

CITY OF LAKE ELMO



**STORMWATER REUSE IRRIGATION
DESIGN STANDARDS**

REVISION DATE: JANUARY, 2022

CITY OF LAKE ELMO, MN.

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STORMWATER REUSE IRRIGATION DESIGN STANDARDS

for

CITY OF LAKE ELMO

STORMWATER REUSE FOR IRRIGATION

Outdoor Stormwater Reuse for Irrigation is allowed when in compliance with state and watershed regulations and in accordance with the City of Lake Elmo Stormwater Reuse Design Standards, Specifications and Details. These design standards apply to any stormwater reuse irrigation system in Lake Elmo utilizing stormwater from stormwater basins owned and maintain by the City, or when irrigating areas open to the public. These Standards are intended to prevent contamination of drinking water supply and minimize health risk exposure.

MANAGEMENT PLAN

- A Management Plan must be submitted for City review and approval that specifies the ongoing operation, maintenance, and performance management of the system.
- The Management Plan must specify a responsible management entity who will maintain ultimate responsibility for implementation.
- The Plan must include a Monitoring Plan that identifies the minimum monitoring parameters and frequencies, and includes a monitoring and testing records retention policy.
- The Plan must include a Reporting Plan that identifies the minimum requirements for the annual operation and maintenance report, and identifies public notification requirements, including anything required by any regulatory entity.
- A Stormwater Reuse Irrigation System Maintenance and Easement Agreement must be dedicated to the City of Lake Elmo in the City's standard form of agreement.

SYSTEM DESIGN

- Stormwater Management design for development and redevelopment must provide storm water basin capacity necessary to meet regulatory requirements for flood protection, assuming no reduction is taken in stormwater rates or volumes for reuse irrigation.
- Design to be in accordance with City Standard Detail C-01, Typical Water Reuse Process Flow Diagram (Base Model) for private irrigation applications.
- Design to be in accordance with City Standard Detail C-02, Typical Water Reuse Process Flow Diagram (Treatment) and Specification 3281-5 for irrigation applications on public spaces (City parks, athletic fields, etc.).
- Irrigation pump, piping and appurtenances to be in accordance with Specification 3282-5.
- Pond pump intake to be in accordance with City Standard Detail C-03.
- Pump station to be in accordance with City Standard Detail C-04. Pump and applicable treatment system enclosures must be located above the 100-year high water level (HWL).
- Irrigation system controls and back flow prevention to be in accordance with state plumbing code, City Standard Detail C-05, and Specification 4090-0(1) or 4090-0(2).
- Recommended to install non-clogging sprinkler heads with a solids tolerance of up to 10 mesh, or implement particulate filtration per Specification 3281-5.
- Minimum reuse water supply pressure to irrigation system should match existing system if retrofitting.

OPERATIONS AND MAINTENANCE

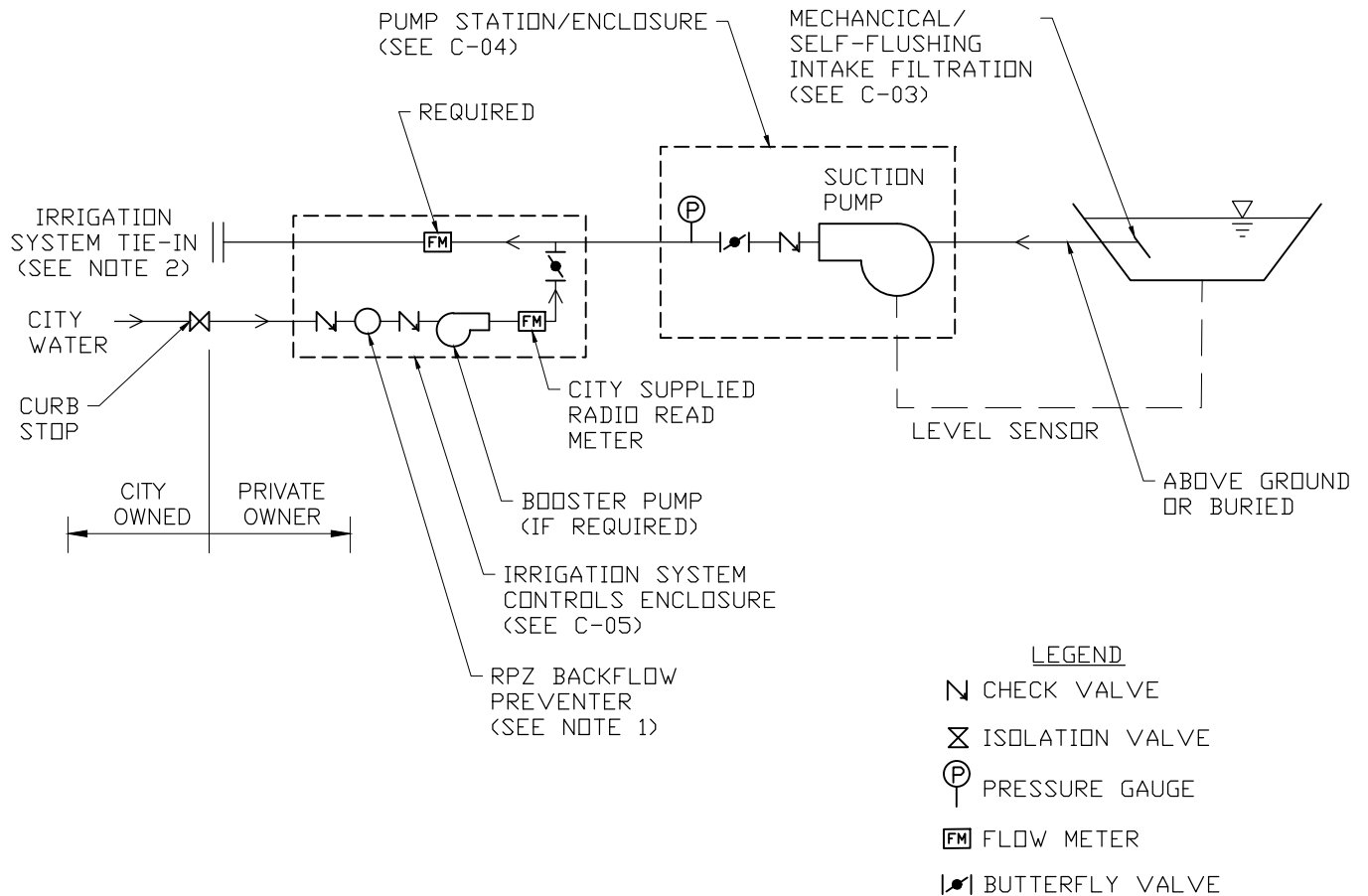
- Irrigation with stormwater can only operate between 10-PM and 4-AM.
- Maximum stormwater pond drawdown to be determined by the City/watershed district and pump manufacturer to protect stormwater basin. No irrigation is permitted that draws the pond level lower than the established minimum pond depth.
- Stormwater reuse signage is required. Minimum of one sign located adjacent to stormwater pond and pump station. Additional signage required at irrigation site(s). Signage language must include: *“Irrigation supply is reused stormwater. Do not drink”*.
- Stormwater pond intake assembly must be removed from the pond and stored over winter.
- Operations and Maintenance (O&M) Manual is required prior to system use. O&M Manual to address training and education to system operators, provide standard operating procedures for the system, includes equipment operation and maintenance requirements, includes documented Monitoring Plan, includes documented Reporting and public notification Plan, and provides owner, operator(s) and regulatory agency contact information.

CITY STANDARD SPECIFICATIONS

- Irrigation Water Treatment SECTION 3281-5
- Irrigation Pump, Piping and Appurtenances SECTION 3282-5
- Instrumentation and Controls for Irrigation Water SECTION 4090-0(1)
- Instrumentation and Controls for Irrigation Water and Treatment SECTION 4090-0(2)

CITY STANDARD DETAILS

- Typical Water Reuse Process Flow Diagram (Base Model) C-01
- Typical Water Reuse Process Flow Diagram (Treatment) C-02
- Typical Stormwater Pond Pump Intake C-03
- Typical Pump Station Plan C-04
- Irrigation System Controls (Typical Potable Water Connection/Backflow Prevention) C-05



NOTES:

1. BACKFLOW PREVENTION TO MEET MINNESOTA DEPARTMENT OF HEALTH REQUIREMENTS.
2. NON-CLOGGING SPRINKLER HEADS RECOMMENDED.

TYPICAL WATER REUSE PROCESS FLOW DIAGRAM (BASE MODEL)

JANUARY 2022

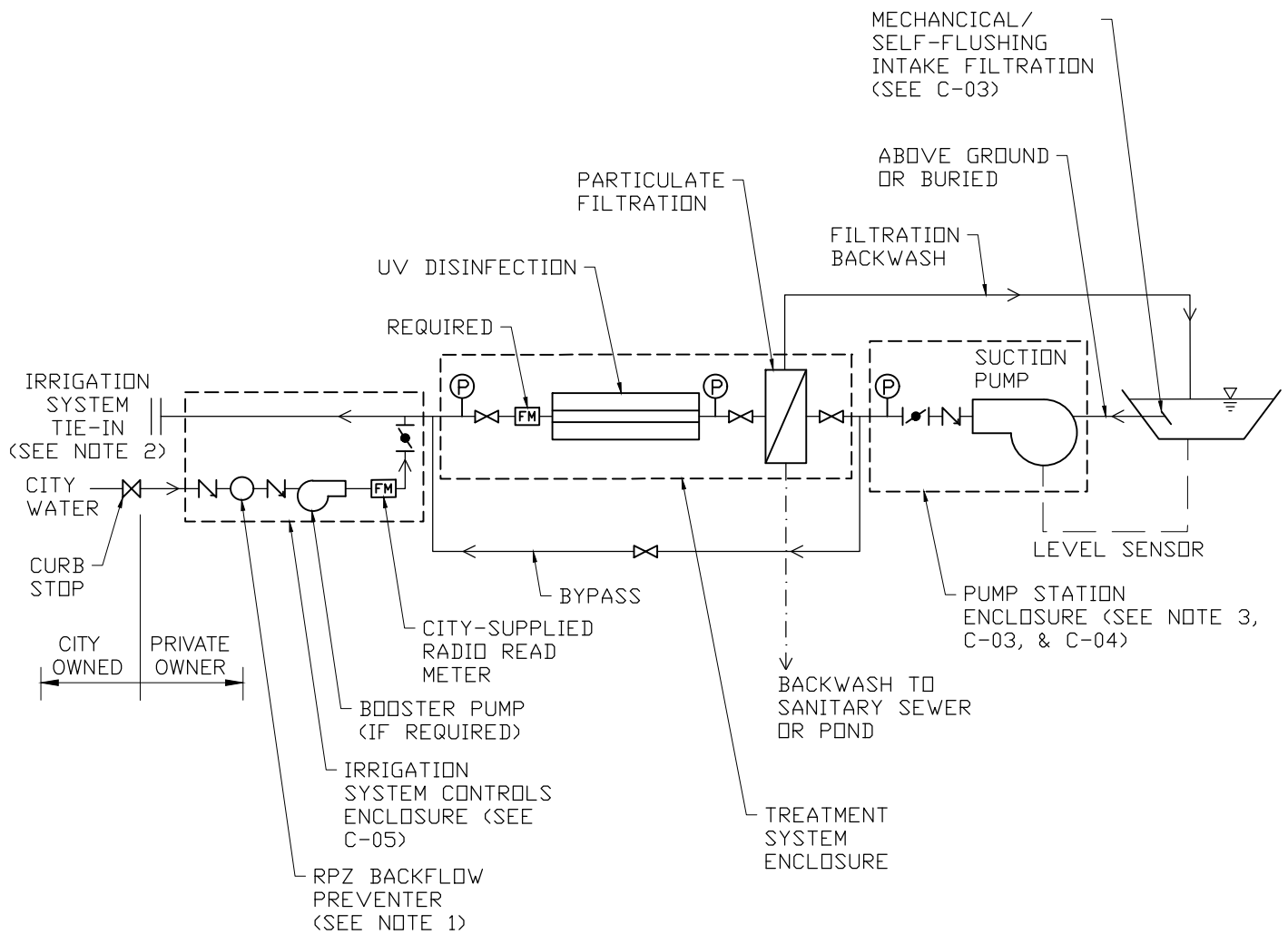


CITY OF LAKE ELMO

STANDARD DRAWING NO.

C-01

LAKE ELMO



NOTES:

1. BACKFLOW PREVENTION TO MEET MINNESOTA DEPARTMENT OF HEALTH REQUIREMENTS.
2. NON-CLOGGING SPRINKLER HEADS RECOMMENDED.
3. PUMP CAN BE LOCATED WITHIN TREATMENT SYSTEM ENCLOSURE IF SUCTION LIFT ALLOWS.

LEGEND

- ◀ CHECK VALVE
- ✕ ISOLATION VALVE
- Ⓟ PRESSURE GAUGE
- FM FLOW METER
- ✂ BUTTERFLY VALVE

POTENTIAL/FUTURE WATER REUSE PROCESS FLOW DIAGRAM (TREATMENT)

JANUARY 2022

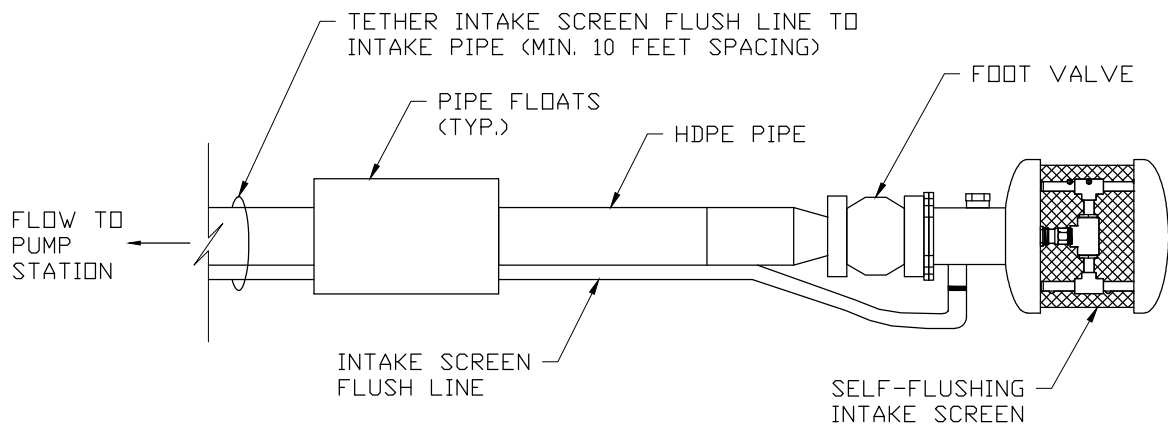


CITY OF LAKE ELMO

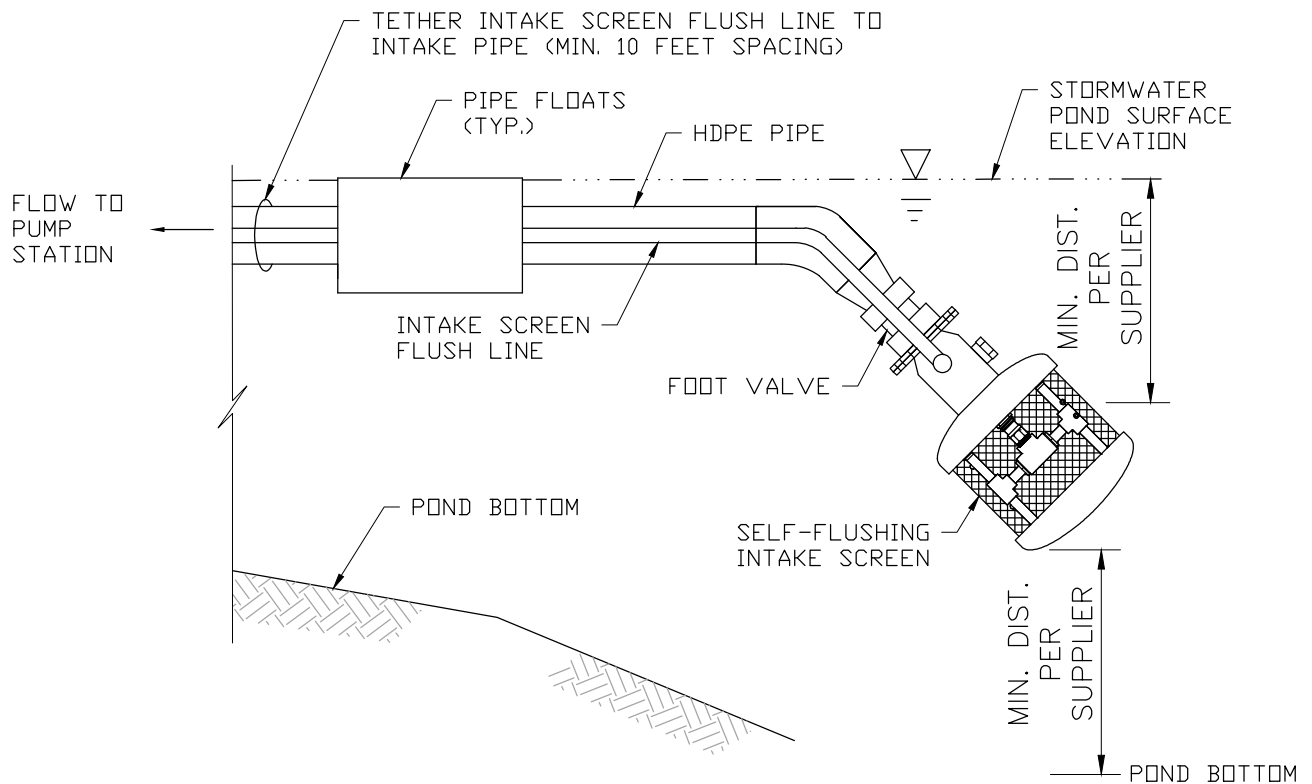
STANDARD DRAWING NO.

C-02

LAKE ELMO



PLAN



SECTION

TYPICAL STORMWATER POND PUMP INTAKE

JANUARY 2022

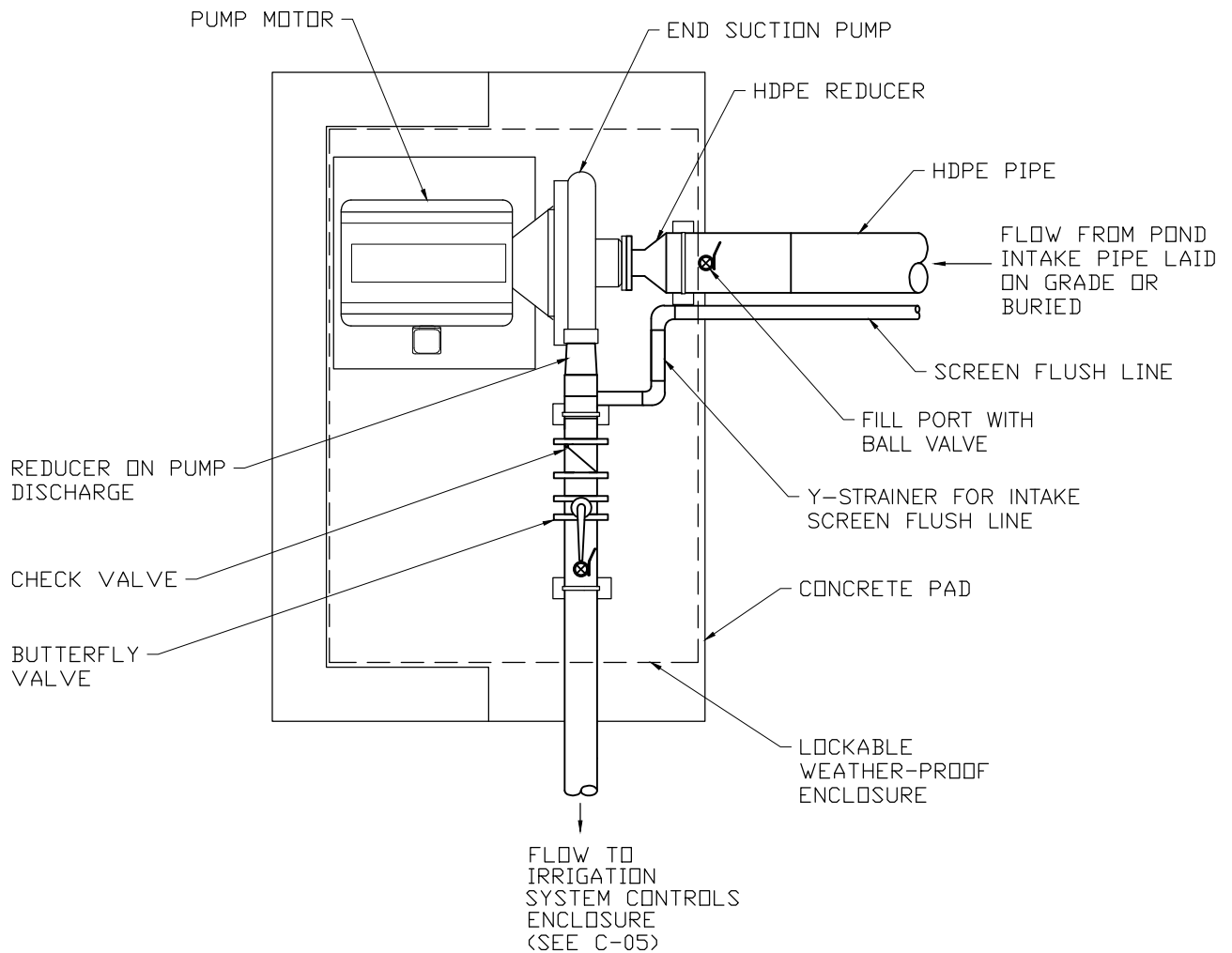


CITY OF LAKE ELMO

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C-03

LAKE ELMO



TYPICAL PUMP STATION PLAN

JANUARY 2022

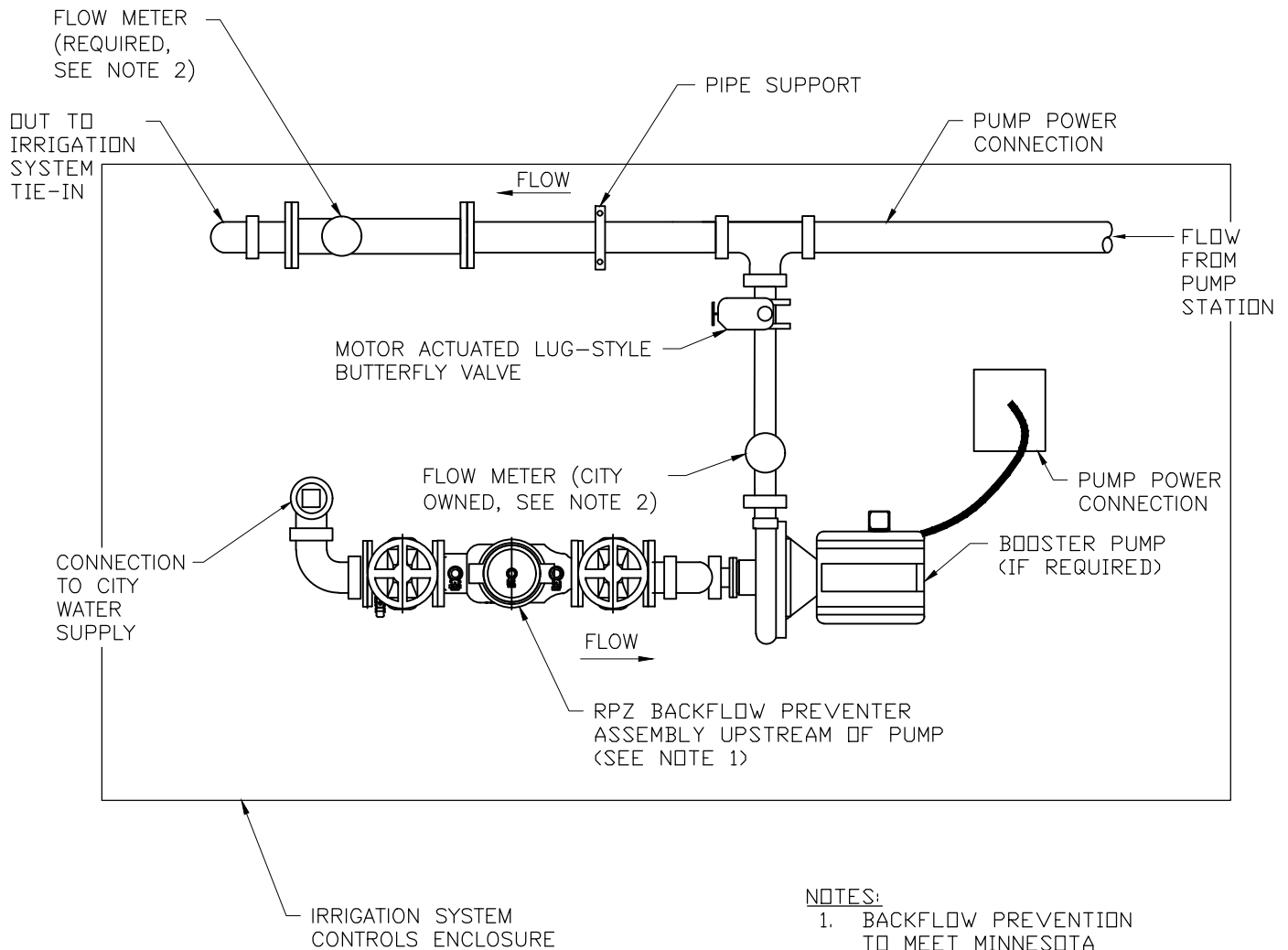


CITY OF LAKE ELMO

STANDARD DRAWING NO.

C-04

LAKE ELMO



NOTES:

1. BACKFLOW PREVENTION TO MEET MINNESOTA DEPARTMENT OF HEALTH REQUIREMENTS.
2. PROVIDE MAXIMUM POSSIBLE LENGTH OF STRAIGHT PIPE UPSTREAM OF FLOW METER (MIN. 5 PIPE DIAMETERS AHEAD, 2 PIPE DIAMETERS AFTER)

IRRIGATION SYSTEM CONTROLS (TYPICAL POTABLE WATER CONNECTION/ BACKFLOW PREVENTION)

JANUARY 2022



CITY OF LAKE ELMO

STANDARD DRAWING NO.

C-05

LAKE ELMO

SECTION 3281-5 – IRRIGATION WATER TREATMENT

Text appearing in yellow is system/application-specific and should be updated accordingly.

SCOPE

Under this Section shall be included furnishing all supervision, labor, materials, and equipment required to construct a stormwater treatment system for non-potable irrigation supply, including, but not limited to providing:

1. Filtration system.
2. Ultraviolet (UV) disinfection system, including a control panel with an operator interface.

REFERENCES

- Section 3282-5 Irrigation Pump, Piping and Appurtenances
- Section 4090-0 Instrumentation and Controls for Irrigation Water Treatment

GENERAL REQUIREMENTS

1. SYSTEM DESCRIPTION AND REQUIREMENTS

- a. The equipment in this Section will be used to treat stormwater for irrigation supply to the irrigation system. The source water for this system is stormwater collected from [PROPERTY DESCRIPTION] and stored in a pond. The irrigation supply pump will deliver water from the pond, through the treatment system and to the irrigation system piping.
- b. The irrigation system requires [FLOW RATE] gallons per minute (gpm) at [PRESSURE] pounds per square inch (psi) pressure at the treated irrigation water connection.
- c. Final design conditions including flow rates and pressures will be determined after equipment selection and shop drawing review.
- d. Filtration backwash will be automatically triggered by pressure differential and the filter shall be able to backwash without taking the system offline.
- e. Influent water quality from sampling on [DATE] is included below. This is the design basis for the influent water quality for the treatment system.
- f. The preliminary design conditions for the treatment system are outlined below. Upon project award, verify the design conditions based on the proposed system operating requirements. It is Contractor's responsibility to coordinate with the suppliers of the system components, including the pump station, to assure that the required pressure and flow are supplied to the existing irrigation system.
 - i. Design flow rate: [FLOW RATE] gpm
 - ii. Treatment system discharge pressure: [PRESSURE] psi minimum, [PRESSURE] psi maximum
 - iii. Total coliform: 2.2 MPN/100 ml

[INSERT STORMWATER QUALITY TABLE – RECOMMENDED STORMWATER QUALITY SAMPLING PARAMETERS PROVIDED IN ATTACHMENT A]

2. **MANUFACTURERS** Treatment system package equipment shall be supplied by one of the following vendors: [PREFERRED VENDORS/MANUFACTURERS]. The same vendor shall supply both the filtration package system and the UV package system.
3. **WARRANTY** Filtration and UV systems shall include a minimum standard warranty of 12 months from start-up.
4. **PERMITS** Supplied equipment shall conform to all state and city regulations, as required. Contractor shall obtain a city plumbing permit.
5. **SHOP DRAWINGS AND SUBMITTALS**
 - a. Shop drawings for approval: all Products furnished under this section.

- b. Operation and maintenance manuals: filtration system, UV system.
 - c. Other related submittals shall be made to Engineer upon request.
- 6. SEQUENCING AND SCHEDULING Coordinate start-up of the treatment system with the Owner's irrigation service provider.
- 7. BASIS OF PAYMENT Refer to Section 1200, Measurement and Payment.

PRODUCTS

1. FILTRATION SYSTEM

- a. Provide a complete package filtration system with the following components and functions.
 - i. Filter
 - 1. 25-micron filter.
 - 2. 316 stainless steel material.
 - 3. Self-cleaning, screen design using filter effluent flow.
 - 4. Rated for minimum 100 psi.
 - 5. [SIZE]-inch diameter flanged influent and effluent connection.
 - 6. Bolts, screws, and other external hardware treated for corrosion resistance.
 - b. Backwash
 - i. Automatically triggered by pressure differential and performed while filter is online. Include pressure instrumentation and logic with the system.
 - ii. Backwash cycle length: less than 30 seconds.
 - iii. Backwash supply: the filtered water by means of a solenoid valve that opens at a set pressure differential.
 - iv. Provide a connection for a 1-inch diameter backwash discharge.
 - v. Discharged through a 1-inch diameter Schedule 40 PVC pipe to an existing storm sewer manhole.
 - c. Instrumentation
 - i. Include all necessary instrumentation for operation including flow switches or pressure transducers, as needed.
 - d. Alarms
 - i. Controls shut down the pump station and / or related components in the event of the following alarm conditions and illuminates a beacon light:
 - 1. Low discharge pressure.
 - 2. High discharge pressure.
 - 3. High or low voltage, loss of phase, or phase reversal.
 - 4. Low water level.
 - 5. Drive failure, output to drive is not met with corresponding running input for set time delay. Indicates overload, phase imbalance or control fuse.
 - 6. VFD fault and VFD bypass status.
 - 7. High pump temperature.
 - 8. Automatic filter alarm. Filter flush to restore screen psi differential.
 - 9. Control panel power alarm. Loss of control panel low voltage circuit power.
 - 10. Pipe fill alarm. System unable to pressurize.
 - 11. Low inlet pressure.
 - e. Piping
 - i. [SIZE]-inch diameter Schedule 40 PVC influent and effluent piping connections.
 - ii. Piping as necessary to connect to influent and effluent and associated instrumentation.

- f. Valves
 - i. Provide all isolation valves as necessary for filter operation.
 - g. Provide all materials required for:
 - i. Equipment support: pipe supports bolted to the concrete floor in accordance with equipment and material manufacturer's recommendations and standard industry practice.
2. UV SYSTEM
- a. Provide a complete package 254 nm UV system with the following components and functions.
 - i. Design conditions:
 - 1. Minimum dose: 30 mJ/cm².
 - 2. Minimum transmittance: [PERCENTAGE] % UVT.
 - ii. UV chamber/ housing: 316L stainless steel.
 - iii. Pressure rating: 150 psi.
 - iv. [SIZE]-inch diameter influent and effluent flanges.
 - v. Minimum system components: reactor, low-pressure lamps, lamp sleeves, a UV intensity sensor, and temperature sensor.
 - b. Instrumentation
 - i. Provide all necessary instrumentation for operation.
 - ii. Monitoring requirements:
 - 1. Adjacent lamp failure.
 - 2. Multiple lamp failure.
 - 3. Status of each reactor.
 - 4. Status of each lamp.
 - 5. Status of each lamp ballast.
 - 6. Lamp age, or end of lamp life (EOLL) alarm.
 - 7. Low UV transmittance.
 - 8. Low low UV transmittance.
 - 9. Low UV dose.
 - 10. Low low UV dose.
 - 11. Low UV intensity.
 - 12. Low low UV intensity.
 - c. Electrical and controls
 - i. Industrial grade control panel (PLC) and operator interface (OIT) that allows the user to view and modify all pertinent operation parameters.
 - ii. Terminate all off-skid devices requiring control interface in a junction box.
 - iii. Provide a manual emergency stop button.
 - d. Alarms
 - i. Include alarms in the PLC.
 - ii. Controls shall shut down the system and illuminate an alarm beacon light in the event of the following:
 - 1. Lamp failure/bulb out.
 - 2. Low UV dose or intensity.
 - 3. High temperature.
3. PVC PIPING AND FITTINGS
- a. Class 200 IPS, SDR 21 ASTM D2241 pipe and fittings for below- grade PVC piping.
 - b. Schedule 40 for above-grade PVC piping.
 - c. Solvent weld joints.
 - d. Adapter flanges and fittings for transition between piping materials.

- e. Support piping per manufacturer recommendations.
- 4. METER
 - a. Provide water meter to measure treated water flow rate.
 - i. Suitable for non-potable reuse water.
 - ii. Flow range: 0-[HIGHER THAN MAX IRRIGATION FLOW RATE] gpm with +/- 2% accuracy.
 - iii. [SIZE]-inch diameter flanged connections.
 - iv. Rated for 150 psi.
 - v. Steel, bronze alloy or cast iron housing with stainless steel trim.
 - vi. Local register, totalizer, and a transmitter, and register in gallons per minute and gallons.
 - vii. Meter manufacturer: [PREFERRED MANUFACTURER] or approved equal.
- 5. BUTTERFLY VALVE
 - a. [SIZE]-inch diameter butterfly valve:
 - i. Ductile Iron Body, lug style.
 - ii. BUNA-N resilient seat.
 - iii. Self-adjusting stem seal, heavy-duty non-corrosive stem bushing.
 - iv. One-piece stainless steel disc and stem.
 - v. Corrosion resistant coating on body.
 - vi. 150 psi pressure rating.
 - vii. Lever operated.
 - viii. Provide at flushing connection and for treatment system isolation.
- 6. FLUSHING CONNECTION AND DRAIN
 - a. [SIZE]-inch diameter cam lock fitting and cap.
 - b. A 0.5-inch diameter hose bib shall be provided on the influent piping for winterization.
- 7. HOUSING
 - a. Treatment system shall be enclosed in a lockable secure facility to protect equipment from severe weather or vandalism, and sit on a concrete housekeeping pad.

EXECUTION

- 1. GENERAL
 - a. Coordinate final location of treatment with Owner and Engineer.
- 2. FILTRATION SYSTEM
 - a. Install screen in accordance with manufacturer's recommendations.
 - b. Install piping supports as recommended by manufacturer.
 - c. Connect filtration system backwash piping to existing stormwater manhole:
 - i. Excavate as required to expose connection location 24 inches below grade.
 - ii. Core drill oversized hole.
 - iii. Securely grout pipe in place. Verify that pipe discharge is free of grout or other obstructions.
 - iv. Pressure test to [PRESSURE] psi.
- 3. UV SYSTEM
 - a. Install UV housing and bulbs in accordance with manufacturer's recommendations.
 - b. Install piping supports as recommended by manufacturer.
- 4. START-UP AND COMMISSIONING
 - a. Coordinate start up with irrigation supply pump installation and irrigation system contractor.
 - b. Technical start-up shall be furnished by the system manufacturer or a qualified certified service agency.
 - c. Technical start-up procedures include, but are not limited to the following:
 - i. Station start-up and pressurization.
 - ii. Pressure, flow and programming adjustments.

- iii. Monitoring of complete operational cycle when possible.
- iv. Customer training and presentation of owner's manual.

5. TRAINING

- a. Filtration system manufacturer shall supply a representative for startup and commissioning and one eight (8) hour training.
- b. UV system manufacturer shall supply a representative for startup and commissioning and one eight (8) hour training.

END OF SECTION

ATTACHMENT A: RECOMMENDED STORMWATER QUALITY SAMPLING PARAMETERS

Parameter	Total or Dissolved	Units	Recommendation ^[1]
General Parameters			
Orthophosphate, as P	Dissolved	mg/l	Typical stormwater quality parameter
Alkalinity, total, as CaCO ₃	NA	mg/l	Typical stormwater quality parameter
Ammonium	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Bicarbonates and carbonates	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Biochemical Oxygen Demand (5-day)	NA	mg/l	Typical stormwater quality parameter
Chloride	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass, influences soil quality and turfgrass performance
Chlorophyll -a, pheophytin-adjusted	NA	ug/l	Aesthetic impacts to grass from irrigation
Electrical conductivity and TDS	NA	µS/cm	Irrigation Water Quality Guidelines for Turfgrass
Nitrogen, ammonia, as N	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass, typical stormwater quality parameter
Nitrogen, Nitrate + Nitrite, as N	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Nitrogen, Nitrate, as N	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Nitrogen, total kjeldahl (TKN)	NA	mg/l	Typical stormwater quality parameter
pH	NA	SU	Irrigation Water Quality Guidelines for Turfgrass, influences soil quality and turfgrass performance
Phosphorus, total, as P	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass
% Dissolved P	NA	%	Typical stormwater quality parameter
Solids, total dissolved	NA	mg/l	Pump suction screen and filtration system (ahead of UV) design
Solids, total suspended	NA	mg/l	Pump suction screen and filtration system (ahead of UV) design, typical stormwater quality parameter
Sulfur	NA	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Turbidity	NA	NTU	Pump suction screen and filtration system (ahead of UV) design, typical stormwater quality parameter
% Ultraviolet Transmittance (UVT)	NA	%	Water treatment vendors
Microbiological			
Bacteria, e. Coli	NA	mpn/100ml	UV disinfection system design, pollutant of concern related to health
Metals			
Boron	Total	ug/l	Irrigation Water Quality Guidelines for Turfgrass
Calcium	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Copper	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Iron	Total	ug/l	Irrigation Water Quality Guidelines for Turfgrass, aesthetic impacts to grass from irrigation
Magnesium	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Manganese	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Molybdenum	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Potassium	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
Sodium	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass, influences soil quality and turfgrass performance
Zinc	Total	mg/l	Irrigation Water Quality Guidelines for Turfgrass
[1] Irrigation Water Quality Guidelines for Turfgrass: https://extension.psu.edu/irrigation-water-quality-guidelines-for-turfgrass-sites .			

SECTION 3282-5 – IRRIGATION PUMP, PIPING, AND APPURTENANCES

Text appearing in yellow is system/application-specific and should be updated accordingly.

SCOPE

Under this Section shall be included furnishing all supervision, labor, materials, and equipment required to construct an intake, pump station, and discharge pipe to function as an integral part of stormwater reuse for irrigation, including, but not limited to providing:

1. A package pump station with pump, valves, piping, and appurtenances housed in a lockable weather tight enclosure.
2. A high density polyethylene (HDPE) pump intake pipe with self-cleaning intake screen, foot valve and floats.
3. A pipe storage container.
4. Buried discharge pipe.
5. Butterfly valve with electric actuator to be installed in irrigation water supply enclosure.
6. Cross connection control between the potable water system and the reuse irrigation system shall be provided meeting Minnesota Department of Health requirements.

REFERENCES

- Section 3281-5 Irrigation Water Treatment
- Section 4090-0 Instrumentation and Controls for Irrigation Water

GENERAL REQUIREMENTS

1. SYSTEM DESCRIPTION AND REQUIREMENTS

- a. The pump system specified in this Section will be an integral part of stormwater reuse for irrigation. The source water for this system is stormwater collected from [RUNOFF COLLECTION AREA DESCRIPTION] and stored in a pond. The pump shall be located above the 100-year flood elevation of the stormwater pond, and all components of the pump system shall be suitable for suction lift conditions.
- b. The pump will be controlled by a variable frequency drive (VFD) housed in the treatment building.
- c. The irrigation system requires [HIGHEST FLOW RATE/IRRIGATION ZONE REQUIREMENT] gallons per minute (gpm) at [PRESSURE REQUIREMENT] pounds per square inch (psi) pressure at the stormwater reuse for irrigation supply connection with the irrigation system.
- d. The preliminary pump design conditions were developed using assumed headloss through the various system components and backflush requirements for an intake screen (approximately [BACKFLUSH FLOW RATE] gpm). Backflush for the treatment filter was assumed to be intermittent and of short duration; thus, no additional flow was included in the design flow. It is the Contractor's responsibility to coordinate with the suppliers of the system components to assure that the required pressure is supplied to the irrigation system.
- e. Preliminary pump design flow: [FLOW RATE] gpm.
- f. Preliminary pump TDH: [TOTAL DYNAMIC HEAD] feet.
- g. Maximum suction lift: [SUCTION LIFT] feet.

2. MATERIALS TO BE FURNISHED All material required for the construction shall be furnished by the Contractor and all materials shall be new, of first grade and shall be products reputable manufacturers known to the trade.

3. SHOP DRAWINGS AND SUBMITTALS

- a. Shop drawings for approval: all Products furnished under this section, excluding guide poles.
- b. Operation and maintenance manuals: pump, intake screen.
- c. Other related submittals shall be made to Engineer upon request.

4. SEQUENCING AND SCHEDULING Coordinate start-up of the pump and intake system with the Owner's irrigation service provider.

5. PERMITS Supplied equipment shall conform to all state and city regulations, as required.
6. BASIS OF PAYMENT Refer to **Section 1200**, Measurement and Payment.

PRODUCTS

1. PACKAGE IRRIGATION PUMP STATION

- a. Provide a single-sourced, complete package irrigation pump station with the following components and functions.
 - i. End-suction centrifugal pump:
 1. All iron construction, ASTM A48 CL30.
 2. Enclosed impeller with renewable wear rings.
 3. Replaceable stainless steel shaft sleeve.
 4. Casing drain with zinc plated steel plug.
 5. Threaded or flanged suction and discharge.
 6. Close-coupled, inverter duty rated TEFC motor.
 - a. Non-overloading over the entire range of the pump curve.
 - b. 1.15 service factor.
 - c. 3Phase/480 VAC/60 Hz.
 - d. Motor controls have been designed based on **[HORSEPOWER]** HP. Make all modifications required to the system if a different horsepower motor is provided at no additional cost to Owner.
 7. Carbon/ceramic/BUNA standard mechanical seals.
 8. Corrosion resistant primer and top coating.
 9. Bolts, screws, and other external hardware treated for corrosion resistance.
 10. Frame-mounted, bolted securely to slab or skid.
 - ii. Valves
 1. Iron or steel body valves, flanged or threaded joints, or wafer style, pressure rated for 150 psi minimum.
 2. Check valve: silent check style, heavy duty spring, resilient seat, full-port.
 3. Lug-style butterfly, resilient seat.
 4. Small diameter ball valves, threaded.
 - iii. Pipe
 1. Galvanized, ASTM A-53 Grade B, seamless or ERW carbon steel, standard weight
 2. Joints: threaded or flanged as shown on the Drawings and as required to install fittings and valves.
 - a. Flanges:
 - b. 150-pound Class ANSI B16.5 forged steel, ASTM 105, RF, weld-neck or slip-on per ASTM A126 or threaded per ANSI/ASME B1.20.1.
 - c. Bolts: hex head stainless steel.
 3. Fittings: ASTM A234, carbon steel, standard weight, threaded ends (3" and smaller).
 4. Coating: hot-dip galvanized inside and outside, conforms to ASTM A123.
 5. Provide appropriate restrained transition from galvanized steel to buried PVC to resist thrust forces developed.
 - iv. Provide all materials required for:
 1. By-pass for priming the suction line and pump.
 2. Measuring pressure of the intake screen wash system.
 3. Adequately supporting and restraining the pipe from thrust forces that may develop.
- b. Enclosure
 - i. Powder-coated steel enclosure, color to be selected by Property Owner.
 - ii. Weather-tight, with gravity ventilation louvers.

- iii. Lockable.
- iv. Suitable for installation on concrete pad as shown on the Drawings.
- c. See 4090 Instrumentation and Controls for additional requirements.

2. INTAKE PIPE AND APPURTENANCES

- a. HDPE intake pipe
 - i. DR26, PE4710, ASTM F714, minimum cell classification 445474C per ASTM D3350.
 - ii. Fittings manufactured from same resin as pipe and supplied by pipe manufacturer.
 - iii. Molded flange adapter with stainless steel back-up ring, high strength, low-alloy steel bolts and nuts. Full-face gaskets.
 - iv. If a lower DR pipe is provided, confirm that the higher friction losses resulting from smaller inside diameter does not adversely affect the suction conditions of the pipe.
 - v. Joints: butt-welded or electrofusion, except as noted below.
 - vi. Provide Victaulic type coupling at location shown in the Drawings to allow for disassembly and storage.
- b. Self-cleaning intake screen:
 - i. Self-cleaning screen design using pressurized flow from the pump discharge.
 - ii. Internal dual rotating jet bars.
 - iii. Rated for minimum [FLOW RATE] gpm intake, [FLOW RATE] gpm backwash flow at [PRESSURE] psi maximum.
 - iv. Materials of construction:
 - 1. 12 mesh stainless steel screen.
 - 2. Galvanized steel screen frame and flange.
 - v. Removable exterior screen drum.
 - vi. In-line Y-strainer for backwash line.
- c. Pipe float(s)
 - i. Impact resistant polyethylene plastic with built in UV inhibitors, galvanized hardware.
 - ii. Split design with molded-in bolt holes for easy removal and installation.
 - iii. Sized to securely clamp around pipe without slipping.
 - iv. Number and size to be determined by supplier based on system supplied.

3. BACKFLOW PREVENTER

- a. Cross connection control shall be provided meeting Minnesota Department of Health by either an air gap or a reduced pressure zone (RPZ) valve backflow preventer.
- b. RPZ valve backflow preventer.
 - i. Double-check, backflow-prevention assembly for continuous-pressure applications unless otherwise indicated.
 - ii. Pressure loss: 5 PSIG, maximum.
 - iii. Body: bronze.
 - iv. End connections: threaded.
 - v. Configuration: designed for horizontal, straight-through flow.

4. PIPE STORAGE CONTAINER

- a. Corrugated Polyethylene Pipe (CPEP).
- b. Bolted or locking end caps.

5. BUTTERFLY VALVE AND ELECTRIC ACTUATOR

- a. Valve
 - i. Body: ductile iron, lug style.
 - ii. BUNA-N resilient seat.
 - iii. Self-adjusting stem seal, heavy duty non-corrosive stem bushing.
 - iv. One-piece stainless steel disc and stem.
 - v. Corrosion resistant coating on body.
 - vi. 150 psi rated.

- b. Electric Actuator
 - i. Provide actuator for worst case valve operating conditions:
 - 1. City water service connection supplies [FLOW RATE] gpm at [PRESSURE] psi.
 - 2. Operation will be at start-up of irrigation system with 0 psi on the irrigation system side of the valve.
 - 3. Valve is used for full open/close operation, no modulation, intermittent duty.
 - ii. Die-cast aluminum standard water proof enclosure, UL, NEMA 4.
 - iii. 1 Phase/120 VAC power supply, Class F insulation or better.
 - iv. Standard stainless steel mechanical limit switches.
 - v. Factory set cam adjustment for 90-degree travel between open and closed positions.
 - vi. Two NPT conduit ports.
 - vii. Manual override handwheel assembly; automatic power cutout when manual override is engaged.
 - viii. Valve position display.
 - ix. Actuator switches pre-wired to the terminal block.
 - x. Self-regulating, temperature-controlled heater.
- 6. PVC PIPE
 - a. Pressure rated pipe and fittings for below and above grade piping:
 - i. Class 200 IPS, SDR 21 ASTM D2241/ASTM D2672.
 - ii. ASTM D1784 Cell class 12454.
 - b. Solvent weld joints.
 - c. Provide restraint for transition between piping materials.
 - 7. DETECTABLE WARNING TAPE
 - a. 2-inch wide, 5-mil tape with aluminum backing for detection by non-ferrous locator.
 - b. Blue in color, message in black letters "Caution Buried Water Line Below".
 - 8. PRESSURE RELIEF VALVE AND VALVE BOX
 - a. High strength cast aluminum with stainless steel shaft, tempered steel spring and Teflon seal and bushing.
 - b. Factory set for a pressure range of [PRESSURE RANGE] psi.
 - c. Provide valve box with locking lid suitable for use with pressure relief valve.
 - 9. SOURCE QUALITY CONTROL
 - a. Provide products that are readily available manufacturer's standard models.
 - b. Provide products of the same type, but different diameter or size, from the same manufacturer.
 - c. Provide package pump station and appurtenances assembled by a single supplier, ready to install in the field.

EXECUTION

- 1. GENERAL
 - a. Coordinate final location of pump station with Owner and Engineer.
- 2. INTAKE PIPE AND APPURTENANCES
 - a. Install intake screen and backwash line in accordance with manufacturer's recommendations.
 - b. HDPE Pipe joints
 - i. Use fully-trained and experienced technicians to perform field fusion of HDPE pipe. If requested by Owner or Engineer, provide documentation of technician qualifications prior to mobilizing equipment and crews for execution of the Work.
 - ii. Butt fuse HDPE pipe in accordance with applicable portions of ASTM F2620 and PPI TR-33.
 - iii. Butt fuse HDPE fittings in accordance with applicable portions of ASTM D3261 and PPI TR-33.
 - iv. If permitted, make electrofusion joints strictly in accordance with manufacturer's

recommendations.

- c. Provide flanged joints as shown on the Drawings and as required to allow disassembly and storage of pipe sections in the storage container.
- d. Locate pipe anchor to assure that there is no strain on the elbow.
- e. Assemble pipe to be vacuum tight.

3. BACKFLOW PREVENTER

- a. Install backflow preventer in the location shown within the irrigation box.

4. PUMP STATION

- a. Install pump station oriented to minimize the need for fittings as shown on the Drawings.
- b. Coordinate with electrical and structural for sequencing of skid installation.
- c. Install all associated components to provide a fully functioning irrigation pumping system.

5. BURIED PIPE INSTALLATION

- a. Solvent weld PVC pipe joints using a two-step process with primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564, and in accordance with manufacturer's recommendations.
- b. Prepare trench and install buried pipe in accordance with ASTM D2774 and ASTM F1668, and in strict accordance with manufacturer's recommendations.
- c. Install warning tape 18-inches below grade above the pipe.
- d. Coordinate with structural for location of pipe through slab penetrations. Wrap PVC pipe that is cast in the slab with expansion joint material to prevent bonding of pipe to concrete.
- e. Connect pipe to appurtenances and fittings in accordance with ASTM D2774. Provide restraint for buried fittings subject to thrust forces.
- f. Connect to irrigation system pipe as shown on the Drawings.
- g. Install pressure relief valve in accordance with manufacturer's recommendations. Provide all fittings and materials required for installation.
- h. Install valve box and drainage gravel as shown on the Drawings.

6. FLUSHING AND TESTING

- a. Fully flush pipes before connection to intake screen and connection to irrigation system.
- b. Hydrostatic pressure test the installed buried pipe prior to connection to irrigation pipe in accordance ASTM F1668 and ASTM D2774 with irrigation system test pressure at minimum 150 psi at the pump.
- c. Hydrostatic pressure test HDPE intake pipe in accordance with ASTM F2164 and manufacturer's recommendations with 25 psi test pressure.

7. BUTTERFLY VALVE/IRRIGATION CONNECTION MODIFICATIONS

- a. Install butterfly valve with electrical actuator in the location shown within the irrigation box.
- b. See electrical for information about electrical connections to be made by Property Owner's irrigation service provider.
- c. Verify that joints are watertight by pressurizing reconfigured piping with City water. Coordinate with irrigation service provider for location of irrigation isolation valve to use for test.

8. FIELD QUALITY CONTROL

- a. Establish and maintain quality control procedures for the Work under this Section.
- b. Maintain records of pressure testing and location of buried fittings.

END OF SECTION

SECTION 4090-0(1) – INSTRUMENTATION AND CONTROLS FOR IRRIGATION WATER

Text appearing in yellow is system/application-specific and should be updated accordingly.

SCOPE

Under this Section shall be included furnishing all supervision, labor, materials, and equipment required for irrigation pumping system process instrumentation and control system.

REFERENCES

- Section 3282-5 Irrigation Pump, Piping and Appurtenances

GENERAL REQUIREMENTS

1. SYSTEM DESCRIPTION AND REQUIREMENTS

- It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by a single-source supplier ("Controls Supplier") except as specifically indicated. Contractor, along with the Controls Supplier, shall assume full responsibility for furnishing, installing and start-up procedures to make the system operate per the intent of the Contract Documents.
- The work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.
- It shall be the responsibility of Contractor (along with the Controls Supplier) to furnish a complete and fully operating system. Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Contract Documents.

2. QUALITY ASSURANCE

- The instrumentation and control system Supplier (or "Controls Supplier"), as a business entity, shall have a minimum of 5 years of experience in the assembly, installation, repair, and maintenance of irrigation control systems. Substitution of individual experience in lieu of the required business experience shall not be allowed.
- The Controls Supplier shall maintain a minimum \$1,000,000 product liability insurance policy.
- The Controls Supplier must maintain and operate a panel shop with both UL-508 labels.
- The Supplier shall modify or supplement the Supplier's "standard products" to meet these specifications. Standard products of a particular Supplier that do not meet the functional and technical requirements of the specification are not acceptable.
- The Supplier shall have a minimum of two (2) full-time qualified, trained service personnel on staff who are capable of maintaining, adjusting, troubleshooting, and programming the system.
- The Supplier shall be capable of offering an extended service contract after completion of the warranty period.
- Supplier shall design, engineer, assemble, program, test, and support the system using its own facilities and employees.
- Supplier shall produce all project drawings using computer-aided drafting.

3. SHOP DRAWINGS AND SUBMITTALS

- Four sets of all documents including:
 - Data sheets for all equipment and components indicated on the Drawings and specified under "PRODUCTS" in this Section.
 - Software packages including complete description of features and capabilities.
- Four sets Shop Drawings in conformance with Division 1 and including:
 - Panel drawings including system schematic drawings, terminal numbering, wire numbering,

- component schematic drawings, dimension drawings, layout drawing and nameplate schedule.
 - ii. Overall system diagram showing all components, converters, cables, and connectors.
 - iii. Programmable Logic Controller (PLC) programs in ladder format. Include verbal description of each rung's function. Assign point numbers to all inputs and outputs, and show point numbering in PLC program.
 - iv. Proposed operator interface unit graphic displays. Submit "rough" or hand-drawn copies prior to programming.
 - v. Provide modifications as requested by the Owner.
 - c. Operation and Maintenance data (four sets) in conformance with Division 1 and including:
 - i. Panel equipment, field devices and instruments, including "as-built" system schematics.
 - ii. Complete software documentation including programming information and operator's guides. Include hard copies of all operator interface unit graphic screens.
 - iii. Point lists for all PLC inputs/outputs. Identify point number (tag), point description, point type, range in engineering units (if analog point), PLC number, rack and slot number, and point address.
 - iv. One of the four sets of operation and maintenance manuals will be titled "Owner's Copy" and it will, in addition to the above items, contain original manufacturers' manuals for all products provided in the panel.
 - d. Start-up report from systems supplier per requirements of **Division 1**.
 - e. Spare equipment lists - provide a list of recommended spare parts and equipment that is considered crucial to the operation of the system. Include list of prices for each item.
 - f. All submittals shall be bound in 3-ring binders with labeled tabs separating sections.

4. TESTING AGENCY CERTIFICATION

- a. All new panels and subpanels furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment".
- b. Each panel and subpanel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standards 508.

5. FUNCTIONAL DESCRIPTIONS – GENERAL

- a. General
 - i. Functional descriptions define how each portion of the instrumentation and control system is to operate. The descriptions, in conjunction with the drawings and the minimum technical requirements for products as described under "PRODUCTS" in this Section, define the minimum requirements for the installation.
 - ii. It is the intent of this specification that all products used to meet the functional descriptions shall be those specified under "PRODUCTS" in this Section.
 - iii. Interface devices, buffer amplifiers, control relays and other components required by Contractor to cause the system to function in accordance with the functional descriptions and schematic drawings shall be considered incidental to the project. Contractor shall show such devices and define them in detail during the shop drawing review to confirm that it understands the requirements of the design.
- b. System Overview
 - i. Contractor shall furnish and install a complete process instrumentation and control system including field instruments, control panel, programmable logic controller (PLC), and panelview installed in the control panel as specified.
 - ii. All system control logic shall reside in the PLC.
 - iii. PLC and control panel components shall be backed by an uninterruptible power supply (UPS). The control panel shall implement a control relay logic circuit that allows the UPS to be removed from the control panel circuiting and automatically provides the controls with bypass power. Additionally, this relay shall provide relay contact indication to the PLC that indicates a UPS failure.
- c. Control Panels - General
 - i. Furnish and install equipment, components and programmable logic controllers (PLCs) as

indicated. Equip each PLC with inputs and outputs as indicated, plus 10% live spares of each signal type. Provide each PLC with a rack having enough empty slots for addition of more input/output modules at each PLC as indicated on Drawings.

- d. Status Indication and Alarms
 - i. Run and fail lights shall be provided for the irrigation pump system.
 - ii. An alarm system shall be incorporated in the control panel and shall send a common alarm signal to an outdoor red light.
- e. Operator Interface Terminal
 - i. Panel shall contain an operator interface terminal ("OIT", i.e. – Allen Bradley Panelview) for observing and changing data within the PLC. The unit shall be programmed so the operator can display and manipulate all control setpoints.
 - ii. Provide graphic screens, prompts, and messages as described in this Specification. All operator interaction with the operator interface shall use screen menu selection and fill-in-the-blanks techniques so that the operator is not required to know special codes, register numbers, etc.
 - iii. The operator interface shall have a screen to display all current alarms in detail. When an alarm occurs, display the alarm description and time of occurrence.
 - iv. Permit the operator to acknowledge alarms at the operator interface. When an alarm is acknowledged, indicate the time and date of acknowledgment.
- f. Equipment "Fail" Alarms
 - i. Where a PLC calls for an equipment item to operate, the PLC shall monitor the associated equipment "RUNNING" contacts. If a RUNNING signal is not returned after five seconds (adjustable), then generate a descriptive alarm point.
- g. Analog Value Alarms
 - i. For all analog values, allow the operator to establish "HIGH" and "LOW" alarm setpoints. Provide adjustable time delay on each setpoint. If the analog value goes out of the setpoint range for a period in excess of the time delay, then generate a descriptive alarm point.
- h. Miscellaneous Status and Alarm Points
 - i. The Drawings show several miscellaneous status and alarm points that are not specifically described in these functional descriptions. Graphic screens shall include all of the status information that is available. Alarms shall be developed for each of the alarm points that are available.
- i. Variable Frequency Drives (VFDs)
 - i. Where variable frequency drives are controlled by the PLC, allow the operator to set maximum and minimum motor speeds. Alarm if a closed-loop setpoint is not maintainable within the motor maximum and minimum speeds. Coordinate with the motor supplier the minimum allowable speed.
 - ii. Monitor VFD alarm contacts. Generate associated alarm.
 - iii. Monitor and indicate motor speed. Alarm if motor speed running does not agree with the motor speed called while drive is in any Auto mode.

6. FUNCTIONAL DESCRIPTION – PUMPING SYSTEM

- a. Pond Level Measurement
 - i. Furnish and install pump supplier's preferred level measurement instruments (float switch and/or level transmitter), as indicated on the Drawings. Assign to an input in the PLC.
 - ii. When applicable, furnish and install a PVC stilling well with perforated sides, a perforated bottom cap. Secure stilling well to structure using stainless steel hardware as required. The stilling well diameter shall be sufficient to allow the float switch to operate without obstructions. Installation shall allow easy removal at the end of the irrigation season and setup at the beginning of each irrigation season.
 - iii. Confirm elevation setpoint of installation during construction.
- b. Irrigation pump
 - i. The pump is driven by a variable speed drive (VFD). The VFD front panel includes the following operator interface devices:

1. Run indicator light (green)
2. Pump fail alarm indicator light (red)
3. Pump elapsed-time meter
4. Pump “hand-off-auto” (HOA) selector switch
5. Pump local speed-control
6. Current transformers (CTs) for motor current indication.
- ii. Input motor thermoswitch into PLC.
- iii. Provide two modes of control for the pump as described further below; “HAND” and “AUTO”. The control status shall be indicated on the OIT. Control mode shall be configurable at the pump station OIT only.
- iv. HAND: Generally used for maintenance and troubleshooting purposes only.
 1. The selector switch in “hand” or “off” position disables control from the Pumping System Control Panel.
 2. With the pump switch placed in the hand position, the VFD will start and run the pump at the configured minimum speed. Pump speed may be modulated via the VFD front panel.
- v. AUTO: This control mode shall be initiated for the first time of the season at the pump station OIT once the irrigation system has been maintained for use. Thereafter it shall be in “automatic” until such time as it is deactivated at the OIT. PLC shall automatically control operation of the pump based on system pressure.
 1. Allow the operator to establish ascending setpoints as follows:
 - a. Low Pressure Alarm
 - b. High Pressure Alarm
 2. The pump shall be enabled once the following occurs:
 - a. PLC detects sufficient pond level via float switch
 - b. PLC detects a remote “RUN” signal from the irrigation controller.
- vi. PLC shall contain a proportional control loop that will vary pump speed to maintain system pressure between “Minimum Speed” setpoint and the “Maximum Speed” setpoint.
- vii. Monitor the associated inputs, as indicated on the Drawings, in Submittals, or as recommended by the Supplier. If any of the alarms occur, generate an alarm condition and stop the associated pump.
- c. Pumping System – General
 - i. Allow the operator to manually select the source of irrigation water:
 1. Re-use System – Normal operation, as described in these specifications.
 2. City Water Supply – The PLC shall send an “enable” signal to the irrigation controller. Under this mode, the re-use shall be disabled.
- d. Pumping System Alarms – in addition to alarms indicated above, provide the following specific alarms:
 - i. The following alarms will shut down its associated pump, generate an alarm, and require a reset at the station OIT after the fault is cleared:
 1. Pump high motor temperature.
 2. Pump VFD fail.
 - ii. The following pump alarms and associated pump station alarms will generate an alarm and engage the alarm beacon, but not shut down the pumps or require a reset:
 1. Pond low level.
 2. PLC control panel UPS fail.
 3. Pump station door intrusion (unless over-ridden by momentary pushbutton).
7. PERMITS Supplied equipment shall conform to all state and city regulations, as required.
8. BASIS OF PAYMENT Refer to **Section XXX-X**, Measurement and Payment.

PRODUCTS

1. CONTROL PANEL FABRICATION – GENERAL
 - a. Enclosures for outdoor control panels shall meet the following minimum requirements:

- i. Stainless steel frame, stainless steel panels, NEMA 3R, unless otherwise specified.
 - ii. Panels shall be flanged, corners welded and ground smooth.
 - iii. Panel shall stand on 18" tall 316 stainless steel legs with louvered skirt with bug screen to cover conduits. Conduits shall enter panel through ventilated skirt area.
 - iv. All inside and exterior surfaces treated to prevent oxidation and painted. White on interior, manufacturer's standard color on exterior.
 - v. The enclosure shall contain an interior sub-panel for mounting all control components and the enclosure shall be sufficiently large to accept all control components without crowding. The panel shall be of not less than 12 gauge type 304 stainless steel with continuously welded seams. The enclosure shall contain door and panel stiffeners as required. The front doors shall have a rolled lip and the door flanged and the corners ground smooth. All enclosure welding seams shall also be ground smooth.
 - vi. The doors shall be fastened to the enclosure with a continuous type stainless steel piano hinge and locking three-point minimum, stainless steel hardware and padlockable handle. The inside of the door shall contain data pockets. The sub-panel shall be painted white.
 - vii. Enclosure shall have full-height dead-front inner 12 gauge carbon steel hinged doors that house all front-panel components including switches, indicating lights, running time meters, overload reset pushbuttons, and other controls that require operator access.
 - viii. Circuit breakers shall be operable from the inner-door.
 - ix. The enclosure shall have thermostatically-controlled heaters to prevent condensation and freezing within the enclosure and per the recommendations of the Supplier.
 - x. Insulated with 1" cell foam insulation. Insulation shall be mechanically secured.
 - xi. Panel shall include a 3-phase power monitor for monitoring incoming 3 phase power. Phase monitor shall be **Time Mark C2644**, or approved equal.
- b. Label components per shop drawings.
 - i. Engraved labels attached with screws.
- c. All wiring terminated on barrier-type terminal strips. Terminal strips shall be labeled with engraved plastic labels.
 - i. Labels shall be attached with two-part epoxy adhesive.
 - ii. 600-volt terminal strips.
 - iii. Ring or spade type crimp connectors.
 - iv. Wiring laced using plastic wire ties and plastic wiring troughs.
 - v. Wiring held down with straps attached to enclosure with screws.
 - vi. Separate power, control and signal conductors.
 - vii. Power wiring: #14 AWG, stranded, 600V copper minimum.
 - viii. Control wiring: #18 AWG, stranded, 600V copper minimum.
 - ix. Signal wiring: shielded, 300V, copper minimum. See Section 16100.
 - x. Provide 15 amp, 10000 AIC breaker on power circuits using #14 wire.
 - xi. Connections to instruments via terminal strip or connectors. Soldering wires to terminal strips not acceptable.
- d. Tag all wires at each end with wire number matching shop drawings.
- e. Electrical Service
 - i. Electrical service will be **60 amp, 480volts, 3-phase, 60 Hz** supplied from the local electric utility, **[ELECTRIC UTILITY COMPANY NAME]**. Coordinate the installation of a new electrical service with the local electric utility.
 - ii. The project developer, **[COMPANY NAME]**, shall initiate the service request and maintain ownership of the service until it can be passed to **[HOMEOWNERS ASSOCIATION NAME]**
 - iii. Include main circuit breaker, wire bending space and barriers as required by NEC and UL standards.

2. PROGRAMMABLE LOGIC CONTROLLER (PLC)

- a. Programmable logic controller capable of performing relay logic, timing, counting, sequencing, mathematical, proportional-integral-derivative (PID) control, and other functions as required by the functional descriptions in this Section. Provide complete unit with rack, power supply, modules, cables and connectors.

- b. Auto start-up after power failure. Retain program and setpoints so that system starts automatically when power is restored.
- c. Provide live digital and analog inputs/outputs as indicated on Drawings and in this specification, plus live spares and extra slots as specified under "GENERAL REQUIREMENTS" in this Section.
- d. I/O Requirements
 - i. Digital inputs
 - 1. Optically-isolated input rated to withstand up to 1500 VAC transients.
 - 2. Voltage as indicated, $\pm 10\%$.
 - 3. Maximum of sixteen (16) input points per common neutral.
 - 4. LED indicator.
 - ii. Digital outputs
 - 1. Voltage as indicated.
 - 2. Capable of continuously driving up to 0.5 amp load.
 - 3. LED indicator.
 - iii. Analog inputs
 - 1. Field selectable 4-20mA dc or 1-5 VDC input on each channel.
 - 2. 16-bit analog-to-digital conversion having overall accuracy of $\pm 0.75\%$ of full scale or better.
 - 3. 250 ohm input impedance (on 4-20 mA input).
 - 4. 1 Megohm input impedance (on 1-5 VDC input).
 - iv. Analog outputs
 - 1. 0 to 20mA dc range. Nominal span of 4-20mA dc.
 - 2. Digital-to-analog conversion having overall accuracy of $\pm 0.75\%$ of full scale or better.
 - 3. Capable of driving up to 750 ohm load.
- e. Programmable in ladder logic using IBM-compatible computer as described in the functional descriptions in this Section. Provide programming software that is a standard product of the PLC manufacturer. Software shall allow on-line program editing without interrupting PLC operation. Software shall have an advanced instruction set including timing, sequencing, relay logic, closed-loop PID control, mathematical, trigonometric, Boolean, floating-point and integer calculations, and time and event-based interrupts.
- f. PLCs shall have ethernet ports and RS-232 serial ports to allow communication between system components, all as described in the functional descriptions in this Section. Provide all required interface modules and converters.
- g. Environmental
 - i. Operating temperature - 0o to 50oC.
 - ii. Humidity - 0 to 95% (non-condensing).
 - iii. Noise immunity - comply with NEMA ICS-2-230.
- h. Manufacturer
 - i. Allen Bradley Micrologix 1400, or approved equal.

3. OPERATOR INTERFACE TERMINAL (OIT)

- a. Manufacturer
 - i. Allen-Bradley model Panel View Plus Touch OIT, or approved equal.

4. VARIABLE FREQUENCY DRIVE (VFD)

- a. Variable frequency drive (VFD) unit shall be pulse-width modulated (PWM) type incorporating volts per Hertz control. Unit shall bear the U.L. label and shall be mounted inside the control panel.
- b. The VFD shall generate a sine-coded, variable voltage/frequency, three-phase output for optimum speed control.
- c. VFD protective features shall include: current limit, auto restart, short circuit protection, input phase loss alarm, electronic motor overload protection and ground fault protection.
- d. The VFD shall incorporate power loss ride-through for a minimum of 2 seconds.
- e. The VFD shall be provided with a push-button programming display with the following:
 - i. Programmable parameters:

1. Acceleration and deceleration time.
 2. Frequency range.
 3. Overload protection – Confirm full-load rating with motor manufacturer and program VFD to limit speed such that motor is not overloaded.
 - ii. Programmable displays:
 1. Frequency.
 2. Voltage.
 3. Percent load.
 4. Percent power.
 - iii. Protection features
 1. Over/Under voltage trip.
 2. Drive overcurrent trip.
 3. Drive overtemp trip.
 4. Motor overcurrent trip.
 5. Motor overtemp trip (monitor thermal switch in motor).
 6. Output ground fault trip.
 - f. Front-panel Components and Control Configuration:
 - g. Running time meter
 - i. Front-panel selector switch shall have the following functions:
 1. HAND – Start up and run based on keypad settings.
 2. OFF – Drive does not operate under any condition.
 3. AUTO – Drive runs when remote start contacts are closed (from PLC). Drive speed shall be based on remote 4-20 mAdc input (from PLC).
 - ii. Generate 4-20 mAdc isolated signal proportional with drive speed from 0 to 100%.
5. SURGE PROTECTION
- a. Main surge protective device (SPD) shall meet UL 1449, latest edition, integrated within control panel including breaker bus connection. All units to use thermally protected metal oxide varistor (MOV) as the core technology. SPD shall provide protection between each of 5 modes (4-wire plus ground) with minimum surge current capacity of 80 kA. Dual-color LED indicating lights shall be utilized to indicate protection status.
 - i. SPD shall be **Cutler Hammer SPD080480Y1K**, or approved equal.
 - b. Control System Protection: 120 VAC, 15 Amp rated in-line device. Listed for protection from ANSI/IEEE C62.41 Category A and B transients.
 - c. 300 V peak clamping voltage.
6. TERMINALS
- a. NEMA-style, barrier type, 0.4-inch spacing, nominal.
 - b. 600V RMS, 55 amp rating.
 - c. UL listed.
 - d. **Allen-Bradley 1492-CA1 series**, or approved equal.
 - e. Terminals for larger power circuits shall be 600 VAC barrier-type, sized for the conductors.
7. DIRECT CURRENT POWER SUPPLY
- a. Switching style with 2% maximum point-to-point ripple voltage.
 - b. Operating source: 120 VAC, 60 Hz.
 - c. Overcurrent protection with automatic reset. Overvoltage protection with 120% minimum shutdown.
 - d. At initial operation power supply loading shall not exceed 50% of rating under any condition.
 - e. Environmental: Operating Temperature of 14 to 140 deg F, 20 to 90% relative humidity non-condensing.
 - f. Convection cooled.
 - g. Din Rail mountable with 10% voltage adjustment on front.
 - h. **Iddec PS5R series**, or approved equal.

8. CONTROL SWITCHES

- a. Electronic Circuits
 - i. Selector, momentary pushbutton or momentary selector as required. Positions as required for application.
 - ii. 30 mm, heavy duty, oil-tight type, contacts as required.
 - iii. Gold flashed contacts; initial resistance, 0.01 ohms; 0.5 amps at 120 VAC, resistive.
- b. Control Circuits
 - i. Selector, momentary pushbutton, or momentary selector as required. Positions as required for application.
 - ii. 30 mm, heavy duty, oil-tight type, contacts as required.
 - iii. Contact rating shall conform to NEMA A-600 designation

9. CONTROL RELAYS AND TIMING

- a. Plug-in type with dust cover, socket and locking spring when relay mounted horizontally.
- b. Coil: continuous operation at 120 VAC +_10% unless shown otherwise.
- c. Contacts, 3 pole, double throw, minimum.
 - i. 10 amps, make-break, 120 VAC, resistive.
 - ii. Insulation resistance: 1000 megohms at 500 VDC.
 - iii. Dielectric: 2000 VAC, 60 Hz.
- d. Operating time
 - i. 35 milliseconds (nominal) energization.
 - ii. 100 milliseconds (nominal) de-energization.
- e. Mechanical life: 106 operations.
- f. Temperature: 0 to 70 degrees C.
- g. Timing relays shall be of the same manufacturer and series as control relays. Provide electronic timers with range as indicated.

10. INDICATING LIGHTS

- a. 30 mm, opaque colored lens.
- b. Press-to-test feature.
- c. Heavy-duty, oil-tight.
- d. NEMA 4 rating.

11. UNINTERRUPTIBLE POWER SUPPLY

- a. 120 VAC, 60 Hz single-phase input and output.
- b. Size at 150% of connected panel load, or 900 VA capacity (continuous), whichever is larger, with 5-minute battery reserve time (at full-load).
- c. Continuous on-line, double-conversion type that continuously rectifies, stores, re-creates the 120 VAC sinusoidal output waveform for the load. Include features that allow operation in critical environments and high-harmonic and/or noisy applications. Include adjustable input voltage parameters so that the input stage will accept low-quality input power.
- d. Alarm beacon (provided by Div. 13) shall run off UPS power.
- e. Control panel shall implement a control relay logic circuit that allows the UPS to be removed from powering the control panel and automatically provides the controls with bypass power. Additionally, this relay logic circuit shall provide a contact closure to the PLC that indicates a UPS failure.
- f. **Powerware**, or approved equal.

12. ENCLOSURE HEAT

- a. Manufactured unit with metal housing with integrated fan and integral thermostat and 0 - 100F adjustable range.
- b. UL labeled.
- c. **Hoffman "Design-Aire"**, or approved equal.

13. FLOAT SWITCH
- a. The float switch shall be self-weighted.
 - b. The float switch shall consist of an individual switch housed in a sealed, submersible, non-corroding float device with neoprene jacketed cable to junction box at the top.
 - c. Float Switch
 - i. Polypropylene with encapsulated non-mercury switch.
 - ii. Contact rating: 3amps, 120VAC resistive.
 - iii. Operating differential: 1 inch, nominal
14. LEVEL TRANSMITTER
- a. The level transmitter shall monitor level and generate a continuous 4-20mA dc signal proportional to the level over the selected span.
 - b. Construction: corrosion resistant PVC and stainless steel construction, with stainless steel lifting and mounting hardware.
 - c. Operating Power: 24VDC from control panel.
 - d. Provide cable for installation between transmitter and control panel, via cable junction box.
 - e. Adjustable zero and span.
15. MAGNETIC DOOR INTRUSION SWITCH
- a. Corrosion resistant hermetically sealed reed switch encapsulated in polyurethane.
 - b. 100 VA, 0.5A contact rating.
 - c. 2.4 inch minimum sensing range, as measured on a non-ferrous surface.
 - d. Switch shall be factory equipped with a 3-foot stainless steel length of armored cable.
 - e. **Sentrol Industrial 2500 Series**, or approved equal.

EXECUTION

1. LABELING
- a. Label all field mounted control devices, instrumentation, switches, etc., with tag number and item description.
 - b. Labels shall be engraved laminated plastic with ¼" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.
 - c. Labels for all components as specified above shall also be provided for all control panel internal components.
2. CALIBRATION, ADJUSTING AND TESTING
- a. Devices requiring field calibration shall be calibrated in the presence of Engineer's representative and documented
3. PROJECT MANAGEMENT
- a. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.
 - b. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.
4. PROGRAMMING SERVICES
- a. Program the programmable logic controllers (PLCs) and panelview as required by the functional descriptions.
 - b. Supplier shall be present at one (1) two (2) hour meeting with Engineer and Owner to work out the details of the functional descriptions, prior to final programming.
 - c. Provide HMI screen programming to fulfill the functionality described herein. Provide a minimum of the following separate screen views:
 - i. Pumping System overall
 - ii. Screen dedicated to alarming

- iii. Trend screens showing pond level trending as well as pump on/off/speed trending
- iv. Up to four (4) additional screens to be determined in consultation with the City
- d. Provide additional programming during start-up, training, and callback periods as specified. A minimum of one (1) four (4)-hour day of follow-up programming shall be provided, but not less than that required per the intent of the specifications.

5. INSTALLATION AND START-UP

- a. Supplier shall provide a skilled programmer/ instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. Engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- b. Conduct a one-day demonstration test and demonstrate proper operation of all system features and functions to Owner's Rep and Engineer.

6. ON-SITE SERVICES

- a. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to perform the following services:
 - i. Software revisions - One (1), four (4) hour days on-site to make software revisions per Owner and Engineer direction.
 - ii. Training - One (1) non-consecutive eight (8) hour days on-site to train Owner's personnel on:
 - iii. Operation and maintenance of all equipment furnished.
 - iv. Panelview software operation and programming including building graphics and modifying tags.
- b. All on-site service shall be at times approved by Owner.
- c. At project completion, Supplier shall certify in writing that all un-used service hours will be provided at Owner's request during the first three years of operation. The remaining service hours shall be fulfilled by either a software engineer or field service technician as required by the task requested by Owner, at no cost.

7. CALL-BACK SERVICES

- a. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to return to the project site for one (1) four (4) hour day during the first year of operation. During trip, the supplier's representative shall be prepared to calibrate and check equipment furnished under contract, give training, and make software revisions.
- b. Call-back trips shall be at times determined by Owner.

8. SUPPLIES

- a. Contractor shall provide all expendable items such as lamps, fuses, etc. for system startup, checkout, and during the acceptance test.
- b. At Final Completion, Contractor shall furnish the following expendable items:
 - i. Twenty (20) percent spare fuses and lamps of each type furnished, but not less than two (2) of each type.

9. SPARE PARTS

- a. Contractor shall furnish the following spare parts to Owner. Spares shall be delivered in boxes labeled on the outside with manufacturer and part number identified on the box:
 - i. One (1) PLC power supply.
 - ii. One (1) PLC processor module.
 - iii. One (1) each of every type of PLC analog and digital input and output module used on project.
 - iv. One (1) DC power supply (as used in control panels).
 - v. Four (4) each of every type of control relay used in control panels.

END OF SECTION

SECTION 4090-0(2) – INSTRUMENTATION AND CONTROLS FOR IRRIGATION WATER TREATMENT

Text appearing in yellow is system/application-specific and should be updated accordingly.

SCOPE

Under this Section shall be included furnishing all supervision, labor, materials, and equipment required for irrigation treatment system process instrumentation and control system.

REFERENCES

- Section 3281-5 Irrigation Water Treatment
- Section 3282-5 Irrigation Pump, Piping and Appurtenances

GENERAL REQUIREMENTS

1. SYSTEM DESCRIPTION AND REQUIREMENTS

- a. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by a single-source supplier ("Controls Supplier") except as specifically indicated. Contractor, along with the Controls Supplier, shall assume full responsibility for furnishing, installing and start-up procedures to make the system operate per the intent of the Contract Documents.
- b. The work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.
- c. It shall be the responsibility of Contractor (along with the Controls Supplier) to furnish a complete and fully operating system. Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. Contractor shall assume full responsibility for additional costs which may result from unauthorized deviations from the Contract Documents.

2. QUALITY ASSURANCE

- a. The instrumentation and control system Supplier (or "Controls Supplier"), as a business entity, shall have a minimum of 5 years of experience in the assembly, installation, repair, and maintenance of irrigation control systems. Substitution of individual experience in lieu of the required business experience shall not be allowed.
- b. The Controls Supplier shall maintain a minimum \$1,000,000 product liability insurance policy.
- c. The Controls Supplier must maintain and operate a panel shop with both UL-508 labels.
- d. The Supplier shall modify or supplement the Supplier's "standard products" to meet these specifications. Standard products of a particular Supplier that do not meet the functional and technical requirements of the specification are not acceptable.
- e. The Supplier shall have a minimum of two (2) full-time qualified, trained service personnel on staff who are capable of maintaining, adjusting, troubleshooting, and programming the system.
- f. The Supplier shall be capable of offering an extended service contract after completion of the warranty period.
- g. Supplier shall design, engineer, assemble, program, test, and support the system using its own facilities and employees.
- h. Supplier shall produce all project drawings using computer-aided drafting.

3. SHOP DRAWINGS AND SUBMITTALS

- a. Four sets of all documents including:
 - i. Data sheets for all equipment and components indicated on the Drawings and specified under "PRODUCTS" in this Section.

- ii. Software packages including complete description of features and capabilities.
- b. Four sets Shop Drawings in conformance with Division 1 and including:
 - i. Panel drawings including system schematic drawings, terminal numbering, wire numbering, component schematic drawings, dimension drawings, layout drawing and nameplate schedule.
 - ii. Overall system diagram showing all components, converters, cables, and connectors.
 - iii. Programmable Logic Controller (PLC) programs in ladder format. Include verbal description of each rung's function. Assign point numbers to all inputs and outputs, and show point numbering in PLC program.
 - iv. Proposed operator interface unit graphic displays. Submit "rough" or hand-drawn copies prior to programming.
 - v. Provide modifications as requested by the Owner.
- c. Operation and Maintenance data (four sets) in conformance with Division 1 and including:
 - i. Panel equipment, field devices and instruments, including "as-built" system schematics.
 - ii. Complete software documentation including programming information and operator's guides. Include hard copies of all operator interface unit graphic screens.
 - iii. Point lists for all PLC inputs/outputs. Identify point number (tag), point description, point type, range in engineering units (if analog point), PLC number, rack and slot number, and point address.
 - iv. One of the four sets of operation and maintenance manuals will be titled "Owner's Copy" and it will, in addition to the above items, contain original manufacturers' manuals for all products provided in the panel.
- d. Start-up report from systems supplier per requirements of **Division 1**.
- e. Spare equipment lists - provide a list of recommended spare parts and equipment that is considered crucial to the operation of the system. Include list of prices for each item.
- f. All submittals shall be bound in 3-ring binders with labeled tabs separating sections.

4. TESTING AGENCY CERTIFICATION

- a. All new panels and subpanels furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment".
- b. Each panel and subpanel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standards 508.

5. FUNCTIONAL DESCRIPTIONS – GENERAL

- a. General
 - i. Functional descriptions define how each portion of the instrumentation and control system is to operate. The descriptions, in conjunction with the drawings and the minimum technical requirements for products as described under "PRODUCTS" in this Section, define the minimum requirements for the installation.
 - ii. It is the intent of this specification that all products used to meet the functional descriptions shall be those specified under "PRODUCTS" in this Section.
 - iii. Interface devices, buffer amplifiers, control relays and other components required by Contractor to cause the system to function in accordance with the functional descriptions and schematic drawings shall be considered incidental to the project. Contractor shall show such devices and define them in detail during the shop drawing review to confirm that it understands the requirements of the design.
- b. System Overview
 - i. Contractor shall furnish and install a complete process instrumentation and control system including field instruments, control panel, programmable logic controller (PLC), and panelview installed in the control panel as specified.
 - ii. All system control logic shall reside in the PLC.
 - iii. PLC and control panel components shall be backed by an uninterruptible power supply (UPS). The control panel shall implement a control relay logic circuit that allows the UPS to be removed from the control panel circuiting and automatically provides the controls with bypass power. Additionally, this relay shall provide relay contact indication to the

PLC that indicates a UPS failure.

- c. Control Panels - General
 - i. Furnish and install equipment, components and programmable logic controllers (PLCs) as indicated. Equip each PLC with inputs and outputs as indicated, plus 10% live spares of each signal type. Provide each PLC with a rack having enough empty slots for addition of more input/output modules at each PLC as indicated on Drawings.
- d. Status Indication and Alarms
 - i. Run and fail lights shall be provided for the irrigation pump, filtration system and UV system.
 - ii. An alarm system shall be incorporated in the control panel and shall send a common alarm signal to an outdoor red light.
- e. Operator Interface Terminal
 - i. Panel shall contain an operator interface terminal ("OIT", i.e. – Allen Bradley Panelview) for observing and changing data within the PLC. The unit shall be programmed so the operator can display and manipulate all control setpoints.
 - ii. Provide graphic screens, prompts, and messages as described in this Specification. All operator interaction with the operator interface shall use screen menu selection and fill-in-the-blanks techniques so that the operator is not required to know special codes, register numbers, etc.
 - iii. The operator interface shall have a screen to display all current alarms in detail. When an alarm occurs, display the alarm description and time of occurrence.
 - iv. Permit the operator to acknowledge alarms at the operator interface. When an alarm is acknowledged, indicate the time and date of acknowledgment.
- f. Equipment "Fail" Alarms
 - i. Where a PLC calls for an equipment item to operate, the PLC shall monitor the associated equipment "RUNNING" contacts. If a RUNNING signal is not returned after five seconds (adjustable), then generate a descriptive alarm point.
- g. Analog Value Alarms
 - i. For all analog values, allow the operator to establish "HIGH" and "LOW" alarm setpoints. Provide adjustable time delay on each setpoint. If the analog value goes out of the setpoint range for a period in excess of the time delay, then generate a descriptive alarm point.
- h. Miscellaneous Status and Alarm Points
 - i. The Drawings show several miscellaneous status and alarm points that are not specifically described in these functional descriptions. Graphic screens shall include all of the status information that is available. Alarms shall be developed for each of the alarm points that are available.
- i. Variable Frequency Drives (VFDs)
 - i. Where variable frequency drives are controlled by the PLC, allow the operator to set maximum and minimum motor speeds. Alarm if a closed-loop setpoint is not maintainable within the motor maximum and minimum speeds. Coordinate with the motor supplier the minimum allowable speed.
 - ii. Monitor VFD alarm contacts. Generate associated alarm.
 - iii. Monitor and indicate motor speed. Alarm if motor speed running does not agree with the motor speed called while drive is in any Auto mode.

6. FUNCTIONAL DESCRIPTION – TREATMENT AND PUMPING SYSTEM

- a. Pond Level Measurement
 - i. Furnish and install pump supplier's preferred level measurement instruments (float switch and/or level transmitter), as indicated on the Drawings. Assign to an input in the PLC.
 - ii. When applicable, furnish and install a PVC stilling well with perforated sides, a perforated bottom cap. Secure stilling well to structure using stainless steel hardware as required. The stilling well diameter shall be sufficient to allow the float switch to operate without obstructions. Installation shall allow easy removal at the end of the irrigation season and setup at the beginning of each irrigation season.

- iii. Confirm elevation setpoint of installation during construction.
- b. Irrigation pump
 - i. The pump is driven by a variable speed drive (VFD). The VFD front panel includes the following operator interface devices:
 - 1. Run indicator light (green)
 - 2. Pump fail alarm indicator light (red)
 - 3. Pump elapsed-time meter
 - 4. Pump “hand-off-auto” (HOA) selector switch
 - 5. Pump local speed-control
 - 6. Current transformers (CTs) for motor current indication.
 - ii. Input motor thermoswitch into PLC.
 - iii. Provide two modes of control for the pump as described further below; “HAND” and “AUTO”. The control status shall be indicated on the OIT. Control mode shall be configurable at the pump station OIT only.
 - iv. HAND: Generally used for maintenance and troubleshooting purposes only.
 - 1. The selector switch in “hand” or “off” position disables control from the Treatment System Control Panel.
 - 2. With the pump switch placed in the hand position, the VFD will start and run the pump at the configured minimum speed. Pump speed may be modulated via the VFD front panel.
 - v. AUTO: This control mode shall be initiated for the first time of the season at the pump station OIT once the irrigation system has been maintained for use. Thereafter it shall be in “automatic” until such time as it is deactivated at the OIT. PLC shall automatically control operation of the pump based on system pressure.
 - 1. Allow the operator to establish ascending setpoints as follows:
 - a. Low Pressure Alarm
 - b. High Pressure Alarm
 - 2. The pump shall be enabled once the following occurs:
 - a. PLC detects sufficient pond level via float switch
 - b. PLC detects a remote “RUN” signal from the irrigation controller.
 - c. PLC detects UV System “RUNNING” signal.
 - vi. PLC shall contain a proportional control loop that will vary pump speed to maintain system pressure between “Minimum Speed” setpoint and the “Maximum Speed” setpoint.
 - vii. Monitor the associated inputs, as indicated on the Drawings, in Submittals, or as recommended by the Supplier. If any of the alarms occur, generate an alarm condition and stop the associated pump.
- c. Treatment System – General
 - i. Allow the operator to manually select the source of irrigation water:
 - 1. Re-use System – Normal operation, as described in these specifications.
 - 2. City Water Supply – The PLC shall send an “enable” signal to the irrigation controller. Under this mode, the re-use and treatment system shall be disabled.
- d. Filtration System
 - i. Monitor available points from Filtration System, review available points with Filtration System submittals. Generate alarms specified in Section 3281-5.
- e. UV Disinfection System
 - i. Monitor available points and generate alarms from UV System as specified in Section 32 81 05.
 - ii. UV System “warm-up” shall be initiated by a signal received from the Irrigation Control Box, calling for the irrigation system to begin. Provide an adjustable software timer, via the OIT, for the operator to select the duration of UV System “warm-up”. Once the warm-up is complete, the Treatment System will be enabled.
- f. Treatment System Alarms – in addition to alarms indicated above, provide the following specific alarms:
 - i. The following alarms will shut down its associated pump, generate an alarm, and require a reset at the station OIT after the fault is cleared:

1. Pump high motor temperature.
 2. Pump VFD fail.
 3. Filtration System fail.
 4. UV System fail.
- ii. The following pump alarms and associated pump station alarms will generate an alarm and engage the alarm beacon, but not shut down the pumps or require a reset:
1. Pond low level.
 2. PLC control panel UPS fail.
 3. Pump station door intrusion (unless over-ridden by momentary pushbutton).
7. PERMITS Supplied equipment shall conform to all state and city regulations, as required.
8. BASIS OF PAYMENT Refer to **Section XXX-X**, Measurement and Payment.

PRODUCTS

1. CONTROL PANEL FABRICATION – GENERAL

- a. Enclosures for indoor control panels shall meet the following minimum requirements:
 - i. Steel frame, steel panels, NEMA 12, unless otherwise specified.
 - ii. Panels shall be flanged, corners welded and ground smooth.
 - iii. All inside and exterior surfaces treated to prevent oxidation and painted. White on interior, manufacturer's standard color on exterior.
 - iv. The enclosure shall contain an interior sub-panel for mounting all control components and the enclosure shall be sufficiently large to accept all control components without crowding. The panel shall be of not less than 12 gauge type 304 stainless steel with continuously welded seams. The enclosure shall contain door and panel stiffeners as required. The front doors shall have a rolled lip and the door flanged and the corners ground smooth. All enclosure welding seams shall also be ground smooth.
 - v. The doors shall be fastened to the enclosure with a continuous type stainless steel piano hinge and locking three-point minimum, stainless steel hardware. The inside of the door shall contain data pockets. The sub-panel shall be painted white.
 - vi. Enclosure shall have full-height dead-front inner 12 gauge carbon steel hinged doors that house all front-panel components including switches, indicating lights, running time meters, overload reset pushbuttons, and other controls that require operator access.
 - vii. Circuit breakers shall be operable from the inner-door.
 - viii. The enclosure shall have thermostatically-controlled heaters to prevent condensation and freezing within the enclosure and per the recommendations of the Supplier.
 - ix. Insulated with ½" cell foam insulation. Insulation shall be mechanically secured.
 - x. Panel shall include a 3-phase power monitor for monitoring incoming 3 phase power. Phase monitor shall be **Time Mark C2644**, or approved equal.
- b. Label components per shop drawings.
 - i. Engraved labels attached with screws.
- c. All wiring terminated on barrier-type terminal strips. Terminal strips shall be labeled with engraved plastic labels.
 - i. Labels shall be attached with two-part epoxy adhesive.
 - ii. 600-volt terminal strips.
 - iii. Ring or spade type crimp connectors.
 - iv. Wiring laced using plastic wire ties and plastic wiring troughs.
 - v. Wiring held down with straps attached to enclosure with screws.
 - vi. Separate power, control and signal conductors.
 - vii. Power wiring: #14 AWG, stranded, 600V copper minimum.
 - viii. Control wiring: #18 AWG, stranded, 600V copper minimum.
 - ix. Signal wiring: shielded, 300V, copper minimum. See Section 16100.
 - x. Provide 15 amp, 10000 AIC breaker on power circuits using #14 wire.
 - xi. Connections to instruments via terminal strip or connectors. Soldering wires to terminal strips not acceptable.

- d. Tag all wires at each end with wire number matching shop drawings.
- e. Electrical Service
 - i. Electrical service will be 60 amp, 480volts, 3-phase, 60 Hz supplied from the local electric utility, [ELECTRIC UTILITY COMPANY NAME]. Coordinate the installation of a new electrical service with the local electric utility.
 - ii. The project developer, [COMPANY NAME], shall initiate the service request and maintain ownership of the service until it can be passed to [HOMEOWNERS ASSOCIATION NAME]
 - iii. Include main circuit breaker, wire bending space and barriers as required by NEC and UL standards.

2. PROGRAMMABLE LOGIC CONTROLLER (PLC)

- a. Programmable logic controller capable of performing relay logic, timing, counting, sequencing, mathematical, proportional-integral-derivative (PID) control, and other functions as required by the functional descriptions in this Section. Provide complete unit with rack, power supply, modules, cables and connectors.
- b. Auto start-up after power failure. Retain program and setpoints so that system starts automatically when power is restored.
- c. Provide live digital and analog inputs/outputs as indicated on Drawings and in this specification, plus live spares and extra slots as specified under "GENERAL REQUIREMENTS" in this Section.
- d. I/O Requirements
 - i. Digital inputs
 - 1. Optically-isolated input rated to withstand up to 1500 VAC transients.
 - 2. Voltage as indicated, $\pm 10\%$.
 - 3. Maximum of sixteen (16) input points per common neutral.
 - 4. LED indicator.
 - ii. Digital outputs
 - 1. Voltage as indicated.
 - 2. Capable of continuously driving up to 0.5 amp load.
 - 3. LED indicator.
 - iii. Analog inputs
 - 1. Field selectable 4-20mA_{dc} or 1-5 VDC input on each channel.
 - 2. 16-bit analog-to-digital conversion having overall accuracy of $\pm 0.75\%$ of full scale or better.
 - 3. 250 ohm input impedance (on 4-20 mA input).
 - 4. 1 Megohm input impedance (on 1-5 VDC input).
 - iv. Analog outputs
 - 1. 0 to 20mA_{dc} range. Nominal span of 4-20mA_{dc}.
 - 2. Digital-to-analog conversion having overall accuracy of $\pm 0.75\%$ of full scale or better.
 - 3. Capable of driving up to 750 ohm load.
- e. Programmable in ladder logic using IBM-compatible computer as described in the functional descriptions in this Section. Provide programming software that is a standard product of the PLC manufacturer. Software shall allow on-line program editing without interrupting PLC operation. Software shall have an advanced instruction set including timing, sequencing, relay logic, closed-loop PID control, mathematical, trigonometric, Boolean, floating-point and integer calculations, and time and event-based interrupts.
- f. PLCs shall have ethernet ports and RS-232 serial ports to allow communication between system components, all as described in the functional descriptions in this Section. Provide all required interface modules and converters.
- g. Environmental
 - i. Operating temperature - 0o to 50oC.
 - ii. Humidity - 0 to 95% (non-condensing).
 - iii. Noise immunity - comply with NEMA ICS-2-230.
- h. Manufacturer
 - i. Allen Bradley Micrologix 1400, or approved equal.

3. OPERATOR INTERFACE TERMINAL (OIT)

- a. Manufacturer
 - i. Allen-Bradley model Panel View Plus Touch OIT, or approved equal.

4. VARIABLE FREQUENCY DRIVE (VFD)

- a. Variable frequency drive (VFD) unit shall be pulse-width modulated (PWM) type incorporating volts per Hertz control. Unit shall bear the U.L. label and shall be mounted inside the control panel.
- b. The VFD shall generate a sine-coded, variable voltage/frequency, three-phase output for optimum speed control.
- c. VFD protective features shall include: current limit, auto restart, short circuit protection, input phase loss alarm, electronic motor overload protection and ground fault protection.
- d. The VFD shall incorporate power loss ride-through for a minimum of 2 seconds.
- e. The VFD shall be provided with a push-button programming display with the following:
 - i. Programmable parameters:
 - 1. Acceleration and deceleration time.
 - 2. Frequency range.
 - 3. Overload protection – Confirm full-load rating with motor manufacturer and program VFD to limit speed such that motor is not overloaded.
 - ii. Programmable displays:
 - 1. Frequency.
 - 2. Voltage.
 - 3. Percent load.
 - 4. Percent power.
 - iii. Protection features
 - 1. Over/Under voltage trip.
 - 2. Drive overcurrent trip.
 - 3. Drive overtemp trip.
 - 4. Motor overcurrent trip.
 - 5. Motor overtemp trip (monitor thermal switch in motor).
 - 6. Output ground fault trip.
- f. Front-panel Components and Control Configuration:
- g. Running time meter
 - i. Front-panel selector switch shall have the following functions:
 - 1. HAND – Start up and run based on keypad settings.
 - 2. OFF – Drive does not operate under any condition.
 - 3. AUTO – Drive runs when remote start contacts are closed (from PLC). Drive speed shall be based on remote 4-20 mAdc input (from PLC).
 - ii. Generate 4-20 mAdc isolated signal proportional with drive speed from 0 to 100%.

5. SURGE PROTECTION

- a. Main surge protective device (SPD) shall meet UL 1449, latest edition, integrated within control panel including breaker bus connection. All units to use thermally protected metal oxide varistor (MOV) as the core technology. SPD shall provide protection between each of 5 modes (4-wire plus ground) with minimum surge current capacity of 80 kA. Dual-color LED indicating lights shall be utilized to indicate protection status.
 - i. SPD shall be Cutler Hammer SPD080480Y1K, or approved equal.
- b. Control System Protection: 120 VAC, 15 Amp rated in-line device. Listed for protection from ANSI/IEEE C62.41 Category A and B transients.
- c. 300 V peak clamping voltage.

6. TERMINALS

- a. NEMA-style, barrier type, 0.4-inch spacing, nominal.
- b. 600V RMS, 55 amp rating.
- c. UL listed.

- d. Allen-Bradley 1492-CA1 series, or approved equal.
- e. Terminals for larger power circuits shall be 600 VAC barrier-type, sized for the conductors.

7. DIRECT CURRENT POWER SUPPLY

- a. Switching style with 2% maximum point-to-point ripple voltage.
- b. Operating source: 120 VAC, 60 Hz.
- c. Overcurrent protection with automatic reset. Overvoltage protection with 120% minimum shutdown.
- d. At initial operation power supply loading shall not exceed 50% of rating under any condition.
- e. Environmental: Operating Temperature of 14 to 140 deg F, 20 to 90% relative humidity non-condensing.
- f. Convection cooled.
- g. Din Rail mountable with 10% voltage adjustment on front.
- h. Iddec PSSR series, or approved equal.

8. CONTROL SWITCHES

- a. Electronic Circuits
 - i. Selector, momentary pushbutton or momentary selector as required. Positions as required for application.
 - ii. 30 mm, heavy duty, oil-tight type, contacts as required.
 - iii. Gold flashed contacts; initial resistance, 0.01 ohms; 0.5 amps at 120 VAC, resistive.
- b. Control Circuits
 - i. Selector, momentary pushbutton, or momentary selector as required. Positions as required for application.
 - ii. 30 mm, heavy duty, oil-tight type, contacts as required.
 - iii. Contact rating shall conform to NEMA A-600 designation

9. CONTROL RELAYS AND TIMING

- a. Plug-in type with dust cover, socket and locking spring when relay mounted horizontally.
- b. Coil: continuous operation at 120 VAC +_10% unless shown otherwise.
- c. Contacts, 3 pole, double throw, minimum.
 - i. 10 amps, make-break, 120 VAC, resistive.
 - ii. Insulation resistance: 1000 megohms at 500 VDC.
 - iii. Dielectric: 2000 VAC, 60 Hz.
- d. Operating time
 - i. 35 milliseconds (nominal) energization.
 - ii. 100 milliseconds (nominal) de-energization.
- e. Mechanical life: 106 operations.
- f. Temperature: 0 to 70 degrees C.
- g. Timing relays shall be of the same manufacturer and series as control relays. Provide electronic timers with range as indicated.

10. INDICATING LIGHTS

- a. 30 mm, opaque colored lens.
- b. Press-to-test feature.
- c. Heavy-duty, oil-tight.
- d. NEMA 4 rating.

11. UNINTERRUPTIBLE POWER SUPPLY

- a. 120 VAC, 60 Hz single-phase input and output.
- b. Size at 150% of connected panel load, or 900 VA capacity (continuous), whichever is larger, with 5-minute battery reserve time (at full-load).
- c. Continuous on-line, double-conversion type that continuously rectifies, stores, re-creates the 120 VAC sinusoidal output waveform for the load. Include features that allow operation in critical environments and high-harmonic and/or noisy applications. Include adjustable input voltage

parameters so that the input stage will accept low-quality input power.

- d. Alarm beacon (provided by Div. 13) shall run off UPS power.
- e. Control panel shall implement a control relay logic circuit that allows the UPS to be removed from powering the control panel and automatically provides the controls with bypass power. Additionally, this relay logic circuit shall provide a contact closure to the PLC that indicates a UPS failure.
- f. **Powerware**, or approved equal.

12. ENCLOSURE HEAT

- a. Manufactured unit with metal housing with integrated fan and integral thermostat and 0 - 100F adjustable range.
- b. UL labeled.
- c. **Hoffman "Design-Aire"**, or approved equal.

13. FLOAT SWITCH

- a. The float switch shall be self-weighted.
- b. The float switch shall consist of an individual switch housed in a sealed, submersible, non-corroding float device with neoprene jacketed cable to junction box at the top.
- c. Float Switch
 - i. Polypropylene with encapsulated non-mercury switch.
 - ii. Contact rating: 3amps, 120VAC resistive.
 - iii. Operating differential: 1 inch, nominal

14. LEVEL TRANSMITTER

- a. The level transmitter shall monitor level and generate a continuous 4-20mA_{dc} signal proportional to the level over the selected span.
- b. Construction: corrosion resistant PVC and stainless steel construction, with stainless steel lifting and mounting hardware.
- c. Operating Power: 24VDC from control panel.
- d. Provide cable for installation between transmitter and control panel, via cable junction box.
- e. Adjustable zero and span.

15. MAGNETIC DOOR INTRUSION SWITCH

- a. Corrosion resistant hermetically sealed reed switch encapsulated in polyurethane.
- b. 100 VA, 0.5A contact rating.
- c. 2.4 inch minimum sensing range, as measured on a non-ferrous surface.
- d. Switch shall be factory equipped with a 3-foot stainless steel length of armored cable.
- e. **Sentrol Industrial 2500 Series**, or approved equal.

EXECUTION

1. LABELING

- a. Label all field mounted control devices, instrumentation, switches, etc., with tag number and item description.
- b. Labels shall be engraved laminated plastic with ¼" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.
- c. Labels for all components as specified above shall also be provided for all control panel internal components.

2. CALIBRATION, ADJUSTING AND TESTING

- a. Devices requiring field calibration shall be calibrated in the presence of Engineer's representative and documented

3. PROJECT MANAGEMENT

- a. Supplier shall provide engineering and administrative services necessary to fulfill the requirements

of this Specification.

- b. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

4. PROGRAMMING SERVICES

- a. Program the programmable logic controllers (PLCs) and panelview as required by the functional descriptions.
- b. Supplier shall be present at one (1) two (2) hour meeting with Engineer and Owner to work out the details of the functional descriptions, prior to final programming.
- c. Provide HMI screen programming to fulfill the functionality described herein. Provide a minimum of the following separate screen views:
 - i. Treatment System overall
 - ii. Treatment System - Filter
 - iii. Treatment System – UV System
 - iv. Screen dedicated to alarming
 - v. Trend screens showing pond level trending as well as pump on/off/speed trending
 - vi. Up to four (4) additional screens to be determined in consultation with the City
- d. Provide additional programming during start-up, training, and callback periods as specified. A minimum of one (1) four (4)-hour day of follow-up programming shall be provided, but not less than that required per the intent of the specifications.

5. INSTALLATION AND START-UP

- a. Supplier shall provide a skilled programmer/ instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. Engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- b. Conduct a one-day demonstration test and demonstrate proper operation of all system features and functions to Owner's Rep and Engineer.

6. ON-SITE SERVICES

- a. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to perform the following services:
 - i. Software revisions - One (1), four (4) hour days on-site to make software revisions per Owner and Engineer direction.
 - ii. Training - One (1) non-consecutive eight (8) hour days on-site to train Owner's personnel on:
 - iii. Operation and maintenance of all equipment furnished.
 - iv. Panelview software operation and programming including building graphics and modifying tags.
- b. All on-site service shall be at times approved by Owner.
- c. At project completion, Supplier shall certify in writing that all un-used service hours will be provided at Owner's request during the first three years of operation. The remaining service hours shall be fulfilled by either a software engineer or field service technician as required by the task requested by Owner, at no cost.

7. CALL-BACK SERVICES

- a. In addition to other services specified, provide a competent programmer/instrumentation engineer or technician to return to the project site for one (1) four (4) hour day during the first year of operation. During this trip, the supplier's representative shall be prepared to calibrate and check equipment furnished under this contract, give miscellaneous training, and make software revisions.
- b. Call-back trips shall be at times determined by Owner.

8. SUPPLIES

- a. Contractor shall provide all expendable items such as lamps, fuses, etc. for system startup,

checkout, and during the acceptance test.

- b. At Final Completion, Contractor shall furnish the following expendable items:
 - i. Twenty (20) percent spare fuses and lamps of each type furnished, but not less than two (2) of each type.

9. **SPARE PARTS**

- a. Contractor shall furnish the following spare parts to Owner. Spares shall be delivered in boxes labeled on the outside with manufacturer and part number identified on the box:
 - i. One (1) PLC power supply.
 - ii. One (1) PLC processor module.
 - iii. One (1) each of every type of PLC analog and digital input and output module used on project.
 - iv. One (1) DC power supply (as used in control panels).
 - v. Four (4) each of every type of control relay used in control panels.

END OF SECTION