

A d d e n d u m

Iowa Department of Transportation
Office of Contracts

Date of Letting: February 21, 2017
Date of Addendum: February 16, 2017

B.O.	Proposal ID	Proposal Work Type	County	Project Number	Addendum
104	25-8177-619	PCC PAVEMENT WIDENING	DALLAS	STP-U-8177(619)—70-25	21FEB104A01

Make the following change to the Proposal Details, Page 2

Change Completion Date:
From: 10/27/17
To: 11/24/17

Make the following changes to the Proposal Special Provisions List and the Proposal Special Provisions Text.

Replace SP-154009 with the attached SP-154009a

SPECIAL PROVISIONS FOR TRAFFIC SIGNALIZATION
Dallas County STP-U-8177(619)--70-25
Effective Date February 21, 2017

SP-154009a Revisions:

- Remove multimode fiber optic cable
- Changing the model of the PTZ camera to be installed
- Added provision for traffic signal poles, pedestal poles, base mast arms and hardware painting system allowed
- Updated pole design specification requirement

Replace SP-154013 with the attached SP-154013a

SPECIAL PROVISIONS FOR ELECTRICAL SYSTEM FOR STORMWATER PUMPS
Dallas County STP-U-8177(619)--70-25
Effective Date February 21, 2017

SP-154013 Revisions:

- Revised to specify the Flygt/Xylem MultiStart pump station controller and the Asea Brown Boveri (ABB) Variable Speed Drive (VFD) motor controller

Make the following changes to the PROPOSAL SCHEDULE OF PRICES:

Change Proposal Line No. 0020 2102-2710070 EXCAVATION, CLASS 10, ROADWAY AND BORROW:

From: 22,562.000 CY

To: 19,817.000 CY

Change Proposal Line No. 0030 2102-2710090 EXCAVATION, CLASS 10, WASTE:

From: 4,153.000 CY

To: 1,424.000 CY

Change Proposal Line No. 0050 2105-8425015 TOPSOIL, STRIP, SALVAGE AND SPREAD:

From: 7,882.000 CY

To: 7,751.000 CY

Change Proposal Line No. 0660 2523-0000100 LIGHTING POLES:

From: 20.000 EACH

To: 18.000 EACH

Change Proposal Line No. 0680 2523-0000310 HANDHOLES AND JUNCTION BOXES:

From: 23.000 EACH

To: 25.000 EACH

If the above changes are not made, they will be made as shown here.

Replace plans sheets with the attached:

A.01, C.02, C.03, C.08, M.15, M.16, M.17, M.18, M.19, N.01, N.02, N.04, N.05, N.08, T.01, T.02, T.03, & T.04

C.02 and C.03:

- Revised Items 2, 3, and 5, earthwork quantities, as it was determined that the Class 10 quantity included portions of the Class 20 excavation for the pedestrian underpass and earthwork was rerun to detail staging needs per question #5.
- Revised Item 66, Lighting pole, quantity per clarification from Question #6
- Revised Item 68, Handhole quantity per clarification from Question #8.

C.08:

- Strike "Reinforced" from all 10" PCC as joint reinforcement is all that is needed per questions #10.

M.15-M.19:

- Revised to depict the wetwell level sensor and float switches to reflect the configuration change of the level sensor and back-up level detector (Multitrode).
- Updated the I/O Schedule and field wiring schedule to show one less point used for the back-up scheme.

N.01:

- Project notes were revised to remove ground rods adjacent to each handhole, removed required pain method as powder coating, removed mention of luminaires and refers to P-sheets for information, and added a note to coordinate splicing of the fiber optic cable with the City.
- Quantities were updated to reflect other sheet changes
- Quantities for EVP detector, Fiber termination rack 24 Position, 7c signal cable, and 5c signal cable were added per question #7.

N.02:

- Signal head arrangement was changed and Fiber hub was removed from item list.

N.04:

- 72 SM was removed, 12MM was replaced with 12 SM, Note 12 and 13 were removed completely including 2" conduit

N.05:

- Detectors 60A,60B,60C were combined to one card rack position and card rack was changed to a Two channel Detector.

N.08:

- Splice diagram was added.



**SPECIAL PROVISIONS
FOR
TRAFFIC SIGNALIZATION**

**Dallas County
STP-U-8177(619)--70-25**

**Effective Date
February 21, 2017**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

154009a.01 DESCRIPTION.

Includes the furnishing of all material and equipment necessary to complete, in place and operational, traffic control signal(s) as described in the project plans.

A. Submittals

1. Follow the General Provisions (Requirements) and Covenants as well as the additional requirements listed below. All of the following must be submitted within 30 days after awarding of the contract for the project. Verify the method of submittal with the Jurisdiction.
2. Schedule of Unit Prices: Submit a completed schedule of unit prices. Estimates of the work performed on the project will be made by the Jurisdiction and the unit costs will be used to prepare progress payments to the Contractor.
3. Material and Equipment List: Submit a completed list of materials and equipment to the Jurisdiction for written approval before any equipment or materials are ordered.
4. Contractor Certification: Submit the name(s) and contact information of the International Municipal Signal Association (IMSA) Level II Certified Traffic Signal Technician(s) working on the project and a copy of their IMSA certificate.
5. Shop Drawings: Submit shop drawings for traffic signal poles and structures to be furnished on the project. Submit catalog cuts and manufacturer's specifications for all items in the equipment list.

B. Special Requirements

1. The installation of the traffic control signals and appurtenances shall comply with the current edition of the MUTCD as adopted by the Iowa DOT.
2. The Contractor shall be responsible for ONE CALL locates of the fiber cables installed under this project until acceptance of the project by the City.
3. The Contractor shall coordinate with the City for splice connections of the fiber into the existing fiber optic system. The Contractor to supply fiber optic wiring diagram as-built drawings. The Contractor shall maintain accurate quantities of the splices and terminations at each location during the project.

154009a.02 MATERIALS.

A. Underground

1. Handhole:
 - a. General:
 - i. Cable Hooks: Provide four galvanized steel cable hooks with a minimum diameter of 3/8 inch and a minimum length of 5 inches.

- ii. Granular Base: Comply with the following gradations; however, the Engineer may authorize a change in gradation, subject to materials available locally at the time of construction.

Sieve	Percent Passing
2"	100
1 1/2"	80 to 90
1"	15 to 20
3/4"	0 to 0.5

- iii. Cover: Include "TRAFFIC SIGNAL" as a message on the cover.
 - b. Precast Concrete Handhole:
 - i. Pipe: Comply with ASTM C 76. Minimum Class III, Wall B (Iowa DOT Class 2000D). Four, 8 inch knockouts (conduit entrance points) equally spaced around the handhole.
 - ii. Casting: Gray cast iron and certified according to requirements of AASHTO M 306 for a 16,000 pound proof-load (HS-20).
 - c. Composite Handhole and Cover: Precast polymer concrete handholes shall be stackable with a minimum depth of 30 inches and an "open" bottom, unless otherwise specified in the plans. Composed of mortar consisting of sand, gravel, and polyester resin reinforced by a woven glass fiber mat or of resin mortar and fiberglass, shall meet or exceed all appropriate ANSI/SCTE 77 tests and requirements. Ensure the cover satisfies loading requirements of ANSI Tier 15. Provide a skid resistant surface on the cover. Provide two 3/8-16 UNC stainless steel hex head bolts with washers.
2. Conduit:
- a. General:
 - i. Furnish weatherproof fittings of identical or compatible material to the conduit. Use standard factory elbows, couplings, and other fittings.
 - ii. Use a manufactured conduit sealing compound that is readily workable material at temperatures as low as 30°F and will not melt or run at temperatures as high as 300°F.
 - b. Steel Conduit and Fittings:
 - i. Comply with ANSI C80.1, latest revision.
 - ii. Use weatherproof expansion fittings with galvanized, malleable iron, fixed and expansion heads jointed by rigid steel conduit sleeves. As an option, the fixed head may be integral with the sleeve, forming a one piece body of galvanized malleable iron.
 - iii. Provide steel bushings.
 - c. Plastic Conduit and Fittings:
 - i. PVC:
 - (a) PVC Schedule 40 plastic conduit and fittings complying with NEMA TC-2 (pipe), NEMA TC-3 (fittings), and UL 651 for Schedule 40 heavy wall type.
 - (b) Solvent welded, socket type fittings, except where otherwise specified in the contract documents.
 - (c) Threaded adaptors for jointing plastic conduit to rigid metal ducts.
 - (d) Provide bell end fittings or bushings.
 - ii. HDPE:
 - (a) Comply with ASTM F 2160 (conduit) and ASTM D 3350 (HDPE material), SDR 13.5.
 - (b) Use orange colored conduit or color as specified in the plans.
 - (c) Continuous reel or straight pieces to minimize splicing.
 - (d) For dissimilar conduit connections, provide an adhesive compatible with both materials.
3. Wiring and Cable: Provide wire that is plainly marked on the outside of the sheath with the manufacturer's name and identification of the type of the cable.
- a. General:
 - i. Shall be rated 600 volts minimum.
 - b. Power Cable: Comply with Article 4185.12 of the Standard Specifications.
 - c. Signal Cable: Comply with IMSA Specifications 19-1 (PVC jacket) or 20-1 (polyethylene jacket) for polyethylene insulated, 600 volt, solid, multi-conductor copper wire, No. 14 AWG.
 - d. Tracer Wire: Comply with No. 10 AWG, single conductor, stranded copper, Type thermoplastic high-heat nylon-coated (THHN), with UL approval, and an orange colored jacket.

- e. Communications Cable: Comply with IMSA Specifications 39-2 or 40-2 for No. 19 AWG, solid copper conductor, twisted pairs. Use polyethylene insulated, aluminum shielded, complying with REA Specification PE-39 for paired communication cable with electrical shielding.
- f. Category 5E (Cat5E) Cable: Provide outdoor use rated cable.
- g. Fiber Optic Cable and Accessories:
 - i. Furnish fiber optic cable of the mode type, size, and number of fibers specified in the contract documents, and all associated accessories.
 - ii. Meet the latest applicable standard specifications by ANSI, Electronics Industries Association (EIA), and Telecommunications Industries Association (TIA).
 - iii. ~~Multimode Fiber – Grade Index:~~
 - ~~Core Diameter: 62.5 $\mu\text{m} \pm 1.0 \mu\text{m}$~~
 - ~~Cladding Diameter: 125.0 $\mu\text{m} \pm 1.0 \mu\text{m}$~~
 - ~~Core Concentricity: $\pm 1\%$~~
 - ~~Max. Attenuation: 3.75 dB/km @ 850 nm~~
 - iv. Single-Mode Fiber:

Typical Core Diameter:	8.3 $\mu\text{m} \pm 1.0 \mu\text{m}$
Cladding Diameter:	125.0 $\mu\text{m} \pm 1.0 \mu\text{m}$
Core Concentricity:	$\pm 1\%$
Attenuation Uniformity:	No point discontinuity greater than 0.1 μm at either 1310 nm or 1550 nm
Max. Attenuation:	0.25 dB/km
 - v. Dual layer UV cured acrylate coating applied by the fiber manufacturer, mechanically or chemically strip-able without damage to the fiber.
 - vi. Glass reinforced plastic rod central member designed to prevent the buckling of the cable. Cable core interstices filled with water blocking tape to prevent water infiltration.
 - vii. Dielectric fillers may be included in the cable core where needed to lend symmetry to the cable cross-section.
 - viii. Buffer tubes of dual layer construction with a polycarbonate inner layer and polyester outer layer. Each buffer tube filled with a water-swallowable yarn or tape. Buffer tubes stranded around the central member using reverse oscillation or “SZ” stranding process. Gel-free cable and buffer tubes.
 - ix. Buffer tubes and fibers meeting TIA/EIA-598A, “Color coding of fiber optic cables.” The single mode cable shall include loose tubes with 12 fibers in each with a total number of tubes matching the number of fibers specified on the plans. ~~The multimode cable shall include one loose tube with 12 fibers.~~ The tube and fiber colors shall follow the industry color code (BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, RS, AQ).
 - x. Cable tensile strength provided by a high tensile strength aramid yarn and/or fiberglass.
 - xi. All dielectric cables, without armoring, sheathed with medium density polyethylene (1.4 mm minimum nominal jacket thickness). Jacketing material applied directly over the tensile strength members and flooding compound. Jacket or sheath marked in a contrasting color with the manufacturer's name and the words “Optical Cable,” the year of manufacture, and sequential meter or feet marks. The markings shall be repeated every meter. The actual length of the cable shall be within the range plus one percent of the length marked. Additionally, provide a durable weather proof label on the cable jacket showing the actual attenuation of each fiber expressed in dB/km.
 - xii. Cable fabricated to withstand a maximum pulling tension of 600 pounds during installation (short term) and 135 pounds upon installation (long term).
 - xiii. Shipping, storing, and operating temperature range of the cable: -40°F to $+160^{\circ}\text{F}$.
 - xiv. Each fiber of all fiber optic cable tested by manufacturer at the 100% level for the following tests:
 - (a) Proof tested at a minimum load of 50 kpsi
 - (b) Each fiber shall be tested for attenuation and the reading shall be part of the cable labeling.
 - (c) Meet the appropriate standard Fiber Optic Test Procedure for the following measurements:
 - Fluid Penetration
 - Compound Drip
 - Compressive Loading Resistance

- Cyclic Flexing
 - Cyclic Impact
 - Tensile Loading and Bending
- xv. Make cable ends available for testing. Seal cable ends to prevent moisture impregnation.
 - xvi. Fiber Distribution Panel: Provide a fiber distribution panel capable of terminating a minimum of 24 fibers, or as specified in the contract documents.
 - xvii. Fiber Optic Connectors:
 - ~~(a) ST type connectors of ceramic ferrule and physical contact end finish shall be used to terminate multi-mode fibers to equipment.~~
 - (b) ST type connectors of ceramic ferrule and physical contact end finish shall be used to terminate single-mode fibers to equipment.
 - (c) ST or mechanical connectors not allowed for cable splices.
 - (d) Maximum attenuation per connector: 0.75 dB.
 - xviii. Fiber Optic Jumpers/Patch Cords:
 - ~~(a) Six fibers in each multimode fiber optic cable shall be terminated in the distribution unit with the traffic signal controller cabinet.~~
 - (b) Duplex pigtail jumpers shall be used to branch traffic signal controller circuits from the distribution panel in the cabinet to controller FO OTR or to other communication equipment.
 - (c) Length of pigtail jumpers will vary according to distribution panel to NEMA controller FO OTR location. Length of jumper should provide for a minimum of 2 feet total slack between distribution panel and OTR connections.
 - (d) Controller cabinet pigtail jumpers shall consist of factory-assembled patch cords, each of which shall contain two multimode fibers. Each such fiber shall have an ST compatible, physical contact connector with ceramic ferrule on one end (i.e., a total of four STPC connectors per cord). Each patch cord shall have a dielectric strength member and a durable outer jacket designed to withstand handling.
 - xix. Fiber Optic Breakout Kits: Provide breakout kits for separation and protection of individual fibers, with buffering tube and jacketing materials suitable for termination of the fiber and fiber optic connector as specified.
 - xx. Splices/ Splice Enclosures: Fusion splice continuous fiber runs or branch circuit connections in splice enclosures as allowed or specified in the contract documents. Provide environmentally protected outside plant splice enclosures with adequate number of trays to splice all fibers. Maximum attenuation per splice: 0.3 dB.
4. Footings:
 - a. Use Class C structural concrete complying with Section 2403 of the Standard Specifications.
 - b. Reinforcing steel shall be the type and size as shown on the plans and shall conform to the requirements of Section 2404 of the Standard Specifications.
 - c. Use uncoated reinforcing steel complying with Section 4151 of the Standard Specifications.
 5. Bonding and Grounding:
 - a. Ground Rods: Provide 5/8 inch by 8 foot copper clad, steel ground rod at each pole and controller footing.
 - b. Bonding Jumper or Connecting Wire: Provide No. 6 AWG bare conductor, copper wire.

B. Detection

1. Inductive Loop Vehicle Detector: A detector consists of a conductor loop or series of loops installed in the roadway, lead-in (feeder) cable, and a sensor (amplifier) unit with power supply installed in a traffic signal controller cabinet.
 - a. Cables: All cables must be UL approved.
 - i. Tube Loop Detector Cable: Comply with IMSA Specifications 51-5.
 - ii. Preformed Loop Detector Cable: As approved by the Engineer.
 - iii. Loop Detector Lead-in Cable: Comply with IMSA Specifications 50-2.
 - b. Detector Loop Sealant:
 - i. Use a rapid cure, high viscosity, liquid epoxy sealant formulated for use in sealing inductive wire loops and leads embedded in pavement. Ensure the cured sealer is unaffected by oils, gasoline, grease, acids, and most alkalis.
 - ii. Use a sealant complying with Materials I.M. 491.18.

- c. Sensor (Amplifier) Unit:
 - i. Use a sensor unit that is solid state, digital, providing detection channel(s) with an inductance range of 0 to 2,000 micro-henries. Output circuits of the sensor unit will be provided by relays. Vehicle presence will result in a continuous call indication.
 - ii. Provide a sensor unit with the following qualities:
 - (a) Sensitivity adjustment to allow as a minimum the selection of high, medium, or low sensitivity.
 - (b) Be capable of providing reliable detection of all licensed motor vehicles.
 - (c) Provide an indicator light for visual indication of each vehicle detection.
 - (d) Will not require external equipment for tuning or adjustment.
 - (e) Provide operation in the pulse mode or presence mode. Ensure mode switch is readily accessible.
 - (f) Provide a self tuning system that is activated automatically with each application of power. Provide automatic and continuous fine tuning to correct for environmental drift of loop impedance.
 - (g) Provide for fail-safe operation (continuous call) in the event of detector loop failure.
 - (h) Ensure each detector channel will respond to a frequency shift in an increasing or decreasing value as occurs with temperature shifts in the pavement without requiring a locked call.
 - (i) Use detector units with delay and extension timing. The delay feature is selected and adjusted externally on the sensor unit housing. Digitally derived timing is selectable in 1 second increments from 0 to 30 seconds. Ensure delay timing inhibits detector output until presence has been maintained for the time selected. Restart delay timer at each new detection.
 - (j) Use a sensor unit capable of normal operation without interference and false calls between sensor units ("crosstalk") when installed in the physical environment of the controller cabinet and the electrical environment of the associated electronic equipment installed therein, including other detectors.
- 2. Pedestrian Push Button Detectors:
 - a. Assembly:
 - i. Ensure the entire assembly is weather tight, secure against electrical shock, withstands continuous hard usage.
 - ii. Provide a removable contact assembly mounted in a die cast aluminum case.
 - iii. Ensure contacts are normally open with no current flowing except at the moment of actuation.
 - iv. Ensure the contacts are entirely insulated from the housing and operating button with terminals for making connections.
 - v. Provide housing with one outlet for 1/2 inch pipe.
 - b. Operating Button:
 - i. Shall be piezo driven solid state switch type with audible confirmation tone.
 - ii. Ensure the button does not protrude out from the case.
 - iii. Supply ADA compliant operating button.
 - c. Signs: Furnish signs complying with MUTCD.

C. Communications

- 1. Traffic Monitoring System: Provide as specified in the contract documents including, video camera in dome, dome mounting bracket and hardware, camera controller, cabling from camera to controller cabinet, and all accessories and hardware necessary for a complete and operational system. The PTZ camera shall be an AXIS ~~Q6032e~~ Q6054-E Weather Resistant Dome Network Camera.
 - a. Pan/tilt/zoom (PTZ) color camera with automatic conversion to monochrome during low light levels, auto focus, auto-iris control, electronic image stabilization, privacy masking and high resolution 1/4 inch CCD imager. Minimum optical zoom: 35X. Minimum digital zoom: 12X.
 - b. Camera system provided in a NEMA 4X or IP66 certified rugged weather-resistant package.
 - c. Shall be IP addressable and come with internet-based camera interface controls.
 - d. Provide all required lightning protection for electronics control, power, and coax video outputs.
 - e. Operating temperature range: -40°F to 122°F.
 - f. Electronic Image Stabilization up to 12dB suppression

- g. Maximum cable length as specified by camera manufacturer.
- h. Provide full 360 degree endless pan and 220 degree tilt under PTZ control.
- i. Dome electronics capable of programming a minimum of 100 preset views and nine preprogrammed pattern sequences of preset views. All views selectable by the central office computer or a remote control device.
- j. Provide encoder and decoder devices as needed to transmit video over existing or proposed communication systems at 30 frames per second.
- k. Provide all necessary rack support devices for video viewing and PTZ control.
- l. Provide ability to control PTZ and view video remotely.

D. Cabinet and Controller

1. NEMA Controller, Cabinet, and Auxiliary Equipment: Comply with the latest edition of NEMA TS1 or TS2 standards.
 - a. Controller:
 - i. Controller shall be a Siemens M50 series with fiber optic communication capability, including a smart malfunction management unit (MMU).
 - ii. Solid state modular design with digital timing and capable of accommodating at least eight phases.
 - iii. Fully prompted, front panel keyboard with menu driven programmability.
 - iv. Local time base scheduler including automatic accommodation for daylight savings time.
 - v. Local coordination control.
 - vi. Local preemption control with at least four programmable internal preemption sequences.
 - vii. Current software and documentation.
 - viii. Data retained in a memory medium that does not require battery backup.
 - b. Cabinet:
 - i. Unpainted aluminum cabinet according to NEMA standards.
 - ii. Aluminum cabinet riser with same dimensions as cabinet, 18 inch height and matching finish on the signal cabinet, as specified in the contract documents.
 - iii. Police door with auto/flash switch and on/off power switch for signal heads only. Controller to remain in full operation regardless of switch positions.
 - iv. Maintenance panel on inside of the main door containing the following test switches.
 - (a) Controller power switch.
 - (b) Detector test switches.
 - (c) Stop time switch.
 - (d) Signal flash switch.
 - v. Heavy-duty clear plastic envelope attached to inside wall of cabinet or cabinet door, for cabinet wiring diagrams, 12 inches by 18 inches minimum.
 - vi. GFI electrical outlet and lamps in accessible location near the front of the cabinet. GFI outlet fused separately from main AC circuit breaker. Two LED cabinet lamps connected and fused with GFI outlet.
 - vii. Back panel positions to accommodate phasing and expansibility specified in the contract documents.
 - viii. Power protection devices including AC power circuit breakers, radio interference suppressors, and lightning and surge protectors.
 - (a) AC field service single pole, nonadjustable, magnetic breaker rated for 117 VAC operation, NEC approved.
 - (b) Radio interference suppressors (RIS) as required to minimize interference in all broadcast transmission and aircraft frequency bands.
 - (c) Lightning arrestor/surge protector capable of withstanding repeated (minimum of 25) 30,000 ampere surges.
 - ix. Neatly train wiring throughout the cabinet and riser. Bundle and attach wiring to interior panels using nonconductive clamps or tie-wraps.
 - c. Auxiliary Equipment: Conflict monitor/malfunction management unit, flasher, load switches, terminals and facilities, and miscellaneous equipment and materials according to NEMA standards.
 - i. All fiber optic cable shall be suitably identified inside the cabinet.

- ii. Included as incidental to Auxiliary Equipment, is any and all jumpers/pigtail cables, splice trays/enclosures, termination panels to accommodate the number of terminations per plan, fiber optic connectors, and fiber breakout kits
- 2. Uninterruptible Power Supply Battery Backup System: Monitors 120VAC input from the electric utility source and automatically switches to/from a system consisting of batteries and electronics.
 - a. Outdoor Hardened Battery Backup System
 - i. Supply a "rack-mounted" UPS unit, including a front panel with indicators and control switches.
 - ii. The system shall include, but not be limited to the following: Inverter/charger, four batteries, battery heater mats, a charge management system, a separate automatic and manually operated bypass switch and all necessary hardware and interconnect wiring.
 - iii. Designed to provide a minimum of 4 hours of normal operation.
 - b. Use cabinet equipment that is plug connected and shelf mounted.
 - i. Designed to cover a temperature range from -30°F to +165°F and include a surge suppressor.
 - ii. Enclosure/Cabinet
 - iii. System should be mounted in a cabinet connected to the side of the traffic controller cabinet.
 - iv. The enclosure will house the batteries, UPS and bypass switches.
 - v. The cabinet must meet the requirements for NEMA 3R enclosures.
 - vi. Dimensions of the enclosure shall not exceed 50 inches height by 17 inches wide by 17 inches deep.
 - vii. The UPS enclosure must not interfere with the opening of the traffic cabinet door.
 - viii. The complete enclosure and door must be made from 0.125 inch thick aluminum. All external seams must be continuously welded. The door must have a double flange for weather sealing purposes.
 - ix. A ventilation fan must be mounted in the air baffle at the top of the cabinet with an air outlet built into the overhang. The bottom of the door must be louvered to allow airflow. The fan must be thermostatically controlled. A removable dust filter must be located behind the vent.
 - x. The enclosure shall be a natural aluminum finish.
 - c. Batteries
 - i. The individual batteries shall be voltage rating type 12V and have an amp-hour rating of 100 amp-hour minimum.
 - ii. Batteries shall be easily replaced and commercially available.
 - iii. Batteries shall be deep discharge, sealed prismatic lead-calcium based GEL/VRLA Gelled Electrolyte/Valve Regulated Lead Acid, and designed for standby operations.
- 3. Emergency Vehicle Preemption System:
 - a. Shall be manufactured by TOMAR with a 2140 OSP card and 2090-ST detectors.
 - b. Provide as specified in the contract documents including, preemption detector, mounting bracket and hardware, cabling from detector to controller cabinet, OSP card, and all accessories and hardware necessary for a complete and operational system.

E. Poles, Heads, and Signs

- 1. Vehicle Traffic Signal Head Assembly: Comply with current MUTCD and ITE standards.
 - a. Housing:
 - i. Individual signal sections made of a durable polycarbonate. The black color to be an integral part of the materials composition.
 - ii. Self-contained unit capable of separate mounting or inclusion in a signal face containing two or more signal sections rigidly and securely fastened together.
 - iii. Equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
 - iv. Doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of noncorrosive material. Doors are to be easily removed and reinstalled without use of special tools.
 - b. Optical System: Designed to prevent any objectionable reflection of sun rays even at times of the day when the sun may shine directly into the lens.

- c. Lenses: 12 inch diameter polycarbonate. Do not use glass lenses.
- d. Visors:
 - i. Standard Installation:
 - (a) Each signal lens is to have a visor with the bottom 25% open.
 - (b) Minimum 0.1 inch in thickness and black in color.
 - (c) Fits tightly against the housing door with no filtration of light between the visor and door.
 - (d) Minimum length of 9 1/2 inches. Ensure the visor angle is slightly downward.
- e. Terminal Block:
 - i. Three-section signal equipped with a six position terminal block.
 - ii. Four- and five-section signal equipped with an eight position terminal block.
- f. Backplate:
 - i. Manufactured one-piece, durable, black plastic capable of withstanding a 100 mph wind.
 - ii. Provides 5 inches of black field around the assembly.
- g. Mounting Hardware:
 - i. Fixed: 1 1/2 inch aluminum pipe and fittings, natural aluminum finish for galvanized poles or match the pole color. Secure to pole with a minimum 5/8 inch wide stainless steel banding material.
 - ii. Universally Adjustable: Rigid mounted, consisting of both top and bottom brackets and easily adjustable in both horizontal and vertical planes.
- h. LED Modules: Comply with current ITE standards.
- 2. Pedestrian Traffic Signal Head Assembly: Comply with current MUTCD and ITE standards.
 - a. Housing:
 - i. Made of a durable polycarbonate. Black color to be an integral part of the materials composition.
 - ii. Self-contained unit capable of separate mounting or inclusion in a signal face containing one or more signal sections rigidly and securely fastened together.
 - iii. Equipped with openings and positive locking devices in the top and bottom so that it may be rotated between waterproof supporting brackets capable of being directed and secured at any angle in the horizontal plane.
 - iv. Doors and lenses with suitable watertight gaskets and doors that are suitably hinged and held securely to the body of the housing by simple locking devices of noncorrosive material. Doors are to be easily removed and reinstalled without use of special tools.
 - b. Visor:
 - i. Tunnel type visor, black in color, attached to the housing door by stainless steel screws.
 - ii. Fit tightly against the housing door to prevent any filtration of light between the door and the visor.
 - iii. Ensure the visor angle is slightly downward.
 - c. LED Module:
 - i. Provide a LED unit(s) for the filled upraised hand symbol, walking person symbol, and countdown timer.
 - ii. Ensure immediate blank out of the countdown timer display upon recognizing a shortened "Walk" or a shortened "Flashing Don't Walk" interval.
- 3. Traffic Signal Poles and Mast Arms:
 - a. General:
 - i. Mast arm length and vertical pole height as specified in the contract documents.
 - ii. Ensure the mast arms, poles, and supporting bases are galvanized inside and out according to ASTM A 123.
 - iii. Poles, mast arms and hardware shall be colored RAL 7043 by IADOT approved methods.
 - iv. Continuous tapered, round, steel poles of the transformer base type. Fabricated from low carbon (maximum carbon 0.30%) steel of U.S. standard gauge.
 - v. When a transformer base is not specified, provide a 6 inch by 16 inch handhole in the pole shaft for cable access. Provide a cover for the handhole. Secure the cover to the base with simple tools. Hardware to be corrosion resistant.
 - vi. Ensure minimum yield strength of 48,000 psi after manufacture. Supply base and flange plates of structural steel complying with AASHTO M 183 (ASTM A 36) and cast steel complying with ASTM A 27, Grade 65-35 or better.

- i. Post: Standard weight (Schedule 40) pipe complying with ASTM F 1083, galvanized inside and out; 2 1/2 inches in diameter.
 - ii. Cap: Waterproof cap complying with ASTM F 626.
 - iii. Anchor Bolts: Four 1/2 inch by 24 inch steel, hot dip galvanized anchor bolts complete with all hardware required for installation.
 - iv. Non-shrink Grout: Comply with Materials I.M. 491.13 or a rodent guard (complying with Materials I.M. 443.01) for placement between the post base and the foundation.
 - v. Base Plate: Provide a 5 inch square, 1/2 inch thick galvanized steel base plate with a 4 1/2 inch bolt circle.
 - vi. Poles, bases and hardware shall be colored RAL 7043 by IADOT approved methods.
6. Traffic Signs:
- a. Comply with Section 4186 of the Standard Specifications.
 - b. Use a universally adjustable mast arm mounted sign bracket.
 - c. Comply with MUTCD and the contract documents for the street name sign dimensions and sheeting. Street name lettering shall be Series C with 12 inch uppercase and lowercase letters.

154009a.03 CONSTRUCTION.

A. Underground

- 1. Handhole:
 - a. Locations:
 - i. Do not construct in ditch bottoms, low areas where ponding of water may occur, or where they will be subject to normal vehicular traffic.
 - ii. With Engineer approval, additional handholes may be placed, at no additional cost to the Contracting Authority, to facilitate the work.
 - b. Excavation: Excavate as necessary to accommodate the handhole and granular base.
 - c. Granular Base: Install 8 inch thick granular base extending a minimum of 6 inches beyond the outside walls of the handhole.
 - d. Placement:
 - i. In paved areas, install the handhole at an elevation so the casting is level and flush with the pavement. In unpaved areas, install the handhole approximately 1 inch above the final grade.
 - ii. Verify ring placement. Invert rings when installed in paved areas.
 - e. Conduit:
 - i. Remove knockouts as necessary to facilitate conduit entrance.
 - ii. Extend conduit into the handhole, through a knockout, approximately 2 inches beyond the inside wall. Conduit to slope down and away from the handhole.
 - iii. Place non-shrink grout (complying with Materials I.M. 491.13) in the opening of the knockout area after placement of conduit.
 - f. Cable Hooks: Install cable hooks centered between the knockouts and the top of the handhole.
 - g. Backfill: Place suitable backfill material according to Section 2552 of the Standard Specifications.
 - h. Casting: Place the casting on the handhole. Ensure the final elevation meets the handhole placement requirements.
- 2. Conduit:
 - a. General:
 - i. Place conduit to a minimum depth of 30 inches and a maximum depth of 60 inches below the gutterline. When conduit is placed behind the curb, place to a minimum depth of 24 inches and a maximum depth of 48 inches below top of curb.
 - ii. Change direction at handholes or by bending, such that the conduit will not be damaged or its internal diameter changed. Ensure bends are uniform in curvature and the inside radius of curvature of any bend is no less than six times the internal diameter of the conduit.
 - iii. On the exposed ends of conduit, place bell-end fittings on PVC or HDPE conduit and bushings on steel conduit prior to installing cable. Extend all conduits a minimum of 2 inches and a maximum of 4 inches above the finished surface of any footing or structural base.

- iv. When it is necessary to cut and thread steel conduit, do not allow exposed threads. Ensure conduits and fittings are free from burrs and rough places. Clean, swab, and ream conduit runs before cables are installed. Use nipples to eliminate cutting and threading where short lengths of conduit are required. Coat damaged galvanized finish on conduit with zinc rich paint. Use only galvanized steel fittings with steel conduit.
- v. Pack conduit ends with a conduit sealing compound.
- b. Trenched Installation:
 - i. Place backfill in layers not to exceed 12 inches in depth with each layer thoroughly compacted before the next layer is placed. Ensure backfill material is free of cinders, broken concrete, or other hard or abrasive materials.
 - ii. Remove all surplus material from the public right-of-way as soon as possible.
- c. Trenchless Installation:
 - i. When placing conduit under pavements, use the trenchless installation methods described in Section 2553 of the Standard Specification.
 - ii. If trenchless methods that compact soils in the bore path are used, provide sufficient cover to prevent heaving of overlying paved surfaces.
 - iii. Do not allow pits for boring to be closer than 2 feet to the back of curb, unless otherwise specified in the contract documents.
- 3. Wiring and Cable:
 - a. Where practical, follow color codes so that the red insulated conductor connects to the red indication terminal, yellow to yellow, and green to green. Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables. Label home runs for cables as follows: northwest corner is red, southeast corner is blue, northeast corner is green, and southwest corner is orange.
 - b. Install continuous runs of vehicle and pedestrian signal cables from the vehicle or pedestrian signal head to the handhole compartment of the signal pole base. Install continuous runs of vehicle and pedestrian signal cables from the handhole compartment of the signal pole base to the terminal compartment in the controller cabinet. Do not splice signal cables in underground handholes.
 - c. Install continuous runs for video detection and emergency vehicle preemption cables from the unit to the controller cabinet.
 - d. Install continuous runs of power lead-in cables from the service point to the meter socket and from the meter socket to the controller cabinet.
 - e. Install continuous detector cable from each detector loop to the first handhole adjacent to the loop. Ensure cables are properly labeled at the controller by durable labels, or other appropriate methods, attached to the cables. Install continuous homerun cable from the splice made in the first handhole to the terminal compartment in the controller cabinet. Attach the drain wire of the shielded cable to the ground in the controller cabinet.
 - f. Provide a minimum of 4 feet of additional cable at each handhole and loosely coil the extra cable on the handhole cable hooks. Provide a minimum of 2 feet of additional cable at each signal pole (measured from the handhole compartment in the pole to the end of the cable). Provide a minimum of 10 feet of additional cable at each controller base.
 - g. Pull cables through conduit using a cable grip designed to provide a firm hold upon the exterior covering of the cable or cables, and minimize dragging on the ground or pavement.
 - h. Install a tracer wire in all conduits with the exception of conduits between detector loops and handholes. Use a silicon-filled wire nut to splice the tracer wire in each handhole and at the controller to form a continuous run.
 - i. Fiber Optic Cable and Accessories:
 - i. General.
 - (a) Cable end shall be secured inside the controller cabinet so that no load is applied to the exposed fiber strands.
 - (b) Minimum bend radius for static storage shall not be less than ten times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer.
 - (c) The minimum bend radius during installation shall not be less fifteen times the diameter of the cable measuring the cable on the outside, or as recommended by the manufacturer.
 - (d) Slack shall be left in each handhole at the top of any conduit riser, junction box, and controller. This slack cable requirement may be deleted where existing handholes

or through points lack sufficient area to maintain the minimum bend requirements. Where slack has been deleted, extra slack equal to the amount that would have been distributed in the through points shall be equally divided between the two controller cabinets and shall be in addition to the slack mandated at the cabinets. Slack in each handhole type shall be provided as designated on the plans. Slack cable shall be coiled and the coils bound at three points around the coil perimeter and supported in their static storage position.

- ii. Use a suitable cable feeder guide between the cable reel and the face of the conduit to protect the cable and guide the cable directly into the conduit off the reel. During the installation, carefully inspect cable jacket for defects. If defects are found, notify the Engineer prior to any additional cable being installed. Take care when pulling the cable to ensure the cable does not become kinked, crushed, twisted, snapped, etc.
- iii. Attach a pulling eye to the cable and use to pull the cable through the conduit. Use a pulling swivel to preclude twisting of the cable. Lubricate cable prior to entering the conduit with a lubricant recommended by the manufacturer. Use dynamometer or break away pulling swing to ensure the pulling tension does not exceed the specified force of 600 pounds or the cable manufacturer's recommendations, whichever is less. The mechanical stress on the cable shall not allow the cable to twist, stretch, become crushed, or forced around sharp turns that exceed the bend radius or scar or damage the jacket. Manually assist the pulling of the cable at each pull point.
- iv. Do not pull cable through any intermediate junction box, handhole, pull box, pole base, or any other opening in the conduit unless specified in the contract documents. The necessary length of cable to be installed shall be pulled from handhole or controller cabinet to the immediate next downstream handhole or cabinet. Carefully store the remaining length of cable to be installed in the next conduit run(s) in a manner that is not hazardous to pedestrian or vehicular traffic, yet ensures that no damage to the cable occurs. Storage methods are subject to Engineer approval.
- v. At each handhole, visibly mark or tag cable, "CITY SM/MM"
- vi. Secure cables inside controller cabinet so that no load is applied to exposed fiber strands.
- vii. Ensure the radius of the bend for static storage is no less than 10 times the outside diameter of the cable, or as recommended by the manufacturer. Ensure the radius of the bend during installation is no less than 15 times the outside diameter of the cable, or as recommended by the manufacturer.
- viii. Provide cable slack in each handhole, junction box, and cabinet as specified:

Traffic Cabinet	50 feet
Type 1 Handhole	50 feet
Type 3 Handhole (tub)	100 feet
- ix. Where handholes or junction boxes lack sufficient area for cable storage or bend radius requirements, provide equivalent additional slack in adjacent facilities. Coil and bind slack cable at three points around the cable perimeter and support in its static storage position.
- x. Install fiber optic accessories according to the manufacturer's recommendations and as specified in the contract documents.
- j. Fiber Optic Cable Field Testing:
 - i. General
 - (a) Each fiber furnished and installed as part of the project shall be tested, both on-the-reel prior to installation and after installation using a high-resolution optical time domain reflectometer (OTDR).
 - (b) Single mode measurements shall be conducted at the 1550 ± 30 nanometer wavelength. ~~Multi-mode measurements shall be conducted at 1300 ± 30 nanometer wavelength.~~
 - (c) The Contractor shall record the identification, location, length, and attenuation measurements of each tested fiber and shall furnish all test reports to the Engineer prior to installation of the cables. All cable readings/measurements shall be compared to the maximum allowable deviations in the cable specification and the levels of acceptance recommended by the manufacturer in their printed documentation. Any cable having measurements outside the allowable range shall be replaced and shall not be acceptable for installation on this project.

- ii. On-reel Testing:
 - (a) Prior to the installation, the Contractor shall perform on-site, on-reel testing. This testing shall be for both attenuation and continuity.
 - (b) The testing shall be performed using an OTDR by means of a pigtail splice. All test results shall be within $\pm 3\%$ of factory-supplied attenuation measurements.
 - (c) Testing shall be done in one direction only.
 - (d) Except for the access to and the test preparation of any one end of the newly furnished cable to be tested, the Contractor shall preserve the cable in its originally-shipped condition. If any fiber of the cable fails the on-reel attenuation test, the cable shall be rejected and shall not be used on this project. The rejected cable shall be replaced at the Contractor's expense.
 - iii. Cable Segment Testing.
 - (a) As each cable segment is terminated, the Contractor shall perform an end-to-end attenuation (power loss) test of each terminated fiber of each FO cable. This testing shall be performed using hand-held optical test sets and shall be tabulated and be included in the documentation package to be provided to the Engineer at the conclusion of the project.
 - (b) Overall loss for each link shall not exceed the cumulative specified maximum losses of the components. For example, at 850 nm, a one kilometer link with two splices and a connector on each end shall not exceed 4.9 dB:
 - 1.0 km x 3.5 dB/km: 3.5 dB
 - 0.2 dB per splice x 2: 0.4 dB
 - 0.5 dB per connector x 2: 1.0 dB
 - Maximum allowable loss: 4.9 Db
 - (c) The cable segment shall be rejected for use on this project if any terminated fiber of the cable segment fails the attenuation test. Rejected cables shall be repaired or replaced by the Contractor at the Contractor's expense. The Contractor shall retest all fibers of any repaired or replaced cable segment. The Contractor shall submit complete documentation of the cable segment attenuation tests. Such documentation shall be submitted in either hardcopy (written) form or in Engineer-approved electronic format on diskette.
 - iv. Final System Testing:
 - (a) After the complete fiber optic system is installed and terminated, but excluding the capping of unused fibers, an OTDR reading shall be performed on all cables to insure that each section is in compliance with the issued specification.
 - (b) A hard copy of OTDR signature traces for all fibers for all sections shall be provided to the Engineer. Fibers which have been terminated shall be indicated in the report. In addition to the OTDR test report, the Contractor shall provide the test results of an Attenuation Test for the installed fibers using the insertion loss test procedure and the Transmitter/Receiver Power Level Test and the Continuity Test.
4. Footings:
- a. Excavation: Excavate to the size, shape, and depth specified in the contract documents. Ensure the bottom of all foundations rest securely on firm undisturbed soil. Minimize over excavation to ensure support and stability of the foundation.
 - b. Footing: Provide a means for holding all of the following elements rigidly in place while the concrete is being placed.
 - i. Forms:
 - (a) Set the forms level or sloped to meet the adjacent paved areas.
 - (b) When adjacent to paved areas, shape the top 11 inches of the footing to be square and flush with the surrounding paved area. Provide preformed expansion material between the footing and paved areas.
 - (c) When installed in an unpaved area, set the top of the footing 2 inches above the surface of the ground.
 - ii. Reinforcing Steel: Install reinforcing steel.
 - iii. Conduit: Install conduit.
 - iv. Anchor Bolts:
 - (a) Set anchor bolts using a template constructed to accommodate the specified elevation, orientation, and spacing according to the pole and controller manufacturer's requirements.

- (b) Center the pole anchor bolts within the concrete footing.
 - (c) Protect the anchor bolts until poles are erected.
 - (d) Orient controller footing with the back of the cabinet toward the intersection such that the signal heads can be viewed while facing the controller, unless otherwise directed by the Engineer.
- v. Concrete:
 - (a) Place concrete to form a monolithic foundation. Consolidate concrete by vibration methods.
 - (b) Finish the top of the base level and round the top edges with an edging tool having a radius of 1/2 inch. Provide a rubbed surface finish on the exposed surface of the footing.
 - (c) Allow the footings to cure a minimum of 4 days prior to erecting the poles and 7 days prior to installing the mast arms. Times may be shortened if supported by strength test results.
- c. Backfill: Place suitable backfill material according to Section 2552 of the Standard Specifications.
- 5. Bonding and Grounding:
 - a. Ensure the traffic signal installation is grounded as required by the National Electric Safety Code.
 - b. Install a ground rod at each signal pole and controller footing.
 - c. Use PVC conduit within the footing to accommodate the connection between the top of the footing and the ground rod.
 - d. Bond poles to ground rods with copper wire. Connect ground wires to ground rods with approved mechanical connectors.
 - e. Bond rigid steel conduit ends in handholes with copper wire and approved fittings.

B. Detection

- 1. Detector Loop Cable Installation:
 - a. Coordinate the location of the detector loop with the Engineer. Obtain the Engineer's approval prior to cutting the pavement.
 - b. Saw to ensure proper depth and alignment of the slot. Make a 2 inch deep clean, straight, well-defined 3/8 inch wide saw cut without damage to adjacent areas. Overlap the saw cuts where the detector loop changes direction to provide full depth at all corners. Do not use right angle or corners less than 90 degrees.
 - c. Before installing the detector loop cable, check the saw cuts for the presence of jagged edges or protrusions and remove if present. Clean and dry the saw cuts to remove cutting dust, grit, oil, moisture, or other contaminants. Clean by flushing with a stream of water under pressure. Use oil-free compressed air to dry the saw cuts.
 - d. Install detector loop cable without damage. Place three turns of the detector loop cable into the saw cut. Seal the ends of the tubing at the time of placement to prevent entrance of moisture.
 - e. Ensure the detector loop cables are in the bottom of the saw cut. Place detector loop sealant within the saw cut area. Comply with the manufacturer's instructions for mixing and using the detector loop sealant.
 - f. Install preformed loop detector according to the manufacturer's recommendations.
 - g. Identify each detector loop cable in the handhole by phase and location. Wind loops that are physically adjacent in an individual lane or adjacent lanes with opposite rotation (i.e. No. 1 clockwise, No. 2 counter-clockwise, No. 3 clockwise, etc.). Rotation reversal can be accomplished by reversing leads at the handhole.
 - h. Twist, with at least five turns per foot, all lengths of loop wires and tubing that are not embedded in the pavement.
 - i. Identify all detector loop lead-in cables with appropriate detector numbers.
 - j. Use a detector loop cable splice kit for the electrical splice between the detector loop cable and the detector loop lead-in cable to the controller.
 - i. Ensure splice kit provides a watertight protective covering for the spliced wire, the shielding on the detector loop lead-in cable, and the end of the tubing containing the detector loop cable.
 - ii. Use a manufactured electrical splice kit approved by the Engineer.
 - k. Test all loops and document by using the following procedures:

- i. Determine the insulation resistance of the loop wire using a "megger" with 500V applied to either loop wire to earth ground. The resistance is to be greater than 100 megohms.
 - ii. Determine the inductance of the loop using a loop inductance meter.
- 2. Pedestrian Push Button Detectors:
 - a. Install according to the manufacturer's recommendations.
 - b. Seal the wire entrance into the pedestrian push button assembly.

C. Communications

- 1. Traffic Monitoring System: Install according to the manufacturer's recommendations and as specified in the contract documents, as well as the following:
 - a. Position camera dome on the pole as directed by the Engineer.
 - b. Test installed system under the supervision of the Engineer, and certify as fully functional.

D. Cabinet and Controller

- 1. Controller, Cabinet, and Auxiliary Equipment:
 - a. Install according to the manufacturer's recommendations and as specified in the contract documents.
 - b. Install on pre-placed caulking material on the concrete base. After the cabinet is installed in place, place caulking material around the base of the cabinet.
 - c. This installation includes any and all jumpers/pigtail cables, splice trays/enclosures, termination panels to accommodate the number of terminations per plan, fiber optic connectors, and fiber breakout kits.
- 2. Controller: Install according to the manufacturer's recommendations and as specified in the contract documents.
- 3. Battery Backup System: Install new corrosion resistant materials according to the manufacturer's recommendations and as specified in the contract documents.
 - a. Enclosure/Cabinet: The enclosure will be mounted to the traffic controller cabinet with six hex head bolts, 1/4 inch by 20 inches. All holes will be field drilled by the contractor to accommodate the specific situation. A grommet must be supplied to protect the cable in a field drilled 1.5 inch to 2 inch hold for cable connection to the traffic controller. The contractor will supply all mounting hardware, bolts, washers, nuts, gaskets, bushings, grommets, caulking, etc., necessary to install the cabinet in a safe and weatherproof manner.
- 4. Emergency Vehicle Preemption System: Install according to the manufacturer's recommendations and as specified in the contract documents.

E. Poles, Heads, and Signs

- 1. Vehicle and Pedestrian Traffic Signal Heads:
 - a. Inspect each signal head assembly while still on the ground for the following:
 - i. Physical defects
 - ii. Visor type
 - iii. LED wattage
 - iv. Lens orientation
 - v. Wiring connections
 - b. Attach signal head mounting hardware according to the manufacturer's recommendations. Apply anti-seize compound to all mechanical fasteners.
 - c. Adjust each signal head both vertically and horizontally to approximate a uniform grade of all like signal heads.
 - d. During the course of construction and until the signals are placed in operation, cover signal faces or turn away from approaching traffic. When ready for operation, plumb and aim the heads.
- 2. Traffic Signal and Pedestal Poles and Pedestrian Push Button Posts:
 - a. Erect all poles and posts vertically under normal load.
 - b. Securely bolt the bases to the cast-in-place concrete foundations.
 - i. Mast Arm Poles: Provide footing type (A through F) as specified in the contract documents. Level by using two nuts on each anchor bolt or according to the manufacturer's recommendations.
 - ii. Pedestal Poles: Level by using metal shims and one nut on each anchor bolt or according to the manufacturer's recommendations.

- iii. Pedestrian Push Button Posts: Weld the post to the base plate using a minimum 3/16 inch weld. Level by using two nuts on each bolt.
 - c. After leveling the poles, use non-shrink grout or a rodent guard between the pole base and the foundation. When non-shrink grout is used, neatly finish exposed edges of grout to present a pleasing appearance, and place a weep hole in the grout.
 - d. Apply anti-seize compound to all mechanical fasteners on pole access doors.
 - e. Install pedestrian push button post caps with tamper-proof set screws per manufacturer's direction or by driving the cap a minimum of 1/2 inch onto the post.
- 3. Traffic Signs: Install signs using universally adjustable sign brackets banded to the pole. Apply anti-seize compound to all mechanical fasteners.

F. Surface Restoration

- 1. Replace or reconstruct features removed as a part of the work, such as sidewalks, driveways, curbs, roadway pavement, unpaved areas, or any other items. This is incidental to the lump sum bid items.
- 2. Complete restoration as directed by the Engineer.

G. Testing

- 1. Notify the Engineer 48 hours in advance of the time and date the signal or signal system will be ready for turn on. Do not turn on the signal or signal system without authorization of the Engineer.
- 2. Ensure a representative from the manufacturer and/or supplier of signal controller or other authorized person is at the project site when the signal controllers are ready to be turned on to provide technical assistance including, as a minimum, programming of all necessary input data.
- 3. All required signal timing data will be provided by the Engineer.
- 4. A test period of 30 calendar days will start upon confirmation from the Engineer that the signal or signal system is operating consistent with the project requirements. Any failure or malfunction of the equipment furnished by the Contractor, occurring during the test period will be corrected by the Contractor at no additional cost to the Contracting Authority. Upon confirmation by the Engineer that any failure or malfunction has been corrected, a new test period of 30 calendar days will start, exclusive of minor malfunctions such as lamp burnouts. Repeat this procedure until the signal equipment has operated satisfactorily for 30 consecutive calendar days.
- 5. After signal turn on and prior to completion of the 30 calendar day test period, respond, within 24 hours, to perform maintenance or repair of any failure or malfunction reported.

H. Documentation

- 1. Provide file documentation packages with each signal system, consisting of the following:
 - a. Complete cabinet wiring diagram.
 - b. Complete physical description of the equipment.
 - c. Controller printout or equal documentation of initial controller settings installed in the field or in the office.
 - d. Product manuals for all cabinet equipment.
 - e. Standard industry warranties on equipment supplied.
 - f. Documentation of field cable labeling scheme.
 - g. Diagram of phasing and detector locations.
 - h. One set of as-built construction plans indicating changes from the original contract documents.
- 2. Supply two complete sets of documentation. One set to be placed in the controller cabinet and the other set (less construction plan) to be delivered to the Engineer.

154009a.04 METHOD OF MEASUREMENT.

Lump sum item; no measurement will be made.

154009a.05 BASIS OF PAYMENT.

The Traffic Signalization will be paid for at the lump sum bid item price, which price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete signal installation and for all equipment, tools, labor, and incidentals necessary to complete the work.



**SPECIAL PROVISIONS
FOR
ELECTRICAL SYSTEM FOR STORMWATER PUMPS**

**Dallas County
STP-U-8177(619)--70-25**

**Effective Date
February 21, 2017**

THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

154013a.01 GENERAL DESCRIPTION OF ELECTRICAL SYSTEM FOR STORMWATER PUMPS

This section specifies the requirements for supplying and constructing the electrical system and its components for the stormwater pumps to be placed adjacent to the pedestrian box as noted in the plans. The Contractor shall protect surrounding areas, prepare the site, and construct the electrical system in accordance with this specification.

The following shall apply to all articles and sections of this Special Provision.

A. SUBMITTALS

1. Submit shop drawings in accordance with the contract documents.
2. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Process Instrumentation & Control.
3. Review of shop drawings constitutes acceptance of general design only and will not release the Contractor for fulfilling the terms and intent of the contract documents.
4. Any additional requirements as listed in this Special Provision.

B. QUALITY ASSURANCE

1. All materials, equipment, and parts shall be new and unused of current manufacture.
2. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.
3. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 3 years of documented experience.
4. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

5. Any additional requirements as listed in this Special Provision.

C. Operation/Maintenance Manuals and Instructions

1. Submit operation & maintenance manuals and instructions in accordance with contract provisions.
2. Submit operation and maintenance manuals for the equipment specified herein in accordance with the requirements that submittals for all motor control equipment be included as part of the submittal for the complete, integrated process instrumentation and control system and in accordance with the requirements specified under Process Instrumentation & Control.
3. Any additional requirements as listed this Special Provision.

D. Warranty

1. See Contract Provisions for additional requirements.
2. Any additional requirements as listed in this Special Provision.

E. Factory Testing

1. Refer to the requirements of Process Instrumentation & Control.
2. Any additional requirements as listed in this Special Provision.

154013a.02 COMMON WORK RESULTS FOR ELECTRICAL

A. DESCRIPTION.

Furnish and install complete and operable electrical systems as indicated on the drawings and as specified herein.

1. Design Requirements
 - a. The table included in this section under Hardware Design Requirements specifies the usage requirements for the hardware and equipment specified in the following sections:
 - i. Hangers and Supports for Electrical Systems
 - ii. Conduit
2. Electrical Work Specified Elsewhere:
 - a. Every attempt has been made to indicate in these specifications and drawings all work required under "Electrical." However, there may be additional specific requirements in the specifications, drawings, or addenda of other trades which pertain to the work of this trade, and any such requirements are hereby made a part of the requirements for this trade.
3. Design Intent:
 - a. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
 - b. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract.
 - c. The details and drawings are diagrammatic. Verify all dimensions at the site and be responsible for their accuracy.
 - d. All sizes as given are minimum except as noted.
 - e. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to inspections, tests and approval from the commencement until the acceptance of the completed work.
 - f. Electrical requirements for equipment are based on design data. It shall be the responsibility of the Contractor to verify actual requirements with the provider of the equipment and adjust electrical installation based upon actual requirements.

4. Substitution of Materials:
Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the specified performance from the system into which these items are placed.
5. Continuity of Existing Services and Systems:
 - a. No outages shall be permitted on existing systems except at the time and during the interval specified by the Contracting Authority and the Engineer. Any outage must be scheduled when the interruption causes the least interference with normal schedules and routines. No extra costs will be paid to the Contractor for such outages that must occur outside of regular weekly working hours.
 - b. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.
6. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - ii. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
7. Submittals
 - a. Shop Drawings shall be prepared and submitted:
 - i. Low-Voltage Electrical Power Conductors and Cables (600 V and Less)
 - ii. Grounding and Bonding of Electrical Systems
 - iii. Hangers and Supports for Electrical Systems
 - iv. Conduit
 - v. Portable Engine/Generator Set
 - vi. Process Instrumentation & Control
8. Operation/Maintenance Manuals and Instructions
 - a. Submittal Requirements for Electrical Operation & Maintenance Manuals and Instructions:
 - a. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to requirements within Division 11 of the Standard Specifications, include the following information:
 - i. Copies of as-built submittals.
 - ii. Wiring diagrams for electrically powered or controlled equipment
 - iii. Records of tests performed to certify compliance with system requirements
 - iv. Certificates of inspection by regulatory agencies
 - v. Parts lists for manufactured equipment
 - vi. Preventive maintenance recommendations
 - vii. Warranties
 - viii. Additional information as indicated in the technical specification sections
 - ix. Test Reports and Demonstration Log:
 - Permanently record checks and tests and demonstrations.
 - Submit copy of complete testing or demonstration report no later than 30 days after testing or demonstration is complete.

9. Quality Assurance

- a. All work and materials shall conform to or exceed in every detail the applicable rules and requirements of the Iowa Electrical Code, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association standards, the National Electrical Safety Code, and present manufacturing standards (including NEMA).
- b. All work shall be performed under the direction of a State of Iowa Licensed Master Electrician.
- c. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.
- d. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
 - i. Underwriters Laboratories Inc.
 - ii. Electrical Testing Laboratories, Inc.
- e. Certificates And Inspections:
 - i. Refer to Division 11 of the Standard Specifications.
 - ii. Obtain and pay for all required inspections including but not limited to state or local electrical inspections and fuel tank inspections. Deliver original inspection certificates to the Engineer.

10. Design Requirements

- a. The following table specifies the usage requirements for the hardware and equipment specified in the following sections:
 - i. Hangers and Supports for Electrical Systems
 - ii. Conduit

HARDWARE USAGE REQUIREMENTS							
Area Classification	Voltage	Type	Installation	Use Conduit	Use Box	Use Support	Use Hardware
Hazardous	All	All	Exposed	RMCCS	PCB	SS	SS
Underground	480VAC	Power	Direct-buried in ground	RNC	---	---	---
Underground	120/240V AC	Power	Direct-buried in ground	RNC	---	---	---
Underground	120VAC	Control	Direct-buried in ground	RNC	---	---	---
Underground	24VDC	Signal/ Intrinsically Safe	Direct-buried in ground	RMCCS	---	---	---
Underground	Low	Data/Comm.	Direct-buried in ground	RMCCS	---	---	---
Underground	---	Fiber Optic	Direct-buried in ground	RNC	---	---	---

HARDWARE USAGE REQUIREMENTS							
Area Classification	Voltage	Type	Installation	Use Conduit	Use Box	Use Support	Use Hardware
---	All	All	Outdoor Exposed	RMCCS	CB	SS	SS
NOTES: 1. All conduit in new structures shall be concealed. 2. No substitutions shall be allowed unless approved by engineer. 3. Transition to exposed conduit shall comply with specified requirements for exposed conduit, regardless of whether transition is rigid or flexible. 4. Transition from underground or concrete encased conduit shall be RMCCS. 5. Sheet metal boxes are not acceptable for exposed installation. 6. Below grade locations shall be considered damp or wet locations.							
ABBREVIATIONS: RNC: Rigid Non-metallic Conduit RNB: Rigid Non-metallic Box RN: Rigid Non-Metallic Box RMCS: Galvanized Rigid Metal Conduit CB: Cast Box GS: Galvanized Steel RMCCS: PVC Coated Galvanized Rigid Metal Conduit PCB: PVC Coated Cast Box SS: Stainless Steel EMT: Electrical Metallic Tubing SB: Steel Box AL: Aluminum							

B. MATERIALS.

1. Access Panels and Doors
 - a. Lay-in Ceilings:
 - i. Removable lay-in ceiling tiles in 2 foot by 2 foot or 2 foot by 4 foot configuration are sufficient; no additional access provisions are required unless specifically indicated.
 - b. Drywall and Plaster Walls and Ceilings:
 - i. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needed service; minimum size is 12 inch by 12 inch.
2. Sealing and Fire-Stopping
 - i. Refer to Architectural requirements.
 - ii. Sealing and fire stopping of sleeves/openings between conduits, cable trays, wire ways, troughs, cable bus, bus duct, etc. and the structural or partition opening shall be the

- responsibility of the Contractor whose work penetrates the opening. Individuals skilled in such work shall perform the sealing and fire stopping.
- iii. Whenever possible, avoid penetrations of fire and smoke rated partitions. When they cannot be avoided, verify that sufficient space is available for the penetration to be effectively fire and smoke stopped.
 - iv. Manufacturers:
 - i. 3M, STI/SpecSeal, Tremco, or approved equal.
 - ii. The same manufacturer shall provide all fire stopping systems.
 - iii. The Contractor will be responsible for selecting the appropriate UL tested fire stop system for each application required on the project.
 - v. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.
 - vi. Contractor shall use fire stop putty, caulk sealant, intumescent wrap strips, intumescent fire stop collars, fire stop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.
3. Non-Rated Penetrations
- a. Conduit Penetrations Through Below Grade Walls:
 - iii. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or a water-stop type wall sleeve.
 - b. Conduit and Cable Tray Penetrations:
 - i. At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

C. CONSTRUCTION.

- 1. Field Measurements
 - a. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections.
 - b. Field verify all measurements. Do not base electrical installation or equipment locations on the plans.
 - c. Identify conflicts with the work of other trades prior to installation of electrical system.
 - d. Electrical installation shall be based upon shop drawing requirements and field verified measurements. Adjust electrical system installation to satisfy field requirements.
- 2. Delivery, Storage and Handling
 - a. Accept electrical equipment on site. Inspect for damage.
 - b. Protect electrical equipment from weather, corrosion, and entrance of debris.
- 3. Installation
 - a. Excavation And Backfill:
 - i. Perform all excavation and backfill work to accomplish indicated electrical systems installation in accordance with other sections of this specification.
 - b. Concrete Work:
 - i. Coordinate the quantity and location of all cast-in-place concrete work with the architectural drawings.
 - ii. All cast-in-place concrete will be performed by the Contractor unless noted otherwise. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.
 - c. Cutting And Patching:

- i. Cutting and patching shall be performed in accordance with the requirements for architectural work. Refer to other sections of these specifications.
- d. Building Access:
 - i. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.
- e. Equipment Access:
 - i. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish access doors and arrange for installation with appropriate trades.
- f. Working Clearances:
 - i. Minimum installed equipment working clearances as required by the NEC shall be maintained.
 - ii. Minimum required dedicated electrical equipment space as required by the NEC shall be maintained.
 - iii. Coordinate these requirements with the work of other trades.
 - iv. Identify conflicts with working space requirements prior to installation of equipment.
- g. Coordination:
 - i. Cooperate with other trades in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Contracting Authority. The Contractor shall check location of electrical outlets with respect to other installations before installing.
 - ii. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panel boards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
 - iii. Coordinate all work prior to installation. Any installed work that is not coordinated and that interferes with the work of another trade shall be removed or relocated at no additional cost to the Contracting Authority.
 - iv. Verify the integrity of fire or smoke ratings where penetrations are required.
- h. Sleeves:
 - i. Process Equipment Areas:
 - New poured concrete construction: cast in place, Schedule 40, PVC sleeve.
 - All other construction: core drill sleeve openings large enough to insert Schedule 40 PVC sleeve and grout around the sleeve.
 - Floor penetrations:
 - Extend top of sleeve 2 inches above the floor.
 - Where installation of sleeve in floor is not practical, provide 2 inch deep housekeeping pad extending 3 inches around cast in place conduits.
 - ii. Non-Process Equipment Areas:
 - Hollow walls: Schedule 40, PVC sleeves, grout around sleeve in masonry construction.
 - All other Areas: core drill sleeve openings large enough to insert Schedule 40 PVC sleeve and utilize the core drilled opening as the sleeve.
 - iii. Conduit Support:

- If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to the floor structure.
- i. Sealing And Firestopping:
 - i. Fire and/or Smoke Penetrations:
 - Install approved product in accordance with the manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wire way, trough, etc.) penetrates a fire rated surface.
 - Where fire stop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Fire stop mortar alone is not adequate to support any substantial weight.
 - ii. Non-Rated Surfaces:
 - When the opening is through a non-fire rated wall, floor, ceiling or roof the opening must be sealed using an approved type of material.
 - Install escutcheons or floor/ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below the ceiling.
 - In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions.
 - At interior partitions, conduit penetrations are required to be sealed for all areas . Apply sealant to both sides of the penetration in such a manner that the annular space between the conduit sleeve and the conduit is completely filled.
- j. Housekeeping and Clean-up
 - i. On a daily basis, clean up and remove all debris and rubbish resulting from work and repair all damage to new and existing equipment resulting from work.
 - ii. Remove all tools, excess material, and unused equipment from the site when job is complete.
- k. General Inspection and Cleaning of Electrical Equipment
 - i. Inspect for physical damage and abnormal mechanical or electrical conditions.
 - ii. Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the Engineer. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.
 - iii. Compare equipment nameplate information with the plans and report any discrepancies.
 - iv. Verify proper auxiliary device operation and indicators.
 - v. Check tightness of accessible bolted electrical joints. Use torque wrench method.
 - vi. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.
 - vii. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.
 - viii. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, horizontal and vertical busducts, MCC's, control panels, and any other similar equipment
 - ix. Clean All Equipment:
 - Loosen attached particles and vacuum them away.
 - Remove any remaining packing material adhesives with suitable cleaning solution.
 - Touch-up factory applied finishes damaged during installation using manufacturer approved means to match original finish.

4. Testing and Start-Up Services
 - a. Refer to the requirements the individual technical sections.
5. Training
 - a. Refer to the requirements the individual technical sections.

154013a.03 UTILITY SERVICES

A. DESCRIPTION.

Provide and install complete and operable utility services as required on the drawings and as specified herein.

1. Summary
 - a. Arrange with the Electric Utility for permanent and temporary electric service.
 - i. Electric Service:
 - Utility Company:
 - Mid-American Energy
 - Phone number: 800-329-6261.
 - System Characteristics:
 - Facility type: Storm Water Lift Station.
 - Required service voltage: 277/480V 3-phase, 4-wire.
 - Required service size: 100A.
2. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards
 - ii. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto, Current Edition.
 - iii. National Electrical Contractors Association (NECA), Standard of Installation, Current Edition.
 - iv. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
 - v. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition.
3. Related Work Elsewhere
 - a. The following divisions may include work which is related to utility services, but which is not included under the scope of this section:
 - i. Heating, Ventilating, and Air Conditioning (HVAC)
 - ii. Process Integration
 - iii. Material Processing and Handling Equipment.
 - iv. Process Heating, Cooling, and Drying Equipment.
 - v. Industry-specific Manufacturing Equipment.
 - vi. Electrical Power Generation.
4. Shop Drawings
 - a. Submit shop drawings in accordance with the requirements of Division 11 of the Standard Specifications.
 - b. The following information shall be submitted specifically for utility services:
 - i. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
 - ii. Documentation required by utility company for approval.

5. Quality Assurance

- a. Service entrance and metering equipment provided under this section shall be UL Listed for the service intended and shall be approved by the utility company.

B. CONSTRUCTION.

1. Division of Work

- a. The Contractor shall be responsible for coordinating conductor marking and color coding requirements with control system equipment supplier(s).

2. Field Measurements

- a. Verify existing conditions and dimensions.
- b. Verify that service equipment is ready to be connected and energized.
- c. Make arrangements with utility company and obtain required inspections before energizing service(s).
- d. Coordinate location of utility company facilities to ensure proper access is available.

3. Installation

- a. Install service entrance conduit and conductors in accordance with utility company instructions.
- b. Install metering equipment in accordance with utility company instructions.

154013a.04 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

A. DESCRIPTION.

Furnish and install complete and operable wire and cable systems as indicated on the drawings and as specified herein.

1. Applicable Publications

- a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - ii. ASTM International, originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
 - ASTM B800-05 Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers
 - ASTM B801-99 Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
 - iii. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
 - iv. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition.
 - U.L. 44 - Rubber-Insulated Wires and Cables.
 - U.L. 50 - Enclosures for Electrical Equipment.
 - U.L. 83 - Thermoplastic-Insulated Wires.
 - U.L. 514B - Conduit, Tubing, and Cable Fittings.
 - U.L. 758 - 220° F Appliance Wiring Materials.
 - U.L. 854 - Service Entrance Cables.
 - U.L. 1063 - Machine-Tool Wires and Cables.

- U.L. 1277 - Type TC Power and Control Tray Cables.
 - U.L. 1569 - Metal-Clad Cables
 - UL 1581 - Vertical Tray.
2. Submittals
 - a. The following information shall be submitted specifically for wire and cable:
 - i. Literature sufficient in scope to demonstrate compliance with the requirements of this specification.
 - ii. Clearly identify the types of wire and cable proposed.
 3. Quality Assurance
 - a. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
 - b. Wire and cable manufacturers shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development and production in accordance with ISO 9001.

B. MATERIALS.

1. Wire and Cable – General Purpose (600V, Copper)
 - a. Manufacturer: Contractor option.
 - b. General:
 - i. THWN/THHN general purpose building wire insulated with polyvinyl chloride (PVC) and covered with protective sheath of nylon intended for lighting and power circuits at 600 volts or less, in residential, commercial and industrial buildings.
 - ii. The wire shall be suitable for 195°F maximum continuous conductor temperature in dry locations and 170°F in wet locations and listed by Underwriters Laboratories for use in accordance with the National Electrical Code.
 - c. Conductors:
 - i. Class B or Class C stranded, annealed uncoated copper per UL Standard 83 or 1063.
 - d. Insulation:
 - i. Each conductor shall be insulated with PVC and sheathed with nylon complying with the requirements of UL Standard 83 for Types THHN/THWN and UL Standard 1063 for Type MTW and CSA C22.2 No. 75 for T90 Nylon.
 - ii. Types THWN/THHN shall comply with the optional Gasoline and Oil Resistant rating of UL Standard 83. The insulation shall also comply with UL requirements for 220°F Appliance Wiring Material.
 - iii. The average thickness of PVC insulation, for a given conductor size, shall be as specified in UL Standard 83 for Types THWN or THHN. The minimum thickness at any point, of the PVC insulation, shall be not less than 90% of the specified average thickness.
 - iv. The minimum thickness at any point of the nylon sheath shall be as specified in UL Standard 83 for Types THWN or THHN.
 - v. The PVC insulation shall be applied tightly to the conductor and shall be free-stripping.
 - e. Identification:
 - i. The wire shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL Symbol, type designations and optional ratings. The wire shall also be identified as C(UL) Type T90 Nylon or TWN75, FT1.
 - f. Tests:
 - i. Wire shall be tested in accordance with the requirements of UL Standard 83 for Types THWN or THHN wire and for the optional Gasoline and Oil Resistant listings; as Type MTW to UL Standard 1063 (stranded items); as AWM to UL Standard 758 (stranded items); and as C(UL) Type T90 Nylon or TWN75.

- vii. Usage:
 - i. General use power wiring, minimum size No.12 AWG.
 - ii. General use control wiring, minimum size No.14 AWG.
- 2. Shielded Power Cable (600V)
 - a. Manufacturer
 - i. Contractor option.
 - ii. General:
 - i. Three conductor type TC Tray Cable insulated with cross linked polyethylene and PVC jacket overall, for use on circuits rated 600 volts and 195°F maximum continuous conductor temperature in wet or dry locations.
 - ii. Cables approved for installation in cable trays in accordance with the NEC and for installation in air, in ducts or conduits, in tray or trough, in open wiring or direct buried.
 - iii. Conductors:
 - i. Shall be Class B stranded uncoated soft copper.
 - ii. Suitable separator over the conductor may be used at the option of the manufacturer.
 - iii. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable non-hygroscopic fillers to make round.
 - iv. Length of lay shall not exceed 35 times the phase conductor diameter.
 - v. The grounding conductor shall comply with the requirements of UL Standard 1277.
 - vi. The cable assembly shall be covered with a copper tape shield with drain wire, applied with a 10% minimum lap.
 - iv. Insulation:
 - i. Each phase conductor shall be insulated with chemically cross linked polyethylene, meeting Type XHHW-2 requirements of Underwriters Laboratories.
 - ii. The average thickness of insulation shall be as specified in UL Standard 44 for Type XHHW-2 conductors. The minimum thickness at any point shall be not less than 90% of the specified average thickness.
 - iii. The insulated phase conductors shall be black in color and shall be printed with the numerals "1", "2", and "3" on their surface.
 - iv. Each cable shall have a PVC protective jacket applied over the taped assembly. The jacket shall meet the Sunlight Resistant requirements of UL Standard 1277.
 - v. The average jacket thickness shall be in accordance with UL Standard 1277. The minimum thickness at any point shall be not less than 80% of the specified average thickness.
 - v. Identification:
 - i. Cables shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and required UL information.
 - vi. Tests:
 - i. Individual conductors and completed cables shall be tested in accordance with UL requirements for Type TC Power Control Tray Cables having XHHW-2 conductors.
 - ii. Cables shall be capable of passing the ribbon burner cable tray flame test requirements of UL and IEEE.
 - vii. Usage:
 - i. Power wiring for motor loads controlled by adjustable frequency drives, where so indicated on the drawings.
- 3. Shielded Instrumentation Cable (300V)
 - a. Manufacturer: Contractor option.
 - b. General:

- i. Power limited tray cable - two conductor, No.16 AWG (7x24) bare copper, PVC insulation, overall shield with No.18 AWG (7x26) tinned copper drain wire, PVC jacket with nylon ripcord.
- c. Electrical Characteristics:
 - i. Max. Operating voltage: 300Vrms
 - ii. Conductor DC resistance at 70°F: 3.7 ohms per 1000 feet
 - iii. Shield DC resistance at 70°F: 5.1 ohms per 1000 feet
 - iv. Capacitance between conductors at 1 kHz: 61 picofarads per foot
 - v. Capacitance between conductor and shield at 1 kHz: 114 picofarads per foot
 - vi. Inductance: 0.19 microhenries per foot
- d. Physical Characteristics:
 - i. Temperature rating: -20°F to 220°F
 - ii. Insulation material: PVC
 - iii. Average insulation thickness: 0.016 inches
 - iv. Jacket material: Sun resistant PVC.
 - v. Jacket thickness: 0.037 inches nominal
 - vi. Shield: Aluminum/Polyester, 100% coverage.
 - vii. Overall lay length: 2 inches (6 twists per foot)
 - viii. Maximum pulling tension: 94 pounds
 - ix. Minimum bend radius: 2.6 inches
 - x. Flame resistance: UL 1581 vertical tray.
- e. Usage:
 - i. Instrumentation cable.

C. CONSTRUCTION.

1. Field Measurements
 - a. Field verify all measurements. Do not base electrical installation or equipment locations on the plans.
 - b. Identify conflicts with the work of other trades prior to installation of electrical system.
 - c. Adjust electrical system installation to satisfy field requirements.
2. Delivery, Storage and Handling
 - a. Accept electrical equipment on site. Inspect for damage.
 - b. Protect electrical equipment from weather, corrosion, and entrance of debris.
3. Installation
 - a. Pre-Installation:
 - i. Verify that interior of building has been protected from weather.
 - ii. Verify that mechanical work likely to damage wire has been completed.
 - iii. Completely and thoroughly swab raceway prior to installation.
 - iv. Verify that field measurements are as shown on drawings.
 - v. Wire and cable routing shown on drawings is approximate unless dimensioned. Route wire and cable to satisfy project conditions.
 - vi. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.
 - vii. Determine required separation between cable and other work.
 - viii. Determine cable routing to avoid interference with other work.
 - ix. Any single conduit or raceway utilized for a feeder circuit shall contain only power conductors of a single feeder circuit. Do not combine feeder circuits without engineer's written approval.

- x. Plans indicate individual homerun equipment connections. Contractor may combine branch circuits of common types in single conduits provided the following conditions are met:
 - NEC requirements for conductor de-rating are satisfied.
 - Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
- xi. No more than eight 24VDC analog circuits may be combined in a single conduit unless specifically stated otherwise on the drawings.
- b. Conductor Sizing:
 - i. Conductor sizes are based on copper unless otherwise noted.
 - ii. Use conductor not smaller than No.12 AWG for power and lighting circuits.
 - iii. Use No.10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
 - iv. Where circuit wiring length exceeds length identified on the feeder schedule, increase wire size as needed to maintain a maximum voltage drop of three percent.
 - v. Use conductor not smaller than No.14 AWG for control circuits.
 - vi. Unless shown otherwise on the plans, power wiring shall be No. 12 AWG.
- c. Wire Pulling:
 - i. Pull all conductors into raceway at same time.
 - ii. No. 4 AWG and larger wire and power cables shall lubricated with pulling lubricant to reduce pulling tension and abrasion damage. The lubricant shall be water or wax based containing no oils or greases that may adversely affect cable jackets.
 - iii. The minimum bend radius and maximum pulling tension ratings of the wire and cable shall not be exceeded.
- d. Splices and Terminations:
 - i. Splices and terminations shall not be made within raceways.
 - ii. Clean conductor surfaces before splicing or terminating.
 - iii. Make splices, taps, and terminations to carry full amp capacity of conductors with no perceptible temperature rise.
 - iv. Insulated spring wire connectors may be used to splice 120V power circuits.
 - v. Control, communication, and data transmission wire and cable shall not be spliced.
 - vi. Use split bolt connectors for copper conductor splices and taps, No. 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150% of insulation rating of conductor.
 - vii. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, No. 8 AWG and smaller.
 - viii. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, No. 10 AWG and smaller.
- e. Motors:
 - i. Motor wiring to motors less than 10 horsepower shall be spliced and terminated with fully insulated crimp-on end cap with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. "SkotchLocks" and similar devices shall not be used.
 - ii. Motor wiring to motors 10 horsepower or larger shall be spliced and terminated with crimp-on ring terminal lugs, brass nuts, bolts and washers with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. "SkotchLocks" and similar devices shall not be used.
- f. Unshielded power cables:
 - i. Unshielded power cables shall be spliced and terminated with crimp-on ring terminal lugs, brass nuts, bolts and washers with a layer of self-vulcanizing rubber tape, followed

by five layers of vinyl electrical tape. "SkotchLocks" and similar devices shall not be used.

4. Testing and Start-Up Services
 - a. Inspect wire for physical damage and proper connection.
 - b. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
 - c. Verify continuity of each conductor.
 - d. Feeder or branch circuits with ampacity greater than 100 amperes shall be tested after installation to measure insulation resistance of each conductor.
 - e. All equipment shall be disconnected and the wire ends shall be cleaned and dried.
 - f. Connect Megohmmeter between conductor and a grounded point in the enclosure and energize until the reading stabilizes.

154013a.05 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

A. DESCRIPTION.

Furnish and install complete and operable grounding and bonding systems as indicated on the drawings and as specified herein.

1. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - ANSI/NFPA 99 - Health Care Facilities.
 - ii. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
 - iii. National Electrical Manufacturers Association (NEMA), Specifications and Standards, Current Edition.
 - iv. Underwriters Laboratories, Inc. (UL), Specifications and Standards, Current Edition.
 - v. Institute of Electrical and Electronics Engineers (IEEE), Specifications and Standards, current edition:
 - IEEE 837 - Standard for Qualifying Permanent Connections Used in Substation Grounding.
2. Quality Assurance
 - a. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms. Additional grounding electrodes shall be used to satisfy ground resistance requirements where required by earth conditions.

B. MATERIALS.

1. Rod Electrode
 - a. Material: Copper-clad steel.
 - b. Diameter: 3/4-inch minimum.
 - c. Length: 10-feet minimum. Rod shall be driven at least 9.5-feet deep.
 - d. Use one or more ground rods to obtain the minimum specified ground resistance. This applies to manholes, padmount switches, transformers, service entrances, and all other equipment requiring a supplemental grounding electrode. Minimum of three ground rods shall be used to ground the service entrance as indicated on plans.

2. Mechanical Connectors

- a. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two bolt type.
- b. Split bolt connector types are not allowed.
- c. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.
- d. Grounding access wells shall be provided for access to underground mechanical grounding connections. Access well shall be ANSI Tier rated for the area in which it is installed.

3. Compression Connectors

- a. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99%.
- b. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
- c. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.
- d. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
- e. Each connector shall be factory filled with an oxide-inhibiting compound.

4. Exothermic Connections

- a. Select the appropriate kit for specific types, sizes, and combinations of conductors and other items to be connected. Field personnel shall be trained in execution of welds.

5. Wire

- a. Material: Stranded copper (aluminum not permitted).
- b. Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.
- c. Manhole and Vault Bonding: No. 4/0 minimum.
- d. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

C. CONSTRUCTION.

1. Field Measurements

- a. Field verify all measurements. Do not base electrical installation or equipment locations on the plans.
- b. Identify conflicts with the work of other trades prior to installation of electrical system.
- c. Adjust electrical system installation to satisfy field requirements.

2. Installation

- a. General:
 - i. Verify that final backfill and compaction has been completed before driving rod electrodes.
 - ii. Install products in accordance with manufacturer instructions.
 - iii. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
 - iv. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
 - v. Attach grounds permanently before permanent building service is energized.

- vi. Install rod electrodes at locations indicated or as required by local code, whichever requires the most rods. Install additional rod electrodes as required to achieve specified resistance to ground.
- vii. Connect grounding electrode conductor and reinforcing steel in foundation footing. Bond steel together.
- viii. Bond all conductive components to meet Regulatory Requirements.
- ix. Bond together metal siding not attached to grounded structure; bond to ground.
- x. All separate ground wires shall be enclosed in rigid galvanized steel conduit and bonded at both ends to the rigid galvanized steel conduit with an approved fitting.
- b. Less than 600 volt system grounding:
 - i. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
 - ii. Copper grounding electrode conductor shall be sized as indicated or as required by NEC, whichever is larger and shall be extended from secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes. Bonding jumper shall be installed around water meter. Install conductor in separate rigid conduit. Bond conduit as described above.
 - iii. Receptacle Grounding: All receptacles installed shall have a separate grounding contact.
 - iv. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
 - v. Bond together each metallic raceway, pipe, duct and other metal objects.
 - vi. Equipment Grounding Conductor: Separate, insulated green conductor shall be installed within each raceway and cable tray, sized per NEC or as indicated in the contract documents whichever is larger. Terminate each end on suitable lug, bus, enclosure or bushing, per NEC. Install a ground wire from each device to the respective enclosure.
- 3. Testing and Start-Up Services
 - a. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

154013a.06 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

A. DESCRIPTION.

Furnish and install supporting devices as indicated on the drawings, scheduled in Common Work Results for Electrical, and as specified herein.

- 1. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American Iron and Steel Institute (AISI), Specifications and Standards, current edition.
 - ii. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - iii. American Society for Testing and Materials (ASTM), Specifications and Standards, current edition:
 - ASTM A653 - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process.
 - ASTM A1011 - Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low Alloy with Improved Formability (Formerly ASTM A570).

- ASTM F1136 - Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners.
 - ASTM A907 - Standard Specification for Steel, Sheet, and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled, Structural Quality.
 - ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - iv. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
 - NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
 - v. Metal Framing Manufacturers Association (MFMA), Specifications and Standards, current edition.
2. Submittals
- a. The following information shall be submitted specifically for supporting devices:
 - i. Submit outline drawings and dimensions for equipment support racks.
3. Quality Assurance
- a. Bolted framing channels and fittings shall have the manufacturers name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request
 - b. Stainless steel bolted framing parts shall be stamped to identify the material. Material certification sheets and test reports must be made available by the manufacturer upon request.

B. MATERIALS.

1. Strut, Channels, and Connectors
- a. Manufacturers:
 - i. Cooper B-Line, Inc.
 - ii. Unistrut
 - iii. Supertrut
 - iv. Or equal
 - b. General:
 - i. Strut shall be 1 5/8 inches wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the drawings.
 - c. Materials and Finish:
 - i. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633 (SC3 for fittings, SC1 for threaded hardware) for indoor use only. For outdoor use, all fittings and hardware shall be stainless steel Type 304.
 - ii. Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 304 or chromium zinc ASTM F1136 Gr. 3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
 - iii. Stainless Steel: All strut, fittings and hardware shall be made of AISI Type 304 stainless steel.

2. Anchors and Fasteners
 - i. Concrete and Structural Elements: Use stainless steel precast insert system, expansion anchors and preset inserts.
 - ii. Steel Structural Elements: Use stainless steel beam clamps.
 - iii. Concrete Surfaces: Use stainless steel self-drilling anchors and expansion anchors.
 - iv. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.
 - v. Solid Masonry Walls: Use stainless steel expansion anchors and preset inserts.
 - vi. Sheet Metal: Use stainless steel sheet metal screws.
 - vii. Wood: Use stainless steel wood screws.
 - viii. All other fasteners: stainless steel screws, suitable for the required usage.
3. Hardware
 - a. Conduit and equipment supports, clamps, and other miscellaneous materials shall be constructed of the following materials as scheduled in Common Work Results for Electrical.
 - i. Steel.
 - ii. Zinc plated steel.
 - iii. Galvanized, malleable iron.
 - iv. PVC coated, galvanized, malleable iron.
 - v. Stainless steel.
 - vi. PVC.

C. CONSTRUCTION.

1. Field Measurements
 - a. Field verify all measurements. Do not base locations and dimensions on the plans.
 - b. Identify conflicts with the work of other trades prior to installation of electrical equipment.
 - c. Adjust equipment support rack installation to satisfy field requirements.
2. Delivery, Storage, and Handling
 - a. Accept supporting devices on site. Inspect for damage.
 - b. Protect supporting devices from corrosion and damage. Do not install damaged materials.
3. Installation
 - a. General:
 - i. Furnish and install supports and fasteners for all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.
 - ii. Thoroughly clean and remove construction debris from installation.
 - b. Strut Channel:
 - i. Install strut in accordance with MFMA-102 "Guidelines for the Use of Metal Framing"; in accordance with equipment manufacturer's recommendations, and with recognized industry practices.
 - ii. Fabricate supports from channel. Rigidly weld members or use hexagon head bolts to present a neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
 - iii. File and de-bur cut ends of galvanized support channel and spray paint with cold galvanized paint to prevent rusting.
 - iv. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
 - c. Anchors and Fasteners:
 - i. Provide anchors, fasteners, and supports in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting".

- ii. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
- iii. Do not use spring steel clips and anchors.
- iv. Do not use powder-actuated anchors.
- v. Obtain permission from Engineer before drilling or cutting structural members.
- vi. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- vii. Use channel supports to stand cabinets and panelboards 1-5/8-inch off interior or exterior surfaces of exterior walls.
- viii. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using anchors and fasteners.
- ix. Install free-standing electrical equipment on 3-inch concrete pads unless indicated otherwise on the drawings.
- x. Use threaded rod, minimum size 3/8 inch, for supports where indicated on the drawings.
- xi. Install products in accordance with manufacturer instructions.

154013a.07 CONDUIT

A. DESCRIPTION.

Furnish and install complete and operable conduit system as indicated on the drawings, scheduled in Common Work Results for Electrical and as specified herein.

1. Applicable Publications

- a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - ANSI C80.1 - Electrical Rigid Steel Conduit (ERSC).
 - ANSI C80.3 - Steel Electrical Metallic Tubing (EMT).
 - ANSI C80.5 - Electrical Rigid Aluminum Conduit (ERAC).
 - NFPA 70 - National Electrical Code.
 - ii. American Society for Testing and Materials (ASTM), Specifications and Standards, current edition:
 - ASTM F2160 - Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter.
 - ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
 - ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
 - ASTM D3350 - Polyethylene Plastics Pipe and Fittings Materials.
 - iii. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
 - NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
 - iv. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
 - NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association.
 - NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association.

- NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit; National Electrical Manufacturers Association.
- NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association.
- NEMA TC 7 - Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.
- v. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition.
 - UL 1 - Standard for Flexible Metal Conduit
 - UL 6 - Electrical Rigid Metal Conduit - Steel.
 - UL 6A - Standard for Electrical Rigid Metal Conduit - Aluminum and Stainless Steel.
 - UL 651A Type EB and A Rigid PVC Conduit and HDPE conduit.
 - UL 651B Continuous Length HDPE.
 - UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit.
 - UL 2239 - Standard for Safety for Hardware for the Support of Conduit, Tubing, and Cable.
- 2. Submittals
 - a. Submit the following information specifically for conduit:
 - i. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
 - ii. Clearly identify the types of conduit and fittings proposed.
- 2. Quality Assurance
 - a. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. MATERIALS.

1. Galvanized Rigid Metal Conduit (Type RMCS)
 - a. Manufacturer: Contractor option.
 - b. Conduit:
 - i. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, a defect free interior surface, and a continuous welded seam.
 - ii. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
 - iii. Top-coated with a compatible organic layer to inhibit white rust and increase corrosion resistance.
 - iv. Factory cut threads, 0.75 inch taper per foot, protected after cutting with an application of molten zinc.
 - c. Conduit Bodies:
 - i. Ferrous metal construction electro-galvanized inside and out and coated with aluminum acrylic paint.
 - ii. Tapered, threaded hubs with integral bushing.
 - iii. Stainless steel hardware.
 - iv. Cover constructed of same material with solid gasket.
 - d. Fittings:
 - i. Ferrous metal construction electro-galvanized inside and out.
 - ii. Components critical to performance such as set screws, split rings, and locknuts constructed of hardened steel or adequately designed to insure positive bonds.
2. PVC Galvanized Rigid Metal Conduit (Type RMCCS)
 - a. Manufacturer:
 - i. Perma-Cote Industries.

- ii. Robroy.
 - iii. Ocal
 - iv. Plasti-Bond
 - v. Or equal.
 - b. General:
 - i. Conduit shall be UL Listed and the coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit.
 - ii. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
 - iii. Conduit immersed in boiling water with a minimum mean time to adhesion failure of 200 hours.
 - iv. Conduit and conduit exposure to 150°F and 95% relative humidity with a minimum mean time to failure of 30 days.
 - v. No trace of internal coating shall be visible on a white cloth following six wipes over the coating that has been wetted with acetone.
 - vi. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.
 - c. Conduit:
 - i. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, and a defect free interior surface, and a continuous welded seam.
 - ii. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
 - iii. Factory cut threads, 0.75 inch taper per foot, protected after cutting with an application of molten zinc.
 - iv. Coating:
 - External: PVC, 40 mils nominal, free of blisters, bubbles, and pinholes.
 - Internal: Urethane, 2 mils minimum.
 - v. Threaded connections:
 - Factory threads: factory coated.
 - Field threads: protected by coating sleeve extension on female fitting. Sleeve extension shall be equivalent in length to the nominal conduit size and the inside diameter less than the outside diameter of the coated conduit.
 - vi. Strength:
 - Coating bond to conduit shall be stronger than tensile strength of coating. Field cut, thread, and bent conduit shall not damage conduit.
 - d. Conduit Bodies:
 - i. Ferrous metal construction electro-galvanized inside and out and PVC coated to match the conduit.
 - ii. Tapered, threaded hubs with integral bushing.
 - iii. Stainless steel or encapsulated stainless steel hardware.
 - iv. PVC coated cover constructed of same material with solid tongue-in-groove gasket.
 - e. Fittings:
 - i. Ferrous metal construction electro-galvanized inside and out and PVC coated to match conduit.
3. Rigid Aluminum Conduit (Type RMCA)
- a. Manufacturer:
 - i. Contractor option.

- b. Conduit:
 - i. Heavy wall tube manufactured of 6063 aluminum alloy in temper designation T-1 with an accurate circular cross section, a uniform wall thickness and a defect free interior surface.
 - ii. Factory cut threads, 0.75 inch taper per foot.
 - c. Conduit Bodies:
 - i. Copper free aluminum construction coated with aluminum acrylic paint.
 - ii. Tapered, threaded hubs with integral bushing.
 - iii. Stainless steel hardware.
 - iv. Cover constructed of same material with solid gasket.
 - d. Fittings:
 - i. Copper free aluminum construction.
 - ii. Components critical to performance such as setscrews, split rings, and locknuts are adequately designed to insure positive bonds.
4. Rigid Non-Metallic Conduit (Type RNC)
- a. Manufacturer:
 - i. Carlon.
 - ii. Cantex
 - iii. Prime Conduit
 - iv. Or equal.
 - b. Conduit:
 - i. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
 - ii. Rated for use with 195°F conductors. Material shall comply with NEMA Specification TC-2.
 - iii. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections, which could mar conductors or cables.
 - iv. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.
 - v. Schedule 80 non-metallic conduit shall be used in locations subject to physical damage. Schedule 40 non-metallic conduit may be used in all other locations.
 - c. Conduit Bodies:
 - i. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
 - ii. Rated for use with 105°F conductors. Material shall comply with NEMA Specification TC-3.
 - iii. Stainless steel hardware.
 - iv. Cover constructed of same material with solid gasket.
 - d. Fittings:
 - i. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
 - ii. Rated for use with 105°F conductors. Material shall comply with NEMA Specification TC-3.

C. CONSTRUCTION.

- 1. Field Measurements
 - a. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections. Conduit rough-in shall be based upon shop drawing requirements.

- b. The Contractor shall be responsible for coordinating conduit location and rough-in with actual equipment conditions and requirements.
 - c. Field verify all measurements. Do not base conduit rough-in or equipment locations on the plans.
 - d. Identify conflicts with the work of other trades prior to installation of electrical equipment and conduit work.
 - e. Adjust conduit system installation to satisfy field requirements.
2. Delivery, Storage, and Handling
- a. Accept conduit on site. Inspect for damage.
 - b. Protect conduit from corrosion and entrance of debris.
 - c. Store conduit above grade. Protect from environment with suitable covering.
 - d. Protect PVC and PVC coated conduit from sunlight.
3. Installation
- a. General:
 - i. Install conduit in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting", all requirements of the NEC, and manufacturer recommended practices.
 - ii. Arrange conduit to maintain headroom and present neat appearance.
 - iii. Design raceway systems to minimize the number of fittings, couplings, kicks, and offsets.
 - iv. Raceways located above lowest floor level:
 - Route conduit parallel and perpendicular to walls.
 - All raceways shall be level and straight.
 - Vertical conduits shall be plumb.
 - vi. Raceways located in or under lowest level floor:
 - Route conduit in and under slab from point-to-point.
 - Do not cross conduits in slab.
 - vii. Do not use flexible conduit in place of bends, conduit bodies, or expansion fittings.
 - viii. Flexible conduit shall be used at all equipment terminations. Maximum length of 24-inches unless specifically allowed otherwise by Engineer based upon field conditions.
 - ix. Do not use cords for equipment connections unless specifically allowed otherwise by Engineer based upon field conditions.
 - b. Raceway sizing:
 - i. Size raceways as indicated on drawings.
 - ii. Where raceways sizes are not indicated on drawings, size in accordance with NEC requirements. Minimum size 3/4 inch.
 - iii. Exposed conduit runs not longer than 10 feet in length and terminating at a single device may be 1/2 inch unless prohibited by NEC.
 - c. Raceway Installation:
 - i. Maintain adequate clearance between conduit and piping.
 - ii. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104°F.
 - iii. Cut conduit square using saw or pipe cutter; de-burr cut ends.
 - iv. Bring conduit to shoulder of fittings; fasten securely.
 - v. Use conduit hubs to fasten conduit to NEMA 4X and NEMA 12 boxes.
 - vi. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic factory elbows for bends in metal conduit larger than 2 inch size.
 - vii. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

- viii. Suitable pull string shall be installed in each empty conduit, sleeves and nipples excepted.
- ix. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- x. Remove all debris and moisture from raceways prior to installing conductors.
- xi. Ground and bond conduit under provisions of Grounding And Bonding For Electrical Systems.
- xii. Identify conduit under provisions of Identification For Electrical Systems.
- xiii. Install plastic coated conduit in accordance with manufacturer's instructions. All 90 degree bends shall be manufactured elbows. Touch-up PVC coating after installation.
- xiv. All field cut threads shall be coated with Thomas & Betts Kopr-Shield prior to assembly.
- d. Structural Coordination:
 - i. Suitable fittings, designed and listed for the purpose, shall be used to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
 - ii. Install conduit to preserve fire resistance rating of partitions and other elements.
 - iii. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
 - iv. Where conduit passes between areas subject to variable temperatures, seal conduits to prevent air interchange and condensation formation. Use conduit fitting specifically manufactured for this purpose.
- e. Raceway Support:
 - i. General:
 - Arrange supports to prevent misalignment during wiring installation.
 - Do not permanently support conduit with wire or perforated pipe straps.
 - Remove wire used for temporary supports.
 - Do not attach conduit to ceiling support wires.
 - Channel, rod, and hardware shall comply with the requirements of Hangers And Supports For Electrical Systems.
 - ii. Hardware:
 - Construct conduit support rack with channel and rod to support conduits not supported from structure.
 - Support conduit with channel anchored to structure when conduit offset from structure is required.
 - Secure conduits to channel with pipe straps.
 - Support conduit from structure when conduit offset from structure is not required.
 - Secure conduits directly to structure with one-hole strap and conduit spacer.
- e. Conduit Separation:
 - i. Separate conduit systems shall be used for the following circuit categories:
 - 120 volt power circuits.
 - 480 volt power circuits. 120 volt control circuits.
 - 24 VDC analog control circuits.
 - Intrinsically safe control circuits.
 - UTP control cables.
 - Manufacturer supplied cables (for example, magnetic flow meter cables).
 - Radio frequency coaxial cables (for example, antenna cables).
 - ii. The plans show individual homerun equipment connections. The Contractor may combine circuits of common types (as identified above) into single conduits provided the following conditions are met:
 - NEC requirements for conductor de-rating are satisfied.

- Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
- No more than eight 24VDC analog circuits are combined in a single conduit, unless specifically stated otherwise on the drawings.
- Motor feeder circuits shall not be combined and shall be run in separate conduits.

154013a.08 IDENTIFICATION FOR ELECTRICAL SYSTEMS

A. DESCRIPTION.

Furnish and install electrical identification systems as indicated on the drawings and as specified herein.

1. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - ANSI Z535.4 - Product Safety Signs and Labels.
 - ii. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.

B. MATERIALS.

1. Nameplates
 - a. Engraved two-layer laminated plastic, black letters on white background.
 - b. Lettering:
 - i. 1/4 inch letters for identifying individual equipment and loads.
 - ii. 1/2 inch letters for identifying grouped equipment and loads.
2. Conductor Marking
 - a. The ends of each conductor shall be marked with circuit number, motor number, wire or terminal number.
 - b. Control system wire marking shall be coordinated with control system and equipment shop drawings.
 - c. Labels shall be typed in black lettering with indelible ribbons on a white, heat shrink sleeve. Markers shall be shrunk around the wire to ensure a tight, non-slip bond with a compatible heat gun.
 - d. Heat shrink wire markers shall be Brady Bradysleeve Type B-321 or B-322.
3. Conductor Color Coding
 - a. Conductors No.6 AWG and smaller shall be provided with color coded insulation as described herein. Conductors larger than No.6 AWG may be color coded with appropriately colored Scotch No.35 tape at each end.
 - b. Color Coding:
 - i. 277/480 vac system shall be colored brown, orange, yellow, and gray for phases A, B, C, and neutral respectively.
 - ii. 120/208 vac system shall be colored black, red, blue, and white for phases A, B, C, and neutral respectively.
 - iii. 120/240 vac shall be colored black, red, and white for Line 1, Line 2, and neutral respectively.
 - iv. 120 vac control wiring shall be colored red.
 - v. 24 VDC control wiring shall be colored purple and purple with white stripe for positive and negative conductors respectively.

- vi. Intrinsically safe control wiring shall be colored light blue.
- vii. Conductors within control cabinets and motor control centers which are supplied from an external source shall be colored yellow.
- viii. Grounding conductor and equipment ground conductors shall be colored green.
- 4. Conduit Marking
 - a. Colored band markers shall be field painted.
 - b. Color:
 - i. 480 Volt System: Yellow.
 - ii. 208 Volt and 240 Volt System: White.
 - iii. Fire Alarm System: Red.
 - iv. Low Voltage Communication System: Black.
 - v. Process Instrumentation and Control System: Blue.
- 5. Equipment, Enclosure, and Cabinet Warning Signs
 - a. Electrical Voltage and Shock Hazard Signs
 - i. Provide OSHA Voltage and Shock Hazard sign for each electrical enclosure, cabinet, or other piece of equipment that presents an electrical hazard under normal operating circumstances or presents an electrical hazard while the enclosure is open.
 - b. Electrical Arc Flash Hazard Signs
 - i. Provide Arc Flash Hazard sign for each electrical enclosure, cabinet, or other piece of equipment that presents an arc flash hazard in accordance with NEC and ANSI Z535.4.
 - c. Electrical Source Signs
 - i. Provide sign indicating voltage level and source for each component of the power distribution system and for all control panels.
 - ii. Provide indicating multiple sources where equipment is fed from multiple sources or where signal wiring is present that is powered from a source external to the equipment.

C. CONSTRUCTION.

1. Installation

- a. Nameplates:
 - i. Provide nameplates for grouped equipment such as panelboards, transformers, motor control centers, and control panels. Nameplate shall identify tag number, voltage, ampere rating, and description.
 - ii. Provide nameplates for individual equipment such as motor control center compartments, field instruments, and field control stations. Nameplate shall identify tag number and description.
 - iii. Provide nameplates for individual receptacles. Nameplate shall identify panel and circuit number supplying the receptacle.
 - iv. Provide nameplates for control cabinets and motor control center compartments which contain wiring supplied from an external source. Nameplate shall state: Multiple power sources within, verify all power supplies are disconnected before servicing equipment.
 - v. Nameplates shall be secured to the front of equipment enclosures with stainless steel screws or rivets. Double sided tape will not be acceptable.
 - vi. Secure nameplates for flush mounted panelboards behind the panelboard door.
- b. Conductor Marking:
 - i. Mark conductors at every termination and splice point.
 - ii. Mark conductors with wire numbers identified by control system supplier, with panel and circuit identification, or with MCC compartment and wire numbers.
- c. Conduit Marking:

- i. Furnish colored band markers for each conduit longer than six feet and mark each conduit a minimum of twenty feet on center.

154013a.09 ADJUSTABLE FREQUENCY MOTOR CONTROLLERS

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of Process Instrumentation & Control. This section specifies the complete furnishing and installation and operation of adjustable frequency drive systems as indicated on the drawings and as specified herein. Motor control equipment specified under this section shall be the product of a single manufacturer unless stated otherwise. Adjustable frequency drive systems work may include work in new motor control centers and/or work in existing motor control centers. Refer to the drawings for detailed description of the work.

1. Applicable Publications

- a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - ii. Canadian Standards Associates (CSA), Specifications and Standards, Current Edition.
 - iii. European Committee for Electrotechnical Standardization (CENELEC), Current Edition.
 - EN 60947 - Low-Voltage Switchgear and Controlgear - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters
 - iv. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
 - v. Institute of Electrical and Electronics Engineers (IEEE), current edition.
 - IEEE 519-1992 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
 - vi. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition:
 - IEC-60439 - Low Voltage Switchgear and Control Gear Assemblies.
 - vii. National Electrical Contractors Association (NECA), current edition.
 - NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
 - viii. National Electrical Manufacturers Association (NEMA), Specifications and Standards, Current Edition:
 - ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
 - ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
 - ICS 4-2000 - Industrial Control and Systems: Terminal Blocks.
 - ICS 5-2000 - Industrial Control and Systems: Control Circuit and Pilot Devices.
 - ICS 6-1993 - Industrial Control and Systems Enclosures
 - ICS 7-1993 - Industrial Control and Systems Adjustable-Speed Drives
 - NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - ix. Underwriters Laboratories, Inc. (UL), Specifications and Standards, Current Edition:
 - 4.UL 508C - Power Conversion Equipment.

2. Submittals
 - a. The following information shall be submitted specifically for adjustable frequency drive systems:
 - i. Submit harmonic voltage distortion analysis based upon the minimum three phase bolted fault short circuit current available at the point of service. Submittal data shall not relieve contractor of specified performance requirements. Analysis shall include:
 - Calculate percent voltage distortion, with respect to fundamental voltage, for all harmonics up to the 99th.
 - Comparison with IEEE 519 standards for acceptable voltage distortions on such systems.
3. Operation/Maintenance Manuals and Instructions
 - a. The following information shall be provided specifically for adjustable frequency drive systems:
 - i. Motor controller data listing identifying the configured values of all adjustable settings and configurable parameters.
4. Quality Assurance
 - a. Manufacturer Qualifications:
 - i. All equipment provided under this section shall be the products of a single company specializing in manufacturing products specified in this section, with not less than twenty years of documented experience.
 - ii. The adjustable frequency drive system manufacturer shall have been engaged in the manufacture of PWM style adjustable frequency drives for a minimum of ten years.
 - b. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
 - c. Adjustable frequency drive system manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

B. MATERIALS.

1. Manufacturer
 - ~~i. Allen Bradley, Bulletin Power Flex 753 Series.~~
 - ~~ii. Eaton/Cutler-Hammer, DG1 Series.~~
 - iii. Asea Brown Boveri (ABB) Model ACQ 800. No substitutions.
 - ~~iv. Or equal.~~
2. General
 - a. Provide adjustable frequency, drive control systems capable of converting the scheduled voltage, 3-phase, 60 Hz, input power into variable voltage, adjustable frequency, 3-phase output of suitable capacity and waveform to serve as input power to squirrel cage induction motors of the scheduled characteristics (constant or variable torque).
 - b. Harmonic Distortion:
 - i. The adjustable frequency drive systems shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when operated from the same bus.
 - ii. Individual or simultaneous operation of the adjustable frequency drive systems shall not add more than 5% total harmonic voltage distortion to the normal bus, nor more than 10% while operating from the standby generator in accordance with IEEE 519, 1992.
 - iii. Maximum total and individual harmonic current distortion limits for each odd harmonic shall not exceed those set forth by IEEE 519, Latest Edition.

- iv. If harmonic filters or reactors are needed to meet these requirements, then the manufacturer shall provide and be responsible for the design and manufacture of these items.
- 3. Ratings
 - a. The drive shall accept an input voltage of the nominal three phase voltage indicated on the drawings, +/- 10%.
 - b. Displacement power factor: shall range between 1.0 and 0.95, lagging, over the entire speed range.
 - c. Efficiency: minimum of 97% at full load and speed.
 - d. Environmental Ratings:
 - i. Storage ambient temperature range: -40°F to 160°F.
 - ii. Operating ambient temperature range: 32°F to 105°F without derating.
 - iii. Relative humidity range: 5% to 95% non-condensing.
 - iv. Operating elevation: up to 3280 feet without derating.
 - e. Provide redundant, thermostatically controlled ventilation fans to maintain interior of drive enclosure within the specified environmental ratings.
 - f. Output power Ratings:
 - i. The output voltage shall be adjustable from 0 to rated input voltage.
 - ii. The output frequency range shall adjustable from 0 to 400Hz.
 - iii. The inverter section shall produce a pulse width modulated (PWM) waveform using latest generation IGBTs.
- 4. Drive Unit Design
 - a. Hardware:
 - i. Utilize diode or fully gated bridge on the input.
 - ii. Utilize DC bus inductor on all drives rated 7.5hp or greater.
 - iii. Utilize switching logic power supply operating from the DC bus.
 - iv. Incorporate phase to phase and phase to ground MOV protection.
 - v. Utilize gold plated plug-in connections on printed circuit boards.
 - vi. Microprocessor based inverter logic shall be isolated from power circuits.
 - vii. Utilize latest generation IGBT inverter section.
 - viii. Inverter section shall not require commutation capacitors.
 - ix. Employ interface common for all horsepower ratings. Interface shall include a LCD digital display and programming keypad.
 - x. Utilize a main control board with common control connections for all ratings.
 - b. Control Design:
 - i. The drive design shall be optimized for NEMA Design B motors.
 - ii. The drive design shall allow for operation of the drive with the motor disconnected.
 - iii. Provide a controlled shut down, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
 - iv. Utilize an adjustable PWM carrier frequency within a range of 2 kHz to 8 kHz to help eliminate audible noise.
 - v. Provide either Selectable Sensorless Vector or V/Hz modes.
 - vi. The drive shall have the capability of selecting operation for either variable or constant torque loads. Selection of variable torque shall provide 115% of rated VT current for up to 1 minute. Selection of constant torque shall provide 150% of rated CT current for up to 1 minute.
 - vii. Provide multiple programmable stop modes including:
 - Ramp

- Coast
 - DC-Brake
 - Ramp-to-Hold
 - S-Curve
- viii. Provide multiple acceleration and deceleration rates.
 - ix. The drive shall have an adjustable output frequency up to 400Hz.
 - x. The drive shall be capable of sensing a loss of the speed reference.
 - xi. All adjustments shall be made with the door closed.
- c. Power Conditioning:
 - i. The drive shall be designed to operate on an AC line which may contain line notching and up to 10% harmonic distortion.
 - ii. An input isolation transformer shall not be required for protection from normal line transients. If line conditions dictate the use of a transformer, the K factor shall be 4.0 or less.
5. Drive Unit Features
- a. Control Mode:
 - i. Selectable sensorless vector or V/Hz mode selectable through programming.
 - ii. The sensorless vector mode shall use motor nameplate data plus motor operating data such as IR drop, nominal flux current and flux up time.
 - iii. The volts per hertz mode shall be programmable for squared, cubed, straight line, pre-programmed or full custom patterns.
 - b. Current Limit:
 - i. Programmable current limit from 20% to 160% of constant torque rating.
 - ii. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
 - iii. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.
 - c. Acceleration / Deceleration:
 - i. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 seconds to 3600 seconds.
 - ii. A second set of remotely selectable Accel/Decel settings shall be accessible through the control interface.
 - iii. An adaptive current limit circuit shall be available and capable of being disabled through programming for fast acceleration of low inertia loads.
 - d. Speed Regulation Modes:
 - i. Open Loop.
 - ii. Slip Compensation with 0.5% speed regulation.
 - iii. Droop - Negative Slip Compensation with 0.5% speed regulation.
 - iv. Traverse Function.
 - v. Closed loop encoder feedback with 0.1% speed regulation.
 - vi. Process PI control.
 - e. Speed Profiles:
 - i. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S-Curve" profiles that provide changing accel/decel rates.
 - ii. S-Curve profiles shall be selectable for fixed or adjustable values.
 - f. Adjustments:
 - i. A digital interface shall be used for all set-up, operation and adjustment settings.
 - ii. All adjustments shall be stored in nonvolatile memory (EEPROM).

- iii. No potentiometer adjustments shall be required.
 - iv. The drive shall provide EEPROM memory for factory default values.
- g. Process PI Control:
 - i. The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.
 - ii. The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the setpoint, the regulator shall adjust the drive output until the feedback equals the reference.
 - iii. Process control shall be capable of being enabled or disabled with a hardwire input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
 - iv. Protection shall be provided for a loss of feedback or reference signal.
- h. Fault Reset / Run:
 - i. The drive shall provide up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
 - ii. Ground fault, shorted output faults, and other internal microprocessor faults shall not automatically reset/restart.
 - iii. The time between restarts shall be adjustable from 0.5 to 30 seconds.
- i. Skip Frequencies:
 - i. Three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.
 - ii. The set points shall have a bandwidth adjustable from 0 Hz to 15 Hz.
- j. Run on Power Up:
 - i. A user programmable restart function shall be provided to automatically restart the equipment after restoration of power after an outage.
- k. Line Loss Restart:
 - i. The drive shall have a line loss restart function. This programmable function shall select the reconnect mode of the drive after recovery from a line loss condition.
 - ii. The reconnect modes shall be Last Speed, Speed Search, Track Volts, or Use Encoder.
 - iii. This feature shall be capable of being disabled thus forcing the drive to start from zero hertz.
- l. Fault Memory:
 - i. The last four faults as well as operating frequency, drive status and power mode shall be stored at the time of fault.
 - ii. Information shall be maintained in the event of a power loss.
- m. Overload Protection:
 - i. The drive shall provide internal Class 10 motor overload protection investigated by UL to comply with N.E.C. Article 430.
 - ii. Overload protection shall be speed sensitive and adjustable for motors with speed ranges of 2:1, 4:1 and 10:1.
 - iii. A viewable parameter shall store the overload usage in percent.
 - iv. An alarm bit shall be available to adjust a process to eliminate an overload trip.
- n. Auto Economizer:
 - i. An auto economizer feature shall automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage. If the load increases, the drive shall automatically return to normal operation.
- o. Flying Start:

- i. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed.
 - ii. The flying start feature shall be operable with or without encoder feedback.
- p. Control Logic Ride Through:
 - i. The control logic shall be capable of "riding through" a power outage of up to 2 seconds in duration.
- q. Inertia Ride Through:
 - i. The drive shall respond to a loss of AC input power by adjusting the output frequency to create a regenerative situation in the motor. The regenerated energy shall be used to power the drive logic during the power outage.
 - ii. The amount of voltage drop required to trigger inertial ride through and the level at which regulation occurs shall both be adjustable.
 - iii. Inertia ride through shall be capable of being enable or disable through programming.
- r. Input and Output Expansion Cards:
 - i. The standard Input / Output expansion cards shall consist of both analog and digital I/O.
 - ii. No jumpers or switches shall be required to configure inputs and outputs. All functions shall be fully programmable.
 - iii. Analog input card shall have the following as standard:
 - One differentially isolated plus or minus 10V (bi-polar) / 20mA, 11 bit plus sign, 10V common mode noise rejection
 - One differentially isolated plus or minus 10V (bi-polar) / 20mA, 11 bit plus sign, 160V common mode noise rejection
 - Analog inputs shall be user programmable for a variety of uses including frequency command and process loop input. Analog inputs shall be user programmable for function scaling (including invert), offset, signal loss detect and square root.
 - iv. Analog output card shall have the following as standard:
 - One differentially isolated plus or minus 10V (bi-polar) / 20mA, 11 bit plus sign.
 - The analog output shall be user programmable to be proportional to one of fourteen process parameters including output frequency, output current, encoder feedback, output power.
 - Programming shall be available to select either absolute or signed values of these parameters.
 - v. Digital input card shall have the following as standard:
 - Six digital inputs rated 115Vac
 - All inputs shall be individually programmable for functions from a list of twenty-nine (29) that includes Start, Run, Stop, External Fault, Speed Select, Jog and Process PI functions.
 - vi. Digital output card shall have the following as standard:
 - Two relay outputs, form C (1 N.O. - 1 N.C.)
 - Contact output ratings shall be 250Vac / 30Vdc (2.0 Amps maximum), resistive or inductive.
 - Relays shall be programmable to 26 different conditions including Fault, Alarm, At Speed, Drive Ready and PI Excess Error.
 - Timers shall be available for each output to control the amount of time, after the occurring event, that the output relay actually changes state.
- s. Reference Signals:
 - i. The drive shall be capable of using the following input reference signals
 - Analog inputs

- Preset speeds
- Remote potentiometer
- Digital MOP
- Human Interface
- Communication module commands
- t. Communication:
 - i. The drive shall be capable of communicating with an Allen Bradley Ethernet/IP network.
- u. Loss of Reference:
 - i. In the event of loss of the reference signal, the drive shall be user programmable to the following:
 - Fault the drive
 - Alarm and maintain last reference
 - Alarm and go to preset speed
 - Alarm and go to minimum speed
 - Alarm and go to maximum speed
 - Alarm and maintain last output frequency
- v. Metering:
 - i. The following parameters shall be accessible through the human interface module:
 - Output Current in Amps
 - Output Voltage in Volts
 - Output Power in kW
 - Elapsed MWh
 - DC Bus Voltage
 - Output Frequency
 - Heatsink Temperature
 - Last eight faults
 - Elapsed Run Time
- w. Faults:
 - i. Fault information shall be accessible through the human interface module.
 - ii. A fault buffer shall store the last four faults in a first-in / first-out manner.
 - iii. At a minimum the following faults shall be displayed:
 - Power Loss.
 - Undervoltage.
 - Overvoltage.
 - Overload.
 - Overtemperature (Heat Sink).
 - Overcurrent detected in instantaneous overcurrent trip circuit
 - Maximum retries.
 - Phase-to-phase and phase-to-ground faults.
- 6. Disconnecting Means
 - a. Provide a door interlocked motor circuit protector disconnect
 - b. Operator Handles
 - i. Provide flange mounted operator handles for free standing units
 - ii. Provide through the door operating handles for wall mounted units
 - iii. Handles shall be padlockable
 - c. The system shall be rated for the available fault current identified on the drawings. The rating shall be shown on the drive label.

7. Drive Input Fuses
 - a. Provide drive input fuses to provide branch circuit protection for the drive.
 - b. The drive input fuses shall be selected by the manufacturer and mounted in fuse blocks.
8. Control Power Transformer
 - a. Provide a control power transformer mounted and wired inside of the drive system enclosure.
 - b. The transformer shall be rated for drive power plus 250VA for customer use.
9. Contractors
 - a. General:
 - i. Contactors shall be IEC or NEMA rated devices suitable for the application intended.
 - ii. Provide Isolation and Output contactors.
 - b. Isolation:
 - i. Input contactor shall provide positive isolation of the controller from line power.
 - ii. Input contactor shall close when motor is signaled to start, energizing the controller and allowing adjustable speed control.
 - iii. Input contactor shall open after the controller has stopped the motor and de-energize the controller.
 - iv. Input contactor shall not switch loaded motor under any circumstances.
 - c. Output:
 - i. Provide an output contactor between the drive output and the motor. The contactor shall close on power up and open after a drive fault or loss of power.
10. Power Conditioning Equipment
 - a. General:
 - i. Provide Input Line Reactors, Harmonic Mitigation Filters, or Load-Side Sine Wave Filter where indicated on the drawings.
 - b. Common Mode Choke:
 - i. Provide a common mode choke at the drive output to help, in conjunction with the proper grounding techniques, reduce or eliminate interference with sensitive electronic equipment or communication devices installed in the same system.
 - c. Input Line Reactor:
 - a. Provide a drive input line reactor mounted within the drive system enclosure
 - b. The line reactor shall meet the following specifications:
 - The construction shall be iron core with an impedance of 3%.
 - The winding shall be copper wound.
 - The insulation shall be Class H with a 240° F rise.
 - The unit shall be rated for system voltage and frequency
11. Pilot Control Devices
 - a. Provide front of panel mounted pilot devices as shown on drawings.
12. Enclosures
 - a. The enclosure shall be NEMA 1, NEMA 12, NEMA 3R, or NEMA 4X Stainless Steel as indicated on the plans.
 - b. Starters shall have an adjustable instantaneous motor circuit protector (HMCP) type disconnect device.

C. CONSTRUCTION.

1. Field Measurements
 - a. Field verify all measurements. Do not base exact equipment locations on the plans.
 - b. Identify conflicts with the work of other trades prior to installation of electrical equipment.
 - c. Identify deviation from physical sizes shown on the plans to Engineer.

- d. Contractor shall be responsible for modifications to the installation due to deviations from physical sizes shown on the plans.
- e. Identify conflicts with the work of other trades prior to installation of electrical equipment.
- f. Record nameplate data for each motor served.
- 2. Delivery, Storage, and Handling
 - a. Accept adjustable frequency motor controllers on site. Inspect for damage.
 - b. The Contractor shall be responsible for all equipment necessary to receive, unload, move into building, and install motor control centers.
 - c. The Contractor shall be responsible for coordinating specific shipping split requirements with the manufacturer/supplier.
 - d. Conform to written instructions of manufacturer.
 - e. Protect adjustable frequency motor controllers from corrosion and entrance of debris.
 - f. Store adjustable frequency motor controllers above grade. Protect from environment with suitable covering.
- 3. Installation
 - a. Adjust disconnecting means trip settings to satisfy motor nameplate requirements.
 - b. Record information for motor data labels and install motor data labels.
 - c. Adjust all programmable drive features, including but not limited to auto restart parameters. The drive system must automatically restart after a power fail condition.
 - d. Provide typed label inside each unit identifying configured values for all programmable drive parameters.
 - e. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of all connections.
 - f. Verify that cooling fans are operating properly.
 - g. Thoroughly clean and remove construction debris from filters, enclosure interior, and exterior.
- 4. Testing and Start-Up Services
 - a. Refer to the requirements of Process Instrumentation & Control.
- 5. Training
 - a. Refer to the requirements of Process Instrumentation & Control.

154013a.10 PORTABLE ENGINE/GENERATOR SET

A. DESCRIPTION.

Provide complete factory assembled portable generator set equipment with standard analog controls and satisfying Tier 4 Emissions requirements. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

- 1. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - NFPA99 – Essential Electrical Systems for Health Care Facilities.

- NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit; component level type tests will not substitute for this requirement.
 - ii. Canadian Standards Association (CSA), Specifications and Standards, current edition:
 - CSA C22.2, No. 14 – M91 Industrial Control Equipment.
 - CSA 282, 1989 Emergency Electrical Power Supply for Buildings.
 - iii. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
 - IEC8528 part 4. Control Systems for Generator Sets.
 - iv. Institute of Electrical and Electronics Engineers, Specifications and Standards, current edition:
 - IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - v. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - NEMA ICS10-1993 – AC Generator sets.
 - vi. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - UL2200. The genset shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
2. Submittals
- a. General requirements specific to this section include:
 - i. Submit complete and integrated document containing all equipment included under the scope of this section.
 - ii. Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
 - iii. Include a complete list of proposed exceptions to and deviations from these specifications.
 - iv. Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
 - v. Additional requirements for the various subsystems are specified in the corresponding sections.
 - b. Submit the following information:
 - i. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - ii. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
 - iii. Manufacturer's certification of prototype testing.
 - iv. Manufacturer's published warranty documents.
 - v. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 - vi. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point to point manner.
 - vii. Manufacturer's installation instructions.
3. Factory Testing
- a. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

- b. Factory testing may be witnessed by the Contracting Authority and consulting engineer. Costs for travel expenses will be the responsibility of the Contracting Authority and consulting engineer. Supplier is responsible to provide two weeks' notice for testing.
 - c. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady state governing, single step load pickup, and function of safety shutdowns.
- 4. Operation/Maintenance Manuals and Instructions
 - a. Submit final revised shop drawings incorporating any modifications made as a result of installation, start-up, operational testing, or for any other cause. Submit results of all field-testing and corrective actions taken for all operational parameters.
 - b. Submit manufacturer's standard operation & maintenance information including installation manuals and safety instructions.
 - c. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Standby Engine/Generator Set.
 - d. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and trouble-shooting guide.
 - e. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with costs.
- 5. Quality Assurance
 - a. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
 - b. The Standby Engine/Generator Set manufacturer shall have been engaged in the manufacture of generator sets for a minimum of 10 years and shall have a factory trained service and parts organization located within 100 miles of the jobsite.
 - c. All control equipment shall be the standard product of the engine/generator set manufacturer. Controls systems that are supplied by a subcontractor of the manufacturer and which are not incorporated into the standard documentation of the manufacturer will not be acceptable.
- 6. Warranty
 - a. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.
 - b. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.
 - c. The manufacturer of the generator set shall maintain service parts inventory at a central location that is accessible to the service location 24 hours per day, 365 days per year.
 - d. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
 - e. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

B. MATERIALS.

- 1. Manufacturer
 - a. Acceptable Manufacturers

- i. Kohler Power Systems.
 - ii. Cummins/Onan.
 - iii. MTU Onsite Energy
 - iv. Caterpillar/Olympian.
 - v. Or Equal.
 - b. These specifications, installation design, and the storage facility design are based upon the first named manufacturer. If the contractor elects to supply a different manufacturer, then the contractor shall be responsible for adjusting the installation of the portable engine/generator set to satisfy the requirements of that manufacturer's equipment.
 - c. Alternate equipment will only be considered if the following information is submitted ten days prior to the bid date:
 - i. Certified dimensional data.
 - ii. Complete interconnecting wiring and piping diagrams.
 - iii. Manufacturer's certification of prototype testing.
 - iv. Load study/profile showing non-overloading of genset under steady-state conditions and during motor starting.
 - v. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - vi. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
 - vii. Short circuit study of the load circuits to verify that selective coordination occurs and that thermal-magnetic stresses on components will not exceed the specified ratings.
 - viii. Listing of similar projects and Contracting Authority contact information for projects completed during the previous 5 years.
2. Generator Set
- a. Ratings
 - i. The generator set shall operate at 1800 rpm, 60 Hz at the following switch-re-connectable voltages. Each supply voltage shall have a dedicated output circuit breaker:
 - 200 Amp - 120/240 volts AC, single-phase, three wire.
 - 100 Amp - 277/480 volts AC, three-phase wye-configuration, four-wire.
 - ii. The generator set shall be rated at 55kW, 72kVA at 0.8 PF, standby rating, based on site conditions of: Altitude 1000 feet, ambient temperatures up to 104°F.
 - iii. The generator set rating shall be based on emergency/standby service.
 - b. Performance
 - i. Voltage regulation shall be plus or minus 1.0% for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
 - ii. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
 - iii. The engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
 - iv. Minimum motor starting capability shall be 261kVA at 35% voltage dip.
 - v. Motor starting capability shall be adequate to start and run two 20 HP pumps (480V,AFD), 5kVA of miscellaneous single phase loads.
 - vi. The Gen-Set shall be sized to start and run the scheduled loads in three or less steps.

- vii. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic.
 - viii. Telephone influence factor shall be less than 40.
 - c. Construction
 - i. The engine generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a corrosion resistant battery tray with hold-down clamps within the rails.
 - d. Connections
 - i. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations for the number and type cables shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
 - ii. Power connections to auxiliary devices shall be made at the devices, with connectors suitable for plug-in connection as shown on the drawings.
 - iii. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.
- 3. Engine and Engine Equipment
 - a. The engine shall be diesel fueled, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories.
 - b. Engine accessories and features shall include:
 - i. Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be factory plumbed to the generator set.
 - ii. An electronic governor system shall provide automatic isochronous frequency regulation.
 - iii. Skid mounted radiator and cooling system rated for full load operation in 104°F ambient as measured at the generator air inlet, based on 0.5 in H₂O external static head. Radiator shall be sized based on a core temperature that is 20°F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.
 - iv. Electric starter(s) capable of three complete cranking cycles without overheating.
 - v. Positive displacement, mechanical, full pressure, lubrication oil pump.
 - vi. Full flow lubrication oil filters with replaceable spin on canister elements and dipstick oil level indicator.
 - vii. Fuel filter with replaceable spin on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
 - viii. Replaceable dry element air cleaner with restriction indicator.
 - ix. Flexible supply and return fuel lines.
 - x. Engine mounted battery charging alternator, 40 ampere minimum, and solid state voltage regulator.
 - xi. Coolant heater
 - Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be 120V as shown on the project drawings and cord connected. The coolant heater shall be UL499 listed and labeled.

- The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
 - The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power cord connection shall be provided for a single AC power connection to the coolant heater system.
 - The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100°F in a 40°F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.
- xii. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer.
- xiii. Starting and Control Batteries shall be calcium/lead antimony type, 12 or 24 VDC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.
- c. Battery Charger
- i. A UL listed/CSA certified 10 amp voltage regulated battery charger shall be provided for this engine generator set. The charger shall be mounted on the generator set assembly within the weatherproof enclosure. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
 - Loss of AC power red light.
 - Low battery voltage red light.
 - High battery voltage red light.
 - Power ON green light (no relay contact).
 - ii. Charger shall include an Analog DC voltmeter and ammeter, 12 hour equalize charge timer, and AC and DC fuses,
 - iii. Provide cord set for quick connection of battery charger to battery terminals.
 - iv. Battery Charger shall operate on 120VAC power and shall be cord connected.
4. AC Generator
- a. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 260°F.
 - b. Generator shall be capable of supplying single-phase output at full capacity rating and unity power factor.
 - c. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5% above or below selected rated voltage.
 - d. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and

- controls shall be capable of sustaining and regulating current supplied to a single-phase or three-phase fault at approximately 300% of rated current for not more than 10 seconds.
- e. The subtransient reactance of the alternator shall not exceed 12%, based on the standby rating of the generator set.
5. Engineer Generator Set Control
 - a. A NEMA 1 enclosed control panel shall be mounted on the generator set with vibration isolators. The control shall be vibration isolated and prototype tested to verify the durability of all components under the vibration conditions encountered.
 - b. The generator set mounted control shall include the following features and functions:
 - i. Three-position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - ii. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 - iii. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power.
 - iv. Generator Set AC Output Metering: The generator set shall be provided with a metering set with the following features and functions:
 - Analog AC Voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency/RPM meter, 45 65 Hz, 1350 1950 RPM, 90 degree scale, +/- 0.6 Hz accuracy.
 - Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. When supplied with reconnectable generators, the meter panel shall be reconnectable for the voltage specified.
 - v. Generator Set Alarm and Status Display: The generator set shall be provided with alarm and status indicating lamps to indicate non automatic generator status, and existing alarm and shutdown conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:
 - Low oil pressure (alarm).
 - Low oil pressure (shutdown).
 - Low coolant temperature (alarm).
 - High coolant temperature (alarm).
 - High coolant temperature (shutdown).
 - Overcrank (shutdown).
 - Overspeed (shutdown).
 - Low fuel (alarm).
 - In addition, provisions shall be made for indication of two customer specified alarm or shutdown conditions.
 - vi. Engine Status Monitoring: The following devices shall be provided on the generator set control:
 - Engine oil pressure gauge.
 - Engine coolant temperature gauge.
 - Engine operation hour gauge.

- Battery voltage (DC volts).
- vii. Engine Control Functions. The control system provided shall include a cycle cranking system, which shall be for three cranking periods of 15 seconds each, with 15 second rest period between cranking periods. Fail to start shall be indicated by operation of the overcrank alarm indication lamp. The control system shall also include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification.
- viii. Alternator Control Functions:
 - The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load induced voltage waveform distortion and provide a pulse-width modulated output to the alternator exciter. The system shall include a torque matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 HZ.
 - Voltage adjusting rheostat, locking screwdriver type, to adjust voltage $\pm 5\%$ from rated value.
- ix. Voltage Range Select Function:
 - The generator set shall be equipped with a full-load rated panel-mounted, rotary switch for de-energized reconnection of alternator leads to provide multiple, individually selectable output voltage levels.
- x. The generator set shall be provided with one mounted main line circuit breaker for each selected output voltage, sized as follows:
 - For 120/240V 1-phase, 3-wire (wye) connection, 200A
 - For 277/480V 3-phase, 4-wire (wye) connection, 100A.
- xi. Circuit breakers shall be equipped with shunt trip and shall automatically open on a genset shutdown alarm.
- c. Sequence of Operation
 - i. Generator set shall start on receipt of a manual start signal at the generator control panel.
 - ii. The generator set control shall initiate the starting sequence for the generator set.
 - iii. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
 - iv. When all start signals have been removed from the generator set, the generator set control shall switch off the excitation system and shall shut down.
 - v. A start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.
- 6. Portable Engine Exhaust System
 - a. Exhaust system shall comply with and be factory certified to all applicable regulatory requirements for portable diesel fueled engines in effect at the time of purchase. Install exhaust system according to the engine manufacturer's recommendations and applicable codes and standards.
 - b. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
 - c. Provide stainless steel, seamless flexible exhaust manifold connector.

7. Portable Diesel Engine Fuel System

a. Diesel fuel sub-base tank

- i. Manufacturer: Contractor option. Manufacturers shall have a minimum ten years' experience in the design and construction of Underwriters Laboratories (UL) listed sub base tank systems.
- ii. Tank construction:
 - Fuel tank shall be sized based upon the fuel requirements of the genset to provide a minimum of twenty-four hours of genset runtime at full rated standby output capacity.
 - Sub base tank shall be constructed in accordance with Flammable and Combustible Liquids Code, NFPA 30; The Standard for Installation and use of Stationary Combustible Engine and Gas Turbines, NFPA 37; and The Standard for Emergency and Standby Power Systems, NFPA 110.
 - Sub base tank shall be rectangular in shape.
 - Sub base tank shall include reinforced steel box channel for generator support, with load rating of 5000 pounds per genset mounting hole location. Full height gussets shall be provided at genset mounting holes.
 - Sub base tank shall be pressure washed with an iron phosphate solution. Interior shall be coated with a solvent-based film rust preventative, providing inter-operational protection.
 - Sub base tank shall be shipped with a certificate of Structural/Mechanical Integrity, certifying that it has met standards through rigorous testing and has demonstrated specified capabilities.
 - Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
 - Sub base tank shall include a direct-reading fuel level gauge.
 - A fuel containment basin leak detector switch shall be provided.
- iii. Tank fittings:
 - Appropriately sized NPT fuel supply.
 - Fuel return fitting.
 - 1 1/4 inch NPT for normal vent.
 - NPT for emergency vent, sized as appropriate.
 - 2 inch NPT for manual fill with containment and audible fill alarm.
 - NPT for level gauge, sized as appropriate.
 - 3/8 inch NPT basin drain.
 - 2 inch NPT for level alarm.
 - NPT fitting for leak detection alarm.
- iv. Tank venting:
 - Normal venting shall be sized at 1 1/4 inch NPT for tanks through 2499 gallons (1 1/2 inch NPT for 2500 to 3000 gallons; 2 inch NPT for 3001 to 10,000 gallons) in accordance with The American Petroleum Institute Standard No. 2000, for venting atmospheric and low pressure storage tanks. Tank shall be provided with atmospheric (normal) vent cap with screen.
 - The emergency vent NPT fitting shall be sized to accommodate the total capacity of both normal and emergency vents, and is not less than that derived from NFPA 30, Table 2-8, based on wetted surface area of the tank (calculated based on 100% of primary tank). A zinc-plated emergency pressure relief vent cap shall be furnished. The vent shall be spring-pressure operated. Opening pressure shall be 0.5 psig; full

opening pressure shall be 2.5 psig. Limits shall be marked on top of each vent. A second emergency vent fitting shall be provided for the secondary containment portion of the tank if applicable.

- v. Testing
 - Primary tank sections shall be pressurized at 3 to 5 psi and leak-checked to ensure integrity of sub base weld seams per UL-142 standards. Containment basin shall be leak-checked by means of weld penetrant and ultraviolet light.
 - b. State of Iowa licensed installer shall install tank.
8. Portable Engine/Generator Set Trailer
- a. Manufacturer: Contractor option. Equal manufacturers shall have a minimum 10 years' experience in the design and construction of Underwriters Laboratories (UL) listed sub base tank systems
 - b. Trailer Design and Construction
 - i. Trailers shall include integral sub base (generator base) tank.
 - ii. Trailer design and construction shall include the following:
 - Tandem axle/single axle.
 - Load rated for the combined weight of the genset, fuel tank, fuel, housing, and accessories.
 - All steel, heavy formed channel construction (tongue and side).
 - Integral cross-members at genset mounting points.
 - Trailer tongue shall be bolt-on extension of side channels with a cross-member providing triangulation support point for standard tongue jack and continuing to an adjustable hitch.
 - Heavy-duty tongue jack.
 - Fenders constructed of formed steel and bolted to side channels. Non-skid material on top surface of fenders.
 - Torflex hydraulic/electric brake axle bolted to trailer frame.
 - 15/16 inch tire and wheel assemblies shall conform to axle.
 - 2 5/16 inch adjustable height ball coupler (or 2 inch ball or 3 inch Pintle eye). Coordinate requirements with Contracting Authority.
 - Heavy-duty safety chains, including slip hook.
 - Two 5000 pound rear stabilizer jack stands bolted to rear cross-member.
 - ICC lighting with six wire connector. Electrical components meet Department of Transportation requirements, including rear taillights, reflectors and wire harness.
 - Tongue mounted, waterproof hinged and gasketed storage box with lockable side-mounted hasp.
 - Trailer and accessories shall be chemically cleaned. Trailer finished with epoxy primer coat and gloss black acrylic enamel paint.
9. Power Connection Cord Sets
- a. Generator set manufacturer shall provide two cord sets, each type W, 50 foot length as follows:
 - i. One four-conductor (plus ground) cable rated for 100A at selected voltage of 277/480VAC (three-phase, four-wire).
 - ii. One three-conductor (plus ground) cable rated for 200A at selected voltage of 120/240VAC (single-phase, three-wire).
 - b. Generator set manufacturer shall provide cord end connectors (plugs) manufactured by Russellstoll for connection to generator and to load-end receptacles, and shall provide matching mating receptacles at generator enclosure and load-end receptacles as noted

below. Load-end receptacles shall be turned over to the Electrical Contractor for installation at service locations indicated. Each cable-end connector shall be selected and installed on its respective cord-set by selected voltage and matched as follows:

- i. Voltage: 277/480V (three-phase, four-wire):
 - Source-side cord-end connector (plug): 100A, Style 1, 4-pole, 4-wire, with ground, reverse service, Russellstoll No. JPS1044F.
 - Service (load-side) mating receptacle for installation on control panel: 100A, Style 1, reverse service, 4-pole, 4-wire, with ground, with angle adapter and back-box.
- ii. Voltage: 120/240V (single-phase, three-wire):
 - Source-side cord-end connector (plug): 200A, Style 1, 3-pole, 4-wire with ground, reverse service, Russellstoll No. JPS2034H.
 - Field verify cord end connector on existing generator cord.
- iii. Cord-end plugs shall be provided with threaded weatherproof covers for protection.
- iv. Receptacles shall be provided with threaded weatherproof covers for protection.
- v. Plugs and receptacles shall be permanently marked with indicated output voltage and corresponding color band.

10. Outdoor Weather-Protective Sound Attenuating Housing

- a. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound pressure level of the generator set while operating at full rated load to a maximum of 69 dBA at any location 20 meters from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
- b. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and pad-lockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
- c. The enclosure shall be provided with an exhaust silencer that is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a rain cap and rain shield.
- d. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. All surfaces of all metal parts shall be primed and painted.
- e. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- f. Enclosure shall protect against entry of rodents, birds, and other wildlife. All openings shall be plugged, sealed, screened or otherwise protected against bird or animal entry.

11. Accessories

- a. Provide supply of consumables (air cleaner, oil filter, etc) in sufficient quantity to last for one year from the date of substantial completion.

C. CONSTRUCTION.

1. Division of Work

- a. The Contractor shall have overall system responsibility and shall provide all materials and labor necessary provide a complete and operable system and comply with all requirements of this section.

- b. The engine/generator set manufacturer shall be responsible for certifying the correctness of installation for all work related to the standby power system regardless of who performs the installation work.
 - c. The plans are diagrammatic in nature; it shall be the responsibility of the manufacturer to supplement the plans and complete the final design of the standby power system and to coordinate exact requirements with the installing contractors.
- b. Field Measurements
 - a. Field verify with exact measurements, the available mounting space for standby power system equipment. Identify deficiencies prior to beginning installation.
- c. Delivery Storage and Handling
 - a. It shall be the responsibility of the installing contractor to receive all standby power system equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.
 - b. Exercise due diligence in storing, protecting, and moving standby power system equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Contracting Authority.
- d. Installation
 - a. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.
 - b. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.
 - c. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
 - d. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
 - e. Installation of equipment shall include furnishing and installing all fuel piping and vent piping as required. The tank installer shall perform this work under the supervision of the equipment supplier.
 - f. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site
 - g. Equipment shall be initially started and operated by representatives of the manufacturer.
 - h. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.
- e. Testing and Start-Up Services
 - a. Standby power system supplier shall provide installation and start-up services required to place the complete system into operation.
 - b. The complete installation shall be tested for compliance with the specification following completion of all site work. Representatives of the manufacturer shall conduct testing, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.

- c. Installation acceptance tests to be conducted on site shall include a "cold start" test and a one step rated load pickup test in accordance with NFPA 110.
- d. Test alarm and shutdown circuits by simulating conditions. Adjust output voltage and engine speed.
- e. Verify fuel system installation and capacity.
- f. Provide for one technician follow-up visit within 1 month of commissioning to consult with Contracting Authority and make any final adjustments, corrections, or repairs.
- f. Training
 - a. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 2 hours in duration and the class size shall be limited to five persons. Training date shall be coordinated with the facility Contracting Authority.

154013a.11 PROCESS INSTRUMENTATION & CONTROL

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated Process Instrumentation and Control System, the following sections shall be included under the scope of this section: Adjustable Frequency Motor Controllers, Control Panel Construction, Control Panel Components, Instrumentation Devices, Programmable Logic Controllers, Human-Machine Interface Equipment.

The work specified herein shall include the furnishing of all materials, equipment, labor, and supervision necessary to fabricate, install, start-up, and test a complete and operable Process Instrumentation and Control System.

The labor specified herein includes but is not limited to engineering, software development, panel fabrication, equipment calibration and adjustment, testing, training, and documentation.

This section identifies the overall functional requirements for the Process Instrumentation and Control System.

This section includes coordination with the work of other sections. This work includes identification of exact interface requirements with motors, control panels, and field instrumentation provided under other portions of this specification. It shall be the responsibility of the system integrator specified under this section to execute this coordination during the shop drawing submittal phase of the work. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.

This section includes coordination with electrical contractor to ensure that the proper number of raceways and conductors are installed. It shall be the responsibility of the system integrator to coordinate this work with the installing electrician. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.

This Contractor shall be responsible for all details which may be necessary to properly install, adjust and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs which may result from unauthorized deviation from the Contract Documents.

It shall be the responsibility of the Contractor and supplier to examine all new and existing equipment that is transmitting a signal to, or receiving a signal from equipment specified in the Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in the Section and existing equipment.

It shall be the responsibility of the System Integrator to provide the OmniSite Crystal Ball alarm annunciation unit and to coordinate with the City of Waukeee to establish service to this unit via the City of Waukeee's existing account.

1. Applicable Publications

- a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, current edition:
 - PLC fail
 - ANSI/ISA-5.1-1984 - Instrumentation Symbols and Identification.
 - ANSI/ISA-5.3-1983 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
 - ANSI/ISA-95.00.01-2000 - Enterprise Control System Integration, Part 1: Models and Terminology.
 - ANSI/ISA-TR99.00.01-2004, Security Technologies for Manufacturing and Control Systems.
 - ANSI/ISA-TR99.00.02-2004, Integrating Electronic Security into the Manufacturing and Control Systems Environment.
 - ii. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - NFPA 70 - National Electrical Code.
 - iii. European Community, Applicable Directives.
 - EN50005 - for Terminal Markings.
 - EN50081-1- Generic Emission Standard.
 - EN50082-1 - Generic Immunity Standard.
 - EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
 - EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.
 - iv. Canadian Standards Association (CSA), Specifications and Standards, current edition:
 - CSA C22.2, Industrial Control Equipment.
 - v. CUL - Underwriter's Laboratories of Canada.
 - vi. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
 - IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
 - vii. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
 - viii. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - UL508 - Industrial Control Equipment.
 - UL508A - Industrial Control Panels.
 - UL 913 - Intrinsically Safe Specification.
 - UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

2. Submittals

- a. Submit the following information specifically for hardware alarm notification system:
 - i. General requirements specific to this section include:
 - Submit complete and integrated document containing all equipment included under the scope of this section.
 - Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
 - Include a complete list of proposed exceptions to and deviations from these specifications.
 - Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
 - Additional requirements for the various subsystems are specified in the corresponding sections.
 - ii. Submit the following information:
 - Bill of Materials:
 - Complete listing of all components identifying exact make and model, quantity, and description.
 - Component Data Sheets:
 - Detailed listing for each type of device, identifying Engineer's tag number, manufacturer, model, options, ranges, and other information necessary to supplement component catalog cut sheets and clearly show compliance with these specifications.
 - Component Catalog Cut sheets:
 - Manufacturer's standard catalog information.
 - Control Panel Construction Drawings:
 - Scaled drawings of all control panels and enclosures.
 - Front panel elevation complete with nameplate legend.
 - Back panel elevation complete with schedule of devices.
 - Control Panel Schematic Wiring Diagrams:
 - Ladder type schematic diagrams.
 - Show all devices requiring electrical connections.
 - Identify all wire and terminal numbers.
 - Identify PLC I/O addresses.
 - Reference Engineer's tag number where assigned.
 - Cross-reference all relay contacts and coils.
 - Identify switching action on all switching devices.
 - Common diagrams will not be accepted.
 - Analog Loop Diagrams:
 - Show all devices requiring electrical connections.
 - Identify all wire and terminal numbers.
 - Identify PLC I/O addresses.
 - Identify location of loop power supply.
 - Identify field devices, back-of-panel devices, and front-of panel devices.
 - Show tabular summary of transmitter output capability, input impedance of each receiver, total loop impedance, and reserve output capacity.
 - Reference Engineer's tag number where assigned.
 - Common diagrams will not be accepted.
 - Control Panel Plumbing Diagrams:

- Show all devices requiring plumbing connections (air or liquid).
- Show pipe/tube sizing.
- Show all control devices (valves, regulators, filters, etc.).
- Control Panel Power and Environmental Requirements:
 - Identify voltage and ampacity requirements.
 - Show sizing calculations for environmental controls (ventilation, heat, air conditioning).
- Interconnecting Wiring Diagrams:
 - Show all interconnections between control panels.
 - Show all interconnections between control panels and motor control centers.
 - Show all interconnections between control panels and field devices.
 - Show all interconnections between motor control centers and field devices.
 - Identify all wire and terminal numbers, including field terminal junction box terminals.
- Control Device Installation Details:
 - Supplement contract documents with additional details necessary for proper installation of control devices.
- Configuration Documentation:
 - Submit complete, documented configuration data for all configurable controllers.
 - Additional requirements for PLC systems and PC based SCADA systems are identified in the individual subsystem sections.

3. Factory Testing

- a. The entire Process Instrumentation and Control System shall be assembled at the manufacturer's facility and tested to the greatest extent possible. This test shall include simulation of all I/O points and demonstration of proper system operation. Document the results of this test in writing and submit to the Engineer.
- b. The Engineer and Contracting Authority may witness the factory acceptance test. Schedule test date a minimum of 2 weeks in advance to allow attendance by the Engineer and the Contracting Authority. Contractor shall provide actual screens, outline of sequence operation and agenda for preliminary review by the Contracting Authority and Engineer one week prior to meeting. Contractor shall supply overnight lodging and meals for four representatives from the Contracting Authority for the factory test.
- c. Correct any deficiencies identified during the test prior to shipping the control system to the job site.

4. Operation/Maintenance Manuals and Instructions

- a. Submit the following information specifically for Lift Station Control system:
 - i. Submit final revised shop drawings incorporating any modifications made as a result of factory test, installation, start-up, operational testing, or for any other cause. Submit results of all field-testing and corrective actions taken for all discrete control devices and for all analog control devices. Submit analog device calibration data sheets.
 - ii. Submit manufacturers' standard operation & maintenance information including installation manuals and safety instructions.
 - iii. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Process Instrumentation and Control System.
 - iv. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and trouble-shooting guide.

- v. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with costs.
 - vi. Provide an operating manual for all graphic interface panels. The manual shall consist of:
 - Color screen print-outs of all graphic screens organized in a logical manner.
 - Narrative description of what is shown on the screen.
 - Description of all operator adjustable values, including the permissible range and start-up values.
 - Suitable Binder.
 - Table of Contents and index tabs.
 - Both hard copy and electronic format (Word or pdf).
5. Quality Assurance
- a. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. MATERIALS

1. System Integrator
- a. The system integrator shall be a firm specializing in the integration of control systems with documented experience in the detailed design, construction, configuration, and maintenance of PLC based control systems and motor control centers for the water/wastewater utility market. This experience must include a minimum of five projects similar in nature to this project during the last 5 years.
 - b. Acceptable System Integrators are as follows:
 - i. Automatic Systems, contact Travis Moran, telephone number (515) 232-4770.
 - ii. Electric Pump, telephone number 515-265-2222.
 - iii. IPS, contact Eric Fisher, telephone number 608-849-4375.
 - iv. Jetco, Inc., contact John Whitacre, telephone number 515-967-5874.
 - v. PRIMEX, contact Dan Origer, telephone number 515-450-7652.
2. General Functional Description
- a. Summary of System Improvements:
 - i. New PLC based control system shall be provided at the following locations:
 - Lift Station Local Control Panel:
 - Provide new LCP in new enclosure, which shall consist of:
 - Motor controllers and components
 - Intrinsically safe barriers for level control
 - Allen-Bradley MicroLogix 1400 Ethernet processor, associated chassis, power supply and scheduled I/O modules
 - Industrial Ethernet switch (N-Tron or Hirschmann.
 - High-brightness Operator Interface
 - Uninterruptible Power Supply
 - Alarm Dialer/System Monitor - Omni-Site Crystal Ball
 - b. General Requirements:
 - i. The process instrumentation and control system consists of the following functional divisions which will be defined in detail for each loop under Detailed Functional Description:
 - Local Control Functions: includes local control panels, pilot control devices, instruments, and sensors.
 - Motor Control Functions: includes hardwired MCCs, Ethernet networked MCCs, and pilot control devices located within these MCCs.

- SCADA System Control Functions: includes PLC hardware, interface devices, and PLC logic.
 - SCADA System Monitoring Functions: includes graphical user interface hardware and configuration, event monitoring and logging functions, analog parameter trending, and alarm handling.
 - SCADA System Historical Data Functions: includes historical database, report configuration, and interface with the existing maintenance management software system, if applicable.
- ii. The process instrumentation and control system includes SCADA system workstations and network infrastructure. It shall be the responsibility of the system integrator to coordinate all efforts specified herein with these existing systems so as to minimize impact on facility operations.
- iii. SCADA/HMI Graphical Interface
- All SCADA/HMI functions shall be configured on the control panel mounted touch screen(s) in a consistent manner in accordance with industry conventions and standards. Screens shall display information in a logical, hierarchical fashion that allows simple navigation and operator understanding of the interface. The Contracting Authority and Engineer shall determine the acceptability of all proposed interface screens; refer to the submittal requirements for this section and to the operator interface functional requirements shown on the drawings.
 - In the event of a localized or complete network failure, the operator interface touch screens shall operate a local application that provides interface only to the associated PLC.
 - The HMI display systems for this project include hardware of varying screen resolutions. Provide HMI display images sized for the display hardware. Distorted display images due to the lack of coordination between display image and display hardware resolutions will not be acceptable.
 - Configure a facility overview display that graphically displays all plant processes. Areas of the facility which are being incorporated into the SCADA system at this time shall be included in this overview. The intent is that this screen will serve as the main portal to the various process display screens. The overview shall include links to the processes presently incorporated into the SCADA system and may be expanded in the future to include additional processes.
 - Operator interface functions shall include an event/alarm log which will time and date stamp each event and alarm occurrence and will also indicate the time an alarm was acknowledged and the time an alarm was cleared. Alarm handling shall be configured such that acknowledgment will only be required in a single location in order to acknowledge a cleared alarm. Refer to the detailed functional descriptions for alarm system interface with the existing plant paging system.
 - Operator interface functions shall include an equipment runtime/starts-per-day log, analog signal trends, and totalization for the signals indicated. Provide a non-resettable totalizer for each runtime and flow total.
- iv. Historical Data
- The historical data shall also be available in tabular format for manipulation and analysis by operations and engineering personnel. Data format and process reporting and graphing shall be coordinated and verified with the Contracting Authority and Engineer.
- c. Typical Motor Control Functions:

- i. Type IV Motor Control - Ethernet capable, adjustable frequency drive.
 - Local Control Functions:
 - Any additional sensors or functions are specified in the detailed functional description.
 - Motor Control Center Functions:
 - Panel HAND-OFF-AUTO selector switch shall control motor operation in HAND position. Motor will run at local HMI selected speed.
 - In OFF position, the motor shall not run.
 - In AUTO position, the motor shall start and stop in response to the Ethernet I-O REQUIRED.
 - Provide time delays on hardwired protective interlock circuits to prevent nuisance tripping.
 - AFD shall be configured with a starting ramp.
 - AFD input contactor shall disconnect the AFD from line power when not required to run.
 - Pilot control circuitry shall be designed such that HAND position control and any additional interlock circuitry identified in the detailed functional descriptions will be functional regardless of the status of the Ethernet network.
 - Adjustable frequency drive shall provide motor protection. Adjustable frequency drive shall monitor the following motor data functions: AFD READY, OVERLOAD, AFD ALARM, AFD FAULT, RUN, OUTPUT CURRENT, and PERCENT SPEED.
 - RUN condition shall activate corresponding panel pilot light.
 - Provide auxiliary contacts to allow Ethernet monitoring of the following conditions: DISCONNECT OPEN and IN AUTO conditions.
 - Provide additional functions as specified in the detailed functional description.
 - SCADA System Control Functions:
 - Graphical display MANUAL-OFF-AUTO selector (unless specified otherwise) shall control the REQUIRED signal. In MANUAL, the signal shall be active and the SPEED COMMAND shall be manually input. In OFF, the signal shall be inactive. In AUTO, the signal and the SPEED COMMAND shall be controlled by the automatic control strategy specified in the detailed functional description.
 - Generate FAIL-TO-RUN alarm based on a discrepancy between RUN and REQUIRED signals after an adjustable FAIL DELAY time has elapsed. FAIL-TO-RUN condition shall prevent motor operation until cleared and reset.
 - Generate ABNORMAL CURRENT signal when motor average current falls below or rises above adjustable MINIMUM/MAXIMUM set points.
 - Provide additional functions as specified in the detailed functional description.
 - SCADA System Monitoring Functions:
 - Display the following status conditions: MCC DISCONNECT OPEN, MCC IN AUTO, REQUIRED, RUN, ABNORMAL CURRENT, PHASE LOSS, GROUND FAULT and MOTOR OVERLOAD.
 - Display, trend, and record the following parameters: AVERAGE CURRENT, PERCENT CURRENT IMBALANCE, and PERCENT THERMAL CAPACITY USED.
 - Incorporate into the plant alarm paging system and display the following alarm conditions: FAIL-TO-RUN.
 - Provide additional functions as specified in the detailed functional description.

- SCADA System Historical Data Functions:
 - Display non-resettable runtime total.
 - Calculate, display, and record daily runtime total.
 - Calculate, display, and record number of daily starts.
 - Provide additional functions as specified in the detailed functional description.
3. Unit Process 1: Lift Station Pumping
- a. Loop 1-1: Influent Pump Control
- i. Motor Control Scheme
- Provide Type IV motor control.
- ii. Local Control Functions:
- Provide pump motor high temperature discrete signal to SCADA.
 - Provide pump high moisture signal for seal fail indication.
- iii. Motor Controller Functions (Local Panel):
- Interlock motor high temperature switch with shutdown of pump at Control panel.
 - Provide hardwired adjustable pump back-spin re-start delay after pump stop.
 - Provide hardwired backup operation scheme which shall become active whenever PLC or submersible level sensor fail, evidenced by alarm float switch being triggered. High and low alarm float switches shall sense and alarm on abnormal level conditions.
 - Provide a discrete, hardwired alternator for back-up float operation, powered off a control power circuit separate from the PLC control system. The back-up hardwired float system shall provide full back-up operating capability independent of PLC control. Pumps shall run until the wetwell level reaches the Pumps Off float, and shall then be started automatically by floats as indicated below. Pumps shall have staggered, time-delayed starts to prevent simultaneous starts on high level. Activate pumps and alarms based upon the following wet well level conditions:
 - High Level Alarm/Back-Up Mode Enable.
 - Lead Pump On. Lag pump on after adjustable time delay
 - Low Level Alarm/Pumps Off.
 - Provide adjustable time delays to prevent simultaneous pump starts.
 - Pump speed in Back-up float control mode shall be pre-set at the VFD via a hard-wired input and shall be set at 100% at start-up.
- iv. SCADA System Control Functions
- Provide alternation entry field for operator to selected pump to operate: manual or automatic alternation.
 - Manual selection of lead pump, Pump 1-Pump 2.
 - Automatic alternation of lead pump when lead pump has been called to run for an operator adjustable time period.
 - Automatic fail-over to start next pump on lead pump fail.
 - Provide operator set minimum pump speed.
 - Operator adjustable parameters to the automatic level control system are as follows:
 - Level set point values: L1, L2, L3, L4, and L5.
 - Delay Time: T
 - Minimum pump speed for operation of one VFD driven pump: Speed 1
 - Minimum pump speed for multiple pump operation: Speed 2
 - Two Pump Automatic Operation shall be as follows:

- L1 – low level alarm/redundant pumps off
- L2 – pumps off
- L3 – lead pump on. Pump speed is adjusted with rising and falling level with minimum pump speed Speed1.
- With falling level to L2, and after delay time T, Lead pump is deactivated.
- L4 – lag pump on. Speed of both pumps varies with rising and falling water level with minimum pump speed Speed2.
- With falling level to L2, and after delay time T, both pumps are deactivated.
- L5 – high level alarm
- Alarm and Back-up Level Control
 - Provide back-up mode On-Off-Auto switch to control enabling of back-up mode. In Off position back-up mode shall not be enabled, in On position back-up mode shall be continuously enabled, in Auto position back-up mode shall be enabled by high-level alarm float switch.
 - At L5, activate high level alarm.
 - At L5, activate float switch control.
- v. SCADA System Monitoring Functions
 - Monitor back-up mode enabled signal.
- vi. SCADA System Alarming
 - Provide pump fail alarm.
 - Provide seal fail alarm.
 - Provide “backup system active” alarm.
- vii. SCADA System Historical Data Functions
 - Provide daily flow calculation based pump runtimes.
 - Incorporate influent wetwell pumping in overall station graphic
- b. Loop 1-2: Wetwell Level Monitoring
 - i. Local Control Functions:
 - Provide analog wetwell level signal from submersible level sensors.
 - Provide discrete high level alarm/back-up enable signal from float level switch.
 - Provide discrete high level/lead pump on signal from float level switch.
 - Provide discrete pump on signal from float level switch.
 - Provide discrete pumps off/ low level alarm signal from float level switch.
 - ii. Motor Controller Functions (Local Panel):
 - None additional.
 - iii. SCADA System Control Functions
 - Initiate backup control on operator adjustable high level signal.
 - iv. SCADA System Monitoring Functions
 - Provide wetwell level indication.
 - Monitor wetwell high level.
 - Monitor wetwell low level.
 - v. SCADA System Alarming
 - Provide wetwell high level alarm.
 - Provide wetwell low level alarm.
 - vi. Historical Data Functions
 - Display, log and trend data per P&ID.
 - Trend wetwell level and incorporate influent pumping and wetwell level in overall plant graphic display and daily process reports.

4. Unit Process 2: Station Power Monitoring
 - a. Loop 2-1: Power Fail Monitoring
 - i. SCADA System Monitoring Functions:
 - Monitor per P&IDs
 - Station Power Fail
 - ii. SCADA System Alarming
 - Station Power Fail
 - b. Loop 2-2: Phase Fail Monitoring
 - i. SCADA System Monitoring Functions:
 - Monitor per P&IDs
 - Station Phase Fail
 - ii. SCADA System Alarming
 - Station Power Fail
5. Unit Process 3: Station Temperature Monitoring
 - a. Loop 3: Panel Temperature Monitoring
 - i. SCADA System Monitoring Functions:
 - Monitor per P&IDs
 - Panel temperature
 - ii. SCADA System Alarming
 - Panel high temperature (adjustable set-point)
 - Panel low temperature (adjustable set-point)
6. Unit Process 4: Control System Monitoring
 - a. Loops 4-1, 4-2 and 4-3: Control System Power Monitoring
 - i. SCADA System Monitoring Functions:
 - Monitor per P&IDs
 - 120V control panel power
 - **PLC Controller** health
 - UPS. Interface all available status signals to **PLC controller** and log events.
 - o Line Fail
 - o UPS Fault
 - o UPS Charging
 - o UPS On Battery
 - o Replace UPS Battery
 - ii. SCADA System Alarming
 - **PLC Controller** fail
 - Control Power Fail
 - UPS Fail
7. Unit Process 5: Intrusion Monitoring
 - a. Loop 5: Intrusion Monitoring
 - i. SCADA System Control
 - Provide unlabeled deadfront panel lighted pushbutton to disable intrusion alarm.
 - Provide operator adjustable time delay to automatically re-arm intrusion monitoring and annunciation.
 - ii. SCADA System Monitoring Functions:
 - Monitor per P&IDs
 - Door Open Signal
 - Intrusion defeat signal
 - iii. SCADA System Alarming

- Intrusion
- 8. Unit Process 6: Station Alarm and Monitoring
 - a. Loop 6: Alarming
 - i. Local Panel Functions
 - Provide front of panel alarm silence pushbutton to silence alarm horn and turn off alarm strobe.
 - Provide local alarm annunciation via alarm horn and alarm strobe.
 - ii. SCADA System Monitoring
 - Provide the following Alarm/Monitoring points to station alarm dialer/monitor.
 - Pump No.1 Fail
 - Pump No.2 Fail
 - Pump No.1 Run time accumulation
 - Pump No.2 Run time accumulation
 - High alarm level (Hard-wired from float relay to alarm annunciator)
 - Back-up control active (Hard-wired from float relay to alarm annunciator)
 - Station Power Fail
 - Control power fail
 - UPS fail
 - High/Low panel temperature
 - Wetwell level trending
 - Pump speed pacing
 - Pump 1 full load amps
 - Pump 2 full load amps
 - iii. SCADA System Alarming
 - Provide common alarm on front of panel.
 - Alarm on following alarm points to station alarm dialer/monitor. Provide OmniSite Crystal Ball unit for remote alarm annunciation. Operator interface/keypad be provided with extension cable and shall be deadfront accessible. Include one year of subscription service. Final determination of alarm configuration shall be done during the shop drawing review phase:
 - Pump No.1 Fail
 - Pump No.2 Fail
 - High alarm level (Hard-wired from float relay to alarm annunciator)
 - Low alarm level (Hard-wired from float relay to alarm annunciator)
 - Back-up control active
 - Station Power Fail
 - Control power fail
 - UPS fail
 - High/Low panel temperature

C. CONSTRUCTION.

1. Software Configuration Services
 - a. General Graphic Screen Design Requirements:
 - i. Present displays in a consistent manner in accordance with industry conventions and standards.
 - ii. Screens shall display information in a logical, hierarchical fashion that allows simple navigation and operator understanding of the interface.

- iii. Provide a minimum of one screen for each unit process as defined in above, and on the Process and Instrumentation Drawings (P&IDs). The exact number of screens and detail will be dictated by the scope and complexity of the project.
 - iv. The System Integrator is encouraged to solicit feedback throughout the development of the graphic screens. Formal feedback will be provided at the point of the pre-submittal coordination conference, shop drawing submittal, and factory witness test.
- b. Graphic Overview Screens:
- i. Process Trending
 - Provide pre-configured trend screens for all analog process variables. In addition, provide two trend screens with operator assignable pens that may be reconfigured as specific trending needs arise. Trend screens shall be quickly accessible through a menu button which allows navigation to the trend screen keyed to that respective process screen. In addition, provide a means to navigate to a selected trend screen from the main menu system. Typical analog process variable trend screens would include the following:
 - Pump Station Parameters (Levels, Pump On/Off, Pump Speed where VFD Controlled).
 - ii. Totalized Information Display:
 - Equipment Totals:
 - Display cumulative, non-resettable runtime.
 - Display daily runtime total for yesterday and today.
 - Display number of starts for yesterday and today.
 - iii. User Security Levels:
 - Configure the following user name and password controlled security levels for each utility (water, wastewater, etc.):
 - Operator Standard - Display Only
 - Operator Advanced - Display, Control, and Reporting Only
 - Supervisor - Display, Control, Reporting, and Set Point Adjustment
 - Engineering - Display and Reporting Only
 - Coordinate additional security levels with Contracting Authority and Engineer during shop drawing review.
 - iv. Process Setpoint Capture:
 - Display all current values for operator adjustable process control set-points; provide print out or screen capture capability.
 - v. Facility Management Screens:
 - Provide screens to facilitate monitoring and control of the following when included on the project:
 - Standby Power Systems and Load Control
 - Alarm Channel Assignment and Control
 - Alarm History
 - Event History
 - Environmental monitoring
 - Access monitoring and control
 - Surveillance monitoring
 - vi. Alarm Management Screens:
 - Provide screens which depict active and historical alarm lists.
 - Alarms shall be grouped in a logical manner, generally in alignment with the Loop sequence.

- Provide Alarm Dialer set-up screens which provide the following alarm management control.
 - Alarm event assignment to a specified dialer channel. Where so equipped with both a software based dialer and a hardwired dialer, channel assignments for both shall be made from the same screen.
 - Enable/Disable toggle for local audio-visual alarm devices for each alarm point.
 - Enable/Disable dial-out toggle for each alarm point.
 - On each alarm window provide a Pareto Chart via an ActiveX control in which one can quickly analyze which alarms and events occur most frequently in a given (by filter) time period, area of plant, piece of equipment, etc. The Alarm Pareto ActiveX shall automatically update every time the alarm display query is updated or changed. Further, the Alarm Pareto should allow for adjustment of number of bars being displayed in the Pareto chart, whether the orientation is horizontal or vertical and colors of bar charts.
- vii. Additional Screens:
- Provide up to five additional screens as directed by the Contracting Authority. The need for these screens will be determined during the shop drawing review, witness testing, and start-up phases.
- c. Display Conventions:
- i. Colors, Screen layout, computer resolution should be consistent among all vendors and shall be coordinated by the System Integrator.
 - ii. Graphic Detail:
 - 3-D only for equipment, process piping represented by lines in a P&ID style.
 - iii. Screen Layout:
 - Main Menu:
 - X=0, Y=-38
 - Width = 1280, Height = 136
 - iv. Main Window:
 - X=0, Y=100
 - Width = 1280, Height = 779
 - v. Alarm Window:
 - X=0, Y=879
 - Width = 1280, Height = 105
 - vi. Indicator Colors:
 - Green:
 - HOA (Hand-Off-Auto) in Auto
 - Pump Run
 - Valve is Open
 - Yellow:
 - Required/Called to Run
 - Valve Traveling
 - HOA in Hand
 - Float for control is activated
 - Light Blue:
 - Valve is closed
 - OCA in Close
 - Red or Blinking Red:

- In Alarm
- Failed
- Float for alarm is activated
- White
 - Pump/Equipment is Off
 - HOA in Off
- Grey:
 - Pump/Equipment is Off
 - Inactive state
 - Unacknowledged, Cleared Alarm
- Blinking Grey:
 - HOA or OCA at MCC not in Auto. Pump/Valve is unavailable for automatic control from PLC.
- vii. Numeric Display and Data Entry Colors:
 - Black background with green text displays a value from field devices such as flow meters and level sensors.
 - White background with black text is a numeric entry for entering setpoints.
 - White background with red text is a numeric entry for entering alarm setpoints.
 - Gray background with black text is a calculated number or accumulator value, such as runtimes, flow totals, and other elapsed timer values.
- viii. Alarm and Event Text Colors:
 - Red text signifies a current unacknowledged alarm.
 - Blue text signifies a current acknowledged alarm.
 - Green text signifies an alarm that has returned to normal.
 - Black text signifies an event such as pump run, setpoint change, or valve closed.
- ix. Alarming:
 - Method of alarm acknowledgement and silencing (horn & dialer) standard set by System Integrator after discussion with Engineer and all involved vendors.
- x. Communication:
 - Networked Microprocessors and Computers
 - IP addressing shall be coordinated and controlled by the System Integrator.
 - Naming convention standards shall be coordinated and controlled by the System Integrator.
 - Control system equipment failure and communication failure procedures shall be discussed and confirmed with all vendors that communicate I/O requests.
 - Setup parameters for I/O communications between PLC's will be coordinated and controlled by the System Integrator.
- xi. Security
 - Create users and security levels for on screen access, and control and setpoint access.
- 2. Field Measurements
 - a. Field verify with exact measurements, the available mounting space for control system equipment. Identify deficiencies prior to beginning installation.
 - b. Where ranges are indicated on the contract documents, they are to be considered preliminary. Field verify the exact ranges required based on field conditions.

3. Delivery, Storage, and Handling
 - a. It shall be the responsibility of the installing contractor to receive all process instrumentation and control equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.
 - b. Exercise due diligence in storing, protecting, and moving process instrumentation and control equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Contracting Authority.
4. Installation
 - a. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.
 - b. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.
5. Testing and Start-Up Services
 - a. System Integrator shall provide installation and start-up services required to place the complete system into operation.
 - b. Each signal and function shall be fully tested. These tests shall be based on actual operation of primary elements and verification of proper control system response. Submit test results as part of Operations and Maintenance Manual.
 - c. Record calibrations of all analog devices.
 - d. Demonstrate proper operation of the process and instrumentation control system to the Contracting Authority and in the presence of the Engineer.
6. Training
 - a. Training shall be suitable for plant operations personnel with limited knowledge of electrical components.
 - b. Provide two instructor days of operator training at the job site. Training shall consist of operations instruction and maintenance/trouble-shooting instruction.
 - i. Operations instruction shall identify all control loops with description of all interlocks, interface with other loops, and operational input requirements. Describe procedures for re-starting the system.
 - ii. Maintenance instruction shall identify periodic maintenance that can be performed by the operator. Provide description of procedures and locations for replacement of consumable devices such as fuses and for checking the calibration or operation of devices.
 - iii. Trouble-shooting instruction shall identify simple procedures and methods for identifying potential causes in the event of failures. For example, instruct operator on correlation of input signals and PLC I/O module indicator lights.

154013a.12 CONTROL PANEL CONSTRUCTION

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of Process Instrumentation & Control.

1. Application Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards:
 - ANSI/NFPA 70 - National Electrical Code and state amendments thereto.

- ANSI/NFPA 79 - Electrical Standard for Industrial Machinery.
 - ii. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, current edition.
 - iii. Canadian Standards Associates (CSA), Specifications and Standards, Current Edition.
 - CSA Standard C22.2 No. 0 - General Requirements - Canadian Electrical Code, Part II
 - CSA Standard C22.2 No. 0.4 - Bonding and Grounding of Electrical Equipment (Protective Equipment)
 - CSA Standard C22.2 No. 14 - Industrial Control Equipment for Use in Ordinary (Non-Hazardous) Locations
 - CSA Standard C22.2 No. 40 - Cutout, Junction, and Pull boxes
 - CSA Standard C22.2 No. 94 - Special Purpose Enclosures
 - iv. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
 - v. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
 - IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
 - IEC 60204 - Safety of Machinery - Electrical Equipment of Machines
 - IEC 60079 - Electrical Apparatus for Explosive Gas Atmospheres
 - vi. National Electrical Manufacturers Association (NEMA), Specifications and Standards, Current Edition.
 - NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
 - NEMA ICS6 - Enclosures for Industrial Controls and Systems
 - vii. Underwriters Laboratories, Inc. (UL), Specifications and Standards, Current Edition.
 - UL50 - Cabinets and Boxes
 - UL508 - Industrial Control Equipment
 - UL508A - Industrial Control Panels
 - UL94 - Flammability of Plastic Materials
2. Quality Assurance
- a. All control panels shall be constructed in accordance with UL 508 standards and shall bear the UL 508 listing.
3. Extra Materials
- a. See Iowa DOT Standard Specifications Division 11 for additional requirements.
- b. Provide one spare vapor phase corrosion inhibiting capsule for each control panel.
- c. Provide a ten or twenty percent of the total number of terminals as installed spares in each control panel.
4. Design Requirements

CONTROL PANEL CONSTRUCTION REQUIREMENTS					
TAG NUMBER	DESCRIPTION	TYPE	SIZE	UPS	NOTES
LCP-1	Storm Water Lift Station Local Control Panel	F	60"Wx42"Hx12"D	X	1, 2
Notes: - Specified size indicates the physical size anticipated by the ENGINEER. CONTRACTOR shall verify actual size with SYSTEM INTEGRATOR and adjust installation accordingly. - Provide 18 inch legs and ventilated front/rear removable panels per "ventilated skirt" lift station panel design.					

B. MATERIALS.

1. General Requirements
 - a. Fabricate, install instruments, plumb and wire in factory.
 - b. Test wiring and plumbing prior to shipment.
 - c. Make external connections by way of numbered terminal blocks.
 - d. Separate electrical components from pneumatic and hydraulic components by metal barriers.
 - e. Conform to ISA standards.
2. Type F – Control Panel Enclosure, Free-Standing, Stainless Steel, Heated, Air Conditioned, and Insulated
 - a. Manufacturer:
 - i. Hoffman Enclosures, Inc. Stainless Steel Two-Door Floor-Mount Type 12 Enclosures
 - ii. Stahlin
 - iii. Hammond
 - iv. Or equal
 - b. Environmental Rating:
 - i. NEMA Type 3R/12, stainless steel
 - c. Construction
 - i. 12 or 14 gauge Type 304 stainless steel, 12 gauge enclosures have 10 gauge backs
 - ii. Seams continuously welded and ground smooth, no holes or knockouts
 - iii. Strong, rigid construction with body stiffeners
 - iv. Gasketed overlapping doors eliminate need for center post
 - v. Plated steel three point latching mechanism and key-locking handle
 - vi. Latch rods have rollers for easier door closing
 - vii. Heavy gauge continuous hinges support each door
 - viii. Data pocket, provided on door with three point latches, is high-impact thermoplastic
 - ix. Floor stands are welded to enclosure
 - x. Heavy duty lifting eyes are Type 316 stainless steel
 - xi. Panel supports
 - xii. Oil-resistant gasket attached with oil resistant adhesive and held in place with steel retaining clips
 - xiii. Insulate interior of enclosure and door
 - xiv. Thermostatically controlled panel heater sized to maintain internal panel temperature within operational parameters of all internal components
 - xv. Collar studs for mounting optional panel
 - xvi. Ground studs in body of enclosure
 - xvii. Bonding provision on doors
 - xviii. Drip shield kit
 - xix. Provide air conditioning unit to thermostatically control internal panel temperatures during warm weather. Size unit accommodate heat generated by control power transformer and VFD operation.
 - xx. Finish:
 - Enclosures are unpainted. Front, sides, top, and back have smooth No.4 brushed finish
 - Steel sub-panels are painted white
 - xxi. Provide hinged dead front inner panels; Right hand door shall be 480V section, Left hand door shall be 120VAC/24VDC control section. Right hand deadfront shall be interlocked to Utility/Generator Main Disconnect circuit breakers.
 - xxii. Mount OmniSite Crystal Ball unit to back pan, with extension cable to deadfront accessible operator interface.

C. CONSTRUCTION.

1. Field Measurements
 - a. Refer to the requirements of Process Instrumentation & Control.
2. Delivery Storage and Handling
 - a. Refer to the requirements of Process Instrumentation & Control.
3. Installation
 - a. Refer to the requirements of Process Instrumentation & Control.
4. Control Panel Fabrication and Environmental Protection Requirements
 - a. Instrument Mounting:
 - i. Locate instruments designated for back-of-panel mounting in manner to allow for maintenance and adjustment.
 - ii. Instrument mounting height shall not exceed 6 feet 6 inches. Minimum height shall be 4 feet 0 inches.
 - iii. Panel cutouts for instruments and other devices, such as lights and switches, shall be cut, punched, or drilled and smoothly finished with rounded edges.
 - iv. Provide steel angle stiffeners on back of panel face to prevent panel deflection under instrument loading or operation.
 - v. Provide internal structural steel framework for instrument support purposes and panel bracing. Internal framework shall permit lifting of panel without racking or distortion.
 - vi. Provide shelf or bracket support for any equipment not secured to panel, such as UPS or router. Shelf placement shall allow for bending space for wiring entering panel.
 - b. Corrosion Protection:
 - i. Provide vapor phase corrosion inhibiting capsules in each control panel to protect all exposed metal surfaces for a period of at least two years. Corrosion inhibiting modules shall be Northern Instrument Corporation, Zerust vapor capsules Model VC-2-2 or Hoffman Engineering Corporation corrosion inhibitor Model A-HCI-5.
 - ii. Provide thermostatically controlled condensation heater in panels located high humidity areas and in areas in which ambient temperature will vary. Heater shall be sized to prevent condensation within panel.
 - c. Heating, Ventilating, and Air Conditioning:
 - i. Provide heating equipment as specified under Part 2.
 - ii. Provide filtered ventilation fan(s) where needed and sized to dissipate heat generated by components located within control panel.
 - iii. Provide filtered air conditioning equipment and insulate panel where needed to maintain internal panel temperature within operating parameters of internal panel components.
 - c. Coordination:
 - i. Clearly mark and coordinate with installation Contractor areas dedicated to intrinsically safe circuits.
5. Control Panel Electrical Requirements
 - a. Electric Service:
 - i. Design control panel to operate on electrical supply indicated on the drawings.
 - Three phase service:
 - Provide main circuit breaker.
 - Provide branch circuit breakers for distribution of three phase and single phase power at voltages above 120VAC.
 - Control panel and internal components shall be rated to interrupt the available fault current.

- Main circuit breaker and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the main circuit breaker.
- Separate 480VAC wiring from control voltage wiring.
- Provide appropriately sized control power transformer.
- Provide miniature circuit breakers for distribution of 120VAC control power in accordance with the following:
 - o No more than 20 devices on any single circuit.
 - o Where multiple units perform parallel operations, do not group all devices on the same branch circuit. The purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.
 - o Do not exceed the ampacity of the branch circuit.
 - o Panel service outlet shall be protected by separate branch circuit breakers
 - o Power supplies shall be protected by separate branch circuit breakers.
- Provide 20 amp, 120VAC deadfront mounted GFCI convenience outlet.
- Control power transformer fuses and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the control power transformer fuses.
- Branch circuit breakers shall be rated for 15A and 250VAC.
- Fuses shall not be substituted for circuit breakers.
- Single phase service:
 - Provide main circuit breaker.
 - Provide miniature circuit breakers for distribution of 120VAC control power in accordance with the following:
 - o No more than 20 devices on any single circuit.
 - o Where multiple units perform parallel operations, do not group all devices on the same branch circuit. The purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.
 - o Do not exceed the ampacity of the branch circuit.
 - o Panel service outlet shall be protected by separate branch circuit breakers
 - o Power supplies shall be protected by separate branch circuit breakers.
 - Provide 20A, 120VAC service outlet circuit within back-of-panel area.
 - Main circuit breaker and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the main circuit breaker.
 - Branch circuit breakers shall be rated for 15A and 250VAC.
 - Fuses shall not be substituted for circuit breakers.
- Uninterruptible power supply:
 - Provide a DIN rail mounted uninterruptible power supply (UPS); provide distribution of 120VAC power on the line and load sides of the UPS.
 - Panel service outlet and other non-critical loads shall be powered from the line side of the UPS. Critical loads, including but not limited to all digital control equipment, shall be powered from the load side of the UPS.
 - Provide UPS bypass circuitry to minimize heating of control panel and unnecessary wear of the UPS battery.
- b. Output Signal Fusing:
 - i. Provide appropriately sized fuses for all output signals to devices located external to the panel in accordance with the following requirements:

- Maximum fuse size: 5A
 - Separate fuse for each device
 - Fuses shall be installed in indicating type fuse holder terminal blocks.
- c. Control Panel Wiring:
- i. Wiring within panels, consoles, racks, and cabinets shall meet the following requirements:
 - Wires for ac circuits shall be 300V or 600V, Type MTW stranded copper and shall be sized for the current to be carried but not smaller than No.16 AWG.
 - Wires for analog signal circuits shall be 300V stranded copper and shall be twisted shielded pairs not smaller than No.18 AWG.
 - Wires for other dc circuits shall be 300V, Type MTW stranded copper not smaller than No.18 AWG.
 - Wiring for special signals such as communications, digital data, and multiplexed signals shall use manufacturers standard cables.
 - ii. Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:
 - Wire all spare or unused panel mounted elements, including PLC input/output points, to terminal blocks.
 - Provide open construction terminal blocks for wiring that is entirely internal to the panel.
 - Provide isolation switch terminal blocks for all wiring that is not entirely internal to the panel.
 - Rail-mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.
 - Size all terminal block components to allow insertion of all necessary wire sizes and types.
 - Provide power distribution blocks for distribution of control panel power at voltages exceeding 120VAC.
 - iii. Grounding:
 - Panels, consoles, racks, and cabinets shall be provided with an isolated copper grounding bus for all signal and shield ground connections. This ground bus shall be grounded at a common single ground point. The signal grounding system shall meet National Electrical Code requirements.
 - Each analog loop shall only be grounded at a single point for the loop. This single point shall be at the location of the dc power supply for the loop.
- d. Power Supplies:
- i. Provide dc power supplies as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
 - ii. Power supplies shall be suitable for intrinsically safe circuits where two-wire transmitters are located in a hazardous area.
- d. Electrical Transient Protection:
- i. All electrical and electronic elements of the control system shall be protected against damage due to electrical transients induced in interconnecting lines from lighting discharges and nearby electrical systems.
 - ii. Surge Suppressor Locations:
 - As a minimum, provide surge suppressors at the following locations:

- Provide 480VAC, panel mounted surge suppressor on the load side of each 480VAC main circuit breaker in each panel.
 - Provide 120VAC, panel mounted surge suppressor on the load side of each 120VAC main circuit breaker in each panel.
 - Provide 24VDC, panel mounted surge suppressor at the panel connections of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.
 - Provide 24VDC, field mounted surge suppressor at the field connection of each analog signal transmitter located outside of a protecting building.
5. Standard Signal Interfaces
- a. Unless otherwise specified discrete input and output signals shall conform to the following:
 - i. Isolated unpowered (dry) contact closures.
 - ii. Power contact from panel receiving signal or device receiving signal.
 - b. Unless otherwise specified input and output analog signals shall conform to following:
 - i. External to panel: isolated, 4-20 mA DC.
 - ii. Internal to panel: 1 to 5VDC signals.
 - iii. For two wire transmitter provide isolated type and power with 24VDC from panel or device receiving signal.
 - iv. Where isolation is required to interface with particular equipment or because of loop impedance, provide isolated, DC-to-DC transmitter.
6. Testing and Start-Up Services
- a. Refer to the requirements of Process Instrumentation & Control.
7. Training
- a. Refer to the requirements of Process Instrumentation & Control.

154013a.13 CONTROL PANEL COMPONENTS

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of Process Instrumentation & Control

1. Applicable Publications
- a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
 - ANSI/IEEE C37.90 - IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
 - ANSI/IEEE C62.11- IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
 - ANSI/IEEE C62.34 - IEEE Standard for Performance of Low-Voltage Surge-Protective Devices (Secondary Arresters).
 - ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - ii. CE - European Community, Applicable Directives.
 - EN50005 - for Terminal Markings.
 - EN50081-1- Generic Emission Standard.
 - EN50082-1 - Generic Immunity Standard.

- EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
- EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.
- iii. Canadian Standards Association (CSA), Specifications and Standards, current edition:
 - CSA C22.2, Industrial Control Equipment.
- iv. CUL - Underwriter's Laboratories of Canada.
- v. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
 - IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
- vi. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
- vii. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - UL508 - Industrial Control Equipment.
 - UL508A - Industrial Control Panels.
 - UL 913 - Intrinsically Safe Specification.
 - UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- 3. Quality Assurance
 - a. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- 4. Extra Materials
 - a. Supply five spare control power transformer fuses of each type supplied for this project
 - b. Supply five spare lamps of each type supplied for this project.
 - c. Supply two spare relays of each type supplied for this project.

B. MATERIALS.

1. Alarm Signal – Audible
 - a. Manufacturer:
 - i. Mallory Sonalert
 - ii. Wolf Automation
 - iii. Jameco
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL listed
 - c. Signal:
 - i. Mechanism:
 - Solid-state, piezoelectric transducer
 - Low power consumption
 - No mechanical wear from moving parts
 - ii. Power Supply:
 - 120VAC, 60 Hz, input power
 - 21 mA typical operating current
 - iii. Intermittent Tone:

- Frequency: 2900 + 500 Hz
 - Pulse Rate: 2 to 10 pulses per second
 - iv. Sound Pressure Level:
 - Process Equipment Area: 80-95 dBA at 2 feet
 - Non-Process Equipment Area: 55-65 dBA at 2 feet
 - d. Mounting:
 - i. Screw-neck, panel-mount
 - ii. Maintain environmental integrity of panel
- 2. Circuit Breaker - Miniature
 - a. Manufacturer:
 - i. Square D QOU Unit Mount Class 720
 - ii. Eaton
 - iii. ABB
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - c. General:
 - i. Surface, flush or DIN rail mounting in one-, two- and three-pole construction.
 - ii. Used for overcurrent protection and switching on both ac and dc systems.
 - d. Construction:
 - i. Terminal lug wire size: 1- No.14 - No.2 AWG Cu or Al
 - ii. Reversible line and load lugs for convenient flush or surface mount wiring
 - iii. DIN mounted (symmetrical rail 35 x 7.5 DIN/EN 50 022)
 - iv. UL Listed as HACR type -- 15A to 70A
 - v. Field installable quick connectors
 - vi. Single handle with internal common trip
 - vii. UL Listed 48VDC (5,000 AIR)
- 3. Control Power Transformer
 - a. Manufacturer:
 - i. Cutler Hammer, Type MTE
 - ii. Square D
 - iii. Acme
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CSA Certified
 - c. Construction:
 - ii. Epoxy encapsulated coils
 - iii. High quality silicon steel laminations
 - iv. Copper magnet wire
 - v. 130° F rise, Class 105 insulation system
 - vi. Molded terminals
 - d. Electrical:
 - i. Capacity:
 - Select transformer VA rating based upon connected load with an additional 25 percent spare capacity.
 - ii. Primary terminals:
 - 240 x 480VAC

- 230 x 460VAC
 - 220 x 440VAC
 - Finger-safe terminal covers
- iii. Secondary terminals:
 - 120VAC
 - 115VAC
 - 110VAC
 - Finger-safe terminal covers
- iv. Fusing:
 - Dual primary fuse block
 - Single secondary fuse block
 - Finger-safe fuse block covers
 - Class CC fuses, sized for VA rating of transformer
- v. Mounting:
 - Back panel
- 4. Intrinsically Safe Barrier
 - a. Manufacturer:
 - i. R. Stahl, Intrinsipak Series 9001/9002
 - ii. PR Electronics
 - iii. Pepperl-Fuchs
 - iv. Or equal
 - b. Certificates:
 - i. Zone 1: PTB 01 ATEX 2088
 - ii. Zone 2: PTB 01 ATEX 2135
 - c. Explosion protection:
 - i. Zone 1: E II (1/2)G [EEx ia/ib] IIC/IIB
 - ii. Zone 2: E II 3G EEx nA II T4
 - d. Enclosure material: Polyamide 6 GF
 - e. Degree of Protection
 - i. According to IEC 60529
 - Terminal enclosure: IP 20
 - Housing: IP 40
 - f. Connection:
 - i. Four cage terminals, each maximum 1.5 sq-mm flexible/solid
 - ii. Two PA-terminals, each maximum 4 sq-mm flexible / solid
 - iii. Replaceable back-up fuse
 - g. Environmental:
 - i. Temperature:
 - Ambient: -5°F to 140°F
 - Storage: -5°F to 170°F
 - ii. Maximum relative humidity 95%, non-condensing
 - h. Leakage current: less than 1 mA
 - i. Installation:
 - i. Panel mounted in accordance with ANSI/NFPA 70.
 - j. Hazardous Location Switch:
 - i. Maximum lead length: 1000 feet
 - ii. Non-energy storing or generating
 - iii. Contains no capacitance or inductance, resistive switch only

- iv. Installed in accordance with ANSI/NFPA 70.
- 5. Intrinsically Safe Relay
 - a. Manufacturer:
 - i. Diversified Electronics, Inc. - Model ISO-120-xx
 - ii. PR Electronics
 - iii. Idec
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL 913
 - ii. Class I, Groups A, B, C, D
 - iii. Class II, Groups, E, F, G
 - iv. Class III
 - c. Construction:
 - i. Surface mount enclosure
 - ii. Life expectancy:
 - Mechanical: 20 million operations
 - Electrical: 50,000 operations at rated load
 - Duty Cycle: continuous
 - iii. Operating Temperature: -4°F to 131°F
 - d. Electrical:
 - i. Control Voltage: 120VAC, 60 Hz, nominal
 - ii. Control Switch:
 - Open circuit voltage: 6.2VDC
 - Short circuit current: 10uA
 - iii. Isolation: 2500VAC, input to output
 - iv. Power Consumption: 2.5VA
 - v. Contact rating:
 - SPST - N.O.
 - 5A per channel, 120VAC, resistive
 - 278VA, inductive
 - vi. Channels: 2, 3, or 4
 - vii. Status LED: One per channel
 - e. Installation:
 - i. Panel mounted in accordance with ANSI/NFPA 70
 - f. Hazardous Location Switch:
 - i. Maximum lead length: 1000 feet
 - ii. Non-energy storing or generating
 - iii. Contains no capacitance or inductance, resistive switch only
 - iv. Installed in accordance with ANSI/NFPA 70
- 6. Pilot Device – Indicating Light
 - a. Manufacturer:
 - i. Allen Bradley Bulletin 800T/800H
 - ii. Cutler-Hammer
 - iii. Square D.
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CSA Certified

- iii. CE Compliant
 - c. Mechanical:
 - i. Size: 30.5 mm
 - ii. Environmental rating:
 - NEMA 4/13 watertight/oiltight: NEMA 1, 12, 3R, 4 control panels
 - NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
 - iii. Life expectancy: 200,000 operations
 - iv. Push-to-test, transformer type, dual input
 - d. Electrical:
 - i. Input power: 120VAC
 - ii. Lamp:
 - High visibility, 28 chip cluster LED
 - Color: red, green, amber, as scheduled
 - iii. Lens: High impact plastic, colored to match lamp
 - e. Nameplate
 - i. Standard or jumbo with engraved service legend
 - f. Field Mounted Control Stations:
 - i. Type I Enclosure: NEMA 4X polycarbonate enclosure
 - ii. Type II Enclosure: NEMA 4X stainless steel enclosure
 - iii. Type III Enclosure: NEMA 7 hazardous location enclosure
7. Pilot Device – Push Button
- a. Manufacturer:
 - i. Allen Bradley Bulletin 800T/800H
 - ii. Cutler-Hammer
 - iii. Square D
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CSA Certified
 - iii. CE Compliant
 - c. Mechanical:
 - i. Size: 30.5 mm
 - ii. Environmental rating:
 - NEMA 4/13 watertight/oiltight: NEMA 1, 12, 3R, 4 control panels
 - NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
 - iii. Life expectancy: 10,000,000 operations
 - iv. Momentary contact, non-illuminated
 - d. Electrical:
 - i. Rated Voltage: 120VAC
 - ii. Continuous current rating:
 - AC: 10A
 - DC: 2.5A
 - iii. Operational current:
 - Make: 7200VA
 - Break: 720VA
 - iv. Operator:
 - Mushroom head: Emergency stop service
 - Flush-head: All other services

8. Nameplate: Standard or jumbo with engraved service legend
9. Field Mounted Control Stations:
 - i. Type I Enclosure: NEMA 4X polycarbonate enclosure
 - ii. Type II Enclosure: NEMA 4X stainless steel enclosure
 - iii. Type III Enclosure: NEMA 7 hazardous location enclosure
8. Pilot Device – Selector Switch
 - a. Manufacturer:
 - i. Allen Bradley Bulletin 800T/800H
 - ii. Cutler-Hammer
 - iii. Square D.
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CSA Certified
 - iii. CE Compliant
 - c. Mechanical:
 - i. Size: 30.5 mm
 - ii. Environmental rating:
 - NEMA 4/13 watertight/oiltight: NEMA 1, 12, 3R, 4 control panels
 - NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
 - iii. Life expectancy: 1,000,000 operations
 - iv. Maintained contact, non-illuminated (spring return from right or left where scheduled)
 - d. Electrical:
 - i. Rated Voltage: 120VAC
 - ii. Continuous current rating:
 - AC: 10A
 - DC: 2.5A
 - iii. Operational current:
 - Make: 7200VA
 - Break: 720VA
 - iv. Operator:
 - Standard knob operator, two-position, or three-position
 - Keyed operator: where scheduled
 - e. Nameplate: Standard or jumbo with engraved service legend
 - f. Field Mounted Control Stations:
 - i. Type I Enclosure: NEMA 4X polycarbonate enclosure
 - ii. Type II Enclosure: NEMA 4X stainless steel enclosure
 - iii. Type III Enclosure: NEMA 7 hazardous location enclosure
9. Power Supply – 12/24VDC
 - a. Manufacturer:
 - i. IDEC PS5R Series
 - ii. Sola/Hevi-Duty Series SDP
 - iii. Allen-Bradley
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CE Marked
 - c. Mechanical:

- i. Enclosure:
 - IP20
 - Sealed plastic
 - Fine ventilation grid
 - ii. Mounting: DIN rail
 - d. Electrical:
 - i. Capacity:
 - Size to power connected loads. Reserve 25% of capacity for future use.
 - Provide multiple power supplies where needed to accommodate load.
 - ii. Input:
 - Voltage: 85-264VAC
 - Frequency: 43-67Hz
 - Efficiency: 88.5%
 - Current: 1.0A at 100VAC
 - iii. Output:
 - Voltage: 24-28VDC or 10-12VDC
 - Voltage regulation: 2%
 - Overvoltage protection: 40VDC
 - Noise suppression: EMI values below EN50081-1
 - Current: 2.1A at 24VDC or 2.5A at 12VDC
 - iv. Monitoring:
 - LED Indicator
 - Output power good status contact
10. Power Supply – 120VAC, Uninterruptible
- a. Manufacturer:
 - i. Eaton/Powerware 9130
 - ii. CyberPower
 - iii. APC
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CE Marked
 - iii. FCC Approved
 - c. General:
 - i. Topology: True online, double-conversion
 - ii. Diagnostics: Full system self-test on power up
 - iii. UPS Bypass Automatic: on Overload or UPS failure less than 4 ms
 - iv. Transfer Time to battery: 0 ms
 - v. Overload Capacity:
 - 125% for 10 minutes before transfer to bypass
 - 150% for 10 seconds before transfer to bypass
 - d. Input:
 - i. Input voltage: 80-144VAC, single phase, 60 Hz
 - ii. Input power factor: greater than 95%
 - iii. Input Line: NEMA 5-15 plug and cord
 - iv. Protection: fuse or circuit breaker
 - e. Electrical Output:
 - i. Voltage Regulation:

- On Utility: +/-2% of nominal
 - On Battery: +/-3% of nominal
 - ii. Nominal Output Voltage: Same as selected input voltage
 - iii. Output Voltage Waveform: Sine Wave
 - iv. Output Voltage Distortion: less than 3% THD
 - v. Output Line: Four NEMA 5-15 receptacles, minimum
 - vi. Output protection: Electronic overload sensing, and circuit breaker protection
 - vii. Efficiency:
 - Online Mode: greater than 86%
 - Hi-Efficiency Mode: greater than 90%
 - f. Battery:
 - i. Internal Battery type: Sealed, lead-acid; maintenance free
 - ii. On Battery Runtime: 10 minutes
 - iii. Battery Replacement: Hot-swappable internal batteries
 - iv. Recharge Time: less than 4 hours to 90% capacity
 - v. Start-On-Battery: Allows start of UPS without utility input
 - g. Environmental:
 - i. Temperature:
 - Operating: 32°F to 104°F
 - Storage: 5°F to 122°F
 - ii. Relative Humidity: 0 to 95% non-condensing
 - iii. Audible Noise at 1 meter: less than 52dB
 - iv. Altitude: 10,000 feet without deteriorating
 - h. Communications:
 - i. Relay Output:
 - Common Alarm
 - ii. User Interface: LCD status screen
 - iii. Audible Alarms UPS alarm conditions, including:
 - On-Battery
 - Low Battery
 - Overload
 - UPS Fault
 - iv. Communications: One RS232 Serial Port; One Communications Slot; One USB Port
 - v. Communications cable: 6-foot communications cable included
 - vi. Power Management Software: Powerware Software Suite CD
 - i. Manufacturers Warranty:
 - i. Warranty: 2 year comprehensive, including battery
 - ii. Equipment Protection Policy: \$25,000 lifetime protection including lightning damage
11. Power Supply – 120VAC, Uninterruptible, DIN-Rail Mounted
 - a. Manufacturer:
 - i. Allen-Bradley 1609-D
 - ii. Sola
 - iii. IDEC
 - iv. Or equal
 - b. Agency Approvals:
 - i. Safety: UL 1778, CSA C22.2 No. 107.3, EN/IEC62040-1
 - ii. EMC: FCC & CE (EN 62040-2)
 - iii. Markings: UL, cULus, FCC, CE, C-Tick

- c. General:
 - i. Topology: True sine wave AC output.
 - ii. Remote Enable/Disable selector switch
- d. Input:
 - i. Input voltage: 90-145VAC, single phase, 60 Hz
 - ii. Capacity frequency: 50/60Hz +/- 3 Hz
 - iii. Input Line: Hardwired
- e. Electrical Output:
 - i. Online:
 - Nominal Output Voltage: 108-132V
 - Transfer Point Accuracy: +/-3%
 - ii. On Battery:
 - Nominal Output Voltage: 120V (sine wave)
 - Frequency: 50/60Hz +/- 3 Hz
 - THD: 10% Full Linear Load
- f. Short Circuit Protection
 - i. Crest Factor: 2.2:1
- g. Efficiency
 - i. On Battery (typical with resistive load): 75%
 - ii. Online (typical with resistive load excluding AVR mode)
 - 600VA: 86%
 - 1000VA: 94%
 - 1500VA: 95%
- h. Protection
 - i. Surge: 380 Joules
 - ii. Overload (Shutdown after 10s): > 110...130%
 - iii. Overload (Shutdown immediately): >130%
 - iv. Output Short Online/Battery: Premises branch circuit over-current protection/Shutdown
 - v. Thermal Protection: UPS inside temperature 140°F
- i. Battery Pack:
 - i. Internal Battery type:
 - Sealed, lead-acid; maintenance free
 - 12V/5Ah (for 0°F to 105°F B.B. BP5-12) 12V/5.5Ah (for 0°F to 125°F B.B. HRL5.5-12)
 - ii. On Battery Runtime:
 - 600VA: >5 min (at 80°F, full R load)
 - 1000VA: >3.5 min (at 80°F, full R load)
 - 1500VA: >2.5 min (at 80°F, full R load)
 - iii. Voltage: 36V
 - iv. Recharge Time: less than 8 hours to 90% capacity after discharge with full load
 - v. Charger: Current limited, constant voltage charger
 - vi. Lifetime: 2 to 3 years at 80°F ambient temperature
 - vii. Additional battery connection to extend run-time or capacity
- j. Environmental:
 - i. Temperature:
 - Operating: 32°F to 104°F
 - Storage: 5°F to 113 F
 - ii. Relative Humidity: 5% to 95% non-condensing

- iii. Audible Noise at 3 feet, front Side: less than 50dB
- iv. Heat Output:
 - 600VA:
 - On Line, Full load: 217 BTU per hour
 - On Line, Full load, Charging: 296 BTU per hour
 - On Battery: Full Load: 1331 BTU per hour
 - 1000VA:
 - On Line, Full load: 142 BTU per hour
 - On Line, Full load, Charging: 221 BTU per hour
 - On Battery: Full Load: 2218 BTU per hour
 - 1500VA:
 - On Line, Full load: 176 BTU per hour
 - On Line, Full load, Charging: 256 BTU per hour
 - On Battery: Full Load: 3344 BTU per hour
- k. Communications:
 - i. User Interface:
 - LED Status lights
 - Output short circuit
 - Output overload
 - Over temperature from heat sink
 - Over temperature ambient
 - Over voltage from Inverter DC/DC Converter
 - Over voltage from Inverter
 - Under voltage from Inverter
 - Over voltage from AVR output
 - Under voltage from AVR output
 - Fan Failure
 - Charger Failure
 - TMOV failure
 - Missing Battery
 - Replace Batteries
 - ii. Audible Alarm, UPS alarm condition
 - iii. Dry Contacts
 - Remote On/Off
 - Three Dry I/O, 1A/24VDC
 - On Battery
 - Low Battery
 - Fault
 - iv. Communications:
 - One USB Port
 - v. Power Management Software
 - vi. Monitoring through SCADA:
 - Line Fail
 - Low Battery
 - UPS Fault
 - Bypass
- l. Physical
 - i. UPS: Overall dimensions 375mm long by 200mm high by 220mm deep

- ii. DIN-rail mounting brackets for heavy-duty DIN rail for both UPS and additional batteries.
- m. Manufacturer's Warranty:
 - i. Warranty: 2 year comprehensive, including battery
- 12. Relay – 120V General Purpose
 - a. Manufacturer:
 - i. Allen Bradley Bulletin 700-HB
 - ii. IDEC RU Series
 - iii. Schneider
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CE Marked
 - c. Mechanical:
 - i. Enclosure: Transparent dust cover
 - ii. Contacts: Silver cadmium oxide
 - iii. Insulating Material: Molded, high dielectric
 - iv. Terminal Markings: In accordance with EN50-0005
 - v. Life expectancy: 10,000,000 operations
 - vi. Operations:
 - Pickup: 20 mS
 - Dropout: 4 mS
 - Maximum Rate: Four operations per second
 - vii. Blade style, quick connect terminals
 - d. Electrical:
 - i. Contacts:
 - Double-pole, double throw
 - Rated thermal current: 15A
 - Make: 60A
 - Break: 6A
 - ii. Coil:
 - 120 VAC + 10, -20%
 - Consumption.
 - Inrush: 2.85 VA
 - Sealed: 1.9 VA
 - iii. Voltage:
 - Rated Insulation Voltage: 250V IEC-300V UL/CSA
 - Dielectric Withstand Voltage:
 - Pole-to-Pole: 1500V
 - Contact to Coil: 6000V
 - Contact to Frame: 4000V
 - iv. Push-to-Test Operator
 - v. Pilot light
 - e. Relay Socket:
 - i. 11-blade
 - ii. Finger-safe terminal
 - iii. DIN rail mounted
 - iv. Double tier
 - v. Retainer clip

- vi. Relay identification snap-in markers
13. Relay – Solid State
- a. Manufacturer:
 - i. Allen Bradley Bulletin 700-SH
 - ii. IDEC RSS Series
 - iii. Eaton
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Recognized
 - ii. CE Marked
 - c. Electrical:
 - i. Input:
 - Voltage: 4-32VDC
 - Impedance: 15mA, maximum, voltage dependent
 - Pick-up voltage: 4VDC
 - Drop-out Voltage: 1VDC
 - Dielectric Strength: 2500VACrms
 - Reverse voltage protection
 - ii. Output:
 - Continuous current: 10A
 - Voltage range: 19-264VAC
 - Contact: SPST - N.O.
 - Off State leakage: 5 mA max (at 100VAC)
 - Turn-On/Turn-Off time; 0.5 cycle
 - iii. Features:
 - Photo isolation
 - Dual SCR output
 - Built-in snubber
14. Relay – Time Delay
- a. Manufacturer:
 - i. Allen Bradley Bulletin 700-HS
 - ii. IDEC, RTE Series
 - iii. Schneider
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - ii. CE Marked
 - c. Mechanical:
 - i. Insulation resistance: 100 Mohms, minimum
 - ii. Dielectric strength: 1500VAC, 1 minute
 - iii. Vibration resistance: 6N
 - iv. Shock resistance: 500N
 - v. Operating temperature: 0 to 150° F
 - vi. Operating humidity: 45 to 85%, relative
 - vii. Blade style: quick-connect terminals
 - d. Electrical:
 - i. Contacts:
 - Two Form C double-pole, double-throw

- 10A, 240VAC, resistive
 - ii. Timing functions:
 - Delay on make/interval
 - Delay on break/single shot
 - Range: 0.1 seconds - 10 minutes, or 0.1 minutes - 10 hours
 - iii. Accuracy:
 - Repeat: + 0.25%
 - Voltage: + 1.0%
 - Temperature error: + 2.0%
 - Setting error: + 10.0%
 - e. Relay Socket:
 - i. 11-blade
 - ii. Finger-safe terminal
 - iii. DIN rail mounted
 - iv. Double tier
 - v. Retainer clip
 - vi. Relay identification snap-in markers
15. Surge Suppressor – 24VDC, Field Mounted
- a. Manufacturer:
 - i. EDCO/Emerson SS65 Series
 - ii. Joslyn
 - iii. Pepperl-Fuchs
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - c. General Description:
 - i. Transient Protection for Low-Voltage Signal Lines
 - ii. Sneak/Fault Current Protection
 - iii. Resettable Fusing-PTCs
 - iv. Differential and Common Mode Protection
 - v. Automatic Recovery
 - vi. Encapsulated in Stainless Steel Pipe Nipples
 - vii. Silicon Avalanche Hybrid Technology
 - viii. UL 497B Listed
 - ix. Protection for One Pair (Two Wires & Shield on SS65)
 - d. Electrical:
 - i. Response Time: less than 1 nanosecond
 - ii. Maximum Signal Voltage: 28VDC
 - iii. DC Clamping Level:
 - Line-to-Ground: 36V +/-10%
 - Line-to-Line: 72V +/-10%
 - iv. Maximum Let-Thru Voltage:
 - Line-to-Ground (10x700 microseconds): 44V at 400A
 - Line-to-Line (10x700 microseconds): 90V at 400A
 - v. Series Resistance (per conductor): 5 Ohms (typical)
 - vi. Capacitance (zero volts bias):
 - Line-to-Line: 600pf typical
 - Line-to-Ground: 1200pf typical

- vii. Number of Occurrences: 400 at 500 Amps (10x1000 microseconds)
- 16. Surge Suppressor – 24VDC/120VAC Signal, Panel Mounted
 - a. Manufacturer:
 - i. Circuit Components Incorporated, Surge Control SPU Series
 - Base Module: SPU-xx-LM
 - Daughter Module: SPU-xx-CD-30/120
 - ii. Allen-Bradley
 - iii. Phoenix Contact
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - c. General Description:
 - i. Performance exceeds highest class severity level of IEC/EN 61000-4-4 and 61000-4-5
 - ii. Enhanced filtering to attenuate high frequency and bring equipment into compliance with IEEE /ANSI C37.90.1
 - iii. Universal hardwired version for all I/O modules including AC, DC, contact output, current output and signal input
 - iv. Multi-stage design provides the most effective suppression and filtering available, and requires no additional secondary protection
 - v. Sub-nano second response time stops failures due to lightning, spikes and over-voltage surges while filtering all other electrical noise
 - vi. Plug-in replaceable daughter card modules contain all active surge suppression
 - vii. Space efficient protector is hermetically sealed and suitable for the most harsh industrial environments
 - viii. Universal DIN-Rail mounting allows easy installation on any standard DIN-Rail configuration
 - ix. Automatic reset and fail safe design requires no maintenance. Eliminates “Out of Service” downtime and repair/replacement costs caused by damaging electrical surges
 - x. Protection for current loop instrumentation and low frequency signal/data lines
 - xi. UL-497B listed for Data Models (60 VDC or less) UL file E205158
 - d. Electrical:
 - i. Signal Channels: 5, 10, 15, or 20
 - ii. Operating: +/-30VDC
 - iii. Maximum Operating Voltage: 33VDC
 - iv. Maximum Operating Current: 0.5A
 - v. Clamping Action Turn-On: 37.1V
 - vi. Maximum Clamping (8x20 micro-seconds): 52V
 - vii. Maximum Surge Voltage: 6kV
 - viii. Maximum Surge Current (8x20 micro-seconds): 2.5kA
 - ix. Response Time: Less than 1 nanosecond
 - x. Operating & Storage Temperature: -40°F to 185°F.
- 17. Surge Suppressor – 120VAC/208VAC/480VAC Power, Panel Mounted
 - a. Manufacturer:
 - i. Intermatic Model AG2401C-IND/AGC6503-IND
 - ii. Schneider
 - iii. Easton
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - c. General Description:

- i. ANSI/IEEE C62.11 for Category 'C' locations. The arrester shall provide protection between each phase conductor and ground. The Secondary Surge Arrester shall employ parallel MOV's and provide protection from Category 'C' level transient surges as defined in ANSI/IEEE C62.11, C62.34, C62.41.1 and C62.41.2 without degradation of components.
 - ii. The Maximum Continuous Operating Voltage (MCOV) shall be comply with the following:
 - 120VAC, single phase system: 150VAC
 - 120/240VAC, single phase system: 150VAC
 - 120/208VAC, three phase system: 150VAC
 - 240VAC, three phase system: 275VAC
 - 480VAC, three phase system: 550VAC
 - iii. The arrester housing shall be constructed of UV resistant polycarbonate or material of equal strength and UV resistance. All electrical connections shall be sealed in a UL component recognized epoxy to exclude moisture, dirt and corrosion. The encapsulation shall have a minimum UL Flame Class rating of 94V-0. A 0.5 or 1/2 inch threaded nipple and locknut shall be provided. Leads shall be a minimum of 12 gauge and 18 inches in length.
 - iv. When subjected to a 8 x 20 micro-second test impulse, the Peak Clamping Voltage shall comply with the following: be no greater than 480V for 1500A, 710V for 5000A or 1,110V for 10,000A (4 x 10 micro-second).
 - 120VAC, or 120/240VAC, single phase systems:
 - 480VAC for 1500A (4 x 10 micro-second)
 - 710V for 5000A (4 x 10 micro-second)
 - 1110V for 10,000A (4 x 10 micro-second)
 - 120/208VAC, 240VAC, or 277/480VAC, three phase systems:
 - 1850VAC for 1500A (4 x 10 micro-second)
 - 2320V for 5000A (4 x 10 micro-second)
 - 2660V for 10,000A (4 x 10 micro-second)
 - d. Electrical:
 - i. Technology: Parallel Metal Oxide Varistors (40 kA Line to Ground)
 - ii. Configuration: Each line to ground/neutral
 - iii. Enclosure: Weatherproof and UV resistant NEMA 4 molded polycarbonate with metal threaded nipple
 - iv. Operational indicators: Monitoring circuits supervise components in each phase. Individual green LED for each phase indicates proper operation. LED's will turn OFF on failure of protection
 - v. Encapsulation: UL component recognized epoxy potting compound. UL Flame class 94V-0; Relative Temperature Index: Electric - 90, Mechanical – 90
 - vi. Mounting: 1/2 inch x 20 threaded nipple
 - vii. Mounting bracket: Right angle aluminum bracket
 - viii. Wiring: 18 inches of 12 gauge stranded copper wire is pre-connected for each phase, neutral and ground
 - ix. Wire color code: Black - phase leads, White - ground/neutral lead
 - x. Ambient operating temperature: -40°F to 185°F
 - e. Manufacturer's Warranty:
 - i. 10 year limited
18. Terminal Block – Indicating Fused
- a. Manufacturer:

- i. Allen Bradley Bulletin 1492-H4 (AC) or 1492-H5 (DC)
 - ii. Phoenix Contact
 - iii. Schneider
 - iv. Or equal
 - b. Agency Approvals:
 - a. UL
 - b. CSA
 - c. IEC
 - c. Specifications:
 - i. Voltage Rating: 300VAC/VDC
 - ii. Maximum Current: 12A
 - iii. Wire Range (Rated Cross Section): No. 30 to No. 12 AWG
 - iv. Leakage Current:
 - 2 mA at 300VAC
 - 2 mA at 24VDC
 - v. Working Voltage:
 - 100 to 300VAC
 - 10 to 57VAC/VDC
 - vi. Fuse Size: 1/4 inch by 1 1/4 inch
 - vii. Wire Strip Length 0.38 inch
 - viii. Tightening Torque: 3 to 7 pound-inch
 - ix. Density: 33 pieces per foot
 - x. Insulation Temperature Range: -40 to 221° F
 - xi. Accessories:
 - xii. Aluminum DIN Rail with Standoff Brackets
 - End Barrier and End Anchors
 - Side Jumper Insulating Sleeve
 - Marking Systems
19. Terminal Block – Isolating Switch
- a. Manufacturer:
 - i. Allen Bradley Bulletin 1492-H7
 - ii. Phoenix Contact
 - iii. Schneider
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL
 - ii. CSA
 - iii. IEC
 - c. Specifications:
 - i. Voltage Rating: 300VAC/VDC
 - ii. Maximum Current: 15A
 - iii. Wire Range (Rated Cross Section): No. 30 to No. 12 AWG
 - iv. Leakage Current:
 - 2 mA at 300VAC
 - 2 mA at 24VDC
 - v. Working Voltage:
 - 100 to 300VAC
 - 10 to 57VAC/VDC

- vi. Dummy Fuse Size: 1/4 inch by 1 1/4 inch
 - vii. Wire Strip Length 0.38 inch
 - viii. Tightening Torque: 3 to 7 pound-inch
 - ix. Density: 33 pieces per foot
 - x. Insulation Temperature Range: -40°F to 221°F
 - xi. Accessories:
 - Aluminum DIN Rail with Standoff Brackets
 - End Barrier and End Anchors
 - Side Jumper Insulating Sleeve
 - Marking Systems
20. Terminal Block – Open Style
- a. Manufacturer:
 - i. Allen Bradley Bulletin 1492-CAM1
 - ii. Phoenix Contact
 - iii. Schneider
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL
 - ii. CSA
 - iii. IEC
 - c. Specifications:
 - i. Voltage Rating: 600VAC/VDC
 - ii. Maximum Current: 65A
 - iii. Wire Range (Rated Cross Section): No. 22 to No. 8 AWG
 - iv. Wire Strip Length 0.38 inch
 - v. Tightening Torque: 10 to 16 pound-inch
 - vi. Density: 30 pieces per foot
 - vii. Insulation Temperature Range: -40°F to 221°F
 - viii. Accessories:
 - Aluminum DIN Rail with Standoff Brackets
 - End Barrier and End Anchors
 - Side Jumper Insulating Sleeve
 - Marking Systems
21. Transmitter – Isolated DC to DC
- a. Manufacturer:
 - i. Wilkerson Instrument Co., Model MM4300A
 - ii. Omron
 - iii. PR Electronics
 - iv. Or equal
 - b. Agency Approvals:
 - i. UL Listed
 - c. Construction:
 - i. 8-pin, relay socket
 - ii. Operating temperature: 15°F to 140°F
 - d. Electrical:
 - i. Input: 4-20 mADC or 0-10VDC
 - ii. Input impedance:
 - Voltage: 200 kOhms

- Current 50 Ohms
- iii. Output range:
 - Voltage: 0 - 10 VDC, 2 kOhm minimum load
 - Current: 4-20 mADC, 24VDC compliance (1200 ohms/20 mADC)
- iv. Response time: Less than 100 ms
- v. Accuracy: + 0.1% of span
- vi. Linearity: + 0.05% of span
- vii. Common mode rejection: 120 dB
- viii. Isolation:
 - 500 megohms
 - 1000VAC
- e. Manufacturer's Warranty:
 - i. 10 year limited

C. CONSTRUCTION

1. Field Measurements
 - a. Refer to the requirements of Process Instrumentation & Control.
2. Delivery, Storage, and Handling
 - a. Refer to the requirements of Process Instrumentation & Control.
3. Installation
 - a. Refer to the requirements of Process Instrumentation & Control.
4. Testing and Start-Up Services
 - a. Refer to the requirements of Process Instrumentation & Control.
5. Training
 - a. Refer to the requirements of Process Instrumentation & Control.

154013a.14 INSTRUMENTATION DEVICES

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of Process Instrumentation & Control.

1. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
 - ANSI/IEEE C37.90 - IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
 - ANSI/IEEE C62.11- IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
 - ANSI/IEEE C62.34 - IEEE Standard for Performance of Low-Voltage Surge-Protective Devices (Secondary Arresters).
 - ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - ii. CE - European Community, Applicable Directives.
 - EN50005 - for Terminal Markings.
 - EN50081-1- Generic Emission Standard.

- EN50082-1 - Generic Immunity Standard.
 - EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
 - EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.
 - iii. Canadian Standards Association (CSA), Specifications and Standards, current edition:
 - CSA C22.2, Industrial Control Equipment.
 - iv. CUL - Underwriter's Laboratories of Canada.
 - v. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
 - IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
 - vi. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
 - vii. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - UL508 - Industrial Control Equipment.
 - UL508A - Industrial Control Panels.
 - UL 913 - Intrinsically Safe Specification.
 - UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
2. Design Requirements

INSTRUMENTATION AND CONTROL COMPONENTS				
LOCATION	TAG	DESCRIPTION	TYPE	NOTES
Lift Station	LT-1-2	SUBMERSIBLE LEVEL TRANSDUCER, STORM WATER WETWELL	L1	
Lift Station	LSHH/LSH/LS L-1-2	LEVEL SWITCH, HIGH ALARM, LAG-LAG ON, INFLUENT PUMP STATION	L6 L1	
Lift Station	LSH-1-2	LEVEL SWITCH, PUMPS ON, STORM WATER WETWELL	L6	
Lift Station	LSL-1-2	LEVEL SWITCH, PUMPS OFF, STORM WATER WETWELL	L6	
Lift Station	LSLL-1-2	LEVEL SWITCH, LOW ALARM, STORM WATER WETWELL	L6	

B. MATERIALS.

1. L1 – Level Element and Transmitter, Submersible
 - a. Manufacturer
 - i. ~~Sigma Controls and shall be Model 6100~~ Flygt DuoProbe, Do Not Substitute.
 - ii. ~~Siemens Model A1000i~~
 - iii. ~~Contegra Model SLX 130~~
 - iv. ~~KPSI Model 750~~
 - v. ~~Or equal.~~
 - b. The transducer shall be of the solid-state head-pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's

instructions. The sensor shall be mounted using a stainless steel cable system in a location and as shown on the plans.

- c. The transducer housing shall be fabricated of Type 316 stainless steel with a bottom diaphragm 2 1/2 inch diameter of heavy-duty, limp, foul-free, molded Teflon bonded to a synthetic rubber back/seal.
- d. A hydraulic fill liquid shall transmit the sensed pressure to a solid-state variable capacitance or piezo-resistive transducer element. Unit shall produce output signal proportional to level with an accuracy of 1.0% of span.
- e. The transducer shall incorporate laser-trimmed, temperature compensation and high quality components and construction to provide a precise, reliable, stable output signal pressure over a factory-calibrated range.
- f. The transducer element shall incorporate high over-pressure protection and be designed to withstand intermittent over-pressures five times the full scale range being sensed. Metallic diaphragms shall not be acceptable in that they are subject to damage or distortion. Sensing principles employing LVDT's, resistive or pneumatic elements shall not be acceptable.
- g. The transducers shall be a two-wire type, operating from a loop power supply of 12 to 40 VDC, and producing a 4-20 mADC signal in direct proportion to the measured level excursion over a factory-calibrated range as indicated.
- h. MultiTrobe Multi-element probe shall be incorporated into the DuoProbe and in conjunction with MultiTrobe MTR Level Relay shall provide fixed set-points for back-up pump operation in dependant of the MultiSmart pump controller.
- i. Provide intrinsically safe barriers and relays for the level transducer and the multi-element probe, in accordance with Class I, Division 1 requirements of the National Electric Code.

~~2. L6 Level Switch, Wet Well Float~~

~~a. Manufacturer~~

- ~~i. Anchor Roto-Float P100NO/NC-SSHT Non-Mercury Float~~
- ~~ii. US Filter/Consolidated Electric Company Model 9G~~
- ~~iii. Siemens~~
- ~~iv. Or equal.~~

~~b. The wetwell float level switch shall be a Type 316 stainless steel, Teflon coated, watertight float enclosing a 20A/115 vac switch. The switch shall contain no mercury. The switch shall have a maximum activation/deactivation level differential of one inch. Float switches identified as detecting high level alarm conditions shall be equipped with normally closed contacts.~~

~~c. The level switch cable shall be provided by the manufacturer and it shall consist of a No.14 AWG copper, three conductor, PVC jacketed, heavy duty SO cord with a maximum O.D. of 5/8 inch. The cable shall include a ground conductor for bonding the float body to the conduit system. The cable length shall be selected to accommodate locations of float and associated junction box. Contractor shall be responsible for selecting length of cable to accommodate initial mounting elevation with enough slack cable to allow 2 foot lower elevation. Excess cable shall be coiled and secured above the maximum water level.~~

~~d. The entire float switch assembly, including cable shall be rated for process fluid temperatures of 150°F, minimum.~~

~~e. Float switch shall be provided with clamps and accessories suitable for fixed pipe mounting.~~

~~f. Where float switch is located in hazardous location, installation shall be intrinsically safe, suitable for use in Class I Division I atmospheres in accordance with the National Electrical Code. Installation shall include an intrinsically safe relay located in the control panel receiving the float signal.~~

3.2. T1 – Temperature Transmitter

- a. Manufacturer:
 - i. ACI A/TT100-0-4X
 - ii. PR Electronics
 - iii. Allen-Bradley
 - iv. Or equal.
- b. Equipment Description
 - i. Two-wire temperature transmitter with local RTD.
- c. References
 - i. National Electrical Manufacturer's Association (NEMA).
 - ii. Factory Mutual (FM).
- d. Environmental Conditions
 - i. Humidity: 0 to 100% relative humidity.
 - ii. Ambient Temperature Limits: -45°F to 185°F.
- e. Process Conditions
 - i. Measurement of exterior ambient temperature
- f. Electrical
 - i. UL Listed.
- g. Conduit connections: 1/2 inch NPT conduit connection.
- h. Power Supply
 - i. 12 to 45 V dc with no load for 4-20 mA dc output.
 - ii. 8 to 12 V dc for 1 to 5 dc low power output.
 - iii. 5 to 12 V dc for 0.8 to 3.2 V dc low power output.
- i. Outputs
 - i. Zero and Span adjustment
 - ii. Analog Output: 4-20 mA output, 700 max at 24 VDC, field scalable, 2:1
 - iii. Turndown. Various faults are indicated at 0 mA, 3.5 mA, 22 mA, and 24 mA (2WLP, 2XLP, 8W2D, 8X2D models only)
 - iv. Outputs shall be a 4-20 mA analog signal, linear with temperature for RTD inputs, linear with input signal for thermocouple or millivolt inputs.
 - v. Low power output option.
- j. Performance
 - i. Accuracy: +/- 0.5% of full range span at room temperature
 - ii. Repeatability: +/- 0.1% full range span
 - iii. Stability: +/- 0.25% of calibrated span per year max
 - iv. Temperature drive: 0.3% full scale/°F.
- k. Enclosure
 - i. Type 4X/IP66 certified epoxy coated aluminum; Explosion-proof models only: Epoxy-coated aluminum cover, tempered glass insert; Conduit, 1/2 inch NPTF stainless steel fitting; 3/4 inch NPTF aluminum casting
 - ii. Faceplate: UV-resistant pressure sensitive keypad and display overlay

4.3. Y1 – Alarm Beacons

- a. Provide LED-type flashing alarm beacons
- b. Powered by the transmitter
- c. 65 flashes per minute
- d. Wall mounted vertically with wall mounting bracket
- e. Weatherproof NEMA 4x for outdoor locations; Explosion Proof corrosion resistant NEMA 7 construction for indoor Class I, Division 1 locations; NEMA 4X for all other indoor locations.

- f. UL listed.
- g. Red, or as shown on plans

C. CONSTRUCTION.

1. Field Measurements
 - a. Refer to the requirements of Process Instrumentation & Control.
2. Delivery Storage and Handling
 - a. Refer to the requirements of Process Instrumentation & Control.
3. Installation
 - a. Refer to the requirements of Process Instrumentation & Control.
4. Testing and Start-Up Services
 - a. Refer to the requirements of Process Instrumentation & Control.
5. Training
 - a. Refer to the requirements of Process Instrumentation & Control.

154013a.15 PROGRAMMABLE LOGIC PUMP STATION CONTROLLERS

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of Process Instrumentation & Control. Equip programmable logic controllers with memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points. Equip programmable logic controller systems with I/O as scheduled on the drawings. Provide modification to existing programmable logic controller systems as specified. The software configuration files shall become the property of the City of Waukee. Identify all protection methods and turn over all keys and passwords to the City of Waukee. System supplier shall draft an agreement with the City of Waukee, to be reviewed by the engineer, identifying any consequences arising from modifications to the configuration files not authorized in writing by the system supplier during the specified warranty period. This agreement will be signed by the City of Waukee and supplier and copies of the document distributed to all parties. Unauthorized modifications to software configuration during the warranty period will result in a void warranty.

1. Applicable Publications
 - a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
 - ANSI/IEEE C37.90 - IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
 - ii. CE - European Community, Applicable Directives:
 - EN50005 - for Terminal Markings.
 - EN50081-1- Generic Emission Standard.
 - EN50082-1 - Generic Immunity Standard.
 - EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
 - EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.
 - iii. Canadian Standards Association (CSA), Specifications and Standards, current edition
 - CSA C22.2, Industrial Control Equipment.
 - iv. CUL - Underwriter's Laboratories of Canada.
 - v. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:

- IEC1131-1. Programmable Controllers - Part 1: General Information.
- IEC1131-2. Programmable Controllers - Part 2: Equipment Requirements and Tests.
- IEC1131-3. Programmable Controllers - Part 3: Programming Languages.
- IEC1131-4. Programmable Controllers - Part 4: User Guidelines.
- IEC1131-5. Programmable Controllers - Part 5: Communications.
- IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
- vi. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - NEMA ICS 2- Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - NEMA ICS 3- Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
- vii. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - UL508 - Industrial Control Equipment.
 - UL508A - Industrial Control Panels.
 - UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- 2. Submittals
 - a. Submit the following information specifically for programmable logic controllers:
 - i. Software configuration consisting of data tables, ladder logic, and other parameters.
 - ii. Identify coordination requirements with other sections.
- 3. Operation/Maintenance Manuals and Instructions
 - a. Submit the following information specifically for programmable logic controllers:
 - i. As-built printout of all software configuration including data tables, ladder logic, passwords, and other parameters. Document software with English language descriptions and tag numbers where appropriate.
 - ii. Electronic documentation shall include fully annotated electronic copies of all PLC programs . As-built documentation shall include all changes made during the first year of operation.
 - iii. Software configuration files shall be included in the manual in two forms:
 - CD ROM.
 - Paper.
 - b. Submit software license certificates, manufacturer provided software documentation, and software installation media.
- 4. Extra Materials
 - a. Supply one spare 120VAC discrete input/output module of each type supplied for this project
 - b. Supply one spare 24VDC analog input/output module of each type supplied for this project
 - c. Supply one spare communication module of each type supplied for this project
 - d. Supply one spare processor of each type supplied for this project

B. MATERIALS.

- 1. Manufacturer
 - a. Manufacturers:
 - i. ~~Allen Bradley/Rockwell Automation~~ Multi-trode/Flygt
 - ii. The Contracting Authority will consider products of another manufacturer only as alternate bid equipment in accordance with Iowa DOT Standard Specifications Division 11.
- 2. General System Requirements
 - a. Common Hardware Specifications

i. Environmental

- Ambient Temperature Rating:
 - Operating: 32°F to 140°F
 - Storage: -40°F to 185°F
- Humidity: 5 to 95% non-condensing
- Shock:
 - Operating: 30 Gs (three pulses, 11 mS)
 - Non-operating: 50.0 Gs (three pulses, 11 mS)
- Vibration:
 - Vibration Operating: 1.0 G at 5 to 2000 Hz
 - Non-operating: 2.5 Gs at 5 to 2000 Hz
- Free Fall (drop test):
 - Portable, 5 pounds or less at 2.5 feet (Six drops)
 - Portable, 5 pounds or more at 0.33 (Three flat drops)
- Electromagnetic Compatibility:
 - Showering Arc: 1.5 kV Per NEMA ICS 2/NEMA ICS 3
 - Surge Withstand Capability: 3 kV per ANSI/IEEE C37.90
 - Fast Transient Burst (impulse): 2 kV for power supplies, 1 kV for I/O and communication lines over 10m, 5 nS rise time
 - Electrostatic Discharge: 15 kV, 100 pF/1.5 kohm model
 - Radiated Electromagnetic Susceptibility: 5W walkie-talkie at 464.5 MHz and 153.05 MHz
 - Noise Immunity: NEMA Standard ICS 2

ii. Safety:

- Dielectric Withstand: 1500VAC per UL 508, CSA C22.2
- Isolation between communication circuits: 500VDC
- Isolation between backplane and I/O: 1500VAC
- Flammability and Electrical Ignition: UL94V-0
- Certification:
 - UL listed
 - CSA certified
 - CUL listed
 - Class 1, Groups A, B, C or D, Division 2
 - CE compliant for all applicable directives

~~b. Configuration~~

- ~~i. The programmable controller, associated I/O, chassis, and power supplies shall be of a modular design. The programmable controller and I/O modules shall mount into the chassis~~
- ~~ii. Processor Systems shall include processor, power supply, input/output modules, communication modules, and remote interface modules as required to meet system requirements.~~
- ~~iii. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.~~
- ~~iv. Modules are to be supplied as specified unless system requirements dictate the use of alternative modules.~~

~~c. Selection~~

- i. The programmable controller shall be selected from a family of programmable controllers with memory capability ranging up to 7.5Mbytes.
 - ii. All system and signal power to the controller and support modules shall be distributed on a single motherboard or backplane.
 - iii. All system modules including the processor shall be removable from the chassis or inserted in to the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.
 - iv. All system modules and chassis shall be designed to provide for free airflow convection cooling.
 - v. Modules shall be designed to plug into a chassis and to be keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying shall perform an electronic check to insure that the physical module is consistent with what was configured for the corresponding slot.
- d. Programming:
- i. Minimum Programming Instruction Set:
 - Language Characteristics: Ladder diagram
 - Logic Operations: AND, OR, XOR, NOT
 - Register Operations: Store, recall
 - Math Operations: Addition, subtraction, multiplication, division, square root, matrix operations
 - Process Control: Proportional-Integral-Derivative
3. Programmable Logic Pump Station Controller System, Micrologix Platform (Expandable) Multi-Smart (Do Not Substitute)
- a. Processor Unit
 - i. Manufacturer:
 - Allen Bradley Micrologix 1400, 1766 L32AWWA Flygt
 - The Contracting Authority will consider products of another manufacturer only as alternate bid equipment in accordance with Iowa DOT Standard Specifications Division 11.
 - ii. Processor requirements:
 - Input Power: 120/240VAC
 - Memory:
 - Non-volatile battery backed RAM
 - User Program / User Data Space: 10 Kbytes / 10 Kbytes
 - Data Logging / Recipe Storage: Up to 128 Kbytes for data logging and up to 64 Kbytes for recipe (recipe memory subtracted from available data logging)
 - Battery Back-up: Yes
 - Back-up Memory Module: Yes
 - Battery-backed RAM: 20Kbytes
 - Throughput: 0.7 ms
 - Communication Ports:
 - Two RS-232: One 8-pin mini-DIN; One 9-pin D-shell

- Two RS485
- Two Ethernet
- USB device port
- SD card port
- Communication Types:
 - TCP/IP
 - UDP
 - RS232
 - RS485
 - Private radio over RS232
 - PSTN
 - Wireless LAN
 - Cellular data (via integral ppm module)
 - Cellular voice
- Communication Protocols
 - DNP3 (master & slave, level 2 compliant)
 - o Change of state reporting
 - o Native date/time and quality stamps for each data point
 - o Event buffering for different classes of data
 - o Support for multiple masters and slaves to be configured on the unit.
 - o DNP Security (for securing communications between master station and RTU)
 - Modbus TCP
 - Modbus RTU
 - Modbus ASCII
 - Support for multiple masters and slaves.
 - o Ethernet TCP/IP
 - o Web Server Capability
 - o DF1 Full Duplex
 - o DF1 Half Duplex Master/Slave
 - o DF1 Radio Modem
 - o DH-485
 - o Modbus RTU Master/Slave
 - o ASCII Read/Write
 - o NP3 over IP
 - o Modbus TCP/IP
 - o DNP3 Slave
 - One 10/100 Mbps Ethernet Port
 - o EtherNet/IP messaging only

iii. Embedded Input/Output:

- Digital Inputs: Twenty 120VAC voltage free input, also configurable as counters
- Analog Inputs: Four 24VDC (10 bit)
- Digital Outputs: Twelve relay 240V, 5A resistive
- Analog Outputs: Two 24VDC (10 bit)

b. Expansion I/O:

i. Analog input module:

- Manufacturer: Allen-Bradley Model 1762-IF4
- Input points: four differential, individually selectable as current or voltage

ii. ~~Analog output module:~~

- ~~Manufacturer: Allen Bradley Model 1762-OF4~~
- ~~Input points: four single ended, individually selectable as current or voltage~~

iii. ~~Digital input:~~

- ~~Manufacturer: Allen Bradley Model 1762-IA8~~
- ~~Voltage Category/Type: 100 to 120VAC~~
- ~~Operating Voltage: 79 to 132VAC Signal Delay, Max.: On: 20.0 ms, Off: 20.0 ms~~
- ~~Off-State Current, Max.: 2.5 mA~~
- ~~IEC Input Compatibility: Type 3~~
- ~~Number of Inputs: Eight~~
- ~~Bus Current Load, Max.: 115 mADC at 5VDC~~

iv. ~~Digital output:~~

- ~~Manufacturer: Allen Bradley Model 1762-OW8~~
- ~~Operating Voltage: 85 to 265VAC~~
- ~~Continuous Current per Output, Max: 0.5 at 140°F; 1.0A at 86°F~~
- ~~Continuous Current per Module, Max: 16A~~
- ~~Number of Outputs: Eight (individually isolated)~~
- ~~Type of Contact Outputs: Normally open~~
- ~~Bus Current Load, Max.: 125 mADC at 5VDC; 100 mADC at 24VDC~~

C. CONSTRUCTION.

1. Field Measurements
 - a. Refer to the requirements of Process Instrumentation & Control.
2. Delivery Storage and Handling
 - a. Refer to the requirements of Process Instrumentation & Control.
3. Installation
 - a. Refer to the requirements of Process Instrumentation & Control.
 - b. Provide interconnect cables of the appropriate type as needed.
4. Testing and Start-Up Services
 - a. Refer to the requirements of Process Instrumentation & Control.
5. Training
 - a. Refer to the requirements of Process Instrumentation & Control.

154013a.16 HUMAN-MACHINE INTERFACE EQUIPMENT

A. DESCRIPTION.

For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of Process Instrumentation & Control. Equip human machine interface systems with memory and functional capacity to perform the specified interface, display, and data recording functions specified. Provide a minimum of 25% tag capacity reserved for future use for software licensed on a tag basis. The software configuration files shall become the property of the City of Waukee. Identify all protection methods and turn over all keys and passwords to the City of Waukee. System supplier shall draft an agreement with the City of Waukee, to be reviewed by the engineer, identifying any consequences arising from modifications to the configuration files not authorized in writing by the system supplier during the specified warranty period. This agreement will be signed by the City of Waukee and supplier and copies of the document distributed to all parties. Unauthorized modifications to software configuration during the warranty period will result in a void warranty.

1. Applicable Publications

- a. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.
 - i. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
 - ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
 - ANSI/IEEE C37.90 - IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
 - ii. CE - European Community, Applicable Directives.
 - EN50005 - for Terminal Markings.
 - EN50081-1- Generic Emission Standard.
 - EN50082-1 - Generic Immunity Standard.
 - EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
 - EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test
 - iii. Canadian Standards Association (CSA), Specifications and Standards, current edition:
 - SA C22.2, Industrial Control Equipment.
 - iv. CUL - Underwriter's Laboratories of Canada.
 - v. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:
 - IEC1131-1. Programmable Controllers - Part 1: General Information.
 - IEC1131-2. Programmable Controllers - Part 2: Equipment Requirements and Tests.
 - IEC1131-3. Programmable Controllers - Part 3: Programming Languages.
 - IEC1131-4. Programmable Controllers - Part 4: User Guidelines.
 - IEC1131-5. Programmable Controllers - Part 5: Communications.
 - IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
 - vi. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
 - NEMA ICS 2- Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - NEMA ICS 3- Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
 - vii. Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:
 - UL508 - Industrial Control Equipment.
 - UL508A - Industrial Control Panels.
 - UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
2. Submittals
 - a. Submit the following information specifically for human-machine interface equipment:
 - i. Provide copies of all graphic screens. Each screen shall be formatted on a single page which shall include a narrative description of the parameters displayed, ranges for adjustable parameters and recommended or typical values. The screens shall be organized in a logical fashion. An Index or Table of Contents shall be provided with a page numbering system or tabs which permit ready access to the information contained therein.
 - ii. Software configuration consisting of data tables and other parameters.
3. Operation/Maintenance Manuals and Instructions

- a. Submit the following information specifically for human-machine interface equipment:
 - i. Provide copies of all graphic screens. Each screen shall be formatted on a single page which shall include a narrative description of the parameters displayed, ranges for adjustable parameters and recommended or typical values. The screens shall be organized in a logical fashion. An Index or Table of Contents shall be provided with a page numbering system or tabs which permit ready access to the information contained therein.
 - ii. As-built printout of all software configuration including data tables, passwords, and other parameters. Document software with English language descriptions and tag numbers where appropriate.
 - iii. Electronic documentation shall include fully annotated electronic copies of all HMI programming. As-built documentation shall include all changes made during the first year of operation.
 - iv. Software configuration files shall be included in the manual in two forms:
 - CD ROM.
 - Paper.
- b. Submit software license certificates, manufacturer provided software documentation, and software installation media.

B. MATERIALS.

1. Operator Interface Terminal – ~~High Brightness~~ Integral to Multi-Smart Pump Controller

- a. Manufacturer:
 - i. ~~Pro Face America AGP-3300U Flygt - Do Not Substitute.~~
 - ii. ~~Beijer~~
 - iii. ~~Advantech~~
 - iv. ~~Or equal~~
 - ii. ~~Agency approvals:~~
 - ~~C-UL certified~~
 - ~~UL listed~~
 - ~~CE marked~~
 - iii. ~~Environmental:~~
 - ~~Temperature:~~
 - ~~Operating: 32°F to 122°F~~
 - ~~Storage: -4°F to 140°F~~
 - ~~Relative Humidity: 10% to 90% non-condensing~~
 - ~~Shock: IEC/EN61131-2 compliant, 147 m/s², X, Y, Z directions for 3 times~~
 - ~~Vibration: IEC/EN61131-2 compliant, 5 Hz to 9 Hz Single amplitude 3.5 mm [0.14 in.], 9 to 150 Hz Fixed acceleration: 9.8 m/s², X, Y, Z directions for 10 cycles (100 min)~~
 - ~~Ratings: IP65f NEMA #250 TYPE 1 (on the front panel when properly installed in an enclosure)~~
 - iv. ~~Electrical:~~
 - ~~Input Voltage:~~
 - ~~85 to 264VAC~~
 - ~~47 to 63 Hz~~
 - ~~Power Consumption: 60 VA maximum~~
 - v. ~~Display:~~
 - ~~Type: TFT Color LCD (Ultra luminance)~~
 - ~~Size 5.7 inch display~~

- Resolution: 320 x 240 pixels
- Dot Pitch: W0.01 x H0.01 inch
- Effective Display Area: W4.54 x H3.40 inch
- Display Colors: 65,536 Colors (No blink)/16,384 Colors (Blink)
- Backlight: CCFL (User nonreplaceable parts. Factory replacement required.)
- Brightness Control: 8 Levels (Adjusted with the touch panel)
- b. Character sizes: Standard font: 8 x 8, 8 x 16, 16 x 16 and 32 x 32 pixel fonts, Stroke font: 6 to 127 pixel fonts, Image font: 8 to 72 pixel fonts
- i. Font Sizes: Standard font: Width can be expanded up to 8 times., Height can be expanded up to eight times.
 - Program Area: 132KB FLASH EPROM
 - Variable Area: SRAM 64 KB (uses lithium battery)
- ii. Touchscreen:
 - Analog resistive
- iii. Memory:
 - FLASH EPROM 6 MB
 - Data Backup: SRAM 320KB (uses lithium battery)
- iv. Communications Ports:
 - Ethernet
 - RS-232 (two)
 - USB
 - Compact Flash Card Slot

C. CONSTRUCTION.

1. Field Measurements
 - a. Refer to the requirements of Process Instrumentation & Control.
2. Delivery Storage and Handling
 - a. Refer to the requirements of Process Instrumentation & Control.
3. Installation
 - a. Refer to the requirements of Process Instrumentation & Control.
4. Software Configuration Services
 - a. Refer to the requirements of Process Instrumentation & Control.
5. Testing and Start-Up Services
 - a. Refer to the requirements of Process Instrumentation & Control.
6. Training
 - a. Refer to the requirements of Process Instrumentation & Control.

154013a.17 METHOD OF MEASUREMENT.

Lump sum item; no measurement will be made.

154013a.18 BASIS OF PAYMENT.

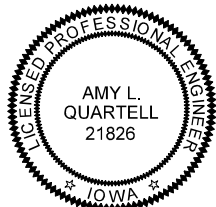
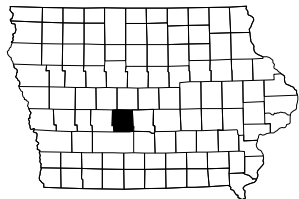
This item will be included in and paid for at the lump sum bid item price for Electrical System for Stormwater Pumps; price shall be full compensation for furnishing all equipment, materials, and all other work necessary or incidental to the construction of the complete installation and for all equipment, tools, labor, and incidentals necessary to complete the work.

INDEX OF SHEETS

No.	DESCRIPTION
A Sheets	Title Sheets
A.01	Title Sheet
B Sheets	Typical Cross Sections and Details
B.01-08	Typical Cross Sections and Details
C Sheets	Quantities and General Information
C.01-16	Quantities and General Information
D Sheets	Mainline Plan and Profile Sheets
D.01-05	Plan & Profile - SE Alices Road
E Sheets	Side Road Plan & Profile Sheets
E.01	Plan & Profile - Private Drive
E.02	Plan & Profile - Future Road
E.03	Plan & Profile - SE Frontier Avenue
E.04	Plan & Profile - SE Olson Drive
E.05	Plan & Profile - Heart of the Warrior Trail
E.06	Plan & Profile - Trail Watermain
EC Sheets	Erosion Control Sheets
EC.01-11	Erosion Control Sheets
F Sheets	Temporary Paving Plan and Profile Sheets
F.01	Plan & Profile - SE Alices Road - Transition
G Sheets	Survey Sheets
G.01-02	Survey Information
H Sheets	Right-of-Way Sheets
H.01-03	Right-of-Way Plan
HE.01	Right-of-Way Plan
J Sheets	Traffic Control and Staging Sheets
*J.01-29	Traffic Control Plan
J.30-37	Pavement Marking and Sign Layout
L Sheets	Geometric Staking and Jointing Sheets
L.01-16	Geometric Staking and Jointing Sheets
M Sheets	Storm Sewer Sheets
M.01-02	Storm Sewer Tabulation
M.03-19	Storm Sewer Sheets
N Sheets	Traffic Signal Sheets
N.01	General Notes & Legend
N.02-03	Signal Layout Plan
N.04	Signal Wiring Details
N.05-06	Signal Information
N.07-08	Signal Details
P Sheets	Lighting Layout Sheets
P.01-05	Lighting Layout Sheets
R Sheets	Removal Sheets
R.01-09	Removal Sheets
S Sheets	Pedestrian Ramp Geometric Sheets
*S.01-09	Pedestrian Ramp Geometric Sheets
S.10-16	Sidewalk Compliance Tabulation
T Sheets	Earthwork Quantity Sheets
T.01-04	Earthwork Quantity Sheets
U Sheets	Detail Sheets
U.01	Box Culvert Backfill Detail
U.02	Modular Block Retaining Wall
V Sheets	Pedestrian Underpass Plans
*V.01-27	Pedestrian Underpass Plans
W Sheets	Mainline Cross Sections
W.01-39	Mainline Cross Sections
X Sheets	Side Road Cross Sections
X.01-21	Side Road Cross Sections
Y Sheets	Trail Cross Sections
Y.01-13	Heart of the Warrior Trail Cross Sections
* Color Plan Sheets	

ALL WORKING DRAWINGS, INCLUDING SHOP DRAWINGS AND FALSEWORK DRAWINGS, SHALL BE SUBMITTED ACCORDING TO ARTICLE 1105.03 OF THE STANDARD SPECIFICATIONS. THESE DRAWINGS SHALL BE SUBMITTED TO AND CHECKED BY:

THOMAS J. CIHA
FOTH IE
8191 BIRCHWOOD CT, STE L
(515) 254-1393
thomas.ciha@foth.com



I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.
Amy L. Quartell
AMY L. QUARTELL, P.E.
License Number: 21826
My license renewal date is DECEMBER 31, 2016
Pages or sheets covered by this seal:
All Except J.01-J.29, M.01-M.19,
N.01-N.08, P.01-P.05, and
V.01-V.27
11/21/2016
DATE



PLANS OF PROPOSED IMPROVEMENT ON THE

URBAN ROAD SYSTEM
DALLAS COUNTY
PCC PAVEMENT WIDENING
IN THE CITY OF WAUKEE, SE ALICES ROAD:
FROM SE UNIVERSITY AVENUE TO 425 FEET
NORTH OF SE OLSON DRIVE
STP-U-8177(619)--70-25

SCALES: As Noted

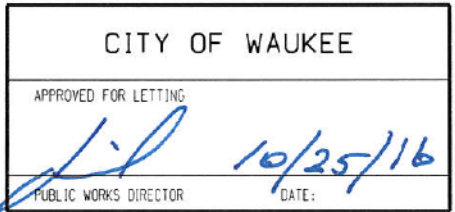
Refer to the Proposal Form for list of applicable specifications.

Value Engineering Saves. Refer to Article 1105.14 of the Specifications.

MILEAGE SUMMARY

			105-1
			09-27-94
DIV.	LOCATION	LIN. FT.	MILES
2	SE ALICES ROAD	2,753	0.521
2	PRIVATE DRIVE	304	0.058
2	FUTURE ROAD	218	0.041
2	SE FRONTIER AVENUE	205	0.032
2	SE OLSON DRIVE	506	0.096
2	HEART OF THE WARRIOR TRAIL	818	0.155

04-30-02		101-5	
DESIGN DATA URBAN			
2012	AADT	<u>3,100</u>	V.P.D.
2035	AADT	<u>39,730</u>	V.P.D.
2035	DHV	<u>4,000</u>	V.P.H.
TRUCKS		<u>5</u>	%
Total			
Design	ESALs	<u>--</u>	



REVISIONS

SHEETS: A.01, C.02, C.03, C.08, M.15, M.16, M.17, M.18, M.19, N.01, N.02, N.04, N.05, N.08, T.01, T.02, T.03, T.04

TOTAL
265

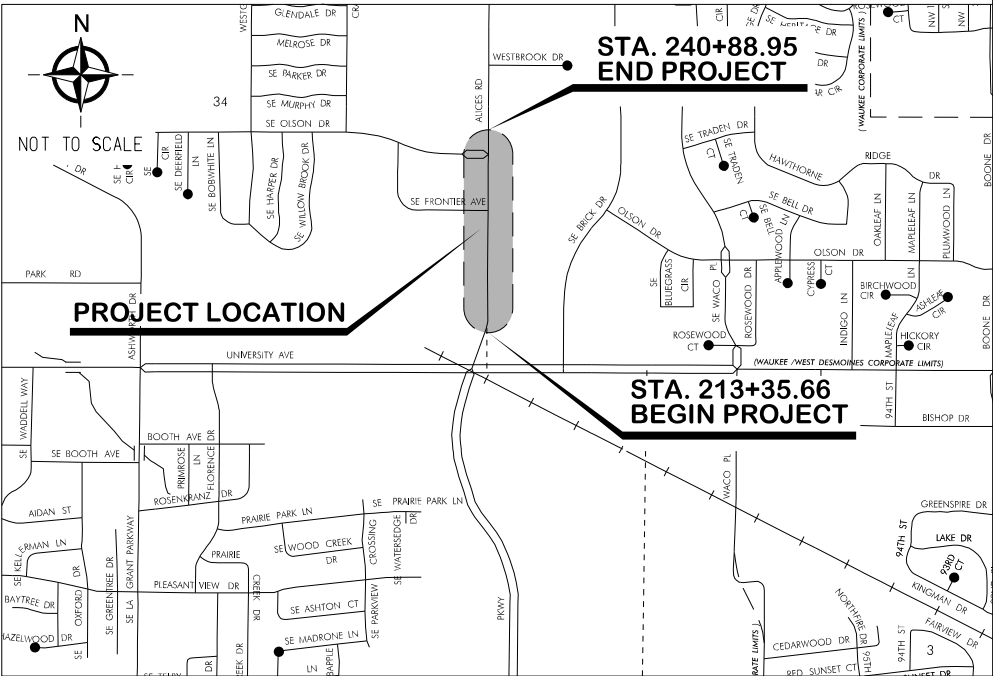
PROJECT IDENTIFICATION NUMBER

PROJECT NUMBER

STP-U-8177(619)--70-25

R.O.W. PROJECT NUMBER

LOCATION MAP



FINAL PLANS
11/22/2016

INDEX OF SEALS

SHEET NUMBER	NAME	TYPE
A.01	AMY L. QUARTELL	PRIMARY SIGNATURE BLOCK
J.03	JASON L. FRERICKS	TRAFFIC CONTROL PLAN
M.01	TYLER M. ANDERSON	DRAINAGE DESIGN
N.01	JASON L. FRERICKS	SIGNAL DESIGN
P.01	MICHAEL JOHNSON	LIGHTING DESIGN
V.01	THOMAS J. CIHA	STRUCTURAL DESIGN

ESTIMATED PROJECT QUANTITIES
(1 DIVISION PROJECT)

Item No.	Item Code	Item	Unit	Total	As Built Qty.
1	2101-0850001	CLEARING AND GRUBBING	ACRE	10	
2	2102-2710070	EXCAVATION, CLASS 10, ROADWAY & BORROW	CY	19,817	22,562
3	2102-2710090	EXCAVATION, CLASS 10, WASTE	CY	1,424	4,153
4	2102-4560000	LOCATING TILE LINES	STA	4	
5	2105-8425015	TOPSOIL, STRIP, SALVAGE AND SPREAD	CY	7,751	7,002
6	2107-0875000	COMPACTION WITH MOISTURE AND DENSITY CONTROL	CY	10,246	
7	2113-0001000	SUBGRADE STABILIZATION MATERIAL, CRUSHED STONE	SY	500	
8	2113-0001100	SUBGRADE STABILIZATION MATERIAL, POLYMER GRID	SY	500	
9	2115-0100000	MODIFIED SUBBASE	CY	5366	
10	2121-7425010	GRANULAR SHOULDERS, TYPE A	TON	470	
11	2301-1033100	STANDARD OR SLIP FORM PCC PAVEMENT, CLASS C, CLASS 3 DURABILITY, 10 IN.	SY	27955	
12	2301-4874106	MEDIAN, DOWELLED P.C. CONCRETE, 6 INCH	SY	558	
13	2301-6911722	PORTLAND CEMENT CONCRETE PAVEMENT SAMPLES	LS	1	
14	2304-0101000	TEMPORARY PAVEMENT	SY	4632	
15	2315-8275025	SURFACING, DRIVEWAY, CLASS A CRUSHED STONE	TON	34	
16	2401-6750001	REMOVALS, AS PER PLAN	LS	1	
17	2402-0425031	GRANULAR BACKFILL	TON	2265	
18	2402-0425040	FLOODED BACKFILL	CY	290	
19	2402-2720000	EXCAVATION, CLASS 20	CY	3463	
20	2403-0100000	STRUCTURAL CONCRETE (MISCELLANEOUS)	CY	262	
21	2403-0100020	STRUCTURAL CONCRETE (RCB)	CY	296	
22	2404-7775000	REINFORCING STEEL	LB	88240	
23	2414-6460000	ORNAMENTAL METAL RAILING	LF	962	
24	2416-0100015	APRON, CONC, 15"	EACH	1	
25	2416-0100018	APRON, CONC, 18"	EACH	1	
26	2416-0100024	APRON, CONC, 24"	EACH	2	
27	2416-0100036	APRON, CONC, 36"	EACH	1	
28	2430-0000100	MODULAR BLOCK RETAINING WALL	SF	593	
29	2435-0140148	MANHOLE, STORM SEWER, SW-401, 48 IN.	EACH	3	
30	2435-0140172	MANHOLE, STORM SEWER, SW-401, 72 IN.	EACH	1	
31	2435-0140196	MANHOLE, STORM SEWER, SW-401, 96 IN.	EACH	1	
32	2435-0250100	INTAKE, SW-501	EACH	7	
33	2435-0250300	INTAKE, SW-503	EACH	5	
34	2435-0250500	INTAKE, SW-505	EACH	3	
35	2435-0250600	INTAKE, SW-506	EACH	2	
36	2435-0250610	INTAKE, SW-506 MODIFIED	EACH	1	
37	2435-0251224	INTAKE, SW-512, 24"	EACH	2	
38	2435-0251236	INTAKE, SW-512, 36"	EACH	3	
39	2435-0600020	MANHOLE ADJUSTMENT, MAJOR	EACH	15	
40	2435-0600120	INTAKE ADJUSTMENT, MAJOR	EACH	5	
41	2435-0700010	SW-211, CONNECTION TO EXISTING STORM SEWER STRUCTURE	EACH	6	
42	2501-8400172	TEMPORARY SHORING	LS	1	
43	2502-8213106	SUBDRAIN, PVC, STANDARD, PERFORATED, 6 IN.	LF	2388	
44	2502-8221006	SUBDRAIN RISER, 6 IN.	EACH	4	
45	2502-8221303	SUBDRAIN OUTLET, DR-303	EACH	20	
46	2503-0111012	STORM SEWER GRAVITY MAIN, TRENCHED, (HDPE), 12 IN.	LF	251	
47	2503-0114218	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 18 IN.	LF	995	
48	2503-0114224	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 24 IN.	LF	363	
49	2503-0114230	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 30 IN.	LF	45	
50	2503-0114236	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 36 IN.	LF	1070	
51	2503-0114615	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 3750D (CLASS V), 15 IN.	LF	1043	
52	2503-0200036	REMOVE STORM SEWER PIPE LESS THAN OR EQUAL TO 36 IN.	LF	1044	
53	2504-0150410	SANITARY SEWER FORCE MAIN, TRENCHED, (PVC), 10 IN.	LF	130	
54	2502-2308110	CONTINUOUS TRENCH DRAIN (500-20)	LF	25	
55	2507-8029000	EROSION STONE	TON	30	
56	2510-6745850	REMOVAL OF PAVEMENT	SY	14804	
57	2510-6750600	REMOVAL OF INTAKES AND UTILITY ACCESSES	EACH	7	
58	2511-0300000	REMOVAL OF RECREATION TRAIL	SY	810	
59	2511-0302600	RECREATIONAL TRAIL, PORTLAND CEMENT CONCRETE, 6 IN.	SY	2893	
60	2511-6745900	REMOVAL OF SIDEWALK	SY	296	
61	2511-7526005	SIDEWALK, P.C. CONCRETE, 5 IN.	SY	868	
62	2511-7528101	DETECTABLE WARNINGS	SF	328	
63	2515-2475008	DRIVEWAY, P.C. CONCRETE, 8 IN.	SY	1001	
64	2515-6745600	REMOVAL OF PAVED DRIVEWAY	SY	2046	
65	2518-6910000	SAFETY CLOSURE	EACH	12	
66	2523-0000100	LIGHTING POLES	EACH	18	20
67	2523-0000200	ELECTRICAL CIRCUITS	LF	5903	
68	2523-0000310	HANDHOLES AND JUNCTION BOXES	EACH	25	23
69	2523-0000400	CONTROL CABINET	EACH	1	
70	2524-6765210	REMOVAL OF TYPE A SIGN ASSEMBLY	EACH	49	
71	2524-9089100	DELINEATOR, RIGID - TYPE I	EACH	4	
72	2524-9276010	PERFORATED SQUARE STEEL TUBE POSTS	LF	518	
73	2524-9325001	TYPE A SIGNS, SHEET ALUMINUM	SF	355	
74	2525-0000100	TRAFFIC SIGNALIZATION	LS	1	
75	2526-8285000	CONSTRUCTION SURVEY	LS	1	
76	2527-9263109	PAINTED PAVEMENT MARKING, WATERBORNE OR SOLVENT-BASED	STA	131	
77	2527-9263117	PAINTED PAVEMENT MARKINGS, DURABLE	STA	88	
78	2527-9263131	WET RETROREFLECTIVE REMOVABLE TAPE MARKINGS	STA	191	

ESTIMATED PROJECT QUANTITIES
(1 DIVISION PROJECT)

Item No.	Item Code	Item	Unit	Total	As Built Qty.
79	2527-9263137	PAINTED SYMBOLS AND LEGENDS, WATERBORNE OR SOLVENT-BASED	EACH	13	
80	2527-9263143	PAINTED SYMBOLS AND LEGENDS, DURABLE	EACH	29	
81	2527-9263152	PRE-CUT SYMBOLS AND LEGENDS, REGULAR MARKING TAPE	EACH	14	
82	2527-9263180	PAVEMENT MARKINGS REMOVED	STA	8	
83	2528-8400048	TEMPORARY BARRIER RAIL, CONCRETE	LF	4551	
84	2528-8445110	TRAFFIC CONTROL	LS	1	
85	2528-8445113	FLAGGERS	EACH	15	
86	2528-9290050	PORTABLE DYNAMIC MESSAGE SIGN (PDMS)	CDAY	240	
87	2533-4980005	MOBILIZATION	LS	1	
88	2554-0114012	WATER MAIN, TRENCHED, POLYVINYL CHLORIDE PIPE (PVC), 12 IN.	LF	610	
89	2554-0202400	FITTINGS BY COUNT, POLYVINYL CHLORIDE (PVC),	EACH	7	
90	2554-0207012	VALVE, GATE, DIP, 12 IN.	EACH	4	
91	2554-0208012	TAPPING VALVE ASSEMBLY, 12 IN.	EACH	4	
92	2554-0210201	FIRE HYDRANT ASSEMBLY, WM-201	EACH	10	
93	2599-9999005	ADJUSTMENT OF FIXTURES	EACH	20	
94	2599-9999005	WATERMAIN VERTICAL RELOCATION	EACH	2	
95	2599-9999010	SUBMERSIBLE CENTRIFUGAL STORMWATER PUMPS	LS	1	
96	2599-9999010	ELECTRICAL SYSTEM FOR STORMWATER PUMPS	LS	1	
97	2599-9999010	STORMWATER POLLUTION PREVENTION PLAN (SWPPP), MANAGEMENT	LS	1	
98	2599-9999010	UNDERPASS LIGHTING	LS	1	
99	2599-9999018	ANTI-GRAFFITI COATING	SY	975	
100	2599-9999020	GRANULAR BEDDING	TON	525	
101	2601-2634100	MULCHING	ACRE	7	
102	2601-2636044	SEEDING AND FERTILIZING (URBAN)	ACRE	7	
103	2601-2642120	STABILIZING CROP - SEEDING AND FERTILIZING (URBAN)	ACRE	10	
104	2602-0000020	SILT FENCE	LF	3656	
105	2602-0000030	SILT FENCE FOR DITCH CHECKS	LF	810	
106	2602-0000071	REMOVAL OF SILT FENCE OR SILT FENCE FOR DITCH CHECKS	LF	3465	
107	2602-0000101	MAINTENANCE OF SILT FENCE OR SILT FENCE FOR DITCH CHECK	LF	347	
108	2602-0000130	TEMPORARY SEDIMENT CONTROL BASIN	EACH	32	
109	2602-0000312	PERIMETER AND SLOPE SEDIMENT CONTROL DEVICE, 12 IN. DIA.	LF	1320	
110	2602-0000350	REMOVAL OF PERIMETER AND SLOPE SEDIMENT CONTROL DEVICE	LF	1320	
111	2602-0010010	MOBILIZATIONS, EROSION CONTROL	EACH	3	
112	2602-0010020	MOBILIZATIONS, EMERGENCY EROSION CONTROL	EACH	1	

ESTIMATE REFERENCE INFORMATION

Item No.	Item Code	Description
1	2101-0850001	CLEARING AND GRUBBING This bid item shall include all equipment, labor and other miscellaneous related work required to properly remove and dispose of existing trees, stumps, hedges and other miscellaneous items. Burning will not be allowed. Wood chips shall be hauled off site. Incidental to this item is the removal of all necessary landscaping features, plantings, edgers, pavers, other debris and abandoned utilities encountered during construction. Contractor shall verify all removals with the Engineer and the City. Included in this item is tree removal including 5,600 sf of tree removal between Station 228+00 and Station 229+50.
2	2102-2710070	EXCAVATION, CLASS 10, ROADWAY & BORROW
3	2102-2710090	EXCAVATION, CLASS 10, WASTE Refer to T-sheets for detailed information. Grading for the side slopes and sidewalk on the east side of SE Alices Road shall to be completed first in the sequence. This bid item includes the following quantities: 19,817 22,562 CY of total available CUT (CLASS 10 + ROCK UNDERCUT) 15,243 17,356 CY of CUT with 1.3 Shrink 13,819 13,200 CY of total FILL 1,424 4,153 CY net WASTE with 1.3 Shrink The volume of fill was calculated using a 30% shrink factor for on-site cut material. Compact to a minimum of 95% of standard proctor density. Payment for this item shall be based on the given plan quantity. Place unsuitable materials a minimum of 2 feet below proposed pavement.
4	2102-4560000	LOCATING TILE LINES Item included for locating and repairing existing field tile encountered during grading operations and for connecting existing tile to proposed storm system. Quantity for payment will be field measured and approved by the Engineer.
5	2105-8425015	TOPSOIL, STRIP, SALVAGE AND SPREAD Refer to T-sheets for detailed information. Strip and salvage topsoil to a depth of 8 inches before excavation occurs. Topsoil to be spread to a minimum of 8 inches thick. This bid item includes the following quantities: 7,751 7,002 CY of stripping

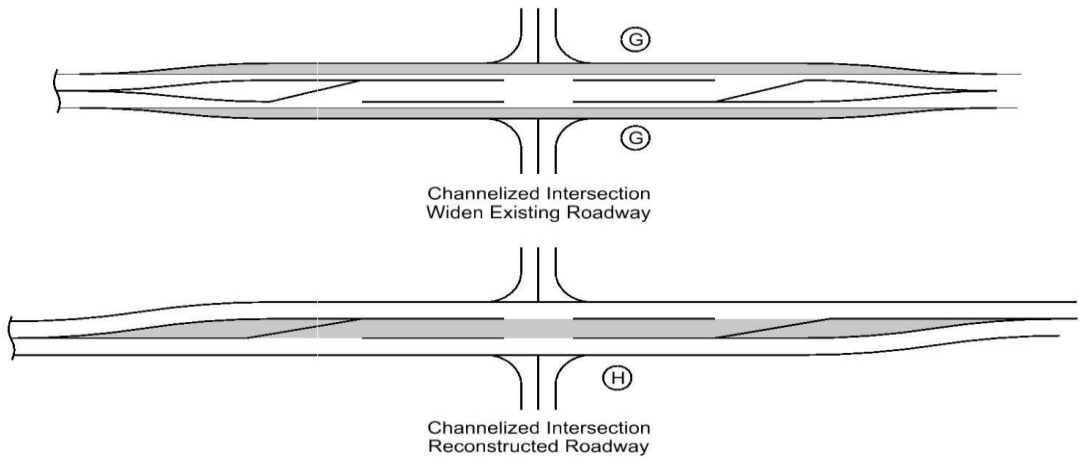
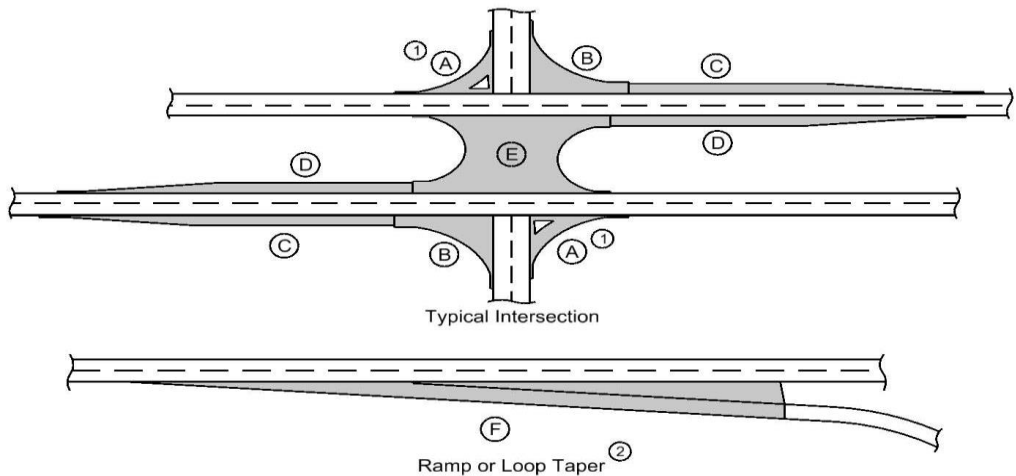
ESTIMATE REFERENCE INFORMATION

Item No.	Item Code	Description
	5,214 1,335 3,879	5310 CY of total available topsoil stripping with 1.5 Shrink 4579 CY of respreading 9734 CY of EXCESS (Incorporate into Fill areas outside pavement)
		The volume of spreading was calculated using a 50% shrink factor for spreading material. This quantity was calculated by stripping the areas identified on the cross sections (typically upper 8-in. of topsoil plus additional depth in existing ditches) and placing of topsoil to a depth of 8-in. for finished grading. This item also includes backfilling behind curb and all required fine grading. Payment for this bid item shall be based on the given plan quantity.
6	2107-0875000	COMPACTION WITH MOISTURE AND DENSITY CONTROL Refer to B-sheets for location and details. Item is labeled Subgrade Preparation and shall be 12 inches thick.
7	2113-0001000	SUBGRADE STABILIZATION MATERIAL, CRUSHED STONE For isolated unstable areas of subgrade encountered during construction. Typical means and methods of subgrade construction, i.e. discing, rolling, ect., must be attempted prior to use of this item. Prior approval of this item must be received before construction begins.
8	2113-0001100	SUBGRADE STABILIZATION MATERIAL, POLYMER GRID For isolated unstable areas of subgrade encountered during construction. Typical means and methods of subgrade construction, i.e. discing, rolling, ect., must be attempted prior to use of this item. Prior approval of this item must be received before construction begins.
9	2115-0100000	MODIFIED SUBBASE Refer to Tab 100-24 on the C-sheets and B-sheets for details, location, and depth. To be placed a minimum depth of 6" beneath all roadway pavement and includes 3' outside of back of curb and gutter of all roadway pavement.
10	2121-7425010	GRANULAR SHOULDERS, TYPE A Refer to typical sections on B-sheets for shoulder thickness information. Quantity is estimated using an application rate of 2.05 tons/cy.
11	2301-1033100	STANDARD OR SLIP FORM PCC PAVEMENT, CLASS C, CLASS 3 DURABILITY, 10 IN. Refer to Tab 100-24 on C-sheets for details. This item includes the 10" driveway pavement into Gilcrest/Jewett from Private Drive and Future Road. Slip formed pavement shall be C-QMC mix in accordance with Proportion Table 4 of IM 529. To maintain the lower water to cement ratio a low or mid-range water reducer may be needed. Well graded aggregates may be used with the C-QMC mix in proportions to fall within Zone II-A, II-B or II-C in accordance with IM 532. Standard C mix in accordance with Proportion Table 1 of IM 529 shall be utilized with hand finished pavement. Refer to typical sections on B-sheets for pavement reinforcing details and additional information. Refer to L-sheets for additional details. Certified plant inspection shall be provided by the contractor. Refer to Tab 100-27 on C-sheets and Standard Specification Section 2316 for Pavement Smoothness. Refer to Standard Specification Section 2521 for Certified Plant Inspection. Refer to Iowa DOT Standard Road Plan PR-120 for details of reinforced pavement over box culverts.
12	2301-4874106	MEDIAN, DOWELLED P.C. CONCRETE, 6 INCH Refer to B-sheets for SUDAS Detail 7010.906.
13	2301-6911722	PORTLAND CEMENT CONCRETE PAVEMENT SAMPLES
14	2304-0101000	TEMPORARY PAVEMENT Refer to Tab 100-24 on C-sheets and J-sheets for additional information. This item is for temporary pavement for access during construction and the proposed temporary transition Sta 1237+40.85 to Sta 1239+71.99 on SE Alice Road. Contractor has the option to use HMA Full-depth or PCC pavement. Pavement thickness shall match adjacent pavement when new temporary pavement is installed on subbase. HMA overlay with a minimum thickness of 2-inches shall be used when temporary pavement is installed over existing pavement to meet grades.
15	2315-8275025	SURFACING, DRIVEWAY, CLASS A CRUSHED STONE This item is for the granular entrance located along Alices Road at Station 1238+90. Estimated quantity is based on 10" depth of crushed stone. Refer to SUDAS detail 9040.20 on the B-sheets except thickness shall be 10 inches. Quantity is estimated using an application rate of 2.05 tons/cy.
16	2401-6750001	REMOVALS, AS PER PLAN This item is for the removal and disposal of existing signs and fire hydrants. Refer to Tab 110-2 on the C-sheets for location of removal of a sign on SE Olson Drive and a sign at Gilcrest/Jewett parking lot. Payment shall include necessary material, equipment, and labor to remove entire structures. Gilcrest/Jewett sign shall be delivered to the property owner. Refer to Tab FOTH-2 on C-sheets and D-sheets for locations of fire hydrants to be removed. This item shall include removing hydrants assemblies including hydrant and valve and backfilling trench. Compact trenches to 95% Standard Proctor Density. The City will provide density testing.
17	2402-0425031	GRANULAR BACKFILL
18	2402-0425040	FLOODED BACKFILL
19	2402-2720000	EXCAVATION, CLASS 20 Refer to V-sheets for details.
20	2403-0100000	STRUCTURAL CONCRETE (MISCELLANEOUS)
21	2403-0100020	STRUCTURAL CONCRETE (RCB) Refer to V-sheets for details.

ESTIMATE REFERENCE INFORMATION

Item No.	Item Code	Description
22	2404-7775000	REINFORCING STEEL Refer to V-sheets for details.
23	2414-6460000	ORNAMENTAL METAL RAILING Refer to V-sheets for details for railing installed on the Heart of the Warrior Trail retaining wall. See B-sheets and U-sheets for railing installed adjacent to modular block retaining walls on SE Alices Road.
24	2416-0100015	APRON, CONC, 15"
25	2416-0100018	APRON, CONC, 18"
26	2416-0100024	APRON, CONC, 24"
27	2416-0100036	APRON, CONC, 36" Refer to List of Intakes and Utility Access (104-5B) on sheet M.01. This includes the installation and supply of apron footing, pipe connectors and galvanized steel apron guards. Last three pipe joints prior to end of apron shall be tied. Refer to concrete footing detail in B-sheets.
28	2430-0000100	MODULAR BLOCK RETAINING WALL Refer to U-sheets for location and details. Refer to B-sheets for design details. Contractor shall use the same modular block size and color found at the Gilcrest Jewett retaining wall. Retaining wall block shall be approximately 8" H x 12" D x 16" L. Cap block shall be 4" H x 12" D with a 14"x16" trapizotal top. Item includes subdrain, backfill, stabilization material, cap block, pins and all other materials to install retaining wall. The Contractor shall provide the structural design and details signed and sealed by a Structural Engineer licensed in the State of Iowa.
29	2435-0140148	MANHOLE, STORM SEWER, SW-401, 48 IN.
30	2435-0140172	MANHOLE, STORM SEWER, SW-401, 72 IN.
31	2435-0140196	MANHOLE, STORM SEWER, SW-401 96 IN.
32	2435-0250100	INTAKE, SW-501
33	2435-0250300	INTAKE, SW-503
34	2435-0250500	INTAKE, SW-505
35	2435-0250600	INTAKE, SW-506
36	2435-0250610	INTAKE, SW-506 MODIFIED See B-Sheets for SW-506 Modified 2 detail.
37	2435-0251224	INTAKE, SW-511, 24"
38	2435-0251236	INTAKE, SW-512, 36" Refer to List of Intakes and Utility Accesses in M-sheets. Pre-cast structures will be allowed. Adjustment rings will not be allowed. Adjustments shall be constructed integral to the boxout pour. By-pass pumping required to complete construction of structures shall be considered incidental.
39	2435-0600020	MANHOLE ADJUSTMENT, MAJOR This item includes all materials, labor, and equipment necessary to adjust existing manholes to proposed rim elevations. Refer to Tab 104-10 on the C-sheets and D-sheets for locations and details.
40	2435-0600120	INTAKE ADJUSTMENT, MAJOR This item includes all materials, labor, and equipment necessary to adjust existing intakes to proposed form grade elevations. Refer to Tab 104-10 on the C-sheets and D-sheets for locations and details.
41	2435-0700010	CONNECTION TO EXISTING STORM SEWER STRUCTURE Refer to M-sheets for information and locations. New opening shall be core drilled and collar poured. Contractor to verify flowlines of existing storm sewer pipes prior to laying new pipe and core drilling and notify the Engineer if elevations differ from those in the plans.
42	2501-8400172	TEMPORARY SHORING Refer to V-sheets for details.
43	2502-8213106	SUBDRAIN, PVC, CASE A, 6 IN. Refer to M-sheets for subdrain locations and Longitudinal Subdrain Tabulation (104-9). Approved manufactures: (1) Contech, A-2000 (2) Advanced Drainage Systems, ADS N-12 or (3) Hanor, HI-Q Includes porous backfill, tees, plugs and all other required fittings. Refer to figure 4040.231 in B-sheets for construction details. Engineering fabric will not be required.
44	2502-8221303	SUBDRAIN RISER, 6 IN. Subdrain type-A cleanout; refer to details on B-sheets and M-sheets for locations and Tabulation of Subdrains. The contractor will be paid the contract unit price per each. This shall be considered full compensation for furnishing all materials, equipment and labor for each subdrain cleanout.
45	2502-8221303	SUBDRAIN OUTLET, DR-303 Refer to details on B-sheets, M-sheets for locations and Tabulation of Subdrains.
46	2503-0111012	STORM SEWER GRAVITY MAIN, TRENCHED, (HDPE), 12 IN.
47	2503-0114218	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 18 IN.
48	2503-0114224	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 24 IN.
49	2503-0114230	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 30 IN.
50	2503-0114236	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 2000D (CLASS III), 36 IN.
51	2503-0114615	STORM SEWER GRAVITY MAIN, TRENCHED, RCP, 3750D (CLASS V), 15 IN. Refer to List of Storm Sewer Pipe (104-5B) on sheet M.01, the M-Sheets locations and details. Bedding shall be Class R-2 for all RCP pipe and Class R-5 for all RCAP. Wrap pipe joints with engineering fabric and backfill with granular bedding material/backfill to a minimum of 6-in above top of pipe for all RCP storm sewer unless otherwise noted in the plans. Storm sewer 18" diameter and less shall be bell and spigot joint pipe. Compact trenches to a minimum of 95% standard proctor density. Incidental to this item is disposal of non-desirable backfill material and replacing with suitable material from elsewhere on the project site. Granular bedding and backfill material is incidental to this item. The City will provide Density testing. Item includes dewatering for storm sewer construction and connections to existing pipe.

PCC PAVEMENT



- ① Does not include raised island area or curb. Refer to tabulation 112-4 for quantities.
- ② Refer to PV-410, PV-411, PV-412, and PV-414.
- ③ Quantity includes Pavement Header.

Location				Mainline			Area (3)								Total Area By Pavement Thickness		Special Backfill	Modified Subbase	Subgrade Prep	Remarks	
Road Identification	Direction of Travel	Station to Station		Width	Length	Area	A^①	B	C	D	E	F^②	G	H							
				FT	FT	SY	SY	SY	SY	SY	SY	SY	SY	SY	SY						
SY																10 IN	8 IN	TONS	CY		CY
SE Alices Road	Both	216+97.66	224+16.05	Var.	718.4	7190.0									7190.0			1269.2	2538.4	Mainline - 10" Reinforced	
SE Alices Road	Both	224+16.05	232+32.45	Var.	816.4	7828.0									7828.0			1517.4	3034.8		Mainline - 10" Reinforced
SE Alices Road	Both	232+32.45	237+40.85	Var.	508.4	5878.0									5878.0			1031.5	2063.0		Mainline - 10" Reinforced
SE Alices Road	Both	237+40.85	240+88.95	Var.	348.1	973.0									973.0			187.2	374.4		Temporary Pavement - 10" PCC or HMA
SE Alices Road		221+67.85, LT		Var.	Var.	112.7										112.7		26.3			Driveway - 8"
SE Alices Road		226+90.68, LT		Var.	Var.	277.0										277.0		53.8			Driveway - 8"
SE Alices Road		232+18.94, LT		Var.	Var.	109.0										109.0		25.5			Driveway - 8"
SE Alices Road		239+73.17, RT		Var.	Var.	118.9										119.0		24.8			Driveway - 8"
Private Drive	Both	702+09.62	703+55.35	Var.	145.7	625.0									625.0			117.5	235.0	Side Road - 10" Reinforced	
Private Drive	Both	704+44.59	706+02.52	Var.	157.9	638.0									638.0			124.3	248.6		Side Road - 10" Reinforced
Private Drive		702+34.58, LT		Var.	Var.	131.0									131.0			28.1		Driveway - 10"	
Private Drive		702+34.33, RT		Var.	11.2	31.4										31.0		8.0			Driveway - 8"
Future Road	Both	502+00.00	504+00.00	Var.	200.0	644.0									644.0			127.4	254.8	Side Road - 10" Reinforced	
Future Road	Both	504+00.00	505+55.50	Var.	155.5	735.3									735.0			136.7	273.4		Side Road - 10" Reinforced
Future Road		502+63.47, LT		Var.	38.8	174.0										174.0		33.5		Driveway - 8"	
Future Road		504+38.30, RT		Var.	16.8	61.2									61.0			11.9			Driveway - 10"
Future Road		504+88.76, LT		Var.	22.3	71.6										72.0		14.8		Driveway - 8"	
SE Frontier Avenue	Both	303+65.00	305+31.59	Var.	166.6	573.0									573.0			113.9	227.8	Side Road - 10" Reinforced	
SE Olson Drive	Both	101+07.29	104+77.54	Var.	370.3	2000.0									2000.0			372.3	744.6		Side Road - 10" Reinforced
SE Olson Drive	Both	105+90.54	107+01.07	Var.	110.5	679.0									679.0			125.6	251.2	Side Road - 10" Reinforced	
SE Olson Drive		102+88.99, RT		Var.	22.8	106.0										106.0		16.6			Driveway - 8"

PAVEMENT SMOOTHNESS + PCC TEXTURE

Road Identification	Begin Station	End Station	Proposed Posted Speed			Remarks
			35 or less	40 - 45	over 45	
SE Alices Road	216+95.45	240+88.95		X		
Private Drive	702+09.62	706+02.52	X			
Future Road	504+00.00	509+94.76	X			
SE Frontier Avenue	303+65.00	305+31.59	X			
SE Olson Drive	101+07.23	107+01.07	X			

CONCRETE MEDIANS

* Bid item						
Begin Station	End Station	Type	Area*	Modified Subbase	Special Backfill	Remarks
			SY	CY	CY	
215+28.08	218+46.51	6 inch, dowelled	252.4			SE Alices Road
219+17.93	224+09.17	6 inch, dowelled	160.7			SE Alices Road
224+80.17	226+31.69	6 inch, dowelled	50.4			SE Alices Road
232+32.45	234+66.96	6 inch, dowelled	78.1			SE Alices Road
235+73.79	236+24.25	6 inch, dowelled	16.6			SE Alices Road

	FIRST LETTER(S)		SUCCEEDING LETTERS		
	PROCESS OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSOUT FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE			CONTROL	
D	USER'S CHOICE	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO(FRACTION)			
G	USER'S CHOICE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT		INDICATE		
J	POWER	SCAN			
K	TIME OR SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOISTURE				
N	TORQUE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		
P	PRESSURE (OR VACUUM)		POINT, TEST CONNECTION		
Q	QUANTITY	INTEGRATE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION				
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE	Y AXIS		RELAY OR COMPUTE	
Z	POSITION, DIMENSION	Z AXIS		DRIVE ACTUATE OR UNCLASSIFIED FINAL CONTROL ELEMENT	

P&ID SYMBOLS (TYPICAL)

Q: A: DESCRIPTION, TOP LINE B: DESCRIPTION, BOTTOM LINE TRS: FIRST LETTER(S) AND SUCCEEDING LETTERS OF INSTRUMENT IDENTIFICATION, REFER TO ISA TABLE W: UNIT PROCESS NUMBER X: LOOP NUMBER Y: UNIT NUMBER, USED FOR MULTIPLE SETS WITH THE SAME X-Y DESIGNATION Z: SET NUMBER, USED FOR MULTIPLE SETS OF UNITS WITH THE SAME W-X-Y DESIGNATION N: NUMBER OF UNITS C: INSTALLATION REQUIREMENT: e.p.: CLASS 1 DIVISION 1 HAZARDOUS LOCATION i.s.: INTRINSICALLY SAFE, INSTALLED IN CLASS I, DIVISION 1 HAZARDOUS LOCATION Q: PROVISION REQUIREMENT: *: EXISTING, RE-USED EQUIPMENT **: EQUIPMENT SPECIFIED UNDER DIVISION 22, 23, 33, 40, OR 44 ***: FUTURE EQUIPMENT BLANK: EQUIPMENT SPECIFIED UNDER DIVISION 26		FIELD DEVICE CONTROL, PANEL DEVICE, FRONT-OF-PANEL, NORMALLY ACCESSIBLE CONTROL, PANEL DEVICE, BACK-OF-PANEL, NOT NORMALLY ACCESSIBLE MCC DEVICE, FRONT-OF-PANEL, NORMALLY ACCESSIBLE FULL VOLTAGE MOTOR CONTROLLER, XX INDICATES LOCATION PROGRAMMABLE LOGIC CONTROLLER INPUT/OUTPUT POINT WHERE Y=QUANTITY AND XX DI: DIGITAL INPUT DO: DIGITAL OUTPUT AI: ANALOG INPUT AO: ANALOG OUTPUT NETWORK (DEVICENT, ETC) CONTROL SYSTEM INPUT/OUTPUT POINT WHERE Y=QUANTITY AND XX DI: DIGITAL INPUT DO: DIGITAL OUTPUT AI: ANALOG INPUT AO: ANALOG OUTPUT		MCC DEVICE, BACK-OF-PANEL, NOT NORMALLY ACCESSIBLE SOFTWARE DEVICE OR FUNCTION, NORMALLY ACCESSIBLE SOFTWARE DEVICE OR FUNCTION, NOT NORMALLY ACCESSIBLE SOFTWARE ALARM FUNCTION, NORMALLY ACCESSIBLE INTERLOCK FUNCTION, REFER TO SPECIFICATIONS MOTOR CONTROLLER, XX INDICATES TYPE OF CONTROLLER AND YY INDICATES LOCATION NON-CONNECTING LINES CONNECTING LINES PARALLEL LINES (PARENTHEUSAL NUMBER INDICATES THE NUMBER OF SIGNALS REPRESENTED)
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MCC COMPARTMENT

FRAME SIZE TRIP SETTING

CONTACTOR TYPE CONTACTOR SIZE

OVERLOAD TYPE O.L.

MOTOR CIRCUIT, SEE SCHEDULE XX=FEEDER

MOTOR, YY=HORSEPOWER

FULL VOLTAGE MOTOR CONTROLLER

MCC COMPARTMENT

FRAME SIZE TRIP SETTING

INPUT FUSE

CONTACTOR TYPE CONTACTOR SIZE

LINE REACTOR

AFD TYPE LOAD

MOTOR CIRCUIT, SEE SCHEDULE XX=FEEDER

MOTOR, YY=HORSEPOWER

ADJUSTABLE FREQUENCY DRIVE MOTOR CONTROLLER

MCC COMPARTMENT

FRAME SIZE TRIP SETTING

INPUT FUSE

CONTACTOR TYPE CONTACTOR SIZE

U.H.F. UNIVERSAL HARMONIC FILTER

AFD TYPE LOAD

MOTOR CIRCUIT, SEE SCHEDULE XX=FEEDER

MOTOR, YY=HORSEPOWER

ADJUSTABLE FREQUENCY DRIVE MOTOR CONTROLLER

MCC COMPARTMENT

FRAME SIZE TRIP SETTING

INPUT FUSE

CONTACTOR TYPE CONTACTOR SIZE

LINE REACTOR

AFD TYPE LOAD

CONTACTOR TYPE CONTACTOR SIZE

MOTOR CIRCUIT, SEE SCHEDULE XX=FEEDER

MOTOR, YY=HORSEPOWER

ADJUSTABLE FREQUENCY DRIVE MOTOR CONTROLLER WITH FULL VOLTAGE BACK-UP

LIVE FRONT TERMINATION

TAG NUMBER

KVA RATING

PRIMARY VOLTAGE RATING

SECONDARY VOLTAGE RATING

IMPEDANCE

SECONDARY TERMINATION

MEDIUM VOLTAGE TRANSFORMER

MCC COMPARTMENT

FRAME SIZE TRIP SETTING

MCC COMPARTMENT

FRAME SIZE TRIP SETTING

LOCATION

L-1 = LOAD INTERRUPTER AMPACITY

P-F = POWER FUSE RATING

LIVE FRONT TERMINATION

MEDIUM VOLTAGE SWITCH

LOCATION

L-1 = LOAD INTERRUPTER AMPACITY

F-1 = FAULT INTERRUPTER RATING

DEAD FRONT TERMINATION

MEDIUM VOLTAGE SWITCH

LOCATION

L-1 = LOAD INTERRUPTER AMPACITY

DEAD FRONT TERMINATION

MEDIUM VOLTAGE SWITCH

SINGLE POLE SWITCH, 2-2POLE, 3-3 WAY, 4-4 WAY, P=PILOT R=RELAY, K=KEYED, I=ILLUMINATED, D=DIMMER M=MOMENTARY CONTACT SIMPLEX RECEPTACLE XP=EXPLOSION PROOF, DUPLEX RECEPTACLE C=CORROSION RESISTANT DUPLEX RECEPTACLE LOWER HALF SWITCHED POWER RECEPTACLE 240V 30=30AMP 60=60AMP R = 50A RANGE OUTLET D = 30A DRYER OUTLET DUPLEX RECEPTACLE MOUNTED ABOVE COUNTER GFI GROUND FAULT INTERRUPTER RECEPTACLE EQUIPMENT CONNECTION SPECIAL OUTLET DATA OUTLET, SEE DETAILS. TELEPHONE OUTLET, SEE DETAILS COMBINATION TELEPHONE/DATA OUTLET. TELEPHONE OUTLET FLOOR TYPE, "F" INDICATES FLUSH MOUNT, "S" INDICATES SURFACE MOUNT. TELEPHONE/DATA OUTLET FLOOR TYPE, "F" INDICATES FLUSH MOUNT, "S" INDICATES SURFACE MOUNT. DATA OUTLET FLOOR TYPE, "F" INDICATES FLUSH MOUNT, "S" INDICATES SURFACE MOUNT. EQUIPMENT CONNECTION, CIRCUIT AS SHOWN FLEXIBLE CORD CONNECTION, TYPE SO CORD REQUIRED ELECTRIC BASEBOARD HEATER, WIRE HVAC SUPPLIED STARTERS, PROVIDE DISC. AS REQD. REFERS TO NOTE WITH NUMBER X REFERS TO DETAIL WITH NUMBER XX XXXXX-XX ATS AUTOMATIC TRANSFER SWITCH TS MANUAL TRANSFER SWITCH xxA DISCONNECT SWITCH xxA/yAT FUSED DISCONNECT SWITCH xxA/yAT CIRCUIT BREAKER xxA DISCONNECT SWITCH xxA/yAT FUSED DISCONNECT SWITCH AFD ADJUSTABLE FREQUENCY DRIVE MS MANUAL STARTER RV x NEMA x MAGNETIC MOTOR STARTER "RV" INDICATES REDUCED VOLTAGE F x xxA/yAT NEMA x/xxA-xP COMBINATION MAGNETIC MOTOR STARTER AND DISCONNECT SWITCH MOTOR CONNECTION	COND. WITH BUSHING ON END BOX AROUND OUTLET INDICATES COMBINATION OUTLET IN COMMON BOX DEVICE MOUNTED AT RECEPTACLE HEIGHT. SAME AS ABOVE EXCEPT DEVICE MOUNTED AT 100° TO BOTTOM. WIREMOLD PLUG STRIP FA FIRE ALARM HORN/STROBE UNIT FI FIRE ALARM INDICATOR FOR SMOKE DETECTORS FS FIRE ALARM STATION S STROBE FACP FIRE ALARM CONTROL PANEL FAP FIRE ALARM ANNUNCIATOR PANEL ARS AREA OF RESCUE STATION ARMS AREA OF RESCUE MASTER ARIS AREA OF RESCUE ILLUMINATED SIGN HD HEAT DETECTOR SD SMOKE DETECTOR DSD DUCT SMOKE DETECTOR ESD ELEVATOR SMOKE DETECTOR MD MAGNETIC DOOR HOLDER SDO SMOKE DOOR OPERATOR/DETECTOR P PSY PAGING SYSTEM HANDSET PPS PAGING SYSTEM SPEAKER SSM SECURITY SYSTEM MOTION DETECTOR DS DOOR SWITCH, SEE DETAIL DC DOOR CONTROL LS LIMIT SWITCH DTL DUAL TECHNOLOGY MOTION DETECTOR LIGHTING IKP INTRUSION ALARM KEY PAD WT WALL MOUNTED THERMOSTAT, V=LOW VOLTAGE PLF POLE MOUNTED LIGHT FIXTURE IFI INC. OR HID FIXTURE FLUSH OR SURFACE MOUNTED IWS INC. OR HID WALL MOUNTED, FLUSH OR SURFACE FF FLUORESCENT FIXTURE EL EMERGENCY LIGHT ELX EXIT LIGHT RELH REMOTE EMERGENCY LIGHT HEAD JB J-BOX JB J-BOX
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	PLUG VALVE		SIZE		THREE-WAY VALVE		ELECTRICALLY ACTUATED BUTTERFLY VALVE		SOLENOID OPERATED THREE-WAY VALVE		BUTTERFLY VALVE
	REDUCER		X"X"X"		FLEX COUPLING		=		FLANGED CONNECTION		PINCH VALVE
	BALL CHECK VALVE		E		PRESSURE REGULATOR		NEEDLE VALVE		NEEDLE VALVE		DRAIN
	ELECTRICALLY ACTUATED GATE VALVE		B		GLOBE VALVE		DRIP TRAP		DRIP TRAP		CHECK VALVE
	Y-STRAINER		SIZE		PRESSURE REGULATOR, SELF CONTAINED		SIZE		PRESSURE RELIEF VALVE		AIR/VACUUM RELIEF VALVE

Ax = 2C#16 SHIELDED, TWISTED PAIR CABLE	
Dx = #14 THIN WIRE (x = NUMBER OF WIRES)	
Mx = 1" CONDUIT FOR CABLE SUPPLIED BY MANUFACTURER BY MFG. (n=NUMBER OF CONDUITS)	
Px = #12 & #12G in (1) 3/4" (x=NUMBER OF WIRES)	
E = ETHERNET	
	SOFTWARE SIGNAL/FUNCTION
	ANALOG SIGNAL, +20mADC OR PULSE FREQUENCY
	PULSE FREQUENCY
	DISCRETE SIGNAL, DRY CONTACT
	MANUFACTURER'S SIGNAL
	PNEUMATIC SIGNAL
	MAJOR PROCESS
	MINOR PROCESS

1. SIZE CONDUIT PER NEC, MINIMUM SIZE 3/4".
2. PROVIDE SEPARATE CONDUITS FOR THE FOLLOWING:
 - a. 4-20mADC
 - b. 120 VOLT CONTROL
 - c. 120 VOLT POWER
 - d. 480 VOLT POWER
 - e. LOW VOLTAGE INSTRUMENTATION
 - f. COMMUNICATION
3. REFER TO SPECIFICATION 16900 FOR DETAILS ON VARIOUS LOOP FUNCTIONS AS WELL AS DETAILS REGARDING OPERATOR INTERFACE FUNCTIONS.
4. REFER TO DIVISION 11000, 13000, 15000 FOR ADDITIONAL DETAILS REGARDING INSTRUMENTATION AND CONTROL EQUIPMENT FURNISHED UNDER THOSE SPECIFICATIONS.
5. (1) 1-1/2" REFERS TO NUMBER OF WIRES AND SIZE OF WIRE REQUIRED, WHILE AS:
 - (1) = ONE WIRE
 - 1-1/2" = THE SIZE OF WIRE REQUIRED

1. (X) #12 & #12G

REFERS TO NUMBER OF WIRE(S) AND SIZE OF WIRE(S) REQUIRED, WHERE AS:

(1) = ONE WIRE
#12 = THE SIZE OF WIRE REQUIRED
G = GROUND WIRE

2. (X) 1-1/2" C

REFERS TO NUMBER OF CONDUIT(S) AND SIZE OF CONDUIT(S) REQUIRED, WHERE AS:

(1) = ONE CONDUIT
1-1/2" C = THE SIZE OF CONDUIT REQUIRED

* REFER TO DRAWINGS FOR REQ'D WIRE AND CONDUIT SIZES AND AMOUNTS

AJD	ADJUSTABLE FREQUENCY DRIVE	EM	EMERGENCY	KVA	KILOVOLT-AMPERES	PC	PHOTO CONTROL
AFG	ABOVE FINISH GRADE	EP	CLASS 1 DIV. 1 EQUIPMENT	KW	KILOWATTS	PPR	PHASE FAIL RELAY
AHU	AIR HANDLING UNIT	EUH	ELECTRIC UNIT HEATER	MAU	MAKE-UP AIR UNIT	PVC	POLYVINYL CHLORIDE
AUTO	AUTOMATIC	EWC	ELECTRIC WATER COOLER	M.C.	MECHANICAL CONTRACTOR	REQD	REQUIRED
AUX	AUXILIARY	EWI	ELECTRIC WALL HEATER	MCC	MOTOR CONTROL CENTER	SPEC	SPECIFICATION
AWG	AMERICAN WIRE GAUGE	FBO	FURNISHED BY OTHERS	MFR	MANUFACTURER	SPD	160KA/PHASE MINIMUM SURGE PROTECTIVE DEVICE
BKR	BREAKER	G	GROUND	MS-AUX	MOTOR STARTER AUXILIARY	SS	STAINLESS STEEL
C	CONDUIT	G.C.	GENERAL CONTRACTOR	mA	MILLIAMPERE	TS	7 DAY TIMECLOCK PROVIDED BY ELECTRICAL CONTRACTOR
CB	CIRCUIT BREAKER	GFI	GROUND FAULT INTERRUPTER	mV	MILLIVOLT	UHS	UNINTERRUPTIBLE POWER SUPPLY
CKT	CIRCUIT	GND	GROUND	mod	MOTOR OPERATED DAMPER	UH	UNIT HEATER
CU	COPPER	HVAC	HEATING, VENTILATING & AIR CONDITIONING	NL	NIGHTLIGHT	UPS	UNINTERRUPTIBLE POWER SUPPLY
DISC	DISCONNECT	HTR	HEATER	N.O.	NORMALLY OPEN	W/	WITH
E.C.	ELECTRICAL CONTRACTOR	I.S.	INTRINSICALLY SAFE	N.C.	NORMALLY CLOSED	WH	WATER HEATER
ECB	ENCLOSED CIRCUIT BREAKER	IO	INPUT/OUTPUT	NF	NON-FUSED	WP	WEATHER PROOF
EDH	ELECTRIC DUCT HEATER	IG	ISOLATED GROUND	NTS	NOT TO SCALE	XFMR	TRANSFORMER
EF	EXHAUST FAN	J-BOX	JUNCTION BOX	O.H.	OVERLOAD	XL	CROSS LINKED POLYETHYLENE
ELEV	ELEVATION	KV	KILOVOLTS	OLD	OVER HEAD DOOR		

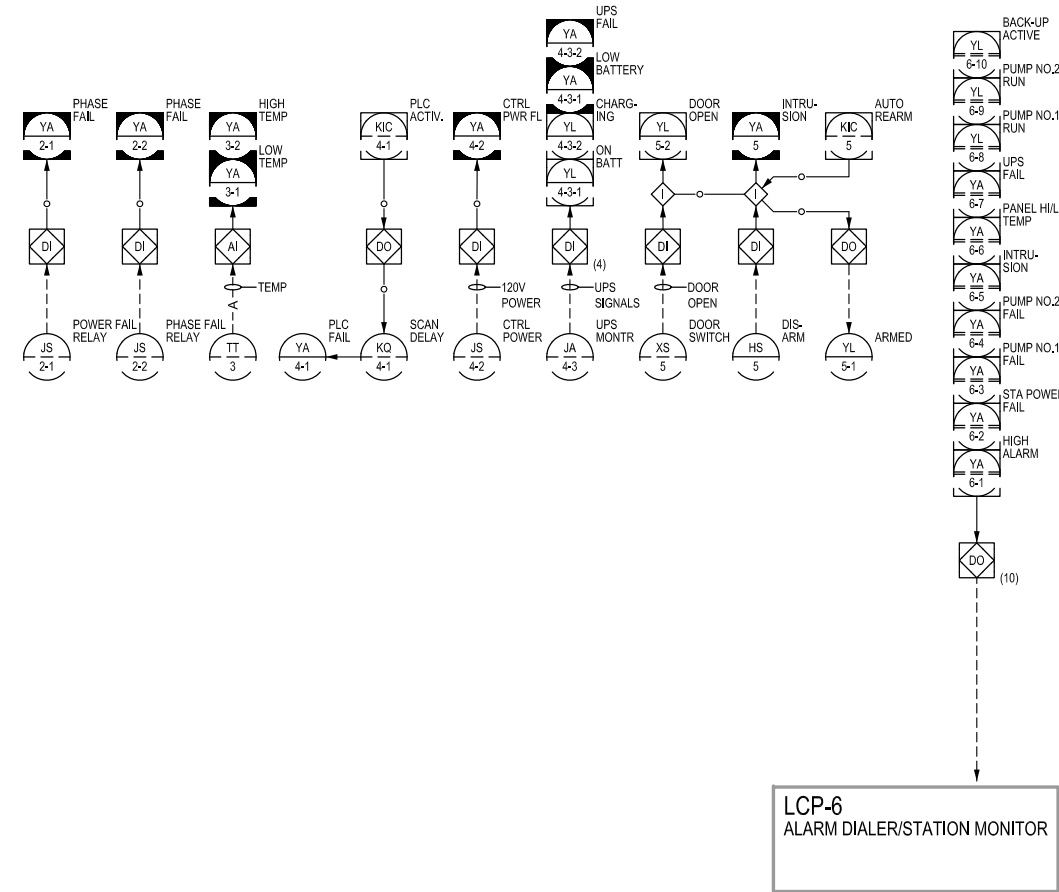
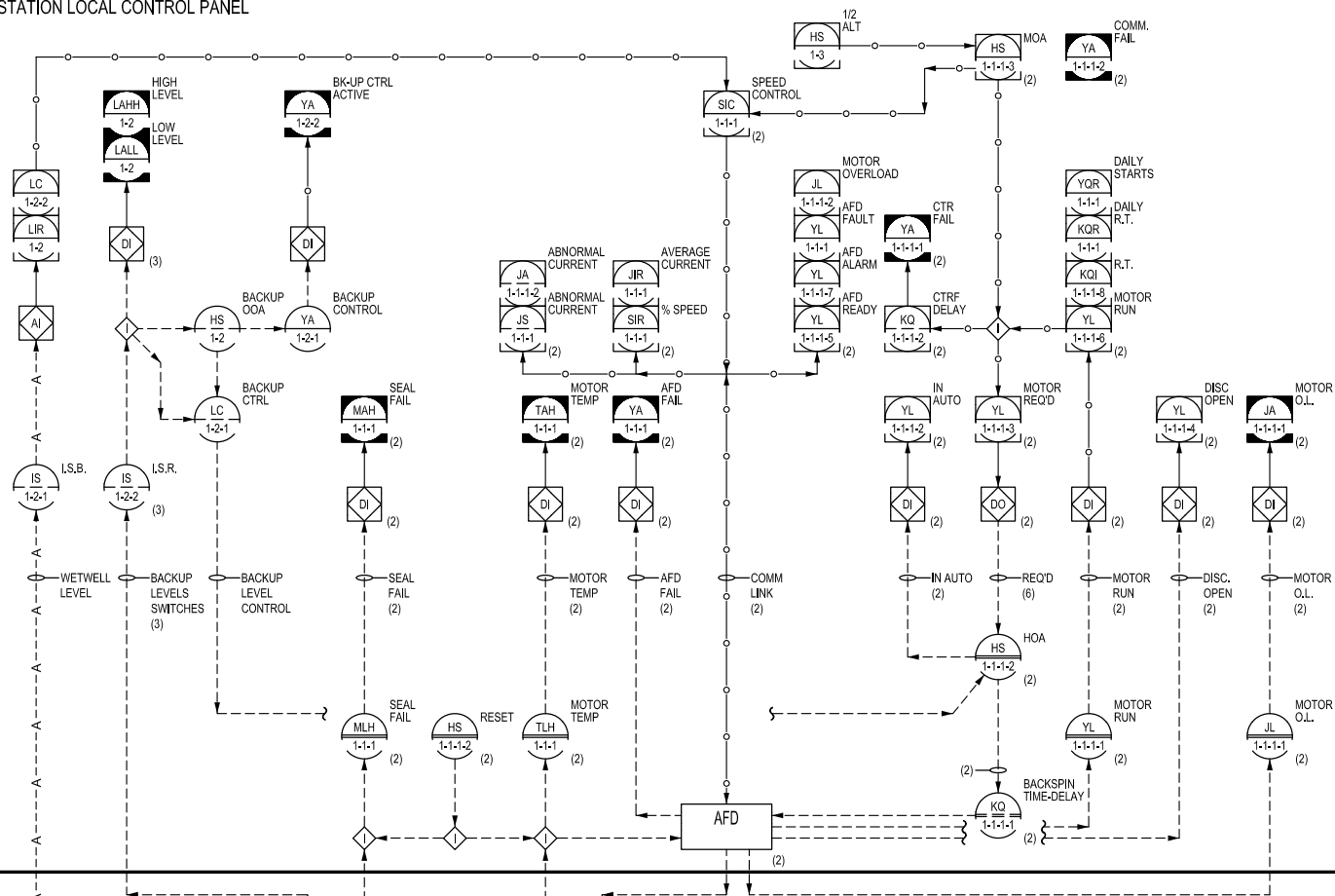
1. THIS DRAWING IS A STANDARD LEGEND. SYMBOLS SHOWN MAY NOT ALL APPEAR ON DRAWINGS FOR THIS PROJECT.
2. ALL CONTACTS ARE SHOWN IN THE DE-ENERGIZED (SHELF) POSITION. BI-STABLE RELAYS ARE SHOWN IN THE RESET POSITION.
3. ONE-LINE DIAGRAMS FOR POWER SWITCHGEAR, USE ANSI STANDARD SYMBOLS AND ABBREVIATIONS.
4. SEE INSTRUMENTATION DRAWINGS FOR INSTRUMENTATION SYMBOLS AND DETAILS.
5. OTHER ABBREVIATIONS PER ANSI 232.13 AND ISA 55.1.
6. ELEVATIONS ADJACENT TO SYMBOLS ARE BASED ON STATION DATUM. HEIGHTS ADJACENT TO SYMBOLS (+4.0') ARE REFERENCED TO FINISHED FLOOR GRADE.
7. THE LETTERS "GF" ADJACENT TO A RECEPTACLE INDICATES A GROUND FAULT INTERRUPTER FEED-THROUGH RECEPTACLE ASSEMBLY. THE LETTERS ADJACENT TO A PANELBOARD CIRCUIT BREAKER INDICATES A GROUND FAULT CIRCUIT BREAKER. THE LETTERS "IG" INDICATE AN ISOLATED GROUND RECEPTACLE. PROVIDE SEPARATE GROUND WIRE.
8. SEE SPECIFICATIONS AND SCHEDULES FOR COMPONENT REQUIREMENTS FOR MOTOR CONTROLLERS AND FOR CONTACTORS.

NO	DATE	BY	REVISION DESCRIPTION

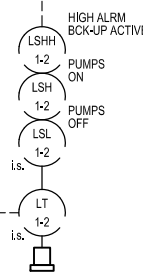


M.15

LCP-1
STORM FLOW PUMP STATION LOCAL CONTROL PANEL



STORM INLET



STORM WATER PUMPING

STORM SEWER

STORM WATER PUMP STATION
MONITORING

PROJECT NO: 16W021.01
PROJECT DATE: OCTOBER 2016
CAD DATE: 2/15/17 2:18 PM
CAD FILE: M.16 P&ID.dwg

DESIGNED BY: SRM
CHECKED BY: SRM
DRAWN BY: DIG

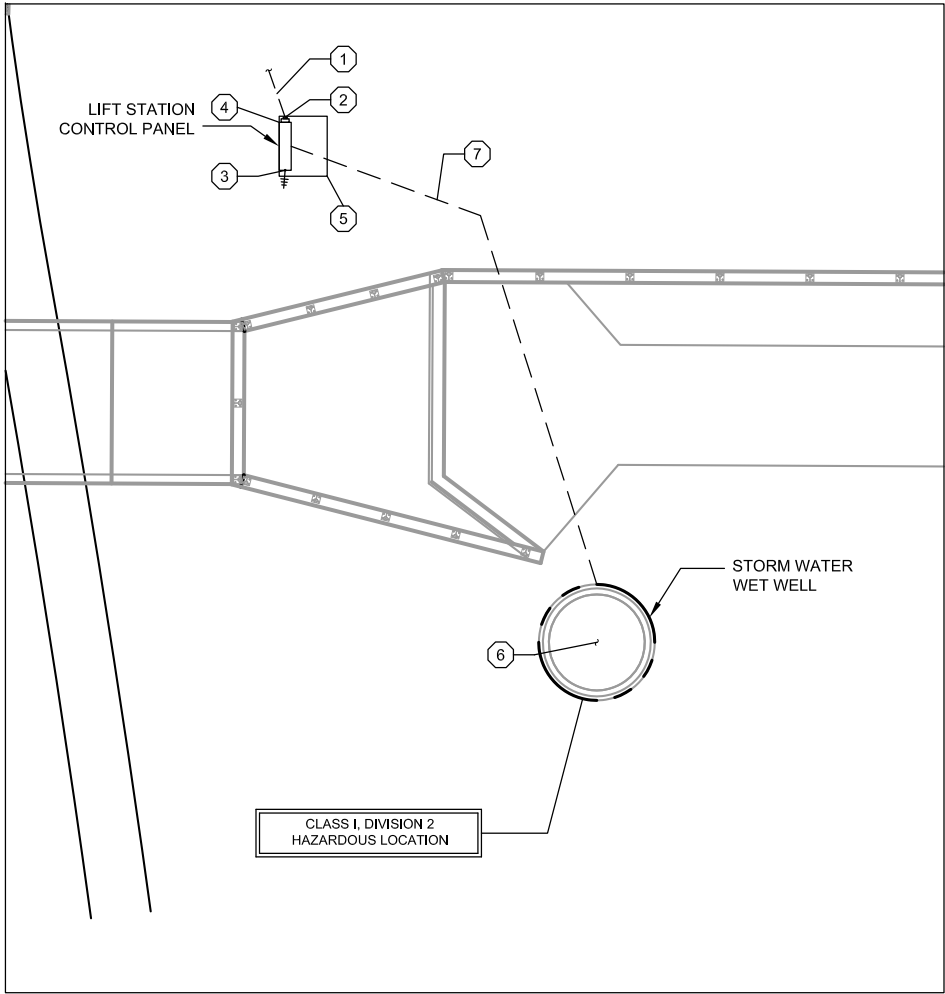
NO	DATE	BY	REVISION DESCRIPTION



SE ALICES ROAD IMPROVEMENTS
UNIVERSITY AVENUE TO NORTH OF SE OLSON DRIVE
CITY OF WAUKEE, IA - STP-U-8177(619)-70-25

P&ID
PIPING & INSTRUMENTATION DIAGRAMS

SHEET NO.
M.16

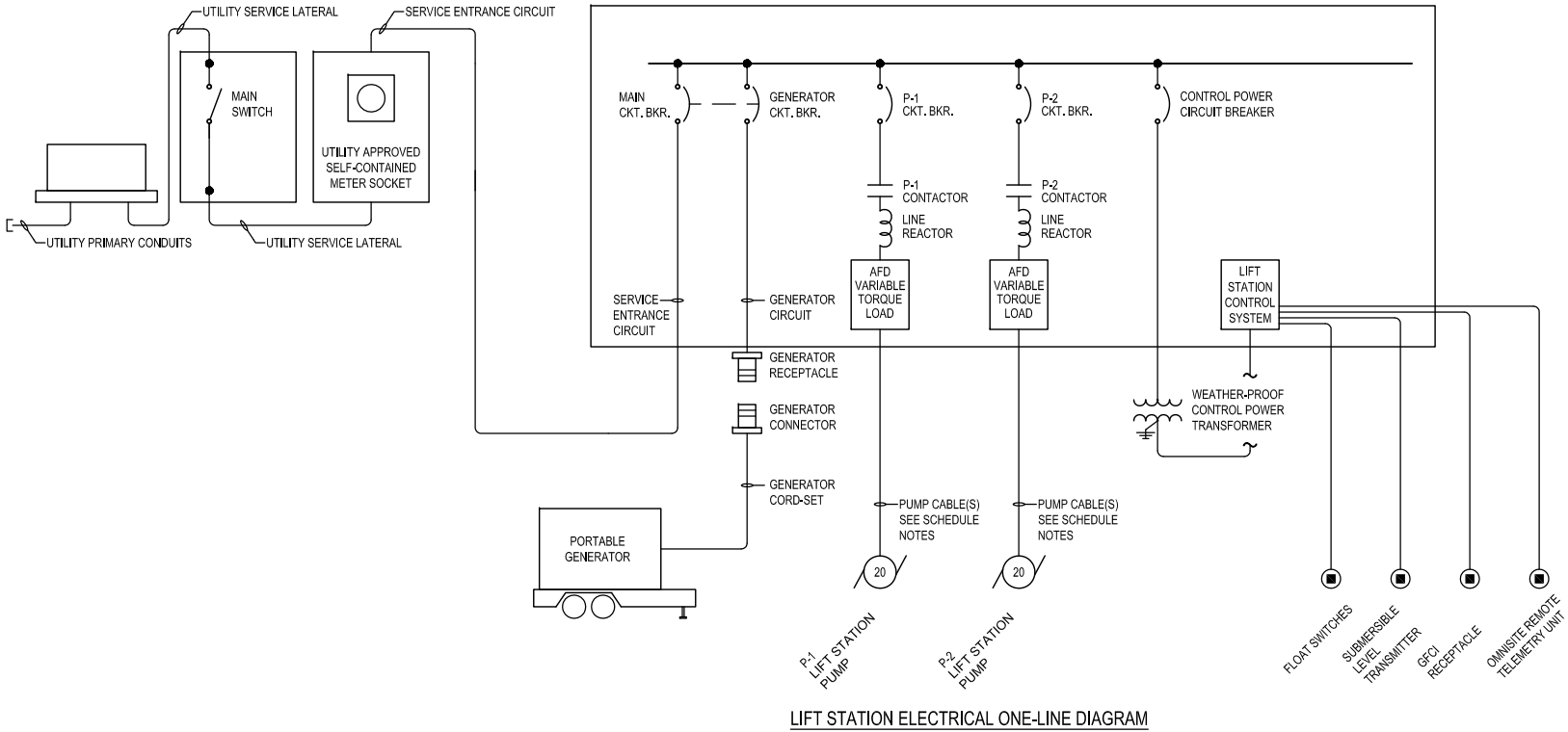


LIFT STATION - ELECTRICAL SITE PLAN



NEW SITE PLAN NOTES:

1. STUB CONDUIT OUT 36", 30" BFG. FOR INCOMING UTILITY SERVICE, PER UTILITY REQUIREMENTS. COORDINATE EXACT LOCATION WITH UTILITY. SEE SITE/CIVIL DRAWING FOR TRANSFORMER PAD LOCATION. INSTALL RACEWAY PER DETAIL 2605-310
2. PROVIDE NEW NON-FUSED DISCONNECT AND UTILITY APPROVED METER SOCKET. PROVIDE HOLE FOR INSTALLATION OF A PADLOCK AND A UTILITY SEAL WITH THE DISCONNECT IN THE "ON" POSITION.
3. TELEMETRY RADIO ANTENNA FURNISHED BY OMNISITE AND INSTALLED BY LIFT STATION CONTROL PANEL PROVIDER.
4. PROVIDE LIFT STATION CONTROL PANEL. INSTALL PER DETAIL 2690-820.
5. CONCRETE SLAB. SEE CIVIL DRAWINGS FOR STRUCTURAL REQUIREMENTS.
6. FLOAT AND TRANSDUCERS LOCATED IN LIFT STATION WETWELL. SEE DETAILS 2690-000 AND 2690-051 FOR MOUNTING REQUIREMENTS.
7. PROVIDE UNDERGROUND RACEWAY FOR FOR CIRCUITS SERVING THE PUMP STATION. INSTALL RACEWAY PER DETAIL 2605-310:
 - 7.1. (2) 2-1/2" 480 VAC MOTOR FEEDERS
 - 7.2. (2) 2" INTRINSICALLY SAFE DISCRETE
 - 7.3. (1) 2" INTRINSICALLY SAFE ANALOG



WAUKEE HEART OF THE WARRIOR TRAIL STORM WATER LIFT STATION ELECTRICAL DATA													
ELECTRIC SERVICE ENTRANCE						PUMP DATA					STAND-BY POWER EQUIPMENT		
VOLTAGE	AMPACITY	SERVICE LATERAL	UTILITY METER LOAD BREAK SWITCH	SERVICE ENTRANCE CIRCUIT	SERVICE DISCONNECT SWITCH	HORSEPOWER	CIRCUIT BREAKER	CONTACTOR	SSRV	AFD	CABLE(S)	PORTABLE GENERATOR	AUTOMATIC TRANSFER SWITCH
480/277V 3Ø 4W	100A	1-3"	100A/3Ø 4W/NF	4#3 & #8G IN 1-1 1/4"C	100A/3Ø 4W/100AF	20	150AF/50AT - MCP	FVNR - SIZE 2		X	1	55 KW	N/A
NOTES: 1. COORDINATE WITH PUMP MANUFACTURER AND DETERMINE NUMBER AND SIZE OF PUMP CABLES. SIGNAL CABLE FOR HIGH TEMPERATURE AND SEAL FAIL SENSOR WIRING MAY BE PROVIDED AS A SEPARATE CABLE OR INTEGRAL TO THE PUMP POWER CABLE BASED ON PUMP MANUFACTURER DESIGN. SIZE PUMP CABLE CONDUITS AS NEEDED TO SATISFY NEC REQUIREMENTS FOR CONDUIT FILL. PUMP SENSOR CABLES MAY BE ROUTED IN SAME CONDUIT AS PUMP POWER CABLES. 2. PANEL AND CIRCUIT BREAKERS SHALL BE RATED 35KAIC.													

LIFT STATION ELECTRICAL REQUIREMENTS:

1. UTILITY PAD-MOUNTED TRANSFORMER: CONCRETE TRANSFORMER PAD PROVIDED BY CONTRACTOR PER UTILITY CO REQUIREMENTS. UTILITY COMPANY FURNISHED TRANSFORMERS SHALL BE PROVIDED TO SERVE THE SCHEDULED ELECTRIC LOADS.
2. UTILITY SERVICE LATERAL: PROVIDE CONDUITS FOR UTILITY INSTALLATION OF SERVICE LATERAL CONDUCTORS AS SCHEDULED.
3. UTILITY METER LOAD-BREAK SWITCH: PROVIDE NON-FUSIBLE DISCONNECT SWITCH PER UTILITY REQUIREMENTS AND AS SCHEDULED.
4. UTILITY APPROVED SELF-CONTAINED METER SOCKET: PROVIDE METER SOCKET SUITABLE FOR THE ELECTRIC SERVICE SCHEDULED AND PER UTILITY REQUIREMENTS FOR UTILITY INSTALLATION OF METER.
5. SERVICE ENTRANCE CIRCUIT: PROVIDE SERVICE ENTRANCE CIRCUIT AS SCHEDULED.
6. SERVICE DISCONNECT SWITCH: SERVICE ENTRANCE DISCONNECT SHALL BE CONTAINED WITHIN THE LIFT STATION CONTROL PANEL.
7. MANUAL TRANSFER SWITCH: MECHANICALLY INTERLOCKED MAIN DISCONNECT AND GENERATOR CIRCUIT BREAKERS SHALL SERVE AS A MANUAL TRANSFER SWITCH MECHANISM.
8. PORTABLE GENERATOR: PROVIDE PORTABLE GENERATOR, ENCLOSURE, FUEL SYSTEM, CORD(S) WITH REVERSE SERVICE CONNECTOR(S), AND TRAILER AS SPECIFIED.
9. GENERATOR CIRCUIT: PROVIDE GENERATOR CIRCUIT AS SCHEDULED.
10. LIFT STATION CONTROL PANEL COMPONENTS: PROVIDE LIFT STATION CONTROL PANEL INTERNAL COMPONENTS AS SCHEDULED.
12. P-1 & P-2 MOTOR CONTROLLERS: PROVIDE MOTOR CONTROL COMPONENTS AS SCHEDULED. INSTALL PUMP CABLES AS DETAILED. PUMP CABLES SHALL BE PROVIDED BY PUMP MANUFACTURER AND BE VFD RATED, SHIELDED CABLES SIZED FOR THE FULL LOAD OF THE PUMP MOTOR. PUMP CABLES MAY INCLUDE SENSOR (HIGH TEMPERATURE AND SEAL FAIL) WIRING OR SECOND CABLE MAY BE PROVIDED FOR THIS PURPOSE.
13. CONTROL POWER SYSTEM: CONTROL PANEL SUPPLIER SHALL BE RESPONSIBLE FOR SIZING CONTROL POWER COMPONENTS BASED ON THE CONNECTED LOAD OF THE BRANCH CIRCUITS FED BY THE CONTROL POWER SYSTEM.
14. FLOAT SWITCHES: PROVIDE AND INSTALL FOUR FLOAT SWITCHES AS DETAILED. FLOAT SWITCH CABLES SHALL BE INSTALLED IN ACCORDANCE WITH NEC REQUIREMENTS FOR INTRINSICALLY SAFE SYSTEMS. MANUFACTURER SUPPLIED CABLES SHALL BE ROUTED TO CONTROL PANEL AND SHALL NOT BE SPLICED.
15. SUBMERSIBLE LEVEL TRANSMITTER: PROVIDE AND INSTALL ONE SUBMERSIBLE LEVEL SENSOR AS DETAILED. LEVEL SENSOR CABLE SHALL BE INSTALLED IN ACCORDANCE WITH NEC REQUIREMENTS FOR INTRINSICALLY SAFE SYSTEMS. MANUFACTURER SUPPLIED CABLES SHALL BE ROUTED TO CONTROL PANEL AND SHALL NOT BE SPLICED.
16. EXTERIOR RECEPTACLE: PROVIDE AND INSTALL ONE GFCI RECEPTACLE ON THE LIFT STATION CONTROL PANEL DEADFRONT.

PROJECT NO: 16W021.01
PROJECT DATE: OCTOBER 2016
CAD DATE: 10/17/16
CAD FILE: M.17 PLAN & ONE-LINE.dwg
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CHECKED BY: SRM
DRAWN BY: DIG

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SE ALICES ROAD IMPROVEMENTS
UNIVERSITY AVENUE TO NORTH OF SE OLSON DRIVE
CITY OF WAUKEE, IA - STP-U-8177(619)-70-25

PLAN & ONE-LINE

SHEET NO.

M.17

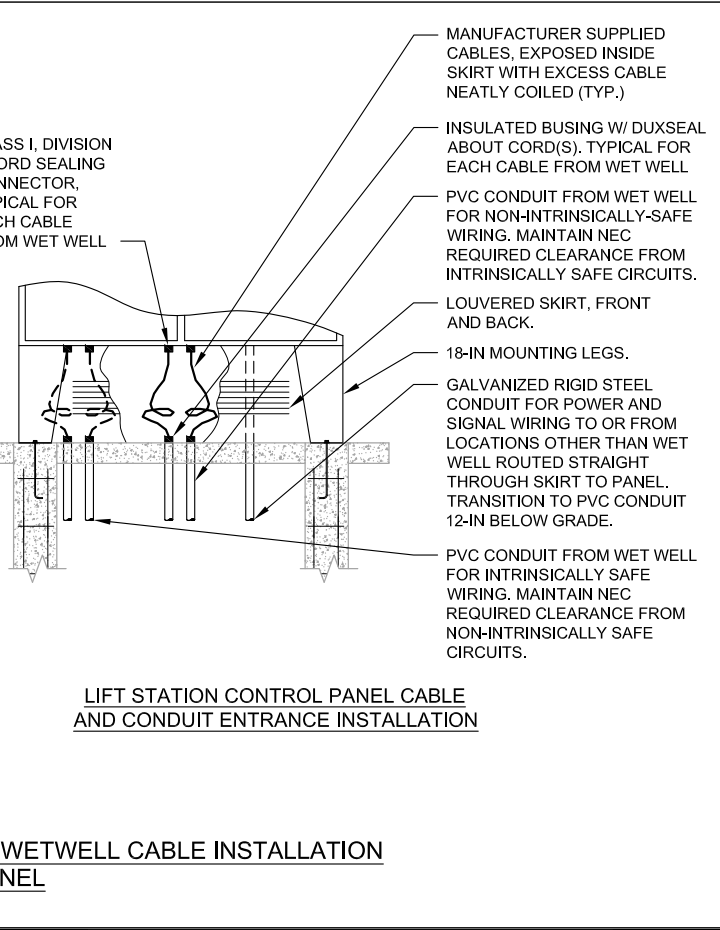
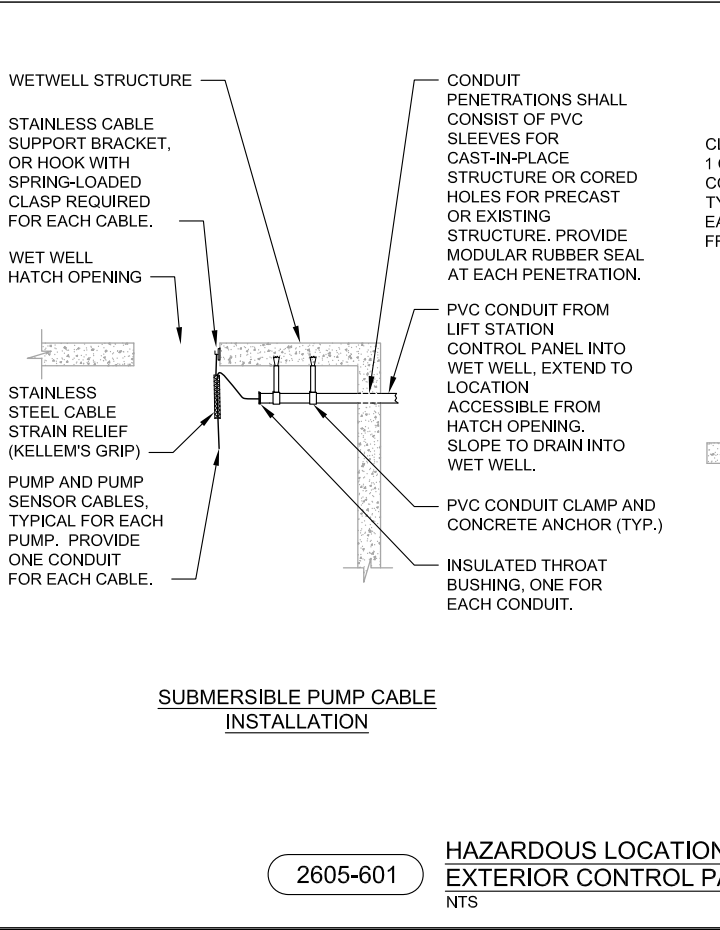
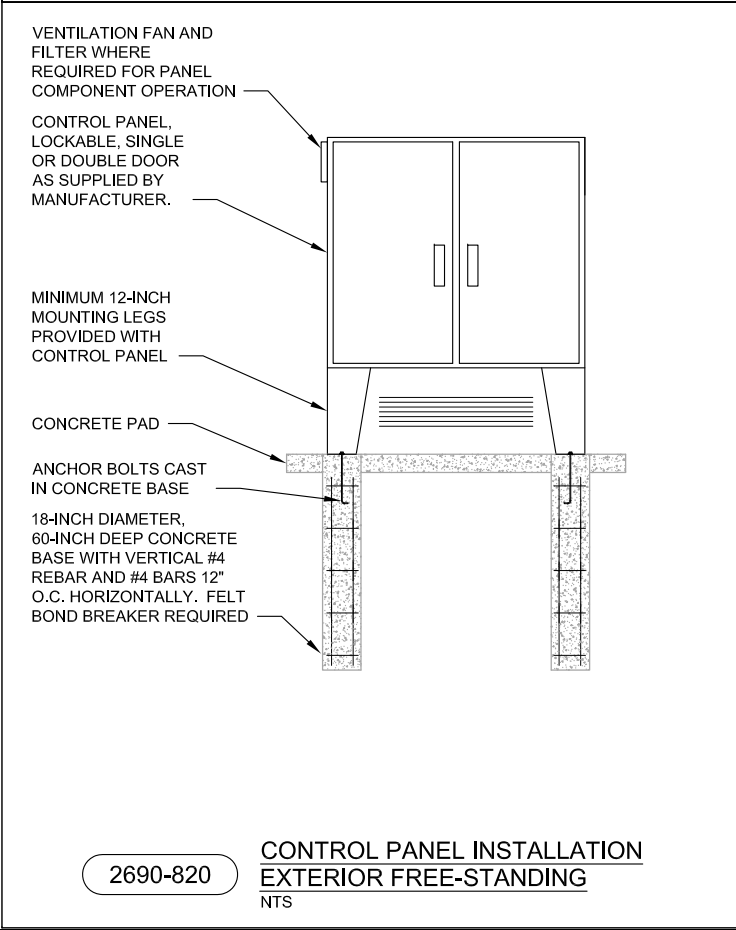
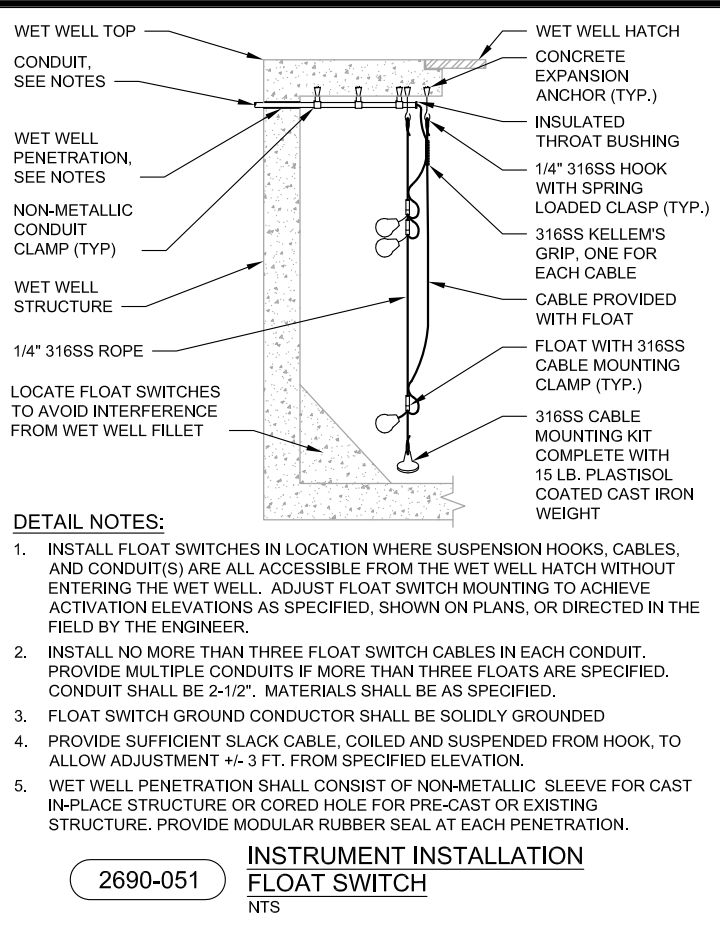
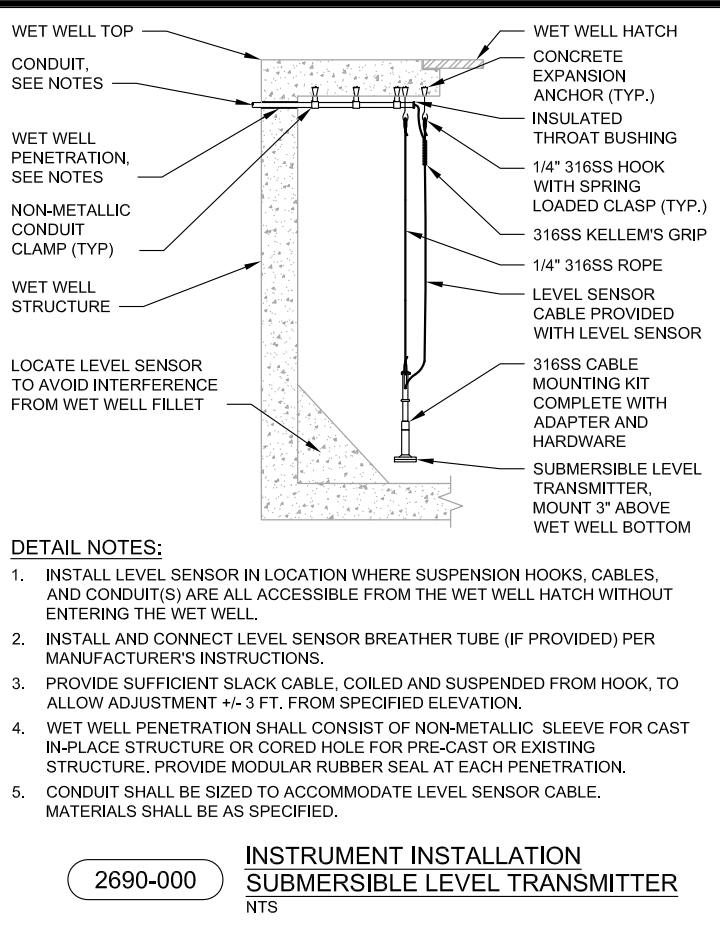
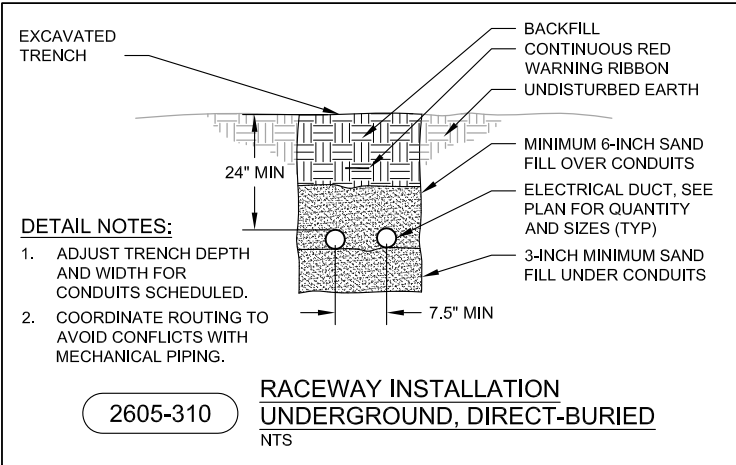
STORMWATER LIFT STATION: PROCESS INSTRUMENTATION AND EQUIPMENT WIRING SCHEDULE													
		FIRST SIGNAL/CONTROL HOMERUN			SECOND SIGNAL/CONTROL HOMERUN			POWER HOMERUN					
TAG NUMBER	DESCRIPTION	DESTINATION	WIRING TYPE	WIRING	DESTINATION	WIRING TYPE	WIRING	CIRCUIT	VOLTAGE	CKT.BKR.	WIRING	DETAIL	NOTES
TSH-1-1-1	TEMPERATURE SWITCH, HIGH, STORM FLOW PUMP NO.1 MOTOR	LCP	120VAC DISCRETE SIGNAL	D2									
ME-1-1-1	MOISTURE ELEMENT, STORM FLOW PUMP NO.1	LCP	120VAC DISCRETE SIGNAL	D2									
ME-1-1-2	MOISTURE ELEMENT, STORM FLOW PUMP NO.2	LCP	120VAC DISCRETE SIGNAL	D2									
TSH-1-1-2	TEMPERATURE SWITCH, HIGH, STORM FLOW PUMP NO.2 MOTOR	LCP	120VAC DISCRETE SIGNAL	D2									
LSL-1-2	LEVEL SWITCH, PUMPS OFF	LCP	I.S. DISCRETE SIGNAL	D2									
LSHH-1-2	LEVEL SWITCH, LAG ON HIGH ALARM/BACK-UP CONTROL ACTIVE	LCP	I.S. DISCRETE SIGNAL	D2									
LSH-1-2	LEVEL SWITCH, LEAD PUMP ON	LCP	I.S. DISCRETE SIGNAL	D2									
LT-1-2	LEVEL TRANSDUCER	LCP	I.S. ANALOG SIGNAL	A1									

LCP-1: CONTROL PANEL PLC I-O SCHEDULE						
RACK	SLOT	POINT	TYPE	DESCRIPTION		NOTES
00	00/00	N/A	N/A	MICROLOGIX 1400 PLC		
00	00/01	00	DI	LOW LEVEL, PUMPS OFF, STORMWATER WETWELL		
00	00/01	01	DI	LOW ALARM LEVEL, LEAD PUMP ON - BACK-UP, STORMWATER WETWELL		
00	00/01	02	DI	HIGH LEVEL, LAG PUMP ON, ACTIVATE BACK-UP, STORMWATER WETWELL		
00	00/01	03	DI	SPARE		
00	00/01	04	DI	HARDWIRED BACK-UP CONTROL ACTIVE		
00	00/01	05	DI	SEAL FAIL, STORMWATER PUMP NO.1		
00	00/01	06	DI	HIGH TEMPERATURE, STORMWATER PUMP NO.1 MOTOR		
00	00/01	07	DI	AFD FAIL, STORMWATER PUMP NO.1		
00	00/01	08	DI	IN AUTO, STORMWATER PUMP NO.1		
00	00/01	09	DI	RUN, STORMWATER PUMP NO.1		
00	00/01	10	DI	DISCONNECT OPEN, STORMWATER PUMP NO.1		
00	00/01	11	DI	MOTOR OVERLOAD, STORMWATER PUMP NO.1		
00	00/01	12	DI	SEAL FAIL, STORMWATER PUMP NO.2		
00	00/01	13	DI	HIGH TEMPERATURE, STORMWATER PUMP NO.2 MOTOR		
00	00/01	14	DI	AFD FAIL, STORMWATER PUMP NO.2		
00	00/01	15	DI	IN AUTO, STORMWATER PUMP NO.2		
00	00/01	16	DI	RUN, STORMWATER PUMP NO.2		
00	00/01	17	DI	DISCONNECT OPEN, STORMWATER PUMP NO.2		
00	00/01	18	DI	MOTOR OVERLOAD, STORMWATER PUMP NO.2		
00	00/01	19	DI	SPARE		
00	00/02	00	AI	LEVEL, STORMWATER WETWELL		
00	00/02	01	AI	PANEL TEMPERATURE		
00	00/02	02	AI	SPARE		
00	00/02	03	AI	SPARE		
00	00/03	00	DO	REQUIRED, STORMWATER PUMP NO.1		
00	00/03	01	DO	REQUIRED, STORMWATER PUMP NO.2		
00	00/03	02	DO	PLC HEARTBEAT		
00	00/03	03	DO	INTRUSION SYSTEM ARMED		
00	00/03	04	DO	SPARE		
00	00/03	05	DO	SPARE		
00	00/03	06	DO	SPARE		
00	00/03	07	DO	SPARE		
00	00/03	08	DO	SPARE		
00	00/03	09	DO	SPARE		
00	00/03	10	DO	SPARE		
00	00/03	11	DO	SPARE		

LCP-1: CONTROL PANEL PLC I-O SCHEDULE						
RACK	SLOT	POINT	TYPE	DESCRIPTION		NOTES
00	00/04	00	AO	SPARE		
00	00/04	01	AO	SPARE		
00	01	00	DI	STATION POWER FAIL		
00	01	01	DI	STATION PHASE FAIL		
00	01	02	DI	SPARE		
00	01	03	DI	SPARE		
00	01	04	DI	CONTROL POWER FAIL		
00	01	05	DI	UPS FAIL		
00	01	06	DI	UPS ON BATTERY		
00	01	07	DI	UPS CHARGING		
00	01	08	DI	UPS LOW BATTERY		
00	01	09	DI	PANEL DOOR OPEN		
00	01	10	DI	DISARM INTRUSION SYSTEM		
00	01	11	DI	SPARE		
00	01	12	DI	SPARE		
00	01	13	DI	SPARE		
00	01	14	DI	SPARE		
00	01	15	DI	SPARE		
00	02	00	DO	ALARM POINT, HIGH WETWELL LEVEL		
00	02	01	DO	ALARM POINT, STATION POWER FAIL		
00	02	02	DO	ALARM POINT, INTRUSION		
00	02	03	DO	ALARM POINT, PUMP NO.1 FAIL		
00	02	04	DO	ALARM POINT, PUMP NO.2 FAIL		
00	02	05	DO	ALARM POINT, HIGH/LOW PANEL TEMPERATURE		
00	02	06	DO	ALARM POINT, UPS FAIL		
00	02	07	DO	MONITORING POINT, PUMP NO.1 RUN		
00	02	08	DO	MONITORING POINT, PUMP NO.2 RUN		
00	02	09	DO	BACK-UP CONTROL ACTIVE		
00	02	10	DO	SPARE		
00	02	11	DO	SPARE		
00	02	12	DO	SPARE		
00	02	13	DO	SPARE		
00	02	14	DO	SPARE		
00	02	15	DO	SPARE		

NO	DATE	BY	REVISION	DESCRIPTION





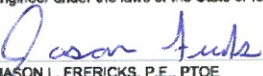
SIGNAL LEGEND

SYMBOL/LABEL	DESCRIPTION
	POWER SOURCE
	CABINET AND CONTROLLER
	FIBER OPTIC HUB CABINET
	BATTERY BACKUP CABINET
 ①	TRAFFIC SIGNAL POLE, FOOTING SYMBOL, AND IDENTIFYING NUMBER
 ③	PEDESTAL POLE, FOOTING SYMBOL, AND IDENTIFYING NUMBER
 ①	WOODEN SIGNAL POLE AND IDENTIFYING NUMBER
 81	TRAFFIC SIGNAL HEAD WITH BACKPLATE SYMBOL AND IDENTIFYING NUMBER
 23	TRAFFIC SIGNAL HEAD SYMBOL AND IDENTIFYING NUMBER
 25	PEDESTRIAN HEAD SYMBOL AND IDENTIFYING NUMBER
 323	PEDESTRIAN PUSHBUTTON IDENTIFYING NUMBER
 C	MAST ARM MOUNTED SIGN SYMBOL AND IDENTIFYING NUMBER
	PTZ CAMERA
	MICROWAVE DETECTOR
	EMERGENCY VEHICLE PREEMPTION
	LUMINAIRE
 31	DETECTOR LOOP SYMBOL AND IDENTIFYING NUMBER
 42	VIDEO DETECTION AREA SYMBOL AND IDENTIFYING NUMBER
 4	24" HANDHOLE (TYPE I) SYMBOL AND IDENTIFYING NUMBER
 1	30"x48" "TUB" HANDHOLE (TYPE III) SYMBOL AND IDENTIFYING NUMBER
---	-TRENCHED SIGNAL CONDUIT
- - - -	-PUSHED SIGNAL CONDUIT
LABELS WITH AN IDENTIFYING NUMBER FOLLOWED BY THE LETTER "E" REPRESENT EXISTING EQUIPMENT.	
LABELS WITH AN IDENTIFYING NUMBER FOLLOWED BY THE LETTER "F" REPRESENT FUTURE EQUIPMENT AND WILL NOT INCLUDED IN THIS PROJECT.	
 1E	EXISTING TRAFFIC SIGNAL POLE, FOOTING SYMBOL, AND IDENTIFYING NUMBER
 4E	EXISTING JUNCTION BOX SYMBOL AND IDENTIFYING NUMBER
— TS —	EXISTING SIGNAL CONDUIT

TRAFFIC SIGNAL PROJECT NOTES

- ALL QUANTITIES SHOWN IN THE PLANS AND SPECIFICATIONS ARE FOR INFORMATIONAL AND ESTIMATING PURPOSES ONLY. THE CONTRACTOR'S LUMP SUM BID FOR THIS BID ITEM SHALL INCLUDE ALL LABOR, TOOLS, EQUIPMENT, AND MATERIALS NECESSARY TO PROVIDE A COMPLETE AND FUNCTIONAL TRAFFIC SIGNAL INSTALLATION AND FIBER SYSTEM INCLUDING TRAFFIC CONTROL AND MOBILIZATION COSTS, IN CONFORMANCE WITH THE PLANS, SPECIFICATIONS, AND SPECIAL PROVISIONS.
- THE PLAN LOCATIONS OF UNDERGROUND UTILITIES ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL NOTIFY ALL UTILITY COMPANIES, INCLUDING CITY AND/OR STATE OWNED UTILITIES, PRIOR TO EXCAVATION ON THE PROJECT AND PRIOR TO ORDERING POLES FOR THE PURPOSE OF VERIFYING MAST-ARM LENGTHS.
- THE LOCATIONS OF ALL FOOTINGS, HANDHOLES, AND CONDUIT ARE TO BE COORDINATED WITH THE CITY OF WAUKEE AND THE ENGINEER AND ARE SUBJECT TO ADJUSTMENT IN THE FIELD BY THE ENGINEER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY CHANGES IMPLEMENTED WITHOUT WRITTEN APPROVAL FROM THE CITY OF WAUKEE ENGINEERING DEPARTMENT.
- THE CONTRACTOR SHALL INSTALL ONE SIGNAL CABLE FROM EACH SIGNAL HEAD TO THE BASE OF THE POLE. A 5-CONDUCTOR CABLE SHALL BE USED FOR A 3-SECTION SIGNAL HEAD, A 7-CONDUCTOR CABLE SHALL BE USED FOR EITHER A 4- OR 5-SECTION SIGNAL HEAD, AND A 2-CONDUCTOR CABLE SHALL BE USED FOR EACH PEDESTRIAN PUSH BUTTON.
- ALL MAST-ARM MOUNTED VEHICLE SIGNAL HEADS SHALL COME FURNISHED WITH BACK-PLATES AND BE CENTERED OVER THEIR RESPECTIVE LANES. THE CONTRACTOR SHALL COORDINATE WITH THE CITY OF WAUKEE ENGINEERING DEPARTMENT TO FIELD VERIFY THE PLACEMENT OF ALL SIGNAL HEADS PRIOR TO INSTALLATION.
- THE STATIONS/OFFSETS LISTED ON THE SIGNAL PLANS ARE TO THE CENTER OF THE ITEM UNLESS OTHERWISE NOTED. THE CONTRACTOR SHALL FIELD VERIFY ALL EQUIPMENT LOCATIONS WITH THE CITY OF WAUKEE AND THE PROJECT ENGINEER.
- AREAS DISTURBED BY CONSTRUCTION SHALL BE RESTORED TO THEIR ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE.
- THE CONTRACTOR SHALL USE CARE WHEN WRAPPING SIGNAL CABLE SLACK ON HANDHOLE HOOKS SO AS TO NOT WRAP THE CABLE SO TIGHTLY THAT CITY PERSONNEL CAN NOT REMOVE THE CABLE FROM THE HOOKS WITHOUT UNWRAPPING THE CABLE.
- THE CONTRACTOR HAS THE OPTION TO BORE OR TRENCH CONDUIT; HOWEVER, THE SPECIFICATIONS REQUIRE THAT CONDUIT BE BORED UNDER PAVEMENT. PAVEMENT SHALL NOT BE DISTURBED BY CONSTRUCTION. ALL INSTALLED CONDUIT THAT WILL CARRY FIBER OPTIC CABLE WILL BE INSTALLED A MINIMUM 42" BELOW FINISH GRADE.
- A #6 A.W.G. BARE COPPER GROUND WIRE SHALL BE INSTALLED IN ALL PVC AND HDPE CONDUITS THAT CARRY 120 VOLT SIGNAL/LIGHTING CABLES. ALL POLES, PEDESTALS, AND CONTROLLER CABINETS SHALL BE BONDED TO FORM A CONTINUOUS SYSTEM AND BE EFFECTIVELY GROUNDED. BONDING JUMPERS SHALL BE #6 A.W.G. BARE COPPER WIRE CONNECTED BY APPROVED CLAMPS.
-  INSTALL A #6 A.W.G. BARE COPPER GROUND WIRE BETWEEN THE GROUND RODS IN THE SIGNAL FOOTINGS AND THE CONTROLLER CABINET TO FORM A CONTINUOUSLY GROUNDED SYSTEM.
- SIGNAL WIRING SHALL ONLY BE SPLICED IN POLE BASES OR SIGNAL CABINETS. USE SILICONE FILLED WIRE NUTS FOR ALL SIGNAL WIRE CONNECTIONS.
- THE CONTRACTOR SHALL HAVE A MINIMUM OF THREE (3) YEARS EXPERIENCE INSTALLING TRAFFIC SIGNALS. THE CONTRACTOR SHALL HAVE AN EMPLOYEE ON THE PROJECT SITE AT ALL TIMES WITH A LEVEL II IMSA TRAFFIC SIGNAL TECHNICIAN CERTIFICATE.
- HANDHOLES SHALL NOT BE PLACED IN DITCH BOTTOMS.
- NO LANE CLOSURES WILL BE PERMITTED BETWEEN THE HOURS OF 7:00 – 9:00 AM, OR BETWEEN THE HOURS OF 4:00 – 6:00 PM.
- IDENTIFY AND LABEL STREET LIGHT WIRING IN POLE BASES.
- NOTIFY THE CITY OF WAUKEE AND THE PROJECT ENGINEER 48 HOURS IN ADVANCE OF PLACING THE PROPOSED TRAFFIC SIGNAL INTO OPERATION AND ANY WEEKEND OR HOLIDAY WORK TO BE SCHEDULED.
- ALL CONDUIT SHALL BE SCHEDULE 40 PVC OR HDPE SDR 13.5. WHEN HEATING PVC CONDUIT TO FORM A BEND, AN APPROVED CONDUIT HEATING DEVICE SHALL BE USED. DIRECT FLAME SHALL NOT BE APPLIED TO THE CONDUIT. TRACER WIRE SHALL BE INSTALLED IN ALL NEW CONDUITS.
- THE MINIMUM BENDING RADIUS OF THE CONDUIT SYSTEM SHALL BE THE LARGER OF THE MANUFACTURER'S RECOMMENDATIONS FOR NATIONAL ELECTRICAL CODE (NEC) REQUIREMENTS.
- THE MAST ARM MOUNTED SIGNAL HEADS, TRAFFIC SIGNS, AND STREET NAME SIGNS SHALL BE MOUNTED BY USING A UNIVERSALLY ADJUSTABLE MOUNTING BRACKET.
- ALL TRAFFIC AND PEDESTRIAN INDICATIONS SHALL BE LED IN ACCORDANCE WITH THE MOST RECENT ITE SPECIFICATIONS. TRAFFIC SIGNAL HEAD COLORS SHALL HAVE BLACK FACES, VISORS, BODIES, AND BACKPLATES. THE CONTRACTOR SHALL VERIFY THE LOCATION OF THE POWER SERVICE AND COORDINATE THE CONNECTION TO THE POWER SERVICE FOR THE TRAFFIC SIGNAL WITH MIDAMERICAN ENERGY.
- THE TRAFFIC SIGNAL CONTROLLER CABINET SHALL BE ORIENTED WITH THE BACK OF THE CABINET TOWARD THE INTERSECTION SUCH THAT THE SIGNAL HEADS CAN BE VIEWED WHILE FACING THE CONTROLLER, UNLESS OTHERWISE DIRECTED BY THE PROJECT ENGINEER.
- PRIOR TO INSTALLING TRAFFIC SIGNAL POLE FOOTINGS, THE CONTRACTOR SHALL CONTACT THE PROJECT ENGINEER FOR TOP OF FOOTING ELEVATIONS.
- FOR STREET LIGHTING POWER FEEDS, THE CONTRACTOR SHALL INSTALL FLOOD-SEAL IN-LINE AND WYE FUSED AND NON-FUSED KITS.
- THE CONTROLLER SHALL BE NTCIP COMPLIANT AND ETHERNET / FIBER READY. ALL MATERIALS AND EQUIPMENT SHALL BE SUPPLIED TO CONNECT THE PROPOSED TRAFFIC SIGNAL TO THE CITY'S EXISTING FIBER SYSTEM INCLUDING NETWORK COMPATIBILITY.
- LOCATION OF THE CONDUIT SYSTEM AND HANDHOLES ON THE PLANS BY THE ENGINEER HAS BEEN PERFORMED WITHOUT FULL CONSIDERATION OF EXISTING GROUND UTILITIES. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE ANY CONFLICTS WITH UTILITIES AT SITES IN THE FIELD PRIOR TO INITIATION OF CONSTRUCTION AT THAT SITE. THE CONTRACTOR IS RESPONSIBLE FOR CONTACTING THE ENGINEER UPON DETERMINATION OF ANY UTILITY CONFLICT.
-  CONTRACTOR TO TERMINATE ALL SPARE SIGNAL CONDUCTORS TO THE GROUND BUSS BAR.
-  TRAFFIC SIGNAL POLES, MAST ARMS, PEDESTAL POLES, BASES, AND HARDWARE SHALL BE COLORED RAL 7043 BY APPROVED IADOT METHODS.
-  CONTRACTOR SHALL CLEAN ALL STREETS OPEN TO PUBLIC AT THE END OF EACH WORK DAY AND PRIOR TO ANY STORM EVENT.
-  SEE P-SHEETS FOR LUMINAIRE INFORMATION.
-  COORDINATE WITH CITY 48-HOURS PRIOR TO ANY SPLICING OF FIBER OPTIC CABLES TO MINIMIZE LOSS OF SERVICE.

NO.	ITEM DESCRIPTION	UNIT	ESTIMATED QUANTITY
1	COMBINATION MAST ARM SIGNAL AND LIGHTING POLE, 45'	EA	1
2	COMBINATION MAST ARM SIGNAL AND LIGHTING POLE, 55'	EA	1
3	COMBINATION MAST ARM SIGNAL AND LIGHTING POLE, 65'	EA	1
4	COMBINATION MAST ARM SIGNAL AND LIGHTING POLE, 80'	EA	1
5	PEDESTAL POLE, 5.5'	EA	3
 6	SIGNAL FACE, 3-SECTION HEAD TUNNEL VISORS, 12" LED WITH BACKPLATE (RED, YELLOW, GREEN)	EA	6 8
7	SIGNAL FACE, 4-SECTION HEAD TUNNEL VISORS, 12" LED WITH BACKPLATE (LT RED ARROW, LT YELLOW ARROW, LT FLASHING YELLOW ARROW, LT GREEN ARROW)	EA	4
 8	SIGNAL FACE, 5-SECTION HEAD TUNNEL VISORS, 12" LED WITH BACKPLATE (RED, YELLOW, GREEN, YELLOW ARROW, RT GREEN ARROW)	EA	6 4
 9	SIGNAL FACE, 16" HAND-WALKING PERSON, COUNTDOWN, SIDE OF POLE MOUNT (LED PEDESTRIAN COUNTDOWN)	EA	8
 10	LUMINAIRE	EA	4 0
 11	4" PVC CONDUIT	LF	308
 12	3" PVC CONDUIT	LF	182
 13	2" PVC CONDUIT	LF	1229 1224
 14	1" PVC CONDUIT	LF	532
15	1c #14 DETECTOR CABLE	LF	8505
16	2c #14 DETECTOR LEAD-IN CABLE	LF	6379
17	2c #14 PB CABLE	LF	1561
18	16c #14 TRAFFIC SIGNAL CABLE	LF	1357
19	1c #10 POWER CABLE (STREET LIGHT)	LF	2366
20	1c #3 POWER CABLE (SERVICE)	LF	280
 21	1c #6 BARE GROUNDING WIRE	LF	9094 6629
 22	1c #10 TRACER WIRE	LF	9094 6629
 23	2c #14 PREEMPTION INDICATION LIGHT CABLE	LF	1008 0
24	3c #20 EMERGENCY VEHICLE PREEMPTION	LF	1008
25	PTZ CABLE	LF	1
 26	PTZ CAMERA Q6054-E	EA	1
 27	PULL ROPE	LF	9094 6629
 28	SINGLE MODE FIBER OPTIC CABLE, 72CT	LF	2945 0
 29	SINGLE MODE FIBER OPTIC CABLE, 12CT	LF	2945 145
30	FIBER OPTIC TERMINATIONS	EA	12
31	FIBER OPTIC SPLICES	EA	12
32	FIBER OPTIC SPLICE ENCLOSURES	EA	1
33	SWITCH, 6KQe	EA	1
34	RM-40 TYPE L-1	EA	8
35	RM-40 TYPE Y-2	EA	4
36	DETECTOR SAW CUT	EA	2731
 37	TWO CHANNEL DETECTOR	EA	2
38	PEDESTRIAN PUSH BUTTON (PB)	EA	8
39	HANDHOLE, PRE-CAST CONCRETE, TYPE I	EA	5
40	HANDHOLE, PRE-CAST CONCRETE, TYPE II	EA	3
41	HANDHOLE, PRE-CAST CONCRETE, TYPE III	EA	1
42	SIGNAL CONTROLLER, CABINET, AND ACCESSORIES	EA	1
43	TRAFFIC SIGN: R3-5L 30" X 36"	EA	4
44	TRAFFIC SIGN: R3-5R 30" X 36"	EA	4
45	TRAFFIC SIGN: R10-3e 9" X 12"	EA	8
46	TRAFFIC SIGN: R12a 30" X 36" LEFT TURN YIELD ON FLASHING	EA	4
47	TRAFFIC SIGN: STREET NAME 84" X 18" GREEN BACKGROUND	EA	4
48	CONCRETE FOOTING: 24" DIA. X 3' DEPTH	EA	3
49	CONCRETE FOOTING: 36" DIA. X 13' DEPTH, TYPE B	EA	1
50	CONCRETE FOOTING: 36" DIA. X 15' DEPTH, TYPE C	EA	1
51	CONCRETE FOOTING: 42" DIA. X 15' DEPTH, TYPE E	EA	1
52	CONCRETE FOOTING: 42" DIA. X 16' DEPTH, TYPE F	EA	1
53	CONCRETE FOOTING: CABINET FOOTING	EA	1
54	ALPHA FXM 1100 POWER SUPPLY	EA	1
55	EVP DETECTOR	EA	4
56	FIBER TERMINATION RACK 24	EA	1
57	7c #14 TRAFFIC SIGNAL CABLE	LF	585
 58	5c #14 TRAFFIC SIGNAL CABLE	LF	595

	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.  JASON L. FRERICKS, P.E., PTOE License Number: 20095 My license renewal date is DECEMBER 31, 2017. Pages or sheets covered by this seal: <u>N.01 to N.08</u> 10/31/2016 DATE
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PROJECT NO: 16W021.01	DESIGNED BY: J. FRERICKS
PROJECT DATE: OCTOBER 2016	CHECKED BY: A. QUARTELL
CAD DATE: 2/13/2017 12:14:27 PM	DRAWN BY: J. KOFOOT
CAD FILE: c:\pw\workdir\pw\te\jae\dms70194\16W021-01.N01 w Addendum1.SHT.dgn	

NO	DATE	BY	REVISION DESCRIPTION
1	2/09/2017	JSW	 SYMBOL INDICATES REVISION

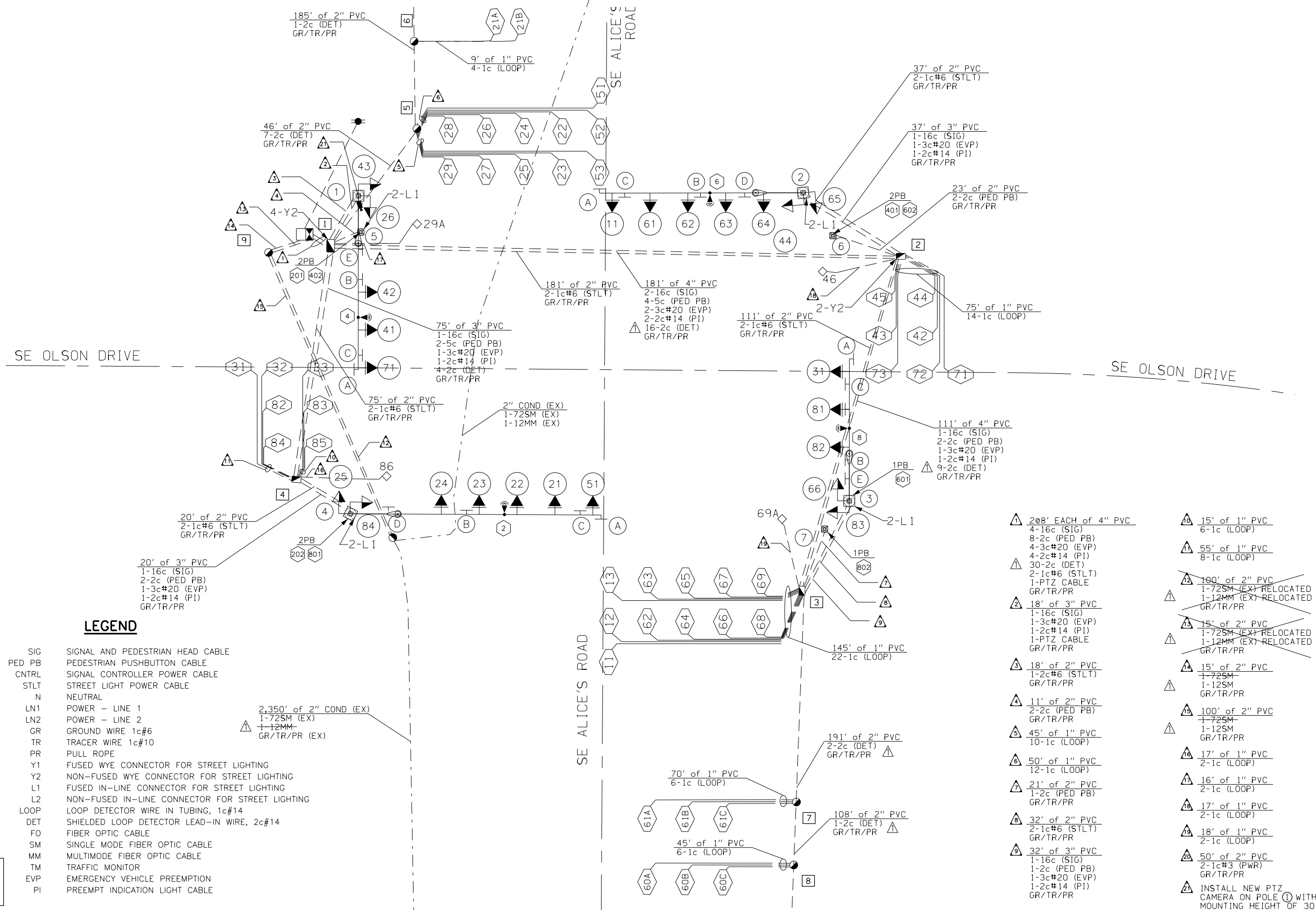


SE ALICES ROAD IMPROVEMENTS
UNIVERSITY AVENUE TO NORTH OF SE OLSON DRIVE
CITY OF WAUKEE, IA - STP-U-8177(619)--70-25

GENERAL NOTES & LEGEND

SHEET NO.

N.01



PROJECT NO: 16W021.01
 PROJECT DATE: OCTOBER 2016
 CAD DATE: 2/13/2017 12:15:06 PM
 CAD FILE: c:\pwworkdir\pwworking\joe\dms70194\DWG

DESIGNED BY: J. FRERICKS
 CHECKED BY: A. QUARTELL
 DRAWN BY: J. KOFOOT

NO	DATE	BY	REVISION DESCRIPTION
1	2/09/2017	JSW	SYMBOL INDICATES REVISION



SE ALICES ROAD IMPROVEMENTS
UNIVERSITY AVENUE TO NORTH OF SE OLSON DRIVE
 CITY OF WAUKEE, IA - STP-U-8177(619)-70-25

SIGNAL WIRING DETAILS
SE ALICES RD AND SE OLSON DR

SHEET NO.
N.04

DETECTOR SUMMARY

DETECTOR NUMBER	LOOP SIZE	PED. PUSH BUTTON	PHASE CALLED	DELAY TIME (SEC.)	NO. OF CHANNELS	IN SERIES	COMMENTS
11	1-6'x8'		1		1		4 TURNS
12,13	2-6'x8'		1		1	X	
51	1-6'x8'		5		1		4 TURNS
52,53	2-6'x8'		5		1	X	
21A, 21B	2-6'x8'		2		1	X	4 TURNS, ADVANCED DETECTION
22,24,26	3-6'x8'		2		1	X	
23,25,27	3-6'x8'		2		1	X	
28	1-6'x8'		2	5	1		4 TURNS
29	1-6'x8'		2	5	1		4 TURNS
29A	1-2'x2'		2		1		4 TURNS
60A,60B,60C	1-6'x8'		6		1		4 TURNS, ADVANCED DETECTION
61A,61B,61C	3-6'x8'		6		1	X	
62,64,66	3-6'x8'		6		1	X	
63,65,67	3-6'x8'		6		1	X	
68	1-6'x8'		6	5	1		4 TURNS
69	1-6'x8'		6	5	1		4 TURNS
69A	1-2'x2'		6		1		4 TURNS
201,202		X	2				
601,602		X	6				
31	1-6'x8'		3		1		4 TURNS
32,33	2-6'x8'		3		1	X	
71	1-6'x8'		7		1		4 TURNS
72,73	2-6'x8'		7		1	X	
42	1-6'x8'		4		1		
43	1-6'x8'		4		1		
44	1-6'x8'		4	5	1		4 TURNS
45	1-6'x8'		4	5	1		4 TURNS
46	1-2'x2'		4		1		4 TURNS
82	1-6'x8'		8		1		
83	1-6'x8'		8		1		
84	1-6'x8'		8	5	1		4 TURNS
85	1-6'x8'		8	5	1		4 TURNS
86	1-2'x2'		8		1		4 TURNS
401,402		X	4				
801,802		X	8				

Δ

TRAFFIC SIGNAL POLE DATA

POLE NO.	POLE TYPE	MAST ARM LENGTH OR PEDESTAL HEIGHT (FT.)	① TRAFFIC SIGNAL HEADS ON ARM		② TRAFFIC SIGNS ON ARM		③ LUMINARE ARM				FOOTING DIMENSIONS		MISCELLANEOUS	TOTAL QUANTITY
			QTY.	LOCATION ON ARM (FT.)	QTY.	LOCATION ON ARM (FT.)	QTY.	SPREAD (FT.)	MOUNTING HEIGHT (FT.)	ORIENTATION (DEGREES)	DIA. (FT.)	DEPTH (FT.)		
1	COMBINATION SIGNAL/LIGHTING	55'	3	30.5, 42.5, 54.5	4	17.0, 26.5, 50.5, 53.5	1	15'	35'	0	3.0'	15.0'	PRE-EMPTION LOCATED AT 38.5 FT. ⑤	1
2	COMBINATION SIGNAL/LIGHTING	65'	5	12.5, 24.5, 36.5, 48.5, 60.5	4	18.5, 32.5, 56.5, 63.5	1	15'	35'	0	3.5'	15.0'	PRE-EMPTION LOCATED AT 29.5 FT. ⑤ ⑥	1
3	COMBINATION SIGNAL/LIGHTING	45'	3	17.0, 29.0, 41.0	4	7.0, 13.0, 37.0, 43.5	1	15'	35'	0	3.0'	13.0'	PRE-EMPTION LOCATED AT 23.0 FT. ⑤	1
4	COMBINATION SIGNAL/LIGHTING	80'	5	28.5, 40.5, 52.5, 64.5, 76.5	4	11.5, 36.5, 72.5, 78.5	1	15'	35'	0	3.5'	16.0'	PRE-EMPTION LOCATED AT 49.0 FT. ④ ⑤ ⑥	1
5	PEDESTRIAN PEDESTAL	5.5'	—	—	—	—	—	—	—	—	2.0'	3.0'		1
6	PEDESTRIAN PEDESTAL	5.5'	—	—	—	—	—	—	—	—	2.0'	3.0'		1
7	PEDESTRIAN PEDESTAL	5.5'	—	—	—	—	—	—	—	—	2.0'	3.0'		1

① AND ② LOCATION REPRESENTS APPROXIMATE LINEAR DISTANCE FROM POLE MEASURED OUTWARD TO END OF ARM.

③ ORIENTATION OF LUMINARE ARM REPRESENTS A CLOCKWISE ANGLE MEASURED FROM THE CENTERLINE OF THE MAST ARM.

④ IN THE EVENT MAST ARM LENGTH IS TOO LONG AND T-BASES WILL BE USED, A HANDHOLE AS LARGE AS POSSIBLE WILL BE REQUIRED.

⑤ UNLESS OTHERWISE DIRECTED, TRAFFIC SIGNAL HEADS ON MAST ARMS WILL BE ALIGNED OVER THE CENTER OF THE LANES. APPROXIMATE LOCATIONS ARE SHOWN ON THE TRAFFIC SIGNALPOLE DATA TABLE. THE CONTRACTOR SHALL FIELD VERIFY SIGNAL HEAD LOCATIONS PRIOR TO INSTALLATION.

⑥ THE FOLLOWING TRAFFIC SIGNAL HEADS ARE FOR FUTURE USE AND SHALL BE BAGGED: 24, 63, AND 64.

Δ CARD RACK DETECTOR POSITION

	1	2	3	4	5	6	7	8	9	
CH 1	Φ1	Φ1	Φ5	Φ2	Φ2	Φ2	Φ6	Φ6	Φ6	PHASE
	11	12,13	-	21A,21B	22,24	28	60A,60B	62,64	68	LOOP NO.
CH 2	Φ1	Φ5	Φ5	Φ2	Φ2	Φ2	Φ6	Φ6	Φ6	PHASE
	-	51	52,53	-	23,25	29A	61A,61B	63,65	69A	LOOP NO.
	-	-	-	-	27	-	61C	67	-	

PREEMPTION	
Φ2	Φ4
P1	P2
2	4
Φ6	Φ8
P3	P4
6	8

	10	11	12	13	14	15	16	17	18	
CH 1	Φ3	Φ3	Φ7	Φ4	Φ4	Φ4	Φ8	Φ8	Φ8	PHASE
	31	32,33	72,73	-	42	44	-	82	84	LOOP NO.
CH 2	Φ3	Φ7	Φ7	Φ4	Φ4	Φ4	Φ8	Φ8	Φ8	PHASE
	-	71	-	-	-	46	-	-	86	LOOP NO.
	-	-	-	-	-	-	-	-	-	

PROJECT NO: 16W021.01
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DESIGNED BY: J. FRERICKS
CHECKED BY: A. QUARTELL
DRAWN BY: J. KOFOOT

NO	DATE	BY	REVISION DESCRIPTION
1	2/09/2017	JSW	Δ SYMBOL INDICATES REVISION



SE ALICES ROAD IMPROVEMENTS
UNIVERSITY AVENUE TO NORTH OF SE OLSON DRIVE
CITY OF WAUKEE, IA - STP-U-8177(619)-70-25

SIGNAL INFORMATION SHEET
SE ALICES RD AND SE OLSON DR

SHEET NO.

N.05

Refer to Standard Road Plans EW-101 and EW-102.

TABULATION OF TEMPLATE QUANTITIES AND ADJUSTMENTS

107-28
04-21-15

Station	Cut						Fill					Checks (EW-102)		Topsoil								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]
	Template Cut Volume	Template Class 10 Volume	Template Topsoil Cut Volume	Template Rock Undercut Volume	Total Cut Adjusted	Total Cut Adjusted w/ Weighted Average 1.3 Shrink Factor	Template Fill Volume	Topsoil Stripping + Fill	Add Quantity +Fill	Total Fill Adjusted	Total Cut Adjusted w/ 1.3 Shrink Factor Minus Fill	Approx. Fill Volume Below 5' And Above 20' Cu. Yds.	Approx. Fill Volume Below 3' Cu. Yds.	Total Topsoil Cut Volume	Template Topsoil Replacement Volume	Topsoil Cut With 1.5 Shrink Factor	Topsoil Cut With Shrink Minus Topsoil Replacement					
Alices Rd Stage 1																						
217+00.00	99	69	30	39	108	83	20	6		26	57	0	0	30	8	20	12					
217+50.00	120	82	38	39	121	93	28			28	65	0	14	38	9	26	17					
218+00.00	137	104	33	59	163	125	20			20	105	0	8	33	6	22	16					
218+50.00	214	154	59	80	234	180	10	47		57	123	0	0	59	4	40	36					
219+00.00	241	153	88	59	212	163	54	47		101	62	0	41	88	12	59	47					
219+50.00	209	128	81	38	166	128	80			80	48	0	65	81	19	54	35					
220+00.00	220	142	78	38	180	138	54			54	84	0	39	78	17	52	35					
220+50.00	224	152	72	38	190	146	41			41	105	0	26	72	14	48	34					
221+00.00	222	158	64	38	196	151	28			28	123	0	13	64	10	43	33					
221+50.00	229	162	67	38	200	154	17	1		18	136	0	2	67	8	45	37					
222+00.00	235	159	76	38	197	152	14	1		15	137	0	0	76	9	51	42					
222+50.00	220	143	77	37	180	138	14	1		15	123	0	0	77	10	52	42					
223+00.00	187	106	81	37	143	110	16	7		23	87	0	1	81	9	54	45					
223+50.00	142	56	86	37	93	72	35	12		47	25	0	21	86	8	58	50					
224+00.00	98	23	75	58	81	62	39	12		51	11	0	31	75	4	50	46					
224+50.00	87	7	79	63	70	54	101	13		114	-60	0	99	79	6	53	47					
225+00.00	119	13	106	42	55	42	214	12		226	-184	0	205	106	19	71	52					
225+50.00	163	41	123	37	78	60	217	12		229	-169	0	203	123	29	82	53					
226+00.00	168	42	126	38	80	62	223	13		236	-174	0	210	126	30	84	54					
226+50.00	116	17	99	31	48	37	257	11		268	-231	0	300	99	22	66	44					
226+90.82	24	2	22	7	9	7	67	3		70	-63	0	288	22	5	15	10					
227+00.00	119	5	114	38	43	33	354	13		367	-334	0	62	114	24	76	52					
227+50.00	106	0	105	37	37	28	317	13		330	-302	0	303	105	19	70	51					
228+00.00	99	0	99	38	38	29	288	13		301	-272	0	275	99	16	66	50					
228+50.00	100	1	99	57	58	45	256	12		268	-223	0	241	99	16	66	50					
229+00.00	104	4	100	76	80	62	175	13		188	-126	0	167	100	8	67	59					
229+50.00	103	3	100	57	60	46	183	13		196	-150	0	175	100	8	67	59					
230+00.00	100	1	99	38	39	30	217	13		230	-200	0	203	99	15	66	51					
230+50.00	98	2	96	38	40	31	171	12		183	-152	0	157	96	14	64	50					
231+00.00	96	1	95	38	39	30	182	12		194	-164	0	168	95	13	64	51					
231+50.00	102	7	95	37	44	34	177	13		190	-156	0	163	95	13	64	51					
232+00.00	104	9	96	40	49	38	157	10		167	-129	0	142	96	13	64	51					
232+50.00	103	4	99	45	49	38	187	5		192	-154	0	172	99	14	66	52					
233+00.00	107	4	103	48	52	40	248	2		250	-210	0	234	103	16	69	53					
233+50.00	112	6	106	49	55	42	374	1		375	-333	0	361	106	18	71	53					
234+00.00	114	6	108	49	55	42	489			489	-447	0	475	108	21	72	51					
234+50.00	91	25	66	67	92	71	260			260	-189	0	253	66	11	44	33					
235+00.00	154	29	125	41	70	54	0	119		119	-65	0	0	125	0	84	84					
235+25.00	27	27	0	40	67	52	0			0	52	0	0	0	0	0	0					
235+50.00	17	17	0	60	77	59	342			342	-283	0	168	0	12	0	-12					
236+00.00	112	3	109	39	42	32	718			718	-686	0	706	109	28	73	45					
236+50.00	126	9	117	37	46	35	738			738	-703	0	726	117	33	78	45					
237+00.00	113	6	106	37	43	33	686			686	-653	0	676	106	29	71	42					
237+50.00	0	0	0	0	0	0	0			0	0	0	319	0	0	0	0					
Subtotals:	5,681	2,082	3,597	1,897	3,979	3,061	8,068	462	0	8,530	-5,469	0	7,712	3,597	599	2,407	1,808					
Alices Rd Stage 2																						
217+00.00	119	91	28	54	145	112	23			23	89	0	0	28	5	19	14					
217+50.00	137	112	25	52	164	126	18			18	108	0	0	25	5	17	12					
218+00.00	187	164	24	92	256	197	15			15	182	0	0	24	4	16	12					
218+50.00	233	212	21	124	336	258	12			12	246	0	2	21	4	14	10					
219+00.00	207	186	21	83	269	207	15			15	192	0	1	21	4	14	10					
219+50.00	182	161	21	51	212	163	18			18	145	0	0	21	4	14	10					
220+00.00	191	170	21	51	221	170	18			18	152	0	0	21	4	14	10					
220+50.00	195	174	21	50	224	172	18			18	154	0	0	21	4	14	10					
221+00.00	192	167	25	50	217	167	30			30	137	0	12	25	5	17	12					
221+50.00	190	161	30	51	212	163	37			37	126	0	19	30	6	20	14					
222+00.00	198	161	37	51	212	163	27			27	136	0	9	37	5	25	20					
222+50.00	192	147	45	51	198	152	31			31	121	0	12	45	4	30	26					
223+00.00	168	112	55	51	163	125	51			51	74	0	33	55	5	37	32					
223+50.00	140	76	65	51	127	98	84			84	14	0	65	65	7	44	37					
224+00.00	121	68	53	76	144	111	55			55	56	0	45	53	4	36	32					
224+50.00	116	64	53	89	153	118	41			41	77	0	32	53	4	36	32					
225+00.00	109	44	64	64	108	83	109			109	-26	0	91	64	6	43	37					
225+50.00	97	34	64	51	85	65	147			147	-82	0	128	64	6	43	37					
226+00.00	97	33	64	51	84	65	144			144	-79	0	124	64	6	43	37					

PROJECT NO: 16W021-01
PROJECT DATE: OCTOBER 2016
CAD DATE: 2/15/2017 5:42 PM
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DESIGNED BY: J. FRERICKS
CHECKED BY: A. QUARTELL
DRAWN BY: J. KOFOOT

NO	DATE	BY	REVISION DESCRIPTION



SE ALICES ROAD IMPROVEMENTS
UNIVERSITY AVENUE TO NORTH OF SE OLSON DRIVE
CITY OF WAUKEE, IA-STP-U-8177(619)-70-25

SE ALICES ROAD
EARTHWORK QUANTITY SHEETS

SHEET NO.
T.1

TABULATION OF TEMPLATE QUANTITIES AND ADJUSTMENTS

Station	Cut						Fill					Checks (EW-102)		Topsoil								
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]
	Template Cut Volume	Template Class 10 Volume	Template Topsoil Cut Volume	Template Rock Undercut Volume	Total Cut Adjusted	Total Cut Adjusted w/ Weighted Average 1.3 Shrink Factor	Template Fill Volume	Topsoil Stripping + Fill	Add Quantity +Fill	Total Fill Adjusted	Total Cut Adjusted w/ 1.3 Shrink Factor Minus Fill	Approx. Fill Volume Below 5' And Above 20' Cu. Yds.	Approx. Fill Volume Below 3' Cu. Yds.	Total Topsoil Cut Volume	Template Topsoil Replacement Volume	Topsoil Cut With 1.5 Shrink Factor	Topsoil Cut With Shrink Minus Topsoil Replacement					
226+50.00	71	69	2	9	78	60	2			2	58	0	7	2	0	2	2					
226+90.82	273	230	43	51	281	216	86			86	130	0	14	43	6	29	23					
227+00.00	172	100	71	51	151	116	144			144	-28	0	125	71	10	48	38					
227+50.00	201	134	68	51	185	142	101			101	41	0	81	68	8	46	38					
228+00.00	274	219	55	78	297	228	46			46	182	0	28	55	8	37	29					
228+50.00	263	234	29	103	337	259	8			8	251	0	0	29	5	20	15					
229+00.00	233	201	32	76	277	213	10			10	203	0	0	32	3	22	19					
229+50.00	279	223	56	51	274	211	19			19	192	0	0	56	5	38	33					
230+00.00	280	220	60	50	270	208	19			19	189	0	0	60	4	40	36					
230+50.00	277	218	59	50	268	206	19			19	187	0	0	59	4	40	36					
231+00.00	277	222	55	51	273	210	21			21	189	0	1	55	6	37	31					
231+50.00	260	211	48	51	262	202	23			23	179	0	4	48	8	32	24					
232+00.00	256	203	53	51	254	195	25			25	170	0	6	53	7	36	29					
232+50.00	244	187	57	51	238	183	29			29	154	0	10	57	7	38	31					
233+00.00	196	140	56	51	191	147	32			32	115	0	12	56	7	38	31					
233+50.00	148	100	48	54	154	118	29			29	89	0	11	48	5	32	27					
234+00.00	256	91	165	84	175	135	13	144		157	-22	0	4	165	2	110	108					
234+50.00	43	43	0	53	96	74	0			0	74	0	0	0	0	0	0					
235+00.00	32	32	0	51	83	64	0			0	64	0	0	0	0	0	0					
235+25.00	26	26	0	82	108	83	114			114	-31	0	54	0	7	0	-7					
235+50.00	77	0	77	62	62	48	364			364	-316	0	351	77	17	52	35					
236+00.00	91	0	91	62	62	48	540			540	-492	0	527	91	22	61	39					
236+50.00	100	0	100	56	56	43	642			642	-599	0	632	100	25	67	42					
237+00.00	0	0	0	0	0	0	0			0	0	0	348	0	0	0	0					
237+50.00	0	0	0	0	0	0	0			0	0	0	348	0	0	0	0					
Subtotals:	7,597	5,606	1,993	2,563	8,169	6,283	3,237	144	0	3,381	2,902	0	2,850	1,993	261	1,342	1,081					
Alices Transition																						
1237+40.85	30	8	23	0	8	6	30			30	-24	0	0	23	0	16	16					
1237+50.00	111	37	73	0	37	28	103			103	-75	0	37	73	0	49	49					
1237+75.00	104	34	71	0	34	26	95			95	-69	0	95	71	0	48	48					
1238+00.00	98	30	68	0	30	23	79			79	-56	0	79	68	0	46	46					
1238+25.00	96	31	65	0	31	24	67			67	-43	0	66	65	0	44	44					
1238+50.00	93	33	60	0	33	25	60			60	-35	0	59	60	0	40	40					
1238+75.00	80	37	43	0	37	28	33			33	-5	0	33	43	0	29	29					
1239+00.00	85	59	27	0	59	45	7			7	38	0	6	27	0	18	18					
1239+25.00	56	37	19	0	37	28	4	7		11	17	0	4	19	0	13	13					
1239+50.00	0	0	0	0	0	0	0			0	0	0	3	0	0	0	0					
Subtotals:	753	306	449	0	306	233	478	7	0	485	-252	0	382	449	0	303	303					
Private Dr																						
702+09.62	38	22	16	11	33	25	3	14		17	8	0	0	16	0	11	11					
702+25.00	18	18	0	8	26	20	0			0	20	0	0	0	0	0	0					
702+34.58	26	25	0	12	37	28	2			2	26	0	0	0	0	0	0					
702+50.00	50	36	14	19	55	42	8	2		10	32	0	0	14	2	10	8					
702+75.00	48	32	16	19	51	39	9	4		13	26	0	0	16	3	11	8					
703+00.00	53	37	16	19	56	43	9	5		14	29	0	0	16	3	11	8					
703+25.00	71	57	14	19	76	58	8	2		10	48	0	0	14	3	10	7					
703+50.00	388	328	60	98	426	328	38	3		41	287	0	0	60	14	40	26					
704+75.00	77	62	15	20	82	63	8	1		9	54	0	0	15	3	10	7					
705+00.00	76	58	18	20	78	60	8	2		10	50	0	0	18	3	12	9					
705+25.00	64	48	16	19	67	52	8	2		10	42	0	0	16	3	11	8					
705+50.00	49	36	13	18	54	42	8	2		10	32	0	0	13	2	9	7					
705+75.00	38	27	10	16	43	33	8	3		11	22	0	0	10	2	7	5					
706+00.00	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0					
Subtotals:	996	786	208	298	1,084	833	117	40	0	157	676	0	0	208	38	142	104					
Future Rd																						
504+00.00	40	6	34	33	39	30	60			60	-30	0	0	34	4	23	19					
504+25.00	25	6	19	9	15	12	28			28	-16	0	49	19	1	13	12					
504+38.31	21	5	16	8	13	10	23			23	-13	0	24	16	1	11	10					
504+50.00	39	6	33	17	23	18	50			50	-32	0	20	33	3	22	19					
504+75.00	22	2	20	9	11	8	27			27	-19	0	43	20	1	14	13					



Refer to Standard Road Plans EW-101 and EW-102.

TABULATION OF TEMPLATE QUANTITIES AND ADJUSTMENTS

107-28
04-21-15

Station	Cut						Fill					Checks (EW-102)		Topsoil				[18]	[19]	[20]	[21]	[22]
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]					
	Template Cut Volume	Template Class 10 Volume	Template Topsoil Cut Volume	Template Rock Undercut Volume	Total Cut Adjusted	Total Cut Adjusted w/ Weighted Average 1.3 Shrink Factor	Template Fill Volume	Topsoil Stripping + Fill	Add Quantity +Fill	Total Fill Adjusted	Total Cut Adjusted w/ 1.3 Shrink Factor Minus Fill	Approx. Fill Volume Below 5' And Above 20' Cu. Yds.	Approx. Fill Volume Below 3' Volume Below 3' Cu. Yds.	Total Topsoil Cut Volume	Template Topsoil Replacement Volume	Topsoil Cut With 1.5 Shrink Factor	Topsoil Cut With Shrink Minus Topsoil Replacement					
504+88.76	43	2	40	20	22	17	55			55	-38	0	22	40	3	27	24					
505+00.00	0	0	0	0	0	0	0			0	0	0	26	0	0	0	0					
505+25.00																						
Subtotals:	210	28	181	103	131	101	264	0	0	264	-163	0	207	181	14	123	109					
SE Frontier Ave																						
303+75.00	39	26	13	16	42	32	12			12	20	0	0	13	5	9	4					
304+00.00	49	36	13	16	52	40	10			10	30	0	3	13	5	9	4					
304+25.00	67	54	13	16	70	54	9			9	45	0	1	13	5	9	4					
304+50.00	94	78	15	16	94	72	10			10	62	0	0	15	5	10	5					
304+75.00	135	112	23	16	128	98	11			11	87	0	0	23	8	16	8					
305+00.00	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0					
Subtotals:	384	306	77	80	386	296	52	0	0	52	244	0	4	77	28	53	25					
SE Olson Dr																						
101+25.00	49	27	22	19	46	35	13			13	22	0	0	22	7	15	8					
101+50.00	55	31	25	21	52	40	13			13	27	0	8	25	7	17	10					
101+75.00	64	39	26	21	60	46	13			13	33	0	7	26	7	18	11					
102+00.00	74	48	25	23	71	55	14			14	41	0	6	25	5	17	12					
102+25.00	85	55	29	24	79	61	15	1		16	45	0	6	29	7	20	13					
102+50.00	91	59	31	25	84	65	14	1		15	50	0	8	31	8	21	13					
102+75.00	48	35	13	14	49	38	7			7	31	0	8	13	5	9	4					
102+89.04	36	29	7	11	40	31	6			6	25	0	4	7	3	5	2					
103+00.00	90	68	22	25	93	72	15			15	57	0	4	22	9	15	6					
103+25.00	98	69	28	25	94	72	17			17	55	0	9	28	10	19	9					
103+50.00	97	69	28	25	94	72	17			17	55	0	9	28	10	19	9					
103+75.00	96	67	29	25	92	71	22			22	49	0	14	29	10	20	10					
104+00.00	99	67	32	26	93	72	22			22	50	0	14	32	10	22	12					
104+25.00	112	76	37	30	106	82	25			25	57	0	16	37	10	25	15					
104+50.00	600	383	217	201	584	449	167			167	282	0	20	217	42	145	103					
106+00.00	75	41	34	30	71	55	35			35	20	0	166	34	8	23	15					
106+25.00	72	37	35	26	63	48	44			44	4	0	37	35	12	24	12					
106+50.00	75	34	40	25	59	45	59			59	-14	0	51	40	16	27	11					
106+75.00	79	34	45	25	59	45	71			71	-26	0	63	45	19	30	11					
107+00.00	0	0	0	0	0	0	0			0	0	0	31	0	0	0	0					
Subtotals:	1,995	1,268	725	621	1,889	1,454	589	2	0	591	863	0	481	725	205	491	286					
Trail W of Alice																						
2002+00.00	9	0	9	0	0	0	2	2		4	-4	0	0	9	2	6	4					
2002+25.00	9	0	9	0	0	0	3			3	-3	0	3	9	2	6	4					
2002+50.00	11	2	10	0	2	2	2			2	0	0	1	10	2	7	5					
2002+75.00	29	14	14	0	14	11	0			0	11	0	0	14	3	10	7					
2003+00.00	66	47	19	0	47	36	0		29	29	7	0	0	19	4	13	9					
2003+25.00	118	97	21	0	97	75	0		35	35	40	0	0	21	6	14	8					
2003+50.00	175	152	23	0	152	117	0		38	38	79	0	0	23	8	16	8					
2003+75.00	229	203	26	0	203	156	0		26	26	130	0	0	26	9	18	9					
2004+00.00	294	266	28	0	266	205	0		26	26	179	0	0	28	11	19	8					
2004+25.00	355	325	30	0	325	250	0		26	26	224	0	0	30	12	20	8					
2004+50.00	398	366	33	0	366	282	0		20	20	262	0	0	33	13	22	9					
2004+75.00	403	370	33	0	370	285	0		20	20	265	0	0	33	13	22	9					
2005+00.00	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0					
Subtotals:	2,096	1,842	255	0	1,842	1,419	7	2	220	229	1,190	0	4	255	85	173	88					
Trail E of Alice																						
2007+00.00	416	377	39	0	377	290	0		11	11	279	0	0	39	20	26	6					
2007+25.00	444	409	35	0	409	315	0		11	11	304	0	0	35	15	24	9					
2007+50.00	399	366	33	0	366	282	0		14	14	268	0	0	33	14	22	8					
2007+75.00	332	301	31	0	301	232	0		14	14	218	0	0	31	12	21	9					
2008+00.00	258	230	28	0	230	177	0		15	15	162	0	0	28	10	19	9					
2008+25.00	196	172	24	0	172	132	0		25	25	107	0	0	24	9	16	7					
2008+50.00	132	113	20	0	113	87	0		24	24	63	0	0	20	8	14	6					

PROJECT NO: 16W021-01
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CAD FILE: c:\pw_workdir\pw_ie\jcd\ms82998\Addendum1-0016W021.01_T01_SHT.xlsm

DESIGNED BY: J. FRERICKS
CHECKED BY: A. QUARTELL
DRAWN BY: J. KOFOOT

NO	DATE	BY	REVISION DESCRIPTION



SE ALICES ROAD
EARTHWORK QUANTITY SHEETS

SHEET NO.

T.3

Refer to Standard Road Plans EW-101 and EW-102.

TABULATION OF TEMPLATE QUANTITIES AND ADJUSTMENTS

107-28
04-21-15

[illegible]

PROJECT NO:	16W021-01	DESIGNED BY:	J. FRERICKS
PROJECT DATE:	OCTOBER 2016	CHECKED BY:	A. QUARTELL
CAD DATE:	2/15/2017 5:42 PM	DRAWN BY:	J. KOFOOT
CAD FILE:	c:\pw_workdir\pw_iejcd\dwms82998\Addendum1-0016W021.01_T01_SHT.xlsm		

NO	DATE	BY	REVISION DESCRIPTION



SE ALICES ROAD
EARTHWORK QUANTITY SHEETS

SHEET NO.

T.4