for State Road and Bridge Construction. Depth of pulverization shall be as designated by the Engineer. The pulverized subgrade material and fly ash shall be mixed thoroughly until a uniform mixture is obtained. All clods shall be reduced in size by mixing until the pulverized subgrade material mixture meets the following size requirement when tested.

Sieve Size	Percent Retained
1 1/2" (38 mm)	0
1/2" (12.5 mm)	50 max.

3. Prior to application of fly ash or cement, the moisture content of the pulverized subgrade material shall be adjusted so that following the application of fly ash or cement; the moisture content of the mixture is within the range specified. If the moisture content of the pulverized material is below the required limit, water shall be added and blended thoroughly with the material by continued mixing. The addition of water in the mixing drum of the stabilizing unit during incorporation of fly ash or cement is acceptable providing it can be demonstrated that adequate control of moisture content can be maintained.
4. The amount of fly ash or cement to be used for modification shall be established by the Engineer and shall be stated in the bid item. If not stated, fly ash shall be furnished and installed at 8" depth, 15% by volume of subgrade material. Cement shall be furnished and installed at 8" depth, 5% by volume of subgrade material.
5. Final moisture content of the mix, immediately prior to compaction shall be uniform and not exceed plus or minus three percentage points of the optimum moisture content of the mix. If the moisture content exceeds the specified limits,

additional fly ash or cement may be added to lower the moisture content to the required limits. Lowering the moisture content by aeration following addition of fly ash or cement will not be allowed. If the moisture contents are below the specified limits, additional water shall be added and uniformly blended with the mixture. Additional fly ash or cement added to lower the moisture content shall be at the expense of the Contractor.

6. If necessary, immediately prior to application of fly ash or cement, the roadway shall be scarified to allow uniform distribution of material.
7. The fly ash or cement shall be spread in an approved manner at the rate specified. Care shall be taken to prevent the fly ash or cement from flowing off the area to be treated.
8. The fly ash or cement shall be distributed at a uniform rate in such a manner as to minimize the scattering of material by wind. Fly ash or cement shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing material becomes objectionable to adjacent property owners or significantly reduces the amount of material incorporated into the work.
9. When required by the Plans, or by the Engineer, retarder shall be applied immediately following distribution of fly ash or cement by an approved distributor capable of providing the specified rate of application. The retarder can be diluted with mix water to ensure more uniform application provided initial soil moisture contents are at a suitable level to accommodate the additional water. Retarder shall be subsidiary to subgrade modification.
10. The pulverized subgrade material shall be thoroughly mixed and the mixing continued until a homogeneous, friable mixture of pulverized subgrade material meets the specified size requirements is obtained.
11. Compaction of the mixture shall begin immediately after mixing and confirmation that the moisture content is within the specified range. Mixing shall be completed within 1/2 hour following incorporation of fly ash or cement. The material shall be sprinkled as necessary to maintain the specified moisture content. Compaction of the mixture shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted with a sheepsfoot to the specified density.
12. All non-uniform (too wet, too dry or insufficiently treated areas which appear shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping and recompacting.
13. The stabilized section shall be compacted to a minimum of 95 percent of the combined materials maximum dry density as determined in accordance with KDOT Standard Specifications for State Road and Bridge Construction Section 2500.
14. In addition to the requirements specified for density, the section shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, the Engineer may require it be reworked as necessary to meet those requirements and/or require the Contractor to change his construction methods to obtain required density on the next section. Additional fly ash cement will be added to the areas that are reworked at no additional cost to the owner, and the amount required will be established by the Engineer. Should the section, due to any reason or cause, lose the required stability, density and finish before the surface is placed or the work is accepted, it shall be reprocessed, recompacted and refinished at the sole

expense of the Contractor. Reprocessing shall follow the same patterns as the initial stabilization including the addition of fly ash or cement.

15. Compaction on the surface of each section shall be completed within two hours after incorporation of the fly ash or cement. Any areas failing to meet this requirement will be rejected and shall be reprocessed.
16. Following the compaction of the stabilized section, the treated section will be trimmed to the required lines and grade. The surface shall then be compacted with a smooth wheel or pneumatic tired roller. During finishing operations the surface will be lightly scarified and bladed to a uniform grade and cross section to eliminate any imprints left by the equipment.
17. After the modified subgrade section has been finished as specified herein, the surface shall be protected against damage. No equipment or vehicles, except a water truck, are permitted on the finished surface during the 3 day cure period. The surface shall be protected against rapid drying by either of the following curing methods for a period of not less than three days:
    - Maintain in a thorough and continuously moist condition by spraying with water during the entire 3 day cure period.
    - Apply an asphaltic prime coat.
18. Proof rolling of the modified subgrade section will be required after the three day curing period with a loaded tandem dump truck which has a minimum GVW of 25 tons (50,000 lbs) for acceptance of finished grade.

B. METHOD OF MEASUREMENT: “Modified Subgrade” will be measured by the square yard of completed and accepted work.

C. BASIS OF PAYMENT: The amount of completed and accepted work shall be paid for at the Contract unit price, per square yard, of “Modified Subgrade”.

S-1107 FLOWABLE FILL: This work shall consist of furnishing all labor, equipment, tools, and materials and the performance of all work necessary to install a fly ash slurry backfill for a trench or utility cut.

A. MATERIALS:

1. No material shall be used until it has been checked or tested for compliance with these specifications and approved by the Engineer. Representative samples of all materials proposed for use under these specifications shall be submitted to a private laboratory by the Contractor, at the Contractor's expense, for testing and preparation of trial mixes to determine the mix design. All tests necessary for determining conformance with the requirements specified herein will be at the Contractor's expense.
2. The slurry for use in installation of fly ash backfill shall conform to the following requirements:

   - Fly ash shall conform to ASTM C618, Class C
   - Fine aggregate shall conform to ASTM C33
   - Mixing water shall conform to ASTM C94
   - Admixtures for retarding or accelerating the set shall only be used when approved by the Engineer.

B. MIXING AND PROPORTIONING:

1. Fly ash slurry mixtures shall consist of Class C fly ash, fine aggregate, a retarder or accelerator, and water.
2. Laboratory test specimen(s) of the slurry mix, combined in proportions of the job mix design, shall be prepared and tested and shall meet the following requirements:

Removable:

28-day Compressive Strength:	75 psi (min) - 125 psi (max)
Final Set, ASTM C266:	2 hrs (max)
Flow:	18.00 in (+/-) 4.00 in.

Mix Design (+/-):

Cement.. ..... ….50 lbs.
Water.. ..... …375 lbs
Sand..... …..2619 lbs
A/E.. .....…...14% (min) – 20% (max)
Class C Fly Ash ……75 lbs

Non-Removable:

28-day Compressive Strength:	400 psi (max)
Final Set, ASTM C266:	2 hrs (max)

Mix Design (+/-):

Cement.. .....……...100 lbs
Water.. .....……..417 lbs
Sand.....…..…… .2766 lbs
A/E.. .....……..4 %
Class C Fly Ash …….300 lbs

C. CONSTRUCTION DETAILS:

1. At the time of delivery, the slurry shall not be less than 50 degrees or more than 90 degrees.
2. Flowable fill shall not be placed on frozen material nor be used to displace water. It shall be placed to fill the voids and to the grades shown on the plans or directed by the Engineer. It shall not be used to displace or replace pavement materials.
3. Flowable fill shall cure a minimum of 12 hours prior to backfilling or paving operations.

D. METHOD OF MEASUREMENT: "Flowable Fill" shall be measured per cubic yard of completed, in-place, and accepted work.

E. BASIS OF PAYMENT: "Flowable Fill" shall be paid for at the contract unit price, measured as stated above.

S-1108 GUARD FENCE: This work shall consist of the construction of guard fence, and the removal and resetting of guard fence in accordance with these Specifications and as shown on the Plans or as directed by the Engineer.

A. When steel plate guard fence is required by the Plans and Contract, any one of the types of steel plate guard fence included in the Plans may be furnished.

B. Erection of Guard Fence: Holes for guard fence posts shall be excavated to the required depth. The holes shall be of sufficient size to permit adequate compaction of the backfill around the posts.

1. Guard fence posts may be set by driving. Post caps that are designed to protect the post from detrimental crushing shall be used during driving operations. If in the opinion of the Engineer, the post or shoulder is being damaged, or unacceptable line and grade is obtained, the Contractor shall excavate for the erection of the posts.
2. The posts shall be set plumb, firm, and true to the lines and grades established. The backfill around the posts shall be placed in thin layers and thoroughly compacted. The top of the backfill shall be of the same material that is used in the construction of the shoulders and the thickness shall be at least equal to the thickness of the shoulder at that point unless otherwise specified by the Engineer. The cost of all excavation and backfill material shall be considered as subsidiary to other items of the Contract.
3. The guard fence cables, plates, shapes, and fittings shall be placed and fastened in accordance with the details shown on the Plans.
4. Guard fence which is removed and is reused on the project shall be thoroughly cleaned of all asphalt material, paint, mud, dirt, etc. prior to erection. The guard fence shall be punched or drilled so as to accommodate the revised post spacing as indicated on the Plans. When guard fence is required to be cut, the cut shall be made by sawing. All such holes and cuts shall be treated with zinc dust paint so as to prevent rusting. The required treated wood or steel blocks shall be subsidiary to the item of reconstruction of steel plate guard fence.

C. Removal of Guard Fence: Guard fence shall be carefully disassembled and guard fence posts shall be dug out or pulled in a manner that will prevent undue injury to the fence, fittings, and posts. The material shall be stored in neat piles at an accessible location on the project approved by the Engineer and shall remain the property of the owners.

1. All galvanized rail elements, end sections and accessories shall be stored in a manner to prevent galvanic action. While in storage the material shall not be in direct contact with the soil and there shall be a minimum of six inches of space between the lowermost element and the ground surface. The material may be stored in the open providing it is properly separated, stacked, and drained.
2. Galvanized surfaces which have been abraded so that the base metal is exposed, threaded portions of all fittings and fasteners and cut ends of bolts shall be protected in a manner as may be specified or directed.
3. The Contractor shall be responsible for the condition of the material in storage. Any material which, in the opinion of the Engineer, shows detrimental galvanic action may be rejected at the time of erection.

D. Reconstruction of Guard Fence: Guard fence and accessories to be reconstructed will be furnished by the owners from a storage site on or near the project or at locations indicated on the Plans. The reconstruction of guard fence shall conform to the methods described above for the construction of new guard fence. All steel plates and fittings for steel plate guard fence required to be reset or reconstructed shall be given two coats of

field paint after resetting or reconstruction, unless otherwise designated on the Plans or in the Specifications. The steel plates and fittings shall be painted with white paint, the first coat tinted, the second untinted. Any surfaces which will be inaccessible to painting after erection shall be field painted before erection.

E. METHOD OF MEASUREMENT: The construction, removal, reconstruction, or removal and reconstruction of guard fence shall be measured by the linear foot. Each separate run of fence shall be measured from center of end post to center of end post along the rail or may be determined by recording the number of standard length panels actually installed. Terminal devices, as specified on the plans, shall be measured per each Terminal Device.

F. BASIS OF PAYMENT: The amount of completed and accepted work, measured as stated above, shall be paid for at the contract unit price per linear foot for "Guard Fence, *type*", "Removal of Steel Plate Guard Fence", "Removal and Reconstruction of Guard Fence, *type*", or “Terminal Device, *type”*.

S-1109 MODULAR CONCRETE RETAINING WALL: The work covered by this section includes the furnishing of all labor, materials, equipment and incidentals for construction and installation of a modular concrete retaining wall including drainage materials as shown on the Construction Drawings or as described by the Contract Specifications. The work included in this section consists of, but is not limited, to the following:

- Excavation and foundation soil preparation.
- Furnishing and placement of the leveling base.
- Furnishing and placement of drainage system at the base of the wall.
- Furnishing and placement of modular unit wall facing units.
- Furnishing and compaction of infill, drainage and retained soils.

A. Work under this section shall be performed in accordance with the sections of the Standard Specifications regarding Classification and Proportioning of Portland Cement Concrete and Concrete Structure Construction, and with the following ASTM Standards:

- ASTM C 90 - Standard Specification for Load-Bearing Concrete Masonry Units
- ASTM C 140 - Standard Methods of Sampling and Testing Concrete Masonry Units
- ASTM D 4751 - Standard Test Method for Apparent Opening Size

B. DEFINITIONS:

- MODULAR CONCRETE RETAINING WALL UNITS are dry-cast solid concrete units that form the external fascia of a modular unit retaining wall system.
- COPING UNITS are the last course of concrete units used to finish the top of the wall.
- INFILL soil is a specified soil that is placed directly behind the drainage soil and within the reinforced zone, if applicable.
- RETAINED SOIL is an in-situ soil or a specified soil that is placed behind the wall infill soil. Typically, the retained soil is native soil unless otherwise specified.
- FOUNDATION SOIL is the in-situ soil beneath the wall structure.
- DRAINAGE SOIL is a free draining soil with natural soil filtering capability, or a free draining soil encapsulated in a suitable geotextile, or a combination of free draining soil and perforated pipe all wrapped in a geotextile, placed directly behind the modular concrete units.
- DRAINAGE PIPE is a perforated polyethylene pipe used to carry water, collected at the base of a soil retaining wall, to outlets in order to prevent pore water pressures from building up behind the wall facing modules.
- NONWOVEN GEOTEXTILES are permeable synthetic fabrics formed from a random arrangement of fibers in a planar structure. They allow the passage of water from one soil medium to another while preventing the migration of fine particles that might clog a drainage medium.

C. DIMENSIONS: All values stated in metric units shall be considered as accurate. Values in parenthesis stated in English units are the nominal equivalents.

D. MODULAR CONCRETE RETAINING WALL UNITS:

1. Type 1 concrete wall modules shall be produced by a licensed manufacturer, such as Anchor Wall or Keystone or an approved equal.
    a. Concrete wall units shall meet the requirements of ASTM C1372, except the maximum water absorption shall be limited to 7 percent, and the unit height dimensions shall not vary more than plus or minus 1/16 inch from that specified in the ASTM reference, not including face texture.
    b. Unit face area shall not be less than 0.67 square feet.
2. Type 2 concrete wall modules shall be produced by a licensed manufacturer, such as Redi-Rock or an approved equal.
    a. Concrete wall units shall meet the requirements of ASTM C94, ACI 301-99, and the minimum specifications of the following table:

Climate	Air Content	Compressive Strength	Slump (in.)	Minimum Concrete Temperature at placement (F)
Severe	4½% - 7½%	4000	3-5	50º

Note: All material used in wall units must meet applicable ASTM and local requirements for exterior concrete.

    b. Exterior dimensions shall be uniform and consistent. Maximum dimensional deviations shall be ¾", not including the textured face.
    c. Wall units shall provide a minimum total weight of 140 pounds per cubic foot.
    d. Exposed face shall be finished as Split Limestone or approved alternate. Other surfaces shall be smooth form type. Dime-size bugholes on the block face may be patched and/or shake on color stain can be used to blend into the remainder of the block face.

E. INFILL SOIL: The infill soil shall consist of free draining sands or gravels with less than 5% passing the 75 *u*m (#200) sieve size or as specified in the Construction Drawings. The suitability of the infill soil for use with the wall shall be determined by the Engineer.
F. RETAINED SOIL: The retained soil shall be on site soils unless specified otherwise in the Construction Specifications or as directed by the Engineer. If imported fill is required, it shall be examined and approved by the Engineer.
G. FOUNDATION SOIL: The foundation soil shall be on site soils, subject to approval by the Engineer.
H. LEVELING BASE MATERIAL: The footing material shall be well-graded (GW – Unified Soil System) compacted crushed stone, or a concrete leveling base, or as shown on the construction drawings.
I. DRAINAGE MATERIAL (if required):
The drainage pipe shall be 4 in. diameter perforated PVC pipe wrapped in a nonwoven geotextile, or as specified on the Construction Drawings. The nonwoven geotextile shall be a 100% continuous filament polyester nonwoven needle punched engineering fabric or as specified on the Construction Drawings. Although selection of the appropriate geotextile specifications is site soil specific, a commonly used geotextile for filtration will have an Apparent Opening Size ranging between U.S. Sieve Sizes 70 to 100 and a minimum unit weight of 5.0 oz./square yard. The coefficient of permeability will typically range between 0.16 to 0.24 in./second.
J. DRAINAGE SOIL:

1. The drainage soil shall be well draining compactable aggregate, 0.25 in. to 1.5 in., with no more that 5% passing a #220 sieve, or as shown on the construction drawings.

K. DELIVERY, STORAGE, AND HANDLING:
1. The Contractor shall check the materials upon delivery to assure proper material has been received. The contractor shall prevent excessive mud, wet cement, and like materials from coming in contact with the materials. The contractor shall protect the materials from damage. Damaged material shall not be incorporated in the project.

L. SITE PREPARATION:
1. The foundation soil shall be excavated or filled as required to the grades and dimensions shown on the Construction Drawings or as directed by the Engineer.
2. The foundation soil shall be proof rolled and examined by the Engineer to ensure that it meets minimum strength requirements according to the design assumptions. If unacceptable foundation soil is encountered, the contractor shall excavate the affected areas and replace with suitable quality material under the direction of the Engineer.
3. In cut situations, the native soil shall be excavated to the lines and grades shown on the Construction Drawings and moved off site or to a suitable location for reuse as retained soil, if applicable. Site preparation shall be either Unclassified Excavation or Compaction of Earthwork as applicable.

M. INSTALLING DRAINAGE SYSTEM:
1. The approved non-woven geotextile shall be laid over the prepared foundation soil with its edge extending at least 3 feet beyond the toe of the wall. The geotextile shall be extended towards the back of the excavation, up the excavation face and on top of the infill soil back to the retaining wall or as shown in the Construction Drawings.
2. The drainage pipe shall be place behind the leveling base, or lower course of facing units as shown in the Construction Drawings or as directed by the Architect or Engineer. The pipe shall be laid at a minimum gradient of 1% to ensure adequate drainage to free outlets.
3. T - Sections and outlet pipes shall be installed on the drainage pipe at 50 ft. centers.
4. The remaining length of geotextile shall be pulled taut and pinned over the face of the retained soil. Geotextile overlaps shall be a minimum of 1 ft. and shall be shingled down the face of the excavation in order to prevent the infiltration of retained soil into the wall infill.

N. LEVELING BASE OR SPREAD FOOTING PLACEMENT: The leveling base material shall be placed and compacted crushed stone, or vibrated concrete along the grades and dimensions shown on the Construction Drawings or as directed by the Engineer. The minimum thickness of the leveling base shall be 6 in.

O. INSTALLATION OF MODULAR CONCRETE RETAINING WALL UNITS:
1. The bottom row of retaining wall modules shall be placed on the prepared leveling base as shown on the Construction Drawings. Care shall be taken to ensure that the wall modules are aligned properly, level and in complete contact with the base material.
2. The backfill in back of the base row shall be placed and compacted to firmly lock them in place.
3. The wall modules above the bottom course shall be placed such that the tongue and groove arrangement provides the design batter (i.e. setback) of the wall face

and that each course is offset from the seams of the blocks below. The minimum batter for Type 1 Modular Retaining Wall Units shall be 7º (1" horizontal to 8" vertical). The minimum batter for Type 2 Modular Retaining Wall Units shall be 4º (1¼" horizontal to 18" vertical).

4. The wall modules shall be swept clean before placing additional levels to ensure that no dirt, concrete or other foreign materials become lodged between successive lifts of the wall modules.
5. The Contractor shall check the level of wall modules with each lift to ensure that no gaps are formed between successive lifts that may affect the pullout resistance of geogrid reinforcement, if applicable.
6. Care shall be taken to ensure that the wall modules are not broken or damaged during handling and placement.

P. DRAINAGE SOIL:
1. The drainage soil will be placed behind the retaining wall modules with a minimum thickness of 1 ft. and separated from other soils using the approved nonwoven geotextile.
2. Drainage soil shall be placed behind the wall facing in maximum lifts of 6 inches and compacted to a minimum density of 95% Standard Proctor.
3. No heavy compaction equipment shall be allowed within 3 ft. of the back of the wall fascia.

Q. RETAINED SOIL:
1. Retained soils shall be placed and compacted behind the drainage soil, or infill soil if applicable, in maximum lift thickness of 6 in. The retained soils shall be compacted to a minimum density of 95 % Standard Proctor.
2. No heavy compaction equipment shall be allowed within 3 ft. of the back of the wall modules.

R. FINISHING WALL:
1. Coping units shall be secured to the top of the wall with a 3/8 in. bead of butyl tape or concrete adhesive positioned in front and behind the tongue of the last course of retaining wall units.
2. Finish grading above the wall to direct surface run off water away from the top of the wall with a soil of low permeability.

S. METHOD OF MEASUREMENT: "Modular Concrete Retaining Wall" shall be measured per square foot of wall face above the leveling base (or spread footing). The leveling base (or spread footing) and the drainage system shall be subsidiary to the installation of the wall. Site Preparation shall be measured as Unclassified Excavation or as Compaction of Earthwork, whichever is applicable.

T. BASIS OF PAYMENT: "Modular Concrete Retaining Wall" shall be paid for at the contract unit price per square foot of wall face measured as stated above. The contract unit price shall include the cost of all labor, materials and equipment necessary to install the Modular Wall.

S-1110 LAND CORNER MONUMENT BOX: This work shall consist of referencing existing monuments prior to disturbance by construction and removal, and resetting of the monument and box, and of installing new monuments at government corners where monuments did not previously exist. Before any construction activity starts in the immediate area of an endangered Public Land Survey System (PLSS) corner, recover all endangered section corners and accessories of the PLSS on the project. Endangered PLSS corners are those defined by the Kansas Statues and/or shown in the Contract Documents as lying within the range from the project centerline to a distance 100 feet (30m) outside the construction limits, throughout the length of the project. Establish a minimum of 6 reference ties for each endangered PLSS corner. Each reference tie must be a direct measurement to a precise (hard defined) point. (Specify Slope or Horizontal Measurement) Complete a Land Survey Reference Report marked as a “Notice of Endangered Activity” for each endangered PLSS corner. File the reports with the appropriate governmental custodian responsible for maintaining those records, as required by Kansas Statues. Provide the engineer with copies of the completed reports.
At locations shown on the Plans, the Contractor shall install a new monument at a government corner, or reestablish and reset the land corner monument that is disturbed by construction operations under this Contract. All land surveying shall be performed by land surveyors registered by the State of Kansas. The land surveyor shall submit a Land Surveyor Reference Report to the Secretary of State of Kansas. The new or reset monument shall conform to the Standard Details and shall be protected by an adjustable cast iron box similar and equal to Neenah Catalog No. R-1968 Type 36-B. Installation of the monument box shall be as shown on the Plans. Prior to disturbing the existing monument (whether a reinforcing bar, other informal monumentation, or an actual monument per City spec), the Contractor shall be responsible for establishing reference ties to aid in resetting the monument. A licensed surveyor shall establish the reference ties.

A. METHOD OF MEASUREMENT: "Land Corner Monument Box" shall be measured per each completed and accepted installation.

B. BASIS OF PAYMENT: "Land Corner Monument Box" shall be paid for at the contract unit price for each "Land Corner Monument Box", complete and in place.

S-1111 PAINTING OF METALLIC FIXTURES (EXTERIOR): The work covered by this section includes the furnishing of all labor, materials, equipment and incidentals for preparation of fixtures and application of a paint system to the fixtures as shown on the Construction Drawings or as described by the Contract Specifications. The work included in this section consists of, but is not limited to, the following:

- Removing the existing paint system from the fixture
- Applying a complete new paint system to the fixture
- Clean-up of all material from the existing paint system.
- Erecting construction fencing or other protection measures as required to prevent damage to vehicles and other property adjacent to the fixtures.
- Clean-up of the construction area.

A. Work under this section shall be performed in accordance with these specifications, and the requirements of AWWA C 210-84.
B. DIMENSIONS:
   1. All dimensions shall be in the English system.
C. PAINT SYSTEM:
   1. The Paint System shall consist of a primer and two topcoats. The Primer shall be specified in the Special Conditions for the particular project. The Topcoats shall be specified in the Special Conditions for the particular project.
D. PREPARATION OF FIXTURES:
   1. Surface shall be cleaned to meet the Steel Structures Painting Council Specification SSPC-SP-3 (Power Tool Cleaning). When viewed without magnification the surface shall be free of all oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining which shall be limited to no more than five percent of each square inch (square cm) of surface area and may consist of slight shadows, slight streaks, or minor discoloration caused by stains of rust, mill scale, or previously applied paint.
   2. After cleaning of the surfaces, the surfaces shall be brushed with clean brushes, blown off with clean compressed air, or cleaned by vacuum to remove any trace of dust and debris from the surface, and also from pockets and corners. The prime coat shall be applied to the cleaned surfaces within twelve hours after cleaning. If cleaned surfaces appear rust tinged before coating is accomplished, they shall be re-cleaned by the Contractor at his expense.
E. INSTALLING PAINT SYSTEM:
   1. No component of the paint system shall be applied when the ambient air temperature is below 45° F. (18° C.), when the air is misty, when the surface temperature of the fixture is 5° F. (-15° C.) or less above the dew point or when, in the opinion of the Engineer, conditions are not satisfactory for the work. It shall not be applied upon damp or frosted surfaces. Application shall cease when the surface temperature of the fixture is below 50° F. (10° C.) or above 135° F. (57° C.) Application shall cease when there is sufficient wind to carry paint material (over-spray) beyond the area where the contractor has provided protection for any type of traffic.
   2. The sequence of work shall be arranged so as to provide ample time for each paint coating to dry before the next coat of paint is applied. In no case shall a coat of paint be applied until the previous coat has been inspected by the Engineer and found to be dry and hard throughout the entire film thickness.

3. Application rates for the particular paint system shall be specified in the Special Conditions. Any product substituted on an “Or Equal” basis shall be applied at the manufacturer’s recommended rate.

F. PROTECTION OF PROPERTY:
   1. The Contractor shall protect pedestrian, vehicular and other traffic near the work area, and all adjoining property against damage or disfigurement by spatters, splashes, smirches and spray of paint materials. Any damage so resulting shall be entirely the responsibility of the Contractor.

G. MAINTAINING TRAFFIC:
   1. Traffic lanes for vehicles shall remain open at all times unless the fixture is within three (3) feet of the lane. Pedestrian ways may be blocked as needed so long as pedestrians can detour around the work area without entering a traffic lane or adding more than 100% to the length of travel.
   2. Disruption of parking areas shall be held to a minimum.

H. MIXING OF PAINT/PRIMER:
   1. The paint or primer shall be mixed in accordance with the manufacturer’s recommendation. Manufacturer’s technical data sheets regarding mixing and application rates shall be submitted at the time of delivery.

I. APPLICATION:
   1. The paint system shall be applied in accordance with the manufacturer’s recommendations so as to produce a tight uniform coating in close contact with the metal and shall be worked into all corners and crevices. The coating shall be applied so that it is free of dry spray, runs, sags, and other defects.
   2. Painting shall be done in workmanlike manner using conventional or airless spray equipment unless otherwise recommended by the manufacturer.

J. METHOD OF MEASUREMENT: “Painting of Metallic Fixtures (Exterior)” shall be measured per each fixture painted, complete and accepted.

K. BASIS OF PAYMENT: “Painting of Metallic Fixtures (Exterior)” shall be paid for at the contract unit price per each fixture, measured as stated above. The contract unit price shall include the cost of all labor, materials and equipment required to install the paint system in accordance with these specifications.

S-1112 PROJECT SIGN: This work shall consist of having project sign(s) installed on the project site in the numbers indicated on the Plans. The sign shall be manufactured by a reputable, professional sign maker, as indicated on the Standard Details. The sign shall be installed at a location approved by the Engineer prior to construction commencing on the project.

A. METHOD OF MEASUREMENT: "Project Sign" shall be measured per each for completed and accepted work.

B. BASIS OF PAYMENT: "Project Sign" shall be paid for at the contract unit price per each "Project Sign".

S-1113 <u>STACKED STONE RETAINING WALL</u>: This work shall consist of constructing retaining walls of stacked stone at locations shown on the Plans and in accordance with the Plans or Standard Details. Stone and mortar (if used) shall meet the requirements of the section of this specification titled “Stone Masonry”.

A. METHOD OF MEASUREMENT: "Stacked Stone Retaining Wall" shall be measured per square foot of wall face, above the top of the footing (or subgrade if no footing is used), of completed and accepted work.

B. BASIS FOR PAYMENT: Payment for retaining walls shall be made at the contract unit price bid per square foot for "Stacked Stone Retaining Wall", measured as stated.

S-1114 <u>SURGE ROCK</u>: This work shall consist of furnishing and placing all materials for the installation of Surge Rock as directed by the Engineer, as shown on the Plans, and/or as shown on the Standard Details. Surge Rock shall be 6” crusher run crushed aggregate. Do not install Surge Rock during rainfall or snowfall. Do not install on frozen ground.

A. METHOD OF MEASUREMENT: "Surge Rock" shall be measured by the ton of material, in place. When Surge Rock is installed, excavation and removal of unsuitable material and compaction of the Surge Rock shall be subsidiary to Surge Rock.

B. BASIS OF PAYMENT: "Surge Rock" shall be paid for at the contract unit price, measured as stated above.

S-1115 PEDESTRIAN RAIL: This work shall consist of the furnishing and erection of steel Pedestrian Rail in accordance with these specifications and as shown on the Plans or established by the Engineer.

A. Shop drawings (maximum size 22” x 34”) shall be submitted to the Engineer for approval on all types of handrail before the materials are ordered or fabricated.
B. The “Pedestrian Rail” shall be constructed in accordance with the details shown on the Plans or established by the Engineer. Unless otherwise provided the vertical members shall be constructed truly vertical and the horizontal members to the grades indicated. All material for the “Handrail”, including anchor bolts, shall conform to the requirements of the Standard Specifications.
C. The anchor bolts shall be set with a template to insure proper alignment. The template and methods used by the Contractor shall meet with the approval of the Engineer. That portion of the anchor bolts exposed above the finish line of concrete shall be suitably protected by wrappings, grease, or heavy oil during the pouring of concrete.
D. All pedestrian rail material shall be stored at the site above the ground on platforms, skids, or other supports with proper spacer blocks to keep tubing separated. The materials shall be kept free from grease, dirt, and contact with dissimilar metals, and protected as far as practical from moisture until they have been properly installed.
E. All fabrication, welding, casting, erection, and painting shall conform to the applicable portions of the section of the Standard Specifications dealing with Structural Steel Construction. All steel handrail shall have a duplex coating system with a finish coat of black. Galvanize all handrail components in accordance with ASTM A123, prepare galvanized surfaces in accordance with ASTM D6386, apply Sherwin Williams Recoatable Epoxy Primer with a dry film thickness of 4.0-6.0 mils, apply Sherwin Williams Hi-Solids Polyurethane with a dry film thickness of 3.0-5.0 mils or approved equals unless otherwise specified in the plans. Field painting of steel handrail shall be in accordance with the provisions for painting structural steel unless otherwise shown in the Plans.
F. The rail shall be set accurately to a transit line and if the posts are of a type having base plates or flanges, they shall be set to grade by the use of shims between the posts and the concrete or base templates. Shims of 1/8 inch thickness or greater may be of either steel or sheet lead, but the thickness of steel shims or plates shall be such that no more than one is required at each post.

G. METHODS OF MEASUREMENT: "Pedestrian Rail" shall be measured per linear feet of top rail complete and in place.

H. BASIS OF PAYMENT: "Pedestrian Rail" shall be paid for as the amount of completed and accepted work, measured as stated above, at the contract unit price per linear foot, which payment shall constitute full compensation for all labor, materials, and equipment required to fabricate and install the handrail.

S-1116 CORE DRILLING AND REINSTATEMENT PROCEDURES:

A. CORING PROCESS: Orientation marks shall be painted onto pavement surface (through the cut of the core) and the coring unit shall be secured and adjusted to ensure that the core is cut level and perpendicular to the horizon and not the pavement surface. A coffer dam or boom shall be used around the location to collect all water and cutting debris. A vacuum unit shall be used to collect all debris.

B. VACUUM EXCAVATION, REPAIR AND BACKFILL: With clear access through the hard surface, vacuum excavation to expose the infrastructure and subsequent repair or inspection portion of the work may proceed. Once complete, the utility shall be padded with the appropriate material as per the utility owners' specification. The hole shall be backfilled within 1-2 inches below the base of the pavement using flowable fill. If the utility is missed by a small amount, a second intersecting core may be cut and both cores reinstated at the same time, per these specifications.

C. REINSTATEMENT PROCESS:

1. The core(s), or coupon(s), removed from the pavement using the rotary cutter shall be reinstated as a permanent repair using Utilibond (or approved equal), after the hole has been properly filled. The first step of reinstating is to properly prepare/clean the cored hole. Wipe clean all cut surfaces of the core and walls of the hole with a clean, damp cloth to remove all loose cutting debris and particulate from the cut surface. Proper bonding depends on achieving a clean surface for the bonding agent to adhere to.
2. Line the bottom of the hole with a 1" – 2" bed of pea gravel. Because the pea gravel is added fill that was not present before, the flowable fill should be left approximately 2 inches lower than the base of the pavement. Undercut the bottom of the existing pavement in the hole about 1" all around to allow the pea gravel to fill under the pavement. Utilibond will impregnate the pea gravel and create a solid base / plug for the core to bond to. The pea gravel will help to compensate for any irregularities (protrusions or indentations) on the bottom of the core.
3. Following the orientation mark on the core and pavement, lower the core back into the hole and check for level and flushness with the existing pavement. Adjust the pea gravel until the core is approximately 1/8" – ¼" below the surface of the surrounding pavement. If necessary, remove the core and carefully adjust the pea gravel as needed.
4. Prepare the bonding compound as per instructions on the package (if the mix is too thick the core will not be able to displace the Utilibond on reinstatement, and if the mix is too thin, the Utilibond will all be displaced and not support the core once it is flush and level with the road).
5. Slowly and carefully, from a height just above the hole, so as not to disturb the pea gravel. Pour the entire pail of Utilibond permanent pavement bonding compound into the hole.
6. Again, following the orientation marks slowly lower the core down into the hole, on top of the Utilibond.
   Rock the core gently back and forth with the core puller, to allow the bonding compound to flow up though the cut spaces around the core (the "kerf"), and out onto the surface of the pavement.

Gently and carefully apply pressure to the top of the core, to get the core level with the pavement being very careful NOT to push the surface of the core below the level of the pavement. Put a board over the core and lightly tamp it to grade

7. Using a trowel, carefully clean off the excess Utilibond from the surrounding pavement before it dries.
   Use a wet whitewash brush to keep the exposed areas of Utilibond in the kerf and in the center pilot hole “wet” while carefully cleaning off the excess Utilibond from the surrounding surfaces.
8. Once the Utilibond has hardened, and gained initial strength use water (high pressure is recommended) to clean off any excess debris and thoroughly sweep the area before leaving.

S-1117 AGGREGATE BASE (AB-3) (PUGGED): The Kansas Standard Specifications for State Road and Bridge Construction, Sections 305 and 1104 shall govern except as otherwise modified herein. This work shall consist of the furnishing of all required equipment, materials and labor necessary to install Pugged Aggregate Base (AB-3) at the locations and thickness shown on the plans unless otherwise specified.

A. METHOD OF MEASUREMENT: Aggregate Base (AB-3) (Pugged) shall be measured by the square yard (of the thickness specified) in place as designated on the plans, per the dimensions measured by the Engineer.

B. BASIS OF PAYMENT: Aggregate Base (AB-3) (Pugged) shall be paid for per square yard of completed and accepted work as measured above.

(END)