

SECTION 11321

VERTICAL WASTEWATER PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The Work herein specified and/or shown on the Plans consists of furnishing all labor, material, equipment, etc., for the fabrication, supply and delivery of six (6) vertical wastewater pumps, complete in all details, as shown on the Plans and/or specified herein.
- B. This Section makes reference to other supportive Sections which shall form a part of this Section and shall govern the work described herein.

1.2 RELATED WORK

- A. Section 01015 – Special Conditions
- B. Section 01300 – Shop Drawings
- C. Section 01730 – Operation and Maintenance Data
- D. Section 01850 – Training

1.3 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG1 - Motors and Generators.
- E. ANSI/NFPA 70 - National Electrical Code.

1.4 INSPECTION AND TRAINING REQUIREMENTS

- A. A factory representative employed by the manufacturer shall visit the site prior to equipment start-up to verify the proper installation of the equipment and to instruct the Owner's operating personnel in the maintenance and operation of these units.
- B. Three (3) separate inspection and start-up visits shall be provided, one for each pair of pumps that becomes installed. A minimum of two (2), eight (8) hour days for each visit shall be included in the lump sum bid.
- C. The scheduling of this service shall be coordinated with the Owner and the cost of this service shall be included in the Contractor's bid price.

- D. Training requirements shall be a minimum 16 hours at the site, unless otherwise specified. The wastewater treatment plant is staffed with two shifts during (day and night). Training shall be provided during both of the shifts. Training shall occur during the first inspection and start-up visit.

1.5 WARRANTY

- A. The pumping units and accessories shall be guaranteed in writing to be free of defects in workmanship and material for a period of (one) 1 year from the date of acceptance.
- B. The pump warranty period shall not commence until such time as acceptable testing is performed on each pump and each pump is accepted by Owner.

1.6 REGULATORY REQUIREMENTS

- A. Furnish Products listed and classified by Underwriters' Laboratories, Inc. (UL), Factory Mutual (FM), and/or Canadian Standards Association (CSA), as specifically indicated, and as acceptable to authority having jurisdiction, as suitable for purpose specified and indicated.
- B. All equipment and workmanship shall be in conformance with all applicable standards and requirements of the following documents:
 - 1. Any and all Federal, State, and/or local codes, ordinances, or regulations, including OSHA/MIOSHA.
 - 2. Latest approved standards of ISA, IEEE, ANSI, NEMA, and Underwriters' Laboratories.

1.7 QUALITY ASSURANCE

- A. Monitor quality control over suppliers, manufacturers, products, services, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform work by persons qualified to produce workmanship of specified quality.
- F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.8 SHOP DRAWINGS AND O&M MANUALS

- A. Shop drawings are required for the items specified in this Section of the Specifications. Each shop drawing submittal shall include as a minimum the following information:
 - 1. Identification of the item, i.e., written description, reference to equipment schedule.

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2. Assembly drawings that identify each part of the item specified. These should include dimensions and a materials of construction list.
 3. Information which verifies that the item meets process specifications, i.e., corrosion resistance, temperature rating, pressure rating, strength, performance curve.
 4. Electrical and control information for the appropriate equipment, including motor nameplate data, wiring diagrams, and control panel layouts, where applicable.
 5. Electrical characteristics and connection requirements including layout of completed assemblies, interconnecting cabling, tubing, dimensions, weights, and external air and power requirements.
 6. Manufacturer's installation instructions including application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation and starting of Product.
- B. Shop drawings for motor driven equipment MUST include the following motor information:
1. Horsepower
 2. Voltage
 3. Phase
 4. Frequency
 5. Speed
 6. Maximum Temperature Rise In Continuous Service
 7. Enclosure Type
 8. Frame
 9. Service Factor
 10. Power Factor
 11. Efficiency
 12. NEMA Design Code Letter
 13. Manufacturer
 14. Full Load Amperes
 15. NEC Code Letter
 16. Insulation Class
 17. Inverter Duty Rated
- C. The equipment supplier shall submit two (2) electronic (pdf version) of shop drawings for approval. The equipment supplier shall submit six (6) sets of approved shop drawings for all equipment items furnished. Each shop submittal item must be reviewed and approved by the Engineer prior to any work commencing for the furnishing of that item.
- D. Upon completion of the installation, but prior to start-up, the equipment supplier shall furnish six (6) complete sets of loose leaf bound operation and maintenance instruction manuals covering each item of equipment, apparatus, and devices furnished or erected, to include, but not limited to:
1. Catalog data or literature
 2. Installation instructions
 3. Manufacturer's operating instructions
 4. Manufacturer's maintenance instructions
 5. Wiring diagrams
 6. Equipment operating characteristics

7. Component parts replacement, adjustments, and preventative maintenance procedures and materials.
8. Final “As-Built” shop drawings showing actual equipment, arrangement, piping and wiring installed, including all field modifications, and Engineer’s comments.

1.9 COORDINATION

- A. The equipment to be pre-purchased by the Owner as part of this Contract shall be installed under a separate contract. The successful bidder shall be required to coordinate with the selected installation contractor for delivery of the equipment, supervision of equipment installation, start-up, and training.

PART 2 PRODUCTS

2.1 SECONDARY EFFLUENT PUMPS SEP – 1 THROUGH SEP – 6

A. SCOPE

1. Furnish six (6) vertical pumps. Each pump shall be equipped with an electric motor connected for operation on a 480 volt, 3 phase, 60 hertz electrical service. Each unit shall be fitted with lifting lugs of adequate strength to install and remove the complete pump assembly.
2. Motors shall be driven by Variable Frequency Drives (VFDs). Pumps SEP-1, 2, 3 and 6 are currently equipped with existing VFDs that will continue to be used on the new pumps. Pumps SEP-4 and SEP-5 will require new VFDs. VFDs shall be furnished by others under a separate contract for installation of the pumps and related appurtenances.

B. PUMP MANUFACTURERS

1. Pumps shall be as follows with “No Substitutions”:
 - a. FlowServe – Model 23 SRH
 - b. Layne/Vertiline – Model 20LM
 - c. Peerless – Model 26HH-OH
 - d. American Marsh – Model 20 MFP
 - e. Cascade – Model 20 MF

C. DESIGN CONDITIONS

1. Pumps SEP-1 thru SEP-6 shall be designed to operate at a speed of 900 rpm under the following conditions:
 - a. Primary Operating Condition – 13,890 GPM @ 31’ TDH (bowl), minimum bowl efficiency 81%.
 - b. Secondary Operating Condition – 12,454 GPM @ 37.5’ TDH (bowl), minimum bowl efficiency 81%.
 - c. The minimum $NPSH_{available}$ at the site is 9’.
 - d. With respect to submergence, the dimension between the wet bottom of the wet well and the normal low water surface in the wet well is 9-feet.
 - e. The pump manufacturer shall calculate friction losses based on $C=100$ and establish pump TDH at the design points. Calculations shall be submitted with the pump shop drawings.

- f. Pumps shall be capable of operating throughout the entire pumping range without exceeding available NPSH. NPSH calculations shall be provided by the pump manufacturer.

D. PUMP DESIGN

- 1. The pumps shall be of the vertical, single stage, turbine, mixed flow or hybrid type complete with above base discharge as specified herein and as indicated on Figure 1. Pumps shall be designed for continuous operation pumping secondary effluent wastewater and shall operate without cavitation, excessive vibration or noise and shall be designed to withstand, without damage, any thrust force which may develop as a result of normal pump operation.
- 2. Each pump shall be complete with a sole plate, gasket and all required anchor bolts, leveling nuts, nuts and washers. Pumps and base plates shall be designed to allow removal of the entire pump assembly through the floor opening sizes indicated on the drawings. The pump base plate shall provide a gas tight seal and shall be as indicated on the Drawings. Mating surfaces of the pump base plate and sole plate shall be machined for proper fit.
- 3. The column pipe and pump bowl shall be made in sections which will permit ready assembly, dismantling and removal of the impeller. The minimum wall thickness of column pipe shall be in no case be less than 3/8 inch. Joints shall be of the flange type with a gasket or other suitable means to make them watertight. Vanes shall not be used in the construction of the discharge elbow.
- 4. After testing and final assembly of the pumps, all pieces shall be matched and marked at the factory. Pumps shall be shipped as completely assembled as possible with respect to size limitations and trucking availability.

E. PUMP CONSTRUCTION

- 1. Pumps shall be manufactured according to the standards of the Hydraulic Institute and to ANSI/AWWA specification E103. In addition to those general specs, the following specifics shall be included.
- 2. Materials
 - a. The various pump components shall be constructed of the following materials:

Discharge Head	-	Carbon Steel, ASTM A53-Grade B, 3/8" thick min.
Pipe Column	-	Carbon Steel, ASTM A53-Grade B, 3/8 thick min.
Bowl Assembly	-	ASTM A48, Class 30 cast iron, 1/2" thick min.
Suction Bell	-	ASTM A48, Class 30 cast iron, 1/2" thick min.
Impeller	-	SAE CA 927 Bronze
Pump Bowl Shaft	-	Pump shaft quality 416 SS
Pump Lineshaft	-	Carbon Steel Lineshaft 416 ss
Lineshaft Bearings	-	High lead bronze or bronze, ASTM B584, Alloy 903
Discharge Bowl Bearings	-	High lead bronze or bronze, ASTM B584, Alloy 903
Thrust Ring	-	304 Stainless steel
Thrust Ring	-	304 Stainless steel

- b. All materials used in the construction of the equipment specified herein shall be new, high grade, of a quality best suited to the requirements of the work, and shall conform to the latest standard specifications of the American Society for Testing Materials for all cases covered by such specifications. Castings with holes, cracks or other defects shall not be accepted.
3. Impeller
 - a. The impeller shall be of the mixed flow, turbine or hybrid design and shall be secured to the pump shaft by double key and thrust collar.
 - b. The impeller shall be statically and dynamically balanced to reduce vibration and wear. Vanes shall be tapered, hand finished and machined to the identical angle of the stationary seat.
4. Discharge Bowl
 - a. The discharge bowl shall be rabbet fit to the discharge column and shall be equipped with straightening vanes to insure efficient operation. The pump bowls, including the suction bell, shall be free of blow holes, sand holes and other detrimental defects. The suction bell shall include a minimum of four ribs to support the suction bowl bearing and a flared inlet designed to reduce suction inlet velocity. The lower suction bell bearing shall be protected by a sand cap or protecting collar designed to prevent the entrance of contaminants.
5. Lineshaft
 - a. The pump lineshaft shall be of open style consisting of maximum 10'-0" long sections with threaded connections. The butting faces shall be machined square to the axis of the shaft with the maximum permissible axial misalignment of the threaded axis with the shaft axis 0.002 inch in 6 inches. The shaft dimensions and bearing spacing shall be so proportioned that no injurious deflection or whip will occur. Bearing spacing of more than five (5) feet will not be allowed. In the design and arrangement of the shaft assembly, provision shall be made for making any necessary vertical adjustment to the shaft after it has been assembled in the pump unit, and without interfering with its alignment. The column pipe, shaft tube, and shaft shall be fitted with necessary joints and couplings to permit dismantling the unit into sections of not more than ten (10) feet in length. Provision shall be made for vertical adjustment of the pump shaft and impeller. All intermediate shaft couplings shall be made for vertical adjustment of the pump shaft and impeller. All intermediate shaft couplings shall be made of high-grade steel of the threaded type.
 - b. The size of the shaft shall be no less than determined by ANSI/AWWA specification E101, section A4.15 line shaft selection and shall be such that elongation due to hydraulic thrust will not exceed the actual clearance of the impellers in the pump bowls.
 - c. The pump head shaft shall be of two piece construction and shall extend through the hollow shaft of the motor. The head shaft shall be keyed and connected at the top of the motor. The connection shall be designed to provide vertical adjustment of the pump lineshaft for impeller clearance adjustment. The pump headshaft shall include a threaded, non-adjustable coupling below the motor. The coupling shall allow the upper shaft to be removed from the top of the motor.
6. Seals

- a. A cast iron stuffing box shall be provided with a bronze removable stuffing box bushing, galvanized split gland, T-bolts with stainless steel clips and brass nuts.
- b. Stuffing box shall utilize a minimum of five synthetic Garlock 8913 packing rings, compressed around the pump shaft and lubricated by the pumped water.
7. Motor Pedestal
 - a. The motor shall be rabbet fit to the pedestal. The motor pedestal shall be designed to provide complete access to the shaft coupling and shall be complete with safety guards.
8. Discharge Column
 - a. The discharge column assembly shall consist of 20 inch or 24 inch OD flanged pipe sections maximum 10'-0" long with rabbet fits. The bottom section shall be tapered for connection to the bowl assembly. The discharge elbow shall consist of at least three welded steel sections to provide smooth transition of the liquid from the vertical to the horizontal plane.
 - b. The column assembly shall have bronze bearing retainers retained by the butted pipe ends. Each bearing retainer shall contain a water-lubricated, cutless rubber bearing designed for vertical turbine pump service.
9. Pump Sole Plate
 - a. Each pump shall be furnished with a sole plate to be permanently mounted to the existing concrete pump pad. The sole plate shall be leveled and grouted in place as shown on the drawings, and shall include at least four support bolts on which the pump base plate will be attached.
10. Tools
 - a. The Contractor shall furnish, in a suitable metal box, a complete set of any special tools needed for operation, maintenance, assembly and disassembly of the pumping units. All wrenches and spanners shall be case hardened steel forgings and shall have a bright finish with working faces dressed to fit nuts and bolt heads.
11. Painting
 - a. All ferrous metal surfaces of the pumping units located above El. 744.50 shall be prepared in accordance with SSPC-SP6 and shall be shop primed and finish painted as follows:
 - Primer (epoxy) – Tnemec Series N69: 3 mils dft
 - Intermediate (epoxy) – Tnemec Series N69: 4 mils dft
 - Finish (Aliphatic/ Acrylic Polyurethane) – Tnemec 1075 Endurashield: 3 mils dft
 - b. All other inside and outside ferrous metal surfaces of the pumping units shall be prepared in accordance with SSPC-SP10 and shall be coated with 16 mils dft Tnemec Hi-Build Tneme Tar 46H-413 coal tar epoxy.
 - c. Surfaces to be coated with coal tar epoxy shall include but not be limited to the following:
 - 1) Bottom of base plate
 - 2) ID & OD of discharge column and elbow
 - 3) Bowl assembly (inside and outside)
 - 4) Intake vane assembly
 - d. Pump motors shall be coated with motor manufacturer's standard coating.
12. Discharge Elbow

- a. The discharge elbows shall be of three piece fabricated miter construction. Elbows shall be 20" diameter with either plain end or flange connection to connect to either the existing plain end x flange spool piece or the existing 20" diameter swing check valve.
13. Pump Motors
- a. Pump motors shall be high thrust, vertical squirrel cage induction type, hollow shaft, 150 horsepower, nominal 900 RPM full load speed, 460 volt, 3 phase, 60 Hz motors, complete with a Open Drip Proof (ODP) enclosure, minimum 1.15 service factor, and rabbet fit to the motor pedestal.
 - b. Motors shall be inverter duty rated for use with Variable Frequency Drives (VFDs), shall include an insulated upper bearing and shall include shaft grounding as manufactured by AEGIS.
 - c. VFDs shall be furnished by others under a separate contract for installation of the pumps and related appurtenances.
 - d. High thrust, insulated top bearing shall be designed to support motor rotor weight, weight of pump shaft and impeller and pump hydraulic thrust. Motor thrust bearing design calculations shall be based on a minimum time factor of 1.71 and shall be included with the pump shop drawings. The thrust bearing shall also be designed to withstand 30% momentary upthrust during pump start-up. Motor bearings shall have a minimum B-10 design life of not less than 44,000 hours (average life of 25 years). Bearing information shall be included on the motor nameplate. Each motor shall also be equipped with a lower steady bushing. Oil lubricated anti-friction ball bearings shall be provided for upper and lower motor bearings. Oil level gages shall be mounted on the motors.
 - e. Motors shall have a Class F (150°C) insulation system suitable for operation in an ambient temperature of 40 degrees C, in accordance with IEEE standards.
 - f. Motors shall have a normally closed thermal switch in each winding which will open upon detection of excessive heating of the windings. All three motor thermal switches shall be connected in series. The wiring of the three motor thermal switches shall be brought out to a separate terminal box for connection to the motor control circuit.
 - g. Motors shall have all copper windings and copper rotor bars.
 - h. Motors shall meet NEMA Design B characteristics.
 - i. Motors shall meet EPACT/EISA values for Premium Efficient motors.
 - j. Motors shall have a visible nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor code letters, ambient temperature rating, temperature rise or insulation class, NEMA design letter (integral horsepower motors), frame size, manufacturer's name and model number, service factor, power factor, and nominal efficiency. Nameplate shall be of stainless steel or other approved corrosion resistant material providing a permanent legible marking. Nominal full load efficiency shall be identified on nameplate in accordance with NEMA MG-1-12.54.2
 - k. The nameplates and connection plates shall be attached to the motor frame by stainless steel rivets or screws.
 - l. Motors shall be rated for continuous duty.

- m. Motors shall include non-reverse ratchet to prevent the motor from rotating in the opposite direction. The ratchet and shall be furnished and stalled by the motor manufacturer.
 - n. Motor leads shall be brought to lug posts on insulated stand-offs. All termination boxes shall be heavy gauge fabricated steel construction with bolted type covers. The motor frame shall have drain plugs.
 - o. Upon receipt of the motors (or within 5 days), the Contractor shall lubricate the motors as recommended by the Manufacturer, and in the presence of the Owner's representative, and at that time, the motors shall be rotated to insure proper lubrication of the bearings.
 - p. Motors shall be tested at the manufacturer's facility prior to shipment. Motors shall have a complete test as defined by IEEE 112 method B or method F. Report of test shall include data on form A2 applicable to the motor tested. Efficiency shall be based on the losses of bearings similar to those used in operation. The additional losses, due to the external thrust of the pump, will be used to correct the tested efficiency of the motor to include these thrust losses. Certified copies of test results shall be submitted and approved prior to shipment of the pumping equipment.
 - q. Motors shall be manufactured by one of the following manufacturers: U.S. Motors, Baldor or General Electric.
14. Pressure Gauges
- a. Connections: Provide tapped openings with bronze plugs for installation of pressure gages on the horizontal run of the discharge elbow. Openings shall be easily accessible for installation and reading of the pressure gauges. Pressure gauges shall be provided and installed under separate contract for construction of the pumps.
15. Factory Testing – Non Witnessed
- a. The pump manufacturer shall perform the following analysis and testing at the factory:
 - 1) Reed Critical Frequency Analysis
 - 2) Hydrostatic Test
 - 3) Performance Tests
 - b. The Reed Critical Frequency Analysis shall verify that the pumping units will operate without vibration. Certified copies of the analysis shall be submitted with the pump shop drawings.
 - c. Pump bowls, discharge columns and discharge heads shall be hydrostatically tested at 150 percent of the maximum shut-off pressure.
 - d. Each pump shall be assembled at the factory to insure fit of adjoining parts. Each pump shall be tested at the factory. Testing shall be conducted in accordance with Hydraulics Institute (HI) Pump Standards, Section 14.6-2011. Vertical Pump Tests and shall meet all criteria contained within this HI Section. The tests shall be such as to satisfy the Owner that the equipment complies with the specification requirements. The Manufacturer shall furnish six certified copies of test reports to the Owner.
16. Spare Parts
- a. The following spare parts shall be provided by the pump manufacturer:
- | <u>Spare Part Description</u> | <u>Quantity</u> |
|--------------------------------------|-----------------|
| Lineshaft Bearings (for each pump) | 1 set |
| Suction Bell/Discharge Bowl Assembly | 1 unit |

- Complete Set of O-Rings (for each pump) 1 set
 - Complete Set of Gaskets (for each pump) 1 set
 - b. All parts shall be packaged for long term storage. The contents of each package shall be clearly labeled.
17. Equipment Storage Prior to Acceptance
- a. The pump manufacturer shall clearly inform the Contractor of all requirements for and during temporary storage of the pumps and motors to protect them from damage while the units are temporarily stored and after the units are installed prior to final acceptance. Manufacturer's instructions include, but shall not be limited to pump/motor lubrication, manual rotation of pump/motor shafts, etc.
 - b. The responsibility for proper care and maintenance shall transition from the pump manufacturer to the Contractor upon proper unloading, checking and temporary storage of the six pumps and ancillary items.

PART 3 EXECUTION

3.1 GENERAL

- A. The pump manufacturer shall furnish and install all necessary supports, framing, hangers, shafting, motors, and all other appurtenances.
- B. The pump manufacturer shall provide certified copies of head capacity curves based on test data from similar pumps indicating pump efficiency, horse power required and NPSH required for various suction water elevations, as part of the shop drawings required for all pumps furnished under these Specifications.

3.2 TESTING

- A. Upon completion of the installation, the Contractor will be required to make performance tests of all pumps in the field. Scheduling of testing and testing procedures shall be coordinated with the Owner. The Pump Manufacturer shall have a representative or representatives present during these field tests. During the tests, the operation of the unit may be under the direction of the Pump Manufacturer's representative, if he so desires. Performance testing shall demonstrate that each pump is capable of starting, running, and stopping without cavitation, excessive noise, or excessive vibration. All observations will be made by the Owner or his authorized representatives. The Contractor shall provide competent personnel to make any necessary alterations to provide for pump performance in accordance with the Contract requirements. The Pump Manufacturer shall provide a formal test procedure and forms for recording data for review and acceptance by the Owner prior to scheduling of field testing.
- B. Vibration and Alignment Testing
 - 1. Instrumentation Requirements – Vibration measurements shall be made with a FFT type analyzer utilizing 800 line resolution. Analyzer shall be set on "auto range," unless otherwise specified, for all vibration measurements. Transducer mounting shall yield a flat response for from 0.4 x running speed to F-MAX. Measurements shall consist of four averages (linear, non-overlapping) using a Hanning window. At a minimum, vibration data shall be acquired at one axial and two radial (ninety degree

offset) locations at each bearing location. Frequencies shall be reported in terms of cpm and “running speed orders” with F-MIN = 0.4 x running speed and FMAX = 120,000 cpm unless specified otherwise. Velocity limits (measured in inches/sec./peak) are “peak amplitude acceptance limits” where the peak amplitude (RMS shall be converted to peak by a factor of 1.414) of any line contained within the band shall not contain or shall not exceed the peak amplitude band limit. Any and all testing equipment that is used to certify that the rotating equipment has met the owner’s specification must have been calibrated within the past year by certified agency.

2. The displacement of rotating equipment shaft (under load) shall not exceed the specified tolerance of the bearings.

3. Motors

a. The maximum allowable vibration levels

Speed (rpm)	Displacement (inch p to p)	Velocity (inch/sec. peak)
999 and below	0.003	0.150
Band	Range	Standard
1	0.4 x rpm – 0.8 x rpm	0.04 inc/sec. peak
2	0.8 x rpm – 1.2 x rpm	0.075 inc/sec. peak
3	1.2 x rpm – 3.5 x rpm	0.04 inc/sec. peak
4	3.5 x rpm – 8.5 x rpm	0.03 inc/sec. peak
5	8.8 x rpm – 60,000 cpm	0.03 inc/sec. peak
6	60,000 cpm – 120,000 cpm	0.03 inc/sec. peak
7	accelerating	0.05 g. peak

Motors shall be free of any vibration confirmed to be at 2x line frequency.

4. Installation

a. Coupling/Assembly Keys

As final assembly, and prior to initial operation, the motor key and the driven unit key shall be co-planer.

Keys shall be of the proper length based on the formula below:

$$\text{Key length} = ((A \times C) + (B \times D)) / (C + D)$$

Where

A = shaft keyway length

B = hub keyway length

C = key depth in shaft

D = key depth in hub

5. Alignment

a. Equipment shall be inspected prior to final piping connection to ensure the equipment is in “free bolt” condition.

- b. Any foot pad of a component shall not introduce more than 0.002-inch “soft foot” condition into the system. The total amount of soft foot introduced by any component shall not exceed 0.004-inches. Each component shall be checked for soft-foot utilizing a minimum of two (2) dial indicators prior to alignment of equipment.
- c. All rotating equipment shall be aligned prior to initial start up with a maximum parallel; misalignment of 0.002-inches at operating temperature. Angular misalignment of the two shafts shall be such that any calculated move of a component is equal or less than 0.002-inches. If thermal growth is a factor in the alignment of the equipment, initial alignment will meet the above specifications when taking into consideration the calculated growth per the manufacturer. The equipment shall then be operated until it has reached thermal stability prior to any alignment checks. Alignment of rotating equipment shall be checked with either a dual dial or laser alignment equipment. Any and all equipment is used to certify that the rotating equipment has met the owner’s must have been calibrated within the past year by certified agency.
- d. All shims shall be stainless steel, manufactured with manufactured tabs. The size of the shim shall be denoted by the manufacturer on the shim. Shims shall be free of burrs or dirt as well as any foreign material such as paint.

END OF SECTION

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SECONDARY EFFLUENT PUMPS
EQUIPMENT DATA SHEET

Manufacturer: _____

Model No.: _____

Motor Manufacturer: _____

Pump Data:

(flow) _____ gpm and (efficiency-bowl) _____ % at 31-feet TDH (bowl)

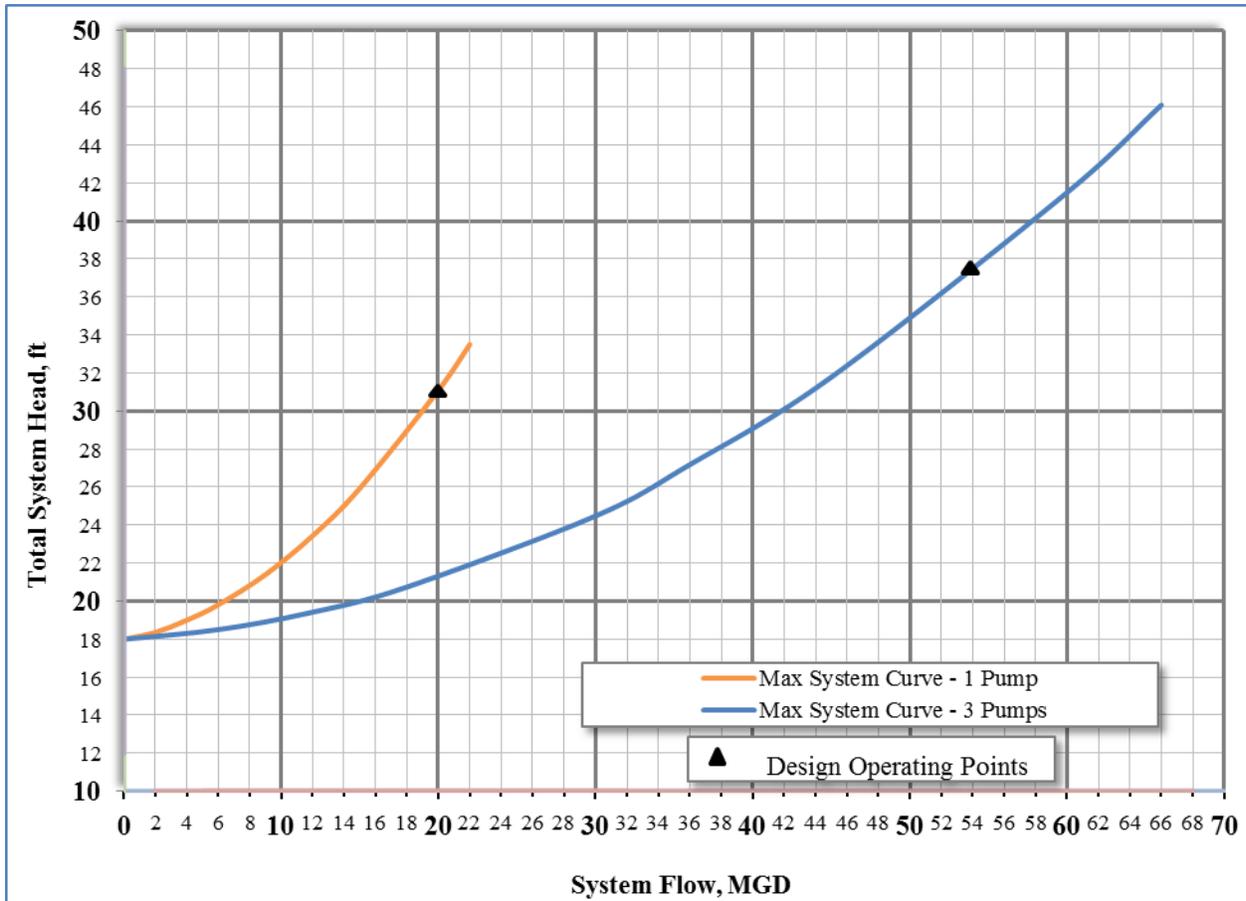
(flow) _____ gpm and (efficiency-bowl) _____ % at 37.5-feet TDH (bowl)

(NPSH_{REQUIRED}) _____ feet at 37.5-feet TDH (bowl)

(low flow) _____ gpm at (TDH) _____ feet at (speed) _____ rpm

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System Curves
City of Ann Arbor – Secondary Effluent Pumps Replacement
Hazen Williams C = 100



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