SECTION 46 33 33.03

BALLAST ADDITION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Society of Mechanical Engineers (ASME).
   2. National Building Code of Canada (NBCC).
   3. National Electrical Manufacturers Association (NEMA): MG 1, Motors and Generators.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Make, model, and weight of each equipment assembly.
   2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   3. Detailed drawings showing the equipment dimensions, size and locations of connections, weights of associated equipment, and construction details.
   4. Motors: See requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
   5. Instruments: See requirements of Section 40 90 00, Process Instrumentation and Control Systems.
   6. External utility requirements such as air, water, and power.
   7. Written certification from professional engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment have been designed for post-disaster structures in accordance with the requirements of the 2010 National Building Code of Canada and the 2011 Manitoba Amendments, at time of shop drawing submittals.

1.3 PREPARATION FOR SHIPMENT

A. Insofar as is practical, equipment specified herein shall be factory assembled and tested. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assembly in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

PART 2 PRODUCTS

2.1 BALLAST ADDITION SYSTEM DESCRIPTION

A. The ballast addition system includes, but not limited to, bulk bag unloader, dry ballast feeder, ballast delivery system, and other accessories as required and as specified herein.

B. The ballast addition system shall be capable of manual or automatic operation and delivery of the ballast to the high rate clarifiers.

C. Bulk Bag Unloader:
1. Fabricated from carbon steel, epoxy painted.
2. Designed to support up to 2000 kg and fully adjustable to suit bulk bags of different sizes.
3. Designed to prevent bridging and rat-holing and completely discharge the contents of the bulk bag without the need for repositioning or adjusting the bag.
4. Equipped with electric vibrator, Iris valve, stainless steel access chamber with side access door and top inlet opening for bag spout. .
5. Cantilevered overhead monorail with motorized trolley and hoist for lifting bulk bags into position.
6. Provide load cell weighing system or an equivalent system complete with indicator and transmitter for controlling batching and for remote indication of bag empty condition.

D. Dry Ballast Feeder:
1. Material: Constructed of abrasion resistant materials suitable for conveying dry Ballast.
2. Capacity: As required by Contractor.
3. Hopper with steep side walls, 304 stainless steel dosing screw
4. Provide dust-tight flexible connections at the feeder inlet and outlet connections.

E. Ballast Delivery System:
1. Type (wet or dry): To be determined by Contractor.
2. Provide all necessary equipment, such as eductor, wetting cone and discharge valves for delivery of the Ballast from the dry feeder to the high rate clarifiers. Provide a high level sensor to detect a potential overflow and stop the system water supply.

F. Control Panel:
1. Ballast addition system shall be controlled by the HRC system master control panel.

2.2 AUTOMATIC VALVES

A. Vendor shall furnish all required automatic valves, complete with all necessary appurtenances such as actuators and limit switches.

2.3 INSTRUMENTATION AND CONTROLS

A. Supply loose instruments in accordance with Section 40 90 00, Process Instrumentation and Control System.

B. Provide a comprehensive control narrative and functional requirements specification in accordance with Section 40 90 00, Process Instrumentation and Control System.

C. Provide items not specifically called out which are required to implement functions required for proper system operation.

2.4 ACCESSORIES

A. See Section 01 61 00, Common Product Requirements.

2.5 FACTORY FINISHING

A. Prepare and prime coat in accordance with Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.1 INSTALLATION

A. By Installation Contractor according to manufacturer's written instructions.

3.2 FIELD TEST

A. Functional Test: Prior to plant startup, all equipment shall be inspected for proper installation, quiet operation, and proper connection.

3.3 FIELD FINISHING

A. Equipment as specified in Section 09 90 00, Painting and Coating.

3.4 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Contractors' Field Services and 46 43 80, High Rate Clarification System.

END OF SECTION

SECTION 46 41 00

VERTICAL TURBINE MIXING EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards that may be referenced in this Section:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. National Building Code of Canada (NBCC).
   4. National Electrical Manufacturers Association (NEMA).

1.2 SUBMITTALS

A. Shop Drawings:
   1. Make, model, weight, and horsepower of each equipment assembly.
   2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   3. System layout, installation, and placing drawings for equipment, drivers, and bases.
   4. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work.
   5. Motors: See requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
   6. Written certification from professional engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment have been designed for post-disaster structures in accordance with the requirements of the 2010 National Building Code of Canada and the 2011 Manitoba Amendments, at time of shop drawing submittals.

1.3 PERFORMANCE REQUIREMENTS

A. Mixers shall be designed to insure that sufficient mixing energy is provided to meet the process performance requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:
   1. Lightnin.
   2. Philadephia Mixers.
   3. Envirequip

2.2 MIXERS

A. General Requirements:
1. Heavy duty, pedestal mounted, gear driven, vertical turbine type mixers.
2. All wetted parts shall be Type 316 stainless steel.

B. Speed Reducer:
1. Designed and manufactured in accordance with AGMA standards with a minimum service factor of 1.5 based on motor nameplate horsepower and 24-hour per day moderate shock application. Speed reducer shall bear AGMA nameplate.
2. Anti-friction type ball or roller bearings designed for minimum ABMA L-10 life of 100,000 hours based on motor nameplate horsepower when operating at design speed.
3. Housing shall be of cast iron, ductile iron, or fabricated steel construction, with oil fill and drain plugs and oil level indicator.

C. Electric Motor:
1. TEFC squirrel cage induction motor, premium efficiency, 1.15 service factor, Class F insulation, suitable for 575V, 3-phase, 60 Hz power supply, 1800 rpm maximum.
2. Designed and manufactured in accordance with NEMA standards and as specified in Section 26 20 00, Low Voltage AC Induction Motors.
3. Inverter duty rated and suitable for operation with variable frequency drive.

D. Mixer Shaft:
1. Solid Type 316 stainless steel.
2. Overhung design. Underwater steady bearings are not acceptable.
3. Connected to speed reducer output shaft with a rigid flanged or integral coupling.
4. Extended keyway to allow adjustment of impeller position.

E. Impeller:
1. Low shear axial flow hydrofoil type.
2. Fabricated from Type 316 stainless steel.

F. Support: Design mixers to be supported from concrete slabs.

G. Ensure that the mixer assembly including shaft, baffles, impeller, platform, and hydraulic flow is designed to ensure that damaging natural frequencies are not created under all operating conditions including steady and transient flows. Submit detailed design documentation for review and confirmation.

2.3 ACCESSORIES

A. Refer to 01 61 00, Common Product Requirements.

2.4 FACTORY FINISHING

A. All non-stainless steel surfaces shall be painted in accordance with the requirements of Section 09 90 00, Painting and Coating.

2.5 SOURCE QUALITY CONTROL

A. Factory Functional Test:
1. Conduct on each mixer.
2. Test equipment for proper alignment, quiet operation, proper connection, and satisfactory performance.
3. Test motors in accordance with the requirements of Section 26 20 00, Low Voltage AC Induction Motors.

PART 3 EXECUTION

3.1 INSTALLATION

A. By Installation Contractor in accordance with Contractor's written instructions.

3.2 FIELD QUALITY CONTROL

A. Functional Test:
1. Conduct on each mixer.
2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

B. Performance Test:
1. Conduct on each mixer as necessary to verify the process performance requirements.

3.3 MANUFACTURER'S SERVICES

A. See Section 01 43 33, Contractor's Field Services and 46 43 80, High Rate Clarification System.

END OF SECTION

SECTION 46 43 80

HIGH RATE CLARIFICATION SYSTEM

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

A. The high rate clarification (HRC) system is a type of enhanced primary treatment that employs coagulant, polymer, lamella technology, and Ballast and/or recirculated sludge to flocculate wastewater into sludge with a high settling velocity which achieves high pollutant removal efficiencies at high surface overflow rates. A coagulant is added to the wastewater and rapidly mixed in a tank. The coagulated wastewater then enters the polymer addition tank where polymer and Ballast and/or recirculated sludge are added and mixed. The wastewater then flows to a flocculation tank for further mixing to improve particle settleability. The flocculated wastewater then flows to a clarifier which separates the fast-settling particles from the effluent using lamella technology. The particles collect as sludge on the bottom of the clarifier where a mechanism collects the sludge. A recirculation system returns sludge and/or Ballast to the polymer addition tank. The HRC system produces a waste sludge for discharge to the sludge handling system. In implementations using Ballast, the waste sludge first passes through a Ballast recovery system to separate the waste sludge from the Ballast; the recovered Ballast is returned to the process. In implementations that do not employ Ballast, sludge is wasted directly from the clarifier.

1.2 GENERAL REQUIREMENTS

A. This performance-based specification is general in nature in order to accommodate the diverse HRC implementations that are available. As such, the equipment covered by these Specifications calls attention to certain features but does not purport to cover all details of the construction of the HRC system. Further, not all components of the Specifications are necessarily required; in particular, not all HRC implementations require Ballast systems. Include ancillary and accessory devices necessary for a fully functioning HRC system meeting the Design Requirements of Clause 2.2, within the confines of the scope of work defined under Section 01 11 00, Summary of Work, whether specified or not.

B. This Section provides an overview of the HRC system and provides overall design and implementation requirements. Other Sections as referenced herein provide further details for HRC component design and implementation.

C. Scope of Work:
   1. Refer to Section 01 11 00, Summary of Work.

D. Engineering:
   1. In accordance with Section 01 61 00, Common Product Requiremets.

1.3 REFERENCES

A. Material and equipment to conform to the latest edition of applicable standards in force at the time of Bid submission. In the case of conflict of these specifications with any standards, the more stringent of the two applies.

B. The following is a list of standards referenced in this section:
   1. National Building Code of Canada (NBCC) and Manitoba Amendments

1.4 DEFINITIONS

A. Refer to the General Conditions (C1. Definitions) and Supplemental Conditions (D3. Definitions).

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 00, Submittal Procedures.

B. Shop Drawings:
   1. Complete list of all components to be supplied.
   2. Dimensioned layout drawings, including plans and sections, of the HRC system including tanks and equipment galleries. Include type and sizes of piping to be supplied by the Installation Contractor e.g. recirculation piping.
   3. General arrangement drawings for all supplied equipment and package sub-systems including relevant dimensions, identification of materials of construction as well as foundation and anchor bolt plans.
   4. Process and instrumentation diagrams (P&IDs) – see Section 40 90 00, Process Instrumentation and Control Systems.
   5. Hydraulic profile, illustrating water levels at minimum and maximum design flows and annotated with elevations for weirs, inverts, obverts, waste sludge discharge, etc.
   6. Make, model, weight, and power of each equipment assembly.
   7. Catalog information, descriptive literature, technical data, specifications, and performance charts and curves as available for all components.
   8. A listing of all utility requirements, including any necessary design criteria (e.g. for plant effluent water, minimum pressure as well as minimum and maximum flow required).
   9. Control narrative document that describes the HRC system operation – see Section 40 90 00, Process Instrumentation and Control Systems.
   10. Written certification from professional engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment have been designed for post-disaster structures according to requirements of the 2010 NBCC with the 2011 Manitoba Amendments at time of shop drawing submittals.
   11. All Shop Drawings required by other applicable technical Specifications beyond those required above.

C. Other Submittals:
   1. Written offloading, storage, protection, and handling instructions.
   2. Written installation instructions and diagrams.

3. Proposed Performance Demonstration Plan including Contractor's procedure for measuring Ballast loss (if applicable). Contract Administrator must approve test procedure and any deviation from requirements stated herein.
4. Quality control documentation in accordance with Section 01 45 16.13, Quality Control.
5. Functional and performance test reports
6. All certificates in accordance with Section 01 43 33, Contractor's Field Services.
7. Operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
8. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
9. List of spare parts required for 5 years of HRC operation.
10. If applicable, Ballast technical specification that allows the City to competitively procure replacement Ballast after the supply of spare Ballast is exhausted.

1.6 EXTRA MATERIALS

A. Furnish spare parts and materials as required for two years of system operation such that all components within the Scope of Work will have available spare parts.

B. Pumps: Furnish spare parts in accordance with Section 43 21 13.29, Centrifugal Pumps or Section 44 42 56.14, Lobe Pumps, as applicable.

C. Air Scour Blower: Furnish spare parts in accordance with Section 43 11 33, Rotary Positive Displacement Blower.

D. Furnish the following spare parts and materials during commissioning or when requested by the Contract Administrator, as applicable:

1. Mixers:
    a. Seals and bearings of each different size: Two (2) sets
2. Circular Clarifier Mechanisms:
    a. Gaskets, O-rings, keys, dowels and pins: Two (2) complete sets
    b. Shear pins: Ten (10) of each different size
    c. Drive chain and/or belts: Two (2) sets for each type and size
3. Rectangular (Chain and Flight) Clarifier Mechanisms:
    a. Collector flights, complete with attachment hardware and wear shoes: Four (4) of each size
    b. Drive chains, of longest length installed: Two (2) sets
    c. Attachment links complete with pins and clips: Ten (10)
    d. Collector chain: 10 m
    e. Shear pins: Ten (10) of each size
    f. Sprocket sets, including one headshaft sprocket, one drive sprocket and one idler sprocket: One (1) set of each bore size
4. Lamellas:
    a. Plates or tubes: five percent extra
5. Ballast Systems:
    a. Ballast: Two year's consumption (two times the Guaranteed Maximum Ballast Loss entered in Form G: Guaranteeed Performance)

b. Sand Ballast Hydrocyclones: Two (2) sets of replaceable wear components
c. Magnetite Ballast Shear Mill Seals and Bearings: Two (2) sets
d. Magnetite Ballast Magnetic Drum: Two (2) sets of replaceable wear components

6. Miscellaneous:
   a. Special tools and appliances necessary to disassemble, service, repair and adjust the equipment and appurtenances: One complete set

1.7 PATENTS

A. Assume all costs of patent fees or licenses for equipment or processes, and safeguard and save harmless the City and its agents from damages, judgments, Claims, and expenses arising from license fees or claimed infringements or any letters of patent or patent right, or because of royalty or fee for the use of any equipment or process, structural feature, or arrangement of any of the component parts of the installation; and the price stipulated for all such patent fees, licenses, or other costs pertaining thereto.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials of Construction:
   1. Provide the materials of construction where stated in this Specification. The Contract Administrator reserves the right to reject materials of construction not meeting this Specification that are deemed inferior to those specified and/or accept those materials deemed superior to those specified.
   2. Use low-carbon stainless steel when the steel is to be welded.

B. Welding:
   1. Perform in accordance with Section 05 05 23, Welding – Quality Assurance
   2. Undertake all welding in accordance with the recommendations of the American Welding Society.
   3. For all welding, use a process suitable for the materials to be welded.
   4. Provide welds free of porosity, cracks, holes, and flux.
   5. Grind all welds smooth and ensure they have a uniform appearance.
   6. Ensure Installation Drawings identify field welds to be passivated prior to equipment being placed in service.

C. Metal Fabrications, including Anchors, Bolts and Hardware:
   1. Furnish in accordance with Section 05 50 00, Metal Fabrications (Basic) and Section 05 50 02, Metal Fabrications (Structural).

D. Use Motors:
   1. That are rated inverter duty for all mixers and clarifier mechanism drives.
   2. That comply with Section 26 20 00, Low Voltage AC Induction Motors.

E. Comply with the City’s tagging standards.

2.2 DESIGN REQUIREMENTS

A. Upon completion of the SEWPCC Upgrading/Expansion Project, the plant will have an annual average daily flow rated capacity of 95,000 m^3/d and peak flow capacity of 420,000 m^3/d, and primary treatment will be limited to a peak flow of 150,000 m^3/d. Design the HRC to operate in parallel with the existing primary clarifiers when wet weather wastewater flows exceed the capacity of primary treatment. Design the HRC system for continuous operation for removal of TSS and capable of repeated startups and shutdowns in response to wet weather events. This application may be considered to be combined sewer treatment.

B. Basic Functional Description:

1. Start the first HRC train when plant influent flow exceeds 140,000 m^3/d;
2. Flow to HRC is controlled to be the maximum of either 20,000 m^3/d or portion of plant influent flow above the 150,000 m^3/d primary clarifier limit;
3. Start the second HRC train when plant influent flow exceeds 285,000 m^3/d; operate both HRC trains together at equal flow;
4. HRC effluent will be diverted to the primary effluent channel for a setpoint start-up duration;
5. Starting November 1 and terminating on or about June 30 of each year, HRC effluent will be disinfected and flow to the outfall;
6. Starting on or about July 1 and terminating at the end of October of each year, a portion of the HRC effluent will be diverted to the primary effluent channel until secondary capacity reaches 225,000 m^3/d; any portion of HRC effluent above 225,000 m^3/d will be disinfected and flow to the outfall;
7. During the spring melt period, the HRC system is anticipated to be started and remain available in a wet condition for approximately four months (March – June) due to frequency of activation and ability to more quickly achieve design TSS removal. If inactive for longer than a setpoint amount of time (variable, Contractor to recommend) the HRC system will automatically perform various functions to place the HRC into an “idle” state (e.g. remove sludge from the clarifier or circulate Ballast for storage in the Ballast addition zone, etc.);
8. In the summer and fall, the time between HRC activation is anticipated to be as much as several weeks and the HRC will typically dry-start to provide buffer storage and typically operate for only the minimum duration.

C. HRC wastewater flows, frequency and duration:

1. Design Flows to HRC:
   a. Minimum: 20,000 m^3/d
   b. Peak Day: 174,000 m^3/d
   c. Peak Hour: 270,000 m^3/d
   d. Total Annual Volume: 1,750,000 m^3
2. Design Frequency of HRC activation:
   a. 100 starts per year
3. Design Duration of HRC operation:
   a. Minimum: 4 hours
   b. 50^{th} Percentile: less than 8 hours
   c. 95^{th} Percentile: less than 34 hours

d. Maximum: 14 days of continuous operation
e. Total Annual Operating Time: 1,400 hours

D. HRC influent wastewater characteristics:
1. Pretreatment:
a. Fine screening: either 6-mm perforated plate or 4.5 mm bar
b. Degritting: cut point 125 microns
c. Chlorination: HRC influent will be dosed with up to 20 mg/L as Cl_2 of sodium hypochlorite for disinfection.
2. Temperature:
a. Daily average minimum: 9.8 degrees Celsius
b. Daily average maximum: 18.4 degrees Celsius
3. Alkalinity:
a. Daily average minimum: 180 mg/L as CaCO3
b. Daily average maximum: 380 mg/L as $CaCO_3$,
c. Annual average: approximately 280 mg/L as $CaCO_3$
4. pH:
a. Minimum (grab sample): 6.5
b. Maximum (grab sample): 8.0
5. TSS:
a. Daily average minimum: 80 mg/L
b. Daily average maximum: 330 mg/L
c. Annual average: approximately 150 mg/L
6. $cBOD_5$:
a. Daily average minimum: 80 mg/L
b. Daily average maximum: 330 mg/L
c. Annual average: approximately 150 mg/L

E. Service Conditions: Design the HRC to respond to rapidly varying flow and loading conditions. A 365-day representative hydrograph and pollutograph are available electronically from the Contract Administrator upon request by the Contractor. These data illustrate hourly flows and influent concentrations that may be useful to the Contractor for understanding the time-varying service conditions.

F. System Design:
1. Coagulant: ferric chloride or alum
2. Polymer: as recommended by Contractor
3. Number of HRC Trains: Minimum two (2), each train to be of equal capacity
4. Maximum Allowable SOR in Settling Tank:
a. With Ballast: 100 m/h
b. Without Ballast: 67 m/h
c. Higher maximum SOR can be used upon approval in accordance with the Bidding Procedures (B.7 Substitutes).
5. Maximum Allowable Start-up Time: 30 minutes after HRC is filled with wastewater
6. Waste Sludge Management:
a. Waste sludge pumping and piping, if required, is excluded from the scope of work.

b. HRC systems using Ballast: HRC waste sludge will flow by gravity to a sludge sump and then be pumped to a sludge mixing tank prior to rotary drum thickening.

c. HRC systems without Ballast: HRC waste sludge will be pumped directly from the HRC clarifier to a sludge mixing tank prior to rotary drum thickening.

G. Performance:

1. TSS Removal: TSS removal efficiency of at least 85% or effluent TSS concentration less than 25 mg/L, over any 24-hour period, based on flow-proportional composite samples of HRC influent and effluent.
2. Maximum Ballast Loss: Less than or equal to the guarantee value entered in Form G: Guaranteed Performance.
3. Maximum Ferric Chloride Dose: Less than or equal to the guarantee value entered in Form G: Guaranteed Performance.
4. Maximum Alum Dose: Less than or equal to the guarantee value entered in Form G: Guaranteed Performance.
5. Maximum Polymer Dose: Less than or equal to the guarantee value entered in Form G: Guaranteed Performance.

2.3 MIXERS

A. Each mixer assembly consists of a heavy duty speed reducer, electric motor, baseplate, agitator shaft, and mixing impellers.

B. Mixer Requirements:

1. Type: Vertical turbine
2. Mixing Cycle: Continuous
3. Mixer Power: Sized by Contractor
4. Impeller: High efficiency design to minimize power consumption
5. Other performance requirements as determined by Contractor
6. Materials: Shaft and Impeller – Type 316 stainless steel

C. Supports:

1. Design mixers to be supported from concrete slabs.

D. Provide in accordance with Section 46 41 00, Vertical Turbine Mixing Equipment.

2.4 CLARIFIER MECHANISM

A. Provide either circular or rectangular (chain and flight) clarifier mechanism.

B. Circular Sludge Scraper Assembly:

1. Consists of a drive assembly, center shaft, rake arms, sludge hopper scraper and necessary supports.
2. Furnish one (1) circular scraper assembly per HRC train in accordance with Contractor’s standards.
3. Diameter: As determined by Contractor based on proposed system dimensions.

4. Material:
   a. Metal parts: Type 316 stainless steel
5. Bottom hopper wear plate:
   a. Material: Type 316 stainless steel
6. Drive Unit: Rated for the torque capacity determined when the full volume of Ballast (if applicable) and sludge is collected at the bottom of the clarifier.
7. Furnish torque overload devices and visual torque indicator gauges.
8. Bridge Supports:
   a. Furnish a walkway support bridge to span the clarifier tank to support loads from the entire sludge scraper assembly, sludge scraper motor, and pedestrian loads.
   b. Walkway:
      1) Minimum 1,200 mm wide.
      2) Expand at drive units to maintain required minimum width.
   c. Material: Epoxy coated carbon steel
   d. Design and furnish in accordance with Section 05 50 02, Metal Fabrications (Structural).
   e. Cover support bridge with removable FRP grating in accordance with Section 06 82 00, Glass Fiber Reinforced Plastic.
   f. Provide FRP handrails for the walkway support bridge in accordance with Section 06 82 00, Glass Fiber Reinforced Plastic.

C. Rectangular (Chain and Flight) Sludge Scraper Assembly:
1. Consists of collector chain, flights, wear shoes, collector chain sprockets, shafting, keys and set collars, wall bearings, sprocket bearing sleeves, return tracks and support brackets, floor and track wear strips, spread reducer and motor, right-angle gearbox, drive base, drive sprocket, torque overload device and appropriate guards, driven sprocket, drive chain and drive chain tightener, sprocket bearing sleeves, associated attachment bolts and anchor bolts.
2. Furnish one (1) longitudinal collector and one (1) cross-collector per HRC train in accordance with Contractor’s standards.
3. Dimensions: As determined by Contractor based on proposed system dimensions.
4. Design components based on design calculations incorporating the following criteria:
   a. Operation under submerged conditions
   b. Wear strip friction factors:
      1) 0.20 to 0.30 (UHMW-PE on UHMW-PE)
      2) 0.05 to 0.10 (UHMW-PE on stainless steel)
   c. Bearing friction:
      1) 0.05 per shaft assembly
   d. Shaft deflection:
      1) Not to exceed 2.75 mm per m of shaft length
5. Materials: All steel components to be Type 316 stainless steel in accordance with Section 05 50 00, Metal Fabrications (Basic).
6. Furnish torque overload devices and visual torque indicator gauges.

2.5 LAMELLA SYSTEM

A. Design Loads: Design all structural support systems to withstand hydrostatic upward and downward loading during operation, tank filling, and tank draining, as well as appurtenance loads, deposited sludge loads and seismic loads in submerged and non-submerged conditions.

B. Lamella Modules and Supports:
1. Type: Hexagonal tubes or flat plates
2. Angle: 55 to 60 degrees from the horizontal
3. Material:
a. Lamella Modules: Contractor’s standard
b. Supports: Type 316 stainless steel
c. Anchor bolts and hardware: Type 316 stainless steel

C. Effluent Troughs and Supports:
1. Freeboard: minimum 50 mm
2. Troughs:
a. Shape: Rectangular
b. Material: Type 316 stainless steel
3. Weirs:
a. V-notch or square-notch
b. Design weirs to be field leveled during installation using adjustable weirs or trough supports that allow level adjustment. Flatten any sharp corners on weir notches to remove sharp edges that pose a safety hazard.
c. Material: Type 316 stainless steel.
4. Supports, Anchor Bolts and Hardware:
5. Material: Type 316 stainless steel

D. Air Scour Blower:
1. Quantity:
a. Duty: 1
b. Standby: none
2. Capacity: As determined by Contractor to support periodic cleaning of the lamella tube modules.
3. Provide in accordance with Section 44 42 10.04, Rotary Positive Displacement Blower.
4. Supply valves for the air scour blower as follows:
a. Suction isolation
b. Discharge isolation
c. Air flow control valves, actuated open/close service, one for each HRC train to allow air scouring of one HRC train at a time
d. In accordance with Section 40 27 02, Process Valves and Operators.

E. Air Scour Piping
1. Design and furnish Type 316 stainless steel air scour piping and supports located under lamella modules. Furnish supply piping to the edge of the HRC tank. Air supply piping beyond the HRC tank shall be provided by the Installation Contractor.

2.6 RECIRCULATION SYSTEM

A. Recirculation Piping:
1. Piping Layout: Designed by Contract Administrator including recommendations of Contractor.
2. Pipe Size: 100 mm minimum diameter, Schedule 80.
3. Material: As required by Contractor.
4. Supplied by Installation Contractor.

B. Recirculation Pumps:
1. Capacity:
    a. As required by Contractor to meet design performance requirements.
2. Quantity:
    a. Duty Units: As required by Contractor
    b. Standby Units: One standby pump shared between every two HRC trains with actuated control valves to provide easy switch-over by operations staff, or one dedicated standby pump for every HRC train (no cross connection valves required between trains)
3. Type:
    a. For HRC systems utilizing Ballast, use centrifugal type in accordance with Section 43 21 13.29, Centrifugal Pumps with materials and mechanical seal suitable for type of Ballast used.
    b. For HRC systems not utilizing Ballast, use rotary lobe type in accordance with Section 44 42 56.14, Lobe Pumps or centrifugal type in accordance with Section 43 21 13.29, Centrifugal Pumps.
4. Supply valves for each recirculation pump as follows:
    a. Suction isolation
    b. Discharge isolation
    c. Discharge check valve (if recommended by Contractor)
    d. Flushing connections
    e. In accordance with Section 40 27 02, Process Valves and Operators.
5. Ship all pumps fully assembled (e.g. frame, motor, pump) for installation by the Installation Contractor on concrete pads.

2.7 BALLAST SYSTEMS (IF REQUIRED)

A. Design piping that transports Ballast/sludge mixtures to be 100 mm minimum diameter schedule 80. Piping to be supplied by Installation Contractor.

B. Ballast:
1. Type: Microsand or magnetite in accordance with Contractor’s standards
2. Quantity: Provide Ballast for the initial charge of the HRC plus extra Ballast in accordance with clause 1.6.

C. Ballast Addition System:
1. An automatic addition system composed of an integrated equipment package capable of preparing and metering Ballast in response to an operator entry in the HRC control system.
2. Type: Slurry or direct dry feed
3. Ballast addition system includes:
a. One (1) supersac support with electric hoist
b. One (1) dry feeder
4. For slurry-based systems, Ballast addition system also includes:
a. One (1) plant effluent water eductor
b. Automatic flow control valves (actuated on/off service) on eductor discharge header, one (1) per HRC train
c. If the current plant effluent water supply pressure is insufficient, a booster pump system will be provided by Others.
5. Provide in accordance with Section 46 33 33.03, Ballast Addition System.

D. Ballast Recovery System:
1. Provide an automatic system composed of an integrated equipment package capable of recovering Ballast from waste sludge and designed to minimize plugging by sludge solids.
2. Type: Based on Contractor's standard design.
3. Quantity: Minimum one complete system per HRC train.
4. Performance: As required to meet the Guaranteed Maximum Ballast Loss entered in Form G: Guaranteed Performance.
5. Requirements for hydrocyclones in sand-ballasted systems:
a. Heavy-duty construction suitable for sand slurry.
b. Design cyclone to provide easy access for cleaning, without disconnecting piping.
c. Design cyclone to allow easy replacement of wear items.
6. Requirements for magnetite-ballasted systems:
a. Sludge shear mixer:
1) Shaft: Type 316 stainless steel
2) Impeller: Type 440C stainless steel
b. Magnetic drum separator:
1) Type 316 stainless steel
7. Return recovered Ballast by gravity to the HRC Ballast injection zone.

2.8 ANCILLARIES

A. Internal Tank Fabricated Metal Components:
1. Supply, as required, those internal tank components necessary for proper HRC functioning such as transfer chutes, draft tubes, mixing tank baffles, polymer distribution ring, etc.
2. Materials: All metal components to be Type 316 stainless steel.

B. Scum Removal System:
1. The scum removal system facilitates removal of scum and floatables that collect on the surface of the clarifier. When the scum removal pipe is rotated to the open

position, water, scum and floatables will flow into the pipe to the sludge sump or a dedicated scum sump equipped with scum pumps provided by others.

2. Provide 150 mm diameter manually-rotated scum trough for each clarifier. Trough rotation to be achieved using a handwheel connected to the trough by a chain and cable mechanism.
3. Trough Material: Type 316 stainless steel

C. Waste Sludge Flow Control Valves:
1. Supply as required for proper system operation.
2. Furnish in accordance with Section 40 27 02, Process Valves and Operators.

D. Sampling System:
1. If required for proper HRC system monitoring and control, provide sludge sampling system comprised of sludge sampling lines, isolation ball valves, Schedule 80 PVC sample pipe and Type 304 stainless steel sample sink in accordance with Contractor's standards.
2. Furnish valves in accordance with Section 40 27 02, Process Valves and Operators.

2.9 INSTRUMENTATION & CONTROL

A. Provide in accordance with Section 40 90 00, Process Instrumentation and Control Systems and Section 40 91 00, Instrumentation and Control Components.

B. Provide the following instrumentation for online process monitoring and control:
1. Influent turbidity
2. Influent pH
3. Effluent turbidity – one per HRC train
4. Effluent pH – one per HRC train
5. Sludge blanket depth – if required for proper system operation, one per HRC train
6. Level switches – as required for proper system operation and control

C. Control System:
1. Hardware for the HRC PLC-based master control panel provided by Others.
2. Prepare a Control Narrative document and Functional Requirements Details document in accordance with Section 40 90 00, Process Instrumentation and Control Systems of sufficient detail suitable for programming (programming performed by Others).
3. Provide in the Control Narrative and Functional Requirements Details an automatic mode whereby the PLC controls operations with set point adjustments through an operator interface on the master control panel or plant computer system node. Also provide a manual mode whereby the operator bypasses the PLC automatic controls and controls the system manually through the operator interface on the master control panel or plant computer system node.

2.10 ACCESSORIES

A. In accordance with Section 01 61 00, Common Product Requirements.

2.11 FACTORY FINISHING

A. Apply a protective coating on the surfaces of exposed metals above the normal operating water level to protect against corrosion due to chlorine vapours.

B. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

2.12 SOURCE QUALITY CONTROL

A. See Section 01 45 16.33, Quality Control.

PART 3 EXECUTION

3.1 ROLES AND RESPONSIBILITIES

A. Refer to Section 01 11 00, Summary of Work.

3.2 SCHEDULE

A. Refer to the schedule in the Supplemental Conditions.

3.3 INSTALLATION

A. By Installation Contractor in accordance with Contractor's written installation instructions.

3.4 QUALITY ASSURANCE

A. Perform quality assurance in accordance with Section 01 45 16.13, Quality Control.

3.5 FIELD QUALITY CONTROL

A. Performance Demonstration Plan:
   1. Develop a Performance Demonstration Plan in accordance with Section 01 43 33, Contractor's Field Services.

B. Supplies:
   1. Wastewater, plant effluent water, chemicals, and electricity to run the tests will be provided by the City.
   2. Installation Contractor is responsible for assuming all other costs, except costs for sample analysis for the Performance Test and Contractor's Representative.

C. Functional Testing:
   1. In accordance with Section 01 43 33, Contractor's Field Services.

D. Performance Testing:
1. The intent of performance testing is to verify the HRC system meets the requirements specified in Clause 2.2 Design Requirements under actual wet weather flow conditions.
2. Perform in accordance with Section 01 43 33, Contractor’s Field Services, the Performance Test Protocol attached to this Section as a supplement, and the Performance Demonstration Plan.

3.6 CONTRACTOR’S SERVICES

A. Provide process engineering and design support to the Contract Administrator to facilitate completion of the HRC system design.

B. Contractor's Representatives:
1. Provide the services of representatives who are experienced in the design, programming, installation, start-up, adjustment, operation and training for the specified equipment.
2. Present in Winnipeg, Manitoba, at a location designated by the Contract Administrator for the minimum person-days listed below, travel time excluded:
a. 3 person-days in 3 trips for design coordination and validation.
b. 10 person-days in 2 trips for programming coordination and validation.
c. 3 person-days in 1 trip for Factory Acceptance Testing of the HRC control system programming.
d. 15 person-days in 4 trips for inspecting the equipment after delivery, training the Installation Contractor, installation assistance and inspection.
e. 1 person-day in 1 trip for a facility startup meeting.
f. 15 person-days in 3 trips for functional and performance testing.
g. 4 person-days in 2 trips for training of City’s personnel.

C. See Section 01 43 33, Contractor’s Field Services.

3.7 SUPPLEMENTS

A. The supplements listed below, following “End of Section”, are part of this Specification.
1. Performance Test Protocol For High Rate Clarification System.

END OF SECTION

SECTION 46 43 80 – SUPPLEMENT

PERFORMANCE TEST PROTOCOL
FOR HIGH RATE CLARIFICATION SYSTEM

The Performance Test is a demonstration of the HRC system's ability to meet the specified performance and the guaranteed maximum consumption of Ballast (if applicable), coagulant and polymer under field conditions during actual wet weather events.

This Performance Test Protocol outlines certain requirements of the Performance Test. A detailed Performance Demonstration Plan that incorporates these requirements shall be developed by the Contractor and approved by the Contract Administrator before any testing may begin. Refer to Section 01 43 33, Contractor's Field Services.

Performance testing is anticipated to occur during the annual spring snow melt period that generally occurs any year between mid-March and mid-June and lasts from three to eight weeks. The plant's screened and degritted wastewater will be used as HRC influent. The test consists of operating the HRC for three (3) consecutive days during a period of relatively higher plant influent flow that will allow operating multiple HRC trains as well as at least one HRC train at peak capacity. Coordinate with the plant's operations staff to shut down one or more of the primary clarifiers during the test to allow diversion of sufficient flow to the HRC to meet the Performance Testing scenarios.

The specified performance requirements apply if the influent wastewater flows and characteristics are within the ranges stated in Clause 2.2 Design Requirements of this Section. In the event that the influent flows and/or characteristics are outside the design conditions, but the associated testing still meets the specified performance requirements and applying best professional judgment as mutually agreed upon by Contractor and Contract Administrator, the sample set may be approved. The results of the Functional Testing may be used in lieu of the Performance Test if the specified influent flow and/or characteristics cannot be met, or there is not enough high flow conditions to achieve the peak capacity of one unit.

Performance Test Requirements:

- Complete during the warranty period.
- Peak Flow Test: Operate one HRC train at 110,000 m^3/d or more for at least one hour and at 70,000 m^3/d or more for 24 hours.
- Multi-Train Operation Test: Operate two HRC trains simultaneously each at 55,000 m^3/d for at least one hour and each at 35,000 m^3/d or more for 24 hours.
- At all times during the Performance Test (except the final 6 hours) operate the overall HRC system at 50,000 m^3/d or higher.
- Low Flow Test: For the final 6 hours of the Performance Test, operate at least two HRC trains simultaneously each at 20,000 m^3/d.

If there are sufficiently high flows, it is acceptable for one peak flow event to satisfy both the peak flow and multi-train operation tests.

The roles of each party to the Performance Test are summarized in Table 1.

Table 1: Roles of each Party to the Performance Test

Party	**Role**
Contractor	• Provide a qualified representative to manage the overall Performance Test and perform the Contractor's required activities • Coordinate with the Contract Administrator to determine an appropriate time to conduct the test (City staff have experience in anticipating the conditions under which peak flows will occur) – a minimum of two weeks' notice is required • Inspect the HRC system prior to Performance Testing and confirm system suitability for conducting the test • Collect samples, coordinate shipment to laboratory for analysis and receipt of results, and assume costs of shipping and analysis • Record any data otherwise required that is not recorded by the City's plant control system • Coordinate with Contract Administrator to obtain recorded online data • Write Performance Test Report and submit to Contract Administrator
Installation Contractor	• Assume all costs for items not provided by Others, excluding sample analysis • Provide refrigerated samplers and/or instruments, as required • Coordinate to provide flow signals to samplers for flow-proportional sampling
Others	• Make available raw wastewater, chemicals, plant effluent water and power • Provide personnel to operate the HRC system in accordance with the operation and maintenance instructions provided by the Contractor • Record data from all online instruments connected to the plant control system • Conduct optional parallel sampling and analysis for verification purposes (paid for by the City) • Calibrate online instrumentation • Provide recorded data from online instrumentation
Contract Administrator	• Select an independent laboratory for sample analysis • Review and approval Performance Demonstration Plan • Attend the Performance Test • Review Performance Test Report

Sampling and data recording shall be performed as outlined in Table 2. Immediately refrigerate all collected samples at 4 degrees Celsius. Send samples to the independent laboratory for analysis. Continuous reading instrumentation shall be calibrated at the start of the Performance Test.

Table 2: Sampling and Data Recording Requirements

Parameter	**Requirements**
Influent Flow	Use online flowmeters
Influent Temperature	Perform 4 spot measurements per day at regular intervals or use online sensor
Influent pH	Use online sensor with 4 spot checks per day using a hand-held device
Influent TSS [a]	24-h refrigerated flow-proportional composite samples and a minimum of 8 grab samples per day at regular intervals to correlate TSS to NTU
Effluent TSS [a]	24-h refrigerated flow-proportional composite samples and a minimum of 8 grab samples per day at regular intervals to correlate TSS to NTU
Influent Turbidity	Use online analyzer
Effluent Turbidity	Use online analyzers
Effluent pH	Use online sensors with 4 spot checks per day using a hand-held device
Effluent Alkalinity [a]	24-h refrigerated flow-proportional composite samples
Ballast Loss	Only applicable to HRC systems using Ballast; methodology to be provided by Contractor for determining quantity of Ballast lost to waste sludge and HRC effluent
Coagulant Usage	Totalization of online coagulant flowmeter and coagulant concentration
Polymer Usage	Totalization of online polymer flowmeter and active polymer concentration

[a] Analyses to be performed according to latest edition of *Standard Methods* in triplicate.

For each 24-h composite sample, the triplicate TSS determinations will be averaged resulting in the "Average Influent TSS Concentration" and the "Average Effluent TSS Concentration". Use standard deviation statistical data analysis to appropriately disregard any erroneous results (outliers). The rejection of any data as outliers will be through mutual agreement between the Contractor and Contract Administrator.

"Average TSS Removal Efficiency" will also be calculated:

$$\frac{\text{(Average Influent TSS Concentration)} - \text{(Average Effluent TSS Concentration)}}{\text{(Average Influent TSS Concentration)}}$$

Compliance with the specified TSS removal performance will be based upon either:

- Average Effluent TSS Concentration is less than 25 mg/L, or
- Average TSS Removal Efficiency is 85 percent or higher.

Ballast loss will be measured according to Contractor's recommended methodology. The "Average Ballast Loss" will be calculated as the mass of Ballast lost during the Performance Test and divided by the total volume of wastewater treated during the Performance Test.

Compliance with the specified maximum Ballast loss will be based upon:

- Average Ballast Loss is less than the Guaranteed Maximum Ballast Loss stated in Form G: Guaranteed Performance.

"Average Coagulant Dose" and "Average Polymer Dose" will be calculated as the totalized mass of coagulant or polymer dosed to the HRC during the Performance Test divided by the total volume of wastewater treated during the Performance Test.

Compliance with the specified maximum coagulant and polymer doses will be based upon:

- Average Coagulant Dose is less than the guaranteed maximum coagulant dose stated in Form G: Guaranteeed Performance.
- Average Polymer Dose is less than the guaranteed maximum polymer dose stated in Form G: Guaranteed Performance.

If a test is interrupted due to equipment failure, the test must be repeated following modifications or repairs to the equipment. If such failure is due to Contractor's Goods, there will be no cost to the City for the Contractor to repeat the test. If such failure is due to equipment furnished by Others, the Contractor's additional time and sampling costs beyond the specified amounts will be reimbursed by the City.

After completion of the Performance Test, obtain any required online recorded data from the City via the Contract Administrator. Analyze and consolidate the test data and results in a written report including the following information as a minimum:

- Project Name
- Dates of testing
- Names, affiliations and roles of all personnel involved
- Summary of Perfromance Test procedures and test conditions
- Summarized test data and analytical results
- Discussion of results calculations, and comparison to specified performance and guarantee values
- Appendix of the Performance Demonstration Plan
- Appendix of detailed data and supporting calculations
- Electronic copy of data in Microsoft Excel format
- Signature page for Contractor and Contract Administrator

Performance Test Report shall include any additional requirements outlined in Section 01 43 33, Contractor's Field Services. Submit in accordance with Section 01 33 00, Submittal Procedures.