Sanitary Sewer Pump Station Design Manual

City of Lancaster
Department of Engineering

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This Sanitary Sewer Design Guideline is hereby approved

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PURPOSE

This manual has been developed to provide guidance to land developers, their consulting engineers, and contractors as to the requirements of the City of Lancaster Department of Engineering for design and technical specifications of sewage pump stations. It is a supplement to standard design procedures. This manual is meant to be a guideline for development in the City and as a supplement to the Subdivision Regulations. The City understands that not all projects will conform to these standards and may require unique solutions suited for the individual site. These situations should be addressed early in the planning stages of the development. The latest edition of the City Zoning Ordinances, Subdivision Regulations, Sanitary Sewer Design Manual, Construction and Materials Specifications (CMSL), Standard Drawings and General Notes shall be followed in planning and designing the project.

References to 10 State Standards shall refer to the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers publication Recommended Standards for Wastewater Facilities, 1990 Edition. References to the Ohio EPA Green Book shall refer to the Ohio Environmental Protection Agency publication, Sewage Collection, Treatment & Disposal Where Public Sewers Are Not Available, 1993 Edition.

POLICY

General Requirements

There are several general requirements for all new and replacement sewage pump stations to be built in City of Lancaster. These include the following:

All new pump stations shall be located outside the public right-of-way on property dedicated to the City of Lancaster. Access to the pump station shall be provided on the City property or by an easement dedicated to the City of Lancaster. Both the property and the easement shall be provided at no cost to the City of Lancaster.

All new and replacement sewage pump stations shall be fitted with submersible pumps.

Typically, new pump stations will be duplex stations, where each of two pumps will be capable of meeting the station's design capacity. In some cases, larger capacity pump stations may be required, which shall be constructed with three or more pumps.

Where possible, the requirements presented in this document have been developed to address both temporary and permanent installations; however, the City reserves the right to modify the requirements for individual projects as deemed necessary for the protection of public health and/or the environment.

In general, ALL pump stations shall be considered to be permanent unless a project exists on the City of Lancasters'5-year Capital Improvements Plan that would eliminate the pump station or the Developer has specific plans for eliminating the pump station within approximately 5 years. However, each pump station will be reviewed at the inception of

design by the City of Lancaster Department of Engineering to determine whether the pump station will be considered permanent or temporary for design purposes. If a pump station is to be temporary (as determined by City of Lancaster Department of Engineering), certain requirements may be modified or omitted at the discretion of City of Lancaster Department of Engineering and the Superintendent of the City of Lancaster Water Pollution Control Department. In general, these modifications and omissions will be as defined in Appendix A.

The City of Lancaster Department of Engineering will also evaluate options for preventing each pump station through the extension of gravity sewers to the site. The Developer may be required to evaluate these options to determine feasibility and estimated costs for the gravity sewer extensions as well as the estimated cost of the proposed pump station and force main. These costs will be compared to assist in determining if a pump station will be allowed or a gravity sewer extension will be required.

Wherever the requirements specify "Developer," they are intended to refer to land developers and their agents, who are typically contractors and their consulting engineers. Nothing in these requirements is intended to assign responsibility contradictory to legitimate contractual arrangements between those parties.

Where these specifications are included with Plans and Bidding Documents for a project publicly bid by the City of Lancaster, the Plans and Detailed Specifications shall govern in the event of conflicts between them and this document.

1.0 SCOPE

A. The specifications herein given are general and subject to any special provision or requirements set forth in the sections of this document.

1.1 Scope of Work

A. The Contractor shall, unless otherwise notified, furnish all labor, materials, equipment, tools, and incidentals necessary to install, test, complete, and make ready for operation a submersible sewage pump station. This includes the furnishing and installation of all necessary and desirable accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, as required for an installation incorporating the highest standards for the types of service which this pump station is to perform.

B. These specifications are intended to give a general description of that which is required and do not purport to describe all details of the equipment to be furnished. Such details are considered to be either standard among all manufacturers or variable in accordance with specific equipment formulations, but resulting, in either case, in equipment equal in performance, long-term reliability, and life-cycle cost-effectiveness.

C. The Contractor shall be responsible for all excavation and removal of obstructions and restoration of all properties involved directly with the construction and/or installation of the pump station.

1.2 Capacity

A. The facility shall be sized to handle all flows from the total upstream watershed, except for the pumps, which shall be sized to handle the peak flow of the upstream watershed or twice the design peak flow of the proposed development, whichever is less. However, the facility shall be designed to permit future installation of pumps sized to handle the peak flow of the upstream watershed.

B. The capacity of a pump station handling flow from existing gravity and/or upstream combined sewers shall be adequate to manage existing flows, including infiltration/inflow, as well as additional flows anticipated to be required for the proposed development.

1.3 Design

A. Design of pump stations shall be coordinated at all stages with the City of Lancaster Department of Engineering. Plans shall be submitted for review and approval along with water and sewer construction plans.

B. Design efficiency of the pumps shall be submitted for review and approval by the City. Pumps that are not properly selected for efficient operation may be rejected.

C. Friction losses through force mains shall be based on the Hazen Williams formula or other acceptable methods. When the Hazen Williams formula is used, the value for "C" shall be 100 for unlined iron or steel pipe. For other smooth pipes, a higher "C" value not to exceed 120 may be allowed.

1.4 Responsibilities of Developer

A. The Developer shall be responsible for all materials stored on the job site and the pump station until it is accepted by the City. The Developer shall bear the responsibility of any damages incurred either to private or public property.

1.5 Inspection

A. Materials provided and work performed shall be subject to inspections by City representatives and/or by appointed agents of the City. Acceptance of the pump station shall be contingent on the condition that all materials, equipment, and workmanship provided pass set inspections, satisfactory completion of all work and proper operation of the completed pump station.

1.6 Warranty

A. A minimum of a full twelve (12) month warranty shall be provided for the pump station. This warranty shall begin on the date the pump station is accepted by the City for operation. The warranty shall cover the following:

1) All equipment, parts, and labor.

2) Site materials, roadways, and fences.

3) Ground subsidence and settlement of valve chamber and wet well.

4) Landscaping and screening plantings

B. The pumps shall have at least an eighteen (18)-month full (all parts and labor) manufacturer's warranty and 5-year prorated manufacturer's warranty, which shall both begin no earlier than the date of shipment to the Contractor. In the event that the pump station is not accepted within six months of shipment of the pumps, the full warranty shall be extended to twelve months from the date the pump station is accepted by the City for operation.

1.7 Tools and Spare Parts

A. All special tools and recommended spare parts required for normal operation and maintenance shall be supplied for each piece of equipment furnished.

B. The following spare parts shall be furnished as a minimum:

1) One set of one upper and one lower mechanical seals and a seal tool

2) One set of gaskets, O-rings, grommets, and other sealing devices

3) One rotating wear ring (if so equipped) or a spare impeller, and one stationary wear ring (if so equipped) or a spare volute

4) One complete set of spare fuses for all electrical devices.

5) Ten spare bulbs for each lamp type.

C. All tools and spare parts shall be properly packed and protected for long storage and placed in containers clearly identified in indelible markings as to contents.

1.8 Submittals

A. The Contractor shall submit to the City for approval five sets of the following prior to ordering equipment and materials or initiating construction. One set of submittals will be returned to the Contractor with comments and/or approvals.

1) Certified shop and erection drawings and data regarding pumps, motors, characteristics, and performance. The data shall include guaranteed performance curves, based on actual shop tests of duplicate pumping units, which show that the units meet the specified requirements for head, capacity, efficiency, and input power. Curves shall be submitted in quadruplicate on 8-1/2-inch by 11-inch sheets. For pumping units of the same size and type, only curves for a single unit need be provided.

2) Literature and drawings describing the equipment and showing all-important details of construction and dimensions

3) Complete data on motors, including schematic electrical wiring diagrams and other data as required

4) Complete schematic electrical wiring diagrams for pump station, control panel, and SCADA.

5) Conduit routing and wire-pulling schedules.

6) Complete grounding scheme.

Submittals shall be provided for each of the items listed in Appendix B of this document.

1.9 Operation and Maintenance Manuals

A. Four complete sets of installation, operation, and maintenance instructions shall be provided for all equipment and electrical components. The manuals shall be prepared specifically for the installation to which they pertain and shall include all available installation manuals, operation manuals, maintenance manuals, catalog cuts, drawings, wiring diagrams, equipment and parts lists, list of spare parts provided, warranties, product descriptions, etc. All four sets of manuals for major equipment shall be original manufacturer's manuals–copies will not be acceptable. Only one set of original manufacturer's literature is required for miscellaneous components; copies of this literature will be acceptable for the other three O&M manuals. All manuals shall be furnished to the City's project manager no later than the date of acceptance.

B. The manual for each piece of equipment shall be a separate document with the following specific requirements:

1) Contents:

- Table of contents and index
- Brief description of each system and its components
- Starting and stopping procedures
- Special operating instructions
- Routine maintenance procedures
- Manufacturer's printed operating and maintenance instructions, parts list, illustrations, and diagrams
- Instrumentation data sheets with calibration data and specifications.
- One copy of each wiring diagram
- Conduit routing and wire-pulling schedules.
- One copy of each approved shop drawing and each Contractor's coordination and layout drawing
- List of spare parts, manufacturer's price, and recommended quantity
- Name, address, and telephone numbers of local service representatives

2) Material:

- Loose leaf, on 24-pound punched paper
- Holes reinforced with plastic, cloth, or metal
- Page size, 8-1/2 inches by 11 inches
- Diagrams, illustrations, and attached foldouts as required, of original quality, reproduced by dry-copy method
- Covers of oil-, moisture-, and wear-resistant material, 9-1/2-inches by 12-inches in size

C) All warranties, completed with the City names as the owner, shall be included as an additional section in the O&M manual with the original manufacturer literature.

1.10 Record Drawings

A. The Record Drawings shall consist of the Contract Drawings revised per as-built conditions and the approved Shop Drawings. As-built revisions to the Contract Drawings shall be professionally drafted. The Record Drawings shall be submitted to City in reproducible form (i.e., 3-mil Mylar) as specified by the City Engineer upon completion of the construction. Electronic records of the drawings shall also be provided in a format approved by the City Engineer.

B. Contract Drawings shall be legibly marked to record actual construction, including:

1) All deviations in location or elevation of any underground installation from that shown on the Contract Drawings

2) Any significant changes in aboveground installations from the approved Shop Drawings or Contract Drawings

3) Indication of City of Lancaster's approval of any such deviations or changes from the Contract Drawings or approved Shop Drawings

C. Specifications and addenda shall be legibly marked to record:

1) Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed

2) Changes made by change order or field order

3) Other matters not originally specified

D. Shop Drawings shall be legibly annotated to record changes made after review.

E. Reproducible Record Drawings shall be submitted within seven calendar days after the date of acceptance.

1.11 Additional Items

A. Each installation shall be individually assessed as to the need for equipment, structures, procedures and other items not named or described in these specifications. Installation of these items may be required at the discretion of the City Engineer or his appointed agent.

B. Any variations from the specifications provided in this document must be approved through the City representative or the appointed agent of the City.

C. These specifications are subject to change or revision without notification.

2.0 SUBMERSIBLE PUMPS

A. The pumps used in all submersible sewage pump stations shall meet the following specifications.

2.1 Pumps, Motors, and Installation

A. Pumps shall be ITT Flygt CP or approved equal, shall be capable of passing solids at least three inches in diameter, shall have a maximum ambient operating temperature of at least 115□ F, and shall be capable of withstanding corrosive materials normally found in domestic and industrial waste.

B. Pump motors shall be 460/480 volt AC, 3-phase, 60 Hz or 230/240 volt AC, 3-phase, 60 Hz, depending upon site constraints, power availability, and pump size and application requirements. The need for dual-voltage motors, which are field changeable, shall be considered on an individual basis dependent on pump size, location, and other factors.

C. A nameplate of #316 stainless steel shall be attached to each pump, giving the name of the manufacturer, rated capacity, head, speed, model number, serial number, and all other pertinent data.

D. All anchor bolts shall be of #316 stainless steel.

E. Each pump shall be provided with a sufficiently long power cable to suit its installation without splicing. The power cable shall be type SPC cable, chloroprene rubber-jacketed, suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and shall meet with P-MSHA approval. Each power cable shall be installed in a separate conduit to the control panel.

F. A #316 stainless steel lifting chain shall be provided for each pump, of sufficient length to reach from the pump attachment to a chain holder, furnished by the equipment manufacturer and installed near the upper guide rail support for that pump. The chain shall be of sufficient strength to allow the raising and lowering of the pump with a safety factor of at least two, but in no case less than 1/4-inch chain links. An ITT Flygt Corp. "Grip-eye" or equal sized for the pump lifting chains shall be provided for each pump station.

G. The pump shall be supplied with a mating cast-iron discharge connection elbow. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter the wet well to install, remove, or maintain the pumps.

H. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by no less than two guide bars and shall be pressed tightly against the discharge connection elbow with metal-to-metal contact. Sealing of the devices by any other means shall not be acceptable. No portion of the pump shall bear directly on the floor of the wet well, and the minimum clearance specified by the manufacturer shall be maintained with at least 4" in all cases. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water to a depth of 65 feet without loss of watertight integrity.

I. Major pump components shall be of gray cast iron, with smooth surfaces devoid of blowholes and other irregularities. All exposed nuts and bolts shall be of AISI-type #304 stainless steel or brass construction. An approved sewage-resistant coating shall protect all surfaces, which will be exposed to sewage, other than stainless steel or brass. The impeller shall be factory-coated with acrylic dispersion zinc phosphate primer. A factory-applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish shall protect the pump exterior.

J. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This shall result in controlled compression of the O-rings without the requirement of a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

K. The design of the cable-entry water seal shall insure a watertight and submersible seal. A single cable entry to the pump housing shall contain all leads. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers, all having a close-tolerance fit against the outside diameter of the cable and compressed by the entry body containing a strain-relief function, separate from the function of sealing the cable. A stator lead sealing gland or terminal board shall separate the cable entry junction chamber and motor, which shall protect the interior of the motor from foreign material that might gain access through the top of the pump. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable. The pump supplier shall provide a watertight connector, equal to a Crouse Hinds type CGB with a neoprene gland to terminate the cable in the pump disconnect.

L. The pump motor shall be designed and manufactured by the same manufacturer as the pump. The pump motor shall be of a squirrel-cage, induction, shell-type design, housed in an air-filled, watertight chamber. The stator winding and stator leads shall be insulated with moisture-resistant Class F insulation that shall resist a temperature of 155□ C. The stator shall be dipped and baked three times in Class F varnish and shall be fitted into the stator housing by heat shrinking. The

use of bolts, pins, or other fastening devices requiring penetration of the stator housing shall not be acceptable. The motor shall be designed for continuous duty, capable of sustaining a minimum of ten starts per hour with the liquid surface located at the top of the pump's volute but below the motor casing, with a temperature rise not exceeding 40° C above ambient temperature.

M. The junction chamber, containing the terminal board, shall be sealed from the motor by an elastomer compression seal (O-ring). Connection between the cable conductors and stator leads shall be made with threaded, compressed-type binding posts permanently affixed to a terminal board.

N. Each motor 20 horsepower or larger shall be provided with an adequately designed cooling system, consisting of a cooling jacket encircling the stator housing. The cooling jacket shall be provided with a separate circulation of the pumped liquid. Cooling media channels and ports shall be non-clogging by virtue of their dimensions. Systems that utilize a closed loop cooling system with propylene glycol shall be acceptable.

O. Each pump shall be protected by thermal switches embedded in the motor windings. In the event of an over-temperature condition, the pumps shall shut down and remain inactive until the motor housing cools off.

P. Each pump shaft shall be of either stainless steel or carbon steel C1034 and shall be completely isolated from the pumped liquid.

Q. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The upper of the tandem set of seals shall operate in an oil chamber located just below the stator housing. This set shall contain one stationary tungsten carbide ring and one positively driven rotating tungsten carbide ring and shall function as an independent secondary barrier between the pumped liquid and the stator housing. The lower of the tandem set of seals shall function as the primary barrier between the pumped liquid and the stator housing. This set shall consist of a stationary ring and a positively driven rotating ring, both of which shall be of tungsten carbide. Each interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment, but shall be easily inspected and replaceable. The following seal types shall not be considered acceptable nor equal to the dual independent seals specified:

- Shaft seals without positively driven rotating members
- Conventional double mechanical seals containing either a common or double spring acting between the upper and lower units (this conventional system requires a pressure differential to offset external pressure and affect sealing).

R. The only functions of the oil chamber shall be as a secondary barrier between the pumped liquid and as a seal lubricant. It shall be designed to compensate for oil expansion that can occur due to temperature variations. Drain and inspection plugs, with positive sealing, shall be easily accessible from the outside.

S. The pump shaft shall rotate on two permanently lubricated bearings. The upper bearing, providing for radial thrust, shall be a single-row roller bearing. The lower bearing shall be a two-row angular-contact bearing to compensate for axial thrust and radial thrust.

T. The impeller shall be of a gray cast-iron, dynamically balanced, double-shrouded, non-clogging design having a long through let without acute turns. The impeller shall be capable of handling grit, solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications. The pump manufacturer shall furnish data on mass moment of inertia for the proposed impeller. The fit between the impeller and the shaft shall be a sliding fit with one key, and a locking assembly that is sealed from the liquid by a protective rubber cap shall make the fastening of the impeller to the shaft and a bolt threaded to the shaft terminal.

U. The volute shall be of a single-piece, non-concentric design and shall have smooth fluid passages large enough at all points to pass any solids which can pass through the impeller. The volute bottom shall be of a suction-bell design. A replaceable wear-ring system shall be installed to provide efficient sealing between the volute inlet and the impeller skirt. The wear rings shall consist of a stationary brass wear ring in the volute. Pumps 14 horsepower or larger shall also have a rotating stainless steel wear ring on the impeller skirt.

V. Cable support shall be provided for the pump power cable and shall consist of a stainless steel braided wire sleeve with attachment tails for connection to supports furnished by the equipment manufacturer and installed in locations indicated in the manufacturer's drawings and approved by the Engineer.

W. A mix-flush system shall be provided for each pump. The mix-flush system shall be equal to an ITT FLYGT 4901 flush valve. The valve shall use the ejector principle, in which water exiting the valve shall violently agitate the liquid in the sump, thereby re-suspending any accumulation of sludge. The flushing period of the valve shall be adjustable. The direction of discharge from the mix-flush system shall be adjustable in 360-degrees to any part of the wet well.

X. Pump removal equipment shall meet the following specifications:

1) Pump stations supplied with pumps weighing 800 pounds or less shall be supplied with sockets at each pump and a single portable stainless steel winch-type hoist system capable of pulling either pump completely out of

the wet well. The winch and hoist shall be rated for at least twice the maximum weight of the pump (minimum 1,000 pounds). The hoist shall be fitted with a static loop and screw pin anchor shackle to support the weight of the pump while regripping the chain with the winch hook. Hoist shall be Halliday Products Series DB (D2B36B for 1,000 pounds) or equal.

2) Pump stations equipped with pumps weighing in excess of 800 pounds shall have a derrick-type lifting system. This system shall be designed to allow lifting, moving, and loading of pumps onto the bed of a standard one-ton truck. The lifting system and the structural design of the derrick shall be rated at a minimum of twice the weight of the heaviest pump installed in the station. The lifting system shall be supplied with a means of operating electrically--for both lifting and rotating. A galvanized steel shield shall be attached to the jib to shield the trolley when not in use.

2.2 Mounting Hardware

A. All slide rails shall be made of 316 stainless steel and shall be of tubular design. Upper guide bar brackets, middle support brackets, and float hangers shall also be made of 316 stainless steel. All other hardware (bolts, nuts, etc.) shall similarly be made of 316 stainless steel.

2.3 Additional Equipment

A. All pumps shall be equipped with seal leak detectors, to give adequate warning if the lower seal unit should fail.

2.4 Shop Testing of Pumps

A. All pumps of 35 horsepower capacity or greater shall undergo certified testing at the factory for capacity, power requirements, and efficiency at specified extremes for rated head, shutoff head, and operating head, and at as many other points as necessary for accurate plotting of performance curves, with the completely assembled pump and motor that will be furnished.

B. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards.

C. Copies of the test logs, a description of the test piping, equipment, and set-up, and a discussion of the test procedure shall accompany certified test performance curves and shall be submitted to the City. The curves shall include head, bhp, overall (wire-to-water) efficiency, rpm, and test NPSHRe plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements.

3.0 STRUCTURES, BACKFILL AND EMBANKMENT

Structures shall be constructed as required, in accordance with the following specifications:

3.1 Wet Well and Valve Pit Design and Construction

A. Wet wells and valve pits shall be constructed using either precast concrete sections or poured-in-place concrete. If precast construction is used, each section shall be set and sealed with the proper gasket and joint sealing compound approved by the City. If the pump station will be constructed of poured-in-place concrete, the concrete shall be reinforced with reinforcement rod in accordance with acceptable engineering design practice and shall be certified by a Professional Engineer registered in the State of Ohio.

B. Either type of construction shall have a foundation designed to adequately support the station. At least one subsurface test boring shall be made at the pump station site to at least five feet below the proposed bottom of the wet well. A complete soil analysis including ground water level shall be submitted with the plans. Soil analysis shall include at least Standard Penetration Tests (ASTM D 1586); classification of soils' textures and consistencies; tests for natural moisture content; engineering classification of predominant soil horizons (including sieve and hydrometer analysis (ASTM D 422), Atterberg limits (ASTM D 4318), and specific gravity (ASTM D 854)); and determination of Rock Quality Designation values. The design engineer to verify that adequate ground support exists for the station as well as to design the structure to prevent flotation shall use this analysis. A Professional Engineer registered in the State of Ohio shall certify this design.

C. Plans shall indicate the elevation of the 25-year and 100-year flood plain at the pump station site. The tops of the wet well and valve pit, as well as the generator and control panel pads, shall be at least one foot above the 100-year flood plain. The pump station shall be designed to operate during the 25-year flood.

D. Design shall be such that a 30-minute cycle time for each pump (i.e. 15-minute overall cycle time for duplex stations; 10-minute overall cycle time for triplex stations) shall be obtained at average design flow. The wet well shall also incorporate a design sufficient to provide at least one hour of storage at twice-ultimate average flow from the high water alarm to the invert of the influent sewer. In no case shall this distance be less than six feet.

E. No more than one influent sewer shall enter the wet well, and it shall be located opposite the pumps.

F. Wet wells shall have a minimum inside diameter of six feet. Valve pits shall have a minimum inside dimension in all directions of six feet. Valve pits shall have an inside depth of no more than 8 feet.

G. A grout fillet shall be properly designed and constructed around the full circumference of the wet well's bottom to direct grit and other solids to the pumps. The slope of this fillet shall be at least 1:1. The inner diameter of this "grout circle" shall be as recommended by the pump manufacturer for the specified pump and approved by City of Lancaster, but in general should be as small as possible without creating a vortex condition around the pumps. The inner "grout circle" shall be centered around the pumps. Either of the following mixes will be acceptable for this fillet, but the final mix design and slump shall be determined by the Contractor and approved by the City:

1) Sand-cement grout consisting of one part Portland cement, two parts fine aggregate and a maximum of 4.5 gallons of water per sack (cubic foot) of cement. Portland cement shall be Type III conforming to ASTM C 150. Fine aggregate shall be natural siliceous sand, consisting of hard, clean, sharp, dense, durable and uncoated particles, free from organic material and injurious amounts of deleterious substances. 100% of fine aggregate shall pass a Size No. 4 sieve.

2) 4,000-psi concrete mix, with 5-7 percent air content and 3/4"-1" slump. Mix shall include 510 lbs. Type I cement conforming to ASTM C 150; 90 lbs. Class F fly ash conforming to ASTM C 618; 1,315 lbs. sand conforming to ASTM C 33, ODOT 703.02; 1,651 lbs. AASHTO M-43 Size No. 8 aggregate; 200 lbs. water; and 2-4 oz./100 lbs. Type A or D water reducer conforming to ASTM C 494.

H. Each valve pit shall be fitted with a drainage system such that any liquid entering the valve pit will be drained back to the wet well. Drainage of the valve pit shall be ensured by a 1-degree slope to the floor of the valve chamber draining to the invert of a drain line fitted with a check valve to prevent sewage from entering the valve chamber. The drain line shall be minimum 2" diameter constructed of schedule 80 PVC, and the check valve shall be constructed of PVC. The check valve should be attached to the drainpipe with a NPT threaded joint to permit changing the valve. The pipe shall extend at least 12" into the wet well but shall not interfere with pump removal. The check valve shall be normally closed, or a "P" trap shall be placed in the drain line to prevent vapors from entering the valve pit.

I. Each valve pit shall also be furnished with a valved connection to the force main beyond the pump isolation valves for emergency pumping. This connection shall be sized to equal the discharge piping from the pumps, unless otherwise directed by the City, and shall have a minimum diameter of four inches. This connection shall be equipped with a galvanized steel Bauer fitting for ease of hose

connection. Equivalent quick-connect fittings are not acceptable. Bauer fitting and accessories shall be as follows, with one discharge connection, one rubber sealing ring, and one end cap.

Part Numbers

Size & Type	Discharge Connection	Lever Ring	HK Rubber Sealing Ring	End Cap
4" Flanged	100-6987	included	105-0140	105-0201
4" Threaded	105-0811	105-0134	105-0140	105-0201
6" Flanged	100-7005	included	107-0140	107-0201
6" Threaded	107-0811	106-0134	107-0140	107-0201
8" Flanged	100-7003	included	108-0140	108-0201
8" Threaded	108-0811	108-0134	108-0140	108-0201

J. All pipe and conduit penetrations through the wet well and valve pit structures shall be sealed with Dura-seal rubber compression gaskets, rubber Link Seal sleeves with stainless steel components, or approved equal products. All voids should be filled with non-shrink grout on both sides of the wall.

K. The wet well shall be provided with at least one "gooseneck" inverted vent pipe. The piping shall be made of epoxy-coated ductile iron, aluminum, or other corrosion-resistant material and shall be at least as large as the largest pump discharge piping (minimum 4"). Black iron pipe will not be allowed. In addition, PVC or other plastic pipe will not be allowed. The exterior end of the pipe shall be covered with a stainless steel screen.

L. Adequate waterproofing of the wet well and valve pit shall be included in the design and performed by the Contractor. A leakage test shall be performed on the entire wet well and valve pit prior to backfilling (see Section 3.2). The Contractor/Developer shall be responsible for properly repairing any leaks or correcting any other problems discovered during this test.

M. All valve pits shall be fitted with either an aluminum ladder or polypropylene manhole steps for access. An aluminum Bilco Ladder-Up safety post or equal shall be provided as well. Wet wells and valve vaults shall be supplied with embedded sockets at each access lid/hatch to support a Halliday Products Model D2B36B portable stainless steel winch-type hoist.

3.2 Leakage Testing of Wet Well and Valve Pit

Wet well and valve pits shall be tested for leakage prior to backfilling as follows: structures shall be filled with water and allowed to remain for 24 hours. Any visible leaks shall be repaired immediately (prior to backfilling). If the water level in the structures drops substantially (generally, more than 6-12") during the leakage test, the Contractor may be required to investigate for additional leaks and another test may be required.

3.3 Shear Gate Manhole

A. A separate manhole with a slab top shall be installed on the influent sewer within 15 feet of the wet well either within the fence or near one of the fence gates. Ductile iron pipe shall be installed between this manhole and the wet well. A shear gate valve shall be installed on the outlet side of this manhole. Polypropylene manhole steps shall be installed in the manhole.

B. A 24" x 24" (minimum) aluminum hatch shall be provided in the top slab of this manhole above the manhole steps and should open away from the manhole steps.

C. A pole with a lifting handle shall be included on the shear gate valve and shall extend to about 6 inches below the top of the manhole when the valve is fully open. A stainless steel eyebolt (2" eye) shall be installed about 4 inches from the

top of the manhole to allow the handle to be chained and the padlocked open. This pole and eyebolt shall be under the hatch near the manhole steps. The pole and handle shall be installed so that the handle is accessible without entering the manhole and the hatch can be closed with the valve fully open or closed.

3.4 Backfill and Embankment

A. The Contractor shall provide all labor, materials, tools, equipment, and incidentals required to place the compacted backfill or embankment where shown on the plans or where directed by the Engineer and as specified herein.

B. Compacted backfill and embankment shall consist of suitable excavated material approved by the Engineer or Compacted Granular Backfill meeting City of Lancaster Materials Standard (CMSL) Item 910. This material may be obtained from suitable excavated material elsewhere on the project, if available. Use of frozen material, wood, rocks, or rubbish for backfill or embankment will not be permitted. If suitable material cannot be obtained from the excavated material, the Contractor shall furnish the material.

C. No fill shall be placed covering other work until such work has been inspected and approved by the Engineer. Where fill is required on both sides of a foundation or wall, the fill shall be placed simultaneously on each side. Fill against building walls shall not be placed until the first floor slab has been poured and set, unless otherwise approved by the Engineer. Fill against other work shall be in a manner and at such time as not to endanger the stability of or damage the work. No fill shall be placed against water bearing walls until they have been inspected, tested, and approved by the Engineer. No fill shall be placed over snow or frozen material.

D. All fill shall be compacted as specified herein, unless otherwise shown.

1) Backfill. Backfill shall be placed in 6" loose layers and each layer compacted to not less than 95% of maximum dry density; the moisture content shall be not greater than 3 percentage points above optimum as determined by ASTM D698. Compaction shall be accomplished with a vibratory double-drum steel wheel roller no less than 2.0 Tons and no greater than 3.0 Tons or by other means approved in writing by the Engineer. Flushing with water before compacting is also encouraged if satisfactory drainage is provided for the free water. The method of compaction within road right-of-ways shall be approved by the City of Lancaster Engineer's Office or the Ohio Department of Transportation, as appropriate.

2) Embankments. Embankment areas shall be constructed in accordance with this specification. Embankment fill shall be placed in 6" loose layers and each layer compacted to not less than the percent of maximum dry density specified herein; the moisture content shall be not less than

optimum and not greater than 3 percentage points above optimum. For material, that displays pronounced elasticity or deformation under action of compaction equipment, the moisture content shall be reduced and proper stability obtained. Moisture density shall be as determined by ASTM D698.

Maximum Dry Density (Lbs/cu ft)	Compaction Percent Maximum Dry Density
90-104.9	102
105-119.9	100
120 and more	98

3) Sub grade. All pavement sub grades for new pavement shall be compacted to a depth of 12". Sub grade soils with a maximum dry density of less than 100 pounds per cubic foot are considered unsuitable for use where sub grade compaction for a depth of 12" is required, and when encountered in the upper 12" of the sub grade shall be replaced with suitable soil or granular material. Soil sub grade with maximum dry density of 100 to 105 pounds per cubic foot shall be compacted to not less than 102% of maximum dry density. All other soil sub grade shall be compacted to not less than 100% of maximum dry density; the moisture content shall be not greater than 3 percentage points above optimum as determined by ASTM D698.

E. The Contractor shall obtain up to three (3) soil samples where directed by the Engineer and transport the samples to an approved testing agency for Standard Proctor dry density testing (ASTM D-698). In addition, the Contractor shall cause a trained and experienced soil technician from an approved testing agency to be onsite during all backfill and embankment placement and to conduct at least two field density tests for every vertical foot of backfill or embankment placed. The Engineer shall review and approve the field density test reports at least every ten (10) vertical feet of embankment and placement of embankment may not continue without this approval.

3.5 Wet Well, Valve Pit and Shear Gate Manhole Lids and Accessories

A. The channel frame shall be 1/4 inch minimum aluminum with anchor flange around the perimeter with a drain into the wet well.

B. Factory finish shall be mill finish with bituminous coating applied to the exterior of the frame.

C. Pump access lids shall be sized according to the pump manufacturer's recommendation. Access hatch (es) on the valve pit shall be large enough to

permit easy installation and removal of the check valves and gate valves, as well as permit access to the Bauer connection. Every structure shall have at least one access lid with a minimum size of 30" x 30" (except that the hatch on the shear gate manhole may be 24" x 24") that will permit entry of maintenance personnel wearing self-contained breathing apparatus.

D. Access lids over the pumps in the wet well shall lift away from the pump guide rails (i.e. toward the influent sewer).

E. Access to the control panels shall meet National Electric Code (NEC) conditions with the lids in the 90° open position. The Contractor shall post the following signs on every aluminum hatch doorframe: 5" x 7" "**DANGER**: CONFINED SPACE: ENTER BY: PERMIT ONLY" and 5" x 7" "FALL PROTECTION REQUIRED". Signs shall be according to State and Federal OSHA requirements. Signs shall be heavy gauge 0.063" aluminum with rounded corners and 1/4" I.D. corner eyelets for mounting. Paint or ink shall be weather-resistant, and the face of the sign shall be covered with a clear Mylar topcoat. Signs shall be mounted on the hatch frames so they are visible with the hatches open or closed. Signs shall be attached with stainless steel self-tapping screws or other appropriate aluminum or stainless steel fasteners. Signs shall be mounted such that they do not present a tripping hazard.

F. Access hatches shall be manufactured by Flygt Corporation or approved equal. Each hatch shall be designed to combine covering of the hole per OSHA standard 1910.23, shall include fall-through protection, and controlled confined space entry.

G. The safety grate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and minimum yield strength of 35,000 psi, per ASTM B221. Grate design shall use safety factors as defined in the "Specifications for Aluminum Structures" by the Aluminum Association, Inc., 5th addition, Dec. 1986 for "Bridge Type Structures".

H. Aluminum grating shall be designed to withstand a minimum live load of 300 lbs per sq ft. Deflection shall not exceed 1/150th of the span.

I. Aluminum grate openings shall be 5"x5", which will allow visual inspection of the pit once the access hatch is opened.

J. Each aluminum grate shall be provided with a permanent hinge system that will lock the grate in the 90-degree position once opened.

K. Design of the system must assure fall through protection is in place after the door has been closed, thereby protecting the next operator/maintenance employee.

L. Each grate shall have an opening arm with a red vinyl grip handle, which will allow opening of the grate, while providing the grate as a barrier between the

operator and the pit. The opening arm shall also be equipped with a controlled confined space entry-locking device (lock provided by others). This locking device will prevent unauthorized entry to the confined space. The grating system will allow anyone to make visual inspection and float adjustments without entering the confined space.

M. Grate shall be painted with OSHA type safety orange paint.

N. Welding shall be in accordance with ANSI/AWS D1.2-90, Structural Welding Code for Aluminum.

4.0 PIPES, ISOLATION VALVES, CHECK VALVES, AND SURGE RELIEF VALVES

A. All pipes and related equipment shall conform to the following specifications:

4.1 Pipes

The force main and other piping at the pump station shall be a minimum of four inches (4") in diameter. Pipe shall be Class 53 ductile iron or High Density Polyethylene.

A. Class 53 ductile iron pipes shall meet ANSI/AWWA C151/A21.51. All pipes shall be cement-lined, meeting ANSI/AWWA C104/A21.4 standards with asphaltic seal coating on the interior.

B. All mating ends in the pump station and valve pit shall be Class 125 flanged meeting ANSI/AWWA C110/A21.10 and C115/A21.15, with a gasket no larger than 0.125 inch between flanges. Flange adapters such as Union Flange will not be allowed. All flanges shall be ductile iron, not gray iron. All flange bolts shall be 316 stainless steel. Exterior of pipes in the wet well and valve pit shall be coated with epoxy-based paint, in accordance with AWWA standards. Only one joint or fitting will be permitted on each pipe between the wet well and the valve pit. This shall be a restrained flexible joint such as a mechanical-joint solid sleeve with Mega Lugs. No flanged joints will be permitted outside the wet well and valve pit.

C. Each pump discharge line shall have a pressure gauge with a lever-operated ball valve installed in the valve pit between the check valve and the gate valve. The gauges shall be stainless steel glycerin-filled diaphragm gauges suitable for raw sewage service. Gauges shall have at least a 2 ½-inch face with a polycarbonate window and a full-scale pressure of twice the shut-off head of the pump. Connections shall be NPT brass or stainless steel with a stainless steel diaphragm seal between the valve and the gauge. Ball valves shall be lever-operated stainless steel with vinyl grip handles and NPT connections. Valves shall be rated for at least 350 psi working pressure. Piping shall be stainless steel or brass with a minimum pressure rating of 200 psi. Hydrostatic tests shall be performed with ball valves turned off. A single pressure gauge on the common force main

(instead of one for each pump) may be approved in some cases; the gauge must be installed between the individual pump isolation valves and the valve on the common force main.

D. Ductile iron force main piping shall have standard push-on bell and spigot joints meeting ANSI/AWWA C111/A21.11 and shall be installed in accordance with ANSI/AWWA C600. Exterior of piping shall be coated with standard asphaltic coating. Ring gaskets shall be of approved composition suitable for the required service. Fittings shall be ductile iron conforming to ANSI/AWWA C153/A21.53 or C110/A21.10. Piping at all bends and at both ends of the force main shall be restrained for sufficient lengths to withstand the higher of: a) the test pressure, or b) the operating pressure plus a reasonable surge allowance. Substitution of concrete thrust-blocks in accordance with AWWA and City of Lancaster standards in lieu of restrained joint pipe will be considered on a case-by-case basis.

E. High Density Polyethylene pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE:345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe O.D. sizes 4-inches to 24-inches shall be available in both steel pipe sizes (IPS) and ductile iron pipe sizes (DIPS). Pipe O.D. sizes 26-inch to 54-inches shall be available in steel pipe sizes (IPS). Pipe shall be minimum DR-11 (160 psi WPR) for pipe sizes up to 36-inches. The pipe shall contain no recycled compounds except that generated in the manufacture's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for us as pressure conduits, listed as NSF 61, and per AWWA C906 Pressure Class (PC)100 have a nominal burst value of three and one-half times the Working Pressure Rating (WPR) of the pipe. Peak flow water velocity of 5 ft/sec shall be used in the hydraulics engineering design.

F. Electrofusion fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Electrofusion fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

G. Flanged and mechanical joint adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and mechanical joint adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe.

H. Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacture's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to temperature requirements of 400

degrees Fahrenheit, alignment, and an interfacial fusion pressure of 75 PSI. The butt fusion joining will produce a joint weld strength equal to or greater than the tensile strength of the pipe itself. All welds will be made using a Data Logger to record temperature, fusion pressure, with a graphic representation of the fusion cycle shall be part of the quality control records.

I. Sidewall fusions for connections to outlet piping shall be performed in accordance with HDPE pipe and fitting manufacturer's specifications. The heating irons used for sidewall fusion shall have an inside diameter equal to the outside diameter of the HDPE being fused. The size of the heating iron shall be 1/4 –inch larger than the outlet branch being fused.

J. Mechanical joining will be used where the butt fusion method cannot be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a ductile iron back-up ring or HDPE mechanical joint with a ductile iron back-up ring.

K. Socket fusion, hot gas fusion, threading, solvents and epoxies will not be used to join HDPE pipe.

L. Force mains shall have a minimum cover of 4.0 feet and a maximum cover of 12.0 feet. High points in the force main should be minimized by the use of deeper cuts through small hills along the alignment. Automatic combination air release valves shall be located at each high point on the force main. The force main shall discharge at an elevation not more than 2 feet above the invert of the receiving sewer, to a separate terminal manhole having no upstream gravity sewer connections. A smooth uniform invert shall be poured in the manhole from the force main discharge to the gravity sewer.

4.2 Isolation Valves

A. Each pump discharge line shall be furnished with an individual isolation valve. Isolation valves shall also be furnished for the Bauer connection and on the common force main beyond the flow meter (before exiting the valve pit, if no flow meter is provided). An isolation valve shall also be installed on the force main side of the surge relief valve, if applicable.

B. Isolation valves shall be of the resilient-seat gate type and shall be as manufactured by Clow Corporation, American Flow Control, Kennedy Valve, M & H Valve, or equal.

C. Gate valves shall conform to the requirements of AWWA C-509 as applicable.

D. Valves shall be furnished with Class 125 flanged ends.

E. All-metal valves shall be manufactured of ASTM A-126 cast iron, Class B, with bronze mounting hardware.

F. Valves shall be of the non-rising stem type, using a double O-ring stem seal, except that packing shall be used when gear operations are required.

G. Valves shall be rated for the following working pressures:

Valve Size	Pressure (psig)	Class
3-in. to 12-in.	200	125
14-in. to 20-in.	150	125

Piping and valves larger than 20-inch diameter shall be individually designed.

H. All valve bodies shall be hydrostatically tested to at least twice the rated working water pressure. In addition, valves shall be seat-tested, bi-directional at the rated working pressure, with seat leakage not to exceed one fluid ounce per inch of valve diameter per hour. A certificate of testing shall be provided.

I. Flanged valves shall have face-to-face dimensions in accordance with ANSI B16.1 and flanges in accordance with ANSI B16.10.

J. All bonnet and packing gland bolts shall be steel, electro-plated with either zinc or cadmium; packing gland bolts shall have bronze nuts.

K. Valves shall be furnished with hand wheels as well as geared operators where required to produce the specified torque with a maximum pull of 80 pounds on the hand wheel.

L. All valves shall be marked in accordance with AWWA standards, including the name of the manufacturer, valve size, working pressure, and year of manufacture.

M. Valves shall open counter-clockwise and close clockwise. Permanent labels shall be provided for each valve, showing both the "Open" position and indicating arrows.

N. Resilient-seated valves shall be coated, interior, exterior, and valve bonnet, with fusion-bonded epoxy, in accordance with AWWA C-550.

O. Each valve gate shall be encapsulated with synthetic rubber that has been bonded and vulcanized in accordance with ASTM B-429, Method B.

P. Recesses in the valve body shall not be permitted.

4.3 Check Valves

A. Check valves for ductile iron pipelines shall be swing-type and shall meet the material requirements of AWWA specification C508 swing-check valves for ordinary waterworks service. The valves shall be of cast-iron body, bronze-mounted, single-disc 175-psi working water pressure, non-shock, and hydrostatically tested at 300 psi. Valve ends shall be 125-pound ANSI B16.1 flanges. Interior and exterior of valve body shall be coated with fusion-bonded epoxy in accordance with AWWA C-550.

B When there is no flow through the line, the disc shall hang lightly against its seat in a vertical position. When open, the disc shall swing clear of the waterway.

C. Check valves shall have bronze seat and body rings, extended bronze hinge pins, and bronze nuts on the bolts of bolted covers.

D. Valves shall be fitted with an extended hinge arm with outside lever and weights. Valves shall be so constructed that disc and body seat may be easily removed and replaced without removing the valve from the line. Check valves shall thus be installed with enough clearance between the valves and the walls of the valve pit to permit removal of the shaft for maintenance purposes.

E. Pump stations designed with a total dynamic head above 100 feet or force main velocity above 4 feet per second shall be evaluated to determine the need for hydraulic cushion check valves. If indicated, check valves shall be equipped with a hydraulic cushion to dampen the last ten percent of the valve closing action. The hydraulic-cushion chamber shall be arranged so that the valve closing speed is adjustable to meet the service requirements.

E. All check valve shafts shall be designed to accept a hydraulic cushion in case future modification is desired.

4.4 Surge Relief Valves

A. Pump stations designed for a total dynamic head greater than 100 feet and/or force main velocity greater than 4 feet per second shall be evaluated to determine the need for a surge relief valve. The surge relief valve shall be designed to prevent damage to any piping, valves, or other equipment in the event of a power failure during operation of all pumps in the station.

B. Any surge relief valve shall be installed in the valve pit with discharge into the wet well.

C. The surge relief valve shall meet the same material and pressure-rating requirements as the check valves.

D. Surge relief valve design and construction shall be approved by the City. Surge relief valves shall have a hydraulic cylinder and externally adjustable spring. Surge relief valves shall be APCO Angle-style Surge Relief Valve (Drawing No. S-3000) or approved equal.

5.0 ELECTRICAL

A. All electrical components shall meet NEMA standards, and shall comply with NEC and UL as applicable to construction and installation of wiring and components. The electrical system inside the wet well shall comply with the National Electric Code for Hazardous Locations, Class I, Division 1, Group D.

B. An enclosure shall be provided to house all electrical equipment outlined in the following specifications. The enclosure shall be located on a separate reinforced concrete pad adjacent to the wet well as close to the wet well as safely and practically possible. The pad shall be of sufficient size to support the enclosure and provide access in accordance with NEC requirements.

C. The enclosure and the electrical equipment, which shall be supplied with each sewage pump station, are described in this section.

D. The utility company electric meter, utility company CT enclosure, service entrance-rated main breaker or fusible disconnect, and automatic transfer switch enclosure shall be mounted on a structure of 3" stainless steel strut (square tubing and U-channel) to one side of the main motor control panel enclosure on the same

concrete pad. The control transformer shall be mounted either on the stainless steel strut or on the side or back of the main control panel enclosure.

5.1 Enclosures

A. The enclosure shall contain both the motor control panel and the Supervisory Control and Data Acquisition (SCADA) remote terminal unit (RTU). The RTU shall be isolated from the motor control panel. Hardwire controls must be kept away from the RTU to prevent electrical noise interference.

B. Enclosures supplied with each station shall be freestanding, double-door Hoffman # A-74H7224SSLP or equal (or appropriately sized equivalent) and shall be rated NEMA Type 4X. The enclosure shall be large enough to provide an unused space equal to at least 30% of the space required. This space shall be reserved for installation of future equipment by the City, and no wiring or controls shall intrude into this reserved space. The construction shall be of 12-gauge 304 stainless steel, in accordance with ASTM A-167, and shall be supplied with a drip shield, a continuous hinge on the panel, and smooth seamless sides. All bolts, screws, pins, and other fasteners used in the enclosure shall be stainless steel.

C. The enclosure shall include add-on kits equal to the Hoffman kits listed by catalog number below:

1) A-DSTOPK Door Stop Kit.

i. A-LF16M18 Light with remote switch (provide 2 lights if panel size or configuration dictates).

ii. Design-air Electric Heater, 115 volt, with built-in thermostat, Model D-AH2001A, or other Hoffman model sized properly to ensure proper air transfer and heating of entire enclosure (provide 20 F temperature rise above ambient). Two heaters will be necessary where the enclosure is divided into separate compartments.

D. Each enclosure shall have a door-in-door arrangement with interior swing-out panels on each side. The alternating on-off switch, circuit breakers, control switches, pilot lights, etc., shall be accessible to the operator from the inner panel without opening the inner doors. The outer panel shall be void of control devices.

E. The outer panel doors of the enclosure shall be secured as follows: Both the right-hand and left-hand doors shall be secured with pad-lockable Hoffman latch, Cat. # A-L1CR.

F. The subpanel in the back of the main enclosure shall be steel painted with white ceramic paint (Hoffman A-72P72 or equal). All other components of the enclosure shall be stainless steel.

G. Each sewage pump station enclosure shall be provided with one duplex service outlet of 120-volt AC 20-amp rating. This outlet shall be supplied from the control transformer and shall have GFCI circuit protection. The outlet shall be located in the motor control panel behind the inner door.

H. All enclosures, panels, etc. (including the motor control panel) shall be UL-listed and shall be fabricated by a UL-approved shop in accordance with NFPA 79 Electrical Standards for Industrial Machinery.

I. An outline drawing of the control panel shall be provided, showing panel elevation, dimensions, and weight. Interconnecting wiring diagrams shall be provided, which show all electrical connections between field-installed equipment and the control panel. Schematic control wiring diagrams shall be provided, showing all control components, switches, pilot lights, relays, etc. The wiring diagrams shall indicate wire and terminal numbers. Each component shall be uniquely labeled. A copy of all as-built electrical/control/instrumentation drawings shall be laminated (or otherwise sealed in plastic) and permanently located in the main control panel enclosure.

J. The Contractor shall provide for City of Lancaster to inspect the motor control panel during fabrication at the following points: 1) Once all components are arranged in their proper positions in the panel (preferably, physically positioned in the panel, but not bolted in place) before any wiring is completed. 2) When the panel is substantially complete, but before it has been shipped from the site of assembly. These inspections shall be by one of the following methods at the discretion of City of Lancaster: either employees of City of Lancaster will travel (at the City's expense) to the site of assembly or the Contractor shall provide to City of Lancaster sufficient digital photographs in a format acceptable to City of Lancaster clearly showing all portions and details of the control panel to City of Lancaster's satisfaction. Work on the control panel shall not progress beyond these points without the approval of City of Lancaster. Any changes required by City of Lancaster because of these inspections shall be performed prior to any further work on the panel.

K. A 24"x24"x8" stainless steel NEMA 4X junction box shall be mounted over the wet well on two 6"x6"x24" vented stainless steel feed-through wire ways (Hoffman F-66W24SS or equal) over two 5" holes through the wet well top slab. The door of this junction box shall open in a direction away from any access hatches in the wet well, and the door shall be pad lockable. All wires entering the wet well (pump power and control wires, float wires, etc.) shall be connected to terminal strips inside this junction box with corresponding wires extending to the main control panel. Terminals shall be labeled as "Pump 1," "Pump 2," etc. Cord

grip connectors or other appropriate components shall be used at the bottom of this junction box for all wires entering the wet well to seal the opening and provide strain relief for the wires. Stainless steel braided wire sleeves with attachment tails shall also be provided for large pump cords.

5.2 Circuit Breakers

A. All circuit breakers shall be heavy-duty thermal magnetic type, with molded case breakers. Breakers shall be UL-listed and CSA-certified, and shall meet Federal Specification W-C-375B/GEN.

B. Three-pole breakers shall be manufactured by Square D and shall have a short-circuit rating equal to 125% of the available fault current. Regardless of the available fault rating, circuit breakers shall not be less than Style FA for applications under 100 amps, or Style KA for applications between 100 and 250 amps.

C. Single-pole breakers shall be Square D QOU series and shall be used for control circuitry and peripheral devices.

D. A main circuit breaker shall be provided inside the main enclosure for the control panel (on the load side of the automatic transfer switch), with separate circuit breakers for each motor and transformer primary, as well as single-pole circuit breakers for control circuitry, RTU, lighting, outlets, flow meter & chart recorder, generator block heater, generator battery charger, etc. Another service entrance-rated circuit breaker or fusible disconnect shall be provided in a NEMA 4X stainless steel enclosure outside the main enclosure on the line side of the automatic transfer switch, lightning arrester, etc.

E. Circuit breakers shall be accessible to the operator through the inner panel door without having to be exposed to open wiring. The main and motor branch circuit breakers shall be lockable.

F. A minimum of two spare 120-volt AC, 15-amp circuit breakers shall be provided and mounted on the panel.

5.3 Starters

A. Motor starters shall be electronic overload starters with adjustable trip phase loss, ground fault, and phase reversal protection. They shall be equipped with three poles and shall be provided with auxiliary contacts for use in the control circuit and for status inputs to the SCADA system. Starters shall be Allen Bradley Bulletin 509 type with SMP-2 adjustable overload relay, Square D Class 8536 full voltage NEMA starters with optional solid state motor logic overload relay (Class

9065 if ordered separately), or Furnas ESP 100 series, Class 14 with Class 20 trip overload, with solid state adjustable thermal overloads. No other starters will be considered equal or allowed.

B. Starters shall conform to all NEMA ratings. The minimum size starter shall be NEMA 1.

C. Electronic soft-start starters, as manufactured by Allen-Bradley, shall be supplied for all motors 30 horsepower or larger or where otherwise required by a local power company or the City. Soft-start starters shall also be provided with a soft-stop feature.

D. Provisions for sequential pump starting shall be made in the controls to prevent more than one pump from starting simultaneously.

5.4 Control Transformers

A. Control transformers shall be dry type, stainless steel enclosed (NEMA 3R), mounted external to the main control panel. Primary voltage shall be 480 or 240 volt AC (same as main power supply) and secondary voltage shall be 120 volt AC.

B. The transformer should be sized for the proposed power requirements of the pump station plus an additional 25% capacity for future loads, with a minimum output current rating of 30 amps. The transformer shall be protected by circuit breakers on the primary and secondary sides.

5.5 Control Relays

A. All control relays shall be of the 8- or 11-pin octal plug-in type, Allen Bradley or equivalent. Relays may be either direct panel-mounted or DIN rail-mounted. Control relays shall be of at least DPDT configuration.

B. Intrinsically safe relays (Warrick Series 27A1D0 Intrinsic Barrier or approved equal) shall be provided for operation with the wet well float switches. Wiring associated with the intrinsically safe relays shall be segregated from other power and control wiring.

5.6 Duplex Alternator

A. The alternating relay shall be rated for 120 - 600 Volts and shall be Furnas, Cat. No. 47AB10A*, Class 47, Square D Class 8501 or approved equal.

B. An alternating on-off switch shall be provided in the panel. For duplex stations, this shall consist of a selector switch with the following options: PUMP 1 -- ALTERNATE -- PUMP 2.

C. The above describes a duplex alternator. Pump stations with three or more pumps shall have an alternator capable of equalizing operating hours among the pumps.

5.7 Probe Control System

A. The probe control system shall provide for the automatic and manual control and alternation of the pumps to maintain a pumped down/up condition of the wet well/tank. Conductive probes adjusted to the levels depicted on the plans shall sense levels. The probes shall sense the "off", "on" and "alarm" levels within the wet well. Multitrode shall manufacture probe.

5.8 Switches and Pilot Lamps

A. All lamps shall be of the transformer type.

B. Switches and pilot lamps shall be oil-tight and shall meet NEMA standards for A600 heavy-duty contacts. Each pump shall have a separate selector switch with the following settings: HAND -- OFF -- AUTO. Each pump shall also have a green pilot lamp connected to auxiliary contacts on the starter to indicate when the pump is running. These switches and lights should be located inside the control panel.

C. All HOA switches and pilot lamps shall be Allen-Bradley 800 series or approved equal. Switches and pilot lamps shall be oil-tight and shall meet NEMA standards for A600 heavy-duty contacts. All pilot lamps shall have the push-to-test feature.

5.9 Over-Current Relays

A. Adjustable over-current relays shall be provided and shall be wired so that every motor lead passes through a separate current loop (i.e. one current loop for each phase of each pump).

B. Output contacts for a remote alarm shall be provided.

C. The over-current relays shall be SSAC Model No. ECS41BC or equivalent for pumps with full-load current up to 20 amps or SSAC Model No. ECSH4HBD for pumps with current rating between 20 and 50 amps.

D. When rated motor current exceeds 50 amps, current transformers shall be provided to satisfy the current requirements (i.e. current shall be reduced to below 50 amps for monitoring purposes). This shall be accomplished by running the motor leads through appropriately sized current transformer "donuts" and running the leads from the current transformers through the current loops of appropriately sized over-current relays.

5.10 Voltage Monitors

A. A voltage monitor shall be supplied to monitor the incoming voltage. This unit shall be manufactured by SSAC, Model No. WVM911AL (480 volt), WVM611AL (240 volt) or equal. The monitor shall be rated at either 480 volt AC or 240 volt AC, according to the incoming voltage source. The restart delay shall be adjustable from 0.25 to 64 seconds. Voltage monitor shall monitor all incoming phases. Protection of the voltage monitor, on the incoming voltage, shall be through 2-amp fast-blow fuses (Bussman KTK-R2 or equal).

B. When an under-voltage condition occurs, an alarm shall be sent via the SCADA system after an adjustable time delay.

5.11 Wire and Cable

A. All wiring and cable installation shall conform to NEC regulations and shall comply with local codes. All conductors shall be copper. Wiring shall not be operated above 75° C.

B. For electrical equipment feeders (motor control centers, motor branch circuits, etc.), located below grade or for exterior control and motor circuits, wiring shall be type THHN through #2 AWG and type RHH for larger than #2 AWG.

C. For branch circuits for lighting and receptacles, wiring shall be type THHN in conduit. For branch circuits for interior control, wiring shall be type MTW.

D. Power wiring shall be 12 AWG minimum, and control wiring shall be 14 AWG minimum.

E. For instrumentation (i.e. 4-20 mA signals), cables shall be 16 AWG copper, NEC-type TC rated at 600 volts (Belden No. 1118A or equal) individually shielded twisted pair cable. All digital signal wires may be of the type of wire specified above.

F. All SCADA and signal wires shall be in conduit separate from any AC power lines. All motor circuits must be in separate conduits apart from any lighting, receptacle, or control wiring.

G. All conductors shall be sized such that voltage drop does not exceed three percent for branch circuits or five percent for feeder branch circuit combinations.

H. The use of pulling compound shall be required in all installations of wire pulled in conduit as needed. All conduits shall be sized in accordance with NEC regulations and/or local codes.

I. All terminal blocks shall be Allen Bradley terminals Model # 1492-CA1 for wire sizes #22 - #8 with mounting channel Model # 1492-N1, end barriers Model # 1492-N16, and end anchors Model # 1492-N23, or approved equal. At least 10% spare terminals shall be provided on all terminal strips. Bare wire ends shall be connected into the recessed terminals. No fork-tongue compression terminals shall be used unless approved by the Owner for specific applications. A UL-listed anti-oxidation compound shall be used on any wires connected with wire nuts.

J. All wiring and components shall be tag-numbered, clearly marked at each termination in accordance with the drawings, and as directed by the Engineer. Wire tags shall be heat shrink type wire markers with permanent legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.

5.12 Raceways and Conduit

A. All conduits shall be of one of the following types:

1) Rigid aluminum, which shall comply with NEC and local codes. Rigid aluminum conduit shall be used for all above-grade installations and shall not be used for buried conduits.

2) PVC plastic, which shall be Schedule 80. All PVC conduits shall comply with NEC and local codes and have glued joints. PVC conduit shall not be used for interior conduits or above-grade exterior conduits, but shall be used for all buried conduits.

3) Liquid-tight, which shall be flexible steel conduit with a high tensile strength galvanized steel core and continuous copper ground built into the core. This conduit shall have a smooth non-wrinkling PVC jacket that will not pull away from fittings. This conduit shall be type LA Liquatite as manufactured by Electri-flex, or equal. Liquid-tight conduit shall be used for any final runs into instrumentation equipment, and shall not exceed 18 inches in length.

B. Conduits between the wet well and control panel shall have a minimum size of 2" and shall be as follows, unless otherwise approved by City of Lancaster:

1 conduit for each pump
1 conduit for future mixer or influent grinder (spare)
1 conduit for high-high level (SCADA)
1 conduit for probe control system.

C. All conduits shall be tagged and identified with brass tags held on by copper wire at both ends.

D. Conduit routing and wire-pulling schedules shall be submitted with shop drawings.

E. Conduits for three phase wires between the main transformer and the transfer switch, as well as between the generator and the transfer switch, shall be encased in a minimum of three inches of concrete on all sides. Other conduits shall be encased in concrete when shown on the plans. Other buried conduits may be encased at the discretion of the Contractor. Concrete encasement shall be colored as required by electrical codes.

F. Plastic conduit spacers shall be used for all buried conduits, whether encased in concrete or not.

5.13 Grounding

A. All submitted site plans shall show a grounding scheme. Grounding shall comply with NEC requirements.

5.14 Security System Devices

A. Security system devices shall be furnished and installed as described below

a. For pump stations with a building, a limit switch shall be mounted on each exterior door such that the switch opens when the door is opened. All such switches shall be connected in series to the Site Entry input point on the SCADA RTU.

b. All outdoor control enclosures shall have a limit switch mounted at each exterior door such that the switch opens when the door is opened. All such switches shall be connected in series to the Site Entry input point on the SCADA RTU.

c. A limit switch shall also be mounted at the control panel subpanel door that covers the SCADA RTU, radio, modules, etc. such that the switch closes when this subpanel door is opened. This limit switch shall be connected to the Tamper Switch input point on the SCADA RTU.

d. Limit switches shall be Allen Bradley model BUL802M-AY5 (or approved equal) with lever arm. Conduit shall be continuous to the limit switch or the Contractor shall install heavy duty, moisture proof cable type ST00W-A 16 AWG 4C by AIW Corp. or equal from the limit switch to the conduit grip end.

e. An Allen Bradley model 800T-H2A switch (or equal) shall be used for the operator ("Entry/Depart") switch.

5.15 Nameplates

A. Engraved nameplates shall be provided for every circuit breaker, control switch, pilot light, etc. Nameplates shall be white-faced tags with engraved black letters.

Letters shall be at least 3/16-inch in height. Use of DYMO type labels is not acceptable.

B. Nameplates shall be attached to the panel by means of stainless steel machine screws.

5.16 Line-Surge Protection

A. A lightning arrester and line-surge capacitor shall be provided on the incoming power lines. The lightning arrester shall be of the 650-volt, 3-phase, "Transquell" type, as manufactured by General Electric Co., Cat. No. 9L15ECC001, Square D Model SDSA3650, or equal. Line-surge capacitors shall be 650-volt, 3-phase, non-toxic liquid-insulated, as manufactured by General Electric Co., Cat. No. 9L18BBB301, or equal. The lightning arrester and line-surge capacitor shall be mounted outside the control panel.

5.17 Local Alarm

A. An audible and a visual alarm shall be mounted on the enclosure. Mounting the alarm on the top or front of the panel shall not be acceptable. Specific site conditions shall dictate the orientation of the alarm and panel.

B. The alarm light shall be visible from 360 degrees.

C. The alarm light shall be a weatherproof, shatterproof, red light fixture with a 40-watt bulb to indicate alarm conditions.

D. The local alarm shall be connected to the probe control system, as described in Section 5.7, Probe Control System.

5.18 Elapsed-Time Meters

A. An elapsed-time meter connected to auxiliary contacts on the pump starter shall be furnished for each pump.

B. A separate elapsed-time meter shall also be furnished to indicate when two pumps run simultaneously.

C. Elapsed-time meters shall have an increment of 1/100 hour.

D. Elapsed-time meters shall be non-resettable.

5.19 Site Lighting

A 1,500-watt Quartz flood light shall be mounted on the SCADA antenna pole at least 15 feet above the ground, but below the antenna. Conduit shall be extended continuously up the pole to the light. A two-position switch shall be mounted on the interior door of the main control panel to control this light. A photoelectric cell shall not be installed.

5.20 Installation

All electrical devices, conduit, wiring, and grounding must be installed and connected by a City licensed electrical contractor. All electrical work shall comply with all local, state, and federal electrical codes.

6.0 STANDBY POWER

A. Standby power shall be provided for each pump station through either a weatherproof receptacle capable of connecting to a portable generator with a manual transfer switch or a permanent on-site generator with an automatic transfer switch.

B. A permanent on-site standby power system shall be required at all permanent sewage pump stations and any other station where required by the Ohio EPA or City of Lancaster (see Appendix A).

C. Each generator shall be sized to supply emergency backup power capable of starting and operating a sufficient number of pumps to pump the maximum design flow for the station, as well as operating all other electrical components. The generator set shall be manufactured by Onan/ Cummins, Kohler, or Caterpillar, for 240 or 480 Volts (same as main power supply), 3 phase, 4 wire, 60 Hz operation, complete with all standard equipment and all accessories described herein.

D. Provisions for sequential pump starting shall be made to minimize generator size and prevent overloading.

E. The backup power supply unit shall be a modular, self-contained package, conforming to NEC and local electric codes, as well as to all EPA, OSHA, and Underground Storage Tank or Wellhead Protection regulations.

F. The power plant driving the generator, whether permanent or portable, shall be diesel or natural gas. Generators located within the Wellhead Protection areas shall be natural gas.

G. Each location with a permanent generator shall be equipped with a fuel tank capable of supplying fuel sufficient for a minimum of twenty-four hours of generator operation at full load. The fuel tank shall be self-contained and double-walled with mechanical fuel gauge, low-level fuel switch, and leak detection.

H. Each permanent generator shall be mounted on a raised reinforced concrete pad in a weatherproof enclosure with louvers and shall have removable panels or housing to allow access to the engine, generator, or controls. Enclosure shall be completely rodent-proofed. Permanent generators shall be located to be accessible by a truck for maintenance purposes.

I. Other required equipment shall include a radiator coolant system, electric block heater, flexible fuel lines, line circuit breaker (100 amp minimum), safeguard breakers, oil drain extension, voltage regulator, overvoltage shutdown protection, 12- or 24- volt battery pack and automatic float battery charger, vibration isolators, alarm horn with silencing switch, critical or residential-grade (as appropriate) exhaust muffler, tail pipe and rain cap. A sound-attenuating treatment shall be provided to reduce sound levels to no more than 85 dbA at 50 feet from the enclosure if any residence is located within 100 feet of the enclosure or if there is a potential for any residence to be located within this distance in the future.

J. Auxiliary contacts shall be furnished and installed to interface with the SCADA system for monitoring purposes. This shall include an engine run relay and a common failure relay (the common failure relay should be wired to a terminal strip near the SCADA system, but not connected to SCADA at installation).

K. The generator set controller shall be a Dec III Controller or equivalent and shall include the following features: oil pressure gauge, engine water temperature gauge, DC battery voltmeter, low water temperature fault alarm, auxiliary pre-alarm senders (incl. low water temperature, approaching low oil pressure, and approaching high water temperature), and battery charger fault and low voltage alarm.

L. The Automatic Transfer Switch (ATS) shall be the electrically operated type that is mechanically held in both operating positions with time delay neutral position. ATS shall be suitable for use in standby systems described in NFPA 70. ATS shall be rated for continuous duty at the continuous current rating specified. All rating data shall be shown on shop drawings, and shall equal or exceed those specified. Switches shall be adequately rated for the application indicated and shall have the following characteristics and features.

1. Voltage: 240 or 480 Volts AC (same as main power supply)

2. Number of Phases: Three (3)

3. Number of Wires: Four (4)

4. Number of Switched Poles: Three (3)

5. Frequency: 60 Hz

6. Type of Load: Total system load

7. Continuous Phase or Main Current Rating: Equal to or exceeding the rating shown, but in no case less than 125 percent of the full load rating of the emergency power source or 100 amperes.

8. ATS Withstand Rating (Fault Current Availability Rating): Rated to withstand an available fault or short-circuit current of at least 22K amperes, RMS symmetrical, at a power factor between 0.0 and approximately 0.20, for a duration of 0.5, 3, 10 cycles at a maximum voltage of 600 Volts AC.

9. Overload Rating: 100 amperes, RMS symmetrical

10. Non welding of Contacts: Rated for non-welding of contacts when used with the appropriate feeder over-current devices and with the available fault current specified.

11. Main and Neutral Contacts: Contacts shall have a silver composition and shall be protected by approved arcing contacts. Neutral contacts shall have not less than 1.5 times the continuous current rating of the main or phase contacts.

12. Features: ATS shall include adjustable time delays between switch positions and an in-phase monitor (unless a programmed transition switch is provided). ATS shall have a manual override and a disconnect plug, if applicable. ATS shall include main shaft auxiliary contacts for Normal and Emergency positions that shall be connected to SCADA. Automatic and Inhibit Transfer switch shall be provided. Include pilot lights to indicate normal or emergency switch position as well as normal and emergency source availability. ATS shall include test switch and auto-exercise capabilities with load/no-load selector switch.

13. Enclosure: Stainless steel NEMA 4X with enclosure heater and drip shield. All switches, lights and other controls for the transfer switch shall be mounted internal to the enclosure–either on an inner door or an inner "standout." No controls shall be mounted through the outside of the enclosure.

14. If no permanent generator is provided, an auxiliary receptacle and manual transfer switch shall be provided suitable for connecting to the City's portable generator. The transfer switch shall be 3-pole, 240 VAC, double-throw (center position off) stainless steel, externally mounted. The transfer switch shall be Square D Class 3140 or equal. The receptacle shall be Killark, 200-amp, Style 1, 4-wire, 4-pole.

7.0 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

A. All pump stations shall be supplied with Supervisory Control and Data Acquisition (SCADA) equipment. The SCADA equipment shall include all materials and software; and all necessary installation, programming, and testing procedures shall be performed by the Contractor or by the City at the Contractor's expense (as determined by the City). SCADA equipment shall conform to the specifications set forth in the following sections.

7.1 SCADA Equipment

A. The SCADA equipment shall be Westerman Controls. The RTU shall be equipped with all input/output (I/O) modules needed to monitor and/or control all functions outlined in Sections 7.4 and 7.5, below. A Metricom spread spectrum radio shall also be included. The radio shall be programmed as necessary to integrate with the City's existing systems. A two pump system shall consist of:

1. One (1) CT 4000 processor board
2. One (1) I/O 4240 analog input card
3. One (1) I/O 4481 status input card (dry contact only)
4. One (1) I/O 4480 digital input/output card
5. One (1) Metricom 900 MHz spread spectrum radio
6. One (1) fabricated back panel
7. One (1) NEMA 4X enclosure
8. One (1) mast pole and Omni 7 DB antenna
9. One (1) polyphaser
10. One (1) power sonic 10AH battery
11. One (1) enclosure strip heater

12. One (1) power supply

13. Eight (8) crydom relays

14. One (1) CA 1511 Modem

7.2 Electrical

A. All wiring, conduits, and grounding shall adhere to the provisions and specifications in Section 5.11, Wire and Cable; Section 5.12, Raceways and Conduit; and Section 5.13, Grounding.

B. Lightning protection must be provided on all DC signal loops connected to the RTU or instrumentation from a location outside of the main control enclosure. Surge arresters shall be CITEL or equivalent.

7.3 Antenna

A. A computer path study and an actual path study at the site shall be performed by Westerman Controls, 245 North Broad Street, Bremen, OH 43107, (740) 569-4143 to determine antenna type and placement. A formal report with all documentation and data obtained from the study shall be provided to City of Lancaster.

B. Antenna shall be an Omni 7DB, as recommended by the path study and approved by the City. Location and height of the antenna shall be such that a 99% communications rate with the Lancaster WWTP shall be guaranteed year round with a 15-year design goal.

C. Mounting shall be as determined by the path study. Wood utility poles used for antenna mounting shall be Class #5 up to 30' long and Class #4 for 30' to 70' long. Installation of poles must be plumb and straight. All mounting brackets shall be aluminum, stainless steel, or galvanized steel. Shop drawings for all antenna and antenna cable assembly hardware shall be submitted and approved.

D. Installation of the cable shall conform to all manufacturers' specifications.

E. The coaxial cable shall be properly grounded. Surge suppression that is rated for exterior weather conditions shall be provided at the RTU end of the coaxial cable. A Polyphaser bulkhead type lightning surge protector shall be provided for the antenna installation and shall be mounted on the outside wall of the main enclosure. This lightning surge protection shall include coaxial impulse suppressors combined with AC line protectors.

7.4 I/O Requirements

A. All input/output points on a standard two-pump sewage pump station are presented in the list below. All inputs and outputs at the sewage pump station shall conform to this listing. Pump stations having more than two pumps will have a slightly different input/output arrangement as directed by City of Lancaster.

1. Loss of Power (RTU).....status input
2. RTU Panel Intrusion.....status input
3. Site Intrusion.....status input
4. Generator On/Off.....status input
5. Pump #1 Start/Stop.....digital output
6. Pump #1 Hand.....status input
7. Pump #1 Auto. .....status input
8 Pump #2 Start/Stop.....digital output
9. Pump #2 Hand.....status input
10. Pump #2 Auto.....status input
11. Pump #1 Seal Fail.....status input
12. Pump #2 Seal Fail.....status input
13. High Water Alarm.....status input
14. Low Level.....status input
15. Battery Voltage.....analog input
16. Wet Well Level.....analog input

7.5 I/O Equipment

A. All input devices shall be identical to existing equipment previously installed on existing SCADA systems within City of Lancaster sewage pump stations.

B. Voltage and current sensors shall be as specified in Section 5.9, Over-Current Relays, and 5.10, Voltage Monitors. If used, relays shall comply with Section 5.5, Control Relays; otherwise, auxiliary contacts shall be compatible with their host equipment (motor starters).

7.6 Programming and Testing

A. Programming of the local RTU, the City's central SCADA system, and other related equipment, as well as all testing procedures (OATs & FATs) shall be performed by the Contractor or by the City at the Contractor's expense (as determined by the City on a case-by-case basis). In the event that the City performs the programming, the Contractor shall ship the CPU module to the City's subcontractor (Westerman Controls, Bremen, Ohio) for programming. Regardless of who performs the programming and testing, the Contractor shall resolve any equipment or wiring deficiencies discovered during the testing.

8.0 FLOWMETERING

A. All permanent pump stations, as well as other pump stations specifically identified by the City, shall be provided with a flow-metering device for monitoring the discharge from each station. Station discharge piping shall be configured with a straight run of pipe with no valves, tees or reducers upstream of the flow meter equal in length to at least ten pipe diameters and downstream of the flow meter equal in length to at least six pipe diameters--or as otherwise recommended by the flow meter manufacturer, to provide an acceptable flow pattern through the flow meter.

B. All flow meters shall be calibrated at the factory prior to shipment to the site. The contractor shall be responsible for the complete installation.

C. All new pump station flow meters shall be magnetic flow meters and shall include the transmitter, the remote-mounted flow tube, and the vendor-supplied shielded cable between the two elements.

8.1 Magnetic Flow meter Flow Element

A. The flow element of the magnetic flow meter shall conform to the following specifications.

B. Pulsed DC electromagnetic induction-type, providing a signal that is linear in relation to the liquid flow rate. **NOTE: AC-type meters may be required if conductivity is below 5 micro Siemens/ centimeter**.

C. Functional/performance specifications shall be as follows:

1) Power requirements shall be matched to the flow transmitter/ converter.

2) Accuracy shall be ±1 percent of rate (including the transmitter/converter).

3) The flow meter shall be suitable for operations in process liquid temperatures up to 70□ C and an ambient temperature of 65° F.

4) RFI protection shall be provided.

5) The flow meter shall be capable of operations under pressures of 240 psi, if 150-pound flanges are used, and 700 psi, if 300-pound flanges are used.

6) The flow meter shall be capable of running under no-flow conditions without damage to any component.

D. Physical specifications shall be as follows:

1) The metering tube of the flow meter shall be carbon steel, unless otherwise indicated.

2) Flow meter flanges shall be ANSI 150-pound carbon steel, unless otherwise indicated.

3) The liner shall be polyurethane or fusion-bonded epoxy, unless otherwise approved by City of Lancaster.

4) Electrodes shall be 316 stainless steel, bullet-nosed or elliptical self-cleaning type, unless otherwise indicated.

5) Flow meters shall be housed in below-grade vaults and shall be designed to withstand accidental submergence in 30 feet of water for 24 hours. Where hazardous areas are indicated on the Contract Drawings, flow meters shall be rated for conditions in those areas.

6) All external surfaces of the flow meters shall be painted with a chemical- and corrosion-resistant epoxy finish.

E. Accessories/options required:

1) All flow meters shall be factory-calibrated. A copy of the calibration report shall be included in the operations and maintenance manual.

2) Flow meters shall be grounded according to manufacturer's recommendation. All accessories, such as a ground ring, ground wires, gaskets, etc., shall be provided as required or as otherwise specified. All materials shall be suitable for the liquid being measured.

F. Flow meters shall be a Foxboro 8000 Series, Fischer and Porter, or Rosemount magnetic flow meter.

8.2 Magnetic Flow meter Transmitter/Converter

A. The flow transmitter/converter shall be supplied by the manufacturer of the flow element.

B. Functional/performance specifications shall be as follows:

1) Power requirements shall be 120 volt AC, ±10 percent.

2) Accuracy shall be as defined for the flow element.

3) The operating temperature range shall be -25 C to 65 C

4) The output shall be isolated 4-20 ma. DC into 0 to 1000 ohms

C. The flow meter transmitter/converter shall be mounted in the main control panel.

D. Accessories/options required:

1) A signal cable shall be provided between the flow element and the signal converter.

2) A local indicator shall be provided with an engineering scale to indicate actual flow rate and total flow.

3) A second flow rate indicator and non-resettable totalizer shall be provided on the enclosure RTU subpanel if the transmitter is not located in the enclosure. This unit shall be a Newport P6000 ratemeter/totalizer.

8.3 Chart Recorder

A. A circular paper chart recorder shall be provided for each pump station that has a flow meter. Recorder shall have a rotation time (recording time per chart) of at least 7 days.

B. Chart recorder shall be a Honeywell Truline.

C. Chart recorder shall have 2-channels and pens and shall include a totalizer display for both channels.

A one-year supply of pens and single-sided charts shall be provided.

8.4 Flow Meter Manhole

A. The magnetic flow meter shall be installed in a five-foot (5') diameter manhole with slab top and a 30"x30" (minimum) aluminum access hatch meeting the requirements of Section 3.5.

B. The flow meter manhole shall be supplied with an embedded socket at the access hatch to support a Halliday Products Model D2B36B portable stainless steel winch-type hoist.

C. The flow meter manhole shall be watertight (except for the aluminum access hatch) and shall not be fitted with any drainage system.

9.0 PERIMETER FENCE

A. The pump station area shall be enclosed with industrial-grade chain-link fence. This fence shall be 9-gauge chain link, with 3-inch end posts and 2-inch line posts. A 1-5/8" top rail shall be placed on the fence. The end posts, line posts, and top rail shall be structural galvanized steel with a rating of SS40. The fence shall be six feet high. The fence fabric shall be kept approximately 3-4 inches off the ground to allow trimming but prevent access under the fence.

B. Access through the perimeter fence shall be by means of a lockable sliding gate with a working length of 16 feet. In the event that the site layout makes a sliding gate impractical, dual-leaf swinging gates (8' each) may be acceptable. Either gate shall be constructed with SS40 structural galvanized steel for the outside frame (2.5" for sliding gate or 2" for dual-leaf swinging gates) and SS40 structural galvanized steel 1-5/8" filler supports. The frame shall be covered in 9-gauge chain link. The gate shall be capable of being padlocked to prevent unauthorized access to the station.

C. A personnel access swing gate (minimum 3 feet wide) shall also be installed in the fence in addition to the sliding gate. This gate shall be located on the perimeter fence as appropriate for convenient access to the station. This personnel access gate shall be capable of being padlocked to prevent unauthorized access to the station. The gate shall be constructed of SS40 structural galvanized steel tubing and 9-gauge chain link. The frame shall be 2" tubing with 1-5/8" filler support.

D. The perimeter fence shall be constructed no closer than twelve feet from the wet well, valve pit, or any building, or six feet from the generator pad, control panel pad, or SCADA pole. Gate placement shall be such that there is adequate truck access to the wet well, valve chamber, and generator, or, if a portable generator is used, to a plug and transfer switch. There shall be sufficient room within the fence to permit the maneuvering of equipment and the later installation of a generator (if one is not initially installed) while still meeting the above requirements.

E. The perimeter fence shall be grounded. Fence grounding shall be installed at maximum intervals of 1500 feet, except as follows:

1. Ground fencing within 100 feet of buildings, structues, walkways and rodways at maximum intervals 750 feet.

    a. Gates and other fence openings shall be grounded on each side of opening.

    1) Bond metal gates to gate posts

2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2-gage wire and bury it at least 18-inches below finished grade.

2. Ground fencing at location of crossings of overhead electrical power lines and at a maximum distance of 150 feet on each side of the crossing.

3. Fences enclosing electrical power distribution equipment shall be grounded as required by Institute of Electrical and Electronic Engineers (IEEE) C2, National Electrical Safety Code.

4. At each grounding location, drive a ground rod vertically until the top is 6-inches below finished grade. Connect rod to fence with No. 6-gage connector. Connect conductor to each fence component at the grounding location, including the following:

1. Each barbed wire strand shall be connected with wire-to-wire connectors designed for this purpose.

5. Connect bonding jumper between gate post and gate frame.

6. Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors and connection methods so metals in direct contact will be galvanically compatible.

1) Use electroplated or hot-tin-coated materials to ensure high conductivity and make contact points closer in order of galvanic series

2) Make connections with clean, bare metal at points of contact.

3) Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4) Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

5) Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

7. If the fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor.

F. The Contractor shall post the following sign on the sliding gate: 14" x 20" "DANGER: HIGH VOLTAGE" (EMED Co., Inc. Sign No. PD102859 or equal). The sign shall be according to State and Federal OSHA requirements. The sign shall be heavy gauge 0.063" aluminum with rounded corners and 1/4" I.D. corner eyelets for mounting. The sign shall be attached with aluminum or stainless steel fasteners. Paint or ink shall be weather-resistant, and the face of the sign shall be covered with a clear Mylar topcoat.

G. Where the zoning code requires a screening fence, the fence shall be a rigid PVC privacy fence in a style and color that harmonizes with the surrounding land use. Screening fences shall meet the requirements of the zoning code and be approved by the City of Lancaster prior to installation.

9.1 Chain Link Fence Specifications

A. The Contractor shall provide all labor, materials, tools, and equipment required to furnish and install in good competent manner the chain link fence and gates complete as shown on the plans and as specified herein.

B. GENERAL

1) Layout. Unless directed otherwise by the Engineer, the fence shall be erected in close conformance with lines, grades, and locations shown.

2) Hot Dip Zinc Coating (Galvanizing) Framework and appurtenances shall be of High Grade or Special High Grade conforming to ASTM B 6 with a maximum aluminum content of 0.01 percent. Galvanized metal by the "hot dip" process in compliance with the following standards:

Class of Work	ASTM
Structural Iron and Steel Shapes	A 123
Rolled-Form Sheet Steel	A 653
Hardware and Accessories	A 153
Fittings	F 626
Pipe	A 53

Provide minimum weights of zinc as follows:

a. Pipe: 1.8 ounces of zinc per foot. Type A coating shall be applied both inside and outside according to ASTM F 1043, as determined by ASTM A 90.

b. Rolled-Form Sheet Steel: 4.0-ounces zinc per square foot of surface area.

c. Hardware and Accessories: Zinc weights in compliance with Table 1 of ASTM A 153.

d. Welded joints: Repair zinc coatings at welded joints by applying a zinc-rich paint.

3) Shapes All post, rails, and gate frames noted herein are nominal size, Schedule 40 steel pipe; however, "H" shapes may be substituted with the approval of the Engineer.

C. APPROVAL DRAWING Shop drawings for all work in this section shall be presented to the Engineer for approval and shall indicate size, gauge, weight and finish of all materials, method of anchorage, gate details, hardware, and a plan layout. Fabrication and erection shall be in accordance with the approved shop drawings.

D. MATERIAL

1) Fabric One-piece fabric widths, for fencing 12 feet and less in height, complying with Chain Link Fence Manufacture's Institute (CLFMI) product requirements. Wire mesh shall be woven throughout in the form of approximately uniform square mesh with parallel sides and horizontal and vertical diagonals of approximately uniform dimensions, of size and gage specified in compliance with ASTM A 817, Type 1, cold-drawn carbon steel wire with minimum breaking strength of 1,290 pounds and coated with aluminized finish with not less than 0.40-ounces aluminum per square foot, complying with ASTM A 491, Class II.

2) Top Rail Top rail shall be 1-5/8 inch at 2.49 pounds per foot of length.

3) Bottom Rail or Tension Wire

a. Bottom Rail Bottom rail shall be 1-¼ inch at 2.27 pounds per foot.

b. Tension Wire Tension wire shall be 0.177 inch diameter, high carbon steel coil spring wire.

4) Line post Line post shall be 2-inch diameter at 3.65 pounds per foot.

5) Terminal and Straining Posts Terminal and straining posts shall be 3-inch diameter at 7.58 pounds per foot.

6) Gate Posts Gateposts shall be sized to meet the following:

a. 2-½ inch at 5.79 pounds per foot for gate leaves up to 6 feet wide

b. 3-½ inch at 9.11 pounds per foot for gate leaves from 6 to 13 feet wide

c. 6 inch at 18.97 pounds per foot for gate leaves from 13 to 18 feet wide.

d. 8 inch at 24.70 pounds per foot for gate leaves over 18 feet wide

7) Post Brace Post brace shall be 1-5/8 inch diameter at 2.49 pounds per foot.

8) Truss Rod Truss rods shall be ½-inch diameter steel rod merchant quality with turnbuckle.

9) Gates The gates shall be of the same height and fabric as the fence to which the gate is installed. Gate frame shall be fabricated from 2-inch diameter galvanized steel pipe at 3.65 pounds per foot (for gate leaves up to 11 feet wide) or 2-½ inch diameter pipe at 5.79 pounds per foot (for gate leaves from 11 to 18 feet wide). Gates shall be adequately braced for the size or sizes shown with all corners electrically welded. Sliding gates shall slide fully open one way with stops at both ends to prevent derailment. Swinging gates shall be capable of opening 180 degrees in at least one direction.

10) Hardware Fence shall come complete with all necessary hardware; such as, tension bars, tension bands, brace bands, end clamps, gatepost caps, nuts, and bolts. Gate hardware shall consist of bottom corner pivot hinge, upper hinge, latch fork with lock keeper and guide, fork catch, stop and hold open, and plunger bar and "mushroom" catch (for double leaf units).

11) Fence grounding Conductors shall be bare, solid wire for No. 6-gage and smaller, stranded wire for No.4-gage and larger. Material above finished grade shall be copper. Material on or below finished grade shall be copper. Bonding jumpers shall be braided copper tape, 1-inch wide, woven of No. 30-gage bare copper wire, terminated with copper ferrules. Connectors and ground rods as listed in UL Standard No. 467. Connectors for below-grade use shall be exothermic welded type. Grounding rods shall be copper-clad steel 5/8-inch by 8 feet-0 inches

12) Concrete Concrete for setting posts in the ground shall be at least Class B.

E. INSTALLATION

1) Clearing and Grading The Contractor shall perform such clearing, grubbing and grading as may be necessary to construct the fence to the required alignment and shall provide a reasonably smooth ground profile at the fence line.

2) Posts

a. Ground Installation Post placed in the ground shall be set vertically in concrete not less than 32 inches below finished grade. Concrete encasement shall be a minimum of 36 inches below finished grade with 6 inches around the post and a 1-inch crown.

b. Concrete Installation Posts placed in concrete slabs, walls, or floors shall be set vertically in preformed holes, not less than 8 inches deep with the inside diameter 1 inch greater than the outside diameter of the post. Fill the annular space with non-shrink grout.

c. Spacing Lines posts shall be spaced at not more than 10 foot centers, except when fence is utilized as railing, then post spacing shall meet all local, state, and OSHA codes.

3) Fabric The fabric shall not be erected until after 5 days from the time of setting posts in concrete. The fabric shall be fastened to the line posts with clips or bands spaced at approximately 14 inches apart and to the top and bottom rails with bands or tie wires at approximately 24-inch intervals. The fabric shall be fastened to terminal posts using a tension bar with tension bands spaced 12 inches apart. Fabric shall be rigid and taut.

4) Horizontal Deflection Special treatment will not be required at deflection points where the fence changes alignment by 5 degrees or less. At points of deflection where the fence changes alignment by more than 5 degrees, a post brace and truss rod shall be provided in each fence panel adjacent to the post located at the angle point.

5) Post Braces A post brace and truss rod shall support each gate, straining, and terminal post. The brace shall extend from the line post back to the gate, straining, or terminal post.

6) Bottom Rail or Tension Wire When a bottom rail is not shown or noted on the plans; a galvanized spring steel wire stretched through the fabric and tied to the posts with the fabric shall reinforce the bottom of the fabric.

7) Barbed Wire Three strands of barbed wire shall be pulled and anchored to the arms. Alternate location of barbs in each strand so that barbs will be spaced not greater than 2½ inches on center in alternate layers.

10.0 FINAL GRADING AND FINISH WORK

A. Initial backfill for the pump station structure shall be non-compacting, washed pea gravel, extending to five feet above the bottom of the wet well. From that point to a point eight to ten inches below final grade, backfill shall consist of compacted fill dirt excavated from the station site, unless otherwise directed by City of Lancaster. No rock or unstable backfill will be accepted. The Contractor shall ensure that compaction is sufficient to prevent any subsidence. All ground shall be stable, and Contractor is responsible for repairing all subsidence and associated damage for 18 month from acceptance of the pump station by the City.

B. Any access driveway longer than 120 feet should be constructed with a turnaround at the pump station allowing a minimum 50-foot turning radius for a truck 8 ft. - 5 in. wide with an overall length of 33 ft. - 6 in.

C. Access driveways and turnarounds shall be blacktopped. Base for blacktopping shall consist of one 6-inch course of Item 304 of the State of Ohio Department of Transportation (ODOT) Construction Materials and Specifications. The surface shall consist of two 1½-inch (minimum) courses of asphalt concrete meeting requirements of CMSL Item 404.

D. A concreted parking area shall be provided for trucks. This area shall be located inside the perimeter fence if site considerations allow; otherwise, it shall be located outside the perimeter fence as near as possible to the sliding gate. This area shall be a minimum of 8" of 4,500-psi concrete with steel mesh reinforcing. A reinforced concrete slab (minimum 4" thick) shall be poured under the control panel. This slab shall have at least four times the horizontal surface area of the control panel to help prevent settlement. A minimum 4"-thick gravel base of ODOT Item 304 shall be provided under all concrete.

E. Six inches (6") of AASHTO M 43 Size No. 57 crushed stone shall be provided around the wet well, valve chamber, generator pad, etc., over all non-concreted areas within the perimeter fence. A solid layer of visquine plastic (minimum 6-mil thickness) shall be placed under the crushed stone to prevent vegetative growth.

F. Pavement sub grades shall be compacted in accordance with Section 3.4, D, iii. of these specifications.

G. Finish grading shall provide positive drainage away from the wet well and valve pit top slabs and control panel. The tops of all structures should be either designed for H-20 loading or raised 6- to 12-inches above surrounding grade to prevent vehicles from driving onto them.

H. All unpaved areas around the pump station shall be finish-graded and planted with grass seed, to meet CMSL 659 requirements. A landscaping plan shall be submitted with the design drawings for approval. Bushes and trees shall be planted in accordance with the surrounding landscaping and anticipated land use. In general, the site shall be left in an aesthetically pleasing manner.

I. All pump stations shall be supplied with a 3/4" frostless hose bib/yard hydrant–Murdock M-75 Compression Hydrant or equal for 4 feet bury. Water service piping shall be Type K copper and shall be sized for a maximum pressure drop of twenty-five pounds per square inch from the water main to the pump station with the hydrant full open. Backflow prevention shall be as mandated by OEPA and shall be located inside the fence.

APPENDIX A: TEMPORARY PUMP STATIONS

In general, ALL pump stations shall be considered to be permanent unless a project exists on the City of Lancaster Department of Engineerings' 5-year Capital Improvements Plan that would eliminate the pump station or the Developer has specific plans for eliminating the pump station within approximately 5 years. However, each pump station will be reviewed at the inception of design by the City of Lancaster Department of Engineering to determine whether the pump station will be considered "permanent" or "temporary" for design purposes.

The criteria to be considered by the Department of Engineering will include: 1) service area of pump station and sewer system, 2) capacity of the pump station, 3) complexity of operation, 4) overflow impact upon customers, 5) overflow impact upon the environment, 6) location and ease of entry/exit for emergency equipment such as sludge trucks, etc., 7) proximity to the nearest gravity sewer and likelihood of a future sewer extension to eliminate the pump station, 8) proximity to existing and proposed residential development, 9) downstream capacities and developments and 10) other factors unique to a given pump station site.

If a pump station is to be "temporary" (as determined by City of Lancaster Department of Engineering), certain requirements may be modified or omitted at the discretion of City of Lancaster Department of Engineering and the Superintendent of Water Pollution Control. An outline of what these modifications and omissions will generally be is provided below.

A. The City will not require the pump station to be sized for the total upstream watershed. Instead, the pump station shall be sized for all existing and planned development (including all preliminary plans) within the watershed, regardless of whether or not all such development is associated directly with the pump station. This means that the pump station shall have the capacity to both eliminate any existing upstream pump stations and serve development in the watershed being planned by others. In addition, the requirement of one-hour emergency storage at twice-ultimate average flow will remain.

B. A permanent on-site generator and automatic transfer switch will not be required. Instead, a manual transfer switch and auxiliary receptacle shall be provided as described in Section 6.0, Paragraph K. There shall be sufficient room within the perimeter fence to park a portable generator or install an on-site generator later (see Section 9.0, Paragraph D). In addition, if the generator required to operate the pump station would be too large to pull on a trailer behind a pickup truck, a permanent on-site generator will be required.

C. The SCADA system described in Section 7.0 Supervisory Control and Data Acquisition (SCADA) will be required.

D. No magnetic flow meter and no flow-metering vault will be required. The pump hour meters will be used to estimate flow rates.

City of Lancaster Department of Engineering will assess each "temporary" pump station individually, based on the criteria listed above, to determine the acceptability of each modification and omission. Therefore, it is possible that a "temporary" pump station will be required to meet some or all of the "permanent" standards.

All other requirements listed within the Sewage Pump station Requirements shall apply universally to all pump stations, regardless of their status as "permanent" or "temporary."

APPENDIX B: REQUIRED SUBMITTALS

The Contractor shall submit at least five (5) copies of submittals for each of the following items. One of the five copies will be returned to the Contractor with comments and/or approvals.

Wet well structure
Valve vault structure
Flow meter manhole
Shear gate manhole
Other manholes & covers (if applicable)
Aluminum hatches
Ladder(s) & safety post
Hoist (if applicable) and hoist sockets
Vent pipe & screen for wet well
Waterproofing (if applicable)
Gaskets/seals for pipe & conduit penetrations through concrete structures

PVC drain pipe & check valve
Gravity sewer pipe (if applicable)
Ductile iron pipe, fittings, flange adapter, mega-lugs, etc.
Polyethylene encasement (if applicable)
Pipe mounting brackets (for mounting to wet well walls)
Gate valves (or plug valves, if applicable)
Check valves
Shear gate & handle
Surge relief valve (if applicable)
Air release valve(s), if applicable
Pipe supports (in valve vault)
Bauer fitting(s)
Pressure gauge, snubber, valves, piping, etc.
Misc. fasteners, anchors, & hardware
Epoxy paint for ductile iron piping

Pumps (incl. discharge bases, other misc. components, & spare parts)
Float switches
Cable support bracket
Stainless steel (Kellems or equal) cable grips
Guide rails
Upper & intermediate guide rail brackets

Chains and Grip-eye for lifting pumps
Influent grinder–incl. frame, hydraulic drive unit, grinder unit, etc. (if applicable)
Flow meter (primary & secondary devices, cables, grounding kit, etc.)
Chart recorder

Water service materials (piping, fittings, valves, meter pit, etc., as applicable)
Backflow preventer
Enclosure for backflow preventer
Frost-proof yard hydrant

Generator and automatic transfer switch (incl. housing, battery charger, controller, etc.)
Enclosure for ATS

SCADA:
- Westerman Inc. RTU, including CPU & all modules
- Radio
- Path study
- Antenna
- Lightning surge protector, grounding kit, connectors, etc.
- SCADA wiring diagram and I/O list

Electrical, Instrumentation & Control:

- Interconnecting diagrams/wiring and control schematics for pump station and control panel
- Panel layout (dimensioned) for all planes
- Site electrical plan
- Conduit routing/layout and wire-pulling schedules
- Grounding scheme
- Bill of materials
- Conduit, wiring & connectors
- Enclosure(s) & junction boxes, incl. all accessories
- Panel supports (i.e. stainless steel strut, anchors, etc.)

Equipment:
- Quartz yard light
- Main disconnect incl. st. stl. enclosure (outside panel)
- Control transformer, incl. st. stl. enclosure (outside panel)
- Power blocks & terminal blocks
- Ground lugs
- Lightning arrestor and surge capacitor
- Main circuit breaker (inside panel)
- Pump circuit breakers
- Voltage monitor, incl. disconnect and fuses
- Motor starters w/ electronic overloads
- Over-current relays (& current transformers, if applicable)

Primary circuit breaker for control xfmr. (& secondary CB, if applicable)
Auxiliary circuit breakers
Handle assembly for main CB (& pump CB's, if applicable)
All fuses and fuse holders
Panel light(s)
Panel heater(s)
Duplex GFCI receptacle & cover plate
Alternator
Alternator selector switch
Time delay relays (if applicable)
HOA selector switches
Indicator lights (pump run, pump fail, SCADA output, hi-hi level, etc.)
Elapsed-time meters
Relays
Intrinsically safe relays
24V transformer for MiniCAS (if applicable)
MiniCAS relay or equivalent relays
Reset push button for MiniCAS (if applicable)
Selector switches for panel light(s) & yard light
Selector switch & push button for high-high level alarm
Silence relay
Alarm light (& flasher, if applicable)
Alarm horn/siren/bell
Limit switches for security and tamper alarms
Operator selector switch
Engraved labels/tags
Other push buttons & switches, as applicable
Other fuses, as applicable

Concrete slabs (incl. reinforcing) for generator, control panel, transformer, etc.
Chain link fence & gates
PVC fence & gates
Signage
Ready mixed concrete
Granular materials & other fill
Testing reports (backfill compaction, leakage tests, etc.)