

APPENDIX J

Construction Specifications

**SPECIFICATIONS
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<u>Spec. No.</u>	<u>Description</u>
02811	Landscape Irrigation System
16500	Residential Roadway Lighting System

SECTION 02811

LANDSCAPE IRRIGATION SYSTEM

PART 1 -- GENERAL

1.01 SCOPE OF WORK

- A. The CONTRACTOR shall construct a multi-row automatic irrigation system, complete and operable, all in accordance with the requirements of the Contract Documents.
- B. Said irrigation system shall include but not be limited to all pipes, fittings, sprinklers, valves, automatic control valves, controllers, valve boxes, drain valves, hose bibb valves, operating wrenches, riser assemblies, direct burial wires, electrical connections, wiring and other appurtenances, piping, connections, testing, cleaning-up, maintenance and adjustments necessary for a complete operating system, ready for immediate use upon completion. Minor items necessary for proper construction and functional operation of this system, not specifically described in the Contract Documents, shall be included as a part of the work of this Section.
- C. All systems shall be designed and construction to meet current City of West Jordan water conservation measures outlined in the Municipal Code 16-10-060.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Landscaping and planting to which the irrigation system is appurtenant shall be constructed in accordance with the requirements of Section entitled, "Landscaping." The Contractor shall coordinate the work of constructing the irrigation system with the planting requirements.
- B. Electrical service shall conform to the requirements of Section entitled, "Electrical General Provisions." Connection to the controller shall be performed as a part of the work of this Section.
- C. Rough grading, final grading, excavation and backfill, and all trenching and trench backfill appurtenant to the installation of the landscape irrigation system shall be performed in accordance with the requirements of Section entitled "Earthwork."
- D. Concrete work as required herein shall be performed in accordance with the requirements of Section entitled, "Cast-in-Place Concrete" and "Minor Concrete," as applicable.
- E. PVC and galvanized steel pipe and fittings shall conform to the requirements of Section entitled "Piping Specialties."

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of other requirements of the specifications, all work specified herein shall conform to or exceed the requirements of the Building Code and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

- B. All work hereunder shall be in full accordance with the latest rules and regulations of the governing authorities, state "OSHA," the Uniform Plumbing Code published by the Western Plumbing Officials Association, and other applicable local codes and regulations. Nothing on the Drawings or in the Specifications shall be construed to permit work not conforming to these codes, rules, and orders.

1.04 CONTRACTOR SUBMITTALS

- A. Manufacturer's literature, samples (where requested by the ENGINEER), and installation instructions shall be submitted in accordance with Section entitled "Contractor Submittals."
- B. Record drawings, showing locations of all valves, pipes (lines) heads, dimensions, controllers, control lines, and electrical wires shall be submitted prior to final inspection.
- C. Controller literature, specifications, installation wiring diagram, and circuit breaker information shall be submitted to the ENGINEER for review prior to ordering.

1.05 QUALITY ASSURANCE

- A. In addition to other inspection, as provided by the ENGINEER, the CONTRACTOR shall give at least 72 hours notice to the ENGINEER for scheduling the following special inspections:
 - 1. Layout of the system
 - 2. Inspection of trenches, backfilling, and equipment
 - 3. Pressure tests
- B. The CONTRACTOR shall notify the ENGINEER at least 72 hours prior to performing the tests. All tests shall be performed in the presence of the ENGINEER. Test requirements shall be as follows:
 - 1. After assembly and installation, all water pipes, fittings, automatic equipment, and appurtenances shall be tested at a hydrostatic pressure of 150 psi at the lowest point of the system for not less than 60 minutes.
 - 2. The first test shall be made in such a manner that all valves in the new water pipe sprinkler lines will be tested for watertight closure. Valves may be tested in groups or singly while subjected to 150 psi water pressure for a period of not less than 60 minutes.
 - 3. The second test shall be made by forcing all air from the pipes with water and capping or plugging pipe risers. After the pipe risers have been plugged or capped, all line valves shall be fully opened and the pipe lines subjected the full static water pressure for a period of not less than 120 minutes. (Pressure pipelines 150 psi.)
 - 4. The third test requires that lateral lines be tested at 100 psi for 120 minutes.
 - 5. The fourth test requires that all pressure lines be tested at 120 psi for 24 hours.
 - 6. Water lines and valves which show evidence of leakage or fail to be watertight shall be repaired or replaced. After all repairs or replacements have been made, the above-required tests shall be performed again.

1.06 EXISTING UTILITIES AND CONDITIONS

- A. Prior to cutting into the soil, the CONTRACTOR shall locate all cables, conduits, sewers, septic tanks, and other such underground utilities, and shall take proper precautions not to damage or

disturb such improvements. If a conflict exists between such obstacles and the proposed work, the CONTRACTOR shall promptly notify the ENGINEER.

- B. The CONTRACTOR shall be responsible for coordinating its work with the operation of existing utilities and new utilities on the Project. The CONTRACTOR shall notify the ENGINEER or its representative when utilities which are in operation require shut-off.
- C. Due to the scale of Drawings, it is not possible to indicate all offset, fittings, etc., which may be required. The CONTRACTOR shall carefully investigate the structural and finished conditions affecting all its work, and plan its work accordingly, furnishing such fittings, etc., as may be required to meet such conditions. The Contract Documents are generally diagrammatic and indicative of the work to be installed. The work shall be installed in the most direct and workmanlike manner, so that conflicts between sprinkler systems, planting, structures, piping, and etc. will be avoided.

1.07 STORAGE OF MATERIALS

- A. The CONTRACTOR shall be responsible for storage of materials and for damage to the WORK covered by these Contract Documents before final acceptance of its work. The CONTRACTOR shall securely cover openings into the system, and shall cover all apparatus, equipment and appliances both before and after being set in place to prevent obstruction in the pipes and the breakage, misuse, or disfigurement of said apparatus, equipment, or appliances.

1.08 SCHEDULING AND COORDINATION

- A. The CONTRACTOR shall be responsible for making arrangements for the coordination of its construction operations with those of all others on the job. The CONTRACTOR shall permit others engaged in work to accomplish their portion of the WORK without undue interference or delay.
- B. The CONTRACTOR shall be responsible for the scheduling and coordination of the electrical and water connections and the installation of the piping and equipment in a manner that will effect the earliest completion of the WORK in conformance with the construction progress schedules of all traces and of the Contract Documents.

1.09 GUARANTEE/WARRANTY OF THE IRRIGATION SYSTEM

- A. The CONTRACTOR shall guarantee the complete irrigation system to be free from leaks or breakage due to defective material or workmanship for a period of one year from the date of acceptance of the complete work by the OWNER. Damage due to sabotage and/or vandalism are specifically excepted from this guarantee.
- B. Other items of the required guarantee shall be as specified in the Section entitled "Landscaping."
- C. The CONTRACTOR shall repair any settling of backfilling trenches occurring during a one-year period after final acceptance without expense to the OWNER including complete restoration of all damaged planting, paving, or other improvements of any kind.
- D. When defective material or workmanship is discovered which will require repair or replacement, all such repair work or replacement work shall be done by the CONTRACTOR at its own expense

within 24 hours after written notification is given to the CONTRACTOR by the OWNER of such required repairs. However, if the CONTRACTOR fails to comply with the requirements of the above guarantee within the 24 hours after notification is given, the OWNER shall proceed to have the repairs made by others at the CONTRACTOR's expense.

PART 2 -- PRODUCTS

2.01 GENERAL

- A. Brand names specified for materials are supplied for the purpose of describing the type, size, quality, and performance of materials. The CONTRACTOR may propose, as substitutions, other manufacturer's materials of equal quality and performance to the ENGINEER for review in accordance with Section entitled "Contractor Submittals."
- B. The CONTRACTOR shall furnish, at no additional charge, all samples necessary for testing as outlined in the Specifications or, when requested, certified evidence of off-site testing.

2.02 PLASTIC PIPE AND FITTINGS

- A. Pipe shall be continuously and permanently marked with the following information: Manufacturer's name, nominal pipe size, PVC type, pressure rating, and extrusion date. Pipe shall conform to the ASTM Specification D-1784-60T.
- B. All plastic pipe for lateral lines shall be PVC (polyvinyl chloride) SDR 21, Class 200, NSF approved.
- C. All materials for pressure main lines shall be PVC (polyvinyl chloride) SDR 21, Schedule 40, NSF approved.
- D. All fittings shall be PVC (polyvinyl chloride) Schedule 40, Type II, NSF, or Schedule 80 as called for in the Contract Documents.
- E. Swing joint ells shall be Schedule 80 PVC.
- F. Pipe shall be 'snaked' in the trench to allow for expansion and contraction.
- G. All changes in direction of pipe shall be made with fittings, not by bending. Appropriate thrust blocks shall be installed per manufacturer's recommendations.

2.03 STEEL PIPE AND FITTINGS

- A. Steel pipe and fittings shall be American Standard Association's schedule 40 galvanized. Street elbows, bushings, and close nipples shall not be allowed.

2.04 COPPER TUBING AND FITTINGS

- A. Copper tubing and fittings shall be seamless annealed conforming to ASTM specifications B-88-58, Type K. Fittings shall be standard wrought copper fittings.

2.05 VALVES

- A. General: Hose bibb valves shall be of bronze construction, size 3/4-inch, angle pattern suitable for 250-psi working pressure as manufactured by Crane, American Standard, Kennedy, or equal, with permanent metal sign at noticeable locations. Signs shall be 5-inch x 3-inch in size and read as shown on the Drawings. The signs shall be permanently fastened to pipe, post, or wall at hose bibb.
- B. Main shut-off valves shall be bronze gate valve with positive seal conforming to AWWA Specifications, Class 150 or better.
- C. Isolation valves for main lines shall be bronze gate valves with wedge disc, Class 125, screwed ends and operating nut as manufactured by Rainbird, Buckner, or equal.

2.06 CONTROL WIRING

- A. Control wiring shall be Standard UF Direct Burial Copper Wire, Type UF Bearing, U/L approved for direct underground burial in National Electrical Code Class II circuits, AWG sizes.
- B. Conductor of electrical conductivity shall be grade copper meeting requirement of ASTM B 3-74 (1980).
- C. All splices shall be made with wire connectors, such as Rainbird Pen Tit, Scotch Lock, or equal. Contractor may splice in pull boxes but underground splices will not be allowed.
- D. Control wiring shall be installed underground in the mainline trench taped to the mainline at twenty foot intervals. Install wires under the main line. Where wires are separated from mainline, install in conduit. Provide a minimum loop of 18 inches at each valve, change or direction, every 500 feet, and at each controller.
- E. "Pulling-In" of wire for installation without trenching will not be allowed unless the wire is being pulled through conduit. All wire shall be laid in trenches and shall be carefully back-filled to avoid any damage to the wire insulation or wire conductors themselves. In rocky areas, the trench shall have a 6 inch layer of clean sand on the bottom of the trench before the wire is laid into the trench and back-filled. The wire shall have a minimum cover of 18 inches. Where wire passes under roadways, walls or any other paved areas, it shall be installed in PVC schedule 80 pipe sleeve of proper size required for the number of wires being placed in it. Maxi satellite control wire is permitted to be laid in the same trench with conduit. but must be physically separated from the conduit as much as possible by laying each in opposite sides of the trench.
- F. For cable/conduit systems, pull boxes are required to be placed at a maximum spacing of 250 feet.

2.07 PRESSURE VACUUM BREAKERS

- A. Pressure vacuum breakers shall be "FEBCO" Model 775, or approved equal. Pressure vacuum breaker assemblies shall consist of an approved body, check valve, vacuum relief, inlet and discharge shutoffs, and field test cocks. Vacuum relief shall have atmospheric opening of greater diameter than IPS of unit. Vacuum relief shall be separate and independent from check valve member. All nipples or other fittings shall be red brass. The unit shall have a protective screen or strainer before the unit to eliminate insects or debris from entering. The breaker shall have approval of the State Division of Drinking Water. Flow loss at 100 gpm shall not exceed 4 psi. A 3/4-inch galvanized steel pipe in sleeve for irrigation blowout shall be provided as shown.

2.08 PVC SOLVENT CEMENT AND PRIMERS

- A. Solvent Cement shall be NSF approved and shall meet requirements of ASTM D 2564-80.
- B. Primer shall be NSF approved and shall be Weld-On, P-70 Industrial Polychemical Service, or equal.

2.09 WORM GEAR CLAMPS

- A. Worm-gear clamps shall be stainless steel.

2.10 VALVE AND CONTROLLER BOXES

- A. Boxes for valves and controllers shall be heavy duty fiberglass, PVC, or concrete and shall be complete with identification lid. Boxes shall be sized for equipment within box, depth of installation, and operation and maintenance space required.

2.11 SATELLITE CONTROLLERS

- A. The Contractor is to supply and install the necessary satellite controller as indicated in the Contract Documents listed under 'Irrigation Legend'. These controllers shall be state of the art, solid state electronic controllers as manufactured by Rainbird, Toro, or an approved equal.
- B. The electrical power source shall be provided by the City. The Contractor shall then be responsible for making the electrical connection to the controller.

2.12 OTHER MATERIALS

- A. Other materials required or necessary shall be as indicated on drawings and/or as required for best quality work.

PART 3 -- EXECUTION

3.01 GENERAL

- A. Installation of the irrigation system shall be performed after the finish grading but prior to landscaping.
- B. All valves, fittings, heads, and piping shall be installed as shown and all connections made to permit the irrigation system to function properly through its entire length.

- C. All materials and equipment shall be installed in strict accordance with manufacturer's written instructions and recommendations and all local and state codes, laws, ordinances, and regulations.
- D. Before proceeding with the installation of any section or unit of the irrigation system, the CONTRACTOR shall check and verify the correlation between ground measurements and drawings and shall advise the ENGINEER of any discrepancies.

3.02 EXCAVATION

- A. Trenches shall be dug as wide and as deep as necessary to properly install the irrigation lines.
- B. Pipe trenches shall be straight, or "snaked" slightly allowing for expansion and contraction of PVC pipe.
- C. Subsoil shall be kept separate from topsoil, where possible.
- D. Minimum cover depth shall be as follows:
 - 1. Supply pressure lines from water source to control valves: 24-inches unless otherwise indicated or noted.
 - 2. Lateral lines from control valves to sprinkler heads shall be 18-inches unless otherwise indicated or noted. Lateral lines under paving, roadways, and driveways shall have 24-inches of cover and be located in Schedule 40 PVC sleeves.
 - 3. Trenches for control wire only shall be 18 inches deep unless otherwise indicated or noted. Control wires under concrete walks and slabs, paving, roadways, and driveways shall be installed in Schedule 40 PVC sleeves.
- E. A trench of sufficient width shall be provided to allow for proper tamping around pipe.
- F. Rocks and other debris shall be removed or cut out to the width of the trench and to a depth of 6 inches below the trench bottom.
- G. Avoid cutting roots of existing trees. Notify the Landscape Architect if roots larger than 1-inch are encountered.

3.03 PIPING - GENERAL

- A. Piping shall be laid out and installed in accordance with manufacturer's printed recommendations and industry standards. Substantial support shall be provided at all points, and pipes shall be snaked slightly allowing for expansion and contraction.
- B. Minimum 1-inch vertical clearance shall be between lines crossing at angles greater than 45 degrees.
- C. Minimum 3-inches horizontal and vertical clearances shall be between all other lines.
- D. Teflon thread sealant 3/4-inch wide (tape or liquid), Rectorseal No. 5, or equal, shall be used at all threaded joints.

- E. Galvanized steel pipes shall have clean standard threads of standard lengths. Joints shall be made up with pipe compound applied to male threads only and not more than 2 threads shall show at the joints when connected.
- F. Pipe sleeves shall be provided under all paving and where necessary for passage under finish surface material, future replacement, and for protection of PVC piping and control wire.

3.04 PLASTIC PIPE

- A. The pipe shall be guaranteed by the manufacturer to be suitable to operation under the conditions of this installation and shall be guaranteed free from defects in workmanship and quality.
- B. The pipe shall be connected by O-ring type or by solvent-weld joints as outlined below. Joints shall be made in strict accordance with the manufacturer's printed recommendation.
- C. The plastic pipe sections shall be placed accurately to line and grade in the prepared trenches. The inside of all pipe shall be clean and free from foreign matter and shall be end-reamed to remove burrs and provide full inside diameter of the pipe end.
- D. Pipe assembly shall have a firm, uniform bearing for the entire length of each pipeline to prevent uneven settlement. All adjustments to grade shall be made by scraping away or filling in with clean earth backfill material, well compacted under the body of the pipe. Wedging of pipe will not be permitted. The inside of all pipe shall be clean and free from foreign materials before joints are assembled.
- E. Sealant tape shall be used on all threaded joints.
- F. All pipeline open ends upon which the WORK has been stopped shall be closed at the end of each day's construction work with a suitable temporary plug to prevent entrance of any foreign materials into the assembled pipeline.
- G. Pressure pipe shall be defined as all piping for this system.
- H. O-ring type flexible coupling pipe shall be used on pressure pipes 4-inch or larger.
- I. Pressure pipe fittings on the 4-inch main lines going to automatic control valves shall be O-ring type with 2-inch threaded outlet.
- J. Three-inch main lines and fittings of pressure piping shall be solvent weld type.
- K. Pressure piping shall be provided with portland cement concrete thrust blocks. Thrust blocks shall be constructed at the following places:
 - 1. Where pipe changes direction at fittings.
 - 2. Where pipe changes size.
 - 3. Where line terminates.
 - 4. Around gate valves (bottom half of valve in concrete bolts exposed for change of top half).
- L. Thrust blocks shall be constructed of 2000-psi concrete, as follows:

THRUST BLOCKS				
Minimum Square Feet of Affected Area				
PIPE SIZE	DEAD ENDS, TEES OF VALVES	90 DEGREE BENDS	45 DEGREE BENDS	22-1/2 DEGREE OR LESS BENDS
3-inch	3.0 sq.ft.	4.0 sq.ft.	3.0 sq.ft.	3.0 sq.ft.
4-inch	3.0 sq.ft.	4.0 sq.ft.	3.0 sq.ft.	3.0 sq.ft.

M. The areas given in the above table shall be measured in a place perpendicular to the longitudinal axis of the pipe or to the longitudinal axis of the thrust developed.

3.05 VALVES

- A. Piping systems shall be supplied with valves at all points as shown or specified herein so arranged to give complete regulating control throughout. Automatic control valves and gate valves shall be as detailed in the Contract Documents or as otherwise directed by the ENGINEER.
- B. Valves shall be the full size of the line in which they are installed unless otherwise indicated.
- C. Hose bibbs shall be installed as shown.
- D. Gate valves shall be line (pipeline) size, shall be installed where indicated on the Drawings, and shall be properly blocked to a cast-iron water works valve box. All gate valves shall be provided with 2-inch square operating nuts. One 5-foot wrench for each 3 gate valves shall be furnished.
- E. Quick-coupling valves shall be provided, located, and installed as shown in the Contract Documents. Quick-coupling valves shall be installed with one-inch swing joint. All quick-coupler lines shall be installed not less than 18 inches below grade.
- F. A main stop and drain valve shall be installed near the point of connection to the main line.
- G. Drain valves shall be installed at low points along the main. It shall be the CONTRACTOR's responsibility to see that the main drains properly.
- H. Gravel sumps 2-feet by 2-feet by 2-feet in size and filled with 3/4-inch to 1-inch size round gravel shall be provided at each manual drain valve and at low sprinkler head locations for drainage, (spray heads only).
- I. Double-check valve shall be installed as shown, with a boiler drain for winter blowout.

3.06 PRESSURE TYPE VACUUM BREAKER

- A. Installation of pressure-type vacuum breaker shall be at location shown and in accordance with manufacturer's printed recommendation and as detailed.

3.07 VALVE BOXES

- A. Valve boxes shall be set 1/2-inch above the designated finish grade in lawn areas and 2-inches above finish grade in ground cover areas.
- B. Valve boxes located near walks, curbs, and paving shall be installed in such a way as to allow for valve boxes to abut those items with top surface matching plane as items listed above.

3.08 WIRING AND ELECTRICAL WORK

- A. All electrical equipment and wiring shall comply with local and state codes and shall be installed by those skilled and licensed in the trade. Unless the governing codes specify otherwise, low voltage control wire may be installed by the CONTRACTOR when code allows. All 115- and 24-volt lines shall be installed. CONTRACTOR shall make necessary "Hot" connections.
- B. All 115-volt wire shall be installed in conduit and taken from appropriate sources as shown in the Contract Documents. CONTRACTOR shall coordinate supplier and installer.
- C. The CONTRACTOR shall provide low voltage, 24-volt direct burial wires. Wire size shall be as shown in the Contract Documents, but shall be not less than No. 14. Where sizes are not shown, they shall be sized per wire manufacturer's sizing charts and specifications.
- D. The CONTRACTOR shall provide all wiring, conduits, sleeves, and connection for the low voltage electrical system between controller and valves, and where else shown and necessary for a complete and operable irrigation system.
- E. Wires shall be color-coded as follows:
 - 1. Control wires shall be red.
 - 2. Ground (neutral) wire shall be white.
- F. All splices shall be moisture proof using specified electrical connectors.
- G. Wires shall be bundled together and wrapped with electrical tape similar to PVC at 5-foot intervals. They shall be buried in same trench as the pipe where possible.
- H. An expansion curl should be provided within 3-feet of each wire connection and at least every 100-feet of wire length on runs more than 100-feet in length. Expansion curls shall be formed by wrapping at least 5 turns of wire around a 1-inch pipe or more in diameter, then withdrawing pipe.
- I. All conduits and sleeves necessary for running wires under concrete, walks, and paving shall be furnished and installed before said concrete, walks, and paving work is constructed.
- J. Wire shall be continuous without splices and shall be routed in main line trench whenever possible.
- K. All wire under paving shall be encased in PVC pipe; changes in direction under paving shall be made with sweep ell.

3.09 PIPE TRENCH BACKFILL

- A. After pipe and wires have been installed, the trenches shall be backfilled. The backfill operation must provide a firm continuous support for the pipe.
- B. Backfill material shall be free of rocks and other materials that may damage the piping.
- C. Bottom of trenches shall be smooth and free of sharp rocks and other objects that may damage pipe.
- D. The initial backfill shall be accomplished by carefully tamping selected material (from material excavated from the trench) under the pipe and between the pipe and the trench walls.
- E. The pipes shall be filled with water and pressurized during backfilling operations if necessary, to prevent drainage to piping.
- F. The backfill shall be carefully installed around and over the pipe to approximately 10-inches of the ground surface, then water shall be allowed to flow in the trench. After this puddling operation has been completed and allowed to stand for 24 hours, the balance of the materials shall be placed in the trench to the sub-grade line (leaving room for topsoil). Rocks and other materials found in the backfill shall be removed. The backfill shall be compacted carefully and thoroughly.
- G. Couplings and fittings shall be left exposed until leakage tests have been completed, unless the ENGINEER orders otherwise.
- H. Topsoil shall be installed prior to planting.

3.10 TESTING AND ADJUSTMENTS

- A. The ENGINEER shall be notified by the CONTRACTOR prior to performing hydrostatic tests on the irrigation system in place. This test shall be done by the CONTRACTOR in the presence of the ENGINEER. With the risers capped, pressurize the system to two times the normal maximum site pressure. Pressure shall be maintained for 24 hour minimum. If leaks develop, repair and re-test until the irrigation system provides water tight. The test results will be acceptable to the ENGINEER when no leakage or loss of pressure is evident during the test period. Defects shall be detected and repaired prior to retesting.
- B. No debris, waste material, or rubbish shall be permitted to accrue on the site. Debris shall be removed on a daily basis and the entire work area returned to playable condition. As construction progresses and when work is completed in one area, debris, waste material, or rubbish shall be completely removed before the CONTRACTOR moves to another area.
- C. A coverage test shall be conducted to check all areas for complete coverage and adequate precipitation.
- D. The operation of all controllers and valves shall be demonstrated to the satisfaction of the Landscape Architect.

3.11 MAINTENANCE

- A. Water shall be applied as necessary to germinate seeds and prevent plant wilt. Automatic irrigation systems shall be operated by the Contractor per manufacturer's specifications and sprinkling program approved by the Landscape Architect.
- B. The Contractor shall continuously maintain all areas included in the contract during the progress of the project until final acceptance of all work by the Landscape Architect and the City. The Contractor shall replace any plant material which dies or is damaged under his care within 48 hours.
- C. The Contractor shall protect his work from damage during the course of this project. Immediate repairs shall be made to areas damaged by vehicular, equestrian, or pedestrian traffic to restore the specified grades and plantings.
- D. Contractor shall exterminate pests or insects as necessary and repair or replace damaged areas and plantings.

*** END OF SECTION ***

SECTION 16500

RESIDENTIAL ROADWAY LIGHTING SYSTEM

PART 1 – GENERAL

1.0 ROADWAY LIGHTING

- A. AASHTO standards require that “Good visibility under day or night conditions is a fundamental requirement that enables motorists to move on roadways in a safe and coordinated manner. Street lighting, properly designed and maintained, should produce comfortable and accurate night visibility, which should facilitate vehicular and pedestrian traffic.
- B. Location – Street lights shall be installed on every street at intersections and at a spacing not to exceed 300 feet.
- C. Construction – See PLANS RD-16, RD-17, RD-17a, RD-18, RD-20, and RD-21 for construction requirements.

1.01 SCOPE OF WORK

- A. The work of this section includes the furnishing and installation of new materials and equipment for a complete and operable residential roadway lighting system, as indicated on the Drawings and as specified herein, all in accordance with the requirements of the City’s “Public Improvement Standards, Specifications and Plans”. The end result shall be a system complete and in operation to the satisfaction of the City Engineer.
- B. The electrical work as referred to herein shall include but not be limited to the following appurtenant items:
 - 1. Furnishing and installation of residential roadway lighting fixtures, ducts, and circuits.
 - 2. Modification of certain existing lighting circuits and relocation of fixtures.
 - 3. Distribution system.
- C. Testing, painting, restoration and salvage of residential roadway lighting systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. All earthwork required for the installation or construction of any of the work specified herein shall be performed in accordance with the requirements of Section entitled, ["Earthwork."]
- B. All concrete work required for installation or construction of any of the electrical work specified herein, shall conform to the requirements of Section entitled, ["Minor Concrete."]

1.03 REFERENCE SPECIFICATIONS AND STANDARDS

- A. General: Without limiting the generality of other requirements of these specifications, all work specified herein shall conform to, or exceed, the applicable requirements of the National Electric Code, all applicable local codes and ordinances, and the referenced portions of the following publications to the extent that the requirements therein specified are not in conflict with the provisions of this Section:
1. National Electric Code, most current edition.
 2. Title 8, Industrial Relations, Subchapter S, Electrical Safety Orders.
 3. Underwriters' Laboratories (UL).
 4. National Electrical Manufacturer's Association (NEMA) Standards, Insulated Power Cable Engineer Association (IPCEA), Underwriter's Laboratories (UL).
 5. ASTM B 3: Standard Specification for Soft or Annealed Copper Wire.
 6. ASTM B 8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, of Soft.
 7. ASTM D 2301: Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
 8. IES: Illuminating Engineering Society.
 9. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
 10. NFPA 70: National Electric Code.
 11. SSPC PS 1.4: Three-Coat Oil-Alkyd (Lead-and-Chromate-Free) Painting System for Galvanized or Non-Galvanized Steel (with Zinc Dust-Zinc Oxide Linseed Oil Primer).
 12. UL: Underwriters' Laboratories, Inc.
- B. Approval: All equipment furnished by the Contractor shall be City approved and shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated, (UL) or of an independent testing laboratory acceptable to the City of West Jordan.

1.04 PERMITS AND INSPECTION

- A. Permits shall be obtained, and inspection fees shall be paid for as specified in the City's Development Processing Manual. The Contractor shall notify and arrange inspection of any improvements prior to backfilling of trenches with the Engineering Department, through its inspection line. The Contractor shall conduct his work during "normal" working hours, which are 7:00 a.m. to 3:30 p.m., Monday through Friday, and excludes holidays.
- B. The Engineering Inspector will check to ensure the trench depth and cable placement is as required, and the electrical cable is of the proper material and size.

1.05 CONTRACTOR SUBMITTALS

- A. Record Drawings: The Contractor shall provide and maintain a complete set of up-to-date electrical drawings in good order on the site. All differences between the location and arrangements indicated on the drawings and those of the actual installation, "As-Built," as well as references to equipment manufacturer's drawing numbers, shall be clearly recorded on this set. At the end of the project, the Contractor shall transfer all changes and reference in ink to 2 sets of black and white prints and one electronic copy and shall submit said "As-Built" drawings to the Engineering Inspector. One set of equipment manufacturer's drawings shall also be submitted to

the Engineering Inspector. The final sheet of each set shall be initialed by the Contractor as being correct and accurate records of the installation as constructed.

- B. Shop Drawings and Product Data: Complete, bound, indexed, large enough for all items to be included, shop drawings and product data shall be submitted for all equipment items to be used on the work unless otherwise indicated by the Engineering Department. Submittal of shop drawings shall conform to the requirements for "Approved for Construction Drawings Required to be Submitted by the Contractor" in Section entitled, ["Contractor Submittals."] When requested, supplement the following list by such other data as may be required, including detailed scale drawings and wiring diagrams of any special equipment and of any proposed deviation from the Contract Documents.
1. Performance data for luminaries, including lighting contours on the roadway surface and average maintained level of light in foot-candles.
 2. Shop drawings for luminaries showing pertinent physical characteristics, type of light source, and wattage.
 3. Shop drawings of ornamental poles.
 4. Luminaire supports.
 5. Pole bases.
 6. Wiring schematics.
 7. Fixture mounting height.
 8. Drawing showing location of poles, underground power conduit, and point of connection.
 9. Warranties and instruction sheets.
 10. Testing results.
- C. Material and Equipment Schedules: Within 15 days after award of the Contract, the Contractor shall deliver to the Engineering Department a complete list of all materials, equipment, apparatus, and fixtures which he proposes to use in accordance with City standards. The list shall include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
- D. No materials, equipment, apparatus, or fixtures shall be purchased or installed unless and until such materials, and other items have been approved by the City Engineer. Any and all materials installed in violation of these provisions, when so directed by the City Engineer, shall be removed and replaced at the Contractor's own expense with materials acceptable to the City Engineer.

1.06 QUALITY ASSURANCE

- A. Field Control of Location and Arrangement: The Drawings indicate diagrammatically the desired location and arrangement of conduit runs, equipment, and other items. All poles shall be located as specified on the plans, unless approval is granted in writing by the City Engineer. The power company shall approve the final location of all poles located near a collector street, or near overhead lines.
- B. Workmanship: All materials and equipment shall be installed in accordance with the manufacturer's recommendations and the requirements of these specifications. The installation shall be accomplished by workmen skilled in this type of work and installation shall be coordinated in the field with other trades so that interferences are avoided. The Contractor shall

not allow or cause any of his work to be covered up or enclosed until it has been inspected and approved by the Engineering Inspector. Should any of the work be enclosed or covered up before such inspections, the contractor shall, at his own expense, uncover the work, and after it has been inspected and approved, make all repairs with such material as may be necessary to restore all work to its original and proper condition.

- C. The Contractor shall provide adequate means for and shall fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the work and until acceptance of the project by the City.
- D. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged or marred.
- E. Tests: All wiring and connections shall be tested for continuity, short circuit, and improper grounds under the observation of the City Inspector. A minimum of 48-hour notice is required for observation of testing.
- F. Any failure shall be corrected in a manner satisfactory to the Engineering Inspector. The Contractor shall pay all costs of testing, including costs of correcting failures and of replacing or repairing any damage to associated work or surrounding areas resulting there from.
- G. The Contractor shall make all tests required by the City Engineer under the observation of the City inspector for the project. The Contractor shall furnish all necessary testing equipment and pay all costs of tests, including all replacement parts and labor necessary due to damage resulting from damaged equipment or from test and correction of faulty installation. The testing shall demonstrate the following to the satisfaction of the City Engineer.
 - 1. That all lighting power and control circuits are continuous and free from short circuits.
 - 2. That all circuits are free of unspecified grounds.
 - 3. That the insulation resistance to ground of all non-grounded series circuits is not less than 50 megohms.
 - 4. That all circuits are properly connected in accordance with applicable wiring diagrams.
 - 5. That all circuits are operable. Tests shall be conducted that include operation of each lighting and power circuit for not less than 1/2 hour.

1.07 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

- A. Notify Engineering Inspector a minimum of 48-hours prior to performing any work on existing systems. The Engineering Inspector will coordinate with the Public Works Department.
- B. Allow 20-foot minimum overhead clearance across thoroughfares and 15-foot minimum clearance above sidewalk areas for temporary electrical. Do not run temporary conductor on top of the ground or across any sidewalk area unless protected in an electrical raceway and barricaded.
- C. Maintain existing electrical systems or approved temporary replacements, in effective operation for the benefit of the traveling public during the work, except when shutdown is permitted to allow for alteration or removal of the systems. Do not interfere with the regular lighting schedule.

1.08 CLEANUP

- A. All parts of the materials and equipment shall be thoroughly cleaned. Exposed parts shall be thoroughly cleaned of cement, plaster, and other materials, and all oil and grease spots be removed with a solvent not detrimental to the equipment or material being cleaned. Such surfaces shall be carefully wiped and all cracks and corners scraped out.
- B. During the progress of the work, the Contractor shall clean up after his employees and shall leave the premises and all portions of the site in which he is working free from debris.

1.09 GUARANTEE

- A. In addition to the guarantee specified in Section entitled, ["Project Closeout"] the Contractor shall guarantee his work against any defects in material and/or workmanship for a minimum of one-year from the official project acceptance date, or the specified guarantee period, including damage resulting from negligence and vandalism. Said guarantee shall be in written form and shall be acceptable to the City Engineer, to whom it shall be delivered before final acceptance and payment is made. Any latent defects in Contractor furnished material or workmanship, which are discovered during the time of the guarantee, shall be repaired or replaced by the Contractor at no cost to the City. The Contractor shall be responsible for all blue-staking, maintenance, repair of underground lines, poles, shrouds or luminaries of the lighting system until final acceptance by the City. A final inspection shall be performed when the Contractor reaches total project completion and before the 100-percent bond release.

1.10 WARRANTY

- A. The manufacturer of the residential street light equipment shall provide a warranty to the City which includes a warranty of 6 years on the electrical equipment, a 7-year warranty against fading and cracking or peeling of the paint system, and a 25-year warranty against discoloring and cracking of the glass.

PART 2 -- PRODUCTS

2.01 GENERAL

- A. All materials furnished under this specification shall be new, and shall comply with the requirements of the current editions of referenced specifications, codes, and standards.
- B. Materials and equipment submitted for approval shall be the regularly cataloged products of companies regularly engaged in the manufacture of such items, shall be the latest standard design that conforms to these specification requirements, and shall essentially duplicate material and equipment that has been in satisfactory use for a least 2 years.

2.02 EXISTING MATERIAL

- A. Where existing systems are to be modified, incorporate new materials unless otherwise specified.

2.03 WIRE AND CABLE

- A. General: Wire and cable shall be as manufactured by Anaconda, General Electric, Okonito, Phelps-Dodge, Rome, Simplex, or an approved equal. All wire and cable shall be delivered to the project site in unbroken packages. Each package shall bear the Underwriters' Laboratory (UL) and manufacturer's label showing the date of manufacture and the maximum allowable voltage.
- B. Materials: All wires shall be copper. Copper wire shall conform to the applicable portions of ASTM B 3 and B 8. Wire sizes shall be on American Wire Gage (AWG). All wiring shall be installed in approved conduit.
- C. Conductors: The Contractor shall install three copper stranded wires #6 or #8 AWG wire to each streetlight from the nearest Rocky Mountain Power (RMP) source (1 black, 2 white, 3 green). Use load calculations to determine size. These conductors shall be placed in a minimum of 1-1/2-inch PVC electrical conduit between junction boxes and anchor base. Install conduit in straight lines, in the public utility easements with a minimum of 24-inches of cover. Conduit must sweep into junction box and anchor bases. Do not install any splices inside of conduit. A 2' "pigtail" or extra length of wire shall be left at the source for the power company to make the final connection. See RMP drawing for additional information. All conductors and conduit shall be inspected by the City inspector prior to backfilling of the trench. Conductors for series street lighting systems shall be No. 6 or 8 AWG copper wire insulated with 0.110-inch thickness Polyethylene insulation. Standard S-61-402 of Insulated Power Cable Engineers Association, and designated for operation at 5,000 volts.
- D. A certificate of compliance with these specifications shall be submitted to the City Engineer with the shop drawings and product data.
- E. Where isolating transformers or ballasts are used, the secondary conductors from transformer to luminaire shall be insulated by No. 10 AWG solid copper wire. Multiple-circuit conductors shall be rated and UL approved, approved for 600-volt operation, and shall be standard THW or THWN grade polyvinyl chloride, conforming to the applicable provisions of ASTM D 2219 and D 2220.
- F. Aluminum wiring is not allowed.
- G. Install to each streetlight from the nearest RMP source, as shown on the Drawings. An extra 2-foot length of wire shall be left at the source for the power company to make the final connection. See RMP drawing for additional information. Please refer to the City's standard drawing regarding the point of disconnect (disconnect diagram).
- H. Underground Junction Box. Underground junction box is to be Carson Industries LLC, L Series 1419-12 or approved equal. Color is to be green or black.
- I. In-Line Watertight Fuseholders. Fuseholders installed in the pole or within the underground junction box are to be Littelfuse Breakaway Part No. LEC-JJ-S or approved equal, with Littelfuse water proof boot part number WPB-1, or approved equal.

2.04 INSULATING TAPE

- A. Type 1 vinyl chloride per ASTM D 2301.

2.05 JUNCTION AND PULL BOXES

- A. Use traffic, for no or low traffic areas, Carson 1419-12-4B-gm street lighting, or approved equal. Use polymer concrete and fiberglass with polymer cover or concrete box with steel cover in high traffic areas. Boxes shall be placed at grade, level, and at additional points. Conduit shall not exceed runs more than 200-feet without a pull box. Prepare the excavation approximately 6-inches deeper than the depth of the box, then add 6 to 8-inches of gravel for drainage. Place long side of box parallel to curb unless indicated. Fill and compact soil to grade, level with cover on box. See RMP for placement.
- B. Any box installed during construction is not to be buried. Plastic body and cover, or pre-cast concrete with screw-on cast iron covers: of types, shapes and sizes to suit each respective location and installation: equipped with stainless steel nuts, bolts, screws and washers.
- C. Cover permanently marked: "Street Lighting". Where box contains street lighting voltage greater than 600 volts, cover to be permanently marked "High Voltage".

2.06 CONDUIT

- A. Unless otherwise specified, buried electrical conduits shall be 1-1/2-inch minimum, grey schedule 80 PVC electrical conduit between junction box and anchor base. Run conduit in straight lines, in the public utility easements with a minimum of 30-inches of cover. Conduit must sweep into junction box and anchor base.
- B. Conduits shall be of the size indicated on the Drawings. It shall be the option of the Contractor to use larger conduit than that specified, provided that where such substitution is made, it shall be for the entire length of the conduit run. No reducing fittings will be permitted.
- C. The ends of the conduit shall be free of burrs and rough edges and shall be capped or sealed.
- D. The maximum bend of a conduit shall be 90-degrees and the minimum radius of a bend shall be not less than six times the inside diameter of the conduit.
- E. For conduits and conduit fittings, in areas specified by the City Engineer for high traffic areas, or special installations, the following shall apply:
 - 1. Conduit and conduit fittings shall be galvanized by the hot-dip, electrodepositing, or metallizing process. Galvanized conduit shall conform to standards for rigid steel conduit as specified by Underwriters' Laboratories, Inc., and shall bear the Underwriters' label on each length.
 - 2. All threads shall be treated with approved joint compound before fittings are placed thereon. Where the galvanized coupling of conduit or fittings has been injured in handling or installing, such damaged areas shall be thoroughly painted with a rust preventive paint.
 - 3. Ends of conduit shall be properly coupled. Running threads, threadless connectors or threadless couplings will not be permitted.

2.07 ANCHOR BOLTS

- A. Anchor bolts shall be of the type and size as shown on the Drawings.
- B. Anchor bolts shall conform to ASTM A 307, and shall be provided with two nuts and washers each. Anchor bolts, nuts, and washers shall be galvanized by the hot-dip process conforming to ASTM A 153, or cadmium plated with Type NS coating conforming to ASTM A 165.
- C. Anchor bolts may also be provided in stainless steel
- D. All nuts shall be symmetrically formed with the hole centered and at right angles to the face, tapped to fit a corresponding thread so that nut can be run the entire length of the thread by the fingers without undue forcing, and without noticeable play or rocking.

2.08 POLES AND LUMINAIRE SUPPORTS

- A. The lighting pole shall be all aluminum or fiberglass, one-piece construction. If aluminum, the pole is to be Wadsworth Series cast aluminum post, model #Z W14 S417 CA BK as shown in the City's, "Public Improvement Standards, Specifications and Plans". If fiberglass, the pole is to be Whatley E30 Series as shown on the City's "Public Improvement Standards, Specifications and Plans".
- B. All hardware shall be tamper resistant stainless steel.

2.09 LUMINAIRE

- A. Luminaire: The luminaire shall be of the traditional acorn shape and shall contain a precision optical system in accordance with US-2586. Approved manufacturers and model numbers are:
 - 1. Hadco, Model #R52BCNA.
 - 2. Halophane, Model #GVU 070HP MA B 4 R S B T FCVRB
- B. High Pressure Sodium Lamps: 70 watts high pressure sodium, 120 volt, as indicated.
- C. Bonding and Grounding: Copper wire strap No. 6 AWG minimum.
- D. Paint: Black.

2.10 CONTROL EQUIPMENT

- A. Photo-electric control sensitive between 1 and 5-foot candles, minimum.
- B. Failure of any electric component will energize the lighting circuit.
- C. Enclosure: NEMA 250 Type 4 with dead front panel, keyed padlock.
- D. Paint: Waterproof paint.

2.11 CONCRETE AND GROUT

- A. Concrete: Class 3000 per Section 03304. Concrete mix shall be a 6.5 bag mix for street light bases.
- B. Grout: Refer to Section 03600.

PART 3 -- EXECUTION

3.01 INSTALLATION - - GENERAL

- A. All conduit, cables, grounds, and supports necessary to insure a complete and operable electrical distribution center for roadway lighting systems shall be furnished and installed as specified and as shown on the Drawings. All equipment shall be installed and mounted to comply with the requirements of the National Electric Code and local code agencies having jurisdiction.
- B. Coordinate utility locations.
- C. Do not disturb roadway surface, sidewalk, curb & gutter, or other obstructions with out having obtained a City issued Encroachment Permit (Engineering Department).
- D. Do not block or restrict pedestrian traffic, vehicular traffic, drainage, or utilities.
- E. Barricade all excavations.
- F. Compact excavated trench material to 95-percent relative density.
- G. After backfilling excavations, maintain smooth and well-drained surfaces until permanent repairs are effected.
- H. Legally dispose of all excess or waste material.
- I. The Contractor shall notify the Engineering Inspector at least two (2) working days prior to beginning street light installation. The City of West Jordan will notify RMP and request the light be energized upon approval from the Engineering Inspector. No bond will be released until the lighting system is inspected, fully functional and all submittals have been completed and approved.
- J. Final Acceptance: The Contractor shall be responsible for all blue staking, maintenance, repair of underground lines, poles, shrouds or luminaries to the lighting system until final acceptance by the City. A final inspection shall be performed when the developer reaches total project completion.

3.02 POLE FOUNDATION

- A. Construct foundation per details indicated in the City's Standard Drawing No. RD-18, and other construction standards referring to Minor Concrete, anchor bolts, plastic conduit, metal conduit, etc.
- B. Stinger bases may be used in lieu of concrete pole base. See City's "Public Improvement Standards, Specifications and Plans".
- C. Fiberglass poles may be direct buried.

3.03 CONDUIT INSTALLATION

- A. Use schedule 80 PVC conduit as the standard, normal type of conduit used for street lighting system installations. Where required, rigid steel conduit may be needed in areas subject to vehicular load, on the surface of structures, inside of structures and foundations, between structures, and the adjacent pull boxes located next to structures. Please see the RMP diagram for additional information.
- B. Place conduits as follows:

Location	Depth of Burial
In front of curb faces	36" to 60" below gutter grade line
Back of the back of curb	30" to 36" below top back of curb
Railroad tracks	36" to 60" below bottom of ties
Primary power cables	40" minimum

- C. Use sizes of conduit indicated or use larger sizes for any run at no additional cost to the City. No expanding or reducing fittings will be permitted.
- D. Make field cuts square and true so that the ends will come together for full circumference. Paint threads on all rigid steel conduit with rust preventative paint before couplings are made. Repair damaged coating on galvanized steel conduit.
- E. Cap all conduit ends with standard pipe caps until wiring is installed. When caps are removed from metallic conduit, provide threaded ends and approved conduit bushings.
- F. Clean all existing underground conduit to be incorporated into new system with a mandrel and flow out with compressed air. Where existing rigid steel conduit systems are to be modified or extended, install rigid steel conduit.
- G. Make changes in direction by bending the conduit to a radius which will meet code, or preferable, by the use of standard bends and elbows.
- H. Install a No. 12 AWG pull wire, mule tape or equivalent strength cord in all conduits which are to receive future conductors. Leave at least 2-feet of pull wire extending beyond each end of the conduit run and secure.
- I. Center conduit ends within the bolt circle of traffic signal poles or pedestals.
- J. Pack conduit ends with sealant after conductors are installed.
- K. Cap all conduits terminated without a pull box and identify its location by monumenting.

3.04 CONDUCTOR INSTALLATION

- A. Install wiring per the appropriate articles of NFPA 70. Neatly arrange and label all wiring within cabinets, junction boxes, etc.
- B. Splice only at junction boxes, transformer leads, in accessible pole bases, or at control equipment. All splices within boxes shall be watertight; heat shrink splices, gel cap, etc. Splice conductors as per manufacturer's recommendations and codes. Provide a fused connector between the line and the ballast, accessible at the hand holes located in all poles. In addition, each disconnect box shall contain an in-line fuse holder with water proof boots.
- C. Provide conduit to separate low-voltage conductors from high-voltage conductors in the same raceway (i.e. poles).
- D. Splice insulation shall consist of vinyl chloride, electrical insulating tape applied to a thickness equal to and well lapped over the original insulation to provide uninterrupted underwater

- operation.
- E. Leave a minimum 2-feet of slack at each pole. Leave 18-inches of slack above top of pull box grade.
 - F. Mark or label (yellow-south, orange-north, red-east, blue-west) termination of each conductor.

3.05 CABLE SPLICING

- A. Connections shall be made by a licensed electrician regularly engaged in this type of work and shall be made as follows:
 - 1. Cast splices shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured in accordance with manufacturer's printed instructions and to the satisfaction of the City Engineer.
 - 2. Vulcanized splices shall be made by using crimp connectors for jointing conductors. The splice shall be made, using compounds furnished by the manufacturer, in accordance with the manufacturer's printed instructions, and to the satisfaction of the City Engineer.
 - 3. Field-attached plug-in splices shall be assembled in accordance with manufacturer's printed instructions. All splices shall be made by plugging directly into mating connectors. In all cases the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2-inches on each side of the joint.
 - 4. Factory-molded plug-in splices shall be made by plugging directly into mating connectors. In all cases, the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2-inches on each side of the joint.
 - 5. Taped splices shall be made in the following manner:
 - a. Cables shall be brought to their final position and cut so that the conductors will butt. Insulation and jacket shall be removed to allow for bare conductor of proper length to fit compression sleeve connector with 1/4-inch of bare conductor on each side of the connector. A sharp knife shall be used to pencil insulation and jacket at approximately the same angle as a pencil point. Care shall be taken to avoid nicking or injuring the conductor during removal of insulation or penciling. Emery paper shall not be used on splicing operation. The copper conductors shall be thoroughly cleaned. Conductors shall be joined by inserting them equidistant into the compression connection sleeve. Conductors shall be crimped firmly in place with crimping tool that requires a complete crimp before tool can be removed. The crimped connection shall be tested by pulling on the cable. The insulation shall be scraped to assure that the entire surface over which the tape will be applied (plus 3-inches on each end) is clean. After scraping, the entire area shall be wiped with a clean lint-free cloth. Solvents shall not be used.
 - b. High-voltage rubber tape shall be applied, one-half lapped over bare conductor. Said tape shall be tensioned as specified in the printed recommendations of the manufacturer. Voids in the conductor area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. Throughout the rest of the splice, less tension shall be used. Tape shall be exactly half-lapped to produce a uniform buildup. Buildup shall be continued to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one-inch over the original jacket. The rubber tape shall be covered with 2 layers of vinyl pressure sensitive tape one-half lapped. Glyptol or lacquer

shall not be used over vinyl tape as they act as solvents to the tape material. No further cable covering or splice boxes are required.

3.06 GROUNDING INSTALLATION

- A. Effectively ground metallic cable sheaths, metallic conduit, nonmetallic conduit grounding wire, ballast and transformer cases, service equipment, anchor bolts, metal poles, and pedestals and make mechanically and electrically secure to form a continuous system. Use a copper wire strap for bonding and grounding jumpers of the same cross-sectional area as No. 6 AWG for all lighting systems.
- B. Ground one side of the secondary circuit of series-multiple and step-down transformers. Ground metal conduit, service equipment, and neutral conductor at service point as required by NEC and electricity company with grounding conductor No. 6 AWG or larger.
- C. In all nonmetallic (PVC) type conduit, provide a No. 8 AWG bare copper wire continuously and ground at each junction box.
- D. At each multiple service point, unless otherwise indicated, furnish a ground electrode. Use copper coated ground electrodes

3.07 LUMINAIRE

- A. Light fixtures shall be assembled in accordance with the manufacturer's printed instructions and the following requirements:
 - 1. Secondary leads of the transformer shall be connected to the fixture leads with a disconnect plug and receptacle without taping the joint.
 - 2. A lamp of the proper rating shall be installed in the fixture.
 - 3. The unit shall be installed on pole per manufacturers recommendations.
 - 4. Each fixture shall be leveled to within one-degree of the manufacturer's printed recommendations.

3.08 TRENCHING

- A. Trenching shall conform to the requirements of Section entitled, ["Earthwork,"] and the provisions of this Section. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Road patrols or graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 24-inches below finished grade, except as otherwise specified herein.
- B. The Contractor shall excavate all cable trenches to a width of not less than 6-inches. The trench shall be widened where more than 2 conduit are to be installed parallel in the same trench. Unless otherwise specified in the Drawings, all cables in the same location and running in the same general direction shall be installed in the same trench.

- C. When rock excavation is encountered, the rock shall be removed to a depth of at least 3-inches below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. The Contractor shall ascertain the type of soil or rock to be excavated before bidding.

3.09 TRENCH BACKFILLING

- A. Trench laid conduit shall be placed not less than 30-inches below grade. The conduit shall be laid over two (2) inches of uniformly spread sand. The first layer of backfill over the conduit shall be 3-inches deep, sand containing no mineral aggregate particles that could be retained on a 1/4-inch sieve. This layer shall not be compacted. The second layer shall be 5-inches deep, loose measurement, and shall contain no particles that could be retained on a one-inch sieve. “Caution – Electrical Line Below “ tape is to be installed 12inches above conduit. The remainder of the backfill shall be excavated or imported mineral and shall not contain stone or aggregate larger than 4-inches maximum diameter. The third and subsequent layers of the backfill shall not exceed 8-inches in maximum depth, loose measurement.
- B. The second, and subsequent layers shall be thoroughly tamped and compacted to a 95-percent relative density, and to the satisfaction of the City Engineer. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.
- C. Trenches shall not be excessively wet as determined by the City Engineer and shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface. Any excess excavation material shall be removed and disposed of in accordance with instructions issued by the City Engineer.

3.10 QUALITY CONTROL

- A. Conduct the following tests on all lighting circuits and record the date and time of test
 1. Test for continuity of each circuit.
 2. Test for grounds in each circuit.
 3. Megger test at 500 volts DC on each completed lighting circuit. The insulation resistance to ground shall be not less than 10 megohms.
 4. Test voltage and current on each circuit.
- B. Functional Test:
 1. Perform a functional test in which it is demonstrated that each and every part of the system functions as specified or intended. Portions of the testing shall be conducted at night in order to ensure various portions of the lighting system, which can only be tested at night, are operational.
 2. A functional test for each new or modified electrical system will consist of not less than 5 days of continuous, satisfactory operation. If unsatisfactory performance of the system develops, correct the condition and repeat the test until the 5-day continuous satisfactory operation is obtained.

3. Do not start functional tests or turn-ons on Friday, or on the day preceding a legal holiday.
 4. Shutdowns caused by factors beyond Contractor's control will not constitute discontinuity of the functional test.
- C. Replace or correct any material revealed by these tests to be faulty.
 - D. Provide equipment, personnel, cable connections, and electrical energy for testing. Certify that each circuit has been completely tested and testing procedures are satisfied.

3.11 SALVAGE

- A. Terminate all conduit abandoned in place at least 5-inches below finished grade.
- B. Exercise care in removing equipment to be reused or salvaged so that it will remain in the condition existing prior to its removal. Salvaged material shall be the responsibility of the contractor, unless specified otherwise.

3.12 RESTORATION

- A. Replace damaged equipment, concrete work or other fixtures disturbed or damaged by the installation.
- B. Restore or replace roadway pavement cuts per the City's Encroachment Permit.
- C. Restore or replace disturbed plantings in landscaped areas.

*** END OF SECTION ***