

Part 1 General

1.1 ADMINISTRATIVE

- .1 Bidders are reminded that requests for approval of substitutes as an approved equal or an approved alternative shall be made in accordance with B7.
- .2 Submit to Contract Administrator submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .3 Do not proceed with Work affected by submittal until review is complete.
- .4 Present shop drawings, product data, samples, and mock-ups in SI Metric units.
- .5 Notify Contract Administrator, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .6 Contractor's responsibility for errors and omissions in submission is not relieved by Contract Administrator review of submittals.
- .7 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Contract Administrator review.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "Shop Drawings" means Drawings, diagrams, illustrations, schedules, performance charts, brochures, and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of the section under which adjacent items will be supplied and installed. Indicate cross references to design Drawings and specifications.
- .3 Submit Shop Drawings for all Goods to be supplied and receive a release for construction from the Contract Administrator before Goods are produced for this Contract.
- .4 At the time of submission inform the Contract Administrator in writing of any deviation in the Shop Drawings from the requirements of the Contract documents.
- .5 Submit five (5) prints on a sheet size appropriate for item and information being depicted and an electronic file in a format acceptable to the Contract Administrator.
- .6 Accompany submissions with transmittal letter, containing:

- .1 Date and revision dates;
- .2 Project title and number; and,
- .3 Name and address of:
 - .1 Subcontractor;
 - .2 Supplier; and,
 - .3 Manufacturer.
- .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements, and compliance with Contract Documents.
- .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication;
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances;
 - .3 Setting or erection details;
 - .4 Capacities;
 - .5 Performance characteristics;
 - .6 Standards;
 - .7 Operating weight;
 - .8 Wiring diagrams;
 - .9 Single line and schematic diagrams; and
 - .10 Relationship to adjacent Work.
- .7 Shop Drawings should include, at minimum, but not be limited to, the following:
 - .1 Detailed information of the proposed equipment in the capacity, size, and arrangement as indicated and specified;
 - .2 Data for accessory items;
 - .3 Certified (if required) setting plans with tolerances for anchor bolts and/or mounting details;
 - .4 Certified results of shop testing;
 - .5 List of recommended spare parts other than those specified; and,
 - .6 Special tools required for the installation, setup or maintenance of the equipment.
- .8 Show following information in the lower right hand corner of each Shop Drawing:
 - .1 Name of pumping station;
 - .2 City's Bid Opportunity Number;
 - .3 Manufacturer's name and description or model number of the item;
 - .4 Serial number(s) of Goods; and,
 - .5 Date (to be revised per resubmission).
- .9 With the Shop Drawings, the vendor shall submit calculations regarding the thermal expansion of the shaft and coupling connecting the pump and the motor, as well as the calculations regarding the harmonic frequency of the system.
- .10 The Contract Administrator will review the Shop Drawings and will release them for construction with reasonable promptness so as to cause no delays. The review is only for conformance with the design concept of the project and with the

- information given in the specifications. The Contract Administrator's review of a separate item shall not indicate approval of an assembly in which the item functions.
- .11 Make any corrections required by the Contract Administrator and resubmit the specified number of corrected copies of each Shop Drawing. Direct specific attention in writing or on resubmitted Shop Drawings for revisions other than the corrections requested by the Contract Administrator on previous submissions.
 - .12 By approving and submitting Shop Drawings, the Contractor hereby represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, or will do so, and that he has checked and coordinated each shop drawing and sample with the requirements of the Work and of the Specifications.
 - .13 Provision of Shop Drawings will be considered incidental to the price for supply and delivery of Goods and materials.
 - .14 Allow seven (7) days for Contract Administrator review of each submission.
 - .15 Adjustments made on Shop Drawings: Contract Administrator is not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Contract Administrator prior to proceeding with Work.
 - .16 Make changes in shop drawings as Contract Administrator may require, consistent with Contract Documents. When resubmitting, notify Contract Administrator in writing of revisions other than those requested.
 - .17 Submit electronic copy of Shop Drawings for each requirement requested in specification sections and as Contract Administrator may reasonably request.
 - .18 Submit electronic copies of product data sheets or brochures for requirements requested in Specification sections and as requested by Contract Administrator where Shop Drawings will not be prepared due to standardized manufacture of product.
 - .19 Submit electronic copies of test reports for requirements requested in Specification sections and as requested by Contract Administrator.
 - .20 Submit electronic copies of manufacturer's instructions for requirements requested in specification sections and as requested by Contract Administrator.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
 - .21 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification sections and as requested by Contract Administrator. Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

- .22 Submit five (5) hard copies and one (1) electronic copy of Operation and Maintenance Data for requirements requested in Specification sections and as requested by Contract Administrator.
- .23 Delete information not applicable to the Project.
- .24 Supplement standard information to provide details applicable to project.
- .25 If upon review by Contract Administrator, no errors or omissions are discovered or if only minor corrections are made electronic copy will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .26 Contractor will be charged for Contract Administrator subsequent reviews of submittal packages exceeding two (2) submissions.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .3 Copy will be returned after final inspection, with Contract Administrator comments.
- .4 Revise content of documents as required prior to final submittal.
- .5 Within two (2) weeks after equipment delivery provide one (1) hard copy and one (1) electronic copy of operating and maintenance manuals in English. The Contractor shall modify and supplement the manual as required by the Contract Administrator. When accepted, five (5) final copies, including one (1) electronic version, shall be provided by the Contractor for distribution purposes within two (2) weeks of receiving the Contract Administrator's review comments. The City's staff shall be in receipt of these manuals prior to the date set out for installation and commissioning of the Goods.
- .6 Ensure spare parts, maintenance materials and special tools provided are new, undamaged and not defective, and of same quality and manufacture as products provided in Work.
- .7 Furnish evidence, if requested, for type, source, and quality of products provided.
- .8 Defective products will be rejected, regardless of previous inspections. Replace products at their own expense.
- .9 Pay costs of transportation.

1.2 FORMAT

- .1 Organize data as instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data consistently in related groupings. Identify contents of each binder on spine.
- .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems under section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

- .7 Text: manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.3 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project; Date of submission; names.
 - .1 Addresses and telephone numbers of Contract Administrator and Contractor with name of responsible parties.
 - .2 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

1.4 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- .3 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .4 Provide servicing and lubrication schedule, and list of lubricants required.
- .5 Include manufacturer's printed operation and maintenance instructions.
- .6 Include sequence of operation by controls manufacturer.
- .7 Provide original manufacturer's parts list, illustrations, assembly Drawings, and diagrams required for maintenance.
- .8 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

- .9 Include test reports.
- .10 Additional requirements: as specified in individual specification sections.

1.5 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to location as directed; place and store.

1.6 OPERATING AND MAINTENANCE MANUALS

- .1 Provide the Contract Administrator with five (5) copies of the manufacturer's technical literature for each component supplied detailing correct installation procedure and recommended operating and maintenance schedule, grades of lubricants required and assembly/disassembly instructions.
- .2 Bind contents in a three (3)-"D-Ring", hard-covered, plastic-jacketed binder with full cover and spine insert. Organize contents into applicable sections of work, parallel to Specifications breakdown.
- .3 Provide all required data in electronic format. Text documents shall be Microsoft Word or Adobe format. Drawings, scanned documents, parts lists, test forms shall be in Adobe format. If possible, documents should be an original electronic format. Documents that require scanning shall be high quality scans and fully legible. Documents shall be submitted on a high quality compact disk. Compact disk and case shall be labelled in type, with the following:
 - .1 Bid opportunity number;
 - .2 Job title; and,
 - .3 Description of Goods.
- .4 In addition to information called for in the Specifications, the following shall be included:
 - .1 Title sheet, labelled "Operation and Maintenance Instructions", containing project name and date;
 - .2 List of contents;
 - .3 Reviewed Shop Drawings of all Goods;
 - .4 Certified factory test results;
 - .5 Full description of entire mechanical system, operation, and control;
 - .6 Names, addresses, and telephone numbers of all major sub-contractors and suppliers;
 - .7 Detailed specification and operating and maintenance instructions for all Goods provided including a preventative maintenance program;
 - .8 An itemized list of spare parts recommended for five (5) years of service, particularly those components where failure of which will render the Goods supplied inoperative. Any special tools or other ancillary items necessary for commissioning and/or proper operation and maintenance shall also be

listed. These prices shall be available to the City at any time prior to the issuance of the Certificate of Acceptance;

- .9 Part books that illustrate and list all assemblies, sub-assemblies, and components;
- .10 Routine test procedures for all electronic and electrical circuits; and
- .11 Troubleshooting chart covering the complete controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.

1.7 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to location as directed; place and store.

1.8 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to location as directed.

1.9 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Contract Administrator

1.10 WARRANTIES

- .1 Assemble approved information in binder and submit upon acceptance of Work. Organize binder as follows:
 - .1 Separate each warranty with index tab sheets keyed to Table of Contents listing.
 - .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
 - .3 Obtain warranties, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten (10) days after completion of applicable item of work.

- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .2 Except for items put into use with City's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .3 Conduct joint eleven (11) month warranty inspection, measured from Date of Substantial Performance, by Contract Administrator.
- .4 Respond in a timely manner to oral or written notification of required construction warranty repair Work.
- .5 Written verification will follow oral instructions. Failure to respond will be cause for the Contract Administrator to proceed with action against Contractor.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SCOPE

- .1 This section refers to the supply, delivery, and testing of the following valves:
 - .1 Rising Stem Gate Valves
 - .1 Eight (8) 250 mm Gate Valves – manually actuated; and,
 - .2 Two (2) 300 mm Gate Valves – manually actuated.
 - .2 Non-Rising Stem Gate Valves
 - .1 Two (2) 150 mm Gate Valves – manually actuated.
 - .3 Communitor Chamber – Non-Rising Stem Gate Valves
 - .1 Two (2) 500 mm Gate Valves, complete with remote manual pedestal operators, stem, wall brackets and all accessories.
 - .4 Three (3) 250 mm Check Valves with “hold-open” device – manually actuated
- .2 Have valves for all systems supplied by the same supplier.
- .3 Supply all other materials, products, and services described in this specification.

1.2 SHOP DRAWINGS

- .1 Submit Shop Drawings in accordance with Section 01 30 00 – Submittal Procedures.

1.3 REFERENCES

- .1 American Water Works Association (AWWA), American National Standards Institute (ANSI) / American society of Mechanical Engineers (ASME).
- .2 ASNI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit data for all valves specified in this section.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.6 SPARE PARTS

- .1 Provide list of recommended spare parts for City's follow-up.

Part 2 Products

2.1 VALVE OPERATORS

- .1 Supply valve operators or actuators for all types of valves specified as follows:
 - .1 Supply removable manually operated hand wheels for all valves.

- .2 Ensure that each valve and operator is of suitable construction and rating for the long term service with the fluid or product being conveyed and at the pressure and operating frequencies required by the relevant service.
- .3 The allowable pull on a manual operator to open or close the valve shall be ≤ 270 N (60 lb force). Manual operators shall operate in a clockwise motion to close the valve. For valves with > 270 N (60 lb force), install spur gear actuators.
- .4 Supply cast iron hand wheels clearly marked with a flow directional arrow and the word "open" cast in relief on the rim. Provide hand wheels > 300 mm in diameter for all valves > 200 mm and 450 mm in diameter for larger valves as required to allow for manual operation. In confined areas, furnish smaller hand wheels with higher ratio gearing of the valve to compensate.
- .5 Supply steel pipe Tee wrenches with socket to suit nut dimensions.

2.2 GENERAL VALVE REQUIREMENTS

- .1 Where there is an applicable recommended standard for the design, construction, and testing of a valve and/or actuator, e.g., AWWA, CGA, CSA etc., equipment to be supplied under this section will refer to this standard. Comply with these requirements for all equipment supplied in all regards. Where specifically requested, provide certificates of compliance with the applicable standards.
- .2 Where it is not intended to supply equipment or valves to a specific standard, the specification will indicate a reference product. Provide flanges as specified for all flanged valves for the line into which they are to be installed. As a minimum standard a Class 125 lb rating will be required.
- .3 The Contractor shall ensure that the valve end connections are compatible with pipe material in which the valve is installed.
- .4 Do not install valves dissimilar with piping to avoid galvanic corrosion.
- .5 All packing, gaskets, seats, diaphragms, lubricants, etc., shall be suitable for the intended operating conditions.
- .6 Supply all valves free of asphalt varnish or other non-potable protective coatings if it is intended for potable water service. Mark valves with size, pressure rating, and manufacturer on a corrosion resistant nameplate mounted on the body.
- .7 Equip the valve with a disc position indicator and a direction of flow indicator where applicable.

2.3 IRON GATE VALVE SPECIFICATION

- .1 This Specification covers Cast Iron and Ductile Iron Gate Valves in sizes 75 mm to 750 mm for above ground installation.
- .2 The valves shall conform to AWWA 500.
- .3 Pressure-temperature ratings:
 - .1 75 mm to 300 mm: 1400 kPa @ sixty-five (65) degrees Celsius.
 - .2 350 mm to 750 mm: 1050 kPa @ sixty-five (65) degrees Celsius.
- .4 Body material: cast iron to ASTM A 126, Class B or Ductile Iron to ASTM-A 536 Grade 65-45-12.

- .5 Non-resilient metal seated.
- .6 Trim material: bronze.
- .7 Direction of opening shall be counter clockwise and shall be clearly stamped or indicated with raised letters and arrow.
- .8 Manufacturer's nameplate shall be attached to the valve body with stainless steel fasteners.
- .9 Knife gate valves are not acceptable.
- .10 End connections: flanged to ANSI B16.1, Class 125 with holes straddling centreline.
- .11 Packing and gaskets: non-asbestos.
- .12 Fusion bonded epoxy coating on the interior and exterior including gland cover, body, and bonnet to AWWA C-550.
- .13 All fasteners, nuts, and bolts shall be stainless steel.
- .14 Submit shop drawings of the gate valve assembly in accordance with Section 01 33 00 – Submittal Procedures.
- .15 Acceptable manufacturers - one of the following:
 - .1 American Valve Company;
 - .2 Pratt;
 - .3 Clow Canada;
 - .4 Dezurik;
 - .5 Mueller Canada; or,
 - .6 Approved equal in accordance with B7.

2.4 COMMUNITOR CHAMBER GATE VALVES

- .1 Cast iron body with flanged ends; double rotating disc or solid disc, bronze trimmed cast iron wedge; bronze stem, double O-ring stem seals and fifty (50) millimeter square operating nut.
- .2 Two (2) gate valves with be equipped with non-rising stems and shall be complete with remote manual pedestal operators.
 - .1 The gate valves with non-rising stems will be installed by others inside the two (2) Communitor Chambers. The distance from the centerline of the pipe the gate valves will be connected, to the floor where the pedestal mounted operator will be installed is approximately 6.25 m (20.5 ft.). These approximate measurements can be used to estimate operator extension stem lengths.
 - .2 The operator extension stem length is from historical drawings and needs to be confirmed by the Contractor prior to fabrication.
- .3 The pedestal mounted gate valve operators shall meet the following criteria
 - .1 Body shall be ductile iron or steel with concrete lining
 - .2 Gate valve operators shall have an indicator gauge with a travelling pointer to show if valve is open, closed or in a position in between.
 - .3 Bushings to be bronze and all bolting hardware to be Type 304 stainless steel.

- .4 Direction of opening shall be counter clockwise and shall be clearly stamped or indicated with raised letters and arrow.
- .5 Contractor to be responsible for confirming all field measurements prior to manufacturing to ensure proper function and fit for the pedestal mounted operators.
- .6 Contractor to verify operating torque requirements for valve and to size stem/spindle accordingly. Provide valve stem/spindle guides.
- .7 Contractor to supply all required valve stem extensions and guide brackets for proper valve operation.
- .4 The gate valve shall be equipped with a spur gear actuator.
- .5 Acceptable manufacturers - one of the following:
 - .1 American Valve Company;
 - .2 Clow Canada;
 - .3 Dezurik;
 - .4 Mueller Canada; or,
 - .5 Approved equal in accordance with B7.

2.5 PROCESS CHECK VALVES

- .1 The valves shall be designed, manufactured, tested and certified to American Water Works Association Standard ANSI/AWWA C508.
- .2 The valves shall have flanges with drilling to ANSI B16.1, Class 125 with holes straddling centreline.
- .3 Check valve to be rapid closure rubber flapper (RF) type with a 45° seating face suitable for horizontal installation.
- .4 The valves will be specified with the “hold open” device.
- .5 The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical disc position indicator.
- .6 The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and reinforced with alloy steel.
- .7 The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron.
- .8 The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG. Optional disc material includes Viton, EPDM, Hypalon.
- .9 Hinge pin to be stainless steel (303/316).
- .10 The exterior and interior of the valve shall be coated with an AWWA C-550 approved fusion bonded epoxy coating.
- .11 All valves shall be hydrostatically tested and seat tested to demonstrate zero (0) leakage. The manufacturer shall provide test certificates, dimensional Drawings, parts list Drawings, and operation and maintenance manuals.

- .12 Submit shop drawings of check valves in accordance with Section 01 33 00 – Submittal Procedures.
- .13 Approved check valve manufacturers:
 - .1 American Valve Company;
 - .2 Clow Canada;
 - .3 Dezurik;
 - .4 Mueller Canada; or
 - .5 Approved equal in accordance with B7.

Part 3 Execution

3.1 SHOP TESTING

- .1 Test AWWA valves in the shop in accordance with AWWA requirements. A certified test report shall be submitted.

3.2 CERTIFICATES

- .1 On completion of installation and testing, submit the manufacturer's certification of the correctness of the installation to the Contract Administrator.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 This Specification shall cover the supply of pumping equipment, complete with motors, drive shafts, drive shaft guards, pump suction elbows, supports and spare parts. It also includes initial on Site start-up inspection of the Goods after installation in the Jessie Wastewater Pumping Station.
- .2 Pumps will be used to pump raw sewage having a temperature range of zero (0) degrees Celsius to thirty (30) degrees Celsius and will operate under conditions of flooded suction.
- .3 Each pump shall be a single stage, non-clogging, centrifugal flow, vertical mounted, pump coupled with a drive shaft to an electric motor suitable for dry pit installation.
- .4 Durable metal nameplates shall be securely attached to each pumping unit supplied. Pump nameplates shall indicate the serial number, capacity, head, rpm, and other pertinent data. Motor nameplates shall indicate the serial number, voltage, phase, hertz, rpm, horsepower, service factor, NEMA Design, insulation class and any other pertinent data.
- .5 Pumping equipment shall include motors, extended drive shafts, anchor bolts, base plates, supporting frame, and all appurtenances required for an operating system.

1.2 GUARANTEES

- .1 The equipment shall be guaranteed to perform to the specified operating conditions.

1.3 REFERENCE STANDARDS

- .1 Pumping units shall generally comply with the requirements of the Hydraulic Institute Standards.
- .2 Pumping unit shall be CSA approved.

1.4 SHOP PAINTING

- .1 All equipment is to be painted with manufacturer's standard coatings.

1.5 STANDARDS

- .1 Have equipment comply with the latest edition of the applicable codes and regulations including, but not limited to, the following:
 - .1 American Society of Mechanical Engineers (ASME);
 - .2 Canadian Standards Association (CSA);
 - .3 Canadian Electrical Manufacturers Association (CEMA);
 - .4 National Electrical Manufacturer's Association (NEMA);
 - .5 American Society for Testing and Materials (ASTM);

- .6 American National Standard Institute (ANSI);
- .7 Electrical Electronics Manufacturing Association of Canada (EEMAC);
and,
- .8 Electrical Safety Association (ESA).
- .2 Have all electrical equipment comply in every respect with the rules and regulations of Manitoba Hydro and be acceptable to their local inspector.
- .3 In cases of any conflict between these specifications and any of the above standards, the most stringent standard will have precedence.

1.6 SUBMITTALS

- .1 Submit Shop Drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop Drawings shall include details of the equipment stand, complete with instructions for attachment of the stand to the concrete base.
- .3 Performance curves shall be submitted with the Shop drawings. Performance curves shall include capacity, head, pump efficiency, BkW, and NPSH from shut-off through the rated point to run-out.
- .4 Submit operation and maintenance manuals in accordance with Section 01 78 00 – Closeout Submittals.
- .5 Attached Data Sheets must be completed and submitted as part of the shop drawings.

Part 2 Products

2.1 CENTRIFUGAL PUMPS

- .1 General:
 - .1 Supply three (3) centrifugal vertical shaft pumps as detailed in this specification.
 - .2 The pump shall be supplied complete with:
 - .1 Motor;
 - .2 Base (four (4) legged);
 - .3 Flanged suction and discharge piping connections;
 - .4 Extended drive shafts and guards; and,
 - .5 Couplings.
- .2 Operating Requirements – Pumps:
 - .1 Duty Point:

.1 Single Pump	156 l/s @ 22.6 m head
.2 Parallel Pumps	185 l/s @ 28.0 m head
 - .2 Minimum Shut off Head 40 m
 - .3 Nominal Speed: 1200 rpm
 - .4 Rotation (viewed from above): CW

- .5 Type of Impeller: Non-clog
- .6 Size of Sphere Impeller Shall Pass: 75 mm (3 in)
- .7 Diameter of Pump Suction: 250 mm (10 in)
- .8 Diameter of Pump Discharge: 250 mm (10 in)
- .9 Pump Efficiency at Duty Point: 70%
- .10 Pump head/capacity curves shall be continuously rising toward shut-off.
- .11 The required net positive suction head (NPSHR) shall not exceed the available NPSH at any point on the curve and cavitation-free performance shall be guaranteed.
- .12 Motor shall be sized so that the pump is non-overloading throughout the pump performance curve from shut-off to run-out conditions.
- .3 Clean Out Port
 - .1 Clean out port to be located at center of pump.
- .4 Unspecified Materials
 - .1 All unspecified materials shall be selected specifically for their suitability considering their duty.
- .5 Casing
 - .1 Pump casing: cast iron conforming to ASTM Specification A48 or A278, for Gray Iron Castings, Class 30 or approved equal in accordance with B7.
- .6 Backhead and Stuffing Box
 - .1 Backhead: cast iron conforming to ASTM Specification A48 or A278, for Gray Iron Castings, Class 30 or approved equal in accordance with B7.
- .7 Bearing Frame
 - .1 Bearing Frame: cast iron conforming to ASTM Specification A48 or A278, for Gray Iron Castings, Class 30.
- .8 Non Clog Impeller
 - .1 Impeller: cast iron conforming to ASTM Specification A48 or A278, for Gray Iron Castings, Class 30 or approved equal in accordance with B7. The cast iron shall contain not less than three (3) percent nickel.
 - .2 The impeller to be of the non-clog enclosed channel type.
 - .3 Impeller to be mid-range in diameter.
- .9 Wear Rings
 - .1 Wear Rings: fabricated from stainless steel conforming to ASTM Standard A296, for Corrosion-Resistant Iron Chromium, Iron-Chromium-Nickel, and Nickel-Base Alloy Castings for General Application, Grade CA-15 or approved equal in accordance with B7.
 - .2 Impeller ring hardness to be at least 300 Brinell (RC 32.1).
 - .3 Casing wear ring to exceed impeller wear ring by at least 50 Brinell.

- .10 Impeller Shaft Assembly
 - .1 Shaft Assembly: fabricated from steel conforming to ASTM A108, Grade 1045 or approved equal in accordance with B7.
- .11 Shaft Sleeve
 - .1 Shaft sleeve where shaft passes through stuffing box: fabricated from 316L stainless steel conforming to ASTM A240 or approved equal in accordance with B7.
- .12 Bearings
 - .1 Bearings: shall be of the heavy duty anti-friction type suitable for oil or grease lubrication. Radial bearings shall be of the self-aligning plain roller or ball type and thrust bearings shall be of the tapered roller or angular contact type.
 - .2 Design bearings for a B-10 life of not less than 100,000 hours in accordance with AFBMA.
- .13 Mechanical Seals
 - .1 Mechanical Seals: Double mechanical seals, cartridge type.
 - .2 Primary sealing mating faces to be silicon carbide to silicon carbide and secondary sealing mating faces to be carbon to silicon carbide or silicon carbide to silicon carbide.
 - .3 As manufactured by John Crane, Flowserve, Burgmann, or approved equal in accordance with B7.
- .14 Mechanical Seal Water Solenoid Valves
 - .1 Where mechanical seals require external seal water, supply one (1) solenoid valve per pump for the purpose of controlling seal water flow.
 - .2 Seal water solenoid valves are not required to be provided if the pumps utilize an internal sealed oil reservoir.
 - .3 Solenoid valves to operate off 120 Vac, 60 Hz supply.
- .15 Paint
 - .1 One (1) prime coat of a rust inhibitive primer, a second adhesive prime coat and one (1) finish coat of manufacturer's standard enamel.
- .16 Shop Drawing Submittals:
 - .1 Submit Shop Drawings of the pumps in accordance with Section 01 33 00 – Submittal Procedures.

2.2 MECHANICAL REQUIREMENTS:

- .1 General:
 - .1 Pumps to be 3" non-clog type, especially designed for use of mechanical seals
 - .2 Casing shall be rated for 1.5 times working pressure.
- .2 General Requirements – Motors
 - .1 Power Supply: 575V / 3 phase / 60 Hz

- | | | |
|----|------------------------------------|----------------------------------|
| .2 | Power Rating: | minimum 55.9 kW –
(75.0 hp) |
| .3 | Nominal Speed: | 1200 rpm |
| .4 | Motor Service Factor: | 1.15 with sine wave |
| .5 | Motor Efficiency: | NEMA premium efficiency
motor |
| .6 | Full Load Amps at Operating Point: | 90% of max |
| .7 | Motor Speed Torque Characteristics | NEMA Design B |
| .8 | Starts per Hour Capability: | 5 |
| .9 | CSA Specification Conformance: | C22.2 No. 100 |
- .3 Motor:
- .1 Vertical shaft, squirrel cage, totally enclosed fan cooled, NEMA premium efficiency induction motor conforming to CSA Specification C22.2 No. 100 and all other CSA Specifications referenced therein.
 - .2 Variable Frequency Drive (FVD) rated and suitable for full voltage or VFD starting.
 - .3 Able to operate, without damage, at full load with voltages from ten (10) percent below to ten (10) percent above rated volts. Motor horsepower shall not be less than maximum of 75 hp or five (5) percent in excess of the maximum power requirement of the pump at any point on the pump characteristic curve. This rating shall be exclusive of the motor service factor.
 - .4 Motors will be subject to a maximum of five (5) start/stop cycles per hour and the stator winding insulation suitable for such operation. In no case shall stator winding insulation be less than Class F.
 - .5 Equipped with heavy duty grease-lubricated and anti-friction bearings with an AFBMA B10 rating of 100,000 hours.
 - .6 Maximum noise level of 85 dBA at 1.2 meter distance.
 - .7 Motors to be suitable for vertical mounting either to the concrete floor or base stand.
- .4 Bearings:
- .1 The upper bearing shall be free to move linearly with the thermal expansion of the shaft and shall carry only radial loads.
 - .2 Lower bearing (nearest to impeller) shall be adequate to carry all radial and axial thrusts developed by largest impeller that bowl can accommodate.
 - .3 Shaft bearing nearest the pump impeller shall be locked in place so that shaft end play is limited to the clearance within the bearing.
- .5 A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.
- .6 Drive Shaft Assembly

- .1 Vertical hollow steel drive shaft with flexible coupling(s) to transmit power from the motor to the pump.
- .2 Drive shaft and coupling(s) shall have a service factor of 2.5 to ensure ample capacity to transmit power continuously for all operating conditions with up to 3 degrees of misalignment which may occur during or develop after installation and should accommodate any thermal expansion based on a temperature differential of one hundred (100) degrees Fahrenheit.
- .3 Submit shop drawings of the drive shaft assembly in accordance with Section 01 33 00 – Submittal Procedures.

- .4 Drive Shaft Guard
- .5 Removable (with tools), minimum 1.6 millimetre thick galvanized expanded metal steel mesh constructed to OSHA standards.
- .6 Fasteners: ASTM A276 Type 316 stainless steel.
- .7 Shop Drawing submittals:
- .8 Submit Shop Drawings of the drive shaft guard in accordance with Section 01 33 00 – Submittal Procedures.
- .9 The drive shaft guard shall extend through the pump room ceiling to the motor room floor
- .7 Shaft and Sleeve:
 - .1 Shaft and shaft sleeve shall be designed for minimum deflection at maximum load. Shaft assembly shall be one (1) piece, ground and polished. Shaft sleeve shall be renewable, positively driven by impeller key.
 - .2 The shaft from the top of the impeller to the lower bearing supporting the impeller shall have a minimum diameter of 1 7/8". The dimension from the lowest bearing to the top of the impeller shall not exceed 6".
 - .3 Removable shaft sleeves will not be acceptable if the shaft under the sleeve does not meet the specified minimum diameter. O-ring shall be provided to prevent leakage under shaft sleeve.
 - .4 Shaft runout limited to .003".
- .8 Pump Support
 - .1 Provide one rigid fabricated steel four-legged stand or a cast suction elbow/cast stand combination for each pump. Pump support shall firmly support the entire weight of the pump and withstand the full motor torque.
 - .1 The pump support shall provide clear access to the cleanout ports on the suction elbow and the pump volute.
 - .2 The pump support should be suitable for mounting onto the existing concrete base using anchor bolts.
 - .1 The installation contractor will have the capability to modify the existing concrete base to suite the pump and pump support.
 - .3 Shop drawing submittals:
 - .1 Submit Shop Drawings of the pump support in accordance with Section 01 33 00 – Submittal Procedures.

2.3 CONSTRUCTION:

- .1 General
 - .1 Castings to be free from flaws and imperfections and machined surfaces finished true.
 - .2 Round off inside and outside corners and edges of all castings.
 - .3 Provide means to prevent nuts and bolts from becoming loose (pins, spring or friction washered fasteners).

- .4 Obtain written permission of the Contract Administrator to patch, plug, shim or employ other means of overcoming defects, discrepancies or errors in manufacturing.
- .5 Statically and dynamically balance all rotating components as an assembled unit in accordance with ISO 1940 G6.3.
- .2 Casing
 - .1 Centrifugal volute type design of ample thickness and rigidity to withstand stresses due to hydraulic forces, weight of piping, erection loads, operating and testing.
 - .2 Inside water passages shall be smooth and free from any significant projections that would hinder the flow of any solid waste.
 - .3 Proportion casings so change in energy of the sewage from the kinetic form, as it leaves the impeller, to the pressure form as it leaves the casing will take place gradually with minimum eddy formation or shock.
 - .4 Front head to permit equal distribution of sewage to all parts of the impeller without the use of stationary guides or vanes on the suction side of the impeller.
 - .5 Design to permit the removal of the rotating assembly without disturbing the suction and discharge piping.
 - .6 Provide a hand hole with bolted cover on the volute to permit access to the inside for cleaning and unclogging of the volute.
 - .7 Provide a tapped 10 mm (3/8") NPT hole on the top of the volute with a suitable length of brass pipe and a shut off ball valve to allow trapped air within the volute to be bled off.
 - .8 Shop test and provide certification that the fully assembled casing is successfully able withstand a hydrostatic test pressure of not less than 1.5 times the shut-off head of the largest impeller size as shown by the characteristic curve.
- .3 Suction and Discharge
 - .1 Suction and discharge shall be flanged, faced and drilled to conform to ASME Specification B 16.1 Class 125.
 - .2 Provide a cast or fabricated ninety (90) degree suction elbow with hand hole and cover plate fastened with bolts, to permit access to the suction side of the impeller for cleaning and inspection.
 - .3 Provide gauge connections tapped for 10 mm (3/8") NPT threaded pipe on each suction and discharge nozzle. Locate tapped connection close to flange ends. Provide pipe plugs in tapped holes.
 - .4 Orient the suction and discharge horizontally opposite each other on the centreline of the pump.
- .4 Backhead and Stuffing Box
 - .1 Backhead shall be a separate piece from the volute casing.
 - .2 Backhead shall be designed to rigidly support the bearing frame and be a self-centering and self-indexing fit with the volute casing to ensure proper alignment.

- .3 Provide a minimum of two large openings opposite each other adjacent to the stuffing box to allow access for maintenance.
- .4 Provide for external axial adjustment of the rotating element to maintain proper clearance between the impeller and front head wearing rings.
- .5 Stuffing box shall be integral with the backhead and suitable for the use of a double mechanical seal.
- .6 Provide tapped 10 mm NPT inlet and vent holes complete with suitable lengths of brass pipe and shut-off ball valves on opposite sides of the stuffing box for seal water inlet and outlet.
- .7 Provide a tapped drain hole on the stuffing box complete with pipe plug.
- .5 Bearing Frame
 - .1 Bearing frame shall rigidly support the motor adapter frame with a self-centering and self-indexing fit with the backhead to ensure proper alignment.
 - .2 Machine bearing frame for accurate and permanent bearing alignment.
 - .3 Completely enclose the shaft between the bearings.
 - .4 Provide lip type seals in contact with the shaft.
 - .5 Include grease fittings in the bearing frame for bearing lubrication.
- .6 Impeller
 - .1 Design impeller to ensure smooth operation without cavitation in the operating range and with minimum vibration.
 - .2 Cast impeller in one piece and balance both statically and dynamically to ISO 1940 G6.3.
 - .3 Trim impeller over its full height if the impeller supplied has been trimmed from a larger impeller leaving no lip or protrusion around the bottom edge.
 - .4 Balance trimmed impeller after trimming.
 - .5 Cast impeller surface to be free from casting blemishes and finished to 250 RMS or better.
 - .6 Securely key the impeller to the tapered shaft and hold in place with an impeller nut.
 - .7 The impeller nut shall be dome shaped with a smooth face and blend into the hub so as not to allow any stringy material to accumulate around the nut. Hex shaped nuts shall not be used.
 - .8 Design the impeller and retaining nut so that the impeller cannot loosen on the shaft due to torque resulting from rotation.
- .7 Wear Rings
 - .1 Provide removable wear rings of the axial or radial type for the front head and impeller.
 - .2 Machine the rings for a close fit to minimize the leakage of sewage from the discharge to the suction.

- .3 Attach the rings in such a way as to allow for ready adjustment or replacement and to prevent loosening under normal operation or under reverse pump rotation.
- .8 Impeller Shaft Assembly
 - .1 Shaft assembly to be of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration or undue deflection at all operating speeds and loads.
 - .2 Accurately machine the shaft along its entire length and provide keyways at both ends.
- .9 Shaft Sleeve
 - .1 Fit and securely fasten the shaft sleeve in place after shaft grinding.
 - .2 Seal shaft sleeve to prevent leakage between the sleeve and shaft.
 - .3 Extend shaft sleeve at least 2 mm above the top of the gland cover.
- .10 Bearings
 - .1 Rigidly support bearings to counteract any possible tendency towards vibration.
 - .2 Grind and match duplex bearings, if used.
 - .3 Adapt lubrication of the bearings to the operation of the units without full-time attendance.
- .11 Mechanical Seals
 - .1 Seals to be oil lubricated or water lubricated.
 - .1 If oil lubricated, oil reservoir to be sealed and integral to pump casing. Oil to be non-toxic with minimum life of 10,000 hours.
 - .2 If water lubricated, seals will be continually flushed and lubricated by filtered domestic water while the pump is operating. Provide solenoids on seal flush lines to stop seal flush water flow to pumps while pumps are off. Solenoids to operate off of a 120 Vac, 60 Hz supply.
- .12 Drive Shaft Assembly
 - .1 The drive shaft assembly coupling arrangement shall permit easy removal of either the pump or motor without disturbing the other. Only one length of shaft shall be used between the pump and motor.
 - .2 Statically and dynamically balance the drive shaft to obtain vibration free operation. Design shaft to ensure a separation of fifty (50) percent between the operating speed and the first harmonic frequency of the system (motor, couplings, shaft and pump).
 - .3 The approximate elevations of the pump room floor and motor room floor for the pumping station is shown in Table 1. The Bidder shall use this to approximate the drive shaft length for bidding purposes. Bidder shall confirm distances prior to manufacture.

.4 Table 1 – Approximate Elevations and Dimensions

DETAIL	ELEVATION (m)
Pump Room Floor	220.57
Motor Room Floor	223.08

.5 After award of this Contract, the Supplier shall be responsible to take exact measurements for final sizing of the drive shaft lengths.

.13 Drive Shaft Guard

.1 Drive shaft guards, as supplied, shall be meet OSHA standards upon installation without requiring any modification. Installation by others.

.14 Paint

.1 Apply one (1) prime coat of a rust inhibitive primer, a second adhesive prime coat and one (1) finish coat of manufacturer's standard enamel to all exterior metal surfaces, except machined surfaces.

.2 Do not paint over nameplates.

2.4 EQUIPMENT MOUNTING

.1 Pump and motor shall be supported by a heavy cast-iron or fabricated steel base with four (4) legs. The height of the base shall be sufficient to permit the use of decreasing suction and increasing discharge elbows, which shall be provided when the nominal pump size is smaller than the suction line. The suction and discharge openings shall be flanged faced and drilled one hundred and twenty-five (125) pound American Standard.

.2 The pump must be secured to base at the factory or in the field, with bolts and/or dowels such that the motor-pump shaft shall be centered, in relation to the motor base within .005".

2.5 SPARE PARTS

- .1 The spare parts shall include:
- .1 One (1) spare mechanical seal; and,
 - .2 One (1) set of pump gaskets/O-rings/shims.

2.6 ACCEPTABLE PRODUCTS

- .1 The pump shall be:
- .1 Flowserve;
 - .2 Sulzer;
 - .3 Cornell;
 - .4 Flygt; and,
 - .5 Or approved equal in accordance with B7.

Part 3 Execution

3.1 TOOLS AND ACCESSORIES

- .1 Tools and Accessories
 - .1 Provide special tools or accessories required for maintenance, adjustment, assembly or disassembly of the pumping equipment supplied.

3.2 TESTING AND INITIAL START UP INSPECTION FOR THE PUMPING EQUIPMENT

- .1 General
 - .1 Each manufacturer shall guarantee his pump(s) for the rated capacity and overall efficiency when installed and operating under the specified conditions of head and discharge.
 - .2 Submit results of factory performance tests to the Contract Administrator as Certified Pump Test Curves including capacity, head, pump efficiency, BkW and NPSH from shut-off through the rated point to run-out.
- .2 Pump and Motor Testing
 - .1 Conduct pump tests in accordance with Hydraulic Institute Standards – Centrifugal Pumps Test Code. All definitions for the purpose of testing shall be as set forth by Hydraulic Institute Standards – Centrifugal Pumps Ratings.
 - .2 Pump test to be non-witnessed performance tested as per Hydraulic Institute Standards 14.6 Grade 1B.
 - .3 Conduct motor tests in accordance with CSA C22.2 No. 100, EEMAC, MG-2. each motor shall be tested for:
 - .1 Running current;
 - .2 Locked rotor current;
 - .3 Hi-pot test; and,
 - .4 Winding resistance.
- .3 Shop Tests
 - .1 Test each pump in the manufacturer's shops over the range of operation from shut-off to run-out.
 - .2 Provide a certified test curve in duplicate showing the head, capacity, pump efficiency and power for each pump to the Contract Administrator for review prior to shipping Goods.
 - .3 Test curves to be signed by the pump manufacturer's official responsible for the test.
 - .4 Final payment for the Goods will be made only after the Contract Administrator has received the certified test curve for each pump supplied.

- .5 Field Tests
- .4 Field tests will be performed on each pumping unit as soon as possible after the Contractor has inspected the installation. Field tests will be to determine and check for the following:
 - .1 Capacity;
 - .2 Noise (bearing, mechanical seal, cavitation, other);
 - .3 Vibration;
 - .4 Electrical energy supplied to the motors from motor control centre; and,
 - .5 The liquid pumped during the field test will be raw sewage with a density taken to be 1.00 kilogram per litre.
- .2 If the field pump tests indicates the Goods supplied does not meet the specified requirements, the Contractor shall promptly correct the problem at his expense to the Contract Administrator's satisfaction.
- .3 If the Contractor is not satisfied with the procedure of the tests or the City's interpretation of the results thereof, the Contractor may have the tests repeated, or their interpretation referred to a referee acceptable to both the City and himself. The cost of the services of such referee shall be borne by the City if the referee rules that the tests as reported by the City were to the detriment of the Contractor but if otherwise, the Contractor shall pay the cost of the services of the referee and of repeating the tests. The decision of the referee shall be final and binding both on the City and the Contractor.
- .5 Initial Start-up Inspection
 - .1 Goods supplied under this Contract will be installed under a separate contract. The pumping equipment supplier will not be responsible for the installation work.
 - .2 The Contract Administrator will provide seven (7) Calendar Days' notice of requirement for an initial pump start-up inspection.
 - .3 Provide the services of a qualified technical representative to be present at the initial start-up of each pumping unit supplied under this Contract to perform the following:
 - .1 Inspect the pumping equipment to ensure they have been properly installed in accordance with the manufacturer's instructions;
 - .2 Conduct and document amp draw, rotation and speed tests;
 - .3 Check for unusual vibration or noises; and,
 - .4 Instruct City personnel in the operation and maintenance of the Goods.
 - .4 Promptly correct any deficiencies with the pumping equipment at own expense to the Contract Administrator's satisfaction.
 - .5 The price provided for "Initial Start-up Inspection" shall cover all costs associated with this item of Work including travel expenses, accommodations, meals, and wages.

3.3 LUBRICATION, GREASE, OIL AND FUEL

- .1 Perform the complete initial lubrication of all equipment in accordance with the manufacturer's instructions. Provide all grease, oil, lubricants, etc., as required for the initial operation of the equipment.

3.4 COMMISSIONING

- .1 The Equipment Manufacturer's Technical Representative or approved alternate shall inspect the pump installation to ensure that the equipment has been installed in accordance with the manufacturer's requirements. If the installation is not in order, Equipment Manufacturer's Technical Representative shall provide instruction for the installation Contractor. The equipment shall be started and run, and adjustments made at this time.
- .2 The Manufacturer's Technical Representative, installation Contractor and Contract Administrator shall jointly commission the works in accordance with the written procedure for commissioning. The installation Contractor shall provide sufficient manpower for the duration of the commissioning period. The installation Contractor shall make necessary adjustments during commissioning to put the works into continuous operation.
 - .1 The Contract Administrator will request that the equipment be operated to demonstrate that it performs as specified. If the Contract Administrator notes deficiencies, the deficiency shall be corrected immediately by the installation Contractor. The installation Contractor shall advise the Contract Administrator, in writing, when the deficiencies have been corrected.
 - .2 Deficiencies of a serious nature, as determined by the Contract Administrator, shall be corrected by the Manufacturer's Representative.

3.5 TRAINING

- .1 Commissioning and training shall be combined. Training sessions shall be documented and include the following as a minimum:
 - .1 Functional description of equipment operation;
 - .2 Identification of components and their purpose;
 - .3 Confirmation of operating parameters and machine limits;
 - .4 Review of routine maintenance procedures and maintenance supplies;
 - .5 Trouble shooting procedures, limits of operator, and maintenance competence; and,
 - .6 Long-term maintenance procedures, including anticipated overhaul frequencies.
- .2 Training for the pumping equipment shall be conducted on Site, in conjunction with commissioning. The Contractor shall provide a qualified instructor as well as the necessary course materials.
- .3 Training shall be provided in one (1) session for operation and maintenance staff, and one (1) session for Electrical and Instrumentation staff.

- .4 No additional payment will be made by the City to an equipment supplier for the training. Cost to be included in the lump sum for the specific equipment.

END OF SECTION