1.0 PART 1 - GENERAL

1.1 DESCRIPTION

1.1.1 SCOPE OF WORK:

1.1.1.1 The work to be performed under these specifications includes furnishing all labor, materials, tools, and equipment necessary to design, fabricate, construct, inspect and test a welded steel elevated water storage tank supported on a concrete support structure, including the design and construction of the foundation and accessories as shown on the drawings and specified herein.

1.1.1.2 The work shall also include all labor, new materials, and equipment necessary to clean, paint and disinfect the water storage tank as specified herein.

1.1.2 RELATED WORK:

The work shall also include all labor, materials, and equipment necessary to construct the site improvements and site piping as shown on the drawings.

1.1.3 DESCRIPTION:

1.1.3.1 The tank and support structure shall be the composite elevated tank style as designed and constructed by CB&I. The tank shall be of all welded steel design and have a dome roof, straight sides, and a cone bottom. The support structure shall be of concrete design. The concrete support structure shall be configured so that a concrete tank floor with a steel liner plate supports the water inside the steel reservoir. Suspended steel tank floor configurations are not allowed.

1.1.3.2 To ensure an aesthetically pleasing tank the design of the cone and shell shall minimize the number and total length of visible weld seams (shop and field). A scaled plate layout sketch must be provided with the bid or be cause for rejection.

1.2 PRE-QUALIFICATION OF CONTRACTOR

1.2.1 Bids will only be accepted from experienced Contractors having a minimum of ten years' experience in the design and construction, using in-house capabilities, of composite elevated tanks of equal or greater capacity. Each bidder shall provide a list of a minimum of ten such tanks that have been in satisfactory operation for at least five years. The list shall include project locations, completion dates, contact names and telephone numbers.

1.2.2 The composite elevated tank and foundation design, welded steel tank fabrication and construction shall be performed by the Contractor's own direct hire employees and shall not be subcontracted in any way. The tank's foundation may be supervised and installed by the Contractor or a qualified local foundation subcontractor.

1.2.3 Contractor's EMR Rating shall be less than or equal to 0.80. Each bidder shall submit their current EMR letter with the bid, as only Contractors with an EMR less than or equal to 0.80 will be considered. Failure to provide this information, and/or ratings above 0.80 (indicating below average safety standards) shall be cause for rejection of the bid.

1.3 STANDARDS, CODES AND GUIDES

The following standards and specifications are referenced. The latest edition shall be used if the edition is not specified.

AWWA D107	Standard for Composite Elevated Tanks for Water Storage
AWWA D102	Standard for Painting Steel Water Storage Tanks
AWWA C652	Standard for Disinfection of Water Storage Facilities
ACI 301	Specifications for Structural Concrete for Buildings
ACI 318	Building Code Requirements for Structural Concrete
NSF 61	Drinking Water System Components
OSHA	Occupational Safety and Health Standards

SSPC-PA1 Paint Application Specification

1.4 OWNER OR ENGINEER SUPPLIED INFORMATION

The Owner or Engineer shall provide the following information with the bid documents:

1.4.1 Geotechnical investigation report that is specific to the site and prepared by a qualified Geotechnical Engineer. The geotechnical investigation report shall include a determination of the Site Class that is to be used for the seismic design of the structure. The determination of the Site Class shall be in accordance with AWWA D107.

1.4.2 Summary of FAA requirements such as height restrictions, obstruction marking or obstruction lighting. The elevated water storage tank may affect navigable airspace. The Owner or Engineer shall file Form 7460-1 with the FAA (http://forms.faa.gov/) to determine requirements.

1.5 SUBMITTALS

1.5.1 Each Bidder shall submit with its proposal a sketch of the composite elevated tank showing major dimensions and plate thicknesses. A sketch of the foundation showing preliminary dimensions and approximate quantities of concrete and reinforcing steel shall also be provided with the bid. Failure to provide either of these sketches shall be cause for rejection of the bid.

1.5.2 Prior to construction, the Contractor shall furnish construction drawings of the tank, concrete support structure and foundation sealed by a Professional Engineer licensed in the State of _____. Construction drawings for the foundation shall show applicable design and construction standards, materials of construction, design loads and allowable soil bearing or pile capacity.

1.5.3 A summary of the design for the foundation, support structure and the tank, shall be provided prior to construction. The design summary shall show applicable design and construction standards, materials of construction, design loads and results showing conformance with the specifications. The design shall be sealed by a Professional Engineer licensed in the State of _____.

1.5.4 Welder's certifications shall be submitted in accordance with AWWA D107.

1.5.5 Provide an operating and maintenance manual containing operating instructions, maintenance instructions, as-built construction drawings, cleaning and painting instructions, a gage table and catalog cuts of equipment supplied.

2.0 PART 2 - PRODUCTS

2.1 GENERAL

Furnish an elevated water storage tank as shown on the drawings and as specified in this section. The design, materials, fabrication, construction, testing and inspection of the tank, support structure and foundation shall comply with AWWA D107, except as modified herein. Tank capacity, head range, height to TCL and top of foundation elevation shall be as shown on the drawings. Tank net capacity shall be _____ gallons.

2.2 MATERIALS

2.2.1 Materials and material tests used for reinforced concrete shall conform to ACI 318 except as modified herein.

2.2.2 The same brand and type of cement, and aggregate from a consistent source shall be used throughout the construction of the concrete support structure to maintain uniformity of color.

2.2.3 The minimum specified compressive strength of concrete shall be 4000 psi. The specified compressive strength of concrete used for the design of the wall and dome shall not exceed 6000 psi and 5000 psi, respectively.

2.2.4 Deformed bar reinforcing steel shall conform to ASTM A615 Grade 60 or ASTM A706 Grade 60. Plain welded wire reinforcement shall conform to ASTM A1064.

2.2.5 Materials and material tests for the steel tank and all tank components shall comply with the latest edition of AWWA D107 except as modified herein

2.3 DESIGN CRITERIA

2.3.1 GENERAL

2.3.1.1 Dead load shall be the estimated weight of all permanent construction and fittings. The unit weight of steel shall be considered as 490 pounds per cubic foot and the unit weight of concrete shall be taken as 144 pounds per cubic foot.

2.3.1.2 Water load shall be the weight of the water when the tank is filled to the overflow. The unit weight of water shall be 62.4 pounds per cubic foot.

2.3.1.3 The roof snow load shall be in accordance with AWWA D107 and based on a uniform roof load of _____ pounds per square foot.

2.3.1.4 Wind loads shall be based on AWWA D107 for an ultimate wind speed, V_{ult}, of _____ mph and Exposure Category C in accordance with ASCE 7 for Category IV (essential facility) structures.

2.3.1.5 Horizontal and vertical seismic loads shall be based on AWWA D107 for Category IV (essential facility) structures, using tank center coordinates of _____ latitude and _____ longitude. The Site Class shall be as specified in the geotechnical report.

2.3.1.6 The structural effects of the applied loads shall be considered with the loads defined according to ASCE 7. Load combinations used for allowable stress design and strength design shall conform to AWWA D107.

2.3.2 FOUNDATION

2.3.2.1 The design of the foundation shall conform to ACI 318 except as modified herein.

2.3.2.2 The foundation design shall be by the Contractor and shall conform to the recommendations given in the geotechnical report. The foundation depth shall be as required for the extreme frost penetration shown in AWWA D107.

2.3.2.3 Earth cover shall be a minimum of _____ feet over top of pipe in accordance with AWWA D107. Any pipe passing through the foundation which does not meet this minimum cover requirement shall be properly insulated until such minimum cover is achieved.

2.3.2.4 Unless modified by the Geotechnical Engineer, shallow foundations shall be sized to provide a safety factor of 3.0 against the ultimate soil bearing capacity in accordance with AWWA D107. For deep foundations, the safety factor shall be as required by AWWA D107 Table 12. When direct vertical loads are combined with wind or seismic, the safety factor for shallow foundations may be reduced to 2.25, and the safety factor for deep foundation shall follow AWWA D107 Table 12.

2.3.2.5 The foundation shall be sized such that there is a minimum safety factor of 1.5 against overturning for wind or seismic events using service load combinations.

2.3.2.6 Foundation piling shall conform to the design and detailing requirements of International Building Code (IBC) Section 1810, including the supplemental design and detailing requirements based on the assigned Seismic Design Category (SDC).

2.3.3 CONCRETE SUPPORT STRUCTURE

2.3.3.1 The design of the concrete support structure shall conform to AWWA D107 and ACI 318 except as modified herein.

2.3.3.2 The minimum wall thickness shall not be less than 8 inches exclusive of rustications or other architectural relief.

2.3.3.3 The concrete support structure walls shall have a minimum reinforcement ratio in accordance with AWWA D107 Table 13. Where the seismic design category determined in accordance with ASCE 7 is D, E or F, the minimum reinforcement ratio shall be 0.25% in the vertical and horizontal directions.

2.3.3.4 The concrete support structure walls shall have reinforcement placed in two layers in each direction with 50% of the minimum required steel in each layer.

2.3.3.5 The vertical load capacity for walls shall be determined using the procedures in AWWA D107 Section 6.3.

2.3.3.6 Horizontal reinforcement shall be provided to resist the ovaling of the wall due to wind pressure, using the procedures in AWWA D107 Section 6.3.

2.3.3.7 The concrete support structure walls shall be designed to resist in plane shear using the procedures in AWWA D107 Section 6.3. The effect of openings shall be considered in the shear design.

2.3.3.8 Openings in the concrete support structure walls that are less than or equal to 24 inches and are isolated do not require a beam and column analysis. Isolated openings shall have a clear distance between openings equal to 0.75 times the cumulative width of adjacent openings. Additional reinforcement having an area of not less than 1.2 times the area of interrupted reinforcement shall be distributed equally to either side of openings. Openings shall have a minimum of one No. 5 reinforcing bar placed diagonally in each corner. All reinforcing shall be fully developed beyond the opening.

2.3.3.9 Openings larger than 24 inches or combinations of openings that are not isolated shall be designed using an effective beam and column analysis as per AWWA D107 Section 6.3. Vertical and horizontal reinforcement shall be provided around the opening in accordance with the requirements of this section.

2.3.3.10 The corners of the openings shall be reinforced with diagonal bars. The area of bars provided shall be equal to the minimum horizontal reinforcement ratio times the column area. A minimum of two No. 5 reinforcing bars shall be placed diagonally in each corner.

2.3.3.11 Reinforcement provided around openings shall be fully developed. Column reinforcement shall extend the greater of half the opening height or the development length above and below the opening or be developed into the foundation. Horizontal reinforcement shall extend the greater of the development length past the midpoint of the column or a minimum of half a development length beyond the column.

2.3.3.12 Local effects at openings shall be considered when the opening is located less than half the opening width above the foundation. The foundation shall be designed to adequately develop the opening reinforcement and redistribute loads across the unsupported width.

2.3.4 CONCRETE TO TANK INTERFACE

2.3.4.1 The concrete to tank interface region includes those portions of the concrete support structure and welded steel tank that are affected by the transfer of forces between the concrete tank floor, ringbeam, tank cone bottom and support structure wall. The design of the interface region shall be based on an analysis using finite element or similar analysis which can accurately model the interaction of the intersecting elements. The analysis shall provide results including the shear, moment and compression or tension caused by the intersecting elements in the interface region.

2.3.4.2 The analysis shall consider the transfer of forces from the intersecting elements under all anticipated load conditions. These conditions shall include the eccentricity of loads, restraint effects caused by shrinkage and temperature differentials, long term effects caused by concrete creep, and the effect of anchorage of the welded steel tank to the concrete.

2.3.4.3 The geometry of the interface region shall provide positive drainage at the top of the wall and ringbeam. Condensation or precipitation shall not be allowed to accumulate in this area.

2.3.4.4 The geometry of the tank shall be established such that the ringbeam provided at the top of the wall is a compression member with gravity loads acting alone (D + F). In this loading condition the

compressive stress in the ringbeam shall be not less than 50 psi to minimize cracking in the interface region. No direct tension in the ringbeam under this loading condition will be allowed. The maximum compression in the ringbeam shall be no greater than 0.18f'C.

2.3.4.5 The ringbeam shall be reinforced as a compression member with a minimum longitudinal reinforcement ratio of 0.40%. Tie reinforcement shall be provided in accordance with ACI 318 for compression members as a minimum. Additional tie reinforcement shall be provided if required by the analysis of the interface region.

2.3.4.6 When a concrete dome supports the tank contents, it shall not be less than 9 inches thick, or less than the mean spherical radius of the dome divided by 50. The minimum reinforcement ratio shall be 0.36% in orthogonal directions. The reinforcement shall be placed in two layers with 50% of the minimum required steel in each layer.

2.3.5 WELDED STEEL TANK

2.3.5.1 The design for all sections of the steel tank shall be per the unit tension/compression stresses allowed for material classes listed in the latest edition of AWWA D107.

2.3.5.2 The tank shall have a domed steel roof to minimize snow accumulating and water ponding on the roof plates. The dome roof also allows visual confirmation of roof accessories for tank security and structural integrity by allowing observation of the roof appurtenances. The roof radius shall be between 0.8 and 1.2 times the tank diameter. Roof plates and supporting structure shall be designed to support the full snow load or 15 psf as a minimum.

2.3.5.3 For areas of the steel tank where the water is supported by a steel cone, the cone plate thickness may be determined using a nonlinear buckling analysis. A nonlinear buckling analysis may only be performed for liquid filled cones with a thickness-to-radius ratio greater than 0.0010 and less than 0.0030. The angle of the cone measured from the axis of revolution to the plate surface shall not exceed 60 degrees. If a nonlinear buckling analysis is not performed, the cone plate thickness shall be determined in accordance with the shell stability formulas provided in AWWA D107.

2.3.5.4 The nonlinear buckling analysis shall include the effects of material and geometric non-linearities, residual stresses and imperfections.

2.3.5.5 The imperfection considered in the analysis shall have a magnitude of not less than $0.04(Rt)^{1/2}$, where R is the radius normal to the plate measured to the axis of revolution, and t is the corroded plate thickness. The length of the imperfection shall be equal to or less than $4(Rt)^{1/2}$ and be appropriate for the type of construction used for the cone. The location and shape of the imperfection shall produce the lowest critical buckling stress.

2.3.5.6 The minimum specified yield strength of the cone plate material shall be equal to or greater than 36 ksi. The yield strength used for the analysis shall be no greater than 40 ksi when the material of construction has a minimum specified yield strength greater than 40 ksi.

2.3.5.7 Plate thickness used for the cone plates shall be no less than 80% of that required by the shell stability formulas provided in AWWA D107 when the thickness to radius ratio is greater than or equal to 0.00143. Cone plate thickness shall be no less than 70% of that required by AWWA D107 when the thickness to radius ratio is less than 0.00143.

2.3.5.8 The nonlinear buckling analysis shall demonstrate that the provided cone plate thickness has a factor of safety of at least 2.0 against buckling in the corroded condition.

2.3.5.9 The concrete tank floor shall be covered with a welded steel liner to provide a water tight boundary. The minimum thickness of the liner plate shall be 1/4-inch. Liner plates may be placed directly on the concrete when the liner plates are formed to match the shape of the tank floor. Liner plates that are not formed to match the shape of the tank floor shall have the space between the liner plates and the tank floor completely filled with a flowable grout.

2.3.5.10 Unless otherwise noted, at junctions in plates where meridional forces are discontinuous such as cone to cylinder junctions, a tension or compression ring may be required to resist the radial forces

generated. In these regions, the allowable stresses shall not exceed those referred to in AWWA D107.

2.3.5.11 Tension ring stresses shall not exceed the lesser of 15,000 psi or one half of the minimum specified yield of the plate material.

2.3.5.12 Compression ring stresses shall not exceed 15,000 psi.

2.3.5.13 To determine the stresses in the ring due to discontinuity forces, the tank plates immediately adjacent to the discontinuity may be assumed to participate for a distance of $0.78(Rt)^{1/2}$.

2.3.5.14 Minimum plate thickness of all tank parts shall be in accordance with AWWA D107.

2.3.5.15 No corrosion allowance is required.

2.4 APPURTENANCES

2.4.1 EXTERIOR DOORS

2.4.1.1 Provide one 36-inch x 84-inch commercial steel door, 1¾" thick, 4¾" 16-gauge jamb, industrial duty type door closer and automatic door bottom. Door to be Deansteel or approved equal. Door shall be minimum 16-gauge and insulated with pre-formed polystyrene insulation. Door shall be thoroughly cleaned, phosphated and finished with one coat of baked-on rust inhibiting primer in accordance with ASTM B117 and ASTM D1735. Provide three (3) full mortise, 5 knuckle hinges, 4½" x 4½" minimum. Hinges shall be steel, phosphated and primed coated for finish painting. Provide a complete and functional door lockset and tumbler-type lock, keyed to the owner's existing system. Door painting shall conform to the tank exterior paint system.

2.4.1.2 Provide one manually operated ____-foot wide by ____foot high overhead steel rolling door located in the base of the support structure. Door slats shall be formed of 22-gauge steel with end locks and designed for a minimum 20-psf wind load. Steel curtain construction with high-grade zinc coating per ASTM A153 hot process, and phosphate coating for paint adhesion. Provide air baffle for entire upper barrel, curtain bottom bar with brush sealing, weather end lock on alternate slats and sealing strips for weather tightness. The door shall be equipped with slide bolt locks on both sides of interior bottom. Overhead door location shall be as shown on the drawings.

2.4.1.3 Provide two (2) 8-inch diameter steel safety posts on the exterior of the overhead door opening to protect the door from vehicle impact. Safety posts shall be filled with concrete.

2.4.2 PIPING & PRESSURE RELIEF

2.4.2.1 A _____-inch diameter inlet/outlet pipe shall be provided from near the low point of the tank floor to a flanged connection at the base of the support structure. The inlet/outlet pipe shall be ASTM A240-304L material. Piping shall conform to ASTM A778 and welded fittings shall conform to ASTM A774. All pipe-to-pipe joints shall be welded. The pipe shall have a minimum thickness of schedule 10S but not less than 3/16-inch. Provide a stainless-steel expansion joint near grade to accommodate differential movements between the inlet/outlet pipe and concrete support structure. The inlet/outlet pipe shall be attached to the support structure with galvanized steel brackets spaced no more than 20 feet apart.

2.4.2.2 A _____-inch diameter overflow pipe equipped with an anti-vortex entrance shall be provided. The overflow pipe within the support structure shall be ASTM A240-304L material. Stainless steel piping shall conform to ASTM A778 and welded fittings shall conform to ASTM A774. The pipe shall have a minimum thickness of schedule 10S but not less than 1/8-inch. Inside the tank, the overflow pipe shall conform to ASTM A53 Grade B and have a minimum thickness of 1/4-inch. All pipe-to-pipe joints shall be welded. The overflow shall be attached to the access tube and support structure, and discharge at a point approximately two feet above grade level onto a splash block. The attachment to the support structure shall be with galvanized steel brackets spaced no more than 20 feet apart. The end of the overflow shall be covered with a No. 4 galvanized steel wire mesh screen.

2.4.2.3 A 3-inch diameter drain pipe shall penetrate the tank at the low point of the tank floor. The drain pipe shall be fitted with a threaded plug and handle inside the tank and have a wall thickness equal to or

greater than standard weight pipe. The drain pipe shall conform to ASTM A53 Grade B and all pipe-to-pipe joints shall be welded. An NSF approved flexible pipe shall be used to connect the drain pipe to the overflow pipe.

2.4.2.4 A minimum of one aluminum pressure-vacuum vent near the center of the roof shall be provided. The vent(s) shall be sized to handle pressure differential caused by water entering or leaving the tank at a maximum rate. The maximum inlet rate is _____ gpm, the maximum withdrawal rate is _____ gpm. The open area of the overflow shall not be considered as a venting area. The vent(s) shall have insect screens and shall be designed to relieve any pressure or vacuum in the event the screen frosts over or is otherwise clogged and shall be easily dismantled for cleaning. The vent(s) shall be self-correcting. The pressure-vacuum vent may be mounted on the exhaust hatch.

2.4.3 ACCESS, LADDERS & PLATFORMS

2.4.3.1 Provide a galvanized steel ladder system attached to the support structure which extends from grade to the walkway and painters access manhole. This ladder system shall consist of a continuous straight run ladder with galvanized climb thru rest platforms provided at no more than 50 feet intervals. This ladder shall be equipped with a ladder safety cable.

2.4.3.2 Provide a painted steel ladder on the interior of the access tube from the walkway to the tank roof. This ladder shall be equipped with a ladder safety cable.

2.4.3.3 Provide a galvanized steel ladder from the walkway to the tank bottom manhole. This ladder shall be equipped with ladder safety cable.

2.4.3.4 The ladder safety cable shall be an OSHA approved galvanized system as manufactured by DBI-Sala, or equal. Provide a removable extension for each ladder that does not extend 48 inches beyond the walkway level. The owner shall be supplied with 2 harnesses, 2 lanyards and 2 sleeves.

2.4.3.5 Provide a galvanized steel walkway immediately below the tank extending from the support structure to the access tube. The walkway shall be a minimum of 48 inches wide with 42-inch high handrails.

2.4.3.6 Provide an access tube located on the vertical centerline of the tank. The access tube shall have a minimum diameter of 48 inches. The access tube shall extend below the tank floor to the walkway level to provide continuous ladder access from the walkway to the tank roof.

2.4.4 MANHOLES, HATCHES & VENTS

2.4.4.1 One 24-inch x 36-inch painter's access manhole/ventilation louver opening shall be provided giving access to the exterior painter's rail located at the top of the concrete support structure. This opening shall have a removable aluminum rainproof louver with bird screen to provide ventilation for the concrete support structure. The louver shall be accessible from the walkway.

2.4.4.2 One 30-inch diameter tank bottom manhole shall be provided in the tank floor with access by ladder from the walkway.

2.4.4.3 Two 32-inch diameter steel hatches shall be supplied. One shall be at the top of the access tube with spring assist, chain, hook, and inside handle. The other shall be adjacent to the access tube for entry into the tank and shall have a handle and hasp. The hatch openings shall have a curb four inches high and the cover shall have a downward overlap of two inches.

2.4.4.4 One 24-inch diameter flanged exhaust hatch shall be supplied, located adjacent to the access tube and so constructed that an exhaust fan may be connected for ventilation during painting.

2.4.4.5 One 24-inch diameter painter's access manhole shall be provided adjacent to each interior painter's rail giving access from the roof. The 24-inch diameter exhaust hatch may be positioned to serve as one of these access manholes.

2.4.5 PAINTER'S RAILS

Provide painter's rails and an interior inspection rail as shown on the drawings and specified herein:

2.4.5.1 Interior Painters Rails. The rails shall be attached to the underside of the roof. Provide one rail near the center of the tank and one rail approximately 18 inches from the tank shell. If the slope distance between these two rails exceeds 32 feet, provide a third rail near midspan.

2.4.5.2 Exterior Painters Rail. The rail shall be located near the top of the support structure and be accessible from the walkway via the painter's access manhole / ventilation louver.

2.4.5.3 Interior Inspection Rail. The rail shall be located near the top of the support structure and be accessible from the walkway. The rail and support brackets shall be galvanized.

2.4.6 ELECTRICAL

Interior waterproof light sockets with rigid conduit, wiring and switch shall be provided inside the support structure and access tube. Total number and location of lights shall be as shown on the drawings. All wiring shall be in conduit. The conduit and wiring shall terminate with a junction box in the base of the support structure. Duplex outlets shall be installed as shown on the drawings. Electric service shall be provided and connected by others.

2.4.7 LIGHTNING PROTECTION

2.4.7.1 Provide a lightning protection system for the elevated tank structure and any roof mounted equipment that may be damaged by lightning.

2.4.7.2 Minimum requirements include two 28 strands by 14-gauge copper conductors bonded to the steel tank 180 degrees apart. The conductors shall be fastened to the interior support wall at 3 feet minimum spacing and shall terminate with buried 5/8-inch diameter by 8-foot-long copper clad ground rods.

2.4.7.3 Lightning protection for obstruction lights shall consist of an air terminal mounted on the support and formed to fit around the fixture. The 1/2-inch diameter copper air terminal shall extend a minimum of 10 inches above the light fixture and shall connect to a copper conductor that terminates in a bonding plate secured to the tank roof

2.4.8 GALVANIC CORROSION PROTECTION

Dissimilar metals (e.g., stainless steel, copper, and brass) more noble than carbon steel and installed inside the tank below the TCL shall be electrically isolated from carbon steel tank components to which they attach. Painting of the dissimilar metals does not eliminate the requirement for isolation.

3.0 PART 3 – EXECUTION

3.1 GENERAL

3.1.1 All concrete formwork, placement and consolidation shall comply with ACI 318 and ACI 301 except as modified herein. Concrete tolerances shall comply with ACI 117 except as modified herein.

3.1.2 Concrete placed in cold weather conditions shall be protected to prevent damage in accordance with ACI 306. The cold weather protection shall continue until the concrete has attained 35% of the specified compression strength and the allowable temperature differential can be maintained.

3.1.3 Concrete placed in hot weather conditions shall be protected to prevent damage in accordance with ACI 305.

3.1.4 Concrete shall be cured in conformance with ACI 318. Curing methods shall be continued until the concrete has reached a compressive strength that will allow for safe jumping of forms without causing damage to previously placed concrete.

3.1.5 Concrete strength tests shall be taken in accordance with ACI 318 except as modified herein. Strength test samples shall be taken as the concrete is delivered from the truck. At least one strength test sample shall be taken for every day that concrete is placed. Additional strength test samples shall be taken for every 50 yd^3 of concrete placed when the total daily pour is less than or equal to 150 yd^3 and for every 150 yd^3 of concrete placed when the total daily pour is greater than 150 yd^3.

3.1.6 Each strength test sample shall provide at least four 6" x 12" molded cylinders. Two cylinders will be used to establish the 28-day strength in accordance with ACI 318. One cylinder should be tested at 7 days to supplement the 28-day test. The fourth cylinder shall be a spare for the other cylinders.

3.1.7 Inspection and testing of the welded steel tank shall comply with AWWA D107 Section 9.

3.2 CONCRETE FOUNDATION

3.2.1 If, during excavation, conditions are encountered which differ from those given in the geotechnical report, appropriate adjustments to construction schedule and price will be negotiated.

3.2.2 An inlet/outlet pipe extending a minimum of three feet outside the foundation wall shall be included as part of the foundation.

3.2.3 All exposed formed surfaces shall receive a smooth as-cast form finish and all unexposed formed surfaces shall receive a rough form finish. All exposed unformed surfaces shall receive a trowel finish and all unexposed unformed surfaces shall receive a float finish.

3.2.4 Provide a 6-inch-thick concrete slab at grade in the base of the support structure. The slab shall be placed over compacted structural backfill and shall be reinforced with welded wire reinforcement. Provide 1/2-inch expansion material at the slab to foundation intersection and at floor penetrations. Provide saw-cut control joints at 18 feet maximum spacing. The slab shall be sloped towards the floor drain. The slab shall be constructed in accordance with the latest edition of ACI 301.

3.2.5 All concrete work shall comply with ACI 301

3.3 CONCRETE SUPPORT STRUCTURE

3.3.1 The concrete support structure wall shall be constructed using a jump form process. The form system shall use curved, prefabricated form segments of the largest practical size to minimize panel joints. Concrete pour height shall be a minimum of 6 feet and a maximum of 12 feet. Form panels shall extend the full height of the concrete pour using only vertical panel joints. Formwork shall be secured using bolts through the wall prior to concrete placement. Working platforms that allow safe access for inspection and concrete placement shall be provided. Form facing material shall be metal, or plywood faced with plastic or fiberglass.

3.3.2 The form system shall incorporate a uniform pattern of vertical and horizontal rustications to provide architectural relief to the exterior wall surface. Construction joints and formwork panel joints shall be located in rustications. Formwork panel joints shall be sealed using closures which combine with the form pattern to prevent grout leakage and panel joint lines. The top of each concrete placement shall be finished with a grade strip. The vertical and horizontal rustications shall be proportioned and combined to impart a symmetrical architectural pattern to the completed structure.

3.3.3 Support wall forming system shall incorporate segmented concrete placement. Temporary vertical bulkheads shall divide the wall pour into segments that are less than a single batch of concrete. The bulkheads shall be located at rustications, braced rigid and tight to maintain vertical alignment under concrete load. Each segment shall be continuously placed with concrete to the full form height. Temporary bulkheads shall not be removed until adjacent concrete is placed.

3.3.4 Formwork shall remain in place until the concrete has attained sufficient strength to support the form removal and subsequent loads without damage to the structure. The Contractor shall base formwork removal procedures and times on early-age test results. However, form movements and concrete placement shall be limited to a maximum of once per day.

3.3.5 Dimensional tolerances for the concrete support structure shall be checked by the contractor prior to each pour and maintained as the structure is built. The tolerances for construction of the concrete support structure are:

3.3.5.1 Support wall variation:

Thickness ……..	-3%, +5%
Diameter ……	0.4% ≤ 3 inch
Vertical alignment:	
in any 10 feet of height …..	½ inch
in any 50 feet of height …..	1 inch
over total height ……..	1 ½ inch

3.3.5.2 Tank floor variation:

Slab floor thickness ……	-3%, +5%
Dome floor thickness ……...	-6%, +10%
Dome floor radius …….	1%
Local deviation from true ……	3/4 inch
(Using a 5-foot sweep board)	

3.3.5.3 Level alignment variation:

From specified elevation …….	1 inch
From a horizontal plane ……..	1/2 inch

3.3.5.4 Offset between formwork:

Exterior exposed surfaces …..	1/8 inch
Interior exposed surfaces …...	1/4 inch

3.3.6 All exterior exposed surfaces shall receive a smooth as-cast form finish. All interior exposed surfaces shall receive a rough as-cast form finish. All exposed surfaces shall be cleaned to remove surface contamination. All tie holes and concrete voids larger than 3/4-inch diameter and/or ½-inch deep shall be filled with a color matching nonshrink grout. All exposed surfaces shall be cleaned to remove any concrete paste leakage from higher placed concrete shaft rings. No additional finish of the exterior exposed surface is required unless excessive form oil remains on the concrete surface.

3.3.7 The top of the concrete tank floor shall receive a float finish

3.4 WELDED STEEL TANK

3.4.1 All welding shall comply with AWWA D107.

3.4.2 All welding procedures, welders and welding operators shall be qualified in accordance with ASME Section IX for the processes and positions utilized.

3.4.3 To minimize corrosion and rust staining on the underside of the roof, the underside roof plate laps and rafter-to-roof plate seams shall be seal welded. The minimum thickness for seal welded roof plates shall be 1/4 inch.

3.4.4 The edges or surfaces of the pieces to be joined by welding shall be prepared by flame cutting, plasma arc cutting, arc gouging, machining, shearing, grinding or chipping and shall be cleaned of detrimental oil, grease, scale and rust. The edges of the pieces may have a protective coating applied to them which need not be removed before they are welded unless specifically prohibited by the welding procedures.

3.4.5 Field and shop welding may be done by the shielded metal arc welding process, the gas metal arc welding process, the flux core arc welding process and the submerged arc welding process.

3.4.6 Plates and component members of the tank shall be assembled and welded following erection methods which result in a minimum of distortion from weld shrinkage. Surfaces to be welded shall be free from loose scale, slag, heavy rust, grease, paint and other foreign material.

3.4.7 The Contractor shall remove weld of slag, spatter, burrs and other sharp or rough projections. The surface of the weld shall be suitable for subsequent cleaning and painting operations.

3.4.8 Full penetration butt-welded joints shall be inspected using the radiographic examination method. The number and location of the radiographs and the acceptance criteria shall be as required by AWWA D107. Inspection by sectional segments is not allowed.

3.4.9 All liner plate welds shall be tested using the vacuum box testing method before the tank is painted.

3.4.10 When the cone plate thickness has been determined using a nonlinear buckling analysis, the contractor shall measure the actual imperfections of the cone plates after welding. The measurements shall be taken in the meridional direction. Measurements shall be taken at each meridional weld seam and midway between each meridional weld seam. Where the actual imperfections exceed the tolerances assumed in the analysis, further evaluation will be required and corrective action such as reworking the shell or adding stiffeners may be required.

3.4.11 In order to assist in the maximization of the paint's lifecycle, all welds on the tank exterior shall be ground smooth and blended to a NACE-D profile. All welds on the tank interior shall be ground smooth and blended to a NACE-D profile. Welds on the interior dry support column can remain in an as-welded condition but must have a profile adequate for the specified paint system. Engineer/Owner reserves the right to provide third-party inspection to ensure compliance to this requirement.

4.0 PART 4 – COATINGS & FINISHES

4.1 GENERAL

4.1.1 All tank painting and paint testing shall be in accordance with AWWA D102, the Steel Structures Painting Council Specification SSPC-PA1, approved paint manufacturer specifications and as specified herein.

4.1.2 Each system shall be from a single manufacturer.

4.1.3 Pre-construction primers may be utilized in the fabrication process to preserve the blast profile and cleanliness. In the field, weld seams and abraded areas will be cleaned on a spot basis. The remaining sound primer will be cleaned to remove dirt and other contaminants. After cleaning, the specified coating system will be applied in its entirety in the field at the mils specified.

4.1.4 No paint shall be applied when the temperature of the surface to be painted is below the minimum temperature specified by the paint manufacturer, or less than 5 degrees above the dew point temperature. Paint shall not be applied to wet or damp surfaces or when the relative humidity exceeds 85% unless allowed by manufacturer's data sheets. Follow the paint manufacturer's recommendations for the specific paint system used.

4.1.5 After erection and before painting, remove slag, weld metal splatter and sharp edges by chipping or grinding. All surfaces that have been welded, abraded, or otherwise damaged, shall be cleaned and primed in the field in accordance with the paint system requirements.

4.1.6 All areas blasted in the field shall be coated before any rusting occurs.

4.2 EXTERIOR COATING SYSTEM

4.2.1 Shop Surface Preparation: Spot clean as required to remove all oil and grease from the surface prior to blast cleaning. All surfaces shall be abrasive blast cleaned to a commercial finish in accordance with the recommended methods outlined in the Steel Structures Painting Council Specification SSPC SP-6/NACE No. 3.

4.2.2 Shop Primer: Immediately after abrasive blasting and before any rusting occurs apply one coat of zinc rich aliphatic urethane to a dry film thickness (DFT) range of 2.5 to 3.5 mils.

4.2.3 Field Surface Preparation for Blast Cleaning: After erection and prior to field touch-up priming, all surfaces shall be cleaned to remove all surface contamination including oil, grease, dust, dirt and foreign matter. Chip or grind as required to remove all slag, weld metal splatter and sharp edges.

4.2.4 Field Blast Cleaning: All rusted, abraded, and bare metal / unpainted areas shall be blast cleaned to a commercial finish in accordance with SSPC SP-6/NACE No. 3. All shop primed areas shall be brush blasted to SSPC SP-7/NACE No. 4

4.2.5 Field Touch-Up: Spot prime with zinc rich aliphatic urethane to a DFT range of 2.5 to 3.5 mils.

4.2.6 Field Intermediate Coat: Apply one coat of Hi-build epoxy, to a DFT range of 2.0 to 3.0 mils. The color shall be tinted to contrast the prime coat.

4.2.7 Field Finish Coat: Apply one coat of gloss finish polyurethane, to a DFT range of 2.0 to 3.0 mils. Finish color shall be selected by the Owner.

4.2.8 The total DFT range of the three coat Exterior Paint System shall be 6.5 to 9.5 mils.

4.3 INTERIOR WET COATING SYSTEM

4.3.1 Shop Surface Preparation: Spot clean as necessary to remove all oil and grease from the surface prior to blast cleaning. All surfaces shall be abrasive blast cleaned to a near-white finish in accordance with SSPC SP-10/NACE No. 2.

4.3.2 Shop Primer: Immediately after abrasive blasting and before any rusting occurs, apply one coat of zinc rich aliphatic urethane, to a DFT range of 2.5 to 3.5 mils.

4.3.3 Field Surface Preparation for Blast Cleaning: After erection and prior to field touch-up priming, all surfaces shall be spot cleaned as required to remove all surface contamination including oil, grease, dust, dirt and foreign matter. Chip or grind as required to remove all slag, weld metal splatter and sharp edges.

4.3.4 Field Blast Cleaning: All rusted, abraded, and bare metal / unpainted areas shall be blast cleaned to a near white finish in accordance with SSPC SP-10/NACE No. 2. All shop primed areas shall be brush blasted to SSPC SP-7/NACE No. 4

4.3.5 Field Touch-Up: spot prime with zinc rich aliphatic urethane, to a DFT range of 2.5 to 3.5 mils.

4.3.6 Irregular surfaces, including weld seams, bolt heads and nuts, corners, and edges, shall be stripe coated by brush or roller after the field spot prime coat has been applied and prior to application of the first full field coat.

4.3.7 Field Intermediate Coat: Apply one coat of Immersion approved epoxy, to a DFT range of 2.0 to 3.0 mils. The color shall be tinted to contrast the prime coat.

4.3.8 Field Finish Coat: Apply one coat of Immersion approved epoxy, to a DFT range of 4.0 to 6.0 mils.

4.3.9 The total DFT range of the Interior Paint System shall be 8.0 to 10.0 mils.

4.3.10 Interior immersion surfaces will be holiday tested per NACE SP0188.

4.4 INTERIOR DRY COATING SYSTEM

4.4.1 Shop Surface Preparation: Spot clean as necessary to remove all oil and grease from the surface prior to blast cleaning. All surfaces shall be abrasive blast cleaned to a commercial finish in accordance with SSPC SP-6/NACE No. 3.

4.4.2 Shop Primer: Immediately after abrasive blasting and before any rusting occurs, apply one coat of zinc rich aliphatic urethane, to a DFT range of 2.5 to 3.5 mils.

4.4.3 Field Surface Preparation for Blast Cleaning: After erection and prior to field touch-up priming, all surfaces shall be spot cleaned as required to remove all surface contamination including oil, grease, dust, dirt, and foreign matter. Chip or grind as required to remove all slag, weld metal splatter and sharp edges.

4.4.4 Field Blast Cleaning: All rusted, abraded, and bare metal / unpainted areas shall be blast cleaned to a commercial finish in accordance with SSPC SP-6/NACE No. 3. All shop primed areas shall be brush blasted to SSPC SP-7/NACE No. 4

4.4.5 Field Touch-Up: spot prime with zinc rich aliphatic urethane, to a DFT range of 2.5 to 3.5 mils.

4.4.6 Field Finish Coat: Apply one coat of Hi-build epoxy, to a DFT range of 3.0 to 5.0 mils.

4.4.7 The total DFT range of the Interior Paint System shall be 6.0 to 8.0 mils.

4.5 LETTERING AND LOGO

Lettering and Logo design, size and location shall be as indicated on the drawings. Lettering/Logo shall be applied using one coat of high gloss polyurethane. Lettering/ Logo color shall be selected by the Owner.

5.0 PART 5 - TESTING AND STERILIZATION

5.1 Sufficient cure, per the manufacturer's recommendations, of the final coat on the interior wet surface shall be allowed before the elevated tank is sterilized and filled with water.

5.2 The tank shall be sterilized per the requirements of AWWA C652. Chlorination Method No. 2 or 3.

5.3 The Owner, free of charge to the Contractor, shall furnish and dispose of sufficient water for testing and sterilization. The water shall be at proper pressure to fill the tank to the maximum working level. Any leaks in the tank that are disclosed by this test shall be repaired by gouging out defective areas and re-welding. No repair work shall be done on any joint unless the water in the tank is at least 2 feet below the joint being repaired. Any paint damaged by repairs shall be properly restored.

5.4 Upon completion of the sterilization procedure, the Owner or his representative shall arrange and bear the cost of any bacteriological testing of water samples from the tank that may be required. The tank shall not be placed in service until safe test results are obtained.

6.0 PART 6 - GUARANTEE

6.1 The Contractor shall guarantee its work for a period of one year from the date of substantial completion. Substantial completion is defined as the date when the tank is placed, or available to be placed, into service. The Contractor will repair any defects of which they are notified during that period which may appear because of faulty design, workmanship or materials furnished under the specifications. Defects caused by damaging service conditions such as electrolytic, chemical, abrasive, or other damaging service conditions are not covered by this guarantee.

6.2 All guarantees and extended warranties offered by the manufacturer or installer of paint, equipment or accessories not manufactured by the Contractor shall be obtained by the Owner directly from the manufacturer or installer. The Owner shall provide the Contractor a copy of all such guarantees and warranties.

7.0 PART 7 - PURCHASER OPTIONS / ALTERNATIVES

The following items are to append or replace paragraphs within the specification by the Engineer / Owner prior to issuing specification for bidding:

7.1 EXTERIOR DOORS

7.1.1 Additional access doors may be added for locations where multiple entry points are required.

7.1.2 Alternate materials of construction and operation can be specified for access doors and overhead doors. Overhead doors may be insulated and/or specified with motor-controlled operation (including remote control).

7.2 INSULATION ROOM AND RISER PIPE INSULATION

7.2.1 For the vertical riser piping, starting at the ceiling of the insulated enclosure up to the bottom of the dome, provide ___-inch thick molded rigid foam polyisocyanurate insulation complete with vapor barrier on inlet/outlet pipe. Securely fasten the insulation to the pipe using aluminum banding.

7.2.2 Provide insulated enclosure, by Extreme Panel Technologies, or approved equal, as a full enclosure for the horizontal floor piping and valves, as shown on Contract Drawings.

7.3 COMPLETE TANK DRAINAGE

7.3.1 A 3-inch diameter non-freeze drain valve (Babco or equal) shall penetrate the tank at the low point of the upper tank floor and connect to the overflow pipe. An NSF approved flexible pipe shall be used to connect the drain valve to the overflow pipe.

7.4 ACCESS, LADDERS & PLATFORMS

7.4.1 A ladder for access to the tank interior from the roof, shall be provided and attached to the access tube. (Note: this is not recommended in cold climates where freezing may occur). This ladder shall be equipped with ladder safety cable.

7.4.2 Provide a 42-inch high circular roof handrail, 20 feet in diameter, to encompass all centrally located roof appurtenances. The roof handrail shall be 42 inches high and shall include a top rail, intermediate rail and toe board. The handrail must be constructed to meet all OSHA requirements.

7.5 MANHOLES, HATCHES & VENTS

For installations where mechanical equipment such as pumps and motors or chlorination equipment will be located in the base of the support structure, reinforced openings for vents and louvers shall be per drawings.

7.6 ELECTRICAL

7.6.1 Exterior lighting shall be provided above the access door(s and/or overhead door(s) for added security, and exterior lighting around the base of the support structure at ground level to illuminate the tank and/or support structure for aesthetic effect, per drawings.

7.6.2 In accordance with the Purchaser's FAA Determination Letter, a double obstruction light shall be provided on the roof of the tank near the apex. The lights shall be enclosed in aviation red obstruction light globes as approved by the FAA, complete with an automatic photo-electric cell type switch. The contractor shall install all conduit and wiring from the light to the electrical service panel.

7.7 GRAVEL FLOOR

The interior of the support structure base shall be finished with a six (6) inch crushed stone or gravel floor. All excavated areas under the crushed stone or gravel floor shall be backfilled with suitable material and compacted

to 90 percent maximum dry density.

7.8 FLOORS

7.8.1 Provide a structural floor located as shown on the drawings. The floor shall be designed for a minimum uniform live load of _____ psf and shall consist of a concrete slab supported by formed galvanized steel decking and galvanized steel girders. The floor shall be a clear span design supported entirely by the support structure wall. Loads transferred from structural floors to support structure shall be considered in the design of the foundation.

7.8.2 Construct stairs and platforms using steel plate for the stair stringers and grating style stair treads. The stair treads shall be galvanized and bolted to the stringers. All stair and platform components shall be galvanized.

7.8.3 Provide a wall mounted jib crane with a 1-ton load capacity and 12-foot span. The jib crane shall be equipped with a 1-ton manual chain hoist and trolley. Locate the jib crane as shown on the drawings.

7.8.4 Provide a 48-inch x 48-inch square aluminum hatch embedded in the structural floor located as shown on the drawings.

7.8.5 The Contractor shall make provisions in the design of the support structure and foundation for installing additional floors at a future date with a minimum uniform live load of _____ psf.

7.8.6 This responsibility is limited to meeting only the structural requirements for the additional loads on the support structure and foundation. Provisions for future penetrations of the support structure are not required. Any architectural requirements such as plumbing, electrical, fire exits, etc. needed to meet the code for fire rating requirements for using the structure for anything other than as an elevated water tank are excluded.

7.9 CORROSION ALLOWANCE

A corrosion allowance of 1/16 inch shall be applied to tank plates in direct contact with the stored water. The corrosion allowance shall be added to the required thickness determined by design.

7.10 ANTENNA RAIL AND CABLE DETAILS

7.10.1 Provide all labor, materials, equipment and installation to make all necessary provisions for future antenna cable(s) routing. This work includes but is not limited to the following:

7.10.1.1 Three (3) 4.5-inch outside diameter pipe penetrations (with caps) in the support structure, located approximately two feet (2') above the tank floor.

7.10.1.2 Three (3) 4.5-inch outside diameter pipe penetrations in the condensate ceiling and platform.

7.10.1.3 Three (3) 4.5-inch outside diameter pipe penetrations (with caps) in the access tube cover.

7.10.1.4 Suitable brackets welded to the inside of the support structure and access tube to safely secure future antenna cables. Bracket spacing shall not exceed 8 feet.

7.10.2 For safety considerations during antenna installation, and for maintenance, a 42" high circular roof handrail shall be furnished with a top rail, intermediate rail, and toe board. Handrail shall be ~ 20 feet in diameter and centered on the tank access tube roof hatch. The handrail shall also provide an attachment point for the antenna(s), based on the antenna quantity and loads provided in this specification.

7.11 TANK MIXING SYSTEM

7.11.1 Furnish and erect a passive tank mixing system.

7.11.2 The storage tank mixing system shall accomplish thorough mixing of the tank contents. The mixing system shall function without the use of mechanical pumps or blowers or other equipment with motor drives or other continuously moving parts. The energy needed to mix the storage tank shall be provided solely by the flow of water through the tank inlet pipe, based on the following fill rate of _____ gpm. The mixing system shall distribute the fresh, newly-disinfected incoming water throughout the tank, reducing microbial growth and related tastes and odors.

7.12 CROW'S NEST

7.12.1 Provide a 3' wide crow's nest platform around the access tube inside the tank above the TCL for tank inspection. The crow's nest shall have FRP grating plate (non-skid), and a 3'-6" high handrail all around. Provide opening in the access tube to the crow's nest platform. Provide tank access ladder from the platform with a chained opening to the ladder.