

N. Heat Dissipation:

1. Provide vents, fans, and cooling equipment on freestanding panels to suitably dissipate heat generated by equipment mounted in or on the panel.
2. Installed vents, fans, and cooling equipment shall not invalidate NEMA 250 enclosure rating. Furnish gaskets, hoods, screens, and other provisions to meet rating required.

2.3 CONTROL PANEL ELECTRICAL

- A. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. Wiring shall be identified with thermally-imprinted heat-shrink wire end markers.
- B. **Wiring Methods:** Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring), unless otherwise indicated.
- C. Power supply to control panel shall be as indicated on the drawings.
- D. Control voltage shall be 24 Vdc and supplied by DIN-rail mounted power supply local to each control panel.
- E. Unless otherwise indicated, instruments, alarm systems, and control relays shall operate on 24 Vdc circuits.
- F. The control panel shall provide the source of power for any dry contacts external to the control panel that interconnect with the control panel.
- G. Interconnection wiring shall be allowed to enter from below and above control panel for indoor panels and from below only for outdoor panels.
- H. Bundle wiring neatly in wireways alongside control components.
- I. Label each terminal for permanent identification of leads.
- J. Wire and terminal identification shall be incorporated into the as-built drawings.
- K. For case grounding, panel shall be provided with a 1/4-inch by 1-inch copper ground bus complete with solderless connector for one no. 4 AWG bare stranded copper cable.
- L. **Main Circuit Breaker:**
 1. Meet requirements of NEMA AB 1 and UL 489.
 2. Voltage: 480, 208, or 120 volts ac, with number of poles as required.
 3. Interrupting Capacity: Same rating as upstream feeder breaker. Coordinate with Division 26 to determine final ratings.
 4. Molded case inverse-time thermal-magnetic circuit breaker, with trip setting sized to protect motor and branch circuit conductors in accordance with NFPA 70 (National Electrical Code).

5. Individual thermal-magnetic trip elements in each pole.
6. Mechanism opens all poles when overcurrent occurs on any single pole.
7. Test button on cover.
8. Using single-pole circuit breakers with handle ties to make multi-pole circuit breakers will not be acceptable.
9. Capable of line side conductors landing at either end.
10. Mechanical lugs, except crimp compression lugs where shown.
11. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
12. Disconnecting Means:
 - a. Doors shall be mechanically interlocked with main circuit breaker by means of a defeatable rotary switch mounted on the door connected to an operating mechanism on the circuit breaker.
 - b. Disconnect shall be padlockable when de-energized with up to three locks.
 - c. Disconnect shall indicate ON, OFF, and TRIP states of main circuit breaker and shall allow reset of breaker without opening the cabinet.

M. Combination Magnetic Starter:

1. Horsepower rated at utilization voltage for size of motor being powered from the control panel; motor size as shown on Drawings.
2. Short Circuit Capacity:
 - a. Same rating as upstream panelboard bus or better. Coordinate with Division 26 to determine final ratings.
 - b. Starter shall be UL labeled for short circuit capacity at control panel voltage with overload protection.
3. Three-phase, full voltage type.
4. Reversing or non-reversing as required.
5. Assembly consisting of motor circuit protector, one or more motor contactors, and overload relay.
6. Contactors shall be mechanically interlocked to prevent simultaneous operation.
7. Starter shall be no smaller than NEMA ICS, Size 1.
8. Coil Voltage: 24 Vdc.

9. Control: As shown on drawings.
10. Auxiliary Contacts: Rated 5A at 120 Vac and 24 Vdc, quantity as shown on drawings.
11. Panel-mounted inside control panel.
12. Molded case motor circuit protector, with trip setting sized to protect motor and branch circuit conductors in accordance with NFPA 70 (National Electrical Code).
 - a. Individual magnetic trip elements in each pole.
 - b. Mechanism opens all poles when overcurrent occurs on any single pole.
 - c. Test button on cover.
 - d. Using single-pole circuit breakers with handle ties to make multi-pole circuit breakers will not be acceptable.
 - e. Capable of line side conductors landing at either end.
 - f. Mechanical lugs, except crimp compression lugs where shown.
 - g. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
13. Motor Overload Protection Relay:
 - a. Solid state, current operated circuitry with adjustable trip.
 - b. Inverse-time characteristic, Class 10/20/30 selectable relay trip.
 - c. Phase loss, phase unbalance, and ground fault protection.
 - d. Normally open (N.O.) and normally closed (N.C.) auxiliary contacts for remote indication.
 - e. Visual trip indication.
14. Manufacturers, or Equals:
 - a. Square D.
 - b. Eaton.

N. Control Relays:

1. Relays shall be plug-in type with indicator LED, manual latching-closed mechanism, rectangular blades, and provided with sockets for screw-type termination and hold-down clips.
2. DIN- or panel-mount, as required.

3. Coil Voltage: 24 Vdc, unless noted otherwise.
4. Contacts shall be dry and rated for 5A at 120 Vac and 24 Vdc.
5. Form C primary contacts (one normally open and one normally closed).
6. Number and configuration of auxiliary contacts as indicated in control diagrams on drawings, or as required for a complete and operable system, whichever is greater.
7. Time delay relays:
 - a. Solid state, combination ON delay and OFF delay (field-selectable), with adjustable range from 1 to 60 seconds, unless otherwise indicated.
 - b. Provide socket with screw-type termination and retaining strap.
 - c. Form C primary contacts (one normally open and one normally closed).
 - d. Number and configuration of auxiliary contacts as indicated in control diagrams on drawings or as required for a complete and operable system, whichever is greater.
8. Manufacturer, or Equal:
 - a. Phoenix Contact.
 - b. Eaton.
 - c. Square D.
 - d. General Electric.

O. Pilot Devices:

1. Devices shall be manufactured in accordance with NEMA ICS 5.
2. Devices shall be heavy-duty, watertight, and corrosion-resistant, and sized to 30 mm.
3. All devices contacts shall be rated 10 amps at 600V.
4. Selector Switches:
 - a. Standard operating lever, lockable in OFF position.
 - b. Maintained contacts, unless noted otherwise.
 - c. Contact arrangement as indicated in control diagrams on drawings, or as required for a complete and operable system, where not indicated.
5. Indicating Lights:
 - a. LED, full-voltage, with push-to-test function.

- b. Color as indicated in control diagrams on drawings.
- 6. Pushbuttons:
 - a. Momentary contacts, unless noted otherwise.
 - b. Color:
 - 1) Black for ON, START, RUN OPEN, or RUN CLOSE.
 - 2) Red for OFF or STOP.
 - c. Contact arrangement as indicated in control diagrams on drawings, or as required for a complete and operable system, where not indicated.
 - d. Emergency stop pushbuttons shall be push-to-de-energize, pull-to-reset type, with number of contacts indicated in control diagrams on drawings, or as required for a complete and operable system, where not indicated.
- 7. Nameplates:
 - a. Engraved laminated plastic, black with white core.
 - b. Stainless steel attachment screws.
 - c. Letter Height: 1/8-inch.
 - d. Text Arrangement: No more than 14 characters or spaces per line.
- 8. Manufacturer, or Equal:
 - a. General Electric.
 - b. Square D.
 - c. Eaton.

P. Uninterruptible Power Supply (UPS):

- 1. Provide and install a UPS in control panels where indicated to provide power outage ride-through power to control devices in such control panels.
- 2. Each UPS shall maintain power to all of its loads, including non-constant loads, for a minimum of 15 minutes. The equipment submittal shall include sizing calculations which support the unit selected.
- 3. Each UPS shall be of rugged industrial design and DIN rail mountable.
- 4. Each UPS shall have an internal or external battery made by the same manufacturer as the UPS for specific use with the UPS. The battery shall be sized to provide run times as indicated.

5. Nominal output voltage: Same as input voltage.
6. Output voltage regulation: Plus or minus 3 percent load regulation under variations of line and load condition within the ratings of the UPS.
7. Each UPS shall have normally open output contacts for “UPS fault”, “low battery”, and “battery on” that are wired to a local PLC discrete input module, where a PLC is used.

Q. Programmable Logic Controller (PLC):

1. Small Systems: Provide a compact, modular microcontroller of the type suitable for controlling a small subsystem.
2. SCADA Cabinet: Provide a compact, modular PLC of the type suitable for controlling a small industrial facility.
3. Each PLC shall be provided with the number and type of inputs and outputs (I/O) and controller memory as required for a complete and operable control system and as indicated on the Contract Documents.
4. Certified or listed to UL 508 requirements or a Nationally Recognized Testing Laboratory (NRTL) equivalent.
5. Power Supply:
 - a. SCADA Cabinet PLC (PLC-090): 24 Vdc.
 - b. Other PLCs: 120 Vac or 24 Vdc, as required to match output voltage of UPS.
6. Communications: Provide one or both of the following:
 - a. Ethernet/IP protocol over one or more RJ45 ports for digital communication. Modbus TCP is not a suitable alternative.
 - b. Modbus RTU protocol over one or more RJ45 ports or RS-485 ports for serial communication.
7. Software: PLC software shall be manufacturer’s standard.
8. Manufacturer and model are subject to final approval by OWNER: Provide the following, or equal:
 - a. **Emerson.**
 - b. **Allen Bradley.**
 - c. **Schneider Electric.**

R. Ethernet Switch:

1. Ethernet switches shall be industrial managed type and DIN rail- or panel-mounted, as required.
2. Each switch shall be certified or listed to UL 508 requirements or an NRTL equivalent.
3. Transfer Speeds: Minimum of one Gigabit per second (Gbps) over copper.
4. Power Supply: 120 Vac or 24 Vdc.
5. Communication Ports: At a minimum, provide the following at each switch:
 - a. Four RJ45 copper ports with Power over Ethernet (PoE).
6. USB Type B configuration port.
7. Manufacturer, or Equal: **Red Lion; N-Tron series.**

S. Control Circuit Wiring:

1. Listed to UL 1063.
2. Wire type and sizes:
 - a. Conductor shall be flexible stranded copper machine tool wire, type MTW, and shall be rated 600 volts.
 - b. Wires for instrument signal circuits and alarm input circuits shall be 14 AWG.
 - c. Other wires, including shielded cables, shall be 16 AWG minimum.
3. Wire Insulation Colors:
 - a. Conductors supplying 24 Vdc power shall have red insulation for positive and black insulation for negative.
 - b. Other conductors shall have gray insulation or vendor's standard.
4. Splicing of wires will not be acceptable.
5. Wiring Across Door Hinge: Use NEMA WC 57 Class C stranding looped for proper twist rather than bending at hinge.
6. Wire connections internal to panel using crimp-on terminations.

T. Power Supply Wiring:

1. Listed to UL 44 or UL 93, as applicable.
2. Main power supply entry shall come from below control panel. Provide adequate space for pulling main power conductors from below to land at top of main circuit breaker terminals.

3. Wire Size and Type:
 - a. Stranded copper, type THHN/THWN-2 for #8 AWG and smaller and type XHHW-2 for #6 and larger, with insulation rated for 600 volts.
 - b. Conductors shall be sized in accordance with NFPA 70 for the motor or other load being powered from the control panel.
4. Wire Insulation Colors:
 - a. 480 Vac Conductors: Brown, orange, and yellow for phases A, B, and C.
 - b. 208 Vac Conductors: Black, red, and blue for phases A, B, and C.
 - c. 240 Vac, Single-Phase Conductors: Black and red for line conductors.
 - d. 120 Vac Conductors: Black for line conductors.
 - e. Neutral Conductors: White insulation.
 - f. Ground Conductors: Green insulation or bare copper.

U. Terminal Blocks:

1. Components shall be manufactured in accordance with UL 486F and UL 1059.
2. Size components to allow insertion of necessary wire sizes.
3. Capable of termination of control circuits entering or leaving control panel.
4. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
5. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
6. Yoke shall guide all strands of wire into terminal.
7. Current bar shall ensure vibration-proof connection.
8. Terminals:
 - a. Capable of wire connections without special preparation other than stripping.
 - b. Capable of jumper installation with no loss of terminal or rail space.
9. Marking system, allowing use of preprinted or field-marked tags.
10. Rotary 90-degree integral disconnect, allowing separation of signals through terminal block without removal of any wire.
11. Manufacturer, or Equal:

- a. Entrelec; M6/8-STP.

PART 3 -- EXECUTION

3.1 GENERAL

A. Preparation for Shipment and Shipping:

1. Panels shall be crated for shipment using a heavy framework and skids.
2. Panel sections shall be cushioned to protect the finish of the panel during shipment. Instruments that are shipped with the panel shall have suitable shipping stops and cushioning material installed to protect parts that could be damaged due to mechanical shock.
3. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.
4. Control panel testing and inspection shall be performed prior to shipping.

3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

A. Wiring Installation:

1. Wires shall be routed in plastic wireways, except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing out panel to components on a part of the fixed structure, and (4) wiring to panel-mounted components.
 2. Wiring routed from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at the terminals.
- B. Wiring routed to control devices on the doors shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.
- C. **Wire Marking:** Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on shop drawings. These numbers shall be marked on conductors at every terminal.

3.3 TESTING

A. Inspection and Approval:

1. Panel fabricator shall conduct the following tests prior to shipment:
 - a. Alarm circuits rung out to determine their operability.
 - b. Electrical circuits checked for continuity and where applicable, operability.

- c. Verify the proper operation of control logic in each mode of control.
- d. Nameplates shall be checked for correct spelling and size of letters.
- e. Any other test required to place the panel in an operating condition.

B. Field Testing:

- 1. In accordance with Section 26 01 26 – Electrical Testing.
- 2. Each control panel shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.
- 3. Control Tests: Controlled systems and apparatus shall be operated from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, remote control actions, remote feedback of status and position, and the like.
- 4. Interlocks: Interlocks between the instrumentation and the motor control circuits and packaged equipment controls shall be checked to the maximum extent possible.

- END OF SECTION -

SECTION 40 90 10 - INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide process instrumentation for the WORK in accordance with this specification and the Contract Documents.
- B. The provisions of this section apply to all instrumentation included in the WORK, except as indicated otherwise.
- C. All process instrumentation is listed in the Instrumentation Schedule under Part 4 – Appendix A of this section.

1.2 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

American Society of Mechanical Engineers (ASME)

Fluid Meters: Their Theory and Application, 6th ed.

Instrument Society of America Standard (ISA)

5.1 Instrumentation Symbols and Identification

20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

National Electrical Manufacturers Association (NEMA)

250 Enclosure for Electrical Equipment (1000 Volts Maximum)

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. **General Submittal Requirements:** Provide the following:
 - 1. Bill of material, with enumerated make and model of all instrumentation included in the WORK.
 - 2. Catalog cuts of bulletins or brochures for each unique instrumentation system.
 - 3. Types of materials and enclosure ratings.
 - 4. Interconnection diagrams that identify external connections between the instrumentation, associated equipment, and equipment provided under other specifications.
 - 5. Nameplates.
 - 6. Power supply requirements.

- C. **Shop Drawings:** Each instrument, transmitter, and analyzer shall be identified with its equipment identification number, as indicated on the drawings.
- D. **Manufacturer's Data:** With the Shop Drawings, furnish certified curves indicating flow versus differential pressure and any other information called for in the individual meter specifications.
- E. **Technical Manual:** Furnish 5 identical copies of complete operation and maintenance instructions of all unique metering and analyzer systems including instrumentation and controls, in accordance with the paragraph "Operational Procedures" in Section 01 33 00.
- F. **Spare Parts List:** The CONTRACTOR shall furnish a list of manufacturer's recommended spare parts.
- G. **Special Tools:** A list of special tools shall be submitted to the ENGINEER.
- H. **Documentation:** After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees, that all instrumentation systems will operate within the published accuracies and flow ranges and meet these Specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

1.4 SERVICE CONDITIONS

- A. **Ambient Temperature Range:**
 - 1. 50°F to 90°F for indoor equipment.
 - 2. 15°F to 100°F for outdoor equipment.
- B. **Site Elevation:** 2,500 feet above sea level.

1.5 QUALITY ASSURANCE

- A. **Accuracy Requirements:** Unless otherwise indicated, flow meters shall be guaranteed to register flow to an accuracy of plus or minus 2 percent of actual flow throughout the range indicated.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Instrumentation shall be listed or certified by a Nationally Recognized Test Lab (NRTL), such as UL or CSA, for compliance with the appropriate American National Standard.
- B. Discrete signals shall be provided by dry contacts rated for 5 amps at 120 VAC.
- C. Analog signals shall be isolated 4 to 20 mA, two-wire signals, unless noted otherwise.

2.2 MAGNETIC FLOWMETERS

- A. Magnetic flowmeter systems shall be of the low frequency, electromagnetic induction type and produce a DC, pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flow metering system shall include a metering tube, signal cable, transmitter and flowmeter grounding rings, where indicated.
- B. Magnetic flow meters and electronics shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.
- C. **Metering Tube:** The metering tube shall have the following:
 - 1. Meter and Coil Housing: Carbon steel, rated to IP68.
 - 2. Line Size: As shown on Instrumentation Schedule.
 - 3. Flanges: ASME B16.5, Class 150 carbon steel, raised face.
 - 4. Process Media: Raw river water (screened).
 - 5. Process Temperature Range: 32 degrees F to 70 degrees F.
 - 6. Flow Range: As shown on Instrumentation Schedule.
 - 7. Liner: Polyurethane.
 - 8. Finish: Polyurethane coating.
 - 9. Conduit Entry: 1/2-inch NPT.
 - 10. Electrode: Standard stainless steel measurement electrodes.
 - 11. Grounding Options: No grounding rings, reference electrode, or lining protectors required.
- D. **Transmitter:** The microprocessor-based signal converter/transmitter shall have the following:
 - 1. Transmitter Housing: Die-cast aluminum, rated to IP66 and NEMA 250 type 4X, with silicone cover gaskets.
 - 2. Mounting: Remote wall mount.
 - 3. Finish: Polyurethane coating.
 - 4. Conduit Entry: 1/2-inch NPT.
 - 5. Utilize DC pulse technique to drive flux-producing coils.

6. Convert DC pulse signal from the tube to a standard 4 - 20 mA signal into a minimum of 700 ohms.
7. A 6-digit LCD display for flowrate, percent of span, and totalizer.
8. An operator interface consisting of keypads which respond to English text entry.
9. Integral zero return to provide a consistent zero output signal in response to an external dry contact closure.
10. Integral low flow cut-off and zero return.
11. Automatic range change.
12. Capable of measuring flow in both directions.
13. Programmable parameters including meter size, full scale Q, magnetic field frequency, primarily constant, time constant.
14. Data retention for a minimum of 5 years without auxiliary main or battery power.
15. Self-diagnostics and automatic data checking.
16. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
17. Utilizes "Smart" technology which employs a hand-held configuration terminal and outputs a digital flow signal superimposed on 4 - 20 mA signal and complies to HART protocol.
18. Can tolerate ambient temperature operating limits of -4 to 140 degrees F (-20 to 60 degrees C).
19. Transmitter Output: 4-20 mA.

E. Performance Requirements:

1. Time Constant: 0.5 to 1000 seconds.
2. Accuracy: 0.50 percent of flow rate from 10 to 100 percent of full scale.
3. Repeatability: 0.25 percent of full scale.
4. Isolation: Galvanic or optic.
5. Power consumption: 40 VA maximum at rated voltage.
6. Power supply: 120 Vac, plus or minus 10 percent.

F. Factory Testing:

1. Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the National Institute of Testing Standards. The calibration procedure shall conform to the requirements of MIL-STD-45662A. A real-time computer generated printout of the actual calibration data indicating apparent and actual flows at 20, 40, 60, 80, and 100 percent of the calibrated range shall be submitted to the ENGINEER at least 30 days prior to shipment of meters to the Site.

G. Manufacturer, or Equal:

1. **Emerson/Rosemount**
2. **ABB**
3. **Schneider Electric**
4. **Yokogawa**
5. **Siemens**

2.3 SUBMERSIBLE PRESSURE TRANSDUCERS

- A. Transducer shall output scalable water level signal based off hydrostatic pressure/water column measurement principle.
- B. Transducer shall compensate for changes in barometric pressure using a reference vent tube contained in the sensor cable.
- C. Vent tube and sensor cable wiring shall be terminated in a readily accessible local terminal box or control panel.
- D. **Type:** Vented gage.
- E. **Housing:** Stainless steel, rated to IP68.
- F. **Nose Cap:** Ported type.
- G. **Installation:** Stilling well, as indicated on drawings.
- H. **Process Media:** Raw river water.
- I. **Process Temperature Range:** 32 degrees F to 70 degrees F.
- J. **Level Range:** As shown on Instrumentation Schedule.
- K. **Accuracy:** Plus or minus 0.25 percent of full-scale, static.
- L. **Supply Voltage:** 24 Vdc.
- M. **Output:** 4-20 mA.
- N. **Cable:** Polyurethane cable jacket, 2-wire plus vent tube, with overall shield and drain wire. Length as required to reach enclosure containing desiccant without straining cable.

O. **Accessories:**

1. Desiccant filter for vent tube termination.
2. Stainless steel cable hanger.
3. Lightning surge line protector.

P. Manufacturer, or Equal:

1. **TE Connectivity**
2. **Keller America**

2.4 VERTICAL-MOUNT FLOAT LEVEL SWITCHES

- A. Mechanical float type switch with fixed vertical actuation for water level detection.
- B. Switch opens when float is in up position and closes in down position.
- C. **Float Material:** Non-metallic. Buna-N Rubber, or other approved material.
- D. **Stem Material:** Non-metallic. Polypropylene, or other approved material.
- E. **Mounting:** 1/8" NPT male. Installation requirements as shown on Drawings.
- F. **Process Media:** Raw river water.
- G. **Process Temperature Range:** 32 degrees F to 70 degrees F.
- H. **Level Differential:** Approximately 3/4" level differential between switch opening and closing.
- I. **Supply Voltage:** 24 Vdc.
- J. **Switch Designation:** Normally closed.
- K. **Cable/Wire Leads:** Length as required to splice at junction box shown on Drawings.

2.5 SUMP PUMP LEVEL SWITCHES

- A. Provide in accordance with the specific pump being controlled, as specified under Section 44 35 56 – Submersible Sump Pumps.

2.6 FACTORY TESTING

- A. Equipment shall be prepared for operational use in accordance with manufacturer's instructions, including bench test and calibration, where required.
- B. Each item shall be subjected to an operating test over the total range of capability of the equipment. Where applicable, tests shall be conducted in accordance with the Test Code of the Standards of the Hydraulic Institute. The CONTRACTOR shall obtain copies of

factory test certifications and shall notify the ENGINEER one week in advance of all tests to be conducted on Site.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. The CONTRACTOR shall assemble and install equipment in strict accordance with the manufacturer's published instructions, and under the supervision of the manufacturer's representative, where applicable. Installation shall be accomplished by competent craftsmen in a workmanlike manner.
- B. Instrumentation systems shall be handled, installed, calibrated, tested, and pre-commissioned in accordance with Section 40 90 00 – Process Instrumentation and Control, General.
- C. Flowmeters shall be installed as shown. Wherever possible, all flowmeters shall be installed in such a way to provide the manufacturer's recommended straight approach and straight piping downstream. Meters and shut-off and balancing valves shall be firmly supported from the structure or from the floor with approved supports. Inline meters shall be installed to provide full-line flow and not less than the manufacturer's recommended head at all times.

3.2 MANUFACTURER'S SERVICES

- A. Manufacturer's services and training for flowmeters shall be furnished in accordance with Section 40 90 00 – Process Instrumentation and Control, General.

PART 4 -- APPENDIX

- A. The following Instrumentation Schedule is a compilation of all process instrumentation included in the WORK:

Instrumentation Schedule						
Instrument ID	Instrument Type	Location	Size	Process Media	Measurement Range	Output
FE/FIT-200	Flowmeter, Magnetic	Meter Vault	12" dia	Raw Water	0 – 1,000 gpm	Analog, 4-20 mA
FE/FIT-201	Flowmeter, Magnetic	Meter Vault	20" dia	Raw Water	0 – 4,500 gpm	Analog, 4-20 mA
FE/FIT-202	Flowmeter, Magnetic	Meter Vault	20" dia	Raw Water	0 – 4,500 gpm	Analog, 4-20 mA
FE/FIT-203	Flowmeter, Magnetic	Meter Vault	12" dia	Raw Water	0 – 750 gpm	Analog, 4-20 mA
LE-200	Pressure Transducer, Submersible	Intake Structure	N/A	Raw Water	0 – 5 ft W.C.	Analog, 4-20 mA
LE-200	Pressure Transducer, Submersible	Intake Structure	N/A	Raw Water	0 – 5 ft W.C.	Analog, 4-20 mA

LSL-280	Level Switch, Sump Pump	Meter Vault – Pump Off	N/A	Sump Water	As shown	Discrete, N.O.
LSH-280	Level Switch, Sump Pump	Meter Vault – Pump On	N/A	Sump Water	As shown	Discrete, N.O.
LSH-281	Level Switch, Sump Pump	Meter Vault – Alarm High Level	N/A	Sump Water	As shown	Discrete, N.O.
LSL-300	Level Switch, Vertical Float	Coho Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-500	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-501	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-502	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-503	Level Switch, Vertical Float	Chinook Bldg – Incubator Head Tank	N/A	Raw Water	3/4" differential	Discrete, N.C.
LSL-660	Level Switch, Sump Pump	Waste Drain Wet Well – Pumps Off	N/A	Waste Drain	As shown	Discrete, N.O.
LSH-660	Level Switch, Sump Pump	Waste Drain Wet Well – Lead Pump On	N/A	Waste Drain	As shown	Discrete, N.O.
LSH-661	Level Switch, Sump Pump	Waste Drain Wet Well – Lag Pump On	N/A	Waste Drain	As shown	Discrete, N.O.
LSH-662	Level Switch, Sump Pump	Waste Drain Wet Well – Alarm High Level	N/A	Waste Drain	As shown	Discrete, N.O.

- END OF SECTION -

SECTION 40 90 18 - VENDOR PACKAGE CONTROL SYSTEMS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide control panels for vendor and manufacturer package equipment, complete and operable, in accordance with the Contract Documents. Control panels supplied by vendors or manufacturers shall meet all applicable requirements of this specification and the Contract Documents.
- B. This section specifically applies to the following systems and their associated appurtenances:
 - 1. Traveling Screens TRS-200 and TRS-201.
 - 2. Booster Pumps P-380, P-580, and P-680.
- C. Each control system shall consist of the following electrical components which are specified under this section:
 - 1. Local control panel, with or without programmable logic controller (PLC) or micro-controller capability, and including the following components:
 - a. Main circuit breaker and externally operable disconnect switch.
 - b. Combination, full-voltage, starter(s).
 - c. All controllers, control relays, pilot devices, and other devices internal to the control panel required for a complete and operable system.
 - d. Input/output (I/O) interfaces with the SCADA PLC, as indicated on the control diagrams on the drawings, to allow for complete operability and monitoring of the gate from a remote location.
- D. Interconnecting wiring and raceway shall be provided under Division 26.
- E. All structural and mechanical components of the controlled apparatus are specified elsewhere, unless noted otherwise.
- F. In general, the provisions of Division 26 apply to materials furnished under this section. Where the requirements of this section conflict with Division 26 requirements, only the requirements of this section shall apply.

1.2 RELATED SECTIONS

- A. Section 35 79 13 – Traveling Belt Intake Screen
- B. Section 44 35 04 – Packaged Booster Pump System

1.3 REFERENCE STANDARDS

- A. The following is a list of standards which may be referenced in this section:

National Electrical Manufacturers Association (NEMA)

AB 1	Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
ICS 1	Industrial Control and Systems: General Requirements
ICS 2	Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
ICS 5	Control Circuit and Pilot Devices

National Fire Protection Association (NFPA)

70	National Electrical Code (NEC)
----	--------------------------------

Underwriters Laboratories, Inc. (UL)

44	Thermoset-Insulated Wires and Cables
486E	Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors
486F	Bare and Covered Ferrules
489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
508	Standard for Industrial Control Equipment
508A	Standard for Industrial Control Panels
1059	Standard for Terminal Blocks
1063	Standard for Machine-Tool Wires and Cables

1.4 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.
- B. All panel drawings shall, as a minimum, be 11 inches by 17 inches and data sheets and manufacturer specification sheets shall be 8-1/2 inches by 11 inches.
- C. **Preliminary Submittal:** The CONTRACTOR shall submit schematic and elementary diagrams for the control panel a maximum of 60 days after Notice to Proceed that clearly demonstrates the functionality required by the control diagrams in the drawings.
- D. After acceptance of Preliminary Submittal, the CONTRACTOR shall submit a control panel engineering submittal (CPES) for the control panel and enclosure. The submittal shall have the following contents:
1. **Bill of material**, with enumerated make and model of all devices used in construction of the control panel.

2. Product data:

- a. Control relays and time delay relays.
- b. Motor contactors and protective devices.
- c. Door-mounted pilot devices (control switches, indicating lights, pushbuttons, etc.).
- d. Circuit breakers and fuse blocks.
- e. Digital meters.
- f. Control power transformers.
- g. Power, signal, and control wiring.
- h. Wireways.
- i. Terminal blocks.
- j. Enclosure data:
 - 1) Gauge and type of steel to be used for fabrication.
 - 2) NEMA 250 type.
 - 3) Backpanel size and color.
 - 4) Panel door handle, lock, and hinge mechanism.
 - 5) Interlock mechanism between panel disconnect and circuit breaker.
 - 6) Vents, fans, and cooling equipment.
 - 7) Panel heat dissipation calculations.
 - 8) Mounting details.
 - 9) Lifting lug locations.
 - 10) Enclosure finish.
 - 11) Nameplate schedule.
 - 12) Print pocket location.

3. Internal and external panel arrangements:

- a. Dimensional drawings for interior and exterior of enclosure, with matching enumeration to devices in bill of materials.

- b. Front panel layout drawing.
- c. Backpanel arrangement drawing.
- 4. **Schematic and elementary diagrams**, as shown in Preliminary Submittal. Changes to diagrams are subject to OWNER'S approval.
- 5. **Interconnection diagrams** that identify external connections between the control panel/control panel devices and associated equipment. These diagrams shall indicate terminal block assignments for interconnections.

E. Control Panel As-Built:

- 1. Prior to Field Acceptance Testing, the CONTRACTOR shall submit an as-built set of the CPES for review.
- 2. After acceptance of the completed WORK by the OWNER, the CONTRACTOR shall furnish the final accepted CPES as-built set to the OWNER:
 - a. One electronic set in format preferred by OWNER.
 - b. Two hard copy sets, size as indicated above.

1.5 QUALITY ASSURANCE

- A. Control panels shall be fabricated and wired in accordance with UL 508A and shall bear the UL label.

PART 2 -- PRODUCTS

2.1 CONTROL PANEL ENCLOSURES

- A. Control panel enclosures supplied with package systems shall meet the requirements of Section 40 90 05 – Control Enclosures and Devices.

2.2 CONTROL DEVICES AND COMPONENTS

- A. All control devices and components supplied with package systems shall meet the requirements of Section 40 90 05 – Control Enclosures and Devices.

PART 3 -- EXECUTION

3.1 GENERAL

A. Preparation for Shipment and Shipping:

- 1. Panels shall be crated for shipment using a heavy framework and skids.
- 2. Panel sections shall be cushioned to protect the finish of the panel during shipment. Instruments that are shipped with the panel shall have suitable shipping stops and cushioning material installed to protect parts that could be damaged due to mechanical shock.

3. Each separate panel unit shall be provided with removable lifting lugs to facilitate handling.
4. Control panel testing and inspection shall be performed prior to shipping.

B. **Pilot Devices:** Use heavy-duty, watertight, corrosion-resistant type.

3.2 CONTROL PANEL SIGNAL AND CONTROL CIRCUIT WIRING

A. **Wiring Installation:**

1. Wires shall be routed in plastic wireways, except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing out panel to components on a part of the fixed structure, and (4) wiring to panel-mounted components.
 2. Wiring routed from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at the terminals.
- B. Wiring routed to control devices on the doors shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.
- C. **Wire Marking:** Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on shop drawings. These numbers shall be marked on conductors at every terminal.

3.3 TESTING

A. **Inspection and Approval:**

1. Panel fabricator shall conduct the following tests prior to shipment:
 - a. Alarm circuits rung out to determine their operability.
 - b. Electrical circuits checked for continuity and where applicable, operability.
 - c. Verify the proper operation of control logic in each mode of control.
 - d. Nameplates shall be checked for correct spelling and size of letters.
 - e. Any other test required to place the panel in an operating condition.

B. **Field Testing:**

1. Each control panel shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.
2. Measure the insulation resistance of starter phase-to-phase and phase-to-ground with the starter contacts closed and the breaker open.

3. The test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.
4. Control Tests: Controlled systems and apparatus shall be operated from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, remote control actions, and remote feedback of status and position.
5. Interlocks: Interlocks between the instrumentation and the motor control circuits and packaged equipment controls shall be checked to the maximum extent possible.

- END OF SECTION -

SECTION 43 00 00 - EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide equipment and appurtenant WORK, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to equipment throughout the Contract except where otherwise indicated.
- C. **Equipment Arrangement:** Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision to meet the actual equipment requirements. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the installation of equipment. **It shall be the CONTRACTOR's responsibility to develop the details necessary to design and construct equipment installation systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.**

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:
 - 1. American Society for Testing and Materials (ASTM).
 - 2. American National Standards Institute (ANSI).
 - 3. American Society of Mechanical Engineers (ASME).
 - 4. American Water Works Association (AWWA).
 - 5. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
 - 6. American Welding Society (AWS).
 - 7. National Fire Protection Association (NFPA).
 - 8. Federal Specifications (FS).
 - 9. National Electrical Manufacturers Association (NEMA).
 - 10. Manufacturer's published recommendations and specifications.

11. General Industry Safety Orders (OSHA).

B. The following standards are referenced in this Section:

ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys
ASME B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ANSI S12.6	Methods for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B31.1	Power Piping
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Carbon Steel Tanks for Water Storage
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. **Shop Drawings:** Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the ENGINEER, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the CONTRACTOR.
- C. **Spare Parts List:** The CONTRACTOR shall obtain from the manufacturer and submit at the same time as Shop Drawings a list of suggested spare parts for each piece of equipment. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.
- D. Certifications that equipment and equipment supports comply with seismic and wind design criteria from Code.

1.4 QUALITY ASSURANCE

- A. **Costs:** The CONTRACTOR shall perform and pay the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives.

1. The CONTRACTOR shall be required to provide and pay for the cost of providing all temporary utilities, including electrical power and utility water, related to the startup, testing, and instruction services of equipment.
 2. If electrical power or utility water is specified to be provided or derived from permanent OWNER's facilities, the OWNER shall be responsible to pay for the consumed electricity and utility water.
- B. **Assistance by OWNER's Staff:** One of the OWNER's on-site staff will be available to provide operational assistance related to support facilities only, during field startup and testing of new equipment (TBD).
- C. **Inspection** The CONTRACTOR shall inform the local county and state authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, and related items to obtain required permits and certificates.
1. All fees required for such local and state permits and inspections shall be paid for by CONTRACTOR.
- D. **Quality and Tolerances:** Tolerances and clearances shall be as shown on the approved Shop Drawings and shall meet the following criteria:
1. Machine WORK shall be of high-grade workmanship and finish, with proper consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.
 2. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The ENGINEER shall be notified of larger defects. No repair welding of such defects shall be carried out without the ENGINEER'S written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the CONTRACTOR'S responsibility as part of the WORK.
 3. Materials shall meet the physical and mechanical properties in accordance with the reference standards.
- E. **Machine Finish:** The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:
1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.
 3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.
 4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.
- F. **Manufacturer's Experience:** Equipment manufacturer shall have a record of at least 5 years of successful, trouble-free operation in similar applications and of size equal to or greater than the equipment required in this Contract. For any "or Equal" supplier or manufacturer submitted upon by the CONTRACTOR, the ENGINEER and OWNER shall maintain the right to require the CONTRACTOR to provide at least three (3) prior installation references (with contact names and phone numbers) who may be contacted by the ENGINEER for verification of acceptable performance.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. **Noise Level:** When in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 105 dBA for one-hour exposure per day.
- B. **Drive Trains and Service Factors:** Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Reciprocating Air Compressors multi-cylinder single cylinder	2.0 2.0	Heavy Shock Heavy Shock
Pumps centrifugal or rotary reciprocating progressing cavity	1.0 1.8 1.0	Uniform Moderate Shock Uniform
Centrifugal Fans	1.0	Uniform
Cranes or Hoists	1.25	Moderate Shock

C. **Mechanical Service Factors**

	Mechanical Service Factors	
	Electric Motor	Internal Combustion Engine
Uniform	1.25	1.50
Moderate Shock	1.50	1.75
Heavy Shock	2.00	2.25

D. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear manufacturer sizing information.

E. **Electric Motor Service Factors.** Service factors of electric motors shall be a minimum of 1.15 unless noted otherwise in Section 26 05 10 - Electric Motors.

F. Where load classifications are not indicated, service factors shall be for standard load classifications and for flexible couplings.

G. **Welding:** Unless otherwise indicated, welding shall conform to the following:

1. Latest revision of AWWA D100.
2. Latest revision of AWWA C206.
3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.
4. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.
5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

H. **Protective Coating:** Equipment shall be painted or coated in accordance with Section 09 96 00 - Protective Coatings, unless otherwise indicated. Non-ferrous metal and

corrosion-resisting, rotating or moving steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

- I. **Protection of Equipment:** Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather-tight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized, and shafts shall be rotated. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, and recoated to restore it to original condition.
- J. **Shop Fabrication:** Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.
- K. **Controls:** Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

- A. **Equipment Supports.** Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed by the Supplier for worst case static, dynamic, wind, and seismic loads. The design horizontal seismic forces shall be the greater of that noted in the general structural notes (see Contract Drawing GS001 or as required by the governing building code, or 10 percent of gravity. Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in the State wherein the project is to be built, unless otherwise indicated.

Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings.

- 1. Wall-mounted equipment weighing more than 250 pounds, or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.
- 2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.
- 3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods that satisfy the building code. Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and shall include a minimum

factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

B. Equipment Foundations.

1. Mechanical equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on minimum 4-inch high concrete equipment bases, unless otherwise indicated, and shall extend at least 4-inches further horizontally than the extent of the equipment frame or skid.
2. Estimates of the required equipment foundations are indicated on the Contract Drawings. The CONTRACTOR through the equipment manufacturer shall verify the size and weight of equipment foundations to insure compatibility with equipment.

- C. **Anchors.** Anchor bolts shall be in accordance with Section 05 50 00 - Miscellaneous Metalwork. CONTRACTOR shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit anchor bolt criteria, sizes, and installation methods with the Shop Drawings.

2.3 COUPLINGS

- A. Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Unless otherwise indicated or recommended by the equipment manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	Coupling Type
Horizontal and end suction pumps	Gear or flexible spring

- B. Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The CONTRACTOR shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.
- C. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may occur, 2 sets of universal type couplings shall be provided.
- D. **Taper-Lock** or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.4 SHAFTING

- A. **General:** Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the

diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

- B. **Design Criteria:** Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of 2 in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.
- C. **Materials:** Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.
 - 1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.
 - 2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.
 - 3. Other grades of carbon steel alloys shall be suitable for service and load.
 - 4. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.
- D. **Differential Settlement:** Where differential settlement between the driver and the driven equipment may occur, a shaft of sufficient length with 2 sets of universal type couplings shall be provided.

2.5 GEARS AND GEAR DRIVES

- A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the ENGINEER.
- B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.
- C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.
- D. Material selections shall be left to the discretion of the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the

service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two positive seals to prevent oil leakage.

- E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.
- F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the CONTRACTOR shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.6 DRIVE CHAINS

- A. Power drive chains shall be commercial type roller chains meeting ASME Standards.
- B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.
- C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.
- D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.7 SPROCKETS

- A. **General:** Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.
- B. **Materials:** Unless otherwise indicated, materials shall be as follows:
 - 1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.
 - 2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.
 - 3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.
- C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.
- D. Finish bored sprockets shall be furnished complete with keyseat and set screws.
- E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with **Taper-Lock** bushings as required.
- F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.8 V-BELT DRIVES

- A. V-belts and sheaves shall be of the best commercial grade and shall conform to ASME, MPTA, and RMA Standards.
- B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.
- C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.
- D. To facilitate installation and disassembly, sheaves shall be provided complete with **Taper-Lock** or **QD** bushings as required.
- E. Finish bored sheaves shall be complete with keyseat and set screws.
- F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.9 DRIVE GUARDS

- A. Power transmission trains, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform to the Division of Industrial Safety General Industrial Safety Orders latest edition. The guards shall be constructed of minimum 10-gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication, and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.10 BEARINGS

- A. Bearings shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).
- B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.
- C. **Bearing Lubrication.**
 - 1. Re-lubricatable type bearings shall be equipped with a hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.
 - 2. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance
- D. **Anti-Friction Type Bearing Life:** Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of five years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life, years	L-10 Design Life, hours
-----------------	--------------------	-------------------------

	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

- E. **Bearing Housings.** Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

2.11 PIPING CONNECTIONS

- A. **Pipe Hangers, Supports, and Guides:** Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 40 23 02 - Pipe Supports.
- B. **Flanges and Pipe Threads:** Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 40 23 00 - Piping, General.
- C. **Flexible Connectors:** Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 14 23 00. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

2.12 NAMEPLATES

- A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.13 TOOLS AND SPARE PARTS

- A. **Tools:** The CONTRACTOR shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by **Snap On, Crescent, Stanley**, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

- A. Inspection, Startup, and Field Adjustment:** Where required by individual sections, an authorized, experienced, and competent service representative of the manufacturer shall visit the Site for the number of Days indicated in those sections to witness or perform the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.
1. Installation of equipment
 2. Inspection, checking, and adjusting the equipment and approving its installation
 3. Startup and field testing for proper operation, efficiency, and capacity
 4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements
- B. Instruction of the OWNER'S Personnel**
1. Where required by the individual equipment sections, an authorized training representative of the manufacturer shall visit the Site for the number of Days indicated in those sections to instruct the OWNER'S personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.
 2. The representative shall have at least 2 years experience in training. A resume of the representative shall be submitted.
 3. Training shall be scheduled 3 weeks in advance of the scheduled session.
 4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the ENGINEER shall be incorporated into the material.
 5. The training materials shall remain with the trainees after the session.
 6. The OWNER may videotape the training for later use by the OWNER'S personnel.
- C. Vibration Monitoring:** For the equipment types listed in paragraph 1.3D, the CONTRACTOR shall arrange for at least 2 Site visits by the manufacturer's specialist during testing of the equipment covered by torsional and vibration analysis submittals to measure the amount of vibration and prepare written recommendations for keeping the vibration within acceptance limits. If vibration readings exceed the specified or the applicable referenced standard vibration limits for the type of equipment, the CONTRACTOR shall make necessary corrections for the equipment to meet the acceptance criteria.

3.2 INSTALLATION

- A. **General:** Equipment shall be installed in accordance with the manufacturer's written recommendations.
- B. **Alignment:** Equipment shall be field tested to verify proper alignment.

3.3 PACKAGED EQUIPMENT

- A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.
- B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the CONTRACTOR shall coordinate such features with the ENGINEER and provide material and labor necessary for a complete installation as required by the manufacturer.

3.4 FIELD ASSEMBLY

- A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with **Never Seize** compound or equal.

3.5 WELDING

- A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

3.6 FIELD TESTS

- A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.
- B. The following field testing shall be conducted:
 - 1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.
 - 2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.
 - 3. Operate equipment indicated in Section 01 75 00.
- C. The ENGINEER shall witness field-testing. The CONTRACTOR shall notify the ENGINEER or OWNER of the test schedule no less than 3 Days in advance.
- D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 25 00 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 00 00 – Equipment General Provisions, apply to the WORK of this Section.
- C. The provisions of this Section shall apply to valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- D. Where a valve is to be supported by means other than the piping to which it is attached, the CONTRACTOR shall obtain from the valve manufacturer a design for support and foundation that satisfies the criteria in Section 43 00 00. The design, including drawings and calculations sealed by an engineer, shall be submitted with the Shop Drawings. When the design is approved, the support shall be provided.
- E. **Unit Responsibility:** A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the manufacturer of the valve.
- F. **Single Manufacturer:** Where two or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings:** Shop Drawings shall contain the following information:
 - 1. Valve name, size, C_v factor, pressure rating, identification number (if any), and specification section number.
 - 2. Complete information on valve actuator, including size, manufacturer, model number, limit switches, and mounting.
 - 3. Cavitation limits for control valves.
 - 4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Data in accordance with Section 26 05 10 – Electric Motors for electric motor-actuated valves.
 6. Complete wiring diagrams and control system schematics.
 7. Valve Labeling: A schedule of valves to be provided with stainless steel tags, indicating in each case the valve location and the proposed wording for the tag.
- C. **Technical Manual:** The Technical Manual shall contain the required information for each valve.
- D. **Spare Parts List:** A Spare Parts List shall contain the required information for each valve assembly, where indicated.
- E. **Factory Test Data:** Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The data shall also include certification of quality and test results for factory-applied coatings.

PART 2 -- PRODUCTS

2.1 PRODUCTS

- A. **General:** Valves and gates shall be new and of current manufacture. Shut-off valves 6-inches and larger shall have actuators with position indicators. Gate valves 18-inches and larger or where chain wheel is required, shall be furnished with spur gear and hand wheel. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 7-feet above working level shall be provided with chain actuators.
- B. **Valve Actuators:** Unless otherwise indicated, actuators shall be in accordance with Section 43 25 01 – Valve and Gate Actuators.
- C. **Protective Coating:** The exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 4-inches and larger shall be coated in accordance with Section 09 96 00 – Protective Coating. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- D. **Valve Labeling:** Except when such requirement is waived by the ENGINEER in writing, a label shall be provided on shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2-inches by 4-inches in size, as indicated in Section 40 23 01 – Piping Identification and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.
- E. **Valve Testing:** As a minimum, unless otherwise indicated or recommended by the reference standards, valves 3-inches in diameter and smaller shall be tested in accordance with manufacturer's standard and 4-inches in diameter and larger shall be factory tested as follows:

1. **Hydrostatic Testing:** Valve bodies shall be subjected to internal hydrostatic pressure equivalent to twice the water rated pressure of the valve. Metallic valve rating pressures shall be at 100 degrees F and plastic valves shall be 73 degrees, or at higher temperature according to type of material. During the hydrostatic test, there shall be no leakage through the valve body, end joints, or shaft seals, nor shall any part of the valve be permanently deformed. The duration shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes.
 2. **Seat Testing:** Valves shall be tested for leaks in the closed position with the pressure differential across the seat equal to the water rated pressure of the valve. The duration of test shall be sufficient time to allow visual examination for leakage. Test duration shall be at least 10 minutes. Leakage past the closed valve shall not exceed 1 fluid ounce per hour per inch diameter for metal seated valves. Resilient-seated valves shall be drop-tight.
 3. **Performance Testing:** Valves shall be shop-operated from fully closed to fully open position and reverse under no-flow conditions in order to demonstrate the valve assembly operates properly.
- F. **Certification:** Prior to shipment, the CONTRACTOR shall submit for valves over 12-inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.
- G. **Valve Marking:** Valve bodies shall be permanently marked in accordance with MSS SP25 – Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

- A. **General:** Materials shall be suitable for the intended application. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Materials not indicated shall be high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, valve and actuator bodies shall conform to the following requirements:
1. **Cast Iron:** Close-grained gray cast iron, conforming to ASTM A48 – Gray Iron Castings, Class 30, or to ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 2. **Ductile Iron:** ASTM A536 – Ductile Iron Castings, or to ASTM A395 – Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 3. **Stainless Steel:** Stainless steel valve and operator bodies and trim shall conform to ASTM A351 – Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.
 4. **PVC:** Poly vinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.

2.3 VALVE CONSTRUCTION

- A. **Bodies:** Valve bodies shall be cast, molded (in the case of plastic valves), forged, or welded of the materials indicated, with smooth interior passages. Wall thicknesses shall be uniform in agreement with the applicable standards for each type of valve, without casting defects, pinholes, or other defects that could weaken the body. Welds on welded bodies shall be done by certified welders and shall be ground smooth. Valve ends shall be as indicated and be rated for the maximum temperature and pressure to which the valve will be subjected.
- B. **Valve End Connections:** Unless otherwise indicated, valves 2-1/2 inches diameter and smaller may be provided with threaded end connections. Valves 3-inches and larger shall have flanged end connections.
- C. **Bonnets:** Valve bonnets shall be clamped, screwed, or flanged to the body and shall be of the same material, temperature, and pressure rating as the body. The bonnets shall have provision for the stem seal with the necessary glands, packing nuts, or yokes.
- D. **Stems:** Valve stems shall be of the materials indicated, or, if not indicated, of the best commercial material for the specific service, with adjustable stem packing, O-rings, Chevron V-type packing, or other suitable seal.
- E. **Stem Guides:** Stem guides shall be provided, spaced 10-feet on centers unless the manufacturer can demonstrate by calculation that a different spacing is acceptable. Submerged stem guides shall be 304 stainless steel.
- F. **Internal Parts:** Internal parts and valve trim shall be as indicated for each individual valve. Where not indicated, valve trim shall be of Type 316 stainless steel or other best suited material.
- G. **Nuts and Bolts:** Nuts and bolts on valve flanges and supports shall be in accordance with Section 05 50 00 –Miscellaneous Metalworks.

2.4 VALVE ACCESSORIES

- A. Valves shall be furnished complete with the accessories required to provide a functional system.

2.5 SPARE PARTS

- A. The CONTRACTOR shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

2.6 MANUFACTURERS

- A. **Manufacturer's Qualifications:** Valve manufacturers shall have a successful record of not less than five years in the manufacture of the valves indicated.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

- A. **General:** Valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the manufacturer's written instructions and as indicated. Gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.
- B. **Access:** Valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.
- C. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are indicated, the CONTRACTOR shall properly assemble and install such items so that systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on Shop Drawing submittals.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 25 01 - VALVE AND GATE ACTUATORS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to valves and gates except where otherwise indicated in the Contract Documents.
- C. **Unit Responsibility:** The valve or gate manufacturer shall be made responsible for coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves, gates, and actuators with the Contract Documents.
- D. **Single Manufacturer:** Where two or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and Section 43 25 00 – Valves, General.
- B. **Shop Drawings:** Shop Drawing information for actuators shall be submitted together with the valve and gate submittals as a complete package.
- C. **Calculations:** Selection calculations showing dynamic seating and unseating torques versus output torque of actuator.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Unless otherwise indicated, shut-off and throttling valves and externally actuated valves and gates shall be provided with manual or power actuators. The CONTRACTOR shall furnish actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. Actuators shall have the torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 – Rubber-Seated Butterfly Valves. Wires of motor-driven actuators shall be identified by unique numbers.
- B. **Manufacturers:** Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer. Where actuators are

furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.

- C. **Materials:** Actuators shall be current models of the best commercial quality materials and be liberally-sized for the required torque. Materials shall be suitable for the environment in which the valve or gate is to be installed.
- D. **Actuator Mounting and Position Indicators:** Actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and be of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. Gear and power actuators shall be equipped with position indicators. Where possible, manual actuators shall be located between 48- and 60-inches above the floor or the permanent working platform.
- E. **Standard:** Unless otherwise indicated and where applicable, actuators shall be in accordance with AWWA C540 – Power-Actuating Devices for Valves and Slide Gates.
- F. **Functionality:** Electric, pneumatic, and hydraulic actuators shall be coordinated with the power requirements of Division 26 and instrumentation equipment indicated in Section 40 90 01 – Process Instrumentation and Control, General.
- G. Fasteners shall be in accordance with Section 05 50 00 – Miscellaneous Metalwork.
- H. Protective coatings shall be in accordance with Section 09 96 00 – Protective Coatings.

2.2 MANUAL ACTUATORS

- A. **General:** Unless otherwise indicated, valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4-inches shall have direct acting lever or handwheel actuators of the manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. Other valves 6-inches to 24-inches in diameter may have traveling nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.
- B. **Buried Valves:** Unless otherwise indicated, buried valves shall have extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as required by the local Utility Company or the ENGINEER. Wrench nuts shall comply with AWWA C500 – Metal-Seated Gate Valves for Water Supply Service.
- C. **Floor Boxes:** Hot dip galvanized cast iron or steel floor boxes and covers to fit the slab thickness shall be provided for operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.

- D. **Tee Wrenches:** Buried valves with floor boxes shall be furnished with 2 operating keys or 1 key per 10 valves, whichever is greater. Tee wrenches sized so that the tee handle will be 2 to 4 feet above ground shall fit the operating nuts.
- E. **Manual Worm Gear Actuator:** The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears or worm gearing. The gear ratio shall be self-locking to prevent "back-driving." The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. The worm gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. Gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Output shaft end shall be provided with spline to allow adjustable alignment. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. Gearing shall be designed for a 100 percent overload. The entire gear assembly shall be sealed weatherproof.
- F. **Traveling-Nut Actuator:** The actuator shall consist of a traveling-nut with screw (Scotch yoke) contained in a weatherproof cast iron or steel housing with spur gear and minimum 12-inch diameter handwheel. The screw shall run in 2 end bearings, and the actuator shall be self-locking to maintain the valve position under any flow condition. The screw and gear shall be of hardened alloy steel or stainless steel, and the nut and bushings shall be of alloy bronze. The bearings and gear shall be grease-lubricated by means of nipples. Gearing shall be designed for a 100 percent overload.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Valve and gate actuators and accessories shall be installed in accordance with Section 43 25 00 – Valves, General. Actuators shall be located to be readily accessible for operation and maintenance without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 25 02 - BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 00 00 – Equipment General Provisions apply to this Section.
- C. The requirements of Section 43 25 00 – Valves, General apply to this Section.
- D. The requirements of Section 43 25 01 – Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and 43 25 00 – Valves, General.
- B. Shop Drawings
 - 1. Complete Shop Drawings of butterfly valves and actuators.
 - 2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.
 - 3. Dynamic seating and unseating torque for any motor actuated valves.
 - 4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.
 - 5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

1.3 QUALITY ASSURANCE

- A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 -- PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES 25 TO 150 PSI (AWWA)

- A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for fresh water service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504 and be as indicated.

1. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 24-inches shall be rated for Class 150B with actuator sized for Class 150B.
 2. Valves 30 inches through 72-inches shall be of the class indicated.
 3. Valves larger than 72-inches shall be of the class indicated, designed in accordance with the intent of AWWA C504.
- B. **Valve Schedule.** Valves of 4-inch diameter and larger shall be of the body type, pressure class, end joint, and actuator type as indicated on the valve schedule on **Contract Sheet GM-002 thru GM-004**. If the operating conditions such as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.
- C. **Construction:** Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A 48, Class 40 or Gray iron, ASTM A 126, Class B, or Ductile iron, ASTM A 536, grade 65-45-12 or 70-50-05
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A 240 or A 276, Type 304
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A 240 or A 276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	Refer to Section 09 96 00 – Protective Coatings
Hardware (Bolts/Nuts)	Per Specification 05 50 00

- D. **Manual Actuators:** Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator or locking lever. Screw-type (traveling nut) actuators will not be permitted for buried or submerged valves.
- E. **Ferrous Surface Coating:** All corrosive ferrous surfaces of valves 3-inches and larger, exclusive of flange faces, shall be properly primed and epoxy-coated per the Manufacturer's standard liquid-applied epoxy coating system. For buried valves, all ferrous surfaces, exclusive of flange faces, shall be given proper primer and fusion-bonded epoxy coatings, per AWWA C550, for buried service.
- F. **Manufacturers, or Equal**
 - 1. Clow / M & H Valve Company
 - 2. DeZURIK Water Controls, Corporation
 - 3. Henry Pratt / Mueller Company. (Series 2FII for valves 20" dia and smaller indoors. Series "Groundhog" for all buried valves.)
 - 4. Kennedy Valve
 - 5. Val Matic / American Darling. (Series 2000 for valves 20" dia and smaller – indoors, and Series 2030 for all buried valves)
 - 6. Rodney Hunt Company (24-inches and larger)

2.2 BURIED BUTTERFLY VALVES

- A. **General:** Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for freshwater service having a pH range from 6 to 9 and temperature range from 35 to 60 degrees F shall conform to AWWA C504 and be as indicated.
 - 1. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 30-inches shall be rated for either Class 75B or Class 150B with actuator sized for Class 150B.
- B. **Valve Schedule.** Valves of 3-inch diameter and larger shall be of the body type, pressure class, end joint, and actuator type as indicated on the valve schedules on **Contract Drawings**. If the operating conditions such as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.
- C. **Construction:** Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A48, Class 40 or Gray iron, ASTM A126, Class B, or Ductile iron, ASTM A536, grade 65-45-12 or 70-50-05
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A240 or A276, Type 316
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A240 or A276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self-lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	See Section 09 96 00 – Protective Coatings
Hardware (Bolts/Nuts)	Per Specification 05 50 00

- D. **Manual Actuators:** Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.
- E. **Worm Gear Actuators:** Valves 30-inches and larger, as well as submerged and buried valves, shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.
- F. **Ferrous Surface Coating:** All corrosive ferrous surfaces of valves 3-inches and larger, exclusive of flange faces, shall be properly primed and epoxy-coated per the Manufacturer's standard liquid-applied epoxy coating system. For buried valves, all ferrous surfaces, exclusive of flange faces, shall be given proper primer and fusion-bonded epoxy coatings, per AWWA C550, for buried service.
- G. **Manufacturers, or Equal**
1. **Clow / M & H Valve Company**
 2. **DeZURIK Water Controls, Corporation**
 3. **Henry Pratt / Mueller Company.** (Series 2FII for valves 20" dia and smaller indoors. Series "Groundhog" for all buried valves.)

4. **Val Matic / American Darling.** (Series 2000 for valves 20" dia and smaller – indoors, and Series 2030 for all buried valves)

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 43 25 00.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 43 25 03 - CHECK VALVES

PART 1 -- GENERAL

1.1 SUMMARY

The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

The requirements of Section 43 25 00 – Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and 43 25 00 – Valves, General.

PART 2 -- PRODUCTS

2.1 SWING CHECK VALVES (3-INCHES AND LARGER)

General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C508 – Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

Body: The valve body and cover shall be of cast iron conforming to ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 125, or be mechanical joint ends, as indicated.

Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B584 – Copper Alloy Sand Castings for General Applications.

Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B584 or B 148 – Aluminum-Bronze Castings or of Buna-N.

Hinge Pin: The hinge pin shall be of bronze or stainless steel.

Dashpot: A bottom-mounted hydraulic dashpot shall be provided to prevent reverse flow and to alleviate water hammer during the closing cycle of the valve. The dashpot shall have 2-stage closing rates: For the 2-stage closing rate, the first stage shall be adjustable from 100 to 10 percent. The second stage shall be adjustable from 10 to zero percent. Each rate shall be infinitely and independently field adjustable depending on the system requirement. The dashpot shall be a self-contained oil system separate and independent from the pipeline fluid. The oil reservoir for the closing cycle shall be stainless steel, open to the atmosphere with an air breather cap to allow oil level changes in the reservoir and to prevent contamination of the oil from any outside source. The oil reservoir for the opening cycle shall be stainless steel, be hermetically sealed to contain pressure (air over

oil) and shall be equipped with a 3-inch diameter pressure gauge and pneumatic fill valve. There shall be a provision for disconnecting each dashpot from the valve for servicing, without removal of the valve.

Limit Switches: Limit switches shall be provided on check valve swing arms where indicated. Switches shall be roller lever rotary actuated type, with contacts rated for 10 amp at 120 VAC. Switches shall be located to actuate when the check valve is fully closed and deactivate when the valve begins to open. Switches shall be **Honeywell Microswitch Model 1LS1, Square D 9007 C**, or equal.

Manufacturers, or Equal

APCO (Valve and Primer Corp.)

Kennedy Valve

Mueller Company

Stockham Valves and Fittings

Golden Anderson

2.2 SILENT CHECK VALVES (10-INCHES AND SMALLER)

General: Check valves shall be of the silent wafer check style

Body: The valve body, bushing, spring, poppet and seat ring shall be of Type 316 stainless steel conforming to NSF 61, suitable for mounting between ANSI 125 lb. flat faced companion flanges. No yellow metals allowed.

O- Rings: The O-rings shall be EPDM.

Manufacturers, or Equal

- a. **Valmatic**
- b. **Flowmatic 888S6**
- c. **Mueller Company**
- d. **Stockham Valves and Fittings**
- e. **Golden Anderson**

2.3 PLASTIC SWING OR WYE-CHECK VALVES

General: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

Construction: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut

positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

Manufacturers, or Equal

ASAHI-AMERICA

George Fischer, Inc.

Spears Mfg. Co. (Plastic Swing Check only)

2.4 SLANTING DISC CHECK VALVES

General: Slanting disc check valves for water service shall have a seating angle of approximately 55 degrees. Valves shall have replaceable seat rings and disc rings. The water passage cross-sectional area shall be equal to the full pipe area. Valves shall have sufficient clearance around the pivot pins to permit free seating of the disc without binding and shall be guaranteed not to stick in the closed position. Slanting disc check valves shall have position indicators and 2 flanged connections for attachment of dashpots or hydraulic snubbers. The valves shall be designed for a water working pressure of 150 psi, unless otherwise indicated.

Body: The valve body shall be of cast iron conforming to ASTM A48 – Gray Iron Castings, or A126, Class B, with flanged ends conforming to ASME B16.1, Class 125, unless otherwise indicated.

Disc: The valve disc shall be designed with an "airfoil" configuration of cast iron or ductile iron, with bronze seating face, except for valves 10-inches or smaller, which may have solid bronze or aluminum bronze discs. The disc shall be partially balanced with a short travel to resist slamming.

Seat Ring: The seat ring shall be of centrifugally-cast bronze, aluminum bronze, or stainless steel, with beveled edges, firmly clamped or screwed into the valve body.

Pins: The pivot pins and bushings shall be of stainless steel, bronze, or aluminum bronze to allow free movement of the disc without binding.

Dashpot: A bottom-mounted hydraulic dashpot shall be provided to prevent reverse flow and to alleviate water hammer during the closing cycle of the valve. The dashpot shall have 2 stage closing rates. For the 2-stage closing rate, the first stage shall be adjustable from 100 to 10 percent. The second stage shall be adjustable from 10 to zero percent. Each rate shall be infinitely and independently field adjustable depending on the system requirement. The dashpot shall be a self-contained oil system separate and independent from the pipeline fluid. The oil reservoir for the closing cycle shall be stainless steel, open to the atmosphere with an air breather cap to allow oil level changes in the reservoir and also to prevent contamination of the oil from any outside source. The oil reservoir for the opening cycle shall be stainless steel, be hermetically sealed to contain pressure (air over oil) and shall be equipped with a 3-inch diameter pressure gauge and pneumatic fill valve.

There shall be a provision for disconnecting each dashpot from the valve for servicing, without removal of the valve.

Limit Switches: Limit switches shall be provided on check valve swing arms where indicated. Switches shall be roller lever rotary-actuated type with contacts rated for 10 amp at 120 volts. Switches shall be located to actuate when the check valve is fully closed and deactivate when the valve begins to open. Switches shall be **Honeywell Microswitch Model 1LS1, Square D 9007 C**, or equal.

Manufacturers, or Equal

APCO (Valve and Primer Corporation)

Crane Company (Without Dashpot, Only)

VAL-MATIC (Valve and Manufacturing Corporation)

2.5 METALLIC BALL SEWAGE CHECK VALVES

- A. **General:** Metallic ball check valves for sewage service, in sizes up to 24-inches, shall be used for vertical up-flow conditions and horizontal positions only.
- B. **Construction:** The valve shall be designed with non-clogging feature for raw sewage. The ball shall be guided to and from its seat by smooth ribs integrally cast into the housing wall. An internal clog-proof design shall insure a completely free and unobstructed flow with no projections or pockets to trap solid material. The valve body and cover shall be of cast or ductile iron and be epoxy-coated suitable for the service condition. Units shall have flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150. Ball shall be made of hollow metal with vulcanized Buna-N rubber or Hypalon cover suitable for the service. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.
- C. Manufacturers, or Equal
 - 1. **Flygt (HDL)**
 - 2. **Golden Anderson**

PART 3 -- EXECUTION

3.1 GENERAL

Valves shall be installed in accordance with provisions of Section 43 25 00 – Valves, General.

- END OF SECTION -

SECTION 43 25 04 - BALL VALVES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 25 00 – Valves, General apply to this Section.
- C. The requirements of Section 43 25 01 – Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and 43 25 00 – Valves, General.

PART 2 -- PRODUCTS

2.1 METAL BALL VALVES (4-INCHES AND SMALLER)

- A. **General:** Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 43 25 01 – Valve and Gate Actuators.
- B. **Body:** Ball valves up to and including 1-1/2 inches in size shall have bronze or carbon steel 2- or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inches to 4-inches in size shall have bronze or carbon steel 2- or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.
- C. **Balls:** The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.
- D. **Stems:** The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.
- E. **Seats:** The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.
- F. Manufacturers, or Equal
 - 1. **Conbraco Industries, Inc. (Apollo)**
 - 2. **ITT Engineered Valves**
 - 3. **Neles-Jamesbury, Inc.**
 - 4. **Watts Regulator**
 - 5. **Worcester Controls**

2.2 PLASTIC BALL VALVES

- A. **General:** Plastic ball valves shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific application. Valves shall have manual actuators in accordance with Section 43 25 01 - Valve and Gate Actuators, unless otherwise indicated.
- B. **Construction:** Plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and Teflon seats. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.
- C. Manufacturers, or Equal
 - 1. **ASAHI-America**
 - 2. **George Fischer, Inc.**
 - 3. **NIBCO Inc., (Chemtrol)**
 - 4. **Plast-O-Matic Valves, Inc.**
 - 5. **Spears Mfg. Co.**
 - 6. **Watts Regulator**
 - 7. **Hayward**

PART 3 -- EXECUTION

3.1 GENERAL

- A. Valves shall be installed in accordance with Section 43 25 00. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

- END OF SECTION -

SECTION 43 25 06 - GATE VALVES

PART 1 -- GENERAL

1.1 SUMMARY

The CONTRACTOR shall provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.

The requirements of Section 43 25 00 – Valves, General apply to this Section.

The requirements of Section 43 25 01 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

Furnish submittals in accordance with Section 43 25 00 – Valves, General and Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 RESILIENT-SEATED GATE VALVES

- A. **General:** Resilient-seated gate valves may be provided in lieu of metal-seated double-disc or solid-disc gate valves, at the discretion of the ENGINEER.
- B. **Construction:** Resilient-seated gate valves shall conform to AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service. The valves shall be suitable for a minimum design working water pressure of 150 psig with flanged, bell and spigot, or mechanical joint ends. The valve body, bonnet, and disc shall be of cast iron or ductile iron and the disc or body shall be rubber coated. Body and bonnet wall thickness shall be equal to or greater than the minimum wall thickness as listed in Table 1 of AWWA C515. The stem, stem nuts, glands, and bushings shall be bronze, with the stem seal per AWWA C515.
- C. **Pressure Ratings:**
 - 1. AWWA C515 valves 3- through 36-inch with outside screw-and-yoke (OS&Y) rising stem and 3- through 16-inch for non-rising-stem (NRS), shall be rated for 200 psig minimum design working water pressure.
- D. **Protective Coating:** Valves shall be factory coated in accordance with Section 09 96 00 - Protective Coating. The CONTRACTOR shall submit a test report from a coating inspector that the valve body coating is holiday-free. The CONTRACTOR shall be aware that if required, it shall retain the services of a third-party coating applicator to achieve the holiday-free requirement.
- E. **Actuators:** Unless otherwise indicated, resilient-seated gate valves shall have manual actuators in accordance with Section 43 25 01.
- F. Manufacturers, or Equal

- 1. **Mueller Company**

2. **M & H**

3. **Clow**

2.2 PLASTIC GATE VALVES (1.5 TO 12-INCHES)

- A. **Construction:** Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined wedges for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a cold-water pressure rating of 150 psig for sizes 1.5 through 8-inches, and 110 psig for size 10 through 12-inches.
- B. **Actuators:** Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 43 25 01.
- C. Manufacturers, or Equal
 - 1. **ASAHI/America**
 - 2. **Spears Mfg. Co.**

PART 3 -- EXECUTION

3.1 GENERAL

- A. Gate valves shall be installed in accordance with the provisions of Section 43 25 00. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

- END OF SECTION -

SECTION 43 25 42 - MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 25 00 – Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

- A. **Air and Vacuum Valves:** Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.
- B. **Air-Release Valves:** Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.
- C. **Combination Air Valves:** Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.
- D. Manufacturers, or Equal
 - 1. **APCO (Valve and Primer Corporation)**
 - 2. **Crispin Valves**
 - 3. **GA Industries**
 - 4. **Val-Matic (Valve and Manufacturing Corporation)**

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, wherever there is any danger of contamination, and where indicated.
- B. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with Section 43 25 00.
- C. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

- END OF SECTION -

SECTION 43 30 56 - HYDRAULIC GATES, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide hydraulic gates with appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to flap gates, slide gates, stop gates, cast iron slide gates, and shear gates, except where otherwise indicated in the Contract Documents.
- C. Single Manufacturer
 - 1. The CONTRACTOR shall assign to a single manufacturer responsibility for the furnishing and functional operation of the hydraulic gates, including operators and accessories.
 - 2. The designated single manufacturer, however, need not manufacture more than one part of the units, but shall coordinate the design, assembly, testing, and installation of the units.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C560	Cast Iron Slide Gates
AWWA C561	Stainless Steel Slide Gates
AWWA C562	Aluminum Slide Gates
AWWA C563	Composite Slide Gates
AWWA C 513	Open Channel Fabricated Metal Slide Gates
ASTM A 276	Stainless Steel Bars and Shapes
ASTM B 21	Naval Brass Rod, Bar, and Shapes
ASTM B 584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with SECTION 01 33 00 - CONTRACTOR SUBMITTALS.
- B. Shop Drawings
 - 1. Submit Shop Drawings of hydraulic gates as indicated in their respective Section.

C. Technical Manuals

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.
2. A list of recommended spare parts for the OWNER to store at the facility shall be included.

D. Certification

1. The CONTRACTOR shall obtain written certification from the designated single manufacturer, addressed to the OWNER, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Contract Documents, and that the designated single manufacturer accepts the CONTRACTOR's assignment of responsibility for coordination of gate equipment, including operators, controls, and services required for proper installation and operation.

E. Field Procedures

1. Prior to installation of the gates, provide instructions for field procedures for installation, adjustments, inspection, and testing.

1.4 QUALITY ASSURANCE

A. Equipment Field Testing

1. The CONTRACTOR shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative.
2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Installation and Startup Assistance

1. Service and testing assistance by the manufacturer's engineering representative for each gate and valve shall be available as needed by the CONTRACTOR during installation and startup.

B. Instruction of OWNER's Personnel

1. The CONTRACTOR shall arrange for the services of a factory service representative to instruct the OWNER's personnel in the operation and maintenance of the equipment.

1.6 SPECIAL WARRANTY REQUIREMENT

- A. The CONTRACTOR shall furnish the manufacturer's written guarantee that the hydraulic gates comply with the indicated requirements.
- B. The CONTRACTOR shall furnish the manufacturer's warranties as published in its literature.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Equipment provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products and which have had previous experience in such manufacture.
- B. The CONTRACTOR shall, upon request, furnish the names of not less than 5 successful installations of the manufacturer's equipment of comparable nature to that offered under the Contract.
- C. Combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the CONTRACTOR and the manufacturer shall be responsible for the compatible and successful operation of the various components of the units.
- D. Indicated and necessary mountings and appurtenances shall be included.

2.2 MATERIALS

- A. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

2.3 HARDWARE

- A. Bolts and nuts shall comply with the requirements of Section 05 55 00 – Miscellaneous Metalwork.

2.4 PROTECTIVE COATING

- A. Coat ferrous metal in accordance with the requirements of Section 09 96 00 – Protective Coating

2.5 TOOLS AND SPARE PARTS

- A. Tools
 - 1. Furnish special tools that are necessary for maintenance and repair of the gates.

2. Such tools shall be suitably stored in metal toolboxes and identified with the equipment number by means of stainless steel or solid plastic nametags attached to the box.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Slide and shear gates shall be installed in strict accordance with the manufacturer's printed recommendations and the indicated requirements.
- B. Operators shall be located as to avoid interference with handrails and structural members.
- C. Damage to surface coatings incurred during shipment or installation shall be repaired.

- END OF SECTION -

SECTION 43 30 58 - FLAP GATES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide flap gates, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 35 20 15 – Hydraulic Gates, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. Complete description of all materials including the material thickness of all components
- C. Installation drawings showing all details of construction, details required for installation, dimensions and anchor bolt locations at least 30 days before flap gates installation.
- D. Maximum bending stress and deflection of the flap under the maximum design head (seating head).

1.3 QUALITY ASSURANCE

- A. All of the equipment specified under this Section shall be furnished by a single manufacturer.

PART 2 -- PRODUCTS

2.1 FLAP GATES

- A. Design
 - 1. Flap gates and frames shall be of cast iron construction, with fully-adjustable top pivot points and bronze sealing surfaces.
 - 2. Gate frames shall be provided with flat backs for attachment to wall thimbles, unless otherwise indicated.
- B. Wall Thimbles
 - 1. Unless otherwise indicated, flap gates shall be mounted against cast iron wall thimbles with Type 316 stainless steel bolts, anchor bolts, nuts, and washers, and sealant or gaskets.
 - 2. The thimbles shall be of the F-pattern type, in order to match the thickness of the walls in which they are installed.
 - 3. Wall thimbles shall be furnished by the manufacturer of the gates, in order to match the bolt dimensions of the gates.

C. Sealant Manufacture, or Equal

1. The elastomeric sealant shall be **Rubber Caulk Sealer** as manufactured by **Products Research Company, Los Angeles**.

D. Grout

1. Gates mounted against concrete walls without wall thimbles shall be installed with one-inch-thick non-shrink grout between the wall and the gate flange.

E. Flap Gate Manufacturer or Equal

1. **Hydro Gate Corp., Model 20C** or **10C** for round openings
2. **Fresno Valves and Castings**
3. **Waterman**
4. **Rodney Hunt Company, Series FV-AC**

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Flap gates shall be installed in strict accordance with the requirements of Section 43 30 56 – Hydraulic Gates, General.

- END OF SECTION -

SECTION 43 30 61 – CAST IRON SHEAR GATES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide slide and shear gates, complete and operable, as indicated in accordance with the Contract Documents.
- B. The requirements of Section 43 30 56 – Hydraulic Gates, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

- A. Shop Drawings
 - 1. Submit the following:
 - a. Drawings of gates, frames, slides, and actuators
 - b. Design load calculations for deflection at the maximum expected head
 - c. Calculations for the lifting force generated by 40 pounds effort on the lever in order to operate the gate.

1.3 QUALITY ASSURANCE

- A. Leakage criteria for field test shall conform to AWWA Standards.

PART 2 -- PRODUCTS

2.1 SHEAR GATES

- A. Construction
- B. Shear gates shall be of cast iron construction with a bronze seat and disc rings, and a flanged frame equipped with a minimum handle length such that the handle is a minimum of 6-inches above the finished surface elevation.
- C. Coating
 - 1. Each gate, including accessories, shall be epoxy-coated in accordance with the requirements of Section 09 96 00 – Protective Coating.
 - 2. Care shall be exercised in order to protect machined surfaces during sand blasting and coating.
- D. Mounting hardware, if indicated or required, shall be constructed of Type 316 stainless steel.
- E. Manufacturers, or Equal
 - 1. **Troy Valve, Model A-2520**

2. Waterman, Model C-16

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Sluice and shear gates shall be installed in strict accordance with the requirements of Section 43 30 56 – Hydraulic Gates, General.

- END OF SECTION -

SECTION 43 30 62 - SLIDE/STOP GATES

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide slide/stop gates, complete and operable, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

- A. Shop Drawings
 - 1. Submit the following:
 - a. Drawings of gates, frames, slides, and actuators
 - b. Design load calculations for deflection at the maximum expected head
 - c. Calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.

1.3 QUALITY ASSURANCE

- A. The leakage allowance for slide gates under the design seating and unseating heads shall conform with the AWWA Standards.
- B. Factory Testing
 - 1. Gates shall be factory-assembled and functionality-tested prior to delivery to the Site.
 - 2. Test certificates shall be submitted.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Gates shall comply with the following Standards:
 - 1. AWWA C513 (unless indicated otherwise) Open-Channel, Fabricated-Metal Slide Gates and Open-Channel, Fabricated-Metal Weir Gates
 - 2. AWWA C561 Stainless Steel Slide Gates
 - 3. AWWA C562 Aluminum Slide Gates
 - 4. AWWA C563 Composite Slide Gates
- B. Gates shall be new and of current manufacture, adequately braced in order to prevent warpage and bending under the intended use.
- C. Gate actuators shall be sized, selected, and furnished by the gate manufacturer.

D. Gate actuators throughout the project shall be products of a single manufacturer.

E. Mounting Requirements

1. Guide frames shall be extended 3 feet, 6 inches above the walkway in order to match the height of the handrail.
2. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.
3. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.

2.2 STAINLESS STEEL SLIDE GATES

A. Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C561 suitable for the service.
2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Disc & Stiffeners	ASTM A276, Type 304 Stainless Steel
Yoke Support Beam	ASTM A36 Structural Steel or ASTM A276, Type 304 Stainless Steel
Frame & Guides	ASTM A276, Type 304 Stainless Steel
Stem and Coupling	ASTM A276, Type 304 Stainless Steel
Stem Guides (at base of Yoke or integral to pedestal style)	ASTM A276, Type 304 Stainless Steel with UHMW bushing
Stem Cover	Transparent plastic pipe with UV inhibitors, Sched. 40 minimum
Disc Seats	UHMW Polyethylene, ASTM D4020
Invert (Base) Seal	For flush bottom gates: Embed "Q-bottom" Neoprene / rubber seal by Waterman or type "Hy-Q" stepped seal. Embeds shall be ASTM A167, A 276, Type 304 Stainless Steel For non-flush bottom gates: Frame Mounted Invert Seal, Neoprene / Rubber, ASTM D 2000, Grade AA625.

Side and Top Seals	"J-bulb" Type or Self-Adjusting Neoprene Cord Seals, Neoprene / Rubber, ASTM D 2000, Grade AA625.
Metal Contact Surfaces for Seals (invert sill & J-side seals where used)	ASTM A167, A 276, Type 304 Stainless Steel
Fasteners (including studs, anchors, assembly bolts, nuts and hardware)	ASTM F593, F594, Type 316 Stainless Steel

- B. **Design Hydraulic Loading.** Each slide gate shall be designed for the hydraulic loading characteristics as defined by the maximum seating head and unseating head conditions as specified in the Gate Schedule on the Contract Drawings.
- C. **Gate Design.** All fabricated steel gate components shall have a minimum thickness of 1/4-inch unless specified otherwise.
1. **Slide Cover (Disc) and Stiffeners.** The gate slide cover (disc) shall consist of a flat plate reinforced with structural or formed members welded to the plate.
 - a. The disc is to be designed to limit deflection of the gate to 1/720 of its span or 1/16-inch at the sealing surface of the gate under maximum specified head.
 - b. The working design stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
 2. **Frame / Guides.** The gate frame shall consist of guides, invert member, and a fabricated operator yoke assembly. The guides shall be of a sandwiched type construction built up of plates, angles, and formed shapes. The guide slot shall engage the disc plate a minimum of 1-inch.
 - a. Disc and frame shall be designed to resist a hydraulic load of the gate being closed under maximum seating head conditions and also opening the gate under these conditions
 - b. The working stresses shall not exceed the lesser of 40-percent of the yield strength or 25-percent of the ultimate strength of the material.
 - c. The disc and frame design shall be arranged such as to allow simple removal of the disc from the frame, when required for maintenance.
 - d. **For non-flush bottom gates to a concrete floor,** frames shall be furnished with a flush seal arrangement. A resilient seal with a minimum width of exposed face of 1.375" shall be securely attached to the frame along the invert, and shall extend to the depth of the guide groove. The resilient seal extrusion shall be constructed to be ribbed and self-retaining. For non-flush bottom gates, invert seal designs that require mechanical retention are not allowed.

- e. **For flush bottom gates to a concrete floor**, a stainless steel embed shall be grouted by the CONTRACTOR into a block-out of the concrete in the channel floor. Either of the following two design approaches are acceptable for the flush bottom seal:
 - 1) A 3-inch deep block-out shall be provided where the stainless steel embed shall retain the neoprene / rubber seal and prevent its dislodging during normal water flow operation over the gate invert. ("Q" bottom seal by Waterman), or
 - 2) A stainless steel L-bracket piece shall be cast or grouted into the floor to be flush with the floor invert. The neoprene step seal shall be fastened to the bottom of the gate structure and shall make a continuous seal with the stainless embed (stepped "HY-Q" flush seal by Rodney Hunt)
- 3. **Steel Yoke Support Beam.** Gate lifting and lowering shall be supported by a steel support framing system (yoke) designed and fabricated by the gate Manufacturer. The yoke shall be designed and fabricated according to the following:
 - a. Designed to span the open width (W) on the top deck as shown on the Contract Drawings.
 - b. Designed for the maximum output of the gate hoist.
 - c. Designed to transmit the full weight of the gate plus the hydraulic (friction) load created when the gate is closed and the seating heads are as defined above. The deflection not to exceed $W/360$, where W equals the width of the opening across which the Yoke is spanning.
 - d. Yoke shall be designed out of parallel C or box-channel members which shall not exceed 12-inches in height. The working stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the material.
 - e. Yoke shall be designed with an integral stem guide to be attached to the bottom of the yoke. Stem guide shall have bronze or UHMW or other approved bushing to guide the stainless steel stem.
- 4. **Seals.** Resilient seals shall be placed along the top, bottom, and both sides of the gate to prevent leakage. The seal attaching hardware shall be stainless steel and attached in a manner to permit replacement of the seals. The gate side and top seals may be of the "J-bulb" type style or may be designed as a self-adjusting neoprene cord seal as described below.
 - a. For the self-adjusting cord seal, the UHMW seats shall impinge on the slide (disc) by way of a continuous loop neoprene cord seal.
 - b. J-bulb seal corners shall be formed by continuous molded sections. Joints between the molded corners and top or side seals shall be a square butt type located a minimum of 12-inches from the corner. The molded corner shall be bonded to the top and side seal and assembled to the gate disc in the manufacturer's shop. Mitered joints shall not be used.

“J-bulb” type seals or self-adjusting neoprene cord seals shall be retained by the frame to restrict leakage to the following limits:

- c. Under a design seating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm/lineal foot of gate perimeter.
 - d. Under a design unseating head (measured from gate invert), perimeter leakage (in GPM per foot of seating perimeter) shall not exceed 0.07 gpm/lineal foot of gate perimeter.
5. **Guide Slots, Sill, and Yoke.** Prefabricated guide slots, sill, and yoke shall be provided as follows:
- a. Guides shall be extended to support no less than 1.66 times the height of the slide in the open position (as measured from the invert of the gate opening). For self-contained gates the frame shall extend at least 36 inches above the operating platform or as shown in the contract drawings. The yoke shall be designed to support the thrust of the actuator with a minimum safety factor of 4 in regard to the ultimate tensile, compressive and shear strengths of the materials. *(Manufacturer is referred to section 4.4.5.1 of AWWA C561-12)*
6. **Stems.** Stems shall be of solid construction, of the **rising-stem** type with threads of the cut Acme type. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 pounds effort on the crank or handwheel.
- a. The L/r ratio of the unsupported stem shall not exceed 200.
 - b. Stem guides, where required to limit the unsupported stem length, shall be UHMW or bronze bushed.
 - c. All gates having widths greater than two times their height shall be provided with two lifting devices connected by a tandem shaft for simultaneous operation.
7. **Stem Covers.** Rising stem gates shall be provided with clear stem covers to provide indication of gate position, permit inspection of the stem threads, and to protect the stem from contamination. Vent holes shall be provided to prevent condensation.

D. Anchor / Mounting Bolts

- 1. The diameter, length, quantity and location of the slide gate anchor hardware shall be determined by the slide gate Manufacturer and clearly shown in installation literature.
- 2. All anchor hardware including studs, adhesive anchor bolts, other bolts, nuts and washers shall be provided by the gate Manufacturer to the CONTRACTOR for installation. Use of expanding style wedge mechanical anchors shall not be allowed.

E. Wall Thimbles

1. F-style wall thimbles shall not be required of the new fabricated slide gates to be furnished. Rather, gate frames shall be mounted to the concrete walls using 316 stainless steel epoxy adhesive anchor bolts per Part 2.2.D above.

F. Lifting Device / Gate Manual Actuator

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
2. The lifting devices shall be weatherproof.
3. Pedestal Mounting
 - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
 - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 3.5 feet above the floor for frame-mounted actuators.
5. Slide gate hoist heads shall be constructed of cast iron.
6. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
7. Operating thrust shall be taken on roller or ball bearings.
8. Parts shall be provided with an alternative lubrication system.
9. Hand Wheel Operator
 - a. The unit shall be designed for a 40–pound maximum effort on the wheel/crank in order to operate the gate.
 - b. Clockwise movement of the handwheel shall close the gate.
 - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

G. Welding

1. All welding shall be performed in accordance with AWS D1.1. All welders shall be certified with current AWS welder certifications.

H. Coatings

1. Any exposed ferrous surfaces (non stainless steel components) shall be blasted to SSPC SP-10 and receive coating system No. 51 (Polyamide epoxy), prior to their

assembly. The polyamide epoxy coating system shall meet the following requirements:

- a. Product shall be a high-build polyamide cure epoxy with a maximum VOC content of 366 g/L. Product shall be suitable for long-term immersion in water and resistant to corrosion.
 - b. Product shall be applied in a minimum of two coats and shall have a total dry film thickness (DFT) of no less than 12 mils.
 - c. Acceptable product manufacturers include Ameron Amercoat 370, or Tnemec Pota Pox Series 20 or Carboline Carboguard 61.
2. Components not requiring painting, (e.g., non-metallic seating surfaces and all 316 stainless steel surfaces) shall be protected from overspray during the ferrous surface coating process.

I. Gate Manufacturers, or Equal

1. **Waterman Industries SS-251-1**
2. **Whipps Model 925**

2.3 ALUMINUM SLIDE GATES

A. Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C562 suitable for the service.
2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Aluminum Gates	
Slide	Aluminum, ASTM B 209 Alloy 6061-T6
Frame	Aluminum ASTM B 308 Alloy 6061-T6
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Aluminum pipe with slots and indicator
Guides and seats	UHMW Polyethylene, ASTM D 4020

Seals	"J" bulb Type, Neoprene, ASTM D 2000. Flat seals are not acceptable
Stainless Steel Gates	
Slide	ASTM A 276, Type 316, or Type 316 L
Frame	ASTM A 276, Type 316, or Type 316 L
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Aluminum pipe with slots and indicator
Guides and seats	UHMW Polyethylene, ASTM D 4020
Seals	"J" bulb Type, Neoprene, ASTM D 2000. Flat seals are not acceptable.

B. Lifting Devices

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
2. The lifting devices shall be weatherproof.
3. Pedestal Mounting
 - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
 - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure.
4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 4 feet above the floor for frame-mounted actuators.
5. Power lifting devices shall be in accordance with Section 43 25 01 – Valve and Gate Actuators.
6. Slide gate hoist heads shall be constructed of cast iron.
7. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
8. Operating thrust shall be taken on roller or ball bearings.

9. Parts shall be provided with an alternative lubrication system.
10. Handwheel Crank
 - a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
 - b. Clockwise movement of the handwheel shall close the gate.
 - c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

C. Manufacturers, or Equal

1. **Rodney Hunt Company**
2. **Hydro Gate Corp.**
3. **Washington Aluminum Company, Inc. (WACO)**
4. **Waterman Gate Company**

2.4 CAST IRON SLUICE GATES (AWWA C560)

- A. **General:** Each gate shall be a heavy duty sluice gate and furnished and installed complete with wall thimble or anchor bolts as indicated in the above schedule. All gates shall be furnished with operating stem, manual operator and other appurtenances as specified or needed to make a complete and operable installation. All component parts shall be of the type of material specified and interchangeable where size and material are the same without grinding, chipping or special fitting in the field. The gate shall be the product of one manufacturer having five or more years of experience in the manufacture of similar gate for similar use. All mating and sliding parts shall be fully machined.
- B. **Materials:** Materials of construction for each gate and mounting assembly shall be as follows:

Description	Materials Standards
Mounting Assembly	
Anchor Bolts and Nuts	Stainless Steel Type 18-8, ASTM F593, F594
Stem Cover	Aluminum, with slots and indicator
Wall thimble	Cast Iron, ASTM A126 Class B, or A 48, Class 30
Gate Assembly	

Frame, Slide, and Guide Rails	Cast Iron, ASTM A126 Class B
Seating Faces and Stem Guide Bushings	Naval Bronze, Alloy 482, ASTM B-21
Wedges	Manganese Bronze Alloy 865, ASTM B-584
Fasteners	Stainless Steel Type 18-8, ASTM F593, F594
Stem Blocks	Manganese Bronze Alloy 865, ASTM B-584
Self-Contained Type	
Yoke	Fabricated A-36 Steel or Stainless Steel Type 316, ASTM A 276. (If A-36 carbon steel is used, yoke shall be coated with liquid epoxy system, 2 coats with total minimum DFT = 20 mils.)
Stem	Stainless Steel Type 316, ASTM A 276

- C. **Frame and Guide Rails.** Frame and guide rails shall be cast one-piece construction or may have guides doweled and bolted to the frame. Guide rails shall be of such length as to retain at least one-half of the vertical height of the slide when it is in the fully opened position. A groove running the full length of the guide rail shall be accurately machined to receive the slide tongue, with a nominal clearance of 1/16-inch.
- D. **Gate Leaf (Slide).** The gate leaf shall be of one piece cast construction with vertical and horizontal ribs.
- E. **Seating Faces.** All seating faces for both gate leaf and frame shall be malleable extruded Naval Bronze of a shape that will fill and permanently lock in the full width dovetail grooves of the leaf and the frame. Seating faces shall be machined to a 63 micro-inch finish, or better.
- F. **Stems and Stem Couplings.** Operating stems shall be of a size to safely withstand, without buckling or permanent distortion, stresses induced by normal operating forces. Minimum stem size for sluice gate shall be 2 inches. Stems shall be fabricated from round bar stock of stainless steel or bronze, as shown on the plans or gate schedule and shall be provided with 29° modified or full acme threads. Stems composed of two or more sections shall be joined by bronze couplings threaded and keyed to stems, or couplings of the same material as the stems, pinned, bolted or welded and pinned to the stems. In section, couplings shall be stronger than the stems.
- G. **Stem Guides.** Stem guides shall be cast iron, with bronze bushings, and mounted on cast brackets. Guides shall be adjustable in two directions and shall be so constructed that when properly spaced they will hold the stem in alignment and still allow enough play to permit easy operation. Stem guide spacing shall be as shown, but in no case shall it exceed an l/r ratio of 150. Brackets shall be attached to the wall by anchor bolts and sufficient strength to prevent twisting or sagging under load.

- I. **Operator Pedestal.** Operator pedestal shall be a fabricated A-36/A-53 steel mounted directly to the yoke.
- J. **Stem Covers.** Rising stem gate shall be provided with slotted aluminum stem covers to facilitate indication of gate position, permit inspection of the stem threads, and to protect the stem from contamination. The cover shall be marked with graduations in feet with minor graduation in 0.01 feet. The graduations shall be installed to match 0.00 when the gate is seated closed. Vent holes shall be provided to prevent condensation.

K. **Mounting Requirements**

- 1. For outdoor applications, guide frames shall be extended 3.5-ft above the walkway in order to match the height of the handrail.
- 2. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.
- 3. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.

L. **Lifting Devices**

- 1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.
- 2. The lifting devices shall be weatherproof.
- 3. Pedestal Mounting
 - a. The lifting devices shall be mounted on pedestals constructed of cast iron or fabricated steel.
 - b. The pedestals shall have an ample base or bracket area to evenly distribute the load to the supporting concrete structure or yoke of the gate.
- 4. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 4 feet above the floor for frame-mounted actuators.
- 5. Power lifting devices shall be in accordance with Section 43 25 01 – Valve and Gate Actuators.
- 6. Slide gate hoist heads shall be constructed of cast iron.
- 7. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.
- 8. Operating thrust shall be taken on roller or ball bearings.

9. Parts shall be provided with an alternative lubrication system.

10. Handwheel Crank

- a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.
- b. Clockwise movement of the handwheel shall close the gate.
- c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

M. **Wall Thimbles.** Wall thimble shall be provided with the gate where indicated in the gate schedule. Thimble shall be of one-piece cast iron construction and of the section and depth as specified in the plans and gate schedule. There shall be an integrally cast water stop around the periphery of the thimble.

1. The front flange of the thimble shall be machined, drilled and tapped to receive the sluice gate attaching studs. Bolt pattern shall match gate bolt pattern.
2. Unless otherwise indicated, sluice gates shall be provided with cast iron, F-pattern wall thimbles to match the thickness of the walls in which they are installed.
3. Thimbles shall be furnished by the manufacturer of the gates and shall fit the bolt dimensions of the gates.
4. Studs shall be constructed of Type 316 stainless steel.
5. If wall thimbles are utilized, elastomeric sealant shall be provided and shall be **Rubber Caulk Sealer** as manufactured by the **Product Research Company**, or equal.
6. Inside water way passage of cast iron wall thimbles shall be lined with liquid epoxy per AWWA C210

N. **Manufacturers, or Equal**

1. **Golden Harvest**
2. **Waterman Industries**
3. **Fresno Valves and Castings**

2.5 ALUMINUM STOP GATES

A. Construction

1. Wall-mounted, hand-lift stop gates with handles shall be fabricated of 1/4-inch aluminum as indicated, and shall be reinforced as necessary in order to assure long life under the indicated operating conditions, in accordance with AWWA C562.
2. Gates shall be provided with “J” bulb type neoprene seals.

3. Calculations and detail drawings, as necessary, shall show the method of fabrication and shall verify that the plates will withstand any normal pressures or forces exerted, without buckling or otherwise being damaged.
4. Mounting hardware, if indicated or required, shall be constructed of Type 316 stainless steel.

B. Manufacturers, or Equal

1. **F.B. Leopold Co. (Division of Sybron Corp.)**
2. **Washington Aluminum Co., Inc.**
3. **Waterman Gate Company**

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 44 35 00 - PUMPS, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

- A. Provide pumps and pumping appurtenances, complete and operable, as indicated in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.
- C. The requirements of Section 43 00 00 – Equipment General Provisions, apply to this Section.
- D. **Responsibilities**
 - 1. The pump manufacturer shall be made responsible for furnishing the WORK and for the coordination of design, assembly, testing, and installation of the WORK of each specific pump Section.
 - 2. The CONTRACTOR shall be responsible to the OWNER for overall compliance with the requirements of each specific pump Section.
- E. **Single Manufacturer**
 - 1. Where two or more pump systems of the same type / style are required, pumps shall be provided by only one (1) manufacturer and shall be of the same model type.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings.** At a minimum, submit the following information:
 - 1. Submit pump name, identification number, and specification Section number.
 - 2. Performance Information
 - a. Submit performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump.
 - b. Require the equipment manufacturer to indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.
 - 3. Operating Range
 - a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration.

- b. Provide a stable operating range as wide as possible, based on actual hydraulic and mechanical tests.
4. Submit assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.
5. For the electric motor proposed for each pump, submit data in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.
6. Submit interior and front-panel elevations of the proposed local control panel, showing panel-mounted devices, details of enclosure type, a single-line diagram of power distribution, current draw of the panel, and a list of all terminals required to receive inputs or to transmit outputs from the local control panel.
7. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items.
8. Submit a complete electrical schematic diagram.

C. Technical (O & M) Manual

1. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

D. Spare Parts List

1. Submit a spare parts list containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Pump Performance Curves

1. Provide centrifugal pumps with a continuously rising curve or with the system operating range not crossing the pump curve at two different flow capacities or “dip region.”
2. Unless otherwise indicated, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or engine and shall not encroach on the motor service factor.

C. Compatibility

1. Provide entirely compatible components of each pump system provided under the specific pump Section.

2. In each unit of pumping equipment, incorporate basic mechanisms, couplings, electric motors or engine drives, necessary mountings, and appurtenances.

2.2 MATERIALS

- A. Provide materials suitable for the intended application.
- B. Pump materials shall be as indicated below, unless specified otherwise in the specific pump sections. Pump materials shall be high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:
 1. Casing and Bowls. Provide cast iron pump casings and bowls constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal.
 2. Impellers. Provide bronze pump impellers conforming to ASTM B 62 - Composition Bronze or Ounce Metal Castings, or B 584 - Copper Alloy Sand Castings for General Applications, where dezincification does not occur.
 3. Shafts. Provide pump shafts constructed of Type 416 or Type 316 stainless steel.
 4. Miscellaneous stainless steel parts shall be of Type 316.
- C. Materials in contact with potable water or fisheries supply water shall be listed as compliant with NSF Standard 61.

2.3 PUMP COMPONENTS - GENERAL

A. **Flanges and Bolts**

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions, unless noted otherwise in the specifications.
2. Flange bolts and hardware shall be in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

2.4 PUMP MOTORS

- A. Unless noted otherwise, furnish all pump motors in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.

2.5 PUMP APPURTENANCES

A. **Nameplates**

1. Equip each pump with a stainless steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. **Pressure Gauges.** Provide pressure gauge assemblies as indicated on the Process Schematic Drawings or Process and Instrumentation Drawings (P&IDs), as follows:

1. Except for sample pumps, sump pumps, and hot water circulating pumps, equip pumps with pressure gauge assemblies installed at the pump discharge lines.
2. Provide pump suction lines with compound gauges, where indicated on the process schematics.
3. Locate gauges in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Where subject to shock or vibrations, wall-mount the gauges or attach the gauges to galvanized channel floor stands and connect by means of flexible connectors
4. Where subject to freezing temperatures, provide gauges with glycol liquid fill fluid, and CONTRACTOR shall minimize the $\frac{3}{4}$ " or 1" connecting pipe nipple length to the
5. Factory Non-witnessed Test
 - a. Test centrifugal pump systems with drives 10 hp up to and including 125 hp at the pump factory in accordance with the *ANSI / HI Rotodynamic Pumps for Hydraulic Performance Acceptance Tests – 2011*, per Table 14.6.3.4) acceptance Grade "1B" or the American National Standard for Vertical Pump Tests (ANSI/HI 2.6) as approved by ANSI and published by the Hydraulic Institute.
 - b. For sump pumps, sample pumps, and smaller pumps of motor size from 0.75 to 10 HP, acceptance grade shall be in accordance with Grade "2B" of *ANSI / HI Rotodynamic Pumps for Hydraulic Performance Acceptance Tests – 2011*, per Table 14.6.3.4, unless otherwise specified.
 - c. Perform tests using the complete pump system to be furnished, including the Project motor and variable speed drive if equipped with variable speed drive.
 - d. For pumps with motors of 100 HP or smaller, the manufacturer's certified test motor will be acceptable for use during factory testing.
 - e. Testing of prototype pump models will not be accepted.
 - f. Conduct the following minimum tests and submit the test results:
 - 1) Hydrostatic test;
 - 2) Performance Test:
 - a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute standards;
 - b) Submit pump curves showing head, flow, bhp, and efficiency results;

- 3) Mechanical test;
- 4) NPSH
 - a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.
 - b) If not required by the specific pump Section, submit the published manufacturer-calculated NPSHr3 curve.
- g. Submit certification signed by a senior official of the pump manufacturer that the pump shaft horsepower demand did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.
- h. Submit test results to the ENGINEER for review prior to delivery to the Site.
- 6. Acceptance
 - a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

- 1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

- 1. Field-test the equipment in order to verify proper alignment and freedom from binding, scraping, shaft runout, or other defects.
- 2. Measure the pump drive shafts just prior to assembly in order to ensure correct alignment without forcing.
- 3. Ensure that the equipment is secure in position and neat in appearance.

C. Lubricants

- 1. Provide the necessary oil and grease for initial operation.

3.2 PROTECTIVE COATING

- A. Coat materials and equipment in accordance with the requirements of Section 09 96 00 – Protective Coatings, unless otherwise specified in the specific pump section.

3.3 FIELD TESTS

- A. Field-test each pump system after installation in order to demonstrate:
 - 1. Satisfactory operation without excessive noise and vibration;
 - 2. No material loss caused by cavitation;
 - 3. No overheating of bearings; and,
- B. Conduct the following field testing:
 - 1. Startup, check, and operate the pump system over its entire speed range.
 - 2. If the pump is driven at constant speed, test the pump and motor at the maximum RPM.
 - 3. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the ENGINEER.
 - 4. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed.
 - a. Perform tests at maximum RPM if equipped with a constant speed drive.
 - 5. Check each power lead to the motor for proper current balance.
 - 6. Bearing Temperatures
 - a. Determine bearing temperatures by a contact-type thermometer.
 - b. Precede this test with a run time sufficient to stabilize bearing temperatures, unless an insufficient liquid volume is available to furnish such a run time.
 - 7. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.
- C. Witnessing
 - 1. Field testing will be witnessed by the ENGINEER.
 - 2. Furnish the OWNER and ENGINEER with at least 7-Days advance notice of field testing.
- D. If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.
- E. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.
 2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.
- F. The CONTRACTOR shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear.
- G. If available, the OWNER'S operating personnel will provide assistance in field testing.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 44 35 04 - PACKAGED BOOSTER PUMP SYSTEM

PART 1 -- GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, material, and equipment required to supply, install, and test process water handling pumps, drive units, controls, and appurtenances to pumping equipment as specified herein and required to make the units complete and fully operable.

1.2 SUBMITTALS

- A. Submit product data and shop drawings in accordance with Section 01 33 00 and operating and maintenance instructions
- B. Submit manufacturer's product data on pump and driver. Submittals shall include the following features:
 - 1. Manufacturer's specifications data and descriptive literature.
 - 2. Factory certified performance curves showing capacity in gpm, NPSH, head, efficiency and pump horsepower from 0 gpm to 110% of design capacity.
 - 3. Motor efficiency and power factor at all design operating points.
 - 4. Drawings showing general dimension, confirming the size of the pump, openings, connections, construction details of the equipment, wiring diagrams, piping drawings, and weights of major components.
 - 5. Procedures for proper installation.
 - 6. Manufacturer's guarantee.
 - 7. Information about the nature and location of parts, service crews, and repair facilities.

1.3 OPERATION AND MAINTENANCE DATA

- A. Operating and adjustment instructions.
- B. Parts lists.
- C. Disassembly, repair, and assembly instruction including drawings.
- D. Maintenance procedures and recommended maintenance intervals.

PART 2 -- PRODUCTS

2.1 UTILITY WATER PUMP

- A. The utility water pump shall be a packaged booster pump system consisting of a pump, hydropneumatic tank(s) and controls to automatically start and stop the pump.
- B. System operation: Upon water demand, water will flow from the pressure tank to the system. This will cause the pressure to drop as sensed by a pressure switch. Upon drop in pressure, the pump will start and run continuously until the water in the volute of the pump heats up (indicating a dead head condition) and trips a temperature switch.
- C. System components shall include: Pressure tank, pressure and temperature switch, suction check valve, pressure and temperature relief valve, completely wired motor control and a steel base.
- D. Pump shall be a bronze fitted, end suction centrifugal pump, with mechanical seal. Pump volute shall be constructed of cast iron and shall be fitted with bronze wear rings.
- E. **Drive Motor:** Pump motor shall be in accordance with the requirements of Section 26 05 10 – Low-Voltage AC Electric Motors.
- F. **Control:** Muster all control and power wiring to one or two control enclosures located on the skid, located on the accessible side of the skid and mounted such that control pilot devices are not installed below 48" above finished floor, including house-keeping pads. Control enclosure(s) shall contain all required motor starting and control components for a complete and operable system. The control panel and all related control components shall be provided in accordance with the requirements of Sections 40 90 18 – Vendor Package Control Systems and 40 90 05 – Control Enclosures and Devices.
- G. Pump shall be Paco model 848A or Tiger Flow System Bengal Duplex Vertical Booster System or equivalent.
- H. Suction strainer shall be provided to prevent debris up to 1" diameter from entering pump and utility water system.
- I. Pump Schedule

Equipment No.	Location	Design Flow, GPM	TDH, FT	Voltage/Phase/Cycles	HP
P-380	Coho Building	50	116	480/3/60	3
P-580	Chinook Building	50	116	480/3/60	3

P-680	Spawning Building	50	116	480/3/60	3
-------	-------------------	----	-----	----------	---

3.1 PRESSURE TANK

- A. Two hydropneumatic pressure tanks with a tank capacity of 80 gallons shall be provided in series with the discharge of each booster pump utility water line. Each tank shall be equipped with an isolation valve, pressure relief valve, pressure gauge, blowdown port, and all ancillary protective devices as per the 2019 California Plumbing Code.
- B. Pressure Tank shall be manufactured in accordance with ASME Section VIII and use an ASME Section VIII approved relief valve.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in accordance with the manufacturer's recommendations. Alignment and adjusting shall be verified after installation.
- B. The pumps shall have an electrical disconnect complying with the NEC.

3.2 TESTING

- A. In addition to testing that may be required by codes, the CONTRACTOR shall perform all tests specified in this section and shall furnish and pay for all material and labor required for tests. Prior to start-up, the pump shall be tested in place. These tests shall duplicate all normal operating modes. Should tests indicate unsatisfactory operation, conditions shall be corrected, and the test repeated at the CONTRACTOR's expense.

PART 4 -- WARRANTY

4.1 GENERAL

- A. The pumps shall be warranted for labor, equipment and all components for a one (1) year period after final acceptance.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 44 35 35 - HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide horizontal process end suction pumps and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 44 35 00 - Pumps, General apply to this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will best satisfy the indicated requirements.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION:

A. Pump Schedule

Equipment No.	Location	Design Flow, GPM	TDH, FT	Voltage/Phase/Cycles	HP
P-200	Intake Structure	20	60	480/3/60	2
P-201	Intake Structure	20	60	480/3/60	2
P-650	Adult Holding Pond	120	15	480/3/60	2

- B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed
Ambient environment	Outdoors
Fluid service	Raw Water
Fluid temperature, degrees F	40 to 80
Fluid specific gravity	1.0

Project site elevation, ft (m.s.l)	2,500
------------------------------------	-------

2.2 PUMP REQUIREMENTS

- A. **Construction:** Construction of horizontal ANSI end-suction pumps shall conform to the following requirements:

Casing, foot-mounted	Cast iron, ASTM A 48 back pullout design with gauge connections
Pump base	Cast iron base plate with drain rim or pan
Impeller	Ductile iron ASTM A395 or A536 statically and dynamically balanced, open
Shaft	Type 416 Stainless Steel designed for max 0.002 inch deflection at sealing face at max load
Seal	Mechanical Seal
Coupling	Flexible heavy duty spacer shaft coupling with guard
Mounting	Frame mounted
Lubrication	Grease with inlet and drain fittings

- B. **Drive:** Direct drive with flexible coupling with heavy duty, horizontal, electric motor suitable for 480 volt, 3-phase, 60-Hz power supply, in accordance with Section 26 05 10 - Electric Motors.

2.3 PUMP CONTROLS

- A. Pumps shall be controlled in accordance with Section 40 90 00 - Process Control and Instrumentation Systems.

2.4 SPARE PARTS

- A. Furnish the following spare parts for each pump:

1. One mechanical seal
2. One set of all bearings
3. One shaft sleeve
4. Two sets of all washers, seals, and O-rings

2.5 MANUFACTURERS OR EQUAL

- A. **Goulds Pumps, Inc.**
- B. **Peerless Pump Company.**
- C. **Worthington (Ingersoll-Dresser Pump Company)**
- D. **Flint & Walling**

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.
- B. General installation requirements shall be in accordance with Section 44 35 00 - Pumps, General.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 44 35 54 – RACEWAY VACUUM PUMP

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide a portable vacuum pump cleaning system, complete and operable, in accordance with the Contract Documents.
- B. The vacuum pump cleaning system includes a cart-mounted self-priming diaphragm pump with suction and discharge hoses and vacuum cleaning head attachment.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.
- B. **Shop Drawings.** At a minimum, submit the following information:
 - 1. Submit pump name, identification number, and specification Section number.
 - 2. Performance Information
 - a. Submit performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over the entire operating range of the pump.
 - b. Require the equipment manufacturer to indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions and the maximum and minimum flow conditions.
 - 3. Operating Range
 - a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration.
 - 4. Submit assembly drawings including part nomenclature, material list, outline dimensions, and shipping weights.
- C. **Technical (O & M) Manual**
 - 1. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

PART 2 -- PRODUCTS

2.1 DIAPHRAGM PUMP

- A. Identification

Equipment Number	P-100, P101
------------------	-------------

Quantity	2
Location	Coho Building; Chinook Incubation Building

- B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed
Fluid service	Raw Water, Sludge
Fluid temperature, degrees F	50 to 70
Fluid pH range	6.5 to 7.5
Fluid specific gravity	1.0
Project site elevation, ft asl	2503.0
Minimum available NPSH, ft absolute	25.0

- C. Performance Requirements

Design flow capacity, gpm	50
Design flow pump head TDH, ft	12
Maximum sphere to pass, in dia	1.625
Maximum pump speed, rpm	1725

- D. Pump Dimensions

Suction ID, in	3
Discharge ID, in	3

- E. Pump Construction

1. **General:** The pump shall be of the single diaphragm type and conform to the following requirements:

Pump base	Cart-Mounted
-----------	--------------

Pump casing	Cast iron, Cast Aluminum
Pump cover, flanged	Cast iron, Cast Aluminum
Diaphragm	Thermoplastic Santoprene, Neoprene
Check valves	Swing checks
Drive	Electric heavy-duty 1725 rpm TEFC motor, 1.5 hp, 208 volt, 1-phase, 60 Hz, cart-mounted
Power Cord	SJOW power cord, maximum 50 ft, with 12/3 AWG conductors. Provide with watertight, twist-lock 6-20P plug connector.

F. MANUFACTURERS, OR EQUAL

1. **AMT Self Priming Diaphragm Pump, Model 337E-96**

2.2 ACCESSORIES

A. Supply Hose

1. **General:** The supply hose shall attach the vacuum pump to the 1 ½" vacuum head swivel port and conform to the following requirements:

Quantity	2
Material	Flexible PVC, EPDM Rubber, Low Density Polyethylene
Diameter (in)	3
Length (ft)	25
Inlet Connection Style	3" NPT
Outlet Connection Style	3" NPT x 1 ½" Socket Reduction

B. Discharge Hose

1. **General:** The discharge hose shall attach the vacuum pump to the waste drain cleaning station 2" cam lock quick disconnect and conform to the following requirements:

Quantity	2
Material	Flexible PVC, EPDM Rubber, Low Density Polyethylene

Diameter (in)	3
Length (ft)	15
Inlet Connection Style	3" NPT
Outlet Connection Style	3" NPT x 2" Cam Lock Plug Reduction

C. Vacuum Head

1. **General:** The vacuum head shall attach to the suction hose and conform to the following requirements:

Quantity	2
Body	Polyethylene with lead weights
Wheels	Adjustable height w/ roller bearings
Width (in.)	22

2. MANUFACTURERS, OR EQUAL

- a. Pentair Model VAC22

D. Extension Pole

1. **General:** The extension pole shall attach securely to the vacuum head and conform to the following requirements:

Quantity	2
Body	PVC
Length	Adjustable 2-ft to 10-ft

2. MANUFACTURERS, OR EQUAL

- a. Pentair Model BH10

PART 3 -- EXECUTION

3.1 DELIVERY/STORAGE

- A. CONTRACTOR shall deliver the units to the site and shall protect and store the units until project completion.

3.2 TESTING

- A. CONTRACTOR shall test the units per the manufacturers recommended operation procedures. CONTRACTOR shall provide training on the operation of the units to the OWNER's operations staff.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 44 35 56 - SUBMERSIBLE SUMP PUMPS

PART 1 -- GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall provide submersible sump pumps and appurtenant work, complete and operable, in accordance with the Contract Documents.
- B. The requirements of Section 43 00 00 - Equipment General Provisions apply to the WORK of this Section.
- C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will satisfy the indicated requirements.

PART 2 -- PRODUCTS

2.1 SUMP PUMPS

A. Pump Schedule

Equipment No.	Location	Design Flow, GPM	TDH, FT	Voltage/Phase/Cycles	HP
P-280	Metering Vault	79	20	120/1/60	1/2
P-660	Settling Pond	150	20	480/3/60	2
P-661	Settling Pond	150	20	480/3/60	2

- B. **Operating Conditions:** The WORK of this Section shall be suitable for long term operation under the following conditions:

Duty	Intermittent
Drive	Constant speed
Ambient environment	Outdoors - Submerged
Fluid service	Waste Water
Fluid temperature, degrees F	40 to 80
Fluid specific gravity	1.0

Project site elevation, ft. a.s.l	2,500
Maximum size of spheres to pass, in. dia	0.5 in.

2.2 METERING VAULT SUMP PUMP; P-280

- A. The Contractor shall provide factory-tested pump, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment.
- B. Submersible Sump Pump shall be capable of handling 79 gpm at 20 feet head. The motor shall be rated at 1/2 HP, 120 volts, single phase, 60 Hz, and shall be hermetically sealed, permanent split capacitor type. Motor shall be protected with integral, automatically-resetting thermal overload. Unit shall come with a UL listed, 20' minimum, 3-wire SJOW cord and molded 20A grounding plug. Discharge shall be 2". Pump body and impeller shall be cast iron with the impeller being two vaned with pressure vanes on the side. Pump shall have support legs to maintain 3-1/2" clearance between pump suction and bottom of sump basin. Pump shall be UL listed. Pump shall be Zoeller Model N161, or approved equal.
- C. Controls shall be field adjustable and shall consist of three direct acting, momentary contact float switches with control panel. Float switches shall be start, stop, and high water alarm, and shall be mounted on the 2" discharge piping. Each switch shall have a 20 ft cable minimum.
- D. The control panel shall be provided in a NEMA 4X enclosure, containing a circuit breaker sized for the application, a magnetic motor contactor, pump run indicating light, and a hand-off-auto selector switch. An externally-mounted alarm light, alarm horn, and horn silence shall be provided on the control panel. The control panel shall have a dry auxiliary contact for high water alarm for remote signal. All the signaling indications and controls shall be mounted inside the enclosure. The outer door, strictly a security door intended to guard against vandalism, shall be padlockable. Control panel shall be Zoeller Model 10-1038 or approved equal.
- E. Replacement Parts: The Contractor shall provide one manufacturer's supplied repair kit including the following components: Seal, "O" ring, Gasket, Spacer, and Grommet.

2.3 SETTLING POND SUMP PUMP; P-680, P-681

- A. The Contractor shall provide factory-tested pump, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment.
- B. Submersible Sump Pump shall be capable of handling 150 gpm at 20 feet head. The motor shall be rated at 2 HP, 480 volts, three phase, 60 Hz, and shall be hermetically sealed. Motor shall be protected with integral thermal winding contact and seal leak sensing. Pump shall be provided with 120V motor protection relay for remote mounting and shall be Flygt MiniCAS II, or approved equal. Unit shall come with a 15' minimum SOOW cord. Discharge shall be 2 1/2". Pump body and impeller shall be cast iron with the impeller being two vaned with pressure vanes on the side. Pump shall have support

legs to maintain 3-1/2" clearance between pump suction and bottom of sump basin. Pump shall be Flygt Model 3068, or approved equal.

- C. Controls shall be field adjustable and shall consist of four direct acting, momentary contact float switches. Float switches shall be pump stop, lead pump start, lag pump start, and high water alarm. Each switch shall have a 20 ft cable. Float switches shall be Flygt Model ENM-10 or approved equal.
- D. The settling pond control panel shall be provided as shown on the Contract Drawings, with components as specified under Division 40.
- E. Replacement Parts: The Contractor shall provide one manufacturer's supplied repair kit including the following components: Seal, "O" ring, Gasket, Spacer, and Grommet.

2.4 CORROSION PROTECTION

- A. All consoles, panels, enclosures, and other equipment containing electrical or instrument and control devices shall be protected from internal corrosion through the use of corrosion-inhibiting vapor capsules.
- B. During construction period, periodically replace the capsules in accordance with the capsule manufacturer's recommendation.
- C. Replace all capsules just prior to final acceptance.
- D. Corrosion-Inhibiting Capsule Manufacturers:
 - 1. Northern Instruments: Model Zerust VC.
 - 2. Hoffmann Engineering: Model A-HCL

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.
- B. General installation requirements shall be in accordance with Section 44 35 00 - Pumps, General.

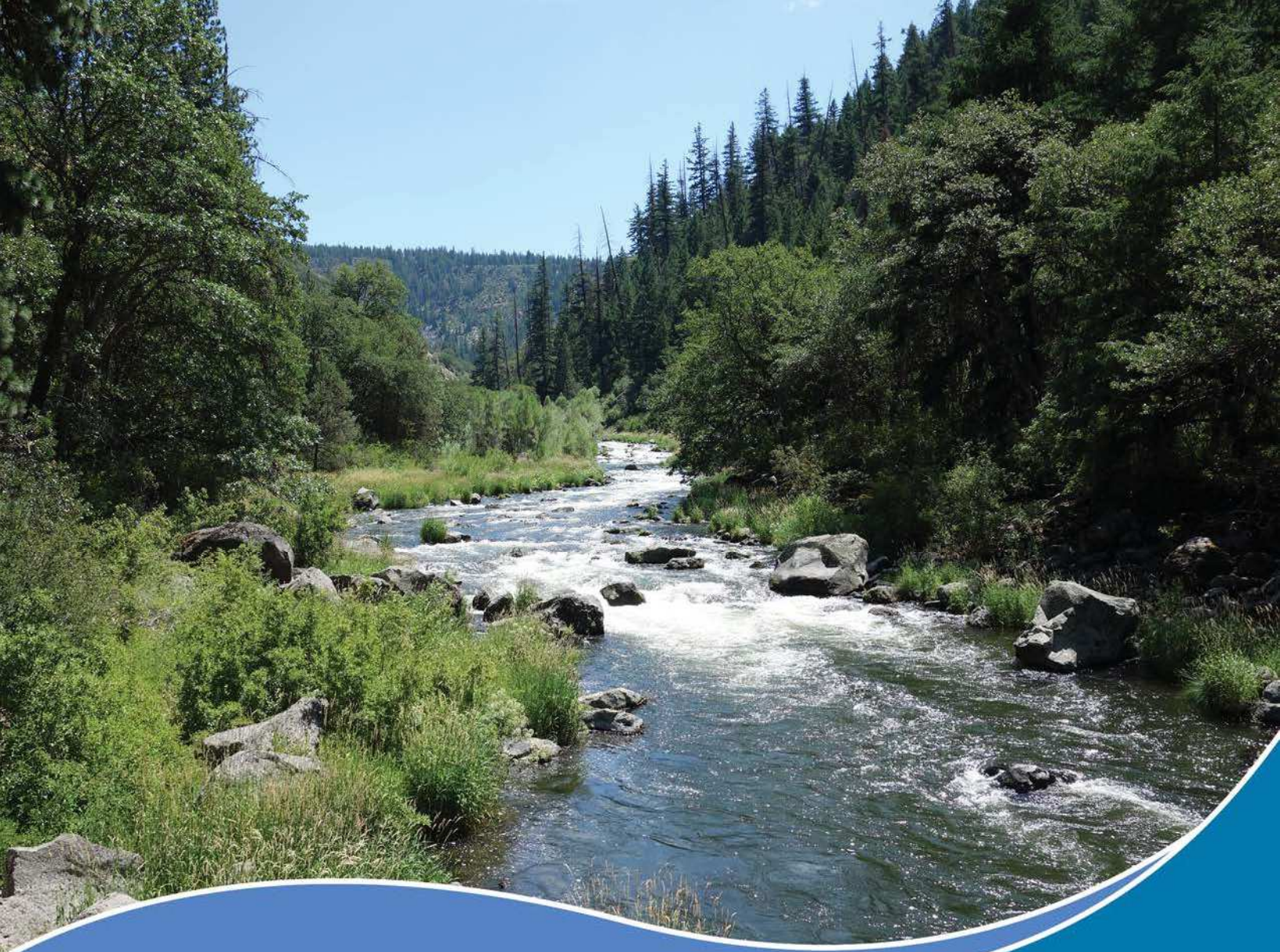
3.2 TESTING

- A. The Contractor shall set the sump pump start, stop, and alarm levels, at the direction of the Engineer. The Contractor shall test the operation of the sump pump by filling the sump with water and verifying the start and stop water levels no less than three full cycles, to the satisfaction of the Engineer.

- END OF SECTION -

THIS PAGE INTENTIONALLY LEFT BLANK

Attachment A
Klamath River Renewal Project – Geotechnical Data Report



Klamath River Renewal Project

Geotechnical Data Report

June 2019



This page intentionally left blank.

Prepared for:

Klamath River Renewal Corporation

Prepared by:

KRRC Technical Representative:

AECOM Technical Services, Inc.
300 Lakeside Drive, Suite 400
Oakland, California 94612

CDM Smith
1755 Creekside Oaks Drive, Suite 200
Sacramento, California 95833

This page intentionally left blank.

Table of Contents

- 1. Introduction 9
 - 1.1 Purpose and Scope 9
 - 1.2 Report Organization..... 9
- 2. Field Investigations.....13
 - 2.1 Subsurface Investigations..... 13
 - 2.1.1 Soil and Rock Borings 13
 - 2.1.2 Piezometers 16
 - 2.1.3 Field Hydraulic Conductivity (Packer) Testing..... 16
 - 2.1.4 Borehole Geophysical Surveys 17
- 3. Laboratory Testing20
- 4. Limitations25

List of Tables

Table	Boring Summary Table
-------	----------------------

List of Figures

Figure 1	Completed Geotechnical Borings (Overview and Sheets 1 through 8)
----------	--

Appendices

- Appendix A: Boring Logs
- Appendix B: Packer Test Data
- Appendix C: Televiewer Data
- Appendix D: Laboratory Test Data
- Appendix E: Core Box Photographs

Acronyms and Abbreviations

GDR	Geotechnical Data Report
psi	pound(s) per square inch
SPT	Standard Penetration Test
bgs	below ground surface
KRRP	Klamath River Renewal Project
ModCal	Modified California
HDD	horizontal directional drilling

A decorative banner with a wavy, undulating shape. It features a dark blue base color and a lighter blue upper section separated by a white curved line. The banner is positioned horizontally across the middle of the page.

Chapter 1: Introduction

This page intentionally left blank.

1. INTRODUCTION

1.1 Purpose and Scope

This Geotechnical Data Report (GDR) includes the results of the field investigation conducted from February 2018 through January 2019, and associated laboratory and geophysical testing.

1.2 Report Organization

After this introductory section, the GDR is organized as follows:

- Section 2: Describes the investigations at Copco and Iron Gate Reservoirs, at Jenny Creek, Camp Creek, Lakeview, Dry Creek, Fall Creek, and Scotch Creek Bridges, and along the proposed City of Yreka replacement water line. The investigations included soil and rock borings, piezometer construction, downhole geophysical testing, and field hydraulic conductivity testing.
- Section 3: Describes the laboratory testing.
- Section 4: Discusses the limitations of the work.

The data collected during the investigations is presented in Appendices A through E.

This page intentionally left blank.

A decorative banner with a wavy, ribbon-like shape. It features a dark blue outer layer and a lighter blue inner layer, separated by a thin white line. The banner curves upwards at both ends.

Chapter 2: Field Investigations

This page intentionally left blank.

2. FIELD INVESTIGATIONS

2.1 Subsurface Investigations

AECOM performed geotechnical investigations for the Klamath River Renewal Project between February 2018 and January 2019. The geotechnical investigations are described below. The field investigations were conducted in general conformance with the following ASTM standards:

1. Rock core drilling, ASTM D2113
2. Soil logging, ASTM D2488
3. Standard penetration test (SPT) sampling, ASTM D1586
4. Thin-walled (Shelby) tube sampling, ASTM D1587
5. Preserving and transporting of soil samples, ASTM D4220

2.1.1 Soil and Rock Borings

Forty-eight soil and/or rock core borings were drilled between February 1, 2018 and January 23, 2019. Boring locations are shown on Figure 1 Sheets 1 through 8 and summarized in Table 1 – Borings Summary Table.

The borings were drilled by Taber Drilling of West Sacramento, California, Gregg Drilling of Martinez, California, and/or Pitcher Drilling of East Palo Alto, CA. The locations of the borings were surveyed with a hand-held GPS unit with an approximate accuracy of ± 15 feet. The coordinate locations for the borings are shown on the boring logs in State Plane Zone 1 coordinates.

Drilling footage totaled 2163.4 linear feet at the Copco Reservoir, Iron Gate Reservoir, City of Yreka Water line, and bridge abutment borings. The borings ranged in depth from 10.5 to 120 feet below ground surface (bgs). All but two borings were drilled vertically; two borings (B-202 and B-206) were drilled at an angle of 60° below horizontal.

The 2.5-inch HQ-3 core, 1.375-inch I.D. Standard Penetration Test (SPT), 2.5-inch I.D. Modified California (ModCal), and 2.0-inch I.D. California drive samples were photographed, labeled, bagged, or boxed (for rock cores), and stored onsite prior to transport of the samples to Tonon USA in Austin, TX, Cooper Testing Laboratory in Palo Alto, CA, or Inspection Services Inc. of Berkeley, CA. Pitcher barrel, Osterberg, and Shelby Tube samples were sealed with paraffin and carefully transported to the laboratory for testing.

City of Yreka Water Line Borings

Nine borings (B-201 to B-203, B-205 through B-208, BI-02 and BI-03) totaling 696.2 linear feet were drilled along a proposed tunnel alignment to determine subsurface geologic conditions for the replacement of the existing City of Yreka waterline by Horizontal Directional Drilling (HDD) or micro tunnel drilling. These boring locations are shown on Figure 1, Sheet 4, and the boring logs are presented in Appendix A.

The borings were drilled from February 21st to 23rd, August 14th to September 21st, 2018, and January 8th to January 11th, 2019. The boring logs and core box photographs are presented in Appendix A and Appendix E, respectively. Borings were advanced using hollow stem auger, rotary wash, and/or rock core drilling methods, and sampling methods included HQ-3 core, SPT, and a ModCal drive sampler. Blows per each 6-inches of driven sample were recorded.

Three of the borings (B-201, B-202, and B-206) were drilled by Pitcher Drilling Company of East Palo Alto, CA with a track-mounted Fraste XL drill rig. Three additional borings (B-205, B-207, and B-208) were drilled by Gregg Drilling of Martinez, CA with a truck-mounted B-53 drill rig. Three borings (BI-02, BI-03, and B-203) were drilled by Taber Drilling of West Sacramento, CA with BI-02 being drilled using a truck-mounted CME-55 and BI-03 and B-203 being drilled using a barge-mounted CME-45 drill rig.

Copco No. 1 Rim Stability

A subsurface investigation with laboratory testing was performed at Copco No. 1 reservoir to characterize and analyze the stability of the fluvio-lacustrine terrace deposits (diatomite) present around the reservoir rim and within the reservoir bed. Twenty-one hollow stem auger and rotary wash borings, described below, were completed as part of the rim stability investigation. The boring locations are shown on Figure 1, Sheets 6 through 8, and boring logs are presented in Appendix A.

Eleven rotary wash borings, BC-01 through BC-10 and BC-8a, were performed by Taber Drilling using a barge-mounted CME 45 between February 1st and 14th, 2018. The boring depths ranged from 11.5 to 96.5 feet below ground surface.

On land, along the Copco Reservoir Rim, five borings (BC-11 through BC-15) were drilled by Gregg Drilling, between October 2nd and 18th, 2018, using a truck-mounted Mobile B-53 (BC-13 through BC-15) and a track-mounted Geoprobe (BC-11 and BC-12). The borings were advanced to bedrock (10.5 to 42 feet bgs). BC-15 encountered bedrock within 1 foot of the surface; where the boring was terminated, and no boring log or laboratory test data is included as part of this GDR.

Soil samples were obtained in BC-01 to BC-15 using SPT, ModCal, and 3-inch diameter thin-walled Shelby tubes. The tubes were advanced by direct push or with a hydraulically activated piston sampler (Osterberg). Blows per each 6-inches of driven sample and hydraulic gage down pressure for undisturbed samples were recorded.

Five additional over-water borings (BC-16 through BC-20) were completed between January 13th and 14th, 2019. BC-16 through BC-20 were drilled without sampling to bedrock, with the goal of identifying the top of

bedrock. Bedrock was inferred when the driller noted significantly harder drilling conditions. Bedrock was sampled with an SPT sampler at the bottom of each exploration to confirm that bedrock was encountered.

Iron Gate Rim Stability

One boring, BI-01 shown on Figure 1, Sheet 3, was completed to characterize landslide history of a feature identified in aerial photograph at Iron Gate reservoir. Two other borings, BI-02 and BI-03 shown on Figure 1, Sheet 4, provided data for the rim stability analysis of Iron Gate, and are described in the City of Yreka Water Line section above.

The one rotary wash boring was drilled on February 20th, 2018 to 22.2 feet below ground surface with a barge-mounted CME-45 by Taber Drilling. The material was sampled with a ModCal or SPT; blows per 6-inches were recorded.

Bridge Abutment Borings

Seventeen borings were planned at the abutments of bridges requiring replacement or improvement during the Klamath River Renewal Project:

- Camp Creek Bridge (four borings, BC-01, BC-02, BC-03, and BC-20), See Figure 1, Sheet 2
- Jenny Creek Bridge (four borings, BC-04, BC-05, BC-06, and BC-07), See Figure 1, Sheet 3
- Lakeview Bridge (two borings, B-08 and B-10), See Figure 1, Sheet 1
- Fall Creek Bridge (two borings, B-13 and B-14), See Figure 1, Sheet 5
- Daggett Bridge (three borings, B-15, B-16, and B-17), See Figure 1, Sheet 4
- Scotch Creek Bridge (two borings, B-18 and B-19), See Figure 1, Sheet 2

The boring locations are shown on Figure 1, Sheets 1 through 5, and boring logs are presented in Appendix A.

Fourteen of the borings were drilled by Gregg Drilling between September 25 and October 18, 2018 with a truck-mounted Mobile B-53 drill rig to depths between 21.2 and 56.9 feet below ground surface. The borings were advanced with hollow stem auger, rotary wash, and/or HQ-3 rock coring. Soil was sampled with a ModCal or SPT; blows per 6 inches of driven sample were recorded.

Three additional borings, B-15 through B-17, were drilled by Taber Drilling with a barge-mounted CME-45 drill rig and a truck-mounted CME-75 between January 12th and 23rd, 2019. The depths of these borings ranged from 24.5 to 51.5 feet below grade. The borings were advanced using solid stem auger, rotary wash, and HQ-3 rock coring. Soil was sampled with a ModCal or SPT; blows per six inches of driven sample were recorded.

2.1.2 Piezometers

Two vibrating wire piezometers (VWP) were installed in each of the inclined borings B-202 and B-206, as shown in Table 1. In B-202, the VWPs were installed at 24.2 feet and at 62.4 bgs (28 and 72 lineal feet on boring trajectory). The VWPs were installed at 21.7 feet and another at 79.7 feet (at 25 and 92 lineal feet on boring trajectory) in B-206. All four VWPs were installed with recording dataloggers. Groundwater level data from the VWPs will be reported as an addendum to this report.

Borings were tremie-backfilled with neat cement grout to the ground surface without installation of a screen or sand sock.

2.1.3 Field Hydraulic Conductivity (Packer) Testing

Nine hydraulic conductivity (packer) tests were performed as part of the geotechnical investigation: seven by Taber Drilling with one in each of borings BI-02 and BI-03, and five in boring B-203 and two by Pitcher Drilling in boring B-206. The tests were performed to characterize hydraulic conductivities of the rock along the new HDD or micro-tunnel alignment for the City of Yreka water line. Results of the packer tests are presented in Appendix B.

Single Pneumatic Packer Tests

For borings BI-02, BI-03, and B-203, testing with a single pneumatic packer was used in a down-stage method, meaning that each successive packer test was performed as the hole was drilled deeper. An In-situ Level Troll 300 water pressure data logger installed in the packer assembly with a surface readout was used to monitor water pressures within the test intervals of the boreholes. Test interval lengths were 20.0 feet.

Prior to conducting the hydraulic conductivity testing, each borehole was conditioned by circulating clear water to remove cuttings and traces of polymer-based drilling fluid. Drill rods were then lifted off the bottom of the hole approximately 20 feet to expose the test section of the borehole.

For each interval a maximum test pressure (P_{max}) of 1 psi/foot of depth to the center of the test section was used to reduce the potential for hydrofracturing of the formation. When the packer assembly was in place and inflated, the testing commenced. Testing generally consisted of a five-step test at varying pressures approximately equal to $\frac{1}{2} P_{max}$, $\frac{3}{4} P_{max}$, P_{max} , $\frac{3}{4} P_{max}$, and $\frac{1}{2} P_{max}$. At each step, the pressure was held constant until a steady rate of flow could be maintained, which was then monitored for approximately five minutes. At the completion of the fifth step, the packer was deflated, removed from the borehole and drilling resumed.

Double Pneumatic Packer Tests

For boring B-206, an upstage technique was used after completion of drilling, with two pneumatic packers sealing off 10-foot intervals of the borehole for testing. A vibrating wire pressure transducer installed in the packer assembly with a surface readout was used to monitor water pressure during the test. Clean water was circulated in the boring after drilling to remove cuttings and traces of drilling fluid.

As for the single pneumatic packer tests discussed above, the maximum test pressure (P_{\max}) of 1 psi/foot of depth to the center of the test section was used to prevent hydrofracturing of the formation. Due to poor performance of the flow metering equipment and hydraulic response of the formation at the test intervals, testing consisted of a one-step test at P_{\max} . The pressure was held constant until a steady rate of flow could be maintained, which was then monitored for approximately five minutes. After the two consecutive tests (85 to 95 feet, and then 75 to 85 feet), the packer was deflated and removed from the borehole. Additional tests were not performed in this borehole due to failure of the pressure monitoring equipment. The boring was subsequently backfilled by tremie-grouting.

2.1.4 Borehole Geophysical Surveys

Televiewer Logging

To identify the orientation and width of planar geologic structural features encountered by the borings, borehole acoustic televiewer logging was performed in two borings drilled along the proposed water tunnel alignment (B-202 and B-206). Televiewer logging was performed by NORCAL Geophysical Consultants, Inc. and the results of which are presented in Appendix C.

A decorative banner with a wavy, ribbon-like shape. It features a dark blue outer layer and a lighter blue inner layer, separated by a thin white line. The banner curves upwards at both ends.

Chapter 3: Laboratory Testing

This page intentionally left blank.

3. LABORATORY TESTING

Representative soil samples obtained from the exploratory borings were tested by Cooper Testing Labs in Palo Alto, California and Inspection Services Inc. in Berkeley, California. Representative rock samples were also obtained from the borings and tested by Tonon Laboratory in Austin, Texas and Cooper Testing Labs in Palo Alto, California. Laboratory test reports are presented in Appendix D.

The following geotechnical tests were performed on soils samples from borings:

1. Moisture Content, ASTM D2216
2. Atterberg Limits, ASTM D4318
3. Consolidated Undrained triaxial Compression Strength Tests, ASTM D4767
4. Unconsolidated Undrained triaxial Compression Strength Tests, ASTM D2850
5. Consolidation, ASTM D2435
6. Grain-Size Distribution Analysis, ASTM D422
7. Percent Passing No. 200, ASTM D1140
8. Moisture-Density tests, ASTM D7263b
9. X-rays of Samples
10. Corrosion Testing (pH and Minimum Resistivity (CT 643), Sulfate (CT 147), and Chloride (CT 422))

The following geotechnical tests were performed on rock core samples from borings:

1. Brazilian Tensile Strength Test, ASTM D3967
2. Moisture Content, ASTM D2216
3. Cerchar Abrasiveness tests, ASTM D7625
4. Point Load tests, ASTM D5731
5. Mohs Hardness
6. Unconfined Compressive Strength tests, ASTM D7012

7. Punch Penetration testing, Colorado Schools of Mines – 13
8. Bulk Density tests, ISRM 1977
9. Petrographic Analyses

This page intentionally left blank.

A decorative banner with a wavy, ribbon-like shape. It features a dark blue base color and a lighter blue upper section separated by a white wavy line. The banner curves upwards at both ends.

Chapter 4: Limitations

This page intentionally left blank.

4. LIMITATIONS

This GDR references geotechnical data obtained from various phases of geotechnical investigation programs and serves as a source of geotechnical information for the Klamath River Renewal Project.

Groundwater levels presented reflect conditions observed at the time of measurement and are expected to vary over time. The conditions indicated in boring logs and geophysical surveys represent only the subsurface conditions at the locations of the borings. The actual subsurface conditions are expected to vary between those locations.

This report does not interpret the available data. It is the Contractor's responsibility to become familiar with the data in this GDR. The Contractor shall make its own interpretation of this data and shall assume full responsibility for its interpretation.

AECOM represents that the work described in this GDR were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession within the limits prescribed by our client. No other warranties, either expressed or implied, are included or intended in this GDR.

This page intentionally left blank.

TABLE 1

[illegible]

Sheet 2

Sheet 3

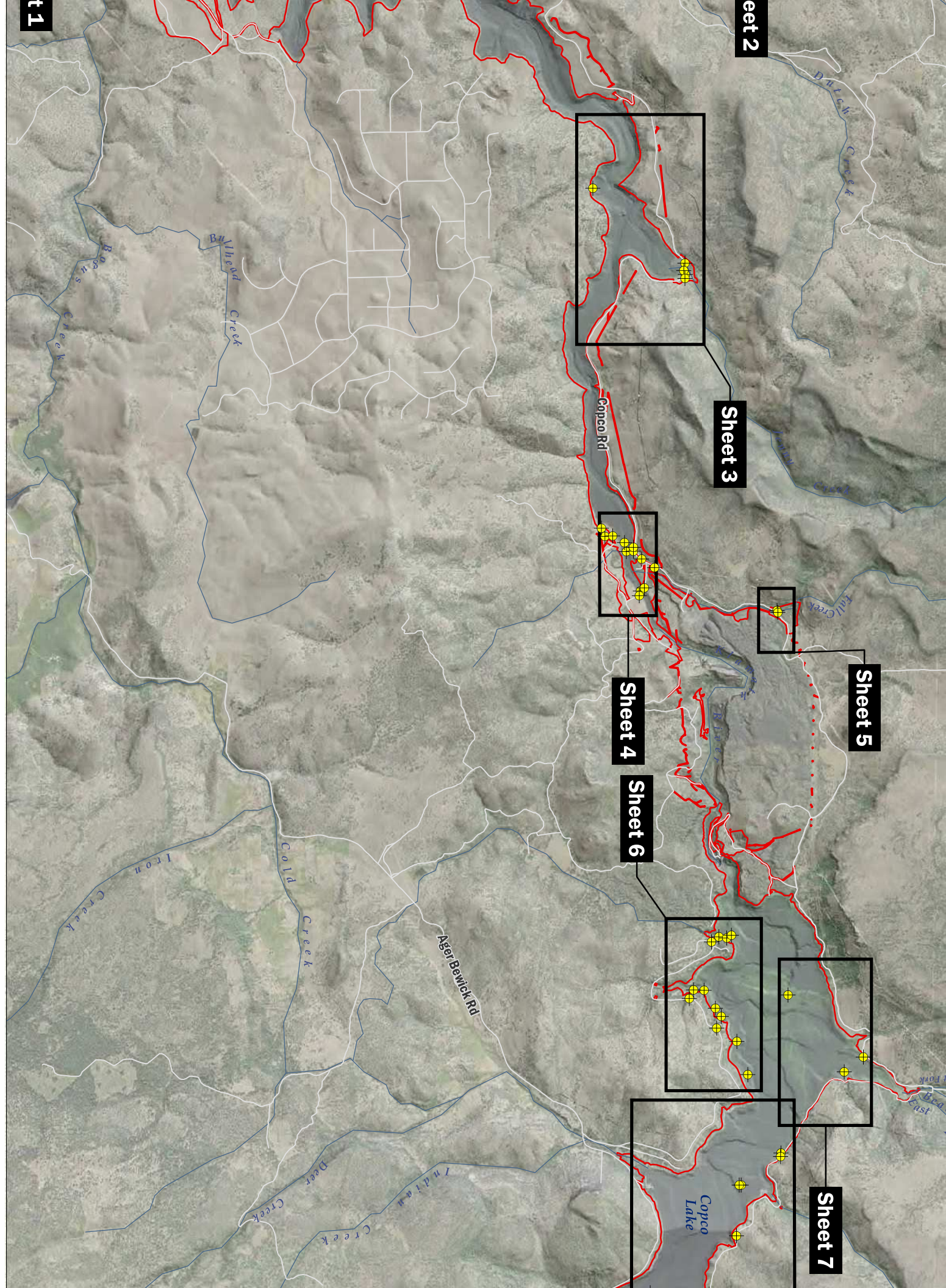
Sheet 4

Sheet 6

Sheet 5

Sheet 7

Sheet 1





Scotch
Creek
Culvert

B-19

Scotch
Creek

Copco
Rd

B-01

B-20

B-02

Camp Creek
Bridge

B-03

Feet

500





BI-01

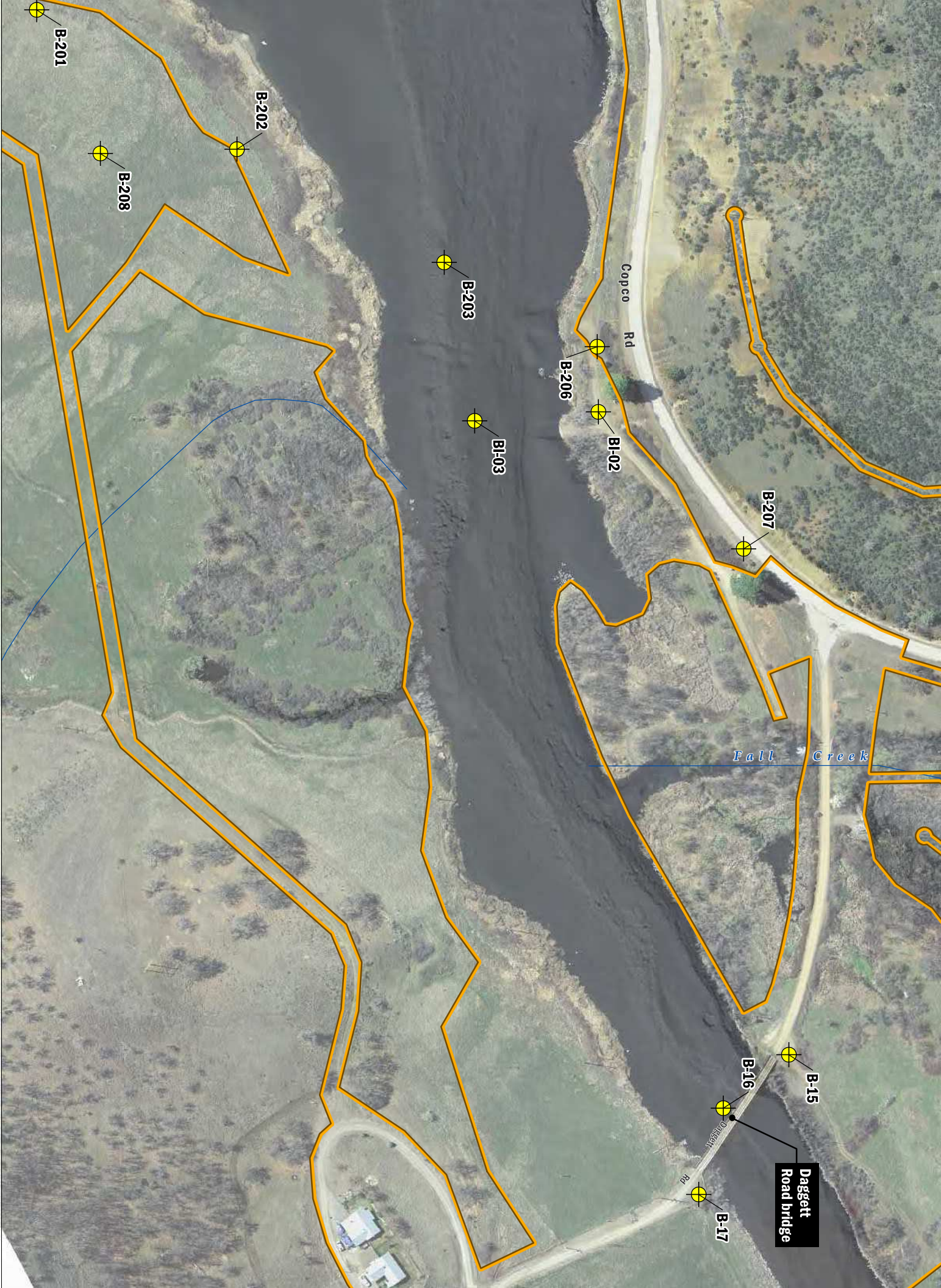
B-04

B-05

B-06

B-07

Jenny Creek bridge



B-201

B-202

B-208

B-203

B-206

B-102

B-103

B-207

Fall Creek

B-16

B-15

B-17

Daggett
Road bridge

500



Copco Rd

Fall Creek

Fall Creek Bridge

B-14

B-13

500

Feet



BC-15

Janice Ave

BC-17

BC-05

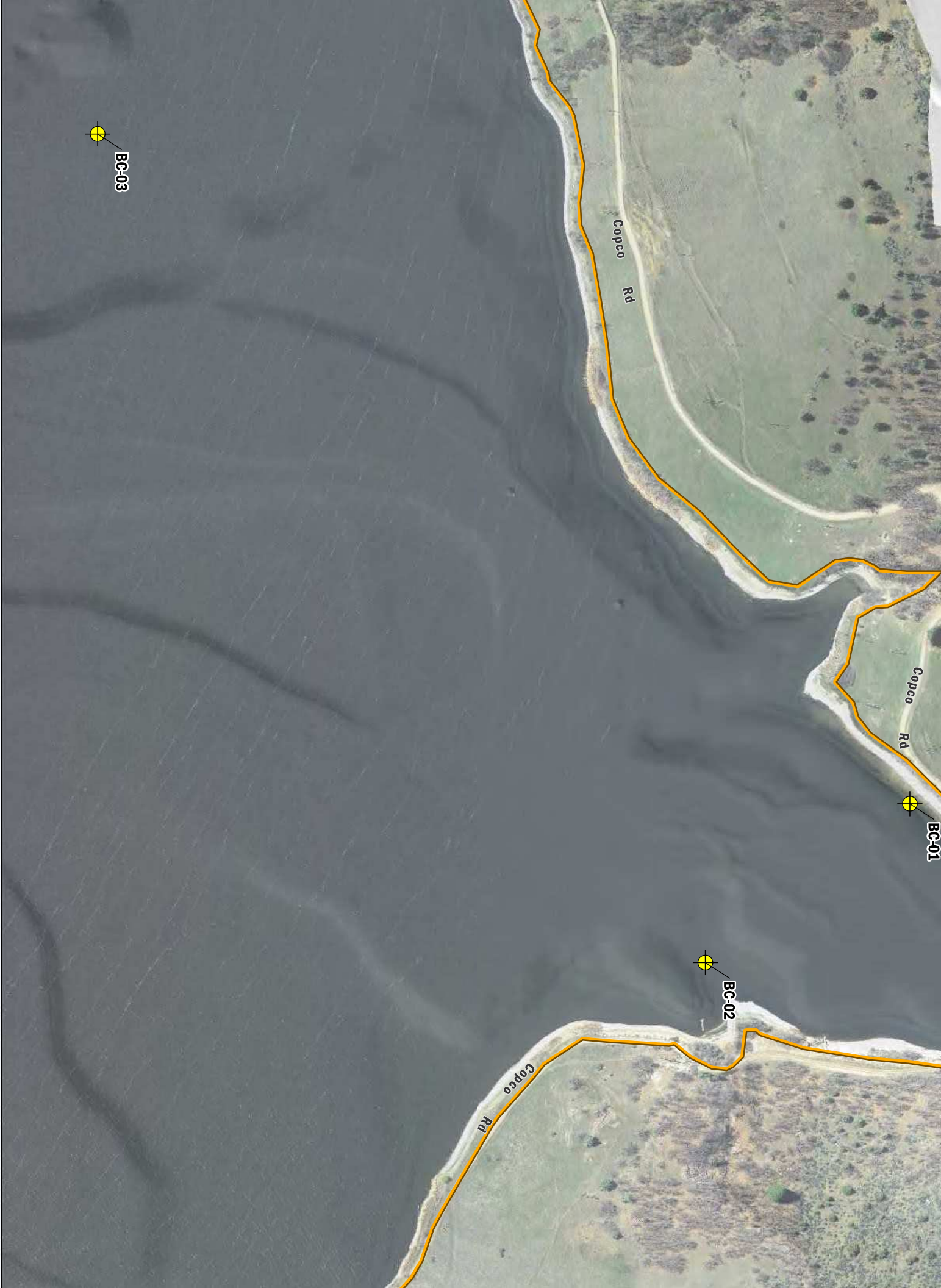
BC-14

BC-18

BC-19

BC-13

BC-06



BC-03

Copco Rd

BC-01

Copco Rd

BC-02

Copco Rd