# GEneral

## Scope of Work

## .1 Under this Section, the Contractor shall supply all materials, equipment, and labour necessary to complete engineering design, fabrication, construction, testing, and commissioning of a Hydrodynamic Mixing System (HMS) as specified herein for the Jane Street Elevated Tank.

### .2 In general, the HMS shall be provided by manufacturers having experience with a minimum of five similar HMS installations including design, manufacture, and construction of such systems, and their associated components. The manufacturer must be able to demonstrate this experience through successful completion of other HMS installations of the design specified in the Contract Documents.

## Related Sections

## .1 Division 1 - General Requirements

.2 Division 9 – Finishes

.3 Division 11 - Equipment

## Definitions

### CFD: Computational Fluid Dynamics

### COV: Coefficient of Variation; Ratio of Standard Deviation of Tracer Concentration over Mean Tracer Concentration.

### Complete mixing: 95% Homogenous solution.

### Hydrodynamic Mixing System: Method of configuring and operating piping, valves and related devices to achieve uniform dispersion or dilution of tank influent water and a homogeneous solution.

### Mixing Time: Time required for the COV to fall to 0.1 (10%).

### Negative buoyancy: condition when incoming water is cooler than the tank contents.

### Neutral buoyancy: condition when incoming water has the same temperatures as the tank contents.

### Thermal Stratification: Layered variations of density and temperature in the stored water volume.

## References

### Comply with the latest edition of the following statutes, codes, and standards and all amendments thereto.

#### American Society of Mechanical Engineers (ASME)

##### ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings

##### ASME/ANSI B36.10, Welded and Seamless Wrought Steel Pipe

##### ASTM International (ASTM):

##### ASTM A53, Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.

##### ASTM A240, Stainless Steel Plate, Sheet and Strip for Pressure Vessels

##### ASTM A774, Welded Stainless Steel Fittings

##### ASTM A778, Welded Stainless Steel Tubular Products

##### ASTM D1330, Standard Specification for Rubber-Sheet Gaskets

##### ASTM D6284-09, Standard Test Method for Rubber Property—Effect of Aqueous Solutions with Available Chlorine and Chloramine

#### American Water Works Association (AWWA)

##### ANSI/AWWA C200, Steel Water Pipe - 6 inch (150 mm) and Larger

##### ANSI/AWWA C206, Field Welding of Steel Water Pipe

##### ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service, 4 inch through 144 inch (100 mm through 3,600 mm)

##### ANSI/AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings

##### ANSI/AWWA C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

##### ANSI/AWWA C220, Stainless Steel Pipe, ½ inch and Larger

#### National Sanitation Foundation (NSF):

##### NSF/ANSI Standard 61 – Drinking Water System Components – Health Effects

## System Description

### Configuration:

##### The HMS is defined as the water inlet/outlet components inside the tank beyond the inlet/outlet tank penetrations. The HMS shall be comprised of a single manifold pipe, fittings, supports and multiple tank inlet ports consisting of nozzles with variable orifice elastomeric check valves.

##### Tanks designed with inlet / outlet pipes larger than 8” shall include a check valve at inlet base that are separated a sufficient distance from tank inlet nozzles in order to provide insurance against duckbill valve damage when the tank is emptying.

##### The HMS shall function automatically as a passive mixing system utilizing the water distribution system pressure and normal tank operation filling and drawdown cycles. No mechanical pumps, blowers or similar equipment are to be used.

##### The HMS shall have less than 10 inlet ports.

##### The top of the manifold pipe shall include an orifice check valve that allows flow to enter the inlet manifold from the tank to prevent inversion of the inlet valves in the event of negative pressure in the inlet pipe. The top of the inlet manifold pipe shall include a max 50 mm opening to allow air to escape the pipe.

##### The system must have a configuration based on Computational Fluid Dynamics (CFD) modeling, conducted by the manufacturer, of a similar configuration in the same tank style, meeting the parameters specified in this specification.

### Performance Requirements:

##### The HMS shall be designed specifically for the actual tank geometry and specified operating data to provide full mixing of the tank contents.

##### Optimize the mixing characteristics (nozzle size, elevations, orientation, style and number) based on the operating data and the CFD Model Assumptions, Requirements and Cases.

##### Distribute influent during fill cycles via turbulent jets and circulation patterns that will maximize mixing efficiency while minimizing system head loss.

##### Minimize stratification and eliminate short circuiting in all seasonal conditions.

## Quality Assurance

### Acceptable HMS Manufacturers:

##### Tideflex Technologies (A division of Red Valve Company Inc.)

##### Or Equivalent.

### HMS Manufacturer Experience Requirements:

##### Five years of experience in the design, manufacture and installation of Hydrodynamic Mixing Systems.

##### The HMS manufacturer shall have successfully installed a minimum of five systems similar to the system to be installed under this Contract. Additionally, the manufacturer is required to comply with the requirements outlined in this Specification.

##### HMS design drawings are to be sealed by a registered Professional Engineer, with a minimum of 5 years of experience in the design of hydrodynamic mixing systems.

## Water Storage Tank Data

### The following physical and operating data shall be used for the design of the HMS for Musselman’s Lake Elevated Tank.

### Water Tank Structure Data

##### Tank Style – Composite Elevated

##### Tank Support – Single Pedestal

##### Central Riser – Yes / Dry

##### Tank Volume (m3) – 8,500

##### Tank Dimensions (m) – 29.7 diameter

##### Overflow Elevation – 324.60 masl

##### Ground (Finished Grade) Elevation – 277.00 masl

### Mechanical Data

##### Inlet Pipe Diameter (mm) – 450-600

##### Common Inlet / Outlet Pipe – No

##### Outlet Pipe Diameter (mm) – 450-600

### Operating Data

##### Normal Operating High Water Elevation – 324.60 masl

##### Normal Operating Low Water Elevation – 317.91 masl

##### Normal Operating Range – xx.xxm

##### Duration of Fill Periods (hours per day) – 10

##### Average Fill Flow Rate during Fill Periods (l/s) – 89

##### Maximum Fill Flow Rate (l/s) – 207

### Other Data

##### A new system is to be installed as part of the scope of the Contract.

##### A Cathodic Protection System installed in tank - Yes

## Analysis and Design

### General Analytical Requirements

##### The following analysis and design specifications are minimum requirements.

##### The proposed HMS design shall be based on an analysis that is specific to the tank geometry, operational data, assumptions and cases under consideration. An analysis based on generic conditions will not be accepted.

##### The CFD model shall be capable of simulating the physical behavior of water mixing in the tank during operation.

##### CFD software shall be capable of analyzing both steady state and transient flow of fluid. Acceptable commercial software packages are CFX Ansys, Fluent or Equivalent.

##### Analysis shall be performed by a skilled analyst having experience in simulating water flow patterns within tanks.

### CFD Model Requirements:

##### Geometry of the tank structure and HMS piping used for the model shall be within 10% of actual.

##### Mesh definition shall be selected by a skilled analyst, having a minimum of 5 years’ experience in CFD modeling of projects of a similar nature to that of the elevated tank described in this Contract. Zones adjacent to inlet and outlet ports and along the inlet jet path shall be modeled with significantly higher concentration of nodes than regions of relatively low velocity.

##### The model shall simulate simultaneous filling and drawing of the tank at Normal Operating High Water Elevation (subsection 1.7.4.1 above) as an acceptable approximation of varying water elevation during intermittent fill – draw cycles. Analysis shall be run until COV reaches 5%.

### CFD Model Assumptions:

##### The primary modeling method to evaluate water mixing and circulation requires a neutrally buoyant tracer. The tracer shall be injected into the inlet water jet at the beginning of the fill cycle. The tracer concentration shall be 1.0 and the tank contents initial concentration shall be 0.0.

##### Coefficient of Variation (COV) shall be used to define mixing time. COV = Ratio of Standard Deviation of Tracer Concentration over Mean Tracer Concentration. Mixing Time is the time required for the COV to fall to 0.1 (10%).

##### CFD simulation shall utilize steady state model for determination of the steady velocity field.

##### CFD simulation shall utilize full transient model for determination of mixing time.

##### The k-epsilon turbulence model shall be used unless a more sophisticated approach is required.

### CFD Modeling Cases:

##### Case 1: Average Fill Flow Rate (subsection 1.7.4.4), Normal Operating High Water Elevation (subsection 1.7.4.1), Neutral buoyancy condition = inlet water same as temperature of tank contents.

##### Case 2: Average Fill Flow Rate (subsection 1.7.4.4), Normal Operating High Water Elevation (subsection 1.7.4.1), Negative buoyancy condition = inlet water 10ºF less than temperature of tank contents.

##### Tank contents shall be at uniform temperature prior to fill cycle.

##### Case 2 provides a relative measure of the effectiveness of the Hydrodynamic Mixing System for lower inlet temperature conditions. Compare with Case 1 to determine the governing condition.

### CFD Modeling Output (Governing Case):

##### Provide the following for the governing case.

##### Mixing Time.

##### Graphic diagrams: Tracer distribution, streamlines and diagrams showing change of tracer concentration with time.

### Inlet Design Requirements:

##### Based on CFD analysis results calculate velocities and head loss at the inlet valves for Average, Minimum and Maximum Fill Flow Rate (subsections 1.7.4.4, 1.7.4.5 and 1.7.4.6).

##### Consider Hydrodynamic Mixing System components and piping within tank only in head loss calculations.

##### Unless otherwise specified, minimum HMS manifold diameter shall be the same as the tank inlet pipe.

##### Provide vacuum relief port at the top of the inlet manifold.

##### Maximum 600 mm. head loss during Average Fill Flow Rate (subsection 1.7.4.4), unless otherwise specified.

##### Maximum 1200 mm head loss during Maximum Fill Flow Rate (subsection 1.7.4.6), unless otherwise specified.

### Structural Design

##### The Contractor’s tank engineer shall review and approve attachment and support points between the HMS and the tank components.

##### Pipe supports and ancillary items shall comply with American Institute of Steel Construction (AISC). Structural analysis shall consider the effects under maximum flow conditions.

##### Tank modifications required to accommodate the HMS shall be fully analyzed and designed in accordance with the applicable structural design codes and standards, as per the OBC.

## Submittals

### Submit Shop Drawings in accordance with Section 01300 – Submittals.

### Work Experience:

##### Provide a summary of completed contracts, including a minimum of five hydrodynamic mixing systems designed, manufactured and installed.

##### Summary to include installation location, year completed, and owner contact including phone number and email.

### Analysis and Design:

##### Provide a summary of the analysis and design for the proposed HMS.

##### Include tank geometry, operational data and CFD model parameters and assumptions.

##### Include calculated jet velocities, head loss for inlet flow, outlet flow and analysis results.

##### Provide required deliverables for all modeling cases.

##### Provide required minimum drawdown resulting in full mixing during a fill cycle for a range of operational flows.

##### Provide a CFD model analysis which defines the estimated mixing time at the operating levels shown in the Contract Drawings, for average and peak flow rates.

##### CFD model output documentation shall include all design variables applied for the simulation, plot of the 3‑D geometry showing the mesh definition, velocity magnitude vector and contour plots at different cross-sections throughout the water volume, and simulated tracer animations showing the spatial and temporal distribution of inlet water in real time during the fill cycle.

##### Hydraulic calculations showing the flow distribution among all inlet ports at minimum, average, and peak fill rates.

##### Manifold hydraulic calculations showing the total headloss of the HMS at minimum, average, and peak fill and draw rates. Headloss shall include all minor losses and headloss of nozzles and outlet check valves.

##### Hydraulic curves for each outlet check valves showing headloss vs. flow.

##### Calculations showing the terminal rise height of the jets that discharge at an angle above horizontal. The terminal rise height shall be calculated assuming 1ºC and 25ºC colder inlet water and calculated at minimum, average and peak fill rates. The theory and equations used to calculate the terminal rise height shall be included.

##### If the calculations and supporting data provided do not show compliance with the hydrodynamic requirements of the system as interpreted by the Consultant, the submittal shall be rejected.

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### Shop Drawings

##### Provide elevation, plan, sectional view and detail drawings of the Hydrodynamic Mixing System as well as all appurtenant equipment, attachments and accessories.

##### Show location, orientation, dimensions, sizing and materials of construction for piping, inlet and outlet ports, valves and equipment.

##### Show the material specification and finish requirements.

##### Define locations of field welds and other connections.

##### Submission shall be sealed by a registered Professional Engineer.

### Fabrication and Construction Procedures:

##### Provide procedures for all shop and field welds.

### Equipment Data:

##### Inlet Valve: Provide drawings and technical specifications including size, materials. Operational characteristics including head loss, jet velocity and back pressure rating.

##### Outlet Valve: Provide drawings and technical specifications including size, materials. Operational characteristics including head loss charts.

##### Provide installation, operation and maintenance data.

### Reports / Certifications:

##### Provide copy of the NSF61 Certified listing for the valves used in the Hydraulic Mixing System. The valves themselves must be NSF61 certified, not just the elastomer used in construction of the valves. NSF61 approved/certified materials will not be accepted in lieu of valve certification.

##### Provide a copy of a test report that confirms there is no degradation in the elastomer when exposed to chlorine and chloramine in accordance with ASTM D6284-09.

### Operation / Maintenance Manuals

##### Design calculations, design drawings.

##### Product specifications for pipe, valves, fittings, anchors, and other specialized items.

##### Operation procedures.

##### Maintenance procedures and schedule.

##### Parts and equipment list with specification numbers for ordering of replacements.

## Record Drawings

### Provide the data required to produce record drawings, including the installation plans with dimensions, design calculations, a detailed parts list, maintenance and operating instructions. Submit record drawings of the constructed mixing system.

### Refer to Section 01450 – As-Built Drawings.

## Measurement and Payment

### All costs associated with the work of this Section shall be included in the price for Item No. A11.xx in the Bid Form.

# PRODUCTS

## Pipe and Fittings

### Stainless Steel

##### Stainless steel pipe shall be Type 316L fabricated from ASTM A-240 materials.

##### Fabrication, inspection, testing, marking and certification of pipe and fittings shall be in accordance with ASTM A-778 and ASTM A-774.

##### Flanges shall be Type 316L stainless steel. Flange design by manufacturer with bolt pattern in accordance with ANSI B16.5.

## Flange Gaskets

### Flange Gaskets

##### Gaskets shall be 1/8” full-faced, in accordance with ASTM D1330.

##### Gasket material shall be Ethylene Propylene Diene Monomer Rubber (EPDM).

## Fasteners

### Fasteners

##### Hex head bolts and nuts shall conform to the requirements of ANSI/ASME B18.2.1 and B18.2.2.

##### Provide Type 316L stainless steel.

##### Provide isolation sleeves and washers for connections with dissimilar metals.

## Vertical Support Brackets (Adjustable)

### All components of the bracket assembly shall be carbon steel in accordance with the associated standards referred to in subsection 1.4 above.

### The bracket assembly shall provide a minimum of 50 mm of lateral adjustment for alignment of the vertical pipe section with the connection to the lateral piping and/or tank penetration.

### The bracket assemblies shall consist of two weldments:

#### A base plate weldment that consists of a base plate with a center-located tubular guide.

#### A top-works weldment that consists of a support plate formed to provide 120 degrees contact area with the pipe, and a center-located pipe stub welded to the bottom of the support plate. U-bolt(s) and hex nuts shall be provided with the top-works.

### The pipe stub shall be inserted into the tubular guide of the base plate weldment during installation of the assemblies.

### The base plate weldment shall be anchored to the concrete shell with stud type expansion anchors. The pull-out rating of the combined anchors shall be a minimum of 10 times greater than the static weight of the vertical pipe section.

### The base plate of the base plate weldment shall be field welded to the tank shell. The location of the base plate shall avoid welded joints and rivets in the tank shell.

### A 3.2 mm (1/8”) thick EPDM strip with a length equivalent to the circumferential support length of the support plate shall be placed between the pipe and the pipe supports.

### The base plate weldment and top-works weldment shall be joined by field welding following proper horizontal adjustment of the assembly.

### Provide dielectric isolation kit for pipe joints of dissimilar metals.

## Vertical Support Brackets (Non-Adjustable)

### Non-adjustable vertical pipe supports consist of a piece of pipe approximately 1/3 the riser diameter to be welded between the riser and tank shell. Alternatively, two carbon steel angle irons can be welded between the vertical riser and the tank shell.

### The angle irons shall be field cut and welded in place at 45 degree angles on each side of the vertical pipe centerline. The included angle between the angle irons shall be 90 degrees.

### The location of the pipe supports (pipe or angle irons) shall avoid welded joints and rivets in the tank shell.

### Brackets, Clips and Supports

#### ASTM A36 steel or equal.

#### Fabricate using flat bar or sealed tubular sections. Details that are difficult to maintain or paint in the field will not be accepted.

#### Bracket or support material directly in contact with stainless steel pipe shall be Type 316L stainless steel.

## Variable Orifice Inlet Nozzles

### Tank Inlet Valves

#### Provide variable orifice elastomeric check valve that allows water to enter the tank during fill cycles while preventing reverse flow through the valves during draw periods. Inlet ports/nozzles may not be fixed-diameter ports or pipes.

#### Inlet ports/nozzles shall have a variable diameter versus flow hydraulic profile that provides a non-linear jet velocity versus flow characteristic and a linear headloss vs. flow characteristic. Provide the headloss of the duckbill valves.

#### Ensure that the valve manufacturer has a minimum of five years of experience in the manufacturing of variable orifice style elastomeric valves.

#### Ensure that the valve manufacturer will have conducted hydraulic testing to determine head loss, jet velocity and back pressure characteristics for discharge to atmosphere and submerged discharge conditions.

#### Manufacturer must have conducted in-house backpressure testing

#### Elastomer shall be one-piece internally reinforced EPDM designed to produce the required discharge velocity and maximum allowable headloss requirements. The flange portion shall be an integral portion of the nozzle with internal reinforcing spanning across the joint between the flange and the nozzle body.

#### Flange backing ring components shall be Type 316L stainless steel.

#### Valves shall be NSF 61 certified.

#### The manufacturer’s name, serial number and product part number shall be bonded onto the surface of the nozzle.

#### Acceptable Manufacturers

##### Onyx Valve Company

##### Tideflex Technologies (A division of Red Valve Company Inc.)

##### Or Equivalent.

### Tank Outlet Valve On Inlet Pipe

#### Wafer style type elastomeric membrane that allows water to enter the outlet pipe during draw cycles while preventing reverse flow (into the tank) during fill periods.

#### Ensure that the valve manufacturer has a minimum of 5 years of experience in the manufacturing of wafer style elastomeric valves.

#### Ensure that the valve manufacturer has conducted hydraulic testing to determine head loss characteristics.

#### Elastomer shall be one-piece internally reinforced EPDM.

#### Flange disc plate and other metal components shall be Type 316L stainless steel.

#### Valves shall be NSF 61 certified.

#### The elastomer used in construction of valves shall be tested in accordance with ASTM D6284-09 to confirm there is no degradation in the elastomer when exposed to chlorine and chloramine.

#### The manufacturer’s name, serial number and product part number shall be bonded onto the surface of the valve.

#### Approved Manufacturers

##### Onyx Valve Company

##### Tideflex Technologies (A division of Red Valve Company Inc.)

##### Or Equivalent.

## Coatings

### All carbon steel and stainless steel pipe, fittings, bolted connections, pipe supports, brackets and appurtenances shall be coated with the wet interior coating system in accordance with Section 09960 – Painting of Steel Tanks and Appurtenances. The exterior surface of all stainless steel piping shall be coated with the approved wet interior coating system in accordance with Section 09960.

# EXECUTION

## Delivery, Unloading and Storage

### Individual nozzles shall be packaged separately from the piping equipment.

### All flanges shall be protected by using plastic inserts or plank wood; pipe sections must be fully supported to prevent pipe deflection or damage to fittings or connections.

### All equipment shall be shipped on pallets capable of fully supporting the pipe sections across their entire length. Pallets shall be accessible for forklift transport or strap and hoist means without causing any load to the pipe equipment.

### All stainless steel components shall be stored separately away from any carbon steel components or other materials that could stain or deface the stainless steel finish from run-off of oxidized ferrous materials.

### All pipe equipment shall be covered and stored in areas free from contact with construction site sediment erosion to prevent accumulation of materials within the pipe and fittings.

### Duckbill nozzles should be protected from contact with rigid objects during handling and storage. The Contractor shall replace any duckbill nozzles or elastomeric components that are damaged after arrival on the Site through installation and start-up of the system.

### Remove from the Site and replace all pipes, specials, fittings and gaskets that are unsound or damaged.

### Place materials in safe storage.

### The Contractor shall safely handle and store all pipes, specials, fittings, gaskets, and any equipment directly involved in, or related to, the flow control system, at its own expense and risk.

### The Contractor shall replace all pipe specials, fittings, gaskets, and any equipment directly involved in, or related to, the flow control system, which, in the sole opinion of the Consultant, are unsound or damaged, both before or after installation. Any damaged materials shall be removed immediately from the Site at the Contractor’s expense.

### Provide factory installed pipe end covers in accordance with OPSS 441 (2016).

## Installation

### Installation of the manifold system shall be in accordance with the guidelines provided by the HMS manufacturer.

## Start-up and Testing Procedures

### The Contractor shall ensure that the HMS manufacturer provides start-up services as required by a factory representative to verify that the system has been installed in accordance with the design specifications and requirements listed within this Specification Section.

### Levelling of Lateral Piping

##### The centreline elevation of all lateral distribution piping shall be installed at the same elevation across the entire system unless eccentric reducers are utilized, then the governing elevation point shall be the bottom invert of the pipes.

##### The Contractor shall provide a levelling instrument during installation of the piping for maintaining manifold pipe constant elevation as specified on the installation drawings.

##### The elevation variance shall not exceed a +/-25 mm difference of the specified elevation on the installation drawings.

### Start-Up Flow Testing:

##### Following installation of the complete manifold piping system, the Region shall open the upstream isolation valve to allow flow into the tank through the manifold system. The isolation valve shall be opened slowly to prevent surge or over-pressurization of the manifold system. The isolation valve shall be fully opened to inspect the flow characteristics of the manifold system.

##### The Contractor shall visually inspect the entire piping system for leakage.

##### The Contractor shall visually inspect all of the inlet nozzles to ensure that flow is being discharged into the tank through all nozzles.

## Warranty

### All piping, pipe support brackets, joint connections, expansion joints, and anchors shall be warranted by the HMS manufacturer against failure under design conditions for a period of 24 months from the date of Total Performance of the Contract.

### Inlet nozzles shall be warranted by the manufacturer against failure under design operating conditions for a period of 24 months from the date of Total Performance of the Contract.

# **END OF SECTION**